SCOTTISH
Golf Environment
GROUP

ENVIRONMENTAL ISSUES IN GOLF COURSE CONSTRUCTION

SCOTTISH GOLF UNION

do a little change a lot

This publication has been produced by the Scottish Golf Environment Group (SGEG).

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INTRODUCTION

Golf construction and the environment

Most of us can visualise a high-quality golf development, when fully operational and mature, as a green, well-managed landscape, well-integrated with its surroundings. In contrast, a common perception of a golf course under construction is a scene dominated by heavy earthmoving plant, cleared vegetation, and bare soil. While these may be the most obvious visual effects, we also know that natural ecosystems are at their most vulnerable when disturbed, and that their innate capacity to recover may be exceeded or destroyed during construction.

Golf course construction in the wider landscape context: new holes under construction at Eastwood Golf Club, Renfrewshire

While these are generalisations, they highlight the specialised nature of potential environmental impacts during the construction phase of development, as distinct from the operational phase. Typically, construction impacts will be temporary and short-term, but with the risk that if they are not adequately assessed, and subsequently avoided or otherwise mitigated, they may lead to permanent, long-term detrimental effects on the environment. Existing policy guidance on environmental assessment stresses that "effects should be identified and evaluated for both the construction and operational stages" and that "in some cases, the more significant effects may be during construction" [1]. This emphasises that assessment of construction effects should be regarded as an integral part of the environmental assessment process (See also Part 1.6: Overview of Environmental Issues).

Purpose of this document

This document is not intended to be a comprehensive guide to good practice in golf course construction, nor to provide exhaustive checklists of potential impacts of construction activities on the environment. However we hope that it will raise awareness of the importance of the construction phase in achieving sustainable golf development, provide guidance on approaches to the key issues, and give pointers towards some other areas which require further detailed consideration. Construction overlaps with many other aspects of environmental management, and cross-reference will be made to information contained in the existing suite of documents published by the Scottish Golf Environment Group (SGEG).[1]

Readership

The publication should be of equal value to:

- golf developers, architects and construction managers, whose primary concern is implementation;
- planning officers, statutory consultees, and others, whose primary concern is to secure sustainable use of land in the long-term public interest.

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[1] *Relevant SGEG publications include:*
- *"The Golf Bag"*
- *"Producing Management Plans for Golf Courses"*
- *"Management Plan Template"*
- *"Nature Conservation and Golf Course Development"*
- *"Landscape Guidelines for Golf Course Development"*

It must be stressed at the outset that these two perspectives are eminently reconcilable, and that good practice is mutually beneficial!
The advice will also be of relevance to golf clubs considering smaller construction projects which may require or may fall outside Development Control / Environmental Assessment legislation.

Golf course construction or agricultural cultivation? St. Andrews Bay, Fife.

How to use the document

The main body of the document is structured as follows:

- Part 1: takes an overview of the construction phase and places it within the wider context of the development process;
- Part 2: focuses in more detail on each of the activities which make up the construction sequence, and discusses some of the key environmental issues related to each operation.
- A summary of the main issues and recommendations in table form.
- Appendices include contact points for sources of more detailed advice.

Throughout, **bold type** is used to highlight key words and important advice, and the body text is complemented by additional information in text boxes, including specific examples and case studies.

PART 1: PROCESS

1.1 Construction and the Development process

The term development process refers to the series of actions which lead from the initial conception of a project right through to its implementation. It encompasses a number of recognisable stages or phases, although these are not necessarily absolutely discrete, nor are they always followed in a simple linear sequence.

Figure 1 illustrates the overall process and places construction in its context relative to the other stages. (Reproduced from "Landscape Guidelines for Golf Course Development" [2], which also gives further detail on the legal and administrative framework for development).

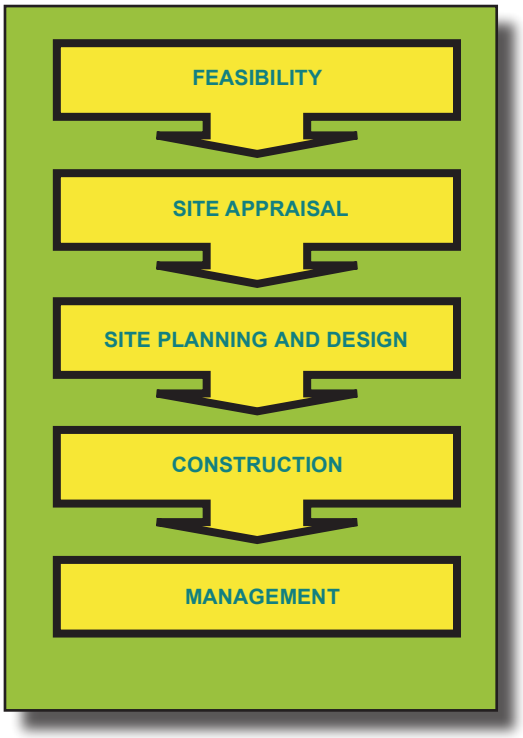

Figure 1: The Development Process

1.2 Definitions and Terminology

The study of construction and construction methods is a discipline in itself and this document can only give the broadest outline of selected aspects which impinge directly on environmental issues. Reference should be made to specialist literature for further detail on the technical aspects of the construction process. A widely respected general text which was consulted in the preparation of this publication, and which provides a good entry to the more detailed literature, is Illingworth's "Construction Methods and Planning" [3].

Illingworth summarises the *Construction Process* as consisting of two basic activities: *handling* of materials and equipment, and their *assembly* to produce the desired completed whole. The planning of these activities, encompassed by the commonly used term *"Construction Method Planning"* he succinctly defines as:

> *"understanding what has to be built, then establishing the right method, the right plant and the right labour force to carry out the works, safely and to the quality required, in the most economical way to meet the client's requirements."* [3].

The production of a *Construction Programme*, or "time related schedule of the planning decisions" is stressed as being distinct from the construction planning process, rather it should be regarded as a subsequent product prepared once the correct methods have been established.

The programme is usually incorporated in the "*Construction Method Statement*" or "*CMS"* as it has become commonly referred to, and Illingworth takes care to distinguish between two distinct types:

- The *Submission Method Statement* - a public document which is used to

communicate the contractor's intentions in broad terms to the client (or others including a Planning Authority), and

- The *Pre-Tender Method Statement* - a confidential, and often very detailed internal document which is used by the contractor at the bidding stage to enable accurate estimation of a tender sum, and may be used in updated and amended form to coordinate activities on site.

In the context of this guidance, most users will be dealing with a statement which is closer to the former type. It is becoming increasingly common for Planning Authorities to request a CMS in support of a planning application. The above distinction emphasises the need for clarity both in specifying the precise purpose of the document and in preparing a CMS fit for the declared purpose.

1.3 The Role of Construction

The success of any project is ultimately judged on the quality of the built product - the golf course itself. While each of the stages of development plays an indispensable role in reaching this end-point, and a weakness in any of them will detract from the final result, construction perhaps has the most direct, obvious and undiluted bearing on the outcome. However detailed the architect's design, without construction the project remains abstract, essentially incomplete. To convert the design, whether virtual or on paper, into concrete reality, requires a professional construction team. As the British Association of Golf Course Constructors (BAGCC) remind us on their website;

> *"The architect may conduct the orchestra but the contractor has to play the music!"* [4].

The quality of the end-product will be directly dependent on the quality of the skills and workmanship of that team, and their level of experience. It follows that the selection of the contractor (ultimately by the client but often with the guidance of the architect) is a crucial decision in the success of the project. The utmost care should be taken in establishing the credentials of companies not previously known to the client or architect.

1.4 Links between Construction and Design

Design interacts with construction in many ways. Clearly the results of construction are only as good as the design allows, and a good constructor can only go so far in overcoming the shortcomings of a flawed design. At the basic level, a design must be "buildable", i.e. capable of being constructed using practicable, economical methods.

CONSTRUCTION AND DESIGN: SOME OVERLAPS

- **A man-made island green may be feasible within a relatively small and shallow inland lake or water feature, but in a coastal context its construction would stretch the limits of expense and technology in relation to numerous parameters: water depth offshore, erosion by currents, winds and waves, the logistics of gaining access.**
- **The cross-sectional profile of a ditch or watercourse as conceived on the drawing board must take account of the capabilities and limitations of the specific excavating machinery available.**
- **Earthworks design which includes steep, open slopes may mean that the site is vulnerable to soil erosion at the construction stage.**

1.5 Links between Construction and Management

Construction sets the parameters for the management stage. At the most basic level, it is pointless to design and build a course to a high standard if it can't be maintained to a high standard.

Some issues to be considered in this regard:

- Conservation of soil structure
  - Compaction, poor storage/stockpiling, and working under wet conditions can all damage structure leading to significant problems during management;
  - Stone burying if not sufficiently deep (c.10-15cm) and stone removal if burying not done;
  - Turf quality may be affected, aeration and drainage of the growing medium more difficult. Remedial operations required, avoidable additional maintenance expenditure and consumption of resources e.g. top-dressing, additional topsoil even.
- Green Construction Methods
  - USGA has more specific requirements for construction (Materials testing for rootzone, gravel layer- if unsuitable materials used, future drainage and turf growth adversely affected)
  - USGA has more specific requirements for maintenance (Trained/skilled staff, irrigation, more sensitive to nutrient balance, etc)
- Shaping
  - Good harmonious slopes and slope transitions reduce landscape impacts but also allow more efficient use of mowers, and save maintenance costs in long term. Where expensive hand-maintenance will be necessary, this must be planned and incorporated into the client's overall budget.
- Soil Fertility
  - Stripping topsoil from out of play grassland can have tremendous ecological benefit in areas of high fertility, e.g. former agricultural sites. Nutrient-poor/species rich grassland can be established, which is not only more playable for the golfer but also requires less ongoing maintenance.

TEAMWORK

- **Projects are rarely successful without good relationships between the key players; client, architect, and contractor. Each must be clear about his own contractual powers and responsibilities, but must also be able to go beyond this, and call on a wide range of skills, including:**
  - **good communication skills, including diplomacy!**
  - **the ability to listen to (and understand) their counterparts' point of view**
  - **the ability to stay focussed on the project outcome**
  - **the ability to juggle the three magic variables - budget, quality, and timescale, and at the same time cope with the urgent pressures of the construction stage.**
  - **a sense of humour helps!**
- **For the project to succeed environmentally, this spirit must extend beyond the construction team to everyone who has an interest in the environmental aspects of the project: notably those specialists who have been involved from the design stages: including the ecologist, archaeologist, and landscape architect.**
- **Building successful team relationships will be much easier where the members respect each other's professionalism and experience.**
- **There may be some benefits to be gained from utilising existing partnerships: between architect and client, architect and contractor, or client and contractor. However, all parties must be wary of compromising their professional and ethical standards.**
- **Particularly on re-modelling projects, the green staff should be an integral part of the team. On new-build projects, appointing the course superintendent prior to the grow-in period can have benefits, but this must be planned carefully in advance, and his role clearly defined.**

1.6 Overview of Environmental Issues

1.6.1 Construction impacts and the EIA process

In the Introduction, it was stressed that current EIA regulations require assessment of the effects of the construction phase as well as the operational phase. This implies that the construction methods would be required to have been determined *before* an Environmental Statement could be accurately/authoritatively written, and *before* a Planning Application could be submitted. Herein lies a dilemma. Theoretically and practically, it is more logical to determine construction methods *after* the design has been finalised, as described in the Tender Documentation prepared by the Architect. Therefore the Tender Stage is the earliest that a fully detailed Construction Method Statement, feeding into an Environmental Statement, could be prepared. However most Clients, (and development control officers!) will be much more comfortable if Planning Consent is in place before a construction contract is put out to tender. In practice, two alternatives therefore arise: either

- A CMS is **not** necessarily required as part of the Planning Application (but the approval of a detailed CMS is required before construction commences) or;
- If a CMS **is** required as part of the Planning Application, the Planning Authority accept that it will be in outline form, and will be required to be amended and approved before construction commences.

Comprehensive checklists of the aspects of the environment likely to be affected by development, and the likely significant effects of development on them, are set-out in the legislation and in the associated government guidance [1,5,6,7]. Specific reference to golf in Circular 15/99 states that

> ***"The main impacts (of new 18 hole courses) are likely to be those on the surrounding hydrology, ecosystems and landscape, as well as those from traffic generation."*** **[6]**

These may apply to the construction phase as well as the operational phase. PAN 43 also draws attention specifically to construction in relation to archaeology, stating that

> *"All construction activities associated with the development of golf courses which involve ground disturbance can have serious implications for archaeological remains. Such activities include earthmoving…drainage, irrigation, tree planting, other landscaping, roads and tracks and the construction of any associated buildings."* [7]

1.6.2 Key Environmental Issues

From experience, the environmental issues most likely to be relevant to golf construction include:

- Archaeology
- Flora and Fauna[2]
- Landscape[3]
- Soil
- Water resources and water quality
- Chemical emissions/pollutants
- Construction traffic
- Noise and Dust

These will be analysed with respect to specific construction methods and activities in Part 2, but may also be considered in the broader sense in relation to the following:

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[2] *See also "Nature Conservation and Golf Course Development" [8]*

[3] *See also "Landscape Guidelines for Golf Course Development" [2]*

- Site-related factors

Clearly negative construction impacts will be reduced by avoiding sensitive areas for the location of permanent features of the course. These may include rare or notable habitats and species, nesting/breeding sites of birds and mammals, visually or historically important landscape features, and archaeological remains. However other elements including temporary features such as access or haul routes, storage compounds, and below ground components such as service utilities, drains, irrigation pipes and tanks, may also be significant sources of disturbance. Where there is potentially close contact with very sensitive locations - the need for **"cordons sanitaires"** should be considered.

- Time sequence / programming of construction activities

Check that activity sequence or timescale is not inherently likely to increase risk to environment, examples include:

- earthworks when soil moisture content high - (usually outside April-September) more risk of damage to soil structure during many operations; soil stripping, excavation, handling, site traffic, etc.
- seeding too late (usually complete before September)- more risk of poor establishment and therefore bare ground vulnerable to erosion over winter.
- timing with respect to breeding seasons - disturbance by presence of men and machinery, noise and dust.

The contractor may therefore have to reconsider or adjust the sequence, or the method used, or the type of plant used, or the amount of labour/plant resources required.

- Design Factors

The nature of the design is a fundamental determinant of environmental impacts, both during construction and in the long-term. A sensitive design which respects the existing site features will be likely to generate fewer construction impacts as well as operational impacts. Two particularly significant factors influencing construction impacts are the requirements for earthworks and drainage.

- The extent of earthworks required by the design is perhaps the single most significant factor. Increases in either the disturbed area (area of topsoil stripped), or the proposed changes in level, lead to likely increases in the intensity and scale of the construction activities. This is then reflected in the type, quantity and scale of the earthmoving plant required, the duration of the work, the volumes of fuel required, potential levels of noise and dust, disturbance of surface vegetation, and so on. At a more detailed level, balancing the earthworks volumes (cut and fill volumes) over smaller localised areas can reduce impacts, by avoiding large volumes of material being transported over large distances, and avoiding the additional disturbance of major haul routes.

- The use of naturally well-drained sites for the playing areas of the course, particularly greens and tees, but also fairways, will reduce construction impacts. (There may also be interaction between soil type and

HEALTH AND SAFETY

Environmental issues frequently overlap with Health and Safety requirements, e.g. the control of noise and dust, the use of explosives in blasting, and the use of hazardous chemicals. Details are set out in the relevant legislation;

- ***Health and Safety at Work etc Act 1974*, and related legislation, including;**
- ***Control of Substances Hazardous to Health Regulations 2002* (COSHH).**

All construction site work must comply with the relevant parts of this legislation.

An introduction to the legislation can be obtained from the Health and Safety Executive website at:
www.hse.gov.uk

relief, e.g. with more freely-drained soils occurring on hummocks or slopes)[4]. Disturbance resulting from excavation of trenches, importing and placing pipes and backfill, together with the potential impacts of drainage discharge into adjoining watercourses, will be reduced. Further detail is provided in Part 2.9 which deals with drainage.

- Management Factors
  Green and tee construction methods clearly also have important overlaps with design decisions, and in turn influence fundamentally the type of management regime which will be appropriate, e.g. in relation to the need for irrigation, nutrient application and herbicide use. Several alternative methods are possible, and the decision on which to use should only be made after careful consideration of the overall performance and environmental impact, preferably with advice from a qualified agronomist. Relevant factors include the depth and composition of rootzone, and whether a "drainage carpet" layer and/or piped drainage system is to be used.

1.7 Summary: Benefits of Construction Planning

Construction planning at a professional level is now regarded as an essential element in the construction process, and good practice is seen to lead directly to benefits in the overall quality of the project outcome. With a good understanding of the contract documentation, a clear picture of the methods to be used, and a logical sequence of activities worked-out prior to the commencement of the works, high standards in site management procedures are then much easier to achieve. This in turn facilitates efficient site operations and good workmanship, leading to a higher probability of a successful end-product, with high environmental standards playing an integral part. Further detail on specific environmental benefits is presented in Part 2. The chief benefits may be summarised under the following headings.

1.7.1 Site Management Procedures

Good communication of information, not only between the contractual parties but also with external bodies, founded on accurate and consistent record-keeping, is the key to establishing and maintaining the good working relationships which facilitate a favourable project outcome.

1.7.2 Supervision and Inspection procedures

Regular inspection visits by the architect, combined with adequate quantity and quality of site supervision, ensure that the design intent is faithfully implemented and that opportunities for design refinements are incorporated at the construction stage.

1.7.3 Schedule of Environmental Commitments

Where relevant, compliance with the "Schedule of Environmental Commitments" as set out in the EIA Regulations [5], although requiring monitoring and regulation by the Planning Authority can provide both an incentive and a benchmark for high environmental standards.

1.7.4 Construction Method Statements

A Construction Method Statement (CMS) is now commonly requested by Planning Authorities before consent is granted and work can begin. The most useful type of CMS in the context of this guidance is considered to be one which focuses on enabling the environmental impacts during the construction phase to be

[4] *It is worth noting that free-draining soils may have less capacity to retain and filter-out additional nutrients or other chemicals applied to the playing areas. For this reason in some countries permission to develop such sites may be more difficult to obtain.*

more accurately predicted and assessed, and to be monitored while construction is in progress. The process of writing the CMS may be beneficial in itself - it should be iterative, as for the overall EIA, and may provide opportunities to reconsider/adjust construction methods, or identify new innovative methods to address certain potential impacts.

PART 2: ACTIVITIES

2.1 Construction Activities

This section will discuss some of the key issues of environmental best practice in relation to each of the main activities in a normal construction sequence for a golf course project. While it will focus on the relevance of construction impacts to the environment, it is not intended to provide a checklist of potential impacts, which is best prepared as part of a comprehensive EIA process, and is in any event very site-specific. In addition, although there will inevitably be some overlap with the content of a construction specification, and the sub-headings reflect the customary structure of a specification document, the coverage is not intended to substitute the detailed and comprehensive description of materials, workmanship and performance required by contract documentation.

2.2 Preliminary and General

Matters covered under this heading are usually addressed prior to the start of actual construction work, or apply generally to the entire sequence.

2.2.1 Construction Method Statements

Part 1 refers to the need for an overall CMS for all work activities, which should feed into the normal EIA process and also help to refine the design outcome. Construction Specification documents also often ask for detailed method statements from contractors for specific operations, e.g. earthworks, where there may be flexibility in how to carry out certain tasks, and where the architect wishes to be able to consider and approve the contractor's suggested methods. This clearly affords the opportunity to select methods which will have less detrimental environmental effects and/or vide enhancement.

2.2.2 Construction Programme

The construction programme provides the means of phasing the main activities and the time required for each. The contractor, construction planner, or project manager will prepare the programme based on a detailed "network diagram" showing the logical sequence of events. It will be influenced by the methods chosen and the resources available. In addition, it will identify which work items and which interim target dates are **critical** if the desired overall completion time is to be achieved. Environmental issues which need to be considered in determining a construction programme include:

- **Growing Season "Windows"**
  Arguably the single most crucial date in a golf construction programme is the date for completion of seeding. If delayed outwith certain margins, this may mean that a full growing season is missed. Apart from the obvious financial implications for postponed opening of the course, serious soil erosion problems may occur where disturbed ground remains unvegetated over the winter period. The probability of certain types of weather and weather-related events which may affect specific activities e.g. flooding/high water table/snow/frost/dry, windy conditions, may also be relevant considerations in some locations.
- **Breeding seasons**
  The construction team should check the dates of breeding seasons/flowering seasons for protected or important fauna and flora (e.g. birds, amphibians, rare plants) and ensure that activities are planned to avoid disturbance at these times.
- **Zonation of Site**
  The programme may also relate to specific locations within the site. Ideally, activities are phased to enable discrete zones to be finished in turn, usually about 3-4 holes at a time. This allows plant to be moved out of an area without having to return frequently or at all, thus minimising "tracking over" and disturbing previously finished areas. This will in turn reduce the

risk of soil compaction, and the need for reinstatement work to make good earlier operations.

2.2.3 Preparatory Works

Cordons sanitaire

Before commencement of work, it is vital to isolate and "ring-fence" particularly sensitive areas. The type of fencing used must be robust enough to deter entry by heavy equipment or it may be conveniently ignored! Commonly, no construction plant and/or construction activities will be permitted within the cordon sanitaire. Examples of areas and features to be protected include:

- **watercourses**
- **habitats**
- **archaeological sites**
- **landscape elements.**

Although cordons sanitaires should always be shown on the contract plans, on-site refinement of the line by the appropriate specialists (ecologist, archaeologist, landscape architect) is recommended.

A dense growth of vegetation may be allowed to grow up on the edge of a watercourse or wetland prior to the start of work, acting as an effective buffer to sediment erosion or chemical ingress.

Specimen trees are a very common example of a landscape feature to be protected. The entire area of the root system of the tree should be included. Within this zone, any change in ground levels, or storage/spillage of chemicals, may cause permanent damage to the root system and ultimately the death of the tree. Physical damage to the trunk, e.g. through collision impact by equipment, should also be guarded against as this can lead to the failure of the vascular system of the tree.

Contrary to the popular misconception, the diameter of root spread is roughly two to three times the height of the tree [9], i.e. protection should be placed well beyond the edge of the canopy.

Site Access and Compound

The establishment of a suitable access point and compound to house temporary offices, storage, toilet facilities, etc will be one of the contractor's earliest priorities at the commencement of the contract. The location of the access point and compound should be carefully selected to take account of environmental as well as operational factors. Happily, these may often be in concert. Operational considerations are primarily linked to cost/time factors: these will include:

- ensuring that the **area** available is adequate (for the scale of project and quantity and size of plant to be used);
- the **ease of access** for offloading and storage;
- linkage to the temporary/permanent **road system**,
- linkage to **service utilities**.

Where access to the site requires the use of narrow and/or busy roads, the potential for hold-ups and general traffic nuisance should be considered. For example, the use of smaller vehicles / more frequent loads may be required when importing bulk materials to site, to avoid ill-feeling among local road-users, but this would have cost implications for the contractor and allowance should be made in the contract. From the environmental perspective, the main access point and compound will be a focus of site traffic, materials handling and storage, and waste disposal.

- To avoid potential detrimental impacts it should be sited **well away from any watercourses and other sensitive habitats**.
- If possible, it should also **take advantage of areas of dry, well-drained ground**, minimising the need for additional temporary works and subsequent reinstatement.
- Consider **"tracking-time"**[5] for plant to and from the compound. This has implications for noise and vibration as well as lost operating time.

[5] *The time taken for large tracked equipment to get into position at the beginning of the day and back to the compound when working day is complete.*

- Use of a **single access point** is also desirable in this regard: although primarily for road safety reasons, it will also restrict the area required to be reinstated.
- Construction of the **hard-standing surface** required for access and parking of vehicles and earthmoving plant can often be coordinated with the permanent road layout so that the base courses may be laid as soon as possible and used as the temporary surface.
- A designated **maintenance area** for plant should also be provided including an area for **wheel-washing**, to ensure that oils and sediments washed from equipment are controlled and intercepted. This may be combined with the need for "road hygiene" – i.e. the requirement for all vehicles to be mud and dust free leaving site. Sediment from the wash-down area should be intercepted by a **silt trap** and if uncontaminated may be re-used as fill on site as appropriate.
- It is normal on larger sites for the compound to be lit at night and a **security service** may be required. This reduces the risk of damage or vandalism of equipment but also helps to ensure that toxic materials are not stolen or spilled in the course of break-ins.
- **Reinstatement** of the compound area on completion of the works should be an integral part of the design and of the contract documents.

Storage of Materials

Closely linked to the establishment and management of the site compound is the storage of materials. While the aim should be to bring all materials to site only as and when required, in practice this may not be possible or economical. The contractor's operations and construction methods will therefore determine the need for storage of many construction materials between the time of delivery and their incorporation in the works. Fuel and chemical storage will also be required and are the most critical from an environmental perspective[6].

The Scottish Environmental Protection Agency (SEPA) publishes detailed guidance on working at Construction Sites in their Pollution Prevention Guidelines series [10] (available via their website[7]), which makes specific reference to topics including

- **storage**
- **delivery**
- **site drainage**
- **silt**
- **waste disposal.**

It is also crucial to have **spillage response strategies** in place as accidents will inevitably occur in the site environment. Diesel, other fuel oil, lubricant, and hydraulic fluid may be contained if sandbags, other absorbent materials or spill kits are available on site. Recent research recommends that filling of sprayer tanks should take place on absorbent surfaces, termed **"biobeds"** (layers of straw or peat which encourage bacterial breakdown of spilled chemicals) [11]. **Temporary storage** at localised working areas, e.g. storage of gravel, sand, rootzone at greensites, should be discouraged, as it is generally more difficult to arrange protection from contamination. If this type of storage is unavoidable, topsoil should be stripped from the area to be used before placing the materials.

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[6] *It is worth noting in this regard that the use of chemicals as distinct from fuel is primarily an issue of golf course management rather than construction. During the construction period, chemical use is normally restricted to translocated herbicide for the initial clearance of vegetation, and fertilisers for the pre-seeding and grow-in stages.*

[7] www.sepa.org

Other relevant publications include Pollution Prevention Guidelines Nos. 2, 5, and 26.

Utilities

The location of underground services is also a key activity to be addressed at the outset of the works. The service provider will usually require a lead-in time of around two weeks to react to requests to locate pipes and wires etc, and even when plans are available, the contractor is normally bound by the contract to verify these at his cost before commencing excavations. Clearly it is to the benefit of all parties to cooperate in **early and accurate location of services** to avoid the potential environmental damage and costly repairs resulting from damage to underground installations.

2.2.4 Site Management Procedures

Implicit in the control of environmental impacts at the construction stage is the efficient running of the site and of the construction operation itself. Some fundamental procedures in this regard are discussed below.

Site Manager

The permanent presence on site of an authoritative representative of the contractor is essential. This person will provide a consistent, **single point of contact**, and will be able to provide an overview of all events on site. Included in the site manager's duties should be **responsibility for communication with external parties** regarding all environmental matters, including liaison with statutory and non-governmental environmental organisations. The golf course architect will normally act as the client's agent under the contract conditions. Needless to say, good communication and a good working relationship between the architect and the site manager will prove beneficial both in avoiding environmental conflicts and in identifying opportunities for environmental enhancement during construction.

Regular meetings / walk-rounds involving the site manager and other parties are crucial. The appropriate frequency may vary, weekly or monthly may be sufficient, and sometimes an open invitation is extended to environmental bodies with an official interest in the site.

Site Records

Clear communication and liaison is dependent on comprehensive written records of decisions and site conditions. Such records will include **minutes of meetings, site instructions, contract variations, drawing issue registers** and other design information. Of specific relevance to the environment, monthly statements to or meetings with the Local Authority will be very helpful, and where a **Schedule of Environmental Commitments** has been included in the EIA process, they will provide a means of monitoring adherence to such commitments. Communication between the main contractor and sub-contractors is often a contentious issue; where this is not working effectively there is a greater risk that agreed procedures and methods will be disregarded. Some Clients may require all personnel working on site to attend an **induction meeting** covering issues including environmental topics (e.g. pollution prevention, COSHH regulations, waste disposal, and spillage response).

SITE REGULATIONS

Loch Lomond Golf Club issues a "Site Rules and Regulations" document to all Contractors working on their land, detailing procedures to be followed. This document is in turn referred to in a Construction Method Statement prepared in support of a planning application for a proposed second golf course at Loch Lomond.

Hours of working

Working hours impinge on environmental issues in terms of potential nuisance caused by

noise and vibration affecting properties and/or activities off-site. In this regard, the limits not to be exceeded may be detailed in the contract documents.

Flexibility in the permitted working hours should be considered, particularly towards the end of the construction process, when lighter machinery is being used e.g. for cultivating and seeding. From the contractor's perspective, this will allow a margin to compensate for time lost e.g. through bad weather earlier in the contract. In practical terms, this suggests that the contract documents are made more specific with regard to machinery which cannot be used outside certain hours.

Waste Disposal

As during the operational stage of golf course management, waste disposal during construction is a key environmental consideration, and moreover is usually more difficult to manage effectively since permanent waste facilities will normally not yet be installed. Points to be considered include:

- No disposal of waste on site;
- Recycling and composting of organic waste to be arranged where feasible;
- Disposal of empty chemical containers to be by licensed agent only;
- Burning of organic material including cleared vegetation only permitted in agreed locations at agreed times;
- Waste materials to be taken off-site to a licensed tip, detailed in the contract documents.

2.2.5 Haul Routes

The layout of a circulation system of temporary roads is a fundamental component of the site preparation stage. If done well, materials and plant can move around the site efficiently, minimising both the construction cost and the potential environmental impacts on the site.

- Prior to work starting, the haul routes should be **located on plan** (normally by the contractor, agreed with the architect), set-out with posts and tape, and the topsoil stripped and stockpiled.
- As noted above, ideally the routes should **coincide with the layout of permanent roadways**, and they should **avoid fairways, wetter areas, and all environmentally sensitive areas.** The potential for run-off to watercourses should also be avoided.
- The **numbers and widths** of routes, and total area covered, should be minimised.
- If possible, **one-way traffic** on haul routes should be required, in order to reduce slewing of vehicle tyres and tracks and consequent damage to soil structure in wet conditions.
- All haul routes should be decompacted by **ripping** prior to reinstatement.
- Haul routes to green complexes should **always lead from the rear of the green** if possible, to avoid compaction of the approach.

2.2.6 Setting-out

Accurate setting-out, best entrusted to a specialist topographic surveyor, is a further crucial preliminary step to achieving the architect's design intent. Nevertheless, both contractor and architect should be alive to opportunities to adjust positions of greens, tees, and other elements in order **to improve the overall environmental "fit" of the course**. (See also "Landscape Guidelines for Golf Course Development" [2] p27)

2.3 Site Clearance/Topsoil Strip

Important gorse scrub habitat conserved during site clearance. Dundonald Links, Ayrshire

2.3.1 Introduction

This stage in the construction sequence represents the initial "ground-breaking", when

the site is made ready for earthmoving and subsequent stages. It includes taking-down man-made artefacts such as fences, walls, or even buildings, but the most sensitive aspects are usually the clearing away of existing vegetation cover, including trees, and the conservation of topsoil. **Site clearance should be regarded as a sensitive and gradual process,** a continuation of site investigation, rather than a predefined, inflexible operation where vegetation is cleared *en masse*.

It is important to ensure that the **minimum extent of the site is cleared** and/or stripped of topsoil, retaining untouched as much as possible of its natural character. The "working area", "area of earthworks", or "extent of area to be cleared", as it may be referred to, is determined by the area within which changes in level are proposed. Sensitive design in the first instance can limit this area, good practice at the construction stage can ensure that it is adhered to, or better still, reduced if opportunities to improve the design emerge. Two possible instances of this are prior to commencing clearance works, when additional environmental features to be retained may be identified, and after each phase of vegetation clearance, when additional trees, tree groups, etc may be revealed and marked for retention. (See also "Landscape Guidelines for Golf Course Development" [2] p27)

2.3.2 Tree felling

Individual trees or woodland areas should be marked by the contractor and checked by the architect before felling[8]. This operation can be covered under the "setting-out" stage of the works. It may also dovetail with the demarcation of cordons sanitaires, where felling operations are not permitted.

- **Specialist forestry contractors**, tree surgeons, or others experienced in tree clearance work should always be used, and felling licences in place. This will usually mean that the work will be required to be sub-contracted.
- Special care will be required when felling to **avoid damage to adjacent trees**, especially where tree canopies overlap, which may mean taking down individual trees in sections if necessary.
- **"Staged felling"** (working outwards from the centreline of each hole) should be used. Indicative widths are:

  Stage 1: 5m each side of centreline,
  Stage 2: 15m each side of centreline
  Stage 3: Remainder of area to be graded, or further clearance to provide a natural-looking woodland edge.

  At each stage, the architect should be given the opportunity to identify specific individual trees or areas of vegetation which could be successfully incorporated into the design.
- **Treatment of stumps** is also important. In preference to burning, stumps should be ground-up or chipped, or completely grubbed-up and removed from site.
- **Chipped material** may be re-used, e.g. as a mulch to suppress weeds in newly-planted woodland areas.
- **Felled timber** may be sold by the contractor or client as agreed, or alternatively may be retained as habitat where appropriate.
- Other uses for felled timber include construction of **logpile holts** for Otters,[9] construction of lake edging, or knee rails on paths.

Clearance of other vegetation

Patches of scrub, heathland, moorland, grassland, or other vegetation communities may be included in the area prescribed for earthworks.

- Seek to **retain** as much as possible of these habitats, incorporating them into both the golfing challenge and the aesthetic character of the course, by

[8] *It may sometimes be possible to transplant a valuable specimen tree or trees to another part of the site. Specialist arboricultural advice should be sought if this is being considered.*

[9] *A leaflet is produced by the Royal Society for Nature Conservation detailing the method of construction.*

utilising them as natural hazards or carries for the shot from tee to fairway.

- Architects should be aware of opportunities to uplift and replant valuable vegetation species or habitats to alternative locations on site. Ideally, this will be recognised at the design and planning stage, although opportunities may also arise during construction. Examples of successful **"translocation"** of vegetation include wetland species, e.g. reeds, protected species, e.g. orchids, and grassland or heathland turf.

Heather turves stripped on-site and re-used on new mound. Dundonald Links, Ayrshire

2.3.3 Clearance of other artefacts

To provide a clear site prior to earthworks operations, all other potential obstructions, rubbish, debris, contaminants and the like are required to be removed. During this operation, field boundary fences, walls, and other structures may be encountered. Adherence to normal professional practice will ensure that the majority of these have already been identified and quantified within the contract documents, but on most sites unforeseen items will still be found!

- Architect and contractor must be sensitive to the potential value of unidentified features: derelict walls for instance may be valuable habitats for insects, birds, small mammals, they may have historical or cultural value as landscape elements, and they might even potentially be restored as features of the golf course.

Field boundary retained as natural hazard: Craigielaw, East Lothian

- **The presence of archaeological remains will normally be identified at the planning stage, through consultation or standard Conditions, but where discovery is made during construction, the planning authority should be informed immediately through their Regional Archaeologist. See Planning Advice Note PAN 42 [12].**

2.3.4 Topsoil Strip

Soil handling

Topsoil is recognised as a valuable resource by all those who work with the land, and its conservation is accepted as a basic principle in landscape and golf course construction. Despite this, its sensitivity to damage if mishandled is often misunderstood or ignored. For golf projects, a shortfall of healthy topsoil at the post-shaping replacement stage is an extremely common occurrence, often with significant implications to the budget. Re-spreading suspect or damaged topsoil is a risk not worth taking, and will inevitably lead to later problems with the quality of the playing surface. Good practice in soil handling will avoid both these problems. General principles include:

- **Handle soil as little as possible.** Although it will not often be possible in a golf course context, the ideal scenario is to avoid the need to stockpile by stripping, transporting and placing in the same operation.
- Soil should always be worked only when in a **dry and friable state**, to avoid damage to its structure, when the aggregations of particles (soil crumbs), and the voids between them, can be lost.

- This is closely linked to **weather conditions**. Handle soil in dry weather, when the soil moisture has fallen to below field capacity. Threshold soil moisture levels, above which work must be suspended, may be set, and tested with a soil tensiometer. Soil should not be worked when frozen. Conversely, if the weather is too dry, especially when combined with windy conditions, soil particles can be lost and may also lead to a dust nuisance.
- **Equipment** for soil handling should be expressly designed for the purpose. Plant with Low Ground Pressure tracks or tyres helps to minimise disturbance to soils e.g. a Caterpillar D4H (LGP) has a track pressure of c.4.16pounds/square inch (less than a human footprint).

Topsoil being stripped by Caterpillar D5 dozer

Topsoil stripping method(s)

It is normal to pre-treat the area to be stripped with translocated herbicide as noted above. Very rough or rank vegetation may also need to be cut down before spraying. When vegetation has died-back, the soil should be rotovated, prior to stripping by suitable plant, e.g. D5 dozer. Where the use of herbicide is not permitted for environmental reasons, the surface vegetation must be cleared solely by mechanical methods.

- The **depth** of topsoil to be stripped may be defined by dimension - the normal average is 150mm - but the local site conditions are important and it is preferable to vary the depth of strip to reflect these.
- A clear distinction must be made in the contract between what is to be regarded as **topsoil and subsoil**. True topsoil is that part of the soil profile which contains organic material and acts as a growing medium. It will usually differ from lower horizons in both physical and chemical properties; colour, texture, pH and nutrient status being the most obvious. Where doubt exists, a sampling and testing procedure can be included.
- **Segregation of topsoil and subsoil**, and soil of different types where there is variation across the site, is vital. For example, it is important to keep topsoil and subsoil of different textures and fertilities separate, and respread them to retain as far as possible the original soil environment. This also allows topsoil of higher quality to be identified for re-use on more critical playing areas: green approaches, green collars, bunker mounds, etc.
- At the stripping stage, **sources of materials**: organic material, sand, or gravel not identified by earlier boreholes or trial pits may be revealed. Provided their quality can be tested and verified as suitable, these may be re-used, for example in the construction of greens and tees, providing opportunities to reduce cost and improving the overall environmental sustainability of the project.
- Where topsoil is scarce, the design/construction team should investigate opportunities to use artificial topsoil substitutes.

USING RECYCLED PRODUCTS

A wide range of recycled products is now available for use in golf course construction. In contrast to the recent past, quality standards are now in place to give confidence to end users.
Products currently on the market include:
Compost **(as a soil ameliorant or mulch in turf establishment)**
Wood Chips **(as a path material or weed suppressant)**
Glass sand **(as a bunker sand or as a component of rootzone – tested by STRI to meet the USGA specification)**
Drainage products **made from recycled plastic.**
Further information is available from the Waste and Resources Action Programme website at www.wrap.org.uk
(See also contact details in Appendix 1)

Stockpiling

As noted above, ideally the phasing of work should be adjusted to utilise materials as soon as they become available, thus avoiding the storage of soil in mounds as far as possible. Where stockpiling is necessary, the environmental intent should be to preserve the original properties of the soil as far as possible during storage, and reduce the risk of erosion while they remain unvegetated.

- Areas for soil storage should be agreed in advance and **located on plan**, with stockpiles sited remote from watercourses and other areas vulnerable to deposition of eroded soil. They should be sited on level, well-drained ground, on soils of a similar type to that to be deposited, and the topsoil should be stripped from the area itself before forming the stockpile.

Oversized topsoil heap – potential problems with soil structure – and health and safety!

- The **dimensions** of the stockpiles and their **management** is important. Architects' specifications differ in detail in this regard, but it is generally good practice to ensure that stockpiles
  - have a high surface area to volume ratio,
  - do not exceed 2-3m in height,
  - do not remain in place for longer than 8 weeks, (the particle size/drainage characteristics of the soil will have a bearing on how long it can safely be stored)
  - are maintained free of weeds,
  - are formed with smooth surfaces to shed rainfall
  - are not trafficked by plant once formed.

  Pragmatic considerations (usually related to restricted space available on the site) often dictate that this guidance is difficult to follow. Where the earthworks are commenced and completed within a single summer season, the height of the stockpile is not so critical in terms of deterioration of soil quality, but will still be a consideration in terms of Health and Safety and the practicality of loading operations.
  Soil type is also pertinent, e.g. clays and gleys are more likely to lose structure over a given period than lighter-textured sandy or loamy soils.

2.4 Earthworks

2.4.1 General Issues

The "bulk" earthworks phase of the project covers the operations required to alter the basic topography of the site, as distinct from the subsequent fine-tuning of surface contours termed shaping. It is at this stage of the work that the largest equipment is required; accordingly, the potential for environmental damage is high. On the other hand, the creative opportunities to enhance a degraded landscape are correspondingly large. Handled efficiently, the earthworks operations may be a major source of profit for the contractor, as they may constitute a significant proportion of the total contract value. Although many contract documents require a specific Method Statement detailing the earthworks activities and sequence, the sensitivity of this phase is sometimes underestimated. The common use of the term "muckshifting" may be indicative of an attitude implying that a certain lack of care or finesse is expected. Prudent contractors and architects will be well aware of the folly of this attitude!

The main activities at the earthworks stage may be summarised as

- **cutting** to reduce surface levels, and
- **filling** to increase levels.

Where suitable, material is transported from areas of cut to areas of fill, aiming to balance volumes. Ideally, the general principle of cutting in low areas and filling in high areas

should be followed, as this will enhance rather than obscure the existing structure of the topography.

- **Balancing** the volume of cut and fill both within localised parts of the site, to limit the distance of transport, and on the site as a whole, to avoid importing[10] or transporting material to tip, is clearly desirable financially. It may also have potential environmental benefits for example by reducing fuel usage, the extent of haul routes and site traffic, and restricting the overall disturbance to well-defined zones of the site.
- The precise **methods** of excavating and filling, and the equipment to be used, are decisions best left to the contractor's expertise, provided that they are appropriate to ensure the safety and stability of the slopes of the completed "formation" levels. Typical plant used at the bulk earthworks stage includes:
  - Euclid 769 Dump Truck (c.24m³ capacity)
  - Volvo 820 Dump Truck (c. 11m³ capacity)
  - Caterpillar "Scraper"

Euclid 769: large-capacity dumper for bulk earthworks

- Although subsequent operations will allow fine-tuning, it is important that the basis of the new topography is aesthetically sound, and therefore the formation levels should be married to existing ground by ensuring that the **crests and bases** of all slopes, whether in cut or fill, are rounded-off.

[10] *Importing foreign material from off-site will also impact on the natural site conditions.*

2.4.2 Specific methods

Disposal of water

Disposal of water in excavations is an important environmental consideration, to avoid siltation or other pollution of watercourses.

Under the Environmental Protection Act 1990, it is an offence to pollute "controlled waters" and SEPA should be consulted where any discharge is planned. A formal discharge consent will be required and may not necessarily be granted [10].

Where pumping is required, the water should either be allowed to drain from land well clear of watercourses, or be discharged to sediment basins or ponds.

Cuttings

From an aesthetic perspective, care is required at the construction stage to ensure that exposed cutting faces are finished to leave no scars from plant, and that an irregular natural appearance is achieved, whether in rock or subsoil. Features such as horizontal terraces, and regularly-spaced drilling holes or lines should be avoided, with the aim of emphasising the **distinctive geological properties of the rock**. In some instances, it may be appropriate to encourage **vegetation establishment** by forming small ledges or pockets on the cutting face. Cuttings may also be potential **wildlife habitat**; there are instances of birds such as sand martins using new cut faces in softer material as a nesting site.

Lake sites or other borrow pits

Where cut and fill cannot be balanced within localised parts of the site, it is sometimes necessary to transport larger volumes of material over larger distances. It has become normal practice to incorporate lakes or water features into a project for this specific purpose. Although this is primarily a design issue, and should be addressed as such at the planning stage of the project, there may be instances where opportunities arise at the construction stage due to unforeseen circumstances, e.g. the need to overcome a shortfall in fill material. (See also Landscape Guidelines for Golf Course Development [2] p 21).

Drilling, blasting and use of explosives

Where excavations are required in rock, normal earthmoving equipment will not be effective without prior drilling or blasting operations. This is clearly a specialist issue with regard to health and safety, but also has the potential to be a significant environmental nuisance with regard to vibration, noise and dust, and the hours of working. **Health and Safety legislation** prescribes acceptable limits.

2.5 Shaping

This phase of the works, when detailed shaping of the surface contours of the main golf course features is carried out, is perhaps the most critical with regard to the final appearance. The skill of the site operators who drive the earth-moving equipment will determine how successfully the architect's drawings are interpreted, to achieve the most aesthetic shapes and challenging playing values for fairways, greens, tees, and bunkers, and harmonious natural transitions to existing landforms.

Integral to the final landform shape is its water-shedding characteristics, the intent should always be to achieve complete **positive surface drainage** away from all playing areas, avoiding any potential ponding. Swales to assist in shedding water to out-of-play areas, wetlands, or water features will also be incorporated at this stage, representing a positive opportunity to create the basis of a genuinely **sustainable drainage system** (see section 2.9 on Drainage).

Accomplished **"shapers"** are genuine craftsmen and are much in demand: they may often be retained by an architect or specifically "nominated" as sub-contractors for his projects. In Europe, there are currently probably only of the order of 20-30 experienced shapers. Of these, a smaller number are the most in demand, due to their ability to interpret an architect's vision, rather than produce a standard, albeit aesthetic, shape. Shaping machines incorporate a mechanism known as Power Angle Tilt (PAT) to allow the blades to be adjusted for angle very sensitively.

Operations are sequenced to work towards progressively finer detail. Initially a large dozer (Caterpillar D5, D6, or similar machine) will be used, as detail increases, smaller dozers, rubber-tyred tractors, excavators and finally hand-work will be required.

The shaping operations will grade landforms to **"formation level"**, that is, the level below the finished surface level to allow for respreading topsoil, and for green and tee construction layers (see also section 2.6 below).

12-Ton excavator shaping green formation level

2.6 Green and Tee construction

This section refers to the construction of the actual playing surface of greens and tees, undoubtedly the most important single operation in determining the playing qualities of the course, focussing however only on environmental issues and implications. The United States Golf Association Green Section's recommended method (usually referred to simply as the **USGA method**) creates a very finely-balanced soil environment for turfgrass. The requirements for the control of soil moisture, irrigation, nutrients, weeds, pests and diseases all tend to be more critical than with other construction methods, leading in general to a more intensive and costly maintenance programme.

Herringbone drains in USGA construction method. Dalmahoy, Edinburgh

Hydrema Dump Truck placing rootzone

2.6.1 Greens

It has become common practice in recent years to adopt the USGA method, but it is by no means always the case that this is the optimum choice. As a recent guidance document points out:

> *"The intention of this document is to produce guidelines for putting green construction* ***appropriate for United Kingdom conditions****. Many of the principles embodied in the USGA construction guidelines are used but these have been adapted to be more relevant to United Kingdom conditions and also include new research data and practical experience available in the country."*
>
> *"If greens are to be firm, well drained and capable of supporting play throughout the year, it is essential that they are well constructed. This means the use of materials that will give good drainage performance but which will also support healthy growth of desirable grass species without the need for excessive management inputs."* [13]

The details of the construction profile of greens, including drains, drainage layer, and rootzone material, are fully documented in the technical literature. [13,14].

With regard to the STRI recommendations for UK, the following points are of relevance here:

- The construction method should be selected relative to **location and soil type**. On links or heathland sites, on deep coastal or glacial sands, neither sub-surface drainage nor a drainage carpet may be required.
- The subsoil levels should be shaped to provide a contoured formation surface which exactly reflects the shape of the final putting surface, allowing for the depth of the drainage layer and rooting medium. It is important to have positive drainage from all parts of the formation level/putting surface, with no drainage "pockets" or ponding areas.
- Where a subsurface drainage system is required, consideration has to be given to **disposal of drainage waters** away from play areas, and to the laws regulating drainage water disposal. (See section 2.9 on Drainage).
- The rootzone mixture consists of sand, soil, and organic matter, with **peat** commonly used as the source of organic matter. Other organic sources are preferable from an environmental perspective and may also be suitable, but advice should be sought from a soil-testing laboratory.
- **Materials** should be brought to the specific greensite as required and storage remote from main compound should be avoided if possible.
- **Lysimeters.** It is becoming increasingly common for a lysimeter to be incorporated into the construction of at least one putting green on new courses as a means of monitoring environmental impacts of water percolating through the rootzone/soil profile. Periodic analysis of the percolate for nutrients and pesticides, especially following applications, will provide information about how successful management practices are in maintaining good water quality.

Lysimeter installed in green sub-base. (Photo Turf-Tec International, Florida)

2.6.2 Tees

Construction may also be to **USGA** specification (with at least 250mm depth of rootzone or preferably 300mm as is used on greens). However tees are often constructed without a gravel raft and rootzone layer, using either sand, good quality selected sandy topsoil or topsoil ameliorated with sand.

Temporary cut-off drains may be required during the construction of greens and tees to prevent erosion prior to establishment of grass.

New tee platforms showing USGA rootzone, with topsoiled surrounds. Dalmahoy, Edinburgh

2.7 Bunkers

Bunker construction begins with the **shaping** operation described above. Greenside bunkers are usually shaped as part of the green complex, while fairway bunkers similarly will be shaped as an integral part of fairway shaping. It is important to **drain** bunkers: the system should be independent of green drainage if possible, as bunker drains are more prone to blockage. It is good practice to provide a silt trap where the bunker drain joins the main carrier drain. This should be situated outside the playing area to avoid disruption when cleaning out.

- Design styles: Choice of **grass face, sand face, or revetted styles** has an impact on maintenance requirements. Turf or hydroseeding is sometimes used to establish grass on the steeper banks of bunkers.

- Although this is primarily a design consideration, correct implementation of the architect's design is vital where **visual impact** of bunkers is a concern.

Reconstruction of a revetted links bunker: Cottage Bunker, Old Course, St Andrews

2.8 Topsoil Replacement

Prior to seeding or turfing, the stripped topsoil must be replaced and respread to all affected areas. Several environmental issues are particularly relevant during this work stage.

- **Methods of placement**: Select and use plant to minimize disturbance, trafficking and compaction.
- There may be significant danger of **storm water erosion** of newly-topsoiled areas. Sand-bagging, erosion-control fences, temporary ditches or other methods may be needed to stem the flow of water and consequent soil erosion. In extreme cases, entire green complexes have been known to be washed-out by storm damage – the frequency of such events is likely to increase in line with predictions for climate change. The probability of such problems should be considered at the design stage and action taken to prevent/minimise them – they should not simply be made the contractor's responsibility! (e.g. long open slopes and/or steep slope angles can be avoided, turfing specified rather than seeding).

2.9 Drainage

Drainage trench invert being controlled by laser levelling

During the construction stage itself, of paramount concern is the need to minimise potential **sediment loading** of watercourses, as unvegetated ground is much more likely to lead to soil particles being eroded either directly from the surface, or in suspension in piped drainage effluent. This can be particularly relevant for sites on river floodplains.

The phasing or sequencing of the drainage construction work should be carefully considered to **minimise repeated disturbance** of shaped and finished areas. This will mean that the trenching, pipe-laying, and backfilling activities will be programmed to take place in each area as it becomes available, normally after the placement of topsoil but before final cultivations, rather than as a continuous operation over the entire site.

The use of tracked vehicles or vehicles with Low Ground Pressure tyres or tracks helps to minimise disturbance to soils during drainage work, particularly to avoid compaction of the topsoil (as noted earlier).

Due to the relatively flat nature of the extensive playing areas of a golf course, falls on drainage runs are often of necessity very shallow, with minimum gradients of no greater than 1:200 common. This places a premium on the accuracy of levelling if costly and damaging re-excavation and re-laying is to be avoided. **Laser guided** excavation/trenching equipment is therefore recommended.

Old field drains are often encountered during drainage construction and should be connected in to the new system where possible. As for all parts of the new system, it is important that purpose-made **pipe junctions** are used. Poorly-fitting junctions are a very common cause of future drainage problems.

The system should **incorporate inspection chambers/silt traps** in key locations, e.g. where a change of direction, gradient, or pipe diameter occurs. These are all potential locations for the deposition of sediment which may therefore be easily removed during routine maintenance to prevent sediment transfer to adjacent watercourses.

Open ditches are often underrated as components in the drainage system. Not only are they a means of achieving efficient, flexible flow rates and are relatively easy to maintain, but from the environmental perspective they provide the potential for enhancement through habitat creation. A well-designed and constructed open ditch, with a variable cross-section and gradient, rough bank profile, and

SUSTAINABLE DRAINAGE

Golf Course drainage design should endeavour to meet current best practice advice on sustainable drainage. [15]

Key principles in this regard include:

- **Collecting and detaining rainwater in ponds and wetlands.**
- **Collecting and detaining surface runoff in ponds and wetlands.**
- **Diverting and detaining golf course drainage in ponds and wetlands.**

Practical recommendations include:

- **Pipe runs to be kept short, leading to positive outlets as soon as possible; ie natural soakaways, ditches, swales and wetlands.**
- **Positive outlets in turn should feed detention ponds and wetlands/reedbeds (which may act as a source of irrigation water).**
- **Use open ditches, swales, soakaways and wetlands to provide solutions to localised drainage problems on the course e.g. to intercept or divert surface runoff, and in low-lying carries and out-of-play areas.**

(Refer also to SEPA's publication: Ponds Pools and Lochans [16] for detailed design of wetland features).

naturally curved alignment, will rapidly colonise to provide a range of ecological niches and will become a useful wildlife corridor. Ditches may also of course be very attractive landscape features and strategic golfing hazards in their own right.

Where piped drainage outfalls to a watercourse or water feature**, headwalls** may be necessary to prevent the erosion of banks and resulting sediment contamination. (This is also of course an aesthetic consideration).

2.10 Irrigation

Environmental issues relating to irrigation focus primarily on fundamental principles of **water conservation**, rather than on the construction of an irrigation system *per se*, and accordingly do not fall within the remit of this document. Although in Scottish conditions, soil moisture rarely if ever falls to levels which would endanger the survival of turfgrass, attributes including its colour and vigour of growth may be affected. This particularly applies where monocultures of modern species and cultivars are used.
In practice, irrigation systems have become a standard component, for greens and tees at least, and increasingly also for fairways. On a new project, their primary functions may be to **safeguard the initial establishment of the seeded or turfed playing surfaces**, and related to this, to **minimise colonisation or invasion by unwanted species.**

Because of its specialist nature, the irrigation system may be separated from the main golf course construction contract, being designed, specified and constructed under a discrete sub-contract or Bill of Quantities "item".

Construction involves installation of several main components which include:

- Water reservoir: (purpose built tank or water feature)
- Pump and control station: (small building)
- Pipes for water: (uPVC and MDPE pipe)
- Cable systems for power and computer control
- Valves and sprinkler heads

The pipes and valves/sprinklers will normally be installed after topsoil respread and before seeding, so the main construction concerns relate to potential **compaction of topsoil** during excavation and backfilling, **and erosion of topsoil** prior to grass establishment.

Irrigation efficiency, and therefore water conservation, may be affected by poor construction standards, e.g. if leakages occur from the system. Use of uPVC pipe may lead to leakage problems due to the greater number of joints, the use of solvents to connect pipes (which can break down over time) and the lack of pipe flexibility.

2.11 Cultivation

The primary purpose of cultivation operations is to create optimum seed-bed conditions: ie

- To enable seed to be evenly distributed,
- To allow all seeds to come into contact with soil, and soil moisture,
- To make the soil friable enough to allow tender embryo roots to penetrate soil.

Environmental issues at the cultivation stage are typically not significant. There may be some danger of wind erosion and dust nuisance where cultivation operations are carried out in very dry conditions.

The plant used is mainly agricultural cultivation equipment, (including rippers, rotovators, harrows), modified if necessary to accommodate the specific requirements of sportsturf seeding, with additional specialist plant including stone-rakes and stone-buriers.

Stone-burier preparing green approach

2.12 Seeding/Turfing

Normally turfgrass should be established from seed. For United Kingdom conditions, suitable grass species include browntop bent, chewings fescue, slender creeping red fescue, highland bent and smooth-stalked meadow grass. Details of suitable cultivars are given in *Turfgrass Seed*, produced annually by the British Society of Plant Breeders, in conjunction with the STRI [17]. In special circumstances, other grasses that might be considered are creeping bent, velvet bent and dwarf ryegrass. Certification and/or testing of seed is recommended. The certificate should show results of tests for germination, purity and composition and be carried out by an Official Seed Testing Station.

Hydraulic seeding is occasionally used where steep slopes or very rough conditions mean that normal cultivation is problematic, or in very poor substrates. The seed is sprayed from a tanker, in a water-based slurry which may include pre-seed fertiliser, soil improver, stabiliser, and mulch.

Whilst seeding is always the preferred method of grass establishment, there are sometimes circumstances when turf has to be used. Under these circumstances, the turf should be custom grown on a matching rootzone or alternatively washed turf should be used.

Pins or pegs are used to hold turf in position on steep banks, typically for bunker construction. Materials used include galvanised wire, 1" square timber pegs, or hazel rods (as used for roof thatching). As pegs are not normally removed, the use of biodegradable materials is recommended.

Original greens turf re-laid on new USGA green construction. Dalmahoy, Edinburgh

The use of pre-seeding fertiliser, pre-emergent herbicide and selective herbicides is normal in establishing turfgrass swards.

In UK, usually the only "windows" of suitable seeding conditions are April/May or August/September – as it is critical for seed to have time to germinate and establish before the onset of dry summer conditions, and low winter temperatures respectively. At the time of the seeding operation itself, calm, dry, but not too hot conditions are required. It is crucial that the seed bed is dry on the surface, to enable even distribution of seed, and to avoid damage from machinery, but preferably the soil should still be moist underneath.

Fairway being seeded from ride-on broadcaster (middle of picture)

- As the golf course irrigation system is the most commonly used method to ensure that the seed bed stays moist prior to germination, **the programme for irrigation installation must be planned to take account of the seeding "window"**.

Post-emergence of the grass seedlings, operations normally included in the construction contract are light rolling, further stonepicking, and a first cut with mower blades set at a specified height.

2.13 Lakes and Ponds

Water features, including wetlands, lakes and ponds, can be among the most beneficial environmental elements of a golf course if designed and constructed to a high standard[11]. Some key principles to be observed include:

- Build close to existing wetland habitats;
- Take care to ensure high water quality in the water source;
- Adopt a varied design (eg use shallow margins, vary depth in relation to the water table, create low islands);
- Emphasise natural colonisation as the main method of establishing plants;
- Ensure that the disposal of spoil has been planned for and can be used to enhance the overall scheme, eg to create a planted buffer to runoff from playing areas).

Pond excavation, Auchterarder Golf Club, Perth and Kinross

2.14 Other Works

The main golf course construction contract may incorporate miscellaneous other works, including;

- Woodland, tree and shrub planting
- Hard Landscape Works (cart paths, bridges, site furniture).

Any significant potential environmental issues related to these activities have generally been covered under earlier headings, and include:

- soil erosion from ground cleared for extensive woodland planting (see Site Clearance and Topsoil Stripping);
- pollution from application of herbicide to clear planted areas (see Site Clearance and Topsoil Stripping);
- sediment loading of watercourses/soil erosion arising from bulk excavations for lakes and ponds (see Earthworks).

[11] *The design of golf course water features from a landscape perspective is covered in "Landscape Guidelines for Golf Course Development" [2]. Further detail on all aspects of creation and management of small waterbodies is available in "Ponds, Pools and Lochans" [16].*

SUMMARY TABLE

CONSTRUCTION STAGE/ACTIVITY	ENVIRONMENTAL ISSUE	RECOMMENDED BEST PRACTICE
PROGRAMME	Growing season windows	• Overall construction programme to be determined by critical target date for completion of seeding
	Fauna breeding seasons	• Construction programme prepared to avoid conflicts in sensitive areas/zones eg between nesting birds and noise or vibration from heavy earth-moving plant
	Zonation	• Activities phased to minimise need for traffic over completed areas
SITE PREPARATION	Cordons Sanitaires	• On-site refinement of boundaries by specialists. Use of robust fencing (metal or concrete posts) • Use buffer strips for watercourses (for width recommendations see SEPA PPGs) • Existing ground levels sacrosanct for specimen trees. Protection of rooting area and of bark/vascular system required. Recommended extent = (30cm/2.5cm of tree bole diameter)
	Site Access/Site Compound	• Avoid watercourses or sensitive habitats. • Use dry, well-drained site. • Use single access point • Minimise “tracking time” • Plan construction of hard-standing in conjunction with temporary surfaces
	Materials Delivery and Storage	• (For detail refer to SEPA Pollution Prevention Guidelines PPG6) • Ensure spillage response strategies are in place • Consider use of “Biobeds” for tank filling areas and wash pads • Storage tanks for fuels, oils, and chemicals to be sited on impervious base within a bund. (Refer also to SEPA PPG2)
SITE MANAGEMENT	Communication	• Appoint site manager as single Point of Contact, responsible for communication with all environmental organisations • Schedule regular meetings / walk rounds with environmental organisations • Maintain clear and comprehensive records of all decisions and site conditions • Monitor compliance with “Schedule of Environmental Commitments” where appropriate • Require induction meeting and issue of “Site Rules and Regulations” for all personnel
	Hours of Working	• Specify permitted noise and vibration thresholds • Specify machinery not permitted outside certain hours

SUMMARY TABLE (2)

CONSTRUCTION STAGE/ACTIVITY	ENVIRONMENTAL ISSUE	RECOMMENDED BEST PRACTICE
HAUL ROUTES	Location	• Locate on plan, and set-out clearly with posts and fluorescent tape • Plan to coincide with permanent roadways where feasible • Avoid fairways, wet areas, and environmentally sensitive areas • Routes to green complexes to lead in from rear
	Number	• Minimise number and width of routes
	Soil conservation	• Strip topsoil before use and decompact before topsoil respread
SETTING-OUT	Environmental Fit	• Work to be carried out by suitably experienced surveyors, but contractor and architect should seek opportunities to improve environmental fit of golf course
SITE CLEARANCE	General	• Adopt sensitive, gradual, and flexible approach to clearance • Seek to minimise extent of working area
	Tree Clearance	• Comply with specialist woodland management plan and obtain felling licence where applicable • Use specialist skilled arboricultural contractors/tree surgeons/forestry contractors • Take down individual trees in sections if necessary to avoid damage to adjacent trees/canopy • Use “staged felling” method - work outwards in phases from golf hole centreline • Grub-up or chip stumps (avoid burning) • Retain unsold timber as wildlife habitat
	Other Vegetation	• Seek to limit clearance of all areas of natural vegetation • Retain /incorporate as golfing hazards where possible • Translocate suitable species/individuals to undisturbed areas of site
	Location of Services	• Ensure accurate location of existing underground services to minimise risk of pollution from damaged pipes and cables
	Other Artefacts	• Incorporate features (eg stone walls) into golf course layout where feasible • Inform Planning Authority immediately via Regional Archaeologist if previously unrecorded features uncovered

SUMMARY TABLE (3)

CONSTRUCTION STAGE/ACTIVITY	ENVIRONMENTAL ISSUE	RECOMMENDED BEST PRACTICE
TOPSOIL STRIP	Working Area	• Seek to minimise extent of working area
	Weather/Soil Conditions	• To conserve structure, handle soil only when conditions are suitable and soil is dry and friable
	Equipment	• Use only plant expressly designed for purpose eg D5 Dozer
	Depth	• Vary depth of strip to reflect local soil conditions
	Segregation	• Strip only true topsoil and maintain integrity of topsoil/subsoil, and of varying types of topsoil
TOPSOIL STOCKPILE	Location	• Locate stockpile sites on plan prior to start of work • Avoid watercourses and other areas susceptible to soil deposition • Site on areas of similar topsoil type
	Dimensions	• Do not exceed 2-3m in height
	Duration	• Do not exceed 8 weeks storage duration
	Management	• Maintain pile free of weeds and avoid trafficking once formed
BULK EARTHWORKS	Disposal of Water	• Discharge Consent from SEPA may be required (Refer to SEPA PPG6 for detail)
	Cuttings	• Emphasise properties of local geology • Seek opportunities for habitat creation and enhancement
	Drilling and Blasting	• Potential for significant environmental nuisance • Refer to legislation for acceptable limits: Health and Safety at Work Act 1974, Control of Substances Hazardous to Health Regulations (COSHH) 2002
SHAPING	Aesthetics	• Accurate interpretation of architect's plans • Experienced, highly skilled operatives essential to achieve good result
	Drainage	• Create positive drainage away from all playing areas through landform • Integrate with sustainable drainage system

SUMMARY TABLE (4)

CONSTRUCTION STAGE/ACTIVITY	ENVIRONMENTAL ISSUE	RECOMMENDED BEST PRACTICE
GREEN & TEE CONSTRUCTION	Use of "USGA" Type construction methods	• Ensure long-term maintenance requirements can be met • Adopt detailed construction method tailored to suit local/UK soil conditions. (Seek expert agronomic advice)
	Drainage	• Integrate subsurface drains with sustainable drainage system
	Rootzone	• Seek to use peat substitute for organic component of rootzone. (Seek expert agronomic advice)
BUNKER CONSTRUCTION	Bunker Sand	• Potential for wind erosion if particle size too small
	Visual Impact	• Accurate interpretation of architect's design to minimise visual impacts from sand surface, sand colour, and mounding. Consider need to adjust on site if necessary
TOPSOIL RE-SPREAD	Soil Structure	• Select plant to minimise disturbance and avoid compaction
	Soil Erosion	• Minimise potential for erosion by sensitive design of topography • Use erosion control fences, temporary ditches and other measures to reduce soil loss
DRAINAGE	Sustainable Drainage Principles	• Keep pipe runs short, leading to positive outlets (soakaways, ditches, swales,etc) as soon as possible • Positive outlets in turn should feed detention ponds, wetlands, reedbeds • Use open ditches, swales, soakaways and wetlands to provide solutions to localised drainage problems
	Soil Erosion	• Minimise potential for sediment loading/discharge to local watercourses
	Soil Structure	• Minimise repeated disturbance of completed areas
IRRIGATION	Soil Structure	• Avoid compaction of replaced topsoil during trenching / installation
	Soil Erosion	• Avoid erosion of topsoil by excessive use of system prior to grass establishment
CULTIVATIONS	Soil Erosion	• Avoid cultivation operations in very dry / windy conditions
SEEDING/TURFING	Sward Establishment	• Select grass species and cultivars to suit local/UK conditions. (Seek expert agronomic advice) • Select seeding in preference to turfing unless very rapid establishment necessary • Consider hydraulic seeding on steep slopes/rough ground or poor substrate • Ensure programme for irrigation installation can meet target for seeding "window"

SUMMARY TABLE (5)

CONSTRUCTION STAGE/ACTIVITY	ENVIRONMENTAL ISSUE	RECOMMENDED BEST PRACTICE
OTHER WORKS	Soil Erosion	• Prevent soil erosion from ground cleared for extensive woodland planting • Prevent sediment loading of watercourses/soil erosion arising from bulk excavations for lakes and ponds
	Herbicide Pollution	• Prevent pollution from application of herbicide to clear planted areas

REFERENCES

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4. *British Association of Golf Course Constructors.* www.bagcc.org.uk *(visited 23.02.04)*
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12. *Planning Advice Note PAN 42 Archaeology – The Planning Process and Scheduled Monument Procedures.* The Scottish Office. 1994.
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15. *Waste Management Toolkit.* Scottish Golf Environment Group. 2004
16. *Ponds, Pools, and Lochans.* Scottish Environmental Protection Agency. 2000.
17. *Turfgrass Seed 2004.* British Society of Plant Breeders Limited, in conjunction with the STRI.

APPENDIX

SOURCES OF ADVICE

Scottish Golf Environment Group (SGEG)

The Stables
Dalkeith Country Park
Midlothian, EH22 2NA
Tel: 0131 660 9480
e-mail: info@sgeg.org.uk
www.sgeg.org.uk

Scottish Environmental Protection Agency (SEPA)

SEPA Corporate Office
Erskine Court
Castle Business Park
Stirling, FK9 4TR
Tel: 01786 457700
www.sepa.org.uk

Scottish Golf Union (SGU)

PO Box 29212
St Andrews
Fife, KY16 0YG
Tel: 01382 549500
e-mail: sgu@scottishgolfunion.org www.scottishgolfunion.org

The R&A

The R&A
Fife, KY16 9JD
Tel: 01334 460000
www.randa.org

British Association of Golf Course Constructors (BAGCC)

Fore!, The Dormy House
Cooden Beach Golf Club
Bexhill-on-Sea
East Sussex, TN39 4TR
Tel: 01424 842380
e-mail: enquiries@bagcc.org.uk www.bagcc.org.uk

Sports Turf Research Institute (STRI)

St Ives Estate
Bingley
West Yorkshire, BD16 1AU
Tel: 01274 565131
www.stri.org.uk

Scottish Natural Heritage (SNH)

2 Anderson Place
Edinburgh, EH6 5NP
Tel: 0131 447 4784
e-mail: enquiries@snh.gov.uk www.snh.org.uk

Historic Scotland

Longmore House
Salisbury Place
Edinburgh, EH9 1SH
Tel:0131 668 8777 (Ancient Monuments and Scheduling)
www.historic-scotland.gov.uk

European Institute of Golf Course Architects (EIGCA)

Chiddingfold Golf Club
Petworth Road
Chiddingfold
Surrey, GU8 4SL
Tel: 01428 681528
e-mail: info@eigca.org www.eigca.org

Waste and Resources Action Programme (WRAP)

The Old Academy
21 Horse Fair
Banbury
Oxon, OX16 0AH
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