PRACTICAL MITIGATION MEASURES IN USE TO PROTECT SENSITIVE WATER ENVIRONMENTS

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This is the text of a presentation given by Duncan Wardrop to a seminar hosted by the then Department of Environment Transport and the Regions.

INTRODUCTION

This paper will outline briefly some of the practical mitigation measures that have been successfully used by the minerals extractive industry to negate effects of mineral workings on the water environment. Practical is the keyword - measures have to be effective, simple, and cheap.

Most of the author's experience has been in dealing with dewatering of quarry workings but this article can offer examples in all of the groups of potential effects. The author's examples all relate to individual site circumstances. A wider area situation such as the Mendips is outside the author's personal experience and outside the scope of this article.

WHEN ARE MITIGATION MEASURES REQUIRED?

1. When effects on the water environment are predicted.
2. When effects are identified that may not have been predicted.

The necessity to implement mitigation should be identified by an effective monitoring scheme before effects of, say, a quarry working are evident at a receptor such as a sensitive wetland or water feature. Monitoring and Mitigation go hand in hand.

Prevention is always better than a cure - but prediction is an imperfect science and we must be able to deal with real situations as they occur. Mitigation schemes need not, and should not, impact on the ability to work mineral resources vital to our economy and standard of living.

1. PREDICTION

The key to prediction is to understand the geology and hydrogeology of a situation, based on appropriate site investigation and research. This understanding must be grasped by all parties - the Operator, the Planners, and the Regulators. Professional judgements should be made on the basis of the aforementioned understanding supported by monitoring and factual data where necessary. Some quarry sites require detailed research, some quarry site situations are perfectly clear in a 10 minute site visit.

Prediction may well start at the land search and site selection stage of exploration, when the desk study can help the design of the mineral proving borehole drilling programme. On a promising mineral prospect it is common practice to equip some of the exploration holes with groundwater observation standpipes to allow some monitoring data to be acquired very early in the site development process.

Early water monitoring data and the understanding of geology gained through the exploration programme will inform the Environmental Impact Assessment prepared for a Planning Application such that potential mitigation measures can be designed at the application stage. Sometimes a monitoring and mitigation scheme will be included in a Section 106 planning agreement or be part of pre-development conditions.

There are difficulties in parts of the country in respect of the level of technical understanding residing in Planning Authorities and Regulators. Where the understanding is lacking it is simply not good enough to invoke the "Precautionary Principle" and sit on the fence.

It is however appropriate to ask the question What If ?... and design some measures accordingly. There are layers to an effective mitigation strategy, and we are rarely facing Armageddon.

2. IDENTIFICATION

When effects on a water feature are identified it is the author’s practice to adopt a “Good Neighbour, Without Prejudice” stance, unless of course a claim is patently spurious. It is almost always very difficult indeed to either prove or disprove cause and effect in hydrogeological situations, and often it is a waste of time and money trying to do so.

Often it is also the case that a water feature has suffered unseen deterioration due to several factors over several years and a mineral working may just provide the last tiny effect which makes a problem appear.

> *An example was a large diameter water well serving a garden centre located a few hundred metres from a sand and gravel pit that was dewatered by pumping. The pump in the well began supplying water intermittently. On inspection of the well, which was lined by concrete rings, the visible ‘tide marks’ made it very obvious that the local water table had dropped by around 2 metres. It was obvious that this drop had happened over several years and long before the gravel pit was opened but went unnoticed because the pump intake was still sufficiently submerged.*
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> *It was also possible that dewatering the gravel pit had lowered the water table just a few additional centimetres – possibly as few as 2 centimetres – and allowed the pump intake to draw air. The quarry operator, without prejudice, was able to lower the pump intake at very little cost and also install as a precautionary measure a low permeability barrier along part of the gravel pit perimeter. The problem was solved.*

A good practice approach - especially in the latter type of case - is for a site operator not to admit any liability when approached by a neighbour, but then do their best to mitigate the identified effect anyway. The effect or feature has to be inspected and measured, and decisions must be made on the basis of fact rather than emotion or supposition. It is rarely necessary to panic!

This approach is usually cheaper than a long dispute, and can yield some very effective good PR.

REAL MITIGATION MEASURES
Taking the typical life cycle stages of a mineral working the table below offers some examples of measures that the author has implemented over the years.

They are without exception simple, effective and cheap.

Life Cycle Stage	Receptor Risk	Setting	Mitigation
Ground Investigation	Creation of pollution pathways	Two layer S&G deposit over Chalk, and S&G quarry over sandstone aquifer. Two aquifers separated by clay with risk of pollution from the upper layer	Use proper sealing between sample tubes in a single monitoring borehole; or preferably drill one borehole to monitor each layer. Oldest paired borehole nest 15 years in 1998.
Physical Presence	Aquifer	S&G quarry in glacial over Chalk, top of Chalk not to be intercepted	Design working scheme for the lowest part of the S&G layer – excavate confidently down to a safe datum above Chalk, followed by careful excavation towards the base of the deposit after a local detailed probing investigation.
	Surface waters	S&G quarry in fluvioglacial valley gravels	Re-designing the diversion of a sensitive Chalk stream using modern ecological criteria and replication of the natural stream bed morphology.
Dewatering	Wetland	Rock quarry with adjacent wet moorland supported by perched water table	Understand the geology and hydrogeology, measure watercourse flows, and install effective monitoring.
	Wetland	S&G quarry in valley gravels over Coal Measures with sensitive wetland close by	As above but due to the likelihood of impacts staged mitigation measures were built to allow direct and/or indirect recharge of wetland. Groundwater monitoring network with trigger levels. Effective for 3 years by 1998.
	Private domestic well supply	Valley S&G with high water table, adjacent river and canal	Upgrading an old dug well by drilling a borehole through the base and lowering the pump intake. 5 years operation to 1998.

	Receiving water	S&G quarry dewatering to a receiving watercourse with very limited capacity and high flood risk	Design of a water handling scheme involving recirculation of as much water as possible on-site using recharge features, discharging the surplus off-site in careful proportions to 2 watercourses. Operational for 10 years.
Contamination	Suspended solids	S&G quarry in floodplain dewatering into sensitive watercourse. Colloidal Chalk	Gravel berms placed in long discharge ditch and vegetation allowed to grow to trap chalk colloids. 8 years of operation.
	Leachate	S&G quarry in terrace deposits with groundwater contaminated by third party landfill leachate.	Bedrock geology allowed the separation of the excavation into two parts, limiting groundwater inflow. Discharge of groundwater to sewer. Operational for 6 years.
Reclamation	Flow paths	Small scale S&G extraction in glacial deposits potentially obstructing groundwater flows to a sensitive watercourse	Understanding of the geology at the small scale and observation of natural drainage. Concentration of restored land drainage to supplement stream flows. 15 years operation to 1998.
	Contamination	Glacial S&G quarry infilled with household waste. Adjacent watercourse.	Understand the natural geology protecting the watercourse and instigate regular chemical monitoring. 12 years to 1998.
Afteruse	Clean uses	Glacial S&G quarry over Chalk	Restored to fishing lake from the mid 1980s.
	Clean uses	Granite quarry flooded	Sub Aqua diving afteruse from the mid 1970s
	Clean uses	Dry glacial S&G quarry in near urban environment	Recreated heathland. Public walks. No chemicals used.

Most of these measures have been in place for many years.

CONCLUSIONS

Most potential effects of mineral workings on the water environment can be avoided or mitigated.

It is vital to understand the technical situation.

Design appropriate monitoring and a layered mitigation strategy.

Use professional judgements, and take decisions based on the facts.

Be a good neighbour.

Keep it simple.