THE IMPACT OF GOLF COURSE CONSTRUCTION AND MANAGEMENT ON SOIL QUALITY: EVALUATING SOIL QUALITY WITH MULTIPLE INDICATORS

by

GREGORY DENNIS PILLAR

B.S., University of Minnesota, Minneapolis, MN, 1999

A THESIS

submitted in partial fulfillment

of the requirements for the degree

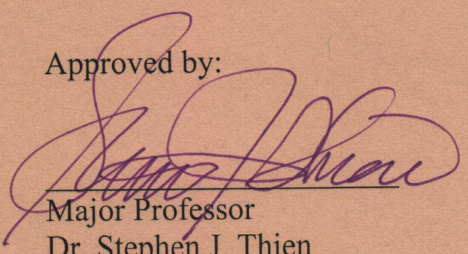
MASTER OF SCIENCE

Department of Agronomy
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2002

Approved by:



Major Professor
Dr. Stephen J. Thien

THE IMPACT OF GOLF COURSE CONSTRUCTION AND MANAGEMENT ON SOIL QUALITY: EVALUATING SOIL QUALITY WITH MULTIPLE INDICATORS

by

GREGORY DENNIS PILLAR

B.S., University of Minnesota, Minneapolis, MN, 1999

A THESIS

submitted in partial fulfillment

of the requirements for the degree

MASTER OF SCIENCE

Department of Agronomy
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2002

Approved by:

Major Professor
Dr. Stephen J. Thien

ABSTRACT

Somewhere in the United States, on average, more than one new golf course opens every day. With the recent boom in golf course construction, there is greater need to understand the environmental impacts of construction and management of golf courses. Golf courses are only as sustainable as their weakest natural component, which is often soil quality. Little research has been conducted on the assessment of the long-term impact and sustainability of golf courses on the soil environment. A method for evaluating environmental quality of large-scale landscapes such as golf courses that connects scientific research and public use is in great demand. The development of a multiple indexing system to gauge the environmental quality of golf courses was used to examine the impact and influence of golf course construction and management on soil quality. The overlying goal was to use the multiple indexing system (spider/radar graphs) to assist golf course superintendents to evaluate environmental quality.

Two studies conducted at Colbert Hills Golf Course in Manhattan, KS were used to assess the impact of golf course management and construction on environmental quality. A small-scale study was used to evaluate the use of swine and dairy compost on high-sand greens and tee boxes. Seventeen soil quality indicators were monitored over six months from May to October 2000. Even over this short time these amendments influenced some of the soil quality indicators. The use of a multiple index system allowed for easy identification of areas requiring remediation or additional attention.

A second study was initiated in 1997-1998 to assess the impact of golf course construction on environmental quality. Measurements of native, or pre-construction conditions were made on a natural grassland site prior to construction to establish base-

line values for a host of physical, chemical, and biological soil quality indicators. After construction was completed in May 2000, the same sites were sampled each spring and fall. Using a multiple indexing system (spider/radar graphs), the status of eighteen different soil quality indicators were monitored. The construction of Colbert Hills and the resulting management have impacted numerous soil properties. The construction of the golf course had an immediate impact on soil quality indicators and while some such as aggregate stability and soil pH have started to slowly return to pre-construction conditions, others such as numerous biological properties continue to be at levels below the pre-construction conditions. Further work is recommended to closely monitor indicators that continue to be below or above established control limits. Additional research will help to strengthen soil quality indices as well as provide more conclusive evidence about the impact golf course management and construction has on environmental quality. Use of the spider/radar graphs to evaluate the status of environmental quality at Colbert Hills Golf Course has illustrated the promise this technique has as a management tool.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

I am indebted to my major professor Dr. Steve J. Thien for his support, encouragement, guidance, and patience throughout my academic career at Kansas State University. Thank you to Bion Technologies Inc. and Kansas State University for funding and support that allowed me to continue my education and studies in soil science.

I am extremely thankful to my graduate supervisory committee members: Dr. Kang Xia and Dr. Charles Rice for serving on my committee and for guidance and assistance through my studies.

Thank you to David Gourlay, Paul Davids and the staff at Colbert Hills Golf Course for their cooperation, support, and patience throughout my research. Special thanks goes to the Department of Agronomy for providing an environment in which to work, learn, and have fun.

Millions of thanks goes to the Kansas State Soil Testing Lab for all their help and enthusiasm. Special thanks goes to Gary Griffth and Sherrie Fitzgerald for being so friendly and willing to answer questions and for handling my ever growing number of soil samples. Thank you to the Microbial Ecology Lab, especially Maysoon Mihka, for all their help with the biological soil studies.

I am very thankful for the help of my research assistants, especially Angela Lickteig for her help over the last two years on this project. I am also extremely grateful to all my friends and fellow graduate students for their help, advice, and friendship

Most importantly, the utmost thanks and gratitude goes to my family, especially my parents Dennis and Mary Pillar. Thank you from the bottom of my heart for your love, support, and guidance.

Dedicated to

My grandfather

Richard A. Williams

with love, respect, and admiration