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NRA

Guardians of the Water Environment

Diogelwyr Amgylchedd Dŵr

MINEWATER DISCHARGES IN SOUTH WALES

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N.R.A

Welsh Region

/ Dwr Cymru

CONTENT

MINEWATER DISCHARGES

1. Terms of Reference

1.1 The object of this paper is to review the potential opportunities and / or disadvantages of minewater discharges to the water resources of South Wales. The potential of minewaters as a resource has been raised many times, particularly during droughts. However, with the announcement of the closure of three of the remaining four British Coal mines in Wales, it is again appropriate to review whether mine discharges might form a useable resource and to consider treatment options where quality is inadequate.

2. Working Group

Ian Barker	Regional Water Resources Officer	NRA
Robert Vaughan	Regional Water Resources Planner	NRA
Logan Jack	Water Resources Manager	Dwr Cymru
Steve Gallimore	Divisional Hydrologist	Dwr Cymru
Alan Freeman	Divisional Scientist	Dwr Cymru

3. Background

3.1 Water which infiltrates permeable rocks (aquifers) from rainfall reappears at the surface as discrete springs and diffuse seepages. These groundwaters form the baseflow of rivers and sustain flows during periods of dry weather.

3.2 The rivers of South Wales flow over generally hard, impermeable rocks which reduces the quantity of infiltration. Groundwater therefore provides relatively little baseflow contribution to the catchments. What little there is can be important, and the quality of this groundwater greatly affects the quality of the river to which it provides baseflow.

3.3 The physical interference of man's mining activities disturbs groundwater flow patterns. Groundwater discharges can be redirected by pumping or drainage adits, or simply by the interconnection between aquifers provided by the workings.

3.4 Following cessation of mining, groundwater levels recover. "Minewater" breakouts occur as the water table reaches the surface. Often these form large point discharges, having followed the routes of old workings to the surface.

3.5 Minewater discharges are generally characterised by a change in chemical quality (typically high iron concentration) as a result of oxidation within the workings. Generally the quality worsens as residence time within the workings increases. In some cases these minewaters have a significant adverse effect upon the quality of river water into which it is discharged.

4. Aims and Objectives

4.1 The working group have been tasked with two objectives :

- identifying if minewaters can be used to meet industrial or potable demands. These minewaters are both from closed mines, and potential or actual discharges from mines yet to close.
- to assess potential for treatment of minewater of poor quality prior to discharge to rivers. Here the aim is to allow discharges to rivers to continue, but after the quality has been improved.

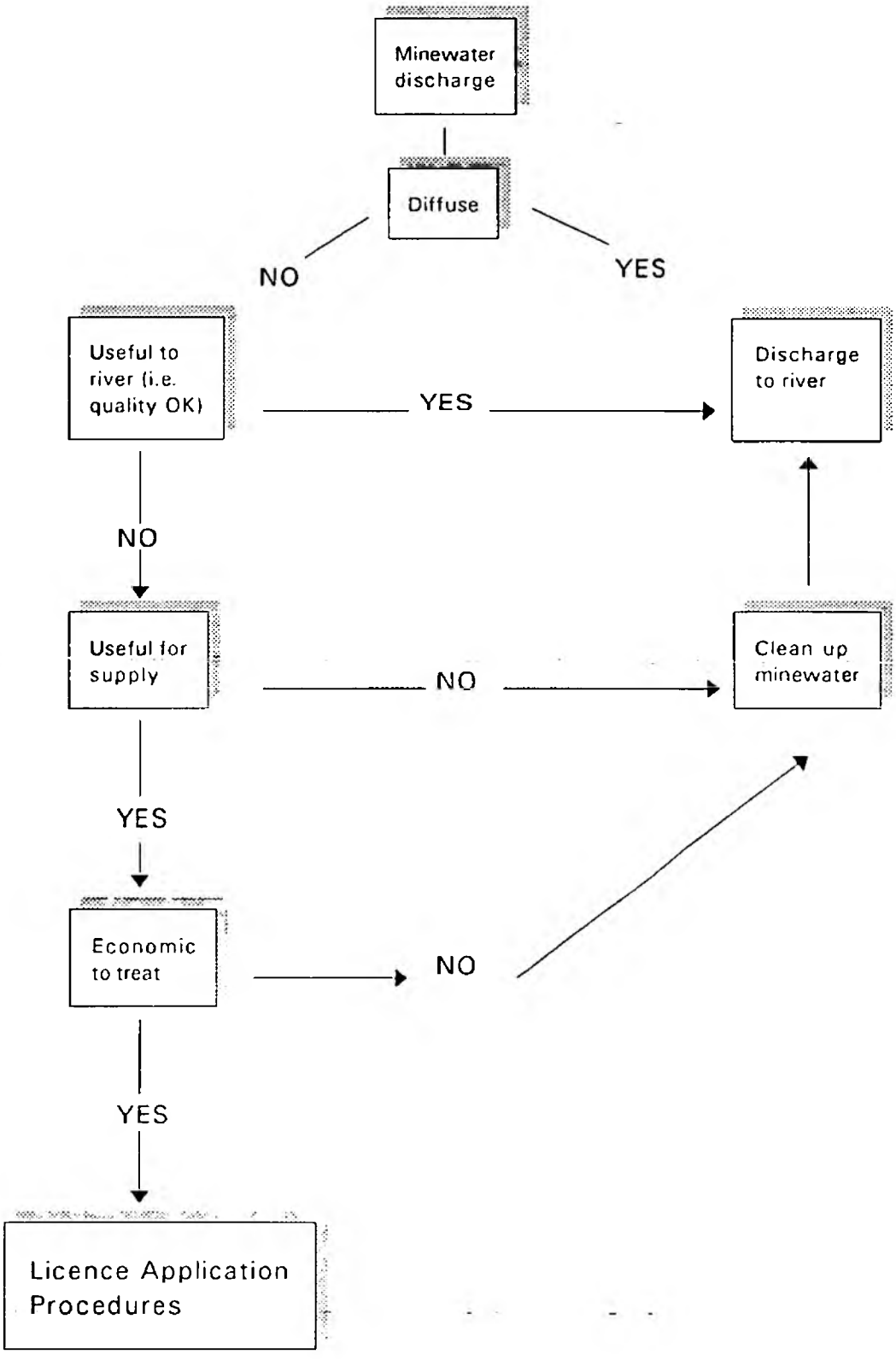
In assessing these objectives it is important to identify the range in volume of the discharge, and its quality.

4.2 As a resource for supply purposes it is the yield available in dry years that is of prime importance. If suitable quantities of water are available then the quality can be assessed to ensure treatment is economically feasible. If this is the case, then a decision can be made, after assessing the environmental impact and the impact on other protected rights, whether an abstraction licence could be granted.

4.3 To treat the minewater and then discharge to the river, again both the range in volume and the quality of the discharge are important. However, in this case, treatment method depends on the concentration of chemicals in the water and the range of flows, both high and low.

4.4 To simplify the options available the following flow chart has been constructed as a general guide :

Fig. 1. Flow Diagram



5. Scope of Study

5.1 In order to consider, within a reasonable timescale, the size and impact of minewater discharges a decision was made to concentrate this review on the South Wales Coalfield. The minewater discharges associated with the North Wales Coalfield and the metalliferous mining industries throughout Wales could be investigated at a later date if thought appropriate.

5.2 Accordingly, the Group resolved that the report should be restricted to South Wales, covering the South East and South West Areas/Divisions, and should cover Coal and Iron Ore workings, including opencast. (N.B. the mining of iron ore pre-dates coal mining in parts of South Wales and the workings are often indistinguishable). These workings can be placed in one of three categories :

i) Collieries which are about to close or will remain active where a discharge is being made (Category A)

ii) Discharges from abandoned workings which are of sufficient volume to form a usable resource (Category B)

iii) Discharges from abandoned workings which have a significant impact on the quality of surface waters but are of little resource value (Category C)

5.3 The NRA is also undertaking two separate surveys investigating the quality implications resulting from the recovery of groundwater levels (often referred to as water table rebound) to the "natural" equilibrium levels. The first is a joint NRA/Welsh Office study involving a survey of ferruginous discharges emanating from or connected with abandoned coal mines in the Welsh Region. The survey will locate the discharges and assess their impact on the water quality, biology and fishery of the receiving watercourse. This study is due for completion in October 1993. It will identify priorities for remedial action and make recommendations where possible.

5.4 The second study: "Assessment for the Potential Generation and Discharge of Acidic Waters From the Taff Merthyr / Trelewis Colliery". is a direct result of the proposed Pit Closure programme. It will assess the potential for the generation and discharge of acidic waters from the Taff Merthyr / Trelewis Colliery and the associated problems that could be caused to the aquatic environment as a direct and / or indirect result of the recovery of groundwater levels following closure of the colliery. This study is currently in Draft form and should be published early in 1993. (see Reference 2).

6. Relevance of Minewaters

6.1 Minewaters originate from mine workings in the Coal Measures. In South Wales the Coal Measures can be divided into two distinct groups :

- o - **The Upper Coal Measures** - these contain large quantities of groundwater and form a multi-layered system within separate sandstone horizons, sandwiched between the low permeability coal and mudstone. It is estimated that an average 250mm per year of rainfall infiltrates to recharge groundwater. This contributes to the baseflow of rivers, with springs emerging from the sandstones. Iron Pyrite (FeS2 - iron sulphide) is present within the coal and mudstone.

- o - **The Lower and Middle Coal Measures** - here the dominant lithology is mudstone with coals and impersistent sandstones. The porosity is lower and it is estimated that around 150mm/year rainfall infiltrates this sequence. These Coal Measures are generally low in iron pyrite.

6.2 Discharges from both active and abandoned coal mines have caused pollution problems in the UK for many years. It often results in significant deterioration in water quality, with consequent detrimental effects on aquatic life. Gross visual pollution has also been caused in many instances.

6.3 In the course of coal mining activities, any iron pyrites present in the coal measures tend to be exposed to contact with the air, water and certain kinds of bacteria. During active operation mines are dewatered for safety reasons and, because contact times of groundwater with the pyrites are short, there is little or no pollution problem. However, when mining ceases the pumping operation also stops. Oxidation of pyrites then occurs converting iron sulphide to sulphuric acid and iron salts. This process is particularly active where groundwater levels fluctuate. At this stage any iron and heavy metals which may be present in the old workings will be dissolved. As the mineworkings become flooded these acidic, ferruginous and possibly heavy metal laden waters may eventually break out and discharge into adjacent watercourses.

6.4 The acid content of the minewater is generally neutralized by the river or stream into which it discharges and the soluble iron is oxidised to the insoluble form. It is this insoluble iron, with its characteristic yellow-orange colour, which so vividly disfigures many rivers.

6.5 As well as changing the colour of watercourses, minewaters may have an impact on aquatic communities which, although less obvious, has serious environmental consequences. The biological effects of minewater pollution may include:

- o - seriously depleted numbers and diversity of aquatic organisms due to the effect of acidic conditions and the toxicity of iron and heavy metals;
- o - significant reduction in numbers and diversity of bottom-dwelling organisms due to smothering of stream beds with iron hydroxide;
- o - loss of spawning gravels for breeding fish and nursery streams for juveniles and
- o - fish mortalities, particularly within salmon, sea trout and trout populations because they are relatively more susceptible to such pollution.

6.6 Difficulties may also occur for legitimate users of stream water who may find that quality impairment renders the waters unsuitable for irrigation purposes or industrial and potable supply. Recovery of groundwater levels will also change the rate of baseflow in certain river stretches.

6.7 The discharge of minewaters from working mines and opencast sites is controlled under current legislation through consents issued by the NRA. Such consents will generally include conditions relating to the quality and quantity of the discharge. Once mining ceases however, there is very limited control over any discharge because the overflow from mines which have been abandoned is exempt from control under existing legislation.

6.8 The NRA sets water quality objectives for classified river stretches. At present 25% of classified river stretches in South Wales, which do not meet their current long term water quality objectives, are affected by ferruginous minewater discharges. Ferruginous discharges are therefore an important limiting factor in the NRA's urbanised river recovery programme. In addition to the classified stretches, the true extent of the impact of ferruginous minewaters on the smaller, unclassified streams and rivers is unknown. Such watercourses are essential nursery areas for fish breeding so necessary for the maintenance of a healthy, diverse aquatic ecosystem.

6.9 Iron is categorised as a List II substance by the EC. In its Dangerous Substances Directive (76/464/EEC) the iron concentration in rivers receiving a discharge must be reduced to less than 2mg/l.

6.10 The Maximum Acceptable Concentrations (MAC's) of iron (Fe) in abstracted water for industrial use is 2 mg/l, with a guidance limit of 1 mg/l. The MAC for water being used for potable supply is much lower. The EC Surface Water Directive states that with minimum treatment the MAC is 0.1 to 0.3 mg/l. However a MAC of up to 2mg/l is acceptable with complex treatment.

6.11 The European Inland Fisheries Advisory Commission (EIFAC) water quality standard for salmonid fisheries is 1 mg/l. The EC Freshwater Fish Directive does not include a limit for Iron, but identifies a range of acceptable pH values of 6 to 9.

7. Description of Collieries and Minewater Discharges. CATEGORY A

This category covers collieries which are about to close or will remain active where a discharge is being made.
A location map is shown as Figure 2.

7.1 Taff Merthyr / Trelewis (ST 105 990)

7.1.1 The Taff Merthyr colliery is situated on the Afon Taff Bargod. Access is by two shafts over 635 metres deep, sunk between 1922 and 1924. The workings are in the Lower and Middle Coal Measures. (see Reference 2).

7.1.2 Trelewis Drift Mine was opened in the 1960's. The workings are in the Upper Coal Measures. Production ceased in 1989 and the lower workings were allowed to flood. Both mines are connected at a high level, and to prevent mine water cascading into the deeper Taff Merthyr workings. pumping at Trelewis has continued. Currently all the lower Trelewis workings are flooded, which accounts for around two thirds of the original workings.

7.1.3 Around 0.45 Ml of water is pumped daily from Taff Merthyr, with between 12.7 and 17.3 Ml/day from the Trelewis Drift. The cost of pumping this water is believed to total over £1 million per year. The large volumes pumped from Trelewis are due to the infiltration of rainfall through the overlying fissured permeable sandstone aquifer. Taff Merthyr pumps less water because the recharge that reaches the deeper workings is smaller, as it has to pass through shales and mudstones.

7.1.4 The time lag response following heavy rainfall to rises in the water level in the workings of both mines is around 5 to 6 weeks.

7.1.5 The iron content of the water pumped from the Trelewis Drift Mine has decreased after the initial filling of the workings from 25mg/l in 199) to around 2mg/l at present. The initial dramatic impact on the river. characterised by red-brown deposits on the river bed, has now diminished.

7.1.6 When Taff Merthyr Colliery closes, the shafts will be plugged, thereby isolating the deep workings. WRc, in their report on the impact resulting from the closure of the colliery (Reference 2) concluded that groundwater levels will rise to ground level but discharges are unlikely to exceed the current pumping total of 0.45 Ml/day. With no man made access to the surface, any discharge will be diffuse. Quality is likely to be similar to the minewater discharged at present. with neutral pH and low iron content.

7.1.7 Similarly WRc reported that the Trelewis Drift Mine will be sealed Flooding of the already partially filled workings will be swift, and an initial flush of iron rich water can be expected. However, no possible breakout points for minewater have been identified so the discharge

will most likely be diffuse.

7.1.8 WRc concluded that no large single discharges are expected post closure. As a result minewaters from the two mines are unlikely to be of any use as a potential resource once the shafts and adit have been plugged. However the diffuse discharges will benefit river baseflows and should have minimal impact on surface water quality in the Afon Bargod Taff catchment.

7.1.9 Continuation of the current method of pumping would be prohibitively expensive and would incur additional costs related to keeping access open to the mines for inspections in accordance with the Mines and Quarries Act.

7.2 Tower Colliery, Hirwaun (SN 949 048)

7.2.1 This mine is not on the immediate closure list. The discharge consent authorises up to 8.2 Ml/d to be discharged into a tributary of the Afon Cynon. Most of the pumped minewater is used within the colliery's washery prior to discharge.

7.2.2 Average total iron concentrations are currently less than 1 mg/l, and the discharge has limited impact on surface water quality. However, suspended coal solids require settling before the water is discharged.

7.3 Betws Drift Mine, Ammanford (SN 648 118)

7.3.1 This colliery is currently under review prior to closure. Production of coal ceased in early January 1993. It is believed to form a potential pollution problem should pumping cease and groundwater levels recover locally. However, approaches have been made by a private company to buy the mine, which could delay the pollution threat.

7.3.2 Currently 0.36 Ml/d is pumped from the workings. No flow gaugings have been done on site, but gaugings are available from the Afon Amman at SN 639 127. Flows in August 1976 dropped to around 4 Ml/d in the river. Currently the maximum iron concentration is around 0.1 mg/l, with pH between 6 and 8.5.

7.4 Private Drift Mines

7.4.1 There are believed to be over fifty small private drift mines in the study area. In all cases the discharges will be very small, arising from both gravity drainages and pumped discharges. However, proximity to the surface means that infiltration of water into the workings is high, and oxidation of any iron pyrite present will occur.

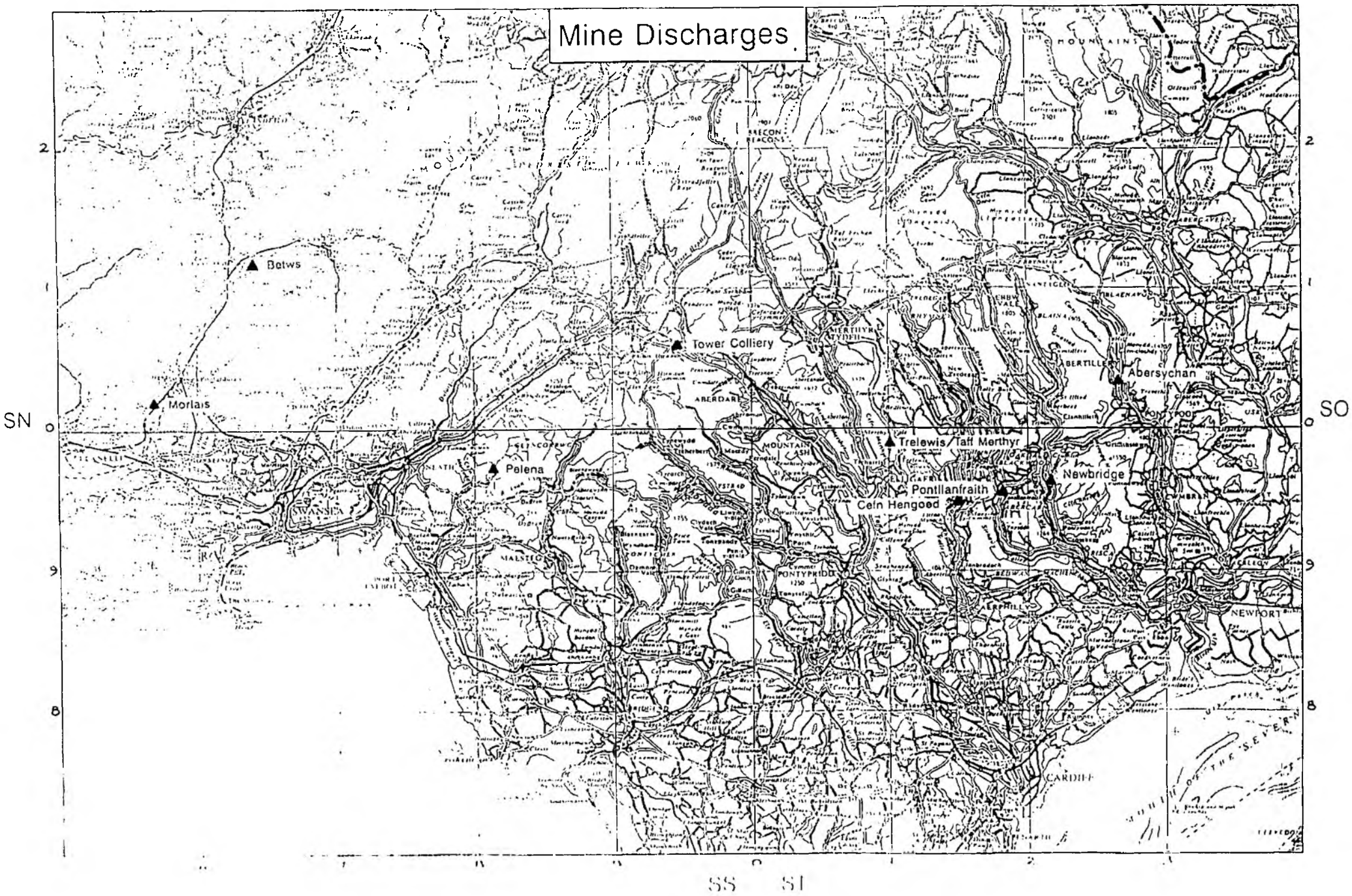
7.5 Opencast Mines

7.5.1 There are currently nine opencast mining sites in operation in South Wales. A further three sites are expected to start operation here in the next few years. Surface discharges from surface mining activities are generally small and comprise surface runoff and "cut" water. Opencast sites tend to have a limited working life, usually of the order of five to fifteen years. Due to the geological structure of the South Wales coalfield (basically "saucer" shaped) the sites are located around the rim where the coal measures outcrop.

7.5.2 The workings have a localised impact on quality and quantity of the groundwater and subsequent surface runoff. This impact occurs in two phases : during the period of mining related activities, and during post reclamation of the site. Little investigation of United Kingdom sites has taken place, but detailed research has been undertaken in the North America (see References 7 & 8). Here groundwater levels and baseflow were reduced during both phases. Recovery post reclamation was very slow and was thought unlikely to recover to pre-mining levels. Mining and reclamation were also noted to cause more increases in groundwater constituents than decreases. Many of the increases, which included Iron and pH, were categorised as "drastic".

7.5.3 In South Wales it has been reported that increased infiltration of rainwater into the exposed Coal Measures occurs following the removal of the overlying low permeability rocks and soils (see Reference 6). However, restoration of the excavations by backfilling and landscaping reduces the impact on ground and surface water.

7.5.4 As further surface mining is proposed, the impact on groundwater and surface runoff requires further investigation.


Mine Discharges
Betws
Morlais
Tower Colliery
Pelena
Trelewis/Taff Merthyr
Pontllanfraith
Cefn Hengoed
Newbridge
Abersychan
SN
SO
SS
ST

8. Description of Collieries and Minewater Discharges. CATEGORY B

This category covers discharges from abandoned workings which are of sufficient volume to form a usable resource.
A location map is shown as Figure 2.

8.1 Cefn Hengoed (Rhymney Valley) (ST 154 962)

8.1.1 In 1990 Britannia Colliery was closed. In February 1991 a breakout of iron-rich water started, via an adit situated at Cefn Hengoed, into the Afon Rhymni. The maximum recorded discharge from a limited number of recent gaugings is around 3.4 Ml/d. The mining activity at Britannia was mainly from the Middle Coal Measures, although the Upper Coal Measures were also worked.

8.1.2 A typical analysis of minewater shows 6mg/l dissolved iron. This precipitates out on exposure to oxygen as ferric hydroxide on the river bed. About 45 tonnes of iron precipitates out per year, and discolours the river for 3km downstream, and is evident in the river's silt for a further 2km. It is particularly noticeable during periods of low flow, and has a significant impact on the benthic invertebrates.

8.1.3 In 1976 there was an abortive proposal to treat the pumped discharge from the Britannia Mine for public supply purposes during the drought (see Reference 1). The present gravity discharge could perhaps be utilised as a resource after treatment, but this would require a detailed appraisal.

8.2 Pontllanfraith (Sirhowy Valley) (ST 180 956)

8.2.1 The breakout of mine waters into the Afon Sirhowy occurred in April 1991, and is thought to be linked with the rebound of groundwater levels following the cessation of pumping at collieries in the vicinity.

8.2.2 The average volume of this discharge calculated from a limited record is about 0.1 Ml/d into the Afon Sirhowy. Total iron is around 6 mg/l.

8.2.3 A study on the impact of the discharge by Hamburger (see Reference 4) concluded that changes in the river chemistry as a result of the minewater discharge were within limits recommended in the EC Fish Directive (Directive Number 78/659). However, the blanketing effect of the ferruginous precipitate was a threat to aquatic life.

8.2.4 The site is more accessible than that at Britannia and so there may also be scope here for using the discharge.

8.3 Newbridge (Ebbw Valley) (ST 215 960)

8.3.1 This breakout, which started in June 1991, has again been linked with the cessation of pumping at collieries in the vicinity

8.3.2 The discharge issues from the top of a shaft on the site of the North Celynen Colliery. The area has been levelled in preparation for development as an industrial estate. The discharge flows into the Afon Ebwy.

8.3.3 The flow is small at less than 0.2 Ml/d with a mean total iron concentration of 17 mg/l. Subject to adequate treatment there may be some scope for using this discharge. It is not clear what will happen when the shaft is capped as development of the site progresses.

8.3.4 As with the Sirhowy breakout, the impact on the river is within acceptable EC Fish limits, although precipitation of iron onto the river bed is an aesthetic problem, and a threat to aquatic life.

8.4 Abersychan (Cwmsychan Brook/Afon Lwyd) (SO 260 035)

8.4.1 The discharge appears in a culverted section of Cwmsychan Brook. Gauging records from the Cwmsychan Brook at SO 270 032 show a variation in flow from around 3 Ml/d to over 72 Ml/d. A large proportion of the 3 Ml/d flow would be from the mine discharge. It has a mean total iron concentration of about 1mg/l.

8.4.2 The discharge comprises of mine drainage from the many mines which were active in the coal measures of the Lwyd valley.

8.5 Morlais Colliery (Talyclun) (SN 570 021)

8.5.1 The discharge of minewater from the Morlais Colliery occurred following the closure of the Brynlliw Colliery in the 1980's. This colliery was located on the eastern side of the Loughor estuary. The workings of the Morlais and Brynlliw collieries are linked beneath the estuary. In addition the workings of a number of other abandoned collieries are also linked underground to the Morlais/Brynlliw system. These include Graig Merthyr Colliery, Great Mountain Colliery, and Garngoch Colliery. The discharge at Morlais Colliery therefore drains an extensive area of underground workings.

8.5.2 The volume discharged under dry weather conditions is estimated at 5Ml/day. It is only slightly acidic in nature with values of the order of pH 6.0 being recorded. However, soluble iron concentrations as high as 100 mg/l have also been recorded.

8.5.3 The discharge enters the lower reaches of the River Morlais, a tributary of the River Loughor. Under dry weather flow conditions the dilution available at the point of discharge of the minewater is estimated at 1:1.

8.5.4 The River Morlais is a good quality stream supporting a native brown trout population and a migratory fishery. Below the point of discharge of the minewater the river is orange and turbid in appearance due to the presence of precipitated iron and the river bed is completely blanketed by ferruginous deposits. Water quality is poor in this stretch although it does not appear to present a complete barrier to migratory fish. It is considered that because the discharge occurs close to the tidal limit migratory fish are able to pass through the affected stretch at high tide because of the increased dilution.

8.6 <u>Afon Pelenna (SS 815 970)</u>

8.6.1 There are five identified discharges from long abandoned coal mines in the Afon Afan catchment in West Glamorgan. These have caused pollution of 17km of the Pelenna and Gwenffrwd tributaries with acidic and ferruginous water for over 30 years.

8.6.2 A study to model the impacts of pollutants from acid mine drainage was undertaken by the Institute of Hydrology in February 1992 (see Reference 5). This report found that EIFAC water standards for salmonid fisheries are not being met. To allow repopulation of the Pelenna by salmonids, iron concentrations in the minewater discharges would have to be reduced by the order of 90% in the Gwenffrwd and 55% in the Blaenpelenna. The report recommends that a wetland treatment scheme be investigated to improve the three worst discharges.

8.6.3 Subsequently, the NRA has commissioned environmental consultants. Richards Moorhead and Laing to undertake a feasibility and costing study for a remedial scheme fulfilling the requirements identified by the Institute of Hydrology study. The feasibility study has confirmed that a full scale constructed wetland system would be capable of achieving the required improvements and a proposed preliminary design and construction programme has been presented at an estimated cost of £931,000.

8.6.4 The report of the feasibility study will now be used to support an application by West Glamorgan County Council for EC "LIFE" programme funding and this will be submitted to the Department of the Environment by mid March. Negotiations with the Welsh Development Agency have been initiated to obtain funding to address land reclamation aspects of the scheme and discussions with other potential funding or contributary organisations including Welsh Office, the BOC Foundation and the Institute of Hydrology are progressing.

8.6.5 Should the funding applications for the above scheme be successful then this will become the first large scale development of a wetland treatment system for coalmine waters in the UK and will be of National and European importance.

9. Description of Collieries and Minewater Discharges. CATEGORY C

This category covers discharges from abandoned workings which have a significant impact on the quality of surface waters but are of little resource value.

9.1 There are a large number of minor discharges throughout the South Wales coalfield area. However, the volume of discharge is low, and as a result the impact on the main local rivers is small. The ferruginous discharge survey (see paragraph 1.3) will provide a comprehensive summary of these sites. As they do not provide a substantial resource, and any requirement to improve quality has yet to be established, this report will not review these sources.

10. Water Resource Implications and Quality Data

Location	Grid Ref	Quality Fe(mg/l)	pH	Quantity Ml/d Min (date) Max (date)
Taff Merthyr	ST105990	1	7	Pumped Vol :0.50 Ml/d
Trelewis	ST102994	5	8	Consented Vol:14.00 Ml/d
Bettws	SN648118	1	8	Not Available
Tower Colliery	SN949048	1	8	Consented Vol :8.10 Ml/d
Cefn Hengoed	ST155968	6	7	1.20 06/92 3.40 10/92
Pontllanfraith	ST181957	6	7	0.08 09/91 0.12 06/91
Newbridge	ST215960	17	7	0.07 09/91 0.16 06/91
Abersychan	SO260035	1	8	3.28 08/84 72.50 12/78
Pelenna :				
Whitworth Lagoon	SS79 97	84	6	11.70 11/91 108.00 01/92
Gwenffrwd mine	SS79 96	11	4	
Whitworth No.1	SS79 97	20	6	(N.B. River Flow Not
Middle Mine	SS814976	1	7	Mine Discharge).
Garth Tonmawr	SS816973	26	6	
Morlais	SN570021	100	6	0.9 08/76 216.0 02/79

11. Options Considered For Use Of Minewaters

The following options for the use of minewater discharges have been identified and considered in this study :

11.1 **Potable Supply** : The South Wales Coalfield is an urban area with high water demand. Minewaters have only been used occasionally for potable supply; the last source was that at Llanover near Crumlin. This provided around 0.25 Ml/d and closed some ten years ago. Treatment costs were expensive and the treated water would be unlikely to meet the current EC standards. It is considered that the cost of treating poor quality water to potable standards is uneconomic. The variability in the quality also makes treatment very difficult and unreliable.

11.2 **Non Potable Supply**

- o - Mains Supply : The industrial legacy of South Wales suggests that minewaters could find a ready market with water for industrial purposes. Working on the basis of a water main laying cost of £100 per metre, it was thought that an investment of up to £500k was reasonable if a customer could be identified. This rule was applied to all mine discharges of suitable quality (see table 5) i.e. those with Fe below 2mg/l. No non potable users were identified within 5 kilometres in any of the searches. There is therefore no obvious market for this water.
- o - Abstractions Licensed By NRA : Any use of minewaters by licence holders would have to involve reasonable quantities of water and close proximity to the discharge to make them economically feasible. A search of licences on the NRA Database within 5Km of the discharges identified around 90 abstractions. The majority of these are small abstractions with seasonal or quality constraints. Supply costs and treatment make these uneconomic options. Those of sufficient quantity to be of interest are Public Water Supply and industrial. However, due distance and the factors outlined in 11.1 above, none are considered currently viable.

11.3 **Compensation Flows** : A number of direct supply reservoirs are situated in the heads of the South Wales Valleys. Compensation releases are made from these sources to ensure that reasonable flow is maintained in rivers. If suitable quality minewater was used to replace these releases, then the amount of water available for potable supply from the reservoir would increase. However the cost of pumping up valley, coupled with the cost of the mains, makes this option expensive. For example, a pipeline of around 23 Km would be required to take water from Taf Merthyr to Pontsticill reservoir. This could cost in the region of £2.3 million. The operational pumping costs due to the differential pumping head of the order of 190 metres would also be large.

11.4 **Hands Off Flows** : A number of Direct River Abstractions have river level conditions in their licences. When river levels drop below these controls, abstraction has to stop. To overcome this restriction river augmentation is often carried out; water is added to the river to prevent it dropping to these control levels. Minewaters could be used for this purpose. Most river abstractions are in the lower reaches of rivers and so gravity feeds from the mine water discharges make this option cheaper. However, the distances involved are large and main laying costs would be great. For example, using the Abersychan discharge to augment the River Usk, via the Berthin Brook, above the Prioress Mill intake would require approximately 8 Km of pipeline at a cost of around £0.8 million.

11.5 **Dilution** : Discharging the minewaters directly into large reservoirs such as Llandegfedd or Ponsticill, is possible. Residence time and dilution overcomes much of the quality problem. The benefit from such a scheme would come from topping up the reservoirs in late summer and early autumn when river water was not available. Although this could be useful the cost of main laying and possible pumping costs to move the water around would be high. For example, a pipeline of around 23 Km would be required to take water from Taf Merthyr to Pontsticill reservoir. The differential pumping head would be of the order of 190 metres. For Abersychan to Llandegfedd, a pipeline of 12 Km would be required at a cost of around £1.2 million. This would however have a gravity head gradient of 150 metres.

11.6 **Treatment Prior To Discharge** : Where minewater discharges have an impact on a receiving watercourse this could be ameliorated by treatment. The level of treatment would depend on the quality of the discharge and its variability, the required standard of the discharge and the quantity of the discharge. To identify the benefit of such works, the cost of the environmental damage caused by the discharge would need to be assessed. If such figures were available, an assessment could be made to justify certain levels of treatment.

12. Conclusions

12.1 General Conclusions : The constraints of quality and quantity reduces the number of sites suitable for assessment as possible supply resources to around four. Even at these locations, only local non potable use would seem cost effective. So far no such existing or forecast demand has been identified. It is therefore unlikely that any of the current or forecast discharges can be put to non potable supply use.

12.2 With the removal of the supply option, only treatment prior to the discharge of minewaters to rivers seems feasible. The likelihood of this occurring depends on the benefit gained from the works. Further work will therefore be required at each discharge location to assess treatment options, costs (capital and running) and benefit to the river. Where an economic benefit is identified, the best method of funding construction and the future operation of the works can be assessed.

12.3 In all cases the value of water in the river, irrespective of its quality, should not be underestimated.

12.4 **Category A:**

12.4.1 With the imminent closure of Taf Merthyr, minewaters are likely to break out at diffuse locations. This will render them unsuitable as useful sources of water. Quality is likely to be poor at first. To utilise the minewaters as a source of supply requires the urgent installation of a means of abstraction prior to sealing of the mine. This is unlikely to be done as no economic market for this water has been identified.

12.4.2 For the other Category A sites identified, yield is thought to be small. However further analysis is required to identify what will happen to the groundwater table when Tower Colliery and Bettws Drift mine close. If, as seems likely, potential groundwater yields are low these sites will be impractical as sources for supply. Also quality may be a problem.

12.4.3 Drift Mines and Opencast sites are unlikely to provide sufficient quantities of water to make them suitable as sources for supply.

12.5 Category B :

12.5.1 Only at Cefn Hengoed, Abersychan and the Pelenna valley are quantities sufficient to render them suitable as useful sources of water. Potential demands have not been identified and the cost of moving the water appears uneconomic. Further work should address the environmental impact of these discharge to identify :

- o - if removal of these discharges is acceptable to the rivers concerned.
- o - the benefits and costs of pre - discharge treatment.

12.5.2 The Pelenna discharges are too far from any demand centres to be of use for supply purposes. The quality is also extremely poor. The only course of action here would seem to be to treat the discharges, as proposed by IoH (see Reference 5).

12.5.3 The sites at Pontllanfraith, Newbridge and Morlais have discharges of low volume. Here only the treatment option would seem applicable as quantities are too small for supply (see Reference 9).

13 ACTIONS

13.1 To capitalise on the availability of groundwater at Taf Merthyr would require installation of a means of abstracting water prior to sealing the mine shafts. This may require a speculative move by a developer. However it would reduce the risk of contaminated diffuse discharges to surface waters.

13.2 The NRA must assess any proposal to abstract minewaters in the same way as any new licence, i.e proper need, impact of abstraction on existing protected rights etc. However, in the case of abstraction prior to groundwater recovery, this may have positive impact by preventing pollution in a river course.

13.3 Dwr Cymru need to identify markets for the minewaters. This is required to justify an abstraction licence and to support the investment.

13.4 Dwr Cymru and the NRA need to liaise further to assess treatment options. This work is applicable to those discharges which are unsuitable for supply due to low yield and/or lack of local demand. This could include the Pelenna minewaters and those mainly in category B..

13.5 The findings of the current studies on mine discharges (see paragraph 1.3) need to be reviewed on their completion.

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31.3.1993

14. REFERENCES :

o - 1. Survey of Groundwater in the Welsh Water Authority, Directorate of Resource Planning. June 1979.

o - 2. Assessment of the Potential Generation and Discharge of Acidic Waters from the Taff Merthyr / Trelewis Colliery, Draft Final Report for NRA by WRc. December 1992.

o - 3. Briefing Note to Regional Rivers Advisory Committee, "Briefing Note on Abandoned Coal Minewaters in Wales", D.H, Williams, NRA.

o - 4. Impact of Ferruginous Minewater Break-outs on the Environmental Quality of the Rivers Rhymney, Ebbw and Sirhowy, M. Hamburger 1991. NRA Internal Report.

o - 5. Acid Mine Drainage In The River Pelenna : Modelling and Pollution Control. Ishemo and Whitehead, IoH, Feb 1992.

o - 6. Bryn Pica Opencast Coal Workings, Aberdare, Mid-Glamorgan. A hydrogeological Assessment Of The Suitability Of The Site For Domestic Waste Disposal. WRC February 1980.

o - 7. Impact of Surface Coal Mining on Three Ohio Watersheds - Physical Conditions and Groundwater Hydrology. J.V. Bonta et al. Water Resources Bulletin Volume 28 Number 3 June 1992.

o - 8. Impact of Surface Coal Mining on Three Ohio Watersheds - Groundwater Chemistry. J.V. Bonta et al. Water Resources Bulletin. Volume 28 Number 3 June 1992.

o - 9. Pollution Problems with Minewaters in Scotland - P.G. Carter and J.M.Reid, Babtie Geotechnical, Glasgow.

15. BIBLIOGRAPHY

o - 1. Constructed Wetlands to Ameliorate Metal-rich Minewaters - Review of Existing Literature. NRA/WDA. R&D Note 102. 1992

o - 2. Constructed wetlands to Ameliorate Metal-rich Minewaters - Study of Natural Wetlands. NRA/WDA. R&D Note 103. 1992

o - 3. The Non-Ferrous Mines of the South Wales Area. J.R.Foster-Smith. British Mining No.18 - Northern Mine Research Society.