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**An Approach to the Assessment of the Agricultural Impacts
of Coal Mining**

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ABBREVIATIONS USED IN TEXT

ADAS	Agricultural Development and Advisory Service
BGC	British Gas Corporation
CAS	Centre for Agricultural Strategy
CC	County Council
CENE	Commission on Energy and the Environment
DAFS	Department of Agriculture and Fisheries for Scotland
DC	District Council
DoE	Department of the Environment
DEn	Department of Energy
DR	discount rate
EIA	environmental impact assessment/analysis
GDO	Town and Country Planning General Development Order
MAFF	Ministry of Agriculture, Fisheries and Food
MCC	Metropolitan County Council
MDC	Metropolitan District Council
mta	million tonnes per annum
NCB	National Coal Board
NCBOE	NCB Opencast Executive
NFU	National Farmers' Union
RC	Regional Council
RWA	Regional Water Authority
SDD	Scottish Development Department
SNG	substitute natural gas
USDEn	United States Department of Energy
USDI	United States Department of the Interior

ABSTRACT

Contentions that expansion of the British coal mining industry into predominantly rural areas may pose serious threats to agriculture and food production are reviewed in the light of the available evidence. It is considered that, whilst the severity of impacts and rate of future development may have been overstated, the conflicts are sufficiently significant to warrant close examination. Further, land use planners are responding for the first time to mining proposals affecting entire coalfields, thus making it essential to establish the correct principles of development from the outset. It is noted that past assessments of agricultural impacts have failed to reflect their diverse and pervasive nature, thus necessitating the identification of more appropriate methods of forecasting.

In the light of current weaknesses in practice, it is argued that a formal system of impact assessment may prove necessary. Those characteristics of mining operations and associated end-uses which are likely to affect agriculture are analysed, as are those aspects of the farm enterprise most vulnerable to disruption. These various characteristics are then used as a basis for the assessment of mining-agriculture impacts. A review of the strategic nature of impacts arising from mining programmes is considered desirable, and limited proposals are made regarding assessment at this scale. More detailed consideration is given to an appraisal framework for individual mining proposals, and this is tested in relation to part of the 'Vale of Belvoir' coalfield.

It is concluded that, although further methodological refinements and field investigations are necessary, the early implementation of an impact assessment procedure is nevertheless justified.

CHAPTER ONE

THE AGRICULTURAL IMPACTS OF COAL MINING - AN INTRODUCTION

An Outline of the Problem

In 1974, following the first oil-led energy crisis, the British coal industry began to emerge from its long years of decline. There quickly followed a period of intense lobbying by the mining unions and National Coal Board (NCB) to promote an expansive Plan for Coal (NCB, 1974) and this initiative was taken up by the government of the day (DEn, 1977). Coincident with this regained confidence was the discovery of massive reserves of coal of power station quality around Selby and the Vale of Belvoir, and development commenced at the former of these prospect areas in 1976. Although this early optimism has since suffered a number of setbacks, it appears that the NCB still wishes to re-structure and re-equip its industry in both a geographical and technological sense. Further, the lucrative and potentially saleable Opencast Executive (NCBOE) seems poised for possible expansion. It appears reasonably certain that, whilst the future coal industry may not be of the scale, ownership and tradition which some of its leaders might desire, its viability is nevertheless assured.

Coal mining has, in the past, been one of our dirtiest industries, and it has been responsible for much the greatest portion of Britain's legacy of derelict land. Its impact in terms of land take has been an area of some 16 500 ha., roughly half of which is actually derelict, together with a legacy of inadequate opencast restorations dating mainly from the 1940s and 1950s. These problems have been compounded by the damaging and blighting effects of subsidence: in areas with a long history of mining up to half the land may be affected in this manner (Barnsley M.D.C., 1979). In places, subsidence of farmland has created permanently flooded areas, but far more extensive are those simply left badly drained, and which eventually become neglected or low quality pasture land. The changes to rural communities consequent on the introduction of large scale mines are equally pervasive. It would be

expected, therefore, that a re-emergence of the coal industry would not be universally welcomed. However, the problem has been made yet more acute by a number of issues of current concern.

First, the 1970s and 1980s have seen a reaction against the large-scale conversion of agricultural land to urban and industrial uses (Coleman, 1977; CPRE, 1981; Anon, 1983). Despite the fact that some commentators believe the threat to agricultural output to have been overstated (Best, 1981; Dawson, 1983) and the Department now gives its official sanction to the use of greenfield sites (DoE, 1980), this view is by no means universal and the long-standing principles that land transfer should be minimised and development steered to poorer agricultural land still command both official and popular support. Given the additional evidence of inadequate restorations and insidious effects of subsidence, the opposition to coal mining has tended to shift away from a basis of aesthetic displeasure, especially now that its industrial architecture has greatly improved, to one of agricultural concern.

Second, despite our continued membership of the EEC, the arguments in favour of national self-sufficiency in both energy and food have tended to increase rather than abate. Yet there is a prima facie case of conflict here; whilst MAFF considers agricultural land loss to be a potential obstacle to increased levels of food production (HMSO, 1975, 1979), the influential Watt Committee on Energy (Watt, 1979) perceived that protected land (notably high quality farmland in the case of coalfield development) could impose real constraints on future energy strategies. In fairness, many observers believe the current drive for agricultural self-sufficiency to be unnecessary and excessive, and to give the farming industry an unfair advantage in competing with other land users (Green, 1981; Pye-Smith and Rose, 1984), whilst others are equally unconvinced about the need for major and immediate expansion of our energy supply base (Manners, 1981). Nevertheless, this view of land use and policy conflict between coal and agriculture has gained widespread credence and, in the absence of clearer guidance, eloquent argument may prevail over the available evidence. Thus, Roberts and Shaw (1982a) have remarked that there is a strong case for "central government to

co-ordinate the operations of the Department of Energy, the Ministry of Agriculture and the Department of the Environment to produce a long-term strategy for energy, agriculture and the environment".

Third, the past decade has seen the emergence of marathon public inquiries. The inquiry into the North-East Leicestershire Prospect ("Vale of Belvoir") was second in length only to that for Windscale (although at the time of writing Sizewell is dwarfing them both), and even minor opencast developments stand a greatly increased chance of delay at the public inquiry stage (Brocklesby, 1979). The justification for the costs and delays incurred by these proceedings has been seriously questioned, especially as the public, whom they are intended to serve, may be unable effectively to contest agencies better able to meet substantial legal fees and time commitments.

Fourth, over the same period, techniques of environmental impact assessment (EIA) have been developed. These have been widely advocated as means of reaching more rational planning decisions, presenting balanced and open accounts of proposals to the public, and streamlining public inquiries by providing a ready and comprehensive factual base and by focussing attention on major issues. Its introduction into the EEC as a mandatory requirement for member states must, despite interminable delays, still be considered probable. The developer-commissioned "Belvoir Prospect" (Leonard and Partners, 1977) was amongst the first EIAs to be prepared in England, although considerable prior experience had been gained on hydrocarbon-related developments in Scotland, and the NCB has expressed interest in building upon this early experience. Lee (1982) has suggested that one of the main future avenues of research should be the production of impact assessment methodologies appropriate to particular categories of industrial use: this "generic" approach has considerable relevance to the present study.

Fifth, the planning system is for the first time responding to applications covering entire coalfields (North and Spooner, 1978); thus, planners must be certain that the correct principles of development and land protection are established at the outset. Further, although NCBOE activities have only recently and hesitantly come under planning control

this has not prevented local authorities from attempting to influence their operations, especially where these appear to be moving onto better agricultural land (Cumbria C.C., 1979; Fife R.C., 1981; Durham C.C., 1983).

Finally, recent years have seen increasing attention focussed on the environmental effects of energy (Watt, 1979); in particular, coal mining has come under the scrutiny of the Commission on Energy and the Environment (Flowers, 1981). The Government has responded to this latter document in a White Paper (HMSO, 1983) which rightly recognises the major issues to be surface disposal of waste, subsidence and the control of opencast operations. Thus, whilst agreeing with the Commission's conclusion that a modern, efficient coal industry, properly designed and operated to a high environmental standard, can make an immense contribution to meeting the country's energy needs, the Government remains genuinely concerned about the price which may have to be paid.

Although there is a consensus that the development of new coalfields must form an integral part of the modernisation of the mining industry, and will provide an important source of employment for miners displaced from exhausted pits, fears have been expressed for a massive loss of agricultural output and the destruction of farming communities (Dodd, 1979). If coaling operations are to expand into new areas, and are to be accompanied by a new generation of giant "super pits", regard must be paid to existing rural land uses and not purely to energy considerations. In the light of the potential scale of agricultural impact, it is essential to seek answers to the following questions:

- how effective are the existing statutory controls and remedies in averting or mitigating agricultural impacts?
- are the contentions of serious disturbance to farming interests justified and, if so, to what extent are they unavoidable or irreversible? and,
- to what extent can techniques of environmental impact assessment assist in identifying, quantifying and evaluating the agricultural impacts of coal mining?

The Study Context

The degree of conflict between mining and agriculture depends in large part on whose estimates are to be believed. Forecasts - admittedly now seen as far too optimistic - made during the last decade indicated a need for an output of 170mta (some 40mta in excess of the 1973 figure) by the year 2000 (NCB, 1974; DEN, 1977). The low level of investment during the era of cheap oil, coupled with the progressive exhaustion of existing capacity, would have meant a major expansion to achieve these targets, entailing the construction of at least twenty new pits and a doubling of opencast output from its mid-1970s level of 10mta. In geographical terms, this would have resulted in new coalfields underlying some 1800 sq. km., whilst the amount of land needed for new collieries and associated landscaping could have totalled around 900 ha.. The focus of mining activity is thus likely to shift to areas previously unaffected by the industry (Spooner, 1981); moreover, there has been speculation that future large-scale mines could be accompanied by plants using novel processes of coal conversion, resulting in the creation of "coalplexes".

Other observers, however, are mindful of the fact that in some years substantial over-production of coal has occurred. The main reasons for this reversal of fortunes include economic recession, relatively slow depletion of North Sea hydrocarbons, declining demand from the steel industry (a major customer of the NCB), increasing competitiveness of coal imports, modest future prospects for use as a feedstock (in the short term, at least), the expensive and unreliable nature of coal for export, difficulties in securing agreement on mine closure, reductions in forecasts of coal burnt in power stations and improved output and productivity in existing pits. Indeed, it has been suggested that there is little or no chance of UK coal demand exceeding present levels in the next decade and that it may even fall. Prospective investment programmes in electricity generation appear to indicate steady increases in the proportion of all but coal-fired stations, although a small absolute increase in coal-fired capacity would transpire.

Since 1974 the forecasts for future coal demand have varied dramatically Table (1.1). The most pessimistic projection of 100mta by the turn of the century is clearly a far cry from Plan for Coal and, indeed, this source further predicts a reduction, at worst, to only 80mta by 2010. These reservations are confirmed by Manners (1984), who - reviewing the alternative energy sources and trends in energy conservation - considers that "...if the coal industry can hold on to a market of about 100 million tonnes throughout the 1990s it will be doing very well indeed". Clearly, the extent of land loss which was envisaged in the early 1970s now seems unlikely to transpire; nevertheless, this is not to deny the future possibility of agricultural impacts associated with the regional consolidation of existing investment, the extension of mining into sensitive and previously unaffected areas, and the development of intensive pithead coalplexes.

Date of forecast	Forecast Year					
	1985		1990		2000	
	range	mid-point	range	mid-point	range	mid-point
1974 (Plan for Coal)	125-150	138	-	-	-	-
1977 (Coal for the Future)	125-135	130	-	-	135-200	168
1977 (Energy Policy, 1978)	-	129.5	-	-	-	-
1979 (Energy Projections)	-	-	124-132	128	128-165	147
1979 (Energy Projections, revised)	-	-	105-126	116	110-159	135
1982 (Energy Projections)	-	-	105-131	118	100-140	120

Table 1.1. Alternative forecasts of total coal demand in the UK in 1985, 1990 and 2000 (units = million tonnes).

Indeed, the balance of opinion probably favours a cautiously expansionist view, and a number of reasons can be cited for a moderately optimistic outlook (Spooner, 1981; Flowers, 1981; Mann, 1981; Chadwick and Lindman, 1982). First, capacity of deep mines cannot be equated with their output, which will be affected by working conditions, labour productivity and so forth; thus, capacity must be allowed to exceed demand by some suitable margin. Second, natural gas reserves must run out some time and, if the UK premium gas market remains at its present level, approximately 100mta coal will be required to satisfy demand for substitute natural gas (SNG). Third, given the long lead times involved in mine planning and construction, over-capacity now may be the price to be paid for avoiding a future energy gap, especially if nuclear stations fail to meet their commissioning dates; a "minimum regret" strategy may lead us to secure investment in coal now despite the currently depressed state of the market. Fourth, productivity from modern pits far exceeds that from older ones, and the NCB will naturally desire to promote a more efficient industry; it has been estimated, for instance, that overall productivity at the new Selby field will be about 5.5 times higher than that of the industry as a whole and four times that for the most productive NCB area in the country (NCB, 1979b). Fifth, new techniques of power generation from coal represent some of the cleanest options available for future energy production; this must represent one of the industry's strongest cards, especially given the recent optimism over the potential for pressurised fluidised bed combustion. Finally, and perhaps most significantly, there is a strong regional linkage of output to markets so that even where the national case for mine development is weak, the local argument may be strong - over 68 per cent of coal consumed by power stations is burnt in or near the coalfield of origin. Nevertheless, even among the supporters of coal, there are many who believe that the arguments in favour of its development are not sufficient to justify major investment now, and that there is considerable scope for manoeuvre as to when the reserves are won. Timing of developments may be critical in terms of the introduction of novel technologies and improved restoration and reclamation techniques.

With regard to the agricultural industry, its protagonists rightly point to the remarkable increases in output which have been achieved since the 1947 Agriculture Act. The major post-war policy objectives of increased self-sufficiency have met with signal success, although there is now evidence of levelling off of agriculture's contribution to net national product (Piggott, 1980). Land losses are the best publicised constraint to future expansion and there is a vigorous commitment to the protection of agricultural land, particularly better quality land, and to improving information on the quantity and quality of land going out of production (HMSO, 1979). Post-war transfers of farmland to urban use have varied for 13-20 000 ha/yr (Best, 1976, 1977, 1984) - although in the depths of the current recession figures as low as 8 000 ha/yr have been recorded - and probable future losses (even with minimal population growth) will lie in the region of 10 000 ha/yr (Countryside Review Committee, 1980) to 13 000 ha/yr (Centre for Agricultural Strategy, 1976). Evidence on the quality of land lost is contradictory, but it has been claimed that 64 per cent of that lost between 1951 and 1971 was of good or medium quality (NFU, 1979).

A significant proportion of this is accounted for by mineral workings, which at present consume some 2 000 ha/yr (Tranter, 1976), and it is likely that by the year 2000 overall requirements for new mineral workings will exceed 0.3 per cent of the present agricultural area. Tomlinson (1980) indicates that the quality of land taken for opencast mining appears to be generally of MAFF Grade 3 or lower and, in some areas, is predominantly Grade 5, although in certain counties (Durham, for instance) there appears to be a trend towards the better quality 3a. Development also tends to engender "urban fringe" effects - trespass, stock worrying, vandalism, etc. - which Coleman (1977) considers may at least double the impacts of actual land loss; further, the threat of encroachment often produces a blighting effect and a consequent unwillingness to invest (MAFF, 1974; Blair, 1980). Weller (1979) also points to the related problems of farm severance and considers the extractive industry to be amongst the worst offenders in this respect.

The strong public and political support enjoyed by farmers has, however, tended to waver in recent years, and the defence of their interests at all costs started to be questioned. Critics have pointed out that many of the products most benefiting from intensification are in surplus within the EEC and that the strategic need for self-sufficiency could equally well be satisfied by a potential capacity to expand rather than actual output. Nevertheless, there is little point in allowing development to be needlessly destructive of the better grades of land. Moreover, agriculture is also an industry characterised by a high degree of local and regional linkage with regard to supplies of inputs and marketing of products. Consequently, it may be, as with coal, that regional priorities become more important considerations than national ones in any particular instance.

Thus, development may create a conflict of interest, for both agriculture and energy policies aim to maximise productivity and minimise reliance on imports (MAFF, 1979; DEu, 1978). Although "energy crises" may now have temporarily abated it is generally acknowledged that the era of cheap energy is over; in addition, intensifying international competition and the variability of world food yields make food shortages more likely in the future. It remains government policy to conserve farmland (DoE, 1976; SDD, 1977), and MAFF/DAFS will generally oppose land loss to minerals unless need and lack of alternative sources (under poorer quality land) can clearly be demonstrated. Despite the varying forecasts regarding the contribution of coal to the future energy budget, the Inspector at the "Vale of Belvoir" inquiry considered it more likely than not that new mine capacity would be required during the mid-1990s (Mann, 1981), a view subsequently endorsed at ministerial level (DoE, 1982). The optimistic coal demand forecasts are also accepted in the prevailing Green Paper on energy policy. At a more detailed level, both energy and agriculture policies seek to achieve a particular "product mix". Thus, applications for mining will be strengthened if the need for a specific grade of coal can be demonstrated. Similarly, it has been suggested that greatest benefit could be derived from expanding production of cereals, sheep meat and beet. Again, such considerations could lead to a focussing of problems at the regional scale.

The trend in the deep mining industry towards regional concentration, particularly in the expanding set of fields in the East Midlands and South Yorkshire, has already been noted. This shift from highland to lowland Britain has naturally affected better quality farmland (North and Spooner, 1978). Large reserves are also known to exist in areas of low geological disturbance, and so it is likely that mining will eventually spread into southern, central and eastern England (NCB, 1979a). In the past few years, further provings in the low-lying areas south of Selby have shown valuable reserves to exist at depths of 500-900m (although faulting is at times severe), and the Nottinghamshire field now appears to stretch almost as far as Lincoln, although rapid thinning and the proximity of water bearing strata limit the value of the easternmost portion. Exploration is currently extending to South Warwickshire to ascertain the extent of reserves worked from the Coventry colliery, and further significant prospects exist in Oxfordshire and under the North Sea (Harrad, 1977; Moses, 1979).

Some impression of the impact on farming of the present coal industry and future mining prospects may be obtained from considering their regional incidence (Figure 1.1). However, a note of caution should be sounded about the confidence to be placed in references to future prospects. In general, forward extraction programmes consider three classes of reserve (Moses, 1979). Class I includes those workable reserves for which the density of geological information is sufficient to give accurate guidance on variations in seam thickness, depth, gradients and other relevant factors; Class II includes reserves where there is a general level of uncertainty regarding the number, location and effect of local hazards; and Class III reserves are those where geological knowledge is insufficient to rule out unpredictable face-stopping hazards. Once "coal in place" has been established, the Board must proceed through the stages of preliminary exploration, intensive exploration, feasibility study, planning and, finally, development. This sequence is commonly referred to as the "ladder of exploration". The implication of this ladder for the present discussion is that by no means all the areas potentially subject to coaling operations should be treated as certainties.

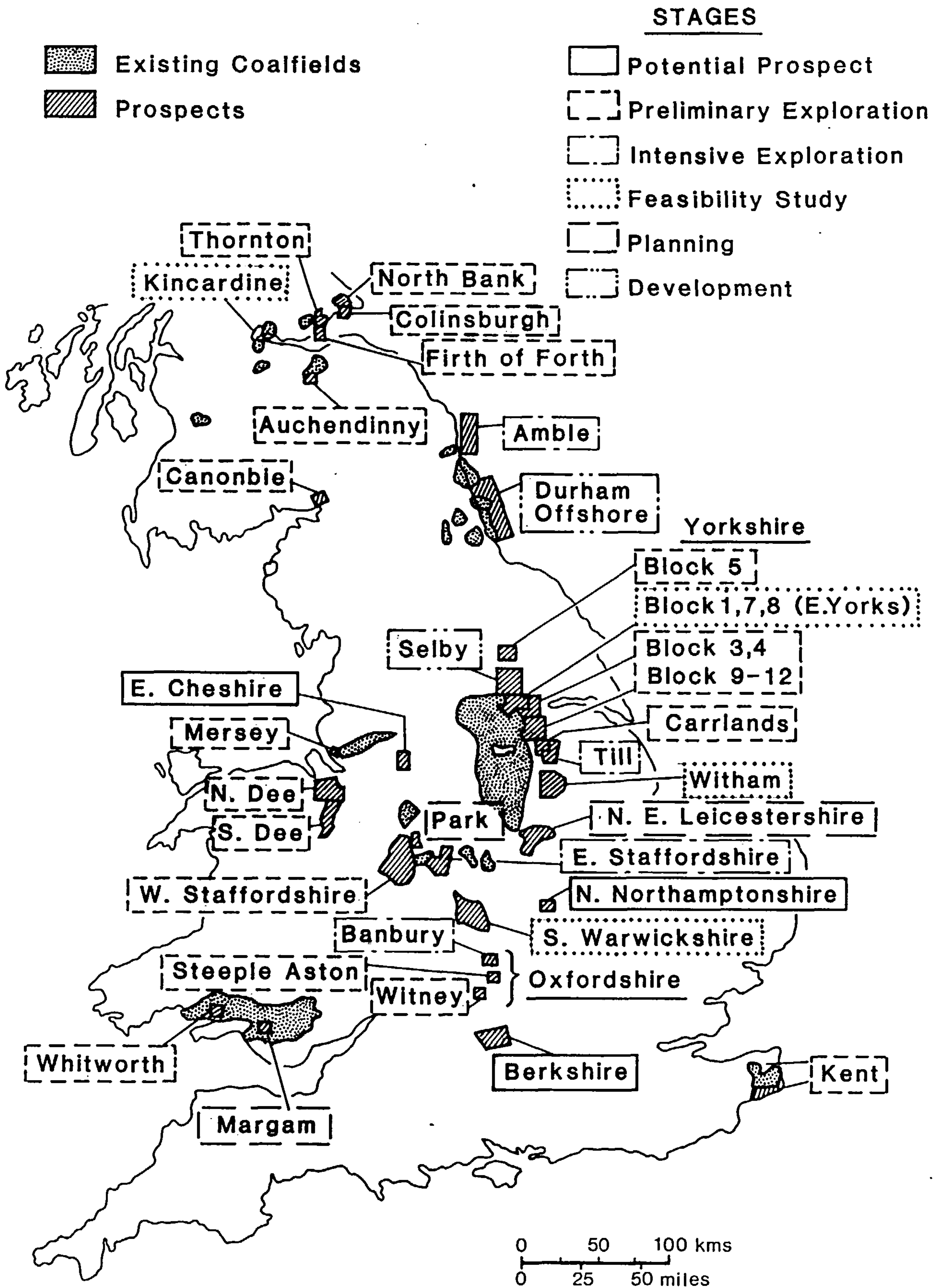


Figure 1.1. Future prospects for deep coal mining.
(Source: Flowers, 1981).

Existing deep mining operations have often avoided the better agricultural areas, although Lancashire and many parts of Yorkshire and the East Midlands are associated with good arable land, whilst the livestock enterprises of Staffordshire rank well above the national average in terms both of standard man days and stocking densities. In respect of those coalfields which are presently at the "planning" and "development" stages, the Selby field seems most likely to affect good arable land, whilst the Margam and North East Leicestershire fields are associated with prosperous dairy, beef and mixed enterprises. Fields at the stage of "intensive exploration" or "feasibility study" most strongly associated with good arable land appear to be those of East Yorkshire, Lincolnshire, South Warwickshire, Banbury and the Upper Forth Valley; looking into the more distant future, the prospects in Cheshire (with its renowned livestock farms) and Oxfordshire (which is fast intensifying its arable production), should they ever be seriously proposed for development, could prove the source of the most vigorous opposition yet.

No comparable programme exists in respect of opencast operations: NCBOE activities are only loosely orchestrated in relation to broad national production targets, whilst the selection of sites for private opencasting is even less predictable. This absence of an agreed framework militates against the preparation of a "programmatic" environmental assessment, which otherwise might have proved a useful direction for the present study, and a rational basis on which the NCBOE could make public their proposals. However, we may assume that opencast working is likely to be associated with many of the former coalfields (Figure 1.2). Although in some cases this will result in an improvement of previously undermined land, the areas which are susceptible to such improvement are becoming fewer. It has been reported that, already, operations are moving onto the better land in Durham, Fife and East Lothian, and this could increasingly become the case in the East Midlands, Yorkshire, Lancashire and Avon.

Sources and Methods

In developing a framework for the appraisal of agricultural impact, the most salient problem has been to identify as comprehensive a range of impacts as possible. One approach might have been to survey a single coalfield in detail to obtain field data on the extent of damage; however, this was rejected on three grounds. First, there is no coalfield

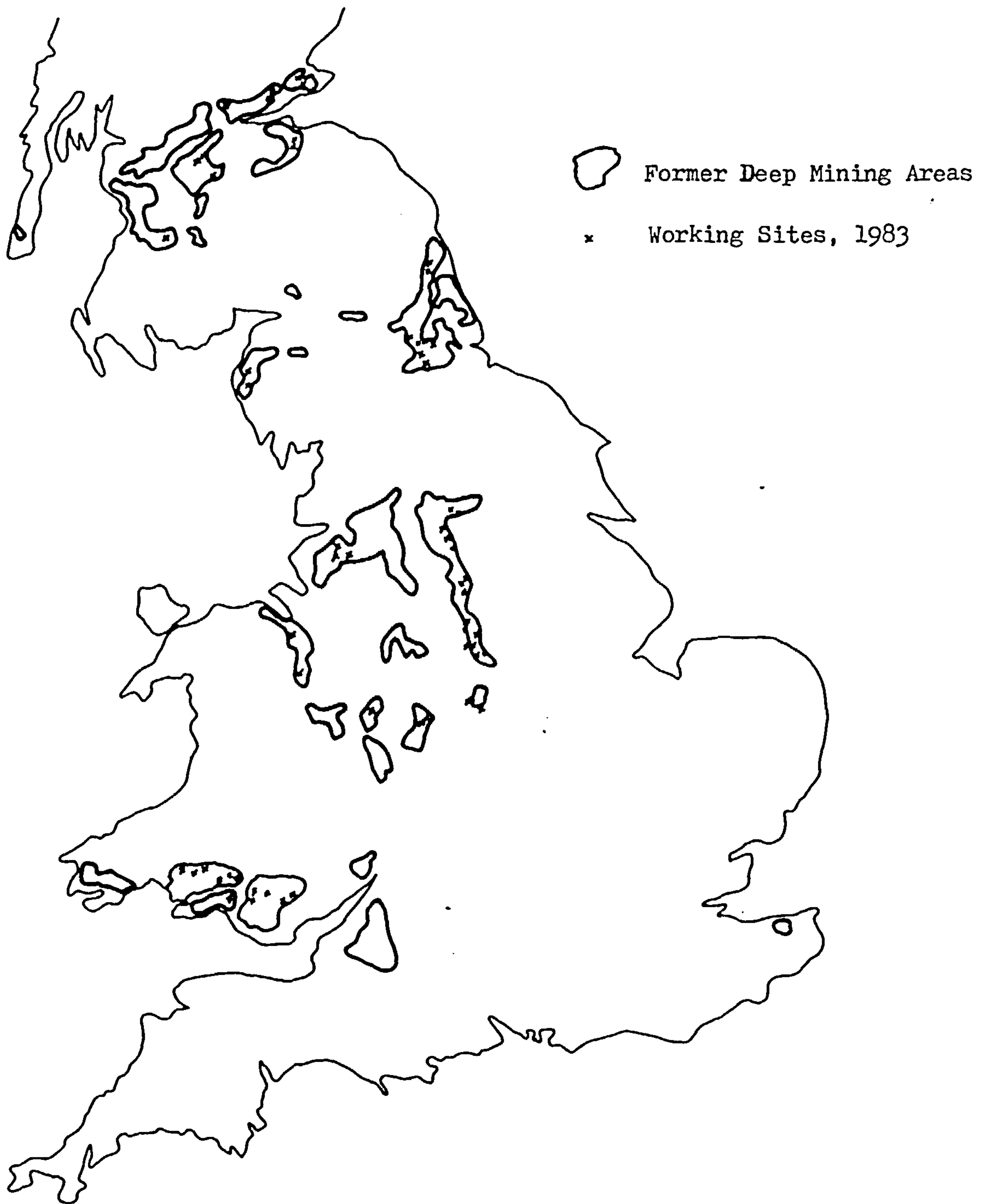


Figure 1.2. Former deep mining areas and working NCBOE sites.

on which adequate information on pre-existing conditions is available to enable the extent of physical and social disruption to be appraised accurately. Second, many of the records held by the NCB relating to claims for subsidence and other mining damage are of a confidential nature and could not be made available in detail for a particular coalfield. Third, and most importantly, there are so many differences between coalfields - as a result of different depths of strata, dates of restoration work, etc. - that a more wide-ranging investigation is justified. Moreover, a framework for environmental appraisal is likely to be concerned more with the probable range of impacts associated with a new proposal than with historical patterns.

Consequently, much of the evidence for this study has been drawn from a consideration of existing literature, supplemented by interviews with representatives of the farming and mining industries, and with planners involved in coalfield development. However, a closer look was taken at two coalfields, one long-established - the Upper Forth Valley - and one whose exploitation was currently proposed - the North East Leicestershire Prospect ("Vale of Belvoir"). In addition to interviews and ground survey, the former study drew upon planning applications, opencast authoriations and various other sources of data, and the latter made extensive use of public inquiry proofs and transcripts, and of forward planning documents. These investigations brought to light a number of site-specific factors and provided corroborative evidence of more generally observed impacts; additionally, they provided the information base for testing impact assessment methodologies.

It will be helpful at this stage to provide brief descriptions of these study areas. The mines in the Upper Forth Valley (Figure 1.3) produce coal predominantly of power station quality, the majority of it for use at the Longannet station. The pit at Kinneil (Bo'ness) has recently been closed, but new mines at Solsgirth and Castlebridge have been sunk (SDD, 1975), which in 1983 employed about 1 000 men and produced 13-14 000t of coal a week, whilst the Polmaise complex faces an uncertain future. The main measure currently being exploited is the Hirst seam, whose total reserves in the area have been estimated at 2 100mt; the most significant prospect is the extension of working this seam between Bo'ness and Larbert/Stenhousemuir (Central R.C., 1980a, 1980b). Much of Falkirk District is underlain by shallower deposits which have, in the past, been worked from pits, but where private opencasting is now extensive

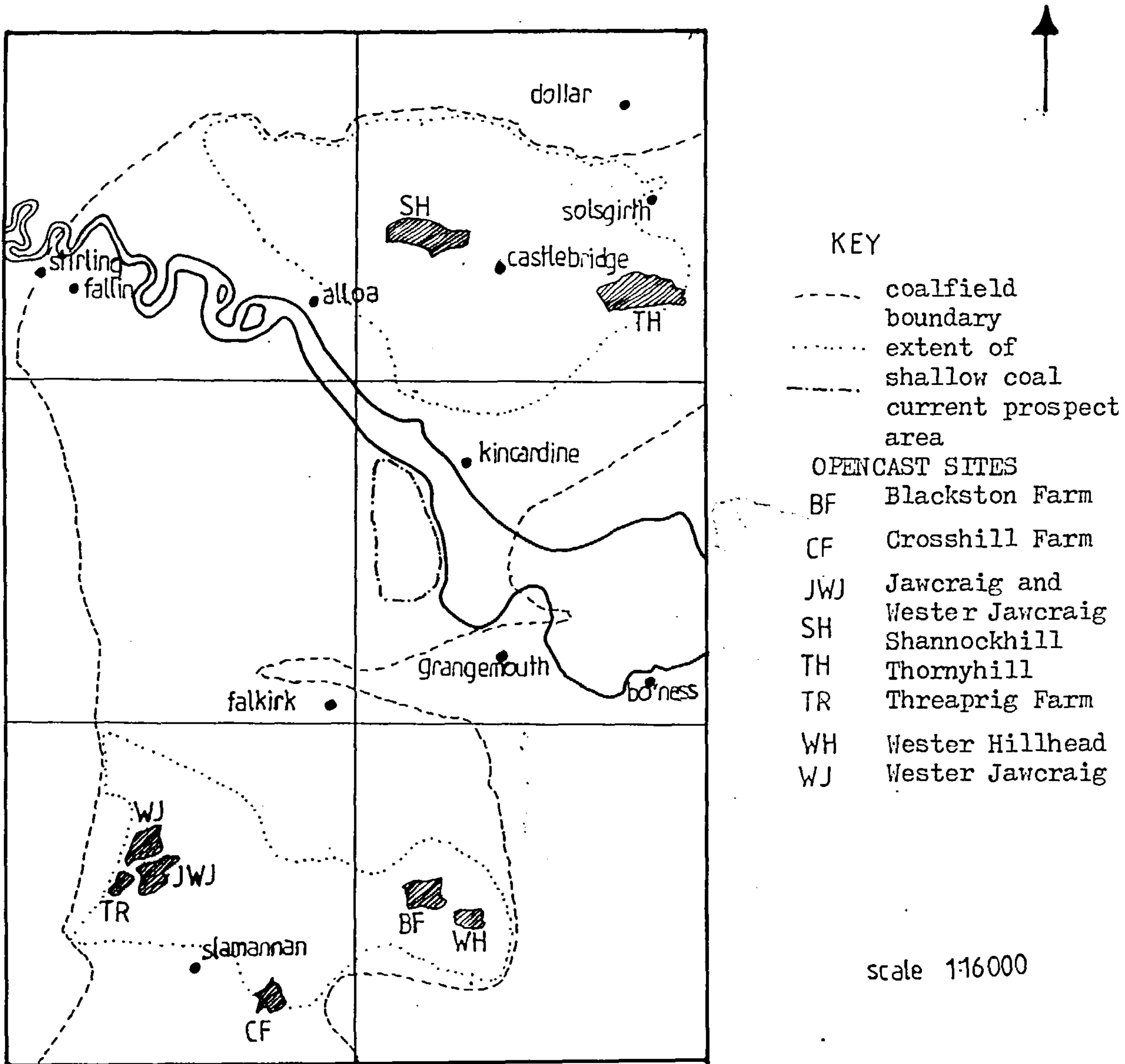
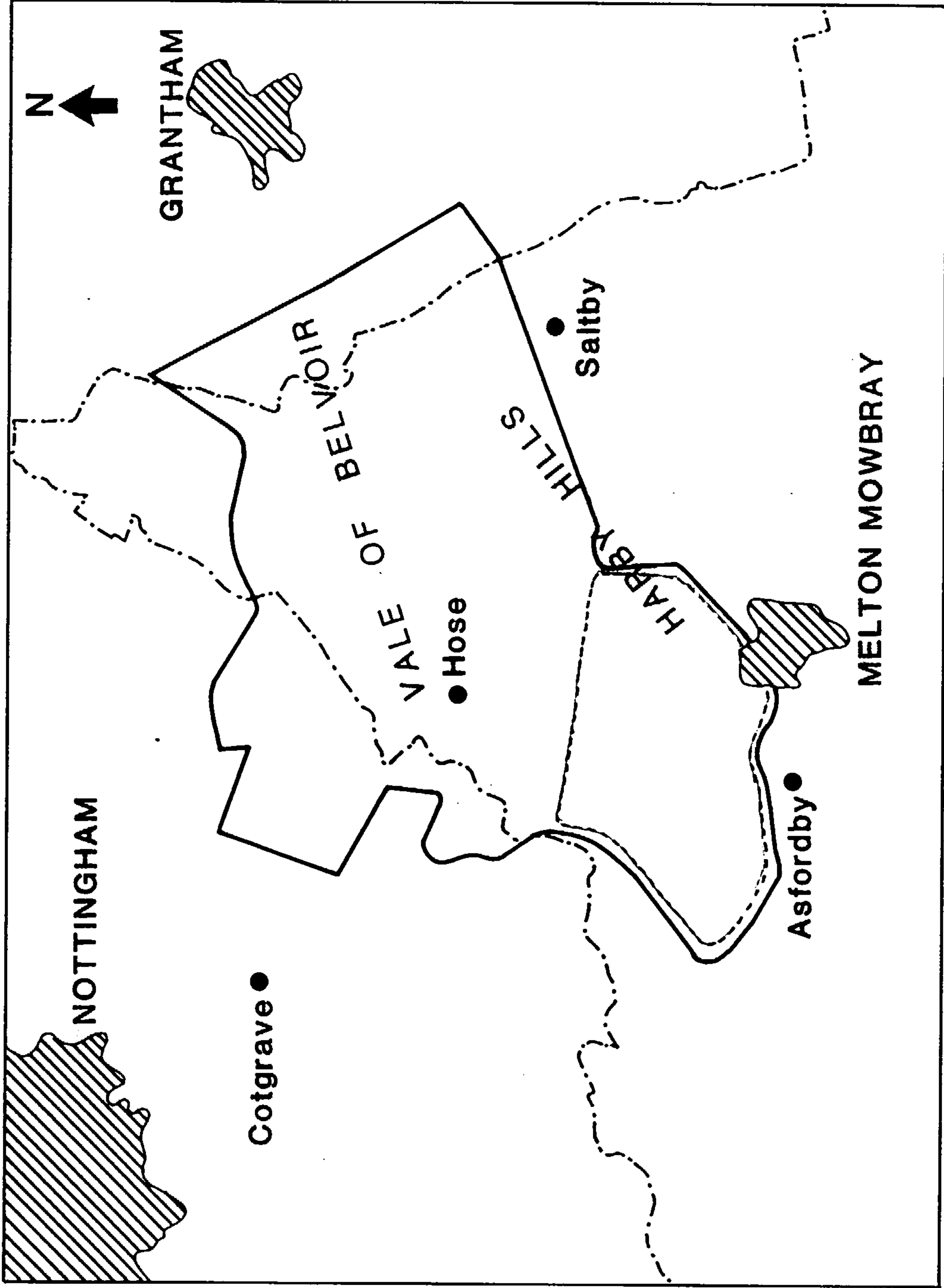


Figure 1.3. Upper Forth Valley study area.

(Falkirk, D.C., 1981). NCBOE operations have affected Clackmannan District and are currently proceeding on contiguous measures in Fife Region.

With regard to agriculture, 73 per cent of the 71 850ha in Central Region is devoted to rough grazing, 20 per cent to grass and 7 per cent to tillage (Agricultural Census, June 1981): this is the same proportion of rough grazing as in Scotland as a whole, there being more permanent grass and a slightly smaller proportion of arable land (Royal Scottish Geographical Society, 1978). Arable land is concentrated on the lower ground alongside the Forth; the hectarage of permanent grass (which has risen steadily) is nearly all grazed and makes a major contribution to livestock production, especially where rainfall is high, for instance on the Slamannan plateau (Matthews, 1974). It would appear that a relatively small area has been underdrained since 1949, although this probably reflects the extent of earlier systems which are still functioning satisfactorily; "secondary treatment" (moling and subsoiling) is relatively little practised in Scotland (Green, 1974, 1979).

Approximately 1 400mt of "coal in place" have been discovered under the Vale of Belvoir (Figure 1.4), of which 510mt appear to be workable. These reserves lie in five seams of variable thickness at depths of 450-850m with the geometric centre lying close to the Harby Hills escarpment some 2.5km ESE of Hose (Lewis, 1979). Despite some geological complications, the Vale proper has mild structures, although the area to the east is more complex. The output would appear to be most suitable for power stations, with the highest seam quality being in the central and southern regions of the coalfield. Potential annual saleable output would be in the order of 7mt, which the NCB believes could provide replacement capacity for pits likely to exhaust in the Midlands. Selection of mine sites had to take into account the number of mines required and their positioning; possible alternative sites were highly constrained by "geological factors" (access to good quality reserves), "travelling distance" and "ventilating requirements". Three options were reviewed for the extraction of coal, namely a single outlet, and two and three



— original prospect area
 - - - area workable from Asfordby
 - · - · county boundary

Figure 1.4. Vale of Belvoir study area.

outlets, the first two being ruled out on grounds of scale and operational complexity (Leonard and Partners, 1977).

In agricultural terms, the area divides between the lowland of the Vale itself (lias clay soils), where mixed farming units predominate, and the Jurassic uplands of north-east Leicestershire (an elevated plateau of limestone progressively overlain by boulder clay) where free-draining soils support a higher proportion of arable farms. Livestock and dairying enterprises have traditionally been important in the Vale and the latter have formed the basis for the production of Stilton cheese (Lewis, 1979). During the past thirty years, cereals have expanded at the expense of grass in the Vale (North and Spooner, 1978), but despite the reduction in permanent grass, the number of livestock has increased, notably cattle and pigs, which tend to be integrated within arable farming systems (Leonard and Partners, 1977).

In 1978 permission was sought to develop mines at Hose (3mta coal + 1.5mta spoil), Asfordby (2.2mta + 0.55mta) and Saltby (2mta + 0.67mta), and a public inquiry was called in 1979. The Inspector subsequently recommended approval for all three mines, but for the construction of a spoil tip at Asfordby only, the other two sites being considered incapable of absorbing such a structure into the landscape (Mann, 1981). The Secretary of State further refused permission to construct a mine at Hose and, quoting Circular 75/76 (DoE, 1976), ruled against tipping at Asfordby on agricultural grounds. He further stated that before local tipping at any of the sites could be contemplated the possibility of remote disposal of spoil should be explored in greater detail, as should the underground stowage of waste (DoE, 1982). An application to develop a mine and revised tip at Asfordby only, including a limited amount of local off-site waste disposal, was submitted (Anon, 1982) and, after formally delaying its determination, the Secretary of State resolved in the spring of 1983 not to intervene further, making approval by Leicestershire County Council a formality. It is also likely that revised proposals will shortly be submitted for a mine at Saltby.

The Asfordby pit will work coal from the Deep Mine, Parkgate and Blackshale seams underlying an area of 57 sq. km. which, from the point of view of subsidence risk, contains approximately 2 000 households. The output will be transported to existing coal-fired power stations in the Trent Valley, using merry-go-round trains along existing or re-instated lines.

Conclusion

It is thus proposed to examine the evidence of the impact of coal mining on agriculture with a view to advancing proposals for improved project and plan evaluation. In order to determine whether some formal method of environmental assessment is warranted, answers must be sought to the following questions:

- what is the current practice with regard to physical remedial measures, compensation for adverse effects, statutory control of operations and monitoring of impacts?,
- what deficiencies exist in current practice and how might these be remedied?
- what are the impacts on individual farm units and the sub-regional farm economy arising from deep and opencast mining?, and
- what are the most appropriate means of identifying, forecasting and evaluating the agricultural impacts of coal mining?

The starting point must be an examination of the relevant features of the mining and agricultural industries, followed by an assessment of current statutory provisions for regulation.

CHAPTER TWO

PROJECT CHARACTERISTICS

The Nature of Mining Operations

1. Deep Mining

In deep mining, seams are reached either by shafts or, where geological circumstances permit, drifts. The higher capital cost of the latter is offset by the advantages of having a continuous conveyor from coalface to surface, and by the much reduced visual intrusion of the winding gear. In the past, coal was generally removed by means of "room and pillar" extraction, a technique still widely used in the USA. Provided this took place at depths of 100m or more little subsidence was encountered, but irregular subsidence occurred near the edge of the pillars and, more especially, when pillars were robbed.

Nowadays, almost all underground coal in the UK is mined by the mechanised longwall method, in which the cutting machine passes along a face of 50-250m in length and automatically loads strips of coal onto the conveyor along which it travels. In a variant of this - longwall retreat mining - a face is established at the extremity of the developed area and retreated along the access roads to the start point. Whilst working is in progress, the roof immediately behind the face is supported by hydraulic chocks but, as the coal is stripped, these are advanced allowing the roof to collapse: this tends to produce a relatively uniform, controlled and predictable pattern of subsidence.

Whereas the means of winning coal underground may change, it is unlikely that methods will be adopted which remove the necessity of longwall faces (NCB, 1979b). There have been attempts to work panels of coal by extracting only narrow headings to reduce subsidence, but this leaves much coal unworked and it would be difficult to operate at depths in excess of 400m. The NCB also remain sceptical about backstowing of colliery waste, as it has only a relatively limited effect on reducing

subsidence and raises considerable safety and technical problems; some observers, however, see much greater potential. At its most efficient, backstowing results in 50 per cent reduction of lowering, but this appears only to be where seams are shallow.

The time taken for subsidence to occur is a function of the time taken for a face to be worked through the critical area (although there may be some 5 per cent residual lowering thereafter). At a typically moderate depth of, say, 500m the diameter of the critical area would be 700m and would require the working of three faces to extract all the coal. Thus, with a seam thickness of around 1.5m producing a maximum possible subsidence of 1.3m and assuming the three panels to be worked out in succession it may take 4-5 years for the critical area to be worked out and a maximum subsidence to occur. The vertical component of differential subsidence - "tilt" - has the most obvious effect on linear structures such as railways and drains.

A deep mine will be accompanied by a variety of pithead land uses: all are provided in the case of a "total" mine, but in the case of a "satellite" shaft only the minimum will be present. The major land using activities are the colliery itself, spoil tipping areas, stockpiles and service facilities, and these consume collectively some 70-120ha in the case of a modern 2-3 mta mine (Figure 2.1). Some pits in Yorkshire and elsewhere have recently been connected underground in a way which permits processing of coal and disposal of waste at a central location, eliminating the need for each pithead to make its own separate local provision.

The impact of solid waste disposal varies in proportion to the ratio of coal to waste, which ranges from 1.3:1 (South Yorkshire, South Nottinghamshire and South Wales) to 3.4:1 (Scotland). In total, about 55mta of spoil is currently produced each year, necessitating some 200ha of new land for tipping (Watt, 1979; NCB, 1979a). Spoil consists of clay and quartz minerals in the form of mudstones, siltstones and sandstones, together with carbonaceous matter and minor quantities

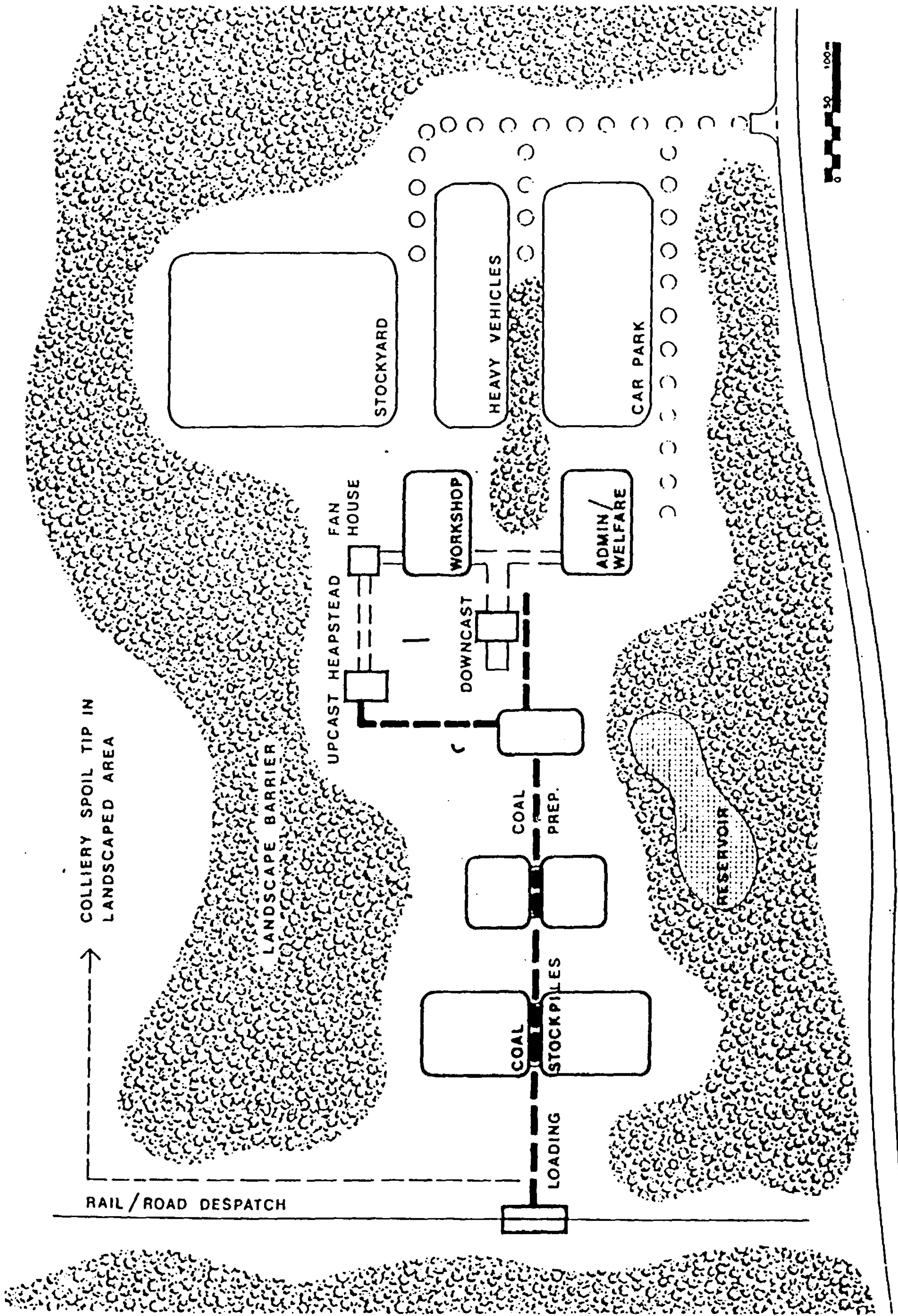


Figure 2.1. Typical zoning plan in modern coal mine (redrawn from Watt, 1979).

of minerals such as iron pyrite and ankerite. The quality of the material in heaps depends on the date of deposition; most notably, the introduction of mechanised methods of coal winning early in the 20th century led to an increase in the non-coal mineral content of the spoil (Table 2.1). The earliest heaps had such a high coal content that most have either been recovered for fuel in later years, or have burnt out, leaving little residue. As the non-coal mineral content of the spoils increased, burning occurred at very high temperatures and led to the formation of massive clinkers often weighing several thousand tonnes each. Later, in the period 1920-1950, the quantity of spoil increased to such an extent that heaps containing several million tonnes of spoil were deposited mechanically by free-fall onto high-rise heaps. The permeability of these heaps was high and the coal content sufficient to support slow combustion induced either accidentally, deliberately or spontaneously. The lower temperatures involved led to the production of "burnt" or "red" shale rather than clinkers. In recent years, spoil heaps have been formed using earth-moving plant which has permitted construction to exact contours and given the option of controlled compaction. The benefits of compaction include increased shear strength, increased density and reduced permeability. The effect of the latter is to eliminate the risk of spontaneous combustion, and of pyritic oxidation which can lead to acidic and ferruginous drainages. The last 30 years have seen considerable changes also in the composition of colliery spoils as a consequence of power-loading at the coal face and improved methods of coal preparation. The non-coal content of the run-of-mine has increased to an average of 35% and with few exceptions all minerals raised to the surface are passed through a coal preparation plant. The average moisture content of freshly produced spoil has increased, whilst the mean and maximum particle sizes have decreased considerably and the fines content has risen from 3% in 1950 to 20% in 1980 (Glover, 1984).

<u>YEAR</u>	<u>SPOIL DEPOSITED ON LAND</u>	<u>SALEABLE COAL PRODUCTION</u>
1900	1	225
1920	10	230
1930	12	240
1940	15	220
1950	15	210
1960	35	157
1970	55	140
1980	50	110

Table 2.1. Estimated quantities of spoil deposited on land as heaps and comparative coal production (units = millions of tonnes per annum) (Source, Glover, 1984).

Spoil tipping sites - "activity areas" are normally scheduled for periods of up to 50 years ahead and generally occupy some 20ha at any one time, assuming a programme of rolling restoration. Even where standards of restoration are high, their return to full productive capacity is unlikely to be attained in less than 25 years, to which must be added the initial 3-8 years whilst soil stripping and tipping activities are carried out. Although the impact of waste disposal can be reduced by careful tip design, there is a limit to which this approach may successfully be applied. At Asfordby, in Belvoir, for instance, it appeared that those designs which consumed the least land posed other serious problems; the slopes were too steep for farming, and would have had to have been afforested; they would not have lent themselves to extension beyond 50 years; and they could only have been constructed with considerably more land out of productive use at any one time. Further, if consent for tipping had only been granted for a limited period in the first instance, eventually more land would have been taken out of agricultural use, or land already restored would have been re-tipped.

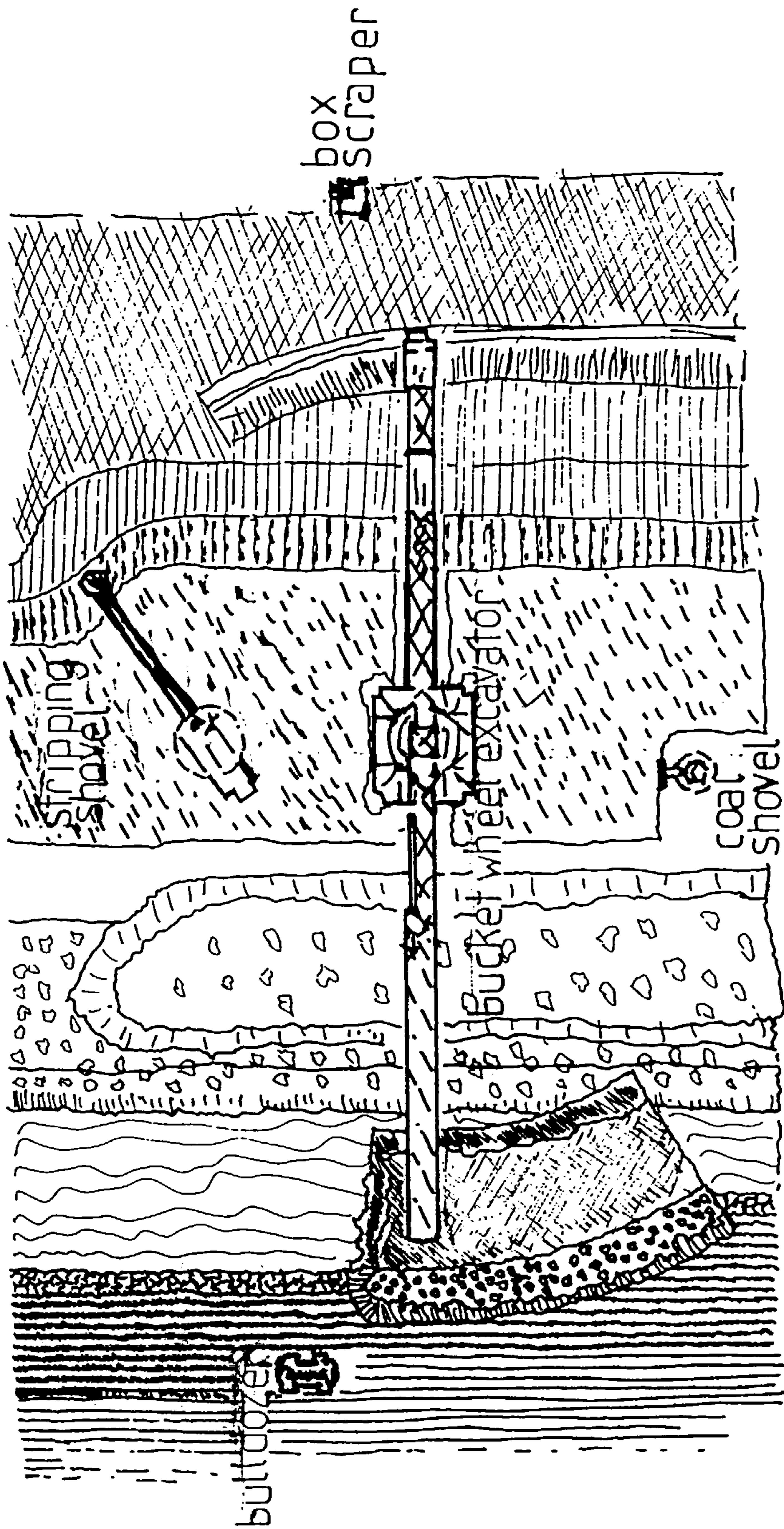
2. Opencast Mining

Opencast extraction has proved a commercially attractive supplement to deep mining, not only because of its relative cheapness but also because, in Britain at least, it often provides scarcer grades of coal such as anthracite and coking coal. Surface extraction has typically been by "area mining" (or "strip mining"), "open pit" mining or "contour" mining; the last method, despite being very destructive, still proves popular in hilly areas of the USA (Schlottman, 1977; Appalachian Regional Council, 1969). Only the first method is normally susceptible to agricultural restoration. Strip mining commonly proceeds at the seam's lowest elevation, from which cuts advance up the dip or slope of the coal, allowing water to drain away from the working areas; overburden is cast into the trench created by the preceding cut. As mining advances, a series of parallel cuts progresses along the mine and a ridge and furrow effect is often formed owing to the swell factor (Marshall, 1981).

In Britain, the accepted practice is to open an initial cut, usually along the outcrop; work then proceeds with successive parallel cuts, the overburden for each new cut being cast into the void of the previous completed cut (Figure 2.2). On completion of the coaling, the final void is filled and the whole site levelled by dozers and graders to precise contours (NCB, undated a). The typical life of an opencast site may vary from 18 months to 15 years.

Summary of Impacts

Whilst the major agricultural impact associated with coaling is that of land take, it is clear that this is by no means the only one. Subsidence associated with underground mining may, over a considerable area, damage farm buildings and land drains and may have adverse hydrologic effects. Settlement of opencast restorations may have a similar, albeit much reduced, impact. New road links or minehead developments may cause severance of farm units and complicate management or delay farm traffic; in some cases, however, improved roads may be of considerable benefit to farmers. Mine drainage may pollute rivers used for farm water supplies and this may be particularly serious where irrigation of sensitive crops is practised. In certain arid



REPLACEMENT COAL STRIPPING

Figure 2.2. Typical method of operation on an opencast coal site.

regions (especially in Australia and the USA) rural water supplies have been reduced by mining and related activities. Airborne emissions from coal-burning utilities, such as power stations, may also damage crops, although there is some evidence of reduced crop sensitivity over time.

There are also likely to be pervasive effects on social structures and the quality of life attendant on the introduction of a large, settled mining community, and the transformation of the rural landscape. Consultations by Leicestershire County Council with parish councils in Belvoir revealed the major areas of concern to include traffic flow, dust, noise, possible damage to rural and gated roads, the effect of tipping on property values, and subsidence.

Not all of these impacts are associated with both surface and deep mining, of course, although there are considerable areas of overlap. A summary of the major spheres of impact attributable to each is shown in Table 2.2.

Novel Extraction and Conversion Technologies

More distant technological developments for coal extraction and conversion are likely to create an additional range of impacts (ECE, 1979; ENDS, 1981; Joint Working Party, 1978; Flowers, 1981). In this respect, the NCB is assuming that increased demand for coal up to 2000 will result partly from increased energy requirements (54 per cent of projected increase) and from conversion for substitute natural gas (34 per cent), distillate oil (3 per cent) and residual fuel oil (9 per cent).

With regard to land use requirements for coalplexes or novel conversion technologies, Messer et al. (1977) note that project design could involve: a coal mining area; a coal preparation plant for crushing, washing, grinding, and/or drying of coal for refining; a steam-electric power generation unit; ash storage areas; gasification and liquefaction plants; synthetic gas and liquid fuel storage tanks; roadway and ancillary

IMPACT

OPENCAST

DEEP MINING

land loss (permanent)
to site installations

absent: all site buildings should
be removed

substantial infrastructure required:
site potentially reclaimable and
planning consents may stipulate
eventual removal of site buildings;
however, loss is very long term
(possibly 100yr. +)

land loss to excavation

should be temporary in the case
of strip mining, although there
may be some permanent
deterioration in productivity
in the case of previously
undisturbed, high quality farm
land; contour mining generally
unreclaimable

not applicable

land loss to tips

should be reclaimed, but generally
takes 20 years + to regain former
productivity; permanent deterioration
in land quality likely on sections of
restoration as a result of steep
slopes, drainage and leaching of chlorides

not applicable

subsidence

may be severe, especially in shallow
workings and areas of marginal drainage;
damage to farm buildings, water/gas
supply, wells and springs, and surface
and in-field drains; remedial measures
possible, but ineffective during period
of undermining

not applicable

Table 2.2. Continued over.

Table 2.2. continued

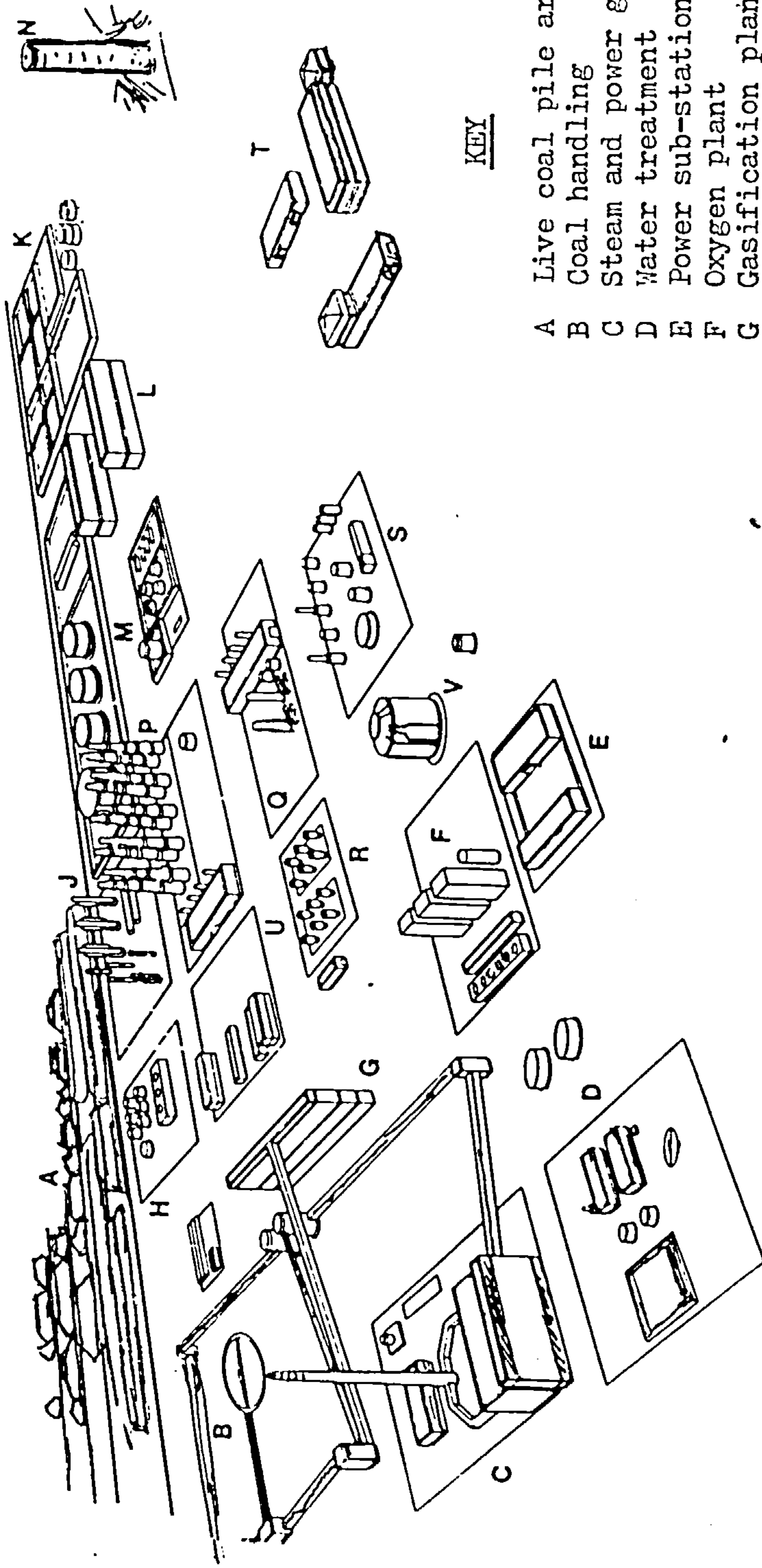
<u>IMPACT</u>	<u>OPENCAST</u>	<u>DEEP MINING</u>
settlement	temporary (generally less than five years) problems due to lack of consolidation - thus delaying final installation of drainage	not applicable
water pollution	drainage waters, high in ferruginous salts or suspended solids may affect adjacent farm water supplies; should be effectively controlled by treatment plant	potential pollution of water supplies by acid mine drainage, or tip runoff and throughflow carrying large quantities of suspended solids and (with certain measures) chlorides; may necessitate expensive treatment facilities
water appropriation	open pit acts as large well, drawing water from adjacent aquifers	in shallow measures, pumping may locally depress water table
damage to soils	topsoils and subsoils may become mixed with each other or with deleterious site materials during handling or whilst in dump; soils stored for long periods tend to lose structure and organic matter	as for opencast
noise, dust	operational noise, and dust blow during dry weather, may cause disamenity	as for opencast, but may be higher noise levels (especially with shaft sinking and tip construction traffic) which may affect productivity of livestock
severance	mining operations and access roads/rails may sever farm units	as for opencast
socio-economic	local agricultural labour "poached"	as for opencast, but effects may continue throughout period of mine

Table 2.2. Major agricultural impacts of opencast and deep mining.

housing areas; electricity transmission lines (if power is generated on site); water intake and discharge structures; and cooling towers. In addition, a variety of fuel and solid waste handling facilities are likely to be required, which may include conveyors, pipelines or barge/railway terminals. In total, as much as 1 600ha could be needed.

Coal gasification relies on the carbon of the coal combining with steam at high temperature and pressure to form methane, the purified end product being substitute natural gas (SNG). The process is likely to entail air pollution - mainly SO_2 , the amount varying according to the technique used -, a limited amount of water pollution, noise from transport media, and large quantities of solid waste resulting from ashes and the residues of compounds used to remove sulphur. A typical plant might extend to 80-120ha (i.e. similar to a conventional coal-fired power station with cooling towers), and would be constrained in its siting by the need for access to large quantities of coal and of cooling water, and the availability of disposal facilities for solid waste. Safety considerations might also warrant a 1km safeguarded zone around the plant. The possible appearance of a SNG plant is illustrated in Figure 2.3.

A particular virtue of burning SNG rather than burning coal itself is that SNG is much cleaner at the point of combustion; sulphur, particulates and smoke are not emitted and no ash is created. The problems of sulphur control and ash disposal are effectively transferred from the point of combustion to the conversion plant, and those problems can be far more easily dealt with at a centralised conversion plant than at a multiplicity of points of individual coal burn (Flowers, 1981). However, such considerations do reinforce the critical nature of initial site selection, and the need for rigorous means of project appraisal to be undertaken.



KEY

- A Live coal pile area
- B Coal handling
- C Steam and power generation
- D Water treatment
- E Power sub-station
- F Oxygen plant
- G Gasification plant
- H Gas-liquor separation area
- J Phenol separation and ammonia recovery
- K Waste water treatment
- L Cooling tower area
- M By-product and storage tanks
- N Flare stack
- P Acid gas removal plant
- Q Product gas drying and compression
- R Gas conversion and methanation
- S Sulphur recovery
- T Administration, control room
- U Gas cooling area
- V Oxygen storage

Figure 2.3. Possible layout of a substitute natural gas plant.
 (Source: Flowers, 1981).

coal liquefaction, which at present appears unpromisingly expensive, is likely to create air pollution (NO_x , CO, particulates and hydrocarbons) and solid wastes, but sulphur recovery is high and pollution problems are limited; total land use for producing an amount of crude oil sufficient to generate 1GW is likely to be about 3.2 sq km (although some authorities suggest a much lower figure), and some 120 l sec^{-1} of process water would be discharged. In situ extraction of coal entails injection of solvents into the coal seam, pumping the fluid produced to a processing plant, recovery of solvents and desulphurisation. Little reliable information exists regarding impacts, although uncontrolled subsidence would be likely and considerable safety measures would be required to avoid leakage of solvents.

The British Gas Corporation foresees that SNG will be needed from the mid-1990s onwards - unless, presumably, it is allowed to purchase supplies from the Norwegian sector - and considers that the adverse environmental effects of this process would be considerably less than for any other coal conversion method. It is estimated that SO_2 emissions could increase by 6 per cent on 1978/79 levels from all fuel sources, about half of which would be from chimneys taller than 27m. This could be cut to half if fluidised bed technology were introduced.

Physical Control of Impacts

In accordance with the "polluter pays" principle, it may be anticipated that the developer should absorb the cost of rectifying or preventing environmental damage. A variety of physical remedial measures is now practised, and it must be acknowledged that NCB can boast some of the best examples of restoration of any mineral operator, whilst in some areas of shallow abandoned mines re-working by opencast has led to considerable improvement in land quality. Despite the best efforts of the NCB, however, such measures can only go a limited way towards allaying the fears of the affected farmer. Although much expertise now exists, many physical problems prove intractable to rectify.

1. Control of Pedological Impacts: Reclamation of Solid Waste

The principal means of mitigating spoil disposal impacts is by restoration. Colliery spoil itself is not a good medium for growth, and abandoned sites for which no after-care conditions exist can thus present major problems of agricultural re-use. With coverings of less than 150mm over colliery shale, the resultant pasture is normally placed in the lowest MAFF category (Grade 5). A mature shale-soil profile is dense in all horizons, suffers severe waterlogging and has little capacity to withstand drought. Pasture on this soil tends to form a dense mat, which is not conducive to the growth of good grasses (Rimmer, 1982; Arnold et al., 1984). Covering with soil to 150mm depth or more allows the land to qualify for Grade 4 or, under the most favourable circumstances, up to Grade 3b. If arable use is to be achieved, however, the minimum covers of 150mm topsoil and 500mm subsoil are necessary, but a total cover of about 1m would be preferable as installation of a land drainage system becomes possible (Doubleday, 1984).

Thus, where there is adequate topsoil for replacement and the tip below is reasonably compacted to prevent over-rapid drainage (and, in the case of unburnt shales, to preclude spontaneous combustion), good husbandry is capable of producing successful results. A minority of spoils have a relatively high sulphur or salt content and where these cannot be buried beneath a sufficiently deep layer of topsoil, special care is required in the neutralisation of acidity (NCB, 1979b). On colliery spoil, pyritic oxidation may cause excessively low pH values (as low as 1.2-1.4), and this in turn may lead to phytotoxic levels of aluminium and some other heavy metals. Nitrogen, phosphate and even potassium deficiency can also occur.

Most reclamation programmes have so far been concerned with old tips; in the case of the most recently initiated tips, a carefully phased soil storage and restitution programme is practicable. Planning of soil movement should preferably commence with a detailed soil survey to identify the characteristics of the existing soil; particular programmes of pre-stripping cultivation have also been advocated (Worthington, 1979).

If it is necessary to supplement the restored site with soil from elsewhere (which NCB will very occasionally consider) great care must be taken to ensure its compatibility with existing site soils. Where conditions are suitable, an activity area should ideally be tipped in phases and restoration of each phase commence immediately it has reached its agreed contours, permitting a scheme of "progressive restoration" to take place. Double handling of the soil and storage in dump can thus almost be eliminated by direct transfer of soil which is presently growing crops to the area of reinstatement and immediately reseeding it to grass. (However, this implies storing in dump the first cut for up to 75 years and an alternative use for this material may be preferable). Minimal short term losses may be achieved by keeping the land actually stripped for tipping to a bare minimum, although this may limit the flexibility of operations. However, if only a 12 months' supply of land is taken at any one time, stripping of the next year's take and restoration of the equivalent area completed during the past year must proceed virtually at a given date regardless of the suitability of soil and weather conditions. However, phasing on an annual basis often simplifies management for the farmer, as he can assess with greater certainty the areas and timing involved.

Prior to reinstatement the tip surface is prepared by creating an impermeable surface layer of dirt and ripping with a subsoiler, and by providing continuous slopes to encourage run-off. The topsoil is then laid, again with ripping, and field boundaries, water supplies and drainage systems are re-established in due course. Model rotations are recommended for the period of restoration: land is usually grassed, especially on the heavier soils and in areas of high rainfall; in low rainfall areas and on lighter soils a course of arable rotations and cereal cropping is practised. Comparatively little experience has been gained of this complex sequence of operations and there are still many difficulties which can arise. The main ingredients for a successful restoration are, as much as anything else, skill, enthusiasm and the selection of the right tenants. It was probably considerations such as

these which led the NCB's agricultural adviser at the Belvoir Inquiry to recommend the appointment of a full-time restoration officer for the scheme - advice which the Board appeared to accept.

A number of alternatives to tipping have been proposed. These include: backstowing, in respect of which it has been argued that "...the NCB should accord...a far higher priority in its research than hitherto" (Flowers, 1981); leaving dirt in the coal, which is considered unacceptable and would create serious pollution; local land restoration, which would only be feasible in areas where suitable abandoned excavations existed; remote disposal, possibly associated with foreshore or derelict land reclamation, which has high transport costs; marine disposal, which is increasingly felt to be unacceptable; and commercial use, such as that promoted by the Board's Minestone Executive (NCB, undated, d), but for which only a limited market exists. Where tips are used, these must normally occupy relatively good land, since the poorer grades tend to be associated with engineering constraints.

2. Control of Pedological Impacts: Restoration of Opencast Sites

Provisions for the restoration of opencast land have greatly improved since 1941, when such operations first began. Fisher (1976, 1982) notes that early authorisations tended simply to require a "return to agriculture", but with a reluctant industry and little understanding of soil requirements the end result was often a low grade or neglected pasture. Detailed restoration conditions are now imposed, but there is a limit to what can be achieved by a "specification", and there is a point where knowledge and willingness of the operator take over as the most important factors. Procedures for stripping, storing and restoring soils are well-established: stripping of topsoil under dry conditions, its removal to dumps which serve a secondary purpose as visual or acoustic screens, the separate stripping and storage of different soil layers and "soil forming materials", and the eventual respreading and "rooting" of the soils are standard elements (NCB, undated a; Harley, 1975; Craig, 1979; NFU, 1980; Tomlinson, 1980). Contouring should ensure free drainage and any ponding which does occur through local settlement

should quickly be rectified, as far as possible, by stripping and regrading. Ripping of soils also takes place to ensure removal of stones and foreign materials (although these often cause an enduring problem). Once topsoiling has been completed and re-instatement of fixed equipment has taken place, a five-year period of after-care commences under the supervision of MAFF/DAFS at the expense of the NCBOE; particular cultivation and grazing regimes are recommended (NCB, undated a; MAFF, 1978).

Some studies suggest, however, that appropriate levels of skill may not persist during the post-release phase (CoEnCo, 1980) and doubts have been raised as to whether the overall record of restoration can be considered satisfactory in terms of damage to soil structure (NFU, 1979). A farmer taking over restored land will be restricted to a limited range of crops and will need to apply more fertiliser and, if put down to grass, heavier seed rates than normal. The variety of crops which can viably be grown is limited to hay, silage and cereals. Root crops generally have not been successful and where they have been grown satisfactorily, there have been difficulties at harvest time especially in the wetter seasons; potatoes have been notably unsuccessful (MAFF, 1978).

NCBOE are constantly experimenting with improved methods of restoration, particularly with regard to land drainage, compaction, grass yield, site documentation, stripping and separate storage of organic matter, aeration of soils in dump, and the re-establishment of agricultural landscapes (Stewart, 1982). Where loess soils are present a poldering technique may be employed, and this has been extensively employed in continental Europe (Peretti, 1976); loess soils conventionally reclaimed may be particularly vulnerable to siltation and erosion (Knabe, 1964). In the Rhenish lignite basin, the Rheinbraun company retains reclaimed farmland for an interim five year period; the fieldwork is conducted by trained personnel working from centrally located company farms to ensure uniform methods of management, and these farms also perform an experimental role.

Three options exist for land management during the after-care period. In increasing order of desirability these are: farming by contract, in which the operator specifies the type of husbandry, but leaves the work in the hands of a contractor, who may have little interest in the long-term aims of after care; direct farming, in which the operator makes capital investment in machinery and buildings, but must manage a fragmented operation from a central headquarters, often unknowledgeable about local conditions; and farm partnership, in which the company enters into an agreement with the farmer, on a profit-sharing basis, and puts in an annual sum for the purchase of seeds, fertilisers, etc., with the only real disadvantage being that the farmer may tend to treat profits as the major motivating factor (Craven, 1983).

Restorations do not always run smoothly and, even where they do, there still tend to be a number of unresolved problems. Soil compaction caused by heavy wheeled vehicles during filling and levelling, inadequate drainage, nitrogen deficiency, soil acidity, reluctant extractive industries, inadequate control by planning authorities and sheer ignorance are the principal defects. On small sites, over-tight definition of the working area by well-intentioned planners may render progressive restoration impractical. Analysis of development control files for private opencast sites in the Upper Forth Valley revealed a wide range of site malpractices, the most common being soil stripping and re-instatement under wet conditions and mixing of topsoil and subsoil in dump, although several others arose, including disruption of land drains, inadequate control over the depth of stripping, pollution of adjacent watercourses, excavation outside the site boundary, slow progress of restoration work, unsatisfactory backfilling, deficient re-instatement of drainage, weed invasion and lack of fencing.

In the early days of opencasting, the limited depth of working resulted in a slight lowering of levels but, with increasing economic dig ratios, the greater depths of excavation are giving rise to increased bulking so that sites are being restored with a slight raising of levels. The

final amount of settlement is a function of the type of overburden, method of backfilling and time taken for groundwater levels to become established, and normally lasts 3-5 years. Drainage problems may arise due to insufficient consolidation of overburden at depth beneath the subsoil, with excessive voids left during replacement causing settlement and slippage, perhaps many years later. In one instance, CoEnCo (1980) reported that settlement had tilted the tile drain system away from its outlet, so that the discharge waterlogged a large area in the centre of the field. MAFF (1978) have pointed to further problems which can occur during the after-care phase. These include: poaching by livestock or damage to the soil structure by ill-timed cultivations; serious erosion problems (a close watch on ditches for signs of scouring can help alert the restoration team to early remedial action); ill-sited and poorly maintained watering points, where leakage could cause damage to soil structure; deep ploughing in the course of cultivations, which may bring up quantities of poorly structured subsoil; problems of stock enclosure on common land; and difficulties of the farmer adjusting to what may need to be a substantially modified enterprise.

Even where early successes in restoration have been achieved, it has been noted that there is frequently a loss of productivity after 5 or 6 years despite regular ameliorative treatment. This is apparently due to compaction and acidification. In West Yorkshire, a certain measure of success has been achieved by recultivating the sites at this stage and incorporating green manure and lime (Simmons, 1984).

3. Control of Subsidence Impacts

Measures employed to reduce subsidence tend either to be rather costly in terms of the coal foregone, or to cause severe technical complications. The most common methods include sterilising complete pillars of coal, harmonic and semi-harmonic mining, and systematic partial extraction, but such approaches could normally only be justified in built-up and heavily industrialised zones (NCB, undated c; Joint Working Party, 1978).

In farming areas it is more likely that remedial measures will take the form of realigning drainage systems or modifying building design, although pillars of support may be appropriate in a few cases. The horizontal component of subsidence - "strain" - accounts for most of the damage to surface structures, and this damage may be reduced by limiting the size of individual buildings and by constructing them as flexibly as possible. With regard to services, the various statutory undertakers will have their own arrangements with the NCB but there will also be many private water and sewage installations serving farms, estates and private properties which need to be identified (Malkin, 1979); here, precautionary measures should include the use on non-brittle materials, avoidance of embedding concrete, provision of clearances where the services enter buildings and, in the case of gravity systems, the provision of adequate falls.

The effects of subsidence on main rivers is largely a function of topography. Thus, if a river flows in a defined valley with a good gradient, subsidence may have little effect and the relative levels of river and land can usually be restored by channel alignment and re-grading. However, river beds may well be flattened by subsidence and this will increase their liability to flooding and siltation. In the case of land drains, any decreases of fall affecting a lateral or main drain may reduce the effectiveness of the system (Miers, 1979) so that extensive re-grading of main rivers, intermediate drainage channels and internal drainage systems, or the provision of electric pumps may prove necessary. Certain problems may arise in the implementation of such remedial measures, including delays in re-grading due to continuing subsidence, inadequate repairs to damaged buildings, and the persistence of wet and cold patches due to a raised water table (NFU, 1979).

A more extreme approach to subsidence control is underground stowage of waste, which has been fairly widely practised in parts of continental Europe, but which remains highly unpopular with the NCB largely, one suspects, because it would cause a major reappraisal of longwall extraction

methods. However, in the longer term it may have to be taken more seriously. It has been argued that, since some 60 per cent of the dirt required to be stowed would be transported back down the shaft again from the coal processing plant there would need to be a considerable reorganisation and expansion of transport methods and shaft facilities. Any breakdown of transport or stowing machinery would inevitably hinder coal production and the drivage of roadways. Moreover, considerable amounts of land would have to be lost to the surface treatment plant for the mine waste and, in turn, the tailings produced from this, which could not be placed underground, would create aggravated disposal problems, there being no coarse shale tips in which at least a proportion of them could be layered.

A major problem would be to keep the area from which the coal had been extracted open for as long as possible in order to retain a void into which to spray the dirt, and therefore create a much longer open coal face with increased roof stability. There would also be a danger from the use of high pressure compressed air, and pneumatic stowing could generally increase health and safety risks to underground workers, particularly from dust and noise levels. Finally, it is not possible to stow dirt and operate coal mining machinery simultaneously, thus requiring a greater number of coal faces, all of which have to be serviced to the same level, but for a shorter period of productive use (Joint Working Party, 1978; Department of Environment, 1983b). Nevertheless, there could be corresponding advantages in subsidence and face control, and favourable experience has been reported from various continental schemes.

4. Control of Pollution Impacts

The viability of agricultural operations may be adversely affected by changes in ambient environmental quality. Reductions in the purity of air or water may lead either directly or indirectly to crop damage or a deterioration of the suitability of the area for processing certain types of agricultural produce, whilst the off-site uses of fossil fuels may cause atmospheric pollution of international dimensions. Other contaminants, including noise, may affect the health or placidity of livestock and may, of course, reduce the quality of life of the farming community.

Tipping operations should seek to reduce dust nuisance by keeping to a minimum the amount of dirt exposed to prevailing winds in the dry seasons of the year, and should aim to provide an earthwork screen at the edge of the proposed activity area early in the operations, grassed and tree-planted where possible. Retreat systems of tipping, which facilitate seeding at an early stage, also help control dust, and partial conveying of waste away from areas where the use of heavy earth-moving vehicles may create dust or noise nuisance may be practised. Surfacing roads, mechanical sweeping of open surfaces, enclosure of conveyors and transfer points, fencing or tree planting, and spraying soil due for stripping by water bowsers, all help reduce dust and grit nuisance.

Contamination of underground waters by iron compounds due to the oxidation of iron pyrite cannot be prevented so long as the pyrite remains exposed to the atmospheric oxygen: flooding of mines is widely practised after abandonment, but control is more difficult during operation. Removal of suspended particles may be effected by chemical means, whilst saline waters may be treated, at considerable expense, in specially constructed plants prior to discharge. The latter practice is rare, however, and direct discharge into a river sufficiently large to provide adequate dilution is more typical.

Discharges from colliery premises and coal stocks may require sedimentation, and some coals produce acidic and ferruginous run-off after prolonged storage, although as far as possible such coals are not stockpiled. High chloride levels are associated with some colliery shales: although these have normally been leached out prior to restoration in the past, modern methods of "rolling restoration" will mean that high levels will persist in newly restored tips for the first decade or so. The implications of this are currently unclear.

Noise may be associated with construction of the plant, operation of mining activities, traffic to the mine site, and local tipping of wastes;

in opencast, machines, vehicles and blasting are the main offenders, and these may be difficult to control, owing to the use of sub-contractors. Reductions in noise nuisance may be attained by silencing vehicles, cladding machinery, controlling the hours of operation and construction, erecting acoustic screens and locating activity areas at least half a kilometre away from settlements.

Conclusion

Coal mining gives rise to an extensive range of impacts, which vary from being substantially reversible or reducible to being enduring and inescapable. This range differs according to the type of mining technology used, the age of the workings and the geological characteristics of the area. As methods of extraction change, and as the number of potential end-use and conversion processes increase, so the variety of environmental effects will broaden. It is understandable that many of those living in areas selected for coalfield development fear lest the problems of the past are repeated and have misgivings about the consequences of future mining activities. In theory, modern planning and environmental controls should be sufficient to allay these doubts. Whether this belief is justified is explored in the next chapter.

CHAPTER THREE

CONTROL OF MINING OPERATIONS

Introduction

Virtually all coal mining activity in Britain is subject to some kind of environmental control. Much of this is extremely stringent, but there are respects in which the provisions for both opencast and underground extraction, and the procedures for public inquiries, are open to question. Some observers maintain that more could be learned from the strip-mining controls now employed in the USA, some advocate a more thorough appraisal of strategic and cumulative effects, whilst others believe application of some kind of EIA to be necessary. These views tend to be complementary, especially in terms of the identification, monitoring and remedy of developmental impacts.

The introduction of EIA would raise many problems of design and effective implementation. There is so far no consensus over the most acceptable format; there is little agreement on the predictive techniques to be used or even, in many instances, the purpose for which forecasts are to be prepared; plan, as opposed to project, assessment is virtually without precedent and yet would be essential where issues of strategic importance are to be raised; and there has been surprisingly little attempt to gather information on the generic agricultural impacts associated with mining, most previous studies having emphasised amenity and visual aspects. Before the case for more thorough and systematic appraisal of mining proposals can be established, however, it is first necessary to consider whether there are genuine shortcomings in extant procedures.

Statutory Provisions for Site Development - Deep Mine

Generally speaking, the development of new mines and tips requires planning permission. However, there is still a considerable amount of ancillary development which is "permitted" by virtue of a development

order made under s24 of the Town and Country Planning Act 1971. Further, under the General Development Order 1977, Article 3 sch.1 specifies certain classes of development which are permitted, including temporary buildings and uses, certain development by mineral operators and development by the NCB (RTPI, 1979). This last category (cl.XX of the GDO) has been criticised for placing the NCB in a privileged position: it permits underground mining and related development "in the vicinity of" a pithead in a mine commenced before 1st July 1948. In a number of cases, the NCB has used these powers to enable older coalfields to be given a new lease of life by effectively amalgamating them underground and, on occasion, to proceed with associated surface installations. The GDO exclusions have also enabled ancillary activities such as stockpiling and tipping to take place at one site, even where the product has originated elsewhere. The situation regarding planning permission in respect of established mines is shown in Figure 3.1.

The control of tipping has enabled long-term agricultural impact to be significantly reduced. Conditions of consent imposed on tips mainly relate to grading, depth of soil on respreading, chemical analysis of shale (prior to tipping) and stripped top- and sub-soil, approval of after-use plans by the local planning authority, maintenance of good agricultural practice on the restored site, phasing of restoration, and provisions for restoration in the event of temporary cessation (e.g. Craig, 1979; NCB, 1979b). Subsidence impacts may also be minimised via planning control: the so-called "High Moor" condition has been used to restrict undermining of sensitive areas without prior agreement and publicity, whilst planners may also require appropriate structural modifications to new buildings within subsidence zones. Further, the GDO 1977 s5(1)(d) requires NCB to consult with local planning authorities regarding likely subsidence, and s30 of the Land Drainage Act 1976 similarly requires British Waterways Board to be notified. A summary of the coverage of agricultural restoration conditions at Asfordby is set out in Table 3.1.

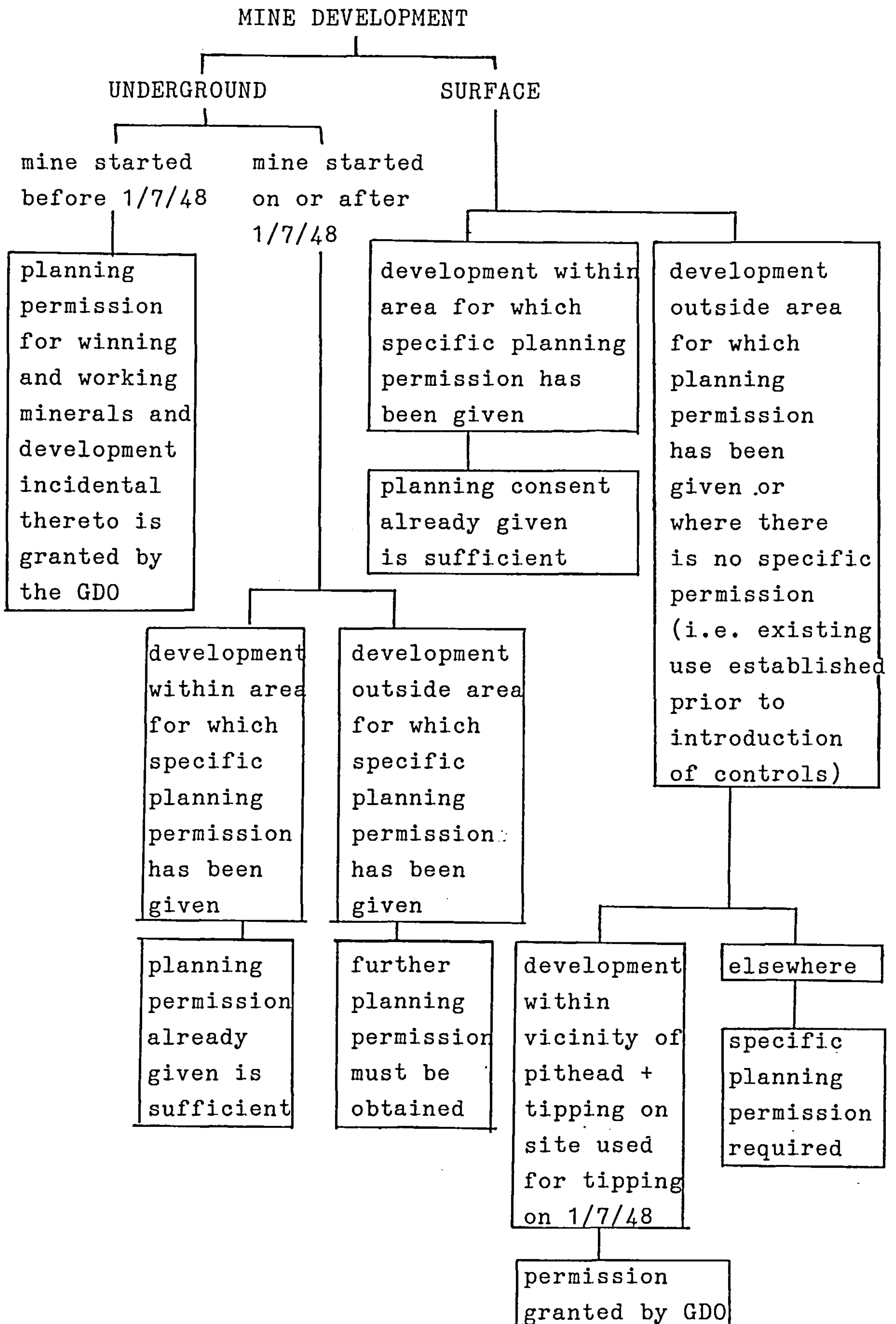


Figure 3.1. Summary of planning control over deep mining (based on Flowers, 1981).

Restoration Conditions at Asfordby - topics covered

- removal of recoverable topsoil from mine site and respreading elsewhere
- outline landscaping of restored tip site, insofar as consistent with agricultural after-use
- timing of submission of tipping phases for detailed approval
- stripping and respreading of recoverable topsoil (with immediate return to agricultural use)
- progressive stripping of topsoil from tip site
- temporary storage of topsoil in dump where necessary
- means of providing topsoil for final tipping phase
- progressive stripping and respreading of subsoil
- progressive restoration of tip
- grading of tip to permit natural drainage; maximum gradients
- subsoiling treatment at 400mm and 700mm of reinstatement
- removal of stones, rocks and other deleterious materials
- grading machines to be of type designed to minimise subsoil consolidation
- usage of topsoil stripped elsewhere on site to make good deficiencies
- treatment of topsoil: subsoiling and stone picking
- imposition of 'weather window' 1st May-1st September; operations only when ground sufficiently dry
- sowing to grass not later than mid-September
- cultivation, application of fertilisers and other treatment

Table 3.1. Coverage of agricultural restoration conditions for the Asfordby site, North East Leicestershire Coalfield.

Four particular points raised by the Inspector at Belvoir are of special relevance to agriculture (Mann, 1981). First, he stressed the need to strip and place topsoil and subsoil when there is a soil moisture deficit of 50mm and when either the rainfall does not exceed a certain limit or the effect of excessive rainfall had been accounted for by transpiration; the NCB had initially objected to the imposition of a "weather window" (from 1st May to 1st September) but were overruled in this respect. Second, the Inspector agreed with MAFF (again disagreeing with the NCB) that if soiled areas were left unseeded during the winter months erosion of newly replaced topsoil could occur, so that restoration sites must be sown to grass not later than mid-September. Third, the Inspector disputed the County Council's request for a minimum specification of topsoil, preferring the MAFF's more flexible requirements for topsoil stripped from mine sites to be used to supplement any shortages. And fourth, the Inspector rejected the County Council's request for detailed restoration schemes for each phase of the tip, considering that this might interfere with the conditions of lease, and that the Council would have adequate powers of control under other provisions.

In some instances, it may be more appropriate to proceed by agreements (made under s52 of the Planning Act, or s50 in Scotland) and assurances than by control. Thus, at Belvoir, assurances were given regarding implementation of remedial land drainage works and the provision of local information offices where the public could consult mining plans, which should presumably satisfy criticisms of failure to alert residents of properties which are about to be undermined. The thorny problem of remote disposal costs, which would have contravened the Minestone Executive's profit-making obligations, similarly appears to have been resolved by planning agreement. (The NCB has been asked to provide, free of charge and on demand, up to 50 000t of spoil per year at any point selected by the County Council within a 30km radius of the mine site, with an additional request that further spoil must be provided if available, subject only to the payment by the Council of transport charges less the costs that would have been incurred in tipping the dirt on site).

The Coal Mining (Subsidence) Act 1957, extended in 1976 by a Code of Practice, affords provision for reparation and compensation in respect of damage caused by subsidence. Where ground movement is likely to continue for some time in a locality it is NCB practice to issue a "stop notice" enabling temporary and emergency repairs to be carried out on a damaged property until such time as permanent repairs can reasonably be effected (NCB, undated c). In the event of damage to a building or land, the owner must issue a "damage notice" to the NCB who will in turn send their surveyors to assess whether the damage has been due to subsidence (Dickie, 1979). It is standard practice for NCB to make good the damage, but on occasion they may prefer to discharge their obligations by payment of compensation. The Code of Practice enables compensation to be extended to damage to chattels, the award of a "home loss payment" where a resident is permanently displaced as a result of subsidence damage, deficiencies in crop yield (taking into account any reduction in expenses incurred by the grower), the award of a "farm loss payment" where a farm is so badly damaged by subsidence that the farmer must move, and the payment of compensation for disturbance to a tenant farmer even where the owner has already been compensated for permanent depreciation. Provision is made for the referral of claims to independent arbitration. Ideally, the determination of compensation levels should be able to draw on detailed baseline information against which damage can be appraised, but this is rarely the case.

Some criticisms have been levelled against the Code of Practice regarding "non-compensatable consequential losses": these might include, for instance, the loss of metered water from fractured pipes (Smith and Hugget, 1979), or reductions in milk yield from a herd disturbed by development operations. It is possible that there will be some further extension of this Code as a result of the 1983 White Paper on Coal and the Environment. Moreover, in view of the vast scale of investment involved in mining operations, it has been suggested that compensation paid to the worst affected farmers could be more generous: in the analagous case of public works affecting farms in North Wales, Jones

(1972) noted the desirability of basing payments on the "transfer earnings value" of the land rather than its "existing use value". Further, one of the authorities cited by Jones to pay additional monies based on the duration of the farmer's occupation, so that tenant farmers close to retirement on meagre incomes and with small savings were not harshly disadvantaged. Other critics of the NCB's provisions have argued that recompense for physical damage to houses and their consequent depreciation is inadequate, and that the Board tends to use cheap contractors and subject claimants to unnecessary delays.

Effects associated with the loss of agricultural land and buildings can be tempered by a carefully sequenced policy of acquisition comprising a combination of land purchase, re-letting and exchange. Care should likewise be exercised in planning for continuity of cropping before land is taken for tipping and after its re-instatement. Where existing buildings are severed in such a manner that they will not remain a viable base for the operation of the farm, the NCB may acquire the freehold and let it to another farmer or else restructure the farmstead. In Belvoir, the Board have been negotiating privately to acquire land, and arrangements have been made for vendors to remain in occupation until the land is required, which might be some years later. Farmers might be reluctant to sell part of a holding since they could be left with a unit too small to be viable; in such instances, the Board would purchase the whole unit and thus enable the vendor to purchase another farm.

Agricultural land drainage, which may be severely affected by subsidence, is (in England and Wales) the responsibility of the Regional Water Authorities and British Waterways Board. Canals often have an important secondary land drainage function, and BWB may make agreements with the NCB for preventive/remedial measures, or for sterilisation of underground reserves as pillars of support, within a designated "area of protection" (Stokes, 1979). The Land Drainage Act 1976 enables the Regional Water

Authority to exercise a supervisory role over land drainage, in part by vetting and consenting to proposals to work in, under, over or adjacent to watercourses (s1), and requires their consent for the erection or alteration of any structure likely to affect the flow of, or impede land drainage into, a main river (lesser controls exist for "non-main" rivers, under s29).

It is necessary for the Authority to ensure an efficient system of arterial drainage, but regular attention also has to be given to smaller local drains and watercourses, especially for agricultural needs: responsibility for these often rests with an Internal Drainage Board. The 1957 Subsidence Act makes special provision for remedying, mitigating or preventing damage caused to land drainage systems maintainable by a drainage authority (s5), but this does not extend to many smaller watercourses. Here, the NCB's duty in respect of subsidence is covered by the general provisions of s1 of the Act, although this only enables them to pay compensation, not to implement remedial works. In such instances, restoration can only take place if agreement can be obtained amongst all the riparian owners involved, and this may not be feasible.

Statutory Provisions for Site Development - Opencast

NCB opencast operations have, since their inception during World War II, proceeded without the need for planning permission, although this anomaly is now in the process of being rectified (DoE Circular 3/84). Under the Opencast Coal Mining Act 1958 the Opencast Executive (NCBOE) has been required to seek ministerial authorisation (via the Secretary of State for Energy/Industry Department for Scotland), and extensive conditions regarding operations and restoration have been placed on authorisations granted. Under this arrangement, however, the local planning authority was reduced to the role of a consultee (albeit a statutory one). The major recourse of planning authorities was to lodge a formal objection to NCBOE proposals, in which case, if the objection remained unresolved, a public inquiry had to be called.

Additionally, many authorities have liaised with the Executive at the forward planning stage, and this practice is likely to continue. Some Councils have adopted explicit stances on this matter. Cumbria

County Planning Department, for instance, have established that sites where an after-use other than agriculture is appropriate will be considered more favourably; where farming is both the pre- and post-restoration user, sites are graded according to land quality and the likelihood of opposition to proposals (Cumbria C.C., 1978, 1979).

Although the authorisation procedure now only constitutes a formality, and will presumably eventually be repealed, it is worth considering it further not only because of its past importance, but also because something similar will doubtless continue to be produced in future, whether on a formal or informal basis. An application for authorisation must contain three schedules: Schedule 1 provides a baseline description of the land and its uses, and of its owners and lessees; Schedule 2 furnishes details of the working proposals, the depth of excavation and the amount of coal to be won; and Schedule 3 shows the proposed after-use. The first of these has especial use in helping determine the compensation payable for diminution in value of the land under s23 of the 1958 Act, as it enables the amount to be based on estimated yields (Craig, pers. comm., 1980).

The contents of the authorisation are aimed simply at satisfying the Secretary of State of the need for the coal and the practicability of extracting it; there is no legal requirement on NCBOE to supply additional supporting information, such as detailed restoration schemes or future prospecting programmes, over and above the fairly basic data sought in the authorisation regulations. Thus, the guidance which has traditionally been offered on strategic environmental aspects has been distinctly limited (Henneberry, 1981). Various site meetings are called throughout the course of operations involving all the affected parties, the main stages being pre-authorisation, pre-entry and pre-release. It has been normal practice for many years for the NCBOE to conduct a five year restoration programme prior to releasing the land, but this has recently been strengthened by the introduction of a "post-release rehabilitation scheme" under which the Executive continues to meet the costs of certain works over a further 3-4 year period (NFU, 1980).

Routine environmental appraisal of opencast sites is far more advanced than for deep mines and their ancillary activities, especially in regard to agricultural operations. For instance, as an aid to their negotiations with the Department of Energy, ADAS will generally consider: land classification (i.e. grades and memoirs of the ALC); a soil analysis of the site; the Schedule of Conditions (Sch. 1 of the authorisation); farm structure; a rather limited "socio-economic appraisal" of the farm labour force in the affected area and how it might be redeployed; an outline restoration plan; and any improvements which might accrue from working the site. The inclusion of a detailed soil survey has been a significant recent advance, and is particularly useful in assisting subsequent soil conservation and reinstatement measures. This survey defines the existing soils and identifies any shortages of topsoil or subsoil. At the soil stripping stage, the soil depth, lime application, movement of equipment over the site, and soil moisture content (which determines when soils may be moved) must be recorded. Finally, at the storage stage, the depth of the mounds and their management must be established and "soil-making materials" identified (Craig, pers. comm., 1980). In addition to the standard authorisation schedules, a number of county planning authorities have reached agreements with the NCBOE to provide supplementary information. Those adopted by Mid-Glamorgan and Cumbria are summarised in Table 3.2.

Private opencast operations - which are conducted on licence from the NCB and are subject to an annual quota - require planning permission in the normal manner. Planning controls in this respect have recently been strengthened by the Town and Country Planning (Minerals) Act 1981 which provides, amongst other matters, for the specification of restoration and after-care conditions. The restoration provisions for Scotland (s22) appear to be more stringent than for England and Wales (s5) since the former section permits the specification of steps consisting of "planting, cultivating, fertilising, watering, draining or otherwise treating the land" in order to bring it up to the standard for use in agriculture, forestry or amenity.

TOPICS ON WHICH ADDITIONAL INFORMATION
SOUGHT BY MID-GLAMORGAN COUNTY COUNCIL

- site topography
- impact on local settlements
- scientific or ecological interest
- existing dereliction
- method of extraction
- extent of blasting
- annual output
- environmental remedial measures
- restoration proposals
- zone of visual influence
- agricultural land quality
- farming patterns
- vehicle movements
- landscape features
- related planning standards and policies
- local economic impact
- proposed market for coal
- effects on site and neighbouring uses
- (including land drainage)

TOPICS ON WHICH ADDITIONAL INFORMATION
SOUGHT BY CUMBRIA COUNTY COUNCIL

- employment potential
- ecological features
- existing dereliction
- possibilities for beneficial after-use
- impact on local communities
- relationship to planning policies
- landscape features
- historical features
- damage to agricultural productivity
- transportation impact
- noise prevention
- landscaping measures
- local and national need for coal produced

Table 3.2 Additional information sought on opencast proposals by two County Planning Departments.

Model conditions are also laid down in the Department of Environment's "Green Book" for mineral planning, but it may not automatically be assumed that the desired end-state can be reached simply by setting out standards, and some anomalies in the latest revision of the book have been noted (Jelley, 1982). Private opencast sites - as with any other planning application - of over 2ha must be referred to MAFF/DAFS for their observations, but concern has been expressed regarding smaller sites which MAFF/DAFS might not find out about and yet which might merit advice on restoration. (In addition, this 2ha threshold in Scotland may be interpreted as only relating to "prime land"). The NCB licence is normally accompanied by a bond which ensures that sufficient funds for eventual restoration are set aside; alternatively, a number of local authorities have preferred to negotiate their own restoration bonds with operators, who then enter into a "royalties only" bond with NCB. It has been suggested that the use of restoration bonds might need to become more widespread following the proposed new legislation for opencast, as the responsibilities of even the NCBOE towards minimising local environmental damage could, presumably, be weakened (Peart and Rutherford, 1984).

With regard to noise, attempts have been made to impose on the NCBOE the same standards that would apply to industry generally, but these have so far been strongly resisted. Whilst the Board say they will stop if excessive noise or other nuisance is being caused, there is no legal basis available to local authorities to force them to take action.

Within the USA, although severe environmental damage has occurred in the past, controls are now in some respects more stringent than in Britain. Comprehensive guidance on the appraisal of energy-related projects has been made available to the Appalachian Regional Council as an aid to interpreting the legal, procedural and analytical responsibilities of EIA (Messer Assoc., 1977). This guidance relates to power plants (including fossil fuel plants), coal mining and refining,

water resources and other infrastructure. Particular regard is paid to projects expected to affect adversely air quality, water quality, noise levels and ecology, and the provisions include monitoring of baseline conditions and quantifying physical and socio-economic impacts. Many states have passed their own acts alongside federal legislation: thus, of the thirteen states in Appalachia, Maryland, North Carolina and Virginia have environmental policy acts of general applicability, whilst acts of geographically limited applicability have been passed in Alabama, Mississippi and Pennsylvania.

The most sweeping legislation, however, has been the 1977 Surface Mining Control and Reclamation Act, together with subsequent regulations which define detailed design and performance standards. Three basic activities are prescribed in the Act: "pre-planning", which requires a permit; "mining practices", which must now seek to minimise environmental damage and adverse effects on public health and safety; and "post-mining reclamation", which requires restoration of land to its pre-mined condition (Federal Register, 1977).

The underlying theme of this Act is that surface mining should not take place where reclamation is not possible or where it would conflict with other important users. States are required to establish procedures for designating lands unsuitable for surface mining. Since environmental conditions vary considerably across the USA only a limited amount of standardised federal advice is set down and most implementation and much interpretation is left to individual states. An Office of Surface Mining Reclamation and Enforcement has been set up by the Act and similar agencies have been established at state level, so that a professional inspectorate now exists. Where prime farmlands are included within the application area, the regulatory authority must ensure that the operator has the technical capability to achieve restoration to at least the former productivity within a reasonable time. Operators must also establish a performance bond to ensure the availability of adequate funds to complete the restoration (McDaniel, 1977).

Provisions for Forward Planning

Statutory controls can only be reactive in their nature, yet environmental protection is often greatly enhanced if decision-makers can be forewarned of development prospects. In his decision letter relating to the Horsegate opencast site in Tyne and Wear, the Secretary of State concurred with the Inspector's conclusion that it was "...not possible to evaluate fully the disadvantages of the proposed working without having regard to the effects of such workings continuing to spread over the surrounding area in years to come" (reported in Brocklesby, 1979). Further, it is common for a development to be the subject of several successive planning applications: Solsgirth colliery in Tayside Region, for instance, involved a total of fourteen applications adding incrementally to the original consent, and there is no reason to suppose that this is untypical.

One approach to this problem might be through the medium of a "subject plan", which could seek to ensure that an adequate and steady supply of the resource was produced, that detailed development control guidelines existed for the determination of individual cases, that operators were alerted as to areas where they should concentrate their searches for new minerals, and that a basis for discussion was available to operators and other interest groups, including the general public. In a similar vein, Walne (1979) has noted that MAFF attaches the greatest importance to consultation with planning authorities at the plan preparation stage as subsequent developments in accordance with the development plan will rarely be refused.

In addition to the extraction of coal itself, forward planning should also consider the production and disposal of waste. At present, apart from the activities of the Minestone Executive, the responsibility for spoil disposal rests with individual colliery managers alone: only exceptionally, and in the case of relatively few large scale projects, is there any coordination within or between NCB, local authorities and

central government. The Commission on Energy and the Environment has argued strongly for the strategic planning of spoil disposal by bodies similar to the Regional Aggregates Working Parties; only by securing far greater liaison between the NCB and planners may the impact of colliery and power station waste (especially pulverised fuel ash) tipping be substantially reduced (Flowers, 1981). The Government has now accepted the need to launch a major study to establish how far such liaison would be practicable (HMSO, 1983).

This has recently been given expression in a DoE project based mainly on the Yorkshire/Nottinghamshire/Derbyshire coalfield. The unpublished brief for their research contract (Heyes, pers. comm., 1984) specifies the need to develop a clear policy framework for spoil disposal to assist sensible local and regional planning and, as part of this, to design a methodology to expose the scale and distribution of costs and benefits arising from various spoil disposal options. This method would be used by the DoE, local authorities and NCB to undertake a comparative assessment of the options as they might arise in relation to particular sites or areas. The importance of relating these options to policies and statements in statutory planning documents is recognised, as is the importance of agriculture as an environmental constraint.

It is often suggested that the NCB should define more clearly the status of potential future coalfields over a much wider geographical area to assist planning authorities. However, it has already been noted that several rungs exist in the "ladder of exploration" and that only in the later stages can a coalfield be thought of as a likelihood within the foreseeable future. Final proving of a coalfield can only be achieved by surface boring, and with costs of around £150 000 per deep hole any major extension of reliable prospecting information would appear unlikely. Nevertheless, the view is gaining official acceptance that the Board has sufficient knowledge of its potential prospects in general terms to be able to give more helpful guidelines to the planning authorities

concerned. Once a mine commences operation, reserves are worked according to a five year plan: although this is open to public inspection, it cannot be adopted as a basis for land use planning as, for a variety of geological and technical reasons, individual faces may not work as foreseen. Two major causes of uncertainty in deep mines tend to arise: unexpected natural phenomena and the need to abandon reserves because of the inability to prove that it is safe to work them. The latter generally arises where there is a possibility of previous working, so that it may be surmised that this particular element of uncertainty could be precluded in new coalfields.

Forward planning for opencast mining has so far been rather more practicable, although difficulties still arise with market fluctuations, and with changing extraction ratios, which may mean that sites (or even deeper seams on sites already worked and restored) which were previously considered unworkable become attractive. NCBOE proposals, coupled with proposals for mine waste tipping, in the Lower Aire Valley prompted the planning authority to prepare a subject plan for the area (West Yorkshire MCC, 1977). Subsidence of up to 5m had already been caused in the area by deep mining, resulting in extensive flooding of agricultural land, and a further 1.4m could be anticipated. The study considered seven options in terms of their benefits for opencasting, sand and gravel working, residential amenity, recreation, nature conservation, washlands and agriculture. Durham County Council have also succeeded in securing agreement on a forward programme with NCBOE, despite the Executive's long-standing contention that such exercises are impracticable (Durham C.C., 1983).

There is thus a need to establish, as far as possible, the cumulative impact of future operations at the outset and to bring mining operations within the general framework of forward planning. A step towards this was made in 1980 when a Code of Practice was agreed between NCBOE and local authorities (Local Authority Associations, 1980) setting out a number of "pre-programming sequential stages". These open with informal

discussion, to be held regularly between the Executive and local authorities, covering such topics as the contribution to national and local targets sought from the area in question, the relevant content of structure and local plan policies, derelict land reclamation schemes within the local authority programmes, and the extent of land instability arising from sub-surface dereliction. Local authorities should be provided with consultation maps by the Executive at this stage in an endeavour to identify areas which may be totally unacceptable on environmental grounds and conversely those areas where the local authority would be willing to look favourably on opencast working; these should display the maximum geological information available for potential sites. If prospecting is decided upon, a Notice of Intention to Prospect must be served on the county planning authority at least 42 days prior to commencement indicating the nature, extent and possible duration of the prospecting. The planners should consider this Notice in the light of their general policies for the area and report their preliminary views to the NCBOE; in return, the Executive should report back the significant results of their prospecting. A five year programme should be made available to the local authority, who should assess it for its general and cumulative impact on the environment in order that consideration may be given to changes in the programme where justified, notwithstanding the Executive's need to retain a certain degree of flexibility.

Various additional improvements to current practice have been suggested. Tomlinson (1980) proposes a desk study in which the present consultation zones are divided into areas in which the likelihood of working could be indicated. Such a plan would not be sufficiently precise to interest the public, and would remain unpublished, but would enable the planning authority to advise the Executive as to those areas where difficulties would be envisaged. It has been noted that present consultation zones are used by the NCB mainly to avoid sterilisation by other development, and often include the entire coalfield even where opencasting is clearly impractical. Henneberry (1981) considers that formal consultative arrangements would suffice: for instance, in Manchester, quarterly

opencast liaison meetings are held between the NCBOE, Greater Manchester Council and the relevant districts to discuss all matters well in advance of any statutory requirement to do so. As a result of this, the Executive has increasingly supplied additional information to the local authorities.

Weaknesses in Current Practice

The major weaknesses evident in existing practice fall into three classes: administrative fragmentation of control and executive agencies; specific inadequacies in legislation and procedures; and ineffective imposition and enforcement of control conditions. Control over mining operations is exercised in a complex manner by central and local government and public boards (Table 3.3). The executive agencies are the NCB, and their Opencast and Minestone Executives, and the private operators; in the case of NCBOE operations, the work is carried out by sub-contractors.

This administrative fragmentation may lead to certain topics receiving inadequate supervision or, alternatively, to duplication of effort and the possible exercise of dual control, with the attendant possibility of duality of appeals. For instance, at the Belvoir Inquiry both Leicestershire County Council and the Severn-Trent Water Authority requested approval of the means of surface water disposal and of the chloride content of the discharges; similarly, it would have been preferable to avoid the public disagreement between the NCB's agricultural consultant and the MAFF over the best means of restoration. In Scotland, the administrative separation which existed within the Department of Agriculture and Fisheries between Lands Staff (who, as part of their normal planning duties, covered private opencasting) and the General Duties Inspectorate (who liaised over NCB opencast) has (until their merger in 1984) led to rather different approaches being advocated and militated against a concentration of expertise.

ENGLAND AND WALES		SCOTLAND
<u>Agency</u>	<u>Topic</u>	<u>Agency</u>
County Council (planning)	strategic intelligence service	Regional Council (planning)
County Council (planning)	determination of applications	District Council (planning)
Department of Energy	determination of OE authorisations	Industry Department for Scotland
District Council (Env. Health)	control of noise	District Council (Env. Health)
Regional Water Authorities	control of site discharges	River Purification Board
RWA, Internal Drainage Boards	maintenance of land drains	Department of Agriculture and Fisheries
Agricultural Devt. and Advisory Service	supervision of opencast operations	Department of Agriculture and Fisheries

Table 3.3 Authorities involved in the control of environmental and agricultural aspects of coal mining operations.

One way of unifying the efforts of individual agencies lies in the establishment of a Coalfield Committee (as happened at Selby) or a Joint Working Party (as happened at Belvoir). In Belvoir, the JWP investigated, via its subsidiary discussion groups, aspects of need, dirt disposal, employment, housing and infrastructure, communications, subsidence and environment. Following the Secretary of State's rejection of the original application, two further groups were set up at his instigation to study remote disposal and backstowing (Sabey, pers. comm., 1982).

However, various shortcomings of this kind of approach may be identified. First, no proper basis exists for identifying those subject areas most meriting attention. Second, because discussions are held in private, the public may not perceive them as being impartial or productive: objectors at the Belvoir Inquiry felt that the JWP had failed to produce any substantial new evidence to present at the hearing (reported in Mann, 1981). Third, not all the interests may be represented. For instance, the Severn-Trent Water Authority signed an agreement with the NCB covering certain arrangements for precautionary and remedial work on the main watercourses; but this approach did not cover other minor watercourses for which the Water Authority and Internal Drainage Board were not responsible, and one witness at the Inquiry considered it essential that formal liaison arrangements should be established by all interested parties (Craig, 1979). And fourth, the final papers of the JWP only presented their "agreed conclusions", thus excluding coverage of matters where differences of opinion remained.

This is not to deny the importance of the technical working parties throughout the life of the coalfield in considering new proposals, conducting regular surveys to monitor change, consulting with interested parties and making recommendations regarding remedial works and revisions to practice. However, at the planning stage at least, it may be that a simpler and more reliable means of coordination might be to adopt something similar to the American practice of commissioning an EIA, to be conducted by a single "lead agency" (USDEn, 1979).

Many specific criticisms have been levelled at current UK measures with regard to both physical problems of site management and broader issues of openness and community involvement. Supervision of site restoration may be hampered by the excessive workload on ADAS (especially where sites are small and numerous) or by the administrative distinctions within DAFS. Further the 1981 "Minerals" Act does not seek to specify what constitutes an acceptable standard of restoration, in contrast to the regulations presently being introduced under the comparable "Surface Mining" Act in the USA. Nor may planning conditions specify the intensity of after-use of a restored site, but may only refer to the state of the land itself.

In respect of water pollution, the situation has improved since 1974, before which date the waters discharged from deep mine workings were exempt from statutory liability. However, the responsibility for discharges from abandoned mines is still unclear and the affected persons may have no recourse to compensation. Further, there is some confusion as to whether surface water runoff, and the leachate from tips and stocks, is classed as trade effluent and thus subject to control (Flowers, 1981). Section 50 of the Control of Pollution Act 1974 empowers Regional Water Authorities to investigate the extent of pollution problems, to determine the corrective measures necessary and to evaluate their cost, but there is no provision yet for them to recoup the cost of remedial works from the offenders. The situation is apparently less unfavourable in Scotland where, in a well-publicised case, the Clyde River Purification Board took the NCB to court over iron-contaminated waters from the abandoned Dalquharran colliery flowing into the River Girvan and, despite the sheriff ruling in favour of the NCB, the RPB were later successful in having this decision overturned by the appeal court judges. Recent reports suggest that the NCB's remedial action has been highly effective.

Where damage has clearly occurred, regional discrepancies in the efficiency of the NCB's compensation machinery have been cited by aggrieved farmers. A major difficulty in establishing how far the productivity of land has been damaged lies in the absence of detailed records of yields to afford an objective comparison. Full restoration of land back to its former quality is generally prolonged, and a study of the Northern Region of ADAS, based on fifty sites, suggested that the full period of restoration may be in the range of 20-30 years with only a few sites being restored within fifteen. In general, it appeared that grade 3a land was less likely to regain its original potential than was 3b (ADAS, 1979). In Belvoir, NCB considered that tipping land at Hose could be restored to full fertility after 25 years, at Asfordby after 20 years and at Saltby after only five years, whereas MAFF felt estimates of 30, 20-25 and 15-20 years respectively to be more reasonable. The Inspector deemed it impossible to judge who would be more nearly right as there was no existing experience of operations along the lines of those proposed.

The point remains that, without more reliable, statistically-based audits of restoration progress, farmers' claims that yields may be reduced by up to half will be difficult to corroborate. It is not unusual for farmers to consider their soil so badly damaged that its previous arable cropping is unable to be resumed, or that cattle must be kept indoors much longer in the spring and autumn (CoEnCo, 1980).

There is also a more general issue regarding the adequacy of compensation as a means of impact mitigation: clearly, even where money has been paid, there is no guarantee that it will be spent on rectifying the damage, whilst many of the more pervasive dimensions of impact will not be compensatable. Given that compensation is an essential part of the statutory provisions, however, there is growing evidence of its parsimony. Although the Government is proposing to make limited improvements including an element for residual loss on property values, the Local Authority Associations, in giving evidence to the Subsidence

Review Committee, clearly do not feel that this goes far enough (Johnston, 1983). Amongst the additional topics which they would wish to see covered are: compensation for strain and mental stress; payment for "consequential" losses; a requirement for the NCB to purchase damaged or blighted property if the owner was unable to sell at a reasonable price; financing and maintenance by the NCB of landscape works in affected areas; payment of additional costs for statutory undertakers (and, presumably, for private service undertakings in rural areas); and an obligation to restore damaged property to its original state.

The lack of openness of the NCB and Department of Energy compares unfavourably with the public participation provisions of much overseas legislature. The British system is often defended on the grounds of the public inquiry provision but, whilst this frequently works satisfactorily, it has increasingly been the subject of debate. It has been noted that the NCBOE have often refused to allow matters of need to be discussed or to allow their geologists to be cross-examined; where the latter has on occasion taken place, the resultant evidence has tended to differ from that initially revealed to the public (Brocklesby, 1979). It is now widely acknowledged that the increasing expense of making representations at major public inquiries is rendering them less accessible to the public, and several proposals have been advanced to restructure and make them more democratic (Le-Ias, 1982; DoE, 1984b). One recent introduction to streamline the process and focus on key issues has been the pre-inquiry meeting; however, this process at Belvoir merely raised more unresolved questions regarding agreement on issues to be discussed, the role and membership of working parties, and considerations of accessibility to and timing of sessions (Hills and Cope, 1980).

Moreover, public inquiries can do little to allay suspicions or resolve conflicts if clear environmental guidelines are not available. The Selby inquiry, for instance, proved inadequate to allay suspicions about serious increases in flooding risk and disruption to land drainage; in addition, repeated upward revisions of such factors as ancillary housing demand or the height of pithead installations underlined the

limitations of the original data put before the inquiry. A letter to the Times noted that "...unless and until the Department of Energy establishes, by means of independent research, environmental criteria which will govern the development of coal mines, the debates the NCB organises to consider its proposals will be so one-sided as to be of no protection whatsoever to the communities in which coal mines are developed and operate" (quoted in Arnold and Cole, 1981).

The final major source of weakness in current practice is the limited effectiveness of development control in certain circumstances, and this may arise in two principal ways. First, the imposition of conditions may be excluded by statutory provisions. Thus, for instance, where existing use rights persist or new development is permitted by virtue of the GDO or a special development order, no planning control may normally be exercised. Similarly, NCB opencast operations have until recently proceeded without formal planning sanction. Second, inadequately worded conditions, or conditions which cannot properly be monitored and enforced, may result in lapses of good site practice.

Although the former of these problems should in future be substantially alleviated by revisions to the GDO, possible abolition of established use certificates, and the introduction of planning control over NCB opencast, it has for many years been a considerable source of frustration and no doubt vestiges of this problem will linger on, especially if exemptions continue to be applied to the NCB. Insofar as tipping commenced prior to 1/7/48 is concerned, only about a quarter of active tips in 1974 fell into this category, and this figure has since fallen very significantly. Furthermore, in 1974 local planning authorities were given limited additional powers (in England and Wales only) to require the Board to submit schemes for waste tipping. Other GDO rights have enabled the NCB to undertake ancillary works within the curtilage of existing development and this has in some cases permitted considerable intensification of activities. Despite the Board's claims that these powers are used only occasionally, when they are used it seems to be in those areas already experiencing the worst effects of concentration, South and West Yorkshire providing the most salient example.

Thus, underground coal mining and working together with underground development incidental thereto in a mine commenced before 1/7/48 has been permitted development, denying the local planning authority control over an extension of the take or the working life of additional seams. In some areas, a new lease of life has been secured by considerable capital investment involving the virtual amalgamation of pits by linkages underground and the concentration of mine output and associated activities at one of the collieries. Such reorganisation could have considerable economic and environmental effects on communities in the area, yet that reorganisation could be carried out without planning control within the terms of development permitted under class XX. Class XX (ii) relates to any development required in connection with coal industry activities as defined in s63 of the Coal Industry Nationalisation Act 1946 which is carried out in the vicinity of a pithead; however, a 'pithead' is nowhere defined, whilst 'in the vicinity of' raises obvious problems of definition.

The Commission on Energy and the Environment (Flowers, 1981) has further queried the use of GDO sites for stockpiling, and for the transport of coal for stocking purposes from one colliery to another. It was felt that stockpiling on a large scale for a number of years could have adverse consequences for the immediate neighbourhood, and that the LPA should, therefore, be in a position to impose conditions on stockpiling, or put forward alternative proposals.

Perhaps an even more serious problem arises from the imposition of inadequate planning conditions. The Report of the Inquiry into the Control of Mineral Workings (Stevens, 1975) included a survey of twelve planning authorities to ascertain the adequacy and performance of planning conditions in achieving satisfactory restoration. From the survey, some 56% of planning consents granted for coal operators were regarded as having unsatisfactory conditions. Of the remaining consents, in some 18% of cases, conditions had not been complied with, whilst in 20% of cases conditions had not been adhered to. In respect of opencast mining, it is possible that the situation could deteriorate rather than improve, with the greater latitude which could be given to private operators were the ceiling to be raised from 25 000ta to 100 000ta.

An appreciation of the sources of ineffectiveness of conditional planning consents for mining operations can be gained from considering the ways in which planning conditions may prove ineffective in general. The classic statement of the virtues of properly worded consents was issued by the DoE in 1968 (DoE circular 5/68, "use of planning conditions in planning permission"). This affirmed that conditions should be: necessary; relevant to planning (and not the domain of some other control agency); relevant to the development in question; enforceable; precise in their wording; and, in terms of their economic consequences for the applicant, reasonable. Expanding on these, we may note some possible circumstances in which mining consents may prove defective.

A common shortcoming appears to lie in inadequate identification of impacts at the outset, making an appropriately worded condition impossible. A second problem arises from the limitations of initial surveys undertaken by operators, particularly in the private opencast sector, leading to unavoidable changes in operations once development has commenced; modifications to the direction of excavation or extensions to the area defined in the original application are typical eventualities and often the original consent conditions are insufficiently robust and flexible to cope. A major difficulty lies in the monitoring of performance, especially in the after-care phase. Few, if any, statistically monitorable criteria (such as crop yields) will be set; the means of monitoring may be uncertain; and, especially in cases of private opencasting where the agricultural extension services may be less routinely involved, planners may be required to make judgments about the agricultural adequacy of measures which are beyond their expertise. In this respect, therefore, many of the conditions set must be deemed imprecise and unenforceable. Moreover, it could be maintained that inadequate consideration had been given to the whole question of after-use of sites; on some sites, reversion to agriculture is almost doomed to failure, when conversion to forestry or recreation would have been quite desirable. Loosely worded conditions may also arise from an inadequate understanding of the industrial processes involved, or from the performance of the plant

in extreme circumstances (for instance, the effectiveness of settlement ponds in freezing conditions or high winds). Similarly, a lack of appreciation of the critical stages of the operation - when either some particularly damaging process is taking place, or when the environment is likely to be peculiarly vulnerable (e.g. excessive soil moisture conditions) - may result in inadequate monitoring and enforcement at crucial times. In many cases, breaches (or genuine misunderstandings) of planning conditions are only noticed after irreparable site damage has taken place. A general problem may arise with the means of control which is selected: thus, planning conditions could be set to influence events more susceptible to control through agreements and assurances (or vice versa), or premature detail might be sought when a requirement to submit precise plans for some particular operation (e.g. restoration) subsequent to the commencement of development would be preferable.

Some evidence of the inconsistencies in treatment accorded to particular sites and of the weaknesses in the performance of planning conditions may be gleaned from a consideration of NCBOE authorisations and private open-casting consents in the Upper Forth Valley (Table 3.4, and see Figure 1.3). Differences between the Shannockhill and Thornyhill authorisations, for instance, comprise conditions requiring the carrying out of grading when the ground is dry "so far as is practicable" or of diverting watercourses "to no greater extent than is necessary". These suggest both the experience of problems in the field and of difficulties in setting out unambiguous operational criteria; although in many cases the Secretary of State is given default powers, these would be time consuming to implement and would not prevent errors of judgment from creeping in. The latter authorisation also contains a number of provisions omitted from the former: noise levels are specified in detail (in terms of L_{eq} and peak particle velocity); additional provision is made for farm tracks; relaid watercourses, drains and ditches are required to adhere as far as practicable to the original line; actual depths to which subsoil must be cleared of deleterious material are specified; and in the event of stripping operations being carried out in stages, specific measures are set down to ensure that topsoil is not damaged on those parts still to be stripped.

TOPICS COVERED IN AUTHORISATIONS OR PLANNING PERMISSIONS	Shannockhill 1977	Thornhill 1980	Threaprig Farm 1976	Blackston Farm 1980	Crosshill Farm 1980	Jawcraig Farms 1979	W. Jawcraig Farm 1980	Wester Hill-head 1981
time limit	x		x	x	x		x	x
access point; wheel cleaning	x	x			x			
maintenance of rights-of-way		x						
hedge maintenance	x	x						
tree preservation	x	x			x			
mains services; field drainage	x	x						
diversion of streams		x						
watercourses kept clear		x						
drainage in adjacent fields	x	x						
erosion, silting, flooding	x	x			x			
removal of suspended solids	x	x	x					x
depth of stripping top/subsoil	x	x				x	x	
soil-making material	x	x						
soil stripping - season					x		x	x
soil stripping - moisture content	x	x				x	x	x
stacking of overburden	x	x			x		x	
stacking of soil	x	x		x	x	x	x	
machinery: movement, silencing	x	x						
baffle mounds, weed control	x	x						
blasting periods, hours of working	x	x						
vibration, dust suppression		x						
hours of coal transport		x						
tree screening	x							
phasing of excavation	x			x				x
commencement of restoration	x	x			x			
replacement of overburden	x	x	x	x	x		x	
grading of overburden	x					x	x	
stabilisation of old shafts	x	x						
respreading of subsoil	x	x	x		x			
removal of injurious material	x	x			x	x	x	
rooting of overburden	x	x			x	x	x	
respreading of topsoil	x	x	x	x	x	x	x	
respreading - moisture content	x	x				x	x	
regrading after settlement	x	x			x			
after-care - cultivation	x	x			x	x	x	x
after-care - fertilisation	x	x						x
after-care - boulder removal	x	x			x			
reinstatement of drainage	x	x		x		x	x	x
tree planting; hedgerows replaced	x	x						
replacement of walls, fences	x	x			x	x	x	x
replacement of gates/stiles/tracks	x	x						
attainment of specified contours				x	x	x	x	
chemical analysis of soils					x	x	x	
pollution prevention - streams	x	x						
limit on land out of farming use			x					
quality of imported fill material						x		
additional drainage	x	x						

Table 3.4. Topical coverage of planning and authorisation conditions covering Forth Valley sites.

The anomalies in respect of private sites are far greater and the general paucity of topics covered by conditions can be inferred from Table 3.4. At Wester Crosshill, the reinstatement brief was completely lacking in final contours (this was corrected in the revised submission), no after-use proposals were stated for part of the site covered by an old bing and peat, and inadequate detail was given on the area for storage of overburden, cultivations, backfilling and grading, and soil analysis. Subsequent inspection of the site revealed a flagrant breach of conditions restricting the area of activity and areas had to be pegged out for top- and sub-soil storage as these were becoming mixed in dump. At Threaprig, the first attempt at restoration proved inadequate, drainage was non-existent (partly because inexperience had led to poor backfilling), there had been insufficient separation of layers when the site had been infilled and possibly also when it was opened up, when drainage was finally reinstalled it was done by heavy machinery in wet weather, and there was an adverse level of weed invasion. DAFS observed that certain fundamental aspects of the restoration works were unsatisfactory but in practical terms these were unable to be remedied. At Wester Jawcraig, the access road severed a narrow strip which became incapable of being farmed, and operations were not worked in identifiable phases so that restoration could not be progressive. At Blackston Farm, the Forth River Purification Board regretted that the site plan did not identify the location of specific uses - for instance, for servicing and fuel tanks - and this increased the possibility of pollution to rivers. The overburden proved harder than expected and had to be blasted, which resulted in complaints from local farmers, excavation took place outwith the site boundary, the site was being worked in a different direction to that shown on the plan, and conditions with respect to soil stripping and backfilling were being ignored. At Jawcraig it was found that, prior to permission being granted, the operators had already encroached upon the site to strip topsoil, and that this had been done in very wet weather.

More general corroboration of these problems has been provided by surveys conducted by the Department of Environment in 1982 (for England only). These reveal that, of the 103 000ha covered by permissions for surface mineral working, some 30% are not considered to have adequate restoration conditions. In respect of the 18 300ha with permissions for surface waste tipping (of which two-thirds of the area is associated with colliery waste) this figure rises to 60% (DoE, 1984a, 1984b).

A Suitable Case for EIA?

In the light of these various criticisms of current practice, the question arises as to whether or not a formal assessment procedure might engage public involvement to a greater extent, replace emotive claims with verifiable fact, ensure a more consistent approach to impact scrutiny and control, and help coordinate the efforts and objectives of individual agencies. It has also been maintained that fuller design information might remove much of the need for planners to return to a developer to seek more comprehensive details of project characteristics; more explicit project evaluation could aid the framing of planning conditions and assist in establishing the relationship between these and other environmental controls; and additional documentary evidence could guide public inquiry conduct and assist in establishing major issues for further study (Clark et al., 1981). In a similar vein, the National Farmers' Union (1979) have argued that the NCB should be obliged to prepare some kind of environmental impact statement on overall land requirements, including ancillary developments, when seeking consent for coal mining proposals. This statement should include an analysis of the likely impacts on food production in the area affected, and information should be made available on precisely how agricultural factors are taken into account in the selection of opencast sites. This view was endorsed by the Commission on Energy and the Environment, who evidently appeared to consider the present arrangements for MAFF to make representations at ministerial level an inadequate safeguard, and felt that a formal study would provide an opportunity for other interested parties to present their views (Flowers, 1981).

In a few cases, substantial EIAs have accompanied applications for planning permission in the UK; indeed, this was the case at Belvoir, although the method adopted has been widely criticised (e.g. Williams et al., 1978). A number of frameworks have been developed in the USA specifically for the environmental assessment of coaling operations but, whilst these may set out more methodically the range of impacts, they are not especially helpful in elucidating specifically agricultural

effects (TVA, 1971; Winder and Lochner, 1974; Messer Assoc., 1977; USDEn, 1979; USDI, 1980). Generally speaking, farming impacts are limited to the taking of agricultural areas, whilst mitigating measures simply refer to eventual site reclamation. Reference is usually also made to loss of topsoil and increased erosion and sedimentation, altered soil fertility and removal of vegetation, whilst indirect effects are stated to include air quality impacts, noise, attraction of related industry and increases in land values.

At the higher tiers of appraisal, shortcomings are also apparent. Some critics have called for more rigorous policy review in respect of the targets for nationalised industries; such an approach might also help establish more clearly the relationship between different national policy objectives and between national, regional and local issues. Whilst in Britain, much criticism has been levelled at the apparently sacrosanct forecasts advanced by the NCB and Department of Energy, Winder and Lochner (1974) criticise an American EIS for "citing vague national energy demands as an excuse for regional development with little discussion of other national energy strategies".

There is thus a case for introducing, at the highest level, a system of "policy review" in order to link project appraisal to overall coal development strategies or to the need for agricultural land. For instance, the Secretary of State (DoE, 1982) required that the decision on Asfordby pit should reflect government policy that the amount of land taken be no more than reasonably necessary for carrying out the development in accordance with proper standards; whilst this policy seems admirable, there is at present no means of determining whether it is correct, meaningful or capable of consistent interpretation.

The most telling recent statement on this has been the Local Authority Associations' memorandum on the development of energy resources (LAA, 1983). They note that lack of clarity of national energy policies creates problems for the inclusion of energy provisions in development

plans. In respect of the coal industry it is argued that without any central indication of the overall levels and the balance between deepmined and opencast coal it is impossible for local government to take proper account of physical and environmental factors in its plans. More generally, if plans for a major energy-related development are not clear enough to be revealed when a development plan is proposed or revised, it is difficult for planning issues to be brought before the public in other than an ad hoc and unsatisfactory manner upon the announcement of the project itself. Equally unsatisfactory is the way in which the major problems associated with generic issues related to national need or acceptable risk are raised at public inquiries for site-specific proposals. Their introduction, it is argued, escalates beyond all justifiable proportions the length and cost of inquiries, and necessitates that highly specialised and technical issues must be settled in an adversarial context.

The Associations appear to suggest that this problem can best be resolved by a return to the regular production of White Papers or Green Papers on energy policy, which could then provide the necessary scenario against which to plan for infrastructure. Consequently, the land requirements of the energy supply industries could be more fully considered in the context of forward plans, which would in turn ensure a better framework for the assessment of planning applications for individual projects. The Associations' recommendations are no doubt couched in the light of existing institutional arrangements, but the environmental assessment process itself provides an opportunity to upgrade existing procedures for the evaluation of mining and other energy-related proposals.

The Nature of Environmental Assessment

Environmental impact assessment has been described as a package of methods whose collective purpose is:

"...to identify and predict the impact on the biogeophysical environment and on man's health and well-being of legislative proposals, policies, programmes, projects and operational procedures, and to interpret and communicate information about the impacts" (Munn, 1979).

An environmental impact statement should contain a discussion of the likely adverse impacts which are unavoidable should the proposed development proceed, alternatives to the proposed action, relationships between long- and short-term benefits from site use, and any irreversible or irretrievable commitments of resources should the proposal be implemented. A major part of this activity will entail:

"...(the establishment of) quantitative values for selected parameters which indicate the quality of the environment before, during and after the action" (Heer and Hagerty, 1977).

EIA is not, however, merely another obstacle to the development process, and there is widespread acknowledgement that it has helped positively to improve the quality of major actions, especially where the environmental and engineering design teams have worked in close collaboration from the outset. Thus, its two major purposes are to assist in the enhancement of the design of the proposal (including the selection of the most appropriate planning conditions) and to help choose amongst alternative projects and locations (Lee and Wood, 1978).

Whilst EIA may be associated with delays, therefore, it may also form the basis of improved procedures. In general terms, Clark et al. (1981) have identified the benefits of integrating environmental assessment routinely into the planning process. A number of advantages come under the "development control" heading: thus, it assists study of the long-term effects of introducing non-conforming uses, it reduces the possibility of having to revoke a consent, it assists in identifying planning conditions and in establishing the relationships between planning and other statutory controls, and it can aid integration of individual development control decisions. In terms of public participation, EIA makes government more open, and provides a basis for streamlining public inquiries and appeals. In respect of forward planning it can assist in site selection and alternative site appraisal and may be integrated with the plan making and survey processes.

To be effective, EIA should be implemented at an early stage of project planning and design. In the USA, preparation and circulation of the draft assessment must occur as early as possible in the review and design process, but in all cases before the first significant decision point is reached (s102(2)(c), National Environmental Policy Act 1969). Preferably, EIA should be an incremental decision-aiding process, incorporating continuous feedback between findings, project design, operation and de-commissioning.

The drawbacks of not having a sound EIA system are alluded to by North and Spooner:

"Certainly the Belvoir EIA was elaborate, but its methodology, excluding such key variables as housing and subsidence, has already been publicly criticised...It certainly does not conform to many of the standards advocated by the DoE's own experts...not least in being open to the charge of bias towards the NCB (by whom it was commissioned). No EIA was published for Selby, and if the 'brilliant' design is environmentally pleasing this seems to be due as much to the combination of favourable circumstances as to a proper public consultation planning procedure and environmental assessment exercise. If there was an EIA did it include the impact of miners' housing and of rerouting nearly 20 kilometres of main line railway? The answer is of course no - hence the protracted squabbles over these matters after the public inquiry" (North and Spooner, 1982).

A wide range of attributes for EIA methodology have been advanced (Golden et al., 1979; Munn, 1979; Keeney, 1980; Lee and Wood, 1980) which may briefly be summarised here. First, any framework should be consistent, adaptable, comprehensive, replicable and explicit, and should establish impact indicators, provide confidence limits to forecasts, and adopt a suitably wide frame of reference. Second, it should permit aggregation of impacts, possibly via a common unit of measurement, thus enabling alternatives to be compared; the impact measures should be susceptible to weighting and allocation to affected groups. Third, the scope of the assessment should be identified, in terms of the range of impacts to be included. This stage of "scoping" has recently gained

considerable prominence in the USA as a consequence of a reivev of the EIA process by the Council for Environmental Quality (Legore, 1984; Haug et al., 1984). Decisions to omit impacts from consideration on an irrational basis may meet with suspicion - as, for instance, occurred over the exclusion of housing and subsidence from the Belvoir EIA (Leonard and Partners, 1977), on the grounds that these would be common to all strategies. Fourth, impacts and projects should be tiered according to their significance: the EEC draft directive on EIA, for example, refers to projects made significant by virtue of their nature, size and location. Finally, it is generally agreed that the sequence of EIA should adhere to preparation of the draft report, public discussion of the draft, preparation of the final report and post-development monitoring and auditing.

Projects for which an EIA or a full appraisal would be inappropriate can be identified by the application of "screening" procedures. Thus, proposals can be screened out - that is, exempted from full or even restricted EIA - if they are of insufficient magnitude. A variety of criteria have been intimated for this purpose, mainly reflecting the scale, incompatibility, controversiality or unneighbourliness of the proposal.

The first significant stage of EIA is that of impact identification, and a number of frameworks have been designed to assist this task, in particular interaction matrices (e.g. Leopold et al., 1971), networks (e.g. Sorensen and Moss, 1973) and environmental evaluation systems (Dee et al., 1973). Without entering into the details of these approaches, it is suggested here that matrices are the most workable, comprehensible, widely applicable and relevant to non-ecological impacts. A composite approach tailored to the British planning system and incorporating a detailed format for project specification and a summary matrix distinguishing between constructional and operational impacts has been prepared by Clark et al. (1981). This is often referred to as the

Project Appraisal for Development Control - PADC - manual, and its matrix is shown in Figure 3.2. (Strictly, the title "PADC" has been superseded, as the proponent team now calls itself "CEMP" - Centre for Environmental Management and Planning - although the older acronym is still generally used). In the case of mineral workings it has been noted that, whilst there may be no distinction between construction and operation, the restoration phase should be separately displayed (Murphy, 1979).

Following the identification of impacts, the assessor must attempt to derive reliable forecasts of the magnitude of impact. In many cases, resort has to be made to subjective assessments and, whilst this is second best, Lee (1982) argues that it is acceptable provided: there is an objective basis to the qualitative information (i.e. it is not a cover-up for inadequate data); it is sufficiently differentiated and the terminology used is interpreted consistently so that rankings can be established; and decision-makers are afforded a sufficiently clear indication of the differences between alternatives. Indeed, quantification, whilst imparting an air of objectivity to an appraisal, may, if it is used as an excuse for indiscriminate aggregation, result in individual impacts being poorly identified and contentious issues being masked (Bisset, 1980).

EIA for mineral developments must necessarily be limited in what they can achieve, since the location of deposits severely restricts the scope for manoeuvre. Down and Stocks (1977) consider that, in relation to mineral planning, an EIA should contain: an expression of the nature and extent of the impact; a definition of acceptable standards and criteria; a comparison of the measured or predicted impact against the relevant standard; and identification of remedial measures, where necessary, to reduce impacts to within acceptable standards. A number of problems arise even with this limited set of objectives, however, since for many types of environmental phenomena there are no consistent and accepted techniques available for impact quantification, well-defined and generally accepted criteria exist for only a minority of

CHARACTERISTICS OF THE PROPOSED DEVELOPMENT		OPERATIONAL PHASE																
		Hazard	Solid waste disposal	Aqueous discharges	Dust and particulates	Odours	Gaseous emissions	Vibration	Noise	Transport of products	Transport of employees	Transport of raw materials	Employment	Local expenditure	Water demand	Severance	Structures	Immigration
Characteristics of the Existing Situation		CONSTRUCTION PHASE																
		Hazard	Solid waste disposal	Aqueous discharges	Odours	Gaseous emissions	Noise	Vibration	Water demand	Local expenditure	Employment	Dust and particulates	Site preparation	Transport of employees	Transport of raw materials	Severance	Immigration	
Climate																		
Land uses																		
Water quality																		
Landscape quality																		
Ecological characteristics																		
Population density																		
Tourism																		
Employment structure																		
Unemployment																		
Local economy																		
Traffic																		
Water supply																		
Sewerage																		
Finance																		
Education																		
Health service facilities																		
Housing																		
Emergency services																		
Community structure																		
Culture																		

Figure 3.2 "PADC" manual impact matrix.

environmental problems, and there may be no remedial measures against a certain type of impact. Nevertheless, mineral EIAs may in broad terms assist in ascertaining the optimal level of production, the timing of development, the technology for extraction and the environmental terms on which development would be acceptable (Tomlinson, 1981b).

One feature of the development of project appraisal in practice has been the preparation of agency-specific manuals. In particular, experience in the USA has shown these to be useful to agency staff in translating the generalised requirements of the National Environmental Policy Act, Council for Environmental Quality guidelines and agency guidelines into detailed advice (Clark, 1983). Similarly, the British Gas Corporation has devised its own impact appraisal procedure for the various installations and activities associated with the industry (ENDS, 1978), whilst the Department of Transport has published a manual for the assessment of new trunk roads (DoT, 1983). The NCB has published assessments for deep mines, notably those commissioned for Belvoir and Park, the coverage of which is summarised in Table 3.5. The environmental appraisal of Park was little more than a prospectus, but even the much more substantial Belvoir Prospect drew criticism. In response to these shortcomings, the Board's Operational Research Executive has prepared a compilation of review papers on EIA, but these remain confidential. At present they give consideration in a limited manner to a restricted range of impacts - visual intrusion, noise, ecology and landscape - although one for agriculture is currently in preparation (Read, pers. comm., 1984). However, these are not intended as EIA manuals, but rather as a form of guidance to middle managers on the types of environmental issues which might be encountered.

Finally, it must be acknowledged that serious problems arise over the conduct of a project assessment. Most EIAs carried out to date in Britain have been prepared by the developing agency or their consultants. Rohe (1982) has pointed out some of the fairly obvious risks in accepting agency-sponsored studies: they are generally conducted in a rather covert manner, they typically consider only a single alternative

<u>Topics covered</u>	<u>Belvoir Prospect (Leonard and Partners, 1977)</u>	<u>Park Colliery (Land Use Consultants, 1977)</u>
investigation of alternative sites	x	x
appearance of buildings	x	x
neighbourhood intrusion of buildings	x	x
waste disposal	x	x
traffic and transportation	x	x
foul and surface water drainage		x
employment		x
noise		x
air pollution		x
induced development		x

Table 3.5 Topical coverage of environmental assessments of proposed collieries in the Vale of Belvoir and at Park, Staffordshire.

at a late stage in the planning process, they adopt a restricted range of impacts, and often exclude non-quantifiable and secondary impacts, especially if these are unflattering to the development proposal. These problems may be somewhat lessened where there are formal arrangements for a statutory authority to vet the assessment, although it has been suggested that this may involve the control agency in as much work as if it had carried out the original study itself. The option of planning departments themselves conducting the EIA is often ruled out on the grounds of lack of expertise; however, this objection may be weaker now that county/region planning departments increasingly appear to be performing a specialist intelligence role. The third, and most workable, option is for a kind of "flying squad" - the Project Inquiry Commission suggested by the Outer Circle Policy Group (1979) - although the government appears to be exceedingly cool on this idea. It is outside the scope of this study to investigate which of these alternatives might be the best; suffice to say that the availability of a study of generic impacts and a standardised appraisal format would afford least opportunity for the presentation of an unbalanced case.

With regard to plan environmental assessment, various potential advantages of its extension to mineral developments may be hypothesised. First, where baseline data have been systematically collected and evaluated on a consistent spatial basis, planning authorities may more confidently engage in the definition of "consultation areas" with operators. Second, a useful function of strategic assessment would be to establish acceptable operational and post-operational standards, and to express these as measurable indices; this approach has been used elsewhere in development control and succeeded in conferring on it a more positive image. And third, systematic isolation of the most appropriate sites for production could aid a more locationally sensitive development strategy, and indicate more clearly the cumulative impacts likely to be associated with minor incremental approvals. This might readily be extended to include a joint identification of sites for extraction and re-working, and of abandoned sites for waste disposal (e.g. Borders Regional Council, 1983).

The functions which a plan environmental assessment should perform closely parallel those of project appraisal, namely the identification, quantification, weighting and aggregation of impacts. Lee and Wood (1980) have also contended that the generation and evaluation of alternative draft plans parallels impact interpretation, whilst plan decision, implementation and monitoring correspond to impact communication. The major differences lie in the greater degree of generalisation and the broader spatial and temporal range of the former.

Conclusion

It has been noted that, whereas Britain possesses a varied and extensive approval procedure for mining operations, there is a growing case for more thorough environmental assessment. Moreover, there is evidence that project appraisals, which can effectively only consider siting factors, should form but part of a tiered system taking into account broader policy and strategic factors. At the top level, policy review would establish the need for opencast or deep mined coal and identify trade-offs between energy need and agricultural implications. Beneath this, a plan EIA could evaluate key factors relevant to the agricultural and mining interests of the region, as well as any regional distinctiveness of products or strong orientation to markets. These two stages would assist the identification of preferred areas for mining operations. Finally, a project or class EIA should be undertaken if local circumstances so prevail.

It has also been noted that a generic study, identifying the key impacts and their means of appraisal, can provide an overall framework for systematic and informed study. A review of generic impacts and applicable forecasting techniques is thus presented in the next two chapters, before moving on to a discussion of possible EIA formats.

CHAPTER FOUR

AGRICULTURAL IMPACTS - IDENTIFICATION AND DESCRIPTION

Introduction

Agricultural impacts have been comparatively little studied in EIAs and in those assessments where they have been considered it has generally been on a straightforward land/stock/crop loss basis (e.g. Davidson and Partners, 1979), which fails to reflect the diverse nature of the disruption liable to occur. A great deal of consideration was given to the most convenient and logical way to classify the generic agricultural impacts of mining; eventually it was decided that it would be most helpful to relate them directly to the entries in the baseline axis of an impact matrix (i.e. the row entries). For the sake of consistency with emerging planning practice, it was felt desirable, if somewhat restrictive, to model the categories on the PADC manual, although this at first yielded an unhelpfully general and vague set of descriptors.

However, the most recent version of the manual demonstrates that the basic matrix may be expanded to highlight particularly complex areas without upsetting the overall structure (Figure 4.1). Thus, the approach adopted was to abstract the relevant initial baseline categories and to express these in more specific terms with respect to farming (Table 4.1). This at once provides an adequate differentiation of impacts for a generic study without divorcing the appraisal of farming impacts from a master EIS which might be being carried out in parallel. A summary of the baseline description developed in this chapter is provided in Appendix A and its interpretation in respect of the Asfordby prospect area in the Vale of Belvoir is set out in Appendix D.

Characteristics of the Proposed
Development

	CONSTRUCTION PHASE		OPERATIONAL PHASE	
	Noise	Vibration	Noise	Vibration
Characteristics of the Existing Situation				
Housing Schemes				
Ancient Monuments				
Educational Establishments				
Isolated houses				
Hospitals and Old People's Homes				
Important Habitats				

Figure 4.1 Example of an expanded matrix, PADDC manual
(source: Clark et al., 1981).

Initial Baseline
Descriptors

Expanded Matrix
Baseline Descriptors

Land uses

farm land

farm livestock

farm crops

Housing

farm buildings

Traffic

farm traffic

Local economy

farm economy

agricultural industries

Employment structure/
Community structure

farmers and farm workers

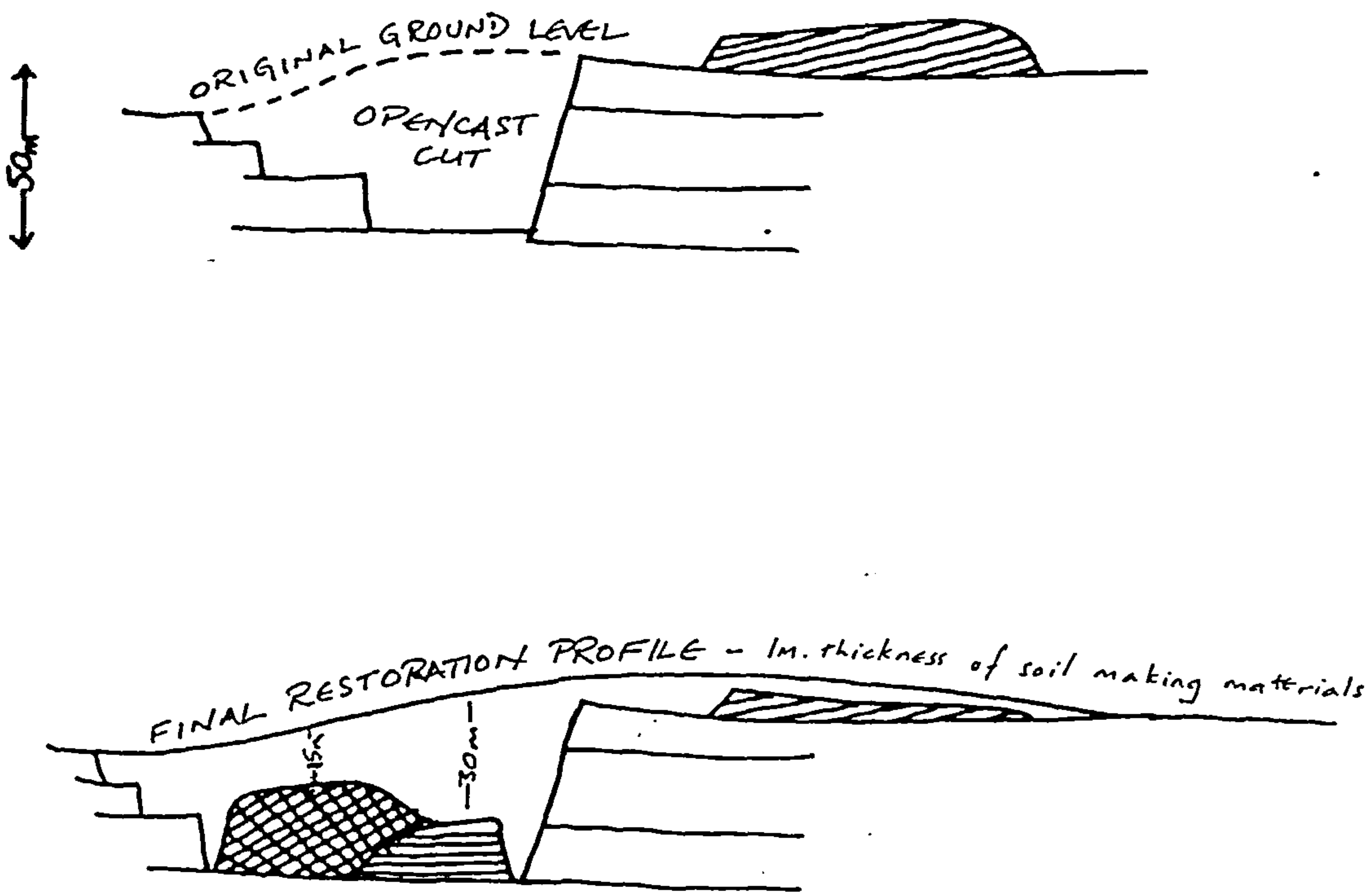
Table 4.1. Relationship between categories in master EIS
and expanded matrix.




Land Use Impacts

Farm Land - topsoil impacts

By far the greatest proportion of spoil is tipped on land. Figures for the mid-1970s indicate that 50mta (some 88 per cent of all spoil tipped) was deposited on land, of which some 4mt was used in local land reclamation projects. A further 7mt (12 per cent) was tipped offshore - a figure which has since declined - and 0.5mt was removed from existing tips for commercial uses (Flowers, 1981). NCB estimates indicate a need for 200ha for every 50mt produced (NCB, 1979a) although this ratio may change in the future; in some parts of the country this is leading to land being lost more quickly than it is reclaimed (Barnsley MDC, 1979; West Yorkshire MCC, 1979). Remote disposal in abandoned mineral workings may become more attractive in the future providing problems of phasing can be overcome: the spoil must be generated on schedule for quarry restoration work, yet experience currently seems to suggest that it is produced slower than sand and gravel are extracted. Where opencasting is taking place in former deep mining areas, the replacement of much of the surface waste in the excavation may be practicable. However, in the case of new deep mining projects, frequently distant from traditional areas, the scope for this is very limited.

An example of joint opencast working and tip reclamation is provided by the Norrells Site, near Denby, Derbyshire (NCBOE No. 5 Region, Drawing No. 05/9902, Contract 11/024). Authorisation was given in 1975, and the site covered 156ha. Parts of the site comprised undisturbed farmland, parts had been previously worked in the 1950s and restored to an indifferent standard, whilst at the southern end remained two tips from the Denby Drury Lowe Colliery which comprised over 800 000m³ of pyritic spoil producing acidic run-off. On completion of coaling in the middle of the site, the floor of the final void was lined with clay and the top 1m of weathered spoil from the two tips was stripped off and brought onto the compacted clay floor. As further tip material



-  original spoil
-  weathered spoil
-  unweathered spoil

spoil naturally produces acid leachate on oxidation, draining as an ochreous discharge; in the final restoration, all spoils are capped with 1m thick clay

ABOVE: opencast workings and colliery spoil
 BELOW: completed restoration

Figure 4.2. Restoration provisions at Norrells Site, Derbyshire. (Source: NCBOE).

was infilled, the sides were progressively sealed with clay and, on completion, the top was similarly capped. The surface of the remaining in situ tip material was graded to 2m below the final restoration profile and over this was placed a 1m depth of compacted clay. A further 1m depth of soil and soil making materials was placed over the finished surface for use as the agricultural growing medium (Figure 4.2).

with respect to opencasting operations, in general the average site is about 110ha (including worked area, processing, transport and despatch, and earthmoving), yields 200 000ta, produces coal for four years and then undergoes a five year restoration period. Thus, assuming an annual output of 15mta opencast coal, a requirement of 8 000ha at any one time, with 10 000ha undergoing restoration, would be anticipated, which conforms well with the estimates published by the NCB. Other authorities, such as the Royal Town Planning Institute (1979), have suggested a significantly higher figure, which appears to be arrived at by assuming rather larger site sizes and longer (and perhaps more realistic) restoration periods. Tomlinson (1980) found that in 1978 there were some 18 400ha in active use of which some 5 800ha were undergoing active restoration (presumably excluding those at the after-care stage), which would appear to give credence to the higher estimate. On the basis of a 15mta target output, however, approximately 70 sites could be expected to be active at any time. Any such forecasts must be treated with caution, however, as the ratios of output to area may alter. For instance, at present, for every hectare of land excavated or used for roads, buildings, etc., a volume of about 3 000m³ of topsoil and 6 000m³ of subsoil must be stacked, but this may well increase in the future, since overburden ratios are changing, leading to a requirement of more land for stacking, as thinner seams at greater depths become economic.

Critics of opencast restoration work have suggested that certain crops may no longer be viable on affected land, and this may inhibit rotations which may in turn lead to further degradation (Brocklesby, 1979), whilst a survey in "Farmers' Weekly" revealed that many farms disturbed by opencast have a productivity of only 40 per cent that of adjacent land

(Balchin, 1982). The major physical characteristics of restored land include high bulk density and a weak, poorly structured soil especially in the early years, zones of compaction in the soil profile, increased stoniness, and reduced depths of topsoil and subsoil above the overburden. Some improvements may occur, particularly with respect to micro-topography, field boundaries and uniformity of soils. Settlement of a site may delay the establishment of permanent drainage and this may be becoming a more serious problem as economic dig ratios increase and lead to a general raising of levels. It may also be difficult to plan for the optimum restoration programme - drought conditions in 1976 produced a desperate shortage of fodder, resulting in high prices which farmers disadvantaged by opencasting could not afford, so that many of them had no option but to leave cattle for an inadvisably lengthy period so long as there was any grazing at all.

In the case of deep mining, the major land use impact has been associated with surface disposal of wastes. On old tips, the main problems have been associated with actual and potential acidity, polluted drainage water, instability, spontaneous combustion, desiccation and gullyng. These effects, although they may be locally problematic, are much reduced in modern designs due to the flatter profile (although this also means that more land is lost), greater compaction, and distribution of a loose layer of discard on the spoil prior to soil replacement. Each site tends to raise its own restoration problems. At Belvoir, concern was expressed over the difficulties of handling the clayey soils at Hose and of their susceptibility to structural change (Craig, 1979), the high pyrite content of the spoils, although this could be overcome at individual sites by deep burial of the spoil or neutralisation with calcium-rich soils (Worthington, 1979), temporary drainage problems where tipping took place over outfalls, and exposure, as at Cotgrave, where a spring barley crop on restored land had recently been flattened by a gale (Burford, 1979).

A particular problem arises if "tailings" are produced, comprising fine particles disposed of into lagoons. If the discard remains soft and wet, reclamation may be considerably delayed. Disused lagoons may be in several different states, but two particularly difficult conditions may be encountered (Tandy, 1975): either saturated and with deep water lying over the silt because of a blocked pipe, or dry and cracked with a pool of polluted water lower down the slope in cases where the retaining bank has not proved entirely sound. Material less than 0.5mm is, in the first instance, in suspension in the colliery circuit and may be treated by a froth filtration process to recover the coal fraction, producing a waste reject (i.e. the tailing). Over the years the number of froth filtration plants has increased and, at collieries producing coking coal, tailings form 15-20 per cent of total waste. This is unlikely to increase further, although if the trend towards cleaner power station coal continues, fines treatment may be installed at more mines. Pressure filtration is the main alternative to lagoons, and it was proposed to use this method at Belvoir, and to layer the tailings cake in the tips. This is currently a very expensive option, but research into making it more generally viable is continuing.

The severity of land take impacts will depend not only on their magnitude, but also on the success of new methods of tipping and restoration. Too little evidence is available from sites which have benefited from direct transfer of topsoil and progressive restoration to reach firm conclusions and, even with such sites, land cannot be expected to regain full fertility for 20-30 years, if ever. Tip design must also take into account flexibility, in particular the ease with which an extension of tipping can be accommodated and the degree to which the amount of land out of productive use at any one time can be minimised. Thus, even though tips may be identified and scheduled for tipping periods of up to 50 years, they may only occupy limited zones of 20ha within the scheduled area at any period. A comparable approach has been developed in the Ruhr, known as the "step-pyramid" design, in which waste is tipped from the periphery to the centre of the dumping area, making reclamation of the perimeter possible from the early stages. A second platform is then tipped on this, leaving the outer (reclaimed) slopes unaffected. This pattern is repeated until the tip reaches the desired height (Chadwick and Lindman, 1982).

A typical modern tipping scheme is provided by the Markham Main Colliery, near Doncaster, South Yorkshire, which represented an extension of 29ha to an existing tip. The site comprised land of ALC Grades 2 and 3a, and a soil survey was conducted to reveal the depths and characteristics of topsoil, subsoil and soil making materials. Prior to stripping, topsoil is to be tested in order to evaluate the ameliorants to be incorporated during storage, although direct transfer methods will be utilised wherever possible. Post-restoration land uses will, however, differ from those on the undisturbed site. Most significantly, the tip margin gradients will in places be so great as to automatically place land into ALC grade 5: these slopes will most suitably be returned to forestry. Gentler slopes (1 in 5 - 1 in 8) will prove suitable for grassland and are anticipated to achieve ALC grade 4 or 3a. Slopes of 1 in 8 or better should eventually prove suitable for sustained cropping and may be equated with ALC grades 3b or 3a (Figure 4.3) (NCB Doncaster Area, Plan M/12-33T 3301 A, 1982). It may be observed that, even with a minutely specified and closely supervised restoration there is an enduring agricultural impact in terms of permanent reduction in land quality. Many commentators would be of the opinion, however, that this case appears particularly bad in terms of the original high grades of the undisturbed land: restoration to original productivity has generally been achieved more satisfactorily where ALC grade is of 3b or lower.

On both tip reclamations and opencast restorations, various studies have identified problems of poaching, difficulty in obtaining a tilth, surface erosion and gullying on the steeper gradients, soil cracking in dry weather and low earthworm activity, the major contributory causes being admixture of topsoil and subsoil, mechanical manipulation of soils under unfavourable moisture conditions and loss of soil micro-organisms (Hunter and Currie, 1956; Batey and Davis, 1971). Bulk density of the soil increases with depth in the storage dump and is influenced by the textural grade of the soil (Miller and Cameron, 1976), with finely textured soils being most sensitive to loss of structure. Effects

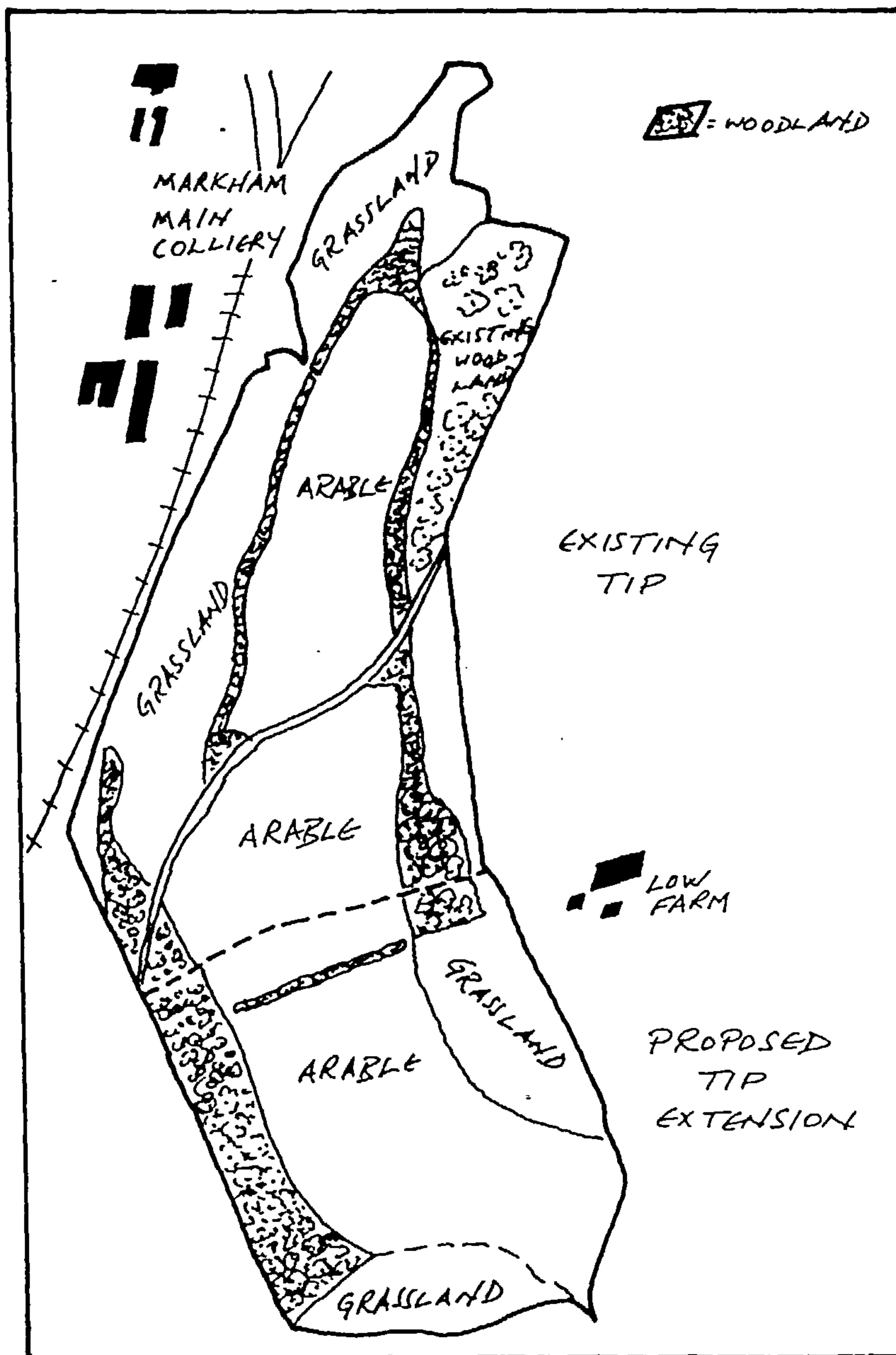
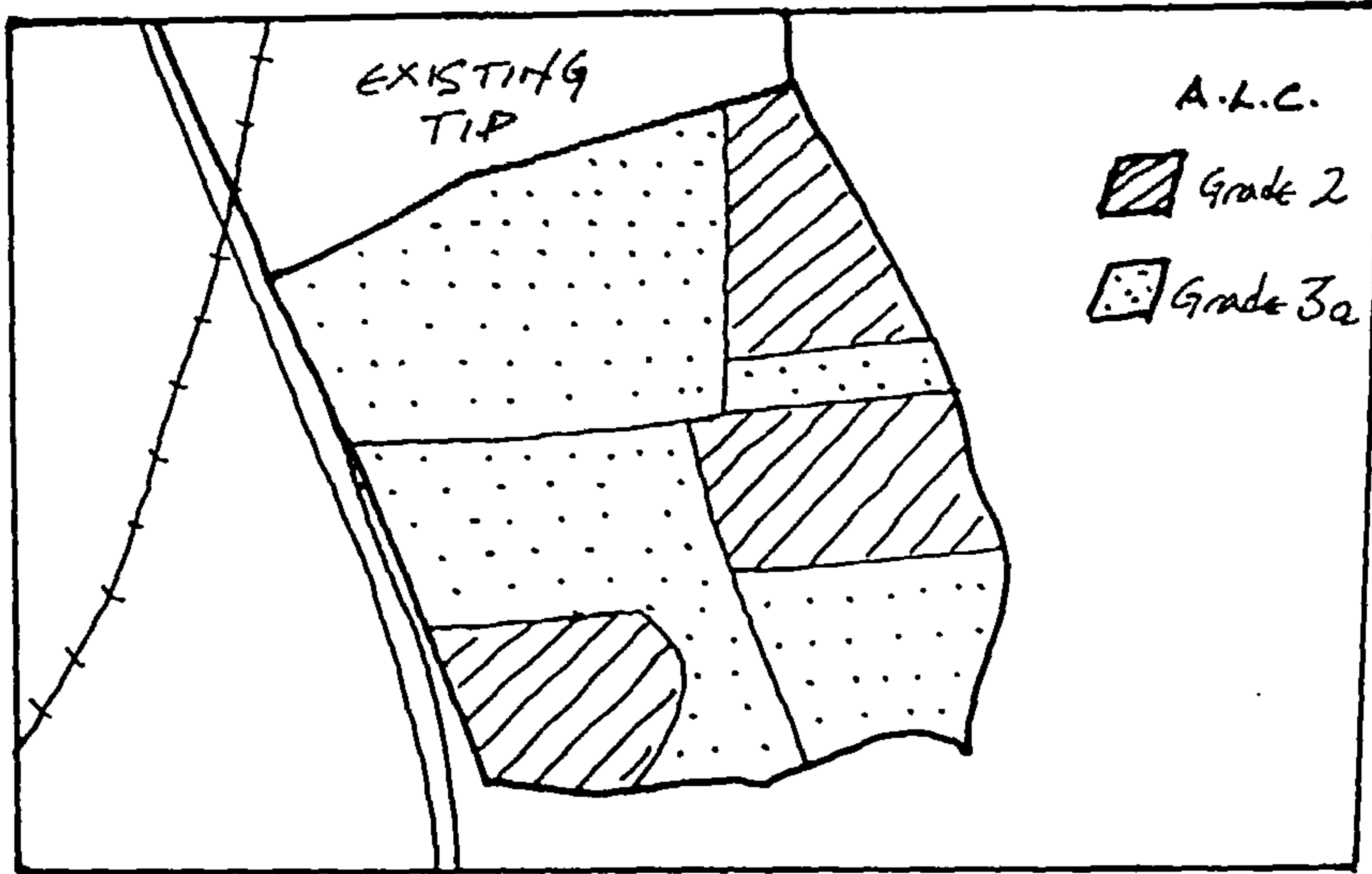


Figure 4.3. Agricultural land quality, tipping and restoration proposals at Markham Main Colliery, South Yorkshire (Source: NCB).

on soil moisture are less clear: one study (Fisher, 1976) reported a negligible impact, whilst another (Miller and Cameron, 1976) recorded a reduction in water holding capacity from 75 per cent in undisturbed soils to 45 per cent in disturbed ones. Generally, a coarse textured, free-draining and weakly structured soil may be moved with a higher moisture content than a finely textured one. Wet soil is easily rendered impermeable to air and water leading to anaerobic conditions which inhibit entry of plant roots, and this is a serious problem which cannot be corrected by normal underdrainage provision.

Land requirements for ancillary development are more speculative in nature. Watt (1979) noted that there was an accompanying demand for coal-fired power stations on prime farm land, since they required low relief and good drainage. At Selby the experience was one of repeated upward revisions of housing targets to accommodate the incoming miners (Arnold and Cole, 1981), and land requirements to house the workforce were not presented in detail until the public inquiry. In Belvoir, it was generally agreed that around 250ha of farmland would be needed for housing, roads and associated facilities, and open space. No figures were produced for losses associated with multiplier employment or for temporary losses arising from exposure of gas mains during subsidence and from the laying of a process water pipeline. Land take (albeit not all agricultural) for rail links would total 52.5ha, whilst estimates for off-site landscaping at the collieries varied from a total of 28ha (NCB) to 100ha (Leicestershire C.C.).

Farm Land - subsidence impacts

Further disruption of farm land would be caused by mislevelment of land drains as a result of mining subsidence. The effects of subsidence on main rivers depend largely on the topography of the area, with lower bed gradient leading to increased liability to flooding and silting, so that embanking of rivers prior to undermining or regrading thereafter may be necessary. It has been suggested that colliery spoil could partly be used in the construction of embankments. In some fields, however, cattle are dependent on watercourses for drinking, and in cases where the channel is to be deepened rather than embanked, special provision may have to be made.

Intermediate drainage channels within a given area may in places have little fall and here subsidence could have an adverse effect; if regrading and embanking are ineffective, internal gravity drainage may have to be re-established at a lower level and a pumping station constructed to lift water from the subsided area, with automatic pumps being installed at farm level. Particular problems arise in the Forth Valley where there are tidal valves, with their outfall between high and low water marks. Thus, even though subsidence has been relatively small in this region, there are critical areas in which even slight changes have had adverse local effects. In parts of South Yorkshire, it is reported that stretches of some rivers have been affected on numerous occasions and are reaching the limits within which remedial action to the banks can be taken. Equally, there are many areas with good bed gradients where disruption will only prove temporary: once the coal face has passed through and beyond the locality, the ground may afterwards return to its former disposition but, of course, at a lower level.

Further problems may arise at the field level: often there is uncertainty as to where all the land drains are located; ditches may serve more than one landowner, and there may be difficulties in securing agreement on the treatment of the channel as a whole; subsidence may cause ill-drained depressions and regrading them might give rise to soil erosion; where land is left flooded, soil structure may be adversely affected, and this is often virtually unavoidable during the period of subsidence; whilst tile drain systems may be rendered ineffective if the receiving watercourse has not been affected by the same amount as the field drainage system. The most favoured temporary remedial measures generally appear to comprise mole drainage or the laying of permeable fill. New permanent drainage schemes should display such features as laterals laid with outfalls direct to ditches (except in fields frequently used for grazing), plastic pipes, and permeable fill over the pipe system (Miers, 1979). It is maintained that if the main watercourse and internal system are appropriately modified, large areas of agricultural land can be undermined without adverse effect on field drainage (NCB, undated c).

Differential subsidence may cause the water table to approach the surface locally, or the field drains and receiving watercourse to be at different levels; similar problems are associated with the "corrugation effect" sometimes created over mine roadways. Such phenomena can hinder practical farming - wet and cold patches can cause poor crop growth, increased gradients can rule out the use of farm machinery, soil erosion may occur (especially where regrading is necessary) and cracks may appear in the land surface. Fissuring and gross changes in level may also spread the soil more thinly; this is most likely to be associated with land where a thin topsoil and subsoil overlie massive sandstones or limestones in which the reaction to horizontal ground strains is concentrated at the major joints.

canals may also serve a land drainage function: in Belvoir it was argued that the Grantham Canal might require infilling, culverting or substantial embanking, together with corresponding works on streams and drains flowing into or beneath it (M. Smith, 1979). A number of farm drainage culverts also run under the canal and would have to be extended in length and repaired as the embankments were raised and strengthened; any existing ditches running parallel to the new embankments would have to be moved further away and clear of the proposed earthworks, and measures would have to be taken to ensure the unobstructed flow of ditches presently draining naturally into the canal (Stokes, 1979).

Where pipelines cross the land and must be exposed during subsidence, inconvenience, lost production, severance and irregular shaped fields can be caused. In addition, there are frequently continuing problems of fertility and drainage after infilling, and instances have arisen where pipelines have been laid at insufficient depth to ensure non-interference with the laying, or subsequent improvement, of drains. Thus, it has been advised that, wherever possible, pipelines should be confined to roadside verges and laid in juxtaposition. It was also noted at Belvoir that diversion of the gas pipeline adjacent to the proposed Hose pit could destroy Hose Land Farm's effluent disposal

system and cut across all the land drains in the home fields. In addition to these effects, construction activities may themselves cause extensive damage to land drains, and reinstatement is often unsatisfactory (Hearne et al., 1977).

Impacts on Farm Livestock

Farm livestock may be disturbed by noise from industrial development, and it would appear that those most likely to be affected are dairy cows and battery hens. Very high levels of steady noise (90dB+) appear to have short term effects on dairy cows, although levels of 80dB seemingly cause no reduction in milk yield (Kovalok and Sottnik, undated, reported in Jones, 1979). High levels of impulsive noise, such as those associated with unconfined blasting, may also tend to startle and may temporarily affect milk yield. Poultry may be similarly affected (Charles, Powell and Dun, 1971). Typical noise levels in a battery, however, are 63dB(A) at night and 72-75dB(A) when the birds are calm after feeding during the day, rising to 90dB(A) during the excitement of a passing feed trolley. Most mining operations should be within these maxima, and the experience at Blackwood Hall Farm near Riccall (Selby coalfield), where laying and rearing houses are 500m and 300m respectively from the shaft, has indicated no adverse effect on egg production or incubation.

However, one dairy farmer near the Wistow site (Selby coalfield) claimed that construction noise built up to such a peak that milk yield was adversely affected and he was forced to sell the herd and convert to arable. Farmers at Belvoir voiced further concern about noise from rail links to be constructed close to livestock units and about disturbance to laying stock during blasting for mine shaft excavation: poultry must be vaccinated regularly, but this cannot take place when they are under stress.

The need to expose the gas pipeline during mine operations or to lay water pipelines could introduce the possibility of transmission of contagious diseases of farm livestock. This can normally be dealt with by suitable precautionary measures including the use of disinfectant procedures for all personnel and vehicles, and careful control of access and "working width" (Stevenson, 1982, pers. comm.).

Impacts on Farm Crops

Apart from the direct loss of cropland, crops may be affected by pollution of farm water supplies, air pollution arising from coal conversion and end-use processes, and appropriation of water supplies. A compounding problem which has arisen in arid areas is that soils which have been stockpiled tend not to be suitable for conventional irrigation.

Appropriation of water supplies is primarily associated with arid regions (Rechard, 1975), especially where opencast mining is envisaged. A coal excavation may be considered as a large diameter well to which water from the surrounding ground will flow and, although the transmissivity of coal is not large, it may be sufficient to lead to de-watering of domestic stock wells in the vicinity during the mining period. In the case of deep mining, there is a small possibility that subsidence may affect the disposition of aquifers leading to a diminution of supply from, or the migration of, springs. This potentiality was a cause of concern to the Belvoir estates, even though the amount of licensed supply suggested that considerable changes in the aquifer transmissivity would be necessary before yields would seriously be reduced by ground movements. It has been reported from Pennsylvania that some shallow wells in mining areas have experienced reduced production (Lee and Abel, 1983). In one instance, a mine face passed within 30m of a 20m-deep well which went dry; however, deepening the well by 12m restored a good supply of water (Sossong, 1973).

Further, substantial quantities of water are used for dust suppression and pipeline slurries (from which it is not generally economic to return the water for re-use). Winder and Lochner (1974) observe that cumulative regional impacts for water demand should be considered - including those from, for instance, coal-burning power stations - and for one site in Wyoming this could have resulted in a loss of roughly six per cent of water available to farmers, in turn leading to a 67 000t reduction in the production of hay.

Polluted water escaping from opencast sites may also have deleterious effects on farm water supplies. At the Westfield site in Fife, high concentrations of solid matter were found to be remaining suspended in the various site waters; after this was remedied by the appropriate chemical treatment, the site was subsequently found to be producing increasing amounts of ferruginous groundwater. The Annual Reports of the Forth River Purification Board (1975-1982) indicate that seven complaints of polluted drainage waters from opencast sites had arisen in 1975, four in 1976, seven in 1978 and two in 1980. Below the confluence of the Lochty and Ore severe pollution by ferruginous waters from Westfield was noted in 1975; the following year the condition of the river bed below this point was described as "blanketed with ferruginous silt". The pilot plant for treatment of ferruginous water had suffered mechanical difficulties and had only operated intermittently and the largest source of such water - from the excavation itself - had not yet been subject to treatment at all. Heavy rain periodically intensified acid ferruginous conditions in the site waters. From 1976 a considerable rise in suspended solid levels was recorded and, although special treatment plant had been installed to permit the solids to settle out, it was found that these were very easily disturbed by wind-induced turbulence. The most recent Annual Reports, however, indicate an encouraging improvement in the quality of these discharges.

In respect of underground mining, workings which possess hydraulic conductivity with the surface present a continual problem of mine drainage, but deeper mines are often hydraulically confined by shales and faulting so that they tend to produce water only in proportion to the quantity of coal extracted (NCB, 1979b). The largest volume of minewater is produced in South Wales, Scotland and North East England and the least in the Midlands. Amounts of water pumped vary greatly from mine to mine: in shallow workings the ratio of water pumped to saleable coal may be as high as 30:1 but for deep workings as low as 0.001:1.

During the mining process, waters which enter workings from adjacent strata become contaminated with coal and clay particles and with the soluble oxidation products of iron pyrite present in the coal measures. Contamination by iron compounds arising from oxidised pyrite cannot be prevented so long as this is exposed to atmospheric oxygen: the only satisfactory means of completely excluding air is to flood the working with water, a remedy seldom practised in a working mine although one widely employed after abandonment.

Once pithead pumping has ceased, following colliery closure, water levels gradually rise and water, rich in iron salts, reaches the surface through "day levels" and faults, potentially causing substantial pollution of streams by the precipitation of red-brown ferric hydroxide. A particular difficulty associated with this phenomenon of "water table rebound" is that its full extent, and the location of future discharge points cannot be predicted. This problem has been experienced acutely in Fife Region, where stretches of rivers have been rendered grossly polluted by ferruginous discharges (Fife R.C., 1981a) (Figure 4.4). The Royal Town Planning Institute (1979) has claimed that some cases of water table rebound have resulted in "substantial areas of agricultural land being destroyed due to saturation by ferruginous water".

In the case of spoil tips, the NCB considers that not more than ten per cent of the salts should be leached out, and that once a tip has been revegetated surface drainage problems may cease, although they are setting up a long-term experiment at Bentick colliery in Nottinghamshire to provide further information on this matter. An alternative view of this phenomenon is that chlorides are eventually leached from the soil and that normally reclamation has been so delayed that, by the time revegetation has taken place, chlorides are no longer a serious problem. Where reclamation takes place promptly, high pH levels may prove to be an inhibiting factor: more research clearly needs to take place on this topic. Small amounts of acidic and ferruginous discharges may also take place from coal stocks after prolonged storage.

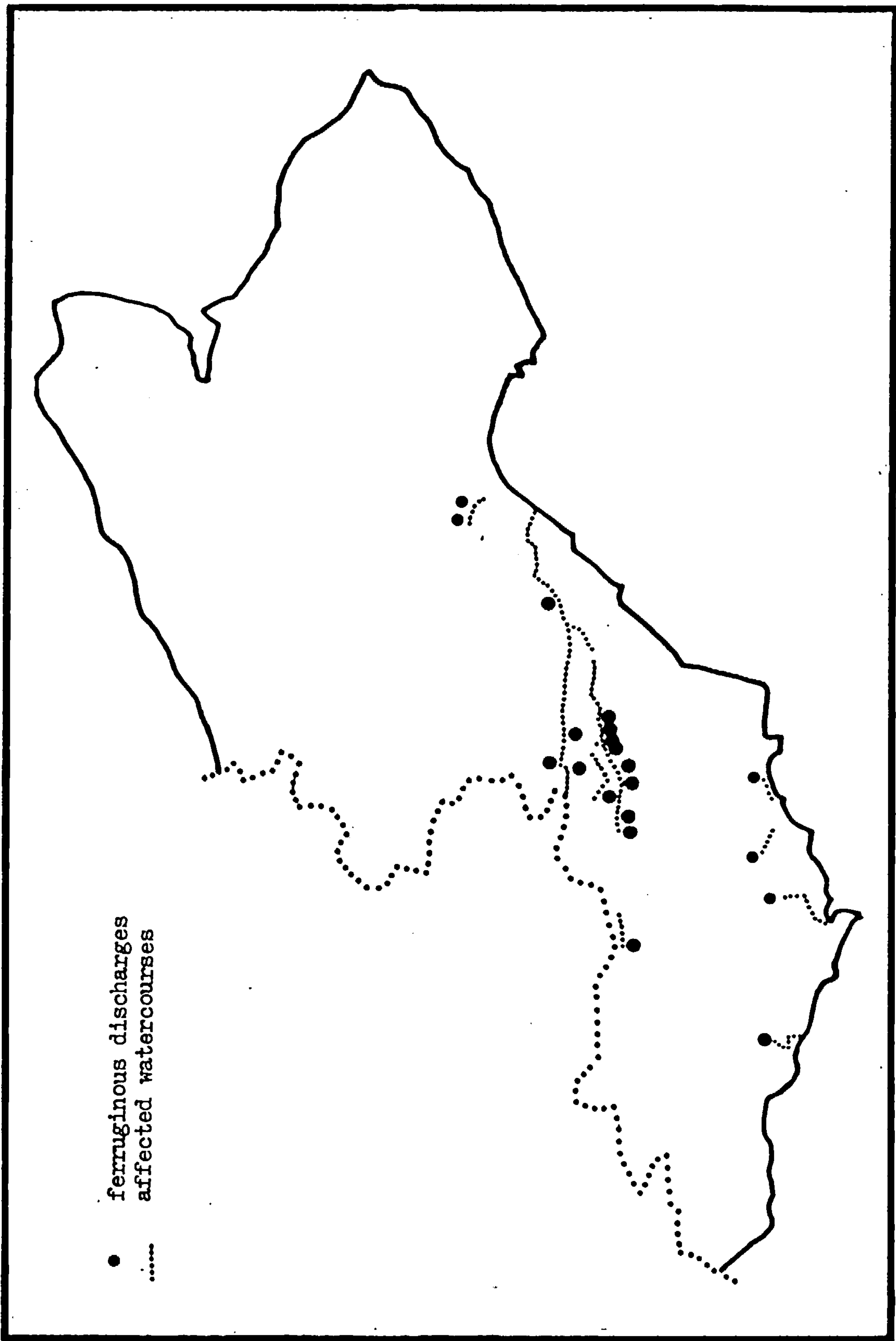


Figure 4.4. Ferruginous discharges from mine sites, Fife.
 (Source: Fife Regional Council).

Seepage is largely a problem associated with older tips where compaction is less; greater compaction, however, may increase levels of surface run-off. At Asfordby (Belvoir), the tip layers are to be compacted by the passage of vehicles, so that penetration by air and water is substantially prevented and leaching is restricted to the layer of spoil exposed to the atmosphere (Milner, 1979). Where such an approach has not been taken, it has been recorded that the cost of seepage treatment has often acted as a deterrent to the re-use of sites. (RTPI, 1979).

contamination of water will cause direct damage to farm water supplies and cattle watering points; the main problem is, however, that associated with crop irrigation. The EEC draft directive on this topic proposes a level of Cl^- concentration of 350 mg l^{-1} as being safe for most crops (although some, such as lettuce, may be susceptible to much lower concentrations). At Belvoir, despite the Severn-Trent Water Authority's recommendation that this should not be exceeded in any river or watercourse into which mine site or tip run-off might be directed, the Country Landowners' Association still expressed concern regarding cases where the water had already been rendered unsuitable for spray irrigation near existing mines.

At Cotgrave, Cl^- concentrations of up to $30\ 500 \text{ mg l}^{-1}$ have been recorded for drainage water, and predicted levels for Belvoir were $15\text{-}25\ 000 \text{ mg l}^{-1}$ at Hose, $1\text{-}25\ 000 \text{ mg l}^{-1}$ at Asfordby and $1\ 000 \text{ mg l}^{-1}$ at Saltby. It is not generally practical to remove chloride from minewater and, if provision is not made to pump this to a major watercourse, concentrations could be raised to very high levels in local tributaries, especially under low flow conditions (Woodward, 1979). It was agreed between NCB and the Water Authority that minewater should go to the Trent by direct pipeline; at times of high water flow, however, it may be possible to discharge that from Asfordby to a local watercourse, the River Wreake, without detrimental effect. In some instances, piping discharge water could involve construction of a large storage reservoir to accommodate peak run-off.

Economic losses resulting from air pollution damage to crops have long been recognised (Bleasdale, 1959; Jeffree, 1976), the most marked effects being caused by SO₂ which in large part arises from coal burn. Levels are occasionally high enough to cause acute responses (Bennet et al., 1975), although chronic effects are more typical. Some reports suggest a tolerance to pollutants may develop in some species over time. Gaseous pollutants enter plant leaves, mainly through the stomata, and affect the palisade and mesophyll cells of the leaf causing irreversible damage to photosynthetic capacity (Holdgate, 1979). Pollution pathways through the atmosphere are complex, and there are seasonal variations in receptor damage, so it is not surprising that considerable differences have been observed under experimental conditions. There is a general consensus, however, that a sensitive target species such as ryegrass S23 shows impaired growth once concentrations of SO₂ exceed about 50-100 µg m⁻³ (Bell and Mudd, 1976; Bell et al., 1979), and continuous exposure of this strain may cause growth impairment without producing visible signs of leaf injury. Similar results have been obtained in respect of various other grasses (Ashenden, 1979; Ashenden and Williams, 1980), barley (var. Abacus) (Brough et al., 1978) and field bean (Black and Unsworth, 1979). The possibility of crop damage being caused by the deposition of polycyclic aromatic hydrocarbons (PAHs) in the vicinity of coal-burning power stations has also been suggested, but the present author has been unable to find evidence that commercially important agricultural crops are vulnerable to typical ambient levels (although some sensitive horticultural produce may be).

Generally, however, levels of SO₂ need consistently to be in excess of 200 µg m⁻³ to affect crops significantly, and these levels are found nowhere in the UK. Less than 10% of crop and grazing land in the UK is exposed to average concentrations above 50 µg m⁻³, and less than 1% to concentrations over 100 µg m⁻³. On this basis, the DoE's Systems Analysis Research Unit estimated possible crop losses from SO₂ pollution in the UK to be around £23m p.a. for worst case conditions. These calculations made no allowances, however, for the possible beneficial effects of SO₂ such as fungus growth repression and the supply of sulphur to plants growing in sulphur-deficient soils.

Although much pollution will be the result of background levels, it is conceivable that concentrations may be increased locally in coal producing areas from power stations and domestic sources (mainly because of the concessionary coal which would be burnt by miners). In the Forth Valley, domestic sources would appear to be the main contributors; point emissions from industrial stacks are difficult to distinguish, especially as the main coal burning power station (Longannet) is close to Grangemouth refinery, though there is an indication from the pollution roses prepared by Warren Spring Laboratory (Keddie et al., 1978) that this station may be closely associated with the direction of pollution. Reference to WSL's modelled levels of pollution, which take into account background imports and attempt to distinguish between different sources, indicates that "large source" SO_2 and "process" SO_2 and smoke emissions are not particularly associated with power stations, only the measurements for one sampling site suggesting that a significant contribution from Longannet is being made. Although SO_2 concentrations are not especially high in the Forth Valley it should be noted that sulphur levels in the coals burnt are only about half that of more typical British coals. Dispersion may sometimes be affected by local topography (especially the Ochil Hills), but long-term means are unlikely to be distorted by this factor. Nicholson (1982) suggests that some impairment of plant growth mechanisms may occur in central Scotland, especially where there are short-term surges of SO_2 and NO_x , but these are not great and are mostly urban-dependent.

In the case of power stations which in the future may have to convert from oil to coal, existing environmental controls may be inadequate due to changes in stack gas composition, exit velocities and gas temperature (Chadwick and Lindman, 1982). Conversely, new technologies, such as fluidised bed combustion (particularly in its most recent, highly pressurised, version) should create a reduced atmospheric impact.

Dust may prove to be a noticeable contaminant around mine sites, especially in dry weather, due to stripping of topsoil and the movement of plant and vehicles on dry roads. There are great variations in the amounts deposited as a result of seasonal and climatic factors, so

that individual, short-term measurement of dust deposition can give a misleading impression. Particular problems tend to be encountered around opencast sites because of the extensive use of sub-contractors. Although crops adjacent to mining areas have been found to have a cover of dust, there is no evidence to suggest that this has suppressed growth.

Impacts on Housing

Farm Buildings

Loss of, or damage to, buildings may cause certain farm operations to become unviable; conversely, land loss may render buildings wholly or partly surplus to requirements and become a financial burden on the farmer. Other essential installations, such as effluent disposal systems, may be damaged or destroyed by development. Minute subsidence can affect sensitive structures such as bulk milk tanks or rafted dairies, whilst the cracking of silo or barn bases could allow toxic silage liquor to escape into watercourses. In areas where seams are shallow and damage great, even recently erected houses have had to be demolished, and in many cases temporary repairs are all that is possible for several months or even years. Neither can final repairs remedy such defects as permanent tilting of dwellings and the conspicuous brick infilling of stepped fractures in house walls.

The primary source of damage in a mining area is curvature and/or strain imposed on foundations by subsidence. The NCB uses a five-point scale based upon change of length of structure resulting from horizontal ground strain: this varies from "very slight" (represented by hairline cracks in plaster), through "slight", "appreciable" and "severe", to "very severe" (in which partial or complete rebuilding becomes necessary).

Monitoring of the East Midlands coalfield over a ten year period revealed that some 20 per cent of properties experienced "very slight" damage, ten per cent "slight", one per cent "appreciable", and 0.125 per cent "severe" or "very severe" damage (NCB, undated c). If similar conditions

were to prevail in Belvoir around 30 per cent of the conventional housing stock would thus experience some kind of damage; allowing for the generally larger dimensions of farm buildings, it was estimated that, of the 335 farms and smallholdings within the prospect area, 185 would incur very slight, 103 slight, 41 appreciable, and six severe or very severe, damage. The 47 in the last two categories would require further consolidation immediately prior to mining (Orchard, 1979). With new farm buildings it is normally possible to incorporate structural modifications to the otherwise simple foundations, for instance by creating an independent mass formation so that movement will not affect any one part of the building (Loynes, 1982, pers. comm.).

An additional source of damage could be associated with vibration. The two components of vibration, amplitude and frequency, are related to peak particle velocity, so that damage depends not on how much, but how fast, the ground under a structure is moved by passing seismic waves. Structures may come into resonance with the disturbance and this may cause damage; the likelihood of this occurring may be obviated by a small change in the frequency of the source.

Impacts on Traffic

Farm Traffic

The principal adverse effects on farm traffic will be those arising from severance, either due to the crossing of units by new access routes or other developments, or to the exacerbation of existing conditions by increased traffic flows. However, it should be borne in mind that the road improvements in rural districts which frequently accompany mineral developments will benefit farmers; many country lanes are inadequate to cope with the 30t transporters now commonly used for conveying farm produce, and bulk milk collection may be withdrawn from remote farms with poor road access (Weller, 1979). Further, it has been pointed out that the main conflict between traffic flows and agricultural movements may well be associated with inconvenience to the former rather than the latter (Mann, 1981).

Increased traffic flows may arise from the import of construction materials, export of coal (although this will normally be by merry-go-round trains in the case of power station output) and journey-to-work, which may evidently involve round trips of up to 30 or 40 miles (Fife R.C., 1981b). The level of impact will depend in part on the extent to which the current road network is at capacity, the timing of mine traffic (whether it coincides with peak flows), and alignment features of existing roads. Although commuter traffic may not be a major element, it would be more widespread than HGV flows, and would impinge on many minor roads.

Farmers in Belvoir expressed concern regarding traffic movements on C class roads, which would inconvenience or even endanger cattle movement or transport of machinery and grass. Further, since farm machinery movements tend to be concentrated in March/April and August/October, these would be likely to coincide with tourist and recreational traffic.

One possible future impact could arise from the transportation of coal slurry by pipeline. Any accidental release of the slurry would have potential for causing damage to crops and aquatic systems, but pipeline operations are not yet sufficiently practised to allow estimates of this risk to be given (Chadwick and Lindman, 1982). In any event, the Commission on Energy and the Environment (Flowers, 1981) considered coal slurry pipelines to be unviable in Britain.

Where remote tipping of colliery waste is contemplated, the material which is to be transported would differ from that which had been allowed to dry and weather on a spoil tip. Its moisture content would be high, since it would only recently have been emitted from the washing process: thus, if transported by rail in ordinary hopper wagons, the fine material could drain away onto the track. Vibration during the journey might cause the solids to become compacted, making unloading difficult. There would also be problems in dealing with the tailings which, after initial treatment, can often be layered in the tip; where shales are

to be transported, therefore, they would also need to be conveyed away from the site or occupy larger lagoons. Movement of the coal itself necessarily involves the escape of fugitive dust, even though precautionary measures are taken. It is estimated that around 0.02 per cent of the coal unloaded may be lost in this manner. Little information so far exists on losses whilst in transit, but some evidence from the USA and USSR suggests that local levels may be sufficient to affect vegetation and mammals (Chadwick and Lindman, 1982).

Impacts on the Local Economy

Farm Economy

Overheads in farm businesses are characterised by fixed costs (depreciation on buildings and machinery, labour and office costs, etc.) and variable costs (fertiliser, seed, sprays, contract work, etc.); when part of a farm is lost to development it will often be the case, in the short term at least, that only the latter of these will be reduced proportionately. Thus, net farm income may be adversely affected and partial land loss may affect certain farms very badly as a result of their particular disposition of buildings to land or proportion of investment in fixed inputs. Upland farms which lose in-bye land to mining have been cited as one such case (Cumbria C.C., 1978).

Some idea of the potential effects of land loss in Belvoir may be gleaned from information on farms' existing management practices (Boddington, 1979): one unit with a high stocking density would have suffered badly from the loss of 9ha; one would have lost cereal land, leading to under-use of its grain storage facility; one stood to experience a substantial reduction in grazing land, leading to a serious under-utilisation of machinery and buildings; one would have had to abandon plans for expansion of the dairy herd; and one would have lost a field recently restored from a derelict railway line at considerable time and expense. The incidence of land loss at the Asfordby site is summarised in Table 4.2.

Welby House Farm

At an early date this would effectively lose the use of all its farm buildings and three dwellings, and a further 28.4ha would be lost to the mine site. An additional 72.6ha would be progressively affected by the tip, so that in total some 55 per cent of the farm would be affected and would be separated from its buildings.

Welby Lodge Farm

This would suffer sequential loss of 60.2ha for tipping (45 per cent of the farm area), but would not be affected until the seventeenth year of mine operation; an incremental annual loss of 2.25ha would be experienced.

Welby Grange Farm

This would remain relatively unaffected, losing less than 8 per cent (9.3ha) of its land to the mine site.

Table 4.2. Farms affected at the Asfordby site
(initial proposals).

It might reasonably be supposed that farmers who were eventually to be displaced would be unlikely to undertake long-term investments and indeed might change their policy toward operational matters like fertiliser application. Farming systems may also alter; there may be a growth in the hectarage devoted to cereals, especially as long-term fertility would not remain an overriding factor, and a reduction in the importance of those enterprises requiring higher costs, especially those outlays which can only be recouped over a number of years. Observed changes in the expansion area for Milton Keynes were found to include: a relative growth in cereals, particularly barley, at the expense of grass (especially temporary grass); a diminishing number of dairy cows, which require relatively inflexible and capital-intensive investment; and an unusually high proportion of followers (which are a residual aspect of the enterprise) to dairy cows, implying that farmers with young dairy stock had sold the herd and kept in heifers to sell at a later stage (Giles et al., 1972, 1977). Within the designated area, not surprisingly, some 95 per cent of farmers said they would make no further investments in fixed equipment or buildings. This would reduce their fixed costs, but the possible activities would become progressively more circumscribed and the profitability of existing systems would probably decline. The approach which NCB attempt to adopt in order to minimise such problems involves coordinated acquisition and careful land management, ensuring that, as far as possible, the complex is managed as a whole.

A number of additional financial problems may also arise for the affected farmer. A stock farmer who is forced to close down his business and hold a dispersal sale, for instance, will find it difficult to re-invest in sufficient time to secure rollover relief on capital gains tax (McWhirter, pers. comm, 1981). If he has a breeding stock and has been developing a bloodline over many years, the effects of a forced sale will be even worse. Some farmers affected by opencasting thus endeavour to continue farming on the pre-development and restored portions of a site, moving their operations about in advance of coal extraction.

It has been argued that the whole viability of farms may be affected by opencasting: the farmer has to contend with soil which is less fertile and more difficult to work, with untried drainage, and with a new stock of animals of unknown worth in place of proven stock (CoEnCo, 1980). Other observers have suggested that mining could upset the rotations possible on a farm, and markets could be lost for particular products if they could not be grown in time. Loss of local business linkages for the displaced farmer could also prove serious. Some critics have also suggested that the NCB's interest in land may lead to minimum management: since the Board may only hold land which is mineral bearing, opencast tenants know that, once the coal is extracted, they will, as sitting tenants, have the right to purchase the land, and that the sale price will be lower if the estate has suffered from neglect. However, benefits may also accrue: farmers in mid-Wales earned supplementary income from increased sales of milk, eggs and poultry, and from letting land for caravans to house construction workers on local projects. Nevertheless, these benefits were only temporary and set against them were the problems of engaging contractors who were busy at construction sites.

A further possibility is that the value of a farm may be blighted by the presence of mining activities. Worthington (1979, under cross-examination at Belvoir Inquiry) denied that this would happen, and maintained that blight was largely confined to old colliery areas where old tips and their associated problems were bound up with factors such as trespass and land deterioration. However, blighting effects caused by impending development or subsidence may be more real. Subsidence has been found to result in a general lowering of property values in an area, and the phasing of development to accord with anticipated ground movements may significantly increase costs. Following the announcement of mining proposals in Belvoir it became very difficult to find buyers for most residential properties in the prospect area and sales fell by some ten per cent, but this effect proved relatively short lived (Strutt and Parker, 1977). A study of a projected section of the M40 motorway found only one farmer in its path adopting a policy

of delayed investment (Hearne, 1978). At the Belvoir Inquiry, the Inspector remarked that it was likely that the imminence of subsidence or tipping would lead a farmer to postpone or abandon plans for capital investment but saw no reason to assume that farmers would run down their holdings (Mann, 1981). There is a measure of agreement that the provision of firm advance information is the best way to alleviate blight.

Agricultural Industries

A number of side-effects of mining could cause damage to agricultural industries. Amongst the possibilities raised at Belvoir were the contamination of water supplies to food processing plants and the deleterious effects of increased dust levels on Stilton cheese production. Absolute cleanliness is essential in the cheese-making plants and this, it was feared, could be jeopardised; further, dust might affect the activity or existence of the bacteria which give the cheese its characteristic properties. More seriously, the plants, which have stringent requirements with respect to humidity, temperature and hygiene, could be damaged by subsidence, and the most careful preventative measures would have to be taken to guard against reductions in operating standards which could so arise. Whilst the fears regarding dust levels appear to have been exaggerated, the need to maintain vigilance with respect to subsidence effects on buildings, water supplies and sewers remains important.

Impacts on Employment and Community Structure

Farmers and Farm Workers

Farmers and farm workers may be affected in two main ways: workers may be attracted from relatively poorly paid agricultural work to construction or mining employment; whilst those who remain may suffer the effects of disamenity and uncertainty. Occasionally, too, there may be cultural considerations - for instance, in the USA many of the deposits underlie Hopi or Navajo reservations.

Labour for construction is often drawn from mobile gangs whilst, in deep mining, skill levels are high and much of the requirement is met by transferees. However, some prospects exist for the training of "green" labour, and farmers may experience the loss of younger and fitter men or a shortage of certain skills. The extent to which this occurs will depend largely on the size, composition and age structure of the local unemployment pool (Economist Intelligence Unit, 1973). Experience from major public works in mid-Wales indicated that the majority of farmers with hired labour had to pay significantly above the minimum wage, but even this appeared to be no guarantee against the loss of workers, especially men of thirty or younger. Within the study area, 64 farm workers quit during a six year period and, whilst some loss would have occurred anyway, it is notable that only one-fifth took up work on other farms whereas one-third moved to construction sites. Moreover, it appeared that many workers employed on marginal holdings, who disliked the long hours and arduous tasks of construction work, moved to larger farms to replace those who had been attracted to the schemes (Jones, 1972). It has also been found by ADAS that higher wages have to be paid near urban areas, resulting in low profitability and less investment. A report on platform construction at Loch Broom (Sphere, 1973) forecast that the Forestry Commission could expect to lose up to half its locally recruited labour force, whilst a study by Oxford Polytechnic (1976) on oil-related development in Buchan found evidence of increases in the average earnings of agricultural workers. However, these impacts are probably largely associated with the construction phase, where labour tends to be relatively mobile between types of work. Another study in Grampian, whilst confirming the construction phase trends, found that the basic structure of wage levels in indigenous industries (which were well below Scottish and UK averages) was little affected by labour market pressures, except in the case of a few key skills (Gaskin and Mackay, 1978).

Farmers remaining in the area may find life less pleasant once mining has started, Critics of opencasting have referred to the bland and featureless landscape left behind, whilst farmers close to tips will have to live with visual intrusion, noise and dust. Some farmers and their families adjacent to the Selby drifts clearly found construction noise intolerable. Perhaps worst of all, experience at Milton Keynes new town (Giles et al., 1973) revealed that most resentment and tension was created by uncertainty - when and where development might start, and how and in what measure compensation might be paid. Further, there is uncertainty about the duration of impacts. Whilst the construction phase is usually claimed to be known in advance, in many cases and for numerous economic and technological reasons, the length of the operational phase cannot be predicted (Shields, 1975).

With regard to noise, ground freezing operations at the Wistow drift site (Selby) led to complaints of intrusive night-time noise levels disturbing residents' sleep up to 680m from the site centre. At 820m, night-time levels (L_{95}) of 35dB(A) were recorded - approximately 10-12dB(A) above pre-existing ambient levels. However, it is the peak noise levels which most often cause annoyance: typical maxima recorded at Selby over a four month period (facade readings taken at 820m) were 57-60dB(A) for rock handling (at times, every fifteen minutes), 45-50 dB(A) for blasting, and 40-42dB(A) for the tannoy system. Stocks (1979) points out that rural sites are especially sensitive to noise at night and to peak levels, even if these are of short duration. An increase of 10dB(A) on existing levels is generally accepted as being the threshold at which complaints will arise; bearing in mind that night-time levels in rural areas may commonly be around 30dB(A) and day-time ones perhaps 50-60dB(A), it would appear that there is a reasonable possibility of this threshold being exceeded.

The Costs of Agricultural Impact

The actual costs of mining impacts on agriculture are difficult to ascertain both because of the problems of measuring change in the absence of control sites, and because of variations in the basis on which agricultural costs are accounted. Thus, historical costs must be considered somewhat spurious, as ignorance of pre-mining conditions, and lack of monitoring of farm output during and after restoration, remove any reliable basis for estimation.

Some evidence from costs associated with former mining dereliction may be elicited from local authority reclamation schemes for collieries. Dawson (1978) reviewed a number of schemes completed in Fife during the 1970s, and produced evidence showing an average cost of £4887 ha⁻¹ for the four most recent schemes involving conversion to agriculture. Projects recently completed in Central Region reveal a similar scale of financial commitment (Table 4.3). At the time when these costs were incurred, average quality pasture was likely to sell at around £1000 ha⁻¹. Clearly, the costs of reclamation cannot be justified on purely agricultural grounds, and so must also be assumed to include a community value.

Costs for reclamation may, however, be substantially higher than those suggested by the preceding cases, especially for urban areas: figures as high as £25 000 ha⁻¹ have recently been suggested (Doubleday, 1984), especially where complex engineering works and restoration to urban/ industrial use is involved. Moreover, the inclusion of acquisition, salary, loan and maintenance costs will appear to inflate prices, as these may account for a substantial proportion of the overall sum (Table 4.4).

A further basis on which agricultural costs could be appraised is to consider the likely general increases in variable inputs and additional farming operations. Thus, Cook (1976) reports the costs of rehabilitation to comprise: saving and replacing the topsoil, \$620-1240 ha⁻¹; regrading the spoil material, \$370-1000 ha⁻¹; seeding and planting, about \$50 ha⁻¹;

location	form of dereliction	area (ha)	cost of works	
			£	£/ha
Devon Colliery phase 1, Fishcross	colliery buildings	0.81	2 575	3 179
Devon Colliery phase 2, Fishcross	colliery tip and damaged ground	53.17	383 535	7 213
Manor Powis, Stirling	colliery tip	3.72	58 679	15 769
Dollar Mine	colliery tip and domestic refuse	10.68	47 775	4 473
Westhaugh, Alva	old shafts and domestic refuse	20.17	98 510	4 884

Table 4.3. Reclamation schemes involving coal-affected land and restoration to pasture in Central Region since 1978 (based on contractual data provided by Central Regional Council, 1978-81).

<u>Operation</u>	<u>% of Cost</u>
land acquisition	24.1
preparatory engineering	24.3
treatment and landscaping	35.3
salaries and overheads	2.5
loan charges	11.9
site maintenance	1.9

Table 4.4. Percentages of costs associated with different aspects of land reclamation schemes (Source: Bradshaw and Chadwick, 1980).

use of mulches, where necessary, \$620-1730 ha⁻¹; and application of nitrogen and potash fertiliser at 90 kg ha⁻¹, approximately \$50 ha⁻¹. Thus, the initial total expense without any supplemental water for seedling establishment was placed at \$1100-4050 ha⁻¹, not including costs of protection and non-use until seedlings are well-established, or of any crop failures. Such figures are, regrettably, difficult to translate into present-day terms as a result of inflation, fluctuating exchange rates and international variations in commodity prices. However, it is possible to identify the percentage of costs associated with contemporary UK opencast operations (Table 4.5) and, further, to note that actual restoration costs generally now fall in the region of £3-4000 ha⁻¹.

Nevertheless, reclamation costs expressed in the foregoing terms are of limited value to EIA, as they represent costs which should be borne by the operator. More relevant to the present study would be private or social losses as instanced by reduced yields or profit margins. Thus, for example, Brocklesby (1979) cites comparisons made between fields restored in the early 1960s and adjacent unworked fields, based on records of trailer loads of grain leaving each field (Table 4.6). However, such results must be treated with caution in the absence of a statistically sound monitoring programme, or a record of inputs of seed and fertiliser. Yet, whilst the reliability of these is suspect, this particular instance is in line with Bradshaw's (1983) observation that more than 80% of original productivity is extremely difficult to achieve.

A further cause of lost production may be exacerbated urban fringe effects associated with ancillary housing. Such impacts appear to be most pronounced immediately adjoining urban areas, with some attenuation after only 1km and comparatively little residual impact beyond 8km (NFU, 1971). No reliable estimates of the actual costs of such effects are available, unfortunately, although it is likely that trespass and livestock worrying in particular will impose economic losses on farmers.

<u>Treatment</u>	<u>% of Cost</u>
five years agricultural management (cultivation, manuring, cropping)	35
permanent land drainage	28
fencing	22
ditching	7
providing water supplies	3
hedging	2

Table 4.5. Percentages of costs associated with different aspects of opencast restorations (Source: Salt, 1980).

<u>year</u>	<u>crop</u>	<u>yields (kg/ha)</u>		<u>comparative yields (%)</u>
		<u>unworked</u>	<u>restored</u>	
1975	winter wheat	4680	3780	81
1976	winter wheat	4320	4140	96
1976	spring barley	4140	3480	84
1977	spring barley	4560	2520	55
				ave = 79%

Table 4.6. Comparative yields on restored and unworked land (based on figures in Brocklesby, 1979).

From the point of view of EIA, therefore, it would appear that the most satisfactory way of measuring agricultural costs is to consider total production losses during coaling activities, and partial losses (and perhaps permanent reductions in yield) associated with restoration. These again are more or less hypothetical as it may prove desirable to reorientate the whole enterprise or restructure land holdings, making any extrapolation from past performance something of a fiction. However, the impact on farm output is probably as reliable an estimate as it is possible to obtain. Figures produced by Leicestershire County Council's Director of Estates for one proposed tip form at Asfordby are set out in Table 4.7. In this variant, it is assumed that the 88ha tip is developed in ten phases. Thus, 8.8ha are wholly out of use at any one time (although the use of "margin" land during all but the final phase increases this to 12ha), but after being active for a five year period restoration can commence on each phase. For reasons already discussed, full productivity will probably only be regained after some 25 years, so that in the early years, when perhaps only 40% of the original yield will be attained, 60% of the restored site can be equated with "nil equivalent" production. Thus, the total effective margin lost to agriculture can be calculated, and this can be related to some suitable measure of financial return per hectare. Estimates produced for the original Belvoir proposals ranged from under £3m (NCB consultant) and just over £4m (objectors' consultant) to £12m (Leicestershire County Council). These relate to mine site losses only, but could be considered to be over-estimates inasmuch as they are undiscounted, and occur over the lifetime of the coalfield. This approach is discussed further in the following chapter.

The choice of measure for financial return has been the source of some debate, and even confusion, in the literature. However, broadly speaking, there are three measures which can be used: total enterprise output, gross margin and net farm income. (Value added is also introduced later, but it is not necessarily accurate to think of this as a measure of financial return). The first of these is self-explanatory; gross margin

PERIOD (YEARS)	WORKING TIP (HA)	AREA (HA) OF TIP PHASES OUT OF FULL PRODUCTION AFTER RESTORATION										TREES (HA)	TOTAL (HA)	
		1	2	3	4	5	6	7	8	9	10			
1-5	12													12
6-10	12	5.3												17.3
11-15	12	3.5	5.3										4	24.8
16-20	12	2.6	3.5	5.3									4	27.4
21-25	12	1.8	2.6	3.5	5.3								4	29.2
26-30	12	0.9	1.8	2.6	3.5	5.3							4	30.1
31-35	12		0.9	1.8	2.6	3.5	5.3						4	30.1
36-40	12			0.9	1.8	2.6	3.5	5.3					4	30.1
41-45	12				0.9	1.8	2.6	3.5	5.3				4	30.1
46-50	8.8					0.9	1.8	2.6	3.5	5.3			4	26.9
51-55							0.9	1.8	2.6	3.5	5.3		7	21.1
56-60								0.9	1.8	2.6	3.5		7	15.8
61-65									0.9	1.8	2.6		7	12.3
66-70										0.9	1.8		7	9.7
71-75											0.9		7	7.9
76 et seq													7	7

Reduced yields during period of restoration:

1-5 years	= 40% margin,	i.e. 5.3ha @ nil equivalent
6-10 "	= 60% "	" 3.5ha @ " "
11-15 "	= 70% "	" 2.6ha @ " "
16-20 "	= 80% "	" 1.8ha @ " "
21-25 "	= 90% "	" 0.9ha @ " "

Table 4.7. Equivalent area of tip phases out of full production after restoration at Asfordby (According to figures produced by Director of Estates, Leicestershire County Council).

is the TEO minus variable costs; whilst net farm income is GM minus overhead/fixed costs and rent of the land. Variable costs are readily shed and represent no continuing burden on the farmer, although any reduction in total enterprise output may be considered undesirable from the national point of view. The social implications of agricultural impact are perhaps best expressed as gross margin, whilst the farmer will experience most acutely any reduction in net farm income. If this approach is adopted, the major problem arises from imputing the costs of inputs and outputs within an individual farm enterprise, both because accurate records may not have been kept and, if they have, they will be treated as confidential. It is probably more realistic to observe land use and then ascribe to this the generalised inputs and returns for the appropriate land use and farm type provided annually by the regional agricultural colleges. Whilst this will not be wholly satisfactory from the point of view of an individual farm, it may reasonably be taken as representing good agricultural practice.

It is generally accepted that a discount rate should be applied to future streams of incomes and losses, so that these can be summed and a net present value obtained. There are arguments for and against this procedure. On the one hand, the whole point of protecting farmland lies in its value in perpetuity; consequently, future generations may not thank us for looking at everything from today's viewpoint. Conversely, discounted revenues are useful in permitting aggregation, and the former objection can be overcome by adopting a level of discount rate which is preferential to farming interests. The present value of a cost or benefit anticipated in the i th. year is calculated as:

$$P = \frac{D_i}{(1+r)^i},$$

where P is the present value

D_i is the cost etc. expected in year i , and

r is the time preference interest rate.

The major advantages of an economic assessment of impact would appear to be that: first, it provides a reasonably accurate reflection of farm losses, and could perhaps be used as an indication on compensation liability; second, it yields data in a convenient unit of measurement, which may facilitate the aggregation of different kinds of impact; and third, it can readily be expanded to accommodate the varied kinds of impact which may be expected at the individual farm level. From the viewpoint of EIA, the use of a discount rate affords additional flexibility to the assessor. Thus, "weighting" of agricultural impacts to make the farming sector appear more or less significant overall, can be effected by adjusting the discount rate downwards or upwards. This is arguably a more rational means of representing relative importance than the application of a hypothetical weight, as it can be based on elaborate economic theory.

The use of a long discount horizon would, strictly, assume technological and economic status quo, as reflected by the relationship of costs to returns, whereas the best land might display a higher marginal revenue product with respect to capital and other inputs, suggesting a changing relationship between grades of land over time. Some evidence appears to be available for this in the form of differential rates of increase of value added for different enterprises (Boddington, 1978). It is suggested here, though, that this could reflect the relatively recent expansion of cereals and grass production, and that the rate of growth may start to level off over time. Whatever the reason, there would seem to be insufficiently strong theoretical evidence to preclude the adoption of a low discount rate. Indeed, it has been proposed that, since governments have the duty of investing for posterity, a social discount rate of only one or two per cent should be adopted for the capitalisation of agricultural returns, this level being based on the costs of borrowing and increases in productivity in the farming industry (C. Smith, 1979).

A useful means of considering the extent of economic impact is to itemise the individual effects which might give rise to increased operating expenses or reduced returns. The various sources of cost and benefit discussed in this chapter are summarised in Table 4.8: ultimately, practically all of these (with the exception perhaps of those relating to social change and quality of life) will be reflected in increased or lost production, and so potentially can be aggregated within the gross margins. Although, as has been indicated earlier, limited evaluations of the costs of agricultural impact have been produced by previous workers, no comprehensive assessment of the effects of a particular proposal has yet been conducted. Although the main task of this study is to provide a generic overview and devise a framework for the appraisal of mining-agriculture impacts, the problem of implementing this to produce a forecast of actual impact in respect of a particular coaling proposal will be addressed in due course.

Conclusion

The nature of farm enterprises is complex, and deserves detailed analysis in the consideration of developmental impacts. Planners have characteristically considered only land quality factors, but it is clear that matters of land use, fixed equipment and buildings, and the internal economy of the farm are inter-related and exist in a balance which can readily be upset by a change in any one element. Thus, if agriculture is to be appraised adequately either as part of a single development project or as an issue in a broader land use strategy, refinements are necessary in both the quantity and quality of baseline information to be included.

Equally, the nature of impact on farming enterprises may be diverse: this may, for instance, be reversible or irreversible, short-term or long-term, strategic or local, or adverse or beneficial. Thus, it is desirable to elicit a full specification of the mining project design and to obtain some quantitative indication of its likely agricultural consequences. The next chapter, therefore, examines the nature of project specification and forecasting methods which can be applied to mining proposals.

FARM LAND

- land surface - cost of lost yields on land permanently or temporarily out of production
- cost of stripping/storing topsoil, etc. (borne by operator)
- restoration - costs of restoration; respraying, soil treatment, fencing, drainage, etc.
- potential (should be borne by operator)
 - continuing cost of reduced production following restoration
 - increased costs of operations (fertiliser applications, stone picking, etc.)
- land drainage - destruction of field drainage system and adjacent channels
 - disruption of adjacent drainage leading to cold and wet patches, and consequently to a restricted range of enterprise options
 - delay in drainage reinstatement due to settlement, continuing subsidence; will restrict range of enterprise options

- infrastructure - damage to main services and similar private undertakings (costs of repair; consequential losses caused by failure of electricity or water supply; loss of metered water; losses of production whilst mains are exposed)

FARM LIVESTOCK

- disturbance - costs of reduced yield
 - costs associated with forced sales or inability to vaccinate
- loss - unquantifiable costs associated with abandoned bloodline
 - lost market value due to premature slaughter
- disease - loss of animals
 - cost of preventive measures, including sterilised swathes of land
- slurry spreading - increased cost of disposal of surplus slurry

FARM CROPS

- irrigation - inability to grow sensitive crops
- air pollution - inability to grow sensitive crops; reductions in yield
- damage - outright loss of crops due to passage of vehicles; poorly phased tipping, etc.
- drought - crop losses
- costs of importing hay

FARM BUILDINGS

- overall - physical damage to buildings generally within subsidence zone, or arising
- distribution from vibration
- on-site structures - demolition of buildings; effective loss of buildings by severance
- sensitive structures - damage to larger farm buildings and structures

FARM TRAFFIC

- intra-farm - costs of providing new roads, underpasses, etc. (borne by operator or
- traffic highway authority)
- costs of increased journey time
- danger to, and possible loss of, livestock on public roads
- inconvenience - as above, but resulting from exacerbation of pre-existing situation

FARM ECONOMY

- profit margins - aggregate effects on net farm income and gross margins
- ancillary enterprises - loss of milk rounds, tourism, animal feed processing, etc.
- income - positive effects of increased local expenditure
- urban fringe - increased incidence of trespass, vandalism, etc; costs of repair and
- effects lost production

Table 4.8. Continued/

AGRICULTURAL INDUSTRIES

buildings - effects of subsidence on agricultural-related buildings and associated infrastructure; costs of repair, effects on food production

processes - effects of mining activity on quality of environment for food processing; costs of additional treatment plant

FARMERS AND FARM WORKERS

tenure - unquantifiable costs of effects on farm tenants

workforce - increased costs of labour recruitment

quality of life - semi-quantifiable costs of loss of scenery, increased noise

communities - uncostable changes in structure of farming communities

Table 4.8. Effects which might give rise to increased operating costs or reduced returns on farms, as a consequence of coal mining activities.

CHAPTER FIVE

FORECASTING THE AGRICULTURAL IMPACTS OF COAL MINING

Introduction

Impact forecasting is, in most cases, still very much in its infancy and will consequently often be the weakest stage in an EIA. In some respects, a review of forecasting techniques is premature and it may, for the present, be best for planners to concentrate on normative approaches to the control of identified impacts and then to ensure that the development is adequately monitored. In this manner, as reliably audited evidence on impacts builds up, predictive methods can be tested and more reliable forecasts produced. Nevertheless, an attempt must be made to offer some kind of package of forecasting techniques, as this alone will enable potential impacts to be quantified and alternative courses of action prepared.

Various means of classifying the range of evaluative techniques were considered and, eventually, a basis similar to that used for generic impacts was adopted. Thus, it proved most logical to relate techniques to impact-originating activities, that is, those aspects of project design which are to be illuminated in detail by a project specification report. These may, in turn, be related directly to the column entries of an expanded impact matrix (Table 5.1). The methods proposed should prove equally applicable to deep or opencast proposals as - with the exception of subsidence - they share the same general areas of impact (land alienation, workforce effects, etc.). On this occasion, it is the topics in the expanded specification which relate to the entries in the PADC matrix.

<u>General Project Specification</u>	<u>Expanded Project Specification</u>
Workforce	Immigration Employment Local expenditure
Transport	Severance Raw materials, products, wastes Employees
Land and Resource Use	Structures Site preparation Solid wastes Subsidence Water demand
Pollution	Noise Aqueous discharges Particulates and gases

Table 5.1. Major areas for which forecasts should be obtained, based on impact-originating activities.

Types of Forecasts

forecasting, as has frequently been pointed out, is not a precise science in planning. Moreover, the purposes of deriving forecasts may vary: on occasion a reliable prediction of local damage may be required to assist in the determination of compensation; elsewhere a rule-of-thumb estimate may suffice, perhaps to indicate whether an impact is likely to merit further detailed study; sometimes an evaluation of the likely scale, characteristics and incidence of an impact may be necessary so that appropriate remedial measures can be incorporated into the design which will, hopefully, render any precise estimate of non-remedied impact irrelevant; whilst at other times a comparison of the likely streams of costs and benefits, however measured, may aid the selection of alternative sites or designs. Thus, as Benson (1982) has observed, two responses are possible to future adverse events. First, some impacts can be identified, enabling responses of avoidance, design precautions and contingency planning to be made. Second, some impacts are unknown, in which case dispersal of the offending industries or the identification of early-warning indicators may be more appropriate.

A number of limitations affect the confidence which can be placed in forecasts, including incomplete baseline or project design information, lack of skills or time within the control agency, changes in perceived priorities over time, uncertainty regarding the future, choice of forecasting techniques, and inadequate feedback from monitoring. In response to these problems, several different approaches have evolved: "environmental" forecasts, which look directly at changes in the ambient systems (Lee and Wood, 1980); "ecologic-economic" forecasts, which attempt to relate environmental change to investment decisions (Isard, 1972); normative forecasts, which assume that remedial measures will be designed into a project to ensure that adverse impacts do not exceed statutory norms; and forecasts based on experience gained elsewhere, which raise problems of relevance, especially where technologies are undergoing fairly rapid change.

The availability of adequate information is clearly a central requirement, so that careful attention must be paid to eliciting detailed design data and to making arrangements for monitoring. Topics on which data should be sought have been drawn, as appropriate, from a number of sources (Stevens, 1975; Joint Working Party, 1978; Down and Stocks, 1977; Clark et al., 1981). Thus, for each source of impact identified, first an appropriate project specification content is proposed, and second, applicable forecasting techniques are identified and discussed. A summary of the project specification developed in this chapter is outlined in Appendix B, and its interpretation in respect of the proposals for Asfordby is set out in Appendix E.

Workforce Factors: employment, local expenditure and immigration

Details of labour requirements should include levels of employment (yearly, or even monthly, where these fluctuate significantly), peak labour force, age structure and provenance of the labour force, number and size of shifts, wage levels to be offered, likely availability of spare capacity locally, and pressures to be placed on particular skills and age groups. Problems of data availability in respect of the last two topics are severe at the local scale, and researchers have generally had to rely on information at standard region or even UK level, or on informed guesses.

The number of additional people who will work in the area as a consequence of the project will depend on the components of labour supply and their possible reactions to changes in demand. On the basis of experience at established mines, the NCB has been able to make available a considerable amount of data on the size and rate of build-up of their own and contractors' labour; the proportions of transferees, juveniles, re-entrants and green adults are more uncertain, but again are reasonably well documented. Selective transfer is the only way to achieve the required nucleus of skilled, experienced mineworkers, and it was aimed at Belvoir to attract around 3 400 men under 55 in this way. About 1 200 juveniles could be trained over the thirteen year development period, and probably 1 100 re-entrants could be attracted since experience suggests that about 20 per cent of those leaving the industry in any year wish to return within five years.

Farm workers may, of course, either be induced to work at the sites or may be displaced from directly affected farms. Estimates of the latter might be obtained simply by determining average labour requirements per hectare and multiplying this by the hectarage which was to be lost. Attraction of farm labour from elsewhere will depend on the size and composition of the local unemployment pool, the wages being offered, the presence of appropriate skills within the agricultural industry and intangible factors, such as job satisfaction. It was envisaged that about 1 300 locals ("green adults") could be trained over the thirteen year period at Belvoir, and concern was expressed that local recruits (within a 30km radius) would eventually increase to become the major source of manpower (Melton B.C., 1979), so that competition for labour between mining and traditional industries could become severe. It may be surmised that certain sections of the farming workforce, notably hired and casual labour, would be particularly vulnerable to poaching.

A second major consideration arises in respect of the potential induced employment and labour market effects: this multiplier derives from demand for direct supplies by the NCB and from the consumer and service needs of the additional population. In the operational period of the Belvoir field, it was anticipated that the Board would become the largest employer in the area and would create additional spending (at 1979 prices) of some £200 000 per week. This element of the expenditure multiplier is relatively straightforward to derive since wage levels should be included in the project specification. Unfortunately, there is no satisfactory method of calculating the increase in income needed to create an additional job in the service sector - in practice, this ratio will depend on the level of spare capacity in the particular area, which is almost impossible to determine reliably. In general, economic multipliers tend to lie in the range 1.24 to 1.54, with rural areas generally towards the lower end of this range (Planning Exchange, 1978). Despite the conceptual simplicity of the multiplier, there are severe problems in its application for planning purposes. The basic

calculations of the initial income injections into a regional economy must be modified to take account of leakages, and evidence suggests that these are high in rural areas. This may especially be the case in mining developments as servicing, in the early stages at least, will probably be provided by established bases outside the area.

Immigrant flows arising from multiplier effects may take far longer to peak than those associated with the mines themselves, although there is some evidence to suggest that in rural areas the effect of the multiplier may be greatly reduced after a period of three to five years (Sadler et al., 1973). Workers in indirect employment may also be more widely scattered. It may be assumed that immigrant flows of construction workers will comprise solely the number of such workers; for other categories, however, the number of dependants must be estimated, and the following empirical formula has been proposed by the Scottish Development Department:

$$\text{total immigrants} = \frac{\text{no. of men} + \text{no. of married women}}{1 - \frac{27}{100}}$$

which gives a total of 2.4 dependants per male immigrant.

A third consideration will be that of cultural and social impact on the established rural communities by an incoming workforce. It has been advocated that monitoring of these effects should be conducted by means of social "profiles". Krebs (1975) has noted a number of social indicators which may be used to differentiate communities based on deep mining of coal from those associated with agriculture. Thus, differential community infrastructure should be detectable in such items as the number of farm equipment dealers, feed mills and suppliers on the agricultural side and the number of extraction and industrial dealers on the mining side, as well as more subtle ones regarding community and welfare provision. The art of social profiling is as yet embryonic, although it has been argued that the appropriate broad topics on which indices should be based include total population, age and income distribution, housing characteristics, use and capacities of public services, and community cohesion (Messer Assoc., 1977).

Jones et al. (1979) note that in areas likely to experience an influx of miners, studies suggest that, rather than integration occurring, parallel lifestyles develop, with the possibility of acute social problems arising between the host and incoming communities. Thus, they contend, it is necessary to develop, and apply on an annual basis, quantitative social indicators relevant to change, including intensive work on profiles in selected communities and interview surveys on residents' own perceptions, satisfactions and dissatisfactions. They also advocate the use of special studies on issues of particular interest, for instance women's employment, effects on the housing market, care of the elderly, provision for under-fives and labour patterns among school leavers.

Transport Factors: severance and traffic movements

In order to obtain some indication of the inconvenience likely to be caused to farming as a result of increased traffic flows, it will be necessary to ascertain the overall size and composition of flows and the radius over which they are experienced. Design data should thus be specified on the volumes of constructional and operational traffic (by mode of transport) which are generated by inputs, outputs and employees. A major uncertainty associated with these data will be the general applicability of estimates based on experience from other mines; particular sources of variation are likely to arise from differences in modal split and the extent to which transport facilities are under the control of the operator.

Bearing in mind that most mineral operations are located in rural areas, special consideration should be given to traffic occurring outside the normal working day, the most objectionable impact being an increase at unsocial hours as a result of shift changeovers (0600 and 2200). Additionally, it has been suggested that traffic noise increases adjacent to buildings of only 5dB(A) in the L_{10} figure could be deemed detrimental (Leitch, 1977). In rural areas, the routing of heavy

vehicles will be critical as many roads are likely to be at, or approaching, capacity pressure. However, much mine traffic would probably not coincide with peak flows on the network and any capacity problems which did arise at the operational and constructional stages would be confined to routes used by HGVs.

Whereas prediction of the magnitude and routing of flows associated with raw materials, products and wastes is relatively straightforward, and can in large measure be approached normatively, the assignment of commuter traffic is problematic, especially where housing locations have not been finalised. However, an assumed workforce distribution may be hypothesised for the operational stage and assignments to alternative routes between home base and mine site calculated according to a time distribution curve (Joint Working Party, 1979). Traffic surveys should be conducted to assess levels and composition of present use, taking into account daily, weekly and seasonal variations. Careful surveys should also be made of the road network: it is unlikely that a single development should cause the capacity of a "rural all-purpose road" (DoE, 1974) to be exceeded, except where operating at or near capacity (Clark et al., 1981), although there may be detailed constraints to free traffic flow such as low and narrow bridges, level crossings, sharp curves, farm usage and single track sections of road.

Reasonably good data are available on traffic generation from existing mines, and further assumptions may be made about which workshops and central depots would be used to service the proposed mines. It has been stated by the NCB that construction of a 3mta deep mine would entail maxima of 500-750 workers and 100 truck loads per day, with peak levels being reached in weeks 86-203; assuming that 20 per cent of workers would arrive by car and the remainder travel by bus, this would produce peak movements of 300 car trips and 26 bus trips in each direction (Rushcliffe B.C., 1978). With regard to operational traffic, forecasts at Belvoir had to be based on a number of assumptions agreed by members of the Joint Working Party in an attempt to derive estimates for usage in the year 1996. Thus, it was accepted that the

proposed development, together with its multiplier effect, would require some 5 000 new dwellings; this enabled a hypothetical distribution of housing to be advanced, which in turn permitted notional levels of traffic generation from residences to be derived (Table 5.2). Predicted base (i.e. "without development") flows were taken from the low growth curves in the Department of Transport's interim memorandum on national traffic forecasts, which indicated a rise of 27 per cent over existing movements. Assignment of flows was based on a full 24-hour day rather than the usual 16-hour period; these were then added to the forecast base flows. In addition to commuter traffic, an allowance had to be made for HGV usage and this was estimated on the basis of existing experience to be around 200 two-way trips per day per mine.

Whereas HGV traffic can be estimated with some certainty, and its routing controlled, the proportion of commuters to mine sites shows wide variation (26-55 per cent). It would appear to be reasonable to assume a figure of around 50 per cent in a rural area, possibly rising to a maximum of 65 per cent by the end of the century.

Farm severance impacts may be thought of in terms of three types of increased costs: extra travel distances for men, machines and animals to reach severed land (which may be considerable if lengthier, but less hazardous, routes have to be adopted); loss of production from land that becomes unviable or inaccessible; and costs associated with the need to rearrange the farm system. The latter two of these are considered elsewhere, but the first is properly treated as a traffic impact. The extent of travel costs associated with severance depends on five variables - the amount of land severed, the number of trips per hectare typically required to perform the tasks of husbandry practised on the severed land, the extra return trips necessary to gain access to the land, the speed of travel, and costs of labour and machinery in the agricultural industry (Boddington et al., 1978; Scott, 1982).

LOCATION	DWELLINGS	TRAFFIC GENERATION	
		Peak hours	Daily
Melton Mowbray	2 150	1 505	15 050
Bingham	650	455	4 550
Bottesford	350	245	2 450
Grantham	1 000	700	7 000
Asfordby	640	448	4 480

Table 5.2. Hypothetical housing distribution and traffic generation in the Vale of Belvoir (Source: Joint Working Party, 1979).

The level of costs incurred as a result of additional travel distances can be calculated as:

$$\text{time spent} = \frac{\text{ha severed} \times \text{trips/ha} \times \text{distance}}{\text{speed (kph)}}$$

and cost = time spent x travel costs.

In general, severance costs for arable farmers are unlikely to be high except in extreme cases, whilst those for dairy farmers will be much greater and may justify the construction of accommodation works. By applying an average travel distance, it was estimated for the Belvoir Inquiry that existing severance along the Bingham-Waltham road entailed a total of 32 000km/yr, thus exposing farmers to significant increases in cost, inconvenience and danger.

Land and Resource Use Factors: structures, site preparation and solid waste disposal

The land requirements associated with the development proposals should be specified in terms of the total amount of land necessary for satisfactory operation, the actual area covered by the application and the area for each additional phase of development. If tipping is involved, it is also necessary to know the proposed restoration scheme (and whether it is progressive), the after-use and its relevance to planning policies, tip design, quantities and nature of waste produced, and means of reducing the output of dirt. Any provisions for the remote disposal of waste, and its implications for the disposal site, should also be noted. It may, however, be desirable to leave certain detailed factors, such as post-restoration rationalisation of field boundaries and fixed equipment, for consideration at a later date.

Much of the foregoing information will have to be based on past experience. In the case of waste tipping, ratios of operational land to deep mined coal have remained reasonably constant at around 200ha/mt/yr; however, NCB anticipate that this is likely to be considerably lower in the case of modern development. Thus, proposals at Belvoir envisaged 109ha

for mine surfaces, 98ha for temporary access and land use, and 616ha for waste disposal (of which not more than $7\frac{1}{2}\%$ would be in use at any one time) in order to attain an output of 7mta. This gives ratios of only 118:1, or 30:1 if the minimum figure for tipping is used. The ratio of waste to saleable coal, which is now as high as 1:2 in some fields, has increased as a result of less selective mechanical cutting methods, but is expected to increase only modestly now that mechanisation of faces is almost complete. Two factors in particular will serve to complicate this. First, the dirtiness of measures locally will be of major importance: waste disposal was only a very minor issue at Selby (although there was an indirect impact of pulverised fuel ash disposal at power stations) whereas quantities were far greater at Belvoir, creating a demand for large areas of land for tipping and washeries. Second, the actual quantity of dirt produced cannot be predicted with great accuracy, since it depends on seam characteristics not fully known at the planning stage; moreover, the rate of production will fluctuate according to the stage at which the dirtiest coal is extracted.

A normative approach to topsoil impacts may be adopted in the form of restoration conditions, thereby reducing permanent loss and deterioration to a minimum. A number of criteria for monitoring the success of site restorations have been suggested, such as agricultural productivity (weight of crop yield), biological productivity (weight of dry matter added per unit time) and soil capability (effectively, re-survey of the land's capacity to sustain economic yields of selected crops) (CoEnCo, 1980; Tomlinson, 1981a, 1983), but all of these pose problems of measurement.

Whilst the re-survey of land capability has been widely canvassed, and occasionally practised, it should be noted that the Land Use Capability Classification and Agricultural Land Classification are based on soil texture, stoniness, natural drainage and other features of natural soils, and it has been suggested that reinstated soils do not conform to the "natural rules" and are generally in a dynamic state which may take twenty years to regain equilibrium. Thus, there has to be a lack of precision in evaluating the success of restorations until an improved system of sampling and classification can be evolved.

Arnold et al. (1984) have more recently used "biological activity" as a standard means of comparing reclamation progress on different sites, and this would appear to hold some promise for post-restoration monitoring. This measure was taken by incubating moist soil samples at 70% (on a weight-by-weight basis) of their water holding capacities for ten days and measuring the CO₂ released over a further ten day period. It was found that biological activity could subsequently be predicted from WHC, pH and levels of partially oxidisable pyrite by means of a multiple regression equation.

Land take impacts could be reduced, and environmental improvements and agricultural gains secured, by the remote disposal of waste. It has been argued that disposal points should have at least 5mt capacity, be conveniently located with respect to the chosen means of transport, and should not conflict with existing or proposed land uses (Leicestershire C.C., 1983; DoE, 1983c). Road transport appears to be the most flexible, but often the least environmentally acceptable and most expensive, mode; rail freight generally stands out as being the most feasible, especially where collieries are rail-linked and lines under-used; canal transport may be possible in some locations, although improvements to navigations would be necessary to accommodate 400-700t barges; whilst slurry pipelines require massive capital investment (South Yorkshire M.C.C., 1976). The principal drawback of remote disposal is clearly that of cost, and the effect that this would have on the price per tonne of coal - the tipping of Belvoir spoil in worked-out clay pits in Bedfordshire, for instance, was calculated at nearly £12m a year (1979 prices). However, the detailed findings of the Remote Disposal Working Party (DoE, 1983c) are open to a more optimistic interpretation, suggesting that longer-distance hauls of waste material may become attractive under particular circumstances (Selman, 1984).

In addition to the main site uses, considerable amounts of land will also be lost to ancillary and indirect uses such as housing, new or re-routed road and rail links, electricity lines and other mains services, remedial works for canals and watercourses, and off-site

tree planting. Whilst most of this will be fairly predictable in terms of location and quantity, housing distribution, especially in the private sector, will be intractable to forecast. In the past, NCB have been landlord for the majority of their workers, but it is now the policy to avoid construction of "mining conurbations" and seek to locate houses for transferees on a more dispersed basis.

Estimates of housing requirements must first draw on assumptions about the number of employees and of the proportion of transferees, probably on the basis of previous experience; further information must then be obtained about the characteristics of the workforce, dependants and the multiplier effect of the development. Commuting patterns present an additional complication: of the 4 000 miners to be employed at Selby, it is anticipated that only about 2 500 will actually move into the area (of whom about 1 500 will wish to buy their own homes), but this pattern largely reflects the relative proximity of existing mining settlements. Similarly, at Belvoir, the NCB's figure of 3 400 men to be brought into the area could not be translated directly into demand for an equivalent number of local houses and the Joint Working Party (1978), although unable to agree on all aspects, put the amount at around 2 500, although this would have to be raised to allow for any multiplier effect. To this was applied a figure for per capita land consumption (presumably of 0.1ha), including community facilities and open space, producing an overall urban land take of some 250ha over a ten-fifteen year period. Catchment areas for each mine were then defined in order to identify more specifically the likely housing locations. Although the exercise was employed primarily as an indication of infrastructure costs, it could equally well serve as a distributional model for agricultural land loss.

The construction workforce would be unlikely to have a significant impact on housing and infrastructure unless large numbers settle permanently in the area, although temporary requirements could arise, especially during the peak construction period in years four to six.

Several methods have been employed to represent the quality of farm land which is lost to development, and thus gauge the severity of agricultural impact. Worthington (1979) has suggested that parish statistics based on June farming census may be used, inasmuch as they describe land uses which are, presumably, indicative of land potential. Thus, the least valuable land may be associated with the least valuable outputs. In the case of arable farming, this is likely to include the least demanding crops (i.e. the arable forage crops such as kale and mangolds), certain cereals, and a higher proportion of uncropped (fallow) land, which reflects a reduced intensity of farming. With respect to stock farming, it is possible to obtain the ratio of "grazing livestock units" to the hectareage of available pasture as a comparable measure of intensity. Problems arise with these assumptions, however, as the crops grown may reflect the particular mix of agricultural specialisations within an area, and measures of grazing intensity may be subject to error, since not all the livestock's feed will come from grass. Furthermore, statistics aggregated at the parish level may be inapplicable to a particular development site.

Agricultural impacts in planning decisions are conventionally evaluated by reference to one of the land capability classifications. However, it has been suggested that, for planning purposes, as opposed to extension services, serious difficulties of consistent interpretation arise, especially at site level (Boddington, 1978; Selman 1982a). It may also be considered that there are significant theoretical constraints which limit the utility of this approach, conceptually simple though it may be, for detailed planning assessments. First, there is no reliable means of converting the scale of land capability to agricultural productivity or economic yields. Although a productivity index has been proposed for use in public sector investment decisions (Jefferson, 1976), it has been shown to be rather suspect. Second, a simple evaluation of land cannot take into account the complex effects of development at farm level, such as those caused by severance or loss of buildings. And third, the various classifications specifically exclude consideration of capital investment or above-average levels

of management expertise. Yet it is the legitimate task of planning to protect the interests and investments of established users, as far as socially desirable, against the adverse effects of development. From the planning point of view, therefore, investment in the land is, to a certain extent, as important as inherent land quality.

A further possibility is to refer to market land values, but these are notoriously poor reflectors of the value of land in terms of farm output and may reflect many other influences (Northfield, 1979). The use of rents at tender, as a measure of the net product of the land and fixed equipment in agricultural use (Ward, 1957), would suffer from similar weaknesses. Nevertheless, the further refinement of this approach has led to the use of a "value added" measure (Roskill, 1970; Boddington, 1973; Leonard and Partners, 1977). Slight variations appear to have been made in the way this is calculated, but it is typically taken to be gross output minus all costs except rent, rates and payment for management. The residual figure thus obtained is assumed to represent the intrinsic value of the land expressed in economic terms. Although it includes the capitalised value of immobile assets (as reflected in actual or imputed rent), which clearly cannot be attributed to land quality, this has not been considered seriously to distort its validity. (Indeed, in view of the points just made regarding the inclusion of investment matters in planning evaluations, this could be a positive advantage). An economic approach is also advocated by the U.S. Bureau of Mines (1980) who favour the measurement of direct losses in terms of reductions in Animal Unit Months (that is, the amount of forage or feed required to sustain one cow, or equivalent, for one month), and of indirect losses, by identifying the financial impacts on ranches and the community caused by the conversion of grazing lands.

Despite his original reliance on the value added measure, Boddington (1978) has more recently drawn attention to some of its more serious ambiguities. For instance, some forms of intensive agricultural and horticultural enterprises may be carried out in any location regardless of land potential and thus produce a misleadingly high figure;

assumptions must be made that a proportional reduction of fixed costs will match exactly the reduction in land area on all farms and that all overheads will be transferred, without reduction in efficiency, instantly to another agricultural use; and, in the case of restored land, that when it becomes available once more, overheads will immediately be available in exactly the right quantities to ensure maximum efficiency and that reduced margins on restored land are attributable solely to its lower productivity. Bearing in mind that most planning decisions entail the loss of only part of a farm, and that fixed overheads are rarely readily transferable, it has been suggested that changes in gross margin may reflect rather more sensitively the impacts of land loss.

A major problem of assessing impact by means of farm income data, however, lies in the collection of adequate baseline information. The study for a third London airport (Roskill, 1970) resorted to the use of parish statistics whose limitations are notorious, but which tend to be minimised when taken over a sufficiently large area. On this basis, numbers of livestock and the hectarages under crops and grass were obtained, and the opinion of local agricultural advisers was then sought on likely levels of yield and prices, making it possible to derive an approximation to total farm revenue in each parish. This was then converted into input costs and gross output data, presumably on the information contained in the regional Farm Management Surveys.

A similar approach was adopted by NCB's consultants in Belvoir. Here, three possible means of interpreting the data were considered: actual losses sustained by the present occupants of the sites, based on their existing operations; losses based on the average of the cropping and stocking statistics for each parish; and losses derived from model farm rotations for each site, inferred from soil and site characteristics. The first approach was rejected because of the difficulty of obtaining cropping and stocking information for individual farms, the possible variation of activities and farm layouts from year to year, and the assumptions which would need to be made regarding average standards of farm management. The second method, although the one which was

eventually used, suffers from the fact that parish statistics may not be indicative of long term value, whilst in some cases the mine site used only a relatively small area within two large parishes. The former drawback is probably not very serious, especially if an economic measure is being sought, although inspection of the parish returns seemed to indicate that the second would lead to considerable inaccuracy. It is probably the case that parish statistics are more appropriate to the pervasive sub-regional considerations rather than to evaluations of site impacts. The third approach is greatly assisted if soil survey data are available, but in the absence of detailed site surveys, assessments of the long-term use of land could be suspect. Further, it was contested at the Inquiry whether there would be major long-term adjustment towards "optimal" land uses in an area where farming had been practised for centuries.

The calculation of losses based on parish statistics was derived by multiplying hectarages of different crops grown by their corresponding gross margin values, and subtracting the level of overhead costs (omitting rent and rates) applicable to the farming system of the whole parish. This yielded a notional figure of value added. Gross margins were obtained by taking a six year mean of published gross margin data for the region utilising an index based on a standardised score of 100 for winter wheat to establish long-term ratios of enterprise profitability, according to the formula:

$$\text{normalised gross margin} = \frac{\bar{x} \text{ winter wheat GM}}{\bar{x} \text{ GM of comparator crop}} \cdot \text{winter wheat GM for base year}$$

Levels of overhead costs were also taken from standard regional sources. The impression is gained that it is at this stage that error can most readily occur, as overhead costs are represented by very generalised regional averages. These data deficiencies would, of course, be repeated for all measures unless actual farm records were available. For the Belvoir Inquiry, Boddington (1979) was, in fact, able to infer such information on the basis of farm records on land use (although little direct indication was available of costs). Although this was useful, it is doubtful whether data of this quality could be obtained for the entire prospect area, which would be desirable for the initial site selection exercise, rather than just for the three application sites.

Unlike permanent forms of land loss, the use of farmland for tips or opencast working make take account of their eventual reclamation. Thus, the loss of value added or gross margin must only be calculated for the period during which land is wholly or partly out of production. Typical cropping yields during the restoration phase have been estimated at 40 per cent of initial gross margin in years 1-5 (grass only), 60 per cent in years 6-10 (four years grass and one of wheat), and 70, 80 and 90 per cent in years 11-15, 16-20 and 21-25 respectively (each, three years grass and two years wheat), although this would naturally vary somewhat with different speeds of restoration. This can more conveniently be expressed as "equivalent area out of agricultural production" (Table 5.3).

At the Belvoir Inquiry, the NCB's consultant maintained that the use of value added was the most appropriate way to measure losses, and insisted that all the overhead costs deducted in the calculation of this figure were transferable. Boddington, representing the objectors (the "Alliance"), preferred to use gross margins, which understandably produced a substantially higher estimate of lost production. It is possible to have considerable sympathy for Boddington's point of view, especially in the case of farms directly affected by site development, since overheads cannot always be lost in proportion to the amount of land lost, and because it may generally be observed that many assets, whilst notionally transferable, are effectively removed from the farming industry in the wake of site development. In practice, it is probable that the true level of loss will lie between gross margin and value added; at the Inquiry a measure of agreement was reached that a reduction of around ten per cent from gross margin would reflect the extent to which farmers would on average be able to reduce excess overheads during restoration.

<u>Period in Restoration Cycle (years)</u>	<u>Equivalent Area (%) out of Agricultural Production</u>
1-5	60
6-10	40
11-15	30
16-20	20
21-25	10
25+	0

Table 5.3. Equivalent area of land out of production during restoration.

Land and Resource Use Factors: subsidence

There is a body of opinion which suggests that subsidence should be excluded from coal mining EIAs on the grounds that it will be common to all strategies and therefore will not aid discrimination between alternatives. This reasoning is not accepted here for three reasons: it may lead to choices being made on the basis of relatively unimportant factors, simply because they vary between different proposals; it is desirable to establish the overall magnitude and consequences of impacts, to guide decision-makers as to whether the proposals should be accepted at all; and subsidence may in fact vary between options, as alternative technologies (for instance, designs incorporating backstowing) may alter its severity.

Subsidence prediction is a highly complex, although increasingly reliable, field, and various manuals have been compiled to assist mining engineers (e.g. NCB, 1975; Lee and Abel, 1983; O'Rourke and Turner, 1979). The present discussion is therefore restricted to those salient features which may influence the response of an environmental assessor to subsidence effects. The key factors which should be ascertained by the assessor are depth to coal, height of working and width of extraction, as well as relevant local geological considerations such as cambered strata, old landslip activity, and tilting and separation of blocks and strata around the edge of the valleys. The main options with respect to subsidence appear to be: when, if at all, operations should be limited to prevent surface effects; what preventive measures should be taken and who should pay for them; what compensation should be available and from what sources; and what restrictions should be imposed on surface development.

Although modern mining techniques may make subsidence relatively predictable once geological factors are known in detail, there is still considerable uncertainty regarding the timing and structural effects of subsidence. Thus, the provisions for forecasting must include a strong normative

element and vigilant monitoring. Although planning conditions have been used on occasion to restrict the actual area of undermining, these do not always prove popular at ministerial level. In Belvoir, a useful compromise situation was reached based on two planning conditions taken together. Thus, the NCB was required: to notify the planning authority at regular intervals of its working proposals for 18 months ahead and of its more general intentions for a period of five years in advance; and to submit further details of coal quantity and quality beneath critical areas, in the absence of which only activities not causing subsidence would be permitted.

With regard to prediction per se, three methods are generally employed by the Board's engineers: an empirical predictive method, relating development curves to a standard underground layout; a nomogram relating strain to length of structure; and the extrapolation of findings from other coalfields. At the Belvoir Inquiry, extensive use was made of the last of these, based on a statistical study of mining in the East Midlands, which provided an indication of the proportion of the prospect area likely to be affected by different degrees of lowering, and the number of farms and smallholdings which could fall into each damage category. Extrapolation of this kind raised issues of relevance, as it took no account of the age or construction of properties within the two coalfields (Dickinson, 1979), and as geological conditions in Belvoir differ from those in the East Midlands and represent strata of a different age from any of the NCB's current working areas (Malkin, 1979). However, the Inspector was advised that the experience in a virgin coalfield was likely to be less, rather than more, serious.

In relation to the nomogram technique, Malkin (1979) observed that it showed clearly how, as the length of building increased beyond about 30m, the intensity of damage rose rapidly for the same amount of strain. As a generality, unless structural precautions have been taken during construction, the large buildings will suffer a proportionately higher degree of damage than domestic properties - a factor of considerable

importance for agricultural estates. This method also found favour with the Inspector, since confidence limits could reliably be applied, and since it appeared to be reasonably robust between different coalfields. The nomogram has been found to provide a reasonable correlation for damage to small and medium-sized properties, and and this would appear to complement the effectiveness of subsidence development curves in predicting damage to large houses. The subsidence development curves, however, although reliable so far as general ground lowering is concerned, do tend to be markedly influenced by the nature of the immediate surface strata and overburden. It would appear that in about 12.5 per cent of cases, such factors could lead to more damage than was predicted (although less in another 12.5 per cent of cases).

A major problem in estimating land drainage impacts lies in obtaining baseline information on the area which is effectively underdrained, and for which no reliable records usually exist. This was obtained in Belvoir by extrapolating from a physically comparable area for which some data were available, by means of the following empirical formula (Orchard, 1979):

$$\text{area effectively underdrained in the application area} = \frac{T_{\text{nat}}}{38} \cdot \frac{G_{\text{div}}}{G_{\text{nat}}} \cdot \frac{A_{\text{nelp}}}{A_{\text{div}}} \cdot 39 \cdot f$$

where,

T_{nat} = total area underdrained with grant aid 1940-78 nationally

G_{div} = greatest area underdrained in a year in a comparator area

G_{nat} = greatest area underdrained in a year nationally

A_{div} = area of agricultural land in the comparator area

A_{nelp} = area of agricultural land in the north-east Leicestershire prospect area

f = correction factor for amount of underdrainage carried out per km² in application area as against the comparator area (= 0.8).

Where conditions appear critical, it is desirable to conduct a detailed survey of the present main drainage system and the relative levels of adjacent lands. In Belvoir, one such zone was aerially surveyed to determine present contours and to investigate the likely effects of subsidence on drainage at various stages of mining operations.

Generally the methods of subsidence forecasting appear somewhat unreliable, and their main purpose seems to lie in providing a broad indication of the NCB's liability and the approximate location and magnitude of problems. It is also useful to be able to make contingencies for the types of problems to be encountered and their potential solutions. Nevertheless, it could be argued that one of the most important phases of assessment associated with subsidence would be monitoring, or prediction, within critical areas once development has commenced.

Pollution Impacts

Design information on pollution should indicate the production of significant quantities of particulate matter or gases, aqueous discharges likely to enter underground or surface waters, and continuous and exceptional operation and constructional noise levels. Any tendency for new developments to cause "creep" of existing levels to unacceptable thresholds should also be noted. Commonly, pollution forecasts will be of a normative nature and specific targets will be set for controllable sources.

Prediction of noise levels will depend on the availability of information on the main construction and mining operations, equipment and machinery to be used, on whether the noise is continuous (and, if not, the duration and timing of a typical noise event), tonal characteristics, impulsive irregularities and variations in noise character (Clark et al., 1981). If a tonal or impulsive character is present (such as that associated with the drivage of mine shafts) an additional 5dB(A) should probably be added to the predicted level. Noise nuisance from transport installations should also be considered - trains hauling colliery wagons are found to create levels of 80-90dB(A).

Once corrected noise levels have been ascertained for each of the measuring locations, these may be compared with background levels or standard norms (BS 4142; DoE, 1973; Wilson, 1963). If any of these are exceeded by 10dB(A) or more, complaints may be anticipated (OCMA, 1972), whilst even smaller increments may contribute to noise "creep".

Acceptable noise levels are frequently expressed in terms of L_{eq} , but the point has been made that rural sites are especially sensitive to nighttime noise and peak levels. In general, community responses seem to suggest that background noise climate would be better expressed in terms of L_{90} or L_{95} , and there is some experience from recent coalfield development to indicate that complaints are likely to arise when the nighttime L_{90} exceeds 40dB(A). There is thus a case for introducing these parameters into normative controls, as the single measure of equivalent continuous noise level may be inadequate to establish the nuisance threshold for the types of activity proposed (Jones, 1979; Stokes, 1979).

A variety of design modifications to limit noise may be employed including siting and silencing of plant, restriction of working and blasting hours, screening by mine waste, and by working tips in a phased manner so that maximum noise levels only occur at any one location for a short time. However, Down and Stocks (1977) note that, in practice, the reduction of noise is often less than that calculated because sound is scattered over the edge of site screens by air turbulence, and because certain topographic features and atmospheric conditions may cause a focussing of noise. Further, there will inevitably be a number of site malpractices occurring which raise peak noise levels.

Whilst dispersion of particulate and gaseous emissions from point sources can be predicted with at least tolerable levels of accuracy via standard formulae, Stocks (1979) has noted that dust blow from mines can effectively only be estimated qualitatively from experience of present sites. In the UK, average annual rates of deposition of insoluble material may range from roughly $60\text{mg m}^{-2}\text{ day}^{-1}$ in rural areas to $200\text{mg m}^{-2}\text{ day}^{-1}$ in industrial settings, although seasonal and climatic factors may cause wide variation around these averages. Dust levels at 22 sites in the Vale of Belvoir were monitored by an engineering consultancy and found to be typical for a rural area; interestingly, those in the region of Cotgrave mine were not significantly

greater, although the material collected there was blacker. Diffusion models may prove appropriate for some aqueous mine discharges, but given the present level of knowledge in pollution modelling, it will for the immediate future probably be more satisfactory to deal with these in a normative fashion.

Decommissioning

Predictions relating to the decommissioning stages of mining projects are necessarily the most difficult to make, especially in the case of underground mining where the time horizon may be upwards of 100 years. However, whilst attempts to place numerical values on post-operational impacts may be spurious, impact assessment should at least attempt to define those areas likely to require continuing attention. One of the more serious planning problems in mining areas has been the short notice of intended pit closures, which has denied local authorities the opportunity to plan adequately to meet changing circumstances or to attempt timely remedial action. Many of the former collieries employed 1000 or more miners, and for planners to try and attract the equivalent number of jobs not only means the provision of expensive infrastructure and loss of additional agricultural land, but also requires long lead times (RTPI, 1979).

Furthermore, certain facilities may be retained, such as washeries, and stores and workshops serving other coalfields, even where mining has totally ceased in the locality. This leads both to large traffic movements and the creation of new spoil heaps. All the problems previously associated with workings are retained without any real employment benefit directly attributable. The length of life of these facilities is uncertain and in some instances it is not even possible to try to reclaim a former colliery site since it is retained as operational land, for instance where an abandoned colliery continues to serve as an air shaft. Although planning conditions and agreements may be used to restrict ancillary or "multiplier" developments, it is debatable how effective these will be in the longer term as the centre of gravity of coaling production shifts towards newer mining areas, or even if such planning conditions would be considered "reasonable" on economic grounds.

When making provision for the decommissioning stage, then, attention must be given to a variety of workforce, transport, land use and physical environment factors. Workforce considerations comprise essentially the redeployment of mine employees, and will be most acute in the case of those installations of relatively long duration (i.e. problems will be much more limited in the case of opencasting). Planners can do little to control this, but, as mines and their workers contribute to the rate revenue of the area, it seems reasonable for local authorities to provide training facilities to develop new skills and to make provision for alternative industries. It is, of course, incumbent on employers to engage in discussions with planners well in advance of intended closure. The prospect of continuing transport movements associated with the residual aspects of the industry and their relationship to adjacent coalfields could possibly require the removal of specified link roads, railheads, conveyors, and so forth. Since traffic movements are the product of land uses, conditions requiring the removal of particular installations could also be effective.

Continuing impacts on the land are twofold. First, disturbed land will require reclamation and, whilst most activity areas associated with modern mines should have been progressively restored, there will be a longer-term problem of tailings ponds. This particular issue may increase or decrease in severity in the future: more sophisticated treatment plant may enable the economical compression of fines into tailings "cake" for layering in the tip; alternatively, backstowage or remote disposal provisions may increase the need for local tailings disposal, since there will be no local tip and material which is insufficiently dewatered cannot readily be transported. Second, subsidence may continue, with all its attendant problems. Whilst the amount of residual lowering should be minimal where there is a combination of longwall extraction methods and deep seams, it is not inconceivable that major changes to present extraction methods could transpire in the future as a consequence of increasing misgivings about the quantities of coal which they sterilise. Where in situ gasification or liquefaction

of coal is employed, the possibility of continued and unpredictable dissolution of seams presumably cannot be excluded. Finally, in the case of environmental pollution, the problems of acid mine drainage on cessation of pumping appear to have abated with the clearer position regarding the NCB's liability for such discharges. The position regarding private operators is also legally clear, but for a variety of reasons may present greater problems of enforcement. Leachate or dust from tips may also present continuing problems, but these can be greatly alleviated by insisting on high engineering standards during tip construction.

However comprehensive a list of decommissioning problems is compiled, it is inevitable that unforeseen eventualities will arise. This underscores the importance of a coalfield committee being established which is equipped to monitor progress throughout the coalfield's life. Although this would rest heavily on the goodwill of the operator, it could to some extent be more formally assured through the drafting of appropriate heads of agreement as part of the forward planning exercise.

Conclusion

The quality of environmental impact forecasting will be severely constrained for some time to come by lack of refinement in predictive methods, inadequate testing of techniques against properly audited data, and insufficiently detailed design and baseline information. Planning and environmental controls can help define normative standards and, possibly, ensure that activities are monitored for the benefit of future practitioners and for the provision of early warning information. Predictive techniques are thus limited in their capability and application, but if their role and purpose are adequately and carefully defined they may be of great value in ascertaining the broad acceptability or otherwise of proposals. Although it would be an enormous task for a single study to test all the approaches discussed, the next two chapters explore in a limited manner the potential for impact evaluation packages in assessing mining-agriculture conflicts.

CHAPTER SIX

THE COMPONENTS OF AN IMPACT APPRAISAL METHODOLOGY

It was noted earlier that, whereas EIA has often been equated with the appraisal of individual proposals, it is more properly perceived as a tiered sequence of policy, plan and project appraisal. In practice, most attention has focussed on the last of these stages, but the higher echelons must not be ignored: indeed, they are peculiarly significant to the planning system, which distinguishes itself from many other environmental control agencies by being strategic and comprehensive in its operation rather than reacting on an episodic basis to localised issues.

Several advantages have been claimed for a tiered system of appraisal (Clark, 1983). First, alternative designs or locations for a project may be severely limited by earlier decisions made at a higher level; for instance, mis-specification of a highway assessment could occur if transport policies had not been subject to such evaluations. Second, assessments of individual projects could only be conducted once proposals had reached an adequate degree of detail. At that stage, repeated project appraisals to ascertain optimum site selection would be prohibitively expensive and time-consuming. Third, by the time the project level has been reached, the operator's willingness to contemplate locational or technological alternatives decreases; whilst, even in the case of viable alternatives, the impacts under review will probably already have been 'scoped' down to a manageable number. Elsewhere, Montbailliu (1983) confirms that EIA rarely allows for a thorough assessment of alternative sites, since assessments are usually implemented when commitments have been made in favour of a particular location. Fourth, project appraisal is generally speeded up if baseline data are already available. Finally, when projects are individually small in size, but collectively large in number, an EIA at the plan and programme stage may both lead to a reduction in the time required for evaluation and ensure that incremental effects are not overlooked. It has similarly been claimed (Fulton and Spiers, 1982) that, where plan environmental assessment had already taken place, major project appraisals could be limited to instances "where development plans are out of date or lacking in quality, or where they are tested by unforeseen demands".

Unfortunately, the methodologies for the more rarefied tiers are weakly developed and prove to be very demanding in their data requirements. As a consequence, most detailed attention has been paid to the more urgent issue of project appraisal. Indeed, this study concentrates primarily on the project stage, but it is felt germane to give consideration, on a speculative basis at least, to the nature which a strategic appraisal of mining-agriculture impacts might take.

Strategic Appraisal and Mineral Developments

The absence of a genuinely strategic dimension to mineral planning has been noted by many researchers. Structure plans and mineral subject plans have provided some kind of framework and have been moderately useful in influencing practice in four major policy areas. These include policies designed to aid the industry, partly through the identification of consultation areas; others which define model standards of control for operations; some which seek to ensure adequate standards of restoration; and finally policies concerned with the location and siting of, and need for, mineral workings. However, the approaches used so far have proved inadequate for the resolution of sub-regional issues of supply, demand and employment, and of local considerations of amenity and conservation (Kellest, 1982). The Guidelines for Aggregates Provision in England and Wales (DoE, 1982b) are concerned only with the crudest equation of inter-regional supply and demand factors in respect of one type of mineral. Environmental and agricultural factors are considered only by implication, and numerical estimates have been allowed to prevail over policies incorporating more qualitative elements (Roberts and Shaw, 1982b; Bate, 1982). From the environmental (if not the supply) point of view the situation in Scotland is rather more satisfactory, having been aided by the publication of National Planning Guidelines, which come closer to bridging the gap between strategic and local issues (Scottish Development Department, 1977a, 1977b). Overall, though, as Roberts and Shaw observe, whilst "it cannot be denied that local authorities have included minerals in development plans...essentially all applications for mineral development...have been considered strictly on their own merits" (Roberts and Shaw, 1982a).

Policy and Programme Review

A major criticism of current practice is the inability to disentangle national and local issues. One solution to this is to have a multi-tier appraisal system, in which different levels of decision-making are effectively interconnected (Lee, 1982). For instance, in British Columbia (O'Riordan, 1981), the Coal Development Appraisal Process moves progressively from a general overview ("prospectus") of a project to a detailed impact assessment, the whole procedure being coordinated by a Coal Guidelines Steering Committee comprising senior officials from government ministries representing economic, environmental and community development interests. The Committee serves as a direct contact with coal companies and their consultants regarding interpretation of the guidelines and provides advice for undertaking the necessary studies. Even under this arrangement, however, complaints have arisen regarding limited public consultation and lack of clear linkages between project assessment and overall coal development plans.

Review of development "programmes", comprising interconnected projects, has been adopted in the USA by the Department of the Interior (USDI, 1980). In relation to mining, these programmatic EISs display four phases. First, the selection of specific tracts of coal to be offered for lease would be brought under the proprietorship of the Bureau of Land Management. Second, specific standards would be used to identify areas where extraction would cause unacceptable damage to land or resources. Third, areas not found unsuitable for mining would be further evaluated and the potential coal development considered in relation to other values, such as watershed management or stock grazing. Finally, from those areas found to be acceptable for further consideration, tracts would be delineated and then ranked on the basis of coal quantity and quality, cost of extraction, and social, economic and environmental impacts of mining.

Where a higher tier of general assessment has already been carried out, it may be possible to subject individual projects to a less exhaustive level of analysis. For instance, the Ministry of Environment for Ontario

has devised a procedure for "Class Environmental Assessment" - a method for dealing with certain classes of project which are relatively small in scale, occur frequently, and have a generally predictable range of effects. The Ministry's manual outlines a common set of processes for the planning, design and implementation of individual projects (Marshall, 1981).

Plan Environmental Assessment

Methodologies for sub-regional appraisal are much less well developed than for project assessment, although several techniques have been canvassed, including checklists, quality standards and targets, data collection and retrieval systems, resource and waste coefficients, diffusion and damage analysis, agency and public consultation, and overlay methods. Several of these may be used in combination, as it is unlikely that any one would cover all the stages in the plan preparation process. In the light of the various methods which have been proposed, it seems reasonable to classify these loosely into "aspatial" approaches, whose content relates mainly to the project specifications of generalised industrial classes, and "spatial" techniques, which concentrate more on the environmental qualities of the locations likely to be affected.

Aspatial Approaches

Several techniques refer, in the main, to the general characteristics of the development class or to the general ways in which plans and programmes can be made to conform to enhanced environmental standards. This can include adaptations of goals- or criteria-achievement matrices (c.f. Hill, 1968; Hill and Alterman, 1974), in which the quality performance of various strategies can be compared. Thus, for instance, Schaenmann and Muller (1974) refer to five categories of impact receptor - local economy, natural environment, aesthetic and cultural values, housing and social conditions, and public and private services - which they proceed to re-interpret as an expanded set of specific policy measures. Performance indicators are then advanced to evaluate alternative draft plans in respect of each of these receptors. Similarly, Hatry (1972) has suggested that developments could be defined in terms of workload measures (which would appear to comprise generalised project

specifications for similar classes of proposal), performance criteria (an expansion of the former, indicating how a particular project might in general affect the environment) and local condition factors (expressing with greater precision the ways in which impacts could be experienced in practice). A limited interpretation of this sequence is set out in Table 6.1.

PROJECT ACTIVITY	WORKLOAD MEASURES	PERFORMANCE CRITERIA	LOCAL CONDITION FACTORS
transport of coal and waste	volume, frequency and mode of site traffic	intrusiveness of routes taken by traffic vibration and noise from vehicles "in transit" pollution	exacerbation of severance in areas of farm fragmentation passage through farming communities characteristics of material likely to be released

Table 6.1. Examples of indices used to assess the environmental performance of a plan; the case of colliery traffic on farm enterprises. (Based on a framework by Hatry, 1972).

An alternative basis would be to prepare general forecasts of environmental change likely to be associated with foreseeable land uses. The inevitable limitation in this case is that of imprecise design data; however, Lee and Wood (1980) reassuringly note that the same degree of precision as that required for project appraisal is unnecessary, and that it should be practicable to distinguish between broad industrial groups with significantly different resource use and waste generation levels. Hall (1977) has proposed an approach based on the concept of "development coefficients", which represent the typical resource use per hectare per unit of development. In parallel with this, a "Master Environmental Impact Report" is compiled, providing an account of the status of various resources at a sub-regional scale. Every time a new project is approved, the report is updated; the project hectareage is deducted from the inventory of developable land and the status of the various services and resources amended. In principle, scope would seem to exist for the expansion of resource accounts to

include finite resources of shallow coal deposits, waste disposal sites, high quality agricultural land, and reclaimable and re-workable waste deposits.

The potential exists, therefore, to express future coaling programmes as sets of performance targets and coefficients indicating the likely magnitude of impact. In effect, the components of mining activities to which these would apply have already been identified, in the previous chapter. Thus, it may be anticipated that the generic characteristics of this particular development class could be subsumed under the various indices of workforce, transport, land and resource use, and pollution.

Spatial Approaches

In view of the difficulty of predicting the characteristics of future developments, it has been mooted that plan appraisal ought rather to concentrate on the inherent qualities of the environment. Thus, alternative locations could be assumed to display different capacities to absorb adverse impacts or, conversely, positive potentials to accommodate particular industrial demands. In the context of EIA, however, this approach has normally been used for the comparison of alternative designs for an individual project rather than in a synoptic manner at a sub-regional scale (e.g. McHarg, 1969). If it were to be extended to generalised plan appraisal the associated exercise in baseline data collection could be formidable; equally, however, it could be argued that this could usefully form the basis of a more structured approach to development plan "Reports of Survey", or a constructive use of the various sources of satellite imagery which are becoming available.

The most commonly favoured spatial comparison technique, especially in regard to the generation and evaluation of alternative strategies, tends to be some kind of overlay or sieving method. (In the American literature, sieve maps are often referred to as "exclusion screening" methods). In mineral planning, the extension of standard sieve map methods has proved popular for identifying potentially exploitable mineralliferous areas, subject to environmental constraints. Some

general problems have been noted with this approach, however, not the least of which is that of visual complexity when several sheets displaying different constraints are overlaid, or the loss of information entailed when constraints are expressed in a purely nominal fashion (that is, wholly acceptable or unacceptable). Bate (1982) has further extended the list of problems associated specifically with mineral planning: the constraints chosen may result in the identification of only very small areas for future working; in the absence of detailed geological survey, the sites identified may prove unsuitable for working anyway; the nominal scale of measurement means that some of the most significant considerations cannot be incorporated, such as volumes of traffic generated; and, as the technique has been applied, it has not usually included any representation from the minerals industry.

One modification of the sieve map has been potential surface analysis, in which grids of the study area are drawn up to represent spatial variations in selected significant factors. These surfaces are typically scored on an interval or ratio scale, facilitating arithmetic manipulation. Thus, the surfaces incorporate baseline data for each spatial unit, and are susceptible to weighting (which reflects the perceived importance of goals and objectives associated with different factors) and to aggregation (which results in the production of a generalised potential surface). South Yorkshire County Council (1977) have summarised the considerable advantages which this approach entails over sieving: instead of defining arbitrary cut-offs between good and bad areas, it allows a range of scores to be given to each factor; it permits systematic and explicit weighting of factors; all the factors can be placed on a comparable basis by scoring them all within a fixed range; it makes possible a logical progression from definition of objectives to survey and recommendations; it allows for public involvement, particularly in the weighting process; it lends itself to storage of data on computer files, which facilitates updating and other future uses; and it identifies quantitatively the main areas of opportunity and conflict, which can then be studied in greater depth.

Naturally, it still retains certain limitations, the most serious of which are the danger of double counting, the manner in which supposedly significant factors are selected and the level of subjectivity involved in defining the absolute and comparative values to be placed upon those factors. However, all evaluation methods suffer from these limitations to some extent, and at least potential surface analysis makes them explicit. Other deficiencies, such as the need for more detailed analysis of critical areas and the exclusion of account costs, demand and social need are less of a drawback once it is accepted that the technique should only form a part of the overall appraisal process.

If this approach were applied to the absorptive capacity of the agricultural baseline, it would not be dissimilar to the method used to determine the ability of Scottish landscapes to absorb mineral working (Scottish Development Department, 1977b). Although this particular exercise may have produced overgeneralised surfaces which do not seem to be proving overly helpful in defining landscape zones in individual Regions, most of the reasons for this appear to be associated with the coarseness of the spatial grid adopted (2.5 km^2) and the limitations inherent in the actual measures used for scoring landscape significance.

Hobbs and Voelker (1978) have demonstrated that alternative sites can be described in terms of factors derived from a number of impact and site characteristics (ISCs). Once these ISCs have been defined and quantified, they may be transformed into abstract measures of desirability or siting factors; the mapped version of these may be thought of as potential surfaces, although Hobbs and Voelker refer to them as "suitability vectors". These surfaces may, it is proposed, be thought of as representing the absorptive capacity or development potential of the region. An indication of the siting factors which might govern mine site selection is provided by Cumbria County Council (1979), in their classification of opencast prospects. Category A comprises those sites having the least serious effect on long-term agricultural interest, and includes locations where either land quality is poor and the effect on farm structure would be minimal, where restoration to at least present land quality and improved structure is feasible and where (in

some cases) there is a bonus from reclaiming derelict land. Category B includes sites where the effect on long-term agricultural interests would be moderately serious. Here, land quality is reasonably good and/or farm structure and fixed equipment become significant, and where the losses to agriculture are unlikely to be offset by derelict land reclaimed to agricultural use. Category C is reserved for sites where either the land quality is very good and/or farm structure and fixed equipment become highly significant, thus affecting good and viable farm units with no compensatory gains from restoring derelict land or other improvements at the end of working.

More generally, however, the kinds of criteria which could be used to describe the absorptive capacity of the agricultural environment have already been identified in Chapter Four. As with spatial methods of plan environmental assessment, the critical factors have already been discussed and tabulated, except that this time it is the baseline elements, rather than the project characteristics, which are relevant. Thus, the key features for mapping would appear to relate to land uses, buildings, traffic, local economy and communities.

Spatial Approaches - a closer look

In order to ascertain whether an approach based on environmental capacity might indeed hold promise, a limited exercise was undertaken in respect of areas underlain by shallow coal deposits in the Upper Forth Valley coalfield. A surface was derived, based on a number of indices relevant to the "farm land" class of the agricultural baseline (c.f. Chapter Four and Appendix A), these measures being:

- Land Surface - arable land quality
- stocking densities
- Restoration - restoration potential
- scope for improvement of derelict land.

These are described in more detail below, and their spatial disposition within the study area shown in Figure 6.1. Although the exercise was conducted in relation to opencast mining, there is no intrinsic reason why it could not be adapted to accommodate indices for deep mining and surface waste disposal.

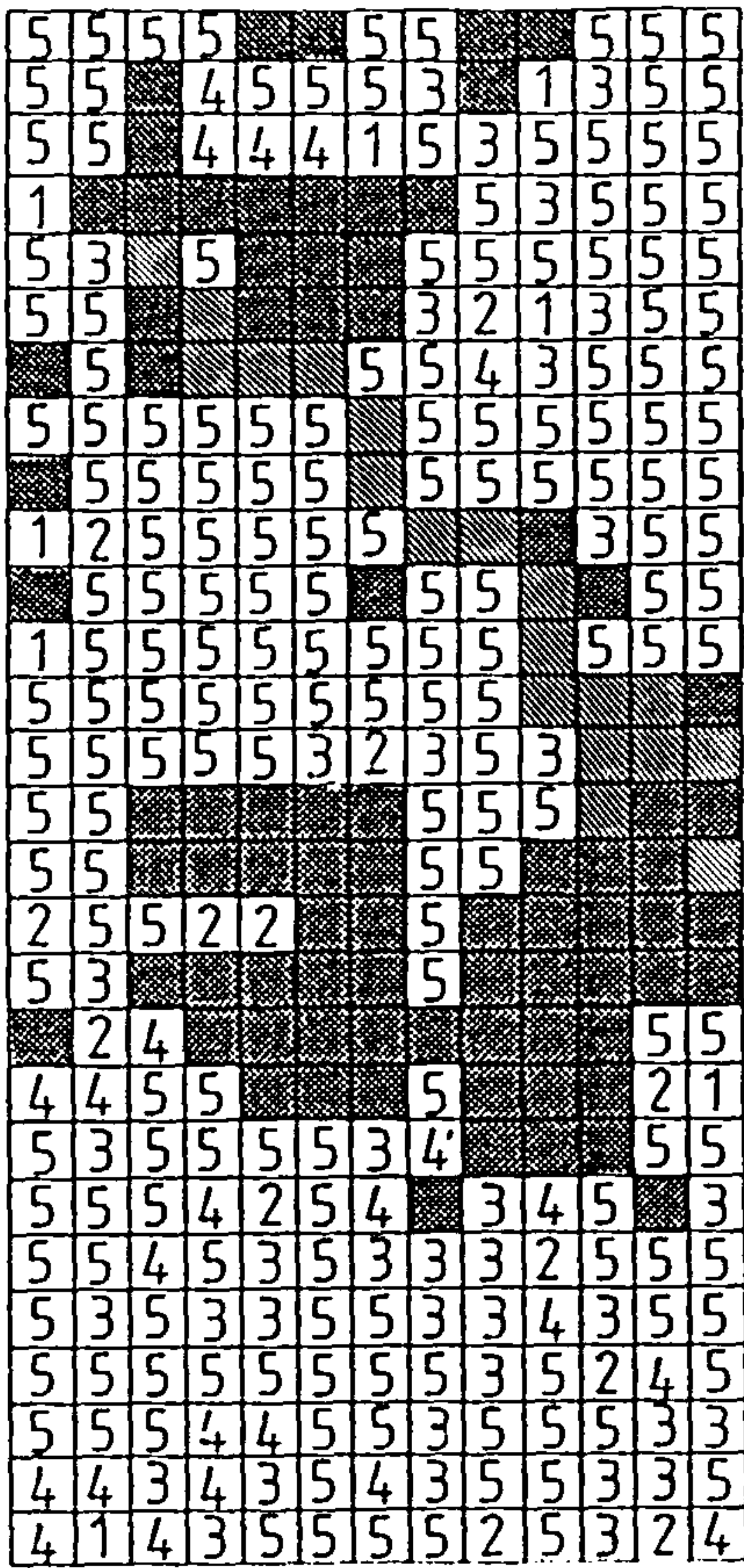
1) Arable land quality. An inverse score of Macaulay Institute's Land Capability Classification was used as a proxy for arable yield. The reliability of this measure as a predictor of output is debatable for a variety of reasons; indeed, within the study area, the carse lands, where rents are among the highest in Scotland, the capability class is rarely better than 3. Even on the very poorly graded Slamannan plateau, field drainage and liming can evidently bring low intensity grazing land into rape and silage production (Glasgow Herald 2/4/83).

2) Stocking densities. Stocking densities were calculated on the basis of the June 1981 Census; again, this produced a very generalised result, especially as the data related to parishes rather than physiographic units. There is a further anomaly in that, where livestock are housed indoors, stocking densities will only indirectly be related to rural land use. This is especially so in the case of pig and poultry production but, fortunately, the major distortions were confined to a few peri-urban parishes, which were not spatially very extensive. Numbers of farm animals and poultry were expressed as livestock units, based on standard conversion factors, producing the scale:

5	4	3	2	1
over 125 lu/ha	100-125 lu/ha	75-79 lu/ha	50-74 lu/ha	below 50 lu/ha

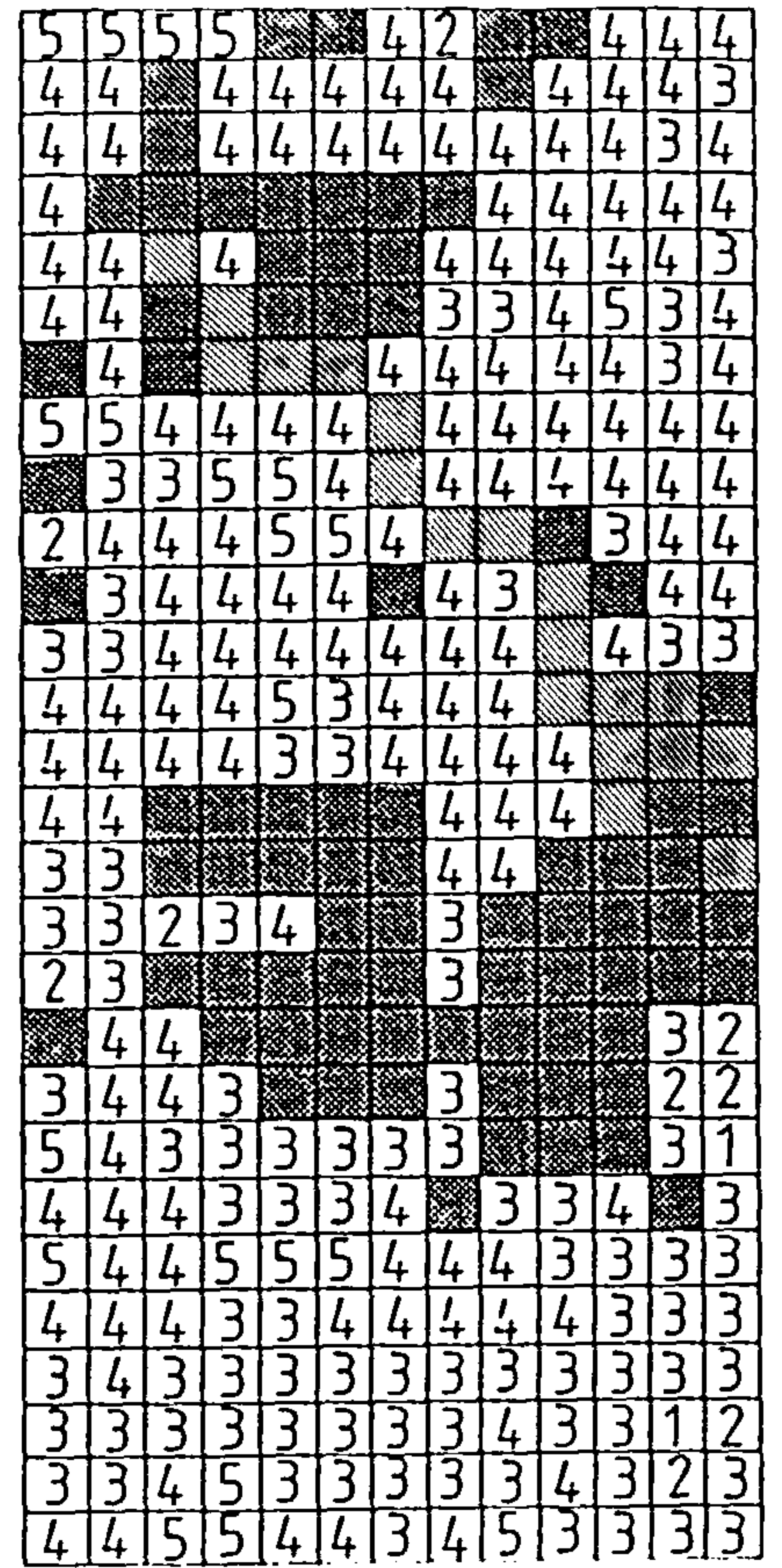
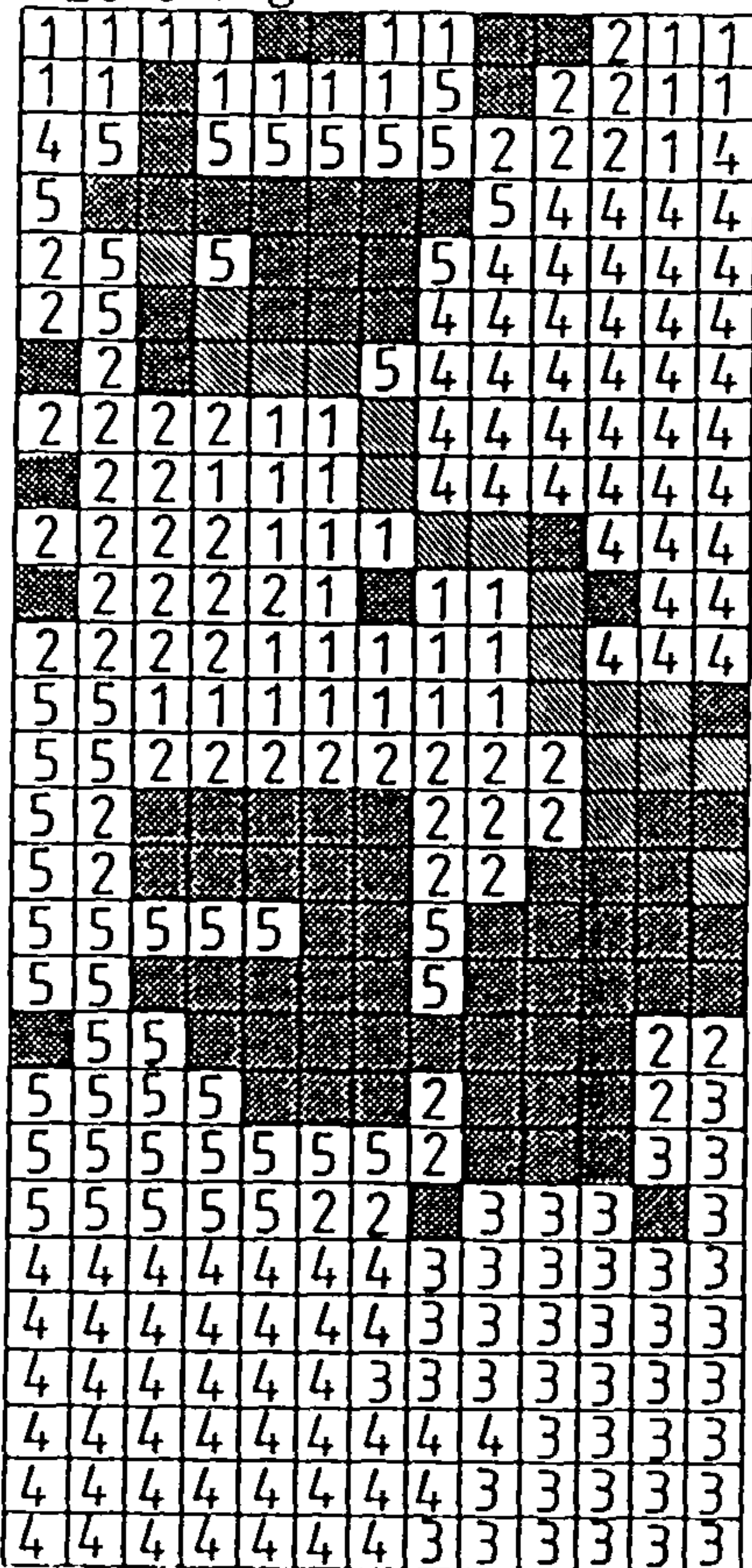
3) Land degradation. This surface was based on shallow workings and presence of derelict land, ascertained from maps, partial ground survey and a derelict land survey conducted by Falkirk District Council under a Manpower Services Commission scheme. This was intended to indicate those areas which could be worked with least detriment to agriculture and greatest prospect of planning gain, and was derived from a scale, developed in a heuristic fashion, incorporating hectarages of derelict land and number of abandoned shafts. Abandoned shafts were taken to be representative of dereliction, shallow workings and liability to subsidence, and were assigned a point penalty equivalent of 3ha of derelict land. This produced a scale of:

5	4	3	2	1
dereliction absent	0.1-1.9ha	2.0-4.9ha	5.0-9.9ha	10+ha



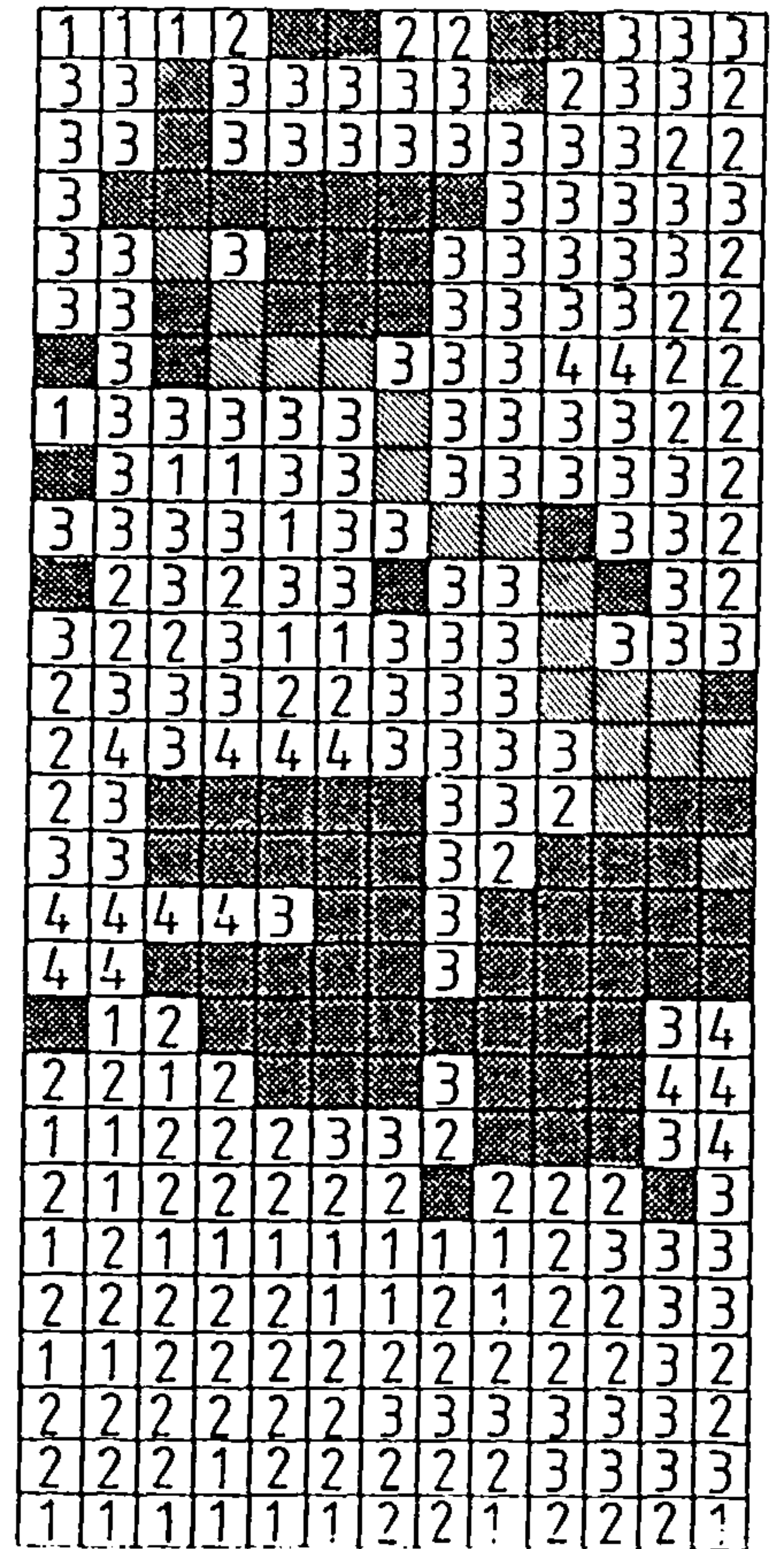
land degradation

stocking densities



restoration capability

arable land quality





 river
 urban areas

Figure 6.1. Surfaces of agricultural factors in the Upper Forth Valley.

4) Restoration capability. This scale, which was somewhat contrary to the others inasmuch as it would have the tendency of directing activity towards the better land, attempted to show the capability of land to recover from mechanical disturbance. The assumption was made that textural and drainage limitations would be the major influencing factors. These were taken from soil maps for the area, accompanied by evidence from soil memoirs; although a memoir has not been prepared to cover the Stirling and Airdrie sheets, on which the exercise drew, many of the series represented on these are also found in the Kilmarnock area, for which a memoir is available. Rooting zone limitations were also taken to be significant, especially in marginal cases of allocating soils to a particular interval. Problems were encountered with the high degree of variability of soils in the area which meant that several series could be represented within a single grid square; however, in practice, it was often the case that intermingling series had similar physical characteristics. The scale derived is set out below:

	poorly & imperfectly drained	freely drained
peat/skeletal	5	5
peaty gleys	4	3
clays, silts and very fine sands	3	3
loam and sandy loam	2	1

A one kilometre grid was selected for the study, although it emerged that a finer mesh may be desirable in practice, both for the more accurate representation of highly variable environmental factors (such as soil types) and the closer approximation to site sizes (as little as two or three hectares in some applications). As has been noted, factors were scored on a scale of 1 (poorest) to 5 (best), permitting interval measurements to be made. This poses some problems of comparability of scales, since none of them were explicitly related to absolute values. In some studies, scales are normalised on a 0-100 range, although if this is to be achieved with more than a spurious degree of accuracy it is a very time- and skill-consuming exercise. Future refinement of a potential surface approach to plan environmental assessment, however, could well involve more comprehensive surveys

and the production of ratio suitability vectors, enabling the results to be interpreted in a more detailed and reliable fashion.

A program was written to aggregate the individual surfaces into a composite potential surface. Areas not known to be underlain by shallow coal deposits were zero weighted, thus excluding them from the analysis. Scores for the generalised surface were automatically allocated to classes representing varying levels of potential severity of mining impact: after trials with different numbers of categories and inspection of the resultant surfaces, it was felt that their initial interpretation would be simplified if the number of classes was reduced to three, broadly representing areas of high, medium and low impact. Furthermore, it was felt that the use of more intervals would have conveyed an impression of accuracy which was probably not warranted by the data or necessary in terms of the exercise.

Insofar as the results are capable of specific interpretation, it would broadly appear that the tracts of highest impact lie adjacent to the main settlements, although there are fairly substantial outlying pockets (Figure 6.2). In general, the areas of current working and prospecting appear to impinge on the "medium" category, but there is some tendency towards the better land in the Alloa and Falkirk fringes. The use of this land would confirm the desirability of a "return to agriculture" after-use and the need to establish model restoration conditions and a vigilant monitoring programme. It is interesting to speculate whether a plan environmental appraisal might not have channelled applications to areas where there would have been the minimum agricultural impact and the maximum community gain from the re-working of derelict land.

Clearly, this approach requires substantial further refinement in terms of the indices used to define the absorptive capacity of the land and of the scale of resolution of baseline survey. Although it was noted in Chapter Four that the average opencast site is over 100ha, clearly many sites - especially private ones - are very much smaller. Similarly, areas of derelict land suitable for re-working are also generally only a few hectares in extent. Consequently, a grid of less than one kilometre square is desirable. However, it has been argued that interpretation

of the Agricultural Land Classification for areas less than 80ha is dubious (Dennis, 1976). The soil survey would appear to be capable of more reliable local interpretation as it is not dependent on patchy climatic or erosion data; nevertheless, intermingling of soil grades does restrict it significantly. It would broadly appear that there was little virtue in adopting a grid of less than 25ha ($\frac{1}{4}$ km²), and this would intuitively seem to be an acceptable resolution of mesh for initial evaluative purposes. This has also been recorded as the finest grid adopted by local authorities in natural resource survey, and beyond which serious problems of staff commitment and data handling arise (Selman, 1982b).

Project Appraisal and Mineral Developments

Whereas techniques of plan environmental assessment have been little explored in practice, a wealth of information now exists on the usage of project appraisal. Nevertheless, even this aspect of EIA has not received a particularly enthusiastic welcome from the British planning fraternity. Indeed, senior members of the local authorities most closely involved with the Belvoir application have been amongst the most open and persistent opponents of EIA, believing it merely to be a re-statement of long-established good planning practice. The Inquiry, and the various investigations which preceded it, have been seen as exhaustive and incapable of substantial improvement.

This point of view, whilst having some force and being the considered opinion of experienced professionals, is nevertheless debatable for a number of reasons. The observation has already been made that, whilst the working party arrangements made a useful contribution, they neither selected their topics on a rational basis nor were open to public scrutiny, nor gave any indication of the level of uncertainty or range of disagreements associated with the group's conclusions. Further, the sheer length of the Inquiry, and its enormous expense (much of which had to be borne privately), suggests that a good deal of the time must have been devoted to over-elaborated arguments, often concerning rather peripheral issues. Perhaps most importantly, although many topics were investigated in great detail, the uses to which these investigations were put was frequently unclear.

In the light of these shortcomings, it is argued that a properly devised project appraisal framework could help focus on key issues, both before and during any inquiry which may be called, and clarify the purposes for which forecasts are being made and the ways in which they are expected to influence decisions. In addition, it could direct investigations of post-development impact and alert operators to activities which must be kept under close surveillance and where remedial action might become necessary. Some areas in which a project appraisal might assist the planning process include: the initial selection of development site alternatives; provision of a quantified basis for comparison between alternative site locations or different modes of operation; communication of the full range of impacts to affected parties and decision-makers; explicit identification of the major impacts and their separation out from minor ones; provision of broad estimates of likely compensation levels and more detailed indications of requisite action on estate management and land acquisition; the identification of topics to be covered by planning and other statutory controls, or by formal agreements and assurances; the selection of topics to be monitored and audited; and provision of "early warning" for circumstances following eventual plant closure.

It is intended that the framework advanced should be able to accommodate major proposals for either deep or opencast working, and should be capable of extension to deal with linked developments at coalplexes. Two reasons are put forward for this. First, the case has already been made against the proliferation of purpose-specific EIA manuals in favour of structured expansions of one basic system. Whilst subsequent experience may suggest some variations in assessment between different modes of coal extraction it is preferred at this stage to keep this, for ease of comprehension and operability, to a minimum. Second, although modes of extraction differ, it is often more useful, especially at the forward planning stage, to consider coalfield development as an integrated exercise, especially as more than one type of coaling operation may affect the same field and as the same localities may be worked by different methods at different times. Moreover, the modes of extraction share many environmental impacts in common - especially those of pedology, hydrology and traffic and employment generation - and are amenable to recognition and evaluation by a common battery of techniques.

Components of a Methodology

Priority areas for the future development of project appraisal have been identified as the preparation of matrices or checklists related to specific classes of project or types of environment, preparation of guidelines on the choice of survey methods for baseline environmental conditions, the provision of guidance on prediction and evaluation of impacts, and the clear presentation of findings in a form suited to the requirements of those who are to be consulted for their opinions (e.g. Lee, 1982; Council of Europe, 1980).

This agenda, in addition to confirming the desirability of directing attention to particular genera of industrial impact and receptor environment, also helps determine the steps in an appraisal sequence. First, it is necessary to establish a set of baseline descriptors which isolate the major features of the farming system vulnerable to impact, together with a systematic project specification capable of eliciting from the developer details of the impacts which are likely to arise. Second, a means of identifying key areas of impact should be devised. This should have the ability to represent the cycle of development associated with mineral workings - from prospecting through to reclamation and decommissioning - and should possess a structure applicable to different methods of coal extraction and minehead facilities. Third, selected forecasting techniques, along with notes on their limitations, and normative measures for the containment of impact should be collated. Fourth, a means of aggregating impacts, to facilitate the comparison of alternative schemes and to help decide whether, all things considered, the project is acceptable at all, should be recommended. Together with this, an executive summary should be made available so that the major features of overall impact, on which decisions are likely to be based, can be readily and succinctly communicated to decision-makers. Finally, consideration should be given to the task of auditing impacts as they occur through the lifetime of the project, looking forward, indeed, to the time when the installation will be decommissioned.

1) The Agricultural Baseline

The purpose of the baseline survey is to establish the initial reference state against which project-induced changes can be evaluated. The content can most logically be based on a review of elements of the receptor environment likely to experience adverse impact. This was established in Chapter Four and comprised:

- land uses - farm land, farm livestock and farm crops
- housing - farm buildings
- traffic - farm traffic
- local economy - farm economy, agricultural industries
- employment and community structure - farmers and farm workers.

The major baseline areas covered by this classification can be summarised as:

land uses

The areas of land affected, their inherent capacity to recover from the sequence of events associated with reclamation, and any fixed investment (such as permanent drainage systems). Further, many of the most obvious costs directly affecting farmers will be related to the disruption of enterprises associated with that land. Thus, total losses of crops or livestock could occur, as could diminution of returns as a consequence of adjacent coaling operations.

housing and traffic

The effects of mining on surface installations in the area has also been noted, both in terms of overall subsidence effects within the area (bearing in mind that many large agricultural structures are especially sensitive) and with respect to individual buildings demolished or made redundant by site works. Severance of buildings from operational land, or of parcels of land one from another, may also be exacerbated by mine traffic.

local economy and communities

Economic and social impacts on the farming community are major elements of the baseline, although in large part they can only be appraised in the context of a more comprehensive evaluation of economic multipliers and social profiles for the community at large. To some extent, the farm economy encapsulates a summary of most other effects, and so to include the total enterprise economy under this heading would involve

an element of double counting. However, specific factors such as loss of ancillary farm enterprises, or the beneficial and/or adverse effects of locally increased population levels may appropriately be considered. Similarly, some evaluation of the local and individual effects on farmers' and farm workers' welfare in the face of impending mining must be incorporated, not so much because it lends itself to quantification or is influential in reaching a final decision, but because it may bring to light cases of especial hardship which must be adequately catered for in any plans.

The proposed baseline content is summarised in Appendix A.

2) The Project Specification

The project specification stage of an EIA is essentially an expansion of the standard proforma for planning permission. The superficial reaction of many developers to this stage, that it demands a degree of forward design or breach of confidentiality which it is unreasonable to expect, does not seem to be borne out in practice. In respect of major developments, the applicant is likely to have been engaged in exploratory talks with the planning department long before any firm proposal is submitted, and many of the topics pertinent to a project specification will already have been discussed. Indeed, developers have often found a formal checklist of this type beneficial both in terms of formalising their own views and gaining an insight into the preferences of the planning authority. Where detailed proposals have not yet reached an adequate level of consolidation, however, it may be possible for these to be treated as reserved matters, and made subject to subsequent approval and amendment (Jelley, 1982).

Guidance on the content of a project specification for mining is available from a number of sources. In addition to the PADC manual's own Project Specification Report, many mineral planning authorities have drawn up their own reasonable detailed application forms, the DoE has provided a standard reference on operational characteristics and applicable planning conditions in its "Green Book", and the Stevens report (Stevens, 1975) proposed an effective checklist for the appraisal of mining proposals. In essence, these documents agree that the major features of interest in respect of mining operations include: method of operation,

plans and sections of the working area, the programme for attaining the proposed rate of extraction and ancillary processes to be carried out; a description of the physical nature of the deposit to be worked, together with any impurities, and the quantities and means of disposal of any wastes produced; the location of nearby developments which could be affected by working; the likely labour requirements and generation of traffic; proposals to minimise visual impact, dust and noise nuisance and pollution and siltation of watercourses; and details of any restoration scheme.

As with the farming baseline elements, the characteristic specifications of coaling projects have already been reviewed (Chapter Five) and were found to comprise:

- workforce - immigration, employment and local expenditure
- transport - severance, raw materials/products/wastes, and employees
- land and resource use - structures, site preparation, solid waste disposal, subsidence and water demand
- pollution - noise and vibration, aqueous discharges, and particulates and gases.

These may be more fully expressed as:

workforce

The size and composition of the workforce associated with the proposed development will govern the magnitude of additional population which require to be housed, in turn involving the further consumption of agricultural land. In addition, the travel patterns of the labour force will provide important inputs to other parts of the EIA concerned with traffic generation. On the positive side, it is also the purchasing power of employees which may contribute locally to enhanced farm incomes.

transport

The transportation of minerals and their waste products, together with associated handling facilities, is an increasingly important issue, especially in the light of follow-up studies of remote and underground waste disposal associated with the North East Leicestershire Coalfield. Furthermore, if extensive blending of coal is required, this will significantly increase site traffic. Employees' travel patterns will depend to a large extent on housing allocations, which may be one of

the multiplier effects most susceptible to control by planning authorities. Thus, proposals must detail the routes and characteristics of new road, rail, pipeline and conveyor links, as well as the corridors of site access along existing routes. Especial care must be paid to this at the design stage as planning agreements may be relatively ineffective in securing the use of "preferred" routes once operations commence; detailed designs which hinder or favour the use of particular routes tend to be more effective in achieving the desired results.

land and resource use

Again, land based impacts will be paramount from the agricultural viewpoint, so that the extent of development or temporary alienation of land must be carefully established. Similarly, any indirect effects on land, notably its lowering, must be specified both in terms of location and timing. In some areas, it has been noted that water availability is critical so that activities likely to entail large-scale water use or indirect impacts on groundwater must be elicited.

pollution

The more traditional "environmental impacts" - of noise, water and air pollution - are of less central agricultural consequence. There are, however, a number of particular ways in which they can affect the potential profitability of farms, and the quality of life of local farmers. However, it is likely that forecasts of ambient levels of pollutants could be borrowed from detailed appraisals carried out elsewhere in the impact assessment.

The recommended components of a project specification are set out in Appendix B.

3) Identification of Impacts

Perhaps the best known stage of EIA is that of identification, for it is with this stage that the most memorable techniques have been associated. Thus, checklists, matrices and networks of various kinds have been elevated to a central status and have popularly but erroneously been considered as EIAs in themselves.

Of the various formats available for the identification and summary representation of impacts, the interaction matrix has proved the most

adaptable and widely applicable. Since it forms the basis of the DoE/SDD manual, adherence to its use would also have the virtue of consistency. Experience of using the interaction matrix has highlighted a number of particular advantages, for instance: it provides for explicit and unambiguous identification of impacts, which may then be amplified in other sections of the assessment; it is capable of systematically relating the information gathered from a baseline survey to that provided in the project specification; and it enables the division of project characteristics into a number of sequential phases which is highly desirable in a cyclical activity such as mineral extraction. Moreover, the use of "expanded matrices" - that is, selective enlargements of the generalised master matrix - permits major sub-systems (such as agriculture) to be considered separately without at the same time becoming divorced from the overall appraisal. The major disadvantage of matrices, that of ignoring indirect consequences of actions, appears to be reduced where a study of generic impacts has already been provided.

Perhaps the major practical virtue of the interaction matrix lies in the readiness with which baseline and project specification data can be related to each other. Surprisingly, this relationship has rarely been made explicit: whereas baseline surveys and project data have been elaborated in great detail, the specific ways in which these are incorporated into the identification or screening technique are seldom expressed, and matrix entries must be assumed to relate in only a general way to the information which has been garnered. In the present study, the topic sub-headings used at the data collection stages are used as the row and column entries in an interaction matrix. This, therefore, continues the logic of an "expanded" matrix which is both directly related to the PADC format, yet which is sufficiently project-specific to permit a systematic review of significant generic impacts (Figure 6.3).

It has been noted that mining is a cyclic activity: thus one site may at various times experience the effects associated with prospecting, construction, various modes of extraction and on-site processing, and decommissioning. Impact matrices are frequently sub-divided into

PROJECT CHARACTERISTICS			WORK-FORCES	TRANSPORT	LAND & RESOURCE USE	POLLUTION
			immigration employment local expenditure severance materials/products/waste employees structures site preparation solid waste disposal subsidence water demand noise & vibration aqueous discharges particulates & gases			
BASELINE						
LAND USES	Farm Land	land surface				
		restoration potential				
		land drainage				
		infrastructure				
	Farm Livestock	disturbance				
		loss				
		disease				
		slurry spreading				
	Farm Crops	irrigation				
		pollution				
		damage				
		drought				
HOUSING	Farm Buildings	overall distribution				
		on-site structures				
		sensitive structures				
TRAFFIC	Farm Traffic	intra-farm traffic				
		inconvenience				
LOCAL ECONOMY	Farm Economy	profit margins				
		ancillary enterprises				
		income				
		urban fringe effects				
	Industries	buildings				
		processes				
EMPLOYMENT & COMMUNITY STRUCTURE	Farmers and Farm Workers	tenure				
		workforce				
		quality of life				
		communities				

Figure 6.3. EIA matrix for mining-agriculture impacts.

constructional and operational phases, but even this refinement may prove inadequate for coal undertakings. Nevertheless, there is no reason why the matrix arrangement should not be expanded horizontally to accommodate as many project phases as necessary; this possibility is explored further in the next chapter.

4) Forecasting

No fixed rules can be made about the ways in which impacts are to be forecast as, for the most part, predictive techniques for environmental problems are still in their infancy. Nor can this situation effectively be improved until more experience is gained in the conduct of EIAs, and audits are used to evaluate and refine the performance of forecasting methods.

However, two general observations may prove useful in attempting to simplify the potential range of predictions to be made. First, the areas of major concern are likely to be known from any generic studies which are available. Second, once the spheres of impact have been defined, the objects of analysis can be ascertained; these will assist the assessor in determining the most appropriate and economical forecasting approach, since there is little virtue in expending resources on forecasting to a greater level of detail and accuracy than is warranted for the purposes of the study. In many cases a broad brush approach, outlining the salient dimensions of impact is sufficient, especially during the initial stages. Particular methods for analysis may then be drawn from those discussed in Chapter Five and deployed so as to satisfy the various analytical objectives.

Whilst the precise distribution of impacts will vary with individual mining proposals, this study has highlighted a number of broad fields of investigation likely to prove significant. These may be summarised as:

- i) "land and resource use" on "land uses" - the effects of temporary and permanent land consumption, and of subsidence;
- ii) "pollution" on "land uses" - the consequences of increased ambient levels of pollution on cropping and stocking;
- iii) "land and resource use" on "housing" - in the case of deep mining only, the impacts of subsidence on farm buildings; for all types

- of mining, total loss of buildings;
- iv) "transport" on "traffic" - the effects of new roads, or increased levels of site traffic, on farm machinery/animal movements;
 - v) "workforce" on "local economy" - the positive impact of increased local expenditure on farm produce;
 - vi) "land and resource use" on "local economy" - the direct and indirect effects of local land use change on farm economies;
 - vii) "workforce" on "employment and community structure" - the attraction of workers away from basic industries and modification of traditional communities;
 - viii) "pollution" on "employment and community structure" - impacts on the quality of life currently enjoyed by farming communities.

These categories of impact, together with observations on the objectives of, and methods for, forecasting are expanded in Appendix C.

5) Aggregation

The aggregation of overall impacts, to provide a composite indication of the relative acceptability of project alternatives has traditionally been a highly problematic stage of EIA. The primary weaknesses have probably lain in the selection of a common unit of measurement, the reduction of unlike impact categories into dubious indices of relative environmental quality, and the use of opaque aggregation procedures which may conceal from the decision-maker the relative performance of project alternatives on key topics.

It has, however, been noted that project comparison tends to be eased where categories of environmental impact are sub-grouped. In theory, therefore, the restriction of the receptor environment to the farming system should facilitate aggregation. Perhaps fortuitously, most of the major impacts which have been identified can be expressed in economic terms, enabling the £ to serve as a unit of measurement without having to resort, in other than a few relatively peripheral cases, to the expression of non-market elements in monetary values. The major exceptions to this are the social aspects of changes in community structure or quality of life, and it is anticipated that these would be more fully explored in a separate social impact assessment.

The emergence of a financial basis for quantification and aggregation should come as no surprise, however. First, it has been widely canvassed that, since farming operates within an economic framework, a financial measure is the most suitable basis for appraising the agricultural interest in land use decisions. Second, a major concern of analysts should be to estimate non-mining costs - compensation, remedial land drainage, accommodation works, and so forth - so that it is preferable that any appraisal technique should provide some broad indication of the developer's liability. The joint consideration of land quality and valuation for compensation has evidently proved possible in Germany (Weiers and Reid, 1974).

A further significant advantage of the use of economic data is the ability to discount the results at various rates over varying time horizons. This both enables total aggregate impact to be estimated over the project's life and the testing of alternative assumptions regarding the social and market values of coal vis à vis those of agriculture. It also permits a consideration of the longer-term value of either resource to society to be made, as reflected by the choice of discount rate. Experimentation with this approach has revealed a potential problem, namely that a simple reversal in direction of a progressive land use, such as surface tipping or subsidence, may decrease or increase the apparent impact. This is because if, for instance, the most valuable land is affected last the impact will appear to be minimised since, by the time the adverse impact occurs, its effect will be substantially reduced when seen from today's viewpoint. This apparent anomaly of the economic approach may in fact be perfectly reasonable since technological or geographical alternatives to the proposed activity may be found before the due date, so that deferred uptake of the best land may indeed be a prudent measure.

6) Summary of Impacts

Environmental impact statements are typically lengthy documents, often running to several volumes. Nevertheless, their salient findings must be effectively and succinctly communicated to politicians and lay public. One of the most effective means of rapid communication of results has been the use of summary sheets to outline the dimensions and nature

of key impacts. The PADC manual includes an example of this, classifying the major impact characteristics - according to whether they are adverse/beneficial, long-/short-term, local/strategic, direct/indirect and reversible/irreversible - but the team now recognise that perhaps something more by way of an executive summary is required. One authority suggests that it is pertinent to include the phase of project developmental activity, nature of impact, duration and radius of impact, and possible mitigating measures within a synopsis (Messer et al., 1977). Once more, the content of a summary sheet has been arrived at in an experimental fashion, and a compact but wide-ranging proforma has resulted (Figure 6.4).

7) Auditing and Decommissioning

Although the legality of planning conditions which seek to require the operator to monitor the environmental performance of his plant is questionable, it is axiomatic that monitoring must be encouraged, by whatever means. Estimation of the degree of compliance with conditions or the effectiveness of remedial measures is meaningless without monitoring, and feedback from this source is essential if EIA forecasting is progressively to be refined. Moreover, a key purpose of EIA is to assign responsibilities for action to the appropriate agencies: it is not simply for the benefit of local planning authorities, but also for a whole variety of control agencies, several of whom may indeed be able to impose monitoring conditions.

As well as requiring the developer to monitor activities, it is equally desirable to exhort control agencies to audit the EIA forecasts. Monitoring itself is merely concerned with identification and measurement of developmental impacts. It is a process of repetitive observation of elements or indicators of the environment according to pre-arranged schedules in time and space in order to test postulates about man's impact (Johnson and Bratton, 1978). Auditing, on the other hand, describes the activities involved in comparing predicted impacts of development with those impacts which appear to have occurred, and is used to test the accuracy and coverage of predictions made in EISs (Bisset and Tomlinson, 1983). Requirements for these activities should clearly be established fully in the EIS, but it is useful also to signal these in the executive summary.

IMPACT:		Description		Impact Dimensions & Importance		Duration		Reversibility & effect on long-term resource use		Avoidability	
NATURE OF IMPACT		direct indirect beneficial adverse radius	major moderate minor	long term medium term short term							
BASELINE		Description of Existing Environment		Dynamics of Existing Environment		Description of Existing Environment		Significant Seasonal Effects			
FORECASTING		Method of Forecasting		Limitations on Confidence		Further Analysis Required?					
IMPACT MITIGATION MEASURES		Applicant	Planning Authority	MAFF/DAFS	Water Authority	Farmer	Other				
TOPICS TO BE MONITORED		Applicant	Planning Authority	MAFF/DAFS	Water Authority	Farmer	Other				

Figure 6.4. Summary sheet for mining-agriculture impacts.

With regard to decommissioning, the Town and Country Planning (Minerals) Act now makes more clear the use of remedial conditions, and enables after-care requirements to be spelt out in detail. There is a widespread view amongst responsible operators that this is sufficient to preclude the necessity for restoration bonds, although their use is still preferred in some quarters. Furthermore, the NCB is now making far more stringent efforts to control hydrological impacts associated with the cessation of mine pumping as they appear increasingly to believe that they are legally liable for consequential damage which might arise. However, the situation is unpredictable, especially with an increasing prospect of privatisation in respect of opencasting and its possible extension into deep mining.

An environmental impact statement should, therefore, attempt to identify specific long-term problems, make explicit recommendations regarding their monitoring, and specify areas to be covered by conditions, assurances and agreements.

Conclusion

Possible methods for the appraisal of mining-agriculture impacts have been proposed at both the strategic and local scales. Whilst the discussion of strategic assessments has been of a rather speculative nature, it does appear possible to base these on two main foundations: a checklist of the characteristics of particular classes of development, together with coefficients reflecting their resource requirements and activity patterns, and performance indicators against which these can be assessed; and an evaluation of the environment at risk, both in terms of the quality of land and amount of spare capacity of infrastructure, and the inherent absorptive capacity of potentially developable land. It would be necessary to match these two elements, and future researchers may well wish to ponder how best this may be done. The approach adopted by the North East Leicestershire Coalfield working party on remote disposal of waste (Leicestershire County Council, 1983; Department of Environment, 1983c) - which entailed matching spoil characteristics and quantities with the availability, capacities and comparative qualities of alternative disposal sites - suggests that this should not be an impossible task.

In the approach to project appraisal, identification of impacts centred on the familiar matrix format, but the temptation to produce a highly purpose-specific framework was resisted, despite the extra freedom which this would have permitted. Instead, so as not to add to the proliferation of matrices which have been promulgated it was decided to operate within the restrictions of the PADC manual. Apart from providing a mechanism for relating this limited study of agricultural impacts to a master EIS, this decision also brought to light a number of theoretical advantages associated with the expansion of selected sections of the main matrix. Furthermore, whereas it has always been assumed that there is a general association between expanded and master matrices, matrix headings, project specification report and forecasting methods, the relationships have seldom been made explicit. The lack of consonance between row and column listings in the PADC manual's expanded and master matrices, it could be suggested, is evidence of this.

It has been demonstrated here that it is feasible to design a detailed baseline survey, directly related to the row entries in the expanded matrix, which is itself simply a broadening of the rows in the master matrix. Likewise, the project specification report can be linked in one direction to a standard package of topic-related forecasting techniques and, in the other, to the matrix columns. It is also anticipated that, in the case of agriculture at least, the major effects can be forecast in economic terms, and this will in due course facilitate impact aggregation. Finally, a summary of the findings, including an assignation of responsibilities for control and monitoring, will help enhance the effectiveness of the project appraisal. This approach, it is argued, facilitates an integrated, step-wise analysis and re-synthesis of overall impact.

CHAPTER SEVEN

PROJECT APPRAISAL IN PRACTICE

Introduction

As a mandatory system of EIA in Britain draws inevitably closer, so the need for packages of project appraisal techniques becomes more pressing. At present, the NCB proceeds on an ad hoc basis towards the evaluation of agricultural impacts associated with its proposals, although a review of methods pertinent to this topic is currently underway (M. Read, pers. comm., 1984). Within the private sector, where the comparatively small scale of operations militates against a consolidation of expertise in either restoration or environmental assessment, the situation is even less satisfactory. It is suggested that the availability of a standardised approach, along the lines of that developed in the preceding chapter, is desirable inasmuch as it provides developers with a uniform and consistent basis for project evaluation and comparison.

The method was examined in relation to the original (1978) and revised (1982) applications for a total mine at Asfordby, near Melton Mowbray. The second of these applications envisaged a reduced land take, on the basis of a re-designed tip and off-site disposal of up to ten per cent of the wastes in local sand and gravel excavations. This revision gained the favour of the Environment Secretary, insofar as he was content to leave the final decision in the hands of the County Council.

A full implementation of the proposed method would have been beyond the resources of the present study, requiring, as it would, expertise ranging from economics and estate management to agronomy and engineering. Moreover, it has not been feasible to obtain certain baseline and design data, partly because of problems of confidentiality, and partly because of time and other constraints. However, despite these caveats, it is believed that the partial test which has been carried out is sufficiently extensive to provide a realistic validation of the operability of the method and a useful insight into the actual agricultural impacts of

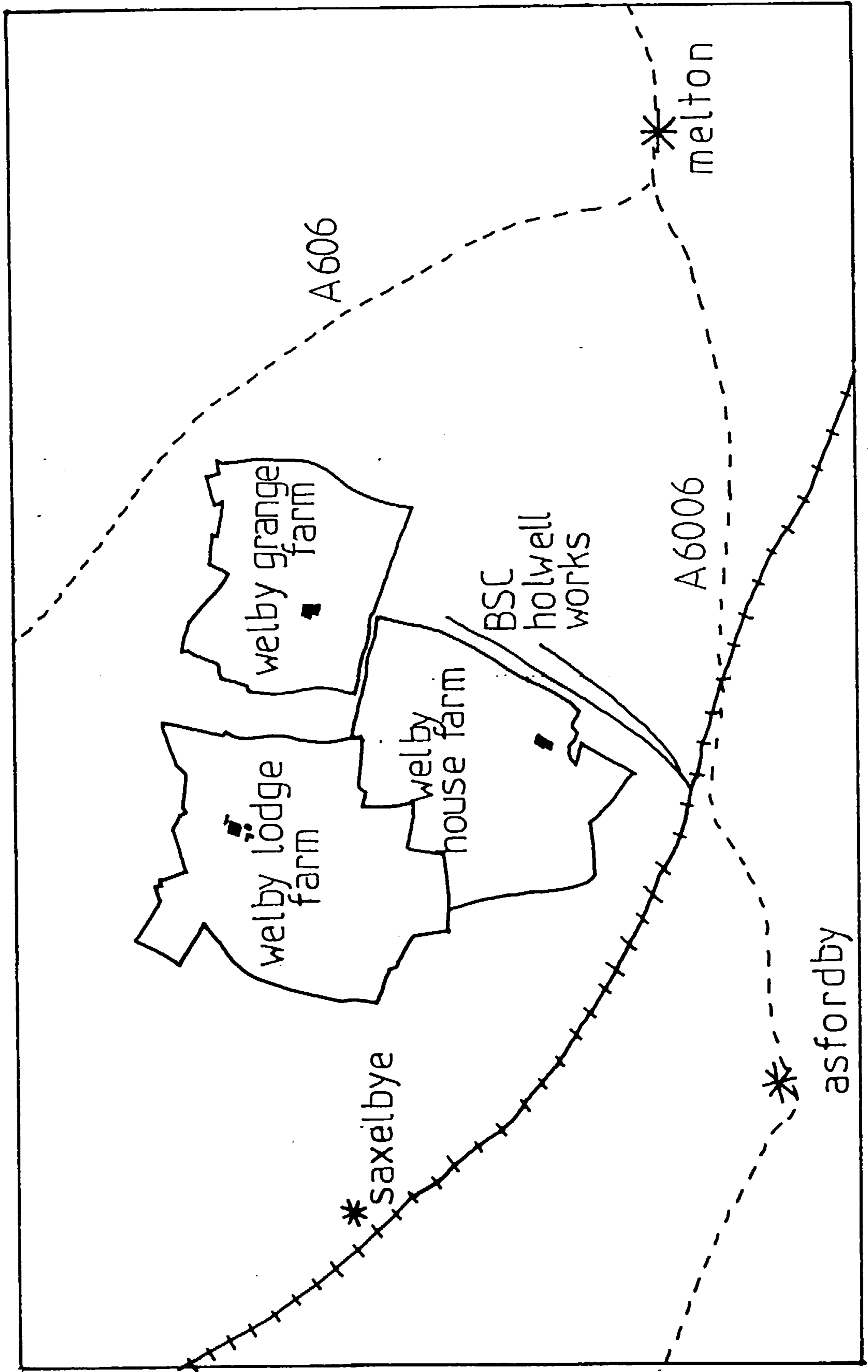


Figure 7.1. Farms affected by tipping proposals, Asfordby mine site. (Scale 1:30 000 approx.)

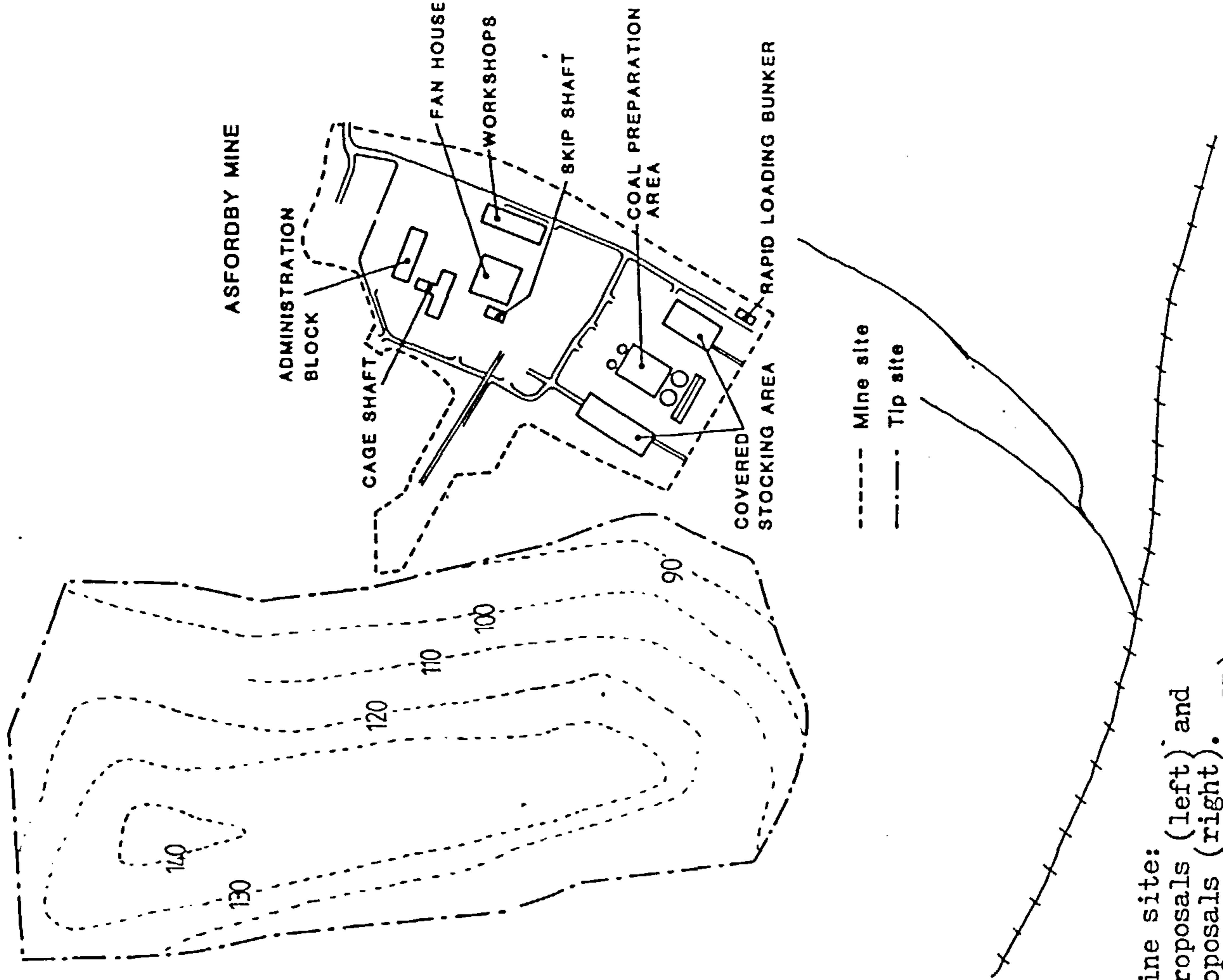
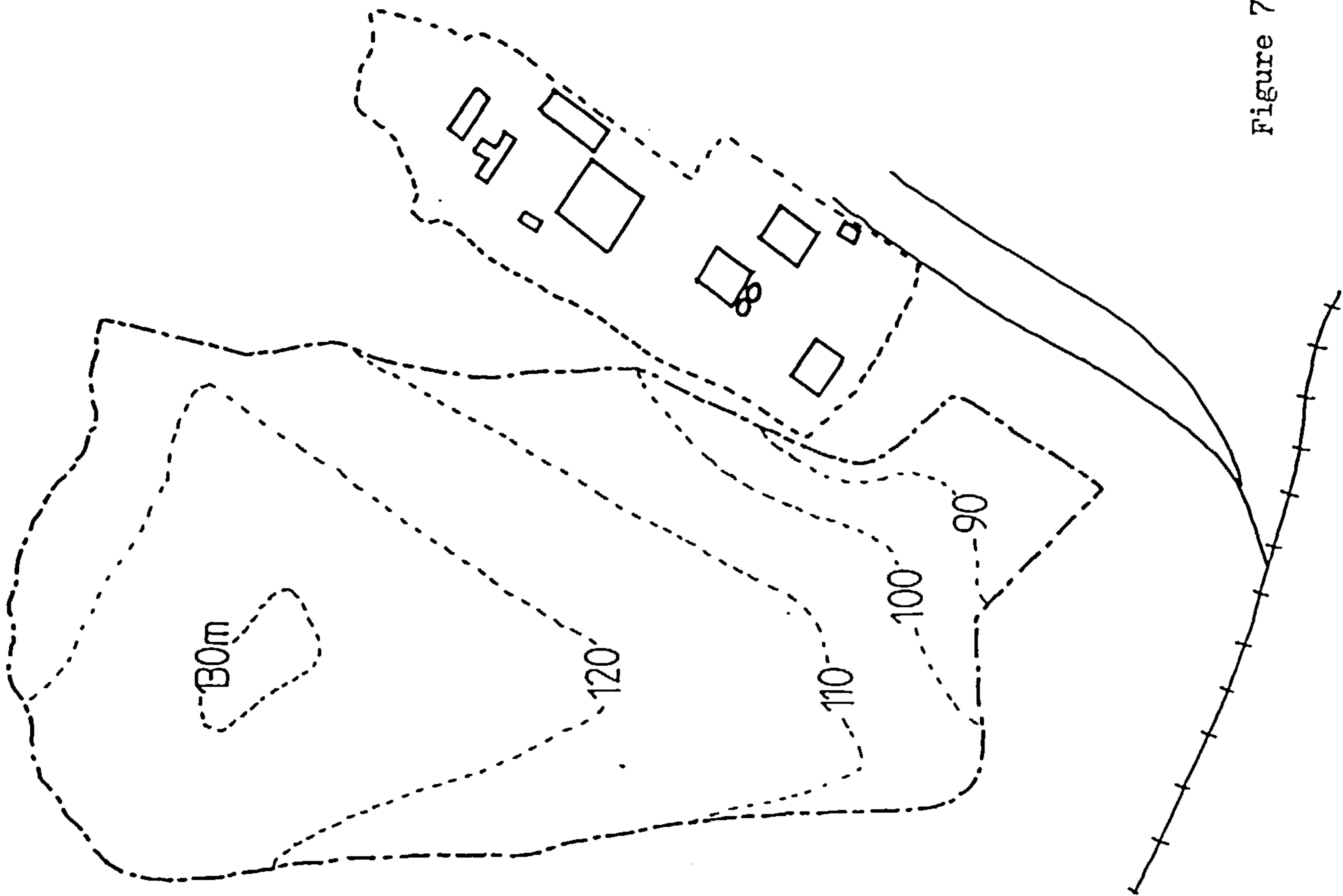


Figure 7.2. Asfordby mine site: original proposals (left) and revised proposals (right). (Tip heights are in metres AOD).

a major mining proposal. A substantial amount of information has been collated on the basis of public inquiry evidence, contoured tipping plans, maps and planning documents; by combining this with informed opinion and site inspections it is anticipated that the baseline and project specification data will be acceptably robust.

The Asfordby Proposals

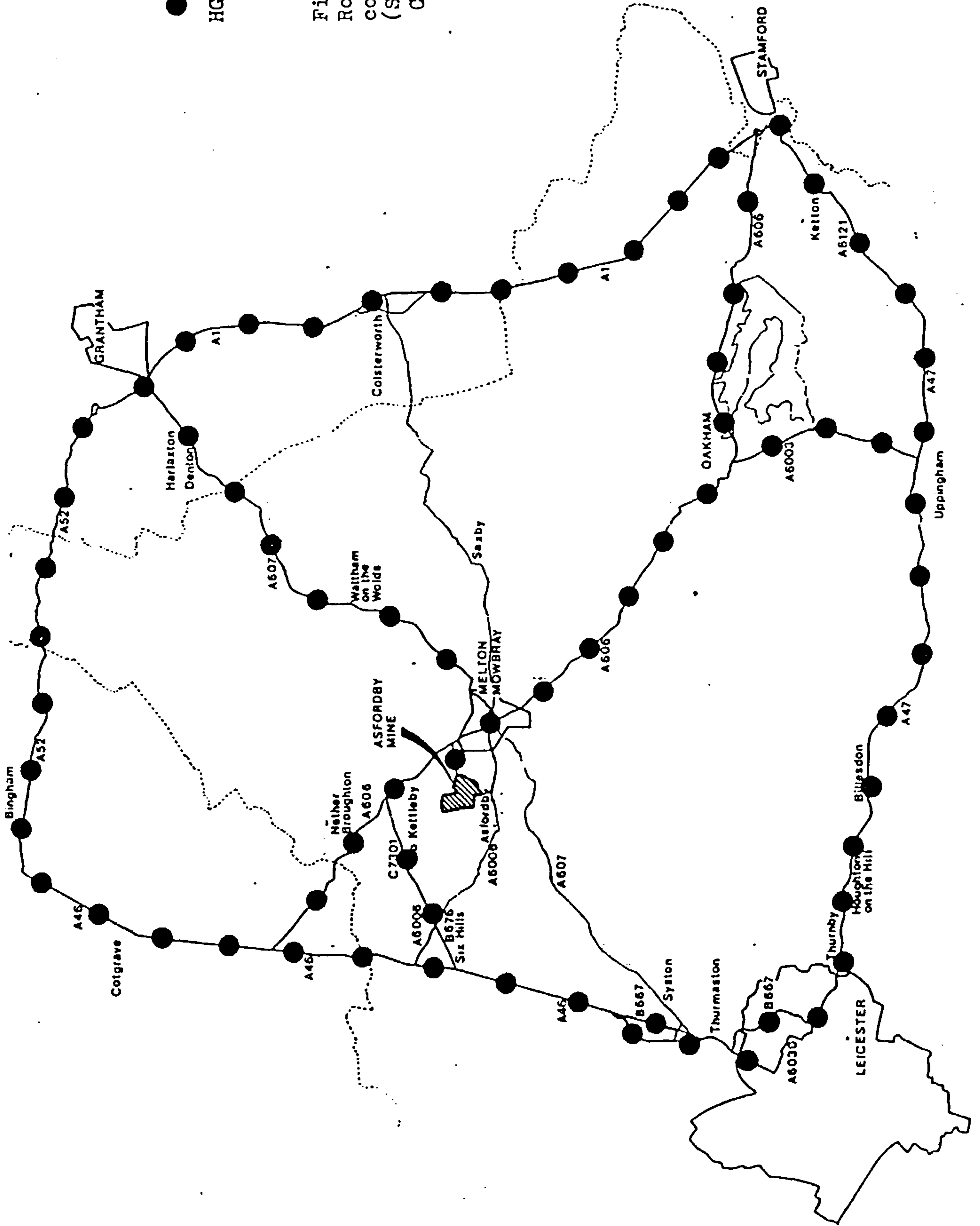
The original (1978) application, of course, related to the whole of the North East Leicestershire Prospect area; the latter (1982) one, only to Asfordby. The comparison of the proposals thus involves restricting consideration of the former to that area which can reasonably be accessed from the site. To gain access to the underground seams, it is proposed to sink two shafts, and to locate in the vicinity of these all the buildings and other surface works necessary to operate a modern mine and to prepare the coal and mine dirt for despatch. Three farms would be directly affected by these surface facilities, these being Welby Lodge, Welby Grange and Welby House (Figure 7.1). The original application totalled 176ha in extent, and the revised one 141ha (Figure 7.2). This overall reduction in land take was accounted for by lessened on-site tipping requirements, although the extent of surface installations actually increased as a consequence of improved run-off treatment facilities.

The flow of vehicles to and from the mine is assumed to be similar for both proposals, except for heavy goods vehicle movements in connection with the short distance haul of 50 000t of dirt per annum. This estimate assumes that dirt could be tipped in the Soar valley in voids created by sand and gravel extractions: there would be approximately 12 HGV round trips per day from the mine site via the access road to the A606, along the A606 through Ab Kettleby to the junction with the Saltway C7301, along the C7301 and the B676 to Six Hills, and then southwards on the A46 (Figure 7.3).

There is no reason to suppose that subsidence effects in the undermined area would differ between the two applications. Objections to the revised application were still received from East Midlands Gas, on

● ● ●
HGV Routes

Figure 7.3.
Routes to Asfordby
colliery.
(Source: Leics.
C.C., 1982)



the grounds of loss of support to the bulk supply gas transmission system, and the NFU, who expressed concern about the effects on agricultural land, buildings and drainage.

Data Collection and Impact Identification

The first step was to obtain as comprehensive baseline and project specification data as possible, according to the format proposed in Chapters 4-6. These are set out, with notes on their sources, in Appendices D and E respectively. The financial data relate to the mid-point between the two applications, to facilitate comparison; since 1980, however, it would be prudent to increase the estimate of impact by perhaps 50% to allow for the effects of inflation.

With this information available, it became possible to identify the potentially significant interactions on the basis of an impact matrix. It was noted in Chapter Six that the basic matrix may be extended horizontally to accommodate more than one phase of mining activity. In this case, the column entries have been repeated to embrace the stages of prospect, construction, operation and closure. For the sake of simplicity and flexibility, and to occasion the minimum departure from the basic model, the column entries remain standard throughout, even though it is clear that some impacts (e.g. subsidence) may not affect all stages (e.g. construction) or all modes of extraction (e.g. opencasting). Although this entails a small degree of superfluity, it makes operation of the technique more straightforward, especially where additional phases may require to be appended to suit particular circumstances - for instance, the operational stage may need to be sub-divided into extraction, beneficiation and end-use (Figure 7.4).

For the purposes of forecasting, however, only those impacts identified at the construction and operational phases have been examined: prospecting impacts were felt to be comparatively insignificant, whilst the effects of decommissioning may prove intractable to predict, although their identification as topics for future scrutiny and surveillance was felt to be important. A slight inconsistency perhaps exists in the case of

tip restoration, which has been counted as an operational activity, as this would be mainly completed during the active lifetime of the pit; its entry in the decommissioning stage would refer to those residual problems which persist after restoration management has been completed. Although it would be laborious to detail all the impacts identified for these two phases, a broad summary is presented in Table 7.1.

Forecasting

Forecasting of impacts was conducted by means of programs written to implement the various evaluative methods outlined in Chapter Five. Guidance on the nature and purpose of forecasts was taken from the summary framework established in Appendix C, which set out not only the main spheres of impact, but also the rationale behind the production of individual analyses.

The facility was built into these programs to discount impacts at a selected rate over any given time horizon, although in the case of impacts involving losses in perpetuity a 100 year horizon was conventionally adopted. Discount rates reflecting complex assumptions about social value, returns to capital and future economic conditions are available, but there is a general convergence of opinion regarding three broad levels which may be adopted outside the purely commercial sector: 7 per cent, which is the Test Discount Rate; 5 per cent, which is the rate commonly adopted by the Treasury in respect of agriculture; and 3 per cent, which is frequently employed to represent a social rate of discount. These three rates were used in the present exercise to examine the differing scales of total agricultural impact which emerged.

In terms of the types of the types of impact summarised in Table 7.1, and drawing on the Asfordby baseline and project specification data in Appendices D and E, forecasts were computed on the basis which follows. (Alphanumeric notation in brackets refers to entries in Appendices D and E, whilst the typology of impact-receptor relationships and approaches to forecasting are based on those in Appendix C).

A. LAND AND RESOURCE USE on LAND USES: the construction of site facilities and the operation of those facilities will affect the land surface; it is assumed that tips will be progressively restored, so that restoration potential of the soils will be an important consideration; subsidence will affect land drainage and associated infrastructure; land loss and disturbance will cause loss of livestock and crops; and may create problems of land availability for slurry spreading.

B. POLLUTION on LAND USES: construction noise may possibly have an adverse effect on livestock; during operation, mine drainage water might pollute local water supplies (with adverse consequences for irrigation and other farm uses), and dust levels might affect crops and cheese-making.

C. LAND AND RESOURCE USE on HOUSING: at the construction stage, some farm buildings would be demolished or made redundant; during mining, subsidence could affect undermined buildings generally and have particularly severe effects on certain sensitive structures.

D. TRANSPORT on TRAFFIC: construction of new access routes and other site works would sever at least one farm unit; intensification of flows of goods traffic and journey-to-work would exacerbate inconvenience associated with existing severance.

E. WORKFORCE on LOCAL ECONOMY: local expenditure by incoming workers would have a positive impact on farm income; an influx of residents would intensify and extend urban fringe effects.

F. LAND AND RESOURCE USE on LAND ECONOMY: land loss to various site uses would reduce profit margins (this has already been counted); land loss to tipping would affect at least one ancillary farming enterprise.

G. WORKFORCE on EMPLOYMENT AND COMMUNITY STRUCTURE: non-owner-occupiers would be particularly disadvantaged; farm workers could be attracted to employment at the mine site; immigration into farming communities would disrupt their traditional character.

H. POLLUTION on EMPLOYMENT AND COMMUNITY STRUCTURE: tipping activities and increases in ambient levels of pollution (especially noise) would adversely affect the quality of life for farmers, farm workers and their families.

Table 7.1. Classes of impacts to be forecast: Asfordby case study.

A: 'Land and Resource Use' on 'Land Uses'

A1. Losses associated with the mine and tip sites were evaluated by obtaining mine site locations and tipping phases from submitted design proposals. These could then be related to gross margin/hectare values for the fields affected (D19). Mine site losses were conventionally discounted over 100 years from the date of commencement of construction, and tip site losses from the year of commencement of tipping to year of completion of restoration, returns during the restoration period being corrected for "equivalent area out of agricultural production". Gross margins were deflated by 10 per cent to allow for likely restructuring of farm investment in response to changed circumstances. Restoration potential of soils was taken into account in the assumed length of time to restore tips to full productivity.(Figure 7.5).

Losses of animals and crops were assumed to be reflected in gross margins. Regrettably, it did not prove possible to cost the effects of land loss on slurry spreading, although it did appear that this might locally be a problem (D9).

A2: In respect of losses associated with disruption of land drainage, the area potentially subject to induced drainage problems was ascertained (E14), as were notional costs of re-draining and losses of production in fields where remedial measures were delayed in implementation (D4). Again, costs were discounted over the relevant period, i.e. the probable duration of subsidence in a particular area (Figure 7.6).

A3: Areas likely to be allocated for the incoming workforce were assumed to be Melton Mowbray and Asfordby parishes and an average gross margin for these areas was obtained from June census data (D19). Predictions of the land use requirements of construction and operational workforces, and their associated multipliers,

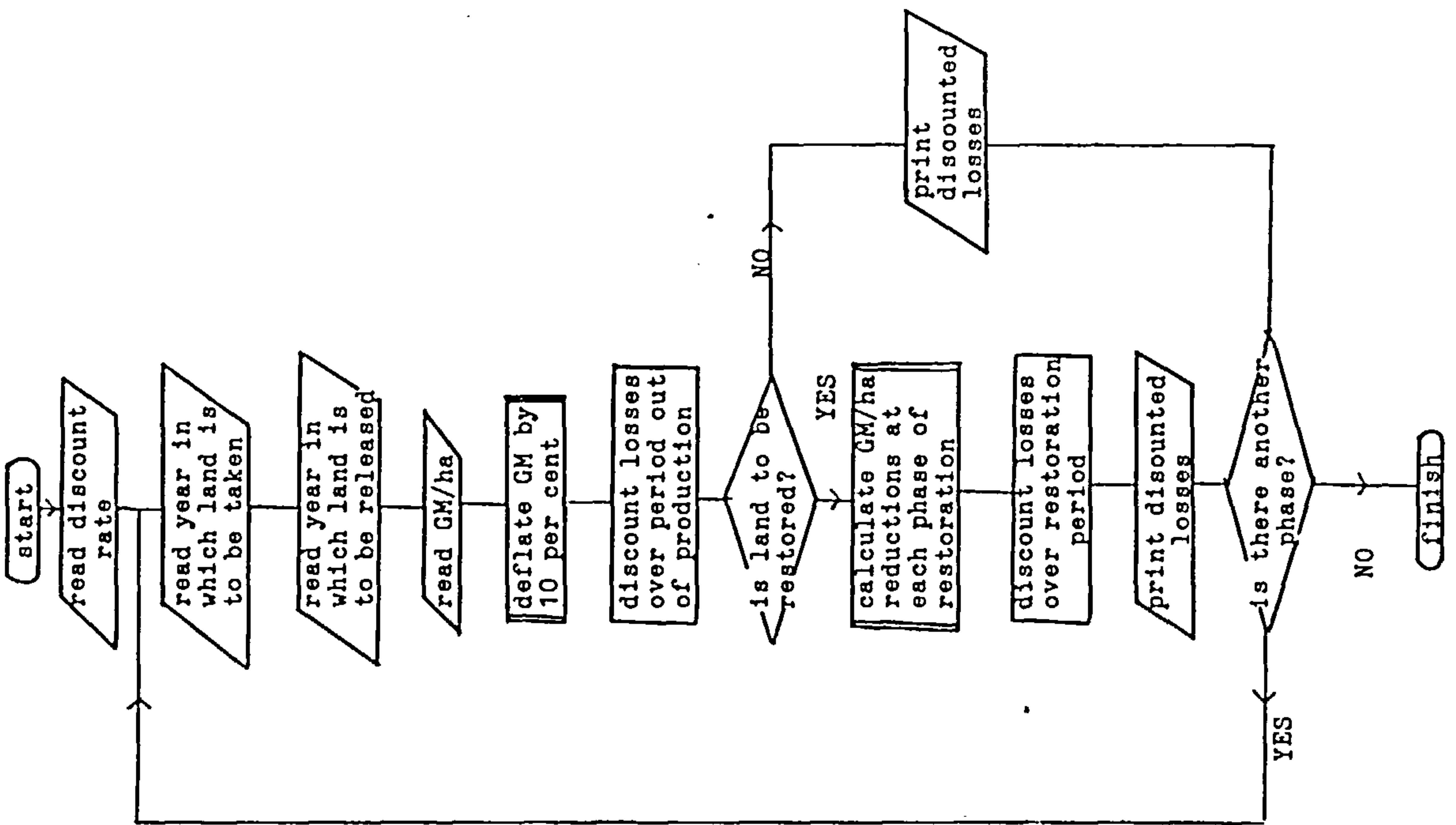


Figure 7.5. Calculation of losses associated with mine and tip sites.

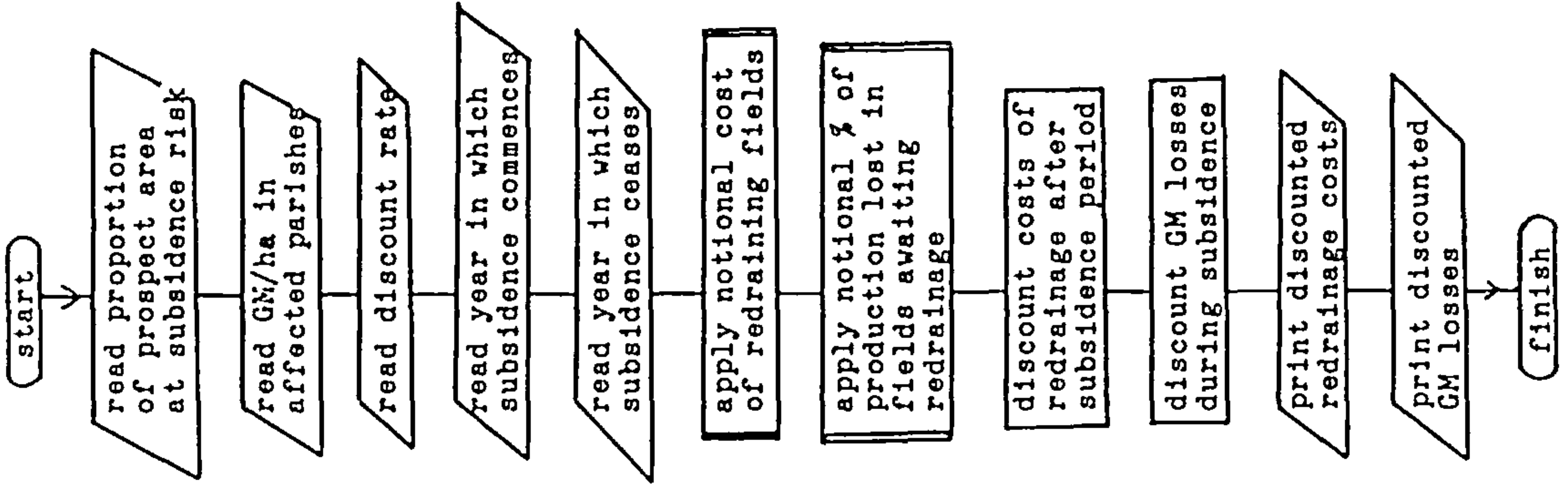


Figure 7.6. Calculation of losses associated with disruption of land drainage.

were calculated separately on the basis of project specification data (E1-E3; E10); the construction workforce was assumed almost in its entirety to require new housing, but only a proportion of the permanent workforce to make these demands. Notional per capita land consumption figures of 0.05ha (construction workforce) and 0.1ha (permanent workforce) (reflecting housing, roads and other living space requirements) were applied to obtain an overall hectarage, and the agricultural losses from this area were discounted from the time of anticipated land conversion (Figure 7.7).

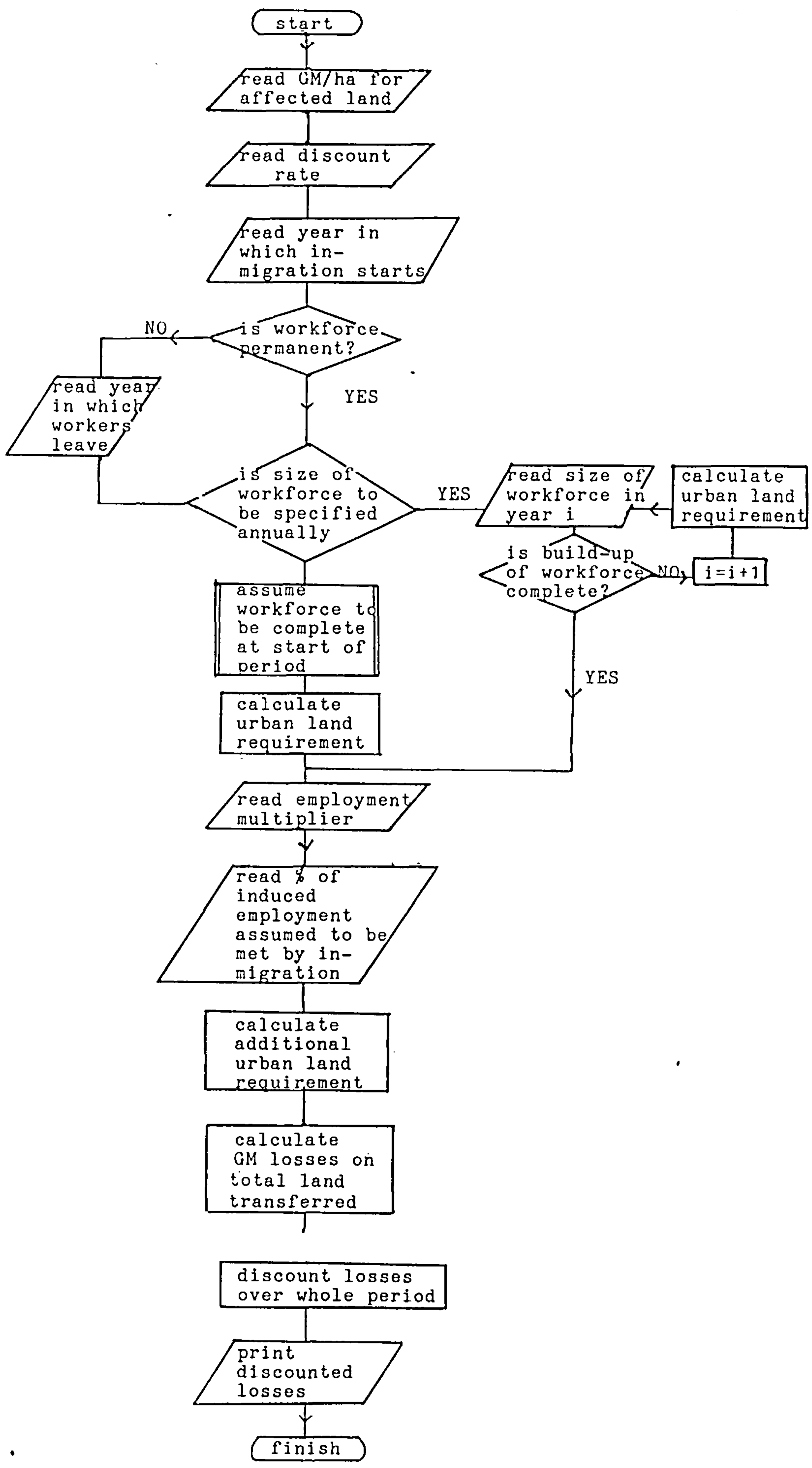


Figure 7.7. Calculation of losses associated with housing incoming workforce.

B: 'Pollution' on 'Land Uses'

No predictions were made for these impacts, as the available evidence suggested that pollution effects on cropping or dust levels on cheese manufacture would be extremely limited. The larger scale effects of atmospheric pollution from coalburn proved beyond the scope of the study.

C: 'Land and Resource Use' on 'Housing'

The proportion of the prospect area likely to be affected by subsidence was estimated (E14), and appropriate repair costs for each of the NCB's damage categories gauged (E15). An extrapolation of the numbers of farm structures in the area at subsidence risk was made on the basis of data for the whole coalfield, and the repair costs discounted and aggregated over the period of subsidence. Especially sensitive buildings were assumed to fall into the severe and very severe damage classes. The program distributed the impacts on buildings over the whole period to reflect the progressive nature of undermining within the area (Figure 7.8).

The loss of buildings at Welby House (E16) was added to the calculation on an undiscounted basis, as their demise would take place at an early stage of operations.

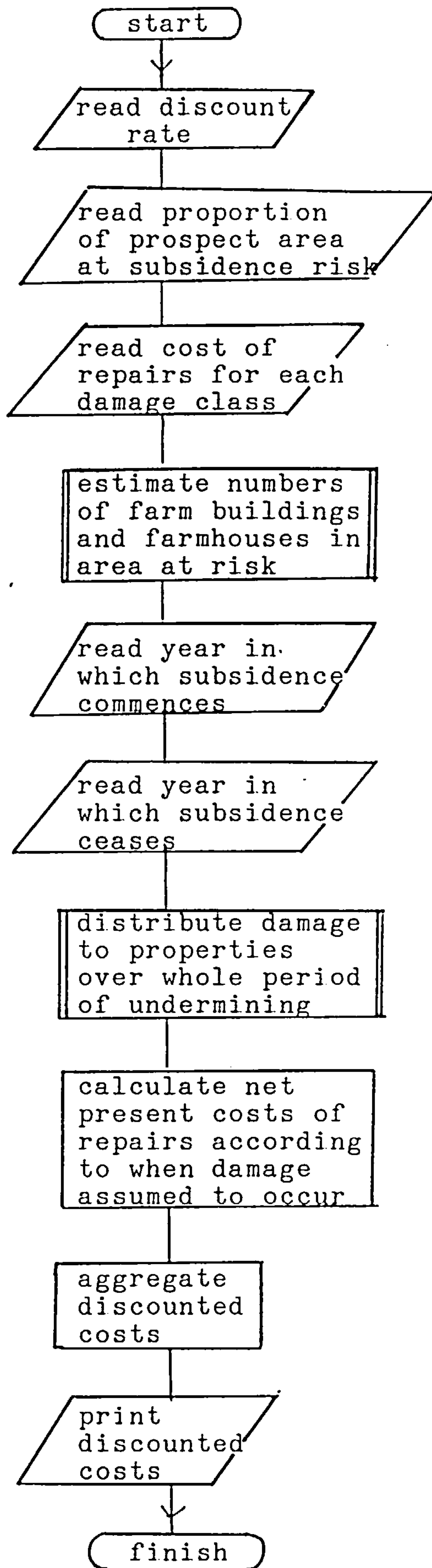


Figure 7.8. Calculation of costs of repairs to farm buildings.

D. 'Transport' on 'Traffic'

Routes to be taken by construction and service road traffic to the mine site were obtained from Leicestershire County Council, and the number of farms along these routes counted. In the absence of firm information on the extent of fragmentation of holdings, an average level of farm severance was postulated for the area, recalculated from Inquiry evidence pertaining to farms along the Bingham-Waltham road (D18). Published data exist for the typical level of journeys per hectare conducted for the mixed farming types in the affected parishes, and these were related to an assumed cost per return trip (D18). The program calculated the anticipated traffic flows (E6, E7) as an increase over existing passenger car unit flows on the affected roads, and related increased costs of farm severance directly to percentage increase in traffic (Figure 7.9).

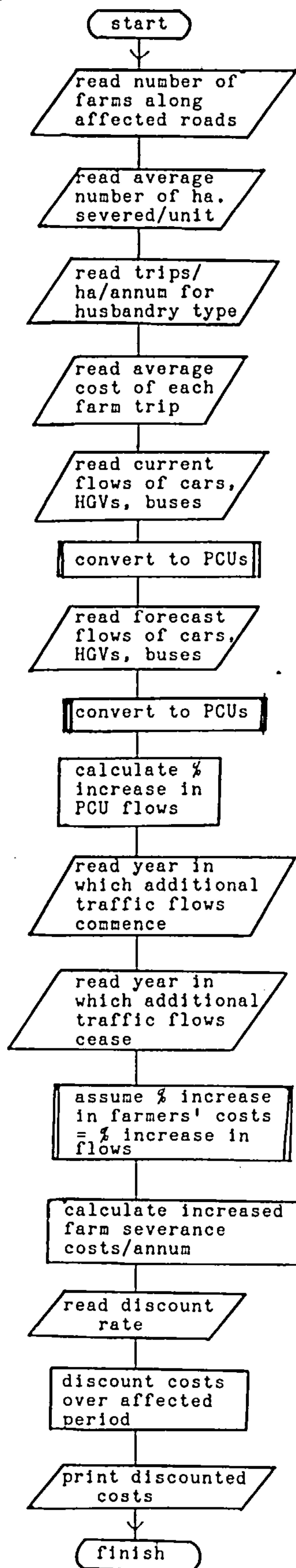


Figure 7.9. Calculation of increased costs associated with farm severance.

E. 'Workforce' on 'Local Economy'

- E1. Increased demand for farm produce was estimated by relating family expenditure on fresh farm produce to the increased local population arising from the development (Figure 7. 10). Assumptions had to be made regarding the proportion of total food expenditure (from the Family Expenditure Survey) which might be spent on local farm produce (E4), and the size of the employment multiplier (E3).
- E2: Urban fringe effects were estimated in respect of Melton Mowbray and Asfordby, the major settlements to be affected by additional housing. A theoretical method was used, in which the population was assumed to be spread uniformly over a surface area, calculated on the basis of notional per capita land consumption, and urban fringe effects to penetrate 2km from the edge of this area. The population was then increased by the expected amount, the increased surface area computed, and the hectarage of the zone of penetration recalculated. The percentage increase in this area was then used to ascertain likely losses (Figure 7.11). Assumptions had to be made about the general level of reduction in profitability resulting from urban fringe impacts (D22).

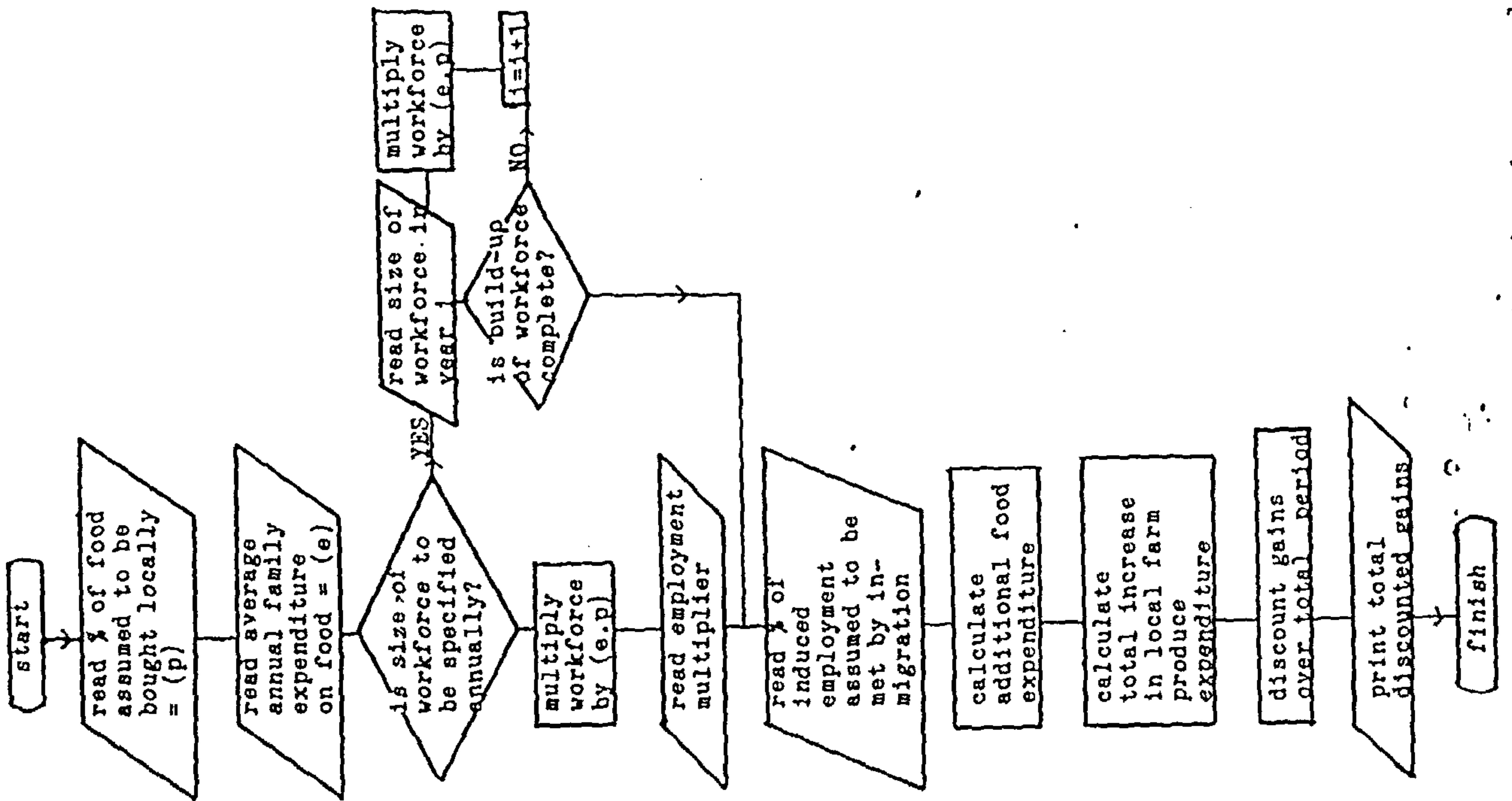


Figure 7.10. Calculation of gains in expenditure on local farm produce.

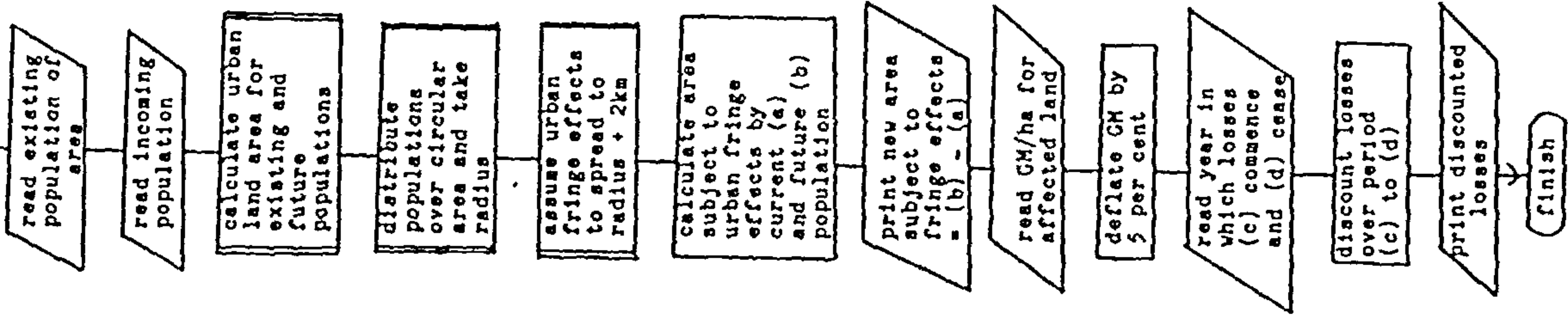


Figure 7.11. Calculation of losses associated with urban fringe effects.

E: 'Land and Resource Use' on 'Local Economy'

The only major ancillary farm enterprise known to be adversely affected by the proposals was the animal feed enterprise at Welby Lodge Farm. Although the turnover of this was confidential, an estimate could be inferred from total gross margin data, after making appropriate deductions for other farming operations (D20). Again, losses were discounted over the period of likely impact (Figure 7.12).

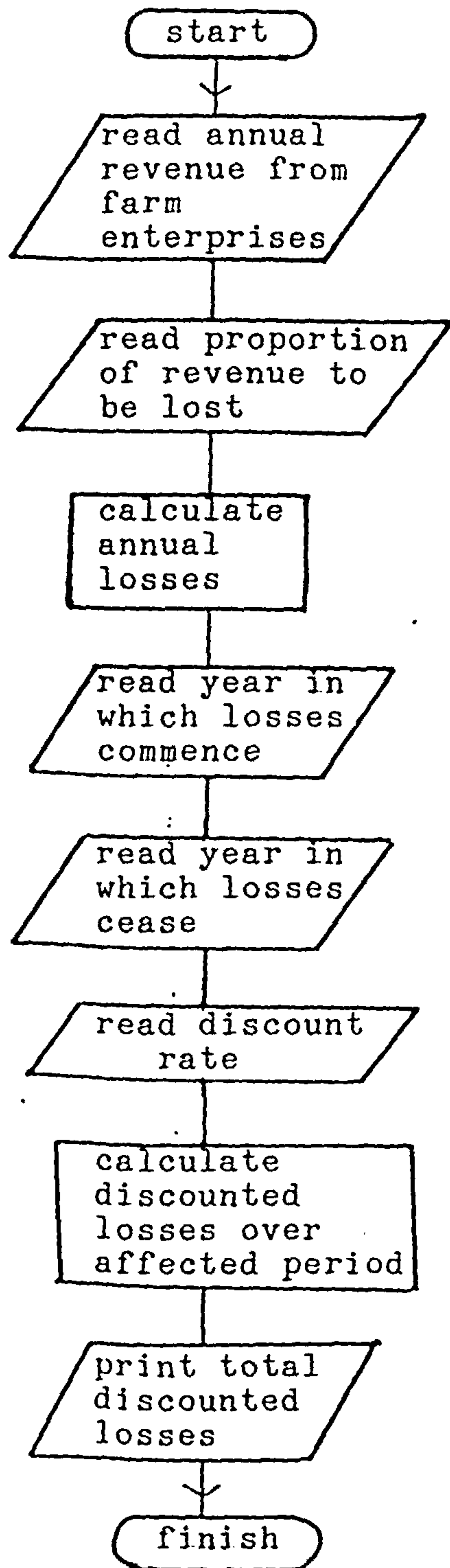


Figure 7.12. Calculation of losses associated with ancillary enterprises.

G: 'Workforce' on 'Employment and Community Structure'

An evaluation of the effects of social change on the structure of the farming community was beyond the scope of the study. However, a crude forecast of the possible effect of mine site employment on farm wage levels was attempted (Figure 7.13).

The number of farm workers in adjacent parishes was obtained, and assumptions were made about average wage levels in the farming industry and the likely scale of supplement which might prove to be payable (D26). In view of the historical evidence of only comparatively minor inflationary movements associated with this source, conservative estimates were made of the size of the supplement and the proportion of the farm workforce to whom it might be paid.

H: 'Pollution' on 'Employment and Community Structure'

Too little evidence was available on the highly subjective topic of quality of life to make meaningful forecasts of change. However, a small amount could be attributed to reduction in property values consequential on increased noise (D27). A more comprehensive economic approach to the costs of visual and aural amenity, and more subtle psychological effects, would be very illuminating.

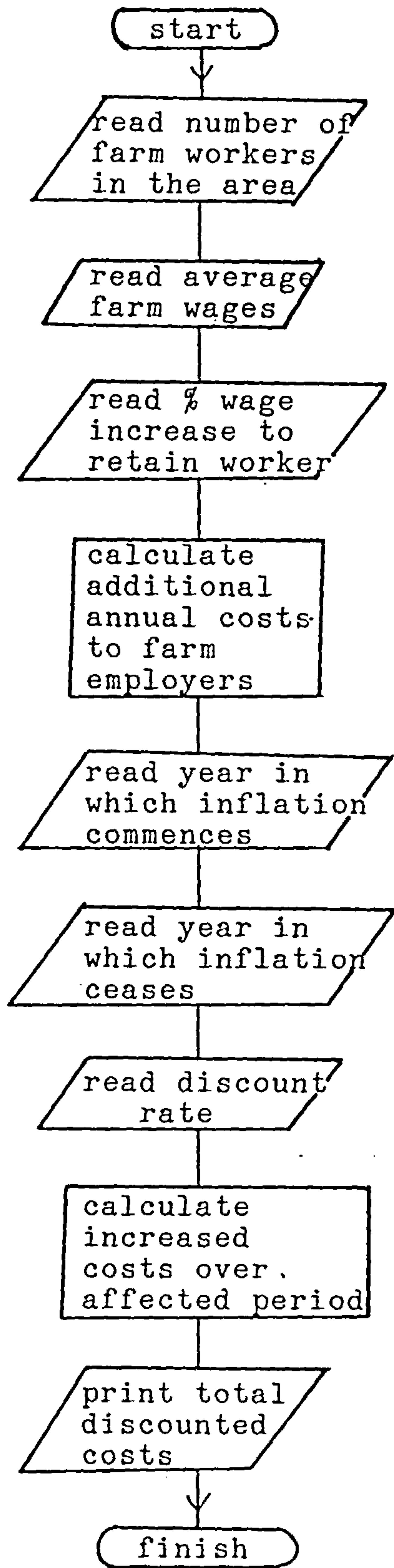


Figure 7.13. Calculation of costs associated with increased farm wages.

Aggregation and Summary of Impact

It has been observed that the spectrum of mining-agriculture impacts can, in the majority of respects, readily be represented in financial terms, and that this greatly assists in their aggregation. Moreover, discounting the forecast reductions or increases in farm revenues at appropriate levels over the anticipated duration of mining activity facilitates a consolidated expression of total impact in terms of present values. Although some agricultural costs would be intractable to assess, especially those associated with the wellbeing of the farming community, further efforts to produce reliable estimates would greatly assist in the evaluation of compensation for such factors as strain and mental stress.

The results of the current exercise are set out in Table 7.2.. Although these findings must, for a variety of reasons shortly to be discussed, be treated with some caution, the figures may reasonably be interpreted as indicative of actual impacts. Thus, the foreseeable scale of agricultural losses in respect of this large 'total' mine (at 1979-80 prices) is seen to vary between just under £1.5m and £4m, depending on the rate of discount adopted, the compensatory benefits apparently being rather limited. Perhaps surprisingly, only around one-fifth of the total impact is attributable to permanent and temporary land loss at the mine itself, most of the disruption being associated with sources which are locally small but cumulatively significant because of the wide radius over which they are distributed. The effects of land loss to housing, and inflationary effects on agricultural wages, appear to be especially worthy of future investigation in this respect.

It may also be observed that the aggregate levels of impact are close for both alternatives and, contrary to expectation, actually appear to be greater in the case of the revised application. The reasons for the latter are accounted for by the reversed direction of tipping which, in addition to affecting some of the best land early on also results in Welby Farm's animal feed enterprise being disrupted

	INITIAL APPLICATION			REVISED APPLICATION		
	discount rate	3%	5%	7%	3%	5%
SOURCE OF LOSS	£M	£M	£M	£M	£M	£M
A1: tip and margin	.478	.292	.203	.397	.238	.166
mine site	.196	.111	.071	.274	.155	.099
A2: lost production due to disrupted land drains + costs of re-draining	.625	.301	.157	.625	.301	.157
A3: housing land - construction stage	.049	.047	.044	.049	.047	.044
housing land - construction multiplier	.006	.006	.005	.006	.006	.005
housing land - permanent workforce	.646	.361	.232	.646	.361	.232
housing land - operational multiplier	.484	.271	.174	.484	.271	.174
C: repairs to, and losses of, farm buildings (including an undiscounted element)	.096	.089	.086	.096	.089	.086
D: inconvenience to farm traffic	.053	.031	.020	.058	.032	.020
E2: urban fringe effects	.182	.103	.066	.182	.103	.066
F: lost farm enterprises	.617	.311	.171	.689	.325	.226
G: additional wages paid to farm workers	.275	.173	.124	.275	.173	.124
H: disamenity from noise	.020	.020	.020	.020	.020	.020
TOTAL LOSS	3.727	2.116	1.373	3.801	2.121	1.419
SOURCE OF GAIN.						
E1: increased expenditure on farm produce by						
- construction workforce	.002	.002	.002	.002	.002	.002
- permanent workforce	.028	.016	.010	.028	.016	.010
- permanent workforce multiplier	.021	.012	.007	.021	.012	.007
TOTAL GAIN	.051	.030	.019	.051	.030	.019

Table 7.2 Aggregate levels of impact at different discount rates:
Asfordby case study. (Notation in left hand column refers
to classes of impact, as summarised in text).

at an earlier date, and by the increased ratio of mine site land to tipping land, so that the benefits of eventual land reclamation (perhaps at a distant time horizon) are masked by the apparently greater effects of land permanently sterilised at an earlier date. In fairness, it must be acknowledged that the original application would also have had to increase permanent land take, as a result of more stringent wastewater treatment requirements which were stipulated as an outcome of Inquiry evidence.

However, the most striking features are that the eventual 'solution' has in effect altered the total agricultural impact only slightly, and that the land related disadvantages are indeed only a fairly small part of overall impact. The absence of an explicit EIA mechanism has allowed the DoE to quote its standard circular regarding agricultural land loss and to claim that the impact has been reduced to an acceptable level, without much fear of contradiction. Thus, it is probable that the revisions in the application afforded a convenient and plausible context for the withdrawal of opposition, rather than causing a genuine change of heart.

In a full environmental impact statement, summary representation of the major consequences of a proposal would prove necessary to convey the findings of the report to the relevant executive agencies and interested parties. This summary could also profitably be used to reinforce the assignation of responsibilities for the imposition of controls, and the conduct of monitoring and auditing. Although it is not truly possible to provide a summary outwith the context of a full-scale EIS, a format for a summary sheet has been advanced (in Chapter Six), and a completed example of one of these is included here to illustrate its potential use in practice (Figure 7.14).

IMPACT: Disruption of Land Drainage due to Subsidence

NATURE OF IMPACT	Description	Impact Dimensions & Importance	Duration	Reversibility & effect on long-term resource use	Avoidability
	Fracturing and mislevelment of land underdrainage and changes in level of main water-courses as a result of subsidence.	direct ✓ indirect ✓ beneficial ✓ adverse ✓ radius - area of undermining	long term medium term short term	may largely be reversed by remedial measures, although there will be considerable short-term losses and some irreversible damage	dependent on mining and remedial techniques employed
BASELINE	Description of Existing Environment need to know extent, location and density of underdrainage + wetness of soil + river bed gradients	Dynamics of Existing Environment improvements to and deterioration of land drains		Significant Seasonal Effects seasonal waterlogging	
FORECASTING	Method of Forecasting determine extent of area underdrained; survey aerially for marginal gradients; estimate area likely to be affected; duration of impact and gross margin losses.	Limitations on Confidence area underdrained rarely known accurately; magnitude and duration of subsidence difficult to predict; difficult to assess effectiveness of remedial measures.		Further Analysis Required? yes no	
IMPACT MITIGATION MEASURES	Applicant compensation; re-grading; provision of pump-assisted drainage	Planning Authority influence area and timing of underground extraction	Water Authority re-grade rivers; seek agreement among riparian owners	Farmer re-lay drains and watering points	Other BWB: re-grade or remainder canals
TOPICS TO BE MONITORED	Applicant extent and degree of damage	Planning Authority -	Water Authority changes in levels of watercourses	Farmer newly occurring poor drainage; consequential reductions in crop yields	Other BWB: changes in canal flows; damage to canal structures

Figure 7.14. Example of impact summary sheet.

Conclusion

The farming lobby has made vociferous representations about NCB operations, and the agricultural impacts of future coal mining have been viewed as a potentially significant constraint to the future development of the industry. Indeed, the original proposals for waste tipping at Asfordby were, in the view of the Environment Secretary, at variance with government policy on the protection of agricultural land. The results of the present study suggest that, whilst the agricultural impacts of coaling proposals may be diverse, and worthy of systematic assessment, they are of comparatively limited magnitude and are unlikely, by themselves, to warrant the cancellation of nationally important energy developments.

It may be, however, that the overall environmental effects of individual proposals do impose an unacceptable cost. In this context, the project appraisal which has been undertaken here is best viewed as but one part of a master EIS. The identification matrix used may, as has already been pointed out, readily be related to the comprehensive matrix advocated by PADC. Also, certain of the agricultural impacts would have been valuably elucidated by the availability of cognate information from parallel investigations: the profiling of structural change in farming communities as part of a social impact analysis, or the amenity effects of waste tipping within the context of a visual appraisal, are cases in point. These could well be expressed in units other than financial ones: however, it has been argued that there is limited virtue in ensuring that all sectors are aggregated in like units and, indeed, the adoption of a single measure of impact throughout may conflate and confuse issues rather than identify and isolate them.

The use of an economic yardstick may be questioned on the grounds that it would resemble cost benefit analysis rather than an EIA. This is not truly the case, though, as the method possesses a number of features which distinguish it from a traditional CBA: it takes systematically into account the whole range of farming impacts; it identifies problem areas for planning, signals actions and assigns responsibilities; and it communicates impacts in terms which make sense to the farmer. Further,

whilst it is not suggested that a direct comparison between the value of coal won and agricultural output lost would produce meaningful results (there would be at least one order of magnitude difference), it is assumed that the determination of certain environmental trade-offs could be assisted, such as the justification for short-distance remote disposal of waste to minimise land loss, or for backstowing to reduce subsidence.

Nevertheless, O'Riordan and Turner (1983) note that, whilst there are differences between EIA and CBA, the two may in the future move closer together. Thus, they argue:

"Detailed EIAs can produce a comprehensive statement of the wider implications of a project, but...they do not help the decision-maker to choose the best among the alternatives: they merely produce an enormous mass of information. The use of more adventurous CBA with separate displays for the distributional implications and alternative objectives...is capable of yielding an ordered display of cost and benefit streams that are more readily comparable. There is clearly scope for the two approaches to converge. CBA can be made to encompass the wider aspects of a project, whereas EIA could be deployed to search for acceptable management compromises including improvements in project design, safety measures, risk-reducing devices and compensatory arrangements, all of which are capable of being costed for useful analytical comparison".

Given the lack of pre-existing evidence from which to work and the problems of collecting data (which would certainly be reduced in the case of an inter-disciplinary team of investigators working in an official capacity), the actual estimate of impact presented can only be treated as an approximation. However, this does suggest some avenues

for future research which could refine the accuracy of subsequent assessments. In particular, it would be valuable to understand more about employment and expenditure multipliers in rural areas, the likely expenditure of residents on local farm produce, the financial consequence of farming in the urban fringe, and the amenity costs of living within the vicinity of a mine. Insofar as the proposed impact assessment technique is concerned, it is felt that the most rewarding direction for future research would be to investigate more fully the effects of mining development on individual farm units, as this is the essential focus of an economic basis for impact appraisal. A study of the actual, and optimal future, responses of individual farming enterprises to disruption could, indeed, lie at the heart of an assessment of agricultural impact.

CHAPTER EIGHT

DISCUSSION

The Nature of Agricultural Impact

Despite unquestionable improvements in pithead design and site reclamation, the relationship between farming and mining cannot on balance be said to be a harmonious one. The immediate and local effects of mining, although quantitatively the greatest, are in some respects the least of the agricultural industry's problems. Experience has shown that it is the more pervasive factors - such as progressively deteriorating land drainage, vague rumours of opencast prospects, uncertainty over the timing, adequacy and extent of compensation, and increased urban fringe effects - which have caused greatest anxiety.

Insofar as strategic conflict with food supplies is concerned, the impact of coal mining must be considered rather minor. Even in the case of a large modern pit with on-site tipping, and assuming a low rate of discount, agricultural losses were shown only to approach £4m over the lifetime of the pit. Allowing for inflation since the costings were derived this could be boosted to around £6m, but even so this loss is very small in comparison either to the value of coal won or the overall annual contribution of agriculture to the GDP. Losses from opencast sites are likely to be substantially lower, with their shorter lifespan, total removal of site buildings and absence of subsidence. However, coal mining is by nature a geographically confined activity, and its increasing concentration into fewer areas is likely to impose a more noticeable economic and social penalty on farming at the sub-regional level.

The scale of impact likely to arise in the future is uncertain. The prospect of imminent extension of deep mining southwards from the major coalfields seems to have receded and the NCB's plans for a sustained programme of 'superpits' from now until the end of the century remains

only in very dilute form. Such a strategy would have implied a high success rate in securing pit closures - the more so, given declining demand for coal. More probable, it seems, will be the upgrading and intensification of pits in the traditional areas, where workers can be retained comparatively locally and the maximum use made of existing investment. From the agricultural viewpoint, this will have both advantages and drawbacks. Whilst farmers in Oxfordshire and Cheshire will remain undisturbed, their colleagues in South Yorkshire and Nottinghamshire will face a complex of enduring problems. Apart from the effects of blight, loss of community character and proximity of the urban fringe, two factors in particular are likely to prove a significant nuisance. First, it has been noted that, in some areas, regrading of rivers following repeated undermining has taken place so many times that they are at the limits of effective remedial action. Further deterioration would clearly have serious consequences for rural land use. Second, the space available for waste tipping is already virtually exhausted in some areas, and pressure will increasingly be placed on planners to agree to the release of good land and the fragmentation of well structured and highly capitalised farms. Moreover, because in many cases existing installations form the basis of new operations, much of this activity may proceed outwith planning control.

In the case of opencast working, the future is even less clear. Already the requirement of NCBOE applications to be argued on their own merits rather than in the light of firm production targets is making 'national need' even more difficult to establish. Moreover, the political, as opposed to environmental, objections to opencasting (inasmuch as it diverts investment from and reduces demand for deep mined coal), may intensify at the planning committee stage. However, the OE's restoration standards are continually improving and their willingness to discuss future plans increasing: together with the formal introduction of planning control, this could ensure a progressive amelioration in conditions. The enhanced status of the private opencast sector and, perhaps, the potential privatisation of the OE again introduces a major source of uncertainty. Certainly, the scope for maverick operators, with scant experience in restoration, increases, but so does the potential involvement

of the larger companies with their own experimental farms and land agency services, backed by respected trade associations. Once more, the effective and consistent application of strong planning measures can help reduce the element of uncertainty to a minimum.

Technological changes introduce a further dimension into the future picture, especially for deep mining. The likeliest significant change seems to be the increased use of off-site waste disposal; indeed, this may almost be inevitable given the opposition to alienation of farmland in the new prospect areas and the exhaustion of suitable land in the traditional ones. A whole range of agricultural and other impacts are associated with the loading, transport and tipping of such wastes. Perhaps the most notable ones are increased land requirements for transport facilities and tailings disposal at the pithead and the scope for reclamation at the destination site. Underground stowage is currently most unpopular with the NCB; however, two factors serve to increase its potential acceptability. First, pressure is building up on the Board to take the subsidence- and waste-reducing measures which this technique could afford; indeed, the compensation bills which they potentially face for repair of subsidence damage make this an increasingly prudent option, especially if the range of compensatable damage is broadened. Second, the main disadvantage of backstowage - that of necessitating a major change to longwall extraction methods - may in the longer term prove a virtue. Already, voices are being raised in the NCB about the wisdom of longwall methods which entail the sterilisation of large amounts of coal; with the Board forced to concentrate more on its existing pits, alternative methods of working, which involve the removal of reserves more nearly to exhaustion, may gain in popularity. Again, the agricultural implications of backstowage are somewhat two-edged: reductions in damage to land drains and agricultural buildings may be offset by increased site demands for crushing and transporting facilities, and for tailings disposal (Selman, 1984).

In situ gasification of coal now seems unlikely, in Britain at least, whilst liquefaction of coal for use as a petrochemical feedstock appears an equally remote prospect. However, the development of coalplexes, especially as the demand for substitute natural gas materialises, must remain a strong possibility for two or three decades' time. The scale and range of impacts associated with such plants have already been summarised. The common factor of all these technological advances lies in the enhanced scale of minehead facilities, making initial site selection the most critical exercise.

The Role of Land Use Planning

In the development of a future coal industry, a great deal of onus will fall on the planning profession to define and enforce the terms on which it is socially and environmentally acceptable. In respect of isolated applications, planners can respond in only a reactive fashion, but even so, there are many issues on which they can force the pace of environmental improvement. Whereas planners exercise surveillance over the greatest range of factors, they are by no means alone as agents of control and so must liaise with, and perhaps coordinate the efforts of, other public agencies.

At the most basic level, they can determine, subject to appeal, whether the development takes place at all. On a more sophisticated plane, there are a range of constructional and operational factors which can be influenced by the imposition of conditions of consent. Thus, the extent, intrusiveness, method and siting of waste disposal provisions can be stipulated. Fixed surface installations, and the various processes of coal treatment which they house, are likewise subject to detailed control. Operational factors, such as noise levels or hours of work, which can upset neighbouring residents or farming activities are, to varying degrees, capable of being influenced. Mine accesses and new approach roads, whose siting is critical in terms of induced traffic patterns, are also subject to restriction. More tenuously, control may be exercised over the pervasive multiplier effects of development, such as housing and servicing.

However, the responsibilities of planning should be seen to extend beyond those of short-term reaction. Long-term, strategic, sub-regional appraisals must be introduced for the systematic upgrading of traditional mining areas and for the optimum use of resources in new ones. In many areas, the worst damage has already taken place and the depressed farmland and visual despoliation which remains acts as a deterrent to the location of new industry. Attention must be given to the formulation of standards to govern future opencasting, re-working of tips and reclamation, perhaps via the medium of a subject plan. In traditional areas where deep mining utilities are to be given a new lease of life, revisions to the GDO should ensure that more activities become subject to planning control than has hitherto been the case. The scale of operations is likely to be such that a coordinated regional approach must be taken to the whole question of waste disposal and landfill. Equally serious, but perhaps more intractable due to its "operational" nature, is the allocation of land for coalstocking.

With regard to new deep mining areas, the planning system is for the first time responding to applications affecting whole coalfields, thus presenting a major opportunity to establish high design standards at the outset. At present, such proposals are rarely built into land use plans, and so are at best only the subject of a project appraisal, as the structure plan is being tested by new and unforeseen demands. However, there is a growing consensus that the NCB should consult far more closely with planning authorities about the status of its future projects which, some would argue, are more clearly identified than the Board is wont to admit. Very similar arguments could be marshalled about extensive opencast programmes. In some parts of the country these appear to be becoming geographically concentrated and to be moving onto the better agricultural land, making the adoption of a sub-regional programme, and the identification of strategic principles of exploitation and design, a priority.

Deficiencies in Current Practice

Given the panoply of environmental controls and codes of practice already in existence, the observer could be forgiven for asking why further provisions were necessary. In one respect, it is the very complexity of current arrangements which does beckon change. The variety of statutes, of operators, of common law remedies, of private negotiations and public assurances, and of control agencies - with all the scope for duplication or inadvertent omission which this raises - calls for a means of coordinating and dovetailing efforts. Apart from this general observation, however, a number of more specific shortcomings of current practice have come to light.

Of all the limitations inherent in statutes, perhaps the most notable has been the exclusion of most opencast and some deep mining activity from planning control. Further concern has arisen over the doubtful status of tip run-off and leachate as an industrial effluent, or the liability of the NCB for drainage from abandoned workings. At the time of writing, however, most of these omissions are being rectified, although transitional arrangements for opencasting bring with them the prospect of substantially increased workloads for skeletal mineral planning sections. It also seems probable that many tipping activities currently covered by the GDO will be brought under control, and that certain of the privileges conferred on the NCB under s20 will be withdrawn. However, a number of exclusions will persist, and the effect of these is likely to be most serious where intensified operations ensue amongst the older mining complexes. It is possible to withdraw GDO rights via planning conditions, but these are unlikely to adhere unless a cogent case is made; any technique capable of demonstrating explicitly the case for such reservations is therefore likely to prove valuable. More generally, as the statutory base becomes stronger, so it is the use and enforcement of statutory measures which become the pre-eminent issues. Again, these can usefully be aided by techniques facilitating the efficient and timeous application of control.

A major point of contention, and one showing every sign of increasing rather than abating, is the big public inquiry. Whilst far-reaching public debates are not of themselves in any respect undesirable, the use of planning inquiries to resolve issues of policy or to pursue the minutiae of peripheral issues is regrettable. The capacity of coal mining proposals to precipitate such inquiries needs no elaboration; the difficulties of the lay public in meeting the financial and time costs associated with them are also well known, and the problems of farmers, whose work commitments become all-consuming at certain seasons, merits especially sympathetic consideration. Once more, the availability of a technique which could decrease the cost and length, but not the openness or comprehensiveness, of public inquiries would be welcomed.

One of the main purposes of planning must be to outline the forward strategy of land and resource use in general, and not simply to resolve the allocation of land in individual cases. It is thus particularly disappointing that so little progress has been made on influencing the broad temporal and geographical features of mining activity. The temporal problems associated with the mining cycle - especially those of decline and closure - have received a great deal of publicity. Although there is comparatively little which can be done in respect of employment beyond the gradual attraction of replacement industry, the omission of effective decommissioning proposals for agricultural interests is less excusable, since the solutions are generally within our technical capability. The spatial problems of coalfield development, or of transition from deepmine to opencast, likewise demand a holistic overview. This has been hampered not only by a lack of awareness of the issues at stake or of future mining proposals, but also of inadequate baseline survey information. The availability of detailed land class data for virtually the whole of Britain is to be welcomed, but its informed interpretation by planners is not always routine, nor is it supplemented in most Reports of Survey by information on aspects of farm structure, fragmentation, farm type or extant dereliction.

Thus, whilst the British system of environmental controls potentially imposes a rigorous framework, decisions are often taken in an uncoordinated manner, within a policy vacuum, and may be implemented in a piecemeal and myopic fashion. This situation cannot be remedied by techniques alone, but appropriate techniques are capable of imposing a discipline of consistency and of uniformly systematic treatment.

The Case for Environmental Impact Assessment

The argument has been advanced that the agricultural impacts of coal mining could be more effectively analysed and remedied in the presence of a system of environmental impact assessment. The introduction of such a technique, however, places severe strains on the quality of data gathering systems and the capability of impact assessors to produce meaningful forecasts. Despite these problems, a number of specific advantages of plan and project EIA can be cited.

First, EIA is systematic in its exposition of baseline and design data requirements, although these are more clearly articulated at the project than the plan level. A full schedule of existing site conditions and complementary survey of the prospect area can, apart from forming the factual basis for forecasts, greatly assist in the future determination of compensation levels and in the attribution of damage to mining. Claims that the level of design specification required from the developer is unattainable are rarely substantiated; much more pertinent is the demonstrable role of EIA in enhancing project design.

Second, is the use of EIA in isolating appropriate planning conditions, agreements, assurances and other remedial measures and in relating these to the range of impacts which have been systematically identified. At the plan level this is likely to involve the exposition of exemplary standards and criteria against which applications are to be judged. Project appraisal should pay increasing attention not simply to attaching model conditions, but in monitoring the degree of compliance with these. Again, EIA provides an important device for overcoming the piecemeal

fashion in which this is undertaken at present. It would doubtless be argued that this would impose additional requirements of control, inspection and enforcement on under-resourced mineral planning sections; however, an EIA could help in highlighting critical phases of activity when the importance of field inspection would be paramount, and could thereby assist in deploying scarce resources to optimum effect.

Third, the desired degree of liaison between developer, planner, water official and agricultural adviser has not always been attained in practice. In some recent cases, the situation has greatly benefited from the establishment of a coalfield committee or joint working party. EIA could further enhance the operation of such groups by assigning responsibility to the most appropriate agent or agents at the outset, and making their apparently covert compromises more public. Conversely, they in turn could enhance EIA by ensuring that it became an ongoing activity associated with the whole life of the coalfield, rather than an isolated exercise.

Fourth, EIA makes the planning process more democratic and communicative, and could help overcome some of the secrecy and vagueness associated with development proposals. Thus, the availability of a draft EIA could make for more open and focussed public inquiries, in which affected parties could in advance examine the extent to which their interests had been adequately appraised. The farming fraternity have voiced doubts about the fairness and uniformity of the NCB's compensation arrangements, misgivings which could be allayed if an EIA were to form the agreed basis of these. Vagueness about future proposals and the ways in which compensation may (or may not) be paid has been seen to be a source of strain and mental stress; the root cause of this is the sheer uncertainty which farmers face, and any means of reducing this is strongly desirable.

Fifth, there are several technical advantages which EIA could afford the planner. Perhaps most notably, it forms a vehicle for the development and refinement of forecasting techniques and for the establishment of the level of accuracy required of particular forecasts. Whilst this will

prove a severely problematic task for some time to come, it should be noted that forecasts may more confidently be made if sound survey and project specification data are available, and if a policy review exists to establish the timescale and magnitude of future intentions. Many difficulties for planners arise from having to take decisions in an isolated fashion: here, plan EIA would be invaluable in establishing the cumulative impacts of incremental approvals. This reinforces the previously observed phenomenon that the scale of individual cases of agricultural impact may be comparatively minor when viewed from a national perspective, but more severe when programmes become compounded at a sub-regional scale. Furthermore, many of the larger coaling proposals can be expected to transgress local authority boundaries and other administrative areas - especially as provisions for remote disposal of waste increase. This is frequently cited as one situation when EIA is especially helpful.

It is true that one of the principal purposes of project appraisal is partially denied coal mining, namely, the selection of the optimum site alternative. This is a problem common to all mineral activities, since the disposition of reserves restricts the room for geographical manoeuvre. However, this is probably at a minimum in deep mining, where some latitude over the location of surface access exists, although ventilating and underground travel time criteria impose their own restrictions. Nevertheless, project appraisal can still make a significant contribution to the determination of planning decisions. Some scope for site selection may exist, and there are frequently technical options available which permit alternative detailed design: EIA can then afford a quantified basis for comparing these alternatives. Further, it can assist in the determination of the nature and extent of likely impact. In conjunction with this, it can be employed to define the acceptable standards and criteria relevant to the proposal, and to compare against these the predicted impact. Finally, it can be used to evaluate proposed remedial measures and serve as a factual base for estate management provisions in restructuring agricultural holdings.

A Structure for Impact Assessment

It has been argued that, for EIA to be utilised to maximum effect, it should be integrated into the policy- and decision-making process in a tiered structure. Although it has only been possible to review the top tiers in a general manner, policy review and plan environmental assessment emerge as desirable precursors to an effective project appraisal stage. Plan EA, it has been suggested, may usefully be viewed as an exercise in matching two elements: the spatial and aspatial aspects of development classes. The problems posed by uncertainties over the type, scale and location of future developments may be circumvented by devising generally applicable resource coefficients of particular development classes, and by selecting measures of the inherent absorptive capacity of the environment likely to be affected. This latter component, which reflects the spatial aspects of potential impacts, may be arrived at via well-established sub-regional planning techniques.

Greater attention has been given to a procedure for project appraisal. Emphasis was laid on the desirability of retaining as much consistency as possible with EIA practice, and a single format for opencast and deepmine project appraisal was advanced, related to the widely-accepted PADC methodology. The interconnected format of baseline survey, project specification and interaction matrix provided a flexible and conceptually simple integrated approach.

The rather controversial choice was made to express agricultural impacts in economic, rather than physical environmental, terms. Various measures were considered and it was felt that the most representative was the farm gross margin, deflated by around 10 per cent to allow for internal adjustment to impacts and the transfer of resources elsewhere within the agricultural economy. Although this ran the risk of replicating the failures of cost-benefit studies, it was preferred on a number of grounds. It enabled the results to be discounted over the lifetime of coaling operations, thereby producing a single, consolidated representation

of impact. It readily permitted aggregation of the major effects of development, although certain of the more hedonic and peripheral aspects were, at least in this limited exercise, problematic to cost. It enabled all the within-farm impacts of development to be integrated, thus giving a measure of the damage (or benefit) inflicted on individual farm enterprises. It could, if so desired, provide the applicants with an approximate indication of their compensation liability. Finally, its results were represented in terms which would be readily recognised by the affected public.

The results of the exercise in project appraisal, although restricted by limitations of resources and data, are considered to represent a reasonable approximation to the actual scale of agricultural impact associated with a large deep mine. Whilst confirming that agricultural considerations alone are most unlikely to warrant the cancellation of coaling projects, the magnitude of costs may be sufficient to justify specific design or locational modifications to the proposals. In respect of opencasting, this has significance for the sequence in which sites are worked, and of deep mining for detailed site selection, tip design, and the evaluation of alternative options for on-site, remote or underground disposal of waste.

Future Directions

Inevitably, this incursion into the field of EIA has raised more questions than it has resolved. Some can be answered by more detailed research, others will have to await the progress of major development projects for more concrete evidence of impacts. Of course, these aspects are closely related, and it will be an important task of environmental assessors to ensure that their reports are properly audited and validated. Without sustained improvement in the quality of impact identification and evaluation, it is unlikely that EIA will maintain its credibility.

A considerable body of research exists on the pedological impacts of coaling operations, and the current range of experimental projects on soil handling and post-restoration farming will supplement this further. The main focus of these investigations could profitably be directed to the long-term effects on top grades of land, poorly structured soils and high rainfall sites. Rather more important here will be refinements in practice to ensure that the results of research are incorporated into site management and that post-restoration performance is adequately monitored: the appointment of restoration officers by the NCB may well be the only effective way of achieving this. Far less adequately investigated are the various hydrological effects of mining, not only in terms of the various mine site discharges, but more particularly in the sub-regional effects on groundwater, water quality and land drainage. In the case of opencast workings, these appear to be controllable by vigilant enforcement of well-established engineering provisions, although in arid areas the problem of groundwater depletion merits further attention. The hydrological effects of deep mining are more extensive, and may persist after mine closure. Again, in most instances there are effective engineering solutions, although further evidence about the impacts on irrigation waters and the extent and control of ferruginous discharges would be helpful.

Reports about the specific local effects of mine development on crops, livestock and agricultural industries are also conflicting. More reliable information should be documented on the response of particular crops to saline waters or to dust, and on the sensitivity of cattle and poultry to industrial sources of noise. High cosmetic and hygiene standards now exist in the food industries, and the levels of ambient pollution which could jeopardise these should also be investigated.

It has been noted that not all the effects of mining are adverse for agriculture. Several commentators have recorded that certain enterprises can thrive in the urban fringe, whilst it is clear that demand for local farm produce will be enhanced by an incoming workforce. Despite the amount of recent research on the urban fringe, however, it is

surprising that only the most general statements have been made about these phenomena, and there are no reliable data about their magnitude. Evidence on the scale of induced farm expenditure could not only prove reassuring for the affected community, but could also provide practical guidance on the best way in which farm units should be restructured.

Technical investigations into the underground stowage and remote disposal of colliery waste must continue to receive favourable funding, for it is these measures perhaps more than any others which can produce a more acceptable image for the deep mining industry. Already, the volume of spoil being generated in certain regions is of major concern and requires a strategic, rather than a piecemeal, solution. The DoE project instigated in 1984 in the Yorkshire/East Midlands coalfield is aimed at developing a methodology for evaluating the scale and distribution of costs and benefits arising from various spoil disposal options, as a basis for the development of local and regional planning policies (Heyes, pers. comm., 1984; Noyce, pers. comm., 1984). The original brief suggests that this study will follow similar lines to the project appraisal format advocated here. The costs of alternatives to local surface tipping might, however, prove prohibitive to the operator, and it would seem reasonable that central government should grant aid a sum at least equivalent to the potential discounted agricultural losses associated with on-site tipping. Whilst this would be a very considerably smaller sum than the cumulative additional costs imposed on the operator, it is likely to be comparable to the cost of installing basic infrastructure.

With regard specifically to impact assessment techniques, perhaps the major task is to refine the quality of forecasting at both the plan and project assessment stages. With regard to plan assessment, it would be useful to define more precise "performance indicators", impact and site characteristics, and coefficients of employment, traffic and waste generation. In the case of project appraisal, the further development of rapid techniques to yield tolerably robust forecasts would be valuable in identifying the scope of topics worthy of more detailed scrutiny.

The strongest imperative for the future, however, lies in the improved standards of practice on the part of both developers and control agencies. To date, most complaints have been levelled at inherent deficiencies in legislation and the unwillingness of the NCB and private mineral operators to engage in meaningful advance discussions. Refinements of law and procedures, including the probable introduction of environmental assessment throughout the EEC, will effectively change this balance and there will be few excuses for inadequate vetting, control or reparation. The focus of concern will thus change from the intrinsic weaknesses of environmental control to implementation of the improved framework in the most potent way possible.

No doubt some planners and many industrialists will continue to contest the need for formal and explicit environmental impact assessment. But the evidence is becoming clear that, in the absence of this, the scope for genuine apprehension and uncertainty on the one hand, and for emotive and unsubstantiated claims on the other, to gainsay rational judgement is against the best interests of developer and public alike. The case for introducing a rigorous and consistent appraisal methodology in respect of key areas of impact, where matters of strategic or national importance are at stake, is becoming inescapable.

APPENDICES

APPENDIX A

ELEMENTS OF THE BASELINE SURVEY

LAND USES

Farm Land

Land Surface: Area of land directly affected by proposed development.

Proportion of area in each LUCC class/MAFF grade. Extent of any common land.

Restoration Potential: Any advantages or disadvantages of soils for restoration purposes. Problems of drainage, shallowness, shortages of topsoil, etc. (preferably a detailed survey should be carried out).

Information on soil moisture content to provide an indication of the likely ability to move stripped subsoil and topsoil within 30 working days in a generally satisfactorily dry condition in most years (should be available from MAFF Technical Bulletins).

Land Drainage: Extent and, if data are available, type and condition of field underdrainage. Areas of critical gradient in arterial drainage system.

Infrastructure: Farmland traversed by electricity lines, pipelines, etc.

Farm Livestock

Disturbance: Livestock enterprises and intensive livestock units close to mine site, especially involving animals and poultry known to be sensitive to noise disturbance.

Loss: Livestock enterprises on affected land for which a forced sale may be necessary.

Disease: Areas where special measures may be necessary to prevent spreading of infectious diseases to livestock.

Slurry Spreading: Land required for slurry spreading. Note any areas where slurry may have to be spread in densities in excess of good agricultural practice.

Farm Crops

Irrigation: Extent of irrigation within the affected area and rivers which are used for this purpose.

Pollution: Any evidence on existing levels of pollution; cultivation of crops likely to be sensitive to saline irrigation water, dust or gaseous emissions.

Damage: Crop damage (as opposed to total loss) from site operations. Pay especial regard to exploration phase and to temporary exposure of mains services crossing farmland.

Drought: Susceptibility of area to drought and water appropriation.

HOUSING

Farm Buildings

Overall Distribution: Number of farm buildings in the application area.

General nature of construction, and age and condition, of buildings.

On-Site Structures: Buildings on or adjacent to proposed development site which may be lost or become redundant.

Sensitive Structures: Buildings and fixed equipment especially sensitive to subsidence.

TRAFFIC

Intra-Farm Traffic: Units likely to be affected by new road and rail links causing severance.

Inconvenience: Increased traffic flows exacerbating existing farm severance.

LOCAL ECONOMY

Profit Margins: Gross margins for fields or parishes in affected area.

Ancillary Enterprises: Milk rounds, farm tourism, etc. at risk from proposals.

Income: Potential of enterprises to take advantage of increased farmgate and local sales.

Urban Fringe Effects: Local vulnerability to increased urban fringe effects.

Agricultural Industries

Buildings: Food processing factories likely to be sensitive to subsidence or other damage.

Processes: Food processing industries likely to be at risk from increased air and water pollution.

EMPLOYMENT AND COMMUNITY STRUCTURE

Farmers and Farm Workers

Tenure: Schedule of tenures, indicating owner-occupiers and tenants.

Workforce: Number of farmers, full-time and part-time employees, hired workers and family workers.

Quality of Life: Quality of farmers' life attributable to environmental quality in the affected area. Existing ambient noise levels.

Communities: Social profiles of openness or closedness of farming communities. Age and skill structure of farm workforce.

APPENDIX B

ELEMENTS OF THE PROJECT SPECIFICATION REPORT

Site Preparation

Actual area of application; proposals for surface extraction, including duration and phasing.

Solid Waste Disposal

Area required for tipping or surface storage of soil and overburden, including duration and phasing.

Subsidence

Area to be undermined; anticipated degree of lowering; timing of subsidence; areas and buildings at risk from undermining. Pay especial regard to any areas to be undermined more than once.

Water Demand

Process water requirements; sources of abstraction.

POLLUTION

Noise and Vibration

Sources of site and traffic noise and vibration; likely levels of daytime and nighttime noise; proposed remedial measures.

Aqueous Discharges

Quantity and quality of mine, surface and process water to be discharged; discharge points; proposed remedial measures.

Particulates and Gases

Likely sources and severity of dust nuisance; sources, quantity and types of gaseous emissions; proposed remedial measures.

WORKFORCE

Immigration

Proportion of workforce likely to be met by transferees and employees attracted from outside the region.

Employment

Size of workforce and phasing of build up. If available - timing of shifts and composition of workforce.

Local Expenditure

Likely magnitude of employment multiplier.

TRANSPORT

Severance

New road and rail links crossing farmland.

Raw Materials, Products and Wastes

Volumes of traffic, by size of vehicles and mode of transport, for import of constructional materials and equipment, and export of coal and waste.

Employees

volumes of traffic generated by employees, by mode of travel.

LAND AND RESOURCE USE

Structures

Land required for site installations, including area in agricultural use. Land demands for ancillary uses (if known).

APPENDIX C

TYOLOGY OF IMPACT CLASSES

"Land and Resource Use" on "Land Uses"

Objects of Analysis:

- compare agricultural impacts associated with surface installations, excavations, tipping or landscaping;
- guide detailed location of surface operations;
- make explicit the implications for estate management, land acquisition and farm restructuring;
- estimate the likely agricultural impacts arising from induced development;
- indicate the broad magnitude of likely subsidence damage and associated agricultural costs;
- identify critical areas of arterial drainage system.

Methods:

- compare site impacts on basis of gross margin per hectare, deflated by 10% to allow for resource economies and transfers. Determine total impact by discounting losses over period for which land is wholly or partially out of production.
(Radius = initially, all sites under consideration; subsequently, alternative layouts on adopted sites).
- determine future additional population from past data on labour force requirements and employment multiplier. Convert to hectareage by capitation formula, and allocate housing and associated facilities by spatial allocation model. Discount and aggregate gross margin losses.
(Radius = areas defined by spatial allocation model).
- determine area to be affected by subsidence and apply probabilistic model to estimate likely level of lowering; deflate gross margins over affected area; estimate costs of remedial works within affected area. For more detailed analysis, identify critical areas of arterial and field drainage system.
(Radius = zone of subsidence).

"Pollution" on "Land Uses"

Objects of analysis:

- identify deleterious effects of pollutants on agricultural produce.

Methods:

- ascertain dilution of polluting aqueous discharges; if pollutant levels appear significant, note farm abstraction points and identify types of crops grown. If crop damage appears likely, discount estimated annual cost of damage; discount and aggregate.

(Radius = watercourses within and adjacent to prospect area).

- estimate dust deposition levels on basis of current experience.

If damage appears likely, note type of crops grown and estimate annual cost of damage; discount and aggregate.

(Radius = c. 2km of activity area).

- predict ambient concentrations of SO₂ and other gases by dispersion formulae. If damage appears likely, note crop types and estimate annual losses; discount and aggregate.

(Radius = sub-region).

"Land and Resource Use" on "Housing"

Objects of analysis:

- assess scale and severity of subsidence impacts on farm buildings;
- identify critical structures;
- ensure that farmers are forewarned of approaching subsidence.

Methods:

- identify area over which subsidence impacts are likely to be encountered. Identify sensitive structures and forecast potential damage from nomogram relating building length to subsidence strain. Obtain estimate of percentage of farm buildings likely to fall into each damage class.

(Radius = zone of subsidence).

"Transport" on "Traffic"

Objects of analysis:

- identify new instances of farm severance;
- estimate the likely exacerbation of existing severance.

Methods:

- adopt normative approach to reconstruction of farm units and provision of accommodation works. Assess costs of new severance in terms of increased traffic flows.
(Radius = affected farm units).
- evaluate existing travel time costs arising from severance and inflate by percentage increase in forecast traffic volumes.
(Radius = area subject to increased traffic flows).

"Workforce" on "Local Economy"

Objects of analysis:

- forecast increased demand for farm produce.

Methods:

- forecast increase in population and apply regional Family Expenditure Survey data to obtain total increase in food expenditure. Obtain estimate of proportion of increased expenditure likely to be spent on local produce.
(Radius = sub-region).

"Land and Resource Use" on "Local Economy"

Objects of analysis:

- identify possible losses of ancillary farm enterprises;
- estimate implications of urban fringe effects.

Methods:

- ascertain current returns from ancillary enterprises likely to be lost as a result of site development.
(Radius = immediate vicinity of mine sites).

- identify additional area likely to be subject to urban fringe impacts and deflate gross margins accordingly.

(Radius = c. 2km of housing and temporary accommodation sites).

"Workforce" on "Employment and Community Structure"

Objects of analysis:

- estimate additional costs of increased farm wages resulting from poaching of farm labour;
- evaluate social changes in farming communities.

Methods:

- allow for, say, 5% increase in wages on appropriate percentage of farms and recalculate net farm incomes accordingly.
(Radius = uncertain, but equate with prospect area until firmer evidence available).
- construct social profiles of farming communities and monitor change.
(Radius = villages identified by housing allocation model).

"Pollution" on "Employment and Community Structure"

Objects of analysis:

- evaluate reduction in farmers' quality of life attributable to mining.

Methods:

- estimate likely reductions in property values arising from visual and aural pollution.
(Radius = c. 2km of mine sites).
- conduct interviews to ascertain perceived reductions in quality of life.
(Radius = sub-region).

APPENDIX D

SUMMARY OF BASELINE CONDITIONS AT ASFORDBY
MINE SITE, LEICESTERSHIRE

LAND USES

Farm Land

- D1 Land Surface: Initial application requires a total of 175.3ha (119ha grade 3a, 43.3ha grade 3b, 12ha non-agricultural). Revised application requires a total of 141ha (92.3ha grade 3a, 35.7ha grade 3b, 13ha non-agricultural). (Source: planning application to Leicestershire C.C. and Melton B.C.).
- D2 Restoration Potential: Heavy soils with a high clay content, derived from Lower Lias; may present some problems of handling and loss of structure. Median end of/return to field capacity = April 7/November 28. In most years have 30 working days with soil in generally satisfactorily dry condition for handling operations. (Source: MAFF, evidence at public inquiry).
- D3 Land Drainage: Likely thorough underdrainage design - wide spacing, permeable fill, moling or subsoiling on grade 3a; 20m spacing, permeable fill, moling or subsoiling on grade 3b. (Source: Worthington, evidence at public inquiry).
- D4 Cost of redraining per hectare assumed to be c. £1000. (Source: West of Scotland Agricultural College). Gross margin per hectare in areas likely to be affected by subsidence assumed to be c. £300. (Source: Boddington, evidence at public inquiry). (For the purposes of forecasts, it was taken that areas requiring remedial work will incur 50% of this cost, and areas requiring complete relaying of drains will incur 100%. Gross margins on land so affected will probably remain at about 50% of present value).
- D5 Infrastructure: EMGAS high pressure gas main crosses prospect area - route confidential. (Source: EMGAS).

Farm Livestock

- D6 Disturbance: Poultry kept by Welby House and Welby Lodge Farms may be affected. Those at Welby Lodge (which will lose substantial areas to tipping) may be most at risk).
(Source: site survey).
- D7 Loss: Losses of pigs and poultry likely at Welby Grange and Welby Lodge.
(Source: site survey).
- D8 Disease: Controlled by safeguards.
- D9 Slurry Spreading: Possible problems associated with pig enterprises at Welby House and Welby Lodge where much slurry is currently spread on the land.
(Source: Boddington, evidence at public inquiry).

Farm Crops

- D10 Irrigation: Minewater could be pumped to the Eye/Wreake system which is used for a variety of purposes, including irrigation. The mine site is drained by Asfordby Brook which flows directly to the Wreake. The Soar is well used for agricultural purposes and the Devon/Smite systems for spray irrigation.
(Source: Mann, 1981).
- D11 Pollution: Rivers in application area are all of 1B or 2 quality. Safe maximum Cl^- concentration for most crops grown in area is considered to be 350mg l^{-1} .
(Source, Severn-Trent Water Authority).
- D12 Damage: Schedule of Conditions would be required prior to commencement of site work.
- D13 Drought: Not applicable, although Wreake should not be discharged into/abstracted from during times of low flow.
(Source: Severn-Trent Water Authority).

HOUSING

Farm Buildings

D14 Overall Distribution: Approximately 3 500 conventional properties in the original prospect area, of which 1 080 are farms and smallholdings. Assume that for the Asfordby area (57 sq.km. out of the original 275 sq.km.) there are

$$1\ 080 \cdot \frac{57}{275} = 207 \text{ farms and smallholdings.}$$

(Source = NCB).

D15 Sensitive Structures: In the absence of a detailed survey, these were assumed to comprise 0.125% of all buildings (i.e. severe and very severe damage classes).

D16 On-Site Structures: Welby House will lose the use of all its farm buildings and three dwellings at an early date.

(Source: Boddington, evidence at public inquiry).

TRAFFIC

Farm Traffic

D17 Intra-Farm Traffic: New access road will worsen existing severance of Welby Grange and Hilltop Farms.

(Source: Dept. of Planning and Transportation, Leicestershire C.C.).

D18 Inconvenience: Some 10 farms along the access routes stand to be affected. According to evidence presented at the public inquiry, the average amount of farm severance in the affected area is 37ha/farm. (For the purpose of forecasting, a cost of £1.50 per return trip was assumed; the typical number of trips generated by the local type of farming is 11.25/ha/yr.).

(Sources: site survey; Boddington, 1979; Boddington et al., 1978).

LOCAL ECONOMY

Farm Economy

D19 Profit Margins: GM/ha in fields affected by tipping = £212-427.
GM/ha in fields affected by mine site = £333. GM/ha for Asfordby parish (affected by urban fringe effects and housing land) = c. £210.
(Sources: University of Nottingham, School of Agriculture, Farm Business Data; and, interpolated from public inquiry evidence and NCB tipping plans).

D20 Ancillary Enterprises: Farm feed enterprise at Welby Lodge Farm; turnover probably c. £160 000/yr.
(Interpolated from evidence presented at public inquiry).

D21 Income: Cereal and pig enterprises at the mine site would stand to gain little, but greater scope for dairy farmers in area to increase local and farmgate sales.

D22 Urban Fringe Effects: No firm evidence. (For the purposes of forecasting, assume to penetrate 2km into farmland adjacent to housing areas and to lead to a 5% reduction in gross margin).

Agricultural Industries

D23 Buildings: Not known in detail, but probably significant (includes Stilton cheese factory at Long Clawson).

D24 Processes: Food industries in Melton Mowbray dependent on abstraction of river water, but quality unlikely to be seriously affected.

EMPLOYMENT AND COMMUNITY STRUCTURE

Farmers and Farm Workers

D25 Tenure: One farmer-tenant on land affected by tipping (Welby Grange); owner-occupiers elsewhere.
(Source: schedule of tenures presented to public inquiry).

D26 Workforce: One farm has 275-600 SMD requirement (Welby Grange); two farms have over 600 SMD requirement (Welby House and Lodge). (Source: Worthington, evidence at public inquiry).

Approximately 300 farm workers in the Asfordby application area. (Source: Census of Population 1981).

(Assume, for the purposes of forecasting, average annual farm worker's wage of £6 000; further assume 10% require a 5% premium over constructional and operational periods).

D27 Quality of Life: Existing noise levels are 48.4-61.2 dB(A) during the day and 44.9-57.6 dB(A) at night.

(Source: Mann, 1981).

(For the purposes of forecasting assume two properties adversely affected; loss of value c. £1 000 each, based on updated data from: Open University, 1972).

D28 Communities: Considerable survey data required. Suitable subject for inclusion in parallel social impact assessment.

APPENDIX E

SUMMARY OF PROJECT SPECIFICATION FOR ASFORDBY
MINE SITE, LEICESTERSHIRE

WORKFORCE

Immigration

E1 Construction phase will employ 420 in first year rising to a maximum of 610 in the fourth, dropping off to only 20 at completion (phasing over first seven years assumed to be: 420, 450, 580, 610, 420, 200, 20). Initially, 50-70% of those employed on surface contract work will be recruited locally; this percentage will rise as work proceeds. Approximately 55% of the permanent workforce will be built up of transferees and 15% as re-entrants.

(Source: NCB planning application to Leicestershire C.C. and Melton B.C.).

Employment

E2 When fully operational, approximately 1100 industrial and 100 managerial and clerical staff will be required. This will be built up over eight years, with only 15 miners employed for the first three years, rising to 515 after five years. (Forecasts assume workforce to be resident during years 7-107).

(Source: as above).

E3 Employment multiplier in rural regions found to range from 1.2 (remote rural) to 1.4-2.0. Evidence also suggests 2.4 dependants per male immigrant. (Forecasts assume an employment multiplier of 1.5).

Local Expenditure

E4 Average weekly expenditure on food per family in East Midlands = £17.44.

(Source: Family Expenditure Survey, 1980).

Assume 5% spent on specifically local produce.

TRANSPORT

Severance

E5 Short access road proposed from Nottingham Road across Hilltop Farm. Most problems will result from increased traffic flows along

the revised application, Welby House farm loses a further 10ha to the mine, but losses to the margin are reduced.

(Source: as above, plus site survey).

E10 Ancillary housing is assumed to be required from year 7.

E11 A new connecting rail link turning southwards off the colliery will take a further 1.8ha.

(Not included in planning application. Source: Report of the Director of Planning and Transportation to Leicestershire C.C. Environment Committee, 4.11.82).

site Preparation

E12 Initial application: 163.3ha of agricultural land.

Revised application: 128.0ha of agricultural land.

(Source: NCB planning application to Leicestershire C.C. and Melton B.C.).

Solid Waste Disposal

E13 Initial application: Welby House Farm will lose 64.1ha and Welby Lodge Farm 50.1ha to the tip. 10 tipping phases over 50 years with a maximum of 24ha out of agricultural production at any one time.

Revised application: Welby House Farm will lose 40.2ha and Welby Lodge Farm 43.3ha to the tip. 10 tipping phases over 50 years with a maximum of 12ha out of agricultural production at any one time.

(Source: Timing and extent of tipping phases were taken from contoured diagrams accompanying NCB planning applications to Leicestershire C.C. and Melton B.C.).

Subsidence

E14 275 sq. km. to be undermined in original prospect area; some 57 sq. km. likely to be accessible from Asfordby pit. All reserves capable of being worked from Asfordby appear to be from the "lower suite"

defined by the northern limit of faulting of the Blackshale seam. (Source: Report of the Director of Planning and Transportation to Leicestershire C.C. Environment Committee 4.11.82).

Some 955ha in the original prospect area was considered likely to have its man-made underdrainage disturbed and, in the absence of precautionary measures, a further 2 250ha was at risk. With respect to Asfordby alone, these were assumed to reduce proportionately to approximately 300ha and 473ha respectively. (Source: Boddington, evidence at public inquiry).

E15 On the basis of evidence from adjacent coalfields it was assumed that the percentage of buildings falling into each damage class would be: very slight damage (55%), slight damage (31%), appreciable damage (12%), severe or very severe damage (2%).

(Source: NCB, undated c).

(For the purpose of forecasting, the damage costs associated with these classes were assumed to be £250 for very slight, £1 000 for slight, and £5 000 for more serious, damage).

Water Demand

E16 30M litres of water per year will be required from the public supply. A further 700M l of non-potable water will be abstracted direct from the Wreake or Trent.

(Source: Mann, 1981).

POLLUTION

Noise

E17 During construction phase, the daytime 12 hour L_{eq} should not exceed 65 dB(A) outside any property in the vicinity for any length of time. During operational phase, about three properties would be within the 60 dB(A) contour during work on the tip. The L_2 is likely to be 5 dB(A) above L_{eq} . Night-time noise levels might include 57-60 dB(A) for blasting and 40-42 dB(A) for tannoy announcements.

(Source: Mann, 1981).

Aqueous Discharges

E18 Pumped mine water likely to vary in Cl^- concentration from 1 000 - 30 000 mg l^{-1} . This would be pumped directly to the Trent, or the Wreake if flows were high.

Surface water runoff would comprise:

- administrative and welfare areas, 73M l (no special contaminants)
- operational areas, 36M l (fine coal and shale; salts in solution)
- spoil tips, 101M l (fine shale; salts in solution).

(Source: Mann, 1981; Severn-Trent Water Authority, evidence at Public Inquiry).

Particulates and Gases

E19 Small amounts of CO_2 , CO, CH_4 , SO_2 and NO_x produced by heating of surface buildings and bathing water.

(Source: NCB, evidence at public inquiry).

Coal processing plants are sources of considerable amounts of dust.

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