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GOLF COURSE MANAGEMENT:

ENVIRONMENTAL ISSUES

A Final Report to the United States Golf Association: Green Section on the Manuscript Submitted to Lewis Publishers Inc.

October 4, 1991

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Contract Performance Period: 3/29/91 to 9/29/91
Completion Date: 10/4/91

1.0 Scope and Objectives of the Project

A report on the environmental effects of golf course and turfgrass management was originally developed by Spectrum Research, Inc. for the United States Golf Association: Green Section (USGA). With growing public concern over environmental, water use, water quality, and health related issues, the USGA recognized the need for accurate and unbiased information on the potential effects of certain turfgrass management practices. With their active commitment to resource conservation and mitigation of potential adverse environmental effects of turfgrass systems, both the USGA and Spectrum Research, Inc. recognized the need to disseminate this report to turfgrass managers, other scientists, and the public. To meet this objective Spectrum Research, Inc. substantially revised and improved the original report for publication by Lewis Publishers, Inc.

The final manuscript for the book titled "Golf Course Management: Environmental Issues", was submitted to Lewis Publishers, Inc. on October 4, 1991. The manuscript significantly updates and augments the original report. The book is a summary and assessment of the technical and scientific research on the environmental effects of turfgrass management and to a smaller extent golf course construction. This book is intended as an introduction to the concepts of the nonpoint source environmental impacts of turfgrass management for turfgrass scientists and specialists, landscape and golf course architects, developers of turfgrass systems and golf courses, golf course superintendents, environmental scientists, and land use regulators.

The manuscript is organized into eight chapters. The introduction provides an overview and historical perspective regarding turfgrass management and environmental quality. The second chapter discusses the relationship of turfgrass management to the critical issues of water resources. This chapter focuses on the issues of water use, water quality, soil and water conservation, and movement within the water cycle. Chapters three and four provide a state-of-the-art scientific review and assessment of the literature regarding the environmental effects of nutrient and pest management practices. The fifth chapter provides an introduction to concepts necessary for development of integrated management systems for turfgrass. Chapter six covers the direct and indirect effects of golf course management and construction on wildlife and aquatic organisms. The seventh chapter is an introduction to the critical issues of conservation and protection of wetlands which is emerging as a critical environmental concern of the 1990s. Chapter 8 contains tables of toxicity tests related to the effect of chemicals used for turfgrass management. Each of the chapters includes a section on research and information needed to resolve the issues surrounding the positive and potentially adverse effects of

turfgrass management. An outline of the manuscript is provided in Section 2.0.

Many individuals made significant contributions in preparing this publication. The contributors and reviewers included staff members of Spectrum Research, Inc., the staff of the USGA; members of the USGA research committee; scientists from Environmental Chemistry and Lockheed Engineering & Sciences Company; and academic scientists (Table 1). All of the contributors were cooperative and made timely contributions to the quality of the publication. Several authors and reviewers were pivotal in enhancing the quality of the book. Spectrum Research, Inc. specifically acknowledges the outstanding efforts by Michael P. Kenna, James R. Watson, Victor A. Gibeault, James T. Snow, and Anne R. Leslie in making this publication possible. In addition to authorship, their reviews and professional guidance were greatly appreciated by the editors and co-authors.

Ultimately, the objective of this project is to objectively distribute information regarding the environmental effects of golf course management. This will be an ongoing process for the USGA environmental research program. The staff of Spectrum Research, Inc. believes the book, Golf Course Management: Environmental Issues, will make a positive contribution to the long term goals of the research efforts of the USGA.

Table 1. List of Contributors.

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2.0 Outline of the Publication

Chapter 1 BACKGROUND AND OVERVIEW OF ENVIRONMENTAL ISSUES

James C. Balogh, Victor A. Gibeault, William J. Walker, Michael P. Kenna, and James T. Snow

1.1 Introduction

1.2 Environmental Issues and Turfgrass Management: A Historical Perspective

1.3 Scope of the Turfgrass Industry

1.4 Environmental Benefits of Turfgrass Systems

1.5 Identification of Environmental Impacts and Nonpoint Pollution Problems in Turfgrass Systems

1.6 Benefits of Implementing Integrated Turfgrass Management Strategies

1.7 Objectives and Sources of Information

Chapter 2 ROLE AND CONSERVATION OF WATER RESOURCES

James C. Balogh and James R. Watson

2.1 Introduction: Water Resources and Turfgrass

2.2 Components of the Water Cycle, Soil, and Turfgrass Systems

2.3 Transport Processes

- 2.3.1 Surface Water
- 2.3.2 Groundwater
- 2.3.3 Water and Chemical Movement in the Unsaturated Zone
- 2.3.4 Soil Properties Affecting Movement of Turfgrass Chemicals
- 2.3.5 Additional Concerns for Susceptibility of Groundwater to Contamination
  - Includes section on leaking underground storage tanks.

2.4 Soil and Water Conservation in Turfgrass Management

- 2.4.1 Sediment and Runoff Control with Turfgrass
  - 2.4.1.1 Processes and Control for Established Turfgrass
  - 2.4.1.2 Runoff and Sediment Control During Site Construction and Turfgrass Establishment
  - 2.4.1.3 Design Considerations to Reduce Runoff and Erosion
- 2.4.2 Turfgrass and Water Conservation
  - 2.4.2.1 Water Stress and Mechanisms to Resist Drought
  - 2.4.2.2 Water Use and Drought Resistance
  - 2.4.2.3 Water Conservation and Cultural Practices: Mowing, Fertilization, and Irrigation

2.5 Research Needs

Chapter 3 ENVIRONMENTAL IMPACTS OF TURFGRASS FERTILIZATION

William J. Walker and Bruce Branham

3.1 Use of Turfgrass Fertilizers and Environmental Impacts

- 3.1.1 Use of Fertilizers in Golf Course Construction and Maintenance
- 3.1.2 Environmental Issues Related to Fertilizer Use in Turfgrass Systems
- 3.1.3 Health Issues of Inorganic Fertilizers and Nitrate in Drinking Water