17 CASE STUDIES

Chapter contents

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17 CASE STUDIES

The process of reclamation within the coal and steel producing regions of Europe is ongoing. The earliest schemes have now stood the test of time, and the lessons learned are gradually being disseminated. The following collection of case studies within the European Community aims to illustrate practical experiences of reclamation in the coal and steel regions, and approaches to some of the challenges these former industrial sites impose on the communities and reclamation teams concerned.

The case studies have been selected to illustrate the variety of scenarios that exist, and examples have been chosen from the UK, France, Belgium, Italy, Germany and Spain.

17.1 Scotland

17.1.1 Introduction

The central belt of Scotland, stretching from the coast west of Glasgow to Edinburgh in the east, has a long industrial history, the mainstay of which was the coal and steel industries. There was one deep coal mine still operating in Scotland in 1993 and the remaining steel production, at Ravenscraig near Glasgow, was being shut down.

A great deal of reclamation has been carried out to remove the scars left by former industry with the aim of bringing economic rejuvenation to the region. Public funding for reclamation was administered by the Scottish Development Agency (SDA), whose Land Engineering Division was set up in 1975 with the aim of reclaiming key areas of derelict land for new uses. In 1991 the SDA merged with the Training Agency to form Scottish Enterprise, which operates through 13 Local Enterprise companies which are associated with local government areas. The aim of each enterprise company is to develop the economy, enhance skills and improve the environment in Scotland.

17.1.2 Easton Bing

Background

Easton Bing (spoil heap) formerly dominated the town of Bathgate, situated almost halfway between Edinburgh and Glasgow in West Lothian District. Bathgate experienced a serious decline in employment in the early 1980s due to a decline in local industries. It suffered from dereliction caused by extractive industries such as coal, oil shale and fire clay which had prospered in the nineteenth century but have since ceased operating. The town is in a prime location in relation to transport infrastructure and urban centres, but development was hindered by the poor quality of the general environment and the physical constraints associated with former industrial sites.

Environmental quality

Easton Bing, the site of the former Easton colliery, covers an area of 30ha. In the early 1980s it consisted of heaps of unvegetated colliery spoil and lagoons containing fine coal waste and water. A series of fires within the spoil caused air pollution.

Site restoration

Restoration of Easton Bing was considered in conjunction with that of another site 2km away, near Bathgate town centre. This second site, Little Boghead, consisted of 44ha of low-lying, boggy ground which, despite its poor ground conditions, was the only area within Bathgate designated by the local plan for private housing. An economic assessment of various reclamation options for these two sites was carried out by a firm of chartered accountants. This assessment took into account the costs of various alternatives and the likely financial return from the sale of developable land. All schemes were found to have a net cost, but this was substantially reduced for the option which used material from Easton Bing to create developable land at Little Boghead, compared with

options which reclaimed the two sites independently of one another. The Easton Bing scheme was approved by the Board of the Scottish Development Agency, who provided funding in 1984. The Land Engineering Division of the SDA acted as the client/employer for the scheme and design and supervision was carried out by the Landscape Development Unit of Lothian Regional Council.

To ensure that the reclaimed land at Little Boghead would be acceptable to housing developers the National House Builders Council were consulted prior to design of the scheme. They had several stringent requirements intended to ensure that materials, such as burnt colliery spoil with a high sulphate content, were not adjacent to the concrete of house foundations and that a house fire could not cause combustion of the underlying spoil. The requirements included independent supervision of earthworks operations and provision of a 600mm deep layer of inert, structurally adequate material above the spoil. Fortunately, a source of suitable clay material was found nearby.

The fires at Easton Bing resulted in the bing being composed of a mixture of burnt, unburnt and partially-burnt colliery spoil. British Coal advised that the partially-burnt spoil was likely to be unstable, liable to swelling and therefore only burnt or unburnt spoil would be used in the fill at Little Boghead. These two kinds of materials were distinguished by their appearance, well-burnt spoil being a bright red colour and unburnt spoil, black. Selection of materials at Easton Bing required constant site supervision. The coal content of unburnt spoil was measured; the risk of spontaneous combustion was considered to be low when coal content was less than 10%, and only spoil which satisfied this condition was placed in areas of the site designated for housing.

At Little Boghead, construction of trial embankments had shown that existing material on the site, consisting of top soil, peat and sandy clay, had to be removed to avoid unacceptable settlement. After their removal to stockpiles, infilling with materials from Easton Bing was carried out. Materials were placed in layers 200mm thick. A minimum of 400mm of

burnt spoil and 600mm of clay was placed over unburnt spoil in order that new concrete foundations did not come into contact with the sulphate-rich burnt spoil. The structural fill was protected by 600mm of the stockpiled material, and high standards of compaction were required for the structural fill (see Box 17.1). The latter was ensured by an extensive supervision and testing programme which required six full-time staff.

After completion of infilling at Little Boghead a surface combustion test was carried out in which a fire, the size of a typical house fire, was lit on top of the structural fill. Thermocouples inserted into the infill layers below showed a negligible rise in temperature, confirming that heat would not penetrate through the fill.

At Easton Bing far more spoil with a coal content of greater than 10% was encountered than had originally been estimated. Dealing with this spoil greatly increased the cost of the contract. Some of these problems could have been foreseen if the original borehole investigation of the bing had been more extensive. A more thorough investigation may also have given a more accurate estimate of the coal content of the spoil, which was found during the work to be far greater than had been estimated. As a result, a coal recovery scheme was carried out after the removal of material to Little Boghead. This scheme was successful in reclaiming

Box 17.1: Compaction requirements for colliery spoil at Easton Bing

The requirements for compaction of colliery spoil are:

- air voids ratio should be less than 10%;
- compaction for unburnt spoil 90%;
- compaction for burnt spoil 95%;
- coal content should be less than 10%;
- moisture Condition Value should be greater than 8.5 %;
- settlement: by Plate Bearing test at:
  100 kN/m^2 8 mm max after 15 minutes
  200 Kn/m^2 16 mm max after 15 minutes.

coal but unsuccessful financially because of the royalties charged by British Coal.

On completion of the coal recovery scheme the bing was regraded and treated with processed sewage sludge cake, followed by direct sowing and planting to form grazing land and woodland. The site now resembles a natural hill. The spoil is, however, generating some acid mine drainage water, which can be seen in a stream on the north side of the bing. Despite the compaction achieved at Little Boghead, some acid mine water has appeared in the culvert crossing the site.

The general air of dereliction at Bathgate has largely disappeared since the reclamation of Easton Bing and similar sites. The reopening of the local railway line to Edinburgh has also made the area a more attractive place to live. Part of the justification for reopening the line was the anticipated increase in population arising from new house building at Little Boghead. As a result of these improvements, prices for development land in Bathgate have risen substantially since the economic appraisal of the reclamation scheme. The revenue that had been anticipated from sale of the whole site has now been received from sale of just one fifth of the area to a private housing developer.

17.1.3 Hallside

Background

The Hallside steelworks, occupying an area of 32ha, was situated on the outskirts of Glasgow on the border between town and country. The works closed in 1978, buildings and structures were demolished and the site was acquired by the Scottish Development Agency (now Scottish Enterprise). An aerial view of the site is shown in Photograph 17.1.

The Hallside site is adjacent to the Strathclyde greenbelt. Several after-uses were considered, of which residential development is no longer seen as either viable or practicable.

The site will be leased or owned by the Strathclyde Greenbelt Company, a charitable company set up in 1991 to sustain and enhance the landscape and ecological value of the Strathclyde greenbelt. The company was set up jointly by Strathclyde Regional Council, Scottish National Heritage and Scottish Enterprise National, and aims to be a partnership between people who live and work in the greenbelt, public authorities with responsibilities for land in the greenbelt and voluntary organisations. Over one tenth of the area covered by the Strathclyde greenbelt consists of derelict, despoiled and unmanaged land. One of the objectives of Strathclyde Greenbelt Company is to restore such land in order to improve environmental quality.

Environmental quality

In 1993 the Hallside site had a derelict appearance, with extensive concrete foundations and remains of slag deposits clearly evident on the

Photograph 17.1: Aerial view of the Hallside site (source: Strathclyde Greenbelt Company)

surface. Much of the slag that was present was removed for use in road construction.

Analysis of water draining from the site indicated little leaching of contaminants.

The area surrounding the site appeared generally degraded in terms of environmental quality. Underdeveloped areas forming a rural fringe were frequently unmanaged and the urban environment was subject to vandalism and decay.

Site restoration

The original proposals for Hallside, drawn up upon purchase of the site by the SDA, involved development for housing or industry. Investigations revealed these proposals not to be financially feasible. In 1990, within the context of the Strathclyde Structure Plan, negotiations took place between the authorities and a developer during which it was agreed to allow residential development on adjacent land in return for the restoration of Hallside to agriculture, recreation or forestry. However, these proposals floundered when it became apparent that conventional restoration of Hallside for such uses would involve importation of massive quantities of good quality subsoil and topsoil at prohibitive cost. The Strathclyde Greenbelt Company designed a scheme along similar lines, where the housing developer will cover the site to a depth of 1-2m with colliery waste from two nearby colliery spoil heaps, freeing the land beneath the heaps for housing development. The greater part of Hallside will then be used for short rotation forestry to provide wood for energy production, with the remainder planted and managed as community woodland.

The short rotation forestry will consist of fast-growing tree species such as willow and poplar. These will be harvested by coppicing every four years. A staggered planting programme will ensure that some harvesting

is carried out every year. A processing plant for the harvested wood was included in the plans for the site.

The community woodland will consist of mixed broad-leaved amenity trees which will provide a screen between the energy forestry and residential areas. Pedestrian and cycle routes through the site will be provided within the areas of community woodland.

An important aspect of the proposals was the use of sewage sludge to improve soil conditions for tree growth. Sewage sludge from Strathclyde Region is currently discharged into the sea west of Glasgow. This disposal route will no longer be available after 1998, when all sea dumping of sludge is to cease within the European Community. Strathclyde Greenbelt Company have produced a strategy to use some of this sewage sludge to grow short rotation energy forestry on derelict sites in the greenbelt. Hallside is seen as a testing ground for this strategy.

During spreading of colliery waste, 9,000t of dried digested sewage sludge cake will be incorporated into the surface layers. Liquid digested sewage sludge will then be applied to the short rotation coppice, as required. The community woodland will not receive liquid sewage sludge. Breakdown of sewage sludge components and build-up of a soil structure will, it is hoped, be encouraged by the introduction of earthworm cultures.

Current leaching of pollutants from the site is considered to be negligible and the colliery waste to be imported contains low levels of hazardous metals and is not acid-generating. The trees will also take metals out of the soil and accumulate them in the roots. However, as a precautionary measure all drainage from the site will pass through a wetland treatment area before discharge to a local stream.

17.2 England

17.2.1 Introduction

England is rich in coal and iron deposits, and has a long history of associated industries. The largest coal field extends from the East Midlands to the North-East coast. The coal and steel industries have been in decline for several decades, and the economic life of several cities and towns has depended upon development of the vast areas of derelict land formerly occupied by these industries. Reclamation has therefore played on important role in environmental and economic regeneration.

17.2.2 Orgreave

Background

This site lies to the south-east of Sheffield, South Yorkshire, one of the heartlands of the coal and steel industry in England. A variety of activities related to the coal and steel industry have taken place at the site. All these activities have now ceased and the area is derelict, except for some small chemicals works which formerly utilised by-products from the coke works, but now use other sources of raw materials. British Coal plan to reclaim the area by extraction of coal from near-surface seams beneath the site by opencast mining, with restoration to enable industrial regeneration of the site. An area to the west, known as Waverley East, was formerly used for the disposal of wastes from the steel industry (slags and flue dusts). Opencast coal removal from this area is nearing completion. Restoration is planned to enable industrial regeneration on the site.

The principal areas of the Orgreave site are as follows:

- **Orgreave colliery:** this mine was sunk in the late nineteenth century and continued production until 1982. However, the coal processing plant of Orgreave colliery continued to treat

run-of-mine from the nearby Treeton colliery until the latter ceased production in 1991.

- **Orgreave tip:** a large colliery spoil heap, covering 36ha, up to 43m deep and containing 12 million cubic metres of material. The tip received the discard from the coal processing plant. A large tailings lagoon is located near the summit of the tip.

- **Orgreave coking works:** located to the north-west of the colliery from which it received coal. The coking works was owned by a steel company, which had purchased Orgreave and Treeton collieries in the early twentieth century, when the coking works were under construction. The coking works produced coke for steel production and the gas was also piped to nearby steelworks. A wide variety of by-products, such as benzene, toluene, xylene, naphtha, ammonium sulphate and resins were produced from the crude tar and ammonia liquor. Production ceased in 1990. Photograph 17.2 shows a view of the coking works.

The area also includes a former domestic landfill site and Woodhouse Mill tip, a 17ha area to the east of Orgreave tip, adjacent to a lake. Woodhouse Mill tip was the site of a slag reduction works and also received a variety of waste from the chemical and metallurgical industries.

Environmental quality

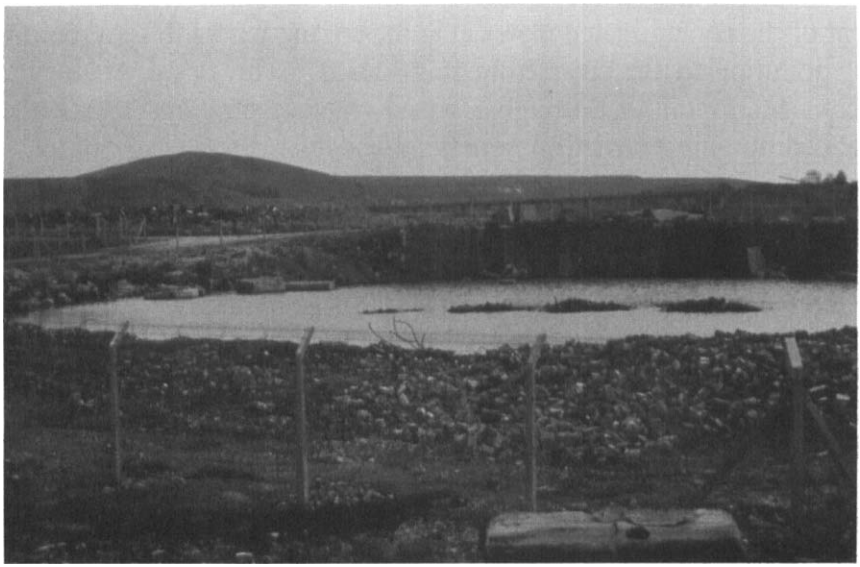
Colliery spoils in the Sheffield area contain high concentrations of sulphate and other salts. Deposits of salts can be seen on the surface of the spoil and plant growth will not occur until most of the salts have been removed for example by leaching. Acid mine drainage is not a major problem. Ammoniacal liquor from the coke works was at one time

disposed of on the tip, where it drained through the spoil into the adjacent river.

Orgreave tip is predominantly unvegetated, but liming and seeding with grass and clovers has achieved an effective cover on one side of the tip and a clump of birch has become established naturally at the north end.

The coal preparation plant was demolished to ground level, and the coal preparation plant area is contaminated by sulphates.

The coke works was demolished soon after closure. Care was taken to preserve records of the location of processes and to obtain information from former workers at the site. Underground pipes which carried organic liquids were then purged during demolition to avoid future loss of their contents into the ground through leaks or through disruption of pipes during later excavation works on the site. A detailed site



Photograph 17.2: Flooded gas holder base at Orgreave coke works, with Orgreave tip in the background (source: Richards, Moorehead and Laing Ltd)

investigation was carried out under the supervision of experts in the field to determine ground contamination. The Draft British Standard for Development Code of Practice for the Identification of Contaminated Land and its Investigation (DD175: 1985)[43] was followed. The works were found to be built upon made ground, contaminated with a wide range of hydrocarbons, including polyaromatic hydrocarbons and phenols.

The Woodhouse Mill tip consists of various types of wastes, including slags and flue dusts from the steel industry. Elevated arsenic concentrations were found in groundwater though the arsenic did not appear to be migrating into nearby surface water. The wide range of materials have varying pH values, resulting in a sparse but diverse flora which includes some locally rare species. Unvegetated areas are important nesting sites for birds.

The River Rother, which flows past Orgreave tip is heavily polluted before it reaches the site. However, the National Rivers Authority plan to substantially improve the quality of the river and have advocated treatment of the contaminated material at the coking works to remove any input of pollution to the river from this source. The Local Authority, Rotherham Metropolitan Borough Council, have aspirations to see the area cleaned up and returned to beneficial use.

Site restoration

British Coal Opencast has plans to commence the Orgreave Reclamation Project by continuing the existing opencast operation at Waverley East in the westerly direction, by removing coal from beneath the chemical works, the former Orgreave coking works, coal preparation plant and Orgreave tip.

Several treatment technologies have been considered for use on the contaminated materials present in the former coking works. Biological treatments, which remove the hydrocarbon contamination, were found, using laboratory tests, to be unable to deal with the wide range of

compounds present, including complex hydrocarbons and heavy metals. Soil washing, followed by biological treatment of the waste water, was also investigated at laboratory scale. However, large volumes of contaminated water would have been produced, with little reduction in the contamination status of the soil material. These remediation technologies were therefore rejected in favour of disposal in an engineered landfill within the site boundary. The landfill is to be lined and located above the water table.

Other materials on the site will be mixed with the overburden and replaced after coal extraction. Very little natural soil exists on the site and the final surface cover will consist of the natural sands and gravels currently beneath the site, rather than soil.

Plans for the opencast working have included consideration of the after-use of the site. Architects have been employed to produce a masterplan for the site which envisages a business park in the north-west of the area, housing, and then open green space in the south, with shallow wetland areas for migrating birds adjacent to the existing lake.

A minimal reclamation treatment is planned for the Woodhouse Mill tip, to maintain and enhance the nature conservation interest of this area. This will involve prevention of fly-tipping, planting of native species in areas of poor vegetation cover and retaining bare areas for nesting birds.

Reclamation of derelict coal and steel sites by opencast coal mining has been practised at several other sites in Britain. It is considered by most local authorities to be more acceptable from an environmental point of view than opencast operations at greenfield sites and provides a means by which derelict land can be returned to beneficial use at minimal cost to public funds.

17.3 Wales

17.3.1 Introduction

The valleys of South Wales have a long history of coal mining and iron making. In addition to the natural deposits of hard coal and ironstone, the densely forested hill sides helped the development of these industries in the eighteenth century by providing valuable wood and timber. The use of charcoal pre-dates coal for the smelting of iron, and when coal mining started to provide a material to replace charcoal as a source of energy for iron-making, the timber which was available provided building materials and pit props for the collieries.

The topography of the South Wales valleys led to the area supporting a large number of small, deep collieries and iron works dotted along the valley floors. Small communities, subsequently evolving into towns and villages, marked the positions of these industries. Large waste heaps dominated the sides of the hills, because of the limited space available for tipping colliery spoil and iron slags on the valley floors.

Coal mining in South Wales has been reduced to a few deep mines and a number of opencast sites, as the remaining coal deposits have become more difficult to mine, and United Kingdom coal production has been reduced in the face of changing world markets.

Since the 1960s, and particularly since the huge colliery spoil tip slide at the village of Aberfan in 1966 (see Photograph 1.1), Wales has implemented an extensive policy of reclamation at colliery, coal processing and associated sites throughout the Principality. This case study concentrates on a large reclamation scheme undertaken in the Ebbw Fach valley, located in the north-eastern corner of the coalfield.

17.3.2 The Nantyglo and Blaina valley

Background

In the eighteenth and nineteenth centuries, the area between Nantyglo and Blaina was densely industrialised. The site contained an ironworks, a number of coke ovens, brickworks, lime kilns and collieries. The Ebbw Fach river passes through the valley, and was culverted underground over long stretches to make more room for industry.

Many of the ironworks closed at the beginning of the 1900s, and the last colliery closed in 1975, following an underground fire. It was this cessation of the local industry, and the vast area of dereliction that had resulted that gave rise to the Rising Sun reclamation scheme, named after the nearby Sun Pit coal mine and the former Rising Sun public house.

At the time of reclamation, the 74ha Rising Sun site, was one of the most dominating examples of industrial dereliction in the South Wales valleys.

Environmental quality

Intense coal washing operations had been undertaken during the early 1970s in the northern part of the site. These operations had left behind numerous large slurry ponds, which formed unsightly and dangerous features of the site. In addition, many large tips were present, consisting of colliery spoil, ironstone shale, iron slags and coal washing slurries. A variety of derelict buildings and structures remained. Only a small proportion of the original valley floor remained unaffected by industry.

Surveys and preliminary reclamation design work commenced in 1973, and a masterplan was presented to the local authorities in March 1974. Reclamation of the area started in 1977; two large tips on the hill side, known as Red Ash and Inkerman, were unstable at this time, and these and other tips were monitored for movement. The history of the site showed that a number of tip slides had occurred in the area previously,

and that some of the unstable tips remaining lay directly above housing on the valley side. A detailed geomorphological survey indicated that, in addition, natural soil slippage was taking place and would require attention if land lying on the valley floor was to be made available for development.

The culverted stretches of the Ebbw Fach river were also found to be in poor structural condition in many places.

Site restoration

The Rising Sun scheme was formulated by collaboration of the local council (Blaenau Gwent), the regional council (Gwent County) and consulting engineers and environmental scientists, and was fully funded by the Welsh Development Agency (WDA). The WDA gave approval for the work to commence in June 1977, and the main contract reclamation works were completed in October 1983. Other work carried out included the construction of bypass and access roads for the area. The reclaimed site was officially opened to the public in April 1984.

The consultants were responsible for the geotechnical, civil and structural engineering and landscaping aspects of the design, as well as supervision of the works.

The aims of the reclamation were wide-ranging. Primarily the scheme was designed to bring the area back into beneficial use, and this involved the demolition of old structures, regrading and stabilisation of unstable waste tips and natural landslips, revegetation, and the provision of building land suitable for both housing and industry.

The final ground profile was achieved by balancing the excavation and filling operations wholly within the site boundary, and this involved the movement of approximately 1.5 million cubic metres of material. The Inkerman tip was completely removed and much of the colliery spoil from this was used to raise the level of the valley floor. A new concrete

pipe river culvert replaced the old stone arch culvert. This new culvert was designed to withstand the substantial surcharge loads from the regraded waste tips.

Nineteen mine shafts were made safe by a combination of grouting and capping with reinforced concrete. Several mine adits along the valley floor were secured by plugging with concrete and/or brickwork, and provisions made for draining these adits. Surface drainage took the form of contour ditches with lined inverts, and some of these were subsequently filled with free-draining stone after the establishment of grass on the site. The newly regraded slopes along parts of the mountain side were drained using stone-filled buttress drains to stabilise the landslip, and open channels diverted run-off water down the slopes towards the Ebbw Fach river. The increased drainage across the site was accommodated in the enlarged storm water drains and river culvert, and also by the construction of two regulating/settlement ponds at the foot of the hill side.

Following the engineering works, a long-term programme of revegetation was undertaken. This consisted of broiler house litter application followed by grass seeding to produce grazing and amenity grass areas. Well-established grass on the slopes has helped to prevent surface erosion, and in places wild flowers, both seeded by hand and naturally colonised, can be seen in abundance. Extensive planting was carried out to provide shelter and enclosure in two recreational 'buffer zones' between the central industrial area and existing and new housing at the north and south ends of the site. Further planting adds interest and shelter belts to the hillside grazing land, and divides lower grazing by hedges. Species were chosen which tolerate the elevation and rainfall, grow on the infertile spoil of the site, and provide food and shelter for wildlife. From these species, mixtures were composed to produce woodland, understorey, edge, waterside and hedge characters.

Particular care was taken to rip the surface of the ungraded colliery spoil in order to counteract the compaction introduced by the civil engineering

machinery. This loosening enhanced root growth and subsequent tree establishment.

Due to the complexity of the scheme and extremely competitive tendering by contractors, three firms and a receiver were forced into receivership during the course of the works. These events had the effect of complicating and extending the time taken to complete what was already a large and complex project.

Costs and after-use

The completed scheme provided 15ha of land for industrial development, 8.5ha for housing, and a further 11ha for amenity use and open space. In addition, 33ha of mountain side were made available as agricultural grazing land. The remainder of the site area was accounted for by roads and further recreational land, including a school nature study area.

The final cost of the reclamation scheme, in the early 1980s, was £7.25 million, which included all the undertakings mentioned here, including the acquisition of land and the ground preparation for building. Today the area comprising the Rising Sun reclamation scheme is a well balanced community of housing, light industry and public open space, where investment has provided new hope for an area once severely affected by industrial dereliction and decay.

17.3.3 Brynbach Park

Background

Brynbach lies within the Borough of Blaenau Gwent, in the north-western corner of the County of Gwent. Blaenau Gwent occupies the north-eastern corner of the South Wales coalfield. The site forms part of an elevated open landscape at the heads of deeply incised valleys which descend to the south.

Shallow coal measures and ironstone deposits were once worked extensively at the head of these valleys. A large number of small reservoirs were constructed to supply water to the iron industry which was established in the eighteenth and nineteenth centuries.

Environmental quality

Brynbach Pond was one of the water supply reservoirs which were situated on land underlain by coal measures and surrounded by waste from many small mines which were once active in the area. In the late 1960s and early 1970s the National Coal Board were mining the coal outcrop by opencast methods, and proposed that one mine should be extended by 80ha including the area occupied by Brynbach Pond.

Site restoration

In 1972 the idea of reinstating Brynbach Pond as an amenity lake was proposed (see Photograph 17.3). Further, an opencast mining operation was proposed which could create the landform for the new lake as part of the restoration process, at no additional cost to the mining operation or the community. This principle was accepted by the National Coal Board. Planning permission was granted by Gwent County Council for the mine extension, incorporating a preliminary plan of the final landform and lake, which had been designed by consulting engineers employed by the Borough Council. The engineers and National Coal Board then agreed a mine backfilling programme in which the basin to accommodate a 20ha lake would be formed by 1978. The lake was to have a maximum depth of 6m and an average depth of 2m, which was to be controlled by an overflow and draw-down system. Islands would be constructed to dissipate wave action and reduce erosion. The lake would be filled with water draining from the surrounding hillsides. As these hillsides were also on land reclaimed after deep mining during the previous hundred years, extensive silt traps were designed to intercept the sediment from this drainage water.

Photograph 17.3: Visitor centre and sports clubhouse at Brynbach Pond and Country Park (source: Richards, Moorehead and Laing Ltd)

The parties involved in the planning phase of this project were:

- The Welsh Development Agency;
- The National Coal Board and their contractors;
- Gwent County Council;
- The Forestry Commission.

The landform was prepared by the National Coal Board, who also established grass and trees and maintained the restored mining site for five years. The Welsh Development Agency funded the elements which make up the lake:

- the 1500 gauge polyethylene sheet liner;
- the drainage system;
- the overflow system;
- the lake edge formation, erosion protection and margins;
- aquatic and marginal planting.

The polyethylene membrane liner was required since the mine backfill was not considered sufficiently impermeable to prevent leakage of water. The lake was prepared, lined and filled between 1978 and 1980.

Site management

A masterplan was prepared in 1978 for a wider area, centred on the new lake but extending to surrounding reclaimed land across the local government boundary. This plan proposed that 600ha of land, reclaimed to grassland and young woodland, would become a public amenity and recreation area, in order to:

- improve the landscape in an area of derelict and degraded landscapes;
- increase opportunities for recreation for the people of the densely urbanised valleys;
- provide alternative recreation facilities to those already in the area, particularly new water-based opportunities;
- assist in the development of tourism;
- increase employment locally.

A management scheme was also prepared in 1978 to establish guidelines and responsibilities for the management of the park over a 7 year period. Eight governmental or non-governmental organisations were involved as well as two neighbouring County and two Borough Councils. Brynbach was by this time recognised as potentially important sports and amenity facility.

After-use and success

The Brynbach reclamation scheme is seen as one of the most successful in South Wales. By the early 1990s the landscape had become well developed despite the elevation (360-430m above sea level) and rainfall (1470mm per year) largely due to good management under the direction of the County Council's forestry officer. In the early years of its

existence the park received few visitors, and these were mainly local people, but in 1989 and 1990 well over 200,000 visitors were recorded. The lake facilities are used by water skiing, sailboarding, angling, canoeing and subaqua clubs. A development study indicates that Brynbach is an important asset to the region with significant potential for growth.

The 1978 management scheme was reviewed and updated by management plans in 1985 and 1990. The important factors illustrated by Brynbach are:

- an early identification of the main aim *i.e.* to create a new lake;
- the stimulation of the plan for a 600ha park;
- the cooperation between many diverse organisations;
- funds were contributed by many organisations;
- perseverance by particular members of the design team who were determined to overcome technical problems;
- the acceptance of a long-term management plan;
- the implementation of a long-term plan with modest funds;
- successes gradually increased the recognition of the park as a real asset.

The 1990 management plan indicates that the objectives set out in the earlier reports have been achieved and goes on to outline a further 10 years of work in management and development on the site.

17.4 France

17.4.1 Introduction

France played an important part in the instigation of the ECSC in 1952. Iron ore was the main mineral resource of the country, helping to rank France third among world steel producers in 1993. The iron ore deposits

are mainly concentrated in the north of Lorraine near Metz which was a major steel producing region in France. The other major steel-producing area of France is in the north, particularly in the Dunkerque area.

Coal deposits in France lie in 3 main regions: lignite is found in the south of France at Gardanne, Provence, while hard coal is found in the Nord-Pas de Calais and Lorraine, with some deposits scattered around parts of Centre-Midi. The coal industry in France, like many other areas of Europe, is in decline. Mines are closing and as a result, coal is now produced only in Lorraine.

The case studies in France will cover the following regions:

- Lorraine;
- Nord-Pas de Calais.

17.4.2 Lorraine

Background

Lorraine is situated in the north-eastern part of France, bordering Luxembourg and Germany. It was a region rich in coal and iron ore deposits. Mining for the main mineral, iron ore, occurred across the region and continued into Luxembourg. All the iron mines in the region have closed leaving behind an underground labyrinth which has given rise to major subsidence problems.

The coal deposits in the Lorraine region are found in the Upper Carboniferous and Lower Permian series, and reach depths of 1700m. They are a high bituminous type with a low sulphur content.

Environmental quality

Derelict land first became a problem in Lorraine during the 1960s with the slump in the textile market and iron mining. The problem has since

increased with the decline of the steel and coal industries. A total of over 3000ha of land and buildings have been left degraded.[87] By 1985 the problem of dereliction had become serious enough for the State and the Regional Authority to plan and define a strategy aimed at reclaiming the abandoned land in order to change the image of the area and restore its economic and social status.

Site reclamation

The Etablissement Public de la Métropole de Lorraine (EPML), a publicly funded organisation, began implementing a reclamation programme in 1986. The role of EPML is to purchase derelict land, reclaim it and prepare it for new use. If, following feasibility studies, the site is found to be contaminated, the principle of 'polluter pays' is adopted wherever possible.

No national standards for reclaiming derelict land or treating contaminated land exist in France; those of the Netherlands are generally followed. These standards are, however, often not suitable to the land type in Lorraine and are usually modified. The EPML are currently working with DRIR (an administrative body), USINOR (a steel company) and Charbonnage de France on the geological context of sites and are developing guidance on safe concentrations of contaminants in relation to background levels, which will be used as reference values. A pragmatic approach.

One coal site, Falquemont, and two steel sites, Micheville and Homécourt, are described in the following paragraphs.

17.4.3 Falquemont

Background

Coal was deep mined at Falquemont and provided the major fuel source for a power station 15km away. The mine closed in 1974. However, coal dust reclaimed from the settling lagoons continues to provide fuel for the power station.

As the mining company has progressively withdrawn, the local council has become involved in promoting new uses of the site for industrial, educational and recreational purposes. A large part of the site is now used as a training college for operators of heavy earth-moving equipment.

The site, which occupies an area of 160ha, is divided into three parts:

- former mine buildings;
- spoil heaps;
- settling lagoons.

Falquemont provides a good example of a long-term project to reclaim derelict land for a variety of new uses.

The former mine buildings

The main reception building serves a double purpose for teaching and student accommodation. Some of the remaining buildings are occupied by small industrial users. However, some of the buildings are in a poor state of repair and only the ground floors are suitable for occupation.

The spoil heaps

The spoil heaps are used as the main driver training ground, and have been found to be ideal for earthmoving operations in all weather

conditions. The spoil heap material is continually moved around by the students practising their driving and operational skills.

The settling lagoons

HBL (Houillière de Basin Lorraine), the original mining company, is exploiting the settling lagoons for recovery of coal dust and the empty lagoons are being filled with spent ash from the power station. HBL are working in conjunction with the EPML to reclaim the lagoon area, and further studies are to be carried out as to how the alkaline nature of the ash will affect the reclamation proposals:

- upper lagoon - this is to be completely filled with ash and will serve as an additional training area for machine operators (see Photograph 17.4);
- middle lagoon - this lagoon is to be partially-filled and a fishing pond/wildlife area is to be created;
- lower lagoon - plans to recover coal dust from the lagoon have been halted due to the low coal content. It is likely that the lagoon will be drained to improve the stability and then planted to create woodland.

Landscape work

Some initial landscape work has been carried out along the old railway line at the periphery of the site to improve the outlook from the nearby residential area. This will also help to reduce the noise from the ongoing earthworks operations on the site.

Shafts

There are two shafts on the site, both of which have been capped. It is planned to utilise water from the flooded workings for local industrial purposes.

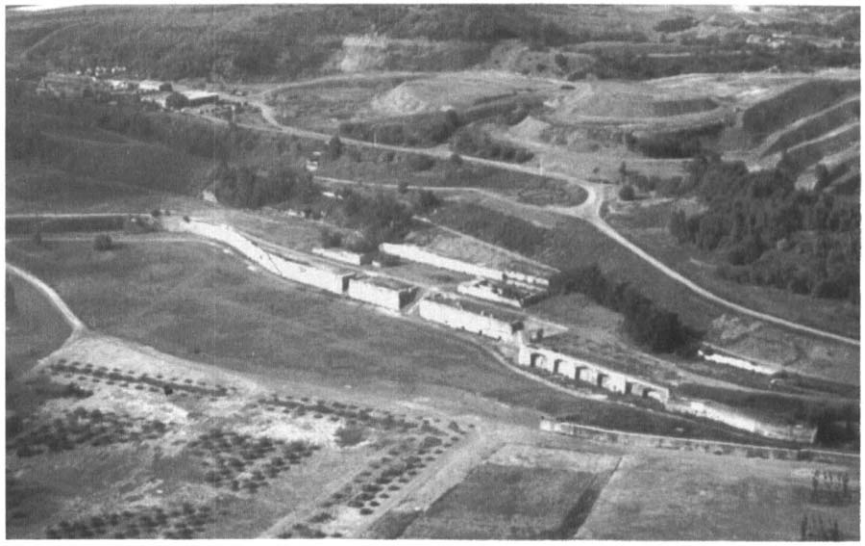
Photograph 17.4: Falquemont. Upper lagoon being filled with ash from the power station (source: Richards, Moorehead and Laing Ltd)

17.4.4 Micheville

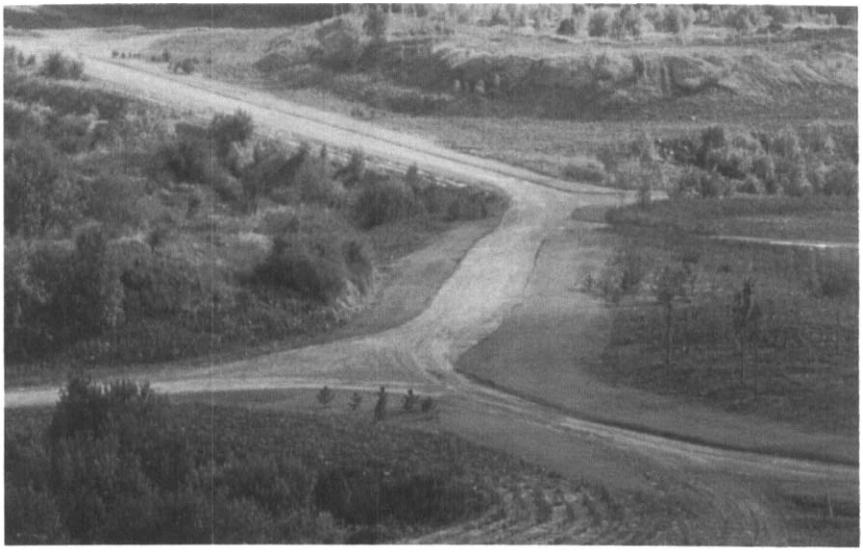
Background

Micheville is situated in the north of the region, 1.5km from Luxembourg. Five communities, with help from the EPML, are combining their forces in an attempt to restore this derelict iron mine and steelworks, in order to promote a more attractive image for the area and to discover new potential for the site (see Photograph 17.5).

The Micheville site first opened in 1871. It covers a surface area of 370ha; 180ha are the former iron workings in the west of the site and 190ha the steelworks area in the east. Installations on the site included a crushing mill, blast furnaces, rolling mills, a coal carbonisation plant, and a power station. At the height of its operations in 1964, Micheville



Photograph 17.5: Micheville. Aerial view of the steelworks site following reclamation and initial landscape works (source: EPML)



Photograph 17.6: Micheville landscape works in the area of former iron workings and slag heaps (source: EPML)

employed 4100 workers. The site finally closed down in 1986 as a result of the decline in the steel industry.

The EPML acquired the site in two parts in 1986 and December 1989 at a total cost of 6,300,000FF. Demolition of the site began in 1987. Landscape work was carried out between 1989 and 1990 and the restoration of some of the buildings in 1991 (see Photograph 17.6). The cost of the feasibility studies undertaken totalled 1,010,000FF, whilst the reclamation and landscape work cost 31,700,000FF.

Micheville is a large site. A symptom of the obvious deprivation its closure caused is the reduction in the population of the town as people moved elsewhere for work. The reclamation of this site is an ambitious project intended to attract new industry and reintegrate the site into the local community.

Former iron workings and slag heaps

Much of the large area of the site left derelict by the opencast iron workings has been landscaped and reclaimed for recreational use with the introduction of tree planting, circular walks and activities areas. In some parts of the site original mining features such as opencast workings and slag heaps have been retained in order to emphasise the mining history of the site. At the foot of a cliff on the mine plateau, a natural amphitheatre provides a striking setting for summer outdoor theatrical events.

Blast furnaces and coal carbonisation plant

Demolition works on the site were completed and redevelopment work commenced. Initially ground contamination was not considered to be a problem. However the steelworks site is in a limestone area, and it was subsequently discovered that there was a risk of contamination from the coal carbonisation area leaching into the groundwater and adversely affecting the water supply for the town. This was overcome by excavating and removing the contaminated material off site to a special

waste tip. In order to avoid contamination of the groundwater during earthworks operations the area of contaminated ground was first encapsulated by the use of a bentonite cut-off trench (see Figure 17.1). The uncontaminated overburden was removed and stored for re-use and a membrane was introduced to prevent access by surface water during the progressive removal of the contaminated material.

Rolling mill

The rolling mill site underwent major changes; all of the buildings and structures have been demolished. The waste materials from the iron

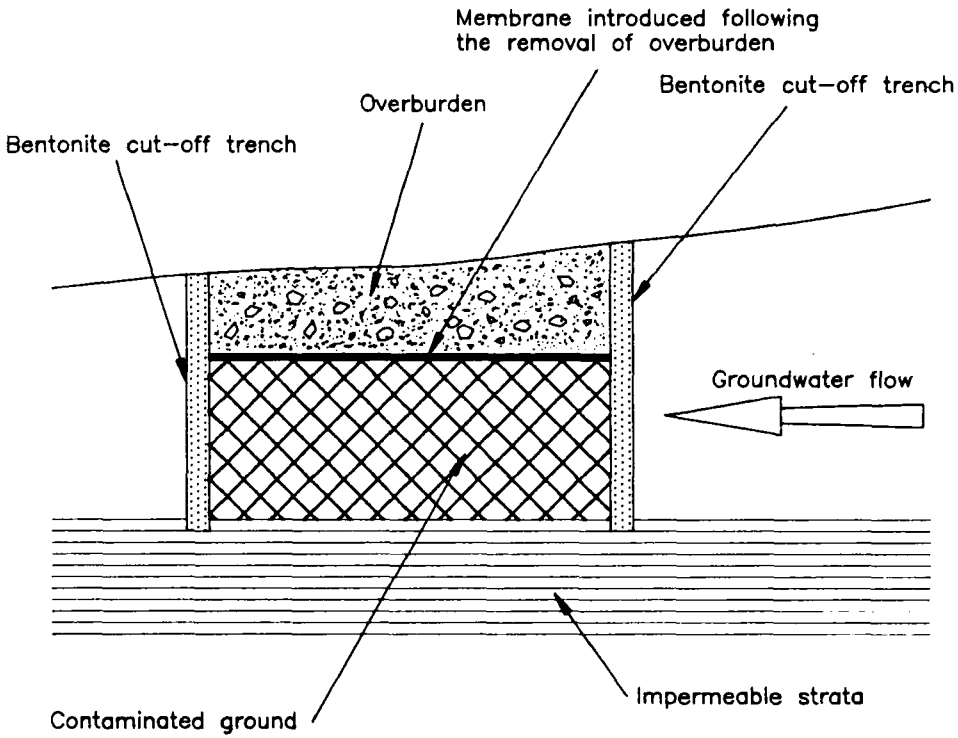


Figure 17.1: Procedure for encapsulation and removal of contaminated material

workings were used to raise the site levels by 2m, and the area is intended for a light industrial after-use. Topsoiling and grass seeding was carried out in some areas, and planting pits were used where trees have been introduced.

Buildings

Many of the buildings on the site were demolished, although a number have been retained and have been converted for industrial use. The original administration and management buildings near the site entrance are of architectural interest and it is intended to convert them for use as apartments.

17.4.5 Homécourt

Background

Homécourt, situated at the bottom of the Orne valley, was once a fishing village. With the construction of the steelworks in the nineteenth century the village expanded and was transformed.

The Homécourt steelworks site, which included the villages of Homécourt and Joeuf, opened in 1881 and covered a surface area of 89ha. The initial activities of the site were iron smelting, coal carbonisation and iron processing. By 1913 production of steel had reached a level of 346,000t/year. Steel products from the site included, railway lines, sleepers, steel plate and steel billets. The site contained iron workings, blast furnaces, finishing works, a coal carbonisation plant, a rolling mill and a power station. The highest number of workers employed at any one time was 5,000, at the end of 1969. Sacilor were the last operators of the site before it closed down in 1983. The EPML acquired the site in December 1987 at a cost of 6,000,000FF.

The reclamation work on the site has been carried out in a series of stages. All the buildings with the exception of one were demolished; the

Photograph 17.7: Homécourt. View of the steelworks site after reclamation works and initial landscape works (source: Richards, Moorehead and Laing Ltd)

retained building is of architectural interest and has been refurbished for industrial use. Feasibility studies cost 600,000FF, reclamation and landscape works 13,800,000FF, and work on the buildings 1,300,000FF.

A new road has been built across the former steelworks site to provide direct communication between the two ends of the town.

At the site of the coal carbonisation plant, which lies at an altitude overlooking the town, an access road has been constructed to allow the site to be redeveloped. The material from the slag heaps has been used for the road construction.

Pollution from hydrocarbons was discovered to be a problem near the coal carbonisation plant. Treatment methods under consideration included the use of a membrane or a clay capping layer.

Some of the slag heaps on the site are still being exploited for use as aggregates and fill material. Where appropriate, the iron-rich slag is subject to metal extraction for reprocessing. Other slag heaps have already been reclaimed and landscaped, mainly with pine trees. Whilst planting pits were used for large trees, a thin layer of topsoil was found to be adequate for small trees and shrubs.

17.4.6 Wingles

Background

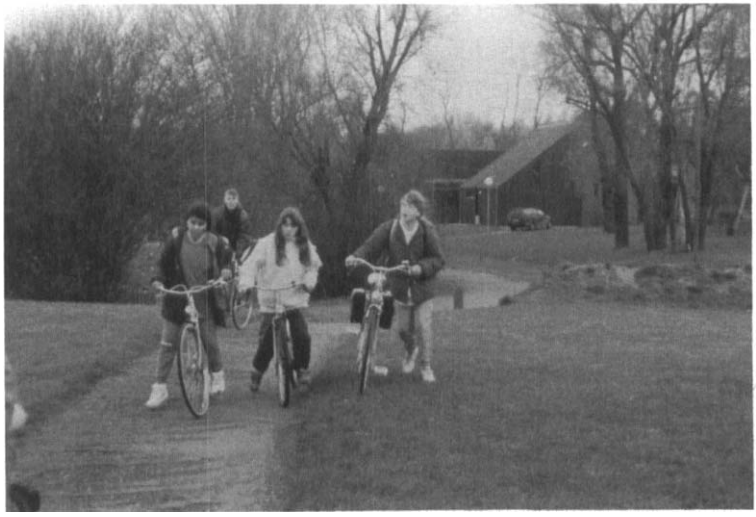
The region of Nord-Pas de Calais in the northern, industrialised corner of France includes a large coal field with many abandoned colliery sites. Reclamation has been carried out in the region for at least 20 years but to date the proportion reclaimed remains small. As a result, prominent spoil heaps dotted around a flat landscape remain typical of the region.

This case study concerns a colliery site which has been transformed into a very successful public park. It is located on the edge of Wingles, a small mining town situated centrally in the coal basin, 20km south-west of Lille, the regional capital

Site description

The site comprises around 200ha of land and water, and is open to the public as a recreation park. Numerous activities are catered for, including sailing, fishing, motor-cross, cycling and jogging (see Photograph 17.8). There is also a campsite, an information centre and various play areas. There is a substantial amount of woodland, with large areas reserved for wildlife.

The park has been developed progressively since reclamation. The 12ha watersports lake, excavated for the purpose in an area of subsidence, was completed in 1986 (see Photograph 17.9).



Photograph 17.8: A network of paths provide for walking, jogging and cycling. The information centre can be seen in the background (source Richards, Moorehead and Laing Ltd)

Photograph 17.9: A large watersports lake has been created by excavation in an area of mining subsidence. The colliery spoil heap on the rigl is untreated, but partially covered in self-sown vegetation (source: Richards, Moorehead and Laing Ltd)

Photograph 17.10: These fishing ponds, formed by subsidence, pre-date the reclamation works (source: Richards, Moorehead and Laing Ltd)

The 20ha of fishing ponds, formed by mining subsidence, were already in existence when reclamation commenced (see Photograph 17.10).

Site history

Three Communes, the lowest tier of local government in France, combined their resources to reclaim (initially) 66ha of derelict colliery and swampy land. The Communes of Wingles and Billy-Berclau collaborated from 1973 and were joined by Douvrin in 1975. The financing of the scheme was divided between the Communes on a population basis. The total population is approximately 17,000.

The Département, the second tier of local government, agreed to finance by 75% the purchase of more land, to give a total of around 200ha.

By 1988, 19,800,000FF had been spent on the site, with a further 14,500,000FF predicted to complete the work.

Site reclamation

The site consisted of many spoil heaps and areas of subsidence. Some of the tips were flattened or reduced, filling low areas, and those which could be utilised were exploited. This practice still continues.

No colliery features, such as pithead gear, were retained.

Studies were carried out regarding ground contamination and none was found. A stream which runs through the site is visibly polluted, but this is said to originate from local agriculture and industry. Acid mine drainage is not an issue as the geology of the site is alkaline.

Other studies considered the soil materials on site for their potential to support vegetation. The site is well-vegetated, although there are some bare and eroding areas where colliery spoil is visible. In many areas, naturally colonised vegetation was retained.

A tip adjacent to the watersports lake continues to burn. Nothing has been done to deal with this and it is not considered to be a problem.

The Département was in charge of the reclamation design and the work was carried out in eight phases.

Management and after-use

At an annual cost of around 400,000FF, the Communes maintain and clean the site and also provide the staff who organise events in the summer. Maintenance of vegetation is carried out by private contractor.

By collaboration of local authorities, a large area of derelict land was reclaimed and transformed, over a period of many years, into a very successful and attractive public facility. Existing site features, such as ponds and self-sown vegetation, were incorporated into the scheme.

The local population is not very large, and it is hoped that people will travel from further afield to visit the site and so encourage new public interest in the area.

17.5 Belgium

17.5.1 Introduction

The province of Liège is the major coal and steel producing area of Belgium. Since 1961 economic development in the region has been promoted by the Société Provinciale d'Industrialisation (SPI), an association of local authorities and other economic and social institutions in the province. The members of SPI now include 68 of the communes of the province, representing 91.5% of the population.

To help bring the increasing amount of derelict land back into beneficial use, SPI set up an affiliated organisation, SORASI (Société de Rénovation et d'Assainissement des Sites Industriels) in 1988. The objective of SORASI is to reclaim derelict land and then sell it for a suitable after-use. Site investigations are carried out prior to purchase of sites by SORASI. If significant problems of contamination are discovered SORASI will not buy the site. Treatment of contaminated sites is the speciality of another public company.

The general approach of SORASI to treatment of sites is to demolish unsafe buildings and structures and remove foundations to 0.5m below ground level. Prospective purchasers are given details of any significant obstructions below this depth.

Two sites, one former coal mine and the other formerly part of a steel works, were visited in the town of Seraing near Liège. The two sites are known as Colard and Aciérie L.D. respectively.

17.5.2 Colard

Background

This is the site of a former coal mine which ceased production in 1979.

Environmental quality

There are two shafts on the site. Prior to reclamation a colliery spoil tip was present at one end of the site, with a few remaining buildings. The spoil is not acid-producing.

Site restoration

A reclamation scheme has been carried in which the spoil heap was levelled to provide land suitable for the construction of light industrial units (see Photograph 17.11). Access roads have also been provided. No building is allowed within 25m of the shafts and this restricted area has

Photograph 17.11: New industrial units at Colard (source: Richards, Moorehead and Laing Ltd)

been fenced. Scrub vegetation is developing within the fenced area. A small trolley from the coal mine has been used as the centrepiece of a roundabout adjacent to the site, as a monument to the coal industry.

17.5.3 Aciérie L.D.

Background

This 14ha site was originally a coal mine, then part of the steelmaking facilities of the local steel company, which still has active blast furnaces adjacent to the site. After closure in 1985 the steelmaking plant was dismantled and transported to China.

Environmental quality

The site is covered with several metres of made ground, consisting of wastes from the coal and steel industries. A site investigation was carried out to determine the ground conditions and contamination status of the waste. It was concluded that the majority of the wastes could remain *in situ,* but should be covered by clay to exclude water. One small area of more contaminated material has been removed. Two shafts are present on the site.

Site restoration

The two shafts have been capped and at the time of the site visit the site was in the process of being restored by infilling with imported materials (Photograph 17.12). This infilling is necessary to give a gentle slope from one end of the site to the other, enabling construction of an access road across the site. Currently the site is at a lower level than the surrounding ground.

The site is to be divided into four zones, for housing, commerce, light industry and recreation. The zones are to be separated by green areas and the recreation area, a sports field, will be a buffer between the existing active steelworks and the other zones.

Photograph 17.12: The Aciérie LD site part way through reclamation. The drainage system is being installed (source: Richards, Moorehead and Laing Ltd)

17.6 Italy

17.6.1 Introduction

Italy is not richly endowed with natural deposits of the raw materials for steel making. The country has, however, developed one of the most significant steel industries in Europe during the twentieth century, through a programme of infrastructural development and importation. This industry, as in most other parts of Europe, is undergoing severe decline, and Italy faces the consequences of industrial dereliction at steel facilities occupying vast areas of urban and urban fringe land. In the latter part of the 1990s action will be taken to move or reduce the size of the steel sites, which often tend to be centrally located in towns and cities. Amongst the most significant areas, many of which are coastal, are Genoa, Naples, Milan, Piombino, Terni and Taranto. In the early 1990s

Taranto was the second largest steelworks in the Community, and although many of the other steel plants are substantially smaller, collectively they are of considerable significance.

Coal mining activities are now largely confined to the south west corner of the island of Sardinia, around the Sulcis area of south-west Carbonia.

17.6.2 Steel sites - general

Background

Eleven priority sites have been identified by the Italian central government as requiring remediation and redevelopment. These include the huge Naples steelworks, which has been in decline since the 1960s.

Environmental quality

The larger steel manufacturers already have much in-house expertise on recycling materials and environmental issues within the industry, and many by-products are recovered. Effluent and flue gas treatment plant, and waste management systems are important support industries to the steel manufacturers. Nickel, zinc and chromium, for example, are recovered from demolition materials and dusts by plasma furnace treatment.

The steel sites, however, are burdened with many of the obstacles to reclamation and redevelopment that are typical of the industry, including contaminated land and the presence of large structures.

Site restoration

There appears to be little direct experience with the reclamation of steelworks sites in Italy, as the industry is relatively recent, and planned reclamation schemes are only just starting on a small scale. Planning

permission for development in Italy can take years to finalise, unless a site is identified as an urgent case.

The introduction of high technology processes is creating smaller steel sites, and consequently more derelict land. Genoa is no exception, and now has a regional development plan which includes the centrally situated steelworks, where it is planned to build a technology park on part of the site. Huge steel plants also exist in Turin and Massa Carrara. The Massa Carrara redevelopment project involves the retention of some existing buildings of industrial and archaeological interest, and the building of others.

In Piombino the local authority seems less positive about redevelopment of the area, despite fears of high unemployment. In Piombino, 860ha is occupied by steel processes, including central urban land and coastal areas owned by the state and leased to the Ilva steel corporation. Here, it is planned to move steel production out of the town, to the east, where it will take a condensed form but maintain jobs.

17.6.3 Sesto San Giovanni, Milan

Background

The Falck steelworks in Milan is at Sesto San Giovanni, outside the city centre, in the industrial region. In 1993 it employs 2500-3000 people, and occupies 150ha. Like many other steelworks, it is undergoing changes that will condense its activities in terms of both site area and employment; in 1970 it employed some 70,000 workers.

Operations at the steel plant involve the production of coils/springs and sheet metal. Much of the work is commissioned, and uses specialised steels.

Environmental quality

The industry, like most, is based on scrap metal, and has one of the largest mills in Italy. Oil and metal contamination is a potential problem at such sites. The provision for recycling the metal parts of scrap cars at the plant indicates the likelihood of other wastes being generated. Since its foundation in 1906, annual production reached about 2 million tonnes in the 1990s, based around two gas operated furnaces. Each furnace handles about 140t/h.

Site restoration

Of the total site area, 80ha is to be retained for industry, and will incorporate part of a new autostrada to take traffic away from the centre of Milan. The other 70ha will be available for development. Many of the workers flats in the area are in a poor state of repair and will require demolition.

Falck is planning to build a 50MW power station at the site, and has experience in the power generation industry through its hydroelectricity operations in northern Italy.

A subsidiary of Falck has a waste immobilisation (solidification) facility which handles industrial waste from the steelworks and elsewhere, and this may be used in the treatment of any contaminated soil materials encountered during the redevelopment works. At this site, inorganic waste is mixed with concrete and calcium silicates, which is pumped, as a slurry, to a landfill, where it cures. The facility treats about 50t/h of waste, and 20,000 - 24,000t/year. Similarly waste water treatment is performed on site by sedimentation, flocculation and sand/charcoal filtration, and water is reused for industry.

17.6.4 Pietrafitta

Background

The Pietrafitta site lies in the Umbria region, approximately 30km from Perugia, near the Nestore river, and comprises a 400ha area of past lignite extraction. Extraction took place between the mid 1950s and the mid 1980s.

Site restoration

Plans have now been detailed for the area, and the University of Venice is working on landscape design. ENEL (national power company), the local authorities, and various landscape architects are working together to initiate the reclamation scheme.

The main features of the site are to be a central facility for power generation, a public park, a palaeontological museum, and a cultural museum dedicated to the steel and coal industries in Italy. The latter is thought to represent an important cultural focus for the area, because of its industrial past.

The parkland is planned to include areas of open water using depressions arising from the coal extraction, artificial oases, and botanical greenhouses, which will be heated directly from the adjacent power station. The power station itself is central to the socio-economic future of the area, and its location in the parkland aims to lower its visual impact on the environment.

Plans for the site have been published in a well-produced book[3], showing artists impressions of the various aspects of the park and the power station. This book is seen as an important part of the programme needed to advance the reclamation scheme.

17.6.5 Santa Barbara

Background

The Santa Barbara site occupies an area of some 2700ha in the Valderno area of Tuscany. It is approximately 50km from Arezzo, near the Tiber river. Opencast coal extraction in the region has largely ceased but some areas are still being worked, although this will end in the latter half of the 1990s.

Site restoration

Many of the tracts left after extraction have already been filled and are now used for agriculture, which was the original land use in many parts of the site. Some zones have been revegetated, and the reclamation plans for the entire area includes further agricultural land and reforestation.

The project has been initiated by ENEL, in conjunction with the University of Bologna, a petroleum chemicals manufacturer, the local authorities and the forestry institute of Arezzo.

17.7 Germany - Saxony (Eastern Länder)

17.7.1 Introduction

The Eastern Länder of Germany have a long and diverse history of coal mining and steel production. The coal industry is typified by opencast brown coal (lignite) fields and associated coal processing industries. The production of iron and steel relied on local deposits of raw materials, and although the industry is in decline, steel is still manufactured from scrap metal.

The climate is typical continental European, with warm summers and cold, wet winters. The topography of the area is generally fairly flat,

becoming more mountainous towards the south, where a metal-rich mining belt occurs.

Industry in the region is in a state of flux due to the consolidation of operations since the reunification of East and West Germany in 1990. This is resulting in high unemployment in industrial areas, where often a single operation or industry has dominated the local social and economic environment. Consolidation is also resulting in further decline to add to the legacy of dereliction left by former industrial activities.

Current German legislation makes it easier to extend the boundaries of an existing mine rather than to open a new one, and thus the brown coal fields continue to expand. After the cessation of mining in an area, the planners take over from the mine legislators, and restoration can proceed.

Whole towns have grown up around the steel industry, relying on the industry for employment and income. As the steel industry declines, the situation is rapidly changing and economic planners look to regenerate the old steel areas for new industry.

Four case studies are presented in Sections 17.7.2 to 17.7.5: coal despoiled areas around Witznitz and the town of Espenhain and the steel towns of Gröditz and Riesa.

The area south of Leipzig is rich in near-surface deposits of brown coal. These have been exploited by opencast mining since the turn of the century. The Witznitz and Espenhain case studies are within this area. Leipzig is approximately 100km to the north-west of Dresden.

The steel town of Riesa lies about midway between Leipzig and Dresden; Gröditz is approximately 20km north of Riesa.

17.7.2 Witznitz

Background

The Witznitz field was first mined in 1922, and continues to be exploited by traditional methods of shallow opencasting. The company MIBRAG (Vereinigte Mitteldeutsche Braunkohlenwerke AG) operates the extraction and processing industry in the area, and gradually towards Leipzig where the coal deposits become progressively deeper. Coal production at the site is being reduced from a previous peak of 100Mt to a projected 12Mt by the mid 1990s.

There are two or three seams of lignite being worked by large bucket and conveyor machines. The seams are worked in strips, and the overburden used to backfill the previously worked strip. The ratio of overburden to lignite is approximately 3:1. In the 1950s the topsoil in the areas to be mined were moved to one side and stockpiled for reuse when the next strip had been mined. Unfortunately, this practice was stopped in the 1960s and 1970s because of economic and political pressures in the area. Therefore, overburden and topsoil were not separated prior to replacement, and the area suffered a serious decline in the quality of surface materials suitable for the establishment of vegetation. The older areas of the site are therefore relatively well colonised with plants, for example, silver birch, but there are now vast areas of extremely poorly vegetated land in the wake of the mining operations.

The opencast site was once surrounded by 28 lignite processing facilities, which are now in decline. A total of 27 villages and local communities have been abandoned and destroyed during the life of the mine, although there is a town on the edge of the current workings that has been saved, and appears as an 'island' on the perimeter of the field.

Environmental quality

The coal contains between 2 and 3% sulphur and about 50% water, and is used to produce briquettes, with the remainder used to feed local power stations. The calorific value of the coal is relatively high at approximately 2400kJ/kg.

The burning of coal in the area leads to the deposition of significant quantities of dust and sulphur compounds on the land. This has led to a decline in the quality of the soil in the locality.

Groundwater in the area is naturally near the surface, and is pumped to keep the water table depressed. This causes problems when mines are closed, and there are areas where large lakes have appeared after pumping has stopped.

Site restoration

There are plans to hold a national garden festival at the Witznitz site by the year 2000, and new industries are to be located in the area. There are many areas where soil improvement will be required prior to revegetation, and although there is potential for the incorporation of the artificially created bodies of surface water into a scheme, it seems likely that these will need treatment to improve water quality.

17.7.3 Espenhain

Background

The community of Espenhain lies to the north of the town of Borna, south-east of Leipzig. The area is worked for lignite, although production has declined; from 40 million t/year and 20,000 workers in 1988 to 14.5 million t/year and 6,700 workers in 1992. This decline continues.

A total of approximately 750Mt coal has been extracted from the Espenhain area. Two pits in the north of the area, as well as others to the south and east are being closed, and there is a corresponding migration of workers out of the area, mostly to the west. The borders of the coal activities in this area are only 30km from the city of Leipzig.

Environmental quality

Much of the reduction in the mining activities is due to the high sulphur content of the brown coal, and the corresponding difficulties in achieving air emission quality standards that the state demands. Therefore, by 1996, two large coal processing plants will close and the operations will terminate.

Over the whole mining and coal processing area there is believed to be many hectares of contaminated land arising from coal processing by-products, and from desulphurisation processes which result in the production of gypsum as a waste product. Coal by-products are said to have been used efficiently in the past and therefore the volumes of waste products were kept to a minimum. However, the fall-out of materials from emissions in the area is thought to have significantly raised the background levels of coal-derived chemicals in the region. Work has been carried out to define the areas of Espenhain that are contaminated, and this data will be used in the future to match the after-use of each area with the levels of contamination encountered. Different areas are likely to be cleaned to different standards according to the after-use of the given area.

Site restoration

Plans for the regeneration of the Espenhain coal field are not yet well defined. However, certain issues appear likely to be addressed.

Two new power stations are to open at nearby Lippendorf, each of 800MW capacity, and these will take coal from a different field. Between 2000 and 2500 jobs are planned to be recreated in this operation.

There are plans to reclaim the land in the area of Espenhain, and this will secure further employment in the area. Soil improvement works are likely to be needed in order to establish vegetation.

By the year 2000, it is likely that there will be three or four large lakes created as a result of the cessation of the mining activities, and the problems or opportunities posed by these do not appear to have been addressed.

Amongst the plans for this area it is hoped to construct a decontamination plant to serve the needs of the area, although the nature of this facility is not finalised. In addition it is planned to use some of the former opencast pits for the disposal of municipal waste.

17.7.4 Gröditz

Background

The iron and steel activities at Gröditz began in 1797, using surface deposits of iron nodules in the area. To this day the iron and steel works dominates the town of Gröditz, which has a population of about 10,000. The steel works employed around 5000 people prior to German reunification, but operations are being slimmed down so that 850 staff will be needed to operate the plant competitively.

Today, the plant produces only 30,000t/year of forged items, including rolled rings for trains, cranes and large machinery. Previous production was in the region of 40 million t/year. The company has been supported by the Treuhandanstalt, and 72% of its products are sold to customers in the west, including: USA, UK, Scandinavia and the Netherlands.

The plant contains one 6000t, one 2000t and two 1000t presses, which are fed by scrap iron and steel.

The site of Gröditz steelworks was approximately 150ha in area, but only about 50ha is now required. The rest of the site is now to be developed for new industry, and awaits Treuhandanstalt funding for support of the architectural bureau's plans for the site. Before this can happen however, the city must become the owner of the land, to allow the subsidy to be provided. The site has the advantage that infrastructural services such as railway and water supply are already in place in the area.

Environmental quality

Contaminated areas at Gröditz are thought to be small. Five sites of between 1500 and 3000m^3 have been identified as contaminated with oil, and these are to be excavated and treated by thermal and biological means. Environmental surveys have been undertaken in order to waive environmental liability in the Saxony region, and the estimate is now 30% of the area previously thought to be contaminated.

Site restoration

Plans aim to encourage new industries to the site, once buildings and space become available during the closure and redevelopment programme.

The buildings at the steelworks are to be reused where feasible, and building materials arising during demolition works *e.g.* stone cobbles, are being recycled where possible.

17.7.5 Riesa

Background

The ironworks in Riesa was founded in 1843, and began to cease operations in 1990. The steelworks operated under the name 'Flik' in the 1920s, employing 12,000 people and producing approximately 1.2Mt/year of raw steel. The site is bordered by the River Elbe to the east.

Operations were based around nine water-cooled Siemens-Martin and four electric furnaces on the plant. Lignite was used to fire the furnaces until the 1950s (as evident from sulphur deposits on building rubble at the plant), but since then natural gas has been the source of energy. Most of the machinery was installed in the 1940s and 1950s, and required three reheatings of the steel raw materials.

Environmental quality

Prior to the closure of the plant a huge tar pit was discovered beneath one of the main buildings. This tar was excavated and burnt in the Siemens-Martin furnaces prior to their demolition. Other contaminated material was largely excavated and removed from the site to a landfill site. A landfill in neighbouring Brandenberg (40km away), received some of this waste in the past, and is now causing pollution problems. There are plans to secure this landfill rather than to treat the wastes within it. New German legislation on waste disposal in the 1990s has now stipulated that different classes of waste have to be disposed of at particular classes of waste sites.

On an area of oil-contaminated ground at the Riesa works two biological aeration treatments have been tested by environmental remediation companies. These have both failed to adequately treat the soil, and a third attempt is planned for the near future. The worst oil contamination tends to be at around 7m (approximate depth of the fill). There is a

natural clay layer at approximately 15m, and there is another layer of oil contamination just above this clay.

Site investigation and restoration

Development plans for the area include retention of many of the former steelworks buildings, many of which are visually attractive (see Photograph 17.13). Redevelopment started on 4 March, 1991, and it is planned to create 1500 jobs in the 'recycling' of the site. The idea is to make the area into an industrial park for Riesa, for small to medium-sized businesses. Already there are 38 new enterprises to be located on the site. These include a Swiss marble and stone preparation company (using one of the main steel mill buildings, retaining an existing crane, and an office block which has been restored), a small steelworks (Italian steel company), heating equipment manufacturer, and a tin plating works. A technology museum for the steel industry is also planned for the area.

Photograph 17.13: Former steel mill undergoing refurbishment (source: Richards, Moorehead and Laing Ltd)

All new businesses are required to provide environmental compatibility studies prior to development.

New investors in the area are keen to know if there is contaminated ground in the vicinity of their planned new developments. The German Federal authorities want the area to be free of liability for clean-up as far as possible. An archival survey of the site (going back 125 years) was undertaken initially, and this focused subsequent soil and groundwater sampling and analysis in areas considered to be of high risk. Contamination was found in these areas. Much of the contamination was due to mineral oils, which are viewed as of high risk to groundwater, and are particularly evident in the vicinity of the old railway lines. Up to 70,000mg/kg oils were found in soils.

PAHs and heavy metals were also found in soil and debris. Metals tended to be in areas of high pH, and were therefore considered to be less of a problem, although high concentrations of zinc and cadmium were discovered on brickwork from the chimney stacks. Five out of six of these chimneys have been demolished, and metals discovered up to 60mm into the bricks, which has consequences for the disposal of demolition waste. Chromium (VI) was used in one part of the area, although no such contamination of ground was discovered.

Boreholes of between 6 and 10m in depth have been drilled in the area for the purposes of sampling.

There are no set soil chemical standards for the area, and those involved use the Dutch (national), Brandenberg and Berlin (regional) soil chemical quality lists.

Due to the quick action of the local District Offices, Riesa secured early funding from the Treuhandanstalt for redevelopment of the steelworks. This situation is unusual, and is thought highly unlikely to happen elsewhere within such a short time-frame.

A video recording was prepared of the closure, demolition, restoration and future development of the Riesa steelworks site. This has been used as an aid to the promotion of the area.

17.8 Germany - The Ruhr (Western Länder)

17.8.1 Introduction

The area around the rivers Ruhr, Emscher and Lippe, where they flow westward into the Rhine, forms the largest industrial region in Europe. The area known as the Ruhr is administered by the Kommunalverband Ruhrgebiet (KVR), the Municipal Association of the Ruhr area. This was formerly known as the Siedlungsverband Ruhrkohlenbezirk (SVR), the Settlement Association of the Ruhr Coal Area, the first German association of local authorities formed in 1920 to control industrial and urban development in the already heavily industrialised region. The KVR encompasses 11 independent cities and four counties with their districts. In all there are 53 separate political areas. The population of the area has increased by twenty-fold in 160 years, with particularly rapid expansion in the last few decades of the nineteenth century. Despite the massive industrial output the Ruhr is not one vast urban conurbation but a series of towns and cities, intermingled with green spaces. Over 50% of the area is designated as 'communal green space'. The decline in the coal and steel industry has brought about high unemployment and the associated problems of an industrial area in decline.

17.8.2 IBA Emscher Park and Duisburg-Nord Country Park

The Internationale Bauausstellung (IBA), *i.e.* International Building Exhibition, of Emscher Park is an extension of the tradition of presenting innovations in building technology at building exhibitions. It covers an area of 802km^2 along the length of the Emscher river, an area with severe problems of industrial decline. The subtitle of the IBA is "Workshop on the future of old industrial areas" and the emphasis of the IBA is on

technological, social and organisational innovations to achieve ecological, economic and social renewal of the Emscher area.

A memorandum setting out the scope of the IBA was issued by the Land of North-Rhine Westphalia in 1988 after consultation with local authorities and other interested parties in the Emscher area. This memorandum sets out seven spheres of activity which include:

- the creation of a landscape park along the length of the Emscher area by extending and linking together existing open spaces (approximately 320km^2);
- registration of important industrial buildings and structures to ensure their preservation by reconstruction and finding new uses;
- creation of working parks for industry and commerce by reclamation of former industrial sites;
- ecological and technical reconstruction of the Emscher system (over the next 20-25 years);
- modernisation and building of houses and dwellings.

The Emscher system presently consists of 350km of canalised watercourses which, historically, carried the waste water from the region (while mining was taking place beneath the area underground pipes could not be laid because of subsidence problems).

The emphasis is on innovation and quality. Each scheme has to demonstrate an ecological net gain and high standards of design. For industrial/commercial parks created on former industrial sites at least 40% of their area must be green to create a pleasant working environment. Parks are being marketed to particular industry groups, with the aim of diversifying the unbalanced economic base of the Emscher area. The registration of industrial buildings of high architectural quality or historic importance is in recognition of the contribution such buildings or structures make to the identity of the region and their role in providing inspiration for new architectural design.

These ideas are captured in the title for this part of the work of the IBA, which translates as "industrial monuments as bearers of culture". In many cases new uses are found for old buildings but where this is not possible buildings may be preserved simply as monuments.

The IBA Emscher Park is not a funding organisation. A planning company, which receives state funding, has been formed to develop ideas, promote exchange of experience and organise the transformation of draft proposals into plans which are capable of implementation. Individual projects are implemented by agents, who may be local government organisations, private companies or citizens groups. These agents are responsible for securing funding for projects from normal private and public budgets and financial sources.

Environmental quality

Duisburg-Nord Country Park is one of the pioneering projects of the IBA Emscher Park. It covers an area of 200ha between the suburbs of Meiderich and Hamborn in the north of Duisburg. This was the first of the integrated sites of August Thyssen, founder of the Thyssen group of companies. Colliery, coke works and iron and steel works were all built on the same site, in the 1890s, to ensure the security of supply of coke for iron smelting. The site has seen many innovations and developments in iron smelting technology, adding to its historical importance.

The coal mine closed some decades ago. The coke works stopped working in 1977, with demolition occuring in 1981, though contaminants have been left in the ground. Smelting of iron ceased in 1985 and much of the blast furnaces and associated plant are still standing. Photograph 17.14 shows the blast furnace area of the park.

The project to convert the site into a country park is the responsibility of the Landesentwicklungsgesellschaft (LEG), a development agency of the Land of North-Rhine Westphalia. Thyssen have provided information on the history of the site and the wastes and contamination present. They have also carried out work to dispose of hazardous wastes.

Photograph 17.14: The blast furnace area, Duisburg-Nord Country Park (source: Umgang mit der Hochofenanlage Bericht der Expertenkommission, IBA)

Site restoration

A competition was held to find a plan for development of the site into a Country Park. Five planning teams, including one from the United Kingdom and one from France, were commissioned to produce a model for development and design of the park. Each team had expertise in urban planning, architecture and landscape architecture. The winning concept was chosen by a jury of architects, landscape planners and representatives of the city of Duisburg. A group of local inhabitants, former workers and neighbours of the company and experts, Interessengemeinshaft Nordpark, was also involved. This group have a continuing interest in the site. The jury was advised by experts on specialist matters. The winning design was by Latz and Partners of Freising. This design builds on existing features of the site to a large extent. The blast furnaces area is largely preserved, as a museum of industrial history and the focus of the Country Park. Over the remainder

of the site a series of parks and gardens are to be formed, in some cases using existing features such as the canalised Old Emscher river and former railway lines. Work is to be done in stages. Work has already been carried out in the area of the blast furnaces to make safe structures and preserve what could be retained. Hazardous wastes from the area, such as flue dusts and ashes have been disposed of in the iron ore bunker, to create a raised area which provides a viewpoint over the site. This project was used to provide training and work experience in the building trade for 60 long-term unemployed, and in landscape design and maintenance for 48 long-term unemployed people.

Some parts of the site are already open to the public. New uses of existing structures include a climbing wall on an old wall in the blast furnaces area. Several publications on various aspects of the site are available. These include descriptions of walks through the site which point out aspects of industrial or natural history. Much of the site, which has been undisturbed for ten years or more, has been colonised by a wide variety of plant species. Some of the plants and animals are on the North-Rhine Westphalia 'red list' of protected species. In some cases, such as in the area of the former coke works, the presence of unusual plants results from soil contamination. Guided tours on various aspects of the site are available.

17.8.3 Sachsen mine, Hamm

The former Sachsen coal mine and coke works covers an area of 50ha near Hamm, in the east of the Ruhr area (see Photograph 17.15). The majority of buildings and structures on the site were demolished in 1979 and the site has been abandoned. The Landesentwicklungsgesellschaft (LEG), a development agency of the state of North Rhine Westphalia, intends to redevelop the site for industrial and commercial use, but with an ecologically orientated design *i.e.* a high proportion of green areas linked to other open, green spaces in the locality to provide a pleasant working environment, minimisation of areas with an impervious covering to maximise infiltration of rainwater, and provision of areas of open

Photograph 17.15: Aerial view of Sachsen mine, Hamm. The large building is the machine hall, the only building on the site which has not been demolished (source: AHU)

water. AHU-Büro für Hydrogeologie und Umwelt GmbH in Aachen, together with various working groups consisting of geologists, planners, civil engineers, chemists and toxicologists from several organisations, have been commissioned to carry out a use-related redevelopment study. The study has included research into the industrial history of the site and investigations of soil and groundwater contamination.

Environmental quality

The site is covered with mine wastes and building rubble to a depth of up to 10m. The uncontrolled manner in which demolition was carried out has resulted in contaminated wastes being distributed over wide areas. Contaminants include polyaromatic hydrocarbons (PAHs), cyanides, ammonia, sulphates, chloride, sulphide, phenols and aromatic compounds.

Disturbance of the ground resulted in substantial odour problems in several areas.

Site restoration

The site has been divided into several areas according to the degree of contamination and proposed use. Contamination has been assessed using an adaptation of the Eikmann and Kloke system (see Section 2.6.5), with addition of values for total and free cyanide concentrations, as shown in Table 17.1. Where the BWIII levels are exceeded, near-surface soil will be excavated, treated to remove contaminants and replaced. In the area of the former gas purification plant-contaminated materials are to be removed and treated off site by thermal methods. In the former by-products plant area groundwater is contaminated with phenols, aromatics, ammonium, PAH, chloride and sulphate. Costs for various options involving different degrees of encapsulation of contamination, protection of buildings and treatment of groundwater have been considered. Costs were least for options which minimised the amount of contaminated groundwater extracted. Treatment methods being considered for extracted groundwater include adsorption on to activated carbon and biological degradation.

17.9 Spain

17.9.1 Introduction

Little reclamation of former coal and steel sites has taken place in Spain, despite the importance of these industries, which are now in decline. This case study will concentrate therefore on the nature of the industries and the problems that have been caused, or may be caused, on their abandonment. The following are described:

- Iron mining sites in the Basque Country;
- Steel producing sites in the Basque Country and Asturias.

Table 17.1. Use-related standards for Sachsen mine

End-use of Kloke and Eikmann (1991)[139]	End-use at Sachsen mine	Soil depth (m)	Soil value	Free cyanide mg/kg	Total cyanides mg/kg	As mg/kg	Pb mg/kg	Cd mg/kg	Hg mg/kg	Zn mg/kg	BaP† mg/kg
Multifunctional use possible			BWI	1	5	20	100	1	0.5	150	1
Children's play areas		0.35	BWII	1	5	20	200	2	0.5	300	1
			BWIII	10	50	50	1000	10	10	2000	5
Houses and small gardens	Area for purification of domestic waste water using plants, open water areas, demonstration of a farmer's garden	0.35	BWII	4	20	40	300	2	2	300	2
			BWIII	40	400	80	1000	5	20	600	5
Parks and open spaces	Semi-paved areas, grassed areas	0.10	BWII	5	25	40	500	4	5	1000	3
			BWIII	50	250	80	2000	15	15	3000	6
Industrial /commercial	Areas of impervious hardstanding	0.10	BWII	10	100	50	1000	10	10	1000	5
			BWIII	50	500	150	2000	20	20	3000	10

† Benzo-a-pyrene

17.9.2 Iron mining - Basque Country

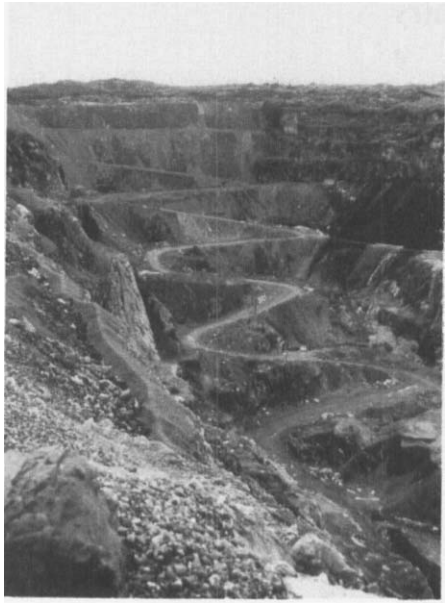
Iron mining has been carried out in the Basque country near to Bilbao for centuries, first by open pit mining (see Photograph 17.16) and then by deep mining. Only one mine area still operates via a drift entered at the base of an open cut, but a substantial number of these mines have also closed in recent years.

Some of these mines are very close to Bilbao itself; for example, those on the Monte de Miribilla and the Mina del Morro. These mines are complexes of pits and spoil heaps, shafts and ruined buildings and have been subject to the fly-tipping of wastes, some of which are toxic. The less-toxic materials have become partly vegetated. The mined areas take up land which could be used for development. Bilbao is short of development land because of its location in a relatively narrow river valley.

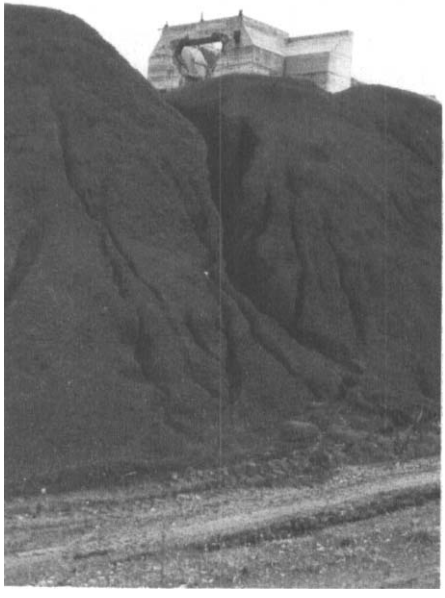
The spoil produced from these mines is not particularly toxic and the mines and spoil heaps have become well-vegetated. The spoil and mines are not apparently responsible for pollution of the nearby river Nervion. The deposition of wastes from other industries on iron mining spoil heaps is, however, more of a problem since the deposited materials include wastes with high concentrations of heavy metals and other contaminants (see Photograph 17.17). During the 1980s, large areas of the former opencast workings were filled with waste materials from construction activities elsewhere in the region in order to provide level ground. The materials dumped included toxic industrial wastes.

The principal constraints on development of the area are therefore:

- the topography of sites;
- the possibility of unstable ground due to mining;
- unsuitable materials on which to construct buildings without prior treatment;
- the presence of potentially contaminating materials due to fly-tipping and the filling of mining voids.



Photograph 17.16:
Open pit iron ore mine near Bilbao. Mining is still carried out underground with access down the haul road (shown in the photograph) (source: Richards, Moorehead and Laing Ltd)



Photograph 17.17:
Eroding illegally dumped wastes at a former iron mine in Bilbao (source: Richards, Moorehead and Laing Ltd)

17.9.3 Steel producing sites - Basque Country and Asturias

The principal steel producing areas of northern Spain are in the Basque Country and Asturias. Steel production in these areas commenced in the nineteenth century. In Asturias the steel industry developed after 1930 on previously non-industrial sites. So whereas in the Basque Country the developments in steel production have been superimposed on one another at the same site, in Asturias much of the steel making is in single generation plants. Both areas, however, support very large steel industries and their economies are dependent on steel production. In the Basque Country there were nearby iron ore and limestone deposits, and in Asturias, coal and limestone.

There was considerable expansion of steel production in the third quarter of the twentieth century. In Asturias in particular considerable expansion took place after 1950 when the Empresa Nacional Siderúrgico S.A (Ensidesa) was formed. A major steelworks was commissioned at the small town of Aviles in 1956, and a further integrated plant at Gijon in 1971. Older steelworks in the area were closed by 1984 so that those in Aviles and Gijon are now the only ones in operation in Asturias. Characteristics of the steelworks are provided in Table 17.2.

In Asturias steel is produced only from iron ore in blast furnaces. In the Basque country there are both blast furnaces and electric arc furnaces which produce steel from scrap metal. In both regions there are coking plants to produce coke for the blast furnaces. There are also secondary industries, such as chemical industries utilising by-products of coke production, and aggregate industries producing road building materials from slag.

Table 17.2: Characteristics of steel production in Asturias

Aviles	
Area	830 ha
Capacity	2.5 million t/year
Source of raw materials	Iron ore by ship to ports at Gijon or Aviles. Coal by railway from port of El Musel.
Coke ovens	300 in batteries of 30. Production capacity 1.85 million t/year
Blast furnaces	4
Steel works	Fully automated with continuous casting machines, hot strip mills, tandem mills, temper mill, and finishing facilities.
Products	Range of steels, plate and sheet, bars, road track materials, cold rolled flat products, tinplate. By-products: Benzol, naphthalene, toluene, ammonium sulphate.
Gijon	
Area	600 ha
Capacity	2.2 million t/year
Source of raw materials	Iron ore by ship to Gijon, coal by rail and conveyer from El Musel.
Coke ovens	45 in 2 batteries. Production capacity of 1.05 million t/year.
Blast furnaces	2
Steel works	Continuous conventional casting and rolling mills.

Assessment

In both the Basque Country and Asturias the situation of the steelworks is typical of many other parts of Europe:

- the steel industry is facing over-capacity and will have close down some of its production in the near future;
- the steelworks and associated industries have caused soil, water and air pollution and are faced with the prospect of having to clean this up before new investment can be attracted to the area.

The steelworks at Gijon in Asturias is a modern, integrated plant built on a greenfield site with little waste deposition on or near the site. The by-products of steel production are sold; gas for thermal electricity production, slag for road making.

At Aviles, the older plant, by-products are similarly sold but there has been pollution of the estuary from steel making and other heavy industries.

There has been no reclamation of steelworks in Asturias, but should parts of the steelworks close there will be an opportunity for commencing reclamation at the demolition stage. This will allow the fate of demolition materials to be decided upon both on the basis of their saleability and their potential as a source of contamination if they are allowed to remain on site, and thus facilitate reclamation of the sites to an appropriate end-use.

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