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A LANDFORM STUDY FOR A GOLF COURSE IN CENTRAL KANSAS

by

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INTRODUCTION

PUBLIC OUTDOOR RECREATION

Public recreation is becoming increasingly more important as a vital planning element which must be incorporated in the planning for man's urban environment. Planning agencies of all types throughout the country are confronted with the problem of limited recreational space and in some cases underdeveloped recreational programs. In the past, insufficient space was allocated for the various recreational activities in urban areas, and now these areas are beginning to feel public demands for these facilities. This is largely due to increases in population, higher living standards, and increased leisure time.

With the current emphasis on public recreation, planning authorities are realizing the numerous restrictions that past planning has placed on the present and future development of recreation. A few of these restrictions are the lack of open space which is suitable for development, legal restrictions dictating land use, restrictions due to uncontrolled growth, and the undesirable relationships of surrounding conditions.

Other restrictions, not directly related to planning, stem from topographical limitations. These include unsuitable soil conditions, undesirable micro-climates, lack of vegetation, excessive slopes, and problems created by poor drainage. When all of these restrictions are considered, many planning agencies will often be required to use by-passed land for the development of recreational programs.

The number and extent of these restrictions will vary from city to city in every state. In Kansas, the one limitation that is outstanding and frequently hinders desirable development is that of the relative uniformity of the topographical features. Portions of the state where flood control reser-

voirs or other similar water containing features are prevalent are now being developed, whereas the remainder of the state, owing to the uniformity of elevation, offers limited desirable land for recreational development. As a result, the recreational pattern in Kansas has become very unbalanced.[1] Where flat topography is encountered, recreation has been developing very slowly, and as a result, adequate facilities are not available.

It is the purpose of this thesis to examine the unsuitable landform limitation, thus suggesting a method of analysis and the development of a study technique to aid in this analysis. The suggested method is used here to develop a golf course, but similar principles could be applicable toward the development of other recreational facilities.

THE NEED FOR GOLF

In the past few years, a nationwide effort to provide the needed public golf facilities has resulted in an increased demand for readily available space suitable for golf course construction. Many public agencies have been initiating action for the construction of new courses to alleviate the current shortage of this public facility.

This shortage is emphasized by recent statistics concerning increases in golfers and the money spent for golfing equipment.

> Over 750,000 persons took up the game last year in the United States. Today there are about forty golfers per thousand population; in 1936, it was sixteen. A look at golf equipment sales shows a similar growth. In 1936, golf equipment sales were less than $11,000,000 a year; today the figure is over $130,000,000.[2]

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[1] Ralph W. Sherman, A Landscape Interpretation of a Region of Kansas to Determine Its Suitability for Recreational Development, p. 3. Unpublished Masters Thesis, Kansas State University, 1964.

[2] Harry C. Eckhoff, What's Happening in Golf Course Development, Park Practice Trends, November 1964, 1:33.

Of the nation's golfing public, approximately seventy percent are men and thirty percent are women. Since 1961, there has been an annual increase in the number of players, but the most substantial increase has been that of women players. Golf authorities attribute the increased popularity and growth to golf television programs, the shorter work week resulting in more leisure time, higher incomes, increased life span, and the emphasis on the physical fitness program.[3]

Cities, counties, and states throughout the nation are becoming increasingly aware of the importance of golf as a national recreation activity and are striving to increase public recreation programs that will include the golf course as the hub of the development. This type of development is needed to reduce the shortage of existing courses.

> As of January 1, 1964, there were 6,804 regulation length golf courses and 673 Par 3 operations in play in the United States. Only about fifteen percent are municipal courses (city, township, county, or state operated), yet they are handling about forty-five percent of the nation's golf play.[4]

From January, 1963, through January, 1964, public courses showed an increase of six percent, while for the previous ten year period, the total increase was only thirty percent.[5]

A comparative study, using the figures compiled from November 1, 1962, through January 1, 1964, clearly shows the rapid growth. As of November 1, 1962, the total number of courses was 7,070, while there were 7,477 courses recorded on January 1, 1964.[6]

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[3]Loc. cit.
[4]Ibid, p. 64.
[5]Ben Chlevin, Golf for Industry, p. 3.
[6]Harry C. Eckhoff, Public Golf Development in the 1960s, Park Practice Guideline: Development, 2:63.

When looking at the relationship of the total population to the total number of courses available, it was discovered that in 1931, one golf course served approximately 21,000 people, while in 1964, one course served 25,000. Basing this relationship on the probable number of people who actually play golf, approximately 7,000,000 people, this roughly indicates that each course serves about 1,000 golfers.[7] In 1957, there was an estimate of 3,700,000 golfers and a total of 5,358 golf courses, or approximately seven hundred golfers per course.[8] In this seven year period, an increase in the number of golfers per course was approximately forty-three percent over the 1957 estimate.

Due to this shortage, the number of public courses in operation is subject to an increased concentration of traffic, and if poorly managed, they soon become unsuitable for play. The need, therefore, must be planned for in advance if a balanced program is to be developed.

This need for additional golf courses follows the same general pattern in Kansas as it does for the nation, showing an unbalanced proportion of public and private courses. In central and western Kansas, this unbalanced condition is more severe. In the study area, there are presently three golf courses, all owned by private organizations, which are not made available to the general public.[9] This is an indicator of the need for a public golf facility in the area under study.

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[7]Loc. cit.
[8]Chlevin, op. cit. p. 5.
[9]Dick Chastain, interview with author, November 5, 1964.

BASIS OF STUDY

With the need established and with the problems created by the topography kept in mind, a program of study was developed. In order to design a public golf facility, it was decided to analyze the accepted standards and from these, derive an aesthetic principle which could be used in a sculptural approach. The aesthetic principle then, permitted the modeling of the topography to compliment the game of golf.

In a sculptural approach, there are two processes used when arriving at a form.

> Sculptors working with clay or with welding tools add pieces together and make form by accretion, or carving in wood or stone they remove bits and chunks from the basic mass and make their forms by subtraction.[10]

The approach to be used in this study is a combination of both processes: accretion and subtraction. Depressions will be carved from some areas, and the study media deposited in other areas to form mounds. Upon completion, the new configuration of the surface will contain sculptural landforms, which refers to the shape into which a land surface has been molded by a sculptural technique conforming with nature's processes.

> We derive our sense of sculpture, our understanding of form, our relation to group composition, our basic choreography through our relationship to natural phenomena.[11]

Earth sculpture has gained new emphasis in recent years due partly to the shortage of suitable topographic relief for construction. In some areas, this has brought about the need to develop previously by-passed land where undesirable topographic features were prevalent. This land is frequently used for commercial development and is often terraced to create plateaus. These

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[10]Lawrence Halprin, "The Shape of Erosion", Land. Arch. 52:87, January 1962.
[11]Ibid, 52:88.

plateaus are not related to the surrounding landforms, and there is no visual evidence of an attempt to compliment nature.

When earth sculpture is to be executed, the first step is to fully analyze the existing topography determining what natural forces have caused it to take that particular form. By examining profiles or other graphic representations of the site, a rhythm or sequence of similar conditions can be determined. By expanding or emphasizing the properties of the existing landforms, new forms that will blend with the surrounding conditions can be determined for use in the development. This is the basis for studying the landform variations of the site and applying modifications of these variations for the development of a golf course.

METHODS AND MATERIALS

After the selection of the problem, a tentative outline of the work to be performed was established. Reference material relating to the accepted standards in the design and construction of a golf course was compiled, and a thorough investigation of these standards established the basic requirements for development.

When the accepted standards were organized for easy reference, attention was turned to the selection of a site. The site was chosen in central Kansas to follow up a study that was conducted in that area by Ralph W. Sherman, entitled, A Landscape Interpretation of a Region of Kansas to Determine Its Suitability for Recreational Development. Mr. Sherman's study encompassed a four-county area: Rice, Barton, Stafford, and Pawnee. After studying this area, a tentative location near Great Bend, Kansas, (Barton County) was chosen. A survey based on the size of the city, the type of people and their employment, the limited golf facilities present, and the minor variations of

the landforms revealed that this location was suitable for this type of development.

Upon examining county and highway maps, several possible sites near Great Bend were chosen. These sites were located on the U. S. Coastal Geodetic Survey Maps to establish the general lay of the land. The map used was at the scale of 1 : 24,000, with a five foot contour interval. The site, finally selected on the basis of map interpretation, was devoid of housing or oilfield operations and encompassed a meandering creek. From the Geodetic survey, the site was blown up to the scale of one inch equals one hundred feet, and the one-foot contours were interpolated. The next step was a two-day inspection trip to the Great Bend area to analyze all of the existing conditions of the site. They were found to be highly desirable, and with this information, the design requirements were next to be established. Both a program for development and an esquisse were worked out, and a technique for study was designed.

The study technique used to fulfill the design requirements of this thesis was the third dimensional examination of all the related aspects of the site to the golf course. In order to conduct a three-dimensional study, a design model was needed that would permit evaluation of the existing landforms and be flexible enough to permit the proposed landforms to be constructed on the same model at a later date.

This study model was constructed so that the site could be viewed from any angle for maximum control of development. The base of the model was a three-fourths inch sheet of exterior plywood, measuring forty inches square. A groove was cut three-eighths of an inch deep and one-fourth of an inch wide on each side of the base, leaving a two-inch margin. This groove accommodated plate glass sides which were 7/32 of an inch thick and 6 3/8 inches high, so

that when in place, the model was thirty-six inches square and six inches high. The use of an epoxy resin glue permitted the joining of all the glass sides to each other and to the plywood base. To complete the shell of the model, a plate glass cover, 7/32 of an inch thick and thirty-six inches square was used to cover the entire model. In finishing the interior surface, the plywood was treated with two coats of marine varnish. The need for a flexible medium to be used for modeling the topographical surface was fulfilled by the use of a moist clay. This clay was dug from a hillside near Manhattan, Kansas, and mixed with water and cooking oil to the desired plastic consistency. This consistency permitted movement of the clay for changes in the surface once the model was in use. A large quantity of this clay was mixed so that the entire site could be constructed at a reduced scale in the glass model.

It was felt that in order to best show how the site would appear in the surrounding landscape, a marginal area should be incorporated. This was accomplished by showing a 500-foot band surrounding the actual site. Since the site was exactly one-quarter section, measuring 2,640 feet on a side, the scale of one inch equals one hundred feet was determined as an appropriate scale at which to work. This scale was large enough to show all the desired relationships and still small enough to be contained within a model that would be moveable. Due to the minor variations of the site and the small horizontal scale, it was decided to exaggerate the vertical scale in the order of one inch equals ten feet to better visualize the landforms.

The transposition of the site from the contour map to a three-dimensional model of the site was accomplished by the use of cross sections. These cross sections were taken every two hundred feet across the entire site by using templates which showed the actual changes in elevation at the various sections.

The templates were cut from chipboard measuring thirty-six inches long and six inches high, so that when the cross sectional area was removed, the template could be taped into the model with the top of the template flush with the top of the glass sides. Once these were in place, the clay was added to the model so that it exactly fit the landforms as described by the templates. When all the clay was in place and the templates removed, the model was then in the same form as the site, except at the reduced scale.

Through the use of the site analysis, the study model and the contour map, a tentative layout for the golf course was determined, following the principles set forth by the examination of the desired standards. This tentative layout was then transposed onto the model for further evaluation and for the process of grading.

In theory, the model would allow the actual grading to be done in the third dimension, and by using a water technique, the proposed contour map could be developed directly from this model. The model also permitted a theoretical balance in cut and fill, provided clay was neither removed from the site nor added to it. This theoretical balance does not include provisions for shrinkage, but is merely a rough indicator of the earthwork to be performed. After the tentative layout was transposed, the desired landforms were created by manipulation of the clay material into the new forms. When the entire site was regraded, the model then was a tentative proposal for development, showing the layout of all the facilities and their relationship to one another and to the site, as well as a grading plan.

When this proposal was finalized, the problem of deriving a contour map was solved by using varying water levels to deliniate the contours. This was done by incorporating a vertical scale of one inch equals ten feet, located

on the glass side adjacent to the lowest point on the topography. The scale consisted of a strip of frosted cellophane tape with horizontal lines spaced at one-tenth of an inch apart from the bottom to the top of the glass wall. From this scale, one foot contours could be determined by adding water to the model at one-tenth of an inch intervals, providing the model was level. As each increment of water was added, the water flowed to all portions of the model of the same elevation, thus determining the actual contour. Each contour was then traced onto the glass cover of the model through the use of a grid system that was drawn on both the clay material and glass cover. This process of adding water one foot at a time and tracing the contour was continued until the entire model was underwater. At that time, the proposed contour map was located on the glass cover. This map was then transferred to tracing paper, and all the proposed slopes and other grading changes were examined to see if they met the desired standards. From this map, detailed areas such as greens and tees were blown up and graded to show one-tenth of a foot contours. After the grading was executed, all other plans, elevations, and perspectives were drawn. These included the planting theme, as well as the clubhouse facilities. When these were developed and drafted in final form, a second model for presentation was built, using semi-permanent materials constructed at the same scale of one inch equals one hundred feet, incorporating all the features that were used in creating the sculptured golf course.

CHAPTER I

PROGRAM ESTABLISHMENT

ANALYSIS OF ACCEPTED STANDARDS

General Layout

Establishing a public recreation program, revolving around the game of golf, calls for a thorough understanding of nature and its processes. Golf architectural authorities recognize the importance of evaluating the natural environment, but this environment does not always provide topography which is suitable for golf. In general, however, sites are selected that will require the least amount of modification. When designing the strategy, the natural hazards should be utilized to their fullest advantage, since they are the most interesting and can be more easily and economically maintained.

If the existing landform is naturally unsuited for golf, there is the problem of designing a course so that every kind of shot found on ideal topography is possible. Variety can be provided on an otherwise undesirable site by varying the length of holes. Another method is to use modern machinery, moving soil from some areas where depressions are necessary and piling soil in other areas to create mounds. This sculptural approach is conceived through the understanding of the limitations established by the theory of golf.

Choosing the proper site is probably the most important element in the planning process, and a poor choice can greatly increase the cost of development. Normally, several prospective sites are evaluated and after thorough site analyses, the most suitable is selected for development.[1] The site should be located along a main highway which is paved and well maintained, so that access to the facility can be possible in all types of weather.

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[1]M. Alexander Gabrielsen, and Casswell M. Miles, Sports and Recreation Facilities, p. 273.

The physical site characteristics, such as the location of property lines and the percentage of slopes, should be carefully analyzed. For example, an irregularly shaped site may afford design opportunities quite different from more regular sites. Rugged topography should be avoided, but a site which is gently rolling with some trees is usually considered ideal. Steep slopes are tiring on players, necessitate many blind shots, and are more costly to maintain.[2] When the topography is gently undulating, the site should contain at least eighty acres for a nine-hole course; 160 acres is considered a desirable minimum for an eighteen-hole course. This acreage will include space for the attendant facilities which are needed for this type of development as well as the demands for future expansion. Frequently, enough land is purchased so that adjacent residential sites can be sold to help cover the initial expense.

Another important factor in selecting a site is the quantity and quality of water. The average eighteen-hole course will require approximately 360 gallons of water per minute to meet irrigation demands.[3] If water features on the site cannot deliver this amount, provisions for storage will be needed.

After the site has been selected and an accurate topographical survey completed, the siting for the clubhouse should be determined. The clubhouse should be located near a boundary abutting a public highway. This will reduce the expense of building roads on the property and will not bisect the site, which otherwise might result in a limited area for play. The clubhouse should have privacy from the highway and provide a view to the greatest portion of the

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[2] Loc. cit.
[3] Gabrielsen, op. cit., p. 289.

course.[4] This can be accomplished by siting the structure on high ground orienting it so that the glass surfaces, terraces, and other similar areas are shielded from the afternoon sun. Other immediate considerations are the nature of the soil, location of trees, accessability of water, and the feasibility of parking.

If the course is to be planned to meet the various interests of the golfer and his family, other forms of recreation should also be provided. These are usually closely associated with the clubhouse and should be an integral part of the site plan. Such facilities often include swimming pools, tennis courts, practice putting greens, driving ranges, a practice hole, and other similar features. The driving range should be oriented so that golfers will be hitting towards the north. Rubber or brush tees, spaced at a minimum of ten feet apart, should be laid out in an arc with all aiming points converging on a central location 160 yards from the center tee. A restraining line is usually located approximately ten feet behind each tee for public safety.[5]

The practice hole, with tees set 150, 190, and 230 yards apart, permits players to play shots to the green without interfering with the use of the regular course.[6] Practice ranges are often lighted for night use permitting golfers to develop skill for conventional day play.

In relating the course to the clubhouse facilities, the first tee, the ninth green, and the eighteenth green should be relatively close to the locker room and pro shop.[7] If possible, the sixth green should also be located near

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[4]William S. Flynn, "Designing the Course", The Bulletin, August 1927, 7:157.

[5]Loc. Cit.

[6]Gabrielsen, op. cit., p. 292.

[7]Clifford Charles Wendehack, Golf and Country Clubs, p. 6.

the clubhouse for those golfers with only one hour to play. This permits players to start at a logical point and to retire at the end of the sixth, ninth, or eighteenth hole. A current trend in course design is three radiating nine-hole loops from the clubhouse, creating six possible eighteen-hole combinations.[8]

After the clubhouse site plan has been tentatively determined, the next step is to lay out the course. The preliminary design is based on probable answers to the following questions: 1. What is the maximum number of green sites? 2. Will the green site be adaptable for a particular type of hole? 3. Is the cost of construction of a green at this location feasible? 4. Does the location have aesthetic qualities, such as background views and possible vistas?

After the green sites are tentatively located, the strategy and sequence of play can be programmed. Robert Trent Jones, for example, divides the strategy of play into three kinds of holes.[9] The first is the penal type, where traps guard the green in a bottleneck or island fashion. One or two holes of this type will suffice for an eighteen-hole course, and these should always meet the par 3 classification. The second, the strategic type, utilizes fewer traps and places them so that any golfer can drive with full power, but must place his shots to obtain the most favorable position. Up to fifty per cent of the course should be of this type, with the length of the holes meeting the standards for a par 4 classification. The third is called the heroic, which is a combination of both the strategic and penal types. The hazards are placed on the diagonal so that a player can choose an

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[8]Raymond Frederick Cain, The Landscape Architectural Approach to Flexible Golf Course Design, p. 11. Unpublished Masters Thesis, University of Illinois, 1962.

[9]Gabrielsen, op. cit., p. 278.

intermediate target within his limitations. The farther he can carry, the more advantageous he will find his position for the next shot. This type of hole is adaptable for any length and should be utilized on thirty to fifty per cent of the course.

The total length of an average eighteen-hole course should be between 6,200 and 6,600 yards, while championship courses are between 6,700 and 6,900 yards in length.[10] The average eighteen-hole course should have eighteen holes of different lengths which fall into several par classifications. The term par means "perfect play without flukes and under ordinary weather conditions, always allowing two strokes on each putting green."[11] The lowest par classification is the par 3 hole, which is generally between 130 to 240 yards in length. Four to five of these should be used on an eighteen-hole course. The par 4 holes have a length of between 350 to 450 yards, and there are generally ten of these used per eighteen holes. Par 5 holes vary in length from 450 to 550 yards, and there should not be more than four of these used.[12] The 240 to 350 yard distance should be avoided if possible. This distance is too long for the average player to make in one shot and not long enough to require two shots. If this length is used, it should be designed as a dog-leg hole, with the direction of play bending at approximately the 225-yard point. It will often include a large trap at the bend and a rather narrow putting surface with some sort of a hazard on the far side of the green.[13]

The length of the holes will be determined by such factors as the direc-

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[10]Ibid p. 279.

[11]"Length of Holes in Relation to Par", The Bulletin, January 15, 1925, 5:11.

[12]Gabrielsen, op. cit., p. 279.

[13]"Length of Holes in Relation to Par", op. cit., p. 277.

tion of play, the natural features of the site, and the desire to obtain a variety of lengths throughout the course. Where steep slopes are encountered, downhill play should be planned; the uphill play should be planned for slopes of lesser grades. Ravines make desirable short hole problems with the tee located on one edge of the ravine and the green on the other.

The east-west direction should be avoided, since the maximum amount of play is in the afternoon. If this is not possible, however, these holes should be located so that a player will come across them early in the game.[14] Blind shots from the approach area should be avoided, and similar shots from the tee should be kept to a minimum. There should be alternate routes to the green, and the course should be designed so that every club in the bag is used.

Programming of Holes

The first hole is usually a par 4 hole, approximately 380 to 400 yards in length and comparatively free from delaying hazards. The holes should become increasingly difficult to play, since it takes the average golfer around three holes to warm up.

Par 3 holes are never consecutive, and the sequence is such that the first one is not encountered earlier than the third hole, nor the second not earlier than the eighth hole. The first par 3 hole is usually 130 to 160 yards in length, while the second is over 180 yards in length. For an eighteen-hole course, four par 3 holes are normally used. These vary in length, but the first two should meet the above standards. Four par 5 holes are often used on an eighteen-hole course, with the remaining ten holes meeting the par 4 classification. Frequently the first par 5 hole encountered is around 480

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[14]Gabrielsen, op. cit. p. 277.

yards in length, while the second is between 520 and 550 yards.[15] Occasionally, par 6 holes are used, but these become boring and delay play for too long a period of time.

A golf course containing only nine holes will normally have a total par ranging from 35 to 37, with 36 the most frequently used. When the course is eighteen holes, the total par is usually 72. Robert Bruce Harris recommends the par order for nine holes to be 4-5-4-3-4-5-4-3-4 for a par total of 36.[16]

Greens

The definition of a putting green, according to the Rules of Golf, is "all ground of the hole being played which is specially prepared for putting."[17] It is the final target for each hole and must always be visable from the approach area. If possible, it should also be visable from the tee and all locations where additional shots are required.

Many factors are involved in creating a suitable surface for the purpose of putting. These factors, grouped according to similar characteristics, will establish a program for evaluation. This program includes site factors such as location and orientation, design factors relating size and shape characteristics, and construction factors based on soil types, slopes, and drainage.

Greens are sited and oriented to blend with the topography in a logical aesthetic and efficient manner. Successful siting is partly measured by traffic patterns which discourage players from using the green as a traffic

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[15]Loc. cit.
[16]Gabrielsen, loc. cit.
[17]United States Golf Association, The Rules of Golf, p. 6.

way.[18] In addition, the relationship of and distance from the green to the next tee must be analyzed and conform to accepted standards. Safety factors relating to the prevention of accidents are also designed into each hole since the line of play directly determines the degree of safety, and the location of the green establishes this line of play.

The green location has a direct effect on the cost of construction since excessive earth moving or drainage facilities can soon destroy a budget. By advantageously using natural features, desirable strategy for a hole can usually be created within economic limitations.

Other site factors, such as proper air circulation, can reduce maintenance costs, as well as improve air circulation. Many problems can be avoided by locating greens at least twenty yards away from existing shade trees, so that the tree roots and shade will not interfere with turf growth or maintenance.

Two important design characteristics, the size and shape of the green, have been under study for many years. The commonly accepted theories include strategy of play, the cup placement and the maintenance as basic design criteria.

The many factors affecting variation in strategies of play help establish a reasonable size for individual greens. Thus, "Green sizes will vary from 5,000 to 8,000 square feet, depending upon the length of the hole and the length of the shot called for."[19] A one-shot hole, for example, 240 yards in length, should have the largest green, whereas a one-shot hole which is shorter, should have a proportionately smaller green. Conversely, with longer

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[18]Charles M. Eckstein, "Putting Green Design", U.S.G.A. Green Section Record, March, 1964, 1:5.

[19]Gabrielsen, op. cit., p. 279.

holes, the size of the green depends upon the length of the approach shot. Usually, these greens are smaller than one-shot holes.[20] The strategic elements, such as traps, however, will determine the shape and outline of the green. Problems of visability can also determine the shape of a green, as will the blending of the green into a topographical feature.

Cup placement is critical and the size and shape of the green will partially determine how many locations are possible. Variable cup placement will add interest to the course, spread traffic uniformly, prevent soil compaction, and reduce the actual wearing of the turf surface. There should be many distinct cup-cutting areas on each surface, and these should be divided by either gently sloping undulations, or long sweeping rolls which will accommodate a pin position without undue penalty to the player.[21] These multiple pin positions also provide for strategic play which can vary in difficulty and will help protect the putting surface from excessive wear. Different pin positions may require a shot to be played from an entirely different angle from day to day.

Pin positions should be on relatively level ground; and the current trend suggests that these pin positions are the targets for the low-handicap player, while the whole green is the target for the average player.[22] Sudden rises or undulations should be avoided, and the upper limit of slope should not exceed ten percent. Fair pin placement specifies that the pin will not be located within ten feet of the edge of the green, while the U.S.G.A. recommends a minimum of fifteen feet.[23] This fifteen-foot-wide band around the

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[20]Eckstein, op. cit., 1:4.
[21]Robert Dunning, "Basic Concepts of Green Construction", The Golf Course Reporter, April, 1962, 30:16.
[22]Ibid, 30:18.
[23]Eckstein, loc. cit.

green greatly reduces the possible area for cup placement.

A system of alternate greens can be used for a temporary putting surface when excessive wear is evident, or when maintenance interferes with playing. They are also used for a winter green and rotation purposes when adverse weather or normal maintenance requires play to be suspended.

On private courses, the area of the alternate greens is frequently from three hundred to four hundred square feet and in close proximity to the regular green, but on public courses this size should be increased to approximately fifteen hundred square feet, due to a larger volume of traffic.[24] These greens are maintained as the regular greens, except that they are watered more deeply and less frequently. Each alternate green is slightly elevated for proper surface drainage but should not be elevated more than one foot with the pitch toward the front.[25]

When analyzing the factors related to the construction of greens, a logical point of departure is a professional soil analysis. A competent soil analysis can be conducted by state agricultural experiment stations or county agents. The significance of such an evaluation is the understanding of the requirements for irrigation, drainage and soil fertility.

The first step in a normal construction program is to remove the topsoil and stockpile it for use as an ingredient in the final soil mix. For a wide range of climatic conditions and turf species, an ideal soil is a sandy loam containing not more than four to six percent clay in the final mixture.[26] A general composition of the topsoil required for a green is approximately eighty-five per cent sand, ten percent upland soil, and five percent peat.[27]

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[24]A. M. Radko, "Eighteen Alternate Greens", U.S.G.A. Green Section Record, September, 1963, 1:11.

[25]Ibid, 1:10.

[26]Bob Dunning, Green Construction, p. 3.

[27]Dr. Ray Keen, discussion with author, October 19, 1964.

These figures should be determined precisely by a laboratory analysis of a soil sample from the site and the proportions varied accordingly. The sand to be used in this mixture is defined by the Bureau of Soils as a mixture of "coarse" and "medium" sand, ranging in size from 1/8 to 1/50 and 1/50 to 1/100 of an inch in diameter respectively. Eighty percent of this sand should be graduated within the 1/8 to 1/50 of an inch category, and the remaining twenty percent must be within the 1/50 to 1/100 of an inch category.[28] If coarse sand is used in a large percentage of the mixture, the soil becomes hard and non-resilient. The advantages of using this sandy soil mixture for greens is that it aids in percolation of water and oxygen through the soil and also facilitates the removal of soluable salts by allowing free water to be carried off by the subsurface drainage system.

When considering the type of soil for the base of the green, the article, "Green Construction", suggests that

> The base of the green may be constructed out of any soil at hand unless it contains material that would cause excessive subsequent shrinkage or would be deleterious to plant growth and shall be compacted and watered to prevent shrinkage.[29]

The finished grade relationships of a green may take several forms. It may be tilted, sloped, or pitched in any direction; it may be terraced or undulated. It can be guarded by adjacent mounds which are not part of the green but which must be carried, or it can be any combination of these.[30]

A successful finished grade also indicates adequate surface drainage of the green and the adjacent slopes. When slopes are used, they should be gen-

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[28]Bob Dunning, Green Construction, p. 2.
[29]Ibid, p. 5.
[30]Eckstein, loc. cit.

tle, provide maximum cupping area and permit mowing from either direction to prevent scalping or undue wear. These slopes will blend into the topography in a natural way, and provisions for avoiding erosion or adjacent traps must be considered.[31]

Since the finished surface of the green is based in the subgrade, it is important that all grading operations be supervised according to written specifications and construction drawings. There should be no pockets where water will stand, and the surface should be constructed so that run-off is handled in several directions--never entirely draining off the front of the green.[32]

Undesirable features, such as greens which are pitched from back to front at a uniform grade of two or three percent, greens which are flat, and those which take the form of an overturned plate should be avoided.

The slope percentage limitations for the putting surface should be handled so that a minimum of 1.5% and a maximum of five percent are used throughout. This maximum slope can be increased according to specific play strategy, but should never be so sever that the ball would gain momentum after being stroked.[33]

On greens which slope from the front to the back, Robert Trent Jones[34] specifies that the slope should not exceed five percent, unless it is a break in the general slope by a depression. This depression, if not too deep, may include slopes up to ten or fifteen percent. He also specifies that the approach slope of a plateaued green may approach twenty percent, as well as the

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[31]Ibid, 1:5.
[32]Dunning, "Basic Concepts of Green Construction," The Golf Course Reporter, April, 1962, 30:18.
[33]Ibid, 1:5.
[34]Gabrielsen, op. cit., p. 280.

side and back slopes. Mounds at the perimeter of the putting surface may be used to divide drainage areas for surface run-off or for orientation and character. They should be graded to permit maintenance with gang-type mowers or multiple reel-power mowers. There should be adequate space for this equipment to operate and maneuver between the traps and the putting surface and this is usually accomplished by specifying a ten or twelve foot apron extending from the perimeter of the putting surface.[35]

Greens are often encountered on hillsides where the slope has been altered, leaving a bank rising above the green, or they are located on the low, flat surface near the base of these hills. The problem of intercepting seepage water and of diverting surface water around the green rather than across it is accomplished by a drainage ditch between the green and the higher ground at a depth below the lowest level of the green.[36] A line of drainage tile is placed on the bottom of the trench, and this tile is connected to a drainage system with an outlet which drains to an out-of-play area. Crushed rock is used as backfill up to the level of the ground surface and treated as a grassy hollow, establishing a problem of strategy as well as serving as a functional drainage element.

A subsurface drainage system usually consists of agricultural clay tile, laid in the bottom of a trench. These tile vary in diameter, depending on the size of the area they are to serve. A three-inch tile is used for a lateral up to four hundred feet in length, while a four-inch tile is used for laterals up to one thousand feet in length. The spacing at the joints should

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[35]Eckstein, op. cit., 1:4.

[36]B. Fitts, "Seepage Water, A Menace to Good Turf Maintenance", The Bulletin, March, 1927, 7:47.

be 1/8 to 1/4 inch and should be covered with tarpaper to keep foreign material from entering the system. A constant slope of at least one-half percent should always be maintained.

The depth of the tile also varies, depending on the area to be drained and the structure of the soil. For fairways and greens on sandy soil, the depth should be from two to 2 1/2 feet, while on greens in clay-like soil, 1 1/2 to two feet is specified.[37]

These tile lines can be laid so that several lines lie parallel with the greatest slope, or they can be used in a herringbone system where the main line follows the direction of the general slope. This main line bisects the green with the lateral positions making a 45-degree angle spaced between ten and twenty feet apart. After the tile is laid, it should be backfilled with pea gravel or crushed rock to within six or eight inches of the surface.[38]

Maintenance needs will often indicate construction faults before they can be detected by any other means. A few of these faults which can cause the greatest amount of trouble are too few pin positions, soils excessively sandy or clay-like, a green badly drained, a green which requires overwatering to hold a golf shot, lack of desirable turf or insufficient space at the green site for maintenance needs.[39]

Consideration must also be given to the efficient use of fertilizer, labor involved in mowing, spraying, aerifying, spiking, and watering.

An eighteen-hole course in Southern California is a good example of the

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[37]Kenneth Nelton, "Golf Course Construction", The Bulletin, August, 1928, 8:159.

[38]Gabrielsen, op. cit., p. 283.

[39]Holman M. Griffin, "Concepts of a Perfect Putting Green", U.S.G.A. Green Section Record, March, 1964, 1:6.

cost of maintenance for greens.[40] On this course, 7,800 man hours were devoted at a labor expense of $21,000, plus $7,000 for materials, supplies, and equipment depreciation. The $28,000 spent for maintenance was approximately twenty-five percent of the total course budget. Located on a 130-acre site, the course has only three acres which are devoted to the twenty greens. This represents about two percent of the total land and clearly shows that the putting green is the most expensive element of the golf course.

Tees

The Rules of Golf defines the teeing ground as "the starting place for the hole to be played."[41] This starting place takes many different forms, and many factors affect the size, shape, location, and number of tees needed per hole.

The out-dated size requirement of "a rectangle two club lengths in depth" has been changed largely due to an increase in play. The modern criteria of design suggests that tees be designed to permit flexibility in the length of the hole and be large enough to accommodate the frequent change of markers which will reduce localized turf damage. In the article "Tees and the Golf Course", it is suggested that

> A good rule of thumb for tee size is a minimum of 100 square feet of useable tee space per 1,000 rounds of golf per year on par 4 or par 5 holes, and a minimum of 200 square feet per 1,000 rounds of golf per year on par 3 holes subjected to iron play from the tee. For tees on par 3 holes played with a wood, the same rule of thumb applies as is suggested for tees on par 4 and par 5 holes.[42]

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[40] W. H. Gengyfield, "Course Maintenance Centers on the Putting Green", U.S.G.A. Green Section Record, March 1964, 1:3.

[41] Rules of Golf, op. cit., p. 8.

[42] Alexander M. Radko, Holman M. Griffen, and Lee Record, "Tees and the Golf Course", U.S.G.A. Green Section Record, May 1964, p. 1.

In addition to size requirements, various tee shapes are possible, but the shape of any tee should blend into the topography and permit the use of power equipment for maintenance. The use of long gentle slopes meeting the existing grade will fulfill both requirements.[43] Among the shapes widely used are the circular, semi-circular, "L" shaped, "T" shaped, and "U" shaped tees. The current trend indicates that tees should be built as close as possible to the natural ground level, unless problems of visability or drainage dictate otherwise. Other considerations when locating tees are the relationship of the tee to the preceding green, the different driving abilities of players, and the traffic patterns.

The distance between the green of one hole and the tee of the next should never exceed seventy-five yards with the recommended length between twenty and thirty yards.[44] While this will reduce fatigue by shortening the overall length a player must walk, the tees must be located or protected to prevent being hit by a wild drive from an adjacent hole.

There have been several solutions advanced for the location of tees in connection with the players' driving abilities. The simplest solution is to use long rectangles with the long axis oriented with the line of play so that players can advance to the location of the tee which best suits their ability. On courses limited to this solution, however, the front third of the tee receives the greatest wear.[45] A second and more practical solution is the use of three different tees. These are staggered so that the line of play does not pass over the forward tees and a color designated system of

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[43]Robert Bruce Harris, "Architectural Matters Affect Maintenance Costs" U.S.G.A. Journal, April 1958, p. 1.

[44]Gabrielsen, op. cit., p. 277.

[45]Alan D. Wilson, "Measurement of Golf Holes and Placing of Tees", The Bulletin, May 1926, 6:194.

marking the tees can be incorporated. The tee farthest from the green is called the championship tee, and the color assigned to it is red. The middle tee, referred to as the regular tee, has a white marker, while a blue marker indicates the ladies' tee which is nearest to the green. When this system is used, a player can associate his ability with the proper color and thus, make the game more interesting for himself and prevent delay. The size of these tees can be reduced for the ladies to approximately one-half the size suggested for the men.[46]

The final consideration of the relationship of the tee to the preceding green is that of maintenance. Tees should be located to receive a minimum amount of traffic and this can generally be accomplished by car paths designed to lead the players around the perimeter of the tee.

When constructing tees, the final grades are executed to appear as a natural surface with natural drainage characteristics. Surface drainage is accomplished by using a minimum slope of 1.5 percent descending from front to rear.[47] This slope will allow sheet flow rather than drainage in narrow channels and will not be detected by the player. On the other hand, internal drainage is accomplished by a four-inch drainage tile laid in the same manner as for greens, with the outlet placed in some out-of-play area.[48]

The teeing site should also include provisions for clean towels, ball washers, trash receptacles, benches, and possible shelters. When shelters are used, they should be large enough to accommodate a foursome and must be grounded if in the open.[49]

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[46]Radko, Griffen and Record, op. cit., p. 2.
[47]Ibid, p. 3.
[48]Loc. cit.
[49]Charles L. Lawton, "Golf Course Rain Shelter", The Bulletin, April 1925, 5:136.

Hazards

The U.S.G.A. defines a hazard as "any bunker or water hazard."[50] Its purpose is to inspire a player to overcome the difficulties at each hole while achieving greater accuracy of play in both direction and distance.[51] Bare patches, scrapes, roads, tracks, and paths are not hazards.

The hazard has as its concept the establishment of a target; the creation of mental hazards pertaining to position, distance, and carry; and to penalize the poor shot, not the poor player. A hazard should be located so that the duffer does not have to risk penalizing strokes in order to play the hole. These hazards determine the degree of ability a player must possess in order for the course to be of real interest for skilled players, while duffers may find it impossible to carry such hazards.

If the course is designed primarily for the average player, his limitations will determine the strategy of the hole. Hazards which do not affect the strategy of play and those which penalize the high-handicap golfer should be eliminated. A well-rounded course is one that offers the opportunity for every player to be successful within his limitations.

There are five basic forms of hazards which are commonly used in establishing strategy of play. These are the sand trap, grassy hollow, bunker, water hazard, and plant material.

A sand trap is a depressed area covered with sand; turf borders or turf within the trap are not part of the hazard.[52] Sand traps can be used in a variety of ways in designing the strategy of a hole. On fairways, they require

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[50]The Rule of Golf, op. cit., p. 4.

[51]Maynard M. Metcalf, "Water Hazards", U.S.G.A. Green Section Record, January 1927, 7:41.

[52]The Rules of Golf, op. cit., p. 4.

precision in distance and placement of a shot. On dogleg holes, they can be used at the location where the direction of play changes, thus guiding players in placement of shots and preventing short cuts to the green. Another use is to guard the entrance to the green and make the final shot a rewarding experience.

On the fairway, a sand trap usually means a sacrifice of one shot in order to get back into a playing position.[53] Since the concept of trapping is to penalize only the bad shot, the traps must be designed so that they fit into the topography in a natural manner and at the same time be clearly visible to the player. Such traps appear as long, gentle slopes which merge naturally with the fairway.[54]

In general, the sand trap should be open in the front and elevated in the rear. This aids in drainage and will make the location and extent of the hazard obvious to the player. A minimum depth of six inches at the entrance to the trap is necessary to retain the sand due to water and wind erosion. The best type of sand to use in the traps in specified "medium sharp", and this sand is placed in the trap in a six-inch layer. The back and side interior slopes should be graded away from the fairway (or green) so that the slope will not exceed thirty to forty percent.[55] The rear edge of the depression should be rather abrupt for approximately nine inches in order to make the ball roll back into the trap if it fails to clear the top edge. The bottom of the trap is graded for drainage by maintaining at least a four percent slope towards the entrance.

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[53]Gabrielsen, loc. cit.
[54]Cain, op. cit., p. 6.
[55]Gabrielsen, op. cit., p. 280.

One of the most important factors in the consideration of sand trap design is the ball position once it lands in the trap. For the ball to be playable, it must settle in the trap so that a proper backswing is possible. A twenty-five percent maximum slope at the entrance of the trap is usually specified.[56]

A current trend is to maintain traps with large and efficient power equipment in order to minimize hand maintenance. Such site factors as slope percentages, the distance between traps and the turning radii of the equipment must be analyzed and the proposed layout adjusted accordingly. It is easier to maintain the areas surrounding sand traps if the edges are smooth, rather than scalloped.

Internal trap maintenance can also be a serious problem. In order for a trap to be readily visable, sand must be maintained on the interior slopes. It is important that players leave the trap in good condition for the following players by raking out all the ball marks, foot prints and other prints which could influence the settling of a wayward ball.

The drainage of a sand trap on the fairway can be easily accomplished by placing a four-inch drainage tile in the bottom of the trap at the subgrade level so that any water entering the trap will percolate through the sand and flow along the subgrade until it enters the tile. The tile is then laid so that it drains off the fairway to a lower point on the topography.

If the trap is to be located on flat topography or in heavy soil, a mound will need to be constructed and the entire trap designed above the existing grade. This will enable good internal trap drainage practices, make the trap more visable to the players and prevent surface water from draining

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[56]Welton, op. cit., p. 175.

into the trap. When the trap is built into the slope of a hill, the problem of visability and internal drainage is solved in a similar manner, but surface water must be diverted by a swale at the upper edge of the trap.

Due to intent, there are certain differences between fairway sand traps and the sand traps guarding a green. On a comparative basis, fairway traps are usually wide and shallow, while green traps are deep and readily apparent from the approach area or that portion of the fairway extending teeward for approximately one hundred and twenty-five yards from the green.[57] Further trapping of greens can often create major drainage problems. Drainage tiles and swales must be carefully planned to blend in with the slopes of the green or damage from inadequate trap drainage may result. The maintenance problems associated with fairway trapping also occur in green trapping, but turf problems are also emphasized due to the concentration of traffic on this centralized area.

The second type of hazard is the grassy hollow which is a depression containing tall or unmowed grass. Similar maintenance problems to the sand trap may be encountered, but the grassy hollow has several advantages.[58] The most important of these is that construction and maintenance costs are relatively less. The hollow is also more natural in appearance and tends to blend better with the surroundings. Another advantage is that drainage swales can be treated as grassy hollows and prevent water from draining onto a restricted surface, but at the same time serve as a penality for the bad shot.

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[57]Gabrielsen, op. cit., p. 277.

[58]H. Kendall Read, "Some Observations on Construction and Maintenance", The Bulletin, May 1927, 7:87.

If the problem of drainage cannot be solved so that the concave surface of the hollow drains, it will be necessary to use the procedure outlined under the sand trap section of this chapter for artificial drainage.

The third type of hazard, the bunker, is a raised mound which can be used as a strategic element, breaking the monotony caused by overuse of the other hazards. Bunkers should blend with the landscape, thus becoming an integral part of the topography. These mounds are not individual elements. Instead, they appear as a portion of a larger one that has taken this particular shape due to the effect of natural forces. The gently rolling surface of the bunker will cast shadows during different times of the day, thus serving as an aesthetic element, as well as an indication of the problem that the landforms help to create.

These bunkers usually vary in height from three feet to as much as eight feet, but as a general rule, a three-foot bunker, if properly constructed, will be adequate. The surface of the bunker facing the tee should be as steep as possible and still maintain a good turf surface. The back and side slopes should be graded out as gently and naturally as possible and at the same time still permit the use of fairway mowers. There should be a minimum of six inches of good topsoil covering the mound for the establishment of turf.[59]

The fourth type of hazard, the water hazard, is "any sea, lake, pond, river, ditch, surface drainage ditch, or other open water course. Any ground or water within the margin of a water hazard, whether or not it is covered with any growing substance, is part of the water hazard."[60] A lateral water hazard is that part which runs approximately parallel to the line of play

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[59]Gabrielsen, op. cit., p. 285.
[60]Loc. cit.

but does not become a forward hazard or one which must be crossed to be a part of the strategy.[61]

When the water element is not intended to be part of the strategy, the layout can be arranged so that the water is for aesthetic purposes only. This is usually accomplished by using water as the connecting link, tying together the other design elements into a naturalistic setting.

This setting can be acquired by using water as a group of ponds, or it can be used as a meandering stream which winds back and forth, creating a relaxing atmosphere, while serving as an element of strategy at the same time. Since many golfers play golf partly for their association with nature and the inspirational effect they can obtain from beautiful and restful surroundings, it is clear that any element which can emphasize this association should be used to the fullest advantage.

Whether or not it is a beautifying element, water becomes an exciting mental hazard.[62] This is because a ball in water is usually considered unplayable. Due to this characteristic, water for penalizing purposes should be kept to a minimum. A good rule of thumb is no more than one water hazard per nine-hole course.

The final type of hazard is plant material. Trees used individually, or in groups, can be employed to place limitations on play which cannot be achieved by any other feature.

A good example is the use of trees as a deterrant to prevent short cuts to the green. They are used where the direction of play changes, and this forces the play in the intended route, rather than a route which might simplify the hole.[63]

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[61] The Rules of Golf, op. cit., p. 4.
[62] Metcalf, op. cit., 7:43.
[63] Cain, loc. cit.

Fairways

The fairway is the intended ground which must be played or carried en route to the final target. On holes where the fairways are played, intermediate targets are established which call for minor variations in design. Among these are the introduction of hazards, possible grading changes which delimit the fairway or the line of play, and alterations in width.

The width of fairways should be governed by the shots they are designed to accommodate. For shots which require a carry of from seventy-five to 120 yards, the fairway width is approximately forty yards. For shots carrying 120 to 180 yards, a fifty-yard width is necessary, while shots 180 to 220 yards in length require a width of sixty to seventy yards.

The length of a hole is measured along the intended line of play from the center of the tee to the center of the green. If the strategy involves a large risk, an alternate route to the green should be provided. This alternate route is then measured in the same manner.[65] Often the fairway is extended beyond the green in the event of overshooting the target. This allows players a suitable surface on which to play back to the green. It is also advisable to place the fairway to one side of the direct line of play, leaving rough or possible sand traps exposed for additional penalties. This is often done on par 4 and par 5 holes, and can occasionally be used on the longer par 3 holes. Throughout the length of the fairway, extreme slopes which create blind shots should be avoided, and grading should permit clear visibility of the target while insuring maintenance through the use of power

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[64]Gabrielsen, op. cit., p. 279.

[65]"The Length of Holes in Relation to Par", The Bulletin, January 1925, 5:11.

equipment. These sloping surfaces are often graded to delineate drainage areas so as to avoid problems of drainage which require subsurface tile or French drains.

Another factor established by the fairway is that of circulation. The circulation on a golf course should be designed so as to permit a logical, safe route to the next station, while at the same time allowing the golfer to enjoy the surrounding scenery. Paths should follow a natural route and be developed to accommodate golf cars as well as foot traffic. Consideration of this traffic will influence the design of the course and help prevent turf damage at critical locations.

In designing the circulation pattern, the introduction of a few well-designed bridges will permit access across ravines, ditches, or other similar features. Overpasses or underpasses affect variety on the site and will often help solve major grading problems while simplifying the circulation pattern.[66]

When constructing bridges, public safety should establish the design requirements. The structure must be adequate to hold such design loads as a large number of golfers or possible maintenance equipment. In addition to the load bearing requirement, the width should accommodate powered carts or occasional fairway cutting equipment. Other requirements, such as height, limit the design possibilities by stipulating that the structure will clear the highest expected water level. Handrails are necessary, and the flooring should be of double thickness, allowing the top thickness to be replaced when

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[66]Gordon W. Brindworth, "Attractive Bridges on the Golf Course", The Golf Course Reporter, March 1964, 32:16.

extensively damaged by golf cleats.

When the underpass is used, it can be constructed by using a large corrugated steel culvert pipe measuring at least ten feet in width and eight feet in height. Often these structures contain asphalt flooring, provisions for drainage, and electric lights.[67]

Plant Materials

In this section, plant materials will be examined for their effect on design and strategy since the suitability of different species will vary according to climatic considerations.

The plant materials most frequently used on golf courses are trees. Trees can serve a variety of functions, but they all tend to follow one major hypothesis. The hypothesis is that "The end product of trees in the urban landscape is the modification of the environment so as to increase man's physical and mental comfort".[68] The golf course atmosphere, to many, is that necessary relief from man's urban environment.

In order to utilize this hypothesis, the design characteristics of trees must be examined. Trees have a fixed place in golf course architecture by adding beauty to a course in the form of picturesque backgrounds and delightful vistas. Their shade offers refuge from the hot summer sun, and they serve a great practical value in segregating the various holes.[69] They can also be used as a strategic element which will introduce variation in play.

The selection of a tree palette for a golf course is partly achieved by

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[67]Ibid, 32:17.
[68]Philip A. Barker, "Learning How, When, Where Trees Work", Landscape Architecture, July 1963, 53:293.
[69]Flynn, op. cit., p. 136.

examining specific tree physical characteristics and thus determining suitability. For example, the type of foliage can often limit the use of various species, and in areas where fallen foliage will interfere with play or become unsightly, deciduous trees should be avoided.[70]

Another problem related to foliage is its effect on air circulation and the varying degrees of shade cast by these trees. Dense shade and low air circulation usually precludes dense turf and is especially critical in areas such as the green and tee where the turf is already growing under conditions of extreme hardship.[71]

A third potential problem is the rooting habit of those species which have a large number of feeder roots growing immediately below the surface of the ground. Trees with this characteristic should not be used near greens or other areas where roots may injure the turf. Surface roots can also rupture asphalt or concrete surfaces, can damage underground utility lines, and can cause other maintenance problems. Several trees with this characteristic are cottonwood, willow, maple, elm, poplar, eucalyptus, and hackberry.[72]

Another problem encountered is undesirable fruiting habits. Among the undesirable fruit droppers are sweetgum, pecan, catalpa, chinaberry, and osage orange.[73]

In addition, problems such as susceptibility to insects and disease, storm damage, and the life expectancy are also important factors. On new courses, a combination of fast growing, short-lived trees, and those with a slower growth rate but a longer life should be used. With adequate maintenance,

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[70]Holman M. Griffen, "Trees for Golf Course Use", U.S.G.A. Green Section Record, January 1964, 1:1.

[71]Loc. cit.

[72]Loc. cit.

[73]Loc. cit.

the fast growing trees are rogued out when the slower growing trees become large enough to carry through the continuity of the original use. The maximum height and crown shape is also important in determining the end result.[74]

A list of acceptable trees which may be used varies from location to location, but the previously listed considerations must always be met. This is true in the useage of shrubs and turf as well. A thorough ecological study of any area must be conducted before species are chosen.

Irrigation

The availability of an adequate irrigation system is one of the most important elements in the development of a successful golf course. The geographical location will dictate the amount of irrigation needed, as will the demands of the golfing public for better turf and more beautiful grounds. According to A. C. Sarsfield in his article "Which Type of Irrigation System",

> One of the principal solutions to the problem of providing beauty and traffic-tough turf is a proper moisture environment, and the only accurate dependable method of providing this while minimizing maintenance cost is with a permanent underground sprinkler system.[75]

As was indicated in the General Layout section of this chapter (page 2), water availability is an important factor in selecting a site for a golf course development. Two general sources that are commonly used are ponding areas and water wells. When ponds are used, they should be large enough so that pumping operations will never lower the water level more than twelve inches. This will prevent the non-vegetated areas below water line from appearing as a distracting element in the landscape.[76]

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[74]Ibid, 1:2.

[75]A. C. Sarsfield, "Which Type of Irrigation System", The Golf Course Reporter, June 1964, 32:20

[76]Gabrielsen, op. cit., p. 287.

The use of well water requires tests to determine if a sufficient quantity is present to handle the irrigation demands and if the mineral content is suitable.

The type of pump required will vary, depending on how far design volume and pressure must be drawn. Centrifugal pumps should not be used when the water has to be lifted in excess of fifteen feet; and when this distance is exceeded, turbine pumps are used.[77]

Water requirements of the soil to sustain desirable turf depend upon the soil texture, the climatic conditions, the rainfall, and the type of turf to be used. These requirements can be determined by specialists in soil testing laboratories in the region where the site is located. Once they are determined, the necessary precipitation in inches per hour for any sprinkler can be determined by the following formula: $\frac{122 \times G}{D}$, where G equals the discharge in gallons per minute, and D equals the diameter of coverage of the sprinkler.[78] The minimum water pressure used for these sprinklers usually is fifty pounds per square inch.

Many methods are incorporated in watering greens, and all vary according to the size and shape of the green, as well as the soil conditions and the type of drainage. Four methods are in general use.[79] The first is a single portable sprinkler in the center of the green which must be frequently moved by hand. The second is the sod cup method, where a water line runs to the center of the green with a brass cup set in the turf. This cup has a removable sod filler which is removed and a sprinkler inserted when the green is to be

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[77]Ibid, p. 288.
[78]Loc. cit.
[79]Ed Shoemaker, 1964 Turf Grass Conference held in Manhattan, Kansas, October 22, 1964.

watered. The third method is a quick-coupling perimeter system. Using this system, there should be at least four sprinklers located at the perimeter so that the water has even distribution on all parts of the green. The fourth is a perimeter system using pop-up sprinklers. This system can be either manually or automatically operated. The use of an automatic system for greens will be discussed under the installation of a fully automatic system.

When determining the kind of a system best suited for any given set of conditions, the cost factor is usually introduced and will vary for all of the four possible underground systems. These four systems are the fully automatic, the semi-automatic, quick coupler, and partial systems which water greens and tees only.[80] A choice of system can be determined when one will

> consider the true cost of any sprinkler system compared to a compromise system by pro-rating the initial installed cost over a minimum useful life of thirty years for a quality installation. On this basis, it will probably be found that the difference in cost per month will not run more than $100.00. This much difference a month or even more for a fully automatic system over a quick coupler system will be saved in labor alone.[81]

The fully automatic system will insure accuracy, variable control of moisture application, reduced labor cost and less human error. This system usually incorporates either single row, double row, triple row, or full coverage piping systems. Single-row systems have sprinklers spaced from seventy to ninety feet apart, with the water line located in the middle of the fairway. Double-row systems use smaller sprinklers, require closer spacing, and will insure a more uniform coverage. Triple-row systems have one line on each side of the fairway and one line in the center.[82] When wind drift is a

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[80]Sarsfield, op. cit., 32:21.
[81]Ibid, 32:27.
[82]Shoemaker, loc. cit.

problem, a minimum of two rows of sprinklers should be used, with three or four rows used on wider fairways.[83] The full coverage or multiple-row system uses medium range pop-up sprinklers spaced on a triangular pattern. They can be used over the entire course or in watering only the most important sections.

The automatic watering line for tees and greens must have valves separating them from the fairways, since their programming is more precise. Greens are watered by sprinklers located around the perimeter and tees by one sprinkler in the center.[84]

When fully automatic systems are used to water the fairways, the sprinklers are valved into sections, providing a flexible operation. These sections can reduce the needed water volume by operating two or more sections at the same time but in different locations, thus reducing the size of the main supply line.[85]

One of the advantages of a fully automatic system is uniform water distribution which will reduce the "scalloped" effect along the edges of the fairway. These systems use medium-range rotary pop-up sprinklers which operate on relatively low pressures, thus minimizing wind drift. Another advantage is that the volume of water can be better utilized by programming the various sprinklers. The volume, however, must be adequate to allow for completion of the total watering cycle meeting the desirable water requirements of the turf.[86]

Fully-automatic irrigation systems can incorporate either electrically or hydraulically operated valves.[87] The valves must be of the "fail closed"

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[83]Sarsfield, op. cit., 32:21.
[84]Loc. cit.
[85]Loc. cit.
[86]Ibid, 32:22.
[87]Loc. cit.

design, which means that the valve will close automatically if the power fails, or if any damage comes to the remote control lines. The electric valves are operated on a twenty-four volt AC current, supplied from a companion controller. The wiring is buried, and individual wires are required for each valve.

Hydraulically operated valves utilize either plastic or copper tubing buried in the ground. Provisions for drainage or blowing the fluid out of the system is necessary to avoid damage from freezing in the winter.

Automatic controllers regulate water cycles through the use of a twenty-four hour clock coupled with a repeating fourteen-day calendar program. Individual station timers will allow adjustments to be made in the watering time for the various sections. The greens and tees are normally watered through the use of separate controllers, allowing independent coverage of the fairway watering schedule.[88]

Semi-automatic systems contain remote control valves on the various sections of the system which control the flow of water to that section, while the timing is accomplished through one or more automatic controllers. The sprinklers are changed manually after the completion of each watering cycle.[89] The use of a manual quick-coupler system will require the setting of a single row of sprinklers for each fairway. Often this type of system will cause the edges to receive marginal coverage.[90]

The pipe used throughout an irrigation system can be of four types: asbestos cement, cast iron, plastic and PVC (polyvinyl chloride) plastic pipe.

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[88]Loc. cit.
[89]Ibid, 32:24.
[90]Ibid, 32:24.

Any one of these will be suitable, providing they are properly installed.[91] After the type of pipe is chosen, the various pipe sizes are determined. "A good rule to follow in selecting the most economical size of pipe is to allow a velocity of between three and six feet per second."[92] If this velocity can be maintained in all the piping, adequate water will be available at the sprinklers.

Laying the pipe calls for a minimum of twenty-four inches of soil over the top of the pipe for protection from heavily-loaded maintenance equipment. This depth will need to be increased if the system is in an area where the frost penetration is below twenty-four inches. When the pipe alignment varies more than seven degrees, some form of elbow must be used in the line. Expansion joints should be installed at 150 to 200-foot intervals to allow for the effect of extreme temperature changes. The individual risers should be offset to one side of the water line by using a double swing elbow, thus preventing the riser from being broken off by pipe movement or bumping from maintenance equipment. All piping with a diameter of two inches or less should be pitched at a minimum of six inches per one hundred feet. Backfilling of the trench should be done in well-compacted six-inch lifts until the original ground surface is reached.[93]

Lighting

With the current increase in the popularity of golf, many courses are being planned to lengthen the duration of play. By extending the length of play until

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[91]C. H. Dolan, "Which Kind of Pipe", The Golf Course Reporter, June 1964, 32:28.

[92]Gabrielsen, op. cit., p. 290.

[93]Ibid, p. 291.

midnight, a course can handle as many as sixty additional players, based on a peak volume, measured from 4:00 to 7:00 P.M. On a greens fee basis, this additional volume will increase revenue approximately $18,000 per year, (calculated by multiplying a green fee of $1.50 per nine holes times the sixty additional players, times a possible two hundred golfing nights).[94] These figures do not include the additional cost of supplying power for night lighting.

The extended playing time has some disadvantages that must be evaluated before a lighting system is installed. Among these are increased turf wear and amplification of routine maintenance problems, such as mowing, watering, and the application of fertilizer and pesticides.

Once the feasibility of a lighting system has been established, the first step in design is to decide which one of the two possible systems to use. While one system utilizes 1500-watt filament floodlights, the other is designed for incorporating mercury floodlights. Both systems are satisfactory, providing each is correctly installed.

According to General Electric's Idea Book for Golf Course Lighting, there are six general rules of thumb for lighting the golf course.[95]

Rule 1: Sufficient light must be provided on tees, maintaining a minimum of ten horizontal foot candles. For the 1500 watt filament system, three floodlights (one wide, one medium, one narrow) should be mounted on a pole directly behind each tee and aimed at the maximum aiming distance for filament systems using a forty-foot pole varying for the types of floodlights. For wide angle floodlights, this distance is thirty-eight feet; for medium angle, the distance is 134 feet; and 210 feet is the maximum aiming distance for the

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[94]General Electric, Idea Book for Golf Course Lighting, GEA - 7604, p. 2.
[95]Ibid, p. 5.

narrow angle floodlights.

When the mercury system is used, two floodlights are needed and located in the same manner. The term maximum aiming distance used here is figured by multiplying the mounting height by a factor of 2.5. For example, a forty-foot mounting height times the 2.5 equals a one hundred foot maximum aiming distance.

Rule 2: Fairways need a minimum of five average-maintained vertical foot candles. Using the 1500-watt filament system, fairways up to 150 feet in width should be spaced and staggered one hundred to 150 feet apart. Over the 150-foot width, poles should be spaced the same but located opposite each other. Two floodlights are used per pole, one medium and one narrow angle, aimed at their maximum aiming distance down the fairway. For mercury floodlight systems, the pole spacing is ninety to 110 feet and located in the same manner as for the filament system. The latter system uses only one floodlight per pole aimed at the maximum aiming distance, which for a forty-foot mounting height is one hundred feet.

Rule 3: The lighting of greens should be handled from at least two directions to reduce harsh shadows. A minimum of three floodlights (wide or medium angle only) should be used for filament systems, locating them at the front of the green and aiming in the direction of play. Mercury systems include at least ten floodlights aimed in the same manner.

Rule 4: To reduce glare, the minimum mounting height for the floodlights is forty feet, with the lights aiming below the horizontal plane.

Rule 5: If possible, use some of the same poles to light two or more adjacent holes.

Rule 6: Plan to adjust final aiming after the installation has been completed.

To insure adequate design, divide the total length of the course, in feet, by the total number of floodlights. This should average one floodlight for every forty to forty-five feet for the filament system and one floodlight for every seventy to ninety feet for the mercury floodlight system.

When lighting other facilities on the golf course, different principles apply. For lighting horizontal surfaces, the pole spacing should not be farther apart than four times the floodlight mounting height, and there should be at least two floodlights contributing to any given area. The floodlights should be chosen using the widest angle consistent within a reasonable utilization factor.[96]

When lighting vertical surfaces, the floodlights should be located so that the beams overlap, insuring that any given area will receive as much light from either side as it does from the floodlight directly in front of it. The linear spacing should not exceed one-half the horizontal diameter of the beam at its widest point, and the floodlight is selected according to the principles for lighting of horizontal surfaces.[97]

TOPOGRAPHIC ANALYSIS

Legal Description of Tract

The site chosen for this study is described as the southeast quarter of Section 5, Township 19, Range 13, west of the 6th principal meridian.[98] It is located in Barton County, on Washington Avenue, three miles north of Great Bend, Kansas.

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[96]Ibid, p. 9.
[97]Loc. cit.
[98]Register of Deeds, Barton Co. Courthouse, interview with author, November 5, 1964.

Present Use

The site is presently being used for farmland under the ownership of Mr. William Bercheck of Great Bend, Kansas. Walnut Creek meanders through the southern portion of the quarter. In 1957, the portion of the creek near the Washington Avenue bridge was rerouted to help control flood conditions caused by the low elevation in the region of the cove. On the east side of Highway 281, a portion of the creek water is rerouted into a manmade canal leading to the Cheyenne Bottoms for maintaining the desired lake level. Between Washington Avenue and Highway 281, the Lake Barton Recreational Area has a private lease for the pumping of a portion of this stream uphill to Lake Barton for maintaining the desired lake level there. A pumping station located a few hundred feet south of the creek and between the two highways supplies water to the city of Hoisington.

Transportation Routes to the Site

There are two major transportation routes which would permit easy access to the property. Washington Avenue, a bituminous asphalt highway, is the eastern boundary of the property, terminating one-half mile north of the site's northern limit. At this point it converges with Highway 281. This two-lane concrete highway leads into Great Bend from the northwest.

Survey of Existing Facilities

There are presently two golf courses serving Great Bend having access from Highway 281. These are Lake Barton Country Club, which is 2 1/2 miles north of the proposed site, and the Great Bend Country Club, located at the edge of the city limits. These are privately owned courses, with the general

public not permitted to use either facility. The city is undergoing a feasibility study for providing a public course on municipally owned property at the Great Bend Airport. A preliminary course layout, executed by Mr. Robert Dunning of Tulsa, Oklahoma, is presently being used to encourage public support for the program.

Population Study

In an interview with Mr. Dick Chastain, golf pro and superintendent of the Lake Barton Country Club, he explained that the golfing population of the Great Bend region is supported by an area encompassing approximately a twenty-five mile radius. The Lake Barton course is used by over two hundred golfing members, while the Great Bend course is supported by approximately seventy golf playing members. He indicated that the city of Great Bend has a golfing population of nearly four hundred of which up to 150 drive to either Larned or Ellinwood, Kansas, to play on their private-public courses. Within the twenty-five mile radius surrounding Great Bend, there are approximately three hundred additional golfers. Including these in the total golfing population, it was discovered that golfing facilities are needed to accommodate approximately seven hundred golfers. Only 270 of these are presently accommodated, leaving a possible 430 golfers who could benefit from the installation of a public course.

Soil and Rock Structure

The soil structure of the site is of two general types. These are described by the Soil Conservation Service of the U. S. Department of Agriculture.[99] In

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[99]The U. S. Department of Agriculture, Soil Conservation Service, Barton County, Kansas, Soil Conservation Survey.

the vicinity of the Walnut Creek floodplain, the soil is described as being moderately deep, dark to brownish-colored, with moderately heavy to friable clayey subsoils. Moderate slopes from five to twelve percent exist which are undulating to gently rolling in character with erosion evident on cultivated surfaces. The upland areas on either side of the flood plain have soil described as deep, very dark to dark in color, with moderately heavy clayey subsoils. The regions containing this soil have gentle slopes--two to five percent--with no erosion or only slight erosion on either grass or cultivated land. The texture of both soils is silt loam to silty clay loam, with an average topsoil depth of ten to twelve inches. There are no visable rock formations on the site, nor are they nearer than twenty to thirty feet from the earth's surface.[100]

Water Table

The distance to the water table is between eighty to one hundred feet below the surface for a suitable supply of quality water.[101] From past drilling, water was reached at approximately sixty feet in a sandstone layer, but the amount was limited and would not be adequate for irrigation purposes. The farmers in this region have found that the most productive wells are those usually located on the south side of Walnut Creek.

Annual Rainfall

Annual rainfall varies considerably, and in order to have a quality course, irrigation would be necessary. The average rainfall is from twenty-

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[100]Soil Conservation Service Technician, Interview with author, November 5, 1964.

[101]Loc. cit.

six to twenty-eight inches per year, but records show that the amount for any single year can be considerably less.

Lay of the Land

The slopes for the majority of the existing landforms are very moderate. Up to seventy percent of the site is under five percent. Portions of the land in the creek bed contain slopes between ten and twelve percent, and all of these slopes are heavily wooded.

There are four drainage patterns, originating on the northern portion of the site, draining into Walnut Creek with little if any surface water draining across the site from the adjacent property. All drainage swales are virtually unnoticeable, and erosion is not a major problem on the site.

Average Temperatures and Prevailing Winds

Average temperatures vary from twenty-eight to thirty-five degrees in the winter and from eighty-five to ninety degrees in the summer, with the average growing season between April and September. Prevailing winds are from the south in the summer and the northwest in the winter.[102]

Existing Plant Material

The native grasses are buffalo grass (Buchloe dactyloides) and Blue Grama (Bouteloua gracilis); however, many other species can be grown if properly maintained. The existing trees are somewhat limited with cottonwood (Populus deltoides), American elm (Ulmus americana), and walnut (Juglans nigra) as the predominate species. Many other species will withstand the climatic conditions

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[102]Sherman, Ibid, p. 10.

once they are established. Among the most widely used for the courses in this region are the cedars, "Chinese" elm, sycamore (Platanus occidentalis), and the oaks.

CHAPTER II

DESIGN EVOLUTION

CLUBHOUSE AND PRO SHOP FACILITIES

Classification of Development

Due to the type of need that has been established in the area under study, incorporating clubhouse and pro shop facilities, it was decided that a private-public designation would be used. The private-public classification is normally associated with a course where the public is welcome to play at a daily fee, or members can join a private organization by paying annual dues.[1] This annual fee also permits the private members to use other facilities of the site, such as the tennis courts, swimming pool, and all clubhouse facilities.

Determining the Size

From the site analysis, it was determined that an immediate need existed for facilities that could accommodate at least three hundred golfers. The other facilities, such as the tennis courts, swimming pool, and the clubhouse could possibly attract an additional two hundred non-golfers.[2] These tentative projections established the desired spatial requirements for the clubhouse and pro shop facility. In the event of a larger membership, the site chosen is adequate to permit expansion of both facilities.

Site Selection of Clubhouse Complex

In the process of locating all the facilities, the site for the clubhouse and pro shop was selected based on the following considerations: access to the site and its cost of development, relationship of these facilities to

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[1]Dick Chastain, Interview with author, November 5, 1964.
[2]Loc. cit.

the course, the layout of the course, availability and cost of providing utilities, potential views, existing vegetation, and the effects of the location of Walnut Creek.

Since the site is paralled by a highway on only the east side, it was determined that this side of the property would be the logical point of departure in locating the clubhouse facilities. With the wooded ravine creating a cove, a possible point of access at a minor grade separation was determined at the southeast corner. Another possibility included access to the north of the ravine which placed the clubhouse facilities on higher ground, but this location afforded little climatic protection and created additional road alignment and grading problems. The cove created by the wooded ravine, therefore, was considered the most desirable.

Further analysis of this location showed that the structures could be blended into the overall pattern of the landforms with the least amount of earthwork. This also afforded a reasonable relationship to the remainder of the site by the use of pedestrian bridges crossing the wooded ravine. These bridges emphasize the minor grade variations, thus helping to establish the desired character for the course.

Further, by locating the clubhouse in this cove, it was found that there was sufficient space on the site to lay out a desirable eighteen-hole course. Since design standards suggest that a maximum of three holes contain water hazards, the clubhouse location on this portion of the site was reinforced. This siting also made it possible to lay out the majority of the holes in a north-south direction, permitting the 4th, 6th, 9th, and 18th greens to be near the pro shop facilities.

Other factors, such as the availability of utilities, aided in establishing

the cove as the optimum location for the clubhouse facilities. From the site analysis, it was determined that the best source of water was south of Walnut Creek, and the most favorable location for the pumping station was directly south of the cove. Gas, electricity, and telephone lines parallel the eastern boundary of the site, making it convenient to tie into these services by the use of underground lines.

From the cove, a variety of views is possible, some of which emphasize the natural site conditions, while others require only slight modification. Since the entire cove is surrounded by mature vegetation, the views to the remainder of the site are enhanced by looking through and beneath foliage masses. The overall view to the west is very delightful at sunset when the various tree structures are silhouetted against the colored sky. To the east, the clubhouse is screened from the highway by the existing vegetation, allowing passing motorists only an occasional glimpse of the site.

In addition to these views, a cooling effect is provided, due to the wind passing through the trees in combination with the shadows and rustling of the leaves. The trees also act as a natural solar screen for the late afternoon sun, while casting an interesting array of shadows.

Pro Shop Spatial Relationships

The architectural design of the clubhouse and pro shop is not within the scope of this study. The intent has been to suggest design principles which could be used in establishing the desired character. The spatial requirements and relationships were determined through orientating both facilities to the golf course which provides a logical association to the recreational environment of the site.

The pro shop facilities were physically separated from the clubhouse due to the private-public designation. By utilizing two separate structures, both the general public and the private member would have separate facilities supplying their needs. This would also permit immediate construction of the golf course and pro shop, leaving the clubhouse for future development. Another advantage is that the pro shop and the clubhouse can be divided into specific use areas, thus eliminating problems of assessment for the various functions each is to serve.

The pro shop was laid out so that pedestrian traffic from the parking lot would enter the structure and proceed to either the locker room or the pro shop sales section. A golfer's route, after he enters the building, would be to go to the locker room to change clothes. From the lockers, he is routed through the pro shop to the equipment storage room to pick up his golf bag and clubs. From there, he can either exit to a courtyard leading to the golf course circulation route, or he can pass from the equipment storage room through the golf cart storage room and pick up motorized transportation.

If, while playing, the golfer desires some form of refreshment or wishes to pick up additional supplies, he can return to the courtyard and enter the food service center. This service center is connected to the pro shop and the pro's office, for easy management. After the golfer is finished playing, he then retraces his steps back through the pro shop to the lockers.

The locker rooms provide facilities for golfers, tennis players, or swimmers. There is a rear exit which leads to the tennis and swimming facilities, separating the golfers' route from the others. The locker rooms adjoin the restrooms and shower facilities with a rear exit to prevent swimmers from tracking water throughout the entire dressing area.

A list of facilities within this structure includes the pro shop (1,050 sq. ft.), the pro's office (300 sq. ft.), storage space for new equipment (300 sq. ft.), women's lockers (1,200 sq. ft.), women's restroom (600 sq. ft.), men's lockers (1,500 sq. ft.), men's restroom (600 sq. ft.), food service center and lounge (1,050 sq. ft.), the equipment storage room (1,200 sq. ft.), and the golf cart storage room (1,800 sq. ft.).

This structure is sited so that the courtyard faces the west and looks through the wooded ravine to the golf course. The ravine has a bridge accommodating pedestrian and golf cart traffic which leads to the sixth, ninth, and eighteenth greens. The first tee is to the north of the structure facing the glass walls of the lounge and pro's office.

The tennis courts are northeast of the pro shop, located so as to become a part of the layout for the supporting recreational facilities. The swimming pool is directly east of the pro shop and is included in these supporting facilities. The putting clock is to the south of the pro shop for a transitional space from the parking lot to the pro shop.

Entry to the pro shop is gained from a sidewalk leading from the parking lot past the putting clock and onto a terrace which is the connecting link between the clubhouse, the pro shop, and the supporting recreational facilities. This terrace is a multi-purpose feature, providing space for different events, such as sunbathing, dining, or dancing. It can also be used for group barbeque dinners, or social gatherings of any related nature. To the west, the terrace affords a wide-angle view of the golf course, while to the north, the view is of the supporting recreational facilities.

By separating the pro shop from the clubhouse facilities, many problems are eliminated. One problem related to the clubhouse is that expensive interior

floor surfaces may be damaged by golf cleats. This separation will allow durable floor materials to be used in the pro shop, while allowing materials subject to damage to be used in the clubhouse where cleats are not worn.

Another problem eliminated is the use of private clubhouse facilities by the public golfers. The public has a structure that will provide them with all the necessary facilities for playing golf, while the clubhouse is reserved for the private-member social activities which are not directly related to the game of golf. This permits a very flexible use of the site for the varied interests.

Clubhouse Spatial Relationships

The entrance to the clubhouse faces a drop-off zone and the parking lot beyond. There is a wide foyer of 1,200 sq. ft., connecting all the facilities of the structure. From the foyer, there is a coat check (150 sq. ft.), men's and women's restrooms (225 sq. ft. each), the manager's office (900 sq. ft.), and a private party room (900 sq. ft.). On the west is the entrance to the dining room (2,800 sq. ft.), which overlooks the terrace and putting clock, with a view through the trees in the ravine to the golf course. The dining room is directly connected to both the food service center and the beverage center.

The food service center (1,600 sq. ft.) is located in the center of the structure for easily dispensing food to any room in the clubhouse. It is directly connected to the beverage center and a walk-through linen storage.

Also from the foyer, a hall on the east side of the structure leads to the all-purpose room (2,800 sq. ft.), the beverage center and lounge (3,000 sq. ft.), and two additional private party rooms (900 sq. ft. each). The

total area of the clubhouse is 17,000 sq. ft.

Since the all-purpose room would also be used for after-dark activities, such as dancing or large meetings, the relationship to the golf course is not as critical as in the other areas. Therefore, it was located on the east side overlooking the eastern segment of the wooded ravine. It has access to the food service center, the beverage center and lounge, and the terrace.

The beverage center and lounge overlooks the swimming pool to the north with a distant view over the wooded ravine to hole number one of the golf course.

Architectural Character

The principle of capitalizing on the existing shapes of the landforms and applying these shapes to the new elements was used. In establishing the architectural character, the structures were treated as elements of the total layout which must have a homogeneous effect. The total effect is attained through a landscape architectural interpretation of the site and the establishment of interior-exterior relationships.

Upon examination of profiles, a series of landforms was noticed that had many physical characteristics in common. The shapes of these landforms were used in establishing the overall appearance of the buildings by using the same form relationships as were found on the landforms of the site.

Another important factor determined from the site analysis was the mass and volume relationship resulting from the types of natural materials and their color association.

By using materials that are indigenous, the color associations of the structures blend with the colors found on the site, thus strengthening the

homogeneous character desired. By grouping interior spaces under a series of individual roofs, the overall appearance is similar to that of the landforms, each roof segment representing a landform as found on the site. Other elements which would help establish the architectural character would be the result of collaboration between the landscape architect and the architect.

Parking Lot and Driveways

Because of the relatively large area required, the location of the parking lot and driveways is critical to the siting of the structures. For parking, a desirable number of spaces is derived by using the standard of "ten spaces per hole, one space per thirty-five square feet of floor area for public assembly, and per 250 square feet of floor area for other uses."[3] By utilizing this index, it was discovered that there is a need for a minimum of 268 spaces, with a maximum of 564. Since many of the facilities would not be used concurrently by large groups of people, i.e., the public-private designation, it was decided that three hundred spaces would be a desirable number for which to plan and that the southern end of the cove nearest the point of access would be the most efficient location. This insures that parked vehicles would not interfere with the view from the clubhouse to the course.

In order to park three hundred cars on the site, there is a need for a minimum of 90,000 square feet of paving. This much paving requires a parking lot which will incorporate planted islands to break the monotony. By developing a perimeter drive around the parking lot and providing a drop-off zone in front

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[3]Arthur B. Gallion & Simon Eisner, The Urban Pattern, p. 218.

of the clubhouse, adequate circulation is possible from the highway to the clubhouse to the parking lot.

Service and Maintenance Facilities

The maintenance facilities are connected to the highway by a service drive at the southern edge of the cove crossing the existing dike. This places all the maintenance facilities on the western side of the cove using the existing vegetation as a screening element.

LAYOUT OF THE COURSE

General Description of the Course

After the clubhouse site had been selected and the related facilities tentatively located, the general layout for the golf course was established. This was done through reviewing the accepted standards concerned with the design principles, thus determining many desirable characteristics. Among these were the proper north-south orientation of holes, the determination of an acceptable par order, the association of par to the length of holes and the relationship of the holes to the site.

In considering these characteristics, the first nine holes were located on the eastern segment of the site, directly north of the clubhouse facilities. This section of the site was chosen for such factors as the relationship of the pro shop to the first tee, sixth green, seventh tee, and the ninth green. By utilizing the eastern side of the site, these tees and greens were designed to radiate from the pro shop and still permit satisfactory utilization of the site.

The second consideration favorable for locating the first nine holes on

the eastern portion of the site was the orientation of topographic features. Drainage patterns established the desired location of the holes, insuring proper trap drainage and surface runoff. Natural drainage swales were emphasized to insure efficient drainage of the area, thus eliminating the possibility of wet spots from the playing surface. The shapes of the landforms also established desirable locations for greens, tees, and intermediate target areas. Still another factor related to the landforms was the possibility of designing a suitable layout to prevent delay on the first three holes. By the use of limited trapping and by well-defined target areas, progress through the first three holes proceeds at a rapid rate.

A third consideration was the effect of Walnut Creek on the course layout. In order to locate eighteen holes on the site, a high concentration of traffic would be necessary for the north-eastern portion of the site. This was the result of a limited amount of playing area available in the southern portion due to the bisecting of the site by Walnut Creek. To effectively utilize the site, the segment on the southern side of Walnut Creek was designed for two holes with the line of play crossing the creek. It was felt that these holes should fall late in the round of play, preferably in the last nine holes, due to the mental hazard created by water.

Therefore, the first nine holes were designed as a unit that would permit a reasonable relationship to the site and to the clubhouse facilities, while still allowing satisfactory utilization of the total site. This permitted adequate space for the remaining nine holes and offered the possibility of creating a new range of strategical problems for the golfer.

After the general locations were established, a desirable par order was determined. For the first nine holes, the par order was 4-5-4-4-3-4-5-3-4

and 4-3-4-5-4-3-4-5-4 for the last nine holes. This breakdown permitted two par 3 holes and two par 5 holes to be located in each nine hole segment. It also permitted a total par of 36 for each nine holes or a total par of 72 for the entire course.

By varying the length of the holes for each of the par classifications, it was possible to provide variety in play and still meet the accepted standards. The total length of the course is 6,270 yards, which is considered to be adequate for a public facility.

Description of the Holes

First Nine Holes. To fully analyze the layout of the course, it was decided to describe all of the factors influencing the layout of each hole as related to both aesthetic and functional aspects.

Hole number one is located on the extreme eastern boundary of the site, the tee within the cove near the pro shop. The approach is from the pro shop to station number one which is the waiting area adjacent to the tee. Hole number one is a dogleg hole, 340 yards in length with a par classification of four. The line of play changes at the 220 yard point, with the remaining 120 yard distance to the green in a northernly direction. For the first shot, there are two possible target areas catering to the variable handicap of the different players, the first being roughly 100 to 150 yards from the tee and the second in the vicinity of 180 to 230 yards from the tee. One of the two sand traps is located in the dogleg for penalizing an extremely long drive from the tee which could possibly carry onto the highway. The second guards the left front of the green. The green is 7,300 square feet in area, slightly elevated for visibility and pitched to the left front for proper drainage.

This is a relatively easy green to play with many variable cup locations which are intended to aid in speeding up play on the first hole.

The first shot must carry the ravine that surrounds the clubhouse site requiring the removal of a few existing trees to permit clear visibility and to make it possible to drive to the target area. The pedestrian and motorized circulation from the tee is along the left of the fairway over the bridge to the target area. From there it follows the left side of the fairway to the green and on to station number two, the waiting area for teeing off at hole number two.

The proposed tree masses along the fairway of hole one serve several functions. The clump of trees in the angle defined by the dogleg aids in preventing injury to other players from a wild drive and prevents shortcutting to the green. The trees on the left of the green are intended to reduce the possibility of accidents and to permit various views through the foliage to the other portions of the course and to the landforms describing various holes. The clump of trees on the right of the fairway is for the protection of passing motorists and will also serve as an aiming point for the first shot. Another tree mass extends beyond the green, thus permitting possible aiming points for the second shot.

The grading of the fairway was executed to insure proper drainage of the playing area and the sand traps. The swale to the left of the fairway permits drainage of portions of both hole number one and hole number four.

Hole number two is a par 5 dogleg hole, 420 yards in length, with the change in direction occurring at the 160 yard point. This is the location for the first target area which is heavily trapped on the left side of the fairway for discouraging a possible short cut. There is one sand trap on the

right side of the fairway to help delineate the target area. If a drive carries this trap, it will leave the property and will be considered in an unplayable lie. The grading of this segment is executed so that the surface slopes toward the northeast corner of the property.

The second shot is an uphill shot to another intermediate target. It is not possible to see the green from this location, but the target area is indicated in the grade separation and is defined by a single sand trap to the left of the fairway. This will aid in establishing the desired carry.

For the average golfer, the shot from this target area will require a carry of approximately one hundred yards to reach the green. Clear visibility of the green is provided by a nearly level surface, with a mass of trees behind the green which offer possible aiming points, as well as for protecting the next tee. The size of the green is 7,000 square feet with shallow undulations allowing surface runoff to be carried off in three directions. The size and shape of the green will allow multiple pin locations providing variety in play. The two sand traps guarding both sides of the green require a straight shot to the green.

The tree massing along the entire left side of the fairway is to aid in preventing accidents from a misplaced shot and also to discourage a short cut which would endanger players on the green of the third hole.

The intended circulation route is from station two along the left edge of the fairway up to the green and then onto station three, near the next tee. This route is under a tree canopy, offering a delightful relationship of the golfer to the space defined by the tree massing.

Hole number three is a par 4 dogleg hole, 310 yards in length. From the tee, a slightly downhill, 170 yard drive will carry to the center of the tar-

get area where the dogleg occurs. There is a large sandtrap on the left of this area requiring a well-placed shot. The target area will also accommodate shots of 130 yards in length which fall short of the sandtrap for a safer landing point. Those players driving over 170 yards will be confronted with an additional trap on the right side of the fairway. The trap is in the direction of play two hundred yards from the tee. This variable target will permit an alternate route to the green regardless of a player's ability.

From this target area, a 140-yard shot is required to reach the center of the green. This shot is on a slight downhill grade to an elevated green. The fairway slopes to the right into a drainage swale along the edge of the fairway. A trap located thirty yards to the front and on the left of the fairway is intended to discourage an approach to the green from that angle.

The green is elevated and has two additional sand traps, one on each side of the green. These traps would be quite difficult, due to the depths requiring a different type of approach than used for the average sand trap. The surface of the green is pitched in two directions and drains to the right rear with an actual putting area of 6,200 square feet. Pin positions are provided that will be relatively easy to play on the right front and more difficult as the cup is moved left and to the rear of the green.

The entire hole is surrounded by trees with an occasional break to create a view to a desirable feature. This massing of foliage was executed to insure both safety in play and also to provide a different atmosphere in which to play; this atmosphere is a strongly defined space.

Motorized circulation from the tee follows the right edge of the fairway through open spaces and under the foliage canopy to station four. The breaks in foliage previously mentioned afford the opportunity for a golfer to

to relate his position to the surrounding landscape.

Hole number four also has a par 4 classification but with many different strategical features. This dogleg hole is only 330 yards in length, but due to the location of the two possible target areas, it can be played several ways. The change in direction of play to the right occurs 205 yards from the tee, and this is considered a desirable aiming point for the average golfer. The higher handicap golfer can choose to place his shot on the secondary target area which will safely accommodate a drive ranging from 110 yards to 150 yards in length. The two target areas are well defined by the use of three sand traps, two on the left side of the fairway and one on the right. These traps guide the golfer in placing his shot and penalizes him if he is careless. An additional feature of this hole is the warped fairway surface intended to spice up play and to blend with the higher landform to the right of the hole. The hole is designed to follow the base of this higher landform which serves as a mental hazard and will also allow the player to witness an ever changing view as he plays the hole.

To be in a suitable position for putting, a shot 125 yards in length from the target area is required. The green is elevated and located on the edge of the ravine creating a positive mental hazard. The total area is 5,500 square feet, with the surface slightly pitched to the right. One trap is used on the right front requiring players to aim at the green regardless of the mental hazard caused by the ravine on the left.

Tree massing is primarily for the protection of the fifth tee, but it also serves an important role in creating a natural setting in a wooded harbor. Trees on the left are to prevent a wayward ball from interfering with the play on hole number one.

The circulation of motorized traffic follows along the bottom of the higher landform to a switchback leading to the top of the higher landform and on to station number five.

The fifth hole is a 220 yard, par 3 hole requiring accurate placement of a drive to avoid the trapping of the green. The line of play parallels the relatively steep slope along the right margin of the fairway. This hole is located on higher ground than the adjacent hole, number four, to the right, permitting an interesting point of view of that hole. The downward slope to the right of hole five is an integral part of the strategy penalizing the golfer who is consistent in slicing. The trap to the right of the green is an additional penalty for the slice, while the trap on the left is a similar penalty for the hook.

The use of tree massing clearly establishes the target and provides a natural setting in the definition of the space. Other factors determined by the planting theme are similar to the effects obtained on the other holes, that is, providing adequate protection and the creation of possible aiming points.

The green, which is 7,300 square feet in area, is elongated to the right, providing a variable target which will become increasingly difficult to play in that direction. The putting surface is slightly pitched providing surface drainage in two directions.

In describing the next hole, attention is directed to the direction of play which permits hole number six to dogleg to the left, establishing the green near the pro shop. This hole aids in the establishment of the desired effect that the entire course radiates from the pro shop area. The layout of this hole was executed to create a feeling of a natural location to termi-

nate play so that a golfer with only one hour to play would feel he was terminating this play at a logical point.

The distance from the tee to the point where the direction of play changes is 220 yards with a possible target area established on either side of this angle. This will facilitate golfers with different playing abilities. The sand trap on the left of the dogleg increases the difficulty of playing to the longer of the two possible target areas.

The landform slopes gently downhill in the direction of play until the region of the dogleg is encountered. At this location the downward slope is much greater, making the longer target out of view and somewhat more difficult to play. This enables the hole to be played in several ways allowing players the opportunity of determining their own strategical limits. Regardless of the target area used, the shot to the green is rather difficult due to the elevated green which is located on the edge of the wooded ravine. Further, the placement of the two traps closely guarding the entrance to the green will require great accuracy in play.

The green area, which is 6,900 square feet, is graded to insure that the shot will hold once it lands. The surface is pitched to the left and to the front, creating two separate drainage areas.

The final target of this hole is well defined by the use of tree massing surrounding the green and the approach area. By using this method of defining the green, the golfer is able to obtain the feeling of the challenge between himself and this particular hole. The location of personal challenge is confined within this space excluding the possible distractions of the activities on the remaining holes near the pro shop.

The circulation route to station seven follows the right margin of the

fairway and down the slope to the green. From this location the golfer can continue to play the course or terminate play and follow the path beneath the tree canopy, across the ravine, and on to the pro shop.

Hole number seven is the longest hole of the eighteen-hole circuit and is designed to permit several possible approaches in playing it. It is a 480 yard, par 5 hole with a slight change to the left in the direction of play at a point 230 yards from the tee. When playing for this location, severe trapping is encountered requiring the best of the golfer using this approach. A second possibility includes a drive which is short of this area for the first shot, and then taking a short cut carrying the traps for the second shot. The third possibility is a drive from the tee carrying the rough and by-passing the trapped area. This approach requires a drive between 240 and 320 yards in length.

The shot from the tee is uphill and regardless of the approach used, there is limited visibility of the first target area. A straight shot, 190 yards in length aiming at the tree mass in the open area slightly northeast of the tee, is the safest method of playing hole seven. This hole, while somewhat deceiving, is designed to cater to the average player's skill, but at the same time, it will provide a rewarding challenge for the golfer with a lower handicap. One advantage of this target area is the relative flatness enabling a shot to hold once it lands in the proper location.

From this area, the shot to the second target is slightly uphill with a nearly flat shelf on which to land, 140 to 200 yards away. This immediate area is free of any form of hazard, but beyond, there is a multitude of traps intended to strengthen the risk of playing this hole in two shots. The two-shot approach is quite possible; but if the hole is played as described

for the average golfer, the results will be more consistent.

The green is located on existing ground level and is pitched to the front to improve visibility. Variable cup cutting areas are possible due to the minor undulations established in segregating the drainage areas. The total area is 5,000 square feet with an irregular shape as determined by the numerous sand traps. With the many methods of playing the hole and the possible variations in cup placement, this hole is probably the most flexible on the entire course.

The circulation route passes behind the tee and follows the left margin of the fairway terminating at station eight. The planting theme as carried out on this hole is to allow the separation of possible points of conflict while enhancing desirable views of the remainder of the course.

After playing number seven, hole number eight looks relatively easy, until close examination is made of the landform on which the green is constructed. To the rear of the green, the landform slopes sharply downhill making a possible playback very difficult.

Hole number eight is two hundred yards in length with a par 3 classification. Trapping is designed to gather in an overshot ball preventing the need for the possibly disastrous playback to the green. The wooded slope to the rear protects the putter from physical injury but complicates the problem of recovering from the overshot ball. Tree massing is intended to strongly define the putting space. The effect of false perspective is created by the open space at the tee being reduced to a limited target area. This was a major factor in determining the strategy for this hole.

The size of the green is 6,300 square feet, with the putting surface undulating so that the portions of the green near the traps are higher than

the areas between them. This warped surface allows a variable degree of complexity in establishing the putting problem. The most difficult pin positions would be on the higher forms which are terminated by the sand traps. Another advantage of the warped putting surface is that the trap locations are raised, insuring that they will be clearly visible from the tee.

The final hole of the first nine-hole circuit is a dogleg hole, 430 yards in length with a par 4 classification. From the tee, a well-placed shot is required with the proper backspin to hold the shot on the first target area. The hole was purposely graded to create a mental hazard caused by the feeling of the terminating space in the region of the dogleg.

Two target areas are possible with the first accommodating shots from one hundred to 180 yards in length and the second accommodating shots from 220 to 260 yards in length. A slice from the tee will locate the ball near to the rim of the higher landform, and this penalty is emphasized by the tree massing and the location of the sand trap. If the drive fails to hold to the surface of the rim, it is certain to roll into a sand trap on the downward side of the slope. The golfer capable of a 240 to 250 yard drive can take a short cut carrying the traps on the left and down the slope to an advantageous position for the next shot. An even better location would be on the right of the fairway at the lower elevation permitting a shot to the green which is relatively free from any additional hazards.

The elongated green is perpendicular to the direction of play and creates a shallow target for the last shot. It is also elevated and located on the rim of the wooded ravine. The shape is determined by the sand trap placement, permitting the use of undulations for separation of drainage areas and for variety of cup placement. The area is 5,300 square feet aiding in the com-

plexity of playing this hole to meet the par 4 classification. It was felt that hole nine should be a reasonably difficult par 4 hole requiring the best of every golfer. The location of tree massing again defines the target, provides a safety factor, and separates the golfer from others.

The Second Nine Holes. The tenth hole is a 450-yard dogleg hole radiating from the vicinity of the pro shop and establishing the direction of play for the second nine-hole circuit. By the primary route, it is a par 4 hole, accommodating a drive of 120 to 230 yards in length. The alternate route, carrying the trap on the right, requires a carry of 240 to 310 yards in length. Either route is satisfactory for playing the hole, but the alternate route will still place the ball in a favorable position for the second shot. Both target areas are easily attainable, well defined, and the grade separation is slight until the position for the second shot is encountered. This shot is uphill to the green which is located in a pocket near the summit. Trapping is severe to the rear to prevent overshooting of the green as a method of approach.

The green and surrounding traps drain to the front utilizing the severe grade separation at that location. The green area contains 6,500 square feet of putting area, thus making the hole relatively easy to play regardless of the steep foreslope.

As the hole is played, the golfer is constantly aware of the varying degrees of enclosure that are created by the massing of vegetation. The spaces defined by these tree masses are a welcome relief from the restricted areas between them, and these spaces appear as natural meadows gently flowing into the surrounding landforms. Through careful placement, they also protect

golfers on the adjacent holes. The benefits of these open spaces and the views created by them are especially appreciated by the golfer as he passes through the circulation route along the left of the fairway to the next station.

The eleventh hole is the third par 3 hole on the course with a straight 180-yard approach to the green. The green contains 6,800 square feet of putting area with three sand traps, one on each side and one at the rear, to penalize the hook, slice, or ball carrying the green.

The tree massing opens at the rear of the green eliminating the normal backdrop of foliage. This extension of space may cause the careless golfer to overshoot the green and be confronted with the trap at the rear. There is a small tree mass to either side of the green to separate this hole from the tees of the two adjacent holes.

The elongated tee of hole number twelve establishes the intended direction of play for the 420 yard, par 4 dogleg hole. Two large sand traps restrict the location where the angle occurs, thus establishing two possible target areas. These targets will accommodate drives from 110 to 330 yards, depending on the target area chosen. Three masses in this location are also intended to emphasize the restricted feeling requiring the golfer to meet the situation with perfect control.

The grade separation on this hole has been reduced with play in the downhill direction permitting clear visibility of the various targets. Surface water from this portion of the property drains across the fairway in a wide swale directly in front of the green. As a result, the green was slightly elevated to aid in the diversion of this surface runoff and also to make the green and the location of its traps more visible.

The green is 6,800 square feet in area, with a slight slope to the front. Tree massing and the trapping to the right and rear defines the target and gives it a suitable backdrop, thus isolating the hole from the surrounding area.

The thirteenth hole is a par 5 hole, 440 yards in length with a direct line of play to the green. This hole will permit the use of the long driver in placing the shot well down the fairway. Unobstructed visibility enables the golfer to analyze the landforms and the two fairway traps for their effect on the long drive. The entire fairway parallels a natural drainage swale, and as a result, the surface gently slopes from the right to the left.

The green is located near the edge of the property, and the putting surface slopes to the left front in the direction of the drainage swale. The putting surface is 7,600 square feet in area and trapped on both sides and to the rear, while the approach from the front is open to permit easy access to the green. Possible cup cutting locations are plentiful, with the right rear of the green the most difficult to play.

The entire fairway is relatively open as far as the effects of tree massing are concerned. Trees were used only where points of possible conflict could occur and were not intended to be a strategical element.

The fourteenth hole parallels the western property line with the direction of play to the south. It is 370 yards in length with the entire fairway as a possible target area. There is a direct line of play to the green once again permitting the use of the long driver. The grade is nearly level, with drainage to the left, except in the region of the fairway sand traps. At this location a steeper grade focuses attention on the left front trap.

The green contains 7,300 square feet of putting surface, with minor grade variation directing surface drainage in three directions. Three sand traps are located around the green with one guarding a direct entry from the front. Drainage of the traps is in two directions, taking advantage of Walnut Creek to the south and the drainage swale to the east. An extension of the existing tree mass in the vicinity of Walnut Creek made it possible to protect the teeing ground of hole number fifteen.

The first water hazard is encountered on the fifteenth hole at the western edge of the property. At this location, the stream bed is approximately one hundred feet with little vertical difference between the flowline and the surrounding banks. Since this hole is the first water hazard hole encountered, it was designed as a par 3 hole, 190 yards in length. Existing trees were removed in the creek area to create a straight shot across the water to the green. The putting surface is 7,100 square feet in area and trapping is provided at three locations, with one restricting the entrance. Due to the size of the green, it was possible to warp the putting surface without creating any undue hardship on the golfer.

From station fifteen, circulation is routed to the left of the fairway and by a bridge across the wooded ravine to station sixteen.

After crossing Walnut Creek, the triangular portion of the property on the opposite side was efficiently utilized by incorporating a 350-yard, par 4 hole. This hole was designed to dogleg to the left to fit the natural landform created by Walnut Creek and also to utilize the existing vegetation.

The first target area is in the vicinity of the dogleg, 170 yards from the tee, with heavy trapping on the left and a single trap on the right for capturing an overshot ball. An alternate target area is possible by driving approximately 220 yards, carrying two of the sand traps on the left. Existing

vegetation and the defined limits of the fairway would prevent cutting the dogleg any shorter.

The shot to the green is straight forward on a nearly level surface. Two sand traps guard the entrance with the land at the rear of the green sloping down to the creek bed so that a badly overshot ball is in a difficult playing position. The surface of the green is moderately pitched to aid the golfer in choosing his landing area.

The second water hazard is encountered on hole number seventeen and is intended to be more difficult than the first. It is a par 5, 430 yard dogleg hole crossing the water on the first shot. A 230-yard drive will carry the ball to the most favorable position on the fairway for the second shot and coincides with the location where the change of direction in play occurs. A sand trap is located on the left, 190 yards from the tee, requiring the golfer to strive for distance on the first shot. The golfer trying to play this hole in two shots is confronted with two traps guarding both sides of the only possible landing area. Where the play crosses the creek, the existing vegetation has been removed creating a channel directing the first shot in the intended direction.

A safer way to play hole seventeen would be to drive 170 yards short of the first trap and then cut the corner on the second shot to carry 150 yards, placing the ball one hundred yards from the green.

The entrance to the green is closely guarded by the location of a large sand trap with two additional traps, one to the right and one at the rear, intended to require the final shot to be played to the left side of the green. The total area of the putting surface is 6,400 square feet, with a moderately rolling surface enabling a variety of cup cutting areas. The hole is nearly

surrounded by tree massing with open areas at various locations to relieve the channelizing effect and to permit a variety of views to the remainder of the course.

The final hole, hole number eighteen, is a par 4 hole, 350 yards in length, with a change in the direction of play located 180 yards from the tee. It is possible for a golfer to play this hole in a number of ways allowing him to finish the eighteen hole circuit at his own discretion. With a long drive, it is possible to cut the corner of the dogleg and try for the green three hundred yards away, or choose any other intermediate target area to suit the player's individual abilities.

The green, located on the rim of the wooded ravine, is elevated with trapping to the right and to the rear. The total area for putting is 7,400 square feet with a slight pitch to the front for drainage and to make it more visible. Tree massing flows into the existing vegetation creating a small private cove for putting. The circulation route terminates at this hole and leads back to the pro shop area via the bridge over the ravine.

The golfer, after playing this eighteen hole course, has had the opportunity to witness a variety of space relationships created by both the landforms and the tree massing. A variable test of skill has been provided to allow the player a thorough cross-section of strategical problems to test his personal abilities.

The Practice Hole

The practice hole has been designed to serve several functions. It will allow a player to warm up before playing the course, or it can be used as a hole to play off a tie. It can also be used for practice in playing out of sandtraps, putting or as a limited facility for a driving range.

The main reason for requiring a versatile hole of this type was due to the limited amount of space on the site. From existing standards, a desirable layout for a practice hole was outlined, but this ideal hole is not possible where space is limited. The same is true for a driving range. Due to the area needed to design an adequate driving range, it was possible to develop that kind of facility. Therefore, this practice hole was conceived to be capable of serving the golfers' various needs.

The Putting Clock

The need for a practice putting surface was fulfilled by constructing a practice green which would be graded to permit a putting problem similar to that of any found on the course. The total area was 9,000 square feet, and up to nine individual cups can be located at any one time. It is closely related to both the pro shop and the clubhouse, and it is intended to be the connecting link for all the facilities and the transitional element from these facilities to the course.

CHAPTER III

CONCLUSIONS

The Golf Course

In analyzing the completed study, there are several areas that require further comment. While the site was favorable for this study as stated in the problem, there was one factor that was not as desirable as it first appeared. During the site selection process, the author was concerned with choosing a location which contained little variation in the vertical elevation and water as an element to be developed. Walnut Creek provided this water and the related vegetation to reduce monotony, but the total effect due to usable acreage was not at first clearly recognizable. For example, two holes based on water hazards were considered desirable, since the creek and adjacent areas were most effectively used in this manner. Furthermore, a large amount of the total acreage was consumed by the creek, leaving limited space to develop play. Therefore, insufficient space was available to develop elements such as a driving range as prescribed by the standards. Instead, the practice hole was conceived to serve as the driving range, and as a location for practicing play. The limitation of space also made the layout of the individual holes more critical and required careful placement of tree masses to prevent injury.

However, the desirable features of the site far outweighed the undesirable. The challenge was very rewarding in modifying the limited landforms to segregate and define the various holes, to provide different strategic problems and to develop an aesthetic for the total site. The cove defined by the wooded ravine provided a delightful relationship between the clubhouse facilities and the remainder of the course, while separating this use from the non-related land use to the south and east.

Even though the creek did reduce the playable area, it still provided a design element often overlooked, that is, the natural movement of water

and the ecological relationships. Many interesting views and divisions of space were possible by emphasizing these existing conditions.

Secondly, an important element for the success of a recreational development of this type is the need for an adequate irrigation system. This was realized from the beginning, and when writing the accepted standards, it was included to emphasize this need. In further defining the problem, however, it was felt that while such a system was essential for optimum playing conditions, it was not directly related to the sculptural approach in the design of this course. It should be further emphasized that to maintain a successful stand of turf in the central Kansas region, an irrigation system would be necessary due to the lack of adequate, timely rainfall. Since this is a maintenance need, it would normally be included within the total planning service, but the scope of this problem included only those maintenance factors that affected the design of the landforms.

Similarly, the development of a lighting system for evening play does not directly affect landform design. This area was investigated in order to illustrate the possible scope of the work related to this type of planning. It is emphasized that to economically provide this facility, it must be planned during the initial development.

In conclusion, it is felt that the layout of the course successfully established the sculptural approach to landform design. From this study, the author found that by altering the natural forms in such a way as to compliment the physical features, the total atmosphere could be altered creating a more suitable surface for this type of development. In using the sculptural approach, the designer has a useful tool in insuring this relationship and also permitting a rapid evaluation of the results. The existing topographical variation was clearly represented on the model, and by using an exaggerated

vertical scale, the natural drainage swales were emphasized. This permitted the retention of existing features as the sculptural approach progressed.

Also emphasized was the degree of importance each landform held in the development of the total site. When grading, these features determined the probable locations for efficient, economical earth movement. The existing drainage swales were further excavated and designed to appear as more pronounced separations from adjacent forms and the soil removed was deposited in the higher areas to also emphasize this vertical separation. Thus, the new landforms were completely compatible with the surrounding area.

Another element with which the landscape architect is concerned, regardless of the problem, is the relation of the vegetation to the proposed facility. In this study, it was especially important due to the effect that type and location of plant material can have on height relationships. By means of a careful selection and by interpreting the effects possible in the uses of these plants, the vertical variation can be greatly emphasized. Subtle placement of tree massing will often create a visual effect not possible by any other means. Where important variations of form exist, the placement of trees as a visual barrier can make these landforms very important by permitting an occasional view or a possible vista.

Therefore, the total effect of landform variation can be greatly increased by controlled earthwork emphasis on natural features and by the types and placement of vegetation.

The Study Method

The results obtained from the use of the study model were very valuable in the execution and analysis of landforms. The technique devised was complete in every detail making it possible to evaluate the existing landforms,

interpret the relationships and develop the proposed landforms based on the findings.

With the theory of the study model proven adequate, the major possible criticism of the technique would be of the materials used in construction. As the model was originally conceived, the use of more durable materials was planned but cost of such materials proved excessive. As a result, the substitute materials were not flexible enough to withstand the varying conditions.

One of the problems encountered was that the clay was not treated to prevent it from drying. This caused the clay to develop numerous small cracks, and these cracks had to be constantly sealed and the surface kept moist to prevent further damage to the surface. A plastic cover was incorporated which helped delay the drying effects. A suggested improvement to eliminate this problem would be the use of a plasticine clay which is a clay treated to prevent drying.

Another problem encountered with the use of local clay was that even though the desired consistency was obtained, continued compaction increased the internal pressure until two of the plate glass sides were broken. The settling did not affect the vertical elevations to a large extent due to the exaggerations of this vertical scale. However, breakage did contribute to leakage when water was added in the final stage. A more flexible material, such as plexiglass would sustain a greater amount of pressure before the breaking point is reached. Also, the use of additional external supports would aid in containing the material in a stabilized position.

It was also discovered that the small cracks in the clay surface permitted water to flow to the bottom of the model and leak along the bond between the glass sides and wooden base. Water seeped into the groove where the glass sides were contained and was able to flow under the sides and eventually

through the layers of the plywood, causing a multitude of leaks.

At first, this appeared to be a serious problem, but upon further examination, it was found that due to the volume of water required to raise the level one-tenth of an inch, the water line was lowered only very little. Also, as the water was brought up to each mark on the vertical scale, it left a water line on the clay so that the original level was still obvious on the clay material.

The improvement suggested to eliminate this problem would be to use plexiglass as for the sides, creating a permanent, leakproof bond by the use of the epoxy resin glue.

A minor problem encountered was the total weight of the completed model. Due to the size and choice of materials, the model weighed approximately three hundred pounds, making it very difficult to move. A relatively permanent location is recommended for its further use.

When using the grid system to transpose the contour lines to the glass surface, as defined by the water line, another solution was revealed that would possibly be more accurate. This solution was to use a photographic method in locating contour lines. By mounting a 35 mm camera at a fixed height over the model to encompass the total area, each contour could be photographed as it was defined on the model by the colored water. Upon completion of this process, it would be possible to mount a slide projector at a fixed distance from a drawing surface and to project each slide onto this surface in the same order as they were taken. By tracing each contour on the paper, a contour map could be developed. As long as both instruments are fixed at a known height and a horizontal scale is included on the model so that it can be measured on the projection, any scale can be determined for the final contour map by varying the distance of the projector from the drawing surface.

FURTHER STUDIES NEEDED

From an evaluation of this thesis, there are several potential areas of study in which further analysis is necessary. Among the kinds of studies needed are

1. A follow-up study to determine if the principles set forth for interpreting the existing landforms and the application of the results to the proposed landforms will accommodate other types of land developments.

2. A study to evaluate the study model and the determination of suggested improvements to reduce the element of wasted time and to suggest more suitable materials for a photographic progression.

3. A parallel study to utilize the model in determining its suitability for the use in evaluating other types of facilities. This might include the effect of changing the graphic scale of the model.

4. A study related to golf to evaluate the results of the private-public designation as used in this thesis. Factors which could be included would be a cost analysis and revenue study, problems caused by the separation of non-related facilities, the acceptance by both the public and private organization, studies related to the element of possible increased maintenance, and studies concerned with the separation of the clubhouse and pro shop facilities.

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APPENDIX

EXPLANATION OF PLATE I

Photograph, showing model of the
golf course and related facilities

PLATE I

EXPLANATION OF PLATE II

Master Plan

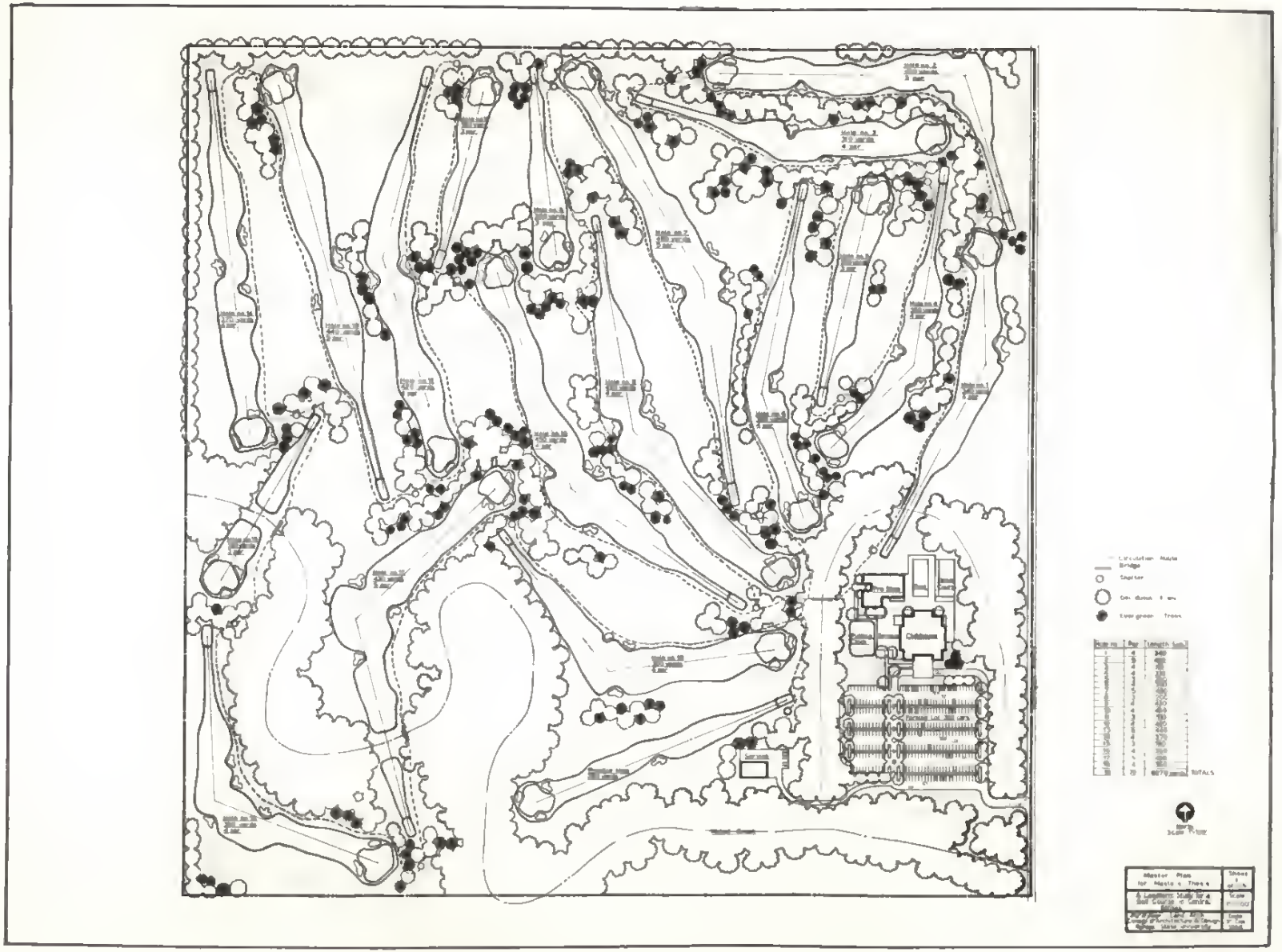

PLATE II

EXPLANATION OF PLATE III

Grading & Staking Plan

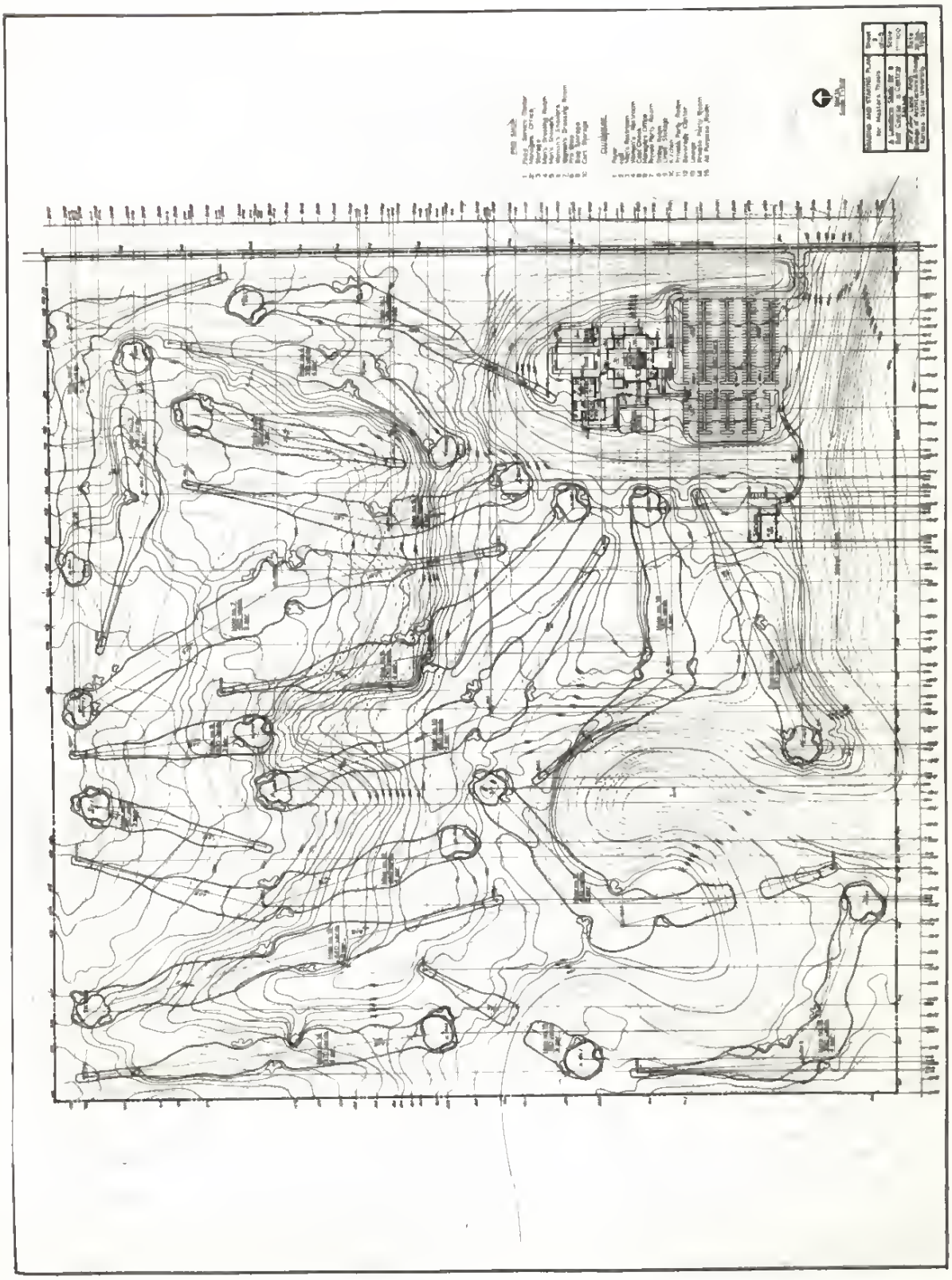

PLATE III

EXPLANATION OF PLATE IV

Tree Planting Plan

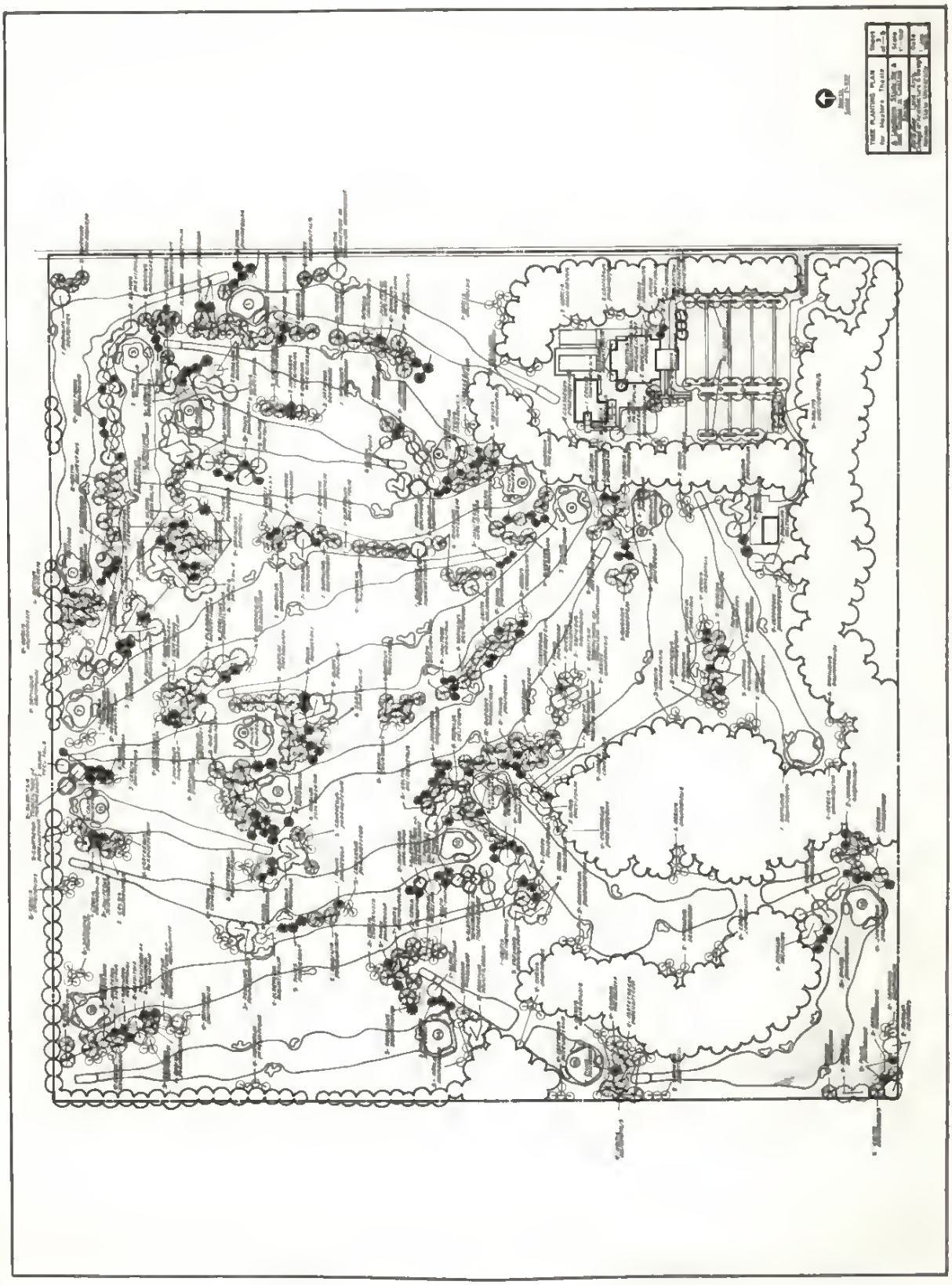

PLATE IV

EXPLANATION OF PLATE V

Cross Sections & Details

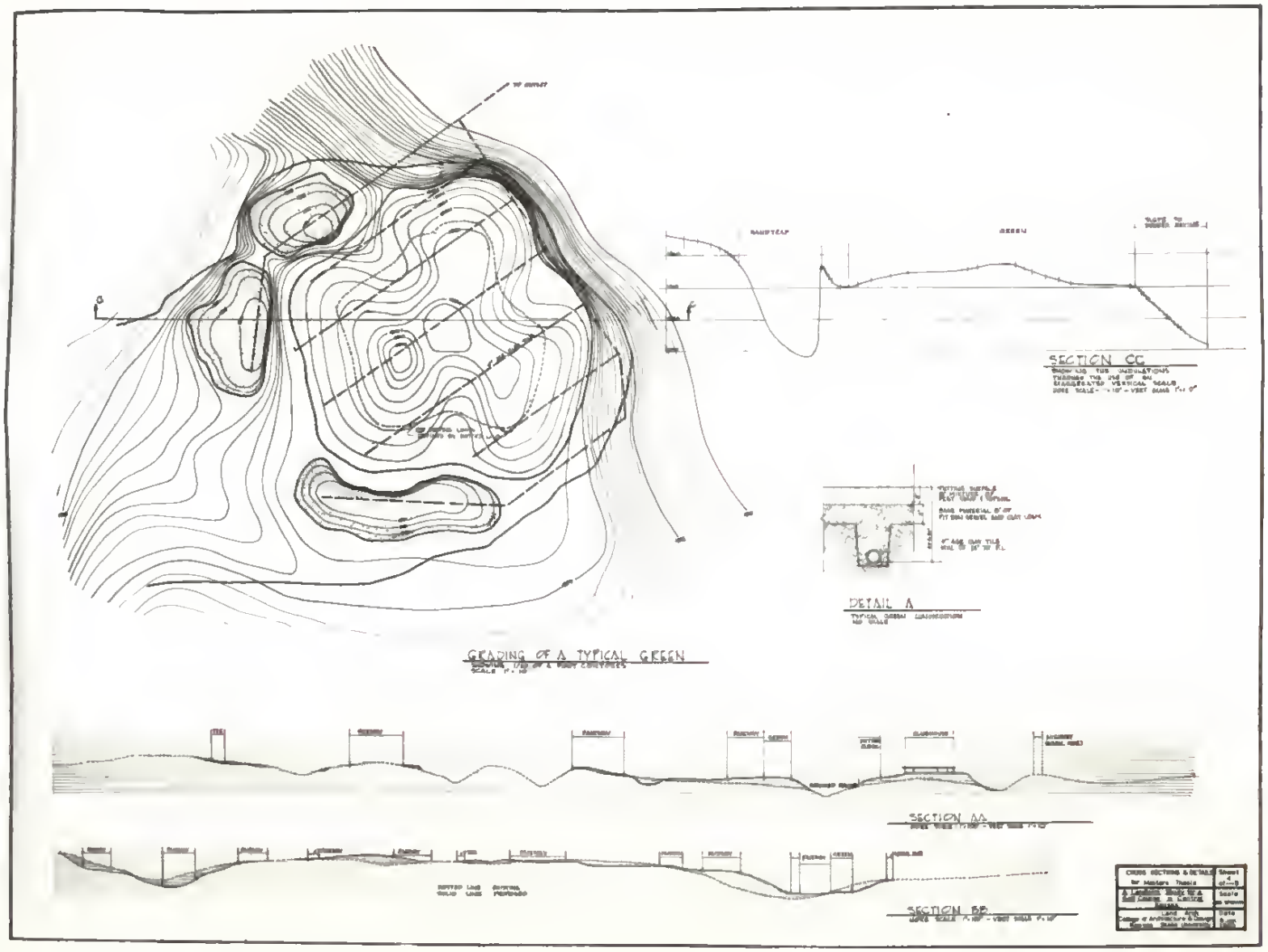
SECTION CC
DETAIL A
GRADING OF A TYPICAL GREEN
SECTION AA
SECTION BB

PLATE V

EXPLANATION OF PLATE VI

Character Sketches

CHARACTER SKETCH
A TYPICAL GREEN

VIEW OF WALNUT CREEK
LOCATED NEAR HOLE NUMBER 18

PERSPECTIVE
OF THE PRO SHOP COURTYARD

CIRCULATION ROUTE
RELATIONSHIP OF A GREEN AND TEE

CHARACTER SKETCHES for Master's Thesis	Sheet 8 of 9
A Landform Study for a Golf Course in Central Kansas	Scale No Scale
Author: Land Arch. College of Architecture & Design Kansas State University	Date 3 Jan 1985

PLATE VI

PLANT KEY

Quantity	Botanical Name	Common Name
	Deciduous trees	
59	Celtis occidentalis,	Common Hackberry
144	Cercis canadensis,	Eastern Redbud
57	Crataegus phaenopyrum	Washington Hawthorn
15	Elaeagnus angustifolia	Russian Olive
21	Fraxinus pennsylvanica	Green Ash
14	Gleditsia triacanthos H.V.,	Morainelocust
9	Gleditsia triacanthos H.V.,	Thornless Honeylocust
19	Populus deltoides,	Cottonwood
122	Quercus macrocarpa,	Bur Oak
4	Robinia pseudoacacia,	Black Locust
60	Sapindus drummondi,	Western Soapberry
93	Ulmus parvifolia,	Chinese Elm
	Evergreen trees	
45	Juniperus scopulorum	Rocky Mountain Juniper
27	Juniperus virginiana	Eastern Redcedar
107	Pinus ponderosa	Ponderosa Pine

VITA

Bill G. Yung was born in Wichita, Kansas, April 24, 1940, and resided on a farm near Halstead, Kansas, until the fall of 1958.

He attended elementary school in the Halstead Public School system and graduated from Halstead Rural High School in the spring of 1958. That fall he attended Kansas State University in Manhattan, Kansas, studying for a bachelors degree and in January, 1964, he received the Bachelor of Science Degree in Landscape Architecture. During this time he was a member of Phi Delta Theta, a social fraternity, and completed the requirements for a commission in the United States Army. That Commission was granted in January, 1964. Upon receiving a delay from reporting to active duty for the purpose of graduate study, the author chose to study for a Master of Science Degree in Landscape Architecture, with the supporting courses in city planning.

During graduate school, he was accepted in Gamma Sigma Delta, an honorary fraternity in Agriculture and was also granted associate membership in the American Society of Landscape Architects.

Upon graduation from graduate school in January, 1965, the author will serve two years in the United States Army.

A LANDFORM STUDY FOR A GOLF COURSE IN CENTRAL KANSAS

by

BILL G. YUNG

B. S., Kansas State University, 1964

AN ABSTRACT
OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

College of Architecture and Design

Landscape Architecture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1965

The purpose of the thesis was to develop an eighteen-hole golf course with the related facilities on topography which is normally considered unsuitable for recreational development. The site chosen is located three miles north of Great Bend, Kansas, and contains the limited topographical variations.

In conjunction with this purpose, the study also was intended to interpret the existing landforms and to determine a series of topographical characteristics. These characteristics were then used in the creation of new landforms suitable for golf course play. A study model was designed that would permit the evaluation of the existing landforms at a reduced scale and constructed of a suitable material for remodeling these landforms relative to the layout of the course. This model also made it possible to theoretically balance cut and fill in the earthwork to be performed and was so designed that it was possible to derive a proposed contour map at a known scale.

After the problem and the method of study was determined, accepted standards presently used in golf course design and construction were compiled and analyzed. Many important relationships were established from this review, and a method of approach for designing the golf course layout was determined. Upon completion of this phase, a tentative location for development was decided upon in the Great Bend area. A two-day inspection trip was made, and the possible need for this type of facility was confirmed as was the final selection of the site. A contour map of the area was drawn and the model of existing topography constructed in order to later derive and construct the suitable landforms.

During the development of the course, the desired relationships among the site, the course, and the clubhouse facilities were determined. The course was designated as a private-public course to meet the demands of a

larger range of people and to provide facilities capable of better satisfying the golfer's needs.

The clubhouse and pro shop facilities were designed to compliment the total development and to effectively utilize the available space. Interior-exterior relationships were established and located on the site to provide facilities which were to be both functional and aesthetic to the viewer. The relationship of these facilities to the course, combined with the information obtained from the standards determined the layout of the holes. The holes were designed and graded to become an integral part of the site and thus established the strategical problems. The finished eighteen-hole, 72-par course was 6,270 yards in length. Clubhouse, pro shop, and supporting recreational facilities were separated according to use.

The work accomplished toward the completion of the thesis showed that a study model was a successful technique in evaluating existing and proposed landforms. With suggested modifications, the technique should be adaptable to a wide range of site developments.