Chapter 1: Introduction

1.1 Overview

Weather-based evapotranspiration (ET) irrigation control has long been a tool of large agricultural operations, maximizing crop yields through pinpoint management of crop watering. The Residential Runoff Reduction (R3) Study was conducted to evaluate the applicability of ET technology for other uses. This chapter of the study report presents the following:

- Background information on study rationale;
- Specific study goals and objectives;
- Identification of study partners and their roles/contributions to the study.

The organization of this report is also described, and commonly-used abbreviations and acronyms are listed. References used during the study are presented in Appendix A.

1.2 Background

Approximately 58 percent of residential water demand is used for outdoor purposes, primarily for home landscape irrigation (AWWARF Residential End Uses of Water, 1999). Excess irrigation results in inefficient use of valuable water supplies and increased runoff that is the transport mechanism of pollutants that enter natural waterways and, ultimately, the Pacific Ocean for areas along the west coast.

Landscape water use efficiency/water conservation and watershed management in the urban sector are linked. Water agencies throughout the state are implementing 14 Best Management Practices (BMPs) to increase the efficient use of urban water supplies including landscape irrigation efficiency. Cities and counties are also implementing National Pollutant Discharge Elimination System (NPDES) permit requirements containing BMPs for watershed management focused on runoff reduction.

Recent studies in Orange County have had promising results. In 1998-1999, Irvine Ranch Water District (IRWD), Municipal Water District of Orange County (MWDOC), and the Metropolitan Water District of Southern California (MWD) conducted a study that evaluated the use of weather-based ET irrigation control technology at 40 residential homes in the Westpark area of Irvine. The report from this research, entitled "Residential Weather-Based Irrigation Scheduling: Evidence from the Irvine 'ET Controller' Study," showed water savings that translated to 37 gallons per day (gpd), or 7 percent of total household water use/16 percent of irrigation water use.

In April 2001, water savings from the ET Controller study in Westpark were evaluated through September 2000, or the second post-retrofit year. This evaluation confirmed the persistence of water savings observed during the initial evaluation. More specifically, this evaluation concluded that ET Controllers were able to reduce total household water consumption by roughly 41 gallons per household per day, representing an 8 percent reduction in total household use, or an 18 percent reduction in estimated landscape water use.

The R3 Study represents the next phase of research associated with the new irrigation control technology linking benefits to watershed management.

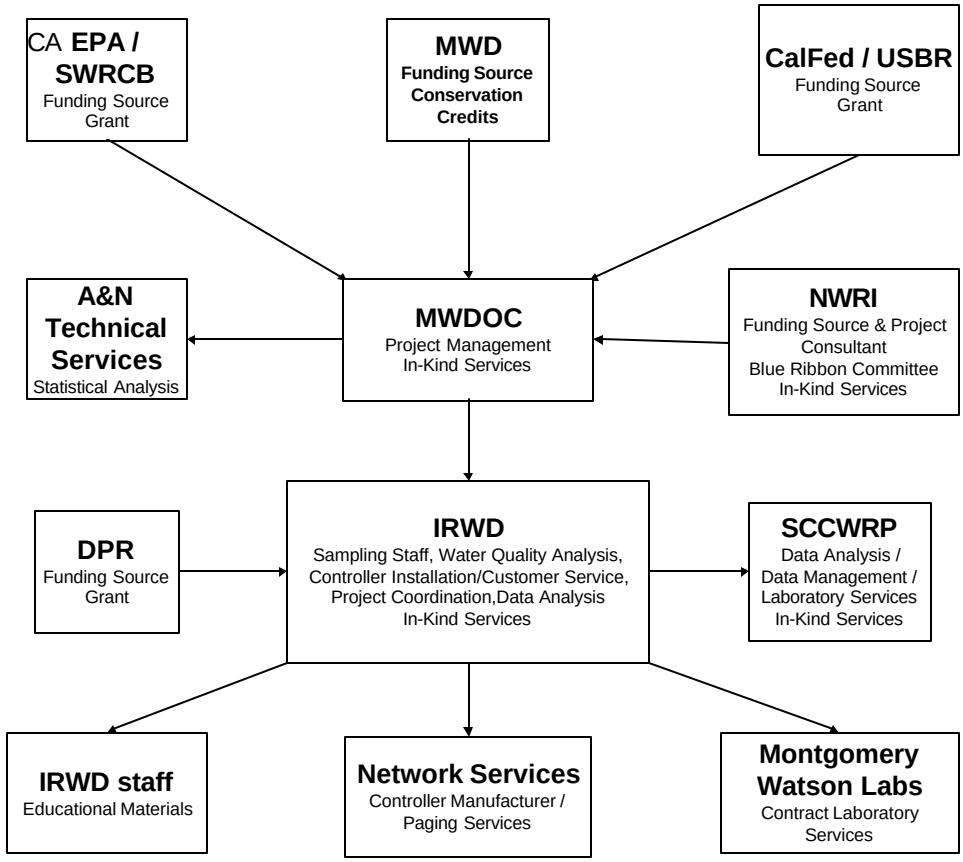
1.3 Study Goal and Objectives

The goal of the R3 Study was to quantify ET Controller savings for single-family residences and large landscape users. The study had four primary purposes: 1) to develop and expand the application and use of pager-signal (electronic controller) technology to manage irrigation water for residential homes and large landscape areas; 2) to evaluate the effectiveness of a targeted education program; 3) to determine the connection between proper water use in the landscape and the quantity and quality of dry weather runoff; and 4) to gauge the acceptance of water management via the controller technology.

1.4 Study Partners

The R3 Study was made possible through a partnership of agencies and organizations committed to improved water use efficiency and watershed management. The members of the partnership are shown on Figure 1-1. The figure also indicates the roles played by each study partner.

Figure 1-1
R3 Study Partners



As shown on Figure 1-1, the R3 Study involved a diverse mix of study participants and funding agencies bringing equally diverse interests and visions to the project. In general, the study was based on the premise that runoff from poor irrigation practices from urban areas in the San Diego Creek watershed constitutes non-point source pollution and contributes to water quality problems both in the Creek and in Newport Bay, the receiving water for the Creek. Although water quality problems in the Creek and Bay have been well documented, data on the specific sources of these pollutants is limited.

The R3 Study was intended to focus on and analyze both the quality and quantity of runoff from relatively small sub-areas of the watershed to provide insight into the sources of pollution in the Creek and Bay. In addition to providing this baseline information, the study was intended to evaluate the effectiveness of two methods of reducing runoff and improving water quality: 1) education; and 2) education combined with ET controller technology. Furthermore, since irrigation runoff is 100 percent water waste, the water agency participants were very interested in the ability of the study intervention methods to reduce customer water usage.

The R3 Study presented a good opportunity to develop valuable information about the relative effectiveness of structural (retrofit) versus non-structural (public education) controls. A technology + education (retrofit group) BMP was applied in one neighborhood, an education-only BMP was applied in a second neighborhood, and a control was established through three additional neighborhoods.

A more detailed discussion of the study participants is provided below. For purposes of simplicity, the organizations are categorized as agencies responsible for water quality, agencies responsible for water supply, and "supporting participants." However, in many cases, these objectives are overlapping and are not mutually exclusive.

1.4.1 Agencies Responsible for Water Quality

Study participants whose major area of responsibility is water quality include the California Environmental Protection Agency (CAEPA), the State Water Resources Control Board (SWRCB), the Regional Water Quality Control Board (RWQCB), the California Department of Pesticide Regulation (DPR), the County of Orange, and the Southern California Coastal Water Research Project (SCCWRP). These agencies are charged with regulating, enforcing, implementing, or researching and monitoring federal and state laws pertaining to water quality and the control of constituents which may degrade water quality. For example, the RWQCB is responsible for establishing limits on the amount of pollutants that can be discharged to Newport Bay. These limits are defined as "Total Maximum Daily Load" (TMDL). The County of Orange, which provided indirect funding to the study through DPR, is the primary permittee on the Municipal Separate Storm Sewer System (MS4) Permit issued by the RWQCB. The County's primary interest in the study relates to their efforts to implement a comprehensive program of BMPs to meet the TMDLs as required by the MS4 permit. In addition to providing improved baseline water quality and runoff information, these agencies focus on gauging the

effectiveness of the two study intervention methods in reducing the quantity of runoff and improving the quality of the water that does run off.

l.4.2 Water Agencies

IRWD and MWDOC are water districts whose primary mission is to provide safe and reliable water service to customers within their respective service areas. The reliability of water service, in particular, is directly related to the efficiency of water use. In other words, since supplies of reasonably priced water are essentially fixed, increases in efficiency can result in additional supplies being available for storage until they are needed during periods of supply shortages.

Both IRWD and MWDOC, as well as MWDOC's "parent" agency, MWD, operate various water efficiency/conservation programs within their service areas. Some progress has been made on increasing water use efficiency from programs targeting outside use for landscape irrigation (which generally accounts for about 50 percent of total urban water use). However, water use in this sector remains closely linked to the ability and responsiveness of landscape personnel with responsibility for controlling and adjusting irrigation control timers.

Two basic issues are associated with this "people to water use efficiency" link. First, there is a wide variation in the abilities of personnel to properly set baseline irrigation schedules based on site factors (type of plant material, soil, exposure, slope, irrigation equipment, etc.). Second, for various reasons, it is believed that very few of these timers are adjusted on a sufficient frequency to promote optimum water use efficiency. Consequently, the water agencies are very interested in technologies such as the irrigation controller tested as a part of the R3 study. This technology allows irrigation schedules to be automatically adjusted based on real-time weather conditions. Equally important, the technology provides the ability to set appropriate base irrigation schedules by site conditions, particularly the soil type (infiltration capacity) and slope. This capability is critical to reducing runoff.

In addition to the potential effectiveness of the water management/irrigation controller program, IRWD and MWDOC were also very interested in determining if the focused educational and communication efforts tested in the study could yield customer water savings. This is particularly important since these efforts can be a very cost-effective way to achieve water savings.

In addition to water conservation, water agencies are becoming increasingly aware of their role as providers of water which, if not used efficiently, may ultimately become a nuisance or source/carrier of non-point source pollution. Consistent with its vision to optimize the use of resources as demonstrated by its globally-recognized recycled water reuse program, IRWD in particular has taken a leadership role in addressing irrigation runoff/non-point source pollution within its service area, which covers a majority of the San Diego Creek watershed. In addition to the current study focusing on potential source control measures, IRWD has prepared a master plan outlining a system of constructed wetlands which will capture and treat runoff and improve water quality in the watershed and Newport Bay.

1.4.3 Supporting Participants

The remaining study participants provided vital support for various aspects of the study. Network Services Corporation (now HydroPoint Data Systems, Inc.) manufactured the ET controllers used in the study and was responsible for compiling weather data and transmitting this information to the controllers. The National Water Research Institute (NWRI) provided input on the study design and evaluation, and A&N Technical Services prepared the detailed analysis of water savings and runoff reduction under a contract. Similarly, a portion of the water quality analysis was conducted under a contract by Montgomery Watson.

1.5 Report Organization

The R3 Study report is organized into two main parts: a body, consisting of seven chapters, followed by eight Appendices containing references and the analyses prepared by the study partners and presented in their entirety.

The first two sections of this report (Chapters 1 and 2) present general information about study goals and methodology. Chapter 1 presents study rationale, goals and objectives, and participating organizations. Chapter 2 describes how the study area was developed and presents the methodology used to develop information on the four main study areas: water conservation savings, dry season runoff/reduction savings, water quality impacts, and customer acceptance/public education.

Chapters 3 through 6 present the evaluations for the four main study areas, respectively, water conservation, dry season runoff, water quality, and customer acceptance. Each chapter provides an overview, summarizes the evaluation approach, presents results, and summarizes major conclusions. More detailed information on the evaluations is presented in the Appendices.

The final section of this report (Chapters 7) integrates study results and describes relevance for future planning and policy. Key findings, conclusions, and recommendations are presented.

The Appendices to this report contain eight sections. Appendix A, References, lists reports, articles, and other documents utilized during the R3 Study. Appendix B, Study Design, provides support information for Chapter 2, Study Methodology, and provides details on the techniques and methods used for data collection, sampling, and analysis. Appendix C, Water Conservation, presents the detailed water conservation evaluation conducted by A&N Technical Services, Inc., and includes detailed information on data models developed for the analysis. Appendix D1, Statistical Analysis of Urban Runoff Reduction, and Appendix D2, 2003 Runoff Data, present the detailed statistical analysis of runoff reduction. These analyses were also prepared by A&N Technical Services, Inc., and include detailed information on the data collection and analysis approach. Appendix E1 and E2 present Water Quality information. E1 was prepared by SCCWRP, and E2 was prepared by GeoSyntec Consultants. Finally, Appendix F, Public Education, presents information on customer acceptance and public involvement.

1.6 Abbreviations and Acronyms

The following abbreviations and acronyms are used in this report:

ADP	antecedent dry period
ANOVA	analysis of variance between groups
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
BACI	before-after control impact
BMPs	Best Management Practices
CAEPA	California Environmental Protection Agency
Calfed	consortium of state and federal agencies who address California and San Francisco Bay-Delta water issues
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CTR	California Toxic Rule
DPR	California Department of Pesticide Regulation
ET	evapotranspiration
fps	feet per second
GIS	geographic information system
gpd	gallons per day
HOA	homeowners association
IRWD	Irvine Ranch Water District
K-W	Kruskal-Wallis
mgd	million gallons per day
mg/acre/day	milligrams per acre per day
mg/L	milligrams per liter
mL	milliliters
MPN	most probable number
MS4	Multiple Separate Storm Sewer System
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
NPDES	National Pollutant Discharge Elimination System
NWRI	National Water Research Institute
OCPFRD	Orange County Public Facilities and Resources Department
OP	organophosphorus
ng/L	nanograms per liter
PCF	pressure control facility
R3	Residential Runoff Reduction Study
RWQCB	Regional Water Quality Control Board
SCCWRP	Southern California Coastal Water Research Project
SWRCB	State Water Resources Control Board
TIN	total inorganic nitrogen
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TN	total nitrogen

TP	total phosphorous
ug/L	micrograms per liter
USBR	United States Bureau of Reclamation
USEPA	Untied States Environmental Protection Agency