QUARRY PLANT IN THE LANDSCAPE

A Study of the Design of Quarry Plant to Minimise Landscape and Visual Impacts
This study, carried out by David Jarvis Associates Limited, has been part-funded by Natural England through Defra’s Aggregates Levy Sustainability Fund. Brett Aggregates Limited has also provided additional funding. The study is in part a companion study to the Minerals Industry Research Organisation/Minerals Industry Sustainable Technology programme-funded Guide to the Visual Screening of Quarries. These two studies deal with extraction and processing; the third key visual impact, namely transportation, remains to be studied.

Disclaimer
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EXECUTIVE SUMMARY

Introduction

- This Study of the Design of Quarry Plant to Minimise Landscape and Visual Impacts is intended to assist the aggregate industry in its efforts to minimise the landscape and visual impacts of aggregate processing plant on receptors in the vicinity of quarries. It examines the need for and nature of fixed quarry plant, the drivers that influence its design, the main landscape and visual impacts of quarry plant and the techniques by which its impacts can potentially be reduced.

- It is hoped that the report will also prove useful to Mineral Planning Authorities (MPAs) and other consultees and stakeholders by attempting to explain the main differences in plant design flexibility, identifying those items, elements and configurations of plant that could potentially be altered to assist visual mitigation, and those that for safety, technical, financial or other reasons are more or less fixed in terms of overall size, vertical and/or horizontal extents, and appearance.

- The research methodology included desktop research, visits to 10 aggregate and 5 non-aggregate sites, and discussions with MPAs, quarry companies, plant engineering consultants, plant manufacturers and other stakeholders including the Campaign to Protect Rural England.

- The report is the output from a research project carried out by David Jarvis Associates Limited, which has been part-funded by Natural England through the Aggregates Levy Sustainability Fund. Brett Aggregates Limited has also provided additional funding. The study is in part a companion study to the Minerals Industry Research Organisation/Minerals Industry Sustainable Technology programme-funded Guide to the Visual Screening of Quarries.

Background

- Minerals have to be quarried where they occur. More often than not, these minerals occur in attractive upland or river valley contexts. The industrial nature of mineral extraction and processing means that there is a tendency to conflict with the surrounding landscape and population unless the quarrying, processing and transportation is carefully planned and executed.

- The key objective should always be to locate quarry plant so that it is not visible from outside the quarry. However, in reality this will not always be possible. In such cases, certain aspects of plant design may have sufficient flexibility to allow changes to be made to minimise the landscape and visual impacts.

- The fixed plant associated with the development of a permitted mineral site would normally be accepted as a legitimate part of that development. Nonetheless, the landscape and visual impacts of the quarry plant would normally be required to be assessed under any Environmental Impact Assessment that may accompany the planning application. Under normal circumstances, much of the fixed plant at a quarry would be
allowed as Permitted Development under The Town and Country Planning (General Permitted Development) Order 1995. For this reason, MPAs normally remove all such Permitted Development rights when planning permission is granted for a mineral operation, instead placing conditions on the permission relating to the quarry plant required for processing the mineral from the site.

Techniques for Removing, Minimising or Mitigating Landscape and Visual Impacts

- Techniques described in the report include:
  - general siting;
  - avoiding skylines;
  - configuration and layout;
  - architectural style;
  - massing;
  - materials;
  - cladding;
  - covering;
  - disguise;
  - lowering;
  - location off-site;
  - direction of working;
  - soil materials storage as screen;
  - landform screening;
  - fence/wall screening;
  - planting screening;
  - screening using buildings;
  - parking/waiting area design;
  - interlocking spurs;
  - progressive restoration;
  - designing afteruse; and
  - alternative technologies or advances in processing techniques.

- Where site conditions and operational requirements permit, careful siting of the plant to minimise impacts is likely to be the most effective technique.

- The other techniques discussed may also be effective in particular circumstances, and are normally most effective when used in combination.

Summary

- UK planning law makes the assessment of the landscape and visual impacts of quarrying operations a priority matter. Where possible, quarry plant should be located to minimise its impacts on sensitive receptors nearby, but where this is not possible a range of techniques exist to minimise the impacts.

The full report may be downloaded from [www.davidjarvis.biz](http://www.davidjarvis.biz).
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1. INTRODUCTION

1.1 Introduction

This Study of the Design of Quarry Plant to Minimise Landscape and Visual Impacts is intended to assist the aggregate industry, planning authorities, other organisations with an interest in quarrying, and the public in addressing the often significant landscape and visual impacts of quarry plant. It examines the reasons why quarry plant may be visible to nearby receptors, how this visibility can be minimised in the first place by good design, and how the significance of any outstanding landscape and visual impacts can be reduced.

![Fixed plant within a medium sized hard-rock quarry.](image)

Figure 1.1: Fixed plant within a medium sized hard-rock quarry.

It is hoped that the output from the study will prove particularly useful to Mineral Planning Authorities (MPAs) and other consultees and stakeholders by illustrating the range of options and techniques that can potentially be employed to reduce the landscape and visual impacts of quarry plant. The report also attempts to explain the main differences in plant design flexibility, identifying those items, elements and configurations of plant that could potentially be altered to assist visual mitigation, and those that for safety, technical, financial or other reasons are more or less fixed in terms of overall size, vertical and/or horizontal extents, and appearance.
The study, carried out by David Jarvis Associates Limited, has been part-funded by Natural England through the Aggregates Levy Sustainability Fund. Brett Aggregates Limited has also provided additional funding. The study is in part a companion study to the Minerals Industry Research Organisation/Minerals Industry Sustainable Technology programme-funded Guide to the Visual Screening of Quarries. These two studies deal with extraction and processing; the third key visual impact, namely transportation, remains to be studied.

1.2 The Nature of Quarrying
Minerals have to be quarried where they occur. More often than not, these minerals occur in attractive upland or river valley contexts. The industrial nature of mineral extraction means that there is a tendency to conflict with the surrounding landscape and population unless the quarrying, processing and transportation is carefully planned and executed.

Aggregate can be obtained from crushed hard rock, from sand & gravel deposits, from marine deposits and from recycled building materials. This report deals with the first two sources. The methods of extracting and processing hard rock and sand & gravel differ, as does the necessary plant. These differences are highlighted throughout this report.

1.3 Scope of the Study
The scope and limitations of this study are defined as follows:

- The study examines the landscape and visual impacts of fixed plant only – e.g. conveyors, crushers, mechanical screens, silos and stock piles. Vehicles and other mobile plant are specifically excluded from the study though consideration is given to the interaction between fixed and mobile plant.

- The study examines plant used in the primary extraction, processing/grading and storage of minerals only. Plant involved in ‘adding value’ to the basic mineral product is specifically excluded – e.g. concrete batching plants, asphalt plants. However, plant that increases the value of the basic mineral product (e.g. through increased consistency of grading) has been considered.

- The study examines the landscape and visual impacts of quarry plant only. Other environmental impacts, such as dust and noise, are specifically excluded, although consideration of such impacts has been considered where it has a direct influence on plant design. Landscape impacts are those relating to impacts on landscape character at national, regional and local scales, on landscape value (e.g. the amenity value and tranquillity of the landscape, the settings of Listed Buildings etc.), and on landscape features and elements (e.g. woodlands, rivers, significant individual trees etc.). Visual impacts are those that have direct effects on the views seen from particular receptors, such as public rights of way or residential properties.

- The study examines fixed plant used in aggregate quarries (hard rock and sand & gravel operations) in England and Wales only. Non-aggregate quarries (e.g. clay or
coal) are excluded from the study, as are quarries outside of England and Wales. Examples of good practice have however been considered from these types of operation, and indeed from non-mineral sites, where they may have practicable applications for aggregate quarries in England and Wales.

1.4 Methodology
Desktop research followed by a series of visits to quarry operators, plant manufacturers and plant design engineers established the typical composition, layout and profile of fixed plant for both hard rock and sand & gravel quarries. Broad design limits and flexibility were established.

Ten aggregate and five non-aggregate sites were visited. From these quarry/plant visits problems and solutions were examined and photographs taken. Key staff and interested parties, where appropriate, were interviewed. The non-aggregate sites were chosen to illustrate how other industries deal with similar problems of landscape and visual intrusion.

Various other interested parties including mineral planning authorities, quarry companies, communities and groups such as the Campaign to Protect Rural England (CPRE) were consulted.

The problems, flexibility and potential solutions for each individual piece of plant (for both hard rock and sand & gravel) were examined individually.

Techniques and mitigation measures were collated and conclusions drawn.

1.5 Quarry Plant

Figure 1.2: Primary screen at a sand and gravel quarry in an open landscape.
WHAT IS IT FOR?

Quarries, the subject of this study, aim to produce aggregate i.e. sand & gravel or crushed hard rock. Aggregates are used in a very wide range of construction projects from roads to hospitals and from runways to houses. They may be used “as-dug” to create landforms or added to cement, tar etc to produce concrete or asphalt, for example.

Apart from the “as-dug” element, all other aggregates have been processed in some way. Once it has been extracted from the rock face, hard rock has to be crushed (often more than once), sorted, graded and blended and, in some cases, washed before it can be stored or distributed to end-users. Sand & gravel has to be washed and screened before storage and/or distribution. In both cases, the processing of the mineral is done through the use of substantial items of fixed plant arranged in such a way as to facilitate the transfer of products from one item of plant to the next and, then, on to storage and distribution.

Such fixed plant is almost always in or near to the quarry.

WHY DOES IT VARY IN DESIGN?

One size and layout of plant design does not fit all the aggregate quarries in England and Wales. There are a range of variables which have key influences. These include:

- Rock type – hard rock types or sand & gravel?
- Size of extracted mineral – some hard rock, depending on geology, may leave the quarry face in m³ blocks. Sand & gravel will generally be in particles less than 15cms.
- End products – what final size or range of sizes are required for the end use?
- Annual output – a small aggregate quarry may produce 100,000 tonnes p.a. while a large quarry may produce 6 million tonnes p.a.
- Length of operation – a small sand and gravel operation may last 5 years while a hard rock quarry may last 50 years.
- Waste material – is the rock “clean” or does it contain unwanted clays or silts etc? Does it need to be washed?
- Processing method – sand & gravel can be extracted above or below the water table. This leads to choices on either “dry” or “wet” processing. Together with any washing requirements, the fixed plant will vary considerably if water is used in the process.
- Water disposal – if water is used, its management/cleaning/re-use, storage and disposal are key design influences.
- Available space – in tight and awkward sites, pressures on space may force variations to more typical design layouts.
WHY CAN IT CAUSE LANDSCAPE AND VISUAL INTRUSION?

Fixed quarry plant at aggregate quarries may cause landscape and visual intrusion for the following broad reasons:

- Physical intrusion – the sheer physical height, width, depth, mass and configuration of the plant may cause visual intrusion. Many items of plant are typically high because the processing of minerals relies in part on gravity to move material from one element of the plant to the next, and to move material through the different plant elements. This means that the structures that house the different elements of the plant will often be of some considerable height. In addition, some elements of plant may be stacked on top of each other to increase the efficiency of material flows. The need for spatial separation between different elements of the plant to allow conveyors to make the required height gains, combined with the potentially significant height and dimensions of some of the structures, means that the overall perceived mass of the quarry plant can be substantial. The movement of mobile plant and vehicles at or in the vicinity of fixed plant will tend to draw the eye towards it, accentuating the visibility of the fixed plant. Other movement, such as conveyors, can also draw the eye.

- Aesthetics – the fixed plant and activities may be aesthetically unpleasing. Shapes, colours, angles, movements etc. may be jarring. Maintenance and tidiness may be inadequate.

- Context – items of quarry plant are often industrial elements in an otherwise rural or countryside setting. Their visibility is therefore increased by their being out of character with their surroundings.

- Location – plant may be more visible at the start of a quarry’s development than at the end because the plant can be moved into already extracted areas as extraction progresses. However, plant always needs to be located so as to have efficient links to the communication/transport network.

- Accumulation – landscape and visual effects may have a cumulative effect when combined with other environmental and social impacts (outside of this study) such as noise, dust etc.

DOES QUARRY PLANT ALWAYS CAUSE UNACCEPTABLE INTRUSION?

The majority of concerns about the siting of quarries relate to vehicle movements (and are therefore outside the scope of this report).

Transport issues aside, a well-planned, well-designed and well-maintained quarry and plant site can potentially be seen by otherwise sensitive receptors as having positive impacts on the community and its environs. There may be negative impacts but, on balance, there may be a net positive impact.
HOW IS IT CURRENTLY PLANNED AND DESIGNED?

Quarrying is a temporary use of land, albeit one that may last for decades. Once the (economically viable) mineral reserves have been exhausted, the site will normally be restored to its former or an alternative use, with such a restoration scheme normally being a condition of the planning permission for the site. Landscape and visual impacts arising from quarry plant will therefore also be temporary in duration.

Under normal circumstances, the planning application for a quarry will include a full environmental impact assessment, of which an assessment of landscape and visual impacts will form a part – see Section 2.8. The reduction of, and mitigation for, any environmental impacts arising from the quarry plant is likely to have design implications.

The management of water on the site and, where it occurs, the restoration of the site by infilling, will normally be undertaken under licence from the Environment Agency. The operation of the quarry and plant will also come under the Health and Safety Executive through the Health and Safety at Work Act 1974 and the Quarries Regulations (1999), and this may place additional requirements on the design of quarry plant.

The processing of mineral needs to be an efficient operation both within the site and in terms of its external linkages. Quarry plant, particularly those elements of it relating to materials management, will therefore need to be integrated with transport and water management facilities.

The requirements of quarry plant may change through the life of a quarry, perhaps through changing geology as the excavation of the site continues or because the market for the quarry’s products has changed. Similarly, technological developments may allow quarry plant to change – to be more efficient, to better meet (changing) market requirements, or to reduce the environmental impacts of the site. Such changes are often evolutionary or iterative, rather than sudden or step changes, and the cumulative environmental effects of such changes will then require consideration, as well as each specific change.
Figure 1.3: Plant sunk below ground level and hidden from external receptors by tree belt.
2. WHAT ARE THE DRIVERS IN PLANT DESIGN?

The drivers in plant design are many and varied, but there is a significant interdependency between them.

2.1 Geology & Nature of the Mineral Material

The geology of the site and nature of the mineral will affect both the methods of extraction (and therefore of processing) and the products that can be produced. These will in turn influence the type and arrangement of plant required at the site, as well as its location within the quarry.

2.2 Product Range

As noted above, the products that are produced at the quarry will be influenced by the geology and nature of the mineral being won, as well as the corporate policies of the quarry operator and the changing market for aggregates. The plant required at the site will be matched to the products required, and changing market forces may lead to a need to change the products, and therefore the plant.

![Figure 2.1: Conveyor moving sand to a stockpile. The nearby screenbelt means that the conveyor head does not in fact break the skyline when viewed from outside the quarry.](image)

2.3 Transportation System

The methods (road, rail, or water) by which aggregate products are exported from the site will affect both the plant that is required and its location.

In ideal circumstances, the plant will be located as close as possible to the point of export in order to, for example, reduce the need for internal tarmac roads and to minimise the time spent within the active quarry by non-quarry vehicles and personnel.
(who are likely to have a lower level of awareness of the health and safety risks). Locating the plant close to, say, a road access may however increase its external visibility.

Where material is exported by rail or road, products are likely to be stored in bins or silos and loaded by loading shovel or by vehicles passing under the silos. Where material is exported by water (barge or ship), loading is likely to be done by overhead loading gantry or conveyor.

### 2.4 Timescale

Sand & gravel quarries typically have shorter lives than hard rock quarries, with 5-20 years being typical. This is because the depth of the mineral deposit is likely to be considerably less than in a hard rock quarry. For hard rock quarries, a 50 year life would not be uncommon and many sites may be worked for considerably longer than this.

The expected or permitted life of the quarry will influence the choice of quarry plant to be installed. A small sand & gravel quarry with a permitted life of just 5 years is more likely to make use of mobile crushers, screens etc. than a major hard rock quarry with a life in excess of 30 years. In the latter case there is more justification for employing a custom-engineered large-scale fixed design of plant that may not need to be replaced during the 30-year operational life.

### 2.5 Output Volume

The proposed output from the quarry will have significant influence on the arrangement of plant employed. There may also be benefits in using a slightly lower capacity plant set-up than is required for planned peak production levels, and supplementing this with mobile plant operating on a campaign basis when required.

### 2.6 Site Configuration and Phasing of Working

The actual or proposed layout of the site, especially the area that can be used to locate the quarry's fixed plant, will have significant influence on the design of quarry plant. The phasing of the extraction of the site will also be important to the efficiency of the plant. Critical aspects of the site configuration include:

- The distance from the extraction faces to the plant, and from the storage facilities to the public highway. Finished product is cheaper to haul than extracted rock or sand/gravel (because of the reduced void within the load and lack of waste), but haulage of finished product is normally undertaken by road vehicles often driven by people not directly employed by the quarry operator.

- Changes in level are probably unavoidable, particularly in hard rock quarries, but haul routes must be designed to be within acceptable and safe gradients. Steep gradients will result in a significant increase in fuel usage for all types of mobile plant, irrespective of the inherent dangers associated with steep gradients. A balance must therefore be struck between the need to keep haul distances to a minimum to maintain efficiency and minimise the sterilisation of mineral reserves, and the need to maintain fuel efficiency and reduce risk.
Any physical barriers within the site which cannot be removed or relocated will affect the efficiency of the operation. Rivers and other watercourses may need to be bridged or culverted, while haul routes that need to cross public highways will need to use bridges, tunnels or traffic light controlled crossings. All such crossings may have significant cost implications. Existing buildings that are to be retained, woodlands or other ecologically valuable and protected areas within a site may need to be left in situ.

![Haul roads in a hard-rock quarry – note the limited gradients which require increased lengths of road.](image)

**Figure 2.2:** Haul roads in a hard-rock quarry – note the limited gradients which require increased lengths of road.

### 2.7 Context

The context of the quarry will also influence the design of the fixed quarry plant as it will affect the importance that is attached to mitigation measures intended to minimise the visibility of the plant from outside the site. Where a quarry is located such that the fixed plant is seen in the context of existing industrial development with existing high or massive structures, the visibility of the plant will normally be considered less significant than if the plant were seen in the context of a National Park, an Area of Outstanding Natural Beauty (AONB) or even just an area of open farmland. Similarly, the visibility of the plant will be considered more significant if there are substantial numbers of residential properties with views of the quarry than if the only receptors with views of the plant are industrial buildings.
2.8 Legislative Requirements

PLANNING AND LICENSING CONDITIONS

If a mineral site is allocated within the relevant Mineral Plan, then the fixed plant associated with the development of that mineral site would normally be accepted as a legitimate part of that development.

Under normal circumstances, much of the fixed plant at a quarry would be allowed as Permitted Development under The Town and Country Planning (General Permitted Development) Order 1995, Part 19. This permits plant up to 15m in height provided it is directly associated with the mineral extraction operations at the site. For this reason, MPAs normally remove all such Permitted Development rights when planning permission is granted for a mineral operation.

In place of the Permitted Development rights, the planning permission for a quarry is likely to include alternative conditions relating to (the maximum permitted height of) the fixed plant associated with the quarry. Conditions are also likely to be attached to the permission requiring that all quarry plant is removed from the site once all mineral extracted from the site has been processed. If the operator wishes to retain the plant
on site after this time (e.g. in order to process mineral from other sites), a new permission will normally be required.

Similarly, effluent discharge licences for the site will include limits on, for example, suspended solids levels in any water that is discharged to nearby watercourses after being used in mineral processing. This will require the installation of appropriate water treatment facilities as part of the fixed plant, which may include flocculation systems and silt presses.

HEALTH AND SAFETY

Quarry plant will be required to meet all current Health and Safety Legislation, including that relating to health and safety of employees, contractors, visitors and neighbours. A design of quarry plant that has minimal visibility will not be permitted if it also fails to provide adequate protection from danger for employees who might be required to undertake maintenance of the plant.

ENVIRONMENTAL IMPACT ASSESSMENT

All quarry designs, whether for new operations or for extensions to existing sites, are likely to include _inter alia_ a comprehensive materials generation/handling schedule, some form of landscape/visual impact assessment and restoration/aftercare proposals. For quarry planning applications, Environmental Impact Assessment (EIA) will be mandatory under Schedule 1 of The Town and Country Planning (EIA) Regulations (1999) where the site area exceeds 25 hectares. Whether an EIA is required on schemes smaller than this (i.e. Schedule 2 projects) turns on the likelihood of significant environmental effects. The more environmentally sensitive the location is, the more likely that an EIA will be necessary.

The formal requirements of an Environmental Statement (ES) are set out in Schedule 4 to the Regulations and in Circular 2/99 at Annex 5.

Annex 5 is subdivided into sections:

- **Section 1 – Information describing the project**
  Which includes a description of land use requirements and other physical features of the project – during construction, while operational and after use has ceased.

- **Section 2 – Information describing the site and its environment**
  Which includes population, soils, landscape and topography.

- **Section 3 – Assessment of effects**
  Including direct and indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the project.
This Section specifically identifies “Visual effects of the development on the surrounding area and landscape.” In addition, it cites effects on land including the physical effects of the development e.g. change in local topography, effects of earth moving etc.

- **Section 4 – Mitigating measures**

This Section includes the requirement for a description of the measures to be taken to avoid, reduce or remedy any significant adverse effects e.g.

“c. aesthetic and ecological measures e.g.
   I. mounding;
   II. design, colour, etc;
   III. landscaping;
   IV. tree plantings;

Section 4 also requires an “Assessment of the likely effectiveness of mitigating measures.”

It can be seen, therefore, from the above requirements that the whole question of the reduction of visual impacts is embedded in the legal requirements for EIA and, thus, in the planning process.

**2.9 Cost**

Cost can be sub-divided into a number of elements as follows:

**CAPITAL COSTS AND DEPRECIATION**

The capital costs of quarry plant are a significant factor. Although it is dangerous to generalise and difficult to specify what a ‘typical’ plant set up contains, a complete ‘set’ of fixed plant for a hard rock quarry, capable of processing 1 million tonnes p.a., is likely to cost in the region of £8 million including storage facilities. This would have a life of perhaps 15-25 years. It should be noted that a mobile crusher and screen with similar capacity would probably cost only £1 million, but this price excludes storage facilities and the plant would have an expected life of only 10-15 years. There are also significant differences between the methods of working for the two set-ups, and it may only be feasible to use one of the systems in a particular quarry.

The equivalent figure for fixed plant for a sand & gravel quarry is likely to be in the order of £2-2.5 million, though the requirement for the longevity of the plant is likely to be considerably shorter than that of the hard rock plant.

Except for mobile crushers and screens, depreciation is perhaps more of an accounting procedure than a method to establish a realistic later life value for quarry plant as it is likely to have negligible second-hand value, particularly as it is likely to have been specifically designed for the site in question – see Decommissioning Costs below.
OPERATING COSTS

The operating costs of quarry plant will have a significant impact on the profitability of the quarry. Even small increases in operating costs per tonne of product can have dramatic effects on margins, especially where a site may be producing millions of tonnes of product a year. In the current climate of increasing energy costs, plant arrangements that reduce the consumption of electricity (e.g. by having automated start-up and shutdown systems on conveyors) can also make significant savings, as well as having other environmental benefits.

COST/EASE OF MAINTENANCE

The processing of rock is very wearing on machinery, and timely and effective maintenance is therefore an essential element of a successful quarrying operation. Whether this is simply the automatic lubrication of conveyor rollers, or the replacement of the wearing parts in a hammer mill, maintenance costs are an important consideration in plant design. As well as the actual maintenance activities themselves, consideration needs to be given to ensuring that personnel carrying out the maintenance are able to obtain access to the plant in a safe and comfortable way, especially in poor weather.

RELOCATION COSTS

In larger quarries, particularly those working hard rock reserves, it is quite likely that the quarry plant will be re-located part way through the life of the quarry. This may be to allow access to other mineral reserves, or reduce the visibility of the plant from outside once space has been created within the quarry, or to increase the efficiency of the operation by moving the plant closer to the extraction face. The cost of relocation will be high under any circumstances and is therefore only likely to be undertaken at the same time as one or more major elements of the plant are being replaced or upgraded.

DECOMMISSIONING COSTS

Decommissioning costs are considered to be of very low significance as by the time a piece of quarry plant is decommissioned it is likely to have little value other than as scrap (metal). The cost of dismantling and removing old plant is therefore likely to be considered as part of the installation/set-up costs for the replacement plant or as part of the restoration costs for the whole site.

2.10 Corporate Policy

In smaller quarrying companies operating only a small number of sites, corporate policy on plant design is in fact likely to be dictated by the requirements of individual quarries. Larger operators may drive design from the other end, perhaps with a board-level decision for a preference for plant from a particular manufacturer, or for a particular system of working. Corporate policies will of course still need to be adapted to suit the
situation at each particular quarry, but the general approach may still be directed from above.

The design of fixed plant may also be a part of a mineral operator’s corporate identity, requiring plant on all its sites to be clad in particular colours or to be of a particular design. An operator might also decide that long-term public relations are such an important aspect of its operation that it is prepared to make certain sacrifices in terms of operational efficiency or capital costs in order to make use of, say, quieter plant that will reduce the environmental impacts of the site on its neighbours. Such ‘sub-optimal’ design may also be used if it makes substantial improvements to working conditions at a quarry, thereby helping to improve staff retention.

Another area where corporate policy may have a significant impact on plant design is the increasing use of external contractors for campaign working, either alongside the mineral operators own staff and plant, or in place of them. This approach is likely to have significantly different plant requirements than the more traditional approach.
3. WHAT ARE THE MAIN ELEMENTS WHICH COMPRISÉ FIXED PLANT?

[Diagram of a typical hard-rock plant site]

3.1 Key Elements of Hard Rock Plant

- **Primary crushers** – large pieces of rock, perhaps up to 1m³, are transported from the extraction face to the primary crusher by dump truck or loading shovel where they are tipped into the feed hopper. They are then broken into smaller pieces by a system of hammers, rollers etc. There are a number of different systems available, each with their own set of advantages and disadvantages. The choice of system will be made according to the mineral type and the target product range. Some sites use large mobile crushers operating close to the extraction face which feed the secondary crusher by conveyor.

- **Secondary/tertiary crushers** – these are fed from the primary crusher either by conveyor or direct feed. They break the rock down to final product sizes.

Fixed crushers for hard rock are typically 27-28m high, may be up to 30m high, but can be reduced in perceived height by making use of different levels within the quarry. Mobile primary crushers are typically 10m high, though they may be larger – the mobile crusher at Torr Quarry in Somerset is the height of a seven-storey building and weighs 1200 tonnes. Road-transportable track-mounted or trailer-based mobile crushers are typically 3-5m high.
Conveyor systems – electrically-powered covered belt conveyors are normally used to move material between different elements of the processing plant. The length of conveyor will depend on the required height gain as the maximum gradient up which hard rock can be moved by conveyor is 15-17°. Where one conveyor feeds onto another (rather than being fed by or feeding into another piece of processing plant), conveyors should ideally be aligned in straight lines. If turns are necessary at the changeover, some form of hopper will normally be required to minimise spillage/overflow.
Screening – single or multi-deck screens are used to sort crushed material by size. These consist of deck(s) containing holes, through which material can pass if it is below the hole-size. The holes in the deck of single-deck screens increase in size as the material moves along the angled screen, separating out the smaller sized material first. Multi-deck screens have different sized holes in each of the decks with the smallest holes in the bottom deck. Single-deck screens can be lower in height but large in the horizontal plane, while multi-deck screens can be more compact but are higher. In both types of screen, the different sized material is collected by a system of chutes leading off from the deck(s) and then moved by conveyor either to be (washed and) stored or, in the case of the largest material, returned to the crushers for further crushing. In the past grids within the decks were normally constructed of hardened steel and replacement of the grids due to wear and tear or a change in specification of the products required was a major engineering operation. Modular plastic grids are now increasingly being used and these can be changed much more easily and quickly.

Washing – hard rock is normally processed dry, though dust-suppression systems may involve the use of water sprays or misting. Where the output is being further processed to asphalt or concrete (value-added products), washing may be undertaken but this is outside the scope of this report.
• Stockpiles, Hoppers and Bins – processed and part-processed material will be stored either in stockpiles or silos/hoppers/bins. Stockpiles may well be massive in scale but are often relatively constant in size as the rates of material addition and subtraction are likely to be broadly similar for most of the time. Hoppers and silos will be fixed in size, the latter often being raised up so that road vehicles can drive underneath them for filling. As a general rule, part-processed material will only be stored in stockpiles, and it may be possible to locate these in the quarry itself (often with associated reduction in landscape and visual impacts). Fully processed material may be stored using any of these approaches, most commonly bins, though the expense associated with the construction of silos means that these are often only used for material that is going to have value added by being made into asphalt and therefore needs to be kept dry. Stripped soils, overburden and interburden will also need to be stored somewhere on site (where they cannot be immediately re-used in progressive restoration of the quarry), though these may well be used to form bunds or landforms as part of the visual mitigation measures.

![Figure 3.4: Covered primary stockpile in a hard-rock quarry.](image)

• Fuel storage – fuel for mobile plant and, if used, generators will be stored in bunded tanks. These may be raised up to allow the use of gravity filling rather than electric pumps.

• Pipes and cables – different elements of the plant will be connected by pipelines and cables. These are likely to be located on overhead gantries, though some will follow conveyor runs and others will be buried.

• Large buildings – the quarry operation is likely to require some large industrial-type buildings in which to house bagging plants, workshop facilities etc.

• Weighbridges and gatehouses – the site will normally require at least one, and possibly two or more, weighbridges. These will typically be positioned near to the
quarry entrance so that vehicles entering and leaving the site can be weighed immediately after leaving and before re-joining the public highway. The gatehouse will often also act as the weighbridge office.

- Wheel washing – quarries are likely to require some form of wheel wash so that vehicles joining the public highway from the quarry do not leave mud on public roads. The wheel wash will need to be located close to the road entrance to the quarry.

- Offices and staff welfare facilities – even the smallest quarry will require an office and some level of staff welfare facilities. These will often be housed in portable buildings (though will in fact be more or less permanently sited), and may be stacked double depending on the amount of space that is required. The operating company may also locate regional or even national offices at one of its operational sites, thereby increasing the amount of office space required.

- Lighting – although extraction is likely to take place during the hours of daylight, during the winter months processing and other activities may take place after dark, though still within the agreed permitted hours of working. This will require the use of external illumination of some areas of the site, as well as the internal illumination of buildings etc, possibly resulting in a limited amount of light ‘spillage’. Planning conditions for the site will normally require that all such external and internal illumination is designed according to The Institution of Lighting Engineers Guidance Notes for the Reduction of Obtrusive Light, and makes use of directional lighting rather than flood lighting. Where internally lit buildings may cause light ‘spillage’, operators may be required to forego the use of translucent cladding on buildings (which allows some daylight into the building) so as to reduce this. As a rule, operators will not normally use any more lighting than is necessary for the safe operation of the site as excessive lighting can significantly increase the electricity requirement of the site.

- Fencing and security – quarries and processing plants are by their very nature dangerous places. All quarries will therefore normally require substantial security fencing around the perimeter of the site to prevent unauthorised entry, as well as lighting at the site entrance to allow security staff to detect any intruders attempting to gain access to the site. Security measures are also necessary to prevent the theft of or malicious damage to valuable fixed and mobile plant.

- Defunct/derelict items – as previously noted, once quarry plant has reached the end of its useful life it normally has little value other than as scrap. Such items may be sold as scrap metal, or in some cases may be retained if it has some potential to provide spare parts for other retained equipment. The fluctuating, but often low, value of scrap metal may mean that it is not cost effective for such scrap to be removed from the site until a significant amount of redundant machinery has been collected together. This may mean that such derelict or defunct items are stored on site for a certain period of time, particularly during a major refurbishment of the quarry plant.
3.2 **Key Elements of Sand & Gravel Plant**

- Primary Screen – separates oversized material which is fed to the crusher.
- (Contraflow) Barrel Scrubber – separates sand and gravel
- Sand cone – uses centripetal force to separate fine and coarse sands.
- Sand towers – fine and coarse sand towers separate sand from sand/water mix using differential water pressure.

N.B. where sand and gravel are processed ‘wet’, out feeds from the various plant elements must be located above the bottom of the respective plant elements to avoid flooding of the receiving conveyor or other plant element.
Figure 3.6: Aerial photograph of a sand and gravel plant site.

Figure 3.7: Diagrammatic layout of a typical sand and gravel plant site.
CHAPTER 3 - WHAT ARE THE MAIN ELEMENTS WHICH COMPRISE FIXED PLANT?

Figure 3.8: Sand tower.

Figure 3.9: Conveyor linking a feed hopper to the main plant site.
Conveyor systems – electrically-powered covered belt conveyors broadly similar to those used in hard rock quarries. The length of conveyor will depend on the required height gain as the maximum gradient up which sand and gravel can be moved by conveyor is 14°. This is less than for hard rock aggregate as the material is generally more rounded and may also be processed ‘wet’. Where one conveyor feeds onto another (rather than being fed by or feeding into another piece of processing plant), conveyors should ideally be aligned in straight lines. If turns are necessary at the changeover, some form of hopper will normally be required to minimise spillage/overflow.

Crusher – similar to those used in hard rock quarries. The crusher breaks down oversized material into useable (for re-screening) and reject materials (that have no saleable value).

Picking plant – allows hand-picking of large pebbles for use as cobbles etc.

Secondary and tertiary screens – sort gravel into different sizes.

Silt thickening systems and silt presses – water that has been used in the processing of sand & gravel will contain large quantities of silt. In the past this was removed from the water before discharge through the use of settlement tanks and lagoons. Silt and water are now more commonly separated by using silt thickening systems and silt presses to produce water that is of appropriate quality to be re-used or discharged to the environment and a saleable silt-cake.

Stockpiles – sand and gravel products are nearly always stored in stockpiles, typically 1500 tonnes for gravel products and 3500 tonnes for sand products. Radial conveyors may be used to allow more than one stockpile to be formed by the same conveyor.
The following plant elements are similar to those found in hard rock quarries – see Section 3.3 above:

fuel storage; fuel storage; pipes and cables; large buildings; weighbridges and gatehouses; wheel washing; offices and staff welfare facilities; lighting; fencing and security; defunct/derelict items.

3.3 Additional Plant Elements
Fixed plant at both hard rock and sand & gravel quarries may also include the following additional elements which are beyond the scope of this study:

- Plant involved in adding value to the basic aggregate products – concrete batching plants, asphalt plants (including associated dry aggregate storage facilities), concrete block plants etc.

- Vehicles – lorries, cars, mobile plant such as loading shovels, explosives drilling rigs, excavators and (articulated) dump trucks, all either moving or parked.

- Water areas (reservoirs, settlement ponds, tanks etc.) – where these are still in use they are beyond the scope of this report. Silt thickening systems and silt presses are included above.

Figure 3.11: Bund planted with wildflower mix separating a plant site from a settlement lagoon.
4. WHAT ARE THE MAIN LANDSCAPE AND VISUAL IMPACTS?

4.1 Industrial Elements in the Countryside

The overriding landscape and visual impact of fixed quarry plant arises because it consists of industrial elements in what is normally a rural or countryside location. Though quarries are sometimes located in areas where the context for the site is existing urban or industrial development, the substantial majority are located in rural, often attractive, landscapes as noted in Section 1.2 above. The industrial nature of the structures will often be at odds with their surroundings, even though there may be modern agricultural buildings in the vicinity which may also be industrial in appearance.

When considering the landscape and visual impacts of changes to or expansion of fixed plant at a site, the context provided by the existing plant also needs to be taken into account.

![Figure 4.1: The nature of quarrying results in unavoidable industrial elements in the countryside.](image)

4.2 Scale/Mass of Structures

Fixed plant structures can be of large scale; and the grouping of different plant elements results in an overall structure of considerable (perceived) mass. Even where there may also be modern agricultural or light industrial buildings in the vicinity of the quarry, these are likely to be less visually intrusive because they are generally of a smaller scale than those associated with a quarry.
4.3 Height of Structures

The height of structures can be a significant cause of impacts. We have seen that the processing of aggregate relies heavily on gravity to move material from one plant element to the next as this is both efficient and minimises the need for mechanically complex systems. This reliance on gravity results in some structures such as primary crushers in hard rock quarries needing to be up to 30m high (though 27-28m is more typical).

It should be noted, however, that many of the tallest structures involved in mineral processing are involved in adding value to basic aggregate products and are therefore outside the scope of this report.

4.4 Form/Ugliness of Structures

Fixed plant and the structures that house them are often angular or blocky, and generally unnatural in form. This further increases the landscape and visual intrusion caused by the plant where the context is natural countryside.

4.5 Structures breaking the Skyline and/or being seen in Silhouette

One of the most significant impacts that can arise from fixed quarry plant is where items of plant break the skyline when seen from sensitive receptors. Even where the plant does not actually break the skyline, it may still be seen in apparent silhouette if the background is very plain, solid, consistent or pale.

Figure 4.2: The breaking of skylines should be avoided, but this may not always be possible.
4.6 **Structures Blocking Views**
The location and dimensions of structures may mean that important views are sometimes blocked or obscured from particular sensitive receptors, including Listed Buildings or Scheduled Ancient Monuments. Alternative locations or arrangements for plant may need to be considered in such circumstances.

4.7 **Colours/Textures/Materials used in Structures**
The external surfaces of structures can have significant effects on the landscape and visual impacts of fixed plant. MPAs seem to be increasingly likely to stipulate the specific nature of external cladding of structures as part of the planning permission for a quarry or quarry extension. The stipulated colour is often a dark or olive green, but this may not always be the best option for reducing the landscape and visual impacts. For example, where a structure breaks the skyline a colour such as goose wing grey may in fact be less visually intrusive than dark green. The background against which plant will be seen should also be considered when deciding on cladding colour for structures.

Translucent materials are also often used as part of the cladding to structures as this allows a certain amount of natural light into the structure which can improve the working environment for those undertaking maintenance work on the plant. Natural light can also make a significant improvement to the quality of images produced by closed circuit television monitoring equipment. However, in some locations, translucent materials will increase the level of light spillage or light pollution from structures where production or maintenance continues after the hours of darkness.

4.8 **Movement of Vehicles and Mobile Plant around Fixed Plant**
Although vehicles and mobile plant are outside the scope of this report, their movement in proximity to items of fixed plant (e.g. dump trucks or loading shovels tipping material into the feed hopper of a primary crusher) will tend to draw the eye of the observer towards them, and in turn towards the fixed plant elements.

4.9 **Lighting**
Mineral working in the UK is normally only undertaken during the hours of daylight. Indeed, the planning permission for most quarries will define the hours during which the site is permitted to be operational. However, in order to make best use of the hours of daylight during the winter some activities, such as moving mobile plant between working and parking areas, and essential regular lubrication and maintenance operations) will go on during the hours of (partial) darkness. The potentially dangerous nature of quarry haul roads means that there is likely to be some use of external lighting within the quarry, particularly close to the fixed plant. The plant itself is also likely to be illuminated to facilitate maintenance, as will employee car parks and welfare facilities. Such lighting should be carefully designed to minimise light pollution (see also Section 4.7 above).

4.10 **Temporary Loss of Land**
Quarries represent a temporary change of land use. The area which contains the plant site represents land temporarily lost to agriculture, forestry or amenity (for example).
Minimising the land take is, therefore, a method of reducing the landscape (rather than visual) impacts.

4.11 Cumulative Effects
In most situations, it is likely that fixed quarry plant will have landscape and visual impacts in more than one of the ways listed above. In such circumstances, the cumulative effects may potentially be greater than the sum of the parts and should therefore be considered separately from but in addition to the individual impacts.
5. REMOVING THE CAUSE OF IMPACTS

5.1 Introduction

In this section, each of the key elements which comprise fixed plant in either hard rock or sand and gravel operations is examined to establish:

i) The typical location, layout and design of such elements;
ii) The typical landscape and visual impacts caused by such elements; and
iii) The scope to reduce such impacts and any solutions.

5.2 Primary Crushers

Typical location, layout and design

There are three principal locations for primary crushers given their scale and position in the sequence from rock face to aggregate dispatch:

- “Fixed” primary crushers have to be located at an early stage in the quarry development and, therefore, tend to be located at a high level. Over the decades as the quarry deepens, dump trucks bring the rock up haul roads to the “permanent” primary crusher.

- Rarely, a primary crusher may be located at the bottom of a “glory hole”. In very large, long term hard rock quarries it may be possible to excavate a vertical shaft and place the primary crusher at the bottom. This system works on “hillside” quarries such that there is a high level input and a low level route from the primary crusher. The quarry gradually deepens until the primary crusher level is reached.

- The final broad alternative for primary crusher location is at the face using a large mobile crusher. Such mobile crushers are the equivalent of a three storey building which “moves” to retain a position near the active faces and is fed by loading shovel. It is connected back to the remaining fixed plant by conveyor systems or dump trucks. Where more than one face is being worked in a quarry, material may be brought to the mobile crusher by dump truck.

Typical problems and impacts

The mobile primary crusher generally has minimal landscape and visual impacts once it has processed the material from the first bench. Thereafter, it is principally below the skyline and close up to the face. As the quarry deepens, it is located at lower and lower levels within the hole.

The most typical “fixed” primary crushers are large rectilinear buildings at a high level within or at the edge of a quarry where the problems of breaking skylines, incongruous silhouettes, dump truck/loading shovel movement and lighting are evident.

The “glory-hole” solution has potentially the least landscape and visual impacts given that the crusher is hidden within a shaft/tunnel. Only certain sizes and configurations of hard rock quarries can use this method.

Scope to reduce landscape and visual impacts

The need to locate a “fixed” primary crusher at the outset of quarrying means that there are increased pressures to find a site where visual impact is minimised. The size and solidity of a
“fixed” primary crusher are such that re-location is a very expensive, if not prohibitive, option. Avoidance of breaking skylines is a priority. Silhouette and colour of the building are important. Lighting, given the elevated position, is also central to minimising visual impact. The constant movement of dump trucks/loading shovels during operating hours can draw the eye to the activity and needs to be screened.

Mobile and “glory hole” primary crushers generally do not require mitigation.

5.3 Secondary/tertiary crushers

**Typical location, layout and design**

Secondary and tertiary crushers are normally fed from the primary crusher by conveyor. They are typically a slightly scaled-down version of the “fixed” primary crusher noted above. Secondary and tertiary crushers may be some distance from the working face or primary crusher (depending on the quarry design) and are likely to be grouped with the other significant items of plant.

**Typical problems and impacts**

Secondary and tertiary crushers pose many of the same problems in terms of their visibility as “fixed” primary crushers, namely breaking of skylines, the forming of incongruous silhouettes, and lighting. Levels of vehicular activity near the crusher are likely to be lower than for the “fixed” primary crusher as material normally arrives at and departs from the crusher by conveyor.
Scope to reduce landscape and visual impacts

As with “fixed” primary crushers, the size and solidity of secondary and tertiary crushers are such that re-location is a very expensive, if not prohibitive, option. Avoidance of breaking skylines is again a priority, and silhouette and colour of the building remain important. The design of lighting is also important in minimising visual impacts.

5.4 Conveyor Systems

Typical location, layout and design

Conveyors are normally located either at or just above ground level, on stilts, or rising up from ground level to another element of fixed plant.

For hard rock aggregate the maximum gradient for conveyors is $15-17^\circ$. For sand and gravel the maximum gradient is $14^\circ$.

Conveyors are normally covered with cladding material shaped to shed water to either side.

Where one conveyor feeds into another they will ideally be arranged so that they are in line. If a change in direction is required the first conveyor will feed into the second via some form of hopper arrangement in order to reduce spillage.

Some conveyors, especially those supplying material from a mobile primary crusher at the rock face to a fixed secondary crusher at the main plant site, are semi-mobile. Some even employ sophisticated guidance systems to allow them to follow the movement of the crusher as it traverses the face.

Typical problems and impacts

Conveyor systems are by their nature linear in form and as such long conveyor runs may seem out of character in the landscape, especially where they cross other more natural linear features. Where conveyors have to rise up and over landforms or bunds, the conveyor may break the ‘artificial’ skyline created by the landform or bund.

The gradient limitations also mean that long runs may be needed in order to gain sufficient height to feed aggregate from one element of plant to the next. This in turn may have knock on effects on the locations of other elements of plant thereby increasing the landscape and visual impacts of the other plant. Such conveyors may also cause vehicular circulation problems.

Conveyors used for placing material onto stockpiles will need to extend above the height of the stockpile. Material constantly falling from the lip of the conveyor onto the stockpile may draw the eye towards both the conveyor and the stockpile below.

Conveyors will also require maintenance access along their entire length, and this will often take the form of a road or track running alongside the conveyor. This in turn emphasises the linear nature of the conveyor.

Scope to reduce landscape and visual impacts

Within the limits on gradients noted above, conveyors are perhaps more flexible than many other elements of fixed plant. Even fixed conveyors are relatively easy to move to new alignments or locations as the development of the quarry progresses.
It is also sometimes possible to sink or bury conveyors below ground level, or to run them through tunnels under roads, public rights of way, watercourses or bunds.

Powered conveyors are an efficient method for aggregate handling which avoids the need for vehicles. However, wherever possible material will be moved by gravity feeds which are technically unsophisticated (and therefore less likely to break down than conveyors) and have low or zero energy requirement.

5.5 Screening/washing

Typical location, layout and design

Screens and washing plant are normally located within the main quarry plant.

Aggregate will be delivered to the top of the screen and/or washing plant and exported from the out feeds by conveyor.

In sand and gravel quarries the sand cone will normally be located towards the base of the primary screen and/or washing plant unit.

Oversized material will be returned to the secondary or tertiary crusher by conveyor for re-processing. Reject material will be collected and removed for disposal by loading shovel.

Typical problems and impacts

Multi-deck screens in particular are often some of the highest structures in the plant layout.

The linear nature of the conveyors feeding and exporting from the screen and/or washer, combined with the movement of loading shovels in the vicinity, will often draw the eye of observers towards the plant.

Washing plants require significant quantities of water. Water that has been used for washing needs to be treated, normally through the use of thickening systems and silt presses (see below).

Scope to reduce landscape and visual impacts

Screens and washing plant can both be clad in appropriately coloured materials to reduce the visual impacts.

Although the screen structures themselves cannot readily be reduced in size without impacting upon operational efficiencies, in some quarries there may be opportunities to lower the complete structures into the ground.

5.6 Sand towers

Typical location, layout and design

Normally situated within the main plant area of sand and gravel quarries, sand towers are fed with a pumped sand/water mixture from the sand cyclone which is normally attached to the primary screen. The sand tower typically incorporates a further cyclone element, raised up on a
frame to a top height of approximately 8m, which separates the sand and water. There may be separate fine and coarse sand towers on a site depending on the variability of the as-dug raw material.

Typical problems and impacts

Although not the tallest items of plant in a sand and gravel quarry, sand towers are often situated slightly away from the main quarry plant (in order to facilitate vehicle movements in and around the plant) and this slight spatial separation may increase their visual impact.

The (normally temporary) stockpiles that are formed as sand leaves the tower before it is moved to the main sand stockpiles may fluctuate in size more than the main stockpiles (see below). However, such stockpiles are generally much smaller in size than the main stockpiles.

Scope to reduce landscape and visual impacts

The size of sand towers is dictated by the design of the sand separation equipment that is being employed. For example, some types require a feed hopper above the main separator and this will increase the overall height. The height requirement is also dictated by the need for the out feed from a sand tower to empty onto a (temporary) stockpile, ideally without the use of powered conveyors.

It may be possible to locate sand towers closer to the main items of plant and thereby reduce the visual separation of the different plant elements, though this may have impacts on vehicle circulations.

Figure 5.2: Sand tower.
5.7 **Stockpiles, Hoppers and Bins**

**Typical location, layout and design**

Stockpiles may be of two broad types of material – as-dug or partially processed materials, and marketable aggregate products or aggregate awaiting further processing into value-added products such as concrete or asphalt.

Stockpiles of as-dug or partially processed material may be located either within the main quarry, alongside the main plant area or on adjoining land under the control of the quarry operator, depending on the size of the quarry. In the case of large hard rock quarries or quarries that are worked on a campaign basis they may contain many tens of thousands of tonnes of material, covering substantial areas and rising to significant heights.

Stockpiles of processed aggregate will normally be located in and immediately around the main plant area, fed directly from conveyors running out from the main plant.

Distribution vehicles are likely to be loaded from the stockpiles using loading shovels.

Where the aggregate is intended for added-value products such as concrete or asphalt, storage may be in covered stockpiles, in silos or hoppers, or in bins. Covered stockpiles will normally be in buildings of substantial dimensions and their contents may be loaded by automated systems. Silos and hoppers are likely to be raised up so that road or rail vehicles can pass under them for filling. Material in bins is likely to be loaded into distribution vehicles by loading shovel.

**Typical problems and impacts**

The main visual impacts from stockpiles arise from their frequently substantial size. This means that they will often be seen to break the skyline or to create silhouettes.

Where material is handled by loading shovel, the constant movement of vehicles in and around the stockpile will tend to draw the eye. Although smaller in scale than stockpiles, the movement into and out of bins will have the same effect.

In the case of covered stockpiles, silos and hoppers, the main visual impacts are likely to be because of their height (and in the case of covered stockpiles, their dimensions), although the movement of vehicles will also be a visual attractor.

A further landscape and visual impact of external stockpiles is the changing size and shape of the stockpiles as material is added and taken away. Such changes are likely to be short-term however, with variations occurring day-to-day. In the longer term, unless demand drops significantly stockpiles are likely to remain more or less constant as operators will need to maintain adequate stocks to supply their customer base.

**Scope to reduce landscape and visual impacts**

There may be potential to reduce the landscape and visual impacts of stockpiles by using a number of small stockpiles in place of one larger one. This approach will require additional base area to store the same volume of material, but the reduced height of the resulting multiple stockpiles may be significant.

Stockpiles can also be positioned in line to screen one another so that only the nearest stockpile is visible from sensitive receptors.

As well as maintaining the aggregate in a dry condition, the use of covered stockpiles may help to reduce the impacts of stockpiles by allowing the use of coloured and/or graded cladding. Covered stockpiles will also be perceived as being more constant in dimensions that open ones.
Storage bins, either covered or open, are likely to be lower in profile than other forms of storage. The potential downside is that they will have limited storage capacity, though a range of smaller bins may be useful where a variety of different products need to be stored.

On some sites, storage systems may be more sophisticated than those described above, with underground retrieval and loading systems that remove the need for loading shovel activity near the storage areas.

5.8 Thickening systems/silt presses

Typical location, layout and design

Quarry washing water treatment plants now normally use a combination of thickening systems and filter presses which are highly variable in size depending on the throughput required. At one end of the scale, the largest in the UK consists of three 7m high thickening cones and five filter presses mounted on a frame that stands 5m above the ground, together with water storage tanks, flocculent dosing and mixing systems, and silt buffer tanks. Though they still consist of the same functional parts, most systems are considerably smaller than this.

The thickeners and silt presses will normally be located close to the washing plant in or near the main plant area, though the dirty water can be pumped to a more distant facility.

Typical problems and impacts

The landscape and visual impacts of the plant relate to its size and massing, and the fact that it is normally located close to, but to the side of, the main plant area, thereby potentially increasing...
the overall massing of the plant site.

As with the activity of mobile plant in and around other parts of the fixed plant, the movement of mobile plant involved in extracting and loading the silt cake will also tend to draw the eye towards the plant, thereby emphasising its presence.

**Scope to reduce landscape and visual impacts**

Mitigation measures for water treatment facilities relate to the use of coloured cladding and/or colouring of the individual components.

There may also be potential to sink the plant to reduce its effective height.

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**Figure 5.4:** Flocculation system and silt press (under construction).

### 5.9 Fuel storage

**Typical location, layout and design**

Fuel for mobile plant is normally stored in bunded tanks located near but separate from the main plant site.

In modern tanks the bunding is normally part of the overall tank. Older tanks may require a concrete or blockwork wall with a sealed lining of sufficient volume to hold 110% of the
volume of the tank to be built around the base of the tank.

Tanks may be located at ground level or may be elevated to 2 or 3m to allow the use of gravity flows for the filling of vehicles.

Remote items of other plant such as primary screens or powered feed hoppers may be powered from portable generators which may require separate fuel storage facilities.

**Typical problems and impacts**

Fire risks mean that fuel tanks will normally be in spatially slightly separate locations from the main plant area. This may have visual impacts by appearing to increase significantly the area of land occupied by the plant.

Elevated tanks, though probably less common, will have even greater visual impacts, particularly if they break the skyline or cause silhouettes.

Fuel tanks will be a focus for vehicle movements and are also likely to be illuminated during after dark working hours – refuelling is often done outside of ‘normal’ working hours in order to maximise productive time for plant.

**Scope to reduce landscape and visual impacts**

Avoidance of elevated tanks.

Minimise spatial separation from main plant area while maintaining separation distances as required by health and safety legislation. Group multiple tanks.

Where feasible, tanks should be coloured in neutral colours (e.g. dark or olive green).

Use of other plant elements to screen fuel tanks from sensitive receptors.

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**5.10 Pipes and Cables**

**Typical location, layout and design**

Pipes and cables may occur throughout a quarry and plant site. They are located broadly in three generic contexts: underground, on poles/pylons/gantries and attached to substantial buildings/structures.

**Typical problems and impacts**

Typical problems with regard to landscape and visual impact are concerned with breaking skylines, silhouettes, untidiness, “industrialisation” of rural contexts and the visual impacts of poles/pylons/gantries etc which support pipes and cables.

**Scope to reduce landscape and visual impacts**

Wherever possible, pipes and cables should be buries or included within runs along/inside buildings/major structures/conveyor routes. Where this is not possible, their siting should be considered to avoid breaking skylines and to provide a simple profile or silhouette.
5.11 Large Buildings

Typical location, layout and design
Large buildings may include bagging plants, vehicle maintenance facilities, covered stockpiles, homogenising sheds or a raft of other functions. They may be located anywhere but are generally found at the core of the plant site.

Typical problems and impacts
Principal problems and impacts occur because of broken skylines, silhouettes, high level lighting, poor architecture, vehicle movements, associated clutter but, fundamentally, the rectilinear shape/mass/height of these structures.

Scope to reduce landscape and visual impacts
Solutions include the considered siting and grouping of these buildings such that they do not break skylines and that their “mass” or “combined mass” is attractive or, at least, sympathetic to the context. Lighting should be low level (with a minimum of windows or translucent panels at high level). The architecture of the building (including style, material, texture, colour, fenestration etc) is key. These buildings may, for example, be camouflaged by the careful use of graded external patterning or murals. The buildings or group of buildings could be lowered (by excavation) or used themselves as a screening mechanism for other less attractive items or activities.

5.12 Weighbridges and Gatehouses

Typical location, layout and design
There may be several weighbridges depending on the nature and scale of the operation. Typically, however, lorries need to be weighed in and out on a single or pair of weighbridges. They are also usually located near the entrance to the site adjoining a weighbridge.
office/gatehouse; these may also double up as general offices/staff facilities on small sites.

**Typical problems and impacts**

Landscape and visual impact problems stem from clear views of the activities from the public highway (or other viewpoints), untidiness, a concentration of lorry movements or the poor quality of the buildings (often portable). The gatehouse/weighbridge office may be a well-lit area which may cause visual intrusion.

**Scope to reduce landscape and visual impacts**

Solutions to these problems can be applied by improving the quality of the buildings, hiding the activity behind bunds/fences/planting/other buildings (especially, interlocking bunds along the public highway), using low-level lighting and locating car/lorry parks and waiting/queueing areas out of sight from public receptors.

![Figure 5.6: Weighbridge and gatehouse.](image)

5.13 **Wheel Washing**

**Typical location, layout and design**

There are several ways to clean the wheels of road-going vehicles before they leave an aggregate quarry plant area. Water dips, mist sprays, manual washing points, vibrating rollers and cattle grids/sleeping policemen. By definition, such techniques need to be applied near to the public highway and, usually, on a piece of metalled access road.

**Typical problems and impacts**

There are various landscape and visual impacts caused by wheelwashing which, while generally minor in nature, can combine with other impacts to have a cumulative effect. These include spray, run-off, mud on the highway, dust (from system failure or very dry periods) and the concentration/movement of lorries.
**Scope to reduce landscape and visual impacts**

Visual impacts from mud/dust on the public highway and the minor visual impacts from the wheel washing process can be very substantially minimised by proper design of the metalled access road of adequate length. A combination of techniques described above located to avoid visual impact increases success.

### 5.14 Offices and Staff Welfare Facilities

**Typical location, layout and design**

The offices, canteen and other staff facilities represent the building or cluster of generally small buildings where the most human activity on site occurs. All staff, visitors and contractors are centred on this complex. It is located, typically, near the access point but also near the core of the plant site. There is a requirement for adequate visitor and staff car parking. The buildings may range from portable cabins to bespoke two storey brick or concrete buildings.

**Typical problems and impacts**

While generally not the most intrusive element in the process, these buildings can look incongruous, temporary, cluttered and ad hoc. The car parking can also be ill-defined, badly surfaced and extensive.

**Scope to reduce landscape and visual impacts**

The solutions to these problems lie in the choice of location, layout, quality of “architecture”, materials, colour, lighting, signage and definition of car park, external areas etc. It can help if the complex has a “theme” where it can reflect or, even, incorporate existing farm or other buildings. This group of buildings represents the main ones which are of a human and domestic scale. As such, they are useful in disguising the industrial nature of the overall process.

### 5.15 Lighting

**Typical location, layout and design**

Generally, lighting falls into four categories: internal to buildings, external on buildings and structures, on poles/posts, or on vehicles. Lighting is essential for the safe and efficient operation of the quarry and plant.

**Typical problems and impacts**

Typical problems from lighting include:
- light escaping to sky;
- moving lights on vehicles;
- reflection of light;
- colour of light (e.g. neon);
- emphasis of “urban” or “industrial” feel in a rural context.
Scope to reduce landscape and visual impacts

There are various solutions to the problems normally encountered. Firstly, external lighting should be downward facing and hooded. All lighting, where relevant, should be time-controlled. All lighting on poles/posts should be avoided on skylines or on rims of quarries. Lighting should not face floors or surfaces which readily reflect light onto unwanted areas or the night sky. Neon or coloured lights should be avoided. Translucent panels or windows should be avoided where internal lights will draw attention to a building. The complete “family” of lighting should be assessed cumulatively in order to minimise or remove any “urban” or “industrial” feel. Moving lights on vehicles should be screened by landform, fences, planting or buildings where it could cause visual intrusion.

5.16 Fencing and Security

Typical location, layout and design

Fencing and security features are an essential requirement of quarries and plant areas; they are dangerous places. Typically, the quarry void will be surrounded by security fencing as will the plant site and any additional areas of potential danger or security threat such as water bodies, silt ponds etc.

Typical problems and impacts

Security fencing varies considerably in design but may be 2 or 3 metres high, of metal and with anti-intruder elements at the top. It tends to be unattractive, stark and divisive. It may break skylines from some viewpoints or provide an unattractive backdrop to others. It requires maintenance and may be the subject of vandalism.

Scope to reduce landscape and visual impacts

Several techniques may be used to minimise the impact of such fencing. Firstly, fencing can be located within landforms which screen them, within planting or within building groups. Skylines can be avoided. Detailed design or material choices may reduce the impact through colour or pattern or variation. Where fencing is for the control of animals, there is a wide range of choices reflecting the local vernacular whether Cornish hedgebanks, Derbyshire dry stone walls or wooden stock/deer fences.

5.17 Defunct/derelict Items

Typical location, layout and design

Quarry operations and processing of products can result in a gradual accumulation of defunct, superceded or surplus fixed or mobile plant. These are often retained for spares or emergency use. Similarly, some buildings and structures are no longer needed and may become empty or derelict.
**Typical problems and impacts**

Accumulations of old plant and spare parts can be unsightly, especially if they are in heaps and/or spread throughout the plant area or the quarry.

**Scope to reduce landscape and visual impacts**

Having a dedicated area for such accumulations is useful in that it concentrates the potential visual impacts into one place. It is also tidier and more efficient. This area can be enclosed by landform, fences, buildings or planting.

Buildings or structures which reach the end of their usefulness should not be allowed to become derelict or unsightly. They should be renovated, given new uses or demolished. The “built” footprint of the quarry/plant area should always be kept to a minimum.
6. TECHNIQUES FOR REMOVING, MINIMISING OR MITIGATING LANDSCAPE AND VISUAL IMPACTS

6.1 Introduction
The research results described in the preceding chapters has identified 24 broad techniques for removing, minimising or mitigating landscape and visual impacts. Their application or relevance to the principal items of plant is shown in Table 1 (overleaf). In this chapter these techniques are described and collated.

6.2 General Siting
The choice for the location of plant site and/or the principal pieces of fixed plant is, perhaps, the most important in minimising any visual impacts. There is, of course, a necessity for the plant area to be located at some point between the original source of the rock (the faces/benches) and the egress onto the public highway, railway network or sea. There is often a separation between the vehicles used within the quarry and those that distribute the aggregate nationwide; the plant site normally represents that changeover point.

Given the infinite variation of landscape context, quarry shape, and factors such as access road length, it is impossible to give definitive guidelines. However, the objective must remain to locate the plant site such that it causes no or minimal visual impact (and destroys no or limited landscape elements of value). Such a location may use distance from receptors, existing planting (such as woodland), existing landform (such as hills or cliffs) and/or existing buildings (such as an industrial complex or farm cluster) to conceal the proposed aggregate plant site.

The landscape context will define the problem; in a flat, open landscape the scope without mitigation may be limited. In an undulating, wooded landscape, the possibilities for complete concealment may be achievable.

6.3 Avoiding Skylines
In the context of aggregate plant, there is not just one skyline but a series depending on the location of the viewer. The users of a footpath may have a series of evolving skylines. Plant which breaks any skyline generally is visually more intrusive than the same plant seen against a backdrop. Any movement (whether vehicles, conveyors, emissions etc) is highlighted when seen against the sky. As part of the general siting consideration, the impact on skylines is essential. A relatively well designed and concealed plant site may become more visually intrusive if just one or two elements breaking the skyline catch the eye and draw the viewer towards the activity below. These elements may be detached from the main plant site (floodlighting, power cables, primary crusher building etc) but they may not only catch the eye but introduce industrial elements into an otherwise organic, rural landscape and context.

Physically or computer modelling of the proposed plant in its proposed broad landscape will help to avoid such impacts. Such modelling needs to take into consideration the
changing context of both the quarried landform over time and also the growth of existing and new planting and vegetation.

Table 6.1: Potential methods for reducing the landscape and visual impacts of different elements of fixed plant
6.4 **Configuration and Layout**

Having established the optimum general location for the plant site and any individual items as described in 6.2 and 6.3 above, it is necessary to plan the actual configuration and layout. While “massing” is dealt with separately in 6.6, there is a general desire to minimise the footprint and confine any potential impact. One building, structure or activity may be used to screen another. Thus, orientation of the layout is important; generally, the wider elevation should not be presented to the most sensitive or extensive receptors. A rotation through 90° may offer a narrow, less intrusive profile.

Such profiles, even if not seen against a skyline are important. The nature of the backdrop against which the profile is to be seen is relevant in deciding a configuration.

While this study is concentrating on fixed plant, it cannot be ignored that such plant is central to lorry and other vehicular movements within the quarry/plant site and the connection with the public highway, railway network or sea. Visual impacts of any plant must be assessed in the context of the vehicle movements associated with it.

6.5 **Architectural Style**

In the past, an aggregate plant site was often an accretion of ad hoc buildings and structures. Today, not only are the visual and landscape impacts of any plant site key to any environmental assessment and planning permission but there is more awareness of the potential to integrate the plant site into the local and wider landscape context.

Two ways to achieve this integration consist of utilising existing buildings (especially farmyard groups) and/or using an homogenous modern style with buildings/structures of similar materials, colours, textures etc.

No prescriptive advice can be offered, given the infinite potential contexts and opportunities, however, it is most important that the issue is addressed thoroughly and the various options evaluated.

6.6 **Massing**

The next sections address the individual techniques which derive from the more generic solutions described above. “Massing” i.e. the impact of the overall weight of the combination of buildings and structures in any view can work in different ways dependent on context. Similarly, with the silhouette of the configuration, the backdrop may or may not help the plant to disappear visually or be accentuated.

In most cases, especially in flatter, open landscape contexts, it may be advantageous to concentrate the buildings and structures so as to minimise the area affected visually. In busier, varied landscapes, a distribution of structures may recede against a complicated backdrop where a stark concentration may stand out.

As with “architectural style”, there can be no prescription but the issue needs detailed consideration against the landscape (especially built landscape) context.
6.7 Materials
Balanced against factors such as cost, safety and operational requirements, the choice of materials for buildings and structures can help to remove or mitigate visual impacts. Where possible, materials should be chosen which relate to the local character of the area and, in particular, to existing retained buildings, walls etc on site. Unusual, uncharacteristic materials or combinations of materials are likely to draw the eye and heighten impacts. Materials should be chosen with maintenance in mind so that degeneration of structure, pattern, colour etc does not occur. Colour, pattern and disguise are discussed in 6.10.

While the vast majority of buildings are likely to be removed on completion of quarrying, some larger buildings may be able to perform a useful function as part of the afteruse. Investment in materials which endure, age and contribute to this long term usage should be considered.

6.8 Cladding
Many buildings may be constructed using proprietary metal and coated metal cladding. Similarly, various awkward shaped processes may be enclosed in frameworks which lend themselves to simple cladding. There is a balance to be struck between the waterproofing of the process and general protection of the workforce and the ease of maintenance, access and Health and Safety.

Structures and equipment which are odd shapes and composed of a high percentage of void may recede when seen against certain, often busy, backdrops. Cladding of such structures and equipment transforms them into formal buildings, almost always rectilinear with hard edges.

Where cladding is used the silhouette, pattern and colour are critical (see below).

6.9 Covering
As with cladding above, some processes and, in particular, storage of materials may benefit from being covered. Stockpiles of a variety of finished aggregate sizes will often be covered to reduce the impact of wind and rain. Such covering needs to be given the same detailed consideration as the other construction materials in the other buildings and structures.

Roofing/covering, again, creates structures which are rectilinear at high level; this often increases the visual impact. Flat and sloping roofs can collect dust which may, itself, accentuate the visual intrusion drawing attention to negative factors.

Assessments need to be undertaken on each project to establish whether one large or several smaller structures can reduce visual impact and whether there is one orientation which presents the narrowest profile to the most sensitive receptors.

In addition to material choice, colour, pattern etc, the option of lowering the area such that high ridged covered stockpiles sit lower in the landscape is an option discussed at 6.11 below.
6.10 Disguise

There are various techniques by which normally visually intrusive buildings and structures may be camouflaged such that the impact is reduced. Camouflage always relates entirely to the surrounding context.

Figure 6.1: Graded colours can help to break up an otherwise solid outline.

Techniques include:

- netting (as used by the military);
- patterns (to break up large, plain monochromatic surfaces);
- trompe l’oeil (to create false perspectives or to create false images; for example, a single, clean, bright external red door in a massive dusty grey façade will fool the eye at distance into believing that the wall is not dusty);
- gradation of colour (grading cladding on a tall building from dark green through light green and from mid blue to light blue upward towards the sky);
- building type (placing a visually unattractive process inside a building which resembles an attractive barn or farm building);
- stretch fabric with a printed photograph or pattern (as used around construction sites or building renovations).
6.11 Lowering

It is assumed that for reasons including cost and visual impact, buildings and structures will be built to the minimum height possible. However, there is clearly scope to lower the ground level on which these buildings and structures sit. With enough excavation they would be rendered invisible to the surrounding receptors.

There are six main factors which can make lowering of the plant site (or part of) a less attractive option:

i) **Timing** – plant sites are usually established at a very early stage. Material (hard rock or sand & gravel) would have to be excavated and stored on the surface while the plant site base level was established.

ii) **Retention walls** – particularly in sand & gravel quarries, the sides of the lowered plant site may need to be retained. If lowering of the plant site is being combined with screening bunds, the latter may also need to be retained on their inner face.

iii) **Drainage and pollution** – where the water table is high (or in areas of high rainfall), it may be impractical to lower the plant site. Drainage can be installed but often this will have to be continually pumped drainage which may have to be combined with oil separation filters and silt settlement facilities.

iv) **Fuel/energy consumption** – lowering the plant site will mean that dump trucks, loading shovels etc. will use significantly more fuel in the day-to-day operations because of the need to traverse the sloping haul roads leading into and out of the plant site. The effect on road haulage vehicles will be even
greater as they will always be travelling uphill fully loaded as they leave the plant site. The increased fuel usage will also increase the overall carbon emissions that arise from the quarry operation.

v) **Emissions dispersal** – although plant involved in adding value to aggregates is outside the scope of this study, such plant will normally be best located close to the main fixed plant area. If the main plant has been lowered to reduce its external visibility there may be impacts on plume dispersal from the stacks associated with the value-adding plant, and this may then require an increased stack height.

vi) **Cost** – each of the five factors described above add costs to the construction, operation and decommissioning of the plant site (or part of).

### 6.12 Location Off-site

A plant site may be located off-site (i.e. not within or immediately next to the quarry providing the raw material) for a variety of reasons. There may be inadequate space or difficult access for vehicles. In the latter case excavated material could be sent by conveyor to a more convenient location. In addition, the situation arises where a quarry exhausts its supply of raw material but the plant site can be used with material supplied from a new site. Operators with substantial investment in the plant and with established markets may wish to continue processing and sale of product.

However, some potential sites may be acceptable environmentally for quarry extraction but unacceptable for the location of a plant site (perhaps for landscape or visual grounds). In these circumstances, it may be possible to locate the plant site elsewhere in an environmentally acceptable location and send raw material by lorry or conveyor to the plant site.

### 6.13 Direction of Working

A plant site is unusual in that its immediate context (or part) changes over time as the quarry is excavated. A plant site that is well hidden from sensitive receptors by existing landforms at the commencement of extraction may be open to view once an intervening hill has been quarried. This poses a potential problem and a potential opportunity.

During the environmental assessment and as part of the overall design, the visual impact of the plant site must be assessed throughout the projected life of the quarry. It may be possible, therefore, to work the quarry in a specific direction (or directions) to leave a plant site hidden for lengths of time (by which woodland may have grown or new intervening landforms created).

Selecting the direction (or directions) of working is one of the principle techniques for minimising or removing visual impact of faces, plant or activities. By working the main face of a quarry towards the most sensitive receptors (with the working face orientated away from the receptors) potentially all views of quarrying activity apart from the initial
soil/overburden strip are removed. Exactly the same site excavated in the reverse direction may give the receptors continuous views of the main face, including all activity associated with the extraction. In Hard Rock quarries, this main face will consist of fresh rock revealed by each blast or extraction method.

![Figure 6.3: A planned direction of working can (a) increase or (b) reduce the visibility of a quarry](image)

Advancing a quarry towards a sensitive receptor leaves the maximum extent of ‘virgin’ ground in place between the main face and the receptor for the longest period of time. This maximises the time for final faces to be ‘softened’ or restored.

This ‘virgin’ ground between the sensitive receptor and the advancing quarry is, in itself, a screening mechanism. The ground may slope upwards from the viewer such that its screening function is enhanced. Equally, temporary screening bunds could be located within this ‘virgin’ ground to screen any particular visual intrusions specific to that location.

The pressure to select one particular direction of working is easily dealt with if there is only one or one group of sensitive receptors. Where there is a wide distribution of such receptors, specific direction of working can only help receptors in one location. In this case, the sensitivity of the receptors needs to be assessed and graded. Direction of working is the technique which should be reserved (all other technical, commercial and environmental factors considered) to protect the most sensitive or highly rated receptor(s).

**6.14 Soil Materials Storage as Screen**

This section (and the following five sections) deals with the mitigation of any visual intrusion by the use of an intervening screening mechanism – in this case – soil
materials. In almost every quarry the initial act is the stripping of topsoils, subsoils and overburden to reveal the rock or sand & gravel for extraction.

These three materials must be stripped and stored separately and must not be mixed.

Topsoil is a valuable, organic “living” material which is the top growing layer. It should not be stored in mounds higher than 5 metres and should not be stored long term. Subsoil is the next layer down in the natural sequence and may be stored to greater heights and for longer periods. Overburden is unwanted generally inert fragmented or weathered rock contaminated with clays or other material of varying particle sizes.

These materials have to be stored somewhere on the periphery of the site in locations where they are not disturbed or will not need to be double handled and moved frequently. Such materials can be used to form screening landforms which can be grassed.

![Figure 6.4: The storage of materials can help to screen a plant site. Planting outside the bunds can help to reduce the visual impacts of the bunds themselves. Technical limitations may prevent the bunds from screening the entire plant site.](image)

Wherever possible such temporary (or permanent) screening landforms should look as natural and in-keeping with the surrounding natural landform (i.e. shapes, slopes, heights, curves etc). Stark, linear, trapezoidal section mounds should be avoided. They may be as visually intrusive as the plant they are attempting to conceal.

Again wherever possible such screening landforms should be permanent and capable of integration into a final restoration landform. This will enable them to be planted at an early stage adding to any screening potential. Clearly, topsoils and subsoils may be
needed for restoration of the plant site or quarry. Overburden and other waste inert rock from the processing stages can be built into permanent sympathetic landforms.

6.15 Landform Screening

Landform screening is the use of existing or newly-excavated landforms to screen the plant site from sensitive receptors. Not only does such a landform screen the plant site from certain directions but, as a minimum, it may provide a natural backdrop to the plant site when viewed from the opposite directions.

Landform screening is one of the alternatives that should be considered at the general siting stage early in the project concept evolution.

6.16 Fence/Wall Screening

Fences and walls offer another screening mechanism where visual intrusion/impact cannot be avoided by other means. They have the advantage of requiring minimal footprint (cf landforms or planting) but providing solid and immediate effect. They can have the disadvantage of being hard rectilinear elements in a soft rural context. Choice of materials is paramount and should be in context with the surrounding vernacular materials and style.

Fences and walls, generally, are restricted to 2-3 metres in height but may be used in combination with existing or new screening landforms to provide additional height.

They may be softened by locating them within existing vegetation or by placing them behind newly planted areas.

They are a useful way to fill in the gaps between other screening mechanisms such as existing buildings or landforms.

6.17 Planting Screening

Vegetation is a common way to screen a plant site and/or help to integrate it into the landscape. Existing vegetation, especially woodlands, tree belts and mature hedgerows provide scope to enclose, partially enclose or screen views from some sensitive receptors. New planting (or the supplementing of existing) can provide the same effect but with the added factor of having to wait for annual growth. The effectiveness of screening is a factor of the height and thickness of any plantation and, in addition, a factor of the species, the understorey, the season and cumulative effect with other elements such as landform, buildings or fences.

Species selection is, therefore, vital both to achieve screening but also so that it reflects the local palette and ecology. A row of alien, fast-growing evergreens may be as intrusive as the plant area it is attempting to conceal. It may also contribute little to local biodiversity. Preparation for planting, the quality and size of stock, the planting technique, the drainage and watering provision, the protection from weather and vermin, the management regime and replacement programme are all key factors in the success of any planted area as a screening device.
In addition to its use for screening, new planting or existing vegetation is beneficial as a backdrop to any view and as an internal softening element within a plant site.

To avoid the removal of maturing vegetation at the end of the quarry extraction, wherever possible, the planting scheme should be part of the overall, final restoration and after use scheme.

6.18 Screening using Buildings
This technique uses existing off-site buildings, existing on-site buildings or new “visually acceptable” buildings on-site to screen any visually intrusive elements from sensitive receptors. The plant site layout can be so configured that elements screen each other and/or present their most attractive or neutral façade towards any sensitive receptors. Parts of the plant process which involve the most movement or lighting may be concealed behind static more neutral buildings, walls or facades.

![Figure 6.5: A domestic scale building close to receptors can screen much larger structures behind.](image)

6.19 Parking/Waiting Area Design
While this study concerns the fixed plant associated with aggregate quarries, there are key areas where the interface with moving vehicles can have negative visual impacts. Staff and visitor car parking requirements may vary considerably in size from a small sand & gravel unit to a large hard rock quarry. However, it is important that the car park is located such that the visual impacts (including movement, lights, glare, dust etc) are minimised. These impacts may be further reduced by surfacing, low level screening, discreet lighting and clear signage. Lorry and mobile machinery parks for on-site vehicles, again, need to be located to avoid visual impacts. All car and lorry parks need to be located to reduce other environmental impacts such as noise.
Lorries entering and leaving the plant/quarry site can be one of the most visually intrusive elements of the whole operation (especially if there are sensitive receptors near the entrance or approach roads). The queuing or layout up of vehicles on public roads waiting for the site to open should be avoided. Adequate queuing and waiting areas (and road-going lorry parks) should be located away from receptors wherever possible and behind mitigating landforms, fences, buildings and planting where this is not possible.

6.20 Interlocking Spurs
Interlocking spurs or bunds are a valuable technique for mitigating the visual impact of a plant site (and the quarry beyond), particularly for views into the entrance. This also applies where bunds need to be breached to provide access or routes for pipelines/conveyors etc. Gaps or notches in bunds may themselves be intrusive or tend to draw the eye. Even if the interlocking bunds do not conceal all of the upper parts of buildings or structures, they may remove all the ground level clutter and vehicular movement.

Figure 6.6: Interlocking bunds at a quarry entrance with a sunken plant site beyond.

6.21 Signage
Signage may seem a minor element in the visual intrusion of a plant site but when added to other visual impacts, it can contribute to the cumulative effect. Signage also draws the eye to and highlights the activities within the plant site. Signage should be planned, discreet and well designed. All signage apart from that required by Health and Safety or legal (particularly, Highway) requirements should be kept to a minimum. Illuminated signage should only be used where legally required.

6.22 Tidiness
External industrial processes where the context changes on a daily basis (such as quarrying and the associated processing) require clear planning, site organisation and
discipline. While these are required for Health and Safety and other reasons (such as efficiency), they can have a large effect on the reduction of visual impact. The removal of clutter, the allocation of car/lorry/scrap designated areas and the demolition/removal of old structures and buildings all help to reduce the potential visual impact.

Maintenance and management ensure that impacts do not increase. Buildings, structures and grounds maintenance need to be regularly undertaken. The cleaning and sweeping of roads and surfaces are equally important. New planting needs on-going management and, particularly, watering, weeding, feeding, draining and vermin control. Failures need to be replaced to maximise growing seasons and to achieve long term objectives.

6.23 Progressive Restoration

Restoration, rehabilitation or reclamation of a quarry or processing and ancillary areas does not need to be only undertaken at completion of extraction. There are many benefits from the early return of parts of the disturbed land to beneficial uses and to an aesthetically attractive state. Apart from the early re-use of soils, early implementation of planting schemes and early re-use of land for positive purposes such as agriculture, forestry or nature conservation, progressive restoration can create attractive land which acts as a barrier or physical/psychological separation between sensitive receptors and quarry plant or extraction activities.

Where an initial location for a plant site is essentially on existing ground level prior to extraction commencing, scope exists to move some or all of the plant site into a completed part of the excavation at an intermediate stage. This may free up the original plant site for early restoration (even if some further extraction needs to be undertaken first).

6.24 Designing Afteruse

Modern quarries and their ancillary areas require planning permissions which will have a final restoration objective defined by Planning Condition(s). While such restoration may be 5 or 50 years hence, it is important that the temporary use of land (which quarrying represents) is time-limited and an agreed restoration scheme is scheduled. If in the intervening period society changes its requirements, laws, needs or expectations scope exists within the process to amend and update any restoration scheme.

There are clear advantages from knowing the afteruse(s) at the outset of quarrying. Firstly, progressive restoration can take place to an agreed plan. Soil/overburden/quarry waste stripping, handling and storage can be done in an efficient way. New landforms, planting and water bodies may be integrated into the overall masterplan. Double handling of materials and the destruction/removal of maturing landscapes undertaken at an early stage of quarrying are avoided.

The future (and long term) visual impacts of old faces, benches, ramps, waste mounds or roads can be predicted and designed out or mitigated against.
While the precise use of pockets of the restored area may not be defined. The landscape structure and infrastructure to support it may be planned and installed. This means that the future landscape and visual impacts of uses as varied as satellite dish complexes, business parks or housing have for the most part been considered.

The removal of the plant site (including stockpiles, waste tips, temporary bunds etc) is likely to improve the landscape quality and reduce visual intrusion, especially as the screening landforms and vegetation are maturing.

6.25 Alternative Technology or Advances

One way to reduce visual impact cannot be pre-planned or detailed. Over the decades that many quarries are operated, alternative technologies and advances are likely to be devised. Many will have immediate environmental benefits, others may create additional potential visual intrusion. Implicit in any planning permission is the need for regular review such that advances may be incorporated providing they have a net environmental benefit and providing any negative (e.g. visual) impacts can be mitigated against.
Appendices A to F

The following appendices, A to F, were previously published as part of a research project into the visual screening of quarries carried out by David Jarvis Associates Limited. The project was part funded by the Minerals Industry Research Organisation through the Minerals Industry Sustainable Technology Programme. Additional funding was supplied by Brett Aggregates Limited and Professor Geoffrey Walton provided the technical input.
A.1 Introduction

Where all possible opportunities to remove the need for screening of a quarry and/or a plant site have been exhausted, and a need for specific physical screening has been identified, the use of a specially created landform as a screen should be the preferred approach.

At this point, the distinction should be made between the use of ‘landform’ for screening, and the use of ‘bunds’. While there is perhaps no specific technical definition of a bund in this context, and the distinction is at best blurred, a bund is normally (though not always) considered as being regular in shape, relatively small in scale (perhaps a maximum of 5-8m high, or less in the case of bunds constructed only of top- or subsoil) and broadly trapezoidal in section. They are located entirely according to the screening and material storage requirements (rather than being designed to fit with the surrounding landscape). Landform screening is generally of larger scale, more naturally (and unevenly) shaped, and designed to fit into its surroundings as well as creating an effective visual screen between sensitive receptors and the quarry and/or plant site.

Gentle, undulating screening landforms (with or without irregular planting, drystone walls etc.) not only provide visual screening during the operational phase of the quarry and/or plant site but also represent the first phase of the final restoration scheme. They are permanent and in place at an early stage. In addition to the rolling screening landforms, there are other varieties that can play a screening role. These include the re-creation (in phases if possible) of the pre-existing landform which can screen other parts of the quarry and/or plant site, and the replication of landforms which can play a similar role.

A.2 Re-Creation of Previously Existing Landform

As mineral extraction progresses across a site, there may be opportunities on the previously worked parts of the site to re-create the contours, soil profiles and land uses that existed before mineral extraction took place. This landform may then help to screen the remaining working areas of the quarry and/or plant site from sensitive receptors. This is generally more feasible in Sand and Gravel than deep Hard Rock quarries where the final bottom level of extraction needs to be completed before infilling begins.

Consideration should be given to the era that is to be re-created. This would normally be that which existed immediately preceding the working of the quarry, as this is the landscape that receptors will previously have been used to. Alternative eras or landscapes (e.g. pre-intensification of agriculture) may offer ecological, historical or amenity benefits.
Fig. A.1: Re-creation of a previous landform to screen a large hard rock quarry. In this instance, the screening is most effective in long-distance views from the surrounding hills.

Maintaining or improving the quality of agricultural land (assessed in terms of its Agricultural Land Classification or ALC) is normally an objective of the restoration process. There may, however, be areas within the quarry boundaries that are of particular ecological value and which may therefore benefit from different, perhaps poorer quality, soil regimes than existed before quarrying took place.

A.3 Replication

Landform replication refers to attempts by excavation or the placement of materials to simulate natural geomorphological features within the landscape. This is a technique developed to deal with visually intrusive limestone and chalk excavations. One method used in limestone quarries has been restoration blasting where the technique seeks to form a scree and headwall type landform found in limestone dales of Derbyshire and Yorkshire, for example. A similar principle can be applied to screening landforms.

The relevant area is assessed to establish those natural local landforms that could be repeated as a visual screen. Obvious constraints relate to slope angles and morphology since screening banks can generally be no steeper than 35°. However it is sometimes possible to simulate the extension of spurs of land to “hide” a quarry face or quarry operations as a prolongation of a natural feature.

Such an approach is difficult in relation to flat valley landscapes but often viable in more hilly areas or places where glacial features such as drumlins and eskers are found. The technique is particularly important for long-term/permanent screening and can be greatly enhanced by planting. It could be
used not just to screen quarry operations and/or plant sites and final quarry faces, but also post quarrying land use within the quarry such as housing, commercial or industrial buildings.

As with re-creation, there is a need to consider which era is to be replicated. In order to create a locally appropriate landscape which gives the maximum possible screening benefit, replication will normally be of currently existing landforms in order to create a blended landscape that is virtually indistinguishable from that which existed before the quarry.

In most situations there will be little visibly noticeable difference between the landscapes created by re-creation or replication, except in the unusual circumstances of the pre-extraction landscape of the quarry area being anomalous with its surroundings. However, re-creation aims to create a landform that is geotechnically and hydrologically stable in the long term, while replication is likely to be creating a more short-term landform with a shorter expected life before removal or re-modelling. For further information on this issue, reference should be made to Walton G (1995) and other appropriate references.

A.4 Land Uses and Land Cover

Land use and land cover on land immediately surrounding a quarry and/or a plant site can have significant implications for its visibility from outside the site. Careful selection and positioning of land cover, particularly vegetation, can add significantly to the screening effects of landform. Equally, poor choices made here can emphasise unsympathetic landforms. As with physical landform, landuse and landcover should be considered in the context of their surroundings. A more detailed analysis of planting as a screening method can be found in Appendix 3.

However, agricultural crop selection, for example, or farming practices may add to visual screening or provide visual distraction. Crops vary in height from mown or grazed grass, through vegetables, wheat and maize, to sunflowers and short rotation coppice (biomass) crops. Individual or stacks/lines of hay or straw bales can provide unobtrusive low-level screening for the very short term.

Consideration should always be given to how the landcover (and landform) will be managed in both the short and longer-terms, and who will carry out this management. Access and health and safety issues should also be considered, e.g. the mowing of grass may pose serious problems on the steep sides of bunds positioned next to a waterbody.
Fig. A.2: Replicated landform screening which merges into natural landform on either side.
A.5 Afteruses

The design of any screening landform should allow it to benefit, and be seamlessly merged with, the final restoration and afteruse of the quarry and/or plant site itself, whether this will be agriculture or woodland, residential or employment development or a combination of any or all of these. For more information on issues relating to the afteruse of quarries and plant sites, reference should be made to the research report *The Planning and Design of Aggregate Quarries for Non-Agricultural Afteruse.*
A.6 Landtake

The land area that will be required for the construction of screening landforms will depend on a raft of factors, most of them site specific. They include:

- the geomorphology of the site and surrounds;
- the subject matter requiring screening;
- the availability and type of materials for construction;
- the combination of other techniques such as planting or fencing;
- any access/maintenance requirements;
- slope angles;
- drainage/runoff limitations and requirements;
- the nature and height of the viewpoint receptor;
- the nature of the rock/surface on which the landform is to be constructed;
- the proximity of public access; and
- the location of security fences etc.

A.7 (Semi-)Permanent External Slopes

The establishment of a permanent gentle external slope to landform screening at an early stage may have benefits both through the early naturalisation of the landform and through the potential for the management for the slope to be undertaken by others (e.g. adjacent land managers). In certain circumstances it may be possible to reach agreement with adjacent landowners that part of this slope will be located on land not in the ownership/control of the quarry operator, potentially reducing the volume of sterilised mineral.

Fig. A.5: Permanent external slopes to landform screening can form part of the final restoration of a site
A.8 Phasing

The transitional nature of quarrying means that the screening requirements may change over time. As extraction operations move across a site, the area of open quarry that may require screening will normally increase, though techniques such as progressive restoration or face amelioration, can reduce this effect.

Where the area of open quarry and/or visibility of the plant site does increase over time, the extent of (re-)constructed screening landforms may also increase. This landform may require an increasingly large footprint and may also require increased volumes of material from which to construct the landform. This too can often be provided from within the site as a consequence of increasing volumes of unsaleable or waste material that would otherwise need to be stored elsewhere on site. In the case of any permanently re-created landform, and where the volumes of waste/unsaleable material are low, this may also provide opportunities to create any necessary screening landforms through the approved importation of inert waste.
B.1 Introduction

Screening by way of sympathetic, long-term landform (especially when it is a permanent part of the final restoration) is the preferred option. Where, however, space or materials are restricted or where the landscape context makes it inappropriate, landform solutions may have to be substituted by linear or compact bunds. Occasionally, these bunds can be a temporary addition to a permanent screening landform dealing, perhaps, with the visual impact from a specific phase or exposed face. Linear bunds, while often unnatural in appearance, are efficient mechanisms for maximising the use of materials in order to provide screening from human eye level \( i.e. \) 1.4m. In addition to their role as soil/overburden stores and screening mechanisms, linear bunds may also act as linear barriers replacing or reinforcing boundary markers such as fences, hedges \( etc. \) demarcating Public Rights of Way or restricted areas.

B.2 Bare Earth Bunds

Apart from the screening of very short-term visually intrusive activities or the short term or temporary storage of soils, overburdens or fine quarry wastes, all bunds should be grassed, vegetated or covered. There are six main reasons why bunds should not be left uncovered:

1. There is increased danger of collapse and injury or damage to persons or property;
2. There is increased erosion from rain;
3. There is increased likelihood of dust creation;
4. There is likely to be more visual impact from a stark, unvegetated mound;
5. There is an increase in the deterioration of the quality of the material, particularly in the case of topsoil. Nutrients may be lost through leaching;
6. Bare mounds (especially topsoil) may become infested by pioneer weed species which can lead to problems in the post-storage usage of the soils (particularly where topsoils are being used for agriculture or specific planted afteruses).

Fig. B.1: This very short-term bare earth bund is designed to screen sand and gravel extraction in the adjoining field from the house. The site is planned to be stripped, extracted and restored in just six months, but such a bund may start to deteriorate in even this short time period.
B.3 Naturally Vegetated Bunds

Allowing bunds to re-vegetate with local, native species has the advantage that the bund is better assimilated visually and ecologically with the surrounding landscape. However, leaving the bund to re-vegetate may raise the difficulties described for Bare Earth Bunds above. In order to speed up the process of re-vegetating, seeds from local sources (preferably from the site/surrounds) or surplus topsoils containing seeds/plants/root systems should be collected/spread over the bund surface. While local native plants are generally less demanding of water than introduced plants, it is important to maximise and accelerate plant growth through watering and, where appropriate, the addition of nutrients.

**Fig. B.2:** This well-maintained grassed bund does not fit well into the surrounding pastoral landscape. The addition of wildflower seeds into the grass mix would have resulted in better integration.

B.4 Grassed and Planted Bunds

Sowing of grass represents the quickest way to cover a bund and reduce erosion. Grass seed mixes vary considerably and should be selected based on six criteria:

1. PH of soils.
2. Fertility/structure of the soils.
3. Climate (in particular, rainfall).
4. The difficulty of maintenance (e.g. mowing).
5. The use of the bund (e.g. as part of an agricultural unit).
6. The potential for adding to ecological value (e.g. by the inclusion of wild flowers).

The following represent grass/wild flower mixes for a variety of generic circumstances; they should only be used as a guide. Full details and advice should be sought from seed suppliers.

**A. General, neutral soils with a need for rapid establishment:**

<table>
<thead>
<tr>
<th>Browntop Bent</th>
<th>Chewings Fescue</th>
<th>Flattened Meadow Grass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Fescue</td>
<td>Small-Leaved White Clover</td>
<td>Strong Creeping Red Fescue</td>
</tr>
</tbody>
</table>

*E.g. British Seed Houses A16*
B. General, acid soils with a need for rapid establishment:

- Chewings Fescue
- Meadow Fescue
- Sweet Vernal Grass

C. General, alkaline soils with a need for rapid establishment:

- Chewings Fescue
- Small-Leaved Timothy

D. General grass mix for minimal maintenance:

- Perennial Ryegrass (60%)
- Slender Creeping Red Fescue (35%)
- Browntop Bent (5%)

E.g. British Seed Houses A22

E. Neutral grass and wildflower mix:

- Betony
- Common Flax
- Lady’s Bedstraw
- Meadow Cranesbill
- Pignut
- Sainfoin
- Small Scabious
- Yellow Rattle

- Birdsfoot Trefoil
- Common Knapweed
- Marsh Trefoil
- Meadow Fescue
- Ragged Robin
- Salad Burnett
- Small-Eared Timothy
- Yellow Rattle

- Cockfoot
- Common Vetch
- Meadow Buttercup
- Ox-Eye Daisy
- Ribwort Plantain
- Self-Heal
- Tall Fescue

E.g. British Seed Houses WFG4

F. Calcareous grass and wildflower mix:

- Bentony
- Clustered Bellflower
- Cranesbill
- Kidney Vetch
- Ox-Eye Daisy
- Small Scabious
- Wild Basil

- Birdsfoot Trefoil
- Cockfoot
- Greater Knapweed
- Lady’s Bedstraw
- Sainfoin
- Small-Eared Timothy
- Wild Carrot

- Black Medick
- Common Knapweed
- Hoary Plantain
- Meadow Fescue
- Self-Heal
- Tall Fescue
- Yarrow

E.g. British Seed Houses WFG5

G. Acidic wildflower mix:

- Betony
- Browntop Bentgrass
- Devil’s Bit Scabious
- Greater Birdsfoot Trefoil
- Ox-Eye Daisy
- Sheep’s Fescue
- Sorrel
- Wavy Hairgrass

- Birdsfoot Trefoil
- Common Cat’s Ear
- Foxglove
- Lady’s Bedstraw
- Ragged Robin
- Slender Red Fescue
- Sweet Vernal
- Yarrow

- Black Knapweed
- Crested Dogstail
- Fragrant Agrimony
- Meadow Buttercup
- Sheep Sorrel
- Sneezewort
- Tufted Vetch
- Yellow Rattle

E.g. Johnsons Pro Flora 2
For tree/shrub planting mixes and techniques, please refer to Appendix C.

Trees and shrubs should only be planted on permanent or very long term temporary bunds. There are three main reasons for not planting short/medium term bunds:

1. Cost;
2. Loss of nutrients/structure;
3. The planting acquires a value and permanency in the landscape which makes it difficult to remove at a later date without additional visual impact.

All seed mixes, tree and shrub planting on bunds should continue beyond the bund into and onto the surrounding land. This helps to integrate visually the bund into the landscape. Changes of mix or maintenance regime at the boundary of the bund only serve to emphasise and highlight an intrusive feature.

**Fig. B.3:** Bund planted with a conservation mix seen in winter, showing continuity of planting onto adjacent land

**Fig. B.4:** Another bund planted with the same conservation mix in mid-summer
B.5 Access and Maintenance

Bunds must be designed to allow access by relevant machinery in order to inspect, maintain and, in due course, add or remove material. Such access must be safe and appropriate to the machinery. Where bunds are next to potential hazards (such as water bodies, quarry face, power lines, pipelines etc.), clear definition, separation and signage should be put in place.

Tracks or transportation routes should never be allowed to traverse bunds as this leads to compaction, pollution and a general loss of soil quality.

Fig. B.5: Vehicles should never be allowed to run across or along soil storage bunds

B.6 Bunds in Restricted Spaces

Occasionally, the available footprint for a bund may be inadequate to provide the height necessary for it to perform its screening function. When all other techniques have been exhausted (e.g. moving plant sites, access/haul roads etc.) there exists the possibility of steepening the inner face by the use of stone-filled wire baskets (gabions), armourstone blocks or, in extreme circumstances, piled steel or blockwork walls.

Fig. B.6: Stone-filled gabions supporting the inside of a bund can help to reduce the footprint of the bund
Where bunds have a hard, steep inner face, clear edge protection is necessary at the top to prevent the public or operatives from danger. This may involve fencing and signage.

**B.7 Interlocking Bunds**

Where bunds need to be breached to provide access or routes for pipelines/conveyors etc., the necessary gap in the bund may provide clear views of any visual intrusion. In addition, gaps or notches in a long linear bund may themselves be intrusive or tending to draw the eye. Such gaps can be avoided by interlocking the bunds such that there is an overlap. This technique is particularly effective at quarry entrances where views of weighbridges, lorry parks, stockpiles, plant and equipment may be concealed from the public highway or nearby properties.

**Fig. B.7:** Interlocking bunds can be used to give access for haul roads, conveyors etc. whilst still obscuring visibility into the site
C.1 Introduction

For many quarries and plant sites vegetation retained or planted at appropriate locations around the periphery of the site can create an effective visual screen. For vegetation to be effective as a screen however, there are a number of factors that need to be considered:

- As a general rule, planting should use locally native species, preferably of local provenance, planted to suit any variation in soils etc. across the quarry where this is significant. This will integrate the planted vegetation with natural vegetation in the surrounding area, as well as increasing rates of successful establishment.
- Species that are native to a particular area can be researched from the Postcode Plants Database on the Natural History Museum’s website at [http://www.nhm.ac.uk/nature-online/life/plants-fungi/postcode-plants/](http://www.nhm.ac.uk/nature-online/life/plants-fungi/postcode-plants/).
- Conifers might be considered to offer a thicker, and therefore more effective, visual screen, but regimented rows of conifers will tend to look out of place and artificial.
- New hedges should normally run towards (false) horizons rather than along them, avoiding breaking the skyline unless this is common feature in the local area. Hedgelines running along a (false) horizon will usually accentuate the skyline, where best practice would normally be to de-emphasise it. Where circumstances dictate that this is necessary, the formality of the line can be broken up by the use of occasional hedgerow trees planted at varied spacings.
- On large sites, the species that occur naturally may vary across the site with soils and geology. Observation of, and research into, this variation can be used to assist in species selection to ensure successful tree establishment, which normally results in a natural-looking graduation of species across the site that will ‘fit’ with the surroundings.

C.2 Protection of New Plants from Herbivore Damage

Before planting new hedges or trees, research should be carried out to ascertain the herbivores found in the area that are likely to cause damage to new plants. Appropriate measures should then be taken to prevent the new plants being eaten. Depending on the precise nature of the site, and the extent of planting, different types of protection will be appropriate:

- rabbit fencing
- stock fencing
- 1.8m high deer fencing
- plastic spiral guards
- plastic quill guards (normally used only for hedge planting)
- 0.6m plastic or mesh shrub shelters
- 0.6m, 1.2m or 1.8m plastic or mesh tree shelters

Under normal circumstances, fencing is more cost effective on larger or regular-shaped areas, whereas individual guards are more cost effective solution in smaller or irregular-shaped areas. Certain types of individual guard also offer an added benefit of creating an ideal micro-climate for the young plants to grow in, effectively forming a miniature greenhouse for each plant where temperature and water conditions are maintained at more or less the optimum for rapid growth.
Figs. C.1 to C.3: 1.2m tree shelters (top left), 0.6m shrub shelters (top right) and net guards (centre)

Consideration should also be given to the need for weed control around the establishing plants, whether this is by the use of herbicides, mulch or mulch mats. Mowing or strimming of grass or weeds around new trees and shrubs should generally be avoided as this in fact encourages weeds and grass to grow more vigorously, increasing competition for nutrients, water etc.

Figs. C.4 to C.5: Spot spraying of vegetation around new planting in tree shelters (left) and mulch mats (right)

An additional benefit of individual tree and shrub guards is the protection that they offer new plants against spray drift (when using herbicides) or strimmer damage (if site circumstances mean that this method of weed control has to be used).
C.3   Hedgerows and Hedges

New Hedges

When planting new hedges, using a larger number of smaller plants (i.e. transplants or small feathered whips) at higher planting densities will normally result in a thicker hedge more quickly than using a smaller number of larger plants.

Fig. C.6: New hedge planted 18 months ago in spiral guards - note the close spacing of the plants and double staggered rows

As noted above, locally native species should normally be chosen. For example, data from the Postcode Plants Database indicates that an appropriate native hedge mix for the White Peak area of the Peak District might include:

- *Corylus avellana* – hazel
- *Crataegus monogyna* – hawthorn
- *Rosa canina* – dog rose
- *Prunus spinosa* – blackthorn
- *Sambucus nigra* – elder

A number of nurseries are now able to supply semi-mature hedgerows in sections, and though this “instant hedging” is an expensive method of establishment, it may be appropriate where instant effect is of importance.

Translocation of Existing Hedges

The translocation of existing (semi-)mature hedges can be a useful tool and, if the correct techniques are used and operations carried out with care, the success rate can be very high. It is particularly appropriate for greenfield sites and for the expansion of existing quarries where an existing hedge would otherwise be lost.

When translocating existing hedgerows from within the site boundaries, research into locally successful techniques that are suited to the particular mix of species will normally pay dividends. In the limestone Mendip Hills in Somerset, for example, experience has shown that there seem to be benefits in cutting the hedge back to 1-1.5m in height towards the end of the previous growing season and, then, translocating the hedge during the autumn or early winter. As with any form of planting, frosty or very dry weather should be avoided. A typical process here is to prepare a trench in the new location, place sub- and topsoils, and then move complete sections of the hedge, together with the understorey species.
Fig. C.7: Translocated hedge after five months

Fig. C.8: Translocated hedge after fifteen months

Fig. C.9: Translocated hedge after eleven years
C.4 Trees and Treebelts

Thin lines of trees positioned along the top of banks will generally look unnatural and should be avoided; a thicker band of trees occupying the entire external slope from base to ridge will normally be more effective as a screen and more natural in appearance. The planting should include both taller (canopy layer) species and smaller (shrub and field layer) species in order to create an effective and natural looking screen. As with hedges, locally native species should be chosen, researched where necessary from the Natural History Museum’s Postcode Plants Database. Examples of typical native species mixes for different situations include:

A. Peak District limestone quarry:

Field Layer

*Corylus avellana* – hazel  
*Ilex aquifolium* – holly  
*Malus sylvestris* – crab apple  
*Prunus padus* – bird cherry  
*Sambucus nigra* – elder

Canopy Layer

*Acer campestre* – field maple  
*Alnus glutinosa* – alder  
*Betula pendula* – silver birch  
*Betula pubescens* – downy birch  
*Fagus sylvatica* – beech  
*Fraxinus excelsior* – ash  
*Populus tremula* – aspen  
*Quercus robur* – pedunculate oak  
*Sambucus nigra* – elder  
*Sorbus aria* – common whitebeam

B. Bedfordshire sand and gravel quarry:

Field Layer

*Corylus avellana* – hazel  
*Ilex aquifolium* – holly  
*Malus sylvestris* – crab apple  
*Prunus padus* – bird cherry  
*Salix caprea* – goat willow  
*Salix cinerea* – grey willow  
*Salix alba* – white willow

Canopy Layer

*Acer campestre* – field maple  
*Alnus glutinosa* – alder  
*Betula pendula* – silver birch  
*Betula pubescens* – downy birch  
*Fagus sylvatica* – beech  
*Fraxinus excelsior* – ash  
*Populus tremula* – aspen  
*Sorbus aria* – common whitebeam  
*Sorbus aucuparia* – rowan

C. Mendips limestone quarry

Field Layer

*Corylus avellana* – hazel  
*Ilex aquifolium* – holly  
*Malus sylvestris* – crab apple  
*Sambucus nigra* – elder  
*Viburnum lantana* – wayfaring tree  
*Viburnum opulus* – guelder rose
Canopy Layer

- *Acer campestre* – field maple
- *Betula pendula* – silver birch
- *Betula pubescens* – downy birch
- *Populus tremula* – aspen
- *Sorbus aria* – common whitebeam
- *Alnus glutinosa* – alder
- *Fagus sylvatica* – beech
- *Quercus robur* – pedunculate oak
- *Salix alba* – white willow
- *Sorbus aucuparia* – rowan

As might be expected for native trees in England, there are few differences in the lists. However, where there are differences these are normally due to geology and soils, as well as local climatic differences, and should not be ignored.

The planting of individual trees should generally be avoided, except where they are part of a hedgerow. Such lone trees tend to draw the eye towards them and may in fact highlight (part of) a quarry rather than helping to hide it.

**Fig. C.10:** Linear planting on top of embankments should normally be avoided
Fig. C.11: This row of conifers is out of character with its surroundings and therefore draws the eye towards them rather than deflecting the viewer away from the quarry.

Fig. C.12: A screenbelt of trees with an offset entrance road combine to completely hide this gravel pit from the adjacent road.

C.5 Woodland and Forestry

Except in landscapes with a predominance of established shelterbelts, larger, irregular-shaped blocks of trees generally appear more natural in the landscape than more linear features. Larger
blocks of woodland can fit better with the scale of larger mineral operations, potentially providing a visual stimulus of sufficient scale to compete for the viewer's attention.

Woodlands, especially where they can be linked together (and to other already established woodlands) by hedgerows, provide a valuable ecological resource for a wide range of flora and fauna. Combining areas of woodland with more open areas (glades) and areas of water adds to this ecological value, leading to the creation of a forest ecosystem. Care should be taken to ensure that trees are not planted right up to the edge of waterbodies, whether still or flowing, as this can lead to detrimental impacts on the nutrient state of the water. An unplanted gap of at least 5m width between the water's edge and the trees is normally appropriate.

Larger areas of woodland can sometimes be managed to provide ecological value and commercial return at the same time.

**C.6 Grass, Heath and Scrub**

Grass, heath and scrub in themselves do not normally provide visual screening. They do, however, represent a 'greening' of bunds and landforms in appropriate soil areas, and are therefore considered under the planting of bunds in Appendix B.

**C.7 Ornamental Planting**

The use of more ornamental planting as a screen may be inappropriate for many, particularly rural, quarries where it may be as visually intrusive as the quarry itself, of lower ecological value than native planting and have a higher cost than more natural planting.

However, for some sites ornamental planting (perhaps mixed in with other more natural planting) may be more appropriate. Such sites might include more urban locations, or those where the intended afteruse is residential development.

**C.8 Management, Access and Maintenance**

When planning the use of planting for visual screening, consideration should always be given to the management and maintenance of the planting, and to the safe access to planted areas for such purposes. The timescales for such maintenance will of course vary according to the type of planting and the site conditions.

**Management of Hedges**

Where they have been used to encourage rapid establishment of hedge plants, plastic quill or spiral guards that have not yet degraded should be cut away once the plants are established. Hedges will then normally need to be trimmed on an annual basis to maintain both the overall shape of the hedge and the required density of vegetation throughout the height and width of the hedge. This operation will normally be undertaken by an agricultural tractor fitted with a flail cutter mounted on a hydraulically operated multi-jointed arm, and the necessary access for such machinery should be designed into the screening from the start, particularly where hedges are positioned on elevated landforms or bunds.
The machines typically have a reach of up to 6m (measured from the centre of the tractor to the outer-most cutting flail), though specialist machines are available with reaches of 8m or more. They are normally mounted on a medium sized tractor (typically of around 100hp and 4500kg minimum weight, or more for long reach machines), and routes from which hedges will be cut will therefore need to be at least 2.5m wide, plus extra at turns and junctions, to allow sufficient room for manoeuvring.

Hedges should normally be cut during suitable weather and ground conditions in the autumn or early winter, at a time when the hedge plants are predominantly dormant, and before wild birds have started nesting in the hedge in the spring.

Management of Treebelts and Woodland

When new trees have been planted as part of the visual screening of a quarry, good management will result in effective screening being established more quickly and thereafter the screening effect being maintained for as long as is required. The general principles set out below will be applicable to the majority of sites, but a management plan specific to the site in question, indicating work that is likely to be required (e.g. thinning) and the corresponding predicted timings, should be drawn up at the time the different areas are planted.

Vegetation around the trees and shrubs should be controlled until canopy closure (i.e. the combined canopy of the plants has increased until it completely covers the ground surface and therefore prevents the germination and growth of ground level vegetation by shading). This is best done by the combined use of mulch or mulch mats and herbicides. This is likely to take 5-10 years from the time of planting, though this will be very dependant on the species planted, their size at planting, planting density, weather and ground conditions, whether individual guards have been used, how well the surrounding vegetation has been controlled, and whether there has been pressure on the young plants from pests and diseases.
Fig. C.14: Young broadleaved woodland showing the growth benefits of individual shelters. Although the grass has been mown across the whole site, spot treatment round the trees with herbicide would have had additional benefits by reducing competition for nutrients and water.

The twin-walled plastic guards are designed so that they will split once the stems within reach the size of the guard. They are also designed to be photo-degradable over time. However, experience has shown that both the splitting and photo-degradation sometimes fail or take too long. In the case of the failure of the guards to split, this can eventually lead to restrictions on stem growth and can also lead to a more-or-less water tight seal developing round the base of the stem. Where this occurs, it may allow water to collect in the space between the stem and the guard, and this can result on the softening and then rotting of the outer bark. The failure of the guards to photo-degrade is also unsightly. For these reasons, the growth of the plants should be monitored in relation to the breakdown of the guards. Where problems are noted, the guards should be forcibly split and removed from the stems. Any stakes that have not rotted away and any remaining ratchet ties should also be removed. Any mulch mats that have been used should also be degradable, but any remaining should be removed at the same time as the guards. Although spiral guards are less likely to cause damage to trees if left on, both these and mesh guards should be removed once they are no longer required to protect plants from grazing animals.

Treebelts and woodlands will nearly always require thinning at some point during their existence. Trees will normally have been planted at 3m (broadleaves) or 2m (conifers) spacing, and thinning is the removal of some of the original trees to give the remainder sufficient room to grow and mature. This approach gives better results than simply planting at wider spacing in the first place as it leads to faster canopy closure and better quality trees, the latter being particularly important if there is to be any economic return from the woodland areas. The length of time between planting and the need for first thinnings will be dependant on a number of factors, but the most important of these will be the species of trees, the spacing between trees, and the growing conditions.

In good growing conditions (fertile soils and optimum water availability), fast-growing broadleaved species such as ash, sycamore and birch are likely to require initial thinning after 15-20 years. Slower growing broadleaves such as oak and beech are likely to be nearer 20-25 years before thinning is necessary. Where they have been used for screening, conifers are likely to need thinning in 15-20 years, though in ideal conditions some species (such as larch) may need thinning sooner. With both broadleaves and conifers, poor conditions will mean a longer period before thinning is
required. Thinning operations will then normally continue at appropriate intervals throughout the life of the trees. As a very general rule, regular light thinning will provide better management than less frequent but heavier operations but at higher financial cost. If large areas of woodland are being managed for screening, it may be possible to make a financial return on thinning operations through the sale of the timber produced, though a more realistic expectation may be that the operation is cost neutral.

The selection of trees to be removed during thinning requires good understanding of the interaction between adjacent trees and the growth patterns of different species. It is therefore suggested that advice be sought from suitably qualified and experienced forestry consultants. It is also important that the thinning operations are carried out with due care for the remaining trees and an experienced and trusted contractor should therefore be chosen to carry out the work.

Although it is unlikely to occur during the operating life of all but the deepest Hard Rock quarries, most woodlands will require felling and restocking at some point. In order to maintain their screening effect, this should normally be done by felling and re-planting (including encouraging natural regeneration) small areas within a wood at appropriate time intervals. Again the advice of suitable professionals should be sought in this matter.

**C.9 Afteruse**

Where possible, screen planting should be designed to become part of the final restoration scheme for the site. This smooths the transition from active quarry to restored landscape, and reduces the potential for visual anomalies between the screen planting and any planting that forms part of the restoration scheme.

Planning permission conditions sometimes require that screen planting is removed after the final restoration of the site. It is suggested that such removal will in fact often be detrimental to the landscape of the area as after, say, 20 years or more, such planting will itself be a significant landscape feature, and its removal may therefore have a detrimental impact.
D.1 Introduction

Fences and walls represent an effective screening mechanism which requires minimal landtake and, potentially, complete screening of intrusions at low levels (particularly human eye level). They may, however, represent intrusive hard elements in their own right in a rural context. Quarries, plant sites and industrial processes may require security fencing such that the selection of an impervious/opaque fence/wall may provide visual screening in addition to keeping out the public. Fencing/walling may also be used to provide aural screening as illustrated by the array of wooden/Perspex and other noise fencing around the M25 motorway in south east England.

Fig. D.1: Noise attenuation fencing on M25 motorway

D.2 Fencing

In a rural context, typical stock or field fencing may not provide visual screening. In this context, solid fencing may be intrusive. Such fencing can, however, itself be mitigated by dense planting in front of the fence. Similarly, the height of the fencing can be reduced by placing the fencing on the top of gentle earth mounding, bunds or, even, walls. Solid fences are more in context in suburban or urban situations where they may not need mitigating.

Security fencing is generally visually unattractive and/or intrusive in its own right. Spiked vertical metal paling may be coloured dark green but may still benefit from the softening of linear planting or hedging.
Fencing (being typically less than 3m high) has maximum screening effect near to the viewer. However, where fencing (or walling) needs to be located on the top of landforms/bunds, consideration should be given to positioning the fence/wall just below any skyline such that it performs specific local screening without causing longer distance intrusion on the skyline.

D.3 Walls

Walls, unlike fencing, are always opaque and, therefore, can provide effective visual screening. Choices of walling style, material, bonding agent, capping, height etc. are critical and the local materials and style should always be followed.

Typical examples of local styles include:

Fig. D.3: Devon hedgebank
**Fig. D.4:** Cotswold dry stone wall

**Fig. D.5:** Cornish dry stone wall

**Fig. D.6:** Peak District dry stone wall - note the use of much larger stones than in the Cornish or Cotswold examples
Appendix D                      VISUAL SCREENING TECHNIQUE No. 4 - FENCES & WALLS

Walls can be positioned in asymmetrical ditches to provide the “ha ha” effect favoured by historical garden/estate designers.

**Fig. D.7:** Section through “ha ha”

![Section through “ha ha”](image1)

The “ha ha” can divert the eye over adjoining landscape while providing some security/stock protection from the other direction.

**Fig. D.8:** “Ha ha” incorporating stone wall

![“Ha ha” incorporating stone wall](image2)

Dry stone walls as part of a restoration field pattern help to disguise the bolder landform or bund screening network while contributing to the overall long term restoration effect.
Figs. D.9 to D.11: Construction of screening landform and associated stone walls
Retaining walls may be constructed of piles, blocks, bricks, stone, concrete, timber or gabions. They can be disguised by planting (and by climbers such as ivy). Such planting must allow for maintenance and not cause any deterioration in the fabric of the retaining wall.

**Fig. D.12:** Gabion retaining wall

![Gabion retaining wall](image)

**Fig. D.13:** Concrete retaining wall

![Concrete retaining wall](image)
Fig. D.14: Large stone retaining wall
E.1 Buildings as Screening Mechanisms

Buildings may be used as screens to visually intrusive aspects of quarries. In particular, domestic scale buildings (e.g. houses, barns etc.) may themselves be of minor or no visual intrusion but may block more distant unattractive elements. Such buildings may be existing or can be part of the proposed quarry development. Frequently, new quarries or quarry extensions are based on farming units where the farmyard complex, farmhouse or cottages offer dual usage as administrative/storage buildings as well as screens to quarrying activity. New buildings, in particular, plant, offices, weighbridges, stores, staff accommodation, canteens, vehicle repair facilities can be designed to resemble rural complexes such as farm buildings.

Domestic scale buildings (often in the range 5-10m high) can be located to divert the human eye such that much larger industrial buildings can be screened or part-screened.

Fig. E.1: A domestic-scale building close to receptors can screen much larger structures behind

Free standing walls (for example 2m high brick walls) can be ‘attached’ to houses and farmyards such that they appear to ‘belong’ in the landscape in a way that they would not if located purely in isolation.

E.2 Minimising the Impact of Buildings/Plant

While a subject in its own right, there are several techniques which can be used to minimise the impact of buildings/plant; they include the use of:

a) Shape  
b) Height  
c) Mass  
d) Material  
e) Colour  
f) Texture  
g) Pattern  
h) Grouping  
i) Silhouette  
j) Lighting
a), b) & c) Shape, height and mass

Buildings and structures should always be designed to minimise their shape, height and mass. Shape plays an important role in two ways: the avoidance of jarring and rectilinear forms in a soft landscape, and the orientation of a structure such that any unattractive shapes do not directly face viewers. Height can also be reduced by placing the structures at natural low points, within the quarry itself, or on purposely excavated platforms. The massing of a building or structure can be used positively or negatively depending on circumstances. As an example, in some situations disparate parts of an industrial process might be best left as an apparently random group, while in other contexts they might benefit from being included in one large (clad) structure.

d), e) & f) Material, colour and texture

The choice of materials, colour and textures can radically reduce the visibility and impact of buildings and structures.

It is generally true that it is best to use materials and colours found locally, and to use as few materials as possible. Texture matters principally in the reflection of light. Matt buildings recede in the landscape. Shiny buildings or elements not only do not recede but also draw the eye. Choice of colour is a subjective matter but the following appears to be generally accepted:

- ‘Earth’ colours are more easily absorbed into the landscape than primary colours.
- ‘Blues’ and ‘greys’ reduce the impact of tall buildings seen against the sky.
- Occasional frequently cleaned bright colour (for example, on an external door or railing) fools the eye into believing that the remainder of the building or complex is equally clean i.e. not covered in dust.

**Fig. E.2:** Light colours towards the top of high buildings can help merge the building with the sky behind
g) Pattern

While pattern can be used to break up the outline and mass of a building it must be used cautiously. The choice of pattern needs to ‘work’ when viewed from different distances or against different backdrops. Generally, camouflage (in a military sense) only works for smaller structures where the viewer is always at a medium or long distance away.

Bold patterning, choice of colours and grading can reduce the impact of large clad building.
Fig. E.5: Graded colours can help to break up an otherwise solid outline

h) Grouping

As with the subject of massing, whether buildings and structures should be grouped depends on context. A few structures distributed through a large, complex landscape may be more easily absorbed than a single large mass. Conversely, in a simpler, more open landscape, a single large clad unit may be less intrusive. As discussed above, where buildings can be clustered at a domestic scale as in the typical farmyard this is generally more visually acceptable.

i) Silhouette

The silhouette of a building or complex depends on the location of the viewer. It is, therefore, important to identify key receptors and viewpoints and assess how the structures break any skyline.

j) Lighting

Buildings and structures may need to be lit for a range of working and safety practices. External lighting should always be kept to a minimum. It should be downward facing and specific rather than flooding wide areas. The reflection of light from surfaces must be kept to a minimum in order to avoid a nighttime glow.

E.3 Structures

A popular technique in the building/urban regeneration sector has evolved in partnership with advertising. The use of fabric or wooden hoardings to screen building works is now commonplace. While the advertising element may not be appropriate to quarrying, the use of images may be.
The following images show how large structures may be enclosed by, in particular, fabric hoardings.

**Figs. E.6 to E.7:** Screening of construction sites by fabric mounted on scaffolding
E.4 False Perspective and Trompe D'Oeil

False perspective has been used extensively by architects and landscape architects for centuries. The objective has always been to fool the viewer into believing that an object or view is larger or smaller than in reality.

The following images illustrate how false perspective and proportion may fool the viewer.

Figs. E.8 and E.9: Diagrammatic representation of true (left) and false (right) perspective in an avenue of trees
Fig. E.10: Portmeirion (for scale, note the steps/handrail between the foreground buildings)
F.1 Introduction

The most effective method of screening a quarry and associated plant will nearly always be through the use of a combination of the different techniques described in the preceding Appendices. Some examples of possible combinations are shown below.

Figs. F.1 and F.2: Existing landform combined with woodland planting. Either technique could have potentially provided the required screening, but together they merge into the landscape more effectively.
Fig. F.3 and F.4: Hedge planting combined with a soil bund. On their own, neither would have made a particularly effective screen - the hedge is too thin to provide effective visual screening and the bund would have visually intrusive in its own right.
Figs F.5 and F.6: Local style of dry stone wall with planting behind. The wall obscures views at low level while the trees obscure those higher up.
**Figs. F.7 and F.8:** Security fence with planting behind. The security fence is necessary but itself visually intrusive, but the addition of planting softens the appearance of the fence and obscures views through the fence.