A STUDY IN THE BUILDING AND MAINTAINING OF FOOTBALL FIELDS IN CLASS AA HIGH SCHOOLS IN JOHNSON AND WYANDOTTE COUNTIES OF KANSAS

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by

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

The popularity of football is reaching an all time high, with the added emphasis of professional football and television. There has been a great deal of publicity concerning the effectiveness of the equipment worn, the rules, and the coaching techniques in regard to the protection of players. Far too little is understood or written relative to the actual playing field. The condition of scholastic football fields is often taken for granted; the common excuse being the effect of natural elements. The personnel in charge of professional playing fields, however, attach more importance to a good field. The importance can be illustrated by the large amount of money and energy that is spent in maintaining a superb playing surface.

I. THE PROBLEM

Statement of the problem. The football fields of class AA high schools in Johnson and Wyandotte Counties in Kansas were surveyed: (1) to determine existing conditions with regard to quality, care, and maintenance; (2) to discover what materials and methods are available to better the existing fields; and (3) to establish a basic model to follow in building new and improved fields.

The hypothesis of this study was that there is a need for improving the playing surface of football fields in Johnson and Wyandotte counties.

Significance of the study. The relationship between poor turf on the football field and injuries to the team is just beginning to be understood. Many times ankle, knee, and shin injuries may be directly related to the playing surface. Some school officials have seen the need and demanded better turf to help reduce player injuries to a minimum. Other administrators have not been concerned with this problem and the maintenance men have not taken the proper action needed to maintain a fine playing turf. Unfortunately some coaches just don't seem to care or do not have resources to do so. Mothers and fathers do care about the welfare of their off-spring. It is also logical to assume that the players themselves are concerned with their safety.

It was the plan of this investigation to provide a basic model in the building of a football field for Turner Unified School District 202. Also, it was hoped to aid the school officials and maintenance personnel who are connected with the management of football fields. Such things as knowledge of the methods, materials, and equipment that are available for caring for the football fields were given. As there is not only a lack of knowledge but, also, little evidence of research being conducted in this particular area, it would seem to warrant an intensive study.

Limitations of the study. The study was limited to the existing football fields of Class AA high schools in Johnson and Wyandotte Counties of Kansas, and by the uncontrollable factors of the natural elements which included, amount of rainfall, climate, and mineral deposits which affect the fields.

II. DEFINITIONS OF TERMS USED

Class AA High School. The present athletic classification of AA high schools in Kansas was established in 1962. This classification included the top fifty-six schools according to enrollment.

Drainage. Drainage refers to the running off of excess water due to the contour of the football fields or by means of pipe and ditches.

Equipment. The term "equipment" shall refer to the articles or machinery that are used in the building and maintaining of football fields.

Football Field. The actual playing field is 360 feet long and 160 feet wide but throughout this report the apron immediately around the actual playing area will be considered as part of the football field. This entire area will include approximately two acres.

Maintenance Personnel. The term "maintenance personnel" shall refer to men who have the responsibility of keeping the tools and equipment in good repair and of caring for the athletic field.

Materials. The word "materials" will be interpreted as meaning the actual objects used in the process of building and developing football fields.

Methods. Methods will relate to the procedures and techniques employed in the development and maintenance of football fields.

Natural Elements. Natural elements will relate to those aspects of resources of nature such as climate, mineral deposits, and water.

Playing Surface. Playing surface refers to the actual area upon which the game of football will be played.

School Officials. Throughout this study, the term "school officials" shall refer to all personnel directly connected with a school system, such as teachers, administrators, and members of school boards.

Soil. Soil will relate to the layer of earth supporting plant life and upon which the turf shall be grown.

Turf. The term "turf" shall relate to the covering of grass and other vegetable matter with its matted roots forming the surface of a grassland.

III. METHODS OF PROCEDURE

Three general techniques, interview, observation, and correspondence were employed. The interview and observation were used jointly in surveying the conditions of the existing football fields of Class AA high schools in Johnson and Wyandotte Counties. Also chemical analyses were taken of each field and tested by the Franklin County Agriculture Commission. A check list was prepared to tabulate specific features during the interview and observation in relation to the conditions, equipment, materials, methods, and personnel in charge of the fields. The interview technique was employed with professional groundkeepers, maintenance personnel, administrators, and coaches. Correspondence was carried on with top educators and research men in the fields of agronomy and horticulture. Companies whose materials and equipment are connected with management of turf were also contacted personally or by correspondence.

The check list data were compiled and shown in table form, comparing the differences of techniques, materials, methods, and existing

conditions of each school. All forms of methods, materials, and equipment directly related to football fields were discussed, with emphasis on those best fitted for the Johnson and Wyandotte County area.

CHAPTER II

REVIEW OF THE LITERATURE

Much has been written on outdoor playing surfaces of play areas in sports and recreation, but very little has been printed on turf for football fields. It was found by the researcher that very little information has been published in books, magazines, and pamphlets on the subject since 1958.

I. LITERATURE ON TURF

Grau cautions that before starting the repairing or building of a playing surface one must first decide on the kind of turf that should be grown to meet the needs. He believes in having a good mental picture of "nothing but the best" because with modern techniques and improved knowledge, in most cases, it is possible to produce the kind of turf desired.[1]

The kind of turf desired by most schools is one that is firm for good footing, and slightly yielding so that the surface will give when it comes in contact with human tissues. The turf should be resilient to take the shock of falls so that players will not be injured by physical contact with the playing surface. Dr. A. S. Reece, at the Gardner Community Hospital, was quoted in the fall of 1963 by the Kansas City

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[1]Fred V. Grau, "Reduce Injuries with Good Turf," Athletic Journal 34:29, April, 1954.

Star, as saying "the extremely hard ground this year is to be blamed for most of the injuries."[2] This statement was in reference to the increase in football injuries in Johnson County during the first stage of the season.

It is generally felt that nearly everyone has some appreciation for beauty. This, too, should be kept in consideration in caring for the field. The appearance of the field may have a psychological effect on both the players and spectators. Many schools have dyed their fields green when a heavy frost turned them brown.[3] Some schools have planted perennial rye grass on fields when the bermuda grass became dormant. The green color is highly desirable, but has no direct relationship to playing quality. Protection from dust and mud is highly important.

Another problem which must be faced is what type of grass is best adapted to a particular area. Grasses for athletic fields need to be sturdy, wear-resistant, disease-resistant, and fast spreading for quick healing of divots and worn areas.[4] The section of the country has dictated which type of grass to use. There are excellent grasses to choose from for the various regions. Bermuda grass has been the base grass for athletic fields in the South, Southeast, and Southwest. In

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[2] Kansas City Star, October 8, 1963

[3] Grau, op. cit., p. 29

[4] Fred V. Grau, Improving Athletic Field Turfgrass, Bulletin 2, West Point Products, West Point, Pennsylvania. p. 5.

these areas it has been the only grass needed. The greatest sins, when bermuda was used, were to starve it, drown it, and cut it too high. All Bermuda grasses thrive under close-mowing, generous fertilization, frequent cultivation, and deep infrequent irrigation. A type of bermuda is Hall's U-3 strain. It has a medium-fine texture, noted for its good resistance to disease, its deep-rooting habits and its resistance to low winter temperatures. U-3 has performed well in the "twilight" or "transition" zone, the broad belt between the regions of the warm-season and the cool-season grasses.

In other sections of the country, Kentucky bluegrass has been considered the base grass. This grass provides excellent spring and fall coverage and has great powers of recovery when properly managed. Two inherent weaknesses, susceptibility to leafspot in spring and summer dormancy, permit weed invasion and limit production of dense wear-resistant sod. Merion bluegrass is an improved variety, somewhat more susceptible to rust, but more tolerant of close mowing than common bluegrass.[5]

In regions that consider bluegrass to be the base grass, the inclusion of creeping red fescue is often desirable. Tall fescue (Alta or Kentucky 31) has been used by itself but tends to clump after a few years; hence it has not been desirable under most conditions. Alta seems to be preferred west of the Rockies whereas Kentucky 31 fescue has been somewhat more disease-resistant and a little finer bladed in the humid

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[5] Ibid., p. 7.

regions. Both are relatively coarse-bladed, deep rooted, drought tolerant grasses with good wear-resistance and a high tolerance to chemicals. The fescue can tolerate low levels of maintenance but will respond to good management.[6]

Ryegrass has the characteristics of being a quick-starting, fast-growing grass. Therefore, it has been a favorite for rapid coverage of bare areas and for providing green color on dormant bermuda. Perennial ryegrass is a trifle slower than domestic (annual) ryegrass but it is tougher and longer lasting. Both form objectionable clumps when plants are not close together. In general ryegrass should be considered as a special purpose grass to be seeded alone and not as part of a seed mixture containing expensive perennial grasses.

Dr. J. R. Watson believes that, where adapted, bermuda should be the only grass used. It may be sprigged or seeded or both methods may be used. A good high quality seed applied at a rate of two or three pounds per 1000 square feet (80 to 100 pounds per acre) will give the most rapid cover and develop the best sod. He recommends that when Kentucky bluegress is used it may be seeded alone at a rate of three pounds per 1000 square feet. Another mixture that has been preferred by some authorities, if red fescue is used, is to seed four pounds of a mixture containing 65 per cent Kentucky bluegrass and 35 per cent red fescue per thousand square feet.[7]

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[6] Ibid., p. 9.

[7] Dr. J. R. Watson, Jr., "Factors To Be Considered in Construction of a Football Field," (Minneapolis: Agronomy Division, Toro Manufacturing Corporation, n.d.), p. 5. (Mimeographed).

When necessary to reseed established fields, the rate of seeding will vary, depending on the amount of cover present. Seed should be divided into two equal lots, one lot broadcast at right angles to the other. This method of seeding insures a uniform stand.[8]

There are many other grasses that have been used, such as Tiflawn, Texas 47, Bahiograss, St. Augustinegrass, Kikuyugrass, Zoysiagrasses, and Buffalograss, in areas where they are adaptable. The ones discussed in detail have been found to be the most successful in this area.

There seems to be general agreement between writers that a sod nursery would make the management of athletic field turf much easier. When there is not sufficient area to develop a sod nursery, it is possible to use the side lines and zones for this purpose.

Reeder used a four inch "turf-plugger" which cuts a plug of turf four inches in diameter and three or four inches deep. The same tool is used to prepare the "receptacle hole" in the scuffed area. To encourage the roots of the plug to take hold with the existing soil, he places in each hole, before it receives a plug, a commercial preparation which is high in phosphoric acid, and also contains potash and nitrogen. Reeder was convinced that the weekly placing of plugs from the sod nursery to

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[8]Dr. J. R. Watson, Jr., "Renovation and Management of Athletic Field Turfgrass," (Minneapolis: Agronomy Division, Toro Manufacturing Corporation, n.d.), p. 7. (Mimeographed).

the torn areas of the field, will do away with the complete overhaul job performed each year in the spring.[9]

Sodding is the most expensive method of initial turf establishment. It involves cost of the sod, whether bought commercially or grown in a sod nursery. In general its use on an athletic field is limited to those situations where it is necessary to provide a mature, wear-resistant turf cover in a short time. A properly laid sod on a well prepared seed-bed will knit for use within four to six weeks. In contrast, comparable turf cannot be produced by seeding short of about one full growing season.[10]

Controlled watering is one of the most important considerations in the development of good turfgrass. The prevailing tendency is to over-water rather than underwater. If grasses are well-adapted and properly managed (enough fertilizer, enough lime, enough aerifying) they can survive long periods of drought.[11] Excessive water, as well as too frequent applications, intensifies soil compaction. Plants growing in water-logged soil cannot function properly because of the reduced amount of oxygen available to the root systems.

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[9]Colonel Red Reeder, "The Backs Go Tearing by on What Kind of Turf?" Athletic Journal, 34:50, January, 1954.

[10]Grau, op. cit., p. 14.

[11]H. B. Musser, J. M. Duich, and J. C. Harper II, Athletic Fields, University Park, Pennsylvania: The Pennsylvania State University, College of Agriculture Extension Service, n.d., p. 13.

On new seedlings, the field should be sprinkled lightly each day until the seed germinates. The amount of water applied should be increased when the seedlings emerge.[12]

Water should be applied to mature turf as the plants approach wilting. One of the best ways to determine water need is to walk over a field in early afternoon and observe if the grass remains pressed down in the footsteps made. A small soil probe made from a handle of an old golf club, with the side ground out so the plug can be observed, has been an excellent and single tool to observe water penetration and distribution. The field should have been soaked to a depth of four or six inches. Soils differ in their ability to absorb moisture. Water should not be applied in excess of that which a given soil can take in and hold. When surface runoff is evident, water should be cut off. If the soil is not soaked to the required depth, wait until the moisture has percolated downard and apply additional water.[13]

There have been many types of water systems made for athletic fields. The four categories are: (1) pop-up system, (2) quick-coupling system, (3) portable pipe, and (4) traveling sprinkler. Consideration should be given to the installation of automatic watering systems on old fields as well as new. The savings in labor and water cost, as well

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[12]Watson, "Renovation and Management of Athletic Field Turfgrass," p. 6.

[13]Ibid., p. 7.

as the control such a system permits, are often sufficient justification to permit installation.

Improper mowing can be ruinous to an otherwise well managed field. A sharp, well-adjusted mower is essential for the cutting of young turf. Mature turfgrass will be maintained in a far more satisfactory condition if the mower is kept properly adjusted and sharp. Common Kentucky bluegrass or fescue fields should be cut at one and one-half to two inches. These grasses cannot survive under close cutting. On the other hand Merion bluegrass or bermuda grass grows much better at a lower cut, one-half to three-fourths inch.[14] New seedlings should not be cut until they are approximately two inches in height. Just as important as the height of cut is the frequency of mowing. Only about one-quarter inch of leaf surface should be removed at any one clipping. If the grass does get out of hand, bring it down gradually. Otherwise there will be only a brown stubble left on the field and the chance for disease is greatly enhanced.

It is also wise to set patterns to follow when mowing. Mowing in the same way every time is not recommended. An example in keeping to a pattern is to mow lengthwise, then crosswise, and the next time diagonally.

The type of mower, such as rotatory type or reel type, is not very important. The reel type mowers will be found at country clubs for mowing fairways, which might be a sign in their favor. Another type which has

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[14] Grau, Improving Athletic Field Turfgrass, p. 19.

been very successful is the Verti-Cut mower which completes the mowing job by removing dead matted grass which has no value in providing weaving turf.[15]

Diseases are not often a problem on athletic fields. Disease resistant grasses, properly managed, are the best insurance against disease problems. Chemicals for disease control generally are not recommended on athletic field turf. Common bluegrass is subject to leafspot. Merion bluegrass and perennial ryegrass are susceptible to rust. This is most likely to occur where there has been some error in the management. Rust most often is a problem where insufficient fertilizer has been used. Snowmold on northern fields sometimes may be damaging. Late fall application of a mercury fungicide can be helpful.[16]

Insects that attack grass may be classified in two groups: (1) surface-feeders—those insects such as sodwebworms, cutworms, and army worms that eat the leaves; and (2) sub-surface feeders such as grubs that eat the roots of the grass.[17]

Chemicals such as Chlordane, D. D. T., Heptachlor, and Dieldrin may be used to control both groups of insects. For surface feeders apply insecticide in the afternoon, leave the material on over night, then water it in thoroughly. For a good general purpose spray use a

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[15] Ibid.

[16] Ibid.

[17] Dr. J. R. Watson, Jr., "Managing Athletic Turfgrass Areas," (Minneapolis: Agronomy Division, Toro Manufacturing Corporation, n.d.) p. 9. (Mimeographed)

mixture of Malathion, Chlordane, and D.D.T. Such will control most insects. Chlordane provides an excellent control for ants and chiggers.[18]

Weeds may be controlled by good culture, by mechanical means, and by chemicals. Chemicals are tools to use when good culture and good mechanical devices have not done the complete job. A dense, well-knit turf of adapted grasses is the best defense against weed invasion. The first step in a successful weed control program is to correct the basic cause or reason for the presence of weeds, then use chemicals to eliminate them. Chemical control consists of using the correct materials under prescribed conditions of moisture, temperature and other factors.

All broad-leaf weeds and crabgrass may be selectively removed from permanent grasses without damage to the desirable grass. For control of broadleaf weeds and clover 2,4-D or 2, 5-T should be used. A mixture of 2, 4-D and 2,5-T is desirable for knotweed and chickweed. Treatment of all weeds in the early spring when they are young and growing actively is considered best. This is particularly true of knotweed and chickweed.

When needing help in combating weeds, one may also get assistance from the County Bind Weed Commission.

II. LITERATURE ON SOIL CONDITIONS

Top soil is of prime importance if there is to be a good turf. There seems to be a slight difference among writers as to the amount of top soil needed. The recommended amount of top soil has varied from four

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[18] Ibid.

to eight inches with the median being six inches when settled. A sandy loam, somewhat lighter than good garden loam, is the best topsoil for athletic fields.[19] Sandy loam soil is considered ideal but it is not always possible to provide the ideal. Excellent turf can be developed even on heavy clay soils under a system of good soil management. A sandy soil is no guarantee against soil compaction. All soils will need careful management to relieve compaction which is inevitable in soils that are subjected to trampling and heavy traffic.

The best time to incorporate sand and organic matter into the soil is when the field is being built. The texture of the topsoil will govern the kind and amount of conditioners needed. Ideally, the seedbed should contain about 10 to 15 per cent organic matter, some coarse sand (10 to 20 per cent), and the remainder a good sandy clay present in the seedbed; however, there should be at least 10 per cent.[20]

If the area is not excavated, the coarse sand and organic matter should be mixed and thoroughly incorporated as deeply as possible with the existing topsoil. These materials should be plowed and harrowed in. No layer should be evident when mixing is complete.

One of the biggest follies on athletic fields is to assume the soil, which has been repeatedly compacted by caterpillars, graders, trucks, spreaders, loaders, etc., will, just because it is level, provide a

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[19]Geoffrey S. Cornish, "Turfing New Fields," Scholastic Coach, 24:53, January, 1955.

[20]Watson, "Factors to be Considered in Construction of a Football Field," p. 3.

satisfactory seedbed. True, it needs leveling and sloping, yet prior to seeding, it should be mechanically loosened to at least a six to eight inch depth.[21] One of the most satisfactory tools for loosening soil is a field cultivator on the hydraulic lift of tractors. The teeth of the cultivator can be regulated to penetrate deeply by going over in several directions until existing compaction is uniformly removed. Following this deep tillage, the limited use of disks or harrows may prepare a surface seedbed.[22]

After a field is in play the best way to work organic matter and sand into the soil without interrupting play is with an Aerifier.

Since a dense turf is desired, it should be realized that most soils, particularly sub-soils and excavated soils, are deficient in the major growth elements. All soil should be tested once a year, even after the turf has matured. The first step in testing should be to find out the degree of alkalinity or acidity in the soil, due to the presence or absence of calcium. When the ph values drop below 6.5 it may be time to add lime. The essential elements that must be present in order for soil to be fertile are termed the "Big Four." They are calcium, nitrogen, phosphorus, and potassium.[23] Dr. Watson refers to Emil Truog's

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[21] W. H. Daniel, "Athletic Field Establishment," (Unpublished paper, Department of Agronomy, Purdue University), p. 7.

[22] Ibid.

[23] John M. Melady, "Turf Surfaces for Play Areas," Sports and Recreation Facilities for School and Community, Alexander Gabrielsen and Caswell M. Miles, eds., (Englewood Cliffs, New Jersey: Prentice-Hall, Incorporated, 1958), p. 251.

method of soil analysis in his material on football fields. Mr. Truog is in the Department of Agronomy at the University of Wisconsin and has worked out a procedure to be followed in soil analysis known better as the Truog Method. After a soil test, the following recommendations are given for reserve fertilizer applications:

1. Lime--raw agricultural--at approximately 1000 to 1500 pounds per acre. If there is evidence of magnesium deficiency, use dolomitic limestone. By the Truog Method there should be approximately 4000 to 6000 pounds of calcium, and 1000 or more pounds of magnesium per acre.

2. Phosphorus--incorporate 500 to 600 pounds of 20 per cent super phosphate per acre (the soil should contain at least 75 100 pounds of available P_2O_5 by the Truog Method.

3. Potassium--mix one to two hundred pounds of 60 per cent Muriate of Potash per acre (Truog Method requires a minimum K_2O--175 to 200 pounds per acre)

4. Nitrogen--sufficient nitrogen should be added to aid microbiological activity and prevent a tie-up of nitrogen by soil organisms. Approximately 40 to 50 pounds of actual nitrogen per acre may be used.[24]

The above materials should be applied prior to final grading of the field. They serve as a reserve source of plant food. The necessity

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[24] Watson, "Factors to be Considered in Construction of a Football Field," p. 4.

for deep mixing of these materials is obvious because the mineral plant food elements move very slowly in the soil. By placing the material deep, prior to establishing grass, the plants are provided with a readily available supply of food. This promotes deep root development.

In addition to the above mentioned reserve fertilizer, a "starter fertilizer" should be used. The starter fertilizer should carry an approximate ration of N-P-K of 2-1-1. One half the nitrogen should be an organic form and one-half in an inorganic form. This fertilizer should be applied about seven to ten days before seeding and at a rate to supply approximately forty to fifty pounds of actual nitrogen per acre. It should be raked into the upper two or three inches of the surface and should be moistened once or twice before seeding.[25]

It should be remembered that fields and play areas that are already in use will also need to be fertilized. This will be to keep grass growing vigorously, and will speed recovery from injury and wear. Monthly applications during the growing season will help to provide a constant supply of available nutrients.

It is wise to use an aerifier before applying fertilizer in order that the material can get down to the plant roots. It is important that the fertilizer be applied uniformly. It is also important to apply fertilizer when the leaves are dry to avoid burning of the leaves. After aerifying and fertilizing, use the dragmat to crumble soil and

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[25] Ibid., p. 5.

work and fertilize down into the holes. Dragging also brushes fertilizer off the grass blades, thereby reducing burning of leaves. A dragmat can be made from a section of chain length fence.

It is difficult to say what type of fertilizer to use as each area may be different. It is recommended to have the soil tested and work from the laboratory results. Since the turfgrass thrives on nitrogen, additional nitrogen should be supplied to it throughout the growing season. Two general types of fertilizers are a good complete fertilizer and a straight nitrogen fertilizer. The supplemental nitrogen may be an organic material such as milorganite, tankage, cottonseed meal, agrinite or similar natural organic carriers; or it may be an inorganic nitrogen material such as sulfate or ammonia, cyanamid or ammonium nitrate.[26] It should be remembered that soluble nitrogen fertilizers can burn the grass when improperly applied, and in inexperienced hands, especially on the cool-season grasses. The fertilizer program on a bluegrass turf or on tall fescue would differ only slightly from the program on bermuda. The main difference would be to omit the monthly application in either July or August and to make another end-of-the season treatment with the complete fertilizer as was done at the start of the season.[27]

To have a good healthy turf, the soil must be taken care of and the drainage must be adequate. Contours and drainage provisions are

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[26] Graw, Improving Athletic Field Turfgrass, pp. 12-13.

[27] Ibid., p. 13.

particularly important from the standpoint of play and to provide for fast removal of surplus water. Good contouring will aid substantially in reducing compaction by providing for rapid removal of excess surface water, which is primarily responsible for chronically wet soil.

One recommended procedure is to put tile two feet out from the sideline and two feet deep. This would run along the entire sides of the field to catch basins at each end. Tile for lines leading to catch basins or to sewers should have a minimum diameter of six inches. Tile lines should slope about one inch per ten feet toward outlets either at a catch basin or a storm sewer line. Catch basins should be covered with a noncorrosive grill that is level with the ground. Basins should be of cement concrete and have a bottom at least twelve inches below the lowest outlet to permit precipitation of sediment.[28]

In certain areas it might be necessary to have field tile to take care of the surplus rainfall. In this case the minimum diameter should be four inches and the tiles should be extended across the field in lines between fifteen to thirty feet apart and at a depth of two to three feet.[29] Except for cases of seepage and high water tables, tiling the entire playing area may be of little value because of surface compaction which impedes water movement to the tile except in the strips immediately over the tile lines.

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[28] Harry A. Scott and Richard B. Westkaemper, From Program to Facilities in Physical Education (New York: Harper and Brothers Publishers, 1958), p. 453.

[29] Ibid., p. 452.

Proper crowning of play areas is a necessity that assures excellent surface drainage without interfering with play. For football fields it should be an eighteen inch crown (1.87 per cent grade) turtle-backed from the center to the sidelines without pockets. The parallel sidelines should be level.[30]

III. LITERATURE ON CONSTRUCTION

Musser, Duich, and Harper feel that a clear, complete set of specifications covering in detail the soil preparation and seeding of any athletic field is necessary. These not only will provide a definite and uniform basis on which bids can be made, but, if properly drawn, they will prevent misunderstandings as to exactly what, when, and how a job shall be done. Good specifications add the assurance of quality and proven techniques to the mutual benefit of customer and contractor.[31]

Cornish relates that "schools, colleges, and recreational committees faced with the problem of establishing turf on brand new fields or on older ones to be plowed over and re-seeded often find it difficult to obtain information based on fact rather than opinion."[32] Although it is not always possible about six months is considered a good period to allow for the building of a new football field. In the supervision of

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[30] Musser, Duich, and Harper II, op. cit., p. 3.

[31] Musser, Duich, Harper II, op. cit., p. 4.

[32] Cornish, op. cit., p. 52.

the construction, the architect or the committee in charge should check each step to see that specifications are being carried out exactly. Cornish gives eight points to serve as a check list to the committee supervising construction:

1. Subsoil graded parallel to finished grade.

2. Sub-drainage at depth and spacing called for and correctly backfilled.

3. Provision of required depth of topsoil of good quality.

4. Provision of required amendments, their even distribution and thorough incorporation, pre-seeding weed control if called for.

5. Careful surface grading.

6. Provision of complete fertilizer at specified rate and its even distribution.

7. Provision of seed of quality and kind called for and its even sowing at ideal periods.

8. Required care after seeding.[33]

IV. LITERATURE ON MAINTENANCE

Grau states that the importance of having a groundskeeper or maintenance personnel with experience in turf management is a prime requisite for having a well-kept field. Adequate equipment must also be provided for proper maintenance.[34]

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[33] Ibid., p. 63.

[34] Grau, "Reduce Injuries with Good Turf," p. 21.

The man in management is important. The ideal situation is to have a well-trained man in charge of the athletic field maintenance. But in high schools this cannot always be possible. If those in charge are not trained in turfgrass management, there are opportunities for them to learn; and it is possible to obtain outside assistance and guidance. Local associations of recreational turfgrass personnel are beginning to come into existence through which competent speakers can bring advice and counsel. Local and regional athletic field tours have helped to focus attention on the better practices. Information will become increasingly available as more and more people demand it.

Cornish has pointed out that no turf program will be effective if maintenance techniques are faulty. He has listed a few of the more common faulty techniques:

1. Clipping with a dull or improperly adjusted mower.

2. Clipping at irregular intervals.

3. Lowering height of cut too quickly.

4. Uneven distribution of fertilizers and other chemical materials.

5. Application in warm weather of caustic materials that burn the grass.

6. Frequent heavy rolling.[35]

The major criticism of most writers has been that there is not enough information available to the men who are actually in charge of maintaining the field.

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[35]Geoffrey S. Cornish, "Better Turf for Athletic Fields," Scholastic Coach, 23:56, January, 1954.

In summarizing, a firm turf is desired. It must provide firm footing, yet be resilient enough to protect players from injuries resulting from falls. It should be pleasing in appearance to both players and spectators. A disease-resistant grass is desired that is fast growing, that will establish a dense turf, and that will withstand heavy use.

Top soil is of prime importance if good turf is to exist. A medium depth of six inches of sandy loam is desired. The soil should be tested yearly to determine if any of the "Big Four"—calcium, nitrogen, phosphorus, and potassium—are lacking.

Six months is considered ample time for the construction of a new football field. The architect or committee in charge should check each step to see that specifications are met.

Having a man trained in turf management is a prime requisite for maintaining a well-kept field. Adequate equipment must also be provided if the work is to be carried out satisfactorily.

CHAPTER III

PRESENTATION AND ANALYSIS OF DATA

I. INTRODUCTION

This study included a survey of existing conditions of football fields in the following nine Class AA schools: Argentine High School, Olathe high School, Rosedale High School, Shawnee Mission North High School, Sumner High School, Turner High School, Ward High School, Washington High School, and Wyandotte High School.

These nine high schools represent six school systems. Argentine, Rosedale, Sumner, and Wyandotte are in the Kansas City, Kansas, school system and are under the same supervisor for buildings and grounds. Each of the remaining five schools has its own maintenance supervisor for building and grounds. The nine schools have lighted football fields which are used for interscholastic competition. The schools are all located in Johnson and Wyandotte counties of Kansas and are in or near the Kansas City area.

Several procedures were used in an effort to collect data. First, the available sources for literature were investigated and letters were sent out to leading men in the Field of Agronomy and Horticulture. Second, personal interviews and visitations were made of personnel working in the field of turf management, maintenance personnel, coaches, and school officials. Third, each field was observed and soil samples were taken for laboratory analysis of the soil content.

II. REVIEW OF RELATED LITERATURE

As was stated in Chapter II, very little information on football fields has been published in books or magazines. Most of the available books and magazine articles dealt with problems generally faced in some particular area. The major amount of literature obtained was through correspondence with research men working in the field of Agronomy and Horticulture. These men were very cooperative in sending pamphlets and mimeographed literature of their own work relating to football fields. Much of this material was general, written to cover broad geographic areas. By careful selection of particular situations the author was able to obtain a great deal of information relative to the Johnson and Wyandotte county area.

III. PERSONAL INTERVIEWS AND VISITATIONS

The desire to work on a topic of this nature was stimulated through visiting with different coaches in regard to their playing fields. As a football coach in Turner High School, the author was somewhat familiar with this area, and consequently in a position to be able to determine that the coaches' comments regarding their football fields were generally unfavorable. To gain further insights into the particular area under question the writer also visited and interviewed professional men who work in the field of grass management in the Kansas City area.

George Toma (groundkeeper for the Kansas City Athletics professional baseball team; and in the fall of 1963, manager of the football

field for the Kansas City Chiefs professional football team) was interviewed. Mr. Toma has been a professional groundkeeper for twenty years and is considered by many professional teams to be one of the best in the entire country. He has also helped some colleges and high schools in their planning, constructing, and maintaining of football fields.

Mr. Toma stated that bermuda grass may be grown successfully in this particular area and it will tend to take a great deal more punishment than will the bluegrasses or fescues. Also bermuda will stand up best under poor management and watering practices. Sodding fields he considered ideal, but sprigging and seeding also work quite well. He found that, if sodding or sprigging, it was best to use U-3 bermuda; but if seeding, plain bermuda seed was just as good. A high grade bermuda seed was recommended and about two to four pounds per 1000 square feet, or about 200 pounds for the field, was considered adequate. When seeding, 50 per cent of the seed should be raked into the disked ground and the other 50 per cent scattered on the top. If bluegrass is to be used it should be half Kentucky bluegrass and half Merion bluegrass, because each is susceptible to different diseases. Also mixtures of fescue work satisfactorily but should have good management and a good watering system to get the desired results. For added color in the fall, shortly before the bermuda becomes dormant, ryegrass may be seeded.

In fertilizer practices for bermuda grass, he recommended 8-16 pounds of nitrogen per 1000 square feet in early spring and throughout the summer months. With cool weather grasses such as bluegrass and

fescues, he recommended four to six pounds of nitrogen per 1000 square feet three times a year in February, in May or June, and in late August. He also considered a good organic base fertilizer should be used in the fall and the soil should be tested yearly to determine other fertilizers needed.

Mr. Toma believes that a definite pattern in relation to direction of mowing should be followed. Also it is better not to mow the grass than to mow it with a dull blade which will bruise and hurt the grass. When speaking of soil conditions, he indicated that the compaction problem was a paramount issue. Mr. Toma urged that fields should be gone over by an aerifier eight to ten times right after the football season, in the spring, and again in August before fertilizing. An effective, established, yearly restoration program should be considered essential in maintaining a highly desirable football field. In closing, Mr. Toma stated that the best protection for football fields against disease, insects, and weeds were good soil, correct height of cut, proper water, and adequate drainage.[1]

Mr. Fred Kresin, a nursery owner in Turner, Kansas, was interviewed to gain overall ideas of conditions existing in Johnson and Wyandotte counties now and in the past. Mr. Kresin has been a long time resident of Wyandotte County and has been responsible for building turfs in many parts of the two counties. He was also of the impression that bermuda

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[1]George Toma, Personal Interview, May, 1964.

grass could be grown satisfactorily on football fields in this area. For bare spots on field perennial ryegrass, soaked in sweet milk for quick germination, was considered good for covering in a short time. From his own work he learned that the soil in this general area tended to be of a natural limestone base. Mr. Kresin strongly advised the obtaining of high grade seed with a high germination percentage. He was greatly concerned about the general opinion and attitudes of schools not caring for their fields properly. He felt there was a definite need for research in this area and a little more practical application of the knowledge at hand.[2]

The writer had the opportunity to interview personnel in charge of the Class AA football fields in Johnson and Wyandotte counties. In general those interviewed were convinced that there was a need for better understanding of problems that existed in their particular locality. All the men were concerned about their football fields and were interested in obtaining information sources they might contact. Paucity of information pertinent to this locality, lack of needed equipment, and inadequacy of budgets were stated as problems faced in bettering the fields. Also the men in charge of the football fields were usually the heads of building maintenance, which took a great deal of their time and energy. The time element in regard to responsibilities was a factor in inadequate time allotted for work on the football field. With the need for

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[2] Fred Kresin, Personal Interview, May, 1964.

knowledge and training in so many fields of work it was found hard to obtain some formal education on turf management. None of the men in charge had any formal education in turf management and only a few had ever attended a lecture or clinic on the subject. Most of their knowledge had been obtained through practical experience. In general most of the men in charge were under a handicap for properly maintaining excellent football fields with all their varied responsibilities.

Much of the information gained in the research, correspondence, and interviews has been arranged in tables for concise reference.

Table I shows the types of use received by the football fields throught the 1963-64 school year. This information was obtained by interviews with coaches and school officials.

Of the nine football fields studied, all of them were used for other games outside their own interscholastic varsity schedule. These games were played by teams made up from other schools which used the field, or their own junior varsity, sophomore, and junior high teams. It may also be noted that all fields of the schools were handicapped, as the football field is the only outside area available for gym classes, and also for football practice. Most of the schools have some track events on the playing field, generally the discus or javelin or both. Some bands use the fields to work out marching maneuvers to be used at half time ceremonies. Two of the fields are used for graduation exercises in the spring, complicating problems of spring construction on the fields. It was found that football fields receive a great deal more use than the varsity game on Friday night.

TABLE I

TYPES OF USE RECEIVED THROUGHOUT THE 1963-1964 SCHOOL YEAR BY FOOTBALL FIELDS IN CLASS AA HIGH SCHOOLS IN JOHNSON AND WYANDOTTE COUNTIES IN KANSAS

Schools	Type of Use					
	Games other than varsity	Used for Football Practice	Used for Track Events	Used by Gym Classes	Used for Band Practice	Used for Commencement Exercises
Argentine	X	X	X	X	X	
Olathe	X					
Rosedale	X	X	X	X	X	
Shawnee Mission North	X		X			X
Sumner	X	X	X	X	X	
Turner	X		X			
Ward	X		X			
Washington	X		X			X
Wyandotte	X		X			

Shown in Table II are methods and practices used by personnel in charge of the football fields.

None of the schools had the soil tested yearly or went by any tests in determining their soil needs. Only one school had a set pattern for mowing, although such a pattern is considered desirable. All schools did do some form of fertilizing throughout the year. Most of the schools had sprayed for weeds, but none had even sprayed for disease and insect prevention. It was unanimously agreed that soil compaction was a major problem by the men in charge. Yet none of the schools added the equipment for, or practiced, aeriation of their fields. All the schools worked on their football fields at some time through the year, but only one had followed a regular restoration program in the last few years. None of the schools had set up a yearly budget specifically for caring for the football field.

TABLE II

METHODS AND PRACTICES USED BY PERSONNEL IN CHARGE OF FOOTBALL FIELDS IN CLASS AA HIGH SCHOOLS IN JOHNSON AND WYANDOTTE COUNTIES IN KANSAS

Schools	Methods Used							
	Yearly Soil Samples	Set Mowing Pattern	Set Fertilizing Pattern	Weed Pre-vention	Disease Insect Prevention	Field Aera-tion	Restor-ation Program	Field Budget
Argentine			X	X				
Olathe			X					
Rosedale			X	X				
Shawnee Mission North		X	X	X			X	
Sumner			X	X				
Turner			X					
Ward			X					
Washington			X					
Wyandotte			X	X				

Table III deals with the kinds of equipment that are available to the schools for working on their football fields. All schools had tractors and trailers of some make, along with some forms of seeders, fertilizer spreaders, and mowers of either the reel or rotary type. Some of the schools had rollers that could be used on the football fields. None of the schools had soil grinders, which are used for mixing soil for topdressing or preparing new soil to be added on the field. Also there were no types of aerifiers which could be used for aeration of the turf without tearing it completely up.

TABLE III

KINDS OF EQUIPMENT AVAILABLE TO WORK ON FOOTBALL FIELDS BY CLASS AA HIGH SCHOOLS IN JOHNSON AND WYANDOTTE COUNTIES IN KANSAS

Schools	Kinds of Equipment							
	Fertilizer Spreader	Seeder	Mower	Aerifier	Roller	Tractor	Soil Grinder	Trailer
Argentine	X	X	X		X	X		X
Olathe	X	X	X			X		X
Rosedale	X	X	X		X	X		X
Shawnee Mission North	X	X	X		X	X		X
Sumner	X	X	X		X	X		X
Turner	X	X	X			X		X
Ward	X	X	X		X	X		X
Washington	X	X	X		X	X		X
Wyandotte	X	X	X		X	X		X

IV. OBSERVATION AND SOIL ANALYSIS

All fields were observed by the writer, and samples of soil were taken from each field. In May when the fields were checked, the conditions of the field were poor. Most of the fields showed the extreme usage absorbed throughout the school year. It was so severe that three of the fields were to be torn up and rebuilt before the 1964 football season.

Table IV shows the types of grasses found on the fields as of May, 1964. Only one field had bermuda grass. The remaining eight fields had varying percentages of bluegrass, fescues, ryegrass, and native grass. Three of the fields were nearly bare, with a little grass growing along the edges. There were different types of weeds found in all fields, with crabgrass being the heaviest.

TABLE IV

TYPES OF GRASSES FOUND ON FOOTBALL FIELDS IN CLASS AA HIGH SCHOOLS IN JOHNSON AND WYANDOTTE COUNTIES IN KANSAS AS OF MAY 1964

Schools	Types of Grasses					
	Bermuda	Bluegrass	Fescue	Ryegrass	*Native	None
Argentine		X	X	X	X	
Olathe		X	X		X	
Rosedale					X	X
Shawnee Mission North	X					
Sumner						X
Turner		X		X	X	
Ward					X	X
Washington		X	X		X	
Wyandotte		X	X		X	

*Note: Native refers to grass commonly found in natural prairie growth in the Johnson and Wyandotte County area.

Table V deals with the types of water systems used on the football fields. As of May, 1964, only one field was found to have a pop-up system built into the field. Five schools used the quick-coupling system of pipes with sprinklers. One school had its own type of portable pipe to be used in a flooding procedure. Only one school did not have a watering system, lacking for a water outlet.

TABLE V

TYPE OF WATERING SYSTEM USED ON FOOTBALL FIELDS OF CLASS AA HIGH SCHOOLS IN JOHNSON AND WYANDOTTE COUNTIES IN KANSAS

Schools	Types of Watering Systems				
	Pop-up System	Quick-coupling System	Portable Pipe	Traveling Sprinkler	None
Argentine		X			
Olathe	X				
Rosedale		X			
Shawnee Mission North		X			
Sumner					X
Turner			X		
Ward		X			
Washington		X			
Wyandotte		X			

Table VI is concerned with the drainage of the football fields. All but two of the fields were found to be crowned to some degree. Two of the fields had a form of tiling to assist with the problem of run-off water. Five of the schools had catch basins at spots around the fields to help run the excess water away from the fields. In general only one of the nine fields was properly equipped to handle large amounts of surface water.

TABLE VI

DRAINAGE PROVISIONS OF FOOTBALL FIELDS AS OF MAY 1964
IN CLASS AA HIGH SCHOOLS IN JOHNSON AND WYANDOTTE COUNTIES IN KANSAS

Schools	Drainage Provisions			
	Crowned Field	Tile System Outside Field	Catch Drains	None
Argentine	X		X	
Olathe	X	X		
Rosedale	X		X	
Shawnee Mission North	X	X	X	
Sumner	X		X	
Turner	X			
Ward				X
Washington	X		X	
Wyandotte	X		X	

Shown on Table VII are the results of the laboratory analyses of the soil samples obtained from the nine football fields.

The soil was tested by the Franklin County Agriculture Extension Service and recommendations given were for growing cool seasons grasses. None of the schools needed lime at the time of testing. In general, when the ph count is above 6.3 the Agriculture Extension Service does not recommend a lime program.

In organic matter one school is considerably below the other eight. One per cent organic matter is the equivalent to between 30-60 pounds of nitrogen and should generally be considered closer to the 30 pounds than to 60 pounds. When the organic matter is 0-2 per cent it is considered low and 80-100 pounds of nitrogen is the recommended application per acre.

If the per cent is between 2-5 per cent the application should be between 60-80 pounds of nitrogen per acre. Considering the available phosphorus 26-50 pounds per acre is considered medium and 50-100 pounds is considered high with anything over a hundred very high. It may be noted that the fields vary from 30 pounds to 250 pounds of available phosphorus per acre. Application on fields is only recommended below 50 pounds and then about 13 pounds of phosphorus per acre should be added. All the fields have enough potassium available ranging from 215-600 pounds per acre. Potassium in soil is considered high at 200-300 pounds per acre with any over 300 pounds considered very high.

TABLE VII

LABORATORY ANALYSIS OF SOIL SAMPLES TAKEN IN MAY 1964
OF FOOTBALL FIELDS OF CLASS AA HIGH SCHOOLS
IN JOHNSON AND WYANDOTTE COUNTIES IN KANSAS

Schools	Laboratory Analysis				
	Organic Matter	Ph Value	Lime Needed Lbs. Per Acre	Available Phosphorus Lbs. Per Acre	Exchangeable Potassium Lbs. Per Acre
Argentine	2.7%	7.55	None	64	270
Olathe	3.0%	6.55	None	45	220
Rosedale	2.4%	7.1	None	135	300
Shawnee Mission North	3.65%	6.7	None	115	360
Sumner	2.7%	7.5	None	250	600
Turner	1.25%	7.1	None	38	215
Ward	2.7%	7.5	None	110	300
Washington	2.1%	7.5	None	88	400
Wyandotte	3.0%	7.6	None	100	400

In conclusion, nine Class AA high schools in Johnson and Wyandotte counties were studied.

All fields were found to have considerable more usage than the traditional varsity game once a week. Three of the fields were found to have extreme usage throughout the school day along with the football program.

Personal interviews with George Toma and Bill Kresin, two professional men in working with turf, were taken to gain knowledge in this particular area. Also personnel in charge of the football fields were taken to obtain methods and materials used. Some school officials and coaches were contacted to gain further insights into the football fields.

Each field was observed and soil samples were obtained for laboratory analysis. The fields showed the wear that occurred throughout the school year.

CHAPTER IV

SUMMARY AND RECOMMENDATIONS

I. SUMMARY

The purpose of the study was to answer questions in regard to the nine Class AA high schools in Johnson and Wyandotte Counties in Kansas. (1) What were the existing conditions with reference to quality, care, and maintenance of football fields? (2) What types of methods, materials, and equipment were used in caring for the fields? (3) What methods and materials were available for use on the football fields?

Maintenance personnel in charge of the football fields were asked in personal interviews to furnish information about their own programs. This information was in regard to methods, materials, and equipment used in maintaining the football fields.

Coaches of the nine schools were visited and asked their opinions concerning the football fields. The use and care given the fields were the primary concern.

George Toma, groundkeeper of the Kansas City Athletics, and Bill Kresin, a nursery owner in Wyandotte County, were interviewed to obtain the professional outlook at working with turf in this particular area. They were asked about practices used and recommended procedures to follow in establishing good football fields in Johnson and Wyandotte Counties.

Letters were sent to companies and universities whose men in agronomy and horticulture are working with the problems related to turf and turf management. The related material sent by them was studied to determine what best fitted this particular geographic area.

The final phase of the study was a general observation of the football fields in regard to drainage, grasses, and watering system. Soil samples were taken of the fields for laboratory analysis. The soil sample results were passed on to the men in charge of the fields along with recommendations given by the agriculture extension service.

Generally speaking the men in charge were not sufficiently familiar with methods and materials used by other schools. No schools have a budget set up for the particular use of maintaining their football fields. The type of equipment, materials, and methods tended to vary with schools having different men in charge. The attitudes of these men in charge were that the fields should be improved and they were interested in learning what could be done to better their own situation.

Some coaches felt the fields were not maintained properly and were abused by the use of too many activities. The desired fields in Johnson and Wyandotte Counties have not as yet been accomplished.

Some methods of procedure that have been recommended by noted authorities in the field of turf management have been used on the football fields. However, far too many phases of maintaining and building fields have been grossly neglected by the schools.

II. RECOMMENDATIONS

As a result of this study general recommendations were made regarding the nine Class AA high school football fields in Johnson and Wyandotte Counties. These are as follows:

1. That a budget be made so a yearly restoration program may be carried out adequately.
2. That the men in charge set up a yearly restoration program for care of the field.
3. Some person in the maintenance department be specifically assigned to responsibility for the football field and given an opportunity to further his knowledge in turf management by attending lectures and clinics.
4. The soil should be tested yearly to determine the fertilizing program that will be needed.
5. Fertilizer should be applied when the field is dry, and dragged over the grass to brush the fertilizer from the leaves so as to reduce leaf burn.
6. Bermuda grass should be used when possible for best all-round purpose.
7. When sodding or sprigging bermuda use Hall's U-3, but if seeding use plain bermuda seed.
8. In using bluegrass and fescues use different types in the mixture to protect from disease wiping out the entire field.

9. A sod nursery should be started to help with the quick rebuilding of damaged areas.

10. Ryegrass should be used only as a special purpose grass to be seeded alone and not as a part of a seed mixture containing expensive perennial grasses.

11. Bermuda grass should be cut between 1/2 to 1 inch in height while bluegrass and fescues are usually kept between 2 to 3 inches in height.

12. The grass should be cut consistently, not allowing it to grow more than twenty-five per cent above the desired height.

13. A definite pattern, alternating direction in successive mowings, should be followed in mowing the grass.

14. When considering a watering system for the football field, the underground pop-up system should have top priority.

15. The football field should be watered seldom but watered deeply.

16. In equipment each school should consider the purchase of some form of aerifier or soil loosener that can be used without completely tearing up the field.

17. Disease resistant grasses, properly managed, are the best insurance against disease problems.

18. The fields should be sprayed in the spring for weed control.

19. The fields, when being rebuilt, should have an 18 inch crown; and tile should be laid along the sideline to help with surface water.

20. When contracting the building of a football field, a good set of specifications should be drawn up to clarify each step or procedure for the benefit of the contractor and the customer.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Couch, Houston B. Diseases of Turfgrasses. New York: Reinhold Publishing Corporation, 1962. 289 pp.

Gabrielsen, M. Alexander and Caswell M. Miles (eds.). Sports and Recreation Facilities for School and Community. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958. 370 pp.

Scott, Harry A. and Richard B. Westkaemper. From Program to Facilities in Physical Education. New York: Harper and Brothers Publishers, 1958. 483 pp.

B. PERIODICALS

Cornish, Geoffrey S. "Better Turf for Athletic Fields," Scholastic Coach, 23:54-56, January, 1954.

_____. "Turfing New Fields," Scholastic Coach, 24: 52-63, January, 1955.

Daniel, W. H. "Establishing and Maintaining the Athletic Field," Athletic Journal, 37:18-52, April, 1957.

Grau, Fred V. "National Clinic on Turf Problems," Athletic Journal, 35:46-48, March, 1955.

_____. "Reduce Injuries with Good Turf," Athletic Journal, 34:28-59, April, 1954.

Griffin, B. F. "Answer to the Problem of Living Football Fields," Athletic Journal, 35:22-48, June, 1955.

Jenne, Eldon I. "Standards and Specifications for the Athletic Field Sprinkling System," The American School Board Journal, 131:58-59, September, 1955.

Kennerly, A. B. "New Fast-Growing Turf for Football Fields," Scholastic Coach, 27:38-40, November, 1957.

Reeder, R. "Backs Go Tearing By on What Kind of Turf?" Athletic Journal, 34:16-51, January, 1954.

C. PAMPHLETS AND ARTICLES

Grau, Fred V. Improving Athletic Field Turfgrass. Bulletin 2, West Point Products, West Point, Pennsylvania, n.d. 24 pp.

Musser, H. B., J. M. Duich, and J. C. Harper II. Athletic Field. University Park, Pennsylvania: The Pennsylvania State University, College of Agriculture Extension Service, n.d. 19 pp.

Planning Facilities for Health, Physical Education, and Recreation. Chicago: The Athletic Institute, Inc., 1957. 154 pp.

Watson, J. R. "Factors To Be Considered in Construction of a Football Field." Minneapolis: Agronomy Division, Toro Manufacturing Corporation, n.d. 6pp. (Mimeographed.)

_____. "Managing Athletic Turfgrass Areas." Minneapolis: Agronomy Division, Toro Manufacturing Corporation, n.d. 11 pp. (Mimeographed.)

_____. "Renovation and Management of Athletic Field Turfgrass." Minneapolis: Agronomy Division, Toro Manufacturing Corporation, n.d. 8 pp. (Mimeographed.)

D. UNPUBLISHED MATERIALS

Daniel, W. H. "Athletic Field Establishment." Department of Agronomy, Purdue University, 1957. (Mimeographed.)

_____. "Maintaining Athletic Areas." Department of Agronomy, Purdue University, 1957. (Mimeographed.)

_____. "Principles In Maintaining Athletic Turf." Paper read at the Oklahoma Turf Conference and Texas Turf Conference, 1963.

_____. "Royerton Athletic Field." Department of Agronomy, Purdue University, 1957. (Mimeographed.)

Stough, John R. "Construction and Maintenance of Athletic Fields." Paper read at the Fiftieth Annual Meeting of the American Society of Agronomy, Lafayette, Indiana, August 4-8, 1958.

E. NEWSPAPERS

Kansas City Star, October 8, 1963.

APPENDIX A

APPENDIX A

I. A BLANKET CONTRACT FORM

Section I. Scope of Contract

These specifications include:

1. Finished grading

   Removal of trash and stones, grading to specified slope and contour, and furnishing and applying topsoil.

2. Preparation of seedbed

   Furnishing and applying lime, fertilizer, and physical conditioning materials, and method of operation.

3. Seeding

   Seed furnished and method of seeding specified.

4. Vegetative planting

   Stolons or sprigs of specified grasses furnished and planting method specified.

5. Sodding

   Sod supplied and method of planting specified.

6. Repair and reseeding

   Provisions for, in cases of an unsatisfactory stand.

7. Maintenance of the turf for a specified period.

   Provisions and specifications for mowing, fertilizing, watering.

8. Payment provisions.

Section II. Seasonal and Weather Limitations

1. Fall planting. Not prior to _____ or later than _____.

2. Spring planting. Not later than _____.

3. All operations shall be performed only (1) when the soil is in proper condition to permit satisfactory work, and (2) with expressed consent of the owner or his designated representative.

Section III. Materials

1. Fertilizer. Shall be of standard quality as designated in paragraph 9 (a) of this section. Shall be delivered to site in original bags or of bulk and protected at all times prior to application against injury or weather damage which would prevent proper distribution. Shall be applied at rates and in manner designated in Section III 9 (a) and Section V, 4 (b and d) respectively.

2. Lime. Shall be standard commercial product of quality designated in paragraph 9 (b) of this section, delivered in bags or bulk and applied at the rate specified in the same paragraph and in the manner designated in Section V, 4 (b).

3. Physical Conditioners. To be material designated in paragraph 9 (c) of this section. Applied at rate specified in same paragraph and section and in manner designated in Section V, 4 (b).

4. Seed. Shall be commercial grades of types specified in Section III, 9 (d), and shall meet requirements of (state-federal) seed law.

   (a) Seed shall be delivered at site in original containers and shall not be mixed or blended except in presence of authorized representative or owner.

   (b) Seed shall have been tested for germination and purity by accepted methods within period of _____ prior to delivery. Shall show germination and purity indicated in table in Section III, 9 (d).

5. Mulch. Shall be as specified in Section III, 9 (e).

6. Stolons. (sprigs) Shall be of variety or strain and quality as specified in Section III, 9 (f).

7. Sod. Shall be of species and quality as specified in Section III, 9 (g).

8. Topsoil. Shall be of the grade and quality specified in Section III, 9 (h).

9. Quality and Rates of Application. All materials shall be of quality and shall be applied on areas at rates shown in the following tables.

(a) Fertilizer

Area	Analysis	Formula	Rate per 1000 Sq. ft. or acre	Total Quantity

(b) Lime

Area	Kind	Minimum Per cent Oxides	Rate per 1000 Sq. ft. or acre	Total Quantity

(c) Soil physical conditioning materials
(1) Organic materials

Area	Type	Organic Matter Content	Moisture Absorptive Capacity	Total Quantity

(2) Sand

Area	Type	Sieve Analysis	Rate per 1000 Sq. ft. or acre	Total Quantity

(d) Seed

Area	Species or Mixture	Minimum per cent Purity	Rate per 1000 Sq. ft. or acre	Total Quantity

(e) Mulch

Area	Type	Quality	Rate per 1000 Sq. ft. or acre	Total Quantity

(f) Stolons (sprigs)

Area	Species or Variety	Quality	Rate per 1000 Sq. ft. or acre	Total Quantity

(g) Sod or sod plugs

Area	Species or Variety	Quality	Size and Thickness	Total Quantity

(h) Topsoil

Area	Quality	Depth in Inches Applied	Total Quantity

Section IV. Extent of Areas

Areas to be planted in accordance with tables shown in Section III, 9 and shall conform to limits shown on drawing. (Description of each area with approximate size as required).

Section V. Methods

1. Finished grading. All areas to be seeded shall be brought to grades shown on plans. (Includes any items for additional excavations and fills).

2. All trash and stones exceeding diameters of _____ shall be removed from areas to a depth of_____ prior to preparation and seeding.

3. Required topsoil as specified in Section III, 9 (h) placed and brought to designated grade.

4. Seedbed preparation.

   (a) All areas to be tilled to minimum depth of _____inches with tillage equipment approved by _____or his representative.

   (b) Following initial tillage, soil physical conditioners, lime, and superphosphate or phosphate--potash fertilizer shall be thoroughly incorporated into the soil to a minimum depth of _____ inches in a manner and with equipment satisfactory to _____ or his representative.

   (c) If above operation mentioned in Section V, 4 (b) is accomplished with rotovater, or similar tool, area shall be firmed with light roller.

   (d) Starter fertilizer shall be applied and worked into depth of one inch maximum with suitable tool.

5. Seeding.

   (a) Seed for each area divided into two equal parts, each to be seeded in separate operation. The second seeding to be over the first and at a right angle to it. Seed can be applied by any method and equipment satisfactory to _____ or his representative.

   (b) If a type of distributor is used which deposits seed on the surface, the seed shall be covered by approved method.

(c) Unless a cultipacker seeder has been employed, areas shall be firmed by light rolling or cultipacking.

(d) Mulch materials shall be applied uniformly at rate specified in tables, Section III, 9 (e) by indicated method.

6. Sodding.

(a) Preparation of bed shall be the same as for seedbed preparation, Section V, 1-2-3-4, (a,b,c,d).

(b) Dry sod beds shall be watered lightly prior to laying sod to prevent rapid desiccation.

(c) Sod joints shall be staggered and tightly butted. Open joints shall be filled with screened, prepared topdressing. Sod shall be lightly tamped in place to insure firm contact with the soil and prevent air pocket formation.

(d) Initial irrigation shall thoroughly moisten sod layer and sod bed. A regular watering program shall be followed until sod is rooted.

Section VI. Repair

1. Areas that do not show an initial stand of a minimum of _____ plants per square foot shall be reseeded at the expense of the contractor. Minimum size of repair area to be designated.

2. Preparation of areas for reseeding shall consist of loosening the surface soil with a tool and in a manner acceptable to _____ or his representative.

3. Quality seed, mixture used, and rate of seeding shall be the same as for initial seeding, unless otherwise mutually agreed.

Section VII. Maintenance

1. Watering. Seeding contractor shall be responsible for any necessary irrigation to secure adequate germination and initial establishment of the grass to the time of first clipping.

2. Mulch Removal. Mulch shall be removed from all seeded areas if necessary by the seeding contractor at any time prior to first cutting as requested by _____ or his representative.

3. Cutting. The seeding contractor shall be responsible for the first cutting of the grass. Clipping shall be to a height of _____ inches when the grass has attained an average height of _____ inches.

Section VIII. Basis for payment

1. Excavation and fill. To be measured and paid for on basis of total number of cubic yards of soil handled in making excavations and fills.

2. Bid price applies to all other materials and operations covered by these specifications.

3. Bid may be submitted at a specified price per unit of area (as per 1000 sq. ft. or per acre). If areas are involved requiring different treatment, unit prices for each must be submitted.

4. If bids are submitted on unit of area basis, total areas will be computed to nearest 1/10 acre, if on acre unit basis, and to nearest 100 square feet, if on 1000 square foot unit basis.

APPENDIX B

APPENDIX B

CHECK LIST USED IN INTERVIEWING PERSONNEL IN CHARGE OF THE FOOTBALL FIELDS

School _____

Person in Charge _____

Job Title _____

1. When was the soil last tested?
2. Do you have a fertilizer program?
3. When was the field last fertilized?
4. What types of fertilizer are used?
5. How much fertilizer was applied?
6. What kinds of grasses have been used?
7. Which grass or grasses have been the most successful?
8. When was the field last seeded?
9. What type of grass was last used?
10. What kind of watering system is used?
11. Do you have any standard practice you follow in watering?
12. Is the field crowned?
13. Is tile laid along the side lines?
14. Does the field have catch basins to help with the drainage?
15. Is any pattern followed in direction of mowing?
16. At what height is the grass cut?
17. How often is the grass mowed?

18. Do you consider soil compaction to be a major problem?

19. Have you ever aerified the field?

20. Do you have an aerifier or access to one?

21. If so, how often do you aerify?

22. Do you spray for weed prevention?

23. Have you ever sprayed for disease or insects?

24. Do you have a set program for a yearly restoration program?

25. Is there a budget set up specifically for the football field?

26. Is any one person specially assigned to work in caring for the football field?

27. How much time is spent in working on the football field?

28. Have you or any of the men had any formal education in turf management?

29. Has anyone been to any lectures or clinics on turf management in the past?

30. What types of use does the football field receive in the off-season?

31. Are football games played on the field other than the varsity games?

32. What equipment do you have for use on the football field?

    1. Fertilizer spreader
    2. Seeder
    3. Mower
    4. Aerifier
    5. Roller
    6. Tractor
    7. Soil grinder
    8. Trailer

33. What do you consider to be the biggest drawbacks in having an excellent field?

34. Are you having trouble getting information on the subject?

35. Do you think your field could be improved?

36. Would it be all right to take a soil sample of your field?

37. Would you like to have the results of the laboratory analysis and recommendations?

38. Are there any other comments?

APPENDIX C

APPENDIX C

CHECK LIST USED FOR PERSONAL OBSERVATION OF THE FOOTBALL FIELDS

School _____

1. Is the field crowned?
2. Other types of drainage systems.
    1. Tile system
    2. Catch basins
3. Watering system used on the field.
4. Type of grass presently on the field.
    1. Bluegrass
    2. Ryegrass
    3. Bermuda
    4. Fescue
    5. Native grass
    6. None
5. General condition of the field.
6. Type of soil found when taking soil sample.