An Environmental Approach to Golf Course Development

American Society of Golf Course Architects

Forewords

Golf and environmental science are more similar than most people believe. Both are complex disciplines that involve the interplay of so many variables that a perfect synthesis approaches the level of art and is a rare achievement. Historically, golf courses and environmental protection have been considered contradictory. It was assumed that you couldn't have a quality golf course without significant environmental impacts. This led to extreme distrust and antagonism which has continued to perpetuate the myths that the golf industry is unconcerned with environmental impacts and that environmentalists want to close all golf courses. As both an environmental scientist and avid golfer, I have been working with courses over many years to challenge these assumptions and to encourage the adoption of design practices that can make golf courses environmentally friendly.

This 3rd Edition of An Environmental Approach to Golf Course Development continues to provide a valuable source of information on the environmental considerations involved in the these design, construction and management practices. The Case Studies in the publication are good examples of courses that were built or renovated to embody environmental principals and at the same time offer an outstanding golf experience. These courses illustrate the characteristics and care taken to address many varied environmental issues and achieve both goals.

Golf and the environment are inextricably intertwined. It is no accident that we golf outdoors. The character that makes a course memorable – whether it's the sound of the surf behind you as you line up a shot or the alligators you avoid on your way to the ninth hole – comes from its natural setting. Acknowledging and respecting this connection through environmentally friendly design principles enhances the golfing experience and helps to protect the environment that supports us all. An Environmental Approach to Golf Course Development provides relevant and comprehensive information for achieving this synthesis and serves as an excellent guide for intelligent and environmentally responsible course design. Now, on to the challenge of achieving the synthesis of a perfect round...

Mark Sudol, Chief, Regulatory Program
United States Army Corps of Engineers

Golf is unique. No other game is so dependent on the elements of the landscape to be its playing field, to be its obstacles and its rewards and indeed to form its character. Ian McHarg in his influential 1969 book, challenged architects and planners to *Design With Nature*. He said it was a must if man was to be a steward of the biosphere. Ironically, golf course designers had been doing this for hundreds of years. Indeed even the earliest golf courses depended on their natural settings to make the great game of golf what it is. Golf course designers have a rich heritage of designing *with* nature. As an environmental planner and a golfer, I can attest that the courses providing the most memorable experiences are the ones that harmonize with their surroundings and use, to the fullest, the potential and the restrictive conditions that the natural landscape offers. The best golf course designers have, over the years, excelled in the art of integrating the game and the natural landscape.

As the modern environmental movement has matured, golf course architects and managers have begun to excel in the field of environmental design and management. Green golf has brought out new environmentally responsible design practices. Not just to harmonize with the landscape, but to benefit the environment. The case studies and practices presented in this 3rd Edition of An Environmental Approach to Golf Course Development illustrate vividly how golf course designers are succeeding in realizing this vision in new and refined ways. Protecting and restoring wetlands streams and wildlife habitat, preserving native vegetation, minimizing irrigation needs, protecting water quality, reclaiming and restoring broken land; these are just a few of the design principles at work in the case studies presented here. The American Society of Golf Course Architects has played an important role in the advancement of environmental design in golf. The first edition of this book was published in 1992 and it has been influential in educating government officials, developers, citizens, architects and course mangers in how to create golf courses in an environmentally beneficial way.

The golf community should be commended for its accomplishments in environmental design and management and it should be eager to advance the tradition in new and innovative ways. In so doing, the golf community can challenge itself and lead the rest of society to excel at being stewards of the biosphere.

Robert Wood, Deputy Director Wetlands Division
United States Environmental Protection Agency

Table of Contents

Cover image:
***Prairie Dunes Country Club**, Hutchinson, Kansas*

An Environmental Approach to Golf Course Development

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Introduction

Cypress Point Club
Monterey, California

The environmental movement that came to the forefront in this country during the 1960s instilled an awareness that has continued to grow over the years until now it seems a part of the social consciousness. Protection of air and water quality, management and conservation of our natural resources and minimizing the impact of land development on the environment have become important concerns for government officials at all levels, as well as the general public. Population growth is also a concern both here and in other parts of the world because it requires the development of new housing, infrastructure, services and recreational opportunities. We now recognize that such development must be accomplished in a responsible manner that protects our environment, improves our existing conditions and ensures a higher quality of life for future generations.

At the same time, there is much more emphasis on physical fitness within our society, and because of this, the game of golf has grown and remains one of our most popular recreational activities. With more leisure time available and a desire for affordable recreation, the number of people playing golf in the United States has steadily increased in the recent past. This trend is expected to continue, especially within certain areas of the country, and the demand and development of new golf courses will keep pace with the growing golf population.

Golf is unlike most other sports in that it does not involve a standard playing field or arena. Instead, golf utilizes the landscape and for that reason maintains a unique relationship with the environment.

Fishers Island Golf Club
Fishers Island, New York

Understanding and addressing this relationship is essential to the design, construction and management of golf courses. Because of this, environmental issues have long since been a priority within the golf industry. Organizations such as the American Society of Golf Course Architects, Golf Course Builders Association of America, Golf Course Superintendents Association of America, United States Golf Association, National Golf Course Owners Association, Club Managers Association of America, Professional Golfers Association of America, National Golf Foundation, the professional golf tours and others involved in the game of golf are striving to find the most environmentally responsible approach to the development of new golf courses and the management of existing facilities. The Green Section of the United States Golf Association and the Environmental Institute for Golf provide the golf industry with extensive, ongoing research and education regarding environmental issues and stewardship.

The development of a golf course is a complex process. To deal with it, qualified professionals provide the expertise necessary to create design solutions for golf courses that are compatible with the environment. A golf course presents the opportunity to meet a need for recreational amenities, while preserving green space that will provide benefits for the future development of an area. Often the green space of a golf course can serve as a protective buffer between sensitive environmental areas and adjacent development. This buffer, which contains extensive turfed areas and vegetation, will also protect water quality by providing stabilization against erosion and storm water management. Efficient and responsible maintenance practices for the golf course will promote the proper use and conservation of water resources. A golf course can provide enhancement to the environment by incorporating areas for conservation and the promotion of wildlife habitat. Where land has been degraded over time by intensive use or mismanagement, golf courses can provide much needed land improvement. These are benefits that can result when an environmental approach is used for the design, construction and maintenance of a golf course.

The Environmental Committee of the American Society of Golf Course Architects was formed in 1970 to address the environmental issues involved with the development and renovation of golf courses. The first edition of An Environmental Approach to Golf Course Development was published in 1992. The Environmental Committee has produced this third edition in an effort to provide the reader with more information about the golf course development process and how it is approached in an environmentally responsive manner. As background, an overview has been included on the history of the game and the development of golf courses. Various aspects of golf course design, construction and management are discussed to show how environmental issues can be identified and addressed in each stage of the development process. Case studies have been included to illustrate how golf courses have provided successful solutions to environmental issues. The major steps involved in the process have been outlined in a checklist for the development of a golf course. Suggested references and the organizations involved in golf and the environment are also included to give the reader a source for further information.

The Growth of Golf

St. Andrews, The Old Course
St. Andrews, Scotland

The game of golf as we know it today originated in the British Isles hundreds of years ago. Along the coasts of Scotland and Ireland, where rivers like the Forth and Eden empty into the sea, the areas referred to as "linksland" were formed by the forces of nature. These unique landscapes are made up of a very particular topography that occupies long stretches of shoreline. Nearby towns utilized the linksland mainly for grazing livestock and some agricultural purposes, but because of its suitable characteristics and the fact that it was mostly under public ownership, linksland also gave the townspeople a natural setting in which to discover the first golf courses.

Early courses simply evolved in the linksland and became known by the names of the towns nearby, such as Prestwick, Guillane and Leith. The most notable of the earliest courses was St. Andrews, considered by many to be the "home" of golf. There are records that indicate a golf course existed in some form at St. Andrews as early as 1414. It was eventually designated "The Royal and Ancient Golf Club of St. Andrews." The rules of the game were first administered out of St. Andrews, and its course became the standard by which other courses were compared.[1]

As interest in golf increased, many early courses were expanded or new ones "discovered" in linksland. These golf courses served as one of the focal points around which the towns grew, providing open space for recreational and social activities by the townspeople. For many of these small towns, golf became a part of everyday life; even people who did not play the game would stroll through the linksland to enjoy the environment and watch their neighbors pursue the sport.

By the mid-1800s, golf had spread throughout the British Isles along the coasts and inland, as well as areas of Europe. By the late 1800s, there were only 150 courses scattered throughout Britain. This situation changed dramatically during the next few decades as a great number of new golf courses were put into play, due to the growth in the game. Today, golf has remained one of the favorite pastimes throughout Britain and become a popular sport in most European countries.

Golf was introduced to the United States in the late 1700s, but did not become an established sport until the late 1800s. Many Americans, upon visiting the British Isles and being introduced to golf, were captivated by the game. Upon returning to the U.S., these new golfers created the first simple courses in order to continue playing the game they had enjoyed overseas. Often it was arranged for people who were involved with golf, professionally as players or managers, at the British golf courses to come and assist with the development of new courses in the U.S. In order to accommodate the

[1]Cornish, Geoffrey S. and Whitten, Ronald E. The Golf Course, New York: Rutledge Press. Rev. 1987

Cape Breton Highlands Links
Ingonish Beach, Nova Scotia

rapidly growing game, the United States Golf Association was established. By the early 1900s, there were almost 1,000 golf courses in this country, more than the number in Britain. Since then, golf has experienced periods of tremendous growth. The first was the late 1920s, often referred to as the "Golden Age of Golf." By successfully competing in championship golf tournaments, golfers such as Bobby Jones and Francis Ouimet brought national attention to the sport and generated a tremendous amount of public interest. As a result, there was a growing demand for new golf courses.

Approximately 500 new courses were being developed annually toward the end of the 1920s. Even at this rate, the need for more courses continued as the number of people playing golf increased steadily. During the Depression and World War II, the growth of golf slowed. At the beginning of the 1950s, there were millions of golfers in the U.S. playing on an estimated 5,000 facilities. The popularity of major golf tournaments and increased exposure from television coverage during the decade refueled the growth of golf. By the 1960s, there were almost 6,000 facilities. Heading into 1970, the demand for new courses accelerated, but the number of new facilities still had not kept pace, having reached only 10,000.

The 1970s and 1980s experienced periods of economic slowdown. In spite of this, golf continued to grow by offering a local, affordable recreational activity. The demand for new golf courses remained strong in the 70s, and by the mid-80s there were 13,000 facilities. In the late 1990s, golf experienced a resurgence with the number of golfers still increasing, but the number of new facilities not keeping pace. After 2000, the growth of golf slowed, as did the development of new facilities. As 2010 approaches, golf participation will likely grow at a slower, but steady pace and the demand for new golf course development and renovation of existing facilities should continue in the future.

Europe and Asia are now experiencing a great increase in golf activity with the development of new facilities outpacing the U.S. The game has now made its way to most parts of the world, and even in countries like Russia and China – where golf has a limited history – new golf courses have been developed.

Royal County Down Golf Club
Newcastle, Northern Ireland

The Development of Golf Courses

The first golf courses of the British Isles evolved in linksland areas because the land was ideally suited to the game. Linksland is characterized by distinct features consisting of valleys and hollows amidst windswept sand dunes, all covered with native grasses and few, if any, trees. The soil is typically sand-based with excellent drainage and provides ideal conditions for growing grass. It was easy for early golfers to walk among the dunes and discover certain grassy hollows as the first golf holes. There were no standards to follow for laying out a golf course at this time, so a series of holes was simply selected with a routing that often ran along the coast and returned near the starting point. The number of holes varied from course to course, and when it became desirable to enlarge the golf course, players would simply venture farther into the linksland and discover more holes.

There was very little construction involved in these initial courses because of their advantageous settings and natural features. Even when the first man-made modifications occurred, they were implemented in concert with the existing land. As golf migrated out of the linksland, new courses had to be constructed on sites that were not as well suited to golf as the seaside locations. Construction techniques were primitive at that time, relying on hand labor and equipment drawn by mules or oxen. The early architects were limited in what they could do to alter the landscape in building a new course. They worked carefully with the topography and existing features to avoid excessive disturbance as well as expense in construction.

Shinnecock Hills G.C.
Southampton, New York

Early courses in the U.S. often followed this tradition. Sites were selected for their inherent character and the ability to produce an outstanding test of golf. Some of the golf courses built in this country years ago, such as Pebble Beach and Cypress Point with their magnificent oceanside holes, Prairie Dunes on its unique Midwest topography, and Shinnecock Hills winding its way through the wind-blown landscape of Long Island, are all still acknowledged as among the best in the game. These

Ballybunion Golf Club
Ballybunion, Ireland

courses were carefully designed in response to their sites, and have since functioned compatibly as an integral part of their environments. The appeal of these golf courses can be attributed to the feeling that each course belongs in its setting.

Not all golf course development since the early years has been based solely on site selection. The growth of the game required that new facilities be more accessible to the public. During the "boom" periods, new golf courses tended to be located where the demand was greatest. Since the 1950s, trends have been established in this country that produced golf courses in roles other than as private clubs. New residential developments feature golf as an amenity of the community and enhancement for home sites. Vacation and resort destinations often include golf as an added attraction. Perhaps the most significant trend, however, has been the increase in public golf courses which provide an affordable recreational activity for local communities. Prior to 1950, private golf facilities outnumbered public. As of 2005, the number of daily fee and municipal courses for public use is over twice that of private facilities.[2]

Today, sites are being selected for demographic and economic purposes, as well as for their suitability as golf courses. Modern construction methods and equipment have made it possible to build golf courses in locations where there is a demand for new facilities. Not all locations offer sites with ideal conditions and outstanding natural character. Often they contain no significant land forms, water features, trees or scenery. In some cases, golf courses have been specifically developed to enhance the visual quality of featureless sites and provide an attractive green, open space. Other sites that have been mismanaged or abandoned after extensive use as agricultural fields, stone quarries, gravel pits, landfills, sludge disposal sites or other operations that degrade the land can be reclaimed, improved and beautified through adaptive reuse as a golf course.

[2]Golf Industry Report, Vol. 5, 4th Quarter 2005, Jupiter, Florida: National Golf Foundation

Environmental Issues Most Often Encountered in the Development of a Golf Course

Any development project being proposed for a particular location, whether a shopping center, residential development, office complex, school or golf course, will undergo a comprehensive review and approval process by local and, at times, state and federal regulatory agencies. When a golf course is being proposed, either as a separate facility or part of a larger project, it must be thoroughly reviewed and evaluated to determine its impacts and benefits to the environment, as well as area residents. Typically, during the review process, public hearings are conducted to allow the residents an opportunity to comment and express any opinions regarding the proposed project. Comments from these hearings or the review process are often about environmental issues. The size of the sites and land use involved in golf course development require that any such issues be identified and addressed in the initial stages of the planning process.

Nissequogue Golf Course
St. James, New York

Over the last few decades, the environmental movement has brought attention to issues involved in land planning and development. This movement has also led to a much more sensitive, responsive approach to how golf courses are planned, designed, built and managed. Because of the unique relationship a golf course shares with the land, and the special nature of its development, environmental issues must be thoroughly addressed during the regulatory review and approval process. While subject to the same applicable review process as projects that affect the natural landscape more dramatically (for example, a shopping center), a proposed golf course should be carefully considered in light of potential benefits for the community, future development and environmental enhancement.

The Golf Club at Chaparral Pines
Payson, Arizona

Collier's Reserve Country Club
Naples, Florida

Every proposed golf course presents a unique case because the existing conditions of every site will vary and no two sites are ever exactly the same. There will be specific issues for design, construction and management that are based on location, site characteristics, climate and local regulations. However, depending on site location and climatic conditions, there are certain environmental issues that must be addressed for most golf course projects at the beginning of the planning and regulatory review process, prior to development.

- *Will there be any impacts to water quality from surface drainage run-off or sub-surface infiltration resulting from the long-term application of chemicals for turfgrass management on a golf course?*
- *What will be the irrigation requirements of the golf course and could water usage adversely affect local water supplies, especially in areas with limited water resources?*
- *Will the proposed golf course avoid or minimize impacts to wetlands and other sensitive environmental areas that may exist on the site?*
- *What impact will the golf course have on the ecological systems of the site or adjacent properties, such as plant communities and wildlife habitat?*
- *How will sensitive areas on site and adjacent properties be protected from potential water pollution due to earth disturbance and erosion during the construction of the golf course?*
- *How will the golf course affect the existing character of a site through alteration of the topography and vegetative cover?*
- *Are there significant historical, cultural or archaeological resources existing on the site that will be adversely affected by the golf course and require research or preservation?*
- *Does the development of a golf course constitute the elimination of open or green space by making use of a site which is currently undeveloped?*
- *Can a golf course provide a viable means of remediation or rehabilitation and environmental enhancement for brownfields and other degraded sites?*

It is essential that these issues be identified and addressed in the initial stages of planning and design for the project. A responsive approach to the issues will avoid or minimize environmental impacts, as well as costly delays in the regulatory review and development process and result in a successfully completed golf course that is environmentally compatible with its site.

Addressing the Environmental Issues in the Golf Course Development Process

Laurel Hill Golf Club
Fairfax County, Virginia

The development of a golf course is a complex process involving a substantial financial investment, extensive environmental review by regulatory agencies and the necessary amount of time for proper design and successful construction. The basic objective for developing a golf course is to provide an enjoyable recreational facility that is environmentally sound, successfully operated and financially viable. To achieve this goal, the golf course must be carefully designed, properly constructed and responsibly managed.

Before the planning and design phase of a project begins, it is necessary to understand the existing conditions of a specific site and the general area in which it is located to determine the proper approach to the development process. A feasibility study is used to analyze the demographics and economy of an area, to assess the need for a facility and determine whether or not it can be supported financially. The study investigates population information, the golf participation rate and potential growth, the number of existing and planned golf facilities, a general assessment of the site for its suitability, estimated costs of development and projected revenues. This information will verify the need for a new facility, determine the type of golf course best suited to meet that need and establish the initial goals of the project.

Once the feasibility of the project has been confirmed, whether the golf course is intended to be a stand-alone facility or part of a larger project, the next steps are to refine the goals, gain a clear understanding of the site on which the course is to be built and formulate the approach to the development process. To best accomplish this, a team of experienced professionals should be assembled. A qualified golf course architect, such as those within the membership of the American Society of Golf Course Architects, is joined by engineers, land planners, landscape architects, environmental specialists and other consultants to form a team for the planning and design of the golf course. The team will benefit by including a qualified, local golf course superintendent to provide consultation on local climatic conditions, agronomic issues, maintenance practices and resource conservation.

The architect will work closely with the client to evaluate and refine the goals of the project, based in part on the information provided by the feasibility study. At this point in the process, it can be determined or confirmed what type of golf course will best meet the objectives set for the project. While demographic and economic factors may have established the need for a golf course and set the initial goals, the proposed site will be the most important factor in determining how the development of the course is approached.

There is no typical site for a golf course, especially from a topographical standpoint. Many consider land with gently rolling hills and partially covered with trees to be an ideal site. However, some of the country's best golf courses have been located on sites that differ significantly in topographic relief, amount of tree cover and other features. The design, playing characteristics and visual quality of a golf course are not based on any standard. It is up to the golf course architect and other consultants to work with a site to produce a course that affords an attractive and engaging setting in which to play the game.

After completing the necessary field reconnaissance, compiling the site information for analysis and identification of the environmental issues that will be involved in the

project, all applicable land use, environmental and construction regulations must be reviewed. A thorough understanding of the regulatory process at each level, from federal to local, will allow the feasibility of the initial goals set for the project to be properly assessed and determine the best approach to accomplishing the goals. Informal meetings with regulatory agencies and local environmental groups will provide input on any prevalent environmental issues in the area where the site is located. There may be instances when the environmental issues involved in the project will require reconsideration of the site or a modification of the project goals. The golf course architect and consultant team must evaluate if environmentally sensitive areas can be incorporated into the design of the golf course or must be avoided to prevent potential impacts. Based on this evaluation of site information, the team can develop creative and responsible design solutions that are sensitive to the environment and meet the goals of the project. This is especially important to design a golf course that will be challenging, enjoyable, attractive and compatible with its site. A thorough understanding of the regulations and their application to the site will also establish realistic goals and produce the most efficient planning and design, thereby avoiding costly revisions and delays during the review, permitting and construction process.

After the site information has been studied, the design criteria for the golf course must be confirmed. The basic criteria will be determined by the feasibility study, as well as the use and operation established for the golf course – either as a stand-alone facility or as part of a larger project.

The basic design criteria will address the intended use of the golf course:

Community asset – Communities, municipalities and counties can provide a golf course as a public recreational amenity for local residents. It will also preserve open space as the development and population of an area grow.

Residential enhancement – Planned residential developments often include golf as a recreational amenity and green space. Integrating the golf course with residential areas will create an attractive setting and enhancement value for home sites. The recreational activity and green space provided by a golf course often serve as a marketing tool for promoting sales.

Recreational amenity – Hotels, resorts and other vacation destinations can include golf, often with more than one course, to increase the activities offered to guests and also to create a beautiful setting.

Cascades Golf Club
Hot Springs, Virginia

Private facility – A group of golf enthusiasts may build a golf course in order to have a place to play the game or as a business venture. Sometimes a landowner will simply want to fulfill a life-long dream of building and owning a golf course.

The operation of the golf course will also contribute to the basic criteria:

Public, daily fee – Municipal or privately owned golf courses open to the public on a pay-as-you-play basis.

Semi-private – Daily fee or semi-private facilities that provide a combination of public play and some restricted play for a limited membership.

Private – A private facility with play restricted to members and their guests.

There must also be specific criteria established for the golf course based on its intended use and operation. The type of course, number of holes and general configuration will be determined in the initial stages of planning and design. There are many variations to these aspects of a golf course, and the golf course architect will work closely with the consultants, as well as the developers of the project to finalize the criteria for a golf course that will best meet the goals for the project.

The golf course architect and consultant team will explore the characteristics and environmental aspects of the site by compiling all available information, performing field reconnaissance to confirm and supplement this information and then completing a thorough site analysis. A series of maps is typically produced to delineate the results of the analysis and illustrate the potential and limitations offered by the site. Information and mapping typically involved in the site analysis that is critical for proper planning and design purposes should include:

Survey of property boundaries *– Location of boundary lines to show what land is contained in the site.*

Map of coordinates or grid system *– Reference points to supplement the survey and locate features on site.*

Climatic conditions *– The orientation of the sun, prevailing winds, annual rainfall and other pertinent local or regional data.*

Topography *– The configuration or relief of the land and the location of natural features on the site.*

Areas of sensitive, steep slopes *– The location of steep slopes that are regulated.*

Water features and surface drainage patterns *– The location and characteristics of water features such as lakes and streams, any required setbacks or buffer areas, as well as the surface drainage patterns within the site.*

Wetlands and required buffer areas *– The location and characteristics of sensitive wetland areas and required setbacks or buffer areas within the site.*

Identification of the watershed *– The size and drainage characteristics of the watershed in which the site is located.*

The specific design criteria will address the physical characteristics of the golf course:

Number of holes – The accepted number of holes for a typical or regulation golf course is 18. A hole consists of a tee complex, fairway and rough areas, and a green complex. There are a number of facilities with only 9 holes and others with as many as 27, 36, 45 or 54. More than 27 holes constitute multiple golf courses. A practice area or driving range and practice green are typically included as a part of most facilities.

Location of the floodplain *– The location, extent and frequency of inundation from storm water run-off.*

Water availability *– The study of both surface and underground sources of water for irrigation.*

Soils survey *– The soil types, characteristics, and in some cases, the geology of the site.*

Locations and identification of vegetative cover *– The types of plant species on site, locations of specimen quality plants and areas of sensitive, high-quality or protected plant communities that are regulated.*

Location and identification of wildlife habitat *– An inventory of existing wildlife communities and their habitat on the site, adjacent properties and general region including areas of sensitive or endangered species and protected habitats that are regulated.*

Existing roads *– The existing road system, both on-site and off, depicting points of access to the site.*

Existing structures *– The structures located on-site and their present use or condition.*

Location of historical or archaeological sites *– The sites, structures or ruins and landscapes that are regulated as historically or archaeologically significant cultural resources and may require relocation or preservation.*

Location of all right-of-ways or easements *– Identification of all utility lines, right-of-ways, scenic and other easements that must be maintained.*

Location of utilities *– Identification of the nearest available sources for power, water, sewer and telecommunications.*

Scenic views *– The location of scenic views, both on-site and off.*

Adjacent land uses *– Location and identification of adjacent land uses that may have a visual or olfactory impact on the site.*

Configuration – The configuration or layout of the course will depend upon the intended use and the site. There are no standards, only basic configurations. A golf course with a core design has all its holes located in one area, adjacent to one another. In single fairway golf courses, the holes are designed in linear loops, either as a continuous 18 holes or two loops of 9 holes each which start and finish in the same location. Double fairway layouts utilize parallel golf holes which can also be continuous or have two separate nines. Configurations that spread out the golf holes across a site are typically used in conjunction with residential development to produce frontage on the course for home sites. Within these basic configurations there are an infinite number of variations.

Length – Regulation golf courses are usually played to a length of between 6,000 to over 7,200 yards for men and 4,500 to 5,800 yards for women or other players requiring shorter distances. There are many courses with lengths above and below these yardages. The technological advances in the equipment for playing golf have affected the length of certain new and existing courses. Yardages in excess of 7400 are often desirable for high level amateur or professional competitions due to the distances in golf shots achieved by accomplished players.

Par – Par is a measurement of the strokes or shots intended for a golf course. Par is indicative of the number of shots an expert player would take for a particular course. A particular par of 3, 4 or 5 is assigned to each hole depending upon length, difficulty and other factors. The regulation 18-hole golf course will typically have a total par of between 70 and 72, although a par of 69 or 73 is not unusual.

Pebble Beach Golf Links
Pebble Beach, California

Acreage – Acreage requirements for the golf course will vary according to the proposed type, configuration and characteristics of the site. An 18-hole regulation course will generally utilize between 160 and 240 acres or more. In general, the advances in equipment have caused an increase in acreage requirements. Both accomplished and average players are capable of hitting shots further off-line with new golf clubs and balls, thus requiring more area being allocated for golf holes. Typically, of the basic configurations, core layouts require the least acreage and single fairway layouts require the most.

In addition to regulation golf courses, there are also executive and par-3 types. These courses are shorter in length and consequently have a lower par. Executive golf courses usually consist of par 3 and par 4 holes only. The par for this type of course will typically range between 58 and 64, with a length between 3,500 and 5,000 yards. Because of their shorter lengths, these layouts require less land, usually between 50 and 100 acres. Par 3 courses are the shortest layouts and sometimes require as little as 30 to 40 acres if the length of the holes has been kept to a minimum.

The key factors of use, operation, configuration, length and par are carefully studied in the initial stages of planning and design to determine the golf course best suited to meet the goals of the project. However, the

The environmental issue of golf courses eliminating open space is addressed prior to the planning and design process. The development of a golf course will not eliminate open space. Because golf utilizes the landscape, open space is maintained as the playing field. In addition to preserving a site as open space, the golf course can serve as a buffer to sensitive environmental areas, provide environmental enhancement, as well as create the opportunity for additional uses. In many instances, a golf course will preserve open space land that might be otherwise developed.

It is during the planning and design phases that responsible solutions are found for the environmental issues. This is very important to the successful development of the golf course. Impacts during construction and management of the course can best be avoided by identifying and addressing the environmental issues beforehand. This will produce a satisfactory plan that can be approved and permitted within a reasonable or predictable timeframe.

After reviewing and evaluating the site information, regulations and design criteria, the golf course architect begins the conceptual design for the golf course. There will be many considerations during the design process which address both the environmental issues and the criteria for the golf course. To illustrate this, case studies have been included on pages 27-53 to show how golf courses can provide responsible solutions to the environmental issues most often encountered during the development process.

At this point, early in the process, the issue of altering or eliminating wetlands and other sensitive areas can be addressed. Through field reconnaissance, environmentally sensitive areas are identified and delineated. By using this information during design, the golf course architect will route the golf course so that play will be adjacent to or over the sensitive areas, incorporating them as a part of the strategy and aesthetics of the golf course. To prevent impacts to these areas during construction, responsible management practices are implemented and then continued as part of the ongoing maintenance practices for the golf course. The most sensitive areas on a site will often be wetlands. Depending upon the location, coastal or inland, there can be a difference in the characteristics and quality of wetlands. In some instances, the best overall design solution may require that there be some minor encroachment into low quality wetland areas. To offset the impact of encroachment, mitigated or new wetland areas will be included as part of the golf course. This provides the opportunity to improve the quality and function of the wetlands while creating an attractive feature for the enhancement of conservation and wildlife habitat. While environmental enhancement for degraded existing conditions on site can often be achieved with mitigation, its use may be limited due to the time and cost involved.

The same approach is taken with the issue of significant historical or archaeological sites. Old buildings, cemeteries and ruins with aesthetic qualities can contribute to the character of a golf course. These areas can be preserved by being located within the golf course, lending interest and a sense of history. Should a site of significance be discovered during construction, it may require modifications to the golf course if relocation proves to be unfeasible.

Amelia Island Plantation
Amelia Island, Florida

environmental issues presented by the analysis of site information must also be studied and evaluated with the design criteria for the golf course.

Typically, the main considerations during the design process will be:

Sensitive environmental areas – A careful study of areas such as wetlands, fragile vegetation and protected wildlife habitat will determine their effect on the design of the golf course. Sensitive areas will often provide some of the most distinctive features and scenery on a site when incorporated as a part of the golf course in a positive, compatible manner.

Topography – The topography and natural features of the site are carefully reviewed to locate the golf course in the most advantageous areas. By properly utilizing the topography, the golf course can be designed to derive an inherent character and strategy of play from the site. Also, the course can be constructed more efficiently and a beneficial relationship can established with other land uses proposed for the site.

Drainage patterns and water features – The drainage patterns and existing water features such as streams and ponds, etc., are reviewed in conjunction with the topography. The golf course must be designed with respect to the existing drainage patterns to provide good playability and efficient maintenance. Existing water features can be incorporated into the strategy of the golf course and provide some of the most dramatic golf holes. Water features are often designed into the golf course for playability and aesthetics, but also to provide erosion control and storm water management. Drainage patterns will determine the best locations for these controls to prevent pollution, either on or off-site, from surface run-off. In addition, the overall watershed of the area is studied to understand the off-site influences on the water quality and quantity of existing drainage patterns.

Historic or archaeological sites – Land for a golf course must be researched to determine if there are ruins or archaeological sites which are significant cultural or historical resources.

Vegetation and wildlife habitat – The trees and other types of on-site vegetative cover is assessed to determine the extent of clearing necessary for the golf course and areas for potential revegetation. Existing vegetation, especially trees, can be an integral part of the golf course strategy and can provide a natural appearance for the golf course. Specific areas of vegetation are also studied for preservation to provide resource conservation and the potential to establish corridors for on-site enhancement and connectivity of adjacent, off-site wildlife habitat.

Climatic conditions – The orientation of the sun, prevailing winds and annual rainfall must be considered for the playability and maintenance of the golf course. Golf holes are strategically located to take advantage of wind direction so that they are not adversely affected by the rising or setting sun. Features, such as tee and green complexes, are located to obtain the necessary amounts of sun and wind for proper agronomics. Average annual rainfall will have an influence on the irrigation requirements for the golf course, design of the irrigation system and determination of water supply.

Access to the site – The existing off-site road system is studied to determine viable points of access for a clubhouse, operations building or maintenance facility. Possible traffic circulation patterns will also be scouted. Access points are often determined by other land uses on the site, topography or traffic controls on the existing roads.

Design of the golf course routing – The routing or layout of the golf holes is based on the proposed use for the golf course and existing characteristics of the site. The topography and natural features should be incorporated into the

routing to create a natural character, unique to the site. By respecting the lay of the land, the golf course can be integrated into its setting. The routing must also take into consideration environmentally sensitive areas, drainage patterns, climatic conditions and other factors which will affect the playability, construction and maintenance of the golf course.

The routing of the course must also achieve the length, par and variety of holes established by the project objectives. Circulation, speed-of-play and safety must be given attention when the individual golf holes are being designed. This is especially important in the case of a development-oriented facility. The golf course will be required to make the best use of the site and provide recreation and enhancement value, but must also maintain the proper relationship to the environment and any adjacent land uses such as housing and roadways.

Design of golf course features – In addition to the natural features of a site, the golf course will incorporate design features, such as teeing areas, green complexes, sand and grass bunkers and water features to define the strategy of each hole and produce the desired visual quality. For sites that lack character or topography, these features are used in conjunction with the routing of the golf course to create playability, surface drainage and aesthetics.

The issue of ecological impacts to plant life and wildlife habitat is also addressed during the routing of the golf course. Natural areas, consisting of specific types of vegetation indigenous to the region, can be designed as features to provide a natural setting, as well as conservation, protection and connection of existing wildlife habitat. These areas can also be designed as habitat to stimulate endangered species. Impacts to sensitive areas of habitat are avoided by carefully clearing the site in phases and providing responsible management practices during the construction of the golf course. Golf holes that are located through stands of trees provide the opportunity to create more diverse habitat and promote wildlife through revegetation at the edges of the cleared areas. Tree-lined holes are often the most exciting and attractive on the golf course. The conservation areas and wildlife habitat are protected through the management of the golf course after its completion.

To provide the proper environmental protection during construction, the location of erosion and storm water management controls must be included as a part of the initial design. Ponds and other detention areas used for storm water management purposes can be incorporated as features to create strategy and to provide a dramatic appearance. These features can also take the form of created wetlands, grass hollows or swales. Most of these features will be installed during construction to prevent adverse impacts to sensitive areas and will remain on a permanent basis as controls for environmental protection.

The design of features can affect the cost and maintenance practices for the golf course. Whether the features are severe or subtle in nature, they should be designed for efficient maintenance. Often golf course features will be designed

The issue of altering the existing character of a site is addressed during the routing process for the golf course. If a site has an inherent character with distinctive natural features, the golf course architect will carefully design the routing of the golf course so that it lays lightly on the land. One of the most appealing aspects of a golf course is its ability to provide a sense of place, which gives an appreciation for the region in which it is located. If the routing has been carefully integrated into the landscape, the golfer will experience the unique qualities indigenous to the region that have been incorporated into the design of the golf course. The golf course architect will also consider construction when routing the golf course. By locating the golf holes with respect to the existing topography, the amount of earthwork and disturbance can be minimized and allow for the most efficient construction. However, many sites may be virtually featureless and lacking in character. This is often true of land that has been abandoned after intensive use as a quarry, landfill or agricultural purposes. Also, land that has been degraded and contaminated can be remediated to address environmental issues through the development of a golf course. The routing can be designed to utilize areas of the site that were severely disturbed and would otherwise remain unproductive. This will often involve a large amount of earthwork to recreate a natural quality and appearance for the golf course. The open space and features of a golf course can be used to improve the land and provide visual quality to enhance value. Land improvement and adaptive reuse can be one of the most beneficial aspects of a golf course.

Black Diamond Ranch
Lecanto, Florida

to blend into the existing landscape for a natural appearance and, as a consequence, will reduce the amount of required maintenance.

Incorporation of natural areas – Natural or conservation areas typically consist of native grasses or other existing vegetation that have been left undisturbed on the site. These natural areas will often be incorporated into the golf course to provide environmental enhancement for the promotion and diversity of wildlife habitat, but also to reduce the area requiring frequent maintenance. Existing vegetation which is preserved during construction, as well as areas designed for revegetation after construction, can increase the amount of habitat and attract a wider range of wildlife. Often, these natural areas serve as corridors to connect areas of existing habitat and provide a connection for the safe passage of wildlife on or through the site. Many golf courses use natural areas to enhance the character of the site by establishing a particular appearance and visual quality.

Irrigation requirements and water supply – The availability of water and design of the golf course will influence the irrigation requirements. By incorporating larger natural, non-irrigated areas and reducing the amount of highly

The issue of potential water pollution from earth disturbance during construction can be addressed with the proper design and location of erosion and storm water management control features. These features, when installed prior to and during construction, will contain the movement of sediment caused by storm water run-off and the erosion of disturbed areas, thereby protecting existing streams, ponds, and sensitive areas from contamination. Once the grading of the site has been completed and turfgrass or other vegetation has been established to stabilize the disturbed areas, some of these features will be removed. However, if properly designed, the major erosion and storm water management control features will often remain on a permanent basis and continue to provide protection for sensitive areas as a part of the responsible management practices involved in the maintenance of the golf course. These features will be used to filter storm water run-off from the golf course, and to prevent fertilizer, herbicides and pesticides from entering adjacent sensitive areas. When a golf course is part of a residential development, storm water management ponds on the course can be used to collect drainage from streets and home sites. This water can then be filtered by vegetative buffers of turfgrass and native or aquatic grasses to remove contaminants before being released into existing streams, ponds, or other water bodies. In many cases, storm water management features are used to collect and recycle water for irrigation purposes, providing a valuable alternative or supplement to groundwater as a source of supply.

Troon Golf & Country Club
Scottsdale, Arizona

maintained turfgrass to primary areas of play into the golf course design, irrigation requirements can be reduced, especially in locations where water supply is strictly controlled. Ponds included in the design of the golf course can serve as reservoirs to supply water for irrigation. To reduce the use of groundwater or offsite water supplies, ponds can be located to capture as much storm water runoff from the site and the drainage from the golf course as possible. Alternative sources, such as recycled water or effluent, are commonly used as irrigation on golf courses to lessen the demand for potable water in areas where there are limitations on supply.

Irrigation system design and application – Golf course irrigation systems can reduce water usage and provide resource conservation through highly efficient control and delivery systems. These systems are capable of being programmed for the application of water precisely where and in what amount it is required. Weather monitoring stations built into the systems allow adjustments in the rate or frequency of application in response to temperature, wind and rainfall.

Turfgrass selection and use of indigenous plant materials – In addition to reducing the amount of turfgrass for play areas of the course, the type of turfgrasses selected for those areas will have an impact on irrigation requirements. Turfgrasses which are suitable for the climatic conditions of the site, as well as being drought and stress resistant, will make the best use of an efficient irrigation system and allow reductions in the amount of irrigation application on the course during both typical and exaggerated weather conditions. Properly selected turfgrasses can also result in less management requirements for chemical use without sacrificing the playing conditions of the course. Ongoing research will continue to provide turfgrasses that are adapted to specific environmental conditions, such as seashore paspalum which can be irrigated with non-potable water.

The issue of irrigation requirements and potential reduction of existing water supplies are addressed during the design of the golf course. Research can be done to determine how the withdrawal of groundwater for irrigation will affect the water supply of an area. Based on this research, irrigation requirements can be altered, if necessary, to prevent any impact to the local water supply. Alternatives to groundwater, such as the collection of storm water and the use of effluent, should be investigated as a source of supply for golf course irrigation. Recycled water for irrigation can lessen the demand on available water supplies in areas that have little rainfall or have experienced drought conditions.

The issue of groundwater contamination from chemical application on turfgrass can be addressed through the development of an IPM program. To provide an environmentally responsible strategy for cultural, biological and chemical methods of turfgrass management, an IPM is designed for each individual golf course and the existing conditions of its site. Through research, the consultant team can determine a program and management practices that will avoid impacts to groundwater from application of chemicals during the maintenance of the golf course. Numerous studies have supported the use of an IPM program and promoted the benefits of quality turfgrass in avoiding impacts to the environment. The Golf Course Superintendents Association of America is one of the leaders in the development of comprehensive IPM for golf courses. Often an experienced golf course superintendent, who is a licensed chemical applicator, will be involved in the design process to provide input in the development of an IMP which addresses the site-specific practices that will be required for a proposed golf course. The responsible management practices contained within an IMP are necessary to address the environmental issues and prevent impacts from maintenance practices.

Natural or conservation areas incorporated into the design of the golf course are typically non-irrigated. In addition to further reducing irrigation requirements, the use of native grasses and plant materials which are indigenous to the location of the golf course will reflect the existing environment and provide consistency for wildlife habitat.

The type of turfgrasses selected for the course, the amount of turfgrass utilized for the areas of play and the use of natural areas have to be reconciled with the project objectives and the intended use of the golf course. Golf courses designed for public use must have sufficiently sized and properly located turfgrass areas to accommodate all types of players with the appropriate challenge. The use of certain turfgrasses and native grasses can result in large areas of a golf course going off color under the stress of heat and drought or winter dormancy. When properly designed, these areas will be compatible with the existing native landscape and provide intriguing aesthetics in addition to environmental enhancement. But, often an educational effort is necessary to overcome misconceptions about off color grasses and provide information of their environmental benefits.

Development of an Environmental Management Program – An Environmental Management Program, or EMP, addresses the environmental issues and existing conditions on-site as a part of the design process for the golf course. Inventories and monitoring of existing conditions provide a basis for considerations in the planning and design of the golf course, as well as establishment of best management practices the construction, grow-in and ongoing maintenance of the golf course. Such items as soil erosion control and storm water management during construction, as well as the control of fertilizer and pesticide applications during daily maintenance, are included as part of the Program. The application of chemicals for turfgrass management is part of a specific program called Integrated Pest Management (IPM). As a part of the EMP, long term management practices are established for continuing protection of water quality and enhancement of wildlife habitat.

The aforementioned considerations are those most often involved in the planning and design of a golf course and are general in nature. There will be other more specific considerations in the design process for any golf course based on project objectives, regulatory review and permitting requirements, as well as the unique characteristics presented by each proposed site.

Based on the knowledge gained from careful evaluation of the site analysis information and their collective expertise, the golf course architect and consultant team will create a preliminary plan showing a conceptual design for the golf course that satisfies the initial goals and addresses the environmental issues. An important step is to then arrange for a pre-submittal meeting with representatives of the regulatory agencies responsible for reviewing and approving the project and interested, local community or environmental groups. The concept for the golf course can be discussed and evaluated along with innovative design solutions being proposed for any environmental issues. These meetings are important as they provide the opportunity to present and receive input regarding concepts that have been carefully designed not only to protect the environment, but to produce the most mutually beneficial results. Discussion of the input received from the various agencies and public groups will determine whether or not the solutions have merit and are likely to be approved. This approach will confirm the project's environmental issues and provide the best method to avoid the substantial costs and loss of time that may occur if a plan does not receive approval after going through an often extensive and lengthy formal review process.

Fox Hollow Golf Course
Lakewood, Colorado

The construction documents will vary depending upon the golf course architect and local regulations, but typically include:

***Staking Plan** – Locates the key points of the golf course (tees, landing areas and greens) in the field for design review, preparation of construction documents and coordination of construction activities.*

***Erosion Control and Storm Water Management Plan** – Shows the location of features and methods of controlling storm water and erosion on disturbed areas of the site during construction.*

***Clearing Plan** – Indicates the limits of clearing necessary for construction of the golf course. Specimen trees to be saved or areas of vegetation to be preserved will be shown on this plan or designated in the field.*

***Grading and Drainage Plan** – Shows the overall grading and elevations for the earthwork required to construct the golf course and specific features. The location and configuration of the features (tees, fairways, bunkers and rough areas) are indicated on the plan with the proposed grading. The surface drainage patterns within the course is determined by the grading and indicated on the plan. The locations of subsurface drain lines to collect and convey surface drainage to the appropriate best management facilities are located on the plan.*

***Green Plans** – Provides details for the construction of each green complex including putting surfaces, surrounding features and sub surface drain lines.*

***Construction Details and Sections** – Indicates how the features (tees, bunkers, mounding, ponds, etc.) are to be constructed in conjunction with the Grading and Drainage Plan.*

***Irrigation Plans and Details** – Provides the information on the design, materials, equipment and installation of the irrigation system and pump station for the golf course.*

***Grassing Plan** – Designates the areas where specific turfgrasses and in some cases, native or ornamental grasses, are to be planted.*

***Landscaping Plan** – Serves as a guideline to show where plant material is to be installed to enhance the design of the golf course. As a part of this plan, conservation or natural areas can be established throughout the golf course.*

***Specifications and Bid Documents** – Outlines the methods and details of construction.*

Once the planning and design process has been completed and a satisfactory plan for the golf course has been reviewed and approved by all applicable regulatory agencies, the construction phase of the development process begins. Environmental issues concerning construction will have been addressed during the design phase and development of the Environmental Management Program. The golf course architect and consultant team will produce detailed plans and technical specifications for use by a qualified golf course builder, such as members of the Golf Course Builders Association of America, to construct the facility. The construction plans and specifications, together with proper construction methods and management, are used to implement the intended design, prevent environmental impacts to the site, and ensure the quality of the golf course.

Prior to the start of construction, a qualified golf course superintendent, such as members of the Golf Course Superintendents Association of America, should be hired on a full time basis. Often the superintendent has been

Harborside International Golf Center
Chicago, Illinois

involved in the project during the design and regulatory review process to provide consultation. During the construction process for the golf course, the superintendent will serve as an on-site representative for the owner and architect to inspect the progress of the construction on a daily basis. This will allow the most responsible management practices to be implemented during construction and continued for the grow-in and maintenance of the golf course.

Greywolf Golf Club
Panorama, B.C., Canada

The construction of a golf course involves a dynamic process, often geared towards performance, as well as meeting the requirements and design intent of the project. A pre-construction meeting will take place between the golf course architect, golf course builder and the developers to review the project requirements, confirm the schedule for completion and review the environmental issues at the site. The locations for protective measures for environmentally sensitive areas, as well as soil erosion control and storm water management features, will be reviewed on the site. A staging area is established by the golf course builder to house field offices and provide secure storage for equipment and construction materials. Protective measures are installed at the yard prior to commencement of construction activities to make certain that there are no impacts to the surrounding site from the storage and maintenance of equipment.

During the construction process, site visits are made by the golf course architect accompanied by the golf course builder and, at times, by other members of the consultant team, to inspect the work and see that the intended level of design and quality in the golf course is being accomplished. These visits are important to give the golf course architect and golf course builder an opportunity to work closely with the land and its distinctive features and to create the character for the golf course. During the visits, controls and management techniques that are in place for environmental protection are also thoroughly inspected for proper installation and performance. The builder may employ special methods for the protection of environmentally sensitive areas, such as restricting access to areas of the site, limiting construction activities in certain areas to specific periods of time and adding to the required protective measures. Throughout the project, the golf course builder must balance implementing the construction in accordance with the plans and permit conditions, while meeting the project requirements of the developers, golf course architect and the regulatory agencies.

The construction process starts with the stakeout of the golf course. The key points and centerlines of each golf hole are staked in the field during the design process to facilitate site reconnaissance and review of environmental issues. The golf course architect reviews the stakeout again to evaluate the location of the key points and their relationship to the natural features of the site for the detailed design of the golf course and preparation of construction documents. Minor field adjustments are often made at that time to improve the golf course by responding to the existing terrain, integrating existing natural features such as trees, rock outcroppings, water features and scenic views into the design and providing further protection for environmentally sensitive areas.

Before any site disturbance, soil erosion control and storm water management features are installed in areas designated for the initial phases of construction activities. These features are installed in accordance with approved plans and continually monitored to ensure their proper

The Olympic Club
San Francisco, California

location and performance. Various methods are used to contain soil erosion and sediment movement during grading activities depending upon the size of the disturbed areas, topography and permit requirements. All sensitive areas and features on the site are protected by these controls, which will remain in place throughout construction and until all disturbed areas on-site have been stabilized. Storm water management controls are often incorporated into the design of the golf course as ponds and grass swales and can be utilized to control run-off from adjacent development. They can also contribute to the water supply for irrigation.

Clearing of trees and brush then begins, and for sites with abundant tree cover, it is critical that this facet of the construction is completed properly. The clearing or tree removal on the site is accomplished in phases to prevent the unnecessary loss of natural features that can contribute significantly to the character of the golf course. After the initial phase of clearing, all specimen quality trees and other unique areas of vegetation to be preserved are identified and protected from disturbance. Preservation and incorporation of existing trees or other vegetation provides one of the best ways to create compatibility between a golf course and its site. Mature trees maintain the natural setting and let the landscape form an integral part of the course strategy and challenge. Tree removal and preservation must be carefully balanced to allow the proper agronomic conditions and operation of the golf course.

The golf course is then graded to provide the topographic changes required by design, while avoiding excessive disturbance, produce the necessary drainage and create the basic shape of the features involved in the course. The site will first be rough graded to accomplish the major earthwork necessary for the construction of features such as tees, greens, mounding and bunkers. As a part of this operation, topsoil is removed from all work areas and stockpiled in designated locations. The features are then more closely graded or shaped to provide the desired strategy and character for the golf course. The topsoil is then replaced and the final grading of the features and all other disturbed areas is completed. Details and specifications are provided to ensure that the features are built properly for both design and maintenance purposes. During site visits, the golf course architect will often require adjustments of the features in order to be more responsive to the existing conditions of the site and achieve a natural appearance in the golf course.

Throughout the construction process, the golf course architect, golf course builder and developer meet to discuss the progress of the project. The builder will identify any issues that need to be addressed for continued protection of environmentally sensitive areas and provide information on the most efficient means of complying with permit conditions from a cost and time standpoint.

Installation of the irrigation system begins in areas of the course where grading has been completed. As each phase of grading is completed, the area is released for the installation of irrigation. The system involves pipe, valves sprinkler heads, as well as wire for computerized controls utilizing state of the art technology. The system must be properly installed at the required depths to function correctly and

Whistler Golf Club
Whistler, B.C., Canada

in the designated areas to provide the coverage for the most efficient application of water. The system must be complete and operational to support the planting of the golf course.

After the irrigation system has been installed, the final grading of all areas is reviewed, and restored if necessary, then carefully prepared as seedbed and then planted with the specific types of turf grass or ornamental grass required by the design. The features of the golf course and all areas highly susceptible to erosion will be sodded or stabilized with various methods and materials. The disturbed areas on the site will be stabilized in accordance with permit conditions, typically through the use of mulch or biodegradable fabric. The grassing of the course is scheduled for the months of the year which provide optimum growing conditions for the types of grasses being used on the golf course.

In conjunction with the planting of turfgrasses, the golf course will be landscaped with trees, shrubs and other plant material, as necessary, to enhance the design of the golf course and provide the desired visual quality. As a part of this landscaping, conservation areas can be developed using native plant material to establish and promote wildlife habitat.

Conservation organizations such as Audubon International and various environmental regulatory agencies have been participating actively with the golf industry concerning its relationship with the environment. Examples are the Audubon Cooperative Sanctuary Program and the Audubon Signature Program for Golf Courses established by Audubon International and the United States Golf Association. The members of the American Society of Golf Course Architects often work with the guidelines established by Audubon International and their programs as they design new golf courses and renovate existing facilities. These programs have been initiated to promote site responsive planning, enhancement of wildlife habitat and methodologies for participation in resource conservation on golf courses. Through their efforts, Audubon International brings recognition to golf courses as important open spaces and provides education to the public and golfing community on the benefits of golf courses and the role they play relative to the environment.

Old Tabby Links
Spring Island, South Carolina

Prior to the completion of construction, the maintenance and management of the golf course will begin. During the grow-in period, environmentally responsible management practices are underway and the golf course is prepared for opening. Controls for environmental protection are monitored during the grow-in period, often being left in place until long after grasses have been established. Once the stabilization of each disturbed area is confirmed to be satisfactory, some of the environmental controls will be removed and others will remain as permanent features of the golf course.

Once the turfgrasses have been established and the maintenance has achieved the desired level, the golf course will open for play. The environmental issues concerning the maintenance of the golf course are addressed by the Environmental Management Program. The program will provide environmentally sensitive practices for the maintenance of the golf course, such as:

- Integrated Pest Management (IPM) for the controlled application of chemicals and other practices to reduce pests and disease with the least impact to the environment.
- Management practices to produce high-quality playing conditions and reduce maintenance requirements.
- Irrigation practices to promote conservation and, when possible, use alternative sources of supply.
- Monitoring of groundwater to detect and eliminate infiltration of chemicals.
- Monitoring of water sources to detect and eliminate pollution from surface run-off.
- Management of natural or conservation areas to promote wildlife habitat.

These responsible maintenance practices will remain in place as long as the golf course is in operation, ensuring environmental compatibility, high-quality conditioning and efficient management of resources.

Golf courses, like any landscape, grow and experience subtle changes with time. As a course ages, minor adjustments may become necessary to maintain the desired level of maintenance and playability. This is often the case with golf courses that have been in play for a number of years. Improvements to the technology and equipment of the game, a substantial increase in the amount of play, maturation of the trees and other landscaping and advanced maintenance practices can all have a significant impact on a golf course that was designed based on criteria of 50, 40, even 20 years ago.

Golf course superintendents will work with consultants such as golf course architects, the USGA Turf Advisory Service and Audubon International when adjustments become necessary. The consultants work together to create and implement environmentally compatible solutions that address the needs of the golf course.

Summary *– A golf course offers an excellent opportunity to provide a recreational amenity, maintain open space and preserve the visual quality of the landscape. The development of a golf course which produces these benefits is a complex process that involves proper planning and design, construction and management. A team of qualified professionals will provide the necessary expertise to accomplish the process and create an outstanding and environmentally sound golf course.*

Environmental issues have become a priority for the golf industry. Organizations such as the American Society of Golf Course Architects, Golf Course Builders Association of America, Golf Course Superintendents Association of America, United States Golf Association, National Golf Course Owners Association, Environmental Institute for Golf and Audubon International are dedicated to continuing education and research to provide the most up-to-date and beneficial methods for the development and management of golf courses.

Checklist for the Development of a Golf Course

The design, construction and maintenance of a golf course has evolved into a complex process. Today's environmental issues, the economic climate, and the many demands established by the project objectives all require careful consideration for the development of a golf course.

Each proposed site and golf course has its own unique characteristics that require specific solutions for its design, construction and maintenance. However, there are certain major steps that are common in the development of almost every golf course. These steps, as discussed in the preceding text, have been listed below to serve as a checklist for an environmentally responsible approach to the development of a golf course.

- Conduct a feasibility study to verify the need for a golf course. Assess the suitability of the site and establish basic goals for the project.
- Assemble a team of qualified professionals led by a golf course architect to address the complex issues involved in the planning, design and construction of the golf course. Perform a thorough site analysis with current and accurate data.
- Determine the environmental issues that may be involved. Review all applicable land use, environmental and construction regulations.
- Confirm site suitability and goals for the project with the client. Establish the design criteria for the golf course.
- Develop a conceptual plan that addresses all environmental issues and design criteria. Include responsible management practices for the construction and maintenance of the golf course.
- Arrange a pre-submittal meeting with the regulatory agencies and interested local citizen or environmental groups to review and receive input on the conceptual plan.
- Refine the concept based on the input received and develop a final master plan.
- Submit the master plan for required approvals.
- Stake out the golf course. Make minor adjustments, if necessary, to take advantage of natural features and adapt compatibly to the site.
- Develop a thorough set of construction plans and specifications for the golf course. Finalize the responsible management practices.
- Submit construction documents for regulatory review and permitting.
- Hire a qualified golf course superintendent prior to the commencement of construction to provide management and administration for the project.
- Undergo a bidding or negotiation process for the construction of the golf course. Consider the retention of a qualified golf course builder who is experienced and specializes in the unique construction techniques required for the development of a golf course.
- Start construction.
- Perform site inspection visits to ensure that the course is being constructed in accordance with the plans and intent of the design. Monitor controls for environmental protection.
- Implement responsible management practices for maintenance prior to the completion of construction.
- Complete construction of the golf course. Maintain environmental controls until all disturbed areas are stabilized.
- Prepare the golf course for opening. Monitor remaining environmental controls during the grow-in period.
- Open for play. Tee it up and enjoy both the game and the environment. Continue responsible management practices during maintenance of the golf course.

Goals Within the Golf Industry to Improve the Golf Course Development Process

1. To educate and participate with legislative bodies and regulatory agencies to bring about more consistent regulations from those respective agencies at the federal, state and local level. The goal is to provide better parameters for design and allow the best possible solutions without costly delays.

2. To work with the regulatory agencies to promote innovative design solutions for today's complex environmental issues. Encourage the agencies to consider solutions that are not limited by the strict application of regulations, but those that produce the best results with the most environmentally responsible approach. Stress the need for only the most qualified individuals from each agency to be involved in the review process to improve cooperation and promote effective design solutions. Request periodic review and revision to regulations which are impractical when implemented and inhibit the most beneficial results. Promote a proactive approach in the relationship of golf course development to issues of environmental protection, conservation and the promotion of wildlife habitat.

3. To continue and expand cooperation within the golf industry for further education and research in environmentally responsible methods of design, construction and management.

4. To provide the related development industries with continued education and information on the environmental and other benefits of golf courses.

5. To increase the effort within the golf industry to educate the general public, golfers and non-golfers alike, as to the importance of environmental issues in golf.

Chambers Bay
Pierce County, Washington

Spanish Oaks Golf Club
Bee Cave, Texas

Restoring a Historical Landscape

Bobby Weed, ASGCA and Chris Monti
Weed Golf Course Design

Spanish Oaks Golf Club is located within a 1,200 acre mixed-use development in Bee Cave, Texas, a burgeoning growth area south of downtown Austin. The property is situated at the gateway of the renowned Hill Country, a unique region that blends distinctive cultural, topographical and vegetative character. Development in the region faces a stringent regulatory review process, one designed to prevent a repeat of previous poor land management decisions. The Hill Country was once rolling grassland, with a fragile layer of topsoil that allowed native grasses to take root. When extensive livestock grazing early last century kept the grasses from regenerating, the exposed topsoil eroded off the hillsides. In the rocky conditions that resulted, the invasive cedar tree took over, robbing the region of ecological diversity.

In this context, the Spanish Oaks team sought a myriad of regulatory approvals from local, regional and federal agencies. Environmental issues that required the team's attention included: endangered species habitats; effluent usage; site disturbance thresholds; floodplain encroachment and wetland or riparian impacts. With the design of Spanish Oaks Golf Club, the golf course architect, planners and developers successfully navigated an extensive approval process, turning what might have been a controversial golf course community into a landscape restoration project of regional significance.

This approval process required an environmentally proactive design. During land-planning, the team committed to the unique strategy of carving out a core golf envelope and meticulously resurrecting the Hill Country grassland within it. The golf course architect and design team specified site disturbance protocols, the seed blends that would be planted, their relative densities, and what other vegetation should return and be featured. Recognizing the strength of the design, the developer felt comfortable taking a number of unprecedented steps that built consensus with the agencies and led to the project's approval, including:

- Executing a voluntary letter agreement with the City of Austin that exceeded their environmental oversight and mandated the grassland restoration as a project objective. The agreement established buffers and setbacks from the creeks, an Irrigation Management Plan, a Nutrient Management Plan, an IPM plan and a Water Quality Monitoring plan.
- Agreeing to voluntary restrictions with the U.S. Fish and Wildlife Service that limited impervious cover and established significant riparian setbacks. The result was the first "no impact" designation by the U.S. Fish and Wildlife Service for an Austin area project.

The creation of each golf hole began with hand-flagging the limits of clearance. Most of the dense cedar trees were felled by hand to avoid mechanical damage of preferred species. Non-cedar specimens in the clearing corridor were flagged for transplant. Over 100 large caliper live oaks, cedar elms and Spanish oaks were moved to the perimeter of the layout, re-establishing the appropriate mix of Hill Country tree species. Following clearing, the rocky ground was prepared for the grasses. Typically, Austin-area courses import off-site sandy soils for capping. At Spanish Oaks, over 125 acres of the golf parcel was plated with native topsoils excavated from on-site fields in the lower portions of the site. These were the same soils that eroded off the hillsides a generation ago. Apart from the obvious compatibility to the proposed seed blend, this soil contained a dormant "seed bank" that would enhance the restorative design intent. The golf course builder then installed a complex irrigation system that provided detailed control to the native areas using multiple head types.

The principle grass reintroduced was Buchloe dactyloides – Prairie buffalograss. Outside the buffalograss, two distinct hydroseed blends were sown. In full sun, the mix included Side Oats grama, Little Bluestem, Blue grama, Common Curleymesquite, Hairy grama, Seep muhly and Big muhly. In shade, the dominant types were Inland sea oats, Texas wintergrass and Green sprangletop. Since planting, the team has observed the reemergence of three additional Hill Country grasses not included in the blends: Big bluestem, Broomsedge bluestem and Yellow indiangrass, each a testament to the success of the restorative efforts.

By focusing the project's resources in an innovative way, the Spanish Oaks design team was able to build consensus and navigate a difficult approval process with a "white hat" reputation. By returning a slice of Texas' legendary landscape to its intended ecology, a memorable and sustainable golf course community resulted.

The Old Collier Golf Club
Naples, Florida

Preserving Habitat and Water Quality

Jan Beljan, ASGCA
Fazio Golf Course Designers, Inc.
Ryangolf Corporation, GCBAA

On 267 acres in Naples, Florida that was zoned for an 800-unit residential development, the Barron Collier family chose to create a premium-membership, stand-alone, private club dedicated to the game of golf, with long-term environmental quality. The project was to have an "Old Florida" feel by making the site look as natural as possible. The par 72, 7069 yard 18-hole golf facility with practice range, putting green and short game area was constructed from January through November 2000, opening for play in September 2001.

The site is 3/4 mile from the Gulf of Mexico and is bounded by major roads to the east, south and west. The Cocohatchee River is the northern boundary and is designated an Outstanding Florida Water (OFW) by the Florida Department of Environmental Protection (DEP). This state designation affords such a water body special protection including a provision which mandates that there can be no degradation of existing water quality beyond the existing levels. This had an impact on the amount, types and methods of application of traditional plant food and pesticides. The concern was the release of high nitrogen or phosphorus content products into an OFW, thus the requirement for water quality and hydrology permits. Permit conditions required more than 50 acres of mangrove and wetland habitat bordering the river be set aside as a wildlife preserve. Imposed by the Florida Game and Fresh Water Fish Commission was the requirement to preserve existing habitat for the gopher tortoise, a state-listed threatened species, that was present on the site. Permit conditions also required preserving 45.6 acres of upland scrub.

Under the authority of the DEP, the South Florida Water Management District (SFWMD) is responsible for permitting water-related issues, including water consumption. The major design issue to be resolved for the golf course was to find a water source for irrigation. There was no surface or underground water available on site and no practical source of treated effluent, the water used in Southwest Florida for public rights-of-way and golf courses. The property had been undeveloped except as a storm water management system for a sizable older community, Naples Park, to the south. SFWMD stated that the golf course could not increase nor impede storm water run-off from that neighborhood into the OFW after completion of construction. To meet permit demands, SFWMD required that a system be designed that retained water draining into, as well as falling on, the site, based on a 25-year storm event. This drove the size and number of lakes, as well as the amount of fill that would be required for the golf course.

One million cubic yards of excavated soil created the new terrain that blends naturally with its surroundings and provides man-made uphill, downhill and side hill shots unique for southern Florida. Sand bunkers mimic the visual characteristics of the upland scrub and vary in size and shape to create the strategy of each hole. Also integral to the strategy and character of each hole was the use of mature trees. Engineering solutions solved the water quality and hydrological concerns of the permitting agencies.

Protective berms were designed and constructed to divert potential surface runoff away from the mangrove buffer and the Cocohatchee River. Eleven water management lakes were built to retain rainfall on the golf course and the drainage from Naples Park. Lake design allowed for the use of natural filtration to maintain pollutant discharge at or below permitted levels. Monitoring of water quality and quantity was required as part of the permit requirements and by Audubon International. Concrete cart paths were installed only in high use areas and on slopes; pervious concrete screenings that blend with the white sand are used elsewhere. Golf course bridge surfaces and course furniture are made of 100 per cent post-consumer plastics.

An irrigation system that could directionally apply brackish water on only turf grass and that could withstand salt water corrosion was required. Collier Enterprises invested in state-of the-art, energy saving, low pressure computerized irrigation system, complete with soil probe analysis and 2700 heads (as opposed to the 800-1200 typically used for a comparable quality course) to achieve a turf-only envelope. Stainless steel components, over-sized pipes and variable frequency drive pumps serve to reduce degradation of the system from operation. The installed system has a five to eight year longer life expectancy than the 20-year lifespan of a typical golf course irrigation system. Because the lowest wind speeds are between midnight and 6:00 AM and coincide with off-period electrical demand, at least $6,000 per year is saved in electrical costs.

The need to pay for irrigation water and for a water use permit was eliminated by the decision to use Seashore Paspalum for the course, a turf that could be irrigated with brackish water readily available from the Cocohatchee River. The impact of salt water on water quality and hydrologic permits were handled by reducing the total amount of turf using irrigation to 77 acres. This also reduced the amount of plant food and possible nutrient run-off. The areas taken out of turf were established as native habitat with indigenous salt-tolerant species. Once established, these plants required no irrigation, plant food or pesticides, thus reducing the chance of these materials reaching the OFW. These areas became part of the 64 additional acres of existing and created native habitat that were preserved for the plentiful wildlife that has increased substantially since the course has opened. The continuous corridors of upland scrub with its distinctive native white sugar sand weave between, around and through golf holes.

Integrating the site's many natural habitats into the course was a primary goal in order to enhance the golf experience. Key to the success of this project was the involvement of Audubon International. Their approach fostered design and operations that improve the long-term health of the site's environment as well as the surrounding watershed through an integrated resource management plan that required that each decision have an economic benefit. Careful execution of construction activities by the golf course builder throughout the project contributed significantly to the successful integration of golf course and site.

The Old Collier Golf Club was the first golf course in the world to irrigate with brackish water, and the first to landscape with indigenous plants that are halophytes. It was the first golf club in the world to be designated Audubon Gold Signature Sanctuary. It took the vision, careful planning, management and commitment by Collier Enterprises to create and maintain a world-class golf course that would be both economically and environmentally sustainable.

The Legends at Parris Island Golf Course
Parris Island Marine Corps Recruit Depot
Parris Island, Beaufort County, South Carolina

Archaeologically Significant Sites

Clyde Johnston, ASGCA
Clyde Johnston Designs, Inc.
Wadsworth Golf Construction, GCBAA

The 18-hole par 72 Legends at Parris Island Golf Course, located within a military base, is open to general public play. Construction on the renovation started in fall of 1999, with the course opening for play in November of 2000. The Parris Island Marine Corps Recruit Depot, Community Services Division, wanted to rebuild the base's 1947 Fred Findley-designed golf course. More than half a century of routine play, maintenance and natural processes had caused the typical problems found on older golf courses: an outdated irrigation system with a limited water source, soil compaction, shade and root encroachment from maturing trees, poor drainage, etc. These conditions were counterproductive to providing the three elements most critical to a successful golf course: playability, aesthetics and maintainability. However, improving these conditions and updating the golf course features and infrastructure could not be accomplished without addressing environmental and historically significant conditions surrounding the site.

Located on the southern-most tip of Parris Island in southeastern South Carolina, the site is bordered by salt marsh wetlands and deepwater creeks on the southern, eastern and western boundaries. Freshwater wetlands are located throughout the interior of the site. The average elevation across the site is seven feet above mean sea level. The area is rich in wildlife, fish

and shellfish habitats. Parris Island also has one of the largest concentrations of Live Oak trees per acre in the state of South Carolina. Before the development of the golf course, the site was used as a dummy bomb target range prior to WWII, as well as for other Marine Corp training exercises. The site was originally used by nomadic American Indians for campsites, hunting and shellfish gathering along the marshes that surround the island. In 1562, the French settled on the site with the establishment of Charlesfort as a strategic outpost on the Port Royal Sound. Later in 1566, the Spanish city of Santa Elena was established on the project site and served as the capital of Spanish Florida until 1587 when the Spaniards evacuated to St. Augustine. Santa Elena is home to the oldest known European pottery kiln discovered in the United States. Three holes of the original golf course, the practice range, and the clubhouse were all located within the Santa Elena archaeology site, which had been under careful study for many years. When planning for the new golf course began, archaeological study efforts were expanded and expedited to determine the total extent of the historical site and if other historical resources existed on the golf course site.

Environmental consultants were brought in to delineate the site's saltwater and freshwater wetland habitats and provide consultation to the owner and golf course architect regarding protection and enhancement of these valuable resources. Both the archaeological and environmental delineations were reviewed and approved by the respective state agencies, then surveyed and georeferenced to the current topographic data of the site. All of the site's large specimen Live Oak tree locations were also surveyed and added to the site data survey. After thoroughly evaluating all of the sensitive environmental and archaeological resources, a policy of avoidance was adopted. The primary design objectives of the golf course architect became routing 18 holes of golf and a practice facility that:

- Avoided all known archaeological and environmental impacts.
- Provided a continuous flow to the golf course.
- Utilized as many existing golf corridors as possible.

The golf course architect was then able to begin the golf course routing studies with full knowledge of the site's opportunities and constraints. The final routing plan utilized 12 of the existing 18 golf hole corridors, but few of the original tee and greens sites. Utilization of the existing cleared areas provided minimal impact to the surrounding wooded environment. The three original golf holes located within the Santa Elena historical area were abandoned and relocated in areas that archaeologists found devoid of artifacts. Due to spatial constraints, the practice range was located within the Santa Elena site utilizing a preservation-in-place method. To prevent disturbance to the area, fill material was carefully placed on top of the existing soil as a buffer zone to contain the irrigation and drainage systems for the golf course.

Paramount to the success of the golf course was drainage improvements. Because of the low-lying nature of the site and proximity to tidal wetlands, small rain events would inundate the golf course for extended periods of time. To counter this, 11 lakes were strategically located throughout the golf course in conjunction with a sophisticated storm water conveyance system. The dredged lakes would provide the fill required to achieve positive drainage on the golf course while providing detention basins to slow storm water discharges from the site. Surface drainage to the surrounding salt marshes was minimized. Almost all surface runoff is directed back to the lakes, which through the use of equalizer piping provides a large primary irrigation water source. The added benefit of this drainage system is that all fertilizer and chemical applications are controlled within the site and recycled to the course with the irrigation system.

The golf course builder was diligent in the installation and maintenance of erosion control and archaeological area protection and preservation of natural buffers. The construction was monitored on a daily basis by the Marine base's Environmental & Historical Department personnel. All environmentally-sensitive areas were protected during construction with heavy duty silt fence, and in many cases, the existing natural buffer areas. Since none of the environmentally-sensitive areas were impacted with construction, the project avoided mitigation. Twice during construction, grading work uncovered pottery shards in small areas that were not discovered during the initial surveys. Construction was halted in those areas until the consultants had time to evaluate and recover the assets.

New hybrid Bermuda grasses were planted on the primary playing surfaces, while native Spartina grasses and native natural areas were incorporated to reduce the total acreage of maintained and irrigated areas and blend the golf course into the surrounding low-country environment.

The project was successful in protecting and enhancing the sensitive environmental areas during construction. After the course grasses were established and regular play recommenced, it was apparent that the preservation and protective measures used avoided any impacts on both environmental and archaeological assets. The new ponds that were built have provided additional wildlife and fish habitat, which have in turn increased in numbers. The ponds also provide much needed storm water management for the golf course.

Bigwin Island Golf Club
Lake of Bays, Muskoka, Ontario, Canada

Storm Water Management and Erosion Control

Doug Carrick, ASGCA
Carrick Golf Design

The Bigwin Island Golf Club located on a 562 acre island in The Lake of Bays near Dwight, Ontario began its second life as a golf course in the summer of 2001. Originally developed in the early 1900's by the founder of The Canadian Leather Company, Charles Orlando Shaw, Bigwin Island was designed to be the finest luxury resort in North America. During the peak years from the 1920's through the 1940's, the resort attracted many celebrities and dignitaries, including Clark Gable, Carole Lombard, Glen Miller and others. Many of the big bands performed in the resort's fabulous dance hall that sat on the edge of the lake. Princess Julianna of Denmark made Bigwin Island her home away from home during the war years.

The Bigwin Island Resort flourished through the early 1940's and following Shaw's death in 1942, began to see numerous ownership changes and financial struggles up until 1970 when the resort eventually closed. The present ownership group acquired Bigwin Island from the Public Trustee in 1986. Unfortunately, many of the resort buildings and the golf course had fallen into complete disrepair during this period between 1970 and 1986. By the time construction began on the new golf course in 1998, the original fairways were barely visible as they had become over grown with nearly 30 years of tree growth.

The original golf course was designed and built by the legendary Canadian golf course architect, Stanley Thompson and was opened for play in July 1922. The course at Bigwin Island was relatively short at less than 5,000 yards in length and fairways were narrow corridors cut through mature mixed forest. Despite the glorious history of Bigwin Island and the pedigree of its legendary designer, the redevelopment of the golf course at Bigwin Island was essentially a new golf course layout. While many of the fairways on the new course followed the original openings in the forest, the configuration of holes is entirely different from the original course. Five holes on the front nine and four holes on the back nine were developed in areas completely removed from the original course layout.

Building a new golf course on Bigwin Island was a very unusual challenge, as it is on a 500 acre island surrounded by the pristine waters of The Lake of Bays. Local residents and cottagers, along with various environmental agencies and interest groups, expressed their concerns with respect to the protection of the water and shoreline around Bigwin Island. In particular, the spawning areas for various species of fish in the lake were of utmost concern both during construction and post construction. The primary challenge was to develop a method of storm water management that would protect the shoreline of Bigwin Island from potential runoff from erosion during construction. It was also necessary to develop a method of filtering storm water runoff before it was released to the lake from fairways, greens and tees on the established golf course.

The golf course design for Bigwin Island was developed to ensure ample buffers existed between fairways and the shoreline of the lake. The only hole on the golf course that comes close to the lake's shoreline is the 18th. All other holes on the golf course are set well back from the lake's edge, but offer glorious views of the lake from various elevated tees and greens. Although 17 of the golf holes are set well back from the lake (at least 300 feet and often much more), the elevation changes of over 200 feet on the island pointed to the potential for silt from erosion to reach the lake.

A series of temporary sediment basins and ponds were constructed at strategic locations on the site to trap and settle out sediments during periods of heavy rain on the exposed soil. The water trapped in the sediment basins typically sat in the ponds for several days prior to being released in order to allow sediments to drop to the bottom of the ponds. In instances

before

where water had to be released sooner than anticipated, the silt-laden water was pumped through silt bags designed to trap sediments. This water then flowed through a series of straw bales and natural wetlands prior to reaching the lake. The primary sediment pond was located in the area of the third fairway and the driving range and encompassed an area of approximately 10 acres in size. With more than a third of the island's drainage directed to this basin, management of the water levels in the sediment pond was of utmost importance.

Many of the smaller watersheds on the island were managed through a series of smaller sediment basins and check dams located in treed areas just off the sides of some of the fairways. Most of the smaller sediment basins located in the treed areas remain in place today and filter runoff from the greens, tees and fairways.

Another area of primary concern was the 18th fairway, because of its close proximity to the shoreline of the lake. A low berm was constructed along the entire length of the 18th hole between the fairway and the shoreline to prevent any runoff from entering directly into the lake. In addition to the berm, a sediment basin was constructed between the lake and the fairway in order to trap water into a concrete catch basin. This water was then pumped up into the main sediment basin in the driving range area. The berm and sediment basin on the 18th hole were established as permanent features for handling runoff on the 18th hole. The water pumped from the catch basin on the 18th hole flows through a naturalized area adjacent to the driving range. It then flows through a pipe and under the 3rd fairway and into a natural wetland before reaching the lake. By the time this water reaches the lake it has been cleansed of all runoff contaminants.

Scheduling delivery of materials on an island required careful planning. Storage of an adequate supply of straw bales, silt fences and extra pumps was required in order to deal with the unpredictable storm events that occur during the life of a two year construction project.

During the 1999 construction season Bigwin Island experienced a deluge of 7 inches of rain over a 48 hour period. This was equivalent to two 100 year storms back to back. The lake levels in the Lake of Bays were elevated by 12 inches as a result of the storms. Two breaches of the sediment basins occurred during this event; however the level of damage from silt entering the lake was minimal, primarily due to the protective measures that were put in place. As the project neared completion in fall of 2000, a decision was made to sod all areas of primary rough on the course in order to reduce the overall area exposed to potential erosion.

Today, Bigwin Island enjoys a fine reputation and the ongoing management of the course by the golf course superintendent ensures that Bigwin Island will continue to be an environmentally-responsible golf course located within a unique and pristine natural setting.

The Nantucket Golf Club
Nantucket Island, Massachusetts

Integrating Golf and the Environment

Greg Muirhead, ASGCA
Rees Jones, Inc.
Wadsworth Golf Construction Company, GCBAA

The planning and development of the Nantucket Golf Club, located on Nantucket Island, Mass., is an extraordinary example of integrating a high quality golf experience into a diverse natural environment. Nantucket Island is home to a variety of unique plant, animal and cultural resources and therefore one of the most scenic and naturally diverse landscapes in North America. During the fall of 1995, plans were conceived to develop a world class golf club on a 250 acre site near the southeastern shore of the island.

In order to responsibly integrate golf into this complex landscape, a thorough understanding of the site's natural and historic resources was essential. Such an education required consultation with numerous environmental experts, interaction with local environmental and special interest groups, the involvement of a variety of governmental agencies with jurisdictional authority over the property and input from the general island community. Prior to any conceptual design development, a comprehensive site analysis study was undertaken. This lengthy and highly detailed investigation identified numerous environmental attributes of the site, each of which influenced the final routing of the golf course and the location and design of all ancillary facilities. The entire northern border of the site is adjacent to land owned and managed by the Massachusetts Audubon Society (MAS). Early and frequent consultation with this organization, throughout the design and construction process, was invaluable to the eventual, highly successful integration of golf within the overall Nantucket landscape.

Several rare and "State-Listed" plant species were found throughout the site. Accordingly, the overwhelming majority of the golf course was routed to avoid any impact of these plants. In limited instances, in order to protect other immovable and high quality natural resources, avoidance was not possible. In these cases all plants were carefully excavated prior to any construction activity and either relocated to areas of the site designated to remain undisturbed, or temporarily relocated in the club's "rare plant nursery" for subsequent transplanting throughout the golf course after construction.

Throughout the island there exists a variety of "Sandplain Grassland" and "Coastal Heathland" vegetative communities. Although these plants are seldom found elsewhere, they thrive within the Nantucket microclimate. Project consultants and local environmentalist identified nearly 60 acres of these rare plants on the project site. These vegetative communities provide essential habitat and hunting grounds for two of the most rare and challenged species, the Northern Harrier Hawk and the Short-Eared Owl. Protection of this habitat, as well as the general environment necessary for these animals to prosper, was also identified as a critical planning issue. Project consultants and local biologists identified over 14 acres of jurisdictional wetlands on the site. In addition, protective "upland buffers" were established around the perimeter of each wetland. The site's largest individual wetland was designated as prime Harrier Hawk and Short-Eared Owl habitat. The golf course was carefully located to avoid any impact of this wetland.

Based on the results of prior studies conducted throughout the overall island, the project site was suspected to possess both pre-historic and historic period archaeological resources. Accordingly, a complete archaeological assessment was conducted early in the design development phase of the project. Fieldwork included the survey of more than 500 test pits. The general survey work identified limited, potentially significant resource areas. Those areas determined to be of potential significance were tested in greater detail and either preserved in an undisturbed condition, or carefully excavated under the supervision of archaeologists, resulting in the complete recovery of all discovered resources.

Upon completion and evaluation of the site analysis phase of the project, the challenge confronting the golf course architect and design team was to harmoniously blend the desired golf experience with the aforementioned unique environmental characteristics of the site. In an effort to accomplish this, numerous golf course routing alternatives were prepared. Comments from various project consultants, local environmental experts and the general island community were then solicited and incorporated to refine each alternative, until a final plan was embraced by all, including the various local approval agencies. The final plan achieved the desired golf experience, while also accomplishing the following environmental objectives:

- Maintained 98% of the 250-acre site as impervious open space.
- By implementing a thoughtfully designed program, increased the total acreage of rare "Sandplain Grassland" and "Coastal Heathland" vegetative communities.
- No net loss of wetlands.
- A "Secondary Rough" component, comprised primarily of native grasses, was created to buffer the routinely maintained and "in-play" areas of the golf course from the undisturbed adjacent grasslands and wetlands.
- An on-site "rare plant nursery" was developed to accommodate transplanting of "state-listed" rare plant species during construction and promote future propagation of rare plant seeds.
- An Integrated Golf Course Management Plan was developed to reduce reliance on chemical methods of disease and weed control, as well as to establish appropriate thresholds dictating future use of herbicides and pesticides on the golf course.
- Groundwater monitoring wells were established throughout the project site.
- Project ownership committed to the purchase, development and long-term maintenance of significant, off-site acreage to increase available Northern Harrier Hawk habitat.

The golf course architect and golf course builder worked together to achieve the desired design intent and meet the environmental objectives for the project. During construction of the project, the golf course builder was thorough in maintaining delineation and protection of the sensitive environmental areas. Over 80 acres of the site were protected by fencing and remained completely undisturbed.

A thorough site analysis process identified critical environmental issues to be addressed while planning and constructing the golf course. Without question, the ensuing design process generated a final golf layout and associated construction methodology that avoided and/or minimized environmental impacts on both plant and animal species. In fact, rare plant species and grassland communities were actually enhanced, thereby improving overall animal habitat. The creation of the Nantucket Golf Club has become a model for subsequent projects attempting to blend world-class golf facilities with unique natural environments.

Hunting Hawk Golf Club
Glen Allen, Virginia

Water Conservation and Habitat Enhancement

Bill Love, ASGCA
W.R. Love, Golf Course Architecture
Ryan Central Incorporated, GCBAA

The Hunting Hawk Golf Club was planned as amenity for the expansion of a planned community in Glen Allen, Va. on the western side of Richmond. The developer of the property, HHHunt Corporation, recognized the environmental sensitivity of the property due to the existing characteristics and the location adjacent to the headwaters of the Chicohominy River. The property had formerly been used for timber production and was left with impairment to surface drainage and large monostands of pine trees. In order to identify the environmentally sensitive areas on site and the issues that would need to be addressed, a team of consultants was assembled to join the golf course architect in the planning of the course.

The objectives established by HHHunt for the course were to provide an amenity for the community, respect the environmental sensitivity of the site and adjacent properties, create a golf course with an emphasis on the natural character of the property and provide an enjoyable golf experience for the general public, as well as residents of the community. The golf course was also to offer affordable play, which required efficiency in construction, as well as maintenance practices. The consultants conducted a detailed site analysis to determine the constraints and opportunities offered by the property and the project objectives were evaluated with this information. The property offered distinct opportunities for the golf course with gently rolling topography, areas of mature trees and other natural features. The constraints consisted of existing wetlands running through and around the periphery of the property, reforested areas, an archeological site and supply of groundwater. The preservation of wetland areas and source of water for irrigation presented the predominant issues in the planning of the course.

An extensive study of routing alternatives for the golf course and residential areas determined that impacts to the environmentally sensitive areas would be more than anticipated. HHHunt made the decision to locate the residential areas on the periphery of the golf course to minimize wetland impacts and allow the course to be compatible with the environmentally sensitive areas. Of 180 acres occupied by the golf course, approximately 16 were wetlands. The final routing of the golf course incorporated most of the wetlands as features with less than a half-acre of impact. Using wetlands as features helped establish the natural character of the course.

Site analysis determined that groundwater resources were minimal and would not provide an irrigation water source for the golf course. The nearby river would not provide a source due a low base flow and the potential effect downstream. Taking advantage of the topography of the property was an alternate solution. The slope of the topography created a drainage pattern that directed practically all the existing surface runoff towards the interior and then to the lower portions of the property near the river. The average annual rainfall on the property could provide enough water for irrigation if the surface runoff was captured and stored in an adequate amount. To accomplish this, a series of ponds was designed into the golf course on the lower portion of the property to capture the runoff after each rain event. Although the ponds were located to provide strategic and aesthetic features for golf holes, they are connected through an underground pipe to create one large impoundment of over eight acres. An additional pond of three acres was constructed just off the golf course for additional storage capacity, which can be pumped to recharge the main ponds in times of little or no rainfall.

The golf course was designed and graded to provide efficient drainage and facilitate collection of the surface runoff. The topography of individual golf holes was enhanced with a modest amount of earthwork to direct runoff to adjacent swales or a

system of drain pipes. Two manmade streams and an existing drainage channel collect all the runoff from the holes, which then flows to the ponds for golf course irrigation.

Conservation and management of water resources was one of the main considerations in determining the areas to be maintained on the golf course, the design of the irrigation system and the selection of grasses. The maintained areas for tees, fairways, greens and primary rough were limited to the areas necessary to provide a reasonable challenge and pace for public play. A minor amount of secondary rough was employed in areas of high traffic. All other open, out of play areas were established as conservation areas consisting of native and adapted grasses that require little or no maintenance. By observing play, conservation areas were increased without adversely affecting the challenge or pace of play on the course. The irrigation system was designed to provide coverage zones in the maintained areas of each golf hole. No irrigation was provided in the secondary roughs or conservation areas. The zones allow the irrigation coverage to be reduced for the roughs, tees and portions of the fairways during periods of minimal rainfall. Entering the dryer times of the year, when recharge to the ponds is minimal, irrigation is often reduced by 50% and up to 70% under drought conditions to prolong the water supply.

Grasses for the maintained areas were selected to provide the most drought tolerance, as well as the best playing conditions with reduced irrigation. The fairways and primary roughs are kept somewhat dry under normal conditions to allow a less stressful transition in periods of reduced irrigation. Grasses selected for the secondary roughs and conservation areas were indigenous to simulate typical pasture in the Virginia landscape and after being established, no irrigation coverage is provided to these areas. The native grasses create a harmonious, natural appearance for the golf course even with differing levels of irrigation and have survived periods of extreme drought without any substantial harm or detrimental impact on playing conditions.

In addition to reducing maintained turf areas, the conservation areas were used to replace monostands of pine trees and enhance the diversity of wildlife habitat on the property. To provide a naturalized setting for the golf course and facilitate the movement of wildlife, corridors of existing trees, shrubs and groundcovers were preserved between and around most of the holes. Over 15 acres of conservation area were integrated into the golf course to provide both a physical and visual transition to the tree corridors, as well as create meadow and edge conditions for the enhancement of habitat. Conservation areas were also used as vegetative buffers to the steams and ponds designed into the golf course. Surface drainage on the course is filtered through these buffers before entering fore bays of created wetlands adjacent to the ponds. The fore bays and a system of littoral shelves in the ponds contain various types of aquatic vegetation that provide additional filtration for surface runoff. When the ponds reach capacity and overflow, the water is directed into mitigation areas of created wetlands for further filtration before reaching existing wetlands adjacent to the river. The streams, ponds and conservation areas were designed into the golf holes as features that facilitate drainage, as well as benefit the environment through water quality and diversity of habitat.

Ryan Central Incorporated, the golf course builder and a member of the Golf Course Builders Association of America, was an enthusiastic partner in meeting the environmental objectives for the development of the project. As a part of site preparation, they confirmed and further delineated all environmentally-sensitive areas to establish clear limits for construction activities and prevent any inadvertent impacts. Soil erosion control devices, storm water management facilities and other best management practices were carefully installed and diligently maintained for the protection of water quality during construction. The removal of trees and earthwork for the project was performed judiciously, not only for the preservation of environmentally-sensitive areas, but also to protect natural features of the site that were being incorporated into the design of the golf course. The construction and golf course superintendent both provided numerous suggestions during construction to enhance the environmental stewardship and best management practices being integrated into the golf course.

Efficiency and economy of management practices were achieved through environmental considerations in the design of Hunting Hawk Golf Club, including the incorporation of naturalized areas, reduction in the amount of high maintenance turf, irrigation conservation and a decrease in chemical applications through the use of an Integrated Pest Management Program. These practices, as well as the responsible approach of the staff, have led to lower than average annual maintenance costs on the golf course, which in turn, contributes to meeting the objective of offering the public an enjoyable and affordable golf experience.

The Wilderness at Lake Jackson
City of Lake Jackson, Texas

Addressing Environmental Issues

Jeffrey D. Brauer, ASGCA and Eric Nelson, ASGCA
Golfscapes, Inc.
Mid America Golf and Landscape, GCBAA

In the early 1990s the City of Lake Jackson, Texas, a former master planned company town in historic Brazoria County, Texas, wanted to add an affordable public golf course to the town's mix of recreations activities using Wilderness Park, a 400 acre site of forested land they had purchased on the west side of the city. The city commissioned a feasibility study and retained the golf course architect, but objections from environmental groups slowed the project for several years citing these factors in their objections to the course:

- Presence of "micro-wetlands" (actually wild hog hoof prints).
- Destruction of migratory song bird habitat and trees.
- Possibility of golf course chemicals reaching groundwater on this site half a mile from the Brazos river and just 14-20 feet above sea level.
- Urged consideration of "better" sites, possibly within housing developments.

The golf course architect began preliminary designs using several environmental consultants with the Army Corps of Engineers overseeing the permitting process, and with environmental groups involved. The extensive review resulted in several design changes from their preliminary plans in final design of the 7200 yard, par 72 course:

- Golf development restricted to 200 acres, with the rest of the site to remain virgin forest.
- Surveyed every tree on site to minimize damage to oaks.
- Avoided historic areas like historic entry road to Stephen F. Austin's ranch.
- Final routing avoided all 54 acres of contiguous wetlands on property.
- Provided spray irrigation to keep wetlands moist as needed.
- Extensive grading to create a self-contained drainage system to capture golf course runoff in ponds for dilution. Removal is accomplished by using the irrigation pumps to move diluted storm water to nearby wetlands and bayous.
- Construction of several acres of wetlands and retention of under story for bird habitat rather than full clearing and brushing.

The Corps of Engineers approved the project in 1996, but the Houston Chapters of the Sierra Club and Audubon Society were still not satisfied, resulting in lawsuits filed against the Army Corps, alleging noncompliance with their own rules for issuing a 404 wetlands permit. The lawsuits were filed when defining a "wetland" was a moving target definition. However, according to many involved, the lawsuit was less about the site's wetlands issues rather than bigger issues against development in general, and that this was simply a test case to determine "strategy" for opposing similar projects.

After another four-year delay, the court ruled in favor of the Army Corps in 2001, not long before a landmark 2001 wetland ruling in a Chicago area lawsuit with many of the same issues. Most doubt the lawsuit would have been as drawn out had that case been decided. The city wanted to put the course out to bid quickly and get under construction before any other problems arose. The golf course architect fast-tracked the plans and bids were let a few months later.

Mother Nature was not kind to the project. Three separate hurricanes made landfall within several miles of the course, delaying construction considerably. Working in a low-lying, self-contained drainage system resulted in many wet weather delays for the golf course builder, who also had to rework much of the course and reestablish all silt control devices adjacent to wetlands numerous times. It eventually required extra manpower to finish in the second construction season. Opening occurred in July 2004, about a year behind schedule.

The City of Lake Jackson demonstrated ongoing construction operational practices which contributed to environmental sensitivity, including:

- Continued work towards achieving Audubon Program certified status, including bird attraction programs.
- Continued expansion and establishment of environmental barriers each year using native grasses and aquatic vegetation on and along lake banks.
- Reduction of turf maintenance areas in out of play areas by:
  - leaving natural vegetation (palmettos).
  - planting wildflower mixtures.
  - mulching using recycled material from their own downed/damaged trees.
  - leaving brush piles for habitat.
  - a tree replacement program, primarily using native gulf coast oak varieties.
- Establishment of good irrigation practices to conserve water.
- Use of IPM to reduce chemical inputs.

The Wilderness was recognized for environmental stewardship as a result of their efforts during the development of the golf course.

White Clay Creek Country Club at Delaware Park
Newark, Delaware

Floodplain Development and Rehabilitation

Steve Forrest, ASGCA
Arthur Hills / Steve Forrest and Associates
Niebur Golf, Inc., GCBAA

In December of 1998, Delaware Park Racetrack and Slots, the state's only thoroughbred racing facility and gambling venue, made plans to celebrate its upcoming centennial anniversary in July of 2000 with the opening of a new championship golf course. Situated in suburban Wilmington and land-locked by two railroads and two major thoroughfares, attention focused on the only undeveloped land on the property–approximately fifty acres of open upland, some forested areas with wetlands, and the floodplains of the White Clay and Mill Creeks. The overall vision included the development of a destination resort complete with a luxury hotel and train station.

In the planning process, the valuable upland areas were quickly set aside for the clubhouse and resort hotel, both of which would be linked to the new railway station. As a result of the fixed clubhouse location, a continuous eighteen-hole routing along the narrow floodplain corridors was necessary. A large wetland area separated the clubhouse from the full-size practice area and the starting and finishing holes on the par-72, 7007-yard, public-access course. The initial routing generated nearly twelve acres of wetland impacts. As more was learned about the extent of the forested wetlands adjacent to Mill Creek (a significant tributary of the White Clay), a series of revisions was enacted that ultimately resulted in the disturbance of less than one acre of wetland. Appropriate mitigation measures in the form of created wetland habitat were developed to offset

the proposed losses. Once the Army Corps of Engineers' wetland restrictions had been met, attention turned to the task of designing a viable golf course on flood-prone land. New Castle County required that all tees and greens on the golf course have finished grades no less than one foot above the 100-year storm elevation. This meant that some of the green sites had to be filled as much as five to seven feet to achieve the required elevation.

Another consideration that arose from working in the floodplain was the protection of the public roadways and adjacent landowners by insuring that the existing volume and velocity of stormwater entering and exiting the project site remained unchanged after development. "Existing condition" flow models along the watercourses were created and later compared to proposed designs. Typically, any fills in the floodplain require compensating cuts in order to maintain the flow characteristics of the existing conditions. Bridges and other types of culverts which disrupt the normal flow create unusual dynamics relative to volume and velocity and require careful study by an experienced civil engineer. The fill requirements for the tee and green sites resulted in the need for areas of excavation for stormwater detention in fairways and the practice area. A fairly elaborate system of sumps and pumps was designed to remove water from these areas which were often below the normal water level of White Clay Creek.

The year 2000 arrived with the project team fully engaged in the permitting process. Actual construction was nowhere on the schedule as Delaware Park celebrated one hundred years of racing history in early July. Then in October, the US Congress enacted The Wild and Scenic River Act and the White Clay Creek was designated as an official "wild and scenic river." However, designation as a wild and scenic river does not lock it up. The idea behind the legislation is not to halt the use of a river. Instead, the goal is to preserve the character of a river. Uses compatible with the management goals of a particular river are allowed and change is expected to occur. Any proposed development must ensure the river's free flow and protect its "outstandingly remarkable resources." The intent of Congress was to create a national system of protected rivers that co-existed with use and appropriate development. The term "living landscape" has been frequently applied to wild and scenic rivers. Of course, each river designation is different, and each management plan is unique. The bottom line is that the National Wild and Scenic Rivers System is not something to be feared by landowners and, in fact, is frequently sought after to preserve quality of life and property values.

Even though White Clay Creek was designated as a scenic river, several sections of it suffered from eroded banks, sediment deposits, accumulated debris, and the existence of invasive, non-native plant species. In an effort to preserve the outstanding qualities of the creek, Delaware Park commissioned a natural channel design restoration and bank stabilization effort. The design used a reference reach approach to re-establish stable channel geometry throughout the project area. The design also restored natural meander geometry and pool/riffle morphology along the creek. The final restoration design included a variety of aesthetic landscape elements including native wildflower, shrub, and tree plantings. The design also used bioengineering techniques such as live staking, live fascines, and brush layering to provide stability for newly established stream banks and restore a functioning riparian buffer to the stream within the project area. A variety of flow deflector structures including single-wing rock vanes, cross weirs, and J-hook rock vanes were installed to enhance and maintain hydraulics throughout the redesigned channel. The U.S. Fish and Wildlife Service reviewed the project and made recommendations relative to clearing and bridge crossings along the White Clay and its tributary. Perpendicular crossings and selective clearings were implemented so as to minimize impacts to water temperatures and other factors associated with fish and wildlife habitat.

Perseverance and flexibility on the part of the golf course architect and design team ultimately resulted in the entire project being approved for construction by the various regulatory agencies. However, not all of the challenges on the project had been encountered. From a severe drought at the beginning of construction in 2002, to an incredible number (18) of 50-year-storm events during the two-year grow-in period, the golf course builder and maintenance crews were pushed to their limits. With perseverance by the golf course builder, several portions of the course were built and rebuilt, seeded, reseeded, sodded, and resodded as the storm waters continued to flow. Mother Nature provided an amazing and confounding demonstration of her power.

New and creative design and engineering elements were incorporated to more effectively manage the flooding and to provide for a speedy return to play if the course ever opened. Diversion berms were installed. A new emergency tee complex was added to a particularly troublesome par-5. State-of-the-art erosion control measures were implemented. Lessons that would prove to be invaluable in the long-term management of the facility were learned early in the grow-in process. The course finally opened for play on June 28, 2005, just in time for the 105th birthday celebration at Delaware Park.

It is possible, but certainly not easy (or inexpensive), to build a golf course in an active floodplain. Years of study, planning, permitting, construction and grow-in by an experienced team of professionals from many disciplines are required. However, the rewards can be very satisfying, such as at White Clay Creek Country Club, where a round of golf is a dramatic experience winding past a racetrack, railroad and casino in a scenic, tree-lined river setting.

Arbor Links Golf Course
Arbor Day Farm, Nebraska City, Nebraska

Partnering for Sustainable Design and Education

Erik Larsen, ASGCA and Victoria Martz, ASGCA
Arnold Palmer Design Co.
Landscapes Unlimited, GCBAA

In the late 1990s a concept was conceived for a golf course in the state of Nebraska that would serve as an educational model for eco-sustainability and yet be affordable to build and maintain. To further that goal a partnership was formed between the golf course builder, the golf course architect and the National Arbor Day Foundation. This team was committed to proactive environmental goals for the development of a golf course that would include:

- Conservation of wildlife habitat.
- Protection and improvement of water quality of existing creeks and watersheds.
- Restoration of degraded prairie.
- Utilizing the course as a living classroom for education both in and out of the golf industry.

300 acres of land adjacent to the Lied Conference Center at Arbor Day Farms was made available for the new golf course. The preliminary review of the project site revealed that the existing prairie land and natural creeks that remained had been degraded by earlier farming practices. The banks of North Table Creek that runs through the property had badly eroded and water quality had also been compromised due to the heavy agronomic use of the land in previous years. Native grassland had become overgrown with a monoculture of species and wildlife habitat had become diminished.

A routing for the golf course was designed to best utilize the natural features of the site with minimal impact and movement of earth. This not only reduced the construction budget but allowed for little disturbance of the land. With a routing plan in place, the design of the course by the Palmer team decided on a natural concept that incorporated large areas for the establishment of native grasses and groves of trees. Bunkers with ragged edges were included to provide a natural and compatible appearance for the windswept prairie look of Nebraska. Water features, such as ponds with littoral shelves and created wetland hollows, were added or adjusted to blend seamlessly into this natural environment.

The restoration of the indigenous prairie grasses in large out-of-play areas was important for enhancing wildlife habitat and also meant that little additional irrigation was required once they had been established. By incorporating these areas into the design, corridors of vegetation were created to connect habitat areas of different animal and bird species. In selected locations around the course, food plots are incorporated to further encourage wildlife. Trees provide an important habitat for birds and with the knowledge that field breaks of trees were found around farmsteads of the Great Plains dating back to the 1930s, a tree planting program was implemented with Arbor Day Farm around the course. Varieties of native species from seedlings to large specimen trees were planted to reestablish this natural wind screen and to provide habitat. Restoring the landscape of prairie, wetland and forest created abundant habitat for wildlife and provided for more biological diversification. Utilizing Best Management Practices and an Integrated Pest Management plan that is designed to protect the environment also reflect cost efficient methods with proven results. Grass types were selected to reduce irrigation requirements and heavy maintenance practices. Estimates are that 140,000 gallons of water a day will be conserved during peak watering seasons. These grass types will be studied for their effectiveness from year to year.

before

The South Table Creek that runs through the site had been altered and straightened to gain more land for farming at one time. With assistance and support from the U.S. EPA and the Natural Resources Conservation Service, the creek has been restored to its original direction and methods were taken throughout construction to stabilize the banks and prevent erosion. To protect the water quality of the creek during construction, silt fence, detention ditches and soil erosion matting were used. At Arbor Links over forty acres of erosion matting was used to assist seed germination and prevent runoff in potential wash areas This replaced the need for sod on tee slopes, lake edges and green banks, which helped to maintain the course as a good steward of the land while keeping construction affordable. In addition, a buffer system of vegetation was implemented along the creek to filter runoff from the golf course. Some of this vegetation can be harvested periodically as biomass for energy production for the conference center.

To complement the goal of constructing a golf course that would protect and enhance the site's natural elements, the design team and Arbor Day Farm elected to provide opportunities for education and research sharing. A variety of construction methods and techniques were employed by the golf course builder for future study. Four methods of greens mix and construction were utilized. The resulting turf characteristics, rate of growth and playing conditions of these greens are being studied and so far, no measurable differences have been detected in playability and quality of turf. The performance continues to be evaluated by the agronomic staff. A golf course pocket guide was developed to educate golfers on the conservation methods that were employed during the design and construction, as well as to provide information regarding sustainable maintenance techniques. One of the partners in this guide was the Natural Resource Conservation Service. Many companies within the golf industry contributed time, talent and materials toward the construction of this course in the knowledge that golf courses can be good stewards of the land with the proper information and guidance.

Arbor Links Golf Course was designed, built and is maintained to meet the initial environmental vision of the partnership. The course has hosted a summit with leaders from the golf industry and the environmental community. It continues to be recognized as a national environmental model and is an educational resource for the community, as well as golfers.

The Hideout Golf Club
Monticello, Utah

Reclamation of a Degraded Site

Arthur Jack Snyder, ASGCA and Forrest Richardson, ASGCA
Forrest Richardson and Associates
Daylen, Inc., GCBAA

Throughout the 1940s, 1950s and into the 1960s, the Town of Monticello in southeastern Utah was home to a large uranium mill consuming nearly 100 acres. Located right in the heart of town, the mill was the biggest industry in Monticello and subsidized by the U.S. Government for its part in defense efforts. The mill and processing of uranium had kept the town alive. Beginning in the 1980s, the U.S. Department of Energy (DOE) had undertaken removal of the mill site. An enormous "depository" on an adjacent parcel of land was built to bury radioactive debris collected from the mill site, as well as debris from throughout the town. Potentially radioactive soils were removed from a 30 square mile area. As part of the clean up process, the town was eventually offered a buyout if it agreed to acquire the old mill site. Since the mill land was now under federal oversight, the best use was to return it, once totally clean, to the public. Under directives from the Environmental Protection Agency (EPA), the DOE not only had to clean up the mill site, but also restore the land to a natural condition. The DOE wanted to find the best possible use for the land, one that would assist the city in both environmental and economic terms.

Because the mill site had been located right across the highway from an old nine-hole golf course, it was felt that there might be potential for an expansion of the course using the land occupied by the old mill. This idea was thought to be even more feasible as a result of the DOE's commitment to return land to a suitable condition, but also to help restore economic vitality to Monticello. During the previous twenty years there had not been much of an economic base in the town due to the closure of the mill and it was determined that an expanded golf course could provide a needed economic boost.

The golf course architects and team of consultants assisted the town in determining the physical viability and environmental issues involved in the expansion and development of the golf

course. Among the environmental considerations were flood engineering, stabilization of hillside topsoil, wetlands establishment and configuration, wildlife corridors and habitat enhancement, long term water quality, public access to the restored site and stream alignment. Both the DOE and EPA requested that a creek once flowing through the property be reestablished with native wetlands and stabilized hillsides. The conclusion was that environmental considerations could be met through the development of a golf course at the mill site with no negative effect to restoration. In fact, the operation and maintenance requirements of the golf course would be positive to the long term viability and stabilization of the site.

An economic feasibility study was undertaken by the town to determine whether an 18-hole course could be supported. Although the small nine-hole course had operated in the town for 40 years, it was frequented mostly by locals. The golf course architects and consultant team concluded that Monticello could realize annual income from a "new and improved" 18-hole course, providing that the following criteria was met: the town would receive approximately seven million dollars in compensation under agreements with the federal government upon restoration of the mill, the development cost would be less than six million dollars, the course would need to be designed to attract its predominant play from outside the area and there would need to be extensive marketing of the course.

In order to satisfy both environmental and economic criteria, a variety of options were explored in the preliminary routing of the golf course including using the existing nine holes and adding nine more on the mill site or scrapping the existing course and building the entire facility on the mill site. The terrain of the old uranium mill proved to be a difficult site due to its steep slopes that were void of any vegetation. Four routing plans were prepared for using the old mill site and each was thoroughly studied for probable cost and environmental issues. The golf course architects then suggested a fifth, somewhat controversial, alternative to build a golf course apart from the old mill land, on detached land. The result would be to restore the mill land as required by the DOE and EPA, but not undertake a golf development on the mill site. There would be two simultaneous projects, one to restore the old mill land and another to build a new golf course. One of the key objectives was a continuation of the town's greenbelt and wildlife corridor. By acquiring land adjacent to the existing golf course, and adding it to the restored mill land, a large and expansive area of open space was created for the community. Ultimately, the city acquired the land to fulfill this option.

Construction on The Hideout Golf Club began in 2000 and continued for 18 months. Earthmoving involved just 80,000 cubic yards, with holes carefully routed in natural glens and across ridges. The work included a fully automatic irrigation system delivering water to 85 acres of turf. Site obstacles involved naturally running springs, wetlands habitats and logging of forested areas. Through advance cutting of centerlines across

the site, the golf course architects were able to work with the golf course builder to work out effective solutions for environmentally sensitive areas of the course that needed to be preserved during construction. The existing stream running through the property had been altered and relocated for ranching operations several decades earlier and was an environmental issue within in the community. Through the construction of the golf course, the stream was restored to its historic alignment and incorporated wetland pockets, stabilized grassland slopes and a trail system.

In working closely with representatives of the town and regulatory agencies, the golf course architects and design team were able to develop a financially successful golf course for Monticello that provided numerous environmental benefits:

- *By thinking "outside the box," the approach to the project allowed more dollars to be spent on environmental restoration work by improving the mill site as a separate work contract.*
- *The acquisition for more acreage adjacent to the old uranium mill created an expansive and fluid greenbelt that now connects the town with continuous open space of a national forest.*
- *Wildlife and residents benefit from the now continuous land which accounts for open space through the town. Wildlife now has an unobstructed (and protected) corridor to move across an existing highway from low to high ground.*
- *Extra funds saved by the town will eventually be used to develop an interpretative center which explains the uranium legacy of the region. This was never a planned program component of the project, but is now feasible as a result of the creative funding and work strategy.*
- *Revegetation of the mill site for golf would have required far more intense work and budget than for passive recreation and open space.*
- *Water use is significantly reduced by keeping golf uses together and contiguous as opposed to separated by a highway; separation would have meant two water reservoirs and significant pumping (energy use, etc.).*
- *Wetlands were increased by six acres by adding wetlands environments to the golf course areas and by restoring wetlands through the old mill site.*

Callippe Preserve Golf Course
Pleasanton, California

Restoration and Mitigation of Habitat

Brian Costello, ASGCA
JMP Golf Design Group
Continental Golf, Inc., GCBAA

Callippe Preserve Golf Course is located in Pleasanton, California which is approximately 45 minutes east of San Francisco. The 18-hole, par 72 golf course meanders through expansive rolling grasslands, coast live oak studded canyons and dramatic ridgelines offering views of majestic Mt. Diablo. Surrounding the core 145 acres of this upscale municipal facility are 280 acres of land preserved as permanent open space which also features three miles of hiking and equestrian trails. Two existing estates from the original landowners remain on the property with the addition of 34 new home sites. The proceeds from the sale of these lots were used to offset, in part, the cost of land acquisition, project and construction costs.

Located at the southern end of the City of Pleasanton, the property was principally ranch land used for cattle grazing with coast Live Oak woodlands and riparian habitat amongst Happy Valley Creek, its main channel branches and the grassy knolls and ridgelines which dominate the southwestern corner of the land. Unmonitored cattle grazing caused habitat degradation to the seasonal creeks and created watering ponds. Despite this condition the site possessed habitat for several sensitive species including the federally endangered California Tiger Salamander (Ambystoma californiense), the federally threatened California Red-Legged Frog (Rana aurora draytonii) as well as the federally endangered Callippe Silverspot Butterfly (Speyeria callippe callippe) which is the project namesake.

In 1994 negotiations began with the landowners of the property. Planning for the golf course began back in 1988 with a citizen committee formed to identify potential sites for the project. The golf course architect commenced work with the city staff and the golf course committee in 1997. During the early stages of design the project team met numerous times with various local, state and federal departments to provide an open forum to present the project objectives and receive feedback from the community and the regulatory agencies. The multi-agency meetings were typically attended by representatives from the following permitting agencies: U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, California Department of Fish and Game, California Regional Water Quality Control Board and the State Department of Health Services. The main concerns of the agencies were impacts to creeks, channels, seeps, seasonal wetlands, groundwater, storm water and irrigation runoff and the resultant water quality, and the potential loss of habitat for the above federal and state listed species.

The primary goal was to integrate all of the requirements of the city, the regulators and the intended design concepts into a challenging and yet playable course with a sequence of unique and memorable golf holes. Towards that end, the golf course architect worked with project consultants to establish design parameters and implementation techniques that conformed to the various permit requirements. Some of these measures included acceptable stabilization and restoration measures applied to both recreated streams and existing creeks. During construction, the project team worked closely with the golf course builder and the general contractor to avoid fenced-off sensitive undisturbed areas as well as adhere to the construction-stage “Storm Water Pollution Prevention Plan.” The golf course builder excelled with their execution of detailed finish work under demanding time constraints while maintaining the protection measures for environmentally sensitive areas.

All of the newly constructed and existing seasonal stream channels were planted with over 4,000 new native plants that included protective cages and drip irrigation. The golf course superintendent was an integral part of the construction management team supervising the revegetation of these environmentally sensitive channels. The management company retained by the City of Pleasanton assumed the post-construction operation and maintenance of the golf course. This responsibility also required the preparation of an annual report to be submitted to the permitting agencies which includes a detailed weed management plan, inspection and repair of the drip irrigation system. Permit requirements specifically identify parameters for inspection intervals, entrance into the channels and cultural activities available for weed suppression and eradication. In total, there are over 20 separate land management plans that govern this cooperative land use project that includes the golf course, trail system, endangered species habitat, created wetlands and dedicated grazing land.

One of the on-going challenges for the course operator is educating the golfers about the "no access" policy for the environmentally sensitive channels which influence play on 16 of the 18 holes. All of the channels are clearly defined with "green topped" environmental stakes. While there are signs stating "Do not enter native area" placed throughout the course along these sensitive areas to alert the golfers, it takes the additional educational notices placed on scorecards, in course guide books and golf carts, as well as friendly reminders by the starter and on-course marshals that entry into these areas is prohibited. The effort seems to be reaping benefits as fellow golfers often remind each other of this important environmental policy. Shortly after opening, Callippe Preserve Golf Course achieved Audubon International designation as a "Certified Audubon Cooperative Sanctuary" by demonstrating a high caliber of environmental dedication in areas such as environmental planning, wildlife and habitat management, outreach and education, chemical use reduction and safety, water conservation and water quality management.

The design philosophy of avoidance, restoration and mitigation, combined with the application of best management practices during construction and post-construction allowed for a drainage watershed that reduced sedimentation and runoff and established new riparian habitats and wetland areas. The golf course was sensitively routed through this enhanced network of existing and recreated wetland channels, which not only added strategic value and interest to the golf experience, but contributed towards the goal of creating a successful and award-winning example of environmental stewardship.

Island Green Country Club
Philadelphia, Pennsylvania

Reuse of a "Brownfields" Site

Jim Blaukovitch, ASGCA
Jim Blaukovitch Associates
George E. Ley Co., GCBAA

1966 was the last time a golf course was built inside the city limits of Philadelphia. To say that land for a golf course in Philadelphia is hard to find is an understatement. Not many large parcels of land exist. However, the opportunity did present itself when the Budd Co./Transit America closed its 214 acre manufacturing plant in 1987. The Island Green Country Club is the result of a long clean-up process and beneficial reuse of the former plant site. The Budd Co. plant opened in 1943 with wartime construction of cargo aircraft for the military. Later the plant switched to rail car and auto body manufacturing and became one of the nation's largest companies in the field. Budd renamed the operation Transit America in 1985. Two years later the 214 acre plant shut down. The company was once a vital part of the local economy, employing more than 2,000 workers during its peak production period.

Transit America voluntarily began site assessment soon after the facility closed. Company officials discovered the contamination during a comprehensive environmental study during the site assessment. The main and site specific environmental issues were that the contamination permeated the buildings, soil and ground water. They alerted the Pennsylvania Department of Environmental Protection, which supervised further testing and the start of the cleanup process. The site contained all sorts of harmful substances like volatile organic compounds, solvents, cleaning fluids, degreasers, asbestos and polychlorinated

biphenyls. Using a technique called "soil vapor extraction" Transit America removed the source contaminants from the ground and continually monitored levels in ground water with 93 testing wells. The wells were removed in 2000 after more than a dozen years of testing showed "full perimeter containment." The entire cleanup process was funded by Transit America at a cost of more than $23 million.


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In 1995 the state legislation known as Act II paved the way for reuse of the site. The new set of laws established the Department of Environmental Protection's Land Recycling Program also known as a "brownfields program." Brownfields are defined as abandoned, idled or underused industrial and commercial facilities where expansion or redevelopment is complicated by environmental contamination. Transit America and their engineer worked closely with the State on the clean-up of the site, which was considered one of the largest brownfields and a model for the Land Recycling Program. The consultants were an integral part of the design team to facilitate permitting and cleanup of the site.

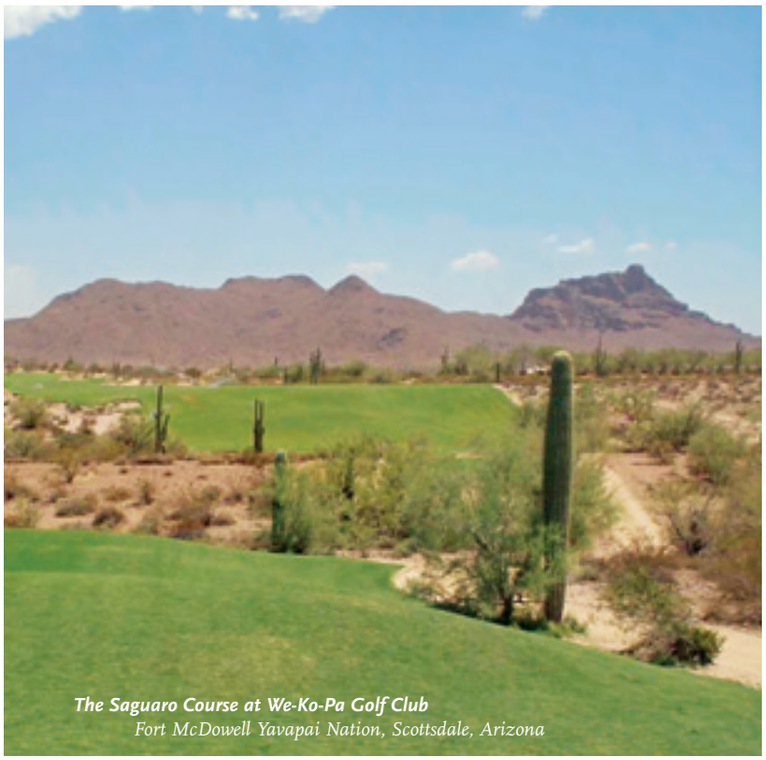
One of the main issues facing the golf course architect was the routing of the golf holes. Another issue was grading for the holes and creating a viable drainage system. While balancing cuts and fills is standard on most golf course construction, the Transit site had many restrictions. In the 188 acres of the site utilized for the golf course, routing and grading was limited to areas called "no cut zones." The golf course architect addressed this issue by designing the course so that cut & fills would balance within the site, since Transit America would not allow any soil to be imported or exported. Certain areas of the site involved in the golf course had to be soil capped at specific minimum depths to provide adequate cover for the irrigation system and tree planting.

The site contained abandoned runways, railroad tracks and a million square foot building that was the manufacturing plant. The area occupied by the plant was determined to be the location for a double ended driving range. The building was constructed of concrete and built to be bomb proof. The ceilings were vaulted so that only a section would collapse and not the entire building. It was estimated that 150,000 cubic feet of soil would be required to cap the million square feet of concrete slab to allow for turf growth and was not available on the site. The alternative solution was to crush the concrete of the building which provided enough material to be reused as a base for an artificial turf driving range and to fill an abandoned ravine used for railroad access.

One area of the site was approved for excavation and provided the source for most of the fill required to build the features of the golf course. The area was excavated as much as possible due to the need for maximum fill material, and after the excavation operation was complete, became a pond to store water for irrigation of the golf course. An island was designed into the final configuration of the pond to serve as a green site and dramatic feature of the golf course. The pond was then lined with a PVC liner. The course is irrigated with water purchased from the City of Philadelphia, since Transit America did not want to use any of the wells on the property for irrigation.

Prior to and during construction, the golf course architect and golf course builder worked closely together to meet permitting requirements and produce a quality golf course. Before the start of construction, the site was surveyed on a 50-foot grid with no cut areas clearly marked. During construction, any material arriving on site was checked and the source verified. No soil was allowed to leave the site after the initial cleanup. The course was built to the restrictions relative to "no cut" zones and the capping of other areas. These areas were surveyed and the information given to the new owners so they would know where than can add irrigation, plant trees, etc. There was one wetland area within the golf course that was carefully protected during construction. As a part of the design, a few other very small wetland areas were relocated during construction in another area of the course. The golf course builder was able to provide a quality golf course while working with the numerous restrictions presented by the site and conditions of permitting.

The project met all of the DEP requirements and allowed Transit America to sell the property as was their original intent. The Secretary of the Pennsylvania Department of Environmental Protection stated that Island Green Country Club is a truly unique project. Most of the sites cleaned up statewide are again used for industrial purposes, whereas this project restored this large expanse of land to productive use a public golf course. Island Green Country Club opened for public play in 2001 and became the first new course in Philadelphia in over 50 years. The 18 hole, par 72 golf course benefits the local community and the environment as a recreational amenity and green space, rather than an abandoned manufacturing plant in a very populated area.



The Saguaro Course at We-Ko-Pa Golf Club
Fort McDowell Yavapai Nation, Scottsdale, Arizona

Preservation of Cultural Resources and Habitat

Bill Coore, ASGCA and Dave Zinkand with Ben Crenshaw
Coore & Crenshaw, Inc.
Landscapes Unlimited, Inc., GCBAA

Open to the public, We-Ko-Pa Golf Club offers two eighteen hole courses located east of Scottsdale on the edge of the Phoenix Valley. The original Cholla Course was opened in 2001. The Saguaro Course was constructed from late 2005 through the summer of 2006 and opened the following December. This second course provided an opportunity to work with great respect to the natural surroundings. Beautiful desert terrain, well suited to the ground game, is dotted with palo verde and mesquite trees, as well as the enormous cacti that are its namesake. The site overlooks the Verde River Valley and is surrounded by foothills and mountains, near and far.

The project was not subjected to the full spectrum of environmental regulations due to its location on an Indian Reservation. However, the Fort McDowell Yavapai Nation and the club's management considered the principles of sound environmental design a significant asset to the course's development. In searching for a design firm that could fulfill their expectations, the golf course architect was chosen to provide the design, shaping and finish work for the new course. The golf course builder was chosen to provide construction management, earthwork, and development of course infrastructure. Additional members of the design team included the facility's maintenance staff and the irrigation consultants.

Foremost to the environmental effort was routing the course without intruding upon numerous washes categorized as regulated areas by the Army Corp of Engineers. This designation is based on size, volume and composition and is used to protect these environmentally sensitive dry creek beds and manage storm water runoff. Only a small portion of the regulated areas could be mitigated or disturbed. As they were spread throughout the property, there was ample space to circumnavigate the washes, playing alongside or across them as hazards on occasion. In so doing, the layout was able to utilize the site's best terrain for golf.

An archeological survey had been carried out prior to the planning of the golf course. However, with a routing in place, further studies were undertaken to ensure there were no artifacts of historical significance within the areas of construction. The examination provided researchers and the Nation with additional information about the farming techniques and plantings carried out by ancient civilizations on the site. It confirmed the previous survey's assessment that there was nothing of significance in the golfing corridors, while offering a helpful reminder for the location of ancient and fragile petroglyphs.

Rather than simply clear the turf areas at the outset, existing plant material was salvaged for later use. The harvesting of trees, saguaros, and a variety of smaller cacti from the desert in areas of proposed fairways allowed the club to economically landscape the facility with native plant material. The effort also lowered the cost of re-vegetating ground disturbed during construction in this fragile, slow-growing environment. Areas of disturbance were negligible, however, as future turf, along with construction and maintenance trails were extensively roped off at the beginning of the project. The task was carried out by the golf course maintenance staff, which deserves much credit for protecting the desert.

The golf course builder was sensitive to the fragile environment and was careful to minimize the disturbance of the site throughout the construction process. An erosion control plan consisting of silt fence and hay bales was implemented to protect nearby washes, while water was applied to the haul roads, earth work and feature shaping to avoid wind erosion

before

of the arid soils. The erosion control measures remained during grow-in and were removed shortly before opening.

Due to the washes and undulating character of the site, efforts were made to provide wide landing areas to contain errant play. However, minimizing the overall irrigated turf acreage was imperative to conserve water. While there is ample space provided in the landing areas, along with additional turf in places balls are likely to collect, alternative methods were employed to accommodate wayward shots. Vegetation was selectively cleared from tee to fairway and along the sides of holes to allow golfers to easily play recovery shots from the desert. Contours were occasionally built to hold running shots. Perimeter bunkers were employed to collect shots running down slopes beyond the margins of the fairways. In doing so, the total acreage of maintained turf was minimized to 61.6 acres, well below the acreage used on a typical desert design.

Details around the course, such as native stone headwalls, were tailored to compliment the native desert environment. The most significant example is the decomposed granite used for cart paths. These "D.G." paths were treated with soil stabilizer, creating a solid surface, which blends in with the desert floor.

An additional benefit of this project was the incorporation of the Nation's previous wastewater treatment plant into the routing. The Tribal Government requested that as part of the project, the outgrown facility be removed. As a result, the land would have to be restored with desert vegetation and/or incorporated into the golf course. Proximity to the clubhouse helped to dictate that the land would be consolidated into the course. Parts and materials that could be recycled were removed by the Nation, followed by demolition and removal of hazardous materials from the treatment plant. This allowed the heavily engineered site to be reshaped compatibly with the natural contours of the surrounding ground and incorporate the area into the design of the course. The former treatment site now includes portions of the eighth and tenth holes, as well as the adjacent irrigation lake.

Through careful routing amongst the washes and desert terrain, the golf course architect, along with their design team members and the golf course builder were able to mold Saguaro's Par 71, 6912 yard layout gently into the landscape. A mere 30,000 cubic yards of earthwork allowed for almost no disturbance outside the fairways and provides a rugged, natural quality to the design. The short distances green to tee and tightly routed holes lend a comfortable feel to this rare desert walking course. Measures such as plant salvage, careful preservation of the native habitat and rehabilitation of the wastewater treatment site helped to protect and enhance the golf course's Sonoran surrounds. As a result, the team was able to create a course at We-Ko-Pa that is in concert with a unique environment.

Banff Springs Golf Club
Banff, Alberta, Canada

Golf Restoration in a National Park

Les Furber, ASGCA
Les Furber Design

The Fairmont Banff Springs Golf Resort is located in Banff National Park in the Rocky Mountains of western Canada. Today the complex consists of 27 holes with the original 18 holes being designed by Stanley Thompson in 1928. It was originally constructed by the Canadian Pacific Railway as part of their national transportation and to promote tourism by rail. It is a resort property presently owned by the Fairmont hotel corporation, although at the time of the project undertaking was still owned by Canadian Pacific. The golf course and a magnificent castle-like hotel structure are located in a valley

below Sulfur Mountain and Mount Rundle. The Stanley Thompson eighteen winds along the Bow River and are aptly named the Sulfur Nine and the Rundle Nine and plays to a Par 72 at 7,083 yards.

Over the period of more than 60 years of operation, the course was in need of a refurbishing. In 1997 management decided to undertake a complete restoration program to elevate the playing conditions to today's standards, including constructing greens to the USGA standard. In a national park, any change being contemplated to the physical structure or associated amenities has to be presented to the Parks Superintendent and approved by the Department of Parks Canada. As part of the preliminary planning, Parks Canada required an Environmental Impact Assessment be done to investigate the impacts on wildlife, vegetation, water, soils, etc. The findings were to be mitigated in the planning and construction process and in return for the permit being granted, other concessions were to be made by management. For example, it was mandated that large areas of the property were to be left to revert back to a native state, creating better habitat for wildlife. This included areas in front of tees, behind bunkers and all of the non-maintained roughs.

The intent was to maintain all original green contours. Over the years, many tees had been added without much thought of planning. They were to be rebuilt according to the original design with a traditional rectangular shape. In some instances, new back tees were to be constructed to give the course added length. Some bunkers were in need of relocation to be more in tune with today's game. A comprehensive survey recording all existing contours was to be done and all features were to be rebuilt to those exact contours. For the greens construction, the intent was to core out the cavity, install drainage and rebuild with USGA approved greens mix. The excavated material was to be used in other construction areas.

As part of the Environmental Impact Assessment, extensive soil testing was done. The results showed alarmingly high rates of mercury contamination in the green complexes due to the use of preventative fungicides against winter kill of the turf grass prior to 1970. Tee and fairway areas indicated high, but tolerable levels of heavy metals in the soil. We were informed that if the soils were disturbed, the mercury could mobilize and become volatile. Therefore, the excavated soils could have no further use on site and due to the high contamination levels, the soils would need to be hauled and disposed of at a controlled land-fill site for contaminated materials. The cost to remove these materials would exceed a half million dollars and require public hearings and mitigation studies and possibly two to five years to get the necessary permission. However, if the soils were left undisturbed, there would be no resulting problems.

In conjunction with the environmental consultant, the decision was made to leave the greens totally undisturbed. Instead of excavating the cavities, the greens were to be reconstructed above the original contours. A network of flat pipe drainage was laid on the existing turf grass putting surface covered with a 6" blanket of drainage rock and 12" of the greens mix. What transpired was a new green surface built 18" above the original putting surface. Many of the green complexes had unique visual lines accentuated with mounding or flashing of sand typical of a true Stanley Thompson design. It is imperative that these features were not lost. To complete the construction process, fill material was imported to elevate the surrounds to maintain the original appearance. Irrigation was re-installed and surfaces were sodded.

Tees and fairway bunkers were reconstructed and sodded. To complete the process, fairways were re-graded to eliminate uneven contours, drainage was installed where necessary and all areas resodded. Continuous cart paths were installed and a tree planting program was completed to compensate for the trees that were removed during the construction process.

Parks Canada personnel continually monitored the restoration program. With the continuous supervision of the golf course architect and on-site meetings with the golf course staff throughout the construction process, we were able to undertake a project that was successfully completed and enthusiastically endorsed by the Canadian National Parks Department. The restoration of the golf course features was an excellent example of consultants and agencies working together to enhance the golf experience while protecting and preserving our environment.

Granite Links Golf Club
Town of Milton and City of Quincy, Massachusetts

Degraded Site Development through Shared Projects

John Sanford, ASGCA
Sanford Golf Design

In 1989, the Commonwealth of Massachusetts and the city of Boston were preparing to undertake an extensive tunnel project for the relocation of a major highway through the city. This project, which became known locally as the "Big Dig," would require the disposal of over 13 million cubic yards of excavated material. At the same time, the nearby Town of Milton and City of Quincy were looking at the closure and end-use of a large landfill that was located in both their jurisdictions. Seeing advantages for both projects, developers proposed using the material excavated from the tunnel for the closure of the landfill and enhancement of degraded areas of the site. The reuse of the landfill site and adjacent areas would become the Quarry Hills Recreational Complex and include a championship golf course. The golf course architect and consultant team provided much-needed expertise throughout the development process of the project.

Altogether, almost 500 acres of land was assembled for the site of the recreational complex from both private and public owners. The site was located seven miles from downtown Boston overlooking the city to the north, Boston Harbor to the east and surrounded on the other two sides by the Blue Hills Reservation, an 8000 acre wilderness park situated in the Town of Milton and the City of Quincy. Most of the land was at one time part of the famous granite quarrying industry dating back to the mid 1800's which supplied building blocks for major buildings on the east coast. In the City of Quincy, one of the first railways in North America was constructed to carry stone from the quarries to the barges at the port. The quarries, once abandoned, became filled with rubbish and eventually developed leachate and invasive plants resulting in many areas being classified as badly contaminated wetlands. As a result of the environmental impact investigation, archeological sites were discovered dating back 8000 to 10,000 years. In addition to the landfill, site characteristics included existing elevation changes of over 300 feet.

Fill material from the excavation of the highway tunnel was perhaps the most important item that made the project possible. Much of Boston was built on filled land with material brought by train, day and night, over many years from the western suburbs. The largest part of the excavated material from the tunnel was labeled as "historic fill." Because the Department of Environmental Protection (DEP) suspected possible contamination from 19th and 20th century industry's indiscriminate dumping, all the excavated material had to be chemically tested, which at times took 8 to 10 days, before it could be released for distribution and construction on the site. The regulators classified this material as waste, and it required the same procedures for disposal as household waste. Other excavated material varied from virgin sandy soils to the infamous greasy Boston Blue Clay, a necessity for sealing the landfill. Of course, the digging for the tunnel was all underground and out of the weather, so trucks removed the excavated material nonstop. As many as 1200 truck loads every 24 hours arrived day and night, resulting in continuous logistical issues at the

site for the disposal operation over a five-year period, especially during spring rains and winter snows.

Permitting the development of the golf course on top of a landfill in two different communities was a significant challenge. Approvals by the Zoning Board, Board of Appeal, Board of Health, Conservation Commission, Assessors, City Solicitor and Town Counsel and Advisory Committees were required by both the Town of Milton and City of Quincy. The State, after sign-off by the Federal Government, had oversight by the DEP once contracts were negotiated by the managers of the Big Dig and signed by the Public Works Department. The U.S. Environmental Protection Agency got involved and required inspections by the U.S. Army Corp of Engineers, since the headwaters of three rivers existed on the property. Citizen input was active from the very beginning of the project. Because of the complexity, location in two communities and being bordered by a highly protected state forest, the project required more than 100 permits and amendments.

Building the golf course on top of a landfill also created challenges. The landfill had to be "closed" by being capped with specific layers and depths of material. After the "historic" fill was placed and graded to the contours designed for the golf course, it had to be sealed with 12 to 18 inches of clay, placed in six-inch layers, de-stoned by hand and compacted to eliminate water infiltration into the landfill or allow leachate to escape. Next, a layer of two to four feet of clean fill material was placed on top of the clay and graded to the design contours. This layer of material was designed to accommodate the sub-surface drainage system, the irrigation and gas recovery system. On top of the two to four foot layer of clean material, titled "sacrificial fill," another six to 12 inch layer of sandy loam was placed to provide a planting medium for the grasses. All of these layers had to feather into the edges of the wetlands, skirt the historic work sites and allow the grading requirements for the features of the golf course. The golf course architect designed green complexes and other features to allow construction without disturbing the "seal" of the layers for drainage and irrigation systems, as well as the collection of the gases. The collection system for methane gas from the landfill involved the installation of some 150 wells and a system of blowers and flares for control. Ultimately, this gas will be channeled to drive an engine to generate electricity and is expected to produce for some 20 to 25 years.

Settlement of the landfill was another concern and required close attention during design of the facilities. Most of the play areas were surcharged with huge stockpiles of historic fill, whenever possible, as construction progressed. This technique accelerated primary settlement. After a year, these areas were well into secondary settlement, and grading of the course was possible with a reasonable degree of confidence that further settlement would not take place.

The site's natural and historic resources presented the golf course architect and design team opportunities as well as challenges. The quarries were incorporated into the design of the golf course to serve as strategic features. Certain holes present risk/reward challenges where there is an advantage in playing over the quarry, while playing around it may be safer, but longer. New and existing wetlands were also incorporated by the golf course architect to influence strategy and enhance aesthetics. These and other wetlands within the Quarry Hills complex totaled 78 acres and raised significant issues. Existing, degraded wetlands were restored and sedimentation basins used during construction were transformed into new wetlands. Two large lined ponds were constructed to provide storage for the golf course irrigation. The edges of the ponds were designed to incorporate additional wetlands.

During construction and the grow-in period of the course, surface drainage and run-off on the site presented another major challenge. An extensive storm water management program

utilizing sedimentation basins, clay berms, riprap check dams, hay bales and silt fences was implemented to protect wetlands and other ecological resources within the complex and nearby residential areas. Sub-surface drainage under the golf course directed drainage to catch basins and prevented surface run-off from percolating down to the clay cap with nowhere to go. The design of the course, the drainage system and elevation changes in the site allowed about 65 percent of the runoff from irrigation and storms to be recovered for reuse on the course.

The aesthetic and infrastructure enhancement of the Boston cityscape, made possible by the highway relocation and tunnel project, also allowed the beneficial reuse of a large landfill as an open space and for the Quarry Hills Recreation Complex. After thirteen years and 900,000 truck loads of fill material, the 27-hole Granite Links Golf Course, athletic fields, rock climbing sites, hiking trails and other amenities provide a recreational facility to be enjoyed by residents and visitors for years to come.

Farmlinks Golf Course
Sylacauga, Alabama

Designing for Practical and Environmental Research

Dr. Michael Hurdzan, ASGCA; Dana Fry, ASGCA and David Whelchel, ASGCA
Hurdzan/Fry Golf Course Design, Inc.
Landscapes Unlimited, Inc., GCBAA

For knowledge to have impact it must be shared with others, especially when it is leading edge technology intended to improve golf course maintenance and reduce environmental impacts. FarmLinks was always envisioned and intended by the Pursell Family to be an outreach education/research facility. Their fertilizer company had pioneered work on encapsulating fertilizer and chemicals in polymers, that would release their materials at precisely the rate that plants could us them. This approach reduced or eliminated leaching of necessary maintenance materials into groundwater, sharply curtailed excessive or misapplications, and saved fossil fuel and manpower by reducing the frequency of applications. To showcase their products and tell their story, they believed that they needed a golf course where visiting superintendents could see first hand the technology in use. They also recruited several other manufacturers and suppliers to participate in the concept and make the golf course a living laboratory and test ground. That concept and program have proven so successful, they have gained worldwide recognition and are highly regarded as an educational experience.

The Pursell Farm in Sylacauga is one hour south of Birmingham, Alabama and covers over 3,000 acres with environments that range from creeks and ponds, wetlands, wet meadows, upland meadows, wet woods, upland woods, shear rock faces and steep wooded hillsides. Most of the upland areas were in one type of agriculture or another. The farm had very diverse ecosystems with a high biodiversity ranging from livestock to every critter and plant known to south central Alabama. The Pursell family served as the developer of the project.

The golf course architect was selected because of their environmentally friendly design methodology that invited input from local experts on environmental issues. Collectively, it was decided that since this was to be a research and demonstration facility, the golf course should be sited to integrate as many of the ecosystems and ecotones as practical and able to permit, to provide the widest range of observations on the impacts of design, construction and maintenance inputs. These areas were mapped and reviewed for a constraints and opportunities map for planning.

Then the challenge was to route the golf holes, based upon the constraints and opportunities map, to flow harmoniously one to the next, but minimally disturb and keep each environment isolated and functioning as it had before the golf course. Clearly, clearing trees and introducing sunlight into some areas would be an impact, but it was rationalized that this would only provide more opportunities to study "edge effects."

Prior to the construction of the golf course, the gold course builder provided beneficial input regarding construction activities and contributed to the results of the project through diligent protection of adjacent non-disturbed areas of the property.

The golf course has been fully operational since 2003 and has hosted thousands of golf course superintendents, students, educators and researchers for demonstrations of their on-going projects. A group of highly respected and successful golf course superintendents have been selected to serve on a "New Innovations Advisory Committee" to suggest future directions for research. The underlying theme is always to produce superior golf playing conditions, but to also currently reduce the input amount of water, fertilizer, pesticide and fossil fuel to produce those conditions. FarmLinks is a work in progress, and it is hoped that the lessons learned will have far reaching impacts.

The Meadows at Mystic Lake
Prior Lake, Minnesota

Combining Cultural and Environmental Issues

Garrett Gill, ASGCA with Paul Miller
Gill Design, Inc.
Duininck Brothers Golf, Inc., GCBAA

The purpose of the project was to provide a destination championship 18-hole golf course to complement the Mystic Lake Casino and to provide golf recreation opportunities for the Shakopee Mdewakanton Sioux Community (SMSC) tribal members and their families. The golf course project should reflect the cultural values of the tribal community in preservation, protection and enhancement of the land.

The golf course site is comprised of approximately 140 acres of the former Lone Pine Golf Course, a short, 18-hole, privately owned, daily fee golf facility located on non-tribal lands in Shakopee, Minnesota and approximately 45 acres of adjoining tribal land adjacent to the Mystic Lake Casino in Prior Lake. Of the 45 acres, approximately 20 acres were comprised of asphalt parking lot area for the casino with the remaining 25 acres in use as a spoil area for the ongoing casino/hotel expansion project. The site of the existing Lone Pine Golf Course consisted of undulating topography with several prominent knolls with overlooks towards the Mystic Lake Casino and future hotel. The site is bounded on the west and north by an expansive wetland/wildlife habitat area, to the south by mixed use urban development, and to the east by the Mystic Lake Casino, supporting parking lot areas and the campground. Vegetation on the site consisted of numerous young to mid-age white and green ash, linden, maple, spruce and pine planted since the original course construction in the late 1970's.

Several environmental issues needed to be addressed or resolved in the development of the project:

- Preservation and protection of existing wetland habitats.
- Improve/treat storm water runoff quality from adjacent impermeable surface areas.
- Reduce/minimize ground water usage from the Jordan and Shakopee aquifers for irrigation purposes.

The site was initially surveyed and mapped for topography, vegetation, wetlands and other natural and physical constraints. The following environmental objectives were formulated during the preliminary design phase of the project by the Shakopee Mdewakanton Sioux Community Business Council and their Land and Resources Department staff:

- Avoid impacts and protect the perimeter wetlands along the property's northern and western boundary.
- Create open water areas in non-wetland areas of the site to increase desirable water-based flora and fauna.
- Develop a storm water capture system from on and off site areas to minimize need for use of groundwater as a source for irrigation. Access to ground water from the Jordan/Shakopee aquifers is restricted and discouraged because of the impact to high quality, calcareous fens reliant on this water.
- Utilize wastewater reclamation from community homes, casino and hotel to minimize need for use of groundwater as a source for irrigation.
- Develop a storm water retention/detention system which would also provide filtration and dilution (deicing salts) of storm water runoff from the impermeable surface areas (parking lots and roofs) of the adjacent casino and hotel/conference complex.
- When possible, preserve and protect the existing vegetation for replanting.
- Establish a culturally-based, indigenous landscape planting theme throughout the course.
- Establish culturally based symbolism through sculpture within the course.

Project permitting was initiated and managed by the Shakopee Mdewakanton Sioux Community Land and Resources Department staff. A wetland delineation was completed by the staff and reviewed and approved by the US Army Corp of Engineers. A tree survey was also initiated and completed by the staff. Trees were tagged based on the size, type, quality and success of transplant survival.

The golf course architect prepared several conceptual routing studies depicting alternate arrangements of holes and their integration with the proposed new clubhouse building and the ongoing casino/hotel expansion project. The Shakopee Mdewakanton Sioux Community Business Council, Legal Department staff, Land Resource Department staff and staff from the casino/hotel development and management entity reviewed the concepts and ultimately approved the selected routing for implementation. Key to selection process was the routing concept's ability to meet the stated development objectives.

During the design and construction process, environmental strategies were implemented to meet the stated objectives. The existing perimeter wetlands were expanded into the golf course by dredging open water outside of the wetland limits adjacent to the new golf holes. A system of large interconnected ponds was constructed in the lower elevations of the course as storm water detention and retention features for the golf course. More than 80 acres of adjacent impermeable surface area that surface drained into or through the golf course were also set aside to reduce the need of a ground water source for golf course irrigation. The water within storm water ponds is used as a blending and dilution source for high salt content runoff from the parking lot areas during the spring snow melt. A 2,600-foot long re-circulating open water creek and waterfall system was incorporated into the golf course to oxygenate and aerate the captured storm water. Water quality in the non-connected ponds is managed through typical aeration practices. Prior to golf course construction, trees of significant quality were relocated from the existing golf course to an off-site nursery location. At the completion of construction, the trees were replanted on the golf course for conservation and to provide a mature appearance. An extensive amount of sod was used in the rough areas to reduce erosion potential on the steeper slopes and expedite stabilization. Blended fescue and bluegrass rough areas will allow course management to make adjustments in the position of rough/natural areas as playing patterns develop. Low fertility and low water use bent-grasses on the green, tee, and fairway areas were used to conserve water resources. Low maintenance, no-mow prairie-type and shrub/tree planting areas were incorporated into the course to promote a culturally and historically accurate indigenous landscape palette. Culturally significant animal sculptures were placed into the visible out of play landscape areas of the course to promote the sensitivity, importance and protection of the land by the Shakopee Mdewakanton Sioux Community.

The golf course builder paid close attention to the sensitive areas and features of the site during the construction process. All wetland areas were protected with heavy duty silt fencing, which were checked and repaired immediately following any rainfall event. Significant trees to remain were protected with orange construction fencing to keep equipment away from their drip-lines. Pond banks were stabilized with a shoreline stabilization mat, then seeded and covered with erosion matting shortly following excavation to avoid any deterioration of the pond banks.

The par 72, 7100-yard golf course, opened in 2006, is a delightful golf experience for both the avid low handicap golfer and the recreational, social golfer. Golfers remark on the beauty of the course and enjoy the bronze animal sculptures located throughout the course that reflect tribal values and culture.

Three Crowns Golf Course
Casper, Wyoming

Reclaiming an Oil Refinery Site

Bruce Charlton, ASGCA
Robert Trent Jones II, LLC
Niebur Golf, GCBAA

The business of refining oil goes back nearly 100 years in Casper, Wyo., when the Midwest Oil Refinery was opened in 1912 to take advantage of the region's oil reserves. This era ended in 1991 when the Amoco Oil Refinery halted operations at the 340-acre site that at one time pumped and refined 48,000 barrels of oil a day. Almost immediately, the question of what to do with the site was an issue facing the people of Casper, Natrona County and the owners of the land, Amoco Oil Company. After nearly 15 years of planning, clean-up and golf design and construction, Three Crowns Golf Course, named after the petroleum grading system formerly used by Standard Oil, opened.

In 1998, a Consent Decree was signed with the Wyoming Department of Environmental Quality. This decree gave the parties interested in the former refinery a framework by which to collaborate and identify the appropriate remedies and corrective actions for the cleanup of the property. The corporation

worked with the entire Casper community to come up with a plan for the land, which, through a Reuse Agreement, stipulated that reuse and remediation be consistent with the full protection of the public health and environment. Also in 1998, BP Products North America, Inc. merged with Amoco and became involved with the project. Called Platte River Commons, the project now houses the Three Crowns Golf Course which sits atop the site and will eventually also include a business park, jogging trail and nature parks.

Prior to construction of the golf course, the site was excavated, capped with fill and topped with 10 - 15 inches of sand. BP installed a remediation system, a series of about 100 reclamation wells (and four of the eight water hazards on the golf course) under the land that would eventually be the site of the golf course. These wells collect contaminated groundwater, which is subsequently pumped through a series of vessels that contain materials designed to absorb the water's contaminants. The reclaimed water is supplied to a local lake and wetland area to encourage wetland growth, as specified by the remediation agreement.

Once the remediation system was installed (at a cost to BP of about $178 million), the irrigation system was laid above the pumps and wells. The golf course builder worked carefully with the owner and design team to construct a golf course without any adverse impact to the remediation of the site while constructing a golf course to meet the requirements of the project. Now that the layout is open, BP's onsite crew comes to the golf course early in the morning, prior to any golfers' arrival, and conducts routine maintenance to the wells and pumps in cooperation with the golf course superintendent's staff. If major repairs need to be made, the crews work together to avoid damaging the irrigation system.

The course hosted 15,000 rounds its first year of operation in 2005. It plays at 7,065 yards from the back tees and features 45 acres of native grass and 110 acres of playable turf. Crested wheatgrass and fescues comprise the majority of the native grass, and occasionally metal parts from the old operation poke through the natural roughs.

Through pump and treat remediation methods, a former oil refinery in Wyoming has found use as a 340-acre multi-use site featuring a golf course, business park, jogging track and nature park. The project was nearly 15 years in the making while the Wyoming Department of Environmental Quality worked with the landowner BP, the City of Casper and Natrona County to identify an environmentally-safe reuse of the land. The land Three Crowns is built on is still owned by BP, but is leased to the BP/Amoco Reuse Agreement Joint Powers Board for 99 years at the cost of $1. The public is welcome to play the course, and it has become a recreational amenity for the people of Casper.

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Audubon International:
www.audubooninternational.org

Club Managers Association of America:
www.cmaa.org

EDGE:
www.eifg.org/edge

Environmental Institute for Golf:
www.eifg.org

Environmental Protection Agency:
www.epa.gov

Environmental Golf in Scotland:
www.scottishgolf.com/environment/

European Institute of Golf Course Architects:
www.eigca.org

Golf Course Builders Association of America:
www.gcbaa.org

Golf Course Superintendents Association of America:
www.gcsaa.org

Golf Environment Europe:
www.golfenvironmenteurope.org/newgolfdevelopment.html

National Fish and Wildlife Foundation:
www.nfwf.org

National Golf Course Owners Association:
www.ngcoa.org

Royal Canadian Golf Association:
www.rcga.org

Society of Australian Golf Course Architects:
www.sagca.org

United States Golf Association Green Section:
www.usga.org/turf/

United States Federal Government Golf and the Environment Web Sites:

United States Army Corps of Engineers:
www.usace.army.mil/

United States Department of Agriculture/
Natural Resources Conservation Service:
www.nrcs.usda.gov/

United States Department of Energy:
www.energy.gov/

United States Environmental Protection Agency:
www.epa.gov/

United States Fish and Wildlife Service:
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United States State Government Environmental
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