ENVIRONMENT AGENCY

RIVER TAVY ALLEVIATION OF LOW FLOWS PROJECT

TAVISTOCK / MORWELLHAM CANAL

INVESTIGATION INTO ENVIRONMENTAL IMPACTS OF PROPOSED FLOW CHANGES

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EXECUTIVE SUMMARY

The River Tavy has experienced a low flow problem over many years as a result of several major abstractions along its length. Water is abstracted for hydropower generation and public water supplies.

Abstraction to the Tavistock/Morwellham canal at Abbey Weir for hydropower represents one of the major abstractions from the Tavy. A Heads of Agreement was signed in 1978 between the then South West Water Authority and the Central Electricity Generating Board with the aim of applying an increasing prescribed flow in the Tavy at the Abbey Weir.

Although it was not the intention of the Agreement to cause the prolonged absence of flow in the canal the Agreement does not contain any measure of what the canal sweetening flow should be. As a result, sweetening flow trials have been progressed by the Environment Agency with the aim of establishing the minimum flow requirements to the canal.

It was recognised by the Environment Agency that there are a wide range of issues along the canal which must be considered when setting flow levels. This includes issues such as recreation, conservation, ecology, archaeology, abstraction rights, potential developments and water quality.

A one day flow trial was carried out in December 1995 with a sweetening flow of 0.140m^3/s. A group of interested parties was asked to assess:

- the suitability of 0.140m^3/s as a winter sweetening flow which may be operational for several weeks; and
- the suitability of 0.140m^3/s as a summer flow which may be in operation for several months.

The group considered that this flow would be suitable as a winter sweetening flow, subject to certain conditions to protect the integrity of the canal liner. However, this flow was considered unsuitable as a summer sweetening flow due to concerns about the integrity of the canal and environmental impacts.

As a result a further trial was carried out in the summer of 1996, with temporary weirs to pond back a sweetening flow of 0.140m^3/s with most of the water returned to the Tavy via the River Lumburn.

It was found that these weirs protected the water depth in the canal, however, with lower velocities. Environmental impacts were assessed and it was found that this operating seenario protected the integrity of the canal, its archaeological context, the water quality and ecology of the canal on the Tavistock side of the tunnel entrance.

There were concerns raised about the lack of flow to users downstream of the tunnel entrance and as a result it is recommended that further trials need to be carried out to establish operating rules to protect Morwellham Combe while maintaining the integrity of the canal.

1.0 INTRODUCTION

1.1 The River Tavy Alleviation of Low Flows Project

1.1.1 The Environment Agency recognises that the River Tavy has a low flow problem. A report by Halcrow [1] (1991) commissioned by the then National Rivers Authority cited the River Tavy as one of several rivers significantly affected by low flows caused by abstractions. The main issues of concern are:

- the impact of low flows on migratory fish, particularly Salmon in terms of reduced breeding areas and the impact on fisheries;
- the visual impact of low flows; and
- ecological impacts of sustained low flows and the reduction in ecological niches and habitats.

1.1.2 A number of studies have been initiated by the Environment Agency as part of the River Tavy Alleviation of Low Flows (ALF) Project to investigate the impact of sustained low flows on the River Tavy.

1.1.3 There are five abstractions under investigation as part of the ALF Project:

- Tavy Cleave - for hydropower
- Hill Bridge - for hydropower
- Tavistock fish farm - for fish farming
- Abbey Weir - for hydropower
- Lopwell Dam - for public water supply.

The location of these abstractions within the River Tavy system is shown on Schematic 1.

1.1.4 The hydropower abstractions at Tavy Cleave and Hill Bridge operate 24 hours a day to divert flow to two storage reservoirs, Wheal Jewel and Bennetts. Water stored in these reservoirs is discharged through Mary Tavy Power Station and returned to the River Tavy via Cholwell Brook. Generally, water is only returned from Mary Tavy Power Station over

a 12 hour period causing a peaked daily flow regime in the river downstream of the power station. Both the Tavy Cleave and Hill Bridge abstractions are licensed, but neither is subject to a residual flow requirement. As a result of these abstractions the 7km reach between Tavy Cleave and the confluence with the Cholwell Brook has significantly reduced flow. When Mary Tavy Power Station is not discharging this reduced flow is 'carried forward' down the river.

1.1.5 The Abbey Weir Abstraction diverts water from the River Tavy in Tavistock for use in Morwellham Power Station. Water abstracted at Abbey Weir is normally lost to the Tavy since it is carried to the Power Station via the Tavistock to Morwellham Canal and discharged to the River Tamar. Unlike the abstractions at Tavy Cleave and Hill Bridge the abstraction at Abbey Weir is subject to a residual flow condition.

1.1.6 The requirement for a residual flow in the Tavy downstream of Abbey Weir arose out of a Heads of Agreement signed in 1978 by the South West Water Authority (now South West Water Services Ltd. and The Environment Agency) and the Central Electricity Generating Board (now National Power). South West Water Authority wished to take all possible steps to increase the flow down the Tavy to mitigate the effect on fisheries of the public water supply at Lopwell Dam. Although the parties agreed to reduce the flow to the canal by gradually increasing the residual flow at Abbey Weir, no targets were set for flow levels to the canal when the River Tavy was below the residual flow. However, one major proviso of the agreement was that any reduction in flow to the canal should not compromise its integrity and viability or the rights of water users.

1.2 Abstraction at Abbey Weir to the Canal

1.2.1 The Tavistock to Morwellham canal was built in 1803 to transport coal to Tavistock and to return wool, minerals and agricultural produce. Following the decline in use of the canal and its fall into disrepair in the 1880's, it was re-opened in 1933 by the West Devon Electric Supply Company in order to supply the hydro electric power station at Morwellham.

1.2.2 Abstraction to the canal is currently controlled by four automatic sluice gates. The gates control the flow into the canal by opening and closing in response to changes in river level

in the fish pass. Flows in the canal therefore vary with flow in the river. They tend to show the expected seasonal pattern being higher in winter and lower in summer. Winter flows in the canal are often above 1.2m^3/s. Summer flows are lower but more variable.

1.2.3 In 1994 the Environment Agency (then the National Rivers Authority) revealed that the arrangements at Abbey Weir for measuring the residual flow were unsatisfactory and had led to National Power unwittingly abstracting more water at low flows than anticipated under the 1978 Agreement. However, in order to revise the balance of flows between the canal and the River Tavy a minimum flow, defined as a sweetening flow, needs to be agreed for the canal.

1.2.4 In December 1995 and summer 1996 the Environment Agency conducted a series of trials in the canal to test potential sweetening flows. The sweetening flow should be sufficient to maintain the integrity of the canal and maintain obligations to supply water to other users.

1.2.5 In October 1996, South West Water Services Ltd. purchased the hydropower stations at Mary Tavy and Morwellham and their associated leats (including the Tavistock to Morwellham canal)..

1.2.6 With the transfer of ownership of the canal from National Power to South West Water Services Ltd. there may be a shift in emphasis in the operational rules for the canal. However, in the short term it is expected that:

- sweetening flows similar to the summer 1995 flow trials will operate during the summer period; when flows in the River Tavy fall below the residual flow at Abbey Weir.
- abstraction at Abbey Weir will continue at similar rates to those experienced in the past during the winter in order to generate power at Morwellham with occasional use of the sweetening flow when levels in the Tavy fall below the residual flow.

1.3 Objectives of the Canal Study

1.3.1 This study has been restricted to the potential impacts of flow changes in the Tavistock to Morwellham Canal and has not considered the impacts of increased flows in the river Tavy

downstream of Abbey Weir. It is assumed that increased flows would be beneficial to the Tavy however, further separate studies are being carried out by the Environment Agency to assess this.

1.3.2 The key objectives of this study have been to:

- investigate the potential environmental impacts of the proposed flow regime;
- identify where further information is required and to progress these studies;
- propose additional management enhancements.

1.4 Key Environmental Issues

1.4.3 The following are considered to be the key environmental issues which may be affected by flow changes to the canal and were therefore considered in this study :

- archaeology of the canal and adjacent structures;
- recreational uses of the canal - existing and potential;
- designated areas - landscape and conservation;
- ecology in terms of fish, invertebrates, birds, mammals and plants;
- water quality and abstraction rights;
- existing planning permissions issued by West Devon Borough Council for proposed developments.

1.5 Sources of Information

1.5.1 Information and data on the canal have been collated from a variety of sources, as given below :

- internal Environment Agency (water quality, water resources, fisheries, invertebrate and macrophyte information);
- local council planning documents (West Devon Borough Council Local Plan);
- statutory bodies such as English Nature;
- non statutory wildlife trusts (Devon Wildlife Trust);

- Devon County Archaeologist and the Sites and Monuments Register held by Devon County Council;
- National Power;
- The Morwellham and Tamar Valley Trust.

1.5.2 Where insufficient data existed on certain environmental issues specific field studies were initiated, these included :

- invertebrate studies;
- macrophyte study.

2.0 THE LAYOUT OF THE CANAL SYSTEM

2.1 Introduction

2.1.1 A brief description of the abstractions on Tavy watercourse system was given in section 1.1 and the layout is shown on schematic 1. The layout of the Tavistock to Morwellham Canal system is briefly described below and is shown on schematic 2.

2.1.2 Water for hydropower generation at Morwellham is abstracted to the canal from the fish pass at Abbey Weir.

2.2 Offtakes from the Canal

2.2.1 In the Meadows area there is an overflow point which drains to the River Tavy. There is an underground land drain from the Meadows area which joins this overflow before it reaches the River Tavy.

2.2.2 The next overflow point is at Locks Cottage where water can be released via a sluice gate to return to the Tavy. This water cascades down a waterfall, and runs along the edge of the field before entering the River Lumburn; a tributary of the River Tavy.

2.2.3 There is a penstock approximately 100m upstream of the tunnel entrance via which water can be returned to the Tavy, via the River Lumburn.

2.2.4 There is a further penstock just prior to the tunnel entrance which can channel water from the canal to the Tavy via the Lumburn.

2.3 Layout below the Tunnel

2.3.1 Below the tunnel entrance the canal flows through a large sluice gate and on to the storage reservoir above Morwellham Power Station.

2.3.2 There is a western arm offshoot of the canal just downstream of the tunnel entrance which is currently disused and dry.

2.3.3 Next to the main sluice gate there is a small sluice gate where water can be released into the western arm of the Combe stream.

2.3.4 Water is released from the storage reservoir, through the hydropower station and is eventually released to the River Tamar.

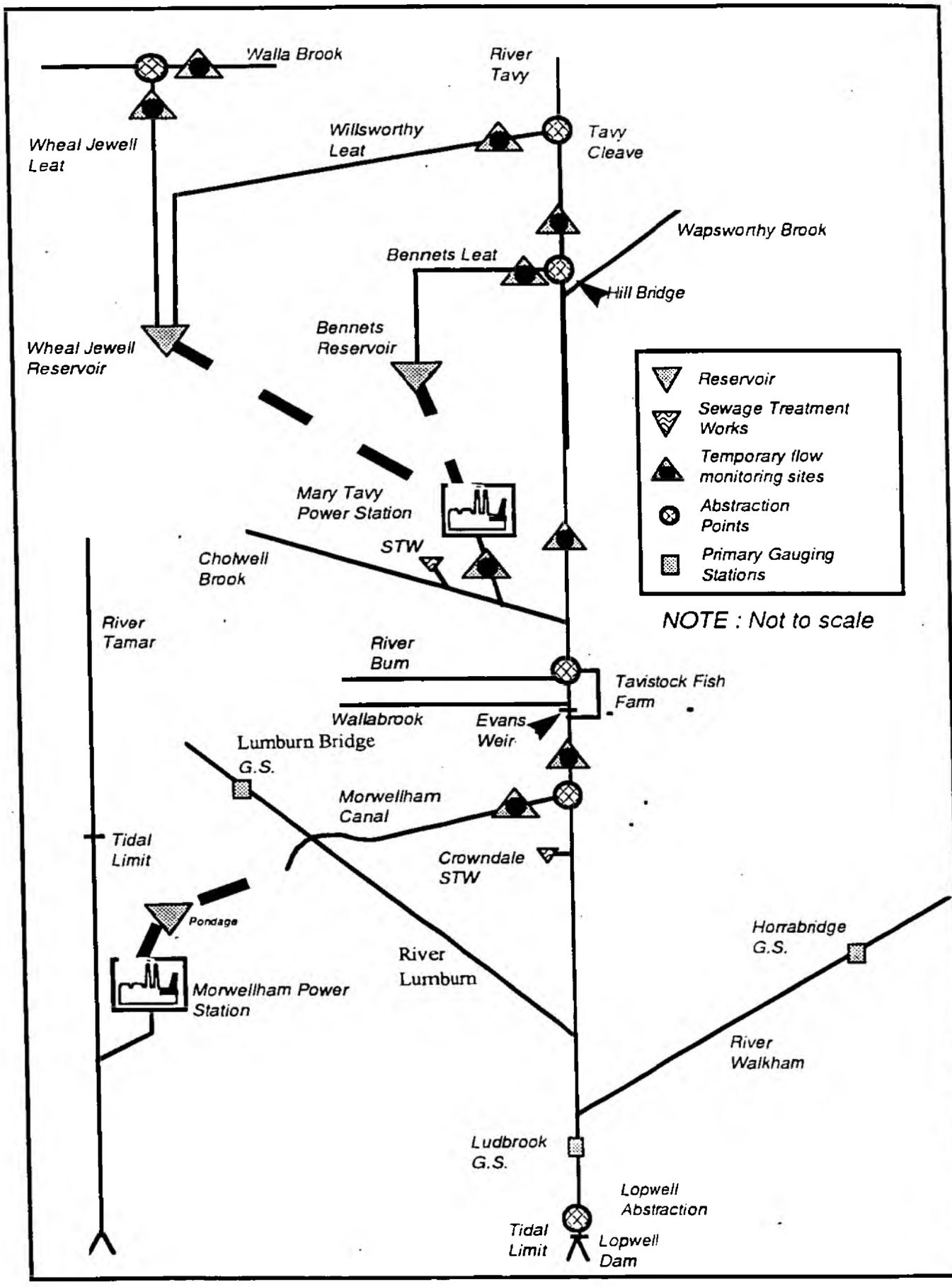
2.4 The Combe Stream

2.4.1 The eastern arm of the Combe Stream is fed from the canal via a small sluice gate .

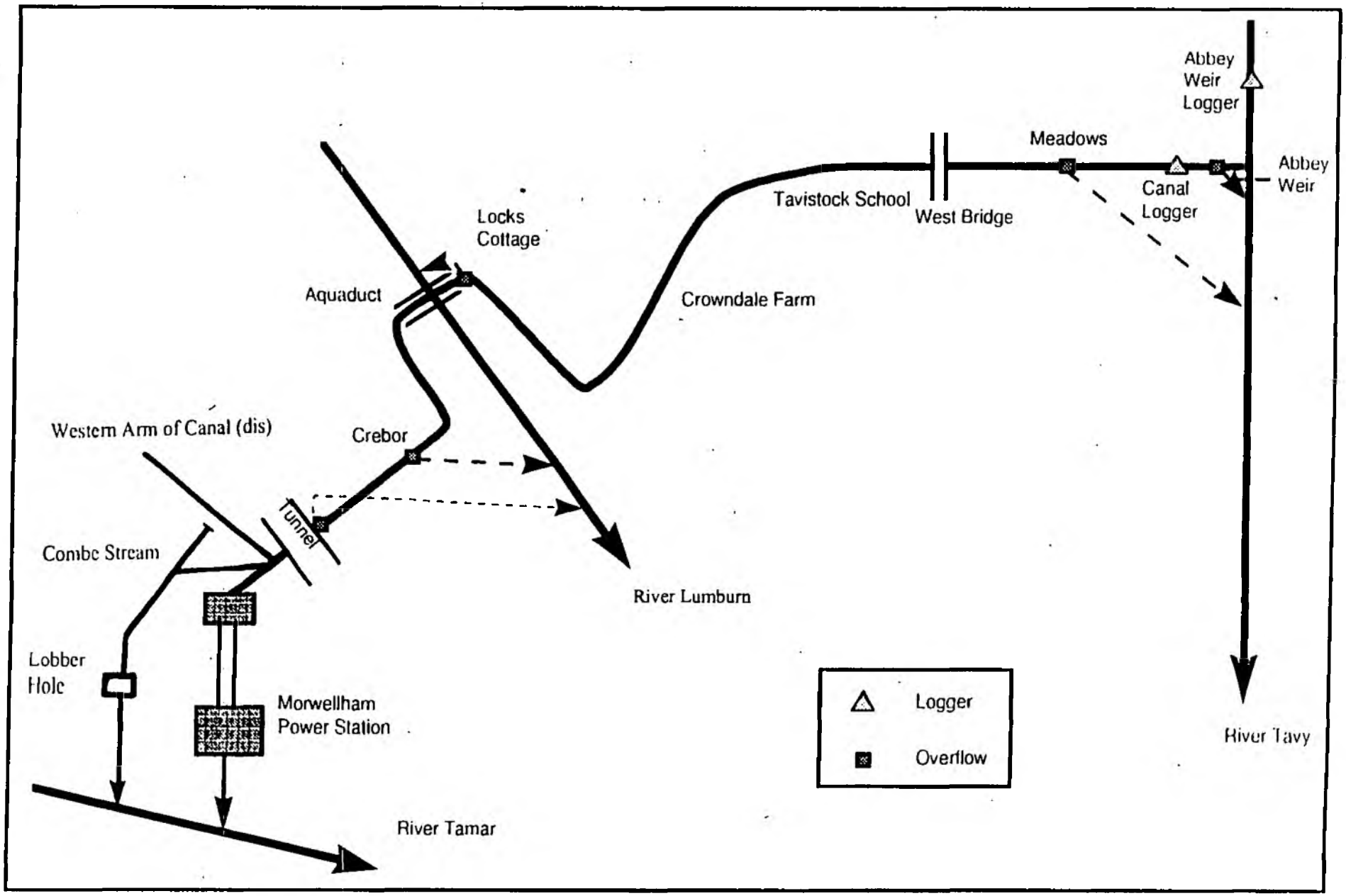
2.4.2 The western arm of the Combe Stream is surface fed from the surrounding catchment area.

2.4.3 These two arms join and drain to the Lobber Hole pond. This overflows to a small stream which drains through Morwellham Quay area and to the River Tamar.

River Tavy and Leat System -Schematic 1



Tavistock-Morwellham Canal Schematic - Schematic 2



3.0 SWEETENING FLOW TRIALS

3.1 Purpose of Flow Trials

3.1.1 The 1978 Heads of Agreement did not define any minimum flow requirements for the canal. As a result, in consultation with National Power, the Environment Agency has initiated a series of flow trials to establish the minimum 'sweetening flow'. These trials are aimed at establishing an acceptable balance between, on the one hand increasing flows to the River Tavy and on the other not compromising the integrity and viability of the canal.

3.1.2 During the December 1995 trial the following key questions were assessed by a group of interested parties:

- what was the impact of the sweetening flow trial during the one day of the trial?
- would a sweetening flow of $0.140m^3/s$ be acceptable for occasional periods in the winter when the flow in the Tavy fell below the residual flow? It was expected that the use of this sweetening flow during the winter would be for short periods only.

The group were also asked to briefly consider if a sweetening flow of $0.140m^3/s$ would be acceptable during the summer when it was expected that this flow would be in operation for longer periods.

The group considered that a sustained summer sweetening flow of $0.140m^3/s$ may lead to a deterioration of aesthetic appeal, water quality, ecology and the structural integrity of the canal liner. The issues considered by the group are summarised in Table 1 in Section 5.0.

3.1.3 The December 1995 flow trial raised concerns over the impacts of a sweetening flow of $0.140m^3/s$ for longer periods during summer conditions. Therefore it was decided to initiate further trials during the summer of 1996 to test the viability of the proposed sweetening flow.

3.2 Flow Trial in December 1995

3.2.1 Full results have been detailed in a draft report dated 28th February 1996 (Ref 5), however a brief outline of the procedure for the trial is given below:

3.2.2 On the 4th December the four automatic gates were isolated and the canal was drained overnight. On the 5th one gate was opened to allow approximately 0.140m^3/s into the canal.

3.2.3 A flow of 0.140m^3/s was chosen as a potential sweetening flow being significantly less than the minimum flow recorded in the winter/spring but higher than the minimum flow recorded in summer 1995. It also represented the annual Q95 flow for the period 1990-1996 (see Appendix 4).

3.2.4 Flow on the 5th December 1995 was monitored at four sites along the canal and a summary is given below:

- Post Office - flow of 0.137m^3/s;
- Tavistock Wharf - flow of 0.162m^3/s;
- Crowndale Farm - flow of 0.047m^3/s;
- Locks Cottage - flow of 0.034m^3/s.

3.2.5 The increase in flow in the canal on the 5th December 1995, monitored at the post office and at Tavistock Wharf, had not reached Crowndale Farm and Locks cottage by the time these sites were gauged.

3.2.6 During this trial flow in the canal was not diverted back to the Tavy via the River Lumburn but was allowed to run on down through the tunnel to the storage reservoir above the Morwellham hydropower station.

3.3 Flow Trial in Summer 1996

3.3.1 It was considered unacceptable by the Environment Agency to drop the flow in the canal to $0.140m^3/s$ in one step as this would have created a marked visual impact particularly in the Meadows area in Tavistock. Flows in the canal were reduced along a sliding scale to achieve a gradual change, partly to reflect flows in the River Tavy and partly to protect the visual amenity of the canal. This gradual flow reduction is shown on the flow duration curve in Appendix 4.

3.3.2 Flows in the River Tavy fell below the residual flow at Abbey Weir during May. The automatic lock gates were switched to manual on the 10th May and were set to pass a sweetening flow of approximately $0.350m^3/s$ (see Appendix 4). Increasing rainfall at the end of May led to rising river levels and the flow trial was temporarily halted. The gates were put back to automatic on 24th May to allow for the generation of hydro-electricity. The flow trial was re-started on the 3rd June when the gates were put back on manual and flow to the canal was gradually reduced from $0.530m^3/s$ to $0.350m^3/s$ over a period of 5 days. Flows were further reduced to $0.260m^3/s$ throughout June and July as river levels fell.

3.3.3 At the end of July flow was reduced to approximately $0.140m^3/s$ to allow construction of the temporary weirs at Crowndale Farm, however this proved unfeasible and flows were put back up to $0.250m^3/s$. On the 8th August flow was dropped to $0.060m^3/s$ to allow the sandbag weir to be built at Crowndale Farm to back up flows in the Meadows area (see Plate 3). Flows were then set at $0.140m^3/s$ for the rest of the flow trial (see Plate 2).

3.3.4 As a result of concern expressed by National Power about the effect of the low flow on the integrity of the canal structure above the tunnel entrance a weir was placed at Crebor to back up flows (see Plate 4). The structure which was between 8 and 9 blocks at the chainage of 4205m backed up flows for some distance upstream. The approximate effects in terms of water levels of different weir heights are illustrated in Appendix 4 (iii). These results are not intended to be accurate representations of actual water levels in the canal; they are indicative of the effect of different sized weir structures.

3.3.5 During the trial, water in the canal was returned to the River Tavy via the Locks Cottage and Crebor 'overflows'. (See Schematic 2 for location of these overflows).

3.3.6 The flow data for the Environment Agency's temporary monitoring site in the canal behind the Post Office shows this stepped flow reduction during 1996 (Appendix 4). Plate 1 illustrates typical flow in the canal during hydropower generation whilst Plate 2 shows flow in the canal during the summer 1996 flow trial.

3.3.7 The impact of both these sweetening flow trials is discussed in section 5.0.

4.0 EXISTING ENVIRONMENT

4.1 Conservation / Landscape Designations

4.1.1 The Tavistock canal falls within an area of considerable natural beauty and therefore a number of landscape and conservation designations need to be taken into account when considering the local context of the canal. Those designations which apply are shown on Figure A1 and are as follows :

- Tamar Valley Area of Outstanding Natural Beauty (AONB);
- Woodland Trust Nature Reserve;
- Ancient Semi-natural Woodland;
- Ancient Replanted Woodland;
- Tamar Valley Wildlife Reserve.

4.1.2 Tamar Valley Area of Outstanding Natural Beauty

4.1.2.1 To the south of Crowndale Farm the canal enters the Tamar Valley AONB which is notified under the 1949 National Parks and Access to the Countryside Act. AONB's are areas which are considered to be of particular importance for their 'natural beauty', both in terms of flora and fauna as well as due to their landscape.

4.1.4 Woodland Trust Nature Reserve

4.1.4.1 To the south of Tavistock Community College lies a Woodland Trust Nature Reserve (Crowndale Wood NGR SX 474733). This is a Local Nature Reserve (LNR), owned and managed by the Woodland Trust. LNR's are designated by local authorities (in this case West Devon Borough Council) under section 21 of the National Parks and Access to Countryside Act 1949 and are protected under local planning policies. This woodland is adjacent to the canal and stretches for approximately 200m. It is a mature broadleaved wood; mainly of Oak, Beech, Sycamore and Holly. It has a low open cover of ground flora and evidence of use by badgers was noted. This wood is a very pleasant feature alongside the canal and the 'Drakes Walk' footpath.

4.1.5 Ancient Semi-natural Woodland and Ancient Replanted Woodland

4.1.5.1 The Woodland Trust Reserve, and the canal side woodland, downstream of Crowndale Farm are both listed as Ancient Semi-Natural Woodland (ASNW). In the vicinity of Morwellham Quay, near to the south portal of the canal tunnel entrance there are two further areas of ASNW and slightly to the west parts of Sheepridge Wood (NGR SX 448698) are also listed as ASNW. The remainder of Sheepridge Wood and Morwell Wood (NGR SX445703) being listed as Ancient Replanted Woodland.

4.1.5.2 These woodlands have been identified in the Nature Conservancy Council Devon Inventory of Ancient Woodlands (1986) and are considered to be of particular nature conservation value because native broadleaved woodland have been documented on this site since 1600 AD. This continuity of woodland cover supports unique plant and animal communities, notably mosses, lichens and invertebrates. These ancient woods are largely undisturbed and are good examples of climax vegetation typical to south western England.

4.1.6 Tamar Valley Wildlife Reserve

4.1.6.1 The Tamar Valley Wildlife Reserve forms part of the attractions at Morwellham Quay and is managed by the Morwellham and Tamar Valley Trust (MTVT); a registered charity.

4.1.6.2 The reserve incorporates a variety of different wildlife habitats including:

- stands of ASNW and Ancient Replanted Woodland at Morwell and Sheepridge Woods, parts of which are actively managed to encourage the hazel understorey;
- stream and adjacent habitat along the Combe stream;
- wet meadows above the Lobber Hole pond;
- Lobber Hole pond fed by the two Combe streams;
- marshland habitat adjacent to the River Tamar;
- Hay meadows maintained by traditional farming techniques.

4.1.6.3 The reserve is actively marketed by the MTVT as an additional attraction at Morwellham Quay. Trails have been established throughout the reserve and a number of hides have been, or are in the process of being, built.

4.1.6.4 The boundaries of this reserve are shown on Figure A2.

4.1.7 Other Designations

4.1.7.1 Although this area does not fall within Dartmoor National Park Boundaries the boundary lies some 2 km to the east of the site and therefore is important in the context of the area.

4.2 Ecology

4.2.1 Introduction

4.2.1.1 The ecology of the canal has been considered in terms of :

- invertebrate populations;
- fish populations;
- in channel vegetation;
- adjacent habitat;
- birds and mammals using the canal corridor.

Habitats have developed along the canal since its construction in 1803. Although not designated, the canal forms an important wildlife corridor in the area.

4.2.2 Invertebrate Populations

4.2.2.1 This study concentrated on aquatic invertebrates.

Three invertebrate surveys were carried out (June, July, September) at one site on the canal (in the area near Tavistock Wharf) in 1993 by Ecologue as part of a wider survey of the Tavy above and below Abbey Weir. The canal supported fewer species than the other sites

above and below Abbey Weir on the Tavy. This was attributed to the lack of habitat diversity, vegetation and the slower speed and relative uniformity of flow. The results of this survey are included in Appendix 1. Although this data could be considered as a baseline, only one site was monitored and therefore it was considered that a 'new' baseline needed to be established.

4.2.2.3 A further survey was carried out at four sites on the canal in September 1996 by Environment Agency staff (grid references and results are given in Appendix 1). Although this cannot be considered a baseline in the true sense of the word as it has been carried out after or during the flow trials. However, it can be regarded as a starting point against which any further invertebrate work to assess the impact of a sweetening flow on the populations of invertebrates can be compared. The survey results are summarised in Appendix 1. It is considered that the species found were fairly typical of slow flowing waters with few habitats ands included beetles, snails and leeches. Habitat diversity was low with the bed of the canal being covered in silt and organic debris. Indicator species of organic sewage pollution (namely Chironomid worms) were not found in large numbers. It is difficult to place the value of the canal in a regional context as relatively few comparative sites have been surveyed in the South West.

4.2.3 **Fish Populations**

4.2.3.1 The canal is not considered to be an important fishery in its own right. Those species present in the canal are there because they have 'escaped' or been washed through the lock gates at Abbey Weir. It would be beneficial to fish stocks on the River Tavy if fish were prevented from being washed into the canal.

4.2.3.2 There is no monitoring of fish populations in the canal. The only data available are the records of species collected during fish rescues when the canal is shut down for maintenance purposes. Species recorded include: salmon (fry, parr and smolts), Brown trout (fry, parr and smolts), Sea Trout (smolts and kelts), Rainbow trout (escapees from Tavistock Fish Farm), Bullheads, Minnows, Eels and Stone Loach. The data from fish rescues is presented in Appendix 1..

4.2.4 Vegetation Surveys

4.2.4.1 Three vegetation surveys have been carried out along the canal, namely:

- a walkover survey alongside the canal to identify key habitats and species;
- a plant survey of channel vegetation at selected sites;
- a River Corridor Survey and transect of the canal .

4.2.4.2 The length of the canal was walked in September 1996 by a staff member of the Babtie Group during the sweetening flow trial and target notes of key habitats were made. An assessment was made of the impact of the sweetening flow of 0.140m^3/s (with weir structures at Crowndale Farm and Crebor).

4.2.4.3 This survey and accompanying plan are presented in Appendix 1.

4.2.4.4 A baseline plant survey of the canal was carried out by the Environment Agency in September 1996. Four representative sites, each approximately 100m long, were selected and channel vegetation was identified. The diversity of species found in the canal was low and no unusual or rare species were recorded. This is due to the fact that the canal has a very uniform channel and therefore the diversity of habitats is low. Unlike a river the canal does not have a variety of features such as riffles, pools, islands or large margins.

4.2.4.5 The results of this plant survey as well as grid references are presented in Appendix 1.

4.2.4.6 A River Corridor Survey (RCS) and transect survey of the canal were carried out in June, July and August 1993 by Eclogue Environmental Consultancy. The RCS was carried out on a 500m stretch downstream of the Abbey Weir offtake, through the Meadows area of Tavistock.

4.2.4.7 The diversity of plant species recorded was very low mainly due to the restricted habitats available. Bankside habitat was very limited by the concrete banks and pathway. Many of the plant species recorded were ornamentals planted alongside the channel.

4.2.4.8 The RCS map and transect survey plan data are presented in Appendix 1.

4.2.5 Adjacent Canal Dependent Habitat

4.2.5.1 Adjacent habitats are considered as:

- the seepage and splash zone above the water level and habitats created by leaks from the canal;
- margin habitats;
- adjacent woodland or open areas.

4.2.5.2 The design of the canal means that there are relatively few adjacent habitats, the canal being a conduit for carrying regulated amounts of water and therefore unlikely to experience regular flooding. Banks are generally steep with the woodland or hedgerow/field bank type species extending to the edge of the channel.

4.2.5.3 Bryophytes (mosses) have been recorded in the splash zone at the edge of the channel. Details of the species are given in Appendix 1 (the macrophyte species list, October 1996).

4.2.5.4 In a few areas the bank alongside the canal has a very shallow gradient, particularly in or adjacent to cattle drinks. This has enabled small areas of seepage margin habitat to develop with colonisation by river edge species although these habitats tend to be very narrow (approximately 0.5m).

4.2.5.5 Near to Locks Cottage an area of willow carr has developed (see 1996 Walkover Habitat Survey) with a ground flora indicative of wet conditions. The canal in this stretch is very narrow with a change in gradient and direction of the canal allows flow to back up leading to overtopping of the bank and hence the development of carr.

4.2.5.6 During the trial in the summer of 1996 most of the water in the canal was diverted back to the River Tavy via the River Lumburn and via the penstocks at Locks Cottage/Crebor. Water released at the Locks Cottage penstock valve cascades down the bank and runs along the field edge back through to the River Lumburn. This cascade has formed a

waterfall type habitat which provides a splash zone colonised by bryophytes (see Plate 6). Although no rare species were observed it is an unusual habitat in the canal corridor.

4.2.5.7 The eastern arm of the Combe Valley Stream is fed via a small sluice gate (see Plate 5) from the canal. This joins with the western stream which drain to the mill pond (known as Lobber Hole). The layout of these drainage arrangements are shown on Schematic 2 in Section 2.0. As a result the eastern stream, downstream of the confluence and the pond habitat are dependent on recharge from the canal. The MTVT have stated that badgers and deer use the meadows above the pond as foraging areas and the pond itself as a water source. These water features are therefore important in the wider context of the reserve.

4.2.6 Birds and Mammals using the Canal Corridor

4.2.6.1 No specific studies have been carried out to assess the level of bird or mammal use of the canal corridor, however, data has been obtained from the following sources :

- Devon Wildlife Trust archives (DWT);
- Observations by Environment Agency wardens;
- Observations during general walkover survey of the site in September 1996;
- discussions with the Morwellham and Tamar Valley Trust.

4.2.6.2 DWT records show that otters regularly breed on the River Tavy, and have been recorded along the length of the canal, however, it is unlikely that they breed along the canal. Otters are of very high conservation importance, and are listed under the Wildlife and Countryside Act 1981 and the EC Species and Habitats Directive 1994.

4.2.6.3 The relatively undisturbed aspect of much of the canal to the tunnel entrance and the mature deciduous woodland adjacent to the canal makes this area valuable to wildlife. Mink, Kingfishers and Dippers have been observed by the local River Warden and evidence of Badgers has been found in Crowndale Wood during the walkover survey in September 1996. Twelve species of birds were observed during the site visit, these mainly being common woodland species (see Walkover Survey in Appendix 1). Approximately 20 ducks

(Mallards and hybrids) were also seen in the canal adjacent to the Meadows area. These are important to members of the public and are frequently fed by them.

4.3 Archaeology

4.3.1 There is considerable archaeological interest in the area. The canal formed a major link between Tavistock and Morwellham and there are historic links with quay buildings both at Tavistock and Morwellham Quay. The importance of the canal cannot be dis-associated from the copper mining history of the area since it's very existence is due to the need to transport ore to the River Tamar for export. This area was at one time the most important copper ore exporting centre in Europe.

4.3.2 A large number of archaeological sites are listed on the Sites and Monuments Register (SMR) held by Devon County Council (DCC), however, only those sites which are of archaeological significance to the canal have been considered. Those sites which do not have direct links to the canal but are of archaeological significance are not considered in this report as it is considered that altering the flow regime will not have an impact on them.

4.3.3 Those archaeological sites considered during this study include:

- the canal, associated leats and tramways;
- quay buildings and warehouses in Tavistock;
- the port at Morwellham quay and associated buildings / structures;
- industrial archaeology and mines associated with the canal;
- structures / buildings important in the context of the canal for example houses built by the Duke of Bedford for mine and canal labourers.

4.3.4 Those SMR listings not included in this study include:

- the Grade I listed Abbey and associated buildings near to Abbey Weir;
- Listed buildings along Plymouth Road;
- any pre-historic archaeological finds.

4.3.5 A summary table of significant buildings and structures is provided below and the sites are located on Figures SMR1 and SMR2 in Appendix 2. A fuller description of the relevant sites and their significance is presented in Appendix 2.

4.3.6 Due to the number of archaeological sites they are considered in two stretches:

- from Abbey Weir in Tavistock to the north portal tunnel entrance;
- from the south portal tunnel entrance to Morwellham Quay.

For the purposes of this report each site is given a code (also shown on Figures SMR1 and SMR2), however, the SMR reference code is included in the tables in Appendix 2.

Stretch 1 - Abbey Weir to the Tunnel Entrance

CODE	DESCRIPTION	STATUS
1a	Tavistock Canal	-
1b	Canal Warehouses	-
1c	Canal wharf building (warehouse)	Grade II Listed Building (LB)
1d	Cottage at entrance to wharf	Grade II LB
1e	Bridge over canal	Grade II LB
1f	Cottage (store buildings)	Grade II LB
1g	Cottage	Grade II LB
1h	Canal quay area	-
1i	Old lime kilns	-
1j	Canal warehouses on wharf	Grade II LB
1k	Industrial housing - Fitzford Cottages	-
1l	Quarry marked on O S Plan	-
1m	Crowndale Mine	-
1n	Quarry marked on O S Plan	-
1o	Aqueduct for canal	-
1p	Abandoned canal	-
1q	Bridge over canal	Grade II LB
1r	Canal tunnel	-

Stretch 2 - South Portal Entrance to Morwellham Quay

CODE	DESCRIPTION	STATUS
2a	Tavistock canal tunnel	-
2b	Weir marked on O S Plans	-
2c	Leat to local mines	-
2d	Tavistock canal	-
2e	Canal farmhouse	Grade II Listed Building (LB)
2f	Inclined plane linking canal to Morwellham	-
2g	Church at Morwellham Quay	Grade II LB
2h	House at Morwellham Quay	Grade II LB
2i	Lime Kiln - mid 18th Century	Grade II LB
2j	Industrial housing for port workers	-
2k	Lime Kiln	Grade II LB
2l	School at Morwellham Quay	-
2m	Morwellham Port	-
2n	Farmstead at Morwellham	Grade II LB
2o	Boundary marker for port	-
2p	Ferry stage at Morwellham Port	-
2q	Wheelpit to power inclined plane	-
2r	Disused leats	-
2s	George and Charlotte Copper Mine	-

4.4 Recreation

4.4.1 Introduction

4.4.1.1 The canal forms an important part of the recreational facilities of Tavistock and surrounding area, particularly from an aesthetic point of view. There are a number of recreational facilities which are either centred on or are important in the context of the canal. These are:

- a canoeing business on the canal based at the Meadows in Tavistock;
- the Meadows recreation ground;
- the Drakes Walk alongside the canal as far as the viaduct;
- a public right of way alongside the canal;
- cycling and dog walking;
- the Morwellham Quay tourist attraction.

4.4.2 Canoeing

4.4.2.1 In the summer there has been a small canoeing business run by Mr & Mrs Croker on the canal which was operated under the licence from National Power. Canoes were available for hire in the Meadows area and it was possible to canoe along the canal, under the Plymouth Bridge Road and towards Crowndale Farm. With the change in ownership of the canal it is not sure if the licence to run this business on the canal will be extended.

4.4.2.2 In the summer of 1996 it was planned to install a temporary weir under Plymouth Road bridge to back up the reduced flow in the canal (as a result of sweetening flows). This would have had a severe impact on the canoeing business and the Environment Agency were contacted by Mr & Mrs Croker with regard to delaying the installation of the structure to the end of the summer season. In August 1996 a temporary weir was in fact placed below Crowndale Farm beyond the point where most canoeists normally turned around.

4.4.2.3 This canoeing appears to be very popular, the boats being very light and manoeuverable and therefore ideal for children. This facility provides an important recreational opportunity in Tavistock.

4.4.3 The Meadows Recreation Ground

4.4.3.1 The open space alongside the canal in the area between the canal wharf and Fitzford (just beyond Plymouth Road bridge) has been an important recreational area in Tavistock for many years. Records as far back as the 17th Century refer to the area as 'Jessops Hay'. The major steps in its development as a recreation ground have been (those steps having connections with the canal):

- in 1874, seats were provided by the Bedford office, alongside the wharf and in 1878 a bridge over the canal was built to improve access;
- public pressure between 1879 and 1888 to improve the area for a public park and to clean up the disused canal;
- the sale of the land from the Duke of Bedford to the local council in 1912;
- cleaning and repair of the canal in 1933 following the decision to use the canal for hydropower generation.

4.4.3.2 The facilities at the Meadows now include:

- the Meadowlands Swimming Pool;
- an Arts Complex in the old wharf buildings;
- a pitch and putt golf course, bowling green and tennis courts on the east side of the canal;
- public open space; a popular area.

4.4.3.3 It is fair to say that the Meadows area forms an important part of the recreational provision in Tavistock and that the canal itself is an integral part of the Meadows area both from active use and from an aesthetic point of view.

4.4.4 Drakes Walk, along the Canal Towpath

4.4.4.1 West Devon Borough Council have published a leaflet entitled "Tavistock Town Trails" in which they highlight walks in and around Tavistock (see Appendix 3). One of these is Drakes Walk which runs from Plymouth Road bridge, along the canal towpath as far as Shillamill viaduct taking in such sights as Fitzford gate and Cottages, and Crowndale Farm, reputedly the birthplace of Sir Francis Drake.

4.4.4.2 The towpath is also a designated public right of way used by walkers, people walking their dogs and occasional cyclists. The canal itself provides an important and visually pleasing feature alongside this walk.

4.4.5 Morwellham Quay

4.4.5.1 Downstream from the south portal tunnel exit is Morwellham Quay and the Tamar Valley Wildlife Reserve both owned and run by a charity The Morwellham and Tamar Valley Trust. (MTVT).

4.4.5.2 Morwellham Quay is a major tourist and recreational facility in the area and attracts a large number of visitors. The attraction provides a wide range of activities for the whole family with activities focused on the history of the mid 1800's and the wildlife of the Tamar Valley (see Appendix 3).

4.4.5.3 The canal is part of the archaeological attraction of the area and has footpaths leading to it. It is an integral part of the history of Morwellham Quay as the canal used to bring ore to the port at Morwellham. There is also access to the hydroelectric power station for visitors to the Quay.

4.4.5.4 The Quay complex provides employment to a large number of people, with approximate staffing levels of up to 40 people in the winter and in excess of 100 during peak periods in the summer.

4.5 Water Quality

4.5.1 The majority of flow into the canal is derived from abstraction from the River Tavy at Abbey Weir and therefore the water quality is dependent on the quality of the Tavy.

4.5.2 To monitor the quality of water at the input to the canal continuous monitoring loggers have been installed at two sites; one near to Bedford House at the Abbey Weir inlet and one at a site further downstream below Tavistock Community College. In addition to this continuous monitoring, spot samples have been taken at the two sites twice each week. Both the continuous monitoring and spot samples have been taken since late May 1996.

4.5.3 Monitoring has indicated that the quality of the canal is well within the RE Class 1 and is therefore considered to be of good quality.

4.5.4 Results from the two monitoring sites are similar however, dissolved oxygen levels are slightly lower at the downstream site which could be attributed to the shaded nature of this site. The Biochemical Oxygen Demand for both sites has been consistently below 2mg/l which indicates no organic pollutant load to the canal.

4.5.5 There are no consented discharges to the canal, however, a small field drain was noted at NGR SX 473736 during the Walkover Survey in September 1996 which appeared to be draining from Daleswood Road estate. It is therefore considered that the quality of water in the canal from Abbey Weir to the tunnel entrance is likely to be consistent with the results obtained at the two monitoring sites.

4.5.6 No recorded problems with the water quality have been reported, however, the Morwellham and Tamar Valley Trust have expressed concern over the lack of dilution caused by low flows during the summer 1996 sweetening flow trials in the canal downstream of the south portal tunnel entrance.

4.5.7 A water quality spot sample was taken below the tunnel in November 1996 after flow trials had ended. There was no indication of pollution or high levels of heavy metals. This data is presented in Appendix 5.

4.6 Abstraction and Water Rights

4.6.1 The most obvious abstraction right is that held by the owners and operators of the canal; namely South West Water Services Ltd who took over ownership of the canal from National Power in October 1996.

4.6.2 Under the abstraction licence for Morwellham power station (licence reference 15/47/41/S/26) there is provision for uses other than for hydropower generation, namely private water undertaking, agricultural and garage use. Although this provision has been made the permissible, abstraction for this purpose is only 0.9 cubic metres per day, a nominal amount compared to the 106,385 cubic metres per day allowable for hydropower generation. Nevertheless, this provision exists and therefore abstraction rights for those purposes also exist.

4.6.3 The Morwellham and Tamar Valley Trust (MTVT) maintain historic water rights to water from Morwellham Combe. One of the streams in the Combe is fed from the canal. Prior to construction of the canal the Combe was fed by local streams, however, the canal and local mines diverted much of the flow from the Combe. During canal construction the Duke of Bedford insisted that the water supply to estate lands fed by the Combe Streams was maintained and overspill arrangements were made.

4.6.4 When the canal was re-opened in the 1930s to supply the hydro power station provision of an overflow/stop gate (see Plate 5) was made. This allowed for continued flow through the sluice gate into the Combe stream.

4.7 Planning Permissions

4.7.1 As part of this study West Devon Borough Council were consulted with reference to any known proposed developments in the vicinity of the canal. A large area to the west of the canal stretching from Abbey Weir, incorporating the canal itself, Meadows Pleasure Ground, Tavistock Community College Grounds and the land as far as, and including, Crowndale Farm has planning permission for "a major recreational / sports facility". This area is shown on Figure A3.

4.7.2 Any proposed flow changes to the canal should be considered in context of this planning permission.

4.7.3 West Devon Borough Local Plan has highlighted the land discussed above under Policy TCO1 with the aim of protecting the green setting of the town. The only development to be permitted is that which is "appropriate to recreational or existing use, provided the environmental quality of the setting is not prejudiced.

5.0 IMPACT OF SWEETENING FLOW TRIALS

5.1 Introduction

5.1.1 The following impacts are considered:

- the actual impact on the canal of the one day flow trial in December 1995;
- the **predicted** impact of an infrequent sweetening flow of 0.140m^3/s in the winter (based on the flow trial in December 1995 without the use of weir structures);
- the actual impact of a sweetening flow of 0.140m^3/s with weir structures in the summer (based on the summer 1996 flow trial).

5.2 Flow Trial in December 1995

5.2.1 During the flow trial a group of interested parties walked the length of the canal (with the exception of the last stretch from the tunnel to the reservoir) and were asked to consider the impact (actual and predicted) of a sweetening flow of 0.140m^3/s on a number of environmental issues presented in Tables 1 and 2.

5.2.2 It was considered by the group that the actual impact of the one day flow trial on the majority of the environmental issues was temporary and would cause no major problems. The one major impact was aesthetic in that the level of water in the canal in the Meadows area of Tavistock had dropped significantly and was visually very obvious. For this reason it was decided by the Environment Agency that flow levels would be dropped gradually during the summer 1996 flow trial.

5.2.3 The group also **predicted** the impact of a sweetening flow of 0.140m^3/s as winter flow abstracted to the canal when flow at Abbey Weir was below the residual flow. It is expected that a sweetening flow in the canal may be in operation for up to several weeks during the winter. The group was asked by the Environment Agency to consider a matrix of potential effects both positive and negative on a scale of 4 to -4. The matrix is presented as Table 1.

5.2.4 The group considered that a sweetening flow of about 0.140m^3/s without structures might be adequate to protect the canal in the winter, subject to certain conditions, but not in the summer. There are still concerns that should a winter sweetening flow of 0.140m^3/s coincide with a period of very cold weather there may be frost damage to the canal liner. Operating rules to protect the canal in these conditions need to be resolved with South West Water.

5.2.5 It was considered by the group that a summer sweetening flow of 0.140m^3/s without structures for a period of up to several months was unacceptable.

5.2.6 A more detailed assessment of the predicted impacts of a winter sweetening flow of 0.140m^3/s is presented in Table 2. .

5.3 Flow Trial in Summer 1996

5.3.1 In the summer a sweetening flow would be required to protect the canal for a much longer period as flows in the River Tavy at the Abbey Weir could be below the residual flow for several months and therefore impacts may be greater.

5.3.2 When the gates at Abbey Weir are set on manual rather than automatic flow changes in the canal are not responsive to changes in flow in the river Tavy. As a result the daily rise in river levels due to pulse of water released from Mary Tavy Power Station will only cause a small rise in level in the canal.

5.3.3 An assessment of the observed impacts from the summer 1996 flow trial (with structures) is given in the Table 3.

5.4 Hypothetical 'No Flow' Scenario

5.4.1 Although a 'no flow' scenario is not proposed it is nevertheless useful to consider this baseline scenario as a hypothetical comparison. This baseline puts in context the proposals for a sweetening flow by emphasising the impacts of totally closing the canal.

TABLE 1 - MATRIX OF POTENTIAL EFFECTS PREDICTED BY THE GROUP

RESPONSIBLE BODY

SWEETENING FLOW SCENARIO																
1, Dec 5 1995 no structural changes	●	○		●	●	●	○	○	○	●	●	●	○	●	●	
	HYDROLOGY			RECREATION			WATER QUALITY			ECOLOGY						AREA AFFECTED
	Abstraction Licence Holders/ Protected Rights	Flooding	Canal Integrity/Leakage	Appearance	Fishing	Canoeing	Algal Blooms	Sedimentation	Consented & Non-consented discharges	Birds	Other Fauna	Flora in canal	Adjacent wetland habitats	Fish	Inverts	
0.140 m³/s	-2	2	-1	-3	0	-4	-4	-1	-1	+1	0	-2	-1	-2	0	Morwellham Canal Abbey Weir - West Bridge
0.140 m³/s 0.040 m³/s	-2	2	-2	-2	0	-4	-3	-1	-1	+1	0	-2	-1	-2	0	Morwellham Canal West Bridge - Locks Cottage
0.040 m³/s	0	2	-2	-3	0	0	-3	-1	-1	+1	0	-1	-1	-3	0	Morwellham Canal Locks Cottage - Tunnel
0.040 m³/s	0	2	-2	-1	0	0	-3	-2	-1	+1	0	-2	-1	-3	0	Morwellham Canal Tunnel - Storage Pond
	0	0	-	-1	-1	0	-2	0	-1	-1	-1	-1	0	-1	0	River Tamar d/s Morwellham
c. 4.5 m³/s	+2	-1	-	+2	+3	+2	4	2	4	+1	+1	+3	+1	4	1	River Tavy d/s Abbey Weir
-	-4	+2	-1	-	-	-	-2	-1	-	-	-	-2	-	-	-	Morwellham Power Station

KEY:

● Direct Effect

○ Indirect Effect

POSITIVE	NEGATIVE
1 slight	-1 slight
2	-2
3	-3
4 significant	-4 significant

TABLE 2

THE PREDICTED IMPACT OF A SWEETENING FLOW OF 0.140M^3/S IN THE WINTER (BASED ON THE FLOW TRIAL IN DECEMBER 1995)	
Environmental Issue	**Predicted Impact**
1. **Conservation/Landscape**	No significant impact on the context of landscape designations. It is not expected that there will be a significant impact on the Tamar Valley Wildlife Reserve if water supply is maintained to the Combe Stream via the sluice gate.
2. **Ecology**, 2.1 Invertebrates	It is not expected that this flow would have a significant impact on invertebrate populations in the canal or in Lobber Hole as the sweetening flow would only be operational for short periods during the winter.
2.2 Fish	The depth of the channel would decline over its length. If this was sustained over long periods it is expected that this would be detrimental to fish populations. However, a short term use of a sweetening flow is expected in the winter and any effects are likely to be temporary, with fish congregating in the deeper sections.
2.3 Channel Vegetation	No significant impact expected.
2.4 Adjacent Wetland Habitat	The carr woodland near Locks cottage appears to be maintained by overtopping flows or seepage through the bank. A temporary sweetening flow in the winter is unlikely to affect this habitat. Habitats associated with the Combe Stream and Lobber Hole are unlikely to be affected provided flow to the Combe Stream is maintained.
2.5 Adjacent Woodland Habitat	No significant impact as they are not dependent on water from the canal.
2.6 Birds/Mammals	No significant impact expected.
3. **Archaeology**	No significant impact on the archaeological context of the canal. As long as there is some flow to the canal it will appear as a functioning canal. Sustained low flows may lead to problems with the integrity of the canal liner and may cause leakages, particularly if frost damage occurs during periods of cold weather.
4. **Recreation**	No significant impact on recreational issues. There is no canoeing use of the canal in the winter. The only impact will be aesthetic with the edges of the bank being exposed to view and low water levels. Again this is only likely to be temporary.

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THE PREDICTED IMPACT OF A SWEETENING FLOW OF 0.140M^3/S IN THE WINTER (BASED ON THE FLOW TRIAL IN DECEMBER 1995)	
Environmental Issue	**Predicted Impact**
5. **Water Quality**	No significant impact expected. No monitoring was carried out during the one day trial in December 1995, however, water quality monitoring was carried out during the summer trial on the same sweetening flow of 0.140m^3/s. This data shows good water quality and therefore it is anticipated that flow of 0.140m^3/s would have good water quality also in the winter.
6. **Abstraction Rights**	Loss of hydropower generating flow to Morwellham Power Station when the sweetening flow is in operation. No significant impact expected to Morwellham and Tamar Valley Trust providing flow to Combe Stream is maintained via the sluice gate.
7. **Proposed Developments**	No significant impacts predicted.

TABLE 3

OBSERVED IMPACTS OF A SUMMER SWEETENING FLOW OF 0.140M^3/S (WITH WEIR STRUCTURES)	
Environmental Issue	**Observed Impacts**
1. **Conservation/Landscape**	As long as there is some flow in the canal and therefore the context of the area does not change significantly there will be little impact on the context of the landscape designation of Tamar AONB or Crowndale Wood Nature Reserve. There was significant impact on the Tamar Valley Wildlife Reserve (see ecology, water quality, archaeology and water rights).
2. **Ecology** 2.1 Invertebrates	The temporary flow structures, particularly the one at Crowndale have had the effect of backing up the flow to maintain water depth. Below the structure, a riffle zone has been created. The oxygenated environment has provided a greater number of niches for invertebrates and therefore may increase ecological diversity over a longer period. By the use of a sweetening flow of 0.140m^3/s under the very driest of summer conditions there will be a net gain in flows, however, under normal summer conditions there will be a net loss of flow in the canal. The use of structures safeguards the depth of the canal over the majority of its length, however, there will be a loss in velocity in the ponded back sections. This change in flow may have an impact on the species composition of invertebrate populations as conditions change. The canal will still be used for the generation of hydro-electricity in the winter and flow and depth conditions are not expected to change compared to previous years (except when a temporary sweetening flow is operated when conditions in the River Tavy fall below the residual flow). The Morwellham and Tamar Valley Trust have reported a significant impact on habitats downstream of the south portal of the tunnel. Lobber Hole nearly dried up and its source stream was at much lower levels than normal.

OBSERVED IMPACTS OF A SUMMER SWEETENING FLOW OF 0.140M^3/S (WITH WEIR STRUCTURES)	
Environmental Issue	**Observed Impacts**
2.2 Fish	No significant impact observed on stretch from canal tunnel to Tavistock. Backed up flow of sufficient depth to provide habitat for fish that have found their way into the canal. Downstream of Crowndale weir water levels were very low (20cm); this may have an impact on fish population. However, much of the canal has experienced 'backed-up' flows so that any shallow areas are more than compensated by increased reach of areas backed up by the temporary weirs. Lobber hole pond - the MTVT reported a total fish kill due to pond drying out.
2.3 Channel vegetation	No significant effect observed. Healthy specimens of Water Crowfoot noted below temporary weir at Crowndale. The temporary weir had created riffle conditions suitable for this species.
2.4 Adjacent wetland habitat	Carr woodland near Locks Cottage. An indicator species (*Fontinalis antipyretica)* was observed on fallen logs in the carr woodland. This is normally found in river channels and therefore indicates that this area is wet during periods of high flow down the canal. This habitat probably fed from higher winter flows overtopping the bank. A summer sweetening flow would not change this situation. Temporary loss of wetland type habitat at Lobber hole reported by the MTVT. Pond now full again due to recharge from surface water fed stream, therefore habitat loss was temporary but significant as most of the aquatic species will have died when the pond dried up. Sustained low flows to the pond would lead to loss of habitat.
2.5 Adjacent woodland habitat	No significant impact.

OBSERVED IMPACTS OF A SUMMER SWEETENING FLOW OF 0.140M^3/S (WITH WEIR STRUCTURES)	
Environmental Issue	**Observed Impacts**
2.6 Birds/mammals	No significant impact observed on stretch from Tavistock to tunnel entrance. Significant impact on Lobber hole reported by the MTVT. Loss of watering area for deer and badgers, ducks and other birds. Change in badger behaviour observed by MTVT. The badgers normally forage in wet meadows above the pond, however, in summer 1996 they tended to forage in other parts of the reserve - nearer the River Tamar.
3. **Archaeology**	No significant impact on archaeological structures in context of canal in area between Tavistock and tunnel. Canal still appears as a functioning canal. Below the tunnel the lack of flow has had an impact on western arm of canal. There was no flow to this area; which was completely dry. Lobber hole which historically fed the mill wheel was reported by the MTVT to be dry. A lower flow may also lead to an increase in vegetation growth on the sides of the canal itself and may cause structural problems and therefore damage an important archaeological resource. Long term management may have to include periodic removal of vegetation from the sides of the canal.

OBSERVED IMPACTS OF A SUMMER SWEETENING FLOW OF 0.140M^3/S (WITH WEIR STRUCTURES)	
Environmental Issue	**Observed Impacts**
4. **Recreation**	Canoeing was still a viable business. The Crowndale weir backed up flow to a sufficient depth to allow canoeists to use this stretch of canal. In fact the weir acted as a 'turn around' point. Ducks were still present in the Meadows area. Feeding the ducks appears to be a popular pastime. Aesthetically the canal appeared as 'normal' therefore there was no significant impact on users of canal towpath to the tunnel entrance. Some aesthetic impact on users visiting the western arm of the canal downstream of the tunnel plus visual impact of the empty Lobber hole pond. The MTVT are aiming to place bird hides at various locations around their reserve. One is located near to the right fork stream; should this be dry (as in this flow trial) the attractiveness of the area to birds and therefore also visitors will be reduced.
5. **Water Quality**	There was initial concern that weirs would cause ponding of stagnant water leading to poor water quality. This does not appear to have occurred during this flow trial. Continuous and spot monitoring has been carried out (see section 3.5) and indicate good water quality of class RE1 standard in the canal upstream from the tunnel entrance. Below the tunnel the reduced flow means that the dilution factor is much less. Concern has been raised by the MTVT that contaminated water from mines in the area on Morwellham Down had entered the canal and was no longer being diluted. Pollution from untreated sewage was also reported by the MTVT. There are no consented sewage discharges to the canal. Water quality monitoring carried out by the Environment Agency showed no deterioration in water quality.

OBSERVED IMPACTS OF A SUMMER SWEETENING FLOW OF 0.140M^3/S (WITH WEIR STRUCTURES)	
Environmental Issue	**Observed Impacts**
6. **Abstraction Rights**	Serious impact on historic water rights of the MTVT. Flow from the canal to Lobber hole was virtually nil.
7. **Proposed Developments**	No impact.

TABLE 4

HYPOTHETICAL 'NO FLOW' SCENARIO	
Environmental Issue	**Potential Impacts**
1. **Conservation/Landscape**	Significant impact on Local Nature Reserve (Crowndale Wood) with loss of adjacent water habitat. Significant impact on context of the area, particularly in terms of loss of surface water feature in the Tamar Valley AONB. Severe impact on the Tamar Valley Wildlife Reserve with loss of source water to stream and Lobber hole pond habitats at Morwellham.
2. **Ecology**	
2.1 **Invertebrates**	Water invertebrate population - total loss in main canal, and stream in Morwellham Combe sourced from the canal. Severe impact on Lobber hole pond with loss of dragonfly population and other invertebrates.
2.2 Fish	Total loss of habitat. Fish rescues would be required to move fish to the River Tavy.
2.3 In channel vegetation	Total loss of habitat.
2.4 Adjacent wetland habitat	Loss of water from overtopping. These habitats may eventually dry out and plant communities change.
2.5 Adjacent woodland	No direct impact on plant communities - significant impact on birds/mammals use of canal for watering and feeding.
2.6 Birds/Mammals	Loss of habitat for (river dependent species) Otters, Kingfishers, Dippers, ducks and loss of watering areas for other mammals/birds.

HYPOTHETICAL 'NO FLOW' SCENARIO	
Environmental Issue	**Potential Impacts**
3. **Archaeology**	Major impact. No flow would be a major change in use of the canal which would significantly affect the context of the canal and associated structures. In effect the canal would be similar to many of the dry leats in the area which have slowly become infilled and overgrown by vegetation. One of the key values of the canal today in archaeological terms is that it is still a functioning canal (even if it is used for a different purpose than it was designed for). There would also be significant impact on Morwellham Quay area in terms of the context of the canal and port. Lobber hole which feeds the mill would dry up for much of the year.
4. **Recreation**	Canoeing business no longer possible. The ducks which are on the canal in the Meadows area would move elsewhere (feeding the ducks is currently a popular past-time). The public right of way and Drakes walk footpath would be unaffected, however, there would be an impact on the aesthetic aspect of no longer having a canal beside the path. There would be an impact on the Morwellham Quay complex in terms of visual impact of loss of water to canal and pond and also the closing of the hydro-electric power station (currently part of the visitor attractions).

HYPOTHETICAL 'NO FLOW' SCENARIO	
Environmental Issue	**Potential Impacts**
5. **Water Quality**	No longer an issue on the canal itself.
6. **Abstraction Rights**	Loss of water rights held by South West Water Services Ltd. and other users under the Abstraction Licence. Total loss of flow to the eastern Combe stream and therefore loss of historic water right of the MTVT. The Lobber hole pond and mill stream feed would dry up for much of the year. The MTVT have historic water rights and therefore may resort to legal action to maintain them.
7. **Proposed Developments**	No significant impact expected as long as the development is not canal based.

6.0 ADDITIONAL PROPOSALS FOR CANAL MANAGEMENT AND DEVELOPMENT

6.1 Structures in the Channel - Weir

6.1.1 Given that a sweetening flow of 0.140m^3/s without any structures is probably not acceptable in the summer and that the use of temporary weirs has proved successful it is worthwhile looking at the nature of these structures in more detail.

6.1.2 The temporary sand bag weir at Crowndale (see Plate 3) could be replaced with a more permanent structure. A possible structure is shown on Figure B1. This would comprise two steel uprights between which wooden boards are bolted. These boards should be approximately 3cm thick by 20cm high such that the height of the weir can be altered simply by adding or removing one or more of the boards. The advantage of this type of structure is that it is easy to install and remove, more permanent than sandbags, less prone to vandalism and also visually more pleasing than sandbags. A similar structure has been used successfully on the River Lyd to create better pool habits for the local fishery.

6.1.3 The type of weir described above could also easily be installed in other locations along the canal (see Figure B2).

6.1.4 The block stone weir at Crebor, just before the tunnel entrance would need to be altered to allow overspill of water into the tunnel and down to Morwellham in order to mainrain flows to the Combe Stream below the tunnel exit.

6.2 Narrowing the Channel

6.2.1 Should the operating rules change and the generation of hydro-electricity cease then effectively the canal would be going through a change in its use. The focus would therefore be much more on its recreational/conservation and ecological use, rather than as a 'working' canal.

6.2.2 The major problem with the sweetening flow of 0.140m^3/s without any structures in the canal is that there is insufficient depth of water to cover the canal and therefore the wetted

area was reduced. Such a reduction had a number of impacts which were considered unacceptable by members of the Environment Agency (see Section 5.0). One possible method of remediation would be the use of weirs (described above) to back up and pool water or to reduce the channel width so that the depth of flow is greater.

6.2.3 It is considered that combining the two types of channel structure would prove effective in maintaining the canal. The weirs only have a limited effective reach i.e. distance to which the water backs up (see Appendix 4) therefore by narrowing certain sections of the canal this deeper reach could be extended.

6.2.4 There are several criteria required of channel narrowing works:

- that the bed of the canal is not punctured i.e. to maintain the integrity of the seal:
- that they are easy and relatively cheap to install;
- designed to be able to withstand differing flow velocities;
- that they are aesthetically pleasing and blend in as far as possible;
- that they could be removed if necessary.

6.2.5 A possible design for this is included in Figure B1. Such a design aims to create a two level channel such that a wetland margin is created extending from one bank which could also act as a mini flood plain should high flows down the canal be required.

6.2.6 This margin would be created by placing sand bags approximately 1m long by 30cm diameter encircled by fibrous matting into the channel. The area between the bank and the bag (the new margin) would be infilled with earth (or sediment from the main channel) to create a wet margin. This could then be planted up with suitable wetland species. The advantages of this matting is that it traps sediment and can also be seeded or planted up such that it eventually is covered by plants and therefore blends in.

6.2.7 The aim of these methods is to create an ecologically more diverse environment. By adding artificial structures the canal can be changed from a basic channel into something more resembling a river habitat such that:

- above a weir a pool is created;
- below a weir a riffle zone is created;
- wetland margins are created.

This will be of benefit to the ecology of the canal since more habitat niches are created and hopefully these features will be aesthetically pleasing to users of the towpath.

6.2.8 A proposed location for these weirs and narrowed reaches is shown on Figure B2, however, more detailed design criteria will be considered should this option be progressed.

6.3 Recreational Opportunities

6.3.1 The canal, the towpath and the meadows are already used for recreational purposes, however there are still possibilities to enhance the recreational facilities. These could include:

- designating the canal and towpath area as a Country Park to encourage its use;
- providing picnic areas and benches at different locations along the towpath;
- establishing the towpath as part of a cycle route, perhaps linking it with any other routes in the area and publicising it as such;
- maintain the canoeing businesses;
- develop the archaeological theme to complement the attractions at Morwellham Quay. For example a canal barge could be restored, converted to an interpretation or visitor centre and moored alongside the canal wharf in Tavistock.

6.4 Maintenance Implications

6.4.1 With the decrease in flow in the canal when the sweetening flow is in operation there may be a need to periodically remove any vegetation from the sites of the canal in order to protect the integrity of the seal. It will also be necessary to inspect the canal when the sweetening flow is in operation to check that the integrity of the seal is holding.

7.0 FURTHER WORK

7.0.1 This assessment of the environmental impacts of the flow trials in December 1995 and summer 1996 has raised a number of issues that need to be resolved. A summary of the current position and way forward is given below.

7.0.2 It is important there is close liaison between South West Water Services Ltd and the Environment Agency so that detailed operational flow arrangements for the canal can be established.

7.1 Further Flow Trials

7.1.1 The major outstanding issue from the flow trial during the summer of 1996 is that a flow is required through the tunnel and down to Morwellham in order to supply sufficient water to protect water rights downstream of the tunnel. It is recommended that trials are carried out with the co-operation of South West Water Services Ltd and the MTVT using an overspill weir at Crebor to allow water to run on into the tunnel. It is important that close liaison is maintained with the Morwellham and Tamar Valley Trust throughout these trials and that flow levels to the Combe streams are monitored.

7.2 Conservation/Landscape

7.2.1 These issues have been covered in sufficient depth in this report and no further work is recommended at this stage.

7.3 Ecology

7.3.1 It is considered that sufficient information on fish ecology, invertebrates and macrophytes now exists as a baseline.

7.3.2 It may be useful to carry out further invertebrate work to target the impacts immediately above and below temporary weirs to see if new habitats are created.

7.3.3 A River Habitat Survey of the River Tavy downstream of Abbey Weir is recommended to test whether increased flows to the Tavy (by reducing flows to the canal) is proving beneficial to habitats along this reach .

7.3.4 Should channel narrowing works be carried out following a change in use of the canal the new margin habitats should be monitored to assess these developing habitats.

7.4 Archaeology

7.4.1 It is considered that archaelogical issues have been considered in sufficient detail in this report and no further studies are recommended at this stage. Should there be a major change in use of the canal then further work may be justified.

7.5 Recreation

7.5.1 There is currently very little information on the recreational use of the canal by the people of Tavistock.

7.5.2 It is recommended that a survey of the users of the footpath and the Meadows area is carried out to include a brief questionnaire and indication of number of users.

7.6 Water Quality

7.6.1 The water quality surveys during the 1995 and 1996 trials indicated no problems with water quality and therefore a continuous monitoring programme is not recommended.

7.6.2 The occasional spot sample should be taken to check whether water quality continues to be good.

7.7 Consultations

7.7.1 Any change in use of the canal or further flow trials will mean that differing viewpoints need to be considered in the management of the canal and therefore it is important that a list of interested parties or consultees is drawn up to include:

- South West Water Services Ltd;
- the Environment Agency;
- West Devon Borough Council;
- the Morwellham and Tamar Valley Trust;
- Landowners along the route of the canal.

REFERENCES

1. Ecologue Environmental Consultancy (Hughes, M.R.) - Alleviation of Low Flows Conservation Investigations - October 1993.

2. Environment Agency - Tamar Estuary and Tributaries - Consultation Report - July 1996.

3. Garrod, G.D. And Willis, K.G - An Economic Appraisal of the Benefits of Low Flow Alleviation in the Rivers in South West England Draft Report to the Environment Agency. University of Newcastle, 1996.

4. Halcrow, Sir William and Partners - National Rivers Authority South West Region Low Flow Study - Final Report Volumes 1 and 2 - April 1991.

5. National Rivers Authority - River Tavy Alleviation of Low Flows Project - First Tavistock - Morwellham Canal Trial, December 5th, 1995. Draft Final Report.

6. National Rivers Authority (Howlett, B. & Murdoch, N.) - Alleviation of Low Flows - River Tavy Phase 1A Hydrological Model Investigation - September 1995.

7. Southern Science - River Tavy ALF Project - Historic Review of Leat Abstractions and Discharges - September 1995.

8. West Devon Borough Local Plan - Deposit Version June 1993 (Document Two: Inset Relating to Policies for Tavistock).

9. West Devon Borough Local Plan - Modifications - October 1995.

10. West Devon Borough Local Plan - Modifications - April 1996.

PLATES

Plate 1 - Tavistock Canal downstream of the Plymouth Road bridge at flow levels used for hydropower generation

Plate 2 - Backed up flows during the summer 1996 flow trial

Plate 3 - Temporary sandbag weir at Crowndale Farm

Plate 4 - Weir at Crebor above the tunnel entrance

Plate 5 - Sluice gate to regulate flow to the Combe Stream at Morwellham

Plate 6 - Waterfall generated by spill from the lock gate at Locks Cottage

APPENDIX 1

ECOLOGICAL DATA

(i) Fish Rescue Data

(ii) Extracts from Eclogue Report
- 1993 Invertebrate Survey
- 1993 River Corridor Survey
- 1993 Macrophyte Survey

(iii) Ecological Surveys - 1996
- Walkover Habitat Survey
- Macrophyte Survey

(iv) Invertebrate Survey - 1996

FISH RESCUE DATA

TO: GIAN ELLIS
BABTIE GROUP

FROM: TERRY GILBERT
ENVIRONMENT AGENCY, FISHERIES SECTION.

DATE: 23 OCTOBER 1996

SUBJECT: TAVISTOCK - MORWELLHAM CANAL

With reference to your Fax dated 24 September 1996, known species are:-

Salmon Fry + Parr + Smolts
Brown Trout Fry + Parr + Smolts
Seatrout Kelts
Rainbow Trout (escaping from nearby Fish Farm)
Bullheads
Minnows
Eels
Stone Loach

Fish recues over the past three years are as folows:-

TAVISTOCK CANAL

19 MAY 1994

25 Seatrouf Smolts
69 Salmon Smolts
359 Salmon Parr
197 Brown Trout

7 - 8 JUNE 1995

77 Seatrout Smolts
48 Salmon Smolts
337 Brown Trout
195 Salmon Parr
33 Eels
1 Rainbow - 2 1/2 lb
1 Seatrout - 2lb (Fresh run)

30 APRIL 1996

386 Trout
129 Salmon Parr
37 Salmon Smolts
17 Seatrout Smolts
1 Seatrout - 2 1/2 lbs

Please do not hesitate to contact me if I can be of further assistance.

Regards

Terry Gilbert

EXTRACTS FROM ECLOGUE REPORT

(Alleviation of Low Flows - Conservation Site Investigations - Eclogue Environmental Consultancy, October 1993)

- **1993 Invertebrate Survey**
- **1993 River Corridor Survey**
- **1993 Macrophyte Survey**

Group 4									
Mollusca									
Ancylidae									
Ancylus fluviatilis	x	x	xx	-	xx	xx	x	x	xx
	-	-	-	x	-	-	-	-	-
Crustacea									
Gammaridae									
Gammarus pulex	x	xx	xxx	-	x	xx	x	-	x
	-	-	-	x	-	-	-	-	-
Group 5									
Hemiptera									
Gerridae									
Aquarius najas	-	-	-	-	-	-	-	-	-
	-	x	x	-	-	-	-	-	-
Corixidae									
Corixid. nymph non.det.	-	x	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Coleoptera									
Elmidae									
Elmis aenae	x	-	x	-	-	x	-	-	x
	-	x	-	-	-	-	-	-	-
Limnius volkmari	x	-	x	-	-	x	-	-	x
	-	-	-	-	x	-	-	-	-
Oulimnius tuberculatus	-	-	-	x	-	-	-	-	-
	-	-	x	-	-	-	-	-	-
Dytiscidae									
Stictotarsus duodecimpust-	-	-	-	-	-	-	x	x	x
ulatus	x	-	-	-	-	-	-	-	-
Oreodytes sanmarki	-	-	-	x	-	-	x	-	-
	x	x	x	-	-	-	-	-	-
Oreodytes septenrionalis	-	-	-	-	-	-	-	-	-
	-	-	x	-	-	-	-	-	-
Platambus maculatus	-	-	-	-	-	-	-	x	-
	-	-	-	-	-	-	-	-	x
Gyrinidae									
Gyrinus urinator	-	-	-	-	-	-	-	-	-
	-	x	-	-	-	-	-	-	-
Gyrinidae [illegible] det.	-	-	x	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Orechtochilus villosus	-	-	-	-	-	-	-	-	-
	x	x	-	-	-	-	-	-	-
Hydrophilidae									
Hydraeana gracilis	-	-	-	-	-	-	-	-	-
	-	-	-	x	-	-	-	-	-
Trichoptera									
Hydrpsychidae									
Hydropsyche siltalai	xx	-	x	-	-	x	-	-	x
	-	-	-	-	-	-	-	-	-

Hydropsyche pellucida	-	-	xx	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Diptera									
Tipulidae									
Dicranota sp.	x	-	x	-	-	x	-	-	x
	-	-	-	-	-	-	-	-	-
Simulidae									
Simulium sp.	-	-	-	-	-	x	-	-	-
	-	-	x	-	-	-	-	-	-
Tricladida									
Dendrocoelidae									
Dendrocoelum lacteum	-	-	x	-	-	x	-	-	-
	-	-	-	-	-	-	-	-	-
Group 6									
Ephemeroptera									
Baetidae									
Baetis rhodani	x	-	xx	x	x	xx	-	-	x
	-	x	-	-	-	-	-	-	-
Baetis sp. non det.	-	x	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Centroptilum pennulatum	-	-	-	x	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Group 7									
Mollusca									
Hydrobiidae									
Potamopyrgus jenkinsi	-	x	-	-	-	-	xx	xx	xx
	x	-	x	x	-	x	-	-	-
Lymnaeidae									
Lymnaea peregra	-	-	x	-	-	-	-	-	x
	x	-	-	-	-	-	-	x	-
Planorbiidae									
Bathyomphalus contortus	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	x	-
Annelida									
Glossiphoniidae									
Glossiphonia complanata	-	-	-	-	-	-	-	-	x
	x	-	-	-	-	-	-	-	-
Erpobdellidae									
Erpobdella octoculata	-	-	-	-	-	-	-	-	x
	-	-	-	x	-	-	-	x	-
Group 8									
Diptera									
Chironomidae									
Chironomus sp.	x	x	-	x	x	xx	xx	xx	xx
	-	-	x	-	-	-	-	-	-

Group 9

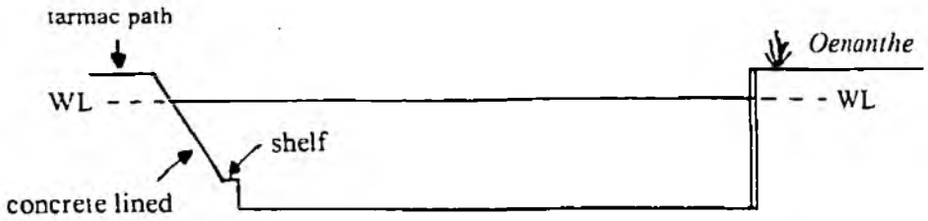
Oligochaeta									
Lumbricidae									
Sp. non det.	-	x	x	-	-	x	-	-	x
	-	-	-	-	x	-	-	-	-
Tubificidae									
Sp. non det.	-	x	-	-	-	-	-	xx	-
	-	-	-	-	-	-	x	-	-
Other Taxa									
Diptera									
Rhagionidae									
Atherix ibis	-	-	x	x	-	x	-	-	-
	x	-	-	-	x	-	x	x	-
Mollusca									
Pisidiidae									
Pisidium subtruncatum	-	-	-	-	-	-	x	x	-
	-	-	-	-	-	-	-	-	x
Hemiptera									
Veliidae									
Velia capraea	-	-	-	-	-	-	-	-	-
	x	x	x	-	x	-	-	-	-
BMWP score	102	65	101	70	72	118	79	71	101
ASPT	7.3	5.9	6.3	7.0	7.2	6.6	7.2	6.5	5.6

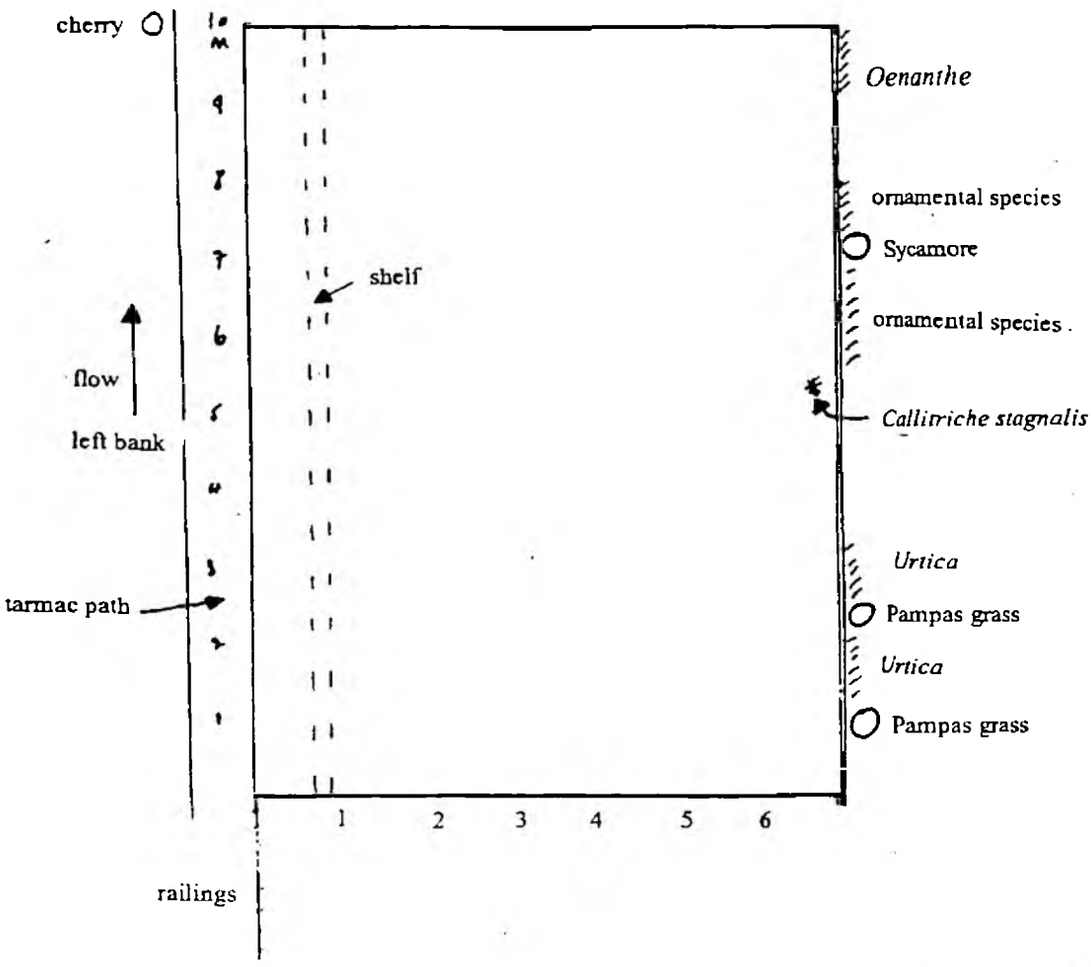
[note: Pisidium (Mollusca) are here considered separately from Sphaeridae]

MORWELLHAM CANAL

MACROPHYTE TRANSECT

21 June 1993 1600 hours



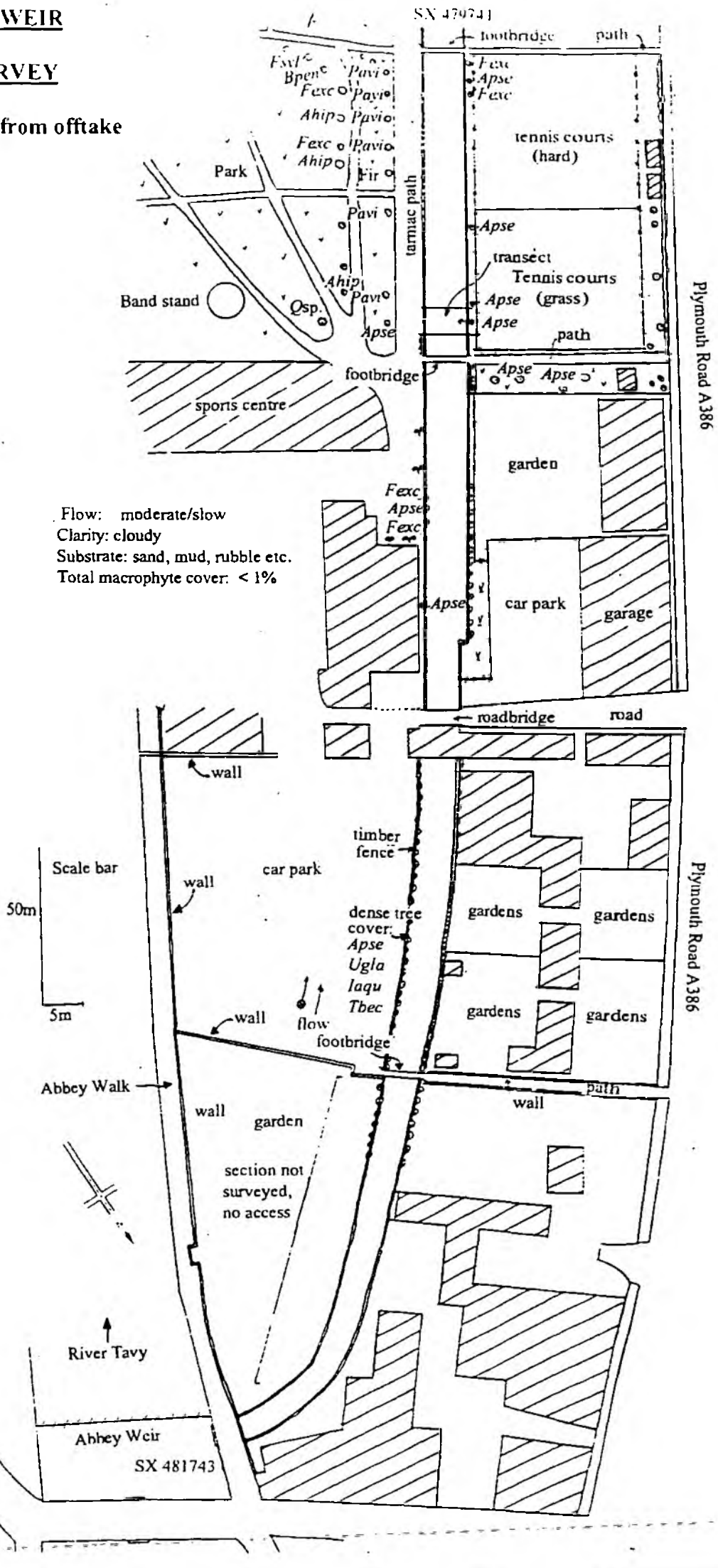


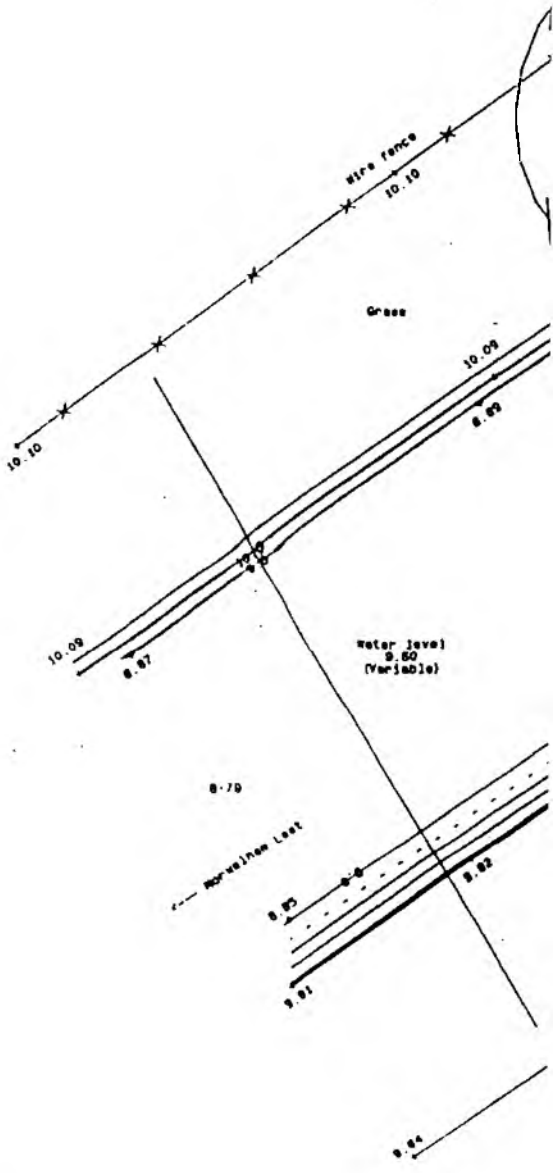
Wholly artificial channel, concrete lined. 1 small patch of *Callitriche stagnalis*.
Small amount of algae attached to occasional stones along margins.

RIVER TAVY - ABBEY WEIR

RIVER CORRIDOR SURVEY

Morwellham canal 500m from offtake

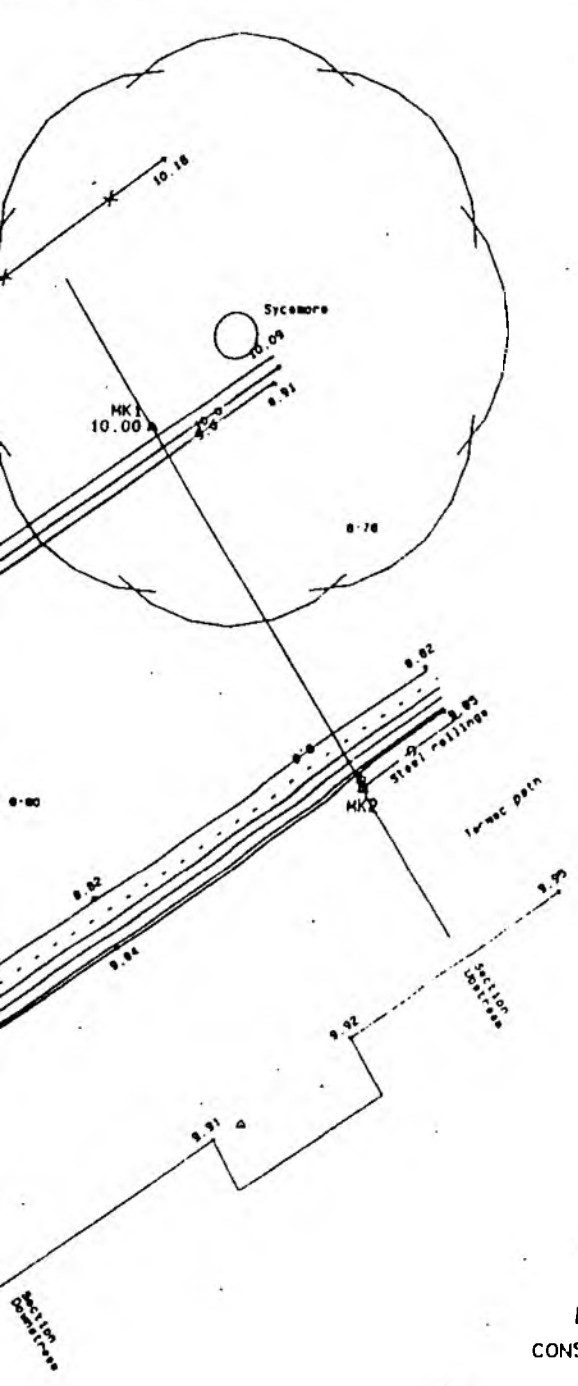




ECLOGUE
ENVIRONMENTAL
CONSULTANCY

NOTES

Water level shown is approximate and relates only to time of survey
Levels are relative to site datum - 10.00m on right bank marker MK1



National Rivers Authority

CONSERVATION SITE INVESTIGATION
Alleviation of Low Flows

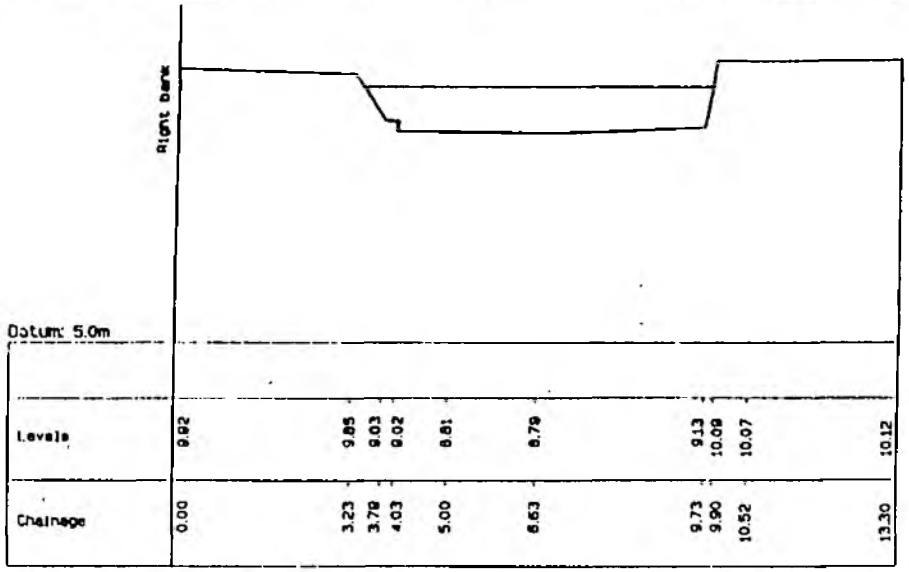
RIVER TAVY

Plan of Transect on Morwellham Canal

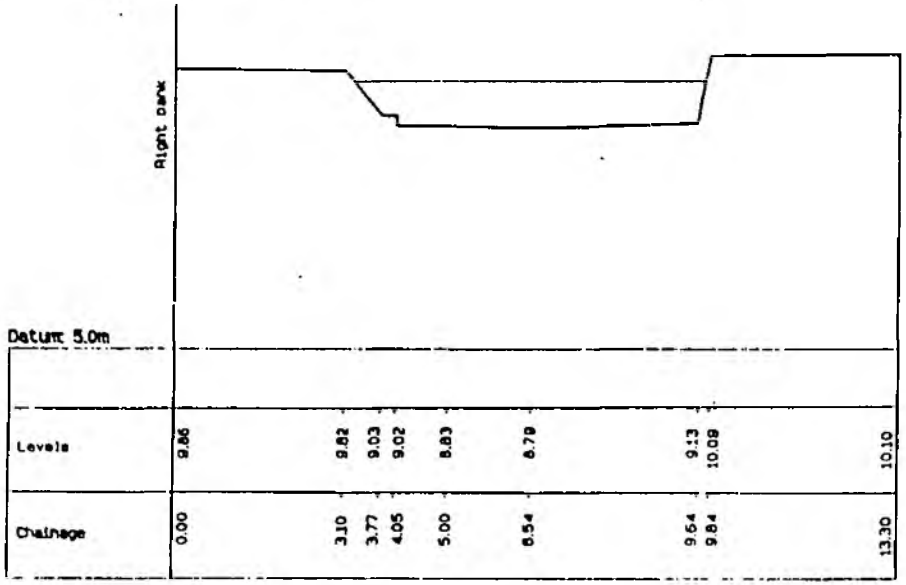
Scale: 1:100

Date of survey: 21st June 1991

1993 MACROPHYTE TRANSECT



Upstream Section – at Markers



Downstream Section – 10.0m Below Markers

ECLOGUE ENVIRONMENTAL CONSULTANCY

NOTES

Water level at ... approximate and relates only to time of survey
Levels are rel... site datum – 10.00m on right bank marker MK1
Sections drawn as seen looking down stream

National Rivers Authority

CONSERVATION SITE INVESTIGATION
Alleviation of Low Flows

RIVER TAVY

Sections Through Transect on Morwellham Canal

Scales: 1:100 vertical: 1:100 horizontal

Date of survey: 21st June 1993

1993 MACROPHYTE TRANSECT

R Tavy - Abbey Weir - Morwellham Canal

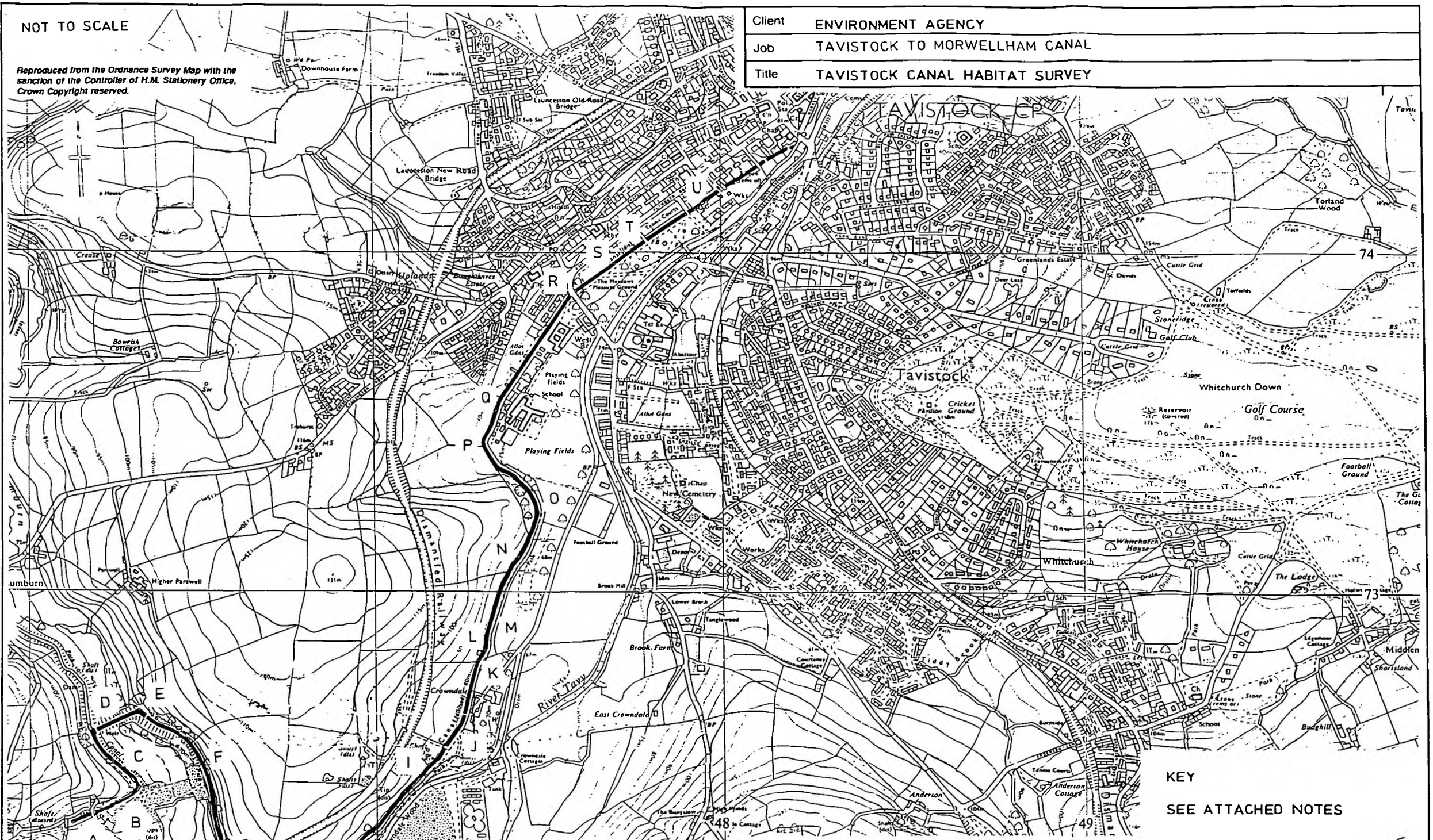
Plant species	Biomass June	Biomass July	Biomass Sept	% cover June	% cover July	% cover Sept
Algae:						
Lemanea mamillosa	1	1	-	A	A	-
Bryophytes:						
	-	-	-	-	-	-
Dicotyledons:						
Callitriche stagnalis	1	1	-	A	A	-
Monocotyledons:						
	-	-	-	-	-	-
Bankside/Marginal species:						
Urtica dioica	2	2	2	A	A	A
Oenanthe crocata	1	1	1	A	A	A
Acer pseudoplatanus	3	3	3	B	B	B
Cortaderia selloana	2	2	2	B	B	B
Ornamental species	2	2	2	A	A	A

ECOLOGICAL SURVEYS - 1996

- **Walkover Habitat Survey**
- **Macrophyte Survey**

NOT TO SCALE

Client	ENVIRONMENT AGENCY
Job	TAVISTOCK TO MORWELLHAM CANAL
Title	TAVISTOCK CANAL HABITAT SURVEY



KEY

SEE ATTACHED NOTES

REV

Babtie	BABTIE GROUP MULTI-DISCIPLINARY CONSULTANTS RENSLADE HOUSE, BONHAY ROAD EXETER EX4 3AY	DRAWN	GLE	JOB No. BWA016552
		CHECKED		DWG No. FIG 1
		APPROVED		DATE SEPT 1996

U.D.O. 3254/95

INVERTEBRATE SAMPLES - RIVER TAVY, ABBEY WEIR

The layout follows the Biological Monitoring Working Party (BMWP) order. The letter coded columns represent each sampling station: A - downstream of weir; B - upstream of weir; C - Morwellham Canal. Sampling station columns are split into three, representing the three sampling times: 1 - 21 June; 2 - 24 July; 3 - 22 September 1993. For each species two rows are given. The top row shows the 3 plus 1 minute sample, the bottom row shows the extra species recorded during the 30 minute sampling. Crosses record the abundance of a species following the NRA code: * = 0-9; ** = 10-99; *** = 100-999 specimens. BMWP and Average Score per Taxon (ASPT) totals are given at the end.

Site	B			A			C		
Sample	1	2	3	1	2	3	1	2	3
Group 1									
Ephemeroptera									
Heptagenidae									
Ecdynurus sp.	x	-	xx	-	x	xx	-	-	x
	-	x	-	x	-	-	-	-	-
Ephemerellidae									
Ephemerella ignita	x	xx	-	xx	x	x	x	x	-
	-	-	-	-	-	-	-	-	-
Ephemera danica	-	-	-	-	-	-	-	-	x
	-	-	-	-	-	-	-	-	-
Caenis rivulorum	-	-	-	x	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Plecoptera									
Leuctridae									
Leuctra fusca	x	xx	xx	xx	xx	xx	-	x	xx
	-	-	-	-	-	-	x	-	-
Leuctra geniculata	xx	xx	-	xx	xx	-	x	-	-
	-	-	-	-	-	-	-	x	-
Perlodidae									
Perlodes microcephala	-	-	x	-	-	-	-	-	-
	-	-	-	-	-	x	-	-	-
Trichoptera									
Leptoceridae									
Mystacides azurea	-	-	-	-	-	-	x	-	-
	-	-	-	-	-	x	-	-	x
Adicella reducta	-	-	-	-	-	-	-	-	-
	x	-	-	-	-	-	-	-	-
Goeridae									
Goera pilosa	-	-	-	-	-	-	-	-	x
	-	-	-	-	-	-	-	-	-

Sericosomatidae									
Sericosoma personatum	x	x	x	x	x	x	x	x	x
	-	-	-	-	-	-	-	-	-
Silo pallipes	-	-	-	-	-	x	-	-	x
	-	-	x	-	-	-	-	-	-
Brachycentridae									
Brachycentropus subnubilis	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	x
Lepidosoma hirtum	xx	-	-	x	-	x	x	x	-
	-	x	-	-	x	-	-	-	-
Group 2									
Odonata									
Agriidae									
Calopteryx virgo	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	x
Group 3									
Plecoptera									
Nemouridae									
Amphinemura sulcicollis	-	-	-	-	-	-	-	-	-
	-	-	-	x	-	-	-	-	-
Nemura cambrica	-	-	-	-	-	-	-	-	-
	-	-	x	-	-	-	-	-	-
Protonemura meyeri	-	-	-	-	-	-	-	-	-
	-	-	x	-	-	-	-	-	-
Trichoptera									
Rhyacophilidae									
Rhyacophila dorsalis	x	x	x	xx	x	xx	-	-	-
	-	-	-	-	-	-	x	-	-
Glossosomatidae									
Glossosoma boltoni	-	-	x	-	-	x	-	-	-
	-	-	-	-	-	-	-	-	-
Agapetus fuscipes	-	-	-	-	-	-	-	-	-
	-	-	-	x	-	-	-	-	-
Polycentropidae									
Polycentropus flavomaculatus	x	-	x	-	x	-	x	x	-
	-	x	-	x	-	-	-	-	x
Lymnephilidae									
Drusus annulatus	-	-	-	x	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Halesus radiatus	-	-	-	-	-	-	-	-	-
	x	-	-	-	-	-	x	-	-
Chaetopteryx villosa	-	-	-	-	-	-	-	x	-
	-	-	x	-	-	x	-	-	-
Potamophylax latipennis	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	x

RIVER TAVY LOW FLOWS ALLEVIATION PROJECT
TAVISTOCK TO MORWELLHAM CANAL

1996 WALKOVER SURVEY TO CHARACTERISE HABITATS ALONG THE CANAL
Site visit 13/09/96
Visited during the Summer 1996 Flow Trials (with weirs at Crowndale and Crebor)

Site	Channel	Habitat Description
A		Canal prior to tunnel entrance. Very steep sides - up to 10m. banks above channel heavily wooded with broadleaved woods
B		Return valve to the River Tavy
C	0.5m deep. Silt and leaves. No plants. No fish seen.	LB mud banks and then wooded higher up. RB stone faced with little vegetation. In unshaded bank areas F- Water pepper (*Polygonum hydropiper*), A- Flote-grass (*Glyceria fluitans*), F- Reed canary grass (*Phalaris arundinacea*) and O- Meadowsweet (*Filipendula ulmaria*). Wooded area - Oak (*Quercus robur*), Ash (*Fraxinus excelsior*), Rowan (*Sorbus aucuparia*), Hazel (*Corylus avellana*), Blackthorn (*Prunus spinosa*).
D	3m width . 1.0 -0.5m depth .Slow flow. No vegetation. Silt / leaves.	Viaduct over River Lumburn. Stone faced banks. No overhanging vegetation. Grassed tow path and broadleaved wood adjacent.
E	As D and extends upstream for 25m	Adjacent habitat. Small patch of willow carr. Probably floods when higher flows in channel. Good wet habitat - occasional ground cover - mainly wetland type species. O- Flote-grass (*Glyceria fluitans*), O- Remote sedge (*Carex remota*), O- Water pepper (*Polygonum hydropiper*). Also other species - O- Red campion (*Silene dioica*), O- Yellow pimpernel (*Lysimachia nemorum*). Also *Fontinalis antipyretica* moss normally found in channel - good indicator of flooding.
F	Much shallower. Max. 0.3m. Stones / leaves Flow faster. Moss in channel.	Stone banks. Adjacent habitat heavily wooded (mature broadleaved) . Channel vegetation - moss O- *Fontinalis antipyretica* and O - pondweed - sp. especially in unshaded areas. O - Hemlock water dropwort (*Oenanthe crocata*) on margin . Occasional Brown trout, pondskaters and dragonflies
G	Shallow riffle - up to 0.2m. Rocky. Varied channel profile.	A small riffle zone just before the viaduct. Upstream of this zone the canal has ponded back with channel depth up to 0.5m with silt deposited.
H	Upstream of viaduct - 0.5m. Leaves / rocks	Small viaduct over ditch draining farmland. Possible slight leak as water appears in ditch below canal. For 50m upstream canal is unshaded. Channel vegetation, A-Water crowfoot (*Ranunculus fluitans* and O- pondweed . Marginal vegetation on LB includes A - Flote-grass(*Glyceria fluitans*) and A- Soft rush (*Juncus effusus*). Upstream adjacent broadleaved wood is a narrow band (max. 5m)
I	d/s of weir channel 0.2	Temporary sand bag weir and canoe end point. Downstream

ABUNDANCE KEY

O - occasional
F - frequent
A - abundant

	-0.3m rocky. u/s ponded back to 0.5m	(20m) a riffle zone has formed. Vegetation includes A -Water crowfoot (*Ranunculus fluitans*) and O- moss *Fontinalis antipyretica* . Upstream ponded back. Temporary weir has created a diversity of habitats - may be beneficial to invertebrates.
I - J	0.5m depth. Channel rocky with occasional vegetation	Open stretch of channel with vegetation. LB field edge boundary with typical hedgerow species - Blackthorn (*Prunus spinosa*), Hawthorn (*Crataegus monogyna*), Hazel (*Corylus avellana*), Bramble (*Rubus fruticosus*), Sycamore (*Fraxinus excelsior*), Elder (*Sambucus nigra*). Channel stone faced banks. RB canal towpath.
J	- Archaeological note	Crowndale Farm - archaeological interest. Reputed to be birthplace of Sir Francis Drake. Towpath named 'Drake's walk'.
K	-	Broadleaved woodland managed by the Woodland Trust. Mature deciduous - Oak (*Quercus robur*), Beech (*Fagus sylvatica*), Sycamore (*Acer pseudoplatanus*) and Holly (*Ilex aquifolium*). Good habitat.
L	-	Old quarry - now filled with stagnant water. Surrounded by narrow hedgerow.
M	0.3 - 0.4m depth.Silted. Wider channel up to 5/6m	Heavily shaded channel. No vegetation.
N	Small riffle.	Cattle drink on edge of farmland. Small riffle zone 0.2 - 0.3m depth. Upstream channel flow slow depth 0.3 - 0.5m. Very shaded and little channel vegetation.
O	-	Boggy area fed by spring flush. Possibly fed by canal? Sheltered willow carr, very wet in places with common species of rushes, ferns, grasses. A lot of insects and birdsong. Very good habitat on edge of deciduous woodland.
P	Depositing silt. 0.4m+	Open stretch of channel. Water crowfoot (*Ranunculus fluitans*) in channel (A). Cattle drink at field edge. Upstream LB margin habitat - mainly Soft rush (*Juncus effusus*). RB - tow path then hedgerow - Hawthorn (*Crataegus monogyna*), Bramble (*Rubus fruticosus*), Elder (*Sambucus nigra*).
Q	0.4 -0.6m silt - 50% vegetated	Marshy area alongside canal - approx. 20m x50m. RB large clumps of Soft rush (*Juncus effusus*). Good habitat. Input drain to canal.
R	No note	
S	0.4 - 0.5m - silt	Canal by Meadows. Concrete banks. RB garden ornamentals. No natural vegetation. Many minnows.
T	0.4m - silt	Overgrown ornamental grass - major shoaling of minnows in the shade from the plants. No other vegetation
U	0.3m - silt / rocks slow flow	Just before car park and past the sports centre. RB - Ivy (*Hedera helix*) covered wall with trees (Sycamore (*Acer pseudoplatanus*)

Note:- LB = Left Bank / RB = Right Bank of canal looking upstream.

General Observations

Birds seen: Blue tit, Buzzard, Chaffinch, Coal tit, Crow, Green woodpecker, Jay, Magpie, Nuthatch, Robin, Swallow, Wren. Mammals seen: Grey squirrel (at least 20).

RIVER TAVY LOW FLOWS ALLEVIATION PROJECT - TAVISTOCK TO MORWELLHAM CANAL

MACROPHYTE SPECIES LISTS

Survey date : 3 - October 1996

Method - Macrophyte species were recorded over a 100 metre stretch at each of 4 sites.

SITE 1 : (SX 478 741)

Presence recorded over 100 metres.

ALGAE :
Cladophora sp(p)

LIVERWORTS :
Pellia epiphylla
Conocephalum conicum
Riccia sp(p)
Lunularia cruciata

MOSSES :
Amblystegium riparium
Fissidens sp(p)
Fontinalis antipyretica
Fontinalis squamosa
Rhyncostegium riparioides
Mnium hornum
Hygrohypnum ochraceum

DICOTYLEDONS :
Oenanthe crocata

SITE 2 : (SX 473 733)

LIVERWORTS :
Pellia epiphylla

MOSSES :
Mnium hornum

OTHERS :
Indet green lichen
Benthic diatoms

SITE 3 : (SX 464 723)

Presence recorded over 100 metres.

ALGAE :
Batrachospermum sp(p)

LIVERWORTS :
Conacephalum conicum

SITE 4 : (SX 462 727)

ALGAE :
Cladophora sp(p)

MOSSES :
Hygrohypnum ochraceum
Fissidens sp(p)
Amblystegium fluviatile

SITE 3 Continued

MOSSES :
Thamnobryum alopecurvum
fissidens sp(p)
Mnium hormum
Amblystegium fluviatile
Fontinalis antipyretica

OTHERS :
Indet green lichen

Site 4 Continued

DICOTYLEDONS :
Callitriche stagnalis
Mentha aquatica
Oenanthe crocata
Rumex sp(p)
Polygonum hydropiper
Galium palustris
Filipendula sp(p)

MONOCOTYLEDONS :
Lemna minor
Juncus effusus
Glyceria fluitans
Phalaris arudinacea
Veronica catenata

HORSETAILS :
Equisetum fluviatile

INVERTEBRATE SURVEY - 1996

MACROINVERTEBRATE COLLECTION METHODOLOGY

A 3 minute kick sample was taken at each site with a naturalist's pond net.In addition a 1 minute search was undertaken for additional species.The samples were preserved with Industrial Methylated Spirits (+ 5% Glycerol) and returned to the laboratory for sorting and identication.

Katherine Ivall : 30 - October 1996

Site 1 : SX 478 741

Site 2: SX 473 733

Site 3: SX 464 723

Site 4: SX 462 727

BMWP SCORING

The standard biotic scoring system used by the Environment Agency biologists is the BMWP (Biological Monitoring Working Party) system. A score of 0 - 10 is awarded to each invertebrate family depending on its reaction to organic enrichment, a high score reflecting intolerance to contamination. The sum of the scores from all the invertebrate families present at a site gives the BMWP. Generally, a BMWP above 150 is considered to indicate good water quality. From thc BMWP it is possible to derive the ASPT (Average Score per Taxon) by dividing the BMWP by the number of scoring families at the site. The ASPT has some advantages over the BMWP which is prone to variation between samplers and sampling seasons.

1996 INVERTEBRATE SURVEY OF MORWELLHAM CANAL

Site: 1 **Grid Ref:** SX 478 741 **BMWP Score:** 52 **ASPT Score:** 4.73

Taxa	Abundance	BMWP Score
Leptoceridae	10 - 99	10
Lepidostomatidae	1 - 9	10
Limnephilidae	1 - 9	7
Ancylidae (Acroloxidae)	10 - 99	6
Elmidae	10 - 99	5
Tipulidae	10 - 99	5
Hydrobiidae	10 - 99	3
Lymnaeidae	10 - 99	3
Sphaeriidae	1 - 9	3
Glossiphoniidae	1 - 9	3
Chironomidae	10 - 99	2
Oligochaeta	10 - 99	1

Other non scoring taxa:
Athericidae 1 - 9, Ceratopogonidae 1 - 9, Hydracarina 1 - 9

Species List:
Potamopyrgos jenkinsi, Lymnaea peregra, Athericidae, Ceratopogonidae, Tipulidae, Chironomidae, *Glossiphonia complanata, Oecetis testacea, Hydracarina, Oligochaeta, Ancylus fluviatilus, Mystacides azurea*, Elimidae, *Pisidium sp.*, Limnephilidae, Lepidostomatidae, *Bactis rhodani*

Site: 2 **Grid Ref:** SX 473 733 **BMWP Score:** 71 **ASPT Score:** 5.92

Taxa	Abundance	BMWP Score
Ephemeridae	1 - 9	10
Leptoceridae	1 - 9	10
Goeridae	1 - 9	10
Sericostomatidae	10 - 99	10
Nemouridae	1 - 9	7
Limnephilidae	1 - 9	7
Elmidae	10 - 99	5
Hydrobiidae	10 - 99	3
Sphaeriidae	10 - 99	3
Erpobdellidae	1 - 9	3
Chironomidae	10 - 99	2
Oligochaeta	10 - 99	1

Other non scoring taxa:
Hyrdacarina 1 - 9

Species List:
Potamopyrgus jenkinsi, Pisidium sp., Oligochaeta, Sericostoma personatum, Ephemera danica, Oecetis testacea, Silo pallipes, Goera pilosa, Mystacides azurea, Limnephilidae, *Erpobdellida octoculata, Hydracarina*, Erpobdellidae, *Limnius volkmari, Oulimnis sp., Nemoura sp., Atherix marginata, Sialis lutaria, Athripsodes sp.*

Site: 3 **Grid Ref:** SX 464 723 **BMWP Score:** 140 **ASPT Score:** 6.36

Taxa	Abundance	BMWP Score
Heptageniidae	1 - 9	10
Leptophlebiidae	1 - 9	10
Ephemereilidae	10 - 99	10
Leuctridae	10 - 99	10
Leptoceridae	1 - 9	10
Goeridae	1 - 9	10
Lepidostomatidae	1 - 9	10
Sericostomatidae	1 - 9	10
Limnephilidae	10 - 99	7
Ancylidae (Acroloxidae)	10 - 99	6
Hydroptilidae	1 - 9	6
Gammaridae (Crangonyctidae)	10 - 99	6
Hydrophilidae	1 - 9	5
Elmidae	10 - 99	5
Hydropsychidae	10 - 99	5
Tipulidae	10 - 99	5
Hydrobiidae	10 - 99	3
Lymnaeidae	10 - 99	3
Sphaeriidae	10 - 99	3
Asellidae	1 - 9	3
Chironomidae	10 - 99	2
Oligochaeta	10 - 99	1

Other non scoring taxa:
Hydracarina 1 - 9

Species List:
Silo pallipes, Oligochaeta, Ecdyonurus venosus, Gammarus pulex, Hydracarina, Paraleptophlebia submarginata, Ancylus fluviatilus, Lymnaea pergra, Tipulidae, *Potamopyrgus jenkinsi, Leuctra hippopus, Hydropsyche angostipennis*, Ohironomidae, *Asellus meridianus, Oulimnius sp., Limnius volkmari, Hydraena sp., Epemerella ignita, Hydropsyche siltali, Elmis aenea, Pisidium sp., Hydroptila sp.*, Limnephilidae, *Glossiphornia complanata*, Leptoceridae, *Sericostoma personatum, Oecetis testacea, Lepidostoma hirtum, Heptagenia sp.*

Site: 4 **Grid Ref:** SX 462 727 **BMWP Score:** 74 **ASPT Score:** 4.63

Taxa	Abundance	BMWP Score
Leptoceridae	10 - 99	10
Sericotomotidae	10 - 99	10
Limnephilidae	10 - 99	7
Gammaridae	10 - 99	6
Hydrometridae	1 - 9	5
Corixidae	1 - 9	5
Gyrinidae	1 - 9	5
Elmidos	10 - 99	5
Hydrobiidae	10 - 99	3
Lymnaeidae	10 - 99	3
Sphaeriidae	10 - 99	3
Giossiphoniidae	1 - 9	3
Erpobdeliidae	1 - 9	3
Aseliidae	1 - 9	3
Chironomidae	10 - 99	2
Oligochaeta	10 - 99	1

Other non scoring taxa:
Hydracarina 1 - 9, Tabanidae 1 - 9

Species List:
Oligochaeta, Gammarns pulex, Chironomidae, *Hydracarina*, Limnephilidae, Corixidae, *Potamospyrgus jenkinsi, Lymnaea peregra*, Tabanidae, *Sericostona personatum*, Erpobdellidae, *Hydrometra stagnorum, Asellus aquaticus; Elmis aenea, Gyninus caspius, Glossiphonia complanata, Oecetis testacae, Pisidium sp., Mystacides azurea, Notonecta sp., Sigara limitata, Sialis lutarea, Potamonectes depressus elegans, Asellus meridianus, Physa acuta, Centroptilum pennulatum, Ephemera sp.*

APPENDIX 2

ARCHAEOLOGICAL DATA

(i) Archaeological Maps and Sites and Monuments Register Listings

Code	SMR Ref Grid Ref	Description
1a	SX 47SE/27 SX 47407300	Tavistock Canal. This was built between 1803 and 1817 by John Taylor to connect Tavistock to the Tamar at Morwellham. More details under 2d
1b	SX 47SE/261 SX 4802 7423	Canal Warehouse. Nineteenth Century warehouse with a cottage attached to the north end is shown on the 1842 OS plan.
1c	SX 47SE/143 SX 48017419	Canal Wharf building. One of the two remaining buildings of canal wharf from where copper was transported to Morwellham. Dated circa 1817. Listed as a Grade II Listed Building.
1d	SX 47SE/144 SX 48027417	Cottage at entrance to Canal Wharf. One of a pair of cottages dated circa 1817. A Grade II Listed Building.
1e	SX 47SE/147 SX 48007419	Bridge over canal. Stone rubble bridge with cambered arch and rusticated voussoirs and keystone. Dated 1817 and is a Grade II Listed Building.
1f	SX 47SE/259 SX 48007416	Cottage. Second of a pair of cottages at entrance to canal wharf (see 1d). Dated circa 1817. A Grade II Listed Building.
1g	SX 47SE/145 SX 48017417	Cottage. Dated circa 1817. Grade II Listed Building.
1h	SX 47SE/262 SX 480-741-	Canal Quay. The south wall of the Abbey Wharf marks the southern limit of the original canal wharf. Shown on the 1842 OS plan with a range of buildings attached which have now disappeared.
1i	SX 47SE/270 SX 480-741	Lime Kilns. 'Old kilns' shown on the 25" 1st Edition 1884 plan. Not shown on the 1974 plan. Probably associated with lime brought up the canal from Morwellham.

Code	SMR Ref Grid Ref	Description
1j	SX 47SE/146 SX 47987415	Canal warehouse. One of only 2 remaining warehouses of wharf where the copper from Tavistock was transported to Morwellham Quay. Dated circa 1817 and is a Grade II Listed Building.
1k	SX 47SE/23-01 SX 475-738	Industrial housing Fitzford cottages. During the copper mining boom in the mid 19th century the Duke of Bedford built these houses for the miners of Fitzford.
1l	SX 47SE/292 SX 4743 7330	Quarry. Old quarry marked on the OS 6 inch 1905/1938 plans. May be associated with the building of the canal.
1m	SX 47SE/19 SX 470-725	Crowndale Mine. Wheal Crowndale mine opened in 1799 and it was one of the main reasons for the building of the Tavistock Canal. Copper, arsenic and tin were mined here. A timbered shaft from the 1924 workings can be seen from the canal towpath. This mine was one of the richest copper mines in the Tavistock area.
1n	SX 47SE/294 SX 47007217	Quarry. 'Old Quarry' marked on OS 6 inch 1905/1938 plan.
1o	SX 47SE/28	Aqueduct. Carries the canal across the River Lumburn to the tunnel
1p	SX 47SE/279 SX 46257250	Canal. Old stretch of canal from NGR SX 46207258 to NGR SX 46147233. Shown on OS 6 inch 1905/1938 as 'Canal (dis)'
1q	SX 47SE/253 SX 462-723	Bridge. A bridge over the Tavistock Canal about 50m NE of the north portal to the tunnel. Built between 1803 and 1817 by John Taylor. A Grade II Listed Building
1r	SX 47SE/29 SX 4612 7230	Tunnel for the Tavistock canal running under Morwell Down

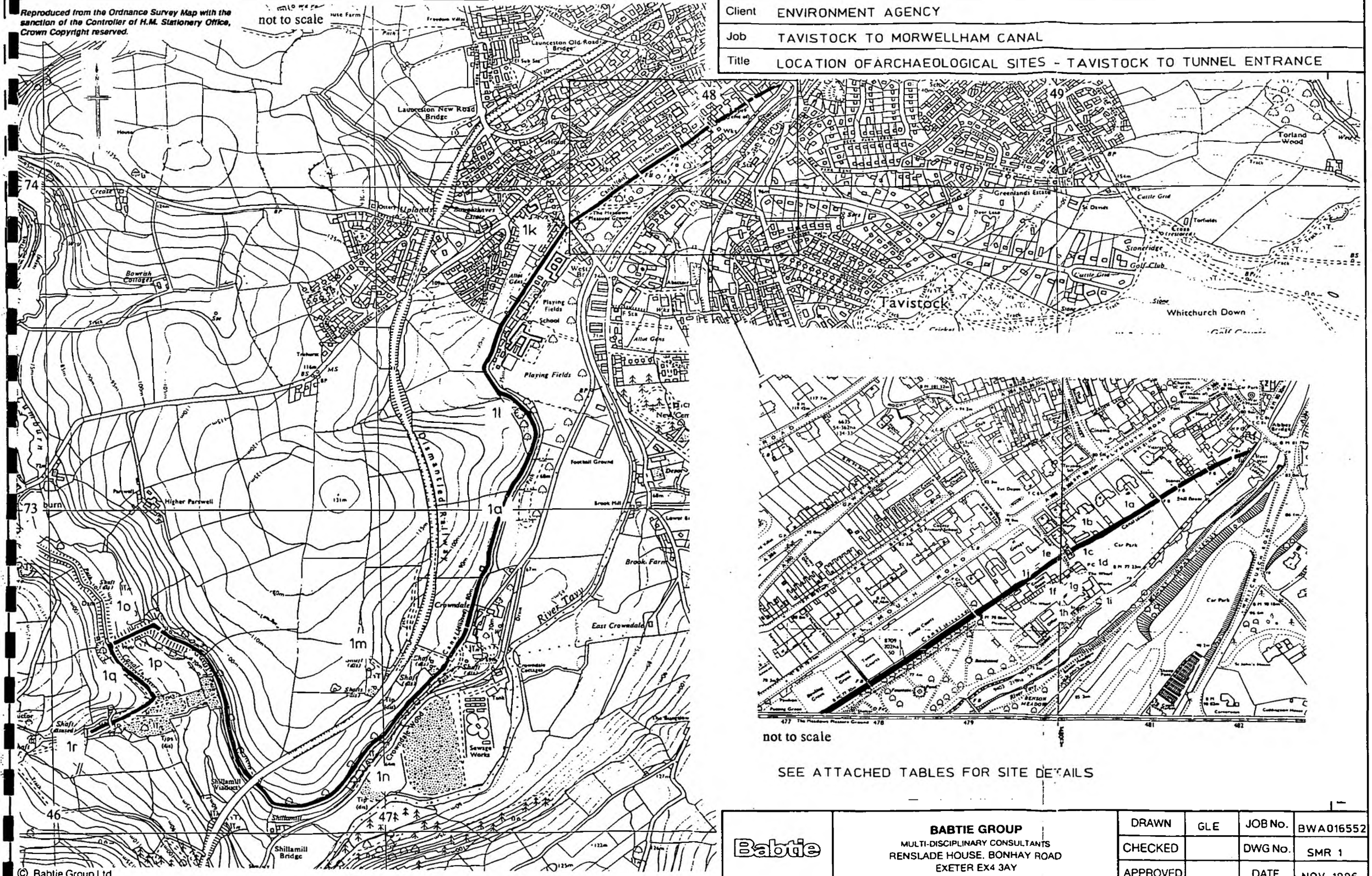
Code	SMR Ref Grid Ref	Description
2a	SX 47SW-509 NGR SX 44887029	Canal Tunnel. South portal to the Tavistock Canal. Dated 1803. Distance in tunnel is 2 miles. Connected to Morwellham by an inclined plane with a drop of 237 ft.
2b	SX 47SW-505/1 NGR SX 44897026	Weir. Marked on 1937 and 1954 OS maps. Weir on canal supplying leat.
2c	SX 47SW-524 SX 44877028	Leat. 19th century leat supplying to Newquay, George and Charlotte Mine and Gawton Mine fed by canal. Still visible above Newquay.
2d	SX 47SW-505 SX.4467016	Tavistock Canal. Built by John Taylor between 1803 and 1817 to connect Tavistock to the Tamar at Morwellham to carry copper ore to Morwellham and coal, lime and sand to Tavistock. Carried ore in iron barges (the first used on English canals) from Wheals Friendship, Crebor and Crowndale. Closed between 1883 and 1898 due to competition from the railways. Ceased to be navigable in 1873. Now used as a source of water to power Morwellham Power Station run by National Power. Subsequently to be taken over by South West Water.
2e	SX 47SW-552 SX 44407005	Canal Farmhouse. Incline keepers cottage - dated circa 1850 Grade II Listed Building. Attached stable on SMR as SX 475W552-01.
2f	SX 46NW-515 SX 4450 6978	Inclined Plane. Served both the Tavistock canal and the Devon Great Consols Mineral railway. Comprises a fall of 237ft. The greatest in southern England. Carried goods in trucks from end of canal to the quay. Driven by water power supplied from canal.

Code	SMR Ref Grid Ref	Description
2g	SX 46NW-532 SX 44606979	Church. Church at Morwellham Quay. Grade II Listed Building.
2h	SX 46NW-534 SX 445-697	House. House at Morwellham Quay. Part of complex. Grade II.
2i	SX 46NW-505 SX 446-698	Lime kiln. Morwellham lime kiln probably mid 18th century. Grade II listed building. Store for lime prior to transport to Tavistock.
2j	SX 46NW-519 SX 445-697	Industrial Housing. Built by the Duke of Bedford in the mid 19th century for the port workers at Morwellham as a result of the copper mining boom
2k	SX 46NW-535 SX 446-697	Lime kiln. Early 19th century kiln, round fronted kiln with charging ramp to side. Grade II Listed Building.
2l	SX 46NW-541 SX 4462-6925	School. School at Morwellham Quay marked on 1907 OS 6 inch plan.
2m	SX 46NW-501-01 SX 446-697	Morwellham Port first mentioned in the 13th century. Held by Tavistock Abbey until the dissolution in 1539. Progress was steady. Imports included coal, bricks, lime and timber. At end of 18th century became a company with copper now a regular export.
2n	SX 46NW-536 SX 447-698	Farmstead at Morwellham. Mid 19th century. Grade II listed building

Code	SMR Ref Grid Ref	Description
2o	SX 46NW-520 SX 44—69--	Boundary stone (Gremure) mentioned in a 13th century grant as one of the bounds of Morwellham Port.
2p	SX 46NW-533 SX 44606952	Ferry stage associated with Morwellham Port. Probably mid 18th century, located approximately 50m south of the lime kiln.
2q	SX 46NW-515-01 SX 444-699-	The wheelpit which powered the inclined plane (2f). Located approximately 10m to the south west of Canal Cottage (2e). Powered by water from the canal.
2r	SX 46NW-515-02 SX 444-699	Two disused leats joined circa 3m north of the wheelpit. Both used water from the canal, taking it from the wheel pit head pond (Lobber hole). Both shown in operation on 1867 OS map and marked on 1906 OS map.
2s	SX 46NE-510-01 SX 453-699-	George and Charlotte Mine. A leat from the canal served this copper mine in the 19th century. Opened in 1806. In 1851 became part of the Devon and Cornwall United Mine.

not to scale

Client	ENVIRONMENT AGENCY
Job	TAVISTOCK TO MORWELLHAM CANAL
Title	LOCATION OFARCHAEOLOGICAL SITES - TAVISTOCK TO TUNNEL ENTRANCE



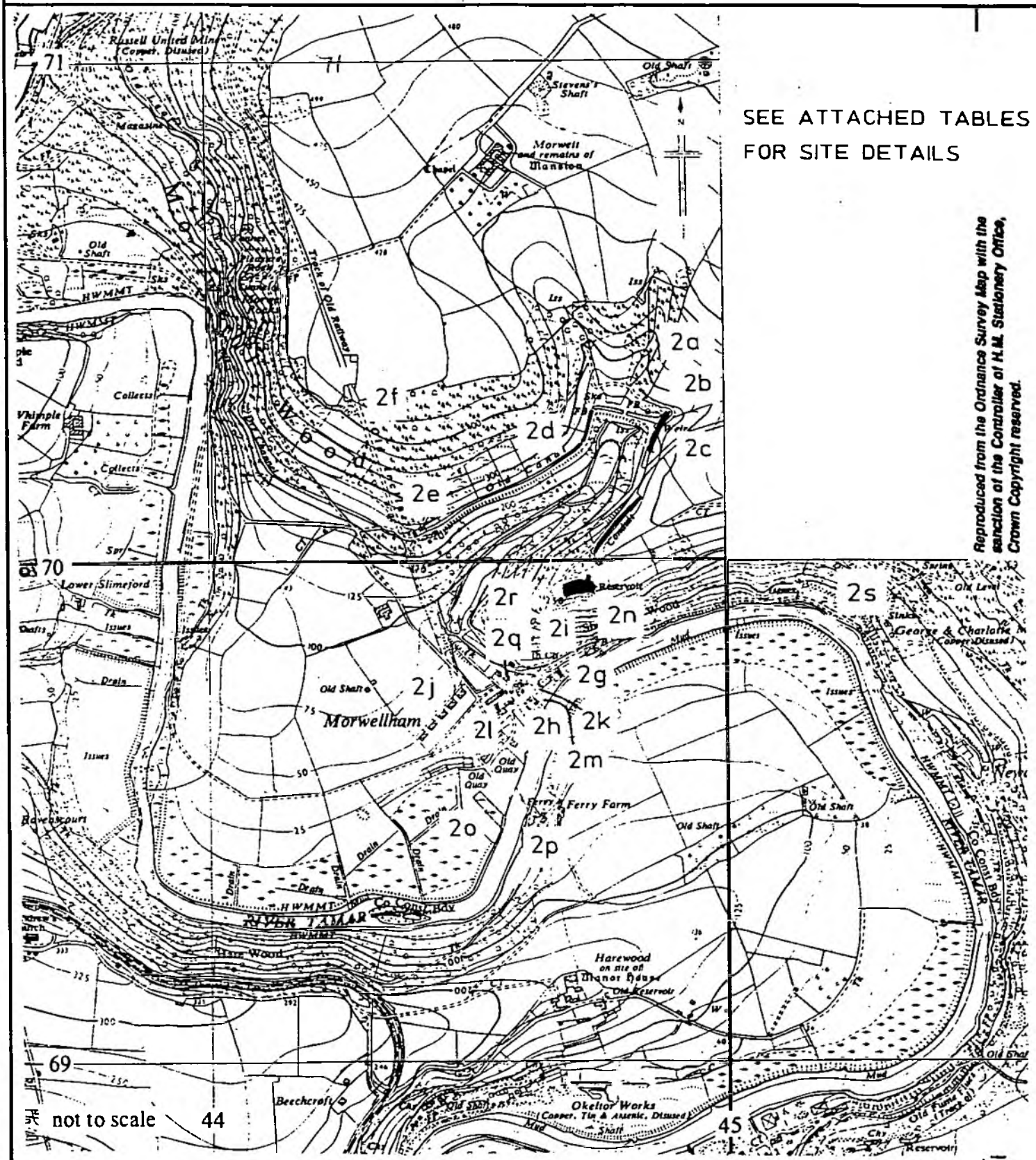
not to scale

SEE ATTACHED TABLES FOR SITE DETAILS

U.D.O. 3254/95

Babtie	BABTIE GROUP MULTI-DISCIPLINARY CONSULTANTS RENSLADE HOUSE, BONHAY ROAD EXETER EX4 3AY	DRAWN	GLE	JOB No.	BWA016552
		CHECKED		DWG No.	SMR 1
		APPROVED		DATE	NOV 1996

Client	ENVIRONMENT AGENCY
Job	TAVISTOCK TO MORWELLHAM CANAL
Title	LOCATION OF ARCHAEOLOGICAL SITES - MORWELLHAM AREA



Babtie

BABTIE GROUP
MULTI-DISCIPLINARY CONSULTANTS
RENSLADE HOUSE, BONHAY ROAD
EXETER EX4 3AY

DRAWN	GLE	JOB No.	BWA016552
CHECKED		DWG No.	SMR2
APPROVED		DATE	NOV 1996

U.D.O. 3255/96

APPENDIX 3

RECREATIONAL DATA

(i) Tavistock Town Trails Leaflet
(ii) Morwellham Quay Leaflet

Tavistock Town Trail, the Viaduct Walk and Drake's Walk

Tavistock Tourist Information Centre,
The Pannier Market, Tavistock. (Under the main arch of the Town Hall). Open 10.00 - 17.00. Tel: (01822) 612938.

West Devon Borough Council produces many other local town and village trail leaflets. These are available from Tavistock and Okehampton Tourist Information Centres, Village Information Points and the Council offices at Kilworthy Park, Tavistock. Tel: (01822) 615911

Tavistock Town Trail

The Trail starts in Riverside Car Park, Pixon Lane, Tavistock's cheapest car park.

1 Riverside Car Park.
Leave the car park via the exit adjacent to the Tourist Information Board, continue along St. Johns Avenue.
At the end of the path go to the left and continue to:

2 Abbey Bridge.
Built in 1860 of large granite stones from Dartmoor.
Continue towards the town centre, pass the Post Office and on your left is:

3 Abbey Chapel.
Formerly the Refectory or dining hall of the Abbey.
Retrace your steps to cross the road at the pedestrian crossing. Walk through the car park to the:

4 Police Station & Guildhall.
Built in the Victorian style in 1848.
Walk straight through an archway known as Court Gate:

5 Court Gate & Bedford Square.
Court Gate was the main entrance to the Abbey and was restored in 1824. Bedford Square is probably one of the most outstanding groups of Victorian buildings in England.
Go through an archway next to the TOURIST INFORMATION CENTRE into:

6 The Pannier Market.
Part of the Bedford improvements of the mid 19th Century.
Take one of the exits on the northern side of the Pannier Market into Duke Street. (You may like to take a break from the walk and visit the shops in Brook Street, Paddon's Row and The Village Shopping Arcade). Cross the road at the pedestrian crossing and turn right, then first left and walk up Pepper Street. Turn left at the top into Barley Market Street. Cross the road and on the right is:

7 The Ordulph Arms.
The name derives from Abbot Ordulph who rebuilt the Abbey after its destruction by the Danes in the 11th Century.
Opposite you will see:

8 Tavistock Printing Company.
Designed by Southcombe Parker in 1906.
Continue along Pym Street for 20 yards bearing right into Market Street. Cross the road towards the Union Inn and pass the mural of The Revenge, turn left into King Street to:

9 ..ık Square, site of Medieval Market Place.
Once the hub of the medieval town.
Proceed down King Street and turn right into West Street. On your right is:

10 The Old Corn Exchange, built in 1835.
Walk up West Street and at the top of the hill turn right into Rocky Hill, refer to Information Board. Walk up the steps to Glanville Road. Turn right towards the Viaduct following the finger posts.

11 The Viaduct.
Built in 1889 by the London and South Western Railway.
Cross the Viaduct and follow the footpath.

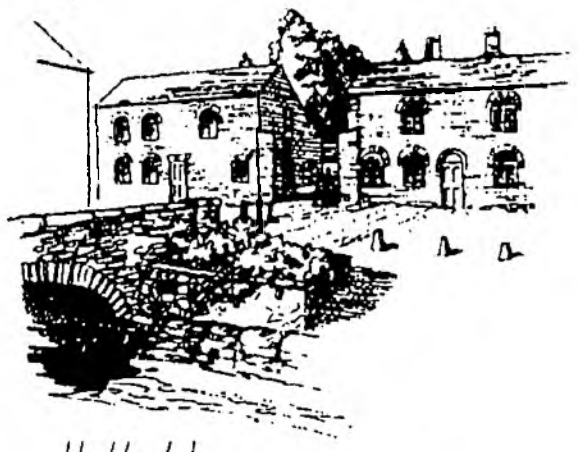
12 The Old Station (Private no access).
Still consisting of platforms, booking hall, main waiting rooms and the station masters office.
Walk back down the hill towards the town centre. At the end of this road turn right into West Street and cross the road at the pedestrian crossing to:

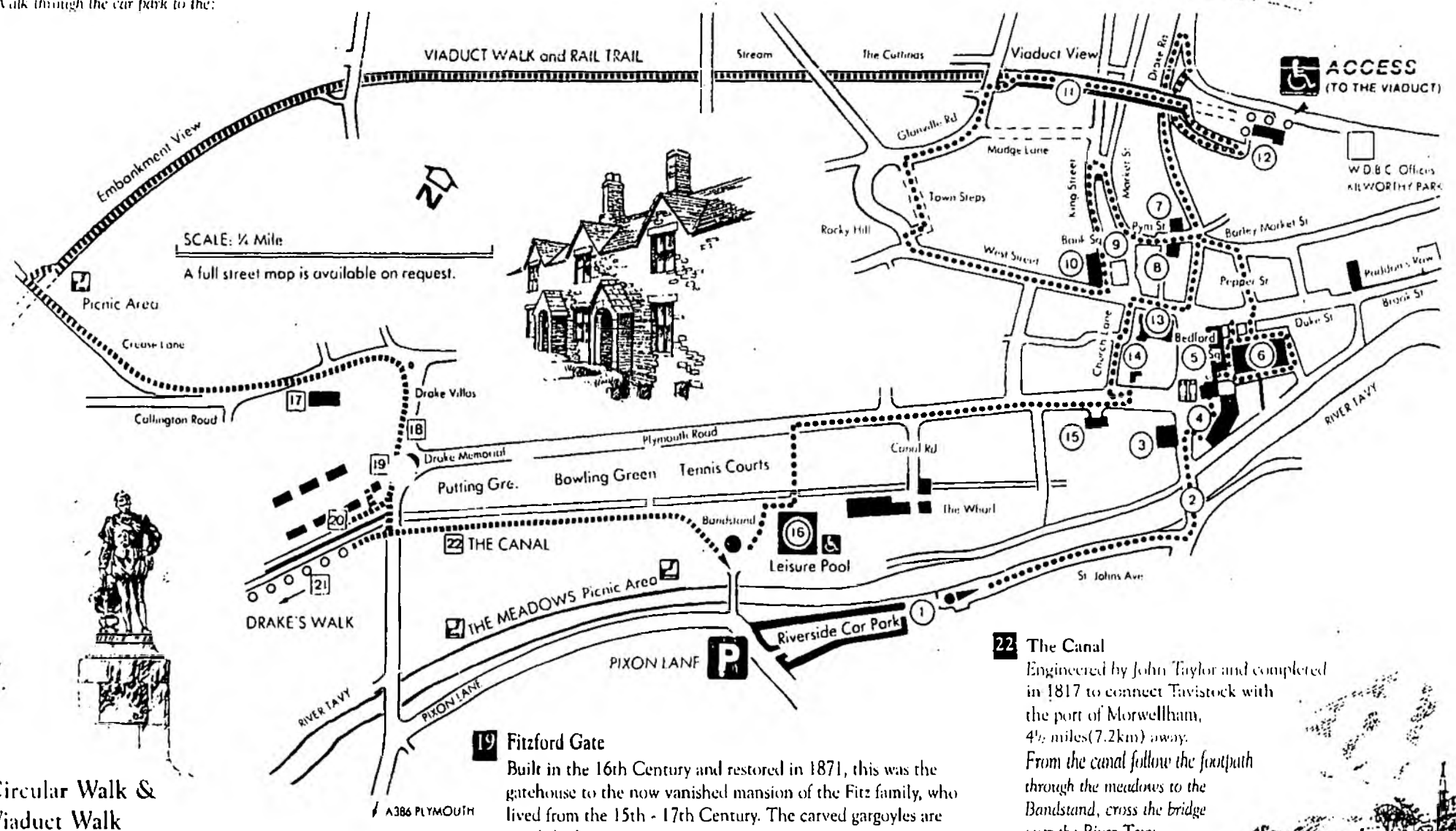
13 The Parish Church Of St. Eustachius.
Built in the early 14th Century.
Turn left into Church Lane and on your left you will see:

14 Abbey Remains.
This 'L' shaped fragment of wall is all that remains of the Abbey Church dating from the 13th Century.
At the end of Church Lane turn left into Plymouth Road. Cross the pedestrian crossing, turn right past the Bedford Hotel, and on your left:

15 'Betsy Grimbal's Tower'.
More properly known as the Great Western Gate of the Abbey and Tavistock. It includes part of the Abbot's lodging and dates from the 15th Century. The name is a corruption of 'The blessed Grimwald', a 9th Century saint.
Continue along Plymouth Road, cross Canal Road and turn left into the Meadows through a narrow gateway with the tennis courts on your right. Cross the canal bridge and on your left is:

16 Meadowlands Leisure Pool.
Exciting river rapid, water cannon and spa pool. Facilities for the disabled are also provided.
Follow the footpath across to the Bandstand, cross the bridge over the River Tavy turn left and follow the footpath back to the Riverside Car Park.





Circular Walk & Viaduct Walk

(Approximately 2 miles, 3.2km)

Follow the directions for the town trail to No.11.
Once on the Viaduct, follow the old railway for approximately 1 mile (1.7km) at the end of which you will find a small picnic area. Walk up the access way to Crease Lane. Turn left down the ...e to Callington Road and pass:

17 Roman Catholic Church
Opened in 1867, designed by Clutton. The nave is reputed to be taller than that of Exeter Cathedral.
Turn right at the mini roundabout into Drake Villas.

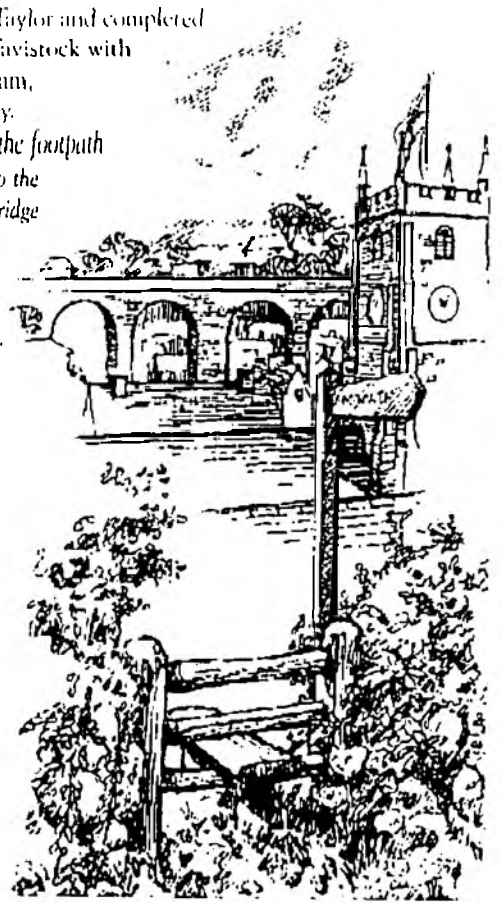
18 Drake Memorial
Erected by the 9th Duke of Bedford in 1883. This Statue is the original from which the replica on Plymouth Hoe was taken.
To the right of Drake Memorial is:

19 Fitzford Gate
Built in the 16th Century and restored in 1871, this was the gatehouse to the now vanished mansion of the Fitz family, who lived from the 15th - 17th Century. The carved gargoyles are worth looking at.
From the roadside you will see:

20 Fitzford Cottages
These cottages were principally built for the miners and their families who worked on the copper mines at Morwellham and Gulworthy.

21 Drake's Walk
(Please refer to details contained later in this leaflet).
An enjoyable diversion walk along the bank of the Tavistock Canal. About a mile from Tavistock is Crowndale Farm (Private No Access) where a plaque marks the site of the old farmhouse, purported birthplace of Sir Francis Drake.
Cross (with caution) the main road into the Meadows and walk alongside:

22 The Canal
Engineered by John Taylor and completed in 1817 to connect Tavistock with the port of Morwellham, 4½ miles(7.2km) away.
From the canal follow the footpath through the meadows to the Bandstand, cross the bridge over the River Tavy. Turn left and follow the footpath back to the Riverside Car Park.



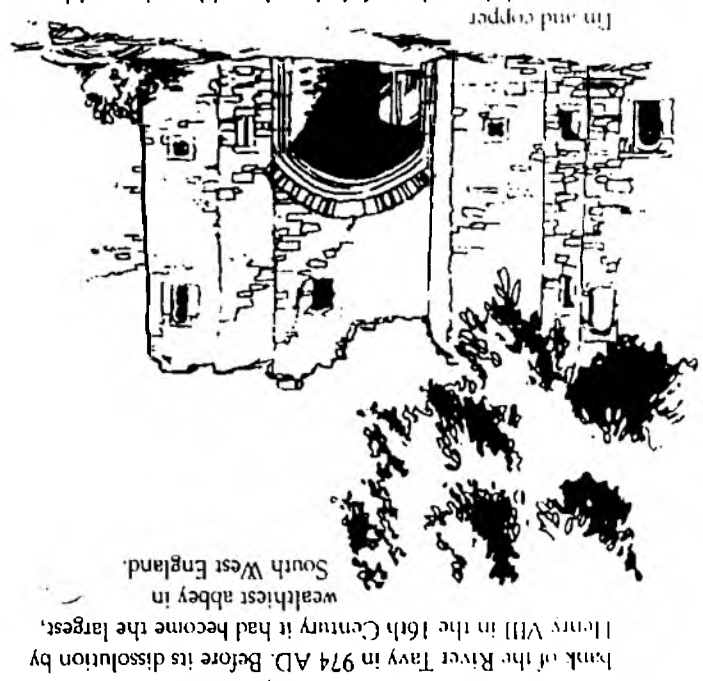
Tavistock TOWN TRAILS

Introduction

Welcome to Tavistock. We are proud of our town and we hope that you will enjoy your visit.

The aim of the Tavistock Town Trail is to help you explore the town and learn a little more about its history.

Tavistock has grown from a Saxon camp into a thriving market town. A Benedictine Abbey was founded on the north bank of the River Tavy in 974 AD. Before its dissolution by Henry VIII in the 16th Century it had become the largest, wealthiest abbey in South West England.



Tin and copper mining and the trading of cloth and wool brought wealth to the town in the mid 18th and 19th Centuries and in particular to the Dukes of Bedford who were the landowners.

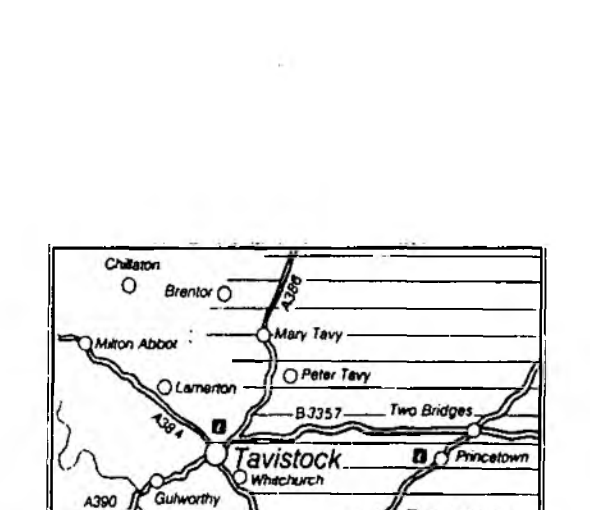
Today Tavistock is the largest town in West Devon. The Pannier Market, first held in 1105, takes place every Friday. The Tuesday antique and craft market and the Wednesday Victorian market add to the fun of shopping in Tavistock with its wide range of local and specialist shops. The Meadows, the park being between the River Tavy and the canal, links the centre of the surrounding countryside to the town. The town's leisure pool, Meadowlands, is for both the serious and fun swimmer.

The Lord Of The Soil

The Russell family - the Dukes and Earls of Bedford - have had a strong influence on Tavistock ever since the Abbey and its former possessions were gained by the family. As 'Lord of the Soil' the then Duke of Bedford made massive profits from the mid 19th Century copper boom. His royalties amounted to one thousand times the average income of a miner.

The 7th Duke of Bedford wanted to improve the standard of Tavistock's buildings. Using local green Hurdwick stone he built a new Pannier Market and Town Hall and was responsible for the design and layout of Bedford Square.

Miner's cottages known as Bedford Cottages, were built on the instructions of the Duke of Tavistock, Morwellham and Gulworthy to help relieve the overcrowded housing conditions of the mine workers. A statue of the Duke - cast in metal from his own mines - stands in Bedford Square.



Drake

Tavistock's most famous citizen, Sir Francis Drake, is remembered by a bronze statue at the end of Plymouth Road. You can visit Drake's home at Buckland Abbey, near Yelverton. This was bought by Sir Francis with part of the fortune made from raids on Spanish treasure ships.

Events

REGULAR MARKETS

in the covered Pannier Market.

TUESDAYS: Antiques, collectables - and hand-crafted wares.

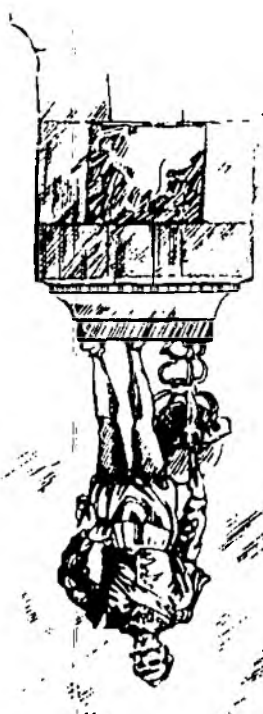
WEDNESDAYS: Victorian Fair. Traders in period dress selling a variety of wares.

FRIDAYS: The traditional charter Pannier Market.

SATURDAYS: Monthly Aladdin's Cave - nothing new sale - Victorian Fair. (Please check local press for dates).

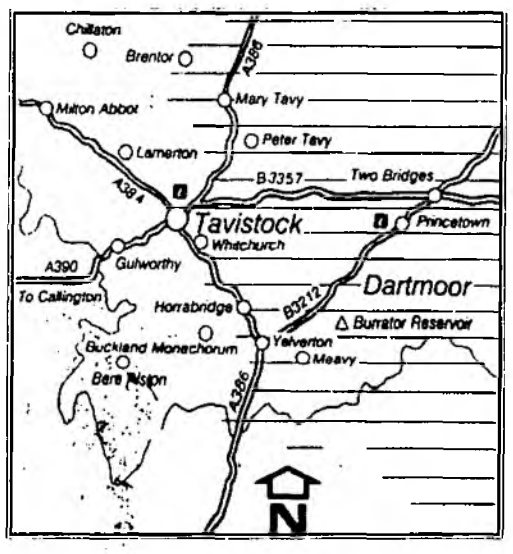
TAVISTOCK GOOSEY FAIR: Second Wednesday in October. An all day event. All the main streets are closed and market stalls, funfairs and local craftsmen gather to celebrate this traditional event. The Goosey Fair originates from earlier days when when geese were brought to market to be fattened for Christmas.

TAVISTOCK CARNIVAL: A week of local activities, culminating in a carnival procession with floats and festivities on the 3rd Saturday in July.



Victorian copper port, Drake's home at Buckland Abbey and Princetown, famous for its prison.

Tavistock and the surrounding area is full of variety. The countryside includes the Tamar, Tavy and Lyd valleys as well as the Dartmoor National Park. You can also visit Morwellham Quay, a recreated Victorian copper port, Drake's home at Buckland Abbey and



The Viaduct Walk

The viaduct walk originally provided the track bed for the London South and Western Railway Company which ran between London and Plymouth. The cutting was constructed by 2000 hard pushed navvies during the mid 19th Century.

Despite a valiant campaign by local people to keep the line open British Rail dispatched its last train on 5th May 1968. By the end of the 1960s the old track had fallen into distrepair. However, in 1991, with assistance from the Department of Environment and Devon County Council, West Devon Borough Council converted the derelict line into an attractive walkway. In addition to enjoying spectacular views of Tavistock and Dartmoor, residents and visitors alike may care to experience an age of 'steam'.

As West Devon's first local nature reserve, the viaduct footpath is a valuable wildlife sanctuary with water, wetland and grassland habitats. En route watch out for slow worms, lizards and sparrow hawks. An Education Pack is available for school groups interested in learning a little more about the history and wildlife of the Walk. Copies are available from West Devon Borough Council.

Drake's Walk~approximately 3 miles (4.8km)

Drake's Walk starts at Drake's statue. From here follow the old canal path. The towpath will take you past Tavistock Community College and through an attractive mixed woodland. En route look out for remnants of former mining activity. Continue a little further until you reach Crowndale Farm, Francis Drake's alleged birth place. Continue past the farm until you reach the Shillamill Viaduct, an impressive structure originally used to carry trains between Bere Alston and Tavistock. Once you have reached the viaduct retrace your steps following the canal towpath back to Tavistock. Return to the Riverside Car Park following the directions outlined in the circular walk.

Other Walks

To explore Tavistock's countryside further, you can purchase a West Devon Way Walks pack from the Tourist Information Centre or the West Devon Borough Council offices at Kilworthy Park. A Tavistock Countryside Walks leaflet is also available from the above.

Don't Miss

Tavistock Museum which is overflowing with fascinating detail and collections relating to this historical town.

The Wharf. Next to Meadowlands Pool, 19th Century Grade 2 listed warehouses have been converted into a major arts and entertainments facility for the performance of music, dance, theatre and cinema.

The Tavistock Mural, painted in 1988 by local artist Janet Shearer, depicts Sir Francis Drake's favourite ship, H.M.S. Revenge sailing out to confront the Spanish Armada.

Devon Bus Enquiry Line

If possible be a green visitor and use local transport. Bus service information is available on (01392) or (01752) 382800 between 8am and 5pm.

Acknowledgements

West Devon Borough Council gratefully acknowledges Tavistock Town Council for its support.

No liability is accepted for any inaccuracies or omissions in this leaflet.
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Printed on chlorine free paper from managed resources.

AA AWARD WINNER

family ticket:: All inclusive (no hidden cost)

Morwellham Quay

NR TAVISTOCK WEST DEVON

This charming riverside village tucked away in 150 acres of Tamar Valley woodland - an area of outstanding natural beauty...

The only place in the world where your

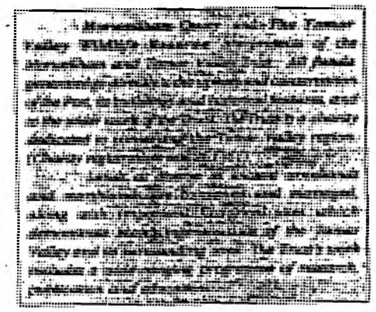
Founded by monks over one thousand years ago it grew to become the 'Greatest Copper Port in Queen Victoria's Empire'...

family and friends can go deep underground

Researched and restored for twenty five years by the Morwellham & Tamar Valley Trust and brought to life.

by train into a real ancient copper mine!

*"Magnificent! Completely different and **real**. One of Britain's quality leading days out. Great value."*



Getting there

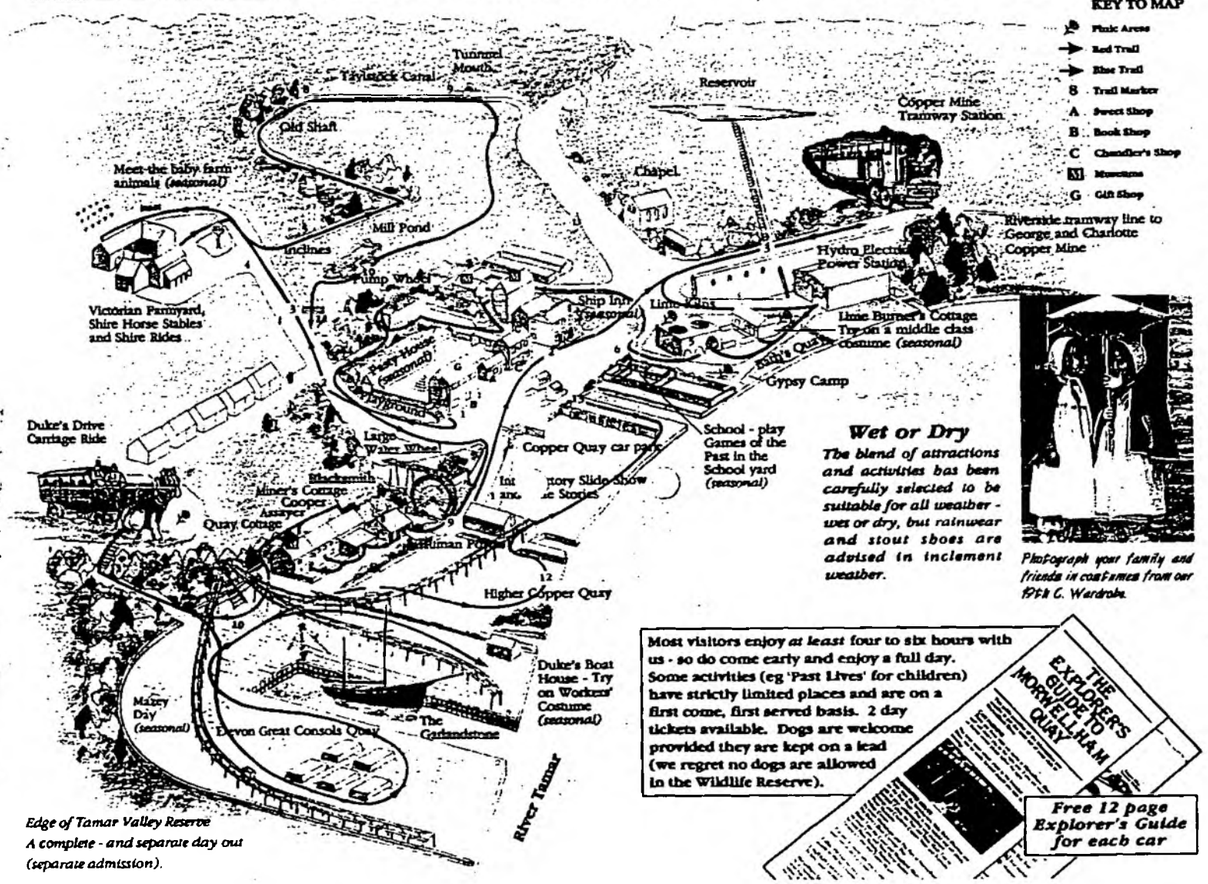
By road. From the main Tavistock to Liskeard road (A390) bear left two miles west of Tavistock, or travelling from Cornwall bear right 2 miles east of Gunnislake. Ordnance Survey map reference SX 446697. To reach us by coach or river boat check with local tour operators.

Open all Year

Open all year, seven days a week 10am to 5.30pm (closed 23rd December - 3rd January inclusive). Last admission 3.30pm. Reduced operation for winter: (Copper Mine and grounds only) 10am - 4.30pm last admission 2.30pm from 28th October until Easter. The Pasty House restaurant and/or Ship restaurant open from Easter to 27th October. Telephone Tavistock (01822) 832766 or (01822) 833808 for information only. Prices and facilities subject to change without notice.

KEY TO MAP

- Picnic Areas
- Red Trail
- Blue Trail
- B Trail Marker
- A Sweet Shop
- B Book Shop
- C Chandler's Shop
- M Museums
- G Gift Shop



Edge of Tamar Valley Reserve
A complete - and separate day out (separate admission).

Wet or Dry

The blend of attractions and activities has been carefully selected to be suitable for all weather - wet or dry, but rainwear and stout shoes are advised in inclement weather.

Photograph your family and friends in costumes from our 1914 C. Wardrobe.

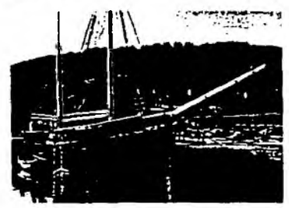
Most visitors enjoy *at least* four to six hours with us - so do come early and enjoy a full day. Some activities (eg 'Past Lives' for children) have strictly limited places and are on a first come, first served basis. 2 day tickets available. Dogs are welcome provided they are kept on a lead (we regret no dogs are allowed in the Wildlife Reserve).

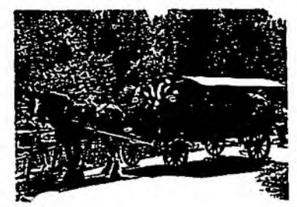
Free 12 page Explorer's Guide for each car

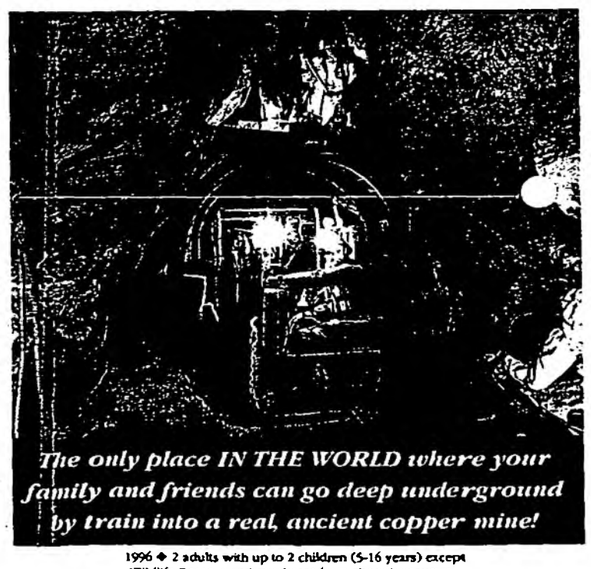
Morwellham Quay

NR TAVISTOCK WEST DEVON

£19 family ticket:: All inclusive (no hidden cost)

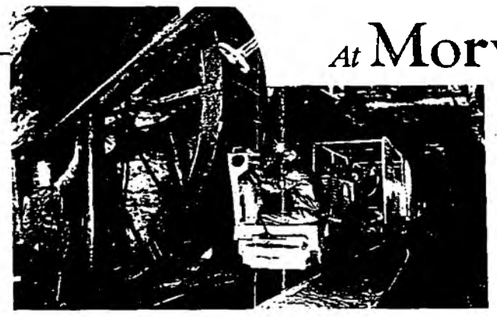




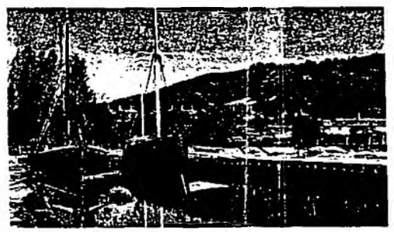


1996 ◆ 2 adults with up to 2 children (5-16 years) except Wildlife Reserve and purchases from shops/restaurants.

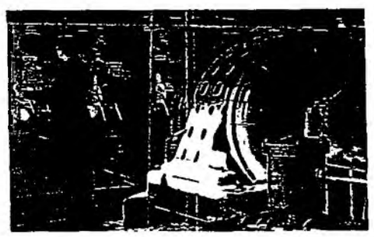
At Morwellham Quay *with just* **ONE** *entrance ticket you can*

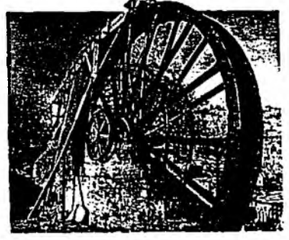


Ride our **RIVERSIDE TRAMWAY** *and go down a* **COPPER MINE**, *try on a period* **COSTUME***. *Play* **GAMES*** *your granny played, meet the baby* **FARM ANIMALS*** *and* **SHIRE HORSES** *and take a Duke's Drive* **CARRIAGE RIDE**

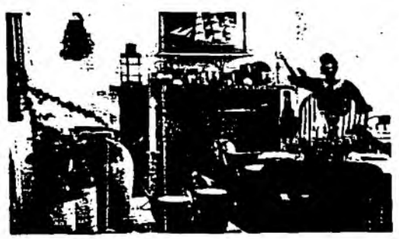


learn about **HUMAN POWER** *then explore an old* **SAILING SHIP** *and our fascinating assay* **LABORATORY** *and* **BLACKSMITHS** *and* **COOPERS** *workshops where you'll meet the* **COSTUMED PEOPLE OF THE 1860's** *and*





see their **COTTAGES.** *There's a working* **HYDRO-ELECTRIC** *power station and* **WATERWHEELS.** *With* **VIDEO SHOWS** *and* **MUSEUMS**, *true* **STORY TELLING***. *Join in the* **ACTION** *and* **FUN** *of a* **MINER'S HOLIDAY***.



OR visit the **NEW TAMAR VALLEY WILDLIFE RESERVE** due to open Easter '96. A tranquil day in 200 acres. Birdwatching hides. Trails. Magnificent Valley views. Rare habitats in an Area of Outstanding Natural Beauty. ***Separate admission.*** We regret no dogs allowed in the Wildlife Reserve.

Dogs are welcome providing they are kept on a lead

With mid-Victorian **GIFT SHOPS** *and food in the Pasty House* or* **SHIP INN** *licensed restaurant**. *Explore woodland* **TRAILS** *with abundant wildlife in this unique area of* **OUTSTANDING NATURAL BEAUTY.**

Most facilities under cover

* These items are seasonal (not winter) - see overleaf

◆ Limited spaces available - book on the day on a first come first served basis (so do come early!)

APPENDIX 4

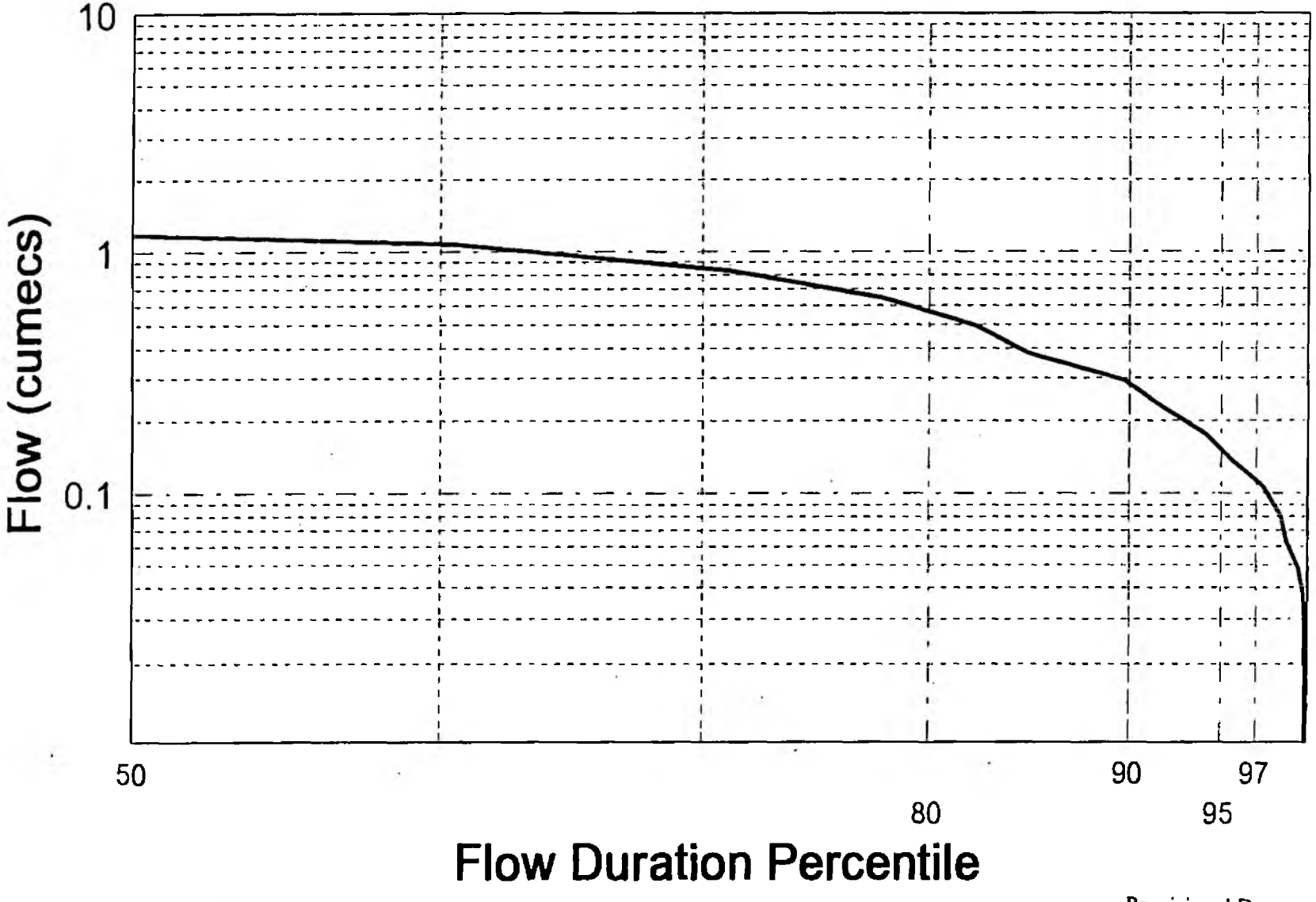
FLOW DATA

(i) Flow Duration Curve for the Canal (1990 - 1996)

(ii) Hydrolog Data During the Summer 1996 Flow Trial Plus Explanatory Notes

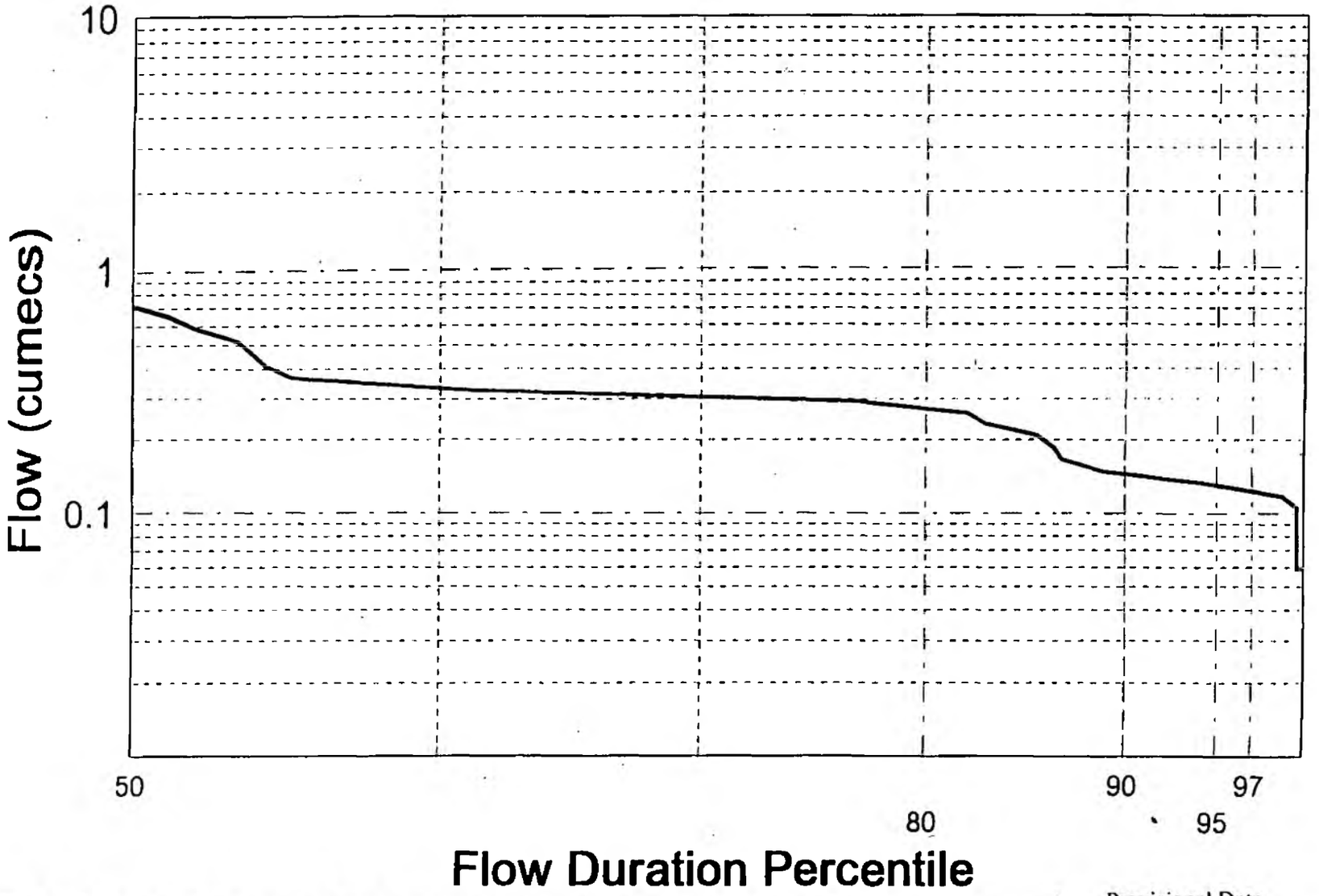
(iii) Different Weir Height Options Showing Effect on Canal Water Levels

Morwellham Canal 1990-1996
All Available Data



Provisional Data

Morwellham Canal 1996



Provisional Data

N.R.A. South Western Region

Auth. Ref.	: **SX47F019**	Station Name	: **Morwellham Canal**
Loc. Desc.	: **Tavistock**	Catchment Ref.	:
Report Type	: **Daily Means For Yr.**	Grid Ref.	:
Parameter	: **Flow**	Gauge Zero	: **0.000 MAOD**
Units	: **m3/s**	Catchment Area	: **0.000 Sq Km**
Period	: **1996**	Start of Day	: **09:00 GMT**

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	1.456	1.227	1.260	0.977	1.216	0.700	0.318	0.230					1
2	1.408	1.288	1.223	0.941	1.129	0.651	0.317	0.218					2
3	1.429	1.251	1.219	1.102	1.097	0.538 (5)	0.316	0.215	0.132				3
4	1.460	1.145	1.376	1.100	0.948	0.566	0.305	0.213	0.125				4
5		1.232	1.582	0.922	0.856	0.419	0.302	0.208	0.126				5
6		1.425		0.924	0.882	0.394	0.300	0.205	0.130				6
7		1.378		0.987	0.835	0.368	0.292	0.114	0.133				7
8		1.577		0.909	0.767	0.350	0.299	0.126 (8)	0.138				8
9		1.507		0.958	0.668	0.350	0.301	0.151	0.134				9
10		1.610		0.942	0.353 (1)	0.350	0.302	0.175	0.127				10
11		1.824		0.627	0.354	0.352	0.301	0.154	0.126				11
12		1.568	1.226	1.114	0.353	0.344	0.303	0.136	0.127				12
13		1.432	1.161	1.153	0.362	0.342	0.306	0.115	0.131				13
14		1.385	0.953	0.901	0.360	0.321	0.308	0.119	0.133				14
15		1.459	0.858	0.787	0.353	0.323	0.303	0.150	0.135				15
16	1.038	1.489	1.054	1.216	0.317	0.325	0.301	0.146	0.142				16
17	1.394	1.605	0.933	0.512	0.305 (2)	0.327	0.293	0.142	0.118				17
18	1.352	1.488	1.217	0.770	0.305	0.314	0.286	0.141	0.000				18
19	0.521	1.332	1.205	1.363	0.359	0.320	0.270	0.146	0.059				19
20	0.823	1.288	1.347	1.212	0.226	0.330	0.280	0.146					20
21	0.831	1.403	1.490	1.208	0.245	0.319	0.278	0.153					21
22	0.961	1.534	1.525	1.356	0.312	0.322	0.271						22
23	0.983	1.563	1.490	1.335	0.302	0.320	0.266						23
24	1.129	1.544	1.450	1.304	1.394 (3)	0.321	0.251						24
25	1.174	1.491	1.472	1.252	1.453	0.320	0.267						25
26	1.249	1.392	1.476	1.228	1.517	0.322	0.266						26
27	1.255	1.399	1.442	1.148	1.464	0.324	0.265						27
28	1.208	1.392	1.386	1.173	1.387	0.317 (6)	0.270						28
29	0.942	1.373	1.300	1.072	1.341	0.318	0.273						29
30	1.096		1.181	0.858	0.711 (4)	0.306	0.188						30
31	1.232		1.060		0.773		0.152 (7)						31
Mean	1.147	1.434	1.275	1.045	0.740	0.372	0.282	0.162	0.119				
Maximum	1.460	1.824	1.582	1.363	1.517	0.700	0.318	0.230	0.142				
Day of Max.	4	11	5	19	26	1	1	1	16				
Min	0.521	1.145	0.858	0.512	0.226	0.306	0.152	0.114	0.000				
Day of Min.	19	4	15	17	20	30	31	7	18				
Total (TCM)	1971	3594	2719	2709	1982	965	756	294	167				
Runoff (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Above summary is for Daily Means of Flow

Notes to explain procedure of flow trial are given overleaf.

Provisional Data

Notes to go With:
Output from HYDROLOG Data Management System

1) Gates at Abbey Weir put on manual to pass approximately 0.350m^3/s. Overflow opened.

2) 20% of flow returned to the Tavy via the lock at Locks Cottage and the River Lumburn.

3) Gates at Abbey Weir opened. All four on automatic.

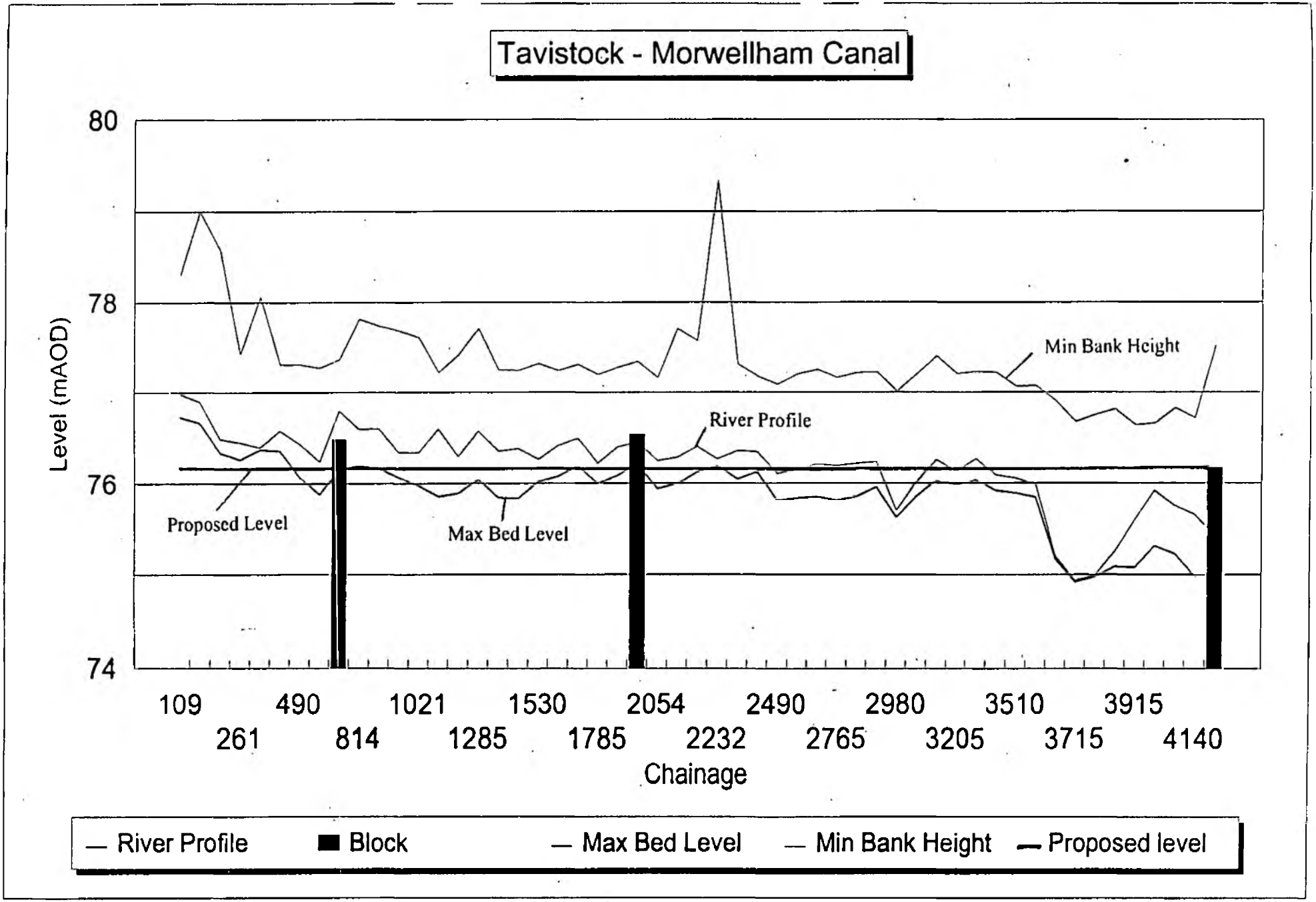
4) Two gates at Abbey Weir closed.

5) Flows at Abbey Weir below the Prescribed Flow. Lock gates put on manual and the overflows opened.

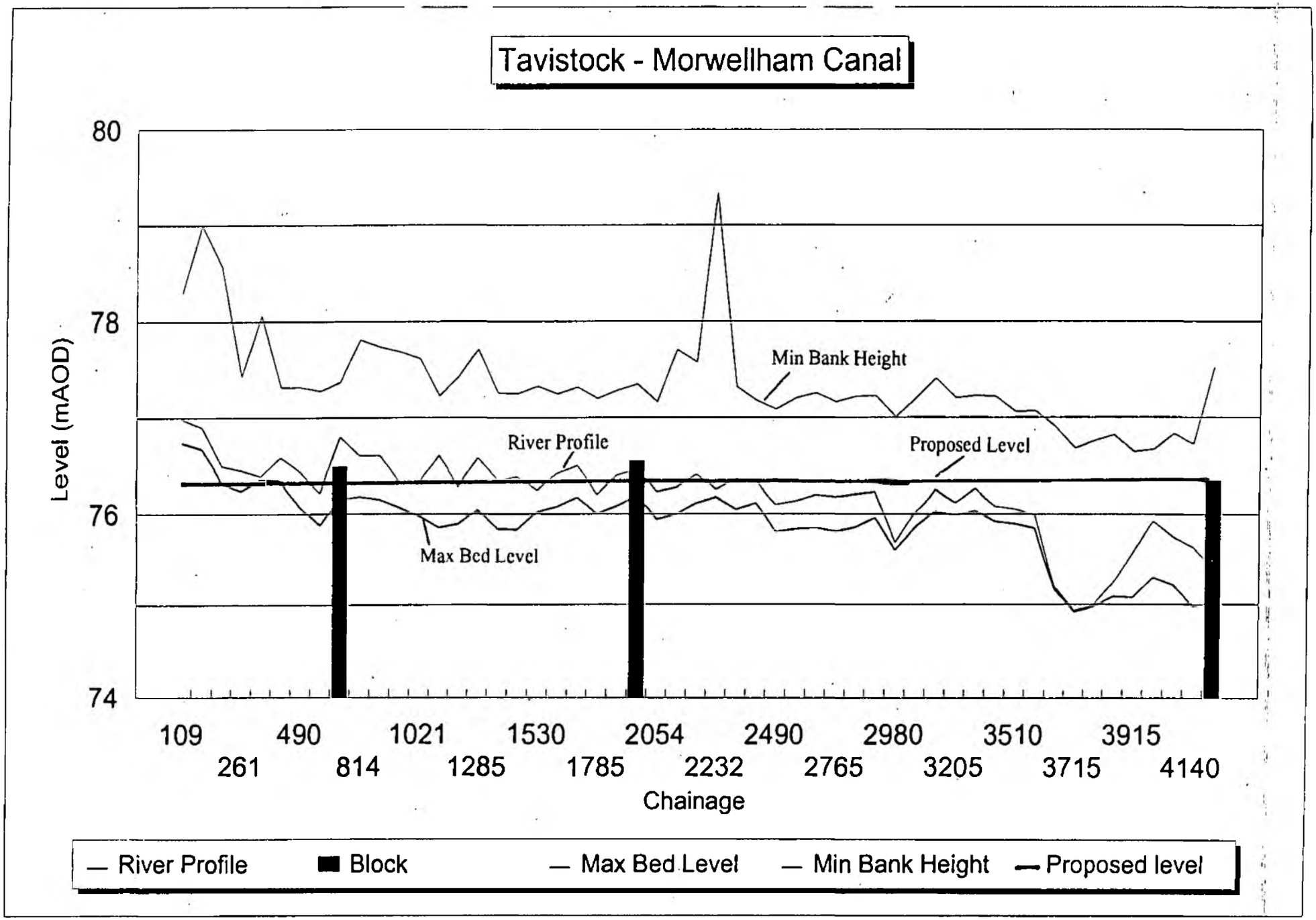
6) Lock gates at Abbey Weir on manual. Flow returning to the Tavy via the River Lumburn.

7) Flow reduced to approximately 0.140m^3/s to put in sandbag weir at Crowndale Farm but flow still too high and the installment was postponed. Flows increased up to 0.250m^3/s.

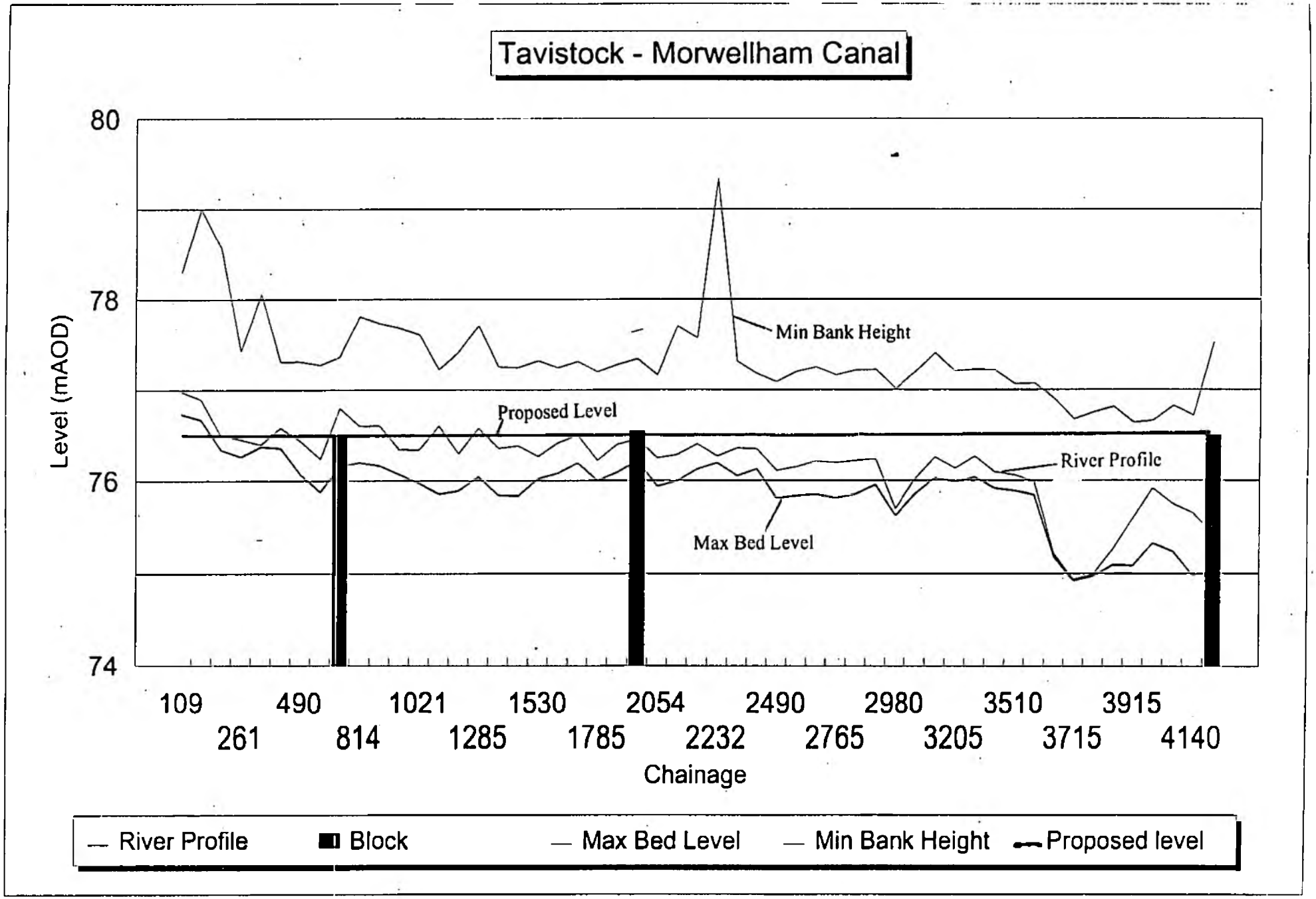
8) Flows reduced to approximately 0.060m^3/s and the sandbag weir was successfully installed at Crowndale Farm. Flow increased back up to 0.140m^3/s.



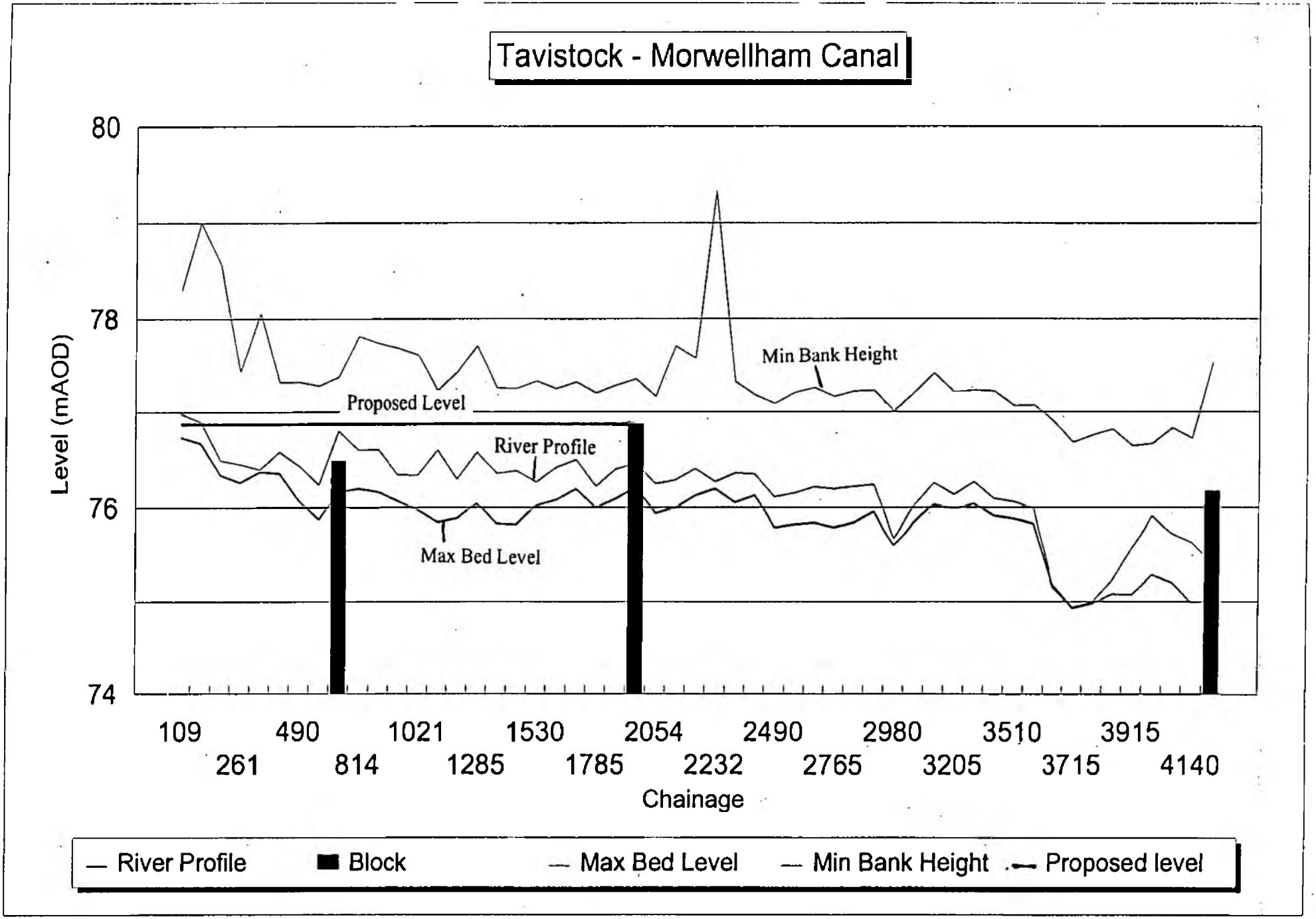
7no. Blocks At Ch4205



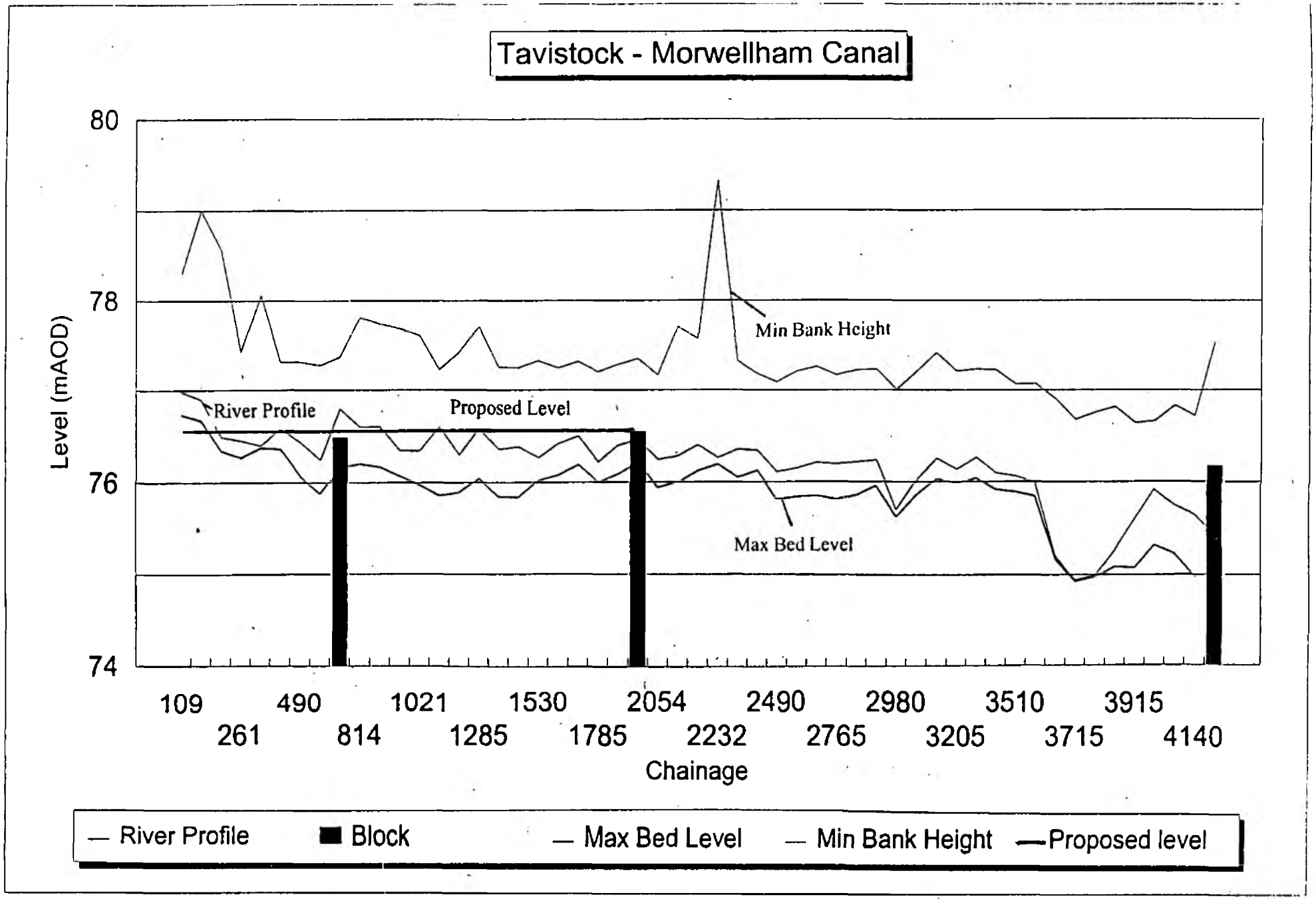
8no. Blocks At Ch4205



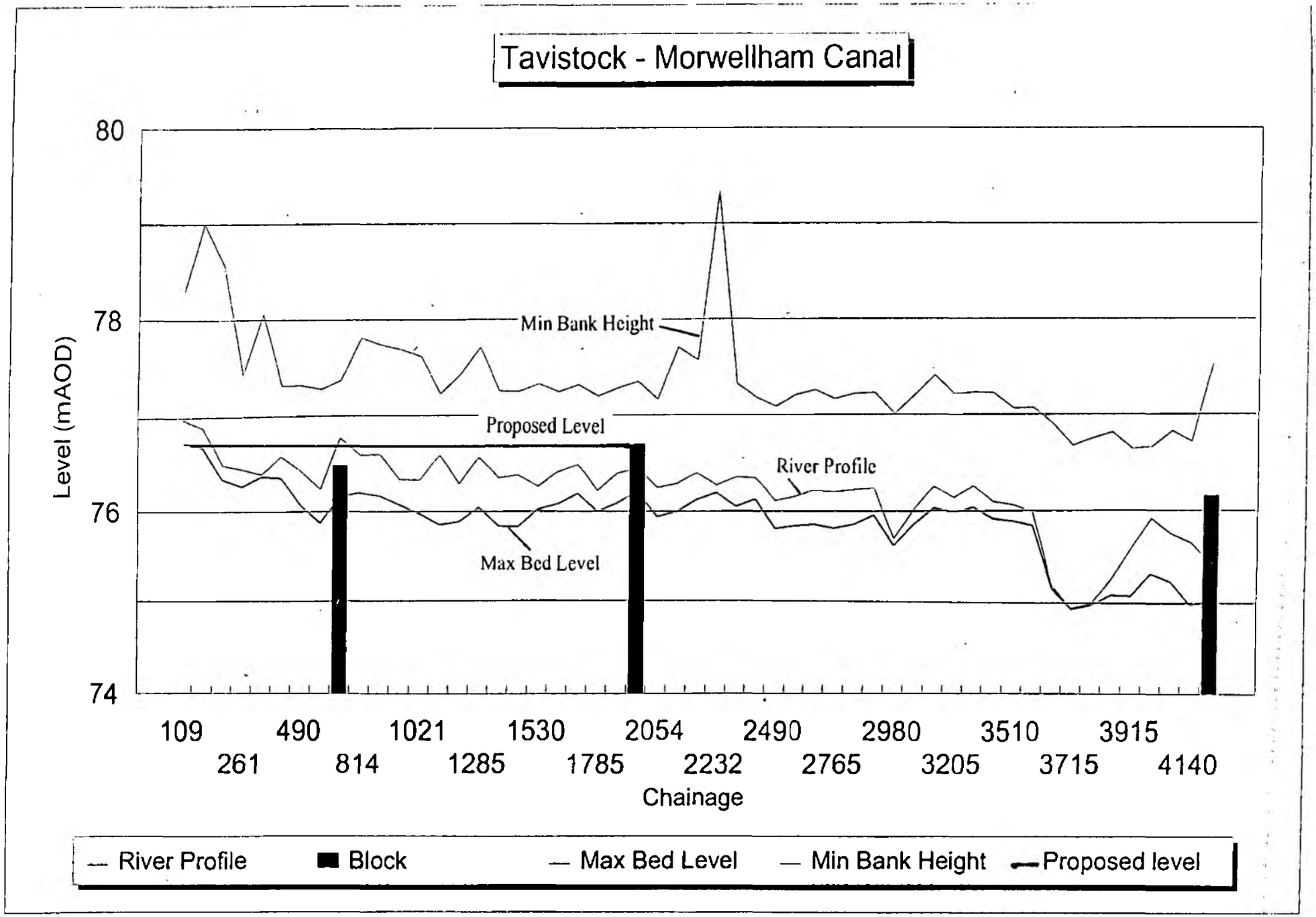
9no. Blocks At Ch4205



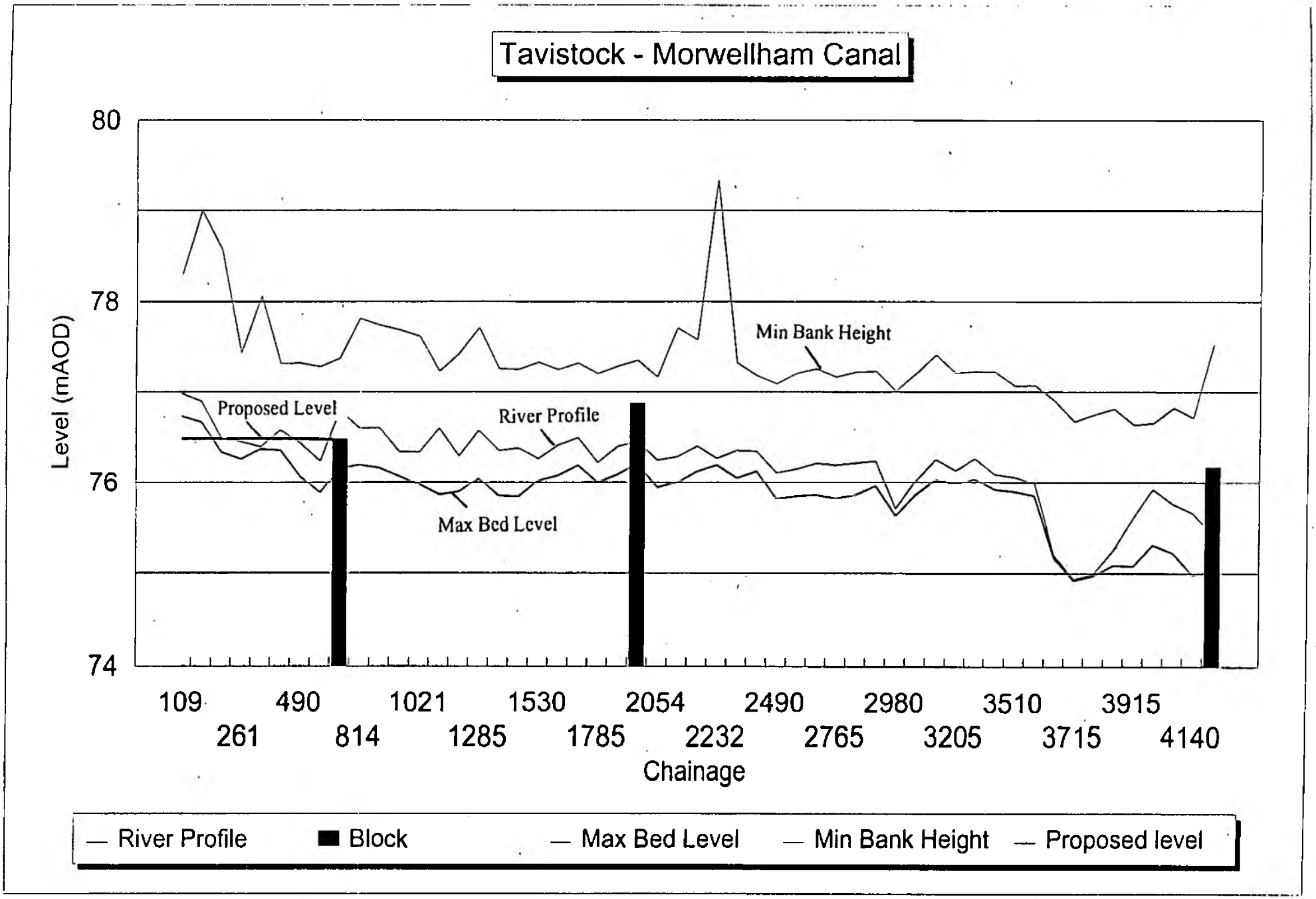
4no. Blocks At Ch1979



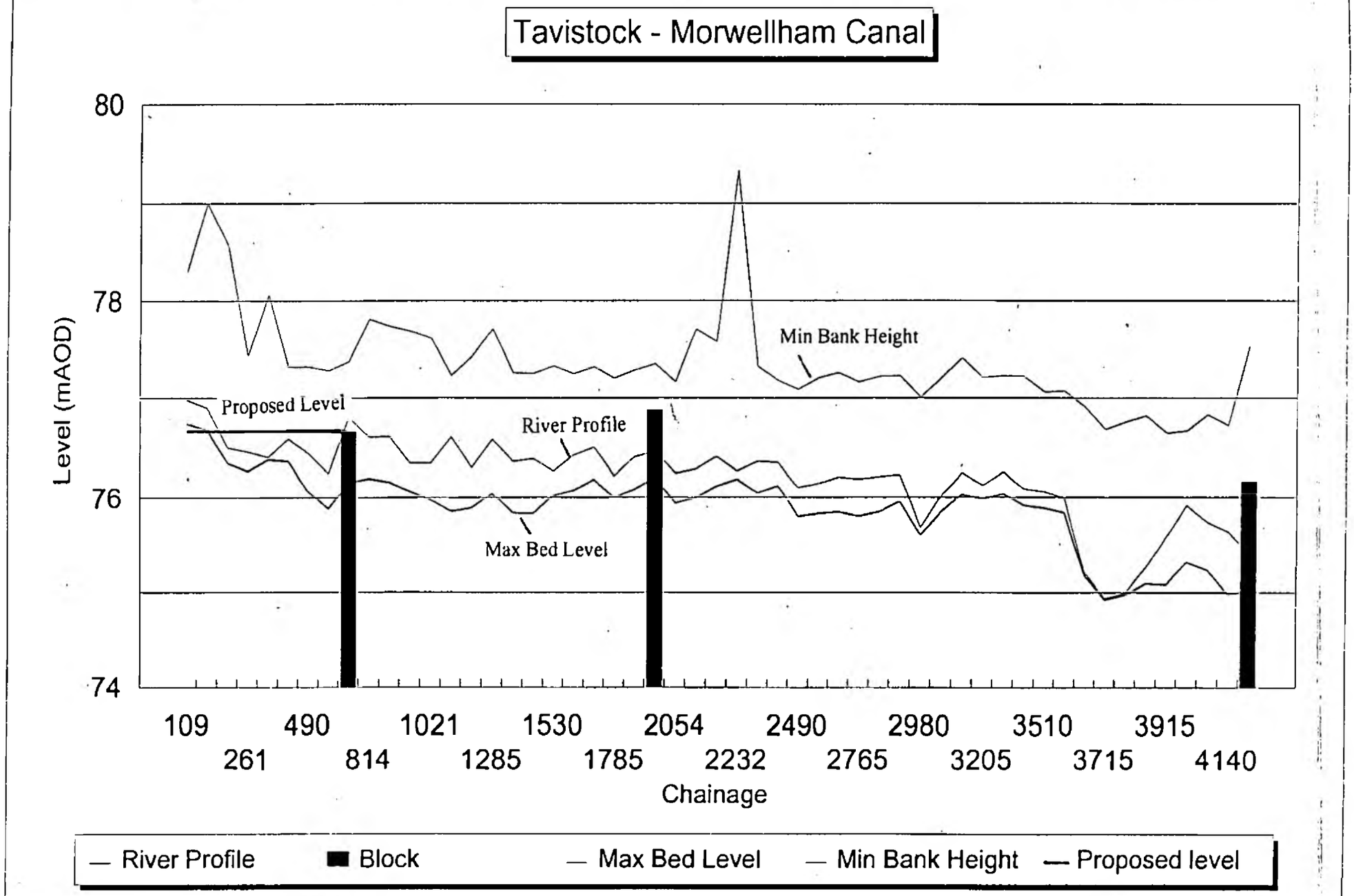
2no. Blocks At Ch1979



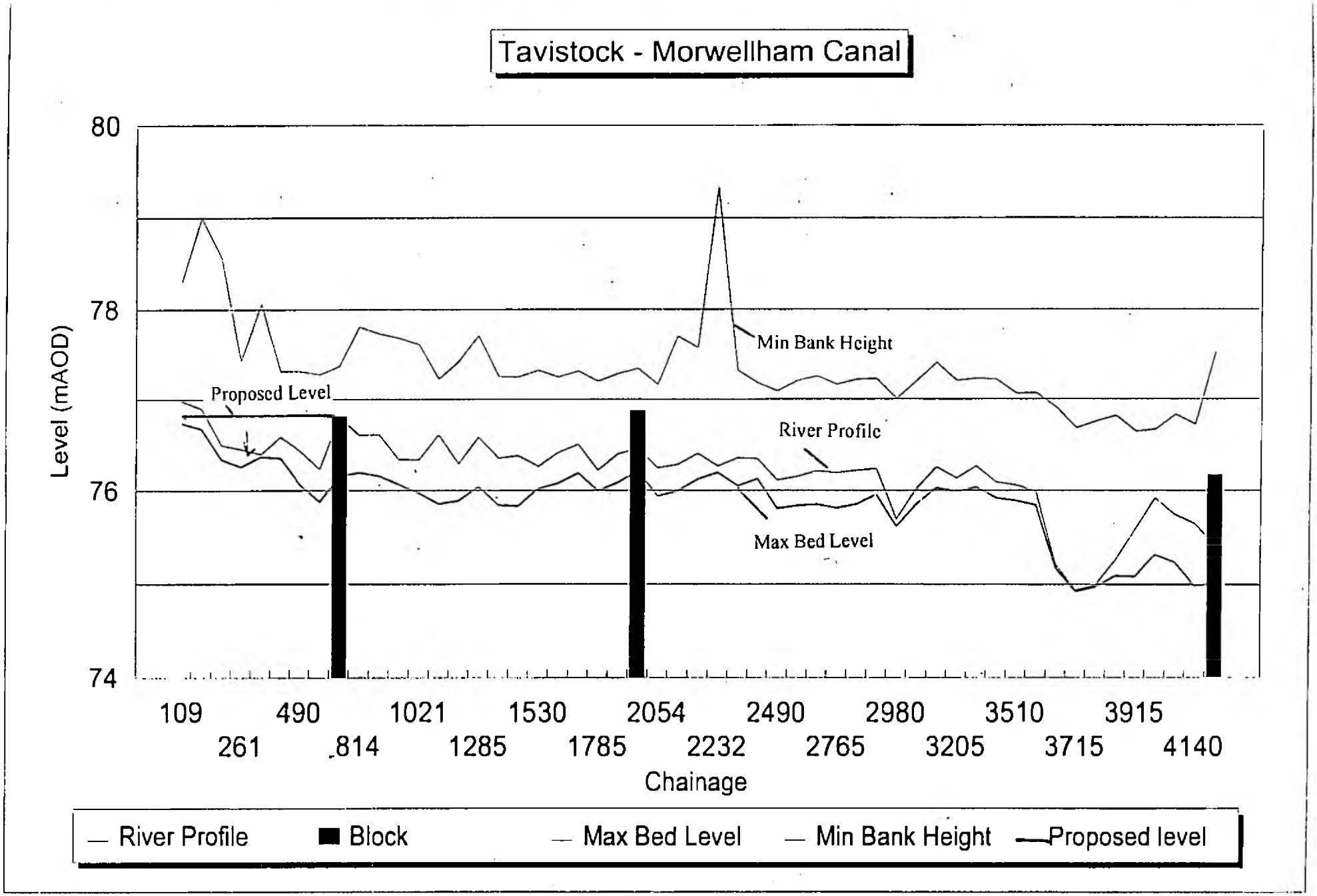
3no. Blocks At Ch1979



2no. Blocks At Ch748



3no. Blocks At Ch748



4no. Blocks At Ch748

APPENDIX 5

Water Quality Data Taken After the 1996 Flow Trial

SW3023A
Release 7

MENSAR V2.0.5
ENVIRONMENT AGENCY NLS EXETER LABORATORY

Automatic Sample Analysis Report Production
Date/Time Report Last Run : 19-NOV-96 03:27

Laboratory Ref. : E611859 Sampling Point : RPL/12C
Date/Time Taken : 12-NOV-96 10:20 Date/Time Received : 14-NOV-96 07:52

Pollution Incidents In Catchment 12c

Address : MORWELLHAM CANAL

Sampler's Comments :
SJW

Det.	Code	Description		Result	
*61	Ph			7.45	pH
76	Temperature Degrees C (In-Situ			8.5	Celsius
81	Oxygen Dissolved % Saturation			95	% O
82	Oxygen Dissolved (Calculated)			11.1	mg/l O
5	Bod Atu			1.1	mg/l O
.06	Cadmium Dissolved Ug/L		<	0.1	ug/l Cd
*108	Cadmium Ug/L			0.2	ug/l Cd
*111	Ammonia Expressed As Nitrogen		<	0.03	mg/l N
*135	Suspended Solids 105c			3	mg/l
*213	Copper Dissolved			0.008	mg/l Cu
*215	Copper			0.008	mg/l Cu
*243	Zinc Dissolved			0.019	mg/l Zn
*245	Zinc			0.021	mg/l Zn
*285	Aluminium Dissolved			0.03	mg/l Al
*326	Lead Dissolved		<	0.002	mg/l Pb
*328	Lead			0.003	mg/l Pb
*373	Chromium Dissolved		<	0.001	mg/l Cr
*375	Chromium		<	0.001	mg/l Cr
*421	Iron			0.11	mg/l Fe
*427	Nickel Dissolved		<	0.005	mg/l Ni
*429	Nickel		<	0.005	mg/l Ni
3169	Ph - In Situ Measurement			No Result	
3170	Conductivity - In Situ Measure			No Result	
*3383	Dissolved Metals Prep			1	Misc
*3387	Total Metals Prep			1	Misc
4027	Ammonia In-Situ Palin Test			No Result	

'*' Indicates that Laboratory Determination Method is NAMAS Accredited.

Automatic Sample Analysis Report Production
Date/Time Report Last Run : 19-NOV-96 03:27

Laboratory Ref. : E611858 Sampling Point : RPL/12C
Date/Time Taken : 12-NOV-96 10:00 Date/Time Received : 14-NOV-96 07:52

Pollution Incidents In Catchment 12c

Address : TAVISTOCK CANAL

Sampler's Comments :
SJW

Det.	Code	Description	Result		
*61		Ph		7.6	pH
76		Temperature Degrees C (In-Situ		8.7	Celsius
81		Oxygen Dissolved % Saturation		96	% O
82		Oxygen Dissolved (Calculated)		11.2	mg/l O
75		Bod Atu		1.3	mg/l O
106		Cadmium Dissolved Ug/L	<	0.1	ug/l Cd
*108		Cadmium Ug/L	<	0.1	ug/l Cd
*111		Ammonia Expressed As Nitrogen	<	0.03	mg/l N
*135		Suspended Solids 105c	<	3	mg/l
*213		Copper Dissolved		0.003	mg/l Cu
*215		Copper		0.33	mg/l Cu
*243		Zinc Dissolved		0.019	mg/l Zn
*245		Zinc		0.31	mg/l Zn
*285		Aluminium Dissolved		0.03	mg/l Al
*326		Lead Dissolved	<	0.002	mg/l Pb
*328		Lead		0.003	mg/l Pb
*373		Chromium Dissolved	<	0.001	mg/l Cr
*375		Chromium	<	0.001	mg/l Cr
*421		Iron		0.13	mg/l Fe
*427		Nickel Dissolved	<	0.005	mg/l Ni
*429		Nickel	<	0.005	mg/l Ni
3169		Ph - In Situ Measurement		No Result	
3170		Conductivity - In Situ Measure		No Result	
*3383		Dissolved Metals Prep		1	Misc
*3387		Total Metals Prep		1	Misc
4027		Ammonia In-Situ Palin Test		No Result	

'*' Indicates that Laboratory Determination Method is NAMAS Accredited.

SW3023A
Release 7

MENSAR V2.0.5
ENVIRONMENT AGENCY NLS EXETER LABORATORY

Automatic Sample Analysis Report Production
Date/Time Report Last Run : 20-NOV-96 03:29

Laboratory Ref. : E610219 Sampling Point : RPL/12C
Date/Time Taken : 08-NOV-96 11:40 Date/Time Received : 09-NOV-96 06:35

Pollution Incidents In Catchment 12c

Address : CANAL AT TAVISTOCK CAR PARK

Sampler's Comments :
S WHITMARSH

Det.	Code	Description	Result		
*61		Ph		7.4	pH
76		Temperature Degrees C (In-Situ		9	Celsius
81		Oxygen Dissolved % Saturation		99	% O
82		Oxygen Dissolved (Calculated)		11.4	mg/l O
`5		Bod Atu		1.3	mg/l O
.06		Cadmium Dissolved Ug/L		0.2	ug/l Cd
*108		Cadmium Ug/L	<	0.1	ug/l Cd
*111		Ammonia Expressed As Nitrogen	<	0.03	mg/l N
*135		Suspended Solids 105c	<	3	mg/l
*158		Hardness Total (Calculated)		22.8	mg/l CaCO3
*213		Copper Dissolved		0.003	mg/l Cu
*215		Copper		0.004	mg/l Cu
*237		Magnesium		1.9	mg/l Mg
*241		Calcium		6	mg/l Ca
*243		Zinc Dissolved		0.018	mg/l Zn
*245		Zinc		0.018	mg/l Zn
*419		Iron Dissolved		0.08	mg/l Fe
*421		Iron		0.19	mg/l Fe
3169		Ph - In Situ Measurement	No Result		
3170		Conductivity - In Situ Measure	No Result		
*3383		Dissolved Metals Prep		1	Misc
*3387		Total Metals Prep		1	Misc
4027		Ammonia In-Situ Palin Test	No Result		
7354		Arsenic Dissolved Ppb	Not Possible		
7356		Arsenic Total Ppb	Not Possible		

'*' Indicates that Laboratory Determination Method is NAMAS Accredited.

Automatic Sample Analysis Report Production
Date/Time Report Last Run : 20-NOV-96 03:29

Laboratory Ref. : E610218 Sampling Point : RPL/12C
Date/Time Taken : 08-NOV-96 11:15 Date/Time Received : 09-NOV-96 06:35

Pollution Incidents In Catchment 12c

Address : CANAL AT MORWELLHAM

Sampler's Comments :
S WHITMARSH

Det.	Code	Description		Result	
*61		Ph		7.35	pH
76		Temperature Degrees C (In-Situ		9	Celsius
81		Oxygen Dissolved % Saturation		98	% O
82		Oxygen Dissolved (Calculated)		11.3	mg/l O
5		Bod Atu		1.4	mg/l O
.06		Cadmium Dissolved Ug/L		0.2	ug/l Cd
*108		Cadmium Ug/L		0.1	ug/l Cd
*111		Ammonia Expressed As Nitrogen	<	0.03	mg/l N
*135		Suspended Solids 105c		4.8	mg/l
*158		Hardness Total (Calculated)		29.4	mg/l CaCO3
*213		Copper Dissolved		0.007	mg/l Cu
*215		Copper		0.01	mg/l Cu
*237		Magnesium		2.3	mg/l Mg
*241		Calcium		8	mg/l Ca
*243		Zinc Dissolved		0.017	mg/l Zn
*245		Zinc		0.021	mg/l Zn
*419		Iron Dissolved		0.1	mg/l Fe
*421		Iron		0.2	mg/l Fe
3169		Ph - In Situ Measurement		No Result	
3170		Conductivity - In Situ Measure		No Result	
*3383		Dissolved Metals Prep		1	Misc
*3387		Total Metals Prep		1	Misc
4027		Ammonia In-Situ Palin Test		No Result	
7354		Arsenic Dissolved Ppb		Not Possible	
7356		Arsenic Total Ppb		Not Possible	

'*' Indicates that Laboratory Determination Method is NAMAS Accredited.

FIGURES

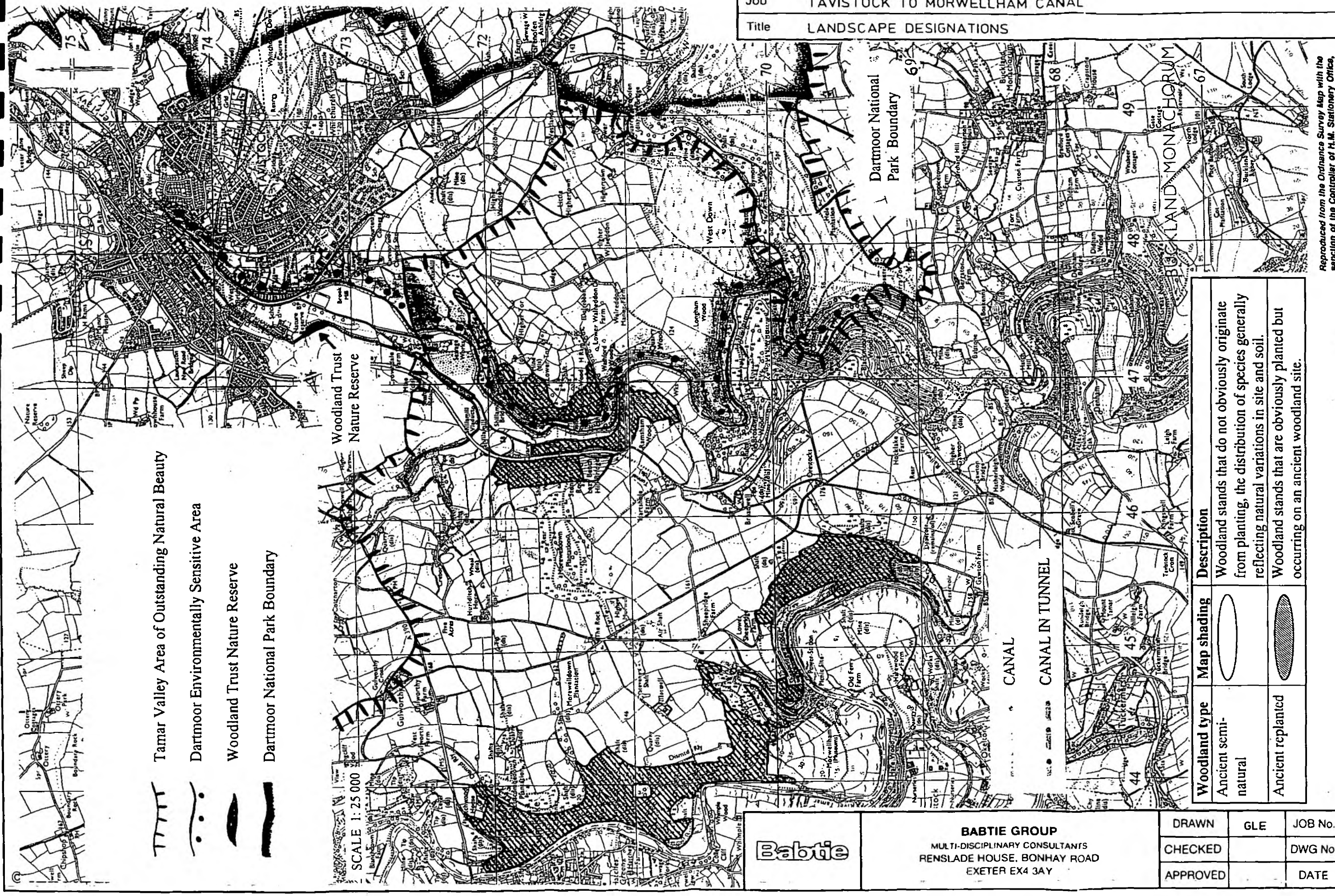
A - Existing Environment

A1 - Landscape Designations
A2 - Boundaries of the Morwellham and Tamar Valley Trust
A3 - Planning Designations

B - Proposals

B1 - Location of Proposed Structures
B2 - Detail of Channel Works

Client	ENVIRONMENT AGENCY
Job	TAVISTOCK TO MORWELLHAM CANAL
Title	LANDSCAPE DESIGNATIONS



MAP SUPPLIED BY THE DEVON WILDLIFE TRUST

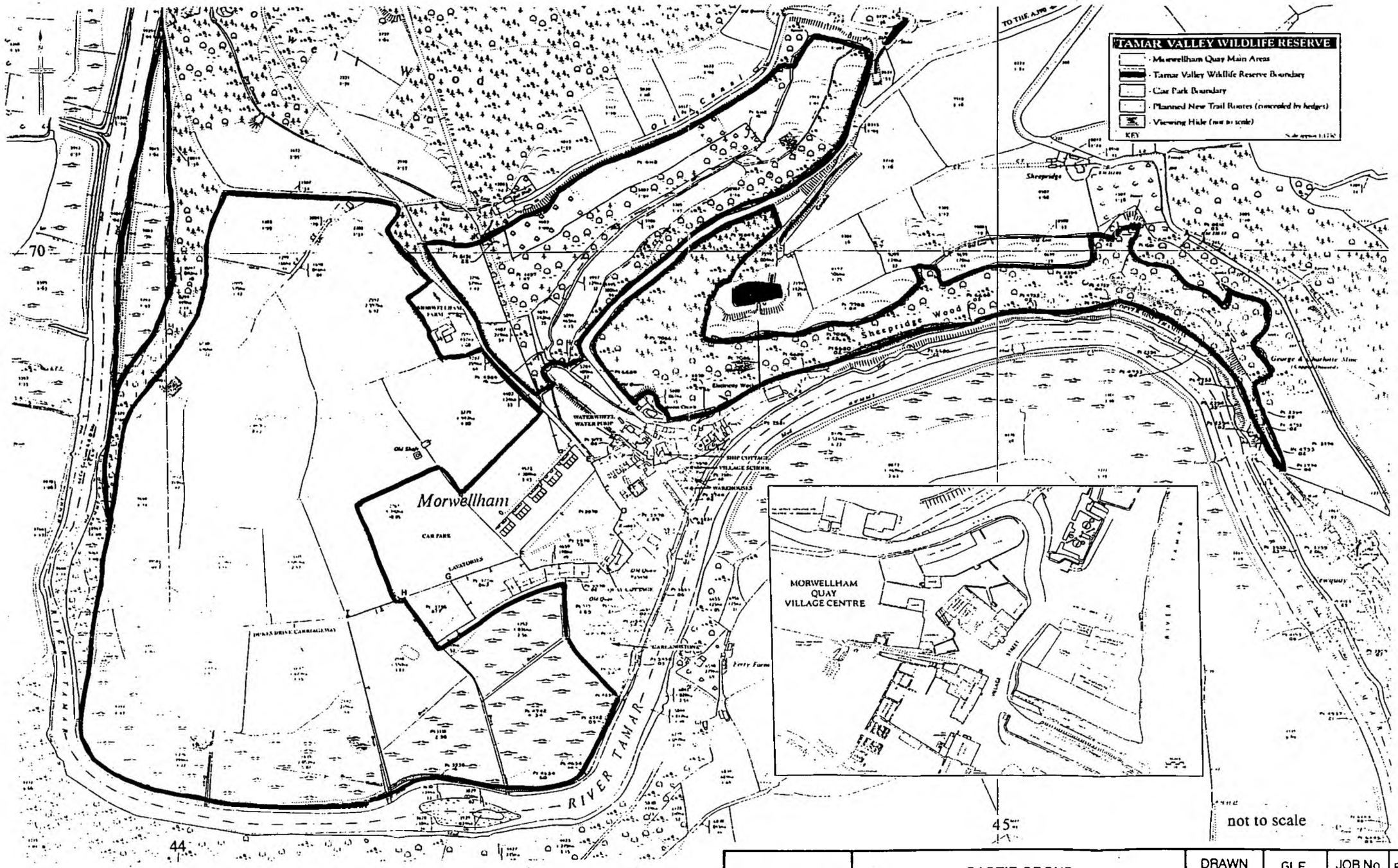
Woodland type	Map shading	Description
Ancient semi-natural		Woodland stands that do not obviously originate from planting, the distribution of species generally reflecting natural variations in site and soil.
Ancient replanted		Woodland stands that are obviously planted but occurring on an ancient woodland site.

BABTIE GROUP
MULTI-DISCIPLINARY CONSULTANTS
RENSLADE HOUSE, BONHAY ROAD
EXETER EX4 3AY

DRAWN	GLE	JOB No.	BWA016552
CHECKED		DWG No.	FIG. A1
APPROVED		DATE	NOV. 1996

REV.

Client	ENVIRONMENT AGENCY
Job	TAVISTOCK TO MORWELLHAM CANAL
Title	BOUNDARIES OF THE MORWELLHAM AND TAMAR VALLEY RESERVE



not to scale

MAP SUPPLIED BY THE MORWELLHAM AND TAMAR VALLEY TRUST

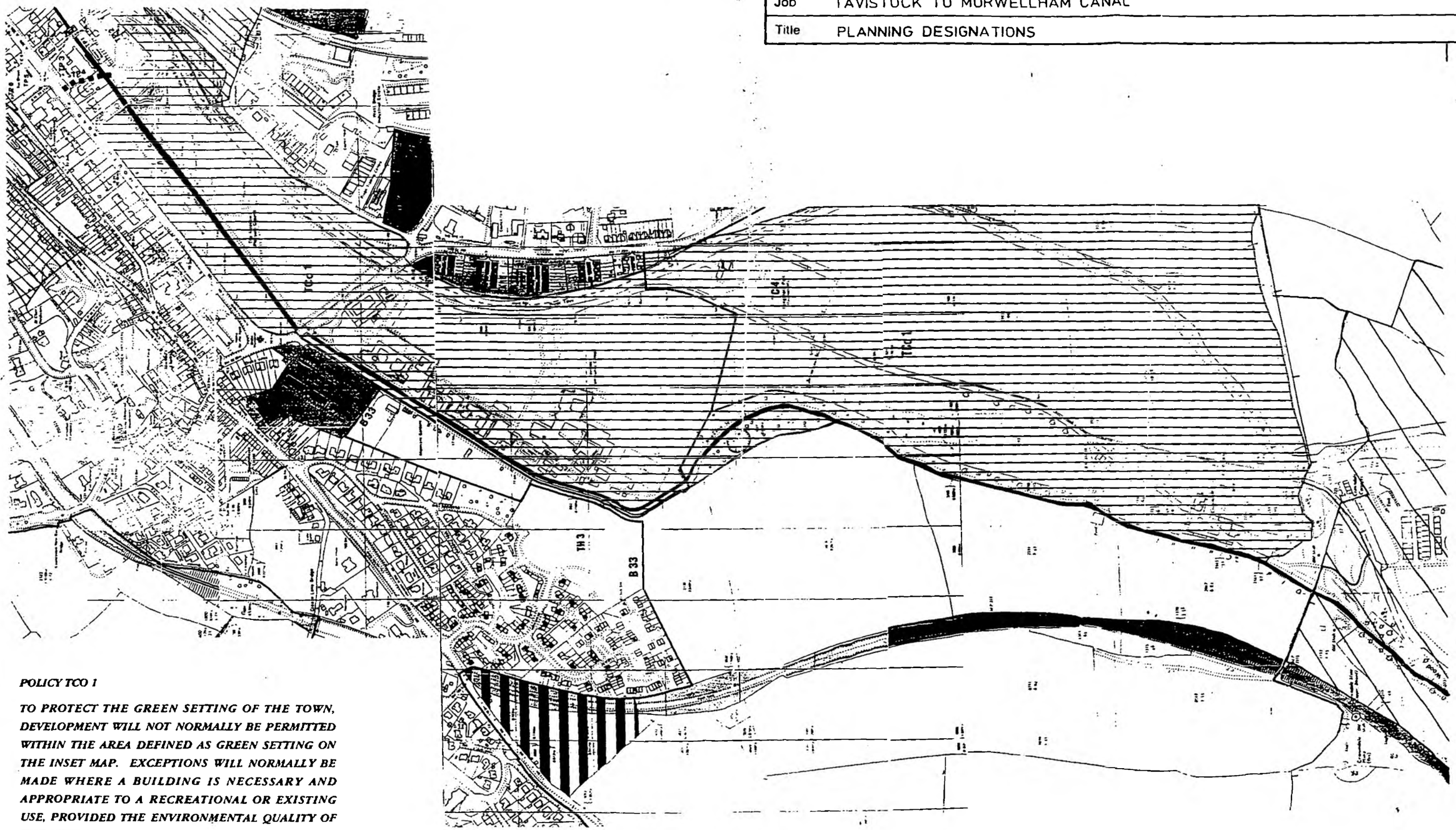
J.O. 3254/95

Babtie	BABTIE GROUP MULTI-DISCIPLINARY CONSULTANTS RENSLADE HOUSE, BONHAY ROAD EXETER EX4 3AY	DRAWN	GLE	JOB No.	BWA016552
		CHECKED		DWG No.	FIG. A2
		APPROVED		DATE	NOV. 1996

REV.

NOT TO SCALE

Client	ENVIRONMENT AGENCY
Job	TAVISTOCK TO MORWELLHAM CANAL
Title	PLANNING DESIGNATIONS



POLICY TCO 1

TO PROTECT THE GREEN SETTING OF THE TOWN, DEVELOPMENT WILL NOT NORMALLY BE PERMITTED WITHIN THE AREA DEFINED AS GREEN SETTING ON THE INSET MAP. EXCEPTIONS WILL NORMALLY BE MADE WHERE A BUILDING IS NECESSARY AND APPROPRIATE TO A RECREATIONAL OR EXISTING USE, PROVIDED THE ENVIRONMENTAL QUALITY OF THE SETTING IS NOT PREJUDICED.

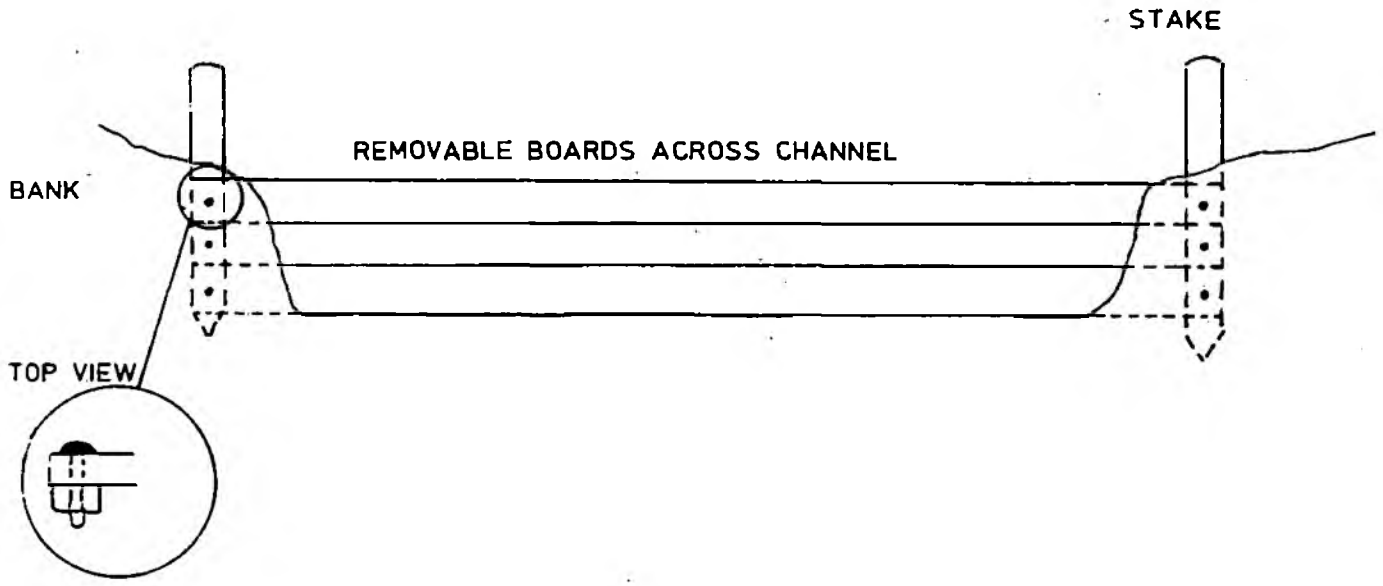
REV.

MAPS SUPPLIED BY WEST DEVON BOROUGH COUNCIL

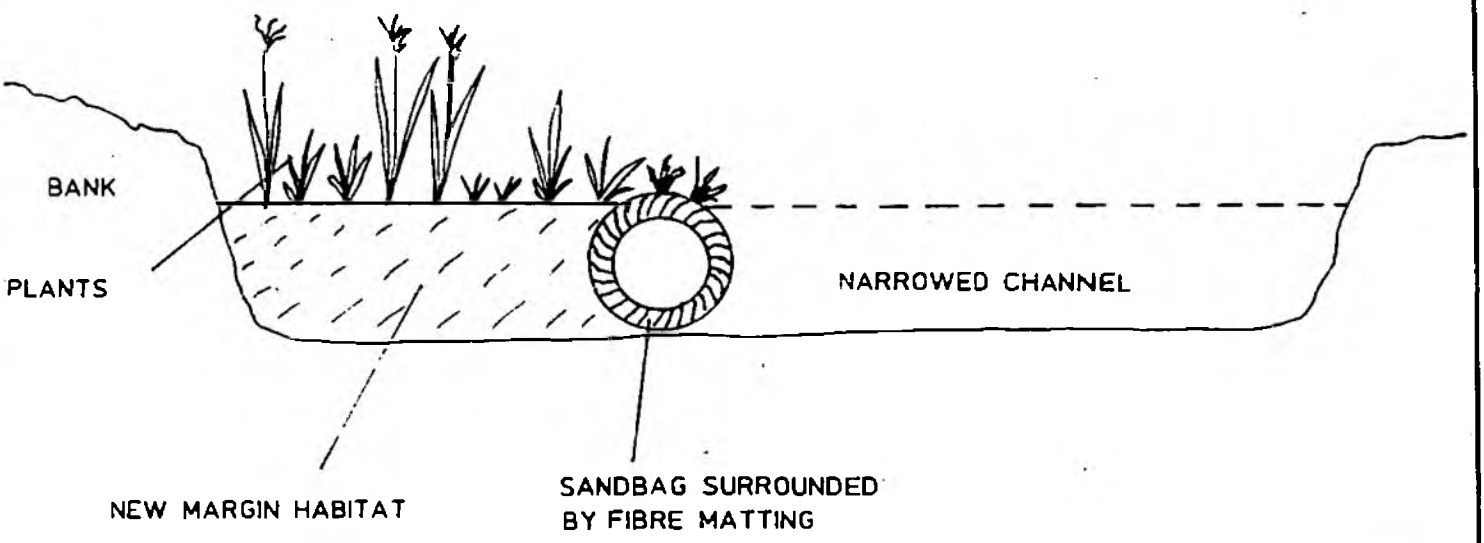
Babtie	**BABTIE GROUP** MULTI-DISCIPLINARY CONSULTANTS RENSLADE HOUSE, BONHAY ROAD EXETER EX4 3AY	DRAWN	GLE	JOB No.	BWA016552
		CHECKED		DWG No.	FIG A3
		APPROVED		DATE	NOV 1996

Client	ENVIRONMENT AGENCY
Job	TAVISTOCK TO MORWELLHAM CANAL
Title	DETAIL OF CHANNEL WORKS

DETAIL OF TEMPORARY WEIR



DETAIL OF NARROWED CHANNEL



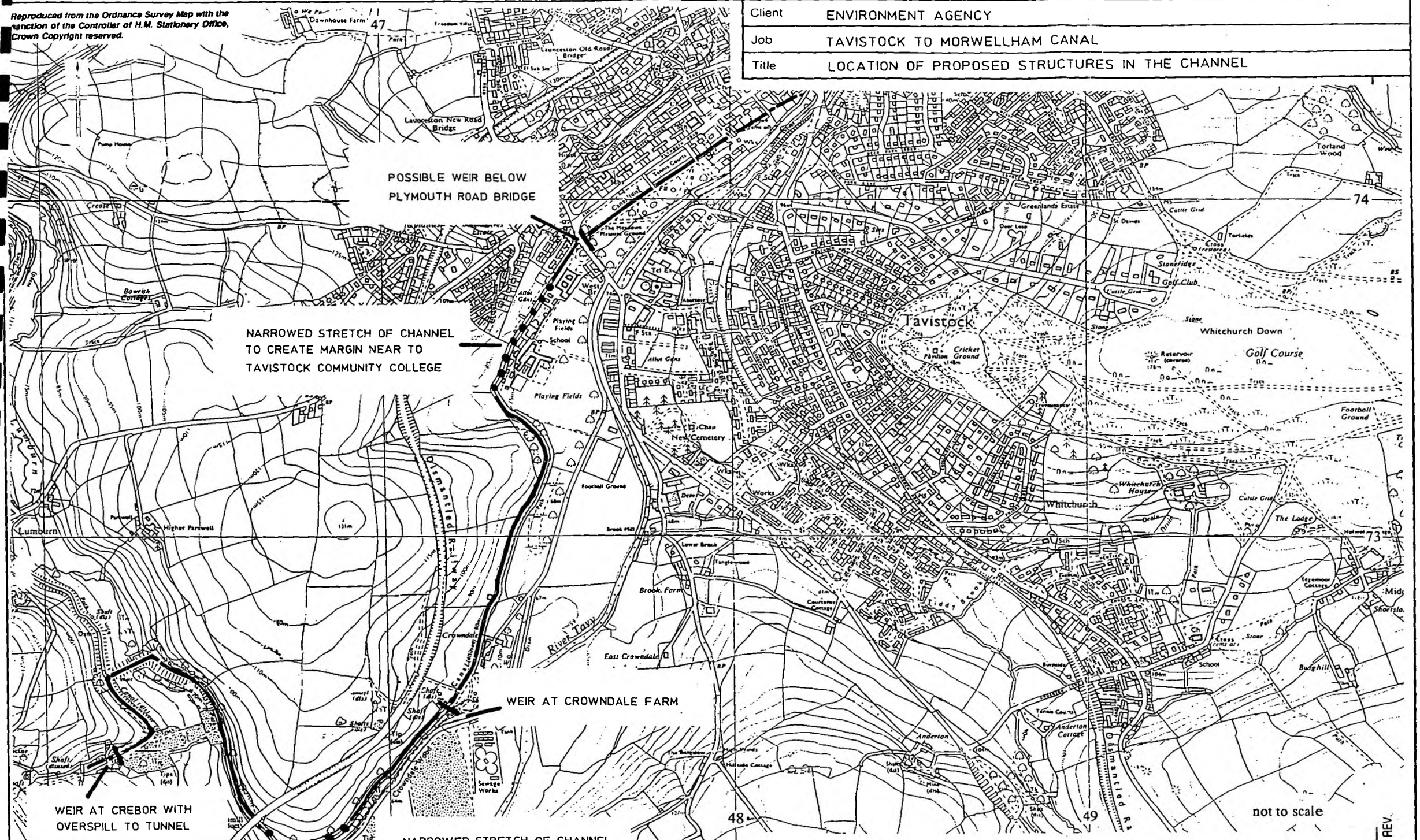
REV.

Babtie

BABTIE GROUP
MULTI-DISCIPLINARY CONSULTANTS
RENSLADE HOUSE, BONHAY ROAD
EXETER EX4 3AY

DRAWN	GLE	JOB No.	BWA016552
CHECKED		DWG No.	B1
APPROVED		DATE	NOV 1996

Client	ENVIRONMENT AGENCY
Job	TAVISTOCK TO MORWELLHAM CANAL
Title	LOCATION OF PROPOSED STRUCTURES IN THE CHANNEL



Babtie	**BABTIE GROUP** MULTI-DISCIPLINARY CONSULTANTS RENSLADE HOUSE, BONHAY ROAD EXETER EX4 3AY	DRAWN	GLE
		CHECKED	
		APPROVED	
		JOB No.	BWA016552
		DWG No.	B2
		DATE	NOV 1996

REV.