Soil-Water Engineering

Field and Laboratory Manual

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Foreword

This manual is one of a series supplied to participants in a workshop titled ``Diagnostic Analysis of Farm Irrigation System." The purpose of this manual is to provide the student with basic measurement procedures, suitable for the laboratory and field, for conducting field studies of farm irrigation systems. The original draft of this manual appeared as part of Volume II of the Monitoring and Evaluation Manual. With its evolvement to the present form, a separate volume for soil-water engineering measurements is provided.

The participant in workshop on ``Diagnostic Analysis of Farm Irrigation Systems" should use this manual as a reference for correct laboratory and field measurement procedures. Personnel conducting actual field studies of irrigation systems should also find this manual to be a valuable reference. The equipment lists for each exercise are for determining equipment needs for planning the field study or a workshop. The analysis and discussion suggestions are appropriate for the data collected during the study.

Comments about or suggestions for improving the manual are welcomed and should be sent to the senior author or the Water Management Synthesis Project. Additional copies are available through the Project.

Wayne Clyma
Project Coordinator
Water Management Synthesis Project

Preface to the Manual

This manual is designed to teach basic methods for measuring the soil-water properties most important to irrigation and drainage engineers. The first three exercises describe methods to measure soil properties which affect the soil water. The following three exercises describe methods to measure soil water. Exercises 7, 8 and 9 describe methods to measure parameters which affect soil-water movement. The final three exercises describe measurements which help to determine the quality of soil water for plant use, and the inflows to and outflows from the soil-water reservoir.

Each exercise is divided into five main sections:

1. Introduction
2. Equipment
3. Procedure
4. Analysis and Discussion, and
5. References

The **Introduction** briefly describes the property to be measured and its use to a soil and water engineer. The equations used to calculate the property are developed and the measurement technique is described. Special equipment is also described in this initial section.

The **Equipment** section lists all equipment required to carry out the exercise. The list is divided into two groups. The first group is the special equipment needed for the exercise, followed by a list of equipment which is also used in several other exercises. This often used equipment which is listed in Appendix 1 should be left accessible to the students. An attempt has been made to use as little specialized equipment as possible.

The third section lists the step-by-step **Procedure** to be followed to make the required measurements and the necessary calculations. All collected data can be recorded on the data sheets which are inserted at the end of each exercise. The sheets also should be used to record calculated values. Sections 2 and 3 give all the information required to carry out the exercise.

The fourth section of each exercise describes any **Analysis** which should be done on the results and suggests possible difficulties in the procedures or implications of the findings which should be discussed in the laboratory report. Appendix 2 described several statistical analyses which can be used.

The final section of each exercise lists several sources of additional information on the various procedures. Emphasis is on alternative standard procedures with the methods of the American Society for Testing and Materials (ASTM, 1930), the American Society of Agronomy (Black *et al.*, 1965), the U.S. Bureau of Reclamation (USBR, 1974), and the British Commonwealth Bureau of Soils (1974) referenced when applicable. When more specific information is required regarding the development of or alternatives to the given procedures and instrumentation, it is suggested that the professional literature be searched with assistance from **Soils and Fertilizers,** an indexing and abstracting publication prepared by the Commonwealth Bureau of Soils.

The laboratory exercises can be best carried out in groups of 3 or 4 students. Sufficient space and equipment should be available to allow the groups to work as independently as possible, although items such as balances, ovens, and dessicators can be used cooperatively. Several exercises involve the use of more than one method to make the required measurements. The equipment for these exercises can be used by the different groups in turn.

In order to develop an appreciation for the variability of soil water properties and the difficulty of precise measurements, the groups should exchange results. A comparison and statistical analysis of the results should be included in each lab report.

The ability to describe clearly, in writing, a measurement procedure, the results of a study, and the implications of the results is very important to engineers. Writing and evaluating laboratory reports can improve this ability. Writing reports is thus strongly recommended. A suggested outline for laboratory reports is given in Appendix 3. Because writing good reports requires a significant investment of a student's time, it is suggested that, for each exercise, one member of each group write the report, while the other members only turn in their results and a one page discussion. The report writing responsibilities are then rotated among the group members so that each student would write a total of three or four major reports.

Because soil properties are often interrelated (for example, porosity calculations require both bulk and particle density values), and because it is instructive to measure several properties of the same soil, use of one soil or the same set of soils for as many of the exercises as possible is strongly recommended.

Due to both predictable and unpredictable weather variations, it is possible that the exercises cannot be completed in the order presented. Exercises 2, 3, 4, 7 and 10 are carried out inside the laboratory, while the remainder are field exercises. In sequencing the labs, both the class subject matter and the relationships between lab topics should be considered.

Acknowledgements

This laboratory manual evolved in response to the need for a manual for a Soil-water Engineering Laboratory (AE300) taught at Colorado State University and for a training manual of field procedures for evaluating farm level irrigation water management. The original manual was developed by Ignacio G. Garcia-Casillar and edited by W.E. Hart. That version was then expanded and extensively revised into the present format. In addition Gerald Buchleiter was the primary contributor to Exercise 12.

The manuscript was graciously reviewed by George Hargreaves of Utah State University, Harold Duke and Gordon Kruse of USDA/ARS, and Dave McWhorter. Bill Franklin, Bob Danielson, Gaylord Skogerboe, Walter Baush, and Terry Podmore of Colorado State University. In addition, the students of AE300, who were forced to work from drafts of this manual, offered numerous suggestions and pointed out numerous errors which has led to an improvement in its accuracy and content.

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