4 DEMOLITION AND SITE CLEARANCE

Chapter contents

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4.1 Introduction

Steelworks are generally larger and more complex than collieries because steel making is a multi-stage, multi-material process where scale of production has brought economic benefits. The size of a deep coal mine is determined largely by the practicalities and economics of the underground conditions, as well as ownership of the minerals. Where these conditions are particularly difficult and complex, individual collieries occupy a relatively small area of land compared with steelworks and are usually grouped in clusters the pattern of which is determined by geology and topography.

Steel making is a complex process which has had a long history of development, and as a result many steelworks have experienced long periods of stability interspersed with periods of rebuilding and development as new processes and techniques have been taken up. Sometimes several generations of steelworks may be present side by side on the same site.

Some of the earliest ironworks and steelworks were located close to their raw materials and can be found established on coal fields and close to both iron ore mines and limestone quarries. In these circumstances topography and other physical constraints have limited the scale of the development or have been overcome only at great expense. More recent and modern steelworks of large size, being sensitive to the cost of importing raw materials and the export of finished products, tend to be located in large areas of flat land well served by road, rail and waterborne transport systems (see Photograph 4.1).

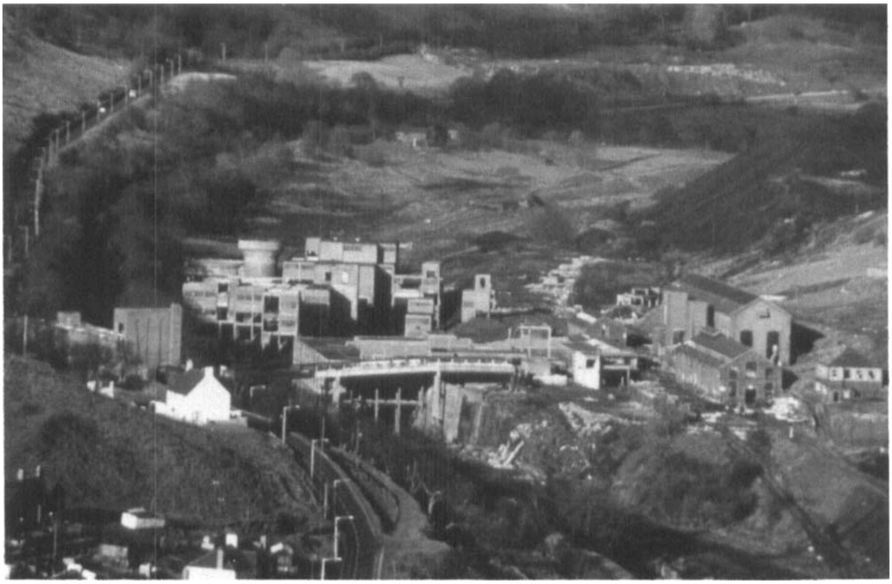
The mining of coal has changed and developed over the 200 years in which coal has been extensively mined in Europe, but abandoned collieries are unlikely to exhibit complex and multiple stages of development in size or working methods at the surface.

Photograph 4.1: A steelworks site in Asturias, Spain (source: Richards, Moorehead and Laing Ltd)

Steel making has always involved large numbers of people and therefore old and new 'steel towns' are large centres of population. By contrast the combination of smaller size and larger number of coal mines found on the coalfields has resulted in mining communities being more 'village-like' in scale producing very different patterns of development and communications.

Although the two industries are closely linked, the marked differences in character between them mean that the issues involved in the demolition and site clearance of a steelworks are different from those concerning collieries (see Box 4.1).

In the past, short-term low cost strategies were often thought to be the best approach to the removal of the old to make way for new industries. It was common for demolition to be carried out during the decommissioning of the site. Machinery may have been sold off intact,



Photograph 4.2: View of an abandoned colliery site in South Wales, UK (source: Richards, Moorehead and Laing Ltd)

but often the demolition work was carried out for the scrap value of the buildings and machinery. Little or no regard was paid to the efficient recycling of materials or the adequate treatment of contaminated ground, or safe disposal of wastes. Generally few records were kept of the work being carried out. Sites were levelled with underground voids being backfilled in an uncontrolled manner. Below-ground features such as old foundations, tanks, flues and culverts frequently received little or no treatment. These demolition methods have subsequently given rise to problems where unforseen ground conditions were encountered during site redevelopment (see Photograph 4.2).

Wherever possible an integrated and disciplined approach should be adopted and the demolition and site clearance works should be carried out as part of a reclamation scheme specifically designed to suit the proposed end-use of the site.

Box 4.1: Steelworks and colliery site characteristics

Site characteristics	Steelworks	Collieries
Processes	Many and varied	Few
Raw materials and products	Many	Few
Sites	Complex	Simple
Wastes	Several in large quantities, several in smaller quantities	One at some sites, many where coal carbonisation has been carried out
Contaminants	Many and varied	Few at some sites, many where coal carbonisation undertaken
Degree of contamination	Severe	Slight, other than where coal carbonisation undertaken
Buildings structures and machinery	Many	Some
Buried structures	Many	Some
Shafts, adits and shallow workings	May be present	Will be present
Industrial archaeological features	May be present	May be present
Recovery and re-use of materials	Likely to be possible	Likely to be possible

4.2 Colliery site features

Features normally associated with colliery sites are listed in Box 4.2.

Buried foundations and other underground structures will be present, and may need to be removed in the parts of the site which are to be redeveloped.

Shafts, adits and shallow workings will be present, some of which may already have been stabilised. Others may still require investigation and treatment.

Spoil heaps and lagoons may be subject to instability problems and can require special treatment (see Section 6.6). Spoil heaps and fill material with a high coal content are susceptible to accidental or spontaneous ignition, and special precautions will be required if the waste on site is shown to have high coal content (see Chapter 7).

Contamination may also be present in certain parts of the site. This is particularly likely in areas where coal carbonisation and by-products storage or disposal was undertaken (see Section 10.1). Fuel and oil spillages are likely to have occurred in some areas *e.g.* around storage tanks or in railway sidings, and asbestos is likely to be present in insulation or construction materials, or as a result of the on-site disposal of waste materials containing asbestos. Asbestos is invariably found in steam-raising plant areas including pithead baths.

In addition to the health and safety aspects of abandoned colliery and coal processing sites, there may also be chemical contamination features that affect underground structural developments at a site. High sulphate levels for example, will be present in some cases and this will give rise to sulphate attack of concrete (see Section 10.5.2).

Deep mines were invariably required to be drained of groundwater by pumping, and pumping usually ceased at the time of abandonment. As

Box 4.2: Features associated with colliery sites

Structural features at colliery sites include:

Headframes and winding gear, ventilating fans and drifts, coal processing plant including crushing, screening and washing plant and associated conveyors. Coking plant with associated by-products areas, and also brickworks, which were sometimes present at the colliery site itself or on nearby land.

Buildings will include offices, laboratories, workshops, boiler houses, motor rooms and buildings housing processing plant, ventilating plant and pumping arrangements.

Underground structures will include buried foundations, basements, retaining walls, tanks, culverts, fan drifts, drains, buried pipework and underground services.

Shafts and adits will be present together with shallow underground workings, and in some cases opencast workings.

Other site features may include coal blending and stockpiling areas and railway sidings. Extensive spoil heaps may be present together with open and buried lagoons. Access roads are likely to be still in existence and there may also be railway lines, embankments, cuttings, canals and wharves.

the water level rises in a closed mine system it compresses mine gases which accumulate in the underground workings, and these gases may find their way to the surface (see Box 4.3). Gas and water migration is a major problem on some sites.

Some colliery sites will contain historic features worthy of recording or retention. Proper consideration should be given to this even before the colliery becomes disused (see Section 4.7).

Box 4.3: Emission of methane from abandoned workings

In active mines methane is channelled from within the mine to the surface where it is utilised at the colliery site for heating or power generation, or it may be piped away for industrial use.

Methane production varies depending on differences in geology, methods of mining and coal seam properties. Methane is emitted from the coal face, from the coal as it is worked, and also from the surrounding strata which have been disturbed.

The rate of gas production is linked to the rate of coal extraction, but methane will continue to be emitted from the workings after coal production ceases, and will find its way to the surface via mine entrances or via fractured strata above the workings. The potential for emission of residual methane from old workings increases in periods of low barometric pressure, or as a result of flooding of the workings, or subsidence of the overlying strata.

Therefore at closed or abandoned mines there is the potential for gas migration, with the associated risk of explosion if a build up of gas in an enclosed space is accidentally ignited.

At mines which have a history of methane production measures should be taken during abandonment to ensure that gas is safely vented to the surface. Where the potential for gas production is unknown, gas monitoring should be carried out during the site assessment in order to establish whether any remedial measures may be necessary.

Remedial measures can include the following:

- provision of gas vents to shafts and adits;
- provision of gas diffusion trenches or boreholes adjacent to buildings considered to be at risk;
- the grouting of underground voids and fractured strata to prevent or reduce gas migration;
- modification to existing buildings such as the replacement of suspended ground floor slabs with solid slabs, and the venting of enclosed spaces within buildings;
- provision of gas-proof membranes beneath new buildings;
- provision of passive or active gas venting systems within new buildings;
- sealing of service ducts and drainage entry points to prevent the ingress of gas;
- for high risk situations gas detection and alarm systems should be provided within buildings.

Following the implementation of remedial measures, ongoing monitoring should be carried out to check that these measures have been effective.

4.3 Steelworks sites features

Features normally associated with steelworks sites are listed in Box 4.4. Buried foundations and other underground structures will be present, and may be complex, extensive and massive. A long-standing or disused site may have been occupied by earlier phases of development for which the foundations still remain.

Iron or coal workings can be present as either former surface or underground workings which could give rise to subsidence. These workings will require investigation and treatment (see Chapter 3). Contaminated ground will exist in discrete parts of the site *e.g.* coking and by-products areas, waste tips, rubble from flues and chimneys, and

Box 4.4: Features associated with steelworks sites

Structural features at steelworks sites include:

Blast furnaces, open hearth furnaces, electric arc furnaces, ore preparation and handling plant and associated conveyors, coking and by-products plant, gas holders, casting machines, rolling mills, finishing mills, pickling and plating plants. Power generating plants, chimneys and cooling towers may also be present.

Buildings will include: offices, laboratories, workshops, boiler houses, motor rooms and buildings housing furnaces and processing plant. Many of these buildings are very large, and may contain overhead cranes and lifting gear.

Underground structures will include massive foundations some of which may be piled. Other underground features may include cellars, pits, tanks, flues, culverts, drains, buried pipework and underground services.

Iron ore or coal workings may be present on or near the steelworks site.

Other site features can include steel stockpiling areas, scrap reception and handling areas, coal stockpiling areas, slag processing plant, and slag heaps. Open lagoons and buried lagoons can be present and access roads are likely to remain, along with railway lines, railway sidings, canals and wharves.

old slurry lagoons. Asbestos may also be present in considerable quantities from insulation or construction materials or as a result of the on-site disposal of waste materials containing asbestos, and must be identified at an early stage so that precautions can be taken to avoid dust inhalation and resulting adverse health effects during and after demolition and site clearance.[71]

Some steelworks slag may be unsuitable for use as fill material for construction purposes, as under certain circumstances some slags can be subject to expansion (see Section 9.2). Where high sulphate levels are present this will lead to sulphate attack of concrete unless new concrete structures in contact with the ground utilise sulphate resisting cements or protective coatings (see Section 10.5.2).

Waste heaps at steelworks may be subject to underground fires which could lead to subsidence damage and health and safety hazards (see Section 7.3). Where underground fires have occurred on steelworks waste heaps this is generally due to the presence of colliery waste which may have been ignited by hot material from the furnaces.

Slag heaps can contain fused material or may have a high scrap iron content, both of which could cause problems during earthmoving activities.

Features of historical interest may be present on the site, as discussed in Section 4.7.

4.4 Site investigations prior to demolition and site clearance

At operating sites or where production has only recently ceased, information on previous site usage and contamination status should normally be available from site staff, or from records. Pre-closure site audits are an extremely useful aid to the identification of structures, process areas, waste disposal areas, and potentially contaminated materials that exist on site (see Box 4.5). It is far easier to obtain useful information about such sites whilst they are still operational, and a well-targeted environmental audit of this sort can provide an excellent foundation to a future development path. Such audits should also highlight historic equipment, buildings or processes.

Where materials are to be reused or recycled during demolition and reclamation works (see Section 4.6) a preliminary site audit will identify at an early stage those materials that are uncontaminated, and those that may require separation and/or treatment due to contamination.[140]

For sites which have been abandoned for some time, or which have inadequate or non existent records, in-depth investigations will be required to provide detailed information regarding the previous history of

Box 4.5: Factors to be included in a pre-closure site audit

Environmental audits of operational industrial facilities are a useful method of accounting for the movement of materials on and off site, and are often used as a management tool to aid the setting of environmental objectives and to minimise waste production and risk at a given site.

For a site identified for closure, an audit, involving existing documentation and members of staff, can provide useful information to aid site redevelopment. A pre-closure audit should address the following:

- location and quantities of waste deposited on site;
- records of accidents, particularly those concerning spillages or leakages of chemicals;
- location of process plant and storage areas;
- environmental data on, for example, groundwater quality or atmospheric emissions;
- locations of features of archaeological importance;
- structures of potential use during subsequent reclamation works e.g. buildings for materials storage, hardstanding, tanks for liquid storage and/or treatment;
- recycling potential of structures and materials on site.

the site and the likely problems to be overcome during the demolition and site clearance works (see Box 4.6).

At sites where some demolition and site clearance works have already been undertaken, the following information should be obtained:

- previous site history;
- scope of previous demolition works;
- method of dealing with toxic and contaminated materials;
- treatment of underground basements, tanks, culverts, drains, flues;
- treatment of buried foundations;
- compaction methods used in placing fill material;
- treatment of any shallow workings shafts or adits;
- location and historic value (if any) of surviving buildings.

Where no records exist, investigations will be required on site in order to determine all or some of the above information.

4.5 Demolition works

The demolition works should be carried out by a specialist demolition contractor with previous experience of the features normally encountered on coal and steel sites. Problematic features include: plant and equipment, large steel structures, massive foundations, chimneys and cooling towers. The contractor should also be familiar with the procedures to be adopted when handling toxic or contaminated materials.

Where necessary, works should be carried out to decontaminate plant and buildings prior to demolition, in order to minimise the spread of contamination during actual demolition works. Steps should in any case be taken during demolition works to minimise contamination of otherwise uncontaminated areas.

Any areas to be protected should be fenced-off at any early stage. Demolition works should be carefully planned prior to actual works commencing on site. Following an investigation of available records and site conditions as outlined in Box 4.6, a detailed method statement for the demolition procedure should be prepared including calculations, drawings and the proposed sequence of operations. Provision should be made for avoidance by the contractor of any areas which have been fenced off for protection.

Box 4.6: Detailed information to be obtained during planning of demolition and site clearance works:[258]

- historical uses of different parts of the site and subsequent changes of use;
- locations of mineshafts, adits and shallow workings;
- uses of pipework and process plant;
- assessment of hazardous materials which may be present;
- available records and drawings;
- survey of structural conditions;
- survey of cladding materials and materials used in construction e.g. asbestos;
- location and condition of public utility services and buried site services;
- details of buried foundations;
- details of underground basements, tanks, culverts, drains, flues;
- likely effects of demolition works on any adjacent properties and structures;
- evaluation of any restrictions on any adjacent properties and structures;
- details of any pre-stressed concrete units or post-tensioned concrete beams;
- interpretation of method and sequence of original construction;
- investigation of existing structure by exploratory probing, coring, drilling, cutting and testing;
- examination of records of any archaeological/conservation designation or listing.

An assessment should be made of any operations involving materials which may be hazardous to health, and of the possible exposure risk to site operatives, for example:[70]

- removal of asbestos;
- work with lead, including flame cutting of painted steel structures;
- other metals such as zinc which give off fumes if flame cut;
- synthetic mineral fibres;
- chemical residues from previous site usage;
- contaminated soils resulting from the spillage and leakage of oils, solvents and other chemicals.

Before demolition commences the contractor should ensure that all power is cut off, water and gas mains disconnected and protection given to existing utility services, as necessary. The demolition methods employed will depend on individual site circumstances but will range from traditional impact methods to the controlled use of explosives. Typical methods used are as follows:[260, 227]

- crane and ball;
- bulldozers;
- hydraulic excavators with grabs, buckets, breakers, magnets, shears, pulverisers and poles;
- thermal cutting;
- diamond sawing/drilling;
- concrete crushing/bursting;
- thermic lance;
- explosives.

The demolition contractor will be expected to comply with current EC Directives or equivalent regional legislation with regard to working practices:[174]

- health and safety requirements;
- control of hazardous substances;
- use of equipment, tools and machines;
- use of personal protection equipment;
- construction sites regulations;
- protection of workers exposed to carcinogens;
- safety signs regulations;
- any other relevant regulations.

The requirement in European Community Council Directives for Risk Assessments to be carried out means that clients and their professional advisers are also involved in the demolition process through their checking of method statements and safety plans. A prior assessment of the risk incurred during demolition and site clearance operations will not only help to reduce risk *e.g.* to workers' health and safety, of pollution and liability, but will also aid the avoidance of unforseen wastage, the loss of valuable materials and the cross contamination of materials.

Where off-site disposal of waste materials is to be carried out, these materials should be analysed and recorded and disposed of safely in accordance with legal requirements (see Section 11.2.5 regarding off-site disposal).

Arrangements should be made for supervision by qualified archaeologists/industrial archaeologists during demolition works so that any features of value which are exposed can be recorded, especially if the site is known to contain features of historic interest.

4.6 Recovery and recycling of materials

The cost of the demolition contract may be all or partly offset by the value of waste materials recovered during the demolition works.

In some cases equipment and processing plant may be sold off intact for re-use elsewhere. Specialist engineers are normally called in to dismantle the plant for transport and re-erection at the new site. In other cases the majority of equipment from a steelworks undergoing closure has been sold and shipped to other countries outside Europe, where it is reassembled to commence a new productive life.

Most of the machinery from disused coal and steel sites is unsuitable for re-use and will therefore be demolished and broken up for its scrap value. Specialist demolition techniques are often required for this process because of the large size of many of the items which are to be broken up.

Some buildings such as steel framed structures may be suitable for dismantling and re-erection elsewhere. Where buildings are to be demolished, building components such as steel beams, columns and trusses may be sold off for re-use, or broken up for scrap. Other building materials such as timber, bricks, stone, tiles, slates and steel cladding may be reclaimed for re-use elsewhere. Concrete and building rubble which is uncontaminated may be crushed and graded for use as fill material. Building rubble containing significant quantities of timber will not be suitable for use as fill beneath building structures. Building rubble containing, for example, gypsum plaster, could be subject to expansion and heave and therefore may also be unsuitable for use beneath buildings. It is therefore very important to adequately test materials prior to re-use.

Steelworks slag may be suitable for crushing, grading and re-use as general fill material, or as aggregates for road construction (see Chapter 9). However, some steel slags may be subject to expansion and could be unsuitable for use beneath structures (see Section 9.2). This problem requires special attention since serious problems have been experienced when buildings have been adversely affected by expansive slags in the ground beneath. Laboratory tests have been developed which will identify expansive slags (see Section 9.2.4).

In some cases the recovery of iron and steel fragments from waste tips on steel sites may be viable using magnetic separation techniques.

Burnt colliery spoil is suitable for re-use as fill material. However high sulphate contents may sometimes be present which could lead to sulphate attack of concrete. Pyritic shales may also be subject to heave making them unsuitable for use beneath structures (see Section 5.6).

Coal recovery from colliery spoil heaps and lagoons should be always be considered appropriate when the coal content is high enough to make the work commercially viable (see Chapter 8).

Both steelworks and collieries may contain shallow reserves of coal suitable for opencast working, which can also provide some of the finance for site clearance and reclamation *e.g.* Section 17.2.2.

4.7 Industrial archaeology

An understanding of industrial archaeology is important not only because of the historic and architectural importance of the subject but also for practical reasons such as the understanding of the development of construction techniques and the physical constraints on old structures in terms of stability and general safety (see Box 4.7).

Any audit of a coal or steel site either in preparation of abandonment or after closure should consider the history of the site, location of mineshafts, ancient structures and interesting features in its development (see Section 2.7).

Box 4.7: Industrial heritage

The first reaction among local people on closure of a coal mine or steel works is usually to clear it all away and make a fresh start. If this is not done, it is common to find that attitudes change, surprisingly quickly, to a preference for conservation of the industrial heritage. This is part of an underlying trend, which has been gaining momentum in some countries for several decades, towards greater awareness of the significance of old industrial sites and processes.

The industrial archaeological interest of an old industrial site involves individual buildings and plant, of course, but it is increasingly recognised that the overall pattern is at least as important. Preservation of a single building in isolation, can be fairly meaningless. The significance of a whole site to the development, way of life and culture of a community can, by contrast, be extremely significant. As part of the preparation for reclamation of the Glengarnock iron and steelworks in Scotland, sociological studies were carried out into the history of the steelworkers, as well as an industrial archaeological investigation which was carried out on site.[47]

The case study on Duisburg-Nord Country Park (see Section 17.8.2) is an example of a site where steelworks plant, which was in production in recent decades, is to be conserved for its historical and educational value.

Any feature identified as being of interest should be recorded photographically and by measured drawings, and if considered necessary an archaeological or structural examination should be undertaken by responsible persons. Copies of results should be lodged with the appropriate bodies.

Contracts for the demolition and regrading of a site should provide for:

- the archaeologist to carry out supervision during the work;
- the reporting and, if necessary, examination of any artifacts or features of historical interest;
- the adequate fencing off of any features on site which are to be retained.

It should be made clear to the contractor that the persons carrying out any archaeological or structural examination on site will cooperate in every way possible to avoid delaying work. Funds should be made available to ensure that any rescue dig or removal of features from site for preservation can be undertaken expediently. The contractor or developer may well improve his standing by providing assistance to the archaeologist and by holding site 'open days' for other interested individuals to visit the site of any feature exposed or under excavation.

Some coal mines, and many steel sites contain several generations of plant and processes alongside each other, which makes them exceedingly important from the historic point of view. The coal and steel industries are waste producers on a large scale so that many items of interest can be found below present ground levels or under the waste tips themselves (see Box 4.8).

4.8 Re-use of existing buildings and structures

Existing buildings should be retained and adapted for new use where appropriate. Buildings and features of architectural interest or of industrial archaeological importance should be retained wherever possible (see Section 4.7).

When existing buildings are to be retained, architects and structural engineers should first be consulted to carry out a feasibility study to confirm that the buildings are structurally sound and can be refurbished and adapted to new use at acceptable cost.

In some cases, where existing structures are to be demolished, subject to investigation it may be appropriate to re-use the existing foundations or floor slabs to support new structures.

Features such as existing roads, bridges, retaining walls, embankments, storage tanks, and drainage may also be suitable for incorporation into the new development.

Box 4.8: Features of industrial archaeological interest

The following are of particular interest on iron and steel sites:

- ore mining techniques, shafts, engine house chimneys, adits, tramways;
- ore preparation, kilns, roasting and calcining areas;
- smelting, bloomeries (furnace, hearth, forge), water power arrangements, charcoal sheds, pig beds, blast furnaces, engine houses, steam engines;
- forges, hammers, anvils, finery, reverberatory furnaces, slags;
- foundries, casting pits, air furnaces, kilns, moulds;
- boring mills, earthworks, water wheel pits;
- secondary trades - forges, rolling mills, grinding mills;
- steel works, Bessemer plant, cementation furnaces, crucible furnaces, finery, open-hearth plant, puddling furnaces, slags.

The following are of particular interest on colliery sites:

- mining techniques, adits, shafts, early surface mining sites;
- power, steam engine houses, boiler houses, chimneys, generator and compressor houses, winding equipment, haulage apparatus, water wheel pits, horse gin circles;
- pumping, engine houses, shafts, lodges, reservoirs;
- ventilation, fan houses, drifts, methane drainage plant;
- heapstead, including headframes, coal tipplers, screens;
- coal preparation plant, waste disposal arrangements;
- general-powder magazines, offices, stables, workshops, saw mills, pithead baths, on-site housing;
- transport, weighbridge, sidings, canal wharves, railways;
- secondary processes - briquetting plant, coke works, tar works;
- ancillary plant, brickworks, timber yard.

There are many examples where all colliery buildings have been re-used as an industrial estate (*e.g.* Madeley Wood Colliery, Shropshire, UK) or as a business estate (*e.g.* Ledston Luck Colliery, Yorkshire, UK). At Ledston the winding house is a listed building but is used as a store, the pit canteen is now a flourishing cafe, and the site now employs almost as many people as when it was a mine. Similar examples exist elsewhere in Europe *e.g.* Riesa steelworks in Germany (see Section 17.7), Maximilian colliery in Hamm-Werries (Germany) and Hottinguer Colliery in Epinac (France), now a paint factory.

Some mines can be converted to tourist centres, as has been done in a number of countries, with or without an underground feature. Individual mine buildings have also been converted to housing, and older colliery sites have been converted to a variety of uses such as farms and recreational centres *e.g.* Grange Colliery, Shropshire, UK.