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OPENCAST COAL MINING IN SOUTH WALES

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ABSTRACT

This paper deals in general terms with opencast coal operations in the No.7 South West Region of the National Coal Board Opencast Executive in South Wales, including more detailed comments on environmental problems and the measures taken on site to mitigate nuisance and deal with minewater and pumped and surface water.

NATURE OF OPENCAST EXECUTIVE

The Executive in South Wales has 6 surface mine sites producing coal and 5 under restoration. Current production from opencast mining is running at about 2 million tonnes a year.

Opencast coal helps the NCB to maximize output, makes an important contribution to profits, and provides additional supplies of special coals. That is especially true of South West Region which produces half of all the anthracite used in the country and valuable tonnages of coking coals.

The South West Region is one of five such Regions in England and Wales operating under a Regional Opencast Director responsible to the Executive's Managing Director at Headquarters in Mansfield, Nottinghamshire. In this Region there is the Regional office and two separate Areas with their own area organizations. Operational branches of Survey, Development, Engineering, Marketing and Preparation, and Lands are represented at all levels of the Executive, and Planning and Administration branches at Region and Headquarters. The Executive is in the portfolio of the Deputy Chairman of the Board.

Apart from NCB staff engaged in overall supervision and direction of operations, all aerial survey, prospecting drilling, coal production, coal preparation, and restoration and rehabilitation work is carried out by contractors. Tenders for production sites are invited from a selected number of contractors up to about six or eight, depending on the size of the job and the workload of contractors at the time. Marketing of opencast coal is dealt with by the Board's Marketing Department acting for the

local deep mine area and opencast together.

When, as is most often the case, the land is to be restored to agricultural use, the site is maintained by the Executive for a 5-year period after coal mining and a separate contractor is engaged on a term contract to carry out rehabilitative agricultural works under the supervision of the Welsh Office Agriculture Department, at Board expense. Where areas of land are derelict it has been shown in the past that by means of opencast mining these areas can be reclaimed for agricultural use at no cost to the tax-payer. Over the years in South Wales over 930 hectares have been brought into beneficial after-use. In addition, nearly 284 hectares are being reclaimed on current working sites.

The Opencast Executive is a substantial employer in South Wales. Nearly 250 people are employed by the Executive directly. Just over 1,520 people are employed on opencast sites and disposal points by the civil engineering contractors who operate them. In addition, over 100 people are employed by the drilling and rehabilitation contractors, and the industry supports a number of local fuel and equipment suppliers, hauliers, service industries and local traders.

GEOLOGY

The Coal Measures in South Wales are more disturbed than elsewhere in England and Wales, in general terms. This fact makes prospecting drilling and investigation a rather more involved and time-consuming process than in other Regions of the Executive. Drilling is normally carried out using tractor-mounted Gryphon air-flush drills to determine geological structure and coal-seam thickness.

On the Ffos Las site in the western part of the coalfield some 6 kilometres west of Llanelli in the County of Dyfed, for example, drilling established a complex coal area comprising eleven coal seams in downward succession. These seams are assessed in the production contract in fifty-six separate coal panels, individually distinguished by the effects of two major thrust disturbances, the Llannon and the Trimsaran, which have a combined throw to the north in excess of 200 metres, and an east-west trend. The Big Seam suffers the greatest disturbance dipping between 1 in 7 and 1 in 2 before being uplifted by 130 metres in a series of thrusts and monoclinal folds by the Llannon disturbance(Fig.1). The overall complexity of structure, steep dips, and the presence of water in drift, strata and old workings were all recognized as major problems of mine operation at Ffos Las.

The extreme folding and fracturing of the strata called for special precautions to be taken to ensure excavation stability. Correct batters are maintained in the drift cover where it is thick, or predominantly sand and gravel, and below rockhead in close proximity to faults, steep rolls, and wherever thick, friable coals are encountered. Safe batters and proper height control in the soil and overburden mounds on the surface tipping areas are specified on the basis of a careful investigation of ground conditions and a detailed geotechnical assessment of dumping proposals. A joint Code of Practice agreed between the Executive, The Civil Engineering Contractors' Federation, and The Health and Safety Executive is applied on site to ensure proper design, construction and management of soil and overburden mounds. The Health and Safety Executive is the government agency statutorily responsible for the inspection and control of working operations.

PLANNING AND THE PRODUCTION CONTRACT

During the prospecting phase, the drilling results are continuously evaluated as the geological plans and sections are prepared. Computer

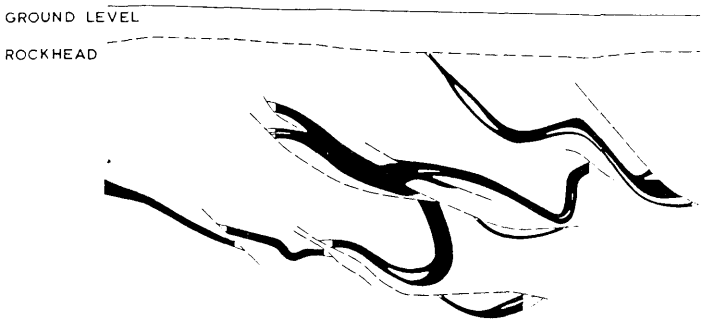

Fig.1 - Section of Big Seam through Llannon Disturbance

systems have been developed within the Executive, in association with the Board's ancillary computer company Compower, to assist in this process. A Schedule of Estimated Quantities is prepared setting out the estimated total tonnage of recoverable coal at a provisional ratio of overburden to coal by volume, measured vertically above the seams. Alternative methods of working the site are evaluated and provisional estimates of cost prepared. Methods of working are also assessed in terms of the possible environmental effects outside the site. Obviously, the site can only be allowed to proceed on the basis that it is likely to be an economic and profitable venture, but with consideration having been given to environmental impact at the same time.

From the 1st March, 1984, the Executive have been obliged to submit a detailed planning application for a proposed new opencast site for determination by the mineral planning authority (the County Council) under the Town and Country Planning Act 1971, in addition to making an application for authorisation for determination by the Secretary of State for Wales under the Opencast Coal Act 1958. It is the intention of government to remove the latter requirement and provisions to make the Executive subject solely to town and country planning law as far as planning permission is concerned are in a Bill currently before Parliament.

Preliminary consultations with the planning authority and district councils cover the Executive's proposals for working and restoring the site, working hours, times of blasting, control of pollution, noise and dust, preservation of topsoil, subsoil and soil-making materials, the location and shape of baffle embankments and overburden mounds, and the routing of coal traffic between the site and the disposal point or railhead, among other things. Once the first draft of the planning application has been prepared, a presentation may be made to members of the county, district and community councils in order to elicit their reactions to the proposals. Often, an exhibition is held where members of the public can view the application and drawings on display. They can discuss points of detail with Executive officers present and put forward

their own view of the proposals. The exhibition is advertised locally and a leaflet is distributed to individual homes containing a summary of the draft proposals and giving the venue and the times when the exhibition can be seen.

As far as possible, all those views made known locally are taken into account in completing the final planning application which is formally submitted to the planning authority after the publication of statutory notices in the local press. If the application is refused, or is not determined within the agreed time scale, following an appeal by the Board the Minister will require a local public inquiry to be held. Similarly, if a district council or a person with an interest in the land within the site objects to the application for authorisation and the objection is not withdrawn, notwithstanding that planning permission may have been granted by the planning authority, the Minister is obliged to hold a public inquiry.

The Board acquires the right to work the land it requires either by outright purchase, or by leasing. Negotiations are undertaken for the Board by the District Valuer as an independent valuation authority. Consultations are entered into with the National Farmers' Union and The Farmers' Union of Wales. In addition, the Countryside Commission are asked to comment on the possible effects on the landscape and the area. Advice is sought from the Nature Conservancy Council, in particular their comments are requested on the provision of suitable areas for conservation, areas of wetland, ponds and woodland. The Forestry Commission are consulted both as landowners and as advisers on proposed restoration to forestry, especially in upland areas. They also act for the Board in an agency capacity, carrying out the establishment and maintenance of plantations at the rehabilitation stage, either on their own land which has been leased by the Board, or on Board-owned land scheduled for forestry restoration.

The Welsh Office Agriculture Department(WOAD) and the Executive have very strong links and an on-going liaison is maintained on all aspects of site works. Regular meetings are held for consultation. WOAD are appraised of the Board's prospecting operations and have an opportunity of assessing the quality of proposed sites at an early stage. They act in two capacities: firstly, as advisers on agricultural matters in general and, secondly, on an agency basis in supervising all agricultural rehabilitation works on behalf of the Board.

In advance of a planning application, WOAD undertake a soil survey and an investigation into the agricultural capacity of the land. They advise on detailed plans for rehabilitation and the proper provision of shelter-belt planting, hedges, ponds and other features, with especial regard for nature conservation. In their capacity as agents, on completion of coaling operations they manage the sites for a five-year period to ensure their proper restoration. They are also responsible for advising the mineral planning authority on the Board's proposals and the suitability of the land for opencast coal operations, and for commenting on the nature of suitable planning conditions to govern restoration of the land after working.

The planning permission granted includes a large number of conditions aimed at controlling many aspects of working operations in accordance with agreements and undertakings arrived at during consultations with the planning authority. All these conditions are written into the production

contract documents in one form or another and when the contract is ready it is issued to a selected list of civil engineering contractors experienced in opencast mining and with the standing to match the scale of the works on offer. At tender stage, the contract offer is for the recovery of a contractual tonnage of clean coal at a contractual ratio and monthly rate of output, and transport of the coal to a designated disposal point for preparation. Coal won is paid for in accordance with a standard schedule of rates including the following main headings:

1 Preliminary items - lump sums for fencing, drainage works, offices,etc.
2 Coal at face - rate per tonne delivered at the required Executive disposal point
3 Haulage to disposal point - rate per tonne delivered
4 Contractual restoration after completion of mining, in preparation for a separate land rehabilitation contract - lump sum.

All these items, except for preliminary lump sums, are adjusted by means of a standard formula to account for movements in the cost of labour and materials over the life of the contract, but only 90 per cent of the value of contract items is adjusted in this way. Payment is made up to date on a monthly certificate. The contract requires restoration of the site on completion of coaling to achieve a landform in accordance with a contractual restoration plan, in preparation for the rehabilitation contractor and WOAD to take over.

Preliminary items required in the early stages include the access point, fencing, erection of offices and plant yard, baffle embankments, site weighbridge, a lorry washbay, and the closure of public footpaths and rights of way. Some of these items are covered in the contract by the payment of lump sums on completion. All other works under the contract are paid for in the coal at face rate for coal produced until completion of coaling and out of the restoration lump sum afterwards, haulage being paid for per tonne delivered. Major civil engineering works are sometimes called for, mainly road or river diversions.

Operational problems confronting the contractor are many and varied. Coal seams vary in thickness from 0.2 metres to 6.0 metres with variable dips, sometimes up to the vertical, and thrusting and folding causing rapid changes in seam interval. The strata between the seams consists mainly of mudstones and siltstones with lesser developments of sandstone and seatearths. Excavation of overburden is carried out mainly by shovels, although backhoes are also employed, either electric or diesel-driven, with dipper capacities from 1 cubic metre to 12 cubic metres. The overburden is hauled by dumptrucks varying in capacity from 35 tonnes to 100 tonnes. Excavation is also done by scrapers, mainly topsoils and subsoils with some drift material and upper measures, and occasionally by dragline when conditions permit. The site is developed to depth in a series of reduction benches, the depth of the bench being governed by the location of the seams and the capacity of the machines. Haul roads and ramps are formed to remove overburden and coal. The coal is excavated by small, diesel-operated excavators direct into coal lorries at the coal face to be transported straight to the disposal point.

Initial excavation is of topsoils and subsoils which are taken off separately by scraper and formed into mounds around the perimeter of the site. The topsoil mounds are used as baffle embankments to screen the works and reduce noise impact outside the site. Overburden from the initial phase of excavation is formed into a dump above ground in the main tipping area. Outward-facing slopes of the overburden dump are dressed

down with drift materials and seeded to grass to improve visual appearance. Subsequent phases of excavation are handled internally with the overburden being tipped within the preceding cuts after decoaling. After completion of coaling, the final void is backfilled from the overburden dump and graded out, and the original subsoils and topsoils are replaced to final restoration landform levels.

ENVIRONMENTAL CONTROLS

One of the most important aspects of working an opencast site is the necessity for effective environmental control measures in order to reduce the impact of the workings on the local community. A substantial number of the contract specification clauses are aimed at controlling various operations in ways which mitigate their effect outside the site and the Executive is engaged in a constant research programme in an effort to improve the methods and techniques which are employed. A constant liaison is maintained with local authority planning officers and environmental health officers to identify areas of concern and to engage in joint monitoring exercises where that may be required. In terms of particular operations which must always be controlled as carefully as possible, the Executive are very conscious of the following matters which are concentrated upon by local authorities:-

Dust: The main source of site dust arises from the dirt haulage roads and ramps within the excavation area. Water bowsers are provided to keep roads damp at all times during dry weather(Fig.2). Main site roads outside the excavation area are constructed in tarmacadam, sometimes concrete. Plant and vehicles are required to have engine exhausts that point upwards and blast-hole drills are fitted with dust-collection equipment.

Noise: The control of noise is one of the most important aspects of site working and it has become a more sensitive and emotive issue in the past few years. All plant and vehicles are required to be adequately silenced before they are allowed to operate on site and the silencing is subject to regular checks. The construction of baffle embankments using the topsoil stripped in the early stages of site development serves to reduce overall noise levels at residential properties outside the site boundary. They are built up to a height of 5 metres. Where scrapers, or other plant, may be working for a relatively short time on the construction or removal of baffle embankments immediately adjacent to the boundary, working hours may be restricted to minimize the effect of the higher noise levels.

Visual amenity: Care is taken to preserve visual amenity as far as is possible. The main overburden mounds and soil mounds are shaped and graded and subsequently seeded to grass to make them as unobtrusive as possible, and the height of the overburden mound is restricted. Vegetation and tree cover in advance of the immediate working area is left undisturbed for as long as possible and as far as is practicable restoration of the site is progressive so that the land can be reinstated and grass re-established quickly. Office areas and the plant yard are set well within the site so as to be unobtrusive and particular attention is paid to the construction and appearance of site access points.

Water discharge: Surface drainage must be led into water-treatment and anti-pollution facilities and this work must be completed in the early stages of the job. Oil traps are provided wherever oil is stored or vehicles are maintained and serviced. All water discharges from site are subject to consent conditions stipulated by the Welsh Water Authority

under the Control of Pollution Act 1974.

Transport: To ensure that no mud or other substance is deposited on the public highway, the lorry washbay is required to be installed and

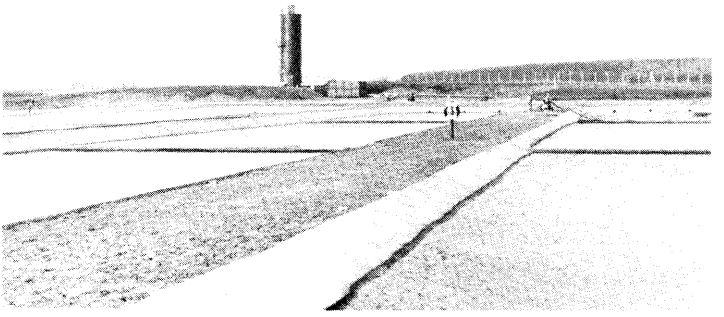

Fig.2 - Water bowser spraying site road

operational before any coal leaves site. Loading of coal lorries is carefully controlled to preclude any chance of coal spillage.

Blasting: Below about 30 metres depth, in general, the overburden must be blasted. Blasting has always been a difficult and emotive operation and the greatest care is taken to ensure proper control, although a constant effort is mounted to improve the understanding of blasting wave patterns and to better blasting techniques. This subject is one in which continual research is being undertaken.

Blasting charges are specified in a contractual blasting schedule based on the information provided by a test blast and vibration investigation carried out by an independent consultant(Fig.3). Blasting schedules are drawn up to ensure that maximum values of peak particle velocity do not exceed 12 millimetres per second, although working values are normally far below this maximum limit. The times when shots can be fired are restricted and the contractor is required to warn local residents that a shot is to be fired and to keep a detailed record of every blast, including co-ordinates on site, depth, distance from nearest property, number of holes, charges and materials used.

Complaints: If a complaint arises, it is recorded on the complaints file and the Board's site engineer is required to enquire into it immediately if possible, if not at the earliest opportunity, and record what action is taken and report. Local people are urged to make a complaint without delay if there is genuine cause for concern, and they can contact the site engineer who is resident on the site, or the Board's area manager, at any time.

Site Liaison Committees: The liaison committees have played an important part in the Executive's on-going liaison with local communities in relation to working operations, since their inception in 1973. Each

Fig.3 - Monitoring of site blasting

committee consists of local residents, representatives of the county, district and community councils, the contractor's agent or his representative, and the Executive's area manager or his representative. It meets on a regular basis and a formal record is kept of the proceedings. The chairman is usually a local resident, or a councillor. The committee forms an excellent link between the community, the Executive and the contractor, and is certainly a useful channel of communication to inform the residents about the progress of the works and the Executive about particular problems or concerns which are matters of discussion locally.

Technical Working Party: Working parties are a recent innovation in South Wales. They consist of representatives of the county and district councils' planning and environmental health departments, and the Executive. Meetings take place on a regular basis with a formal record being taken of the proceedings which is confidential to those participating, although arising out of the discussions the local authority officers compile progress reports for their respective councils on a six-monthly basis. Matters are dealt with on a technical level and include all the more sensitive environmental issues, blasting, noise, dust and water-pollution control.

CONTROL OF MINEWATER AND SURFACE WATER

The control of water, whether it be surface water drainage across the site, or rainfall, or draw-down water into the excavations, or minewater contained in old mine workings at depth, is always given very careful attention, both in terms of containing and channeling the water discharge and in terms of ensuring no pollution of streams outside the site.

On the Ffos Las site, for example, the main watercourse crossing the site will require to be diverted in the middle and later stages of site working. The diversion watercourse has already been constructed in preparation. Diversion works consisted of the excavation for and construction of 3.6 kilometres of trapezoidal open channel of bed width 4.9 metres to take the river around the northern perimeter of the excavation area. The bed is armoured with loose stone, or stone set in concrete, according to the gradient. Of the total length, 1.1 kilometres is in previous opencast backfill over part of the site(Fig.4), some 0.5 kilometre in rock, and the remaining 2.0 kilometres in natural ground.

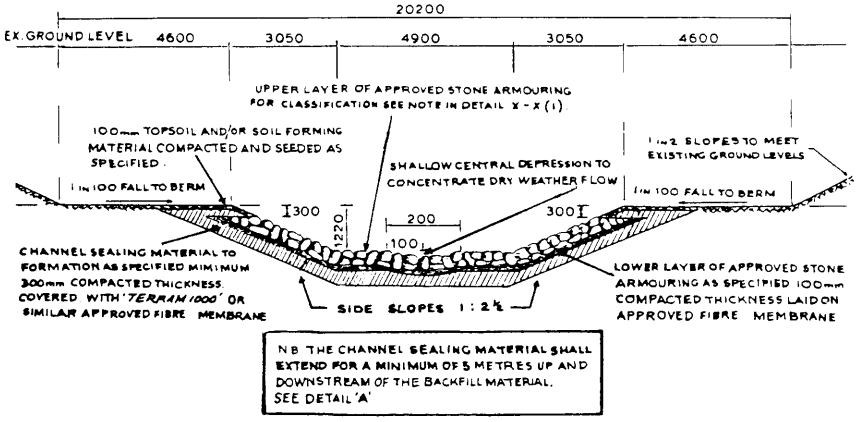

Fig.4 - Diversion of Afon Morlais around excavation

Along the length of the diversion there are four bridges in reinforced concrete to facilitate access between different parts of the site. Also included is a flat vee-weir at the diversion channel intake for flow gauging, a twin-Armco pipe-arch culvert beneath the road bordering the site, and a reinforced concrete outfall structure at the discharge point of the diversion where it re-enters the existing river downstream.

Treatment of minewater

Most of the prospecting boreholes had recorded water at various depths and a major problem was anticipated in that deep-mining abandonment plans showed that old workings in the northern and southern portions of the site would be filled with water in hydraulic continuity with old workings in several seams linked by cross-measure drivages. The water levels in the northern workings indicated a maximum potential head of water of 108 metres and the southern workings a head of 34 metres above the base of the excavation. It was clear that these bodies of water would be encountered during excavation and that advance precautions were necessary to deal with them. Sampling showed that the water had a ferruginous content which was likely to be very variable, sometimes minimal, but often rising to high levels. The contractor was therefore required to de-water in advance of excavation and to treat the pumped minewater as may be

necessary to meet the requirements of effluent discharge control. Advance de-watering was carried out by sinking a borehole into a main gallery at depth, installing and operating a submersible pump and piping the pumped discharge direct to a water-treatment plant sited in a separate water-treatment compound some distance from the main workings(Fig.5).

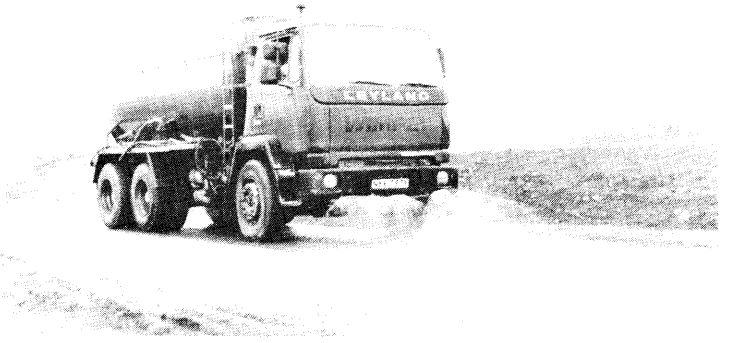

Fig.5 - Minewater treatment plant

Siting the borehole proved to be a delicate operation but the drilling was finally completed successfully. The borehole was drilled to a depth of 160 metres reducing in diameter from 810 millimetres at the collar to 480 millimetres at the base. An eight-stage 150-millimetre-diameter Pleuger pump rated at 9.8 million litres per day at a head of 170 metres was installed and became operational in February 1984. During the previous winter, work had continued on the construction of the water-treatment facilities and they were completed in time to be ready for use when pumping started. The plant comprised a lime-addition and mixing facility to control levels of acidity in the minewater, an aeration tank to complete adequate mixing of the minewater and lime, four lines of three settling bays, and two final de-watering sludge ponds. These last two ponds are used to dry out the sludge and are used alternately, one being in commission while dried-out sludge in the other is being excavated for disposal at depth in the excavations.

The plant was designed to handle pumped water flows of up to 13 million litres per day in the initial stages of dewatering, dropping to lower recharge flows as the excavation progresses. Final effluent standards set by the water authority were a maximum of 5 mg/l for iron, pH values between 6.0 and 9.0, a stringent limit of 1 mg/l in combination for heavy metals (Copper,Nickel,Zinc and Cadmium), and suspended solids 100 mg/l.

Treatment of surface and pumped water

In addition to the specialized treatment of minewater, the normal requirement of a treatment facility for pumped water out of the

excavations and surface run-off from disturbed areas of the site called for a separate treatment area within the water-treatment compound. This facility also was completed and commissioned before major disturbance of the excavation area took place. It consists of a 14-million litre attenuation basin linked to four upward-flow settling lagoons by associated pipework, valves, penstocks and channels.

The attenuation basin served to settle solids out during the initial stages of the excavation. As it filled with sludge, however, the settling lagoons received water and sludge from the low end of the basin and thereby maintained the sludge at a low level in the basin itself. During periods of dry weather, the attenuation basin can be drained down by means of the settling lagoons and the thickened sludge on the floor of the basin excavated for disposal within the excavations. This operation occurs perhaps once or twice a year.

Water and sludge flows from the attenuation basin to the settling lagoons under gravity. The outlet from the attenuation basin is 600 millimetres above its floor and 1000 millimetres below its surface. Water flow is controlled by a sluice valve which can be adjusted to maintain the overall operation at optimum efficiency. Each lagoon is controlled independently by means of a penstock valve and when it becomes necessary to pump out sludge from a lagoon it can be isolated in its turn and pumped individually without disrupting the continued operation of water treatment. Sludge is pumped out into a tanker by means of a mobile diesel-powered sludge pump and transported into the site for spreading with the backfill material.

CONTRACTUAL RESTORATION

There is a sense in which restoration and rehabilitation really commences with the operation of soil stripping in the early stages of the production contract. Opencast sites in South Wales are invariably located in areas of poorer land quality where soils are thin, or sometimes non-existent. It is therefore tremendously important that topsoils and subsoils should be preserved properly for use in restoring the site and that, wherever possible, suitable drift materials should be recovered, whenever they are encountered as the site proceeds to depth, in sufficient quantity to make up for any deficiency in soils, topsoil especially, at the end of the contract. This is a main preoccupation of WOAD as the Executive's agents and advisers and their officers are on site during soil stripping to ensure proper recovery and storage of soils for eventual restoration. All available topsoil is recovered in whatever quantity it is present and up to 0.9 metre of subsoil. Great care is taken to store these soils in mounds separate from each other, and the overburden, and soil-making materials.

Land restoration is planned from the start in general terms and details are added by agreement with the various parties involved as the works progress. The main overriding requirement is that the restored site should conform to the surrounding landform and should be self-draining. The restoration contour plan details the final landform to be achieved, although final levels are dependent upon the bulkage of the overburden as it is returned to the void. Careful monitoring of bulkage continues during the life of the site and marginal adjustments in final contour levels may prove to be necessary.

The production contractor backfills the final void to the required level

and the surface of the overburden is then rooted in order to remove compaction. The larger boulders dragged up are removed. The rooting implement is a heavy winged tine designed to cause maximum heave in the overburden surface. Subsoil is then replaced in layers not exceeding 450 millimetres in depth to a total depth of 900 millimetres. Each layer is rooted by a winged tine or chisel cultivator according to soil type and disced. The larger stones are removed. Finally, topsoil is replaced to the required contour level in a single pass so as to minimize compaction. It is then disced to produce a tilth and any stones remaining are removed. The operations of subsoiling and topsoiling should follow each other in an uninterrupted sequence of working and, ideally, they should be carried out when the ground is dry, but if bad weather prevents progress then the surface is sealed with a levelling sledge to stop the ingress of water and to avoid too long a delay in being able to get back on to the land to recommence operations. Proper organization to enable this sequence of restoration operations to proceed most effectively is essential in South Wales, where the weather is often bad for long periods of time, where rainfall is heavy on the upland sites and the "weather window" available for soil stripping and/or replacement may be only a matter of weeks in a bad year.

In recent years, the Executive have expended considerable time and effort in designing and developing special equipment and implements to carry out restoration tasks. Previously, most of the implements in use had been designed for civil engineering purposes rather than for agricultural type operations and their effectiveness fell short of what is required to meet the higher standards of restoration expected of the Executive these days. The range of implements now in use are, in effect, modified and upgraded agricultural tools halfway, as it were, between civil engineering and normal agricultural equipment and built to cope with the heavier duties involved in opencast restoration work. They have been designed with a view to being drawn by a Caterpillar D8, or similar, tractor because this is the most common size of tractor to be found on opencast sites.

After soiling is complete, the site is handed over to WOAD and the agricultural contractor and the land is rehabilitated for five years during which time grass is sown, trees and hedges are re-established, surface drainage and under-drainage systems are installed, and generally the land is brought back into good heart and reinstated to the best possible condition, in accordance with plans and agreements arrived at with WOAD and all the other bodies involved in opencast operations and restorations.

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