SEPTEMBER 1968

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association

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VOL. 6 No. 3 SEPTEMBER 1968

Cover Photo: A time-saving and neat job of installing automatic irrigation systems is possible by the new technique of "pulling pipe" through the ground without need for digging ditches. This "instant" way to course watering with flexible pipes is one more innovation in the trend toward complete irrigation of golf fairways. See the article by John H. Madison on automatic irrigation starting on Page 10.

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Cold weather covering of automatic control center for watering systems is easily achieved as shown above. A plastic bag is first placed over the console (Figure 1, left). A heavy insulation material (Figure 2, center) next goes over the plastic cover. Finally the whole thing is enclosed in a wooden box built to fit securely over the unit (Figure 3, right).

Winter Protection for Automatic Controllers

by LEE RECORD, Agronomist, USGA Green Section

The golf course superintendent has learned a great deal about the installation, the flexibilities and reliabilities of automatic watering systems. One of his most important realizations is that the automatic controller is the "brain" of the system and therefore must be functional at all times.

During the spring or early summer periods when desiccation is most prevalent on many Eastern courses, little can be left to chance. The insured protection of the controllers, which are scattered throughout the course, now becomes an important factor in the success the golf course superintendent will have with his turfgrass maintenance program.

Winter months are the most critical time of year for the controller, for this is when damage may occur most easily. Although the controllers are not needed at this time for distribution of water, the accumulation of moisture and rust formation on working parts may lead to unnecessary deterioration of the mechanisms. This in turn can lead to the failure of the early spring irrigation program.

Another way of protecting automatic controllers is to use a large steel barrel over the unit to keep out harsh weather (Figure 4).

Controllers stand like pyramids facing all elements of nature: freezing rain, sleet, blizzards and the accumulation of drifting snow. Therefore, additional protection, above that already provided by most manufacturers, must be furnished.

Manufacturers of various controllers now on the market have built-in safety factors which will cut down on moisture, rust damage, etc. Heating elements and rust-proofing of the controller are two of the basic requirements now provided.

Bob Capstick, Superintendent of the Country Club of New Canaan, New Canaan, Conn., has given every consideration to the protection of his controllers throughout his course. Figure 1 shows the first step Capstick employs, putting a plastic bag over the controller. In Figure 2 heavy insulation is placed over the plastic bag. Figure 3 is the final step. He has constructed a wooden box to fit snugly and securely over the controller.

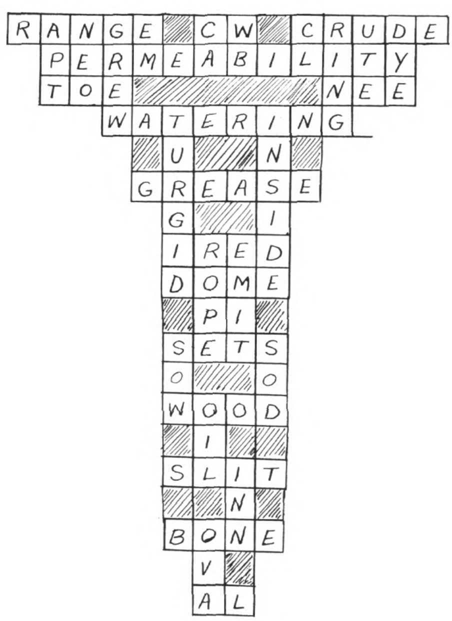
This added protection assures Capstick that when spring comes his controllers will be operational. Should he have to work on the controllers during the winter, it is easy to remove the wooden box, insulation, and plastic bag without chipping ice away from hinges or thawing out the lock. The chance of moisture getting into the controller, causing rust or hindering working parts, is minimal.

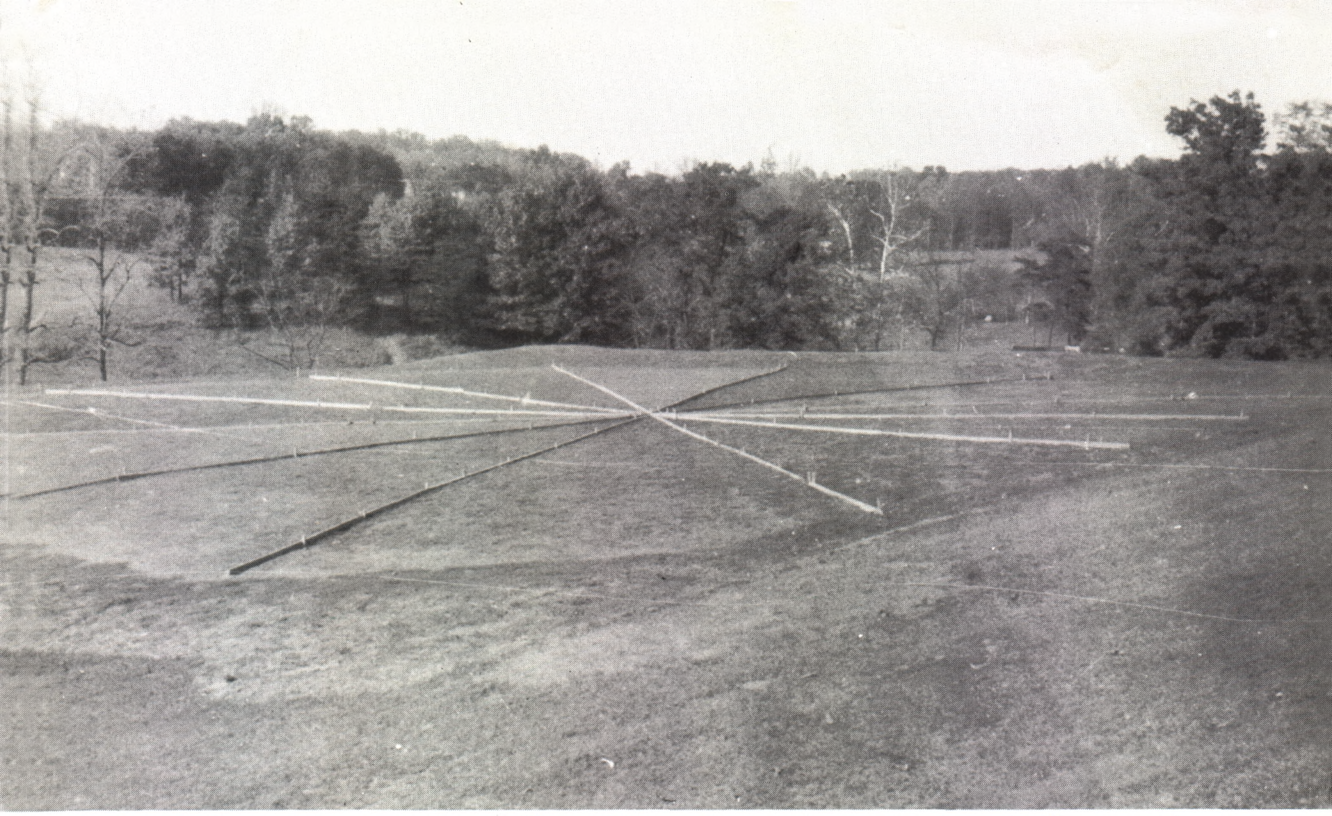
In Figure 4 we find what Vernon Burnham, Superintendent of the Country Club of Darien, Darien, Conn., does for the added protection of his controllers. By placing a 55-gallon drum over each controller, he has obtained excellent results in keeping the elements of nature away from the controllers on his course and preventing damage.

Even though Capstick and Burnham have additional protection for their controllers, they recognize the importance of continuing to cycle them during the winter. One of the more common practices is to cycle them from 15 to 30 minutes daily, while other practices call for continuous cycling for the entire winter.

Manufacturers are continuing their efforts to assure operational success of their equipment. In addition, the golf course superintendent must still use his ingenuity to give added protection to meet his own local conditions.

Solution of Crossword Puzzle for Last Issue





Pine Valley's pie green test area (Figure 1), providing a close comparison of different putting green turfgrasses, shows how an early strain of C-7 was rated.

The Story of Cohansey

by E. R. STEINIGER, Superintendent, Pine Valley Golf Club, Clementon, N. J.

In 1933 an outstanding patch of creeping bentgrass was first observed on our fourth green of Pine Valley, which is an old South German mixed bentgrass green. In 1935, after close watching and recording the behavior of this strain, one square foot of it was planted in our nursery along with other selected strains. Later in the year the first sizable plot (3,500 square feet) was established in our turf garden. Its fine texture and upright growth made it a fine putting green turf, and its light green color was pleasing to see.

In 1939 Dr. John Monteith, Jr., and Fred V. Grau introduced this strain into the turfgrass gardens at Arlington, Va., and designated it as C-7. The "C" designation was the code for creeping bentgrass selections tested by the Green Section. C-7 did very well at Arlington, and later at Beltsville, Md., except for a little dollar spot; in fact it did so well that prior to World War II, when the "pie greens" (Figure 1) were laid out all over the country by the Green Section, C-7 was included. The performance of the nationwide tests was reported in the June, 1944, issue of the Green Section's publication "Timely Turf Topics" as follows:

Four-Year Summary of Ratings of Creeping Bents in Experimental Greens

"Data from the experimental greens established in 1939 and 1940 by the Green Section in many parts of the country have been summarized during the past winter. Since the summaries reveal much of interest to those responsible for putting greens now and in the postwar period, it seems advisable at this time to publish some of the inescapable conclusions.

"For those who are not acquainted with

these experimental greens it may be stated that the typical green is composed of 12 or more wedge-shaped sections, each planted with a single strain of creeping bent. So far as possible the greens were used throughout the test period as regular or practice greens so as to expose each of the grasses to the customary wear and tear of play. For comparison purposes each green contained wedges of one or more of the three commercially available vegetative strains — Washington bent (C 50), Metropolitan bent (C 51), and Old Orchard bent (C 52).

"In addition, sectors were planted with one or more of the following commercially available seed: Seaside creeping bent (C 60), Astoria Colonial bent (C 61), and Highland Colonial bent (C 65). The remaining sectors were planted vegetatively with strains of creeping bent which had been assembled by the Green Section from various parts of the country and had proven most promising in the tests over a period of years in plots maintained under putting green conditions in the trying climatic conditions on the turf garden at Arlington, Va. Usually only six or seven of these strains were included on any one green. In all, 19 strains were tried on one or more of these experimental greens.

"They are as follows:

Strain	Club Where Found Originally	City	State	Date
C 1	Country Club of Atlantic City	Atlantic City	N.J.	1928
C 4	Arlington Turf Garden	Arlington	Va.	1934
C 5	Arlington Turf Garden	Arlington	Va.	1934
C 7	Pine Valley Golf Club	Clementon	N.J.	1935
C 8	Baltimore Country Club	Baltimore	Md.	1935
C 9	Washington Golf & Country Club	Arlington	Va.	1936
C 11	Washington Golf & Country Club	Arlington	Va.	1936
C 12	Los Angeles Country Club	Beverly Hills	Calif.	1936
C 14	Toronto Golf Club	Long Branch	Ontario	1936
C 15	Toronto Golf Club	Long Branch	Ontario	1936
C 16	Rolling Green Golf Club	Springfield	Pa.	1936
C 17	Manor Country Club	Norbeck	Md.	1936
C 19	Congressional Country Club	Bethesda	Md.	1936
C 27	Washington Golf & Country Club	Arlington	Va.	1937
C 28	Washington Golf & Country Club	Arlington	Va.	1937
C 32	Congressional Country Club	Bethesda	Md.	1936
C 35	Manor Country Club	Norbeck	Md.	1937
C 36	Manor Country Club	Norbeck	Md.	1937
C 38	Arlington Turf Garden	Arlington	Va.	1937

Commercial Strains

C 50 — Washington bent
C 51 — Metropolitan bent
C 52 — Old Orchard bent
C 60 — Seaside bent
C 61 — Astoria bent
C 65 — Highland Colonial bent

"It will be recalled that, at the request of the Green Section, the grasses were rated in order of preference, all characteristics, both favorable and unfavorable, being considered. The most desirable grass was rated as 1, and the least desirable as 12 (when, as was usually the case, 12 grasses were under test on the green). It was hoped that the ratings

ABOUT THE AUTHOR

Eberhardt R. Steiniger has been at Pine Valley continuously since 1927 (except for military duty World War II). Eb, as he is known to turf people all over the world, is a man of unusual personality with a spark that generates interest in all fields when he is on the scene. Mr. Steiniger is Vice-President of the Pennsylvania Turfgrass Council; Chairman of the Joe Valentine Memorial Fund; Past President of the Philadelphia Association of Golf Course Superintendents and he is active in the civic affairs of Camden, New Jersey. He serves on the USGA Green Section Committee.

would be made at intervals throughout the growing season so that progressive seasonal changes in the relative ratings of the grasses might be followed over a period of years.

"In order to summarize the results, all of the ratings for each climatic season during which the grasses were actually growing (spring, summer and fall) were averaged for each green. Consequently a green which was established in the spring of 1939 had a possibility of 14 seasonal averages through the fall of 1943.

"It is noteworthy that of the 23 greens established in that year, only one experimental green enjoys the distinction of having that number of seasonal ratings to its credit. Also, only one of the remaining greens which were established either in the fall of 1939 or spring of 1940 has a perfect record since it was established. However, in spite of these facts, for some of the strains such as C 52 and C 19, which were established on 36 and 35 of the experimental greens, respectively, we have as many as 173 seasonal averages from which to draw conclusions.

"Of the total number of 19 strains included on the experimental greens, five of them were tested along with the commercially available vegetatively propagated strains (Washington, Metropolitan, and Old Orchard) on 32 or more of the greens. Therefore between 150 and 175 seasonal averages have been obtained for these grasses. Comparable number of seasonal averages were also obtained for the seed-propagated bents — Seaside creeping bent and Astoria and Highland Colonial bents. For two other Green Section strains there were as many as 73 seasonal averages, whereas for most of the others not more than 20 are available. Since the results from so few ratings could scarcely be considered significant, only those strains for which 70 or more seasonal averages are available are included in the accompanying summary.

"In order to arrive at a satisfactory basis for comparing the relative merits of these strains, summaries were made for each season for each of the experimental greens. From these summaries it was easy to determine how many seasons on each green each strain took first, second, third, or fourth place, respectively. It was believed that it might be unfair to the strains to limit the summaries to the number of times the grasses fell in first place since so much of personal prejudice is inevitable in the selection of the best of the superior strains. For this reason in the accompanying summary the grasses are arranged in order of the percentage of seasons in which they fell in any of the first four places. Figures also are included, however, which indicate the frequency with which each strain was given first, second, third, or fourth choice, respectively.

		Percentage of Seasonal Averages In Which Each Strain Falls in				
Strain	No. of Seasonal Averages	1st 4 Places	1st Place	2nd Place	3rd Place	4th Place
C-7 Cohansey	155	61.9	12.9	16.1	14.2	18.7
C-19 Congressional	173	60.7	20.2	16.8	15.0	8.7
C-36 Norbeck	73	58.9	12.3	26.3	11.0	9.6
C-15 Toronto	162	58.0	27.2	10.5	11.1	9.2
Old Orchard (C-52)	173	45.1	15.0	6.9	15.0	8.1
C-17	155	38.7	4.5	9.0	9.0	16.1
C-28	73	37.0	5.5	9.6	11.0	11.0
Washington (C-50)	165	36.4	2.4	11.5	13.3	9.1
C-1 Arlington	162	30.9	8.0	12.4	6.2	4.3
Metropolitan (C-51)	167	19.2	3.0	4.8	4.8	6.6
Seaside (C-60)	153	17.0	0.7	2.6	3.3	10.5
Astoria (C-61)	153	10.5	1.3	1.3	5.9	2.0
Highland (C-65)	147	9.5	0.7	2.7	3.4	2.7

"A study of the table will show that the first five grasses are the superior strains, regardless of whether one considers their occurrence in 1st place only or in the first four places. However, the relative standing of these five superior strains is significantly different, depending upon the basis of comparison. C 15 and C 7 exchange places when first place only is considered, instead of the present arrangement. C 19 remains in the same relative position by either method of comparison, whereas Old Orchard would move up to 3rd place instead of 5th place if compared with the other strains on the basis of 1st choice only. C 1, although 9th in order under the present arrangement would fall in 6th place if only first choices were considered.

"It is obvious that in general the Washington and Metropolitan strains have been the least desirable of the vegetatively propagated creeping bent strains under test in this series of experimental greens. The seeded bents conspicuously are in a class by themselves at the foot of the list, although they did show possibilities in Pittsburgh, Tulsa, and Portland.

"It should be remembered that the figures given here represent the average behavior of the grasses in greens distributed over all parts of the country and under many types of maintenance programs. Therefore although a strain

Pine Valley's 18th — a view of a great finishing hole for a great golf course.

may rate at the bottom of the list it is not surprising to find that in specific limited situations it may be a superior grass.

"It appears significant that these five superior strains have excelled in diverse parts of the United States. To indicate the widely distributed geographical areas in which these grasses produce superior turf, C 7 may be cited as being one of the first four choices for the entire test period on experimental greens in the following districts: two out of four in the District of Columbia; one in Virginia; one in Massachusetts; one in Ontario; two in upper New York State; one out of three in the Metropolitan area; two in Pennsylvania; three in Ohio; one in Indiana; two out of three in Missouri; one in Detroit; four out of five in Chicago; one in Omaha; one in Tulsa; and two out of three in California.

"These figures illustrate the fact that although these grasses are generally superior in many parts of the country they do not necessarily lead in ratings on all of the greens in any one area. It would therefore seem advisable before deciding to use any single or several strains which have been superior on one or more experimental greens in your vicinity to try the grasses under your specific conditions and maintenance program."

The C-7 strain was distributed to interested commercial growers in 1946, and so a name for it had to be found. Overzealous people concerned began to assign their own names, and one commercial firm erroneously assigned the name "Clementon," after the town where Pine Valley's post office is located. This was hurriedly retracted. Soon after, at my instigation, a contest was held among Pine Valley members and many names were suggested. Among them was "Crump" after the founder of Pine Valley, "Pine Valley," "The Valley," and numerous other names. After many discussions with John Arthur Brown, Pine Valley's President, the name "Cohansey" was selected and this announcement was made:

C-7 is to be named —

"In trying to decide a given name of designation C-7 we came to the conclusion that the selection should be identified with a little considered element in the place where this hopeful strain was developed and not with the place itself. So excuse please if we seem to digress.

"The average golfer playing on the greens and fairways of Pine Valley takes for granted the many acres of beautiful grass which he finds at that Paradise. However he is apt to give particular attention to the fast sandy traps and bunkers which he probably thinks have been created by a power something beyond that of an artistic golf amateur. But there is no warrant for taking for granted the 40 acres of greens, tees and fairways with their various types of bent and other grasses. These all grew, believe it or not, on sand. The turf has

This is Pine Valley. The avenues to a good score seem as narrow and remote as this path in the foreground to No. 17 green.

taken years of study, of topdressing and nourishment with careful watering, to withstand the heavy use and violent treatment which seems to be the daily burden.

"Grass grown on sand needs more than a normal rainfall to retain its sparkling vigor under severe conditions and close croppings. WATER is *The* essential element. Nature in ages by and gone laid down the water courses in strata through which today comes this essential element in abundance, serving the many lakes, as well as the black water for the grasses and the white water for the players.

"That water course we call "The Cohansey." How else should be called our young hopeful C-7 but . . . Cohansey!"

The thought about naming this grass Cohansey came to us while we were drilling some new wells for our drinking water supply. Pine Valley is blessed with good water supply and most of this water comes out of the Cohansey strata.

The Cohansey strain of bent is fine-bladed, has an apple green color, is a rapid spreader, heals itself quickly after injury, grows upright, and produces a very fine-textured putting green.

It has been found suitable for putting greens in all regions where bent can be grown. It is liked from Virginia to St. Louis to Oklahoma and everywhere north.

H. BURTON MUSSER

The Green Section of the United States Golf Association lost a valued friend with the passing of H. Burton Musser of State College, Pa., on August 12. Professor Musser retired in 1959 as Professor of Agronomy in the School of Agriculture at the Pennsylvania State University and since had served as the Executive Director of the Pennsylvania Turfgrass Council. He was a Fellow of the American Society of Agronomy.

In January 1966, when he was 72 years old, Professor Musser became the sixth recipient of the Green Section Award of the United States Golf Association for "distinguished service to golf through work with turfgrass." He was responsible for the development of Penncross bentgrass and Pennlawn fescue.

He wrote numerous technical works for trade journals and articles for magazines, and was the author of *Turf Management,* a textbook published by the USGA.

The Correct Sand for Putting Greens

by CHARLES G. WILSON, Head Agronomist, Milwaukee Sewerage Commission

Surprisingly enough, there is considerable agreement among turfgrass soil scientists on the subject of correct sand particle size to be used in construction and top-dressing of putting greens. Unfortunately, we have sometimes lowered our standards in the mistaken belief that the customer would not pay the cost of using the correct materials. This is a mistake needing correction!

The right gradation and size of sand particles can be justified by the builder and the golf superintendent, as well as those who pay the bills.

The first step is to refuse any sand that is retained above a 10 mesh Tyler standard screen. Materials passing through the 10 mesh size are 1.410 mm or .0555 inch or smaller. As the Tyler mesh size drops (10, 8, 6, etc.) the particles get larger. Coarse clinkers (those above 10 mesh) should be eliminated, or tolerated if present in only fractional percentage amounts. The reason is simple. Once the green is turfed it is virtually impossible to work anything larger than .065 inches (10 mesh) into the turf fiber when the putting green is top-dressed.

Suppose, for example, your course has purchased a "concrete grade" of sand under the mistaken belief that it is cheaper because it costs less per ton or per cubic yard. Dr. Donald V. Waddington at Penn State University has found that sand grades are quite variable in particle size, so let us also suppose 50 percent of this sand is retained above a 10 mesh screen, a not uncommon occurrence. You mix this carefully in proper proportions with soil and humus to match the USGA soil specifications used in construction. You even compost the mixture to be sure the particles won't separate in the act of top-dressing. You have a physical soil analysis made just to be sure it's the proper mix. The tests show the 7 parts sand, 2 parts peat and 1 part soil by volume in the mixture to be excellent in terms of infiltration and percolation after compaction.

Then the greens are top-dressed. Your labor crew is a good one. They work carefully and diligently to brush, board and drag mat the top-dressing into the turf. In fact, they spend many extra hours in this attempt. But lo and behold, almost all of the coarse sand fraction is eventually carried to the green collar where it must be picked up and hauled away to create even more work.

The small percent of coarse clinkers that remain on the green and on top of the grass does not escape notice. The golfers are angry, and the mechanic is paid overtime for keeping the dull mowers sharpened by extra grinding and lapping in bedknife and reel. And what of the poor grass after the dust (literally) has settled? Instead of the 7-2-1 mix originally specified and intended in this example, the grass has received a 4-2-1 ratio that makes an excellent substitute for concrete.

Assuming all the peat and all the soil applied can be worked into the grass, look at what this act of removal does to our original mixture on a "by volume" percentage basis. The 70 percent of sand in the original 7-2-1 mixture (100 percent) drops to 57 percent contact on the green after three parts of the coarse sand is hauled away. The peat increases from 20 percent to 28.5 percent, and the soil content jumps from 10 percent to 14.5 percent.

"Hardly the original mixture," you say. *And you are correct!* Even the act of aerating and core removal prior to top-dressing won't solve the problem, because there is still two inches of turfed area between each hole that refuses to accept the coarse sand particle.

So, why not buy an acceptable sand in the first place? Penn State recommends a minimum of 80 percent in the 14-65 mesh size (1.190-0.208 mm, 0.0469-0.0082 inches). Dr. Raymond Kuntze, of Michigan State, who did the original work on the USGA specifications at Texas A & M, favored a gradation of 0.25 mm to 1.0 mm in size. This comes very close to Penn State's suggestion. Most turfgrass soil scientists also would prefer a round sand to a sharp, angular sand where a choice is available, and in this discussion on sand we are referring only to true silicas and not some substitute such as crushed limestone or slag.

Seldom will you find such a sand available without special screening. One sample we analyzed from Ottawa, Ill., is as near perfect in "run of the pit," as we have seen. It is ideally suited for bunkers as well as construction and top-dressing. The mesh size was as follows:

Mesh	mm	Inches	Percentage Retained
10	1.651	.065	0.30
16	.991	.039	11.24
28	.590	.0232	58.91
48	.295	.0116	26.62
100	.147	.0058	2.60
Pan	—	—	0.33

We would hold out for nothing coarser than the above 10 mesh in screen size, and only then in a fraction of 1 percent as being acceptable. We would approve as much as 20 percent falling below the 48 mesh size, but retained on a 65 mesh screen.

Such a sand screened to specifications, essentially passing through a 10 or 12 mesh and being retained on a 65 mesh screen will obviously cost more per ton than common concrete or mortar sand. Yet, one ton of this sand is equivalent to two tons of the sand used in our horrible example, since none is wasted in top-dressing.

It is appreciated that most of the savings in freight and bulk handling will be realized after and not during construction. Although, even during construction the finer grade of sand specified should go farther because there are more particles per unit of measure now that the coarse clinkers have been removed.

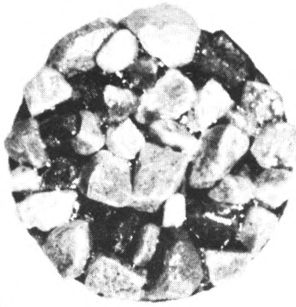
And just think of the fringe benefits. Less labor down time involved in top-dressing; happier golfers; and by no means last, protection in perpetuity of the putting green soil profile you so laboriously and expensively put together in the first place.

Thus, one should provide a physical soil laboratory, with the competence to carry out the tests described in the USGA Green Section Specifications, with decent sand in the first place. The same can be said for humus and soil, which is another subject and too lengthy to include here.

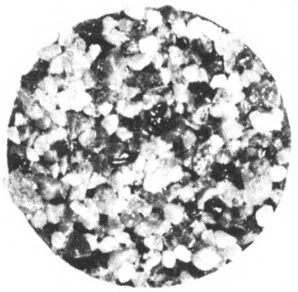
Follow the USGA Green Section specifications on mixing and construction *exactly* as written.

And finally, each club should require an Act of Congress before anyone is permitted to tamper with or alter the soil mixture decided upon, no matter how well-meaning he may be.

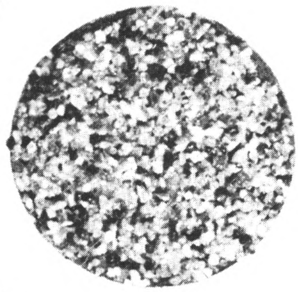
PARTICLE SIZE CHART



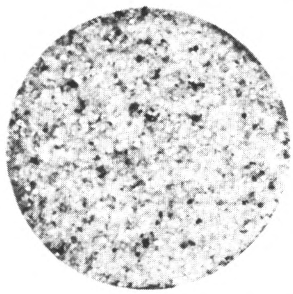
VERY FINE GRAVEL
(5-10 mesh)
(4-2 mm. diam.)



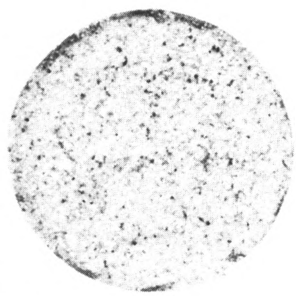
VERY COARSE SAND
(10-18 mesh)
(2-1 mm. diam.)



COARSE SAND
(18-35 mesh)
(1-0.5 mm. diam.)



MEDIUM SAND
(35-60 mesh)
(0.5-0.25 mm. diam.)



FINE SAND
(60-140 mesh)
(0.25-0.1 mm. diam.)

VERY FINE SAND
(140-300 mesh)
(0.1-0.05 mm. diam.)

Lessons Learned in Automatic Irrigation

by JOHN H. MADISON,

Department of Environmental Horticulture, University of California at Davis

Irrigation costs in much of the nation are second only to labor. If we can increase our capitalization with the expectation of present and future savings of labor and water costs, the long term savings may be worthwhile. Automatic irrigation systems are increasing in number, and the justification is long term economy. An *automatic irrigation system* has real value for the superintendent to the extent that it is a management tool. Without high management capability it may create its own costly problems. Automatic systems have not always resulted in the savings projected to justify them, and their management capability is the remaining good that can make the system worthwhile or — by its lack — a burden.

We can all recognize the good of economical operation. But automatic irrigation has come to us without our being prepared. We have not known what to ask of it in the way of management capability. We are still experimenting and improving, still discovering new things we want our system to do. We need to develop our criteria for high management capability as soon as possible. The longer we take, the more systems will be installed that are inadequate and soon become obsolete. Here I propose six criteria I should want to use in buying a system.

1. *The irrigation design should be adequate.*

In the Northeast where a sprinkler system is used to supplement a generally adequate rainfall, second- and third-class design is used, and is tolerable. In the irrigated West where one depends fully upon irrigation, only first-class design should be used in an automatic system. *The most sophisticated controller* is only as good as the system it controls, and the controller cannot make up for deficiencies in the system. In the West, not only is the single fairway line wholly inadequate but also first-class agricultural sprinkler design is inadequate on turf. With the compaction and traffic it receives, turf has lower infiltration rates than agricultural soils. Application rates are apt to be too high, and the higher they are the more inefficient the operation, the more water is wasted.

Also, agricultural crops send out roots through a large volume of soil holding hundreds to thousands of gallons of water. The large root system compensates in part for inadequacies of application. More water is taken from the wet areas, less from the dry. The turfgrass plant, on the other hand, may explore only a few cubic inches of soil and have only a part of a cubic inch of water available after an irrigation. The only water available is that which enters the soil immediately beneath the plant. There is no adjustment possible between an area that receives too little and one a couple of feet away that receives too much.

Inadequacies of sprinkler irrigation are illustrated by a bowling green irrigation system worked out by Tom Byrne, Farm Advisor in Alameda County, Calif. After much effort to develop the best system possible, 5 per cent of the green was underwatered and 45 per cent received more than twice the needed water. This illustrates the inadequacies and inefficiencies of even the best sprinkler design.

2. *The minimum programmed time should be about two weeks.*

There are two reasons to want this:

(a) In the spring, water applied more often than needed greatly increases weed germination and establishment.

(b) Deep rooted fairway grasses such as bermudagrass will conserve water — will use it more economically only if forced to by using long intervals between irrigations. Water is held with increasing tension by the soil as it dries, and bermudagrass can respond with physiological adaptations which enable it to survive and grow with less water.

For these two reasons we want at least a 14-day program time.

3. *Different stations within the controller must be able to have different automatic programs.*

Shrubs have different requirements from turf; bermudagrass requirements differ from those of bluegrass; those of shade turf from grass in the sun; those of fairways differ from those of the rough. Unless you can irrigate the grass in the shade, for example, every six days, while that in the sun is irrigated every three, you end up irrigating everything according to the needs of the most demanding area of shallow-rooted turf. You should not have to manipulate the controls by hand every few days to get this difference in program.

4. *A single station within the controller should be capable of being programmed differently (and independently) on different days.*

Turf has more roots near the surface, fewer at deeper depths. When the surface layer has dried, soil of the lower root zones may still contain adequate water. However, there are not enough deep roots to take up water fast enough to meet peak needs. Consequently, afternoon wilt develops. A tensiometer-controlled irrigation program at UCLA has given results indicating how we may most economically apply water to use the whole root zone and still avoid mid-day wilt. Their records indicate that the most economical program is one that applies about two shallow irrigations before applying a deep leaching irrigation. The controller should be able to handle this program without need to reset it.

5. *There should be a ratio control so that all stations within a control box can be changed with a single setting and so that each station puts on water in the same proportion to the others as it did before.*

The reason for this is the wish to meet the change in demand with change of the seasons. A box should be reprogrammed about 10 times a year for optimum water economy. If each station were to be reprogrammed individually, some systems I have seen would require 10 to 20 days per year of skilled management time. This discounts much of the labor saving advantages.

Also, suppose you have one station set so that it controls sprinklers in the north shade and another controls heads on a sunny south slope. By trial and error you have adjusted them so that the first puts on about 35 per cent of the second, and both meet the demands of the areas they control. It is unlikely that you could reset these several times a year and still maintain this difference. As a result you would like to be able to set one control and change every station within the box by a proportionate amount.

6. *The controller should be able to apply any single irrigation as a series of repeated short irrigations.*

One difficulty of sprinkler irrigation is that efficiency of application is obtained only at high application rates — rates that are too high. At these rates efficiency of infiltration, of use, is low. Too much water runs off and high spots are left dry. One of the great potentials of automatic irrigation is the possibility of solving this dilemma. By using a high degree of overlap we can increase our efficiency of application but at application rates that are too high. However, the turf mat is able to hold a fraction of an inch of water.

By applying water at a high rate for a short time the water is held in the sponge of the mat until it infiltrates the soil. The application is repeated again and again at spaced intervals until the full application is given. The system operates at a high capacity throughout the interval it is on, but at a single spot, the mean application rate averages out to a suitably low value.

At present all controllers have some of the features I have asked for — none has all. The manufacturer will design a controller with what he considers to be sales features unless you can tell him what you need — what you demand. Automatic irrigation is still young, and controllers will continue to undergo a slow evolution. You can hasten that evolution with a clear statement of your needs and wants.

An example of good use of existing equipment to provide flexible management is provided by the new system at the San Francisco Golf Club, engineered by Don Hogan.

Each station of the controller controls heads of similar elevation and exposure. Each station is set for a short irrigation period (a few minutes) and the times are adjusted (by trial and error) to compensate for differences due to sun, shade, slope, elevation, etc., so each receives a proportion of water appropriate to the area. The entire controller is itself controlled by one station of another controller in the superintendent's office. This two echelon system permits the superintendent easily and quickly to change his program — easily to exercise management flexibility.

A long irrigation is given by allowing a large number of cycles to repeat, a short one by repeating only a few cycles. With the water applied in short cycles, the effective rate of application is reduced, which helps to increase wetting of dry areas and to reduce runoff.

Having a suitable automatic system is not enough. Poor use of it can lead to problems. With poor operation one often sees a tremendous increase in crabgrass and other weeds during the second season of operation.

A new system is not automatic in its programming; the program must be set up by trial and error. The best tool for programming is a soil tube. You must know where the water is going, and nothing beats the soil probe for examining a large number of locations in a short time. Wet and dry soil are easily distinguished, so that you can determine how deep your water is going and whether you are wetting the entire root zone or only part of it.

Once the system is programmed it still requires management to achieve goals of water economy.

The advertised "set it and forget it" exemplifies the abdication of management. The following offers some guidelines for management use of an automatic system after you have it.

1. *Patrol the system regularly.* Operating at night the system is out of sight and often out of mind. Damaged heads, malfunctions, or vandalism may go unnoticed until they show up as dry turf. In a schoolyard a missing head went unreplaced for over a year. A geyser every night caused a permanent wet spot, and the loss of pressure created doughnuts around other heads. But the system was run by a custodian who was uninterested and who responded to the brown turf by increasing the irrigation time. Diddling the controller will not replace a missing head. Patrol for missing or damaged heads, heads not turning, heads cocked at an angle, heads set too low so that they operate under water, or heads blocked by overgrown grass. Check nozzles periodically. An inexpensive set of drills provides a good set of plug gauges for checking nozzle sizes. At longer intervals check pressures at the nozzle with a Pitot gauge. Low pressures may indicate hidden leaks, worn nozzles, corrosion, or dirt blockages.

2. *Start slowly in the spring.* Irrigate as infrequently as you can, but when you irrigate, apply enough to wet through the root zone. This will assist greatly in keeping down crabgrass and other weeds. The cracks that develop as the soil becomes dry will help get the water in with reduced runoff.

3. *For economical water use, change the program according to the season.* Use will depend on the solar energy input. This is affected primarily by the angle of the sun's rays, length of days, and degree of cloudiness. Weekly difference in turf water use tends to be small near the solstices, large near the equinoxes. Economical water use in the irrigated West will require about 10 changes of program a year, each involving at least a 10 percent change in water use. In any location, East or West, close control of water applica-

tion can be achieved by adjusting water application to parallel loss from a Bureau of Plant Industry evaporation pan. This is a pan six feet in diameter, 2 feet in depth, set flush with the ground and having the water surface about four inches below soil level.

4. Avoid daily wetting. Daily sprinkling leads to heavy invasion of crabgrass, Poa annua, dallisgrass, and other weeds. Daily sprinkling keeps the soil at moisture levels where it is most subject to compaction from traffic. Compaction is our biggest turf problem. Daily sprinkling keeps the soil at its lowest infiltration rate so that waste from runoff is maximum. Daily sprinkling stops the cycle of wetting and drying, shrinking and swelling which restores soil texture and aids soil aeration. Daily sprinkling favors disease, buildup of lawn moths, and promotes a soft growth readily injured by stress.

5. Know when to make an exception to Number 4. Sometimes in the middle of summer two or three days of over-irrigation will stimulate the grass, help wet up dry spots, leach salts and improve appearance. Again in late August a few days of heavy irrigation may help relieve summer stressed areas so that they begin to recover. Also, when summer disease has injured roots, a daily sprinkle may keep grass alive until new roots form.

6. Decrease irrigation by increasing intervals. When cutting down on water use after the summer peak, decreasing irrigation frequency is preferable to giving shorter irrigations. More frequent irrigation favors weeds and abuses the soil as discussed above. In addition, remember: a little water does not wet the soil a little bit — a little water wets a little soil and leaves the rest dry.

Several years ago I presented some irrigation design formulas based on plant soil relationships. These are very useful for checking out a system and finding weak points in it. Their usefulness is limited by the fact that often we do not have figures for evapotranspiration and infiltration rates to insert into the formula. However, if we are concerned with the worst month in the worst year in a series of dry years, we can use an ET figure of 2 inches per week and an infiltration rate guessed at 0.1 inch per hour. For a low ET and a high infiltration rate we can use 1 inch per week and 0.5 inch per hour as exploratory values. Even though inaccurate, these values used in the formulas will often point out system weaknesses and indicate the kind of compromises that will need to be made.

(1) $$\frac{\text{Evapotranspiration (in/week)}}{\text{Infiltration rate (in/hour)}} = \text{Hours per week water must be on an area to rewet it.}$$

(2) $$\frac{\text{Irr. operating hours per week}}{\text{Hours to rewet an area}} = \text{Number of sprinkler sections.}$$

(3) $$\frac{\text{Number of acres to be irr.}}{\text{Number of sprinkler sections}} = \text{Number of acres to be irrigated at one time.}$$

Combining equations 1 and 2:

(4) $$\frac{\text{Irr. time (hrs/wk)} \times \text{infiltration rate (in/hr)}}{\text{Evapotranspiration (in/week)}} = \text{Number of sprinkler sections.}$$

Combining 1, 2, and 3.

(5) $$\frac{\text{Total acres} \times \text{ET (in/wk)}}{\text{Irr. time (hrs/wk)} \times \text{infiltration rate (in/hr)}} = \text{Acres to be irrigated at one time.}$$

The flow required to accomplish this:

(6) $$\frac{\text{ET (ins/wk)} \times \text{acres} \times 453}{\text{Irrigation time (hrs/wk)}} = \text{gallons per minute required (gpm)}$$

An approximation of the HP required is given by:

(7) $$\frac{\text{Well dp. (ft)} + \text{av. ht. outlets} + 2 \times \text{op prs. (psi)} \times \text{gpm}}{2000} = \text{approx. static h.p. (assuming 50\% efficiency)}$$

(8) Inches of water applied in a month should not be less nor greatly more than total evaporation for the month less rainfall.

$$\text{Inches applied in a month} = \frac{\text{gpm pumped} \times \text{hours run}}{\text{Acres irrigated} \times 453}$$

One Final Tip

Occasionally someone digs through a cluster of control lines. The following summarizes steps to repair the damage:

Hydraulic	Electrical
1. Join any control line to any valve line. (If system uses pressure to open valves—bleed the line)	1. Cut power.
	2. Join all ground wires.
	3. Join any switch wire to any valve wire of the same wire size.
2. Turn each line on manually to see which switch now operates which valves.	4. With power on operate switches to see which switch controls which valve.
3a. Relabel and reprogram the controller. or	5a. Relabel and reprogram the controller or
3b. Reconnect lines at the controller so each switch controls the desired valve.	5b. Reconnect lines at the controller so each switch controls the valve you want it to.

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TURF TWISTERS

POA ANNUA CONTROL IN BERMUDA FAIRWAYS

Question: I have been told Paraquat has been giving good control of *Poa annua* on dormant bermuda here in the South. Is this a good practice? (Georgia)

Answer: If you are sure the bermuda is dormant, one quart of Paraquat per acre has given control of most weeds, *Poa annua* included. It would be advisable to spray a small area the first year and observe it under your growing conditions. You may find reduced rates will give good control. The spray equipment must distribute the chemical evenly or streaking will occur. Do not plan to seed immediately after spraying.

GOLFER DAMAGE TO WINTER GREENS

Question: Is there an effective means of determining how much damage golfers can do to greens in wet or cold weather? (Missouri)

Answer: Quite a lot has been written regarding this problem and numerous talks have been given at turf conferences; the following quite well summarizes this information:

1. Do not play when the soil is saturated with water or overwet. This means that shoes actually sink through the soil or carts leave ruts. Not too often does this condition prevail.
2. This is of paramount importance: Do not walk on grass when a "white frost" is visible. When this is done, ice crystals in the cell vacuole will cause cell wall rupturing and death to the plant.
3. Never allow traffic on soil, especially putting greens, when all but the upper one or two inches of the soil is frozen. This can cause permanent damage to turf, as well as develop rough, bumpy putting conditions.

OVERSEEDING AND PYTHIUM

Question: There has been Pythium on overseeding of bermuda in the fall and again in the spring. What is the best practice for control at this time? (Florida)

Answer: *Pythium aphanidermatum* (pythium blight) is most common on grasses used for overseeding. However, other Pythium can be present. The use of 8 to 16 ounces of 50% Captan plus an antibiotic such as Actidion at the company's recommended rate per 1,000 square feet at seeding time has been very effective. Also, a strict weekly spray of fungicide (Thiram, Kromad, Daconil 2787, etc.) while establishing the seedlings and Dexon during Pythium outbreaks has been very effective in controlling this pest. Even under close supervision, occasionally disease can develop. (Note: use of manufacturer's name is for illustration only and does not constitute a recommendation.)