domesday *to the dawn of the* new millennium

ENVIRONMENT AGENCY

The hand of man and the neglect of our ancestors have deprived us of a river which must have been a vision of glittering beauty

ERNEST PHILLIPS 1921

The Don was once one of the country's finest salmon rivers. They have been absent from Salmon Pastures in Sheffield for more than two centuries. In fact for much of that time the river has been virtually fishless.

Chris Firth's fascinating history of the river is timely. We now have a thriving coarse fishery again and the first salmon was found in Doncaster on 31 December 1995. Chris's study shows how man's exploitation of the Don devastated its ecology long before the pollution of the industrial revolution.

Much has been achieved in recent years but much more remains to be done to protect and sustain the river.

JOHN FAWCETT

CHAIRMAN 1983 - 1997
YORKSHIRE REGIONAL FISHERIES ADVISORY COMMITTEE

Born and raised in the Don catchment, I have witnessed the river's misery throughout my childhood and into adult life. When in my professional life, the opportunity presented itself to begin the restoration of the Don I was eager to be involved. That is not to say that this document has been easy to produce. The collation of information from many varying sources has proved to be extremely challenging.

The final product of many months of hard work is not a scientific record but a reflection borne of personal and professional experience. As such the views it includes may not universally reflect the opinions of fellow professionals, it is however an account of the destructive demands that man's activities have imposed upon the Don system.

The success of the work undertaken over the last twenty years to restore this once magnificent river and its ecosystem is a testimony to the efforts of many hundreds of past and present employees of the Environment Agency and its predecessor organisations.

I hope that as a result of all our efforts future generations will be inspired to exercise greater care and consideration in the management of rivers everywhere and of the Don in particular.

CHRISTOPHER J FIRTH MBE

AREA FISHERIES OFFICER - RIDINGS AREA
ENVIRONMENT AGENCY

CONTENTS

The name Don or Dun as the river was originally called, is an ancient British word implying a deep or low channel. The name Dun is still retained by the Dun Drainage Commissioners, the largest Internal Drainage Board on the system. The village of Barnby Dun also retains the name, originally being *Barnby on the Dun.*

ACKNOWLEDGEMENTS

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GENERAL DESCRIPTION OF THE CATCHMENT

TOPOGRAPHY

The Don/Rother/Dearne catchment is bounded by the Pennines to the west, the Calder and lower Aire catchments to the north and the Trent catchment to the east and south.

From the heights of the Pennines, the main River Don flows east to its confluence with the River Ouse in the lowlands around Goole. The combined waters of the Ouse and Don then flow into the Humber Estuary.

The River Rother has its headwaters in the Peak District National Park where its tributary, the River Hipper rises. However, the Rother soon flows through urban and industrial areas around Chesterfield and Rotherham before its confluence with the Don just east of Sheffield.

The Dearne drains the high ground to the south and east of Huddersfield and the west of Barnsley. The steeply sided Dearne Valley opens out at Bretton Hall Country Park before passing through Barnsley, Wath and Mexborough, joining the main River Don at Conisbrough.

GEOLOGY

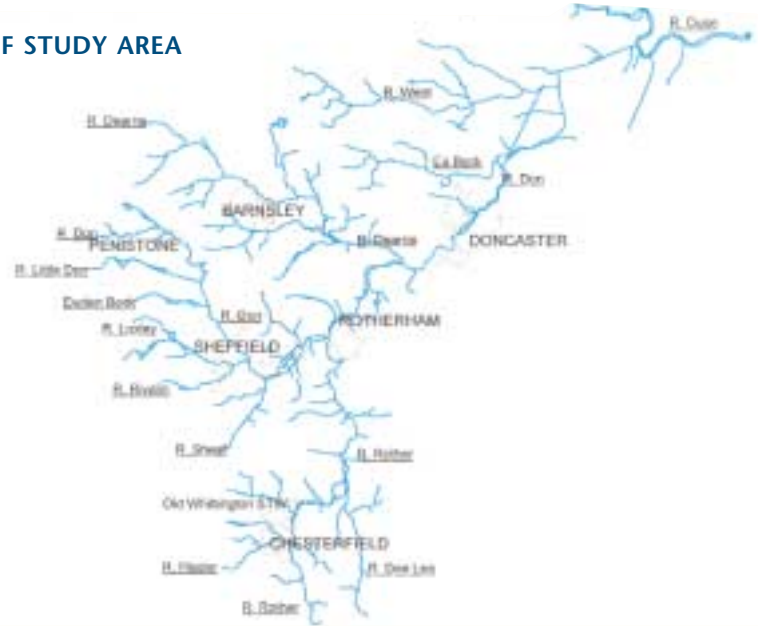
The headwaters of the catchment are formed in the Millstone Grit, a sequence of shales and grits that produce the characteristic moorlands of the Pennines. These are the oldest rocks in the catchment and they are overlain eastwards by successively younger groups of rocks.

The Coal Measures, also of carboniferous age comprise shales, grits and coal seams. Some of the grit horizons produce ridges of higher ground, such as the Wooley Edge Rock. Coal mining has been extensive in the past, originally in the area of outcrop but later moving eastwards and deeper. Many coal seams have been mined but the most notable has been the thick Barnsley seam.

The magnesian limestone that overlie the coal measures form a ridge running in a north south direction. This forms the eastern edge of the Rother catchment and controls drainage patterns as the waters of the Don, Rother and Dearne are channelled through the narrow valley in the limestone between Rotherham and Doncaster. The porous nature of the limestone also gives rise to an absence of watercourses flowing across it.

The soft Sherwood Sandstones form the low lying floodplain between Doncaster and Goole, where there are also extensive areas covered by glacial and alluvial material up to 20 metres thick.

MAP OF STUDY AREA



Introduction

"In that pleasant part of merry England which is watered by the River Don there extended in ancient times, a large forest covering the greater part of the beautiful hills and valleys which lie between Sheffield and the pleasant town of Doncaster. The remains of this ancient woodland, remain to be seen at the noble seats of Wentworth and Wharncliffe and around Rotherham".

1819

These words, written in 1819 are the opening lines of Sir Walter Scott's novel Ivanhoe and help to create an attractive picture of the Don Valley as Scott found it in the early part of the LAST CENTURY.

To present day inhabitants, the area would not be recognisable from this description. Industry, particularly iron and coal, and the attempts to tame the river for drainage, navigation and impoundment have left little of what apparently gladdened Scott's eye. Many of the beautiful hills and valleys that he referred to have been replaced by spoil heaps, factories, housing estates and the associated infrastructure. True, a part of the ancient forest at Wharncliffe is still apparent but even here, industrial activity intrudes upon the tranquil beauty of the area.

Beautiful as Scott found the valley, he could hardly have believed the extent to which man's activities had already changed the original river. For almost seven hundred years the inhabitants of the valley have been altering, manipulating and constraining the Don for their own purposes and insidiously the river's natural character has been eroded.

Impoundments, in the form of weirs, constituted the first major impact. These were formed to harness the power of the flow and served to supply the newly emerging technology of the time - water mills. Originally the mills were constructed to grind corn for flour, but progressively their use was broadened out to serve other needs, particularly the grinding wheels of the Sheffield cutlers and for textile and paper manufacture.

Following some four centuries after the introduction of impoundments came the next impact. Techniques for draining land by altering or manipulating the natural course of the river were introduced from the continent at the beginning of the 17th Century by Dutch engineers. These entrepreneurs quickly recognised the opportunities presented by the Don, and so began a process of remodelling that was to continue well into the present century.

Next came navigation, the Don had for centuries provided a dangerous passage for small boats as far as Doncaster. However, by the beginning of the 18th Century the developing industries of Rotherham and Sheffield were beginning to demand a cheaper and more reliable way of getting their goods to market. The construction of the navigation, as far as the outskirts of Sheffield, resulted in the creation of further, and often larger, impoundments as well as straightening and manipulating the natural channel.

The physical changes resulting from these three impacts were themselves extremely destructive to the life of the river but it was the final impact, one which occurred a half century after Scott's visit to the valley, which finally condemned the river to a period of almost total ecological destruction.

By 1850 chemical pollution of the water environment began to have serious effects on the River Don and by the turn of the century, the river had been reduced to little more than a foul smelling, lifeless sewer. These abominable conditions were to persist throughout most of the 20th Century and managed to earn for the Don the unenviable reputation for being one of the most polluted rivers in Europe.

These then were the four impacts which served to reduce the Don to the river it was in 1974. The following chapters chart the history and effects of each of these impacts, and use principally fish populations to demonstrate the changes which have occurred.

Fish have been chosen to serve this purpose for two reasons:

- they are at the top of the aquatic food chain and therefore reflect changes which have occurred lower down the order, in this case as a result of physical and chemical habitat alteration/destruction.
- historical records of fish populations tend to be more readily available due to their importance as a food resource.

Part 2 of the report charts the history of the restoration and management work undertaken on the Don system by the statutory bodies responsible for water management, Yorkshire Water Authority (1974-1989), National Rivers Authority (1989-1996) and the Environment Agency from April 1996. It attempts to combine the various sources of information regarding chemical quality, ecological status and river management practices and relate these to the improving biodiversity of the river through the 1990's.

Part 3 contains details of the Environment Agency's Local Environment Agency Plans (LEAPS) for the river Don catchment, which will identify the major issues and explains how improvement objectives will be achieved in the future.

THE VALLEY OF THE RIVER DON PRE-1100AD

In common with many of the river catchments of England and Wales, the lower parts of the river Don once consisted of a massive flood plain with a mosaic of open water and wetland habitats linked to the river itself.

On the higher ground rising away from these areas, willow and alder carr would have been present, which in turn, as the ground rose higher and became dryer would have given way to forests of broad leaf trees. These extensive forest areas which consisted of species such as oak, birch, wych-elm, ash, hazel, elder and holly extended over huge areas of land surrounding the river and upstream to the edge of the Pennine moorland.

An example of these forest conditions, as earlier mentioned, can still be seen at Wharncliffe above Sheffield. Here the remnant woodlands have remained on the steep valley sides where agricultural improvement has been impossible. The soil, being generally thin and acid, supports a vegetation dominated by birch and oak, in particular the sessile oak, *Quercus petraea*. This type of woodland often grades into ash and wych-elm woodland in the valley bottom.

In its original condition, the Don had three separate channels feeding its waters to the sea. The channels formed a delta, with two arms extending in a south-easterly direction towards the Trent, and a third heading in a northerly direction towards the Aire. Running through the low lying lands of the flood plain, these channels frequently spilled over as a result of tidal fluctuations, and by doing so, helped to maintain an amazing biodiversity.

Indicative of the area's rich fauna was its importance as a Royal hunting ground. As well as fish and fowl in great abundance, these wetlands supported huge herds of deer and on the fringes of the forest, wild boar were present in large numbers.

In the 11th Century the Don boasted two tributaries, the rivers Idle and Torne which are no longer connected. They have long since been diverted to flow directly into the Trent, but originally they flowed out to this river via one of the Don's south-easterly flowing channels.

The tidal influence on the Don extended, as it does today, to the outskirts of Doncaster. Throughout this tidal section the river was bordered with marshes some of which remained intact well into the last century. In 1836 Laman Blanchard, writing in an article for the Sheffield Mercury described the river at Barnby Dun as being shallow, of considerable width and flowing through a green savannah. These conditions would have been typical of much of the river in its original state.

Upstream of Doncaster the character of the river began to change. As it passed through the magnificent Magnesium Limestone cliffs of the Don Gorge at Sprotborough, the river began to be characterised by long deep pools interspersed with sections of shallow fast flow where the river passed over rock outcrops in the bed. These pools formed the resting places for huge numbers of salmon as they waited for rain higher up the valley to induce them to proceed further towards their traditional spawning grounds high up in the headwaters. When the conditions became favourable the salmon would have been faced with a choice of continuing up the Don or of turning into one of its two major tributaries the Dearne or the Rother. Both contained excellent spawning and nursery facilities which ensured the success of the salmon population of the Don system.

Upon reaching what is now the centre of the city of Sheffield, the salmon would have found the river opening out into a complex of open water and marshes which had been formed as a result of the converging flows of the river Don with that of tributaries such as the Loxley and Sheaf. This fluvial plain helped to dissipate the energy of the floods which bore down the steep valleys following heavy rain high in the catchment.

The vegetation of this area probably consisted of reed beds, interspersed with willow carrs, enclosing shallow pools. These pools provided breeding and nursery areas to a range of coarse fish species which would have found rich feeding in the relatively warm, productive environment. The fish, in turn, would have supported a range of piscivorous birds such as herons, kingfishers and ospreys as well as mammalian predators such as otters.

Above this fluvial plain the river changed yet again assuming the characteristics of a typical Pennine spate stream. The gradient of the bed increased significantly and with it the velocity of the flow. From this point the river became the resident haunt of the brown trout and dipper. The woodlands described earlier, ran right down to the water's edge at this point often shrouding the bed under a verdant expanse. Towards the headwaters of the river, this cover began to open out giving way to alders spaced along the banks in very much the same way as they can be seen today around Hazelhead near Penistone. The headwaters then travelled across Pennine moorland characterised by wide expanses of semi-treeless open ground. Originally these moorland areas had themselves been part of the great forest that had covered most of old England in prehistoric times, but the trees had been removed by our ancestors many centuries before.

In these clear oxygen-rich upland headwaters which formed the infant river Don, the salmon which had travelled through the varied habitats of the lower river fulfilled their reproductive cycle. These salmon by their very abundance, demonstrated the biological quality of the river Don as it existed in 1100AD and have provided us with a baseline upon which we can assess the damage affected by man's destructive demands over the following nine centuries.

LIST OF FISH SPECIES IDENTIFIED IN RIVER DON AND TRIBUTARIES PRE 1850

SPECIES	LATIN NAME
Atlantic Salmon	Salmo salar
Sea Trout	Salmo trutta
Brown Trout	Salmo trutta
Grayling	Thymallus thymallus
Sturgeon	Acipenser sturio
Smelt	Osmerus eperianus
Pike	Esox lucuis
River Lamprey	Lampetra fluviatilis
Brook Lamprey	Lampetra planeri
Roach	Rutilus rutilus
Dace	Leuciscus leuciscus
Chub	Leuciscus cephalus
Minnow	Phoxinus phoxinus
Rudd	Scardinius erythrophthalmus
Tench	Tinca tinca
Gudgeon	Gobio gobio
Barbel	Barbus barbus
Bleak	Alburnus alburnus
Bronze Bream	Albramis brama
Silver Bream	Blicca bjoernka
Carp	Cyprinus carpio
Stone Loach	Neomacheilus barbatulus
Spined Loach	Cobitis taenia
Eel	Anguilla anguilla
Burbot	Lota lota
Three-spined Stickleback	Gasterosteus aculeatus
Ten-spined Stickleback	Pungitius pungitius
Perch	Perca fluviatilis
Ruffe	Gymnocephalus cernua
Bullhead	Cottus gobio
Flounder	Platichthys flesus

PART 1 - CHAPTER 1a

Impounding the Flow of the River Don

BULLHOUSE WEIR
One of the oldest & largest structures built across the River Don was the weir at Bullhouse which provided water for a flour mill

Few rivers in Britain have contributed so significantly to the prosperity of the inhabitants of its valley as the River Don. The topography of the river, with its many suitable tributaries and ideal gradients, lent itself to the development of industries which could exploit the power provided by its descending flows.

The first opportunists in Britain to exploit these natural phenomena were flour millers who, using the technology developed in Europe, built water mills to grind their corn. From the contents of the Domesday Book we can ascertain that over 5,000 such operations were in existence in Britain by 1086. Strangely, it appears that the opportunities were not immediately exploited by the people of the Don Valley, who were somewhat late in taking advantage.

One of the first water mills to be constructed on the system was at Bedgrave on the River Rother. This structure was completed around 1100 and part of the mill is today used as the Visitor Centre of the Rother Valley Country Park. Others were to follow at Lady's Bridge, Sheffield 1210 and Sprotbrough 1279. The goit, or feeder channel, for this former operation is still in existence adjacent to the Kelham Island Industrial Museum in Sheffield.

In terms of longevity these early industries have few parallels and many continued operating for many centuries, the site at Sprotbrough being an excellent example. This mill was in almost continuous use until it was finally demolished in 1934 after almost 700 years of service.

BEDGRAVE MILL
Built around 1100AD the mill was one of the first water powered operations on the Don System

In order to harness the power of the river's flow, the millers built impoundments (weirs) across the channel to create the 'head' which they required, and directed the water they needed through a race or goit to the water wheel.

These structures constituted the first serious attempt at harnessing and controlling the power of the river and were to become a very significant factor in the future exploitation of the Don and its tributaries.

By the 17th Century several other forms of industry were developing using water power. The burgeoning cutlery trade was in existence, using the flow of the river to turn the grinding wheels which were to proliferate along the Don and its tributaries in the Sheffield area. In 1630, twenty eight such operations were in existence and this figure was to quadruple within the next century.

By 1770 the figure had grown to 161, equating to an impoundment structure feeding water to a grinding wheel every 328 yards (300 meters) of river length.

During periods of normal flow the operation of the grinding mills had only a minimal impact on the river. Only a percentage of the water was diverted, leaving an adequate amount to maintain the ecology of the channel. However, when low flow or drought conditions prevailed, the situation changed rapidly with every available drop of water being conserved to ensure the continuation of the mill's operation. In these conditions it was common for the entire flow to be diverted through the mill pond or goit to the water wheel, leaving the river bed dry between the intake and the outfall.

UPPER CUT WHEEL DAM ON RIVER RIVELIN
A good example of the dams which were constructed to provide water to the mill of a cutlers grinding operation. The mill wheel can be seen in the foreground

The scale of some of these later impounding structures can be determined from the survey report produced by William Palmer in 1722, which was carried out to identify the difficulties likely to be encountered in making the Don navigable.

Palmer surveyed the river downstream of Sheffield, below where most of the cutlers wheels were situated, however the information in his report gives a clear indication of the size and potential impact of some of the impoundments. The largest of the structures was Attercliffe Forge Dam at a staggering 5 yards (4.8 meters) high, with Holmes Slitting Mill near Rotherham at 4 yards (3.75 meters) coming a close second.

Between Doncaster and Sheffield, Palmer found that there were 13 major impoundments with others existing on the Dearne and Rother. By the turn of the 18th Century it is estimated that the Don and its tributaries had almost 200 such structures controlling their flow.

With the development of navigation, which was fully operational by 1750, further control of river flow was imposed. Locks to regulate the movement of water were introduced with bypass channels around weirs and areas of shallows. The history of the development of the navigation and its impacts is described in Part 1, Chapter 3a and 3b. As industrial operations grew in size and number, the difficulties of ensuring a supply of water for the continuation of their processes began to pose a serious problem to the early industrialists of the valley. Low flows were severely restrictive and often reduced daily operations to just a few hours. It is therefore, not surprising that these enterprising individuals began to look for ways of conserving water during high flow periods for use when the river levels began to drop.

WATER MILLS - CASE STUDY

Most mills in Sheffield employed what is termed the bypass method of harnessing the power of flowing water. This method commonly involves the construction of a weir, head goit, wheel pit and tail goit. The weir is effectively a low dam built across the river with a sloping downstream face. Water has to back up against the dam before it can overtop the weir and continue downstream. This causes an increase in depth of water upstream of the weir, allowing a proportion of river water to be drawn off via a shuttle into a head goit.

The head goit, or mill race, is a channel that feeds water to the mill dam. The goit slopes downwards more gently than the bed of the river, which creates a difference in height between water in the mill dam and that in the river. It is the difference in height, or head, which determines the power output of the wheel. The mill dam stores the water required to turn the wheel during the working day, and also acts as a buffer against variations in river flow caused by weather or by the operation of mills further upstream. As the level of water in the dam falls, more is drawn from the river via the head goit. It is important that the dam remains watertight, and this is usually achieved with a lining of puddled clay. To guard against excess water entering the dam and flooding the mill, the goit below is connected from the downstream end directly back to the river. Deep drains may be incorporated in the overflow, controlled by shuttles, to allow the dam to be drained for maintenance. The downstream end of dam is termed the forebay. Often massively reinforced with stone, and further supported by the wall of the mill itself, it is the point where water is drawn off to turn the wheel. Water is fed into a pentrough, which is basically a wooden or cast iron box which sits over the wheel pit. From here it tumbles onto the paddles of the wheel below, causing it to turn. The rate at which water flows out of the pentrough, and thus the rate at which the wheel turns, is controlled from within the mill by means of a shuttle at the end of the pentrough called the penstock. It is vital that the flow of spent water away from the bottom of the wheel is unimpeded, otherwise the efficiency of the wheel is reduced. Therefore, the tail goit has to slope freely from the wheel pit to a point where the river is low enough to enable water to be discharged back to it. The tail goit also has to be sufficiently deep to offset the accumulation of silt and rubbish underneath the mill building. Excellent working examples of this method of water power are provided

at the Shepherd Wheel on the River Sheaf and at Abbeydale Industrial Hamlet. The system described above utilises an overshot wheel that is fed onto the top of the wheel. This is fine in areas where the river slopes steeply and a sufficient head of water can be developed. However, in areas where a river slopes more gently, such as the lower Don Valley, it is often not possible to create a sufficient head of water to utilise an overshot wheel. In this case, the wheel has to be mounted at a low level in relation to the river, and a much longer tail goit with sufficient gradient to allow a strong flow of water underneath the wheel is constructed. Such wheels are termed undershot wheels, because the water turns them from below. An example of an undershot wheel can still be seen at Malin Bridge on the River Loxley. An intermediate system between overshot and undershot, not surprisingly called breast shot, can also be employed. Royds Mill had a breast shot wheel.

IMPOUNDING RESERVOIRS

The first project to store water for augmentation purposes was conceived in 1785. The site chosen was called Deadmans Ford, several miles above Penistone on the south side of the river. This reservoir, which was to be approximately 29 acres (12 hectares) in surface area and about 10 feet (3 meters) deep, would have retained about 24 million gallons (109 million litres) of water had it been completed. However, due to engineering difficulties, the scheme was finally abandoned leaving the mill owners frustrated and desperate for a solution to their problems.

They were to wait for almost half a century before any major moves were made to address their difficulties. By this time other industries were beginning to demand a more secure water supply. Steel manufacturing was reliant on copious amounts for quenching. Even more importantly, the rapidly growing population of workers which the industries needed to man their operations, required a reliable source for drinking purposes.

Their needs had, for almost a century, been supplied from five small drinking water reservoirs known as Whitehouse Dams which were situated adjacent to what is now Langsett Road. Later, other dams were added but as the population of the city expanded, demand continued to outstrip supply.

In 1830 by Act of Parliament the Sheffield Water Company was constituted. It commenced work on a series of projects including a large service reservoir at Crookes but far more significantly, began construction of the first major damming project on the Don system. This site was at Redmires, where the Wyming Brook was dammed forming Redmires Middle Reservoir.

The success of this project sparked off a series of further reservoir developments over the next century, which took full advantage of the ideal topography of the Don and its tributary valleys. Most were instituted by the Sheffield Corporation Water Works which assumed responsibility for the city's supply in 1887.

REDMIRES MIDDLE RESERVOIR
The first large reservoir built on the Don system to provide water for drinking and industrial purposes constructed in 1830

Important to these reservoir developments was the maintenance of a reliable supply of water down the rivers which had been dammed. For this purpose compensation reservoirs were built below the supply reservoirs and a statutory compensation release of water was imposed to protect the interests of industries which abstracted or utilised the flow downstream.

When setting the minima for these compensation releases, little or no consideration appears to have been given to the ecology of the rivers, as is amply demonstrated by the fact that many of the releases were timed to coincide with the working periods of industrial users. When the factories closed, the flow from the reservoirs ceased, denying the river its flow and leaving its aquatic inhabits struggling to exist.

The development of reservoirs on the upper Don system helped to satisfy the industrial and drinking water needs of Sheffield and neighbouring towns until the end of the Second World War, but by then it was becoming apparent that even the massive reserves held in the valleys would be inadequate to meet the future needs of its people and their industries.

Other forms of supply, using groundwater reserves, had been almost fully exploited by the late 1940's and it was becoming increasing clear that the catchments of the River Don system would be inadequate to meet the growing needs of its human population. The history of drinking water supply to the major population centres of the area and the way this impending shortfall was addressed is contained in Appendix II.

RESERVOIRS ON THE RIVER DON 1996

Name	Grid Ref	Year Built	Useable TCM Capacity	Max Depth (meters)	Surface Areas (hectares)
Redmires Upper	SK 250 855	1854	1423	13.5	23
Redmires Middle	SK 264 855	1836	784	11.5	19
Redmires Lower	SK 268 855	1849	566	12.5	12
Rivelin Upper	SK 271 868	1848	220	9.1	4
Rivelin Lower	SK 277 867	1848	525	14.6	12
Strines	SK 232 905	1869	2059	23	22
Dale Dyke	SK 243 917	1875	2118	22.5	25
Agden	SK 261 923	1869	2541	25.9	25
Damflask*	SK 284 907	1896	5037	27	47
Broomhead	SK 269 959	1934	4919	27.9	50
More Hall *	SK 287 958	1930	2027	21.3	26
Langsett	SK 214 002	1905	5901	30.3	51
Midhope	SK 223 994	1903	1632	26.5	21
Underbank*	SK 253 992	1907	2727	16.5	42
Wharncliffe (no longer used)	SK 308 978	1878	65	6.1	3
Ingbirchworth	SE 216 060	1868	1332	15.5	23
Royd Moor	SE 222 048	1934	832	18.4	15
Scout Dyke*	SE 235 047	1928	709	13.2	16
Windleden Upper	SE 153 013	1890	606	17.5	8
Windleden Lower*	SE 158 019	1872	357	14.7	5
Snailsden	SE 136 040	1899	176	12.2	4
Harden	SE 153 037	1899	348	18.3	5
Winscar*	SE 153 026	1975	8296	41.8	47
Broadstones	SE 196 064	1859	367	11.1	8
Rivelin Depositing Pond	SK 287 869	1869	30	5.5	1.6

* indicates compensation reservoirs

RESERVOIRS ON THE SYSTEM WHICH ARE NO LONGER OPERATIONAL

NAME	GRID REF	PREVIOUS USE
Thrybergh	SK 477 961	Drinking water supply
(includes Firsby)	SK 494 958	
Lineacre System	SK 334 725	Drinking water supply
Crowhole	SK 321 748	Drinking water supply
Worsborough	SE 349 034	Canal Feeder
Elsecar	SE 384 995	Canal Feeder
Ulley	SK 753 876	Drinking water supply
Woodhall	SK 427 884	Canal Feeder (dry)*
Killamarsh	SK 431 870	Canal Feeder*
Harthill	SK 488 806	British Rail Feeder

Supplied water to the Barnsley Canal

* Supplied water to the Chesterfield Canal

PART 1 - CHAPTER1b

THE IMPACT OF IMPOUNDMENTS ON THE DON FISHERY

The construction of weirs and dams across the channels of the Don and its tributaries to harness the power of the descending waters was to have serious consequences for the fish populations of the river. Initially, most of the structures were relatively small and probably posed only minor difficulties to the salmon and sea trout populations as they ascended the river on their way to the spawning grounds in the headwaters. Progressively, the size and number of the structures was to increase as the centuries passed, gradually placing ever greater restrictions on the free movement of fish within the system.

SALMON
Once prolific in the Don System, the Salmon had almost disappeared by 1800

Water power, as described earlier, was to prove the key to the prosperity of the valley and in relation to the opportunities it provided, damage to the fishery was probably a minor consequence. In their defence, it was unlikely that our forefathers fully understood the implications of their actions, particularly as the damage was insidious and took many generations to fully manifest itself.

Initially it was the river's coarse fish populations which were subjected to the greatest impact. For the first time, their free movement within the system was restricted. Not possessing the salmon's ability to jump or swim over the structures, some species were trapped in isolated sections of the river and in some cases they would have been unable to reach traditional spawning areas. Initially the distance between the weirs would have been considerable and in its original condition, even in these isolated sections, the Don would have provided spawning habitats for the majority of the species present. However, as more and more structures were added, the sections became shorter and therefore less likely to be able to provide an appropriate range of habitats.

In addition to restricting movement, the weirs served to change the natural flow regime, creating ponded areas above the structures. These semi-static conditions allowed particles of sediment, which were normally carried downstream in the water column, to settle onto the river bed. Very quickly, deep accumulations of silt would have formed in these areas and aquatic plant life more suited to ponded conditions would have become established. In addition, subtle changes would also have occurred in the invertebrate communities which had been supported by the natural river conditions giving way to species more suited to the altered environment. In terms of fish populations, the semi-static conditions above the weirs favoured more sedentary species such as roach, bream and perch and it is likely that progressively such species became more common as further impoundments were added to the lower and middle reaches of the river.

WEIR AT SPROTBROUGH
The weir at Sprotbrough impounded water for two milling operations. The earliest which was used for production of flour, was built around 1279 and remained in operation well into the 20th Century

Below the weirs the opposite conditions were created. Falling water quickly scoured deep pools in the bed of the river forcing the scoured material downstream to create gravel bars as the velocities decreased. These areas became increasingly important to the maintenance of the populations of riverine species such as dace, chub, barbel and grayling. These were the species which had been increasingly denied the opportunity to follow their traditional migratory spawning routes. Their populations would have been under stress as the conditions changed and became more ponded.

To the early inhabitants of the valley the river provided an important source of food. Fish were a common item in the diet of the local people but surprisingly, salmon does not appear to have been favoured. Coarse fish species such as pike, perch and bream appear to have been the most popular, along with the eel and probably the burbot. (This latter species now believed to be extinct in Britain.)

It is recorded that in 1356 Edward Balliol, the ex-king of Scotland took up temporary residence at Wheatley, on the banks of the Don. Balliol was a renowned hunting and fishing man and within a short space of time was reputed to have killed two pike of 3 feet (1.15 meters) long, three of 3 feet (1 metre) long and 20 of 2 feet (0.75 metre) long as well as a large number of perch and bream. Whilst there appeared to be no laws or regulations to control Balliol's activities, which also included the killing of thirty nine deer, his actions brought disapproval and interference from the highest level, (probably the King). This does help to demonstrate the importance of the fish species concerned and also suggests a basic understanding of the need to conserve and protect against over exploitation.

PIKE
An important predator species in the Don System which was valued more highly than salmon for eating purposes between the 14th & 16th Centuries

By all accounts no such consideration was given to protecting salmon. Their numbers appeared to have been so great up until the late the 17th Century, that they were not deemed important enough to require protection. Salmon poaching, as we know it today, did not appear to be unlawful and in the main commoners were at liberty to catch what their tables required. Towards the end of the 17th Century several of the larger weir structures were fitted with hecks - a form of salmon trap. Regrettably no records exist to demonstrate the efficiency of these traps. However, if the price of salmon on Doncaster market was anything to go by, quantities available were not limited. In the historical notices of Doncaster, published in 1856, it refers to there being no regular commerce in salmon being carried out in 1689 in local markets as the fish was selling for less than 2d per pound (approx. 2p per kilogram).

By 1630 the use of water power to serve needs other than flour milling was well established. In the Sheffield area 28 cutlers wheels were operating using the flows of the Don and its tributaries the Loxley, Rivelin, Sheaf and Porter. It would appear that these operations were having only a limited effect on salmon movements according to Harrison writing in 1631 and referring to the Don at Sheffield, .." ye chiefest river within this manor is ye river that passeth through the same, wherein we get store of salmon, trout, chevins (chub) and other small fishes..".

During the next one hundred and fifty years, conditions were to change dramatically as the industries exploiting water power proliferated in the Sheffield area. Every possible opportunity to utilise the river's flow appears to have been taken both on the tributaries and on the Don itself. By 1770 the number of water powered operations had grown to a staggering 161 and the effects of this exploitation had disastrous implications for the salmon populations. Not only were they required to negotiate many obstacles on their journey upstream, but they were also subjected to heavily manipulated flow patterns. In order to ensure the continuation of their operations during periods of low flow, it became common practice for mill owners to divert as much water as possible through their mill ponds, often placing wooden boards across the weir crests to ensure that the whole flow was captured. In these conditions the bed of the river would often dry out between the weir and the outfall channel from the mill, in some cases a distance of several hundred meters. Inevitably the consequences for fish in these sections was dire. Some would have managed to exist by dropping back to take advantage of the outflow. Small fish would have survived temporarily in small static pools which were left as the water receded. But for salmon, this situation spelt disaster. Waiting to ascend the weirs, they were effectively trapped in any small pools of water that were left. In these conditions they were subjected to increasing temperatures and rapidly reducing dissolved oxygen levels. Such conditions were untenable for salmon, and unless the mill owners quickly released water over the weir, the salmon would inevitably have died.

It is doubtful that the mill owners would have been sympathetic to the salmon's needs. It is more likely that, along with their employees, they would take advantage of the opportunity presented to them and harvest the trapped salmon. The fish would be easily caught and either sold to local merchants or taken for food.

Under such intense pressures, it seems most unlikely that a self-sustaining salmon population remained in existence on the upper Don and tributaries such as the Loxley and Sheaf by the middle of the 18th Century.

Requiring less depth of water, brown trout and grayling managed to exist as remnant populations between the weirs, relying on the habitat conditions of their own isolated sections of the river to serve their needs. In some cases suitable spawning facilities, particularly suitable gravels, would have been limited or even totally absent. In these areas populations would have disappeared entirely or have relied on the fallout of immature stock from upstream sections.

In contrast, for more sedentary species of coarse such as roach and perch impoundments provided some benefits. Suitable habitats had been created by the mill owners in the form of mill ponds, which provided ideal feeding and spawning facilities. The fallout of stock from the mill ponds also helped to ensure their continued existence in the main river, where the semi-static state provided by the weir of the next operation downstream guaranteed suitable conditions.

TIN MILL DAM
An example of a mill dam which originally provided water for milling purposes but has since been developed as a coarse fishery with exceptional recreational value

By this means, the fish populations of the River Don and its tributaries through and above Sheffield changed markedly. The salmon had all but disappeared from this area by 1750. Undoubtedly occasional strays did appear, but no longer were these the progeny of parents who had laid their eggs in the gravels of the remote moorland areas above Penistone, more likely they were the results of spawning success in the Dearne and Rother. These rivers remained relatively undamaged by impoundments in comparison to the Don and still contained considerable salmon populations in the mid 18th Century. Unfortunately, there were other impacts which were beginning to pose a threat by this time, including the construction of a navigation. This impact will be described in more detail in a later chapter.

Despite the impact that milling had on parts of the upper river and its tributaries, some areas still supported good populations of fish. Brown trout, and probably grayling, existed in many of the upper reaches of streams such as Ewden Beck, which was renowned for the quality of its stocks well into the 19th Century. Regrettably, even in such relatively isolated areas, things were beginning to change. With the industrial base of the valley developing at a frantic pace, the demand for a more secure supply of water mounted. Seasonal variations in flow were starting to seriously affect industrial output, and the demands for drinking water from the growing army of workers could not be ignored.

For the fish populations in these upper reaches of the river the prospects were becoming increasingly bleak. The demand for water could only be supplied by the creation of impoundment reservoirs and in 1836 the first of these was built at Redmires above Sheffield. This effectively severed the Wyming Brook from its parent river, the Rivelin. Over the next half century, reservoirs were built on almost all of the Don's major tributaries above Sheffield. The reservoir construction had a disastrous effect on downstream fish populations. Fish which managed to survive the devastating effects of this construction work on water quality, were then faced with further problems. Isolated from their upstream spawning grounds, they were left with little option but to utilise the limited facilities available in the river below the dam.

Above the newly constructed reservoirs, the populations were slightly more fortunate, but even here they were often isolated in the headwaters of the streams. In these conditions, they were frequently subjected to flushes of acidic water, which flowed from the moorland peat areas following heavy rain. In many cases these conditions were untenable, and populations quickly disappeared, in other cases the native brown trout adapted to a life in the reservoir itself, utilising the streams only to serve their reproductive requirements. Few of these populations thrived, but examples of the Don's original genetic stock still exist in several of the reservoirs, most notably Agden.

The early water management regimes, employed for the operations of the reservoirs, posed yet another threat to those fish populations which had retained a hold in the river below. Minimum compensation flows were agreed by Act of Parliament, to ensure that downstream users were not denied their rights to water. However, these 'users' were invariably industrialists who required the water for the continuation of their processes, and generally cared little about the ecology of the river. As a result, compensation releases were timed to meet the operating requirements of industry, and would often cease at the end of the working day. When this happened the river below was often left to rely on a base flow derived from seepage from land adjacent. In some cases this was inadequate and often the result, particularly in periods of drought, could be a dry river bed. In these unstable conditions populations of fish, particularly brown trout and grayling, struggled to exist as the permanency of both their feeding and reproductive environments could not be guaranteed. Gradually these higher species disappeared, leaving only environmentally-less sensitive fish such as stone loach and sticklebacks remaining.

By the middle of the 19th Century there was at last recognition of the impact that construction of impoundments across river channels could have on fish populations. The status of the salmon, by this time had changed and it was the effect on their populations which prompted Parliament to introduce legislation. The new law required all new impoundments which imposed a restriction to the passage of migratory salmonids, to be fitted with a fish pass to ensure free passage for fish to their spawning grounds. For the Don Salmon population, legislation had come almost a century too late. The regulating, impounding and obstructing effects of dams, weirs and reservoirs on the river had dealt the system a decisive blow, which had been exacerbated by other impacts which are to be described in detail in the following chapters.

FISH PASS
Current legislation demands that new obstructions or existing obstructions which are restored or rebuilt over more than 50% of their length are fitted with a fish pass

THE ORIGINAL RIVER DON
This shows the Don System before Vermuyden's scheme to encourage the whole flow of the River Don down a channel to the River Aire

PART 1 - CHAPTER 2a

THE HISTORY OF LAND DRAINAGE AND FLOOD ALLEVIATION ON THE RIVER DON

PRE. 19TH CENTURY

The earliest recorded date of land drainage work being carried out on the River Don was between 1626 and 1630 when Dutchman Cornelius Vermuyden made an agreement with Charles I to drain the low-lying lands to the east of Doncaster in exchange for a third of the area so drained. At that time, the River Don split into three channels at Thorne with two branches discharging to the River Trent and the more northerly branch discharging to the River Aire. Vermuyden blocked the channels leading to the River Trent and endeavoured to divert the whole of the flow of the River Don into the River Aire. Whilst this ingenious scheme succeeded in part, in that Vermuyden's land was temporarily prevented from flooding, it resulted in flooding of land to the north of the river which had previously been unaffected.

Following considerable litigation and riots almost leading to civil war, Vermuyden was enforced to construct an artificial channel from New Bridge, near Rawcliffe, leading to the River Ouse at Goole. This channel was originally designed to operate only as a flood relief channel. However, following a particularly high flood, the sluices constructed near New Bridge were washed away and the river continued along the more direct course to the Ouse and the branch leading to the Aire, part of which can still be seen, quickly silted up. To this day the length from New Bridge to Goole is known as the Dutch River.

No doubt local drainage courts and other interested parties carried out minor works to the flood banks of the River Don over the following centuries, but it was not until the 19th Century that a concerted effort was made to carry out further land drainage improvements to the river.

DUTCH RIVER
The channel constructed by Vermuyden to alleviate the flooding to land on the north side of the river which his drainage of the Hatfield Chase had caused

OLD COURSE AT TURNBRIDGE
This relatively small bridge spanned the northern arm of the River Don leading to the Aire

POST. 19TH CENTURY

LOWER RIVER DON CATCHMENT

In the latter part of the 19th Century, one of the larger Internal Drainage Boards known as the Dun Drainage Commissioners, carried out works on the river in the vicinity of Doncaster, mainly raising and strengthening floodbanks and completing minor channel improvements. At about the same time a protective bank known as the Sykehouse Barrier Bank was constructed to reduce the frequency of flooding to large areas of agricultural land from the River Went.

The Sheffield and South Yorkshire Navigation Company also utilised sections of the River Don as canal and carried out substantial works. For example, the section between Doncaster and Long Sandall was canalised and a 'flood drain' channel was constructed to the north for the discharge of flood waters. Ultimately the canal was isolated from the river and the 'flood drain' became the river as it is known today.

FLOOD DRAIN, DOWNSTREAM OF DONCASTER
The flood drain was constructed to take excess water from the newly constructed navigation

Between Doncaster and Stainforth, where the Dun Drainage Commissioners had raised and strengthened the flood banks, provision had been made for controlled over-spill of flood water by means of of a series of earthen spillways constructed in the northern flood embankment. The most upstream of these was at Black Pond on the opposite side of the river from where Doncaster Prison now stands. During extreme floods land to the north operated as a flood relief route and the extent of flooding was controlled by a secondary barrier bank constructed some 600 yards (548.5 meters) to the north of the main river bank. This route for relieving flood waters in Doncaster operated during the floods of 1886, 1892, 1931, 1932 and 1947.

FLOOD ARCHES
These arches allow passage of flood water along the flood channel of the Don at Doncaster

In a report produced by the Doncaster Regional Planning Board dated 1922, land in the Bentley and Arksey area was 'zoned', because it provided poor health and drainage conditions. The following paragraph appeared as one of the principle recommendations. 'The low lying land below the 25-30 feet (7.62-9.144 meters) contour should be reserved for agriculture or industry, and no new dwelling- houses should be built on it except what are absolutely essential for local agricultural purposes' .

The report stated that the greater part of Bentley was located on low-lying land unsuitable for housing. However, a report from the Doncaster Drainage Board in 1932 mentioned that between 1922 and 1931, 1029 houses were built in the Urban District of Bentley.

The River Don, as previously stated, was not and had never been capable of discharging more than a normal winter flood without overflowing its banks. The overflow principally spilled onto areas of land used for grazing purposes and which were known to flood at such times. The lands subjected to flooding extended nearly to the site of the Bentley Colliery and as the colliery workings proceeded, a subsided basin was formed which ultimately extended into the floodable area. As a result, the flood waters no longer stopped short at Bentley but poured into the subsided basin which had developed into a built-up urban area. Various schemes for dealing with this threat were assessed. All these schemes had to consider that as subsidence continued, the area and depth of flooding would increase and the problem would become even more acute and difficult to remedy.

Most of the land drainage problems which resulted from subsidence were dealt with under the legislation of the Doncaster Drainage Act 1929, and the Coal Mining (Subsidence) Act 1957. The majority of these problems were solved at that time, by raising floodbanks, such as the Bentley Barrier Bank and floodbanks along Tilts Drain (Ea Beck), and through improvements to existing colliery pumping arrangements.

There were a number of collieries working one or more seams in the Doncaster district which had caused subsidence of between 4-12 feet (1.2-3.7 meters). In view of this the Catchment Board decided that the only satisfactory solution was to enlarge the River Don to the extent necessary to render it capable of taking the maximum estimated flow of the river. The water from the subsided areas would be pumped back into the river and to ensure that the river bed itself did not subside a pillar of coal was to be left beneath for its support.

BENTLEY COLLIERY
This and other collierys in the Doncaster area was responsible for subsidence problems in the land adjacent to the River Don.

This was the state of affairs when the River Ouse (Yorkshire) Catchment Board was inaugurated in 1931. Flooding still occurred at frequent intervals, particularly in the vicinity of Fishlake and Stainforth where the tidal effect was a predominant factor. The River Don had, in the past, been enlarged by banking and other means to contain a normal flood flow of up to 9,000 cusecs [cubic feet per second] (254700 lps [litres per second]). The gauging of the flow of the river during the flood of May 1932 revealed that the waters were arriving at Doncaster at approximately 12,000 cusecs (339600 lps). It was decided therefore, to enlarge the river to contain a flood of 12,000 cusecs. (Approximately 38 cubic feet per second [1.1cumec] per thousand acres of catchment area of the Don above Doncaster.)

In 1934 the River Ouse (Yorkshire) Catchment Board implemented the lower Don Improvement scheme which has been described earlier.

From Thorne to Long Sandall a number of river diversions were cut at Thorne Waterside, Fishlake, Stainforth, Wilsic, Barnby Dun and Thwaite House and whilst small 'cradge' banks were constructed alongside the channel, the main floodbanks were set back several hundred feet from the main channel so as to provide a storage capacity at high tide.

FLOODING AT SPROTBOROUGH & BENTLEY
Land to the north of Doncaster in the Bentley & Arksey area was frequently subjected to flooding before the new defences were completed

DIVERTED CHANNEL, BARNBY DUN
One of the oxbow sections of the lower River Don which were left separated from the main river by the flood defence operations carried out by the Yorkshire Ouse River Board between 1934-51

Between Long Sandall and Doncaster the improvements were effected primarily by enlarging the channel and raising the flood embankments. The construction of the six major river diversions shortened the course of the River Don by 1.25 miles (2 km) and these works, together with the widening and deepening of the river, involved the excavation of 2,500,000 cubic yards (1911381 m^3) of material with over 40 miles (64.37km) of floodbank constructed.

This work was well underway when in 1947 a disastrous flood, which was even more severe than that of 1932, inundated more of the Bentley district of Doncaster than ever before. The flood affected almost a thousand houses and a considerable area of the surrounding countryside. During the flood, the Bentley Barrier Bank breached and the Army was called into blow a further hole in the floodbank at Grumble Hirst to allow the flood water to return to the river channel. The lower Don Improvement Scheme continued and was completed in the early 1950's.

Following commencement of the works on the lower Don improvement scheme, considerable development took place within the catchment area which would cause an increased rate of surface water run-off from road drainage and other sources. This situation was realised when the scheme was prepared, but the required works to offer flood protection in excess of 12,000 cusecs (340 cumecs) could not be justified economically. It was decided that the situation would only be met cost effectively by improved use of areas of flood water storage such as the washlands upstream of Doncaster, particularly in the Dearne and Rother Valleys.

After the completion of the lower Don scheme, a number of further improvements commenced in the late 1950's on the river system upstream of Doncaster. Most of the controlled washlands later constructed in the catchment lay within the South Yorkshire Coalfield, and hence the National Coal Board had to contribute to construction costs to meet the requirements of the Coal Mining (Subsidence) Act 1957. The formation of the majority of the controlled washlands typically consisted of the construction of embankments along the river channel with a spillway, boundary embankments, outlet sluices and improvements to the river channel for hydraulic efficiency. A number of controlled washlands of this design were constructed upstream of Doncaster along reaches of the rivers Don, Rother and Dearne. On the River Don itself, controlled washlands were formally constructed at Hexthorpe, Sprotbrough and Kilnhurst.

The lower River Don is influenced by natural tidal fluctuations. The maximum recorded level of the tide at Goole in 1969 was equal to the height of the floodbanks some 10-12 miles (16-19.3km) upstream. In order to retain a maximum flood within the embankments at high tide, it was necessary to raise the embankment considerably so as to permit a continuous discharge of 12,000 cusecs (339600 lps). During 1972, from Goole to New Bridge near Thorne (a distance of 9 miles/14.5km), the channel was improved by widening and deepening the channel and raising the flood embankments.

RIVER ROTHER CATCHMENT

The River Rother Improvement Scheme was proposed in September 1958 to relieve areas of regular flooding in the Rother catchment. Treeton, Catcliffe, Beighton and Woodhouse Mill were areas which were particularly badly affected, most notably in 1958 when severe flooding occurred as a result of the River Rother over-topping its banks. A study of previous flood events had shown that the peak of flow from the River Rother was normally delayed until after the flood peak of the River Don had passed the confluence in Rotherham town centre. At that time it was identified that any improvements to the channel on the River Rother could cause an acceleration of flow, reducing the time lag between the flow peaks of the River Rother and River Don. This factor had the potential for compounding the flood problems at Rotherham and Doncaster.

Many of the natural washlands on the River Rother have been lost to uncontrolled land tipping and industrial development. However, between Canklow and Bedgreave viaduct, it was possible to utilise about 40 acres of low lying land for storage. This area had a history of mining subsidence. Subsequently a series of washlands

were formalised at Canklow, Treeton and Woodhouse Mill and in 1959 a regulator was installed in the Woodhouse Mill washland to enable more efficient use of the available area for flood water storage.

CANKLOW REGULATOR
One of the control structures on the River Rother which helps to protect areas on the lower Don around Doncaster from flooding

In 1961 a scheme commenced on the washland at Bedgreave. The village of Killamarsh had suffered frequent inundation due to inadequate sewer systems, which were prone to backing up during high river levels. Channel improvements were carried out in 1963 which lowered the river levels helping to relieve the drainage problem. In addition, a further washland was brought into use at Killamarsh Meadows, and together these two areas provided a total 1177156 yd^3 (900,000 cubic meters) of flood water storage.

In 1971 it was proposed by Sheffield City Council that following an extensive study, the floodplain be landscaped for active recreational use as part of the Mosborough Comprehensive Development Area. During this period, the National Coal Board Opencast Executive was independently planning to excavate coal seams beneath the area and were considering proposals for future land use in conjunction with Derbyshire County Council. Following discussions between the two parties, the proposals were later married together in a scheme for the development of a country park, which it was hoped would relieve pressure on the nearby Peak District National Park. Details of this and other washland improvement schemes, which were undertaken after 1974, are described in Part 2 of this document.

A further flow regulator was constructed in 1969 at Canklow in a revised scheme to allow for the construction of the M1 motorway and A630 trunk road across the washlands.

ROTHER VALLEY COUNTRY PARK
Created out of the restoration of land which had previously been used by the coal mining and other industries. The Park is now one of the most important recreation sites in South Yorkshire

MEADOWGATE REGULATOR
This regulator controls flood water on the Rother below Staveley and in extreme conditions helps to flood the washland areas which are part of the Rother Valley Country Park Complex

RIVER DEARNE CATCHMENT

The River Dearne Improvement Scheme was initiated a few years after work had commenced on the River Rother. The scheme was carried out in the period 1963 to 1973, working progressively upstream from the confluence of the River Don. Near the confluence, a series of formalised controlled washlands were formed from the Dearne Mouth to Adwick Bridge. These washlands became known as Dearne Mouth (also known as Denaby Ings Nature Reserve), Harlington and North Ings. The Dearne Mouth washland was constructed with a manually operated sluice which was installed in 1963 (rebuilt in 1973). The sluice, constructed in the floodbank, allows the washland to fill if critically high flood levels are reached at the confluence with the Don.

WINTER DAWN AT DENABY INGS NATURE RESERVE
The Ings, created as a result of subsidence, are now an important wetland habitat managed by Yorkshire Wildlife Trust

The river channel through this section was realigned and straightened substantially. Between Adwick Bridge and Wath Railway Bridge, a further washland was formed which included a flood relief channel at Bolton upon Dearne.

In addition, works between Wath Railway Bridge and Marles resulted in two formalised controlled washlands being created, later to become known as Bolton Ings and Old Moor. The Bolton Regulator was installed in 1972 to compensate for some lost flood storage area in these washlands as a result of mining works. Subsequent to the completion of the Bolton and Old Moor sites, further controlled washlands were constructed at Wombwell Ings, (at the confluence of the River Dove), Darfield, Houghton and Cudworth.

PART 1 - CHAPTER 2b

EFFECTS OF LAND DRAINAGE AND FLOOD ALLEVIATION ON THE RIVER DON FISHERY

Without question, the most profound effect of land drainage works on the ecology of the Don system was that caused by Vermuyden's drainage of the Hatfield Chase and his diversion of the river's natural channels in the 17th Century.

The destruction of the wetland habitats of the chase would, by today's standards, be regarded as an ecological disaster of enormous proportions. The loss of the myriad of meandering channels, saltmarshes, freshwater ponds and reedbeds, which provided habitats to an almost unimaginable range of birds, animals and fish, could be argued as equal in proportion to the present day destruction of rainforests.

The river's two lower tributaries, the Rivers Idle and Torne, were lost to the Don System when they were diverted via a series of drainage channels directly to the River Trent.

Few areas of wetland were left untouched, as is clearly demonstrated by the general absence of natural lakes and ponds in the district today. In their place are left a series of straight drainage channels that provide little in terms of habitat diversity. To maintain their drainage capabilities, these channels need to be regularly dredged and the weed cut in order to remove any accumulation of material which could impede flow in flood conditions. The result is a largely sterile environment which provides little or no protection for juvenile fish from being swept away by the increased velocities associated with flood events

There are few records in existence which document what happened to the vast populations of fish including roach, bream, rudd, tench, pike, perch which must have thrived in the ponds, meres and lakes in the area before the drainage took place. Inevitably, many will have been buried as the shallow waters were drained and in-filled to level out the land for farming purposes.

In his book "Thorne Mere and the Old River Don", Martin Taylor describes the ecological significance of the pre-1626 Hatfield Chase as rivalling the wetland areas of the Cota Donana in Southern Spain. (This park is designated by UNESCO as a Biospheric Reserve.)

THE NORFOLK BROADS
Probably a similar habitat to that which existed on the lower River Don before Vermuydens drainage of Hatfield Chase

WILD DEER
The Hatfield Chase was an important Royal hunting ground and deer roamed through woods & marshes in great numbers

In addition to the loss of the fish populations, mammals such as deer, wild boar and otters, were displaced as the waters receded and their wetland habitats were destroyed. Birds, both resident and migratory were also severely affected. In its original condition, the Chase undoubtedly provided an important feeding and nesting area for many species of wildfowl which in turn provided one of the mainstays to the diet and income of the local human population.

As with the coarse fish of Hatfield Chase few records exist which allow us to accurately assess the effects of the channel diversion on the migration of salmon and other anadromous and catadromous fish species which ran into and out of the River Don. It is likely that most originally found their way into the river system by the most direct channel, an outfall into to the River Trent close to what is now called "Trent Falls". With this route and the other channel to the Trent severed, migrating anadromous fish, particularly salmon and sea trout, would initially have had to seek the more northerly channel which flowed into the River Aire. However, this was soon to be closed to them when the newly constructed channel, later to become known as the Dutch River, was completed taking the Don's water to the River Ouse at Goole.

It can be assumed that the initial impact was quite severe, with runs of fish substantially reduced. However, records suggest that the overall impact was fairly short term, as in 1689 the Corporation of Doncaster began erecting salmon hecks on a mill dam at Doncaster.

SKETCH OF A TYPICAL SALMON HECK
Hecks were used to catch salmon as they attempted to jump the weirs which obstructed their passage up the river system. They were fitted to the front of the weir and trapped fish which failed in their attempt to ascend.

As previously stated, there was no regular commerce in salmon in the mid 1650s , with the fish only raising 2d per pound (2p per kg) on local markets, as recorded in Doncaster Historical Notices of 1856. This seems to confirm that salmon was still a cheap and very abundant local food, and certainly not the delicacy it is today. This is supported by details in several apprentice contracts of the time, which restricted the serving of salmon as a meal on more than three occasions per week so as to provide some variety to a predominantly salmon-based diet.

The River Went was another small River Don tributary, which would have been seriously affected by Vermuyden's operations. Originally a tributary of the River Aire, it had at some point in history formed a connection with the River Don. The two then flowed out to the Aire using the Went's original course via the village of Turnbridge.

When Vermuyden constructed the new channel, the Went became a tributary of the Don and was therefore subject to the same effects on its fish population as the main river. Little is known about salmon stocks in the Went, although it is likely that a small population of this species existed. The Went was, however, highly regarded at the time as an eel fishery and appears to have contained very substantial populations of this species. Adrian de Prime, Vicar of Thorne 1701-1704, described the Went in his diaries such 'The River is no more than six yards wide but the crookedest and the deepest that I ever saw in my life. Every turn makes a great bog on the other side on which the water is thrown by the current and there is delicate fish therein. But such quantities of eels like was never seen. Sometimes there will break out or fall out from the hollow bank sides when the people are a-fishing such knots of eels, almost as big as a horse, that they break all their nets to pieces'.

It would be difficult to recognise the present River Went from this description given by de Prime. The river has clearly undergone many drainage operations since his time, and is essentially now a straight drainage channel.

In a further paragraph of his observations, de Prime describes the Went as feeding Trumfleet Water Mill. This indicates that the course has been substantially altered as Trumfleet is now a considerable distance from the river channel. The author goes on to describe annual elver migrations at Trumfleet Water Mill as follows, 'Commonly every May such vast numbers of young eels comes over the wheels with the waters and run into the mills, that they are forced to give over working and to send into town for the swine to devour them, for they are as innumerable as sand grains on the seashore'.

Eels are still commonly found in the River Went but the staggering quantities as described by de Prime have long been a thing of the past.

THE RIVER WENT
The Went was described by Adrian De Prime in 1701 as one of the crookedest river channels he had seen in his life. The photograph shows the effect that land drainage & canalisation had on the river

AN OTTER
Once very common on the Don, this important species declined rapidly as the industrial revolution gained momentum

By 1650 landowners along the lower Don Valley began to realise the commercial potential of draining their land and over the next century many expanses of important wetland alongside the river were reclaimed for farming.

The drainage of fringe wetlands alongside the River Don to improve agricultural yield and/or protect land against flooding had disastrous effects on the ecology of the river. These habitats were essential for the maintenance of the populations of many species of mammal, birds and fish and their loss would have inevitably resulted in a decline in their numbers, or in some cases, their complete eradication. To fish populations the wetland areas had provided sanctuary, particularly to juvenile fish in flood conditions and their disappearance would have inevitably resulted in less stable recruitment patterns. Particularly affected would have been the more sedentary species such as roach, bream and perch. Previously they had utilised the adjacent still waters as spawning grounds, but with the loss of the fringe areas, they were forced into reproducing in the main river channel. The result of this enforced change was that their eggs, larvae and fry were subjected to the variable, and sometimes adverse conditions which prevailed in the more volatile environment of the main channel.

Indicative of the wider damage that was done to the ecology of the river, by drainage operations was the progressive disappearance of the once common otter. As the pinnacle of the aquatic food chain, this predator's numbers provide a clear picture of the fish populations which existed. Although the species was zealously hunted, it was partly the loss of natural habitat and the dwindling fish populations that reduced its numbers and finally drove it from the lower reaches of the Don (see Appendix VI, Decline of Otters in River Don Catchment).

The landowners' determination to ensure that their land remained in a dry condition is well demonstrated by their opposition to the development of the river as a navigation. Records which appear in the publication 'The Early History of the Don Navigation' by T S Williams, indicated that opposition was almost unanimous amongst landowners and focused mainly on the fear that their drainage would be adversely affected by the further construction of weirs and locks which were necessary to allow boat passage. The Bill to allow the development of the navigation was eventually passed with the landowners receiving compensation and guarantees regarding the protection of their land. (Further details of this are contained in Chapter 3 on Navigation.)

As well as the desire to improve agricultural yields, there was also an increasing interest in altering the rivers' course to create land advantage. Early industry recognised the potential of diverting the channel to meet the needs of development and during the 19th Century a number of such schemes were implemented.

One good example was the site of the Duke of Norfolk's Hecla Steel Works at Attercliffe in Sheffield. Here, in 1884 the Duke diverted the course of the river and canalised it in order to create a flat site on the south bank to facilitate extensions to his works. As was common practice, the channel took little account of either the needs of the fishery or the general ecological value of the river corridor.

About 1 mile (2km) above the site of the Duke's diversion was the land adjacent to the confluence with the River Sheaf. Over the last century, fluvial deposits discovered during construction works in this area, indicated that originally a large expanse of wetland consisting of reed beds, pools and willow sallows existed at this location. This flat expanse of land would naturally have dissipated the flood flows of the river in ancient times. Evidence for this comes from the accumulations of blue clay and the remains of vegetable materials which can be traced to the Pennine headwaters of the system. It was probably at this point that the first, very basic attempt at land drainage was carried out on the Don system.

This is supported by further excavations at this location which have revealed the presence of hollowed out tree trunks, which appear to have been used to drain water away from these shallows back into the river's main channel. These primitive conduits probably represent the first attempts by man to alter the River Don's environment to suit his own purposes. It was at this place in 1112 that Sheffield Castle was built by William de Lovelot, a Norman knight, and it is almost certain that the site was chosen to take advantage of the marshy areas which provided the security of natural defensibility.

Progressively the whole of this area was drained and embanked and today the river is contained within its corridor by walls 19 feet (6 meters) or more in height.

Along with the drainage work which later took place further downstream, the reclaiming of this area would have had a considerable impact on fish populations. As well as the loss of habitat associated with the draining of shallow pools etc, constraining the river's flow within banks would have destroyed the naturally energy dissipating effects of this flood plain. The inevitable result would have been a far less stable environment for fish, with regular damage to both habitat and populations as the energy of floods carried on down river.

More modern land drainage activities have continued to affect adversely the potential of the river environment to sustain a healthy ecosystem. As described earlier, the River Don has always had a reputation for flooding and the land to the north east of Doncaster including the parishes of Bentley and Arksey was an area which was regularly inundated.

As was described in the section on the History of Land Drainage, a scheme was designed by the River Ouse (Yorkshire) Catchment Board in 1934 to control flooding in the Doncaster area. Work was carried out from Doncaster almost to the river's confluence with the River Ouse at Goole. It was achieved by channel enlargement, embanking and the draining of subsidence areas by pumping. Following the example of previous generations, the work took little account of the river's future potential as a fishery. It should be recognised, however, that at the time the river was grossly polluted and unable to sustain fish life.

The 'improvement' works continued until the early 1950's, latterly under the control of the Yorkshire Ouse River Board. Following the completion of this scheme, work commenced on the River Don above Doncaster and in particular on the two principal tributaries, the Rivers Dearne and Rother. By the time the work on the The lower Don had been completed, the river had lost almost a mile and a quarter of its original channel length between Doncaster and Goole.

As a result of intense mining activity in the Dearne valley, the river had for many years suffered serious subsidence problems. This was particularly evident in the vicinity of Denaby. The Dearne's natural channel was typical of a meandering lowland river and the remains of the old course can still be seen today adjacent to Denaby Ings Nature Reserve. The subsidence created by the mining caused serious flooding problems, as the river's natural gradient to the River Don was lost. Large areas of valuable farm land remained under water for long periods and in the late 1950's a scheme was designed to alleviate the problem. This involved the construction of a new channel which began above Harlington and eventually connected with the river Don downstream of Denaby. Once again, the design of this channel took little account of the river's future ecological potential, for at that time it too was polluted and fishless. Details of restoration work carried out on this section of the Dearne can be found in Part 2 - Chapter 3 of this report.

From the turn of the 20th Century, the physical characteristics of the River Rother were also increasingly subjected to change. Industrial opportunism often resulted in sections of the river being straightened and re-channelled to create extra land for development. This destructive activity accelerated towards the end of the 1950's era, as opencast mining operations became more popular and profitable. In many cases, coal deposits lay beneath the bed of the river itself and to successfully exploit these reserves, it was necessary to re-channel the river. Rarely was consideration given to the profile of the new channel to allow natural features to re-establish. The result was often the creation of a very straight and sterile river course. One extreme example of this type of activity commenced in the late 1960's between the villages of Beighton and Killamarsh. Here the river was diverted to facilitate the exploitation of huge coal reserves and on completion, the void which had been created, was infilled and a new channel constructed to take the river's flow. This area today is known as Rother Valley Country Park.

PART 1 - CHAPTER 3a
THE DEVELOPMENT OF THE RIVER DON AS A NAVIGATION

SAILING KEELS (BARGES) ON RIVER DON
Commercial navigation on the Don relied on sail and horse until many vessels became motorised in the period between the two world wars 1918-1939

Navigation in its most primitive forms undoubtably took place on the River Don back into pre-history. Stone-Age Man had already devised means of crossing water long before the invention of the wheel or before he had domesticated animals. Using rafts made of tree branches or trunks lashed together or simple skin covered coracles, he was able to traverse rivers or lakes or use the craft in his efforts to catch fish.

The stage when craft began to be used for mercantile purposes is less clear, but certainly early man perfected means of water transport suitable for the transfer of goods. It is almost certain that the bluestone he used at Stonehenge, was transported by water from the hills of Pembroke via the Bristol Channel and up the rivers of Somerset and Wiltshire.

The Romans were the first people in Britain known to alter and manipulate watercourses for the purpose of navigation. They created channels between the Rivers Cam, Bedfordshire Ouse and Nene and then developed the Caer Dyke which ran for 40 miles (64.4km) to the River Witham at Lincoln. To complete the system, the Foss Dyke was then constructed to allow access to the River Trent. Having completed this work, the Romans were then able to easily transfer goods, principally grain, from East Anglia to the important provincial capital of York, or as they called it, Eboracum.

As they sailed down the Trent to reach the Yorkshire Ouse, these early navigators would have passed the confluence with the River Don. This would have provided a corridor by which they could gain access to their fort at Doncaster (Danum) which was well established by AD250.

Whether the Romans actually took advantage of this opportunity cannot be verified, but remains of a Romano-British settlement have been found at Sandtoft, on the banks of what would have been the River Idle, then a tributary of the River Don (see original map at the beginning of Chapter 2a). Evidence suggests that this site was not unique and that many other settlements existed adjacent to the lower river, all able to take advantage of the navigational facilities it provided.

RIVER CHESWOLD
The origin of the Cheswold is unclear, it may have been a natural secondary channel of the Don which was widened and deepened or was possibly constructed as part of the fortification of the island on which stood the Roman fort and later a Greyfriar's Monastery.

By the 12th Century, mercantile navigation had become well established on the tidal Don with busy ports at Turnbridge, Stainforth and Fishlake. The most important local port of the period was Bawtry on the River Idle, which still remained a tributary of the River Don. Through this corridor much of the commercial transfer of goods to and from Doncaster, Rotherham and Sheffield took place.

With favourable tides and on flood flows, small craft had the ability to negotiate the difficult passage up the Don to Doncaster. However, the quantity of goods they were able to transfer, coupled with the unpredictability of their timings, made their operations less profitable and despite the difficulties of road transport, merchants preferred the more secure route provided by Bawtry.

Some indication of the hazardous nature of navigation on the lower Don can be gained from the fact that Henry IV's parliament was petitioned by local merchants to remove obstructions and impediments from the bed of the river. In particular, they wished to see improvements to the bridge at Turnbridge (see illustration in Chapter 2a) near

the confluence with the River Aire, which was so hazardous that accidents were reportedly occurring daily.

Craft that managed to complete the dangerous passage up river to Doncaster would probably have moored in the River Cheswold, reputedly the shortest river in Britain. This channel, which was less that half a mile long, left the main river at a point just upstream of what is now St Mary's Bridge in Doncaster. It then looped around towards the parish church before re-entering the Don close to where the retail market now stands. These craft would by necessity have been small and unable to carry large loads. This in itself would have seriously limited their commercial viability. The beneficiaries of these difficulties were the merchants of Bawtry who had a virtual monopoly on the movements of goods to and from the middle and upper Don valley.

It is not surprising then, that the Corporations representing the towns of Doncaster, Rotherham and Sheffield turned their attention to improving the Don as a navigation. However, serious attempts to carry out improvements did not begin until the end of the 17th Century.

The main initiative for improvement seems to have come from Rotherham Council in 1697, when the House of Commons gave leave for a Bill to be brought in to make the Don navigable. The Bill was prepared by Sir Godfrey Copley of Sprotbrough, who at the time was the MP for Thirsk.

It was introduced to the House on 21 January 1698, but only 5 petitions were presented in its support. These came principally from the traders of Doncaster and Rotherham, but support was also provided by the Corporation of Leeds. Strangely, Doncaster Corporation opposed the bill on the grounds that it would destroy their Mills for which they had recently spent £1,000 on repairs.

Not unexpectedly, opposition also came from those with interests in the navigation on the River Idle, clearly feeling that the proposals posed a serious threat to their investments. With no support from Sheffield, and no official support from Doncaster, the motion to commit the bill was defeated by 92 votes to 202.

For 6 years the issue went quiet, but in 1703 Doncaster Corporation took the initiative and voted monies to be spent on a further study. On 28 November 1704 the Corporation petitioned the Commons for leave to bring in a Bill for making the Don more navigable. It stressed the need to overcome the difficulties posed by rocks, shallows and mud banks if Doncaster's role as a market for corn was to be fully realised. The Bill received its first reading on 13 December 1704, but its second reading was repeatedly postponed and in fact never took place.

In 1721, the project was again revived with strong support from the Company of Cutlers of Hallamshire. They required an improved form of transport to move the goods produced by their more than 6,000 strong workforce. At the time, they claimed to be producing goods worth over £100,000, more than half of which was going for export. Despite this claim, opposition continued to be strong, principally from milling interests and landowners. They feared that the impoundments required to navigate the fall of nearly 120 feet (36.6m) between Sheffield and Barnby Dun, downstream of Doncaster, would cause flooding of their land.

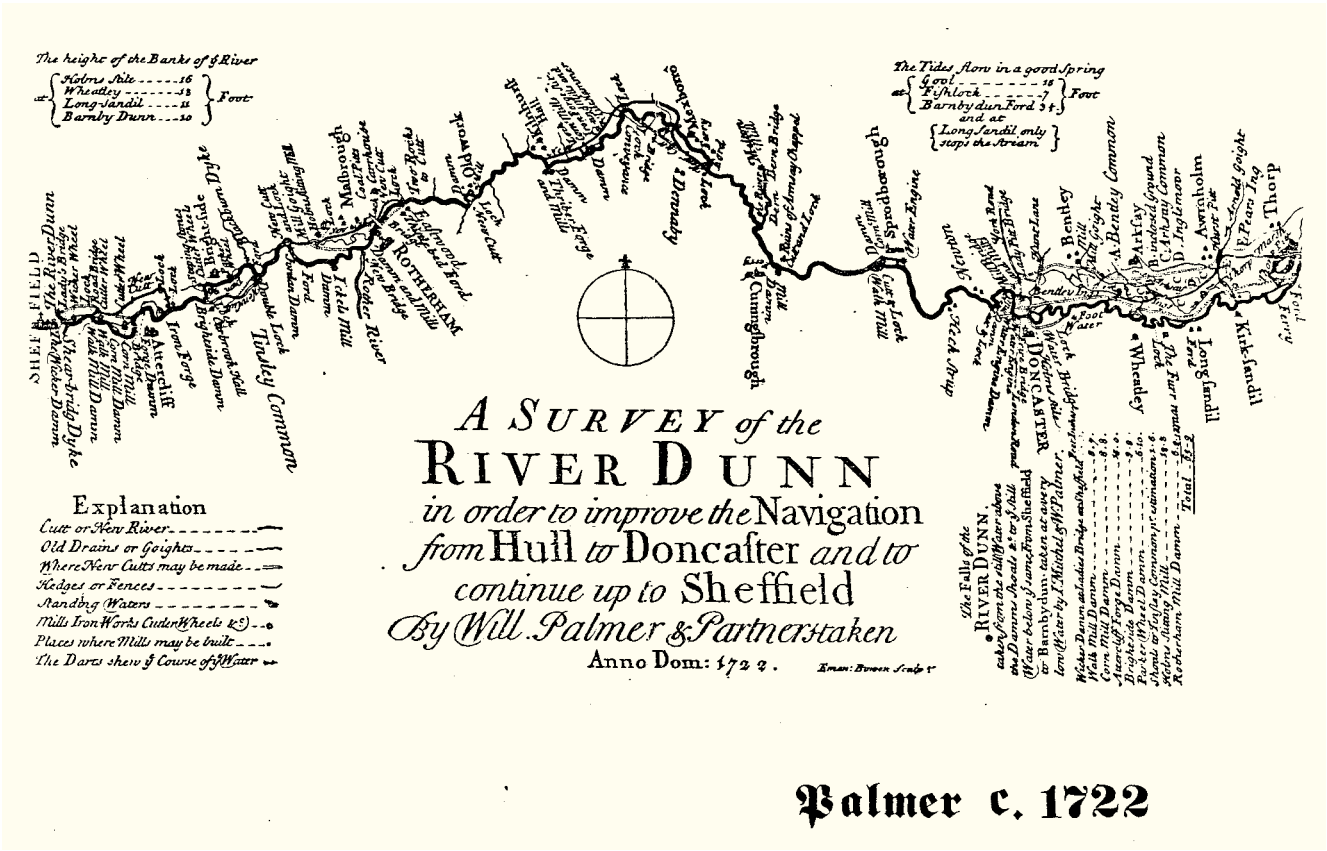
By far the most influential opponent was the Duke of Norfolk. He was concerned about the effects on his mills and forges in Sheffield. He also supplied most of the coal to industries in the Sheffield area and this was likely to be threatened if navigable access was made available to the South Yorkshire Coalfields. The Company of Cutlers tried many ways to persuade the Duke, but his claim that he should have the monopoly over all wharfs and warehouses on the canal, could not be accepted by the Company. They pointed out that bills for river navigation always gave the undertakers such rights. Disputing this, the Duke continued to oppose the Bill by inserting a number of clauses to protect his interests, rather than attempting to defeat the whole project.

The Duke was not alone in his opposition. Most of the influential landowners along the Don were against the navigation, fearing it would impair drainage of their property and cause flooding. However, when it came to committing funds towards the fight, most were niggardly and were only prepared to invest small sums, some as low as £10.

On 1 October 1722 a meeting was held at Rotherham attended by representatives of the Company of Cutlers, the Corporation of Doncaster and the landowners. It was agreed at this meeting that a survey of the river would be carried out by William Palmer & Partners. Palmer was to consider 3 alternatives for the navigation up to Doncaster:

1 by locks on the river;
2 by cutting a channel through the swamp or low grounds;
3 by a cut through the higher grounds.

Despite their efforts, it was all in vain, and leave to bring in the Bill was defeated on 19 February 1723.



If the landowners believed they had won a final victory, they were soon to be disappointed. By August 1723, Doncaster and Sheffield were again negotiating over the navigation. Their cause was assisted by the Duke of Norfolk's change of attitude who, whilst insisting that his interests be protected, was less concerned having learnt that the new navigation was to end at Tinsley and not the centre of Sheffield. It was finally the Company of Cutlers who took the initiative and petitioned for a Bill which would give them the necessary powers to make the river navigable from Holmstile, just below Doncaster, to Tinsley.

On 6 May 1726 the Bill passed its third reading and gave the Company of Cutlers, as undertakers of the scheme, the power to make the Don navigable for boats of up to 20 tons (20.3 tonne) and to cut, deepen and widen the river. However their powers did not entitle them to erect any new dam or weir, or heighten or lower any existing dam or weir, or to destroy any forges, ironworks or mills. Compensation to landowners was to be assessed by a named body of Commissioners.

Having achieved this victory, it followed that a further Act was necessary for improving the river below Doncaster and on 27 February 1727, Doncaster Corporation petitioned for leave to improve navigation between Holmstile and Wilsic House, near Barnby Dun. The Bill was introduced and passed without incident.

This Act differed from the first one as it allowed for damming of the river and included a structure of 4ft (1.2m) high at Long Sandall and one of 4ft (1.30m) high at Redcliffe. Works commenced on the navigation funded principally by the sale of shares and the new company held its first general meeting at Sheffield on 9 August 1733. The following month the company laid down its scale of charges for lockage and a levy of 3 shillings per ton (15p per tonne) on most goods was imposed per passage between Aldwarke and Doncaster.

Extending the navigation from Aldwarke up to Tinsley continued to pose problems which took several years to resolve. By 1740 the company claimed to have spent a total of £24,750 of capital and 2 years income of £900 on making the river navigable between Rotherham and Wilsic House.

On 23 January 1740 the company applied for a further Bill to extend the navigation further downstream from Wilsic House to Fishlake Ferry. This was finally passed and constructed at a cost estimated at £3,700. The commencement of this operation meant that work was now being carried out at both the upper and lower sections of the new navigation and by 1751 boats were at last able to navigate as far as Tinsley. This effectively meant that the construction of the Don navigation was complete. The total capital costs incurred being approximately £40,000.

On completion, the company settled into a period of quiet prosperity raising a total of £70,051 in tolls between 1759 and 1769. By far the greatest contributor to this income was the toll on coal which annually raised an average income of £3,732.

Between 1770 and 1815 several new cuts were created to improve the navigation including the one at Thrybergh and many further disputes arose with landowners over water rights.

It was in 1815 that a separate group obtained an Act for a canal from Tinsley to Sheffield. This was opened on 22 February 1819 and for the first time it became possible to sail directly from the Humber to the centre of Sheffield.

In 1802 the Stainforth & Keadby Canal was constructed as a further addition to the network. It was an independently owned waterway connected to the Dun Navigation at Stainforth and took traffic to the River Trent at Keadby. This was a far less difficult route to navigate not being influenced by the tidal effects bedevilling the lower River Don. Gradually this tidal section of the navigation fell into disuse until it was replaced entirely by the Stainforth/Keadby system.

In 1847 the Dun Navigation finally closed its books and was legally amalgamated with the South Yorkshire, Doncaster and Goole Railway. Being a competitor for its trade, the Rail Company quickly allowed the navigation to fall into neglect and concentrated its investments on its rail network.

The canals continued to deteriorate until 1888 when a new company took over control following pressure from Sheffield industrialists and the City Council. The company was named the Sheffield and South Yorkshire Navigation and brought about a new lease of life for the waterway.

In 1905 collaboration between the company and its neighbour, the Aire & Calder Navigation, resulted in the construction of the New Junction Canal which connected the South Yorkshire Navigation at Kirk Bramwith with the Aire at Southfield, near Sykehouse. Once again direct navigation between Sheffield and Goole became possible.

CONFLUENCE OF NEW JUNCTION AND STAINFORTH/KEADBY CANALS
The beginning of the New Junction & Stainforth & Keadby Navigations at Kirk Bramwith. The entrance to the New Junction Canal is on the left of the picture.

STRAWBERRY ISLAND MARINA
One of the oxbows created by the straightening of the course of the River Don to improve navigation at Doncaster. It is now an important marina for recreational craft

DEARNE AND DOVE NAVIGATION
Only the locks and lower pounds of the canal are left at Swinton

The canals were flourishing and in 1913, the company announced that for the first time more than 1 million tons (1.02 million tonne) of cargo had travelled the waterway. This prosperity continued until 1948 when the country's canal network was nationalised coming under the control of the Docks and Inland Waterways Executive. This led to further investment and improvements to several bottlenecks were carried out, most notably the lock at Kirk Sandall which was widened and lengthened.

In 1966, the British Waterways Board applied to the Government for funds to improve the network to accommodate vessels of up to 400 tons (406.4 tonne). This work was completed in approximately 1974 but the anticipated boom in traffic never materialised as many of the area's traditional heavy industries had fallen into rapid decline shortly after its completion. The Sheffield and Tinsley section was remaindered (taken out of use) in 1974 but was later to be restored.

Today, the South Yorkshire Canal network remains under the control of British Waterways, who regulate all commercial and recreational use of the waterways. Commercial navigation on the system is now relatively light but the reduction in freight transportation has been compensated for by a significant increase in the number of leisure craft which enjoy the improving condition of the river and canal environment.

Several marinas providing mooring and comfort facilities have been developed along the system including sites at Thorne, Stainforth and Strawberry Island, Doncaster. This latter facility using the oxbow of the old course of the Don which was created when the river was straightened to aid navigation. On the Sheffield and Tinsley section mooring facilities were later developed at Tinsley Top Locks and Sheffield Basin.

The construction of the Dearne & Dove Canal received Royal assent in June 1793 and connected with the Dun Navigation at Swinton. Completed in 1804, it principally aided the exploitation of coal deposits in the area around Barnsley and opened at a cost of £100,000.

Elsecar and Worsbrough Reservoirs were constructed to supply water for the navigation, the latter effectively severing the River Dove from its headwater streams.

Ironically, it was coal, the very lifeblood of the canal, which caused its demise. Severe subsidence problems resulting from the extensive underground working made maintenance a constant and costly problem. The Dearne & Dove eventually passed into the control of the Dun Navigation in 1844 and then on to Railway control in 1850. The last vessels to pass along its length were in 1934, although its lower end served the Manvers Colliery until 1952.

PART 1 - CHAPTER 3b

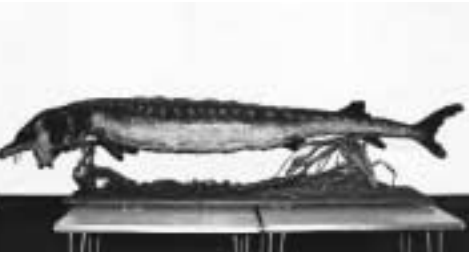
THE EFFECTS OF DEVELOPMENT OF NAVIGATION ON THE DON FISHERY

The creation of a permanently navigable channel on the River Don in 1732 had both positive and negative effects on the river's fishery. Initially under pressure from adjacent landowners, the Company of Cutlers and their agents had to concede to demands that weirs were not raised to protect drainage. However, this concession was relatively short lived and within a few years work was moving apace to raise levels, create bypass channels and to generally manipulate the river channel to facilitate boat passage.

The impact of these works on migratory sea trout and salmon would undoubtedly have been severe as weir crests were raised and a proportion of the normal flow was diverted through new channels. Ascent of larger structures, which since their original construction, had impeded migration became even more difficult and fish increasingly had to rely on a significant rise in water level to continue their upstream movement.

Trapped in the pools below the weirs, they were extremely vulnerable to predation from a range of fish-eating birds and mammals. Otters were still relatively common in the Don Valley in the 18th Century and they would undoubtedly have taken full advantage of the easy source of food provided by the trapped fish.

Human exploitation must also have increased. Trapping, netting or spearing of fish in such a vulnerable situation would have been both simple and an attractive and increasingly lucrative way of making money. Amongst the species affected by this form of exploitation was the sturgeon, which was an infrequent though regular visitor to the system. (Details of sturgeon captures can be found in Appendix VII.)



STURGEON
The above specimen on view at Doncaster museum is believed to be the fish killed with a pitch folk in 1860.

Of all the work undertaken to facilitate the navigation, the construction of tidal locks at Sandal below Doncaster in 1729 seems to have had the most significant impact and by all accounts dealt a decisive blow to the river's migratory salmonid runs.

By the middle of the 1750s the hecks at Doncaster were no longer profitable and were falling into a state of decay and by 1776 all commercial interest in them was lost. To add to the problem, the value of salmon had increased in relation to the declining availability of the resource, making them a more attractive proposition to those who sought to exploit them.

According to the Historical Notices of Doncaster 1856, poaching became a major problem and it even became common practice for unscrupulous individuals to search out fish which, despite the difficulties, had reached the headwater spawning areas. Here the fish even though gravid and hardly suitable as human food were speared and gaffed in the shallow water and taken for sale.

Surprisingly, considering the problems of keeping them fresh during transportation, many of the fish were shipped to the continent, especially Paris, where they commanded a premium price on French markets.

Under such intense pressure it is not surprising that salmon numbers declined alarmingly during the last half of the 18th Century. In a publication 'The History of Doncaster and its Vicinity (1804)', it is reported that 'Barbel, pike, bream, roach, dace, eels are common but there are no salmon; trout are also very rare in the Don at Doncaster'.

This statement may be a little misleading. According to records, salmon did occasionally appear but they were probably the victims of pursuit by estuarine predators, such as seals or porpoises, both common inhabitants of the Humber at that time. These fish were probably on course for one of the Dales rivers such as the Wharfe or Ure, both good salmon fisheries in the early 19th Century, but seeking sanctuary from their pursuers found themselves swimming in the water of the Don.

This phenomena continued to occur certainly until the 1850s and then spasmodically throughout the duration of the 20th Century. However by the 1860s, levels of pollution in the Don were becoming a very significant problem. Fish entering the river would rarely have been able to ascend beyond the lower tidal limits before being killed by the effects of toxic pollutants or low dissolved oxygen.

It seems clear therefore, that in terms of a self sustaining population, the salmon had disappeared from the Don by the year 1800.

In contrast the navigation created certain benefits to the coarse fishery. The bypass channels which were constructed to allow boats to navigate around obstructions on their way up and down river, provided a means by which fish could also pass around certain impoundments. To what extent riverine species such as dace, chub and barbel were able to exploit this facility is unclear but certainly roach, bream and gudgeon, amongst others, have been found to take advantage of boats travelling through locks to move up and down navigable rivers.

In the ponded conditions of the bypass channels, marginal and submerged weeds would have been encouraged to develop along the edges of the channel as organic material normally carried in suspension by the flowing river was allowed to settle and provide the nutrients required for their growth.

Planktonic development would also have been more vigorous in these conditions providing the food source for the early development of coarse fish fry. The accumulation of body fat, essential to first winter survival, would have been more rapid as less energy expenditure was involved in maintaining station in the ponded channels, than in the flowing and often uncertain conditions of the main river.

The overall effect was probably a significant increase in the biomass of coarse fish, particularly in the lower middle reaches of the river between Rotherham and the upper tidal section. The composition of the population would also have changed with a further bias towards the more sedentary species such as roach, bream, and perch.

With the development of the Stainforth Keadby Canal in 1802 and a century later the New Junction Canal, a new impact was created on the Don.

To serve the needs of these important waterways, major engineering works were carried out on the river around Doncaster. The original channel which had been heavily impounded was further altered by the removal of a number of bends. This left oxbows where the original course had flowed. Examples of these can be still be seen at Strawberry Island and at the rear of the Dupont factory on Wheatley Hall Road. More importantly, from the point of view of its effect on the fishery, a new completely separate channel was created which took flow in excess of what was required for navigational purposes.

The Flood Channel, as it was called, is what we today regard as the natural channel of the River Don. The flows along the course of this flood channel were greatly dependent on the demands of the navigation and in periods of drought could reduce very significantly. Even in normal conditions, a considerable proportion of the Don's flow was, and still is, diverted away from this channel into the canal network eventually finding its way to the Trent at Keadby or via the New Junction to the Aire & Calder Navigation.

At the height of its commercial use in the early part of the 20th Century the lockage requirements of the canal network below Doncaster were such that, in low water conditions, a very substantial proportion of the flow was being diverted along the canal. As traffic gradually transferred to road and rail, usage reduced but even today a significant proportion of the flow of the River Don finds its way via the canal network.

Again there were both positive and negative effects to this development. On the positive side, the Don began to serve a new extensive waterway which was eventually to develop as an excellent coarse fishery with a high recreational value. On the negative side, a significant proportion of the river's flow was permanently diverted away from its natural course.

The significance of this net loss of flow on the fishery is difficult to determine. The salmon runs had already virtually disappeared by the time this network was operational and were not therefore adversely affected.

This is unlikely to have been the case with certain types of coarse fish, particularly riverine species such as dace and barbel which require clean, well oxygenated gravels in which to deposit their eggs. Reduced flows would have resulted in fewer suitable areas for reproduction with the added problems of increased silt deposition coating the gravels and starving the eggs of oxygen.

The problems of silt deposition would have been a progressively worsening one as the demands of the navigation combined with the deteriorating quality of the water passing down the river. The Industrial Revolution was, by this time, gathering momentum and the emerging industries of Sheffield and Rotherham with their urbanising effects on human populations was beginning to seriously affect water quality. These effects were to continue and by 1865 the remaining fish populations in the middle and lower Don were facing an uncertain future.

PART 1 - CHAPTER 4a

HISTORY OF WATER POLLUTION ON THE RIVER DON SYSTEM

GROSS POLLUTION
Sheffield in the early 19th Century

There were few locations in Britain which offered our forefathers the opportunities for prosperity that were available in the Don Valley. The area was rich in iron and coal deposits with boundless supplies of energy available from the rivers and streams which tumbled from their sources on the high ground surrounding the valley. In addition there were vast deciduous woodlands which in the 12th Century stretched from the edges of the moors, all the way down to the wetlands bordering the tidal areas.

With reliable supplies of drinking water, wood to burn and game to exploit in the woods and streams, our early forefathers probably lived in perfect harmony with their environment.

It was the accidental discovery that a certain type of stone, when brought into contact with prolonged heat, formed into a hard durable material suitable for making tools and weapons, that sealed the fate of the Don Valley.

The stone was to be found in abundance and using the seemingly endless supplies of wood available to them, the early settlers of the valley were to become the ancestors of the Iron and Steel Barons who were eventually to turn the Don Valley into one of the largest and most important industrial centres in the world.

During their occupation of Britain, the Romans were probably the first to significantly exploit these natural resources. Smelting of iron would likely have taken place to serve the needs of their legions who were stationed at forts throughout the valleys. Remains of these sites have been found at Bradwell, Wincobank, Templeborough, Attercliffe, Kimberworth, Barnsley, Ecclesfield and Doncaster amongst others.

COLLIERY MINE WATER
Ochre (Iron Hydroxide) covers the bed of the River Don below the Bullhouse minewater discharge

The early effects of this 'industrial' activity were insignificant, occasionally perhaps small ochreous deposits were induced by the disturbance created by digging into the earth for iron stone but such pollution was extremely localised and had little overall effect.

As demand for iron developed, it became necessary to dig deeper and deeper to reach supplies and gradually mines began to develop. Two sites are included in the records of Archbishop Grey of York 1215-1257 situated at Silkstone and Tankersley. The mine entrances were usually situated on a hillside and used the drift technique to exploit the deposits. This must inevitably have resulted in run-off from the sites finding its way down the valley side and into the stream which flowed at its foot.

These early sites were by today's standards extremely small and any effect on the receiving river or stream would have been minimal. Progressively, however, over successive centuries demand grew and slowly the effects on the surrounding watercourses became more significant. Industries reliant on the supply of iron and coal were developing and more sophisticated methods had to be employed to meet their requirements.

Good examples of the effects of this activity can still be quite vividly seen at Bullhouse on the River Don and Sheephouse Wood on the Little Don. Here the orange discolouration caused by ochre (iron hydroxide) washed in from the old workings blankets the bed of the watercourse killing plant and invertebrate life.

Despite these still relatively localised effects records suggest that water quality remained good at the turn of the 19th Century. Tremendous advances had been made by industry by this time including the development of steel manufacture. The infant coal industry was also developing with supplies required to serve the smelting processes which had turned from using charcoal to coke.

Taking advantage of the ready supplies of raw iron, and later, steel were dozens of cutlery manufacturers with mills using the water power provided by the Don and its many suitable tributaries to turn their grinding wheels.

Of even more significance was the development of the Samuel Walker & Bros, Masborough Ironworks in 1767. This site constituted the biggest iron foundry in Britain and possibly the world at that time and in 1768 employed more than 500 people.

Considering the damaging pollution which sites of this nature were destined to cause to the River Don in the future it seems remarkable that at the time they seem to have had only minimal effect.

Records of fish populations in the Don half a century later lay proof that this was the case with pollution intolerant species, such as brown trout and grayling still present. There were basic pollution laws in existence at that time exercised by bodies known as the Commission of Sewers. The enforcement powers of these Commissions, which were principally designed to improve land drainage and protect against flooding, had been granted in the reign of Henry VIII and allowed for action to be taken against people who disposed of polluting material into drains and rivers. The form of pollution which the Commissions were most concerned about was that related to human bodily functions as many of the population still relied on the rivers to supply their drinking water. More complex forms of pollution such as those likely to arise from steel manufacturing are unlikely to have been fully understood, yet despite this the rivers appear to have remained relatively undamaged.

In his account of a 'Tour of the Don' published in 1836 Laman Blanchard, is very descriptive in his observations. He refers to the Forges at Wortley as follows: 'The environment of the river at this point is repugnant in which the retirement of nature appears to have been outraged by the dull fiery, smokey atmosphere'.

Despite this damming description he goes on to describe the flora and fauna of the river with no reference whatsoever to any polluting effect on the water emanating from the earlier mentioned industry.

Only once in his book, which describes the Rother and Dearne as well as the Don, does Blanchard mention water pollution. This is in relation to the blast furnaces at Attercliffe. Coal and coke to serve the site was supplied by barges which unloaded from the Sheffield Tinsley Canal. Here he describes the water in the canal as of the deepest ochreous yellow. This was probably the result of the pumping of mine water into the canal from the nearby Nunnery Colliery owned by the Duke of Norfolk.

Clearly where the canal entered the river's natural course adjacent to what is now the Tinsley Viaduct, some pollution must have occurred as water used for the lockage of craft passed into the river. However Blanchard makes no further reference to pollution and continues on to describe the varied flora of the river downstream towards Rotherham.

By the early 19th Century, supplies of local iron ore to meet the now insatiable demand were rapidly becoming exhausted and manufacturers increasingly turned to ore from Sweden which was brought up the Dun Navigation by barge. Most convenient to this supply were sites around Rotherham which, at that time, had a considerably larger population than Sheffield. The earlier mentioned site of Walkers at Masborough was by 1836 an enormous operation. It had supplied virtually all the cannon for the British Forces during the Napoleonic Wars and had also cast, in sections, the Southwark Bridge which still spans the River Thames today. It seems almost inconceivable that these operations were not causing serious pollution of the river but according to available evidence fish populations were still abundant.

With the development of the railway system in 1840 connecting Rotherham and Sheffield with London, came a massive shift of population. Large manufacturers had at last an easy and convenient means of transporting their goods to the world and needed large numbers of workers to man their operations.

Sheffield's manufacturing base grew apace with companies such as Spear & Jackson developing new works in the Brightside area of the city, and John Brown's massive Atlas Works opened, covering an area in excess of 2 acres (10 hectares).

The population of Sheffield grew alarmingly to sustain these developments rocketing from 90,000 in 1830 to 150,000 by 1854. With no adequate means of treating or disposing of the waste created by the workers, the streets became awash with human sewage which flushed into streams and gullies and finally into the rivers.

The powers of the Commission of Sewers to control pollution were conveniently ignored as it was tacitly accepted that they could not contain the problem. Rapidly the River Don, between Sheffield and Rotherham, became little more than an open sewer and by 1860, was reported to be black and foul smelling. With the river in this condition, industrialists saw little point in restricting the release of the pollution caused by their operations and gladly accepted the opportunity to use the river as a conduit for disposing of their waste products.

From 1850 onwards, the lower reaches of the Don around Doncaster began to suffer the effects of the pollution caused upstream. The river, via its tributary the Cheswold, still supplied much of the town's drinking water yet despite this, the pollution was allowed to continue.

With the population of Sheffield still rapidly increasing and reaching 300,000 by 1881 something had to be done to alleviate the foul and unsanitary conditions.

By this time, many of the wealthier citizens had taken advantage of the new water carriage system, a primitive form of flush toilet. Installed in their homes, these facilities washed their excrement away into cesspools which were often inadequate and overflowed into adjacent streams or surface water sewers. The increased liquid content naturally accelerating the rate of transfer of their effluent and some people quickly recognised that they could avoid the smell nuisance created by cesspools altogether by directing their discharge direct to streams. For the poor, however, the use of primitive privy middens was to continue well into the 20th Century and the sound of the contents of your toilet being shovelled into a disposal cart remained a regular source of nightly disturbance.

The creation of sub-surface sewer systems towards the latter end of the 19th Century helped to relieve the nuisance in the streets, particularly in the more affluent areas. Initially these systems simply provided a means by which the effluent could more rapidly be deposited in the river but eventually it was recognised that this could not continue.

In his report of 1891, the Medical Officer of the City described the situation as follows: 'It would be hard to find in any town poorer conditions than are to be found in the centre of Sheffield. Nuisance and unsanitary conditions of every description abound. Diseases such as cholera and typhoid spread from privy middens and filthy unpaved courts into rubble sewers and contaminated water and waste flows down steep hill slopes into the river and streams.'

In 1886, the first sewage treatment facility in Sheffield was opened at Blackburn Meadows. The treatment it provided was very basic and relied mainly on a lime precipitation process which is described here in more detail.

BLACKBURN MEADOWS SEWAGE TREATMENT WORKS (1896)

SEWAGE TREATMENT IN SHEFFIELD

The first known sewage treatment facility at Blackburn Meadows was built in 1886. Prior to this time Sheffield, with a population of around 300,000, had no sewage treatment facilities. The first works operated a lime precipitation process plus aeration over weirs and finally coke filtration. They were designed to treat 10 million gallons (45460 cumecs) of effluent per day but with no provision for storm treatment. Initially the works was only operated in the daytime and only afforded 50% treatment. Despite these inadequacies the works were considered a 'model' and were visited by interested parties 'from all parts of the kingdom.'

In 1910 as a result of pressure from the 'Local Government Board' and the 'West Riding Rivers Board', the old plant was remodelled with the intention of providing extensive bacteria beds. These were finally brought into operation in 1914. It is interesting to note that during these deliberations, Sheffield Council considered several other options to remodelling the works including piping the sewage all the way to the North Sea.

In 1916 the then Manager of Sheffield's Sewage Disposal Department, Mr John Howarth, developed the Sheffield aeration system. The technique was not sanctioned for Blackburn Meadows until 1922 and brought into use in 1932. This system became the role model for all the sewage treatment works in the Sheffield Council area, and was also adopted at Chesterfield, Stavely and Swinton.

This Sheffield system, whilst providing good treatment for Biochemical Oxygen Demand (BOD) was poor at removing ammonia (NH^3). (*See glossary for definition).*

Despite its inadequacies, the plant at Blackburn Meadows does appear to have had a limited effect which increased when the works was upgraded in 1914. Records which indicate the temporary return of fish to the lower reaches of the Don from the turn of the century would seem to confirm this.

As the industrial base of the Don Valley had developed so had the demands for fuel to provide its massive energy requirement. South Yorkshire was rich in coal deposits, the seams of which outcropped along the edges of the Pennines. These easy to obtain supplies had been exploited for centuries using drift mining techniques, but this method was inadequate to meet the growing demand by the early 19th Century.

RIVER DEARNE

The River Dearne lay wholly within the coal measures and was therefore a prime target for pollution from this source. By the end of the 18th Century, a number of small deep mine collieries were in existence including

MILL ON RIVER DEARNE AT DENBY DALE
A working example of a woollen mill built on the upper Dearne

those at Smithies, Honeywell, Queens Ground and Mount Osborne. Initially contamination from these sources was either non existent or very localised as indicated by the presence of good fish populations in the river.

In 1810 the Dearne and Dove Navigation opened which provided for the first time an easy means of transporting large quantities of coal to the steel works of Sheffield and Rotherham and down the Don for transfer to other areas of the country. With this development came a significant increase both in the number and size of collieries along the Dearne and with it a rapid increase in population.

Unlike the urbanising effects of Sheffield's steel industry, coal exploitation encouraged the development of small village communities which grew around the newly sunk shafts.

The urgency to exploit the economic boom, which was occurring, left colliery owners little time to consider the environmental impact of their operations or in many cases even the welfare of their workers. Sanitation was a secondary consideration and in many instances, the local watercourses became the most convenient form of disposal for both domestic and industrial waste.

In addition to its coal reserves, the upper Dearne Valley provided very similar conditions to the Colne and Holme Valleys, which along with the Calder Valley formed the world centre of the woollen trade, in the 19th Century.

The headwaters of the Dearne and Holme rise only a few kilometres from one another and it was therefore inevitable that this industry overspilled into the Don catchment. Mills sprang up along the upper Dearne principally centred around the villages of Denby Dale, Scissett and Clayton West. As with the collieries, the woollen mills encouraged the development of worker populations who, because of the tight confines of the upper valley, were generally housed in terraced dwellings backing onto the river. Initially with no sewage disposal systems in place, it was inevitable that domestic waste conveniently found its way to the river.

Combined with the caustic washing agents, dyes, etc and the thermal effects of the untreated discharges from the mills, the river was subjected to a lethal cocktail of pollution.

In their report of 1902, the West Riding River Board refer to improvements that they had managed to secure in the preceding 6 year period and this information helps us to understand the extent of the pollution problems which existed at that time.

In 1896 the following trade effluents were discharging to the Dearne system:

	PARTIALLY TREATED	UNTREATED
Woollen Mills	1	6
Bleaching Units	1	4
Coalwashing Plants	5	0
Other (Glassworks, Breweries, etc)	3	8

By 1902 the situation had slightly improved as follows:

Woollen Mills	4	4
Bleaching Units	4	1
Coalwashing Plants	8	–
Other (Glassworks, Breweries, etc)	8	1

In addition to these industrial discharges, there were 44 separate small sewage treatment plants serving the village and town communities all providing at best, only partial treatment. The Board's report describes the Dearne as 'much polluted by domestic sewage and by untreated or partially treated trade refuse'. These conditions were to persist for a further 80 years.

RIVER ROTHER

The condition of the River Rother was very similar to that of the Dearne at the beginning of the 20th Century. The rich coal deposits beneath the valley floor, offered huge opportunities which where being eagerly exploited by business interests. Like the Dearne, the Rother appears to have escaped the worst excesses of this development, until the 1880's although localised impacts would have been inevitable.

With the proliferation of coal mines came the same problems of localised urban development that had occurred on the Dearne. Tributaries such as the Doe Lea, River Drone and Pools Brook became repositories for the filth created by industry and its servants and their collective effects quickly reduced the Rother to a lifeless sewer.

One of the first mines to be developed in the Rother valley was Dore House Colliery adjacent to the site of Orgreave Hall. This mine commenced operation around 1820 and continued to produce coal until the turn of the 19th Century.

The sinking of Dore House shaft commenced nearly 170 years of mining and associated industrial activities in this part of the Rother Valley which were to leave a legacy of contaminated land and grossly polluted watercourses. (see Appendix V - Orgreave Reclamation Site.)

Chesterfield, the main centre of population in the valley had small industries such as glassmaking and pottery manufacture but essentially, at the turn of the century it remained a small market town. Lead mining had for centuries been practised in the hills to the east of the town, but with little apparent effect on the surrounding watercourses. The rapid development of the coal industry was soon to change all this.

INDUSTRY IN CHESTERFIELD IN THE 19TH CENTURY

In 1801 Chesterfield was a small market town with a population of 4,267.

Its main industries, though these were generally one man operations, were lead mining, iron stone mining and stone quarrying.

In 1840 Chesterfield was linked to the newly developed railway system and this provided opportunities for the expansion of commerce.

Lead mining which had probably existed in the area since Roman times peaked around 1850 with merchants from various areas of the country coming to the town to buy ingots of lead from miners who sold their goods at the local markets. By 1880 the trade in lead had gone into rapid decline to be replaced by a number of small manufacturing industries.

Probably the largest employer at that time was the tobacco works, but other industries important to the local economy were Carpet Weaving, Boiler Making, Cannon Casting, Lace Making and Cutlery.

Locally the Staveley Iron and Steel Works founded in the mid 18th Century was perhaps the most important development in the area. It was active and provided trade to the Chesterfield Canal when the canal opened in 1777.

A photograph contained in a publication entitled 'The Making of the Rother Valley Country Park' produced by the Country Park Joint Committee may give a clue to the condition of the Rother in 1900. It shows two ladies sitting on the banks of the river just downstream of Bedgreave Mill which today forms part of the visitor centre at Rother Valley Country Park. (See Part 1 Chapter 1a photo titled Bedgrave Mill).

THE POLLUTION OF THE RIVER ROTHER.

At the Chesterfield County Court yesterday Mr. N. J. Hughes-Hallett, Clerk to the Derbyshire County Council, applied for orders to be made against a number of authorities to prevent them continuing to pollute the River Rother.

Mr. Hughes-Hallett said he was pleased to say that the cases would not occupy much time, as the authorities concerned had agreed to orders being made, and to carry out certain requisite works which were to prevent the overflow of sewage into the river in its course through their districts by dates specified on the orders.

The authorities concerned were the Chesterfield Corporation, represented by Mr. J. Middleton, Town Clerk; Newbold and Dunston Urban District Council, represented by the Clerk, Mr. George Carline; Whittington Urban District Council, represented by the Clerk, Mr. H. T. Twelves; and the Chesterfield Rural District Council, for whom the Clerk, Mr. R. F. Hurtwright, appeared, and who were interested in two parishes, viz., Beighton and Eckington.

His Honour Judge Lindley made the orders, which require the Corporation to carry out the works in three years; Newbold and Whittington in one year; Beighton in one year, and Eckington in two years.

SHEFFIELD TELEGRAPH, FRIDAY 28 APRIL 1905

On the surface of the river can clearly be seen what appear to be extensive growths of filamentous algae (Blanket Weed), which would indicate that the river was highly nutrient enriched. The source of the nutrients which would encourage this excessive growth of algae could almost certainly have been traced to partially or untreated sewage entering from the developing upstream mining communities.

In 1905, as a result of extreme public concern the Clerk to the Derbyshire County Council applied to the Chesterfield County Court for orders to prevent various local authorities from continuing to pollute the river. These orders were granted and the authorities concerned were given a maximum of 3 years to provide treatment facilities for the sewage created by their parishioners. Regrettably, their efforts were never able to adequately keep pace with the demands of an increasing population and as a result the Rother continued to deteriorate.

Throughout most of the 20th Century the sad story of the exploitation of the River Don and its tributaries has continued. The steel industry created thermal pollution problems which raised the ambient temperature of the river reducing dissolved oxygen concentrations, discharged acids from pickling processes and coated the river surface with oil from quenching and lubricating.

Coal mining and its associated industries produced gross solids which coated the bed of the river and streams, discharged highly toxic heavy metals, arsenic, cyanides and phenols and contaminated adjacent land with tar liquors.

FOAM ON RIVER
This was a common sight towards the end of the 1960's occurring as a result of increasing household use of detergents

In combination with this miasma of destruction was the organic pollution created by the human population of South Yorkshire. Inadequately treated sewage raised BOD and lowered dissolved oxygen levels. It created ammonia concentrations well in excess of that which could sustain fish life and produced the phosphates which encouraged algal development and destroyed natural in-stream flora.

Foam, created by the use of non-biodegradable detergents, became perhaps the most visibly obvious indicator of the river's condition in the 1950's and 60's. Huge banks of grey brown bubbles created by the re-agitation of detergents were formed as the water tumbled over weirs. Often these banks covered the river's surface to a depth of several feet, and in windy conditions clouds of foam were lifted from the water and carried through the air for hundreds of yards.

The combination of all of these and many other forms of pollution from a range of industrial activity served to create for the River Don, the well deserved but unenviable title of one of Europe's filthiest rivers. A title which it retained well into the 1980's.

PART 1 - CHAPTER 4b

EFFECTS OF WATER POLLUTION ON THE RIVER DON FISHERY

The chemical destruction of the water environment was the final and perhaps most devastating human effect on the fish populations of the River Don. It is clear from reports indicating the presence of salmon that chemically, the Don remained in good condition until the end of the 18th Century. Salmon populations had declined markedly by this time, but this was undoubtedly attributable to the physical changes which occurred rather than to deteriorating water quality.

Reports of salmon continuing to enter the lower Don between 1800 and the late 1840's confirm that the tidal reaches at least remained chemically capable of sustaining their presence but by 1850 things were deteriorating rapidly.

Powers as mentioned earlier, to control the pollution of river and streams had been introduced in 1531 during the reign of Henry VIII by a statute called the Bill of Sewers. This allowed for the appointment of Commissioners Of Sewers who were to oversee, amongst other things, land drainage and basic pollution control.

One of the principal responsibilities of the Commission was to ensure that sewers to convey surface water were maintained and did not contaminate the rivers or streams many of which provided drinking water to the local population. Protection of aquatic life, including fish, was probably not seriously considered but, never the less, ensuring their drinking water supply also helped to protect the aquatic environment.

Gradually as the pace of the Industrial Revolution gained momentum, so the problems of water pollution began to increase. It was the drift of workpeople to towns to serve the needs of developing industries that was to create the most significant effect. Human waste began to find its way into streams and eventually to the main river damaging and destroying the fish populations which existed.

As well as affecting water quality in the main river, the destruction of these tributary streams denied certain species of fish the habitat necessary to the maintenance of their populations. Brown trout stocks would have been particularly hard hit by this deterioration as traditional spawning and nursery areas became unsuitable for use.

Their loss however, was to be of little consequence considering the damage which was occurring to the environment of the main river. Industry had continued its rapid expansion and by 1860 the population of the City of Sheffield had reached almost 200,000.

By this point in time the river throughout the city and downstream to Rotherham was being grossly polluted by human and industrial effluent and fish had been almost totally annihilated. Natural purification was, however, still allowing coarse fish populations to maintain a tenuous hold in the lower river, but the numbers and range of species present, even here, was in rapid decline.

It was the collapse of Dale Dyke Reservoir at the head of the Loxley Valley which dealt a final and decisive blow to these remaining populations. The resulting flood rapidly carried the gross pollution from Sheffield down to Doncaster leaving thousands of fish dead in its wake.

The people of the lower valley were greatly incensed at having to endure the nuisance caused by the pollution of their upstream neighbours and in 1868 the local MP for Doncaster, Mr FJS Foljambe raised the matter in Parliament.

LETTER OF COMPLAINT FROM MR F S J FOLJAMBE

F S J Foljambe Esq MP has taken the initiative toward the purification of the River Don. In a letter to the Mayor of Doncaster dated Aldwalke December 1868 he states:

I have desired of my solicitor at Rotherham to give notice to the local board of steps to abate the nuisance (draining to the river) and I cannot but think that if your corporation would take a similar step we might get something done. If we allow them to take their own time it may be years before they would move!

Letter prompted by the result of a flood on December 1868 when over half a ton of dead fish was removed from the Don at Doncaster.

He complained that the large quantities of filth and sewage from Sheffield, Rotherham and other expanding industrial towns along the Don were poisoning the river and killing the fish. He also made a plea for steps to be taken to abate the nuisance draining into the river.

His pleas clearly fell on deaf ears for no action was taken and sadly the people of Doncaster were left to witness the insidious demise of their once prolific fishery.

Fish which did survive, according to the Yorkshire Anglers Guide written by Tom Bradley in 1894, were confined to the tidal reaches below Doncaster. Bradley described the Don between Hazlehead and Doncaster as un-fishable and a solid inky mass of pollution.

Surprisingly in his article, Bradley mentioned salmon which ran into the tidal river as far as Wheatley. These fish could not have been a self sustaining population as access to suitable spawning grounds was by then, an impossibility. Their presence must, therefore, have been the result of seal or porpoise activity in the Humber Estuary, leading to the fish being diverted away from their original course to the Dales rivers of Yorkshire. How long these fish were able to survive in the Don is a matter for conjecture, but it is likely that their continued existence relied heavily on flood flows maintaining reasonable dilution. As conditions returned to normal, they would rapidly have succumbed to the effects of the pollution.

There were also areas, principally in the headwaters of the river and its tributaries, where brown trout populations managed to maintain a tenuous hold.

Gannister mining which was extensive around the Bullhouse area above Penistone was the first major source of pollution entering the Don, but above that the river remained relatively clean.

GANNISTER MINING

Gannister is a refractory siliceous sedimentary rock which occurs beneath coal seams. It is commonly used as a lining for blast furnaces and as such was important in the development of the steel industries of the Don Valley.

There were many gannister mines situated along the upper Don Valley, several of which still cause ochreous deposition as a result of uncontrolled discharges.

The most visible and probably the most damaging is on the Don at Bullhouse just above Penistone.

Here a small brown trout population managed to maintain a toe hold for the next century despite the construction of reservoirs in the headwaters. The story of this population is covered in Part 2 Chapter 1.

The history of the demise of the Don fishery is not quite complete without reference to the apparent improvement which occurred following the start of the 20th Century. Basic treatment was by this time being

applied to the effluent created by the citizens of Sheffield and this was to extend as new facilities were developed throughout the system.

The introduction of this treatment appears to have had quite a significant impact, certainly in the Doncaster area. According to Howes, 'The History and Distribution of Fish in the Doncaster District', the length between the town and Sprotbrough was of considerable amenity value between 1900 and 1940. The river was used for a range of recreational purposes including boating, swimming, fishing and regular angling competitions were held. Towards the end of the period conditions began to steadily deteriorate once more and with dwindling success the anglers and other users increasingly turned their backs on the river.

THE RIVER ROTHER

In the aforementioned publication 'A Tour of the Don' published in 1836 by the Sheffield Mercury, Laman Blanchard described the River Rother as a beauteous stream and refers to anglers enjoying catching chub, roach and perch from its waters.

The Rother had previously been one of the principal sources of salmon stocks to the Don and had remained a pristine stream throughout the early part of the 19th Century. Regrettably, it too was destined to fall victim to the ravages of industry as coal mines were sunk to take advantage of the rich deposits in the coal measures beneath its waters.

The information available suggests that the destruction of the Rother fishery occurred some 30 years or possibly more, after that of the Don. However, its effects were no less complete and by the turn of the 20th Century its waters had been reduced to little more than an open sewer.

Like the Don, several of the Rother's upper tributaries did manage to retain their fishery status. The most significant of these was the River Hipper which flows down from the Pennines to join the Rother at Chesterfield. In this small stream there were as well as brown trout, the last remnants of the Don's once prolific population of grayling.

THE RIVER DEARNE

The pattern of destruction on the Dearne was similar to that which befell the Rother. By all accounts the river managed to maintain its fish population for some years after the destruction of the stocks in the main river but this was only a temporary reprieve. Coal mines urgently required to serve the insatiable appetite of industry, were being sunk all along the valley between Clayton West and the river's confluence with the Don at Denaby.

Human populations increased accordingly to man the mines and the combined effluent from the industry and from those who served it quickly began to take its toll on fish populations.

By the turn of the 20th Century the River Dearne was effectively dead, certainly from Barnsley to its confluence with the Don.

Although a similar fate befell a number of its tributaries, including the River Dove, several streams because of their more rural location, managed to escape their populations of brown trout. Probably the most important of these was Cawthorne Dyke.

THE LAST STRAW

The onset of the Second World War, with its effect on industrial production, proved to be the final nail in the coffin of the Don's fish populations.

By 1940 the massive war effort, so ably supported by the Industries of the Don Valley, was exercising a profound effect on water quality. Apart from the populations isolated in the headwater streams, the remaining pockets of fish were quickly eliminated as the river was reduced to a complex cocktail of industrial and human pollution.

The insidious destruction of the Don's fish populations had taken the inhabitants of the valley eight centuries to achieve and was now all but complete. It had been won by the negligence, greed and apathy of successive generations, who had finally earned for the river an international reputation for gross pollution and environmental degradation.

ANGLERS ASSOCIATION OFFICIALS
Officials of Doncaster Angling Association hold their annual protest match on the River Don at Doncaster in the 1960's. They were to wait a further 25 years before fish were regularly caught at this point. Sadly the gentleman on the left of the picture, Mr Ray Garrity, did not live to enjoy the benefits of the improvements.

Modern History of the RIVER DON Catchment

1974-96

The insidious damage which the demands of man had imposed upon the natural environment of the Don system gained momentum throughout the centuries. This progressive destruction had almost reached its peak by the turn of the 19th Century leaving the river and most of its tributaries severely damaged. Little remained of the diverse ecosystem which once existed and in its place was an open sewer carrying away the filth created by industry and its servants. Although attempts were made to stem the destruction, little changed over the following seventy years, other than the addition of a more complex array of polluting material.

With the river in such a severely degraded physical and chemical condition, it is perhaps understandable that the work carried out to protect against flooding during the period 1934-51 on the Don and later on the Dearne and Rother, took little account of the catchments future potential for rehabilitation, though it did compound the rivers sad situation.

It was in this chronically degraded condition that in April 1974 the responsibility for managing the Don system passed into the hands of the newly formed Yorkshire Water Authority. This new organisation had for the first time the opportunity to apply a more holistic approach to the management of rivers. In addition to assuming responsibility for water supply and sewage disposal, the new Authority encompassed responsibility for pollution control, water resource management, flood defence and fisheries.

For the staff appointed to deal with water quality problems in particular, the prospects could hardly have been more daunting. It was not without justification that the Don was commonly referred to as one of Europe's most polluted rivers.

The following chapters describe the progress that has been made since 1974. Again it uses fish populations as a guide and charts how, through natural recolonisation and reintroduction, fish populations have mirrored the water quality improvements which have been achieved over the 22 year period to 1996.

To complete the picture, overviews of the work carried out to protect against flooding, manage water resources, control pollution and enhance and protect the re-emerging ecosystem are included together with a description of the opportunities that a cleaner River Don offers for recreation.

WINSCAR RESERVOIR
Built to replace the smaller Dunford Bridge Reservoir in the 1970's. It serves as a compensation reservoir which provides the base flow to the upper River Don

PART 2- CHAPTER 1

THE REHABILITATION OF FISH POPULATIONS DON HEADWATERS TO THE RIVER DEARNE

By April 1974 what remained of the Don's once proud fish stocks had been reduced to a small number of brown trout isolated in a few upstream locations.

Of particular significance was the population which existed in the upper Don system between Bullhouse and Dunford Bridge. This part of the river had to endure the damage caused by severe siltation during the construction of Winscar Reservoir yet despite the loss of almost all of the natural spawning gravels a small number of wild brown trout had managed to survive. It was the presence of this population which was to provide the incentive for the first attempt at restoring the River Don as a fishery.

Early in 1975 the Yorkshire Water Authority received an application for a licence to abstract 113652m^3 (25 million gallons) of water per day from the Don at Hazlehead. As is legally required, the application was advertised and as a result came to the attention of the local branch of the Salmon and Trout Association who requested their local organiser, Mr Gerald Stocks, to assess the potential impacts.

The investigation carried out by Gerald Stocks identified the presence of trout and also revealed that the section of river offered considerable potential for development as a recreational fishery and on the strength of these findings the association lodged an objection to the application.

DON AT HAZLEHEAD
Part of the Don which was developed as a trout fishery by the Salmon & Trout Association in the 1970's

Despite the objection a licence was eventually granted but for a lesser amount of 68191m^3 (15 million gallons) per day but strict conditions were applied which ensured that most of the water after use was returned to the river in a condition which would not significantly alter quality. Encouraged by this the Salmon and Trout Association acquired fishing rights and more importantly the support of land owners in undertaking a restoration programme on this upper section of the Don. Help and support was also forthcoming from the Fisheries department of the Yorkshire Water Authority who initially set about addressing the problems of siltation. Flushes of water were released from Winscar Reservoir which helped to disperse accumulated silt from spawning gravels and in addition work was carried out to improve the quality of the effluent from a small sewage treatment works at Dunford Bridge.

BROWN TROUT RELEASE
Releasing brown trout into the upper Don to assist in the development of the fishery

The benefits of this work were quickly recognised and on 10 October 1975 the first introduction of fish to assist in the redevelopment of the Don fishery was delivered to Hazlehead. The consignment which consisted of 250 brown trout of between 12.5-30.5 cm (5 to 12 inches) in length was provided by the Yorkshire Water Authority.

Over the following 5 years various habitat improvement schemes were carried out along sections of the Don between Hazlehead and Penistone and despite chronic and persistent problems associated with ochreous discharges from long abandoned mine workings and other industrial and agricultural practices, the trout population rapidly improved in both quality and quantity.

To record their efforts, the Salmon and Trout Association produced a report which graphically described the environmental degradation which they encountered during their restoration work. This document includes the following lists which helps to illustrate the conditions.

FORMS OF POLLUTION	REFUSE REMOVED FROM THE RIVER INCLUDED
1 Iron Hydroxide (ochre)	1 Corrugated sheeting
2 Detergents (foaming)	2 Prams
3 Oil	3 Car bodies
4 Offal	4 Metal drums and crates
5 Salt	5 Tyres
6 Sewage	

GRAYLING
This species was re-introduced to the Don system in 1984 after almost a 150 year absence

CHEESEBOTTOM STW
The first large sewage treatment works on the River Don near Penistone. Improvements to this works in the late 1970's allowed the fishery downstream to begin its recovery.

By 1983 with the future of the brown trout population on the upper Don apparently assured, the Salmon and Trout Association following discussions with Yorkshire Water Fisheries department, turned its attention to the re-establishment of the Don's once prolific grayling population. A stock of this species was available from cropping operations carried out by the Authority on the West Beck near Driffield and a decision was taken to release 200 fish into the river at Hazlehead. The extremes of environment, from the gentle flow of a chalk stream to the harsh and volatile conditions of a Pennine spate stream could not have been greater, yet despite this the fish survived. Indeed their adaptation to their new environment was remarkable. Within 4 months of their release a number of the larger mature specimens reproduced in the Don and their progeny began the recolonisation of sections both up and downstream of the original introduction point.

The development of this population was extremely rapid and within 3 years the species was being recorded in fishery surveys from sites some 15 kilometres ($9^1/_4$ miles) below the release point.

This downstream recolonisation process continued throughout the next decade with stocks progressively edging further towards the centre of Sheffield. This movement to a great extent mirrored the improvements being achieved in water quality and by 1995 grayling had been confirmed as far down as the Don's confluence with the River Sheaf.

CHEESEBOTTOM STW - CASE STUDY

Toward the end of the 1970's in the upper part of the River Don catchment, around the Penistone area, sewage was treated at one of 5 sewage treatment works: Green Moor, Oxspring, Thurgoland, Thurlstone and Spring Vale. All 5 works produced poor quality effluent and Thurlstone afforded little better than primary treatment. The flow was allowed to settle in shallow lagoons, and then passed over an old ash tip and then to the river.

The following table shows the mean values for BOD, SS and NH_3 for the final 3 years discharge quality prior to the works closure:

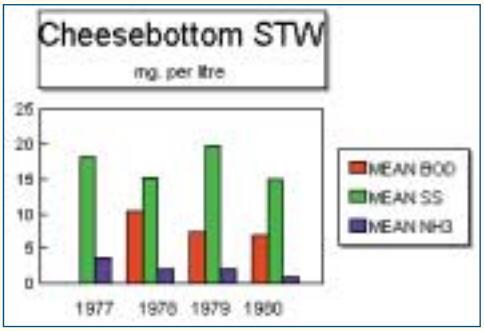
Works	BOD	SS	NH_3
Green Moor	64	87	39
Oxspring	65	117	23
Spring Vale	116	120	30
Thurgoland	101	120	17
Thurlstone	55	64	15

Green Moor, Oxspring and Thurgoland were relatively small works, where as Spring Vale and Thurlstone served the Penistone conurbation. These works were inherited by Yorkshire Water Authority on it's inauguration in 1974 and to remedy the situation the Authority commissioned the building of a brand new works at Cheesebottom to replace these 5 works. The works started discharging in 1977 and the following table gives some idea of the works first few years performance.

Early Performance of Cheesebottom STW

YEAR	MEAN BOD	MEAN SS	MEAN NH_3
1977	-------	18.3	3.7
1978	10.4	15.3	2.1
1979	7.3	19.7	2.1
1980	7.0	15.0	0.9

All analysis in $mg.l^{-1}$



Along the upper river between Penistone and Oughtibridge remained several of the disused dams which had provided the supply to the water wheels of the mills and grinding operations during the industrial development of the valley. Several of these were developed as coarse fisheries by local angling interests in the 1960's and early 1970's and as a result they began to feed small numbers of fish, principally roach and perch into the river via their outlets. The ability of the fish to survive encouraged angling interests to attempt to develop the river as a coarse fishery by transferring excess stock from the dams. To some extent this proved successful particularly in the ponded conditions around the weirs.

However, in terms of an environment suitable for natural maintenance of coarse fish populations the river at this point was generally unsuitable having a topography more suited to trout. A considerable proportion of the stocked fish introduced in these exercises drifted downstream often during flood flow conditions and as water quality improvements continued, began to form the nucleus of the developing populations of coarse fish in the river in and around Sheffield.

THE DON AT OXSPRING
Coarse fish were introduced to the river in this vicinity but the environment of the river was more suited to trout

Similar use of disused dams as coarse fisheries had occurred on many of the tributaries including the Rivelin and Loxley and fall out of stock from these streams also contributed.

The first appreciable concentration of coarse fish to develop in the Don within the City of Sheffield occurred downstream of the confluence with the River Loxley in the early 1980's. The diluting effect of the Loxley's flow helping ameliorate the conditions in the main river sufficiently for their short term establishment and survival. Increasingly these populations began to spread, with further concentrations beginning to occur below the numerous weirs which provided slightly improved conditions due to their aerating effect.

Fishery survey results obtained from an operation carried out in October 1984 showed a small fish population consisting of roach, gudgeon and minnows downstream of Lady's Bridge which suggested better conditions than indicated by the rivers chemical classification at that point.

Despite these encouraging signs it was clear that the larger coarse fish species did not represent a self sustaining population and that the fish present were generally the product of still water reproduction. This could often be confirmed by scientific examination which revealed the presence of parasites normally associated with still water conditions.

Throughout the 1980's the closure of traditional heavy industries, the introduction of more stringent consent conditions on dischargers and the development of the Don Valley trunk sewer progressively resulted in improving water quality along the section of the Don between the mouths of the Loxley and Sheaf. This improvement was reflected by the first evidence of self sustaining populations of minnows towards the end of the decade, with growing populations of roach, perch and gudgeon maintained by continued fall out from upstream fisheries.

DON VALLEY INTERCEPTOR SEWER - CASE STUDY

(The development of this system contributed significantly to the improvements in water quality which allowed the rehabilitation of fish populations throughout Sheffield.)

The earliest trunk sewers serving Sheffield were laid in the early 1880's with further major works carried out in 1910. The sewers conveyed both foul and storm sewage along the valley of the River Don to Blackburn Meadows at the eastern end of the city where the first treatment plant was opened in 1886. At the time of construction they were of sufficient capacity to serve the flows from the city. Relief was provided by the provision of storm sewage overflows which discharged directly to the river in wet weather.

Since the last century, Sheffield has grown in size, industry has expanded and the usage of water increased such that the original sewers became overloaded and excessive quantities of sewage discharged to river in only light rainfall and sometimes even in dry weather. Inadequate sewerage also lead to localised flooding to properties in low lying areas.

In the 1960's the City Council became increasingly concerned with the condition and operation of the main sewers. They found the structure of the sewers were deteriorating and such inspections that they could make, revealed that it would be unreasonable to expect the system to remain in use for many more years without major reconstruction. Works investigating a practical and economic solution to the problem were commenced. The solution was to tunnel a new sewer in the Carboniferous strata. The new sewer would serve the inner part of the Sheffield drainage area and would result in 26 large unsatisfactory storm sewage overflows being abandoned.

The initial contract was let in 4 phases and work on Phase 1 commenced in 1979. This involved laying 2.14km ($1^1/_3$ miles) of tunnelled main sewer with an internal diameter of 5.5m (6 yds) to a drop shaft in Hawke Street. It also included the building of a new pumping station and associated works at Blackburn Meadows. This first stage was completed by July 1983.

Phase 2 commenced in the autumn of 1983 and involved driving a 2.23km ($1^1/_2$ miles) length of sewer with a diameter of 3.81m (4 yds) towards a drop shaft next to Furnival Road in the centre of Sheffield.

Phase 3 was concerned with a stretch of sewer from Furnival Road to the Whitbread Brewery with a small section commencing at the Sheaf valley sewer towards the central bus station.

Phase 4, completed in 1993, extended the Don Valley sewer to Gilpin Street.

Section 5A has recently been completed and extends the sewer from Gilpin Street to Livesey Street, Hillsborough.

Two further sections of the interceptor sewer are still necessary, i) extension to the Sheaf Valley sewer to Millhouses, and ii) extension to the Don Valley sewer to the Sheffield Wednesday Football Ground, to include a Loxley trunk sewer leg to Malin Bridge. To date no decisions have been taken about when this work will commence.

Also beginning to appear below the weirs in Sheffield were dace and chub. These fish owed their origin to restocking work carried out by the YWA and by local angling interests in the Wortley area in 1988. The fish used for the stocking were some of the first to become commercially available from experimental breeding of riverine species carried out by the Yorkshire and Severn Trent Water Authorities at their sites at Aldwarke and Calverton during the late 1980's.

Encouraged by the improving conditions Yorkshire Water Fisheries staff commenced a series of coarse fish introductions during 1987-88 using fish obtained from a number of local still waters. The stock introduced consisted principally of small roach, perch and bream which had been removed from their parent water because of overstocking problems. One such water was Herries Road Pond at Hillsborough which provided more than 5000 fish. Stock from such sources were far from ideal for river re-development, the fish were often stunted and in generally poor physical condition and in addition lacked the muscle development inherent in fish bred in flowing water conditions.

HERRIES ROAD POND
Surplus fish were netted from this and other waters in the 1980's to assist the re-establishment of fish populations in the River Don throughout Sheffield

Being so disadvantaged many of the fish were quickly carried downstream once subjected to the flowing conditions of the river. Many eventually found slack water areas off the main channel particularly where the river linked into the South Yorkshire Navigation so beginning the development of the fishery in this system. Most of the fish introduced around this period were released close to the confluence of the River Loxley. This point was chosen to take advantage of the diluting effects of the cleaner flow of the tributary. Despite the downstream displacement, some of the introduced stock did gradually adapt to life in the river and provided good catches for a time to some of the more adventurous anglers who were beginning to recognise the river's developing potential.

The main breakthrough came in 1989 when large numbers of riverine stock, including roach, chub, dace and barbel became available from the Severn Trent Water Authority's Calverton Fish Farm. This facility pioneered the supply of hatchery reared fish which had been entrained to flowing water conditions on the farm before delivery. (The fish are placed in tanks and gradually subjected to an increasing flow which helps to develop the tail muscles.)

The first large scale stocking using this supply occurred on 11 January 1990 when a grant of 2,000 chub and 2,000 dace was made to assist the river's recovery by the newly privatised Yorkshire Water PLC. Introduced between Salmon Pastures and Meadowhall in Sheffield the fish very rapidly adapted to their new environment, clearly demonstrating the benefits of flow entrainment by the numbers which took up residence close to the introduction points.

By 1990 the presence of juvenile gudgeon and roach in the river throughout Sheffield was indicating that a self sustaining coarse fish population was becoming well established. However, below the City's main sewage treatment works at Blackburn Meadows the picture was far from encouraging. Poor water quality continued to limit the population to small numbers of fish which had dropped downstream following stocking operations. Their progress down to the confluence with the Rother at Rotherham was usually rapid as they tried to escape the almost intolerable conditions. Suddenly on reaching Rotherham the fish found their progress blocked by the even more extreme conditions created by the grossly polluted waters of the Rother.

Fish population surveys carried out in 1987 and again in 1990 located large concentrations of fish, predominantly roach just above the Rother confluence which showed indications of having originated from still water sources. Many undoubtably owing their origin in the river to the restocking work described earlier.

These concentrations naturally attracted angler attention and from this source of information it was possible to monitor through catch reports the way that the fish reacted to changing conditions. It was clear that during

DISCHARGE FROM BLACKBURN MEADOWS STW
Serving the city of Sheffield, it is the largest STW in the Don catchment

periods of low flow the numbers of fish present continued to build, whilst during a flood, (which provided some measure of dilution to the polluted Rother,) many of the fish continued their downstream movement.

By 1994 significant improvements had been achieved in the quality of the effluent from Blackburn Meadows Sewage Treatment Works as a result of a major modernisation of the plant. The most toxic component was ammonia and it was imperative that the new STW reduced the levels. Following completion of the improvement scheme the mean concentrations of ammonia leaving the works dropped dramatically from their 1991 level of 18.9 milligrams per litre to 2.4 milligrams per litre by 1994. Meanwhile conditions were also improving in the River Rother. The benefits of these improvements on the Don below Rotherham through to its confluence with the Dearne were not long in being realised as fish populations quickly began to build.

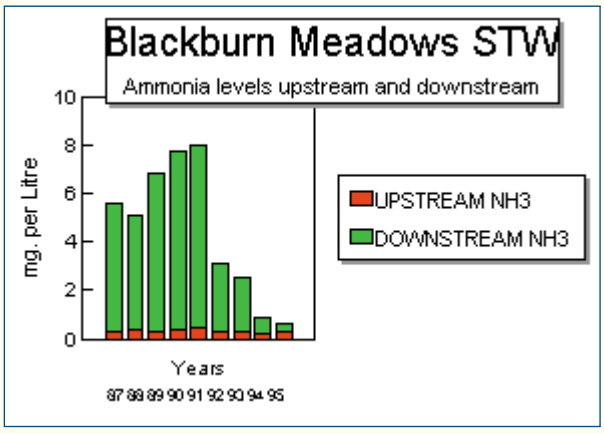
BLACKBURN MEADOWS STW - CASE STUDY

The first sewage treatment facilities to serve the city of Sheffield were built in 1886, at Blackburn Meadows, adjacent to what is today, the Meadowhall Shopping Complex.

Originally, the works operated on a lime precipitation process, plus aeration over a series of weirs and finally coke filtration. By today's standards, the treatment was extremely crude and had no facilities to deal with storm flows. Despite this it was considered a 'model' when constructed and was visited by interested parties from all over Britain.

In 1910 as a result of increasing pressure from the local Government Board and the West Riding Rivers Board, the plant was remodelled with the intention of introducing extensive bacteria beds. These were finally brought into operation in 1914.

It is interesting to note that the City Council before commencing these improvements actually considered, as an alternative, piping the sewage all the way to the North Sea.

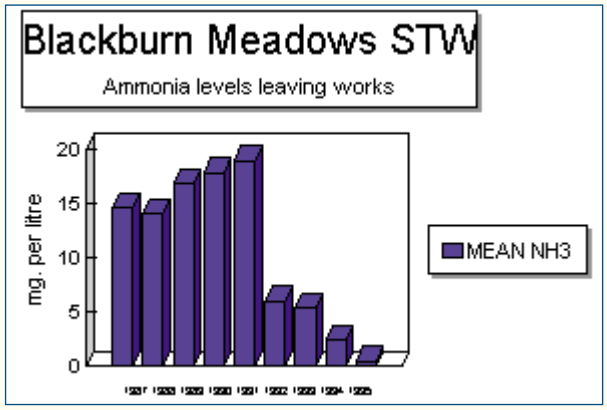


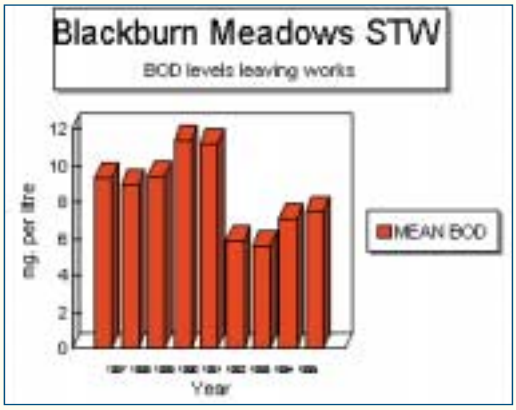
In 1916 the then manager of Sheffield's Sewage Disposal Department, Mr John Howarth, developed the Sheffield aeration system which was finally introduced at the works in 1932. This system became the role model for sewage treatment throughout the Sheffield area and was adopted by several other local councils. This system proved effective in treating the Biochemical Oxygen Demand but poor at removing ammonia (NH_3). As a result, the works regularly discharged effluents which contained ammonia levels in excess of 20 mg/litre. In later years as the volume of effluent in relation to river flows increased due to greater public use of drinking water the dilution factor would often in summer drop as low as 1.1 (one part effluent to one part river water) giving an ammonia level in the river below the discharge of 10 mg/l.

In 1992 work began on major improvements to the works which included the introduction of a modern system utilising a series of anoxic zones and diffuse air activated sludge treatment.

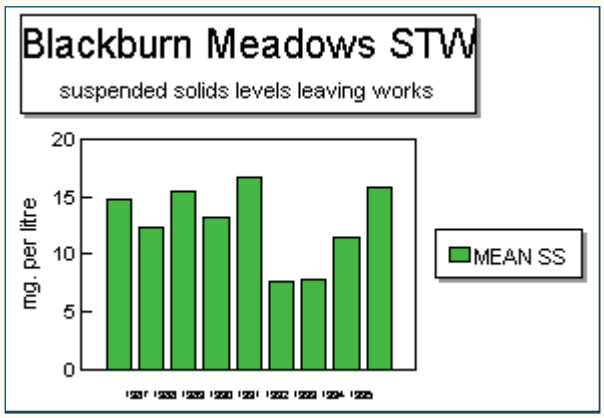
The benefits of this investment are clearly demonstrated on the chart below which shows a massive reduction in the mean levels of ammonia between 1987 and 1995.

Free ammonia is a powerful organic poison which is lethal to fish in quite small doses. The toxicity of this contaminant is increased by a rise in the pH value of water and by temperature. The smaller the fish, the more sensitive it is to ammonia. At concentrations as low as low as 0.2-0.4 mlg/ltr it can destroy fish fry, at 0.6 mlg/ltr it can kill small fish and at between 1-2 mlg/ltr few fish are able to tolerate it. It was the decrease in ammonia levels which had the most beneficial effect on the developing fishery of the Don system.





Over the following two years the development of these populations was assisted by further restocking carried out by the National Rivers Authority and by introductions made by angling interests to the South Yorkshire Navigation in the Swinton/Mexborough area. By the end of 1996 the section of river between Rotherham and Mexborough had become established as one of the most popular locations for anglers.



PART 2 - CHAPTER 2

THE REHABILITATION OF FISH POPULATIONS IN THE LOWER DON - DEARNE MOUTH TO GOOLE

At about the same time as the Salmon and Trout Association's efforts to restore the fishery on the upper River Don were gaining momentum in the mid 1970's evidence was also beginning to emerge of fish being present in the tidal river below Doncaster.

Water quality on this section had shown no discernable improvement since the rapid deterioration caused by the massive industrial effort of the Second World War, yet despite this, occasional fish were being found on the water intake screens at Thorpe Marsh Power Station, near Barnby Dun.

THORPE MARSH POWER STATION
Evidence of fish reappearing in the lower River Don were found here when fish were found trapped on the intake screens in the 1970's

The appearance of these fish lead to some speculation amongst local anglers that a breeding population had become established. But this optimism was quickly dispelled by scientific examination of the victims. Invariably the fish showed signs of having originated from adjacent still waters and were clearly transient, being swept rapidly downstream. Many of the fish appeared during, or shortly after, a flood event and their continued existence in the polluted conditions of the Don was probably reliant on the dilution afforded by flood water.

Occasionally members of the public reported seeing small numbers of fish sheltering in the mouth of the River Ea Beck where despite the Ea Beck's generally poor water quality some amelioration of the Don's appalling conditions could be found. Rarely did these accumulations exist for more than a few days, before the fish disappeared, presumably to recommence their downstream journey.

Despite the pollution it was still receiving from coal mining activity and inadequately treated sewage discharges in its upper and middle reaches, the River Went, by the time it neared its confluence with the Don, was benefitting from a degree of natural purification. This improvement allowed some of the fish descending the Don to find sanctuary in the area immediately upstream of its confluence with the main river. Quickly an appreciable population of coarse fish established which was supplemented by small numbers of flounders and eels which had managed to ascend the short distance from the River Ouse at Goole.

By the late 1970's the existence of this population had been noted by anglers and so began the first angling activity on the lower Don system for almost half a century.

As well as the Went there was one other location on the lower river were a small number of fish could usually be found. In Doncaster the overflow channel which served to control levels between the head of the navigation and the natural river provided some sanctuary. This channel remained ponded, unless in flood conditions and as a result some limited natural purification was able to occur. During the early 1970's sightings of large fish were regularly reported and occasionally fish became trapped on the intake screens to Doncaster Power Station which took its supply from the river at that point. Surprisingly these were regularly found to be common carp, a species which was not widely distributed in South Yorkshire at that time. The origin of these fish still remains a mystery though it is likely that they, like the other early sightings, were fall out from adjacent still waters.

With the exception of a gradual improvement on the River Went, (details of which are included at the end of this chapter) conditions changed little on the lower Don over the following decade and it was not until 1985 that signs of further improvement began to emerge.

FLOOD CHANNEL (CHESWOLD)
All that remains visible of the River Cheswold is the section which connects the navigation to the Don Flood Channel adjacent to Doncaster Prison. Doncaster Power Station took its cooling water supply from the Don at this point.

These signs centred around the outfall from the River Ea Beck which had itself improved sufficiently for a breeding population of roach, perch and gudgeon to establish. From this source a population of these species began to develop in the main river, gradually spreading both up and downstream. Monitoring of this population's development using the techniques available to them proved extremely difficult for the Fisheries department of the Yorkshire Water Authority. Anecdotal information collected from the very small number of anglers who fished the river confirmed fish presence but attempts to carry out electro fishing surveys were thwarted by the depth, variability of flow and turbidity in the tidal conditions.

PROSPER DE MULDER - CASE STUDY

(Improvement to the effluent from this industrial site assisted in the rehabilitation of fish populations in the Don below Doncaster.)

The Prosper De Mulder factory at Bentley is a long standing Doncaster family firm. The company now operates throughout the UK with the headquarters remaining in Doncaster. The factories produce animal by-products by processing the offal produced from slaughterhouses.

The Doncaster site produces bonemeal and other animal feeds. Their processing plant requires large amounts of water which is obtained from the company's on-site borehole. The effluents are treated by the company's own biological effluent treatment plant, before being discharged to the River Don downstream of North Bridge in Doncaster.

Substantial improvements have been made to the effluent treatment plant since the 1970's. The treatment plant originally consisted of a primary treatment element only and the poorly treated effluent caused pollution of the Don downstream. Biological treatment was later added along with final settlement facilities. To improve the efficiency of the biological treatment system an anaerobic tank was added and improvements continued with the addition of tertiary settlement tanks. Finally in 1995 the company completely re-built the primary treatment part of the effluent plant. This improvement work involved substantial investment by the company and has enabled the final effluent to be further improved resulting in further benefits to the river.

By 1989 regular reports of fish rising in the river at Doncaster were being passed to Fisheries Staff and in September of that year a survey was carried out which proved to be something of a revelation. By this date more sophisticated survey equipment had become available. The river conditions in the upper tidal section around Doncaster also tended to be shallower and less turbid. The range of species and the sheer numbers of fish present was far above expectations and caused quite a stir amongst local angling interests. The survey revealed the presence of perch, pike, chub, roach, dace and gudgeon. There was also evidence that at least the latter 2 species were reproducing successfully in the river. Also surprising was the condition of the fish caught, apart from some of the larger chub which showed signs of scale erosion, their general health was good despite still far from satisfactory water quality.

Despite these encouraging signs the improvements were not being mirrored in the non tidal part of the river. Between Doncaster and the confluence with the Dearne the ponding created by the impoundments developed centuries earlier to serve the navigation, provided a much more hostile environment. The ponded river was acting as a form of secondary treatment for the vast quantity of organic effluent the river was still

receiving from upstream discharges. This created unstable ammonia and dissolved oxygen levels which frequently created conditions untenable to most fish species.

Only one location along this 7 km ($4^1/_3$ miles) section of the river provided some relief from these conditions. The aerating effect of the weir at Sprotbrough helped to raise the level of oxygen and to dissipate a certain amount of the ammonia content, such that it was possible for small numbers of fish to survive.

As early as 1981 fishery surveys had revealed evidence of fish presence at this point, though the species and numbers found indicated barely tolerable conditions. In a survey in 1981 only 3 three-spined sticklebacks and one small eel were caught (both of these species have a high tolerance of the effects of organic pollution). By 1984 small numbers of gudgeon had also begun to appear in survey catches and by 1987 the numbers of this species had increased considerably with the first evidence of the development of a self sustaining population. Despite these encouraging signs this population was still extremely localised with no evidence of it expanding away from the weirpool.

It was to be a further 3 years before evidence emerged of this happening. In May 1990 a member of the public reported sighting a number of fish rising in the river in the vicinity of Hexthorpe Flatts, Doncaster. The reportee was convinced that the fish were roach, and later that year his observations were confirmed when both roach and perch were captured during a survey at Sprotbrough. Though their numbers were small, examination of the fish suggested that they had been resident in the river for some time. This apparent improvement in conditions was supported by a large increase in the numbers of gudgeon present. Again confirming the establishment of a breeding population of this species.

Throughout the remainder of 1990 and into 1991 the development of fish populations in this section of the Don were carefully monitored by visual observation and by collection of catch information from the small number of anglers who were beginning to fish the river. Water quality was also carefully monitored and though the improvement was slow signs were emerging of a reduction in the mean levels of ammonia.

In the light of these improving trends a decision was taken by the Fisheries department of the National Rivers Authority to commence a series of trial restockings. Initially the fish used were obtained from netting and fish rescue operations carried out on local still waters. Because of the ponded condition of the river along this section these fish were able to adapt more readily than those from similar sources stocked into the faster flowing conditions in Sheffield. This stock, consisting mainly of roach, perch and bream vigorously spread throughout the section between the Dearne mouth and Doncaster and quickly formed the nucleus of a population which was to rapidly expand throughout the next 5 years.

NETTING OF FISH FOR TRANSFER TO RIVER DON
A fishery management operation carried out by fisheries staff in the early 1990's. Fish from such sources were regularly used to develop fish populations in the Don & Dearne

To assist in the re-establishment of former indigenous species many further restockings were carried out between 1993 and 1996 both in this section and in the upper tidal reaches below Doncaster. Most of the stock used for these operations were obtained from the Agency's fish farm at Calverton and consisted principally of chub, dace and barbel.

Benefitting from water quality improvements upstream the lower River Don had by 1996 developed into an excellent coarse fishery in both the tidal and non tidal section. A fact which is clearly demonstrated by the massive increase in angler activity which has occurred since 1993.

Exponents of the sport now travel from all parts of Yorkshire, North Derbyshire and beyond to fish the river and their success rate has been exceptional by any standard. Roach catches in excess of 20 kg (44lb) were common in the summer of 1995 and on numerous occasions the more skilled exponents could easily achieve nets of fish of double that weight.

Perhaps the most startling example of the improving condition of the lower Don was the event detailed in the following announcement.

SALMON FROM DON
The reports author shown holding an 4.1kg (11lb) salmon found dead in the Don just downstream of Doncaster on 31 December 1995. Perhaps the most vivid demonstration of the river improvement.

NRA PRESS RELEASE - 3 JANUARY 1996

SALMON FOUND IN RIVER DON

A 3' 11lb salmon found in the River Don is further proof that water quality is continuing to improve according to the National Rivers Authority.

The dead salmon was found and reported to the NRA by Mr James Ions, a local resident, on New Years Eve, one mile below Doncaster town centre.

NRA Fisheries Officers who examined the salmon found that it was freshly dead and was showing visible signs that it had recently spawned or had attempted to. These signs indicate that the fish had survived in the river for a period of three or four months.

Chris Firth, NRA Fisheries Officer for Southern Yorkshire commenting on the find said: "This is the first time in 150 years that a salmon has been seen in this condition at this time of the year. It is a very significant occurrence and it is the best indication we have had so far that water quality is greatly improving in the Don."The fish had been migrating upstream but a sluice on the river had stopped it progressing any further.

THE CANAL NETWORK BELOW DONCASTER

The enormous potential of the South Yorkshire, Stainforth and Keadby and New Junction Canals as recreational fisheries had for many years remained a source of frustration to local angling interests before their active redevelopment commenced in 1981. In the lower reaches of the New Junction and more especially the Stainforth and Keadby, natural purification had allowed fish stocks to redevelop on several occasions during the course of the 20th Century. However, the continued existence of these populations had always been tenuous, relying on the Don to supply water absent of lethal concentrations of toxins. Invariably before 1981 this had failed to be the case and several large mortalities had occurred over the years.

By 1981, water analysis results were indicating that the Stainforth and Keadby and New Junction Canals close to their confluence with the South Yorkshire Navigation, had improved sufficiently for the re-introduction of fish. In response to this, local angling interests in co-operation with Yorkshire Water Authority Fisheries staff, transferred stock from a number of local still waters to the canals. The first of these introductions taking place at Stainforth in 1981.

ANGLING ON CANALS
The canal network below Doncaster is now an important match fishery hosting the 1997 First Division National Federation of Anglers National Championships. This is a good indication of the quality of the fishery that has developed. Here the Secretary of Doncaster Angling Association weighs in a 22.5kg (50lb) catch of roach.

Initially, redevelopment was slow with little evidence of successful reproduction from the introduced stock. Steadily this began to change and by 1987 several year classes of roach were regularly appearing in angler catches.

Further introductions of stock to enhance this development were carried out over the next few years and with water quality continually improving, populations continued to expand throughout the early 1990's. By 1995, the entire canal network from Doncaster downstream had established as a quality coarse fishery providing pleasure to hundreds of anglers. The popularity of the canal network can perhaps be best demonstrated by its inclusion in the list of waters regularly used by the National Federation of Anglers as National Championship venues.

RIVER WENT

In common with many of the other rivers and streams connected to the lower River Don, the Went was seriously affected by coal mining development during the late 19th and early 20th Centuries. The effects of this industrial activity and its associated urbanisation were felt throughout the system resulting in the almost total eradication of its fish populations. The Went remained in this condition until the 1970's then, as a result of some natural purification of the effluents it was receiving upstream, it became once again capable of supporting fish in its lower reaches.

Over a period of time, small numbers of fish which had been accidentally swept into the River Don from adjacent still waters found sanctuary in the lower Went and so began the redevelopment of the river's fish population.

By 1980 this population was beginning to show signs of becoming self sustaining. Roach, bream and perch, together with eels were the predominant species and steadily, as water quality continued to improve, the populations moved further and further upstream.

Above the village of Sykehouse the Went changes its character slightly. The very ponded conditions beginning to give way to faster flowing water. These conditions favoured riverine species such as chub and dace but regrettably the stocks of these species had been eliminated from the system by pollution, preventing any chance of natural redevelopment.

To address this problem, the Fisheries department of the Yorkshire Water Authority sought and eventually found a source of chub and dace to introduce as brood stock to the Went. The fish were found in the River Ouse at Cawood concentrated around the outfall from the Bishop Dyke. The operation to net them from the Ouse was a difficult one, but one which eventually proved successful.

In 1981 more than 2,000 young chub and dace were released into the Went downstream of the A19 road bridge near Askern. The fish quickly adapted to their new environment rapidly colonising both upstream and downstream sections. From this original stock has developed a self sustaining population which has helped transform the Went from a polluted and fishless environment into an excellent coarse fishery. It is also likely that the chub and dace found later in the Don around Doncaster originated from this source.

PART 2 - CHAPTER 3

THE REHABILITATION OF FISH POPULATIONS IN THE RIVER DEARNE

UPPER DEARNE, DENBY DALE TO BROOMHILL

During the 10 years preceding 1974, some progress had been made in tackling the Dearne's appalling water quality problems. In their Annual Report for 1960, the Yorkshire Ouse River Board stated that virtually all industrial effluent was still entering the river untreated. Waste from mining, paper making, brewing and textile manufacture combining to produce a lethal cocktail of pollution which was reducing the river to an open sewer.

By 1974, as a result of pressure from the River Board and Local Authorities, many of the industrial discharges were at last receiving some partial treatment. Although chemically the river remained in Class E (poor quality) and, in places, Class F (grossly polluted) small isolated pockets of fish had begun to appear. In this respect the Dearne had a slight advantage over the River Don which still remained essentially fishless in 1974. (See Chapter 5 for definition of classifications.)

Regrettably the impetus to maintain this advantage could not be sustained and a series of serious pollution incidents throughout the remainder of that decade and well into the 1980's consistently setback any progress which was being made in the further development of the fishery.

Like the Don, the Dearne had managed to retain some remnant indigenous fish populations in isolated pockets in some of the upper reaches of its tributaries. Most important of these was the Cawthorne Beck, which flowed down from its headwaters near Denby Dale to pass through the artificially created lakes at Cannon Hall. This beck still contained a stock of brown trout, which despite intermittent agricultural pollution problems, had managed to maintain itself in the relatively undisturbed habitat in the upper reaches of its course.

CANON HALL PARK FED BY CAWTHORNE DYKE
One of the few tributaries of the Dearne which managed to retain its original population of brown trout

Brown trout in the upper River Dearne itself had fared less well. Textile factories built to take advantage of the clean water in the upper part of the valley had extended upstream as far as Denby Dale, less than 2.5km (1 1/2miles) from the river's source. The untreated effluent from this development had long since eliminated fish populations downstream of their discharges but above the uppermost mill a small hardy population had managed to cling on. Regrettably these fish had limited opportunity to contribute to the future re-development of downstream populations as the mill owners had dammed the course when building the mills to conserve as much water as possible.

In 1974, despite some efforts to improve their effluent, the textile mills were still exercising a severe deleterious impact on the upper Dearne. Highly toxic mothproofing agents used in their processes, were still entering the river making conditions untenable to fish. Resolving this issue became a priority for Pollution staff of the Water Authority but despite their efforts it was not until 1979 that the effluent was finally re-directed to sewer for treatment. This was a major step forward but regrettably, it did not completely eliminate the problem. Land contaminated by years of spillage continued to leach mothproofing agents into the river and it was almost 10 years before attempts to re-establish brown trout in the river showed any measurable success.

The first signs that fry restocking work carried out by the Yorkshire Water Authority was succeeding were found during a fishery survey carried out in July 1988. Substantial numbers of yearling trout which had been released in April 1987 were found, with particularly large concentrations centred around the village of Scissett.

ELECTRO FISHING ON THE DEARNE
Electro fishing is the most regularly used method for monitoring fish populations. The operation involves the use of an electrode which temporarily stuns the fish, allowing them to be caught and examined before being returned to the river

Despite minor mortalities originating from isolated pollution incidents this population managed to maintain its hold assisted by further fry introductions.

Six years later, the first evidence of natural reproduction in the river began to emerge. In 1994 the first naturally bred brown trout for more than a century were found in a survey conducted between Denby Dale and Clayton West. This population continued to develop over the following two years and by 1996 the upper Dearne once again had a healthy self sustaining trout stock.

Below Clayton West the Dearne's physical characteristics begin to change, the fast shallow water suitable for trout begins to give way to deeper slower pools which originally supported mixed populations of both trout and various coarse fish species. It was around this point that in 1974 the effects of the textile mill discharges began to combine with those of mining and sewage pollution. From here the river's course took it through Barnsley where other forms of industry contributed their lethal load.

As mentioned earlier, some improvements to water quality had been achieved by 1974 as a result of partial treatment of industrial effluent. Modest as this improvement was, it had allowed fish to exist in the river.

This very localised population made up of fish which had dropped out of upstream still waters such as Cannon Hall and Bretton Lakes was concentrated below the Star Paper Mill Weir in Barnsley. It relied for its continued existence on the aerating effects of the weir which helped to maintain tolerable oxygen conditions.

STAR PAPER MILL WEIR
According to reports, small numbers of fish were present at this location in 1974

In flood events many of the fish were dislodged to continue their downward journey, but their loss was relatively quickly made up by further fall outs from the upstream still waters.

Not withstanding the fact that this was not a self sustaining population, it did act as a source of encouragement to the Pollution and Fisheries Staff of the newly formed Yorkshire Water Authority. It suggested that at least the middle section of the Dearne where it passed through Barnsley was slightly less polluted than comparable sections of the Don, despite the effects of several major sewage treatment facilities which discharged both above and below the town.

The first serious attempt at surveying the fish population of this middle section of the Dearne was undertaken in 1982. Only 2 sites were fished, at Stairfoot just below Barnsley and Broomhill near Darfield. This survey confirmed the presence of coarse fish at both locations although the population was limited, consisting only of gudgeon, minnow and the pollution tolerant 3 spined stickleback. Of most significance was the range of year classes of the former species which strongly suggested that its numbers were being maintained by natural reproduction in the river.

Further survey work in 1985 confirmed these findings and showed that the populations of both gudgeon and minnow had continued to grow. These results were further supported by the catch from a third survey site which had been added at Hoyle Mill in the centre of Barnsley. Here too, there was firm evidence of natural reproduction amongst these 2 species.

Tragically, between April 1987 and June 1988, this middle section of the Dearne was struck by a series of serious pollution incidents which resulted in the deaths of many thousands of fish. The effect of these incidents was quite clearly demonstrated in the results obtained in a fishery survey carried out in 1988. On this occasion a more extensive range of sites was fished, 8 of them on the middle section of the river. The picture which

DEAD FISH
Roach & bream float dead on the River Dearne near Bolton On Dearne following one of the many fish kills caused by a pollution incident in the early 1980's

emerged from this work was of a chronically damaged ecosystem with few, and in some areas, no fish present. It was clear that the conditions were not simply the result of the tragic effects of the incidents which had occurred during the previous 12 months but of chronic water quality problems associated with inadequately treated sewage and minewater.

The results of the 1988 survey were made doubly disappointing to Fisheries staff by the fact that during the preceding 3 years a major restocking programme had been carried out to assist what had appeared to be a recovering fishery. More than 10,000 mixed coarse fish had been released by YWA and angling interests in an attempt to assist in this development, yet in the 1988 survey few if any of the small numbers of fish caught could be traced to this restocking work.

Over the following 3 years the middle Dearne suffered yet more acute pollution incidents which were compounded by the chronic effects of poorly treated sewage. Heavily implicated in the incidence of these conditions were the 2 sewage treatment works serving Barnsley at Darton and Lundwood.

DARTON SEWAGE TREATMENT WORKS - CASE STUDY

For many years the final effluent from Darton Sewage Treatment Works was unsatisfactory. The problem mainly was the result of a strong industrial effluent received at the works from the premises of a local carpet manufacturer. The dye residues in the carpet effluent accounted for approximately 40% of the BOD load received at the works and were difficult to treat biologically. As a consequence, the final effluent from the works always had a deep red colouration.

Until the early 1980's the problems at Darton were mitigated by the pollution that the River Dearne was receiving from upstream sources. However, when remediation of these inputs was carried out, the true effects of the discharge from Darton became apparent. The works identified itself as one of the most serious polluters of the river, certainly in the Barnsley area.

In 1985 the YWA took the difficult decision to apply to the Department of the Environment for a relaxation of the discharge consent conditions for the works. Their objective was to allow the works to comply with a less stringent consent until improvements through further investment could be achieved. Their application was turned down by the DoE.

This left the Authority with little alternative but to seek ways of meeting the existing consent which they did in the following ways:

i) Pressure was brought to bear on the carpet manufacturers to improve their effluent before discharge to the foul sewer. This the company achieved by improving the provision of their own treatment facilities. Initially the company's objective was to produce an effluent which was of a quality suitable for release directly to the River Dearne, however this was never achieved and in 1996 their effluent was still being received at Darton works for final treatment;

ii) An improvement scheme at the works which included an improved inlet, new storm tanks, new primary tanks and refurbished and extended tertiary treatment lagoons.

This work, which was completed in 1992, has resulted in Darton STW meeting a discharge consent of 40 mg/l of suspended solids, 30 mg/l BOD and 15 mg/l of NH_3. The most obvious effect of the improvement scheme is the lack of any dye discolouration in the effluent.

The following table shows the performance of Darton STW between 1986-1995

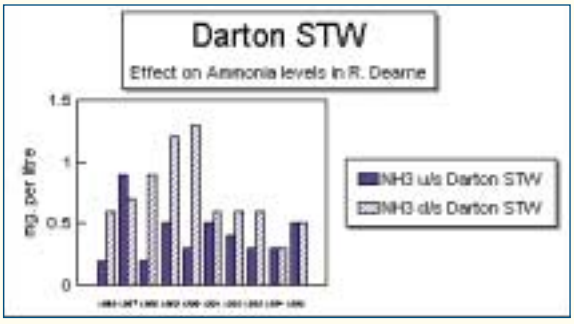
YEAR	MEAN BOD	MEAN SS	MEAN NH_3
1986	55.8	5.9	49.7
1987	103.0	6. 0	65.4
1988	83.5	9.5	59.4
1989	38.3	7.5	45.5
1990	54.4	9.5	49. 0
1991	53.5	11.9	73.3
1992	16.9	5.2	23.2
1993	11.4	3.3	13.8
1994	9.5	1.9	9.9
1995	5.4	2.5	8.5

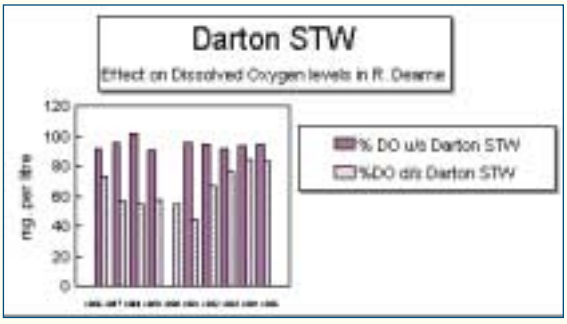
All the above analysis is in $mg.1^{-1}$

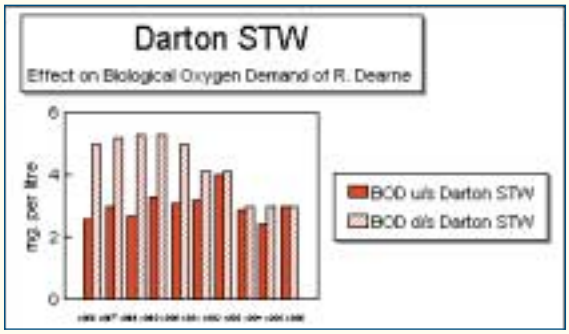
The following table shows the effect of Darton STW on the receiving watercourse:

YEAR	RIVER DEARNE U/S DARTON STW			RIVER DEARNE D/S DARTON STW		
	%DO	BOD	NH_3	%DO	BOD	NH_3
1986	92	2.6	0.2	73.5	5	0.6
1987	95.3	3	0.9	57.1	5.2	0.7
1988	101.5	2.7	0.2	54.5	5.3	0.9
1989	90.6	3.3	0.5	57.6	5.3	1.2
1990	----	3.1	0.3	54.2	5	1.3
1991	95.5	3.2	0.5	44.1	4.1	0.6
1992	94.4	4	0.4	66.6	4.1	0.6
1993	91.3	2.9	0.3	76	3	0.6
1994	93.5	2.4	0.3	84.8	3	0.3
1995	95.2	3	0.5	83.8	3	0.5

All the above values are annual means in $mg.1^{-1}$







The next fishery survey, carried out in 1991, confirmed that the middle section of the Dearne, through Barnsley, was suffering severe water quality problems. Few fish were found and in some cases, sites which had previously produced catches were fishless.

Surprisingly the most downstream site on this middle section of the river, at Broomhill near Wath, had markedly improved in terms of fish population. Gudgeon remained the predominant species in the catch, but on this occasion they were accompanied by several other types of coarse fish. This apparent improvement may have been the result of downstream displacement, as fish attempting to avoid the effects of Barnsley's pollution dropped down river.

The most recent survey of fish populations on the middle Dearne was carried out in September 1994. This operation at last revealed indications of a modest improvement in the general status of the fishery, although little evidence was found to suggest that it was becoming self sustaining. Major refurbishment of the sewage treatment plant at Darton was completed in late 1991 and the results of the improved effluent quality from this site were clearly demonstrated by the re-appearance of fish in significant numbers below the Star Paper Mill Weir in the centre of Barnsley, where they were first found in 1974.

In response to the improving condition of the Dearne between Darton and the centre of Barnsley (resulting from the work at Darton STW), Yorkshire Water PLC and the Environment Agency have carried out extensive restocking of this section of the river. The success of this work has yet to be fully evaluated by survey, but anecdotal information collected from anglers suggests that it has been successful and that once again a resident population exists.

Below Barnsley, however, the condition of the river has yet to show any significant signs of improvement. In terms of fish populations the situation remains unchanged from that of 1988 with no fish found in the 1994 survey at Cudworth. Clearly implicated in these unacceptable conditions is the sewage treatment works serving Barnsley at Lundwood. Here major investment is planned by Yorkshire Water PLC and work on refurbishing the works is scheduled to be completed by 1998. With these improvements in place, water quality in this section of the Dearne should markedly improve allowing the fishery to once again be re-established.

LUNDWOOD STW
The main sewage treatment works for Barnsley continues to have a serious detrimental effect on water quality. An improvement scheme which commenced in 1996 should result in a significant improvement in water quality in the Dearne downstream of the town

LUNDWOOD STW - CASE STUDY

As a result of improvements to the STW at Darton (described earlier) significant improvements have occurred in chemical river quality which has enabled the redevelopment of a coarse fish population. This population extends down to the discharge from Lundwood STW. Below this point the river deteriorates significantly as a result of poor quality effluent from the works. There are two principle reasons for this:

a) The works was not constructed to meet the needs of an increasing population and as the amount of effluent received at the works increased over the years, its effluent quality deteriorated.

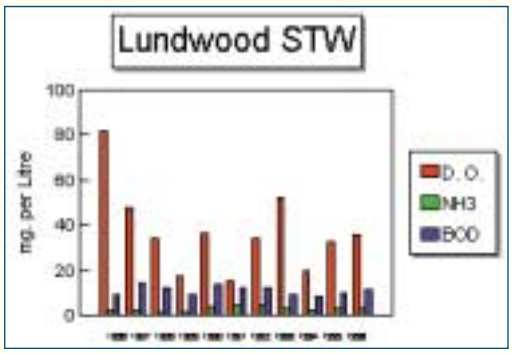
b) There has been a significant deleterious effect caused by mining activity which has affected the outfall stream from the works. The Cliffe Bridge Dyke, which acts as the conduit conveying the effluent 400m to its discharge point into the Dearne has settled as a result of subsidence, which causes ponding. This can result in the effluent becoming septic before it reaches the main river.

Below the works fish populations are almost totally absent until the river reaches Darfield. From this point natural purification allows a steady improvement to occur and various species of coarse fish begin to reappear. In January 1997 contracts were awarded by Yorkshire Water PLC for major capital works to begin at Lundwood as agreed with the Environment Agency. On completion these improvements will allow the River Dearne to achieve its water quality objectives which will allow the redevelopment of the fishery below the discharge from the works. The improvement scheme is scheduled for completion by the end of 1998.

The tables below show the unacceptable levels of ammonia, BOD and dissolved oxygen in the river below Lundwood STW.

YEAR	%DO	NH_3	BOD
1986	81.76	2.52	8.81
1987	47.87	2.19	14.56
1988	33.9	1.2	12.25
1989	17.08	1.58	9.3
1990	36.25	3.7	13.7
1991	15.09	4.44	12.03
1992	34.34	4.47	11.78
1993	52.32	3.2	9.4
1994	19.44	2.1	8.28
1995	32.78	3.02	10.06
1996	35.36	3.14	11.21

All the above analys is in mg.1-



LOWER DEARNE, BROOMHILL TO THE DON CONFLUENCE

The redevelopment of the fishery on the lower Dearne was initially consistent with that of the middle reaches of the river. Fluctuating general water quality combined with a series of acute pollution incidents served to frequently reduce the populations which had developed either as a result of fall out from adjacent still waters or, as in the case of gudgeon, from natural reproduction in the river.

When first surveyed in 1981 the site at Pastures Road, Denaby, approximately 1 kilometre (1/2 mile) above the confluence with the Don, produced a surprising variety of fish. Species present included pike, gudgeon, tench, roach, perch, eels and chub. Evidence suggested that the majority of the fish present owed their origin to connected still waters and the concentrations at this point indicated that their transient downstream movement had been temporarily halted as they neared the more hostile chemical conditions of the River Don.

Of some significance was the capture of one chub. This species was common in the Don system before the river's fish populations were destroyed by the effects of the industrial development of the area. Being a riverine species, it's presence could not be accounted for in the same way as other coarse fish and, as far as was known, no populations had survived in the Don system. Although the origin of this fish remains a mystery, it could have been one of the first examples of illegal stock transfer to the Dearne by local anglers. (Under Section 30 of the Salmon & Freshwater Fisheries Act 1975 consent is required from the Agency to introduce fish into inland waters.)

CHUB
Once common in the Don, populations of this species were believed to be totally eliminated until they were reintroduced in the late 1980's

Between 1983 and 1988 considerable time, effort and expense was committed by the YWA Fisheries department and local angling interests to the redevelopment of fish stocks in the lower Dearne. In excess of 12,000 fish were released at points between Bolton-on-Dearne and Denaby comprising of a range of species. Included in the later introductions were 100 chub measuring between 8 and 15 centimetres (3-6in) which were the product of an experimental fish breeding unit set up by the Yorkshire Water Authority at Aldwarke, near Rotherham.

Despite considerable angler activity, little evidence of the benefits of this work emerged over the following 3 years, particularly in the higher reaches of the section. This was consistent with conditions in the middle river and was without doubt due largely to the effects of intermittent acute pollution problems.

Gradually signs of improvement began to emerge. Angler catch rates slowly increased and this evidence was confirmed by the 1991 fishery survey results which showed low levels of natural recruitment at Denaby. It was clear from this information that the fishery was not yet self sustaining but some modest improvements in water quality were being achieved which pointed to the river achieving this status if acute pollution incidents could be avoided.

Throughout the following 3 years the steady improvement was maintained and anecdotal and visual evidence emerged of a rapidly developing fishery. The small improvements in general water quality which were being achieved, coupled with a dramatic reduction in acute pollution incidents was at last beginning to show benefits.

The most recent fishery survey to be carried out on the lower River Dearne was completed in 1994. This operation confirmed the improvements in overall fish populations in the lower river and clearly identified the emergence of a self sustaining population of coarse fish. Included in the catch at Denaby were significant numbers of chub and dace, some of which clearly owed their origin to reproduction in the river.

By 1996 the lower River Dearne had become established as one of the most popular local angling venues and catches reported by exponents of the sport were clear testimony to the improvements which had been achieved.

HABITAT RESTORATION SCHEME ON THE RIVER DEARNE AT DENABY - CASE STUDY

The site chosen for improvement at Pastures Road, Denaby had been the subject of massive rechannelling work in the 1960's. This work was necessary to address the problems of subsidence which had resulted in the natural bed of the river sinking, thereby causing flooding of surrounding farmland. Regrettably, because of its chemical condition, the future ecological potential of the Dearne was not considered when the new channel was designed, resulting in a straight trapezoidal section being created. Whilst this channel was able to support a fish population as water quality improved, it provided a hostile environment to juvenile fish which could easily be swept away in flood conditions. In addition it provided little opportunity for certain species of riverine coarse fish such as dace and barbel to reproduce successfully as its ponded condition allowed large deposits of sediment to accumulate on the river bed coating any suitable areas of gravel.

PASTURES ROAD - BEFORE AND AFTER
In an attempt to recreate some of the features originally present and to provide improved spawning conditions a section of this channel was re-engineered in 1995 to create a series of bends. The full benefits of this work are unlikely to be realised for several years as they require the river's natural influences to scour and deposit bed material in a way which provides the deep pools and shallow gravel riffles so important for the maintenance of fish populations. The scheme is, however, a good example of the work which needs to be carried out on many physically degraded sections of the Don and it's tributaries.

PART 2 - CHAPTER 4

THE REHABILITATION OF FISH POPULATIONS IN THE RIVER ROTHER

Of all of the rivers in the Don Catchment in 1974, the Rother was probably the most grossly polluted. The conditions were principally the result of coal mining and its associated processes and it was a sad irony that some of worst excesses had come about as a result of mans desire to improve his environment.

The clean air campaign of the 1960's sought to reduce the levels of air pollution which frequently caused dense smogs to blanket parts of urban Britain. The problem mainly stemmed from the use of coal as a household heating fuel and in an attempt to control the nuisance, legislation was introduced to restrict its use.

To provide for the sudden massive demand for alternative smokeless fuels, coal carbonisation plants proliferated in the Rother Valley such that the valley quickly became one of the largest concentration of such industries in the world. Unfortunately the process of removing the offending chemicals resulted in an extremely toxic by product in the form of liquors rich in ammonia which proved extremely difficult to dispose of. One commonly used method was to pour the liquor on to the tops of colliery spoil heaps. This process allowed a certain amount of natural purification to occur as the liquor percolated down towards the base of the heap. Inevitably many of the spoil heaps became saturated and leachate from them slowly began to find its way into the Rother and several of its tributaries.

LEACHATE
Highly polluting leachate drained into many water courses on the Don system as a result of spoil heap effluent disposal and poor site management

RIVER HIPPER
Grayling were reported to be still present in this tributary of the Rother in the 1970's but fishery surveys failed to confirm this

This legacy of land contamination was to prove one of the most difficult problems to overcome as efforts to restore water quality and to re-establish fish populations continued over the following 20 years (see Appendix V, Case Study - Orgreave Reclamation).

In common with the Don & Dearne, the Rother's original fish populations had not entirely been eliminated by the valleys industrial development. Several small tributaries most notably the River Hipper and Barlow Brook had at least partly escaped the destruction.

Running down from their sources in the Derbyshire Peak District these two streams remained in very much their original condition in 1974. Both still contained indigenous populations of brown trout and in the case of the Hipper, anecdotal evidence suggested that the final remnants of the Don systems grayling population still existed. (This has never been confirmed in fishery surveys). There were also small numbers of coarse fish present in the Hipper, just above its confluence with the Rother in Chesterfield. Examinations carried out on samples of these fish clearly showed that they owed their origin to upstream still waters connected to the river by overflows. Never the less they did represent a potential source of stock for the Rother if water quality improvements could be achieved in the future.

One other tributary, the River Doe Lea, a stream later to become synonymous with gross pollution, was in position to assist with this form of re-development. It held a small remnant population of brown trout in its upper reaches around Stainsby and frequently coarse fish were present which had dropped out of the lakes at Hardwick Hall. Unlike the Hipper however, the Doe Lea was subjected to its own direct sources of pollution, particularly around the town of Bolsover and even today these sources continue to restrict downward movement of fish towards the main river.

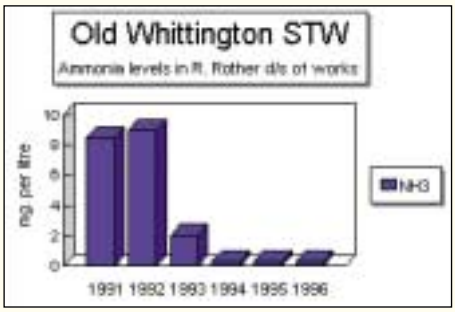
Despite the grossly polluted condition of the Rother in 1985 Yorkshire Water Fisheries staff commenced a 3 yearly rolling programme of fish surveys in an attempt to confirm the absence of fish in the river. The first of the surveys surprisingly revealed the presence of a small number of 3 spined sticklebacks. Whilst this at first appeared to be an encouraging sign, enthusiasm was soon tempered by the realisation that the fish were closely confined around an input of clean water entering from a small land drain. Clearly the permanency of this population was extremely tenuous, relying for its existence on wet weather maintaining flow from the drain, a fact that was confirmed by their absence when a further survey was carried out 3 years later.

It was not until 1989 following pressure from the newly formed National Rivers Authority that determined attempts were made to address some of the most serious sources of pollution. Several major schemes were announced that year which were to herald profound improvements to water quality in the Rother.

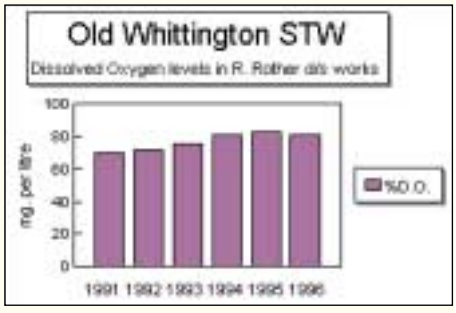
The plants concerned, Rhone Poulenc Chemicals at Staveley, Coalite Chemicals at Bolsover and Yorkshire Water PLC's Old Whittington Sewage Treatment Plant at Chesterfield, had for many years been recognised as significant contributors to the seriously polluted state of the river and improvements to their effluent was regarded as crucial to the rivers future redevelopment as a fishery.

OLD WHITTINGTON STW - CASE STUDY

Old Whittington STW treats the sewage from Chesterfield. It is located to the North of the town and discharges into the River Rother. Originally built in 1926 it utilised the revolutionary Sheffield system of sewage treatment which is described in the case study on Blackburn Meadows STW. This system served for approximately 60 years. The works were extended in late 1980's and further improvement works were carried out in 1993. This latter scheme involved the transfer from the Sheffield aeration system to a modern process incorporating surface aeration, anoxic zones and nitrification. This resulted in a general improvement in downstream water quality as demonstrated in the following chart.

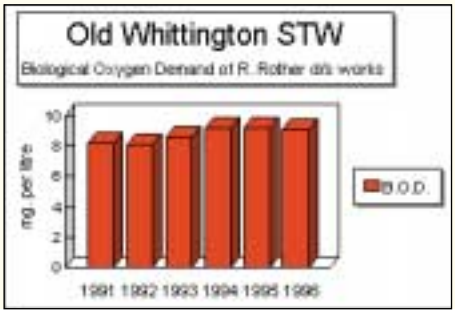


Partly due to the improvements at Old Whittington, the River Rother is now able to support a coarse fishery downstream of the Chesterfield conurbation the first time in almost 100 years!



YEAR	%DO	BOD	NH_3
1991	69.9	8.2	8.5
1992	71.7	8.1	9
1993	75.1	8.6	2
1994	81	9.2	0.3
1995	82.8	9.2	0.3
1996	81.2	9.1	0.3

The above results are annual means for the River Rother at Cow lane. The limits for BOD & NH_3 are in $mg.l^{-1}$.
The values for %D.O. are absolute.



The potential benefits of the huge investments made by the above companies was given a further boost in 1991 when it was announced that the Orgreave Coal & Coking Plant was to close. Whilst this was a blow to the employment prospects of many people, ending almost 150 years of coal related industrial activity at the site it helped eliminate yet another source of chronic pollution.

The effects of these positive developments were carefully monitored by Pollution Staff throughout the early 1990's and by the summer of 1993 it was clear that significant improvements had been achieved. Ammonia and BOD had fallen sharply and dissolved oxygen levels had risen to levels which were clearly capable of supporting fish life once again.

However, it was recognised that this was only part of the story and that despite the improving trend, the Rother was still an unstable and potentially hostile environment. For years the river had been used as a repository for every kind of offensive waste and it was necessary to educate both industry and the public about their role in protecting and sustaining the improvements. Clearly the best way of achieving this was to re-introduce fish but there were grave concerns above the ability of the river to provide food to sustain them.

To confirm that it could, a site at Rother Valley Country Park was chosen for a biological survey to be carried out. The results of this operation were not encouraging. Only 7 types of pollution tolerant invertebrate were recorded with the populations of all at a low level.

It was recognised however that this poor result was not just the effect of chemical water quality, physical habitat factors were also contributing. The channel at this point was extremely uniform having been artificially created during the restoration of land following opencast coal extraction. It had few natural features and its bed was heavily coated with deposited silts, some of dubious origin.

In an attempt to address these limitations a small physical habitat restoration scheme was designed by Fisheries Staff. The scheme involved the construction of a lump stone weir with a bay dug out of the right hand bank some 100 metres (109yds) above. (see illustrations below) The purpose of the weir was to increase flow velocities in the channel which would scour away accumulated silt and leave a clean gravel bed. In addition it assisted in maintaining dissolved oxygen levels by means of natural re-aeration. The bay on the other hand was designed to provide a sanctuary areas into which fish could escape during flood conditions or when slugs of pollution were passing down the main channel.

WEIR & BAY ON RIVER ROTHER LOOKING DOWNSTREAM
These improvements were carried out to assist in the rehabilitation of the fishery on the river at Rother Valley Country Park

RESULTS OF BIOLOGICAL SURVEYS CARRIED OUT AT ROTHER VALLEY COUNTRY PARK IN FEBRUARY 1994 & SEPTEMBER 1995

Taxa		**Abundance**		
	(site 1 = below new weir) (site 2 = above new weir)	Site 1 Feb '94	Site 1 Sept '95	Site 2 Sept '95
Roundworms	-Nematoda	0	0	1
Snails	-Hydrobiidae	2	117	756
	-Lymnaeidae	0	60	28
	-Planorbiidae	0	2	0
	-Ancyliidae	0	0	8
Bivalves	-Sphaeriidae	1	206	27
Worms	-Oligochaeta	224	930	1
Leeches	-Glossiphoniidae	0	4	8
	-Erpobdellidae	0	5	19
Water Mites	-Hydracarina	1	1	5
Crustaceans	-Asellidae	185	3	1023
	-Gammaridae	0	1	145
Mayflies	-Baetidae	0	4	470
Damselfly Larvae	-Coenagriidae	0	9	0
Bugs	-Corixidae	0	5	0
Caddis Fly Larvae	-Hydropsychidae	0	0	2
	-Hydroptilidae	0	0	11
Black Fly Larvae	-Simuliidae	12	0	7
Non-biting Midge Larvae	-Chironomidae	82	424	242
Other Fly Larvae	-Empididae	0	0	2
	-Muscidae	0	0	29
BMWP Score		17	45	53
No Scoring Taxa		6	13	14
ASPT		2.83	3.46	3.78

On completion of these works a decision was made to carry out a trial restocking. As a gesture the 3 companies who had invested in improving their effluents, Yorkshire Water PLC, Rhone Poulenc and Coalite Chemicals were invited to contribute towards the cost of purchasing the fish from the National Rivers Authority's fish farm at Calverton. They agreed and at the beginning of April 1994 a consignment of fish consisting of 2,500 roach and 2,500 chub were delivered to the river. Half of the batch were released at the aforementioned site at Rother Valley and the remainder at a site at Hall Road Staveley.

Throughout the following summer visual monitoring confirmed the survival of the fish and in October 1994 a fishery survey was carried out. Recapture rates during this operation were low but the general condition of the fish was good and their growth rates confirmed that they had found an adequate food supply.

FISH STOCKING ON THE RIVER
The first introduction to the River Rother at Rother Valley Country Park took place in April 1994. The first fish to swim in the Rother for almost a century.

Over the winter of 1994/95 NRA Fisheries staff carried out further restocking work involving the introduction of a further 40,000 fish. Speculative angling by a number of individuals had revealed that significant numbers of fish from the original release had colonised sections well downstream from Rother Valley and this evidence was used as justification for such a large introduction. More than 85% of the fish stocked originated from routine management operations on still waters carried out by the NRA and it was recognised that the retention rates of these fish was likely to be low. However it was also recognised that fish which eventually drifted out of the Rother would assist in the development of stocks in the River Don. The other 15% of the stock introduced consisting principally of chub, dace and

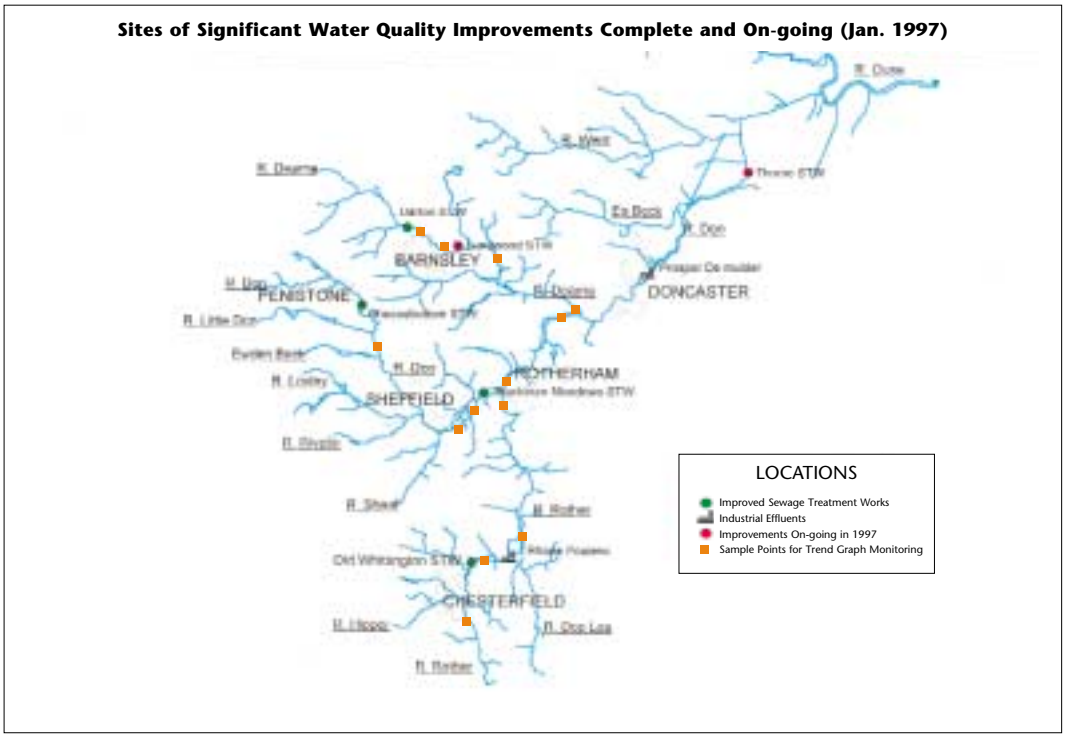
barbel were flow entrained stock from Calverton Fish Farm, and it was these fish that were to form the nucleus of the developing population.

In September 1995 the river was again surveyed, this time including several new sites. The results were extremely encouraging revealing populations established at all but one location. Growth rates of fish, particularly barbel were unusually fast, providing yet another indication of the improving chemical and biological condition of the river. As if to confirm these improvements the survey also produced a number of brown trout. This species is highly intolerant of organic pollution and requires higher dissolved oxygen levels than coarse fish for its survival. The trout were believed to have originated from either the River Hipper or possibly Barlow Brook.

SURVEY RESULTS
Fish caught from the Rother at Woodhouse Mill during a fish population survey. The fish were weighed, measured and returned to the river

Throughout 1996 work continued to establish and monitor fish populations in the Rother. In April of 1996 the first batch of chub and dace were introduced at Old Whittington, extending fish stocking upstream as far as the outskirts of Chesterfield. In addition, angling rights were leased from the Environment Agency at Renishaw and Catcliffe and organised angling recommenced for the first time in almost a century. Also appearing was the first evidence of natural reproduction in the river with the capture in surveys of roach and gudgeon fry. This discovery gave great encouragement to Environment Agency Fisheries staff as it represented the first evidence that the River Rother was once again becoming a self sustaining fishery after more than a century of neglect, abuse and exploitation.

Sites of Significant Water Quality Improvements Complete and On-going (Jan. 1997)



PART 2 - CHAPTER 5

AN OVERVIEW OF WATER QUALITY IN THE RIVER DON CATCHMENT 1974-1996

RIVER DON AT SHEFFIELD
Pollution can be seen pouring into the river from a factory in 1974

The same location in 1996 showing part of the Five Weirs Walk.

The River Don is split into four sub catchments for river quality management. They are upper Don, lower Don, Dearne and Rother. Each sub catchment has had its own unique water quality problems in this period, but the problems of sewage treatment and sewerage are common to all of them. Increasing population has meant that new sewage works and sewers have had to be built and existing ones upgraded to treat the increasing flows to a suitable standard. This has allowed for transfer of smaller unsatisfactory works flows and the opportunity to impose stricter consent conditions and also the addition of ammonia standards. Over time with this investment and rationalisation there has been a steady decrease in pollution from sewage sources creating a reduction in levels of ammonia and biochemical oxygen demand. This has allowed the rivers to improve in chemical and biological quality.

Industrial pollution during this period principly came from steel, mining, coal carbonisation, chemical, textiles. Other pollution sources effecting water quality in the catchment are abandoned minewaters, contaminated land and agriculture.

TABLE OF CLASSIFICATION FOR BIOLOGICAL GRADING OF WATERCOURSES

Grade A - Very Good	The biology is similar/better than that expected for an average & unpolluted river of this Size/Type/Location
Grade B - Good	The biology shows minor differences from Grade A & falls a little short of that expected for an unpolluted river of this S/T/L
Grade C - Fairly Good	The biology is that expected for an unpolluted river of this S/T/L. Grade C is the target aimed for by the EA
Grade D - Fair	The biology shows big differences from that expected for an unpolluted river of this S/T/L
Grade E - Poor	The biology is restricted to animals that tolerate pollution, sensitive species will be rare or absent
Grade F - Bad	The biology is limited to a small number of very tolerant families, often only worms, midge larvae, leeches & water hoglouse. In the very worst case, there maybe no life present in the river

TABLE OF CLASSIFICATION FOR CHEMICAL GRADING OF WATERCOURSES

	DO % saturation	BOD (mg/l)	NH3 (mg/l)
Grade A - Good	80	02.5	0.25
Grade B	70	04.0	0.60
Grade C - Fair	60	06.0	1.3
Grade D	50	08.0	2.5
Grade E - Poor	20	15.0	9.0
Grade F - Bad	0	0	0

For dissolved oxygen the figure must not drop below the stated saturation for more than 10% of a 36 month period.

For biochemical oxygen demand and ammonia the figure must not rise above the stated saturation for more than 10% of a 36 month period.

FACTORS AFFECTING WATER QUALITY IN THE UPPER DON CATCHMENT

Running down from its source in the high Pennine moorland above Dunford Bridge the upper Don is mainly rural until it reaches the outskirts of Sheffield. Here the associated industries in 1974 were mainly steel manufacture and its fabrication but the most serious source of pollution were from the sewerage network of the city. In 1974 the River Don throughout this section was mostly poor quality (Class E) and grossly polluted in stretches (Class F).

SEWAGE TREATMENT (see glossary for definition)

In 1974 there were 23 sewage treatment works in this catchment, 6 of which the Yorkshire Water Authority classed as producing an unsatisfactory effluent at the time. There are presently 13 sewage treatment works, with all 6 of the unsatisfactory sewage works now gone, their flows diverted to larger and more modern treatment plants. The main sewage works in the catchment and hence the ones whose effluent quality has the greatest effect on water quality are Cheesebottom, Blackburn Meadows and Aldwarke.

Cheesebottom STW

This works, constructed in 1978, replaced 5 smaller ones serving the Penistone area. All were classed as unsatisfactory in 1974 and produced poor quality effluents. The new works has allowed the upper Don around Deepcar to improve and the trend graphs for ammonia and BOD show a decline in this period.

Blackburn Meadows STW

This is the largest sewage works in the whole of the Don catchment, serving most of Sheffield with a dry weather flow of 145,000 cubic metres per day (TCMD) (32 million gallons per day) in 1976 rising to 368 TCMD (81 million gallons per day) in 1991. Construction of a new plant at Blackburn Meadows began in 1991 and was completed in 1994 with the works then able to nitrify its effluent (ie remove toxic ammonia). This nitrified effluent has led to a huge improvement in the River Don downstream of the discharge, this can be seen in the steep decline in ammonia on the trend graphs.

Don Valley Interceptor Sewer

Construction began in 1979 and completion of Phase 5A was achieved in 1993. It consists of a new sewer at a depth of about 20 metres (22yds), this being below the level of the existing sewers whose flows it intercepts and transfers to Blackburn Meadows STW. A total of 26 inadequate overflows serving the inner and central areas of Sheffield have been abandoned as a result and there has been an approximate 50% reduction in pollution load to the River Don. The construction of the Don Valley Interceptor sewer has resulted in an improvement in water quality, by stopping the premature operation of historical storm sewage overflows in dry weather in the Sheffield area.

Aldwarke STW

Aldwarke is the primary sewage works serving the Rotherham area. Rebuilt in the late 1980's, it accommodates the flows from 4 surrounding smaller works and enables nitrification to be achieved.

INDUSTRY

Steel

The Sheffield area was and still is heavily industrialised, with the main concerns being steel manufacture and fabrication. The decline in this industry has lead to a reduction in the solids and metals load discharged to the river from various process waters, such as cooling waters and scrubbing liquors. A lot of oil is used in this industry for quenching and heating and spillages and leakages have given rise to contamination of surface water with many pollution incidents occuring during the last 30 years.

Jamont Paper Mill

This mill, formerly British Tissues, manufactures paper in the upper Don catchment at Oughtibridge. The waste produced is treated by an activated sludge (biological) treatment plant built in 1985, and has consistently produced a good quality effluent.

FACTORS AFFECTING WATER QUALITY IN THE LOWER DON CATCHMENT

In the Lower Don water quality was heavily influenced by activities in the catchments upstream and the poor quality discharges in the area will have been to some extent masked. The main water quality improvements in this period have come about due to improvements upstream in the upper river which have had a knock on effect in this catchment, eg the ability of Blackburn Meadows to nitrify its effluent has had the greatest effect on the lower Don. In 1974 the river in this area was of a poor quality (class E).

SEWAGE & SEWERAGE

There are 20 sewage works in the catchment with the major sewage works being at Sandall, Thorne and South Elmsall.

Sandall STW

This is the major sewage works in the lower Don serving most of the area of Doncaster. The works had investment in 1974 to add activated sludge to the existing filter works. On completion the works became totally activated sludge treatment, but does not nitrify.

Thorne STW

This works serves the Thorne area and in recent years Stainforth sewage has been diverted to it. The works provides only primary treatment and has a detrimental effect on water quality. Improvements to Thorne will be carried out in the near future.

South Elmsall STW

This works serves the area of Frickley, Elmsall and Hemsworth. It was upgraded in 1992 to receive Hemsworth's sewage and to improve water quality to achieve class D downstream. The works discharges to the River Eabeck.

INDUSTRY

The catchment contained extensive coal mining and with it the corresponding problems already discussed in the Dearne catchment. Other industry is mostly centred around Doncaster and is not specific in nature. Two firms which have invested in improving their effluent treatment in the last 5 years are Prosper De Mulder and John Carr's.

Prosper De Mulder are animal food manufacturers (from animal carcasses etc). The waste from their processes is highly polluting and was originally discharged with little treatment. Considerable investment was carried out by the firm on biological and physical treatment and they now consistently achieve a good nitrified effluent.

John Carr's, a joinery firm, have polluted the land they work on with wood preservatives over this period. The wood preservative contains a number of Toxic Red List substances which should not be allowed into controlled waters. They now intercept the groundwater and surface drainage through an activated carbon plant which absorbs the toxic material.

FACTORS AFFECTING WATER QUALITY IN THE DEARNE CATCHMENT

This catchment was effected by agriculture and textiles in its upper reaches before it reached the urban area around Barnsley, where the river became grossly effected by the mining industry and sewage treatment. The river is then effected by these sources all the way to its confluence with the River Don.

In 1974 the river was of poor quality (class E) and grossly polluted (class F) in places.

SEWAGE TREATMENT

The catchment had 55 sewage works discharging to it in 1974, 15 of which were classed as unsatisfactory at the time. Today there are 39 sewage works. The major sites at Darton and Lundwood serve the area of Barnsley, and Clayton West in the upper reaches serves the villages of Denby Dale, Scissett and Clayton West itself.

Darton STW

This works receives approximately 1/3 of Barnsley's sewage. It produced a poor effluent prior to it being rebuilt in 1991, causing the river downstream to be in the poorest class, class F. Since 1991, the works has produced a good quality effluent, enabling the river to improve in quality, by one class. All the trend graphs show an improvement in the river downstream at Star Paper Mill, with increases in DO and declining BOD and ammonia.

Clayton West STW

The works serves the mill towns in the upper reaches of the catchment. The works was rebuilt in the mid 1980's to treat sewage from outlying villages. There is little dilution for it's effluent and, up until its renewal, had a deleterious effect on the river. The works now produces a good quality effluent.

Lundwood STW

The major works in the catchment serving approximately 2/3 of Barnsley. The works does not produce a good effluent and causes dissolved oxygen deficiencies in the river downstream. The site has been affected by mining subsidence, reducing the efficiencies of the settlement tanks, but work is being carried to rectify this problem. Further programmed investment by YW PLC will ensure that class D can be achieved in the river downstream by 1998.

INDUSTRY

Mining

The catchment runs through a heavily mined area which made up the Barnsley coalfield. In 1974 there were 26 collieries and 57 discharges of minewater from collieries and pumping stations. Minewater is pumped from underground workings to prevent flooding and allow coal to be extracted. This water can be high in ochre/iron hydroxide due to dissolution from the pyrites (iron sulphide) associated with the coal measures. Minewaters can also have a low pH. which causes deposition of ochre on the river bed.

Ochre causes damage:-

- by reducing the diversity and quantity of biology

- reducing the extent of fish spawning grounds

- being directly toxic to fish

- rendering watercourses unfit for abstraction, recreation

- spoiling aesthetic appearance.

As can be seen from the trend graphs at the end of this chapter, the amount of iron present in the river has decreased dramatically over the years due to pit closures and minewater treatment plants being constructed in the catchment to reduce this type of pollution, ie North Gawber, Wharncliffe, Silkstone. There are other forms of pollution caused by the mining industry. Surface drainage from pit yards, coalstocking grounds etc, cause large solids loadings to the watercourse and deposition on the bed smothering plant and invertebrate life.

In 1995 there remained just one colliery in the catchment, a private mine in the upper reaches of the Dearne. Minewater is actively pumped at the old Woolley Colliery site by the Coal Authority to prevent uncontrolled minewater outbreaks. This discharge did have a detrimental effect on the river when pumping commenced in 1994, but investment in new lagoons, filters and a large reedbed/wetland has since removed ochre and significantly improved water quality.

Textiles

In 1974, 5 mills in the upper Dearne discharged to river. The main pollution problems associated with this industry were waste dyes and washing effluents. Treatment at the time included land and spoil heap irrigation, but these were not wholly successful. There are now no discharges to the river from any of these mills, they either discharge direct to foul sewer or the mills have shutdown. The Upper Dearne currently has high levels of a mothproofing agent from an unknown source, that has not been in commercial use for some years, the pollution may be due to historical practices of land treatment.

Coal Carbonisation

In 1974 there were 4 coking plants in the catchment. The spent liquor from coal carbonisation is highly polluting and all of the works would have contributed to poor water quality in the vicinity. The liquors were treated by activated sludge treatment plants and irrigation onto spoil heaps. Only one coking works is still active in the catchment at Monkton which discharges direct to foul sewer, with an overflow to watercourse in storm conditions. At Grimethorpe the liquor was irrigated over a spoil heap, although the site is now derelict there is still a discharge to the Dearne of tip leachate which is high in ammonia.

FACTORS AFFECTING WATER QUALITY IN THE ROTHER CATCHMENT

The Rother catchment, mainly an industrial area, runs through the urban areas of Rotherham and Chesterfield. In 1974 the river was grossly polluted, being class F along most of its length. The main pollution stemmed from coal carbonisation, sewage treatment and chemical manufacture.

SEWAGE TREATMENT

In 1974, 48 sewage works served the catchment, 11 of which were classed as unsatisfactory at the time. Many of the smaller works including the unsatisfactory ones have since been closed leaving the total number of STW in the catchment at 29. The main treatment facilities in 1996 are Old Whittington, Staveley, and Woodhouse Mill.

Old Whittington STW

The major works serving Chesterfield was improved in the late 1980's and in 1993 and now operates under stricter consent conditions and achieves nitrification. Apart from the Coal carbonisation industry, the works and its improvement was the biggest single factor affecting the River Rother in thisperiod. The trend graph for the river downstream at Cow Lane, shows a dramatic decline in ammonia since 1993.

Staveley STW

A new works was constructed in 1993 and operates under stricter consent conditions and achieves nitrification. The river downstream at Renishaw shows an improvement in ammonia since 1993, on the trend graphs.

Woodhouse Mill STW

This works, commissioned in 1979, replaced a number of smaller sewage works that had been producing poor effluents in the South East Sheffield area. The works was designed to enable the River Rother downstream to achieve class D.

INDUSTRY

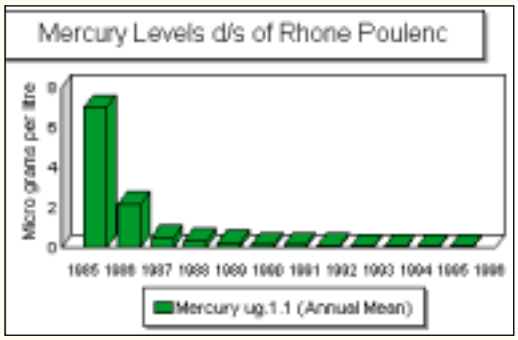
Chemicals

The chemical industry has grown alongside the coking industry. The main chemical plants being Staveley Chemicals (Rhone Poulenc), and Coalite Chemicals. The discharges from Staveley Chemicals came from the treatment plants. The polluting material tended to be mercury and ammonia. A mercury removal plant has been built and the levels of Toxic Red List substances reduced from about 23kg (51lb) per year in 1987 to virtually zero in 1995 to comply with EC Directives.

RHONE POULENC CHEMICALS - CASE STUDY

One of the major pollutants affecting water quality in the River Rother during the 1980's and early 1990's was the List 1 metal mercury. This form of pollution is highly toxic to fish and at levels of less then 1mlg/ltr can be lethal.

One of the principal sources of this contaminant was found to be the Staveley Chemicals site (now Rhone Poulenc Chemicals) at Staveley. The company operates a Chloralkali plant where they electrolyse brine to produce chlorine and sodium hydroxide. The contamination came from the process which uses a floating mercury electrode.



In the early 1980's the European Community issued two directives relating to discharges of mercury into the water environment setting limit values and quality objectives. Using the directive the EA's predecessor, the YWA made representations to Staveley Chemicals Ltd which eventually resulted in the company installing a total mercury recovery plant. This plant removes the mercury from waste water by absorbing it onto a resin and then binding it chemically into a solid form. The graph above demonstrates the effectiveness of the process by showing the reduction of mercury levels in the River Rother downstream of the Rhone Poulenc Chemicals before and after the plant was installed.

Chlorinated compounds are manufactured at Coalite Chemicals from the distillation of coking liquors. The wastes from the manufacture are dealt with in conjunction with the coking liquors at the adjacent coking works.

Coal Carbonisation

There were 4 coking plants in the catchment - Orgreave, Brookhouse, Avenue and Coalite which significantly affected water quality.

POLLUTING DISCHARGE
A typical discharge from a coking plant during the early 1980's

Until its closure in 1991, Orgreave coking works treated its coking liquors by activated sludge with discharge to the River Rother. The impact of this discharge was to significantly increase the BOD and ammonia loads to the river, in 1985 the 95%ile BOD and ammonia concentrations were 138mg/l and 146mg/l respectively. The high BOD levels were not the major problem because of adequate dilution but the ammonia levels would have had to be reduced by about 100mg/l to allow the river to achieve class D. From the trend graphs it can be seen that the River Rother downstream at Canklow has improved dramatically with respect to ammonia since the plants closure in 1991.

Avenue coking works closed in 1992. There were 2 discharges from the site, one of general works drainage and the other of lagoon effluent. Both discharges increased the BOD and ammonia loads to the river. The treatment of coking liquors at the Grassmoor lagoons consisted of aeration before discharge to Spittal/Grassmoor Brook. This discharge was highly polluting and eventually the effluent was diverted to foul sewer in 1986 to be treated at Old Whittington sewage works. There are still problems associated with the lagoons of phenolic oils leaching into the Rother.

Coalite coking works is still in operation. The liquors and general site drainage are treated together by activated sludge and discharged to the River Doe Lea a major tributary of the Rother. Investment in treatment and a gradual tightening of consent conditions i.e. in 1984 and 1989 has improved the effluent. In 1994 the works came under the control of Her Majesties Inspectorate of Pollution and new storm storage lagoons were built in 1996 to further protect the river. From the trend graphs (see end of chapter) it can be seen that there was a general decrease in BOD dowstream in the River Rother at Renishaw throughout the 1990's consistent with the improvement of effluent quality from the Coalite Plant. Brookhouse coking works was in comparison a small plant which treated its effluent by activated sludge. It discharged to Pidgeon Bridge Brook and produced an unsatisfactory effluent. It was shut in the early 1980's. The 4 coking works combined, created the most significant impact on water quality on the River Rother in this period. With their closures and improved effluent quality at Coalite, the river has now been allowed to improve along most of its length.

FACTORS COMMON TO THE CATCHMENT AS A WHOLE

Abandoned Minewaters

Abandoned minewaters are free flowing from historical mineworkings issuing from adits into surface waters. They are generally of a poor quality being acidic and high in iron. They can have an adverse effect on water quality and are also aesthetically unpleasing.

The worst cases in the Don catchment are Bullhouse and Sheephouse Wood in the upper Don and Fender on the River Rother. Although all of the catchment is affected to some extent by abandoned minewater. Many of the mine discharges were abandoned prior to nationalisation, and legally no one took responsibility for them. Throughout the period 1974-95 they have been allowed to pollute the rivers of the Don catchment.

The Environment Agency and the Coal Authority are addressing the issue of abandoned minewaters and are seeking to obtain funding for minewater remediation. The EA have produced a ranked list of discharges in order of highest environmental impact for the Coal Authority to work against.

OCHRE
The effects of the abandoned minewater discharge into the Don at Bullhouse above Penistone

Contaminated Land

It is estimated that enough waste is produced in this country to fill a void the size of Lake Windermere every nine months yet, until the 1980's simply dumping waste into a convenient hole in the ground was accepted as the best way of dealing with the problem. In the late 1980's realisation of the polluting potential of this practice, led to a move away from the dilute and disperse approach, to containment.

The dilute and disperse approach allowed the leachates produced from waste tips into the water environment. The leachates can be highly polluting with large amounts of BOD, ammonia and heavy metals, but the theory was that when mixed with surface and groundwaters they would not have any polluting effect.

Containment sites as the name implies, contain all waste and leachates by having engineered lining and leachate management systems. Environment Agency requirements to protect the water environment have become increasingly stringent, often involving multiple liners complete with leakage detection layers and pumps connected to telemetric alarms.

The Agency has strived to minimise the risk of pollution from waste disposal sites by:

- encouraging planners to favour sites where the hydrogeology affords a high degree of natural protection
- requiring conditions on Waste Management Licences
- taking direct action against polluters
- being actively involved in the formulation of guidance on best practice techniques
- implementing a tax on waste disposal to land fill following a decision by the EU

Agriculture

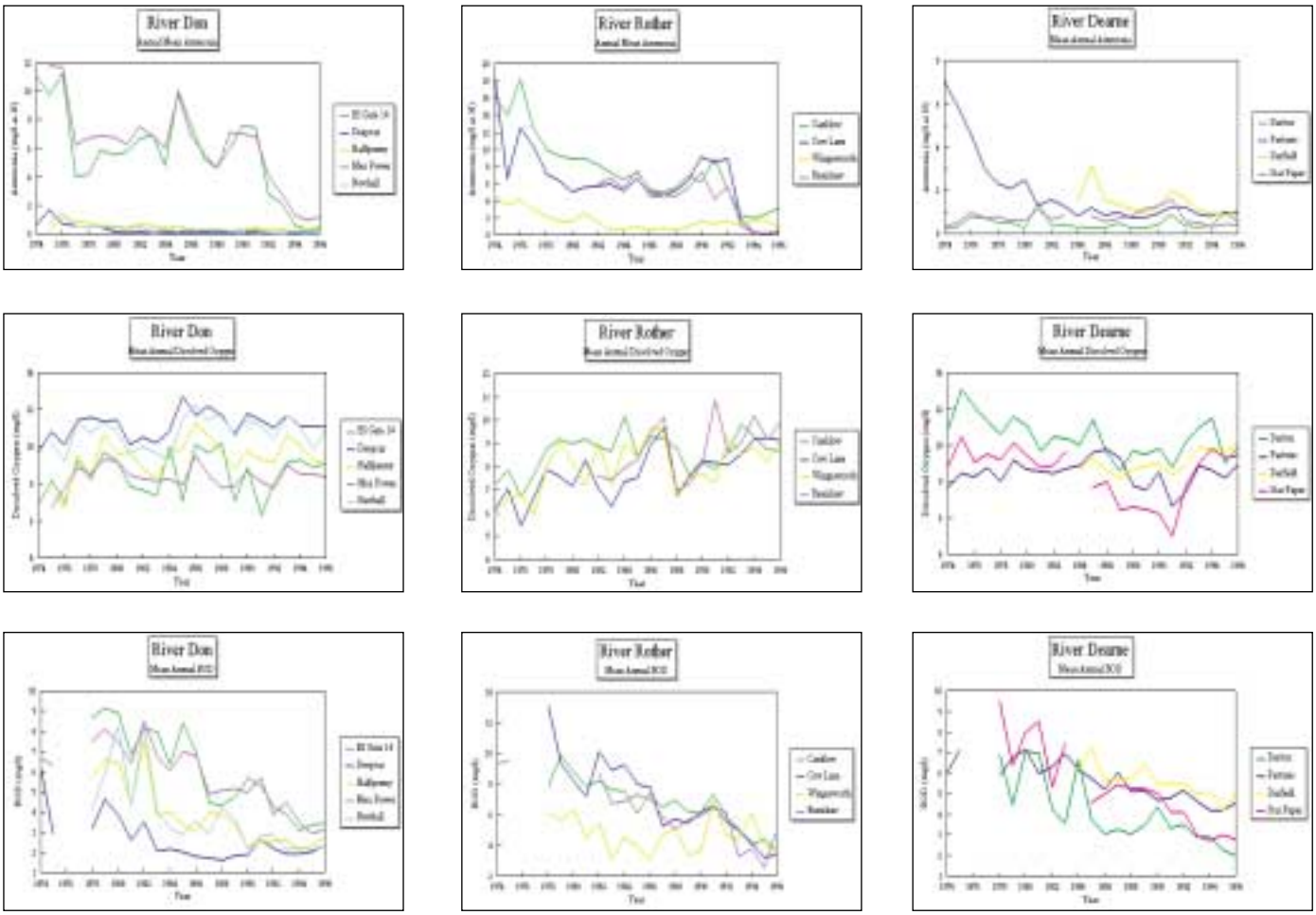
Agriculture will to some extent have affected water quality throughout the Don catchment. Pollution from farming practices has tended to be in the form of major incidents, with large polluting loads entering the watercourses for short periods due to accidents, malpractice and inadequate storage of waste.

The Code of Good Agricultural Practice (COGAP) was put together by the Ministry of Agriculture, Fisheries and Food to encourage farmers into using safe working practices to minimise the pollution of surface waters.

Further to this the 1989 Farming Regulations controlling the storage of silage, slurry and agricultural fuel oil, has given the EA an active part in the waste management on farms and has had great benefit in preventing pollution and improving a lot of farm waste storage facilities.

Summary

Overall water quality in the catchment has improved with the decline of heavy industry and improved treatment of effluent from industry and household waste. Issues and objectives for sustaining the recovery of the ecology of the river are described in Part 3.



Trend Graphs for Don, Rother, and Dearne 1974 - 96

The trend graphs indicate decline in ammonia and BOD as a result of improved water quality and the subsequent rise in the DO levels.

PART 2 - CHAPTER 6
AN OVERVIEW OF THE BIOLOGICAL STATUS OF THE RIVER DON CATCHMENT

Interest in microscopic life forms in water has been around since the invention of the microscope in the early 17th Century. However this interest has focussed on cataloguing and naming the myriad of organisms and not on investigating their ecological requirements. This trend in interest continued into the early part of this century when taxonomy probably reached its peak. The Victorian biologists were very fond of collecting and cataloguing new species.

At around the turn of the century some work had appeared in the European literature defining the 'saprobic' (pollution) status of various micro-organisms and the list of organisms thus detailed continued to grow as more studies were carried out. However in this country little interest was shown in this approach. A few early studies were conducted on specific river reaches in connection with specific pollution problems, but it was not until the late 1960's and early 1970's that the use of aquatic animals and plants to indicate water quality began to get wide scale use. Local river authorities had been set up in response to the appalling pollution problems in rivers resulting from the industrialisation of the late 19th century. In the main these had concentrated on the chemical specification of pollution. Towards the end of the 1960's most river authorities had, in their employ, a biologist but the amount and type of work carried out was minimal. The transfer of the role of the river authority duties to the new water authorities in 1974 resulted in an increase in the numbers of biologists employed by the industry and an increase in the understanding of the ability to use aquatic organisms to assess the health of the aquatic environment.

As a consequence of this there is little historical biological data on the River Don system. The fact that the river supported salmon in the past indicates that the other biological components of the aquatic system were in a healthy condition, but details of community structure remain guesswork. We can only speculate on the impacts of the changing management regimes and make assumptions about their effect on the ecology of the system.

Impoundment of the headwater parts of the catchment will have affected flow regimes which in turn will have altered the types and abundance of plant and animal communities in the system. These alterations will have been compounded by changes in water quality with the coming of industrialisation. Pollution in terms of chemical additives, changes in water temperature, fluctuating daily flows. In the lower part of the catchment the land drainage works would have had a dramatic effect on the total wetland area not just on the river itself. A once thriving wet marshland community, suddenly deprived of water would transform into dry land with a resultant loss in habitat and species richness.

Also the newly transformed river channels lack suitable habitat for plant and animal colonisation and again there is a loss of species richness. All these influences on the River Don system over the centuries has thus left the legacy of a severely impacted river system, which has needed, and still needs, very careful management to restore some form of ecological balance and rectify as far as possible the neglect and destruction carried out in the past.

RIVER DON CATCHMENT 1974 ONWARDS

The Don is regulated in it's headwaters by reservoirs and as such does not maintain a natural regime. This is reflected in the fact that the fauna at Dunford Bridge has been fairly stable for the period from 1980 onwards. There is a diverse range of animals present representing the major groups - caddisfly, stonefly, mayfly, beetle, fly and worm. However there is no overall dominance by one group but there is a consistency of occurrence. There are fluctuations in occurrence season to season and this may be linked to flow fluctuations although no analysis has been carried out to date.

Further down the river, below Penistone there were historic problems of pollution by small sewage treatment works providing inadequate treatment. This was addressed in 1977 by the building and commissioning of the

Cheesebottom Sewage Treatment Works. The small discharges upstream were stopped in 1978 as sewage was transferred to the new works. The site at Oxspring (upstream of Cheesebottom) showed early signs of immediate improvements in 1978. A single sample from 1984 and samples since 1992 have all indicated a moderate quality. Caddisfly, occasional mayfly and stonefly, midges and worms all now appear in the faunal lists for the site.

Downstream of Cheesebottom, at Soughley Bridge, slight improvements in quality began in late 1976 with the appearance of some caddisfly and freshwater shrimp. Throughout the 1980's this improved quality was consolidated with a slight increase in diversity and the establishment of sustainable numbers of individuals of all groups present. Quality has fluctuated slightly through the 1990's and the recent samples suggest further improvements seen in 1993 have not been sustained.

Downstream of the confluence with the River Little Don the quality of the river has been poor. There has been little improvement over the years with sites at Oughtibridge, Hillsborough, Hadfields Weir all dominated by worms, midges and water hoglouse, all indicative of severe pollution. Recent work on Blackburn Meadows Sewage Treatment Works and the construction of the Sheffield Trunk Sewer are expected to provide the basis of improvement of the river through and beyond Sheffield. At present these improvements are not appearing in the fauna, all samples have restricted, pollution tolerant faunas. This is probably a result of the legacy of poor quality sediment, and until there is a clean up by sediment removal under natural conditions (carried away by floods) the improvement in biological quality will be delayed.

RIVER ROTHER CATCHMENT 1974 ONWARDS

The upper reaches of the River Rother have restricted faunas indicative of poor to moderate quality. Despite closure the coking works at Wingerworth has left a legacy of tar pollution that still devastates aquatic life. The river quality can only be described as bad.

Some recovery takes place through Chesterfield. A poor (as against bad) fauna has become established since 1986/1987. However downstream of the Whittington Sewage Treatment Works the fauna returns to bad quality and has been so since early 1970's. The latest survey indicates a possible improvement to poor although this needs to be maintained in future surveys. Further downstream at Killamarsh, there have been improvements in the fauna with the appearance of mayfly, freshwater shrimp, snails and caddisfly. Even as far as Canklow mayfly and freshwater shrimp are beginning to appear in the river, albeit in low numbers.

RIVER DEARNE CATCHMENT 1974 ONWARDS

Upstream of Denby Dale the River Dearne is of good biological quality, with a diverse fauna comprising stonefly, mayfly, caddisfly, freshwater shrimp, beetles etc. A variety of discharges of effluent from mills, minewater, Combined Sewer Overflows cause a deterioration in quality below Scissett with a reduction in numbers and types of the sensitive animals and an increase in snails, leeches, worms and midges.

Sewage effluent and industrial discharges cause further deterioration in quality by the time the water reaches Haigh and flowing through Darton the river is of moderate to poor quality. At Darton the effects of saline minewaters is evidenced by the occurrence of the saline tolerant shrimp *Gammarus duebeni.*

In the lower reaches of the river there has been much engineering of the channel which has caused restriction in habitat and hence this is reflected in a paucity of faunal diversity which may not be solely related to water quality.

Recent improvements at Pastures Bridge designed to restore a range of habitats will be monitored to assess the faunal recovery.

RIVER WENT CATCHMENT 1974 ONWARDS

The River Went has only moderate to poor biological quality in the upper reaches, mainly resulting from organic pollution. The fauna comprises mainly worms, midges, leeches, snails and water hoglouse, all pollution tolerant animals. Freshwater shrimp and caddisfly do occur at times. Although heavily engineered in the lower reaches, the river has in the last few years shown an improvement in quality. The fauna still retains a pollution tolerant component but additionally mayfly, caddis, beetles and damselfly are now found.

CURRENT STATUS OF BIOLOGICAL ASSESSMENT OF RIVERS

In 1996 agreement was reached on a national biological quality classification system, the Biological General Quality Assessment (GQA) scheme. This was used to provide information on the quality of all our river systems using data collected in both 1990 and 1995 and allowed an assessment of change in quality over that five year period. The Biological GQA will be the main descriptor of biological quality used by the Environment Agency over the coming years, and will be applied to aid prioritisation of capital expenditure for discharge improvements and in assessing other improvement schemes.

Within the Don, Dearne and Rother catchments, whilst there is still a difference between biological and chemical quality assessments, there have been significant improvements in biological quality in a number of river reaches.

Wide ranging biological surveys are carried out on a five yearly basis and in the intervening years a reduced monitoring programme is undertaken to provide a baseline of data against which other survey data can be assessed. Specific problem areas can then be targeted for biological assessment. In the period from 1995 the drought has necessitated a specific programme of biological monitoring which will be ongoing for at least three years.

PART 2 - CHAPTER 7

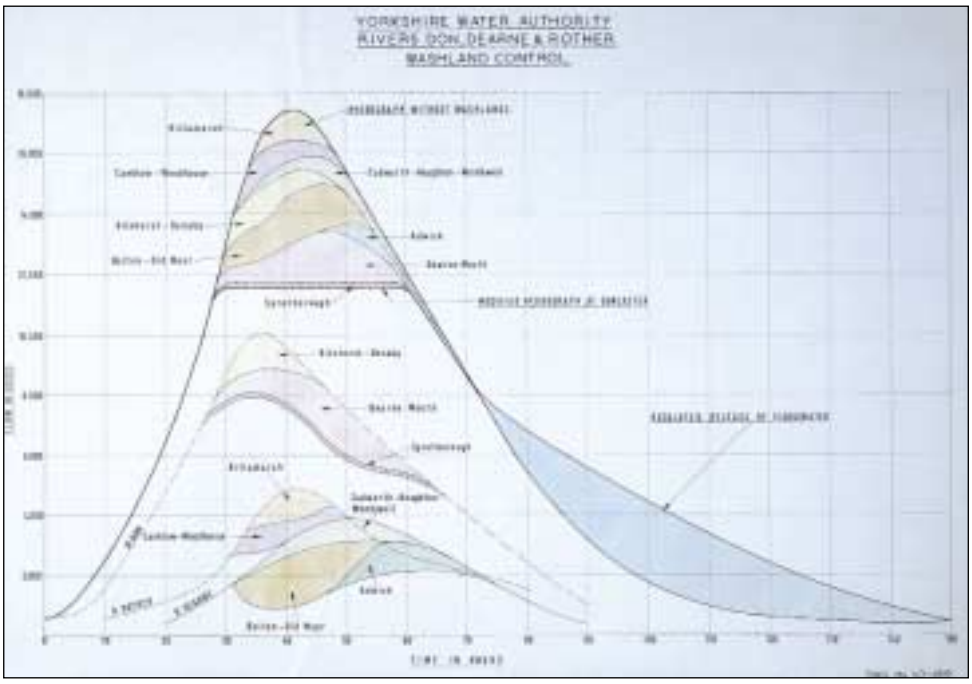
AN OVERVIEW OF LAND DRAINAGE OF THE RIVER DON CATCHMENT

In this section, it is perhaps best to start by describing the overall strategy behind the Flood Defence schemes which were carried out as flood prevention measures prior to the formation of the National Rivers Authority in 1989.

A WASHLAND AT DONCASTER
Part of the old channel of the River Don can be seen in the centre of the picture

In 1983, after a series of recorded flood events in 1958, 1965, 1970, 1977 and 1982 in the River Don catchment, a flood defence strategy was developed to improve the effectiveness of the washlands for flood control. The strategy involves the operation of six river control sluices on the River Rother and Dearne. The effect of the sluices and controlled washlands was to reduce the risk of flooding in Doncaster from an estimated 1 in 40 year flood to an estimated 1 in 150 year flood.

The hydrograph below shows the peak flood flow at Doncaster taking account of the combined flows of the Don, Dearne and Rother. Each of the coloured compartments represents the reduction in flow as a result of washland operation. Flood water is stored in the washlands until the flood subsides. The hydrograph shows that the River Don peaks after 36 hous, the Dearne after 42 hours and the Rother after 50 hours. The modified hydrograph line shows the total reduction in peak flood flow as a result of the combined washland operation.



As described in Part 1-Chapter 2, one of the early measures to relieve flooding of Doncaster from the River Don was the development of the flood relief route on the north side of the river. This was designed to reduce flood waters spreading through the town and encouraged flows through the natural floodplain along a route from Black Pond (Newton Ings) through a series of flood arches built under the Great North Road (now A638), the York Road (A19) and finally under railway embankments which carry the lines to Leeds and York.

FLOOD ARCHES DONCASTER
Flood water passing down the historical flood relief route flowed under these arches beneath the A638 Trunk Road.

If the river channel capacity at Doncaster is in the future exceeded, then the historical flood relief route should still help reduce the spread of flood water through Doncaster. However the development which has occurred in its path since the route last operated in 1947 will undoubtably suffer from flooding. At present there are over 500 houses/shops, 40 industrial premises and 130 residential caravans at risk.

Lower Don

Since the early 1980s relatively little flood defence work has been carried out on the lower Don. Of the small number of protection works undertaken, perhaps the most important has been the raising of the tidal defences at Goole. The floodbanks here were raised based on a recorded tide level of 5.8 metres ($6^1/_3$yds) AOD at Goole in 1983. The defences have been raised with a freeboard taking account of a predicted rise due to global warming and tectonic changes for an estimated 40 years period.

Other works on the lower Don have involved the reconstruction of the flood gate at the River Went outfall in 1985, which improved the protection of the Went catchment against the high levels encountered in the Don as a result of tidal and flood conditions.

In 1990, a scheme commenced on Ea Beck to improve floodbanks which had suffered from subsidence and erosion. This comprehensive scheme which was still ongoing in 1996 will improve the flood defence upstream as far as the village of Skellow.

Upper Don

From the mid 1980s onward most of the flood protection works carried out on the upper Don catchment have been concentrated on tributaries such as the River Sheaf.

RIVER SHEAF FLOOD ALLEVIATION SCHEME - CASE STUDY

The River Sheaf and its tributary, Porter Brook, rise in rural moorland south of Sheffield, but their lower reaches run through densely built-up urban areas. The River Sheaf drains an area of 68 square kilometres (16803 acres) to the south west of Sheffield and flows into the River Don in the city centre. The upper part of the catchment is mainly rural. The lower part of the catchment is suburban becoming increasingly urban as it passes towards the city centre. At Granville Square, the river enters a complex underground system of culverts which allows water to pass beneath the Midland Station, the Ponds Forge sports centre and the Sheaf Market before joining the River Don downstream of Lady's Bridge.

Flooding on the Sheaf generally occurred at a threshold of approximately 1 in 7 years with recent major floods having occurred in 1958, 1973, 1982, and 1991. Approximately 20 hectares ($49^1/_2$ acres) of land, comprising mainly of industrial, commercial and retail property, and at least 80 houses are at risk. The flooding occurred when flood water escaped from the channel onto the road system towards the city centre. The industrial history of the area left a legacy of culverts, weirs, low services, poor defences and low bridges along the river, which caused restrictions in the channel. The river also suffers from severe debris accumulation, which comprises mainly of dead vegetation, litter and illegally dumped items, this was recognised as a major cause of flow restriction.

The comprehensive Flood Alleviation Scheme commenced in 1991, and consisted of 4 phases from the River Don confluence to Archer Road, which were completed in February 1997. The cost of the works was £3.6 million. The phases involved the following works;

- Constructing a mechanised screen at Granville Square to keep the culverts free of debris
- Streamlining culvert transitions to improve self cleansing.

- Cleaning and regrading the river bed - Lowering weirs
- Building retaining walls - Raising bridges and pipes
- Improving access to make maintenance easier

The scheme generally protects property from flooding for up to a 1 in 50 year flood. During the works a flood occurred in 1991 caused by a complete blockage of the debris screen at Granville Square, resulting in flooding at Granville Square and the Midland Station. The debris screen was later modified with an innovative design which increased the screen area whilst incorporating an overflow facility, without any channel enlargement.

The biological water quality of the River Sheaf is generally good for an urban watercourse, though deterioration has been noted around the discharge points of storm sewer overflows. In habitat terms the river has considerable interest, the majority of the channel exhibits good flow characteristics and in-stream features such as riffles, runs and pools. As part of the scheme some fish passes and pools were installed to maintain and improve the fishery which presently consists of stoneloach and minnow with brown trout present above Archer Road.

River Rother

The River Rother and its tributaries have had a number of flood alleviation schemes carried out on their reaches since 1974. Most of these works formed part of the comprehensive River Rother Improvement Scheme.

As development increased in the catchment, flood alleviation was an issue to be considered. The Rother Valley Country Park was formed after opencast mining operations were completed in 1981. As a condition of this scheme going ahead the Yorkshire Water Authority required that the existing flood storage volume of the Bedgreave washland was to be maintained, and also the drainage problem at Killamarsh was not to be made worse. To take account of increased surface water run-off from the extensive Mosborough Development Area an additional storage of 200,000 cubic metres (44 million gallons) of flood storage was also to be provided. The country park was completed in 1985 and now serves an important function in the strategy for flood alleviation downstream as well as providing a popular leisure amenity. A fish-belly bottom hinged regulator known as Meadowgate Regulator, with an unobtrusive appearance was installed in 1979 to provide the flood storage requirement from the three washland compartments upstream. The recreation lake, being one of the compartments, would be the last in a very severe flood event to be filled for flood storage from the River Rother. The recreation lake is used for various human water activities, and because of the poor quality of the River Rother, is filled with water from the River Moss abstracted at a weir upstream of Eckington.

In the 1980's improvement schemes were carried out upstream of the Rother Valley Country Park on the River Rother and its tributary, the River Whitting. At Slitting Mill, near Renishaw a scheme was carried out on the Rother to formalise a controlled washland and reduce the frequency of flooding to the Staveley to Eckington Road (B6053) and nearby farms. In Staveley a scheme was carried out to improve the channel capacity where it was restricted. Further upstream in Chesterfield improvements for the protection of properties from Rothervale Road to Sherwood Street, off the Derby Road, were carried out where 48 houses and 3 small industrial premises were inundated during the 1982 flood event.

In the mid 1980's a flood alleviation scheme was carried out on the River Whitting in Chesterfield, a tributary of the River Rother, to protect property particularly at Whittington Hill against flooding. The scheme extended from the confluence with the River Rother to the Sheffield Road Bridge (A61). In this scheme flood levels were reduced by regrading and re-sectioning the channel, obstructions were also removed and floodbanks constructed.

Road improvements in the catchment have also had their effect on the Rother. One example carried out in the late 1980's was a channel diversion to allow for the construction of a roundabout for the Tapton Bypass. This resulted in a section of the natural course being re-routed, reducing the channel length.

River Dearne

From the early 1980's onward most of the flood defence work carried out on the Dearne system has been related to channel maintenance, particularly those sections which had been straightened and widened by earlier works. In low flows the river deposits considerable sediment loads in these sections as the velocities begin to reduce, leading to reductions in channel capacity. The problem of siltation has particularly affected some of the downstream reaches of the river between Adwick and Denaby. Recent channel improvements between Pastures Road and Mill Lane to improve the fishery habitat with a narrower sinuousoidal channel has resulted in a faster flow helping reduce silt deposition and producing some self cleansing benefits.

Wath Upon Dearne was an area which had suffered from dereliction after coal mining had ceased. As a result of reclamation works, a large scale development area has been formed , known as the Wath Manvers Regeneration area. The area included the development of the controlled washland at Old Moor from which some of the fill material used for the large scale earthworks at Manvers had been obtained. In 1996 , a wetland and wildlife reserve was created from the voids and the function of the reserve as a controlled flood storage area was maintained in the design.

Flood Control & Nature Conservation

After a history of engineering solutions to resolve flooding problems from rivers, there are sites where flood control works have been carried out which are now Sites of Special Scientific Interest (SSSI) such as Denaby Ings Nature Reserve and Sprotborough Flash. These areas are protected for their ecological value, but still serve a function for flood control. As the main operating authority, the Agency's Flood Defence department has initiated a consultation process with interested organisations such as English Nature and RSPB, with the aim of producing a Water Level Management Plan. These plans will ensure that maintenance and operational activities do not detrimentally affect water levels in important wetland areas.

PART 2 - CHAPTER 8

AN OVERVIEW OF WATER MANAGEMENT OF THE RIVER DON CATCHMENT

ABSTRACTIONS

The water power available from the fast flowing Pennine streams was one of the attractions for the development of heavy industry in the catchment in the 19th Century. The rivers also provided water for cooling purposes, which was essential for the steel and engineering industries.

Public water supplies had been developed in the Pennines to serve the needs of a growing demand as early as 1836 (see details of reservoirs in Part 1, Chapter 1a) but by 1937 even these reservoirs were becoming inadequate. To address this problem water began to be imported into Sheffield from the Derbyshire Derwent reservoirs. This supply is still fed via a pipeline into the reservoirs at Rivelin.

Lower down the valley, the Sherwood Sandstone around Doncaster is a major aquifer which since the early part of this century has supplied most of the drinking water needs of the area. Most of the supply sources are within the Trent catchment towards the south east of the town with two of the larger boreholes at Sandy Lane and Nutwell. The magnesium limestone which underlies the sandstone is also a source of water.

In 1964 water for public supply began to be imported into the Don catchment from the Elvington abstraction on the Yorkshire Derwent (see Appendix II, Case Study - Drinking Water Supply). This addressed the problem of a rapidly developing supply deficit and since, most of the increased demand in South Yorkshire has been met from this source.

Most of the reservoirs in the catchment were developed following the promotion of local Acts of Parliament. These acts specified amounts of water to be released to the rivers to compensate water power users further downstream for the effects of the impoundments. These were mainly water powered operations. This latter use has now diminished but the release of “compensation water” is very important to maintain low flows for the protection of fisheries and wildlife and also serves to ensure supply to several more modern industrial users.

The most recent reservoir development was Winscar at the head of the Don Valley. This reservoir came about as a result of the enlargement of an existing facility at Dunford Bridge and water from this source entered supply in 1975.

The Water Resources Act 1963 brought in a widespread system of abstraction licencing. Existing abstractors from surface and underground waters, including the public supply reservoirs were given a “licence of right” with conditions on the volume of water that they are entitled to take based on use at the time or the rates specified in the Acts of Parliament. Many of these licences are still in use today.

Industry, farmers or water companies wishing to develop new abstractions or change existing ones are required to obtain an abstraction licence from the Environment Agency. The terms under which a licence is granted, (which includes any conditions attached to it) must prevent any derogation from the rights of existing lawful abstractors and is designed to minimise impacts on the Environment.

The table opposite shows the amount of surface water abstracted from the Don catchment in 1974. When compared with the table showing comparable figures for 1996 it can be seen that there has been a considerable reduction in the use for cooling by power stations and industry. This results from the closure of several small inland power stations eg. Neepsend, Blackburn Meadows, Mexborough, Doncaster and Thorpe Marsh and steel works in the Rotherham and Sheffield areas.

Conversely there has been a rise in the amount abstracted for spray irrigation by farmers. This is a relatively small proportion of the total water use on the Don System but it can have a significant impact on smaller tributaries particularly the River Went. Since 1986 all licences for consumptive use have been issued subject to a time limit and a condition which requires abstraction to cease at times of low river flow.

SURFACE WATER

	1974 (NoL)	TCMA		1996 TCMA	(NoL)
Water Undertaking	(38)	104,467,360	increase to	125,790,200	(13)
Industrial	(185)	662,631,800	decrease to	30,653,110	(59)
Agriculture	(53)	81,820	decrease to	74,950	(51)
Other	(25)	22,400,000	decrease to	19,604,691	(65)

(TCMA - Thousand cubic metres per annum)
(NoL-Number of licences)

There has been a similar if not more dramatic reduction in ground water use by industry. This has largely resulted from the decline in the mining industry of South Yorkshire. To maintain the workings in a dry condition it was necessary to pump out water from the bottom of pit shafts. Some of this water was used on the surface for coal washing plants etc. but the majority was discharged following settlement treatment to adjacent streams.

The cessation of controlled pumping at disused colliery sites has resulted in a significant recharge of groundwater reserves. As water levels rise the possibility of this resulting in the emergence of uncontrolled discharges of highly polluting minewater increase. The EA document Environmental Assessment of Selected Abandoned Minewaters in the North East Region has recently been published and gives details of the problems associated with this phenomena. The following table gives the quantities of ground water abstracted from the catchment to serve the needs of water undertakings (drinking water supply), agriculture (mainly spray irrigation), industry (mainly mining) and other,(bottling plants, private drinking water supply).

GROUND WATER

	1974 (NoL)	TCMA		1996 TCMA	(NoL)
Water Undertakings	(17)	7,968,181	decrease to	218,784	(6)
Industrial	(168)	595,063,060	decrease to	7,283,637	(39)
Agriculture	(67)	495,409	decrease to	201,303	(81)
Other	(11)	86,096	increase to	1,718,576	(39)

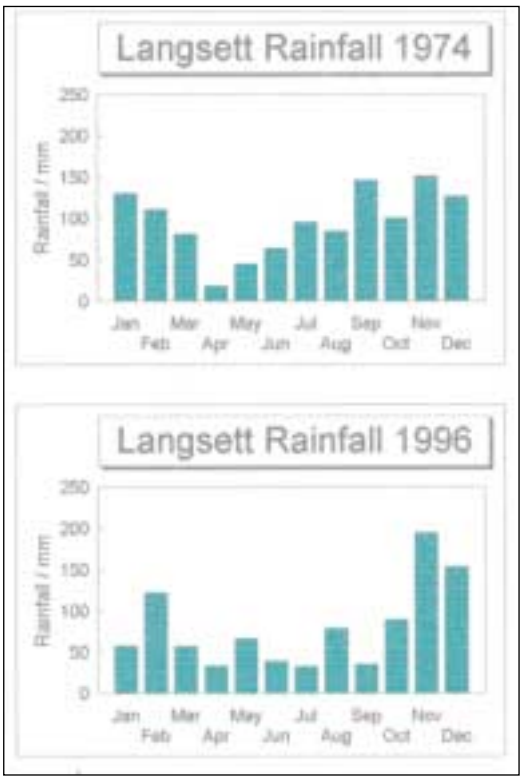
(TCMA - Thousand cubic metres per annum)
(NoL-Number of licences)

Most of the surface water sources in the Don catchment have been fully exploited hence the need to import water from the River Derwent at Elvington. It should be recognised that much of this water, after being used for household and other purposes, is treated and then discharged to rivers and streams in parts of the Don catchment. This net import of water is significant and contributes greatly to the flow of the Don during dry weather conditions. It is estimated that the discharge from Blackburn Meadows STW in Sheffield constitutes more than 50% of the daily flow of the river during a period of low rainfall.

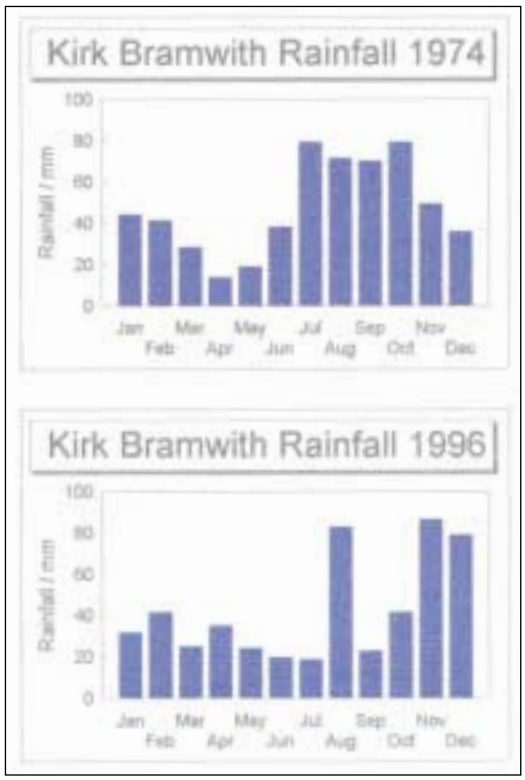
RAINFALL GUAGING

Graphs 1 and 2 show the variability of rainfall levels throughout the 22 year period between 1974 and 1996. Graph 1 is for the guage at Langsett in the upper catchment and Graph 2 is for the guage at Kirk Bramwith in the lower tidal area of the catchment. Graphs 3 and 4 show the rainfall levels for the 12 month period Jan-Dec during 1974 and 1996 (a drought year) at Langsett and Kirk Bramwith. Graphs 5 and 6 show the daily flow at Hadfields Weir at Sheffield during 1974 and 1996. These are compared with the long term minimal flow.

1.


Langsett Rainfall 1974
Rainfall / mm
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Langsett Rainfall 1996
Rainfall / mm
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

2.


Kirk Bramwith Rainfall 1974
Rainfall / mm
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Kirk Bramwith Rainfall 1996
Rainfall / mm
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
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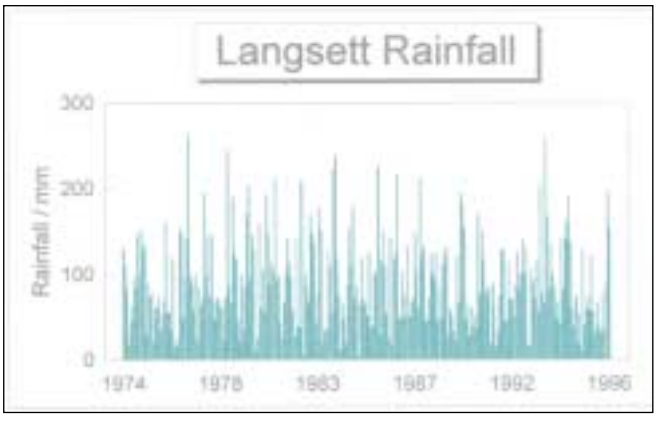
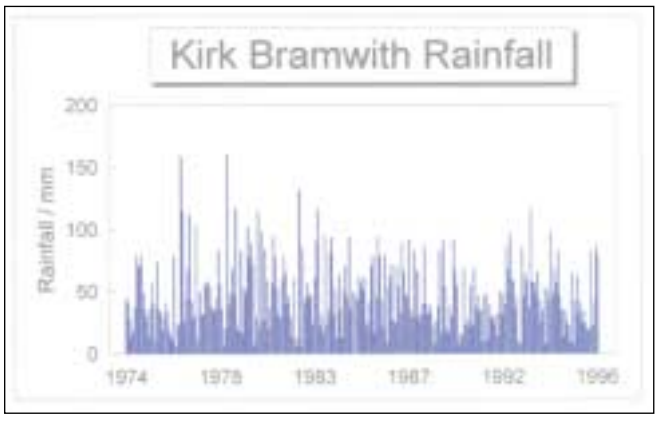
Sep
Oct
Nov
Dec

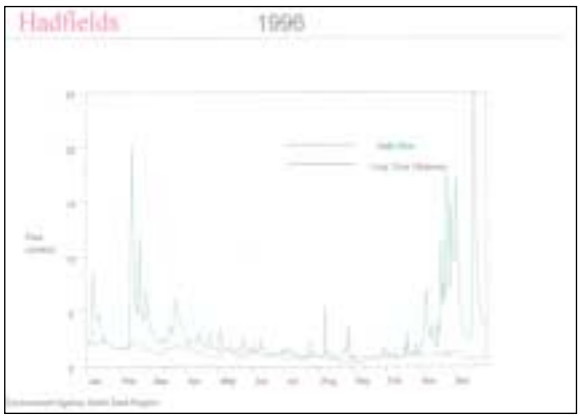
3.


Langsett Rainfall
Rainfall / mm
300
200
100
0
1974
1978
1983
1987
1992
1996

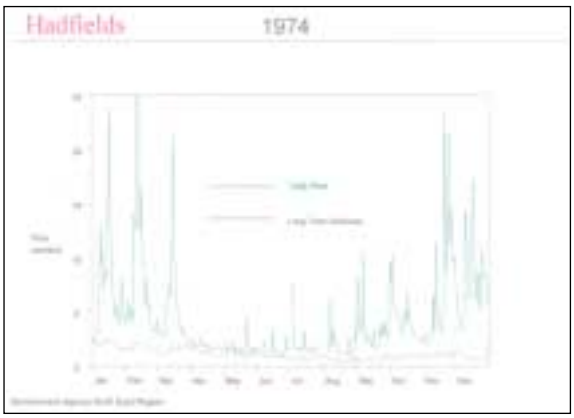
4.


Kirk Bramwith Rainfall
Rainfall / mm
200
150
100
50
0
1974
1978
1983
1987
1992
1996

5.


Hadfields
1996

6.


Hadfields
1974

PART 2 - CHAPTER 9

AN OVERVIEW OF THE CONSERVATION STATUS OF THE RIVER DON CATCHMENT

KINGFISHER
Now a common site along the banks of the River Don

Throughout most of this century the Don Catchment has, to a large extent been ignored as a conservation resource. The loss of wetland habitats and the decline of the river itself led to many people writing off the whole catchment with the exception of a few isolated sites, which had managed to survive or which had been inadvertently created by mans activities. Since the mid 1970's there has been an increasing effort to assess the current conservation status of the catchment and also to identify the potential for improvements to be carried out. At the same time, public awareness of environmental issues has grown immensely. Surveys of land use, the identification of sites of existing conservation value and increasing sensitivity in the way in which flood defence work has been carried out, have all led to improvements in the catchment. The recent dramatic improvements in water quality have allowed some significant changes in the status of both individual species and habitats in general. For example, the sighting of kingfishers in the centre of Sheffield has become commonplace.

HIMALAYAN BALSAM
One of the alien weeds which has colonised parts of the Don system

In common with many of the river catchments in England, the Don has seen very extensive colonisation by alien weeds such as Japanese Knotweed and Himalayan Balsam. The river in places has been noted for the presence of other aliens such as the famous fig trees. These Mediterranean trees have grown at a number of locations in Sheffield over the past 60-70 years. There are in excess of 30 specimens recorded, usually growing at the base of retaining walls at the river's edge. The seeds of figs are thought to derive from sewage. Experiments on the silt downstream of sewage works found that seeds could be germinated from figs, tomatoes, strawberries and citrus fruits. Germination of these exotics is thought to depend on warm water inputs which were formally very common from industrial sites throughout Sheffield. Records are available which show that the river ran at a constant 20°C (68°F) all year round and would exceed this temperature during times of peak production in the local steel industry.

Lower down the system the loss of natural wetland areas adjacent to the river channels as a result of land drainage work has, to some extent been compensated for over the last century by the formation of open water areas which were a result primarily of mining subsidence. A number of these sites, most notably the flashes at Denaby, Sprotborough and Broomhill are of regional and in some cases, national importance for nature conservation. At Wath Ings, drainage work in the 19th Century led to formally wet areas used for grazing and hay cropping being made available for more intensive agriculture. However, mining subsidence in the 1960's and early 1970's reversed this trend so that open water re-appeared on the site. In recent years the open water area became sufficiently large that it was attractive to migrating birds on their spring and autumn journeys. Birds such as snipe, redshank, golden plover and dunlin are common on these subsidence areas, whilst from time to time rare species such as osprey, marsh harrier and avocet have been known to visit.

In winter the sites are used by large numbers of wildfowl. The Wath Ings site is part of a complex of complimentary habitats located around the River Dearne and including Broomhill Ings and Flash, Gypsy Marsh and Wombwell Ings. At Denaby Ings also adjacent to the Dearne, the Yorkshire Wildlife Trust manage another important area of open water and associated habitats. More than 300 species of plant have been recorded from this site as well as nearly 170 species of bird. Insects are also an important part of the conservation value of this reserve. Alongside the River Don at Sprotborough lies another of the Yorkshire Wildlife Trust's sites. Sprotborough Flash was formed by subsidence around 1924. It runs parallel with the river for a distance of

almost 1.2km (3/4 mile), connected only by an overspill pipe at it's eastern end. Like Denaby Ings, the Flash is important for its bird, plant and insect life and incorporates within its boundary part of the magnificent wooded limestone heights of the Don Gorge. Here despite quarrying and latterly land filling, there still remain substantial areas of the ancient woodland which once covered most of the Don Valley. Ash and Wych Elm are present with a very diverse shrub layer. Invertebrates are also an important element in the conservation interest of this area. In early 1997 the EA carried out works at Sprotborough which will enable the water levels in the reserve to be more sensitively managed.

SPROTBOROUGH FLASH
One of the areas of subsidence adjacent to the river which has developed as an important wildlife site

On the tidal section of the River Don the large scale drainage of the catchment had the effect of modifying the tidal regime of the river, allowing much of the former flood plain to be developed for agriculture and increasingly isolating the river from the surrounding land. In the early years many of these species rich areas, particularly those sites of unimproved grassland were managed as hay meadows. Today, few of the hay meadows survive, but examples such as Went Ings Meadows near Stainforth show what much of the area would have been like. Grass species such as Yorkshire fog, sweet vernal grass and tufted hair grass are present in a sward which commonly included great burnet, common knapweed, ribwort plantain, yellow rattle as well as relatively uncommon species such as adders tongue, dyers greenweed and pepper saxifrage. Regrettably modern grassland management throughout the rest of the Don catchment has removed the vast majority of these species rich meadows. The examples described above represent only a small proportion of the sites of conservation value in the catchment. Many others exist which in their own right are equally important. Some sites such as the Yorkshire Wildlife Trust washland reserve at Woodhouse Mill on the River Rother require extensive remediation to fulfill their true potential. Here the Trust is working in close co-operation with the Environment Agency to raise the capital investment required to carry out works which will, with the hard work and commitment of the Trusts volunteers, eventually return this section of the Rother Valley to something like its pre-industrial condition.

THORNE MOORS NATIONAL NATURE RESERVE

The Thorne, Goole and Crowle Moors, together form the largest remaining area of lowland peatland in England. They are a grade 1 SSSI covering 1918 hectares (4740 acres). The moors complex which exists today is all that remains after various attempts at drainage and land reclamation. The work which was carried out by the Dutch land drainage engineer, Cornelius Vermuyden in the early 17th Century was not entirely successful and resulted in flooding of previously drier land. A further process of improving land for agriculture was started in the early 19th Century and this was commonly known as warping. It involved the construction of warping drains connected to the tidal rivers. At each tide, water from the drains was allowed to flood into embanked areas to deposit nutrient rich silt on the land surface. The process was very successful and the fertility of large areas of acidic peat was improved so that large areas of marshland were converted to good agricultural land.

The inner part of Thorne Moor was not improved in this way and remains a peatland. For hundreds of years local people removed peat from the area for various purposes including cattle litter and for use as fuel. Later these removal operations became commercialized, eventually under the control of Fisons PLC. The national nature reserve was purchased from the company in 1995.

The site supports a range of specialist plants including bog rosemary and sundew, a plant which relies on trapping insects on its sticky leaves to obtain additional nutrients. More than 2,800 invertebrate species have been recorded from the reserve and it is a stronghold of the nationally rare large heath butterfly. The vast area of moorland also provides an important wintering refuge for birds including the hen harrier, hobby and short eared owl. Resident populations of the nightingale and nightjar are also present. Access to the reserve is by permit only from the Warden, English Nature, Bull Ring House, Northgate, Wakefield, West Yorkshire, WF1 3BJ.

CONSERVATION AREAS & SITES OF SPECIAL SCIENTIFIC INTEREST (SSSI'S) WITHIN THE DON CATCHMENT

Name	Description	Designation
Went Ings Meadows	Spring fed hay meadow	Flora
Sprotborough Gorge	Ancient Woodland	Trees
Denaby Ings	Open water	Birds, Flora
Little Don Stream	Watercourse	Geological
The Dark Peak	Moorland/Wetland	Birds, Flora, Fauna
Moss Valley	Watercourse & associated land	Plants, invertebrates
Moss Valley Meadows	Woodland	Plants, trees
Doe Lea Stream	Watercourse	Geological
Carr Vale Flash	Open Water	Plants, birds
Catcliffe Flash Nature Reserve	Wet grassland & open water	Plants, birds
Blackburn Meadows Nature Reserve	Reclaimed slag heap	Invertebrates, Fauna

PART 2 - CHAPTER 10
AN OVERVIEW OF THE RECREATIONAL USE OF THE RIVER DON CATCHMENT

Watercourses have always been attractive to man, initially because they were a source of food and a means of transport. Over the centuries rivers developed into a recreational amenity with water based activities such as fishing, boating, swimming and river bank walking.

As the valleys of the Don, Dearne and Rother became increasingly industrialised, so their potential as a source of recreation began to diminish.

Anglers were left to mourn the loss of what had previously been a fine fishery as deteriorating water quality reduced and finally eliminated fish populations. Pursuits such as swimming and boating also lost their attraction as the once clear waters were reduced to a smelly cocktail of pollution.

In the major towns, the development of industry up to the waters edge hemmed in the river, hiding it from view and eliminating the traditional footpaths along which generations of the valleys inhabitants had strolled. The destruction of flora and fauna also led those with an interest in the natural world to seek other areas to pursue their recreation.

Undoubtably there were those who rallied to try to reverse these trends but their protestations generally fell on deaf ears. One such attempt prompted the Sheffield City Council on the 9 November 1908 to prepare plans for a section of the river near the city centre to be widened and deepened to provide for public boating. However, after due consideration the plans were abandoned primarily on the grounds of engineering difficulties but there were undoubtably fears concerning the risks to public health.

The loss of the rivers as a recreational resource also had financial implications for many of the former recreators. Angling was and still is, a pastime enjoyed by many. Miners, steelworkers and others working in the filthy, smelly and noisy heavy industries of the Don Catchment enjoyed the sport as a means of escape from the drudgery of their everyday working lives. As fish populations disappeared from the rivers, anglers were forced to seek alternative waters, such as ponds and lakes to pursue their hobby and many had to travel many miles to reach such facilities.

By the 1940's, the relative prosperity of these workers had improved such that they were able to look ever further afield for suitable fisheries. The large angling associations which had developed in Sheffield and the other large towns began to acquire their own waters in places as distant as the Fenlands of East Anglia. Each weekend, a mass exodus of anglers occurred numbering many thousands of men. Special trains were made available by the railway company and large numbers of motor coaches took organised parties to fish at locations as far afield as the Great Ouse Relief Channel in Norfolk and the Dales rivers of North Yorkshire.

By the late 1980's the effects of water quality improvements on the water environment began to encourage the return of recreational activities on the Don system. Returning fish populations attracted the attention of a new generation of anglers who increasingly began to turn their attention to the river. The steady return of birds and wildlife and the emergence of marginal plant life encouraged people once again to experience the pleasure of a walk along the river bank. Use of the navigation by pleasure craft also began to increase as the general ambiance of the Don Valley improved.

Following is a brief description of some of the recreational activities and opportunities which are currently available.

ANGLING

Organised angling by means of day ticket or club membership is available on a number of sections of the Don and its two major tributaries, the Dearne and Rother.

Good fishing can now be enjoyed throughout much of the Don catchment with good brown trout sport to be

had in the Don above Penistone. Below Sheffield, the river becomes predominantly a coarse fishery which offers excellent sport for species such as roach, dace, barbel and chub. As the river becomes more canalised as a result of its use as a navigation, it begins to offer opportunities for organised match angling with species such as roach, bream and perch predominating. On the canal network below Doncaster there has developed one of the premier match fisheries in Britain, hosting many prestigious events annually.

WALKING & NATURE STUDY

FIVE WEIRS WALK

The Five Weirs Trust was established in order to ensure that the regeneration of the River Don became a central feature of the renewal of Sheffields east end and that public access to the 7.5km of river with its five magnificent and historic weirs was given back to the people of Sheffield. The aims of the Trust are:-

- to promote the idea of the walk in local planning policy and to ensure that sections of it are built as part of major construction projects on the Don wherever possible.
- to persuade local authorities such as Sheffield Development Corp. and the City Council to contribute to the achievement of the walk.
- to carry out construction of certain sections itself.
- to promote local community involvement in and 'ownership' of the walk and to encourage responsible recreational and educational use of it

75% of the walk is now completed or under way. Salmon Pastures is one of the 3 last remaining sections to be achieved to link Sheffield City centre and Rotherham Town centre. (For further information see Appendix IX, Case Study - Five Weirs Walk)

TRANS PENNINE TRAIL

A major route for walkers, cyclists and horse riders coast to coast, Liverpool to Hull via significant tracts of the valleys of the Rivers Don, Dearne and Rother. The trail was afforded EEC status by its formal adoption as the western extremity of 'E8', the major through route over continental Europe to Turkey. Millennium funds have been granted for its development and several sections of Environment Agency owned river bank are being used.

The improving ecology of the river corridor offers increasing opportunity for the enjoyment of the environment for bird watchers and naturalists. A number of sites adjacent to the river (as described in Part 2- Chapter 9) are now of national importance (managed by Yorkshire Wildlife Trust). New opportunities to encourage the return of once indigenous species of birds, animals and plants are constantly being sought and exploited. A good example of this is the work carried out at Old Moor Washlands near Wath Upon Dearne to create an exiting variety of wetland habitats.

PLEASURE CRAFT ON THE RIVER DON AT SPOTBOROUGH

BOATING

The navigation rights on the Don system are controlled by British Waterways and licences are obtainable from them for the use of craft on the waterways. The redevelopment of the Sheffield Canal Basin and the establishment of a number of marinas and mooring facilities on the Don system offer increasing opportunities to navigate between Sheffield and the River Trent via the Stainforth and Keadby Canal and to Goole via the New Junction and the Aire and Calder navigations. Work is also underway to open up the Chesterfield Canal and in the future it should be possible to navigate between Chesterfield and the River Trent at Stockwith.

Local Environment Agency Plans (LEAPS)

The future

The 900 years of the Don's history covered by this document has seen remarkable events enacted. It would be difficult to exaggerate the rivers contribution to the prosperity of the valleys inhabitants or even to Britain's economy as a whole. However, their achievements lacked one element which denied them permanency. In their abuse of the river and its associated environs our ancestors gave little thought to the sustainability of this precious resource. The result was a grossly degraded river which later generations of the valley have had to endure for almost a century and a half.

As we head into a new millennium we have the opportunity to reverse the mistakes of the past and pass on to our children an environment which can be sustained and enjoyed by all whilst still helping to serve the demands of a modern society.

The formation of the Environment Agency for England and Wales on 1 April 1996 helped to create one of the worlds most powerful environmental regulators. It merged the former National Rivers Authority with Her Majesty's Inspectorate of Pollution and the Waste Regulation Authorities helping to provide an integrated approach to environmental protection and enhancement. This integrated approach along with an increased level of public participation will help the Agency and the community contribute to the worldwide environmental goal of sustainable development.

PART 3 – THE FUTURE LOCAL ENVIRONMENT AGENCY PLANS (LEAPS)

THE ENVIRONMENT AGENCY'S VISION IS:

A better environment in England and Wales for present and future generations.

THE AGENCY WILL:

- Protect and improve the environment as a whole by effective regulation, by its own actions and by working with and influencing others;
- operate openly and consult widely;

ITS AIMS ARE:

- To achieve significant and continuous improvement in the quality of air, land and water, actively encouraging the conservation of natural resources, flora and fauna;
- To maximise the benefits of integrated pollution control and integrated river basinmanagement;
- To provide effective defence and timely warning systems for people and property at risk of flooding from rivers and the sea;
- To achieve significant reductions in waste through minimisation, re-use and recycling and to improve standards of disposal;
- To manage water resources and achieve a proper balance between the needs of the environment and water users;
- To secure, with others, the remediation of contaminated land;
- To improve and develop salmon and freshwater fisheries;
- To conserve and enhance inland and coastal waters and promote their use for recreation;
- To maintain and improve non-marine navigation;
- To develop a better informed public through open debate, the provision of soundly based information and rigorous research;
- To set priorities and propose solutions which do not impose excessive costs on society.
- To achieve significant and continuous improvements in the quality of air, land and water.

The Agency takes a much wider view of environmental regulation than was possible for its predecessors, while remaining an independent, impartial, and firm regulator in their best traditions.

LOCAL ENVIRONMENT AGENCY PLANS

In the Department of the Environment's Statutory Guidance under Section 4 of the Environment Act 1995 reference is made as to how the Agency should contribute towards the objective of attaining sustainable development. Local Environment Agency Plans will be used as integrated planning tools to take an holistic approach to protection and enhancement of the environment and encourage work in partnership with the public, local authorities, organisations and public bodies.

LEAPs will also play a key role in

- the efficient and effective delivery of services through integrated activity and priority business planning
- promoting openness and accountability
- providing a focus for liaison and partnerships with other key stakeholders
- educating the local public on environment management issues.

The Agency will seek active input into Local Environment Agency Planning from individuals and organisations concerned with the environment, and would wish to see the document used to influence and/or assist in the planning processes of others whose decisions may impact on the management of the environment.

Local Environment Agency Plans (LEAPs) are the successors to Catchment Management Plans produced by the National Rivers Authority

THE CONSULTATION REPORT

The South Yorkshire & North Derbyshire Local Environment Agency Plan will form one of several plans to be produced by the North East Region of the Environment Agency.

The publication of a consultation report due in June 1997 marks the start of a 3 month period of formal consultation enabling external organisations and the general public to work with us in planning the future of the environment of the River Don catchment area.

It describes the area, reviews the state of the local environment and identifies the uses and issues which need to be addressed and the proposals for action to address them.

The purpose of the consultation phase is to:

- establish the current state of the local environment;
- obtain views on the issues facing the environment;
- begin the process of identifying and implementing an Action Plan.

THE ACTION PLAN

The Local Environment Agency Action Plan will include:

- a final vision for the River Don catchment;
- a policy framework based on identified issues for the management of the environment over a five year period;
- costed action plans to address identified issues.

These elements will only be prepared once the period of consultation on this document has been completed and full consideration has been given to the responses received.

The Agency will monitor the implementation of the plan through regular consultationboth internally and with committed parties. Although these plans are non-statutory their aim is to provide a framework for the integrated management of the local environment between ourselves and other bodies.

THE ANNUAL REVIEW

The Agency will be jointly responsible, with other identified organisations and individuals, for implementing the Action Plan. Progress will be monitored and normally reported annually, by means of a review document which will be publicly available.

The review document will comprise of the following information:

- a detailed comparison of actual progress against planned progress;
- identification of additional actions necessary to maintain progress in the light of changes in the area;
- consideration of the need to update the LEAP.

APPENDICES INDEX I - VIII

APPENDIX I

Time Line of Events Which Helped to Shape the Future of the Don Valley

1100	Bedgrave Mill constructed on the River Rother. Today the mill forms part of the visitor centre at Rother Valley Country Park.
1112	William de Lovelot built a wooden castle at Sheffield.
1215-57	In the register of Archbishop Gray of York, references to iron mining at Silkstone and Tankersley.
1328	Weir at Brightside known to be in existence, serving a corn mill owned by Thomas de Furnival.
1531	Bodies called the commissions of sewers are set up by act of Parliament to regulate drainage and basic pollution control.
1578	Attercliffe Mill, a corn mill known to be in existence, this took water from a weir (Burton's weir) just downstream of Norfolk Bridge in Sheffield.
1581	Lady's Bridge Weir, Sheffield known to be in existence. Attercliffe and Nether Forges constructed, probably the earliest water powered Iron and Steel Works.
1626	Cornelius Vermuyden started draining the Hatfield Chase and diverting the course of the lower River Don.
1644	English civil war – Sheffield Castle besieged and conquered by Parliamentary army, including John Bright of Carbrook Hall and Kelham Homer, the Town's Armourer.
1648	Sheffield Castle demolished.
1703	John Yarnold began providing a water supply to Doncaster using a primitive pump known as the Water Engine. This took water from the River Cheswold. See Appendix ii(c)
1709	Abraham Darby first used coke for iron smelting in Coalbrookedale, Shropshire.This form of smelting was later adopted in the Don Valley.
1722	William Palmer carried out a survey of structures on the River Don to identify the difficulties likely to be encountered making the Don navigable.
1725	Act passed to make the Masters, wardens of the company of cutlers as undertakers of the River Dun Navigation from Holmes Stile to Tinsley.
1726	Act of Parliament passed which enabled work to commence on making the Don a navigation.
1729	Tidal locks constructed at Sandal just below Doncaster, probably the most significant event in the gradual demise of the salmon population.
1732	Amendment Act passed to divide interests of the two corporations; the Doncaster Navigation and the Master Cutlers. The Company of Proprietors of the Navigation of the River Dun was formed.
1740's	The development of crucible steel by Benjamin Huntsman proved to be an extremely important industrial breakthrough resulting in the transformation of Sheffield from a cluster of small metal working hamlets to the largest producer of steel in Europe by the late nineteenth century. See Appendix iv(a)
1742	Thomas Bolsover, a cutler accidentally invented silver plate (Sheffield Plate). While trying to repair a knife made out of copper and silver he unintentionally fused the two metals. This gave him the lucrative idea of making cheap copper items look expensive by coating them with a thin layer of silver. See Appendix iv(b)
1746	Masborough Ironworks, Rotherham founded by Samuel Walker and his brothers. In 1800 Walker's was probably the biggest ironworks in the country, supplying virtually all the huge cannons employed by the British Forces in the Napoleonic wars.
1773	The silversmith's industry of Sheffield acquired its own assay office. See Appendix iv(b)
1785	Benjamin Blonk & Co. opened the first steam powered grinding shop which gave the name to Blonk Street Bridge, Sheffield.
1787	John Read moved his Silver refining business from Green Lane, Sheffield to Royds Mill Farm. He is named as one of the lease holders of Royds Mill works in the Brightside rate books of 1834. This business was the forerunner of today's THESSCO works.
1796	Walker Bros. build the 'Milton Ironworks' at Elsecar because of an excellent supply of local iron ore.

1802	Stainforth Keadby Canal opened.
1810	Dove and Dearne Canal opened.
1815	Act of Parliament granted to extend the navigation from Tinsley to the centre of Sheffield. The canal opened in 1819 and for the first time it became possible to navigate from Sheffield to the North Sea on the Sheffield and South Yorkshire Navigation.
1820	Dore House Colliery opens adjacent to Orgreave Hall. This commenced a 170 year history of coal based industries in this area.
1825	First organised supply of water to Chesterfield. The water which was taken from Holme Brook was provided by the Chesterfield Waterworks and Gaslight Company. See Appendix ii(d)
1827	First piped supply of water to Rotherham, provided by a private company. Supply came under the Rotherham and Kimberworth Board of Health in 1853. See Appendix ii(b)
1830	Sheffield Water Company formed, it was privately owned and continued to provide supplies to Sheffield until 1887. George & Robert Stephenson use 'The Rocket' steam locomotive to open the first passenger railway from Manchester to Liverpool.
1836	The first major impoundment reservoir in the Don Valley is created at Redmires above Sheffield.See Appendix ii(a)
1839	A Superintendent was appointed to take charge of land drainage functions in the Dun Drainage Area.
1840	The first through railway opened (Sheffield/Rotherham/London).
1840	Aetna Works of Spear & Jackson established, makers of saws and tools. One of the first large companies to move to the East end of Sheffield.
1849	Firth Iron Wharf built on the Sheffield Canal at Tinsley. Swedish iron bars were delivered here from Hull. By several Acts of Parliament the navigation of the Dun became vested in the South Yorkshire Railway and the River Dun Company.
1856	Henry Bessemer discovered the Bessemer process of steel making. This produced an inferior quality steel to the crucible method but vastly increased production. This inferior steel was ideal for railway products ie. rails etc.
1857	John Brown opens the Atlas Steel works, over 25 acres in size.
1858	Robert Hadfield born, served a brief apprenticeship at Jonas & Colver before joining his father's new business as a metallurgist, and was only 24 when he discovered manganese steel. See Appendix iv(c)
1864	Collapse of Dale Dyke Dam. 250 people drowned.
1867	Vickers established their River Don works. The works grew rapidly, having 300 melting holes by the 1870's. Major armour plate and artillery production followed in the 1880's, and with the acquisition of the Maxim Gun Company in 1887 the company became a truly national concern.
1868	Barnsley Corporation started construction of their first water supply reservoir at Ingbirchworth.See Appendix ii(e) FJS Foljambe Esq, a local MP attempted to get an injunction against the Councils of Rotherham and Sheffield for allowing sewage to contaminate the River Don.
1873	Act passed leading to appointment of 12 Drainage Commissioners. A scheme for drainage improvement for the Doncaster Area was passed.
1881	Population of Sheffield reaches 300,000 serious pollution from inadequate sewage treatment facilities.
1883	160 million tonnes of coal in mined in Britain
1886	First reference to sewage treatment in Sheffield at Blackburn Meadows using the lime precipitation process. At the time they were opened, the works were considered a model and were visited by interested parties 'from all parts of the Kingdom'. Cost £44,730.
1889	Act passed to provide for the water rights of the Doncaster Corporation Mills in respect of the River Cheswold.
1910	As a result of pressure from the 'Local Government Board' and the 'West Riding Rivers Board', the old plant at B. Meadows was re-modelled and extensive 'bacteria beds' were provided. The estimated cost was either £360,000 or £480,000 depending whether or not the sewage needed to be passed once or twice through the beds.

1913	Harry Brearley became an expert metallurgist and it was while he was working for Firth's Research Department in 1913 that he discovered a type of steel extremely resistant to corrosion. This 'Stainless Steel' was to revolutionise the cutlery trade in particular. See Appendix iv(d)
1914	The start of the First World War which was to continue until 1918
1918	Doncaster Corporation successfully sink a borehole which provides adequate quantities of water to serve the towns needs. See Appendix ii(c)
1920	Sheffield's first Labour Council opened the Corporation Abattoir. Prior to this date the town's slaughterhouses were situated on Castlegate adjacent to the river and discharged their untreated effluent direct to the Don.
1928	The partial amalgamation of Vickers, Vickers Armstrong, Cammel Laird led to the title 'English Steel Corporation'.
1929	Doncaster Area Drainage Act – Obligations of mineowners.
1930	Land Drainage Act
1931	River Ouse Yorkshire Catchment Board inaugurated with responsibilities for land drainage.
1932	Chemicals are first used to kill insects on farm crops.
1937	Importation of water from the Derbyshire Derwent to supply Sheffield.
1939	The Start of the Second World War which was to continue until 1945
1948	River Boards Act. The navigation comes under the control of Docks and Inland Waterways Executive, later to become the British Waterways Board. Yorkshire Ouse River Board formed taking over the tasks of the West Ridings Rivers Board and the Catchment Board.
1952	Formation of 'Yorkshire Ouse River Board' – Pollution Prevention and Fisheries Functions added. Great Smog (air pollution) of London kills upto 4000 people.
1956	First flow measurement facilities purpose built on the Don system at Hadfields Weir Sheffield. See Appendix ii(h)
1961	Land Drainage Act.
1963	Water Resources Act.
1964	First piped supplies to Don Valley from Elvington on the River Derwent in North Yorkshire. See Appendix ii(f)
1965	Responsibilities for land drainage, water resources, water pollution control and fisheries passed to Yorkshire River Authority who had previously been known as Yorkshire Ouse & Hull River Authority.
1973	Water Act
1974	Yorkshire Water Authority is inaugurated and incorporates the Yorkshire River Authority. For the first time a holistic approach to water management is possible. The new authority have responsibility for sewage treatment, water supply, land drainage, pollution control, resource management and fisheries. See Appendix ii(a)
1976	Land Drainage Act consolidates previous drainage legislation. Severe summer drought in Britain. Water supplies to many homes and industries are restricted to a few hours a day.
1981	Wildlife & Countryside Act – to protect and conserve our areas of natural beauty.
1989	Water Act instigates the Privatisation of Yorkshire Water and establishment of National Rivers Authority.
1991	Land Drainage Act & Water Resources Act consolidation Acts for duties, powers ect., of all drainage bodies and local authorities in respect of all watercourses
1994	Land Drainage Act – imposed environmental responsibilities upon internal drainage boards and local authorities.
1995	Environment Act. Drought conditions in Yorkshire require massive movements of water by road tankers to top up reservoirs.
1996	Formation of Environment Agency.

APPENDIX II

THE HISTORY OF DRINKING WATER SUPPLIES TO THE MAJOR CONURBATIONS OF THE DON VALLEY

A) SHEFFIELD

The organised supply of water to the Sheffield area began in the early 15th Century, when men with a sense of civic responsibility began to build up local spring sources with troughs and convenient outlet pipes. These men clearly had in addition, some sense of personal pride which may be implied from records which indicate that the works constructed tended to vie with each other in the splendour of their designs. By far the most adventurous of its day was a pool in Balm Green, Sheffield created in 1434 by a gentleman called Barker. This site in the heart of the city is still known as Barkers Pool to this day.

This pool, fed by wells and springs, sufficed for a considerable length of time but was eventually overtaken by developments in the area which polluted its sources and rendered it unsuitable for use other than flushing open channels in the street and extinguishing fires. Between the 15th and early 19th Centuries, many sources of a similar type were constructed advancing up the valleys to keep clear of the continuing development of the towns in the area.

During the early 18th Century, attempts were made to secure a more reliable supply by creating small reservoirs. The first of these sites was probably at Whitehouse Dams and was situated adjacent to what is now Langsett Road. The first of 5 dams was completed in about 1737 and served to provide water which was sold by the bucket or barrelful. The first piped supply began from these sources in about 1741, when pipes made of hollowed out oak trees of between 9 and 12 inches in diameter were laid, connecting the dams with receptacles in the town. From here the water was transferred into casks which were fixed on wheelbarrows and then taken about town by men whose business it was to sell it to householders.

Throughout the remainder of the 18th Century and well into the 19th, the development of similar facilities continued with the size of the dams or reservoirs gradually increasing in size. In 1827 the 'Sheffield Mercury' records that a cast iron pump was fixed at the bottom of Sheffield Moor. This was a great improvement to that part of the town, as they had previously had to procure their supply from an open well which was often subject to contamination. The reservoir or tank connected to this pump held 10,000 gallons of water and for the first time afforded a reliable supply during the summer months. By 1830 the population of Sheffield had reached 90,000 and the demand for clean water was well outstripping easily available supplies. Many of the traditional sources were by this time polluted either by the effluent of old or developing industries or by the waste of its servants and urgent attention had to be given to securing supplies for the future. This was achieved when the first large impounding reservoir was built at Redmires and successively as demand increased, by the many other reservoirs listed in Part 1, Chapter 1a.

The original body responsible for the development of Sheffield's water supply was the privately owned Sheffield Water Company. They were formed by Act of Parliament in 1830 and continued to manage supplies to the city until 1887.

Following the disaster caused by the collapse of the reservoir at Dale Dyke, the company had obtained parliamentary powers to levy a 25% increase in its water rates to cover it for the losses incurred during the resulting flood. This expired in 1887 and the Company applied to Parliament to make the levy permanent and to further increase its charges.

In response to the Company's application, the Corporation of Sheffield gave notice that it was applying for a bill for compulsory acquisition of the undertaking. The two bills were keenly fought before a committee of the House of Lords, but finally Parliament found in favour of the Corporation. The amount paid by the Corporation for the company's assets was £2, 092,014 which was a considerable amount considering that in 1831 the

company had acquired all rights for only £41,800. The Corporation of Sheffield continued to manage water supplies to the city until 1974 when the responsibility became that of the Yorkshire Water Authority.

B) ROTHERHAM

Prior to 1827 the town of Rotherham relied on wells, springs and on the unpolluted waters of the Rivers Don and Rother for its water supply. Several of the wells used are recorded in parish documents dating back to 1549 with the sites at Wellgate, Domine and St Annes amongst the most important.

The waters of Wellgate spring were the most popular amongst the population and in 1791 an aqueduct was created which fed its waters to several spouts across the town from which people could obtain supplies. This continued until 1827 when a private company was formed who undertook to provide a piped supply to the town. Again it was the waters of Wellgate spring which were used, and from the well the water was pumped up to 2 service reservoirs at Quarry Hill and The Crofts, and subsequently through metal mains to the consumers.

In 1853 the supply of water came under the public control of the Rotherham & Kimberworth Board of Health. This body was responsible for erecting pumping engines connected to retaining tanks at College Fields and also constructed service reservoirs at Boston Castle and Kimberworth. These works, which came into operation in 1855, were still using water from Wellgate spring and this practice was to continue until the well became polluted by the growth of population and by increased agricultural activity in the area. It was finally abandoned in 1894. An example of the pollution problems are described below:

REPORT OF WILLIAM LEE ESQ INTO THE SANITARY CONDITIONS IN ROTHERHAM IN 1850

Conditions and Recommendations

1. There is much preventable disease and mortality in the townships of Rotherham and Kimberworth, that epidemics are very frequent and low typhoid fever almost constantly present in certain localities
2. That with the exception of the reparation of the public highways in the townships of Rotherham all the local arrangements having reference to the health of the inhabitants are exceedingly defective
3. That there are many narrow courts and alleyways in the town admitting little ventilation and that privy conveniences are constructed with open cesspools and pits to contain the night soil; they are frequently placed on the sides of the hills so as to be above the level of the other houses with the result that the offensive matter percolates through the walls of the dwellings below.

It is recommended that the health of the town would be much improved by a constant supply of pure water and by a system of drainage, the abolition of all privies and the substitution of soil pan apparatus with water laid on to convey the soil away from the town.

By the early 1860's it had become clear to the Board of Health that its springs supply could not be relied upon to adequately provide for the town's needs, and it therefore sought Parliamentary Powers to create an impounding reservoir. In 1874 Ulley Reservoir was completed harnessing the flows of Ulley and Morthern Brooks and this supply, together with a small impoundment on Dalton Beck, was initially adequate to meet needs. For a further 20 years, Rotherham's water requirements were satisfied, but by 1896 demand was showing signs once again of outstripping supply.

To meet the impending shortfall the Board entered into an agreement with the Corporation of Sheffield and Doncaster to construct the reservoir at Langsett, from which Rotherham were to be entitled to a daily supply of 1.6 million gallons. This supply came on stream in 1905, delivered by pipeline to the Boston Castle supply reservoir. It came just in time as, in 1906, the Dalton Brook became polluted by discharges from Silverwood Colliery and, along with several of the traditional spring sources which had also become unusable, it was abandoned.

Despite having secured its immediate needs the Corporation, who by this time had assumed responsibility for water supply, were not complacent and when an opportunity arose to obtain a further supply from Derwent Reservoir via Sheffield's Rivelin Valley Reservoir the Corporation took it. Their foresight secured the needs of the town for almost half a century, and it was not until 1960 that extra supplies were required. These, like the needs of Barnsley and Sheffield, were to be met by the Yorkshire Derwent Water Transfer Scheme, which is described later.

C) DONCASTER

Supplies of water to the settlements of the lower valley had traditionally been obtained from the rivers or from small wells. The first reference to water supply in the accounts of the Doncaster Corporation occurred in 1598 for the maintenance of wells and again in 1704 when they were fined £1.10s.0d for not removing dead cats and vermin from a well.

The first organised water supply to the town was provided by John Yarnold in 1703. Yarnold operated a primitive form of pump known as the water engine, which extracted water from the River Cheswold and passed it through pipes of wood and lead up to the town. In 1775 the Corporation purchased these works for the sum of £2,300 (a very considerable sum in those days) and continued to maintain them until 1916.

By the end of the 19th Century, Doncaster had become an influential railway town, being an important junction on the main route between London and the North of England. The population of the town had risen accordingly, with the development of a major locomotive manufacturing works and coal mining in the surrounding villages. By 1900 the town was beginning to suffer annual problems of insufficient supply which caused great concern. The river water was, by this time, too polluted to be used as drinking supply, and attempts to tap into known reserves in the Bunter Sandstone below the town had failed in 1862 when the borehole which was sunk unfortunately penetrated the magnesium limestone layer. The water obtained being of very poor quality.

In desperation the Corporation turned to impounded sources and built the reservoir at Thrybergh. This facility assisted in providing supplies, but its reliability was always threatened by mining activity around and beneath its catchment. Nevertheless, it allowed the town to prosper and with an additional 4,500 cubic metres per day purchased from Sheffield Corporation via its Langsett Reservoir, the supply requirements of the town were initially satisfied.

In 1918, 50 years after the first unproductive borehole was sunk, the Corporation of Doncaster decided to try again. This time they were very successful, managing to hit the sandstone and obtaining an excellent supply.

Meanwhile the rural areas surrounding the town still relied on local wells and small boreholes. After years of extreme difficulty and water shortage between 1905 and 1923, the Doncaster & Tickhill Joint Water Board, later to become the Don Valley Water Board, was formed and several very successful boreholes were sunk which, at last, provided these rural areas with a reliable supply.

D) CHESTERFIELD

The first organised supply of water to Chesterfield was provided by a company known as the Chesterfield Waterworks and Gaslight Company which was formed in 1825.

The supply obtained by this company was from the Holme Brook, which was dammed by a masonry weir built some 2 miles upstream of the town. From this point, the water was piped by gravity down to a supply tank or reservoir situated near what is now West Street in Chesterfield, and was then distributed by piped supply.

This supply received no treatment and its condition often raised criticism from the townspeople.It was once described thus: 'The condition of the water is such that the poor sometimes use it as soup.'

Despite its condition, no water borne epidemics were ever reported from this supply and it continued to satisfy demand until 1855 when a second company was formed and plans were prepared for an impounding supply. This was achieved by damming the Holme Brook to form Lineacre Lower Reservoir with a capacity of

31 million gallons. Within 10 years this supply was proving inadequate and Lineacre Upper Reservoir was added providing a further 126 mill/gals of water to serve the town's needs.

In 1895 the Chesterfield Waterworks and Gaslight Company relinquished its water supply responsibilities into the public ownership of the local Board of Health, who subsequently prepared plans to add yet another reservoir to their Lineacre group.

Lineacre Middle Reservoir was completed in 1904 and provided a further 90 million gallons of supply. With the addition of this third impoundment, the Holme Brook catchment was fully exploited and attention turned to securing additional water from borehole supplies. These were sunk at Whispering Well and Hunger Hill and with these extra reserves the towns needs were, in the short term, secured.

In 1920 the functions of gas and water were separated, water being taken over by Chesterfield Corporation. By this time, it is reported that over 50% of households in the town had water closets and 15% were enjoying the luxury of piped supply to baths. Demand continued to grow and in 1933 the Corporation, which by this time had formed the Chesterfield and Bolsover Water Board, sunk a further borehole at Whaley Hill.

Further amalgamations occurred in 1957 and 1963 and finally resulted in the formation of the North Derbyshire Water Board, with responsibility for supplying the needs of over 314,000 people covering an area of 450 square miles.

E) BARNSLEY

At the start of the 19th Century, the population of Barnsley was still reliant on its traditional well and spring sources and on the River Dearne for its drinking water supply. This continued to be the case until 1837 when the responsibility for providing supplies was taken over by the Barnsley Waterworks Company, who constructed a small reservoir at Smithies to the north of the town. Water for the reservoir was obtained from the adjacent River Dearne, and in turn, it was pumped from Smithies down to a service reservoir at Bailey Hill in the town. Water from this source initially received no treatment, and this continued to be the case until a new service reservoir was constructed with a filtration plant at Jordan Hill.

By 1852 the population of the town had grown to 15,000, yet despite this increase, approximately 40% of the houses were already receiving a piped supply, a much higher proportion than most other local towns. In 1858 the supply of water became a public responsibility under the control of the local Board of Health. They quickly recognised that the waters of the Dearne were becoming too polluted to be used for human consumption and began to search for other forms of supply.

Impoundment was the obvious answer and the Corporation commenced work on a new reservoir at Ingbirchworth which commenced operation in 1868. This supply sufficed to serve the needs of the town for a further 30 years, but by 1890 the Barnsley Corporation, who by that time had assumed responsibility for water, had begun to recognise the need for further reliable sources. This they obtained by the building of Midhopes Reservoir which was completed in 1903.

With adequate supplies now available, the Corporation extended its supply area providing water for many of the surrounding villages. They managed to meet demand until 1920, but again recognised that a further reservoir would be needed if future supplies were to be safeguarded. In 1923 Scout Dyke Reservoir was completed and this enabled the corporation to prosper, assured that its water needs were satisfied. For a further quarter of a century this remained the case, but by 1947 demand was once again beginning to outstrip supply.

This time the Corporation turned to the reserves in the coal measures below the town and sunk a series of boreholes between 1947 and 1962 which served to supplement their reservoir stocks. By 1962 the Corporation of Barnsley had assumed responsibility for supplying an area extending from Dunford Bridge in the west, South Elmsall in the east, Wintersett in the north and Wortley to the south, and even with these extra supplies, they were finding it difficult to meet increasing demand.

By the early 1960's it had become evident that the natural supplies available within the Don Valley were no longer able to meet the rapid increase in public demand. To meet this shortfall a new source of supply had to be developed and this is described in the next section.

F) HOW THE IMPENDING WATER SHORTAGE IN THE DON VALLEY WAS ADDRESSED

After the Second World War when all local sources had been utilised, the rate of increase in demand for potable water indicated that a new source would have to be found by the mid 1960's. A decision was taken at that time, that the most suitable source would be the River Derwent just before it became tidal, at a point some 11.3 km from York. Works were proposed to treat the water concerned at a new water treatment plant at Elvington, near Sutton on Derwent and to pump it through nearly 64.4 km of pipeline to Sheffield and Rotherham, making supplies available en route to Leeds and Barnsley. This scheme, which came into operation in 1964, was by 1974 supplying approximately 18.5 million gallons of water per day, an amount equal to that supplied by all the impounding reservoirs in Southern Yorkshire.

The earliest supplies from impounding reservoirs had been put into service without any treatment whatsoever and depended entirely for their purity on prevention of pollution at source. Later lime was added to prevent pick up of lead from supply pipes and subsequently simple forms of filtration were added. However, the supply from these sources was generally of reliable quality, and apart from the addition of chlorine to sterilise supplies, (a precaution added shortly before the Second World War) the process remained fundamentally the same in 1965.

In comparison, the supply from the Derwent required substantial treatment. This river, which rises on Fylingdales Moor about 12.9 km north west of Scarborough, flows down through the Vale of York to its confluence with the River Ouse at Barmby. En route it picks up the effluents from the towns of Pickering, Malton and Norton. Whilst the Derwent was classified as a Class 1 (clean river) it was, compared with the sources previously developed, highly polluted and required treatment of an entirely different standard. In addition, safeguards had to be built in so that in the event of failure of any critical part, alarms would sound and suspect water would be prevented from entering the distribution system.

Further complications were also presented by the fact that there was also an extremely variable character to the Derwent's water. This required an automatic installation to monitor these changing characteristics and to adjust the dosing accordingly. This was achieved by a plant which in comparison to those serving the Dons reservoir supplies, was extremely complex and required skilled operatives to man it.

The development of the River Derwent Water Transfer scheme added a new dimension to the Don's problems. The river was now receiving an additional 12 mgd later to increase to 18.5 mgd of water per day by way of the household and industrial use that the Elvington Supply was being put to. The majority of this water entered the river by way of sewage treatment works discharges, which placed a further huge burden on the rivers ability to dilute the vast amount of effluents it was receiving by 1974.

G) HISTORY OF RAINFALL RECORDING

In the 19th Century all the known reliable recording stations in this country were listed by G J Symons in 'Symons British Rainfall', the first edition of which appeared in 1860. He continued the task of listing the stations and their statistics until 1900, when ill health forced him to give up the job and pass it on to 2 able successors. At this time the number of stations listed was 3,500 compared with 424 in Symons original list of 1860. The number increased to about 5,300 by 1930 and by 1965 stood at 6,500.

The oldest records from stations in Yorkshire are from gauges installed in 1800 at Counter Hill, near Addingham and Thorne Fell, near Burnsall, both in Wharfedale. On the Don system, the first records were collected from a gauge at Goole Docks installed in 1863 and this site remains part of the Agency's recording network.

In 1932, following the establishment of the River Ouse (Yorkshire) Catchment Board and the River Hull Catchment Board, networks of stations were set up reporting directly to those Authorities. 'British Rainfall' was studied for the most suitable existing stations from which to request copy records month by month and

several new stations were installed. Because the Don was one of the first rivers the River Ouse Catchment Board intended to carry out works on, it was in this valley and that of the River Derwent that the first of these facilities were developed.

In 1948 further gauges were established on the Don and Rother catchments to act as an early flood warning system and information from these facilities was instrumental in the development of measures to control and alleviate flooding over the following decade and beyond.

The statutory requirement to record rainfall was continued under the Water Resources Act of 1963. This merged the Yorkshire Ouse Catchment Board and the River Hull Catchment Board into the Yorkshire River Authority. Under Section 15 of the 1963 Act, river authorities were obliged to prepare a 'hydrometric scheme' with proposals for the systematic measurement of rainfall, evaporation and river flows, and to submit this to the Water Resources Board. With the merger of the two Catchment Boards, the need to rationalise the rainfall recording networks became necessary, and a number of the more closely spaced gauges were terminated and new ones opened in areas where cover had previously been sparse.

By 1974, when the responsibility for rainfall measurement became that of the Yorkshire Water Authority, there were 22 recording stations on the Don system (including its tributaries). The highest of these stations was at Redmires above Sheffield at an altitude of 338 metres above sea level, the lowest was at the aforementioned Goole Docks at just 5 metres. The full list of sites on the Don in 1974 is included in The List of Rainfall Gauging Station in 1974.During the period of monitoring to 1974, the highest annual rainfall figure recorded in the Don, Rother and Dearne Valleys was at Dale Dyke Reservoir gauging station in 1905, when 1,341 millimetres of rain fell. The lowest figure recorded was at Thorne in 1951 with just 709 millimetres.

H) HISTORY OF FLOW MEASUREMENT

The earliest facilities for recording flow measurement in Yorkshire were installed on the River Nidd at Hunsingore in 1934. These early gauging stations were generally reliable for the purpose of giving satisfactory measurements of the average and high flows required for the land drainage and flood defence requirements for which they were built. They were not, however, accurate enough to provide the more detailed information required for water resources investigations. This information was essential for the satisfactory management of the resource in terms of assessing the existing and potential impacts of abstraction from the river by industry, agriculture and for domestic supply.

In addition, the Rivers Prevention of Pollution Acts of 1951 & 1961 gave powers to the River Boards to impose consent conditions on effluent discharges to rivers. In determining these conditions, it was essential to understand the characteristics of the river in question, and particularly to have records of the 'dry weather flow'. This factor was critical, as it formed the basis upon which the rivers ability to dilute the effluent was calculated.

The earliest flow measurement facilities on the Don system were at Hadfields Weir in Sheffield, built in 1956. For the first few years of its existence this facility provided only water level information, but in 1960 was upgraded to record river flow.

Further flow gauges were added, mainly during the period 1959-1965, to the Don at Doncaster and to several of the tributaries including the Rother and Dearne and for the first time it became possible for River Board Engineers and Scientists to begin to build a picture of the actual effects of rainfall, abstraction and pollution dilution on the Don.

I) ADDITIONAL INFORMATION

LIST OF FLOW GAUAGING STATIONS ON THE DON SYSTEM IN 1974 (NON TIDAL)

RIVER	LOCATION	NGR	RECORDS FROM
DEARNE	ADWICK	SE477 020	01.11.63
DOE LEA	STAVELEY	SK443 746	01.07.70
DON	DONCASTER	SE569 040	01.10.60
DON	SHEFFIELD	SK390 910	01.10.65
ROTHER	WHITTINGTON	SK394 744	01.10.63
ROTHER	WOODHOUSE MILL	SK432 857	01.10.61

LIST OF RAINFALL GAUGING STATIONS IN 1974

STATION NAME	NGR OF STATION	ANNUAL AVERAGE RAINFALL (mm)	START OF RECORD
Upper Don			
Ingbirchworth Reservoir	SE 213 056	991	1932
Langsett Reservoir	SE 211 003	1059	1948
More Hall Reservoir	SK 289 957	856	1916
Dale Dyke Reservoir	SK 242 917	1100	1905
Redmires Reservoir	SK 262 857	1082	1898
Sheffield	SK 339 873	780	1883
Rother			
Upper Linacre Filters	SK 339 727	848	1932
Whaley Well	SK 509 718	653	1944
Bolsover	SK 463 710	744	1952
Coisley Hill	SK 414 843	714	1951
Woodhouse Mill	SK 432 857	–	1961
Lower Don			
Thrybergh Reservoir	SK 474 961	645	1875
Dearne			
Emley Moor	SE 223 130	–	1964
Bretton Hall	SE 283 129	–	1963
Cannon Hall	SE 273 084	739	1914
Worsbrough Dale	SE 363 035	673	1947
Wath Wood Reservoir	K 437 993	620	1932
Tidal Don			
Doncaster	SE 581 033	–	1971
Thorne	SE 675 145	576	1951
Ackworth	SE 441 160	597	1952
Goole Docks	SE 745 235	622	1863

APPENDIX III

HISTORY OF FLOODING IN THE DON CATCHMENT

The steep sided valleys and high rainfall in the upper reaches of the catchment and the very high tide levels which can be experienced in the Lower Don, mean that large areas are at risk from flooding. Consequently, there is a long history of extensive engineering improvements which have been carried out as a matter of necessity to sustain and protect life and property from the disastrous effects caused by extreme flooding conditions in the river catchment. As with most large river catchments, the Don catchment has a history of notable floods (see below).

A GUIDE TO SERIOUS FLOODS ON THE DON SYSTEM PRE 1974

Date	River	Comments
1768	Sheaf	Part of Talbots Hospital washed away 5 residents drowned
Jan 1850	Lower Don	Flooding of Goole and surrounding land
11/3/1864	Loxley, Don	250 people drowned when Dale Dyke Dam bursts
4/5/1886	Don, Rother	Serious flooding in Doncaster, Rotherham
7/8/1922	Rother Valley	Serious property flooding
4/9/1931	Don, Rother	Extensive flooding of Rother and Don Valleys
24/5/1932	Don, Rother, Drone	Extensive flooding particularly in Doncaster/Bentley& Chesterfield
1/10/1941	Don	Highest recorded discharge of flood water through Doncaster
20/9/1946	Dearne	Large area of land flooded
19/3/1947	Don	Widespread flood of long duration. Doncaster levels similar to the October 1941 incident
July 1958	Rother, Sheaf	Highest recorded levels in these rivers
5/12/1960	Don	Areas upstream of Sheffield worst affected
10/12/1965	Don	Highest levels in Sheffield & Upper Don
13/4/1970	Dearne	Highest recorded levels in this system
July 1973	Rother tributaries, Sheaf	Intense storms causing severe flooding

Perhaps the most disastrous fluvial flood recorded in the catchment occurred on 11 March 1864, on the River Loxley in Sheffield. This flood was the result of a dam failure at Dale Dyke reservoir, near the village of Bradfield. The effects of the flood were felt as far as Attercliffe on the River Don and resulted in the loss of about 250 lives (still the most serious flood recorded in terms of loss of life in Britain).

On 14 May 1886, a notable flood occurred on the Rivers Don and Rother when information suggested the highest level was reached in Doncaster (see table above). The level reached during this event was estimated at 11.5 ft. A.O.D. (Liverpool Datum).

The most damaging flood on the Don system during the period 1974-1996 occurred on the River Sheaf on 21 December 1991. The flood happened due to the blockage of a debris screen. It caused flooding to Sheffield Railway Station and several commercial premises in the surrounding area.

APPENDIX IV

FOUR IMPORTANT INDUSTRIAL BREAKTHROUGHS IN THE IRON & STEEL INDUSTRY

A) CRUCIBLE STEEL

The development of crucible steel in the 1740s by Benjamin Huntsman proved to be extremely important, resulting in the transformation of Sheffield from a cluster of small metalworking hamlets to the largest producer of steel in Europe by the late 19th Century.

Huntsman, a Lincolnshire born clockmaker, moved to Handsworth from Doncaster in the early 1740s. By then he was already researching ways of refining poor quality blister steel in order to make better components for his watches and other instruments. He devised a method whereby blister steel was remelted in clay crucibles or pots in enclosed melting holes. The resulting refined steel had a much more even carbon content. It was the first cast steel, which made it well suited to the production of high quality agricultural and industrial edge tools.

However, because it was harder and superior to the blister steel, the cutlers and toolmakers in Sheffield at first refused to use Huntsman's invention, complaining that it was too difficult to work with. Unmoved, Benjamin simply exported his crucible steel. When it came back to Sheffield converted into vastly superior products, the local industrialists were forced to take notice.

A major advantage of the crucible steel making method was that it was ideally suited to working in small scale units. This encouraged the expansion of steel making from riverside mills and backyards to the large enterprises of the east end. Contrasting examples are the toolmaking operation at Abbeydale (which can still be seen at the industrial hamlet) employing five melting holes, and the main melting shops at Thomas Firth's which had over a hundred melting holes. The crucible method was also well suited to the production of specialist alloy steels, which were to figure prominently in Sheffield's industrial development. An example of a large crucible melting shop can still be seen at Sanderson Kayser's Darnall Works.

B) SHEFFIELD SILVER PLATE

While Benjamin Huntsman was busy inventing crucible steel, a cutler by the name of Thomas Bolsover was accidentally inventing silver plate. In 1742 while trying to repair a knife made of copper and silver, Thomas unintentionally fused the two metals. This gave him the lucrative idea of making cheap copper articles look expensive by coating them in a thin layer of silver. He started by silver plating simple articles like buttons and snuff boxes and then extended the idea to larger objects such as tea urns, tankards and candlesticks. On the back of Bolsover's invention the silversmiths industry in Sheffield grew to such a size that the town acquired its own assay office in 1773. Sheffield's assay mark before 1975 was a crown. Now it is a Tudor Rose, one of only four such marks remaining in the UK.

Thomas moved to Whiteley Wood Hall and set up a rolling mill and forge on the nearby Porter Brook. He died aged 84 in 1788 and was buried in St Pauls churchyard, now the Peace Gardens in the city centre.

By the mid 19th Century Bolsover's fused silver plating method was superseded by cheaper electroplating, to such an extent that articles plated by means of the old process are now extremely valuable.

C) SPECIAL STEELS

Sheffield's reputation as a premier producer of steel was built upon quality as much as quantity, and the development of special steels within the city was a key factor in enhancing that reputation.

Robert A Hadfield was born in Attercliffe Hill Top in 1858. Working for the small steel castings firm set up by his father, he was only 24 when he developed manganese steel, a steel which was tough, durable and non-magnetic. Hadfield went on to become an expert metallurgist, developer of alloy steels and builder of one of the largest steel making enterprises in the city, employing some 15,000 people in 1919. He was Master Cutler

in 1899, Knighted in 1908 and made Freeman of the City of Sheffield a year before his death in 1940. The firm he helped to create only outlived him by some 40 years.

D) STAINLESS STEELS

Harry Brearley was born near the Wicker in 1871. Like Robert Hadfield he became an expert metallurgist, and it was in 1913 while working in Firth's research laboratories that he discovered a type of steel extremely resistant to corrosion. This discovery of 'stainless' steel was to revolutionise the cutlery trade in particular, but at the time Brearley's employers were singularly unimpressed. They concluded that his discovery was neither of commercial value nor scientific interest. The rest is history.

APPENDIX V

ORGREAVE RECLAMATION SITE

The site of the Orgreave Coking & By Products Plant is typical of the industrial degradation created by coal mining and its associated industries.

Industrial activity commenced on the site in 1820 when the Dore House shaft was sunk adjacent to Orgreave Hall. This shaft and several others which were subsequently sunk were acquired by the Fence Colliery Company, later to become the Rother Vale Colliery Company and were operated as such until 1919. In 1919 the sites were acquired by the United Steel Companies who used the coal obtained to supply their new Orgreave Coking and By Products plant.

This operation continued until 1947 when the coal industry was nationalised and the mining operations were separated. The coal processing and chemicals interests remained with United Steel Companies under their subsidiary, the United Coke & Chemicals Company.

Under nationalisation the 2 main collieries of Orgreave and Treeton were linked and together used coal washing facilities at Orgreave Coal Preparation Plant. By 1992 when the collieries were closed the spoil heap created by 170 years of mining activity had amassed to a total of more than 12 million cubic metres of material.

In addition to coal spoil, part of the area was used for the disposal of steel works slag, which was imported from a number of sites. This material was deposited into 2 depressions which had been created by the opencast exploitation of shallow coal reserves in 1946 and 1948.

The spoil heaps at Orgreave had a history of overheating caused by the slow burning of discarded coal within the tip and for many years ammonical liquors, a by product of the coal tar distillation process were pumped on to the stacks. This had the benefits of partly neutralising the liquor and of helping to cool the burning of the coal deposits. Unfortunately some of the liquor was able to percolate through the material eventually seeping into the River Rother, a problem experienced at several similar sites throughout the Don system.

The industrial activities which were carried out in and around this site over 170 years led to both physical degradation of the area and in places serious land contamination. Following the closure of the Orgreave Coke & By Products plant in 1990 opportunities for restoration of the area were investigated and in 1995 planning permission was sought by British Coal Opencast.

The scheme which received approval involves reclamation of approximately 256 hectares of land and will be achieved principally by the creation of an opencast void from which available coal will be removed. When extraction is complete an impervious cell will be created at the base of the void into which all contaminated material will be sealed. The void will then be infilled and the whole site landscaped.

The restoration strategy which is to be implemented in agreement with Rotherham Metropolitan Borough Council will pay particular attention to the recreation of the valley form of the River Rother and will involve the planting of significant areas of new woodland. Some diverting of the river channel will be necessary but the design of the new course will incorporate features which will benefit the ecological recovery of the river, in particular its recovering fish populations.

APPENDIX VI

THE DECLINE OF THE OTTER IN THE RIVER DON CATCHMENT

The changes in otter populations, perhaps more than those of any other animal, typify the decline of many of the rivers of England and Wales. Its position in the food chain and its sensitivity to man's activities mean that the degradation of the aquatic environment has had devastating consequences for this shy and secretive creature.

Records of otters in the catchment have been collated by Colin Howes from Doncaster Museum and this case study is based directly on his research.

Until the middle part of the 18th Century otters were certainly present throughout the Don catchment as well as much of the surrounding area. Contact with man was apparently frequent and the records certainly show that fish rearing ponds and ornamental lakes were visited. William Guest, an angler from Bentley recalled that during the 1790's he 'frequently met with otters in the Don'. The island in the Don at Sprotborough was locally known as Otter Island. Many of the early reports of otters come from the records of churchwardens and parish constables who were able to pay bounties for the control of vermin. A number of parishes paid one shilling for otters (bowsons) as compared with 2d for a weasel (weevil) or 4d for a polecat (foulmart). In the parish of Arksey the annual otter cull up until the late 1790's was around one per year up to the maximum of five.

Hunting for sport also occurred. Two notable otter hunters were Messrs Whittaker 1710-1794 and Lee 1755-1814 both of Auckley. Both were renowned for their skills in tracking the animals and Whittaker was allegedly a master in the use of the otter spear and delighted in recounting his otter hunting exploits.

Whittaker evidently played an important role in the destruction of otters which fished the ornamental lakes and ponds in the Doncaster area and Hatfield in his 'Historical Notices of Doncaster' recounts that 'Every hall and mansion of consequence in the neighbourhood received him... the more he protected the stew pond, the more cordial were his receptions'.

In the Dearne and Dove valleys, particularly in the Worsbrough, Rockley and Stainborough areas where, during the early 1700's, otters had abounded a marked fall in population was inferred in 1853 by the poet-naturalist, Thomas Lister who wrote in his 'Tributary Ode to Stainborough'

> 'The brown diving Otter no longer is gliding, Beneath the fring'd banks of the cool valley rill
> Nor bitten is calling, nor curlew is hiding, Nor badger is housed in the cleft of the hill.'

And referring to the Tankersley area, Wilkinson in his history of Worsbrough 1872 comments, 'It certainly possesses not permanent abode here, having become a great stranger'

Otters were also quite common in the valley of the River Rother in the 18th Century as indicated by parish records at Whiston Church. Between 1722 and 1729 bounties were paid on 5 otter heads by church wardens, all it would appear to a hunter by the name of David Snowden.

The last recorded evidence of an otter in the valley of the Rother was a specimen shot by T Livesley Jnr on 14 December 1895 near Hartington Colliery.

Away from the main urban and industrial centres and in areas relatively free from water pollution, small relict populations still survived in the early 20th Century. In 1910 Denny noted in the 'Proceedings of the Sheffield Naturalists Club' that otters were present in unpolluted waters above Sheffield and Corbett knew of them persisting in the lower Don area

Despite the decline of the species, otter hunting continued to be carried out up to the late 1940's. Annual late summer visits were made by the Buckinghamshire pack which based itself at Bawtry. These sorties were generally successful indicated by the killing of 3 otters in 1946 from Serlby Lake, which used to lie adjacent to the River Ryton, near Bawtry.

As far as the Don system is concerned it would appear that otters have been absent from the river and its tributaries for most of the 20th Century. No further records are available in support of their continued existence following the information provided by Denny and Corbett. As the river continues to improve, and lost habitats are restored, the fish populations which this most charming creature relies upon will redevelop perhaps attracting the otter back to its original haunts.

As this document went to publication in March 1997 confirmation was received that an otter was once again resident in the Don catchment.

APPENDIX VII

STURGEON IN THE RIVER DON

Records of this species occurring in the Don has been researched by Colin Howes, Environmental Records Officer for Doncaster Museum and the following information is produced from his document 'The History and Distribution of Fish in the Doncaster District'.

Up until the turn of the Century, Sturgeon were infrequently, though regularly reported from the Ouse, Trent and the Don, specimens coming in from the sea usually during the early summer. The Salmon nets on the Ouse at Goole and at various points along the Trent regularly caught specimens, though only a handful of accurate records are available. Individuals which were unfortunate enough to find their way up the Don were energetically and mercilessly harpooned, netted, shot or stabbed to death whenever they reached the weirs and locks at Doncaster. A specimen which appeared in Doncaster Museum had apparently been killed with a pitchfork and landed at Sandall Lock during the 19th Century and was for years displayed in Claybourn's fish shop in St Sepulchre Gate, Doncaster. The following is a catalogue of recorded occurrences in the Ouse at Goole, the Trent and the Don. No doubt further investigation through old histories would reveal more.

1639	one in the Don at Mill Pit, Doncaster
1670	one in the Don at Dockin Hill, Doncaster
1688	one in the Don at Engine Dam, Doncaster
1727	one in the Don at Engine Dam
1824	one in the Don at Sandall near Doncaster
10.6.1835	one in the Don at Sandall, a 198.12cm (6ft 6in) specimen with a girth of 112.7cm (3ft 3in)
28.7.1843	one 213.36cm (7ft) specimen weighing 120lb caught in the Don at Corn Mill Bridge, Doncaster 'Others were recently taken their'
15.6.1858	one 213.36cm (7ft) specimen caught in the Don at Sandall, one of two which reached the area on the spring tide
28.4.1860	one 243.84cm (8ft) specimen with a girth of 117.7cm (3ft 5in) caught in the 'Wash Hole', Marshgate, Doncaster
4.7.1860	one 274.32cm (9ft), 127kg (20st) specimen with a girth of 140cm (4ft) was speared with a hay fork and later found dead at Barnby Dun. Its preserved skin was donated to Doncaster Museum
25.7.1861	one 193.04cm (6ft 4in) specimen caught near Parkinsons Corn Mill, Doncaster
6.1869	one 243.84cm (8ft) 82.55kg (13st) specimen was shot near Wheatley Hall by Henry Poppleton. One the same day a smaller specimen was caught near the Corn Mill Weir.
1870	one in the Don at Dockin Hill, Doncaster
1.6.1871	one 259.09cm (8.5ft), 95.25kg (15st) specimen was shot near the railway bridge
1871	one $8^{1}/_{2}$ft specimen weighing 16 stones, caught in the Trent at Muskham near Newark on 10 June

(Extracted from Howes, CA (1997) 'The Sturgeon (Acipenser sturio L.) in Yorkshire waters, the tributaries of the Humber and the Dogger, Tyne and Humber sea areas'. Unpublished MS in Museum & Art Gallery, Doncaster

APPENDIX VIII

THE FIVE WEIRS WALK, SHEFFIELD

The Five Weirs Trust was established in order to ensure that the regeneration of the River Don became a central feature of the renewal of Sheffields east end and that public access to the 7.5km of river with its five magnificent and historic weirs was given back to the people of Sheffield. The aims of the Trust are:

- to promote the idea of the walk in local planning policy and to ensure that sections of it are built as part of major construction projects on the Don wherever possible.
- to persuade local authorities such as Sheffield Development Corp. and the City Council to contribute to the achievement of the walk.
- to carry out construction of certain sections itself.
- to promote local community involvement in and 'ownership' of the walk and to encourage responsible recreational and educational use of it.

75% of the walk is now completed or under way. Salmon Pastures is one of the 3 last remaining sections to be achieved to link Sheffield City centre and Rotherham Town centre.Since 1988 the Trust itself has constructed 1km of walk at a cost of £500k. A further 2km has been built by others within a strategy and design framework prepared by the Trust.

The Lower Don Valley is Sheffields heavy industrial heartland where intense development by the steel companies in the 19th and early 20th Century was followed by decline in the 1980s leaving a devastated and impoverished environment.

Salmon Pastures, probably the most mature and attractive part of the Lower River Don in Sheffield, is now once again popular with anglers and naturalists, but it has had a most varied and interesting history. An idyllic area of water meadows in the pre-industrial era, it was the site of one of the earliest crossing points of the River Don, Washford Bridge. In the 16th Century the Burton Weir was constructed to provide power for a series of rural cutler wheels. In the 19th Century the banks became lined with steam powered factories and the landscape was grossly disfigured by the establishment of coke ovens which created a large slag heap on the river's edge and apparently obliterated all vestige of a natural habitat. The river then effectively 'died' for a century.

In 1959 the City Council carried out a major bank stabilisation and a reclamation scheme which included the creation of new banks and formal tree planting. In the 1980's water quality in the urban Don improved dramatically as a result of better control of pollution, the closure of many factories and the construction of a new trunk sewer which diverted storm water overflows of sewage.

AMENITY

Since the late 19th Century industry in Sheffield has gradually moved away from the riverbank locations which were originally dictated by the need for water power. This happened first in the city's south western river valleys where the parks and green links which have now largely replaced factories. The east end of the city has, until recently remained densely industrialised and as a result access to natural environment has been very limited for residents of the valley side communities of Darnall, Tinsley, Brightside, Wincobank, Burngreave and Manor, which include some of the city's most disadvantaged people.

In recent years the lower Don Valley has also become a popular location for educational field-study trips by schools and universities looking at the effects of industrial change and regeneration. The Trust has sought to provide a facility which initially meets the needs of local residents and workers but which will also gradually become an attraction for visitors from a wider area as it develops and links to other routes and attractions. In particular the Walk relates closely to the recently restored Sheffield Canal which follows a parallel route down

the Valley and which is now fully accessible. Taken together the two will soon offer a 16km circuit of continuous waterside paths with cross links at various points.

Beyond the immediate locality the Walk will form part of a wider strategy to open up the whole River Don from the Pennines to the Humber with complementary action taking place in the upper Don Valley, in Rotherham and in Doncaster. The route will link Sandersons Mill Race Ecology Park, the Blackburn Meadows Nature Reserve and the Earth Centre. The Fiver Weirs Walk will also connect to the Trans-Pennine Trail via the proposed Chapeltown Railway cycle-footway.

ANGLING

Sheffield is a city of half a million inhabitants located far from either coast, yet it has more licenced anglers per capita than any other city in the UK. Traditionally most of these were obliged to seek out fishing on the rivers of rural Nottinghamshire and Lincolnshire because local waterways were too polluted and inaccessible. Now the Don in Sheffield supports a good and improving coarse fishery and a salmon has appeared downstream of Doncaster. The Sheffield Canal is now the most heavily fished waterway in British Waterways ownership.

As a heavy industrial centre Sheffield has a particularly high proportion of disabled people and a strong disabled anglers association, but facilities do not meet current demands. The development of fishing opportunities close to home assist the disabled and also encourage children to participate in the sport.

The Walk is available for free public fishing and the Trust has taken trouble to ensure involvement and ownership from both the Environment Agency's Fisheries Recreation and Conservation Department and wheelchair anglers groups. (In common with all waters in England and Wales, a licence to use a fishing rod is required to fish waters on the Don system. Also local byelaws should be checked and followed.)

HERITAGE

Although water powered industry is now virtually extinct in Sheffield, the physical infrastructure remains often surprisingly intact. There are few better locations to appreciate and understand Sheffield's industrial heritage than from its riverbanks, especially in the east end with its five magnificent weirs and two surviving goyts one of which is located at Salmon Pastures.

WILDLIFE & ECOLOGY

The ecology of the urban Don is among the best documented in Europe thanks to the efforts of local naturalists. Its proximity to the gathering grounds of the Peak District and its history of industrial change make it particularly rich now that water quality is improving.

Salmon Pastures is a fascinating and dramatic case study of environmental devastation followed by spectacular recovery. An ecological survey commissioned by the Trust substantiates this statement and indicates a particularly rich insect population and breeding sites for a number of water birds as well as unusual areas of heather and other species possibly dating from before the industrial exploitation of the site.

GLOSSARY

ALLUVIUM	–	fine, fertile soil of mud, silt and sand deposited by flowing water
ANADROMOUS	–	saltwater-living, freshwater-reproducing eg salmon
ANAEROBIC	–	does not require oxygen for breakdown by bacteria
BIODIVERSITY	–	the variety of species within a given natural environment
BIOMASS	–	quantity weight of living material in a unit of area
BIOSPHERE	–	the part of the earths surface/atmosphere inhabited by living things
CATADROMOUS	–	freshwater living, saltwater-reproducing eg eel
CORACLE	–	small round boat made of waterproof hides stretched over wicker frame
CRADGE	–	temporary/intermediate flood bank
ECOLOGY	–	study of plants, animals in relation to environment
ECOSYSTEM	–	involving the interactions between a community and its non-living environment
FLUVIAL	–	occurring in a river
GAFF	–	a large hook on a pole
GLACIAL	–	characterized by the presence of masses of ice
GOIT	–	colloquial word for trench bringing water to a mill wheel
GRAVID	–	preparing to spawn, ready to deposit eggs or milt
IMPOUNDMENT	–	to collect water in a reservoir, dam or weir
INDIGENOUS	–	native, occurring/originating naturally (in a country etc)
INVERTEBRATE	–	any animal lacking a backbone
HECK	–	form of fish trap
PISCIVOROUS	–	fish eating
RACE	–	a channel/stream conducting water to or from a mill water wheel
RIVERINE	–	normally only found in flowing water conditions
SALMONID	–	of the Salmon species ie. salmon and trout
SAPROBIC	–	pollution, decaying
SINUOUSOIDAL	–	full of turns & curves
SPATE	–	a flood, sudden rush or increased quantity, fast flow
TAXONOMY	–	classification of organisms
TECTONIC	–	art/science of construction or how earths surface attained its present structure
TOPOGRAPHY	–	detailed study, description of features of a limited area
TOXIC RED LIST		a list of hazardous substances as identified by the DOE and EEC

ABBREVIATIONS

AOD	–	Above Ordanance Datum
ASPT	–	Average score per Taxa
BMWP score	–	Biological Monitoring Working Party System
BOD	–	Biochemical Oxygen Demand
Cumecs	–	Cubic metres per second
Cusecs	–	Cubic feet per second
DOE		Department of Environment
EA	–	Environment Agency (1 April 1996)
EEC		European Economic Community
EU	–	European Union
HMIP	–	Her Majesties Inspectorate of Pollution
LEAPS	–	Local Environment Agency Plan
NRA	–	National Rivers Authority (1989-1996)
RSPB	–	Royal Society for the Protection of Birds
STW	–	Sewage Treatment Works
UNESCO	–	United Nations Educational, Scientific & Cultural Organization
YWA	–	Yorkshire Water Authority (1974-1989)
YWplc	–	Yorkshire Water Public Limited Company (1 September 1989)

DEFINITIONS

Gauging Flow Station

The term is used in this document to refer to a place on a river where water levels or some other factor related to the flow of a river is recorded continuously or at fixed and frequent intervals so that the flow of the river can be calculated.

Dry Weather Flow

The definition adopted in the document is that the dry weather flow at a point on a river is the average of all the 'seven day minimum flows' for all the years in the period of records of flows at that point.

Biochemical Oxygen Demand

The requirement for oxygen excess is called the *biochemical oxygen demand*, usually abbreviated to BOD. If there is an excess of oxidizable organic matter in a river or pond, arising from a discharge of an effluent such as that from a sewage treatment works or liquid manure slurry from a farm, the bacteria carrying out the oxidation may utilize all the available dissolved oxygen causing an acute shortage of oxygen for fish, which then die from asphyxiation. A simple measure of the potential of biologically oxidizable matter for de-oxygenating water is given by the biochemical oxygen demand (BOD). The BOD is obtained in the laboratory by incubating a sample of water for five days at 20°C and determining the oxygen utilized. Typical values of BOD are <3mg/l for Class 1A rivers in the UK (the least polluted Class), <5mg/l for Class 1B, 9mg/l for Class 2 (more polluted and only suitable for potable supply after advanced treatment) and 17mg/l for Class 3 (poor quality water with few fish present).

pH

Potential of hydrogen; a measure of the acidity or alkalinity of a solution. Pure water has a pH of 7, acid solutions have a pH less than 7 and alkaline Solutions a pH greater than 7.

Sewage Treatment

Primary Settlement – After the rags and grit have been removed from the sewage, the next stage is to separate the solids from the liquid sewage. This is done in a settlement tank.

Biological Treatment – Biological filters are beds of clinker or stone about 6ft deep over which the tank effluent is sprinkled. The surface of the stones become covered with a jelly like film containing bacteria and other small organisms which 'eat' the sewage. As the liquid is passed through the bacteria and other organisms remove the waste matter. In the Activated sludge process bacteria are added to the sewage and the two are mixed and aerated continuously. The bacteria congregates around small sludge particle hence the term activated sludge. The sludge and sewage are then mixed together.

Final settlement – The remaining dead bacteria, micro-organisms and slime is settled out in tanks. It decomposes in covered tanks without air, allowing the Anaerobic Bacteria to 'eat' the organic material in it. The sludge is disposed of at sea or incinerated. Also it is sprayed on to land to improve soil or used in solid form as manure.

Industrial effluent however may not be suitable for the latter.

Metric & Imperial Measures

Please note that calculations from metric to imperial and vice versa may not be exact but rounded up or down to the nearest $^1/_4$ or .25 decimal point.

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