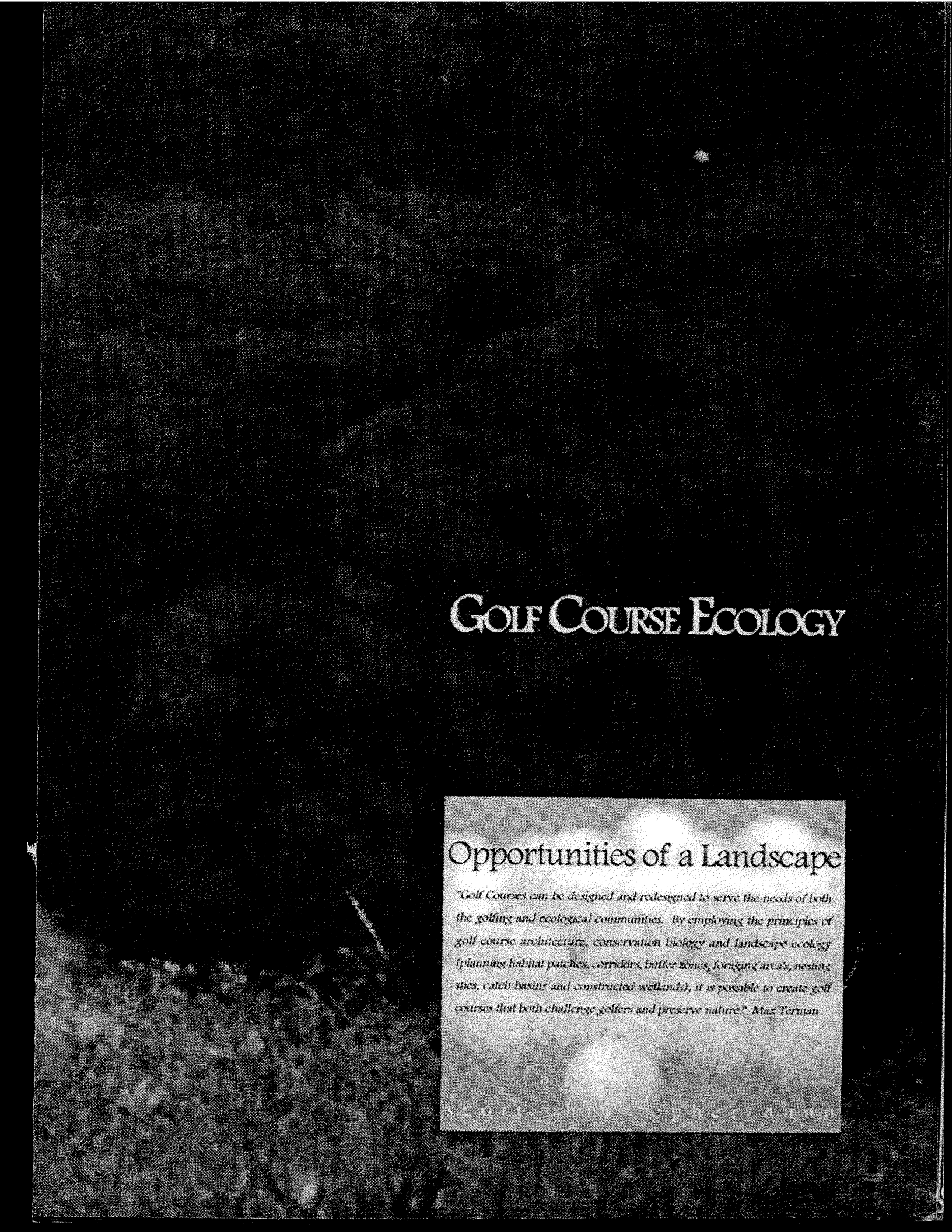

Golf Course Ecology

Opportunities of a Landscape

"Golf Courses can be designed and redesigned to serve the needs of both the golfing and ecological communities. By employing the principles of golf course architecture, conservation biology and landscape ecology (planning habitat patches, corridors, buffer zones, foraging area's, nesting sites, catch basins and constructed wetlands), it is possible to create golf courses that both challenge golfers and preserve nature." Max Terman

scott christopher dunn

GOLF COURSE ECOLOGY

OPPORTUNITIES OF A LANDSCAPE

BY

SCOTT C. DUNN

A Practicum
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements
for the Degree of

MASTER OF LANDSCAPE ARCHITECTURE

Department of Landscape Architecture
University of Manitoba
Winnipeg, Manitoba

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GOLF COURSE ECOLOGY

OPPORTUNITIES OF A LANDSCAPE

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A Thesis/Practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements for the degree of

MASTER OF LANDSCAPE ARCHITECTURE

ABSTRACT

The purpose of this practicum is to explore the principles of golf course architecture and the principles of landscape ecology manifested in the design of an 18 hole golf course in Sechelt, British Columbia.

This practicum consists of five major parts. The first part examines the history, theories and spatial elements of golf architecture. Included in this section is a discussion on the move towards an environmental expression in golf architecture and the importance of the spirit embedded in a place. This is followed by the second part which is an analysis of the site. The third part explores the components of landscape ecology and suggests four guiding principles to aid in the development of the golf course. The fourth part reveals the programmatic elements of the golf course and the initial course routings. The final section describes the synthesis of the previous sections in the design of an 18 hole golf course.

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ACKNOWLEDGEMENTS

This practicum is dedicated to my mother and father, without their support I would never be in the place I am today.

I wish to thank my committe members, Dr. Mary-Ellen Tyler, Derek Murry for their time, knowledge and expertise, and my advisor Professor Carl Nelson who's advice was instrumental in accomplishing this practicum.

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GOLF COURSE ECOLOGY

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TECHNICAL SUPPORT

This document was accomplished using the following technological innovations.

Hardware

Powerbook 165, 8 mb of ram, 165 mb hard drive.

Power Mac 6100, 21 mb of ram, 500 mb hard drive.

Quantum TRB850S external hard drive, 850 mb.

Iomega zip drive.

Software

Word processing
Microsoft word 6.0

Desktop publishing
Pagemaker 5.0a

CAD
Minicad 5.0.2

Formz

Input

Microtech flatbed scanner

Output

Color Stylewriter 2400

HP 4mp Laser printer

1.0 INTRODUCTION

golf course ecology

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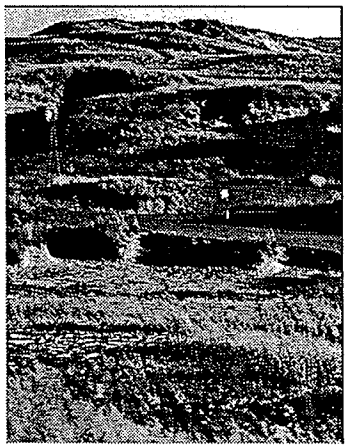
"Golf Courses can be designed and redesigned to serve the needs of both the golfing and ecological communities. By employing the principles of golf course architecture, conservation biology and landscape ecology (planning habitat patches, corridors, buffer zones, foraging area's, nesting sties, catch basins and constructed wetlands), it is possible to create golf courses that both challenge golfers and preserve nature."



Max R. Terman, Ph.D.
The Promise of Natural Links, 1994

1.0 Introduction

The tradition of golf has evolved over the years from the classic courses of Scotland meandering through the landscape, to modern courses located in almost every biogeoclimatic zone. By listening to the land, many of the great golf course architects have transformed the land into art and the air into memories. "Within a hole, architect's strive to create features that flow and blend together with the land around them." (Robert Trent Jones. Jr. 1994) After a decade of environmentalism, listening to the land has come to mean more to golf course architects than just a pleasant ordering of golf elements on a landscape. Routing a golf course into the landscape must also respect the ecology of the place.

This practicum is a response to the growing environmental concern of golf course development. Golf courses can be designed anthropocentrically, providing a memorable experience for golfers as well the thousands of other species that inhabit the site. It is hoped that this document will establish the importances and potential of landscape ecology principles in golf course architecture.

Previous Page: #17 at Sand HillsGolf Club, Hooker County, Nebraska. Source: Golf Digest, 1995.

1.1 Goals and Objectives

Golf Course Architecture has developed and evolved over the last two hundred years. During this time, there have be many factors that have effected the anatomy of a golf course. Recently, issues of regionalism, environmentalism and ecology in regards to human modification of the landscape have come to the forefront of social consciousness. Golf course architecture must re-examined how it can work with the landscape and not ignore it. A golf course presents many opportunities to be compatible with it's environment and enhance the structure and function of a site.

The major purpose of this practicum is to design an 18 hole golf course which explores the opportunities and potentials presented by a specific landscape.

Specific objectives are:

-to identify and apply principles of golf course architecture

-to identify and apply ecological principles in the creation of a golf course

-to explore the relationship between a golf course and the surrounding landscape

-to synthesis golf course architectural principles and ecological principles in the design of a golf course

1.2 Methodology

a. The first stage of this practicum explored the historical background of the game of golf. An attempt was made to identify . This stage identified architectural theories, strategies and the move towards environmentalism in golf course architecture. Through this exploration insight in to the relevance and opportunities for design development was gained.

b. The second stage identified landscape ecology principles and determined the appropriate principles for this project. Through this exploration insights were gained as to the relevance and opportunities for design development.

c. The site was assessed according to its present condition. The structure, function, behaviour and interrelationships of the site were explored using three dimensional analysis. This stage revealed possible opportunities and constraints presented by the site.

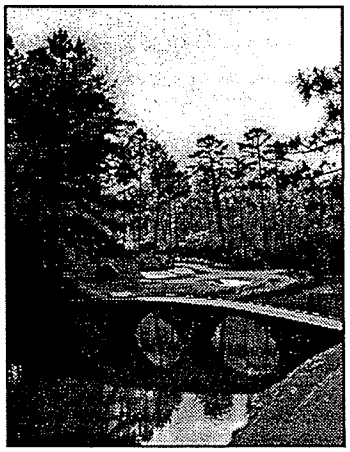
d. The final stage investigated the possibilities of increasing the heterogeneity in the landscape on the golf course. This stage was a synthesis of knowledge gained from the analytical process manifested in an appropriate design expression.

The final product emphasised the possibilities of a golf course on a specific site. The written component outlined the theoretical framework of golf course architecture and landscape ecology, documented and analysed the site and presented a design concept for the development of a golf course. The graphic component demonstrated the application of golf course architectural issues and landscape ecology principles and exhibited how they can be incorporated on a specific site.

2.0 THE SPIRIT OF THE GAME

"The strategy of the golf course is the soul of the game. The spirit of golf is to dare a hazard, and by negotiating it reap a reward, while he who fears or declines the issue of the carry, has a longer or harder shot for his second; yet the player who avoids the unwise effort gains advantage over one who tries for more than in him lies, or who fail under the test"

George Thomas,
Golf Architecture in America, 1927



2.0 The Spirit of the Game

The architecture of golf is embedded with many different aspects. The spirit of the game is a five part exploration of these aspects. The history of the game of golf, the theories of golf architecture, the spatial elements required, environmental challenges and the spirit of a place. The object of this section is to gain an understanding of golf architecture and how the elements can be utilized in the design of a golf course.

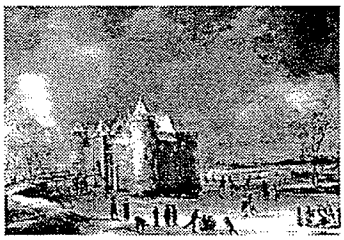
Preceeding Page: The 12th hole at Augusta National, Georga. Photo by Mike Klemme appearing in The Golfer Magazine, 1995.

2.1 Historical Background

"Golf was originally played on "linksland," a word still used to describe a golf course - the links. Many persons assume that links refer to holes joined together like sausages, but it denotes a particular type of coastal terrain characterized by hummocky topography and sand dunes often covered with turf and coarse, grazed grasses. The exposed location heightens the impact and awareness of atmospheric conditions of wind, rain and light, which in summer last well into the evening. The original golf courses were built on linksland."
Helphand 1995

The history of golf is an important element for any golf course architect. It is a game built on tradition. An understanding of where the game originated and how it has developed assists in understanding where the game is going. The following is a brief history of a game that spans a five hundred year period.

The origins of golf have been traced back to the middle ages. The game originated from a group of sports described as target ball games. Golf is believed to be of dutch dissent where a game called "Kolben" was played. (Platts, 1995) It involved hitting a ball with a club across frozen rivers and lakes aiming at specified targets.



Above: The game of kolben being play on a pond. The castle of Muiden in Winter. Painted in 1658 by Beerstraaten. Source: An Illustrated History of Golf, Mitchell Platts, 1995.

Golf is a game based in honour and trust. The concept of the game is simply to hit a ball with a club into a hole and attempt to accomplish this in fewer hits than your opponent. In the attitude of sport, it is this simple concept that has produced many great rivals, the Ryder Cup is one example.

"The rules under which people played were a matter of local custom, on-thee-spot agreements and wagers. Scorecards were yet to be though of. All golf was of the match play variety, and handicaps a rudimentary give and take between individuals, be they dukes or cobbles. Leading players were, however, already sufficiently celebrated to be the subject of poetry."
(Barrett & Hobbs, 1995)

The first claim to the game is attributed to the Scots when King James II put a ban on the game in 1457 to prevent his soldiers from removing their minds and bodies from battle training. The next notable addition to the Scots claim is when James IV lifted the ban, ordered a set of clubs and balls and became an adamant player.

St. Andrews, now called the home of golf was first conceived by the Archbishop of St. Andrews who allowed people to play on the links ground on the outskirts of town. In the ensuing years, a club developed and a loyal following occurred. The similar events occurred in Edinburgh around the same period. Edinburgh was the first to hold a tournament where players played for a sliver club. At the time, the club in Edinburgh was first to initiate new developments but a political decision would shift the ruling power from Edinburgh to St. Andrews. In 1834, King William IV gave St. Andrews the title of Royal and Ancient Golf Club, thus becoming the official ruling body in the world of golf.

From here golf architecture can be examined in three periods; the Links of the 19th Century, the Classic Era between 1900-1930 and the Modern Era post 1945.

The links of the 19th century developed under the guiding hand of mother nature. The early courses usually evolved around a parkland area or open space that allowed a ball to be pitched. Often it was up to the individual groups to determine the location of the green sites. The Links land was the most popular playing terrain due to the short weedy grass and open landscape. Shaped predominately by tide and wind forces the landscape is characterized by sandy and undulating topography. Maintenance was the occupation of grazing animals that consumed the short tuffs of grass. Often, as in the case of St. Andrews, course's would play straight out on the links for a given number of holes then the players would turn around, playing the holes in reverse. Greens sites were characteristically large and fairways where very wide, to allow for windy conditions which would make a small landing area impossible to hit. It is the wind and the firm ground, not the architectural hazards that creates the difficulty in a links course. Initial architects of links courses would include the players, who determined the location of the green sites and the length of the holes which would frequently change due to changing weather conditions. During the late part of this period, golf club's became established and the rules were officially written.

The classic period is an era of expansion across the globe. Scottish settlers carried the game with them to new countries. Courses were developed in new types of terrain, expanding the game from the links landscape. As the Scot's exposed golf to different cultures, it's popularity accelerated increasing the number of players. Demand for new courses was overwhelming and with global prosperity, construction of new courses was economically possible. Many courses were laid out in one day by a person with golfing knowledge.

"Someone who knew how golf was played would hammer a stake into the ground to mark the tee and another to mark the green, both on as flat a piece of ground as could be found. And so on round the course."
Barelay, 1992

This was also a time of improved golfing technology. The feather ball was replaced with a rubber ball and hickory shafts were switched to steel allowing the ball to be hit further. The new equipment increased the total length of golf courses, increasing the required area.

This period is noted for the development of the golf course architect. Some of the architects who left their mark include; Harry S. Colt, Alister Mackenzie, Charles Alison, Herbert Fowler and Tom Simpson from Britain. Charles Blair MacDonald, Donald Ross, A.W. Tillinghast and George Thomas from America. (Cornish, 1991) This period flourished until the 1930's when the great depression made expansion of recreational facilities difficult.

The Modern Era is marked by many innovations. The main influencing factor of this period was the development of post war technology. Large earth scrapers and tilt blade bulldozers replaced mules and drag pans. Architects could now sculpt the landscape to accommodate their designs. This also allowed for barren and unproductive sites to be developed. Golf course could now be built in any type of terrain. Another major element which large machinery provided was the ability to mimic existing holes and established regular shapes on any site. This produced a uniformity in golf courses detracting from the natural uniqueness of individual sites.

Influential architects of this period include; Robert Trent Jones, Stanely Thompson, Robert Trent Jones Jr., Pete Dye, Jack Nicklaus, Tom Fazio and Bill Robinson.

The game of golf has changed greatly in the last hundred years. The links and classic era's are periods when architects worked with the landscape. The modern ear is typified by imposed designs on to the landscape. Recently, there has been a return to the notion of working with the landscape exploring the traditional roots of golf.

The game of golf has grown from a few dedicated Scotsmen and women to a game played around globe with participants numbering in the millions. It is estimated that 40 million people play world wide. (Barrett, Hobbs, 1995) The trials and tribulations of the sport has created a rich and extensive history. It is important to have an understanding of this rich history and how it has influenced elements of the game and the landscape it is played upon.

2.2 Golf Architectural Theories

Golf architecture theories have always been part of the game of golf. The early players on the Scottish links had to design the best routes from tee to green. A player negotiated the natural hazards to reach the green which was usually positioned where the best turf occurred. The hazards were natural hollows and hillocks in the landscape. As golf developed, approaches to golf course architecture were examined on two levels: the ingredients of the whole golf course, and the strategies of playing an individual hole.

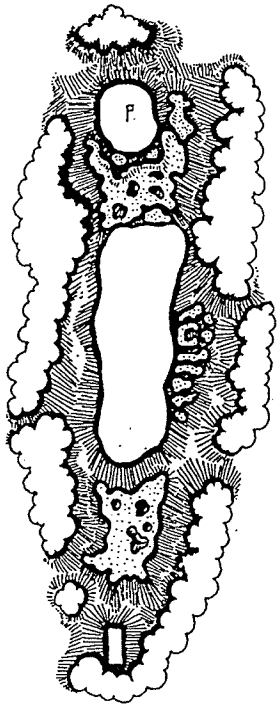
Many of the early architects devised lists of key elements that should be included to create an ideal golf course. Charles Macdonald and Alister Mackenzie, two of golf's most influential architects each devised a list of essential ingredients ranging from the type of landscape required to the fairness of play. (Appendix A) This laid out the foundation for the whole golf course.

The strategy of the individual holes is the second component. As anyone who has played the game can attest to, golf requires more than physical ability. It is a mental game filled with strategy against a players ability. The thrill of golf comes from the ability to deify the hazards and successfully complete the hole. It is the arrangement of the hazards on a hole that creates three schools of thought.

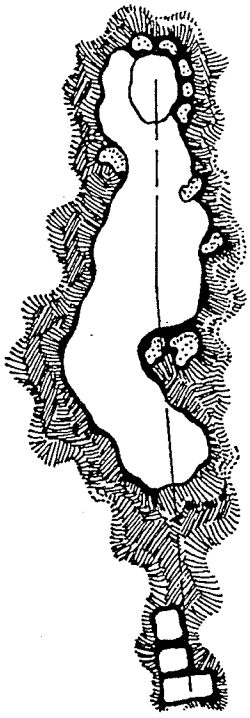
> *"Many designers share my philosophy of "listening to the land" and tailoring the design of the course to it. Accomplished designers often blend "strategic," "penal" and "heroic" holes to create a golf course with balance and rhythm.*
> *(Jones Jr., 1994)*

The penal, strategic and heroic schools of architecture create the foundation for which architects design in. These three schools of thought will become an intricate component of this project and will be conveyed in the final design. The following examines the three school's of thought as outlined in Tom Doak's book, *The Anatomy of a Golf Course.*

The penal school stems from the beginning of the game where hazards were placed to increase difficulty. This would include placing bunkers to penalize topped, hooked or sliced drives. Green sites are heavily bunkered making approach shots difficult. This style usually hinders weaker players and has less effect on low handicap golfers, who are able to focus on a given target and view beyond the hazards. The greatest penal golf hole presents the player with only one safe

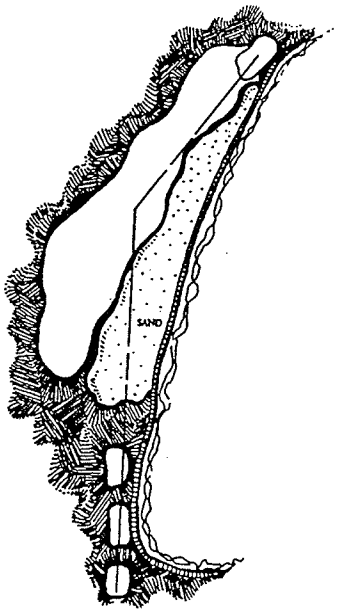


Above: An example of a penal golf hole. Bunkers capture any miss hit shots. Source: Tom Doak, 1992



Above: An example of a strategic golf hole. Bunkers provide a choice of shot selection. Source: Tom Doak, 1992

Below: An example of a heroic golf hole. The diagonal bunker allows a golfer to assess their ability. Source: Tom Doak, 1992



route to the hole.

The strategic school is the most commonly used and thought provoking style in golf architecture. The essence of this style is to provide a choice of shot selection. The object is to position the ball so that the subsequent shot will easily follow. The green is heavily defended on one side or tilted significantly, so there is a distinct advantage to placing the drive in a certain part of the fairway. Fairway hazards are positioned at optimum area's so that attacking the green is risky. A player is rewarded for thinking ahead and accurately positioning the shot. A strategic hole presents a variety of options from tee to green. The best strategic hole is where a hazard is clearly presented with a hundred different possibilities of concurring that hazard. This forces the golfer to assess how much risk they are willing to take against how much margin for error they need.

A heroic hole provides a thrill for all levels of golfers by presenting a clear advantage in the approach by making a significant carry from the tee. The ideal heroic hole is laid out on a diagonal. This allows the golfer to assess their ability to limit the distance to the green by playing close to the hazard. Hazards with irregular edges adds to the excitement especially if the irregularity is the distance that a golfer usually drives. A successfully designed heroic hole creates the illusion that the required shot is harder than it appears, increasing the excitement of the player who defies the odds.

As it will become apparent is project an 18 hole golf course is a combination of these three schools of thought.

2.3 Spatial Elements

"Any design is a manipulation of the basic programmatic elements (the tee, fairway, green, rough, hazards, bunkers) and the two major course types (the linksland archetypes and the inland forested course). These are coupled with the conventions of course design regarding orientation, strategy, the sequence and frequency of par 3,4, and 5 holes, and the relationship of the holes to clubhouses and adjacent land uses."
(Helphand ,1995)

The design of a golf course encompasses a number of physical elements that must be considered. These physical elements define the structure of the golf course. The following section explores the physical properties of a golf course providing an understanding of the shape, size and configurations that are required.

2.3.1 Spatial Criteria

The amount of land necessary for a golf course varies depending on the type of course, the shape of the site, and the degree of topographical change. Most golf courses that have 18 regulation golf holes and a practice facility are around 150 acres. (Doak 1992, Hawtree 1983) Acreage is usually increased for hilly area's, due to the number of possible green sites and the grade of the fairways. The Handbook of Landscape Architectural Construction suggests that the gradient of the fairway should vary from two to fifteen percent. If the long slope of the fairway is more than ten percent the ball will have difficult stopping. Steep slopes on many courses are incorporated into elevated tees, where the tee is above the green. This becomes important later due to the extensive topography of the chosen site.

"Simply speaking, the greater the variety of contours and elevations a property contains, the more chance there will be for the architect to differentiate his course from the rest."
Tom Doak ,1992

Technology has had a profound effect on the length of a golf course. With new materials for clubs and balls a golfer is able to propel the ball further and straighter than in the past. (Barrett & Hobbs 1995) This new technology has changed the average maximum shot

length. (figure 2.3a) This directly effects the positioning of landing zones and the length of the holes.

The National Golf Foundation has established a par number for a range of distances from the tee. Typically there are three types of golf holes distinguished by the par for the hole; par 3, par 4 or par 5. A par 3 is up to 250 yards, a par four is 251 to 470 and a par 5 is any hole of greater length usually not exceed 550 yards. The total length of a course from tee to green is around 6200-6700 yards, with Championship tee's playing over 6700 yards. The par three hole is a short hole requiring one shot to get from tee to green. Most 18 hole course have four par threes. The par four requires two shots from tee to green. It is the most frequent hole on a course, with a minimum of ten. The par five is the longest hole which requires three shots to reach the green. Like the par 3 most 18 hole courses have four par fives. The combination of the different holes creates the rhythm of the golf course, maintaining the interest of the golfer and providing for a memorable experience.

Each hole can be dissected into four basic elements. The Green complex, Tees, Fairway and Rough, and Bunker and Water Hazards.

2.3.2 The Green

The green is the face of the golf course. It reveals the character of the hole, and is the target to which players aim. Lower handicap players will obtain half their strokes on the putting surface making it a very important element.

There are four critical factors concerning the green complex. The first being the approach, the second; size, the third; is the shape and the fourth is the surface of the green.

Approach

Existing contours should tie into the green's contours so that the green is set into the landscape and does not look out of place. When developing a public course the majority of green site's should slope

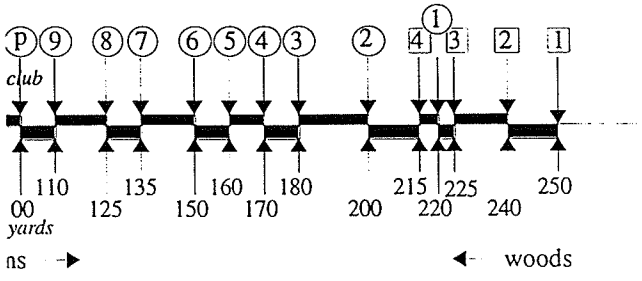


Figure 2.3a: The average maximum shot length (yards) Source: The Handbook of Landscape Architectural Construction, 1976.

towards the fairway reducing the speed of an approaching ball. A green sloping away from the fairway is very difficult to land on, especially with a bump and run shot.

Size

The size of a green varies due to a volume of play, the tolerance of the grass, available area, extent of contouring and the surrounding hazards. Northern public courses, which receive more rounds per year (25,000 to 30,000) than private courses require larger green site's. The number of pin placements is increased so that wear and deterioration is kept to a minimum. In different biogeoclimatic zones the tolerance of the grass varies. The less tolerable the grass, the higher maintenance budget, which becomes a concern for smaller courses. The available area in a given site is also a factor. For example if a green is positioned between two natural features, such as a rock outcrop and a stream then the size of the green would be adjusted accordingly. Another element which increases the size of the green is contouring. The final factor depends on the surrounding hazards. The greater the number of hazards the more intimidating the approach shot is to the green. As Tom Doak points out it is not the size of the green versus the length of the approach, but the size of the hazard-free area around the hole versus the difficulty level of the approach.

Average courses that experience average volumes of traffic (25,000 - 30,000 rounds per year) have greens around 4,500 ft^2 (420 m^2). This number usually increases due to the previously mentioned factors.

The shape

There are two general trends in green shapes, the classic shapes, established at the turn of the century and the modern shapes that have developed in the last thirty years. The classic shapes include round, oval and rectangular. Simple in plan, the complexity is compounded by the contouring, hazards and relationship to the surrounding area. Eccentric shaped greens are a phenomenon of a few architects such as Desmond Muirhead, who's greens become artforms in the landscape. The difficulty of eccentric green shapes, other than the fact they appear out of place, is that the shape may prevent a ball that comes to rest on one corner of the green from a clear path to the hole. The shot must either be played through the edge of the green or to an area away from the hole.

The other component of shape is the relationship between the green and the fairway. Not every player can project the ball over a hazard and onto a green. As well high handicap players are often aiming at a green with a long iron or wooden club, where the speed and trajectory would make it impossible to stop the ball on the green.

It is therefore best if an area is left open so that the ball has the chance of rolling or bouncing on to the green. Another strategy is to contour an area, where high handicap players are likely to hit the ball, so that the ground kicks the ball towards the green. This will be demostrated in the details of the golf course.

The surface.

Putting difficulty is a combination of slope and speed. The putting surface is an area where dreams come true, and is often the place where tournaments are won. As demonstrated in the story of Clancy on the green. The mighty Clancy, a heroic golfer from the Duck Hook Club had the world in his hand but ...

> *There wasn't even any need, they knew to hold their breath. One simple putt, and Clancy then would win in sudden death. A beaming Clancy doffed his cap to the euphoric sound, then calmly stroked his putt to its appointment underground.*
> *Oh, somewhere in this favored land, the sky is warm and sunny. A band is playing somewhere and the world is milk and honey. And somewhere men are laughing, and women also --- but there is no joy in Duck Hook. Mighty Clancy missed the putt.*
> *(printed in Golf Illustrated march 1990, see appendix for complete story.)*

The surface gives the green it's character and should receive great attention. The speed of the putting surface relies on the length of the grass and the slope of the green. The maximum slope is five percent when the grass is maintain at a reasonable height. If the grass is maintain at modern tournament speeds then the maximum slope is three percent. The minimum slope is dictated by the water drainage. All water must be shed from the green so that surface pooling does not occur.

The components of the green are a critical element in the design of a golf course and will be revealed in the design of the course.

2.3.3 The Tee

"The great thing about designing a golf hole is the architect gets to put the spectator or the player at a certain starting point. It is a perfectly controlled perspective, one of the few perfectly controlled perspectives in life. We put two tee markers down and we say, 'Stand here, golfer, and nowhere else, and you will look at what we put in front of you.'"
Steve Wynn, "The story of Shadow Creek," USGA Green Section Record, March/April 1991.

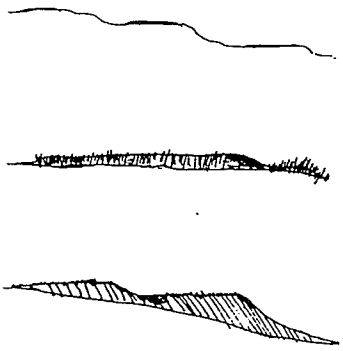
The tee box is the beginning of every hole. It is the place where a player re-groups their thoughts, exchanges small talk, examines the forthcoming hazards and decides on the best strategy to successfully accomplish the next hole. The tee box is the first impression of the hole. Size, distance, drainage and shape are all important factors that must be considered when placing teeing areas.

The tee must be of sufficient size to handle the volume of play. Each hole should have approximately one square foot of teeing area for every round of golf played during an average month. This equates to 3,000 to 5,000 sq. ft. per hole for most courses. Par four's and five's should be at least 3,200 to 3,800 sq.ft. (300 to 350 sq. m.). Par three's experience more wear and tear due to the large number of iron's that are used to tee off. The size of the teeing area for par three's should be 4,300 to 5,300 sq. ft. (400 to 500 sq. m.) (Hawtree, 1989)

Multiple tee decks are often used to separate skill levels of players. Most modern courses offer four separate teeing area's. The total yardage of the course differs dramatically from each tee box. At the newly constructed Nicklaus North Golf Course at Whistler B.C. the distance from the red tee area is 4693 yds, the yellow is 5503 yds, the white is 6046 yds and the black is 6438 yds. When multiple tee area's are used, the middle area or third tee box (the white tee in the previous example) from where the majority of players hit the ball from, should be 50% of the total area. The tee decks should be elevated slightly above each other from front to back to increasing the view of the fairway.

The tee deck must be well drained to prevent pooling of water. The tee box should be at a 1% sloped either front to back, crowned in the middle or incorporated into the existing grade.

The shape of the tee area is up to the architects discretion and can vary from long and rectangular to small and round. It should fit aesthetically into the surrounding landscape. Large long solid tee box are appropriate to a flat expansive site as small individual tee



Above: Typical relationships between tee boxes. Top - three seperate teeing area's. Middle - a flat tee box. Bottom - a two tired tee box. Drawn by Author

Left: Typical width of a fairway. Drawn by Author

area's are appropriate for steep slopes. The positioning of the tee box is important. A player should be able to step into the tee box and be directed towards the target. A strong rectilinear shaped area subconsciously entices a player to set up parallel to the area. If constructed improperly this might not lead the player down the fairway but into the rough.

The other element is the distance between the previous green and the next tee. Historically the next tee was two club lengths away from the hole. The ball was teed on a tuff of grass made with the club. Now there is a need for separation between tee and green to avoid acoustic and some would argue visual disturbance from other groups of players.

2.3.4 Fairway and Rough

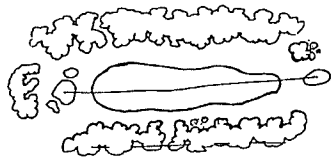


Figure 2.3.4a: An example of a Straight golf hole. Drawn by Author

The fairway and rough is defined as the area between the tee box and the green. The fairway is where the grass is maintained at a particular height so that it does not intervene between the ball and the clubface. The rough is an area where the grass or other obstacles intervenes between the ball and the clubface.

The general width of the fairway is between twenty to fifty yards. The edge between the fairway and the rough should oscillate to reflect the surrounding landscape. The wider portion of the fairway should occur in the landing zones of typical drives by average handicap players. On most holes this would occur around the 175 to 250 yard mark. This makes the landing zone appear larger to the average player, where as to the long ball hitter the fairway tightens up, making the target difficult to obtain. In the fairway both the shape and mowing pattern can be used to guild the golfers shot.

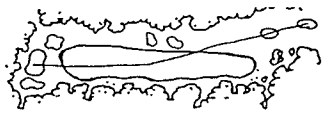


Figure 2.3.4b: An example of an Offset golf hole. Drawn by Author

The majority of fairways fall under one of the following four categories. The four types create the dialogue used to discuss individual golf holes.

Straight - the hole plays straight ahead. (figure 2.3.4a)

Offset - the majority of the fairway is set to the right or left of the direct tee line. (figure 2.3.4b)

Dogleg - is were the green is offset enough that it is not visible from the tee area. The critical component of a dogleg is that the landing zone is close enough to the tee so that a well played tee shot is given the chance of a clear approach to the green. (figure 2.3.4c)

Delayed dogleg - is a dogleg where the fairway does not turn towards the green until the fairway is beside the green. (figure 2.3.4d)

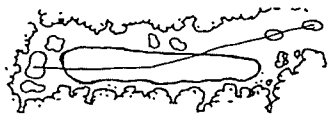


Figure 2.3.4c: An example of a Dogleg golf hole. Drawn by Author

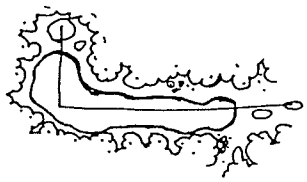


Figure 2.3.4d: An example of a Delayed Dogleg golf hole. Drawn by Author

2.3.5 Bunker and Water Hazards.

"At the short hole bunkers should abound. They should be so numerous and so fearful in aspect that the player delivers his tee shot almost without hope of escape."
John Low, Concerning Golf, 1903.

The thrill of golf is the ability of the individual to deify the hazards. The architect must provided hazards which, from one perspective, seem impossible to conquer, yet are obtainable.

The two most used hazards are water and sand. Early bunkers on the links were patches of sand, eroded by animals and enlarged by the wind. The water occurs either in the form of small poorly drained area's or in the adjacent sea. Over time, the container which holds material has be modified and changed. Modern courses now incorporate a number of types of hazards which add to both the strategy and aesthetics of a hole.

Sand bunkers come in a variety of sizes and shapes. Bulkheaded, grass-faced and sand-faced are the three typical bunker types which differ in aesthetics and method of construction.

Bulkheaded bunkers are faced with railway ties or boards at an angle in the ground. (figure 2.3.5a) They are used best on open sites where their shadows give definition to the fairway. Railway ties provide a strong edge to a fairway.

Grass-faced or sod-wall bunkers are very deep and have a steep facing wall. (figure 2.3.5b) They also create deep shadows that give definition to a fairway. Best in well drained soils, so pooling of water doesn't occur, the grass-faced bunker can be a sandless bunker. In this fashion the grass inside the bunker is allowed to grow. This type of bunker placed around a green has a greater difficulty than a bunker with sand in it.

Sand-faced bunkers are bunkers which are shallow and allow for the sand to come to the top edge of the bunker. (figure 2.3.5c) They are best used on wooded golf course where the dark forest background contrasts the light color sand.

The profile of a bunker usually depends on the distance from the green. The further a bunker is from the green, the shallower and flatter the lip.(figure 2.3.5d) Green side bunkers usually have a steep face into the green and are best placed 10 to 12 feet from the putting surface minimizing maintenance.

Sand bunkers can be used for a variety of reasons incorporating them into one of the three school's of thought. Bunkers can be used to penalize errant shots. They can be used visually for distance

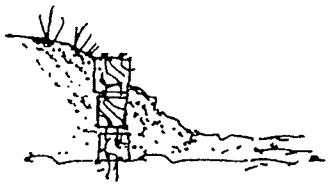


Figure 2.3.5a: An example of a Bulkheaded bunker. Drawn by Author

Figure 2.3.5b: An example of a Grass-faced bunker. Drawn by Author

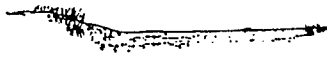
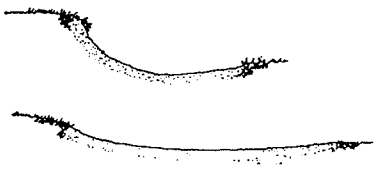
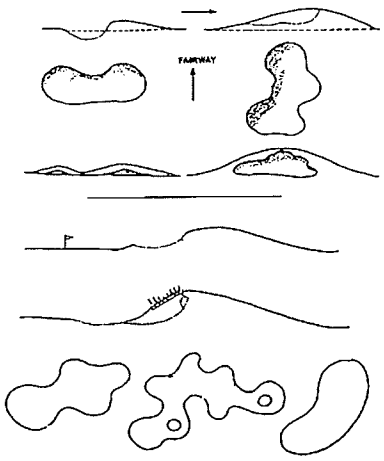


Figure 2.3.5c: An example of a Sand-faced bunker. Drawn by Author



Far Above: Green side bunker.
Above: Fairway bunker.
Figure 2.3.5d: Example of the change in form of the bunker lip the closer the bunker is to the green. Drawn by Author



Above: Typical bunker shapes. Source: The Golf Course, F.W. Hawtree, 1983.

perception, guidance around a dogleg corner or to threaten a player from attempting a particular shot. Bunkers can be used to stop a shot from certain loss, such as a strip of sand before a water feature that catches a rolling ball before entering the water.

The water hazard is the ultimate hazard in golf, and should be used cautiously. As Bobby Jones once mentioned "Getting in a water hazard is like being in a plane crash - the result is final. Landing in a bunker is similar to an automobile accident - there is a chance of recovery." Water hazard's come in a variety of forms ranging from the ocean to small settling ponds. It is only in modern times that water hazards have been developed as stand alone features in the aid of the heroic school of thought. Water hazards can also be used for irrigation ponds, to collect surface drainage, increase aquatic and bird species, as settlement ponds or as an aesthetic enhancement of an area.

Tom Doak suggests three factors that must be considered when using water on a golf hole. The hazard must be visible. There must always be a way around the hazard. And third, the effect of the hazard should be maximized for the scratch player.

It is the combination of these physical features that are incorporated into a landscape to produce a golf course. Through the manipulation, orientation and relationship of each component, the whole golf course can be perceived. Each component will become apparent in the detailed design.

2.4 The Environmental Challenge

> *"In recent years, golf courses have come under scrutiny from environmental groups and regulatory commissions for the quantities of pesticides, herbicides, fungicides and fertilizers that are routinely applied to keep the fairways carpet-smooth and Astro turf-green. Increasingly, golf course architects and superintendents, as well as the USGA, have been forced into an awareness of the need to build new courses and retrofit old ones so that they are environmentally friendly" (Thompson 1993)*

The environmental quality of golf courses in the landscape has been a major concern to both the golf profession and the general public for many years. This section will discuss the growing environmental consciousness in the golf course industry, then illustrate examples of programs in place that provide a foundation which can

used to develop golf courses that work with the environment.

Golf as an environmental problem was first exposed by the public. Original objects where due to chemical, pesticides and excessive water use. (Ling 1993, Tatterall 1991, Tiner 1991) Reaction was meet by scientist, who researched the effects that golf has on the environment, generating a varitey of reports. (Beard 1994, Brandenbur 1994, Cox 1991) The U.S.G.A. Turf grass management magazine and Golf Course Management & Construction: Environmental issues, are key literature examples of this response. The golfing body as a whole was next to reacted to environmental issues. (Miller 1995, Ostmeyer 1995, Brennam 1994) In the late 1980's, individual golf clubs started to adopt programs such as Audubon Cooperative Sanctuary program in an effort to create a better relationship between their golf course and the environment. In the last few years Architects have responded to questions of environmental problems in a positive way. Many architects are now stating that a primary design consideration is the function of the environment. (Andrew 1987, Conard 1992, Whitten 1995, Warbach 1993)

> *"I think we are going to a less manicured look, a greater use of native grasses and cutting down on fungicides. That's the key, creating a minimum of manicured area."*
> *Thomas McBroom*

The relationship between golf courses and the environment is becoming increasingly important. Dr. Michael P. Kenna, Director of the USGA Green Section has noted, "No issue will have a greater effect on the way golf courses are built and maintained, now or in the future. Golf courses have been heralded as sanctuaries and condemned as waste sites, depending on your point of view."

Overall the general public raised the issue of environmental degradation, then there was a response by the golf industry which lead to the successful development of guidelines that aid in the construction and maintenance of golf courses. The United States Golf Association and the Royal Canadian Golf Association have general guideline packages. Federal, province and local government agencies publish a variety of information. For instances, in Canada the Department of Fisheries and Oceans and Ministry of Environment have developed guidelines for when a golf course results in the replacement of ecosystems supporting diverse and productive fish and wildlife populations. The following is an brief outline of existing programs that encourage the integration between golf and the environment.

The United States Golf Association

The USGA was one of the first golfing bodies to implement or suggest environmental policies. The USGA's key environmental message as stated

in thier International Internet Web Site is that golf courses can be developed and managed to protect and enhance wildlife habitat and existing courses can fine-tune management practices to achieve these same goals. The document outlines the following key points.

- Enhancement of plant and wildlife habitat.
- Conservation of endangered or protected species.
- Protection and enhancement of habitat on existing courses.
- Establishment of an integrated pest management program.
- Wildlife consideration in the development of new golf courses.

The most recent program offered by the USGA is the Wildlife Links Program established in early 1995. It represents golf's first comprehensive investigation of the game's relationship with wildlife and its habitat. The project intends to provide critical information on wildlife management issues.

Royal Canadian Golf Association guidelines

> *"Golf course development employing effective principles of environmental design can complement our natural environment. A golf course can enhance urban development and heal scarred landscapes such as former quarry sites."*
> *RCGA Green section.*

The RCGA, the Canadian version of the USGA supports many of the same positions. They have published a set of guidelines of design considerations for Canadian golf courses. Some of the major points include:

- Select plant species that are best suited to the local climate and require the minimum of inputs.
- Investigate the feasibility of alternative or supplemental sources of irrigation water, e.g. on-site storage reservoirs for storm water runoff collection or effluent. On-site retention of storm water runoff should be considered on soils with low infiltration rates.
- Maintain a vegetative buffer zone of at least ten metres adjacent to all water courses to assist in filtering any nutrients or pesticides from storm water runoff and to moderate water temperatures
- Retain as much natural cover as possible and enhance vegetation through supplementary planting of trees, shrubs and grasses, especially along fairways, to provide wildlife habitat and along water courses supporting a fish habitat.
- Incorporate as many natural features and area in the design as possible to minimize disturbance of existing ecology.

Government Environmental guidelines

In 1994, the government of British Columbia published guidelines to protect, maintain and enhance fish and wildlife habitat on and adjacent to proposed golf course developments in lowland areas. Key guidelines include the following.

- All streams must have a leavestrip of sufficient width extending horizontally landward from each bank. All leavestrips should be vegetated with native species of trees and shrubs, existing natural vegetation should not be disturbed.
- In primary undyked streams, utilized directly by fish, the leave strip must extend 15 horizontal meters landward from the high water mark of the stream. For dyked streams the leavestrip extends 15 horizontal metres landward from the toe of the upland side of the dyke. In Ravines leavestrips extend 15 horizontal metres landward from the toe of the upland side of the dyke.
- Secondary Streams in ravines must have a leavestrip extending 9.0 horizontal metres from the top of the ravine bank. In other areas leavestrips extend 9.0 metres landward from the high water mark of the stream.
- Fairways should be situated parallel to streams to reduce the need for crossings and to maintain the undisturbed nature of the covenant areas. Visual pathways must be done by raising the tee, green or both.
- A minimum 10 metre pesticide and fertilizer free zone should be maintained adjacent to the leavestrips associated with all streams and around water hazards.
- Ponds and water hazards, discharging to streams must maintain cool water temperatures. They must discourage excessive growth of submergent aquatics which may result in oxygen depletion via the subsequent decomposition process. They must provide some natural filtering capability of deleterious substances i.e., pesticides, fertilizers via uptake by aquatic vegetation.
- The purpose of design is to maximize use of these wetlands by those wildlife species which utilize aquatic habitats while at the same time recognizing the need, where applicable, to maintain the quality of fish habitat.

Golf Course Management & Construction

One of the most comprehensive manuals on golf course management and construction is written by James Balogh and William Walker. It is an extremely scientific manual geared for superintendents that contains a number of general guidelines. Key guidelines include:

- The introduction and culture of exotic vegetation is generally discouraged. Not only will it be less suitable for wildlife, but it may

be poorly adapted to the area and require more labour and chemical-intense management for its success (NCC 1989)

- Roughs can be made into wildlife sanctuaries. By preserving or maintaining native local vegetation (trees, shrubs, herbaceous plants, and flowers), a rough will become an oasis for endemic wildlife species (Gavareski 1976). This is especially true in desert areas such as the South west (Edmondson 1987).
- Native trees are capable of supporting several hundred different wildlife species, including invertebrates, birds, and mammals. The opposite is often true of exotic tree species (NCC 1989).
- Even dead trees and snags provide vital wildlife habitats in sage areas where they are left standing (NCC).
- The use of integrated management strategies will enable the manager to understand the natural processes which operate within a course (Lieslie and Metcalf 1989).

Audubon Cooperative Sanctuary program

The Audubon society initiated a sanctuary program that promotes ecologically sound land management and the conservation of natural resources. The program provides advisory information services on how to conduct proactive environmental projects for golf courses. The program has seven categories that a golf course can apply for a certificate of achievement. The seven categories include; environmental planning, public involvement, wildlife cover enhancement, wildlife food enhancement, integrated pest management, water conservation and water enhancement. The goal of the program is for golf courses to achieve all seven certificates then they become a Certified Audubon Cooperative Sanctuary course.

By examining these different programs, an understanding of existing environmental issues can be gained. This has direct implication on the form of the golf course and will be demostrated in the final design.

2.5 The Spirit of Place

Above: 13th green at Teton Golf and Country Club, view beyond to Teton Mountain Range, Wyoming. Photo appearing on the USGA web site, 1996.

The Spirit of the game explores two elements. The first is the experiential qualities of the game of golf and the passion that it invokes. The second is a love for the landscape and the sensual qualities that are experienced, intertwining through a landscape.

The thrill of golf provides a rewarding sensation to anyone who plays. The excitement for all players, of any ability, is established by two conquests. The first is the ability to overcome a hazard by positioning a ball next to a target, creating a feeling of triumph. The

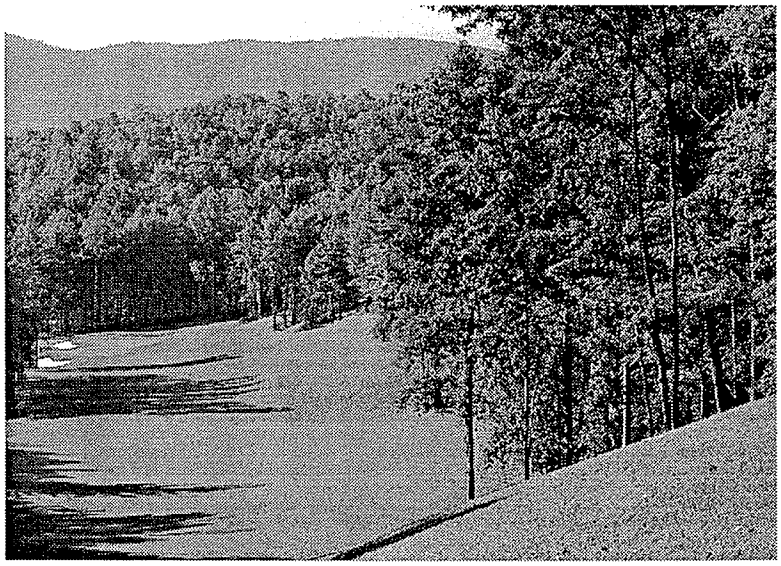
second is match play, where two players engage in one on one competition. The spirit of golf has been emphasized with the advent of the television age. Watching professional golfers stroke the ball with endless effort and incredible precision, inspires every golfer. For anyone playing a round of golf there will be one or two shot's where the target appears impossible, the lie of the ball inconceivable and the odds of success incredible. The excitement is elevated, for the end of the round is near and you are one shot behind your opponent in the proceeding circumstance. To make matters worst your opponent has shot and is on the green. The club is chosen, the line is sited and the club swung. The club rotates around striking the ball and releases off the club face, through the grass and into the air. For a brief moment everything goes silent as the ball travels through the air towards the target. For that moment, the feeling of success and accomplishment propels you to another level as the ball roles onto the green and a few feet from the pin. It is at that moment that makes the whole game worth while.

Above: Deer crossing a fairway. Photo appearing on the USGA web site, 1996.

The second element of the spirit of golf is the ability to draw people into the landscape and allow them to experience it. The extensive area a golf course encompasses often allows for a variety of ecotone(s) to be experienced. During the experience a number of types of flora and fauna will be experienced. Playing through the ecotone(s) allows for a personal connection with the natural environment within the course and beyond to the adjacent surroundings.

Nearing the end of the day, the sun is slowly setting, walking down one of the final holes. The view from tee to green is framed by Douglas fir, western red cedar, hemlock and a variety of other shrubs and herbs shivering in the wind. An eagle gracefully rides the warm air currents as the sun slowly descends beyond the distant mountains. The eye is drawn down the contoured edge of the fairway along the forest stopped only by the low casting sunrays glistening off the pond beside the green. A trout penetrates the skin of microscopic insects feeding on the pond surface. A blacktailed deer breaks the moment moving back towards the sound of the adjacent creek. It is this moment that propels an individual out of the urbane framework of everyday living.

Below: Playing in context, West Wood Plateau Golf & Country Club, British Columbia signature hole. Photo appearing in The Golfer, 1996.



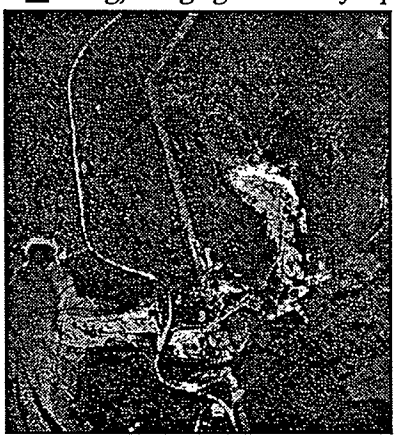
3.0 SITE ANALYSIS

golf course ecology

opportunities of a landscape

"*The site is analysed for fitness to purpose but also in its own right as a living, changing community of plants and animals. Such a community has its own interests. We expect our interests to prevail, yet we must at least consider those of the existing occupants.*"

Kevin Lynch 1984



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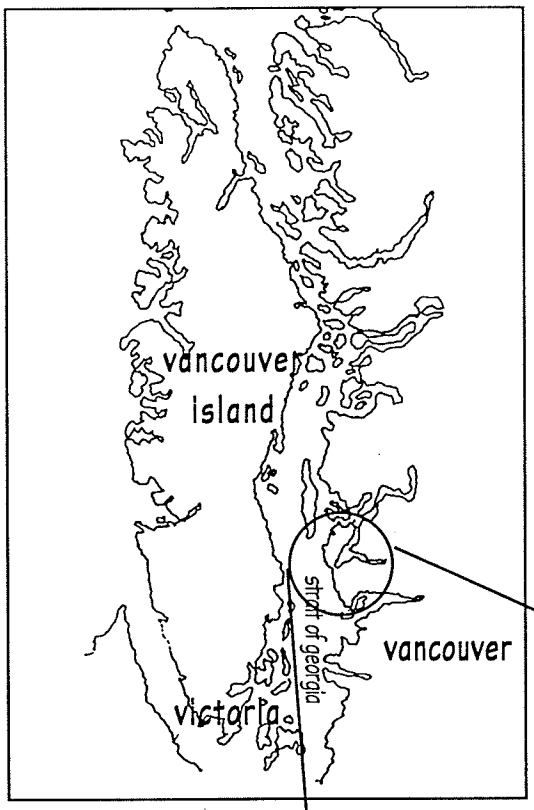


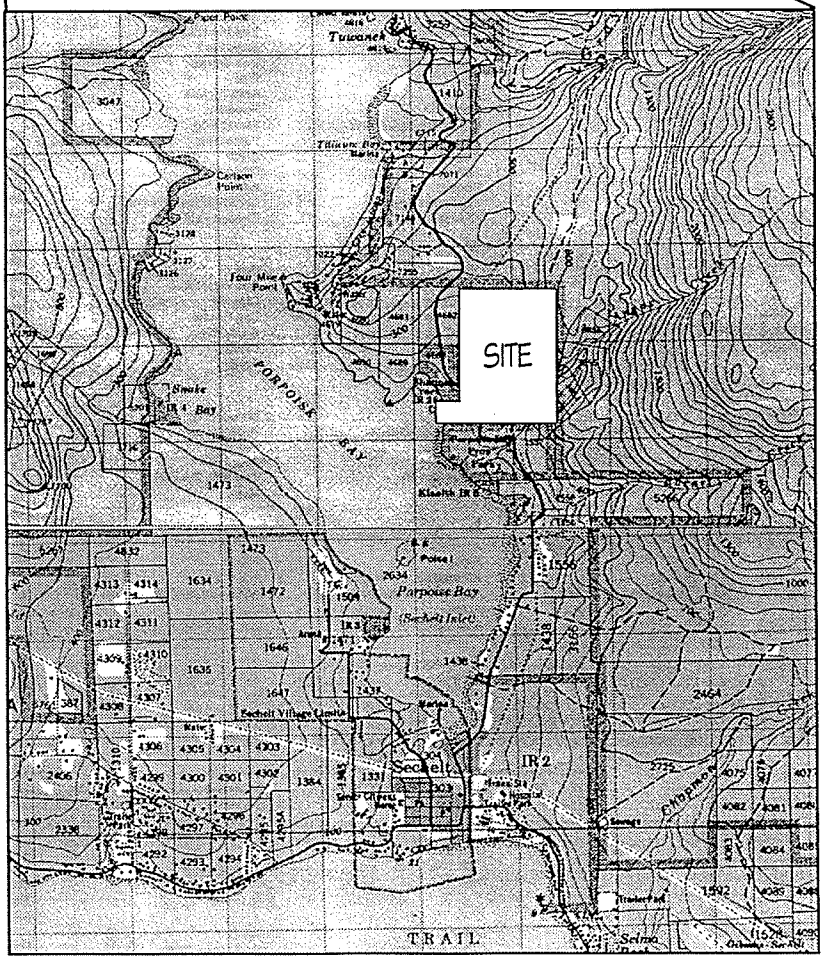
Above: Location of the Sunshine Coast in Southwestern British Columbia.

3.0 Site Analysis

This section analyses the existing site conditions through the exploration of the physical, social/cultural and historical context as well as the physical characteristics and features of the site. In review of the exploration, a list of opportunities and constraints was developed.

3.1 Physical Context

The site is located on Sechelt Inlet road, 4 kms north of the Sechelt Town Centre. The town of Sechelt is located 100 kms north of Vancouver on the Sechelt Peninsula in an area called the Sunshine Coast. The Sunshine Coast a peninsula in the Strait of Georgia is isolated from the Vancouver area by the rugged Coastal Mountains making the only accessible via boat. Sandy Hook and Tuwanek, two small communities are located to the north and East Porpoise Bay (a division of Sechelt) is located south of the site.



Right: Location of the Site in relationship to the Town of Sechelt and Porpoise Bay. Map courtesy of The Surveys and Mapping Branch Department of Energy, Mines and Resources, 1980.

Preceeding Page: Airphoto of the site. Courtesy of Pottinger GahertyEnvironmental Consultants, 1995.

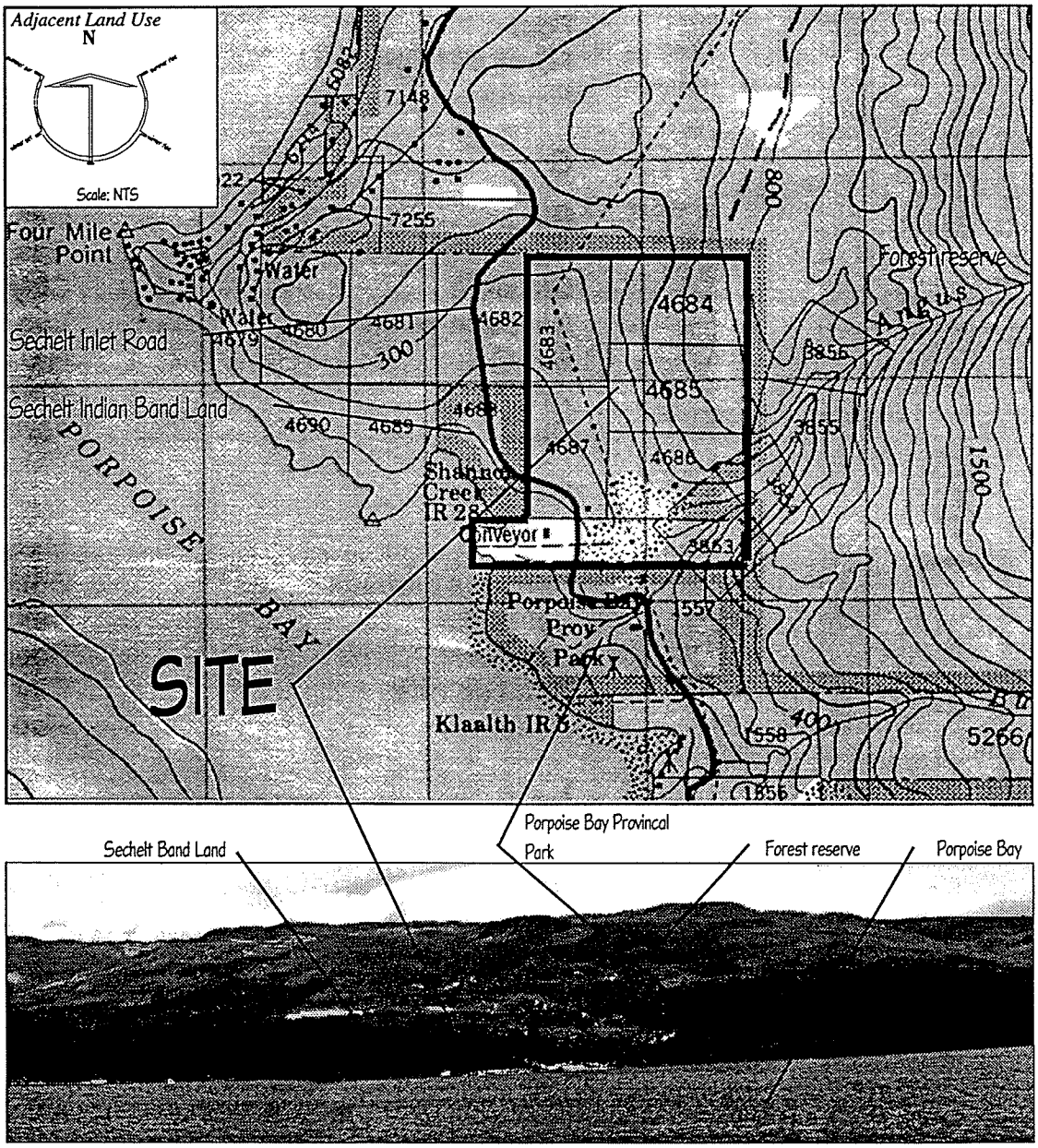
The site is approximately 145 hectares. Ninty two meters (300 feet) of the site is adjacent to Porpoise Bay. Shannon Creek (also called Unnamed Creek and Walter's Brook) traverses the southwest corner of the site, emptying into Porpoise Bay. The mouth of Angus Creek is directly south of the site.

The site is bounded by Sechelt Indian Band land on the western boundary, Porpoise Bay Provincial Park to the south, and a forest reserve on the northeast and eastern boundaries.

The surrounding land use is considered rural in nature.

Below: Map showing adjacent land use. Map courtesy of The Surveys and Mapping Branch, Department of Energy, Mines and Resources, 1980.

FarBelow: View of the site from across Porpoise Bay. Photo by author, 1995.



3.2 Social / Cultural Context

The first human use of the site was trapping and hunting which still occurs to date. Presently fishing occurs in Angus creek. Human settlement has never occurred previously on the site and the Cultural Heritage Resource Inventory System of the Heritage Conservation Branch of the B.C. Ministry of Small Business, Tourism & Culture has no records of significant about this particular site.

Sechelt is primarily a retirement and bedroom community for the nearby metropolis of Vancouver. The current population of Sechelt is 7,000 people and the population of the Sunshine Coast is 35,000. (Pottinger,1995)

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Right: Birdseye view east of Downtown Sechlet, the Straight of Georgia is to the right, Porpoise Bay is to the left. Photo by Author, 1995.

3.3 Historical Context

The entire site was logged 50 to 80 years ago.

B.C. Hydro constructed transmission lines across the site between 1948 and 1964.

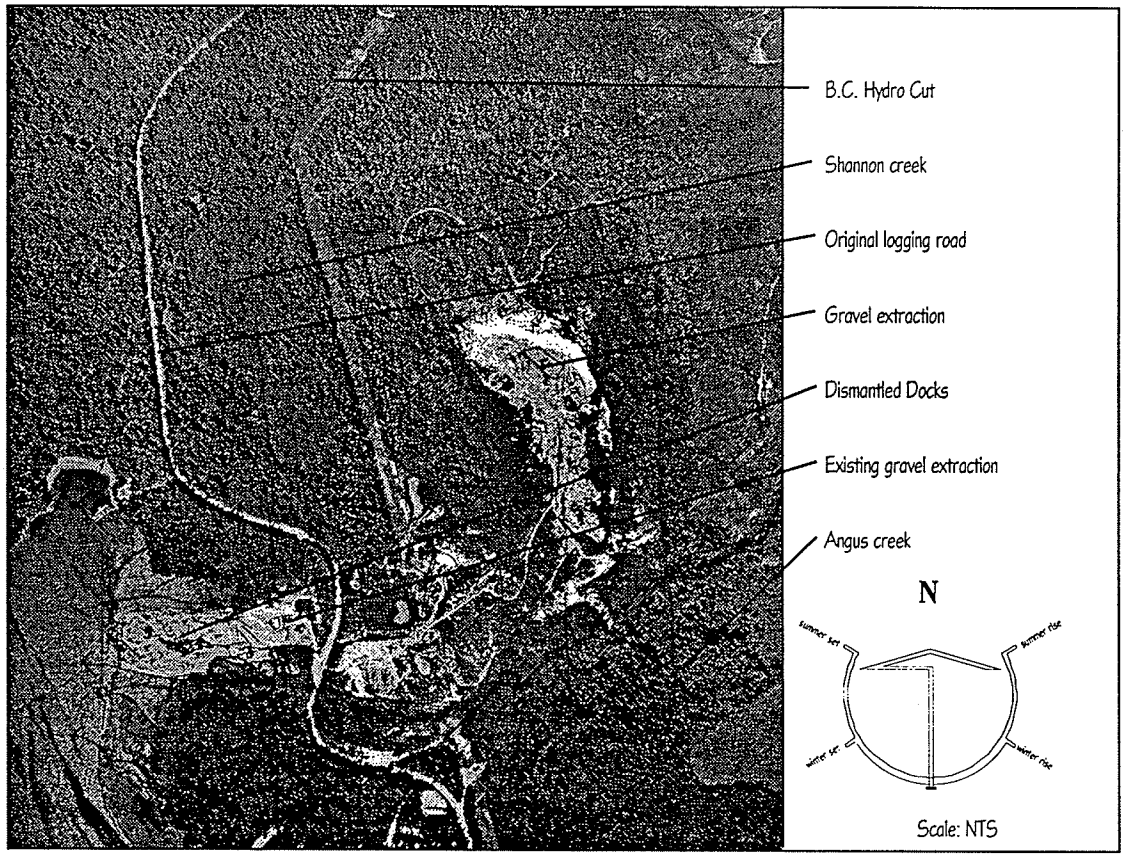
Road access was provided originally by a logging road which was later paved from Sechelt to Sandy Hook.

In the early 1970's, the estuary between Angus and Shannon Creeks was filled for the construction of a gravel process area and dock completed in 1973. Mined gravel was placed on barges in Porpoise Bay with main destinations being Vancouver, Seattle and San Francisco.

Gravel extraction occurred in the central portion of the site until 1993, at which time 10% of the site had been physically altered by mining. Due to the success of a larger gravel facility south of the site, mining was considerably downsized.

Presently, gravel extraction occurs on a small scale in the south west corner of the site. Shipping via Porpoise Bay is no longer feasible. The gravel is used locally for cement and is shipped via trucks.

Below: Airphoto of the site and surrounding landscape showing historical elements. Photo courtesy of Pottinger and Gaherty Consultants, 1995.



3.4 Physical Characteristics & Features

3.4.1 Climate

The climate of this region is that of a typical coastal maritime region. Coastal maritime regions experience periods of high rainfall during the fall and winter seasons and summer droughts. Total average rainfall for the Sechelt region is 1,099.0 mm, with the highest averages occuring in the months of October (122.8mm), November (146.3mm), December (161.6mm), and January (149.2mm). Snowfall is low in the Sechelt region the average is highest in January with an average of 17.8 mm. There are on average 149 days with precipitation. The greatest rainfall in 24 hours occurred in January with a total of 68.1 mm of precipitation. Summer droughts occur during the months of June (51.7mm total precipitation on average), July (41.7mm) total precipitation on average), and August (51.7mm total precipitation on average).

Information for the Sechelt region was based on the Canadian Climate Normals from 1951 to 1980 record at the Sechelt weather station. (Environment Canada, 1980). The station is located at 49° 28 minutes north, 123° 46 minutes west at a height of 23 m above sea level (ASL).

3.4.2 Soil Condition

The majority of the soils in the site are heavy disturbed due to the sand and gravel extraction, roads, transmission line right of way, and other anthropogenic activities. Where sand and gravel extraction occurred there is a lack of topsoil. The top soil that was removed before excavation of the sand and gravel has been stockpile above the Sechelt Inlet Road.

Soil horizon's completed for the Environmental Assessment revealed a thick forest floor over a well-drained and leached silty sand, which is typical of podzolic soils.

Soil productivity is greater at lower elevations and in water-receiving areas.

The site has been rated as class 7 (no agricultural value) within the Canadian Land Inventory System. This is due to the steep topography and the proximity to bedrock.

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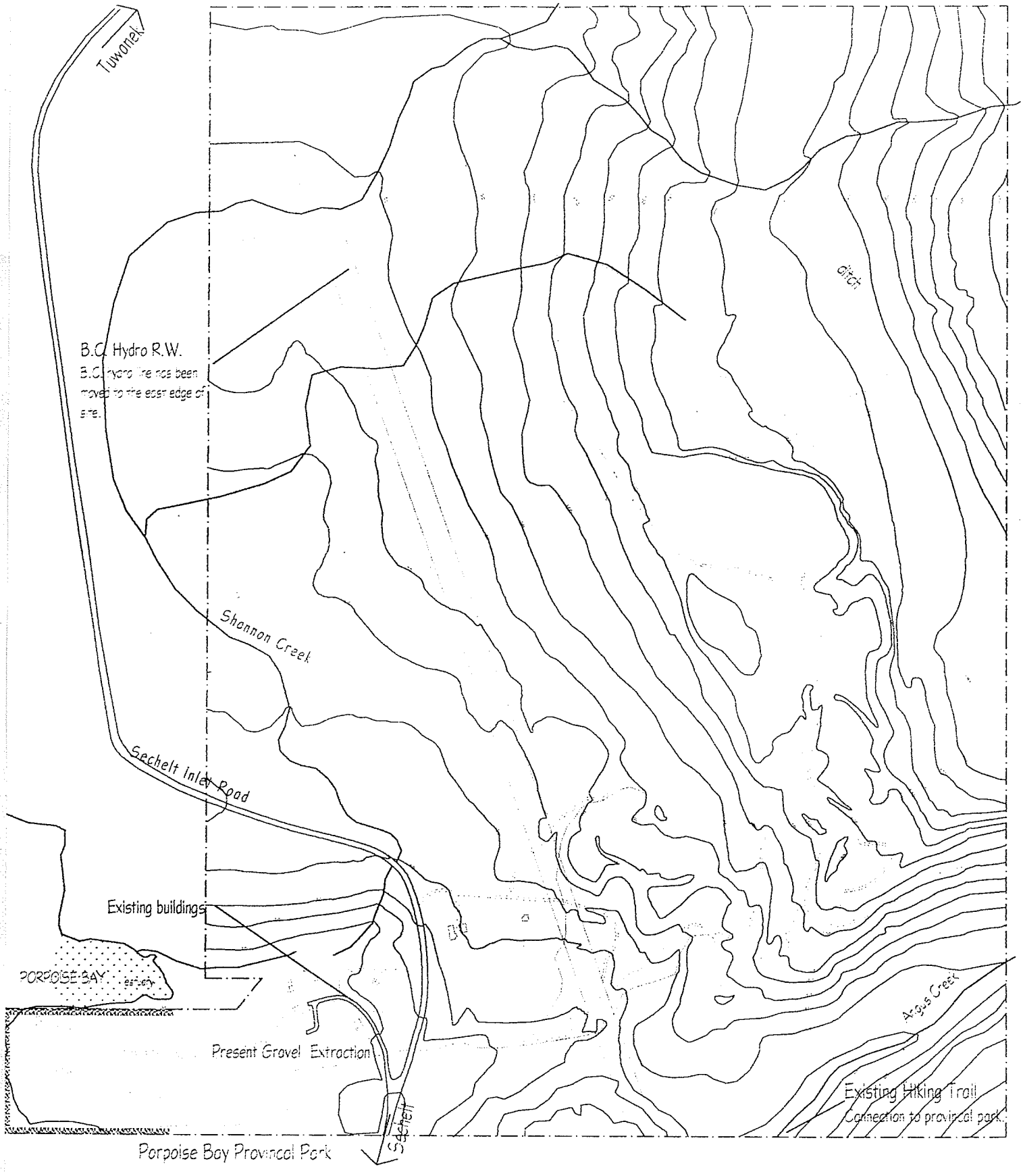
Opposite Page:Existing Land Use.



EXISTING LAND USE

Scale 1:6500

N

LEGEND

Property boundary

Gravel Road / Trail

Sensitive foreshore area

3.4.3 Topography

The existing topography is very dramatic. The lower portion of the site is at sea level and the top portion is at 230 meter. Area's with the greatest slope exist along the Angus Creek ravine, in areas altered by gravel extraction and in the upper north east portion of the site. The north east section and the docking area have the gentlest slope.

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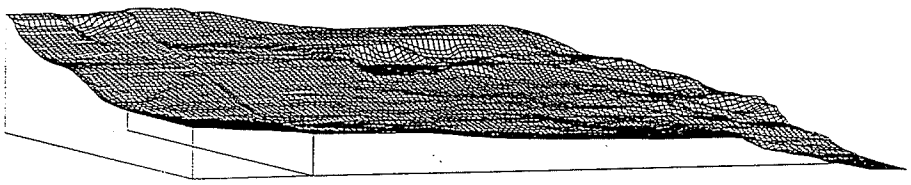
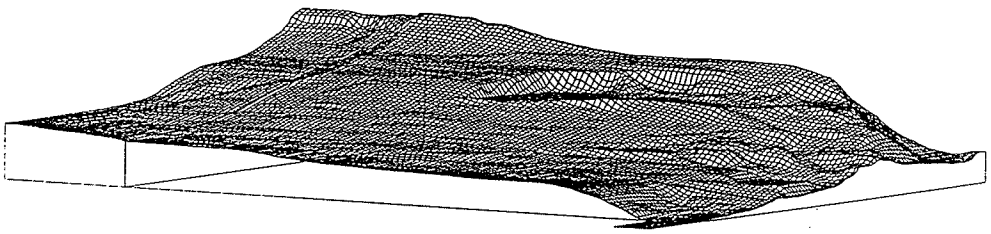
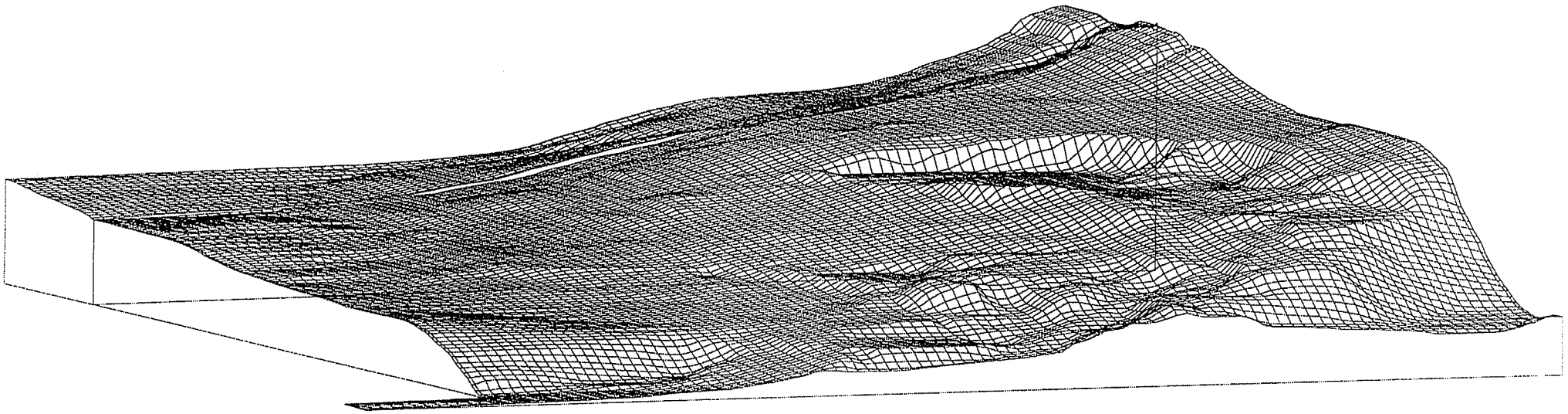


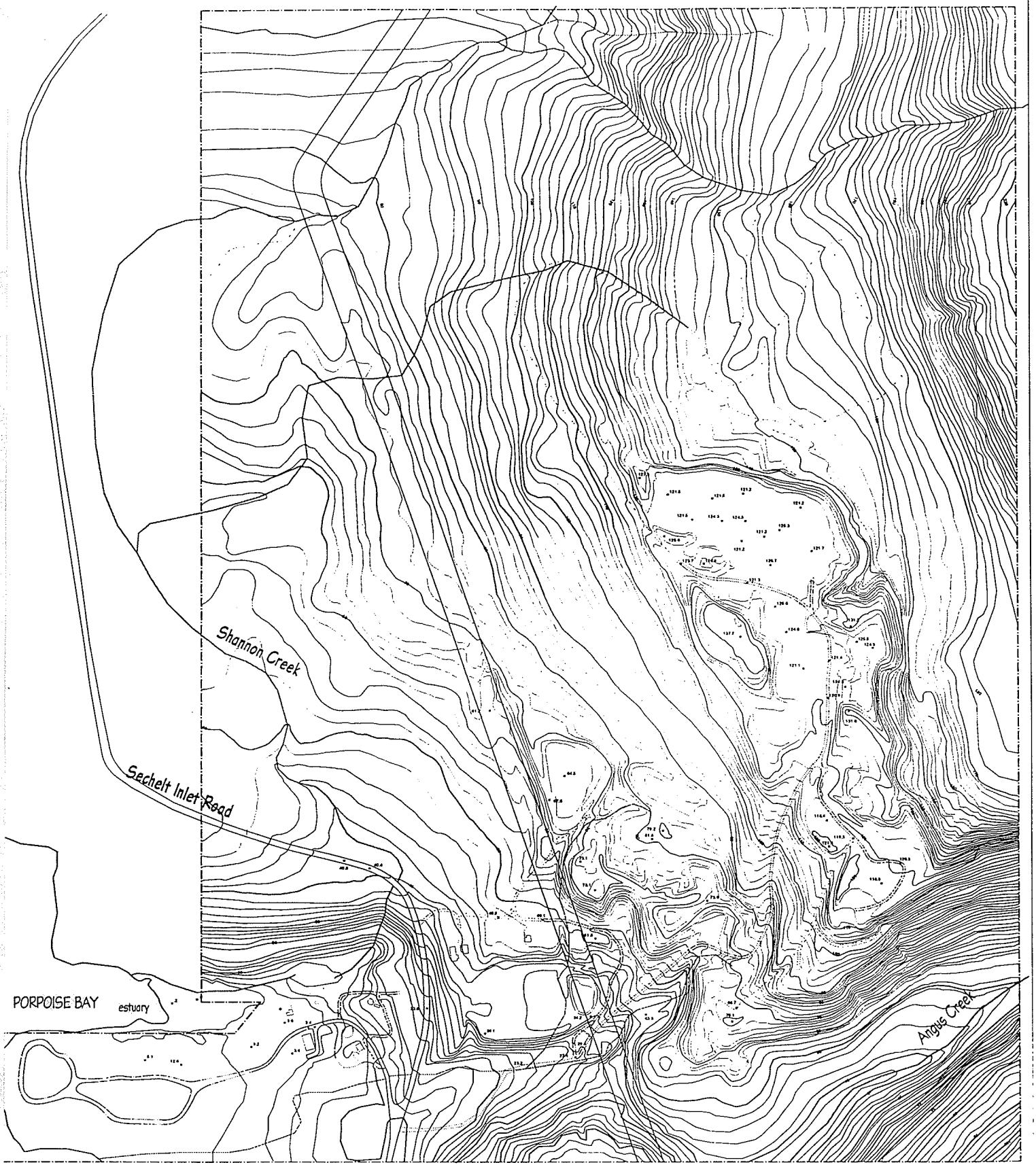
Right: Birdseye view to the south east from Porpoise Bay. n.t.s.

Right: Section viewing east. n.t.s.



Opposite page: Digital Terrian model of site. Birds eye view to the north east. n.t.s.





TERRAIN - TOPOGRAPHY

Scale: 1:6400

Contour Interval: 10 m

feet 0 50 100 200 400 600
meters 0 25 50 100 200

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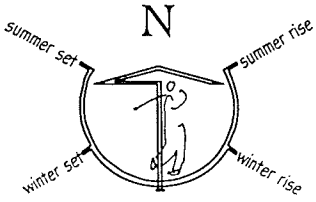

TERRAIN - SLOPE

Scale: 1:6400

Contour Interval: 10 m

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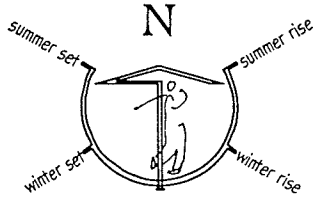
meters 0 25 50 100 200

COMPILED FROM: Base Mapping Corp. Ref. no. 93-1459, Pottinger Gaherty Consultants Vegetative Composition and Terrain Associates Ltd. to water courses.



LEGEND

- 0% - 10%
- 11% - 15%
- 16% - 25%
- 26% - 50%
- over 51%

3.4.4 Views and Vistas

Above: The Straight of Georgia. Photo by Author, 1995.

The extensive topography of this site allows for many unobstructed views towards Porpoise Bay, the town of Sechelt, the Straight of Georgia and beyond to Vancover Island. This view shed facing south-west produces spectacular sunsets when the sun drops behind the adjacent mountains.

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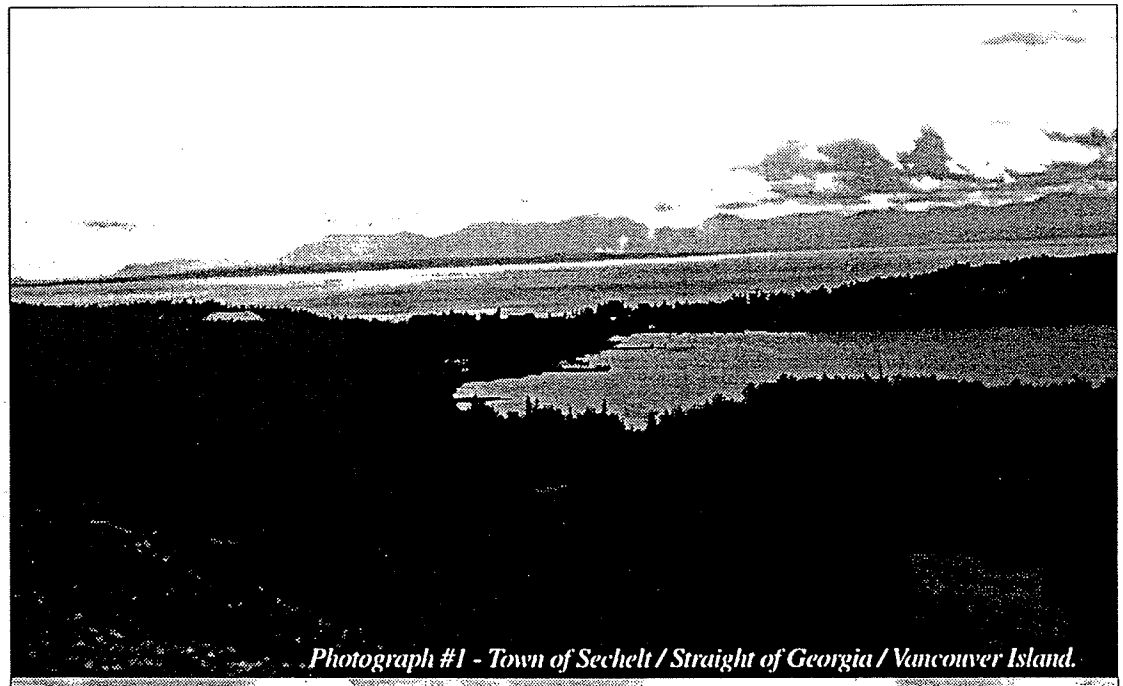
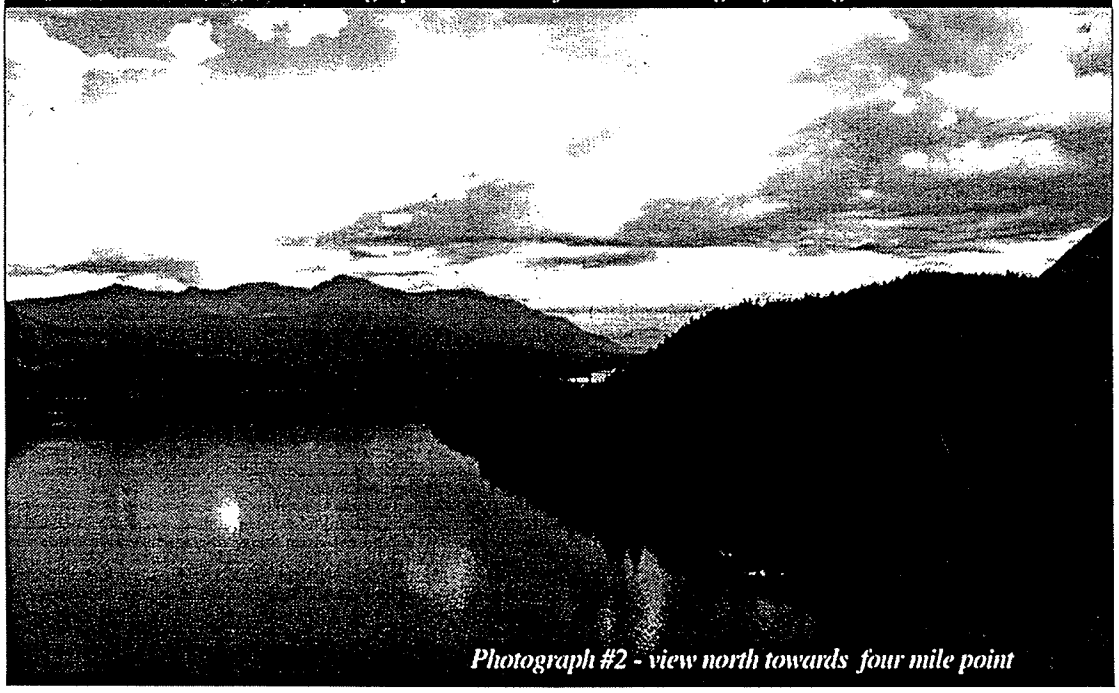
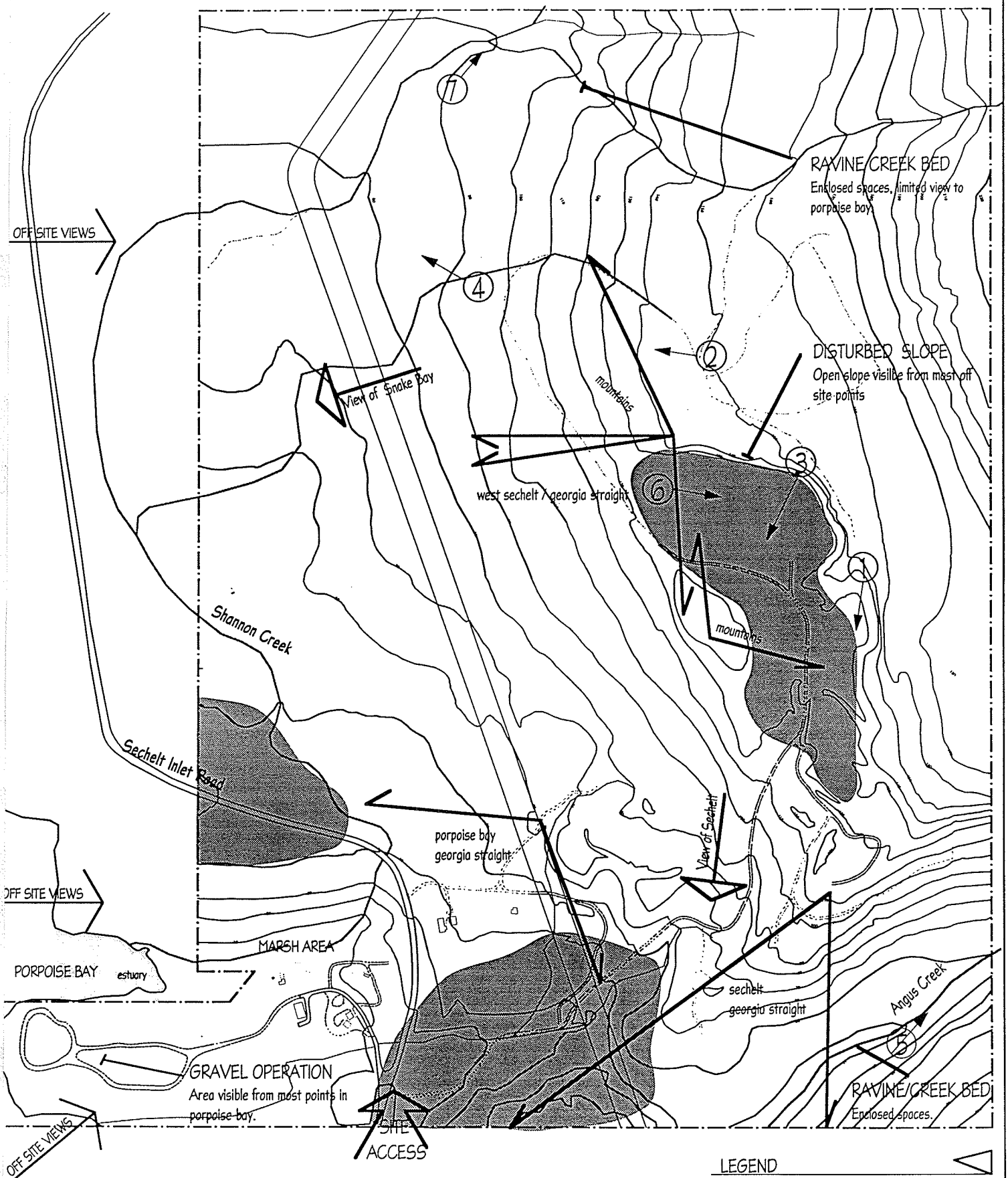


Photograph #1 - Town of Sechelt / Straight of Georgia / Vancouver Island.



Photograph #2 - view north towards four mile point



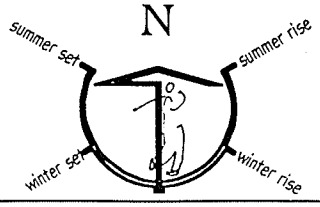
VISUAL IMPACT

Scale: 1:6400

Contour Interval: 10m

feet 0 50 100 200 400 600
meters 0 25 50 100 200

COMPILED FROM : Nadar Mapping Corp., Ref. no. 93-1459, Pamenger Gaherty Consultants Vegetative Composition and monitor Associates Natural water courses.



LEGEND

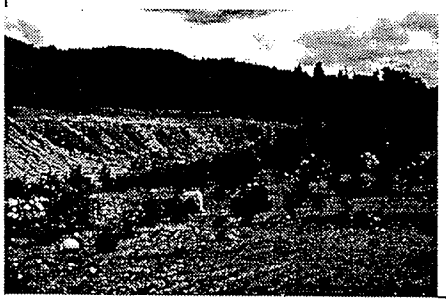
- Major Views
- Possible Views
  From the majority of positions on the site views are set towards Porpoise Bay and the Georgia Straight
- Constricted Views
- (3) Photographs

Views

Above: Photograph #3 - view of Sechelt/West Sechelt and Snake Bay

Above:Photograph #4 - mixed forest

Above: micro-ecosystem on site



Above: Photograph #5 - Angus Creek, viewing upstream

Left: Photograph #6 - disturbed area from gravel extraction

Right: Photograph #7 - Shannon Creek, viewing upstream

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Above: Airphoto of Site. Photo courtesy of Pottinger and Gaherty Consultants, 1995.

3.4.5 Vegetation

The site area is within the coastal western hemlock biogeoclimatic ecosystem zone. This zone experiences the most vegetative growth among British Columbia's thirteen biogeoclimatic zones due to high mean annual temperature, precipitation and long growing season.

The site, as perviously stated was logged between 50 and 80 years ago and due to the rapid rate of succession the site has naturally reforested and is now approaching second harvest. The site is comprised of a number of different stands ranging from young stands (20 to 50 years old) to old stand's 60 to 80 years. The younger stands contain a high percentage of deciduous pioneer tree species (alder and bigleaf maple) and the older stands contain more coniferous species (Douglas-fir, western red cedar and western hemlock).

The five main groupings of vegetation types on the site are Mixed Forest, Deciduous Forest, Coniferous Forest, Shallow Water Wetland, and Disturbed Areas.

The mixed forest occupies the largest area of the site 87 ha (60%). It is mainly located in the north portion of the site. The dominant trees in the mixed forest area consist of Red Alder (Alnus rubra), Bigleaf Maple (Acer macrophylum), Douglas-fir (Pseudotsuga menziesii), Western Redcedar (Thuja plicata) and Western Hemlock (Tsuga heterophylla). Arbutus trees (Arbutus menziesii) are also present, scattered throughout the site. One pure stand occurs adjacent to the site north of the mouth of Shannon Creek. The most common shrubs which form a thick layer under the upper canopy include: Salmonberry (Rubus spectabilis), Vine Maple (Acer circinatum) and Salal (Galtheria shallon). It is to be noted that several mature hemlock trees (Tsuga heterophylla) scattered through out the site are dying from Hemlock Dwarf Mistletoe.

The deciduous forest consists of uniform Red alder *(Alnus rubra)* stands. The Red alder *(Alnus rubra)* comprises 36 ha of the site (25%) with colonized areas where human disturbance was the greatest.

The coniferous forest encompasses 8 ha (5%) of the site and consists of Douglas-fir *(Pseudotsuga menziesii),* Western Redcedar *(Thuja plicata)* and Western Hemlock *(Tsuga heterophylla).* The western hemlock is most dominate with trees being 100 to 120 years old. The stand is located in the southeast corner of the site, above Angus Creek and three locations west of the B.C. Hydro right-of-way. The most common shrubs in this area are: Vine Maple *(Acer circinatum),* Salal *(Galtheria shallon),* Salmonberry *(Rubus spectabilis).* A variety of ferns also appear in the understory. They included Deer fern *(Blechnum spicant),* Swordfern *(Equisetum Spp.)* and Bracken *(Pteridium aquillinium).* The herb layer

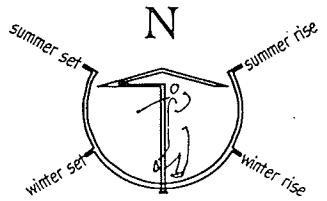
VEGETATION

Scale: 1:6400

Contour Interval: 10m

feet 0 50 100 200 400 600
meters 0 25 50 100 200

COMPILED FROM: Base Mapping Corp. file no. 93-1659, Partridge Gaherty Consultants Vegetative Comission and Hamilton Associates Nature water courses



LEGEND

- MIXED FOREST
- CONIFEROUS FOREST
- DECIDUOUS FOREST
- SHALLOW WATER WETLAND
- DISTURBED AREA

included Bunchberries *(Cornus canadensis)* and Bleeding heart *(Dicentra formosa)*. Mosses and Liverworts were also commonly observed. Step moss *(Hylocomium splendens)* and Oregon beaked moss *(Kindbergia oregana)* occur in the greatest numbers in the herb layer.

The shallow water wetland is a result of the sand the gravel extraction operation. Six ponds, occupying less than 1% of the site (1ha) where constructed for silt management and water retention. The ponds were in use for over a decade by the sand and gravel operation. Three ponds are located west of Sechelt Inlet Road and the other three near the B.C. Hydro right-of-way. Cattails *(Typha latifolia)*, bulrushes *(Scirpus spp.)* and sedges *(Carex spp.)* have begun to grow in the three ponds west of Sechelt Inlet Road and in the one pond east of Sechelt Inlet Road. The other two ponds have dried out and contain no vegetation. Red alder *(Alnus rubra)*, horsetail*(Equisetum spp.)* , blackberry*(Rubus ursinus)* and salmonberry*(Rubus spectabilis)* dominate the banks of all six ponds.

The disturbed areas encompasses approximately 14ha or 10% of the site. In this area significant human disturbance has occurred in the last 5 to 10 years. Area's that experience disturbance in the last 3 to 5 years remain sparsely vegetated. Red Alder *(Alnus rubra)* is the first successional tree to re-vegetate these disturbed areas and is the dominant species. There are a variety of shrubs that have also colonized the disturbed area. They include Nootka rose *(Rosa nutkana)*, Blackberry *(Rubus ursinus)*, Himalayan raspberry *(Rubus discolor)*, Elderberry (*Sambucus racemosa)*, and Scotch broom *(Cytisus scoparius)*. The herbs that where scattered throughout the disturbed area include; White clover *(Trifolium repens)*, Fireweed *(Epilobium angustifolium)* and Pearly everlasting *(Anaphalis margaritacea)*.

The following is a list of the predominant tree, shrub and herb species found on the site.

Trees

Bigleaf Maple *(Acer macrophylum)*

Red Alder *(Alnus rubra)*

Douglas-fir (*Pseudotsuga menziesii)*

Willow *(Salix sp.)*

Western Redcedar *(Thuja plicata)*

Western Hemlock *(Tsuga heterophylla)*

Shrubs

Vine Maple *(Acer circinatum)*

Red-osier dogwood *(Cornus sericea)*

Scotch broom *(Cytisus scoparius)*

Sweet-scented bedstraw *(Galium triflorum)*

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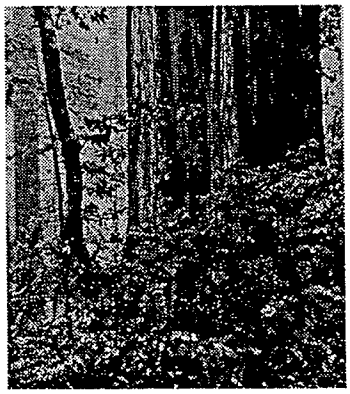

Below: A Western Hemlock ecosystem. Courtesy of The British Columbia Forest Service, 1995.

Salal *(Galtheria shallon)*
Dull oregon-grape *(Mahonia nervosa)*
Nootka rose *(Rosa nutkana)*
Himalayan raspberry *(Rubus discolor)*
Thimbleberry *(Rubus parviflorus)*
Salmonberry *(Rubus spectabilis)*
Blackberry *(Rubus ursinus)*
Elderberry *(Sambucus racemosa)*
Alaskan blueberry *(Vaccinium alaskaense)*
Oval-leaf blueberry *(Vaccinium ovalifolium)*
Red huckleberry *(Vaccinium parvifolium)*
Ferns
Deer fern *(Blechnum spicant)*
Horsetail *(Equisetum spp.)*
Swordfern *(Polysticum munitum)*
Bracken *(Pteridium aquillinium)*
Herbs
Pearly everlasting *(Anaphalis margaritacea)*
Bunchberry *(Cornus canadensis)*
Bleeding heart *(Dicentra formosa)*
Fireweed *(Epilobium angustifolium)*
White clóver *(Trifolium repens)*
Grasses, Sedge, Rushes
Bluejoint *(Calamagrostis canadensis)*
Sedge *(Carex spp.)*
Bulrush *(Scirpus spp.)*
Cat-tail *(Typha latifolia)*
Mosses and Liverworts
Step moss *(Hylocomium splendens)*
Oregon beaked moss *(Kindbergia oregana)*
Lanky moss *(Rhytidiadelphus loreus)*

3.4.6 Water

Ground water flow follows the topography from west to south towards Porpoise Bay. Alterations to the drainage patterns have occurred due to the sand and gravel excavation. A ditch, constructed in the north east section of the site diverts water away from the gravel operation.

The perched ground water was found at depths between 1.5m and 5.1m Water depth was recorded at 7.6m near the foreshore area. An engineering report for this development has suggested that ground water is not an adequate supply for the golf course irrigation and a retention pond should be constructed. (Hamilton, 1994)

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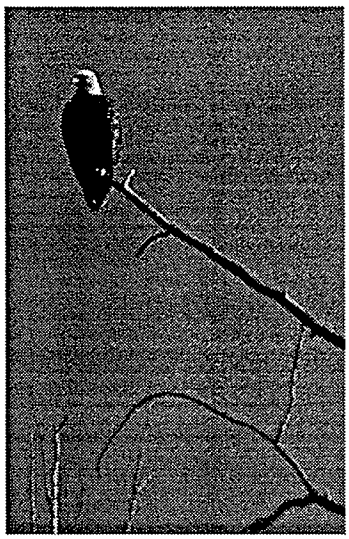


Above:A Bald Eagle perched above a feeding area.

Right: Cougars are frequently sited around Sechelt.

Below: Blacktailed Deer are abundant in the mixed forest area.

Above:Canadian Geese reside in the area for the summer months.

4.4.7 Wildlife

The wildlife is one component that draws people from around the world to British Columbia. The site is no exception, it is home to an abundant array of wildlife. Representative species in this area include: Blacktailed Deer, Black Bear, Cougar, Deer Mouse, Great Horned Owl, Barred, Blue Grouse, Ruffled Grouse, Red-tail Hawk, Hairy Woodpecker, Chestnut-backed Chickadee, Winter Wren, Western Toad, Pacific Treefrog, Red-backed Salamander, Ensatina, Northern Alligator Lizard and the Northwestern Salamander. In the estuarine portions of Porpoise Bay representative species include: Racoon, Mink, Harbour Seal, Bald Eagle, River Otter, Pygmy Owl, Red-throated Loon, Canada Goose, Northwestern Crow, Great Blue Heron and White-winged Scoter.

The following existing wildlife habitat use was derived from the Environmental Assessment report done by Pottinger Gaherty Environmental Consultants (1994). They based the Wildlife Habitat Use on Brown's (1988) habitat model which specifies breeding and feeding area's. The habitat area's are grouped according to vegetation classification.

The mixed forest comprised primarily of red alder and western hemlock/redcedar in the upper canopy and a dense shrub layer potentially supports habitat for: Hutton's Vireo, Nashville Warbler, Rufous-sided Towhee, Blacktailed Deer, California Myotis, Yuma Myotis, Lewis Woodpecker and the Orange-crowned Warbler.

The deciduous forest is comprised primarily of Red alder in the upper canopy and has a sparse understorey providing an ideal area for grazing mammals. The deciduous forest has a moderately high variety of species using this area. Potential species in this area include: Blacked-capped Chickadee, Cedar Waxwing, Downy Woodpecker, Pacific slope Flycatcher, Pine Siskin, Ruffled Grouse, Swainson's Thrush, Western Flycatcher, Bushy-tailed Woodrat, Dusky Shrew, Porcupine, Shrew Mole, Fox Sparrow, Northern Oriole and the Warbling Vireo.

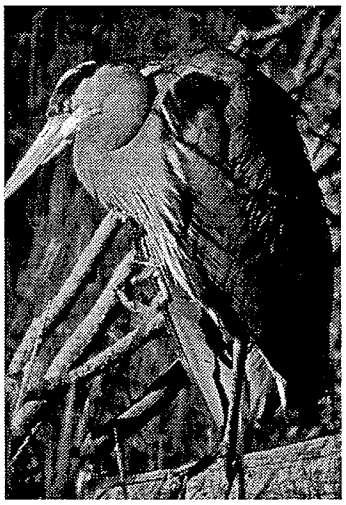
The coniferous forest provides a significantly different trophic structure hence supports a different wildlife regime. There is a high level of plant species diversity, high structural diversity and an

abundant coarse woody debris. The typical wildlife species found in the coniferous forest area's include: Brown Creeper, Chestnut-backed Chickadee, Common Raven, Dark-eyed Junco, Evening Grosbeak, Golden-crowned Kinglet, Hairy Woodpecker, Hammond's Flycatcher, Hermit Thrush, Olive-sided Flycatcher, Pine Siskin, Pygmy Owl, Red Crossbill, Red-breasted Nuthatch, Ruby-crowned Kinglet, Rufous Hummingbird, Sharp-shinned Hawk, Solitary Vireo, Steller's Jay, Swainson's Thrush, Townsend's Solitaire, Varied thrush, Western Tanager, Western Wood Peewee, Winter Wren, Bushy-tailed Woodrat, Dusky Shrew, Cougar, Cinereus Shrew, Fisher, Hoary Bat, Martin, Shrew Mole, Southern Red-backed Vole, Townsend's Chipmunk, Hairy Woodpeckers, Northern Goshawks, Olive-sided Flycatchers and Martens. Tertiary consumers include cougar, deer, bear and raccoons.

Above: A Townsend's Chipmunk found in the coniferous forest's

The shallow water wetlands provides habitat for many smaller amphibians and birds. Typical species include: American Bullfrog, Spotted Frog, Western Toad, American Bittern, Blue-winged Teal, Bufflehead, Cinnamon Teal, Marsh Wren, Red-winged Blackbird, Willow Flycatchers, Bendire Shrew Muskrat and Striped Skunk.

The estuary of Angus and Shannon Creeks have a high habitat value. This area is used extensively by migrating animals during the fall and spring. Typical species potentially using this area include: Northwestern Crows, Mallards, Canada Geese, Sandpipers, Red-legged Frogs, Bald Eagles, Gulls, Pintail, Sanderling, Beaver, Deer Mouse, Mink and Wandering Garter Snake.



Above: The Great Blue Heron is often found feed in the estuaries of Porpoise Bay.

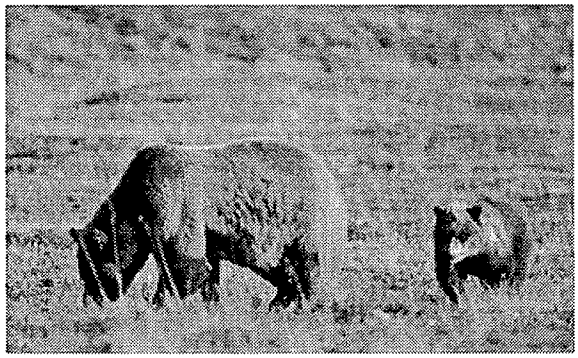
Shannon and Angus creeks provide good riparian habitat area's. This acts as an important corridor for many species of animals and has the greatest amount wildlife potential. Potential riparian habitat includes: American Bullfrog, Dipper, Downy Woodpecker, Ruffled Grouse, Willow Flycatcher, Hoary Bat, Bendire Shrew, Muskrat, and the Western Skunk.

Left:A Pacific Treefrog.

Below: Bear's can be found periodically foraging on the site. All wildlife images on p. 56,57 courtesy of the Corel Draw image library,1995.

Angus creek is the large and more significant of the two tributaries. It supports Pink, Coho and Chum Salmon and Steelhead and Cutthroat Trout.

Through proper design the pleura of wildlife on the site can continue to remain and possible increase in frequency.



4.0 LANDSCAPE ECOLOGY

golf course ecology

opportunities of a landscape

"The ecosystem is emerging not only as a way of sustaining our resources, but as a way of framing our thinking."

Southwick-Trask 1995

4.0 Landscape Ecology

"Until a few years ago, the main factors the developer and golf architect had to consider in evaluation property were acreage, topography, soil, and vegetation. Today, a fifth factor must be included the all-encompassing environmental considerations. These can be so complicated in modern practice that property should only be optioned after environmental factors are fully explored.
Tom Doak 1992

"It costs no more to follow nature than to ignore her..."
A.W. Tillinghast

Perceeding page: A mature coastal western hemlock forest. Photo by The Forest Service of British Columbia, 1995.

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Landscape ecology is a relatively new discipline which merges geography and ecology. Walter Westman in his book Ecology, Impact Assessment and Environmental Planning defines Landscape ecology as "the melding of geographic approaches to land planning with the ideas concerning immigration, emigration and extinction of species between landscape patches that developed from consideration of the equilibrium hypothesis of island biogeography" (Westman 468). General ecology in the past has attempted to analyse ecosystems and how they interact with the environment. Scientific ecology was concerned with individuals, populations, communities, and ecosystems which excluded human population. Landscape ecology examines humans as an integral part of the ecosystem. Forman and Godron define landscape ecology as the "study of the structure, function, and change in a heterogeneous land area comprised of interacting ecosystem types, and the application and use of these principles to formulate and solve problems." Landscape ecology can be used to spatially study the landscape and provide methods by which humans can interact with the environment in a sustaining manor. The intention of this section is to delineate and define the components of a landscape, explore emerging principle of landscape ecology and illustrate how the principles can be integrated into golf architecture and used on the site.

4.1 Landscape Components.

All landscapes share a common structure. Any landscape viewed from an airphoto will reveal distinct patterns. Each pattern is comprised of three major components; patches, corridors and the surrounding matrix. By understanding the structure of a landscape, the components can be arranged so that the function of the ecosystem is strengthened.

Patch

A patch by definition is a nonlinear surface that differ in appearance from its surroundings. Patches differ is size, shape, origin, connectivity and boundary characteristics. In the landscape they are usually plant or animal communities and differ sharply in their persistence. Patch characteristics play an important role in determining the flow of energy, organisms and abiotic factors throughout the landscape. Existing patches in the landscape can be identified by their origins. Forman and Gordon identify the following five types of patches: disturbance patches, remnant patches, environmental resource patches, planted patches and habitations. A disturbed patch occurs from a disturbance in the matrix such as a fire. It is usually characterized by successional vegetation. A remnant patch is a area that originally was part of the surrounding matrix. Through disturbance the area becomes isolated. An example of this is a forest that is cut for farming and a portion of the forest remains but is isolated due to the fields. An environmental resource patch is an area that differs from the surrounding matrix because of the environmental conditions or resources. These type of patches are relatively permanent and patch change is low over time. An example of this is a prairie pothole where hydraulic and soil conditions differ from the surrounding prairie landscape. Planted patches are introduced and maintained by humans. Through a high maintenance regime planted patches retain a homogeneous structure. The greens, tees and fairways on a golf course are considered planted patches. Habitation patches are areas of human settlement. These are areas where natural ecosystems are temporarily removed.

The structure of a patch directly influences the function. The shape and size are key components in determine the type and number of species that a patch will support. Patch size affects biomass, production, nutrient storage per unit area, species composition and

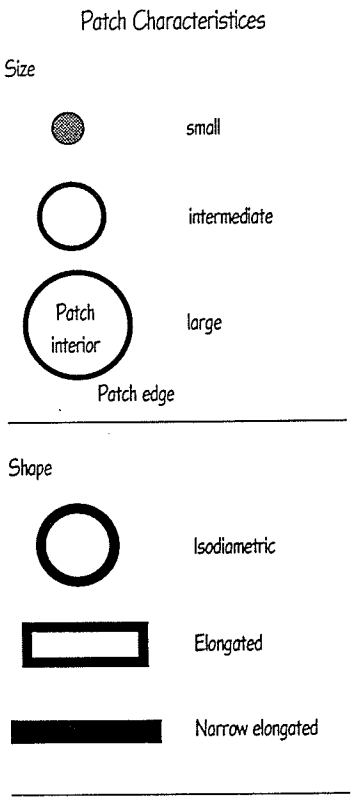
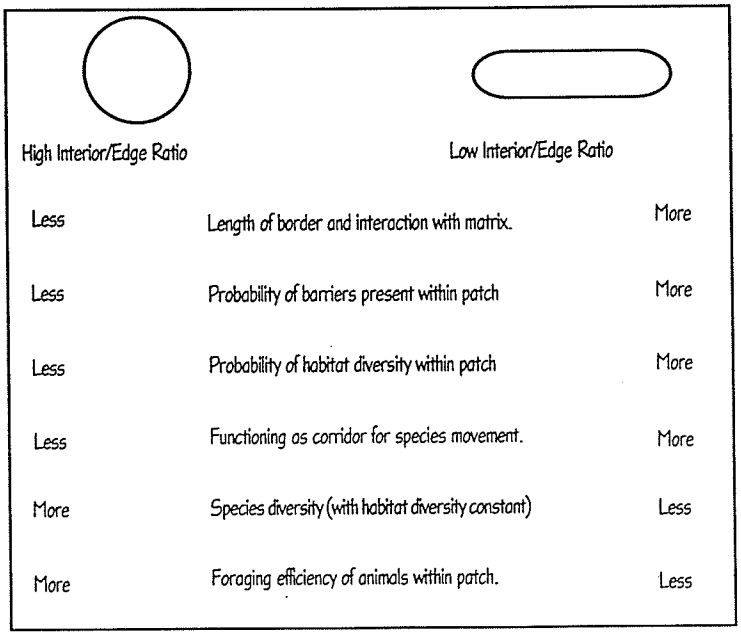


Figure 3.1a: Interior and edge areas as affected by patch size and shape. Source: Forman and Godron, 1986

Figure 3.1b: The interior-to-edge effect on several ecological characteristics. Source: Forman and Godron, 1986.



diversity. The shape of a patch is critical related to the edge effect. (figure 3.1a) The difference in structure between the patch edge and interior effects the species of the patch. Patches that are elongated have a higher number of edge species as compared to Isodiametric patches that contain a great number of interior species. (figure 3.1b) (Forman & Godron 1986) For example a minimal perimeter-to-area-ratio associated with round compact form (with minimal appendages) is characteristic of a form that functions to conserve energy, matter (water and nutrients), and organisms and therefore can be extremely valuable in animal ecology and habitat management. Conversely, a convoluted (highly irregular and dispersed) form is characteristic of considerable interchange of energy, matter and organisms with the surrounding environment which is designated as a high perimeter-to-area ratio. (Tyler 1994)

In golf architecture the fairways, greens and tees compose the human managed disturbance patches. The shape and size of these patches will effect the surrounding environment. The area between these patches can become shapes that increase the ecological function of those areas.

Corridors

Elongated strips of land that differ from the matrix on either side and usually connect patches together are considered corridors. Forman and Godron (1986) define three main types of corridors. (figure 3.1c) Line corridors are narrow strips in the landscape such as roads, ditchs, railways, dikes and hedgerows. They are typical dominated by edge species. Strip corridors are wider bands where the interior of the corridor is of significant size to support interior species. Power lines and pipelines are examples of strip corridor.

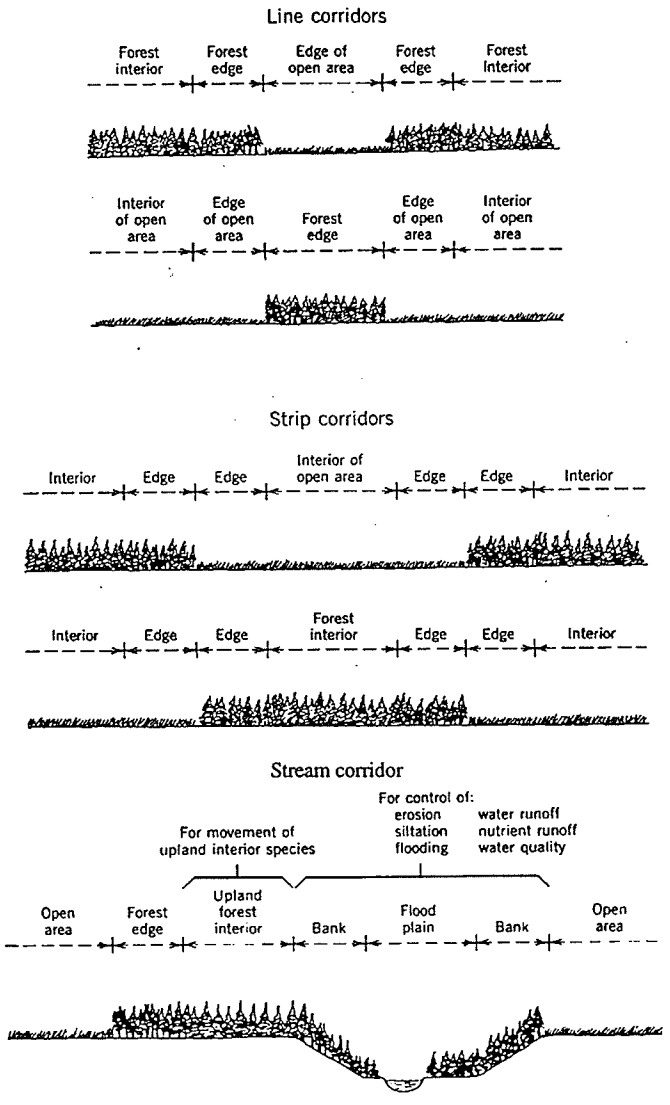


Figure 3.1c Comparison of line, strip and stream corridors. Source: Forman and Godron, 1986.

Stream corridors are bands of water courses. The width varies according to the size of the lotic system. Corridors play an important role providing transportation routes for energy movement through the landscape.

Corridors can be used in golf to connect larger natural areas where the golf patches divide areas in the matrix. Corridors can be used to connect small habitat areas with other habitat units. (Terman 1994) These connections are important between a green and the next tee where areas of native species can be connected to the greater landscape.

Matrix

"How many red spots make a white cow red?
how many clearings make a forest, a prairie?
A score? More? A coalescing core?
A threshold reached? " Forman & Godron

The matrix is the dominate landscape feature in an area. The matrix plays the major role in flows of energy, materials and species. All patches and corridors are embedded in a matrix. The matrix could be considered the greatest landscape unit. Forman and Godron identify three criteria to determine the matrix of a landscape. There are as follows:

a) has a greater relative area than any patch type within it.

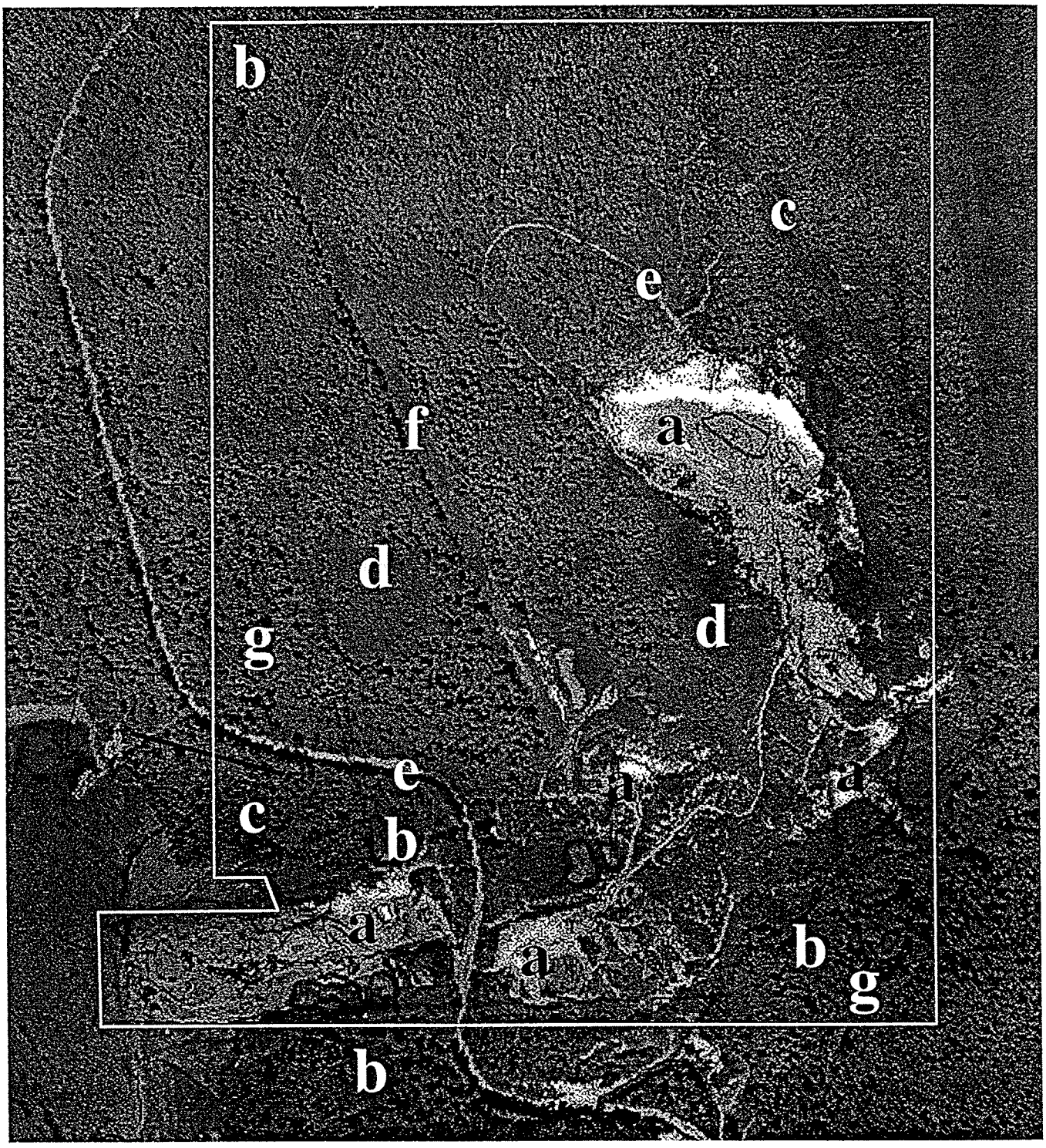
b) is the most connected portion of the landscape.

c) plays a predominant role in the dynamics of the landscape.

Presently the mixed forest comprises the matrix of the site. With development on this site, the matrix should become a coniferous forest with the patches and corridors embedded within it.

Opposite Page: The existing patches and corridors on the site. Airphoto courtesy of Pottinger Gaherty Consultants, 1995

Patch, corridor and matrix are the fundamental components of every landscape. The current site has a structure that contains a variety of patches and corridors embedding in a matrix of mixed forest. The development of a golf course can allow the function of the landscape progresses towards a common structure.



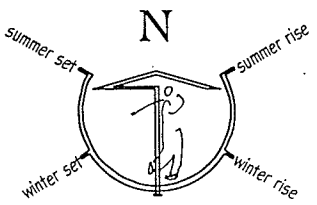
PATCH & CORRIDORS

Scale: 1:6500

Contour Interval: 10m

feet 0 50 100 200 400 600
meters 0 25 50 100 200

COMPILED FROM: Nadir Mapping Corp.: Ref. no. 93-1459, Pottinger Gaherty Consultants Vegetative Composition Associates Natural water courses.



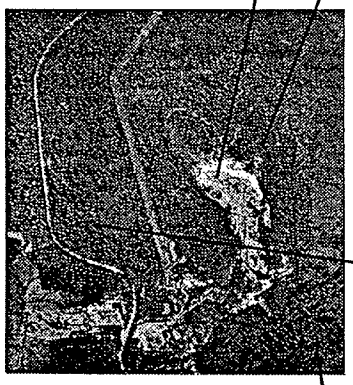
LEGEND

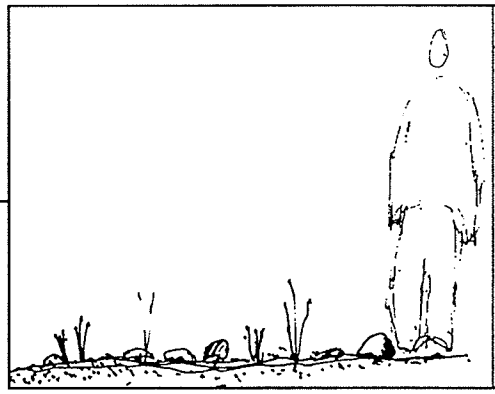
- a Disturbance patch
- b Remnant patch
- c Environmental resource patch
- d Temporal patch
- e Line Corridor
- f Strip Corridor
- g Stream Corridor

Existing Structure

The site presently exists in a number of conditions each represents different ecological attributes. The figures on the right demostrate the existing vertical structure of the four stages in the succession of this site.

The final stage is what the matrix of the site will become. (Diaz, 1993)

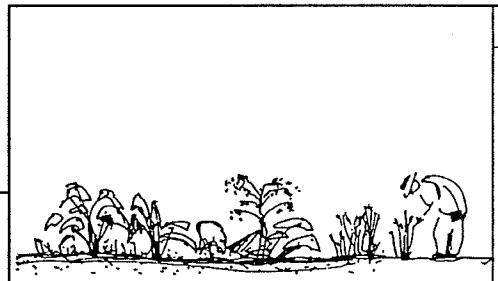




0 - 5 years

Low herb layer

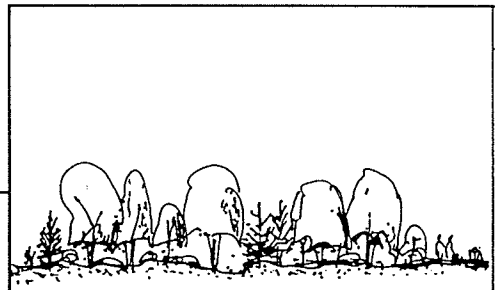
- Dominant vegetation includes: Fireweed, Grasses, Tansy and Herbs.
- Low biomass.
- High rate of energy and nutrient flows.
- Low number of species.
- Low species diversity.
- Overall lack of decomposers, vegetation and consumers.



5 - 20 years

Herb and Shrub layer

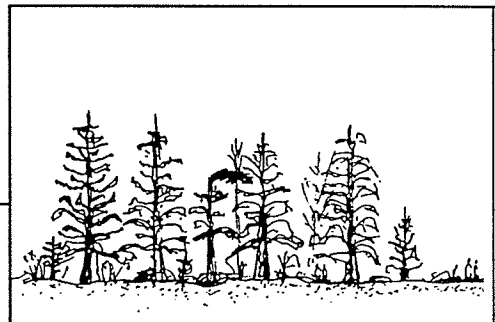
- Dominant vegetation includes: Herbs, Blackcap, Vine Maple and Thimbleberry,
- Increased biomass.
- Increased number of species.
- Increased species diversity.
- Overall increase of decomposers, vegetation and consumers.



20 - 80 years

Herb, Shrub and Tree layer

- Dominant vegetation includes: Douglas-Fir, Vine-Maple, Red Alder and Sword Fern.
- Greater biomass.
- Lower rate of energy and nutrient flows.
- Greater number of species.
- Greater species diversity.
- Overall greater number of decomposers, vegetation and consumers.



80 - 200+ years

Herb, Shrub and Tree layer

- Dominant vegetation includes: Douglas Fir, Western Hemlock, Western Redcedar, Vine-Maple and Oregon beaked moss. .
- High biomass.
- Low rate of energy and nutrient flows.
- High level of species diversity.
- Overall significant number of decomposers, vegetation and consumers.

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4.2 Landscape Principles

Having identified the structural components of the landscape, principles that transform the structure and function can be investigated. Each restructuring principle has direct implications on development of a golf course.

Forman and Godron have suggested seven landscape ecological principles which create change in the landscape. (Appendix C) The following four principles will be used to aid in the structuring of the golf course.

a) Landscape Structure and Function Principle

Landscapes are heterogeneous and differ in the structurally in the distribution and flows of energy, matter and materials among patches, corridors and matrix present. Consequently, landscapes differ functionally in the flows of species, energy, and materials among these structural landscape elements.

In order to increase landscape diversity (and heterogeneity as a result) on the site, a more complex structure will be required resulting in increased biomass and altered flows of energy and matter. Golf architecture has the ability to effect and shape a landscape into more complex structure. If the structure should be altered both vertically and horizontally, there are several physical characteristics that are effected. Direct implications to the golf course are as follows.

Isodiametric patches have greater species diversity and are able to conserve energy and nutrients more efficiently than rectangular patches. Isodiametric patches tend towards a homogeneous landscape where the flows of species, energy and materials are greater in the interior of a patch. Overall, a small edge to interior ratio is good. (Terman,1994)

Designs should be done to maximize natural habitat. This can be accomplished by elevating tee areas so golf shots can be hit over areas of natural habitat. Bird species are a good example of habitat use which depends on the vertical structure of an area. Research shows that the introduction of ground cover usually adds one to two bird species to an area, a layer of shrubs will add one to four species of birds and a tree layer will add twelve to fifteen species. (Wilson, 1974)

The vegetative cover should be at least 70% of the site to allow for rainfall to permeate the soil, enhancing the flow of streams and ground water and reducing water runoff and soil erosion.

b) Biotic Diversity Principle

Landscape heterogeneity decreases the abundance of rare interior species, increases the abundance of edge species and animals requiring two or more landscape elements, and enhances the potential total species coexistence.

The rate of porosity is high on a golf course which increases the

abundance of edge species. If an individual golf hole functions as a patch then the area between golf holes must function as a different landscape unit to increase the heterogeneity of the site. The biotic diversity of this unit must be greater than that of the golf hole.

Biotic diversity is significant for ecotone(s) (i.e. riparian zones) since they are natural habitat for edge species. A key element in building up these area's is to have a diversity of microflora and macroflora in order to recycle plant material. These areas are most useful when they consist of native vegetation and support the characteristic producer (plants), consumers (herbivores and predators and decomposers (small microorganism such as fungi and bacteria) of an area. As previously noted both the British Columbia Ministry of Environment and the Royal Canadian Golf Association have recommendation for buffer zone's adjacent to water courses. Biotic diversity can be increased by retaining as much natural cover as possible and enhancing vegetation through supplementary planting of trees, shrubs and grasses. This is especially important along fairways, to provide for wildlife habitat. Fairways should be situated parallel to streams to reduce the need for crossings and to maintain the undisturbed nature of the covenant areas. Woodlands along streams should be about 80 feet wide to harbour adequate numbers of birds. (Terman,1994)

The shape of the areas between the golf holes is important. Elongated patches with low interior/edge ratios will have greater habitat diversity. Bird species particularly increase in numbers when low interior/edge ratios are present. (Terman, 1994)

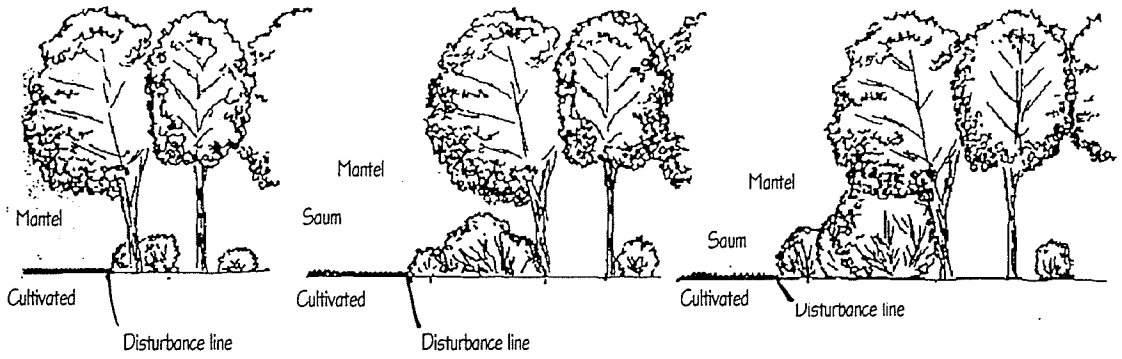
c) Landscape Change Principle

When undisturbed, horizontal landscape structure tends progressively towards homogeneity; moderate disturbance rapidly increases heterogeneity; and severe disturbance may increase or decrease heterogeneity.

This applies to the undisturbed landscape that is not maintained. The successional process of the ecosystem is towards a homogeneitic structure. The coastal western hemlock biogeoclimatic ecosystem is an example of this where the natural succession is from invasive deciduous colonizing vegetation (i.e. fireweed, salmonberry, red alder) to a mature coniferous forest dominant by a few species (Douglas-fir, western redcedar and western hemlock). Without the presence of a disturbance such as fire the stand will continue towards homogeneity.

The other extreme is a site subjected to chronic disturbance resulting in a predominantly homogeneous landscape. This reduces the amount of diversity in a landscape reducing the number of species. If the amount of pedigreed area is reduced then speciation will be greater.

The site should be allowed to develop into a mature western hemlock ecosystem. This implies that no maintenance would occur in the out of



Above, Figure 3.2a: Different edge structures relating the saum and mantel to disturbance line location. The saum is dominated by perennial herbs, and the mantel by shrubs and small trees. Source: Forman and Godron, 1986.

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play areas on the golf course.

d) Species Flow Principle

The expansion and contraction of species among landscape elements has both a major effect on, and is controlled by, landscape heterogeneity.

Increased heterogeneity and biodiversity will result in increased magnitude and decreased velocity of energy and nutrient flows. This results in greater fluctuations in species flow which expands and contracts at a greater rate.

The primary and secondary roughs should be maintained native drought-resistant grasses requiring little water, fertilizer or pesticides. This will allow for an increase of biomass for greater species to develop.

A specific example is the components of good bird habitat include a diversity of native trees, shrubs and grass with song posts, nest sites (boxes and snags) and trees of varying heights and widths. This can be easily created in the unplayable areas. There should be a variety of shrub layers along with good ground cover (litter), dead standing grass and dead logs. (Terman, 1994) This can be accommodated along the fairway edge. (figure 3.2a)

Through the use of these basic principles the landscape can be viewed differently. The entire site should have a high level of heterogeneity, with specific areas not incorporated into the golf patches to develop and progress towards a mature landscape. Overall the principles will consciously aid in the exploration of the site, ensuring that the final design integrates with the landscape.

It should be noted that these principles can be applied specifically to the site, but can and should be incorporated into the larger matrix. This could be investigated in another study about how golf courses can be used as open green space to connect larger areas of natural resources. For example, there is a forest reverse to the west and a provincial park to the south of the site. Angus creek would be considered a significant corridor used to connect larger landscape features. In a land use plan these areas could be used to strengthen the ecology of the existing matrix.

4.3 Opportunities and Constraints

The combination of the site analysis in chapter three with the research information in chapters two and four reveal a number of opportunities and constraints.

Opportunities:

Tee, green and club house placement can capture the view towards Porpoise Bay, the Sechelt area and the Straight of Georgia.

The variety in topography provides opportunity for increased variety of golf holes. The slope is most accommodating in the northwest section of the site.

The upper northeast ridge of the site has accommodating slopes and significant views and should be utilized.

There is great opportunity to increase the carry capacity of Shannon creek. The riparian area has the greatest possibility to act as a corridor, providing a transportation route for energy movement.

Portions of the coniferous forest can be incorporated and retained to maintain existing species stock.

The disturbed area's of the site provide a good starting point for housing.

The wood that is cleared from the golf course can be utilized as biomass to re-establish forest edge conditions and the construction of course features.

Opportunity exist to provide habitat for the various species of flora and fauna abundant in the area.

The need for an irrigation pond creates opportunity to be utilized in the design of specific golf holes. It can also provide habitat for various species of flora and fauna. As well it can act as a settling pond for nutrients before entering Shannon Creek.

Constraints:

Due to the significance of Angus creek, there should be no development within the reach that enters the site.

The Sechelt Inlet road is the main strip corridor. Increased population will subsequently increase the traffic volume. It is best not to have the course cross Sechelt Inlet road. The disturb area west of the Sechelt Inlet road is a prime area for protection and enhancement.

Areas with significant slope that can not accommodate fairway slopes should be utilized for housing.

5.0 THE PROGRAM

golf course ecology

opportunities of a landscape

"I have endeavored to conserve the existing natural features and, where these were lacking, to create formations in the spirit of nature herself. In other words, while always keeping uppermost the provision of a spledid test of golf, I have striven to achieve beauty." Alister MacKenzie, 1934.

5.0 The Program

There are a number of general development considerations for the site. These considerations relate to the programmatic requirements of the project.

The proposed course is to be a semiprivate facility capable of hosting tournaments. The design aims to accommodate golfers of varying ability. As noted in the social/cultural section the general demographics of the Sechelt peninsula are shifting towards a retirement community. It is therefore anticipated that the primary user group of the golf course will be older individuals. Extra precaution has been used so that the design accommodates the general physical ability of this group, not making the course extremely penal. The holes have been routed to not be overwhelming to the high handicap golfer and still provide a challenge to the low handicap player. The four sets of tees will present unique challenges to all calibre golfers.

Previous Page: Opening hole at Champion Hills, North Carolina. Source: The Golfer, 1995

The golf course

This is an eighteen hole golf course. The holes encompasses the three styles of holes; strategic, penal and heroic holes. The strategic style should be utilized most often.

The greens are to be designed large, with an average area of 6500 sq. ft. This gives the low handicap player an visible target to aim for and allows for maximum pin placement reducing compaction.

Four tee areas should be used in an attempt to relate to the topography. The overall size of the four areas will be between 3,000 to 5,000 sq. ft.

The general width of the fairways is between twenty-five to sixty yards. Typically landing zones have been increased in width, this will be demonstrated in the separate holes. The hazards on each hole will be a combination of sand, water and natural forest.

Facilities.

For this golf course to function successfully the following facilities are required:

- A clubhouse and pro shop around 6,000 sq. ft.
- A cart storage area, for twenty five units with area to expand. Parking capacity for one hundred vehicles.
- A practice area, consisting of a large practice green (8,000-10,000) sq. ft. and a larger sand bunker. This is to be located near the proshop and 1st tee.

- A maintenance area, consisting of a 4000 ft^2 building, a fuel storage area and a storage compound for machinery.
- An irrigation pond capable of holding 45,000,000 (US) gallons of water.
- A pump house facility that is associate with the irrigation pond.

Housing

Outside of the golf course area will be a variety of housing types ranging from multi-family to single family. This project will identify the housing areas but will not locate specific units.

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5.1 Routings

Routing is the process of finding the best sequence of golf holes for the site. The organization of the golf course must accommodate the programmatic requirements, the site analysis information and the environmental considerations to produce a rhythmic sequence of golf holes through the landscape. The routing of the course was accomplished at two levels. The first was to define particular elements that would be utilized for all possible routing plans. The second stage was to explore specific combinations of golf holes. This process generated many possibilities of which three are represented. Ultimately the superior routing plan was chosen and developed further in section six.

The progression through the landscape is important. The golfer should experience the variety offered within the site. The lower mixed decidous portion of the site, (Shannon Creek) and the elevation change, in the upper portion of the site, are experienced. The different view sheds have been capitalized by placing the tee facing the particular view.

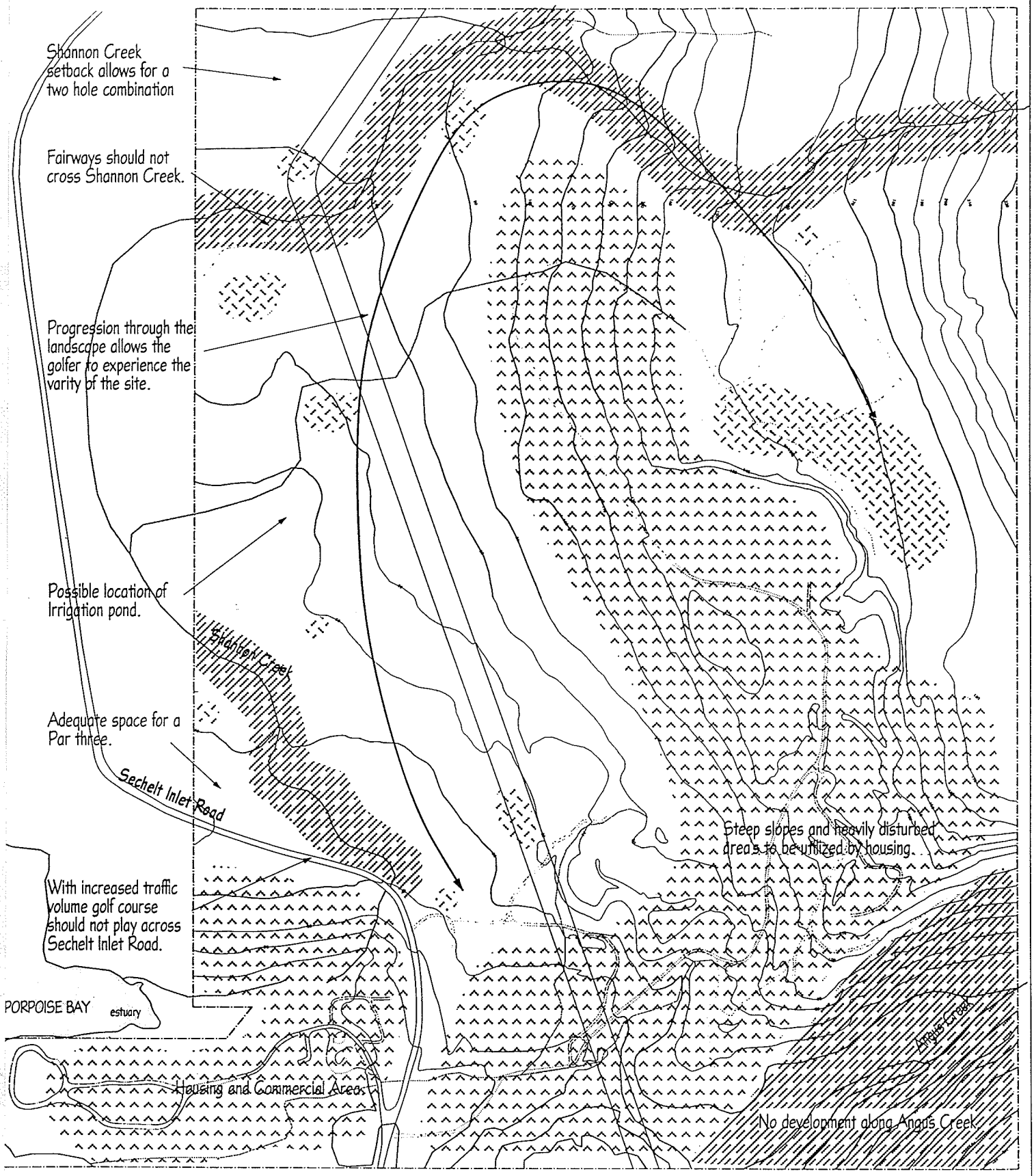
The extensive slope of the site played a large part in the siting of the holes. The area in the north west section contained the most appropriate slope and therefore contains the greatest number of holes. Possible green sites are situated in low sloping areas. The steep terrain has provided possibilities for tee area's to be place significantly higher than the fairway, providing a dramatic back drop for well hit tee shots.

Incorporating the idea of corridors and patches, Shannon Creek is to become a corridor for energy and nutrient flow through the site. This means that the fairways will not cross over the creek and only the cart paths bridge the creek. The area between holes was utilized to created corridors linking larger patches of habitat. These corridors are then linked to the Shannon Creek corridor, making a connection to the larger landscape. Using the British Columbia's guidelines for primary streams, a 15 meter setback was placed on Shannon Creek.

The Hydro right of way is placed within the golf course. Overtime, with the construction of the golf course, the right of way will grow in and become indistinguishable.

The irrigation pond was positioned to collect the flow of an ephemeral stream which intercepts drainage from the upper portion of the site. The area chosen is most accommodating for the excavations of a large pond.

Housing is to be located on the most disturbed and the steepest sloped area's of the site. The disturbed area's provide for a good



GENERAL ROUTING

Scale: 1:6400

Contour Interval: 10m

feet 0 50 100 200 400 600
meters 0 25 50 100 200

COMPILED FROM: Nadr Mapping Corp. Ref. no. 93-1459, Partridge Golterra Consultants Vegetative Consultants and Hamilton Associates Natural water courses.

N

summer set
summer rise
winter set
winter rise

LEGEND

- Property boundary
- Significant Green or Tee site
- No development area's
- Housing development.

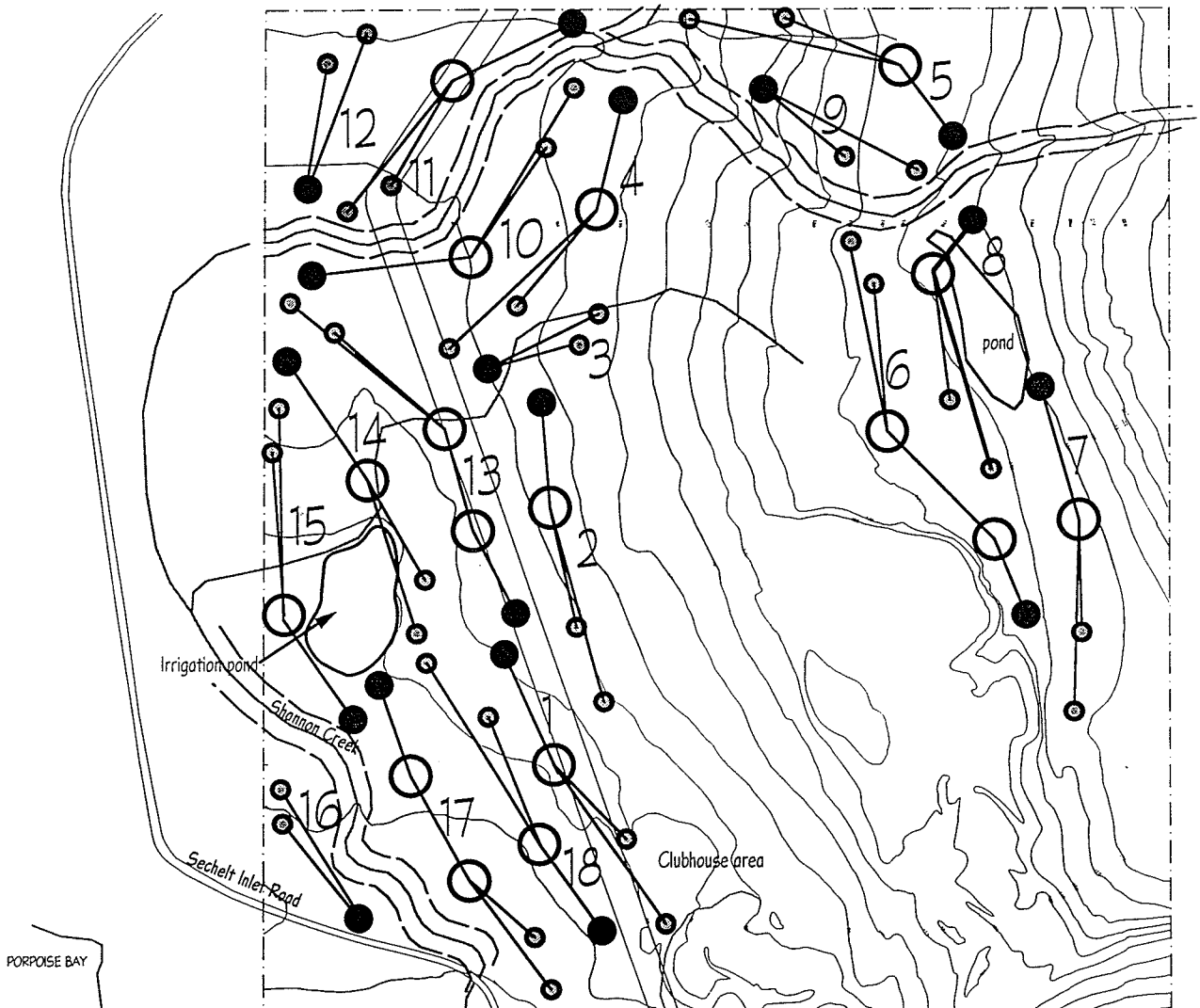
starting point for housing construction.

Using the preceding elements, the development process of each routing plans was to identify possible green sites, significant natural features and possible landing zones. Then working back from the identified greens, the length of individual holes was determined by positioning the tee area's. A scorecard was used to document the lengths of each hole and examine the rhythm of the course.

Each routing plan took into consideration the length and width of fairways, appropriate landing zones and the size of green sites. The routing plan provides the general structure for the golf course. The relationship, dimensions and details of each hole are further explored in the next section.

Routing number one

The first routing is a single loop system, with the halfway house located in the northern portion of the site. The advantage of the single loop course is that the golfer experiences the entirer course with no stops. The holes on the lower portion of the site play predominantly with the slope.



SCORECARD

HOLE	1	2	3	4	5	6	7	8	9	Out
Back Tee	397	380	156	392	376	518	402	335	213	3175
Front Tee	290	284	115	293	263	465	278	240	130	2358
PAR	4	4	3	4	4	5	4	4	3	35

HOLE	10	11	12	13	14	15	16	17	18	In	Out	Total
Back Tee	420	368	203	485	375	403	184	440	403	3281	3175	6456
Front Tee	336	305	141	420	315	345	148	370	304	2684	2358	5042
PAR	4	4	3	5	4	4	3	5	4	36	35	71

ROUTING NUMBER ONE

Scale: 1:8000

Contour Interval: 10m

feet 0 50 100 200 400 600
meters 0 25 50 100 200

N

summer set
summer rise
winter set
winter rise

LEGEND

4 Hole Number

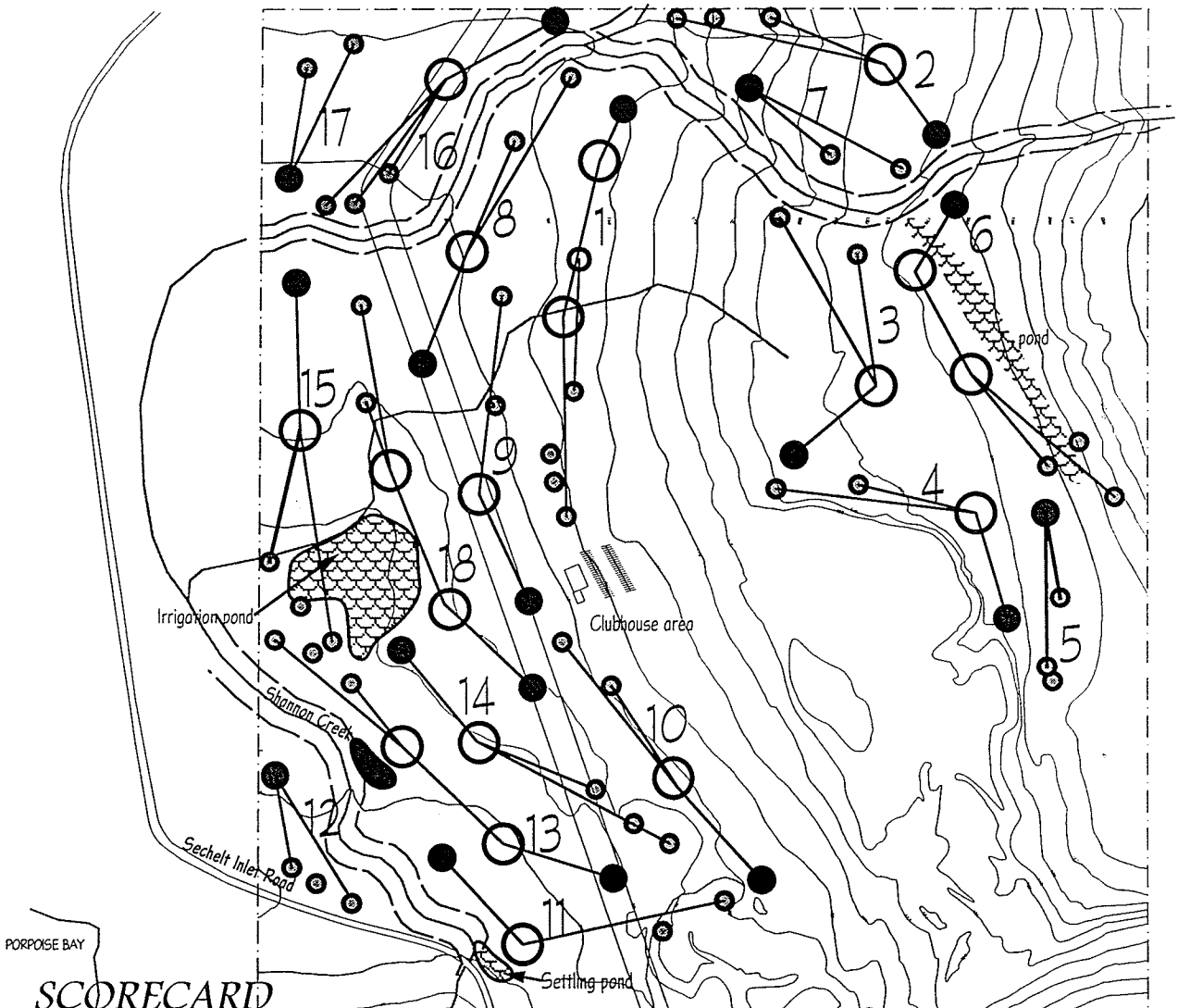
Green location

Tee location

Landing zone

Routing number two

The second routing is a two loop system with the club house located in the middle of the site. The two loop system allows all facilities to be concentrated in one area. Access to the clubhouse is through the housing division. Cross slopes are utilized more often in this layout, specifically on holes 11, 13 and 14.



SCORECARD

HOLE	1	2	3	4	5	6	7	8	9	Out
Back Tee	518	370	375	388	190	476	213	402	395	3327
Front Tee	387	258	300	287	108	392	130	300	261	2423
PAR	5	4	4	4	3	5	3	4	4	36

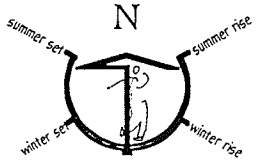
HOLE	10	11	12	13	14	15	16	17	18	In	Out	Total
Back Tee	518	370	375	388	190	476	213	402	395	3327	3327	6654
Front Tee	387	258	300	287	108	392	130	300	261	2423	2423	4846
PAR	5	4	4	4	3	5	3	4	4	36	36	72

ROUTING NUMBER TWO

Scale: 1:8000

Contour Interval: 10m

feet 0 50 100 200 400 600
meters 0 25 50 100 200



LEGEND

4 Hole Number

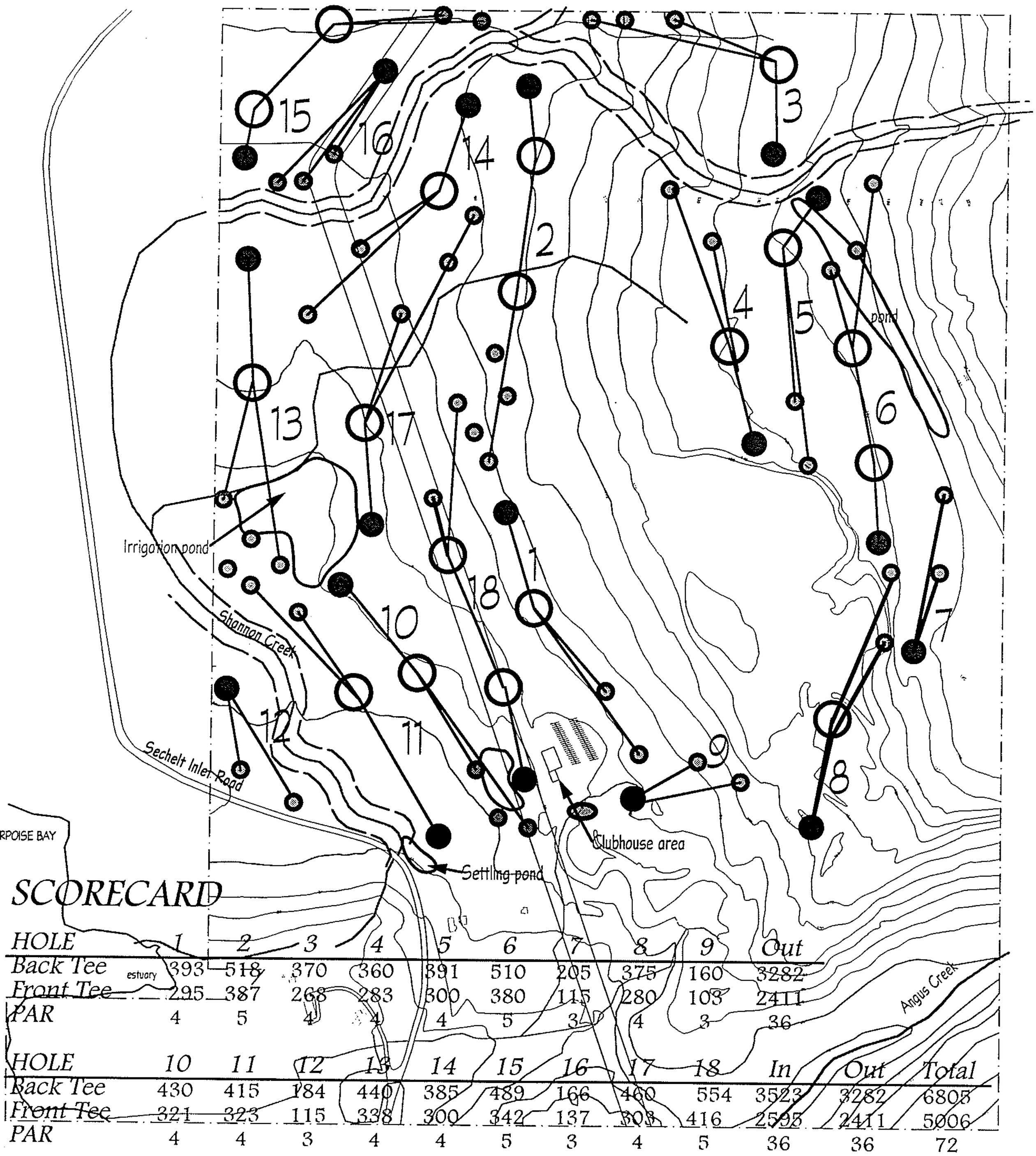
Green location

Tee location

Landing zone

Routing number three

The third routing is a two loop system that plays north to Shannon creek, then east up and across the plateau. The route then loops through the housing on south end of the site and back to the clubhouse. The second loop plays out on the lower northwest portion of the site, crossing Shannon creek three times. The clubhouse, perched above the 18th green and the 10th tee is accessible from the Sechelt Inlet road.



SCORECARD

HOLE	1	2	3	4	5	6	7	8	9	Out
Back Tee	393	518	370	360	391	510	205	375	160	3282
Front Tee	295	387	268	283	300	380	115	280	103	2411
PAR	4	5	4	4	4	5	3	4	3	36

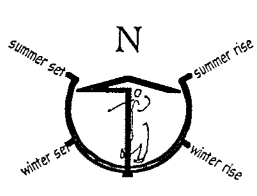
HOLE	10	11	12	13	14	15	16	17	18	In	Out	Total
Back Tee	430	415	184	440	385	489	166	460	554	3523	3282	6805
Front Tee	321	323	115	338	300	342	137	303	416	2595	2411	5006
PAR	4	4	3	4	4	5	3	4	5	36	36	72

ROUTING NUMBER THREE

Scale: 1:8000

Contour Interval: 10m

feet 0 50 100 200 400 600
meters 0 25 50 100 200

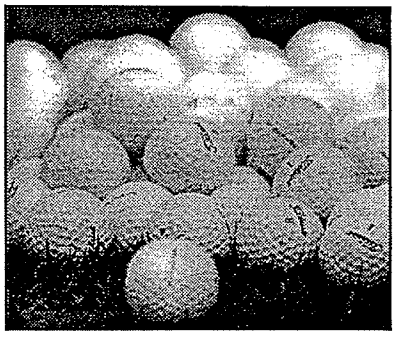


LEGEND

- 4 Hole Number
- Green location
- Tee location
- Landing zone

6.0 THE GOLF COURSE

"Behind every golf hole lies an influence on every golfer's game that few golfers ever contemplate: the course architect. Why a hole dog-legs left and not right, why bunkers end up where they are, the length of a hole, the view from the tee - all these factors and many more are the result of choices made by the golf architect to challenge, and sometimes intimidate, any golfer's game."



Tom Doak, The Anatomy of a Golf Course 1992

6.0 Tsuga Golf Course

This section will describe the elements of the golf course. The first component will be a description of the layout and the general rhythm of the holes. This is proceeded by a description of each hole. The final component will describe specific details of the golf course.

Previous Page: Elements of the game. Source: The Golfer magazine, 1994.

The Golf Course

This is an eighteen hole golf course. The course encompasses the three styles of holes; strategic, penal and heroic holes with the strategic style utilized most often. The course has four sets of tees with the back tee playing to 6959 yards, and the front tee at 4994. There is a challenging distribution of four par threes, four par fives and ten par fours.

The course begins on the moderately sloping western section of the site. The first two holes, a par four and five, play north towards Shannon creek where the vegetation is approaching a mature coniferous forest. The third hole, a short par four, climbs east to the upper portion of the site. Crossing Shannon creek, the next four holes, a par four, four, five and three respectively play in a mixed forest along the upper plateau. Number four, six and seven greens are set on the edge of the old gravel operation, thus exposing golfers to the magnificent views extending beyond the site. The eighth and ninth holes, a par four and three are positioned to play across the slope of the site, bringing the golfer down from the plateau and back to the clubhouse.

The second loop is located on the lower portion of the site. A par four opens the back nine playing out to the irrigation pond. The pond is utilized as a feature on three of the first four holes, number ten, eleven and thirteen. Number eleven and twelve, a par four and three play parallel to Shannon creek on the lowest portion of the site. Two par four holes follow playing slightly up hill to the north. Number fifteen and sixteen, a par five and three are situated in the northwest portion of the site and have been incorporated into the existing coniferous forest. Seventeen is a long down hill par four returning the player back to the irrigation pond. The finishing hole is a par five that plays south back to the clubhouse.

The greens are designed large, with an average area of 6500 sq. ft. All greens are planted with bent grass (*Agrostis palustris Huds.*) and are to be constructed with a 4 inch gravel layer underneath a 14 inch compacted sand mixture. In general, the approach to the green is open to allow a bump and role shot to be played. Classic shapes were employed for the greens. The complexity of the shape and

surface of the greens are derived from the contouring, hazards and relationship to the surrounding environment. This is demonstrated in the detailing of the finishing hole.

On each hole the tee areas have been divided into four areas relating to the topography. The tee area's have been elevated above the fairway to maximize view lines and provide for a native herb layer of vegetation to grow between the tee area and the fairway. This results in the fairway starting away from the tee. The overall size of all four tees on each hole is between 3,000 to 5,000 sq. ft. with the par three tees being slightly larger. The tee decks are constructed of a 4 inch layer of sand on top of the sub base and planted with bent grass (*Agrostis palustris Huds.*).

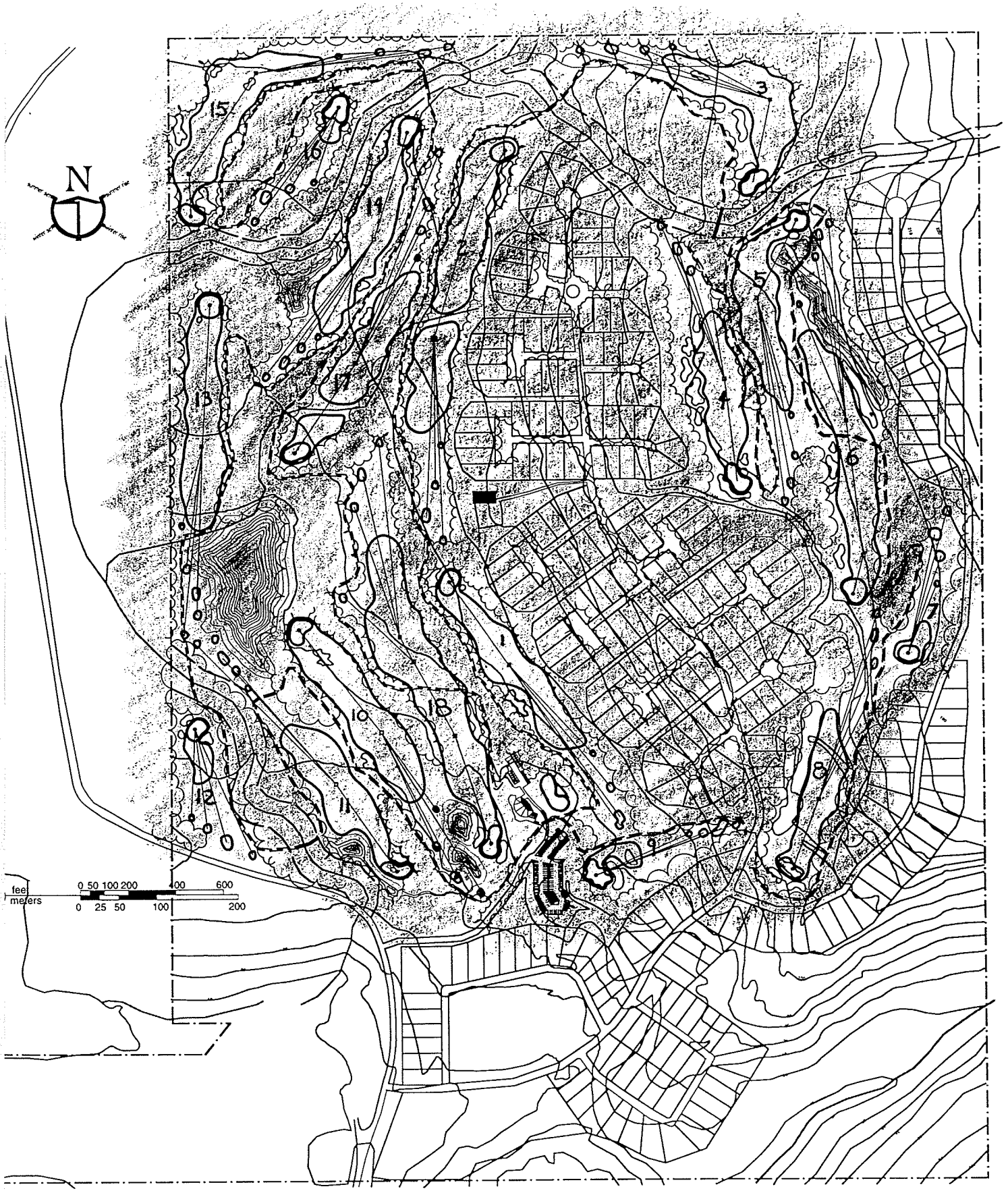
The golf course uses a combination of straight, offset and dogleg fairways with a general width between twenty-five to sixty yards. Landing zones have been increased in width around the 200 yard mark and are predominantly forgiving on the right side of the fairway. The fairways are seeded with Rye grass (*Lolium perenne L.)* on a 4 inch sand/top soil mixture placed on the subbase.

A variety of hazards have been incorporated into each hole to penalize, threaten, direct or entice the golfer. Hazards have the highest penal value from the back tee and the least from the front. Holes which require a golfer to hit over a hazard from the tee, have been designed with a forward tee that either negates or plays over a portion of the hazard. The relationship of the hazards to the green will become more apparent in the detail of each hole.

The main ecological resource on the golf course is the Shannon Creek corridor. Fairways have been situated parallel to Shannon Creek, allowing the vertical structure of the creek to remain undisturbed. With no development in the reaches of the creek the area is allowed to become a stream corridor. Habitat areas between the holes are connected to the Shannon creek corridor. Left undisturbed, the areas between the holes will overtime increase in homogeneity. The increased biomass in the corridors will slow the flows of energy and matter from the site allowing a complex structure to develop that supports a variety of species.

Areas between the tee and the fairway and in the rough will comprise of a native herb layer. The edge of the fairway has been detailed to allow for a natural progression from the fairway to the forest. Native vegetation is allowed to grow in all areas outside of the fairways, tees and greens.

Three layers of vegetation have been provided where settling ponds enter Shannon Creek to maintain cool water temperatures.



TSUGA GOLF COURSE

Scale: 1:6500

Contour Interval - 2m

COMPILED FROM: Slide Mapping Corp. Ref. no. 93-1139, Bolinger Gilkey Consultants Vegetation Composition and Hamilton Associates Natural water courses

Facilities

The clubhouse and proshop are perched above the 18th green and 10th tee, maximizing the view towards Porpoise Bay. This area is accessible via the Sechelt Inlet road. Parking is located south of the clubhouse and has a capacity for one hundred vehicles. The cart storage area is located to the north of the clubhouse.

The practice area, consisting of a large green (9000 sq. ft.) and sand bunker is located east of the clubhouse between the proshop and the first tee.

A maintenance area, consisting of a 4000 sq.ft. building, a fuel storage area and a storage compound is centrally located between the first and second hole.

The pump house facility is located east of the irrigation pond.

Housing

Housing has been situated in the middle of the golf course along a central spine. A cul-du-sac form was utilized to maximize the number of houses adjacent to the golf course.

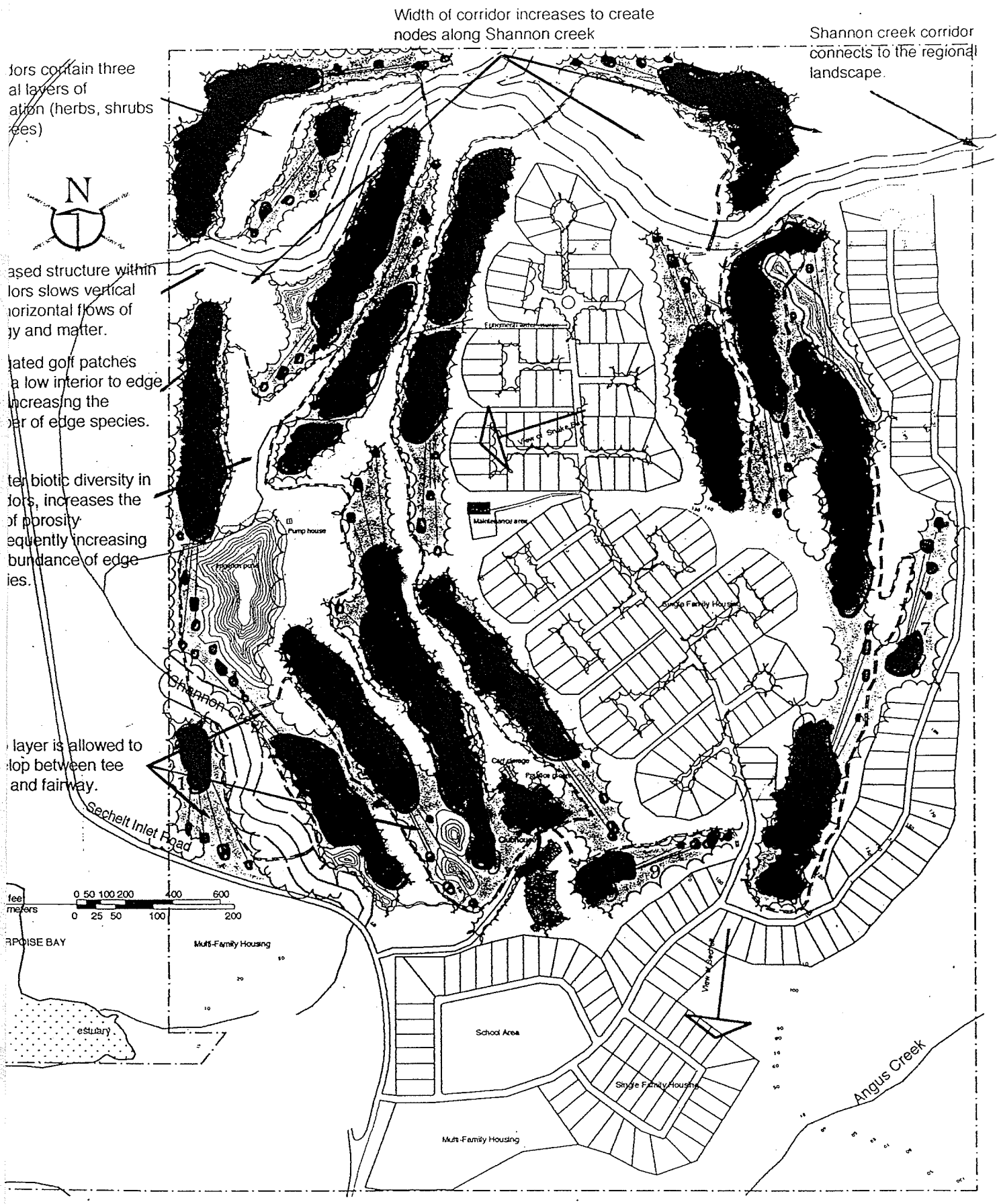
Facing Page: Layout plan for the golf course.

Proceeding Page: Plan illustrating the connection of habitat areas between golf holes to the Shannon creek corridor.

The Scorecard

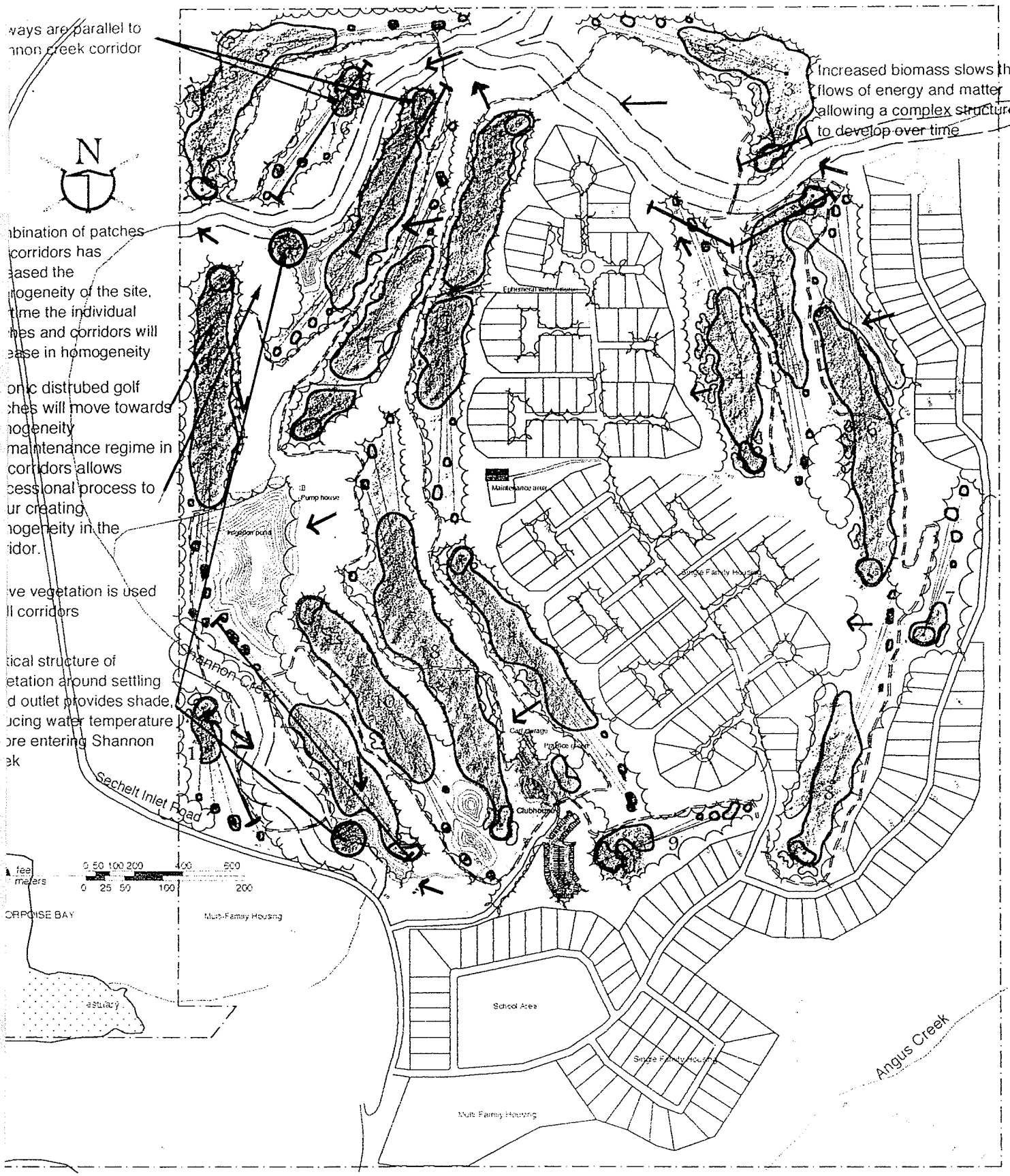
Hole	1	2	3	4	5	6	7	8	9	Out
Gold	405	556	380	366	403	511	161	368	202	3352
Sliver	395	522	340	332	378	496	155	342	181	3141
Bronze	355	480	300	301	341	469	130	308	155	2839
Copper	305	426	265	253	286	410	103	250	136	2434
Par	4	5	4	4	4	5	3	4	3	36

Hole	10	11	12	13	14	15	16	17	18	In	Out	Total
Gold	420	415	188	453	393	489	194	454	564	3570	3352	6922
Sliver	399	375	160	424	361	481	157	385	532	3274	3141	6415
Bronze	352	350	136	361	332	451	131	350	494	2957	2839	5796
Copper	307	323	120	304	306	401	108	314	436	2619	2434	5053
Par	4	4	3	4	4	5	3	4	5	36	36	72



TSUGA GOLF COURSE

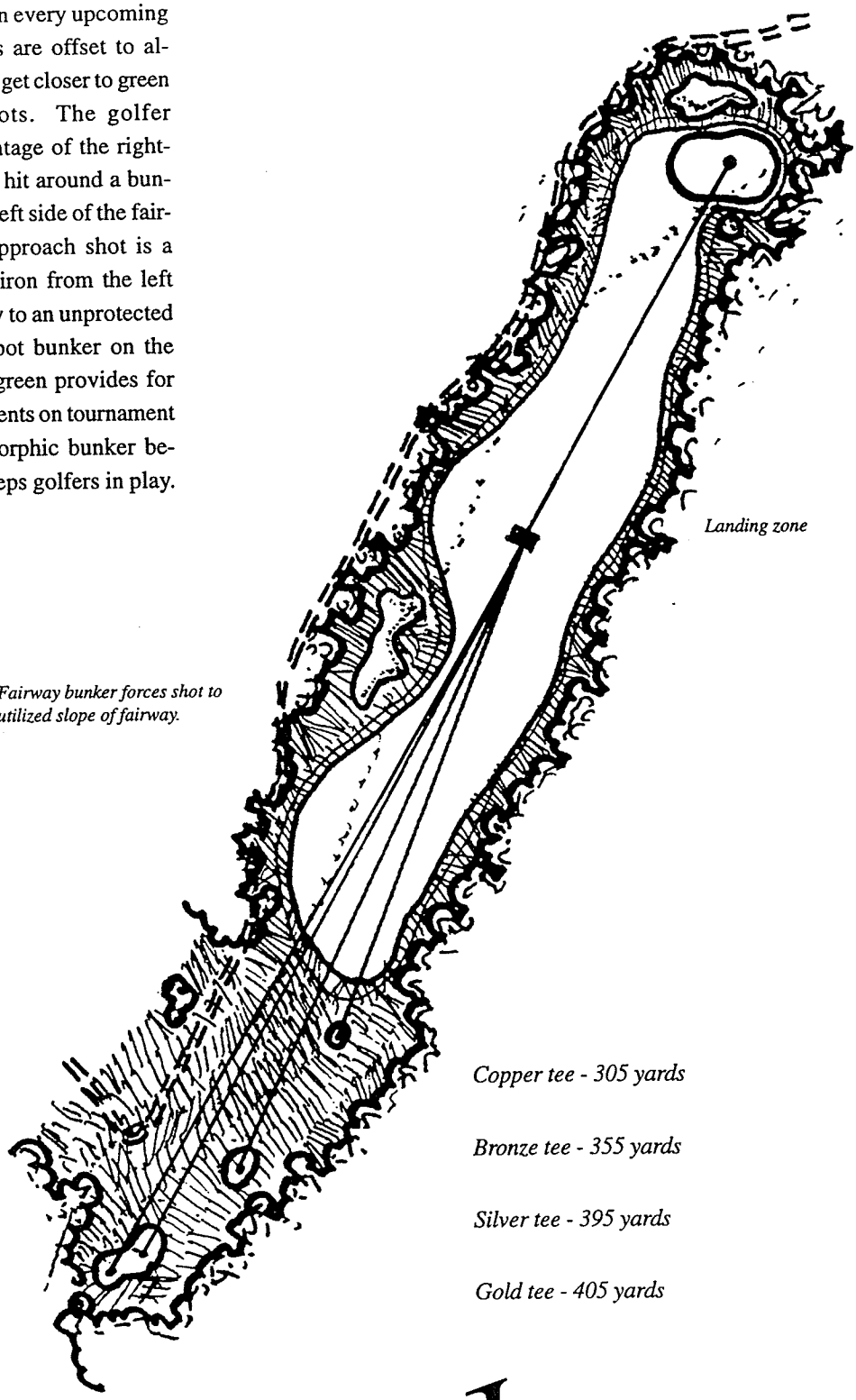
Scale: 1:6500



TSUGA GOLF COURSE

Scale: 1:6500

he opening hole is a straight par
ur. As utilized on every upcoming
ole, forward tees are offset to al-
w short hitters to get closer to green
r approach shots. The golfer
ould take advantage of the right-
ft cross slope to hit around a bun-
er placed on the left side of the fair-
ay. The best approach shot is a
hort to medium iron from the left
ide of the fairway to an unprotected
reen. A small pot bunker on the
ight side of the green provides for
arder pin placements on tournament
ay. A large amorphic bunker be-
ind the green keeps golfers in play.



Two teired green tilted towards the fairway.
Small pot bunker gaurds front of the green.

Green size 6300 sq.ft.

Landing zone

Fairway bunker forces shot to utilized slope of fairway.

Copper tee - 305 yards

Bronze tee - 355 yards

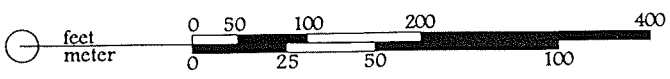
Silver tee - 395 yards

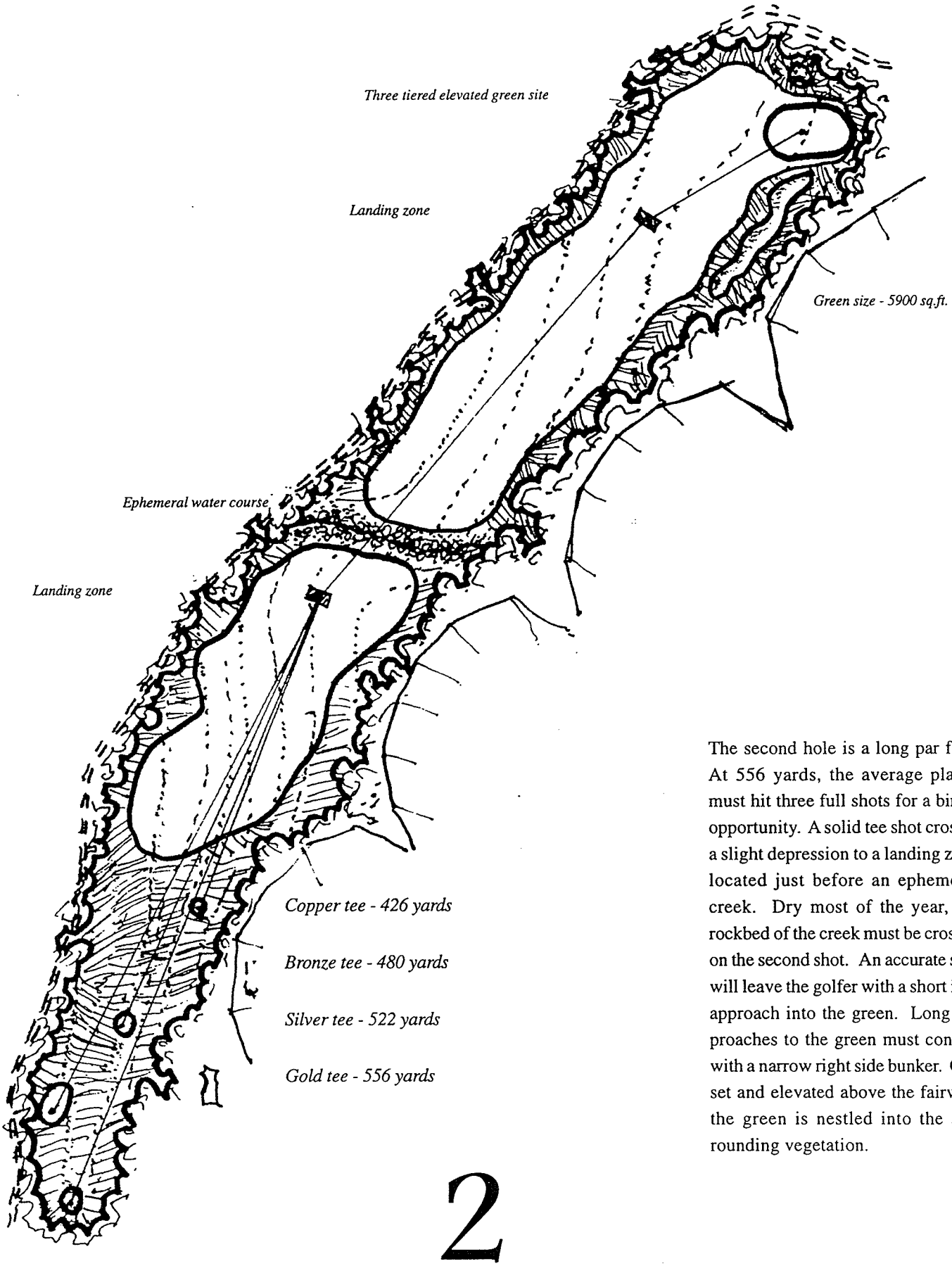
Gold tee - 405 yards

1

Par 4

Contour Interval - 2m



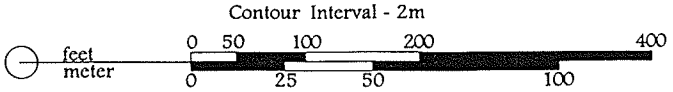


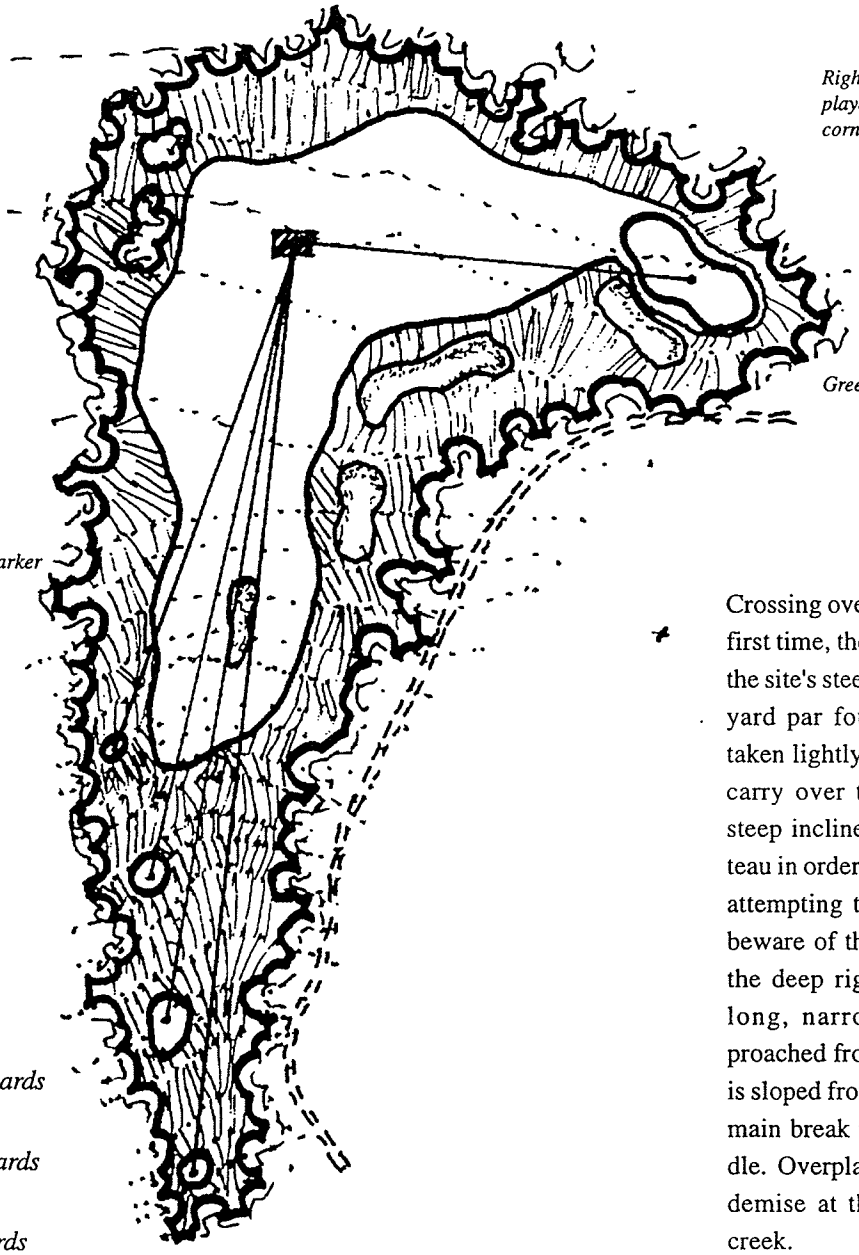
The second hole is a long par five. At 556 yards, the average player must hit three full shots for a birdie opportunity. A solid tee shot crosses a slight depression to a landing zone located just before an ephemeral creek. Dry most of the year, the rockbed of the creek must be crossed on the second shot. An accurate shot will leave the golfer with a short iron approach into the green. Long approaches to the green must content with a narrow right side bunker. Offset and elevated above the fairway, the green is nestled into the surrounding vegetation.

2

Par 5

Contour Interval - 2m





Right side sand bunker's, test players attempting to cut the corner.

Green size - 6600 sq.ft.

Steep uphill tee shot

Fairway bunker used as a marker

Copper tee - 265 yards

Bronze tee - 300 yards

Silver tee - 340 yards

Gold tee - 380 yards

Crossing over Shannon creek for the first time, the golfer is introduced to the site's steep topography. This 366 yard par four dogleg is not to be taken lightly. A short tee shot must carry over the front bunker, up a steep incline to the designated plateau in order to see the green. Those attempting to turn the corner must beware of the penalty bestowed by the deep right side bunkers. The long, narrow green is best approached from the left side where it is sloped from back to front with the main break running down the middle. Overplayed shots will find their demise at the bottom of Shannon creek.

3

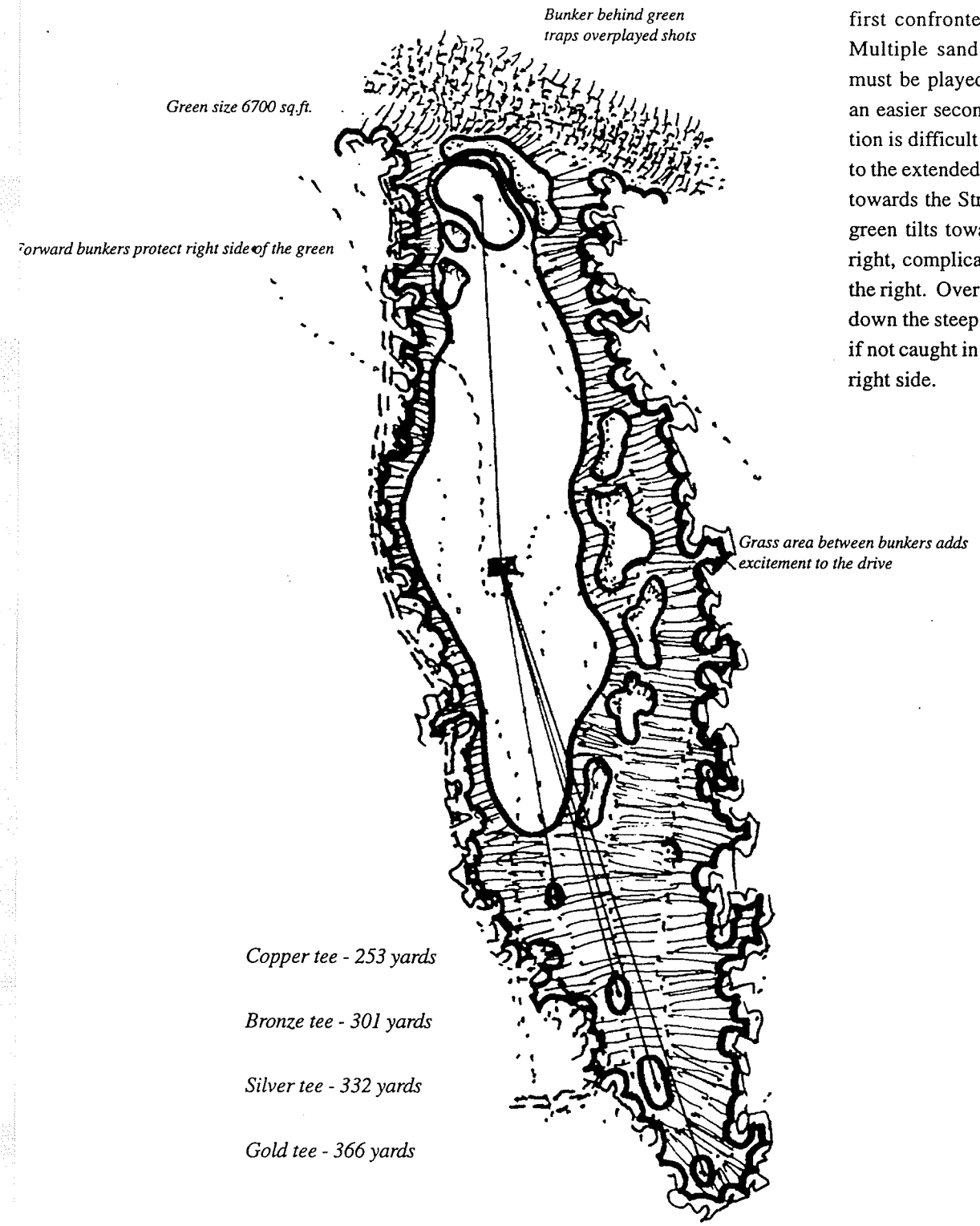
Par 4

Contour Interval - 2m

feet 0 50 100 200 400

meter 0 25 50 100

On this short heroic par 4, the golfer is first confronted with a sea of sand. Multiple sand bunkers on the right must be played close to allowing for an easier second shot. Depth perception is difficult on the second shot due to the extended view beyond the green towards the Straight of Georgia. The green tilts towards the bunker on the right, complicating an approach from the right. Over hit shots can disappear down the steep slope behind the green if not caught in the large bunker on the right side.



4

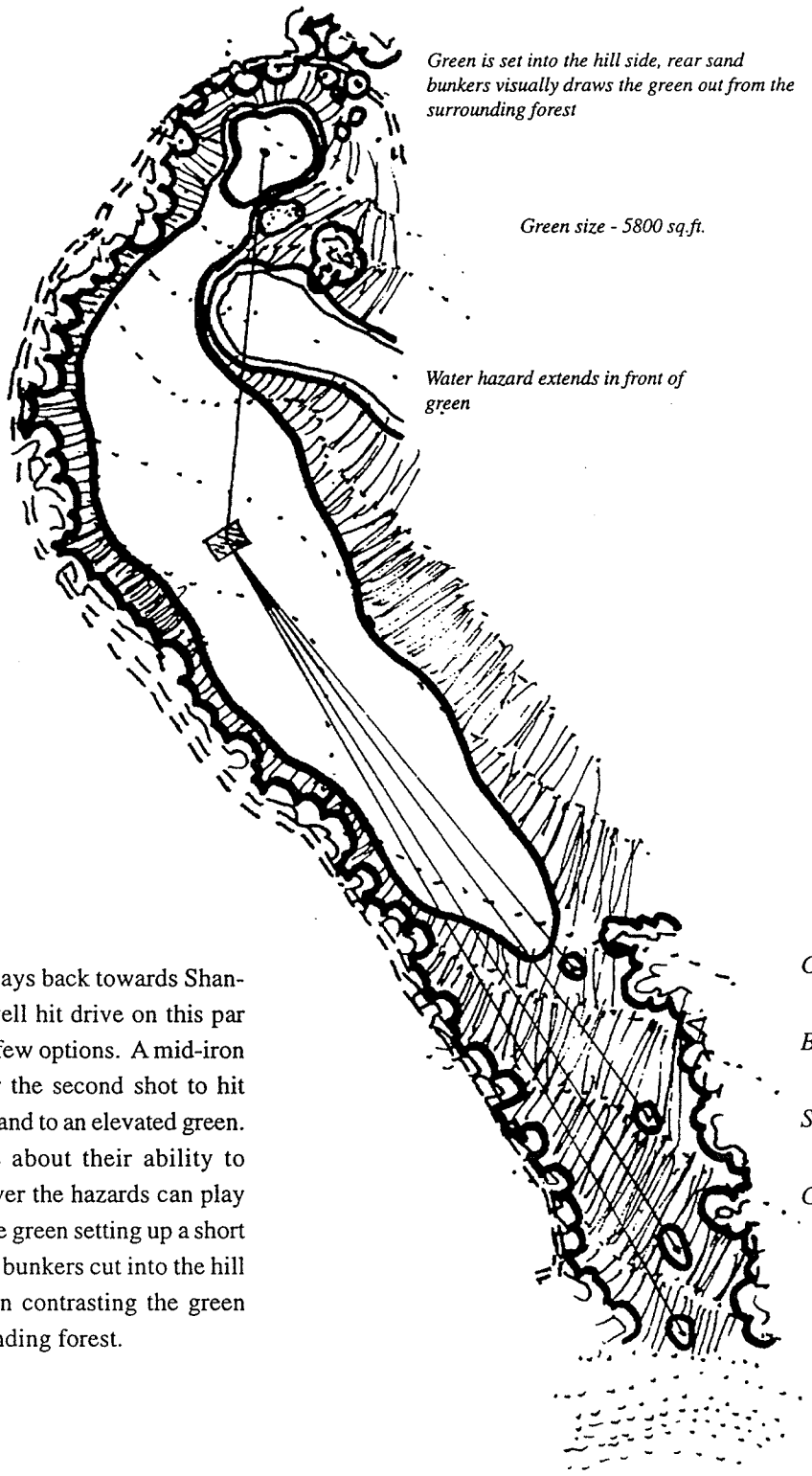
Par 4

Contour Interval - 2m

feet 0 50 100 200 400

meter 0 25 50 100

olfers not attempting to carry the ater will want to drive to the left side f the fairway, allowing for a second hot to the front of the green



Green is set into the hill side, rear sand bunkers visually draws the green out from the surrounding forest

Green size - 5800 sq.ft.

Water hazard extends in front of green

The fifth hole plays back towards Shannon creek. A well hit drive on this par four provides a few options. A mid-iron can be used for the second shot to hit over water and sand to an elevated green. Those insecure about their ability to carry the ball over the hazards can play to the front of the green setting up a short chip shot. Sand bunkers cut into the hill behind the green contrasting the green with the surrounding forest.

Copper tee - 286 yards

Bronze tee - 341 yards

Silver tee - 378 yards

Gold tee - 403 yards

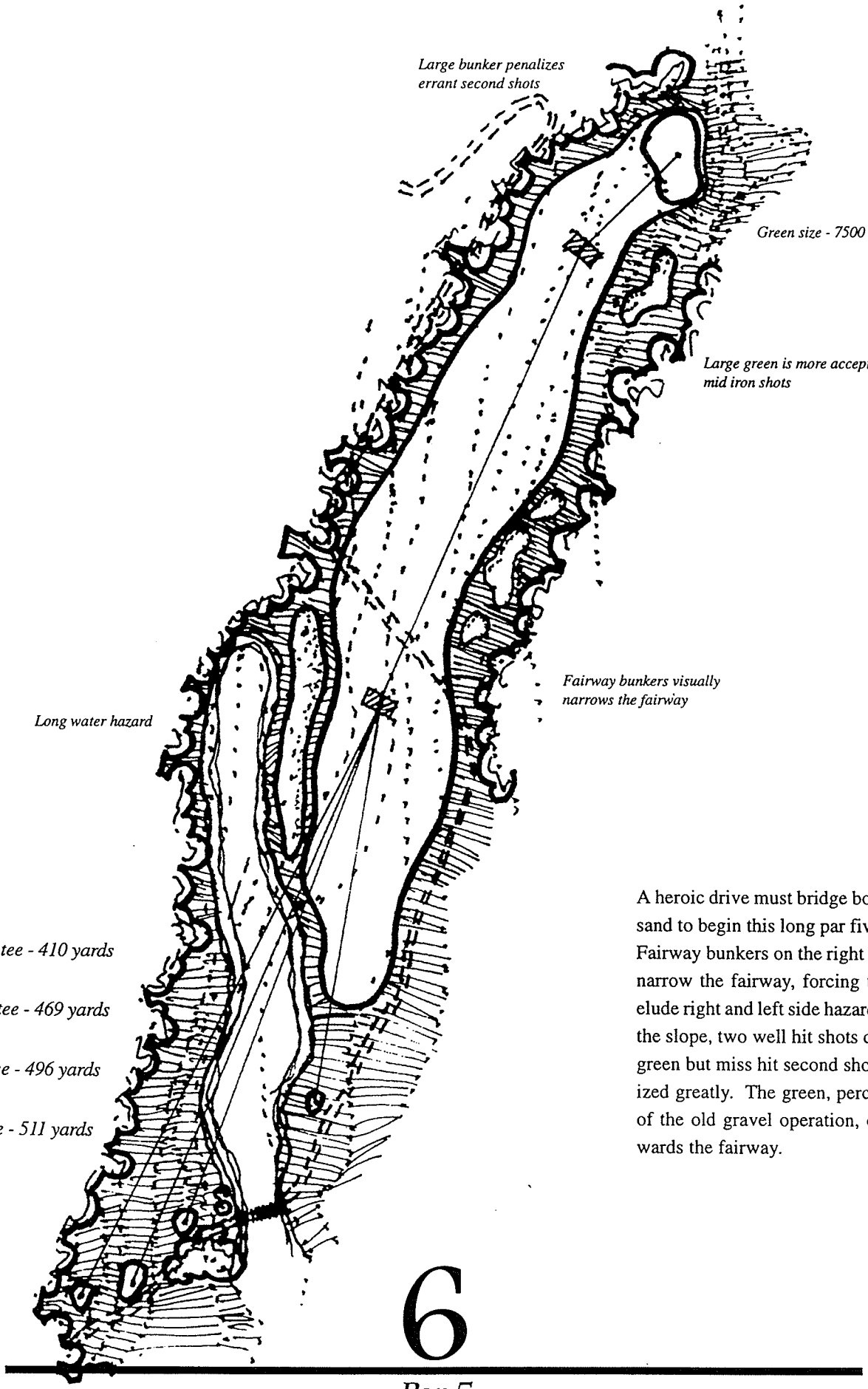
5

Par 4

Contour Interval - 2m

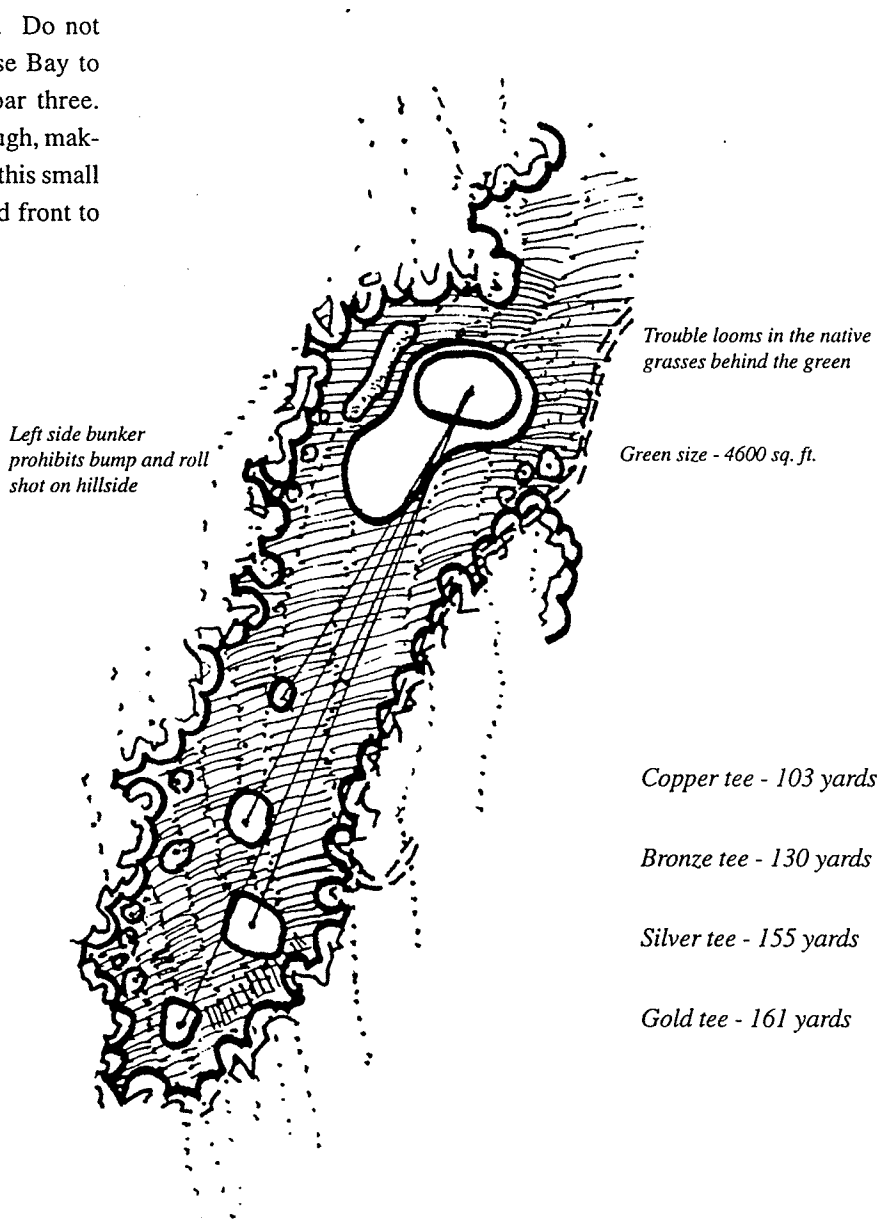
feet 0 50 100 200 400

meter 0 25 50 100



A heroic drive must bridge both water and sand to begin this long par five sixth hole. Fairway bunkers on the right side visually narrow the fairway, forcing the golfer to elude right and left side hazards. Utilizing the slope, two well hit shots can reach the green but miss hit second shots are penalized greatly. The green, perched on edge of the old gravel operation, opens up towards the fairway.

Jpon a short climb, the seven hole descends ownhill from elevated tee boxes. Do not llow the sublime view of Porpoise Bay to e over powering on this short par three.)ver played shots will find deep rough, mak- ng a recovery shot very difficult to this small reen which slopes left to right and front to ack.



7

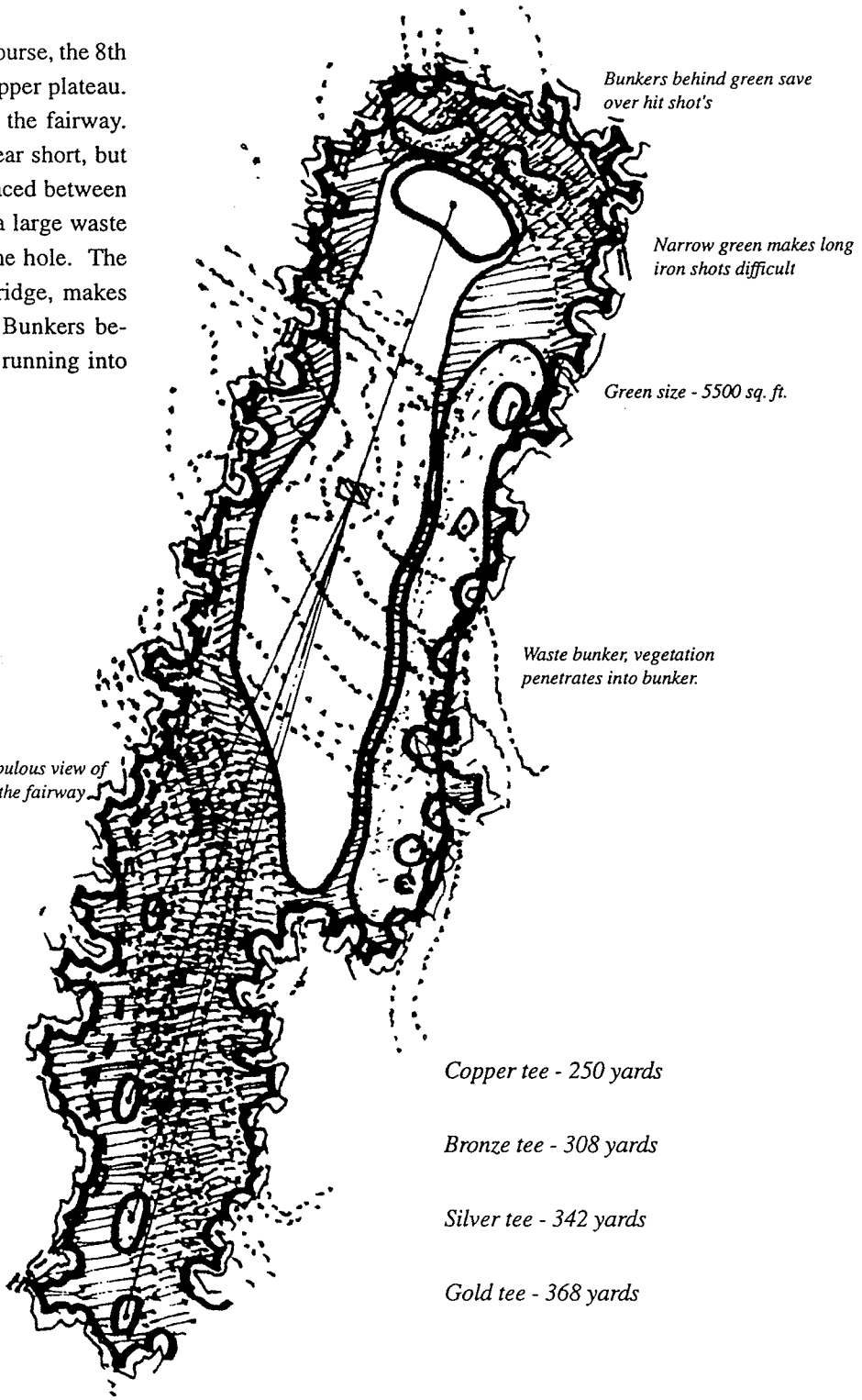
Par 3

Contour Interval - 2m

feet 0 50 100 200 400

meter 0 25 50 100

As majestic as any hole on the course, the 8th hole is the last hole to use the upper plateau. Tee shots cascade 35 meters to the fairway. At 368 yards the hole may appear short, but the drive must be accurately placed between the steep slope on the left and a large waste bunker the runs the length of the hole. The shallow green, sited on a flat ridge, makes long approach shots difficult. Bunkers behind the green trap shots from running into the red alders.



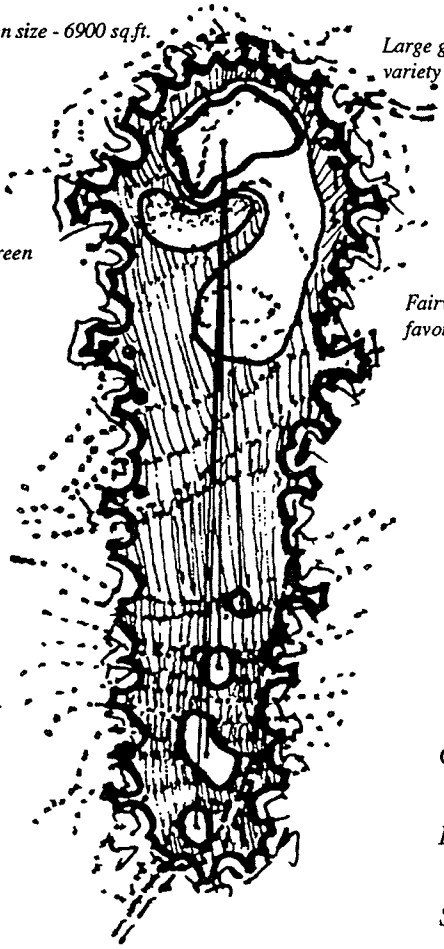
8

Par 4

Contour Interval - 2m

feet: 0 50 100 200 400

meter: 0 25 50 100



The final hole on the front nine is a taunting par 3. At 202 yards, the green sits 25 meters below the gold tee. The large irregular shaped green is guarded by a large front bunker. The green tilts towards the bunker, best shots are to the right side of the green.

Copper tee - 136 yards

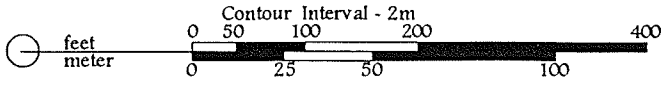
Bronze tee - 155 yards

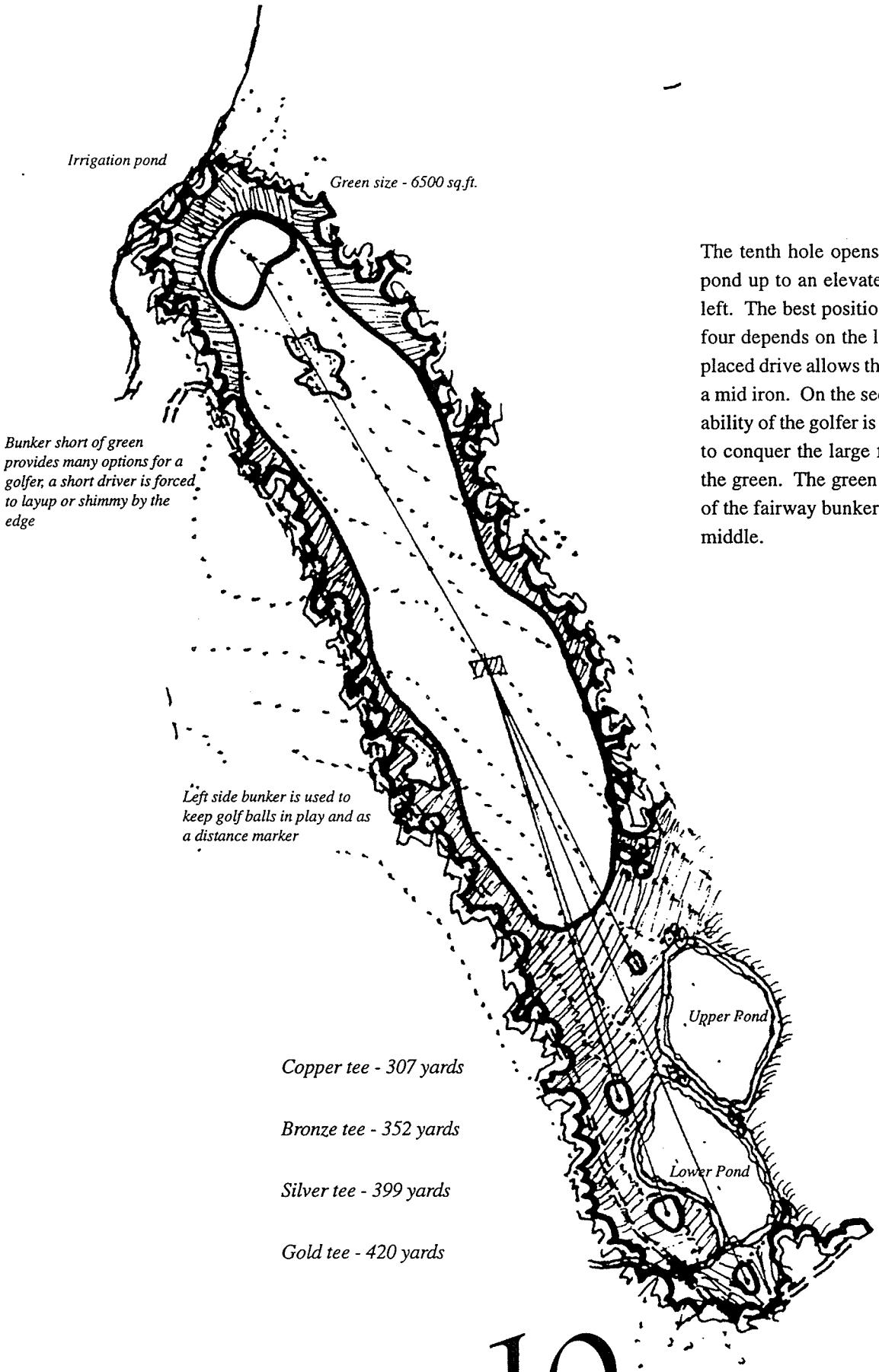
Silver tee - 181 yards

Gold tee - 202 yards

9

Par 3





The tenth hole opens by hitting over the lower pond up to an elevated fairway sloping right to left. The best position for a tee shot on this par four depends on the location of the pin. A well placed drive allows the green to be attacked with a mid iron. On the second shot, the strategy and ability of the golfer is the decisive factor in order to conquer the large fairway bunker in front of the green. The green slopes up from either side of the fairway bunker to a high point in the back middle.

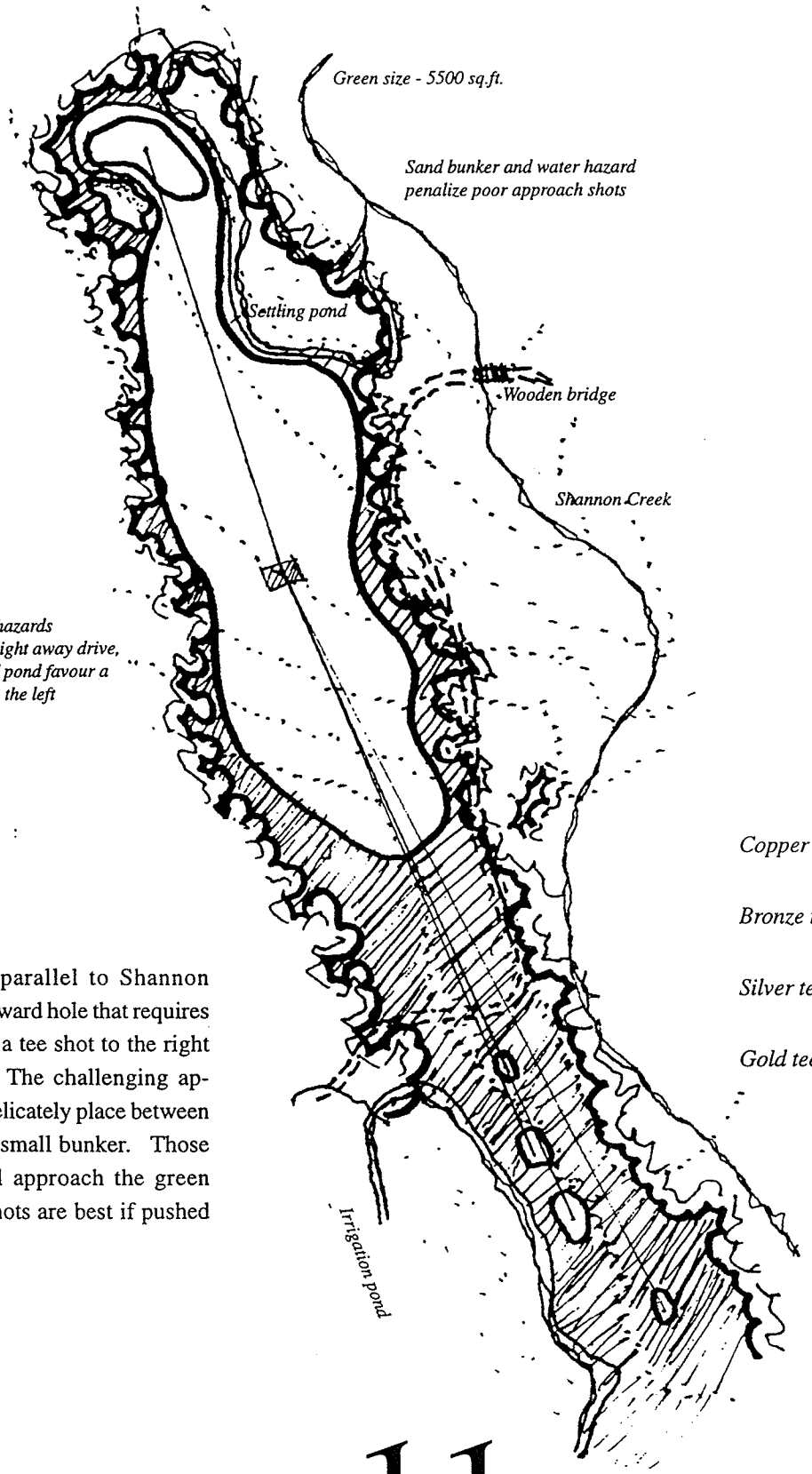
10

Par 4

Contour Interval - 2m

feet: 0 50 100 200 400

meter: 0 25 50 100



Copper tee - 323 yards

Bronze tee - 350 yards

Silver tee - 375 yards

Gold tee - 415 yards

The eleventh hole, parallel to Shannon Creek, is a straight forward hole that requires good placement with a tee shot to the right side of the fairway. The challenging approach shot must be delicately place between a settling pond and a small bunker. Those with confidence will approach the green straight on. Errant shots are best if pushed left.

11

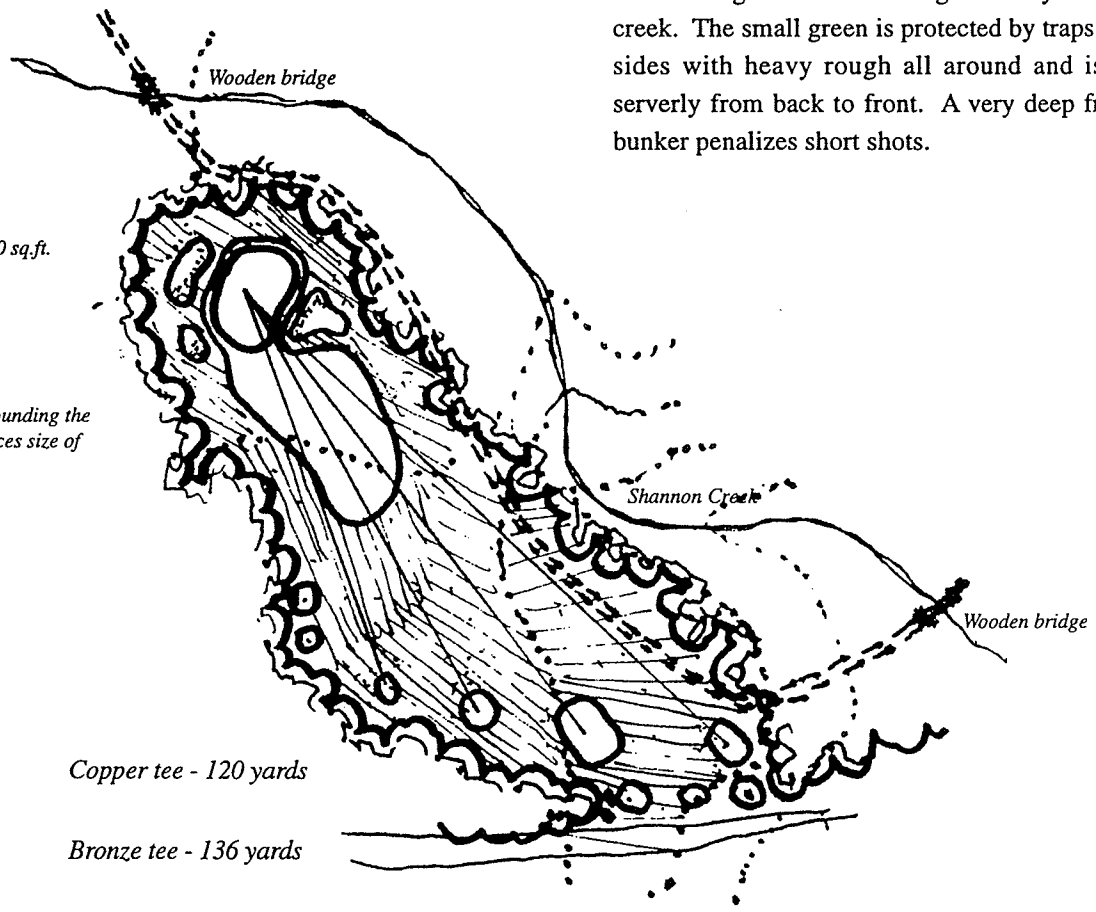
Par 4

Contour Interval - 2m

feet: 0 50 100 200 400

meter: 0 25 50 100

The twelfth hole is a short par three. Tee shots must be hit straight to avoid the right of way of Shannon creek. The small green is protected by traps on three sides with heavy rough all around and is sloped serverly from back to front. A very deep front side bunker penalizes short shots.



Green size - 5100 sq.ft.

Deep bunkers surrounding the green visually reduces size of the green

Copper tee - 120 yards

Bronze tee - 136 yards

Silver tee - 160 yards

Gold tee - 188 yards

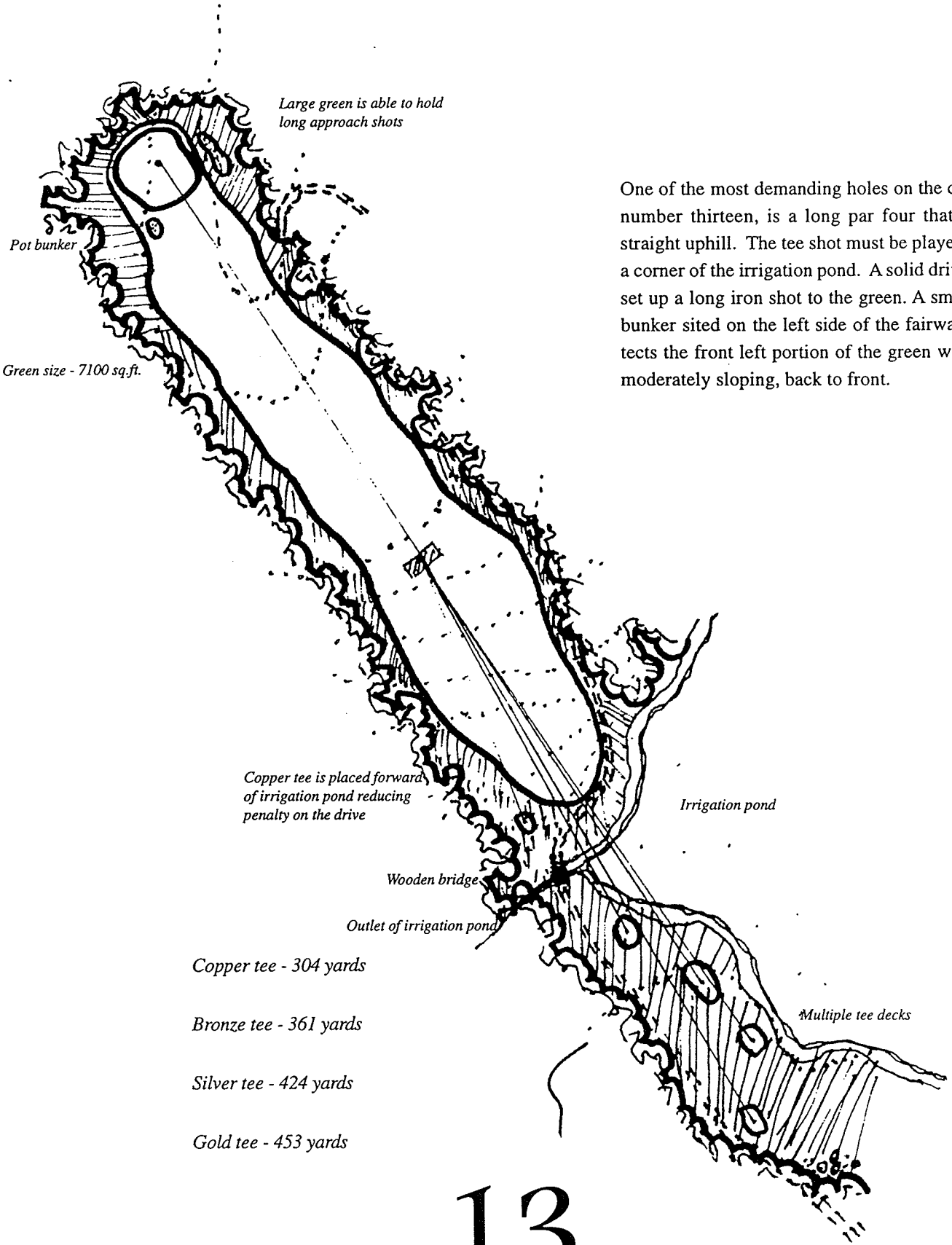
12

Par 3

Contour Interval - 2m

feet 0 50 100 200 400

meter 0 25 50 100



One of the most demanding holes on the course, number thirteen, is a long par four that plays straight uphill. The tee shot must be played over a corner of the irrigation pond. A solid drive will set up a long iron shot to the green. A small pot bunker sited on the left side of the fairway protects the front left portion of the green which is moderately sloping, back to front.

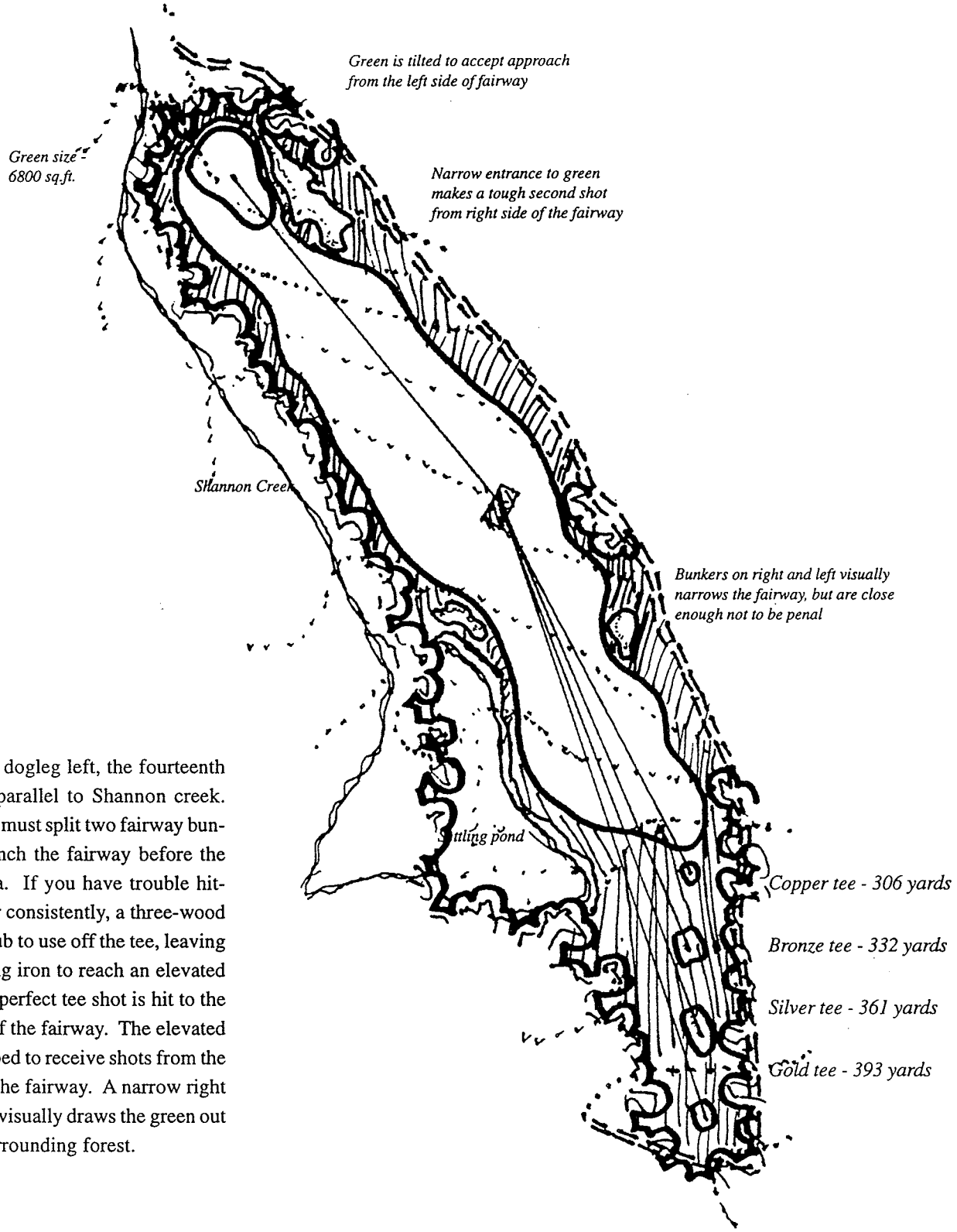
13

Par 4

Contour Interval - 2m

feet: 0 50 100 200 400

meter: 0 25 50 100



A moderate dogleg left, the fourteenth hole plays parallel to Shannon creek. The tee shot must split two fairway bunkers that pinch the fairway before the landing area. If you have trouble hitting a driver consistently, a three-wood is a good club to use off the tee, leaving a mid to long iron to reach an elevated green. The perfect tee shot is hit to the left center of the fairway. The elevated green is sloped to receive shots from the left side of the fairway. A narrow right side bunker visually draws the green out from the surrounding forest.

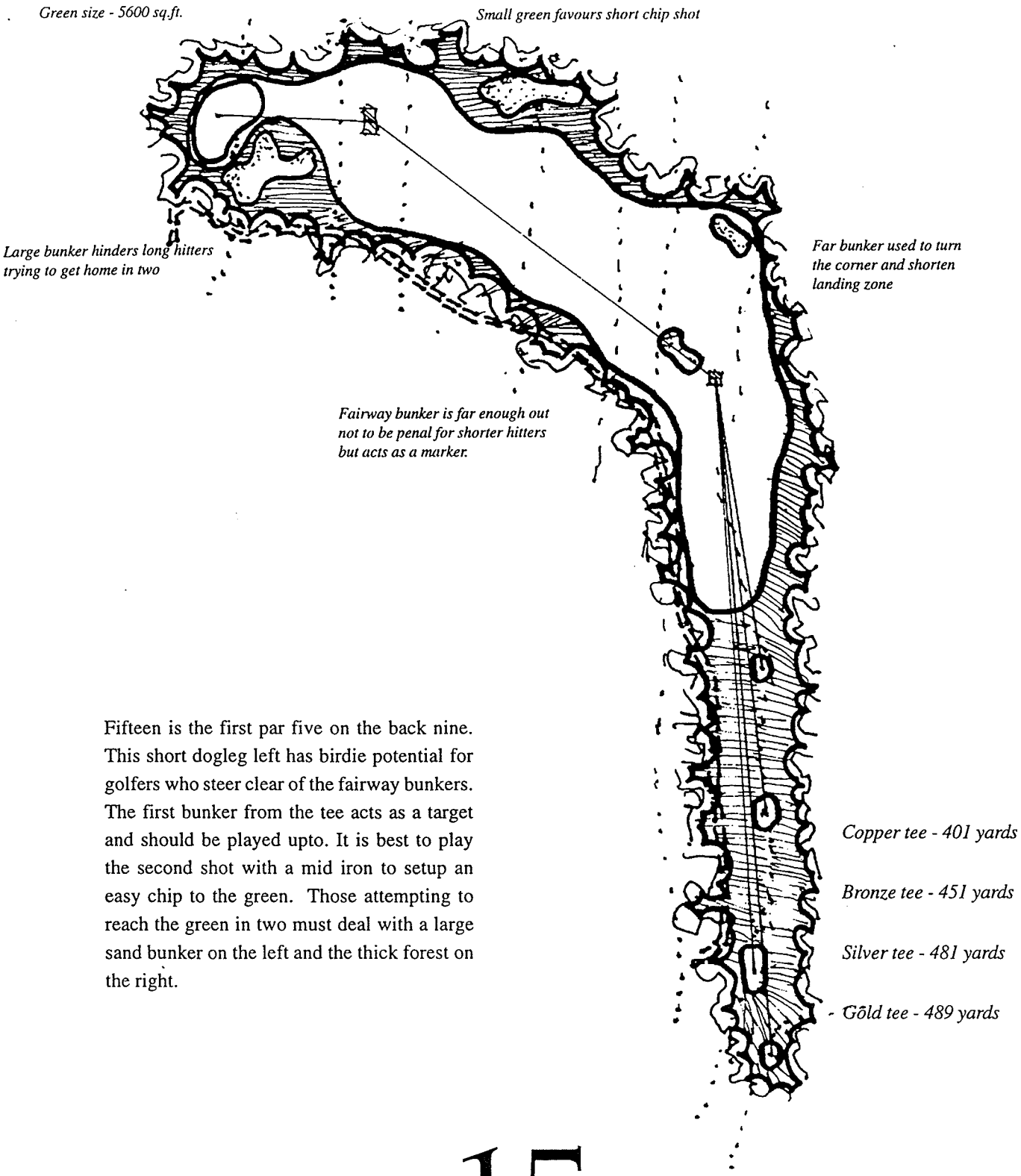
14

Par 4

Contour Interval - 2m

feet 0 50 100 200 400

meter 0 25 50 100



Fifteen is the first par five on the back nine. This short dogleg left has birdie potential for golfers who steer clear of the fairway bunkers. The first bunker from the tee acts as a target and should be played upto. It is best to play the second shot with a mid iron to setup an easy chip to the green. Those attempting to reach the green in two must deal with a large sand bunker on the left and the thick forest on the right.

15

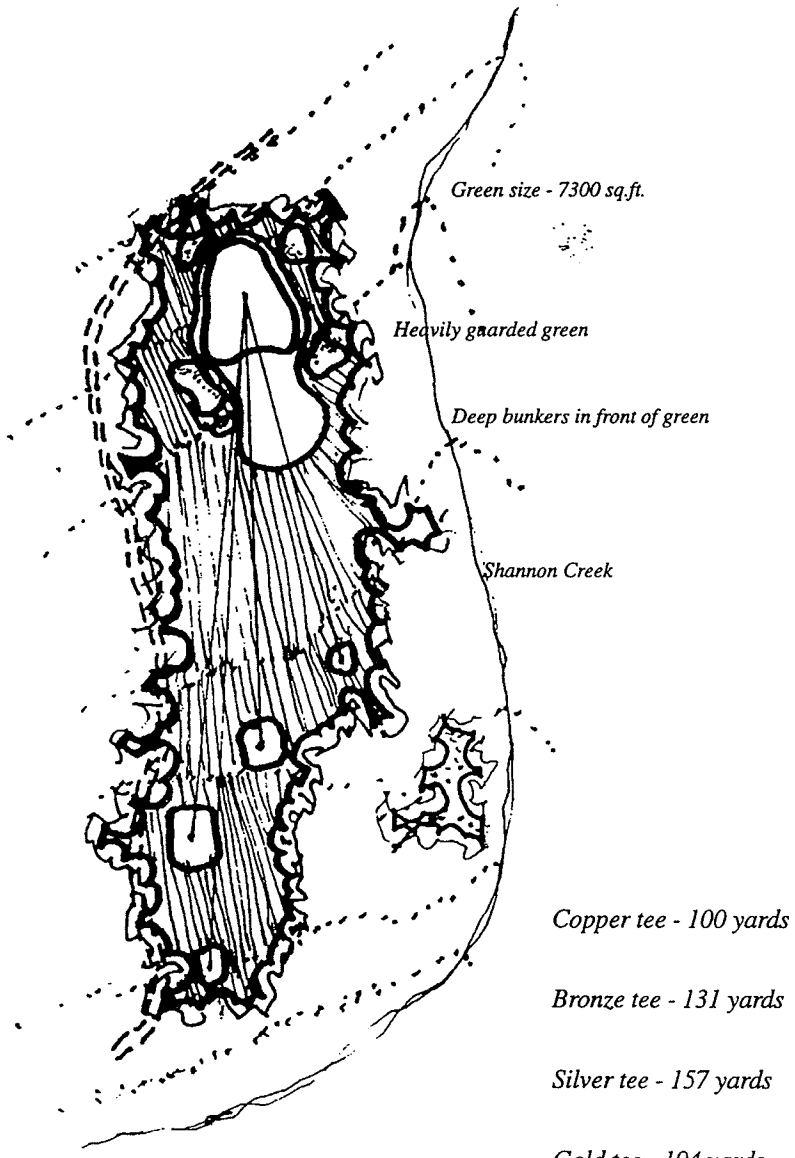
Par 5

Contour Interval - 2m

feet 0 50 100 200 400

meter 0 25 50 100

The last par three on the course, is surrounded by five deep bunkers. Slightly elevated above the fairway the butterfly green is pressed into the landscape. The three tiered green slopes back to front and left to right.



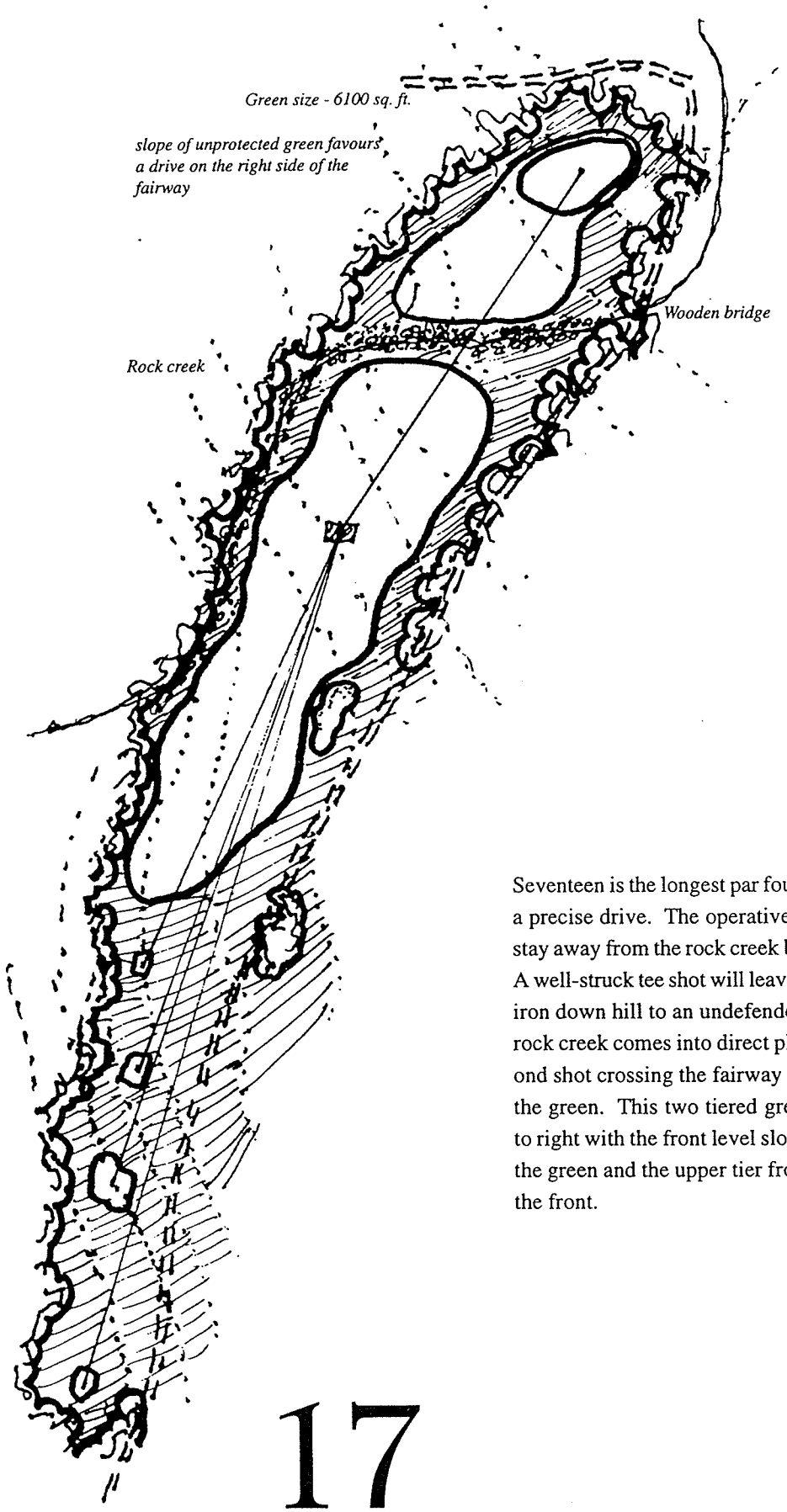
16

Par 3

Contour Interval - 2m

feet 0 50 100 200 400

meter 0 25 50 100



Copper tee - 314 yards

Bronze tee - 350 yards

Silver tee - 385 yards

Gold tee - 454 yards

Seventeen is the longest par four and requires a precise drive. The operative strategy is to stay away from the rock creek bed on the left. A well-struck tee shot will leave a mid to long iron down hill to an undefended green. The rock creek comes into direct play on the second shot crossing the fairway 74 yards from the green. This two tiered green slopes left to right with the front level sloping back into the green and the upper tier from the back to the front.

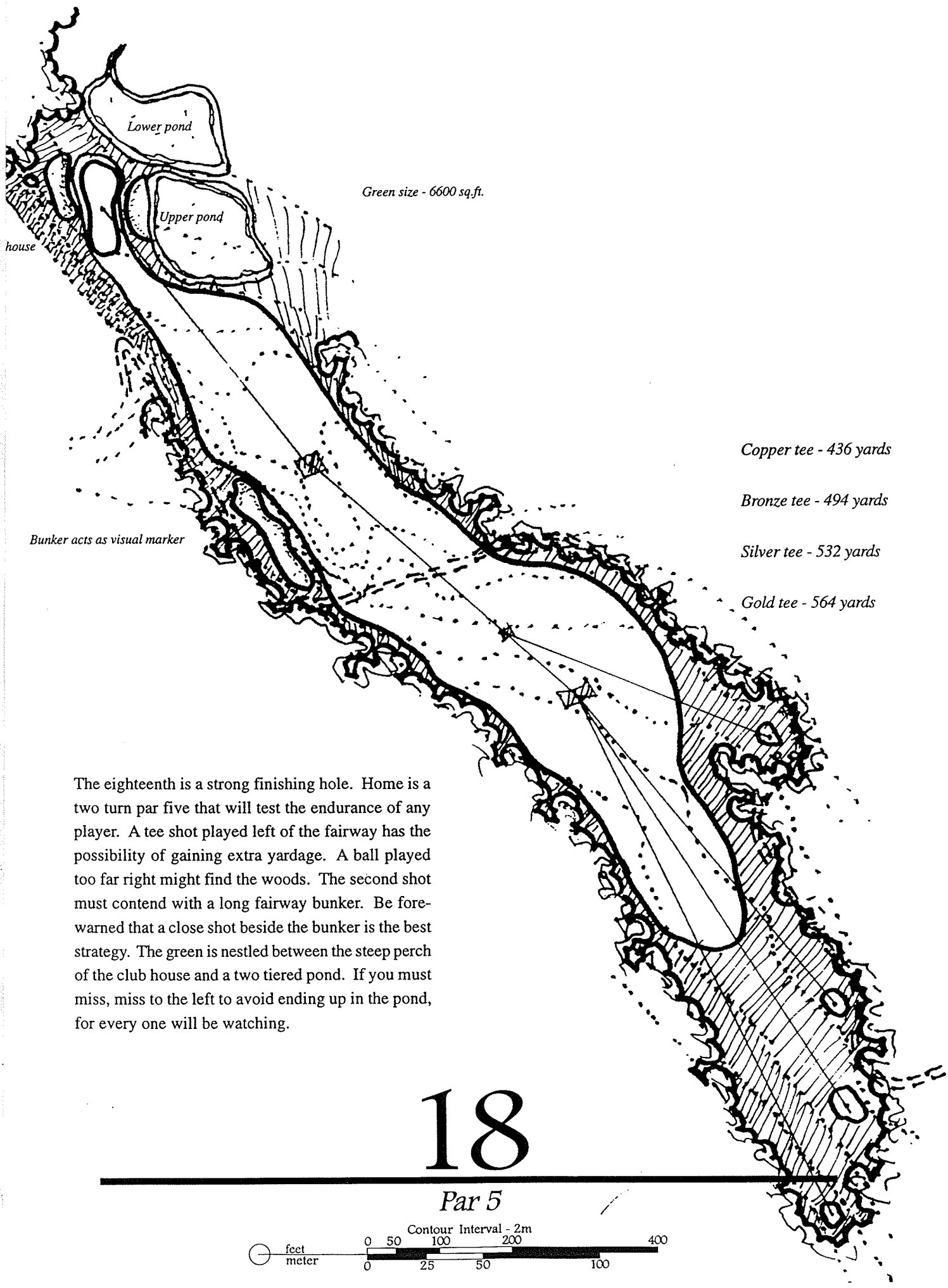
17

Par 4

Contour Interval - 2m

feet: 0 50 100 200 400

meter: 0 25 50 100



The eighteenth is a strong finishing hole. Home is a two turn par five that will test the endurance of any player. A tee shot played left of the fairway has the possibility of gaining extra yardage. A ball played too far right might find the woods. The second shot must contend with a long fairway bunker. Be forewarned that a close shot beside the bunker is the best strategy. The green is nestled between the steep perch of the club house and a two tiered pond. If you must miss, miss to the left to avoid ending up in the pond, for every one will be watching.

18

Par 5

Contour Interval - 2m

feet 0 50 100 200 400

meter 0 25 50 100

gold tee - 564 yards

silver tee - 532 yards

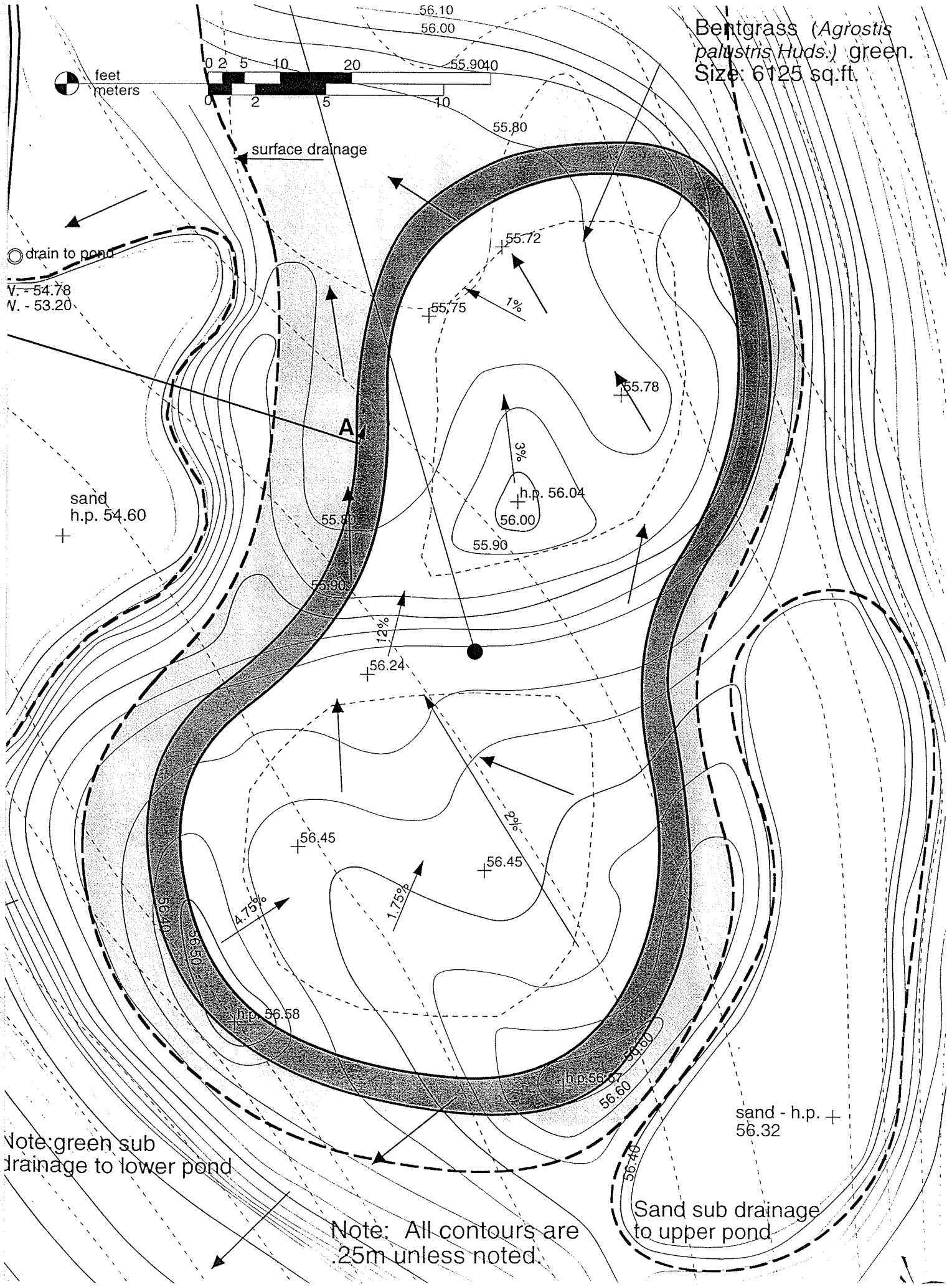
bronze tee - 494 yards

copper tee - 436 yards

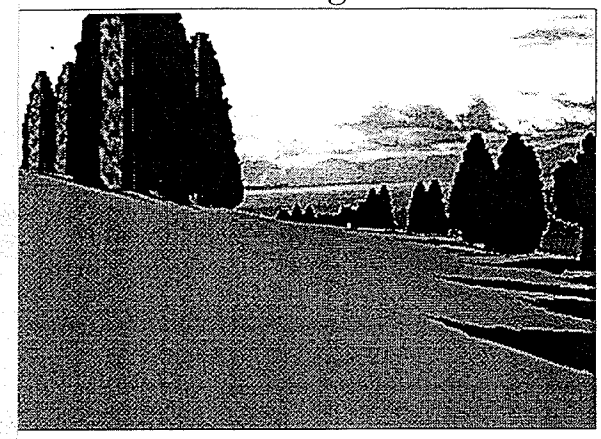
18

Scale: 1:1000

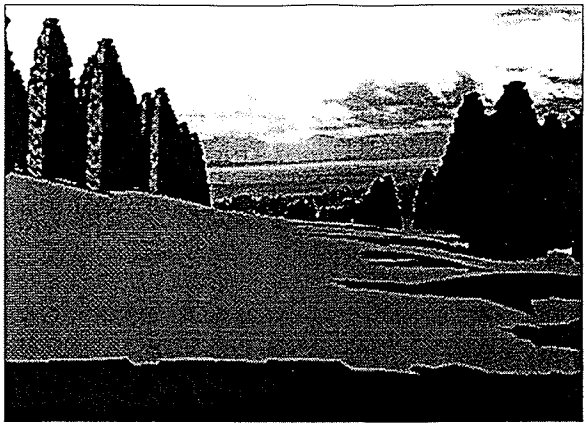
Contour Interval - 1m


Bentgrass (*Agrostis palustris Huds.*) green.
Size: 6125 sq.ft.
feet
meters
0 2 5 10 20
0 1 2 5 10
56.10
56.00
55.90
55.80
surface drainage
drain to pond
V. - 54.78
V. - 53.20
55.72
55.75
1%
55.78
A
3%
h.p. 56.04
56.00
55.90
55.80
55.90
sand
h.p. 54.60
12%
56.24
2%
56.45
56.45
4.75%
1.75%
56.50
56.50
h.p. 56.58
h.p.56.67
56.60
56.60
56.40
sand - h.p.
56.32
Note:green sub
drainage to lower pond
Note: All contours are
.25m unless noted.
Sand sub drainage
to upper pond

view from gold tee



view from silver tee



view from bronze tee

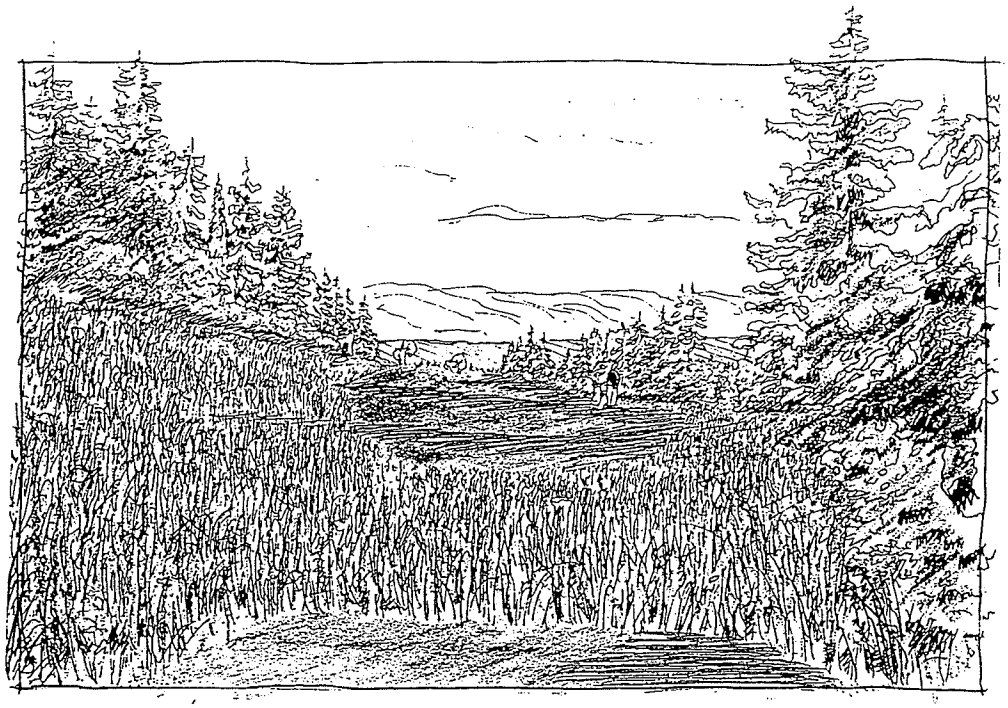
view from copper tee

view towards green from 300 yards

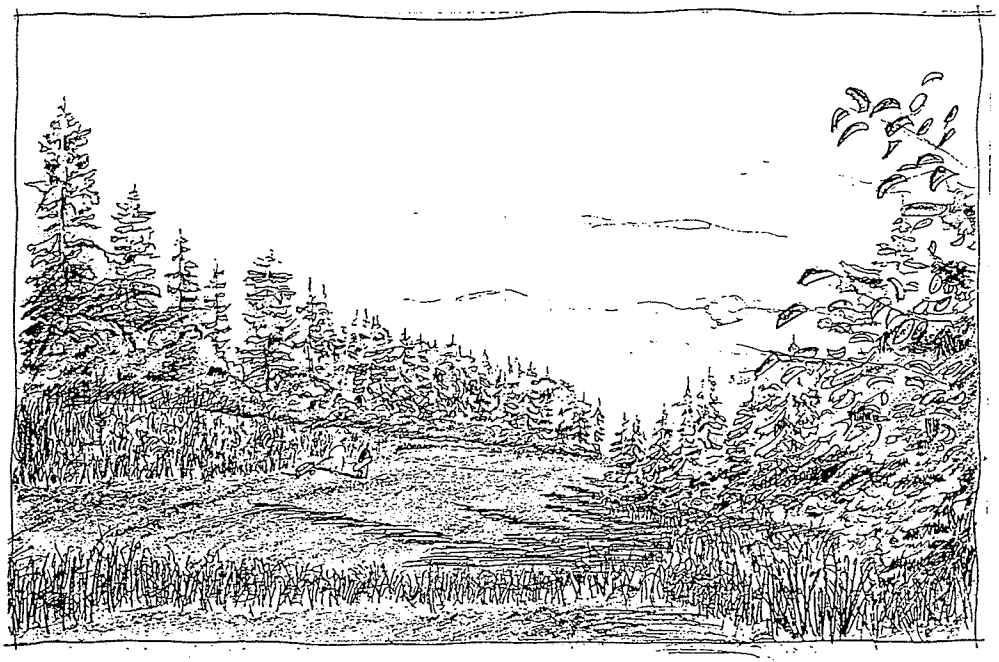
view towards green from 150 yards

18

Computer generated perspectives revealing views from hole number 18.

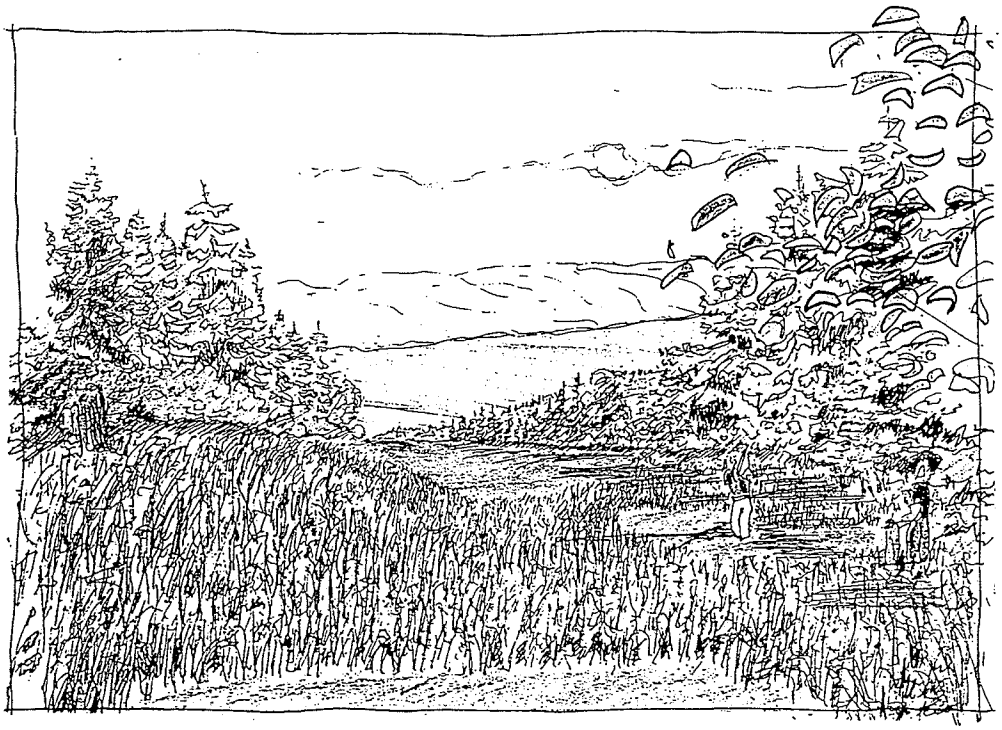


View from Bronze Tee

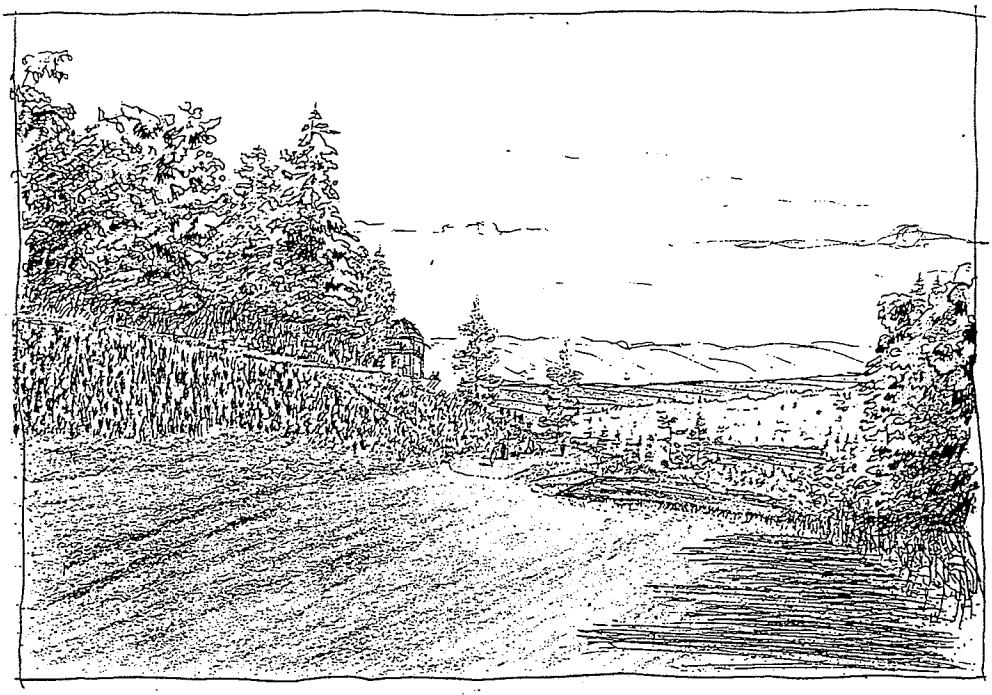


View from Copper Tee

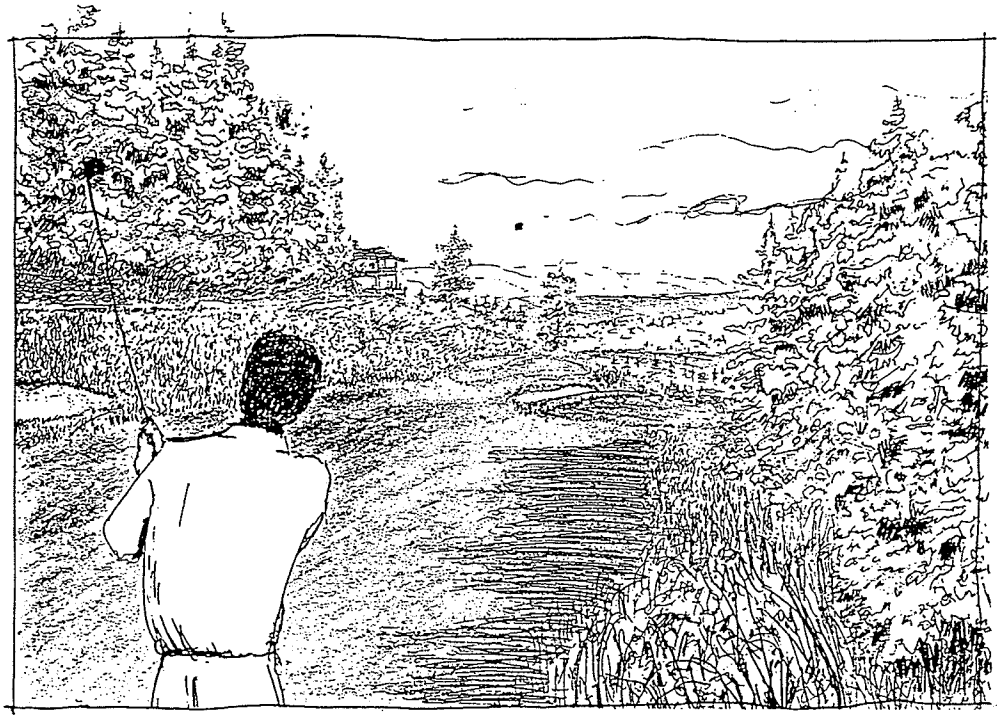
View from Gold Tee



View from Silver Tee



View 150 yards from Green



View 300 yards from Green

course
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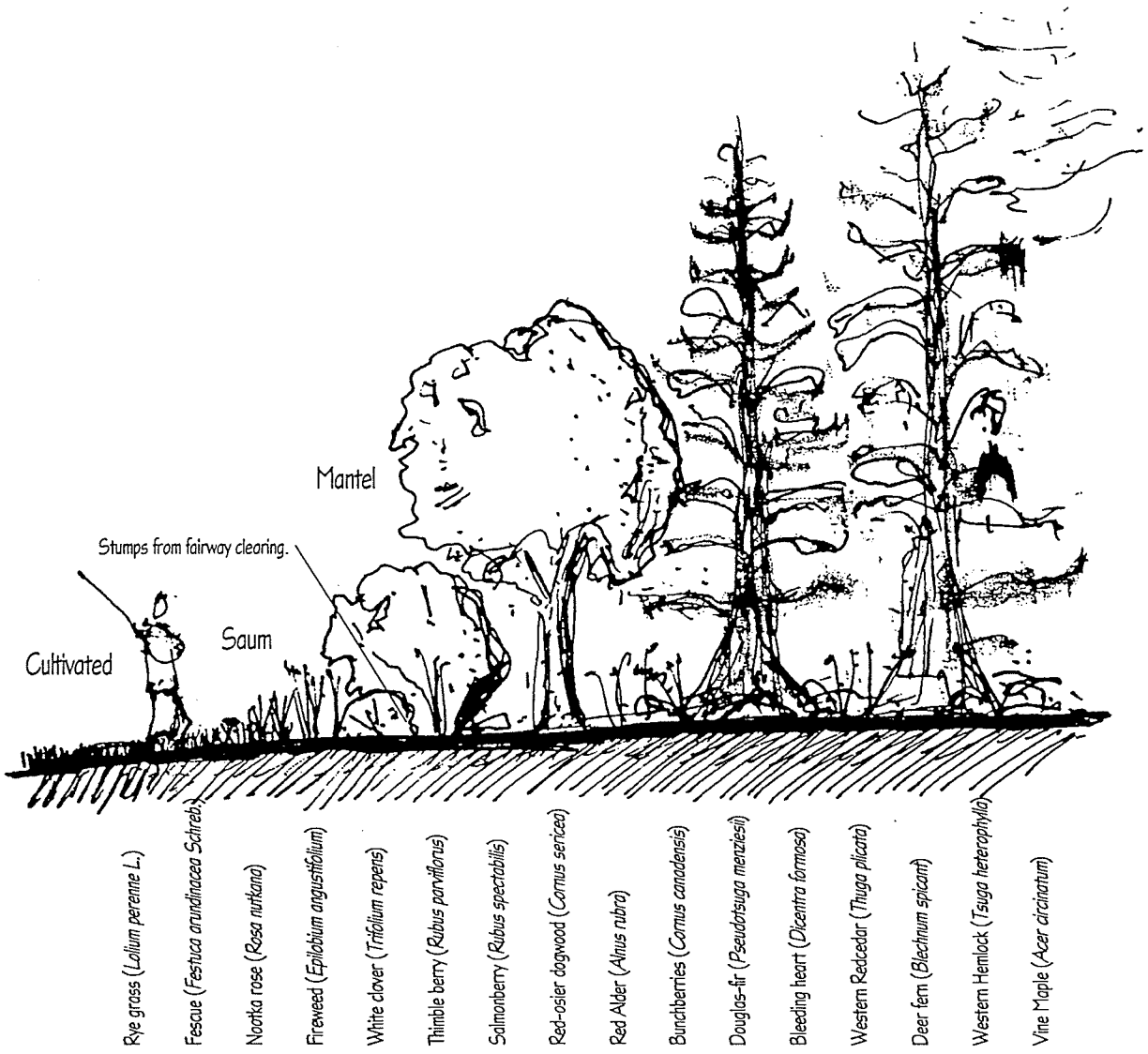
dscape

The edge of the fairway is to have three levels of plant material. To aid in the development of the edge, logged material from the fairways will be placed between the fairway and the forest. This increases the biomass of that area and aids in the development of shrubs along the edge of the fairway and reduces the wind and sun pressure on the interior of the forest.

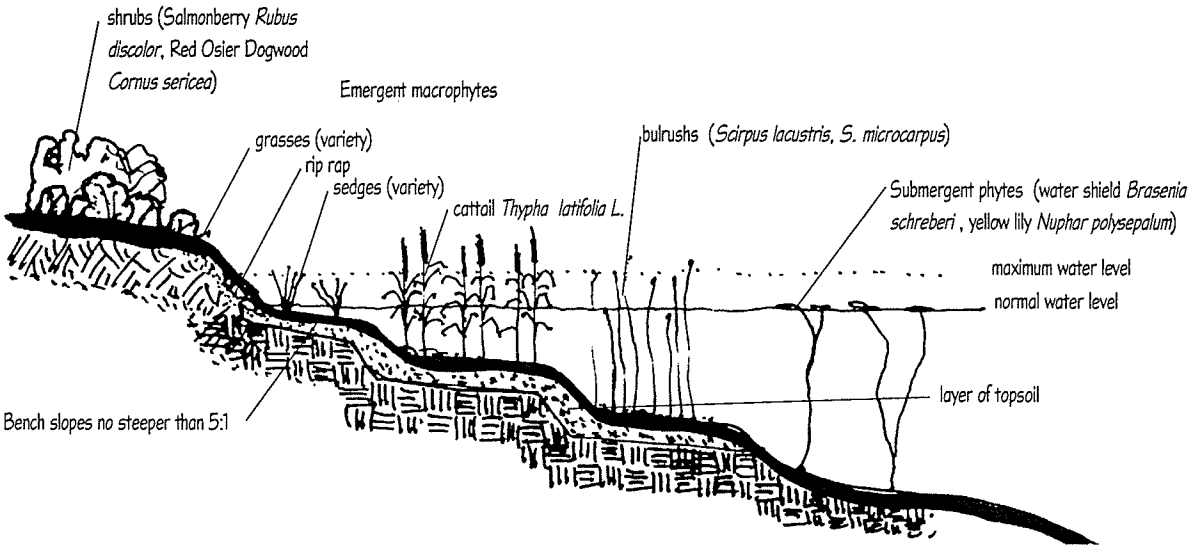


Edge Detail

Typical cross section through the fairway edge, showing vertical structure and species.

NTS

Settlement ponds have been placed to intercept runoff from the course before entering Shannon Creek. This allows nutrients and energy to settle before entering Shannon Creek. The edge of the pond has been detailed to allow for a number of species to propagate, increasing the level of biodiveristy in the pond.

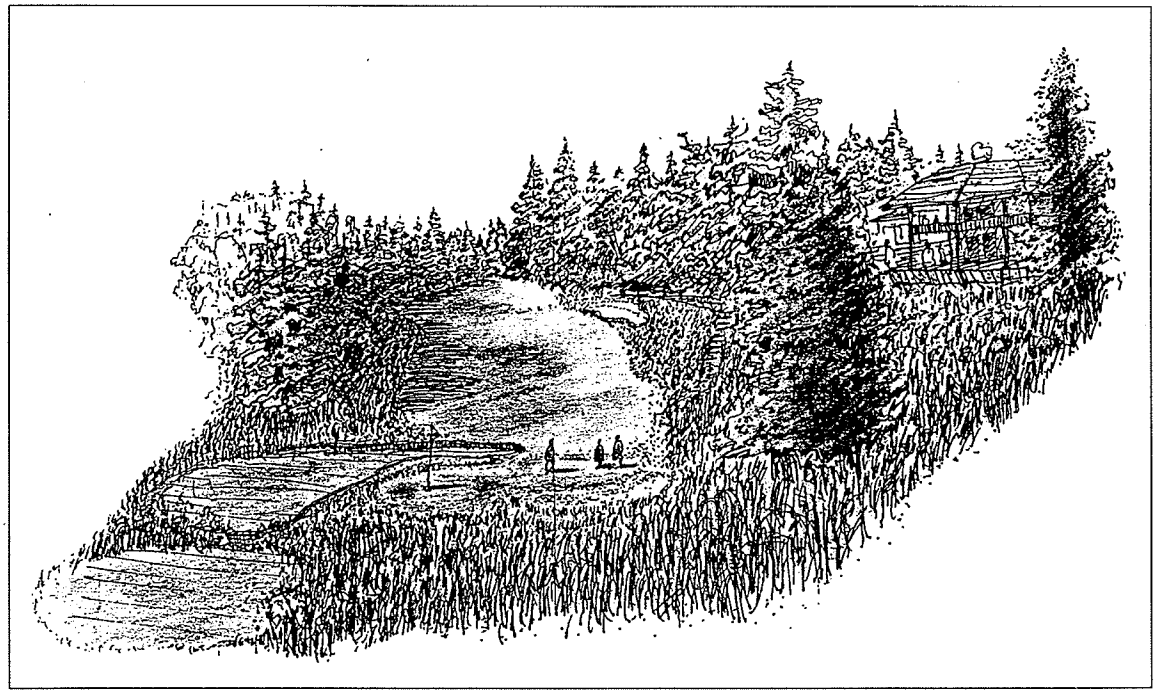


Pond Detail

Cross section through pond, showing planting benches and species.

NTS

7.0 CONCLUSIONS



7.0 Conclusion

Previous Page: View of the 18th hole and clubhouse. Tsuga Golf & Country Club, 1996.

Our landscapes present opportunities and potentials for a variety of uses and activities. Golf is one activity where humans engage the landscape in competition. This practicum has primarily dealt with the issues of golf course architecture on two levels. The first being the tradition and strategies of golf as a target ball game and the second, a respect for the environment in which the golf course is being placed. Travelling over 7,000 yards a golfer can experience a variety of elements. The excitement and intrigue along this journey, can come from the variety of hazards and obstacles, challenging the skills of each player. It is the magnitude of the landscape that provides for memorable experiences that can be recreated and rebuked for many years.

This study has illustrated how the principles of golf course architecture can be applied on a coastal site. It has illustrated how ecological principles can be applied in the creation of a golf course. A golf course can provide an environment for a variety of species including humans to interact with the landscape. Through the synthesis of these elements an unique golf course has been created on the Sunshine Coast. Tsuga golf course has be anthropocentrically constructed, providing an environment for flora, fauna and humans to reside together. The entire golf course embodies the essence of coastal life exposing the users to the incredible variety of life encapsulated on the site.

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GLOSSARY

Approach - the shot to the green, or , the area just in front of the green where the approach shot may land and bounce onto the green.

Bail-out area - a portion of fairway relatively unguarded by hazards, where the golfer may aim for safety instead of attacking the primary target area.

Bay - a distinct compartment of sand within a bunker.

Berm - an artificially constructed mound, usually long and narrow shape.

Biomass - the total weight or mass of living organisms in an area.

Cape - a grassy promontory projecting partway into a bunker, dividing it in to sections or bays.

Carrying capacity - the maximum number of individuals or mazimum biomass that a particular environment can support.

Championship course - term implying suitability of a course to host a tournament. In some countries, champiion ship courses are designated by golf associations, bu in the United States it is simpley a marketing catchphrase without meaning.

Chocolate drops - a series of small mounds covered by rough grass, frequently found on courses of the classic era. Often these were built to bury rocks and debris dug up during the construction process.

Connectivity - a measure of how connected or spatially continous a corridor or matrix is.

Contour moving - the mowing of a fairway in curvilinear lines, usually designed to narrow the fairway in less frequently used strectches and thus lower the total acreage of intensely maintained turf.

Corridor - a narrow strip of land that differs from the matrix on either side.

Crowned green - a green that is highest along its central spine and drains to either side.

Degrading - gradually decreasing in biomass or structure.

Disturbance - an event that causes a significant change from the normal pattern in an ecological system.

Disturbance patch - an area that has been disturbed within a matrix.

Dogleg - a hole requiring the drive to be played away from the direct line to the green because of intervening trees, rough or hazards.

Double green - a green serving two different holes, each wit its own separate flag.

Ecology - the scientific study of the relationships between organisms and their environment.

Ecotone - a relatively narrow overlap zone between tow communities.

Edge - an outer band of a patch that has an environment significantly different form the interior of the patch.

Edge effect - a distinctive species composition or relative abundance in the outer band of a patch (i.e., different from the species compostion or relative abundance of the patch interior).

Edge Species - a species found only or primarily near the perimeter of a landascape element.

Elephant or buried elephant - a large mound or countour within the putting surface.

Ephemeral patch - an area caused by animal social behavior or by low-intensity, shor-lived fluctuations in environemental factors within a matrix.

Function - the flow of mineral nutrients, watere, energy, or species.

Grading - the changing of the ocntours of the ground by mechanical means.

Grass bunker - a deliberately created depression of rough grass.

Green speed - the relative speed at which a ball rolls on the green, dependent upon the type of grass, heigh of cut and firmness of the surface. Specified either in general terms (slwo, medium, fast) or measured by a Stimpmeter (q.v.).

Heather - a low-growing flowering shrub or ground cover common to British links and inland courses, from which a shot may be played with some difficulty. The term in erroneously used in North America as a synonym for long rough.

Homogeneous - having all parts identical to each other.

Island biogeographic theory - theory explaining the number o species on islands as related to an island's are, isolatin, and age, as cause by the balance between colonization and extinction.

Landscape change - the alteration in the structure and function of the ecological mosaic over time.

Landscape ecology - the study of the structure, function, and change in a heterogeneous land area composed of interacting ecosystems.

Landscape function - the flows of energy, materials and species among the component ecosystems.

Landscape organization - the integration of structure and function, i.e., the spatial configuration and the patterns of flows in a landscape.

Landscape recovery - the return of a system, subjected to a moderate disturbance level, to its original equilibrium.

Landscape resistance - the effect of structural characteristics of a landscape on the rate of flow of objects.

Landscape structure - the distribution of energy, materials and species in relation to the sizes, shapes, numbers, kinds and configurations of landscape elements or ecosystems.

Lay-up - a shot deliberately played short of a hazard, where the lie would have other wise allowed a longer shot to be played.

Line corridor - a narrow band essentially dominated throughout by edge species.

Links - a seaside golf course constructed on naturally sandy ground with undulations formed by wind and receding tides. The first golf ocurse in Britain were all links. Frequently the term is misused in America t describe a) any course, b) any seaside course, or c) a course which does not return to the clubhouse at the 9th hole.

Linksland - is coastal terrain characterized by hummocky topography and sand dunes often covered with turf and coarse, grazed grasses. Linksland is an old scottish word for the earth at the edge of the sea.

Macroheterogeneity - a pattern wherby the assemblage of landscape element types differs markedly in the extreme portions of the area examined.

Managed landscape - a landscape, such as rangeland or forest, where native species are harvested.

Matrix - the most extensive and most connected landscape element type present, which plays the dominant role in landscape funcitioning. Also, a landscape element surrounding a patch.

Microheterogeneity - a pattern where the assemblage of landscape element types around a point is similar wherever the point is located in the landscape.

Migration - a cyclic movement of animals between separated areas that are used during different seasons.

Natural landscape - an area where human effects, if present, are not ecologically significant to the landscape as a whole.

Node - a patch attached to a corridor, both of the same landscape element type. Also, an intersection of corridors, and a source or sink of flows of objects.

Par - the expected integral score of a scratch player on a given hole, allowing tow puts per green. Determined almost exclusively on the basis of length, with some modifications for topography or elevation, but not for relative difficulty. For men, par-3 is any hole under 250 yards, par-4 between 251 and 470 yards and a par-5 over 471 yards. For women, par-3 is any hole under 200 yards, par-4 between 201 and 400 yards and a par-5 over 401 yards.

Patch - a nonlinear surface area differing in appearance from its surroundings.

Patchiness - the density of patches, or the fineness of a mosaic.

Pin placement - the actual location of the hole on a green, or , a distinct poriton of the green where holes may be fairly placed.

Postage-stamp green - a very small green (roughly 4,000 square feet and under).

Pot bunker - a fairly small and relatively deep bunker, named because of its appearance. Most bunkers on links courses are generally of the pot variety.

Punch bowl - a green located in a hollow, so a ball hitting at its edge will generally roll toward the middle. Frequently found on early courses, where the water-collecting properties of such a site helped keep a good stand of turf.

Regenerated patch - an area that becomes free of disturbance within a chronically disturbed matrix.

Remnant patchb - an area remaining from a former large landscape element and now surrounded by a disturbed area.

Resistance - the ability of a system, when subjected to an environmental change or potential disturbance, to withstand or resist variation.

Routing - the positioning and sequence of holes on the landscape.

Short hole - a par-3 hole, or any hole usually requiring a short iron approach.

Shotmaking - athe deliberate alteration of a shot's trajectory from a straight flight pattern.

Slope rating - a measure of the severity of a course, or its added difficulty for a handicap player as opposed to a scratch golfer, used to determine if a player should receive extra handicap strokes for a match. An average course has s Slope rating of 113: the most difficult are slightly over 150, meaning the the higher-handicap player should receive 150/133 times his usual handicap allowance.

Sod-wall bunker - a bunker whose face is made almost vertical by tacking strips of sod one atop the next. Common on links courses to stabilize an erodable bunker face.

Species diversity - the number of species present. Also called "species richness." Sometimes an index (Shannon-Wiener) of species diversity is calculated, which includes not only the number but the relative abundance (evenness) of species.

Specimen tree - a tree with special visual impact on the landscape

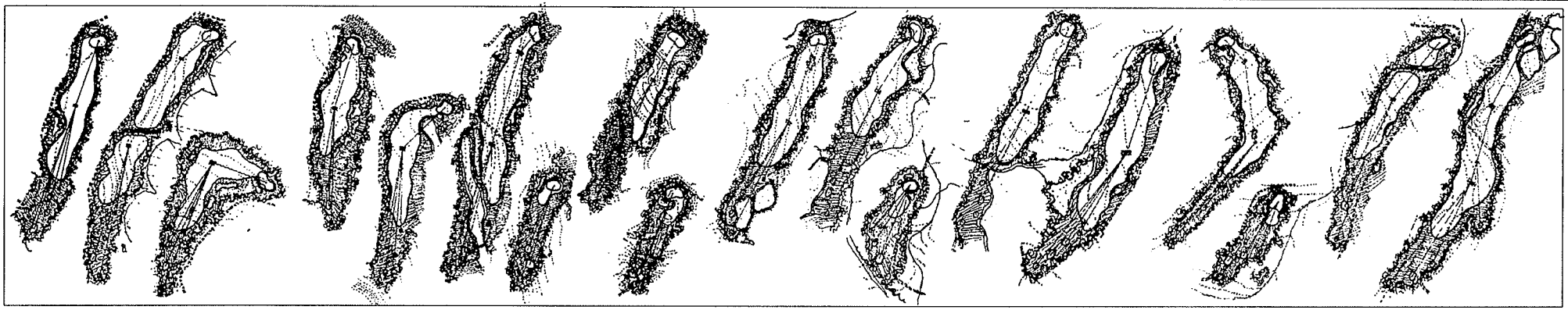
Stadium course - a course designed with mounds at the sides of the fairways to facilitiate spectator viewing during orurnament play.

Stream corridor - a band of vegetation bordering stream or river.

Strip corridor - a wide band with a central interior environment that contains an abundance of interior species.

Succession - a directional species replacement process, often leading through a series of recognizable stages to a climax community.

USGA green - a putting green constructed in accordance with the recommended method of the United States Golf Association's Freen Section. The method provides for subdrainage under three concurrent layers of gravel, coarse sand, and a special sand/ peat/soil mixture low in the root zone of the grass.



HOLE	1	2	3	4	5	6	7	8	9	Out	Initials	10	11	12	13	14	15	16	17	18	In	Out	Total	Hdcp	Net
GOLD	405	556	380	366	403	511	198	368	202	3389		420	415	188	453	393	489	194	454	564	3570	3389	6959		
SILVER	395	522	340	332	378	496	165	342	181	3151		399	375	160	424	361	457	157	385	532	3250	3151	6401		
MEN'S HANDICAP																									
PAR	4	5	4	4	4	5	3	4	3	36		4	4	3	4	4	5	3	4	5	36	36	72		
LADIES' HANDICAP																									
BRONZE	355	480	300	301	341	469	145	308	155	2854		352	350	136	361	332	397	131	350	494	2903	2854	5757	Slopes & Ratings are Posted in The Golf Shop	
COPPER	305	426	265	253	286	410	103	250	136	2432		307	323	120	304	306	342	108	314	436	2560	2434	4994		

Player _____ *Date* _____ *Attest* _____

SCORECARD

TSUGA GOLF COURSE

Sechelt

British Columbia

Appendix A

Charles Macdonald list of nine ingredients that were essential for an ideal golf course.

1. There can be no really first-class golf course without good material to work with. The best material is a sandy loam in gentle undulations, breaking into hillocks in a few places. Securing such land is really more than half the battle. Having such material at hand to work upon, the completion of an ideal course becomes a matter of experience, gardening and mathematics.

2. The courses of Great Britain abound in classic and notable holes, and one has only to study them and adopt their best and boldest features. Yet in most of their best holes there is always room for improvement.

3. Nothing induces more to the charm of the game than perfect putting greens. Some should be large, but the majority should be of moderate size; some flat, some hillocky, one or two at an angle, but the great majority should have natural undulations, some more and others less undulating. It is absolutely essential that the turf should be very fine so the ball will run perfectly true.

4. Whether this or that bunker is well-placed has caused more intensely heated arguments (outside of the realms of religion) than has ever been my lot to listen to . Rest assured, however, when a controversy is hotly contested over several years as to whether this or that hazard is fair, it is the kind of hazard you want and it has real merit. When there is unanimous opinion that such and such a hazard is perfect, one usually finds it common place. I know of no classic hole that doesn't have its decriers.

5. To my mind, an ideal course should have at least six bold bunkers at the end of two shot holes or very long carries from the tee. Further, I believe such holes would be improved by opening the fair green to one side or the other, giving short or timid players an opportunity to play around the hazards if so desired, but of course properly penalized by loss of distance for so playing. Other than these bold bunkers, no other hazards should stretch directly across a hole.

6. What a golfer most desires is variety in the one, two and three shot holes, calling accuracy in placing the ball, not alone in the approach but also from the tee. Let the first shot be played in relation to the second shot in accordance with the run of the ground and the wind. Holes so designed permit the player to , if he so wishes, take risks commensurate to the gravity of the situation.

7. Tees should be in close proximity to previous greens. This

Appendix B

reprinted from Golf Illustrated March 1990

The outlook wasn't happy
For the Duck Hook Club that day.
The crosstown match was even
With but one hole more to play.

Their champion was Clancy,
And in him they placed their trust.
But somehow Clancy now was tied;
The 18th was a must.

When Clancy strode up to the tee,
His visage was enough
To tell his fans they'd naught to fear ---
But Clancy found the rough.

Some Duck Hook patrons groaned aloud,
But, pluckily, the rest
Clung to the hope eternal
That springs in the human breast.

They knew that Clancy didn't fear
Tall grass or hidden lies;
They knew his booming second shot
Would sear the summer skies.

So when his dread opponent split
The fairway with his drive,
The faithful smiled. They know it would
Make Clancy come alive.

There was ease in Clancy's manner,
And a grin caressed his face.
There was nonchalance aplenty
As he stooped to tie a lace.

His takeaway was classic
And his downward stroke was true.
At impact, no one doubted
Mighty Clancy had come through.

Majestically the shot took wing,
And, with uncanny sense,
Flew flagward through the gentle air
As Clancy's foe went tense.

But then, a sudden gust of wind
Sprang up and caught the sphere,
And dropped it in a trap, from which
It did not reappear.

A roar of pure frustration sprang
>From all the Duck Hook lungs,
But Clancy raised his hands and stilled
The venom on their tongues.

Then Clancy's foe, upon whose lips
A sneer was clearly seen,
Drew back his iron and coolly struck
The ball --- well past the green.

A gasp of passionate relief
Escaped the choking throats
Of those who'd feared they'd have to write
Large promissory notes.

But happiness is fleeting
In this cruel and callous world;
The flags of hoped-for victory
Must sometimes be refurled.

O heartless fate! The dreaded foe
Produced a pitch-and-run
The likes of which the Duck Hooks
Had seen precious few --- or none.

The loathsome ball rolled to the cup ---
Look in --- and all but dropped.
A chill swept through the Duck Hook clan.
Their breathing all but stopped.

The hopes of Duck Hook sank.
In fact, they could not be much sunker.
Could Clancy get it up and down
When buried in the bunker?

They watched as Clancy ground his feet
Into the powdered loam.
Some Duck Hook members closed their eyes,
And some wished they were home.

Then Clancy's wedge was flashing high,
Then downward digging in!
The pellet came to graceful rest
Just two feet from the pin!

Up from a gladdened multitude
Arose a joyous yell.
They heard it up in Heaven
And, doubtless, down in Hell!

The Duck Hook members went berserk,
With handshakes, hugs and kisses ---
For Clancy had a two-foot putt,
The kind he never misses!

There wasn't even any need,
They knew, to hold their breath.
One simple putt, and Clancy then
Would win in sudden death.

A beaming Clancy doffed his cap
To the euphoric sound,
Then calmly stroked his putt
To its appointment underground.

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Oh, somewhere in this favored land
The sky is warm and sunny.
A band is playing somewhere,
And the world is milk and honey.

And somewhere men are laughing,
And women also --- but
There is no joy in Duck Hook.
Mighty Clancy missed the putt.

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Appendix C

Seven Landscape Ecology Principles

a) Landscape Structure and Function Principle

Landscapes are heterogeneous and differ in the structurally in the distribution and flows of energy, matter and materials among patches, corridors and matrix present. Consequently, landscapes differ functionally in the flows of species, energy, and materials among these structural landscape elements.

b) Biotic Diversity Principle

Landscape heterogeneity decreases the abundance of rare interior species, increases the abundance of edge species and animals requiring two or more landscape elements, and enhances the potential total species coexistence.

c) Landscape Change Principle

When undisturbed, horizontal landscape structure tends progressively towards homogeneity; moderate disturbance rapidly increases heterogeneity; and severe disturbance may increase or decrease heterogeneity.

d) Landscape Stability Principle

Stability of the landscape mosaic may increase in three distinct ways, toward a) physical system stability (characterized by the absence of biomass), b) rapid recovery from disturbance (low biomass present), c) high resistance to disturbance (usually high biomass present.

e) Nutrient Redistribution Principle

The rate of redistribution of mineral nutrients among landscape elements increases with disturbance intensity in those landscape elements.

f) Energy Flow Principle

The flow of heat energy and biomass across boundaries separating the patches, corridors, and matrix of a landscape increase with increasing landscape heterogeneity.

g) Species Flow Principle

The expansion and contraction of species among landscape elements has both a major effect on, and is controlled by, landscape heterogeneity.