San Antonio

Evapo-Transpiration

Pilot Study Report

1997

Water Is Life
Don't Waste It

Conducted by:

Texas Agricultural Extension Service - Bexar County
Bexar County Master Gardeners
Texas A&M University

For:

San Antonio Water System

Texas Agricultural Extension Service

The Texas A&M University System

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Dear Citizens of San Antonio and Bexar County:

Based on consideration of the results of the Evapo-Transpiration Project by the ET Advisory Board, we submit the 1997 report to SAWS. The report offers considerable data, the high points of the discussion of the data, and a plan to continue the experiment with revisions in 1998. The funds budgeted to operate the program in the original budget are sufficient for the changes offered in this report.

Please contact us if you would like to discuss the conclusions and plans further.

Sincerely,

Calvin R. Finch
County Extension Agent — Horticulture

Joe G. Taylor
County Extension Agent — Agriculture

Karen Guz
County Extension Associate — Horticulture

Dee Emory
Environmental Coordinator
Bexar County Master Gardeners

CRF:clw

SAN ANTONIO EVAPO-TRANSPIRATION PROJECT

In the summer of 1997 a partnership between the Texas Agricultural Extension Service and the Bexar County Master Gardeners with funding from the San Antonio Water System, conducted the SA Evapo-Transpiration (ET) Pilot Project.

The objective of the project was to determine if it is feasible to develop a public program that is effective in reducing water use on area lawns through utilization of ET data to plan home irrigation.

The report is organized in the following manner:

- Executive Summary
- The plan for 1998 leads off the report.
- The discussion of the results of 1997.
- The results, in the form of tables, graphs and charts are offered after the discussion.
- At the rear of the report is the procedures handbook provided to the homeowners who participated in the experiment in 1997.

Executive Summary

In 1997, an experiment was conducted to determine how potential Evapo-Transpiration information could be utilized to determine irrigation needs for homeowners in the San Antonio area towards the end of reducing water use on lawns.

The experiment shows that one inch water/week during the hottest part of the year is 100% of ET, and over a variation of soils and turf varieties maintains a lawn's appearance. The experiment also shows that by applying one half that rate (approximately .5 inch/week) you see a reduction in the quality of the appearances of the lawns during the hottest part of a year, but the decline in appearance is not drastic and that the lawn recovers quickly in the fall.

We can conclude that using the ET method offered in this experiment significantly reduces water use over the commonly used recommendation of applying 1 inch per week throughout the growing season. One inch of irrigation per week is only needed during the hottest part of the year and only if the homeowner will not tolerate a temporary decline in lawn appearance.

The experiment determined that the weather station at the SAWS' Jones Maltsberger site provided data that was adequate for use over the whole city. Moisture meters in every experimenters' lawn proved to be difficult to use and only in ideal situations were they useful in monitoring soil moisture levels.

The city was divided into four (4) quadrants based on soil type and water use. The goal was to recruit four (4) homes with Zoysia, St. Augustine, Bermuda, and Buffalo lawns in each quarter to serve as experimenters (64 yards). Experimenters were organized into four (4) irrigation treatments: Protocol A (100%) weekly watering at 100% of PET; Protocol A (deficit) weekly watering at approximately 70% of PET; Protocol B (100%) watering at 100% of PET when the soil reservoir dropped by 3/4 inch; and Protocol B (deficit) watering at approximately 70% of PET when the soil reservoir dropped by 3/4 inch.

All the experimenters reduced water use when it was compared to the one (1) inch per week recommendation normally used. Only in the hottest part of the year did PET dictate the use of 1" irrigation per week. The experiment operated from July 21 through November 15. Protocol A (100%) averaged .72 inch/water/week; Protocol A (deficit) .48 inch/water/week; Protocol B (100%) .62 inch/water/week; and Protocol B (deficit) .41 inch/water/week.

Lawn ratings remained relatively level at the 100% of PET irrigation levels. They dropped up to 1 rating level for deficit watering regimes during the summer. Lawns under all watering regimes returned to original appearance ratings in the fall when cool weather returned. Ten per cent of the lawn rating were accounted for by soil depth. Homeowners participating in the experiment found the procedures relatively easy to follow and would recommend it to their neighbors. They reported that they preferred the weekly watering regime (Protocol A).

A committee made up of experimenters, horticulturists, irrigators and other interested parties formed the ET Advisory Committee. The committee examined the data collected in 1997 and ideas for the second stage of the experiment in 1998.

In 1998, 60 lawns will be enrolled in 3 different watering regimes; weekly watering at 100%, 70%, and 50% of PET. Soil depth and bulk density will be measured to better determine the impact of soil on irrigation needs. The experiment will be operated from April 20 - November 15, 1998.

The Bexar County Master Gardeners and the Texas Agriculture Extension Service will train and manage two teams of volunteers to assist homeowners in reducing landscape water use. The Water Resource Teams will advise homeowners requesting their help to reduce water use by auditing landscape and obvious irrigation features. A smaller team will offer an actual irrigation system audit to a few homeowners. Water use before and after the audit will be evaluated.

It was decided to postpone enlistment of the media to promote ET to the public until 1999.

1998 Planning

There are three major decisions to make about the 1998 program.

1. How will the experiment be operated in 1998?
2. Will there be a Master Gardener water resource team and how will it be organized?
3. Will there be a public program and how will it be organized?

The experimental part of the ET program will be revised in 1998

Sixty lawns will be recruited to test three protocols. All protocols will be irrigating on Mondays. The protocols will be at 100%, 70% and 50% replacement of total ET, rounded off to the nearest quarter inch of water.

The sixty lawns will include one each of Bermuda, Zoysia, and Buffalo grass in each of the four quadrants for each of the three protocols (thirty-six lawns). For St. Augustine, one lawn for each protocol in each quadrant will be recruited, plus four additional St. Augustine lawns in each protocol will be recruited for a total of twenty-four St. Augustine lawns in the experiment.

1998 ET Study
Participant Plan

	Q-1	Q-2	Q-3	Q-4
Bermuda	1 @ 100% 1 @ 70% 1 @ 50%	1 @ 100% 1 @ 70% 1 @ 50%	1 @ 100% 1 @ 70% 1 @ 50%	1 @ 100% 1 @ 70% 1 @ 50%
Buffalo	1 @ 100% 1 @ 70% 1 @ 50%	1 @ 100% 1 @ 70% 1 @ 50%	1 @ 100% 1 @ 70% 1 @ 50%	1 @ 100% 1 @ 70% 1 @ 50%
St. Augustine	2 @ 100% 2 @ 70% 2 @ 50%	2 @ 100% 2 @ 70% 2 @ 50%	2 @ 100% 2 @ 70% 2 @ 50%	2 @ 100% 2 @ 70% 2 @ 50%
Zoysia	1 @ 100% 1 @ 70% 1 @ 50%	1 @ 100% 1 @ 70% 1 @ 50%	1 @ 100% 1 @ 70% 1 @ 50%	1 @ 100% 1 @ 70% 1 @ 50%

Raleigh St. Augustine, 609 Buffalo, Emerald Zoysia, and common Bermuda lawns rated as a 1 or 2 lawn, in the sun irrigated by an in ground system will be targeted. If other selections must be utilized they will be noted and compared to the other selections in the 1998 report.

Soil depth and quality will be given more attention in 1998. Two soil depth probes will be made by the area monitor and a soil quality determination will be made.

Monitors will take daily moisture meter readings on 1 lawn in each protocol for each of the 4 turf varieties for a total of 24 lawns examined.

A new "computer entry and homeowner friendly" data collection form will be created. Homeowners will receive better training because of our experiences in 1997. The training will be offered 2 times in 1998 as part of a stronger commitment required from experimenters, a representative of each household will be required to attend one of two offered sessions. The experimenters will again be offered a bag of slow release lawn fertilizer and be required to follow the **DON'T BAG IT** management plan for lawn care.

Homeowners who were experimenters in 1997 and meet the requirements for 1998 in terms of lawn rating, commitment and varieties will be invited to rejoin for 1998.

Monitor performance will also be reviewed and monitors who met the commitment in 1997 will be re-invited to join the experiment. We will seek to have 12 active monitors involved in 1998. They will have responsibility for 2 moisture meters and 4-6 lawns. Monitors will be required to attend training in early spring, as the summer heat begins and then again in the fall.

The ET data will be offered on an ET phone hotline and on the Internet in 1998
The experiment will begin on April 20, 1998 and end on November 15, 1998. Reports on the ET project will be completed every two months (June 30 for June 15, August 30 for August 15, and October 30 for October 15. The final report due by mid December will include the November data. At or around the report due date the ET advisory board will meet to review and discuss the report. A final report for the year will be completed for SAWS by mid January.

1998 Experiment Time Line

3/98	Review Experimenter Performance 1997	K. Guz
3/98	Devise Bulk Density Method	J. Taylor
3/98	Devise Soil Depth Method	J. Taylor
3/98	Collect signs and moisture meters from 1997 experimenters.	D. Emory
3/98	Invite Committed experimenters to participate in 1998	K. Guz
3/98	Invite committed monitors to participate in 1998	D. Emory
3/98	Revise data entry form for 1998	W. Watje / K. Guz
3/98	Revise experimenter notebook for 1998	K. Guz / J. Taylor
3/98	Recruit experimenters for 1998	D. Emory
3/98	Recruit monitors for 1998	D. Emory
4/98	Homeowner Experimenter Training	D. Emory/K. Guz/J. Taylor
4/98	Monitor Training	D. Emory/K. Guz/J. Taylor
4/98	Establish computer system	K. Guz/J. Taylor
4/20/98	Begin Experiment	
6/98	Hot weather training for monitors	D. Emory
9/98	Cool weather training for monitors	D. Emory
4/20 through 11/15	Maintain phone line	D. Emory / K. Wrider

DISCUSSION

The 1997 data was brought before the ET Advisory Committee **(see membership list - page 14)** on 12/19/97. The following tentative conclusions were offered.

1. Deficit watering under Protocol B used the least water and required the fewest irrigations **(tables 1-2).**

2. Lawn rating across all protocols were roughly the same with a dip in mid summer and improved ratings in the fall. Deficit watering generally showed more reaction to summer drought than 100% of PET did **(graphs 1-20).**

3. Zoysia grass showed the most variation in week to week ratings. Buffalo grass showed the least. St. Augustine grass stayed relatively consistent at 100% of **PET,** but showed considerable variation at deficit watering **(graphs 1-20).**

4. When lawn ratings by Master Gardener monitors were compared to the homeowners ratings of their own lawns, the monitors were more consistent and rated the lawn performance higher across all lawns **(graph 21).**

5. The difference between lawns in various parts of the county was minimal. The curves were similar to the protocol curves where deficit watered lawns did not score as high as 100% of **PET** lawns. In quadrant 2 there is an unusual phenomenon in that the deficit irrigation lawns out performed the 100% lawns. The results will need to be explored further in the 1998 version of this experiment **(graphs 22-29).**

6. It was expected that soil depth would be a factor in lawn performance in this experiment. Across the entire experiment, soil depth only accounted for approximately 10% of the initial and final lawn ratings with very large variation across the range of turf variety and protocol **(table 3).**

7. In the graph for Wilbur Watje's lawn, the moisture meter readings performed as expected with high readings between waterings with drops after waterings. Moisture meter readings across the entire experiment were not analyzed because of difficulty in determining whether the readings were taken before or after irrigation **(graph 30).**

8. One of the important determinants in deciding whether to go public with the Bexar County ET program is whether ET data can be provided every day. The **PET** graph shows that the **PET** readings from 4 San Antonio weather stations have the same curve. One station, the Sonterra Golf Course, collected the same values as the Jones-Maltsberger station operated by the MG's. It could be used as a second source of information if the JM station broke down **(graph 31).**

9. The homeowner feedback survey provided information about the experimenters reaction to the experiment **(Appendix 1).**

10. Two thirds of the participants who responded to the survey said they would be content with dormant or less than green grass **(Appendix 2, result 1).**

11. Slightly more than half believed that they used less water this year than last because of involvement in the experiment **(Appendix 2, result 2)**.

12. In a related question, participants felt they averaged watering 1.6 times this year because of the experiment, when they wouldn't have watered normally **(Appendix 2, result 4).** On the other hand, they believed on average to have passed up watering 1.6 times this year when they would have watered if they were not part of the ET experiment **(Appendix 2, result 5)**.

13. The experimenters believed that in 1996 their lawns averaged a 2.56 rating. This is a poorer rating than all lawns averaged before or after the experiment **(Appendix 2, result 3, graphs 1 to 4).** Only Bermuda and Zoysia lawns in mid-summer reached this low rating **(graphs 1 and 2).**

14. The survey responders found the experiment concepts relatively easy to understand. The hardest part for them was finding time to do the tasks including sending in the data sheets **(Appendix 2, result 6)**.

15. Only 4 participants would not recommend ET use to a neighbor **(Appendix 2, result 7).** Nearly three quarters of the participants who answered the questionnaire said that they preferred **Protocol A to Protocol B.** Most preferred watering a different amount on a specific day of the week to refill the reservoir rather than watering when the reservoir levels dropped to a certain level **(Appendix 2, result 8).** Most experimenters seemed content with the phone method of receiving ET information. The rated the phone line good or fair **(Appendix 2, result 10)**.

16. Weekend watering was preferred by 17 of the experimenters replying to the question, but Monday was the single day that most people preferred to water **(Appendix 2, result 9)**.

17. A consistent pattern was noted in Protocol B with watering intervals averaging seven days in mid-summer and watering intervals averaging 10-14 days in September **(table 2)**.

18. Over the 17 weeks of the experiment, Protocol A (weekly) lawns averaged the use of .72 inches per week under the 100% of ET regime; Protocol A deficit lawns averaged .48 inches per week: Protocol B (refill) averaged .62 inches of irrigation; and Protocol B under the deficit regime averaged .41 inches of irrigation **(tables 1, 2)**. In the hottest part of the summer, lawns were receiving 1 inch per week only at the Protocol A, 100% of PET treatment **(table 1)**.

    Considered on that basis, the experiment results bring into question the longtime recommendation that 1 inch of water per week is necessary to maintain hot weather grasses, especially St. Augustine grass at peak appearance throughout the growing season.

    Only during the hottest part of the summer only the experimenters in the Protocol A, 100% PET were applying 1 inch. When the lawn ratings are examined **(graphs 5, 6, 7, 8)**, ratings appear to be more consistent (less dip) across mid summer for the 100% watering regime, especially for St. Augustine grass.

The measure of variation offered in Table 4 also confirms less variation occurs in the 100% PET watering regime than in deficit watering.

The appearance ratings for all watering regimes generally were as high as the original ratings in the fall when temperatures cooled and rainfall became more of a factor in meeting lawn moisture needs.

In examining the "how much water does a lawn need" question, it is also interesting to note that the reduction of lawn appearance ratings over the summer in even the most reduced watering situations (A and B deficit) only declined by 1 rating point or less before improving when cool weather arrived **(table 6)**.

The experiment shows that one inch water/week during the hottest part of the year is 100% of ET, and over a variation of soils and turf varieties maintains a lawn's appearance. The experiment also shows that by applying one half that rate (approximately .5 inch/week) you see a reduction in the quality of the appearances of the lawns during the hottest part of a year, but the decline in appearance is not drastic and that the lawn recovers quickly in the fall.

We can conclude that using the ET method offered in this experiment significantly reduces water use over the commonly used recommendation of applying 1 inch per week throughout the growing season. One inch of irrigation per week is only needed during the hottest part of the year and only if the homeowner will not tolerate a temporary decline in lawn appearance.

The continuation of the experiment in 1998 may allow us to fine tune how much appearance a homeowner will have to sacrifice for greatly reduced water use. We will also better determine the role of soil depth, soil quality and turf species in lawn water requirements. We will also be able to offer a calendar of water needs that includes the spring as well as the summer and fall.

WATER RESOURCE TEAM

A Master Gardener Water Resource Team will be will be organized and in operation by June 1998. The team will have the goal of helping homeowners reduce their outdoor water use.

Master Gardeners will be recruited to serve as resources in their neighborhoods for homeowners who want a walk-through analysis of landscape practices that might be changed to decrease the need for water in the landscape. Irrigation inefficiencies will be covered to a limited extent, but a full scale irrigation audit will not be conducted. Homeowners needing irrigation changes will be referred to their current or other cooperating irrigators. A curriculum outline for the water resource advisers is attached.

TIMELINE...WATER RESOURCE TEAM

4/98	Finalize Curriculum	Karen
4/98	Complete visit checklist	Karen
4/98	Schedule training and instructors	Dee
4/98	Organize structure to process and fulfill request	Dee
5/98	Tell the public that the resource is available	Calvin
5/98	Conduct training	ET Team & outside sources
6/98	Begin service	Dee
1/1999	Check back with client to see if advice followed	Joe
1/2000	Check 1999 water bills against 1998 to see if water was saved	Joe

IRRIGATION AUDIT TEAM

A special experiment will be conducted to see how Master Gardener volunteers operate as irrigation auditors. Six Master Gardeners will be recruited to receive special training from a Horticulture / Engineering team. The team will provide a method of operation in addition to the training. The training is scheduled for March 4, 1998.

The auditors will audit 12 homes and their water use will be monitored to see what savings if any are achieved.

If the experimental stage of the Irrigation Audit Team works well, the trained volunteers will become part of the Water Resource Team.

Timeline Irrigation Audit Team

2/1/98	Receive curriculum and schedule from Doug Welsh at A & M
2/98	Recruit Master Gardeners
3/24/98	Train Master Gardeners
4/98 - 8/98	Conduct Audits
Summer 1999	Monitor water use

PUBLIC PROGRAM

The major public program will not be initiated until 1999. A limited program will operate in 1998.

Summaries of the results for 1997 will be published in the San Antonio Gardener newsletter and The San Antonio Express News. The full report will be available to individuals interested who send a self addressed stamped envelope. The availability of the report will be publicized on one or more radio stations, TV stations and suburban newspaper in addition to the SAG and San Antonio Express-News.

The summary and the offer of the full report will be mailed to all media weather departments along with contact names and phone numbers. Weather persons who express interest in using the ET information will be encouraged to wait until 1999.

A homeowners "HOW TO USE ET DATA IN SAN ANTONIO" bulletin will be prepared and made available to interested homeowners who send a self addressed stamped envelope. They will be allowed to use the ET information line. If the phone lines get too busy for the experimenters to reach the ET report, other arrangements will have to be made.

PUBLIC PROGRAM...TIME LINE

3/98	Complete preliminary report	C. Finch
3/98	Complete Homeowner ET use bulletin	K. Guz
Early February	ET Committee meet and review	C. Finch
3/30/98	Complete report and Submit to SAWS	C. Finch
3/30/98	Letter to weatherman	C. Finch

ET PROJECT ADVISORY COMMITTEE

Chris Brown	San Antonio Water Systems
Guy Phipps	Texas Agricultural Engineering Extension
Mark Wahnke	Irrigator
John Troy	Landscape Architect
Leticia Zavala	Landscape Contractor
Frank Suarez	Landscape Contractor
Vernon Mullens	Bexar County Master Gardeners
Loris Perkins	Et Project Monitor
Wilbur Watjie	Et Project Team
Karen Guz	Et Project Team
Bob Webster	Media
Calvin Finch	Et Project Team
Ed Etter	Arborist
Dee Emory	Bexar County Master Gardeners
Joe Taylor	ET Project Team
Mark Fanick	Nurseryman

Water Use For Protocol A

Date	100%	Deficit
7/21	1.0"	.75"
7/28	1.0"	.75"
8/4	1.0"	.75"
8/11	.75"	.50"
8/18	1.0"	.75"
8/25	1.0"	.75"
9/1	1.0"	.75"
9/8	.75"	.50"
9/15	.75"	.50"
9/22	.75"	.50"
9/29	.50"	.25"
10/6	.75"	.50"
10/13	0" *	0" *
10/20	.50"	.25"
10/27	.50"	.25"
11/3	.50"	.25"
11/10	.50"	.25"
Total Water	12.25	8.25

* No water was applied due to rain

Water Use For Protocol B

Date	100%	Deficit
7/18	.75"	.50"
7/25	.75"	.50"
8/1	.75"	.50"
8/6	.75"	.50"
8/13	.75"	.50"
8/19	.75"	.50"
8/25	.75"	.50"
9/1	.75"	.50"
9/8	.75"	.50"
9/15	.75"	.50"
9/22	.75"	.50"
10/1	.75"	.50"
10/14	0" *	0" *
10/26	.75"	.50"
11/8	.75"	.50"
Total Water	10.5	7

* No water was applied due to rain.

As of November 14, Total PET was at .162, well below the critical ET.

Table 3

Soil Depth vs. Rating				
	Initial		Final	
	Correlation *	r^2	Correlation	r^2
All Lawns Initial	.134	.018		
All Lawns Final			.096	.009
Buffalo A 100%	.5	.250	.866	.75
Buffao A Deficit	0	0	0	0
Buffalo B Deficit	.811	.658	.585	.342
St. Augustine A 100%	.398	.158	.398	.158
St. Augustine A Deficit	-.149	.022	.374	.140
St. Augustine B 100%	-.804	.647	0	0
St. Augustine B Deficit	.786	.618	-.612	.374
Bermuda A 100%	-.721	.519	.302	09
Bermuda A Deficit	.684	.468	.957	.916
Bermuda B 100%	1.00	1.00	0	0
Bermuda B Deficit	-.736	.542	.368	.136
Zoysia A 100%	0	0	0	0
Zoysia A Deficit	.763	.583	.588	.346
Zoysia B 100%	.756	.571	-.945	.893
Zoysia B Deficit	.993	.987	.803	.645

Mean soil depth _____

All soils over 12" listed as 12"

* 0 correlation indicates that soil depth was not related to quality in the particular sample
- correlation indicates the deeper the soil, the lower the grass quality ratings,
+ indicates that deeper soil relates to higher ratings

Table 4

SUMMARY
San Antonio Area Evapotranspiration Project
July 14 to November 14, 1997, 18 weeks

PROTOCOL A 100%		PROTOCOL A DEFICIT		PROTOCOL B 100 %		PROTOCOL B DEFICIT	
# Waterings	Total Irrigation	# Waterings	Total Irrigation	# Waterings	Total Irrigation	# Waterings	Total Irrigation
17	12.25"	17	8.25"	15	10.50"	15	7.0"

SUMMARY
San Antonio Area Evapotranspiration Project

PROTOCOL A 100%				PROTOCOL A DEFICIT				PROTOCOL B 100 %				PROTOCOL B DEFICIT		
Grass	Orig. Rating	Final Rating	Difference	Grass	Orig. Rating	Final Rating	Diff.	Grass	Orig. Rating	Final Rating	Diff.	Orig. Rating	Final Rating	Diff.
St. A	1.5	1.5	0	St. A	1.5	1.7	-.2	St. A	1.8	1.5	+.3	2.0	1.5	+.5
Ber.	2	1.5	+.5	Ber.	1.3	2.0	-.7	Berm.	2.3	2.0	+.3	2.0	2.0	0
Zoy.	1.5	1.5	0	Zoy.	2.5	2.3	+.2	Zoy.	1.3	2.3	-1.0	1.4	1.5	-.1
Buff.	1.5	2.0	-.5	Buff.	2.3	2.0	+.3	Buff.	NA	NA	NA	2.0	1.7	+.3

SUMMARY
San Antonio Area Evapotranspiration Project

PROTOCOL A 100%		PROTOCOL A DEFICIT		PROTOCOL B 100 %		PROTOCOL B DEFICIT	
Variation from Original Rating * (total change divided by # lawns)		Variation from Original Rating		Variation from Original Rating		Variation from Original Rating	
St. Augustine	2.63	St. Augustine	3.83	St. Augustine	2.50	St. Augustine	7.50
Bermuda	1.75	Bermuda	2.67	Bermuda	2.67	Bermuda	4.25
Zoysia	6.50	Zoysia	4.75	Zoysia	8.33	Zoysia	3.50
Buffalograss	2.00	Buffalograss	2.25	Buffalograss	NA	Buffalograss	2.33
All Lawns	3.22	All Lawns	3.38	All Lawns	4.50	All Lawns	4.40

* Variation, any change in rating week-to-week (up or down) in all lawns in the sample divided by the total lawns in the particular sample

Table 5

LNAME	07/18/97	07/21/97	07/25/97	07/28/97	08/01/97	08/04/97	08/06/97	08/11/97	08/13/97	08/18/97	08/19/97	08/25/97	09/01/97	09/08/97	09/15/97	09/22/97	09/29/97	10/06/97	10/13/97	10/20/97	10/27/97	11/03/97	11/10/97
100% Replacement	2.14	2.14	2.29	2.29	2.29	2.43	2.43	2.50	2.64	2.57	2.43	2.43	2.43	2.29	2.29	2.14	2.29	2.29	2.00	1.71	1.71	1.86	1.86
Bermuda Deficit Replacement	2.00	2.00	2.00	2.50	2.36	2.75	3.00	2.50	2.75	3.00	2.75	2.75	2.50	2.50	2.25	2.25	2.00	2.25	1.75	1.75	1.75	2.00	2.00
Buffalo 100% Replacement	1.33	1.33	1.33	1.33	1.50	1.67	1.67	1.67	1.83	2.00	2.00	2.33	2.00	1.67	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Buffalo Deficit Replacement	2.14	2.14	1.93	1.71	1.86	2.29	2.43	2.43	2.36	2.29	2.29	2.14	2.00	2.00	2.00	1.86	1.86	1.71	1.71	1.71	1.71	1.71	1.71
St. Augustine 100% Replacem	1.63	1.75	1.69	1.75	1.75	1.75	1.75	1.75	1.75	1.88	1.88	2.13	1.75	1.88	1.75	1.94	1.88	1.81	1.56	1.63	1.63	1.63	1.50
St. Augustine Deficit Replacem	1.70	1.80	1.90	1.90	2.15	2.20	2.25	2.00	2.15	2.40	2.45	2.20	2.05	2.10	2.00	2.00	1.83	1.80	1.70	1.60	1.70	1.60	1.56
Zoysia 100% Replacement	1.40	1.40	1.30	1.40	1.90	1.80	2.00	1.80	2.00	2.40	2.40	2.40	2.30	2.20	2.40	2.20	2.40	2.20	1.60	2.00	2.00	2.00	2.00
Zoysia Deficit Replacement	2.14	2.14	1.93	1.58	1.96	2.43	2.43	2.29	2.50	2.57	2.50	2.29	2.14	2.00	2.00	2.14	2.14	2.00	1.86	2.00	2.14	1.93	2.08

Table 6

LNAME	07/18/97	07/21/97	07/25/97	07/28/97	08/01/97	08/04/97	08/06/97	08/11/97	08/13/97	08/18/97	08/19/97	08/25/97	09/01/97	09/08/97	09/15/97	09/22/97	09/29/97	10/06/97	10/13/97	10/20/97	10/27/97	11/03/97	11/10/97
Bermuda A Rating	1.7	1.7	1.9	2	2.1	2.3	2.3	2.3	2.4	2.4	2.3	2.3	2.3	2.3	2.2	2.3	2.1	2	1.9	1.7	1.7	1.9	1.9
Bermuda B Rating	2.1	2.1	2.1	2.4	2.6	2.9	3	2.8	3	3	2.9	2.9	2.7	2.6	2.4	2.3	2.3	2.4	2	1.9	1.9	2	2
buffalo A ratings	1.9	1.9	1.7	1.6	1.8	2.1	2.1	2.1	2.1	2.1	2.1	2.3	2.1	2	2.1	2	2	2	1.9	1.9	1.9	1.9	1.9
buffalo B ratings	2	2	1.8	1.7	1.7	2	2.3	2.3	2.3	2.3	2.3	2	1.7	1.7	1.7	1.7	1.7	1.3	1.7	1.7	1.7	1.7	1.7
St. Augustine A Ra	1.5	1.6	1.8	1.9	1.9	1.9	1.9	1.8	1.9	2	2	1.9	1.8	1.8	1.8	2.2	1.9	1.9	1.7	1.7	1.8	1.7	1.6
St. Augustine B Ra	1.9	2	1.9	1.8	2.1	2.1	2.3	2	2.1	2.4	2.5	2.5	2.1	2.3	2	1.8	1.8	1.8	1.6	1.5	1.5	1.5	1.5
Zoysia A Ratings	2.2	2.2	1.9	1.7	2	2.3	2.3	2.3	2.4	2.7	2.6	2.5	2	2	2.1	2	2.2	2.2	1.8	2.2	2.2	2.2	2.2
Zoysia B Ratings	1.5	1.5	1.4	1.5	1.9	2	2.2	1.8	2.2	2.3	2.3	2.2	2.4	2.2	2.3	2.3	2.3	2	1.7	1.8	2	1.8	2

Table 7

LNAME	07/18/97	07/21/97	07/25/97	07/28/97	08/01/97	08/04/97	08/06/97	08/11/97	08/13/97	08/18/97	08/19/97	08/25/97	09/01/97	09/08/97	09/15/97	09/22/97	09/29/97	10/06/97	10/13/97	10/20/97	10/27/97	11/03/97	11/10/97
Bermuda A 100% Replacement	2.00	2.00	2.25	2.25	2.13	2.00	2.00	2.00	2.13	2.25	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.75	1.50	1.50	1.75	1.75
Bermuda Deficit Replacement	1.33	1.33	1.50	1.67	2.00	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.50	2.67	2.33	2.00	2.00	2.00	2.00	2.00	2.00
Buffalo A 100% Replacement	1.33	1.33	1.33	1.33	1.50	1.67	1.67	1.67	1.83	2.00	2.00	2.33	2.00	1.67	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Buffalo A Deficit Replacement	2.25	2.25	2.00	1.75	2.00	2.50	2.50	2.50	2.38	2.25	2.25	2.25	2.25	2.25	2.25	2.00	2.00	2.00	1.75	1.75	1.75	1.75	1.75
St. Augustine A 100% Replacement	1.50	1.75	1.63	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.75	1.75	2.38	2.00	2.13	1.63	1.75	1.75	1.75	1.50
St. Augustine A Deficit Replacement	1.50	1.50	1.83	2.17	2.08	2.17	2.08	2.00	2.08	2.33	2.25	2.17	2.00	1.83	1.83	2.00	1.83	1.67	1.67	1.67	1.83	1.67	1.67
Zoysia A 100% Replace	1.50	1.50	1.50	1.50	1.75	2.00	2.00	2.00	2.00	2.50	2.50	2.50	1.50	1.50	1.75	1.50	2.00	2.00	1.50	2.00	1.50	2.00	1.50
Zoysia A Deficit Replace	2.50	2.50	2.13	1.75	2.13	2.50	2.50	2.50	2.63	2.75	2.63	2.50	2.25	2.25	2.25	2.25	2.25	2.25	2.00	2.25	2.50	2.25	2.25

Table 8.

LNAME	07/18/97	07/21/97	07/25/97	07/28/97	08/01/97	08/04/97	08/06/97	08/11/97	08/13/97	08/18/97	08/19/97	08/25/97	09/01/97	09/08/97	09/15/97	09/22/97	09/29/97	10/06/97	10/13/97	10/20/97	10/27/97	11/03/97	11/10/97
Bermuda B 100%	2.33	2.33	2.33	2.33	2.50	3.00	3.00	3.17	3.33	3.00	3.00	3.00	3.00	2.67	2.67	2.33	2.67	2.67	2.33	2.00	2.00	2.00	2.00
Bermuda B Deficit	2.00	2.00	2.00	2.50	2.75	2.75	3.00	2.50	2.75	3.00	2.75	2.75	2.50	2.50	2.25	2.25	2.00	2.25	1.75	1.75	1.75	2.00	2.00
Buffalo B Deficit	2.00	2.00	1.83	1.67	1.67	2.00	2.33	2.33	2.33	2.33	2.33	2.00	1.67	1.67	1.67	1.67	1.67	1.33	1.67	1.67	1.67	1.67	1.67
St. Augustine 100%	1.75	1.75	1.75	2.00	2.00	2.00	2.00	2.00	2.00	2.25	2.25	2.75	2.00	2.00	1.75	1.50	1.75	1.50	1.50	1.50	1.50	1.50	1.50
St. Augustine B Deficit	2.00	2.25	2.00	1.50	2.25	2.25	2.50	2.00	2.25	2.50	2.75	2.25	2.13	2.50	2.25	2.00	1.75	2.00	1.75	1.50	1.50	1.50	1.50
Zoysia B 100%	1.33	1.33	1.17	1.33	2.00	1.67	2.00	1.67	2.00	2.33	2.33	2.33	2.83	2.67	2.83	2.67	2.67	2.33	1.67	2.00	2.33	2.00	2.07
Zoysia B Deficit	1.67	1.67	1.67	1.67	1.83	2.33	2.33	2.00	2.33	2.33	2.33	2.00	2.00	1.67	1.67	2.00	2.00	1.67	1.67	1.67	1.67	1.50	1.89

Table 8.

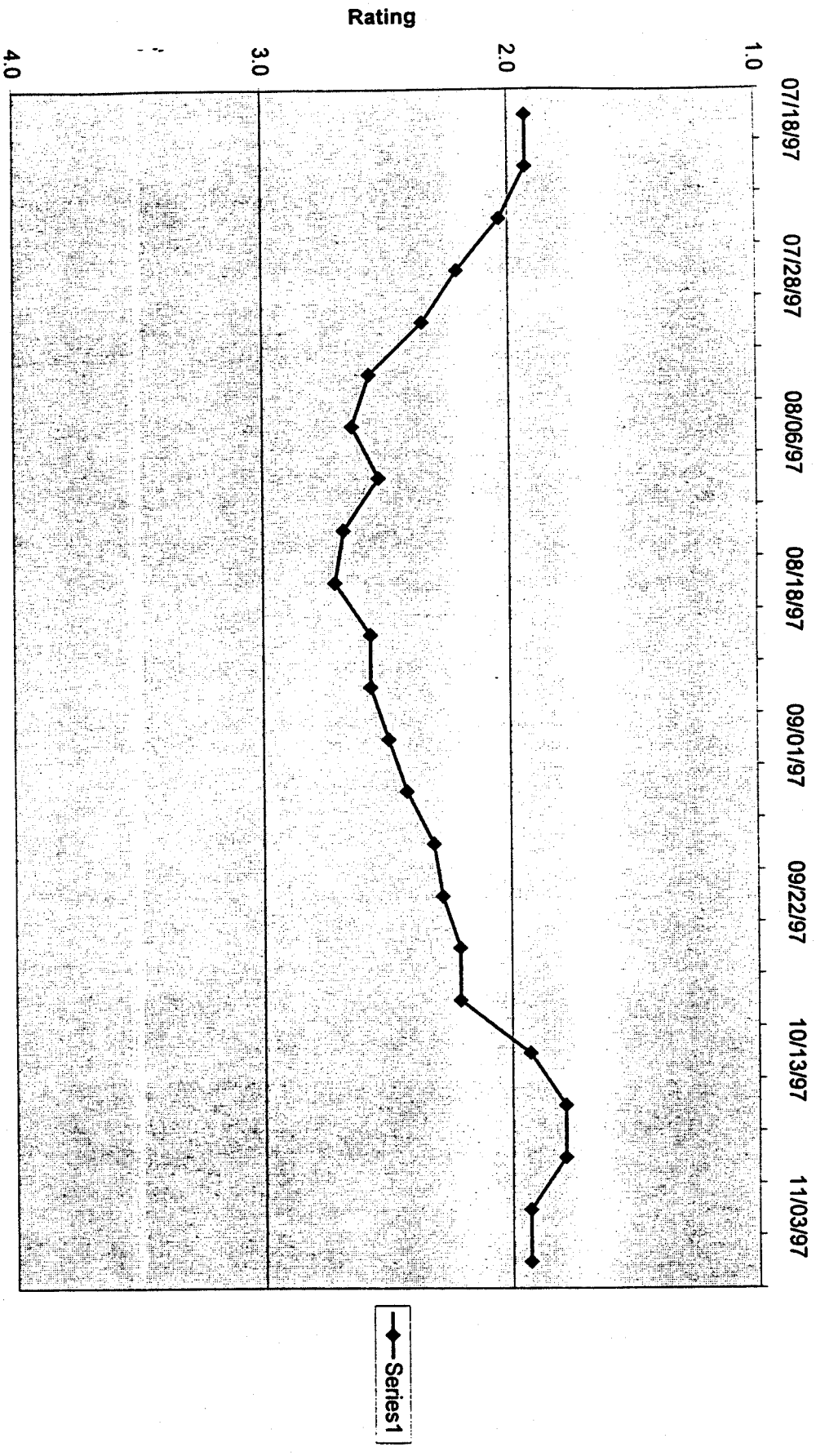
LNAME	07/18/97	07/21/97	07/25/97	07/28/97	08/01/97	08/04/97	08/06/97	08/11/97	08/13/97	08/18/97	08/19/97	08/25/97	09/01/97	09/08/97	09/15/97	09/22/97	09/29/97	10/06/97	10/13/97	10/20/97	10/27/97	11/03/97	11/10/97
Bermuda B 100%	2.33	2.33	2.33	2.33	2.50	3.00	3.00	3.17	3.33	3.00	3.00	3.00	3.00	2.67	2.67	2.33	2.67	2.67	2.33	2.00	2.00	2.00	2.00
Bermuda B Deficit	2.00	2.00	2.00	2.50	2.75	2.75	3.00	2.50	2.75	3.00	2.75	2.75	2.50	2.50	2.25	2.25	2.00	2.25	1.75	1.75	1.75	2.00	2.00
Buffalo B Deficit	2.00	2.00	1.83	1.67	1.67	2.00	2.33	2.33	2.33	2.33	2.33	2.00	1.67	1.67	1.67	1.67	1.67	1.33	1.67	1.67	1.67	1.67	1.67
St. Augustine 100%	1.75	1.75	1.75	2.00	2.00	2.00	2.00	2.00	2.00	2.25	2.25	2.75	2.00	2.00	1.75	1.50	1.75	1.50	1.50	1.50	1.50	1.50	1.50
St. Augustine B Deficit	2.00	2.25	2.00	1.50	2.25	2.25	2.50	2.00	2.25	2.50	2.75	2.25	2.13	2.50	2.25	2.00	1.75	2.00	1.75	1.50	1.50	1.50	1.50
Zoysia B 100%	1.33	1.33	1.17	1.33	2.00	1.67	2.00	1.67	2.00	2.33	2.33	2.33	2.83	2.67	2.83	2.67	2.67	2.33	1.67	2.00	2.33	2.00	2.07
Zoysia B Deficit	1.67	1.67	1.67	1.67	1.83	2.33	2.33	2.00	2.33	2.33	2.33	2.00	2.00	1.67	1.67	2.00	2.00	1.67	1.67	1.67	1.67	1.50	1.89

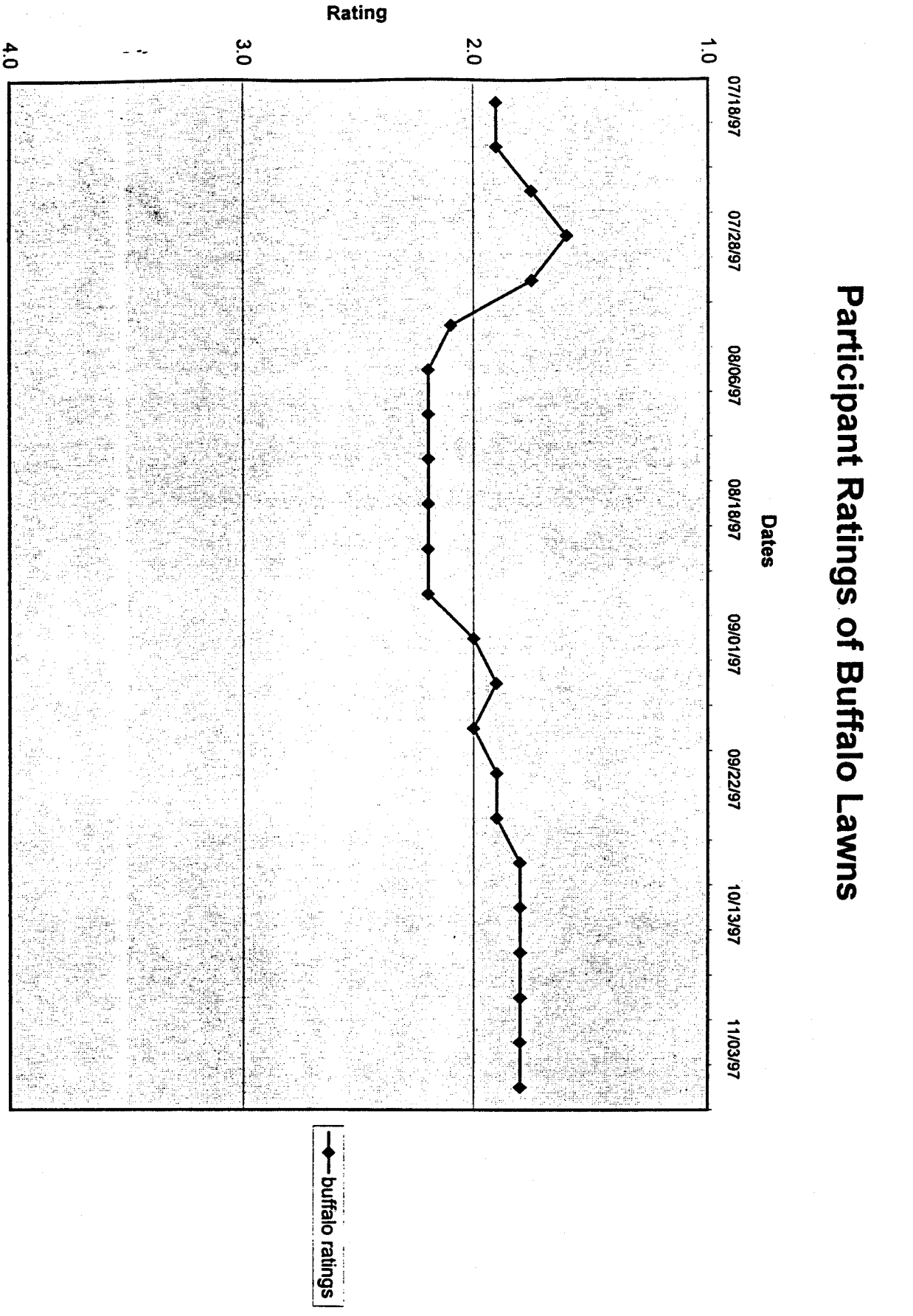
Table 9.

	First Name	Last Name	Protocol	Treatment	Turf Type	1 - last summer	2 - 1996 lawn rating	3 - water due to protocol	4 - refrained from watering due to protocol	5 - 1997 water usage vs 1996	6 - Understanding	7.- Making time	8 - Actually applying the water according to instructions	9 - Rating the Lawn	10 - Sending in data sheets	11 - Recommend ET	12 - Which protocol do you prefer	13 - Day of week preferred	14 - Phone Line effectiveness	Soil Depth
1	Bexar County	Center	A	100	Bermuda	3.00	3.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00	3.00	1.00	3.00
2	The	Dominion	A	100	Bermuda	1.00	1.00	2.00	3.00	2.00	1.00	2.00	3.00	1.00	2.00	1.00	1.00	2.00	2.00	6.00
3	Karen	Guz	A	100	Bermuda	3.00	3.00	3.00	0.00	2.00	1.00	2.00	2.00	1.00	2.00	1.00	1.00	7.00	1.00	6.00
4	Cecil	Mayo	A	100	Bermuda	1.00	3.00	1.00	1.00	2.00	1.00	1.00	2.00	2.00	1.00	1.00	1.00	8.00	1.00	3.50
5	Irene	Mechler	A	100	Bermuda	1.00	1.00			1.00	1.00	1.00	3.00	2.00	1.00	1.00	1.00	2.00	1.00	7.00
6	Joe	Taylor	A	100	Bermuda	3.00	3.00	1.00		1.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	2.00	1.00	
7	The	Dominion	A	deficit	Bermuda	1.00	1.00	2.00	3.00	2.00	1.00	2.00	3.00	1.00	2.00	1.00	1.00	2.00	2.00	6.00
8	Wayman	Marshall	A	deficit	Bermuda	3.00	4.00	1.00	2.00	2.00	1.00	2.00	1.00	2.00	1.00	1.00	1.00	3.00	1.00	1.50
9	Sonia	Ricks	A	deficit	Bermuda	2.00	3.00	1.00	2.00	2.00	1.00	2.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	4.00
10	Jarvis	Brown	B	100	Bermuda	3.00	1.00	1.00	2.00	2.00	1.00	2.00	1.00	2.00	1.00	1.00	2.00	2.00	1.00	6.00
11	The	Dominion	B	100	Bermuda	1.00	1.00	2.00	3.00	2.00	1.00	2.00	3.00	1.00	2.00	1.00	1.00	2.00	2.00	6.00
12	Calvin	Finch	B	100	Bermuda	2.00	3.00	1.00	2.00	3.00	2.00	2.00	1.00	1.00	2.00	1.00	1.00	2.00	2.00	
13	Ann	Stephens	B	100	Bermuda	1.00	2.00	1.00		2.00	1.00	2.00	2.00							6.00
14	The	Dominion	B	deficit	Bermuda	1.00	1.00	2.00	3.00	2.00	1.00	2.00	3.00	1.00	2.00	1.00	1.00	2.00	2.00	6.00
15	Donald	MacCauley	B	deficit	Bermuda	2.00	3.00	2.00	3.00		3.00	3.00	1.00	2.00	1.00	1.00	2.00		3.00	3.00
16	Phillip	Marshall	B	deficit	Bermuda	2.00	2.00	2.00		1.00	4.00	2.00	2.00	4.00	4.00	1.00	1.00	8.00	2.00	7.00
17	Bob	Paullin	B	deficit	Bermuda	1.00	3.00	1.00	2.00	2.00	1.00	2.00	1.00	1.00	2.00	1.00	2.00	2.00	3.00	5.00
18	Rosa	Rendon	B	deficit	Bermuda	3.00	4.00	1.00		1.00	1.00	2.00	2.00	2.00	3.00	1.00	1.00	5.00	1.00	8.00
19	Debbie	Byrd	A	100	Buffalo	3.00	1.00	0.00	0.00	3.00	1.00			2.00	1.00	2.00	1.00	1.00	2.00	6.00
20	Betty	DePhillips	A	100	Buffalo	3.00	2.00	2.00		1.00	1.00	3.00	3.00							3.50
21	Anita	Franklin	A	100	Buffalo	1.00	2.00	1.00	1.00	2.00	1.00	1.00	1.00	1.00	3.00	1.00	1.00	7.00	1.00	3.50
22	Dennis	Fortassin	A	deficit	Buffalo	3.00	4.00	2.00	1.00	1.00	3.00	1.00	1.00	1.00	2.00		1.00	2.00	3.00	36.00
23	Robert	MacAnelly	A	deficit	Buffalo	3.00	3.00	3.00	1.00	1.00	1.00	4.00	1.00							48.00
24	Tina & Roy	Sawyer	B	70	Buffalo	2.00	3.00	1.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	1.00	1.00	1.00	1.00	3.00
25	Charles	Bartlett	B	deficit	Buffalo	3.00	4.00	3.00	1.00	1.00	1.00	3.00	1.00	1.00	3.00	1.00	2.00	8.00	1.00	100.00
26	Tina	Coralla	B	deficit	Buffalo															3.00
27	Stephen	Wilhelm	B	deficit	Buffalo			3.00	1.00		1.00	3.00	2.00	2.00						4.00
28	Cleon	Warren	A	70	St. Augustine	1.00	1.00	1.00	3.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	72.00
29	Leslie	Brandt	A	100	St. Augustine	1.00	1.00	1.00	2.00	3.00	1.00	0.00	2.00	4.00	3.00	1.00	2.00	2.00	2.00	6.00
30	Shannon	Brennand	A	100	St. Augustine	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	2.00	2.00	1.00	2.00	8.00	1.00	3.50

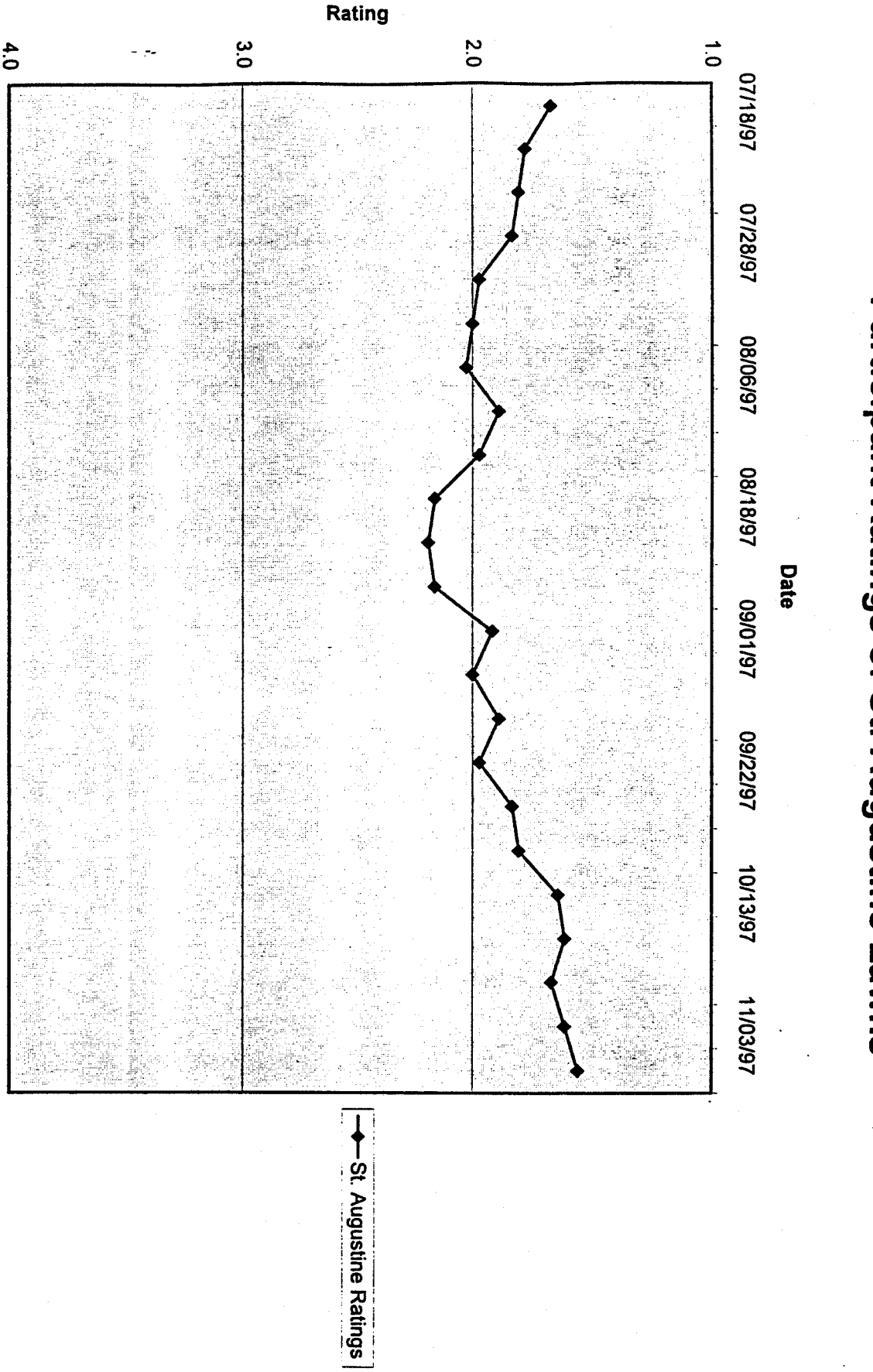
31	Metta	Miller	A	100	St. Augustine	2.00	4.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	9.00
32	Dorothy	Mote	A	100	St. Augustine	1.00	1.00	2.00		2.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00	2.50
33	Frank	Dickson	A	deficit	St. Augustine	1.00	4.00	1.00	3.00	2.00	2.00	3.00	2.00	3.00	4.00	1.00	2.00			5.00
34	Kenneth	Hovis	A	deficit	St. Augustine	2.00	3.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	1.00	1.00		2.00	3.00
35	Phillip	Marshall	A	deficit	St. Augustine	2.00	2.00	2.00		1.00	4.00	2.00	2.00	4.00	4.00	1.00	1.00	8.00	2.00	7.00
36	Alberto	Santos	A	deficit	St. Augustine															3.00
37	Millie	Brewer	B	100	St. Augustine	1.00	2.00	0.00	0.00	3.00	2.00	3.00	2.00	1.00	2.00	1.00	1.00	7.00	3.00	2.50
38	Carrie	Hammer	B	100	St. Augustine															3.00
39	Michael	Jobe	B	100	St. Augustine															5.00
40	Sir Oliver	Smith	B	100	St. Augustine	2.00	3.00	2.00	2.00		3.00	3.00	2.00	1.00	4.00	2.00	1.00	7.00	3.00	4.50
41	Victor	Mendez	B	deficit	St. Augustine															6.50
42	Renate	Meyer	B	deficit	St. Augustine	2.00	4.00	2.00	1.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00	3.00	1.00	6.00
43	Rosa	Rendon	B	deficit	St. Augustine	3.00	4.00	1.00		1.00	1.00	2.00	2.00	2.00	3.00	1.00	1.00	5.00	1.00	8.00
44	Wilbur	Waljle	B	deficit	St. Augustine	2.00	3.00	1.00	2.00	2.00	2.00	3.00	4.00	1.00	1.00	1.00				4.00
45	Ruth Anne	Hubert	A	100	Zoysia	3.00	4.00	2.00	2.00	1.00	1.00	3.00	2.00	2.00	1.00	1.00	1.00	2.00	2.00	5.00
46	Neil	Krasnoff	A	100	Zoysia	3.00	4.00	2.00	0.00	3.00	2.00	3.00	3.00	2.00	2.00	1.00	1.00	1.00	1.00	5.00
47	David	Cahill	A	deficit	Zoysia	2.00	2.00	1.00	2.00		1.00	3.00	2.00	2.00	5.00	1.00	1.00	3.00		5.00
48	Karen	Guz	A	deficit	Zoysia	3.00	3.00	3.00	0.00	2.00	1.00	2.00	2.00	1.00	2.00	1.00	1.00	7.00	1.00	6.00
49	Bob	Lozano	A	deficit	Zoysia	1.00	4.00	2.00	2.00	1.00	2.00	3.00	3.00	3.00	3.00	2.00	1.00	8.00	2.00	2.00
50	Loris	Perkins	A	deficit	Zoysia	2.00	3.00	1.00	1.00	2.00	2.00	3.00	3.00	3.00	2.00	1.00	2.00	2.00	1.00	4.50
51	Robert	Alton	B	100	Zoysia	1.00	2.00	3.00	1.00	1.00	2.00	1.00	2.00	3.00	2.00	1.00	2.00		3.00	9.00
52	Frank	Lucio	B	100	Zoysia	2.00	2.00			1.00	1.00	1.00	2.00	1.00	1.00	1.00	2.00		1.00	6.00
53	Mike	Rega	B	100	Zoysia	2.00	3.00	2.00		1.00	5.00	4.00	5.00	4.00	3.00	1.00	2.00		1.00	7.00
54	Allen	Crites	B	deficit	Zoysia	1.00	2.00	1.00	2.00	2.00	1.00	2.00	2.00	1.00	1.00	1.00	2.00		2.00	4.00
55	Rissa	Schultz	B	deficit	Zoysia						1.00	3.00	3.00	2.00	1.00	1.00	1.00	8.00	3.00	5.00
56	Joe	Taylor	B	deficit	Zoysia				4.00	1.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	2.00	1.00	
						1.94	2.56	1.60	1.67	1.72	1.55	2.10	1.98	1.81	2.00	1.09	1.28	3.85	1.66	9.43

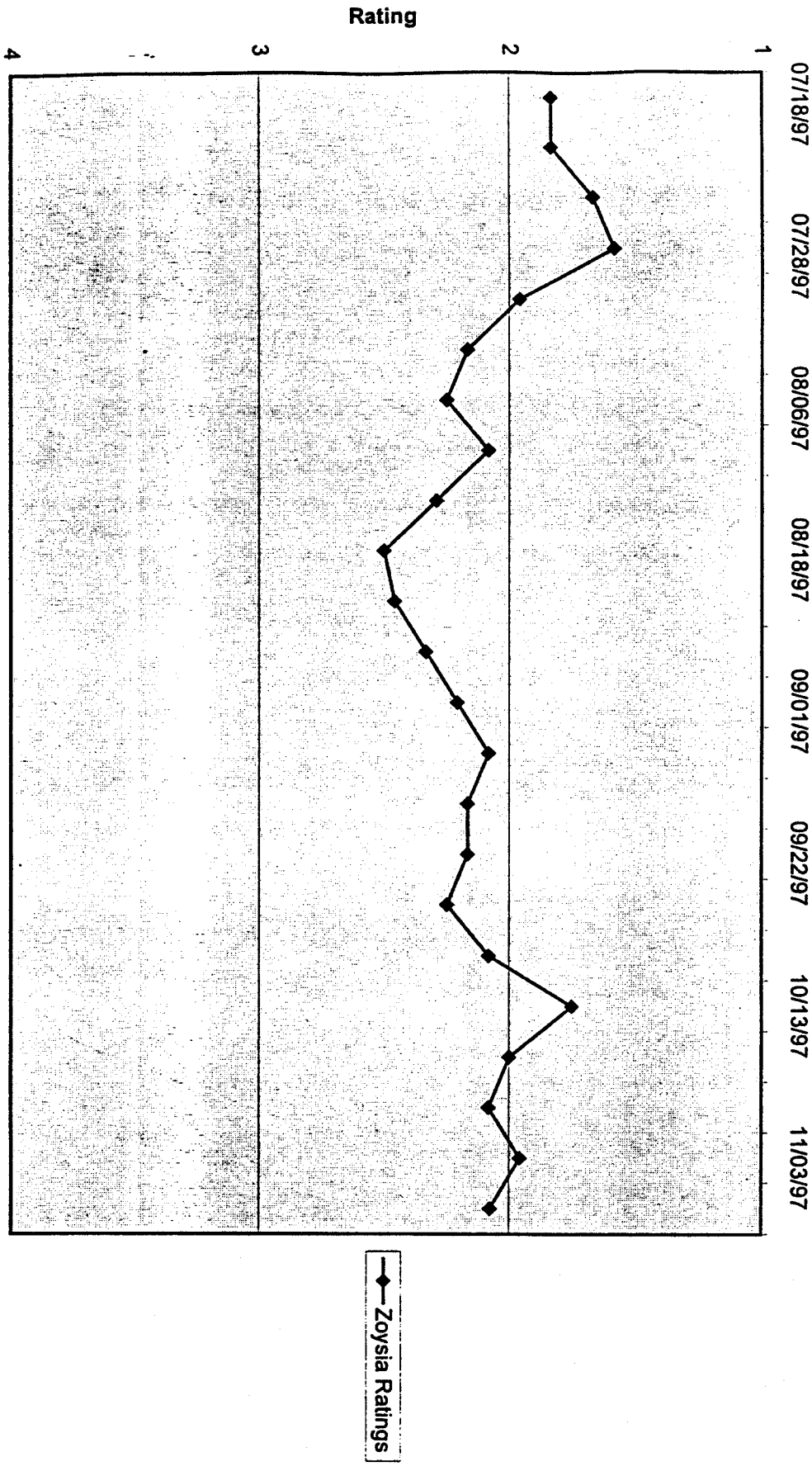
31	Metta	Miller	A	100	St. Augustine	2.00	4.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	9.00
32	Dorothy	Mote	A	100	St. Augustine	1.00	1.00	2.00		2.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00	2.50
33	Frank	Dickson	A	deficit	St. Augustine	1.00	4.00	1.00	3.00	2.00	2.00	3.00	2.00	3.00	4.00	1.00	2.00			5.00
34	Kenneth	Hovis	A	deficit	St. Augustine	2.00	3.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	1.00	1.00		2.00	3.00
35	Phillip	Marshall	A	deficit	St. Augustine	2.00	2.00	2.00		1.00	4.00	2.00	2.00	4.00	4.00	1.00	1.00	8.00	2.00	7.00
36	Alberto	Santos	A	deficit	St. Augustine															3.00
37	Millie	Brewer	B	100	St. Augustine	1.00	2.00	0.00	0.00	3.00	2.00	3.00	2.00	1.00	2.00	1.00	1.00	7.00	3.00	2.50
38	Carrie	Hammer	B	100	St. Augustine															3.00
39	Michael	Jobe	B	100	St. Augustine															5.00
40	Sir Oliver	Smith	B	100	St. Augustine	2.00	3.00	2.00	2.00		3.00	3.00	2.00	1.00	4.00	2.00	1.00	7.00	3.00	4.50
41	Victor	Mendez	B	deficit	St. Augustine															6.50
42	Renate	Meyer	B	deficit	St. Augustine	2.00	4.00	2.00	1.00	2.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00	3.00	1.00	6.00
43	Rosa	Rendon	B	deficit	St. Augustine	3.00	4.00	1.00		1.00	1.00	2.00	2.00	2.00	3.00	1.00	1.00	5.00	1.00	8.00
44	Wilbur	Waljle	B	deficit	St. Augustine	2.00	3.00	1.00	2.00	2.00	2.00	3.00	4.00	1.00	1.00	1.00				4.00
45	Ruth Anne	Hubert	A	100	Zoysia	3.00	4.00	2.00	2.00	1.00	1.00	3.00	2.00	2.00	1.00	1.00	1.00	2.00	2.00	5.00
46	Neil	Krasnoff	A	100	Zoysia	3.00	4.00	2.00	0.00	3.00	2.00	3.00	3.00	2.00	2.00	1.00	1.00	1.00	1.00	5.00
47	David	Cahill	A	deficit	Zoysia	2.00	2.00	1.00	2.00		1.00	3.00	2.00	2.00	5.00	1.00	1.00	3.00		5.00
48	Karen	Guz	A	deficit	Zoysia	3.00	3.00	3.00	0.00	2.00	1.00	2.00	2.00	1.00	2.00	1.00	1.00	7.00	1.00	6.00
49	Bob	Lozano	A	deficit	Zoysia	1.00	4.00	2.00	2.00	1.00	2.00	3.00	3.00	3.00	3.00	2.00	1.00	8.00	2.00	2.00
50	Loris	Perkins	A	deficit	Zoysia	2.00	3.00	1.00	1.00	2.00	2.00	3.00	3.00	3.00	2.00	1.00	2.00	2.00	1.00	4.50
51	Robert	Alton	B	100	Zoysia	1.00	2.00	3.00	1.00	1.00	2.00	1.00	2.00	3.00	2.00	1.00	2.00		3.00	9.00
52	Frank	Lucio	B	100	Zoysia	2.00	2.00			1.00	1.00	1.00	2.00	1.00	1.00	1.00	2.00		1.00	6.00
53	Mike	Rega	B	100	Zoysia	2.00	3.00	2.00		1.00	5.00	4.00	5.00	4.00	3.00	1.00	2.00		1.00	7.00
54	Allen	Crites	B	deficit	Zoysia	1.00	2.00	1.00	2.00	2.00	1.00	2.00	2.00	1.00	1.00	1.00	2.00		2.00	4.00
55	Rissa	Schultz	B	deficit	Zoysia						1.00	3.00	3.00	2.00	1.00	1.00	1.00	8.00	3.00	5.00
56	Joe	Taylor	B	deficit	Zoysia				4.00	1.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	2.00	1.00	
						1.94	2.56	1.60	1.67	1.72	1.55	2.10	1.98	1.81	2.00	1.09	1.28	3.85	1.66	9.43

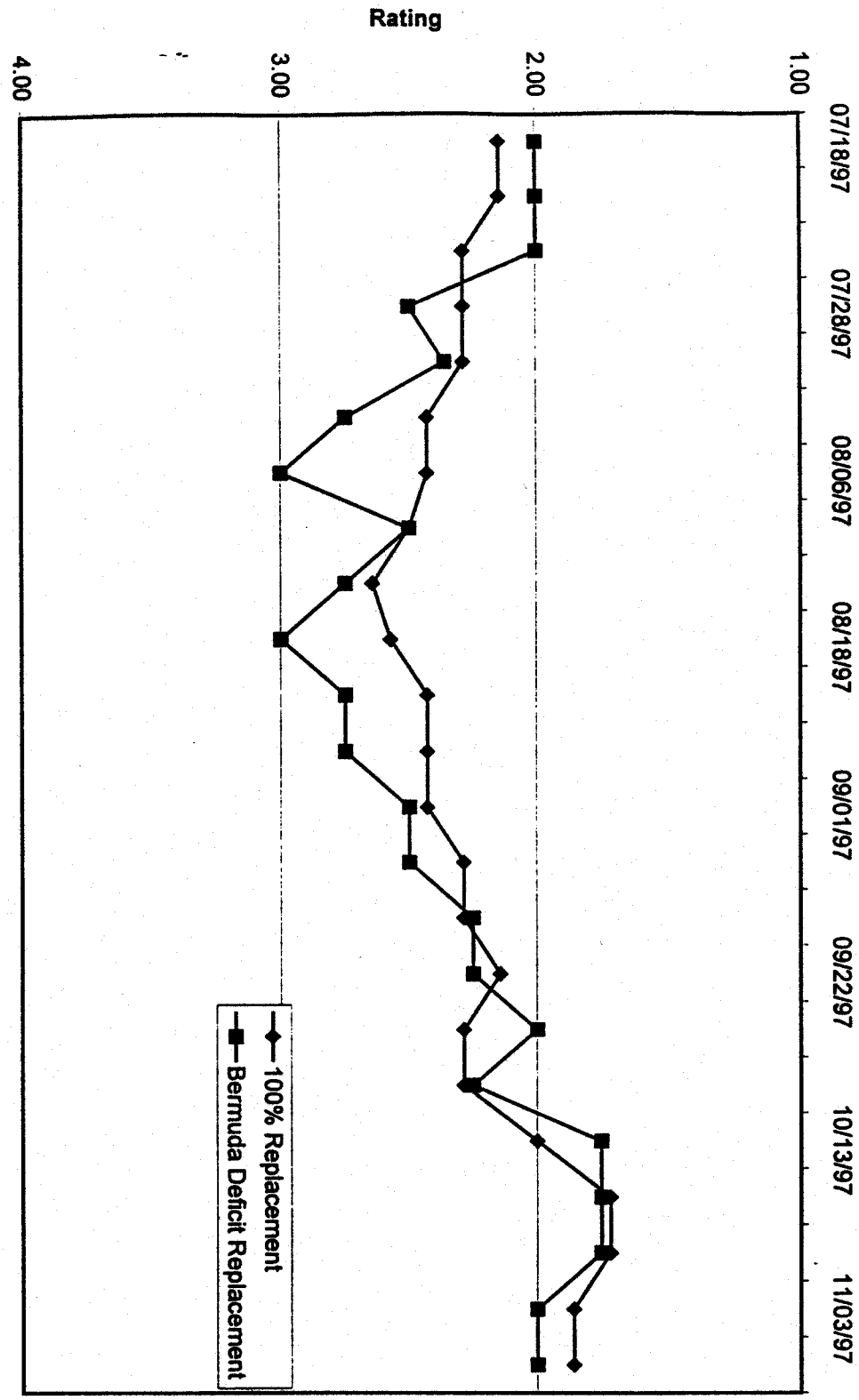

Participant Ratings of Bermuda Lawns
Rating
1.0
2.0
3.0
4.0
Date
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Series1

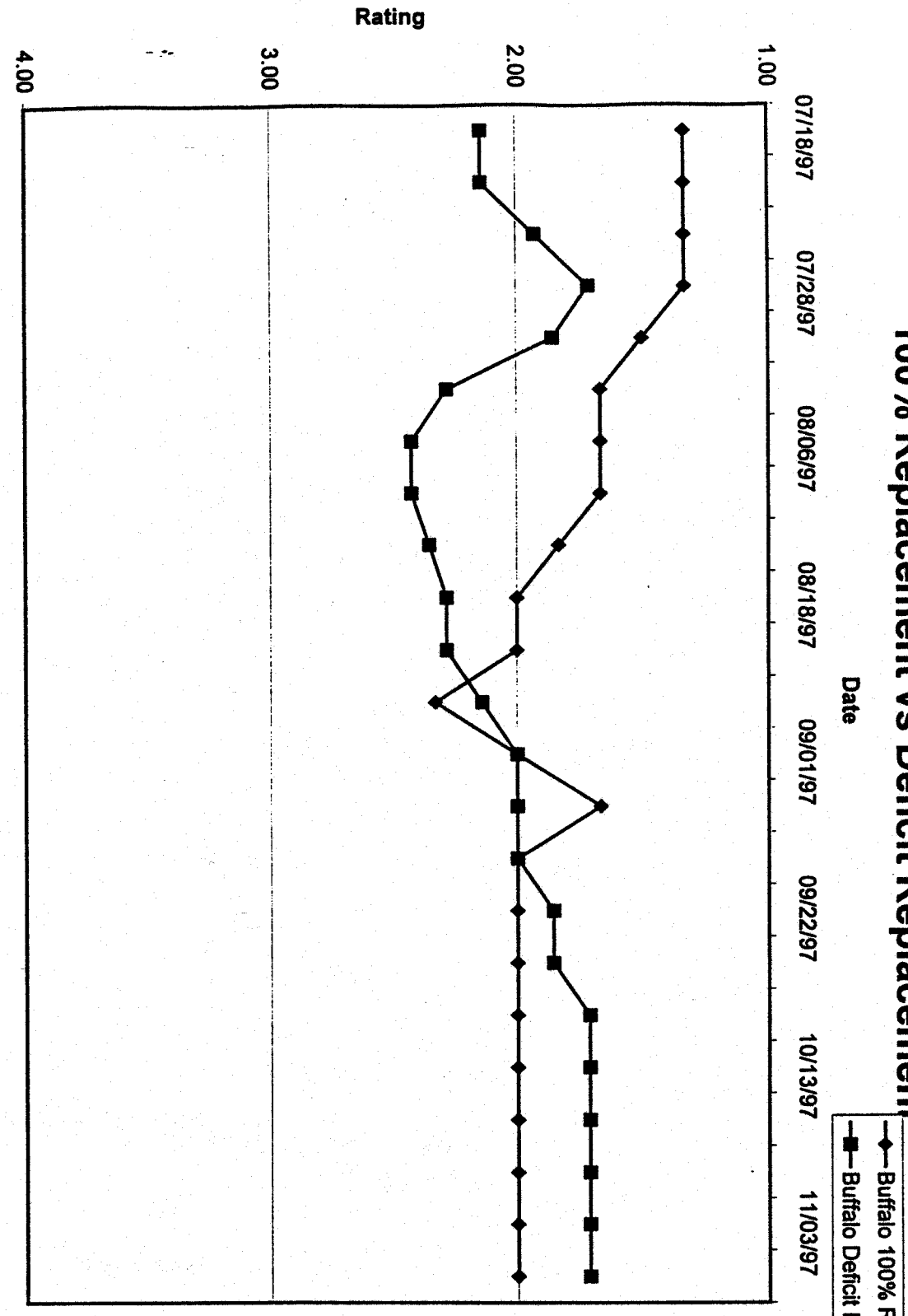

Participant Ratings of Buffalo Lawns
Rating
1.0
2.0
3.0
4.0
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Dates
buffalo ratings

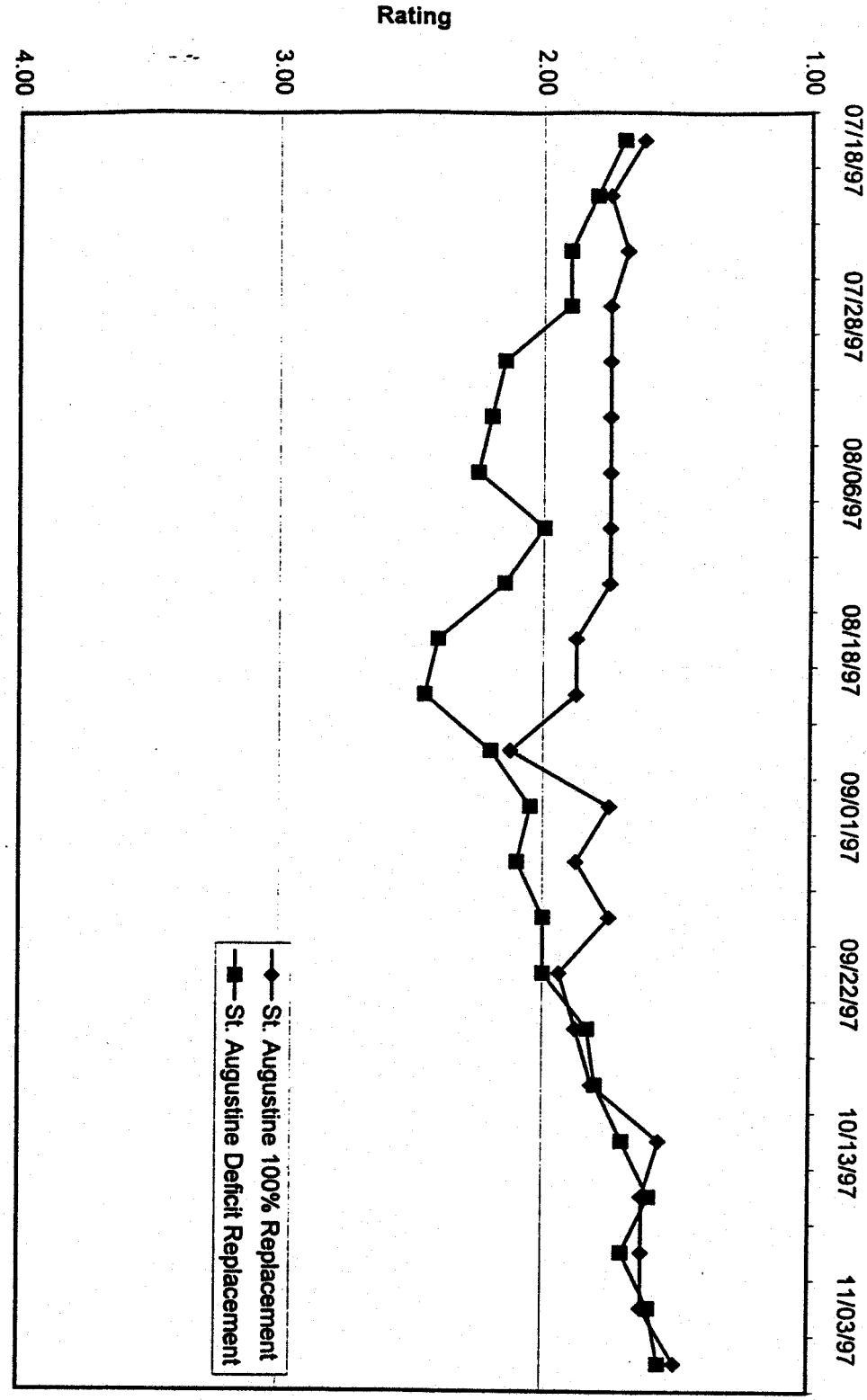
Participant Ratings of St. Augustine Lawns

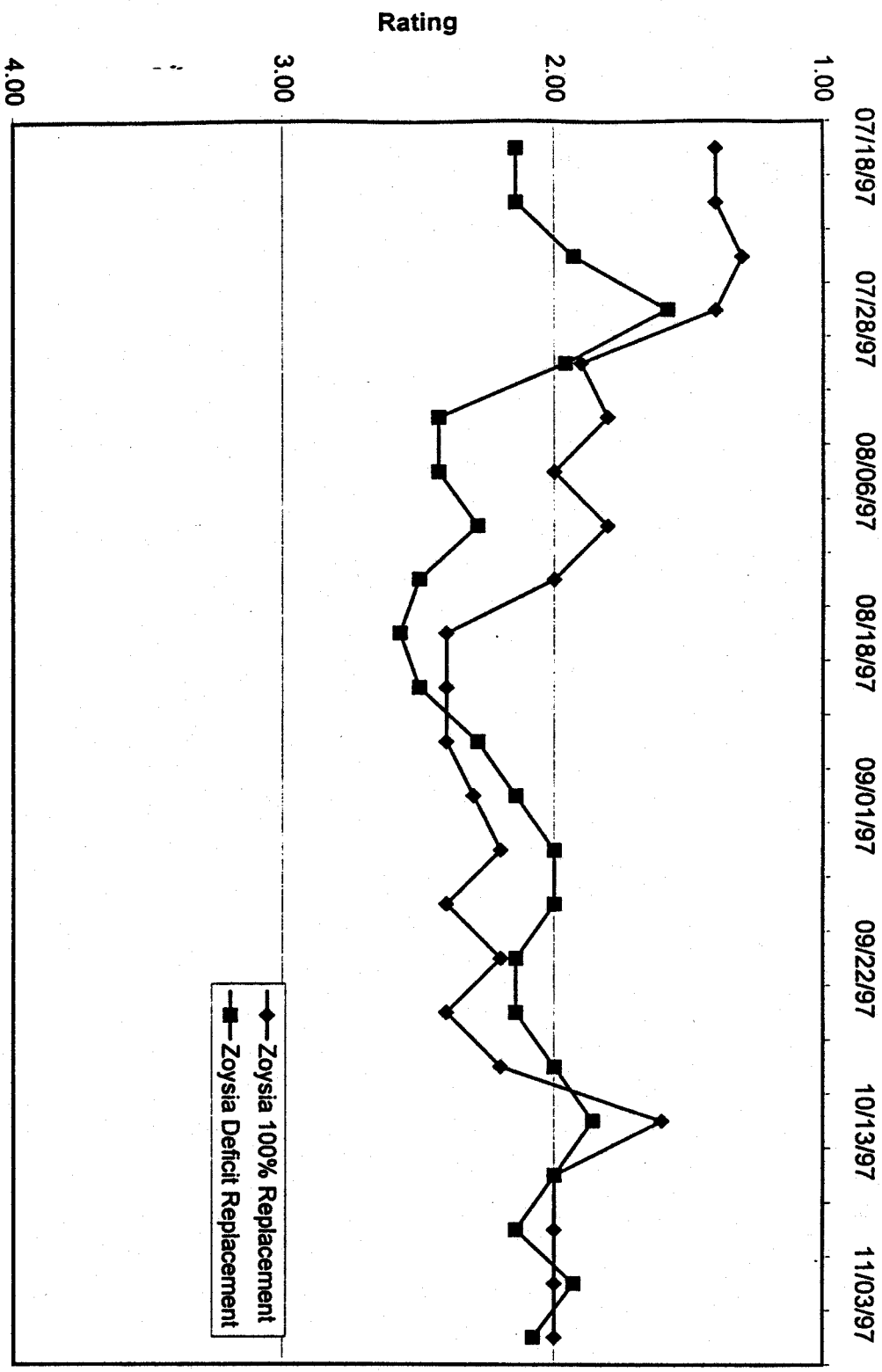


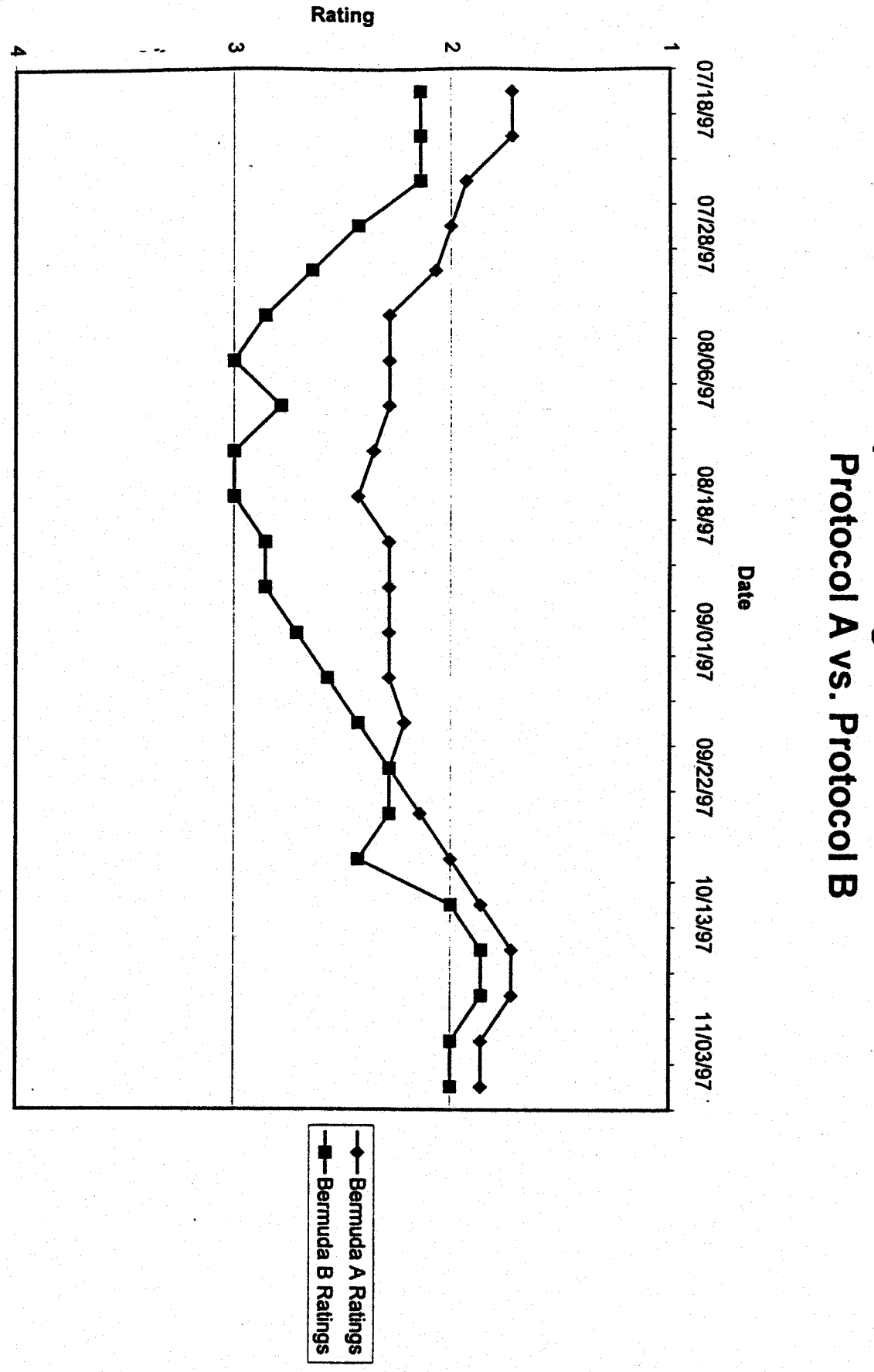

Participant Ratings of Zoysia Lawns
Rating
1
2
3
4
Date
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Zoysia Ratings

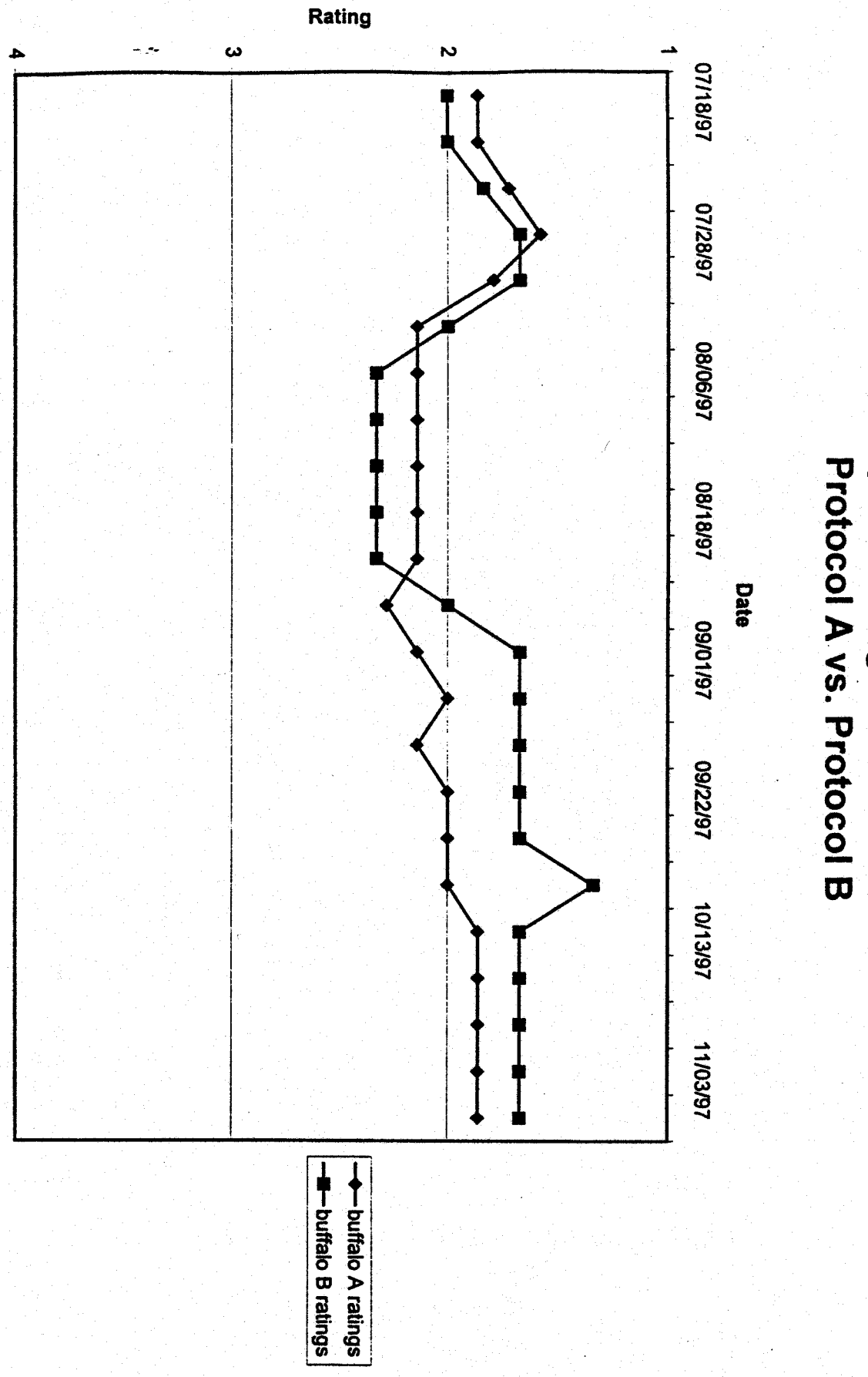

Participant Ratings of Bermuda Lawns
100% Replacement vs. Deficit Replacement
Rating
1.00
2.00
3.00
4.00
Date
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
100% Replacement
Bermuda Deficit Replacement

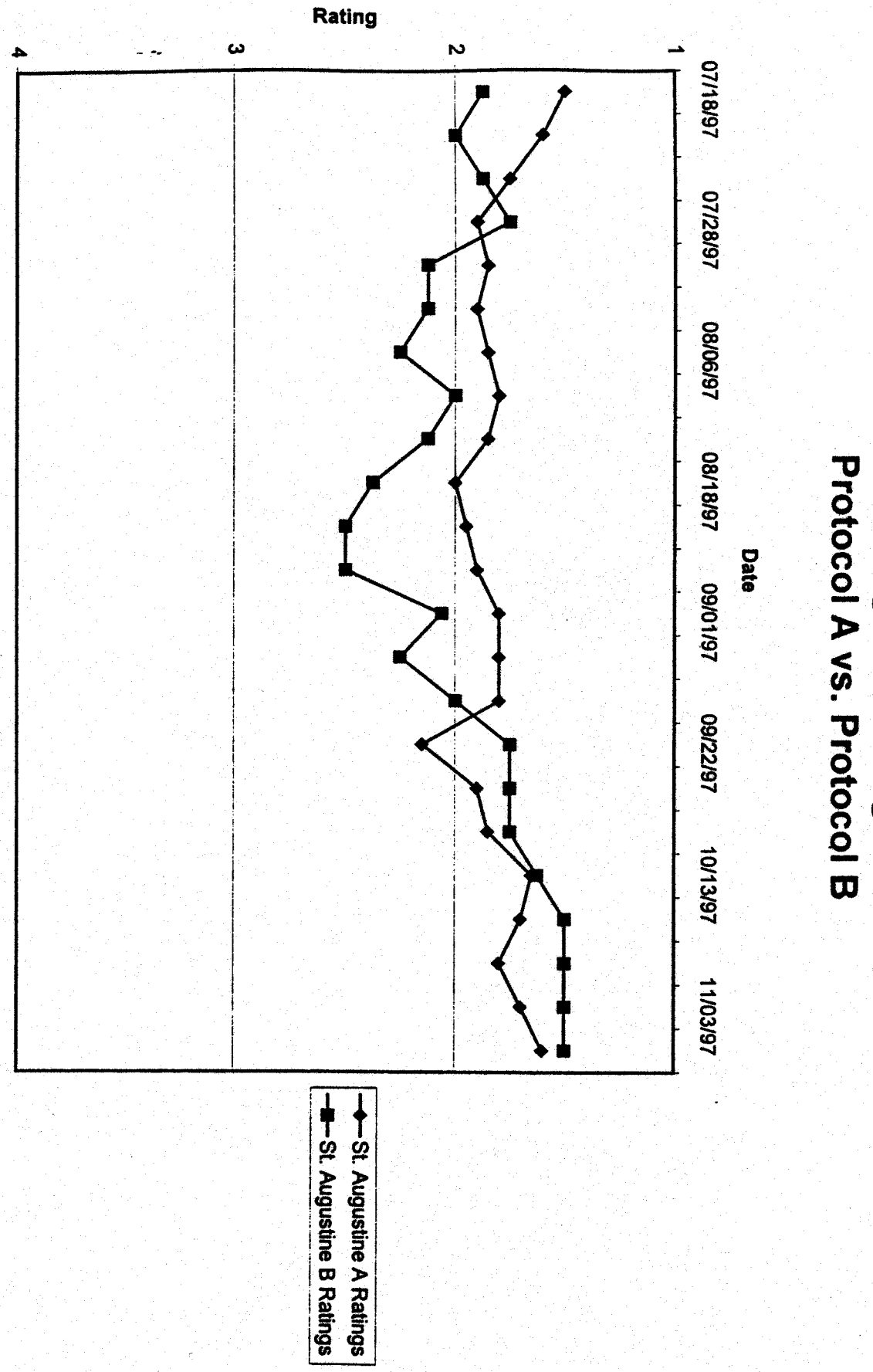

Participant Ratings of Buffalo Lawns
100% Replacement vs Deficit Replacement
Rating
1.00
2.00
3.00
4.00
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Date
Buffalo 100% Replacement
Buffalo Deficit Replacement


Participant Ratings of St. Augustine Lawns 100%
Replacement vs. Deficit Replacement
Rating
1.00
2.00
3.00
4.00
Date
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
St. Augustine 100% Replacement
St. Augustine Deficit Replacement

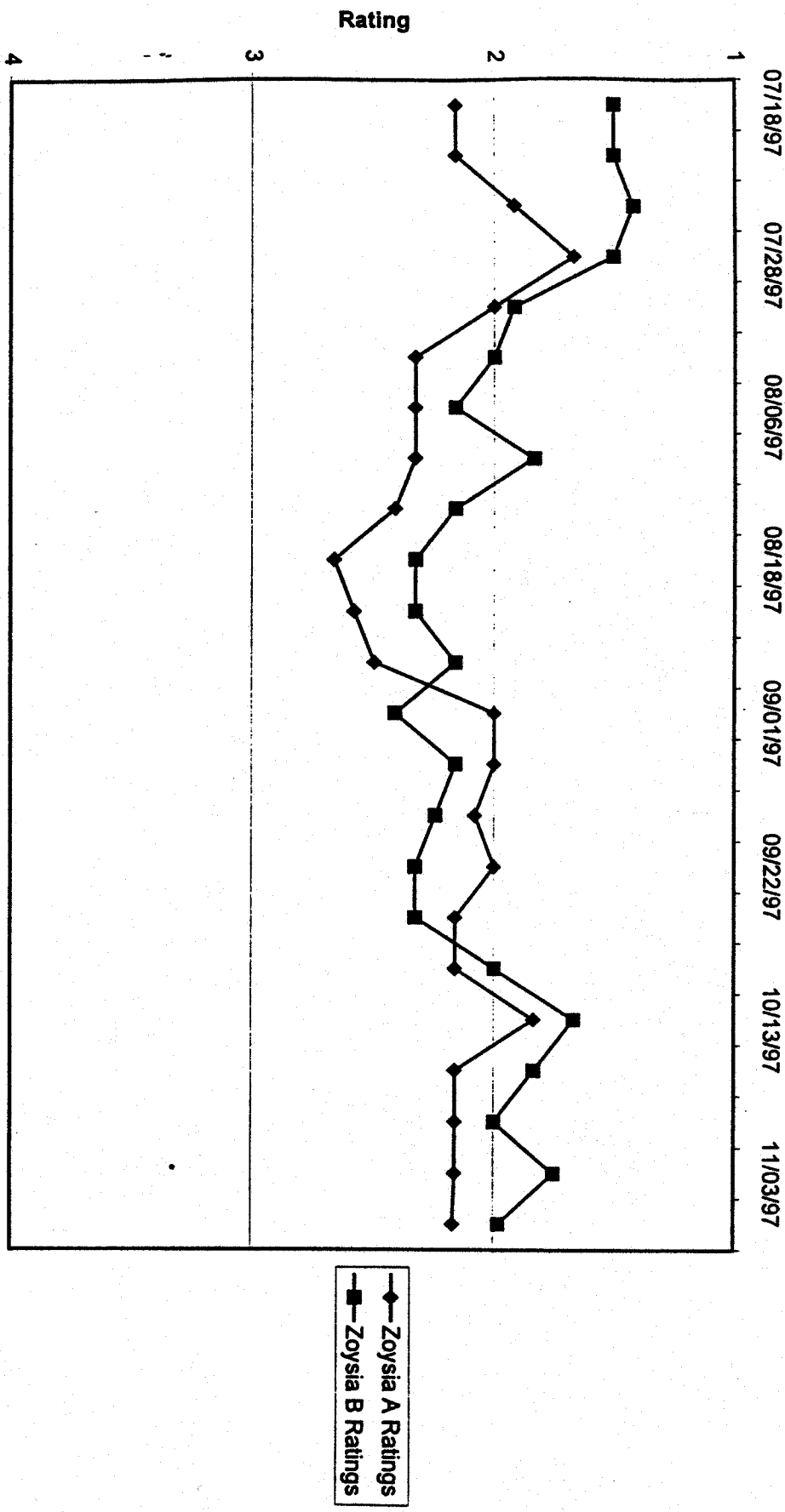

Participant Ratings of Zoysia Lawns
100% Replacement vs. Deficit Replacement
Rating
1.00
2.00
3.00
4.00
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Date
Zoysia 100% Replacement
Zoysia Deficit Replacement


Particpant Ratings of Bermuda Lawns
Protocol A vs. Protocol B
Rating
1
2
3
4
Date
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Bermuda A Ratings
Bermuda B Ratings

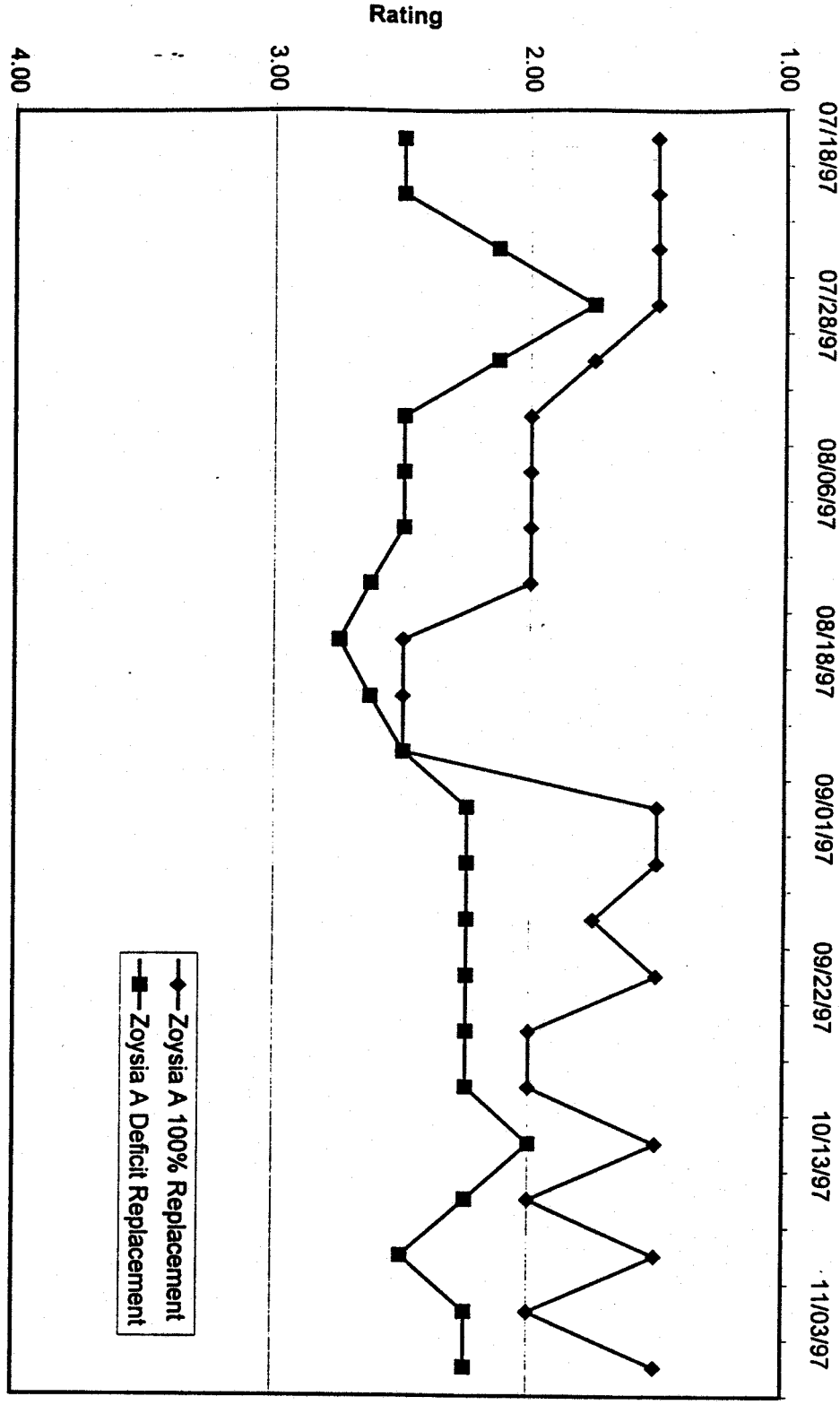

Participant Ratings of Buffalo Lawns
Protocol A vs. Protocol B
Rating
1
2
3
4
Date
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
buffalo A ratings
buffalo B ratings


Participant Ratings of St. Augustine Lawns
Protocol A vs. Protocol B
Rating
1
2
3
4
Date
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
St. Augustine A Ratings
St. Augustine B Ratings

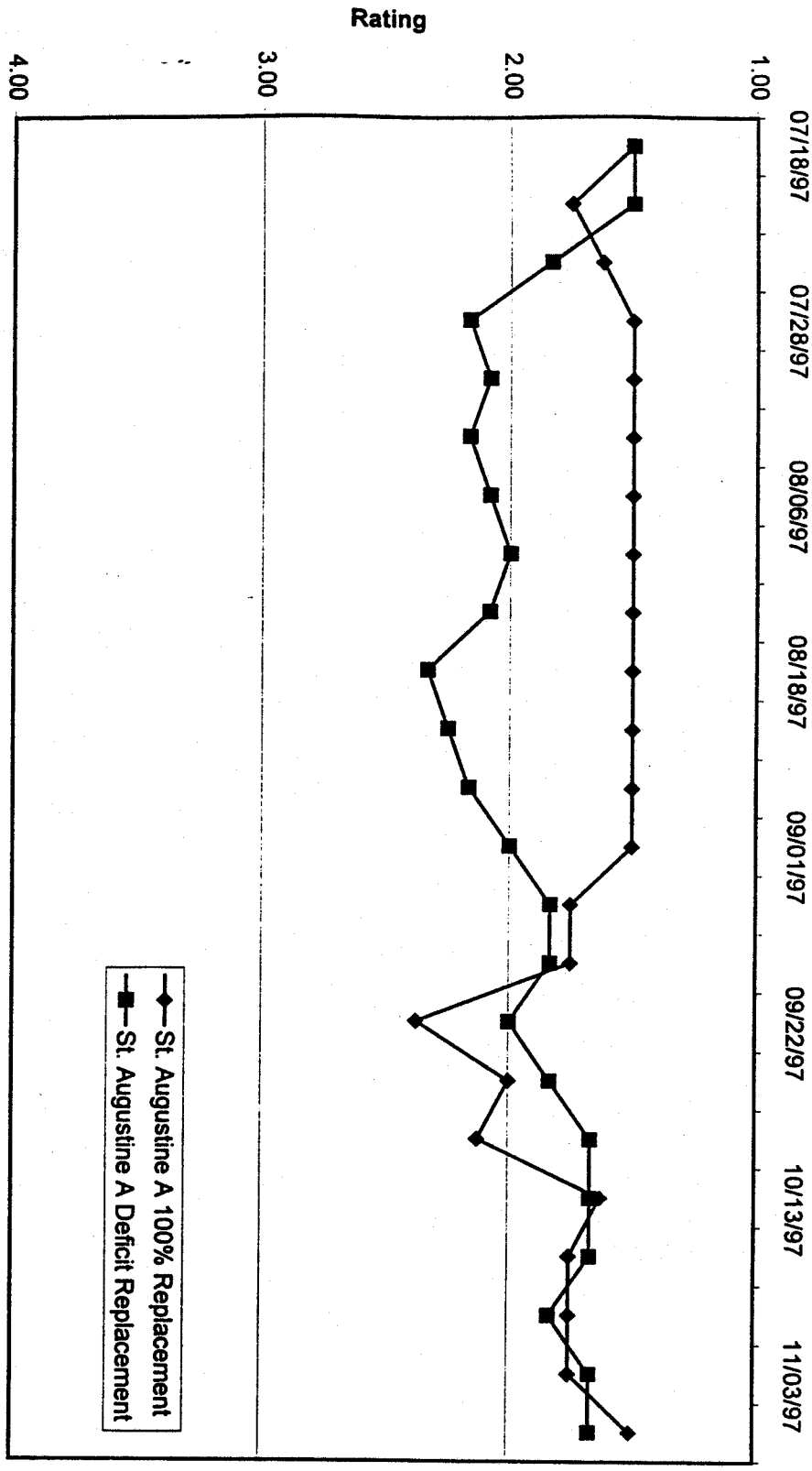
Participant Ratings of Zoysia Lawns
Protocol A vs. Protocol B

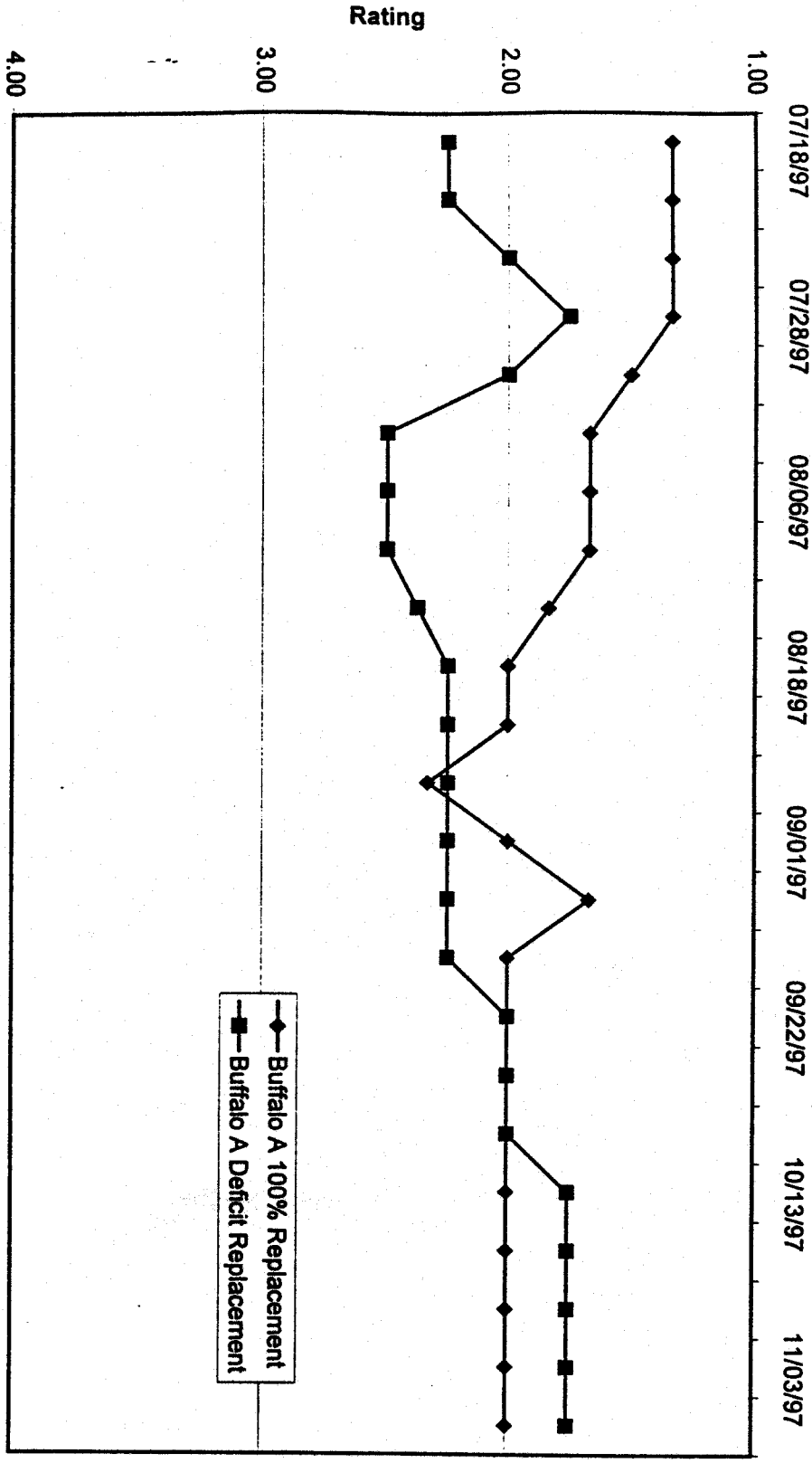


Participant Ratings of Zoysia Lawns Protocol A 100% Replacement vs. Deficit Replacement

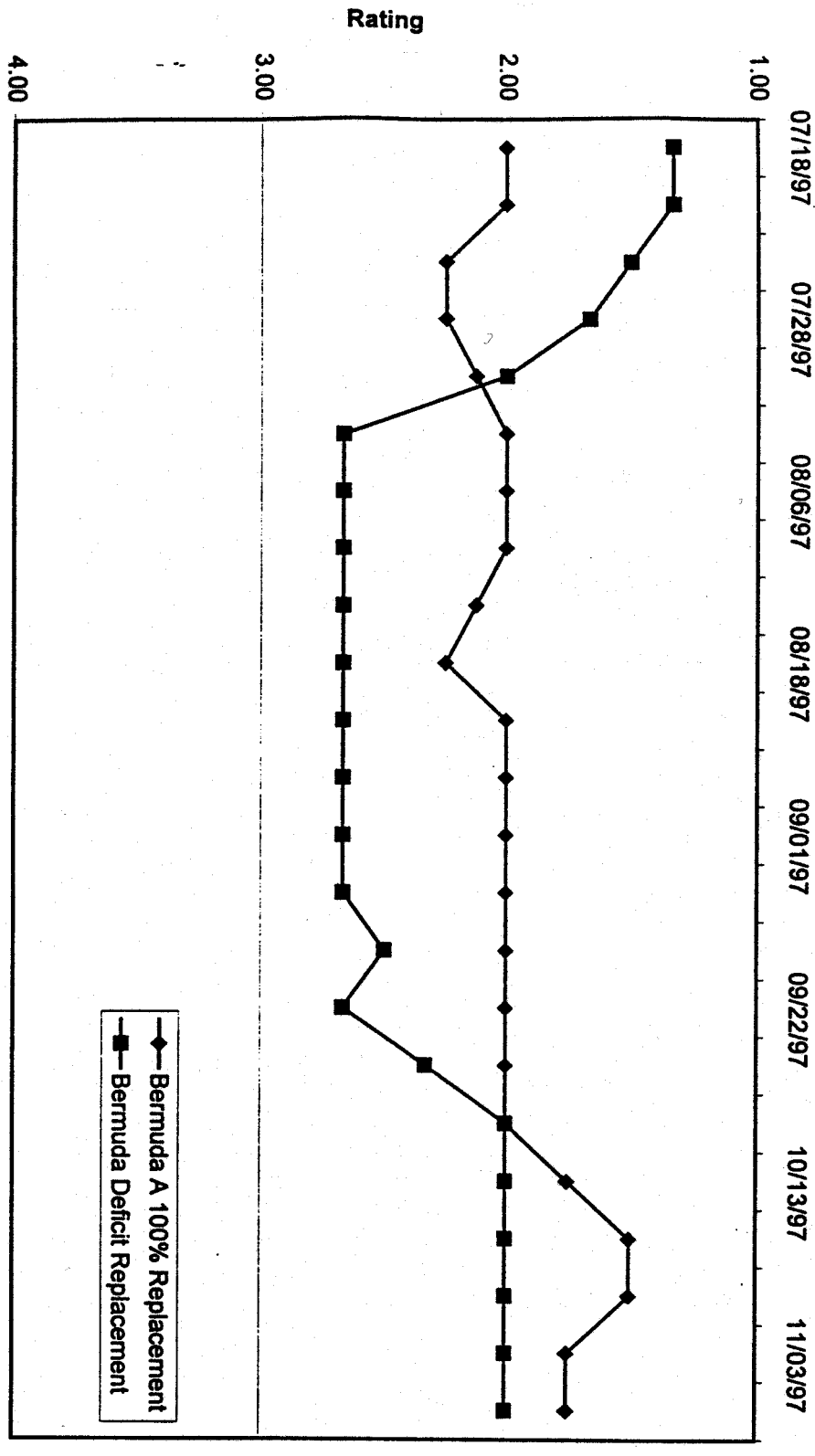


Participant Ratings of St. Augustine Lawns
Protocol A
100% Replacement vs. Deficit Replacement

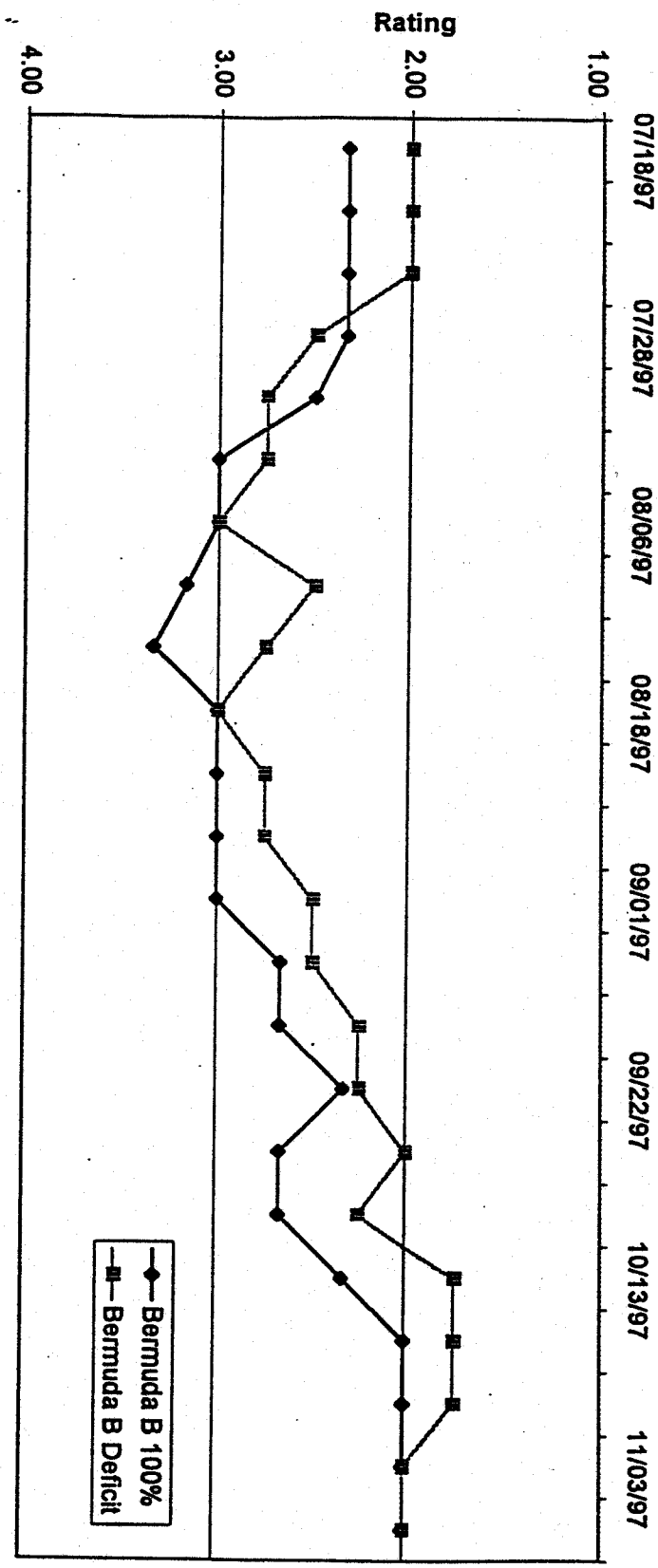


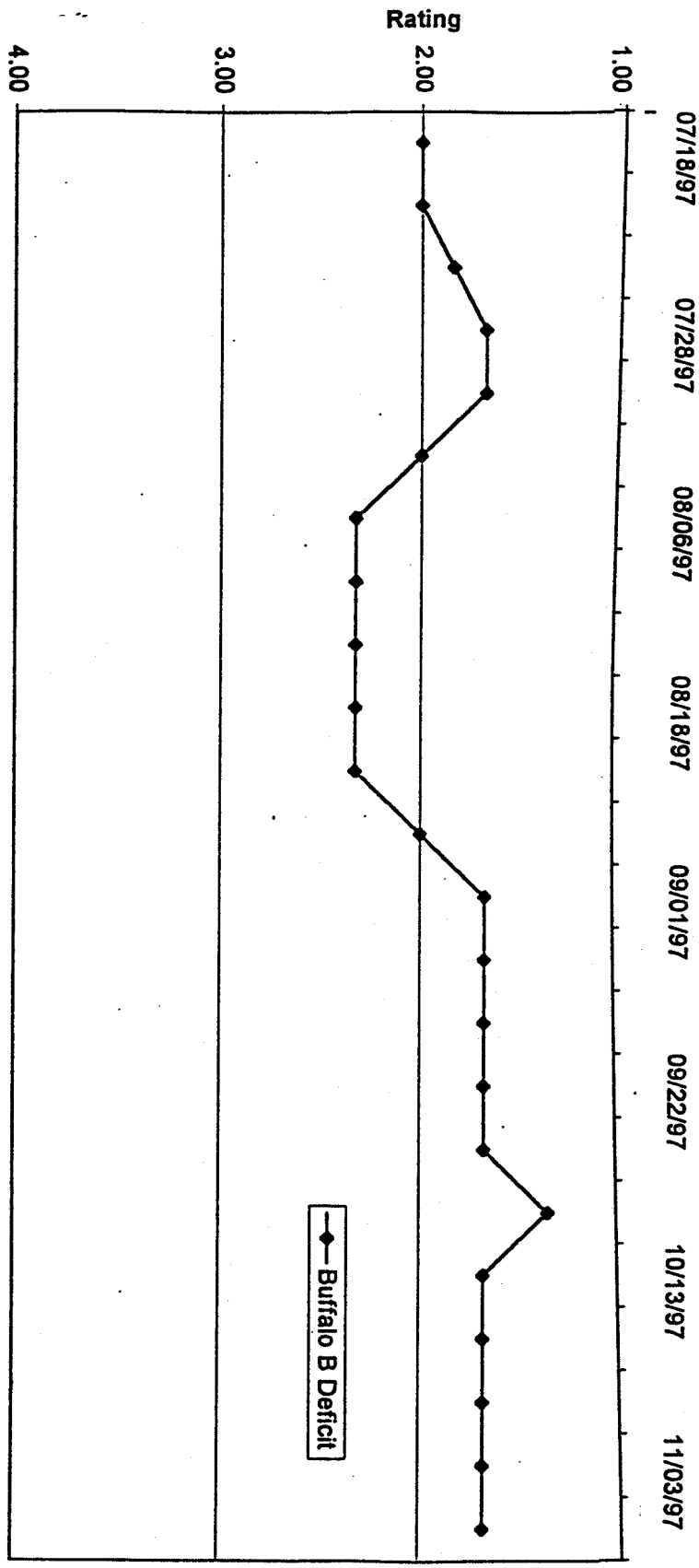

Participant Ratings of Buffalo Lawns
Protocol A
100% Replacement vs. Deficit Replacement
Rating
1.00
2.00
3.00
4.00
Date
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Buffalo A 100% Replacement
Buffalo A Deficit Replacement

Participant Ratings of Bermuda Lawns
Protocol A
100% Replacement vs. Deficit Replacement

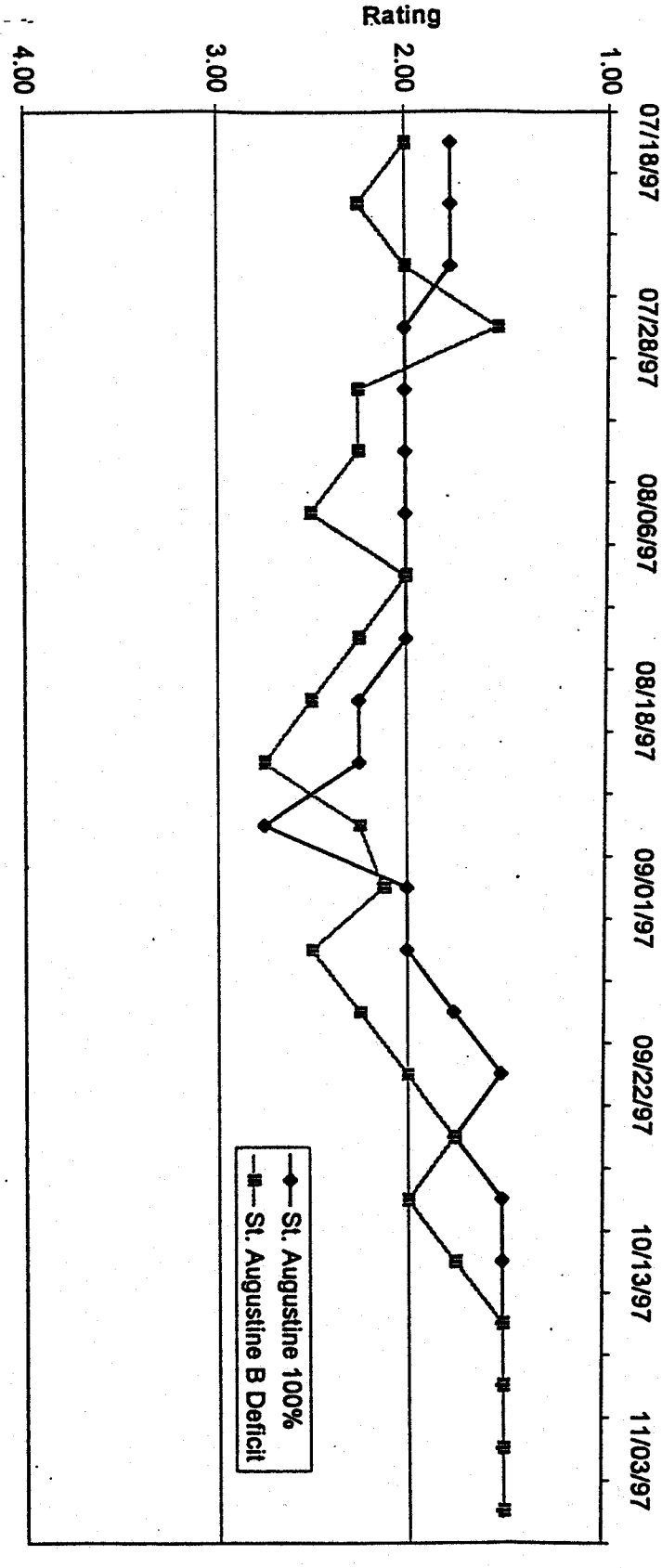


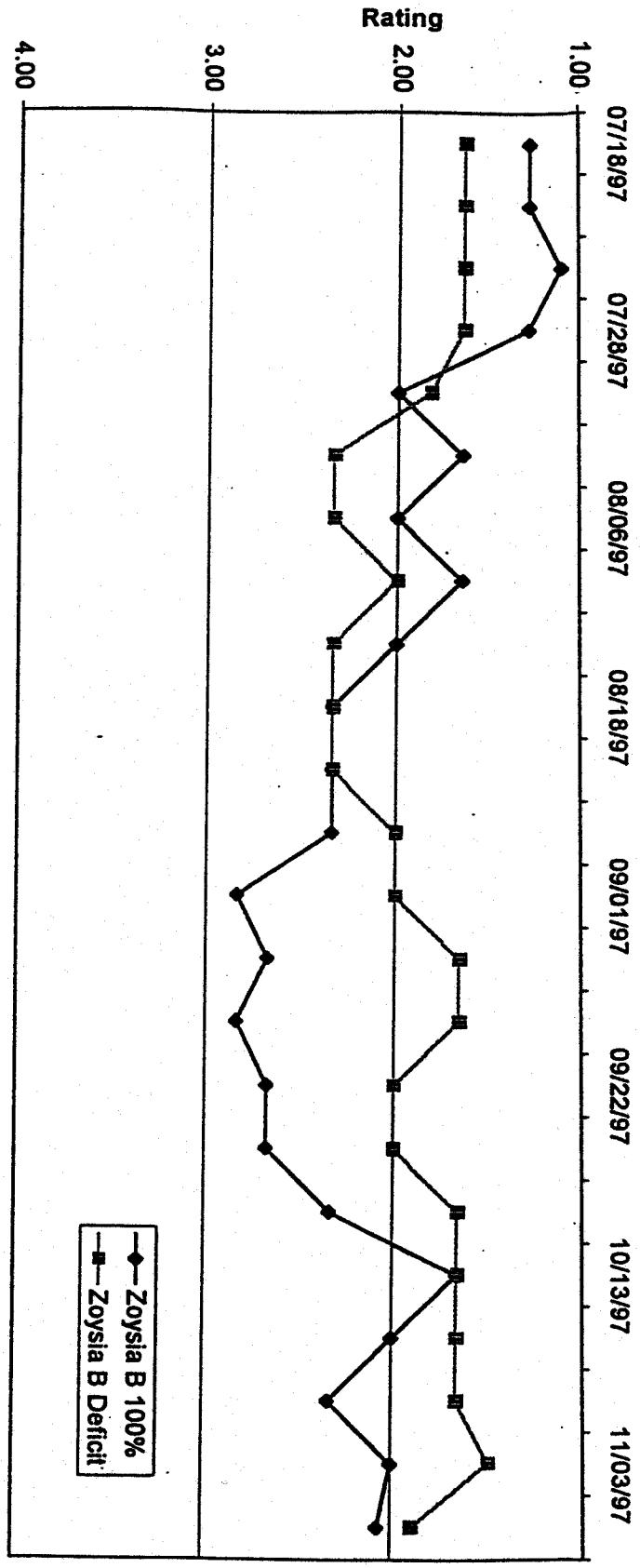
Participant Ratings of Bermuda Lawns
Protocol B
100% Replacement vs. Deficit Replacement

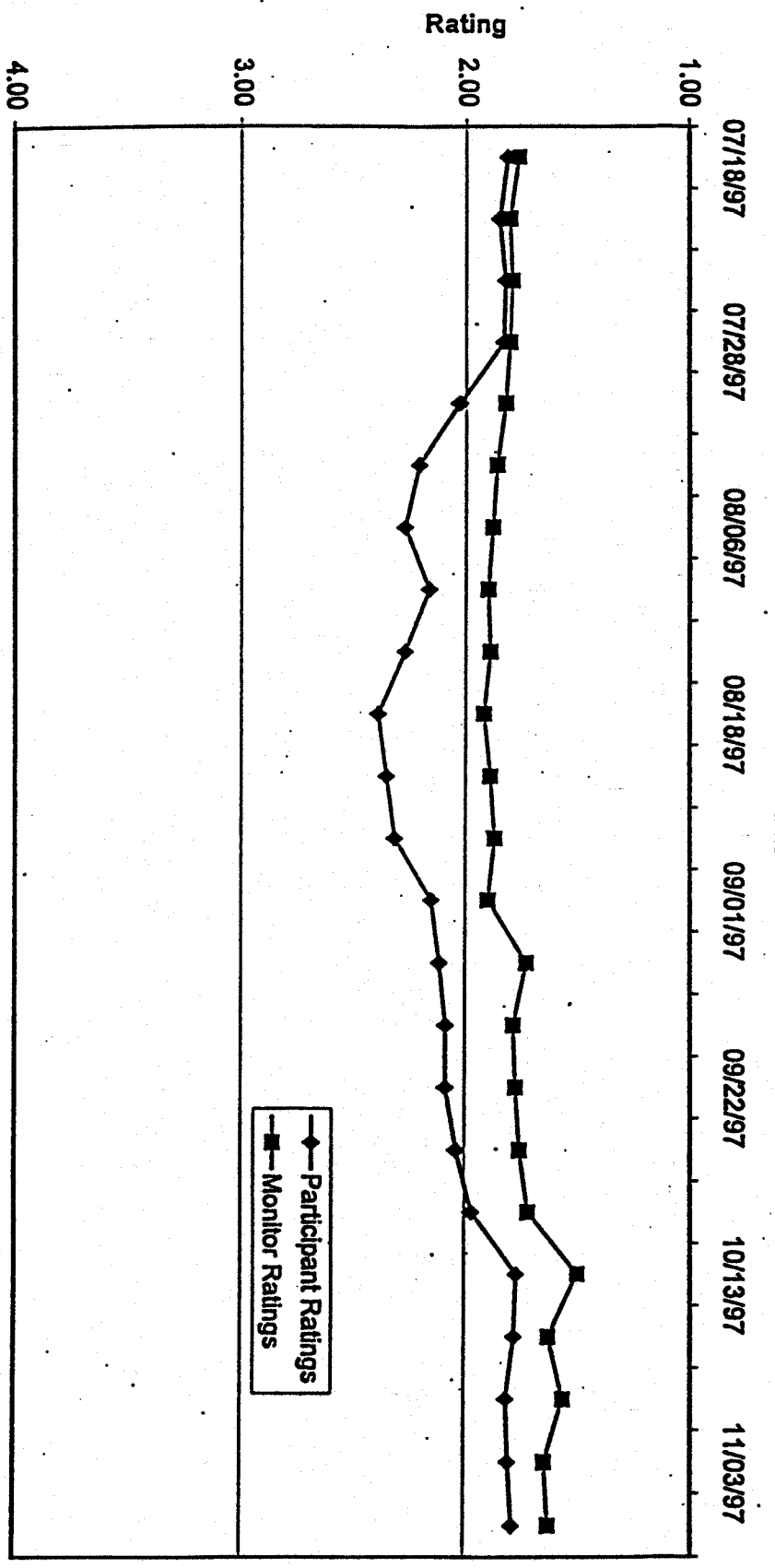


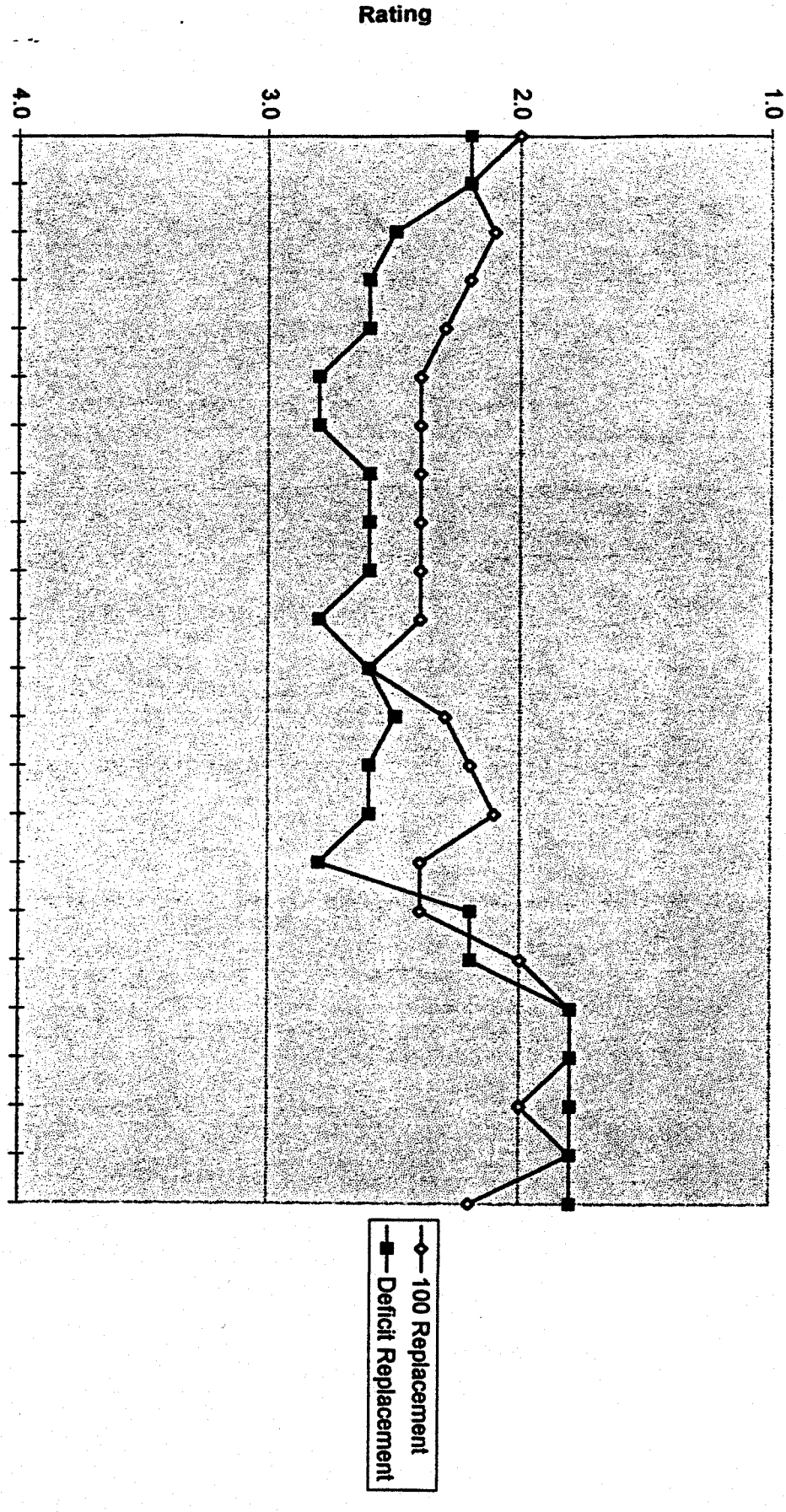

Participant Ratings of Buffalo Lawns
Protocol B Deficit
Rating
1.00
2.00
3.00
4.00
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Date
Buffalo B Deficit

Participant Ratings of St. Augustine Lawns
Protocol B
100% Replacement vs. Deficit Replacement




Participant Ratings of Zoysia Lawns
Protocol B
100% Replacement vs. Deficit Replacement
Rating
1.00
2.00
3.00
4.00
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Date
Zoysia B 100%
Zoysia B Deficit


Monitor Ratings vs. Participant Ratings
Rating
1.00
2.00
3.00
4.00
07/18/97
07/28/97
08/06/97
08/18/97
09/01/97
09/22/97
10/13/97
11/03/97
Date
Participant Ratings
Monitor Ratings


Participant Rating Quadrant 1 All Lawns 100% Replacemnt vs. Deficit Replacement
Rating
1.0
2.0
3.0
4.0
Date
07/18/97
07/21/97
07/25/97
07/28/97
08/01/97
08/04/97
08/06/97
08/11/97
08/13/97
08/18/97
08/19/97
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09/15/97
09/22/97
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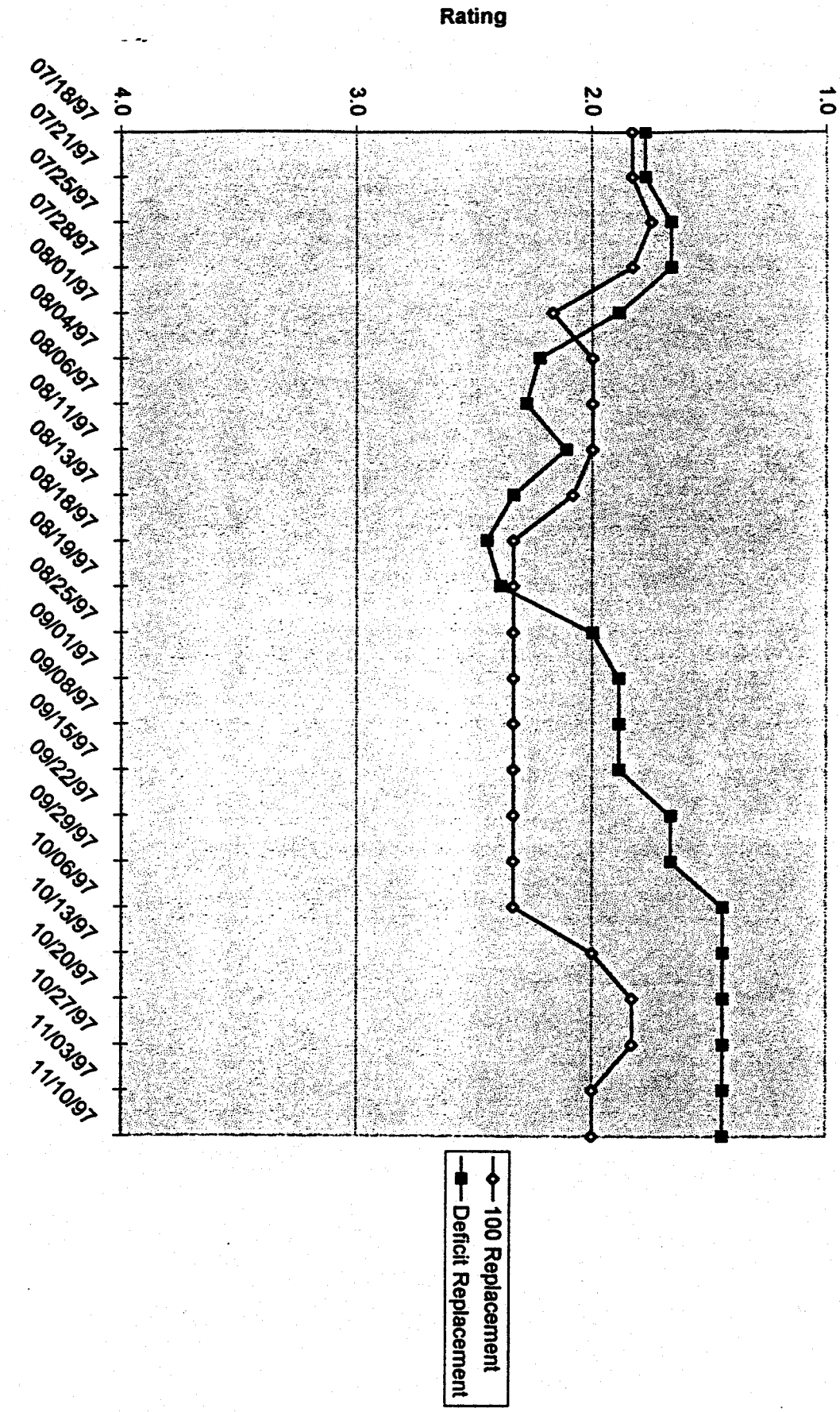
10/20/97
10/27/97
11/03/97
11/10/97
100 Replacement
Deficit Replacement


Participant Rating Quadrant 2 All Lawns 100% Replacement vs. Deficit Replacement
Rating
1.0
2.0
3.0
4.0
Date
07/18/97
07/21/97
07/25/97
07/28/97
08/01/97
08/04/97
08/06/97
08/11/97
08/13/97
08/18/97
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09/22/97
09/29/97
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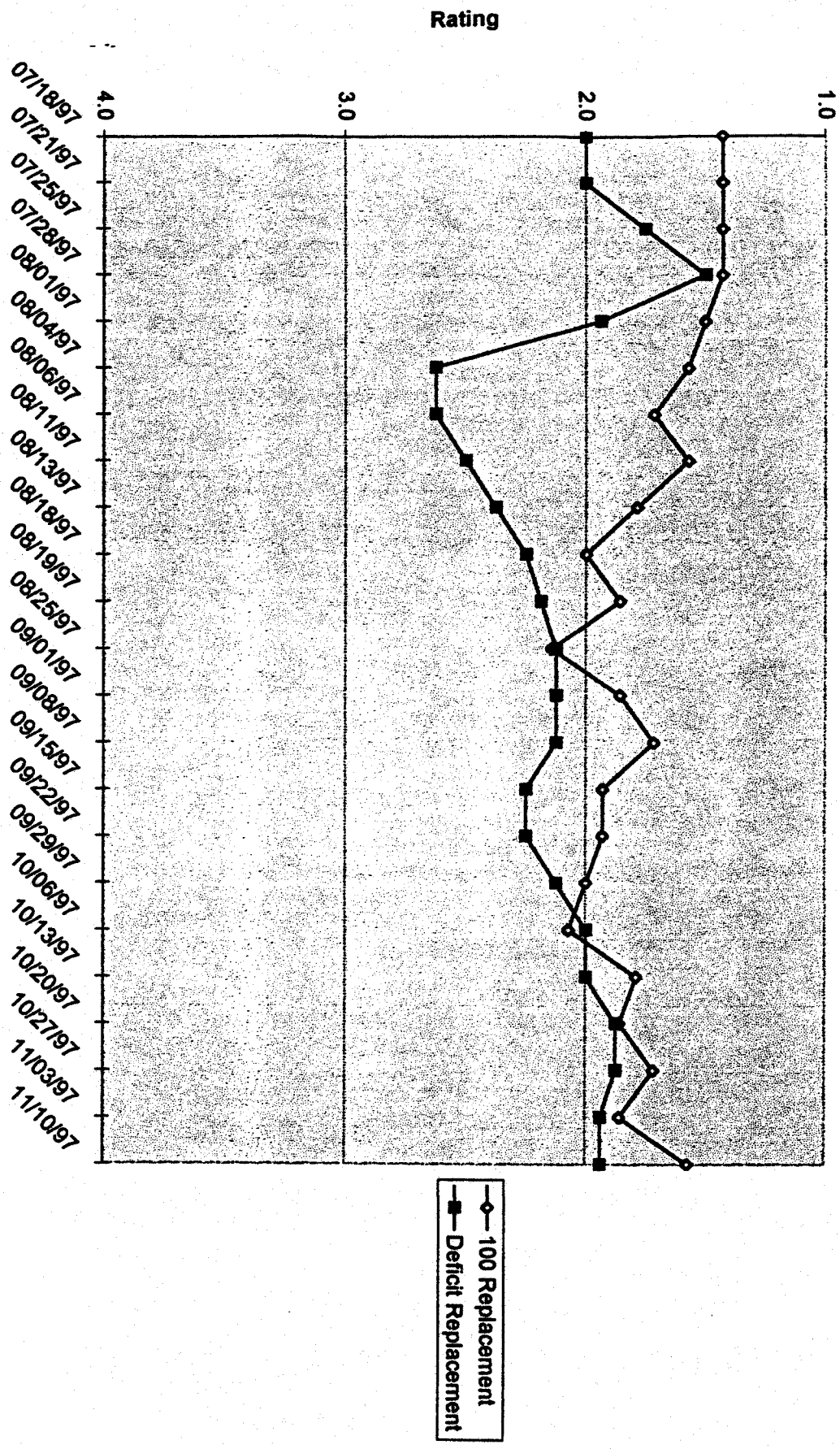
10/13/97
10/20/97
10/27/97
11/03/97
11/10/97
100 Replacement
Deficit Replacement


Participant Rating Quadrant 3 All Lawns 100% Replacement vs. Deficit Replacement
Rating
1.0
2.0
3.0
4.0
Date
07/18/97
07/21/97
07/25/97
07/28/97
08/01/97
08/04/97
08/06/97
08/11/97
08/13/97
08/18/97
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09/22/97
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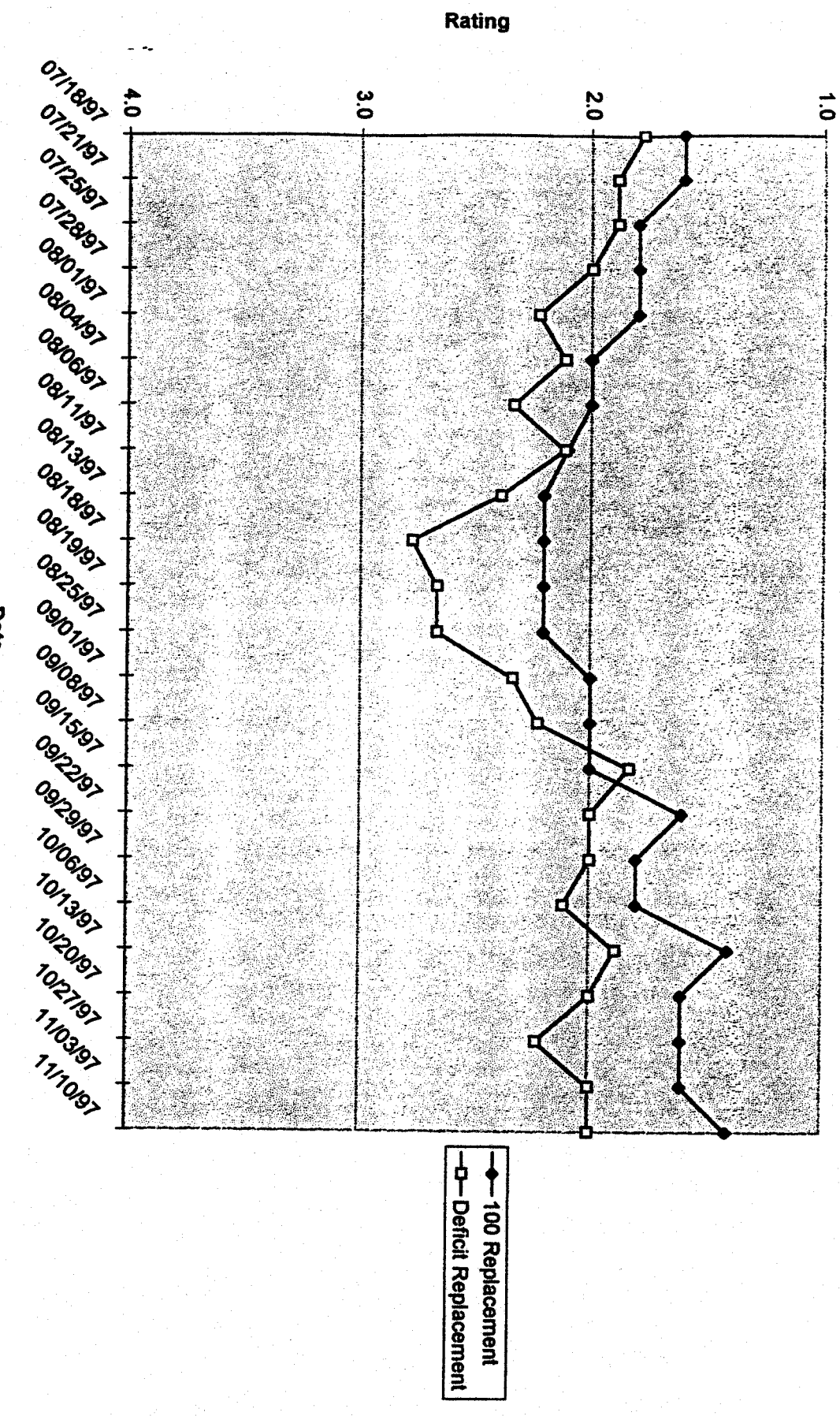
11/03/97
11/10/97
100 Replacement
Deficit Replacement


Participant Rating Quadrant 4 All Lawns 100% Replacement vs. Deficit Replacement
Rating
1.0
2.0
3.0
4.0
Date
07/18/97
07/21/97
07/25/97
07/28/97
08/01/97
08/04/97
08/06/97
08/11/97
08/13/97
08/18/97
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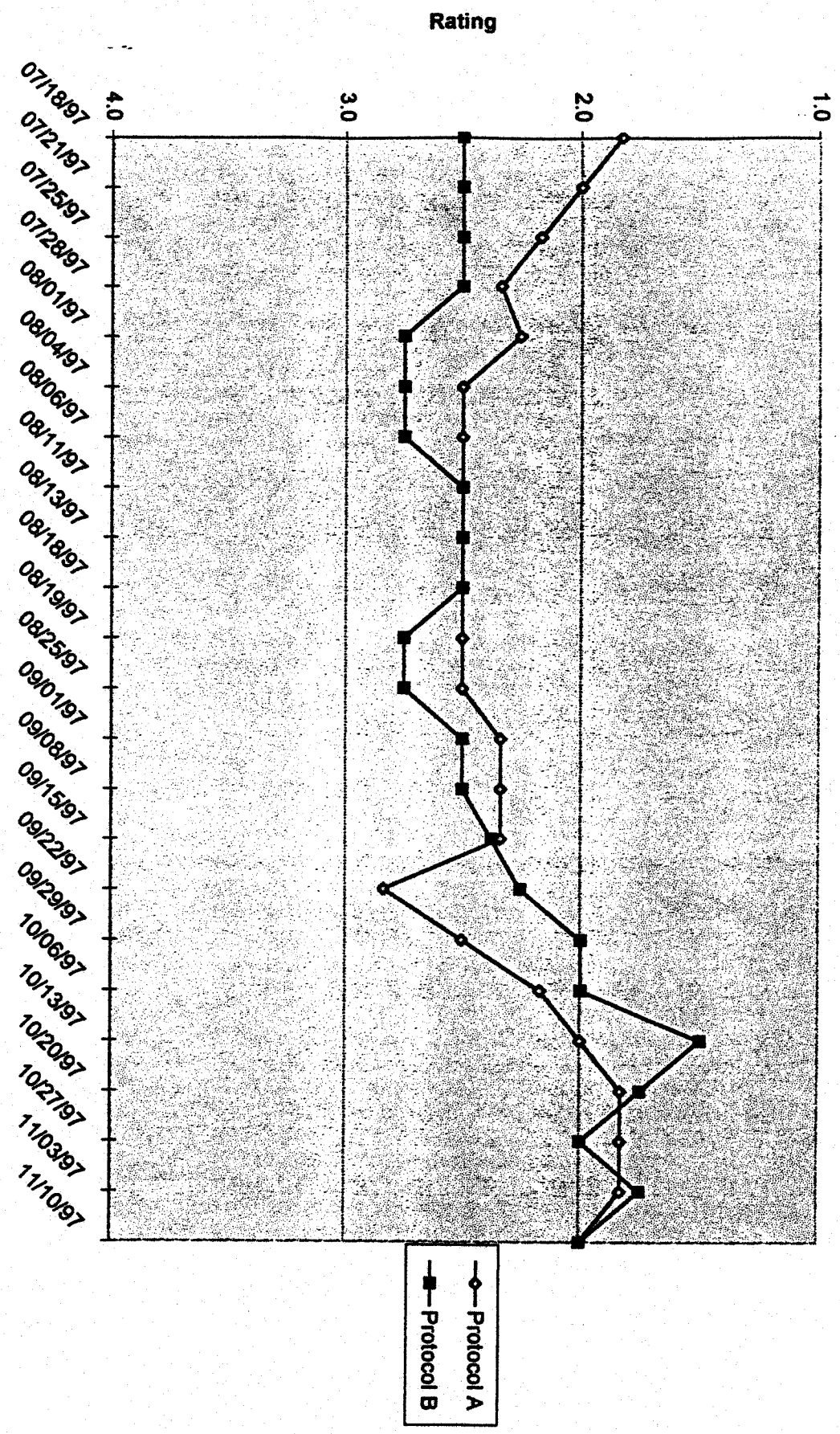
09/22/97
09/29/97
10/06/97
10/13/97
10/20/97
10/27/97
11/03/97
11/10/97
100 Replacement
Deficit Replacement


Participant Rating Quadrant 1 All Lawns Protocols A vs. B
Rating
1.0
2.0
3.0
4.0
Date
07/18/97
07/21/97
07/25/97
07/28/97
08/01/97
08/04/97
08/06/97
08/11/97
08/13/97
08/18/97
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09/22/97
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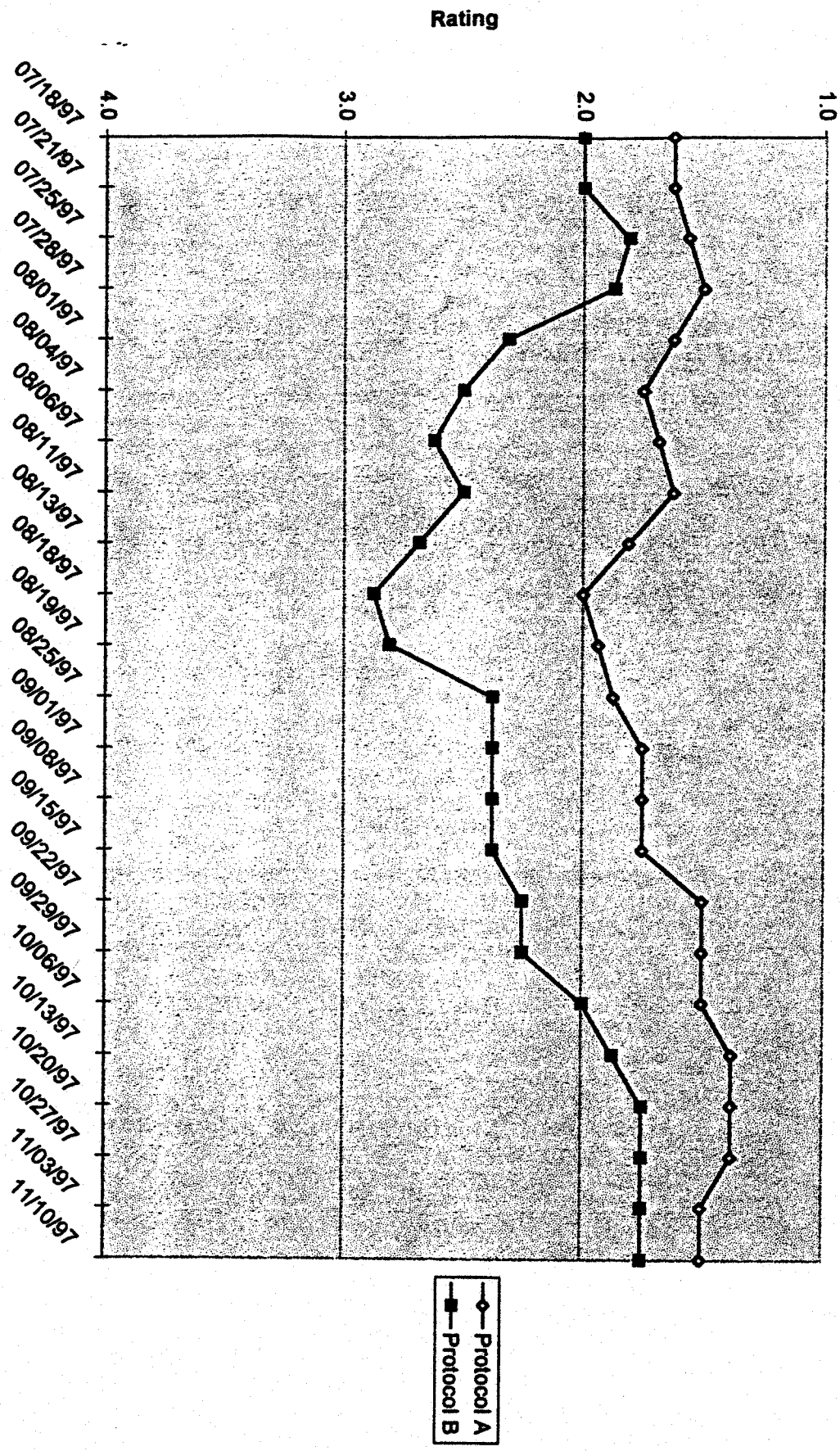
10/27/97
11/03/97
11/10/97
Protocol A
Protocol B


Participant Rating Quadrant 2 All Lawns Protocol A vs. B
Rating
4.0
3.0
2.0
1.0
07/18/97
07/21/97
07/25/97
07/28/97
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08/11/97
08/13/97
08/18/97
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09/15/97
09/22/97
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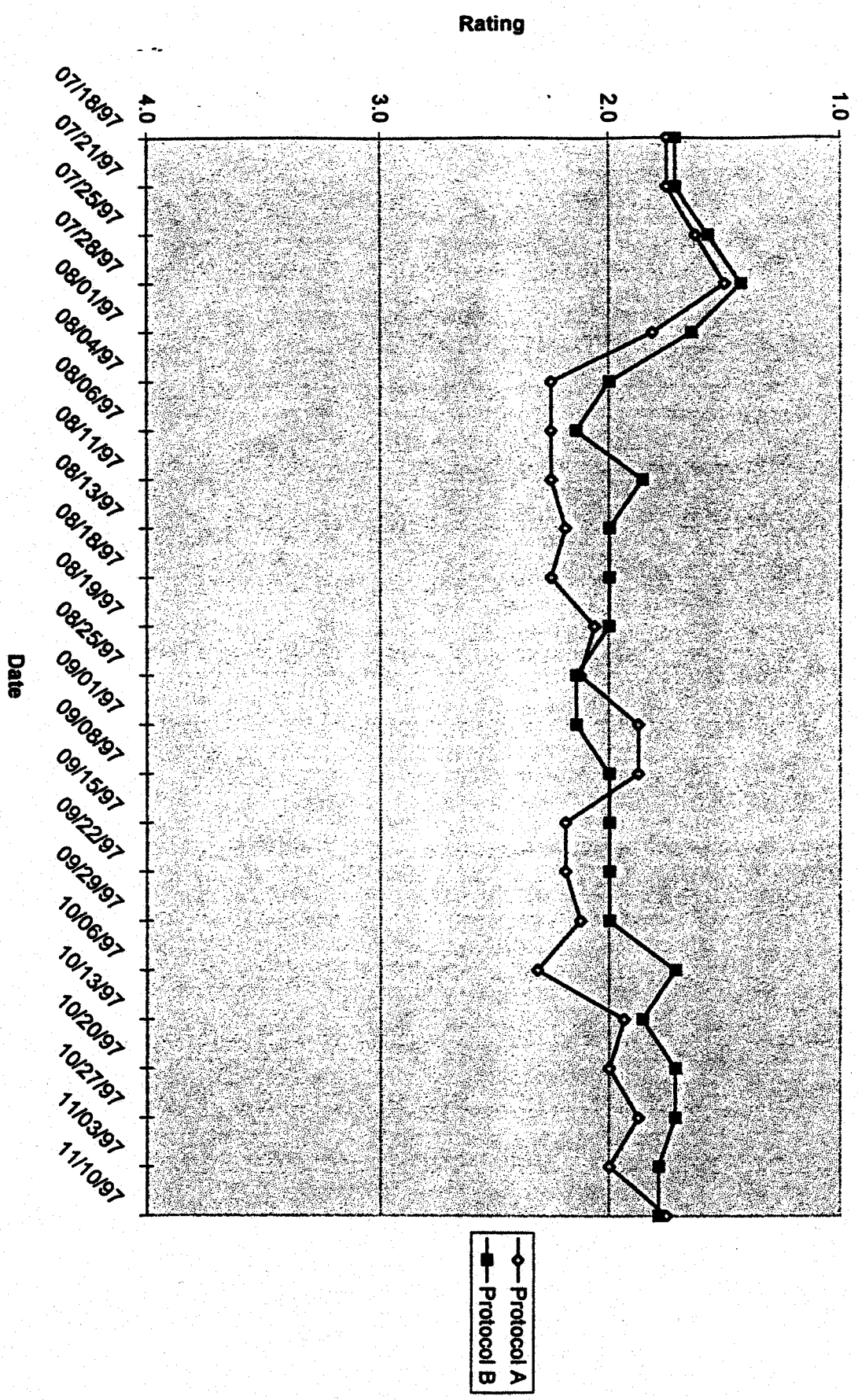
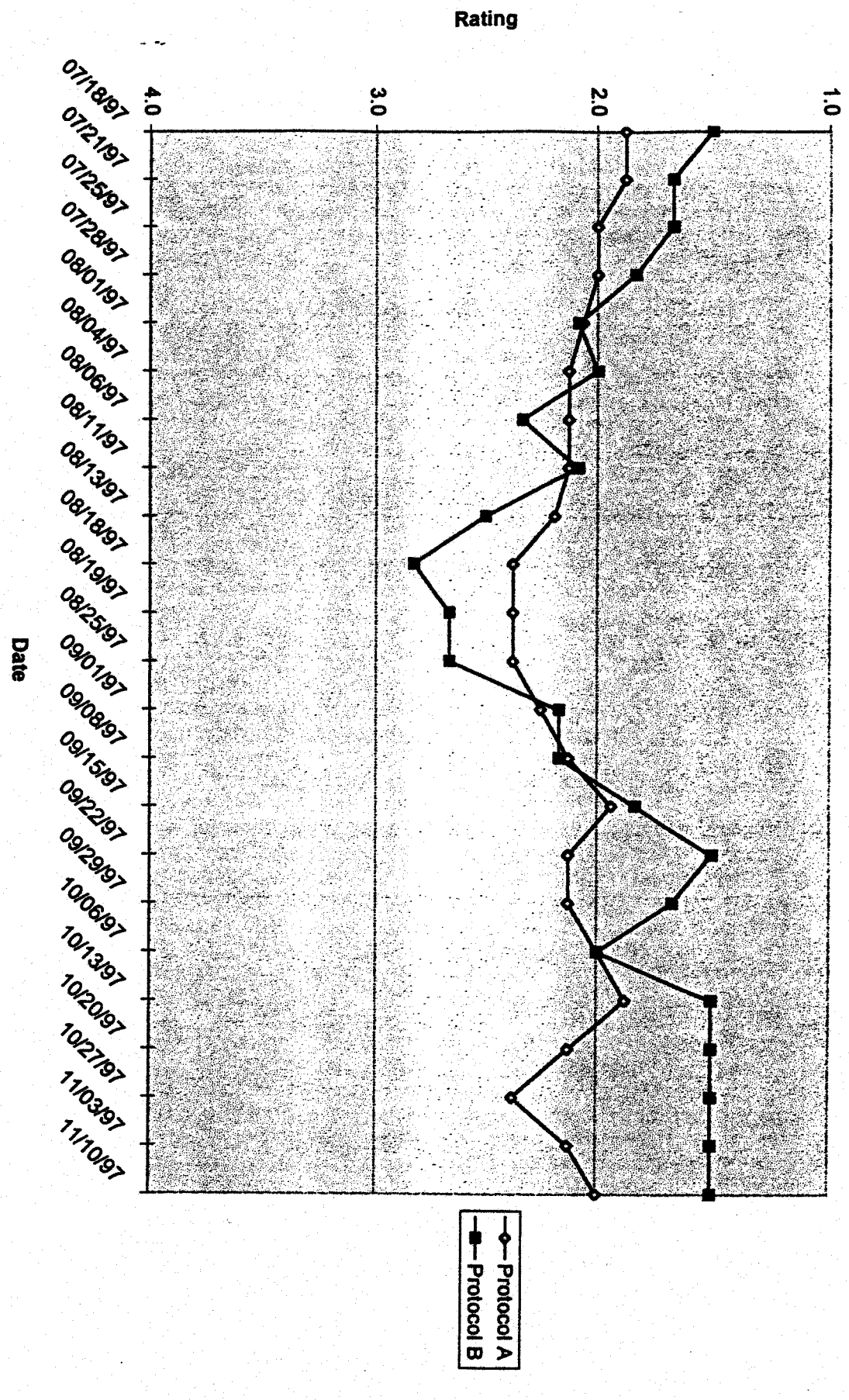
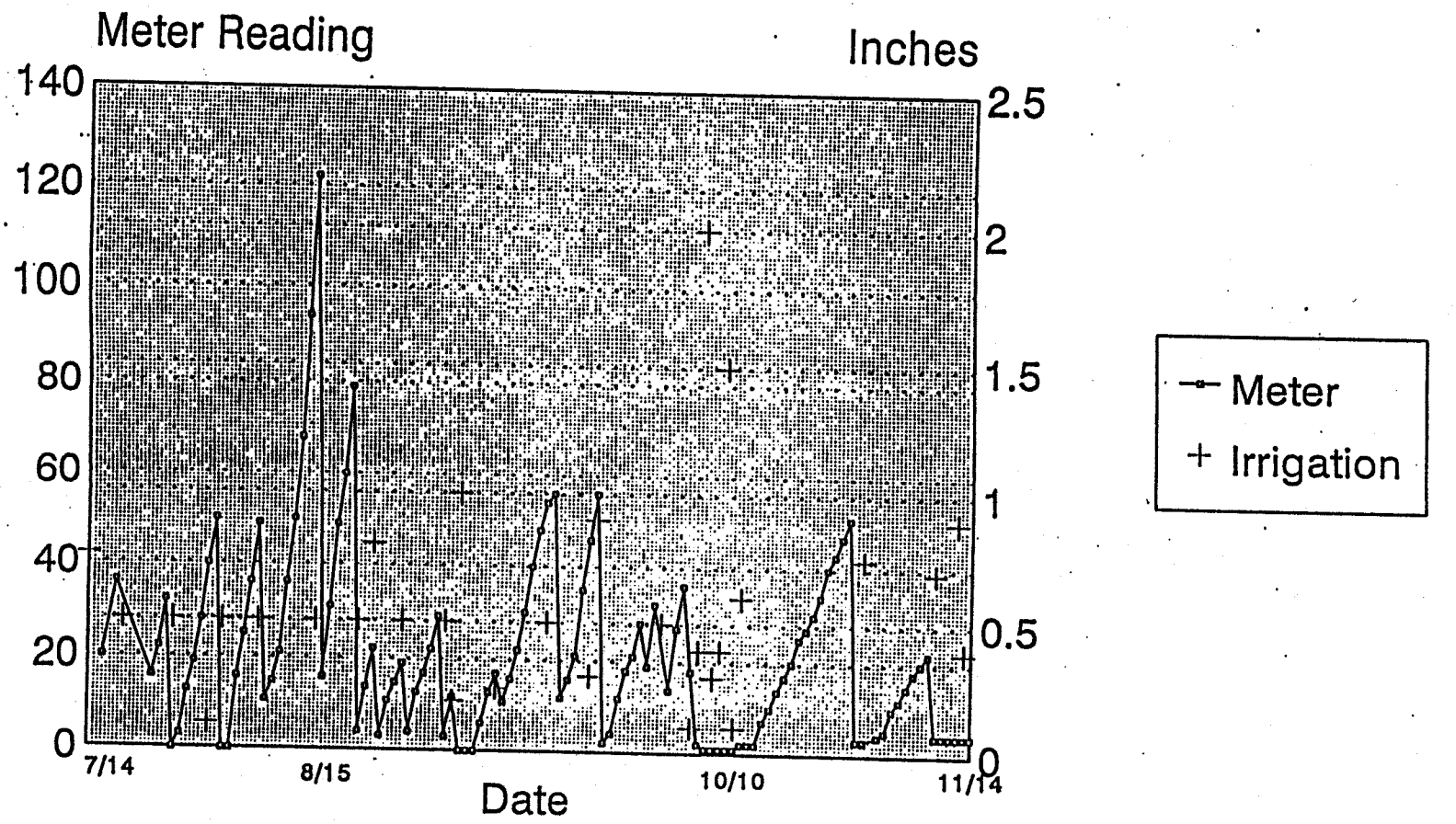
11/03/97
11/10/97
Date
Protocol A
Protocol B



Participant Rating Quadrant 3 All Lawns Protocol A vs. B

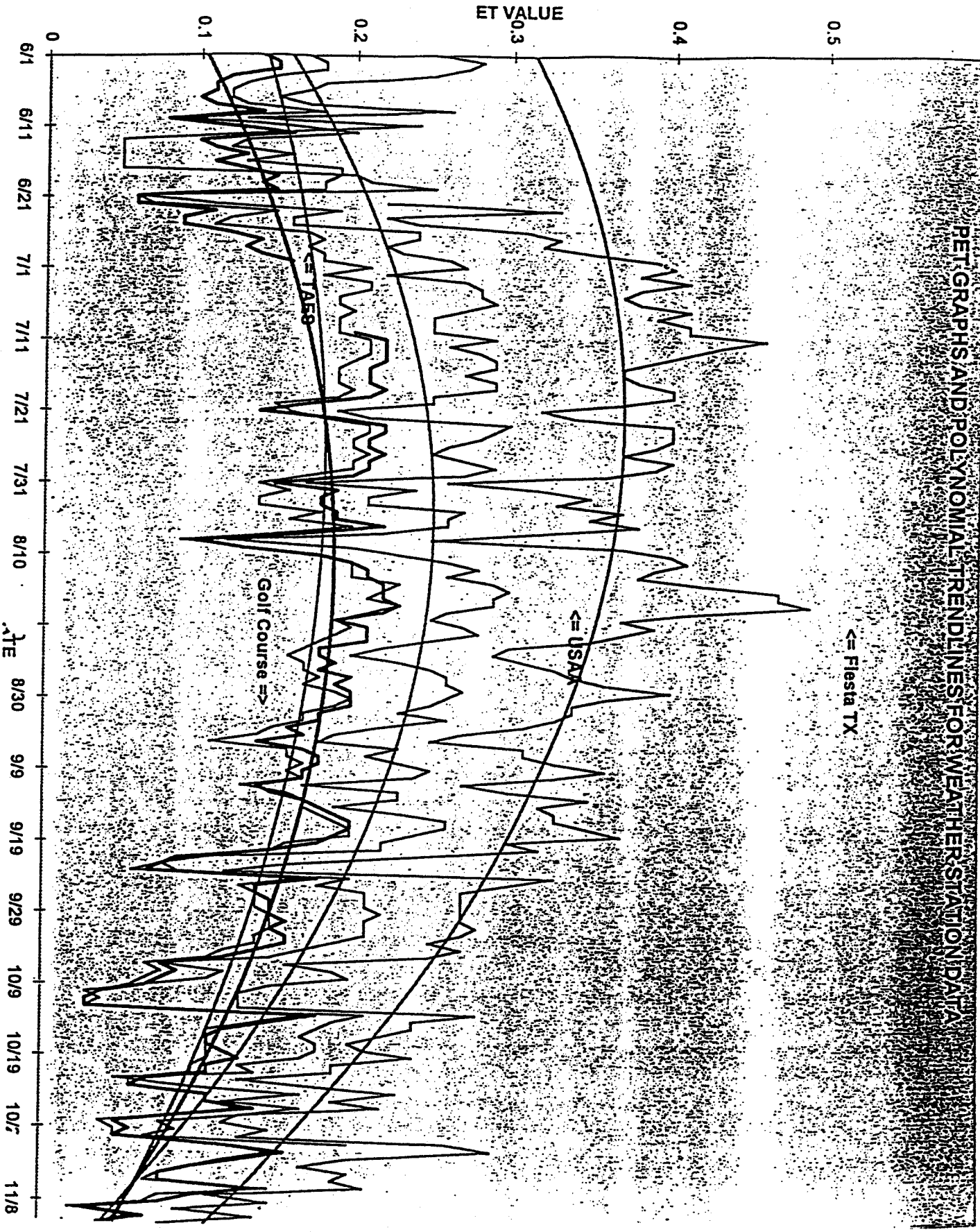

Participant Rating Quadrant 4 All Lawns Protocol A vs. B
Rating
1.0
2.0
3.0
4.0
Date
07/18/97
07/21/97
07/25/97
07/28/97
08/01/97
08/04/97
08/06/97
08/11/97
08/13/97
08/18/97
08/19/97
08/25/97
09/01/97
09/08/97
09/15/97
09/22/97
09/29/97
10/06/97
10/13/97
10/20/97
10/27/97
11/03/97
11/10/97
Protocol A
Protocol B

Moisture Meter Reading



Readings and irrigation record from Wilber Watje's
Irrigation includes rain recorded on the site.

Graph 31 -


PET GRAPHS AND POLYNOMIAL TRENDLINES FOR WEATHER STATION DATA
ET VALUE
0
0.1
0.2
0.3
0.4
0.5
0.6
6/1
6/11
6/21
7/1
7/11
7/21
7/31
8/10
8/20
8/30
9/9
9/19
9/29
10/9
10/19
11/8
<= TAES
<= USAA
<= Fiesta TX
Golf Course =>

ET Experimenter Feedback

Name_____

Protocol (A/B)_____

Treatment (100/def)_____

Turf Type_____

Please help us design a use-friendly ET-based watering program by giving us feedback on how following your protocol has worked for you.

1. **We will be comparing water use for the time period you followed ET-based watering protocols vs. last summer. We need to know if last summer you let your grass go dormant during the drought, or if you attempted to keep it green.**

   Check one:
   Last summer I tried to keep my grass green _____
   Last summer I tried to keep my grass looking OK _____
   Last summer I allowed my grass to go dormant _____

   Last summer my lawn rating was probably: _____ (1-4)

2. **We are curious to know how your watering habits while following the study protocol compared to what they would have been otherwise.**

   How many times do you think you watered due to the protocol when you otherwise would have waited? _____

   How many times did you refrain from watering due to the protocol when you otherwise would have watered? _____

   Do you think your water use will be higher or lower for the time period you followed this study than it was last summer? _____

3. **Please rate how hard was it to follow your protocol in terms of:**
   1 = easy 5 = very difficult

   Understanding what to do:
   1 2 3 4 5

   Making the time to keep up with what to do:
   1 2 3 4 5

   Actually applying the water according to instructions:
   1 2 3 4 5

Rating the lawn:

1 2 3 4 5

Sending in data sheets:

1 2 3 4 5

4. Would you recommend ET to a neighbor to guide their watering habits? Why or why not?

5. Which protocol do you think you would prefer if you had to choose one:

   Protocol A: Watering one day per week, differing amounts

   Protocol B: Different watering days, same amounts of water

6. If we were to design a program based on a once per week watering, which day of the week would be easiest for you? _____

7. How effective was the ET Phone Line? How can it be improved?

8. Can you suggest other ways we might help you get ET data? How might television, radio or newspaper data be useful? In what form and when?

9. What did you like about participation in this study?

10. What did you dislike about participation in this study?

11. Is there any other feedback you can give us about how your lawn performed or how you felt about your participation in this study?

Summary of Participant Feedback

Result 1: **When asked about last summer's lawn watering habits:**

18 indicated they tried to keep grass green

15 indicated they tried to keep grass looking OK

15 indicated they allowed their grass to go dormant

Result 2: **When asked will your water use during this study be higher or lower than last summer:**

18 indicated it would be higher

23 indicated it would be lower

4 indicated it would be the same

Result 3: **When asked to the rating of their lawns last summer:**

The average rating was 2.56

Result 4: **When asked how many times they watered when they would have otherwise waited:**

The average was 1.6

Result 5: **When asked how many times they refrained from watering when they otherwise would have:**

The average was 1.6

Result 6: **We asked participants for feedback on various aspects participation. 1 was easy and 5 was very difficult.**

Aspect of Participation	Rating of Difficulty
Understanding What to Do	1.55
Making time for study	2.10
Apply water by instructions	1.98
Rating the lawn	1.81
Sending in data sheets	2.0

Result 7: **When asked if they would recommend ET use to a neighbor:**

Only 2 participants said that they would not recommend the program. The others all indicated that they would recommend the program.

Result 8: **When asked if they preferred protocol A or protocol B:**

33 participants preferred Protocol A

13 participants preferred Protocol B

Result 9: **We asked participants what day of the week they would like to water if we designed a once a week water program. Their preferences were:**

Sunday	2	Thursday	2
Monday	16	Friday	0
Tuesday	4	Saturday	5
Wednesday	0	Any weekend day	7

total indicating a preference for weekend watering — 17

Result 10: **We asked about the effectiveness of the ET phone line:**

Most participants rated the phone line as either good or fair in effectiveness.

Appendix 3: Coding Used For Analysis

ET Feedback Coding For Analysis

1. Water use last summer for lawn irrigation

   1 = tried to keep grass green

   2 = tried to keep grass looking OK

   3 = allowed grass to go dormant

2. Rating of lawn last summer

   1 = Excellent

   2 = Good

   3 = Fair

   4 = Poor

3. Number of times you watered when you would have waited if not in study.

4. Number of times you waited to water because of sudy.

5. Will your water use be higher or lower than last summer as a result of participation in study?

   1 = higher

   2 = lower

   3 = same

Evapotranspiration Project

Project Goals:

- To conserve water by irrigating on the basis of evapotranspiration data.
- To determine the best ET based watering practices for San Antonio.
- To utilize the results of this pilot project to develop a broad ET Based Lawn Watering Program.

Project Partners: Texas Agricultural Extension Service
Bexar County Master Gardeners
Texas A & M University
San Antonio Water System

How the Project Will Work:

Our weather station located at the Jones-Maltsberger demonstration site collects data necessary to calculate evapotranspiration rates. We will determine ET rates for each day and communicate them to you using our ET Phone Line. You will use the information on the ET Phone Line to follow your ET Study Protocol. The feedback you give us through your data sheets and comments will help us make any necessary adjustments in how we use the ET data.

Terms We Will Be Using:

Evapotranspiration (ET) is water lost due to evaporation and transpiration

Evaporation: This is the process which causes water out in the sun to disappear as water molecules change state from liquid to gas.

Transpiration: During transpiration water is taken up by plant roots, used in photosynthesis and released into the atmosphere.

Soil Water Reservoir: This refers to water stored in the soil under plants. The amount of water which can be held depends on the type of soil and the depth of soil. The amount that soil can hold is expressed in inches.

Water Application Rate: This refers to the amount of water that is applied to grass by a sprinkler system over a period of time. It is expressed in inches/hour. You measure this by conducting a "catch-can" test while your sprinkler system is running.

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Questions You May Have On The ET Program

Why A Watering Program Is Needed:

25% of our potable water is used for landscape irrigation. During hot summer months, landscape irrigation may account for up to 60% of total water use. Because most people unknowingly over-water, this can be reduced through appropriate irrigation methods. Reducing our high water use will save money, assist in efforts to keep aquifer levels above drought levels and help assure that San Antonio will not be limited in growth capacity by water shortage.

Appropriate Watering Produces Healthy Grass:

Appropriate water application is perhaps the most important factor contributing to turf quality. Watering too much and too often encourages shallow rooted grass which will not withstand the extreme heat of our summers. However, no irrigation results in brown and dormant grass that does not meet the quality preferences of most home owners.

Appropriate irrigation is thought to "drought train" grass by encouraging deep roots and lower water usage. Grass that is drought trained is thought to use less water, be more resistant to disease and to stay greener during the hottest parts of the summer.

How Do We Know How To Appropriately Water?

Grass should be watered when the soil reservoir under grass is nearly depleted. When very little water is left in the soil, the grass will show signs of water stress. At this time, the reservoir should be refilled. Waiting until the reservoir is nearly empty encourages grass roots to go deeper into the soil so that more of the soil reservoir is used.

What Are Signs of Water Stress?

When grass is deprived of water in the soil, it becomes less firm and elastic. Grass that has enough water available will spring back after being stepped on. When a footprint is left in the grass, there is water stress. Other signs of stress include leaf blade curling, wilting and discolorations.

How Does ET Data Fit Into All of This?

Evapotranspiration data will give us an estimate of when the soil water reservoir is nearly depleted. We will refill the soil reservoir with only the needed amount of water. This should be healthy for the grass and should also conserve water.

Why Your Participation In This Pilot Study Is Important:

If our pilot program is successful, we will use the information you provide to develop a city wide ET based water conservation program. Your reactions to the pilot study will be critical in the design of any future program. No lawn care program works unless the home-owners find it simple to follow. The program must also result in grass that meets the aesthetic needs of home-owners. Your attention to these issues will give us the feedback we need to create a successful program for our city.

Please help us by staying in touch during the entire study period. We especially need your attention in the following areas:

- Data Forms: Fill in the data forms as completely as possible. We need to know about each of the topics listed on the bottom of the Calendar Data Sheet.
- Extra Information: When in doubt write any extra information on separate paper with dates for each comment.
- Call Us With Questions: If something isn't clear, we NEED TO KNOW!
- Tell Us About Grass Problems: Tell us if your grass seems to be getting more water than it needs OR if you think it is looking too stressed to meet your aesthetic standards.

Can Other People Try Using The ET Data?

We encourage anyone who is interested in the project to try following one of the study protocols. For the purposes of this study we were only able to accept a limited number of homes to evaluate. However, we hope that everyone who inquired about it will decide to try using the ET data as a means to plan their irrigation.

The ET Project Team

The Evapotranspiration Pilot Study is a joint project being conducted by the Texas Agricultural Extension Service, The Bexar County Master Gardeners and A&M University. Funding to complete the pilot was provided by San Antonio Water System.

Texas Agricultural Extension Service:
The ET Pilot Study is being directed by three Bexar County Extension Service Staff including Dr. Calvin Finch, County Extension Agent- Horticulture, Joe Taylor, County Extension Agent- Agriculture, and Karen Guz, County Extension Associate – Horticulture. Each of us will be actively involved in the ET Pilot Study and will be pleased to address questions or concerns you may have.

Bexar County Master Gardeners:
The Bexar County Master Gardeners have adopted the ET Pilot as one of their community service projects. Master Gardener staff person Felipe Camacho is coordinating the study and the efforts of Master Gardener volunteers working on the project. Felipe will be keeping all records for the study and tracking the results as it continues. Master Gardener volunteers who are Team Leaders will make regular site visits to home test sites to check soil moisture levels and to determine how well the grass at each site is responding to the study. Master Gardener Team Leaders will also be available to address the concerns of the home-owners assigned to them.

Texas A&M University:
Experts in turfgrass and irrigation are being consulted on a regular basis for the design and implementation of the ET Pilot Study. The PET Home Page on the World Wide Web which is maintained by Dr. Guy Fipps is our primary source of ET data. You may wish to visit this site to learn more about how ET data is used in other parts of Texas. The site address is:

San Antonio Water System:
SAWS has provided materials and funding necessary to conduct the pilot study. In addition, the weather station used for San Antonio ET calculations is located at the Jones-Maltsberger SAWS Pumping Station.

Protocol A: Refill Once A Week

We are trying two methods of using ET data for lawn irrigation in order to discover which one works best for home owners. We need a method of using the data which both produces healthy lawns and is easy to follow. The feedback from this study will help us decide which of the two methods we should use for a broader program in the future.

Summary:
Home owners following Protocol A will water their lawns on the same day each week. Each day we will add up how much water is removed from the soil. At the end of the week, we will have a total amount in inches that they will need to add to their soil in order to refill the soil reservoir. This method should result in water savings because participants will apply no more than is necessary to refill. We will track rainfall during the week and subtract any rainfall from the refill amount. During an extremely hot and dry week, the refill amount may be over one inch. However, during a cloudy or rainy week the refill amount may be only ¼."

Important Tasks For Participants:

1. Participants will have to be very familiar with their sprinkler application rate and know how long it will take to apply water in ¼" increments. Those with automatic systems will have to adjust their timer to make the system only run for as long as it is necessary to apply the refill amount.

2. Rating of lawns must be done on Monday morning. This will give us feedback on whether your lawn is responding well to this schedule.

Why This Method?
We believe this method of using ET data will be easy for home owners. It only requires attention to ET rates on one weekday and there is only one watering day. However, it will be important that we obtain feedback on the quality of lawns on this protocol. We are hopeful that one watering day per week will be sufficient. If it is not, we may need to try two watering days per week.

What Is the Difference Between the 100% and 70% Refill?
Previous studies of evapotranspiration have shown that grass can perform well even when it is not given optimal water supplies. Grass which is only given 70% of the total water which was removed from its soil reservoir may still look as good as grass which is given 100% replacement of water. In fact, when grass is given less than 100% replacement of water it may adapt to the low water conditions and end up needing less water. We would like to find out how well grass performs at replacement rates of less than 100% so we can determine how much water we can conserve. We will be comparing the ratings home owners on 100% give their grass to the ratings given to grass on only 70% replacement. If the grass on 70% is of poor quality, we will need to go to higher replacement rate. If it looks just as good or very similar, we will be able to recommend the lower replacement rate for everyone.

Directions For Participants In the Bexar County ET Pilot Study: Protocol A

We are hoping to discover the best way to utilize ET data for home lawn care. Because this technology has never been applied to turfgrass in this area, we are pioneers and will need to learn as the study progresses. This protocol is our starting point. The directions we ask you to follow will most likely change as you provide us with feedback.

Daily Tasks:

1. Note any measurable rainfall on your data sheet.

2. Note any lawn efforts you make such as cutting or fertilization.

Every Monday:

1. Call the ET Phone line (press 3 when recording starts) to get the total ET for the past week The recording will tell you how many inches to apply if you are on a 100% replacement rate and how much to apply if you are on a 70% replacement rate.

2. Rate your lawn before 10:00 a.m.

3. Record your ratings and observations on your data sheet.

Watering:

1. Water your lawn with amount instructed on the ET phone line either on Monday evening (after 8 p.m.) or on Tuesday morning (before 10 a.m.)

2. Carefully time your watering so that you can apply only the amount instructed on the ET phone line.

3. Note any deviation from watering instructions on your data sheet.

Communicating Your Data:

We will need to see your data sheets every two weeks. Either mail in your data sheet or fax it to our office at 930-1753.

Communicating Problems:

PLEASE CALL FELIPE IF THERE IS A PROBLEM WITH YOUR LAWN OR YOU NEED CLARIFICATION ON INSTRUCTIONS! If for some reason you find you are unable to follow the instructions or your lawn is responding very poorly, we need to know immediately! Call Felipe at 828-4120. He will be checking his messages daily.

Protocol B: Empty The Reservoir, Then Refill

We are trying two methods of using ET data for lawn irrigation in order to discover which one works best for home owners. We need a method of using the data which both produces healthy lawns and is easy to follow. The feedback from this study will help us decide which of the methods we should use for a broader program in the future.

Summary:

Homeowners following Protocol B will water their lawns when we determine that there is no available water left in their soil reservoir. We have estimated that each lawn can hold an average of 1 ½" of water in the soil under the grass. However, once half of this water has been removed the plants will show signs of stress and the reservoir should be refilled. Therefore, we will water when our ET data indicates that ¾" of water has been removed from the soil. We are calling this the "Critical ET." During hot and dry weather it will take only a few days to reach the Critical ET of ¾." When the weather is cloudy or there has been rain to replenish the reservoir, it may take as many as 10 days to reach the Critical ET of ¾."

Important Tasks For Participants:

1. Call the ET Phone Line each day to determine whether we have reached the Critical ET of ¾." A message on the recording will tell you the total ET since your last watering and whether you need to water.

2. When the ET Phone message indicates that we have reached the Critical ET, you will need to water that evening or the next morning. You will apply ¾" if you are in the 100% replacement group and ½" if you are in the deficit irrigation group.

Why This Method?
We believe that this method of using ET data may produce the best quality turf. Because we will allow the water to be depleted, the grass will be encouraged to develop a deep root system and to adapt to a lower overall water use. We also believe this method will predict when grass is just beginning to show signs of water stress, but will provide water just before the grass declines in quality. This method may be optimal for the turf, but it requires a daily attention to the ET data by participants. We will need feedback from participants on how difficult they find this responsibility and on whether we are successful at predicting when grass needs water.

Why Are Some of Us Applying Less Water Instead of the Whole Amount?
Previous studies of evapotranspiration have shown that grass can perform well when it is not given optimal water supplies. Grass which is only given 70% of total water which was removed from its soil reservoir may still look as good as grass which is given 100% replacement of water. In fact, when grass is given less than 100% replacement of water it may adapt to the low water conditions and end up needing less water. We would like to find out how well grass performs at replacement rates of less than 100% so we can determine how much we can conserve. We will be comparing the ratings home owners on 100% replacement give their grass to the rating given to grass on deficit irrigation. If the grass on deficit irrigation is of poor quality, we will need to try a higher replacement rate. If it looks just as good or very similar, we will be able to recommend the lower replacement rate for everyone.

Directions For Participants In the Bexar County
ET Pilot Study: Protocol B

We are hoping to discover the best way to utilize ET data for home lawn care. Because this technology has never been applied to turfgrass in this area, we are pioneers and will need to learn as the study progresses. This protocol is our starting point. The directions we ask you to follow will most likely change as you provide us with feedback.

Daily Tasks:

1. Note any measurable rainfall on your data sheet.

2. Note any lawn efforts you make such as cutting or fertilization.

3. Call the ET Phone line (press 4 when recording starts for Protocol B) to determine whether the total ET has added up the Critical Point of ¾".

Monday Rating:

- Please give your grass a rating on our scale of 1-4 each Monday morning.

When the Critical Point Is Reached:

- When the recording indicates that the measured ET since last watering is ¾," plan to water that evening or the following morning.

- Evaluate your grass on our scale of 1-4 the morning after total ET has reached ¾." Please do your evaluation rating before 10:00 a.m.

Watering Instructions:

1. Watering only takes place AFTER the ET phone line recording indicates Total ET has reached the Critical Point of ¾" of water lost!

2. Water either on the same evening (after 8:00 p.m.) that the ET phone line indicated reaching the Critical ET or on the following morning (before 10:00 a.m.).

    - 100% Replacement Group: Apply ¾" of water to your lawn.

    - Deficit Irrigation Group: Apply ½" of water to your lawn.

Communicating Your Data:

We will need to see your data sheets every two weeks. Either mail in your data sheet or fax it to our office at 930-1753.

Communicating Problems:

PLEASE CALL FELIPE IF THERE IS A PROBLEM WITH YOUR LAWN OR YOU NEED CLARIFICATION ON INSTRUCTIONS! If for some reason you are unable to follow the instructions or your lawn is responding very poorly, we need to know immediately! Call Felipe at 828-4120. His will be checking his messages daily.

How to Determine Your Sprinkler Application Rate

We cannot tell you any average numbers for the output of sprinkler systems, because there are none. Each station of an individual sprinkler system varies tremendously in output. And, different locations and sprinkler equipment cause vastly different amounts of water to be applied in the same time period. For this reason, it is imperative that you conduct your own test to determine your sprinkler application rate.

Equipment Needed:

Three straight sided containers such as cake pans or tuna cans.
A ruler
A watch or timer

Steps To Follow:

1. Place out your pans in the area where you will be evaluating your grass. Space the pans apart several feet from each other in a triangular pattern.
2. Turn on your sprinkler system for 15 minutes.
3. Measure the depth of the water in each pan.
4. Add the water you measured in each pan and divide by three to obtain the average depth.
5. You now know for that area of your lawn, the application rate for a fifteen minute period.
6. To determine the sprinkler application rate for one hour, multiply by four.

**We will only ask you to apply water in increments of ¼" of water. If you find out how long it takes to apply ¼" of water, it will be easy for you to follow the instructions.

How To Obtain ET Data

We have set up an "ET Phone Line" for your convenience. Each day the message on the phone line will be updated for you.

The ET Phone Line Number is:

828-4120

Protocol A Participants:

Call the ET phone line every Monday. A pre-recorded message will have the information that you need. You may access this message by pressing three (3).

Protocol B Participants:

You will need to call the Phone Line daily to determine if the Critical Point ET has been reached. A pre-recorded message will have the information that is needed. You may access this message by pressing four (4).

If You Get A Busy Signal

If you are unable to access the Bexar County Master Gardener ET Hotline, call the Texas Agricultural Extension Office at 930-3086 and ask to speak with a member of the ET Project Team.

Questions On the ET Study: Who To Call

1. Try to Reach Your Volunteer Team Leader First
You have been assigned to a volunteer team leader in your area. This volunteer team leader will be familiar with your lawn because he/she will be making site visits regularly to check the soil moisture equipment and to see how your grass is responding to the protocol. Please try to reach this person first with any questions. You can find his/her phone number on our participants list.

2. Call ET Technical Coordinator Felipe Camacho
Felipe is responsible for coordinating the ET Pilot Study under the direction of the Texas Agricultural Extension Service. He can be reached at 828-4120 during the week. If it is an urgent matter, Felipe can be reached at his home number of 665-2901.

3. Call The Texas Agricultural Extension Service
Three staff members at the Texas Agricultural Extension Service are collaborating on the ET Project. The Texas Agricultural Extension Service Office number is 930-3091.

"DON'T BAG IT" LAWN CARE PROGRAM

Calvin R. Finch, Ph.D.
County Extension Agent—Horticulture
Texas Agricultural Extension Service

Joe G. Taylor
County Extension Agent—Agriculture
Texas Agricultural Extension Service

Fertilizing Plan

The rate of fertilizer application, the frequency of application, the ratio of nutrients in the fertilizer, and the source of the nitrogen all have a great deal to do with how fast the lawn grows.

The following fertilizing plan is designed to allow the lawn to grow at a reasonable rate and still have a good color.

Fertilizer Ratio (NPK)	**Fertilizer Analysis**	**Application rate-Pounds Per 1000 sq ft**
3-1-2*	12-4-8	8
	15-5-10	7
	21-7-14	5
or		
4-1-2	16-4-8	6
	20-5-10	5
	19-5-9	5
Other	27-3-3	4

For slow, even growth, use a fertilizer containing either sulfur-coated urea or ureaformaldehyde as a nitrogen source, rather than soluble forms, for the spring. The soluble forms, such as urea or ammonium sulfate, tend to produce very fast growth for short periods of time. Organic fertilizers are also good sources of slow release fertilizer.

Organic	9-1-1	11
	7-2-2	14

Yellowing is often caused by iron deficiency in our alkaline soil. A Fe-Iron Treatment may be necessary to improve green color of grass.

Watering Plan

Grass varieties and their need for water:

1. St. Augustine (needs the most water)
2. "Tif" Bermuda
3. Zoysia
4. Common Bermuda
5. Buffalo (needs the least water)

During the driest period of summer, our lawns usually need about 1" of water every 5 to 6 days. If water runs off the lawn before one inch is applied, turn off the sprinkler, let the water soak in for about an hour, then continue watering. To get a watering rate measure actual irrigation with use of shallow pans placed in the yard and timed. For the ET project you will be adding the water needed to replenish your soil reservoir.

The best time to water is early morning, so less water is lost by evaporation. Lawns watered too frequently tend to develop shallow root systems which make them more susceptible to grub damage and limit drought tolerance.

Mowing Plan

The "rule of thumb" for mowing home lawns is not to remove more than one-third of the leaf surface at any one time. If you use the following mowing schedule, you no longer will need to bag your grass clippings.

Type of grass	Mower Setting (Inches)	Mowing when or before this height (inches)
Common Bermuda	1 ½	2 1/4
"Tif" Bermuda	1	1½
Buffalo	4	6
St. Augustine	3	4½
Zoysia	2	3

Grass clippings left on your lawn will not contribute to thatch, but will return valuable nutrients to the soil. They usually contain about 4% nitrogen, ½% phosphorus and about two percent potassium, as well as all the necessary minor elements that plants need.

Grass clippings make an excellent compost for gardens. Compost use is the best way to improve garden soil because it returns nutrients to the soil and improves the soil's physical characteristics.

Fertilizer Application Dates

Common Bermuda:	May 1 and October 1
"Tif" Bermuda:	May 1 and October 1
Buffalograss:	May 1 or October 1
St. Augustine:	May 1 and October 1
Zoysia:	May 1 and October 1

*Slow release—spring; winterizer—fall

E. T. Project

Name: _____ Turf Variety: _____

Address: _____ Soil Depth: _____

_____ Soil Type: _____

Protocol A or B Mower Height: _____

Quadrant: _____ Stress Factor: 70 or 100

SEPTEMBER 1997

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Lawn Rating 1 2 3 4				1	2
3	4 Lawn Rating 1 2 3 4	5	6	7	8	9
10	11 Lawn Rating 1 2 3 4	12	13	14	15	16
17	18 Lawn Rating 1 2 3 4	19	20	21	22	23
24	25 Lawn Rating 1 2 3 4	26	27	28	29	30
31	This ET Calendar worksheet is designed for you to include rating your lawn quality each Monday. 1) Excellent 2) Good 3) Fair 4) Poor					

Also, please include the following information on your calendar as the event occurs:
A) Fertilizer Applications B) Herbicide Applications C) Rainfall D) Insect Damage
E) Disease F) Mechanical changes G) Mowing Date

* Rate your lawn prior to watering.

EVAPO-TRANSPIRATION TESTING AGREEMENT

In order for the lawn demonstrator to be an eligible participant of the Evapo-transpiration Project testing he/she must agree to the following:

1. Test sites must have a well-established turf grass.

2. Allow Master Gardener, Extension Service and other ET officials to have access to the part of your property involved in the experiment for the purposes of the experiment.

3. Attend a training session where the following will be reviewed:

   A. Watering program procedures
   B. Determine the sprinkler application rate
   C. Measure PET (Potential Evapo-transpiration)
   D. Rate turf quality
   E. Look for signs of disease and stress

4. Bury one (1) soil moisture sensor in the yard.

5. Record all data on provided data table.

6. Follow Texas Agricultural Extension Service recommendations for lawn care.

   A. Mow at height and frequency recommended for your grass variety.
   B. Apply recommended amounts of fertilizer.
   C. Lawn clippings cannot be bagged.

7. Post a sign in a visible spot identifying the lawn as part the experiment. The sign will help educate area residents to the potential of ET.

8. Allow the San Antonio Water System to release to ET staff information on your water usage for two years past and during the experiment for analysis of changes in water use. No names will be published and your data will be used only as part of the statistics of the project.

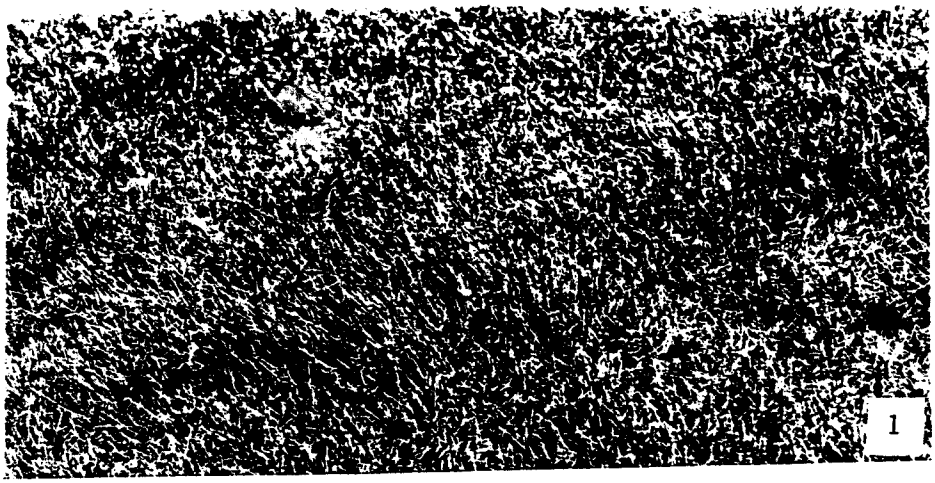
I agree to follow the Evapo-transpiration study guidelines as described above. As part of my participation, I will receive free lawn fertilizer, a Lawn Care/Evapo-transpiration Notebook, and will have available Master Gardener and Extension Agent resources for consultation on my lawn as needed.

_____ _____

Lawn Demonstrator Signature Date

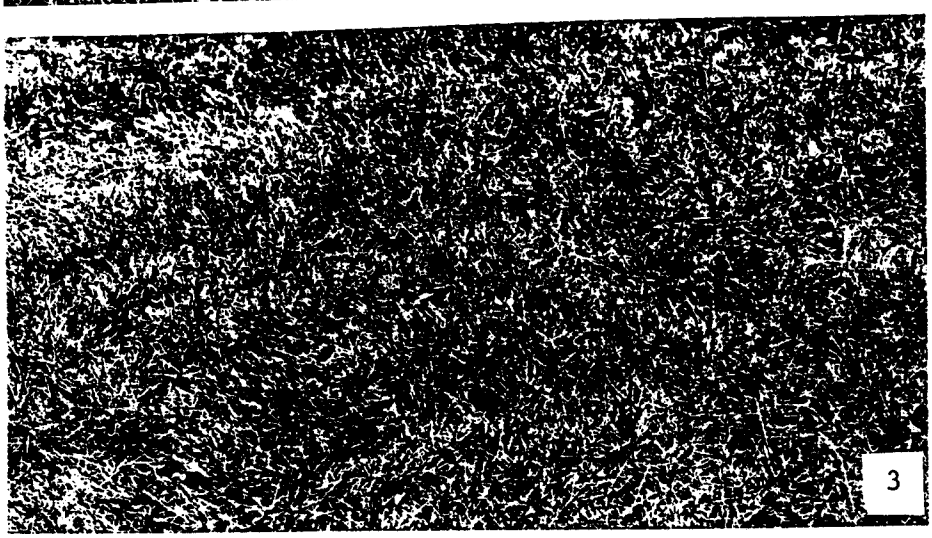

E
II
III
IV
IV
KENDALL CO.
COMAL
COUNTY
GUADALUPE
COUNTY
ATASCOSA
COUNTY
WILSON
COUNTY
LEON SPRINGS
MILITARY
RESERVATION
Leon Springs
Grey Forest
San Geronimo
Bexar
Helotes
Oakland Estates
Boerman
Hill Country Village
Shavano Park
Wetmore
Selma
Live Oak
Converse
Universal City
Schertz
Windcrest
Monte Noble Park
SAN ANTONIO
Macdona
Von Ormy
Atascosa
Mitchell Lake
Buena Vista
Elmendorf
Lonaya
Theims
Martinez
St Hedwig
Thins Grove
Sayers
Lone Oak
BRAUNIG PLANT DIKE
98°15'
SOUTHERN PACIFIC
MISSOURI PACIFIC

ZOYSIA

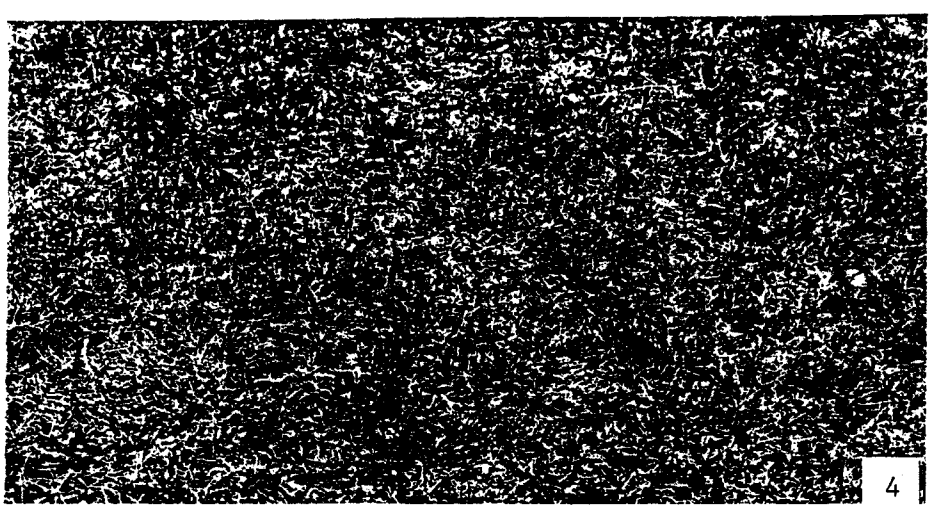


1. EXCELLENT: The turf is very dense with no ground visible when looking from above. The color is a uniform green with no yellowing. No weeds or bare spots are evident.

2. GOOD: No ground is visible when looking from above. The color is uniform green nearly throughout. There may be a few areas with color variation. Very few weeds are evident and there are no completely bare spots.

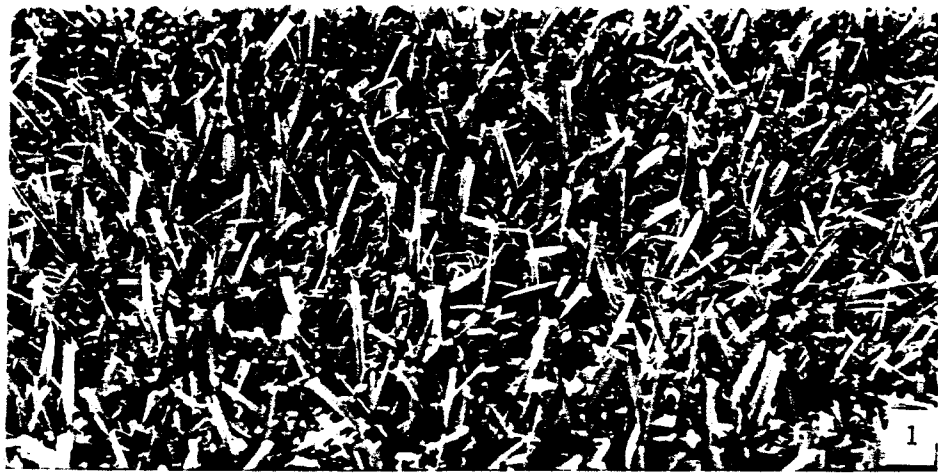


3. FAIR: There are areas in the lawn where the grass is thin enough to see soil through the stems, but most is dense enough to cover the lawn. Variations of green color and some browning are evident. Some weeds may be evident in the thin areas.

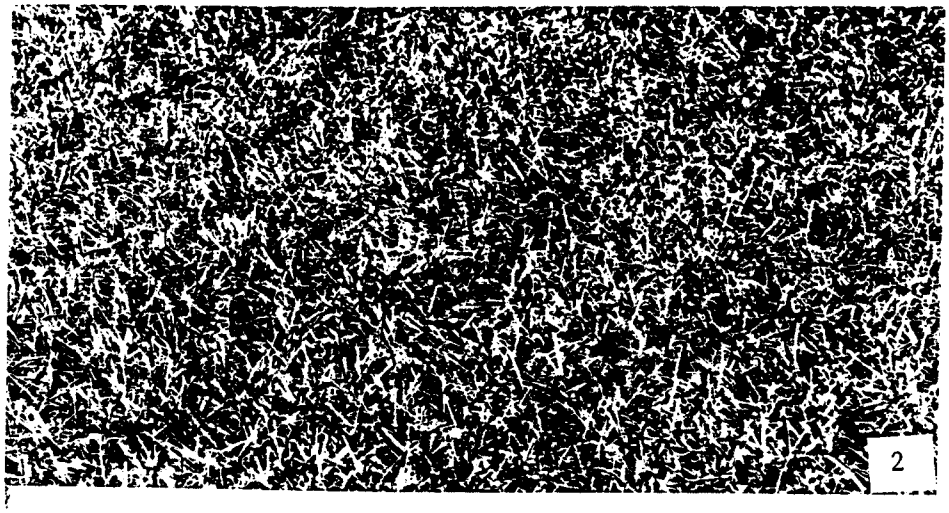


4. POOR: The lawn is not dense enough to cover the soil. There are brown patches and bare spots. Weeds have invaded the lawn and are obvious.

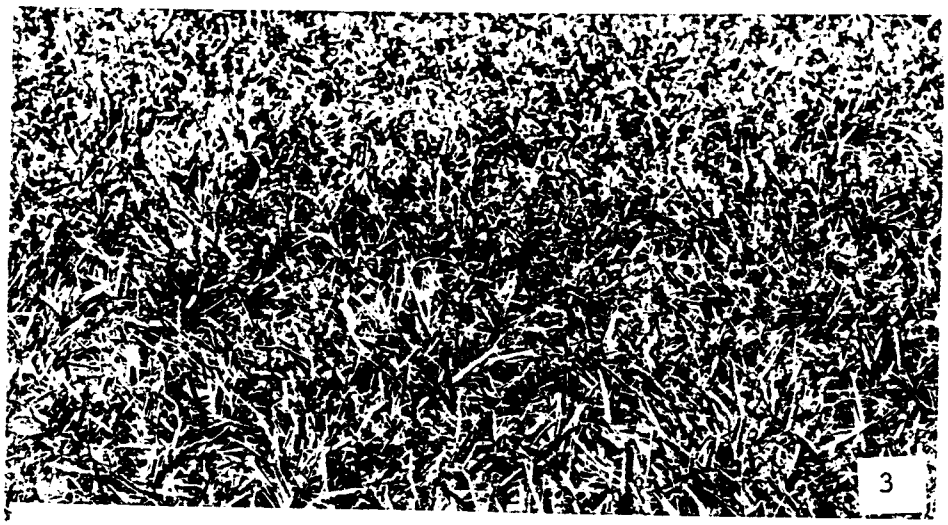
ST. AUGUSTINE



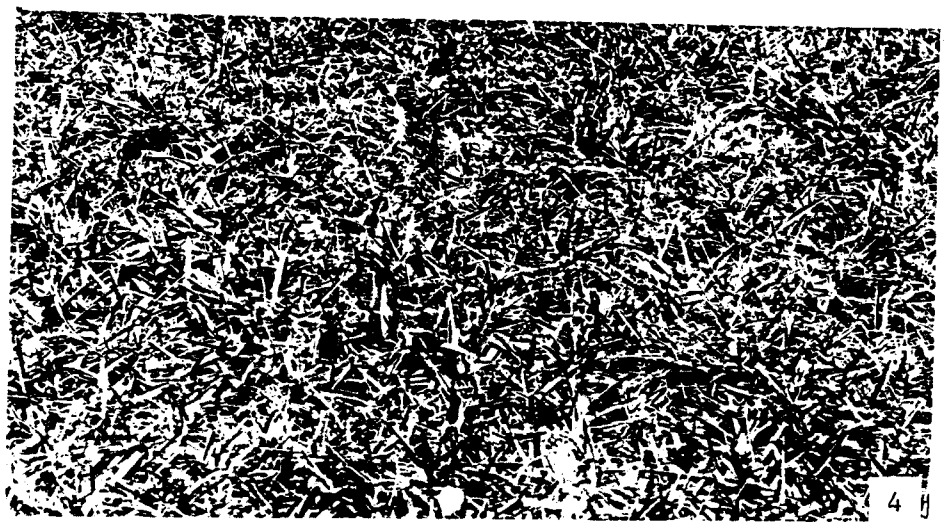
1. EXCELLENT: Density — very thick; lush green color; no yellowing; Blades flat and wide; sod springs back after walking over in the morning; no evidence of weeds.



2. GOOD: Density — No evidence of bare ground, however grass blades are not thick and close; green in color, may be mottled dark and light green areas; blades are flat but may curl in the heat of the afternoon on hot days; no evidence of weeds.

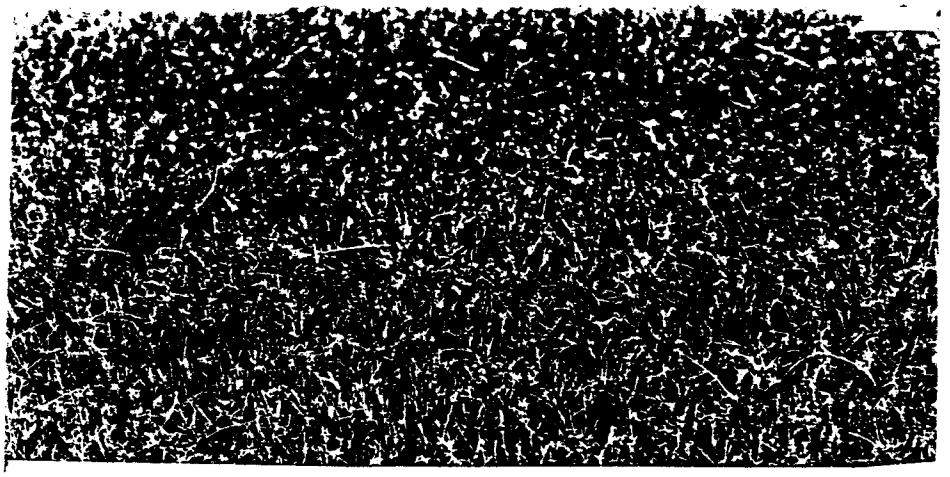


3. FAIR: Density — finding sparse, scattered bare spots; yellowing may be present; leaf blades may be curled and show browning of leaf margins; weed encroachment is evident. Grass doesn't spring back after walking over.

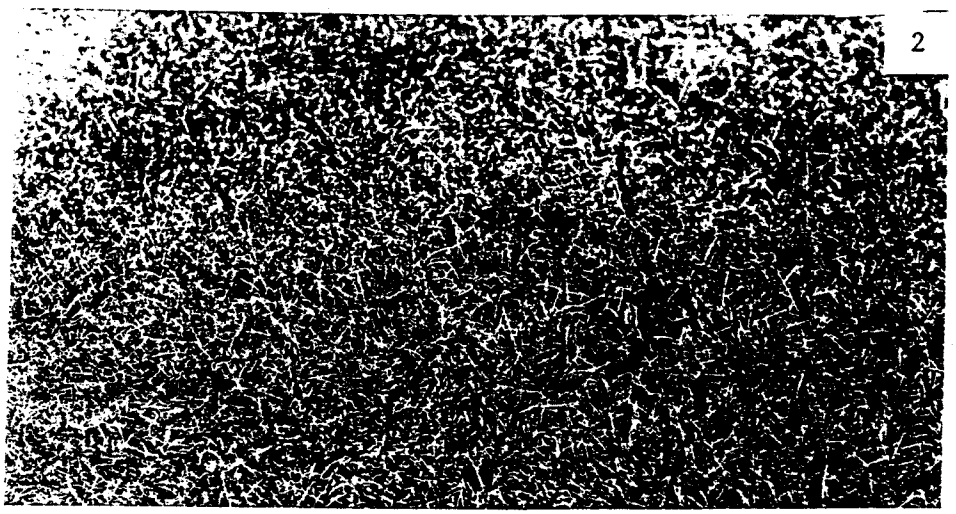


4. POOR: Density — finding several scattered bare spots; yellowing and off-green color is present; leaf margins are brown; disease symptoms may be present; weeds are present and represent more than 25% of turf area. Grass is stressed and does not respond or spring back after walking over.

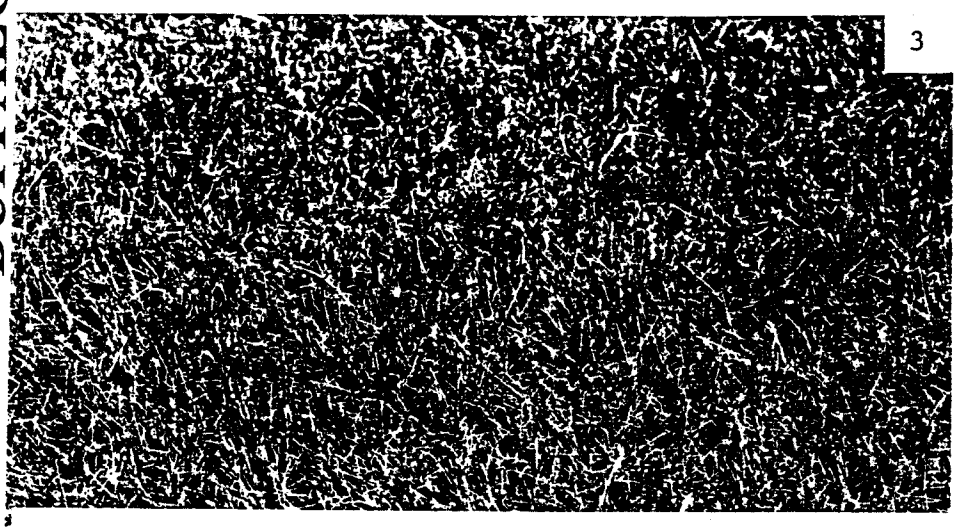
BUFFALOGRASS



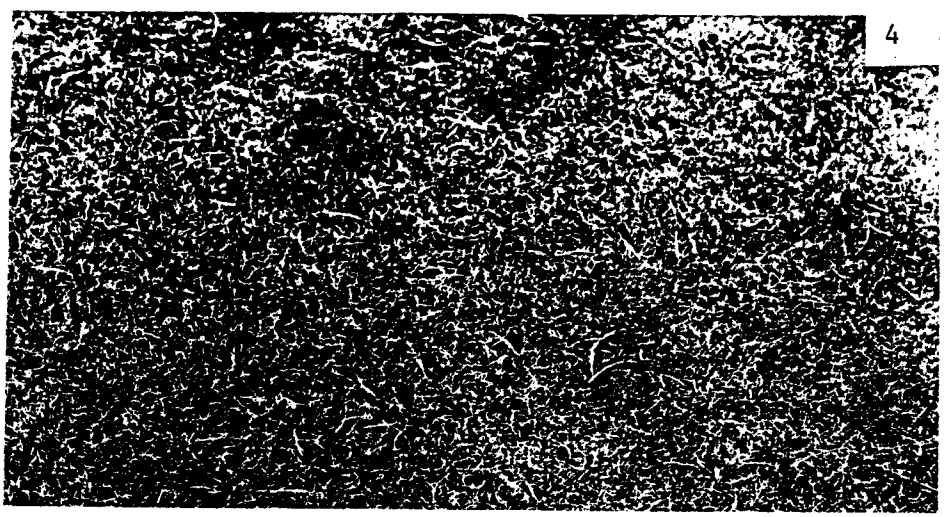
1. EXCELLENT: The turf is a pure stand of buffalograss with no Bermuda grass or other weeds evident. The entire lawn is growing at the same rate and the color is uniform.



2. GOOD: The turf appears to be a pure stand of buffalograss with no weeds evident. The lawn may have some areas of shallow surface browning, but is generally a uniform green throughout. Growth is generally even throughout the lawn.

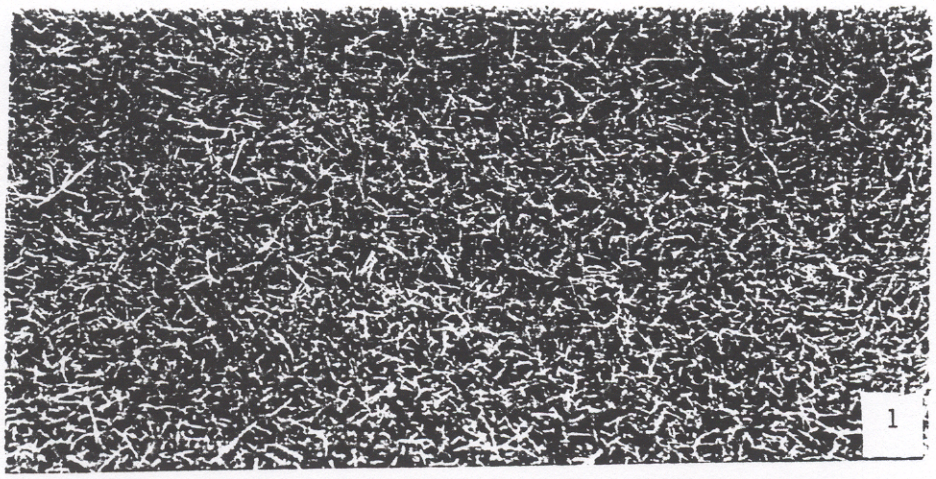


3. FAIR: There is Bermuda grass or other weeds in the lawn but the lawn still is dominated by buffalograss. Some off-color areas and variations in density are evident.

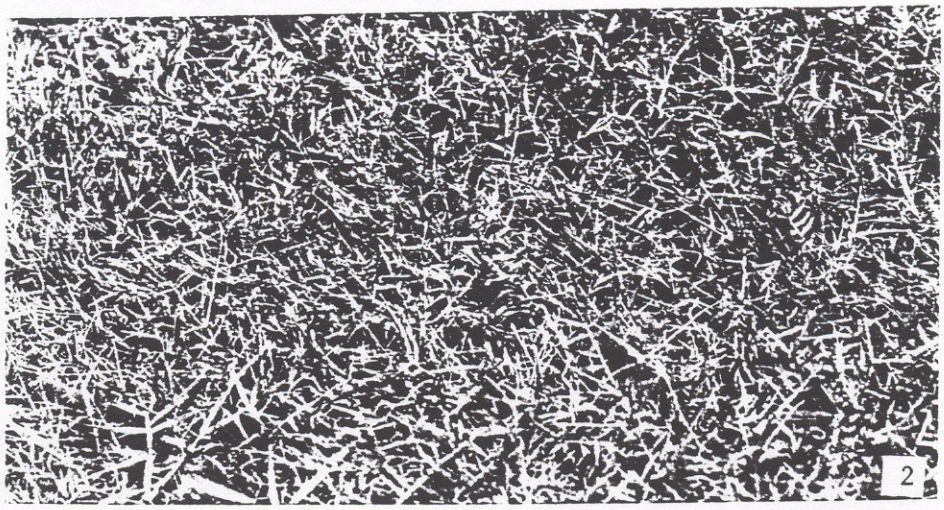


4. POOR: The density of the grass is uneven through the lawn. Weeds are very evident. Bare spots and areas of uneven growth exist and off-color areas are obvious.

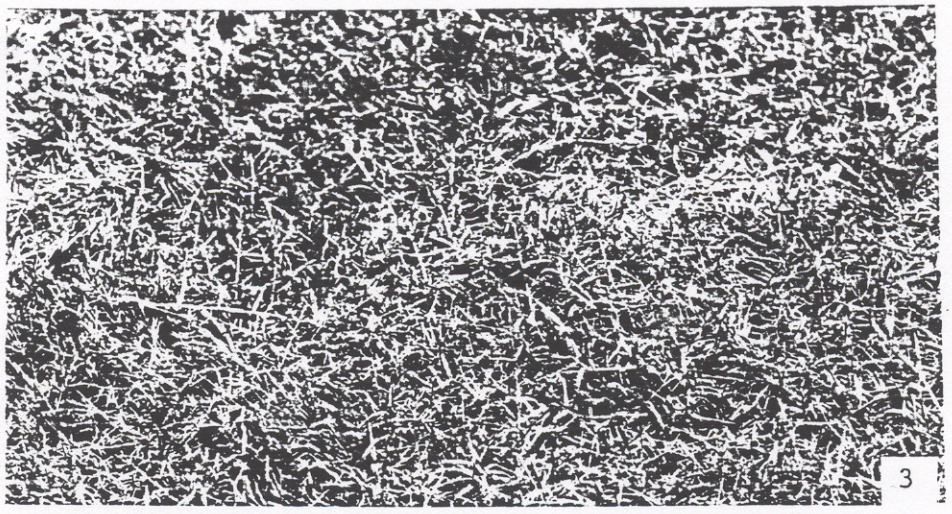
BERMUDA



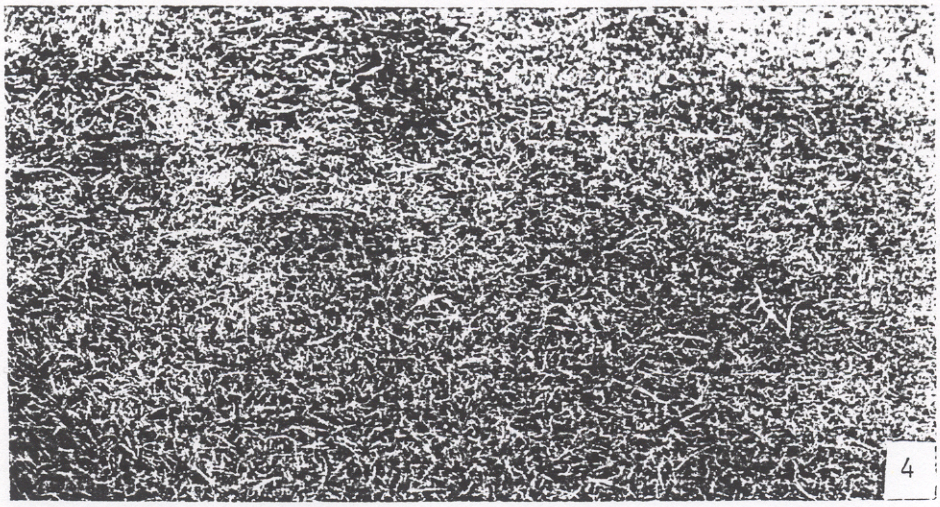
1. EXCELLENT: Density — very close spacing of leaves and stolens; lush green in color; no brown on leaf margins, no evidence of weeds; appearance is similar to that of a well kept golf green.



2. GOOD: Density — no evidence of bare ground, may see runners moving to thin areas; green in color; grass springs back well to walking pressure; no evidence of weed encroachment.



3. FAIR: Density — Plant stolens are thin, evidence of bare spots sparsely scattered, lots of runners may be present; evidence of weeds is noticed; brown and yellowing or light green plants are seen.



4. POOR: Density — thin with lots of bare ground; grass is brown under heat and water stress; grass may be dormant in excessively dry areas; evidence of weeds such as crouton, pig weed, purslane, and dollar weed are present.