US Army Corps
of Engineers
Engineer Institute for
Water Resources

HANDBOOK OF METHODS FOR THE EVALUATION OF WATER CONSERVATION FOR MUNICIPAL AND INDUSTRIAL WATER SUPPLY

OCTOBER 1985

CONTRACT REPORT 85-C-3

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This Handbook is one of a series of reports and documents intended to assist the the Corps field planners in applying the appropriate techniques for evaluating water supply and water conservation This Handbook provides guidance to Corps field staff in applying The Evaluation of Water Conservation for Municipal and Industrial Water Supply: Procedures Manual, (12) (Procedures Manual) for various situations which may be encountered
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ABSTRACT (CONT.)

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HANDBOOK OF METHODS FOR THE EVALUATION OF WATER CONSERVATION FOR MUNICIPAL AND INDUSTRIAL WATER SUPPLY

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PREFACE

This study was conducted for the U.S. Army Corps of Engineers Institute for Water Resources, (Contract DACW72-83-C-0015) by THE GREELEY-POLHEMUS GROUP, INC., with Roy F. Weston, Inc. and William B. Lord and Associates, Inc., as subcontractors. The project involved demonstration of four illustrative examples for a previously prepared report, The Evaluation of Water Conservation for Municipal and Industrial Water Supply: Procedures Manual, April 1980, under conditions of varying data availability.

Sixteen water suppliers were contacted and queried for their ability to provide needed information and data, and for their willingness to cooperate in a lengthy project involving use of their resources and time. Eleven of these water suppliers responded with interest in the project and a willingness to support our data needs. Four of the eleven were selected to represent the four examples in this project. Because of concern for disclosure of some information, the case studies are referred to in this Handbook by masked names:

Level 1 Example: Western Mountain Water Department
Level 2 Example: East Coast Water Department
Level 3 Example: West Coast Water and Sewer Utility
Level 4 Example: Southeastern County Water Authority

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CHAPTER 1

PURPOSE OF THE HANDBOOK

BACKGROUND AND OBJECTIVES

The U.S. Army Corps of Engineers plans, designs and constructs water resource development projects which typically include water supply as one of a number of purposes. In the planning of those projects, Corps field planners have to evaluate non-structural alternatives to more conventional water supply augmentation options. This analysis requires an evaluation of water conservation as a method for augmenting existing water supply projects.

This Handbook is one of a series of reports and documents intended to assist the Corps field planners in applying the appropriate techniques for evaluating water supply and water conservation. This Handbook provides guidance to Corps field staff in applying The Evaluation of Water Conservation for Municipal and Industrial Water Supply: Procedures Manual, (12) (Procedures Manual) for various situations which may be encountered.

The Procedures Manual provides a conceptual approach or process to water conservation proposal development and evaluation. A water supply/conservation plan is intended to supplement existing procedures devoted to the development and evaluation of water supply plans. Because water conservation plans are to be integrated with structural options, the approach balances the benefits and costs of water conservation by using the same principles and standards.

In the Procedures Manual, water conservation is described as one approach to good water management and not as a replacement for provision of new water supplies. Therefore, water conservation can provide for:

- o more efficient utilization of existing supplies
- o beneficial reduction in water use

By considering measures which may improve the efficiency of utilization of existing supplies (measures which reduce water loss) and which may reduce future levels of water use, a more effective water plan can result.

Water conservation is therefore defined as any "beneficial reduction in water use or in water losses." A water conservation measure is a practice or action which meets the following tests:

(1) "Implementation of the measure results in water use (or water loss) which is, at some time, less than it would have been had the measure not been implemented (with/without comparison). This reduction in water use conserves supply, making some portion of the existing or future supply available for uses which would not have otherwise been served."

(2) "The water use reduction is beneficial. Implementation of the measure must produce a net positive contribution to the National Economic (NED) objective...(consistent with protecting the

environment). This requirement insures that the water conservation measure is consistent with conservation of all scarce resources."

As a result, the Procedures Manual concept permits a consistent and balanced approach to the evaluation of water conservation and new supply alternatives and assessment of tradeoffs. This Handbook provides details of how the process can be implemented under various situations of data availability.

Although there is great reliance on the concepts and approach of the Procedures Manual, this Handbook is intended as a stand-alone-volume and has attempted to minimize, if not avoid, the need to go back-and-forth between the Procedures Manual and the Handbook. As a result, this volume contains the steps and definitions that are consistent with the development and evaluation of water conservation proposals for municipal and industrial water supply.

Most importantly, this Handbook directs the user to analysis methods that are applicable given limited data resources and the specific analysis requirements of the Procedures Manual. The intent of this Handbook is to provide guidance in the development and evaluation of water conservation proposals as a part of water supply planning. It also provides references to other sources where actual situations may differ from the examples presented here. References to other sources are presented throughout this Handbook to assist the user.

This Handbook develops four examples which are real situations. In each case, an actual water supplier coooperated and provided some or all of the data and other information that are required by the Procedures Manual. The example water suppliers vary, therefore, with regard to available data, and the Handbook provides the needed methods to be able to accomplish the Procedures Manual intent.

In each example, the level of data varies from Level 1 (a relatively deficient available data situation) to Level 4 (a situation where data are most abundant). This approach assumes that there are very limited situations where the Procedures Manual cannot be implemented, and that reliable methods can be used to obtain information even in the most difficult dataless situations. Chapter 2 of this report deals with the definitions of data requirements for each Level in detail.

ORGANIZATION

This Handbook is organized with seven chapters and four appendices. The material presented here is framed as closely as possible to the Procedures Manual to provide clarity and amplification of the Manual's intent and to use the concepts, procedures and measurement techniques proposed by the Manual.

Because of changes in national water policy, the Procedures Manual basis (Water and Related Land Resources Planning, Principles, Standards and Procedures, U.S. Water Resources Council [11]) has been modified. Now, instead of emphasis on National Economic Development (NED), Environmental Quality (EQ) and regional objectives, the current policy basis (Economic and Environmental

Principles and Guidelines for Water and Related Land Resources Implementation Studies [10]) focuses only on contributions to the National Economic Development (NED) objective (consistent with protecting the Nation's environment). As a result, this Handbook does not refer to the other previously used objectives, although methods are presented for evaluation of environmental impact and regional or local impacts.

The seven chapters are organized as follows:

1. PURPOSE OF THE HANDBOOK - includes information on the background and objectives and organization of the Handbook, and its intent to provide methods and case study examples of the Procedures Manual approach, as it is applied to real data situations ranging from a Level 1 case study (where data are limited) to a Level 4 situation (where data are readily available).

2. DATA REQUIREMENTS - defines the circumstances of data availability that describe Levels 1 through 4, and provides a generalized guide for the Handbook user to identify the Level which is most like his situation.

3. GENERAL ISSUES - involves numerous concerns that must be addressed in any water planning study. From data bases and information sources, that may be useful in developing a water conservation plan, to issues on multi-jurisdictional study areas, water supply plans, and risk and uncertainty, this section addresses the real problems that are frequently encountered and provide some guidance on how these concerns should be handled.

4. LEVEL 1 EXAMPLE - provides an example of the Procedures Manual approach to a Level 1 data availability situation. The example, where the minimum data are available, examines a Western Mountain Water Department (WMWD) that faces increasing costs of water supply augmentation and significant benefits from water supply conservation with regard to "local" and Federal water supply projects.

5. LEVEL 2 EXAMPLE - provides an example of the Procedures Manual approach to a Level 2 data availability situation. In this case, the Procedures Manual's data requirements are somewhat better satisfied than for the Level 1 example. An East Coast Water Department (ECWD) provides the real data and issues situation for this Level 2 example and the application of the Manual.

6. LEVEL 3 EXAMPLE - provides an example of the Procedures Manual approach to a Level 3 data availability situation where more information is available than for Levels 1 and 2. The example water supplier is a West Coast Water and Sewer Utility (WCWSU) that has seen significant growth recently in exterior residential water use (lawn irrigation) and opportunities for beneficial water conservation in all user classes. More sophisticated analysis methods are applied in this example than for the Level 1 and 2 situations.

7. LEVEL 4 EXAMPLE - provides an example of the Procedures Manual approach to a Level 4 data availability situation. In this example, quality and depth of data are excellent. The example reveals relevant analysis approaches for this Southeastern County Water Authority (SCWA).

Four appendices also accompany the Handbook. They provide supporting information that can be easily applied in developing a water supply conservation plan and in collecting the needed data and information.

APPENDIX A - GLOSSARY OF TERMS AND WATER CONSERVATION MEASURES - provides definitions relevant to water conservation plan development as required by the Procedures Manual, including specification of equations and descriptions of water conservation measures that can be used in applying the Procedures Manual.

APPENDIX B - HANDBOOK APPLICATION - provides a step-by-step section on the approach of the Procedures Manual. This Appendix identifies for each data availability Level (1) what methods are appropriate (ie., to forecast water use) and (2) how to implement the Step in a concise presentation. Because of the problems that arise from limited data availability, methods that are appropriate for a Level 4 situation may not be appropriate for a Level 1 or 2 example.

APPENDIX C - DATA REQUEST FORMS, QUESTIONNAIRES, INFORMATION REQUIREMENTS - provides ideas for data collection and information gathering. Because of the significance of quality data for the preparation of a water conservation plan, methods are suggested for concise data gathering. Since a cooperative relationship between Corps field personnel and a water supplier is essential, this Appendix suggests ways to minimize the time involvement of the water supplier in obtaining the information requirements for the study.

APPENDIX D - BIBLIOGRAPHY - presents a bibliography of data sources and reference materials that can be valuable sources of information.

CHAPTER 2

DATA REQUIREMENTS

DATA REQUESTS

The purpose of this Handbook is to demonstrate the application of the Procedures Manual in four different illustrative examples. Each example varies according to data application and availability and ranges from Level 1 (the most data deficient situation) to Level 4 (the most data available situation). This section provides information on each Level and the data availability which describes it.

Extensive information is necessary from water suppliers for which a water conservation plan and evaluation would be developed. As an example, the Procedures Manual lists the following information requirements:

SAMPLE PROCEDURES MANUAL DATA REQUEST

- o Average water use by month for each customer class (residential, multi-family, commercial, industrial, public/institutional, and unaccounted-for) for the past 5 years.
- o Number of water connections for each customer class for the past 10 years.
- o Amount of water wholesaled to other communities for each month for the past 5 years.
- o List of names, addresses and amount of water purchased by the largest customers (identity concealed).
- o Water produced and sewer flow for each month for the past 10 years.
- o Water and sewer main maps and size distributions.
- o Water and sewer rate schedules for the past 5 years.
- o Water and sewer revenues and expenditures by source and billing category for the past 5 years.
- o Information on existing water conservation programs, at the state, county and local levels, including (ie., ordinances, leakage tests, costs, pilot projects, water meter program information, etc.).
- o Peak day water use for largest customers.
- o Annual reports, budget information, financial status (audits), bond rating, etc., for the water and sewer systems for the past 10 years.
- o Staff size information and work assignments for existing personnel.

- o Information/data related to water production and operation, maintenance and repair costs for the past 5 years.

- o Capital improvement programs for water supply and wastewater treatment for the next 50 years (or available future time frame).

- o Other consultant reports dealing with systems and management, including projected capital improvements for water and sewer systems and specific studies (ie., water reuse potential, etc.).

- o Water use and sewer flow projections for the next 50 years (or available time frame) and information on "safe-yield".

- o Current effluent water quality conditions and limitations.

- o Data on water use or changes in water use and the effects on other users of water supply sources (ie., water conservation flow reductions and hydroelectric power changes, land subsidence, wildlife impacts, etc.).

This information and more are required to propose and assess the impact of a potential water conservation program on a water utility and its future needs for water supply. However, many water utilities do not have this depth of information available. Also, other characteristics, sometimes causing the data limitations, are useful for defining the differences in water suppliers and characterizing four Levels of data availability. Although it is very difficult to characterize water suppliers based on size (for example, large vs. small and level of sophistication, computer literacy, staff capability, etc.), and ownership (for example, public vs. private and information availability), there are some factors to consider:

- o economies of scale should benefit larger companies with larger service areas and improve data prospects, although this is not always the case.

- o policies regarding water management such as metering, customer class breakdown, pricing, and information management methods will largely characterize needed data requirements and available information.

LEVEL DEFINITIONS

As a result, the following definitions were developed for Levels 1 throught 4:

LEVEL 1: Mostly unmetered water use; use of flat rate pricing; metered water use of total system and large users, but no data for single family residential; aggregate data for utility revenues and costs with limited historic information; limited future budget projections, water use projections and forecast; generalized and aggregate data available for population and service area characteristics; very limited wastewater system information.

LEVEL 2: Metered water use with biannual metering and quarterly billings (quarterly metering prior to 1980); manual data management techniques, including ledger accounts with major categories of water use disaggregated; availability of county and local planning information (reports), including generalized water use information; minimal annual report and other financial detail of operations; some previous experience with water conservation; very limited wastewater data.

LEVEL 3: Metered water use; use of a structured rate schedule; disaggregated water use by customer classes; data on water revenues and costs, including rate study reports; good historic information, with minimal projections and forecast information on population water use, budgets, etc. Good descriptive information from local planning agency on population and future growth. Limited wastewater data.

LEVEL 4: Metered water use; use of sophisticated water pricing policy with water conservation efforts; complete disaggregated data for water customers and large water users; good depth of historic water use and financial/budget data information, including well documented and prepared projections and future planning information.

All of the examples can be described as complex and having the potential for multi-jurisdictional problems, including: (1) Complex service areas which contain numerous political jurisdictions (cities, towns, counties), as well as wastewater districts and authorities, and (2) simple, single entity service areas like water departments for a town that are competing for water supply and other resources with neighboring communities and are subject to policies, and regulations from other higher level entities. No service area is free of multi-jurisdictional issues when dealing with water supply planning. As a result, data are required from many sources to identify and evaluate the complex study area. The next chapter on GENERAL ISSUES identifies some of the potential study problems.

CHAPTER 3

GENERAL ISSUES

INTRODUCTION

Water supply planning is a complex process of data collection, selection and application of analysis methodologies, identification and evaluation of technical, socio-economic and political issues, formulation and evaluation of alternatives, project selection and presentation. This chapter approaches some of the issues that are of primary concern to the development and evaluation of municipal and industrial water supply conservation plans.

Four areas of interest are described here:

General Information Resources On Water Conservation

This section describes available sources of information and data that will be invaluable to any water conservation planning effort. The attempt in this section is to initiate an "information trail" that will begin here and expand with local site-specific sources as well as with future sources as more research contributes to water conservation planning. In addition, a bibliography is presented in Appendix D with more references and leads to sources of information.

Plan Setting

Many issues arise with regard to the realities of the plan setting. The study area is never a homogeneous place with uniform data availability for implementation. This section addresses many fundamental issues involving procedure and technique that are at the foundation of a final plan that is accurate and believable, and that can be implemented.

Technical Problems and Methods

A variety of common problems will be encountered in a study of the water supply alternatives that are available for a study area. This section addresses many issues; some are described from other research projects, and others were developed as a direct result of this project.

Risk and Uncertainty

This section deals with the approaches to water management involving long-term investment and short-term water supply management which combine to yield an acceptable or adequate level of water supply for an urban community. "Safe yield", "design droughts", drought warning systems and other factors that relate to an optimal strategy of water supply projects and controls are discussed.

Since the objective of a Municipal and Industrial Water Conservation Plan as developed by this Handbook is to achieve beneficial water reduction and to realize benefits (reduced costs and delays in required projects) or more efficient use of existing water supply sources (ie., to reduce leakage in a water distribution system and utilize other water conservation measures to prevent the construction of inefficient water supply projects with local and Federal resources), two key issues must be considered.

- o Water conservation is a technique that can support water supply augmentation, but cannot replace it.

- o Risk of municipal and industrial shortage during drought must be evaluated. Short-term contingency plans should supplement the long-term investment program.

With regard to the first key point, numerous sources of information are available on water conservation methods and their effectiveness. This Handbook does not try to be an authority on water conservation measures. Appendix A - Glossary of Terms and Water Conservation Measures presents some information on what certain water conservation measures are intended to do, and where information on water conservation measures is now relatively well established (ie., measures and results are presented in the literature, also, see Appendix D - Bibliography). This need for reliable information on water conservation measures and results of applications is a very important beginning in developing and evaluating a water conservation plan for an area. Also, other points such as how well these water conservation measures will function, how permanent they will be (ie., die-off rates of education programs and removal rates of devices by dissatisfied water users) are essential to the success of a program and are also discussed here.

When a water supply program is implemented, either for supply augmentation or conservation, it is expected to work. If the program cannot produce the desired results, unexpected economic impacts will result, as well as social and public "costs" due to lost faith in water supply planners, or perhaps worse. These concerns are at the heart of water supply planning and, specifically, water conservation program planning and account for the traditional very safe and conservative approach taken by water planners. Typically, water supply planners minimize the "down-side risk" and provide for more than sufficient supplies, even if supplies exceed some level that is consistent with economic efficiency.

As a result, the other general issues discussed in this section, including data sources, planning approach and risk and uncertainty, all are directly related to developing confidence that the proposed plan of water supply augmentation and water supply conservation will provide adequate water supplies and no unnecessary economic losses for a water supplier's service area. This section considers these issues, as well as some methods for their solution.

GENERAL INFORMATION RESOURCES ON WATER CONSERVATION

Examples ranging from Level 1 (the minimal data situation), to Level 4 (where abundant data are available) are presented as real applications of the Procedures Manual. This Handbook has proposed methods ranging from simplistic to complex, data intensive techniques. The purpose is to select methods that make the best use of available information and data to provide credible, reliable results. Several documents are suggested for background information and more illustrations of water conservation planning.

IWR Publications

The U.S. Army Corps of Engineers, Engineer Institute for Water Resources has focused on the research needs of water supply planning, including water demand forecasting and water conservation methods. The following publications are briefly described as key resources for developing a water conservation program.

The Role Of Conservation In Water Supply Planning, Contract Report 79-2, Contract Number DACW72-78-0022, April 1979. (65) This report establishes an intellectual basis and terminology for the Procedures Manual on which this Handbook is based. The report was motivated by the Presidential Water Resources Policy Reform Message of June 6, 1978, which asserted a national commitment to water conservation as a national priority. The fundamental definition of water conservation is established in this report: Water conservation is any beneficial reduction in water use or in water losses (reductions in the use, or loss, of water without disproportionately increasing the use of other resources are labeled conserving). The report also provides a summary and appraisal of conservation measures.

The Evaluation Of Water Conservation For Municipal And Industrial Water Supply: Procedures Manual, Contract Report 80-1, Contract Number DACW72-79-C-0018, April 1980. (12) The Procedures Manual followed Contract Report 79-2 and provides the conceptual approach that is demonstrated through examples in this Handbook.

An Annotated Bibliography On Water Conservation, Contract Report 79-3, Contract Number DACW72-78-M-0752, April 1979. (79) This report contains 237 described sources of information ranging from general water planning and trends in water use information to publications from the mid-1970's on specific water conservation methods.

The Evaluation Of Water Conservation For Municipal And Industrial Water Supply: Illustrative Examples, Contract Report 82-C1, Contract Number DACW72-82-M-0160, February 1981. (80) This report used hypothetical, as well as actual data from Atlanta, Georgia and Tucson, Arizona metropolitan areas to demonstrate through illustrative examples the application of the Procedures Manual.

The Evaluation Of Drought Management Measures For Municipal And Industrial Water Supply. Prepared for the U.S. Army Corps of Engineers, Institute for Water Resources, October 1983. (66) The purpose of this report was to formulate and apply a planning method for determining optimal strategies for shortage mitigation in municipal and industrial water supplies. The model "Drops" was formulated and applied to Springfield, Illinois; the report contains a good annotated bibliography of drought contingency planning literature. In a separate volume, the documentation of data gathering and analysis methods is provided.

Analytical Bibliography For Water Supply And Conservation Techniques, prepared for the U.S. Army Corps of Engineers, Institute for Water Resources, Contract Report 82-C07, January 1982. (18) This report includes an extensive inventory of methods and techniques for water conservation.

National Data Bases

A compiled national data base for water conservation does not exist. If one were available, it would present regional variations on precipitation, drought impact and approaches for water conservation. Two publications have aggregated a considerable amount of water conservation data, including:

Residential Water Conservation Projects, Summary Report, prepared for U.S. Department of Housing and Urban Development, Number PDR903, (Brown and Caldwell, Inc.), 1984. (92) This report identifies many water conservation techniques and assesses their effectiveness to reduce water consumption.

Algorithm For Determining The Effectiveness Of Water Conservation Measures, prepared for the U.S. Army Corps of Engineers, Waterways Experiment Station, Contract DACW39-82-C-0080, (Roy F. Weston, Inc.) May 1983. (9) This report presents an algorithm for determining the effectiveness in reducing water use by the implementation of a variety of water conservation measures. Fractional water use reduction, coverage of conservation measures and interactions between water conservation measures are developed for numerous conservation measures based on evaluated literature experience.

PLAN SETTING

Several issues regarding the study area or plan setting should be addressed first. These include data sources, the study area definition and the related issue of multi-jurisdictional complications. Briefly these topics are presented here (additional information is available in the IWR report: Forecasting Municipal And Industrial Water Use: A Handbook Of Methods). (67) These issues are interrelated and will affect the approach to the study, as well as the ability to implement the study results.

Study Area Definition

The first step is to define the geographic area for which the water plan is to be developed. Frequently, such a study boundary is defined by a utility service area or a hydrologic area (ie., a river basin), which is completely independent of the government/political boundaries for which data are generally available. The other option is to define the area in terms of the political or jurisdictional boundaries, an approach that is unrelated to hydrologic boundaries and related data. Counties, towns, cities, Standard Metropolitan Statistical Areas (SMSA's) and/or water utility jurisdictions provide a basis for this approach.

Points to consider that may be important to a planned study area definition include:

(1) Potential expansion of a service area during the forecast period. The study area should be defined to coincide with the largest service area expected.

(2) Inclusion of large unserved area in the region that is currently not serviced by the water utility and is unlikely to receive service

during the study period. It may be helpful to exclude these areas from the study area definition.

(3) Existence of large self-supplied water users within the study area, or of services (ie., large industries) that are located outside of the study area with private pipelines connected to the water supply service. These important water users should be included in the study area definition.

(4) Alignment of study area and political subdivision data. Two solutions are available: (a) disaggregate demographic and socio-economic data to the service area (this method results in lower quality explanatory variables because of the necessary arbitrary disaggregation techniques), or (b) define the service area to coincide with the political subdivision(s) (this method results in lower quality water use data). In each case, the analyst must consider which approach will cause the least difficulty.

Multi-Jurisdictional Concerns

Two important concerns relate to multi-jurisdictional aspects of a study area. Institutional issues are important when the study area is characterized by more than one jurisdiction. In addition, the availability and quality of data will not be uniform across a multi-jurisdictional study area.

The institutional issues are the most important of the multi-jurisdictional concerns and relate to the ability to implement a project recommendation. Where more than one political entity or water supply service area is involved, thought should be given to separate forecasting and plan development for each entity. In some states, this is more apparent (ie., in Pennsylvania, a home rule state, local towns and boroughs are empowered to make decisions in lieu of counties and regional jurisdictions; in California, districts are frequently created, and multi-jurisdictional approaches may be more appropriate). As a result, the study area should be defined in terms of jurisdictions and their willingness and ability to cooperate and implement project results.

Related to the differences among communities and service areas, the quality of data will also be a factor in a complex plan setting. Sub-areas can be identified with relatively uniform data characteristics in order to maintain the overall quality of the study area effort. In sub-areas where data are of better quality, advanced analysis methods can be used. In the sub-areas with poorer quality data, additional collection may be required or simpler analysis methods may be appropriate. Analysis of trade-offs between additional data collection needs and analysis techniques would be made for each sub-area.

Data Sources

Appendix B provides the data request forms that will help to define much of the data required for an application of the Procedures Manual. The data required will consist of both historic information and projected data. The following list suggests sources of commonly used water supply planning data:

Historic Data

1. Water Use (Municipal and Industrial)
   - Water Utility
   - Regional Water Planning Agency
   - State Permit Data, Water Planning

2. Population Data
   - State, Regional or Local Planning Agency
   - Water Utility
   - Economic Development Agency
   - City or Regional Planning Agency
   - U.S. Census of Population

3. Number of Households or Dwelling Units: Other Demographic Variables
   - State, Regional or Local Planning Agency
   - U.S. Census of Population, Housing

4. Number of Connections
   - Water Utility
   - Wastewater Utility

5. Climatic Data
   - National Weather Service, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce
   - State Water Resources Agency
   - Regional Water Resources Agency
   - Dept. of Meteorology or Climatology, State University
   - Water Utility

6. Water and Wastewater Rate Structure
   - Water Utility
   - Wastewater Utility

7. Other Economic Variables
   - State or Regional Agency Water Charges/Infrastructure Fees
   - Property Values (State, County and Local Real Estate Assessor Agency)
   - Industry and Business (State, Regional and Local Planning, Chambers of Commerce)
   - Manufacturer

8. Policy Information
   - State and Local Governments
   - Water Utility

9. Manufacturing Employment, Output, Processes
   - Local or Regional Economic Development Agency
   - State Employment Agency
   - U.S. Census of Manufacturers
   - U.S. Bureau of Labor Statistics
   - Individual Firms

Projected Data

10. Population, Household Size, Number of Households, etc.
   - State, Regional or Local Planning Agency
   - Economic Development Agency
   - Bureau of Economic Analysis (OBERS)

11. Economic Variables
   - State, Regional or Local Planning Agency
   - Bureau of Economic Analysis (OBERS)

12. Manufacturing Employment
   - State, Regional or Local Agency
   - Economic Development Agency
   - Bureau of Economic Analysis (OBERS)
   - Individual Firms

Other sources of data could include Water Resource Research Institutes, Water Resource Associations, U.S. Geological Survey, and universities (especially Urban Planning, Environmental Resources and Engineering Departments). As is indicated in the Level 3 example, California has initiated numerous projects to research the water conservation potential for landscape modification and alternative irrigation methods. Sources of new research can frequently be tracked down only by persistent detective work, although it is helpful to know in advance that certain areas of the country are actively working to identify methods for water conservation, including California, Arizona, New Jersey and Colorado. Also, some national associations are devoting more effort to water conservation, including the American Society of Plumbing Engineers (Washington, D.C.).

TECHNICAL PROBLEMS AND METHODS

A number of technical problems arise when preparing an analysis of water conservation options. This section presents a variety of problems and proposes some methods for their solution.

Minimum Data Definition

Although the intent of this project is to demonstrate the Procedures Manual approach under varying circumstances of data availability from "minimum" data (Level 1) to a "maximum" data availability (Level 4), it was not possible to define a Level 1 "minimum" to include virtually no data. A Level 1 data availability definition could have described an unmetered system such as the following:

NO DATA LEVEL: Unmetered water use with no metering of individual water users, or production; unsophisticated accounting and data records with one year of data available; uniform/flat rate charges to each user; limited water plan information and budget data/information with a one or two year horizon and no continuity between the water supply plan future requirements and the budget.

This situation is not remote. Based on responses to a project Water Supply System Check List (Appendix C) regarding available water use, water conservation, revenues, costs planning and budget data, water systems can vary considerably.

The major needs are to obtain information on water use by customer class and to tie the water plan information (future project needs) to the budget process. Depending on time, available budget and the type of study (Level A, B or C) (13) options are available that permit application of the Procedures Manual even under more restrictive conditions than the Level definitions suggest.

A key requirement for developing and evaluating water conservation proposals is an understanding of how much water is used by each user class. This is important because water conservation measures are applied to users in a class, and the water reduction and coverage varies based on characteristics of these users, and effectiveness is directly related to the quantity of water used by the class. Two options are available for improving the limited information available:

(1) Use literature information on water use by user class for other communities that are comparable to the study area. Based on demographic information (population and number of households), commercial/industrial information, public sector information, etc., and comparison to other similar areas, it is possible to estimate the aggregate water use, base and seasonal use and quantities used by each user class and by month.

(2) Install water meters to gain information on water use within the community. Meters can be installed to sample selected users, or groups of users, to obtain needed information. A program could be developed for reading the meters over a period of time, perhaps one to three years, in order to get needed information on base and seasonal use.

With and Without Project

The traditional approach to project evaluation involves comparison of regional conditions with and without a project or program. Typically, large water projects directly affect input and output prices and related benefits and costs of a project because of the significant influence of the project. For this reason, it is required that future water use and associated prices be determined in the absence of the project ("without-project" condition), as well as for conditions in the presence of the project ("with-project" condition).
In the "without-project" condition, local water needs and associated prices are influenced by local actions and initiatives. In the "with-project" condition, the Federal project provides a substitute for all or part of the locally-planned alternatives.

For a typical Federal project where a water supply reservoir or flood control project is planned, the project generally is sufficiently large to increase the supply of water or electricity (if hydroelectric power is generated) and, therefore, to drive down the price at which the new larger quantities are demanded. As a result, the "with-project" represents the lower limit of prices for outputs, and the "without-project" represents the smaller output and associated upper limit of prices.

The same argument applies to supply. If a project bids up the prices of factor inputs, the "without-project" represents the lower limit of prices and the "with-project" represents the upper limit of input prices (ie., wages would be bid up as the increased quantity of skilled labor is required). The issues of price variation in evaluating "with" and "without" project conditions are developed in Water-Resource Development, The Economics Of Project Evaluation, Otto Eckstein (68), as well as other potential consequences of proposed projects, including "increasing returns", benefits and costs concepts, and other issues such as evaluations of projects in full employment and other circumstances.

In dealing with smaller water conservation projects for municipal and industrial water demand, the "with" and "without" project concepts are the same, however, the degree of influence of a "with" project condition may be more difficult to detect. Economic And Environmental Principles And Guidelines For ...Studies (10) provides additional information on "with" and "without" project concepts.

The water demand forecasts can reflect the project induced "with" project effects. Methods that incorporate per capita use are insensitive to changes in price, and judgement is required in making such forecasts to accommodate project influences in future water use. These methods are generally not endorsed by Principles And Guidelines. More advanced techniques, particularly those incorporating demand models, permit consideration of related changes in prices.

For this Handbook, the "without" project water demand represents unrestricted water use. The "with" project forecast is obtained by subtracting the calculated effectiveness of water conservation measures from the "without" project conditions. Where supply augmentation was required to assure "without" project supplies to the year 2030 (planning horizon), the costs of local new supply were incorporated into the future demand forecasts.

Alternative Futures

Since precise forecasting of future conditions is impossible, particularly for a 50-year planning horizon, it is necessary to consider a base case situation and other alternative futures that may result. A "base case" or "most likely" future is usually evaluated, as well as other possible situations. Each alternative future can therefore be described in terms of alternative assumptions.

This method of developing alternative futures is useful in preparing and evaluating project conditions. The alternative futures serve as conditions for sensitivity tests. If the alternative futures indicate that radical changes in project cost or reliability are possible under the alternative conditions, greater concern is given to specification of the assumptions for the "most likely" alternative and in understanding which variables are "critical" or highly sensitive to a successful project. (More is provided on this in a following section on "Risk and Uncertainty".)

Planning a Water Conservation Program

Care must be taken in defining and planning a water conservation program. Several considerations are presented here: (1) Appendix A identifies and defines numerous conservation measures that can be used, but this list is not complete. In addition, the list identifies measures in broad conceptual terms. Variations in products based on differences in vendor specifications, state regulations concerning accepted devices and other similar details must be considered, and (2) "Where to begin?" in planning a water conservation program is also not as apparent as it may seem. If a water supply area is experiencing, or may experience shortages, which are already quantified, and an "exact" quantity or level of water conservation is already "known", portions of the 16-Step Handbook approach should be applied as an iterative procedure to assure the "required" level of water reduction. The approach used here has placed "priority" on the Steps 1-4 screening process to select the "correct" set of applicable, technically feasible and socially accepted measures, and the resulting reduction in water use is secondary in concern.

Other concerns in specifying a future water conservation program involve some initial information concerning the area:

(1) To what extent are water conservation measures already implemented? In the Level 2 and 3 examples, existing water conservation programs have residual effects that must be considered (addressed in the following section on Residual Water Conservation Program Effects).

(2) Is the area experiencing growth, or is it stable? Where growth is expected, certain water conservation measures are easily installed in new construction as part of a long-term effective program (ie., low flush/shallow trap toilets, drought-tolerant landscaping, etc), and an effective long-term program is possible. Where retrofits are the primary solution (in non-growth areas), these are easily installed (generally) and are also easily removed (see Level 3 example for the effect of time and the residual effects of previous water conservation programs).

These concerns suggest that a water conservation program can be defined through the steps in this procedure, however, it may not achieve very much water conservation. As a result, Steps 1-6 and the overall effect of water conservation versus water supply and safe yield should be reviewed before continuing with the subsequent Steps in the analysis.

Residual Water Conservation Program Effects

A very significant problem involves the determination of what measures are already in place and how effective they are. In many parts of the country, communities have implemented water conservation programs (in many cases only partially) as a method to either deal with a drought, or reduce water consumption because of system limitations (ie., because of overloaded wastewater or water treatment plants). In addition, existing plumbing codes possibly at state or local levels may require water-saving fixtures and appliances (and in some cases, these codes are not effectively enforced). It is necessary to determine what the residual from a previous water conservation program is, and what has been done, more generally, to reduce water consumption in a service area.

Three key questions should be asked before proceeding:

1. Where have water conservation measures been implemented in the study area during the recent past? (Concepts of time are considered later in this section where die-off rates of water conservation projects are presented.)

2. Have definite commitments been made to implement water conservation measures within the study area during the planning period? and, or

3. Are previous programs for water conservation fully implemented and enforced, and will future programs be implemented effectively? (ie., Just because a regulation exists requiring water conservation does not mean reductions in water consumption will result. Cases are apparent of State Plumbing Codes requiring water conservation fixtures in new single family and multi-family residential areas that, despite licensing of inspectors, are poorly implemented.)

This section presents some ideas on how to determine the residual effects of previous water conservation programs.

Only two of the Level examples previously employed water conservation programs. In the Level 2 example, the ECWD had experienced drought in 1980, and previously had employed a conservation program to provide relief when existing water supply limitations were restricting new development and construction in the late 1970's. In the WCWSU example (Level 3), previous severe drought provided a basis for extensive water conservation in 1977.

By 1984, the utility believed it had finally returned to pre-drought levels of water consumption. Table 3-1 presents information on the post-drought water consumption for the WCWSU and Figure 3-1 provides generalized graphic information (based on literature experience).

FIGURE 3-1
Generalized Residual Water Conservation Program Effects

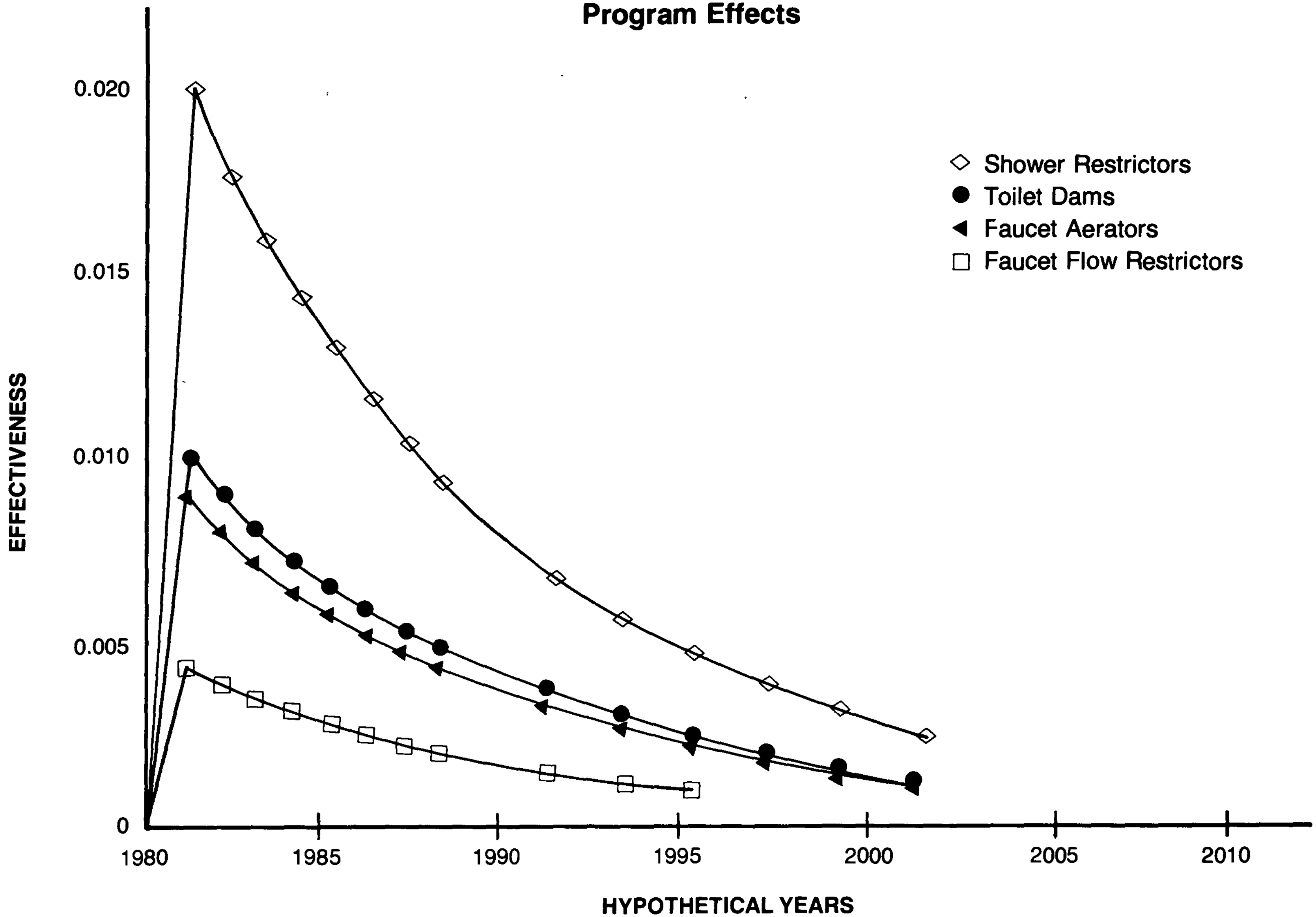


TABLE 3-1
CHANGES IN POST-DROUGHT WATER CONSUMPTION
PERCENT OF 1975 CONSUMPTION

	1975	1976	1977	1978	1979	1980	1981	1982	1983
January	100			64	83	88	91	90	90
February	100			68	84	88	92	90	91
March	100	(1976-1977		72	87	97	98	91	92
April	100	Drought Period)		69	85	90	99	90	75
May	100			70	84	80	94	88	85
June	100			73	83	79	93	85	89
July	100			75	82	82	92	86	95
August	100			76	83	80	89	88	94
September	100			81	86	88	88	89	92
October	100			89	89	96	88	92	-
November	100			90	83	100	88	90	-
December	100			80	79	88	85	84	-

Note: Unadjusted for growth, however, the area experienced insignificant growth during this period.

What actually happens following the drought involves at least two things:

(1) New growth in water customers increases consumption.

(2) Water customers who used water conservation measures during the drought have removed the devices (note: faucet aerators may clog, low-flow showerheads may not provide the level of satisfaction required in non-drought times, displacement devices in toilets may cause problems, and these devices will be removed).

In addition, the situation is complicated by the influence of wet and dry years.

The Level 2 and 3 examples provide some suggestions for identification of this residual effect.

The East Bay Municipal Utility District (EBMUD) was one of the water supply service areas significantly affected by the West Coast drought in 1977. Table 3-2 indicates the results of a survey effort by the Kennedy School of Public Policy, conducted during the summer of 1980, to determine the die-off rates of water conservation measures at the end of three years following the drought. The survey indicates that the residual effects of the previous programs are still significant with from 18 to 79 percent of the programs still in use.

TABLE 3-2
WEST COAST WATER CONSERVATION RESPONSE[1]
DURING AND AFTER 1977 DROUGHT

	DURING DROUGHT (% PEOPLE USING MEASURE)	DECREASE (% DECL.)	STILL IN USE (%)
Toilet Displacement	65	34	31
Caught Water in Bucket (shower/sink)	61	80	(?)
Did Not Water Landscape	59	72	(?)
Flush Toilet Less	77	59	18
Did Not Wash Car	81	52	29
Full Dishwasher Load Only	84	0	84
Took Quicker Showers	91	31	60
Turn Off Water (Dishwashing)	93	14	79
Turn Off Water (Brushing Teeth)	95	17	78

NOTE: Kits distributed during drought.

- o Book on Water Conservation
- o Water Bag (toilet displacement)
- o Shower Flow Restrictor
- o Two Dye Tablets (toilet leak detection)

[1]Kennedy School of Public Policy, Harvard University, January 1981. (Survey conducted July - August, 1980.)

One approach is to use a questionnaire to identify the water conservation measures that are currently in place and how they are enforced. This method will establish a base condition and avoid the possibility of double counting potential water conservation effects of a proposed program. Other methods, including available information can also be used in establishing the residual levels.

Where existing information is used, the approach would be to:

1. Prepare Table of trends in water use since the drought and identify pre-drought "base year".

2. Delete years from analysis where precipitation was abnormal (ie., wet and dry years).

3. Review trends in new connections and adjust trends in water use to exclude water consumption by new accounts.

4. Compute percent of base year water use represented by each post-drought year water data.

5. Evaluate results for trends and possible limits.

This approach was used for the West Coast Water and Sewer Utility in the Level 3 example.

Another approach is possible for situations where the purchase of water-saving devices is controlled. In the Level 2 example, for instance, information was available regarding how many water conservation devices (ie., flow restrictors, toilet displacement devices, low-flow showerheads, etc.,) were purchased, and information was available on the possible extent of removal. Therefore, it was possible to estimate what residual might still be in place. Where the water utility jursidiction is larger, however, and where drought represented a pending severe emergency (ie., as in the Level 3 example on the West Coast), the ability to control purchase information of water conservation devices was not possible, and such information was not available for that area.

As suggested previously, a questionnaire approach might be used to obtain this needed information. Questions regarding the existence of water conservation measures in individual homes could be prepared, a sample strategy would be developed, data would be collected, and the results would be analyzed. Since questionnaires may be developed to obtain other information (ie., the public's attitudes toward water conservation and knowledge of alternatives), care should be taken to limit the questionnaire information request to a single effort with the least number of questions.

Although the questionnaire approach seems to be an effective method for acquiring the needed information, some problems should be considered:

1. Homeowners frequently do not know if aerators are in place, if toilets are low-flush devices, etc.

2. Questions may not be correctly answered because they were not clearly stated (ie., in some approaches, questions were asked about the public's willingness to use certain water conservation measures, and the responses were negative. Although at first it was thought that the public did not favor the devices, instead it appears that many of the devices were already installed, and the response was that another device was not needed).

These problems can be overcome with a carefully-worded questionnaire.

<u>Supply vs. Distribution Considerations</u>

Water conservation measures can affect decisions regarding the quantity of water required by a system (ie., the need for new reservoirs and storage) and also decisions affecting internal system operations (ie., pipe sizes, tank storage, pump sizes, etc.). Typically, a system's storage requirements are based on average demand, and the distribution system is based on peak use requirements. Care must be taken in down-sizing pipe sizes, pumps, etc., based on reductions in peak use since frequently fire flow requirements, insurance policy specifications and even energy considerations impose other constraints on system design requirements. (As an example: in certain large water systems, electric utilities charge demand rates for pumping during peak energy use periods of the day. These demand rates are the highest rates charged by utilities and are so significant as to justify over-sizing pipe sizes and storage systems to allow all pumping of water during non-demand periods.)

Growth Projections

Population forecasts, family size, growth in housing and economic activity are critical elements of future water demand projections. Will the trends of the past continue? Are significant factors likely to stimulate growth, like new highway routes and state and local policies? The political aspects of population and economic projections also become apparent as communities and regions compete for future economic development. What planning basis of population growth and future economic activity should be used? Since the objective is to obtain projections that are as reliable and realistic as possible, the approach should rely on methods that are appropriate to the task.

Many county, city and township levels of government are highly sophisticated in their analysis of population and growth tendencies. Full-time demographers, planners and engineers are continually reviewing past trends and future policies, as well as fertility rates, household size and migration patterns of people and industry. Projections based on these inputs are suitable for water demand forecasting.

Checks can be made of the "local" growth projections. Information, such as growth projections prepared by other government units (which include the service area of interest) can be reviewed, OBERS and BEA (Bureau of Economic Analysis, U.S. Department of Commerce) projections can be checked and other growth-related local information (ie., trends in building permits for new construction) can be reviewed.

Modifying Growth Projections

If for some reason, available demographic projections are judged to be unreliable, it may be appropriate to modify projections, or prepare new projections. New projections can be developed based on available techniques (ie., Forecasting Municipal And Industrial Water Use: A Handbook Of Methods, U.S. Army Corps of Engineers, July 1983). (67) Where modification of projections can be sufficient to correct under or over estimation, methods may be simple to use.

For the ECWD (Level 2 example), comprehensive plan documents were developed and adopted during the mid-1970's. They included forecasts that were prepared in conjunction with County Planning Board efforts, and represented professionally well-prepared estimates of future growth. Recent information, however, has altered the previously optimistic forecasts to show more modest growth. This method for modifying these growth projections is presented in Chapter 5 as an alternative approach. The method uses a graphical "shift-share" approach.

Water Use Trends

Residential per capita water demand and water demand for commercial and industrial production changes over time. Changes in taste, income, price, production methods and other factors will alter water use. For example, for years per capita water use was increasing as consumers purchased more water-consuming appliances such as clothes washers, dishwashers, garbage disposals, swimming pools, etc. Over that time period, water was priced cheaply, and increasing income levels led to increases in water use. In the future, water prices are likely to increase, as water quality of drinking water supplies is monitored (at increasing costs) and expensive treatment systems are installed. The Federal Safe Drinking Water Act will require these additional costs of the majority of water supply systems in the country. The effect may be reductions in per capita water demand, as well as reduction in purchased water for commercial and industrial purposes. Table 3-3 provides an example of industrial water use trends changing dramatically for major water using industries of the nation. This Table shows significant increases in industrial water reuse and, in many cases, a declining effect on the consumptive use of water. These data are for specific industry facilities in the Delaware River Basin, and care should be used in interpreting these results to other facilities and areas of the country.

Indoor and Outdoor Water Use

The application of water conservation measures to most classes of water users will vary depending on indoor and outdoor water use. In some parts of the country (ie., the West and Southwest), 60 percent and more of total residential water use is for outside purposes, while in other areas (ie., the humid East and even urban settings in the West) outside water use may be 20 percent or less of total residential water use. Since the accuracy of the effectiveness analysis (Step 6) is highly dependent on information regarding indoor and outdoor use by user class (note: most user classes have a summer outside water use increase), it is essential that careful consideration be given to the methods and assumptions used in determining this mix.

For the Level 4 analysis, actual utility data by user class by month was disaggregated to winter and summer use (note: summer peak use periods range significantly around the country; for the Northeast, this summer season may be from May - September; for the Southeast, possibly April - October; in the West, April - November; and the South, possibly all year for some areas). As a result, it is necessary to define the peak use period for each analysis. The analysis of Level 4 in Chapter 7 indicates the seasonal variation in water use for each user class for that situation.

TABLE 3-3

CHANGING TRENDS IN INDUSTRIAL REUSE AND CONSUMPTIVE USE*

SIC CODE	INDUSTRY DESCRIPTION		AVERAGE WATER REUSE FACTOR 1971	1981	RATIO OF 1981 TO 1971 CONSUMPTIVE WATER USE/UNIT OF PRODUCT
20	Food & Kindred Products				
		(1)	.01	.08	.001/.002 = .50
		(2)	.03	.50	.001/.003 = .33
26	Paper & Allied Products				
		(3)	.01	16.19	.001/.003 = .33
		(4)	.01	17.79	.002/.002 = 1.00
		(5)	10.00	10.00	.006/.004 = 1.50
28	Chemicals & Allied Products				
		(6)	.01	.01	.027/.022 = 1.23
		(7)	.01	.01	.009/.026 = .35
		(8)	.84	8.35	.004/.009 = .44
29	Petroleum Refining & Related Industry				
		(9)	7.27	23.19	.029/.049 = .59
		(10)	.01	1.38	.016/.015 = 1.06
		(11)	.01	.01	.012/.013 = .92
		(12)	.08	1.33	.010/.041 = .24
33	Primary Metals				
		(13)	2.26	10.19	.011/.038 = .29

*Based on (13) Selected Industries in the Delaware River Basin. (17)

In the Level 3 example, the West Coast Water and Sewer Utility also has variation in peak use for urban and suburban areas; a situation that should be considered in each application of this methodology.

RISK AND UNCERTAINTY

The objective of a water supply plan is to provide adequate future water supply through a single purpose plan, or as a water supply element of a multi-purpose plan. Until recently, engineering and water supply planners have approached water supply planning with structural solutions based on a "worst-case" situation, and facilities, including reservoir storage requirements, and system distribution and internal storage requirements, have been sized to conservatively provide for future adequate water supply needs.

Water utility managers and other water supply planners have learned that this "fail safe" approach to operations is prohibitively expensive, and that they and the public will have to take some risk of water shortage. As a result, the concepts of water supply planning have been expanded, including consideration of:

- Demand reduction practices
- Potential for more efficient utilization of existing water supplies
- Drought contingency plans, and
- Need for new supplies

The addition of these non-structural measures to the traditional expansion of new supplies (structural measures) introduces problems with increased possibility of risk and uncertainty of providing adequate water supply for an area.

The public is also more sensitive to the increasingly prohibitive costs of the "fail safe" water supply. Although the level of "acceptable" risk varies, water restrictions and water conservation (as a long-term solution to water supply management) for public water supplies could be tolerated by the public as a part of "normal" service. Discussions with water utility managers have indicated that the public is willing in some areas to accept water restrictions possibly on the order of one in ten years. It is the purpose of this Handbook, therefore, to present methods that will achieve a plan for "adequate" water supply and which incorporates water supply augmentation and water conservation, and understands the trade-offs and risks of alternative plans.

The term "adequate" involves the principles of efficiently using limited resources and balancing the costs of supply additions and/or long-term water conservation programs against the expected damages that may result from recurrent droughts in the long run. The next sections consider various factors that will affect the ability of a water plan to satisfy the provision of adequate water supply and the related concepts of risk and uncertainty.

Factors Affecting Risk and Uncertainty

Two general areas encompass the various factors that contribute to risk of having sufficient water to meet future water requirements:

(1) Concepts and Planning Methods
(2) Data limitations and the Unknown

The discussion which follows identifies many of the factors that contribute to these two general areas.

Concepts and Planning Methods

A comprehensive approach to the evaluation of structural and non-structural water supply measures involves:

Long-term Plan Elements: A strategy for long-term water supply provision involves the balancing of the investment and other costs of additional supply and water conservation programs (in the context of increasing demand for future water supply) with the expected damages from recurrent droughts. The concept is based on the principle of economic efficiency and involves determination of the expected damages from temporary shortages of water in the long run. The concept is dependent, however on estimation of damages that are difficult to precisely estimate unless intensive data gathering is undertaken.

"Safe Yield": A traditional concept used in water supply planning involves the determination of safe yield and reliability of supply. The concept implies that a water supply project can satisfy projected water needs during a severe drought such as the worst drought of record in the historic record or otherwise specified. For example, a safe yield indicates the probability of a drought occurring in any one year such as one in forty years 1/40 or 2.5 percent.

The design drought is a key factor, since it implicitly sets the magnitude of the economic losses that may be incurred, including establishing the planning horizon, and the level of demand at the end of the planning horizon.

Short-Term Plan Elements: The water manager has little choice but to use restrictive measures during a drought. The system is fixed in size and physically limiting to most structural options, and the concept of safe yield is of limited value. To keep the risk of running out of water reasonably low, the manager will always try to adjust the demand for water to the existing drought conditions. Typically, drought contingency plans are activated based on arbitrary levels of reservoir storage with drought watches, warning periods and emergencies. The objective is to avoid reaching the critical level of storage. The optimal solution would be that combination of measures and restrictions that achieve the reduction objective and minimize the total monetary and non-monetary losses from the drought, including possible costs of emergency supplemental sources, implementation costs of water conservation programs, net monetary losses from revenue shortfall to the utility and bill reductions to water customers.

Reservoir Sizing Methods: Traditional techniques for sizing reservoirs involve estimates of the expected water demand at the end of the given design period and a level of risk. These inputs are the basis for the method for determining reservoir capacity developed in the 1800's.

Linear programming techniques and more advanced methods were developed during the 1970's and '80's, and references are described in the report The Evaluation Of Drought Management Measures For Municipal And Industrial Water Supply. (66)

Analysis Methods: The techniques used to project future water supply requirements and the dependability of supplies are potential contributing factors in planning for adequate water supplies. Principles And Guidelines (10) provides guidance on acceptable and unacceptable techniques. The U.S. Army Corps of Engineers publications, such as Forecasting Municipal And Industrial Water Use: A Handbook Of Methods (67) provide direction on the effectiveness of various methods. Methods that are based on explanatory variables are more reliable than simplistic per capita techniques, and are generally accepted, ie., multiple coefficient methods and contingency tree methods (a probabilistic approach) offer reliability and accuracy in projecting future water demands.

Sources of Information: Several publications are excellent sources on the analysis concepts and methods related to drought management. Attention should be directed to Bibliography references 69 -78.

Data Limitations and the Unknown

Typically, water supply planners build in an additional conservative factor or contingency to allow for the unknown. A risk of 2.5 percent (1 in 40 years) which was described before is based on steady demand and continuation of historic data on climate and drought recurrence. These concepts are limited by the historic data period and the likelyhood that these data represent the future planning horizon.

In California, for example, in a study commissioned by the State Department of Water Resources, serious concern was expressed about the reliability of project yield (safe yield) forecasts based solely on 20th century data. A tree ring study (of trees more than 300 years old) revealed that the period since 1890 has been one of precipitation surplus, and that drought cycles of sufficient intensity and duration to have economic and social impacts have occurred six times between 1600 and 1960. The worst drought occurred from 1760 to 1820, and levels of precipitation were about 20 percent lower than the worst cycle in the 19th century and over 40 percent lower than the worst cycle in the 20th century.

With this as an example, and data limitations can extend from the limits of knowledge of climate to limits of data on socio-economic, financial and other impact analysis needs, the intent of a water supply planner is to:

1. Provide adequate water supply for long-term and short-term needs.

2. Minimize the possibilities of down-side risk, particularly the prospects of running out of water.

3. Be concerned about up-side risks, for example, the additional costs of over investment in water supply storage believed necessary to prevent down-side risks.

4. Integrate structural and non-structural measures into a comprehensive water plan that will effectively balance the potential damages from drought with the costs of new supplies.

CHAPTER 4

LEVEL 1 EXAMPLE: WESTERN MOUNTAIN WATER DEPARTMENT

INTRODUCTION

The Level 1 example is a small western City (referred to as a Western Mountain Water Department (WMWD) that provides water supply to City residents and service areas outside of the City boundaries. The City is located within an expanding Standard Metropolitan Statistical Area (SMSA) that has shown nearly 50 percent increase in population over the past 15 years. The City is characterized by growth rates that exceed the SMSA expansion. Historically, the community was engaged primarily in agriculture; now the area supports a diverse local economy.

The climate of the area is arid with average annual temperatures ranging from mid 20° F to the 70° F range. Rainfall averages about 12 to 13 inches per year and is distributed to the April through July months when nearly 60 percent of the rain falls.

HISTORICAL GROWTH AND DEVELOPMENT

Population

In 1983 the WMWD City had an estimated population of 45,900 people. Table 4-1 summarizes the population growth over the past two decades.

TABLE 4-1
WMWD CITY POPULATION GROWTH

YEAR	POPULATION	PERCENT INCREASE OVER PREVIOUS YEAR
1960*	11,489	-
1970*	23,209	102.0
1971	24,823	6.9
1972	27,182	9.5
1973	29,986	10.3
1974	32,538	8.5
1975	33,070	1.6
1976	34,187	3.3
1977	36,460	6.6
1978	39,020	7.0
1979	41,270	5.8
1980*	42,942	4.0
1981	43,500	1.2
1982	44,000	1.1
1983	45,900	4.3

(*U.S. Census, 1980)

Since 1970, population has increased in the WMWD City by 98 percent. Between the Census counts of 1970 and 1980, the City's population increased by 85 percent; over the past 12 years, the average annual rate of growth has been 7.5 percent.

The population is distributed by race (1980) as follows: 94 percent White; Black less than 1 percent; and others, including American Indian, 5 percent. Persons of Spanish origin, including Mexican, Puerto Rican, Cuban and others are estimated to total 3,710, or 8.6 percent of the 1980 total population.

The marital status of the City's population is estimated as follows:

TABLE 4-2
WMWD CITY MARITAL STATUS (1980)
(OVER 15 YEARS OF AGE)

	MALE	FEMALE	TOTAL
Single	3,782	3,007	6,789
Married	10,187	10,195	20,382
Separated	197	266	463
Widowed	234	1,635	1,869
Divorced	1,006	1,511	2,517

(U.S. Census, 1980)

The population of the City is distributed normally with respect to national statistics, and approximately 75 percent of the population is over 15 years of age.

Households

The household composition is made up as follows:

TABLE 4-3
WMWD HOUSEHOLD COMPOSITION

	NUMBER	PERCENT
Married Couple Family Households	9,996	65
Single Person Households	3,057	19
Female Headed Families	1,188	8
Non-Family Households (more than one person)	890	6
Male Headed Families	352	2
TOTAL	15,483	100

There were estimated 15,483 total households in the WMWD City in 1980 (Census).

Census and local estimates of dwelling units in the WMWD City indicate a rapid increase in the housing stock. While the City's population grew by 85 percent between 1970 and 1980, the housing stock increased by 110 percent over the past 12 years at an average annual rate of 9.6 percent.

The housing stock growth is presented in Table 4-4.

TABLE 4-4
WMWD TOTAL DWELLING UNITS 1960-1981

	NUMBER OF UNITS	PERCENT INCREASE OVER PREVIOUS YEAR
1960*	4,124	-
1970*	7,777	88
1971	8,429	8
1972	9,341	11
1973	10,430	12
1974	11,457	10
1975	11,790	3
1976	12,342	5
1977	13,331	8
1978	14,452	6
1979	15,486	9
1980*	16,341	5
1981	16,560	1
1982	16,736	1

(*U.S. Census)

These dwelling units are occupied by owners and renters (Number of Households, Table 4-3), and some of the units are vacant as follows:

TABLE 4-5
WMWD OCCUPANCY OF DWELLING UNITS (1980)

	NUMBER OF UNITS
Owner occupied	9,983
Renter occupied	5,500
Vacant (rate 5.2%)	858
TOTAL	16,341
Population in occupied units	42,621
Population in renter occupied units	13,211

Based on occupied units only, the occupancy rate is 2.75 persons/unit, and overall rate is 2.63 persons per unit, which includes vacancy.

Land Use

Based on information from the WMWD City's planning department, developed land use in the community has been primarily residential with commercial, industrial and public uses each accounting for a smaller part. The 1980 estimates of community land use are as follows:

TABLE 4-6
WMWD LAND USE 1980

		ACRES		PERCENT
Residential		2,527		37
Single family	2,153		(32)	
Multi-family	374		(5)	
Commercial		371		6
Industrial		148		2
Park/Recreation		365		5
Public/School/Utilities		401		6
Streets		1,472		22
Subtotal		5,285		78
Vacant Water		1,491		22
TOTAL		6,776		100

The trends indicate a fairly stable distribution of land use to each category, despite the fact that the community has increased in size from a total acreage of 1,867 acres in 1961 to 5,259 acres in 1973 and to 6,776 acres in 1980.

Commercial/Industrial Business

In 1981, the WMWD City was like many other cities in its makeup of commercial and industrial business. Nearly 60 percent of the City's business activity (in terms of numbers of firms and employees) was in Services, and in Wholesale-Retail Trade. Although the community is thought of as a farming community, only 2 percent of the firms and 1 percent of employment is directly involved in agricultural business.

Table 4-7 presents some information on the commercial and industrial aspect of the WMWD City. These data were collected by a local consulting firm as part of a county employment and economic impact survey. The WMWD City, like many cities, has a large number of firms in the Services business (30 percent) and Wholesale-Retail Trade (27 percent). Industry that may be water intensive would be in Agricultural, Mining/Construction, and Manufacturing sectors, although many of these firms would be distributors of equipment, etc.

TABLE 4-7
WMWD NUMBER OF FIRMS AND EMPLOYEES BY INDUSTRY (1981)

	FIRMS		EMPLOYEES	
	NUMBER	PERCENT	NUMBER	PERCENT
Agriculture	21	2	133	1
Mining/Construction	156	15	936	7
Manufacturing	52	5	2,273	17
Transportation/Utilities/Communications	83	8	668	5
Wholesale-Retail Trade	280	27	2,273	17
Finance, Insurance, Real Estate	94	9	668	5
Services	311	30	4,681	35
Government	42	4	1,739	13
TOTAL	1,039	100	13,370	100

Also, based on local data, the major employers in the City include public services, as well as industry. The following Table 4-8 presents some more information on the character of selected large "businesses" in the WMWD City.

TABLE 4-8
MAJOR EMPLOYERS IN THE WMWD CITY

FIRM	PRODUCT	EMPLOYEE RANGE
WMWD School District	Education	1700-1800
WMWD Foods	Turkey Food Products	900-1000
WMWD Hospital	Medical Care	500-550
Federal Service	Government Services	500-550
WMWD City	Manage City	400-500
S. Enterprises	Computer Apparatus	350-400
D. Products	Parts and Accessories	200-250
W. Cutlery	Knives	150-200
WMWD Daily Times	Daily Newspaper	150-200
E. Measurements	Meters and Controls	100-150
BioMed	Bio-Medical Equipment	90-100
Computers	Computing disk-drives	1,500

(WMWD Chamber of Commerce)

Historic information on commercial and industrial business is not available, however, the area is becoming increasingly industrialized.

Public and Education Facilities

The community has numerous buildings, such as a civic center, neighborhood facilities, schools and park and recreation facilities. The following provides some information on these facilities:

Civic and Education Facilities

- Civic Center - covers an entire block and includes a public library, administrative offices of government, and City council chambers.
- Service Center - includes City water and sewer and electric utility administrative offices.
- Memorial Building - for City parks and recreation department and includes a gymnasium, meeting rooms, kitchen, etc.
- Senior Center - for senior citizen administration with lounges, activity rooms, kitchen and other recreational rooms.
- Neighborhood Facility - space provided for WMWD Housing Authority, Women's Center and the Salvation Army.
- V.B. Auditorium - cooperatively used by school district and the City.
- Over 200 acres of developed park and recreation facilities, including 23 facility locations: 17 with restrooms, 2 with swimming, 4 with wading pools, 2 with golf (60 and 143 acres each), and 7 and 9 facilities with soccer, softball and related outside recreation.
- Junior High School - over 500 students enrolled.
- Sr. High School - over 1,000 students enrolled.

FUTURE GROWTH AND PROJECTIONS

If past trends continue, the future for the WMWD City will involve substantial growth. The community anticipates growth in population, housing and employment.

Population Growth

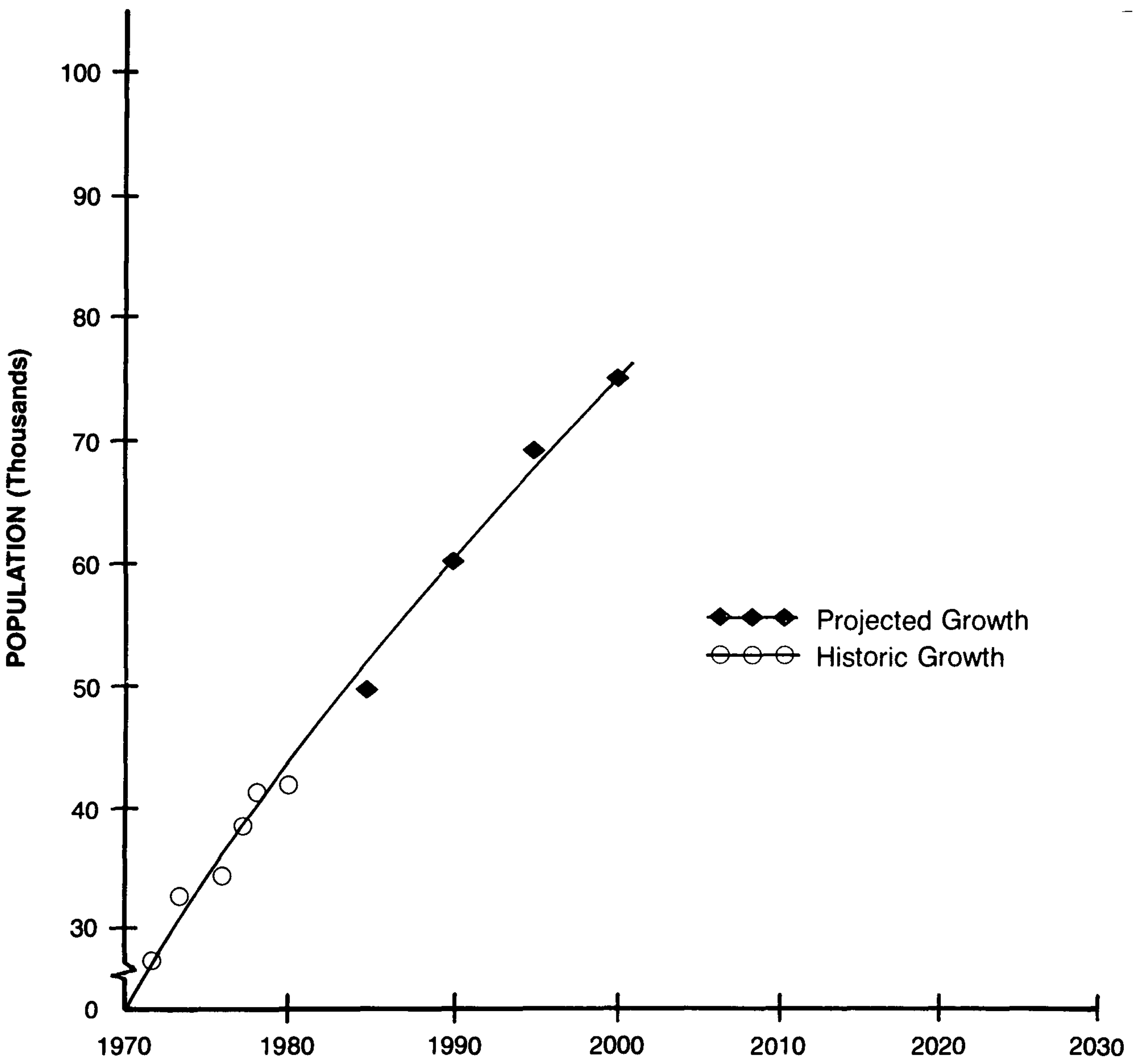
Table 4-9 and Figure 4-1 present the WMWD City historic and projected population growth based on City estimates of growth through the year 2000. Population is estimated to increase as follows:

TABLE 4-9
WMWD CITY FUTURE POPULATION

	POPULATION
1985	49,800
1990	60,900
1995	68,200
2000	76,500

These figures are used by the City for planning purposes and reflect local official views on the nature of growth for the City. These projections are presented here for background information. The estimates in Figure 4-1 indicate a 200 percent increase in population between 1970 and 2000 which are double the regional rates in the OBERS 1980 projection for the SMSA. (14) However, the local share of this growing area has consistently been substantially greater than the regional share.

FIGURE 4-1
WMWD City/Service Area
Local Perspective on
Future Growth



SOURCE: WMWD City Office of Planning and Development

Housing Growth

Assuming a constant occupancy rate of 2.63 persons per dwelling unit, the number of future dwelling units was projected by the community. Increase in housing units was projected as follows:

TABLE 4-10
WMWD PROJECTED NUMBER OF HOUSING UNITS

YEAR	NUMBER OF HOUSING UNITS
1985	18,900
1990	23,150
1995	25,900
2000	29,100

Commercial and Industrial Growth

The WMWD City has been identified as a location for nationally recognized high technology firms. Estimated additional employment is proposed by two major firms. The S.T. Corporation plans to add 1,500-2,000 employees by 1995. The H.P. Organization will supplement its staff with from 2,300 to 6,900 additional employees over the same time period.

The growth potential of the area is recognized by the Regional Council of Governments which allocated an additional 45 percent employment growth for the 15-year period.

TABLE 4-11
WMWD PROJECTED EMPLOYMENT

YEAR	WMWD CITY EMPLOYMENT
1985	20,000
1990	24,800
2000	29,000

WATER AND WASTEWATER SYSTEMS

The WMWD City has developed a diverse water system, including numerous water supply sources, treatment and distribution, and wastewater collection and treatment facilities.

Water Supply

The WMWD water supply system has grown over the past decades along with the increases in population. Table 4-12 shows the number of accounts and the total water use since 1976.

The City maintains a complete water supply treatment and distribution system to provide potable water to its customer population (both inside and outside the City) of approximately 43,500 (1983).

TABLE 4-12
WATER USE IN WMWD

YEAR	# /ACCOUNTS	TOTAL ANNUAL WATER (MILLIONS OF GALLONS)	AVER. CONSUMP. (MILLION GAL./DAY)	PER CAPITA CONSUMP.* (GALLONS/CAPITA)
1976	10,361	2,966.9	8.13	237
1977	11,250	3,565.0	9.77	267
1978	12,069	4,084.8	11.19	286
1979	12,702	3,370.1	9.23	223
1980	13,046	3,670.5	10.06	234
1981	13,010	3,681.0	10.08	231

*Based on Population from Table 4-1 and Average Consumption from this Table.

The City's existing treatment facilities are comprised of three water filtration plants:

TABLE 4-13
WMWD WATER TREATMENT PLANTS

	CONSTRUCTED		CAPACITY (MGD)*
(1)	1935		14
(2)	1967		10
(3)	1985		22
		Total	46

*Millions of gallons/day

The addition of a new water filtration plant with 22 mgd capacity, which recently came on line, was essential since the WMWD could not meet water demands.

The water provided to those plants is of excellent quality and exceeds the State Health Standards. The water is chemically pretreated, processed by coagulation-flocculation, followed by sedimentation, filtration through rapid sand filters, and chlorination. The treated water is discharged into the City's treated water pipeline and transported 5.75 miles to the City's distribution system.

In addition to the City's treatment system (46 mgd capacity), facilities include 44 miles of transmission lines for raw and treated water, six dams and reservoirs, four treated water storage tanks (combined storage of 25 million gallons), two pump stations and 143 miles of distribution mains and laterals.

Water Resources

The WMWD City has acquired water rights to various sources of water (Table 4-14). The City's basic sources of supply are direct flow rights out of two local rivers (snow melt) and shares of several ditch companies and reservoir companies. The WMWD City also owns contract rights to water from a local district project (C-BT) which is also dependent on snowfall. The yield of the project various from 30 to 70 percent of the 8,224 acre-foot allotment, however, delivery has been 100 percent in dry years. The following sources are currently available:

TABLE 4-14
WATER SOURCES OF WMWD

	APPROPRIATION DATES	AVERAGE YIELD (ACRE-FEET/YEAR)
City-Owned Diversions	1865-1909	3,566.0
Ditch Rights	1861-1881	12,216.6
Reservoir Shares	1882-1956	1,102.6
C-BT Project Contract Rights	-	8,224.0
Total Sources		25,109.2*
1985 Estimated Safe Yield		20,000.0**

*WMWD Data (January 1985)
**Consultant Report: WMWD Water Study 1979-2040, Jan. 1980.

This water supply is estimated by the WMWD to provide for the needs of 74,022 people.

The City has developed a complex network of water sources which reflects the effects of water requirements for growth and the region's allocation procedures. Because of the many sources that are used, various reports reflect different available supply yields. However, a recent consultant report estimated the "safe-yield" of the WMWD system at 20,000 acre-feet.

These sources are represented in a recent Water Bond Prospectus which describes a future project (LOCAL-1) that is planned to provide for future water needs in the WMWD City well after the year 2000. This new project will be administered by a water district in which the City owns contract rights (16 2/3 percent). LOCAL-1 will supply the City with 8,000 acre-feet of water per year (water for an estimated additional 28,571 persons), according to the City's consultants. The LOCAL-1 project will include a diversion dam (with an embankment and a spillway) with a maximum height of 25 feet and a total live storage capacity of 320 acre-feet between normal minimum operating level and normal maximum operating level. The project also includes: four pumping plants rated at 150 cubic feet per second (cfs) each (total discharge capability of 600cfs); a pipeline approximately 30,000 feet in length; and an inlet works to an existing inlet structure.

The project, however, is regarded as an expensive source of water for the community. The City's annual payments for the proposed water source are set forth in the Prospectus (Table 4-15). These annual charges are as follows (estimates):

TABLE 4-15
WMWD LOCAL-1 PROJECT

YEAR	WMWD CHARGE	$/ACRE-FOOT
1982	$ 76,600	—
1983	76,600	—
1984	160,000	—
1985*	1,378,000	—
1986	2,214,000	$276.00
1987	2,278,000	284.00
1988	2,491,000	311.00
1989	2,567,000	320.00
1990	2,652,000	331.00
1991	2,745,000	343.00
1992	2,846,000	355.00

(*Project completion date)

Although the project has been initiated and is planned for completion in 1985, the City is considering selling its rights to this source of water.

In addition, two Federal projects are proposed for the WMWD City area to serve the water, as well as possible flood control, power, and recreation needs of the growing area. A cooperative effort through a Conservancy District has proposed projects to provide for urban and farm irrigation water needs. In lieu of this approach, these water users "face the possibility of having municipalities condemn agricultural water to meet the growing demands of the urban areas." (Consultants Report, December 31, 1982.)

The "FED-1" project is a large project that consists of a dam and reservoir (selected from 3 alternative approaches) with a capacity of 116,000 acre-feet (32,000 acre-feet for the WMWD City needs), a power and water supply tunnel connecting with an existing WMWD City reservoir, a pump storage hydroelectric facility with an installed capacity of 156 megawatts and relocation for 5.3 miles of highway.

The project will be on-line January 1990 and have a total capital cost of approximately $373,469,000. Estimated charges for storage of water in FED-1 will be approximately $16.65 per acre-foot per year (1980 dollars) assuming an active storage of 102,000 acre-feet and fifty percent financed by a municipal bond issue.

Total annual costs of the project are estimated at $28,646,000 per year. Estimated revenues are: Sale of power $26,832,000 ($172.00/kw/y); storage revenues $1,698,000; and recreation revenues $106,000.

The "FED-2" project is a much smaller project with a total capacity of 25,000 acre-feet (16,000 agriculture and 9,000 domestic, municipal and industrial). The main components of the project are a dam and reservoir with purposes to provide municipal, industrial and agricultural water supplies, flood control, water quality control, and recreation.

This project would have a total capital cost of $106,834,000, assuming fifty percent municipal bond financing, and is assumed to be on-line by January 1990, according to the 1982 Consultant Report. The costs for storage of water in FED-2 would be $169.00/acre-foot in 1980 dollars. The hydroelectric potential for the project was determined to be infeasible.

Sewer System

The WMWD also provides wastewater treatment for its residents. The sewage treatment facilities have a hydraulic design capacity of 8.2 million gallons per day (mgd) and an organic treatment capacity of 13,100 pounds per day of five-day biochemical oxygen demand (BOD). The facilities are capable of serving 51,000 residents, according to WMWD estimates. Because the treatment plant is currently operating at 80 percent of design capacity, (hydraulic and BOD), plans are being prepared for treatment plant expansion to accommodate a population of 83,000. City sewer customers (Table 4-16) have increased in number, as follows:

TABLE 4-16
WMWD SEWER CUSTOMERS

YEAR	NUMBER
1975	NA
1976	9,924
1977	10,812
1978	11,635
1979	12,273
1980	12,616
1981	12,707

Due to high soluble BOD loading from industrial wastewater and in-plant recycling, the actual organic capacity is diminished, resulting in organic loads that are near and sometimes exceed the plant capacity and NPDES permit requirements. Without the industrial concentrations problem, the plant on an "average" month basis would have remaining plant capacity for an equivalent population of 10,000. An industrial wastewater pre-treatment program is currently being developed to address the problems of unregulated discharge of industrial wastewater to the City's wastewater disposal system.

Wastewater/sewer rates (1983) are based on monthly water use for:

Flat Rate Water Users: (Monthly water bill minus $3.70 water administrative cost, multiplied by 73.8 percent plus $2.90 sewer administrative cost) to decline to 69.4 percent (1984) and 64.9 percent (1985).

Metered Water Users: ($1.42 per 1000 gallons of water consumption plus $2.90 sewer administrative cost).

LOCAL GOVERNMENT ADMINISTRATION

The WMWD community was incorporated in 1885, and became a Home Rule City with voter approval in 1961. The Charter provides for a Council-Manager form of government. The Mayor and City Council (6 members) are elected, and the City Manager, in whom all administrative functions are vested, is appointed by the City Council.

The City Council effects its decisions through the passage of ordinances, resolutions and motions. The City Council meets not less than twice each month. Four members of the Council constitute a quorum. All legislative enactments must be in the form of an ordinance. Ordinances may be initiated, or their repeal sought, by motion of the Council or petition of 10 percent of the registered electors of the City. Ordinances require two readings, publication, and a public hearing before passage of a majority of the entire Council can occur. Ordinances initiated or whose repeal is sought by petition must be passed or repealed within thirty days of the petition's presentation or be submitted to the electorate for a vote. Ordinances authorizing the issuance of bonds, levying taxes, making annual appropriations, and ordering improvements funded by special assessments are exempt from the initiative and referendum provisions.

The City's day-to-day operations are the responsibility of the City Manager. Personnel supporting him include: City Attorney, Director of Water and Sewer Utilities, Director of Development Services, Chief Accountant and the City's 476 permanent, full-time employees and 50 seasonal employees.

WMWD PROCEDURES MANUAL APPROACH

This section presents the Procesures Manual approach for the Level 1 example. Since Level 1 is the most data deficient situation, the methods are most reliant on ways to fill in the data voids and the appropriate methodologies for doing the analysis.

STEP 1: Universe of Water Conservation Measures

For this project, a broad list of water conservation measures was developed and is explained in Appendix A. Table 4-17, Potential Water Conservation Measures, serves as a Summary Table for the analysis in Steps 1-4. This sequence of four Steps is a screening method that reduces the universe of water conservation options down to a short list of "applicable", "technically feasible" and "socially acceptable" options. The water conservation methods that pass through this screening have a chance for implementation in the Level 1 WMWD City.

TABLE 4-17

POTENTIAL WATER CONSERVATION MEASURES: WMWD CITY/LEVEL 1

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
REGULATION			
LONG-TERM			
Federal & State Laws & Policies			
A. Federal Laws and Policy	No		
B. State Policy	No		
1. Plumbing Code	No		
2. Other Policy	No		
Local Codes & Ordinances			
A. Plumbing Codes for New Structures			
1. Low-flow showerheads	Yes	F	Yes
2. Shower flow restrictors	Yes	F	Yes
3. Toilet dams	Yes	F	Yes
4. Displacement devices	Yes	F	Yes
5. Flush mechanisms	Yes	F	Yes
6. Shallow trap toilets	Yes	F	Yes
7. Pressure toilets	Yes	F	Yes
8. Dual-flush toilets	Yes	F	Yes
9. Faucet aerators	Yes	F	Yes
10. Faucet restrictors	Yes	P	Yes
11. Pressure-reducing valves	Yes	F	Yes
12. Service line restrictors	Yes	P	Yes
13. Insulated hot water lines	Yes	F	Yes
14. Pre-mixed water systems (thermostatic mixing valves)	Yes	F	Yes
15. Low water-using clothes washers	Yes	F	Yes
16. Low water-using dishwashers/ appliances	Yes	F	Yes
17. Dry composting toilets	Yes	P	Yes
18. Grey water systems (reuse)	Yes	P	Yes
19. Leakage repair (private systems)	Yes	F	Yes
20. Industrial recycle	Yes	F	Yes
B. Plumbing Codes--retrofitting			
1. Low-flow showerheads	Yes	F	NA
2. Shower flow restrictors	Yes	F	NA
3. Toilet dams	Yes	F	NA
4. Displacement devices	Yes	F	NA
5. Flush mechanisms	Yes	F	NA
6. Shallow trap toilets	Yes	F	NA
7. Pressure toilets	Yes	F	NA
8. Dual-flush toilets	Yes	F	NA
9. Faucet aerators	Yes	F	NA
10. Faucet restrictors	Yes	F	NA

TABLE 4-17 (CONTINUED)
WATER CONSERVATION MEASURES: WMWD CITY/LEVEL 1

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
11. Pressure-reducing valves	Yes	F	NA
12. Service line restrictors	Yes	F	NA
13. Insulated hot water lines	Yes	F	NA
14. Pre-mixed water systems (thermostatic mixing valves)	Yes	F	NA
15. Low water-using clothes washers	Yes	F	NA
16. Low water-using dishwashers/ appliances	Yes	F	NA
17. Dry composting toilets	Yes	F	NA
18. Grey water systems (reuse)	Yes	F	NA
19. Leakage repair (private systems)	Yes	F	NA
20. Industrial recycle	Yes	P	No
C. Sprinkling Ordinances			
1. Alternate day	Yes	F	NA
2. Time of Day	Yes	F	Yes
3. Hand-held hose	Yes	F	NA
4. Drip irrigation techniques	Yes	F	NA
D. Changes in Landscape Design	Yes	F	Yes
E. Water Recycling	Yes	P	No
Restrictions			
A. Rationing			
1. Fixed allocation	Yes	P	Yes
2. Variable percentage plan	Yes	P	NA
3. Per capita use	Yes	P	No
4. Prior use basis	Yes	P	No
B. Restrictions on Specific Uses			
1. Recreational uses	Yes	F	NA
2. Commercial & Industrial uses	Yes	F	No
3. Car washing	Yes	F	No
CONTINGENT			
Local Codes & Ordinances			
A. Sprinkling Ordinances	Yes	F	NA
B. Water Recycling	Yes	P	No
Restrictions			
A. Rationing			
1. Fixed allocation	Yes	P	Yes
2. Variable percentage plan	Yes	P	Yes
3. Per capita use	Yes	P	Yes
4. Prior use basis	Yes	P	Yes
B. Restrictions on Specific Uses			
1. Recreational uses	Yes	F	Yes
2. Commercial & Industrial uses	Yes	F	No
3. Car washing	Yes	F	No

TABLE 4-17 (CONTINUED)
WATER CONSERVATION MEASURES: WMWD CITY/LEVEL 1

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
MANAGEMENT			
LONG-TERM			
Rate-Making Policies			
A. Metering	No 1	F	Yes
B. Rate design			
1. Marginal cost pricing	Yes	F	NA
2. Increasing block rates	Yes	F	No
3. Peak load pricing	Yes	F	NA
4. Seasonal pricing	Yes	F	No
5. Summer surcharge	Yes	F	NA
6. Excess use charge	Yes	F	NA
Tax Incentives & Subsidies	Yes	F	Yes
CONTINGENT			
Rate-Making Policies			
A. Rate design			
1. Marginal cost pricing	Yes	F	NA
2. Increasing block rates	Yes	F	No
3. Peak load pricing	Yes	F	NA
4. Seasonal pricing	Yes	F	NA
5. Summer surcharge	Yes	F	NA
6. Excess use charge	Yes	F	Yes
EDUCATION			
LONG-TERM			
Direct Mail	Yes	F	Yes
News Media	Yes	F	Yes
Personal Contact	Yes	F	Yes
Special Events	Yes	F	Yes
CONTINGENT			
Direct Mail	Yes	F	Yes
News Media	Yes	F	Yes
Personal Contact	Yes	F	Yes
Special Events	Yes	F	Yes

FOOTNOTES: TABLE 4-17

APPLICABLE:

"Yes" Applicable

"No" Currently in use (1) Required by utility policy, (2) Required by state or local plumbing code, (3) Required by some other authority, or (4) Requested for voluntary implementation (ie., "No (1)" means currently in use, as a result of utility's authority. "No (14)" means utility authority and voluntary).

TECHNICALLY FEASIBLE:

F Not in use, but technically feasible (will not adversely affect water use (other than flow reduction if implemented). For example, a sector of a water service area has low water service pressure and flow restrictors will adversely affect use. Such devices are not technically feasible.

P Not in use, but potentially technically feasible once possible small technical obstacles to implementation are overcome.

SOCIALLY ACCEPTABLE:

"Yes" or "No" Based on analysis of social acceptability, measure is acceptable to public.

NA Not available.

STEP 2: Applicability

The WMWD City has had some experience with water conservation over the past several years. Because of peak water demand problems and an undersized water treatment plant, restrictions were placed on water use for lawn and outside use. An alternate day (every third day) and time-of-day restriction was imposed by local ordinance. This ordinance constituted a long-term water conservation program, because of the permanence of the policy and its enforcement over an extended period of time.

The local ordinance provided the following:

- restricted domestic water use for garden, lawn or other exterior watering or sprinkling from May 15 through September 30 of any year, except from the water mains of and upon the premises with an even street address on even calendar days and with an odd street address on odd calendar days, and only between the hours of 5:30 P.M. and 10:00 A.M. (with some exceptions: for the 31st day of months and some watering of new seed and sod).

- o emergency watering restrictions in the event of emergency water conditions due to climatic conditions which may establish further restrictions.

- o special assessments (fines) for violations.

- o appeal process regarding violations.

Previously, the WMWD water system was described, including the completion of a new 22 mgd water filtration plant. As a result, the water restrictions were repealed by Council action on May 8, 1984. At this time, the community has no water conservation measures in effect.

The community has a very strong attitude about local business development and, as a result, is very reluctant to consider restrictions on industrial and commercial water uses.

There are no state-level requirements for water conservation and, with the exception of metering which is currently being installed for residential customers and is used for other customer classes, all measures are applicable.

The City Council will be responsible for formulating and adopting a new water conservation program, and the City Manager will assume the responsibility for its implementation.

STEP 3: Technical Feasibility

Water conservation measures in Table 4-17 were screened to determine if they are technically feasible (F), or potentially technically feasible (P), based on knowledge of the measures and aspects of the WMWD water system that could affect their function.

Measures that would be used for new construction (plumbing codes for new structures) were generally considered technically feasible, with the exception of faucet restrictors and service line restrictors (methods that are generally applicable only in retrofitting applications) and dry composting and grey water systems which are only for special case situations. The conventional water conservation measures were otherwise thought to be technically appropriate for the WMWD City area, and no inconveniences would be experienced by customers or by the water department in the application of such measures.

With respect to retrofitting existing structures (Plumbing Codes--retrofitting), all of the measures were judged to be technically feasible. A reservation could relate to individual problems that can develop in modifying existing plumbing. However, the issue can be avoided by voluntary program implementation and owners doing the installation themselves or having the work done by a local plumber.

Sprinkling ordinances were judged to be technically feasible based on recent effective use of such a long-term approach by the WMWD, as were landscape design changes which have been successful in other areas as a means of reducing outside water use. Recycling water was judged to be potentially technically feasible based on treatment plant locations and available users (ie., golf course locations) as well as water law problems (water discharges are committed to downstream water users).

Restrictions, such as rationing, were not believed to be appropriate approaches for long-term water conservation because of western water law issues, and more acceptable approaches are available. Restrictions on recreational, commercial/industrial and car washing were all judged to be technically feasible.

On a contingent/short-term basis, most of the water conservation measures were identified as potentially technically feasible with the exception of a few measures: Leak detection was judged to be technically feasible, and metering is not applicable since residential meters are being installed for the 85 percent of the system that is not now metered.

Both for long-term, as well as contingent plan purposes, an education program on water conservation was judged to be technically appropriate.

STEP 4: Social Acceptability

Since very little information is available on the public's attitude regarding water conservation measures and the public's willingness to implement them, either on a long-term or contingent basis in the WMWD City, this analysis is based on available literature information. A survey of literature was conducted to determine the social acceptability of water conservation measures as they have been implemented in various situations around the nation. The relevance of the literature to the WMWD was tested based on the background information on the WMWD community. The community is a typical, rapidly growing suburban area with a "normal" mix of housing and occupancy (owner occupied and rental), industry (manufacturing, "high tech", and services) and supporting infrastructure. This approach has the advantage of using past experience in assessing how the local population may respond to certain measures. This is particularly useful for determining the public's attitude toward measures that have been used in numerous locations (ie., certain measures are examined more often in the literature than others).

Of the 56 responses that are reported in Appendix B, Table B-2, General Literature Review's Results Of The Social Acceptability Of Specific Water Conservation Measures, 42 are favorable, and 14 are unfavorable (a ratio of 3:1). Also, the higher frequency of favorable responses for any reported measure suggests that the measures that have been evaluated for public attitudes have generally been supported by the public.

The social acceptability analysis identifies measures as socially acceptable (Yes), not socially acceptable (No), and information not available (NA).

Care and judgment are required in order to interpret possible social acceptability of measures that are listed, particularly, the (NA) category must be reviewed carefully. Although information is not available on these measures, this should not be taken as an indication of a negative attitude. As a result, for this example, a factor of judgment is required that is based on generally favorable public attitude about efficiently run government. For example, although there is no indication about the social acceptability of a water system leak detection program, this is reasonably assumed to be acceptable to a water utility (with more water to sell), to the public (with more water available for beneficial use and probably at a lower cost than for developing new supplies) and generally to commercial and industrial business, (since water supply is presumably managed well and is cheaper).

The results for the WMWD City indicate a favorable social acceptability for plumbing codes for new structures employing water-saving devices, ordinances for long-term sprinkling restrictions (methods recently used by the WMWD), a fixed allocation plan rationing approach, water recycling for non-potable purposes (that do not conflict with downstream water user rights), metering (which is now being installed) and an education program. These results are believed to accurately reflect the community's attitude based on familiarity with the community which is not atypical of many communities across the nation, (ie., based on Section Historical Growth and Development, the community is not predominantly multi-family, or commercial, or industrial, etc., and national data sources should be fairly representative).

Summary of Steps 1-4 Screening

Based on the analysis of Applicability (Step 2), Technical Feasibility (Step 3), and Social Acceptability (Step 4), the long list of available water conservation measures has been narrowed to reflect those measures that are not now in use, or are only partially used (applicability analysis), those measures that are capable of achieving water use reduction and are compatible with the WMWD water system (technical analysis), and those measures that are consistent with the overall philosophy of the community (public, local officials, water users and other interests), (social acceptability analysis). The results indicate the following measures should be further evaluated, through Steps 5 through 16, for other aspects of their effectiveness, cost, and impact on the area:

TABLE 4-18
SUMMARY: WMWD MEASURES FROM SCREENING STEPS 1-4

LONG-TERM MEASURES

1. Distribution and retrofitting of water-saving devices to existing residences, commercial, industrial, public and institutional buildings.

2. Conservation ordinance requiring water-saving fixtures in all new construction.

3. Utility leakage reduction program.

4. On-going public education.

CONTINGENT MEASURES

1. Restrictions on lawn and other exterior sprinkling.

These measures can easily be incorporated into the WMWD City through actions by City Council and implemented through the City Manager's authority and the City Water and Sewer Department. The enforcement capability of the City, building inspectors, and personnel resources of the City should be sufficient without any major changes to undertake these actions, if they are determined to be implementable in the following analysis.

STEP 5: Implementation

The WMWD City will take the primary responsibility for implementing the water conservation measures. The conservation measures consist of permanent measures, enacted to reduce water use over the long-term, and one contingency measure, implemented only when additional short-term reductions are necessary. The permanent measures consist of:

Measure (1): Distribution and retrofitting of water-saving devices to existing residences, commercial, industrial, public and institutional buildings.

Measure (2): Conservation ordinance requiring water-saving fixtures in all new construction.

Measure (3): A utility leakage reduction program.

Measure (4): An ongoing public education program.

These measures are all initiated during the first year of the study period (1980) with the first year of any observed water conservation reductions assumed to occur starting in 1981. The contingency measure consists of,

Measure (5): Restrictions on lawn and other exterior sprinkling, and is only enacted when short-term additional water reductions are required, so it is generally evaluated separately in this analysis.

Measure 1

The water-saving devices being distributed and retrofitted to existing buildings include shower flow restrictors and toilet displacement devices. Shower flow restrictors are devices which are inserted between the existing conventional showerhead and the showerhead arm. They are an addition to the shower apparatus and are generally only retrofitted to existing systems. Reductions from shower flow restrictors occur only in the interior residential and public water use categories.

Toilet displacement devices are space-occupying objects such as plastic bottles which reduce the volume of water normally used for flushing by displacement rather than damming. Reductions from displacement devices occur only in the interior residential, commercial, and public water use categories.

These devices made available as kits, would be installed on a voluntary basis by residents and would, if properly installed, reduce shower flows and flushing volumes. The distribution of the kits would be achieved by making them available at public places at no cost to the recipient, and depend on the interest of the residents to pick them up.

The program would require media assistance and use of voluntary organizations to promote the program. Initial efforts would be required of the Department of Water and Sewer Utilities (Water and Sewer Engineering Section) to develop fliers and promotional material describing the program and its benefits to the public.

Since the program is offered on a voluntary basis and homeowners are responsible for installation, no problems are anticipated in implementation.

Measure 2

The conservation ordinance to be enacted will mandate the use of water-saving fixtures or devices to bring about permanent reductions in water use in all new construction. This will be accomplished by modifying the plumbing code to limit the quantity of water per toilet flush to no more than 3.5 gallons and the maximum rate from all showerheads and faucets to 3.0 gallons per minute. Thus, reductions from the conservation ordinances will occur in the interior residential, commercial, industrial, and public use sectors.

Local agencies which normally enforce building codes and standards (ie., Department of Public Works, Building Inspection Division) could monitor compliance with these plumbing code changes. Since the function of the water fixtures is similar to that of older types, no inconvenience or consumer resistance to the change is expected.

Measure 3

The leakage reduction measure includes a program to check the accuracy of the master and customer meters, pipeline leakage detection, and repair. A wide variety of specific leak detection programs are available, each with different expected results. The WMWD City's actual unaccounted-for water included in the water use projections is only a very rough estimate of 15 percent, however, so the actual unaccounted-for water use to be impacted by this measure is basically unknown. For this reason, the use of specific reduction factors for actual leakage reduction programs does not seem warranted, rather the impact of this measure has been included by assuming the measure will reduce the unaccounted-for water to 10 percent by 1990 and maintain it at that level thereafter.

The program would be implemented with existing Department of Water and Sewer Utilities personnel. The program could be implemented with minimal equipment purchases and rely primarily on inspections and water pressure testing. If significant leakage problems are detected, the program could be expanded to include purchased or leased equipment to locate distribution system leaks.

Since no leakage detection program is currently in use, the goal of 10 percent reduction by 1990 should be easily achieved by 1990 without a major investment in equipment. No problems are anticipated in program implementation.

Measure 4

The public education program will consist of several methods to alert the public to the need and advantage of conserving water. It will include direct mail campaigns providing information on how to save water to customers. News media campaigns, including the use of radio and newspapers to convey educational messages on conservation will also be included. Special events such as lectures to civic organizations or school assemblies would also be part of the public education program. Reductions from public education will occur in all water use sectors except the unaccounted-for water use sector.

Typical education programs are focused on school age children and local media channels for getting information to the public. The program would be structured by the WMWD City Manager, Department of Water and Sewer Utility and the advisory Water Board, submitted to the City Council for discussion and approval and implemented by the City Manager utilizing existing (ie., Department of Public Safety) and new channels for getting information to water users.

Little or no opposition is anticipated from this approach.

Measure 5

The restrictions on sprinkling use, enacted only on a contingency basis, consists of restricted outdoor watering to every third day and then only allowing sprinkling to occur in the early morning and during the evening hours to avoid excessive evaporation. This measure was enacted by the WMWD City on a temporary basis in the past. Reductions from this measure can only occur in the outdoor water use categories.

Measure 5 is very much like the previous time-of-day and alternate-day sprinkling ordinance used in the WMWD service area. No problems are anticipated from this approach.

STEP 6: Effectiveness

The effectiveness analysis for the WMWD City consists of four Substeps and evaluations:

- Substep 6.1 Disaggregated Water Demand Forecasts
- Substep 6.2 Determine Fraction of Water Demand Reduction
- Substep 6.3 Determine coverage
- Substep 6.4 Analysis of Effectiveness

Substep 6.1 Disaggregated Water Demand Forecasts

For the WMWD City, the projected number of connections for each residential customer class is a function of population growth and changing housing characteristics, together with the rate of conversion from flat rate to metering now in process. The number of commercial, industrial, and other non-residential water users increases in proportion to population growth. Projected water use for each residential customer class is a function of water rates and household income. Water rates also influence future commercial and small industrial water use, but not large industrial and institutional users. Total mean annual system water use is the sum of aggregate use for each customer class, together with a 15 percent estimated leakage. Peak daily usage is a function of both indoor and outdoor daily water usage, and the observed variability of each.

The method used for projecting medium ("most likely") water demand for the WMWD City (and high and low estimates, used later for sensitivity analyses) includes four parts:

(1) Project connections by customer class
(2) Estimate future annual water use
(3) Combine the data to project annual water use
(4) Estimate peak daily water usage

(1) Project Connections by Customer Class: High, medium, and low projections of the number of connections in each customer class were generated as follows:

Step 1: Obtain Estimates of Future Population Growth

High, medium, and low growth scenarios were obtained from a current planning study. The estimates used in that study for the years 1980 through 2020 were synthesized by consultants from a variety of local sources. The year 2030 projections were obtained by extrapolating the 2010 to 2020 growth rates to the year 2030. The high growth scenario is based upon the assumption that the population growth rate will be 4 percent annually between 1983 and 1990, 3 percent between 1991 and 2000, and 2.5 percent between 2001 and 2030. The medium growth scenario is based upon the assumption that the population growth rate will be 3.5 percent annually between 1983 and 1990, 2.5 percent between 1991 and 2000, and 2 percent between 2001 and 2030. The low growth scenario is based upon the assumption that the population will grow by 2.4 percent annually between 1983 and 2000, 2 percent between 2001 and 2010, and 1.85 percent between 2011 and 2030.

Step 2: Define the Customer Classes

The five customer classes employed by the WMWD water utility since 1983 are flat rate single family residential (SFR FLR), metered single family residential (SFR Met), multi-family residential (MFR), commercial and small industrial (COMM), and special. A special category consists of a small number of large industrial, institutional, and public water users. For this study, the special category is divided into industrial (IND.) and public and institutional users (PUB/INST.).

Step 3: Application of Growth Rates to Customer Classes

The high, medium, and low population growth rates were applied to the 1983 number of customer class connections to obtain high, medium, and low projections of the number of connections by customer classes for future years, assuming no change in the mean number of persons per household and no shifts in the proportion of the population residing in each housing category. Mean household size has declined significantly in recent years, but it is believed that this trend will soon stabilize, if not reverse, and, therefore, no change in mean household size was assumed. However, the increasing proportion of households residing in multi-family as opposed to single family residences and the conversion of single family residences from unmetered flat rate status to metered status constitute trends which are expected to continue.

Step 4: Adjustment for Conversion to Universal Metering

Prior to 1978, the WMWD City did not meter single family houses except for those outside the City limits. In that year, it initiated a program to attain universal metering by requiring the installation of water meters in all new dwelling units and in all existing dwelling units upon change of ownership. The annual rate of turnover of the existing stock of single family residences is approximately 9 percent; therefore, 9 percent of the existing single family unmetered residences are assumed to be converted to metered status annually.

Step 5: Adjustment for Decline in Single Family Housing

A major trend occurring in the WMWD City, as in other U.S. cities, is the disproportionate growth in the number of multi-family housing units. The share of the housing stock composed of single family units decreased between 1976 and 1982. Using linear regression, a trend line was calculated to predict the percentage of all housing units which would be in the single family category in 1990, 2000, 2010, 2020, and 2030.

The results of this procedure for the 50-year period 1980 through 2030 are presented in Table 4-19 which assumes medium population growth.

TABLE 4-19
WMWD CUSTOMER MEDIUM GROWTH CONNECTION PROJECTIONS
(SHARE IN SFR AND MFR VARIES OVER TIME)

YEAR	1980	1990	2000	2010	2020	2030
CUSTOMER CLASS						
SFR FLR	11,292	5,123	1,995	777	303	118
SFR Met		10,689	17,772	22,743	27,663	33,117
MFR	559	1,190	1,998	3,011	4,376	6,190
COMM	1,055*	962	1,231	1,501	1,830	2,230
IND.	4	6	8	10	12	15
PUB/INST.	8	14	18	22	27	32
TOTAL	12,918	17,985	23,022	28,064	34,210	41,702

*Note: In 1980, the WMWD City distinguished only flat rate, multi-family, and all other metered water users. "Commercial" contains in that year only a number of residential connections which were outside the City limits and which were already metered at that time.

(2) Estimate Future Annual Water Use: The next task is to estimate annual water use for each customer class. This is done in a four-step process.

Step 1: Obtain Water Consumption Data for the WMWD City

The data obtained for the WMWD City were for the years 1976 through 1983 and included the number of connections by customer class, the water consumption by month for each year for each customer class, and the revenue obtained for each customer class for each month for each year.

Step 2: Estimate Seasonal Water Consumption by Customer Class

The 1980 data were used to calculate seasonal water use because 1980 represented a "typical" weather year. Seasonal water use was estimated in a three-step process.

- Divide the year into winter and summer. Winter is considered November to April, and summer is May to October. Winter months are considered typical indoor water usage months while summer months contain indoor and outdoor water use.

- Calculate the average water use per connection for each month.

- Subtract the winter months average use from the summer months average use to obtain domestic and seasonal usage. When this is done, water consumption per connection by customer class is obtained. These data are presented below.

SFR Indoor:	8,120	gallons per month (for 12 months)
SFR Outdoor:	15,580	gallons per month (for 6 months)
MFR Indoor:	37,400	gallons per month (for 12 months)
MFR Outdoor:	22,100	gallons per month (for 6 months)
COMM Indoor:	38,110	gallons per month (for 12 months)
COMM Outdoor:	23,060	gallons per month (for 6 months)
IND Indoor:	5,791	gallons per month (for 12 months)
IND Outdoor:	1,337	gallons per month (for 6 months)
PUB/INST. Indoor:	223	gallons per month (for 12 months)
PUB/INST. Outdoor:	236	gallons per month (for 6 months)

Step 3: Specify the Equations Used to Calculate Water Use

The models used are based loosely upon the equations specified in the IWR-MAIN handbook (page A-4). (81) Simplifications have been developed to ease data requirements. In addition, the elasticity of demand (exponent of the price term) in these models, unlike those of IWR-MAIN, increases as price increases. The equations presented on page A-4 are based upon national average data from prior research. The first step in using these equations is to specify or calibrate the models for the WMWD City conditions. When the model is calibrated, the following equations are obtained.

SFR FLR Ind: $Q = 8.12 * 12 * C$

SFR FLR Out: $Q = 21.05 * 6 * C$

SFR Met Ind: $Q = 75.65 * p^{-.2-.2n} * Y^{0.4} * C$

SFR Met Out: $Q = 78.33 * p^{-.6-.2n} * Y^{0.4} * C$

MFR Ind: $Q = 451.49 * p^{-.2-.2n} * Y^{0.4} * C$

MFR Out: $Q = 189.13 * p^{-.6-.2n} * Y^{0.4} * C$

COMM Ind: $Q = 227.11 * p^{-.2-.2n} * C$

COMM Out: $Q = 94.68 * p^{-.6-.2n} * C$

IND Ind: $Q = 5{,}791.01 * 12 * C$

IND Out: $Q = 1{,}806.80 * 6 * C$

PUB/INST. Ind: $Q = 223.07 * 12 * C$

PUB/INST. Out: $Q = 363.19 * 6 * C$

In the above equations, Q = annual water use per connection; C = the number of connections for each customer class; p = the price of water; n = the differences in price over the previous period; and Y = mean household income. The initial numeric constant (the Y - intercept) was calculated using the known (1980) data on all of the variables. For projection purposes, Q may be calculated by substituting the price, the change in price (if any) since the previous period, family income, and the number of connections projected for each class to obtain the annual quantity of water used for the target year.

<u>(3) Combine the Data to Project Annual Water Use</u>: The preceding data are combined (based on the medium population growth scenario with the price of water at $1.05 per 1,000 gallons) to determine the system water usage for projected years. A leakage factor of 15 percent is included to represent unaccounted-for losses of water (terms used synonymously in the Level 1 example). The medium scenario with water priced as in 1983 at $1.05 per 1000 gallons is presented in Table 4-20. The base year (1980) corresponds with historic data in Table 4-12.

TABLE 4-20
WMWD WATER DEMAND FORECAST
TOTAL ANNUAL WATER USE, INDOOR & OUTDOOR
(MILLIONS OF GALLONS)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR FLR	2,158.0	1,146.3	446.4	173.8	67.6	26.3
SFR Met		1,613.9	2,683.3	3,433.9	4,176.8	5,000.2
MFR	325.9	750.7	1,260.3	1,899.4	2,760.1	3,904.2
COMM	311.1	304.7	390.1	475.5	579.6	706.6
IND	287.8	511.0	654.1	797.4	972.0	1,184.9
PUB/INST	37.0	67.9	86.9	106.0	129.2	157.5
LEAK	550.5	775.5	974.3	1,215.2	1,532.7	1,937.6
TOTAL	3,670.5	5,170.4	6,495.6	8,101.4	10,218.4	12,917.6

ANNUAL WATER USE - INDOOR
(MILLIONS OF GALLONS)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR FLR	1,098.5	499.2	194.3	75.7	29.4	11.4
SFR Met		800.7	1,331.3	1,703.7	2,072.3	2,480.8
MFR	249.9	532.1	893.3	1,346.3	1,956.4	2,767.4
COMM	238.8	216.3	276.9	337.5	411.4	501.5
IND	258.0	442.0	565.8	689.8	840.8	1,025.0
PUB/INST	24.4	37.4	47.9	58.4	71.2	86.8
TOTAL	1,869.9	2,527.9	3,309.8	4,211.6	5,381.8	6,873.2

ANNUAL WATER USE - OUTDOOR
(MILLIONS OF GALLONS)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR FLR	1,059.4	647.1	252.0	98.1	38.2	14.8
SFR Met		813.1	1,351.9	1,730.1	2,104.4	2,519.3
MFR	75.9	218.6	366.9	553.1	803.7	1,136.8
COMM	72.2	88.4	113.2	138.0	168.2	205.0
IND	29.7	68.9	88.2	107.6	131.1	159.9
PUB/INST	12.5	30.4	39.0	47.5	58.0	70.7
TOTAL	1,250.0	1,866.8	2,211.5	2,674.6	3,303.8	4,106.7

Note 1: Total Annual Water Use equals Total Annual Water Use Indoor plus Total Annual Water Use Outdoor plus Leakage.

Note 2: Water use data and projections are truncated throughout this Handbook. As a result, totals may not add exactly.

(4) Estimate Peak Daily Water Usage: Peak daily water usage is calculated by using the indoor and outdoor monthly water usage in conjunction with the number of connections by customer class. Specifically, the formula is:

Peak Daily Use = (3 * [average monthly Outdoor use/30] +
[average monthly Indoor use/30]) *
number connections

This formula is used for each customer class. The data that are substituted are the average monthly Indoor and Outdoor water consumption and the number of connections for each customer class for each of the projected years. The data for the medium growth rate with the price of water at $1.05 per 1000 gallons are presented in Table 4-21.

TABLE 4-21
WMWD WATER DEMAND FORECAST
PEAK DAILY WATER USE, INDOOR & OUTDOOR
(MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR FLR	20.709	12.173	4.740	1.846	.718	.279
SFR Met	.000	15.777	26.231	33.569	40.831	48.880
MFR	1.960	5.121	8.597	12.958	18.830	26.635
COMM	1.867	2.074	2.656	3.237	3.946	4.811
IND	1.213	2.377	3.043	3.709	4.522	5.512
PUB/INST	.277	.612	.783	.955	1.164	1.419
LEAK	4.593	6.730	8.127	9.931	12.355	15.448
TOTAL	30.622	44.866	54.179	66.207	82.368	102.986

PEAK DAILY WATER USE - INDOOR
(MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR FLR	3.051	1.386	.540	.210	.081	.031
SFR Met	.000	2.224	3.698	4.732	5.756	6.891
MFR	.694	1.478	2.481	3.739	5.434	7.687
COMM	.663	.600	.769	.937	1.143	1.393
IND	.716	1.228	1.571	1.916	2.335	2.847
PUB/INST	.068	.104	.133	.162	.197	.241
TOTAL	5.194	7.022	9.193	11.699	14.949	19.092

PEAK DAILY WATER USE - OUTDOOR
(MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR FLR	17.658	10.786	4.200	1.635	.635	.248
SFR Met	.000	13.553	22.533	28.836	35.074	41.989
MFR	1.266	3.643	6.116	9.218	13.395	18.947
COMM	1.204	1.474	1.886	2.300	2.803	3.417
IND	.496	1.149	1.471	1.793	2.186	2.665
PUB/INST	.209	.508	.650	.793	.966	1.178
TOTAL	20.834	31.114	36.858	44.577	55.063	68.446

Substep 6.2 Determine Fraction of Water Use Reduction

The fraction of water use reduction that can be achieved with a water conservation program in the WMWD City will be measured against the projected water demands without water conservation that were developed in Substep 6.1 and displayed in Table 4-20 (average) and 4-21 (peak) for the medium growth assumptions. The following Tables 4-22, 4-23 and 4-24 present the WMWD water forecasts based on high, medium and low assumptions and express them in millions of gallons per day, including average and peak use. For the purpose of simplifying the Handbook effectiveness analysis, SFR and MFR categories have been combined into interior and exterior residential (Int. Residential and Ext. Residential), and unaccounted-for (Unacc. For) use has been added as a general category that includes leakage and other losses.

TABLE 4-22
WMWD WATER DEMAND FORECASTS
MEDIUM POPULATION GROWTH CASE
AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	3.695	5.019	6.628	8.564	11.119	14.410
Ext. Residential	3.111	4.600	5.400	6.524	8.072	10.058
Commercial	0.852	0.835	1.069	1.303	1.588	1.936
Industrial	0.789	1.400	1.792	2.185	2.663	3.246
Public/Inst.	0.101	0.186	0.238	0.291	0.354	0.432
Unacc. For	1.508	2.125	2.669	3.329	4.199	5.309
TOTAL	10.056	14.165	17.796	22.196	27.995	35.391

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	3.746	5.089	6.720	8.683	11.273	14.610
Ext. Residential	18.924	27.983	32.850	39.690	49.110	61.185
Commercial	1.868	2.075	2.656	3.238	3.947	4.811
Industrial	1.213	2.377	3.043	3.710	4.522	5.512
Public/Inst.	0.277	0.612	0.784	0.956	1.165	1.420
Unacc. For	4.593	6.730	8.127	9.931	12.355	15.448
TOTAL	30.621	44.866	54.180	66.208	82.375	102.986

TABLE 4-23
WMWD WATER DEMAND FORECASTS
HIGH POPULATION GROWTH CASE
AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	3.695	5.181	7.186	9.759	13.310	18.119
Ext. Residential	3.111	4.734	5.840	7.425	9.658	12.643
Commercial	0.852	0.864	1.161	1.486	1.902	2.434
Industrial	0.789	1.448	1.946	2.491	3.189	4.082
Public/Inst.	0.101	0.193	0.259	0.331	0.424	0.543
Unacc. For	1.508	2.192	2.893	3.793	5.026	6.674
TOTAL	10.056	14.612	19.285	25.285	33.509	44.495

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	3.746	5.253	7.286	9.894	13.495	18.370
Ext. Residential	18.924	28.796	35.528	45.168	58.753	76.913
Commercial	1.868	2.146	2.884	3.692	4.726	6.050
Industrial	1.213	2.459	3.305	4.230	5.415	6.932
Public/Inst.	0.277	0.633	0.851	1.090	1.395	1.785
Unacc. For	4.593	6.933	8.798	11.307	14.785	19.421
TOTAL	30.621	46.220	58.652	75.381	98.569	129.471

TABLE 4-24
WMWD WATER DEMAND FORECAST
LOW POPULATION GROWTH CASE
AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	3.695	4.681	5.781	7.463	9.543	12.185
Ext. Residential	3.111	4.319	4.804	5.695	6.932	8.506
Commercial	0.852	0.775	0.944	1.134	1.363	1.637
Industrial	0.789	1.299	1.584	1.902	2.285	2.745
Public/Inst.	0.101	0.173	0.211	0.253	0.304	0.365
Unacc. For	1.508	1.985	2.367	2.903	3.605	4.489
TOTAL	10.056	13.232	15.781	19.350	24.032	29.927

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	3.746	4.746	5.952	7.567	9.675	12.354
Ext. Residential	18.924	26.276	29.222	34.644	42.171	51.747
Commercial	1.868	1.925	2.347	2.819	3.386	4.068
Industrial	1.213	2.206	2.689	3.230	3.880	4.661
Public/Inst.	0.277	0.568	0.693	0.832	0.999	1.201
Unacc. For	4.593	6.304	7.218	8.663	10.608	13.064
TOTAL	30.621	42.025	48.121	57.755	70.719	87.095

In order to obtain data on the fractional reduction to be achieved by the water conservation measures identified previously in Step 5 for the WMWD City analysis, a review of the national literature on these measures was conducted. Three large and up-to-date literature bases were used. These were the Corps of Engineers Analytical Bibliography For Water Supply And Conservation Techniques, (10) the bibliography included in the Corps of Engineers Algorithm For Determining The Effectiveness Of Water Conservation Measures (9) and the literature search services of the American Water Works Association's "WATERNET". (82) These literature bases provided the source material used to subsequently determine conservation reduction fractions for use in the Level 1 analysis.

In order to help evaluate and determine the emphasis to be given to the different sources of information, a priority system was established. This priority system establishes various weights depending upon the type of study that provided the conservation reduction information (actual implementation vs. laboratory, etc.), the comparison method used to determine reductions (with/without vs. before/after), how specific the values are, how recent the values are, the size of the tested population, and an evaluation of the accuracy of the data. The priority has been used to indicate the most preferred data sources when more than one information source is available. As no single method for determining such priorities can be favored over another, the details of how the literature sources were prioritized is not provided, rather each use of the Procedures Manual must determine how preference can be given to the most appropriate studies obtained from the literature survey.

Data in the studies are reported in three ways. First, data are reported as a percent reduction for the specific volume of water impacted by a conservation measure. For example, a low-flow showerhead reduces the shower use by 40 percent. Secondly, data are reported as a percent reduction of a total water use category, ie., a low-flow showerhead reduces interior residential demand by 12 percent. Finally, data indicate a specific volume reduction in a period of time. For example, a low-flow showerhead reduces the volume of water used by a household by 20 gallons per day. All data provided by the data sources were converted to a single basis for reduction determinations. The percent reduction achieved within the individual water use categories was selected as the basis and is appropriate for use in the effectiveness equation.

For shower flow restrictors, fourteen sources shown in Table 4-25 provided values for fractional reduction ranging from 0.0 to 0.20. The overall fractional reduction was determined as 0.112 for the average daily flow for interior residential water use.

TABLE 4-25
REDUCTION VALUES FOR SHOWER FLOW RESTRICTORS

SOURCE	REDUCTION
Bailey, et al (21)	0.10
Palmini and Shelton (22)	0.081
Bishop (23)	0.0
Nelson (utility) (24)	0.125
Nelson (manufacturer) (24)	0.203
Metcalf and Eddy (25)	0.105
Gilbert (26)	0.11
Feldman (27)	0.19
Stone (28)	0.06
Ecological Analysis (29)	0.018
CA Dept. of Water Resources (30)	0.105
Illinois Task Force (31)	0.12
Sharpe (32)	0.203
Nelson (North Marin Co.) (33)	0.098

Reduction Factor = 0.112

Ten sources of fractional reduction data were obtained for the toilet displacement device measure. Reduction fractions for these sources ranged from 0.039 to 0.19 as shown in Table 4-26. The overall fractional reduction due to toilet displacement devices was determined as 0.129.

TABLE 4-26
REDUCTION VALUES FOR DISPLACEMENT DEVICES

SOURCE	REDUCTION
Washington Suburban (apartments) (34)	0.12
Washington Suburban (homes) (34)	0.19
Metcalf and Eddy (Santa Clara) (25)	0.16
CA Dept. of Water Resources (30)	0.14
U. of Calif., Davis (35)	0.175
Illinois Task Force (31)	0.18
CA Dept. of Water Resources (field tests) (20)	0.14
Nelson (24)	0.039
Sharpe (36)	0.11
Schaefer (37)	0.167

Reduction Factor = 0.129

The availability of reduction data for conservation ordinances is limited. Since the adoption of conservation-oriented plumbing codes has taken place only in recent years, assessment of its effectiveness has not been well documented. Only two sources of data were found similar to the program proposed for the WMWD City (prepared by Brown and Caldwell and the Marin Municipal Water District).

Both studies implemented programs limiting toilet flushing to 3.5 gallons and showerhead flow rates to 3.0 gallons per minute, the same as the proposed WMWD program. While the Brown and Caldwell studies also had faucet rates at 3.0 gallons per minute (as proposed), the Marin Municipal Water District limited faucet rates to 2.75 gpm. Marin also required pressure-reducing valves to keep building pressure to 50 psi. The reduction fractions for these sources are shown in Table 4-27. The determined fractional reduction is 0.136.

TABLE 4-27
REDUCTION VALUES FOR CONSERVATION ORDINANCES

SOURCE	REDUCTION
Marin Municipal Water District (20)	0.11
Brown and Caldwell (Calif.) (19)	0.15

Reduction Factor = 0.136

Of the fourteen studies obtained to determine the fractional reduction reported from public education programs, ten ranged from 0.016 to 0.092 and the remaining four range from 0.156 to 0.299. These reductions apply to all water uses except the unaccounted-for use sector. The values obtained as shown in Table 4-28 and the determined overall reduction factor is 0.089.

TABLE 4-28
REDUCTION VALUES FOR PUBLIC EDUCATION

SOURCE	REDUCTION
Westchester Co., NY (38)	0.050
East Bay Mun. Dist. (39)	0.055
Stillwater, OK (40)	0.211
Mowen (40)	0.092
Marin Mun. Water Dist. (20)	0.071
Fresno, CA (20)	0.299
Morgan and Pelusi (42)	0.034
Flack (Denver) (43)	0.044
Washington Suburban (44)	0.016
Connecticut (44)	0.156
Madison, WI (44)	0.023
New York (44)	0.078
Blackburn (45)	0.222
Culp (South Tahoe) (46)	0.047

Reduction Factor = 0.089

Two studies describe exterior watering restrictions comparable to those in the proposed contingency lawn watering restrictions. As shown in Table 4-29, these ranged from 0.316 to 0.375 when converted to the percentage of exterior water use. The overall reduction factor was determined as 0.346.

TABLE 4-29
REDUCTION VALUES FOR SPRINKLING RESTRICTIONS

SOURCE	REDUCTION
Denver (47)	0.375
Los Angeles (48)	0.316

Reduction Factor = 0.346

No specific reduction factor was determined for the leakage reduction measure. The WMWD estimate for the unaccounted-for water use is simply 15 percent of the total use. Instead, this measure is assumed to reduce the unaccounted-for use to a 10 percent figure by 1990 and to maintain that percentage through the remainder of the study period.

There is almost a complete lack of data on appropriate reduction factors for peak daily flows. Where data are available for peak conditions, it is almost always reported for peak season or peak month. For the measures under consideration, no relationships were found between peak flow reductions and average daily flow reductions. In the cases of those enacted in the permanent conservation program, it was concluded that the same reduction factor determined for average daily flow was applicable for peak flow.

In the case of the contingency measure of restricted lawn watering, it was assumed that the reduction factor for peak day would increase to 0.50 due to the fact that the exclusion of watering during day-time hours (and the reduction of evaporation on hot days) would further reduce the peak flow.

Substep 6.3 Determine Coverage

The level of effort and committment planned by the WMWD City were compared to those efforts described in the sources obtained in the literature base. Although such comparisons are difficult and only limited information on coverage is available in the literature, the assessment of the proposed program is that it would be considered an average program among those reported. The City has recently appointed an individual to oversee the conservation program and has selected measures typical of many of the applications reported in the literature.

The initial coverage factor is considered equal to the fraction of water users in a water use sector who are actually impacted by the implementation of a measure. For the conservation ordinance measure, the initial coverage is zero since the coverage only takes affect as new buildings are constructed. For the retrofitting of water conservation devices, the initial coverage is the fraction of users in each category who are expected to receive and actually install the devices which are distributed. For public education, the coverage factor reflects the fraction of customers in each use category who are reached by the education program. The leakage reduction program covers all of the unaccounted-for use category. The contingency lawn watering restriction measure impacts that fraction of exterior water use customers who comply with its provisions. This was assumed to be approximately three-quarters of the total outdoor use. For the commercial, industrial, and public use sectors, the coverage factor for restricted sprinkling must also reflect the fraction of outdoor use within those categories.

The Corps of Engineers Report, Algorithm For Determining The Effectiveness Of Water Conservation Measures (9) provides suggested initial coverage values which are considered appropriate for modest, moderate, and maximum conservation programs. These values were selected based upon experience in recent and on-going conservation programs as well as from the limited data reported in the literature. They are regarded as appropriate for this level of analysis. Thus, initial coverage values reported for a moderate conservation program were selected for the WMWD City. These values are provided in Table 4-3Ø.

TABLE 4-3Ø
INITIAL COVERAGE VALUES

CONSERVATION MEASURE	INT. RES.	EXT. RES.	COMM.	IND.	PUB/ INST.	UNACCOUNTED-FOR
Shower Flow Restr.	Ø.4Ø	-	-	-	Ø.2Ø	-
Displacement Devices	Ø.5Ø	-	Ø.5Ø	-	Ø.5Ø	-
Conservation Ord.	Ø.Ø	-	Ø.Ø	Ø.Ø	Ø.Ø	-
Public Education	Ø.75	Ø.5Ø	Ø.5Ø	Ø.5Ø	Ø.75	-
Sprinkling Restr.	-	Ø.75	Ø.22	Ø.1Ø	Ø.45	-
Leakage Reduction	-	-	-	-	-	1.Ø

Coverage for many conservation measures will change with time. Retrofitted water-saving devices may cease to function over time or may be removed by the customer. As a public education program progresses, its impact increases until eventually the entire customer population has been reached, and if the program is continued, it will continue to affect the habits of existing customers and be received by new customers. The coverage of a conservation ordinance increases as the proportion of new construction subject to its provisions increases. Reasonable values for the anticipated change in coverage for these measures must be estimated. As the restricted watering measure is enacted as a contingency measure, it will have no change in coverage with time. Similarly, since the leakage reduction measure maintains a certain percentage of unaccounted-for use over time, no other correction for time need be applied to it. For those measures requiring the reflection of a change in coverage with time, this can be accomplished by determining an annual ratio of change in the coverage of a measure. The coverage in one year would be equal to the coverage of the previous year multiplied by the annual ratio of change in coverage. For any year since the initiation of a conservation measure, the coverage would be equal to:

$$C_n = C_i * a^{(n-1)},$$

where

C_n = Coverage in year n
C_i = Initial coverage
a = Annual ratio of change in coverage

The conservation ordinances measure requires additional information to determine its appropriate coverage factor. This measure reflects the gradual introduction of water-saving fixtures into new construction as the result of promulgated ordinances. Thus, the coverage will gradually increase from an initial value of zero with the rate of increase in coverage depending upon the annual rate of new construction. Thus, a rate of new construction must be provided. The annual ratio of change in coverage will then be applied as 1.0 plus the annual rate of new construction, and the coverage factor for any year after initiation of the conservation ordinance will be evaluated as:

$$C_n = 1 - 1/(1+r)^{n-1}$$

where

r = Annual rate of new construction

For the WMWD City analysis, the rate of new construction was equated to the annual rate of population growth. For the medium population growth case, this was 0.0265,or 2.65 percent, while the respective rates for the high and low population cases were 0.0313 and 0.0230 respectively. For the retrofitted water-saving devices, an annual removal or failure rate of 5 percent was assumed, which is equivalent to an annual ratio of change in coverage of 0.95. It was also assumed that a continuing public education program would reach an additional 10 percent of the customers each year until the entire customer base had been impacted and then would maintain 100 percent coverage for the remainder of the study period. This would be equivalent to an annual ratio of change in coverage of 1.1 with a maximum coverage value of 1.0.

Substep 6.4 Analysis of Effectiveness For The WMWD City

Based on the disaggregated demand forecast, the factional reduction, the initial coverage and annual ratio of change in coverage (the two latter parameters providing the means to determine coverage in any year), the effectiveness of the water conservation program is estimated. Example calculations are used to illustrate the effectiveness of various measures, and results for the Level 1 analysis are provided later in Tables 4-31 and 4-32.

Frequently, the estimation of effectiveness may be required for years intermediate to those for which disaggregated flow projections are available. In these circumstances, it is necessary to interpolate between values in the disaggregated forecast. To illustrate the effectiveness determinations for the WMWD City analysis, such an intermediate year, 1985, has been chosen. A linear interpolation between the 1980 and 1990 disaggregated flows is considered appropriate. Thus, the disaggregated water flow for 1985 is greater than the 1980 flow by one half of the difference bewteen the 1980 and 1990 flows. For the interior residential water use sector, the 1985 flow is:

3.695 mgd + (5.019 mgd - 3.695 mgd) (1985-1980)/(1990-1980) = 4.357 mgd

By similar determinations, the 1985 disaggregated demand for the remaining water use sectors is 3.856 mgd for exterior residential, 0.844 mgd for commercial, 1.095 mgd for industrial, 0.144 mgd for public/institutional, and 1.817 mgd for unaccounted flow. The total 1985 water demand forecast is for 12.110 mgd.

The coverage values to be applied in determining the effectiveness for the WMWD City conservation program are calculated using the initial coverage values, annual ratio of change in coverage, and the equations described in Substep 6.3. For the interior residential use category for the shower flow restrictors, displacement devices, and public education, the coverage values for 1985 are determined below:

$$c_n = c_i * a^{(n-1)}$$

Shower flow restrictors	$(0.4)(.95)^{(5-1)}$	= 0.3258
Displacement devices	$(0.5)(.95)^{(5-1)}$	= 0.4073
Public education	$(0.75)(1.1)^{(5-1)}$	= 1.0981
	(Use maximum coverage of 1.0)	

For conservation ordinances, the coverage value is dependent upon the rate of new construction and is determined as:

$$c_n = 1 - 1/(1+r)^{n-1}$$

$$1 - 1/(1.0265)^{(5-1)} = 0.0993$$

The leak reduction and sprinkling restriction measures do not impact the interior residential water use category. By similar calculations, the coverage for each conservation measure for all water use categories can be determined for every year for which an effectiveness estimate is desired. The coverage values calculated for 1985 are shown in Table 4-31.

TABLE 4-31
1985 COVERAGE VALUES, LEVEL 1 ANALYSIS

CONSERVATION MEASURE	INT. RES.	EXT. RES.	COMM.	IND.	PUB/ INST.	UNACCOUNTED FOR
Shower Flow Restr.	0.326	-	-	-	0.163	-
Displacement Devices	0.407	-	0.407	0.407	0.407	-
Conservation Ord.	0.092	-	0.092	0.092	0.092	-
Public Education	1.00	0.732	0.732	0.732	1.00	-
Sprinkling Restr.	-	0.750	0.218	0.101	0.449	-
Leakage Reduction	-	-	-	-	-	1.0

Once the disaggregated flow and the coverage appropriate for any year have been determined, the fractional reductions from Tables 4-25 through 4-29 can be used to calculate the effectiveness of each conservation measure, independent of any interactions between the measures. The effectiveness of the measures is the product of the disaggregated flow, the fractional reduction, and the coverage. For average daily flow, for the interior residential water use category in 1985, the calculation of effectiveness for the conservation measures is as follows:

Shower flow restrictors
Effectiveness = QRC = (4.357 mgd)(.112)(.326) = 0.159 mgd

Toilet displacement devices
Effectiveness = (4.357 mgd)(.129)(.407) = 0.229 mgd

Conservation ordinances
Effectiveness = (4.357 mgd)(.136)(.099) = 0.058 mgd

Public education
Effectiveness = (4.357 mgd)(.089)(1.0) = 0.388 mgd

To determine the overall effectiveness of the permanent conservation program, interactions between measures must be considered. In most cases, there will be no interaction between measures, and the interaction factor for determining overall effectiveness is equal to one. At times, however, the combined effect of two or more measures is different from the sum of their individual effects. Values of interaction factors were determined in the Corps of Engineers, Algorithm For Determining The Effectiveness Of Water Conservation Measures (9) from four sources of information which reported reductions due to conservation measures conducted simultaneously. From this source material, it is assumed that there is an interaction between the public education measure and both the retrofitting measures (with an interaction factor of 0.917) and that there is no interaction beteen the other measures. Thus, the total effectiveness for the interior residential use sector for average daily flow is determined as:

$$E_T = E_1 + I_{1-2} * E_2 + I_{1-3} * E_3 + E_4$$

where

E_T = Total Effectiveness (mgd)
E_1 = Effectiveness due to public education measure (mgd)
E_2 = Effectiveness due to toilet displacement devices (mgd)
E_3 = Effectiveness due to shower flow restrictors (mgd)
E_4 = Effectiveness due to conservation ordinances (mgd)
T_{1-2} = Interaction factor of public education to displacement devices
T_{1-3} = Interaction factor of public education to shower flow restrictors

or

$$E_T = 0.388 \text{ mgd} + (.917)(.229 \text{ mgd}) + (.917)(.159 \text{ mgd}) + .058 \text{ mgd}$$
$$E_T = 0.801 \text{ mgd}$$

Similar computations were made for the other water use sectors for all years in which effectiveness evaluations were desired for both average daily flow and peak daily flow for 1981, 1985, 1990, 1995, 2000, 2010, 2020 and 2030. These are provided in Table 4-32. The projected flows with permanent conservation measures (equal to the disaggregated demand forecast minus the effectiveness) are given in Table 4-33. The conservation program effectiveness results in immediate reductions in the unrestricted flow of just about 9.8 percent in the first year increasing to reductions of 19 percent by the year 2030 as the impact of the conservation ordinances on new construction and the leakage reduction programs take on their full impact (comparison of Tables 4-22 and 4-32).

TABLE 4-32
EFFECTIVENESS OF CONSERVATION FOR THE WMWD CITY ANALYSIS
MEDIUM POPULATION GROWTH CASE
(PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	0.639	0.801	0.905	1.055	1.188	1.568	2.097	2.802
Ext. Residential	0.145	0.251	0.409	0.430	0.481	0.581	0.718	0.895
Commercial	0.085	0.107	0.129	0.161	0.175	0.226	0.291	0.370
Industrial	0.038	0.086	0.164	0.200	0.254	0.350	0.466	0.605
Pub/Inst.	0.016	0.024	0.031	0.034	0.041	0.052	0.066	0.083
Unacc. For	0.061	0.346	0.787	0.881	0.988	1.233	1.555	1.967
TOTAL	0.984	1.615	2.425	2.761	3.127	4.010	5.193	6.722

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int.Residential	0.648	0.812	0.917	1.069	1.205	1.589	2.126	2.841
Ext. Residential	0.882	1.528	2.490	2.614	2.924	3.532	4.371	5.445
Commercial	0.188	0.250	0.320	0.391	0.435	0.563	0.722	0.920
Industrial	0.059	0.141	0.278	0.336	0.431	0.595	0.791	1.027
Pub/Inst.	0.045	0.074	0.102	0.111	0.135	0.171	0.216	0.274
Unacc. For	0.187	1.078	2.493	2.683	3.010	3.678	4.575	5.722
TOTAL	2.011	3.884	6.601	7.204	8.139	10.128	12.802	16.228

TABLE 4-33
WMWD PROJECTED WATER DEMAND WITH CONSERVATION
MEDIUM POPULATION GROWTH CASE
(PERMANENT MEASURES)
AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	3.695	4.114	5.440	6.996	9.022	11.608
Ext. Residential	3.111	4.191	4.919	5.943	7.354	9.163
Commercial	0.852	0.706	0.894	1.077	1.297	1.566
Industrial	0.789	1.236	1.538	1.835	2.197	2.641
Public/Inst.	0.101	0.155	0.197	0.239	0.288	0.349
Unacc. For	1.508	1.338	1.681	2.096	2.644	3.342
TOTAL	10.056	11.740	14.669	18.186	22.802	28.669

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	3.746	4.172	5.515	7.094	9.147	11.769
Ext. Residential	18.924	25.493	29.926	36.158	44.739	55.740
Commercial	1.868	1.755	2.221	2.675	3.225	3.891
Industrial	1.213	2.099	2.612	3.115	3.731	4.485
Public/Inst.	0.277	0.510	0.649	0.785	0.949	1.146
Unacc. For	4.593	4.237	5.117	6.253	7.780	9.726
TOTAL	30.168	38.265	46.041	56.080	69.570	86.758

Tables 4-34 and 4-35 show the impact of the contingency conservation measure included with the permanent conservation measures. As expected, the contingency measure does have a considerable impact, especially on the peak flow, due to its limitations on outdoor usage. The reductions shown in Tables 4-34 and 4-35 assume that the contingency measure has been enacted only in the year for which the results are presented, not for any years in between, and do not reflect any changes in the effective measure with time. It also assumes that there is no interactive effect between the contingency measure and the permanent conservation program so that their effectiveness is additive.

TABLE 4-34
EFFECTIVENESS OF CONSERVATION FOR THE WMWD CITY
MEDIUM POPULATION GROWTH CASE
(WITH CONTINGENCY MEASURES)
EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000
Int. Residential	0.639	0.801	0.905	1.055	1.188
Ext. Residential	0.991	1.252	1.603	1.683	1.882
Commercial	0.149	0.171	0.192	0.238	0.256
Industrial	0.068	0.124	0.213	0.254	0.317
Public/Inst.	0.033	0.046	0.060	0.066	0.078
Unacc. For	0.061	0.346	0.787	0.881	0.988
TOTAL	1.941	2.740	3.760	4.176	4.709

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000
Int. Residential	0.648	0.812	0.917	1.069	1.205
Ext. Residential	10.802	13.261	16.488	17.306	19.357
Commercial	0.463	0.537	0.622	0.749	0.821
Industrial	0.149	0.262	0.438	0.510	0.636
Public/Inst.	0.115	0.174	0.239	0.259	0.311
Unacc. For	0.187	1.078	2.493	2.683	3.010
TOTAL	12.365	16.124	21.199	22.575	25.339

TABLE 4-35
WMWD CITY, PROJECTED FLOWS WITH CONSERVATION
MEDIUM POPULATION GROWTH CASE
(WITH CONTINGENCY MEASURES IN 1990, 2000)

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000
Int. Residential	3.695	4.114	5.440
Ext. Residential	3.111	2.997	3.518
Commercial	0.852	0.643	0.813
Industrial	0.789	1.187	1.475
Public/Inst.	0.101	0.126	0.160
Unacc. For	1.508	1.338	1.681
TOTAL	10.056	10.405	13.087

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000
Int. Residential	3.746	4.172	5.515
Ext. Residential	18.924	11.495	13.493
Commercial	1.868	1.453	1.835
Industrial	1.213	1.939	2.407
Public/Inst.	0.277	0.373	0.473
Unacc. For	4.593	4.237	5.117
TOTAL	30.168	23.667	28.841

Sensitivity Cases For Level 1 Analysis

A sensitivity analysis was conducted to determine the potential variability in the Level 1 effectiveness evaluation with changes in some of the basic parameters. The sensitivity analysis consisted of re-doing the effectiveness evaluation for the permanent conservation program with high and low population demand forecasts and by re-doing the evaluation with initial coverage values reflecting maximum and modest level of effort conservation programs. Because the high and low population sensitivity cases would result in different flow forecasts, for comparison, the effectiveness was evaluated as a percentage of the flow without conservation, rather than expressed in mgd as is the normal convention.

The high and low population disaggregated demand forecasts have been presented in Tables 4-23 and 4-24. The initial coverage values used in the maximum and modest coverage sensitivity cases are presented in Table 4-36. The results of these four sensitivity cases are presented in Table 4-37 with the medium population growth, moderate coverage case for comparison.

TABLE 4-36
INITIAL COVERAGE FOR THE WMWD CITY SENSITIVITY CASES
MAXIMUM COVERAGE SENSITIVITY CASE

CONSERVATION MEASURE	INT. RES.	EXT. RES.	COMM.	IND.	PUB/ INST.	UNACCOUNTED FOR
Shower Flow Restr.	0.95	-	-	-	0.33	-
Displacement Devices	0.90	-	0.90	0.90	0.90	-
Conservation Ord.	0.0	-	0.0	0.0	0.0	-
Public Education	0.90	0.90	0.75	0.75	1.00	-
Leakage Reduction	-	-	-	-	-	1.0

MODEST COVERAGE SENSITIVITY CASE

CONSERVATION MEASURE	INT. RES.	EXT. RES.	COMM.	IND.	PUB/ INST.	UNACCOUNTED FOR
Shower Flow Restr.	0.25	-	-	-	0.10	-
Displacement Devices	0.25	-	0.25	0.25	0.25	-
Conservation Ord.	0.0	-	0.0	0.0	0.0	-
Public Education	0.50	0.25	0.25	0.25	0.50	
Leakage Reduction	-	-	-	-	-	1.0

TABLE 4-37
COMPARISON OF CONSERVATION EFFECTIVENESS FOR SENSITIVITY CASES
WMWD CITY ANALYSIS
AVERAGE DAILY FLOW (1980-2030)
TOTAL EFFECTIVENESS (%)

CASE	1981	1985	1990	1995	2000	2010	2020	2030
Medium Pop. Growth (moderate cov.)	9.4	13.3	17.1	17.4	17.6	18.1	18.6	19.0
High Pop. Growth (moderate cov.)	9.4	13.5	17.4	17.8	18.0	18.5	19.0	19.5
Low Pop. Growth (moderate cov.)	9.4	13.3	17.0	17.2	17.3	17.7	18.2	18.7
Maximum Coverage (medium pop.)	15.2	17.4	19.7	19.5	19.2	19.0	19.2	19.4
Minimum Coverage (medium pop.)	5.6	9.4	14.2	16.3	16.9	17.6	18.3	18.8

As expected, the sensitivity of the effectiveness analysis to the population growth forecast is greatest at the end of the study period as the high and low forecasts diverge from the medium growth forecast. Conversely, the sensitivity f the analysis to the initial coverage values is greatest during the initial years of the study and is minimized by the end of the planning period. This illustrates that if the water supply study goals are primarily oriented to long-range planning and projected design capacities, then the demand forecast is a particularly important parameter. However, if the major concern is short-term reduction, then every effort should be made to properly assess the initial coverage of the conservation measures, as this parameter will have a major impact during the early years of the study period.

STEP 7: Advantageous Effects (Indirect)

The following section provides a brief overview of the effectiveness of the water conservation program as it affects the future balance between available water supply and projected water demand. The Step 7 analysis focuses on the indirect advantageous impacts of each water conservation measure to residential, multi-family, commercial, industrial and public/institutional water users. Cost savings to the WMWD water and wastewater utilities are addressed in Step 9: Foregone Supply Costs.

Description of Conservation Measures

Measure 1: Distribution and retrofitting of water-saving devices to:

- o residential
- o commercial business
- o industrial
- o public/institutional

The program begins in 1980 and partial implementation produces results by 1981. Retrofit devices are installed based on the public acceptance reflected in initial and projected coverage factors.

The water-saving devices are included in a kit which contains:

Home/Apartment Kit

(2) toilet displacement bags (reduction 2/3 gallon/flush)
(2) sets of shower flow restrictors
(2) dye tablets
(1) instructions for using kit
(1) informational pamphlet packaging

The contents of this kit are based on many water conservation programs used in Caifornia (86) but are not unlike kits used in water-reduction programs in the east (ie., Washington Suburban Sanitary Commission, [85]). The contents of this kit cost $0.72 in 1981 (84),(86). Economy of scale is a primary factor in planning a kit program. Large orders usually cost much less per unit to purchase than a small one. For the smaller distribution required in the WMWD area, a cost of $2.00 per kit is assumed for 1980.

The kit is available free at public places; program costs are discussed in the next section.

TABLE 4-38
WMWD KIT PURCHASES (1980)

INSTALLED DEVICES			PURCHASES*
Shower Restrictor	Toilet Device	Other	
4,740	5,925	575	6,500

*based on 1980 SFR and MFR customers (Table 4-19), coverage factor for shower flow and toilet devices Table 4-30 to identify percentage of WMWD customers using water conservation measure with the greater quantity of toilet devices (.50) determining total number of kits required and a 10 percent surplus factor for other commercial, industrial and public/institutional customers.

Measure 2: Conservation Ordinance requiring installation of water-saving fixtures:

- o residential
- o commercial
- o industrial
- o public/institutional

The ordinance affects all new construction through a revised plumbing code. Toilets are limited to 3.5 gallons per flush, and showerheads are limited to 3.0 gallons per minute.

Table 4-19 indicates the initial customers for each user class. The growth in users above the initial levels are affected by the new ordinance.

Measure 3: Leakage Reduction affects WMWD operations:

The leak detection program identifies the accuracy of master and customer meters and locates and repairs distribution system pipeline leaks. Water savings and energy and treatment costs can be reduced by an improved leakage reduction effort.

Phase 1 involves increased inspections and pressure testing by WMWD personnel; Phase 2 (optional) involves the purchase/lease of leakage detection equipment.

Measure 4: Public Education affects all customers through direct mail, news media and program preparation.

The public education program is a continuing effort which informs and educates water users as to the benefits of water conservation as a long-term method. The program consists of (1) an initial conservation plan introduction prior to distribution of the water-saving kits with focus on newsletters to customers, media publicity, school children education programs, news "spots" and local speakers programs, and then (2) continued efforts to remind the public of the long-term benefits of water conservation.

Initial Program Content

- o Literature/brochure distributed to 1980 residents introducing water conservation program;
- o Follow-up reminders (pamphlets);
- o Media publicity (newspapers);
- o School program (literature and preparation);
- o Announcements (radio/TV);
- o Speaker program.

Continued Efforts

- o Bill stuffers
- o Media
- o Speakers/school program

Measure 5: Contingency Plan (lawn watering) affects all residential and commercial properties with irrigable lawns.

Plan is implemented during drought emergency to restrict lawn watering to alternate and time of day water use.

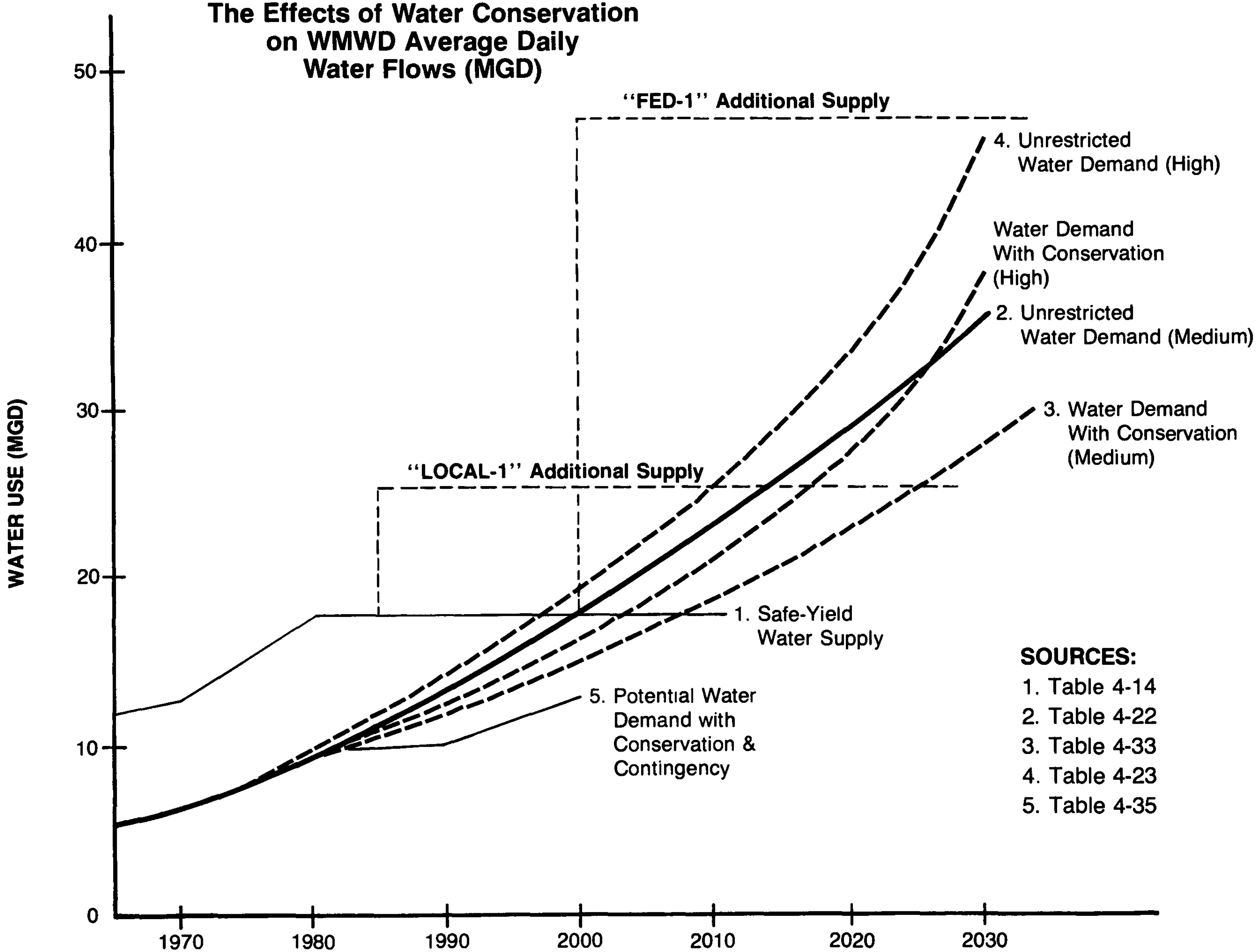
Conservation Effect

Figure 4-2 graphically presents the current water supply situation for the WMWD service area. Current "safe yield" water supply is obtained from a variety of sources. The Water Supply curve indicates that current safe yield is 17.85 mgd (20,000 acre feet/year), as presented previously in Table 4-14. The curves are presented based on historic growth in water demand and future projections. Water Demand (medium) (Table 4-22) presents the most likely future growth situation. The alternative scenario, Water Demand (high), is also presented from data in Tables 4-23.

Comparison of the supply and demand curves indicates that current supply is sufficient to the year 2000, based on "medium" growth and to about 1995 with the "high" growth alternative demand projection. Assuming a five-year lead time for the necessary studies, permits, and design and construction for the implementation of new sources of water supply, preparation for a future project would have to begin before 1990.

If water conservation programs are implemented as presented in Table 4-33, the available water supply can be extended to meet future demands until about the year 2008 for the medium projection (Water Demand with Conservation Medium curve) and to about 2002 for the high projection (Water Demand with Conservation High). The economic value of this approximately 8-year delay in project construction is addressed in Step 9: Foregone Supply Costs. The final curve presented in Figure 4-2, Potential Water Demand with Conservation and Contingency is based on Table 4-35 data. This curve indicates that a potential reduction in the Unrestricted Water Demand (medium) is possible for short periods of time with the contingency program as an additional program. This contingency plan, therefore, has the ability to cushion the impact of shortage over short periods of time and therefore provide some added assurance of reliable future water supply for the WMWD area.

FIGURE 4-2
The Effects of Water Conservation on WMWD Average Daily Water Flows (MGD)



Level 1: Advantageous Effects

In addition to the reduction in water demand, which results from implementing water conservation measures, other advantageous effects are also experienced for each measure considered. Table 4-39 summarizes the indirect advantageous effects of the four permanent water conservation measures proposed. The following text describes the cost savings that result from implementing the measures.

TABLE 4-39
ADVANTAGEOUS EFFECTS (INDIRECT)
PRESENT VALUE (1980 $)

	MEASURE 1 Retrofit	MEASURE 2 New Const.	MEASURE 3 Leakage	MEASURE 4 Education	MEASURE 5 Lawn Wat.
ENERGY SAVINGS					
Resid. Household	$1,293,000	$2,060,000		$320,000**	
Resid. Multi-family	63,500	362,300		32,000*	
Pub/Inst.	4,000	21,000		2,000*	
UTILITY BILLS*					
Water				66,600	
Sewer				31,300	
PEAK WATER USE REDUCTION					(Minimal)
TOTAL	$1,360,500	$2,443,300		$451,900	

*See text (for potential double counting)
**Brief savings, assumed for 1980-1982.

Energy savings will result for residential households, multi-family residential, and institutional/public water users. Households, multi-family and institutional/public energy uses decrease as a result of reduction in hot water use. The utility energy use reduction is a function of pumping less water.

Table 4-40 presents the percentage of WMWD customers using a water conservation device in future years. As was indicated previously, the coverage factor reflects the initial level of use of a measure, as well as the die-off. Although the concept normally applies to water flow, it is expressed here, as well as in the Level 2 example, as a percentage of users affected, a permissible approach if the "users are expected to be either approximately equal in their use of water, or to be randomly distributed with respect to implementation." (65) Therefore, the coverage factor represents the percentage of customers initially, as well as in future years, who will use water conservation measures.

TABLE 4-40
PERCENTAGE OF WMWD CUSTOMERS USING WATER CONSERVATION MEASURES
(CHANGE IN COVERAGE BY USER CLASS 1980-2030)

	1980*	1990	2000	2010	2020	2030
LOW-FLOW SHOWERHEAD						
Int. Residential	.40	.25	.15	.09	.05	.03
Pub/Inst.	.20	.12	.07	.04	.02	.01
TOILET DISPL.	.50	.31	.18	.11	.06	.04
PUBLIC EDUCATION						
Int. Residential Pub/Inst.	.75	1.00	1.00	1.00	1.00	1.00
Ext. Residential Comm. Ind.	.50	1.00	1.00	1.00	1.00	1.00
SPRINKLING RESTR.	(Varying Degrees)					
LEAKAGE REDUCTION	1.00	1.00	1.00	1.00	1.00	1.00

*Initial coverage (Table 4-30)

Table 4-41 presents the percent reduction in water use by water use sector that will be achieved in the future as a result of implementing water conservation measures. These levels of effectiveness describe the overall effect on the reduction of water use and represent many other indirect changes that will produce possible advantageous and disadvantageous effects on water users and suppliers. In some cases, the percentage reductions have significant impacts on other costs that will be reduced (ie., chemicals used by the WMWD will be reduced significantly and in approximate proportion to the overall reductions in water use from 9.7 to 18.9 percent per year, addressed in Step 9). In other cases, the reductions are only partially reflective of the associated cost reductions (ie., household energy costs decrease as low-flow showerheads reduce the quantity of hot water used, but only related to the water conservation portion of Interior Residential).

Tables 4-40 and 4-41 provide some guidance as to where benefits of water conservation may be found (other than reduced water use itself). The following section identifies and evaluates many of the advantageous effects of the proposed water conservation program.

TABLE 4-41
WMWD PERCENT REDUCTION BY WATER USE SECTOR IN WATER DEMAND FORECASTS
(WATER CONSERVATION EFFECTIVENESS VS. UNRESTRICTED WATER DEMAND)
MEDIUM POPULATION GROWTH, REDUCTION IN AVERAGE DAILY DEMAND

CUSTOMER CLASS	1981*	1990	2000	2010	2020	2030
Int. Residential	17.2	18.0	17.9	18.3	18.8	19.4
Ext. Residential	4.6	8.8	8.9	8.9	8.8	8.8
Commercial	9.9	15.4	16.3	17.3	18.3	19.1
Industrial	4.8	11.7	14.1	16.0	17.4	18.6
Public/Inst.	15.8	16.6	17.2	17.8	18.6	19.2
Unacc. For	4.0	37.0	37.0	37.0	37.0	37.0
TOTAL	9.7	17.1	17.5	18.0	18.5	18.9

Source: Comparison Tables 4-22 and 4-32 (4-33)
*Compared to 1980 Water Demand

Single Family Residential: Table 4-42 presents the increments of customers who are using low-flow showerheads as a result of retrofits to existing systems based on the initial customer base of 11,292 connections, coverage factor adjustments, and as a result of new growth, the use of low-flow showerheads in new construction which are part of the effect of the conservation ordinance. The following calculations of in-house energy savings are based on the changes in customer use of showerheads and assumed annual household energy savings over the fifty-year period and are discounted to present value at the current Federal discount rate 8-3/8 percent for Measure 1 "Retrofits" and Measure 2 "New Growth".

Based on literature sources and local 1980 WMWD electricity rates at $.04/kwh, the annual household savings in energy was calculated. The low-flow showerheads used in the retrofit program and in new construction provide 3 gallons per minute as opposed to conventional showerheads that provide 4 gpm. A 25 percent savings in water for shower use was therefore assumed.

Sharpe (83) estimated annual gas savings at $22.77 for gas priced at $.49/100 cu.ft. (1975 $), or $31.93 in 1980 when escalated (at 7 percent per year). Savings in electric hot water use for a family of four (the typical energy source for heating hot water in the WMWD area) is about 850 kwh/yr. At $.04/kwh, the annual savings is $34.00 in 1980. The present value of in-house energy savings for Measure 1 is calculated to be $1,293,000. Based on greater permanence of water conservation measures installed in new construction (no die-off assumed), and an assumed $34.00/yr. energy savings, the present value of the Measure 2 indirect energy savings is $2,060,000.

Growth in new residential development is presented in Table 4-42.

TABLE 4-42
WMWD RESIDENTIAL CUSTOMERS USING LOW-FLOW SHOWERHEADS (1980-2030) AND HOUSEHOLD ENERGY SAVINGS (1980 DOLLARS)

YEAR	TOTAL CUSTOMERS	RETROFIT CUSTOMERS	NEW GROWTH CUSTOMERS	TOTAL L-F SHOWER USE CUSTOMERS	HOUSEHOLD ENERGY SAVINGS ($000) RETROFIT MEASURE #1	NEW GROWTH MEASURE #2	TOTAL
1980	11,292	4,516	0	4,516	154	0	154
1990	15,812	2,823	4,520	7,343	96	154	250
2000	19,767	1,693	8,475	10,168	58	288	346
2010	23,520	1,016	12,228	13,244	35	416	450
2020	27,966	564	16,674	17,238	19	567	586
2030	33,235	338	21,943	22,281	12	745	758

Multi-Family: Water conservation in multi-family residential housing will also result in energy savings. In this analysis, single family residential equivalents are addressed instead of apartment complexes as single units. Table 4-43 presents the retrofit efforts based on Table 4-19 Customer Connections (559 multi-family 1980) and the coverage factors Table 4-40 (Interior Residential coverage .40 in 1980, decreasing to .03 in 2030). New multi-family connections increase from 0 in 1980 to 5631 in 2030 based on Table 4-19. Energy savings are estimated at $34.00 per year (previously estimated for single family residential energy savings). Total annual savings for multi-family retrofits are small and decline from $7,600 in the first year to $500 in 2030. The present value of the energy savings for retrofits is $63,500.

TABLE 4-43
WMWD MULTI-FAMILY CUSTOMERS USING LOW-FLOW SHOWERHEAD

	TOTAL*	NUMBER OF CUSTOMERS RETROFIT	NEW	TOTAL	ENERGY SAVINGS/ $34.00/YR. RETROFIT	NEW	TOTAL
1980	559	223	0	223	$7,600	$0	$7,600
1990	1190	139	631	770	4,700	21,400	26,100
2000	1998	83	1439	1522	2,800	48,900	51,700
2010	3011	50	2452	2502	1,700	83,300	85,000
2020	4376	27	3817	3844	900	129,800	130,700
2030	6190	16	5631	5647	500	192,000	192,500

*Table 4-19

Because of the future multi-family residential growth in the WMWD area, new construction accounts for $0 of energy savings in 1980 and increases to $21,400 per year in 1990, increasing to $192,000 per year in 2030. The present value of these savings is $362,300.

Public/Institutional: Energy savings are also possible from public and institutional water users which number 8 in 1980 and increase to 32 in 2030 (Table 4-19). Other than schools, public and institutional users include two "Homes" and a Hospital (Table 4-44):

TABLE 4-44
WMWD PUBLIC/INSTITUTIONAL FACILITIES

	WATER USE (GPD)	WATER BILL (1984 $)	ELECTRIC BILL (1984 $)
Home #1	6,500	$2,300	$34,000
Home #2	6,600	2,300	15,200
Hospital	10,800	3,400	36,200 (est.)
TOTAL	23,900		

The energy savings associated with low-flow showerhead use depends on the initial coverage factor and its die-off in the future (how many showerheads are in use), the annual energy savings, and the water use escalation for the fifty year study period. Table 4-45 presents the projections and the energy savings for selected future years. A 1980 energy use was calculated as a deflated 1984 energy use of $23,400 (the average of the electric bills for the three facilities using low-flow showerheads, deflated at 5 percent/yr), and was multiplied by 10 percent to obtain an assumed 1980 energy savings of $2,300, an average for the existing (3) public/institutional customers.

TABLE 4-45
PUBLIC/INSTITUTIONAL WATER CONSERVATION
ENERGY USE SAVINGS FROM LOW-FLOW SHOWERHEADS (1980-2030)

	TOTAL PUB/INST. CONNECT.	# RETROFIT CUSTOMERS & ENERGY SAVINGS (1980 $)	RETROFIT COVERAGE FACTOR	# RETROFIT SHOWERHEADS	ANNUAL ENERGY SAVINGS RETROFITS (1980 $)	# NEW CONNECTIONS & ENERGY SAVINGS (1980 $)	# NEW SHOWERHEADS
1980	8	$2,300 (3)	.20	46 (230 units)	$460	$ 0 (0)	0
1990	14	2,300 (3)	.12	28	260	1,540 (2)	160
2000	18	2,300 (3)	.07	17	160	3,070 (4)	320
2010	22	2,300 (3)	.04	10	90	3,830 (5)	400
2020	27	2,300 (3)	.02	5	50	5,360 (7)	560
2030	32	2,300 (3)	.01	2	20	6,900 (9)	720

The projected number of "Pub/Inst." connections is presented in Table 4-19; those using showers (ie., not schools) are projected as a 3/8 ratio of total "Pub/Inst." customers and are identified as retrofit customers (the existing 3) and new connections. The new connections are assumed to be 100 percent using low-flow showerheads. The number of showerheads was calculated as the daily water use (23,000 gpd) divided by a 100 gallon per capita per day use (or 230 units for the two "Homes" and Hospital). The new energy savings and number of showerheads was calculated as a ratio of the existing 3 facilities. The present value of the future energy savings for these "Pub/Inst." water users is small: Retrofits $4,000 and New Connections $21,000. This total energy savings is $25,000.

Measure 4 (Public Education) provides indirect benefits to residential water customers, as well as commercial and industrial water users. Single family residential water use is greatly affected by conservation during drought. Table 3-2 indicated significant changes in the habits of water users, (quicker showers, changes in dishwashing practices with full loads and turning water off). The energy effect of the public education program interacts (could be double-counted) with the effects of Measure 1, and would be less than the full effect of the retrofit program. Twenty-five percent of Measure 1 retrofit savings were assumed for Measure 4.

Measure 3 (Leakage Detection) has no energy impact on residential, multi-family, commercial and industrial water users; however, the "saved water" could reduce WMWD treatment costs and ultimately reduce water rates.

The energy conservation relationships to water conservation programs can be significant. In fact, the State of California has developed policies directed at water use reduction as a method for alleviating the State's energy shortfall. By the year 2000, annual energy use connected directly with heating water (only) can be reduced by $90-116 million (energy savings due to reduced pumping by utilities are not included). (84)

Utility bills are also affected by water conservation. Initially, metered water use drops and metered charges decline. This affect is generally short-term except for the real cost reduction in energy and chemical costs that are passed on to customers. Interior residential water use for 1981 declines by 17.2 percent, and combined commercial and industrial use decreases by 7.5 percent (comparison of Tables 4-22 and 4-32). This reduces metered water (a portion of the delivered service) and also the basis for wastewater charges. However, Table 4-19 indicates that flat rate customers (SFR) and some commercial and industrial represent the major sources of revenue (perhaps 91 percent). As a result, 9 percent of the total connections, mostly commercial and industrial service connections (half are assumed affected), may benefit from reduced water service bills. These are estimated in Table 4-46 based on $1.05/thousand gallon charge (see [4] in Method 2 Estimate Future Annual Water Use), Table 4-22 WMWD Water Demand Forecasts for 1980 and Table 4-32 effectiveness estimates.

TABLE 4-46
WATER UTILITY BILL CUSTOMER SAVINGS

	1980 DEMAND (MGD)
COMMERCIAL	.852
INDUSTRIAL	.789
	1.641 MGD
7.5% REDUCTION	.123 MGD
50% AFFECTED	.062 MGD
@ 1.05/THOUSAND GALLONS	$24,000/YR.

Since none of the customers are residential, Measures 1 and 2 are not the source of this benefit. Public Education (Measure 4), applied by commercial and industrial users, is assumed the source, as is reported in Table 4-39. Eventually, the rates may be adjusted to recover some of these revenues. As a result, the present value considers benefits for 1980-1982 based on $24,000 each year at $66,600.

Sewer bills are also affected by the water conservation. (87) WMWD revenues from charges for wastewater collection and treatment services in 1980 are 47 percent of the water service charges. These savings are realized by the same non-residential customers who realize the savings in water use at $31,300.

Reduction in peak water use also benefits the WMWD customers indirectly. Figure 4-3 presents the capacity of the WMWD water system. Treatment and internal reservoir storage limits the peak flows in the system to 46 mgd, sufficient capacity to about 1992. The system is in need of additional capacity at that time, however, and water conservation reduces peak flows (Tables 4-22 and 4-23) by about 15 percent (44.866 mgd - 38.265 mgd) in 1990. When implemented, this reduction produces indirect advantageous effects in electric charges (demand charge reduction), although they appear to be minimal. During 1983 and 1984, demand electricity use was 1,360 and 1,290 kwh/yr (total electricity consumption was between 370,000 and 380,000 kwh per year for this period), and peak system water consumption (Table 4-47) in 1979 was as follows:

TABLE 4-47
WATER TREATMENT PLANT 1979 (MILLION GALLONS)

Jan.	152
Feb.	171
March	177
Apr.	246
May	273
June	426
July	544
Aug.	365
Sept.	387
Oct.	288
Nov.	180
Dec.	154

Even if all the demand charges are eliminated and the unit charge were three times the average (ie., $.12/kwh), the total annual savings would be insignificant.

In this situation, peak daily water conservation effects and even use of contingency plans (lawn watering restrictions) appear to be necessary for near term system operations, and capacity additions to the system are required as well in the future.

STEP 8: Disadvantageous Effects (Indirect)

Implementation costs are the primary Disadvantageous Effects of the proposed program. Table 4-48 summarizes the cost effects of the program for each Measure.

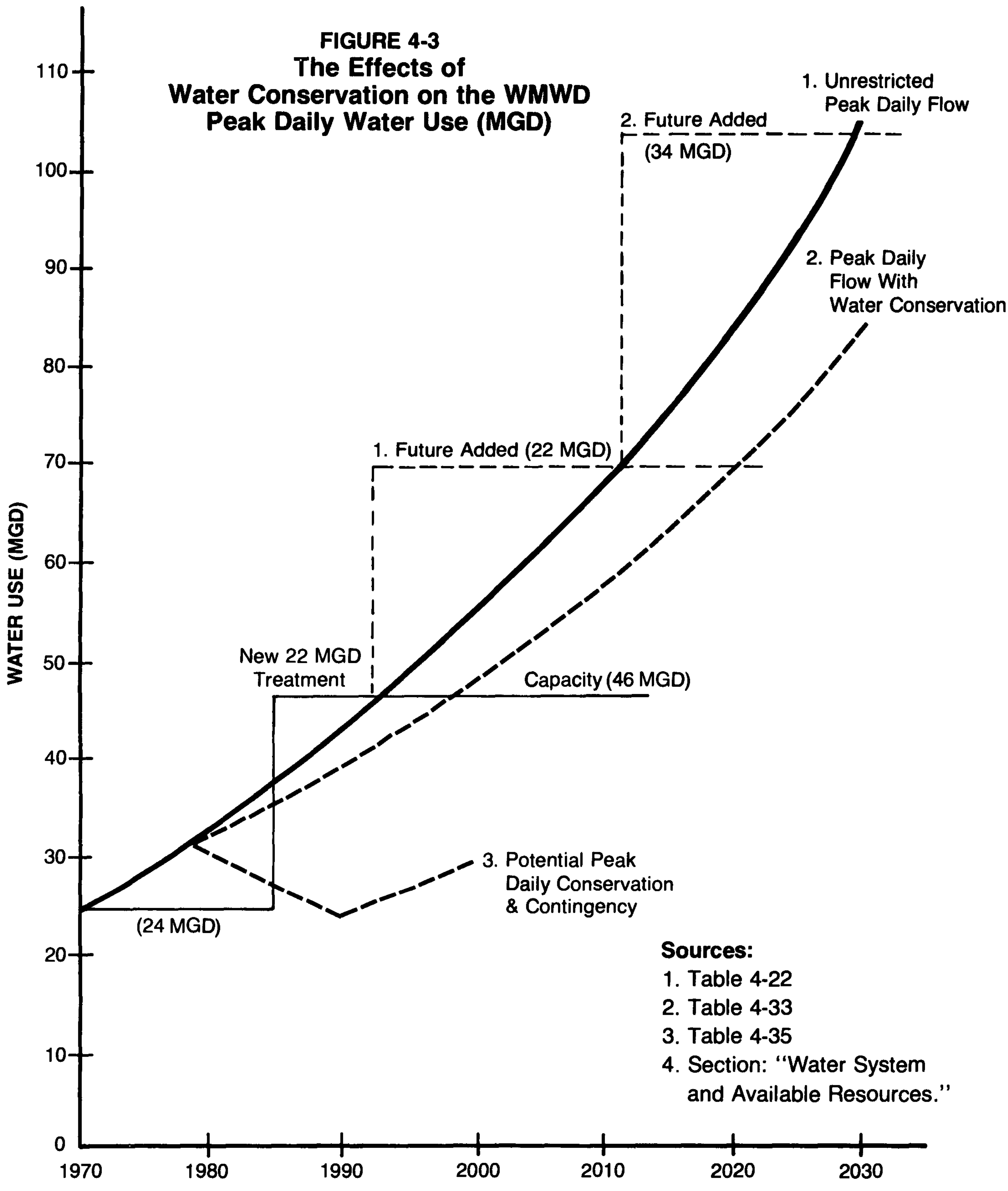


FIGURE 4-3
The Effects of
Water Conservation on the WMWD
Peak Daily Water Use (MGD)
WATER USE (MGD)
110
100
90
80
70
60
50
40
30
20
10
0
1970
1980
1990
2000
2010
2020
2030
1. Unrestricted
Peak Daily Flow
2. Future Added
(34 MGD)
2. Peak Daily
Flow With
Water Conservation
1. Future Added (22 MGD)
New 22 MGD
Treatment
Capacity (46 MGD)
3. Potential Peak
Daily Conservation
& Contingency
(24 MGD)
Sources:
1. Table 4-22
2. Table 4-33
3. Table 4-35
4. Section: "Water System
and Available Resources."

Substep 8.1 Implementation Costs

Measure 1: (Shower Restrictor and Toilet Displacement) In Step 5 and Step 7, the contents of the kit and the approach for distribution of the 6,500 kits are described, as well as the cost of the kits at $2.00 each. Total cost of materials is estimated at $13,000. This kit includes necessary instruction materials for installing the shower flow restrictors (2) and the toilet displacement bags (2). Instructions are also provided for the use of dye tablets (2) for finding toilet leaks.

TABLE 4-48
DISADVANTAGEOUS EFFECTS (INDIRECT)
PRESENT VALUE (1980 $)

	MEASURE 1 Retrofit	MEASURE 2 New Const.	MEASURE 3 Leakage	MEASURE 4 Education	MEASURE 5 Lawn Wat.
MATERIAL COST					
Kits	$13,000	-	-	-	-
Fixtures/equip.	-	$ 0	$15,500	-	
Pamphlets	6,500	500	-	$207,300	
Supplies	-	-	73,200	78,200	
Postage	6,000	200	-	56,000	
Other	-	-	-	11,800	
SERVICE PURCHASES					
Media (TV, Radios)	-	-	-	5,000	
Newspapers	-	500	-	1,000	
Rentals	1,500	-	-	-	
LABOR					
WMWD	-	73,600	-	-	
Speakers	-	-	-	-	
Summer help	-	-	-	-	
CONT. (10%)	3,000	7,400	8,800	-	
TOTAL COST	$30,000	$82,200	$97,500	$359,300	

Typically, kits are assembled from the components that are purchased from various vendors. The $2.00 per kit cost is based on this approach, however, commercial interest in water conservation may produce commercially available kits. In this event, assembly is required, space is required for storage estimated at $1,500/3 months. Local banks, post offices, supermarkets and the WMWD utility office are assumed to be the pick-up places. Water Department vehicles are used to distribute the kits to maintain stocks for customer use as part of their normal rounds. The packaging effort is undertaken by volunteers (ie., local Boy Scout and community groups), a method that has worked successfully in other areas.

The WMWD has a Water Conservation Specialist on staff. His role is to coordinate the effort, develop necessary pamphlets and arrange mailing. This effort is considered part of his already defined assignment and results in no additional cost to the community.

Although bill stuffers are enclosed at little or no additional cost, an additional special effort is required to alert the public to the intent of the program. All 12,918 customers are sent a pamphlet estimated to cost $500 per thousand ($6,500 total for layout and printing). Mailing is an additional $6,000 for postage.

Local newspaper and radio and TV public service advertising are used to announce the program and encourage participation. There are no additional costs for this effort. (84) A contingency of 10 percent is also estimated at $3,000 to cover unexpected costs; the total cost of the program is $30,000. This is a one-time cost incurred during the implementation year.

Examples of the costs of such programs are contained in bibliography references (20), (38), (84), (85), (86).

Measure 2: (New Construction/Ordinance Requiring Water Saving Fixtures) The costs of the low-flow showerheads (2) installed, low flush toilets (3) installed in future construction (residential [single and multi-family], commercial, industrial and public/institutional) are a function of new construction and the incremental costs of water saving versus conventional non-conservation fixtures. The following incremental fixture costs are relevant for new construction as well as for retrofitting existing structures*.

TABLE 4-49
SELECTED MEASURE 2 COSTS
DIFFERENTIAL COSTS OVER STANDARD (1980 $)

	FIXTURE $	O & M $	SOURCE
Low-flush Toilet	$0-$15.00	0	(88)(20)
Low-flow Showerhead	0-$ 7.00	0	(20)
Low-flow Faucet	0-$ 7.00	0	(20)
Pressure-Reducing Valves*	$37.00	0	(20)
Flow restrictor	$1.00	0	(20)
Insulate hot water pipes	$0.50/ln.ft.	0	(20)

Future customers (New Growth Customers) were projected previously (Table 4-42). Based on an assumed $0 differential cost versus standard facilities for low-flush toilets and low-flow showerheads, the ordinance requiring use of water-saving fixtures has no additional fixture costs.

The new ordinance, however, must be advertised. A mailing to local plumbing supply distributors and heating and plumbing contractors is required. An estimated cost of $500 for an explanatory pamphlet and $200 for distribution are realistic costs of materials. The ordinance is reproduced and made available to contractors and other interested parties at cost. Newspaper announcements (legal notice section) and articles are planned. These costs are estimated at $500 during the implementation phase.

The effectiveness of the conservation ordinance is dependent on WMWD enforcement. Existing personnel were described previously as having responsibility for enforcement. Department of Public Works, Building Inspection Division is already responsible for monitoring enforcement of building codes. This additional function imposes no hardship or extra cost. However, experience in other states indicates that water conservation plumbing codes are sometimes ineffective because of lax inspection procedures. The required inspection requires that approved fixtures are installed. To assure this installation, $5,000 annually is available for "spot" checks on construction to determine that inspections for water conservation fixtures were appropriately conducted over the fifty-year period. The present value of this cost is $63,600. License revoking procedures and possible fines for errant inspectors are used as an incentive for an effective program.

The development of the conservation ordinance involves additional effort for WMWD personnel, including the water conservation specialist, and legal counsel. Existing water conservation plumbing code ordinances provide the necessary background and style for the WMWD effort. An estimated $10,000 for the extra costs is needed to implement the program. Together with the inspection enforcement procedure, the present value of labor requirements is $73,600.

Total present value for Measure 2 implementation is $77,200, including 10 percent contingency.

Measure 3: (Leak Detection) The cost of leak detection and repair varies widely from system to system. Costs involve equipment, including detection options such as pressure test gauges, acoustical equipment and computer-assisted devices which range significantly in price. Replacement of leaky parts and road surface materials are other major cost items. Measure 3 assumes that current WMWD personnel are available for leak detection. Emphasis is placed on locating significant leaks with acoustical equipment and pressure testing, although the computer-assisted equipment can find leaks at a fraction of a gallon per minute with pinpoint accuracy and range in cost from $18,000 to $45,000. The computer-assisted leak detection equipment has the advantage of reducing excavation time and labor costs. (88)

Acoustical equipment ranges in price from $500 to about $2,600. (88) In Boston, a leak detection program was implemented in 1979 which found and repaired 112 leaks. (38) The cost per leak in 1980 dollars is about $200, according to accompanying data. The following costs are estimated for leak detection in the WMWD area, assuming 100 new leaks are found in 1980 and 1981 and 50 new leaks thereafter:

TABLE 4-50
SELECTED MEASURE 3 COSTS

LEAK DETECTION PURCHASES (1980 $)	$ INITIAL YEAR
(2) Acoustical Detectors and Amplifiers ($2,600 each, every 5 years)	$5,200
Repair parts, road surface material ($200 per leak, 50/yr 1980/81 25 per year thereafter)	$10,000
INITIAL YEAR TOTAL	$15,200

The present value of the acoustical detectors purchased every five years (assumed life expectancy) is $15,500. The material costs, including repair pipe, connections, etc., fill and road material has a present value of $73,200. Present value of the total cost, including $8,800 contingency of the leak detection program is $97,500. See Reference 86 for similar successful programs.

Measure 4: (Public Education) The public education program is a continuing effort involving (1) an initial effort, and (2) a continuing effort. Several sources of information are available on effective water conservation education programs, including:

- o How to Conduct a Program
- o School District Involvement
- o Workshops and Teacher Training
- o Curriculum Materials
- o Promoting Education Programs
- o Promotional Contests
- o Other Methods

Bibliography references include: (84, 86, 88).

The program developed for the WMWD area relies on effective no and low-cost methods. In Phase 1, literature and brochures are printed; "reminder" post-cards are printed for follow-up; and visuals are obtained (ie., bumper stickers and other eye catching/low cost vehicles are obtained). Phase 1 also sets in motion the school program for introducing local children to the benefits of water conservation and initiates the other message carriers (ie., newspapers, radio and TV).

Phase 2 settles in for the long-range reminders, bill stuffers, speakers, etc., to keep the program at an effective level.

The East Bay Municipal Utility District developed a comprehensive water conservation program, and intensive efforts were directed toward public education. The advice provided is from experience, (ie., instead of using paid advertising, James Lattie, Director of Public Information states, "...a water agency is probably better advised to use only the free aspects of the news media, and spend the limited funds available to it for other types of information programs."). (84)

TABLE 4-51
SELECTED MEASURE 4 WMWD PHASE 1 COSTS (1980 $)

MATERIALS DESIGN/PRINTING	QUANTITY	COST $
Pamphlets (4-6pp/2X/Yr/$1.25 ea.)	40,000	$50,000
Newsletters (4/Yr/$0.50 ea.)	80,000	40,000
Bumper Stickers (City Vehicles/$1.00 ea.)	2,000	2,000
Bus Posters ($2.00 ea.)	2,000	4,000
Postcards (printed/stamped/$0.40 ea.)	40,000	16,000
Postage		40,000
	Subtotal	$152,000
MEDIA		
Newspaper Advertising (free if possible)		$1,000
Radio/TV Spots (free if possible)		5,000
	Subtotal	$6,000
SCHOOL PROGRAMS		
(Lower Elementary: K-3)		
Water Play Workbook ($1.00 ea.)	5,000	$5,000
Water Play Teacher's Guide ($3.00 ea.)	200	600
(Upper Elementary: 4-6)		
Captain Hydro-type-Workbook ($1.00 ea.)	4,500	4,500
Captain Hydro-type-Guide ($3.00 ea.)	165	500
(Secondary: Jr.-Sr. High School)		
Water Conservation in the Community ($1.00 ea.)	9,000	9,000
	Subtotal	$19,600
	TOTAL COST	$177,600

The Phase 1 program also uses local community personnel as speakers at luncheons, breakfasts, etc., other media material are available, including films (ie., "Miss Drip", "My Water World", "Water Follies"). The American Water Works Association also has educational material (ie., "The Story of Water Supply").

Continuing effort beyond year 1 is a key factor in the success of the water conservation program. Follow-up is required to achieve the highest potential water reduction, but costs are reduced substantially from Phase 1.

TABLE 4-52
SELECTED MEASURE 4 WMWD PHASE 2 COSTS (1980 $)

MATERIALS DESIGN/PRINTING	QUANTITY	COST $
Bill Stuffers ($0.50 ea.)	10,000	$5,000
Newsletters ($0.50 ea.)	10,000	5,000
MEDIA		
Newspaper Advertising		0
SCHOOL PROGRAM		
(Lower School: K-3)		
Water Play Workbook		5,000
Films (Water Conservation)		500
	TOTAL	$15,500

Continued updates of the progress of the water conservation effort are reported regularly. The present value of this program for 50 years is $359,300.

Measure 5: (Contingency Lawn Watering Ordinance) In 1984, the WMWD City Council repealed a similar ordinance to establish seasonal water use limitations. This ordinance was based on problems in delivering peak water demand and repealed after the new water treatment plant was opened. The measure was acceptable to the community and can be re-activated as described here (at end of Chapter 4: WMWD Example Flow Reduction Contingency Plan). Costs to the community of implementing Measure 5 are minimal.

Substep 8.2 Other Disadvantageous Effects

Measure 1: Retrofit Showers and Toilets
No other disadvantageous effects are anticipated.

Measure 2: Conservation Ordinance
No other disadvantageous effects are anticipated.

Measure 3: Leakage Reduction
No other disadvantageous effects are anticipated.

Measure 4: Public Education
No other disadvantageous effects are anticipated.

Measure 5: Contingency Measure
No other disadvantageous effects are anticipated.

STEP 9: Foregone Supply Costs

Advantageous effects associated with future operations of water supply and wastewater facilities at the local level, and water supply systems at the Federal and regional levels may be produced by the proposed water conservation measures. Advantageous effects consist mostly of foregone costs of supplying water and wastewater services. Other effects may be external costs or opportunity costs, that are reduced as well. The analysis that follows identifies the costs associated with future water supply plans at the local and Federal levels and identifies and quantifies the cost reductions that are associated with the water conservation program for the WMWD area. This analysis is divided into the following Substeps:

- Substep 9.1 Local Water Supply and Wastewater Plans
- Substep 9.2 Federal Water Supply Plans
- Substep 9.3 Non-Federal (regional) Plans
- Substep 9.4 External Opportunity Costs
- Substep 9.5 Summary Foregone Supply Costs

The Water Supply needs of the WMWD area were described previously. One regional project, LOCAL 1, and two Federal projects, FED-1 and FED-2, were also described. These projects and WMWD water and wastewater infrastructures are evaluated in conjunction with the water conservation program. Existing water supply and wastewater system costs of operation were also presented. These options and the existing systems are evaluated here.

Substep 9.1 Local Water Supply and Wastewater Plans Incremental Supply Costs.

Water Supply: Table 4-53 describes the expenditures of the WMWD water supply system. Only the variable costs associated with water production and water conservation reductions are presented (omitted are administrative costs, debt service, intra-fund transfers, depreciation and plant expansion expenses). Accounting methods changed over the reported years; in 1980 and afterward, administrative costs declined sharply and other expenditures increased, as a result of new WMWD practices for distributing administrative and overhead costs to operations activities. The future savings in WMWD operations budget are based on the 1980 based budget and a water production cost of $.374/1000 gallons determined from the historic data, Table 4-53, and historic water production and projections (Table 4-33) and projected effectiveness of water conservation (Table 4-32), expressed as future annual WMWD water system savings.

TABLE 4-53
WMWD WATER SUPPLY OPERATING EXPENDITURES 1977-1982
(ADJUSTED) CURRENT DOLLARS ($000)

	1977	1978	1979	1980	1981	1982
Raw Water Storage	$ 12	$ 20	$ 32	$ 54	$ 136	$ 185
Pumping Station	7	7	15	-	-	-
Treatment Plant	277	302	399	670	561	627
Transmission/Distrib.	207	277	404	532	554	813
Customer Service	21	39	39	-	-	-
Water Resources	-	-	-	98	62	101
Water Acquisition	106	157	250	21	49	119
Total Operations	$ 633	$ 804	$1,143	$1,375	$1,362	$1,845
Water Produced (MG)	3,565.1	4,084.9	3,370.2	3,670.4*	(NA)	(NA)
Cost/1,000 GAL.	$0.18	$0.20	$0.34	$0.374		

* Estimated based on Table 4-33, 1980 Demand

Table 4-54 presents the effectiveness projections and the annual savings in 1980 dollars for selected future years. The present value was determined based on the current Federal 8-3/8 percent discount rate.

TABLE 4-54
FUTURE WMWD WATER SUPPLY SAVINGS (FOREGONE SUPPLY COSTS)
1981 TO 2030 (1980, $000)

	REDUCTION IN WATER DEMAND (MGD)	WATER SYSTEM SAVINGS ($/YR.)
1981	.984	$134,000
1985	1.615	220,000
1990	2.425	331,000
1995	2.761	376,000
2000	3.127	426,000
2010	4.010	547,000
2020	5.193	708,000
2030	6.722	917,000

The present value of these future savings is $3,767,000 (not including Measure 5) and reflects the energy ($551,000) chemicals ($340,000) and supplies that would have been needed to produce the water that is conserved by the proposed permanent water conservation measures.

The contingency plan (Measure 5) provides benefits also. Comparison between Table 4-32, water conservation with permanent measures only, and Table 4-34 indicates that the contingency measure alone, (as a supplement to permanent measures), produces about 1 mgd (.957 mgd in 1981 and 1.049 mgd in 2000) of additional water use reduction (outdoor use). Based on the cost of producing water ($.374/1000 gallons) and an assumed managed drought event of one in five years, for the first 10 years and 1 in 10 thereafter, the annual savings of $136,500 has a present value of $216,500.

Based on the average ratio 2.4 of effectiveness of conservation on peak daily flow to average daily flow (Table 4-32), the present value of the benefits of Measure 5 affect on peak daily water demand for reducing water treatment costs is 1.4 (adjusted ratio to avoid double-counting benefits of average flow conditions) * $216,500 = $303,100.

Wastewater: Foregone costs are also produced by the effects of water conservation on wastewater treatment plant operations. Reduction in indoor water use can have an impact on the quantity of wastewater that is treated at the wastewater treatment plant. However, there are some issues that arise which make these savings questionnable.

(1) As water conservation reduces flows to the wastewater treatment plant, concentrations of organics increase and can "upset" the treatment process without operations and possibly design changes.

(2) Many wastewater collection systems are subject to inflow and infiltration (I&I) problems. These systems are frequently interconnected with storm sewer systems or leak to increase the total flow that ultimately arrives at the wastewater treatment plant.

(3) O&M cost data on existing plants varied in a "scatter shot" pattern from -5 percent to +4 percent in a survey of secondary treatment plants as a result of water conservation effects. An average difference amounted to only -0.3 percent. (87)

These issues, however, are relevant to operations of existing facilities. New systems can be designed with reduced flows and increased concentrations in mind. Also, new systems do not integrate the storm and wastewater sewers. The following analysis of operations costs foregone, therefore, is based on new plant expansions and increased capacity in the future. The analysis relies on current WMWD data.

Table 4-55 presents the historic sewage treatment "Disposal Plant" costs which are variable and potentially affected by water conservation (adjusted to omit Administration, Intra-Fund Transfers, Sewer Construction, Depreciation, Debt Service, and Storm Sewer Operations).

TABLE 4-55
SELECTED WMWD WASTEWATER DISPOSAL PLANT EXPENDITURES
($000 CURRENT)

	ANNUAL "DISPOSAL" COSTS
1977	$ 373
1978	424
1979	561
1980	689
1981	792
1982	1,101

The 1980 disposal plant expenditures ($689,000) were used as the basis for determining the annual treatment cost reduction. The potential foregone expenditures and the additional capacity generated in the wastewater treatment system by water conservation greatly benefit the WMWD area directly in off-setting future costs and by making room for additional growth. Previously, the wastewater treatment plant was described as having organic loads that exceed the NPDES permit. These organic concentrations are of industrial origin. Water conservation increases the hydraulic capacity of the system, but may add to the concentration problems.

This problem is corrected in a 1985 treatment plant modification (Substep 9.2) and the full benefits of water conservation are realized by the wastewater treatment facility. The portion of water conservation that affects the treatment facilities are determined from the total effectiveness (adjusted) from Table 4-32 (sum of 1981 Int. Residential (.639 mgd); Commercial (.085 mgd); Industrial

(.038 mgd); and Pub/Inst. (.016 mgd)). The adjusted total is, therefore, .778 mgd, less 10 percent losses (ie., consumptive use), or .700 mgd. This is the water that no longer is treated at the wastewater treatment plant. Future years are calculated in the same manner.

The 1980 cost of treatment for a thousand gallons of water (eventually wastewater) is based on the total volume of water approximated by annual water demand (Table 4-33) (10.056 mgd adjusted for Exterior Resid. (-3.111 mgd) and Unaccounted-for water (-1.508 mgd), less 10 percent losses is 4.893 mgd). The unit cost of treatment for a thousand gallons is $.385 ($689,000/4.893 mgd * 365).

The savings in 1981 of $98,300 are calculated as the product of the .700 mgd water conservation * $.385/1000 gallons * 365 days/year. Savings in future years are calculated (Table 4-56) by the ratio of future increased effectiveness to 1981 effectiveness from Table 4-32: 1990 (1.57); 2000 (2.13); 2010 (2.82); 2020 (3.75); 2030 (4.96).

TABLE 4-56
WMWM WASTEWATER TREATMENT SAVINGS (SELECTED YEARS)

1980	$ 98,300
1990	154,300
2000	209,300
2010	277,200
2020	368,600
2030	487,500

The present value of these savings is $2,060,000. Water Conservation benefits are applicable to all permanent measures. However, for Measure 5 (Lawn Watering Restrictions), no foregone costs are anticipated for the wastewater treatment facility.

Long-Run Incremental Supply Costs

Water Supply: The WMWD treatment and distribution system were presented previously (Figure 4-3). The figure indicates that the recent addition of a 22 mgd water treatment plant has extended the system capacity to about 1992 (with no conservation) and to about 2000 with conservation before more capacity is required. The effect of this possible delay of eight years represents significant foregone investment costs to the community.

The effects of water conservation are significant, when it is applied to future projects scheduled for the years 1992 (22 mgd at $5.5 million) and 2011 (34 mgd at $8.5 million), sufficient to meet the 50-year planning period. With the water conservation program described for the WMWD, these two plants and necessary trunk lines would be required later at 2000 and 2019, respectively. The present value of these delays are $994,000 for the first 22 mgd plant and $333,000 for the second 34 mgd plant, a total present value of $1,327,000.

Wastewater Treatment: Currently, the WMWD community plans to expand the capacity of the 8.2 million gallons per day wastewater treatment facility. The expansion will increase the capacity of the plant to meet a future population equivalent of 102,000 people which should be reached according to WMWD reports near the year 2000.

The proposed expansion involves two elements:

(1) expansion of the wastewater treatment facilities to utilize the capacity of the existing site, and

(2) a first stage construction plan for immediate implementation.

Construction requirements:	$5.3 Million.

- o headworks and primary treatment facilities
- o new laboratory and personnel facilities

Chemical Ammonia Removal System:	$1.0 Million
Anaerobic Sludge Disposal System:	$3.5 Million
Total Project Cost:	$9.8 Million

Water conservation can produce benefits in down-sizing treatment plants, such as:

- o Headworks
- o Primary and Secondary Clarifiers
- o Effluent Chlorination Facilities
- o Effluent Outfall

Those units can produce about 22 percent savings of the total secondary treatment plant costs as a function of indoor water conservation, with reduction of 12 percent at 10 percent indoor use reduction to 22 percent at 20 percent to 35 percent indoor use reduction. (87)

Table 4-41 previously presented the percentage reduction in water use. Internal Residential water use alone accounts for 17.2 percent to 19.4 percent reduction from 1981 to 2030, and conservation for other uses easily places the WMWD indoor reduction in the 20 percent to 35 percent range. As a result, 22 percent of the $9.8 million capital cost currently planned for construction is $2.156 million. This type of facility would be required again by the year 2000 to meet the planning needs of the 50-year study period. The present value of the savings of these two projects built in 1985 and 2000 is $2,243,000.

Foregone costs of future wastewater collection systems provide another potential benefit of water conservation. Maximum pipe sizes (137.2cm, or 54 inches) can be reduced in size (<u>ie</u>., as a result of indoor water conservation "pipes can be selected one size smaller at 10 percent, 20 percent, 30 percent and 35 percent reductions in overall indoor water use." [87]). For systems requiring larger sizes, 152.4cm (54 inches) to 213.4cm (84 inches) "pipes can be selected one size smaller at 10 percent reduction and two sizes smaller at 20 percent, 30 percent and 35 percent reductions." (87) These additional benefits are potentially available to the WMWD for the new collector system that evolves beyond 2000. Collection system capital cost savings of $1,420,000 are reported for water conservation programs in California for 12.5 mgd plants. When adjusted for an 8.2 mgd plant ($930,000), in 2000. The present value of this savings is $186,000.

Substep 9.2 Federal Water Supply Plans

Two "Federal" projects provide water supply alternatives for the WMWD area. Dam and reservoir technical studies have been completed on these projects and costs are available, which for FED-1 are very low $16.65/acre-foot per year ($1980) for storage of water (assuming an active storage of 102,000 AF and 50 percent municipal bond financing at 9.5 percent interest for 40 years). The FED-2 project is comparable to LOCAL-1 with water estimated to cost $169.00/ acre-foot per year ($1980).

The FED-1 project has a capacity of 116,000 acre-feet (32,000 acre-feet for WMWD City needs). The project is planned for service in 1990 and capital costs are approximately $373,469,000. The project is multi-purpose, including: water supply, irrigation, hydropower and recreation.

In order to meet WMWD's needs, the FED-1 project would have to be on-line by the year 2000 in lieu of the regional option (LOCAL-1) and without water conservation. The proposed water conservation program provides an eight-year delay time to 2008. Based on the assumed annual costs of water ($532,800) for the WMWD: 32,000 acre-feet per year at $16.65 (1980 $) assuming all the water must be purchased (which exceeds WMWD's needs), and the possibility of delaying the project from 2000 to 2008 as a result of water conservation effects, the foregone costs of FED-1 are $655,000.

Substep 9.3 Regional Plans

The LOCAL-1 project (Table 4-15) is nearly built and will add 8,000 acre-feet of water per year (7.1 mgd) to the available "safe-yield" as described in Figure 4-2. This added supply extends the adequacy of the system resources to 2014 with unrestricted demand (medium growth) and to 2023 with conservation. The importance of conservation is about a nine-year delay in the construction of a similar project that would have to be initiated in 2010. The present value of the LOCAL-1 project, the WMWD area's share (5 other participants are involved), is determined as the present value of the sum of payments required of the WMWD for project repayment (Table 4-15) $14.211 million at the Federal discount rate of 8-3/8 percent. The present value (of foregone supply costs) of delaying a similar project that is necessary for the fifty-year planning period from 2014 ($923,000 present value) to 2023 ($447,000 present value) is $476,000 (the difference in the present value of the project in those years).

The LOCAL-1 project is nearly completed. At $276 to $355 an acre-foot of water, this is expensive water. The WMWD is possibly interested in selling these water rights, although this appears to be about the right size for the community. The FED-1 and FED-2 projects are very tentative. FED-1 is much larger and could settle the WMWD water problems until way after the study period with WMWD's share of the project 32,000 acre-feet (28.6 mgd) at an estimated $16.65/acre-foot ($1980).

Substep 9.4 External Opportunity Costs

External opportunity costs of water conservation programs by the WMWD include the effects of potentially reduced discharges into receiving streams and the downstream impacts of the reduced flow. Potential impacts incude water supply and irrigation, hydropower and recreation.

These possible impacts are considered to be insignificant. Western Water Law is based on entitlements. Communities downstream have rights to water similar to those described previously for the WMWD (Table 4-14), and downstream communities depend on upstream community discharges. Also, water conservation means that the sources of water supply are not drawn-down to the non-water conservation level.

A problem could result from increased discharge of solids etc., from the wastewater treatment plant and affect downstream quality, but this is controlled by NPDES permits and is monitored by the State Environmental Agency. Concerns would be appropriate for external opportunity costs and downstream impacts if water conservation resulted in greater consumptive use (ie., evaporation, incorporated into products, etc.); however, this program produces reductions in exterior residential water use from 4-6 percent to 8.8 percent (Table 4-41) and reduces this 100 percent consumptive loss.

Substep 9.5 Summary of Supply Cost & Savings

Table 4-57 summarizes the effects of water conservation on the costs of operations and future expansion of the WMWD water and wastewater systems. This section combines the effectiveness of each water conservation measure (Step 6) and the supply cost savings (Step 9). A method has been used that allocates the present value of the savings to each measure.

TABLE 4-57
FOREGONE SUPPLY COST (WMWD)
PRESENT VALUE (1980$, WITH 0.08375 FEDERAL DISCOUNT RATE)

	MEASURE 1 Retrofit	MEASURE 2 New Const.	MEASURE 3 Leakage	MEASURE 4 Education	MEASURE 5 Contingency	TOTAL
OPERATING COSTS						
Water Supply Treatment	$377,000	828,000	$1,017,000	$1,544,000 Peak Use	$216,000 303,000	$3,982,000
Wastewater Treatment	247,000	659,000	0	1,154,000 Peak Use	0	2,060,000
Subtotal	$624,000	$1,487,000	$1,017,000	$2,698,000	$519,000	6,042,000
CAPITAL COSTS						
Water Supply Treatment	133,000	292,000	358,000	544,000	-	1,327,000
Water Trans.	-	-	-	-	-	(included w/ treatment)
Wastewater Treatment	269,000	718,000	0	1,256,000	-	2,243,000
Wastewater Trans.	22,000	60,000	0	104,000	-	186,000
Subtotal	424,000	$1,070,000	$ 358,000	$1,904,000		$3,756,000
ALT. WATER PROJECTS						
FED-1	66,000	144,000	177,000	268,000	-	655,000
LOCAL-1	48,000	105,000	128,000	195,000		476,000
EXTERNAL OPP. COSTS	-	-	-	-	-	Minimal
TOTAL	$1,162,000	$2,806,000	$1,680,000	$5,065,000	$519,000	$10,875,000

Effectiveness calculations for selected years presented in Table 4-58 indicate the approximate contribution obtained for each measure in each year. These contributions are expressed as percentages of the annual water savings for all permanent measures. The "average contribution" of each measure is estimated based on comparison of the sum of the annual effectiveness for each measure relative to the total effectiveness of all measures. This is presented in Table 4-59 and ranges from 10 percent for Measure 1 to 41 percent for Measure 4. Table 4-58 indicates the initial effectiveness of Measure 1 is over 47 percent in 1980 and then declines to 20 percent in 2030. The second part of Table 4-59 presents the effectiveness impact on wastewater flows. Leakage reduction is assured to have no impact on wastewater, and the percent effectiveness of Measures 1, 2 and 4 are proportionally redistributed (Table 4-58) to obtain the impacts on wastewater flows.

The Table 4-57 summary indicates the significant present value benefits from each measure which range from about $.5 million for the contingency plan to over $5 million for the public education program.

TABLE 4-58
LEVEL 1 WMWD
PERCENT EFFECTIVENESS WATER USE REDUCTION BY MEASURE

	MEASURE 1 Retrofit	MEASURE 2 New Const.	MEASURE 3 Leakage	MEASURE 4 Education	TOTAL
1981	47.4	0.0	6.2	46.3	100
1985	26.9	5.3	21.4	46.4	100
2000	9.7	16.6	31.5	42.2	100
2020	3.5	26.2	29.9	40.4	100
2030	2.0	30.0	28.5	39.5	100

TABLE 4-59
LEVEL 1 WMWD (SELECTED YEARS)
EFFECTIVENESS IN WATER AND WASTEWATER USE REDUCTION BY MEASURE (MGD)

WATER USE	MEASURE 1 Retrofit	MEASURE 2 New Const.	MEASURE 3 Leakage	MEASURE 4 Education	TOTAL
1981	.467	0	.062	.455	.984
1985	.434	.086	.346	.749	1.615
2000	.303	.519	.985	1.320	3.127
2020	.181	1.361	1.553	2.098	5.193
2030	.134	2.017	1.916	2.655	6.722
AVERAGE % REDUCTION	10	22	27	41	100

Source: Table 4-32 and Table 4-58.

WASTEWATER	MEASURE 1 Retrofit	MEASURE 2 New Const.	MEASURE 3 Leakage	MEASURE 4 Education	TOTAL
1981	.396	0	.020	.382	.778
1985	.346	.071	.0	.601	1.018
2000	.232	.398	.0	1.028	1.658
2020	.146	1.080	.0	1.694	2.920
2030	.116	1.621	.0	2.123	3.860
AVERAGE % REDUCTION	12	32	0	56	100

Source: Table 4-32 and Table 4-58 adjusted for no leakage effect and omits "unaccounted-for" and "exterior residential" water use.

STEP 10: Foregone NED Benefits

Guidelines for the formulation and evaluation of plans for all Federal water and related land resources activities are contained in the U.S. Water Resources Council's Economic And Environmental Principles And Guidelines For Water And Related Land Resources Implemented Studies March 10, 1983. (10) These Guidelines were developed to serve as a guide in achieving the objective of water and related land resources project planning. This Federal objective is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. The Federal objective as stated in the Guidelines also includes:

> "(a) Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective."

"(b) Contributions to national economic development (NED) are increases in the net value of the national ouput of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed."

Water conservation in the WMWD area has the potential for reducing the net economic benefits contributed to NED. This Step evaluates those impacts. The FED-1 project (1080 option referring to pool elevation) was evaluated against NO ACTION, 1075 and 1085 options. The FED-1 plan was ranked second in NED (second to 1085) with $6,047,000 in Total Average Annual Benefits (October 1981 price level with a 7-5/8 percent interest rate and a 90-year remaining economic life). Total Average Annual Costs for FED-1 are $4,868,000 and net benefits are $1,179,000. The Benefit/Cost Ratio is 1.24.

Versus NO ACTION, the 1075, 1080 and 1085 projects achieve little support from the local public and only 1080 and 1085 are supported by regional groups (state and regional agencies). The 1080 (FED-1) project is ranked "high" on effectiveness and efficiency, certainty and stability.

Without the 6.722 mgd total effectiveness (Table 4-32) of the proposed water conservation program from the WMWD (or 7,500 acre-feet per year), the total impact on the WMWD allocation is negligible at $125,000 per year (7,500 AF * $16.65/AF allocated to measures based on Table 4-59), which reduces the project benefit/cost ratio from 1.24 to 1.21. The alternative projects would be affected similarly since each project was designed to produce comparable water supply needs.

This impact, about 6 per cent of total storage, will possibly produce additional benefits to irrigation demand and hydro-electric power generation. No negative impacts are likely to recreation benefits.

STEP 11: Reduced Negative EQ Effects

Based on review of the FED-1 MAIN REPORT AND APPENDICIES, the environmental impact statement for the project indicates that the proposed project is ranked number 1 (least impact) of the four alternative projects.

The environmental impacts are presented in Table 4-60.

TABLE 4-60
FED-1 ENVIRONMENTAL IMPACTS

	FED-1 (1080 PLAN)
Terrestrial Habitat	All losses are fully mitigable
Wetlands	19 acres of potential wetland adjacent to pool
Lake Fishery	330 acres, warm water, excellent quality, eutrophied
Downstream Fishery and Water Quality	Mediocre quality, warm stream fishery
Archaeological Sites and Elevation	Antonio Site - no effect Bockus Site - completely inundated Merritt Site - partially inundated
Historical Sites and Elevation	Beecher's Island Church - no effect (Close Farm Site completely inundated)
Nelson Falls	5 Feet Drop

The analysis in Step 10 (Foregone NED Benefits) indicated that the proposed WMWD water conservation program could negate the need for 7,500 acre-feet of water (about 6 per cent of total storage). This could result in a higher project pool elevation.

The 1080 plan (referring to pool elevation) provides a 1,090 acre lake with about 17.3 miles of shoreline. The plan includes water supply and hydroelectric power, as well as recreation opportunity. The 1085 plan provides an 1,170 acre lake with about 18.1 miles of shoreline. The water supply potential of the 1085 project provides slightly less additional storage (5,600 AF), than the additional water (7,500 AF) added by the WMWD conservation effort. The environmental effects of these plan options are compared. The 1085 plan produces no reduced environmental effects. Additional environmental impacts are described in Step 12.

There is a strong possibility, however, that the additional water made available by the WMWD conservation effort can be marketed. The low storage cost for FED-1 water provides an excellent opportunity for other City water departments or local irrigation interests to acquire the excess water.

STEP 12: Increased Negative Environmental Effects

In Step 11, two possibilities were discussed: (1) WMWD water conservation increases pool elevation in the FED-1 project, and (2) the additional water, 7,500 acre-feet, could be acquired by other water utilities or irrigation interests.

In Step 11, the environmental impacts of FED-1 (1080 Plan) were presented. The 1085 Plan discussed in Step 11 (with a 5ft. increase in pool elevation) which approximates the new pool elevation and storage, has additional environmental effects associated with the 1,170 acre lake and 18.1 mile shoreline. Table 4-61 identifies the additional environmental impact of the 1085 plan.

TABLE 4-61
ADDITIONAL ENVIRONMENTAL IMPACTS FROM WMWD WATER CONSERVATION

	1085 PLAN ENVIRONMENTAL IMPACT	ADDITIONAL 1085 PLAN IMPACTS
	1170 acre lake	80 acres
	18.1 mile shoreline	.8 mile shoreline
Terrestrial Habitat	All losses are fully mitigable	None
Wetlands	Wetland fringe around pool	Reduced
Lake Fishery and Water Quality	300 acres, warm water fishery, excellent quality eutrophied	30 acre loss
Downstream Fishery and Water Quality	Mediocre quality, warm water fishery	None
Archaeological Sites and Elevation	Antonio Site - no effect	None
	Bockus Site - completely inundated	None
	Merritt Site - completely inundated	None
Historical Sites and Elevation	Beecher's Island Church - no effect	None
	Close Farm Site - completely inundated	None
Nelson Falls	Completely inundated	Eliminated

The impact of 7,500 acre-feet is particularly important to losses of lake fishery (9 percent loss) and the archaeological Merritt Site loss. The Nelson Falls are also lost; however, it is not an unusual feature in this area.

These impacts may not occur if the water in question is sold to other water utility or irrigation interests.

STEP 13: Measure Evaluation

The results of the analysis from Steps 7, 8, 9 and 10 are summarized in Table 4-62. The information contained in this Table was taken from previous Summary Tables for the various steps. The Advantageous Effects of each measure outweigh the Disadvantageous Effects in every case.

Because water conservation reduces the demand from the FED-1 project (which even initially exceeds the WMWD future needs), the impact has a cost effect on other participants of the project described in Step 10: Foregone NED Benefits. The economic effect as well as the environmental impact (Step 12) can be reduced if the other participant or new participants purchase the WMWD share. This is considered to be likely.

TABLE 4-62
WMWD SUMMARY OF NED ADVANTAGES AND
DISADVANTAGES EFFECTS OF WATER CONSERVATION MEASURES (1980$)
MEASURES (DOLLARS/YEAR)

ADVANTAGES	MEASURE 1 Retrofit	MEASURE 2 New Const.	MEASURE 3 Leakage	MEASURE 4 Education	MEASURE 5 Contingency
a. Unrelated to Water Use	0	0	0	0	0
b. Indirectly related to Reduction	1,360,000	2,443,000	0	452,000	-
c. Foregone Supply Cost:					
- operations	624,000	1,487,000	1,017,000	2,698,000	519,000
- facilities	424,000	1,070,000	358,000	1,904,000	-
- external opp. cost	-	-	-	-	-
d. TOTAL NED ADV.	2,408,000	5,000,000	1,375,000	5,054,000	519,000
DISADVANTAGES					
a. Implementation costs	30,000	82,000	98,000	359,000	-
b. Other disadv.	-	-	-	-	-
c. Foregone NED Benefits	13,000	27,000	34,000	51,000	-
d. TOTAL NED DISADV.	43,000	109,000	132,000	410,000	0

Table 4-63 summarizes the environmental impacts of the proposed water conservation measures. The likely outcome will involve no local impacts and potential mitigation or avoidance of the environmental effects of conservation on the FED-1 project.

TABLE 4-63
WMWD SUMMARY OF ENVIRONMENTAL IMPACTS OF
WATER CONSERVATION MEASURES

ADVANTAGES	MEASURE 1 Retrofit	MEASURE 2 New Const.	MEASURE 3 Leakage	MEASURE 4 Education	MEASURE 5 Contingency
a. Unrelated or indirectly related to water use reduction	(None anticipated for all Measures)				
b. Directly related to water use reduction					
i. Federally Planned facilities;	(None anticipated for all Measures)				
ii. Non-Federal facilities	(None anticipated for all Measures)				
TOTAL ENVIRONMENTAL ADVANTAGES	None	None	None	None	None
DISADVANTAGES					
a. Unrelated or indirectly related to water use reduction	(None anticipated for all Measures)				
b. Directly related to water use reduction					
i. Federally Planned facilities	(Pool elevation will increase as a result of WMWD water conservation; impacts include loss of wetlands, archaeological site inundation and loss of waterfall. These impacts would be of concern to local residents, however, the need for mitigation is unlikely, if water is purchased by other project participants)				
ii. Non-Federal facilities	(None anticipated for all Measures)				
TOTAL ENVIRONMENTAL DISADVANTAGES	Slight	Slight	Slight	Slight	Slight

STEP 14: Develop Water Conservation/Supply Plan

The five water conservation measures under consideration for the WMWD area all meet the tests of applicability, feasibility, acceptability and effectiveness as well as providing net advantageous effects with respect to the NED objective. Individually or in combination, all of these measures potentially contribute to the slight loss of environmental habitat in the region of a proposed Federal project FED-1.

The purpose of this analysis is to maximize the Net Economic Development in achieving the long-run water demands for the WMWD area. Table 4-64 summarizes the measures. If any of the measures proposed possess greater NED Disadvantageous Effects than Advantageous Effects, it would be omitted from the analysis, and the water conservation effect of Tables 4-32 and 4-33 would be recalculated.

TABLE 4-64
SUMMARY OF WMWD
WATER CONSERVATION MEASURES

MEASURE	AVERAGE ANNUAL EFFECTIVENESS (MGD)	EFFECTS			
		ADVANTAGEOUS		DISADVANTAGEOUS	
		PRES. VALUE NED (ØØØ$/198Ø)	ENV.	PRES. VALUE NED (ØØØ$/198Ø)	ENV.
M1 Retrofit	.467 (1981) .134 (2Ø3Ø)	$2,4Ø8	None	$43	(1)
M2 New Const.	Ø (1981) 2.Ø17 (2Ø3Ø)	5,ØØØ	None	$1Ø9	(1)
M3 Leakage	.Ø62 (1981) 1.916 (2Ø3Ø)	1,375	None	$132	(1)
M4 Education	.455 (1981) 2.655 (2Ø3Ø)	5,Ø54	None	$41Ø	(1)
M5 Contingency	1 MGD	519	None	Ø	(1)

(1) Environmental impacts caused by conservation effect on FED-1. (1Ø8Ø) project. Pool elevation increase which is mitigable by other project participants.

Table 4-65 presents the measures in rank order. Measure 2 provides the highest ($4,891,ØØØ) net NED effect followed by Measure 4 with ($4,644,ØØØ). Measures 1 and 3 respectivelly provide $2,365,ØØØ and $1,243,ØØØ each. The contingency plan, which is implemented infrequently, produces only $519,ØØØ in net NED effects.

TABLE 4-65
NED MERIT ORDER
PRESENT VALUE (1980$)

MEASURE	NED EFFECT ADVANTAGEOUS	NED EFFECT DISADVANTAGEOUS	NET EFFECTS
M2 (New Const.)	$5,000,000	$109,000	$4,891,000
M4 (Education)	5,054,000	410,000	4,644,000
M1 (Retrofit)	2,408,000	43,000	2,365,000
M3 (Leakage)	1,375,000	132,000	1,243,000
M5 (Contingency)	519,000	0	519,000

In Table 4-66, proposals are formed by combining the water conservation measures. The objective is to maximize the net NED advantage, as well as the water reduction capabilities of the possible plans. The Table presents the combined effects of the proposed measures based on the ranking from Table 4-65 NED MERIT ORDER. Because of the mutually-exclusive nature of the proposed measures in producing advantageous and disadvantageous effects (ie., no cost savings are possible by combining implementation programs), the preferred plan includes all four permanent measures which produce a NET NED ADVANTAGE of $13,143,000 (present value).

TABLE 4-66
SUMMARY OF TRIAL WATER CONSERVATION
PERMANENT PROPOSALS FOR WMWD (NED EFFECTS)

NED PROJ. PLAN	MEASURES	WATER (MGD) 1981-2030	ADVANT. EFFECTS (P.V.000$)	DISAD. EFFECTS (P.V.000$)	NET NED ADVANT. (000$)
1	M2	.000-2.017	$ 5,000	$109	$ 4,891
2	M2,M4	.455-4.672	10,054	519	9,535
3	M2,M4,M1	.922-4.806	12,462	562	11,900
4	M2,M4,M1,M3	.984-6.722	13,837	694	13,143

If the water conservation measures M1 through M5 had been identified initially as variations of a common approach, the analysis here would have found the measures that, when combined, produced the maximum NED effect. Such water conservation measure proposals which are variations on a single concept would be evaluated for the interactions of costs and benefits in the implementation of the measures separately and combined, a technique used in other studies. (80) The effect on NET effects would be maximized by combining only the mix of measures that produced the maximum effect. The five measures considered here are virtually independent, and with the exception of excluding a measure in this Step, either for NED disadvantages possibly exceeding NED advantages or for environmental issues, the set of 5 measures represents a balanced water conservation program that will benefit the local community in conjunction with future water supply projects.

The LOCAL-1 project is scheduled for operation in 1985. Based on Figure 4-2, this project will be available and provide additional water supply until after 2010 without conservation. In combination with 4 permanent measures, this supply is extended until after 2020. At about that time in the future, a second project, either a second LOCAL-1 or FED-2 (the smaller Federal project) would provide the needed additional storage until after the 50-year planning horizon. Table 4-67 compares the Federal and Regional projects.

TABLE 4-67
SUMMARY OF WATER CONSERVATION MEASURES
AND FEDERAL AND REGIONAL ALTERNATIVE PROJECTS

	TECHNICAL FEASIBILITY	SOCIAL ACCEPTABILITY	NET IMPACT FED-1 NED OBJ.	NET IMPACT FED-1 ENVIR. IMPACT	REGIONAL LOCAL-1 REG. OBJ.	REGIONAL LOCAL-1 ENVIR. IMPACT
M1 (Retrofit)	Feasible	Acceptable	+	-	+	+
M2 (New Const.)	Feasible	Acceptable	+	-	+	+
M3 (Leakage)	Feasible	Acceptable	+	-	+	+
M4 (Education)	Feasible	Acceptable	+	-	+	+
M5 (Contingency)	Feasible	Acceptable	+	-	+	+

The FED-1 project, although it provides low-cost water storage at $16.65 per acre-foot, provides too much additional water for the WMWD needs. This project also involves the environmental impacts that are not part of the other project impacts.

The LOCAL-1 project, therefore, in conjunction with the permanent water conservation measures, offers the WMWD and economically efficient approach to water supply management for the future.

This is the selected plan for the WMWD area. The costs of the plan are presented in Table 4-68.

TABLE 4-68
WMWD WATER PLAN 1980-2050

YEAR		INCREMENTAL PROGRAM COSTS ($1980) PRESENT VALUE
1980	Water Conservation Plan Implementation	
	Measure 1: Retrofit Existing Systems	$ 43,000
	Measure 2: Ordinance for New Construction	109,000
	Measure 3: Leakage Detection and Repair (System)	132,000
	Measure 4: Public Education Program	410,000
	Measure 5: Contingency Plan (Lawn Watering)	0
Subsequent Years.	Phase II Education Program Follow-up	15,500
1985	LOCAL-1 Project: Additional Water Supply 8000 Acre-feet (7.1 MGD)	14.211 Million
2000	Water Treatment Plant (22 MGD)	5.5 Million
2019	Water Treatment Plant (34 MGD)	8.5 Million
2023	LOCAL-2 Project: Additional Water Supply 8,000 Acre-feet (7.1 MGD)	14.211 Million

STEP 15: Supply Reliability Considerations

Water supply reliability and the risks associated with drought are described generally in Chapter 3 ("Risk and Uncertainty"), including concerns about data and analysis methods and concerns for the unknown. The safe-yield of the WMWD system is estimated at 20,000 acre-feet per year (17.85 MGD). The sources of water supply for the area are numerous (Table 4-14), and average yields are estimated to be 25,000 acre-feet or more.

Figure 4-2 presents the available supply and the present and future demand relationships. Demand functions are presented with and without water conservation, and medium and high demand curves indicate elements of uncertainty in demand. Similar variations in supply can be shown to indicate the risk associated with shortage in water supply availability.

Figure 4-3 identifies the peak day capacity of the WMWD water system and the additional system improvements needed over the 50-year plan horizon. Because of the importance of water conservation in achieving the project timing in Table 4-68 and assuring adequate supply, sensitivity tests were conducted on ranges of coverage from maximum to modest and with variation in the population projections from low to high. Table 4-36 presented the conditions, and Table 4-37 presented the results. These are examples of the methods used to bound the analysis to areas of certainty and to understand where the boundaries are with regard to insufficient supply.

Other reports deal with these issues, including Table format for considering performance under drought conditions (80) and methods for determining safe yield, risk and uncertainty. (66)

STEP 16: Documentation

(See Appendix D: Bibliography)

WMWD EXAMPLE: Flow Reduction Contingency Plan

The following is a flow reduction contingency plan for the WMWD service area. Permanent water supply conservation measures have the ability to reduce water demand over the next decades as an increasing percentage of total demand. This gradual reduction reflects the increasing reductions attributed to the conservation ordinance (Measure 2) which affects future construction. The use of water conservation and new supply development will satisfy the water requirements of the WMWD area under normal conditions, however, a contingency plan is required to manage possible future water supply shortage.

The contingency plan is structured in three phases:

Phase I: Preparatory
Phase II: Voluntary Reductions
- Drought Warning
- Drought Watch
Phase III: Mandatory Reductions
- Drought Emergency

The degree of protection from water shortage presented here is comparable to the level previously implemented by the WMWD in the early 1980's as a means of extending the effectiveness of the water supply treatment system, the capacity of which was exceeded under previous unconstrained water use conditions.

A. Phase I: Preparation

Develop Water Contingency Plan Ordinance Relating to Outside Water Restrictions, Establishing Seasonal Use Limitations, and Providing a Surcharge and Administrative Appeal Process for Violations Thereof.

1. Establish Water Restrictions.

a. Non-Emergency Water Restrictions.

- Domestic garden lawn or other exterior water or sprinkling.
- May 15 through September 30.
- Even street addresses on even calendar days.
- Odd street addresses on odd calendar days.
- Only between hours of 5:30 P.M. and 10:00 A.M.
- 31st day of month odd numbered address in morning hours and even numbered addresses in evening hours.
- Define exceptions (ie., new seed and sod watering).

b. Emergency Water Restrictions.

- o All outside water use prohibited.
- o Announcement methods defined (newspaper publication) for implementation, modification and rescinding emergency water restrictions.

c. Assessments and Fines.

- o Establish fine for violation of emergency restriction (per calendar day).
  - $25.00 first violation
  - $50.00 second violation
  - $100.00 subsequent violation
- o Include fines as an additional charge in water bill.

d. Appeal Process.

- o Establish appeals procedure.
  - burden of proof on WMWD
  - suspend fine upon adequate assurance of future compliance
  - subsequent appeal according to State Rules of Civil Procedure

B. Phase II: Voluntary Reductions

- o Establish "Drought Warning" and "Drought Watch" circumstances, based on precipitation or snow melt (ie., Palmer Index: normal precipitation; x per cent below normal = Drought Watch; y per cent below normal = Drought warning; z per cent below normal = Drought Emergency.
- o Utilize local media to announce water shortage conditions and requested compliance.
- o Provide status reporting (feedback to community).

C. Phase III: Mandatory Reductions

- o Utilize local media to announce water shortage conditions and requested compliance.
- o Request intensive participation effort.
- o Provide status reporting (feedback to community).

CHAPTER 5

LEVEL 2 EXAMPLE: EAST COAST WATER DEPARTMENT

INTRODUCTION

The Level 2 example is a small eastern community (referred to as an East Coast Water Department [ECWD] that provides water supply to its residents. The community is located in the suburbs of the New York - Washington, D.C. megalopolis and has grown rapidly in the past, as city people have shifted to the urban locations. During the late 1970's and early 80's, however, growth in the area has been slowed greatly by recessions and population migration, and future expectations are shifting to a more modest view of future prospects.

The climate of the area is humid with monthly average temperatures that range from 32° F to 76° F. Precipitation is uniform over the year with about 41 inches average annual based on records over the past 100 years.

HISTORICAL GROWTH AND DEVELOPMENT

Population

In 1980, the Census indicated that the ECWD community had a population of 37,711. Table 5-1 summarizes the growth in population over the past decades.

TABLE 5-1
ECWD COMMUNITY POPULATION GROWTH

YEAR	POPULATION	PERCENT GROWTH
1960	19,965	-
1970	34,166	71.1
1980	37,711	10.3

It is clear that growth in the area has slowed considerably over the 1970's.

Census information also provides details (Table 5-2) on the 1980 population:

TABLE 5-2
RACIAL COMPOSITION (1980)

	NUMBER	PERCENT
White	33,900	89.9
Black	530	1.4
Spanish	640	1.7

The community has about 1900 senior citizens (5.1 percent). A large portion of the population are high school graduates (81.8 percent), and only 3.4 percent of the population is below the poverty level.

Also, typical of the eastern suburbs, the community income levels suggest the strong middle class character of the area. Per capita income is $9,879, and median household income is $30,498.

In 1980 there were 11,450 housing units, 9,494 units (84.9 percent) are owner occupied with an average of 3.6 persons per house. The median value of these houses is $80,200. The median gross rent for renter occupied housing is $328 per month.

This community profile does not suggest any unusual residential population characteristics that could negatively influence the effectiveness of a proposed water conservation program.

The community is located in a large metropolitan county that grew very rapidly during the 1960's, and during the 1970's grew by only 2.1 percent. The county has nearly 600,000 residents and is generally representative of the community; however, household size is typically smaller county-wide with 2.93 people/household.

The county has 196,708 households. Sixty-five percent (129,336) of the households are traditional married families, 19,065 (9.6 percent) are headed by a female and 35,667 (18 percent) are occupied by only one person. Per capita income county-wide is $12,464 (higher than for the ECWD community); however, the median family income is $25,603 (lower than the community median family income). These income differences are probably related to the significantly higher persons per household for the ECWD community vs. the county.

TABLE 5-3
YEAR STRUCTURE BUILT

	PERCENT
1970-1980	17.2
1960-1969	25.7
1939 or earlier	22.4

The mix indicates that very few structures were built after the 1978 changes in the State Plumbing Code when water conservation measures were supposed to be included in all new construction.

The ECWD community is 22.7 square miles (1980) or 13,764 acres. Current use of land (Table 5-4) follows:

TABLE 5-4
CURRENT 1975 LAND USE

	ACRES	PERCENT
Residential	4,949	36
Rural	713	
Low Density	4,330	
Medium Density	93	
High/Med. Density	0	
Industrial	948.0	7
Gen. Industrial	499.2	
Limit. Industrial	314.7	
Office-Res.	134.1	
Agricultural	2,147	16
Commercial	690.7	5
Business Off.	-	
Prof. Off	45.8	
Retail	46.1	
General Com.	598.1	
Community Facilities	2,403	17
Public	2,088	
Semi-Pub.	315	
Vacant	2,626	19
TOTAL	13,764	100

The community has considerable open space with apparent opportunity for growth; however, these are fragile environmental areas and generally lack wastewater collection facilities and sometimes public water service.

FUTURE GROWTH AND DEVELOPMENT

Population

The ECWD community grew very rapidly between 1960 and 1980. This surge of building and expansion influenced planning throughout the area and generated projections that have been the official basis for planning for the area until recently. The ECWD has a highly-qualified planning department, and regional plans are prepared by the county which include detailed sub-area components, including the ECWD area. (See Chapter 3 sections "Growth Projections" and "Modifying Growth Projections" for background information on use of available data. Also, see Chapter 5, Substep 6.1 where an example method is presented for modifying projections.)

The community sees itself, as do developers, as an ideal area for future growth. The local population (Table 5-5) is projected by the community planners to increase:

TABLE 5-5
LOCAL PLANNER POPULATION PROJECTIONS

YEAR	ECWD COMMUNITY POPULATION	PERCENT CHANGE PER DECADE
1960	19,965	
1970	34,166	71.1
1975	41,000	53
1985	50,100	21
2000	60,000 - 65,000	20

Commercial and industrial development opportunities will also increase, given the industrial nature of the region and the excellent transportation network. However, this development represents primarily increases in business office and services business growth.

Land Use

The future land use for the community is viewed as short range (1985, based on 1976 plan document information) and long-range (year 2000). These community anticipated land use changes (Table 5-6) are presented here.

TABLE 5-6
FUTURE LAND USE

	PRESENT PERCENT OF TOTAL AREA	SHORT-RANGE (1985) ACRE INCREASE		LONG RANGE (2000) ACRE INCREASE	
		ACRES	PERCENT	ACRES	PERCENT
Residential	36	1,214	44.7	1,604	56.4
Rural		636		900	
Low		193		275	
PRD		107		240	
Low Med.		167		160	
Med.		90		-	
Med-High		21		29	
Industrial	7	296	9	442	12.6
Gen. Ind.		275		413	
Limit. Ind.		-		-	
Office-Res.		21		29	
Agricultural	16	-	5	-	
Commercial	5	68	5.7	96	6
Bus. Off.		19		29	
Prof. Off.		44		63	
Rental Conv.		5		4	
Gen. Comm.		-		-	
Community Facilities	17	151	18.6	208	20
Public		144		197	
Semi-Pub.		7		11	
Vacant	19	-	17	-	0
TOTAL	100		100		100

These projected future growth trends indicate significant increases in residential development and small increases in industrial, commercial and public land uses and declines in agricultural and vacant land areas.

WATER AND WASTEWATER SYSTEMS

The ECWD relies on local groundwater and purchased surface water supply. Services are also provided to the community for wastewater treatment.

Water Supply

The ECWD has a water supply system that relies on groundwater and surface water to meet its needs. The system (fully metered) has grown over the past years, as required by increases in population. Table 5-7 indicates the increasing number of customers and water use from 1976 to 1980.

TABLE 5-7
ECWD CUSTOMERS AND WATER USE

YEAR	# OF ACCOUNTS	TOTAL WATER Thousands/Gal.	AVER. CONSUMP MGD	PER CAPITA CONSUMP.[1] Gallons/Capita
1976	9,545	1,603,056	4,391	122
1977	9,611	1,550,361	4,247	115
1978	9,824	1,464,966	4,013	108
1979	10,075	1,420,918	3,892	104
1980	10,291	1,583,353	4,337	115

[1] Based on interpolation of population data from Table 5-1.

These historic data show the increasing numbers of water customers (# of Accounts), an 8 percent increase in the 5-year period from 1976 to 1980. Table 5-7 also shows the effects of water conservation during the late 1970's.

Table 5-8 provides additional information on the changes in customers by user class and water demand over this period.

TABLE 5-8
GROWTH IN CUSTOMER CLASS ACCOUNTS AND DETAILS OF RESIDENTIAL WATER USE (MGD)

	1976	1977	1978	1979	1980
Residential	8,689	8,848	9,036	9,254	9,426
Res. Water Use (MGD)	(2.829)	(2.273)	(3.294)	(2.656)	(2.904)
Commercial	757	654	676	722	736
Industrial	52	60	63	50	73
No Charge	41	43	43	43	50
Multi-Family	6	6	6	6	6
TOTAL	9,545	9,611	9,824	10,075	10,291

These data indicate that residential accounts increased by 8.5 percent over the 5-year period. The commercial and industrial accounts increase and decrease according to business cycle fluctuations. The no charge accounts are municipal public buildings, churches, fire hydrants and schools (metered but not billed) and show the increasing public use of water. In both cases, the growth in total accounts and residential accounts suggest that water use in the community is consistent with the community's growth expectations of about 20 percent per decade.

The ECWD currently uses a semi-annual meter reading and billing program. Because of the gross quality of the water user data, little information is directly available on indoor/outdoor (ie., seasonal use).

The user charges have increased during the past 5 years, partially as a result of revenue losses associated with reduction in water sales during the drought period. The user charge fees over the 1976 to 1980 period are presented in Table 5-9.

TABLE 5-9
ECWD WATER USER CHARGES

YEAR	USER CHARGE ($/THOUSAND GALLONS)
1979	$ .94
1980	1.12 + surcharge (for capital improve.)
1981	1.12 + surcharge
1982	1.12 + surcharge
1983	increasing block rate
1984	increasing block rate

In 1983 the flat rate charges ($1.12 per thousand gallons) plus an increasing block rate surcharge were replaced with increasing block rate charges (graduated) for blocks of 25,000 gallons consumption per six month period, beginning at $1.52/1,000 gallons and increasing to $1.89/1,000 gallons (the highest rate).

The ECWD currently obtains water from 2-2,000 gallons per minute wells (with state water allocation of 3.0 mgd) and purchases an additional 2.8 mgd from a nearby community. The nearby N.B. community has an excess raw water supply of 3.9 mgd and could supply an additional 3.0 mgd to the ECWD. As a result, the two communities have entered an agreement for 4.0 mgd to be purchased (an additional 1.2 mgd, price $426.38/mgd). The status of the ECWD supply is:

- current yield: 5.8 mgd
- future yield: 7.0 mgd

The community has considered the possibility of drilling additional wells, a proposal which was rejected by the state and resulted in the "non-crises" water conservation project in 1979 (described later in Step 2: Applicability).

The ECWD system has several interconnections with neighboring water distribution systems, including:

- o Borough of S. River — (2) six-inch connects
- o Borough of M-Town — (2) six-inch connects
- o N.B. Community — (1) 30-inch main

The system has three elevated storage tanks (1.5 mg, 1 mg and .5 mg) distributed to provide needed storage and pressure.

Additional water that will be available to the ECWD community will come from state-developed water projects (like the purchased water now being used to augment the community's wells (purchased through a neighboring community water system). Current state water charges are presented in Table 5-10.

TABLE 5-10
CURRENT STATE WATER CHARGES

	FEES FOR STATE WATER
Allocation Charges	$81.80/MGD
Bond repayment charges (to 1988)	23.59/MGD
Bond repayment charges (1988-2002)	14.07/MGD
Standby Service Charges	(minimum charge)
Late payment charges	(prime + 2%)

The state is capable of selling additional water from the existing projects and anticipates no future projects until after the year 2000. Two projects could be considered at that time: State 1: "C" with an estimated potential supply of 50 mgd and State 2: "S" with a similar potential of 50-55 mgd.

Although feasibility studies have been done on these projects (in the early 1970's and in the 1960's, respectively), no current costs are available. However, state personnel believe the water from these projects will be at least double the current charges.

The ECWD community is currently building an expanded water intake system to accommodate the increased water purchases from the nearby community to increase its available supply to 7.0 mgd.

A Federal project is also under consideration for the ECWD community and the surrounding region. The project "FED-LAKE" is designed to provide water supply, flood control and recreation benefits. The water supply storage is 25,600 AF, with an average Non-Federal annual cost of $3,720,000 construction and $48,000 for annual operation and maintenance.

Sewer System

The ECWD community is a member of a regional wastewater collection and treatment system. The community is responsible for its own collection system and has created a local ECWD Sewerage Authority to bill customers for their contribution to the regional system.

The regional system serves 25 communities with a combined population of 600,000 people. The ECWD community represents about 6 percent of the current system flows. The flows to the regional treatment plant vary considerably from 80-85 mgd (dry day flow) to about 200 mgd (wet day flow). In the near future, the regional wastewater authority will increase its service area by adding two more communities with combined dry flows of about 14 mgd and wet flows of 70 mgd. The system is affected by significant Infiltration and Inflow (I&I) problems.

ECWD PROCEDURES MANUAL APPROACH

This section presents the Procedures Manual approach for the Level 2 example. This example (like the Level 1 analysis) also addresses a situation where data are deficient. The community has developed some planning reports which, although very optimistic in terms of future growth potential, are based on acceptable methods by local and county planners and are similar to previous broader-regional studies that show growth. The community has experienced drought emergencies in the past, and residual effects of these programs are still affecting water use.

The methods of analysis used for Level 2 are more reliant in this case on "local" information than data from generalized literature. Where literature values are synthesized for the ECWD analysis, geographic weighting was used to improve the applicability to the situation.

<u>STEP 1: Universe of Water Conservation Measures</u>

Table 5-11, Potential Water Conservation Measures, serves as a Summary Table for the analysis in Steps 1-4. Each of the water conservation measures described in Appendix A was evaluated as to its "applicability", "technical feasibility" and "social acceptability". A list of potential water conservation options results from this screening process. Each of these measures has a chance for implementation as a part of long-term and contingency plan program to reduce water use.

TABLE 5-11
POTENTIAL WATER CONSERVATION MEASURES: ECWD/LEVEL 2

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
REGULATION			
LONG-TERM			
Federal & State Laws & Policies			
A. Federal Laws and Policy	No		
B. State Policy	No		
1. Plumbing Code	Yes		
2. Other Policy	No		
Local Codes & Ordinances			
A. Plumbing Codes for New Structures			
1. Low-flow showerheads	No	F	Yes
2. Shower flow restrictors	No	F	Yes
3. Toilet dams	No	F	Yes
4. Displacement devices	No	F	Yes
5. Flush mechanisms	No	F	Yes
6. Low-flush toilets	No	F	Yes
7. Pressure toilets	Yes	F	
8. Dual-flush toilets	Yes	F	Yes
9. Faucet aerators	Yes	F	Yes
10. Faucet restrictors	No	F	Yes
11. Pressure reducing valves	Yes	P	Yes
12. Service line restrictors	No	F	Yes
13. Insulated hot water lines	Yes	F	Yes
14. Pre-mixed water systems (thermostatic mixing valves)	Yes	F	Yes
15. Low water-using clothes washers	Yes	F	Yes
16. Low water-using dishwashers/ appliances	Yes	F	Yes
17. Dry composting toilets	Yes	F	Yes
18. Grey water systems (reuse)	Yes	P	Yes
19. Leakage repair (private systems)	Yes	F	Yes
20. Industrial recycle	Yes	F	Yes
B. Plumbing Codes--retrofitting			
1. Low-flow showerheads	Yes	F	Yes
2. Shower flow restrictors	Yes	F	Yes
3. Toilet dams	Yes	F	Yes
4. Displacement devices	Yes	F	Yes
5. Flush mechanisms	Yes	F	NA
6. Low-flush toilets	Yes	F	NA
7. Pressure toilets	Yes	F	NA
8. Dual-flush toilets	Yes	F	NA
9. Faucet aerators	Yes	F	Yes
10. Faucet restrictors	Yes	F	Yes
11. Pressure-reducing valves	Yes	F	NA

TABLE 5-11 (CONTINUED)
WATER CONSERVATION MEASURES: ECWD/LEVEL 2

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
12. Service line restrictors	Yes	F	NA
13. Insulated hot water lines	Yes	F	NA
14. Pre-mixed water systems (thermostatic mixing valves)	Yes	F	NA
15. Low water-using clothes washers	Yes	F	NA
16. Low water-using dishwashers/ appliances	Yes	F	NA
17. Dry composting toilets	Yes	F	NA
18. Grey water systems (reuse)	Yes	F	NA
19. Leakage repair (private systems)	Yes	F	Yes
20. Industrial recycle	Yes	F	Yes
C. Sprinkling Ordinances			
1. Alternate day	Yes	F	NA
2. Time of Day	Yes	F	Yes
3. Hand-held hose	Yes	F	NA
4. Drip irrigation techniques	Yes	F	NA
D. Changes in Landscape Design	Yes	F	Yes
E. Water Recycling	No	P	Yes
Restrictions			
A. Rationing			
1. Fixed allocation	Yes	F	Yes
2. Variable percentage plan	Yes	F	NA
3. Per capita use	Yes	F	Yes
4. Prior use basis	Yes	F	No
B. Restrictions on Specific Uses			
1. Recreational uses	Yes	F	NA
2. Commercial & Industrial uses	Yes	F	Yes
3. Car washing	Yes	F	Yes
CONTINGENT (For Declared Drought)			
Local Codes & Ordinances			
A. Sprinkling Ordinances	Yes	F	NA
B. Water Recycling	Yes	P	Yes
Restrictions			
A. Rationing			
1. Fixed allocation	Yes	F	Yes
2. Variable percentage plan	Yes	F	Yes
3. Per capita use	Yes	F	Yes
4. Prior use basis	Yes	F	Yes
B. Restrictions on Specific Uses			
1. Recreational uses	Yes	F	Yes
2. Commercial & Industrial uses	Yes	F	No
3. Car Washing	Yes	F	NA

TABLE 5-11 (CONTINUED)
WATER CONSERVATION MEASURES: ECWD/LEVEL 2

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
MANAGEMENT			
LONG-TERM			
Leak Detection	No	F	NA
Rate-Making Policies			
A. Metering	No	F	NA
B. Rate design			
1. Marginal cost pricing	Yes (partial)	F	NA
2. Increasing block rates	No	F	No
3. Peak load pricing	Yes	F	NA
4. Seasonal pricing	Yes	F	No
5. Summer surcharge	Yes	F	NA
6. Excess use charge	Yes	F	NA
Tax Incentives & Subsidies	Yes	F	Yes
CONTINGENT			
Rate-Making Policies			
A. Rate design			
1. Marginal cost pricing	Yes	F	NA
2. Increasing block rates	Yes	F	No
3. Peak load pricing	Yes	F	NA
4. Seasonal pricing	Yes	F	NA
5. Summer surcharge	Yes	F	NA
6. Excess use charge	Yes	F	NA
EDUCATION			
LONG-TERM			
Direct Mail	Yes	F	Yes
News Media	Yes	F	Yes
Personal Contact	Yes	F	Yes
Special Events	Yes	F	Yes
CONTINGENT			
Direct Mail	Yes	F	Yes
News Media	Yes	F	Yes
Personal Contact	Yes	F	Yes
Special Events	Yes	F	Yes

FOOTNOTES: TABLE 5-11

APPLICABLE:

"Yes"	Applicable
"No"	Currently in use (1) Required by utility policy, (2) Required by state or local plumbing code, (3) Required by some other authority, or (4) Requested for voluntary implementation (ie., "No (1)" means currently in use, as a result of utility's authority. "No (14)" means utility authority and voluntary).

TECHNICALLY FEASIBLE:

F	Not in use, but technically feasible (will not adversely affect water use (other than flow reduction if implemented). For example, a sector of a water service area has low water service pressure, and flow restrictors will adversely affect use. Such devices are not technically feasible.
P	Not in use, but potentially technically feasible once possible small technical obstacles to implementation are overcome.

SOCIALLY ACCEPTABLE:

"Yes" or "No"	Based on analysis of social acceptability, measure is acceptable to public.
NA	Not available.

STEP 2: Applicability

The ECWD has had some experience with water conservation. In the late 1970's, the community implemented a program to reduce water use through conservation. This program was not motivated by drought, but in response to a denial by state government of the township's application to sink a third deep well into an already highly used aquifer. This, in conjunction with municipal forecasts of increasing growth (50 percent increase in population by the year 2000), provided the impetus for a "limited" water conservation program.

In 1980, the region entered a period of severe drought. By Executive Order, the Governor mandated a number of conservation measures for communities affected by the drought, including the ECWD. In addition, in 1977, the state adopted the National Standard Plumbing Code which, as of 1978, includes an appendix on water conservation for all new construction. The code requirements are enforced by local plumbing inspectors who are licensed by the state. Inspectors are supposed to review building plans for all new construction as part of a permit application process.

Permit applications should include vendor and water flow information. Based on local observations, the program is only partially implemented. The higher cost of water conservation equipment provides an incentive to use non-water conserving devices instead, and local inspectors "look the other way."

As a result of these actions, some water conservation measures have been partially implemented through mandatory and voluntary efforts, including:

Late 1970's Program in ECWD

Pilot Program (free kits to 564 water customers)
- o toilet dams
- o low-flow aerators
- o instructions on installation of water-saving devices
- o booklet on water-saving tips
- o low-flow showerhead (part only)

Phase I Program (free kits to 564 water customers)
- o three toilet dams
- o low-flow aerators
- o plastic flow-reducing button for existing faucet aerator
- o plastic flow-reducing control shower insert
- o water conservation brochure

State Plumbing Code
- o toilet maximum flow 3.5 gal/flush
- o urinal maximum flow 1.5 gal/flush
- o sink faucets maximum flow 2.75 gal/minute
- o showerhead maximum flow 2.75 gal/minute

Drought Executive Order

These recent actions and their impact on the applicability of various water conservation options are summarized in Table 5-12. With regard to water conservation in new construction, several potential options still remain, including specification of dual flush toilets, low water-using appliances and increased water reuse, as well as improved use of the existing (or a local version of) the State Water Conservation Plumbing Code.

With regard to retrofitting existing water systems, a small residual of water conservation measures currently exists as a result of previous conservation efforts taken by customers (measures indicated as not applicable at this time in Table 5-11). Although no primary data are available on how many devices are still in place, research by a local university was conducted and reported in national publications on the effectiveness of the program, including proportions of households installing water-saving devices for the Pilot and Phase I projects. In addition, the following tabulation includes estimates of the current residual of those programs and the residual from recent drought actions.

Table 5-12 presents information on the numbers of units and percent installation (coverage factors) for the water conservation project which was conducted in two parts (Pilot: 134 customers, and Phase I: 564 customers), and the drought of 1980. Based on information obtained from the university researcher who conducted the water conservation project, only 20 percent of households where water conservation devices were installed during the project are still using those devices. Information in Table 5-12 includes coverage (percent installation during the project) and the sales and distribution of water-saving devices during the drought (all of which were assumed to be installed). According to the journal article prepared by the university researcher describing the ECWD's experience with water conservation measures, "the sale of low-flow aerators increased from a rate of 10 per week to more than 180 per week. Sales of shower-flow control devices (plastic flow restrictors) increased from 20 per week to almost 340, toilet dams from 5 to 180, and showerheads from about 4 to 75 per week."

The effect of time and the assumed 20 percent of units still in use resulted in an estimate of how many units and percent of the ECWD customer base that still use the devices. Toilet dams and faucet flow restrictors, 3 percent and 4 percent of the customer base, respectively, are the largest residuals with aerators at about 2 percent. Shower-flow controls and low-flow showerheads are less than 1 percent.

TABLE 5-12
INFORMATION ON ECWD HOUSEHOLDS INSTALLATION AND USE OF
WATER-SAVING DEVICES IN 1979-1980
(TOTAL RESIDENTIAL CUSTOMERS 9,400)

	TOILET DAMS	AERATORS	FAUCET FLOW RESTRICTORS	SHOWER-FLOW CONTROLS	SHOWERHEAD DISTRIBUTED	SHOWERHEAD SOLD
WATER CONS. PROJECT						
Pilot (% Installed) (134 project customers)	53	46	-	-	20	7.5
Phase I (& Installed) (564 project customers)	56	45	21	24	-	2.5
Est. still in place (Project customers)						
Percent	20	20	20	20	20	20
Number	80	60	20	30	5	5
DROUGHT 1980						
Units Sold(#)	761	404	689	-	-	217
Units Dist.(#)	310	240	1120	-	20	-
Est. still in place (drought customers)						
Percent	20	20	20	-	20	20
Number	214	128	362	-	4	43
EST. STILL IN PLACE, OVERALL						
Number	294	188	382	30	9	48
Percent	3	2	4	<1	<1	<1

STEP 3: Technical Feasibility

The water conservation measures in Table 5-11 were screened to determine if they are technically feasible (F) or potentially technically feasible (P), based on knowledge of the measures and of aspects of the ECWD water system that could affect their function.

Although some long-term regulation measures on the list of options considered for new construction are not normally combined with other similar options (ie., toilet dams and toilet displacement devices and the existing state and local programs which require use of low-flow toilets and showerheads), the technical feasibility of certain options is not impaired if they can be used (technically) in the ECWD system. However, these devices are evaluated to be not applicable. With regard to retrofitting existing systems, some experience with displacement devices and flow restrictors is not considered to be a restriction on the applicability, and these previously used measures and substitute measures are considered applicable and technically feasible (F).

For long-term water conservation, water recycling (use of renovated wastewater for irrigation) is not feasible. New state regulations provide restrictions on recharge of groundwater aquifers with wastewater as a means of controlling the quality of highly-used groundwater supplies. Other restrictive and contingent measures are considered feasible. Some of the contingent measures have been used previously (implemented by order of the State Governor) and will probably be used again in that manner.

The ECWD has recently set a goal to reduce leakage in their water system. The reduction in water loss from this program is reflected in the baseline water demand projections. This option is not available for use in a new program. Metering is required by state and local authority, and the community is 99.9 percent metered. An increasing block rate water pricing policy has been in effect since 1983. Previously, a uniform block rate structure was in effect through 1980 and then through 1982 with a capital surcharge which was added to compensate for revenue losses during the 1980 drought/water conservation program. Non-technical obstacles are apparent to the use of restrictive measures and contingent measures (during declared drought).

An education program is in effect in the ECWD service area. Fliers are sent to customers occasionally along with bills to promote interest in water conservation. During the non-drought water conservation program in the late 1970's (for the purpose of capital expenditure reduction) and following in the drought of 1980, an education program helped to reduce water consumption.

STEP 4: Social Acceptability

Public attitudes toward water conservation measures have been partially demonstrated in the ECWD's jurisdiction. The recent water conservation project undertaken during 1979-1980, which was motivated by non-drought water use reduction objectives, and the subsequent drought in 1980, provide some local information on social acceptability of selected water conservation measures. This information, in conjunction with the literature survey that was conducted for the Levels 1 and 2 analyses, provides the basis for evaluating the social acceptability of water conservation measures for the ECWD.

Based on the literature search (see Appendix B, Table B-2), numerous water conservation measures are potentially socially acceptable. In addition, the ECWD has had local experience with water conservation programs that were implemented at the state and local levels. Acceptance of some of these measures has, and other have not, been reported in the literature.

In Table 5-11, the analysis shows social acceptance (Yes) for all plumbing code options for new construction, although some of the measures are already in use (Partially). With regard to retrofitting existing construction with water conservation measures, however, indication of social acceptance is sporadic in the literature. Local experience has shown the public's willingness to use the simpler devices (ie., toilet dams and faucet aerators) and has shown less willingness to use "more difficult to install" devices (ie., low-flow showerheads and faucet flow restrictors), as indicated in Table 5-12 for the Pilot and Phase I projects. Under local authority requirements, the ECWD service area has become acquainted with ("accepts") leakage repair and industrial recycling.

As a result of widespread drought, the state used per capita water allocations (50 gpcd) to extend use of limited water supplies, and the community is fully metered.

Summary of Steps 1-4 Screening

As a result of the analysis undertaken in Steps 1-4, a long list of water conservation measures have been identified and reduced to a list of measures that are applicable, technically feasible and socially acceptable. These measures have a good probability of achieving water conservation because they are technically compatible with the ECWD water system and will be acceptable to the public. The measures that have passed through this screening are evaluated for other aspects of their effectiveness in subsequent steps. The screened measures include:

TABLE 5-13

SUMMARY: ECWD MEASURES FROM SCREENING STEPS 1-4

LONG-TERM MEASURES

1. Enforcement of the requirements of the state adopted water conservation-oriented building code.
2. Availability and encouragement of the use of pressure toilets.
3. Distribution of toilet leak detection kits and encouragement of elimination of detected leaks.
4. Reinforcement of previous program for the retrofitting of water-saving devices (toilet dams, low-flow showerheads and faucet aerators).

CONTINGENT MEASURES

5a. Mandated restricted water use limitations.
5b. Rationing program in addition to restricted uses (when necessary).

STEP 5: Implementation

The community has taken an active part in planning its future in the past, including, for example, the development of the Comprehensive Master Plan and a Comprehensive Master Plan Water Plan Amendment adopted respectively in 1976 and

1978. The process of developing these plans involved the interaction of the Mayor, Township Council, Planning Board, citizen study committees, review committees and consultants. The community has developed goals and objectives for these plans and has integrated its planning process into the regional plans prepared and adopted by the County Planning Board. This process provides the needed basis for implementation of the proposed water conservation program that could be utilized by the ECWD community.

A conservation plan resolution would be approved by the Community Planning Board and the Township Council and then implemented by the ECWD and community inspectors and authorities. Each measure would be implemented as follows:

Measure 1

The State Building Code requires the use of water-saving fixtures in all new construction. Among its features, the code restricts the quantity of water per toilet flush to less than 3.5 gallons and the maximum flow rate from showers and faucets to 3.0 gpm. The code has been in existence in the state since 1978, however, it has not been effectively enforced within the ECWD according to local observations. The water conservation program thus requires the local building and plumbing codes to abide by the state code and for the local government to enforce the code during licensing and permitting. Reductions in water use due to this measure would occur in interior residential, commercial, industrial, and public use sectors.

This measure would be implemented through the community government. The Township Council and Planning Board will structure a program which will utilize the water utility for oversight of new construction to assure that plans are developed using approved water-conserving devices. This procedure will be used:

1. Water utility will be informed of new building permits or substantial improvements to existing structures.

2. Either a new water planning group will be created in addition to the existing meter, production and maintenance activities, or the responsibilities for water system planning and inspections will be undertaken by an existing activity.

3. Plans submitted for building permits will be reviewed and approved by the water utility, and a construction inspection will be made to assure compliance.

4. Occupancy permits will be withheld from structures that are not in compliance.

Measure 2

The ECWD previously investigated the potential use of pressure toilets during an experimental project that evaluated the process and determined that this measure could be effectively used. It is proposed that pressure toilets be available as an alternative to standard flush toilets and that their use be promoted. Pressure toilets use compressed air to assist in the flushing action and generally restrict water use to less than 1 gallon per flush. They may or may not be designed to operate similarly to conventional toilets and may involve modification of user habits. Reductions from pressure toilets occur only in the interior residential, commercial, and public water use categories.

The use of pressure toilets can be implemented by the ECWD in two ways: (1) available as a voluntary application for replacement of existing toilets and for new construction, or (2) incorporated into the Measure 1 requirements for building code enforcement. The second option would ensure greater use of these devices. This either voluntary or mandatory approach will require promotional efforts by the utility to demonstrate the effectiveness of this device and compatibility with local habits and preferences.

Measure 3

Toilet leak detection and repair requires a concerted effort to discover and eliminate leakage in toilets. The most common techniques are the use of dye tablets or food coloring. The toilet leak repair conservation measure would achieve reductions as a result of advertising, publicizing, and distributing dye tablets, etc., (ie., not from the normal leak repair that is expected without any by a management agency). Reductions from toilet leak repair occur only in the interior residential, commercial, and public use sectors. The water utility can make free dye kits available as a bill insert at little cost to assist the local residents in locating leaks. These kits are easy to use and effective. Instructions are included in packets to identify typical toilet leak problems and solutions. (A one-time service could also be available upon request for a utility maintenance person to inspect plumbing systems and make minor repairs. This method is used in other systems, however, it was not evaluated here.)

Measure 4

A pilot program of retrofitting water conserving devices was previously undertaken by the ECWD. This modest program served to demonstrate the potential for carrying out a more thorough effort and, thus, continued retrofitting of toilet dams, low-flow showerheads, and faucet aerators is included as a possible conservation program element. However, in order to keep the analysis of the newly-implemented conservation program separate from any reduction achieved previously, the impact of the earlier retrofit program was first applied to the water use projections in Substep 6.1. This resulted in a disaggregated water demand that included the effect of the pilot retrofit program and, thus, served as the basis for analysis of the proposed conservation program. This measure can be implemented through the water utility as was previously done.

Measure 5

The contingency measures proposed for response to a temporary water emergeny include (a) mandatory restrictions on non-critical water uses and/or the implementation of a (b) rationing program under severe conditions. The restricted use measure includes limits upon the use of outdoor watering, the banning of unnecessary outdoor use and commercial, municipal, and industrial restrictions on uses such as car washing, washing down facilities, etc. Reductions from the restricted use measure occurs in exterior residential, commercial, industrial, and public water use categories. Rationing can be applied when a temporary water emergency proceeds to the point that more severe restrictions are required. In the ECWD, rationing can be accomplished by enforcing a specific amount of water use per customer and levying fines or extra charges for non-compliance.

Actions for mandatory restrictions or rationing will require passage of resolutions by the Town Council. The water utility would establish the level of restrictions or rationing required, and action would be taken by the Council to authorize the reductions. The water utility would monitor the measure's effects and recommend enforcement, if needed.

STEP 6: Effectiveness

The effectiveness analysis for the ECWD community consists of four Substeps and evaluations:

Substep 6.1 Disaggregated Water Demand Forecasts
Substep 6.2 Determine Fraction of Water Demand reduction
Substep 6.3 Determine Coverage
Substep 6.4 Analysis of Effectiveness

Substep 6.1 Disaggregated Water Demand Forecasts

The ECWD community has developed a Comprehensive Master Plan (adopted in 1976) and a Comprehensive Master Plan Water Plan Amendment (adopted in 1978). These plans were prepared to assist the ECWD community in dealing with complex future development issues. The Master Plan was developed within the context of regional plans for the larger, county area and is consistent with the views of growth that were mutually felt to be possible for the area. The water demand forecasts for the ECWD were prepared based on base data obtained from these planning documents. (For demonstration purposes, to illustrate a common problem in water demand forecasting, the ECWD forecasts may be criticized as overly optimistic, and current debate has not resolved the issue.) Methods are suggested for altering the projection to levels that are consistent with possible changes in planning assumptions. (See Chapter 3, GENERAL ISSUES, "Modifying Growth Projections". A method and example for modifying projections is presented at the end of Substep 6.1.)

The water demand projections were developed in two stages. Stage 1--based on future connection projections and water use per connection projections, and Stage 2--based on Stage 1 results and the impact of an existing, recently implemented limited Pilot and Phase 1 water conservation program that continues to reduce future water uses (ie., Stage 1 calculations do not include the recent water conservation effects).

Stage 1: Stage 1 describes the methodology employed to produce disaggregated water demand forecasts for the ECWD and consists of four parts. Part I describes the method used to project the number of connections in each customer class. Part II describes the method used to project water use per connection. Part III describes the method used to project mean annual total water use. Part IV describes the method used to project peak daily water use.

Part I

Step 1: Project population and economic activity

Low, medium, and high population growth rate projections were obtained from the local planning agency. These projections were available for the years 1990 and 2000. The growth rate trends which characterized these projections were analyzed in order to estimate low, medium, and high growth rates for the period 2000-2030. The annual growth rates used are presented in Table 5-14.

TABLE 5-14
ECWD ANNUAL GROWTH RATES

PERIOD	LOW	MEDIUM	HIGH
1980-90	0.6	1.9	1.4
2000-30	1.0	1.2	1.4

Economic activity, as indicated by number of employees, in the commercial, industrial, and public (no charge) sectors was assumed to grow in proportion to population.

Step 2: Project number of connections

The ECWD recognizes five customer classes. SFR (single family residential), MFR (multi-family residential), COMM (commercial), IND (industrial) and NO CHARGE (public uses). The number of connections in each class was estimated for the base year (1980) in the following way:

> The actual number of single family residential and multi-family residential connections recorded by the water utility in 1980 were used without adjustment.
>
> Utility records revealed sharp year-to-year fluctuations between 1976 and 1980 in the numbers of commercial and industrial connections. Therefore, a linear trend line was fitted to each of these categories and 1980 values were read from those trend lines.

The number of connections (Table 5-15) in each customer class was projected to grow in direct proportion to population and employment throughout the planning period. Analysis of the ECWD historical data provided no basis for projecting changes in household size, changes in land use (ratio of single family to multi-family dwelling units), or changes in employment per household. Analysis of a more complete data set might have indicated such changes.

Part II

Step 1: Estimate base year mean annual water use per connection

Mean annual water use was determined from utility records for each customer class for the period 1976-1980. The data displayed substantial seasonal fluctuations in the residential categories and substantial annual fluctuations in the commercial and industrial categories. Therefore, mean monthly winter water use in 1980 was taken to be equal to 1980 indoor water use and the difference between mean monthly summer use and mean monthly winter use in 1980 was taken to be equal to 1980 outdoor water use in the residential sectors. Mean water use over the 1976-1980 period was taken to be equal to base year water use for the commercial and industrial sectors.

TABLE 5-15
ECWD CONNECTIONS PROJECTED (HIGH, MEDIUM, LOW)

LOW PROJECTIONS

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	9,426	9,992	10,991	12,090	13,299	14,629
MFR	6	6	7	7	8	9
COMM	736	780	858	944	1,038	1,142
IND	73	77	85	94	103	113
NO CHARGE	50	53	58	64	71	78
TOTAL	10,291	10,908	11,999	13,199	14,519	15,971

MEDIUM PROJECTIONS

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	9,426	11,028	13,234	14,690	16,306	18,099
MFR	6	7	8	9	10	11
COMM	736	861	1,033	1,147	12,273	1,413
IND	73	85	102	114	126	140
NO CHARGE	50	59	70	78	86	96
TOTAL	10,291	12,040	14,449	16,038	17,802	19,760

HIGH PROJECTIONS

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	9,426	11,311	14,026	16,130	18,227	20,596
MFR	6	10	13	15	17	19
COMM	736	1,016	1,168	1,320	1,491	1,685
IND	73	101	116	131	148	167
NO CHARGE	50	69	79	90	101	114
TOTAL	10,291	12,507	15,402	17,685	19,985	22,583

Step 2: Project Mean Future Water Use

The ECWD instituted a rate change after the 1976-1980 period for which data were used to determine base year water use for each customer class. The effect of that rate increase, which raised the marginal cost of water from $1.12 per thousand gallons to $1.62, $1.89, $1.77, and $1.52 for single family residential, multi-family residential, commercial, and industrial customers respectively (based upon the new rate schedule and the mean monthly consumption for each class) was considered in projecting future water use. To do so, an estimation equation was of the form:

$$Q = A * P^e$$

where Q = mean annual water use per connection, P = the marginal price of water, e = the price elasticity of water, and A = a constant term which must be determined empirically. The price elasticity of water was assumed to be 0.2 - 0.2P for indoor residential use and 0.2 - 0.6P for outdoor residential use. Both commercial and industrial water use were assumed to be insensitive to price (e = 0). The value of the constant term was then estimated through substitution, using the baseline year data.

Part III

Step 1: Project Total Mean Annual Water Use Per Customer Class

Mean annual water use per connection from Part II was then multiplied by the projected number of connections in each customer class from Part I to obtain projected mean annual water use per class. Tables 5-16, 5-17, and 5-18 present the low, medium and high projections for the ECWD.

TABLE 5-16
ECWD SUMMARY OF PROJECTED MUNICIPAL REQUIREMENTS
(WITHOUT PLUMBING CODE EFFECTS) (LOW)

AVERAGE DAILY WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	2.564	2.717	2.989	3.288	3.617	3.979
MFR	.180	.191	.210	.231	.254	.280
COMM	.458	.485	.534	.587	.646	.711
IND	.361	.383	.421	.463	.509	.560
NO CHARGE	.042	.044	.049	.053	.059	.065
Sub-Total	3.606	3.822	4.204	4.625	5.087	5.596
LEAKAGE	.432	.305	.336	.370	.407	.447
TOTAL	4.039	4.128	4.541	4.995	5.495	6.044

TABLE 5-17
ECWD SUMMARY OF PROJECTED MUNICIPAL REQUIREMENTS
(WITHOUT PLUMBING CODE EFFECTS) (MEDIUM)

AVERAGE DAILY WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	2.564	2.999	3.599	3.995	4.435	4.923
MFR	.180	.211	.253	.281	.312	.346
COMM	.458	.536	.643	.714	.792	.879
IND	.361	.422	.507	.563	.625	.693
NO CHARGE	.042	.049	.059	.065	.072	.080
Sub-Total	3.606	4.219	5.063	5.620	6.238	6.924
LEAKAGE	.432	.337	.405	.449	.499	.553
TOTAL	4.039	4.556	5.468	6.069	6.737	7.478

TABLE 5-18
ECWD SUMMARY OF PROJECTED MUNICIPAL REQUIREMENTS
(WITHOUT PLUMBING CODE EFFECTS) (HIGH)

AVERAGE DAILY WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	2.564	3.076	3.815	4.387	4.958	5.602
MFR	.180	.306	.399	.458	.518	.586
COMM	.458	.632	.727	.821	.928	1.049
IND	.361	.498	.573	.648	.732	.827
NO CHARGE	.042	.058	.066	.075	.085	.096
Sub-Total	3.606	4.572	5.581	6.391	7.222	8.161
LEAKAGE	.432	.365	.446	.511	.577	.652
TOTAL	4.039	4.938	6.028	6.903	7.800	8.814

Note: Water use data and projections are truncated throughout this Handbook. As a result, totals may not add exactly.

Step 2: Project Total Mean Annual System Water Use

Mean annual water use was then aggregated across all customer classes, and estimated leakage was computed and added to the total to obtain projected total mean annual system water use. Leakage was estimated by the water utility to be 12 percent and a current program was developed to reduce leakage to 8 percent, a level at which it would be maintained thereafter.

Part IV

Step 1: Determine ratios of peak to average water use

Based on consultant studies, the ECWD projected that the ratio of peak day demand to average day demand for the system as a whole would fall from 2.15 in 1985 to 2.10 in 2000. Based upon their analysis, it was assumed that the ratio would be 2.17 in 1980, 2.15 in 1990, and 2.10 in 2000 and subsequent years.

Step 2: Project Peak Daily Water Use

Peak daily water use was projected by calculating projected mean daily use from Part III and multiplying by the appropriate peak/average ratio from Step 1.

Information on peak daily water use was not available for the ECWD system. However, detailed monthly water use data by customer class and consulting reports were available for a community within 100 miles with similar climate, suburban quality and diversity. Table 5-19 identifies the proxy peak water use factors (PF) which equals peak/average water use for each water customer class for indoor and outdoor use. These peak use factors were applied to the ECWD average annual forecasts in Tables 5-16 through 5-18 to develop the peak use projections. Table 5-19 indicates that peak use and indoor and outdoor use of peak water demand varies within each customer class and over time. The significant factor in Table 5-19 is that outdoor use in an eastern-humid state is about 21 percent of total use and varies for each water use class from 8 and 9 percent (multi-family residential, and public and institutional, respectively) to 23 and 30 percent, respectively for residential use (SFR) and commercial/industrial. Table 5-19 includes an FED category (Federal agencies) which has a significant outdoor use and would be important for some areas in the East; however, it was not used in the ECWD assessment which does not include any Federal use (if the Federal use was similar to the public/institutional category, the two categories could be combined). (Note: These factors may be low [peak water use can exceed average flows by factors of 2 or 3 times] and more detailed information such as daily pumping records could be integrated with other data [ie., similar information to that used here] to obtain peak daily water use estimates. Also, care should be taken to avoid using the very generalized peak use figures that are frequently used in making peak month, week, day and hour forecasts.)

TABLE 5-19
PEAK WATER USE FACTORS APPLIED TO THE ECWD

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR (PF)*	1.66	1.73	1.79	1.86	1.92	1.95
Indoor (%)	77	76	76	76	75	75
Outdoor (%)	23	24	24	24	25	25
MFR (PF)	1.49	1.49	1.49	1.47	1.46	1.49
Indoor (%)	92	92	92	92	92	91
Outdoor (%)	8	8	8	8	8	9
COMM/IND. (PF)	1.36	1.36	1.35	1.33	1.30	1.28
Indoor (%)	62	61	60	59	59	59
Outdoor (%)	38	39	40	41	41	41
PUB/INST. (PF)	.64	.56	.49	.47	.46	.45
Indoor (%)	91	91	91	90	90	90
Outdoor (%)	09	09	09	10	10	10
FED (PF)	1.24	1.33	1.49	1.46	1.43	1.40
Indoor (%)	.70	.69	.69	.68	.68	.67
Outdoor (%)	.30	.31	.31	.32	.32	.33
TOTAL WATER USE						
Indoor (%)	79	78	78	77	77	77
Outdoor (%)	21	22	22	23	23	23

*PF (Peak Factor) = Peak/Avg. Water Use.

Tables 5-20 through 5-22 present the peak day water demand for the ECWD community for low, medium and high growth projection forecasts. Peak demand was calculated and distributed based on Table 5-19 peak use factors.

TABLE 5-20
ECWD SUMMARY OF WATER DEMAND (PEAK DAILY, MGD)
TOTAL WATER USE AND INDOOR AND OUTDOOR (LOW)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	5.879	6.183	6.773	7.434	8.110	8.835
MFR	.372	.374	.396	.412	.433	.475
COMM	.860	.869	.913	.949	.981	1.036
IND	.678	.684	.719	.750	.774	.816
NO CHARGE	.037	.030	.030	.030	.031	.033
LEAKAGE	.938	.651	.705	.765	.825	.894
TOTAL	8.764	8.793	9.536	10.340	11.154	12.089

PEAK DAILY INDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	4.527	4.699	5.147	5.650	6.083	6.626
MFR	.342	.344	.364	.379	.398	.432
COMM	.533	.530	.548	.560	.579	.611
IND	.420	.417	.431	.443	.457	.481
NO CHARGE	.023	.027	.027	.027	.028	.030
TOTAL	5.845	6.017	6.517	7.059	7.545	8.180

PEAK DAILY OUTDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	1.352	1.484	1.626	1.784	2.027	2.209
MFR	.030	.030	.032	.033	.035	.043
COMM	.327	.339	.365	.389	.402	.425
IND	.258	.268	.288	.307	.317	.335
NO CHARGE	.014	.004	.003	.003	.003	.003
TOTAL	1.981	2.125	2.314	2.516	2.784	3.015

NOTE: Total Water Use equals Indoor plus Outdoor use, plus Leakage.

TABLE 5-21
ECWD SUMMARY OF WATER DEMAND (PEAK DAILY, MGD)
TOTAL WATER USE AND INDOOR AND OUTDOOR (MEDIUM)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	5.879	6.825	8.154	9.030	9.946	10.932
MFR	.372	.413	.477	.502	.531	.586
COMM	.860	.960	1.099	1.154	1.202	1.281
IND	.678	.755	.866	.910	.948	1.010
NO CHARGE	.037	.035	.037	.038	.038	.041
LEAKAGE	.938	.718	.850	.930	1.012	1.107
TOTAL	8.764	9.706	11.483	12.564	13.677	14.957

PEAK DAILY INDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	4.527	5.187	6.197	6.863	7.460	8.199
MFR	.342	.380	.439	.462	.489	.533
COMM	.533	.586	.659	.681	.709	.756
IND	.420	.461	.520	.537	.559	.596
NO CHARGE	.023	.032	.034	.034	.034	.037
TOTAL	5.845	6.646	7.849	8.577	9.251	10.121

PEAK DAILY OUTDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	1.352	1.638	1.957	2.167	2.486	2.733
MFR	.030	.033	.038	.040	.042	.053
COMM	.321	.374	.440	.473	.493	.525
IND	.258	.294	.346	.373	.389	.414
NO CHARGE	.014	.003	.003	.004	.004	.004
TOTAL	1.981	2.342	2.784	3.057	3.414	3.729

TABLE 5-22
ECWD SUMMARY OF WATER DEMAND (PEAK DAILY, MGD)
TOTAL WATER USE AND INDOOR AND OUTDOOR (HIGH)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	5.879	7.057	8.692	9.977	11.191	12.520
MFR	.372	.605	.756	.823	.889	1.000
COMM	.860	1.139	1.249	1.335	1.418	1.539
IND	.678	.898	.984	1.054	1.119	1.214
NO CHARGE	.037	.042	.041	.043	.046	.049
LEAKAGE	.938	.778	.937	1.057	1.172	1.304
TOTAL	8.764	10.519	12.659	14.289	15.835	17.626

PEAK DAILY INDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	4.527	5.363	6.606	7.583	8.393	9.390
MFR	.342	.557	.696	.757	.818	.910
COMM	.533	.695	.749	.788	.836	.908
IND	.420	.548	.590	.622	.660	.716
NO CHARGE	.023	.038	.037	.039	.041	.044
TOTAL	5.845	7.201	8.678	9.789	10.748	11.968

PEAK DAILY OUTDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	1.352	1.694	2.086	2.394	2.798	3.130
MFR	.030	.048	.060	.066	.071	.090
COMM	.327	.444	.500	.547	.582	.631
IND	.258	.350	.394	.432	.459	.498
NO CHARGE	.014	.004	.004	.004	.005	.005
TOTAL	1.981	2.540	3.044	3.443	3.915	4.354

Stage 2: Stage 2 describes the method used to estimate the effect of the existing limited water conservation program and to integrate it with the Stage 1 projections. Since the ECWD has already implemented a limited water conservation program among its residential users, the impact of this program needs to be included within the water demand projections, prior to the evaluation of the effectiveness of any new programs. The ECWD does have an evaluation of both the reductions accomplished and the coverage achieved by its previously implemented program. These are summarized in Table 5-23.

TABLE 5-23
ECWD EXISTING CONSERVATION PROGRAM
FRACTIONAL REDUCTION AND COVERAGE VALUES

CONSERVATION MEASURE	FRACTIONAL REDUCTION	COVERAGE
Shower Restrictors	.081	.24
Toilet Dams	.018	.56
Faucet Aerators	.020	.45
Faucet Flow Restrictors	.0204	.21

These fractional reductions and coverage factors were used to determine the effectiveness of the existing program and to provide a baseline forecast against which future water conservation can be measured. The baseline demand projections are shown in Tables 5-24 through 5-26 for the three population forecasts. These baseline forecasts can be compared against projections in Tables 5-16 through 5-22 to identify the effect of the current limited water conservation program.

For example, comparison of Tables 5-17 Average Annual Water Demand (medium growth), without the existing water conservation program and Table 5-25, with the existing program, indicates a residual impact of less than 1 percent (28,000 gpd) of total annual water use in 1990. Although in this case the residual is minor, in other cases existing water conservation efforts and interaction between measures can be a factor in the design of an effective program. For the purpose of simplifying the Handbook effectiveness analysis, SFR and MFR categories have been combined into interior residential and exterior residential (Int. Residential and Ext. Residential), NO CHARGE is public institutional (Pub/Inst.) and LEAKAGE and other losses are unaccounted-for (Unacc. For).

TABLE 5-24
ECWD BASELINE (PROJECTED FLOWS WITHOUT ADDITIONAL CONSERVATION)
LOW POPULATION GROWTH

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	2.403	2.548	2.802	3.081	3.390	3.729
Ext. Residential	0.342	0.362	0.399	0.439	0.482	0.531
Commercial	0.458	0.486	0.534	0.588	0.646	0.711
Industrial	0.361	0.383	0.421	0.463	0.510	0.560
Public/Inst.	0.042	0.045	0.049	0.054	0.059	0.065
Unacc. For	0.433	0.306	0.336	0.370	0.407	0.448
TOTAL	4.039	4.105	4.532	4.991	5.493	6.043

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	4.869	4.994	5.492	6.022	6.478	7.057
Ext. Residential	1.382	1.514	1.658	1.817	2.062	2.252
Commercial	0.860	0.869	0.913	0.949	0.981	1.036
Industrial	0.678	0.684	0.719	0.750	0.774	0.816
Public/Inst.	0.037	0.030	0.030	0.030	0.031	0.033
Unacc. For	0.938	0.651	0.705	0.765	0.825	0.894
TOTAL	8.764	8.742	9.517	10.333	11.151	12.088

TABLE 5-25
ECWD BASELINE (PROJECTED FLOWS WITHOUT ADDITIONAL CONSERVATION)
MEDIUM POPULATION GROWTH

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	2.403	2.811	3.374	3.744	4.156	4.218
Ext. Residential	0.342	0.400	0.480	0.533	0.592	0.656
Commercial	0.458	0.536	0.643	0.714	0.793	0.880
Industrial	0.361	0.422	0.507	0.563	0.625	0.694
Public/Inst.	0.042	0.049	0.059	0.066	0.073	0.081
Unacc. For	0.433	0.338	0.405	0.450	0.499	0.554
TOTAL	4.039	4.556	5.468	6.070	6.738	7.083

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	4.869	5.513	6.614	7.316	7.946	8.731
Ext. Residential	1.382	1.671	1.995	2.207	2.528	2.786
Commercial	0.860	0.960	1.099	1.154	1.202	1.281
Industrial	0.678	0.755	0.866	0.910	0.948	1.010
Public/Inst.	0.037	0.035	0.037	0.038	0.038	0.041
Unacc. For	0.938	0.718	0.850	0.930	1.012	1.107
TOTAL	8.764	9.652	11.461	12.555	13.674	14.956

TABLE 5-26
ECWD BASELINE (PROJECTED FLOWS WITHOUT ADDITIONAL CONSERVATION)
HIGH POPULATION GROWTH

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	2.403	2.944	3.691	4.255	4.811	5.438
Ext. Residential	0.342	0.412	0.511	0.587	0.663	0.750
Commercial	0.458	0.633	0.727	0.822	0.929	1.049
Industrial	0.361	0.499	0.573	0.648	0.732	0.828
Public/Inst.	0.042	0.058	0.067	0.075	0.085	0.096
Unacc. For	0.433	0.366	0.447	0.511	0.578	0.653
TOTAL	4.039	4.912	6.016	6.898	7.798	8.814

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	4.869	5.863	7.277	8.330	9.207	10.229
Ext. Residential	1.382	1.742	2.146	2.460	2.869	3.220
Commercial	0.860	1.139	1.249	1.335	1.418	1.539
Industrial	0.678	0.898	0.984	1.054	1.119	1.214
Public/Inst.	0.037	0.042	0.041	0.043	0.046	0.049
Unacc. For	0.938	0.778	0.937	1.057	1.172	1.304
TOTAL	8.764	10.462	12.634	14.279	15.831	17.625

Optional Growth Projection Method

In Table 5-5, population projections prepared by the ECWD indicate strong future growth in the service area. A debate, however, is now underway which is considering the possibility that growth may not materialize as was projected. Although this analysis uses the "official" plan projections, another method is presented here that could be used to modify the results.

Developers, for example, see a continued strong demand for housing. A recent newspaper article, ie., "Out-Of-Staters Are Buying Homes In The ECWD Community" indicates that in 1980 (Census) "about 7 percent of the community's population had moved from out-of-state...within the past five years." Also, the article indicates that sales of developer housing are strong. "In the past 18 months, since the company opened its first (ECWD community) development, more than 800 homes have been sold."

The following is a method for adjusting water projections that could be used for areas where overstated population growth must be revised, although for the ECWD area, the "official" projections provide the basis for this analysis. Figure 5-1 presents the projected population and current estimates based on recent assumption changes.

A current water supply study was recently initiated for the region that includes the ECWD community. This study involves sufficient resources to permit an indepth evaluation of the future growth trend issues in the area. Two factors have been identified, according to regional planners, that will reduce the future projected population below levels used in the Chapter 5, Level 2 analysis.

(1) The infrastructure capacity of the community can accommodate approximately 50,000 people without major and costly modifications.

(2) The household size of 3.6 reported by the Census (a high rate for the region/county) will decline. Trends indicate a loss of household size of .3 persons/decade.

As a result, county planners in a preliminary unofficial effort projected ECWD community population to increase to 44,800 by the year 2000 as compared to 60-65,000 presented earlier (Table 5-5). This revised population forecast presented in Figure 5-1 provides the basis for revising the initial water demand projections presented in Table 5-16. The following provides an approach that could be used to revise forecasts for similar circumstances.

The ECWD jurisdiction is primarily residential (92 percent of all connections and 63 percent of water demand), 8 percent of connections are commercial/industrial, and insignificant numbers of connections are multi-family residential and public/institutional. Table 5-27 presents water demand projections from Table 5-16 based on the local population projections (which may be too high) and also presents water demand forecasts (Revised Forecast) revised downward based on the "revised projections 1984" from Figure 5-2.

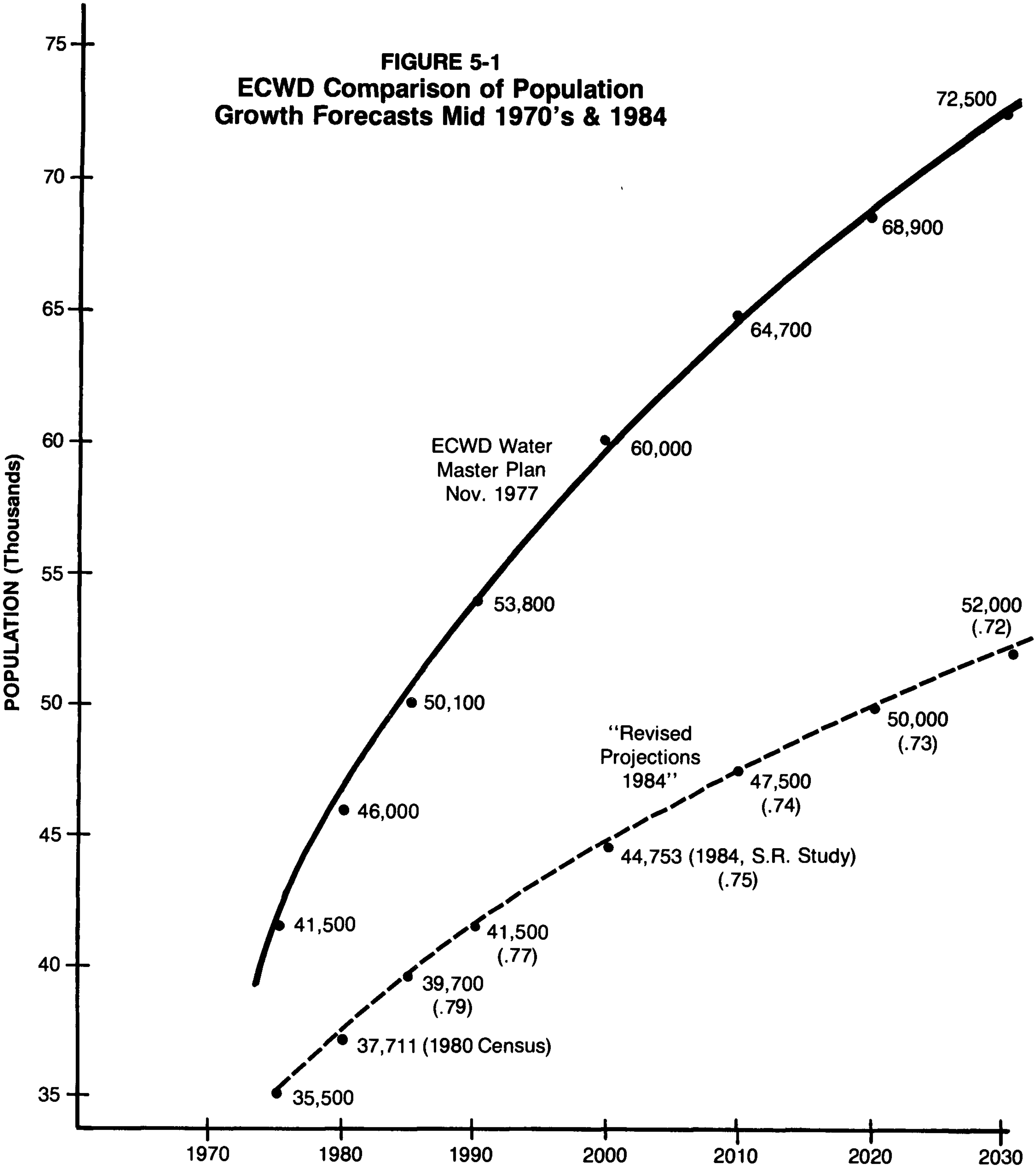


FIGURE 5-1
ECWD Comparison of Population Growth Forecasts Mid 1970's & 1984

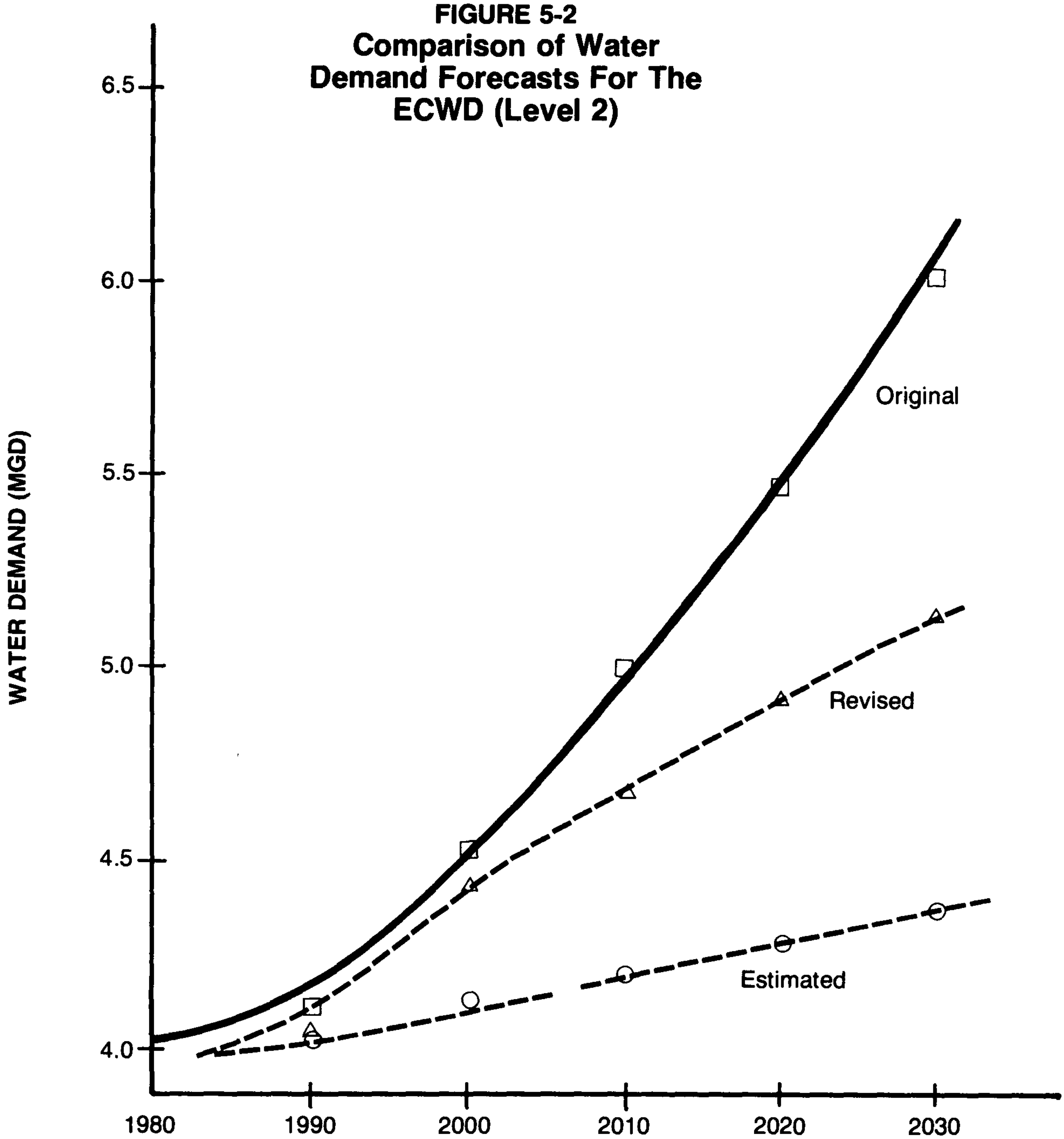


FIGURE 5-2
Comparison of Water
Demand Forecasts For The
ECWD (Level 2)
WATER DEMAND (MGD)
6.5
6.0
5.5
5.0
4.5
4.0
1980
1990
2000
2010
2020
2030
Original
Revised
Estimated

TABLE 5-27
AVERAGE ANNUAL WATER DEMAND PROJECTIONS (MGD)

	ORIGINAL FORECAST	REVISED FORECAST[1]	ESTIMATE OF WATER DEMAND[2]
1980	4.039	4.039 (.00)	4.039 (.00)
1990	4.128	4.089 (.01)	4.089 (.00)
2000	4.541	4.416 (.03)	4.120 (.07)
2010	4.995	4.681 (.07)	4.200 (.11)
2020	5.495	4.915 (.11)	4.280 (.13)
2030	6.044	5.112 (.16)	4.350 (.15)

[1] Percent variation from original.
[2] Percent variation from revised forecast.

The "revised forecast" is consistent with current 1980 water use and declines as a percentage of the original forecast to 84 percent, nearly 1 mgd less than the original forecast by the year 2030.

By using curve fitting interpolation between 1980 census-based water demand (actual use) and the projected year 2030 estimated use (based on comparison of "original" and "revised" population forecasts from Figure 5-1 for the ECWD area, ie., [.72] * [6.044 mgd] = 4,350 mgd), an "estimate" of water demand was prepared.

The estimate closely resembles the "revised forecast" for the initial years with a maximum variation of 15 percent by the year 2030, as shown in Figure 5-2. This approach can produce acceptable results if the water demands are correlated closely with population. Improved results could be achieved by projecting only SFR and MFR water use with this technique and using other similar techniques for the other water use sectors.

Substep 6.2 Determine Fraction of Water Use Reductions

The data on the fractional reduction to be achieved by each of the water conservation measures in the ECWD has been obtained from the use of reported literature within the same geographical and climatological region (northeastern and mid-eastern U.S.) and from contacts with appropriate water resource agencies, basin commissions, and universities within that region. These sources have provided the base material which was used to subsequently determine conservation reduction fractions in analyzing the ECWD.

As with the Level I, WMWD analysis, the individual studies used as data sources for fractional reduction, must be evaluated and prioritized by the analyst as to the degree of emphasis to be placed on them. This priority must emphasize actual implementation over laboratory studies, with and without measure comparisons over before and after comparisons, etc. Thus, the utilized fractional reduction for each measure is generally not a straight average of the data sources available, but, instead is more reflective of the most preferable data sources. In this analysis, in order to appropriately use the effectiveness calculations (as with the Level I WMWD analysis), all data were converted to the common basis of percent reduction achieved within an individual water use category.

Three regional sources, including one from a river basin commission, were utilized for determining the fractional reduction for pressure toilets, and are shown in Table 5-28. Similarly, regional fractional reduction values reported for toilet dams, low-flow showerheads, and faucet aerators are provided in Tables 5-29, 5-30 and 5-31. These sources include literature studies, state and other water resource agencies, and university reports. Each of these studies was evaluated for its accuracy and appropriateness to the ECWD and a fractional reduction was determined for each measure. The reduction factor derived for each measure and used in the effectiveness evaluation is also indicated in each Table.

TABLE 5-28
REDUCTION VALUES FOR PRESSURE TOILETS

SOURCE	REDUCTION
New England River Basin Commission (38)	0.36
Bailey, et al., (21)	0.375
Feldmann (27)	0.36

Reduction Factor = 0.366

TABLE 5-29
REDUCTION VALUES FOR TOILET DAMS

SOURCE	REDUCTION
McGhee, et al., (49)	0.16
Powell (50)	0.20
Lewanowicz (Hamilton, NJ) (51)	0.154
Sharpe (36)	0.12
Borchert (Elmhurst, IL) (52)	0.09

Reduction Factor = 0.138

TABLE 5-30
REDUCTION VALUES FOR LOW-FLOW SHOWERHEADS

SOURCE	REDUCTION
Cohen and Wallman (53)	0.01
Bishop (Washington Suburban) (23)	0.12
Wentz (54)	0.143
Baker (55)	0.26
Sharpe (56, 57, 58)	0.145

Reduction Factor = 0.146

TABLE 5-31
REDUCTION VALUES FOR FAUCET AERATORS

SOURCE	REDUCTION
Baker, et al., (55)	Ø.Ø2
Bailey, et al., (21)	Ø.ØØ83
Sheldon (59)	Ø.Ø1
Stone (28)	Ø.ØØ83
Illinois Task Force (31)	Ø.Ø2
G.A.O. (6Ø)	Ø.Ø1

Reduction Factor = Ø.Ø126

No additional data on building codes has been obtained other than those utilized for the conservation ordinance measure in the Level I WMWD analysis. Thus, the same fractional reduction of Ø.136 is used for the ECWD.

Despite the relative ease and popularity of using dye pills for detecting and repairing toilet leaks, very little data are available which isolate this measure from interactions with other conservation measures. In all the actual cases reviewed, toilet leak repair was implemented in conjunction with another measure(s), (ie., shower flow restrictors and a displacement device in a water conservation kit). Thus, the reduction factor for this measure is based on subjective analysis of its use in combination with other measures and has been assumed to be Ø.14 of interior residential use.

The impact of restricted water use programs are realized in industrial, commercial, public, and exterior water use categories. Of the two studies identified with reduction data for this measure, one, Pawtuckett, RI, (61) included all four of these categories while the other, (38) in Stamford, CT, did not include industrial restrictions. The first reported fractional reductions of Ø.17 while the latter reported reductions of Ø.125 in its three categories. Because the former is closer to the type of program considered for the ECWD, a reduction factor of Ø.157 was used.

Because the reduction due to rationing is dependent upon the specific goal and level of enforcement established by a community, literature reports are valuable only to show that a goal is, in fact, achievable. Studies have indicated that western communities have frequently been able to achieve or exceed goals of between 1Ø and 35 percent reduction. Eastern communities have more frequently failed to achieve rationing goals, although there are fewer examples upon which to base this. However, the ECWD has previously had to implement a rationing program and was, in fact, able to achieve a 2Ø-22 percent reduction. Based on this past achievement, it is assumed that a fractional reduction of Ø.21 would be obtained in the future by implementing a rationing program.

Substep 6.3 Determine Coverage

Local implementation conditions were evaluated to determine the likely response of the ECWD and its customers to the implementation of the conservation program. The social acceptability study results (Step 4) and the ECWD data from the previously implemented pilot conservation program allowed evaluation of the level of effort, commitment, social and technical acceptability of specific measures. These results could then be compared to other reported studies in the same geographic region, as reported in the literature. ECWD officials were interviewed to determine how they would conduct the conservation program and what results they would expect to obtain.

Based upon these discussions and the social acceptability analysis, it was determined that the ECWD is prepared to implement a maximum effort in the new conservation measures being implemented and to step up the previous modest program in retrofitting water conserving devices in existing buildings. Maximum effort would be anticipated in implementing either of the two contingency measures of restricted water use or rationing during a temporary water emergency.

The initial coverage factor used in the effectiveness calculations is assumed equal to the fraction of water users in a customer class (water use sector) who are actually impacted by the implementation of a measure. For the building code enforcement (Measure 1), the initial coverage is zero since the measure only impacts new buildings or new construction. The coverage of the remainder of the permanent conservation measures reflects the fraction of water users in each category who are expected to actually install the water-saving fixtures or use the toilet leak detection tablets and correct any detected leaks. The mandatory restricted use and rationing measures apply to all users within an impacted water use category.

The Corps of Engineers Report, Algorithm For Determining The Effectiveness Of Water Conservation Measures, (9) provides suggested initial coverage values which can be considered appropriate for modest, moderate, and maximum conservation programs. These values were selected based upon experience in recent and on-going conservation programs and are regarded as appropriate for a Level 2 analysis. Maximum coverage values from this source were utilized for the conservation measures of pressure toilets (Measure 2), toilet leak detection (Measure 3), restricted uses, and rationing (Measure 5). Moderate values were used for the extension of the pilot retrofit program (Measure 4). These initial coverage factors are provided in Table 5-32.

TABLE 5-32
INITIAL COVERAGE VALUES (ECWD)

CONSERVATION MEASURE	INTERIOR RESIDENTIAL	EXTERIOR RESIDENTIAL	COMMERCIAL	INDUSTRIAL	PUB/INST.
Pressure Toilets	.05	-	.05	-	.05
Toilet Dams	.50	-	.50	-	.50
Low-Flow Showerheads	.40	-	-	-	.20
Faucet Aerators	.50	-	.50	-	.50
Toilet Leak Detection	.10	-	.10	-	.10
Restricted Uses	-	1.00	1.00	1.00	1.00
Rationing	1.00	1.00	1.00	1.00	1.00

As previously described in Chapters 3 and 4, coverage for many conservation measures changes with time. For the measures considered in the ECWD, several can expect to have such changes. Retrofitted water-saving devices may cease to function or be replaced by the individual user. After an initial effort in distributing toilet detection tablets and correcting leaks, it is expected that many newly-developing leaks will occur and not be detected. The coverage due to enforcing the building codes will increase as the proportion of buildings in compliance with its conservation provisions increases. However, the pressure toilets, and low-flow showerheads installed as permanent fixtures, as part of Measure 1 (Building Code Enforcement) or Measure 2 (Pressure Toilets), are not expected to show any change in coverage with time. Similarly, the two contingency measures, (implemented only during a temporary emergency and not expected to remain in effect for extended periods of time), are not expected to experience reduced coverage over the period in which they are implemented.

Change in coverage is determined as the annual variation from initial coverage and is used to modify each year's effectiveness based on annual change in coverage from the previous year. The annual ratio of change used for those conservation measures identified above as varying with time were 0.9 for the retrofitted toilet dams and aerators and for toilet leak detection (representing 10 percent reduction in coverage annually from the previous year). The increase of coverage due to the building code enforcement reflects the annual rate of new construction. For the ECWD, this is considered equal to the annual rate of increase in population (0.6 percent for the low use projections, 1.9 percent for the medium use projections, and 1.4 percent for the high use projections). From these annual rates of change, changes in coverage values were computed for every year for which results were examined (see Chapter 4, Level 1 Substep 6.4 for example calculations). An example of the 1985 coverage values used are provided in Table 5-33.

TABLE 5-33
1985 COVERAGE VALUES (ECWD)

CONSERVATION MEASURE	INTERIOR RESIDENTIAL	EXTERIOR RESIDENTIAL	COMMERCIAL	INDUSTRIAL	PUB/INST.
Pressure Toilets	.050	-	.05	-	.050
Toilet Dams	.328	-	.328	-	.328
Low-Flow ShowerHeads	.400	-	-	-	.400
Faucet Aerators	.328	-	.328	-	.328
Toilet Leak Detection	.066	-	.066	-	.066
Conservation Ordinance	.073	-	.073	.073	.073
Restricted Uses	1.000	1.000	1.000	1.000	1.000
Rationing	1.000	1.000	1.000	1.000	1.000

Substep 6.4 Analysis of Effectiveness for the ECWD Area

Based on the disaggregated demand forecast, the fractional reduction, the initial coverage and the changes in coverage with time, the effectiveness of the ECWD water conservation program is estimated. The effectiveness equation (see

Appendix B) is used in this analysis. An examination of previous literature does not indicate the potential for interactions between any of the measures as they are being applied in the ECWD. The results for the ECWD for the low, medium, and high use projections for the permanent conservation measures are given in Tables 5-34, 5-35 and 5-36, respectively. When the restricted water uses contingency measure is applied, the expected results are illustrated in Tables 5-37, 5-38 and 5-39. Similarly, the combined impact of the permanent conservation measures and a temporary rationing program are shown in Tables 5-40, 5-41 and 5-42.

A typical example of the effectiveness determination is provided for the effectiveness calculation for the interior residential water use for all six permanent measures in 1985. Since there are no interactions between these measures, the total effectiveness is the sum of the products of unrestricted water use times the fractional reduction times the coverage in 1985 for all six measures. The interior residential unrestricted water use in 1985 is 2.593 mgd (an interpolated value from Table 5-25). The fractional reductions for each measure were determined and described in Substep 6.2, and the coverages for 1985 were shown in Table 5-33. Using these values, the effectiveness for 1985 (the medium projection) of 0.377 mgd (Table 5-35) was calculated as follows:

Effectiveness (Interior Residential 1985) =

$\sum Q * R * I$ for six measures (pressure toilets, toilet dams, low-flow showerheads, faucet aerators, toilet leak detection, building codes)

$$= (2.593)(0.366)(0.05) + (2.593)(0.138)(0.328) + (2.593)(0.146)(0.40) + (2.593)(0.0126)(0.328) + (2.593)(0.14)(0.066) + (2.593)(0.136)(0.073)$$

$$= 0.377 \text{ mgd}$$

All other effectiveness calculations in Tables 5-34 through 5-42 were calculated in the same manner.

The results of the analysis for the ECWD water conservation program (medium projection examples, Tables 5-35 [permanent measures], 5-38 [restricted uses plus permanent measures] and 5-41 [ration plus permanent measures]) indicate that water conservation as a long-term approach for the community can achieve about a 10 percent water use reduction (with the residential water customer class accounting for nearly 90 percent of the conservation). The effectiveness declines slightly between 1980 and 1990 and then increases through 2030. This happens because of the interaction between the effectiveness of the existing program and the new measures that are slowly introduced at first and later more rapidly as a a result of future growth and new construction. Similar, although slightly smaller percent reductions are possible for peak day use.

For drought emergencies (Table 5-38), the analysis indicates that added restricted water uses can contribute an additional 3-6 percent reduction in water use with percent reductions ranging from 14.2 to 16.8 percent for the study period. Peak daily water use would be reduced between 14.0 and 16.1 percent.

In Table 5-41, rationing and the long-term water conservation measures are combined. For severe emergencies, rationing is shown to be a very effective method for reducing water use. Average daily flows can be reduced by about 30 percent and peak daily use by a similar degree.

As in the other level studies, the sensitivity of the analysis to variations in the level of water demand (high, medium and low projections) indicates that the quantity of water conserved increases as the water projection increases, and the percent reduction are consistent with the medium projection results.

TABLE 5-34
EFFECTIVENESS OF CONSERVATION FOR ECWD
LOW WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	0.401	0.341	0.299	0.291	0.289	0.316	0.361	0.417
Ext. Residential	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commercial	0.050	0.038	0.029	0.026	0.024	0.026	0.031	0.038
Industrial	0.0	0.001	0.003	0.004	0.006	0.010	0.014	0.019
Pub/Inst.	0.006	0.005	0.004	0.004	0.004	0.004	0.005	0.005
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.457	0.385	0.335	0.325	0.323	0.356	0.411	0.479
PERCENT	11.3	9.6	8.2	7.4	7.1	7.1	7.5	7.9

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	0.811	0.684	0.592	0.577	0.568	0.618	0.690	0.789
Ext. Residential	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commercial	0.093	0.069	0.052	0.045	0.041	0.042	0.047	0.055
Industrial	0.0	0.002	0.005	0.008	0.011	0.016	0.022	0.028
Pub/Inst.	0.005	0.004	0.003	0.003	0.002	0.002	0.002	0.003
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.909	0.759	0.652	0.632	0.622	0.678	0.761	0.875
PERCENT	10.4	8.7	7.5	6.8	6.5	6.6	6.8	7.2

TABLE 5-35
EFFECTIVENESS OF CONSERVATION FOR ECWD
MEDIUM WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	0.406	0.377	0.369	0.402	0.436	0.517	0.619	0.671
Ext. Residential	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Commercial	0.050	0.043	0.040	0.042	0.046	0.057	0.072	0.089
Industrial	0.0	0.004	0.009	0.015	0.021	0.032	0.044	0.057
Pub/Inst.	0.006	0.005	0.005	0.005	0.006	0.007	0.009	0.011
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.462	0.429	0.423	0.464	0.509	0.613	0.743	0.827
PERCENT	11.3	10.0	9.3	9.1	9.3	10.1	11.0	11.7

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	0.820	0.754	0.731	0.795	0.858	1.011	1.118	1.389
Ext. Residential	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commercial	0.094	0.079	0.071	0.073	0.078	0.092	0.109	0.129
Industrial	0.0	0.007	0.016	0.026	0.035	0.052	0.067	0.083
Pub/Inst.	0.005	0.004	0.004	0.004	0.004	0.004	0.005	0.005
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.919	0.844	0.822	0.897	0.975	1.159	1.363	1.607
PERCENT	10.4	9.2	8.5	8.3	8.5	9.2	10.0	10.7

TABLE 5-36
EFFECTIVENESS OF CONSERVATION FOR ECWD
HIGH WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	0.408	0.382	0.375	0.408	0.444	0.536	0.650	0.785
Ext. Residential	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commercial	0.051	0.046	0.044	0.041	0.045	0.056	0.071	0.090
Industrial	0.0	0.003	0.008	0.013	0.018	0.029	0.042	0.056
Pub/Inst.	0.006	0.006	0.006	0.006	0.006	0.007	0.009	0.011
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.466	0.437	0.432	0.468	0.514	0.628	0.772	0.942
PERCENT	11.3	9.8	8.8	8.5	8.5	9.1	9.9	10.7

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	0.826	0.766	0.747	0.809	0.876	1.050	1.244	1.487
Ext. Residential	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commercial	0.096	0.084	0.079	0.072	0.077	0.090	0.109	0.132
Industrial	0.0	0.006	0.014	0.022	0.031	0.048	0.064	0.082
Pub/Inst.	0.005	0.004	0.004	0.004	0.004	0.004	0.005	0.006
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.927	0.861	0.844	0.907	0.988	1.192	1.421	1.707
PERCENT	10.4	9.0	8.1	7.8	7.8	8.3	9.0	9.7

TABLE 5-37
EFFECTIVENESS OF CONSERVATION FOR ECWD
LOW WATER USE CASE
(RESTRICTED USES PLUS PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	0.401	0.299	0.289	0.316	0.417
Ext. Residential	0.054	0.057	0.063	0.069	0.083
Commercial	0.122	0.106	0.108	0.118	0.150
Industrial	0.057	0.063	0.072	0.083	0.107
Pub/Inst.	0.012	0.011	0.011	0.012	0.016
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	0.647	0.535	0.543	0.598	0.772
PERCENT	16.0	13.0	12.0	12.0	12.8

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	0.811	0.592	0.568	0.618	0.789
Ext. Residential	0.219	0.238	0.260	0.285	0.354
Commercial	0.228	0.189	0.184	0.191	0.218
Industrial	0.107	0.112	0.123	0.134	0.156
Pub/Inst.	0.011	0.007	0.007	0.007	0.008
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	1.376	1.138	1.143	1.235	1.524
PERCENT	15.7	13.0	12.0	12.0	12.6

TABLE 5-38
EFFECTIVENESS OF CONSERVATION FOR ECWD
MEDIUM WATER USE CASE
(RESTRICTED USES PLUS PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	0.406	0.369	0.436	0.517	0.671
Ext. Residential	0.055	0.063	0.075	0.084	0.103
Commercial	0.123	0.124	0.147	0.169	0.227
Industrial	0.058	0.075	0.100	0.121	0.166
Pub/Inst.	0.013	0.013	0.015	0.018	0.023
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	0.654	0.644	0.774	0.907	1.190
PERCENT	16.0	14.2	14.2	15.0	16.8

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	0.820	0.731	0.858	1.011	1.389
Ext. Residential	0.222	0.262	0.313	0.346	0.437
Commercial	0.230	0.222	0.251	0.273	0.330
Industrial	0.108	0.135	0.171	0.195	0.241
Pub/Inst.	0.011	0.009	0.010	0.010	0.012
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	1.390	1.359	1.603	1.835	2.410
PERCENT	15.7	14.1	14.0	14.6	16.1

TABLE 5-39
EFFECTIVENESS OF CONSERVATION FOR ECWD
HIGH WATER USE CASE
(RESTRICTED USES PLUS PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	0.408	0.375	0.444	0.536	0.653
Ext. Residential	0.055	0.065	0.080	0.092	0.105
Commercial	0.126	0.143	0.159	0.185	0.218
Industrial	0.059	0.086	0.108	0.131	0.157
Pub/Inst.	0.013	0.015	0.017	0.019	0.022
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	0.661	0.684	0.808	0.963	1.155
PERCENT	16.0	13.9	13.4	14.0	14.7

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	0.826	0.747	0.876	1.050	1.245
Ext. Residential	0.223	0.273	0.337	0.386	0.448
Commercial	0.235	0.257	0.273	0.300	0.328
Industrial	0.110	0.155	0.186	0.213	0.237
Pub/Inst.	0.011	0.011	0.010	0.011	0.012
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	1.404	1.444	1.682	1.962	2.269
PERCENT	15.7	13.8	13.3	13.7	14.3

TABLE 5-40
EFFECTIVENESS OF CONSERVATION FOR ECWD
LOW WATER USE CASE
(RATIONING PLUS PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	0.909	0.829	0.875	0.962	1.200
Ext. Residential	0.072	0.076	0.084	0.092	0.112
Commercial	0.145	0.131	0.136	0.149	0.187
Industrial	0.076	0.083	0.095	0.107	0.137
Pub/Inst.	0.015	0.013	0.014	0.015	0.019
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	1.218	1.133	1.204	1.326	1.654
PERCENT	30.1	27.6	26.6	26.6	27.4

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	1.835	1.641	1.721	1.882	2.271
Ext. Residential	0.293	0.318	0.348	0.382	0.473
Commercial	0.274	0.235	0.233	0.241	0.273
Industrial	0.143	0.149	0.161	0.174	0.2000
Pub/Inst.	0.013	0.009	0.009	0.009	0.010
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	2.558	2.351	2.472	2.687	3.226
PERCENT	29.2	26.9	26.0	26.0	26.7

TABLE 5-41
EFFECTIVENESS OF CONSERVATION FOR ECWD
MEDIUM WATER USE CASE
(RATIONING PLUS PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	0.918	0.954	1.142	1.302	1.557
Ext. Residential	0.073	0.084	0.101	0.112	0.138
Commercial	0.148	0.152	0.181	0.207	0.273
Industrial	0.077	0.098	0.127	0.150	0.203
Pub/Inst.	0.015	0.015	0.018	0.021	0.028
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	1.231	1.303	1.570	1.792	2.198
PERCENT	30.1	28.8	28.8	29.5	31.0

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	1.856	1.889	2.247	2.547	3.223
Ext. Residential	0.296	0.351	0.419	0.463	0.585
Commercial	0.276	0.273	0.309	0.334	0.398
Industrial	0.144	0.175	0.217	0.243	0.295
Pub/Inst.	0.013	0.011	0.011	0.012	0.014
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	2.585	2.698	3.203	3.600	4.515
PERCENT	29.2	28.0	27.9	28.7	30.2

TABLE 5-42
EFFECTIVENESS OF CONSERVATION FOR ECWD
HIGH WATER USE CASE
(RATIONING PLUS PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	0.924	0.993	1.219	1.430	1.927
Ext. Residential	0.073	0.087	0.107	0.123	0.158
Commercial	0.151	0.177	0.198	0.228	0.311
Industrial	0.079	0.113	0.138	0.165	0.230
Pub/Inst.	0.015	0.018	0.020	0.023	0.031
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	1.243	1.387	1.683	1.970	2.656
PERCENT	30.1	28.2	28.0	28.6	31.0

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	1.869	1.978	2.404	2.799	3.650
Ext. Residential	0.298	0.366	0.451	0.517	0.676
Commercial	0.282	0.318	0.340	0.371	0.456
Industrial	0.147	0.203	0.238	0.269	0.337
Pub/Inst.	0.013	0.013	0.012	0.013	0.016
Unacc. For	0.0	0.0	0.0	0.0	0.0
TOTAL	2.609	2.877	3.444	3.969	5.134
PERCENT	29.2	27.5	27.6	27.8	29.1

Tables 5-43 and 5-44 summarize the future water demand projections for the ECWD area with medium and high growth scenarios, respectively. The medium growth projection indicates that average water demand increases by 55 percent by 2030 with the permanent conservation measures as compared to 75 percent growth without conservation. Peak growth likewise is reduced from a growth of 70 percent to 52 percent when permanent conservation measures are used. Table 5-45 summarizes the effect of permanent water conservation measures and rationing as a contingency (the most significant reduction that can be achieved with the conservation measures under consideration).

TABLE 5-43
ECWD PROJECTED WATER DEMAND WITH PERMANENT CONSERVATION
MEDIUM POPULATION GROWTH CASE

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1981	1990	2000	2010	2020	2030
Int. Residential	2.403	1.997	2.442	2.938	3.227	3.537	3.547
Ext. Residential	0.342	0.342	0.400	0.480	0.533	0.592	0.656
Commercial	0.458	0.408	0.496	0.597	0.657	0.721	0.791
Industrial	0.361	0.361	0.413	0.486	0.531	0.581	0.637
Pub/Inst.	0.042	0.036	0.044	0.053	0.059	0.064	0.070
Unacc. For	0.433	0.433	0.338	0.405	0.450	0.499	0.554
TOTAL	4.039	3.577	4.133	4.959	5.457	5.994	6.255

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1981	1990	2000	2010	2020	2030
Int. Residential	4.869	4.049	4.782	5.756	6.305	6.828	7.342
Ext. Residential	1.382	1.382	1.671	1.995	2.207	2.528	2.786
Commercial	0.860	0.766	0.889	1.021	1.062	1.093	1.152
Industrial	0.678	0.678	0.739	0.831	0.858	0.881	0.927
Pub/Inst.	0.037	0.032	0.031	0.033	0.034	0.033	0.036
Unacc. For	0.938	0.938	0.718	0.850	0.930	1.012	1.107
TOTAL	8.764	7.845	8.830	10.486	11.396	12.375	13.350

Based on comparison of Tables 5-25 and 5-35.

TABLE 5-44
ECWD PROJECTED WATER DEMAND WITH PERMANENT CONSERVATION
HIGH POPULATION GROWTH CASE

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1981	1990	2000	2010	2020	2030
Int. Residential	2.403	1.995	2.569	3.247	3.719	4.161	4.653
Ext. Residential	0.342	0.342	0.412	0.511	0.587	0.663	0.750
Commercial	0.458	0.407	0.589	0.682	0.766	0.858	0.959
Industrial	0.361	0.361	0.491	0.555	0.619	0.690	0.772
Pub/Inst.	0.042	0.036	0.052	0.061	0.068	0.076	0.085
Unacc. For	0.433	0.433	0.366	0.477	0.511	0.578	0.653
TOTAL	4.039	3.574	4.479	5.533	6.270	7.026	7.872

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1981	1990	2000	2010	2020	2030
Int. Residential	4.869	4.461	5.116	6.401	7.794	8.557	9.444
Ext. Residential	1.382	1.382	1.742	2.146	2.460	2.869	3.220
Commercial	0.860	.809	1.095	1.204	1.279	1.347	1.449
Industrial	0.678	.678	.890	.966	1.025	1.077	1.158
Pub/Inst.	0.037	.031	.035	.035	.036	.037	.038
Unacc. For	0.938	.938	.778	.937	1.057	1.172	1.304
TOTAL	8.764	8.299	9.656	11.689	13.651	15.059	16.613

Based on comparison of Tables 5-26 and 5-36.

TABLE 5-45
ECWD PROJECTED WATER DEMAND WITH PERMANENT MEASURES AND RATIONING
MEDIUM POPULATION GROWTH CASE

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	1.485	1.857	2.232	2.442	2.661
Ext. Residential	.269	.316	.379	.421	.518
Commercial	.310	.384	.462	.507	.607
Industrial	.284	.324	.380	.413	.491
Pub/Inst.	.027	.034	.041	.045	.053
Unacc. For	.433	.338	.405	.450	.554
TOTAL	2.808	3.253	3.899	4.278	4.884

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1990	2000	2010	2030
Int. Residential	3.951	3.624	4.367	4.769	5.508
Ext. Residential	1.086	1.320	1.576	1.744	2.201
Commercial	.584	.687	.790	.820	.883
Industrial	.534	.580	.649	.667	.715
Pub/Inst.	.024	.024	.026	.026	.027
Unacc. For	.938	.718	.850	.930	1.107
TOTAL	7.117	6.953	8.258	8.956	10.441

Based on comparison of Tables 5-25 and 5-41.

Table 5-46 indicates projected peak daily water demands unrestricted (Table 5-25) and the results with permanent conservation and restrictions (Table 5-38) and with rationing (Table 5-41).

TABLE 5-46
PROJECTED POTENTIAL DEMAND WITH PERMANENT CONSERVATION
MEASURES AND RESTRICTIONS OR RATIONING

PEAK DAILY USE (MGD)

	1980	1981	1990	2000	2010	2030
Unrestricted	8.764	8.764	9.652	11.461	12.555	14.956
Restrictions	-	7.374	8.293	9.858	10.720	12.546
Rationing	-	6.179	6.954	8.258	8.955	10.441

STEP 7: Advantageous Effects (Indirect)

The following section provides a brief overview of the effectiveness of the water conservation program as it affects the future balance between available water supply and projected water demand. Then, the Step 7 analysis focuses on the indirect advantageous effects of each water conservation measure to residential multi-family, commercial, industrial and public/institutional water users. These impacts are frequently reduced costs indirectly related to water use reduction (ie., decreased energy use as a result of conservation of hot water in shower use and savings on water bills). The cost savings to the ECWD water supply program and as a result of reduced wastewater flows to the regional wastewater authority are addressed in Step 9: Foregone Supply Costs.

Description of Conservation Measures

Measure 1: (M1-Building Code Enforcement) requiring the installation of water-saving toilets (less than 3.5 gallons per flush) and showerheads and faucets (less than 3.0 gallons per minute) to users:

- residential
- commercial
- industrial
- public/institutional

The program begins in the base year (1980) and gradually produces results as new growth progressively adds additional conservation fixtures to the service area. The ordinance, (currently applicable as a state requirement) when properly enforced at the local level, affects all new construction. The indirect effects of water conservation are significant primarily to the residential single family and multi-family residential customers from reduction in hot water use.

Measure 2: (M2-Pressure Toilets) provide an option for water conservation in new construction by using one gallon or less per flush. The units are highly effective and use compressed air to achieve satisfactory performance for users:

- residential
- commercial
- public/institutional

Pressure toilets can be used in either new construction or retrofits, although the predominant application is new residential construction.

Two methods of implementation are considered:

Option 1: Voluntary installation
Option 2: With the Measure 1 requirements (in special cases)

There are minor indirect effects from Measure 2.

Measure 3: (M3-Toilet Leak Detection) provides an opportunity for reducing household water leakage. Dye tablets or food coloring are used to identify leaky toilets. The effect is to reduce losses for existing customers:

- residential
- commercial
- public use

There are minor indirect effects from Measure 3.

Measure 4: (M4-Extension Retrofit) offers an intensive effort of the previous Pilot and Phase I projects to install toilet dams, low-flow showerheads, and faucet aerators in existing structures:

- o interior residential
- o commercial
- o public use

Indirect effects are identified as a result of the Measure 4 implementation, primarily from household energy use reduction from hot water conservation (low-flow showerheads).

Measure 5: (M5-Contingency) for drought emergency and severe emergency involves the use of mandatory restrictions and rationing, respectively. Although infrequently used, these measures significantly reduce water use for all customers, and have associated effects, including reductions in energy use. Mandatory restrictions and permanent conservation are expected to achieve between 14 and 17 percent reduction in average water use, and the rationing program with conservation reduces average water use by 28 to 31 percent.

Conservation Effects

Figure 5-3 graphically presents the current average daily water supply situation for the ECWD service area. Based on average daily demand (medium growth), the current available supplies of 5.8 mgd (current yield: 3.0 mgd allocation from the 2-2000 gpm wells and 2.8 mgd purchases from the City of N.B.) appear to be sufficient to the year 2005 and additional purchases (current agreement) are sufficient to the year 2030. With water conservation, the current 5.8 mgd supply appears sufficient to about 2015.

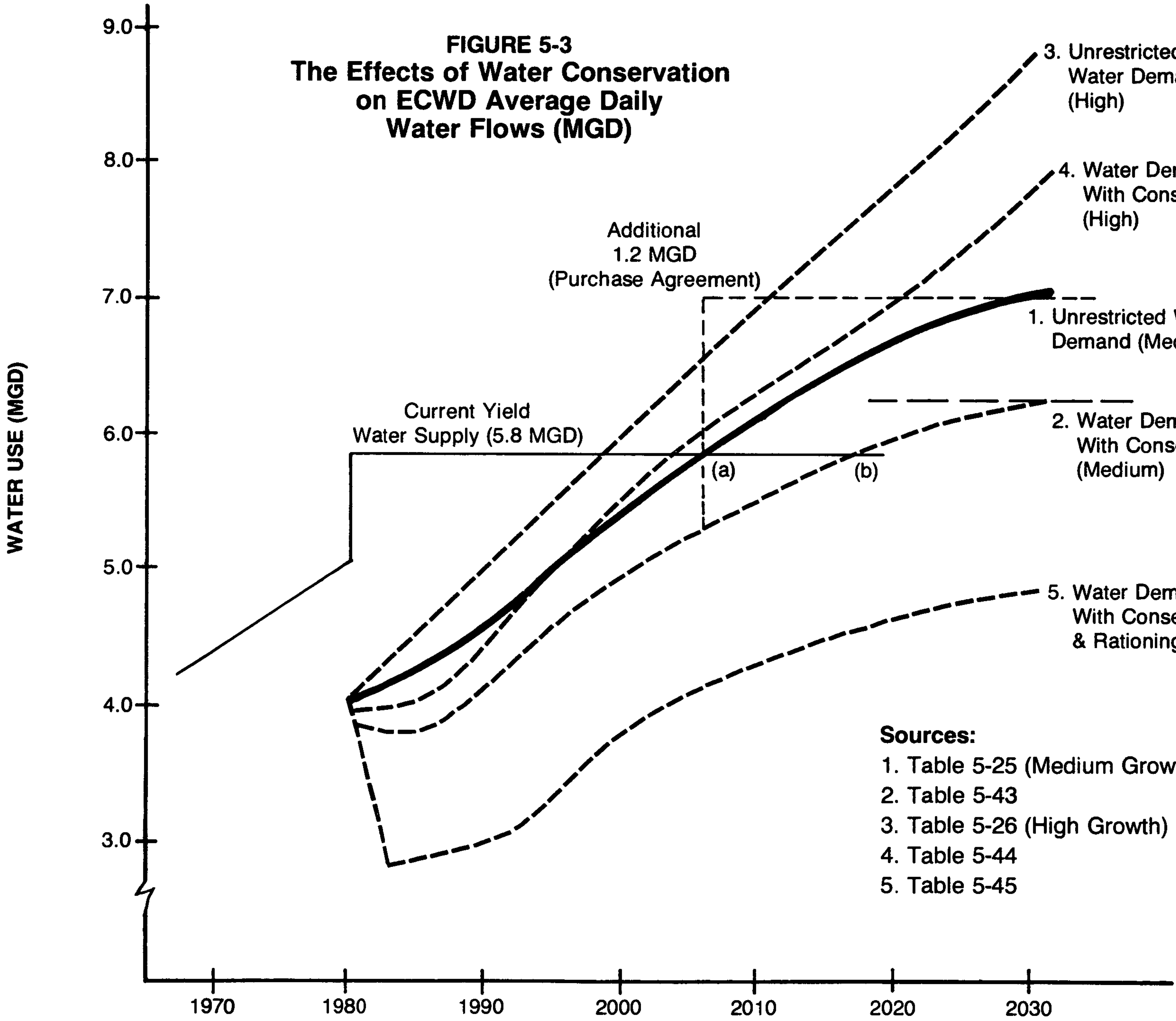
The ECWD system, however, frequently has exceeded the purchase agreement maximum day rates in the past to meet the growing demands of the community. Prior to 1983, the community was allowed to purchase 4.0 mgd at peak rates not to exceed 8.0 mgd. These maximum rates were exceeded an average of 26 days per year between 1972 and 1976 (Table 5-47).

TABLE 5-47
ECWD PEAK WATER USE EXCEEDENCE RATE

	NUMBER OF DAYS
1972	26
1973	26
1974	27
1975	9
1976	41
5-YR. TOTAL	129 (AVG. 26 DAYS/YEAR)

The current supplies (7.0 mgd) and internal storage (3.0 mg) of the ECWD system are insufficient to meet this need.

FIGURE 5-3
The Effects of Water Conservation on ECWD Average Daily Water Flows (MGD)



Sources:
1. Table 5-25 (Medium Growth)
2. Table 5-43
3. Table 5-26 (High Growth)
4. Table 5-44
5. Table 5-45

Figure 5-4 projects the Peak Daily Water Demand. The Peak Daily Unrestricted (1) projection is for medium growth. The effect of conservation on this projection is shown in (2) Peak Daily Flow with Conservation. It is apparent that the current 5.8 mgd supply and the additional purchases for a total supply yield of 7.0 mgd are insufficient. A consulting report concurs with the average day analysis and also with the need to provide additional purchases capability to meet the peak requirements. The other curves indicate the effect of high growth population projections on water demand (curves [3] and [4] with and without conservation) and the ability of restrictive measures and rationing to reduce demand (curves 5 and 6).

The consulting study indicated that peak daily demand would be 10.2 mgd in 1980 and increase to 15.0 mgd in 2000. The ECWD analysis indicates somewhat less peak demand, approximately 10 mgd in 1990 and nearly 11.5 mgd in 2000. By 2030, the ECWD demand is projected here to be about 15.0 mgd. The following deficits (Table 5-48) are projected based on an available yield of 7.0 mgd.

TABLE 5-48
ECWD SUPPLY DEFICITS (1980-2030)

YEAR	PEAK DAILY (MED) DEMAND (MGD)	CURRENT SOURCE (MGD)	DEFICIT (MGD)
1980	8.7	7.0	1.7
1990	9.6	7.0	2.6
2000	11.4	7.0	4.4
2010	12.5	7.0	5.5
2020	13.7	7.0	6.7
2030	15.0	7.0	8.0

The consulting report oriented to peak supply needs considered the following options:

(1) Expansion of the current groundwater source (not permitted by the state).
(2) Expansion of other marginal aquifer sources (Old Bridge Sands) (also, not likely to be permitted by the state).
(3) Purchases of additional N.B. community water supply (of which 4 mgd is already considered in the water supply yield estimate of 7 mgd for the ECWD); and additional 2 mgd may be available for purchase at $426.38/mg.
(4) Purchases of water from 2 other nearby large and moderate size water companies would be available at higher current costs:

4 mgd - "E-Town Water Co." $500.00/mg
2 mgd - "M-X Water Co." $600.00/mg

These sources would be available to supply the ECWD needs as indicated in Figure 5-4:

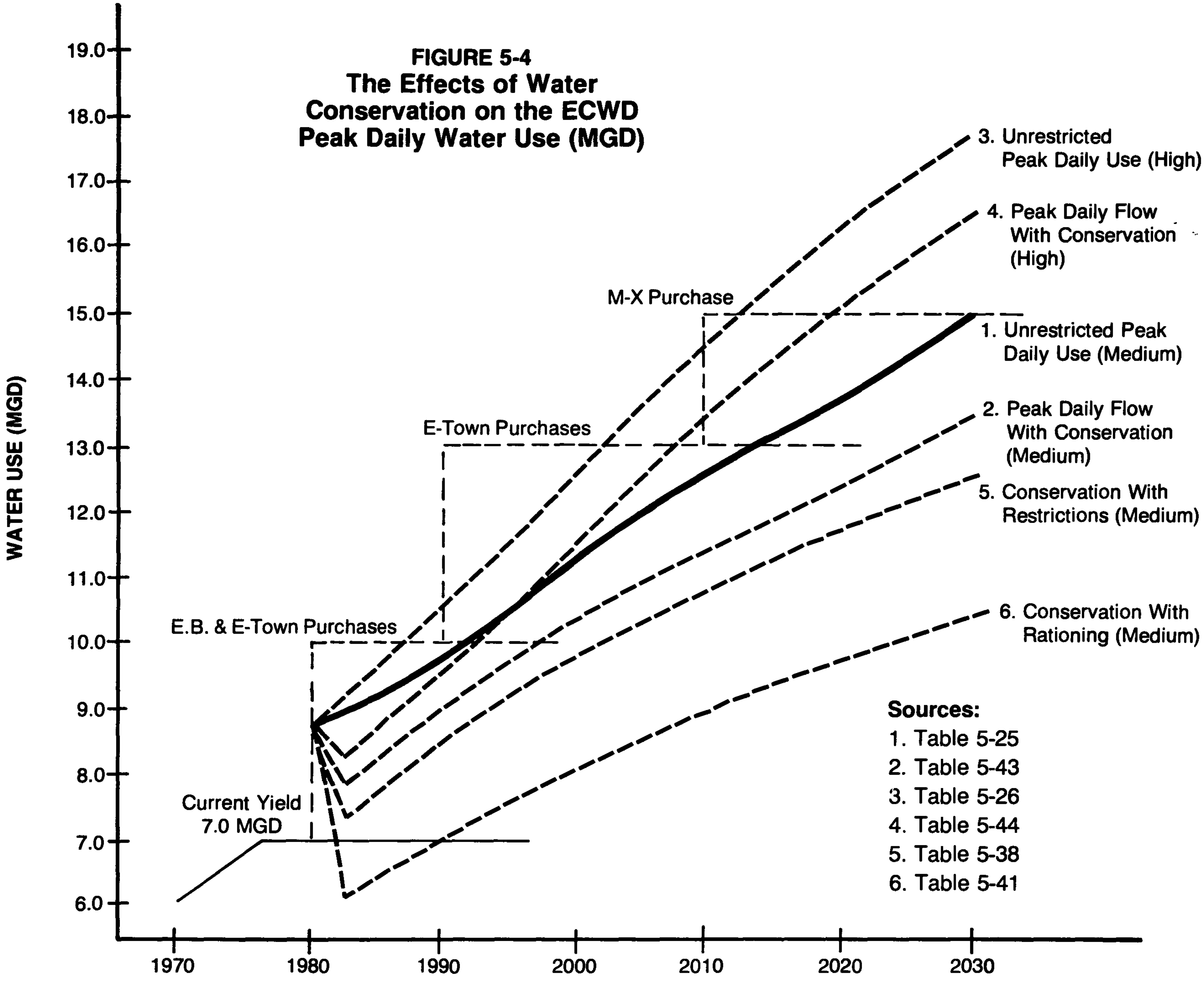


FIGURE 5-4
The Effects of Water Conservation on the ECWD Peak Daily Water Use (MGD)

TABLE 5-49
ECWD SUPPLY AUGMENTATION POSSIBILITIES

	SOURCE	INCREMENT (MGD)	ECWD YIELD (MGD)
1980:	E.B. Community Purchases	2	9
1980:	"E-Town" Purchases	1	10
1990:	"E-Town" Purchases	3	13
2010:	"M-X Water" Purchases	2	15

This water would not be required for purchase year-round, only to supplement the peak demand requirements, based on the average historic exceedence levels about 26 days per year. Delays in constructing the system to deliver this needed water can produce significant economic advantages to the ECWD. These delays can be achieved through water conservation, and the cost savings (Foregone Costs) are described in Step 9.

The FED-LAKE project provides another possible project for providing additional water to the ECWD. Water supply storage in FED-LAKE is 25,600 acre-feet (22.8 mgd). The project also includes flood control and recreation benefits. This potential reservoir is located upstream of the ECWD community and is designed to provide releases to the Mid-State River which can be withdrawn by the community. The project share for the ECWD is 7.0 mgd and will be available in 1990. The project is supported by state and regional officials; however, it is not without controversy, since it will impact historic and archaeological sites.

The Non-Federal share of the cost of the water supply component of this project is $3,720,000 with $48,000 annual operation and maintenance expense. If the investment cost is financed at 10 percent for 20 years ($437,100/yr.) and the operation and maintenance costs are added, the annual cost of the project to local water suppliers is $485,100 ($58.30/mg or $18.95/AF). The project offers significant cost advantages over the water purchase alternatives, and water conservation can also produce benefits by delaying future water demands.

Based on this background, the advantageous effects of water conservation and the analysis of subsequent Steps are presented.

Level 2: Advantageous Effects

In addition to the reduction in water demand, which results from implementation of water-saving measures, other advantageous effects are also produced for each measure considered. Table 5-50 summarizes these benefits for each measure.

TABLE 5-5Ø
ECWD ADVANTAGEOUS EFFECTS (INDIRECT)
PRESENT VALUE (198Ø $)

	MEASURE 1 Build. Code	MEASURE 2 Press. Toilets	MEASURE 3 Toil. Leak Det.	MEASURE 4 Ext. Retrofit	MEASURE 5 Contingency
ENERGY SAVINGS					
SFR (and equivalents)	$96Ø,ØØØ	-	-	$1,Ø78,ØØØ	$7Ø,ØØØ
UTILITY BILLS					
Water	Ø	$56,8ØØ	$43,5ØØ	377,7ØØ	Ø
Sewer	Ø	3,5ØØ	2,7ØØ	23,6ØØ	Ø
PEAK WATER USE REDUCTION	(Additional Sources Are Needed)				
TOTAL	$96Ø,ØØØ	$6Ø,3ØØ	$46,2ØØ	$1,479,3ØØ	$7Ø,ØØØ

Energy Savings: Table 5-51 indicates the incremental development trends for each sector (growth in new connections, based on Table 5-15). Table 5-51 indicates that the significant growth (92 percent) in the ECWD area is attributed to residential water use (SFR) customers. Multi-family users (MFR) would also experience reduced energy expenses as a result of conservation.

TABLE 5-51
ECWD INCREMENTAL GROWTH IN CONNECTIONS (NEW CONSTRUCTION)
MEDIUM GROWTH CASE

	198Ø	199Ø	2ØØØ	2Ø1Ø	2Ø2Ø	2Ø3Ø
SFR	Ø	1,6Ø2	2,2Ø6	1,456	1,616	1,793
MFR	Ø	1	1	1	1	1
COMM	Ø	125	172	114	127	139
IND.	Ø	12	17	12	12	14
NO CHARGE	Ø	9	11	8	8	1Ø

In Table 5-52, the number of single-family residential equivalents was added to the SFR connections to calculate the total energy savings based on $34.ØØ/year savings (adjusted rate based on discussion in Level 1 example Step 7). (Note: In Table 5-17, MFR is identified separately. In Table 5-25, MFR is combined with interior residential.) Based on Table 5-17, the additional SFR equivalents are determined as follows: MFR Average Daily Water Use (Table 5-18), divided by SFR per capita water consumption (115 gallons/day, 198Ø, Table 5-7), divided by 198Ø census household size (3.6 persons).

TABLE 5-52
MFR EXPRESSED AS SFR EQUIVALENT CONNECTIONS

	1980	1990	2000	2010	2020	2030
Total SFR Equiv.	436	741	964	1,108	1,252	1,415
Incremental Growth		305	223	144	144	163

TABLE 5-53
NEW GROWTH: SFR AND SFR EQUIVALENTS AND ENERGY SAVINGS

	1980	1990	2000	2010	2020	2030
SFR	0	1,602	3,808	5,264	6,880	8,673
SFR (Equivalent)	0	305	528	672	816	979
TOTAL	0	1,907	4,336	5,936	7,696	9,652
ENERGY SAVINGS @ $34/yr. per connect. (1980 $)	0	$64,800	$147,400	$201,800	$261,600	$328,100

Over the fifty-year planning period, these energy savings are discounted at the Federal rate 8.375 percent. The present value of the projected savings is $960,000.

Energy savings are also achieved by Measure 4. The extended program to retrofit existing customers with water conservation devices in particular with low-flow showerheads achieves a reduction in household energy use. Table 5-54 presents the change in coverage by user class for the water conservation measures under consideration for the ECWD (users are expected to be either approximately equal in their use of water or to be randomly distributed with respect to implementation, as was assumed in Level 1).

Based on the assumption of $34.00/year annual 1980 savings and the percentage of customers using the low-flow showerheads (Table 5-54) which decreases from 50 percent in 1980 to 7 percent in 2000 and finally to 0, the existing single family residential (Table 5-15) and multi-family residential customers (expressed as SFR equivalents, as described previously, Table 5-52), experience savings in energy use. Table 5-55 identifies the number of SFR and equivalents of the existing 1980 customers that have reduced energy costs.

TABLE 5-54
ECWD CUSTOMERS USING WATER CONSERVATION MEASURES
(COVERAGE BY USER CLASS 1980-2030)

CONS. MEASURE	1980	1985	1990	2000	2010	2020	2030
M1: Building Code		(No Change)					
M2: New Const. Preserve Toilets (Int.Res, Comm, Pub/Inst.)	.05	.05	.05	.05	.05	.05	.05
M3: Exist. Const. Toilet Leak Det. (Int.Res, Comm, Pub/Inst.)	.10	.07	.04	.01	0.0	0.0	0.0
M4: Retrofit Toilet Dams							
Int. Resid.	.50	.33	.19	.07	.02	.01	0.0
Comm.	.40	.26	.15	.05	.02	.01	0.0
Pub/Inst.	.50	.33	.19	.07	.02	.01	0.0
Low-Flow Showerheads							
Int. Resid.	.50	.33	.19	.07	.02	.01	0.0
Comm.	-	-	-	-	-	-	-
Pub/Inst.	.50	.33	.19	.07	.02	.01	0.0
Faucet Aerators							
Int. Resid.	.50	.33	.19	.07	.02	.01	0.0
Comm.	.20	.13	.08	.03	.01	0.0	0.0
Pub/Inst.	.50	.33	.19	.07	.02	.01	0.0
M5: Contingency		(Varying Degrees)					

*Initial Coverage Table 5-32.

TABLE 5-55
HOUSEHOLD ENERGY SAVINGS FROM RETROFIT
SFR AND MFR SHOWERHEAD USE (SAVINGS 1980 $)

	1981	1985	1990	2000	2010	2020	2030
SFR	9,426						
MFR (Equiv.)	436						
TOTAL # (Equiv.)	9,862						
# Using Showerheads	4,931	3,254	1,874	690	197	99	0
ANNUAL ENERGY SAVINGS	$167,600	$110,600	$63,700	$23,400	$6,700	$3,400	0

The present value of these Measure 4 savings at 8-3/8 percent (Federal discount rate) is $1,078,000.

Occasionally, permanent water conservation measures will not be sufficient, and contingency restrictions and rationing are needed (Measure 5). Comparison of Tables 5-25 (unrestricted demand) and Tables 5-43 and 5-45 indicate that the proposed rationing program achieves an added 24-26 percent reduction in interior residential water over demand with permanent water conservation only. The effect could be an additional energy use reduction based on Table 5-55 (ie., 25 percent * $167,600 = $42,000 in 1981). Table 5-55 provides the future annual savings that would be increased by the effect of rationing. The present value of these savings depends on the probability of using the rationing program which is assumed to be one in five years (the region has experienced numerous drought warnings and emergencies over the past 20 years, and the frequency is increasing), with a drought duration of one year in each case. (Note: Water use restrictions, also considered in Measure 5, are implemented more frequently, however, do not affect interior residential water use and related energy savings.) The present value of the rationing program impact on energy savings is $70,000.

Effectiveness By Measure

Table 5-56 provides an estimated effectiveness of the permanent water conservation measures by year. This Table is used in some of the following analyses for determining the significance of each conservation measure in producing the annual total effectiveness in water use reduction, in this case, the water conservation effect on water and wastewater utility bills.

TABLE 5-56
LEVEL 2 ECWD
PERCENT EFFECTIVENESS WATER USE REDUCTION BY MEASURE

	MEASURE 1 Building Code	MEASURE 2 Pressure Toilet	MEASURE 3 Toilet Leaks	MEASURE 4 Retrofit	TOTAL
1981	0.0	11.9	9.1	79.0	100
1985	8.1	13.5	6.7	71.6	100
2000	36.7	14.7	1.4	47.3	100
2020	53.7	12.4	0.1	33.8	100
2030	58.3	11.4	0.0	30.3	100

Utility Bill Savings

Based on marginal water utility rates (per thousand gallons) presented previously in Substep 6.1 (for residential $1.62, multi-family $1.89, commercial $1.77 and industrial $1.52) and estimated water savings by customer class (Table 5-35) from permanent measures for 1981 and 1982 (interpolated values), the annual savings in water utility bills for single family residential and commercial classes only (the predominant water users) were determined (Table 5-57).

TABLE 5-57
ECWD CUSTOMER WATER BILL SAVINGS (1980 $)

	SFR	COMM.	TOTAL
1981	$240,000	$32,000	$272,300
1982	236,000	31,000	267,000

The present value of these savings for the two years in which they are assumed to take place is $478,000. Based on Table 5-56 (1981), this benefit is contributed by Measure 1: $0; Measure 2: $56,800; Measure 3: $43,500; and Measure 4: $377,700.

Wastewater collection and treatment charges are also based on metered water use. The regional utilities authority charges the ECWD community for debt service and operation maintenance based on flow, biological oxygen demand (BOD), suspended solids (S.S.) and chlorine demand (C.D.). With the exception of the flow charge (based on gallons), the other charges are based on weight. In 1984, the ECWD community paid over $186,000. (Table 5-58)

TABLE 5-58
ECWD COMMUNITY 1984 WASTEWATER CHARGES ($)

FLOW	$108,800	(1,475 MGY FLOW)
B.O.D	33,500	
S.S.	43,200	
C.D.	600	
TOTAL	$186,100	

In addition to these charges, the ECWD area sewer customers pay for the local ECWD sewerage authority costs, including staff, wastewater collection system maintenance and overhead. These local costs are not likely to vary based on water conservation and are not included here.

The resulting total cost deflated to 1980 at 6 percent per year is $147,400 or $99.90/million gallons of treated wastewater (with about 4.04 mgd treated). Water conservation in 1981 and 1982 is again assumed to reduce these charges (although the time frame could be considerably longer for these savings in this case given that the ECWD represents only 6 percent of the total regional authority flow, and this percentage will decrease as the authority increases its membership, including new communities).

From Table 5-35, the flow reduction in 1981 is .462 mgd (assumed also for 1982). The daily savings in wastewater treatment costs is therefore (.462 mgd) * ($99.90/mgd) * (365 days) = $16,800 per year. The present value of these savings for 1981 and 1982 is $29,800. These reductions in charges are allocated to measures based on Table 5-56: Measure 1: $0; Measure 2: $3,500; Measure 3: $2,700; Measure 4: $23,600.

STEP 8: Disadvantageous Effects (Indirect)

Implementation costs are the primary disadvantageous effects of the proposed program. Table 5-59 summarizes the cost effect of the program for each measure and option.

Substep 8.1: Implementation Costs

Measure 1: (Building Code Enforcement). In Steps 5 and 7, the general aspects of Measure 1 are described. The key aspects of the program are:

- o an existing building code requiring water conservation for new construction that is not enforced.
- o local capability for inspection and enforcement.

TABLE 5-59
DISADVANTAGEOUS EFFECTS (INDIRECT)
PRESENT VALUE (1980 $)

	MEASURE 1: Building Code	MEASURE 2 Press. Toilets	MEASURE 3 Toilet Leak	MEASURE 4 Retrofit	MEASURE 5 Restr./Ration
MATERIAL COST					
Kits	-	-	$12,000	$74,000	
Fixtures & Equip.	$302,100	$ 82,000	-		
Pamphlets	-	1,000	-	24,000	
Supplies					
Postage	-	100	2,000	6,000	
Other	-	-	-	-	
SERVICE PURCHASES					
Media (TV, Radio)		-	200	-	
Newspapers	-	-	200	-	
Rentals	-	-	-	1,500	
LABOR					
ECWD	Option 1	Option 1			
	429,500	0			
	Option 2	Option 2			
	0	86,500			
Speakers	-	-	-	-	
Summer help	-	-	2,400	2,400	
CONT. (10%)	42,900	8,600	2,000	11,000	
TOTAL COST	$774,500 (op-1)	$91,700 (op-1)	$18,000	$118,900	Minimal
	$345,000 (op-2)	$178,200 (op-2)			

The existing unenforced code requires low-flush toilets, and low-flow showerheads and faucets. The existing program is not properly implemented because of the reported additional costs of low-flow alternatives and the availability of conventional rather than low-flow fixtures. (Note in the Level 1 situation, vendors handle low-flow fixtures primarily, although there is no law requiring their use.) The following Table 5-60 differential costs are reported in the literature:

TABLE 5-60
DIFFERENTIAL COSTS OVER STANDARD (1980 $)

	FIXTURE $	O & M	SOURCE
Low-flush toilet	$0 - 15.00	0	(88) (20)
Pressure toilet	700.00	*	(88)
Low-flow showerhead	0 - 7.00	0	(20)
Low-flow faucet	0 - 7.00	0	(20)

*Requires periodic user maintenance.

Based on the assumed higher cost, (the maximum values are used in assessing the incremental costs of this measure over use of conventional fixtures), and new growth projections (Table 5-53 includes the single family residential [SFR] and SFR equivalents for multi-family residential growth), the future additional costs of this measure were determined. As assumed, use of fixtures per dwelling unit was also used.

Low-flush toilets - 3/unit (for 95 percent of units)
Low-flow showerheads - 2/unit
Low-flow faucets - 10/unit

Only 95 percent of the units are constructed with low-flush toilets because Measure 2 (Pressure Toilets) are used by the other 5 percent. Other fixtures are used by 100 percent of the new customers. The future added costs are presented in Table 5-61.

TABLE 5-61
ECWD MEASURE 1: ADDITIONAL FIXTURE AND EQUIPMENT COSTS, SELECTED YEARS (1980 $)

	1980	1990	2000	2010	2020	2030
Total SFR Equiv. #	0	1,907	4,336	5,936	7,696	9,652
10-yr. Increment		1,907	2,429	1,600	1,760	1,956
Low-flush Toilets ($)	0	8,600	10,900	7,200	7,900	8,800
Low-flow Showerhd ($)	0	2,700	3,500	2,200	2,500	2,800
Low-flow Faucet ($)	0	13,300	16,900	11,200	12,300	13,600
TOTAL COST ($)	0	24,600	31,300	20,600	22,700	25,200

Based on the future additional costs of these water-saving fixtures, the present value at 8-3/8 percent (Federal discount rate) is $302,100.

Measure 1 also includes other costs which are incurred over the 50-year study period. An average of 193 new residential or single family equivalents are inspected each year in this measure. This inspection load and review of plans requires about one hour for each unit. Since most of the future ECWD area development will be in "developments" or multi-family housing, the inspections and plan reviews can be efficiently handled by one person at an estimated 15 percent of annual activities (300 hours/year). This effort can be added, and a new staff person included as a Water Conservation Specialist (Option 1), or added to the efforts of existing personnel (Option 2).

The Option 1 approach involves adding a person. Estimated minimum salary and fringe benefits for a licensed professional engineer in the ECWD area with 2-4 years experience is $25,000 base salary, with $8,750 fringe benefits (35 percent). Total annual cost (1980 $) is $33,750 for this added person. Transportation, office space and supplies are available from the existing ECWD government operations. The present value of this expenditure over the planning period is $429,500.

The Option 2 approach involves no additional cost. Existing ECWD personnel (ie., from the Operations Department) review the building plans for new subdivisions/apartment complexes, and other new construction. The Department Supervisor coordinates their existing assignments with the needed inspections.

In both cases, written reports (check-off forms) are prepared, and favorable compliance findings are forwarded to the permits section and serve as approval documents for a building occupancy permit.

If Measure 1 is implemented according to Option 1, the total present value of the disadvantageous effect is $774,500, including $42,900 as a contingency. Option 2, which does not create a new Water Conservation Specialist position in the ECWD staff, has a present value of $345,000 for implementation.

Measure 2: (Pressure Toilets) Details of the Measure 2 approach were presented in Steps 5 and 7. The key cost of this measure is the incremental cost of the pressure toilet. The incremental cost was estimated at $700.00 above a standard toilet in the previous discussion of Method 1, and some operation and maintenance costs may be involved.

The pressure toilet uses less than 1 gallon of water per flush, however, it depends on air pressure to achieve this significant water use reduction with a comparable level of efficiency. Based on 5 percent installation of SFR and SFR equivalents for MFR (Table 5-53), the number of pressure toilets installed each year is small (average of 10 per year). The present value of this additional cost is $82,000.

Two options (Table 5-62) are proposed for implementation. Option 1 involves a voluntary approach. Existing staff are given additional assignments for promoting pressure toilets. Promotional material are available, for example, pamphlets and other literature from "qualified" vendors, and small costs are anticipated for mailing material.

Option 2 integrates the Measure 2: (Pressure Toilet) with Measure 1: (Building Code). Under certain circumstances, for example, in high water use conditions such as large houses (4 bedroom and larger), pressure toilets are designated. Additional effort above Option 1 would include more involvement with contractors and evaluations of pressure toilet effectiveness.

TABLE 5-62
MEASURE 2: ANNUAL COSTS OF IMPLEMENTATION (1980 $)

	OPTION 1	OPTION 2
Personnel	$ 0	$6,800*
Pamphlets	1,000	1,000
Postage	100	100
	$1,100	$7,900

*20 percent of Water Conservation Specialist (base salary + fringe)

The annual cost ($6,800) of a Water Conservation Specialist has a present value of $86,500.

Measure 2 includes $8,600 as a contingency against ECWD expenditures. With voluntary implementation, the present value of the total cost is $91,700 (Option 1). If the Measure 2 program is integrated with the Measure 1 Building Code and mandatory use of pressure toilets is enforced (where appropriate), the implementation cost is $178,200 (present value).

Measure 3: (Toilet Leak Detection) Previously in Steps 5 and 7, the toilet leak detection measure was described. The major costs of the program are minimal, including:

- o Purchase of kits, including (6) dye tablets (foil sealed), instructions on the operation and repair of toilets and other water conservation literature.
- o Publicity of water conservation effort and the use of the kits.
- o Distribution of kits to ECWD customers.

The toilet leak detection kits are packaged in clear plastic and are sufficiently small to be inserted into the quarterly bills of the ECWD. The following costs (Table 5-63) represent a short-term effort to distribute the kits and notify the local water customers of the benefits of the toilet leak detection measure.

TABLE 5-63
TOILET LEAK DETECTION COSTS (1980 $)

	UNIT PRICE	TOTAL COST
Purchase 12,000 kits	$1.00 ea.	$12,000
Additional Postage	.20 ea.	2,000
Newspaper Notices	-	200
Local Radio Notices	-	200
		$14,400

The kits are distributed during the summer months by two part-time summer help people. They are used to prepare the kits over a six-week period (2,000 kits per week). The estimated hourly wage is $5.00. The cost of this effort is $2,400.00.

The present value of the implementation cost for Measure 3 is $18,800, incuding $2,000 as a contingency.

Measure 4: (Extension Retrofit Program) The primary cost of the retrofit program is the purchase of toilet dams, low-flow showerheads (not flow restrictors) and faucet aerators (Table 5-64) for the existing customers. Actual purchases of fixtures by the ECWD and distribution to the target customers makes this an effective program.

TABLE 5-64
MEASURE 4
COSTS OF WATER CONSERVATION FIXTURES (1980 $)

	#/DWELLING	FIXTURE $/UNIT	O&M	SOURCE
Toilet Dam	2	$2.00	0	(8)
Low-flow Showerhead	1	5.00	0	(8) (20)
Faucet Aerator	4	.50	0	(8) (20)

Toilet dams are flexible rectangular plates of plastic or metal with plastic edges which can be fitted into the toilet tank. These dams hold back a portion of the water (about 1.65 gallons) and prevent it from leaving the tank. These devices can be installed and regulated to establish an effective, although reduced, flow. The cost of a toilet dam is $2.00.

Well made low-flow showerheads with brass fittings can be purchased for $5.00 each, and faucet aerators are about $.50 each. Kits are assembled by the ECWD, including:

(2) Toilet dams
(1) Low-flow showerhead
(4) Faucet aerators
(1) Pamphlet on water conservation
(1) Instructions for installation of flow-reducing devices
(1) Plastic bag for the kit

Each kit costs $12.50.

Because of the cost of these kits, the Measure 4 conservation effort is targeted. A mailing program (including program information) is used to identify interested potential users. Since only 50 percent of the ECWD customers are predicted to use the flow-reducing devices, the program is carefully designed, and purchases for the kits are made accordingly.

Table 5-15 presents the existing connections. Again, single family (9,426 customers) and multi-family residential (436 equivalents) water use is the target. A total of 9,862 customers are targeted for this measure.

Table 5-54 presents the percentage of the customers who will use the retrofit measures. Purchases are over-bought by 10 percent to assure maximum installation.

The experience of previous kits projects are varied (8), (20), (84), (86), (88). In the Washington Suburban Sanitary Commission's effort (85), the difficulty in hitting the target is apparent. The WSSC distributed almost 300,000 "water saving and sewage-reduction kits" designed to promote water conservation and extend the effective use of the wastewater treatment system. The follow-up, a sample of 6,240 customers, indicated that 64 percent did not receive the kit. In an effort to minimize this problem, a mailing program is used initially.

All ECWD customers are sent a questionnaire (plus other explanatory materials) to determine the willingness of customers (1) to receive a free water-saving kit, (2) to participate in the program, and (3) to follow-up with information on the approach. The customer is asked to return the form (pre-stamped and addressed) to the ECWD with his own name and address. These customers are targeted to receive the kits.

Summer part-time help is used in preparing almost 6,000 kits (60 percent of the 1980 customers based on Table 5-54 and 10 percent extra). Over a six-week period, two people prepare and mail the kits. The hourly wage is $5.00, and the cost of this effort is $2,400. Storage is provided in a rented trailer for $1,500. These costs are summarized in Table 5-65. The cost of the program for Measure 4 is $107,900. A contingency of 10 percent ($11,000) brings the total to $118,900.

TABLE 5-65
ECWD MEASURE 4 1980 COST

Questionnaire Layout materials/reproduction (12,000 forms and envelopes)	$12,000
Water Conservation Pamphlet (describing benefits of water conservation)	12,000
Postage	6,000
Kit Purchases (60% of 1980 customers @ $12.50 each)	74,000
Summer part-time help	2,400
Rental of storage trailer	1,500
Contingency	11,000
TOTAL COST	$118,900

Measure 5: (Water Restrictions and Rationing). The effective implementation of contingency plans to reduce water consumption during emergency depends primarily on:

(1) Information about the program and the intent of officials to enforce it.

(2) Perception of customers that the program is needed, and all customers are treated fairly.

(3) Feedback to the customers that their effort is effective.

The potential additional costs associated with Measure 5 involve the use of the media. This is assumed to be as a free public service since the water shortage is apparent to everyone.

As an expected role for ECWD staff, assignments are assumed to change from normal activities to efforts to manage the water shortage.

Substep 8.2 Other Disadvantageous Effects

Measure 1: Building Code Enforcement.
No other disadvantageous effects are anticipated.
Measure 2: Pressure Toilets
No other disadvantageous effects are anticipated.
Measure 3: Toilet Leak Detection
No other disadvantageous effects are anticipated.
Measure 4: Extension Retrofit Program
No other disadvantageous effects are anticipated.
Measure 5: Water Restrictions and Rationing
No other disadvantageous effects are anticipated.

STEP 9: Foregone Supply Costs

Advantageous effects associated with future operations of water supply and wastewater facilities at the local level, and water supply systems at the Federal and regional levels may be produced by the proposed water conservation measures. Advantageous effects consist mostly of foregone costs of supplying water and wastewater services. Other effects may be external costs or opportunity costs that are reduced as well. The analysis that follows identifies the costs associated with future water supply plans at the local and Federal levels and identifies and quantifies the cost reductions that are associated with the water conservation program for the ECWD area.

Substep 9.1 Local Water Supply and Wastewater Plans
Substep 9.2 Federal Water Supply Plans
Substep 9.3 Non-Federal (Regional) Plans
Substep 9.4 External Opportunity Costs
Substep 9.5 Summary Foregone Supply Costs

Previously in Figures 5-3 and 5-4, the water supply needs of the ECWD area were graphically presented. The effect of the proposed water conservation programs is to shift the timing (delay) the necessary investments and other costs, as well as reduce some expenditures. The differential in present value of projects that are delayed or costs reduced are the benefit of the water conservation program. Table 5-56 indicates the effect of each water conservation measure over the fifty years and provides a key tool in allocating the cost savings to each measure.

Substep 9.1 Local Water Supply and Wastewater Plans Incremental Supply Costs

Water Supply: The ECWD water supply system is budgeted annually for three divisions. The budget categories are listed below in Table 5-66. An * indicates the budget elements that are associated directly with water production changes. Table 5-67 describes the expenditures of the ECWD water supply system. Only the variable costs associated with water production and water conservation reductions are presented (omitted are fixed costs ie., administration, debt service, etc.).

TABLE 5-66
ECWD BUDGET CATEGORIES

7001 METER DIVISION

101 Permanent Full Time (Salary & Wages)
105 Overtime (S&W)
201 Office Materials & Supplies
202 Uniforms Clothing & Acc.
203 Lubricants & Motor Fuel
206 General Equip. & Machine Parts
207 Bldg. Materials & Supplies
212 Plumb., Air Cond., & Heat
213 Janit., Laund., & Hshld Supplies
219 Books, Subsc., & Articles
229 Other Materials & Supplies
304 Postal & Express Charges
308 Maintenance of other Equip.
310 Printing & Binding
312 Prof. Consul & Spec. Serv.
313 Travel Exp.
315 Training Aids & Programs
316 Other Expense
400 New Equipment
405 Office Equipment
409 Plumb., Air Cond., & Heat Equip.
410 Fire & Other Safety Equip.
412 Furniture & Furnishings
413 In Kind Costs

7002 PRODUCTION ACTIVITY

101 Permanent Full Time (Salary & Wages)
102 Permanent Part Time
103 Temporary Part Time
104 Seasonal (S&W)
105 Overtime (S&W)
201 Office Materials & Supplies
202 Uniforms Clothing & Acc.
203 Lubricants & Motor Fuel
204 Fuel-Heating & Lighting
205 MV Parts & Accessories

7002 PRODUCTION ACTIVITY (CONTINUED)

206 Gen. Equip. & Machine Parts
207 Bldg. Materials & Supplies
209 Gen. Hrd & Minor Tools
210 Emerg. & Safety Materials
211 Elec. Equip. & Supplies
212 Plumb, Air Cond., & Heat.
213 Janit., Laund., & Hshld Supplies
215 Hospital & Lab Supplies
217 Precision & Arts Mats. Sup.
219 Books, Subsc., & Spec. Articles
*220 Chemicals & Gases
*302 Gas & Electric
*303 Water
305 Rents
306 Maint. of Motor Vehicles
307 Maint. of Bldg. & Improv.
*308 Maint. of Other Equipment
310 Printing & Binding
311 Advertising & Promotion
312 Prof. Consul & Spec. Serv.
313 Travel-Expense
314 Dues
315 Training Aids & Programs

7003 MAINTENANCE ACTIVITY

101 Permanent Full Time (Salary & Wages)
104 Seasonal (S&W)
105 Overtime (S&W)
202 Uniforms Clothing & Acc.
203 Lubricants & Motor Fuel
205 MV Parts & Accessories
206 Gen. Equip. & Mach. Parts
208 RD Materials & Supplies
209 Gen Hrd. & Minor Tools
210 Emerg. & Safety Materials
211 Elect. Equip. & Supplies
212 Plumb, Air Cond. & Heat
213 Janit., Laund., & Hshld Supplies
219 Books, Subscr., & Spec. Articles
220 Chemicals & Gases
229 Other Materials & Supplies
305 Rents
306 Maint. of Motor Vehicles
308 Maint. of Other Equipment
314 Dues
316 Other Expenses
7102-6000 Capital, Bond & Note Payment and Other Non-Variable Accounts

The purpose of listing these accounts is to place in perspective the numerous charges associated with running a water utility and focusing on those relevant to water production (that vary as production changes). Also, with the exception of the salary categories and the capital and bond repayment accounts, the other significant accounts over $20,000/year are the variable costs on chemicals, energy, water (purchases) and maintenance in the water production activity. These costs are presented in Table 5-67.

TABLE 5-67
ECWD WATER SUPPLY VARIABLE OPERATING BUDGET 1977-1981
CURRENT DOLLARS ($000)

ACCOUNT #	1977	1978	1979	1980	1981
PRODUCTION DIV.					
220 Chem. & Gases	$ 26.4	$ 37.8	$ 37.8	$ 37.8	$ 42.7
302 Gas & Elec.	104.2	115.0	115.0	115.0	140.0
303 Water Purch.	226.5	265.0	250.0	250.0	300.0
308 Maint. of other Equip.	26.1	25.0	25.0	25.0	26.7
Total Variable Cost	383.2	427.8	427.8	427.8	509.4
Total Production Div.	586.5	707.8	678.2	661.5	763.5
Total Meter Div.	132.3	307.8	305.7	301.7	306.6
Total Maint. Div.	110.4	173.3	199.2	177.8	205.0
Operations Total	$829.2	$1,188.9	$1,183.2	$1,141.1	$1,275.2

Note: 1977: Annual expenditure; 1978-1981: Adopted or modified budgets.

Based on the water demand estimated for 1980, (4.039 mgd, Table 5-25), the ECWD produced 1,474.2 million gallons of water. The variable cost for 1980 $427,800 indicates a unit production cost of $0.290/1000 gallons. (This cost is somewhat lower than the $0.374/1000 gallons determined from the less detailed Level 1 data.)

Based on the water savings for the medium growth scenario with permanent water conservation measures (Table 5-35), the percentage effect by a measure (Table 5-56), and the unit price of producing water ($.29/1000 gallons), the annual savings in production and water purchase costs are projected for each measure. For example, in 1981 for Measure 2 (.462 mgd) * (.119) * ($.29) * (365 days per year) = annual savings.

Table 5-68 presents the annual savings for each measure for selected years (interpolations were made between years in calculating the present value of each measure): Measure 1 (Building Code): $78,100; Measure 2 (Pressure Toilets): $74,000; Measure 3 (Leak Detection): $26,600; Measure 4 (Retrofit): $346,700. The total present value is $525,400.

TABLE 5-68
FUTURE ECWD WATER SUPPLY OPERATIONS SAVINGS (FOREGONE SUPPLY COSTS)
1981 - 2030 (1980 $)

	TOTAL REDUCTION IN WATER DEMAND	ANNUAL SAVINGS IN SUPPLY OPERATIONS COSTS ($)				
	(MGD)	M1	M2	M3	M4	Total
1981	.462	$ 0	$ 5,800	$ 4,400	$ 38,700	$ 49,000
1985	.429	3,600	6,000	3,000	32,200	45,000
2000	.509	16,500	6,600	600	21,300	54,000
2020	.743	42,400	9,800	100	26,700	79,000
2030	.827	51,300	10,000	0	26,700	88,000
PRESENT VALUE		$78,100	$74,000	$26,600	$346,700	$525,400

Future savings in water supply purchases are also included. The current arrangements for 5.8 mgd in well-supplied and purchased water from the N.B. community takes the ECWD community to about 2005, and supplemental supplies (1.2 mgd) are also available that take the ECWD to the year 2030 based on average daily projections (Figure 5-3). Water conservation delays a portion of these purchases (from the N.B. community purchase agreement) about .75 mgd by 2030 from (a) to (b) (by ten years). The total supply required by 2030 is 6.25 mgd instead of 7.0 mgd.

The purchase agreement with the N.B. community makes 4.0 mgd available to the ECWD at $426.38/mg. The savings of .75 mgd/yr. from 2005 to 2030 is $116,700/yr (1980 $). The area between the curves: Unrestricted Water Demand (1) and Water Demand with Conservation (2) in Figure 5-3, graphically presents the water savings. The present value of these savings is $177,200 (about 1/3 of the total $525,400 present value of the operations savings).

The Measure 5 conservation effort provides benefits only very infrequently (assumed to be one in five years, for the first 10 years and 1 in 10 thereafter). For restrictions on water use, comparison of Table 5-35 and Table 5-38 indicates an additional reduction in water use in 1981 of .192 mgd (.654 mgd-.462 mgd) that increases to .363 mgd in 2030. Based on the marginal cost of producing water $.29/1000 gallons, the present value of these annualized savings is $52,600. Comparison of Tables 5-38 and 5-41 provides the added effectiveness attributed to the rationing program which increases from .577 mgd in 1981 to 1.008 mgd in 2030. Again, based on the cost of producing water ($.29/1000 gallons) and the use of the program 1 in 5 years at first and then 1 in 10 years thereafter, the present value of the annual benefits is $162,300.

Peak use of water is also reduced by about 98 percent more than average use, based on comparison of average and peak reductions in Table 5-35. Because the peak demand is infrequent, the savings are small.

Peak daily water demand is also impacted by the water conservation program. Figure 5-4 graphically shows the significance of reduced peak daily demand which ranges from .919 mgd in 1981 to 1.607 mgd in 2030 (Table 5-35). The annual savings depends on the following: The level of water reduction achieved, the price of purchased water ($426.38/mg) and an assumed average 26 days per year (when maximum rates exceed 8.0 mgd, see Step 7, Section on "Conservation Effects"). For 1981, for example, the annual savings is (.919 mgd) * ($426.38/mg)(26 days/year) = $10,100. Future savings on peak daily use are summarized in Table 5-69.

TABLE 5-69
ANNUAL SAVINGS IN PEAK DAILY WATER PURCHASES
(1980 $)

	ANNUAL SAVINGS
1981	10,100
1985	9,300
1990	9,100
2000	9,900
2010	10,800
2020	15,100
2030	17,800

The present value of these peak demand savings is $176,200, distributed to water conservation Measures 1-4 based on the distribution of average savings (Measure 1: $26,100; Measure 2: $24,800; Measure 3: $8,900; Measure 4: $116,300). Measure 5 provides an additional savings in purchased water at $426.38/mg, based on previously stated assumptions of recurrence and duration and Table 5-41 water use reductions of 2.585 mgd 1981 to 4.515 mgd in 2030. The Measure 5 present value of supply purchases is $72,600.

Wastewater: Wastewater treatment is provided by the Regional Sewerage Authority. They will experience reduced quantities of sewage for treatment and reduced revenues. The neighboring communities (25 current members) are anticipated to take up the "slack". The local ECWD community residents experience reduced sewer bills and may benefit for the long-term.

Long-Run Incremental Supply Costs

Water Supply: The ECWD water treatment and distribution systems need to be expanded to meet the projected future water demands. Figures 5-3 and 5-4 describe the projected average day and peak day demands, respectively. The current water supply yield is 5.8 mgd and satisfies the average daily demands as indicated in Figure 5-3. The peak daily demands, however, are currently greater than the available supplies, and system modifications are required. At the present time, the ECWD is enlarging its main connections with the N.B. community water system. Since the possible approach for meeting future demands involves the use of existing wells (the quantity is fixed at 3.0 mgd) and treatment of that water, as well as purchases of additional treated water from other communities, the possible foregone costs involve transmission and storage only (no new treatment facilities are required), since the existing ECWD wells are considered the base supply, and only this water is treated.

The consultant report recommended additional storage and main improvements to achieve a distribution and storage system for the ECWD that can deliver a dependable 15.0 mgd. Many of the costs items identified in the consultant report are now part of the ECWD projected budget. The following identifies the needed system modifications (timed to provide 15.0 mgd by 2030 [not 2000], based on small projected water demand increases identified here, and the assumed dates 1990 and 2010 when additional supplies would have to be purchased [Figure 5-4]), and then the effects of water conservation on system construction requirements. The 1990 added facilities could be delayed for about 5 years, based on the Figure 5-4 comparison of Unrestricted Peak Daily Use (medium curve) (1) and the Peak Daily Flow with Conservation (2). By the year 2010, conservation in new construction (Measure 1) has significantly impacted the area's water use, and delays of 12 years are possible.

Table 5-70 presents the construction schedule and investments required to achieve the future water demands of the ECWD area (1) 1980 cost and original schedule as presented by the local budget and a consultant report, (2) with no water conservation--as modified for the 2030 time-frame, and (3) with water conservation--delayed by water conservation effects. The difference in the present value of the 1980 investment costs with no water conservation and with water conservation is $1,045,000.

TABLE 5-70
FUTURE ECWD WATER SUPPLY INVESTMENT NEEDS
AND THE IMPACT OF WATER CONSERVATION-INDUCED DELAYS

INVESTMENT REQUIRED	COST (1980 $)	ORIG. SCHED. (1980-2000)	NO WATER CONS. MOD. SCHED. (1980-2030)	WATER CONS.-INDUCED DELAYS
N.B. Community Mains (under const.)	$645,000	1980	1980	(No Effect)
Fern Road Main	180,000	1984	1984	1986
Tices Lane Section Main & Pump	4,700,000	1984	1984	1986
YEAR TOTAL	$4,880,000			
Route 18 Main	310,000	1985	1990	1995
Yates 1.5 mg Tank	1,500,000	1987	1990	1995
Cranbury Road Main	825,000	1987	1990	1995
YEAR TOTAL	$2,635,000			
Fern 0.8 mg Tank	835,000	1992	2010	2022
Yates 1.1 mg Tank	1,500,000	1992	2010	2022
YEAR TOTAL	$2,335,000			
	PRESENT VALUE		$4,925,600	$3,880,100
	FOREGONE COSTS (DIFFERENCE)		$1,045,000	

The following tabulation indicates the timing of these investment savings: 50.2 percent during the water conservation-induced 1984-1986 investment shift; 37.3 percent during the 1990-1995 delay, and 12.3 percent in the final shift of investments. Table 5-56 indicates in various years (1985, 2000, and 2020) when certain measures are contributing to the water conservation. As a result, the following contributions were determined. (Table 5-71)

TABLE 5-71
INVESTMENT SAVINGS BY MEASURE
(1980 $) PRESENT VALUE

	MEASURE 1 Building Code	MEASURE 2 Press. Toilets	MEASURE 3 Toilet Leak	MEASURE 4 Retrofit	TOTAL
1985	$ 42,500	$70,900	$35,200	$376,300	$525,600
(c.2000)	143,200	57,300	5,400	184,600	390,400
2020	69,500	15,900	0	43,700	129,500
TOTAL	$255,200	$144,100	$40,600	$604,600	$1,045,000

Wastewater: Although flow reduction can reduce facility sizes and transmission line requirements (87), the impact is minimal for the ECWD because the community only provides collection and transmission capability and links to a large regional system for final treatment and disposal.

Substep 9.2 Federal Water Supply Plans

One Federal project has been planned for the ECWD area. The project will make 25,600 acre feet of water available annually. "FED-LAKE" water is estimated to cost $18.95/AF ($58.30/mg based on the Non-Federal share for capital and operation and maintenance costs recovery. The ECWD share is 7.0 mgd. Since this water would provide an excellent alternative to the purchased sources of water now available at current rates of $426.38/mg (and higher possible future rates of $500 and $600), including regional transmission costs, repayment of state bond issues and other costs, the FED-LAKE project supply is an ideal, cost-effective alternative. The objective would be to utilize this source in lieu of other purchased sources as quickly as possible. As a result, water conservation by the ECWD gains no foregone costs with respect to the FED-LAKE project.

Substep 9.3 Regional Plans

Two future state projects (regional plans) are possible in the future. These projects (1) "C" project (50 mgd), and (2) "S" project (50-55 mgd) were studied in the early 1970's and in the 1960's, respectively. These projects, according to the state, would not be needed until after the year 2000, and no cost data are available.

Substep 9.4 External Opportunity Costs

The effect of water conservation by the ECWD community is negligible with respect to downstream water users. The community is currently 1 of 25 communities in the regional wastewater system and represents 6 percent of current flows. Membership is increasing in the regional system. Two new members (much larger communities) are joining the regional system. As a result, water conservation reduces the final flows from the system (affecting downstream uses) by immeasurable amounts, especially considering the infiltration and conditions of the system (regional system wastewater flows were described for wet and dry periods and vary from 85 mgd to 200 mgd). No external opportunity costs are detectable from reduced flows from the wastewater system on downstream water users.

Measure 5, however, during drought emergency periods, reduces average and peak water demand by about 14 to 17 percent with water use restrictions. When rationing is used, over-all reductions are about 28 to 30 percent. Impacts to residential lawns, as well as parks, golf courses and other water-dependent landscaping is serious (90). Comparison between Tables 5-25 and 5-38 indicates that exterior residential water use is reduced by about 16 percent. This is accomplished with alternate day sprinkling limitations and does not seriously affect landscaping and gardens. Rationing achieves about 21 percent reduction in outside watering (comparison of Tables 5-25 and 5-41). This, also, is judged to be a minor impact. If outside water is prohibited, however, (not the case here), significant costs are incurred (see [90] where landscaping replacement costs of fairways, tees, greens and shrubs were estimated for the eastern portion of Pennsylvania).

Substep 9.5 Summary of Supply Cost & Savings

Table 5-72 summarizes the effects of water conservation on the costs of operations and future expansion of the ECWD water system. Because of the limited treatable water supply (3.0 mgd) available to the ECWD community and the opportunity to purchase treated water from neighboring communities, and the efficient arrangements for wastewater treatment by a regional wastewater authority, the community's water conservation plan produces benefits only in the water supply area with regard to operations ($989,100 in present value foregone costs) and capital investments ($1,045,000 in present value foregone costs). The total foregone costs are $2,034,000 with half of the benefit contributed by the Measure 4, retrofit program.

TABLE 5-72
FOREGONE SUPPLY COST (ECWD)
(1980 $)

	MEASURE 1 Build. Code	MEASURE 2 Press. Toil.	MEASURE 3 Toil. Leak	MEASURE 4 Retrofit	MEASURE 5 Contingency	TOTAL
OPERATING COSTS						
Water Supply Purchases & Treatment						
(Avg.)	78,100	74,000	26,600	346,700	52,600 (restr.)	740,300
(Peak)	26,100	24,500	8,900	116,300	72,600 (ration)	248,800
Wastewater Treatment	-	-	-	-	-	-
Subtotal	104,200	98,800	35,500	463,000	287,500	989,100
CAPITAL COSTS						
Water Supply Treatment	-	-	-	-	-	-
Water Trans.	255,200	144,100	40,600	604,600	-	1,045,000
Wastewater Treatment	-	-	-	-	-	-
Wastewater Trans.	-		-	-	-	-
Subtotal	255,200	144,100	40,600	604,600	-	1,045,000
ALT. WATER PROJECTS						
FED-LAKE	-	-	-	-	-	-
EXTERNAL OPP. COSTS	-	-	-	-	-	-
TOTAL	$359,400	$242,900	$76,100	$1,067,600	$287,500	$2,034,100

STEP 10: Foregone NED Benefits

In Chapter 4, the requirements for evaluating foregone NED benefits were discussed. Because of the lower cost of water from the FED-LAKE project, and the continuing need for additional water supply, it offers an ideal future water supply project for the area, including the ECWD.

Water conservation by the ECWD does not reduce the estimated total annual benefits of $6,047,000. The current FED-LAKE benefit cost ratio of 1.24 is unchanged by the water conservation program.

STEP 11: Reduced Negative EQ Effects

Since the ECWD water conservation program does not affect the water output requirements, timing, or any other aspect of the FED-LAKE project, the program is neutral. No reduced negative EQ effects are anticipated.

STEP 12: Increased Negative Environmental Effects

Since the ECWD water conservation program does not affect the water output requirements, timing, or any other aspect of the FED-LAKE project, the program is neutral. No increased negative environmental effects are anticipated.

STEP 13: Measure Evaluation

The results of the analysis from Steps 7, 8, 9 and 10 are summarized in Table 5-73. The information contained in this Table was taken from the previous Summary Tables for the various Steps. Each measure produces NED advantageous effects that are greater than the NED disadvantageous effects. Even higher cost implementation options are outweighed by the advantageous effects of Measures 1 and 2.

TABLE 5-73
ECWD SUMMARY OF NED ADVANTAGEOUS AND DISADVANTAGEOUS EFFECTS OF WATER CONSERVATION MEASURES (1980 $)
(PRESENT VALUE)

	MEASURE 1 Build. Code	MEASURE 2 Press. Toil.	MEASURE 3 Toil Leak	MEASURE 4 Retrofit	MEASURE 5 Contingency
ADVANTAGES					
a. Unrelated to Water Use	0	0	0	0	0
b. Indirectly Related to Reduction	$960,000	$60,300	$ 46,200	$1,479,300	$ 70,000
c. Foregone Supply Costs:					
- operations	104,200	98,800	35,500	463,000	287,500
- facilities	255,200	144,100	40,600	604,600	-
- ext. opp. cost	0	0	0	0	0
d. TOTAL NED ADV.	1,319,400	303,200	122,300	2,546,900	357,500
DISADVANTAGES					
a. Implementation Costs	774,500 (Op-1) 354,000 (Op-2)	91,700 (Op-1) 178,200 (Op-2)	18,800	118,900	Minimal
b. Other Disadv.	0	0	0	0	0
c. Foregone NED Benefits	0	0	0	0	0
d. TOTAL NED DISADV.	$774,500 (Op-1) $345,000 (Op-2)	$ 91,700 (Op-1) $178,200 (Op-2)	$18,800	$118,900	Minimal

Table 5-74 summarizes the environmental impacts of the proposed water conservation measures. Only the contingency measure (rationing) could produce negative environmental effects; however, none are anticipated.

TABLE 5-74
ECWD SUMMARY OF ENVIRONMENTAL IMPACTS OF
WATER CONSERVATION MEASURES

	MEASURE 1 Build. Code	MEASURE 2 Press. Toil.	MEASURE 3 Toil. Leak	MEASURE 4 Retrofit	MEASURE 5 Contingency
ADVANTAGES					
a. Unrelated or indirectly related to water use reduction	(None anticipated for all Measures)				
b. Directly related to water use reduction					
i. Federally Planned Facilities	(None anticipated for all Measures)				
ii. Non-Federal Facilities	(None anticipated for all Measures				
TOTAL ENVIRONMENTAL ADVANTAGES	None	None	None	None	None
DISADVANTAGES					
a. Unrelated or indirectly related to water use reduction	(None anticipated for all Measures)				
b. Directly related to water use reduction					
i. Federally Planned Facilities	(None anticipated for all Measures)				
ii. Non-Federal Facilities	(None anticipated for all Measures)				
TOTAL ENVIRONMENTAL DISADVANTAGES	None	None	None	None	None

STEP 14: Develop Water Conservation/Supply Plan

The five water conservation measures under consideration for the ECWD area all meet the tests of applicability, feasibility, acceptability and effectiveness, as well as providing net advantageous effects with respect to the NED objective. Also, these measures are neutral with respect to environmental impact locally, regionally and concerning a proposed Federal multi-purpose reservoir project.

The purpose of Step 14 is to maximize the Net Economic Development in satisfying the long-run water demands of the ECWD area. It is apparent from the analysis of Steps 7-13 that the benefits of the proposed water conservation measures vary in time, while one measure is gaining effect, another is diminishing, and both the benefits and costs are in flux. As proposed, the over-all effect of each has been reduced to present value (1980 $). Table 5-75 summarizes the measures. If any of the measures proposed possess greater NED disadvantageous effects than advantageous effects, it would be omitted from the analysis, and the water conservation effects of Tables 5-34 through 5-36, and 5-43 would be recalculated.

TABLE 5-75
SUMMARY OF ECWD
WATER CONSERVATION MEASURES

MEASURE	AVERAGE ANNUAL EFFECTIVENESS (MGD)		EFFECTS: ADVANTAGEOUS PRES. VALUE NED (000$/1980)	EFFECTS: ADVANTAGEOUS ENV.	EFFECTS: DISADVANTAGEOUS PRES. VALUE NED (000$/1980)	EFFECTS: DISADVANTAGEOUS ENV..
M1 Building Code	0.0	(1981)	$1,319.4	None	$345.0-774.5	None
	.482	(2030)			(Op-2) (Op-1)	
M2 Pressure Toilet	.055	(1981)	303.2	None	91.7-178.2	None
	.094	(2030)		None	(Op-1) (Op-2)	
M3 Toilet Leak Det.	.042	(1981)	122.3	None	18.8	None
	0.0	(2030)				
M4 Retrofit	.365	(1981)	2,546.9	None	118.9	None
	.251	(2030)				
M5 Contingency	(.6-2.2)		357.5	None	Minimal	Minimal

Table 5-76 presents the measures in rank order and distinguishes between Measures 1 and 2 and the two options for implementation of each.

TABLE 5-76
NED MERIT ORDER
PRESENT VALUE (1980 $)

MEASURE	NED EFFECT ADVANTAGEOUS	NED EFFECT DISADVANTAGEOUS	NET EFFECTS
M4 Retrofit	$2,546,900	$118,900	$2,428,000
M1 Building Code (Option-2)	1,319,400	345,000	974,400
M1 Building Code (Option-1)	1,319,400	774,500	544,900
M5 Contingency	357,000	0	357,000
M2 Pressure Toilets (Option-1)	303,200	91,700	211,500
M2 Pressure Toilets (Option-2)	303,200	178,200	125,000
M3 Toilet Leak Det.	122,300	18,800	103,500

The Measure 4 (retrofit program) provides the greatest net effect, followed by the Measure 1 (building code) with the existing ECWD personnel providing implementation (Option-2). Table 5-76 shows the declining net effect of the other options.

In Table 5-77, proposals are formed by combining the water conservation measures. The objective is to maximize the net NED advantage, as well as the water reduction capabilities of the possible plans. Because of the options used in implementation of Measures 1 and 2 and the possible interaction of these implementation costs, seven (7) plans are considered. Plans 1-4 consider the highest ranked measures from Table 5-76. For Measure 1, Option 2 with the highest net effect (of the M1 Options) is selected, and Option 1 with the highest net effect for Measure 2 Options is selected. The maximum net NED advantage is achieved in Plan 4 of $3,717,400, indicating that the greatest effect is achieved by combining all of the permanent measures.

TABLE 5-77
SUMMARY OF TRIAL WATER CONSERVATION
PERMANENT PROPOSALS FOR ECWD (NED EFFECT)

NED PROJ. PLAN	MEASURES	WATER REDUCTION[1] (MGD) 1981-2030	ADVAN. EFFECTS (PV,000$)	DISAD. EFFECTS (PV,000$)	NET NED ADVANTAGE (000$)
1	M4	.365-.251	$2,546.9	$ 118.9	$2,428.0
2	M4, M1(Op-2)	.365-.733	3,866.3	463.9	3,402.4
3	M4, M1(Op-2) M2 (Op-1)	.420-.827	4,169.5	555.6	3,613.9
4	M4, M1(Op-2) M2(Op-1),M3	.462-.827	4,291.8	574.4	3,717.4
5	M4, M1 (Op-1)	.365-.733	3,866.3	892.2	2,974.1
6	M4, M1(Op-1) M2 (Op-2)	.420-.827	4,169.5	983.9	3,185.6
7	M4, M1(Op-1) M2(Op-2), M3	.462-.827	4,291.8	1,001.5	3,290.3

[1] Table 5-35 and 5-56.

Plans 5-7 were prepared by taking advantage of plan implementation cost reductions associated with Measure 1 (Option 1). This measure involves the use of a Water Conservation Specialist over the planning horizon, however, only at a part-time level. The additional capability of M1 (Option 1) can be used to reduce the costs of other permanent measures. The present value of the cost changes are presented in Table 5-78.

TABLE 5-78
COST CHANGES ($ PRESENT VALUE)

MEASURE	COST CHANGE
M1 (Building Code)	+ $429,500
M2 (Pressure Toilet)	- 86,500
M3 (Toilet Leak Det.)	- 1,200
M4 (Retrofit)	- 1,200

The effect, however, is not sufficient to overcome the use of existing staff for M1 (Option-2) and the voluntary aspects of M2 (Option-1). As a result, the plan 4 water conservation program is selected for the ECWD area based on NED effects. The plan is consistent with the analysis results in Tables 5-34 through 5-46.

Since there are no identified environmental impacts associated with these measures, the plan consists of:

Plan 4:

Measure
M4 (Retrofit) Program With Free Distribution
- o toilet dams
- o low-flow showerheads
- o faucet aerators

M1 (Option-2) (Building Code) Use Of Existing ECWD Staff
- o low-flush toilets
- o low-flow showerheads
- o low-flow faucets

M2 (Option-1) (Pressure Toilets) Voluntary Selection
M3 (Toilet Leak Detection) Homeowners
- o dye tablets

Table 5-79 summarizes the effect of the water conservation measures analysis.

TABLE 5-79
SUMMARY OF WATER CONSERVATION MEASURES
AND FEDERAL AND LOCAL ALTERNATIVE PROJECTS

	TECHNICAL FEASIBILITY	SOCIAL ACCEPTABILITY	NET IMPACT FED-LAKE NED OBJ.	NET IMPACT FED-LAKE ENVIR. IMPACT	LOCAL PURCHASES REQ. OBJ.	LOCAL PURCHASES ENVIR. IMPACT
M1 (Building Code)	Feasible	Acceptable	+	+	+	+
M2 (Pressure Toilets)	Feasible	Acceptable	+	+	+	+
M3 (Toilet Leak Det)	Feasible	Acceptable	+	+	+	+
M4 (Retrofit)	Feasible	Acceptable	+	+	+	+
M5 (Contingency)	Feasible	Acceptable	+	+	+	+

The objective is to use purchased supplies from the E-B community and other local sources until the FED-LAKE project is available. The program of infrastructure improvements evaluated in Step 9 (Foregone Supply Costs) are needed if either current purchases are continued throughout the planning period or the FED-LAKE supply becomes available.

Table 5-80 identifies the timing and ECWD costs of the water plan for 1980-2030.

TABLE 5-80
ECWD WATER PLAN 1980-2030

YEAR		INCREMENTAL PROGRAM COSTS ($1980) PRESENT VALUE
1980	Water Conservation Plan Implementation	
	Measure 1: Building Code	$ 42,900
	Measure 2: Pressure Toilets	9,700
	Measure 3: Toilet Leak Detection	18,800
	Measure 4: Retrofit	118,900
	Measure 5: Contingency	Minimal
Subsequent Years		
1986	Fern Road Main	180,000
1986	Tices Lane Suction Main & Pump	4,700,000
1990	FED-LAKE Project (Water Purchases)	(off-set current purchases)
1995	Route 18 Main	310,000
1995	Cranbury Road Main	825,000
2022	Fern 0.8 mg Tank	835,000
2022	Yates 1.1 mg Tank	1,500,000

STEP 15: Supply Reliability Considerations

Water supply reliability and the risks associated with drought are described generally in Chapter 3 ("Risk and Uncertainty"), including concerns about data and analysis methods and concerns for the unknown. The "safe-yield" of the ECWD is estimated at 5.8 mgd with additional purchases capable of increasing the yield to 7.0 mgd. The system has 2 wells that provide about 3.0 mgd. Figures 5-3 and 5-4 present the supply situation in comparison with the average and peak daily water demands. The peak daily use is the key concern; however, the current supplies, if interrupted (ie., from groundwater contamination/pollution), could impact the average demand severely.

The sensitivity of the future water demands to changes are presented in various Tables that indicate the effect of high growth, for example, as a factor that could affect future planning. Figures 5-3 and 5-4 contain high growth demand functions to identify aspects of uncertainty and risk in meeting the ECWD's future water needs. For example, in Figure 5-4, if peak daily water demand (high growth) materializes by 2030, an additional 3.0 mgd of purchased water is needed. And, because of the steeper slope of the high growth water demand function, the water conservation reduction in water use does not produce the same 12-year delay in 1990 achieved by conservation effects on medium growth. Instead, the high growth delay in 1990 is only 7.5 - 8 years.

Because of the changing growth trends in the ECWD area, the medium growth is a likely future scenario, and the plan as developed here is appropriate for the community's needs. In the event that changes take place that were not foreseen, the contingency plans are suitable for such uncertainties.

STEP 16: Documentation

(See Appendix D: Bibliography)

ECWD EXAMPLE: Flow Reduction Contingency Plan

The following is a flow reduction contingency plan for the ECWD service area. Permanent water supply conservation measures have the ability to reduce water demand over the next decades by varying rates. Table 5-56 provides an indication of the changing effect of each water conservation measure to reduce water demand, and Table 5-35 indicates that the effect increases rapidly in the first year to 11.3 percent in 1981 and then declines to a low of 9.1 percent by 1995 and then increases again to 11.7 percent at the end of the study period. These permanent conservation measures have a significant effect on annual ECWD water demand and the monetary benefits of implementing a conservation program, which is summarized in Table 5-77 (NED Project Plan 4). The use of water conservation and new supply purchases and development will satisfy the water requirements of the ECWD area under normal conditions; however, a contingency plan is required to manage possible future water supply shortage.

The contingency plan is structured in three phases:

Phase I: Preparatory
Phase II: Voluntary Reductions
- Drought Warning
- Drought Watch
Phase III: Mandatory Reductions (Drought Emergency)
- Restrictions
- Rationing

The degree of protection from water shortage presented here is comparable to the level previously achieved by the community in a recent water shortage.

A. Phase I: Preparation

This contingency plan focuses on the Phase III water use restrictions and rationing that were evaluated here; however, the plan proposes a more gradual use of water use reduction techniques in a Phase II with the earlier introduction of voluntary measures first. The ultimate impact of the Phase III mandatory efforts varies over the study period, as a result of the effects of new growth and existing permanent water conservation measures (at future points in time). Restrictions (Table 5-38) begin at 16.0 percent effectiveness, for average annual demand, decline slightly, and then increase again to 16.8 percent by 2030. Rationing (Table 5-41) achieves between 28 percent and 30 percent reductions at various points in the study period.

In preparation for this plan, a local ordinance is developed prior to the period of water shortage. This ordinance makes the nature of the program apparent to those who are affected (in advance of the shortage) and permits them to make adjustments to the proposed program (ie., to initiate technology changes, introduce recycling, etc.). Non-critical or non-essential water use is targeted in Phases II and III. These uses include:

- o outdoor watering.
- o certain outdoor uses such as decorative fountains, street cleaning, hydrant flushing.
- o certain commercial, municipal and industrial practices, such as car washing, washing down facilities, etc.

B. <u>Phase II: Voluntary Reductions</u>

1. Ordinance defining water use restrictions and implementation.

Develop a Water Use Restrictions Ordinance

a. Define Restricted Uses.

(1) Watering of lawns, gardens, shrubs, except:
- o spray irrigation of sewage or storm water systems.
- o minimum requirements for tennis courts and golf-courses.
- o minimum requirements for residential and non-residential newly seeded or sodded grass areas with hand-held hose equipped with automatic shut-off nozzle, between hours of 5:00 P.M. and 9:00 A.M. (alternate day may also be used).
- o agricultural irrigation for production of food and fiber and maintenance of livestock (none expected.

(2) Washing paved surfaces such as roads, sidewalks, driveways, garages, parking areas, tennis courts and patios.

(3) Use of decorative water in fountains, artificial water falls, reflecting pools, etc.

(4) Use of water for washing or cleaning automobiles, trucks, trailers and boats, except:
- o recycled water
- o emergency equipment

(5) Use of water in restaurants, clubs, unless specifically requested.

(6) Use of water in swimming pools to fill or top-off, except:
- o if approved by public officials for public pool use.
- o if available from a water company serving the area where constraints are not in effect.

b. Define Implementation Procedure.

(1) Water use restrictions go into effect given any of the following:

- o formal public notice of drought by the State Governor.
- o formal public notice of drought by the mayor of the ECWD community.

(2) Notice includes identification of:

- o drought warning - (possible drought) - voluntary reductions.
- o drought watch - (probably drought) - voluntary reductions.
- o drought emergency (and severe drought emergency) - mandatory reductions with details of procedures to be taken.

C. Phase III: Mandatory Reductions

1. Ordinance Defining Mandatory Restrictions

a. Identify Restrictions of Phase II for Mandatory Restrictions.

b. Define Enforcement Methods.

(1) Fines

(2) Other measures

c. Define Plan De-Activation Process.

(1) Establish procedure

d. Define Appeal Process.

(1) Establish procedures

2. Ordinance Defining Rationing Program

a. Identify Water Use Permitted Residential Per Capita - 50 gallons per day.

(1) Commercial - 30 percent cut (based on meter reading)

(2) Industrial - 20 percent cut (based on meter reading)

(3) Public/Institutional - 35 percent cut (based on meter reading)

b. Define Plan De-Activation Process.

c. Define Enforcement Methods.

d. Define Appeals Process.

CHAPTER 6

LEVEL 3 EXAMPLE: WEST COAST WATER AND SEWER UTILITY

INTRODUCTION

The Level 3 example is a large, municipal combined water and sewer utility district spanning portions of two counties. The district, referred to as a West Coast Water and Sewer Utility (WCWSU), includes a western coastal, heavily urban area together with an eastern rural and growing suburban area. The district was formed in the 1920's to supply water from a mountain watershed 90 miles away, and broadened its service in the 1940's to include wastewater collection and treatment. Today the WCWSU provides water to roughly 1,000,000 people spread over 310 square miles, and sewer service to about 625,000 people and many industries within an area of 85 square miles. Fresh water sold and distributed by the WCWSU may flow into any one of 11 separately operated and maintained sewage collection systems.

The WCWSU has been selected as the Level 3 example because it has essentially complete data for water customers by class of customer, including large water users, for over ten yers; has extensive financial data for that period; meters its water use; has a well-thought out water pricing policy; and has projections of average water use by customer class through the year 2000. It only lacks various disaggregated projections of water use, some financial information and a long-term plan with projections to be considered a Level 4 example.

The district lies along the coast with a topography rising inland to a series of hills which give way to an arid eastern region. The district is near, but does not include a major river, and contains five small, independent watersheds. The geology of the district includes eight geologic formations, ranging from Holocene estuarine mud and Quaternary alluvium along the coast, to Quaternary and Tertiary sedimentary rocks and Tertiary volcanic rocks further inland. Two major active seismic faults are present, both of which experienced major earthquakes during the nineteenth century.

The climate is moderate, with approximately equal, distinct wet and dry seasons. The western portion is relatively dry, whereas the eastern portion across the hills is semi-arid. The overall average rainfall during the past 100 years has been about 22 inches per year, ranging from a low of 9 inches in 1975-76 to a high of 40 inches in 1981-82. The region has recently suffered from one of the longest dry spells in recent history, followed by the wettest year in this century, including a "100-year" storm. The air temperature for the area averages about 57° F with a range between 32-94° F. Winds during the summer are from the west averaging about 12 mph in the morning and 15 to 30 mph in the evening. Thermal inversions occur frequently, causing air pollution problems. Winds during the fall, winter and spring are more variable, but are more prevalent from the south than from other directions.

HISTORICAL GROWTH AND DEVELOPMENT

Population

The WCWSU currently provides metered water service to 325,800 customers in 17 incorporated cities and 13 unincorporated communities with an estimated 1983 population of 1,080,000. The district lost population between 1970 and 1980, after gaining at a compound annual rate of about 1.1 percent between 1950 and 1970, as shown in the Table 6-1.

TABLE 6-1
WCWSU DISTRICT POPULATION FIGURES

YEAR	POPULATION	PERCENT CHANGE DURING DECADE	RATE (%)*
1950	851,100	58 (1940-1950)	4.5
1960	978,500	15	1.4
1970	1,067,200	9.1	.87
1980	1,058,000	(- .86)	(- .09)
1983	1,080,000 (est.)	2.1 (3 years)	.69

*Annual compound rate.

Households

The number of households, on the other hand, continued to increase regularly between 1950 and 1980, as shown in Table 6-2:

TABLE 6-2
WCWSU HOUSEHOLDS 1950-1980

YEAR	HOUSEHOLDS	PERCENT CHANGE DURING DECADE	RATE (%)*
1950	287,000	-	-
1960	336,000	17	1.6
1970	395,000	17	1.6
1980	448,000	13	1.3

*Annual compound rate.

Industry and Commerce

The WCWSU service area contains three large oil refineries and 22 other major industrial users of water. Other major water users include 12 chemical manufacturers or processors, 13 food and beverage processors or distributors, 2 laboratories, 4 laundries, 11 machinery manufacturers, 5 pulp and paper products firms, 3 other manufacturing facilities, 2 utilities, 3 major transportation facilities, 5 Federal facilities, 3 hospitals and a major university. Numerous small-scale irrigated facilities include 18 golf courses, 10 cemeteries, 1 equestrian center, 20 parks, 4 public gardens and roughly 100 farms.

Employment in the service area increased rapidly between 1950 and 1970 but levelled off between 1970 and 1980. Nearly all of the industrial and commercial employment is located in the western coastal region of the district, with the residential areas lying inland.

Land Use

The WCWSU service area is heavily urbanized along the coast, with industrial and port facilities and government installations directly on the waterfront, high density (15 or more net housing units per acre) residential areas occurring inland in the cities, low density suburban residential areas occupying the rising slopes and hills to the east, lower density suburban and rural residential areas over the hills further east, relatively small agricultural areas in the valleys to the east, and considerable parkland along the ridges of the hills and down the arid slopes to the east. Rough estimates of land use are as follows:

TABLE 6-3
WCWSU LAND USE

TYPE OF LAND USE	PERCENT
Industrial/Commercial	10
Residential	
(High Density)	20
(Low Density)	35
Agricultural	5
Parklands	30

FUTURE GROWTH AND PROJECTIONS

Population

The regional government has made projections of the population of the WCWSU service area based on U.S. Census Bureau Series A through E assumptions of demographic variables and net in-migration. Two mid-range estimates are shown in Table 6-4.

TABLE 6-4
WCWSU POPULATION PROJECTIONS

	POPULATION	
YEAR	Estimate C	Estimate D
1980	1,058,000	1,058,000
1985	1,125,000	1,130,000
1990	1,190,000	1,200,000
1995	1,210,000	1,215,000
2000	1,215,000	1,225,000

Previous estimates, made in 1974, projected much higher values, ranging from 1,341,000 to 1,562,000 in the year 2000. The 1980 census which indicated a slight drop in population from 1970 has caused the regional planners to become considerably more cautious in their estimates. However, the increase in population since 1980 appears to be real, and gives credence to the above continuing increase in population estimates.

The higher estimate given above includes potential areas to be annexed by the WCWSU. At this time, these areas are relatively small. The "ultimate" service area boundary is considerably larger, but is not expected to be realized in this century. The population is expected to shift from the older cities in the western part of the district to the suburban and rural areas towards the east.

Housing

The increase in housing, which has continued since 1970 despite the temporary decline in population, can be explained by the changing character of households in which larger numbers of single persons and smaller families are requiring housing units of their own. This trend is expected to continue. The WCWSU estimate is described in Table 6-5.

TABLE 6-5
WCWSU HOUSING PROJECTIONS

YEAR	ESTIMATED HOUSING UNITS
1980	448,000
1985	480,000
1990	525,000
1995	540,000
2000	551,000

Industry and Commerce

Industrial and commercial production and employment decreased substantially during the recession of 1981-83, but have regained much of the losses with the economic upturn. The oil refineries, however, are still operating considerably below capacity. Increased warehousing activities along the waterfront is to be expected because of the excellent transportation facilities there, but little increase in manufacturing is likely because of pollution regulations and lack of land for new plants. The food processors may tend to move closer to the growing areas in the central valley out of the WCWSU boundaries. Otherwise, no large water-using industries are expected to move into or out of the WCWSU area. Some increase in employment may occur in the finance/insurance/business and other service sectors.

WATER AND WASTEWATER SYSTEMS

Water Supply

The WCWSU principal source of water supply is a mountain river which was dammed for that purpose in the 1920's. Runoff from snow and rain in the mountains is stored in the reservoir above the dam and conveyed 90 miles through three aqueducts to the WCWSU service area. A second reservoir was later constructed downstream from the storage reservoir to provide for downstream water rights and flood control, but is not physically connected to the aqueducts. The WCWSU has water rights to 325 mgd from this primary supply source, but the safe yield (the maximum continuous amount of water available during the worst drought of record) has been downgraded to 212 mgd, following the drought of 1975-1978. Further upstream diversions in accordance with existing rights expected to be exercised, and additional channel losses due to declining groundwater tables, lead to an estimate of 173 mgd as the safe yield by the year 2000.

The raw water is conveyed to five earthfill dam reservoirs within the WCWSU boundaries, built between 1875 and 1964. This local reservoir system is designed to deliver water to the WCWSU treatment plants and distribution system, re-regulate the imported water supply, provide emergency service capability, and conserve local watershed runoff. In an average year, only about 5 percent of the total district water supply is derived from local runoff since evaporation and other losses are generally slightly less than annual inflow. Total storage capacity is 2,026 billion gallons.

Nine raw water tunnels/aqueducts convey water from the local storage to 7 water treatment facilities, constructed between 1890 and 1967. Total nominal treatment capacity is 469 mgd. The four oldest plants provide aeration, coagulation, sedimentation, filtration and chlorination while the three newer plants provide only filtration and chlorination. The oldest plant is not currently used but is available for emergency service.

Four tunnels/aqueducts convey the treated water to the distribution system consisting of 111 pressure zones and a total of 838 million gallons of treated water storage in 168 tanks and reservoirs.

Water Quality

Raw water from the mountain river is of excellent quality, averaging roughly 40 mg/l total dissolved solids (TDS). However, local runoff into the terminal reservoirs ranges from 400 to 900 mg/l TDS. Some of the mountain water is delivered directly to customers following filtration and chlorination in the treatment plants, and the resulting end-use water quality remains excellent with less than 40 mg/l TDS and 20 mg/l alkalinity. In other parts of the WCWSU system, the mountain water is mixed with local runoff, and the resulting end-use water quality can range from 40 to 60 mg/l TDS and 20 to 80 mg/l alkalinity (as $CaCO_3$). Even with these local variations, all WCWSU water is considered to be of excellent quality.

Recently, concern has been expressed over the possible formation of trihalomethanes from the action of chlorine on naturally-occurring organic material in the water. Tests have shown that trihalomethane concentrations in WCWSU end-use water are well below the level established by the U.S. Environmental Protection Agency. The WCWSU is completing construction of a chlorine injection system between the storage reservoir and the local storage to provide a "booster treatment" so as to decrease the amount of chlorine needed in the primary treatment and reduce even further the potential for trihalomethane formation. The use of chloramines as a disinfectant instead of straight chlorine is also being tested.

Tests on WCWSU delivered water for asbestos and a wide variety of organic compounds indicates zero to very low levels of any potential harmful materials, all below existing or recommended regulations. Fluoride is added to the treated water, in accordance with a 1976 vote of the population served, and lime and sodium hydroxide are added to prevent corrosion in the distribution pipelines.

Water Use

Historic water use is illustrated in Figure 6-1 and listed in detail in Table 6-6 for the user categories of residential, public authority, commercial, industrial, and oil refineries. The first three categories are divided between "Suburban" (a primarily arid region in the east) and "Urban" (the western urbanized area) because of the marked difference in per capita and total water use between these sections of the WCWSU service area. Table 6-7 gives per capita consumption for the period 1960 through 1974. Table 6-8 gives gross residential and per capita (gpcd) residential consumption.

TABLE 6-6
WCWSU METERED CONSUMPTION BY CATEGORY (1960-1974)
(MGD)

YEAR	RESIDENTIAL		PUBLIC AUTHORITY		COMMERCIAL		IND.	OIL
	SUB.	URB.	SUB.	URB.	SUB.	URB.		REF.
1960	9.76	68.30	0.420	12.11	0.901	14.45	19.72	14.84
1961	10.20	66.45	0.487	12.22	1.33	14.87	20.60	15.24
1962	11.66	69.90	0.552	13.06	1.59	15.39	21.49	15.36
1963	10.94	66.02	0.482	12.31	1.58	15.60	21.93	16.00
1964	12.43	71.17	0.542	13.24	1.84	16.28	21.27	17.02
1965	14.14	72.56	0.621	13.37	2.16	17.03	22.45	18.25
1966	16.25	76.10	0.678	14.95	2.31	17.17	23.38	20.09
1967	16.39	74.81	0.686	15.53	2.32	17.66	24.18	23.15
1968	19.18	78.62	0.804	16.09	2.84	18.88	23.48	24.74
1969	18.67	77.41	0.861	16.22	2.81	19.84	24.59	23.42
1970	22.67	85.39	1.021	17.83	3.18	20.65	25.31	24.88
1971	21.76	81.80	1.021	17.79	2.92	20.39	22.64	23.56
1972	24.57	85.02	1.230	18.74	3.42	21.18	20.90	24.20
1973	24.50	82.33	1.167	17.14	3.19	19.44	21.62	24.22
1974	23.72	78.88	1.230	16.85	3.68	19.52	21.62	24.20

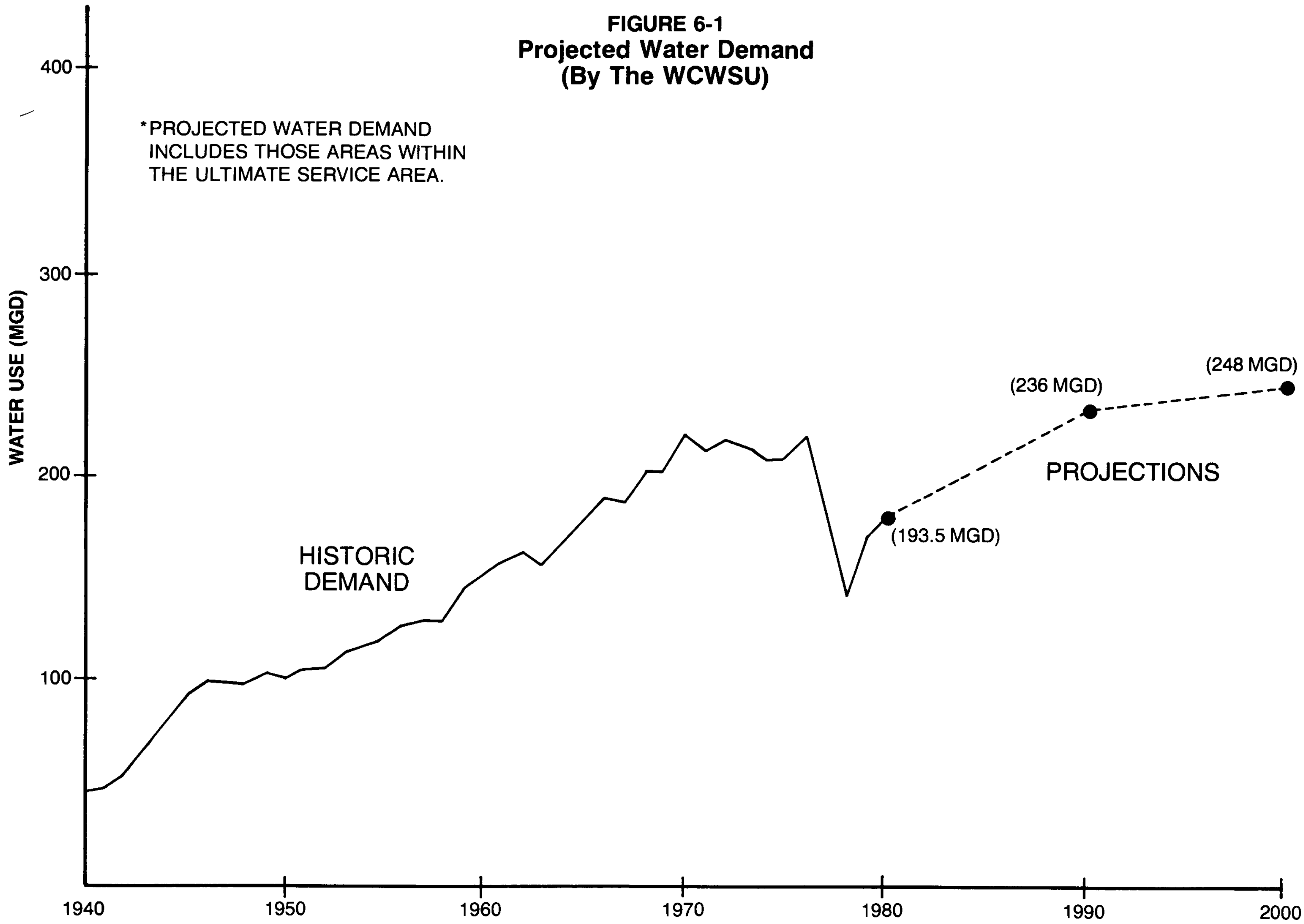


FIGURE 6-1
Projected Water Demand
(By The WCWSU)

TABLE 6-7
WCWSU METERED PER CAPITA CONSUMPTION (1960-1974)
(GALLONS PER CAPITA PER DAY)

YEAR	RESIDENTIAL		PUBLIC AUTHORITY		COMMERCIAL		IND.	OIL
	SUB.	URB.	SUB.	URB.	SUB.	URB.		REF.
1960	133.0	75.4	5.7	13.4	12.3	16.0	20.6	15.1
1961	130.1	73.1	6.2	13.4	17.0	16.3	20.9	15.3
1962	139.5	76.5	6.6	14.3	19.0	16.8	21.5	15.4
1963	123.2	71.9	5.4	13.4	17.8	17.0	21.8	15.9
1964	132.2	77.2	5.8	14.4	19.6	17.7	20.9	16.7
1965	142.5	78.4	6.3	14.5	21.8	18.4	21.9	17.9
1966	155.7	81.9	6.5	16.1	22.1	18.5	22.6	19.5
1967	149.7	80.2	6.3	16.7	21.2	18.9	23.2	22.2
1968	167.4	84.0	7.0	17.2	24.8	20.2	22.3	23.5
1969	156.0	82.4	7.2	17.3	23.5	21.1	23.2	22.1
1970	181.8	90.6	8.2	18.9	25.5	21.9	23.7	23.3
1971	168.3	86.7	7.9	18.9	22.6	21.6	21.1	22.0
1972	179.9	90.0	9.0	19.8	25.0	22.4	19.4	22.5
1973	177.7	87.1	8.5	18.1	23.1	20.6	20.0	22.4
1974	166.8	83.2	8.6	17.8	25.9	20.6	19.9	22.2

TABLE 6-8
WCWSU GROSS RESIDENTIAL CONSUMPTION, TOTAL DISTRICT
FISCAL 1960-1974

FISCAL YEAR	GROSS RESIDENTIAL CONSUMPTION (MGD)	PER CAPITA CONSUMPTION (GPCD)
1960	84.4	86.3
1961	84.5	85.5
1962	88.2	88.4
1963	82.4	81.9
1964	91.0	89.6
1965	95.9	93.6
1966	102.5	99.2
1967	97.8	93.9
1968	107.4	102.2
1969	105.1	99.3
1970	117.8	110.4
1971	113.4	105.7
1972	119.6	110.9
1973	117.6	108.8
1974	113.3	104.0

Total water use increased regularly from about 100 mgd in 1945 to over 220 mgd in 1970 and then varied between about 210 to 220 mgd between 1971 and 1976. In 1977, the full impact of the drought hit the WCWSU, and mandatory restrictions on water use were applied. Water consumption fell to 135 mgd in that year.

Since the drought, water use has recovered somewhat, increasing to 170 mgd in 1978, 183 mgd in 1979, and 196 mgd in 1980. The extremely wet year of 1981 caused consumption to decrease to 189 mgd in that year, but increased again in 1982 to 191 mgd and to 203 mgd in 1983.

WCWSU estimated water demands are illustrated in Figure 6-2 for three scenarios of future population growth, industrial and commercial activity, and residual impacts of the 1975-1978 drought. These projections were made in 1979. Table 6-9 gives a breakout of the individual user categories for actual consumption in 1975, 1976 and 1977. Table 6-9 presents summarized historic water information for metered and gross water use, including residential use for the east suburban and west urban areas, and use by 25 major water users, as well as information on "unaccounted-for water", including WCWSU use and variance which account for about 11 percent of the total water requirement. The historic years presented also include the drought of 1976-1977. Table 6-9 also includes projections for the three scenarios for 1980, 1990 and the year 2000. The actual consumption for 1980, 196 mgd, is exactly the same as the "most likely" scenario. Individual category projections of demand are shown in Figure 6-3 for the 1979 estimates, and in Figure 6-4 for estimates published in the five-year plan 1985-1989 published in March 1984.

The drought had a much greater impact on the major water-using category, residential use, than on commercial and industrial use. Residential water use rebounded promptly after the drought, but not to historic levels. In a survey published in January 1981, most individual users reported that they were still conscious of the need to conserve water and were continuing to do so, though not to the degree that was mandated during the height of the drought. Industrial and commercial water use is expected to continue to increase as the recession ends and production returns to previous and then to increased levels.

All of the projections of future water demand illustrated in Figures 6-2 through 6-4 indicate estimates exceeding the primary water supply source safe yield of 173 mgd in the year 2000. Therefore, additional sources of water are being sought to decrease the probability and risk of another severe water shortage during a future period of drought.

Table 6-10 shows the "drought carry-over reduction factors" estimated in 1979.

TABLE 6-10
WCWSU DROUGHT CARRYOVER REDUCTION FACTORS (PERCENT)

	EAST-SUBURBAN	WEST-URBAN	DISTRICT-WIDE
Case I (High)	0	0	0
Case II (Low)	30	20	23
ML (Most Likely)	15	10	11.5

FIGURE 6-2
Gross Water Requirements
(By The WCWSU)

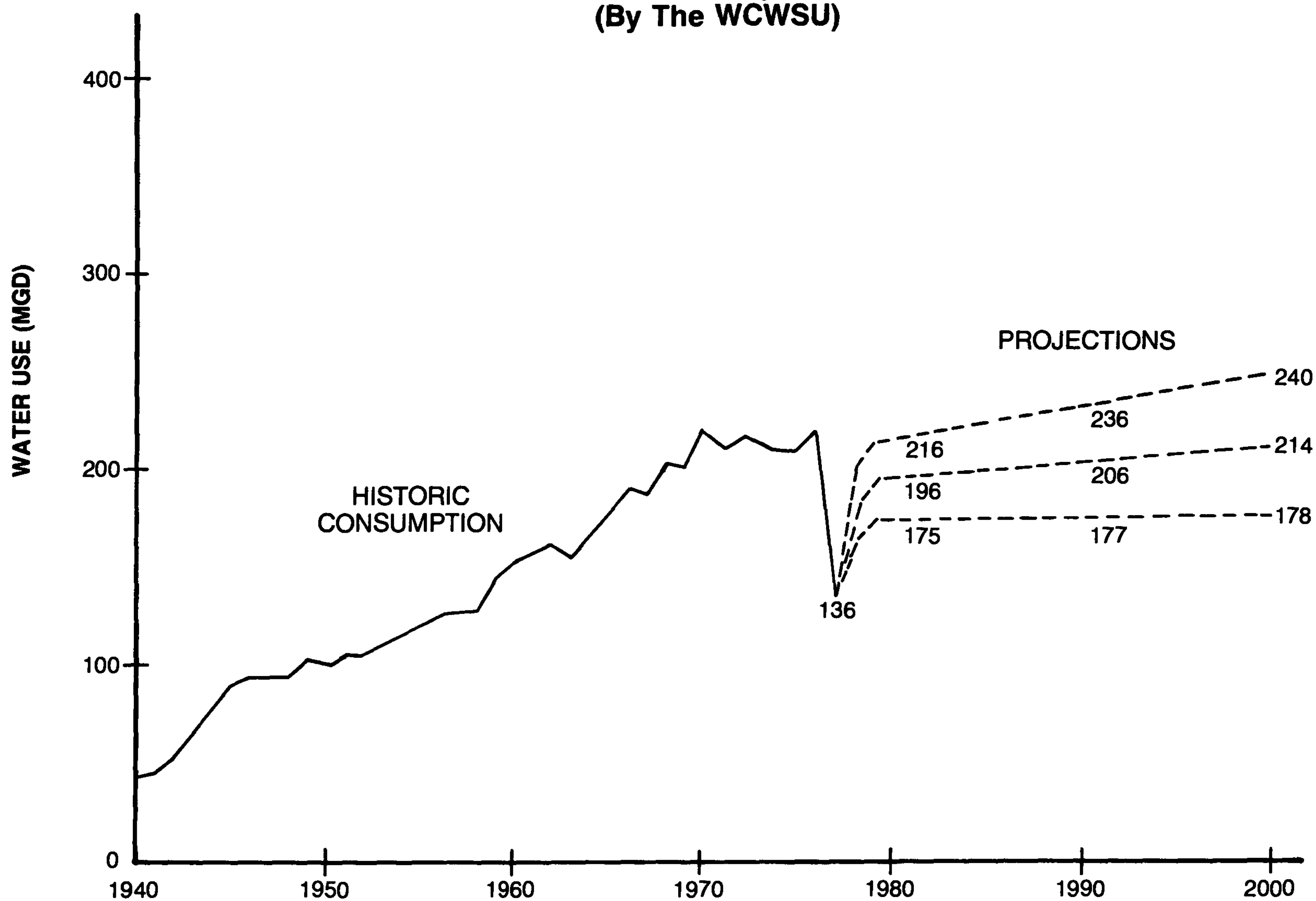
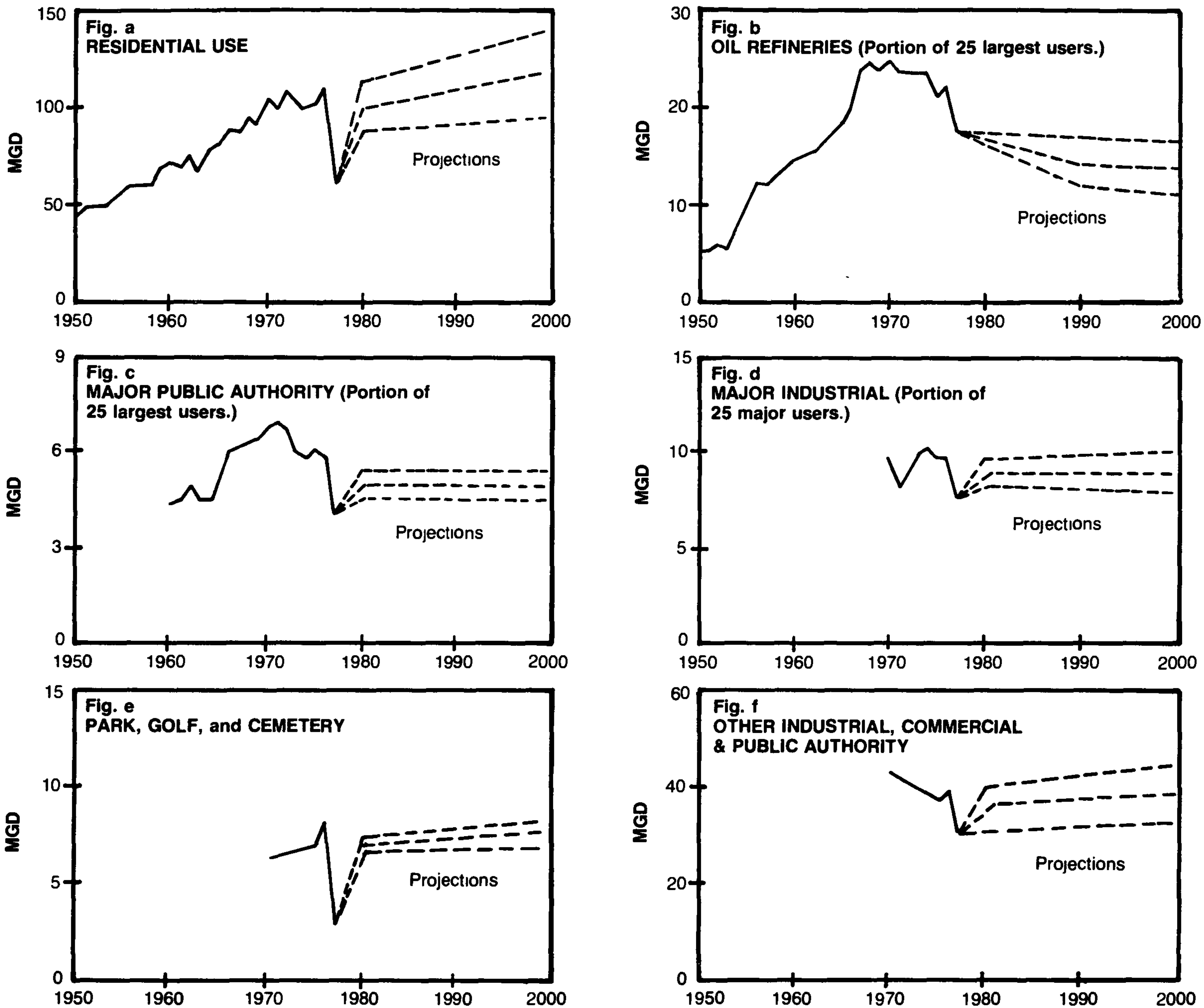


TABLE 6-9
WATER REQUIREMENTS BY CATEGORY
(Million Gallons Per Day)

CATEGORY	1975	1976	1977	CASE II (LOW) 1980	CASE II (LOW) 1990	CASE II (LOW) 2000	CASE ML (MOST LIKELY) 1980	CASE ML (MOST LIKELY) 1990	CASE ML (MOST LIKELY) 2000	CASE I (HIGH) 1980	CASE I (HIGH) 1990	CASE I (HIGH) 2000
METERED USE:												
Residential:												
Suburban	25.6	28.9	12.0	24.6	30.7	31.1	28.0	35.9	36.6	31.1	40.8	41.9
Urban	81.1	85.2	47.0	66.8	66.2	68.1	76.6	78.6	84.7	85.3	89.9	100.2
Subtotal	106.7	114.1	59.0	91.4	96.9	99.2	104.6	114.5	121.3	116.4	130.7	142.1
25 Major Users:												
Oil Refinery	21.2	22.3	17.5	16.6	11.9	11.2	17.1	14.2	14.0	17.5	16.8	16.9
Major Ind.	9.7	9.5	7.5	8.3	8.0	8.0	8.9	8.9	8.9	9.6	9.8	10.0
Maj. Pub. Auth.	6.1	5.9	4.0	4.6	4.5	4.5	5.0	4.9	4.9	5.4	5.4	5.4
Subtotal	37.0	37.7	29.0	29.5	24.4	23.7	31.0	28.0	27.8	32.5	32.0	32.3
Parks,Golf,Cem.	7.0	7.9	2.7	6.6	6.8	6.8	7.0	7.4	7.5	7.4	7.9	8.1
Other, Ind., Com. and Pub. Auth.	37.3	39.3	30.2	31.7	32.6	32.1	35.8	37.7	37.9	39.8	42.7	43.7
TOTAL METERED:	188.0	199.0	120.9	159.2	160.7	161.8	178.4	187.6	194.5	196.1	213.3	227.2
GROSS WATER USE:												
District Use	1.2	1.0	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Variance	19.0	21.9	13.6	15.2	15.4	15.5	17.0	17.8	18.6	18.7	20.4	21.6
TOTAL REQUIREMENT	208.2	221.9	135.2	175.4	177.1	178.3	196.4	206.4	214.1	215.8	234.7	248.8

FIGURE 6-3
WCWSU Use Projections
By Category (By The WCWSU)



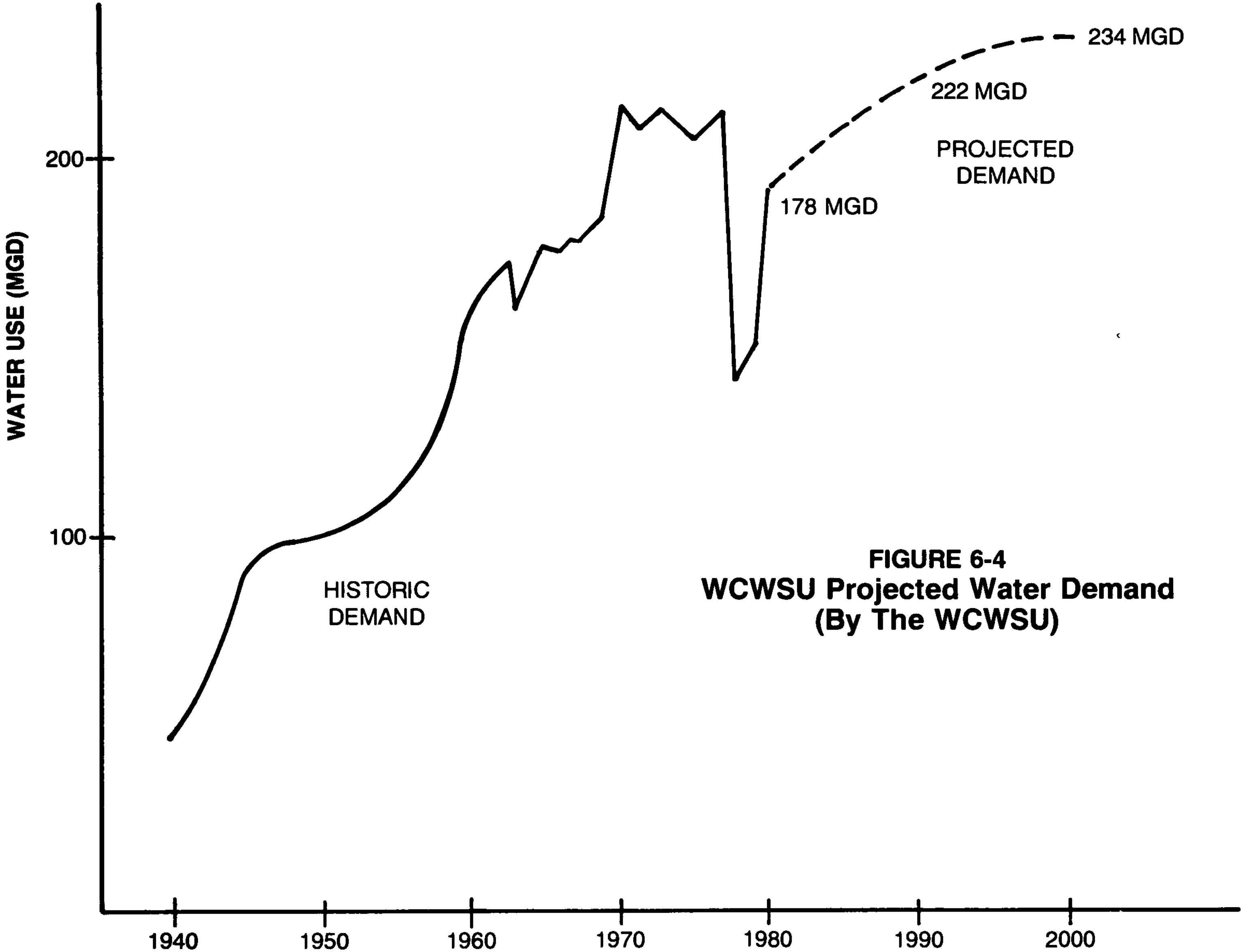


FIGURE 6-4
WCWSU Projected Water Demand (By The WCWSU)

Water Resources

The annual consumption of water above the safe yield of the primary supply source means that during one or more years of drought, there will be a shortfall requiring the imposition of, first, voluntary and later mandatory conservation measures and/or rationing, as occurred during 1976 and 1977. As annual average consumption increases, the likelihood of deficiencies and the probability of imposing conservation measures also increases. Table 6-11 indicates the expected deficiencies at various levels of "nominal draft" (annual average consumption) based on 76 years of hydrologic records up through 1982. For instance, given the most likely value of consumption in the year 2000, about 250 mgd, there has been one year with a deficiency greater than 25 percent (62.5 mgd). These probabilities are plotted in Figure 6-5 which illustrates the frequency with which a given level of deficiency would be experienced for various levels of consumption.

TABLE 6-11
WCWSU EXPECTED DEFICIENCIES
BASED ON 76 YEARS OF HYDRAULIC RECORDS

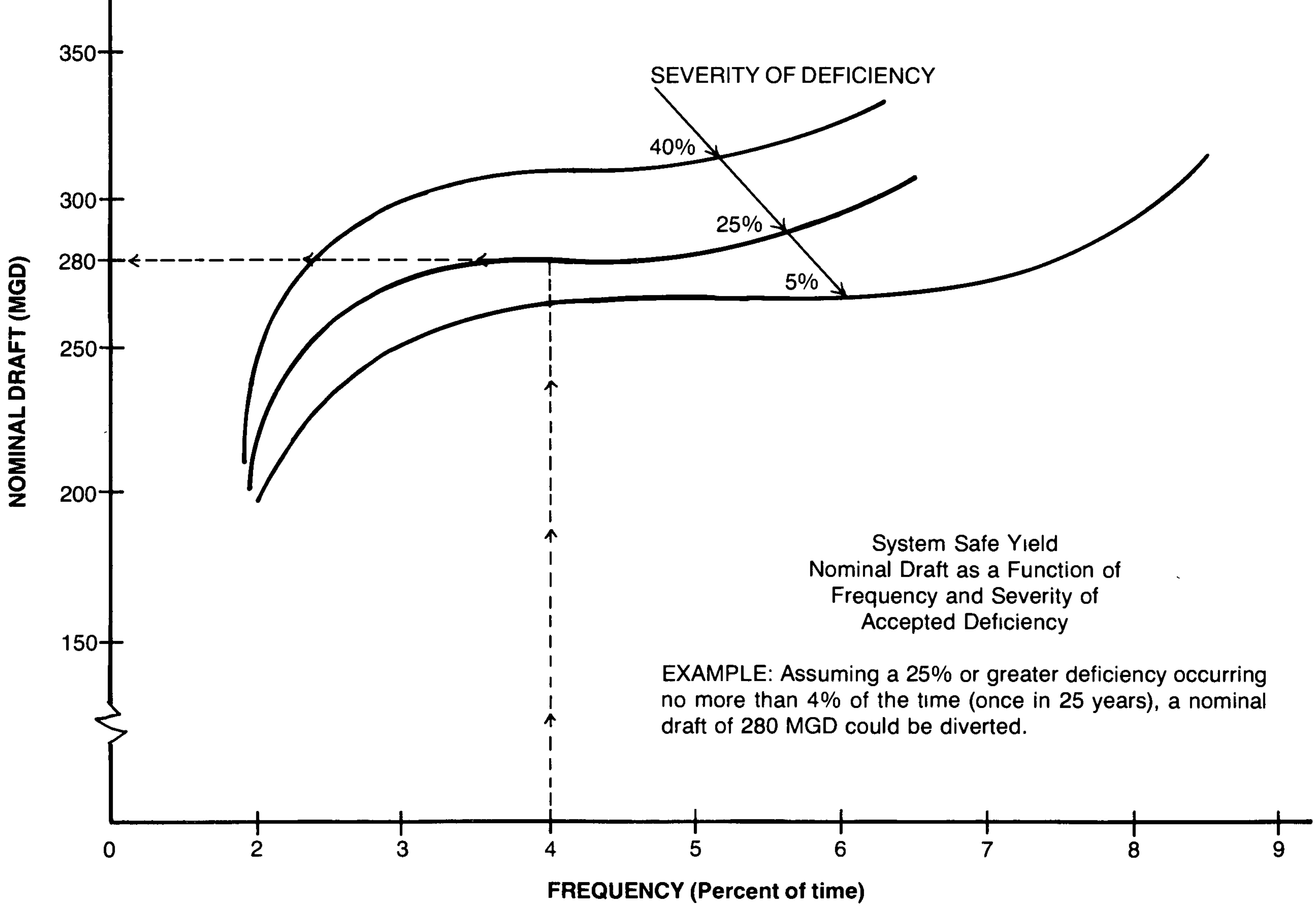
NOMINAL DRAFT (MGD)	TOTAL NUMBER OF YEARS WITH DEFICIENCIES	---NUMBER OF YEARS WITH DEFICIENCIES OF--- UP TO 10%	10% TO 25 %	25 % AND GREATER
325	8	4	0	4
300	8	4	1	3
280	7	3	2	2
275	7	3	3	1
270	7	4	2	1
265	7	5	1	1
260	5	4	0	1
255	2	1	0	1
250	1	0	0	1
240	1	0	0	1
220	1	0	0	1
200	1	0	1	0
180	1	1	0	0
178	0	0	0	0

Since the duration and severity of a drought are uncertain, WCWSU planners have been concerned with augmenting the primary source with additional assured water supply sources. There are five additional sources of water supply potentially available to the WCWSU:

1. Further development of the primary supply: This option is an extremely remote possibility because in obtaining its previous increase in entitlement from 200 mgd to 325 mgd, the district indicated it would not seek any added water from the basin. No further consideration of this option will be made.

2. Additional development of groundwater supplies: This option has probably already been foreclosed. Groundwater was an early source of water in the area. With the availability of the primary supply in the 1920's, WCWSU use

FIGURE 6-5
Risk of Deficiency
WCWSU Safe-Yield



of groundwater was discontinued. However, private wells continued to be used. During the 1975-1978 drought, many new private wells were drilled. Current estimates by WCWSU of the safe yield of groundwater is about 7 mgd, roughly equivalent to the estimated current withdrawal from the private systems. There appears to be little potential for significant WCWSU use of groundwater.

3. De-salting of ocean or bay waters: This option appears to be far too expensive to consider further.

4. Reclaimed water: This option was studied extensively by a private contractor for WCWSU in 1979. Appropriate uses for water reclaimed from waste-water treatment or other uses include (a) industrial cooling, (b) certain industrial process waters, and (c) irrigation of golf courses, cemeteries and parks. Inappropriate uses include potable water supplies, non-potable domestic supplies (using dual water supply systems), groundwater recharge, and stream flow augmentation/marsh enhancement/recreation impoundments. Twenty-eight wastewater reclamation projects were formulated for the WCWSU area. Without grants to reduce costs, financial costs of the projects range from $738 to $4,160 per million gallons as compared to water rates charged by the WCWSU of $454 to $589 per million gallons (excluding meter charges) in 1978. (Wastewater reclamation costs in 1980 are estimated at $845 to $4,760, based on a 7 percent/year escalation.) The study recommended against proceeding with any major water reclamation project primarily because of the estimated project's non-viable economics.

5. Development of an additional major river source: This option was recognized during the 1960's by the WCWSU when rapidly increasing consumption indicated that additional water supply sources would be needed by the mid 1980's. After numerous studies and extensive negotiations with the U.S. Bureau of Reclamation, WCWSU contracted with BuRec in December 1970 for up to 150,000 annual acre-feet (about 134 mgd) from an existing canal which presently conveys water from a tributary of the nearby major river south to agricultural and other users outside of the WCWSU district. This was the highest quality water available from the only agency in the area with water available for sale. The contract requires the WCWSU to take and pay for an increasing amount of water starting in 1974 at $16 per acre-foot for 40 years. Water not taken can be credited to amounts needed in future years.

WCWSU actually drew water under this contract only in 1977 during the height of the drought. A total of approximately 25,000 acre-feet were diverted into the existing aqueduct system from a pumping station constructed on an emergency basis in the delta area of the main river, rather than on the canal from the tributary as originally conceived. A filtration, chemical treatment and chlorination facility was also installed to treat the low quality delta water.

Controversy has arisen over the location of the diversion point for WCWSU to take the contracted-for water from BuRec. The state and other agencies have urged that the water be taken either from the main river or from the delta region, rather than from the canal. The WCWSU would have to construct a major aqueduct from the canal to its local storage system and has developed a conceptual design which would minimize earthquake and flooding problems and serve as a backup to the existing primary source aqueducts in case of damage to them. A study of the impact of the various sources of water on the water quality of the

WCWSU system was completed in September 1983. Additional studies on the location of the diversion point are being conducted.

This option, to implement the 1970 contract with BuRec for up to 134 mgd (possibly only about 70 mgd safe yield), is considered the "LOCAL-1" project for analysis (see below) as to the impact of water conservation measures on the need for additional water supplies. The future costs of this LOCAL-1 supply were established in a 40-year contract (Table 6-12).

TABLE 6-12
MINIMUM PAYMENT FOR LOCAL-1 SUPPLY

YEAR	MINIMUM WATER USE (A-F)	ESTIMATED MINIMUM PAYMENT ($)
1974	1,500	$ 24,000
1975	3,000	48,000
1976	4,500	72,000
1977	6,000	96,000
1978	7,500	120,938
1979	9,000	146,250
1980	10,500	170,625
1981	12,000	195,000
1982	13,500	219,375
1983	15,000	224,950
1984	15,000	246,150
1985	15,000	246,150
1986	15,000	246,150
1987	15,000	246,150
1988	15,000	246,150
1989	15,000	246,150
1990	15,000	246,150
1991	22,500	369,225
1992	30,000	492,300
1993	37,500	615,375
1994	45,000	738,450
1995	52,500	861,525
1996	60,000	984,600
1997	67,500	1,107,675
1998	75,000	1,230,750
1999	82,500	1,353,825
2000	90,000	1,476,900
2001	97,500	1,599,975
2002	105,000	1,723,050
2003	112,500	1,846,125
2004	120,000	1,969,200
2005	127,500	2,092,275
2006	135,000	2,215,350
2007	142,500	2,338,425
2008	150,000	2,460,750
2009	150,000	2,460,000
2010	150,000	2,460,000
2011	150,000	2,460,000
2012	150,000	2,460,000
2013	150,000	2,460,000

A number of additional water supply augmentation projects outside the WCWSU area have been under study for several years by other local, state, and Federal agencies. The local and state projects were effectively quashed by the voters in June 1982 by the rejection of Proposition 9 which would have allowed the construction of the "Peripheral Canal", groundwater storage, and two large surface reservoirs. The Federal Bureau of Reclamation has been studying the safety of a proposed dam on a major river (this Federal project is referred to as the "BR-1" project) in the area and may become involved in some of the projects noted above.

The BR-1 project is capable of providing additional water supply for municipal, industrial and agricultural use, flood control, and recreation. The water supply storage is 25,600 acre-feet (22.8 mgd). The cost of this water supply, all of which would be allocated to the WCWSU, is $18.95/AF ($58.30/mg), based on the Non-Federal share for capital and operation and maintenance cost recovery.

Sewer System

The WCWSU provides wastewater collection and treatment services for about 625,000 people and many industries in an 85 square-mile service area. Water sold by the WCWSU, however, may flow into any one of 11 separately operated and maintained sewage collection systems. Eight of the 11 service areas operate sewage treatment plants located within the WCWSU's water supply area; these are:

1. WCWSU Service
2. C-Val Service
3. City of P. Service
4. WCC Service
5. City of R. Service
6. City of S.L. Service
7. R. Service
8. O.L. Service

The other three areas include the C.V. Service which only operates a collection system, with wastewater treated at the O.L. Service area. Two other services operate sewage treatment plants outside of the WCWSU area, including:

1. CCC Service
2. V.C. Service

During 1975, the breakdown of wastewater production was approximately:

	WCWSU AREA (MGD)
Western "Urban" Area	110
Eastern "Suburban" Area	20
WCWSU TOTAL (Water Service Area)	130

Most of the wastewater in the eastern "suburban" area flows into the CCC Service. This wastewater is treated at the CCC's new treatment plant which is outside the WCWSU area. The treated effluent is the source for a 15 mgd industrial water reclamation facility in the CCC area.

Wet and dry period flows vary significantly for the area and for each plant. Table 6-13 presents the wet and dry flows for wastewater plants in the WCWSU water service area and the hydraulic and secondary treatment capacity for the WCWSU treatment facility.

TABLE 6-13
WCWSU WATER SERVICE AREA
WASTEWATER TREATMENT PLANT DRY AND WET WEATHER FLOWS (MGD) [1]

	WCWSU PLANT		S.P. PLANT		CITY OF R. PLANT		S.L. PLANT		R. PLANT		P. PLANT	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
1975	68	102	6.13	10.73	6.14	12.90	6.98	9.42	.78	NA	1.50	1.97
Drought	56	-	4.45	-	4.78	-	3.81	-	.49	-	.82	-
1980	90	135	6.94	12.15	6.49	13.63	7.0	9.45	1.07	NA	2.48	3.25
1990	100	150	8.16	14.28	6.78	14.24	7.6	10.26	1.28	NA	4.33	5.67
2000	110	165	8.61	15.07	7.12	14.95	7.6	10.26	1.28	NA	5.28	6.92

[1] Dry Weather Flow based on WCWSU 1979 report Wastewater Reclamation Project Report (Table VII-1); Wet Weather Flows estimated based on Wastewater Reclamation Study prepared for the WCWSU in 1974 by a consulting firm (Figure 8-1).

It is apparent from these wet and dry weather flows that the wastewater systems are experiencing a considerable amount of inflow and infiltration (I&I). The WCWSU is attempting to locate the source of this 50 percent increase in flows during wet weather. The City of R. Plant flow increases by more than 100 percent during wet weather.

WCWSU PROCEDURES MANUAL APPROACH

This section begins the Procedures Manual approach for the Level 3 example. Appendix B (Level 3 methods) describes the general procedures followed. Each Step in the analysis is described here for this situation where fairly extensive data are available.

STEP 1: Universe of Water Conservation Measures

Appendix A, Table A-1 again provides the long list of possible water conservation measures that can be considered. (See Appendix A for descriptions of measures, and Chapter 3, GENERAL ISSUES, for relevant cautions, especially "Planning a Water Conservation Program.") Table 6-14, "Potential Water Conservation Measures", serves as a Summary Table for the screening analysis in Steps 1-4. The water conservation methods that pass through this screening have a chance for implementation in the Level 3 WCWSU area.

STEP 2: Applicability

In terms of jurisdictions and institutional authority, the WCWSU area is extremely complex. The water service area boundary includes major portions of two counties, completely contains numerous cities and communities, sanitary districts, commissions, planning agencies and is influenced directly by state and Federal regulatory bodies, including the U.S. Army Corps of Engineers. As a result, the analysis of the existence of previously implemented water conservation measures required an intensive effort to determine who, in addition to the WCWSU, had initiated measures in the past and what measures were implemented previously as long-term devices to achieve water use reduction.

TABLE 6-14

POTENTIAL WATER CONSERVATION MEASURES: WCWSU/LEVEL 3

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
REGULATION			
LONG-TERM			
Federal & State Laws & Policies			
A. Federal Laws and Policy	No		
B. State Policy (1983)	No		
1. Plumbing Code	No		
2. Other Policy	No		
Local Codes & Ordinances			
A. Plumbing Codes for New Structures			
1. Low-flow showerheads	No	F	
2. Shower flow restrictors	No	F	
3. Toilet dams	No	F	
4. Displacement devices	No	F	
5. Flush mechanisms	No	F	
6. Low-flush toilets	No	F	
7. Pressure toilets	No	F	
8. Dual-flush toilets	Yes	F	NA
9. Faucet aerators	No	F	
10. Faucet restrictors	No	F	
11. Pressure reducing valves	No	F	
12. Service line restrictors	No	F	
13. Insulated hot water lines	No	F	
14. Pre-mixed water systems (thermostatic mixing valves)	No	F	NA
15. Low water-using clothes washers	No	F	
16. Low water-using dishwashers/ appliances	No	F	
17. Dry composting toilets	Yes	F	NA
18. Grey water systems (reuse)	Yes	F	Yes
19. Leakage repair (private systems)	Yes	F	Yes
20. Industrial recycle	Yes	F	Yes
B. Plumbing Codes--retrofitting			
1. Low-flow showerheads	Yes	F	Yes
2. Shower flow restrictors	Yes	F	Yes
3. Toilet dams	Yes	F	Yes
4. Displacement devices	Yes	F	Yes
5. Flush mechanisms	Yes	F	Yes
6. Low-flush toilets	Yes	F	Yes
7. Pressure toilets	Yes	F	Yes
8. Dual-flush toilets	Yes	F	Yes
9. Faucet aerators	Yes	F	Yes
10. Faucet restrictors	Yes	F	Yes
11. Pressure-reducing valves	No	F	
12. Service line restrictors	No	F	

TABLE 6-14 (CONTINUED)
WATER CONSERVATION MEASURES: WCWSU/LEVEL 3

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
13. Service line restrictors	Yes	F	Yes
14. Pre-mixed water systems (thermostatic mixing valves)	Yes	No	NA
15. Low water-using clothes washers	Yes	F	Yes
16. Low water-using dishwashers/ appliances	Yes	F	Yes
17. Dry composting toilets	Yes	F	NA
18. Grey water systems (reuse)	Yes	F	Yes
19. Leakage repair (private systems)	Yes	F	Yes
20. Industrial recycle	Yes	F	Yes
C. Sprinkling Ordinances			
1. Alternate day	Yes	F	Yes
2. Time of Day	Yes	F	Yes
3. Hand-held hose	Yes	F	NA
4. Drip irrigation techniques	Yes	F	NA
D. Changes in Landscape Design	Yes	F	Yes
E. Water Recycling	Yes	F	Yes
Restrictions			
A. Rationing			
1. Fixed allocation	Yes	F	Yes
2. Variable percentage plan	Yes	F	NA
3. Per capita use	Yes	F	No
4. Prior use basis	Yes	F	No
B. Restrictions on Specific Uses			
1. Recreational uses	Yes	F	NA
2. Commercial & Industrial uses	Yes	F	NA
3. Car washing	Yes	F	NA
CONTINGENT (For Declared Drought)			
Local Codes & Ordinances			
A. Sprinkling Ordinances	Yes	F	Yes
B. Water Recycling	Yes	F	Yes
Restrictions			
A. Rationing			
1. Fixed allocation	Yes	F	Yes
2. Variable percentage plan	Yes	F	Yes
3. Per capita use	Yes	F	Yes
4. Prior use basis	Yes	F	Yes
B. Restrictions on Specific Uses			
1. Recreational uses	Yes	F	Yes
2. Commercial & Industrial uses	Yes	F	Yes
3. Car washing	Yes	F	Yes

TABLE 6-14 (CONTINUED)
WATER CONSERVATION MEASURES: WCWSU/LEVEL 3

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
MANAGEMENT			
LONG-TERM			
Leak Detection	No	F	
Rate-Making Policies			
A. Metering	No	F	
B. Rate design			
1. Marginal cost pricing	Yes	F	NA
2. Increasing block rates	Yes	F	No
3. Peak load pricing	Yes	F	NA
4. Seasonal pricing	Yes	F	No
5. Summer surcharge	Yes	F	NA
6. Excess use charge	Yes	F	Yes
Tax Incentives & Subsidies	Yes	F	Yes
CONTINGENT			
Rate-Making Policies			
A. Rate design			
1. Marginal cost pricing	Yes	F	NA
2. Increasing block rates	Yes	F	No
3. Peak load pricing	Yes	F	NA
4. Seasonal pricing	Yes	F	No
5. Summer surcharge	Yes	F	NA
6. Excess use charge	Yes	F	Yes
EDUCATION			
LONG-TERM			
Direct Mail	Yes	F	Yes
News Media	Yes	F	Yes
Personal Contact	Yes	F	Yes
Special Events	Yes	F	Yes
CONTINGENT			
Direct Mail	Yes	F	Yes
News Media	Yes	F	Yes
Personal Contact	Yes	F	Yes
Special Events	Yes	F	Yes

FOOTNOTES: TABLE 6-14

APPLICABLE:

"Yes" Applicable

"No" Currently in use (1) Required by utility policy, (2) Required by state or local plumbing code, (3) Required by some other authority, or (4) Requested for voluntary implementation (ie., "No (1)" means currently in use, as a result of utility's authority. "No (14)" means utility authority and voluntary).

TECHNICALLY FEASIBLE:

F Not in use, but technically feasible (will not adversely affect water use (other than flow reduction if implemented). For example, a sector of a water service area has low water service pressure and flow restrictors will adversely affect use. Such devices are not technically feasible.

P Not in use, but potentially technically feasible once possible small technical obstacles to implementation are overcome.

SOCIALLY ACCEPTABLE:

"Yes" or "No" Based on analysis of social acceptability, measure is acceptable to public.

NA Not available

Because of the effects of recent drought in the WCWSU area, efforts have been initiated at the utility and state levels to permanently reduce water use. Proposed water conservation has been prescribed to reduce water use in new construction by requiring low-flow plumbing fixtures and in existing construction through education programs and efforts to retrofit older, high-flow plumbing fixtures. Even state energy conservation programs have required the use of water-conserving devices (and have lists of approved devices), including flow reductions for hot water faucets, required insulation of hot water lines and other measures for public and private use.

In addition, the state has adopted standards developed by the American National Standards Institute regarding water-conserving fixtures and appliances; State Health and Safety Codes apply regarding minimum allowable flows; the Department of Housing and Community Development (Division of Codes and Standards) has information on accepted appliances. The state's objective is to require a high standard of efficiency for plumbing fixtures, including specification of flow limits and self-closing faucets (starting in 1985 for public facilities). Water closets are limited to a maximum average flush of 3.5 gallons (total flush volume). This applies to tank-type and flush valve devices; Blow-out water closets and associated flushometer valves are exempt. Urinals are limited to 1.5 gallons per flush (maximum average).

Flow from lavatory faucets, sink faucets and showerheads is restricted to 2.75 gallons per minute at water pressures up to 80 pounds per square inch for private sector use. As of 1 January 1985, new public facilities must have very low flow faucets or metering faucets, as well as devices to limit outlet temperature. Flow of hot water (maximum temperature 110° F) is limited to 0.5 gallons per minute or be equipped with self-closing faucets that limit delivery to a maximum of 0.25 gallons (recirculating systems) and 0.5 gallons (non-recirculating systems). During the drought of 1976 and 1977, residential water users achieved a reduction in water use of 67 percent compared with a district-wide reduction of 38 percent. These levels of reduction are attributed in part to a program to retrofit existing water fixtures and reduce water use. Table 6-15 indicates the level of response.

TABLE 6-15
POPULATION INSTALLING CONSERVATION DEVICES (1976-1977)

	MEASURES	PERCENT
(1)	Waterbags	28
(2)	Shower restrictors	19
(3)	Toilet leak detection (dye tablets)	30

In a retrofit program like this, the effectiveness of these devices and techniques for reducing water use diminish with time. Many devices are removed when the drought passes and normal water availability returns (see discussion in Chapter 3, "Residual Water Conservation Effects").

The WCWSU also has an extensive program to minimize losses within the water supply system. Meter verification and testing, leak detection in the distribution and pumping systems (motivated by potential lawsuits related to landslides) and various pilot projects to asses the potential for water savings are underway.

Table 6-14 shows the significant required use of these devices in the WCWSU jurisdiction, where "No" is reported in the Table concerning the Applicable use of these potential measures for new construction. Because of the significant rebound in water use following the drought of 1976-1977, and the recurring need to re-new retrofit programs, all of the retrofit options except those affected by existing pressure-reduction policy would be applicable.

Regarding contingency plans and water use restrictions that could be implemented during a declared drought, the WCWSU has previously adopted regulations to reduce water use by residential and non-residential customers. Although not in effect now, the utility regards such measures as essential to managed water supply and would implement a restrictive policy again during a declared drought emergency.

STEP 3: Technical Feasibility

The water conservation measures in Table 6-14 were screened to determine if they are technically feasible (F), potentially technically feasible (P), or not technically feasible (No), based on knowledge of the measures and of aspects of the WCWSU water system that could affect their function. Although many of the measures were shown to be not applicable because of existing policy which requires their use, no technical limitations are known that would exclude use of the measures identified in Table 6-14.

Since many of the water conservation measures are in use now or have been used previously, it is apparent that they are technically appropriate. WCWSU personnel were interviewed to determine their reactions to the measures under consideration, and their attitudes are reflected in the Table 6-14 results.

STEP 4: Social Acceptability

The WCWSU has repeatedly undertaken projects to determine the water consumption and conservation behavior and attitudes of customers so that current water management and conservation programs might be evaluated and improved. Recent 1980 WCWSU projects were conducted to determine:

- o How water is used both inside and outside the house.
- o The extent of customer knowledge concerning water use.
- o Household preferences for the different types of water conservation techniques available.
- o Current and drought-year use of specific water conservation techniques.
- o Customer attitudes towards mandatory water rationing and water quality in supplemental or emergency water supply sources.

Other efforts have also been undertaken to determine water conservation attitudes and practices. On several occasions in the past, intensive efforts were undertaken by the WCWSU, done in conjunction with other agencies (ie., the counties which make up a large part of the service area).

In 1967, a survey was conducted: "A Survey of Customer Awareness of and Attitudes Toward (WCWSU) Water" (survey of 1,155 customers). The survey did not evaluate attitudes toward drought emergency, conservation and water use reductions, but instead was directed at overall satisfaction with service (87 percent were "very satisfied" or "somewhat satisfied" with service), and only 10 percent of the surveyed customers indicated unfavorable overall attitude toward the WCWSU (as opposed to 3 to 22 percent dissatisfaction with other utilities, especially other nearby water companies, telephone companies and gas and water companies). This survey effort was also directed at customer knowledge of the WCWSU. This study represents a "policy" of the utility to be recognized for its customer service, to be distinct from other utilities and to understand the concerns of the customers.

Since the drought of 1976-1977, the WCWSU has undertaken or been involved in other efforts:

- o County Residential Water Conservation and Retrofit Kit Surveys.
- o Water Pollution Control Public Opinion Survey.
- o Residential Water Use Survey.

The water-use surveys were directed to determine:

1. Percentage of households not currently using specific water conservation devices which were being distributed to residential customers.

2. Attitudes of households toward water conservation.

3. Potential and probable benefits which could accrue to WCWSU customers from implementation of water conservation measures.

4. Effectiveness of past conservation information efforts and recommendations for future direction.

5. Attitudes toward rationing.

These surveys reported favorable results at the 95 percent confidence level with 2,400 questionnaires in one survey and 1,500 randomly selected households. Responses from the surveys are reported in Table 6-16.

"If you were to receive the following devices free in the mail, do you think you would be likely to use them or not?"

TABLE 6-16
WCWSU SURVEY OF ACCEPTABLE MEASURES
PERCENT RESPONSE TO QUESTIONNAIRE, RAW AND (CORRECTED)*

	VERY LIKELY	LIKELY	NOT LIKELY	DEF. NOT	ALREADY HAVE	TOTAL
Toilet Leak Det.	71 (71)	20 (20)	7 (7)	1 (4)	1 (1)	100
Low-flow Showerhds.	46 (26)	18 (11)	12 (10)	4 (2)	20 (51)	100
Shower-flow Restr.	46 (23)	20 (12)	18 (11)	5 (3)	11 (51)	100
Water Bags or Bottles for Toilet Tank	46 (33)	16 (14)	9 (9)	4 (3)	25 (41)	100
Aerators for Faucets	52 (31)	18 (14)	5 (5)	1 (1)	24 (49)	100

*(Corrected for customers currently unaware that they already have water-conserving devices.)

Variations were also asked to determine the effect of utility installation as an inducement for achieving greater response. Only 1 or 2 percent increases in possible use of measures was reported. It is apparent that the WCWSU residential customers are willing to cooperate in reducing water use and that many, although willing to be cooperative, do not know about existing measures already in place in their homes.

Efforts were also undertaken to determine the reaction to specific devices after they were installed. Four to six weeks after the kits were distributed, customers were asked:

- o "Did you install the device?"
- o "Did you have any problems?"
- o "Are you generally satisfied?"

TABLE 6-17
RESPONSE TO FOLLOW-UP

	YES INSTALLED (% RECIPIENTS)	YES PROBLEMS (% RECIPIENTS)	SATISFIED (% INSTALLED)
Water Bags for Toilet Tank	38	20	74
Shower-flow Restrictors	27	17	62
Toilet Leak Detector	42	-	92

Questions were also asked (Table 6-18) about current water use practices, such as:

TABLE 6-18
WCWSU SURVEY OF CURRENT
WATER CONSERVATION PRACTICES (%)

WATER CONSERVATION MEASURE	USE NOW?	EFFECTIVE?	CONVENIENT?	WOULD USE?
Turn off tap when brushing teeth or shaving	73	62	40	17
Turn off shower or tap when washing hair	33	53	18	32
Turn off tap when washing or rinsing dishes	64	60	32	19
Turn off tap when cleaning vegetables	54	46	28	22
Take fewer or shorter showers or baths	44	46	22	25
Flush toilet less often	36	42	18	26
Fill basin to wash face and hands	26	32	17	28

In addition, the survey addressed outside water use practices. The following responses (Table 6-19) indicate that outside water conservation is currently practiced. If water use restrictions were imposed, additional, although limited efforts would be made to reduce outside use.

TABLE 6-19
WCWSU LAWN AND GARDEN WATER CONSERVATION PRACTICES
(PERCENT USAGE)

CONSERVATION MEASURE OR TECHNIQUE	USE OR HAVE NOW	WOULD USE OR GET TO CUT WATER USE BY 25%
o Water plants or lawn only in morning or evening	80	8
o Water only when really needed	69	7
o Mulch garden or ornamental plants	34	5
o Plant drought-tolerant plants	30	4
o Keep lawn mower blades set high	51	4
o Plant other groundcover in place of lawn	21	4
o Replace planted areas with permanent bark or rock	19	3
o Use "grey water" (water recovered from other uses such as rinse water from washer) to water plants	11	7
o Sweep rather than hose off paved areas	57	7
o Use an automatic time-controlled sprinkler system to water lawn or garden	30	5
o Use drip irrigation system to water garden or ornamental plants	15	5

The effect of the recent 1976-1977 drought is a significant factor in the customer responses. For example, 54 percent of the WCWSU customers (67 percent East/Suburban and 52 percent West/Urban) experienced losses in landscaping during the drought. Many replaced the lost landscaping with drought-tolerant landscaping (40 percent district wide, 48 percent East/Suburban and 39 percent West/Urban). The mean cost to restore lost landscaping was $507.

Attitudes were also surveyed on the use of rationing methods and pricing. The public generally agreed strongly with the use of 25 percent mandatory reduction in time of drought (73 percent district-wide, 80 percent East/Suburban and 72 percent West/Urban) and generally opposed significant water rate increases

(50 percent rate increase) to eliminate the need for rationing during drought (84 percent of the district opposed the higher charge).

The "Social Acceptability" results of these surveys of customer attitudes are summarized in Table 6-14.

Summary of Steps 1-4 Screening

As a result of the analysis in Steps 1-4, the long list of water conservation measures that were available for use in the WCWSU area has been reduced to a list of measures that are applicable, technically feasible, and socially acceptable. These measures have a good probability of achieving water conservation in the WCWSU area. The screened measures that will be subject to subsequent analysis Steps include:

TABLE 6-20
SUMMARY: WCWSU MEASURES FROM SCREENING STEPS 1-4

LONG-TERM MEASURES

1. Retrofit of low-flow showerheads and toilet displacement devices in existing buildings.

2. Availability and encouragement of the use of dual-flush toilets in existing and new buildings.

3. Adoption and promotion of water reuse and recycling water in high use industrial and commercial facilities.

4. Promotion of consolidation of green space and the use of low water use landscaping and plant cover for single family homes in the East/Suburban area.

CONTINGENT MEASURES

5A. Restrictions on use of unnecessary outside water.

5B. Rationing program of 50 gallons per capita per day for all residential customers.

STEP 5: Implementation

The WCWSU has actively pursued measures to increase water supply and to reduce unnecessary losses in the service area. The WCWSU has an excellent education program that informs the public of water practices and water conservation approaches. In addition, the utility has developed comprehensive surveys for identifying the attitudes of the customers and used this information in developing effective programs for future water use reduction. The utility currently has over 1,300 employees, including 206 in Engineering, 530 in Maintenance, 200 in Operations, as well as a full-time Water Conservation Specialist. For each measure proposed, the WCWSU is proposed as the implementing entity.

Measure 1 (Retrofit)

The WCWSU is experienced with retrofit programs, including low-flow showerheads and toilet displacement devices for existing buildings. The proposed low-flow showerhead limits flow-rates to 3 gpm or less and affects water use for interior residential and public water categories. Displacement devices are space-occupying objects such as the traditional brick (not a good idea) or plastic bottles which reduce the volume of water normally used for flushing. Interior residential, commercial and public water use categories are affected. Retrofits will be used among existing customers who did not install them during the previous water conservation programs.

This program is implemented by the WCWSU staff, patterned after previous programs and targeted at the customers who are likely to use the devices. The devices are made available to customers free of charge, and promotional materials and media exposure of the program are coordinated to encourage use of the devices.

Measure 2 (Dual-Flush Toilets)

Dual-flush toilets are designed to deliver two different quantities of water for liquid waste flushing and for solid waste flushing. They are designed to appear similar to conventional toilets but require user habit modifications for the flushing mechanism to be effective. Reductions from dual-flush toilets occur only in the interior residential, commercial, and public water use categories. They are promoted for use by WCWSU customers both in existing and new construction.

The WCWSU staff implements the program which encourages use of dual-flush toilets:

1. Preparation of information on the advantages, costs and use of dual-flush toilets.

2. Distribution of information to builders to encourage their use of these fixtures.

Measure 3 (Commercial/Industrial Reuse and Recycle)

This measure refers to actions taken by industries and commercial businesses to recycle water or reuse water in production processes. Commercial and industrial water use sectors are the target for water-use reductions. Both the actual reductions and the coverage can be assumed to vary significantly among differing industrial and commercial users. As a result, the WCWSU targets efforts at promoting recycling and reuse at large industrial and commercial water users and particularly at customers that have not previously undertaken reductions that similar industries have seen to be profitable (see Chapter 3, "Water Use Trends" and Table 3-3). The assumption is that some large water-using industries and commercial businesses are not taking full advantage of new technologies that can reduce water use in a cost-effective manner.

The WCWSU staff implements the Measure 3 program through promotional efforts and training sessions:

1. Identify large water-using industrial and commercial business by SIC Code.

2. Compare water use, size, and process technologies of possible candidates.

3. Conduct education sessions to inform these businesses of cost savings, investment profitability and water savings associated with modification of processes.

4. Provide in-plant expert advice to potential candidates expressing interest in the education sessions.

In 1980, the state, pursuant to a legislative mandate, conducted studies and investigations on the availability and quality of wastewater. As a result, the state has developed a policy favoring wastewater reclamation, and has authorized a loan program for development of wastewater reclamation facilities, established health regulations for wastewater reuse, established a capability for surveys and investigations regarding wastewater use and a method for comprehensive reporting and enforcement. (88)

As a result, the WCWSU undertook two projects to evaluate the potential for use of treated wastewater from the district's system. These studies indicated severe problems with distribution and, as a result, the costs of using reclaimed water vs. potable sources were prohibitive. The distribution problem is minimized when recycling is considered for industry.

During the drought of 1976-1977, 45 businesses in Los Angeles reduced water use an average of 45 percent. Five of the firms reduced consumption by 50 percent or more. They were Standard-Nickel-Chromium Plating Company, 79 percent; Anheuser-Busch, 63 percent; National Standard Company, 63 percent; Tyre Brothers Glass Company, 56 percent; and Airesearch Manufacturing Company of California, 50 percent. Most of the reductions were due to recycling.

This example is not unusual, and many industries have effective water reuse and recycling programs, however, much more can be done.

Measure 4 (Landscaping)

Modified landscapes controlled irrigation systems, and use of drought-tolerant vegetation can save significant amounts of water, especially during peak use periods. In the suburban portions of the service area, this program promotes the use of innovative landscaping techniques to reduce exterior residential and multi-family (complexes) irrigation water use. The WCWSU provides information on water savings that are possible from use of new landscaping concepts (ie., consolidated green space for more efficient irrigation and use of drought-tolerant vegetation to significantly reduce the need for irrigation). The methods are effective and are becoming accepted as developers are encouraged to use this water reduction approach.

The WCWSU implements this program by providing incentives to developers to consider use of lower exterior water use designs. A goal might be a 15 percent reduction in outside water use.

1. Review builders' development plans. Determine normal landscape (conventional irrigated turf grass) water requirements (budget) for proposed development or complex.

2. Determine acceptable budget for the development or complex based on socially acceptable minimum use of water (ie., a 15 percent reduction goal).

3. Provide connection fee discount to developers of water use application fee based on the differences in original budget (1) and revised budget (2).

This approach can save hundreds of dollars per unit in connection fees and provides a significant cost-saving inducement to developers for designing water-saving landscapes. This approach is also acceptable to homebuyers because of the cost savings for lawn/garden irrigation.

In California, for example, landscapes use about 40 percent of urban water, and average outside water use is estimated at 44 percent of total residential water use. (20) In unmetered areas, outside water use can be much higher. In addition, studies showed that metered community outdoor water use was about 76 percent of total use by residential customers during the six-month irrigation season. (62)

Despite this significant outdoor use, only recently have researchers focused on methods to reduce irrigation water use. A California publication indicates that twelve new landscape projects were initiated in October 1984. (63) Typically, these projects concentrate on developing real useful data. Two of the projects provide information for housing developers, including a basis for deciding whether or not to install low water-using landscapes. Other projects develop information on the best methods for encouraging reductions in water use at existing homes; how to use less water on turf grass; and how to use less water on highway landscapes (ie., median strips and other highway landscapes are irrigated in California). These projects are distributed across the state, including Los Angeles, Orange County, Lake Tahoe, Palm Springs, Marin, Fresno, as well as for state agency offices of Parks and Recreation, Transportation and Forestry.

Past efforts to develop accurate research data are very limited. Efforts have been undertaken by the East Bay Municipal Utility District to develop real data on water reduction and public acceptance of low water-using garden landscapes for urban single family homes. Results are now available for one year of operation and have been compared with traditional landscape water use. The Residential Demonstration Garden Project description and results include:

Project Description

- o Three urban homes (front yards) re-landscaped with drip irrigation systems.
- o Results of metered front yard water use, metered for Summer 1984 (June through September).
- o Water use for comparison, conventional urban landscapes for the same summer period.

Results

- o Overall water use at Demonstration Garden homes compared to comparison homes.
  - 25 percent overall water use reduction, including inside and outside water use.
  - 70 percent reduction in front yard water use.

When the results are extrapolated to include assumed landscape modifications to backyard water use also (typically of comparable size), the overall results of residential landscaping could be a 50 percent reduction in residential water use during peak use periods.

For multi-family use of water for outside purposes, analyses have been conducted in the North Marin County Water District. In 1980, in a community of 50,000 people, planned urban developments (PUD's) with modified landscapes were compared against other PUD's with no controls. Outside water use was metered or imputed in both cases and compared; a 40 percent reduction in outside water use was reported for the PUD's with modified landscapes.

The modified landscapes consisted of:

- o Pooling turf into large areas, away from buildings and walkways with vehicle access from the rear.

- o No turf on slopes.

The result is that total irrigable turf area is reduced, irrigation is restricted to turf (away from impervious surfaces) and runoff is minimized. The aesthetics is maintained as compared to more conventional approaches, although the turf per dwelling unit is reduced. At a minimum, outside water use reduction could be 20 percent with the achieved reduction of 40 percent considered very possible during the peak use period.

Other landscape irrigation reduction projects have been conducted in California. A test involving the use of tensiometers to measure soil moisture and control automatic irrigation systems was very successful. In the southern part of the State of California, 60 to 80 percent of total water use is estimated for irrigation at the average home. As a result, the Desert Water Agency initiated a program utilizing tensiometer-type hydrostats applied to an automatic irrigation system for Victoria Park in the City of Palm Springs. (64)

A previous effort by the City to reduce water use at the 6.5 acre park (the site is flat with turf and mature trees; the soil is sandy and the site experiences a good deal of wind) was successful in reducing annual average water consumption from 3.4 million cubic feet to 2.6 mcf from 1970 to 1979 (a 22.3 percent annual average reduction).

The tensiometer project involved equipping half of the park with tensiometers to control the irrigation system, and the project was monitored in two 12-month segments. The overall reduction was 53.7 percent reduction in water use on the half of the park equipped with tensiometers over the 24-month period (February 1981 to January 1983). During the first 12 months, a reduction of 58.6 percent was achieved; in the second 12-month period, a reduction of 48.5 percent was achieved (lower presumably because of vandalism).

These studies are impressive and indicate that significant peak and average annual water use reductions are possible. For this project, these previous results were used as a basis for assuming water use reductions for single family and multi-family outdoor water use reductions. However, it was also necessary to assume the social acceptability of these measures. Each of the projects described above has some, although very limited, experience with related public attitudes:

- East Bay Municipal - Residential Garden Project - local neighbors were impressed with the aesthetic and effectiveness of the Project.
- North Marin County Water District - incentives are used to encourage developers to reduce water use through landscape modification.
- City of Palm Springs - "The condition of the turf was no different than the area without tensiometers," Superintendent of Parks & Golf Course.

Educational and incentive programs are currently in use or being considered, including:

- Information on Drought Tolerant Plants, including plant characteristics, plant specialists and literature sources.
- Nurseries with tagged, drought-tolerant plants.
- Fee discount proposals for encouraging developers to reduce the average and peak water demand for new project developments. Connection charges are in the $600 range in North Marin County for each unit in a PUD. A $200 discount is proposed for significant reductions in average and peak demand and would represent a significant savings to developers.

Because research in residential single family and multi-family outside water use reduction has been sporadic, conclusive results are not available. Based on the above information, the following assumptions have been made regarding effectiveness and acceptability of landscape modifications for the purposes of achieving outside water use reductions and the acceptability of such measures.

Single Family Residential

New Construction: Modified landscapes for residential gardens and plantings can be extremely efficient. Typically, measures involve little or no turf grass, use of indigenous vegetation (requiring little or no irrigation during drought, many types of which are the flowering variety) and drip irrigation. Other approaches include conventional plantings with automated drip irrigation systems. For this project, conventional plantings with drip irrigation are assumed, although greater water-use reduction could be achieved with indigenous vegetation approaches.

Based on East Bay MUD research, front yard irrigation was reduced by 70 percent. For this analysis, front and backyards are assumed to be equal in size and water needs, representing 40 percent each of total outside water use. Other outside water use is assumed to be 20 percent (for car washing and other purposes). The 70 percent reduction factor translates into 50-60 percent reduction in total outside water use (assumed to be 50 percent).

For single family residential developments, homeowners are responsible for the landscaping, and, at this time, no incentives are in place to encourage outside water use reductions. A moderate acceptability is assumed with no (0) use for new single family construction in 1980, 50 percent by 1990 and 90 percent from 2000 to 2030. Since future SFR growth is modest, the result will be minimal.

Retrofitting Existing SFR: Much less acceptance is assumed for retrofitting existing lawns. It is assumed that drought-tolerant landscaping will be considered only if the resident is in the market for modifying an existing landscape. Effectiveness is assumed to be 50 percent as was assumed for new construction, but acceptability, (coverage) will be much less. In 1980, no (0) retrofits are assumed, by 1990, 5 percent of existing landscaping will be modified, and from 2000-2030, 10 percent of existing development will utilize landscape modifications and drought-tolerant vegetation or drip irrigation systems.

Multi-Family Residential

New Construction: Based on the North Marin County Water District research, reductions in outside water use of 40 percent are achievable with minimum levels of 20 percent possible if turf is pooled in planned urban developments, and slopes and areas near walkways, etc. are not planted. For this analysis, 30 percent water-use reductions are assumed in outside water use.

Because of the existence of incentives to encourage developers in the use of water-conserving landscaping, new multi-family construction will be very likely to cooperate. Currently, developers pay about $600 per dwelling unit (with a possible $200 per dwelling unit discount) as a buy-in charge in North Marin County Water District. In the Marin Municipal Water District, developers pay $6,300 per acre-foot of water for planned developments. These fees can be discounted by showing significant reductions in peak and average water requirements for the developments constructed.

The $200 incentive for a 150 unit PUD could reduce developers' costs by $30,000. As a result, by 1990 and through 2030, 100 percent of new multi-family construction is assumed to use drought-tolerant landscaping.

Retrofitting Existing MFR: As was the case for single family residential, (landscape) retrofits are difficult to install once a development has been graded and the buildings constructed. Only if a multi-family development is in the market for modified landscape will any change be made. The result: Effectiveness will be a 30 percent reduction in outside water use (as with new construction), but acceptance will be low with no (0) MFR retrofits in 1980, 2.5 percent of existing MFR in 1990 and 5 percent from 2000 to 2030.

Measure 5 (Contingency)

Two methods of water-use reduction are considered for periods of water shortage. Restricted water uses are imposed by the WCWSU in response to temporary water emergency. The WCWSU is experienced with these measures and would announce (decree) a period of restricted uses. The mandatory decree would restrict water uses in the exterior residential, commercial, industrial, and public water use categories. Rationing of water to the residential sector (50 gallons per capita per day) is also implemented as a mandatory measure with fines and penalties. This approach is taken only in a severe situation.

STEP 6: Effectiveness

The effectiveness analysis for the WCWSU service area consists of four substeps and evaluations:

Substep 6.1 Disaggregated Water Demand Forecasts
Substep 6.2 Determine Fraction of Water Demand Reduction
Substep 6.3 Determine Coverage
Substep 6.4 Analysis of Effectiveness

Substep 6.1 Disaggregated Water Demand Forecasts

The water demand projections were developed in two stages: Stage 1 based on future connection projections and water use per connection projections for average annual and peak daily water use, and Stage 2 based on Stage 1 results and the impact of the recently implemented water conservation efforts from the drought of 1977 at the local level that continues to reduce water uses (ie., Stage 1 projections do not include the effects of current water conservation programs but do contain the effects of previous state efforts).

Stage 1: For the WCWSU, Stage 1 disaggregated water demand forecasts consist of a four-part analysis:

Part I: Project the number of connections in each customer class.
Part II: Project water use per connection.
Part III: Project average annual water use.
Part IV: Project peak daily water use.

This analysis and subsequent sections of this example focus on two key aspects of the WCWSU system. The system has a major industrial water use sector and historic data on water use by these major water users, and the WCWSU water service area has two distinct regions, one in the west which is older and urbanized and one in the east which is suburban. The following Stage 1 analysis was conducted:

Part 1: Project the number of connections in each customer class: High, medium and low projections of the number of connections in each customer class were generated as follows:

Step 1: Project Population and Economic Activity

Population projections for the years 1985, 1990, 1995 and 2000 were obtained from the Regional Planning Agency for each community in the WCWSU area. These communities were separated into those in the WCWSU "Urban" and "Suburban" areas. Then the community population projections were aggregated to obtain projections for the two WCWSU areas.

Since the Regional Planning Agency does not provide alternative growth rates, OBERS (14) projections (forecast to the year 2030) were used to give the high and low range assumptions and to extend the Regional Planning Agency projections. Although OBERS projections are considered less reliable (based on census and related secondary data) than the more specific and detailed local data available from the Regional Planning Agency, the percentage differences between respective OBERS projections were suitable for preparing high and low population projection ranges from the Regional Planning Agency data. The method used, for example, reviewed the "no-change-in-share" (highest) OBERS population projection for a particular WCWSU community for a given year. If the estimate was 15 percent above the "moderate-change-in-share" (medium) projection for that same year, then the high projection used for forecasting water demand was set at 15 percent greater than the Regional Planning Agency projection for that community for that year.

The resulting high, medium, and low population projections for the several communities which are included in the WCWSU service area were then added to produce aggregate population growth projections for the two geographic areas for the period 2000-2030. The annual growth rates (Table 6-21) which characterize these population projections were then calculated, inspected visually and compared, and then smoothed in order to remove meaningless irregularities to obtain final growth rate projections for applying to the number of base-year residential connections in the WCWSU service areas. These growth rates are:

TABLE 6-21
WCWSU PROJECTED GROWTH RATES
PERCENT

SUBURBAN AREA

PERIOD	LOW	MEDIUM	HIGH
1980-1990	0.9	1.4	1.6
1990-2000	0.0	0.3	0.5
2000-2030	0.0	0.0	0.5

URBAN AREA

PERIOD	LOW	MEDIUM	HIGH
1980-1990	0.4	0.6	0.7
1990-2000	-0.1	0.0	0.1
2000-2030	-0.1	0.0	0.1

Economic activity, as indicated by number of employees, in the various two-digit SIC categories represented in the WCWSU service area, was projected using OBERS projections. These projections are available for the years 1985, 1990, 2000, and 2030, for low, medium, and high growth scenarios. They are not consistent with Regional Planning Agency population projections (thus creating the possibility that forecasts of population and of employment may be inconsistent), but were used anyway because the Regional Planning Agency did not project industrial employment.

It should be noted that the projections of population and economic activity produced for this Handbook are quite different from those which were available at the time from the water utility. The utility's forecasts were examined and judged to be inadequate because they were based upon growth projections which did not reflect the results of the 1980 census. Those census results revealed that population growth was significantly lower during the preceeding intercensal decade than was previously thought. The Regional Planning Agency projections, which form the basis for this analysis, reflect the 1980 census results and are considerably lower than the projections which the Regional Planning Agency had issued prior to the availability of the new census results. It would have been improper to use the outdated and inflated utility forecasts when more recent information challenged their credibility.

Step 2: Project number of connections

The WCWSU classifies water users into the traditional residential categories of single family (SFR) and multi-family (MFR), respectively presented separately for the suburban and urban areas. It classifies commercial and industrial water users into thirteen catefories which are quite similar, but not identical, to the two digit SIC categories used by the Bureau of the Census. Public use is identified by the "Cemetary, Golf, Park" and "Schs/Hosp." categories. The number of connections in each of those classes for the base year (1980) was obtained from WCWSU records.

The number of connections in each customer class was projected to grow in direct proportion to population and employment throughout the planning period. Analysis of demographic data provided no basis for projecting changes in household size, changes in land use (ratio of single family to multi-family dwelling units), or changes in employment per household, except that the urban and suburban areas are characterized by different land use patterns and different growth rates. Analysis of a more complete data set might have indicated additional changes. The results of this procedure are presented in Table 6-22.

TABLE 6-22
WCWSU CONNECTIONS PROJECTED (HIGH, MEDIUM, LOW)

LOW PROJECTION

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	616	598	586	584	583	582
Food Procs.	296	299	312	321	330	339
Wood, Paper, Chem.	788	823	843	856	869	882
Petro	65	66	69	70	72	74
Metal, Plate, Clay	1,091	1,140	1,167	1,185	1,203	1,221
Trans/Commun.	1,539	1,524	1,508	1,502	1,496	1,490
Elec/Gas/Steam	144	143	141	141	140	139
Whole/Resale, Misc.	12,817	13,650	14,333	14,619	14,912	15,210
Cemetery, Golf, Park	3,126	3,564	4,020	4,233	4,457	4,693
MFR East (Suburban)	4,895	5,385	5,390	5,395	5,401	5,406
MFR West (Urban)	19,578	20,459	20,254	20,052	19,851	19,653
Lndry/Lab/Auto	2,132	2,430	2,742	2,887	3,040	3,201
Schls/Hosp.	4,112	4,688	5,288	5,568	5,863	6,174
SFR East (Suburban)	54,483	59,931	59,991	60,051	60,111	60,171
SFR West (Urban)	217,933	227,740	225,463	223,208	220,976	218,766
Misc (Hyd/M.Off&Out)	5,159	5,520	5,493	5,465	5,438	5,411
TOTAL	328,774	347,959	347,599	346,138	344,742	343,413

MEDIUM PROJECTION

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	616	625	647	657	667	677
Food Procs.	296	309	337	346	356	366
Wood, Paper, Chem.	788	839	893	918	944	970
Petro	65	68	74	76	78	80
Metal, Plate, Clay	1,091	1,162	1,236	1,271	1,306	1,343
Trans/Commun.	1,539	1,564	1,607	1,620	1,633	1,646
Elec/Gas/Steam	144	146	150	152	153	154
Whole/Resale, Misc.	12,817	13,842	14,881	15,297	15,726	16,166
Cemetery, Golf, Park	3,126	3,595	4,105	4,331	4,569	4,821
MFR East (Suburban)	4,895	5,605	5,762	5,767	5,773	5,779
MFR West (Urban)	19,578	20,753	20,773	20,794	20,815	20,836
Lndry/Lab/Auto	2,132	2,452	2,800	2,954	3,116	3,288
Schls/Hosp.	4,112	4,729	5,400	5,697	6,011	6,341
SFR East (Suburban)	54,483	62,383	64,130	64,194	64,258	64,322
SFR West (Urban)	217,933	231,009	231,240	231,471	231,703	231,934
Misc (Hyd/M.Off&Out)	5,159	5,726	5,732	5,738	5,744	5,749
TOTAL	328,774	354,807	359,768	361,284	362,852	364,473

TABLE 6-22 (CONTINUED)
WCWSU CONNECTIONS PROJECTED (HIGH, MEDIUM, LOW)

HIGH PROJECTION

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	616	665	707	720	733	746
Food Procs.	296	329	365	382	399	417
Wood, Paper, Chem.	788	883	955	984	1,013	1,043
Petro	65	72	80	84	88	92
Metal, Plate, Clay	1,091	1,222	1,322	1,362	1,403	1,445
Trans/Commun.	1,539	1,647	1,724	1,741	1,759	1,776
Elec/Gas/Steam	144	154	161	163	165	166
Whole/Resale, Misc.	12,817	14,355	15,676	16,146	16,630	17,129
Cemetery, Golf, Park	3,126	3,657	4,199	4,442	4,700	4,972
MFR East (Suburban)	4,895	5,752	6,039	6,341	6,658	6,991
MFR West (Urban)	19,578	21,046	21,257	21,469	21,684	21,901
Lndry/Lab/Auto	2,132	2,494	2,864	3,004	3,151	3,306
Schls/Hosp.	4,112	4,811	5,523	5,794	6,078	6,375
SFR East (Suburban)	54,483	64,018	67,218	70,579	74,108	77,814
SFR West (Urban)	217,933	234,278	236,621	238,987	241,377	243,791
Misc (Hyd/M.Off&Out)	5,159	5,804	5,978	6,157	6,342	6,532
TOTAL	328,774	361,187	370,690	378,355	386,287	394,497

Part II: Project Water Use Per Connection

Step 1: Estimate base year mean annual water use per connection

Mean annual water use was determined from utility records for each customer class for the period 1976-1980. The data displayed substantial annual fluctuations in all customer classes. The base year (1980) was characterized by summer precipitation about twice the long-term average. Therefore, 1980 "as if" water use estimates were compiled, based upon the more nearly normal years of 1978 and 1979, and adjusted upward for growth in numbers of connections between those years and 1980.

The mean monthly water use in 1980 for the six months of lowest water use (November through April) was taken to be equal to 1980 indoor water use, and the difference between mean monthly water use in the six months of highest water use and estimated indoor water use was taken to be equal to 1980 mean monthly outdoor water use.

Step 2: Project mean future water use

Water use per employee in the commercial and industrial sectors was assumed to remain constant throughout the projection period, for want of information to the contrary. However, water use per residential connection was assumed to increase as a function of real household income. The income elasticity of demand has been estimated to be as low as 0.04 and as high as 1.3. (91) After a review of research findings, 0.4 was selected as a reasonable approximation.

No change in the marginal cost of water was assumed to occur. However, the price elasticity of demand for residential water use was included in the estimation equations for use in subsequent analyses in which water rate changes might be of interest. The estimation equation for each customer class, and for both indoor water use and outdoor water use in the residential classes, was of the form:

$$Q = A * P^e * Y^n$$

where Q = mean annual water use per connection, P = marginal price of water, Y = mean real income per household, e = price elasticity of water demand, n = income elasticity of demand, and A = a constant term which must be determined empirically. After a review of the extensive and varying literature on this topic, expressions were selected based on the price elasticity of water which seemed consistent with findings for this geographical area and which reflected the theoretically correct expectation that elasticity would increase as price increased (most of the literature reports single values for elasticities, an analytical convenience but one which cannot be defended theoretically). The price elasticity of demand was assumed to be -0.2 - 0.2P for indoor residential use and -0.6-0.2P for outdoor residential use. Both commercial and industrial water uses were assumed to be insensitive to price (e = 0), because the literature on price response of industrial water use is too limited to depend upon.

The value of the constant term in the prediction equation was then estimated through substitution, using the baseline year data. The projected annual rate of real income increase, as reported by the Regional Planning Agency, was 0.6 percent between 1980 and 1990 and 0.4 percent between 1990 and 2000. These estimates were used for all three projection levels, and the 1990-2000 projection was assumed to apply to the 2000-2030 period as well.

Part III: Project Average Annual Water Use

Step 1: Project total mean annual water use per customer class

Mean annual water use per connection from Part II was then multiplied by the projected number of connections in each customer class from Part I to obtain projected mean annual water use per class.

Step 2: Project total mean annual system water use

Mean annual water use was then aggregated across all customer classes and distributed to indoor and outdoor use based on analysis of winter (primarily indoor use) and summer (indoor and outdoor use). Also, leakage was computed and added to the total to obtain projected total mean annual system water use. Leakage was estimated by the WCWSU district to be 11 percent historically. It was assumed that leakage would grow in direct proportion to the number of connections, rather than in proportion to water use.

Tables 6-23 through 6-25 present the results of the projection method for average annual water use (low, medium and high growth scenarios). Detail is also presented on indoor and outdoor use. These projections represent the first step in developing baseline projections in Stage 2 for the WCWSU area. The projections in Tables 6-23 through 6-25 do not contain the conservation effects of the recently established retrofit program for drought reduction in water use in the WCWSU area. In subsequent steps, the effect of current and residual water conservation programs are introduced. Also, to conserve space, full detail of total, and indoor and outdoor use is presented only for the medium growth scenario.

TABLE 6-23
WCWSU PROJECTIONS OF TOTAL ANNUAL WATER USE
(LOW PROJECTIONS PARTIAL EXISTING CONSERVATION)
MILLIONS OF GALLONS

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	258.4	250.7	245.6	245.2	244.7	244.2
Food Procs.	2,451.8	2,476.3	2,585.3	2,657.7	2,732.1	2,808.6
Wood, Paper, Chem.	1,091.6	1,140.8	1,168.2	1,185.7	1,203.5	1,221.5
Petro	5,572.2	5,628.0	5,875.6	6,040.1	6.209.2	6,383.1
Metal, Plate, Clay	1,857.2	1,940.8	1,987.4	2,017.2	2,047.5	2,078.2
Trans/Commun.	810.9	802.8	794.7	791.6	788.4	785.2
Elec/Gas/Steam	160.9	159.3	157.7	157.1	156.5	155.9
Whole/Resale, Misc.	3,118.3	3,321.0	3,487.1	3,556.8	3,628.0	3,700.5
Cemetery, Golf, Park	2,914.6	3,322.7	3,748.0	3,946.6	4,155.8	4,376.1
MFR East (Suburban)	1,744.8	1,919.3	1,921.2	1,923.1	1,925.1	1,927.0
MFR West (Urban)	6,978.7	7,292.8	7,219.8	7,147.6	7,076.2	7,005.4
Lndry/Lab/Auto	951.4	1,084.6	1,223.5	1,288.3	1,356.6	1,428.5
Schls/Hosp.	3,215.5	3,665.6	4,134.8	4,354.0	4,584.7	4,827.7
SFR East (Suburban)	5,161.7	5,677.8	5,683.5	5,689.2	5,794.9	5,700.6
SFR West (Urban)	20,646.9	21,576.0	21,360.3	21,146.7	20,935.2	20,725.9
Misc.(Hyd/M.Off&Out)	1,169.1	1,253.4	1,247.6	1,241.8	1,236.0	1,230.3
Leakage	6,964.0	7,479.0	7,509.0	7,509.0	7,509.0	7,509.0
TOTAL	65,069.0	68,991.7	70,350.1	70,898.4	71,484.0	72,108.3

Note: Water use data and projections are truncated throughout this Handbook. As a result, totals may not add exactly.

TABLE 6-24
WCWSU PROJECTION OF TOTAL ANNUAL WATER USE
(MEDIUM PROJECTION PARTIAL EXISTING CONSERVATION)
MILLIONS OF GALLONS

TOTAL ANNUAL

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	258.4	262.3	271.5	275.5	279.7	283.9
Food Procs.	2,451.8	2,562.1	2,790.2	2,868.3	2,948.6	3,031.2
Wood, Paper, Chem.	1,091.6	1,162.6	1,237.0	1,271.7	1,307.3	1,343.9
Petro	5,572.2	5,823.0	6,341.3	6,518.8	6,701.3	6,889.0
Metal, Plate, Clay	1,857.2	1,978.0	2,104.6	2,163.5	2,224.1	2,286.3
Trans/Commun.	810.9	823.9	846.9	853.7	860.5	867.4
Elec/Gas/Steam	160.9	163.5	168.1	169.4	170.8	172.2
Whole/Resale, Misc.	3,118.3	3,367.8	3,620.4	3,721.8	3,826.0	3,933.1
Cemetery, Golf, Park	2,914.6	3,351.8	3,827.8	4,038.3	4,260.4	4,494.8
MFR East (Suburban)	1,744.8	1,997.8	2,053.8	2,055.8	2,057.9	2,059.9
MFR West (Urban)	6,978.7	7,397.5	7,404.8	7,412.3	7,419.7	7,427.1
Lndry/Lab/Auto	951.4	1,094.1	1,249.5	1,318.2	1,390.7	1,467.2
Schls/Hosp.	3,215.5	3,697.8	4,222.9	4,455.1	4,700.2	4,958.7
SFR East (Suburban)	5,161.7	5,910.1	6,075.6	6,081.7	6,087.8	6,093.8
SFR West (Urban)	20,646.9	21,885.7	21,907.6	21,929.5	21,951.5	21,973.4
Misc.(Hyd/M.Off&Out)	1,169.1	1,297.7	1,299.0	1,300.3	1,301.6	1,303.0
Leakage	6,964.0	7,479.0	7,509.0	7,509.0	7,509.0	7,509.0
TOTAL	65,069.0	70,255.5	72,930.7	73,943.8	74,997.8	76,094.6

ANNUAL INDOOR USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	221.3	224.6	232.4	235.9	239.5	243.1
Food Procs.	2,165.1	2,262.6	2,464.0	2,532.9	2,603.9	2,676.8
Wood, Paper, Chem.	1,064.7	1,133.9	1,206.5	1,240.3	1,275.0	1,310.7
Petro	5,491.3	5,738.5	6,249.2	6,424.2	6,604.0	6,789.0
Metal, Plate, Clay	1,704.0	1,814.8	1,930.9	1,985.0	2,040.6	2,097.7
Trans/Commun.	657.8	668.3	687.0	692.5	698.1	703.6
Elec/Gas/Steam	147.5	149.8	154.0	155.2	156.5	157.7
Whole/Resale, Misc.	2,826.9	3,053.0	3,282.0	3,373.9	3,468.4	3,565.5
Cemetery, Golf, Park	1,123.4	1,292.0	1,475.4	1,556.6	1,642.2	1,732.5
MFR East (Suburban)	1,563,6	1,790.3	1,840.5	1,842.3	1,844.2	1,846.0
MFR West (Urban)	6,253.9	6,629.2	6,635.8	6,642.5	6,649.1	6,655.7
Lndry/Lab/Auto	900.8	1,035.9	1,183.0	1,248.1	1,316.7	1,389.1
Schls/Hosp.	2,510.6	2,887.2	3,297.2	3,478.5	3,669.8	3,871.7
SFR East (Suburban)	3,811.6	4,364.3	4,486.5	4,491.0	4,495.4	4,499.9
SFR West (Urban)	15,246.5	16,161.3	16,177.5	16,193.7	16,209.9	16,226.1
Misc (Hyd/M.Off&Out)	1,106.9	1,228.6	1,229.9	1,231.1	1,232.3	1,233.5
TOTAL	46,796.6	50,434.9	52,532.4	53,324.3	54,146.2	54,999.4

TABLE 6-24 (CONTINUED)
WCWSU PROJECTION OF TOTAL ANNUAL WATER USE

ANNUAL OUTDOOR USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	37.1	37.7	39.0	39.6	40.2	40.8
Food Procs.	286.6	299.5	326.2	335.3	344.7	354.3
Wood, Paper, Chem.	26.9	28.7	30.5	31.3	32.2	33.1
Petro	80.9	84.5	92.0	94.6	97.2	100.0
Metal, Plate, Clay	153.2	163.2	173.6	178.5	183.5	188.6
Trans/Commun.	153.0	155.5	159.9	161.1	162.4	163.7
Elec/Gas/Steam	13.4	13.7	14.0	14.2	14.3	14.4
Whole/Resale, Misc.	291.4	314.7	338.3	347.8	357.5	367.6
Cemetery, Golf, Park	1,791.1	2,059.8	2,352.3	2,481.7	2,618.2	2,762.2
MFR East (Suburban)	181.2	207.4	213.2	213.5	213.7	213.9
MFR West (Urban)	724.7	768.2	769.0	769.8	770.5	771.3
Lndry/Lab/Auto	50.6	58.2	66.5	70.1	74.0	78.1
Schls/Hosp.	704.8	810.6	925.7	976.6	1,030.3	1,087.0
SFR East (Suburban)	1,350.0	1,545.8	1,589.1	1,590.7	1,592.3	1,593.9
SFR West (Urban)	5,400.3	5,724.4	5,730.1	5,735.8	5,741.5	5,747.3
Misc (Hyd/M.Off&Out)	62.2	69.0	69.1	69.2	69.3	69.4
TOTAL	11,308.3	12,341.5	12,889.2	13,110.4	13,342.5	13,586.1

TABLE 6-25
WCWSU PROJECTION OF TOTAL ANNUAL WATER USE
(HIGH PROJECTIONS PARTIAL EXISTING CONSERVATION)
MILLIONS OF GALLONS

TOTAL ANNUAL WATER USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	258.4	279.1	296.7	302.0	307.5	313.0
Food Procs.	2,451.8	2,721.5	3,026.3	3,162.5	3,304.8	3,453.5
Wood, Paper, Chem.	1,091.6	1,222.6	1,322.9	1,362.6	1,403.5	1,445.6
Petro	5,572.2	6,185.2	6,877.9	7,187.5	7,510.9	7,848.9
Metal, Plate, Clay	1,857.2	2,080.1	2,250.7	2,318.2	2,387.8	2,459.4
Trans/Commun.	810.9	867.6	908.4	917.5	926.7	936.0
Elec/Gas/Steam	160.9	172.2	180.3	182.1	183.9	185.8
Whole/Resale, Misc.	3,118.3	3,492.5	3,813.8	3,928.3	4,046.1	4,167.5
Cemetery, Golf, Park	2,914.6	3,410.1	3,914.8	4,141.9	4,382.1	4,636.3
MFR East (Suburban)	1,744.8	2,050.2	2,152.7	2,260.3	2,373.3	2,492.0
MFR West (Urban)	6,978.7	7,502.1	7,577.2	7,652.9	7,729.5	7,806.8
Lndry/Lab/Auto	951.4	1,113.2	1,277.9	1,340.5	1,406.2	1,475.1
Schls/Hosp.	3,215.5	3,762.1	4,318.9	4,530.5	4,752.5	4,985.4
SFR East (Suburban)	5,161.7	6,065.0	6,368.2	6,686.6	7,021.0	7,372.0
SFR West (Urban)	20,646.9	22,195.4	22,417.4	22,641.6	22,868.0	23,096.7
Misc (Hyd/M.Off&Out)	1,169.1	1,314.3	1,351.7	1,390.3	1,430.0	1,470.9
Leakage	6,964.0	7,479.0	7,509.0	7,509.0	7,509.0	7,509.0
TOTAL	65,069.0	71,913.1	75,565.7	77,515.2	79,543.6	81,654.6

Part IV: Project Peak Daily Water Use

Step 1: Determine ratios of peak to average water use

The ratio of peak day demand to average day outdoor demand for the system as a whole was estimated to be 2.50, based upon reports from communities in similar climatic zones. It was not projected to change over the forecast period.

Step 2: Project peak daily water use

Peak daily water use was projected by calculating projected mean daily use from Part III and multiplying by the appropriate peak/average ratio from Step 1. The results of this procedure are presented in Tables 6-26 through 6-28. Details are presented only for the medium growth scenario.

TABLE 6-26
WCWSU PEAK DAILY WATER USE (MGD)
(LOW PROJECTION PARTIAL EXISTING CONSERVATION)

TOTAL PEAK DAILY USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	1.1	1.0	1.0	1.0	1.0	1.0
Food Procs.	9.9	10.0	10.4	10.7	11.0	11.3
Wood, Paper, Chem.	3.2	3.4	3.5	3.5	3.6	3.6
Petro	16.1	16.3	17.0	17.5	18.0	18.5
Metal, Plate, Clay	6.7	7.1	7.2	7.3	7.4	7.6
Trans/Commun.	3.9	3.8	3.8	3.8	3.8	3.8
Elec/Gas/Steam	.5	.5	.5	.5	.5	.5
Whole/Resale, Misc.	11.7	12.5	13.1	13.4	13.7	13.9
Cemetery, Golf, Park	27.9	31.8	35.9	37.8	39.8	41.9
MFR East (Suburban)	6.8	7.4	7.4	7.4	7.5	7.5
MFR West (Urban)	27.2	28.4	28.1	27.8	27.5	27.3
Lndry/Lab/Auto	3.1	3.6	4.0	4.2	4.5	4.7
Schls/Hosp.	16.6	19.0	21.4	22.5	23.7	25.0
SFR East (Suburban)	29.1	32.1	32.1	32.1	32.2	32.2
SFR West (Urban)	116.7	122.0	120.8	119.6	118.4	117.2
Misc (Hyd/M.Off&Out)	3.8	4.2	4.1	4.1	4.1	4.1
Leakage	19.0	20.4	20.5	20.5	20.5	20.5
TOTAL	304.3	324.2	331.7	334.7	337.9	341.3

TABLE 6-27
WCWSU PEAK DAILY WATER USE (MGD)
(MEDIUM PROJECTION PARTIAL EXISTING CONSERVATION)

TOTAL PEAK DAILY USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	1.1	1.1	1.1	1.1	1.2	1.2
Food Procs.	9.9	10.3	11.2	11.5	11.9	12.2
Wood, Paper, Chem.	3.2	3.5	3.7	3.8	3.9	4.0
Petro	16.1	16.8	18.3	18.9	19.4	19.9
Metal, Plate, Clay	6.7	7.2	7.7	7.9	8.1	8.3
Trans/Commun.	3.9	3.9	4.1	4.1	4.1	4.2
Elec/Gas/Steam	.5	.6	.6	.6	.6	.6
Whole/Resale, Misc.	11.7	12.7	13.6	14.0	14.4	14.8
Cemetery, Golf, Park	27.9	32.1	36.7	38.7	40.8	43.1
MFR East (Suburban)	6.8	7.7	8.0	8.0	8.0	8.0
MFR West (Urban)	27.2	28.8	28.8	28.8	28.9	28.9
Lndry/Lab/Auto	3.1	3.6	4.1	4.3	4.6	4.8
Schls/Hosp.	16.6	19.1	21.8	23.0	24.3	25.7
SFR East (Suburban)	29.1	33.4	34.3	34.3	34.4	34.4
SFR West (Urban)	116.7	123.7	123.9	124.0	124.1	124.2
Misc (Hyd/M.Off&Out)	3.8	4.3	4.3	4.3	4.3	4.3
TOTAL	285.2	309.5	322.9	328.1	333.6	339.3

PEAK DAILY INDOOR USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	.6	.6	.6	.6	.6	.6
Food Procs.	5.9	6.1	6.7	6.9	7.1	7.3
Wood, Paper, Chem.	2.9	3.1	3.3	3.3	3.4	3.5
Petro	15.0	15.7	17.1	17.6	18.0	18.6
Metal, Plate, Clay	4.6	4.9	5.2	5.4	5.5	5.7
Trans/Commun.	1.8	1.8	1.8	1.8	1.9	1.9
Elec/Gas/Steam	.4	.4	.4	.4	.4	.4
Whole/Resale, Misc.	7.7	8.3	8.9	9.2	9.5	9.7
Cemetery, Golf, Park	3.0	3.5	4.0	4.2	4.4	4.7
MFR East (Suburban)	4.2	4.9	5.0	5.0	5.0	5.0
MFR West (Urban)	17.1	18.1	18.1	18.1	18.2	18.2
Lndry/Lab/Auto	2.4	2.8	3.2	3.4	3.6	3.8
Schls/Hosp.	6.8	7.9	9.0	9.5	10.0	10.6
SFR East (Suburban)	10.4	11.9	12.2	12.3	12.3	12.3
SFR West (Urban)	41.7	44.2	44.3	44.3	44.4	44.4
Misc (Hyd/M.Off&Out)	3.0	3.3	3.3	3.3	3.3	3.3
TOTAL	128.2	138.1	143.9	146.0	148.3	150.6

TABLE 6-27 (CONTINUED)
WCWSU PEAK DAILY WATER USE (MGD)

PEAK DAILY OUTDOOR USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	.5	.5	.5	.5	.5	.5
Food Procs.	3.9	4.1	4.5	4.6	4.7	4.9
Wood, Paper, Chem.	.3	.3	.4	.4	.4	.4
Petro	1.1	1.1	1.2	1.3	1.3	1.3
Metal, Plate, Clay	2.1	2.2	2.4	2.4	2.5	2.6
Trans/Commun.	2.1	2.1	2.2	2.2	2.2	2.2
Elec/Gas/Steam	.1	.1	.1	.1	.1	.2
Whole/Resale, Misc.	4.0	4.3	4.6	4.8	4.9	5.1
Cemetery, Golf, Park	24.8	28.6	32.6	34.4	36.3	38.3
MFR East (Suburban)	2.5	2.8	2.9	2.9	2.9	2.9
MFR West (Urban)	10.0	10.6	10.6	10.6	10.7	10.7
Lndry/Lab/Auto	.7	.8	.9	.9	1.0	1.0
Schls/Hosp.	9.7	11.2	12.8	13.5	14.3	15.0
SFR East (Suburban)	18.7	21.4	22.0	22.0	22.1	22.1
SFR West (Urban)	75.0	79.5	79.5	79.6	79.7	79.8
Misc (Hyd/M.Off&Out)	.8	.9	.9	.9	.9	.9
TOTAL	157.0	171.4	179.0	182.0	185.3	188.6

TABLE 6-28
WCWSU PEAK DAILY WATER USE (MGD)
(HIGH PROJECTION PARTIAL EXISTING CONSERVATION)

TOTAL PEAK DAILY USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	1.1	1.2	1.2	1.3	1.3	1.3
Food Procs.	9.9	11.0	12.2	12.7	13.3	13.9
Wood, Paper, Chem.	3.2	3.6	3.9	4.1	4.2	4.3
Petro	16.1	17.9	19.9	20.8	21.7	22.7
Metal, Plate, Clay	6.7	7.6	8.2	8.4	8.7	9.0
Trans/Commun.	3.9	4.2	4.4	4.4	4.4	4.5
Elec/Gas/Steam	.5	.6	.6	.6	.6	.6
Whole/Resale, Misc.	11.7	13.2	14.4	14.8	15.3	15.7
Cemetery, Golf, Park	27.9	32.7	37.5	39.7	42.0	44.4
MFR East (Suburban)	6.8	7.9	8.3	8.8	9.2	9.7
MFR West (Urban)	27.2	29.2	29.5	29.8	30.1	30.4
Lndry/Lab/Auto	3.1	3.7	4.2	4.4	4.6	4.9
Schls/Hosp.	16.6	19.5	22.3	23.4	24.6	25.8
SFR East (Suburban)	29.1	34.3	36.0	37.8	39.7	41.6
SFR West (Urban)	116.7	125.5	126.7	128.0	129.3	130.6
Misc (Hyd/M.Off&Out)	3.8	4.3	4.4	4.5	4.6	4.8
Leakage	19.0	20.4	20.5	20.5	20.5	20.5
TOTAL	304.3	337.3	355.1	364.8	374.9	385.5

Tables 6-29 and 6-30 present the projected average annual and peak day projections summarized in millions of gallons per day for the medium population projection. These projections are converted (Tables 6-32, 34, 35) to baseline estimates of future water demand based on the effects of the past programs and recent retrofit program impacts for the WCWSU area.

TABLE 6-29
SUMMARY WCWSU AVERAGE ANNUAL WATER DEMAND FORECAST (MGD)
(MEDIUM PROJECTION PARTIAL EXISTING CONSERVATION)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	.708	.718	.743	.755	.766	.777
Food Procs.	6.717	7.019	7.644	7.858	8.078	8.304
Wood, Paper, Chem.	2.990	3.185	3.389	3.484	3.581	3.681
Petro	15.266	15.953	17.373	17.859	18.359	18.874
Metal, Plate, Clay	5.088	5.419	5.766	5.927	6.093	6.264
Trans/Commun.	2.221	2.257	2.320	2.339	2.357	2.376
Elec/Gas/Steam	.441	.448	.460	.464	.468	.471
Whole/Resale, Misc.	8.543	9.226	9.918	10.196	10.482	10.775
Cemetery, Golf, Park	7.985	9.183	10.487	11.064	11.672	12.314
MFR East (Suburban)	4.780	5.473	5.626	5.632	5.638	5.643
MFR West (Urban)	19.119	20.267	20.287	20.307	20.327	20.348
Lndry/Lab/Auto	2.606	2.997	3.423	3.611	3.810	4.019
Schls/Hosp.	8.809	10.131	11.569	12.205	12.877	13.585
SFR East (Suburban)	14.141	16.192	16.645	16.602	16.678	16.695
SFR West (Urban)	56.567	59.961	60.021	60.081	60.141	60.201
Misc (Hyd/M.Off&Out)	3.203	3.555	3.559	3.562	3.566	3.569
Leakage	19.079	20.490	20.572	20.572	20.572	20.572
TOTAL	178.271	192.480	199.810	202.585	205.473	208.478

TABLE 6-30
SUMMARY WCWSU PEAK DAY WATER DEMAND FORECAST (MGD)
(MEDIUM PROJECTION PARTIAL EXISTING CONSERVATION)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Agri/Const.	1.122	1.139	1.178	1.196	1.214	1.232
Food Procs.	9.913	10.359	11.281	11.597	11.921	12.255
Wood, Paper, Chem.	3.291	3.505	3.729	3.834	3.941	4.051
Petro	16.168	16.896	18.399	18.915	19.444	19.989
Metal, Plate, Clay	6.797	7.238	7.702	7.917	8.139	8.367
Trans/Commun.	3.928	3.991	4.103	4.136	4.169	4.202
Elec/Gas/Steam	.591	.601	.617	.622	.627	.632
Whole/Resale, Misc.	11.793	12.736	13.691	14.075	14.469	14.874
Cemetery, Golf, Park	27.955	32.149	36.714	38.733	40.863	43.111
MFR East (Suburban)	6.800	7.786	8.005	8.013	8.021	8.029
MFR West (Urban)	27.200	28.832	28.861	28.890	28.919	28.948
Lndry/Lab/Auto	3.171	3.647	4.165	4.394	4.635	4.890
Schls/Hosp.	16.668	19.168	21.890	23.094	24.364	25.704
SFR East (Suburban)	29.194	33.427	34.363	34.397	34.431	34.466
SFR West (Urban)	116.776	123.783	123.907	124.031	124.155	124.279
Misc (Hyd/M.Off&Out)	3.896	4.325	4.330	4.334	4.339	4.343
TOTAL	285.270	309.588	322.941	328.183	333.659	339.380

Stage 2: Previously, a number of water conservation measures were implemented in the WCWSU area, and through the projection methods used in the Stage 1 analysis, their effects are included in the projections presented in Tables 6-23 through 6-30. The recent retrofit program, however, that was implemented during the 1977 drought as an intensive effort to reduce water use is not included. The program included use of retrofitting devices (low-flow showerheads and displacement devices to residential customers). The impact of the retrofit program was estimated based on the substep techniques in sections 6.2 and 6.3 (discussed later) to produce baseline projections for testing the effects of proposed water conservation measures considered in this analysis. The reduction fractions, coverage and annual rates of change are provided in Table 6-31.

TABLE 6-31
WCWSU PREVIOUS RETROFIT PROGRAM
FRACTION REDUCTION, COVERAGE, AND ANNUAL RATIO OF CHANGE

RETROFIT MEASURE	FRACTIONAL REDUCTION	1980 RESIDENTIAL COVERAGE	ANNUAL RATIO OF CHANGE
Low-flow Showerheads	0.04	0.43	0.88
Toilet Displacement Devices	0.044	0.42	0.88

Tables 6-32, 6-33 and 6-34 provide the baseline conditions, including projected effects of all existing water conservation measures. These baseline projections provide the basis (point of comparison) for the effectiveness analysis of possible additional conservation measures in Substeps 6.2 through 6.4.

TABLE 6-32
WCWSU BASELINE (PROJECTED FLOWS WITHOUT ADDITIONAL CONSERVATION)
LOW WATER USE CASE

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential (U)	58.905	60.860	60.748	60.277	59.712	59.126
Int. Residential (S)	14.725	16.016	16.164	16.217	16.243	16.263
Ext. Residential (U)	16.780	17.535	17.360	17.186	17.014	16.345
Ext. Residential (S)	4.194	4.613	4.618	4.622	4.627	4.631
Commercial	11.149	12.069	12.905	13.273	13.655	14.051
Industrial	33.343	33.969	35.108	35.875	36.661	37.470
Public/Inst.	19.911	22.484	24.828	26.047	27.237	28.490
Unacc. For	19.079	20.617	20.617	20.617	20.617	20.617
TOTAL	178.086	188.163	192.348	194.114	195.766	196.993

TABLE 6-32 (CONTINUED)
WCWSU BASELINE (PROJECTED FLOWS WITHOUT ADDITIONAL CONSERVATION)

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential(U)	110.607	114.278	114.069	113.186	112.125	111.022
Int. Residential(S)	27.562	30.072	30.351	30.451	30.502	30.536
Ext. Residential(U)	33.367	34.870	34.521	34.176	33.834	33.495
Ext. Residential(S)	8.341	9.175	9.184	9.194	9.203	9.213
Commercial	14.963	16.174	17.265	17.744	18.242	18.755
Industrial	41.811	42.448	43.794	44.705	45.641	46.602
Public/Inst.	48.519	55.073	61.571	64.596	67.785	71.141
Unacc. For	19.079	20.490	20.572	20.572	20.572	20.572
TOTAL	304.249	322.580	331.327	334.624	337.904	341.336

For the analysis which follows, the WCWSU customer classes were re-aggregated into the following categories (Table 6-33).

TABLE 6-33
WCWSU: CUSTOMER CLASS CATEGORIES

INTERIOR RESIDENTIAL: Identifies urban (U) and suburban (S) interior water uses and includes the interior protions of SFR and MFR use.

EXTERIOR RESIDENTIAL: Identifies urban (U) and suburban (S) exterior water uses and includes the exterior portions of SFR and MFR use.

COMMERCIAL: Identifies wholesale and retail business water use, including "Whole/Resale, Misc." and "Lndry/Lab/Auto", which includes laundries/laboratories and automobile-related use of water.

INDUSTRIAL: Includes sewer categories of water users: "Agri/Const." (agriculture and construction), "Food Procs." (food processing), "Wood, Paper, Chem." (wood, paper and chemicals), "Petro" (petroleum), "Metal, Plate, Clay" (metal, plating, clay), "Trans/Commun." (transportation and communications), and "Elec/Gas/Steam" (electricity, gas and steam production).

PUBLIC/INSTITUTIONAL: Identifies water use by cemeteries, golf courses and parks ("Cemetery, Golf, Park"), use for public facilities, including schools and hospitals ("Schls/Hosp.") and utility use ("Misc. Hyd/M. Off & Out"), which includes unmetered, filtered water estimated for fire use, irrigation at utility facilities, flushing and washing facilities related to construction or repairs, accidental losses due to main breaks or sheared fire hydrants, and observed leakage at reservoirs, pumping plants and filter plants.

UNACCOUNTED FOR: Includes leakage estimated at 11 percent.

TABLE 6-34
WCWSU BASELINE (PROJECTED FLOWS WITHOUT ADDITIONAL CONSERVATION)
MEDIUM WATER USE CASE

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential (U)	58.905	61.733	62.305	62.509	62.611	62.686
Int. Residential (S)	14.725	16.071	17.278	17.336	17.364	17.384
Ext. Residential (U)	16.780	17.786	17.804	17.822	17.840	17.858
Ext. Residential (S)	4.194	4.803	4.937	4.942	4.947	4.951
Commercial	11.149	12.223	13.342	13.807	14.292	14.794
Industrial	33.343	35.000	36.689	38.688	39.705	40.750
Public/Inst.	19.911	22.774	25.519	26.735	28.019	29.373
Unacc. For	19.079	20.490	20.572	20.572	20.572	20.572
TOTAL	178.086	191.480	198.446	202.411	205.350	208.368

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential (U)	110.607	115.919	116.993	117.375	117.567	117.706
Int. Residential (S)	27.562	31.304	32.446	32.551	32.604	32.644
Ext. Residential (U)	33.367	35.370	35.405	35.441	35.476	35.512
Ext. Residential (S)	8.341	9.551	9.818	9.828	9.838	9.847
Commercial	14.963	16.383	17.856	18.468	19.104	19.764
Industrial	41.811	43.731	47.012	48.219	49.458	50.731
Public/Inst.	48.519	55.642	62.933	69.161	69.567	73.158
Unacc. For	19.079	20.490	20.572	20.572	20.572	20.572
TOTAL	304.249	328.390	343.035	352.021	354.186	359.934

TABLE 6-35
WCWSU BASELINE (PROJECTED FLOWS WITHOUT ADDITIONAL CONSERVATION)
HIGH WATER USE CASE

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential (U)	58.905	62.607	63.755	64.538	65.225	65.890
Int. Residential (S)	14.725	17.107	18.111	19.060	20.026	21.031
Ext. Residential (U)	16.780	18.039	18.218	18.401	18.585	18.771
Ext. Residential (S)	4.194	4.928	5.175	5.433	5.706	5.990
Commercial	11.149	12.617	13.949	14.434	14.938	15.458
Industrial	33.343	37.064	40.271	42.281	43.904	45.595
Public/Inst.	19.911	23.155	26.166	27.473	28.849	30.294
Unacc. For	19.079	20.835	21.189	21.659	21.958	22.353
TOTAL	178.086	196.352	206.834	213.279	219.191	225.382

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential (U)	110.607	117.559	119.714	121.187	122.476	123.723
Int. Residential (S)	27.562	32.124	34.407	35.791	37.603	39.490
Ext. Residential (U)	33.367	35.870	36.230	36.591	36.957	37.327
Ext. Residential (S)	8.341	9.801	10.291	10.805	11.346	11.913
Commercial	14.963	16.918	18.682	19.324	19.988	20.677
Industrial	41.811	46.298	50.770	52.659	54.626	56.673
Public/Inst.	48.519	56.579	64.410	67.792	71.356	75.114
Unacc. For	19.079	20.490	20.572	20.572	20.572	20.572
TOTAL	304.249	335.639	355.076	364.721	374.924	385.489

Substep 6.2 Determine Fraction of Water Use Reductions

The data for determining the fraction of water use reduction for the proposed conservation measures in the WCWSU area were obtained from similar conservation programs in the same geographic area and under similar circumstances, as well as from some field data obtained in earlier WCWSU programs. Specific sources of data have all been taken from studies conducted within the state in which the WCWSU is located.

The fractional reduction for the retrofit program of low-flow showerheads and displacement devices was determined based upon the previous retrofitting program. During that program, a combined fractional reduction of 0.084 had been obtained. Because there is no interaction between these two measures, this combined fractional reduction is the sum of the fractional reduction of the two individual measures. A study (92) including another near-by utility similar to the WCWSU showed that savings from 3 gpm showerheads had fractional reductions 90 percent of the fractional reduction from toilets limited to 3.5 gallons per flush. Thus, the combined fractional reduction of 0.084 for the WCWSU was applied as a fraction reduction of 0.04 for the low-flow showerheads and a fractional reduction of 0.044 for the toilet displacement devices.

Three sources of fractional reduction data (from the WCWSU's state) for dual-flush toilets were evaluated and are shown in Table 6-36. As with the analyses for Levels 1 and 2, the individual studies used as data sources were evaluated and prioritized as to the degree of emphasis to be placed on each. From the evaluation of these sources, a fractional reduction of 0.228 was determined as appropriate for the WCWSU.

TABLE 6-36
REDUCTION VALUES FOR DUAL FLUSH-TOILETS

SOURCE	REDUCTION
Calif. Dept. of Water Resources (20)	0.30
Metcalf and Eddy (25)	0.258
Calif. Water Resources Center (35)	0.080

Reduction Factor = 0.228

As relatively untried techniques, the consolidation of turf landscaping measures are infrequently cited in the literature, and data are limited. Thus, the fractional reduction factors to be used were based upon local programs and experiences of nearby utility personnel. This experience indicated that the reduction fraction for the turf landscaping consolidation measure within multi-family complexes would be 0.30. Similarly, the fractional reduction for landscaping and ground cover for single family residences was estimated at 0.50.

The WCWSU has categorized its industrial customers into seven categories and has water use data for each of these. The industrial use categories include: (1) agricultural and construction; (2) food processing; (3) wood, paper, and chemical; (4) petroleum; (5) metal, plate, and clay; (6) transportation and communication; and (7) electric, gas, and steam. Commercial users are categorized as: (1) wholesale, retail, miscellaneous; and (2) laundry, laboratory, auto. The proposed WCWSU program promotes water reuse and recycling as a water conservation measure among its largest industrial and commercial users and among smaller users where the anticipated reduction from this measure is high. The total number of industrial and commercial connections are approximately 20,000, so this prioritized effort appears appropriate. Because the agricultural/construction and electrical gas/steam categories combined use only 3.3 percent of the total, the WCWSU is not targeting these industries in its effort. Similarly, since the wholesale, retail, and miscellaneous commercial category does not show much promise in terms of the fraction reduction that may be achieved, it also is not targeted.

In order to determine realistic fractional reductions for the industrial users, each targeted industrial category was examined independently. Fourteen sources of fractional reduction data for industries within these categories were identified and are presented by category in Table 6-37. Each study within each industrial category was evaluated, and an appropriate fractional reduction was developed for each category. These are also provided in Table 6-37.

TABLE 6-37
REDUCTION FRACTIONS FOR INDUSTRIAL RECYLE/REUSE

FOOD PROCESSING INDUSTRIES	REDUCTION FACTOR
Animal By-Products (20)	0.30
Tomato Processing (20)	0.125
Tomato Processing (60)	0.87
Chicken Processing (93)	0.32
Reduction for Food Processing	0.344
WOOD, PAPER, CHEMICAL INDUSTRIES	
Paperboard (20)	0.26
Papermill (60)	0.45
Fiber Plant (60)	0.30
Chemical Company (94)	0.51
Pulp and Paper (95)	0.154
Reduction for Wood, Paper, Chemical	0.310
PETROLEUM INDUSTRIES	
Oil Refining (94)	0.069
Reduction for Petroleum	0.069
METAL, PLATE, CLAY INDUSTRIES	
Metals Process (20)	0.977
Carbon Black Process (20)	0.982
Electroplating (38)	0.930
Reduction for Metal, Plate, Clay	0.961
TRANSPORTATION, COMMUNICATIONS INDUSTRIES	
Aircraft Company (38)	0.30
Reduction for Transportation, Communication	0.30

TABLE 6-38
1980 FLOW FOR TARGETED INDUSTRIAL CATEGORIES

INDUSTRIAL CATEGORY	MGD
Food Processing	6.7
Wood, Paper, Chemical	3.0
Petroleum	15.3
Metal, Plate, Clay	5.1
Transportation, Communication	2.2
	32.3

The individual industrial category fractional reductions were then combined and weighted by the quantity of water use in each category (Table 6-38) to derive an overall fractional reduction for reuse/recycle to be applied to the future industrial water use for these categories. The products of flow and fractional reduction were summed for all five targeted categories and divided by the total flow of the five categories. This calculation is shown below and results in a fractional reduction for industrial reuse and recycle of 0.305.

Fraction Reduction =

$$\frac{(0.344)(6.7MGD)+(0.310)(3.0)+(0.069)(15.3)+(0.961)(5.1)+(0.300)(2.2)}{6.7+3.0+15.3+5.1+2.2}$$

$$= 0.305$$

No data sources were identified for reuse and recyle within the commercial categories. Based on discussions with the WCWSU personnel, the same fractional reduction determined for industrial recycle/reuse was judged to be applicable for the commercial laundry, laboratory, automobile sector as well.

The proposed restricted water use programs will impact industrial, commercial, public, and exterior residential water use categories. In examining the available reduction data, a nearby application (8) of a restricted use program resulted in a fractional reduction of 0.25. Careful examination of this program showed it to be similar to that proposed by the WCWSU and with a reasonably comparable population. Thus, the reduction fraction of 0.25 was used for the WCWSU effectiveness analysis.

The second contingency measure, a 50 gpcd restriction on all residential customers represents an upper limit total that each residential customer can use. It is assumed that the WCWSU goal of 50 gpcd is achieved on a system-wide basis and that the number of residential customers and quantity of use that exceed this value is offset by the number of customers and quantity of use that remain under it. Thus, the total restricted residential flow with this measure is estimated by multiplying the population by 50 gpcd. It should be noted that the restricted use measure as it applies to residential use and the per capita restriction measure interact completely with each other. That is, the reductions made in residential water use through the restricted use measure are, in fact, part of the per capita day reduction. This interaction results in the combined actual reduction during the implementation of these contingency measures being the larger of the two individual reductions. This is shown with respect to interactions in Substep 6.4

Substep 6.3 Determine Coverage

Local implementation conditions were evaluated to determine coverage in implementing the proposed water conservation program. The WCWSU officials were interviewed regarding methods for implementation of water conservation measures, as well as the level of effort, committment and funding. Social acceptability study results of the previous conservation programs (Step 4) were used to determine the likely response of the individual sectors of the community to the implementation of each of the measures. In the case of the industrial categories targeted for promotion of reuse and recycling, different coverage was applied depending on the level of effort the WCWSU would expend on each industrial category.

Unlike the Levels 1 and 2 analyses, the Level 3 analysis requires an evaluation of the actual fraction of flow impacted by the conservation measures to be evaluated, rather than simply relying upon the fraction of users. This necessitates differentiating high volume users or others who are to be targeted for particular emphasis. This is best illustrated in the determination of coverage for the reuse/recycle measure for industrial water use. Table 6-39 presents the flows and number of connections in 1980 for the seven industrial categories in the WCWSU service area. It is apparent that estimates of coverage based on the number of connections rather than percentage of flow impacted can lead to inaccuracies. For example, the petroleum industries represent 45.8 percent of the total industrial flow in 1980 but only represent 1.4 percent of the total number of industrial connections. Estimating coverage for a measure impacting petroleum industries based on the percentage of connections would substantially underestimate the coverage value.

TABLE 6-39
FLOW AND CONNECTIONS FOR INDUSTRIAL AND COMMERCIAL CATEGORIES (1980)

	FLOW		CONNECTIONS	
INDUSTRIAL CATEGORY	MGD	PERCENT	NUMBER	PERCENT
Agricultural, Const.	0.7	2.1	616	13.6
Food Processing	6.7	20.1	296	6.5
Wood, Paper, Chemical	3.0	9.0	788	17.4
Petroleum	15.3	45.8	65	1.4
Metal, Plate, Clay	5.1	15.3	1,091	24.0
Transp., Comm.	2.2	6.6	1,531	33.9
Electric, Gas, Steam	0.4	1.2	144	3.2
	33.4		4,539	
COMMERCIAL CATEGORY				
Wholesale, Retail, Misc.	8.5	76.6	12,817	85.7
Laundry, Laboratory, Auto.	2.6	23.4	2,132	14.3

The WCWSU plans to concentrate its efforts in promoting reuse and recycle on the largest users and on industrial categories where reuse and recycle has been shown to be particularly effective. For this reason, it is not targeting (at all) the agricultural/construction and the electrical gas/steam categories which together, represent only 3.3 percent of the total flow. The coverage factor for these two categories is, therefore, zero. Maximum effort is placed on the petroleum users, however, since they represent nearly half of the total industrial flow. Substantial effort is also placed on the food processing and wood/paper/chemical categories since these flows can be impacted by a relatively small number of industrial customers. Because the number of industrial customers who would have to adopt reuse and recycle to achieve equivalent flow reduction is high in the metal/plate/clay and transportation/communication categories, these industries received only minimal effort. Based on planned budgets (Step 8), it is estimated that the WCWSU effort results in impact to 60 percent of the petroleum flow, 33 percent of the food processing and wood/paper/chemical categories flow, and 10 percent of the metal/plate/clay and transportation/communications category flow. A similar analysis of commercial flows and connections resulted in the wholesale/retail/miscellaneous category not being targeted. The laundry/laboratory/auto category was included with 33 percent of its flow impacted by implementing recycle and reuse.

The coverage of the recycle/reuse measure for the industrial water use sector for future projections is then the sum of the products of the individual industry category coverage and the percentage of the total industrial flow in that category. Thus, the total industrial coverage for the reuse/recycle measure is:

Industrial Coverage =

$$(0)(.021)+(.33)(.201)+(.33)(.09)+(.6)(.458)+(.10)(.153)+(.10)(.066)+(0)(.012)$$

$$= 0.393$$

Similarly, the total commercial coverage for the reuse/recycle measure is 0.077.

The consolidation of turf landscaping in multi-family residential complexes is a relatively untried measure, and estimating its coverage is difficult. If included with the planning for new construction, all new multi-family dwellings could incorporate this concept. Thus, the initial coverage would be zero, and coverage would increase with time as a function of the rate of new construction. This coverage is represented by

$$\text{Coverage} = 1.0 - \frac{1.0}{(1.0+r)^{n-1}}$$

where r = fractional rate of new construction and
n = year since the start of the measure

Based upon the number of connections projected for the suburban service area, a fractional rate of new construction of 0.002 was used for all three projections.

Consolidation of turf landscaping in existing multi-family residences is much more difficult as it represents a major effort. It is assumed that only about 2.5 percent of existing multi-family connections adopt the measure by 1990, and a maximum of 5.0 percent would implement it by the year 2000 and beyond. This represents an initial coverage of 0.0134 with an annual ratio of change of 1.072 until the year 2000, and a coverage of 0.05 with an annual ratio of change of 1.0 thereafter. (This is equivalent to a coverage of .0134 in 1981, .025 in 1990, and .05 from 2000 on.)

The landscaping and use of drought-tolerant vegetation approaches are new measures for which coverage is difficult to estimate. From discussions with WCWSU personnel, and based on the inducements outlined for the measure, it is assumed that by 1990, 50 percent of the newly-constructed suburban single family homes incorporate this measure, and from the year 2000-2030, 90 percent of new single family construction incorporates it. By using the relationship for coverage due to new construction (presented above under consolidation of turf landscaping), coverage for newly-constructed single family residences in 1990 (r = 0.002, n = 10) is 0.018 of the total, and in 2000, (n = 20) is 0.037 of the total. The actual coverage in 1990 is, therefore, 50 percent of 0.018 (or 0.009) and the coverage in 2000 is 90 percent of 0.037 (or 0.033). From 1980 to 2000, this can be accurately represented by using an initial coverage of 0.0028 with an annual ratio of change of 1.14. (This results in coverage of 0.0028 in 1981, 0.0091 in 1990, and 0.0337 in 2000.) From 2000 to 2030, the coverage is represented as a coverage of 0.033 in 2000 with an annual ratio of change equal to 1.0 plus the fractional rate of new construction (1.002).

For existing single family homes where re-landscaping and re-planting are difficult, the coverage is assumed to be 0.05 by 1990 and reaching and sustaining a maximum coverage of 0.10 by 2000 and thereafter. This was represented by using an initial coverage of 0.0267 with an annual ratio of change of 1.072 until year 2000 (resulting in coverages of 0.0267 in 1981, 0.05 in 1990, and 0.10 in 2000) and using a coverage of 0.10 with an annual ratio of change of 1.0 thereafter.

The coverage for the retrofitted devices, low-flow showerheads and toilet displacement devices, were derived from the previous WCWSU experience with these devices. The earlier program achieved an initial coverage of 0.62 for the showerheads and 0.65 for toilet displacement devices. It also was determined that the coverage had dropped to 0.43 and 0.42 within four years, which is equivalent to an annual ratio of change of 0.88. In implementing a new retrofit program, it is assumed that the WCWSU achieves the same level of coverage on that portion of the customer flow not already impacted by the earlier program. (Remember, also, that the impact of the earlier program is already included within the disaggregated forecast.) Thus, the initial coverage for low-flow showerheads is 0.62 times the remaining flow not covered by the earlier program, or (0.62)(1-0.43) = 0.36. Similarly, the toilet displacement device coverage is (0.65)(1-0.42) = 0.37.

Since non-residential water use was not included in the earlier retrofit effort, coverage in commercial and public use categories reflects a first-time implementation. Based on WCWSU interviews and results of social acceptability studies, initial coverages of 0.50 for the toilet displacement devices in the commercial and public categories and of 0.20 in the public-institutional categories are assumed.

The WCWSU and nearby water utilities have not had experience in the implementation of dual-flush toilet mechanisms. One source (9) has indicated, however, that a moderate program could anticipate a coverage of 0.05 for this measure. This coverage was applied to both existing and new construction. No change in coverage with time is anticipated.

During possible future water emergencies, the WCWSU enforces the restricted use measure on all exterior residential, commercial, industrial and public/institutional water users. Similarly, the per capita day restriction applies to all residential use. Thus, the coverage is 1.0 for these measures within those use sectors.

Based upon the coverage factors and changes with time (established above) Table 6-40 presents the coverage for each measure in 1985. These coverages are used in the evaluation of effectiveness for that year as is demonstrated later in Substep 6.4.

TABLE 6-40
WCWSU 1985 COVERAGE VALUES
PERMANENT AND CONTINGENCY MEASURES

MEASURE	INTERIOR RES.	EXTERIOR RES.	COMM.	IND.	PUBLIC INST.	UNACC. FOR
Low-flow Shwhds.	0.216	-	0.300	-	0.300	-
Displ. Devices	0.222	-	-	-	0.120	-
Dual-flush Toil.	0.050	-	0.050	-	0.050	-
Reuse/Recycle	-	-	0.077	0.393	-	-
Cons. Turf (existing)*	-	0.018	-	-	-	-
Cons. Turf (new)*	-	0.008	-	-	-	-
Tensiometer (existing)*	-	0.035	-	-	-	-
Drought-Tolerant (new)*	-	0.005	-	-	-	-
Restricted Uses	-	1.0	1.0	1.0	1.0	-
Per Capita Restr.	(50 gpcd total resid.)		-	-	-	-

*East/Suburban service area only.

Substep 6.4: Analysis of Effectiveness for the WCWSU Area

In this section, the effectiveness of the WCWSU water conservation program is estimated. It is based on the disaggregated demand forecast, the fractional reduction, the coverage and changes in coverage with time.

Interactions between measures are a factor when the rationing plan is implemented. The interactions occur between the per capita contingency measures and all other measures within residential water use. During severe drought, while the other measures are in effect, residential customers simultaneously have a 50 gallon per person per day upper limit imposed upon them. With this combination of measures, it is anticipated that one of two circumstances occurs. If the other measures result in an effectiveness that brings the residential use below the 50 gpcd upper limit, no further reduction will occur. Conversely, if the other measures result in a reduction that does not achieve the 50 gpcd limit, further reductions occur until that level is achieved. Thus, the effectiveness that is achieved in residential water use is the larger effectiveness of the per capita measure and the other measures. This is a complete interaction of the per capita measure with the other measures and is represented in the effectiveness equation as an interaction factor of zero.

Example calculations of the effectiveness of the WCWSU conservation program are presented for the residential water use category. The calculations present permanent and contingency measures in 1985 for the medium average day water use projection. Each of the conservation measures except reuse/recycle impact the residential water use. The fractional reduction for each of the measures was provided in Substep 6.2. The coverage factors for each measure in 1985 were presented in Table 6-40. The disaggregated residential flows for suburban and urban service areas (as interpolated between 1980 and 1990) are provided in Table 6-41. In addition, the flow bases for using (1) the consolidation of turf landscaping measure for multi-family residential suburban water use, and (2) the landscape measure for single family residential suburban water use are respectively 11.8 percent for multi-family residential (of the outdoor suburban residential flow) and 88.2 percent for single family use. With these values, the effectiveness of the individual measures are determined as follows:

MEASURE	FLOW		REDUCTION		COVERAGE		EFFECTIVENESS
Low-Flow Showerheads	76.017	X	0.040	X	0.216	=	0.657 MGD
Toilet Displ. Device	76.017	X	0.044	X	0.222	=	0.742 MGD
Dual-flush Toilet	76.017	X	0.228	X	0.050	=	0.867 MGD
Turf Landscaping (existing)	(4.498)(0.118)	X	0.300	X	0.018	=	0.003 MGD
Turf Landscaping (new)	(4.498)(0.118)	X	0.300	X	0.008	=	0.001 MGD
Landscape (existing)	(4.498)(0.882)	X	0.500	X	0.035	=	0.069 MGD
Landscape	(4.498)(0.882)	X	0.500	X	0.005	=	0.010 MGD
Restricted Uses	21.781	X	0.250	X	1.000	=	5.445 MGD
TOTAL EFFECTIVENESS WITHOUT PER CAPITA RESTRICTION							7.794 MGD

TABLE 6-41
WCWSU 1985 INTERPOLATED RESIDENTIAL FLOWS

CATEGORY	FLOW (MGD)
Interior Residential - Urban	60.319
Interior Residential - Suburban	15.698
Exterior Residential - Urban	17.283
Exterior Residential - Suburban	4.498
Total Interior Residential	76.017
Total Exterior Residential	21.781
Total Residential	97.798

The total WCWSU population in 1985 is 1,125,000 (Table 6-4, Estimated) for the medium water use case. Thus, the maximum total residential water use allowed by the 50 gpcd restriction is 50 x 1,125,000 or 56.25 mgd. The effectiveness of this measure is the difference between the unrestricted flow of 97.798 mgd and the restricted flow of 56.25 mgd. Thus, the effectiveness of the per capita restriction is 41.598 mgd. Since this is larger than the effectiveness of the combined other measures, it represents the total residential effectiveness. Mathematically, as evaluated by the effectiveness equation and an interaction factor of 0.0, this is equvalent to:

$$= 41.548 \text{ mgd} + (0) * (7.794 \text{ mgd}) = 41.548 \text{ mgd}.$$

The results of the WCWSU effectiveness evaluation for the low, medium, and high water use cases are presented for the permanent measures in Tables 6-42, 6-43, and 6-44, respectively. The overall impact is summarized in Tables 6-45 and 6-46 for medium and high growth. The addition of the contingency measures is shown in the low, medium and high water use cases in Tables 6-47, 6-48 and 6-49.

The effectiveness of the permanent measures ranges from 2-5 percent (with the industrial conservation accounting for over 50 percent), while the effectiveness during the contingency program ranges from 33-36 percent. This analysis indicates that current programs for reducing water use (currently required low-flow fixtures in new construction, on-going education programs, leak detection and meter verification programs, low water-using appliances, energy-related water reduction measures, as well as other methods) and the limited growth anticipated for the area (in contrast, in Levels 1 and 2 future growth provides major opportunities for water saving), have already cut into the region's ability to achieve additional water conservation. This analysis also indicates the significant reduction that can be achieved by rationing.

TABLE 6-42
EFFECTIVENESS OF CONSERVATION FOR WCWSU
LOW WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS OF AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	3.281	2.063	1.157	0.629	0.351	0.108	0.033	0.010
Ext. Residential	0.057	0.082	0.127	0.161	0.287	0.290	0.295	0.300
Commercial	0.639	0.513	0.421	0.371	0.348	0.326	0.325	0.331
Industrial	4.004	4.034	4.072	4.155	4.208	4.300	4.394	4.491
Public/Inst.	0.835	0.540	0.313	0.180	0.104	0.033	0.011	0.003
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	8.817	7.231	6.089	5.496	5.298	5.057	5.082	5.144
PERCENT	4.9	3.9	3.2	2.9	2.8	2.6	2.6	2.6

EFFECTIVENESS OF PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	6.157	3.871	2.172	1.182	0.660	0.202	0.063	0.020
Ext. Residential	0.114	0.162	0.253	0.369	0.570	0.576	0.587	0.596
Commercial	0.858	0.687	0.546	0.497	0.466	0.436	0.435	0.442
Industrial	5.019	5.050	5.088	5.190	5.249	5.359	5.471	5.586
Public/Inst.	2.036	1.319	0.766	0.444	0.258	0.082	0.027	0.009
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	14.184	11.089	8.843	7.682	7.203	6.655	6.626	6.667
PERCENT	4.6	3.5	2.7	2.4	2.2	2.0	2.0	2.0

TABLE 6-43
EFFECTIVENESS OF CONSERVATION FOR WCWSU
MEDIUM WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS OF AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	3.289	2.085	1.181	0.647	0.364	0.113	0.035	0.013
Ext. Residential	0.057	0.083	0.132	0.195	0.306	0.310	0.315	0.320
Commercial	0.640	0.516	0.426	0.381	0.360	0.339	0.340	0.349
Industrial	4.026	4.101	4.195	4.300	4.398	4.637	4.759	4.884
Public/Inst.	0.836	0.544	0.317	0.184	0.107	0.034	0.011	0.004
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	8.848	7.329	6.251	5.707	5.535	5.482	5.461	5.568
PERCENT	4.9	4.0	3.3	3.0	2.8	2.7	2.7	2.7

EFFECTIVENESS OF PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	6.175	3.914	2.217	1.215	0.685	0.210	0.066	0.021
Ext. Residential	0.114	0.166	0.263	0.388	0.609	0.617	0.627	0.637
Commercial	0.859	0.692	0.571	0.510	0.481	0.454	0.455	0.466
Industrial	5.035	5.127	5.242	5.479	5.635	5.780	5.928	6.081
Public/Inst.	2.038	1.327	0.774	0.452	0.263	0.084	0.027	0.009
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	14.221	11.225	9.068	8.044	7.673	7.145	7.103	7.214
PERCENT	4.6	3.5	2.8	2.4	2.2	2.1	2.0	2.0

TABLE 6-44
EFFECTIVENESS OF CONSERVATION FOR WCWSU
HIGH WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS OF AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	3.294	2.103	1.201	0.663	0.306	0.118	0.038	0.012
Ext. Residential	0.058	0.085	0.136	0.203	0.321	0.341	0.364	0.388
Commercial	0.643	0.525	0.440	0.394	0.376	0.355	0.356	0.365
Industrial	4.041	4.220	4.443	4.619	4.827	5.068	5.263	5.465
Public/Inst.	0.838	0.548	0.322	0.187	0.109	0.035	0.011	0.004
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	8.874	7.481	6.542	6.067	6.009	5.917	6.032	6.234
PERCENT	4.9	4.0	3.3	3.0	2.9	2.8	2.8	2.8

EFFECTIVENESS OF PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	6.187	3.949	2.257	1.246	0.707	0.221	0.071	0.022
Ext. Residential	0.114	0.168	0.270	0.403	0.639	0.679	0.723	0.771
Commercial	0.862	0.704	0.590	0.528	0.504	0.475	0.476	0.488
Industrial	5.065	5.281	5.550	5.817	6.086	6.312	6.548	6.793
Public/Inst.	2.042	1.338	0.787	0.460	0.270	0.086	0.028	0.009
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	14.270	11.440	9.453	8.455	8.205	7.773	7.846	8.083
PERCENT	4.6	3.6	2.8	2.5	2.3	2.1	2.1	2.1

TABLE 6-45
WCWSU WATER DEMAND WITH PERMANENT CONSERVATION
MEDIUM POPULATION GROWTH CASE

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1981	1990	2000	2010	2020	2030
Int. Residential	73.630	70.341	77.223	79.219	79.732	79.940	80.057
Ext. Residential	20.974	20.917	22.457	22.436	22.454	22.472	22.489
Commercial	11.149	10.509	11.797	12.982	13.468	13.952	14.445
Industrial	33.343	29.317	30.805	32.291	34.051	34.946	35.866
Public/Inst.	19.911	19.075	22.457	25.412	26.701	28.008	29.369
Unacc. For	19.079	19.079	20.490	20.572	20.572	20.572	20.572
TOTAL	178.086	169.238	185.229	192.912	196.929	199.890	202.798

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1981	1990	2000	2010	2020	2030
Int. Residential	138.169	131.994	145.006	148.754	149.716	150.105	150.329
Ext. Residential	41.708	41.594	44.658	44.614	44.652	44.687	44.722
Commercial	14.963	14.104	15.812	17.375	18.014	18.649	19.298
Industrial	41.811	36.776	38.489	41.377	42.439	43.530	44.650
Public/Inst.	48.519	46.481	54.868	62.670	69.077	69.540	73.149
Unacc. For	19.079	19.079	20.490	20.572	20.572	20.572	20.572
TOTAL	304.249	290.028	319.322	335.362	344.876	347.083	352.720

Based on comparison of Tables 6-34 and 6-43.

TABLE 6-46
WCWSU WATER DEMAND WITH PERMANENT CONSERVATION
HIGH POPULATION GROWTH CASE

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1981	1990	2000	2010	2020	2030
Int. Residential	73.630	70.336	78.513	81.560	83.480	85.213	86.909
Ext. Residential	20.974	20.916	22.831	23.072	23.493	23.927	24.373
Commercial	11.149	10.506	12.177	13.573	14.079	14.582	15.093
Industrial	33.343	29.302	32.621	35.444	37.213	38.641	40.130
Public/Inst.	19.911	19.073	22.833	26.057	27.438	28.838	30.290
Unacc. For	19.079	19.079	20.835	21.189	21.659	21.958	22.353
TOTAL	178.086	169.212	189.810	200.825	207.362	213.159	219.148

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1981	1990	2000	2010	2020	2030
Int. Residential	138.169	131.982	147.426	153.414	156.757	160.008	163.191
Ext. Residential	41.708	41.594	45.401	45.882	46.717	47.580	48.469
Commercial	14.963	14.101	15.590	18.178	18.849	19.512	20.189
Industrial	41.811	36.746	40.748	44.684	46.347	48.078	49.880
Public/Inst.	48.519	46.477	55.792	64.140	67.706	71.328	75.105
Unacc. For	19.079	19.079	20.490	20.572	20.572	20.572	20.572
TOTAL	304.249	289.979	326.186	346.871	356.948	367.078	377.406

Based on comparison of Tables 6-35 and 6-44.

TABLE 6-47
EFFECTIVENESS OF CONSERVATION FOR WCWSU
LOW WATER USE CASE
(PERMANENT MEASURES WITH CONTINGENCY)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	41.596	41.215	41.863	39.218	40.040	39.902	39.646	38.865
Commercial	3.799	3.624	3.547	3.544	3.603	3.651	3.740	3.844
Industrial	12.356	12.448	12.564	12.822	12.985	13.269	13.560	13.859
Public/Inst.	6.904	6.473	6.278	6.263	6.409	6.571	6.826	7.128
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	64.655	63.760	63.063	61.847	63.037	63.393	63.772	63.696
PERCENT	36.1	34.5	33.5	32.8	32.8	32.7	32.6	32.3

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	77.420	76.827	75.779	72.964	74.545	74.295	73.820	73.291
Commercial	5.098	4.860	4.754	4.744	4.820	4.881	4.997	5.132
Industrial	15.488	15.582	15.700	16.015	16.198	16.535	16.881	17.236
Public/Inst.	16.832	15.816	15.377	15.476	15.894	16.295	16.989	17.798
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	114.838	113.085	111.610	109.876	111.457	112.006	112.687	113.457
PERCENT	37.5	36.1	34.6	33.9	33.6	33.5	33.3	33.2

TABLE 6-48
EFFECTIVENESS OF CONSERVATION FOR WCWSU
MEDIUM WATER USE CASE
(PERMANENT MEASURES WITH CONTINGENCY)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	41.674	41.548	41.493	39.894	41.574	41.659	41.762	41.829
Commercial	3.804	3.648	3.592	3.637	3.725	3.798	3.915	4.048
Industrial	12.424	12.655	12.945	13.269	13.570	14.309	14.685	15.072
Public/Inst.	6.914	6.517	6.359	6.401	6.587	6.744	7.022	7.348
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	64.816	64.368	64.389	63.201	65.456	66.510	67.384	68.297
PERCENT	36.1	34.8	33.6	32.7	33.0	32.9	33.1	32.8
[1]Annual Demand	113.270		127.091		132.990	135.901	137.966	140.071

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	77.794	77.493	77.309	74.222	77.415	77.561	77.755	77.883
Commercial	5.105	4.893	4.815	4.870	4.985	5.080	5.233	5.408
Industrial	15.535	15.819	16.175	16.907	17.388	17.835	18.293	18.764
Public/Inst.	16.852	15.903	15.536	15.747	16.245	16.690	17.436	18.302
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	115.286	113.108	113.835	111.746	116.033	117.166	118.717	120.357
PERCENT	37.6	36.1	34.7	33.5	33.8	33.3	33.5	33.4
[1]Daily Demand	188.963		214.555		227.002	234.855	235.469	239.577

[1]Based on Table 6-34.

TABLE 6-49
EFFECTIVENESS OF CONSERVATION FOR WCWSU
HIGH WATER USE CASE
(PERMANENT MEASURES WITH CONTINGENCY)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	41.761	41.942	42.181	41.045	42.659	43.632	44.542	45.432
Commercial	3.818	3.709	3.708	3.766	3.894	3.970	4.092	4.229
Industrial	12.470	13.021	13.709	14.254	14.895	15.638	16.239	16.864
Public/Inst.	6.927	6.575	6.465	6.530	6.754	6.930	7.230	7.579
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	64.976	65.247	66.063	65.595	68.202	70.212	72.103	74.104
PERCENT	36.1	34.9	33.6	32.9	33.0	32.9	32.9	32.9

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2010	2020	2030
Int. Residential	77.960	78.229	78.589	76.680	79.824	81.248	82.932	84.591
Commercial	5.123	4.976	4.972	5.046	5.215	5.315	5.475	5.657
Industrial	15.630	16.294	17.124	17.950	18.778	19.477	20.204	20.961
Public/Inst.	16.884	16.046	15.797	16.041	16.626	17.102	17.884	18.792
Unacc. For	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	115.597	115.545	116.482	115.717	120.443	123.142	126.495	130.001
PERCENT	37.6	36.1	34.7	33.8	33.9	33.8	33.7	33.7

STEP 7: Advantageous Effects (Indirect)

The following section provides a brief overview of the effectiveness of the proposed water conservation program as it affects the future balance between available water supply and projected water demand. Then, Step 7 analysis focuses on the indirect advantageous effects of each water conservation measure to residential, multi-family, commercial, industrial and public/institutional water users, as well as unaccounted-for use. These impacts are frequently reduced costs indirectly related to water use reduction. In this example, for instance, where residential and industrial water uses are targeted, energy savings result from reduced use of hot water in houses and apartments and from water recycling/reuse process changes in industry and commercial business. The direct cost savings to the WCWSU water supply and wastewater systems that result from water conservation are addressed in Step 9: Foregone Supply Costs.

Description of Conservation Measures

Measure 1: (M1-Retrofit) requires the voluntary installation in existing buildings of low-flow showerheads (3 gpm or less) and toilet displacement devices, which reduce water use to 3.5 gallons per flush. The retrofit program affects users:

- Residential
- Commercial
- Public

The program is implemented on a one-time basis. Kits of showerheads (1 per kit), toilet displacement bags (6 1-qt. bags per kit) and instructions, are packaged and made avilable free to WCWSU water customers. The program is advertised to encourage installation.

Measure 2: (M2-Dual-Flush Toilets) requires the voluntary installation of dual-flush toilets. The program is designed to affect users:

- o Residential
- o Commercial
- o Public

The use of the dual-flush toilet (2-3.5 gallons per flush) is not expected to be extensive, although the design is very similar to conventional toilets, and the costs are the same as a conventional toilet. (38) As a retrofit, dual-flush mechanisms are available at about $15.00. (96)

Measure 3: (M3-Recycle/Reuse). Water recycling and reuse (limited to industry and commercial businesses) represents an effective way to reduce water supplies to industrial customers as well as possible self-supplied industrial water use (private wells). Based on previous Step 6 analyses, the industries and commercial businesses targeted are determined and presented in Table 6-50.

TABLE 6-50
WCWSU AREA FIRMS INVOLVED IN WATER RECYCLE/REUSE

INDUSTRIES	COVERAGE FLOW IMPACTED (%)	TOTAL CONN. (#)	CONNECTIONS AFFECTED (%)	AFFECTED CONN. (#)
Food Processing	33	296	17	49
Wood, Paper, Chem.	33	788	17	131
Petroleum	60	65	30	20
Metal, Plate, Clay	10	1,091	5	55
Transp., Comm.	10	1,531	5	77
COMMERCIAL BUSINESS				
Laundry, Labs, Auto	33	2,132	-	-
TOTAL				332

The number of firms potentially involved (connections) is only 65 for petroleum and over 2,000 for the laundry, labs and auto category. Based on a focused program on major water users, first, and second priority to the smaller but significant users, the percent of flow that is impacted by the proposed program to encourage water reuse and recycling ranges between 60 percent and 10 percent, reflecting the likely previous successful efforts at industrial by these water users and the limits of budget and program potential to convince users to modify their systems. The final column in Table 6-50 identifies the number of connections that are impacted by the program and actually make water saving changes.

Measure 4: (M4-Landscaping). Based on the significant amount of water used for residential exterior purposes, it is apparent that efforts can be successful in reducing exterior water use. The proposed program represents interests currently being explored by the WCWSU as well as by the state in developing pilot projects to test water use reduction possibilities and public acceptance. The proposed program effects exterior multi-family and single family water use, primarily for new construction where program incentives are directed.

Based on the assumptions made in Step 6, the landscaping program affects new multi-family (MFR) complexes with consolidated turf grass and single family (SFR) developments with drought-tolerant landscaping. The use of tensiometers is planned for existing MFR use. Table 6-51 identifies the affected existing and new developments.

TABLE 6-51
SFR AND MFR AFFECTED BY LANDSCAPING MEASURE

MEASURES	1980	1990	2000	2010	2020	2030
Consolidated Turf						
New MFR	0	87	182	276	367	457
Tensiometers/Irrig.						
Existing MFR	0	140	289	289	289	289
Drought-Tolerant Veg.						
New SFR	0	561	2,135	2,174	2,223	3,270
Existing SFR	0	2,724	5,448	5,448	5,448	5,448

Measure 5: (M5-Contingency). During periods of water shortage, mandatory measures are implemented to reduce water use, first for low priority uses then later for uses that do not threaten the health and safety of the public.

Conservation Effects

Figure 6-6 graphically presents the current average daily water supply and demand situation for the WCWSU service area. The water supply situation was described earlier in the section on "Water Use." During the 1970's, the safe yield of the system was re-evaluated and reduced to 212 mgd from 325 mgd in 1980. This revised 1980 safe yield is based on the drought of the late 1970's and is expected to be 173 mgd by 2000, according to WCWSU studies. The forecasts presented in Figure 6-6 indicate the effects of unconstrained water use and the effects of conservation for medium and high growth scenarios. Previously, Figure 6-1 presented WCWSU projections. In 2000, the utility's estimated demand was 248 mgd (about 25 percent more than forecast here, even without additional conservation). The existing programs for conserving water implemented by the state, as well as by the WCWSU have had a significant apparent effect.

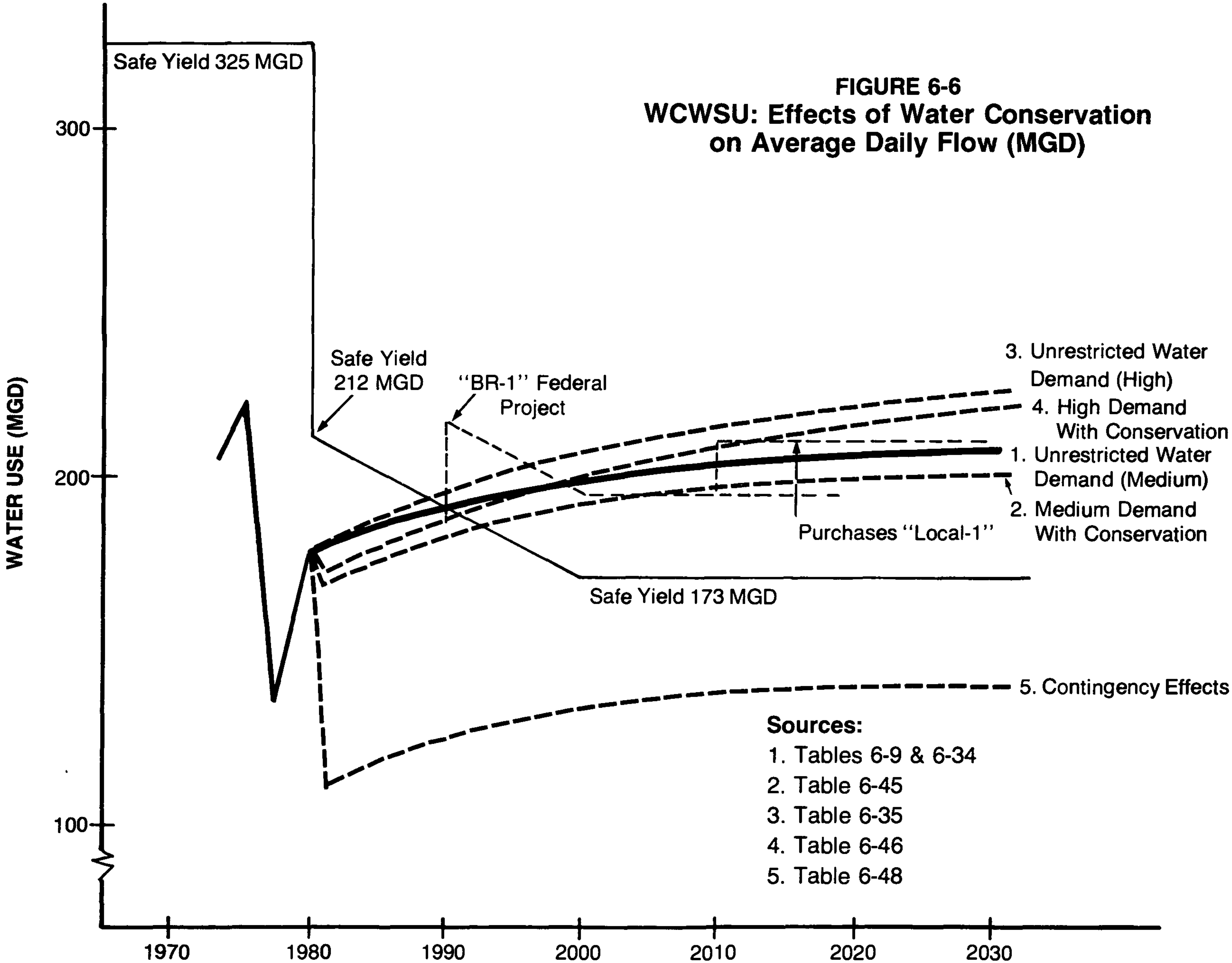


FIGURE 6-6
WCWSU: Effects of Water Conservation on Average Daily Flow (MGD)

Because of continued growth in water use and the de-rated safe yield, the WCWSU system needs additional water supplies in the future. The severe rationing contingency plan, however, can reduce demand sufficiently to "get by" if a drought like that of the late 1970's occurs again.

Options for meeting future water needs in the WCWSU area were discussed previously in the section on "Water Resources." Additional supplies are available from the "LOCAL-1" project (134 mgd) and the Federal project "BR-1" (22.8 mgd).

Based on unconstrained water demand (medium growth) projections, additional water supply is needed in 1990. The BR-1 Federal project (22.8 mgd) could be used, or purchases from the LOCAL-1 project in 1990. The BR-1 project would meet the WCWSU needs until 2000 when additional purchases are needed from LOCAL-1 (about 15 mgd). This approach is evaluated in the subsequent analysis, and the effects of water conservation on project benefits, costs and timing are determined.

In Figure 6-7, the WCWSU peak daily water use is presented graphically. The current potential constraint on the system's ability to meet peak day needs is the 469 mgd treatment system. Based on the projected peak day water use, medium and high projections, the system is adequate throughout the planning period. Nearly 100 mgd of additional capacity is available even under the worst case situation.

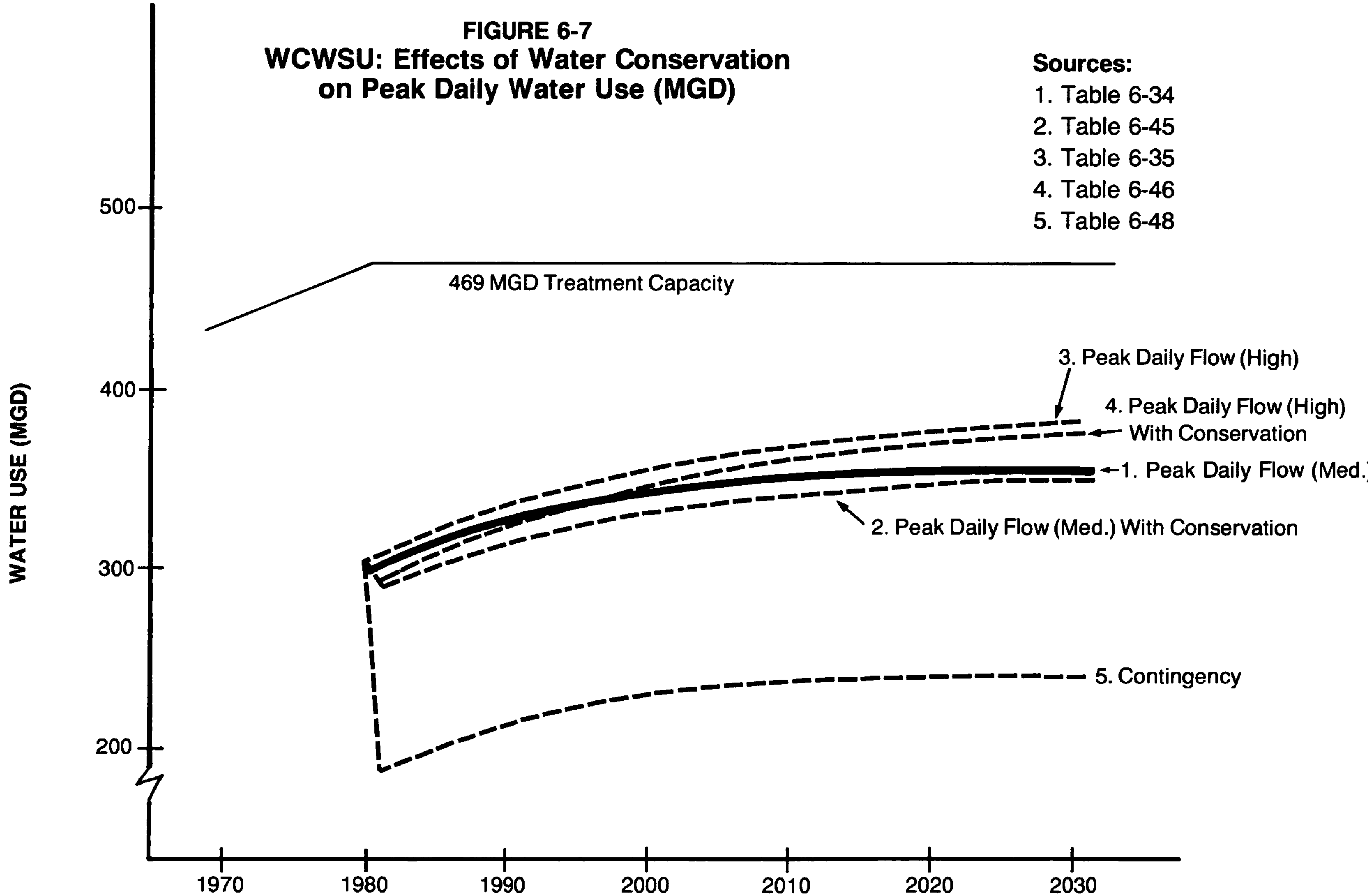
Level 3: Advantageous Effects

In addition to the reduction in water demand, which results from implementation of water-saving measures, other indirect advantageous effects are also produced for each measure considered. Table 6-52 summarizes these benefits for each measure, based on a Federal discount rate of 8-3/8 percent.

TABLE 6-52
WCWSU ADVANTAGEOUS EFFECTS (INDIRECT)
PRESENT VALUE (1980 $)

	MEASURE 1 Retrofit	MEASURE 2 Dual-Flush	MEASURE 3 Recycle/Reuse	MEASURE 4 Landscaping	MEASURE 5 Contingency
ENERGY SAVINGS					
SFR (and equiv.)	$18,556,000				
Ind/Comm.	-	-	$28,500,000	-	$2,588,000
UTILITY BILLS					
Water	1,683,000	$739,000	2,312,000	$286,000	-
Sewer	272,000	119,000	374,000	46,000	-
CONN. FEES					
Water	-	-	-	2,337,000	-
TOTAL	$20,511,000	$858,000	$31,189,000	$2,669,000	$2,588,000

FIGURE 6-7
WCWSU: Effects of Water Conservation on Peak Daily Water Use (MGD)



Energy Savings: Measure 1 (Retrofit) impacts current household energy use for those SFR households and MFR equivalent households that install the low-flow showerheads, as well as for institutional users. An approximate annual energy savings of $34.00 per year per household (1980 $) was determined previously (Level 1).

Table 6-53 presents information used for assessing the future use of Measures 1 and 2. The methods for determining future coverage were discussed previously (Level 1, Substeps 6.3 and 6.4) and assume the initial coverage values in Table 6-53 and the annual ratio of change (.88) determined in this example Substep 6.3.

TABLE 6-53
PERCENTAGE OF WCWSU CUSTOMERS USING (M1) AND (M2) MEASURES
COVERAGE CHANGE WITH TIME

	1980	1981	1985	1990	2000	2010	2020	2030
LOW-FLOW SHWRHD. M1								
Int. Res.	.360	.320	.216	.114	.032	.009	.002	.000
Pub/Inst.	.200	.180	.119	.063	.017	.005	.001	.000
TOILET DISPL. M1								
Int. Res.	.370	.325	.222	.117	.033	.009	.002	.000
Comm.	.500	.440	.299	.158	.044	.012	.003	.000
Pub/Inst.	.200	.180	.119	.063	.017	.005	.001	.000
DUAL-FLUSH TOILET (M2)								
Int. Res.	.050	.050	.050	.050	.050	.050	.050	.050
Comm.	.050	.050	.050	.050	.050	.050	.050	.050
Pub/Inst.	.050	.050	.050	.050	.050	.050	.050	.050

Table 6-54 identifies the 1980 total WCWSU customers (medium growth) in each affected user category (Table 6-22) and, based on the future coverage factors (Table 6-53), estimates the number of affected users (connections) in future years.

TABLE 6-54
WCWSU ENERGY SAVINGS FROM RETROFIT SHOWERHEAD USE
(1980 $)

	1981	1985	1990	2000	2010	2020	2030
CONNECTIONS							
SFR	272,416						
MFR (Equiv.)	24,473						
Pub/Inst. (Equiv.)*	4,112						
AFFECTED CONNECTIONS							
SFR	87,173	58,841	31,055	8,717	2,451	544	0
MFR	7,831	5,286	2,789	783	220	48	0
Pub/Inst.	740	489	259	70	20	4	0
Showerheads in Effect	95,744	64,616	34,103	9,570	2,691	596	0
Annual Energy Savings (000 $)	$3,255	2,196	1,159	325	91	19	0

*Category including hospitals, only.

The annual energy savings (1981) from reduced use of hot water by 95,000 SFR, MFR and Pub/Inst. connections ranges from $3.255 million/year in 1981, to just over $1 million/year in 1990. By 2020, only $19,000 in energy savings are still produced because of the "die-off" in the program. The present value of these savings is $18,556,000.

The contingency plan also impacts on hot water use. The rationing impact on household water use is 33 percent of the 1981 water use with water conservation (comparison of Tables 6-45 and 6-48). It is assumed that this 55 mgd savings in water use produces at least the same energy savings ($34.00/year) estimated for use of low-flow showerheads in 1981. The frequency of this savings for a year-long program is assumed to be once in 10 years. The annual savings are $3,255,000. The present value of these savings is $2,588,000.

Industry water recycling is important individually to firms where the cost of water supply and treatment are a significant cost of business. In some industries, however, despite high water use, other high costs of production mask the water costs and, as as result, priorities do not address water use reduction. The automobile assembly industry is an example. Some typical projects that would cost in the range of $2,000 to $6,000 each for the reported water savings are examples: (97)

	CAPITAL COST
Douglas Aircraft Company (38) (installed a direct reuse system (cooling water reused for evaporation loss, make-up and rinse). 30 percent Reduction.	$6,000

Chemical Milling Industry (38) (installed a system which recycles scrubber water. 85 percent Reduction (30 mgy to 4.5 mgy); Savings ($): $22,000/Yr. $5,000

Dow Chemical (chlor-alkali plant) Pittsburg, CA (96) 95 percent Reduction/10 Yrs. NA

Atlantic Richfield Company's Watson Refinery, Carson, CA, (96). 20 percent Reduction/5 Yrs. NA

Chevron USA (96). 15.5 percent Reduction/1 Yr. NA

General Motors Assembly Division (97). (Contemporary $50-100k for long-range efforts): $2,000-5,000

1. Eliminate blow-down of cooling towers by the use of electrostatic water treatment. Potential water saving: 3,500 gallons per day.

2. Reuse the over-flow water from the rinse stages of body metal washers (rinse off oil and grease before metal painting). Potential water savings: 46,000 gallons per day.

3. Recycle water from conductivity transducers for deionized water. Potential water savings: 10,000 gallons per day.

4. Recycle spray booth (metal painting) water for bearing water make-up at the sludge processes facility and for chemical feed. Potential water savings: 31,000 gallons per year.

5. Modify process for detecting water leaks in auto bodies. Potential water savings: 15,000 gallons per day.

6. Control automatic rinsing equipment during spaces between cars. Potential water savings: 5,000 gallons per day.

7. Modify boiler blow-down controls from manual to automatic modes. Potential water savings: 11,000 gallons per day.

In addition, some projects are more complex and involve greater expenditure. Projects involving recycling of car wash water (required by state law in this example) could cost from 50 to 100 thousand dollars and achieve water savings of 50 to 75 thousand gallons per day.

Examples of other industrial water conservation efforts include:

STAR-KIST FOODS (97)

Average Water Consumption	27.4 mg/month (mg/m)
Water Conservation (Total)	5.7 mg/m
Percent Reduction (Total)	21
Cost to Implement (Total)	$418,000

- o Cold Storage Plant (Recycle water through condensers)

Average Water Consumption	1.8 mg/m
Water Conservation	1.7 mg/m
Cost to Implement	$40,000

- o Modify can washers to use high pressure hot water (recycle)

Average Water Consumption	.765 mg/m
Water Conservation	.750 mg/m
Cost to Implement	$55,000

- o Modify can manufacturing process to recycle water

Average Water Consumption	.50 mg/m
Water Conservation	.497 mg/m
Cost to Implement	$55,000

- o Recycle water in retorts for final sterilization

Average Water Consumption	5.5 mg/m
Water Conservation	2.75 mg/m
Cost to Implement	$268,000

These examples indicate the significant water savings possible in industrial water uses and the range of costs involved. In each case, the savings to industry include energy savings.

For example, water that is recycled, that was previously intentionally heated, has a beneficial heat content and represents an energy savings to industry if recycled. Very little information is available on this energy savings, although industry water conservation is addressed frequently in cited literature (20), (38), (96), (88) and (97). According to the Water Conservation Reference Manual, individual benefits vary among users. "In some cases, there may be significant reductions in energy used for heating and pumping water." (86) In many cases, industrial process water is high temperature water and recycling 200° F water can save considerable energy, versus the 55° F water supplied by the WCWSU or from self-supplied private wells.

For this analysis, recycled water is assumed to have a 50° F heat content that is now recycled (a very conservative estimate). This is equivalent to:

- o 415 Btu/gallon water.
- o 415 x 10^6 Btu/mg.
- o For 1981, (415 X10^6 Btu/mg) * (4.026 mgd) * 350 days/year) = 58.47 x 10^{10} Btu/year (based on Table 6-39 and an assumed 350 day industrial work year).

- For 1981 Energy Saving (1980 $), (58.47 x 10^{10} Btu/yr) * ($4.00/mBtu) = $2.3 million/year (based on $4.00/mBtu cost of residual fuel oil).

Table 6-55 presents the annual industrial water savings and the estimated energy savings per year. Based on the analysis of existing industry, 332 firms are assumed to participate in industrial recycling and reuse in the future (connections, Table 6-50; water savings, Table 6-43).

TABLE 6-55
WCWSU INDUSTRY ENERGY SAVINGS FROM RECYCLING
(1980, MILLION $)

	1981	1985	1990	2000	2010	2020	2030
Water Savings (MGD)	4.026	4.101	4.195	4.398	4.637	4.759	4.884
Energy Savings ($ Million)	$2.3	2.4	2.4	2.5	2.7	2.7	2.8

In 1981, this represents an average annual energy savings of $7,000 for each firm. The present value of these annual savings is $28,500,000, based on the current Federal discount rate of 8-3/8 percent.

Utility Bill Savings: In 1980, operating revenues from sale of water were as follows, based on annual report data.

TABLE 6-56
WCWSU WATER SALES REVENUES AND UNIT PRICES

	1980 ANNUAL REVENUE	WATER USE (MGY)	AVG. PRICE ($/1000 gal.)
Residential	$31,063,000	34,530	$ .90
Commercial	6,793,000	4,069	1.67
Industrial	7,393,000	12,170	.60
Public & Other	4,395,000	7,267	.60
TOTAL	$49,644,000	58,036	.85

Information on water use by user class is from Table 6-34 (multiplied by 365 days/year), and the average price was calculated. The effect of water conservation on water utility bills is the value of the water that is conserved ($0.85 per 1,000 gallons).

Annual cost savings to customers for 1981 and 1982 are based on the 1981 water savings 8.848 mgd (Table 6-43) and an interpolated savings of 8.468 mgd in 1982, and the average price of WCWSU sold water in 1980 ($.85/1000 gallons).

TABLE 6-57
ANNUAL SAVINGS IN WATER CHARGES ($ MILLION/YEAR)

	WATER BILL SAVINGS	WASTEWATER BILL SAVINGS
1981	$2.744	$0.435
1982	2.627	0.435

These savings (about 5 percent of total annual revenues) are assumed to have a short life expectancy since the WCWSU is likely to increase rates to make up any revenue loss due to conservation (revenue loss adjusted for changes in operating costs). The present value of these savings in water bills is $4,769,000.

Similar benefits also are short-lived for wastewater bill reduction (based on metered water use). Total annual revenues from wastewater billings is 29 percent ($14,500,000) of the WCWSU annual water revenues ($49,644,000) in 1980. The wastewater system serves about 625,000 people, and the service area is about 85 square miles (considerably smaller than the 1 million or more population served by the water system). The typical operating revenue per account for wastewater service was about $75.00/year in 1980. $435,000 (3 percent of annual revenue) is assumed saved in 1981 and 1982 on annual wastewater bills for the WCWSU sewer customers. The present value of these savings is $772,000. The water and sewer bill savings are produced by each of the permanent measures. The allocation of these savings is distributed to each measure based on the percent effectiveness of each measure, as indicated in Table 6-58.

TABLE 6-58
LEVEL 3 WCWSU
PERCENT EFFECTIVENESS WATER USE REDUCTION BY MEASURE

	MEASURE 1 Retrofit	MEASURE 2 Dual-Flush	MEASURE 3 Reuse/Recycle	MEASURE 4 Landscape
1981	35.3	15.5	48.5	0.6
1985	26.4	12.7	59.7	1.1
2000	5.6	3.8	85.1	5.5
2020	0.5	0.5	93.3	5.8
2030	0.1	0.2	94.0	5.7

The savings in water bills are distributed as follows: Measure 1: $1,683,000; Measure 2: $739,000; Measure 3: $2,312,000; and Measure 4: $286,000. The wastewater bill savings are distributed to each measure as follows: Measure 1: $272,000; Measure 2: $119,000; Measure 3: $374,000; and Measure 4: $46,000.

Connection Fee Savings: In addition, the builders who are installing landscaping water reduction measures in new construction (Table 6-51) have been induced to participate in this program. The assumed connection fee reduction of $200 per unit produces a benefit to builders (Table 6-59) over the fifty years.

TABLE 6-59
DEVELOPER CONNECTION FEE REDUCTION FOR
NEW CONNECTIONS WITH LANDSCAPING MEASURE

	1980	1990	2000	2010	2020	2030
New Connections	0	648	2,317	2,450	2,590	2,727
Annual Fee (Savings) (1980 $)	0	129,000	463,000	490,000	518,000	545,000

The present value of these connection fee savings is $2,337,000.

STEP 8: Disadvantageous Effects (Indirect)

Implementation costs are the primary disadvantageous effects of the proposed program of water conservation measures. Table 6-60 summarizes the present value cost effect of the program for each measure and option, based on a Federal discount rate of 8-3/8 percent.

TABLE 6-60
DISADVANTAGEOUS EFFECTS (INDIRECT)
PRESENT VALUE (1980 $)

	MEASURE 1 Retrofit	MEASURE 2 Dual-Flush	MEASURE 3 Recycle/Reuse	MEASURE 4 Landscape	MEASURE 5 Contingency
MATERIAL COST					
Kits	$1,171,000	-	-	-	
Fixtures/Equip.*	-	30,000	2,324,000	204,300	
Pamphlets	135,000	15,000	50,000	10,000	
Supplies	-	-	10,000	-	
Postage	94,500	5,000	5,000	4,000	
Other	-	-	-	-	
SERVICE PURCHASES					
Media (TV, radio)	45,000	2,000	5,000	-	
Newspapers	5,000	-	-	1,000	
Rentals	1,500	-	-	-	
Consultant	-	-	150,000	-	
LABOR					
WCWSU	-	8,000 (Op-1)	20,000	-	
Speakers	-	4,000 (Op-1)	5,000	-	
Summer Help	7,200	-	-	-	
CONT. (10%)*	145,000	3,400	25,000	1,500	
TOTAL COST	$1,605,100	$67,400	$2,594,000	$220,800	

*Note: WCWSU costs only are included in the contingency.

Substep 8.1: Implementation Costs

Measure 1: (Retrofit). In Steps 5 and 7, the general aspects of Measure 1, as well as the other measures are described. The key aspects of the program are:

- o Kit with (1) showerhead and (6) toilet displacement bags, available free to WCWSU customers.
- o Mailer to target kit distribution to interested customers (without previous retrofit or low water-using fixtures already in place).
- o Promotional advertising and instructions material.
- o One-time effort.

The retrofit devices are available free to WCWSU customers following response by customers to fill out a mailer enclosed with a regular water bill. The returned mailers are evaluated by the WCWSU in targeting the retrofit program. Based on broad distribution of these mailers in other areas, responses of about 30 percent are expected. (98).

Typically, more customers (including commercial and public water users) install toilet displacement devices than low-flow showerheads or restrictors. In this analysis, the purchased devices are determined from the total number of customer connections in Table 6-22 and the 1980 (initial) coverage factor in Table 6-53 (note, in Table 6-54, estimates are made of the number of showerhead fixtures in service in 1981, and subsequently, to determine indirect energy benefits). Table 6-61 summarizes the number of devices required for the retrofit kits.

TABLE 6-61
WCWSU RETROFIT SHOWERHEAD AND DISPLACEMENT

	TOTAL CONNECTIONS	INITIAL COVERAGE	INSTALLED DEVICES	PURCHASED DEVICES (+10%)
LOW-FLOW SHOWERHEAD				
Int. Residential	296,889[1]	.360	107,000	117,700
Pub/Inst.	4,112[2]	.200	820	900
TOTAL			107,820	118,600
TOILET DISPLACEMENT				
Int. Residential	296,889[1]	.370	110,000	121,000
Comm.	14,949[3]	.500	7,500	8,200
Pub/Inst.	4,112[2]	.200	820	900
TOTAL			118,320	130,100

[1]Sum SFR and MFR.
[2]Schools and Hospitals, only.
[3]Wholesale/Resale/Misc., and Laundry/Lab/Auto.

In this case, 11,500 more toilet displacement devices are expected to be used than showerheads. This difference, although sizeable in cost if these showerheads are not installed, is not sufficient to make two differnt kinds of kits for distribution.

The low-flow showerhead selected for this program was also used for the ECWD retrofit program (Level 2). The cost of this device is $7.00. The displacement bags (6 1-qt. bags) are available to permit adjustment of flush volume and for more than one toilet. These displacement devices cost $.50 for six bags. In addition, promotional material describing the benefits of installing these retrofit devices, as well as instructions for installation, are included in a plastic promotional bag to be distributed or hung on doorknobs, the cost for which is $1.50 for the volume anticipated. Total cost of this kit is $9.00. For 130,100 kits, the cost is $1,171,000.

TABLE 6-62
WCWSU KIT MATERIALS

	PRICE/UNIT	QUANTITY	COST (1980 $)
Low-Flow Showerhead	$7.00	130,100	$910,700
Displacement (Toilet Bags)	.50	130,100	65,100
Literature/Package	1.50	130,100	195,200
TOTAL			$1,171,000

The program also includes a bill-stuffer/mailer, to be returned by customers interested in the program, and promotional material. This part of the program is targeted to the likely areas for retrofit. Previously, the WCWSU has evaluated where low-flow fixtures are already required in new construction and can, through computer billing, direct these mailers to customers who can use retrofit measures. A customer receives the mailer and promotional material included with a monthly water bill.

In Table 6-61, the Residential customers (296,889), Commercial (14,949) and Public/Institutional (4,112) represent the total potential connections (-15 percent excluded, already have low-flow fixtures), or 270,000 are targeted for response.

TABLE 6-63
WCWSU MAILER MATERIALS (1980 $)

	UNIT COST	TOTAL COST
Mailer (type set and postage)	$0.35	$ 94,500
Pamphlet	.50	135,000
		$229,500

In addition, the program is advertised. Budget for media exposure, including TV "spots", radio announcements and newspaper ads is $50,000 (intensively used prior to mailer distribution). The media campaign is maintained for about 6 weeks during and after distribution of the kits. The WCWSU has a large staff. Distribution of the kits is coordinated by the full-time Water Conservation Specialist (WCS). Kit packaging is also coordinated by the WCS using six summer help ($5.00/hour) persons for 6 weeks ($7,200 total). Storage for the kits is rented for a three-month period at $500/month ($1,500 total).

The total cost of this effort is $1,605,100, including a 10 percent contingency.

Measure 2: (Dual-Flush Toilets). Dual-flush toilets provide another alternative for reducing water use in residential, commercial and public water use sectors.

The estimated coverage factor (Step 6) assumes that 5 percent of the 1980 residential, commercial and public (hospital and schools) water use sectors choose to use this measure. This decision is based on WCWSU efforts to educate builders and the public about the benefits of this approach.

The following tabulation of 1980 connections for residential, commercial and public connections indicates some of the potential for new installations and retrofits.

TABLE 6-64
WCWSU DUAL-FLUSH 1980 CONNECTIONS (TOTAL)

SFR	272,416	
MFR	24,473	
COMM	14,949	
PUB.	4,112	
TOTAL	315,950	
(5%)	15,800	(Total number assumed to install dual-flush. Assumes 2,000 connections retrofit with dual-flush.)

Table 6-65 presents the increments of growth in new connections based on Table 6-22.

TABLE 6-65
WCWSU INCREMENTAL GROWTH PER DECADE
IN CONNECTIONS (NEW CONSTRUCTION)
MEDIUM GROWTH CASE

	1980	1990	2000	2010	2020	2030
SFR(S)	0	7,900	1,747	64	64	64
SFR(U)	0	13,076	231	231	232	231
MFR(S)	0	710	157	5	6	6
MFR(U)	0	1,175	20	21	21	21
COMM	0	1,345	1,387	570	591	552
IND.	0	174	232	96	96	160
PUB/INST.	0	1,086	1,181	523	552	582
MISC.	0	567	6	6	6	5
TOTAL	0	26,033	4,961	1,516	1,568	1,621

Between 1980 and 1990, SFR, MFR, Comm. and Pub/Inst. produce over 25,000 new connections. The dual-flush toilet program is assured to produce almost 14,000 converts from the required "conventional" low-flush toilets.

This program has capital costs (retrofit dual-flush units cost $15.00, each and new units are equal in price to standard toilets), and promotional costs necessary for getting developers and plumbers to retrofit with dual-flush units.

TABLE 6-66
WCWSU CAPITAL COSTS, DUAL-FLUSH TOILETS

	# OF UNITS	COST/UNIT (1980 $)	O & M COST ($)	TOTAL COST ($)
Retrofits	2,000	30,000	0	30,000
New Installations	14,000	0	0	0
TOTAL COST				$30,000

It is assumed that the population of plumbers and construction businesses that serve the WCWSU area is about 15,000. This group is fundamental to the overall concept of water conservation in the WCWSU area. They are the focus of the promotional effort to convince the public of the merits of the dual-flush measure. Technical materials are developed for the businesses, and promotional material for the public. Pamphlets are estimated to cost $15,000, with $5,000 in postage and an optional series of workshops with WCWSU staff (extra) and speakers to introduce dual-flush technology to plumbers and builders, an additional $12,000. With a 10 percent contingency, the overall 1980 cost of Measure 2 is $67,410.

Measure 3: (Recycle/Reuse). This option provides an opportunity for industry to save water and also future operation costs. For many water recycling projects, simple pay-back, internal-rate-of-return or other methods of determining the potential profitability of proposals indicate very attractive projects. Experience with industry, however, indicates that many opportunities are overlooked in the producing product. Old habits are hard to break, and economic recessions (capital shortage) have caused industry to miss many opportunities for projects that represent returns on investment in excess of 30 percent (a reasonable hurdle rate used by many industries in making decisions for in-plant investments). This measure focuses on convincing industry of the opportunity for water recycling. In Step 7, many examples are presented. Each situation is unique, however, the costs are frequeny low for initiating significant in-plant water savings, and energy benefits and reduced water bills quickly off-set the investment costs.

Capital costs are assumed to average $7,000 per recycling project (1980 $), based on the analysis in Step 7 (which indicated that many, typical recycling project costs range from $2,000-6,000 with some costs in the $30,000 to $150,000 range), and annual energy-related savings alone are about $7,000 per firm (an average payback of one year). In Table 6-50, 332 industries (9 percent of the 1980 industry total) were identified that undertook a water recycling project. The total capital and installation cost of industrial recycling projects is $2,324,000.

The operation and maintenance costs of these projects vary. Frequently, recycled water has to be treated, as well as pumped. These same requirements, however, are often imposed on industries for once-through water use (where pre-treatment of wastewater is required). As a result, the incremental operation and maintenance costs of recycling (treatment and pumping) are assumed to be zero.

Alerting and educating industry to the opportunities of water recycling are the major factors in achieving a successful program. Literature is again developed as a vehicle for informing industry of the benefits, and a series of conferences is undertaken to present successful case studies and expert advice.

It is assumed that the WCWSU acquires the services of a consulting firm to develop a report: Manual for Industrial Water Recycling and Reuse: Engineering, Benefits and Costs. This report provides instructions for identifying the likely opportunities for water recycling in various types of industries and case studies describing successful recycling efforts. The report then serves as the vehicle for several conferences involving industry speakers to present their cases, and the consultant to provide the overview, technical and economic continuity with their report effort.

The costs of this part of the Measure 3 program are:

Consultant	$150,000	(with report)
Pamphlets	50,000	
Supplies	10,000	
Postage	5,000	
Media	5,000	
	$220,000	

The consultant budget of $150,000 involves a state-wide effort to identify a broad range of industry water recycling projects and to develop a manual with case studies that can benefit other industrial water users in their own water reuse projects. Pamphlets ($50,000) are developed by the WCWSU, and the consultant report is reproduced for distribution ($10,000). Postage and media efforts are assumed to be $5,000 each.

Other costs are also anticipated. Expenses ($5,000) for some of the speakers (assumed to provide the time free) and additional WCWSU staff efforts ($20,000) are budgeted.

The total 1980 cost of this measure with a 10 percent contingency on WCWSU costs is $2,594,000.

Measure 4: (Landscaping). The text in Steps 5 and 7 describes the significant exterior water use in the WCWSU area and the conservation opprtunities for a program to reduce lawn irrigation for residential and multi-family water users. The approach includes methods for new construction and retrofits for existing development.

As is the case in Measures 1-3, education of the public, builders and plumbers is a fundamental part of a successful program to reduce exterior water use. In Table 4-51, the number of SFR and MFR connections affected by landscaping water conservation measures was identified. This level of effort was, in part, produced by the incentive of reduced connection fees (assumed to be $200/unit) and the opportunity for reduced water bills to the customers who use the landscape water use reduction measures.

The costs for new construction (MFR and SFR) of using consolidated turf for more efficient irrigation and drought-tolerant (indigenous) vegetation are assumed to be equal to those for conventional landscape (in fact, because the square footage of turf area is reduced, the costs of Measure 4 for new construction could be less). (86)

Costs for retrofitting existing lawns (assumed to be undertaken by residents and multi-family project owners who already have existing irrigation systems) are minimal. In these situations, irrigation systems over-water lawns. If properly controlled with tensiometers (to determine soil moisture), water use can be significantly reduced. Tensiometers cost from $15-$30 each. (38) Installed, these units are assumed to cost $30-$60 each.

The California experiments (ie., reference, 64) with tensiometers indicate "The condition of the turf was no different than the areas without tensiometers" (controlled by conventional-timed irrigation system), and 50 percent to 60 percent reductions in lawn irrigation water use was reported. These experiments also indicated that it was not necessary to install tensiometers at each valve and "only a few" are required for the test (6-1/2 acre) area.

Two tensiometers ($120.00) are assumed for each MFR (existing) in Table 6-51. The annual costs are:

TABLE 6-67
EXISTING MFR TENSIOMETER ANNUAL COSTS (1980 $)

	1980	1990	2000	2010	2010	2030
Tensiometer Installation	0	16,800	34,680	34,680	34,680	34,680

The present value of these 1980 costs is $204,300.

The WCWSU has developed three low water-using landscape demonstration projects (designed at $1,400 each) and landscaped by a contractor for a total of $17,400 for the three projects. These retrofit projects provide a guide on possible costs, if a modified landscape were installed and a conventional landscape were removed. This measure does not attempt to persuade residential customers to undertake this conversion unless they are already in the market to make landscaping changes. As a result, the resident would incur these costs for a conventional or modified low water-using landscape (about $7,000 per SFR landscape), and the incremental cost of the measure is zero.

Other costs associated with implementing Measure 4 involve promotion and advertising. The WCWSU makes a one-time effort to influence landscapers and developers and to announce the connection fee incentive system. Costs of pamphlets are estimated at $10,000, and distribution to landscape architects and developers is $4,000 for postage. Newspaper announcements cost an additional $1,000. The total cost of this measure is $220,800, with contingency.

Measure 5: (Contingency). The effective implementation of contingency plans to reduce water consumption (restrictions and rationing) during emergency depends primarily on:

1. Information about the program and the intent of officials to enforce it.

2. Perception of customers that the program is needed, and all customers are treated fairly.

3. Feedback to the customers that their effort is effective.

The potential additional costs associated with Measure 5 involve the use of the media. This is assumed to be as a free public service since the water shortage is apparent to everyone.

WCWSU staff assignments are assumed to change from normal activities during this period of emergency; however, this is an expected role for these personnel.

Substep 8.2: Other Disadvantageous Effects

Measure 1: Retrofit (showerheads and toilet displacement devices)
No other disadvantageous effects are anticipated.

Measure 2: Dual-Flush Toilets
No other disadvantageous effects are anticipated.

Measure 3: Recycle/Reuse (Industrial/Commercial Water)
No other disadvantageous effects are anticipated.

Measure 4: Landscaping
No other disadvantageous effects are anticipated.

Measure 5: Contingency
Losses of residential and multi-family complex turf, gardens and plantings are expected with the 50 gallon per capita per day rationing program.

In Step 4, the mean cost to restore lost landscaping from the 1976-1977 drought for 54 percent of the WCWSU residential customers was $507. Forty percent of those replaced with drought-tolerant landscaping. Additional (one year) residential costs (losses) from future drought are estimated at nearly $30 million, based on assumed impact to 20 percent of 1980 SFR urban connections (55,000, Table 6-22) (reduced as a result of landscape modifications since the 1976-1977 drought and from this program) and, $540 average SFR loss (inflated $507 loss from 1979 to 1980 at 7 percent). These losses are often accepted as part of a rationing program in lieu of even higher assumed costs associated with restricted uses to other water-using sectors (ie., industry and commercial business).

STEP 9: Foregone Supply Costs

Advantageous effects associated with future operations of water supply and wastewater facilities at the local level, and water supply systems at the Federal level may be produced by the proposed water conservation measures. Advantageous effects consist mostly of foregone costs of supplying water and wastewater services. Other effects may be external costs or opportunity costs that are reduced as well. The analysis that follows identifies the costs associated with future plans at the local and Federal levels and identifies and quantifies the cost reductions that are associated with the water conservation program for the WCWSU area. This section has five Substeps:

Substep 9.1 Local Water Supply and Wastewater Plans
Substep 9.2 Federal Water Supply Plans
Substep 9.3 Non-Federal (regional) Plans
Substep 9.4 External Opportunity Costs
Substep 9.5 Summary Foregone Supply Costs

Previously, in Figures 6-6 and 6-7, the water supply needs of the WCWSU area were graphically presented. The effect of the proposed water conservation programs is to shift the timing (delay) of the necessary investments and other costs and to reduce the quantities of energy and chemicals needed for the smaller quantity of water (vs. baseline conditions) supplied. The differential (reduced) present value of projects that are delayed is one estimate of benefit of water conservation. Table 6-58 provides calculated estimates of the percent effectiveness of each measure over the fifty years and provides a key tool in allocating the cost savings to each measure.

Substep 9.1: Local Water Supply and Waterwater Plans Incremental Supply Costs

Water Supply: Water supply system operating costs are reduced by water conservation (less water is treated and pumped to customers). Table 6-68 presents the operating costs of the WCWSU over the years 1976 to 1981. The years 1976 through 1978 show drought and immediate post-drought expenses and then normalization in the subsequent years. The experience with drought indicates that transmission and storage expenditures increased, as may have been the case with treatment costs, and the sources of supply and power generation costs declined as hydropower generation dropped off.

TABLE 6-68
WCWSU WATER SYSTEM OPERATING EXPENDITURES
CURRENT DOLLARS ($000)

EXPENSES	1976	1977	1978	1979	1980	1981
Power Generation	185	160	140	196	249	274
Source of Supply	552	616	1,254	551	775	901
Trans./Storage	1,852	2,653	2,160	1,572	1,827	2,957
Rec. Area (net)	414	466	525	327	341	399
Treatment	1,598	1,998	2,514	2,207	2,753	2,847
Distribution	6,207	7,120	7,396	7,608	8,908	11,467
Customers	1,908	2,190	2,377	2,204	2,656	2,857
Administration	6,410	7,345	7,183	6,696	7,642	8,884
Depreciation	8,218	8,562	8,864	9.101	9,267	9,827
Temp. Drought Fac.	-	-	1,325	91	-	-
TOTAL EXPENSES	27,344	31,110	33,738	30,553	34,418	40,413

However, a water conservation program produces changes in expenses that are anticipated (planned for), and certain costs decline and benefit the utility.

With 1980 expenses as a representative normal year and the categories: Source of Supply ($775,000), Transmission and Storage ($1,827,000) and Treatment ($2,753,000) considered as variable cost budget categories, the unit variable cost of producing water is $0.082/1,000 gallons, based on 1980 produced water (178.086 mgd, Table 6-34).

Based on the water savings for the medium growth scenario with permanent water conservation measures (Table 6-43), the percentage effect by measure (Table 6-58), and the unit price of producing water ($.082/1,000 gallons), the annual savings in production and water purchase costs are projected for each measure. For example, in 1981 for Measure 1 (8.848 mgd) * ($.082) * (365 days per year) * (.353 Table 6-58, Measure 1) = $93,600 (annual savings from Measure 1 in 1981).

Table 6-69 presents the annual savings for each measure for selected years. The present value of operations cost savings for each measure is: Measure 1 (Retrofit): $521,000; Measure 2 (Dual-Flush Toilet): $250,000; Measure 3 (Recycle/Reuse): $1,589,000; Measure 4 (Landscaping): $57,000. The overall benefit is $2,417,000.

TABLE 6-69
FUTURE WCWSU WATER SUPPLY OPERATIONS SAVINGS
FOREGONE SUPPLY COSTS
1981 - 2030 (1980 $)

	TOTAL REDUCTION IN WATER DEMAND (MGD)	ANNUAL SAVINGS IN SUPPLY OPERATIONS COSTS ($)				
		M-1	M-2	M-3	M-4	TOTAL
1981	8.848	93,600	41,100	128,500	1,600	264,800
1985	7.329	57,900	27,900	131,100	2,400	219,300
2000	5.535	9,200	6,300	140,900	9,100	165,600
2020	5.461	800	800	152,400	9,400	163,400
2030	5.568	200	300	156,600	9,500	166,600

The contingency plan also produces water use reductions that imply savings in energy use and chemicals, but Table 6-58 indicates that the WCWSU budget may have increased slightly during the drought of 1977 and subsequently in 1978. Note the drop in expenditures in 1979. The net effect is assumed to be zero.

Benefits of water conservation are also available from reducing peak daily water use. Additional benefits are determined in the same manner as above, based on Tables 6-34 (Peak Daily Flow) and 6-43 (Effectiveness of Peak Daily Flow). The additional benefits (above those determined for average daily water use) are attributed to reductions in peak daily flow based on the number of days per year the peak day use is achieved.

This analysis of peak daily benefits from reduced operations is based on the difference in peak and average day flows in Table 6-43. These differences are summarized in Table 6-70, "Water Reduction".

TABLE 6-70
FUTURE WCWSU WATER SUPPLY OPERATIONS SAVINGS
PEAK DAILY FOREGONE SUPPLY COSTS
1981 - 2030 (1980 $)

	WATER REDUCTION (MGD)	ANNUAL SAVINGS IN SUPPLY OPERATIONS COSTS				
		M-1	M-2	M-3	M-4	TOTAL
1981	5.373	4,600	2,000	6,400	100	$13,200
1985	3.896	2,500	1,200	5,700	100	9,500
2000	2.138	300	200	4,500	300	5,300
2020	1.642	-	-	3,700	300	4,000
2030	1.646	-	-	3,700	300	4,000

For example, in 1981 (Table 6-43) Peak Daily Use (14.221 mgd) - Average Daily Use (8.848 mgd) = 5.373 mgd. Annual savings are based on $.081/1,000 gallons (unit costs), and 30 days per year (assumed number of days peak use is achieved). The benefits are distributed to each measure based on Table 6-58. The benefits of conservation on reducing peak daily water use (on utility operations) are Measure 1: $20,000; Measure 2: $11,000; Measure 3: $62,000; and Measure 4: $2,000.

Wastewater: Wastewater collection and treatment are provided by the WCWSU and 10 other districts in the area. Eight of the eleven districts provide wastewater treatment. Although conservation-induced wastewater flow reduction can provide benefits to operation and capital costs of wastewater collection and treatment systems, the WCWSU system, as well as the other 10, experience significant infiltration and inflow (I&I) problems. According to a WCWSU report, "nearly 25 percent of the wastewater treatment at the water pollution control plant in a typical year is I&I. This amounts to seven billion extra gallons to process at a cost of $1.7 million."

In 1981, total water reduction (8.848 mgd from Table 6-43) minus "Unaccounted-For" and "Exterior Residential" water (water not going into the sewer system ordinarily) equals 8.79/mgd (3.2 billion gallons per year) or 45 percent of the 7 billion gallons I&I mentioned in the report. As a result, the conservation reduction can reduce wastewater treatment system costs by $760,000 in 1981. In subsequent years, reductions in costs are determined in the same manner. The contribution played by each measure in achieving this reduction was determined from Table 6-58. The present value of these foregone costs are: M1, $1,500,000; M2, $722,000; M3, $4,532,000; and M4, $162,000.

Long-Run Incremental Supply Costs

Water Supply: The water supply system (treatment and distribution) is adequate to meet the needed flows in the WCWSU area for the 50-year period. Reasonable and ordinary maintenance and replacement are required only. Foregone supply costs are not anticipated.

Wastewater: Only the WCWSU water pollution control system (one of eleven in the water service area) is considered here. The wastewater (WW) district was created in 1944 to eliminate discharge of untreated sewage into coastal waters. The system was funded initially through local bond issues and later on with combined local money and Federal grants.

Previously, the text has indicated the problems with I&I from leakage into the system, and storm water interconnections severely affect the system's capability for adequately treating the area's wastewater. Coliform bacteria counts in receiving waters have reached 10,000 MPN/100 ml (most probable number of colonies) on a frequent basis and 24,000 less frequently during 1978 and 1979. Because of the significant impact to the beneficial uses of the receiving waters, a major wastewater system improvement program is planned.

Over sixty alternatives were considered, and alternative 9 (Table 6-71) was selected:

TABLE 6-71
WCWSU OVERALL WASTEWATER SYSTEM AND
DESCRIPTION WITH ALTERNATIVE 9

Design rainfall return period (years)	20
Frequency of overflows from WCWSU facilities	0.2
Full secondary treatment	168 mgd
Primary treatment for overflows	168-290 mgd
I&I treated 20-year storm	5% I&I
User charge increase ($/household/yr.)	13.80

TABLE 6-72
WCWSU PLAN
ALTERNATIVE 9 COST ESTIMATE

CAPITAL COST	COST ($ MILLION)
Interceptor Improvements	9.0
Storage Facilities	44.9
WCWSU Plant Improvements	1.8
Power Facilities	0.8
Telemetry Facilities	0.7
Subtotal, capital cost	$57.2
Contingency	8.6
Engineering, Legal, Admin. Cost	9.9
TOTAL CONSTRUCTION COST	$75.7
OPERATION AND MAINTENANCE	**COST ($/YR.)**
Labor	$100,000
Materials	98,000
Energy	101,000
Chemical	8,700
TOTAL OPERATION AND MAINTENANCE COST	$307,900

This proposed system (Table 6-72) and costs can be impacted by the proposed water conservation program. The schedule construction date is assumed to be 1986.

A recent report by the WCWSU itemizes the major components of the utility's existing system, including about 90 items (ie., pump stations, chlorine systems, digesters, tanks, interceptors, buildings and structures, de-watering equipment, laboratory equipment). The life and original costs of the equipment are included ranging from 10-75 years (average 44 years), with a total cost of $108 million:

"Expendable items" (ie., pump equipment, treatment system, disposal equipment, not including buildings, etc.) have a shorter life expectancy:

TABLE 6-73
WCWSU REPLACEABLE WASTEWATER TREATMENT FACILITIES
AND COSTS

EQUIPMENT (NUMBER)	AVERAGE LIFE	TOTAL COST ($ MILLION)
Pump Station (12)	40	1.143
Treatment System	44	3.672
Effluent Disposal (3)	58	4.084
Digester (7)	38	19.845
Secondary Treatment (16)	33	38.904
Process Water (1)	20	1.989
Primary Treatment (6)	25	10.236
Sludge De-water (1)	20	.437
Post Chlorination (1)	20	.213
TOTAL	35 (weighted)	$80.523
		$140.000 (1980 $)

These items are considered to be replaceable in the future and can be impacted by the proposed water conservation program. The $80.5 million cost is assumed to be 1972 $; inflated at 7 percent per year, the 1980 cost for replacement is $140 million. These replacement costs and the 1986 I&I project are presented in Table 6-74.

TABLE 6-74
EFFECT OF WATER CONSERVATION ON
FUTURE WASTEWATER SYSTEM PLANS
(1980 $ MILLION)

	ORIGINAL SCHEDULE	CONSERVATION DOWN-SIZE EFFECT
1986	$ 75.7	$ 74.2
2007	140.0	137.2

The WCWSU ordinance requiring connection to the system was passed in 1972. It is therefore assumed, based on the weighted average 35-year life, that major system renovations are required in the year 2007.

In the report, "Effects of Water Conservation-Induced Wastewater Flow Reduction--A Perspective" (87), sewer system cost savings are described, including:

- o Capital cost savings to 8 percent at 40 percent reduction in indoor use.
- o Sewer line cost savings at about 7 percent.
- o O&M cost savings at about 2 percent for 40 percent reduction in indoor use.

Based on this information and reductions to the wastewater treatment plant of 3-5 percent, cost savings of 2 percent on capital costs are assumed for the two projects.

The system is assumed to be currently sized to meet the needs of the 2030 population (given the modest growth projected). Because the 2007 project is scheduled as a replacement requirement based on aging facilities, no opportunity exists for time-delay benefits (project rescheduling) that might be induced from water conservation flow reductions.

The present value of the wastewater savings is $900,000 for the 1986 revision distributed to each measure based on Table 6-58 (1985 percent effectiveness for each measure) and $400,000 distributed, based on year 2000 percent effectiveness of each measure. The present values are: Measure 1 (Retrofit): $263,000; Measure 2 (Dual-Flush): $131,000; and Measure 3 (Recycle): $903,000. Landscaping (Measure 4) does not impact the wastewater system.

Substep 9.2 Federal Water Supply Plans

One Federal project is planned for the WCWSU area. The project "BR-1" will provide 25,600 acre-feet of water available annually (22.8 mgd). This water is estimated to cost $18.95/AF ($58.30/mg), based on the Non-Federal share for capital and operation and maintenance costs recovery.

In Figure 6-6 (Step 7), the relationships between projected safe yield and future water demand (average flow and medium growth) indicated that the Federal project is needed by 1990 and can be delayed, as a result of water conservation reductions in water use, by about 2 years. This short time delay is a function of the downward-sloping safe yield curve and the upward-sloping water demand curve (note, where safe yield is assumed flat and the demand curve slope decreases, for example, after the year 2000 when the safe yield is 195.8 mgd, including the BR-1 project, the time delay effect of water conservation is about 15 years, when the unrestricted (1) and water conservation (2) medium growth functions are compared).

Since the BR-1 project will be built entirely for the benefit of the WCWSU area for the purpose of supplying additional water needs, the project can be delayed by the two-year period. The delayed investment costs and operation and maintenance costs of the project are $48,777,000.

TABLE 6-75
BR-1 PROJECT COSTS (1980 $)

WATER SUPPLY	INVESTMENT COSTS
Investment/Construction	48,729,000
O & M (Annual)	48,000

This delay-caused benefit (present value (1980 $) is $3,243,000 and is allocated to each measure: Measure 1: $856,000; Measure 2: $411,000; Measure 3: $1,936,000; and Measure 4: $40,000. The allocations are based on the year 2000 percent effectiveness by water conservation measure from Table 6-58.

Substep 9.3 Regional Plans

The LOCAL-1 project is considered a regional plan because of the extensive region serviced, but the project basically serves the needs of the single WCWSU area. The LOCAL-1 project provides up to 134 mgd of water to the WCWSU area at increasing rates. Table 6-12 provides the minimum annual payments required (whether or not water is purchased).

In Figure 6-6, water is delivered to the WCWSU area under this contract in the year 2010. Water conservation can benefit the district if the 15 mgd (16,800 AF) purchases can be limited to the minimum purchase amount (150,000 acre-feet). Obviously, this is not possible; the delivered water is minimal compared to the minimum purchase requirement. No foregone supply cost benefits related to LOCAL-1 are available to the WCWSU water conservation program.

Substep 9.4 External Opportunity Costs

The evaluation of external effects is a controversial subject. These external effects (technological and pecuniary) can be both "benefits and costs (excluding all transfer items) which are not taken into account in economic decisions by individuals, firms and government agencies, but which, nevertheless, are functionally related to these decisions." (99) Issues relate to the conceptual framework (based on full employment, mobile factors and ample entrepreneurial resources, including capital). For example, externalities can shift the firm's production possibility frontier outward (benefits) inward (costs). These issues and many others are included in reference (100).

The following are mentioned as sources of external economies, J. Margolis, (100):

1. "Growth of productivity as the size of market increases.

2. Reduction in risk and uncertainty usually attendant on expansion of complementary industries.

3. New investments bringing in new industrial techniques for labor, managers and entrepreneurs.

4. Regionalization of industry.

5. Positive efficiency effects from regional development.

6. Expansion of social overhead capital such as schools, roads, and urban centers which usually have unused capacity.

(All of these)...refer to the improvement (or loss) in economic efficiencies resulting from the incidental and uncompensated impacts of a project."

In this procedure, the external opportunity costs (the impacts that are incidental to the project) at the local or regional scale are addressed here (for example, the loss in hydroelectric power benefits from modified WCWSU operations).

In Step 10 (Foregone NED Benefits), the incidental impacts on Federal projects and identified NED benefits are addressed.

The WCWSU also produces hydroelectric power. In Table 6-68, utility revenue sources list "power generation" which indicates lows and highs of $140,000 and $274,000 over the 1976 to 1981 period. In 1977 and 1978, during the drought and immediately afterward, these revenues were $160,000 and $140,000, respectively. Reduction in total water use amounted to about 36 percent during the drought, causing estimated reduced revenues from $274,000 (maximum of the period) to $140,000 (the drought low). This revenue loss ($134,000 for 36 percent water use reduction) provides a method for estimating the revenue loss associated with the 3 to 5 percent reductions caused by the WCWSU water conservation program. If a 4 percent average reduction is assumed, the ratio of the effectiveness of the proposed program to the drought "effect" (4 percent/36 percent) indicates that the proposed program is 11 percent as "effective" as the drought. This suggests a loss of revenue (11 percent) * $134,000 = $15,000 per year. The present value of the lost revenues over the fifty years totals $191,000, and for each measure is M-1: $41,000; M-2: $20,000; M-3: $125,000; and M-4: $5,000.

Substep 9.5 Summary Foregone Supply Costs

Table 6-76 summarizes the effects of water conservation on the costs of operations and future expansion of the WCWSU water and sewer systems, as well as to a future Federal project. In addition, the economic impact of the water conservation measures on other external opportunities (ie., generation of hydroelectric power) are identified for the negative impacts they represent. The present value of total operating costs foregone are $9,428,000. Measure 1: $2,041,000; Measure 2: $983,000; Measure 3: $6,183,000; Measure 4: $221,000; and Measure 5: Minimal.

TABLE 6-76
FOREGONE SUPPLY COSTS (WCWSU)
(1980 $)

	MEASURE 1 Retrofit	MEASURE 2 Dual-Flush	MEASURE 3 Recycle	MEASURE 4 Landscape	MEASURE 5 Contingency	TOTAL
OPERATING COSTS						
Water Supply Purchases & Treatment						
(Avg.)	521,000	250,000	1,589,000	57,000	-	2,417,000
(Peak)	20,000	11,000	62,000	2,000	-	95,000
Wastewater Treatment	1,500,000	722,000	4,532,000	162,000	-	6,916,000
Subtotal	2,041,000	983,000	6,183,000	221,000	Minimal	9,428,000
CAPITAL COSTS						
Water Supply Treatment	None Anticipated					
Water Trans.	None Anticipated					
Wastewater Treatment	263,000	131,000	903,000	-	-	1,297,000
Trans.	None Anticipated					
ALT. WATER PROJECTS						
LOCAL-1	-	-	-	-	-	
BR-1	856,000	411,000	1,936,000	40,000	-	3,243,000
Subtotal	1,119,000	542,000	2,839,000	40,000	-	4,540,000
EXTERNAL OPP. COSTS						
Hydropower	-41,000	-20,000	-125,000	-5,000	-	-191,000
TOTAL	3,119,000	1,505,000	8,897,000	256,000	-	13,777,000

Significant foregone supply costs are also generated by water conservation program effects on capital costs. The wastewater treatment facilities are downsized, and delays are possible of 2 years for the Federal water project, which can benefit the WCWSU area. The present value of these benefits total fore: Measure 1: $1,119,000; Measure 2: $542,000; Measure 3: $2,839,000; and Measure 4: #40,000. These total $4,540,000.

In addition, external opportunity costs (impacts instead of foregone costs) result to hydroelectric power generation, producing losses in power generation revenues for the WCWSU. The net effect is $13,777,000 in present value benefits for the overall program of water conservation measures. The retrofit (Measure 1) program produces $3,119,000 in benefits; the dual-flush toilet (Measure 2) produces an additional $1,505,000 in benefits; and the industrial/commercial recycle program (Measure 3) produces the greatest benefits at $8,897,000.

Landscaping (Measure 4) produces the least net benefits at $256,000, and the contingency program (Measure 5) has little or no impact on foregone supply costs.

STEP 10: Foregone NED Benefits

The Federal project BR-1 will provide flood control and recreation benefits to the WCWSU area. The proposed WCWSU water conservation program precludes these NED benefits to the region (Table 6-77) for two years (1990 and 1991 in Figure 6-6):

TABLE 6-77
FOREGONE FEDERAL PROJECT BENEFITS

	ANNUAL NED BENEFITS (1981, $ 000)
Flood Control (Foregone)	$ -6
Recreation	453
TOTAL	$447

The "no action option" (absence of proposed project) provides over $13.7 million of average annual flood control benefits to the region without the "BR-1" modification. The BR-1 plan reduces flood control benefits by $6,000 per year. The project, however, adds $453,000 in average annual recreation benefits. The loss of these benefits for 2 years has a present value of $384,000 and is shared by measures: M1: $101,000; M2: $48,000; M3: $229,000; M4: $6,000.

STEP 11: Reduced Negative EQ Effects

The size of the Federal BR-1 project, as well as location and operations are unchanged by the proposed WCWSU conservation plans. No reduced negative EQ effects are anticipated, although the project is delayed 2 years.

STEP 12: Increased Negative Environmental Effects

The size of the Federal BR-1 project, as well as location and operations are unchanged by the proposed WCWSU conservation plans. No increased negative environmental effects are anticipated, although the project is delayed 2 years.

STEP 13: Measure Evaluation

The results of the analysis from Steps 7, 8, 9 and 10 are summarized in Table 6-78. The information contained in this Table was taken from previous Summary Tables for the various steps. Each measure produces NED advantageous effects that are substantially greater than the NED disadvantageous effects. The ratio of benefits to costs for each measure is: Measure 1 (13.8); Measure 2 (20.5); Measure 3 (14.1); Measure 4 (12.9); and Measure 5 (6.7).

TABLE 6-78
WCWSU SUMMARY OF NED ADVANTAGEOUS AND DISADVANTAGEOUS
EFFECTS OF WATER CONSERVATION MEASURES (1980 $)

	MEASURE 1 Retrofit	MEASURE 2 Dual-Flush	MEASURE 3 Recycle	MEASURE 4 Landscape	MEASURE 5 Contingency
ADVANTAGES					
a. Unrelated to water use	0	0	0	0	0
b. Indirectly, Related to Reduction	20,511,000	858,000	31,189,000	2,669,000	2,588,000
c. Foregone Supply Costs:					
Operations	2,041,000	983,000	6,183,000	221,000	Minimal
Facilities & Alt. Proj.	1,119,000	542,000	2,839,000	40,000	-
Ext. Opp. Costs	-41,000	-20,000	-125,000	-5,000	-
c. TOTAL NED ADV.	23,630,000	2,363,000	40,086,000	2,925,000	2,588,000
DISADVANTAGES					
a. Implementation Costs	1,605,100	67,400	2,594,000	220,800	Minimal
b. Other Disadv.	0	0	0	0	Extensive When Impl.
c. Foregone NED Benefits	101,000	48,000	229,000	6,000	384,000
d. TOTAL NED DISADV.	1,706,100	115,400	2,823,000	226,800	384,000

Based on economic impacts, the 5 measures are well selected. They will provide long-term benefits to the WCWSU area.

Table 6-79 summarizes the environmental impacts of the proposed water conservation measures. Only the contingency measure (rationing) could produce negative environmental effects; these rationing impacts affect residential lawns, gardens, etc., and probably commercial and public areas when outside watering is prohibited during severe drought. The text indicated that economic impact would be significant, however, these impacts are infrequent and the alternatives, ie., restricting water use to industry, would have much more severe impacts. The rationing environmental impacts are, therefore, judged to be acceptable.

TABLE 6-79
WCWSU SUMMARY OF ENVIRONMENTAL IMPACTS
OF WATER CONSERVATION MEASURES

	MEASURE 1 Retrofit	MEASURE 2 Dual-Flush	MEASURE 3 Recycle	MEASURE 4 Landscape	MEASURE 5 Contingency
ADVANTAGES					
a. Unrelated or indirectly related to water use reduction		(None anticipated for all Measures)			
b. Directly related to water use reduction					
i. Federally Planned Facilities		(None anticipated for all Measures)			
ii. Non-Federal Facilities		(None anticipated for all Measures)			
TOTAL ENVIRONMENTAL ADVANTAGES	None	None	None	None	None
DISADVANTAGES					
a. Unrelated or indirectly related to water use reduction		(None anticipated for Measures 1-4)			Damage to lawns and landscape
b. Directly related to water use reduction					
i. Federally Planned Facilities		(None anticipated for all Measures)			
ii. Non-Federal Facilities		(None anticipated for all Measures)			
TOTAL ENVIRONMENTAL DISADVANTAGES	None	None	None	None	Acceptable

STEP 14: Develop Water Conservation/Supply Plan

The five water conservation measures under consideration for the WCWSU area all meet the tests of applicability, feasibility, acceptability and effectiveness, as well as providing net advantageous effects with respect to the NED objective. Also, these measures are neutral, or acceptable, with respect to environmental impact locally, regionally and concerning a proposed Federal multi-purpose reservoir project.

The purpose of Step 14 is to maximize the Net Economic Development in satisfying the long-run water demands of the WCWSU area. It is apparent from the analysis of Steps 7-13 that the benefits of the proposed water conservation measures vary in time-- while one measure is gaining in effect, another is diminishing (as described in Table 6-58), and both the benefits and costs are in flux. As proposed, the overall effect of each measure is described in present value (1980 $). Table 6-80 summarizes the effects of each measure. If any of the measures proposed produced NED disadvantageous effects greater than the advantageous effects, it would be omitted or modified to reduce costs, or to increase the benefits it produces and the water conservation effects of the approach. As a result, the water conservation effects indicated in Tables 6-42 through 6-49 would be recalculated.

TABLE 6-80
SUMMARY OF WCWSU
WATER CONSERVATION MEASURES

MEASURE		AVERAGE ANNUAL EFFECTIVENESS (MGD)	EFFECTS			
			ADVANTAGEOUS		DISADVANTAGEOUS	
			Pres. Value NED (000$/1980)	Env.	Pres. Value NED (000$/1980)	Env.
M1	Retrofit	3.123 (1981) 0.005 (2030)	23,630.0	None	1,706.1	None
M2	Dual-Flush Toilet	1.371 (1981) 0.011 (2030)	2,363.0	None	115.4	None
M3	Recycle/ Reuse	4.291 (1981) 5.233 (2030)	40,086.0	None	2,823.0	None
M4	Landscaping	0.053 (1981) 0.317 (2030)	2,925.0	None	226.8	None
M5	Contingency	64.816 (1981) 68.297 (2030)	2,588.0	None	384.0	Acceptable

In Table 6-80, average annual effectiveness (mgd) is based on medium growth reductions (Table 6-43) and percent effectiveness by measure (Table 6-58). Table 6-81 presents the measures in rank order.

TABLE 6-81
NED MERIT ORDER
PRESENT VALUE (1980 $)

MEASURE	NED EFFECTS ADVANTAGEOUS	DISADVANTAGEOUS	NET EFFECTS
M3 Recycle	$40,086,000	$2,823,000	$37,263,000
M1 Retrofit	23,630,000	1,706,100	21,923,900
M4 Landscaping	2,925,000	226,800	2,698,200
M5 Contingency	2,588,000	384,000	2,204,000
M2 Dual-Flush Toilets	2,363,000	115,400	2,247,600

The Measure 3 industrial and commercial business water recycling and reuse program provides the greatest net effect, followed by Measure 1 (Retrofit). These programs produce more than $36 million and $21 million in net benefits, respectively.

The other measures each produce about $2 million in present value net NED effect with M4 (Landscaping) ranked 4th, followed by the contingency plan (M5) and the dual-flush toilet program (M2). This ranking helps to prioritize the implementation of water conservation program. If, for example, implementation funds are limited, the selection of measures would be from the rank order list beginning with Measure 3.

TABLE 6-82
SUMMARY OF TRIAL WATER CONSERVATION
PERMANENT PROPOSALS FOR WMWD (NED EFFECT)

NED PROJ. PLAN	MEASURES	WATER REDUCTION (MGD) 1981-2030	ADVAN. EFFECTS (PV,000$)	DISAD. EFFECTS (PV,000$)	NET NED ADVANTAGE (000$)
1	M3	4.291-5.233	$40,086.0	$2,823.0	$37,263.0
2	M3, M1	7.414-5.238	63,716.0	4,529.0	59,187.0
3	M3,M1,M4	7.467-5.555	66,641.0	4,795.0	61,846.0
4	M3, M1, M4, M2	8.838-5.566	69,004.0	4,910.0	64,094.0

In Table 6-82, proposals are formed by combining the water conservation measures. The objective is to maximize the net NED advantage, as well as the water reduction capabilities of the possible plan.

Each of these measures is independent of the others with the exception of Measure 5 (contingency plan), and each is implemented as a one-shot effort. Long-term additional personnel are not required (as was the case in the Level 2 example, Chapter 5), and options for combining measures and modifying the program costs and benefits are not planned for the purpose of arranging a mix of measures and options. As a result, all of the measures can be implemented (NED Project Plan 4) for the maximum NED benefit. Aspects of the proposed plan for implementing permanent measures include:

Selected Plan:

Measure

M3 (Recycle). WCWSU assistance to industry to identify opportunities for recyling water.
- o Consultant research.
- o Conferences.

M1 (Retrofit). Program with free distribution and voluntary use of:
- o Showerheads.
- o Toilet displacement bags.

M4 (Landscaping). Program focusing on developers and landscape architects.
- o Incentive program with $200 connection fee reduction.
- o Consolidated turf area - new MFR.
- o Drought-tolerant vegetation - new SFR and SFR renovations.
- o Tensiometers to control existing timer-irrigation systems for existing MFR.

M2 (Dual-Flush Toilets). Program for voluntary use of dual-flush toilets.
- o Promotion aimed at developers and plumbers.

Table 6-83 summarizes the effect of the water conservation measures analysis.

TABLE 6-83
SUMMARY OF WATER CONSERVATION MEASURES
AND FEDERAL AND LOCAL ALTERNATIVE PROJECTS

			NET IMPACT			
			BR-1		LOCAL-1	
	TECHNICAL FEASIBILITY	SOCIAL ACCEPTABILITY	NED OBJ.	ENVIR. IMPACT	REG. OBJ.	ENVIR. IMPACT
M1 (Retrofit)	Feasible	Acceptable	+	+	+	+
M2 (Dual-Flush)	Feasible	Acceptable	+	+	+	+
M3 (Recycle)	Feasible	Acceptable	+	+	+	+
M4 (Landscape)	Feasible	Acceptable	+	+	+	+
M5 (Contingency)	Feasible	Acceptable	+	+	+	+

The water conservation plan, in addition to the Federal (BR-1) and local (LOCAL-1) projects, meets the future needs of the WCWSU area in the most advantageous way (achieves the NED, regional, and environmental objectives). The water conservation program is implemented immediately and provides some delay advantage in bringing the Federal project (22.8 mgd) "on-line" (Figure 6-6), until it is required in 1990. The LOCAL-1 project is finally required in the year 2010, when it adds about 15 mgd to the safe yield of the system.

Table 6-84 identifies the timing and WCWSU costs of the water plan for the period 1980-2030.

TABLE 6-84
WCWSU WATER PLAN 1980-2030

YEAR		INCREMENTAL PROGRAM COSTS ($1980) PRESENT VALUE
1980	Water Conservation Implementation (Only WCWSU Costs)	
	Measure 1: Retrofit	$ 145,100
	Measure 2: Dual-Flush Toilets	37,400
	Measure 3: Recycle/Reuse	270,000
	Measure 4: Landscaping	16,500
	Measure 5: Contingency	Minimal
Subsequent Years		
1986	Wastewater System (I&I) (Capital)	74,200,000
1992	BR-1 Water Supply (Capital)	48,777,000
2007	Wastewater System Renovation (Capital)	137,200,000
2010	LOCAL-1 Water Supply (Purchases)	-

STEP 15: Supply Reliability Considerations

Water supply reliability and the risks associated with drought are described generally in Chapter 3 ("Risk and Uncertainty"), including concerns about data and analysis methods and concerns for the unknown. The safe yield of the WCWSU system was estimated at 325 mgd during the 1970's until the drought of 1976-1977 when the region experienced a great shortfall in available water supply. As a result, the safe yield was recalculated and estimated at 212 mgd in 1980 and to be 173 mgd in 2000 (Figure 6-6). These calculation changes reflect the reductions in risk implicit in this analysis.

The value or benefit of risk reduction to society of reduced impact from drought emergency is, from an economic viewpoint, society's willingness to pay for the marginal risk reduction. The literature is extensive on this matter with regard to environmental hazards such as air and water pollution, toxic substances and safe drinking water. (101) However, the data necessary for evaluating these risks for water supply shortage are not adequate for making this type of analysis.

In Step 6, high, medium, and low population projections were used to forecast comparable scenarios of water use. The analysis results are graphically presented in Figure 6-6 for average demand and Figure 6-7 for peak daily use. These growth factors are apparently minor concerns as compared to the potential impact of drought.

Also, from Figure 6-5, the recurrence interval for water deficiency that will be experienced in the WCWSU area is 1 in 40 years, assuming the system nominal draft requirement is 230 mgd (maximum water required to meet the projected average daily water needs 1980-2030 from Figure 6-6), and assuming a willingness to experience a deficiency of 25 percent. (For example, read approximately from Figure 6-5 at the intersection of 230 mgd and the 25 percent "Severity of Deficiency" curve, or 2.5 percent of the time.) Water users are often willing to experience shortfall more frequently than 1 in 40 years, however, perhaps not a 25 percent reduction. In this example, water conservation only slightly reduces the impact to water users.

STEP 16: Documentation

(See Appendix D: Bibliography)

WCWSU EXAMPLE: Flow Reduction Contingency Plan

The WCWSU has had previous experience with water restrictions and household water rationing. This program is directed at:

- o Water restrictions for temporary water emergency.
- o Water rationing (per capita limitation of 50 gpcd) for severe drought emergency.

The program is implemented infrequently according to the Step 15 risk analysis and has the ability to achieve reduction in water use of about 36 percent (Table 6-48).

The rationing program is estimated to cause landscaping damage (environmental impact) to about 20 percent of the residential connections for a drought similar to the 1976-1977 event, and economic losses will be substantial; however, the costs of alternative emergency programs may be even greater.

The program for the WCWSU is structured in three phases:

Phase I: Preparatory
Phase II: Voluntary Reductions
- Drought Warning
- Drought Watch

Phase III: Mandatory Reductions (Drought Emergency)
- Restrictions
- Rationing

In Chapter 5, a similar program was structured for the ECWD. Refer to that for additional plan detail.

CHAPTER 7

LEVEL 4 EXAMPLE: SOUTHEASTERN COUNTY WATER AUTHORITY

INTRODUCTION

The Southeastern County Water Authority (SCWA) was selected to represent the example for Level 4 data availability. The SCWA is considered representative of Level 4 because it has comprehensive historical data and projections as follows:

- o Metered water use for all customer classes
- o Water pricing policy based on conservation objectives
- o Fifteen-year water plan with projections of average daily, maximum day and peak hour use by customer class
- o Disaggregated data on revenues, costs and future budgets
- o Available 50-year plan with projections of water demand

GENERAL DESCRIPTION OF THE AUTHORITY

The SCWA was formed under the State Water and Sewer Authorities Act and chartered by the State Corporation Commission in 1957 to acquire existing water systems and to provide a comprehensive, county-wide water supply system. It is responsible for providing water supply to nearly 700,000 persons throughout the County and certain adjacent areas. The Authority has no responsibilities for wastewater treatment, although its activities are influenced by the available sewage collection, transportation and treatment facilities and their capacities in the region. The SCWA subsequently acquired 22 water systems over the course of the next decade at a total cost of $60.7 million. Coincident with the acquisition of each system, the Authority undertook an immediate capital improvement program to eliminate deficiencies in service and to extend service where needed. As of 1982, the SCWA had the following charateristics:

TABLE 7-1
SCWA CHARACTERISTICS (1982)

Population Served	668,100
Metered Customers	125,561
Water Produced and Purchased	25.79 Billion Gals. (70.65 mgd)
Water Sold	23.19 Billion Gals. (63.53 MGD)
Water Sales Revenues	$18.44 Million
Other Revenues	$ 7.88 Million
O&M Expenses	$10.02 Million
Other Expenses	$ 0.71 Million
Net Revenues	$15.59 Million
Capital Improvements	$13.49 Million
Utility Plant Value	$305.66 Million
Outstanding Long-Term Debt	$176.58 Million

TOPOGRAPHY, CLIMATE AND GEOLOGY

The County which makes up the major portion of the SCWA operating region is an integral part of a large, 3,000 square mile metropolitan area encompassing portions of two states and an independent District. The metropolitan area is situated on the Atlantic Coastal Plain at the fall line of two major rivers which both serve as sources of water supply for the area. A third, smaller river has been impounded within the County to serve as the principal source of water for the SCWA.

The rivers drain portions of five distinct physiographic provinces, including the Appalachian Plateau, the Ridge and Valley, the Blue Ridge, the Piedmont Plateau and the Atlantic Coastal Plain. The County lies primarily within the Coastal Plain and has gently rolling terrain which rises from sea level in the east westward into the Piedmont Plateau to its highest point 580 feet above sea level.

The climate is temperate ranging from an average 36.1° F in January to 78.4° F in July, with a minimum monthly average of 27.5° F and a maximum monthly average of 87.9° F. The precipitation throughout the year is seasonally well distributed and averages 39.0 inches per year with monthly values ranging from 2.6 to 4.4 inches. Winds are moderate and likewise seasonally well distributed.

The geology of the Coastal Plain and Piedmont Plateau consists of unconsolidated sedimentary formations of gravel, sand, silt and clay, underlain by metamorphic schists and gneisses of Precambrian age (600 million years or older) which outcrops where erosion has stripped away the sediments. The sediments contain four principle water-bearing strata which provide groundwater resources for the region. Mineral resources of the area include principally sand, gravel, clay and building stone.

HISTORICAL GROWTH AND DEVELOPMENT

Population

Historic trends in population of the County, taken from U. S. Census data, are shown below:

TABLE 7-2
COUNTY POPULATION

YEAR	POPULATION	PERCENT CHANGE DURING DECADE	RATE*
1950	98,557	141 (1940 -1950)	8.8
1960	248,897	153	9.3
1970	454,275	83	6.0
1980	596,901	31	2.7
1983	630,443 (Jan.1,1983)	5.6 (1980-1983)	1.8

*Annual Compound Rate

The growth in population has moderated sharply since the early 1970's, decreasing from a peak of over nine percent per year during the 1960's to under two percent at the present time.

The population density varies from a peak of roughly 4,500 persons per square mile in the highly urban eastern region to under 850 persons per square mile in the rural western region, with an overall average of 1,725 persons per square mile for the 365.41 square mile total area.

The racial composition of the population in the 1980 census was as follows:

TABLE 7-3
COUNTY RACIAL COMPOSITION (1980)

	NUMBER	PERCENT
WHITE	509,790	85.4
BLACK	34,994	5.9
SPANISH	19,535	3.3
ASIAN	22,725	3.8
OTHER	9,857	1.6

Households

The number of households increased during the recent past as follows:

TABLE 7-4
COUNTY HOUSING UNITS

YEAR	TOTAL HOUSING UNITS
1970	133,000
1980	215,700
1981	220,100
1982	223,900
1983	230,000

The average household size is estimated as follows:

TABLE 7-5
COUNTY HOUSEHOLD SIZE (1983)

	PERSONS/HOUSEHOLD
Single Family	3.10
Townhouse	2.52
Multi-Family	2.20
Overall Average	2.85

Sixty-seven percent of the households are traditional, headed by a husband and wife, with 10.7 percent being single parent homes and 22.7 percent being non-family households. The median family income was $41,600 in 1981, with 6.3 percent of the families earning less than $10,000.

Industry and Commerce

In 1980, non-agricultural employment in the County was 192,361, largely in services, trade and government agencies as follows:

TABLE 7-6
COUNTY NON-AGRICULTURAL EMPLOYMENT (1980)

	EMPLOYMENT
Services	52,387
Wholesale/Retail Trade	48,153
Government Agencies	43,833
Construction	17,268
Finance, Real Estate	13,096
Manufacturing	8,702
Transportation, Utilities	7,734
Other	1,188
TOTAL	192,361

There were 187 farms in the County in 1978, having an average size of 109 acres. Total farm acreage was 20,464 acres, roughly 9 percent of County area. Total agricultural employment was less than 1,000 persons.

Roughly 77 percent of the employed persons were in "white collar" activities. Sixty-two percent of employed County residents commuted to work outside the County. Unemployment remained low, less than 5 percent, among County residents throughout the 1970's and early 1980's.

Land Use

Most of the land in the County is devoted to residential use, 212,641 acres or 90.9 percent is zoned for residential or residential-related use. More than 136,500 acres are zoned for a density of one unit per acre or less, of which 66,232 acres are zoned for one single-family unit per acre. Current land use is shown in the following Table:

TABLE 7-7
LAND USE (1983)

	ACRES	PERCENT
Residential	102,422	43.8
Industrial	8,260	3.5
Commercial	5,514	2.4
Recreation	23,350	10.0
Public	21,401	9.1
Vacant/Natural	72,916	31.2
TOTAL	233,863	100.0

More than 88 percent of the vacant land is zoned for residential development, 3 percent for commercial, and 7 percent for industrial development.

FUTURE GROWTH PROJECTIONS

Population

The County Office of Research and Statistics has forecast the future population of the County as follows:

TABLE 7-8
COUNTY FORECAST POPULATION

	FUTURE POPULATION	
1980	596,901	(Actual, U.S. Census)
1983	630,443	(Est. 1/1/83)
1985	649,065	
1990	685,887	
1995	711,883	
2000	741,939	
2005	758,200	
2010	765,300	

The number of housing units is estimated to be as follows:

TABLE 7-9
COUNTY FORECAST NUMBERS OF HOUSING UNITS

YEAR	TOTAL # UNITS	OCCUPIED (# HOUSEHOLDS)	AVERAGE HOUSEHOLD SIZE
1980	215,700	205,200	2.91
1983	230,000	221,100	2.85
1985	241,300	232,400	2.75
1990	266,500	256,600	2.63
1995	289,900	279,200	2.51
2000	312,600	300,800	2.43
2005	331,600	319,300	2.37
2010	345,100	332,300	2.30

At complete buildout, the number of housing units is planned to total 362,357, including 219,401 single family, 65,570 townhouses, and 77,386 multi-family units.

Employment is expected to increase as follows:

TABLE 7-10
COUNTY FORECAST EMPLOYMENT

YEAR	EMPLOYMENT
1980	192,800 (Actual)
1985	229,400
1990	271,600
1995	311,500
2000	347,500

A total of 2,100 acres has been set aside for commercial-office space, 3,200 acres for commercial-retail space, and 9,900 acres for industrial use. A total of 24,400 acres is planned for future public facilities, governmental areas and institutional uses.

WATER AND WASTEWATER SYSTEMS

Water Supply

The SCWA water supply facilities have been constructed in stages during the period 1950 to 1982. The initial principal water supply was a small river draining 570 square miles of watershed throughout the County and adjacent jurisdictions. Two dams were constructed, the first in 1950 impounding 55 million gallons and the second in 1957 about 3,000 feet upstream impounding 9.8 billion gallons. The dependable yield is approximately 65 mgd. During the months of November through April surplus stream flow is used by hydroelectric generating facilities to provide power for pumping and treating the water. Provisions were made in the design and construction of the larger dam to increase its height by five feet, increase storage by three billion gallons, and increase the dependable yield to approximately 84 mgd (112 mgd maximum).

Three interconnected plants provide water treatment for this primary water supply. The combined maximum capacity of these treatment facilities is 111.6 mgd. They provide removal of magnesium, manganese and iron, pH control, addition of fluoride, and disinfection with chlorine followed by dechlorination. Supplemental sources of water include 26 wells and the purchase of water from surrounding community systems when appropriate.

Only one project is planned for the SCWA service area. The "FED-1" project is planned to meet the future water supply needs of the SCWA area. This project is capable of providing 25,600 acre-feet (22.8 mgd) of additional water supply for municipal and industrial use, as well as flood control and recreation benefits. The project is planned for implementation after the year 2000, and the cost for water supply is $18.95/AF ($58.30/mg), based on the Non-Federal share for capital and operation and maintenance cost recovery. The project is opposed by environmentalists, however, it is supported by local and state agency officials as necessary to meet the future water needs of the SCWA area.

In 1982, over forty-one years after the original concept was proposed and over ten years from the authorization of preliminary plans, the Authority completed a 50 mgd supply system located on an adjacent, major river about ten miles upstream from the tidal limits of the estuary. The new supply system is designed for later expansion to 200 mgd. The new system provides for solids and metals removal, pH control, fluoridation, and disinfection. The treatment plant contains 5.5 million gallons of water storage capacity, and is connected to the existing storage, transmission and distribution system by about 18 miles of large diameter main. The current system provides 162 mgd of maximum water supply capacity.

The dependable yield of the river serving the new system is less than sufficient to provide all permitted withdrawals of the three jurisdictions using the river, including the SCWA 50 mgd. Therefore, the permit for the SCWA provides for allocation of river water during drought emergencies. The allocation formula depends on the proportion of use by the three jurisdictions during the preceding winter, less other available supplies.

The transmission and distribution system includes about 1,400 miles of mains with 18 pumping units plus 33 booster pumping stations. A total of 21 million gallons is stored in 44 tanks and reservoirs. The major water storage tanks include 9 million gallons in three tanks in A-dale, 5 million gallons in two tanks in G-springs, 4.3 million gallons in three tanks in P-wood and 1 million gallons at the county hospital. The distribution system is interconnected at 69 locations with 12 other water systems. Five of these other systems have their own independent water supply sources.

The water supplied to the system during the last decade is as follows:

TABLE 7-11
HISTORIC WATER SUPPLY (MILLION GALLONS)

YEAR	MG
1974	21,363.71
1975	21,367.77
1976	23,805.18
1977	23,868.60
1978	23,244.34
1979	22,804.41
1980	25,112.71
1981	24,049.80
1982	25,786.64
1983	27,884.78

Water Quality

Water quality is generally rated good-to-excellent following the extensive treatment and conditioning provided by the three water treatment plants.

Provisions have been made to augment the water supplies of one of the adjacent jurisdictions with water drawn from the major river estuary during a severe drought or other emergency. Even though the systems of the three jurisdictions drawing on the river are interconnected, the allocation formula states that withdrawals from the river are determined by the available supplies, so it is unlikely that estuarine water would be used in the SCWA system.

Water Demands

Water Use by five billing classes and wholesale sales are as follows:

TABLE 7-12
SCWA WATER CONSUMPTION AND SALES (MILLION GALLONS)

YEAR	SINGLE FAMILY	TOWN-HOUSES	APARTMENTS	COMMERCIAL	MUNICIPAL	TOTAL	WHOLE-SALE
1979	6,889	1,139	2,963	1,693	520	13,205	8,284
1980	7,699	1,269	2,995	1,754	530	14,247	8,965
1981	7,474	1,350	2,897	1,799	484	14,006	8,380
1982	7,768	1,445	2,904	1,803	470	12,587	8,804
1983	8,344	1,643	3,051	1,878	588	15,504	9,077

The projected total water demand is as follows:

TABLE 7-13
SCWA PROJECTED WATER DEMAND (MGD)

YEAR	MGD	YEAR	MGD	YEAR	MGD
1980	68.60	1995	89.40	2020	126.20
1985	73.80	2000	96.90	2030	141.00
1990	81.80	2010	112.60		

The water was consumed by the following numbers of users in each billing class:

TABLE 7-14
SCWA RETAIL CUSTOMERS BY CLASS (NUMBER)

YEAR	SINGLE FAMILY	TOWN-HOUSES	APARTMENTS	COMMERCIAL INDUSTRIAL	MUNICIPAL-INSTITUTIONAL	TOTAL
1974	71,977	8,650	1,188	2,635	515	84,965
1975	73,547	9,431	1,211	2,715	538	87,442
1976	75,795	10,800	1,263	2,800	552	91,210
1977	80,201	12,027	1,322	2,988	566	97,104
1978	84,609	13,570	1,353	3,160	580	103,272
1979	89,325	15,462	1,383	3,339	600	110,109
1980	92,749	17,727	1,412	3,684	618	116,190
1981	95,729	19,756	1,452	3,894	633	121,464
1982	98,012	21,367	1,482	4,054	646	125,561
1983	101,531	23,803	1,538	4,264	657	131,793

The revenues obtained were as follows:

TABLE 7-15
SCWA TOTAL WATER REVENUES (DOLLARS)

YEAR	RETAIL	WHOLESALE	CON. CHARGE	OTHER	TOTAL
1979	$11,727,556	$3,683,889	$8,069,480	$2,398,582	$25,879,507
1980	13,494,332	4,269,752	8,124,776	2,761,904	28,650,764
1981	12,508,080	4,082,908	6,529,867	3,202,199	26,323,054
1982	13,498,430	4,938,727	4,961,359	2,922,766	26,321,282
1983	15,030,550	5,632,579	8,066,121	3,490,048	32,219,298

Sewer System

The County also operates a sanitary sewer system consisting of 2,157 miles of gravity sewers, 51 lift stations with a pumping capacity of 178 mgd, 30 miles of force main, and 3 wastewater treatment plants with a capacity of 42.65 mgd. The County has contracts with two jurisdictions and two sewerage authorities to treat up to 57.386 mgd. The County facilities serve 109,658 single family residences, 56,197 apartment units, 31,763 townhouses, 4,897 trailers, and 6,756 commercial-industrial establishments as of February 1984. The average dry-weather flow per unit connected has been 300 gallons per day + or - 10 percent for six years. An infiltration/inflow (I&I) study performed recently showed that 25 to 30 percent of the total flow results from I&I.

The remainder of the County housing units are served by individual septic tank systems or by sewer systems operated by other jurisdictions.

SCWA PROCEDURES MANUAL APPROACH

This section provides the Level 4 analysis for the SCWA area. The level of data available from the authority is extensive and provides a strong technical foundation for analysis of a potential water conservation program.

STEP 1: Universe of Water Conservation Measures

Appendix A provides the list of possible methods for water conservation in the SCWA area. Table 7-16, " Potential Water Conservation Measures", serves as a Summary Table for the analysis in Steps 1-4. These four Steps are used to screen the broad list of water conservation measures to a list of measures that are "applicable", "technically feasible", and "socially acceptable".

STEP 2: Applicability

The SCWA has had some experience with water conservation over the past years. In 1977, the Eastern states were affected by a drought, and water restrictions were implemented in August and September by the Authority. However, efficient use of resources (capital savings) and "good will" (not drought) were the major factors that initiated water conservation efforts in the area.

County government's Plumbing Code is one source of water conservation requirements for new construction. The Plumbing Code requires:

- o low-flow showerheads
- o flow restrictors/faucet aerators
- o low-flush toilets (3.5 gallons/flush)
- o industrial recycling (including commercial, industrial and recreational uses)

These measures are indicated in Table 7-16, as well as water conserving measures and policies of the Authority, including:

- o metering (100 percent metered)
- o pressure-reducing valves (maintain pressure between 35-80 pounds)
- o leakage repair (authority policy requires customers to repair leaks)
- o peak load and excess use charge pricing policy (although not implemented for water conservation purposes)

TABLE 7-16
POTENTIAL WATER CONSERVATION MEASURES: SCWA/LEVEL 4

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
REGULATION			
LONG-TERM			
Federal & State Laws & Policies			
A. Federal Laws and Policy	No		
B. State Policy (1983)	No		
1. Plumbing Code	No		
2. Other Policy	No		
Local Codes & Ordinances			
A. Plumbing Codes for New Structures			
1. Low-flow showerheads	No	F	Yes
2. Shower flow restrictors	No	F	
3. Toilet dams	No	F	
4. Displacement devices	No	F	
5. Flush mechanisms	No	F	
6. Low-flush toilets	No	F	Yes
7. Pressure toilets	No	F	
8. Dual-flush toilets	Yes	F	Yes
9. Faucet aerators	No	F	Yes
10. Faucet restrictors	No	F	
11. Pressure reducing valves	No	F	
12. Service line restrictors	No	F	
13. Insulated hot water lines	Yes	F	Yes
14. Pre-mixed water systems (thermostatic mixing valves)	Yes	F	NA
15. Low water-using clothes washers	Yes	F	Yes
16. Low water-using dishwashers/ appliances	Yes	F	Yes
17. Dry composting toilets	Yes	F	NA
18. Grey water systems (reuse)	Yes	F	Yes
19. Leakage repair (private systems)	No	F	
20. Industrial recycle	No	F	Yes
B. Plumbing Codes--retrofitting			
1. Low-flow showerheads	Yes	F	Yes
2. Shower flow restrictors	Yes	F	Yes
3. Toilet dams	Yes	F	Yes
4. Displacement devices	Yes	F	Yes
5. Flush mechanisms	Yes	F	Yes
6. Low-flush toilets	Yes	F	Yes
7. Pressure toilets	Yes	F	Yes
8. Dual-flush toilets	Yes	F	Yes
9. Faucet aerators	Yes	F	Yes
10. Faucet restrictors	Yes	F	Yes
11. Pressure-reducing valves	Yes	F	Yes
12. Service line restrictors	Yes	F	Yes

TABLE 7-16 (CONTINUED)
POTENTIAL WATER CONSERVATION MEASURES: SCWA/LEVEL 4

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
13. Insulated hot water lines	Yes	F	Yes
14. Pre-mixed water systems (thermostatic mixing valves)	Yes	F	NA
15. Low water-using clothes washers	Yes	F	Yes
16. Low water-using dishwashers/ appliances	Yes	F	Yes
17. Dry composting toilets	Yes	F	NA
18. Grey water systems (reuse)	Yes	F	Yes
19. Leakage repair (private systems)	Yes	F	Yes
20. Industrial recycle	Yes	F	Yes
C. Sprinkling Ordinances			
1. Alternate day	Yes	F	Yes
2. Time of Day	Yes	F	Yes
3. Hand-held hose	Yes	F	Yes
4. Drip irrigation techniques	Yes	F	Yes
D. Changes in Landscape Design	Yes	F	Yes
E. Water Recycling	Yes	F	Yes
Restrictions			
A. Rationing			
1. Fixed allocation	Yes	F	Yes
2. Variable percentage plan	Yes	F	NA
3. Per capita use	Yes	F	No
4. Prior use basis	Yes	F	No
B. Restrictions on Specific Uses			
1. Recreational uses	Yes	F	NA
2. Commercial & Industrial uses	Yes	F	NA
3. Car washing	Yes	F	NA
CONTINGENT (For Declared Drought)			
Local Codes & Ordinances			
A. Sprinkling Ordinances	Yes	F	Yes
B. Water Recycling	Yes	F	Yes
Restrictions			
A. Rationing			
1. Fixed allocation	Yes	F	Yes
2. Variable percentage plan	Yes	F	Yes
3. Per capita use	Yes	F	Yes
4. Prior use basis	Yes	F	Yes
B. Restrictions on Specific Uses			
1. Recreational uses	Yes	F	Yes
2. Commercial & Industrial uses	Yes	F	Yes
3. Car washing	Yes	F	Yes

TABLE 7-16 (CONTINUED)
WATER CONSERVATION MEASURES: SCWA/LEVEL 4

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
MANAGEMENT			
LONG-TERM			
Leak Detection	Yes	F	Yes
Rate-Making Policies			
A. Metering	No	F	
B. Rate design			
1. Marginal cost pricing	Yes	F	NA
2. Increasing block rates	Yes	F	No
3. Peak load pricing	No	F	No
4. Seasonal pricing	Yes	F	No
5. Summer surcharge	Yes	F	No
6. Excess use charge	No	F	No
Tax Incentives & Subsidies	Yes	F	Yes
CONTINGENT			
Rate-Making Policies			
A. Rate design			
1. Marginal cost pricing	Yes	F	NA
2. Increasing block rates	Yes	F	NA
3. Peak load pricing	Yes	F	Yes
4. Seasonal pricing	Yes	F	Yes
5. Summer surcharge	Yes	F	Yes
6. Excess use charge	Yes	F	Yes
EDUCATION			
LONG-TERM			
Direct Mail	Yes	F	Yes
News Media	Yes	F	Yes
Personal Contact	Yes	F	Yes
Special Events	Yes	F	Yes
CONTINGENT			
Direct Mail	Yes	F	Yes
News Media	Yes	F	Yes
Personal Contact	Yes	F	Yes
Special Events	Yes	F	Yes

FOOTNOTES: TABLE 7-16

APPLICABLE:

"Yes" Applicable

"No" Currently in use (1) Required by utility policy, (2) Required by state or local plumbing code, (3) Required by some other authority, or (4) Requested for voluntary implementation (ie., "No (1)" means currently in use, as a result of utility's authority. "No. (14)" means utility authority and voluntary).

TECHNICALLY FEASIBLE:

F Not in use, but technically feasible (will not adversely affect water use (other than flow reduction if implemented). For example, a sector of a water service area has low water service pressure and flow restrictors will adversely affect use. Such devices are not technically feasible.

P Not in use, but potentially technically feasible once possible small technical obstacles to implementation are over.

SOCIALLY ACCEPTABLE:

"Yes" or "No" Based on analysis of social acceptability, measure is acceptable to public.

NA Not available.

The policy of the SCWA is to promote procedures and programs designed to eliminate wasteful water practices and to provide assistance to customers who desire to practice water conservation. The Authority recognizes the benefits of this approach to include:

1. Potential reduction or delay in the need for additional water supply facilities.
2. Potential reduction or delay in the need for additional wastewater treatment facilities.
3. Economic advantage to customers and better informed customers with regard to methods and procedures of water conservation.

The SCWA program is broad; SCWA:

- Utilizes a peak use charge, as part of the rate schedule, which has resulted in a reduction of peak use consumption (mentioned previously).
- Notifies civic and social organizations regarding the availability of SCWA personnel to discuss water conservation.

- o Participates in classroom programs on water conservation in cooperation with the County school system.

- o Issues pressure-reducing valves, without cost, to customers whose plumbing predates existing County codes to eliminate the wasting of water because of excessive pressure.

- o Alerts customers to unusually high consumption and investigates the cause. If the high consumption is attributable to leaks, the SCWA makes a one-time liberal adjustment to the bill which substantially offsets the cost of repairs.

- o Periodically mails pamphlets to customers denoting prudent water use practices.

- o Maintains a library of information on water-saving devices that are available on the market.

- o Upon request, checks customer's premises for leaks.

- o Maintains a stand-by service to shut down reported main breaks within one hour of notification on a 24-hour, seven-days-a-week.

- o Maintains a program for periodic water testing and repair.

- o Periodically, trains Customer Service Representatives regarding methods, procedures and devices available to customers.

- o Assists civic and social organizations in establishing water conservation programs in their neighborhoods.

- o Provides water conservation information to any interested customers, including tailoring the information to the customer's specific requirements.

- o Submits suggestions for plumbing code revisions relative to water conservation to appropriate jurisdictions.

In terms of jurisdictions and institutional authority, the SCWA area is fairly simple, and authority for water supply and wastewater management are primarily with the State, County and Authority. However, in terms of adjoining areas and interrelationships of plans with other large water systems, the management of water resources in the region is complex. Multi-jurisdictional plans have been prepared to deal with drought and water shortage, and, yearly, these jurisdictions and large self-supplied water users "play" water shortage games to deal with assumed drought and water shortfall.

As a result, the SCWA or other jurisdictions have already implemented numerous water conservation measures in the region. Table 7-16 indicates, however, that many methods are still applicable for new construction, retrofits (single family and multi-family construction), system leak detection (now only voluntarily used for finding household leaks), and education. Many options are also applicable for water use restrictions during water shortage.

STEP 3: Technical Feasibility

The water conservation measures in Table 7-16 were screened to determine if they were technically feasible (F), potentially technically feasible (P), or not technically feasible (No), based on knowledge of the measures and of aspects of the SCWC water system that could affect their function. Although many of the measures were shown in Step 2 to be Not Applicable because of existing policy which requires their use, no technical limitations are known that would exclude their use.

STEP 4: Social Acceptability

The SCWA implemented some water conservation measures in the past but, until now, has not attempted to determine the willingness of its customers to participate in their use. As part of this project, the SCWA conducted a survey to evaluate the willingness of the public to use water conservation measures. The survey form (Procedures Manual, Appendix B) was sent with a cover letter to a representative sample of SCWA customers (enclosed with a regular water bill). The completed questionnaire (included in Appendix C) presented eight water conservation measures for consideration and asked questions concerning each. The measures include:

A. Individuals install new water-conserving plumbing fixtures such as low-flow toilets and showerheads in their new homes.

B. City and State governments engage in active campaigns to educate the public on how to conserve water.

C. Sewage is processed and treated water reused for manufacturing and irrigation of crops.

D. Building codes require the installation in new buildings of water-conserving plumbing fixtures such as low-flow showerheads and toilets.

E. As the amount of water used increases, the price per gallon is raised.

F. The City controls the rate of urban growth and, thus, the demand for water by issuing only a limited number of building permits each year.

G. The use of water for lawns and gardens is reduced by half.

H. During a severe drought, the government imposes restrictions on water use that, if violated, results in stiff fines.

I. To be effective, some of the measures described above would have to be made into law and enforced by government. Generally, how do you feel about this?

Questions asked of recipients of the questionnaire included:

1. How much do you know about this particular water conservation measure?

2. How well do you think it would work?

3. How economical do you think it would be?

4. How serious would the need for water conservation have to be before you think this measure should be adopted?

5. Overall, how do you evaluate the conservation measure?

Respondents were offered a range of four choices on each answer, which are approximately:

1. None, not at all, unacceptable.
2. Just a little, not too good.
3. A fair amount, pretty good.
4. Quite a bit, big, enthusiastic approval.

The responses 3 and 4 (the "fair" to "enthusiastic" expressions) are considered positive acceptance of the proposed water conservation options. The public responded to the questionnaire as follows:

TABLE 7-17
SCWA SOCIAL ACCEPTANCE SURVEY RESULTS

	PERCENT POSITIVE RESPONSE				
QUESTIONNAIRE MEASURES	KNOWLEDGE?	WILL IT WORK?	COST?	ONLY FOR SERIOUS PROBLEM?	OVERALL?
A. Retrofit	71	78	71	51	82
B. Education	48	67	57	37	8Ø
C. Reuse	24	83	61	5Ø	77
D. Building Codes	39	86	86	29	88
E. Price	39	45	61	7Ø	5Ø
F. Growth Control	23	61	58	59	61
G. Lawn Restriction	71	78	84	67	75
H. Severe Drought Restriction	65	86	77	85	82
I. Use of Laws/ Enforcement	-	-	-	-	77

It is apparent that, with the exception of pricing water at higher rates (E) and growth controls (F), the public is willing to support an active program of water conservation based on the overall response.

Summary of Steps 1-4 Screening

As a result of the analysis in Steps 1-4, the long list of water conservation measures that were available for use in the SCWA area has been reduced to a list of measures that are applicable, technically feasible, and socially acceptable. These measures have a good probability of achieving water conservation in the SCWA area. The screened measures that will be subject to subsequent analysis steps include:

TABLE 7-18
SUMMARY: SCWA MEASURES FROM SCREENING STEPS 1-4

LONG-TERM MEASURES

1. Promotion of water-conserving clothes washers and dishwasher appliances (through modified building codes).

2. Use of pressure-reducing valves (more intensive use) in areas of high water pressure.

3. Adoption of a utility pipeline leak detection and repair program.

4. Retrofit of low-flow showerheads and toilet displacement devices (with renewal every 15 years).

5. Adoption of a public education program (more intensive effort with renewal every 15 years).

CONTINGENT MEASURES

6. Mandatory restrictions on water use.

STEP 5: Implementation

The SCWA has actively pursued measures to increase water supply and reduce unnecessary wasted water. The County and State have also been active in these areas. The SCWA has a large and well-trained staff with capabilities for implementing each of these measures, or as in Measure 1, assisting the County in making modifications to the County BOCA code.

Measure 1 (Water-Saving Appliances)

The SCWA previously investigated water-saving appliances on a small scale basis. Water-saving dishwashers use a minimum of about 7.5 gallons per load (standard dishwashers range from 7.5-16 gallons per load (20), and water-conserving clothes washers use from 16 to 19 gallons per load (standard clothes washers range from 27 to 54 gallons per load. (20) This measure impacts residential single family and multi-family housing, commercial and industrial development and encourages existing development to make the change to water-saving appliances when they are replacing appliances.

The SCWA promotes the change in County plumbing code requirements to 10 gallons per load dishwashers and 42 gallons per load clothes washers (assumed reductions of 28 percent and 10 percent, respectively), and County building inspections for new construction to ensure compliance (along with routine investigations for other building code requirements). The SCWA also promotes the change-over from standard appliances to water-saving appliances by local plumbing supply and appliance distribution centers.

Measure 2 (Pressure Reducing Valves)

The SCWA area County codes require pressure-reducing valves (PRV) for utility service districts, and the utility installs these devices in the mains or individual connections on a cost-effectiveness basis. Where existing household service areas have line pressure greater than 80 psi (Uniform Plumbing Code, 1973 edition calls for a maximum of 80 psi and a minimum of 15 psi household delivery pressure), the SCWA now provides free pressure-reducing valves (cost of $20.00 per valve for 3/4" or 1/2" size, brass valves) to customers for connections installed before the mid-1970's. The program is based on the customers' interest in reducing pressure and is voluntary, and the cost of installation is borne by the customer (estimated at $50 - $100). The existing PRV program is as follows:

Objective: maintain system water pressure between 35 and 80 pounds.

New Construction (assumed for all new construction since mid 1970's):

- Utility installs PRV for system pressure reduction, or
- Developers install PRV in individual homes with County plumbing inspection/enforcement.

Existing Neighborhoods (without PRV'S)

- PRV available free to any home (once, 2 sizes).
- Homeowner installs (or plumber).
- County waves plumbing inspection fee.
- Cost (utility) of PRV ($20.00), installation (homeowner) $50 - $100 (plumber cost).

Failure/Replacement

- Life of PRV 7-15 years.
- Replacement at homeowner's expense.

This program is believed to be effective, especially with new construction. However, with regard to existing older neighborhoods (without system PRV's) and replacement of units when they fail, additional water conservation is possible. Homeowners are usually aware of pressure-reducing valve failures. Annoying water hammer problems develop and washing machines and other water-using appliance valves may be damaged, but a significant percentage of the service population may not be aware of the problem. As a result, in conjunction with the water conservation program, PRV's are promoted, and information regarding the use of PRV's and the availability of free PRV's for homeowner installation will be made available.

This measure promotes the installation of pressure-reducing valves (limiting pressure to 8Ø psi, provided free) to these areas and replaces valves in other service areas where failure may be expected (based on the 7-15 year life expectancy of the devices). This measure is implemented by the SCWA staff with a more intensive effort to an existing program and impacts water savings in residential (interior and exterior), multi-family, commercial, and industrial water use sectors.

Measure 3 (Pipeline Leak Detection)

The SCWA has a relatively low percentage of unaccounted-for water, ranging from 9-1Ø percent. The utility currently has a meter management program that provides inspection, verification of all meters greater than 3" (tested and tagged) and random verification of smaller meters; however, no program for comprehensive system leak detection and repair has been implemented. Attention has focused in the past on main breaks ranging from a low of 145 per year to 215 per year over the five-year period from 1978 to 1982.

Main breaks and large pipeline leaks often cause disruption to transit, commercial business and communications within the SCWA service area, and, in general, inconvenience to the public from the interrupted water supply. The SCWA recognizes this problem and wishes to direct its leak detection effort at identifying major main breaks before they cause an emergency situation. The proposed leak detection program, therefore, identifies leaks in major commercial areas so that repairs are made during non-business or off-peak hours.

The proposed leak detection program has a goal of maintaining a 9 percent level of unaccounted-for water.

Measure 4 (Retrofit)

As indicated previously in Table 7-16, the SCWA has not implemented any retrofit programs in the past. However, there has been a great deal of experience with these measures in neighboring service areas. The residents are familiar with the impacts of drought to the area and are willing to conserve water as indicated in the social acceptability survey. The SCWA will implement a kit distribution program, including a low-flow showerhead and displacement devices for interested water users. The program provides these devices and necessary literature free of charge. This program reduces water use in interior residential, multi-family, commercial and public water use categories. This program is implemented in 198Ø and then renewed every 15 years as a long-term water-reducing technique.

Measure 5 (Education)

The SCWA has used bill stuffers and developed literature on water conservation methods for its customers in the past. This proposed education program is implemented as an intensive SCWA effort to coincide with the retrofit program distribution of water-saving showerheads and toilet displacement devices. The program consists of direct mail campaigns providing information to customers, radio and newspaper campaigns and lectures and meetings with civic and business organizations (an expansion of current programs) and is targeted at residential, multi-family, commercial and industrial customers and is renewed to coincide with the retrofit program 15-year interval.

Measure 6 (Restrictions)

For periods of water shortage, a contingency program is initiated that focuses on exterior residential, commercial, industrial and public water use categories. The impact is on unnecessary water use (low priority water use relative to human health and well being). The SCWA implements this program during temporary drought emergency.

STEP 6: Effectiveness

The effectiveness analysis for the SCWA service area consists of four substeps and evaluations:

Substep 6.1 Disaggregated Water Demand Forecasts
Substep 6.2 Determine Fraction of Water Demand Reduction
Substep 6.3 Determine Coverage
Substep 6.4 Analysis of Effectiveness

Substep 6.1 Disaggregated Water Demand Forecasts

Unlike the Step 6 analysis for Examples 2 and 3 (where projections were first made in Stage 1 of future water demand without the full impact of current recently implemented and programmed water conservation, and then adjusted in Stage 2 to develop a baseline water demand that was fully impacted by the current and programmed water conservation programs), this analysis, like Example 1, provides the necessary baseline projections directly.

A baseline water demand projection was prepared as a part of a Federal water supply study which included the SCWA service area. This baseline projection was prepared in 1979 and involved a significant effort and expenditure including the use of sophisticated analyses of historic and future water demand by water customer groups. The projections include the future effect of current water conservation efforts in the SCWA area, including the effect of existing plumbing codes with required water-saving fixtures (referenced previously in Step 2 Applicability). The effect of these water-saving devices was to reduce water use in new construction by 27.5 percent for residential use, 19.0 percent for commercial/industrial use, and 15.0 percent for public use. As a result, the baseline projections for the years 1980-2030 represent the implementation of current water conservation policy that will affect future water use. These baseline water demands represent a minimum reduction in water use.

A computer model was used in the Federal water supply study to project water use in the SCWA service area in each water customer class at ten year intervals from 1980-2030. Inputs to the program included:

- o Total use per category by month for both indoor and outdoor use in 1976.
- o Water demand growth indicators, including valves for 1976 and the projected year 2030.
- o Effects of any water conservation measures (reduction factors) that were evaluated.

The program determined much of the essential information needed for the projections:

- o Existing employment or dwelling units in each user category.
- o Per unit water use in each user group (current water use divided by an existing appropriate growth indicator value).
- o Change in water use per unit for residential user classes resulting from changes in household size.
- o Aggregate effects of water conservation measures in each user category.

The results of the analysis were checked with projections available from the Authority and with other available cross-reference information (ie., population, housing, household size) and were accepted as an appropriate baseline with which to work.

Tables 7-19 through 7-21 (Summary of Water Demand), present the baseline projections for the SCWA area for the medium, low and high growth projections, respectively.

Since the Federal study did not use a range of projections, and only presented a most likely condition (used as the medium growth projection), the low and high projections were based on information available from the authority to develop the high and lower growth ranges (note the low range is significantly lower than the high and medium ranges). The assumptions for a limited possible higher growth and greater potential for low growth are typical of expectations for the eastern urban/suburban areas where growth and population migration have established the likelihood of limited expansion and more probable out-migration. Table 7-22 presents these population assumptions for the high and low growth.

TABLE 7-19
SCWA SUMMARY OF WATER DEMAND (AVERAGE ANNUAL MGD)
MEDIUM GROWTH CASE[1]

TOTAL ANNUAL WATER USE INDOOR AND OUTDOOR

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	29.280	35.732	40.408	44,380	49.393	54.805
MFR	15.826	19.982	23.483	26.768	31.237	34.111
COMM/IND	9.499	12.164	14.400	16.727	19.709	22.661
PUB/INST	5.226	7.586	10.151	11.856	14.040	16.202
FED.	4.719	5.564	5.861	6.806	8.017	9.216
UNACCOUNTED	6.509	8.171	9.510	10.743	12.343	13.815
TOTAL	71.059	89.200	103.813	117.279	134.739	150.809

ANNUAL INDOOR USE[2] (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	24.624	30.051	33.983	37.324	41.540	46.091
MFR	15.098	19.063	22.403	25.537	29.800	32.542
COMM/IND	6.640	8.503	10.066	11.692	13.777	15.840
PUB/INST	5.148	7.472	9.999	11.678	13.829	15.959
FED	3.690	4.351	4.583	5.322	6.269	7.207
TOTAL	55.200	69.440	81.034	91.553	105.215	117.639

ANNUAL OUTDOOR USE[2] (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	4.646	5.681	6.425	7.056	7.853	8.714
MFR	.728	.919	1.080	1.231	1.437	1.569
COMM/IND.	2.859	3.661	4.334	5.035	5.932	6.821
PUB/INST	.078	.114	.152	.178	.211	.243
FED	1.029	1.213	1.278	1.484	1.748	2.009
TOTAL	9.350	11.588	13.269	14.984	17.181	19.356

[1]Supply and Demand Annex Report, Federal Water Supply Study, Tables 40-45.

[2]Indoor/Outdoor allocations determined from Conservation and Demand Annex Report, Table II-17.

Note: Total Water Use equals Indoor plus Outdoor use, plus Unaccounted-For water.

TABLE 7-20
SCWA SUMMARY OF WATER DEMAND (AVERAGE ANNUAL MGD)
LOW GROWTH CASE

TOTAL ANNUAL WATER USE INDOOR AND OUTDOOR

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	24.888	30.372	34.347	38.832	43.218	47.954
MFR	13.452	16.984	19.961	23.422	27.332	29.847
COMM/IND	8.074	10.339	12.240	14.636	17.245	19.828
PUB/INST	4.442	6.448	8.628	10.374	12.285	14.176
FED	4.011	4.729	4.982	5.955	7.014	8.064
UNACCOUNTED	5.532	6.945	8.083	9.400	10.800	12.088
TOTAL	60.400	75.820	88.241	102.619	117.896	131.957

ANNUAL INDOOR USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	20.930	25.543	28.885	32.658	36.347	40.329
MFR	12.833	16.203	19.042	22.344	26.075	28.474
COMM/IND	5.644	7.227	8.556	10.230	12.054	13.860
PUB/INST	4.376	6.351	8.499	10.218	12.100	13.964
FED	3.136	3.698	3.895	4.656	5.485	6.306
TOTAL	46.920	59.024	68.878	80.109	92.063	102.934

TOTAL OUTDOOR USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	3.598	4.829	5.461	6.174	6.871	7.624
MFR	.619	.781	.918	1.077	1.257	1.372
COMM/IND	2.430	3.111	3.684	4.405	5.190	5.968
PUB/INST	.066	.097	.129	.155	.184	.212
FED	.875	1.030	1.086	1.298	1.529	1.757
TOTAL	7.947	9.850	11.278	13.111	15.033	16.936

TABLE 7-21
SCWA SUMMARY OF WATER DEMAND (AVERAGE ANNUAL MGD)
HIGH GROWTH CASE

TOTAL ANNUAL WATER USE INDOOR AND OUTDOOR

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	29.280	36.089	41.216	45.711	51.369	57.545
MFR	15.826	20.182	23.953	27.571	32.486	35.816
COMM/IND	9.499	12.286	14.688	17.229	20.497	23.794
PUB/INST	5.226	7.662	10.354	12.212	14.601	17.012
FED	4.719	5.620	5.978	7.010	8.337	9.676
UNACCOUNTED	6.509	8.253	9.700	11.065	12.836	14.505
TOTAL	71.059	90.092	105.889	120.797	140.128	158.349

ANNUAL INDOOR USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	24.624	30.352	34.662	38.444	43.201	48.395
MFR	15.098	19.254	22.851	26.303	30.992	34.169
COMM/IND	6.640	8.588	10.267	12.043	14.328	16.632
PUB/INST	5.148	7.547	10.199	12.028	14.382	16.756
FED	3.690	4.394	4.675	5.482	6.519	7.567
TOTAL	55.200	70.134	82.654	94.299	109.423	123.520

ANNUAL OUTDOOR USE

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	4.656	5.738	6.553	7.268	8.167	9.149
MFR	.728	.928	1.102	1.268	1.494	1.647
COMM/IND	2.859	3.698	4.421	5.186	6.169	7.162
PUB/INST	.078	.115	.155	.183	.219	.255
FED	1.029	1.225	1.303	1.528	1.818	2.204
TOTAL	9.350	11.704	13.534	15.433	17.868	20.323

TABLE 7-22
SCWA POPULATION PROJECTIONS (THOUSANDS)

	1980	1990	2000	2010	2020	2030
HIGH GROWTH[1]	673.8	889.1	1,054.5	1,203.2	1,391.5	1,563.6
	(0.0%)	(+1.0%)	(+2.0%)	(+3.0%)	(+4.0%)	(+5.0%)
MEDIUM GROWTH[2]	673.8	880.3	1,033.9	1,168.2	1,338.0	1,489.9
NS	28.2	21.7	22.2	12.7	3.8	0.0
LOW GROWTH[1]	572.7	748.3	878.8	1,022.1	1,170.8	1,303.6
	(-15.0%)	(-15.0%)	(-15.0%)	(-12.5%)	(-12.5%)	(-12.5%)

(%) = increases or decreases above or below medium growth.
NS = numbers represent population not served by public system.

[1]Adjusted SCWA printout on population projections (Low, Medium and High) and approximate differentials from medium growth.

[2]Supply and Demand Annex Report, Federal Water Supply Study, Table V-7, p. 129.

The SCWA has detailed monthly data on water use by user category and additional data were available in the Federal water study to allocate the average water use to indoor and outdoor categories by the following method:

1. Analysis of water use by customer class for 1976 indicated the summer use period was from May to October (see Table 7-23).

2. Calculate average month, average summer month, average winter month and determine ratio of average summer use (difference summer average minus winter average) to average monthly use.

3. Use ratio to allocate water use by user class in Tables 7-19 through 7-21 to indoor and outdoor uses.

The effect of this analysis was to determine the percentage of annual water use represented by outdoor use (the difference would be indoor use):

SFR:	15.9%
MFR:	4.6%
COMM/IND:	30.1%
PUB/INST:	1.5%
FED:	21.8%

TABLE 7-23

MONTHLY (1976) WATER USE BY USER CATEGORY (MGD)

CUSTOMER CLASS	SFR	MFR	COMM/IND	PUB/INST	FED
January	12.49	4.42	1.66	.98	1.84
February	20.40	5.04	1.44	1.74	2.02
March	18.88	5.53	1.78	1.03	1.82
April	12.80	4.32	1.76	.94	2.06
May	20.97	5.04	2.13	1.77	2.06
June	21.48	5.32	2.39	1.17	2.35
July	15.34	4.45	2.41	.88	2.67
August	24.07	5.63	2.89	1.90	2.97
September	24.96	6.23	2.88	1.19	2.21
October	15.29	4.92	2.35	.96	2.07
November	21.71	5.44	2.39	1.93	1.93
December	17.87	5.37	2.00	1.15	1.81
AVG.	18.83	5.14	2.17	1.30	2.15
Summer Avg.	20.35	5.26	2.51	1.31	2.38
Winter Avg.	17.35	5.02	1.84	1.29	1.91
Outdoor Avg.	3.0	.24	.07	.02	.47
Allocation Factor	3.0/18.83	.24/5.14	.67/2.17	.02/1.30	.47/2.15
Percent	(15.9)	(4.6)	(30.1)	(1.5)	(21.8)

Summer: May-October

Based on Table II-17, Conservation and Demand Annex, Federal Water Supply Study, (average of combined user groups).

Peak day water use projections were provided by the Federal water supply study and are presented in Table 7-24. Again, these projections were assumed to be a medium growth projection. By a method similar to that used in determining the indoor and outdoor shares for average use, the annual average, as well as summer and winter averages and differentials were determined in Table 7-24.

TABLE 7-24
SCWA PEAK DAY WATER USE PROJECTIONS (MGD)
AND DETERMINATION OF OUTDOOR WATER USE[1]
MEDIUM GROWTH CASE

	PEAK DAY (MGD)					
	1980	1990	2000	2010	2020	2030
January	66	85	99	111	128	142
February	67	84	97	109	125	140
March	68	85	98	111	127	142
April	81	101	118	132	152	169
May	84	106	123	139	160	179
June	96	122	142	161	186	209
July	104	132	155	176	203	228
August	96	122	142	161	186	209
September	90	114	133	151	174	195
October	78	98	114	129	148	165
November	73	91	106	119	136	152
December	73	91	105	118	136	151
Annual Avg.	81.3	102.6	119.3	134.8	155.1	173.4
Summer Avg.	91.3	115.6	134.8	152.8	176.1	197.5
Winter Avg.	71.3	89.5	103.8	116.6	134.0	149.3
Summer-Winter Differential	20.0	26.1	31.0	36.2	42.1	48.2

[1]Supply and Demand Annex, Federal Water Supply Study, Tables V-30 to V-35.

In 1980, for example, the peak day water use is 104 mgd and the summer:winter differential is 20.0 mgd. Table 7-25 provides the results of the process to allocate the summer and winter use to user classes by the following steps:

1. Obtain peak day water use in Table 7-24.
2. Determine leakage (unaccounted for water) at 9.1 percent for the SCWA area.
3. Determine peak day outdoor water use (Table 7-24) by difference method Summer - Winter (ie., 1980 = 20 mgd).
4. To determine peak day indoor use, subtract from total use (ie., 104 mgd (1980) 9.526 mgd for unaccounted and 20 mgd for outdoor - 74.474 mgd).
5. Based on Federal study data presented in Table 7-25, shares of the summer peak day indoor and outdoor water use were detemined by each user class and allocated.
6. Determine total water use by summing the indoor and outdoor uses.

TABLE 7-25
SCWA PEAK WATER USE ALLOCATIONS[1]
MEDIUM GROWTH CASE

	SFR	MFR[2]	MFR[3]	COMM/IND	PUB/INST	COMM	FED	TOTAL
TOTAL USE	226.26	30.09	93.39	48.53	17.29	3.69	25.81	445.06
SUMMER	122.11	15.59	47.63	27.77	8.88	2.36	14.33	238.67
WINTER	104.15	14.50	45.76	20.76	8.41	1.33	11.48	206.39
DIFFERENCE (SUMMER INCREMENT)	17.96	1.09	1.87	7.01	0.47	1.03	2.85	32.28

SUMMER WATER USE ALLOCATION TO EACH CATEGORY (OUTDOOR)

TO GET:			PERCENT OF SUMMER WATER USE INCREMENT BY EACH CATEGORY
SFR:	17.96/32.28	=	55.7
MFR:	1.09 + 1.87/32.28	=	9.2
COMM/IND:	7.01 + 1.03/32.28	=	24.9
PUB/INST:	.47/32.28	=	1.5
FED:	2.85/32/28	=	8.7
			100.0

WINTER WATER USE ALLOCATION TO EACH CATEGORY (INDOOR)

TO GET:			PERCENT OF WINTER WATER USE INCREMENT BY EACH CATEGORY
SFR:	104.15/206.39	=	50.4
MFR	14.50 + 45.76/206.39	=	29.3
COMM/IND:	20.76 + 1.33/206.39	=	10.7
PUB/INST:	8.41/206.39	=	4.1
FED:	11.48/206.39	=	5.5
			100.0

[1]Conservation and Demand Reduction Speciality Annex, Table II-17, Federal Water Supply Study, p. 37.
[2]Townhouses.
[3]Apartments.

Tables 7-26 through 7-28 present the peak demand projections for the medium, low and high growth projections.

TABLE 7-26

SCWA SUMMARY OF WATER DEMAND (PEAK DAILY)[1]

TOTAL WATER USE AND INDOOR & OUTDOOR

MEDIUM GROWTH CASE

TOTAL WATER USE (PEAK DAY JULY, MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	48.675	61.818	72.607	82.497	95.173	106.940
MFR	23.661	29.888	35.024	39.568	45.568	50.996
COMM/IND	12.949	16.536	19.468	22.248	25.709	29.005
PUB/INST	3.353	4.238	4.967	5.615	6.466	7.238
FED	5.836	7.429	8.736	9.950	11.489	12.935
UNACCOUNTED	9.526	12.091	14.198	16.122	18.595	20.886
TOTAL	104.000	132.000	155.000	176.000	203.000	228.000

PEAK DAILY INDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	37.535	47.280	55.340	62.334	71.723	80.093
MFR	21.821	27.487	32.172	36.238	41.695	46.562
COMM/IND	7.969	10.037	11.749	13.234	15.226	17.003
PUB/INST	3.053	3.846	4.502	5.071	5.834	6.515
FED	4.096	5.159	6.039	6.801	7.827	8.741
TOTAL	74.474	93.809	109.802	123.678	142.305	158.914

PEAK DAILY OUTDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	11.140	14.538	17.267	20.163	23.450	26.847
MFR	1.840	2.401	2.852	3.330	3.873	4.434
COMM/IND	4.980	6.499	7.719	9.014	10.483	12.002
PUB/INST	.300	.392	.465	.544	.632	.723
FED	1.740	2.270	2.697	3.149	3.662	4.194
TOTAL	20.000	26.100	31.000	36.200	42.100	48.200

[1]Supply and Demand Annex, Federal Water Supply Study, Tables V-30 to V-35.

TABLE 7-27
SCWA PEAK WATER USE (MGD)[1]
(LOW POPULATION PROJECTION)

TOTAL WATER USE INDOOR & OUTDOOR (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	41.374	52.545	61.716	72.185	83.276	93.573
MFR	20.112	25.405	29.770	34.622	39.872	44.621
COMM/IND	11.006	14.056	16.548	19.467	22.495	25.379
PUB/INST	2.850	3.602	4.222	4.913	5.658	6.333
FED	4.961	6.314	7.425	8.706	10.053	11.318
UNACCOUNTED	8.097	10.277	12.068	14.106	16.270	18.275
TOTAL	88.400	112.200	131.750	154.000	177.625	199.500

PEAK INDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	31.905	40.188	47.039	54.542	62.758	70.081
MFR	18.548	23.364	27.346	31.708	36.483	40.742
COMM/IND	6.773	8.531	9.987	11.580	13.323	14.877
PUB/INST	2.595	3.269	3.827	4.437	5.105	5.701
FED	3.482	4.385	5.133	5.951	6.848	7.648
TOTAL	63.303	79.737	93.332	108.218	124.516	139.050

PEAK OUTDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	9.469	12.357	14.677	17.643	20.519	23.491
MFR	1.564	2.041	2.424	2.914	3.389	3.880
COMM/IND	4.233	5.524	6.561	7.887	9.173	10.502
PUB/INST	.255	.333	.395	.476	.553	.632
FED	1.479	1.929	2.292	2.755	3.204	3.670
TOTAL	17.000	22.185	26.350	31.675	36.838	42.175

[1]Based on Table 7-22 variations from medium growth and Table 7-26.

TABLE 7-28
SCWA PEAK WATER USE (MGD)[1]
HIGH POPULATION PROJECTION

TOTAL WATER USE INDOOR & OUTDOOR (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	48.675	62.436	74.059	84.972	98.980	112.287
MFR	23.661	30.187	35.725	40.755	47.391	53.546
COMM/IND	12.949	16.701	19.857	22.916	26.737	30.455
PUB/INST	3.353	4.280	5.066	5.784	6.724	7.600
FED	5.836	7.503	8.911	10.248	11.948	13.582
UNACCOUNTED	9.526	12.213	14.482	16.605	19.339	21.930
TOTAL	104.000	133.320	158.100	181.280	211.120	239.400

PEAK INDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	37.535	47.753	56.447	64.204	74.592	84.098
MFR	21.821	27.762	32.815	37.325	43.363	48.890
COMM/IND	7.969	10.137	11.984	13.631	15.835	17.853
PUB/INST	3.053	3.884	4.592	5.223	6.067	6.841
FED	4.096	5.211	6.160	7.005	8.140	9.178
TOTAL	74.474	94.747	111.998	127.388	147.997	166.895

PEAK OUTDOOR WATER USE (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
SFR	11.040	14.683	17.612	20.768	24.388	28.189
MFR	1.840	2.425	2.909	3.430	4.028	4.656
COMM/IND	4.980	6.564	7.873	9.284	10.902	12.602
PUB/INST	.300	.396	.474	.560	.657	.759
FED	1.740	2.293	2.751	3.244	3.808	4.404
TOTAL	20.000	26.361	31.620	37.286	43.784	50.610

[1]Based on Table 7-22 variations from medium growth and Table 7-26

Substep 6.2 Determine Fraction of Water Use Reduction

Projections of average annual and peak daily water use were developed in Substep 6.1. These demands are aggregated to interior residential (combining indoor SFR and MFR), exterior residential, commercial, industrial, public/inst. and unaccounted-for uses) and summarized here in mgd in Tables 7-29 through 7-31.

TABLE 7-29
SCWA BASELINE PROJECTED FLOWS (WITHOUT ADDITIONAL CONSERVATION)
LOW WATER USE CASE

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	33.763	41.746	47.927	55.002	62.422	68.803
Ext. Residential	4.217	5.610	6.379	7.251	8.128	8.996
Commercial	8.074	10.339	12.240	14.636	17.245	19.828
Industrial	4.011	4.729	4.982	5.955	7.014	8.064
Public/Inst.	4.442	6.448	8.628	10.374	12.285	14.176
Unacc. For	5.532	6.945	8.083	9.400	10.800	12.088
TOTAL	60.039	75.817	88.239	102.618	117.894	131.955

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	50.453	63.552	74.385	86.250	99.241	110.823
Ext. Residential	11.033	14.398	17.101	20.557	23.908	27.371
Commercial	11.006	14.056	16.548	19.467	22.495	25.379
Industrial	4.961	6.314	7.425	8.706	10.053	11.318
Public/Inst.	2.850	3.602	4.222	4.913	5.658	6.333
Unacc. For	8.097	10.277	12.068	14.106	16.270	18.275
TOTAL	88.400	112.199	131.749	153.999	177.625	199.499

TABLE 7-30
SCWA BASELINE PROJECTED FLOWS (WITHOUT ADDITIONAL CONSERVATION)
MEDIUM WATER USE CASE

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	39.722	49.114	56.386	62.861	71.340	78.633
Ext. Residential	5.374	6.600	7.505	8.287	9.290	10.283
Commercial	9.499	12.164	14.400	16.727	19.709	22.661
Industrial	4.719	5.564	5.861	6.806	8.017	9.216
Public/Inst.	5.226	7.586	10.151	11.856	14.040	16.202
Unacc. For	6.509	8.171	9.510	10.743	12.343	13.815
TOTAL	71.049	89.199	103.813	117.280	134.739	150.810

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	59.356	74.767	87.512	98.572	113.418	126.655
Ext. Residential	12.980	16.939	20.119	23.493	27.323	31.281
Commercial	12.949	16.536	19.468	22.248	25.709	29.005
Industrial	5.836	7.429	8.736	9.950	11.489	12.935
Public/Inst.	3.353	4.238	4.967	5.615	6.466	7.238
Unacc. For	9.526	12.091	14.198	16.122	18.595	20.886
TOTAL	104.000	132.000	155.000	176.000	203.000	228.000

TABLE 7-31
SCWA BASELINE PROJECTED FLOWS (WITHOUT ADDITIONAL CONSERVATION)
HIGH WATER USE CASE

AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	39.722	49.606	57.513	64.747	74.193	82.564
Ext. Residential	5.384	6.666	7.655	8.536	9.661	10.796
Commercial	9.499	12.286	14.688	17.229	20.497	23.794
Industrial	4.719	5.620	5.978	7.010	8.337	9.676
Public/Inst.	5.226	7.662	10.354	12.212	14.601	17.012
Unacc. For	6.509	8.253	9.700	11.065	12.836	14.505
TOTAL	71.059	90.093	105.888	120.799	140.125	158.347

PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1980	1990	2000	2010	2020	2030
Int. Residential	59.356	75.515	89.262	101.529	117.955	132.988
Ext. Residential	12.880	17.108	20.521	24.198	28.416	32.845
Commercial	12.949	16.701	19.857	22.916	26.737	30.455
Industrial	5.836	7.503	8.911	10.248	11.948	13.582
Public/Inst.	3.353	4.280	5.066	5.784	6.724	7.600
Unacc. For	9.526	12.213	14.482	16.605	19.339	21.930
TOTAL	103.900	133.320	158.099	181.280	211.119	239.400

Data from the SCWA's field studies on water conservation and customer water use provide site-specific reduction estimates for most of the measures being considered. A pilot study compared available low-water using dishwashers and clothes washers to existing units and showed that a 4 percent reduction in interior water use could be expected to be achieved. Field testing of pressure-reducing valves in residential areas of high pressure showed reductions of 5 percent of both interior and exterior use. Retrofit programs that were implemented only in portions of the SCWA service area indicated that reductions in interior residential use of 12.0 percent from low-flow shower heads and 13.3 percent from toilet displacement devices can be expected. Previous public education programs resulted in estimated reductions of 4.8 percent in metered water use. Prior implementation of a restricted use program during a temporary water emergency indicates that a reduction of 17 percent of use within the exterior residential, commercial, industrial and public use categories can be anticipated. Data on the effectiveness of pipeline leak repairs in the SCWA is not available, however, the proposed program is being developed to maintain the present level of unaccounted-for water of 9 percent. It is assumed that the level of effort of that program will vary in order to obtain that goal.

The fractional reduction values for use in the effectiveness evaluation were then based upon these site-specific studies. They are summarized in Table 7-32.

TABLE 7-32
SCWA CONSERVATION MEASURES

MEASURE	FRACTIONAL REDUCTION
Conserving Appliances	0.04
Pressure-Reducing Valves	0.05
Public Education	0.048
Low-Flow Shower heads	0.120
Toilet Displacement Devices	0.133
Restricted Uses	0.170
Pipeline Leak Repair Program*	0.09

*Pipeline leak repair program designed to maintain the SCWA existing level of 9.0 percent unaccounted water.

Substep 6.3 Determine Coverage

A detailed analysis was conducted of the local implementation conditions. The previous field studies and pilot programs provided an excellent basis on which to estimate the coverage of future programs. The social acceptability study allowed the differentiation of coverage from one water use sector to another. And the examination of trends from the previous studies and programs allowed evaluation of how the coverage of several of the conservation measures varied with time.

In determining the coverage factors for the SCWA, actual flows for each water use category were considered, not simply the number of customers in each sector. This was made possible by the development of the disaggregated water use demand by flow in the residential, commercial, industrial, and public use sectors and the ability to place emphasis or differentiate any changes between major users within each use category over the project period. For example, if the ratio of single family to multi-family residential use had changed substantially between the beginning of the program in 1980 and the design year of 2030, adjustments in coverage could have been made to account for the greater ability to retrofit in apartment complexes. Since the percentage of multi-family residential flow changed only gradually from 35 percent of total residential use in 1980 to 38 percent in 2030, such an adjustment was not made.

The initial coverage factors for each water use category thus reflect the fraction of the actual quantity of water in each sector expected to be subject to the implementation of each conservation measure. The estimates of each initial coverage value are therefore equal to the observed coverage achieved in the previous field studies. This assumes from the social acceptability study and evaluation of utility personnel that the SCWA makes a maximum effort to achieve the same coverage system-wide that was achieved in the field study. These initial coverage values are shown in Table 7-33.

TABLE 7-33
INITIAL COVERAGE VALUES (SCWA)

CONSERVATION MEASURE	INT. RES.	EXT. RES.	COMM.	IND.	PUB/ INST.	UNACC. FLOW
Conserving Appliances	.05	-	.02	.02	-	-
Pressure-Reducing Valves	.25	.25	.25	.25	.25	-
Public Education	.90	.90	.75	.75	1.00	-
Low-Flow Showerheads	.40	-	-	-	.20	-
Toilet Displ. Devices	.50	-	.50	-	.50	-
Restricted Use	-	1.00	.75	.75	1.00	-
Pipeline Leak Repair	-	-	-	-	-	1.0

The change in coverage with time was estimated from the SCWA's previous experience with its conservation studies. Experience with pressure-reducing valves does not indicate any noticeable changes in customer water use over a four-year period following installation of these devices. The retrofit program, however, shows that reductions in residential water use in the implemented areas are only 73 percent of what they were initially, three years after the shower heads and displacement devices were installed. This is equivalent to a 10 percent reduction each year or a 0.9 annual ratio of change. Similar analysis estimates a 0.8 annual ratio of change for change in effectiveness following discontinuance of public education programs. Since the restricted use contingency measure is implemented infrequently and only for a short period of time, no changes in coverage are considered.

Because the installation of water-conserving appliances is occurring as new buildings are available and as existing appliances are replaced, the coverage for this measure increases over time. A precise determination of the increase in the number of water-saving appliances is not available and since existing appliances are also being replaced as they are removed, the rate of increase should be greater than the rate of new construction (about 2 percent per year). For this analysis, it is assumed that the increase in water saving dishwashers and clothes washers is about 5 percent each year, or an annual ratio of change of 1.05. This minimal coverage (portion of total building) reflects the assumed small percentage of units constructed and sold with appliances. From these values, the change of coverage values in time can be determined according to the same procedures illustrated in the Level 1, 2, and 3 analyses. The coverage values that are anticipated in 1985 from these annual ratios of change and from the initial coverage values (Table 7-33) are thus shown in Table 7-34.

TABLE 7-34
1985 COVERAGE VALUES (SCWA)
(PERMANENT MEASURES)

CONSERVATION MEASURE	INT. RES.	EXT. RES.	COMM.	IND.	PUB/ INST.	UNACC. FOR
Conserving Appliances	.061	-	.024	.024	-	-
Pressure-Reducing Valves	.250	.250	.250	.250	.250	-
Public Education	.369	.369	.307	.307	.410	-
Low-Flow Showerheads	.262	-	-	.131	-	-
Toilet Displ. Devices	.328	-	.328	-	.328	-
Pipeline Leak Repair	-	-	-	-	-	1.0

Substep 6.4 Analysis of Effectiveness For The SCWA Area

Having determined the disaggregated demand forecast, the fractional reduction, the initial coverage and the changes in coverage with time, the effectiveness of the SCWA water conservation program can be estimated. An examination of the literature (18) does indicate that an interaction between the public education measure and the retrofit measures of low-flow showerheads and toilet displacement devices does exist. The interaction factor for the retrofit measures as each impact the public education measure is given as 0.789. The use of this interaction in calculating effectiveness is illustrated in the following example.

The calculation of the effectiveness of the SCWA conservation program in the interior residential water use category for the medium water use case in 1985 is illustrated. Five of the six water conservation measures impact the interior residential water use. They are the water conserving appliances, the pressure-reducing valves, public education, low-flow showerheads and toilet displacement devices. The fractional reduction for each of these measures was provided in Table 7-32 and the coverage factors in 1985 in Table 7-34. The disaggregated interior residential flow as interpolated from Table 7-30 between 1980 and 1990 is 44.418 mgd. The effectiveness of the individual measures are determined as follows:

Conserving Appliances $E=QRC=$ (44.418 mgd)(0.04)(0.061) = 0.108 mgd

Pressure-Reducing Valves $E=QRC=$ (44.418 mgd)(0.05)(0.250) = 0.555 mgd

Public Education $E=QRC=$ (44.418 mgd)(0.048)(0.369) = 0.7867 mgd

Low-Flow Showerheads $E=QRC=$ (44.418 mgd)(0.12)(0.262) = 1.397 mgd

Displacement Devices $E=QRC=$ (44.418 mgd)(0.133)(0.328) = 1.938 mgd

The combination of the individual effectiveness is modified by the impact of the interaction of low-flow showerheads on public education and the interaction of displacement devices on public education as follows:

TOTAL EFFECTIVENESS = 1.938 mgd + 1.397 mgd + (.789)(.789)(0.7867 mgd)
+ 0.555 mgd + 0.108 = 4.488 mgd

The results for the SCWA effectiveness analysis for the low, medium, and high water use cases are shown in Tables 7-35, 7-36 and 7-37, respectively. These results emphasize the impact of repeating the implementation of the public education and retrofitting efforts periodically. This effect is illustrated in Figure 3-1 (Chapter 3). This shows the initial impact of the retrofit program, with the impact of that program decreasing for 15 years until the next retrofit effort is initiated.

TABLE 7-35
EFFECTIVENESS OF CONSERVATION FOR SWCA
LOW WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1996	2000	2011	2026	2030
Int. Residential	5.388	3.920	2.692	7.127	5.102	9.098	11.343	8.479
Ext. Residential	0.243	0.170	0.111	0.331	0.221	0.404	0.680	0.311
Commercial	0.898	0.660	0.458	1.244	0.890	1.683	2.164	1.575
Industrial	0.201	0.139	0.094	0.240	0.164	0.329	0.431	0.320
Public/Inst.	0.645	0.490	0.339	1.082	0.776	1.461	1.861	1.275
Unacc. For	0.010	0.058	0.133	0.153	0.155	0.193	0.226	0.233
TOTAL	7.385	5.436	3.826	10.177	7.308	13.168	16.504	12.193
PERCENT	12.0	8.0	5.0	12.3	8.3	12.6	13.1	9.2

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1996	2000	2011	2026	2030
Int. Residential	8.069	5.918	4.097	11.000	7.918	14.346	18.216	13.657
Ext. Residential	0.633	0.440	0.284	0.885	0.592	1.170	1.452	0.948
Commercial	1.224	0.898	0.622	1.684	1.203	2.207	2.776	2.015
Industrial	0.251	0.180	0.125	0.348	0.245	0.463	0.602	0.449
Public/Inst.	0.406	0.290	0.189	0.548	0.380	0.698	0.841	0.570
Unacc. For	0.016	0.088	0.197	0.216	0.231	0.277	0.336	0.352
TOTAL	10.600	7.814	5.515	14.681	10.569	19.161	24.223	17.991
PERCENT	11.7	7.8	4.9	11.9	8.0	12.1	12.7	9.0

TABLE 7-36
EFFECTIVENESS OF CONSERVATION FOR SWCA
MEDIUM WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1996	2000	2011	2026	2030
Int. Residential	6.339	4.612	3.167	8.385	6.002	10.439	12.979	9.690
Ext. Residential	0.306	0.207	0.130	0.394	0.260	0.468	0.551	0.356
Commercial	1.057	0.776	0.538	1.464	1.047	1.930	2.476	1.800
Industrial	0.237	0.164	0.110	0.283	0.193	0.378	0.493	0.366
Public/Inst.	0.759	0.576	0.399	1.273	0.913	1.674	2.128	1.458
Unacc. For	0.013	0.071	0.157	0.172	0.183	0.213	0.255	0.266
TOTAL	8.710	6.406	4.502	11.970	8.598	15.103	18.882	13.935
PERCENT	11.9	8.0	5.0	12.3	8.3	12.5	13.1	9.2
RESULTING DEMAND[1]	62.339		84.617		95.215	102.177		136.875

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1996	2000	2011	2026	2030
Int. Residential	9.493	6.963	4.821	12.941	9.315	16.458	20.842	15.608
Ext. Residential	0.745	0.518	0.335	1.041	0.696	1.342	1.661	1.083
Commercial	1.440	1.056	0.732	1.981	1.415	2.532	3.177	2.303
Industrial	0.296	0.212	0.147	0.409	0.288	0.531	0.689	0.513
Public/Inst.	0.478	0.341	0.223	0.645	0.447	0.801	0.962	0.651
Unacc. For	0.019	0.104	0.232	0.255	0.273	0.318	0.385	0.402
TOTAL	12.471	9.193	6.489	17.272	12.434	21.981	27.715	20.561
PERCENT	11.7	7.8	4.9	11.9	8.0	12.2	12.7	9.0
RESULTING DEMAND[1]	91.529		125.511		142.566	154.019		207.439

[1]Based on comparison with Table 7-30.

TABLE 7-37
EFFECTIVENESS OF CONSERVATION FOR SWCA
HIGH WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1996	2000	2011	2026	2030
Int. Residential	6.346	4.637	3.198	8.528	6.122	10.978	13.601	10.175
Ext. Residential	0.307	0.209	0.132	0.401	0.265	0.485	0.577	0.374
Commercial	1.058	0.780	0.544	1.489	1.068	1.998	2.596	1.889
Industrial	0.237	0.165	0.111	0.287	0.197	0.391	0.517	0.384
Public/Inst.	0.760	0.580	0.403	1.296	0.931	1.735	2.232	1.530
Unacc. For	0.013	0.071	0.159	0.175	0.187	0.220	0.267	0.279
TOTAL	8.721	6.442	4.547	12.175	8.770	15.626	19.788	14.631
PERCENT	11.9	8.0	5.0	12.3	8.3	12.5	13.1	9.2
RESULTING DEMAND[1]	62.338		85.546		97.118	105.173		143.716

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1996	2000	2011	2026	2030
Int. Residential	9.505	7.001	4.869	13.163	9.502	17.029	21.843	16.389
Ext. Residential	0.741	0.519	0.338	1.058	0.710	1.388	1.741	1.137
Commercial	1.442	1.062	0.739	2.015	1.444	2.620	3.329	2.418
Industrial	0.296	0.213	0.148	0.416	0.294	0.549	0.722	0.539
Public/Inst.	0.479	0.343	0.225	0.656	0.456	0.828	1.008	0.684
Unacc. For	0.019	0.104	0.235	0.261	0.278	0.331	0.404	0.422
TOTAL	12.481	9.243	6.555	17.569	12.683	22.746	29.047	21.589
PERCENT	11.7	7.8	4.9	11.9	8.0	12.2	12.7	9.0
RESULTING DEMAND[1]	91.419		126.765		145.416	158.534		217.811

[1]Based on comparison with Table 7-31.

In addition, the contingency measure, which restricts water use to only necessary uses in outdoor residential, commercial, industrial and public use categories during water emergencies, also reduces water use. This is illustrated in Table 7-38 for the medium population growth case. The results represent the implementation of a mandatory restricted use program coincident with the permanent conservation program during a water emergency for any of the years shown. The effect is to provide an overall reduction in average water use ranging from a high of 17 percent to a low of 8 percent over the reported years. Peak daily water use is also reduced by about the same percentages.

TABLE 7-38
EFFECTIVENESS OF CONSERVATION FOR SWCA
MEDIUM WATER USE CASE
(PERMANENT MEASURES)

EFFECTIVENESS ON AVERAGE DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2011	2020	2025
Int. Residential	6.339	4.612	3.167	2.305	6.002	10.439	5.335	4.258
Ext. Residential	1.225	1.216	1.249	1.288	1.525	1.874	1.758	1.809
Commercial	2.283	2.147	2.086	2.085	2.869	4.118	3.460	3.484
Industrial	0.838	0.813	0.817	0.800	0.933	1.288	1.211	1.303
Public/Inst.	1.673	1.657	1.686	1.826	2.626	3.694	3.120	3.088
Unacc. For	0.013	0.071	0.157	0.169	0.183	0.213	0.238	0.252
TOTAL	12.371	10.516	9.162	8.472	14.138	21.626	15.122	14.194
PERCENT	17.00	13.12	10.27	8.86	13.62	17.96	11.22	9.94
RESULTING DEMAND[1]	58.678		80.037		89.675	95.654	119.617	

EFFECTIVENESS ON PEAK DAILY FLOW (MGD)

CUSTOMER CLASS	1981	1985	1990	1995	2000	2011	2020	2025
Int. Residential	9.493	6.963	4.821	3.551	9.315	16.458	8.482	6.833
Ext. Residential	2.981	3.039	3.206	3.387	4.087	5.370	5.171	5.440
Commercial	3.112	2.922	2.835	2.823	3.879	5.401	4.514	4.472
Industrial	1.046	1.049	1.091	1.149	1.391	1.809	1.735	1.818
Public/Inst.	1.054	0.982	0.942	0.934	1.285	1.766	1.437	1.400
Unacc. For	0.019	0.104	0.232	0.250	0.273	0.318	0.357	0.380
TOTAL	17.705	15.058	13.127	12.094	20.230	31.122	21.696	20.343
PERCENT	16.58	12.76	9.94	8.50	13.05	17.22	10.67	9.44
RESULTING DEMAND[1]	86.295		118.873		134.770	144.878	181.304	

[1]Based on comparison with Table 7-30.

STEP 7: Advantageous Effects (Indirect)

The following section provides a brief overview of the effectiveness of the proposed water conservation program as it affects the future balance between available water supply and projected water demand. Then, Step 7 analysis focuses on the indirect advantageous effects of each water conservation measure to residential, multi-family, commercial, industrial and public/institutional water users. These impacts are frequently reduced costs indirectly related to water use reduction. In this example where the residential multi-family and commercial sectors are targeted (representing 88 percent of the 1981 reduction, Table 7-36), the savings that are experienced come primarily from these sectors and represent indirect energy savings (reduced hot water use) and savings in utility bills. The direct cost savings to the SCWA are addressed in Step 9: Foregone Supply Costs.

Description of Conservation Measures

Measure 1: (M1-Water-Saving Appliances) requires modification of the county code through an existing procedure. This effort is minimal, and inspection/-enforcement is a minor expansion of current County inspector responsibilities. The program is based on purchases of appliances for new construction and replacement by some existing households. The assumptions of purchases are based on the .05 coverage factor for residential dwelling units and .02 factor for commercial businesses.

In Table 7-39, the projected number of dwelling units is presented from the Federal Water Supply Study (Annex G, Non-Structured Studies). Other units are also presented based on an assumed constant ratio of growth in connections between dwelling units and the other connections from Table 7-14.

TABLE 7-39
SCWA PROJECTED DWELLING UNITS AND OTHER CONNECTIONS
(NEW UNITS ADDED DURING TIME PERIOD)

DWELLING UNITS	1980	1980-1990	1990-2000	2000-2010	2010-2020	2020-2030
SFR	150,185	53,745	36,953	34,490	39,253	42,551
MFR	77,815	30,255	24,647	22,510	32,947	24,449
TOTAL/DECADE	228,000	84,000	61,600	57,000	72,200	68,000
CUMULATIVE GROWTH BY END OF DECADE	228,000	312,000	373,600	430,600	502,800	570,800
OTHER CONNECTIONS						
COMM/IND	3,684	1,326	995	921	1,167	1,099
MUN/INST.	618	222	167	155	196	184
CUMULATIVE COMM/MUN	4,302	5,850	7,012	8,100	9,463	10,746

However, a smaller number than the total dwelling units is assumed to purchase the appliances (discussed previously in Substep 6.3). The gradual purchase of units by existing households and installation in new units is expressed by the following:

Appliances (Dwelling Units) = $(0.05)(1.05)^{n-1}$ (# of 1980 connections) - $(0.05)(1.05)^{n-2}$ (# of 1980 connections)

By 2020, the total number of units purchased for either clothes washers or dishwashers (based on Table 7-39) is:

Appliances (Dwelling Units) $= (0.05)(1.05)^{n-49}$ (# of 1980 connections), or

$= 0.546$ (# of 1980 connections)

$= 124,500$

Appliances (Comm/Ind) $= (0.02)(1.05)^{n-49}$ (# of 1980 connections), or

$= 0.218$ (# of 1980 connections)

$= 800$

Based on these assumptions, 2,500 units (clothes washers and dishwashers) are installed each year.

Measure 2: (M2-Pressure-Reducing Valves) requires the voluntary installation of pressure-reducing valves by customers. The valves are distributed free to customers who request them. These residents install them as do-it-yourself projects, similar to previous arrangements with the SCWA. The difference between this proposed approach and the previous PRV program is the intensity of promotion used to get more units installed. Only existing connections are affected by this measure. The estimated number of connections affected by this measure is 25 percent of the existing connections. These installations are undertaken over the initial twenty-year period, as a result of a continued effort by the SCWA to identify and alert customers to the benefits of making this change. The number of PRV's installed is significant at first (80 percent of the total in the first 2 years), as a result of the public education program (Measure 5) impact and the retrofit program (Measure 4). The number of PRV's installed per year is based on the residential connection (single family and townhouses) Table 7-14 for 1980.

TABLE 7-40
SCWA PRESSURE-REDUCING VALVES (CONNECTIONS)

	1980	1981	1982	1985	1990	2000	TOTAL
Installed PRV's	10,000	8,000	6,000	3,000	400	219	27,619

Measure 3: (M3-Pipeline Leak Detection) requires additional staff commitment and effort by the SCWA and existing personnel. This effort includes a contractual arrangement with a firm specializing in leak detection and repair by the SCWA "main break crew". The program results in reduced losses from the pipeline system, lower energy, treatment and facility costs for the utility and reduced economic losses in the SCWA area business community.

Measure 4: (M4-Retrofit) requires the voluntary installation in existing buildings of low-flow showerheads (3 gpm or less) and toilet displacement devices, which reduce water by 1-2 gallons per flush. The retrofit program impacts the following customers:

- o Residential
- o Commercial
- o Public

The program involves the distribution of free kits consisting of (1) showerhead, (8) displacement bags and instructions. These kits are targeted to potential users based on a preliminary mail survey. The kit program is renewed every 15 years to re-establish use of water-saving devices.

These kits (Table 7-41) are distributed to residents based on the return mail response. This response, plus a 10 percent surplus, determines the purchase requirements. Table 7-33 (Initial Coverage Values, .50 for toilet displacement devices) and the 1980 dwelling unit totals and numbers of connections for commercial and municipal/institutional determines the initial purchases. Although some over-purchase of showerheads is anticipated, the convenience of preparing one kit for distribution, as opposed to distributing two different kits is preferred, and the availability of the extra showerheads may lead to their being used. The initial kit purchase is:

TABLE 7-41
SCWA RETROFIT KITS

	TOTAL UNITS	PURCHASE KITS (+) 10%
Residential	228,000	125,400
Commercial	3,684	2,000
Municipal/Inst.	618	400
TOTAL	232,300	127,800

Table 7-42 indicates that in 1995, 2010 and 2025 additional purchases are made when the program is renewed, based on the same initial coverage value (.50) and the projected total numbers of dwelling units and other connections (Table 7-39) which are:

TABLE 7-42
RETROFIT KIT PURCHASES (SCWA)

	1980	1995	2010	2025
Total Units/Connections	232,300	349,200	438,700	547,000
Purchases (+) 10%	127,800	192,000	241,000	301,000

Measure 5: (M5-Education) The public education program involves several methods to alert the public to the need for and the advantages of water conservation. The program involves an initial program of one year duration and subsequent programs in 1995, 2010 and 2025 to renew the public's awareness of conservation and willingness to participate. The program is aimed at the total number of dwelling units and connections in Table 7-39.

Measure 6: (M6-Restrictions) The SCWA has a contingency plan ready for emergencies. The plan focuses on reducing the lowest priority water uses and is implemented as a current responsibility of the SCWA staff. Restrictions for short durations may be imposed on outside water use by residential, commercial and public/institutional users.

Conservation Effects

Figure 7-1 graphically presents the water supply and demand situation in the SCWA area. The demand curves identify the average daily flows for the medium and high growth scenarios and the effect of conservation on each. The water supply curve identifies the dependable yield of the SCWA 2-Reservoir System and the allocation to the SCWA from the 1982 River Project. The dependable yield of the 2-Reservoir System is 84 mgd. The River Project provides allocations to the SCWA according to the schedule in Table 7-43.

TABLE 7-43
SCWA FUTURE SUPPLY (MGD)
RIVER ALLOCATIONS

	2-RESERVOIR	RIVER ALLOCATIONS		TOTALS	
	DEPENDABLE YIELD	UNRESTRICTED	1988 FREEZE	UNRESTRICTED	FREEZE
1980	84	-	-	84	-
1990	84	32	31	116	115
2000	84	38	31	122	115
2010	84	43	31	127	115
2020	84	50	31	134	115
2030	84	57	31	141	115

Source: Federal Water Supply Study (Supply and Demand Speciality Annex), Table 6-2, based on 1/100 year recurrence, 30-day supply, August.

The dependable yield of the 2-Reservoir System is the only really dependable yield since the River Project cannot satisfy all water demands of the four participating water users during a recurrence of the drought of record.

As a result, an agreement was developed to equitably allocate the available sources during low-flow periods in the river. Therefore, the allocations presented in Table 7-43 reflect a low-flow share of the river supply to which the SCWA is entitled under future drought conditions. The agreement also provides an option for any signatory party to "freeze" the formula used for determining future allocations at the 1988 allocation, if a new negotiated agreement is desired. This situation could occur if growth in water demand varies significantly in any of the four areas.

Figure 7-1 indicates that the current 84 mgd dependable yield is sufficient without conservation, given the medium growth projection (curve 1), until about 1987. Briefly, the SCWA area shows a water deficit until 1990 when the unrestricted additional river water supply allocations begin at 32 mgd. Subsequently, in the year 2000 and 2010, additional water is available and the

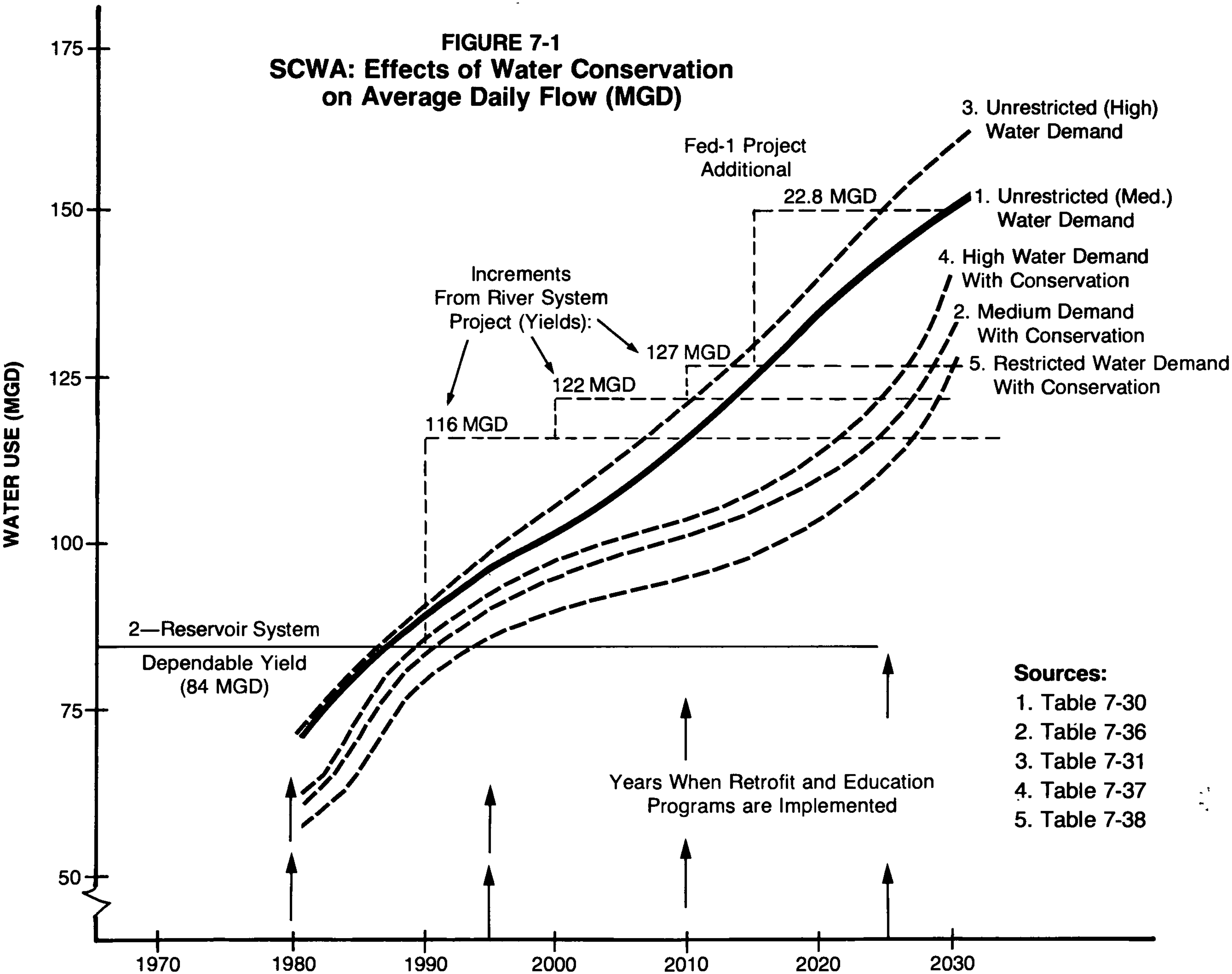


FIGURE 7-1
SCWA: Effects of Water Conservation on Average Daily Flow (MGD)

Unrestricted Water Demand (curve 1) is satisfied. By 2020, however, the unrestricted demand exceeds the supply of 127 mgd, and the deficit becomes more apparent.

The FED-1 project is introduced in the year 2015 with an additional 22.8 mgd water supply to carry the SCWA area through the year 2030.

Figure 7-1 indicates the significant impact that water conservation offers to the SCWA area. Curve 2 (Medium Demand with Conservation) immediately reduces the water consumption of the Unrestricted Water Demand, and the allocations from the River Project with the base (84 mgd) dependable yield are sufficient, without the FED-1 project throughout the study period.

The Medium Demand with Conservation (curve 2) fluctuates (as well as the other curves with conservation) considerably over the 50-year period. These variations are the result of the renewed retrofit (M4) and education (M5) water conservation proposals, which are indicated in the Figure by the arrows identifying when the retrofit/education cycles are initiated.

The Restricted Demand (curve 5) fluctuates, also. It is important to note that the cycles of the retrofit/education programs tend to reduce the impact of the restrictions if restrictions are implemented to meet an emergency water supply problem in a year that follows shortly after a renewal program.

Figure 7-2 presents the peak daily water demand situation in the SCWA area. The Figure indicates that the System's 2-Reservoir Treatment Plant capacity is 112 mgd (maximum one day). In 1982, the River System's additional 50 mgd capacity (under construction) comes on-line, and the combined capacity (162 mgd) meets the System's requirements for intake and treatment to the year 2004.

The River System was designed to be expanded in the future to 200 mgd. This expansion is implemented in 2004, and the additional capacity is sufficient until the year 2020 when an additional 30 mgd capacity is added to meet the study area requirements of 228 mgd.

Water conservation effects are also indicated in Figure 7-2. The Unrestricted Water Demand (medium growth, curve 1) can be reduced. Medium Demand with Conservation (curve 2) shows the significant reduction possible. It also shows that conservation definitely can benefit the SCWA by delaying the planned expansion to 200 mgd. Conservation also eliminates the future 30 mgd expansion in 2020.

In both the peak daily (Figure 7-2) and average daily (Figure 1) projections, high growth scenarios are presented to indicate the possible effect of additional population and economic growth. These scenarios, however, were constrained (Step 6), and the effect is minimal.

Level 4: Advantageous Effects

In addition to the reduction in water demand, which results from implementation of water-saving measures, other indirect advantageous effects are also produced for each measure considered. Table 7-44 summarizes these benefits for each measure.

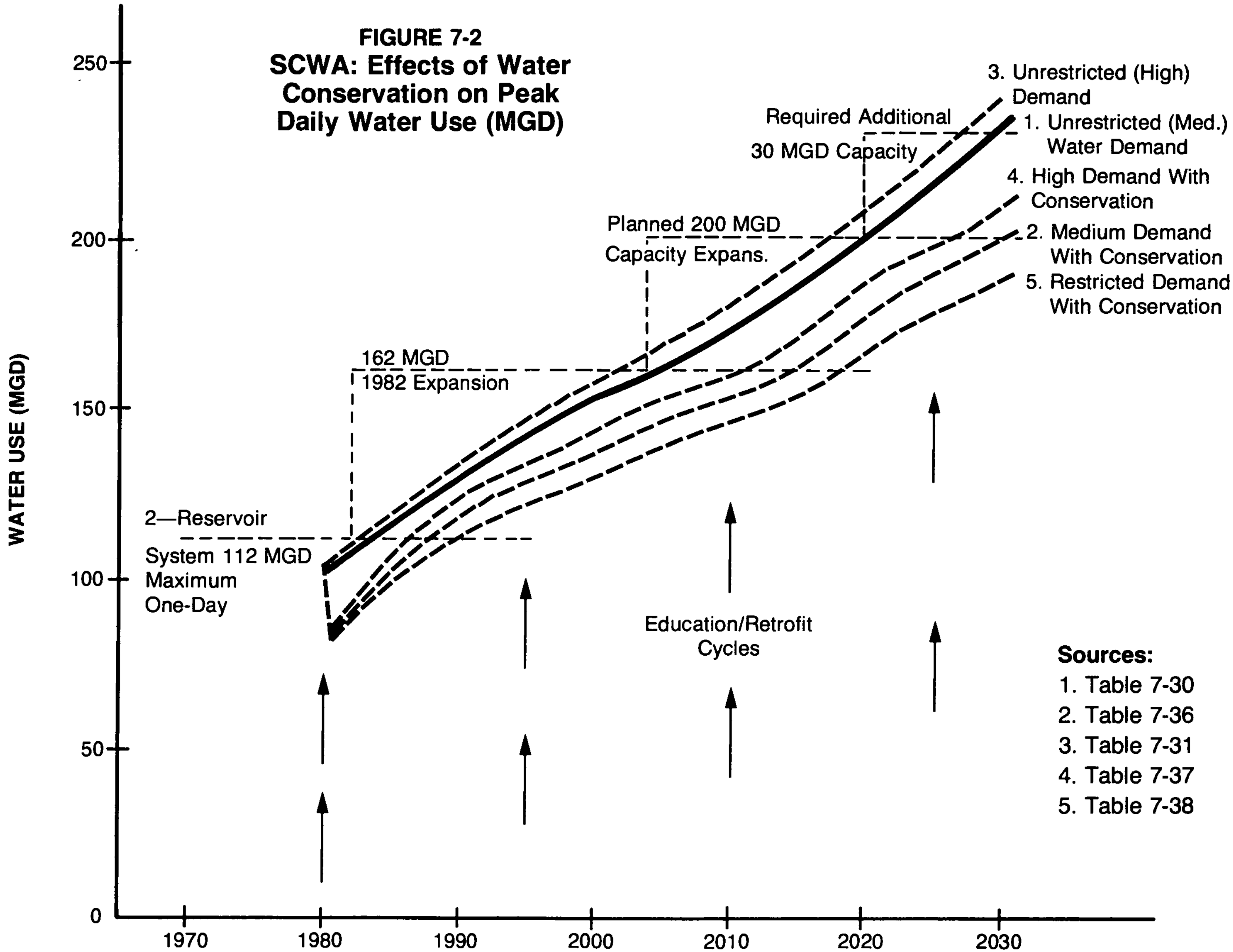


FIGURE 7-2
SCWA: Effects of Water Conservation on Peak Daily Water Use (MGD)

TABLE 7-44
SCWA ADVANTAGEOUS EFFECTS (INDIRECT)
PRESENT VALUE (1980 $)

	MEASURE 1 Appliances	MEASURE 2 PRV	MEASURE 3 Leak Det.	MEASURE 4 Retrofit	MEASURE 5 Education	MEASURE 6 Restrictions
ENERGY SAVINGS						
SFR (and equiv.)	749,000	-	-	29,815,000	-	-
UTILITY BILLS						
SFR (and equiv.	34,000	295,000	0	1,922,000	854,000	-
Comm/Ind						
Red. Repairs/ Appliance Costs	-	Minimal	-	-	-	-
REDUCED ECO. LOSS	-	-	1,590,000	-	-	-
TOTAL	783,000	295,000	1,590,000	31,737,000	854,000	-

Energy Savings: Residential energy use is affected by Measure 1 (Water-saving Appliances), and combined Measure 4 (Retrofits) and Measure 5 (Education).

Measure 1: The water-saving appliances significantly reduce water use as opposed to standard appliances (dishwashwers - 28 percent and clothes washers - 10 percent reductions). The majority of this saving is hot water, which is the most significant (73 percent) water use saving reported in Table 7-36.

The approach used here is to first estimate the water saved by these appliances, second to estimate the energy that is saved and aggregate this by year (a method similar to that used in the Level 3 example to determine the energy savings from industrial water recycling and reuse).

Various reports estimate that the proposed water saving appliances can each save between 0 -5 percent of total interior water use. (20) Based on reductions expected from the proposed appliance and tests conducted by SCWA personnel, the combined effect of these devices is assumed to be 5 percent of interior water use for the residential sector.

The energy saved is based on an assumed 140° F temperature of water used in these appliances and an initial water temperature of 55° F (an 85° F temperature saving for each gallon of water saved). This is equivalent to:

- 705 Btu/gallon of water.
- 705 x 10^6 Btu/mg.
- For 1981, (705 x 10^6 Btu/mg) * (1.988 mgd) * 365 days/year) = 51.15 x 10^8 Btu/yr.
- For 1981 Energy Saving (1980 $), (51.15 x 10^8 Btu/yr) * ($10.00/mBtu) = $51,200/year (assuming use of electricity for heating hot water).

($10.00/mBtu electricity energy price was obtained and adjusted from the report Pennsylvania Least-Cost Energy Project, prepared by Applied Energy Services, Inc. Subcontractor to the Mellon Institute, Carnegie-Mellon University, 1979).

Table 7-45 summarizes these annual energy savings from Measure 1. The present value of these annual savings is $749,000, based on a Federal discount rate of 8-3/8 percent.

TABLE 7-45
SCWA APPLIANCE ENERGY SAVING (ANNUAL)
(1980 $)

	1981	1990	2000	2010	2020	2030
WATER SAVINGS (MGD)	1.988	2.455	2.819	3.143	3.567	3.931
ENERGY SAVINGS ($)	51,200	63,200	72,500	80,900	91,800	101,200

Measure 4: Retrofitting low-flow showerheads into existing housing also impacts household energy use. Tables 7-41 and 7-42 estimated the total number of households that receive the water-saving kits based on a .50 coverage factor for toilet displacement devices. Showerheads (with a coverage factor of .40) are installed in 91,200 dwelling units (228,000 * .40) based on the number of units in 1980 (Table 7-39 and interpolation). In 1995, another 137,000 showerheads are installed; in 2010, 172,200 units are installed and in 2025, 214,700 more units are installed. Table 7-46 indicates these installations and the die-off (removal and failure of the devices for the subsequent 14 years) of these devices.

TABLE 7-46
SCWA SHOWERHEAD INSTALLATION AND DIE-OFF

	1980	1994	1995	2009	2010	2024	2025	2030
Inst. & in place	91,200	8, 300	137,000	12,500	172,200	15,700	214,700	56,300
Annual Energy Savings ($ 000)	3,100	282	4,658	425	5,855	534	7,299	1,914

In Table 7-47, the die-off is calculated for the final year of each cycle based on the initial coverage factor and a 0.9 annual ratio of change (see discussion for Tables 7-33 and 7-34).

TABLE 7-47
PERCENTAGE OF SCWC CUSTOMERS USING RETROFITS,
TOILET DISPLACEMENT AND LOW-FLOW SHOWERHEADS

	1980	1981	1994	1995	2009	2010	2024	2025	2030
Toilet Displ.	.500	.500	.114	.500	.114	.500	.114	.500	.328
Low-Flow Showerhd.	.400	.400	.091	.400	.091	.400	.091	.400	.262

The annual energy savings are based on an assumed $34.00/year savings used previously and explained in examples 1 and 3. This $34.00/year savings (1980 $) is for electrically-heated hot water, the predominant energy used in the area for hot water heating. The residual effect of low-flow showerheads past the 15-year cycle is ignored in this calculation and, therefore, these estimates are conservatively low. The present value of these savings is $29,815,000. From Table 7-47, it is clear that the cyclical program of installation and promotion of low-flow showerheads can significantly increase the future benefits of residential water conservation.

Reduced Water Bills: Water conservation by residential, commercial and other users reduces the quantity of water on which annual charges are based. In this example, as with the previous examples, annual water savings multiplied by average water charges indicates the annual savings in water bills. The operating revenues of the SCWA provide the basis for calculating these indirect benefits of water conservation in conjunction with the average day water savings for each sector (Table 7-36).

Again, these benefits are assumed to be short-lived. Although the SCWA also experiences operating cost savings, it is assumed tht the water rates eventually are increased (in two years) to restore lost revenues, and at that time, the savings are lost.

Table 7-48 identifies the revenues from water sales from 1979 to 1983 by type of sale:

TABLE 7-48
TOTAL REVENUES FROM WATER SALES
(MILLION DOLLARS)

TYPE	1979	1980	1981	1982	1983
Retail	11.727	13.494	12.508	13.498	15.030
Wholesale	3.683	4.269	4.082	4.938	5.632
Connection	8.069	8.124	6.529	4.961	8.061
Other	2.398	2.761	3.202	2.922	3.490

Retail sales are produced by the "residents" who are impacted by the water conservation measures. The 1980 revenue is $13.494 million. From Table 7-30, the estimated water sales for 1980 are 64.540 mgd (71.049 - 6.509 unaccounted-for water). The average cost per 1,000 gallons is $0.57. When this average cost is multiplied by the water savings for 1981 and interpolated saving for 1982 (adjusted for savings in unaccounted-for water) from Table 7-36, estimates of annual (* 365 days per year) savings are produced.

TABLE 7-49
ANNUAL SAVINGS ($ MILLION/YEAR)

	WATER BILL SAVINGS	WASTEWATER
1981	$1.809	None
1982	1.686	None

The present value of the savings from Table 7-49 is $3,105,000. These savings are generated by each water conservation measure based on the share of water savings each produces in 1981 and 1982. Table 7-50 presents the percent effectiveness of each permanent water conservation measure over the planning period, and the resulting shares are: Measure 1: $34,000; Measure 2: $295,000; Measure 3: $0;
Measure 4: $1,922,000; Measure 5: $854,000.

TABLE 7-50
LEVEL 4 SCWA
PERCENT EFFECTIVENESS WATER USE REDUCTION BY MEASURE

	MEASURE 1 Appliances	MEASURE 2 PRV	MEASURE 3 Leak Det.	MEASURE 4 Retrofit	MEASURE 5 Education
1981	1.1	9.5	0.1	61.9	27.4
1985	1.9	14.2	1.1	61.9	20.9
2000	3.4	12.1	1.9	64.2	18.4
2020	12.8	17.5	2.5	58.4	8.9
2030	12.4	10.8	1.7	58.5	16.5

Reduced Economic Loss: The SCWA could have used a questionnaire and follow-up telephone surveys to obtain realistic information on the benefits of reduced interruption resulting from water main breaks and the benefits of a targeted pipeline leak detection (Measure 3) program. Two typical business areas that experienced main breaks might be studied. The businesses would be identified that potentially experienced reduced sales and other forms of economic loss and then survey forms would be sent to those businesses, including:

- o Retail firms
- o Services industry
- o Wholesale firms
- o Banks
- o Parking lots
- o Restaurants
- o Movie theaters
- o Other

The survey would ask for information on business loss and damages. The business losses would probably range greatly but could be quantified. A check would be made of these data by cross checking with retail sales tax receipts, parking lot use, movie theater receipts and other customer or sales revenue-related sources. Damages would probably come from merchandise stored in basements that might be flooded, electrical and telephone cable damages, etc. These damages could be verified by contacting the relevant utilities that serviced the area and by cross checking with insurance claims.

Because no real data are available, the method used to estimate the loss was based on estimated gross daily revenues in the area and assuming a loss of 10 percent.

Commercial business in high traffic business areas frequently gross in excess of $1 million per year. The two study areas each have 10 businesses that are directly affected with business losses of $2,700 combined and assumed damages to yield a total loss of $5,000. By preventing 25 situations per year like this, the annual benefit is $125,000. The present value of these benefits is $1,590,000.

Wastewater Bills: The Director of the Office of Waste Management was interviewed during this study to determine the effect of water conservation on the SCWA region's wastewater treatment facilities.

Subsequent to the interview meeting, a letter was sent to the Director's attention regarding potential advantages and disadvantages of water conservation to the wastewater system, particularly in regard to smaller flows and the potential for facility size reduction and related cost savings. He was asked to provide the following:

- o "Description of the current County wastewater systems that can be affected, including service areas, size, number and type of connections; current budget (revenue and costs); and use of system by other than County Water Authority service area."

- o "Description of future wastewater system expansion plans, including service areas (size, number and type of connections); construction schedules, proposed capital improvements plan (including capital and O&M costs with debt service); and use of the improvements by users outside of County Water Authority jurisdiction."

- o "Description of the I&I problems of these systems. Will water conservation of 10-15 percent, for example, produce wastewater flow changes that could be significant and provide an opportunity for modification of projects and reduction of capital and O&M costs? How much flow reduction would be needed from water conservation in order to affect the wastewater investment plan?"

- o "Discussion of any issues that you believe water conservation would impose on the current and future wastewater system, for example, any flow problems? Any revenue or cost problems? other issues?"

The SCWA area wastewater treatment capacity is 100 mgd currently through "own service" (42.65 mgd) and "treatment by contract" (57.386 mgd), and the system is subject to significant I&I problems (in fact, a branch within the County Wastewater Authority was established prior to 1976 to reduce I&I with a budget of at least $.5 million and has had a budget of $1 million, since 1981).

The following response was received from the Director of the Office of Waste Management:

"Regarding your question of cost savings at wastewater treatment facilities versus reductions in water consumption, we believe some savings could be realized but they would be a small part of the total costs since:

- Infiltration/Inflow add to the volume of flow to be treated and cannot be reduced through consumption reductions;

- relatively speaking, the volume of flow would have to be drastically reduced (greater than 10-15 percent) to realize significant cost reductions in treatment since most costs are independent of flow;

- reduction of water consumption at the source will not reduce the loading of pollutants to be treated at the plants; the flow will be more concentrated with pollutants."

Since the water reductions projected from conservation for the SCWA area are variable over the study period, with a low of 5.0 percent and a high of 13.1 percent, no beneficial impact was identified for reduction in near-term operating costs for the wastewater authority or its customers. (Later, however, in Step 9, the needed future expansion of the wastewater system from its current 100 mgd capacity produces foregone supply cost advantages.)

With the exception of the pressure-reducing valves, the other measures produce only direct benefits to the utility. Measure 2, however, reduces water pressure to residential, commercial, and industrial services. This reduction produces water savings and reduced water bills. It also reduces repair costs for appliances and extends their useful life. No estimate is made, however, for these benefits, but they are expected to be small.

STEP 8: Disadvantageous Effects (Indirect)

Implementation costs are the primary disadvantageous effect of the proposed program of water conservation measures. Table 7-51 summarizes the cost effect of each measure.

TABLE 7-51
DISADVANTAGEOUS EFFECTS (INDIRECT)
PRESENT VALUE (1980 $)

	MEASURE 1 Appliances	MEASURE 2 PRV	MEASURE 3 Leak Det.	MEASURE 4 Retrofit	MEASURE 5 Education	MEASURE 6 Restrictions
MATERIAL COST						
Kits	-	-	-	-	-	-
Fixtures/ Equip.*	$478,500	494,400	-	1,934,000	-	-
Pamphlets	-	104,000	-	-	2,488,000[2]	-
Supplies	3,000	-	165,400	-	178,000[3]	
Postage	2,000	16,600	-	331,700[1]	-	-
Other	-	-	-	-	-	-
SERVICE PURCHASES						
Media, (TV, Radio)	-	-	-	71,000	227,000	-
Newspapers	-	4,100	-	35,000	-	-
Rentals	-	2,800	-	8,000	-	-
Consultant	-	-	159,000	-	-	-
LABOR						
SCWA	-	58,200	-	-	125,000	-
Speakers	-	-	-	-	-	-
Summer Help	-	-	-	65,900	-	-
CONT. (10%)*	0	62,000	32,000	245,000	302,000	-
TOTAL COST	$483,500	$742,100	$356,400	$2,690,600	$3,320,000	-

*Note: SCWA costs only are included in the contingency.
[1]Mailer Package
[2]Promotional Material
[3]School Material

Substep 8.1: Implementation Costs

Measure 1: (Water-Saving Appliances). In Steps 5 and 7, the general aspects of Measure 1, as well as the other measures are described. Key elements of the program include:

- o Formulate modification to County Plumbing Code.
- o Provide for minor additional inspection enforcement.

These efforts are minimal and are assumed to be added to the current SCWA staff responsibilities, including inspection and enforcement. Presumably, an additional line is added to the inspection check-off sheet to verify that low water-using appliances have been installed.

The additional cost of the program is related to small differential cost of the units used instead of standard appliances.

TABLE 7-52
DIFFERENTIAL COSTS OVER STANDARD (1980 $)

	FIXTURE	O & M	SOURCE
Dishwasher	$ 0	$ 0	(20) (38)
Clothes Washer	$ 15-30	$ 0	(20) (38)

Dishwashers, either standard or water-saving, range in cost from $175-350. There is no cost disadvantage of buying the water-saving unit. Prices of water-saving clothes washers, however, range from $15-30 more than a standard unit. Fifteen dollars was assumed as the incremental price of water-saving clothes washers, since the 42 gallon size specified for use in the SCWA area is near the low end of the range from 27-54 gallons.

Based on the estimated $15 cost differential and on the estimated 2,500 clothes washers (Step 7) that are purchased annually over the study period, the annual costs of the measure to homeowners is $37,500. The present value of these future costs is $478,500. Minor notification costs (postage and supplies) are also anticipated in the initial year at about $5,000 (to alert builders of the change to the code).

Measure 2: (Pressure-Reducing Valves). Table 7-40 projected the continuing effort to put more pressure-reducing valves in place. PRV's for 1/2 and 3/4 inch services are routinely purchased by the SCWA at $20.00 each.

This measure involves voluntary installation by the homeowner (as is the current practice), however, with a program that encourages this installation.

The SCWA has detailed records of areas where line pressure exceeds the requires maximum 80 psi level. The Authority develops a pamphlet on the "advantages of installing a PRV" and, in general terms, "how the PRV is installed". This pamphlet is enclosed with a regular water bill to the targeted customers. At the same time, newspaper advertisements and "news items" are distributed to local newspapers to assist in alerting customers to the benefit of PRV installation.

Those customers who notify the SCWA of their interest and willingness to install PRV's are provided one "free of charge" with the necessary installation instructions.

The program is ambitious for the first three years, then tapers off and finally ends by the year 2000. During the initial three years, assuming 250 workdays a year, the SCWA must promote with pamphlets and distribute an average of 40 units a day in 1980, 32 units a day in 1981, and 24 units a day in 1982. Pamphlets are assumed to be distributed to 30,000 connections in each of the first three years. As a result, a full-time stockroom clerk/driver is hired for the initial period, and in the following years, the effort is continued by other SCWA staff.

Table 7-53 itemizes the purchases needed for Measure 2 (note: many of the purchases are distributed over the planning period) and identifies the present value of each cost.

TABLE 7-53
PRESSURE-REDUCING VALVES PURCHASES/PROMOTION/DELIVERY
PRESENT VALUE (1980 $)

ITEM	UNIT PRICE $	QUANTITY	COST PRESENT VALUE
PRV Purchases (various years)	$ 20.00	27,600	$494,400
Pamphlets (4pp/30,000/Yr.)	1.25	90,000	104,000
Postage (30,000/Yr.)	.20	90,000	16,600
Newspapers (advertisements)	1,500.00/Yr.	3 Yrs.	4,100
Rentals (trailer for storage)	1,500.00/Yr.	2 Yrs.	2,800
SCWA Personnel			58,200
Contingency (10%)			62,000
TOTAL COST			$742,100

The total cost (present value) of this measure to have pressure-reducing valves installed in areas where line pressure exceeds 80 psi is $742,100, including 10 percent contingency on SCWA-incurred costs.

Measure 3: (Pipeline Leak Detection). The costs of leak detection and repair varies widely from system to system. Costs involve equipment, including detection options such as pressure test gauges, acoustical equipment and computer-assisted devices which range significantly in price. Replacement of leaky parts, and road surface materials are other major cost items, and then, finally, personnel. In the SCWA area, the system has 145-215 main breaks per year, and the personnel currently on staff are capable of excavating and repairing damaged water mains and lines.

The program proposed here is modest in its expectations. Current system leakage is 9-10 percent, and the Measure 3 program has a goal of establishing a maximum leakage of 9 percent. No additional personnel are added to the road crew responsible for repairing main breaks, however, additional capability is brought in to assist them in locating leaks.

The SCWA has detected that main breaks are not distributed evenly over the year. As a result, there is a 2-3 month period when the road crew is "available". The SCWA also decided it did not want to purchase equipment and train personnel to undertake the leak detection responsibility. Equipment, for example, acoustical detection devices used in the Level 1 example, range from $500 - $2,600. (86)(88) Computerized, highly-sophisticated mobile equipment, including a van, costs between $25,000 and $45,000. (86)

The SCWA, therefore, decided to hire a consulting firm on an annual basis to locate leaks that had not previously been identified. The consultant (a 2-man crew with computerized leak detection equipment) is brought in during the slack period for two weeks each year. The charge for the crew ($8,000) and the use of the vehicle and equipment ($5,000) totals $13,000 per year. This approach locates about 25 leaks each year which would eventually become major main breaks. The SCWA methodically uses the crew in high breakage areas and in areas where disruption from breaks is costly to the utility and merchants. This method permits a more deliberate and appropriately timed approach to each repair.

Since the additional leakage repairs can be accommodated by the slack in the "main break crew", no additional labor costs are incurred. Materials are estimated at $500 per leak ($12,500 per year), and the total annual cost is $25,500. The present value of the costs to implement Measure 3 are $356,400, including 10 percent contingency.

Measure 4: (Retrofit). The SCWA has a limited experience with retrofit programs. Surrounding water systems have used low-flow showerheads, flow restrictors, toilet displacement devices and dye tablets (leak detection in toilets), as methods to extend the use of their overloaded wastewater treatment facilities, but the SCWA has not had these experiences. The program proposed here involves:

- Kit with (1) showerhead and (8) toilet displacement bags, available free to SCWA customers.
- Mailer to target kit distribution to interested customers.
- Promotional advertising and instructional material.
- Initial effort in 1980 with renewal programs in 1995, 2010 and 2025.

The retrofit devices are available free to SCWA customers following response by customers to fill out a mailer enclosed with a regular water bill. The response from the mailer is expected to produce requests for 127,800 kits (including 10 percent surplus) as indicated previously in Table 7-42.

For this program, kits containing low-flow showerheads and toilet displacement devices are assembled by the SCWA personnel. The low-flow showerhead selected for this program was also used for the ECWD and WCWSU retrofit programs (Levels 2 and 3, respectively). The cost of this device is $7.00 based on local telephone survey results. The displacement bags (8 1qt. bags) are available to permit adjustment of flush volume and for more than one toilet. These displacement devices cost $.50 for eight bags, (information also obtained in the telephone survey). The kit also contains promotional material describing the benefits of installing these restrofit devices, as well as instructions for installation. The kit is packaged by the SCWA personnel in a plastic bag suitable for hanging on doorknobs. The total cost of this kit is $9.00. The costs of this program (1980 $) for the initial and renewal efforts are presented in Table 7-54: $1,150,000 (1980), $1,728,000 (1995), $2,169,000 (2010) and $2,709,000 (2025). The present value of these costs is $1,934,000.

TABLE 7-54
SCWA RETROFIT KIT MATERIALS

	PRICE/UNIT	QUANTITY	COST (1980 $)
Low-Flow Showerhead	$7.00		
Displacement (Toilet Bags)	.50		
Literature/Package	1.50		
Kit	$9.00	127,800 (1980)	1,150,000
		192,000 (1995)	1,728,000
		241,000 (2010)	2,169,000
		301,000 (2025)	2,709,000
		PRESENT VALUE TOTAL (@ 8-3/8% Federal Discount Rate)	$1,934,000

The program also includes a promotional effort and mailer to identify customers who would install the free devices. This material is distributed with a regular water bill to all SCWA customers (dwelling units and connections, Table 7-42).

This promotional campaign (Table 7-55) is repeated in the future years, also.

TABLE 7-55
MAILER PACKAGE (1980 $)

	PRICE/UNIT	QUANTITY	COST (1980 $)
Mailer (type set and postage)	$0.35		
Pamphlet	0.50		
Total	$0.85	232,300 (1980)	$ 197,000
		349,200 (1995)	297,000
		438,700 (2010)	373,000
		547,000 (2025)	465,000
		PRESENT VALUE TOTAL (@ 8-3/8%)	$ 331,700

In addition, for 1980 and the future years when the retrofit program is renewed, the program budget provides for media exposure, including TV "spots", radio announcements and newspaper ads for one year in each case.

TABLE 7-56
MEDIA AND OTHER COSTS

	1980 COSTS	PRESENT VALUE (1980 $)
TV and Radio	$ 50,000	$ 71,000
Newspapers	25,000	35,000
Rental	6,000	8,000
Summer Help	10,400/man year	65,900

Also, the program requires rented storage space for the 2,500-6,000 kits distributed each week (Table 7-41) and "summer help", or unskilled personnel to package the kits and assist in the distribution program. The rental is assumed to be 2 trailers at $500 per month or $6,000 per year (present value $8,000). The summer help personnel requirement is for 4 people in 1980, 5 people in 1995, 7 people in 2010 and 8 people in 2025. The hourly wage is $5.00 or $10,400 per year per person. The annual costs start at $41,600 and increase to $83,200 during the last renewal effort. The present value of these personnel requirements is $65,900.

The total cost (present value) of Measure 4 is $2,690,600, including a 10 percent contingency.

Measure 5: (Education). In the same manner that Measure 4 provides an initial one-year effort to implement a retrofit program (renewed once every 15 years), Measure 5 (education) is implemented in the same way. The purpose of the education program is to encourage the installation of as many water conservation devices as possible preceding and following the distribution of the kits.

Discussion in the previous Level 1 example (Step 8) described sources of information for structuring an education program for short-term and long-term effect. The program planned here is one year in duration and involves the efforts of existing SCWA personnel. The program is supplemented by additional clerical staff and stock personnel. Costs of materials assumed for the WMWD example, Level 1 were verified in the local market.

The program has three key elements:

1. Promotional Materials Program
2. Media Efforts
3. School Programs

Information about retrofit devices, and newsletters citing the benefits of their use are prepared and distributed to the SCWA customers. In addition, bumper stickers are used on government vehicles, and bus posters are prepared and displayed. The promotional materials needed include:

TABLE 7-57
PROMOTIONAL MATERIALS PROGRAM (1 YEAR)
COSTS (1980 $)

MATERIALS DESIGN/PRINTING	QUANTITY	COST
Pamphlets (4-6pp/2x/yr/$1.25 ea.)	465,000	$ 581,000
Newsletters (4/yr/$0.50 ea.)	930,000	465,000
Bumper Stickers (city vehicles/$1.00 ea.)	5,000	5,000
Bus Posters ($2.00 ea.)	4,000	8,000
Postage		420,000
TOTAL		$1,479,000

The 1980 promotional materials cost $1,479,000. In 1995 and in future years the costs increased by the ratio of (future customers)/(1980 customers) (Table 7-41). Therefore, the 1995 cost is 349,200/232,000) = 1.50 * $1,479,000 = $2,226,000; 2010 (ratio 1.88) cost is $2,793,000; and, for 2025 (ratio 2.35) cost is $3,484,000. The present value of these materials is $2,488,000.

Media, including radio, TV and newspapers are used to promote the retrofit program directly (Measure 4). Although this measure is designed to assist the retrofit program, it is focused more broadly to promote the efficient use of water.

TABLE 7-58
MEDIA EFFORTS (1 YEAR)
COSTS (1980 $

	COST $
Newspaper Advertising (free, if possible	$ 10,000
Radio, TV Spots (free, if possible)	150,000
TOTAL	$160,000

The SCWA staff prepares news briefing material, develops a SCWA logo for water conservation and generally promotes the benefits of energy conservation from energy savings and other beneficial impacts.

The costs of the media effort are estimated at $160,000 for each effort 1980 as well as the future years. The present value of these costs is $227,000.

The school program (Table 7-59) represents an opportunity for long-term change in user habits, the program used in Level 1 provides the model for the SCWA area. Current SCWA County public school population is available by grade for 1980 and is projected to 1988 in local reports. These data provide the basis for estimating the quantities of school materials needed.

TABLE 7-59
SCHOOL PROGRAMS (1 YEAR)
COSTS (1980 $)

*(1980 Students)

	QUANTITY	COST
LOWER ELEMENTARY: K-3 (31,000 Students)		
Water Play Workbook ($1.00 ea.)	31,000	$ 31,000
Water Play Teacher's Guide ($3.00 ea.)	1,000	3,000
UPPER SECONDARY: 4-6 (29,000 Students)		
Captain Hydro-Type-Workbook ($1.00 ea.)	29,000	29,000
Captain Hydro-Type Guide ($3.00 ea.)	1,000	3,000
SECONDARY: JR.-SR. HIGH SCHOOL (63,000 Students)		
Water Conservation in the Community ($1.00 ea.)	63,000	63,000
TOTAL		$129,000

The school enrollment data indicate an historic decline in school population that is projected to continue. By 1990, an additional decline of 5 percent is expected. The trend will probably continue through the year 1995 with an additional decrease of 2.5 percent. This level of student population is then assumed to hold throughout the remaining study period. Therefore, the school program costs are estimated to be $129,000 in 1980 and $119,000 for 1995 and for each of the future program renewal years. The present value of these costs is $178,000.

The SCWA requires additional staff to implement this program (Table 7-60). Clerical helpers are needed to handle the promotional material, and manage equipment to address envelopes, and stock people are needed to manage the thousands of workbooks and materials to be distributed. School materials have to be distributed during the summer for the start of school in September. The use of some summer help keeps program costs down.

TABLE 7-60
ADDITIONAL STAFF REQUIREMENTS (1 YEAR)
COSTS (1980 $)

	UNIT COST	QUANTITY	COST
Clerical	$18,000/Yr	2	$36,000
Stock Handlers/	16,000/Yr	2	32,000
Summer Help	$5.00/hr/8wks	4	6,400
TOTAL			$74,400

This staffing is appropriate for 1980. The program is increased in future years by the ratios of current to future customers (used previously): 1995 (1.5), $111,600; 2010 (1.88), $139,800; and 2025 (2.35), $174,800.

The program is managed by the existing staff. Priorities concerning other programs are shifted to accommodate the implementation of the education program. The present value of the staff requirements for 1980 and the future renewal projects is $125,000.

The present value of the Measure 5 program is $3,320,000, including a 10 percent contingency.

Measure 6: (Contingency Plan/Restrictions). Existing SCWA staff assignments are assumed to change from normal to emergency activities during a period of water shortage. This is an expected role for these personnel, and no additional costs are incurred.

Substep 8.2: Other Disadvantageous Effects

Measure 1: Water-Saving Appliances
No other disadvantageous effects are anticipated.

Measure 2: Pressure-Reducing Valves
No other disadvantageous effects are anticipated.

Measure 3: Pipeline Leak Detection
No other disadvantageous effects are anticipated.

Measure 4: Retrofit (Showerheads and Toilet Displacement Devices)
No other disadvantageous effects are anticipated.

Measure 5: Education
No other disadvantageous effects are anticipated.

Measure 6: (Contingency Plan/Restrictions)
No other disadvantageous effects are anticipated.

STEP 9: Foregone Supply Costs

Advantageous effects associated with future operations of water supply and wastewater facilities at the local level, and water supply systems at the Federal level are affected by the proposed water conservation measures. Advantageous effects consist mostly of foregone costs of supplying water and wastewater services. Other effects may be external costs or opportunity costs that are reduced as well. The following analysis evaluates future plans at the local and Federal levels and identifies and quantifies the cost reductions that are associated with the water conservation program for the SCWA area. This section has five Substeps:

Substep 9.1 Local Water Supply and Wastewater Plans
Substep 9.2 Federal Water Supply Plans
Substep 9.3 Non-Federal (Regional) Plans
Substep 9.4 External Opportunity Costs
Substep 9.5 Summary Foregone Supply Costs

Previously, in Figures 7-1 and 7-2, the water supply needs of the SCWA area were graphically presented. The effect of the proposed water conservation program is to shift the timing (delay) of the necessary investments and other costs and to reduce the quantitites of energy and chemicals needed for the smaller quantity of water (vs. baseline conditions) supplied. The differential (reduced) present value of projects that are delayed is one estimate of benefit of water conservation. In some cases, as with this example, projects can be avoided altogether, and the water conservation program can affect cost reductions (avoidance) and prevent project-related environmental impacts.

The specific participation of each water conservation measure varies over the study period. In Chapter 3, the residual effects and die-off of measures are discussed. Table 7-50 presented, for selected years, the percent effectiveness of each measure over the study period. Figures 7-1 and 7-2 graphically display the combined varied effect of these measures. Table 7-50 is a key tool in allocating the cost savings to each measure.

Substep 9.1: Local Water Supply and Wastewater Plans
Incremental Supply Costs

Water Supply: Water supply system operating costs are reduced by the SCWA water conservation program (less water is treated and pumped to customers). Table 7-61 presents detailed operating costs of the SCWA for 1981 and 1982 and aggregate operating costs for 1977 to 1982.

TABLE 7-61
SCWA WATER SYSTEM OPERATION AND MAINTENANCE EXPENDITURES
CURRENT DOLLARS ($000)

EXPENSES	1982	1981	1980	1979	1978	1977
2-Reservoir Supply & Treatment	3,097	3,471				
River System Supply & Treatment	1,407	24				
Well Supply & Treatment	84	67				
Purchased Water Facilities	356	643				
Transmission Facilities	554	602				
Distribution Facilities	831	843				
General Plan Facilites	545	873				
Customer Accounts	1,636	1,574				
Administration & General	1,509	1,542				
TOTAL O&M	10,023	9,643	9,676	7,305	6,998	6,621

The operation and maintenance costs for the period 1977 to 1982 have increased at an average rate of 10 percent per year, however, since 1980, the increase has been only 3.5 percent. The 1981 and 1982 data are the relevant data for this analysis, since the River System Supply and Treatment System became functional in 1981. Again, the objective is to identify the variable costs associated with water supply production and to deflate to 1980 dollars.

The obvious changes in the 2-Reservoir, and the River System supply and treatment costs indicate their variable nature. These 1982 expenses adjusted to 1980 $ are presented in Table 7-62.

TABLE 7-62
SCWA VARIABLE COSTS

	ADJUSTED 1980 COST ($000)
o 2-Reservoir Supply & Treatment	$2,989
o River System Supply & Treatment	1,358
o Well Supply & Treatment	81
o Purchased Water Facilities	343
o Transmission Facilities	534
TOTAL VARIABLE COSTS	$5,305

As a result, the estimated 1980 variable cost of treating, pumping, purchasing water and maintaining the System is $5,305,000. The unit variable cost of producing is $0.204/1,000 gallons, based on 1980 produced water (71.049 mgd, Table 7-30).

Based on the water savings for the medium growth scenario with permanent conservation measures, Table 7-36), the percentage effect by measure (Table 7-50), and the unit price of producing water ($0.204), the annual savings in production and water purchase costs (variable costs) are projected for each measure and presented for selected years in Table 7-63. For example, in 1981 for

Measure 1 (8.710 mgd) * ($0.204/1000 gallons) * (365 days per day) * (.011 Table 7-50 Measure 1) = $7,100 (annual savings from Measure 1 in 1981).

TABLE 7-63
FUTURE SCWA WATER SUPPLY OPERATIONS SAVINGS
AVERAGE DAILY FOREGONE SUPPLY COSTS
1981 - 2030 (1980 $)

	TOTAL REDUCTION IN WATER DEMAND (MGD)	ANNUAL SAVINGS IN SUPPLY OPERATIONS COSTS ($) M-1	M-2	M-3	M-4	M-5
1981	8.710	$ 7,100	$ 61,600	$ 600	$401,400	$177,700
1985	6.406	9,000	67,700	5,200	295,200	99,600
2000	8.598	21,700	77,400	12,100	411,000	117,800
2020	7.000	66,700	91,200	13,000	304,400	46,400
2030	13.935	128,600	112,000	17,600	607,000	171,200

Based on these annual savings (Table 7-64) for each measure and a Federal discount rate of 8-3/8 percent, the estimated present value for each measure is: Measure 1 (Appliance): $214,000; Measure 2 (PRV): $842,000; Measure 3 (Pipeline Leak Detection): $84,000; Measure 4 (Retrofit): $4,152,000; and Measure 5 (Education): $1,361,000.

The contingency plan (Measure 6) imposes restrictions on water users during periods of water shortage. The plan is implemented infrequently, and the differential with average daily flows (comparison of Tables 7-36 and 7-38) ranges from approximately 4 to 6.5 mgd.

TABLE 7-64
POTENTIAL ANNUAL SAVINGS IN OPERATING COSTS
SELECTED YEARS (1980 $)

	REDUCED WATER USE	ANNUAL SAVINGS (MG)
1981	3.919	$292,000
1985	4.110	306,000
1990	4.660	347,000
2000	5.540	413,000
2011	6.523	486,000

If the restrictions are implemented approximately once every 10 years (1981, 1990, 2000, 2011) with a one-year duration, the present value of the operation savings is $548.000.

Benefits of reduced water use on operation and maintenance costs are also produced by reducing peak daily water demand. The benefits are determined as the additional saving from reduced peak daily water demand above those determined for average daily water use. These benefits are calculated based on comparison of the effectiveness of each water conservation measure in Table 7-36 and allocated to measures based on Table 7-50. Table 7-65 presents these annual savings for selected years.

TABLE 7-65
PEAK DAILY WATER SAVINGS AND OPERATION COST REDUCTIONS
FOR 30 PEAK DAYS/YEAR (1980 $)

	INCREMENTAL REDUCTION IN WATER DEMAND (MGD)	ANNUAL SAVINGS IN SUPPLY OPERATION COSTS				
		M-1	M-2	M-3	M-4	M-5
1981	3.761	$ 200	$2,100	$ 0	$14,200	$6,300
1985	2.787	300	2,400	200	10,500	3,500
2000	3.836	800	2,800	400	15,000	4,300
2020	3.500	2,700	3,700	500	12,500	1,900
2030	6.626	5,000	4,300	700	23,700	6,700

The values in Table 7-65 represent minimum annual savings on peak daily water demand from water conservation. It is anticipated that the cost of producing peak daily water demand is significantly higher than the average cost (.204/1,000 gallons) used in this calculation (ie., energy peak demand charges may apply, as well as other similar escallation factors). However, the minimum presented here produces the following estimates of present values savings: Measure 1: $8,000; Measure 2: $30,000; Measure 3: $3,000; Measure 4: $151,000; and Measure 5: $49,000.

Wastewater: Previously in Step 7 (Wastewater Bills), the results of discussions with the County Director of Waste Management indicated that wastewater system I&I problems would mask flow-related potential benefits of a water conservation program. As a result, no foregone operating costs are anticipated.

Long-Run Incremental Supply Costs

Water Supply: The SCWA water supply treatment and primary distribution system (Figure 7-2) is currently sized for 112 mgd maximum one-day service. A construction project is nearly complete, however, to expand this capability to 162 mgd. Without the proposed water conservation program, the system is expanded again in the year 2004 to the River System's planned maximum capacity of 200 mgd. This expansion is sufficient to meet the medium growth demand (curve 1) until about the year 2020 when a second future expansion project is needed (30 mgd additional pumping, treatment and primary intake structure).

By implementing the proposed water conservation program and renewing the retrofit and education programs periodically, the 162 mgd expansion in 1982 can provide sufficient capacity over a longer period. Conservation adds 11 years life to this capacity. Instead of adding the additional 38 mgd capacity (to achieve the 200 mgd maximum ultimate capacity) in 2004, it is possible to delay this expansion to 2015. At this point, the 200 mgd with the water conservation program can meet the System needs until the year 2030, and the second 30 mgd expansion project is not required. The effect of this delay in the expansion to 200 mgd and the elimination of the second expansion of 30 mgd is significant long-term foregone supply costs.

The SCWA has a detailed capital improvement plan for the Water System. The Authority typically spends between $10-15 million per year on System improvements. The majority of these expenditures are for upkeep and repairs, and are not subject to down-sizing as a result of water conservation-induced water use reductions. The improvement program for 1985 is presented as a typical year (Table 7-66). Elements of the plan potentially affected by water use reductions are marked with an "*".

TABLE 7-66
SCWA 1985 CAPITAL IMPROVEMENT PLAN

PLAN ELEMENTS	COST (1980 $)
2-Reservoir Facilities	
Treatment Plant Disposal Facilities	$ 10,000
Transmission Mains	
2-Reservoir & River System Interchange	-
29-211 Water Main	-
P.W. County Water Main (wholesale)	2,500,000
Booster Pumping and Storage Facilities	
T. Corner Storage and Pumping Station	-
Misc. Extensions and Improvements	
*Mains, Interconnections Extensions (routine)	300,000
System Supervisory Control	12,000
Shop, Storage yard	-
Lake Project	200,000
River System Water Supply Facilities	
River Supply Project (complete)	-
River Supply Transmission (complete)	-
River Maintenance Facility	100,000
General	
Inventory, Administration, etc.	4,135,000
Extraordinary Maintenance	
*Supply Facilities (routine)	74,000
*Treatment Facilities (routine)	266,000
*Transmission System (routine)	416,000
Distribution System	387,000
General Plant	53,000
Additions and Extensions	
*Supply Facilities (routine)	26,000
Supply Facilities (Federal)	95,000
*Treatment Facilities (routine)	35,000
Transmission System Facilities	180,000
P. Storage Tanks	1,600,000
Distribution System Facilities	660,000
General Plant Facilities	516,000
TOTAL	$11,565,000

*Facility components that can be down-sized.

Over 35 percent of the plan represents General or Administrative improvements, and some of the transmission and facility improvements are directed at the

SCWA wholesale water customers and intakes (no impact from proposed program), but the elements of the plan identified with the "*" can be down-sized, as a result of water conservation efforts. These "*" costs represent $1,117,000, or about $1 million per year in routine expenses.

The range of cost savings is up to 7 or 8 percent for mains and treatment facilities in wastewater plants. (87) This range is probably appropriate here, however, it is phased in (1 percent in 1981, [$10,000 in annual savings] to 5 percent in 2030 [$50,000]). Pipes for mains and transmission lines can be reduced one or two sizes in appropriate locations. It is assumed that a "down--sizing" plan is developed, if the future saving is sufficient to justify these modifications. The present value of this capital cost saving is $240,000. The saving is allocated to each measure based on the year 2000 percentage effectiveness (Table 7-50). Measure 1: $8,000; Measure 2: $29,000; Measure 3: $4,000; Measure 4: $154,000; and Measure 5: $44,000.

The water supply intake and treatment facility (38 mgd) expansion offers a much greater opportunity for cost savings. The plant expansion from 162 mgd to 200 mgd is planned. The structure capacity is already 200 mgd, as well as the intake and raw water conduit. The expansion requires modification to the existing water treatment plant is presented in Table 7-67.

TABLE 7-67
SCWA 38 MGD EXPANSION REQUIREMENTS

(3) Sedimentation Basins (high rate)
(6) Filters (high rate) and Media
Back Wash
Finished Water Storage
(2) Pumps (800 Hp)
(3) Pumps (1,500 Hp)
(1) Press (Solids Dewatering)
(1) Plant Control System
Studies
Construction Management (5%)

ESTIMATED TOTAL COST: $40,000,000

Without the proposed water conservation program, this project is required in the year 2004. With the program, it can be delayed until 2015.

The present value of delaying this project is $3,408,000 and is produced by each measure (based on Table 7-50, year 2000 effectiveness estimates): Measure 1: $116,000; Measure 2: $412,000; Measure 3: $64,000; Measure 4: $2,188,000; and Measure 5: $627,000.

A second 30 mgd water plant expansion is required in the year 2020 without the proposed water conservation program. This plant is slightly (8 mgd) smaller than the plant modification described above, however, the plant requires an intake structure, raw water conduit, raw water pumping station, and transmission mains. These factors double the project cost. The 30 mgd water plant is estimated to cost $80 million. The water conservation program negates the need for this plant. The present value of this cost saving ($3,205,000) distributed to each measure is: Measure 1: $410,000; Measure 2: $561,000; Measure 3: $80,000; Measure 4: $1,871,000; Measure 5: $285,000. The effectiveness percentages (Table 7-50) for the year 2020 were used in estimating the effect of each measure.

Wastewater: No foregone supply costs are anticipated (see previous wastewater section).

Substep 9.2 Federal Water Supply Plans

One Federal water supply project is planned for the SCWA area. The project "FED-1" will provide 25,600 acre-feet of water (22.8 mgd) for the SCWA'S use. However, this project is not required before the year 2030 if the proposed water conservation program is implemented. In Figure 7-1, the dependable yield of the existing 2-Reservoir System is augmented by allocations from the River System project (completed in 1982). These combined water sources are not sufficient to meet the projected Unrestricted Water Demand (medium growth, curve 1), and by the 2015, the FED-1 project is required to supplement the SCWA supplies (and is just sufficient to meet projected demand until 2030). Figure 7-1 indicates, however, that the proposed water conservation program reduces unrestricted demand significantly. The Medium Demand Curve with Conservation (curve 2) sufficiently depresses demand so that the River System allocations can adequately supply the system throughout the study period.

The FED-1 project provides water supply, flood control, and recreation benefits to residents in the SCWA area and the region. The project investment costs are $59,183,000. This project is assumed to be de-authorized, or perhaps the site is preserved for distant future use. The local share of the project cost $57,964,000 is a benefit of the proposed water conservation program. This foregone supply cost (present value 1980 $) is $3,472,000 and allocated to each measure: Measure 1: $444,000; Measure 2: $607,000; Measure 3: $86,000; Measure 4: $2,027,000; Measure 5: $309,000. The allocations are based on the year 2020 percent effectiveness by water conservation measure from Table 7-50.

Substep 9.3 Regional Plans

There are no regional plans for water supply augmentation in the SCWA region. The River System project (1982) was a local/regional project that has been implemented and will be expanded in the year 2015 to its ultimate capacity 200 mgd to meet peak daily requirements.

Substep 9.4 External Opportunity Costs

These external effects of a proposed project were discussed previously in the Level 3 example. Typically, losses of production of hydroelectricity (privately produced) or other incidental impacts (regional) of the water conservation proposal are external opportunity costs. None are anticipated as a result of the proposed water use reduction effort.

Substep 9.5 Summary of Supply Cost & Savings

Table 7-68 summarizes the effects of water conservation on the costs of operations and future expansion of the SCWA Water System, as well as to a future Federal project. Although water reductions would normally reduce the quantity of wastewater flowing to the treatment plant, this benefit is undetectable because of a severe infiltration and inflow problem that overloads the County plant.

The overall present value cost savings for the combined measures is $17,768,000.

The retrofit program contributes about 60 percent to the total foregone supply costs, followed by the education program with 15 percent of the total. Reduced operating costs account for $7,442,000 (over 40 percent) of the cost savings primarily from reduced treatment plant pumping, energy and other annual costs. Capital cost savings of $6,853,000 (slightly less than 40 percent) are produced as a result of water conservation-induced delays and down-sizing of two future water treatment plants expansions. Finally, benefits are derived by the postponement (perhaps indefinitely) of the FED-1 project. Savings of $3,473,000 (about 20 percent of total) are generated by the water conservation program.

TABLE 7-68
FOREGONE SUPPLY COSTS (SCWA)
PRESENT VALUE (1980 $000)

	MEASURE 1 Appliances	MEASURE 2 PRV's	MEASURE 3 Leak Det.	MEASURE 4 Retrofit	MEASURE 5 Education	MEASURE 6 Conting.
OPERATING COSTS						
Water Supply						
O&M						
(Avg.)	214	842	84	4,152	1,361	548
(Peak)	8	30	3	151	49	-
Wastewater Treatment			None Anticipated			
Subtotal	222	872	87	4,303	1,410	548
CAPITAL COSTS						
Water Supply Treatment						
38 MGD	116	412	64	2,188	627	-
30 MGD	410	561	80	1,871	285	-
Water Trans.	8	29	4	154	44	-
Wastewater Treatment			None Anticipated			
Trans.			None Anticipated			
Subtotal	534	1,002	148	4,213	956	-
ALT WATER PROJECTS						
FED-1	444	607	86	2,027	309	-
EXTERNAL OPP. COSTS			None Anticipated			
TOTAL	1,200	2,481	321	10,543	2,675	548

STEP 10: Foregone NED Benefits

The Federal project FED-1 is not required as a result of the proposed program of water conservation measures. The avoided local project water supply costs are benefits to the region in Step 9. The multipurpose project, however, provides future flood control and recreation benefits. These annual NED benefits would be produced following construction of the project in 2015 as described in Figure 7-1. These benefits, however, are lost to the region as a result of project de-authorization.

TABLE 7-69

FOREGONE BENEFITS FROM FED-1

		ANNUAL NED BENEFITS (1981 $ØØØ)
Flood Control (Foregone)		$ -6
Recreation		453
	TOTAL	$ 447

The loss of these NED benefits has a present value of $447,ØØØ. Each measure contributed to this loss (based on the year 2Ø2Ø percent effect of measures in Table 7-48): Measure 1: $57,ØØØ; Measure 2: $78,ØØØ; Measure 3: $11,ØØØ; Measure 4: $261,ØØØ; and Measure 5: $4Ø,ØØØ.

STEP 11: Reduced Negative EQ Effects

The local public is opposed to the FED-1 project. It produces environmental, social, archaeological and historic impacts that are adverse. By eliminating the need for the FED-1 project, and existing lake and wetlands area is preserved. The following (Table 7-7Ø) impacts of the proposed FED-1 project are described in the Main Report, including the environmental inpact statement and public views.

TABLE 7-70
COMPARATIVE IMPACT OF THE FED-1 PROJECT

	WITHOUT PROJECT CONDITIONS (No Action)	FED-1 PROJECT
Terrestrial Habitat	1,530 acres	All losses are fully mitigable.
Wetlands	4 acres of emergent vegetation	19 acres of potential wetland adjacent to pool.
Lake Fishery & Water Quality	170 acres, warm water, good quality, eutrophied	330 acres, warm water, excellent quality, eutrophied.
Downstream Fishery & Water Quality	Mediocre quality, warm stream fishery	Mediocre quality, warm stream fishery.
Archaeological Sites	Antonio Site	Antonio Site - no effect.
	Bockus Site	Bockus Site - completely inundated.
	Merritt Site	Merritt Site - partially inundated.
Historical Sites	Beecher's Island Church	Beecher's Island Church - no effect.
	Close Farm Site	Close Farm Site - completely inundated.
Nelson Falls	10 Feet Drop	5 Feet Drop.

The Main Report also summarizes the quality of these significant environmental impacts (Table 7-71).

TABLE 7-71
ENVIRONMENTAL QUALITY IMPACTS

ENVIRONMENTAL QUALITY	NO ACTION	FED-1 PROJECT
a. Effects on Terrestrial Resources (with mitigation)	No Change	Minor Adverse
b. Effects on Lake Fishery Resources	No Change	Major Beneficial
c. Effects on Wetland Resources	No Change	Major Beneficial
d. Effects on Downstream Aquatic Resources	No Change	Minor Beneficial
e. Effects on Aesthetic Resources	No Change	Moderate Beneficial
f. Effects on Water Quality	No Change	Moderate Beneficial
g. Effects of Water Supply Draw-downs	No Change	Moderate Adverse

These impacts are mostly beneficial because the project increases the size of an existing lake and improves the lake's water quality. The adverse impacts of the project are mostly minimal. Operation of the project (water supply draw-down) causes moderate adverse impact. In addition, the proposed FED-1 project displaces none of the area's residents and has a minor increasing effect on area income and employment. The overall environmental effect of precluding construction of this project is considered neutral.

STEP 12: Increased Negative Environmental Effects

No increased negative environmental effects are anticipated (see Step 11).

STEP 13: Measure Evaluation

The results of the analysis from Steps 7, 8, 9, and 10 are summarized in Table 7-72.

TABLE 7-72
SCWA SUMMARY OF NED ADVANTAGEOUS AND DISADVANTAGEOUS
EFFECTS OF WATER CONSERVATION MEASURES
PRESENT VALUE (1980 $000)

	MEASURE 1 Appliances	MEASURE 2 PRV'S	MEASURE 3 Leak Det.	MEASURE 4 Retrofit	MEASURE 5 Education	MEASURE 6 Contingency
ADVANTAGES						
a. Unrelated to water use	0	0	0	0	0	0
b. Indirectly Related to Reduction	783	295	1,590	31,737	854	-
c. Foregone Supply Costs:						
Operations	222	872	87	4,303	1,410	548
Facilities	534	1,002	148	4,213	956	-
Alt. Proj.	444	607	86	2,027	309	-
Ext. Opp. Costs	-	-	-	-	-	-
d. TOTAL NED ADV.	1,983	2,776	1,911	42,280	3,529	548
DISADVANTAGES						
a. Implementation Costs	483	742	356	2,690	3,320	Minimal
b. Other Disadv.		None Anticipated				
c. Foregone NED Benefits	57	78	11	261	40	-
d. TOTAL NED DISADV.	540	820	367	2,951	3,360	Minimal

The information contained in Table 7-72 was taken from previous Summary Tables and text. (The Table sources include: Table 7-44, Table 7-51, Table 7-68.) Each measure produces NED advantageous effects that are substantially greater than the NED disadvantageous effects. The ratio of benefits to costs for each measure is: Measure 1 (3.6); Measure 2 (3.3); Measure 3 (5.2); Measure 4 (14.3); Measure 5 (1.1) and Measure 6 (+).

Based on economic impacts, the 6 measures are well selected. They will provide long-term benefits to the SCWA area.

No environmental impacts are anticipated from the proposed water conservation measures with the exception of short-term possible impacts to lawns from Measure 6 outside water use restrictions. These impacts are infrequent and acceptable (See Step 13, Level 3). Table 7-73 summarizes these environmental impacts.

TABLE 7-73
SCWA SUMMARY OF ENVIRONMENTAL IMPACTS
OF WATER CONSERVATION MEASURES

	MEASURE 1 Appliances	MEASURE 2 PRV'S	MEASURE 3 Leak Det.	MEASURE 4 Retrofit	MEASURE 5 Education	MEASURE 6 Contingency
ADVANTAGES						
a. Unrelated or indirectly related to water use reduction	(None anticipated for all Measures)					
b. Directly related to water use reduction						
i. Federally Planned Facilities	(None anticipated for all Measures)					
ii. Non-Federal Facilities	(None anticipated for all Measures)					
TOTAL ENVIRONMENTAL ADVANTAGES	None	None	None	None	None	None
DISADVANTAGES						
a. Unrelated or indirectly related to water use reduction	(None anticipated for Measures 1-5)					Damage to lawns and landscape
b. Directly related to water use reduction						
i. Federally Planned Facilities	(None anticipated for all Measures)					
ii. Non-Federal Facilities	(None anticipated for all Measures)					
TOTAL ENVIRONMENTAL DISADVANTAGES	None	None	None	None	None	Acceptable

STEP 14: Develop Water Conservation/Supply Plan

The six water conservation measures under consideration for the SCWA area all meet the tests of applicability, feasibility, acceptability and effectiveness, as well as providing net advantageous effects with respect to the NED objective. Also, these measures are neutral, or acceptable, with respect to environmental concerns.

The purpose of Step 14 is to develop a plan that maximizes Net Economic Development in satisfying the long-run water demands of the SCWA area. In this example, especially, the variation over time of the effect of certain measures is apparent. The retrofit and education measures 4 and 5, respectively, are implemented every fifteen years in an intensive year-long program. The analysis shows the public's response and then the expected die-off of the program with declining effectiveness, as shown in Table 7-5Ø. The other measures are also varying depending on their implementation programs so that the overall effect is always changing, as indicated in Figures 7-1 and 7-2.

Table 7-74 summarizes the effects of each measure. If any of the measures proposed produced NED disadvantageous effects greater than advantageous effects or if environmental impacts were severe, it would be omitted or modified to reduce costs or to increase the benefits it produces and the water conservation effects of the approach. As a result, the water conservation indicated in Tables 7-35 through 7-38 would be recalculated.

TABLE 7-74
SUMMARY OF SCWA
WATER CONSERVATION MEASURES

MEASURE	AVERAGE ANNUAL EFFECTIVENESS (MGD)	EFFECTS			
		ADVANTAGEOUS		DISADVANTAGEOUS	
		Pres. Value NED (ØØØ$/198Ø)	Env.	Pres. Value NED (ØØØ$/198Ø)	Env.
M1 Appliances	Ø.Ø95 (1981) 1.727 (2Ø3Ø	1,983.Ø	None	54Ø.Ø	None
M2 PRV'S	Ø.827 (1981) 1.5Ø4 (2Ø3Ø)	2,776.Ø	None	82Ø.Ø	None
M3 Leak Det.	Ø.ØØ8 (1981) Ø.236 (2Ø3Ø)	1,911.Ø	None	367.Ø	None
M4 Retrofit	5.391 (1981) 8.151 (2Ø3Ø)	42,28Ø.Ø	None	2,951.Ø	None
M5 Education	2.386 (1981) 2.299 (2Ø3Ø)	3,529.Ø	None	3,36Ø.Ø	None
M6 Contingency (With Perm. Measures)	12.371 (1981) 14.194 (2Ø3Ø)	548.Ø	None	-	Acceptable

In Table 7-74, average annual effectiveness (MGD) is based on medium growth reductions (Table 7-36) for permanent measures only and percent effectiveness by measure (Table 7-5Ø). Table 7-75 presents the measure in rank order.

TABLE 7-75
NED MERIT ORDER
PRESENT VALUE (1980 $)

MEASURE	NED EFFECTS ADVANTAGEOUS	DISADVANTAGEOUS	NET EFFECTS
M4 Retrofit	$42,280,000	$2,951,000	$39,329,000
M2 PRV'S	2,776,000	820,000	1,956,000
M3 Leak Detection	1,911,000	367,000	1,544,000
M1 Appliances	1,983,000	540,000	1,443,000
M6 Contingency	548,000	-	548,000
M5 Education	3,529,000	3,360,000	169,000

The Retrofit (Measure 4) produces the greatest net effects of nearly $40 million, followed by PRV's, Leak Detection and Appliances, all in the range of $1.5-2 million. The last ranked is the Education program (Measure 5). It is the most expensive program and probably accounts for some of the advantageous effects of the retrofit program.

In Table 7-76, proposals are formed by combining the water conservation measures. The objective is to maximize the NED advantage, as well as the water reduction capabilities of the possible plans.

TABLE 7-76
SUMMARY OF TRIAL WATER CONSERVATION
PERMANENT PROPOSALS FOR SCWA (NED EFFECT)

NED PROJ. PLAN	MEASURES	WATER REDUCTION (MGD) 1981-2030	ADVAN. EFFECTS (PV,000$)	DISAD. EFFECTS (PV,000$)	NET NED ADVANTAGE (000$)
1	M4	5.391-8.151	$42,280	$2,951	$39,329
2	M4, M2	6.218-9.655	45,056	3,771	41,285
3	M4,M2,M3	6.226-9.891	46,967	4,138	42,829
4	M4, M2 M3, M1	6.321-11.618	48,950	4,678	44,272
5	M4,M2,M3 M1, M5	8.707-13.917	52,479	8,038	44,441

Because each of these measures is independent and because of the short-term one to three year implementation approach used, it is not possible to share personnel if measures are combined. The work load and the level of skills required typically prevent any options for sharing work loads that might raise the productivity of the personnel involved, as was the case with the Level 2 example, Chapter 5. As a result, the permanent measures are combined in Plan 5 for the selected plan, since advantageous effects of each measure are greater than disadvantageous effects. Aspects of the plan for implementing permanent measures include:

Selected Plan 5:

Measure

M4 (Retrofit) program (renewal every 15 years) with promotion and free distribution and voluntary use of:
- o Low-flow showerheads
- o Toilet displacement bags

M2 (Pressure-Reducing Valves) program with promotion and free distribution and voluntary use of PRV's.

M3 (Leak Detection) program to locate and repair leaks in commercial and other areas.
- o Annual consultant leak detection project (2 weeks to locate leaks)
- o Use of existing main break repair crew

M1 (Appliances) program to change County Building Code to require water-saving appliances.
- o Dishwashers
- o Clothes washers

M5 (Education) program (renewed every 15 years) to promote water conservation.
- o Promotion
- o Media
- o School program

All of these measures are acceptable and feasible (Table 7-77). Each meets the NED objective to maximize net economic development, and none has any severe long-term detrimental environmental impact.

TABLE 7-77
SUMMARY OF WATER CONSERVATION MEASURES
AND FEDERAL AND LOCAL ALTERNATIVE PROJECTS

			NET IMPACT			
			FED-1		RIVER SYSTEM	
	TECHNICAL FEASIBILITY	SOCIAL ACCEPTABILITY	NED OBJ.	ENVIR. IMPACT	REG. OBJ.	ENVIR. IMPACT
M1 (Appliances)	Feasible	Acceptable	–	+	+	+
M2 (PRV's)	Feasible	Acceptable	–	+	+	+
M3 (Leak Det.)	Feasible	Acceptable	–	+	+	+
M4 (Retrofit)	Feasible	Acceptable	–	+	+	+
M5 (Education)	Feasible	Acceptable	–	+	+	+
M6 (Contingency)	Feasible	Acceptable	–	+	+	+

With regard to the FED-1 project, the water conservation program precludes its development and reduces flood control and recreation benefits to the area, however, overall economic development benefits by this impact. The River System project requires expansion of intake and treatment facilities in the future. The intakes, pumping station and conduits are already sized to the future expanded size. This project is acceptable regarding regional objectives and environmental impacts. The proposed water conservation plan, in conjunction with continued use fo the 2-Reservoir System and the River System (with future planned allocations) provides an excellent approach for meeting future water needs in the SCWA area. This approach precludes the need for the FED-1 project. Table 7-78 identifies the timing and SCWA costs of the water plan for the period 1980-2030.

TABLE 7-78
SCWA WATER PLAN 1980-2030

YEAR				INCREMENTAL PROGRAM COSTS ($1980)
1980	Water Conservation Implementation (Only SCWA Costs)			
	Measure 1:	Water-Saving Appliances		
		Postage & Supplies	$ 5,000	$ 5,000
	Measure 2:	Pressure-Reducing Valves		
		PRV's (10,000)	200,000	
		Pamphlets (30,000)	37,500	
		Postage/Media	9,000	
		Staff	21,000	267,000
	Measure 3:	Leak Detection (1980-2030)		
		Consultant	12,500	
		Material	13,000	25,000
	Measure 4:	Retrofit (Showerhead/Displ.)		
		Kits (127,800)	1,150,000	
		Mailers	197,000	
		Media	81,000	
		Staff	42,000	1,469,000

TABLE 7-78 (CONTINUED)
SCWA WATER PLAN 1980-2030

	Measure 5:	Education		
		Promotion	1,479,000	
		School Material	129,000	
		Media	160,000	
		Staff	74,000	$ 1,842,000
1981	Measure 2:	PRV's		
		PRV's (8,000)	160,000	
		Pamphlets (30,000)	37,500	
		Postage/Media	9,000	
		Staff	21,000	227,000
1982	Measure 2:	PRV's		
		PRV's (6,000)	120,000	
		Pamphlets	37,500	
		Postage/Media	7,500	
		Staff	21,000	186,000
1985	Measure 2:	PRV's		
		PRV's (3,000)	60,000	60,000
1990	Measure 2:	PRV's		
		PRV's (400)	8,000	8,000
1995	Measure 4:	Retrofit		
		Kits (192,000)	1,728,000	
		Mailers	297,000	
		Media	81,000	
		Staff	52,000	2,158,000
	Measure 5:	Education		
		Promotion	2,223,000	
		School Material	119,000	
		Media	160,000	
		Staff	111,000	2,614,000
2010	Measure 4:	Retrofit		
		Kits (241,000)	2,169,000	
		Mailers	373,000	
		Media	81,000	
		Staff	73,000	2,696,000
	Measure 5:	Education		
		Promotion	2,793,000	
		School Material	119,000	
		Media	160,000	
		Staff	139,000	3,212,000
2015	EXPANSION WATER TREATMENT PLANT TO 200 MGD			40,000,000
2025	Measure 4:	Retrofit		
		Kits (301,000)	$2,709,000	
		Mailers	465,000	
		Media	51,000	
		Staff	83,000	3,338,000

STEP 15: Supply Reliability Considerations

Water supply reliability and the risks associated with drought are described generally in Chapter 3 ("Risk and Uncertainty"), including concerns about data and analysis methods and concerns for the unknown. The dependable yield of the SCWA water system is 84 mgd (Figure 7-1) until the year 1990, when increments from the River System project increase the supply to 116 mgd, and in subsequent years until the supply is 149.8 mgd. On a daily basis, the River System supply (on-line in 1982) makes 162 mgd available as a one day maximum. Without water conservation, Figures 7-1 and 7-2 indicate the SCWA System is not sufficient to meet future demands throughout the study period. However, with conservation, and if growth in demand follows the medium growth projections, the System appears to be adequate.

Permanent water conservation measures with the contingency plan (restricted water use) measure provides some additional protection from shortage. The SCWA with its additional source of water supply from the River System has modified its operations practices. In 1982, it began shifting away from the 2-Reservoir system to the River System for more water, presumably for cost saving, as well as risk reduction (holding the known reliable supply as the back-up) purposes.

STEP 16: Documentation

(See Appendix D: Bibliography)

SCWA EXAMPLE: Flow Reduction Contingency Plan

Prior to the late 1970's (when the 2-Reservoir System was purchased), the SCWA was dependent on purchases of raw and finished water to meet its needs. In 1978, the Authority purchased the 2-Reservoir System and became relatively independent. However, as the previous analysis of the System indicates, the peak day capability and long-term needs of the System are now augmented with the River System water.

Because the SCWA is one of four partners in the use of the River System (which is known to be unable to meet all the water needs of these partners), the agreements between the parties involve a water contingency plan. The formal agreements reduce intake to all the participants and require reductions in withdrawal. In addition, the 2-Reservoir System has another set of parameters for control of limited water supplies. This System involves a triggering procedure that is geared to reservoir pool elevation. When reservoir surface elevation drops below certain levels (triggers), the procedure (based on known volume of water in the reservoirs and the number of days of available supply remaining) imposes various levels of restrictions.

The SCWA operates its two sources as a System for the purpose of minimizing costs of operation and risks of shortage. If either of the Water Systems is triggered by reduced flows or available storage, the following staged procedure is implemented:

STAGE I: Voluntary restrictions.

- o Similar to Level 2 ECWD Example (B. Phase II: Voluntary Reductions).

STAGE II: Mandatory restrictions.

- o Similar to the levels of water use reduction evaluated in this example.
- o Similar to Level 2 ECWD Example (C. Phase III: Mandatory Reductions).

Stage II assumes that limited supplies are available and that restrictions are ordered or absolute curtailment of less essential uses of water are required (ie., Stage I uses).

STAGE III: Mandatory Reductions.

- o Comparable to the rationing program described in the Level 3 Example.
- o Involves penalties.

Stage III assumes that critically limited supplies of water are available and water use is restricted to purposes which are absolutely essential to life, health and safety.

APPENDIX A

GLOSSARY OF TERMS AND WATER CONSERVATION MEASURES

APPENDIX A

GLOSSARY OF TERMS AND WATER CONSERVATION MEASURES

Appendix A provides definitions for the terms used in this Handbook, as well as definitions and information on literature availability for many water conservation measures. The water conservation measures presented here are representative of the Regulatory, Management and Education approaches discussed in this Handbook. This Appendix is neither intended to be totally inclusive, nor to present all water conservation measures that are available.

Because the intent of this Handbook is to provide guidance and to stimulate thinking about localized approaches to water conservation, this information on water conservation measures should be supplemented with local tests of water conservation measure effectiveness, updated manufacturer certification and other relevant data that can improve the reliability of a water conservation program.

This Appendix is organized in two sections:

- o Terminology
- o Water Conservation Measures

1. TERMINOLOGY

ACCEPTABLE MEASURE : A water conservation measure for which there is no known obstacle to implementation.

ADVANTAGEOUS EFFECTS (Indirect) (STEP 7): These are benefits of water conservation to residential, multi-family, commercial, industrial and public institutional sectors (non-water supply and wastewater utility benefits). Reduced energy costs, reduced water and sewer bills, for example.

BASE YEAR: The earliest year in which implementation of any water conservation measure under consideration would begin, or any earlier year, which may correspond to the base year used in the water supply plan of which water conservation is to be a part.

BENEFICIAL REDUCTION: A reduction in water use (or water losses) which creates net advantageous effects which exceed the net disadvantageous effects required by the actions which accomplished the reduction.

CONTINGENT WATER CONSERVATION MEASURES: Measures which are implemented only under pre-specified circumstances, and then only for a limited time span. Such measures are basically crisis oriented, and are capable of rapid implementation.

COVERAGE (Coverage Factor): The fraction of water use that is actually subject to reduction as a result of a conservation measure. Coverage relates to the willingness (social acceptability) of water users to implement water conservation measures and varies by user class and to the change in effectiveness (duration) of a a water conservation measure over time ("phasing-in" of measures or "die-off" of measures). (Expressed as C_{ijt} in the Effectiveness equation.)

DISADVANTAGEOUS EFFECTS (STEP 8): These are the implementation and other costs of undertaking a water conservation measure.

DISAGGREGATE WATER USE: Community water use stated separately for each user class or sector. Seasonal water uses may also be stated separately from nonseasonal uses.

EDUCATION: A range of methods used to encourage and facilitate voluntary changes in water use habits and water use technology, including the use of direct mail, news media, personal contact and special events.

EFFECTIVENESS: The fractional reduction in unrestricted water use resulting from the implementation of a water conservation measure. The following formula is used to obtain estimates of effectiveness.

$$E_{ijt} = Q_{jt} * R_{ijt} * C_{ijt}$$

where E_{ijt} = effectiveness of conservation measure i for use sector j at time t, in quantity per unit time (ie., gallons per day).

Q_{jt} = predicted unrestricted water use in sector j at time t, in quantity per unit time (ie., gallons per day).

R_{ijt} = fraction reduction in water use (or loss) of water for sector j, at time t, expected as a result of implementing measure i.

C_{ijt} = coverage of measure i in use sector j at time t, expressed as fraction of sectoral water use affected by conservation measure.

EXTERNAL OPPORTUNITY COSTS (Substep 9.4): These are costs or the sacrifices (or benefits) that are made external to the implementing entity and involve water conservation-induced changes in downstream flows and impacts on hydropower, recreation, navigation, other water users, etc. These effects are frequently referred to as incidental and uncompensated impacts of a project, and in this Handbook, are limited to local and regional. Foregone NED Benefits refer to external effects that impact on Federal projects.

FEDERAL PLAN: The Federal plan may be either a water supply plan, or a water supply/conservation plan.

Water Supply Plan: Refers to the measures included in the NED, EQ and other plans* (as formulated without consideration of additional water conservation measures) to satisfy future water needs. The water supply

*Note: As a result of changes in national water policy, objectives now focus on contributions to national economic development (NED) only, although aspects of the Procedures Manual environmental analysis are still addressd here.

plan may be a single purpose plan, or it may be the water supply element of a multi-purpose plan.

Water Supply/Conservation Plan: Refers to a water supply plan modified to include a water conservation proposal. The water conservation proposal should be formulated to provide a net positive contribution to the objective served by the water supply plan.

FOREGONE NED BENEFITS (STEP 10): These are incidental impacts on Federal projects (ie., losses in benefits of a proposed multi-purpose reservoir which is perhaps now oversized as a result of the proposed water conservation effort); comparable to external opportunity costs.

FOREGONE SUPPLY COSTS (STEP 9): These are the operations and capital investment savings (costs foregone) of water conservation program induced water reduction. The primary benefits are from down-sizing and delaying future projects consisting of local, regional and Federal projects.

FRACTION REDUCTION (Reduction Factor): The fractional (percentage) reduction in water use resulting from the implementation of a water conservation measure (expressed as R_{ijt} in the Effectiveness equation).

INTERACTION BETWEEN CONSERVATION MEASURES: The synergistic effect of two or more conservation measures working at the same time that causes the effectiveness of the combined measures to be different than both measures considered separately. In most cases, the interaction factor will indicate no interaction between conservation measures (ie., a toilet displacement device and a low-flow shower-head) or complete negation of one device (ie., in cases where devices are mutually exclusive, such as a toilet displacement device and a toilet dam).

LONG-TERM WATER CONSERVATION MEASURES: Measures which, once implemented, remain continuously in effect throughout the remainder of the planning period.

MANAGEMENT: Water use reduction attributable to management actions taken by the water supplier itself. Water users respond to management measures through economic incentive rather than threat of sanction. Metering, pricing strategies, and a leak detection fall into this class. Public water use reduction also qualifies as a response to management action. (One of three major approaches to water conservation, including regulation and education.)

NONSEASONAL WATER USE: Those water uses which are presumed invariant throughout the year; the minimum level of water use experienced during a year.

PLANNING AREA: The geographical area containing those water uses which are the subject of water conservation planning.

PLANNING PERIOD: The period of time, beginning with the base year, for which benefits and costs attributable to water conservation measures will be identified and measured.

POTENTIALLY ACCEPTABLE MEASURE: A water conservation measure for which there is some obstacle to implementation (technical, social, political, institutional, etc.), but the obstacle is either one which is reasonably likely to disappear at some future time, or one which is substantially within the power of the affected community to remove.

REGULATION: Water use reduction attributable to direct or indirect responses to laws, policies, ordinances, or restrictions which are enforced through penalties or sanctions for non-compliance. (One of three major aporoaches to water conservation, including management and education).

SEASONAL WATER USE: The difference between total annual water use and total nonseasonal water use; those water uses which are expected to vary with season.

SOCIAL ACCEPTABILITY: The willingness of the public (residents, elected officials, and water users by customer class) to implement a water conservation measure, measured by its congruence with the core or basic social ideologies that characterize a community.

TIME HORIZON: The last year of the planning period; also, the length of the planning period.

UNACCEPTABLE MEASURE: A water conservation measure for which there is some obstacle to implementation (technical, social, political, institutional, etc.); furthermore, the obstacle is one which cannot be reasonably expected to disappear at a future time, and which is not substantially within the power of the affected community to remove.

UNRESTRICTED WATER USE: Water use predicted in the absence of any, or any additional or new water conservation measures. Practically all water users have implemented, at least on a voluntary basis, some water conservation. This water use by user class is projected for the future and provides a basis for the estimation of effectiveness (expressed at Q_{jt} in the Effectiveness equation).

WATER CONSERVATION: Any beneficial reduction in water use or water losses.

WATER CONSERVATION MEASURE: Any act, regulation, incentive, or practice which conserves a given supply of water through a beneficial reduction in water use (or losses).

WATER CONSERVATION PROPOSAL: One or more water conservation measures intended for implementation in a given planning area, the aggregate effect of which is a beneficial reduction in water use (and/or losses).

WATER LOSS: Water which, having once been defined as part of supply, is no longer available for use.

WATER SUPPLY: The quantity of water, at a particular time and place, which is available for use.

WATER SUPPLY PLAN: See "Federal Plan."

WATER SUPPLY/CONSERVATION PLAN: See "Federal Plan."

WATER USE: Water intentionally withdrawn, diverted, or physically segregated from supply so that it is temporarily or permanently unavailable for other purposes.

WATER USER CLASS OR SECTOR: A grouping of individual water users expected to display similar use characteristics; for example, residential users, commercial users, etc..

2. WATER CONSERVATION MEASURES

For the purposes of demonstration, this Handbook identifies many water conservation measures that may be applicable for water use reduction in a specific situation. This section provides definitions and some information on these measures, and is presented in the format of the Procedures Manual (Regulatory, Management and Education) in order to maintain conceptual continuity.

Table A-1 Potential Water Conservatin Measures lists the measures and in tabular form indicates a range of measures which have been evaluated and reviewed in the literature (for which information is available on reduction factors, social acceptability, and costs). This Table lists many devices (technological approaches) for water conservation that are mutually exclusive (for example, several devices are described that reduce toilet flow, however, only one device per toilet would be used at a time). As a result, choices must be made between certain devices in developing a specific water conservation program. The following section is formulated according to Table A-1 and provides definitions of terms.

Descriptions of water conservation measures for this Handbook and relevant characteristics were obtained from the following publications: Water Conservation in California (3), The Alternative is Conservation (4), Water Conservation and Reuse (7), Before the Well Runs Dry (38), Algorithm for Determining the Effectiveness of Water Conservation Measures (9), and Interim Report Residential Water Conservation Demonstration Projects (19). Full references for these sources are provided in the Bibliography.

Federal & State Laws & Policies

A. Federal Laws and Policy: Regulatory measures which directly or indirectly achieve water conservation. Although no direct measures are currently in use for water use reduction on a national scale, localized policy could be promoted by the U.S. Army Corps of Engineers or Bureau of Reclamation (ie., as a requirement for obtaining additional water from Federal projects), or in situations of water emergency under Presidential directive.

A more likely situation exists where indirectly Federal policy promotes water conservation. The Federal Water Pollution Control Act in 1972 (PL92-500) and the Clean Water Act Amendments (1977) are examples of Federal regulations that caused significant reduction in water use indirectly as industry and municipal wastewater treatment was improved and water use recycling and other process changes were undertaken. Other examples could include possible Federal energy conservation policies that could have similar effects, although the past

TABLE A-1

WATER CONSERVATION MEASURES

	SUITABILITY						INFORMATION AVAILABILITY		
REGULATION	LONG TERM	CONT	NEW CONST	RETRO	INT	EXT	RED.FACT. % OF USE	COV. FACTORS	UNIT COST $
FED. LAWS/ POLICY	X	X	X	X	X	X	N/A	N/A	N/A
STATE POLICY LOCAL CODES, ORDINANCES	X	X	X	X	X	X	N/A	N/A	N/A
(A,B) PLUMBING									
L-F Showerheads	X		X	X	X		X	X	X
Shwr-Flow Restr.	X			X	X		X	X	X
Toilet Dams	X			X	X		X	X	X
Displ. Devices	X			X	X		X	X	X
Flush Mech.	X				X		X	X	X
Low-Flush Toil.	X		X		X		X	X	X
Pressure Toil.	X		X		X		X	X	X
Dual-Flush Toil.	X		X		X		X	X	X
Faucet/Aerator	X		X	X	X		X	X	X
Faucet Restr.	X			X	X		X	X	X
Pr. Red. Valve	X		X	X	X	X	X	X	X
Serv. Line Rest.	X			X	X		X	X	X
Ins. HW Pipes	X		X		X				X
Pre-mx.Wtr Syst.	X		X		X				
Low Wtr-Using Clothes Washer	X		X		X		X	X	X
L Wtr-Using Dishwasher	X		X		X		X	X	X
Dry Comp. Toil.	X		X		X				X
Grey Wtr. Syst.	X		X		X		X		
Leak. Repair (Toilets)	X				X		X	X	X
Ind. Recycle	X		X				X	X	X
(C) Sprinkling Ordinance									
Alt. Day		X				X			
Time of Day		X				X			
Hand-Held Hose		X				X			
Drip Irrigation	X		X	X		X			X
(D) Changes in Landscape Des.	X		X	X		X			X

TABLE A-1 (CONTINUED)

	SUITABILITY		INFORMATION AVAILABILITY						
	LONG TERM	CONT	NEW CONST	RETRO	INT	EXT	RED.FACT. % OF USE	COV. FACTORS	UNIT COST $
(E) Wtr. Recycl.	X		X	X		X	X		
Restrictions									
Rationing									
Fixed Alloc.		X			X	X			
Variable (%)									
Plan		X			X	X			
Per Capita		X			X	X			
Prior Use		X			X	X			
Restr. On Uses									
Recreational	X	X	X	X			X		X
Comm/Ind.	X	X	X	X			X		X
Car Washing	X	X	X	X			X		X
MANAGEMENT									
Leak Detect. (Pipeline)	X	X					X		X
Rate-Making Policies									
(A) Metering	X		X	X	X	X	X		X
(B) Rate Design									
Marginal Cost	X				X	X			
Incr. Block Rates	X				X	X	X		
Peak Load	X	X			X	X			
Seasonal	X	X			X	X	X		
Summer Charge	X	X			X	X			
Excess Use	X	X			X	X			
Tax Incentives	X		X	X	X	X			
EDUCATION									
Direct Mail	X	X	X	X	X	X	X	X	X
News Media	X	X	X	X	X	X	X	X	X
Personal Cont.	X	X	X	X	X	X	X	X	X
Special Events	X	X	X	X	X	X	X	X	X

decade of increasing energy costs has probably had a significant positive impact on water conservation as energy use has been reduced.

B. State Policy

1. Plumbing Code: Some states have developed detailed laws regarding water conservation that is mandated at the State level. California law, for example, requires a high standard of efficiency for plumbing fixtures. Flow limits have been set for showerheads and faucets (2.75 gallons per minute) and flush volume limits have been set for water closets (3.5 gallons per flush) and urinals (1.5 gallons per flush). The State of California recognizes that such laws conserve water and also reduce consumption of energy needed to purify, pump and heat it. Starting in 1985, self-closing faucets will be required on all new public restrooms, or limit flow of hot water (43 C) to a maximum of Ø.5 gallons per minute.

2. Other Policy: Other sources of water conservation policy can be found in regional water agencies (ie., River Basin Commissions, such as the Delaware River Basin Commission where emphasis is being placed on water conservation. Well permits for municipal public water supplies of the North Wales Water Authority and Hatfield Borough Municipal Authority in Pennsylvania have been granted for one year instead of five years, regarding the development of alternative sources of water and "improved conservation measures"), energy agencies (such as the California Energy Commission' state wastewater control agencies, and other sources.

Local Codes & Ordinances

A/B Plumbing Code: Regulatory measures that require installation of water conserving plumbing fixtures for new structures and retrofitting is one of the most easily implemented program elements. The advantages of the approach includes (1) ease of installation (installed by builder/plumber as part of the house construction), (2) ease of inspection by local authority (can be inspected before occupancy), (3) wider range of conservation options available than for retrofits, (4) actual cost of installation will probably be less than for retrofits and (5) costs will be included in mortgage payment for "painless" payment. The following water conservation measures are typically considered in local plumbing codes.

1. Low-Flow Showerheads: (Flow-Reducing Showerheads) are showerheads designed for a maximum discharge of 2.75 gallons of water per minute (those meeting the American National Standards Institute requirements) over a range of test pressures from 2Ø to 8Ø pounds per square inch. Shower water use can be reduced by as much as 75 percent with these devices.

2. Shower Flow Restrictors: (Flow control devices) are devices that limit the rate of flow from showerheads and faucets. These devices are usually inserted between the existing conventional showerhead and the showerhead arm. Flow is usually limited to 2.5 gallons per minute with water savings of 5Ø to 7Ø percent claimed for flow-limiting showerheads and up to 5Ø percent for faucets.

Toilet Flow Reduction

3. Toilet Dams: are flexible devices that are inserted into a toilet tank in order to hold back a portion of the water normally used for flushing. Water saving is typically 1-2 gallons per flush for the conventional gravity-operated toilet that uses 5-8 gallons per flush (10 to 40 percent reduction).

4. Displacement Devices: are space-occupying objects, such as weighted plastic bottles and water bags which reduce the volume of water normally used for flushing. Water savings, similar to toilet dams of 1-2 gallons per flush, are possible. (Bricks, which are frequently thought of as convenient displacement devices, are subject to deterioration and are not recommended.)

5. Flush Mechanisms: Are retrofit devices which change the mechanical operation of the conventional 5-8 gallon toilet and thereby reduce the volume of water used in flushing.

6. Shallow Trap Toilets: are toilets designed with a smaller reservoir than a conventional toilet and use only 3.5 gallons per flush. They operate in the same way and are similar in appearance to conventional toilets.

7. Pressure Toilets: are specially designed toilets that use air pressure to provide velocity and aid flushing action. These toilets are typically designed to use only 2.5 gallons per flush; however, some designs which use compressed air from air compressors can reduce water use to two quarts per flush.

8. Dual-Flush Toilets: (Dual-flush devices) are toilets that have been designed to deliver two different quantities of water for flushing. By pushing up on the handle, a smaller amount of water is flushed for liquids; by pushing down, a larger normal flow is available for flushing solids.

Faucet Flow Reduction

9. Faucet Aerators: (Faucets) are water-saving devices which reduce flow rates by mixing water with air. Flow reduction to 2.5 gallons per minute are achievable over a range of test pressures from 20 to 80 pounds per square inch for water conservation faucets and aerators.

10. Faucet Restrictors: (Same as shower-flow restrictors)

General Flow Reduction

11. Pressure-Reducing Valves: are devices that can be installed individually at services or for small service areas for the purpose of reducing water pressure delivered by the water utility. (Generally used in areas where pressure is 80 pounds per square inch [psi] or more.) Pressure reduction in a service connection can reduce water use by 5-30 percent.

12. Serviceline Restrictors: are devices that are inserted into water pipes (other than shower and faucet restrictors) to reduce line flow.

13. Insulated Hot Water Pipes: insulation reduces loss of heat from hot water pipes and reduces water wasted while householder awaits the flow of hot water at the tap. A 1-4 percent water reduction in water use and energy savings can result.

14. Premixed Water Systems: (Thermostatic mixing valves) are valve systems which mix hot and cold water to preset temperatures. Water is not wasted while temperature is being adjusted, since water issues from the tap at this temperature.

15. Low Water-Using Clothes Washers: conventional automatic clothes washers use from 27-54 gallons of water per load. Low water-using washers typiclly require 16-19 gallons, a potential water reduction of 40 percent.

16. Low Water-Using Dishwashers: conventional automatic dishwashers use from 7.5 to 16 gallons of water per load. Low water-using dishwashers use 7.5 gallons, a potential average water reduction of 40 percent.

17. Dry Composting Toilets: are waterless toilets that rely on bacterial action to break down wastes. These devices (and other unconventional toilets) offer potential for rural and vacation homes.

18. Grey Water Systems (reuse): provide an opportunity to reuse shower and sink water for lawn, flower garden, shrubbery and tree irrigation. Grey water is usually treated for solids removal and sometimes filtered.

19. Leakage Repair (private systems): includes all methods directed toward discovering and eliminating toilet leakage. The most common approach involves the use of dye tablets followed by maintenance.

20. Industrial Recycling: includes actions taken by industries and commercial businesses to reuse water in process and cooling operations.

C. Sprinkling Ordinances: for long-term, if designed as a permanent water conservation measure, or contingent use local water codes can use sprinkling ordinances to reduce external water consumption.

1. Alternate Day: lawn and garden watering is allowed on alternate days only (ie., every other, or every third day).

2. Time of Day: lawn and garden watering is allowed during designated hours of the day only (usually during the evening hours when evapotranspiration is at reduced levels).

3. Hand-Held Hose: requires that all watering of lawns and gardens be performed by hand-held hose, thus eliminating the use of conventional and in-ground irrigation methods which are more convenient to use.

4. Drip Irrigation: provides a very efficient method of garden watering. In elaborate systems, each plant is supplied with water through individual tubes that drip water into plant's root zone

D. Changes in Landscape Design: use of drought-tolerant or native vegetation for lawn and garden planting can be an excellent water conservation approach. Native vegetation can survive naturally in the existing climate without supplemental water. Consolidated turf provides another method which maintains visual benefit with efficient use of smaller turf areas. Tensiometers and other irrigation control systems are also used to reduce landscape irrigation requirements.

E. Water Recycling: industry and commercial establishments can recycle or reuse water in process and/or cooling operations.

Restrictions

A. Rationing: an effective water conservation measure for contingent application; however, very expensive in terms of economic impact. Rationing involves restricting water use by user class to a specific amount by statute based on various concepts. Typically, rationing programs are enforced by fines and shut-offs.

1. Fixed Allocation: can be applied to any user class. Usually used in the residential sector (ie., each household is limited to 200 gallons per day).

2. Variable Percentage Plan (or sliding program): can be applied to any user class. Restrictions can vary over the year based on water usage and possible supply increases or decreases. Typically, decreasing consumption allowances are permitted as summer approaches.

3. Per Capita Use: is typically applied to the residential user class. An allocation is determined for each person on a daily basis (ie., 40 gallons/capita/day).

4. Prior Use Basis: can be applied to any user class. Restrictions are based on a percent reduction of prior use.

B. Restrictions on Specific Uses: Based on assumed value of water in use, restrictions are frequently applied to water uses that are judged non-essential. Human health is generally the assumed highest use followed by maintenance of labor employment and economic factors and industry impact.

1. Recreational Uses: restrictions are sometimes placed on swimming pool filling and refilling, irrigation of golf course fairways, greens and tees, and other obvious water uses.

2. Commercial and Industrial Uses: restrictions are usually placed on water use for various non-productive business activities (ie., decorative pools, fountains, car and truck washing, window washing, landscape needs, etc.).

3. Car Washing: unless water is recycled, car washes are usually restricted from using water.

Management

Leak Detection: involves the detection and elimination of leaks within a water utility's distribution and transmission lines. This type of water conservation can benefit a water utility by increasing the amount of water available for sale to customers.

Rate-Making Policies

A. Metering: consists of the monitoring and charging for water based upon the volume used by the customer. Water metering also provides valuable information on where and when water is used.

B. Rate Design: water pricing can impact the consumption of water. Depending on the price elasticity of water (a measure of the users' response to price changes, which is influenced by factors such as (1) the new price level, (2) users' income, (3) number of people per household, and (4) rainfall and temperature) and the type of price structure selected, degrees of water conservation can be achieved through new pricing policies. Rate design can be used to achieve long-term or contingent water conservation objectives.

1. Marginal Cost Pricing: the practice of setting the price of water equal to its marginal cost. The practice is consistent with the efficient use of resources.

2. Increasing Block Rates: the practice of setting the unit price for a volume of water and a higher price for the next volume, and so on. The cost of the water to a consumer increases at an increasing rate and, thus, the incentive to conserve water increases.

3. Peak Load Pricing: the practice of setting the price of water higher during hours of peak use. Since water systems are designed for maximum flow requirements, this pricing structure recovers the costs from the daily peak load users. Rates are established with volume and peak use components.

4. Seasonal Pricing: the practice of setting the price of water higher during periods of seasonal use (summer) as opposed to lower winter rates. This is similar to the daily peak load pricing strategy except that seasonal design flow requirements are charged to the seasonal water users.

5. Summer Surcharge: an additional charge that is added on to a rate structure for the purpose of recovering the delivery costs of summer peak water use.

6. Excess Use Charge: an additional charge that is added on to a rate structure for the purpose of discouraging water use exceeding some pre-specified level.

Tax Incentives and Subsidies: Various inducements that can be used to achieve water conservation. Tax incentives achieve water reduction by encouraging water users to avoid the tax penalty for undesirable levels of water use. Subsidies, however, also work to encourage water reduction through subsidy payments to users who achieve the required reduction.

Education: Various opportunities are available for government agencies, public bodies, public interest groups and the water supplier itself in educating water users regarding water conservation. The results can be effective for long-term and contingent programs. An education program is generally voluntary in nature.

1. Direct Mail: involves the use of mail service to distribute information included with water supplier bills and as a direct mail objective of other entities.

2. News Media: involves the use of radio, television, newspapers, billboards, etc., to encourage and facilitate water conservation habits and water use technology.

3. Personal Contact: involves the direct contact of individuals with water users to achieve water conservation. Primarily, contact between large water users and government officials may be appropriate or programs where Boy Scouts or other groups may go door-to-door in personalizing the program.

4. Special Events: involves public relations efforts to bring increased attention to the water conservation program.

APPENDIX B

HANDBOOK APPLICATION

APPENDIX B

HANDBOOK APPLICATION

This Appendix presents the analysis methods for data collection and analysis for each Level. Because the four Levels are different, based on data availability, different analysis methods are frequently appropriate for each Level. Where the "maximum" data are available in Level 4 (a full range of information that will allow analysis of technical feasibility, social acceptability, effectiveness, etc., of various conservation measures), methods should be used that utilize this information base in the water plan development and evaluation. However, where data are "minimum" and little or no information exists, methods for data collection and analysis should be used that supplement the deficiencies with outside data sources (such as literature values, for example on social acceptance, etc.), and appropriate analysis techniques applied to this data situation in developing and evaluating a plan.

A Water Supply System Check List was developed to aid in data collection (Appendix C). This list was used to develop a familiarity with water supply system data availability for the examples in Chapters 4-7, and can serve as a basis of identifying what information is available, as well as the depth of data. The check list also serves as a preparation device when used in conjunction with a descriptive cover letter to prepare a utility for future data collection efforts that will require their cooperation and time.

This Handbook provides a 16-STEP approach (Figure B-1) for the evaluation of water conservation for municipal and industrial water supply. Each STEP is keyed to the Procedures Manual (PM) for reference purposes.

Appendix B identifies for each data availability Level:

1. What methods are appropriate for each STEP.
2. How to implement the STEP in a concise presentation.

Although the objectives of each STEP are the same, the methods vary by Level, depending on the availability of data. As a result, this Appendix provides some general direction that is detailed in the Level examples.

The methods are presented by Level from one to four, and specify analysis approaches for the lowest levels (Ø, 1 and 2) which rely on literature and general data sources, followed by methods that rely on more local data sources and techniques such as local field tests and survey methods.

Although the Handbook begins with STEP 1, each example is introduced with a description of the local area. These introductions include:

Historical Growth and Development: Includes population, households, land use, commercial/industrial business and various other categories that define the area and establish that the area is "normal" or "unique" in some way. (For example, an area that has no industry would not be appropriate for industrial recycle of water, and lawn sprinkling restrictions would be less effective for a community with primarily multi-family rather than single family development.)

FIGURE B-1

PROCEDURES MANUAL STEPS

STEP 1: Universe of Water Conservation Measures (PM. 3 & 4-2(a)(1)).
STEP 2: Applicability (PM.4-2(a)(2),4-3).
STEP 3: Technical Feasibility (PM.4-4).
STEP 4: Social Acceptability (PM.4-5).
STEP 5: Implementation (PM.4-7).
STEP 6: Effectiveness (PM.4-2(b),4-8 & 5-3a(2)).
- 6.1 Water Demand Forecasts
- 6.2 Fraction of Water Use Reduction
- 6.3 Coverage
- 6.4 Analysis of Effectiveness

STEP 7: Advantageous Effects (Indirect) (PM.4-9).
STEP 8: Disadvantageous Effects (Indirect) (PM.4-10).
- 8.1 Implementation Costs
- 8.2 Other Disadvantageous Effects

STEP 9: Foregone Supply Costs (PM.5-1).
- 9.1 Local Water/Wastewater Plans (PM.5-2,5-3a(1),(2),(3)
- 9.2 Federal Water Supply Plan (PM.5-2,5-3a(1),(2),(3) & (4)(a))
- 9.3 Non-Federal Water Supply Plan (PM.5-2,5-3(a)(1),(2),(3) & (4)(b))
- 9.4 External Opportunity Costs (PM.5-3(d))
- 9.5 Measure Foregone Supply Costs (PM.5-3(e))

STEP 10: Foregone NED Benefits (PM.5-4).
STEP 11: Reduced Negative EQ Effects (PM.5-5).
STEP 12: Increased Negative EQ Benefits (PM.5-6).
STEP 13: Measure Evaluation (PM.5-7).
STEP 14: Develop Water Conservation/Supply Plan (PM.6-2,6-3).
STEP 15: Supply Reliability Considerations (PM.6-4).
STEP 16: Documentation.

Future Growth and Projections: Presents the perspective of the area being studied, including local projections of population, housing and other relevant available factors.

Water Systems and Available Resources: Includes local, regional and other sources of water, infrastructure, safe yield, treatment capacity, future sources and costs of current and future water. This section also includes descriptions of the wastewater system(s) that serve the area.

Local Government Administration: Describes the water purveyor or local government role in water supply, as well as other entities that could be involved in the implementation of the water conservation measures planned for the future.

This introduction includes graphs of trends and projections, maps of jurisdictions and other relevant data that can be used in the STEPS that follow.

STEP 1: UNIVERSE OF WATER CONSERVATION MEASURES (ALL LEVELS)

LEVELS 1-4

1. Develop a list of water conservation measures to address possible water conservation in the private and public sectors.

- o Use information provided in this Handbook for some options that are available. (Table B-1)
- o Use other sources (ie., journals, vendor information, state certification, etc.) in structuring a list for consideration and evaluation.

2. Prepare list in format of Table B-1 to facilitate analysis (see Section 4 for discussion).

STEP 2: APPLICABILITY (FOR ALL LEVELS)

LEVELS 1-4

Applicability defines those conservation measures that are already implemented or planned by local, regional, state or other authority, either totally or partially. It is necessary to identify all water conservation measures that are already implemented or are planned and, therefore, are not available for use (or are available for improved implementation if they are only partially implemented).

Determine by questionnaire keyed to STEP 1, Table B-1:

1. What water conservation measures are now in use or planned?

o Planned includes measures that are "on the books" and capable of being activated, or have been introduced into water demand analysis to reduce future water use projections.

- o What water users are affected?

TABLE B-1

POTENTIAL WATER CONSERVATION MEASURES

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
REGULATION			
LONG-TERM			
Federal & State Laws & Policies			
A. Federal Laws and Policy			
B. State Policy			
1. Plumbing Code			
2. Other Policy			
Local Codes & Ordinances			
A. Plumbing Codes for New Structures			
1. Low-flow showerheads			
2. Shower flow restrictors			
3. Toilet dams			
4. Displacement devices			
5. Flush mechanisms			
6. Low-flush toilets			
7. Pressure toilets			
8. Dual-flush toilets			
9. Faucet aerators			
10. Faucet restrictors			
11. Pressure reducing valves			
12. Service line restrictors			
13. Insulated hot water lines			
14. Pre-mixed water systems (thermostatic mixing valves)			
15. Low water-using clothes washers			
16. Low water-using dishwashers/ appliances			
17. Dry composting toilets			
18. Grey water systems (reuse)			
19. Leakage repair (private systems)			
20. Industrial recycle			
B. Plumbing Codes--retrofitting			
1. Low-flow showerheads			
2. Shower flow restrictors			
3. Toilet dams			
4. Displacement devices			
5. Flush mechanisms			
6. Low-flush toilets			
7. Pressure toilets			
8. Dual-flush toilets			
9. Faucet aerators			
10. Faucet restrictors			

TABLE B-1 (CONTINUED)

WATER CONSERVATION MEASURES

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
11. Pressure reducing valves			
12. Service line restrictors			
13. Insulated hot water lines			
14. Pre-mixed water systems (thermostatic mixing valves)			
15. Low water-using clothes washers			
16. Low water-using dishwashers/ appliances			
17. Dry composting toilets			
18. Grey water systems (reuse)			
19. Leakage repair (private systems)			
20. Industrial recycle			
C. Sprinkling Ordinances			
1. Alternate day			
2. Time of Day			
3. Hand-held hose			
4. Drip irrigation techniques			
D. Changes in Landscape Design			
E. Water Recycling			
Restrictions			
A. Rationing			
1. Fixed allocation			
2. Variable percentage plan			
3. Per capita use			
4. Prior use basis			
B. Restrictions on Specific Uses			
1. Recreational uses			
2. Commercial & Industrial uses			
3. Car washing			
CONTINGENT (For Declared Drought)			
Local Codes & Ordinances			
A. Sprinkling Ordinances			
B. Water Recycling			
Restrictions			
A. Rationing			
1. Fixed allocation			
2. Variable percentage plan			
3. Per capita use			
4. Prior use basis			
B. Restrictions on Specific Uses			
1. Recreational uses			
2. Commercial & Industrial uses			
3. Car washing			

TABLE B-1 (CONTINUED)

WATER CONSERVATION MEASURES

WATER CONSERVATION MEASURES	APPLICABLE	TECH. FEASIBLE	SOCIALLY ACCEPTABLE
MANAGEMENT			
LONG-TERM			
Leak Detection			
Rate-Making Policies			
A. Metering			
B. Rate design			
1. Marginal cost pricing			
2. Increasing block rates			
3. Peak load pricing			
4. Seasonal pricing			
5. Summer surcharge			
6. Excess use charge			
Tax Incentives & Subsidies			
CONTINGENT			
Rate-Making Policies			
A. Rate design			
1. Marginal cost pricing			
2. Increasing block rates			
3. Peak load pricing			
4. Seasonal pricing			
5. Summer surcharge			
6. Excess use charge			
EDUCATION			
LONG-TERM			
Direct Mail			
News Media			
Personal Contact			
Special Events			
CONTINGENT			
Direct Mail			
News Media			
Personal Contact			
Special Events			

o How many services are affected by this measure? For each class? For current water use? For future new water use?

o Is the measure effectively used? Could it be implemented more effectively?

o Were water conservation measures made available to water customers?- Free? For a Price? How many were obtained by customers? Was a follow-up survey conducted to determine how many were installed? What are the survey results?

2. (Substep initiates analysis to be summarized after STEP 4). Identify for each water conservation measure:

o What action is to be taken? When would the measure be planned for implementation?

o What agency or private group would take the action?

o What class of water use is to be affected? For current water uses? For future/new water uses? For both?

3. (Substep initiates analysis to be summarized after STEP 4). Is a measure to be implemented on a long-term or contingent basis? Specify timing, if intermittent use is planned. (Begin analysis to be summarized following STEP 4).

4. Identify in the STEP 1 Table, Potential Water Conservation Measures, the measures that are:

Applicable (Yes); or Not Applicable (No) because they are currently in use: (a) required by utility policy, (b) required by state or local plumbing code, (3) required by some other authority, or (4) requested for voluntary implementation.

STEP 3: TECHNICALLY FEASIBLE

Water conservation measures are technically feasible or are potentially technically feasible if, when implemented, they actually bring about some measurable reduction in water use, and are technically compatible with the water system in which they will be implemented. A potentially technically feasible measure defines some obstacle to implementation that can be overcome.

LEVELS 1-4

Identify in Table B-1 those measures that are technically feasible (F) and those measures that are potentially technically feasible (P).

LEVEL 1

1. Use literature sources on water conservation measures to achieve a broad understanding of technically feasible options. (An example: Before the Well Runs Dry, A Handbook for Designing a Local Water Conservation Plan. (38)

This publication presents advantages and disadvantages of using many water conservation measures. Also, see other references in the Bibliography.)

2. Use literature on the water system and judgement to assign value to measures.

LEVEL 2

1. Use Level 1 literature as a basis for understanding technical feasibility of water conservation measures.

2. Use "local" literature to supplement the national experience.

LEVEL 3

1. Use Level 2 literature.

2. Contact local water suppliers, wastewater authorities, and state and regional agencies to identify and determine the technical feasibility of each measure. Use questionnaire and direct interviews to gain the needed information and perspective.

LEVEL 4

1. Use Level 3 approach.

2. Supplement with field testing of measures for technical feasibility.

STEP 4: SOCIAL ACCEPTABILITY

A social acceptability analysis is a technique used to determine whether certain water conservation measures are acceptable to the community. Since the number and complexity of factors involved in public attitudes about changes in community policy (ie., adoption of new water conservation measures) is primarily a function of its congruence with the community's dominant social ideologies, the analysis must attempt to measure the harmony of the proposed policy with the community's basic ideology and commitments. Both the number and complexity of factors involved preclude the prediction of community response with certainty. As a result, the goal is to improve the quality of the judgements made as to the probable response a community will make to a proposed measure.

Because of the limited available information on the Level 1-3 examples, this method relies on the national literature and other sources of information on social acceptability of water conservation programs to determine the acceptability of water conservation options. This approach is taken in lieu of the more detailed and site specific data collection activity required in Level 4 by the Procedures Manual which includes:

- Identification of advisors.
- Identification of issues, influential individuals and organizations.
- Sample selection and instrument design (questionnaire).

- o Data collection.
- o Data analysis.
- o Determination of social acceptability.

This approach, using literature data sources and experience of other communities, is based on the assumption that the Level 1-3 communities are typical of other communities, and that the literature on water conservation measures is sufficient to be representative of individual situations. As a result, the following method describes the Level 1-3 approach:

LEVELS 1-4

Use local demographic and economy information to determine the character of the community. Is the community typical with respect to residential, commercial, industrial, multi-family and public composition? Is the community typical with respect to income levels? Are there any reasons why a generalized literature on water conservation social acceptability would not be representative?

LEVEL 1

1. Conduct a literature search of water conservation measures and social acceptability. Summarize the results (similar to Table B-2) according to the three areas of water conservation approach: Regulations, Management and Education (ie., in format of Table B-1). (For atypical communities, a selective search of literature will be required based on nature of the community.)

2. Based on familiarity with the community and the results of the literature survey, identify those measures that are considered socially acceptable.

3. Where literature information is not available (NA), use judgement on the assumed social acceptability responses based on public attitude toward government (ie., measures would be acceptable if they promote more efficient use of resources, cost the public and other users less money, etc.)

LEVEL 2

1. Use Level 1 information.

2. Refine information, if possible, to the locale/region of the project (note: very little data are available to support geographic variation [ie., east vs. west] in attitudes toward acceptance of water conservation. If any regional preferences are distinguishable, they relate to areas that have experienced drought vs. those that have not).

LEVEL 3

1. Use Level 2 information.

2. Contact universities, regional agencies and others for available studies of social acceptability to obtain local information that

TABLE B-2

GENERAL LITERATURE REVIEW'S RESULTS OF THE SOCIAL ACCEPTABILITY OF SPECIFIC WATER CONSERVATION MEASURES

WATER CONSERVATION MEASURES	VERY FAVORABLE	UNFAVORABLE
REGULATION		
LONG-TERM		
Federal & State Laws & Policies		
A. Presidential Policy		
B. PL 92-500	None tested this group	
C. 1977 Amendments (Clean Water Act)		
D. Safe Drinking Water Act		
Local Codes & Ordinances		
A. Plumbing Codes for New Structures		
B. Plumbing Codes--Retrofitting		
C. Sprinkling Ordinances		1
D. Changes in Landscape Design		
E. Water Recycling (Except for Drinking)		1
F. Growth Restrictions	2	1
Restrictions		
A. Rationing (General, not specified)		
1. Fixed allocation		
2. Variable percentage plan		
3. Per capita use		1
4. Prior use basis		1
B. Restrictions on Specific Uses		1*
1. Recreational uses		
2. Commercial & Industrial uses		
3. Car washing		
4. Time/day watering restrictions		1
5. Outside restrictions		
6. Lawn size		1
CONTINGENT (For Declared Drought)		
Local Codes & Ordinances		
A. Sprinkling Ordinances		
B. Water Recycling		
C. General Useage Control	1	
Restrictions		
A. Rationing (General, not specified)		
1. Fixed allocation		
2. Variable percentage plan		
3. Per capita use		
4. Prior use basis		

*Generally against all restrictions.

TABLE B-2 (CONTINUED)

WATER CONSERVATION MEASURES	VERY FAVORABLE	UNFAVORABLE
B. Restrictions on Specific Uses		
1. Recreational uses		
2. Commercial & Industrial uses	2	
3. Car washing		
4. Time/day water restrictions		
5. Outside use restrictions	1	
6. Lawn size		
MANAGEMENT		
LONG-TERM		
Leak Detection		
Rate-Making Policies		
A. Metering	4	
B. Rate design		
1. Marginal cost pricing		
2. Increasing block rates		2
3. Peak load pricing		
4. Seasonal pricing		1
5. Summer surcharge		
6. Excess use charge		
Fine for Mis-use	1	
Tax Incentives & Subsidies		
CONTINGENT		
Rate-Making Policies		
A. Rate design		
1. Marginal cost pricing		
2. Increasing block rates		2
3. Peak load pricing		
4. Seasonal pricing		
5. Summer surcharge		
6. Excess use charge	1	
Fine for Mis-use	2	
EDUCATION		
LONG-TERM	3	
Direct Mail		
News Media		
Personal Contact		
Special Events		

TABLE B-2 (CONTINUED)

WATER CONSERVATION MEASURES	FAVORABLE	UNFAVORABLE
CONTINGENT		
Direct Mail	2	
News Media		
Personal Contact		
Special Events		
New Supplies	1	
Leak Detection	1	
"Voluntary Measures" (Drought)	2	
Cooperation During Drought	1	
Devices	1	
System Overhaul		1

may be available. Contact water managers for local impressions, however, previous experience indicates that they do not necessarily have a good perspective of the customers' attitudes.

LEVEL 4

1. Use Level 3 information.

2. Prepare a social acceptability survey to obtain primary data. An example format is available in the Procedures Manual (Appendix B).

3. Collect information on preferences from customers:

- o Residential.
- o Multi-family.
- o Commercial/industrial.
- o Public/institutional.

Summary of Level 1 Measures From Screening

The results of STEPS 1-4 screening should be summarized. This requires the selection of water conservation measures that are Applicable (STEP 2), Technically Feasible (STEP 3), and Socially Acceptable (STEP 4). A broad understanding of how these measures would be implemented should also be formulated. Measures that are socially unacceptable and can be modified to ameliorate shortcomings should be identified and modified.

1. Identify the water conservation measures that have successfully passed through the STEPS 1-4 screening.

2. If information is available that indicates certain measures would be socially acceptable, if modified, identify those measures and modify.

3. Identify in broad terms how measures that pass through the STEPS 1-4 screening could be implemented.

STEP 5: IMPLEMENTATION

LEVELS 1 and 2

Conduct an institutional analysis to determine agencies and private sector capabilities and responsibilities for implementing the water conservation measures. The analysis consits of:

1. identify barriers to implementation, if any.

2. Identify agencies, public entities and private organizations with the potential to implement conservation measures, use local contacts, reports and other readily available sources, including experience with similar situations. Use Figure B-2 Authority/Responsibility Matrix, if needed, to assign responsibilities.

FIGURE B-2

AUTHORITY/RESPONSIBILITY MATRIX

Example Entities	AUTHORITY/RESPONSIBILITY					
	Planning	Financing	Distribution	O&M	Promotion	Enforcement
WATER UTILITY						
Fed. Agencies						
U.S. EPA						
U.S. COE						
U.S. B.REC.						
State Authority						
Dept. of Env. Prot.						
Pub. Util. Comm.						
State Energy Agency						
Regional Agencies						
Basin Commissions						
A-95 Review Agency						
Reg. Planning Comm.						
Local Entities						
Cities						
Counties						
Private Interests						
-						
-						
-						
-						

LEVELS 3 and 4

1. Obtain list of agencies and private sector organizations with the potential to implement conservation measures. Use local contacts and directories.

2. Obtain names and telephone numbers of key representatives and contact them to determine willingness of agencies to implement measures, including political/areal coverage, long-term and contingent.

3. Based on analysis of responses, assign implementation responsibilities.

STEP 6: EFFECTIVENESS

Effectiveness relates to the reduction in water use that can be expected from implementation of water conservation measures that have passed through the screening os STEPS 1-4. At all levels, the determination of effectiveness is estimated by the following formula:

$$E_{ijt} = Q_{jt} * R_{ijt} * C_{ijt}$$

Where E_{ijt} = effectiveness of conservation measures i for use sector j at time t, in quantity per unit time (ie., gallons per day).

Q_{jt} = predicted unrestricted water use in sector j at time t, in quantity per unit time (ie., gallons per day).

R_{ijt} = fraction reduction in the use (or loss) of water for sector j, at time t, expected as a result of implementing measure i.

C_{ijt} = coverage of measure i in use sector j at time t, expressed as fraction of sectoral water use affected by conservation measure.

Thus, the determination of effectiveness in STEP 6 requires the estimation of the predicted unrestricted water use, the fraction reduction water use, and the coverage. These three factors are determined in three Substeps:

6.1 Disaggregated Water Demand Forecasts.
6.2 Fraction of Water Demand Reduction.
6.3 Estimate Coverage.
6.4 Analysis of Effectiveness

A final Substep 6.4, Analysis of Effectiveness, presents the future water demand reductions. Note in the Level 1 discussion some general information is presented for all Levels.

LEVEL 1: (Metered Use)

Substep 6.1 Disaggregated Water Demand Forecasts

1. (a) Obtain local water supplier information, billing records by water use class (sector or group), population, previous water use and forecasts, industrial, commercial and public entitites data and peak day use;

1. (b) Or, obtain local water supplier disaggregated water demand forecasts and verify assumptions. Make comparison with trends in growth of population and economic development.

Such forecasts must be disaggregated by customer classes (ie., single family residential, multi-family residential, commercial, industrial, public). They must consider the potential effects of land use and housing changes, changes in the types of industries included in the economic base, changes in water rates, and any other aspects likely to influence water use in the community. Forecasts which meet these requirements should be used, provided that the assumptions about population growth rates, housing mix, industrial growth and composition, and price elasticity of demand for water are reasonable. However, many utility forecasts are extremely naive, such as those which project water use to grow in direct proportion to population (constant gpcd forecasts), with no allowance made for the several factors enumerated above which are likely to substantially affect future gpcd. These forecasts are not acceptable. If acceptable forecasts are not available, then develop disaggregated water demand forecasts.

2. Disaggregate water data by estimates of water use by each group, based on similarity to other areas with disaggregated water use patterns for the following groups:

- residential
- multi-family
- commercial
- industrial
- additional uses (public service, fire, etc.)
- unaccounted-for water

3. Forecast water use by sector based on data availability, trends of past activity and projections of future population, and general economic activity. Express as million gallons per day (MGD).

4. Estimate (1) maximum (peak) day use; (2) average day use; (3) average day sewer contribution; (4) average day water consumption (water not returned to the sewer), and the seasonal and nonseasonal water use for sectors based on literature values and available data. (Nonseasonal water use reflects the lowest rate of water use by a sector during the period of a year.)

5. Project seasonal and nonseasonal water use based on available trends.

(See Level Examples for specific methods and data used here; however, note that numerous forecasting methods are available, ie., references (8), (67).

Substep 6.2: Determine Fraction of Water Use Reduction

1. Use available literature to assign levels of water use reduction to each water conservation measure considered, ie., references (18) and (82).

2. For all Levels of analysis, evaluate the studies obtained for their relevance to the existing situation and critically assess the accuracy of the reported results. Preference is to be given to actual application of water conservation measures over laboratory testing, theoretical estimates, or manufacturers' claims. When actual studies are available, give preference to studies which compare water use "with and without" conservation measures, as opposed to surveys relying upon evaluations "before and after" the enactment of measures. Evaluate the amount of judgement required to derive the reported results and the effort undertaken in the study to provide controls or account for other influences such as normal variations in water use. Be prepared to contact authors to

resolve any outstanding questions for otherwise appropriate studies. (This evaluation process is also applicable to all assessments of literature data for fractional reduction data in Levels 2, 3, and 4.)

3. Examine results from the most appropriate studies to be sure they are aggregated by the same water use sectors and flow dimensions as Substep 1, above. If not, but sufficient use data are available, convert the results to those of the disaggregated demand forecast.

4. From the most appropriate studies, determine specifically the percentage reduction of water use that has occurred within each water use sector as a result of the implementation of the conservation measure. This is accomplished by taking the reduction for each water use sector reported in the literature and converting for units when necessary, to obtain the percentage reduction. For example, if the water use reduction for a measure was reported as 48,000 gpd in residential water use, and the unrestricted residential use was 0.6 MGD, then the reduction factor for this measure is 0.08 (.048/.6 = .08). Occasionally, reductions are reported in the literature on the basis of per capita reduction. To convert this to a percentage reduction, additional data on the unrestricted per capita use is required or must be estimated. The percentage reduction for a water use sector would then be the per capita reduction for that use sector divided by the unrestricted per capita use in that use sector. All studies used for determining reduction factors should have a coverage of 100% (1.0). If not, the reduction factors determined must be divided by the actual coverage achieved by the study as reported in the literature.

Substep 6.3: Determine Coverage

1. Estimate for each water use sector, based on expected implementation conditions in the study area and literature:

- the portion of the sector that will implement the conservation measure (consider partial coverage voluntary or mandatory application) and phasing of implementation (only new facilities or all).

2. Summarize the coverage for each water use sector.

General Information:

A. Evaluate the implementation conditions expected to be encountered when the water conservation measure is to be initiated and those throughout the planning period. This is accomplished by assessing the level of effort, commitment, and funding to be provided by the responsible agencies and comparing these to the coverage achieved for similar measures under similar conditions in the literature. This requires information or assumptions regarding how agencies will carry out the water conservation programs.

B. Determine the coverage as a percentage of flow within each use sector which is impacted by the implementation of a measure. For Level 1 and 2 analysis, the coverage factor is considered equal to the fraction of water users within a water use sector who are actually impacted by the implementation of a measure. This determination is appropriate unless certain classes of users within any use sector are known to vary considerably in their use of water, and these atypical users are not receiving the same emphasis in implementation as typical users. For example, if a few industries are particularly high water users, and they are targeted to receive special attention during the conservation program, then the Level 1 and 2 analysis is not appropriate, and a Level 3 or 4 analysis should be applied. A Level 1 or 2 analysis requires an estimate of the number of water customers within residential, commercial, industrial and other water use categories.

C. Evaluate how the coverage of the implemented water conservation measures varies with time during the planning period. Measures such as conservation ordinances for new construction or phased leak detection programs have increasing coverage with time. Factors such as failure to replace devices after their serviceable life or decreases in funding for programs reduces coverage.

For conservation measures that are determined to vary with time, modify the coverage factor determined in "B" above on an annual basis, in accordance with the determined variance (see Chapter 3, Residual Water Conservation Program Effects). When a measure is assumed to vary uniformly with time, this modification can be accomplished by multiplying the previous year's coverage by the annual ratio of change in the coverage value. For example, when a conservation ordinance requires new construction to contain water-conserving devices and the community has an annual rate of new construciton of 3 percent, multiply the previous year's coverage by a ratio of 1.03 to obtain the new coverage values (coverage cannot exceed 1.0 or drop below 0). For changes that occur abruptly, such as a substantial drop in funding, simply change the coverage appropriately for the year the change occurs and all subsequent years that the change remains in effect. Some data on changes in coverage with time will be available from the literature. Otherwise, reasonable judgement is required to evaluate when a conservation measure may vary with time and by what magnitude it will change.

LEVELS 1-4: Non-Metered Use and Aggregated Billing Systems

Substep 6.1: Disaggregate Water Demand Forecasts

Non-metered water use and aggregated billing systems pose problems in analysis of the effectiveness of water conservation measures. As a result, additional disaggregated information is needed to permit an analysis of water reduction (Substep 6.2) and coverage (Substep 6.3).

Non-metered Systems

Objective: To obtain local site-specific information on water use from the study area in order to produce disaggregated water demand forecasts, estimates of seasonal and nonseasonal use and a minimum basis for water use projections by use sectors.

This method is essential for determining accurate information in situations where project costs of supply alternatives are significant and study time and budgets are sufficient to permit an effective study approach. Also, because of the extent to which non-metered systems prevail, this method must be considered. The necessary information can only be obtained by metering and collecting community data.

"At a minimum" according to the Procedures Manual, "residential, non-residential and public/unaccounted-for water use should be separated." The study design for this approach will consider this minimum, if it will be sufficient. A more detailed design (ie., see Customer Class categories used in Handbook examples) will be directed at determining: (1) residential (including indoor uses and outdoor uses, such as lawn irrigation and car washing), (2) commercial (including water use for retail and wholesale trade, offices, hospitals, schools, medical laboratories, restaurants, service industries, etc.), (3) industrial (including all water used by manufacturing industries as an input to production processes), (4) additional uses (including public service uses, ie., fire protection), and (5) unaccounted-for water (ie., leaks and fire hydrant flushing).

1. Determine the least number of meter connections that will be needed to accurately sample water use by each water using sector. (Plan to meter all anticipated intensive water users).

2. Purchase and install meters.

3. Initiate data management system.

4. Read meters on a monthly basis for a period 24 to 36 months.

5. Review data, check meters, and evaluate results.

These data will provide necessary input for Levels 1-4 situations, and permit consideration of a broader range of conservation measures, including metering and related pricing structures.

Aggregated Billing System (Metered)

Objective: To obtain local site-specific disaggregated information on water use by customers on an aggregated billing system which is metered. Such systems may be evaluated following modification to current meter reading and billing procedures.

1. Code customer accounts according to water use sectors: residential, commercial, industrial, additional uses and unaccounted-for water.

2. Establish a data management system for the newly-designated categories.

3. Read meters of coded water users for a period of one to three years.

4. Use results of meter readings to produce a disaggregation of annual water use. (Trends in water use may be estimated by applying results to previous years of disaggregated data.)

Substeps 6.2 and 6.3

Prepare estimates of fraction of water use reduction and coverage according to methods for the appropriate level described in this section.

LEVEL 2: (Metered Use)

Substep 6.1 Disaggregated Water Demand Forecasts

1. (a) Collect local data from water suppliers and wastewater utilities, including flows by season, billing records and water use by user sector, population data and projections, industry and economic data.

1. (b) Or, obtain local water supplier disaggregated water demand forecasts and verify assumptions. Make comparison with trends in growth of population and economic development (see discussion under Level 1, Metered Use).

2. Disaggregate water use (if not already) by analysis of users. Use manual approach to separate largest users (ie., industry) and divide remaining water use between residential and non-residential categories according to meter size. Use literature, previous studies and judgement in producing a disaggregated estimate of water use by sector.

3. Forecast water use based on a shift share analysis, and express as millions of gallons per day (MGD).

- project total water use based on trend analysis.
- apply shift-share analysis techniques to determine various changes in fraction of disaggregated water use by sector (use planning agency and similar sources as input to support changing shares, ie., residential use is currently 50 percent, and trends in community development suggest it will increase to 55 percent).

4. Estimate (1) maximum (peak) day use; (2) average day use; (3) average day sewer contribution; and (4) average day water consumption (water not returend to the sewer), and seasonal and nonseasonal water uses for sectors based on literature values and available data. (Nonseasonal water use reflects the lowest rate of water use by a sector during the period of a year.) Seasonal use is the difference between total use and nonseasonal use (the minimum water supply flow), and can be determined by comparison of water supply output and wastewater treatment plant input.

5. Project seasonal and nonseasonal water uses for each sector based on knowledge of local sectors (ie., industries and their responses to water quality regulations and changing water uses), as well as literature.

Substep 6.2: Determine Fraction of Water Use Reduction

1. Use available literature to assign levels of water use reduction to each water conservation measure considered.

Substep 6.3: Determine Coverage

1. For first estimates, use available literature on coverage for each conservation measure and water use sector.

2. Adjust coverage estimates with knowledge of the study area and based on social acceptability analysis (STEP 4, Level 2, where geographic sensitivity was introduced to identify percent of population that would implement measure).

3. Summarize the coverage for each water use sector.

LEVEL 3: (Metered Use)

Substep 6.1: Disaggregate Water Demand Forecasts

1. (a) Collect data, reports, available surveys.

- local demographic data relevant to each sector, including past trends and available forecasts.

- local water use and projections, billings, flows, wastewater flows from local water suppliers and wastewater authorities.

- economic trends, lists of industries, sales, production, expansion plans.

- obtain state agency reports on major water-using industry and plans for future water withdrawal and contingency supply.

- obtain information on allocations and limits on withdrawal and use.

1. (b) Or, obtain local water supplier disaggregated water demand forecasts and verify assumptions. Test sensitivity of forecasts by considering alternative growth scenarios. Tests may be run on water supplier models, if they are suitable for such analysis.

2. Conduct telephone surveys of major water users in each sector.

- determine current water uses and future plans for water use.
- determine potential for major changes (increases or decreases) in water use, including causes and degree of change.

3. Based on data collection effort and telephone survey, disaggregate water use to residential, commercial, industrial, additional uses and unaccounted-for water use.

4. Forecast water use based on regression model techniques or a modified reduced version of the IWR MAIN Model for each sector of water user, and express as millions of gallons per day (MGD).

5. Estimate (1) maximum (peak) day use; (2) average day use; (3) average day sewer contribution, and (4) average day water consumption (water not returned to the sewer), and seasonal and nonseasonal water use based on analysis of available data from the water supplier and wastewater utilities for each use sector. Use the method of difference between total use and minimum water supply flow (nonseasonal) to determine seasonal use.

6. Project seasonal and nonseasonal water uses for each sector based on knowledge of the local sectors from available data.

Substep 6.2: Determine Fraction of Water Use Reduction

1. Use available local literature and studies to assign levels of water use reduction to each conservation measure considered.

Substep 6.3: Determine Coverage

1. For first estimate, use available literature on coverage for each conservation measure and water use sector.

2. Adjust coverage estimates with knowledge of study areas and based on social acceptability analysis (STEP 4, Level 3, local information regarding experience with conservation measure testing and experience with drought).

LEVEL 4: (Metered Use)

Substep 6.1: Disaggregate Water Demand Forecasts

1. (a) Collect data, reports, available surveys.

- local demographic data relevant to each sector, including past trends and available forecasts.

- local water use and projections, billings, flows, wastewater flows from local water suppliers and wastewater authorities.

- economic trends, lists of industries, sales, production, expansion plans.

- obtain state agency reports on major water-using industry and plans for future water withdrawal and contingency supply.

- obtain information on allocations and limits on withdrawal and use.

1. (b) Or, obtain local water supplier disaggregated water demand forecasts and verify assumptions. Test sensitivity of forecasts by considering alternative growth scenarios. Tests may be run on water supplier models, if they are suitable for such analysis. Other models, (ie., IWR MAIN) could be used in verification.

2. Conduct a limited telephone survey of major water users in each sector.

- determine current water uses and future plans for water use.
- determine potential for major changes (increases or decreases) in water use, including causes and degree of change.

3. Based on data collection effort and telephone survey, disaggregate water use to residential, commercial, industrial, additional uses and unaccounted-for water uses. Express as millions of gallons per day (MGD).

4. If appropriate, collect data for input to the IWR MAIN computer model or comparable forecasting method.

5. Prepare water use forecasts by user sector.

6. Estimate (1) maximum (peak) day use; (2) average day use; (3) average day sewer contribution, and (4) average day water consumption (water not returned to the sewer), and seasonal and nonseasonal water use based on analysis of available data from the water supplier and wastewater utilities for each use sector. Use the method of difference between total use and minimum water supply flow (nonseasonal) to determine seasonal use.

7. Project seasonal and nonseasonal water uses for each sector.

Substep 6.2: Determine Fraction of Water Use Reduction

1. Use available literature to assign levels of water use reduction to each conservation measure considered.

Substep 6.3: Determine Coverage

1. Use Level 3, methods 1 and 2 and supplement with results from the social acceptability survey.

STEP 7: ADVANTAGEOUS EFFECTS (Indirect)

A. Description of Conservation Measures (Information from STEPS 7 and 8)

Assumptions and/or actual data are needed regarding the local water conservation program in order to determine the extent of advantageous and disadvantageous effects, especially for high level computations (ie., Levels 3 and 4). Basic information is needed for:

- Types of devices to be distributed and installed.
- Percentage of households, commercial businesses, industries receiving devices.
- Timing of distribution.
- Methods of distribution.
- Percentage of device removal and/or alternation.
- Discount rates and amortization periods for developing present value estimates.

B. Conservation Effects

Summarize the effect of the water conservation measures proposed, the safe yield of system supplies and the likely scheduling of new water supplies to meet the future demand, for average day and peak day water use. Indicate the effect of alternative projections (ie., high and low demands).

C. Advantageous Effects (Indirect)

Evaluate the advantageous effects to water system users, including possible:

- o Energy savings.
- o Bill reductions.
- o Other cost reductions.

LEVEL 1

1. Identify potential advantageous effects from energy reduction based on assumed distribution and use (A) above).

2. Use literature parameters to determine foregone costs of energy reduction from similar situations.

3. Review/identify other potential sources of advantageous effects.

LEVELS 2 AND 3

1. Identify potential energy reduction advantageous effects based on assumed distribution and use (A above).

2. Use literature parameters to determine foregone costs.

3. Identify other potential sources of advantageous effects and estimate cost savings to residential, commercial and industrial users, including improvements related to beneficial effects of conservation devices and reduced water use induced cost reductions.

4. Review study area conditions for relevance.

LEVEL 4:

(Same as Levels 2 and 3 (Tasks 1-4), however, include another Task).

5. Review implementation conditions (STEP 5) and effectiveness to identify possible additional sources of advantageous effects.

STEP 8: DISADVANTAGEOUS EFFECTS (Indirect)

(See STEP 7 A for basis of assumptions).

Substep 8.1: Implementation Costs

LEVEL 1:

1. Based on program assumptions (A above), identify broadly defined implementation costs experienced elsewhere from literature sources for similar water conservation programs.

2. Allocate costs on a per capita or similar basis to the study area; update costs to base year dollars.

LEVELS 2 AND 3

1. Based on assumptions (A above) for program devices and distribution, make additional assumptions based on literature for individual or specific implementation costs.

2. Use experience in other programs, in the local area and professional judgement in determining implementation costs.

LEVEL 4

1. Based on input from STEP 4 (social acceptability analysis) and Substep 6.3 (coverage analysis), develop study area specific information concerning program implementation.

2. Obtain local estimates on costs of implementation from implementing agencies, including:

- Devices.
- Distribution (material and labor).
- Newsletters (design and printing).
- Television/radio time.
- Other items.

Substep 8.2: Other Disadvantageous Effects

LEVELS 1 and 2

1. Identify possible sources of other disadvantageous effects.

- Lost consumer surplus.
- Environmental effects.

2. Review literature for estimates of the significance of these losses.

LEVEL 3

(Same as Levels 1 and 2 (Tasks 1 and 2), however, include other Tasks).

3. Estimate the value of lost consumer surplus based on assumptions of changes in water demand induced by relevant water conservation measures and lost satisfaction and inconvenience related to use of the measure.

4. Estimate the value of negative environmental effects based on assumptions of impact of water conservation measures on quality of landscaping, gardening, etc.

LEVEL 4

(Same as Level 3, however, include Task 5.)

5. Use input from STEP 4 to determine some site-specific information on perceived community impacts.

STEP 9: FOREGONE SUPPLY COSTS

Benefits of water supply conservation are realized as conservation affects existing water supply plans at the local, Federal and Non-Federal (regional) scales. As a result, methods are needed for estimating the beneficial trade-offs of water conservation for each water conservation measure considered. The following Substeps refer to analysis of:

Substep 9.1: Local Water Supply and Wastewater Plans.
Substep 9.2: Federal Water Supply Plans.
Substep 9.3: Non-Federal (regional) and local component of Federal Plan.
Substep 9.4: External Opportunity Costs.
Substep 9.5: Foregone Supply Costs.

Substep 9.1: Local Water/Wastewater Plans

Foregone supply costs relate to operations (short run incremental costs) and future long-run capital costs. Savings in future costs relate to the quantities of water saved in the future (not treated and pumped) and the sizing reductions and delays of facilities. These values are calculated based on present value analysis for the four level examples.

LEVELS 1-4

1. Collect historic water supply and wastewater system operations data on existing and planned activities. Obtain from annual reports and other available literature.

2. Disaggregate cost data to the following categories:

	VARIABLE COST DATA (FLOW RELATED)		
Water Supply	Labor	Materials	Services
- storage			
- treatment			
- distribution			
Wastewater*			
- collection			
- treatment			
- discharge			

*Costs responsive to changes in wastewater volume, only.

3. (a) Determine present value costs and/or project future trends of data by simple extrapolation methods for water supply and wastewater activities for Task 2 categories:

- o Existing operations.
- o Future operations.

3. (b) Or, obtain water supply and wastewater utility projections and verify assumptions and techniques.

4. Obtain water supply and wastewater system capital improvement plans (if available) and identify future sources of water and planned wastewater facilities, including:

CAPITAL IMPROVEMENTS

CAPITAL COSTS	$ COST/(YEAR)*	PLANNED START-UP DATE	CAPACITY (MGD)
WATER SUPPLY			
Reservoirs			
Source Works			
Raw Water Transmission			
Treatment Facilities			
Finished Water Storage			
Finished Water Transmission			
Other Facilities			
WASTEWATER**			
Plant Expansion			

*Note year for which cost was specified, ie., (1980) dollars.

**Costs relate to planned improvements anticipated because of increase in wastewater volume, only.

5. Determine incremental foregone supply costs (water supply and wastewater systems) for each water conservation measure based on Tasks 2 and 4 expressed as constant ($/gallon) times (gallons water reduction).

Substep 9.4: External Opportunity Costs

LEVELS 1 AND 2

1. Identify water reduction impacts to groups/individuals other than suppliers and users:

- Who will experience these impacts?
- Are water reductions and impacts large?

2. If groups or individuals are identified, estimate impacts ($) for large/significant external opportunity costs based on literature estimates.

LEVELS 3 AND 4

(Same as Levels 1 and 2 analysis [Tasks 1 and 2] with additonal Task.)

3. Contact local officials and review social acceptance study of the study area to help identify impacted groups and individuals.

Substep 9.5: Measure Foregone Supply Costs

LEVELS 1-4

1. Combine results for each measure of previous steps:

- Effectiveness Analysis (STEP 6)
- Supply Cost Reduction (STEP 9)

2. Identify results (summarize) by the following categories:

- Average day use.
- Maximum day use, and
- Average day sewer contribution.

3. Present results as present values or uniform annualized series (note: the lumpiness of all benefits suggests an approach that focuses on present value analysis).

- Discount non-uniform streams to present value.
- Re-Annualize present values to uniform streams, if appropriate.

STEP 10: FOREGONE NED BENEFITS

LEVELS 1-2

1. Based on available data from Federal Multi-Purpose Plan:

o Identify water supply plan (conservation reduction) impacts on non-water supply activities. Consider:

- Recreation
- Hydropower
- Flood Control
- Others

o Use judgement in estimating percentage changes (minimal, moderate, significant) in reduced benefits and quantify foregone net benefits (loss in NED benefits associated with proposed water conservation measures).

LEVELS 3-4

1. Based on available DATA:

- o Identify water supply plan (conservation reduction) impacts on non-water supply components of Federal Plan. Consider:

  - Recreation
  - Hydropower
  - Flood Control
  - Others

- o Estimate change in NED net benefits resulting from smaller reservoir design or other project changes. Estimate:

  - Change in NED benefits.
  - Change in NED costs.

- o Estimate similar changes in hydropower, flood control, etc.

STEP 11: REDUCED NEGATIVE EQ EFFECTS

LEVELS 1 AND 2

1. Based on Federal Multi-Purpose Plan (with water supply component), identify potential reductions in negative EQ environmental impacts (improved environment) resulting from proposed water conservation measures. Consider environmental impacts of water conservation measures, such as:

- Conservation leads to possible (1) increased stream flow, (2) reduced subsidence due to groundwater overdraft, and (3) reduced reservoir drawdown.

- Conservation leads to postponed, scaled down and/or avoided water supply facilities and resulting reduced negative environmental EQ effects.

2. Use judgement, modify Federal Plan Water Supply Component based on new assumptions, and describe avoided or postponed environmental effects. Summarize findings.

LEVELS 3 and 4

(Same as Levels 1 and 2 [Task 1] with Tasks 2-4 as follows:)

2. Evaluate the impact of proposed Federal Project modifications on water resources (ie., stream flow, groundwater drawdown, reservoir drawdown).

3. Contact Federal Plan sponsors (telephone interview) and discuss findings. Identify potential impacts and EQ reduced negative effects.

4. Describe and quantify results of reduced environmental impacts, if possible, and summarize.

STEP 12: INCREASED NEGATIVE EQ EFFECTS

LEVELS 1 and 2

1. Based on Federal Multi-Purpose Plan (with water supply component), identify potential increases in negative EQ environmental impacts resulting from water conservation measures:

- Conservation of water may postpone a large Federal project and require a staged series of local, smaller, more environmentally harmful alternatives.

2. Describe impacts for each conservation measure.

LEVELS 3 and 4

(Same as Levels 1 and 2 [Task 1] with Tasks 2 and 3 as follows:)

2. Obtain local views on potential environmental impacts from the water consrevation program changes. Contact state environmental agencies and U.S. EPA, for example, to determine views on impacts and relative beneficial and negative effects.

3. Describe environmental changes and summarize negative EQ effects.

STEP 13: MEASURE EVALUATION

LEVELS 1-4

1. Summarize Advantageous and Disadvantageous Effects. Use Table format in the Procedures Manual (Table 5-1). Prepare one Table concerning NED effects and one for EQ effects.

2. Input to NED Table results of STEPS 7, 8, 9 and 10 for NED Table for each conservation measure.

3. Input to EQ Table results of STEPS 7, 11 and 12 for EQ Table for each conservation measure.

4. Evaluate each measure that has passed the applicability (STEP 2), technical feasibility (STEP 3), and social acceptability (STEP 4) by the following criteria:

- Combined advantageous NED effects must outweigh the combined disadvantageous NED effects, and

- Combined advantageous EQ effects must outweigh the combined disadvantageous EQ effects.

Measures that pass these tests can be integrated into the Federal plan (carry forward measures that fail test for STEP 14).

STEP 14: DEVELOP WATER CONSERVATION/SUPPLY PLAN

LEVELS 1-4

1. Rank water conservation measures, feasible and potentially feasible, in merit order:

- o Determine ranking criteria:
  - Maximize NED objective. Arrange measures in order of decreasing net NED advantage (sum of all advantageous NED effects less the sum of all disadvantageous NED EFFECTS).
  - Maximize EQ objective. Arrange measures in order of decreasing net EQ advantage (sum of all advantageous EQ effects less the sum of all disadvantageous EQ effects). Use judgement since quantification of differences is subjective. Rank based on decreasing NED advantage if environmental differences are indistinguishable.
  - Combined NED and EQ objective. Arrange measures in order of decreasing combined NED and EQ advantage for plans in consideration.
- o Rank water conservation measures according to selected criteria.

2. Consider interactions.

- o Evaluate interactions between measures.

3. Develop plan which maximizes NED net benefits.

- o Add merit order projects to achieve maximum net contribution to NED objective.
- o Reduce net NED advantages if interactions between measures reduces water conservation effect of combination.
- o Add measures until next measure in the merit order fails to contribute to the net NED effect.

4. Consider environmental impacts.

5. Consider potentially feasible or potentially acceptable measures, if necessary.

- o Measures that did not pass Task 4 (STEP 13) are categorized as "potentially feasible" or "potentially acceptable".

- Are these measures in the Plans developed in Tasks 3, 4 and 5?

o Plans that contain any "potentially feasible" or "potentially acceptable" measures should be reformulated on the same criteria, however, excluding the "potentially feasible" or "potentially acceptable" measures.

o Contrast the two plans to determine the consequences of not implementing potentially acceptable measures.

o Described the results of the comparison.

6. Describe the selected plan by year and cost.

STEP 15: SUPPLY RELIABILITY CONSIDERATIONS

LEVELS 1-4

1. Identify sources of potential reliability problems in providing water supply with water conservation program implementation.

2. Estimate "without" water conservation program, ability of water supply system to meet drought of record (use literature sources).

3. Estimate "with" water conservation program, ability of water supply system to meet drought of record (use literature sources).

4. Compare Tasks 2 and 3 to determine reliability of "with" project plan.

5. Consider available literature for drought contingency plan--does system meet drought of record conditions? Or, obtain available drought contingency plan from water supplier.

- Evaluate plan capability.

- Compare plan capability with drought of record results in Task 4.

- Recommend modifications if not sufficiently capable.

STEP 16: DOCUMENTATION

LEVELS 1-4

Fully document water supply/conservation plan.

APPENDIX C

DATA REQUEST FORMS, QUESTIONNAIRES
INFORMATION REQUIREMENTS

APPENDIX C
DATA REQUEST FORMS, QUESTIONNAIRES, INFORMATION REQUIREMENTS

This Appendix includes three sets of letters, forms, tables and questionnaires designed to identify and request the various data required from water purveyors. These are:

Part 1: Letter and Checklist

Part 2: Letter and Data Collection List

Part 3: Letter and Tables 1, 2 and 3

These forms provide guidance in defining the data and information required for developing a water conservation plan, and also provide direction to the water purveyors and alert them to the dimensions of the data needs and detail required.

A successful approach at collecting these data involves minimization of the number of times data are requested and a clear description of the data required.

The Greeley-Polhemus Group, Inc.
418 Roundhill Road
St. Davids, Pennsylvania 19087
(215) 688-2176 • (215) 793-1562

Dear

THE GREELEY-POLHEMUS GROUP, INC. (GPG), is under contract with the U.S. Army Corps of Engineers, Engineer Institute for Water Resources to develop a Handbook of Methods for the Evaluation of Water Conservation for Municipal and Industrial Water Supply, (Handbook of Methods). This research will produce a handbook of four illustrative examples that demonstrate the application of a previously prepared study: The Evaluation of Water Conservation for Municipal and Industrial Water Supply: Procedures Manual, (Procedures Manual).

This project will demonstrate how a water conservation program, as one part of a water resources development program, (which in the broadest context includes supply augmention and water conservation), can be developed for water supply systems (public and private organizations) that span a range of data availability characteristics. The focus of this project will be on applying the Procedures Manual to four selected cases and developing a Handbook of Methods with illustrative cases that can be used by District, Corps of Engineers personnel in developing water conservation program elements and assessing program effectiveness and impacts for other water supply systems.

As you know from our recent telephone conversations, the GPG is in the process of selecting water supply organizations/ systems that will be the subject of these illustrative examples. We are very interested in your organization as a candidate for one of the four examples. The objective will be to select four organizations that cover a range of data availability spanning four levels, from complete data availability (Level 4) as required by the previously prepared Procedures Manual, to minimal data (Level 1). The Handbook of Methods, which GPG will develop, will provide techniques for filling in data voids for each of the incomplete data sets in order to achieve the complete data required by Procedures Manual.

THE GREELEY-POLHEMUS GROUP, INC.

HANDBOOK OF METHODS/WATER CONSERVATION PROJECT:
U.S. ARMY CORPS OF ENGINEER INSTITUTE FOR WATER RESOURCES

WATER SUPPLY SYSTEM CHECK LIST

Name/Address of Water Supply Organization: ______________________

____

____

Contact/Respondee name and title: ______________________

____

Telephone Number: ______________________

Is your organization willing to cooperate with THE GREELEY-POLHEMUS GROUP, INC., on this project over the next 6 - 8 months?

_______ Yes _______ No

Does your organization also manage wastewater collection (___Yes, ___No); and treatment (___Yes, _____No)? Do you serve the same water supply area (___Yes, ___No)?

WATER USE DATA

1. Is your water system fully metered _____% What is not metered?

____

2. Do you have water use data by the following user classes?

	Yes	No	% of Total	Comments
Residential	____	__	__________	______________
internal	____	__	__________	______________
external	____	__	__________	______________
Multifamily	____	__	__________	______________
Commercial	____	__	__________	______________
Industrial		__	__________	______________
Institutional/Public	____	__	__________	______________
Unaccounted	____	__	__________	______________

3. What measures of water user data do you have for the classes identified in question #2?

	Yes	No	Comments
average day	___	___	___
total year	___	___	___
total quarter	___	___	___
peak day	___	___	___
peak hour	___	___	___

4. How are user classes determined?

	Yes	No	Comments
Actual knowledge of customers	___	___	___
Estimated, based on:			___
meter/pipe size	___	___	___
location/type of building	___	___	___

5. Do you have water use data for your largest water users? __Yes, __No (Firms/organizations not to be identified in the project).

6. What water uses are included in "Institutional/Public" and "Unaccounted" for water classes (question No. 2)?

	Yes	No	Comments
Institutional/Public	___	___	___
schools	___	___	___
government buildings	___	___	___
golf courses/parks	___	___	___
hospitals	___	___	___
___			___
___			___
Unaccounted			
leaks	___	___	___
hydrant flushing	___	___	___
fires	___	___	___
___			___
___			___

7. Do you supply all the industry and other largest water user needs?
System supplied % ___
User self supplied % ___

8. What are the major sources of your water supply?
surface water (% of total) ___
groundwater (% of total) ___

9. Are other water companies serving your area? ___Yes, ___No.

10. Is your water system interconnected with other systems?
Number of interconnects? ______________________
Monthly water sales/purchases available ?______________

11. What percent of total water use in your area does your system provide? __________%.

12. Available data records for questions 1-11:

	Yes	No	Comments
water use (5 yrs)	___	__	______________
Number of users (10 yrs)	___	__	______________
wholesale water (5 yrs)	___	__	______________
water production (10 yrs)	___	__	______________
sewer flow (10 yrs)	___	__	______________
water system maps	___	__	______________
pipe sizes (schematic)	___	__	______________
wastewater system maps	___	__	______________

13. Water system program information:

Comments

<u>leak detection program</u> ___Yes ___No ______________
years in operation ______________ ______________
cost data ___Yes ___No ______________

<u>Meter Program</u> ______________
inspection/verification ___Yes
___No ______________
cost data ___Yes ___No ______________

<u>WATER CONSERVATION MEASURES</u>

14. Do you have an active water conservation program? ___Yes ___No.

15. What is the purpose of your water conservation program?

	Yes	No	Comments
drought emergency (short term)	___	__	______________
capital savings (long term)	___	__	______________
other	___	__	______________

16. What conservation measures were utilized? See following Table and respond.

MEASURES	IN USE?	EFFECTIVE? % Water Reduction	CUSTOMER ACCEPTANCE? (Yes/No)	REQ'D BY PLUMBING CODE? (Yes/No)
TECHNICAL/DEVICES/PROCESS CHANGES				
• Residential/Commercial/Public				
flow restrictors				
low flow showerheads				
toilet devices				
etc.				
• Industrial				
process changes				
re-cycle				
etc.				
• Institutional/Agricultural				
drip irrigation				
re-cycle				
etc.				
• Unaccounted for				
leak detection/repair				
reduced reservoir evaporation				
etc.				
POLICY/REGULATORY				
• Plumbing Codes				
• Pricing/Economic				
rate structure				
fines (excess water use)				
incentives (conservation)				
service charges				
• Rationing				
• Restrictions on Use				
lawn watering				
car washing				
• Metering				
• Audits				
• Leak Detection/Repair				
• Public Education				
• Provide Technical Measures				

17. What reduction was achieved in total water use? ________%

____

18. What estimates of water use reduction do you have?

	Yes	No	Comments
Reduction by user category	___	___	________
Reduction by flow category	___	___	________
Avg. Day	___	___	________
Max. Day	___	___	________
Peak Hour	___	___	________
Public Acceptance	___	___	________

19. Briefly describe your water pricing policy.
Was your pricing policy designed with water conservation in mind? ___Yes ___No. If not, what was purpose? ________

____

____

20. Do you have any information on duration of achieved water use reduction (ie., "die-off" of conservation measure effectiveness)? ___Yes ___No.

____

____

21. Was the water reduction effectiveness evaluated for any individual measures? ___Yes ___No.

____

____

REVENUE AND COST DATA

22. Do you have the following financial information for the past 5 years for each user class?

	Yes	No	Comments
1. Water rate schedules	___	___	________
2. Revenues (water sales)	___	___	________
3. Costs (water system)	___	___	________
Fixed Costs	___	___	________
Variable Costs	___	___	________
4. Wastewater rate schedules	___	___	________
5. Revenues (wastewater)	___	___	________
6. Costs (wastewater)	___	___	________

23. Are wastewater charges based on metered use? ___Yes ___No.

SYSTEM WATER SUPPLY PLAN

24. How are you going to meet expanding water needs?

	Yes	No	Comments
Not expanding:			
residential	___	__	________________
industrial	___	__	________________
commercial	___	__	________________
public/institutional	___	__	________________
Expanding:			
residential	___	__	________________
industrial	___	__	________________
commercial	___	__	________________
public/institutional	___	__	________________

25. Do you have a local water supply plan? ___Yes ___No. What is the planning time frame? ____________________(years). Does it include projects for future:

	Yes	No	Comments
surface water development?	___	__	________________
groundwater development?	___	__	________________
additional water conservation?	___	__	________________
distribution system?	___	__	________________

26. Are water demand forecasts or use projections available? ___Yes ___No. What is the projection period? ____________(years). Are demand forecasts available for average daily use? ___Yes ___No; for maximum daily use? ___Yes ___No; for peak hour use? ___Yes ___No.

27. Are water demand projections available by user class? ___Yes ___No. How are these made? ______________________

28. Is the public generally receptive ___ or opposed ___ to the proposed plan?

29. Do you have a drought contingency plan? ___Yes ___No.
   residential use ______________________
   commercial use ______________________
   industrial use ______________________
   others ______________________

30. Is a framework (existing legislation/policy) available to develop a drought contingency plan, if a plan is not now in effect? ___Yes ___No.

CAPITAL BUDGET

31. Describe your water supply budget updating process.
    a. Is it directly tied to your water supply plan process?
       ___Yes ___No.
    b. What is the Budget time frame? ____________(years).
    c. Is it updated annually? ___Yes ___No; How often? ______

32. Is the Budget detailed concerning:

	Yes	No
Storage capital costs	___	___
Distribution system capital costs	___	___
Treatment system capital costs	___	___
Equipment purchases	___	___
Operation and Maintenance relationships? For example:	___	___
labor	___	___
chemicals	___	___
electricity	___	___
fringe/benefits	___	___
Land purchases	___	___

33. What are the major elements of your water supply Budget?

____

____

____

____

____

34. Do you have a wastewater Budget? ___Yes. ___No.

____

OTHER WATER SUPPLY PLANS

35. Do other water supply plans exist for your area with potential to supply water to your system?

FEDERAL PLANS/PROJECTS	DESCRIBE/COMMENTS
Corps of Engineers	______________
Bureau of Reclamation	______________
Soil Conservation Service	______________
______________	______________

REGIONAL PLANS/PROJECTS — DESCRIBE/COMMENTS

River Basin Commission ______________________

Compact Agencies ______________________

STATE PLANS

Water Supply Master Plan ______________________

______________________ ______________________

36. Are State and/or Regional Drought Contingency Plans available covering your area? ___Yes ___No.

DETAILS OF YOUR ORGANIZATION

37. How is your water supply system organized?

____ Private Company ______________________

____ City Agency ______________________

____ County Agency ______________________

____ Authority ______________________

____ District ______________________

____ Other ______________________

38. Does your organization have responsibility for all water system management? ___Yes ___No.
Who else is resposible? ______________________

____

____

39. Is your data system computerized? ___Yes ___No. Can we obtain information about your system to determine for example: costs/units of capacity; costs of delivered water; marginal cost; price elasticity, etc.? ___Yes ___No.

40. Have internal or consultant studies recently evaluated your water supply system? ___Yes ___No.

THANK YOU FOR COMPLETING THIS CHECK LIST. PLEASE RETURN TO:

Van Dyke Polhemus, Vice President
THE GREELEY-POLHEMUS GROUP, INC.
418 Roundhill Road
St. Davids, PA 19087
(215) 793-1562

The Greeley-Polhemus Group, Inc.
418 Roundhill Road
St. Davids, Pennsylvania 19087
(215) 688-2176 • (215) 793-1562

April 9, 1984

Re: Handbook of Methods/Water Conservation Project

Dear

At this time, we are requesting water use and other specific data from the

Information requested represents data requirements for the U.S. Army Corps of Engineers document: The Evaluation of Water Conservation for Municipal and Industrial Water Supply: Procedures Manual, April 1980, which you previously received (ie., Table 4-1). In addition, other data items have been requested which will be used in running the IWR MAIN water forecasting computer model (ref: Forecasting Municipal and Industrial Water Use, IWR MAIN System User's Guide for Interactive Processing and User's Manual, U.S. Army Corps of Engineers, Research Report 83R-3, July 1983).

In some instances, information was previously provided. Please disregard those requests. Also, information is also requested for wastewater systems. Unless your utility provides service for a sewer system also, please disregard these requests unless the information is readily available (advise).

We are assuming 1980 is the Base Year, so we will need data for that year. Projections, when requested, should include information for 1980, 1990, 2000, 2010, 2020, and 2030 (a fifty-year planning horizon), or the best information available.

If you have any questions, please do not hesitate to contact me.

Thank you for your continued cooperation.

Very truly yours,
THE GREELEY-POLHEMUS GROUP, INC.

VDP:MP
Enclosure

Van Dyke Polhemus
Vice President

DATA COLLECTION LIST

HANDBOOK OF METHODS/WATER CONSERVATION PROJECT

1. POPULATION

a. Specify Population for the Base Year. (1980)
b. Specify Future Population Projections - High, Medium, Low with (1) total population and (2) growth rates (Example growth rates - Medium projection: 3%, 1980-1990; 2%, 1991-2000; etc.)
c. Specify any Major Trends Occurring (Example: The community plans to attract high technology industry; build a power plant in 1990, etc. Any "key" items the planning department is examining and the time line for these changes.)

2. WATER UTILITY INFORMATION

A. From Billing Records:

a. Specify Customer Classes (CC) in Base Year.
b. Specify Number of Connections by CC in Base Year and for each of the past ten years.
c. Specify water use per dwelling unit (or connection) for each billing month for each CC for the past 5 years.
   - by CC for Base Year
   - by Month for Base Year
d. Specify the amount of water wholesaled (to other communities) for each month for the past 5 years.
e. Provide a list with the name, address, and amount of water purchased (by month and peak use) for the largest customers. (The identity of these customers will not be revealed in the report.) Of particular interest are golf courses and other facilities that can use re-cycled water (either from wastewater treatment plants, or internally).

B. From Production Records:

a. Specify the total amount of water produced for each month for the past 10 years.
b. Specify (if applicable) the total sewer flow for each month for the past 10 years.

C. From Financial Records:

a. Specify price (rate schedule) of water for the past 5 years (prices in $/1000 gallons).
   - by CC
   - by Method (Example: declining block, constant price, etc.) give the details of the Method for each CC
   - Outline the pricing data if the price switches from "summer" to "winter" months.

b. Specify wastewater (sewer) rates (if applicable) for the Base Year and past 5 years (prices in $/1000 gallons).
   - by CC
   - by Method (Example: declining block, constant prices, etc.)
   - outline unique pricing methods
c. Specify total water revenues for the past 5 years.
d. Specify (if applicable) total wastewater (sewer) revenues for the past 5 years.
e. Specify annual water Operation and Maintenance (O&M) budgets (of actual expenditures) for the past 10 years.
f. Specify (if applicable) annual wastewater (sewer) O&M budgets (or actual expenditures) for the past 10 years.
g. Provide any other information which would assist in determining the relationship between water produced and O&M.

D. From Future Plans:

a. Please provide water demand projections that you are currently using (for 50-year horizon, if available).
b. Specify the assumptions used in preparing water demand projections.
c. Please provide capital improvement programs for water supply system for the next 50 years (or longest future time frame).
d. Please provide sewer flow projections for the next 50 years (if applicalbe).
e. Please provide capital improvement programs for sewer systems (if applicable).

E. From Water Program:

a. Please provide:
   - maps of major sewer and water mains
   - number of miles of water mains of various sizes
b. Please provide:
   - results of past tests for leakage
   - costs of these tests
c. Please provide:
   - description of current metering program
   - current status of meter verification and inspection programs
d. Please provide:
   - any data relating to actual or proposed re-cycling or groundwater recharge plans (treated effluent)
   - current treated effluent water quality conditions
e. Specify any major trends that may be relevant (Example: conversion from unmetered to metered, and other significant changes.)
   - plans, programs, policies that may affect water conservation or drought management
f. Please provide:
   - copy of local plumbing code (if conservation devices required)
   - copy of State plumbing code (if conservation devices required)

- local drought contingency plan
- regional or state drought contingency plan

F. From Other Information:

a. Please provide:

- available data/information related to the effects of water use or changes in water use on <u>other uses</u> of water supply sources. (Example: for surface sources, water use may affect hydroelectric generation, inland navigation, recreation, water supply for other localities, etc. For groundwater sources, water use may be affected by increased plumbing costs to the utility and/or other uses, land subsidence, fish and wildlife impacts, etc.)

The Greeley-Polhemus Group, Inc.
418 Roundhill Road
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(215) 688-2176 • (215) 793-1562

April 23, 1984

Re: Handbook of Methods/Water Conservation Project
Current and Potential Future Water Conservation Efforts

Dear

In addition to the detailed water use information requested in our April 9 letter, we may need additional information in several areas. None of these requests (perhaps 2 or 3 more) will be as extensive as that information already requested. Also, we are trying to package the data/information requests in a manner that will simplify your effort and direct your attention to fairly well-defined areas. This request deals with water conservation measures.

Since the objective of this project is to evaluate the potential for water conservation, as one method for future water supply management (in addition to providing additional water supply augmentation), we need information on the water conservation measures that are currently in use and those measures that will be technically feasible for future use.

1. Please complete the attached table (Table 1: Potential Water Conservation Measures) by indicating measures that are:

APPLICABLE

- * Currently in use (a) Required by utility policy (b) Required by state or local plumbing code, (c) Required by some other authority, or (d) Requested for voluntary implementation (ie., "*a" means currently in use, as a result of your own authority).
- ** Currently but partially implemented (ie., only used in a portion of your service area, or by a portion of a customer class).

TECHNICALLY FEASIBLE

- x Not in use, but technically feasible (will not adversely affect water use (other than flow reduction), if implemented). For example, a sector of your service area has low water service pressure and flow restrictors will adversely affect use. These devices could not be considered technically feasible and would not be checked.
- xx Not in use, but potentially technically feasible.

<u>SOCIALLY ACCEPTABLE</u>

- o Based on your analysis, measure is acceptable to the public.

2. Please complete the attached form (Table 2) for <u>each</u> partially implemented (**) measure.

3. Please complete the attached form (Table 3) of general information.

Thank you very much for your continued cooperation, and if there are any questions, please do not hesitate to contact me.

Very truly yours,
THE GREELEY-POLHEMUS GROUP, INC.

Van Dyke Polhemus
Vice President

VDP:MP
Enclosures

TABLE 1

POTENTIAL WATER CONSERVATION MEASURES[1]:

Water Conservation Measures	Applicable	Technically Feasible	Socially Acceptable
REGULATION			
LONG-TERM			
Federal & State Laws & Policies			
A. Federal Laws and Policy			
B. State Policy			
1. Plumbing Code			
2. Other Policy			
Local Codes & Ordinances			
A. Plumbing Codes for New Structures			
1. Low-flow showerheads			
2. Shower flow restrictors			
3. Toilet dams			
4. Displacement devices			
5. Flush mechanisms			
6. Shallow trap toilets			
7. Pressure toilets			
8. Dual-flush toilets			
9. Faucet aerators			
10. Faucet restrictors			
11. Pressure reducing valves			
12. Service line restrictors			
13. Insulated hot water lines			
14. Pre-mixed water systems (thermostatic mixing valves)			
15. Low-water using clothes washers			
16. Low-water using dishwashers/ appliances			
17. Dry composting toilets			
18. Grey water systems (re-use)			
19. Leakage repair (private systems)			
20. Industrial re-cycle			
B. Plumbing Codes--retrofitting			
1. Low-flow showerheads			
2. Shower flow restrictors			
3. Toilet dams			
4. Displacement devices			
5. Flush mechanisms			
6. Shallow trap toilets			
7. Pressure toilets			
8. Dual-flush toilets			
9. Faucet aerators			
10. Faucet restrictors			
11. Pressure reducing valves			
12. Service line restrictors			
13. Insulated hot water lines			
14. Pre-mixed water systems (thermostatic mixing valves)			
15. Low-water using clothes washers			

[1]See April 23rd letter for evaluation criteria definitions.

TABLE 1 (Continued)

POTENTIAL WATER CONSERVATION MEASURES:

Water Conservation Measures	Applica-cable	Technically Feasible	Socially Acceptable
16. Low-water using dishwashers/ appliances			
17. Dry composting toilets			
18. Grey water systems (re-use)			
19. Leakage repair (private systems)			
20. Industrial re-cycle			
C. Sprinkling Ordinances			
1. Alternate day			
2. Time of day			
3. Hand-held hose			
4. Drip irrigation techniques			
D. Changes in Landscape Design			
E. Water Re-cycling			
<u>Restrictions</u>			
A. Rationing			
1. Fixed allocation			
2. Variable percentage plan			
3. Per capita use			
4. Prior use basis			
B. Restrictions on Specific Uses			
1. Recreational uses			
2. Commercial & Industrial uses			
3. Car washing			
CONTINGENT			
<u>Local Codes & Ordinances</u>			
A. Sprinkling Ordinances			
B. Water Re-cycling			
<u>Restrictions</u>			
A. Rationing			
1. Fixed allocation			
2. Variable percentage plan			
3. Per capita use			
4. Prior use basis			
B. Restrictions on Specific Uses			
1. Recreational uses			
2. Commercial & Industrial uses			
3. Car washing			
<u>MANAGEMENT</u>			
LONG-TERM			
<u>Leak Detection</u>			
<u>Rate Making Policies</u>			
A. Metering			
B. Rate design			
1. Marginal cost pricing			
2. Increasing block rates			

TABLE 1 (Continued)

POTENTIAL WATER CONSERVATION MEASURES:

Water Conservation Measures	Applica-cable	Technically Feasible	Socially Acceptable
3. Peak load pricing			
4. Seasonal pricing			
5. Summer surcharge			
6. Excess use charge			
Tax Incentives & Subsidies			
CONTINGENT			
Rate Making Policies			
A. Rate design			
1. Marginal cost pricing			
2. Increasing block rates			
3. Peak load pricing			
4. Seasonal pricing			
5. Summer surcharge			
6. Excess use charge			
EDUCATION			
LONG-TERM			
Direct Mail			
News Media			
Personal Contact			
Special Events			
CONTINGENT			
Direct Mail			
News Media			
Personal Contact			
Special Events			

TABLE 2: WATER CONSERVATION MEASURES
INFORMATION ON PARTIALLY IMPLEMENTED (**) MEASURES
(Response to Question 2, April 20, 1984 Letter)

1. Water Utility Name: ______________________

2. Type of Water Conservation Measure: ______________

3. Year Measure Implemented: __________

4. Planned for Long Term Use: ____Yes ____No, or

   Drought/Emergency Only ____Yes ____No.

5. Customer Classes Affected (% using measure):

   Residential (Indoor) ________

   Residential (Outdoor) ________

   Commercial ________

   Industrial ________

   Public ________

   Unaccounted for ________

6. Why was measure only partially implemented?

   Condition Expected to Change (Explain)

   ____Budget Limitations ______________________

   ____Personnel Limitations ______________________

   ____Customer Opposition ______________________

   ____Limited Distribution Program ______________

   ____Other ______________________

7. Do you think the measure could be more effectively used?

   ___ Yes ___ No. Explain: ______________________

TABLE 3: WATER CONSERVATION MEASURES
GENERAL INFORMATION
(Response to Question 3, April 20, 1984 Letter)

1. Provide an estimate of the rate of new construction by customer class (new connections/total connections).

	%
Residential	______
Commercial	______
Industrial	______
Public	______

2. Provide an estimate of the annual water conservation budget that will be used to implement future program (1984 $) $________. Is it likely that this budget will be available in future years?

Long Term	____Yes	____No
Short Term	____Yes	____No

Are personnel assigned full-time or part-time? (Circle)

Percent time available, if part-time ______%.

3. Have you conducted any studies (rather than using literature values) on water conservation measures that are currently in use by your utility? Did the studies specify:

a. Water use reduction fraction (the percent reduction in water use resulting from the institution of a conservation measure)?

____ for individual measures by customer class? ___Yes ___No. Specify: ________________

____ for combinations of measures? ____Yes ____No. Specify: ________________

____ for combinations of water use sectors? ___Yes ___No. Specify: ________________

b. Coverage (the fraction of water use, or the fraction of customers) that is actually subject to reduction because (1) the measure has been adopted by only a fraction of users within a customer class; (2) partial coverage may be inherent in the measure (applies only to certain users or areas), and (3) progressive implementation over time affects a larger portion of total water use (ie., plumbing codes which affect new construction? ____Yes ____No.

Specify: ________________

c. Public Acceptance (the willingness of customers in various classes) to utilize water conservation measures?

___Yes ___No. Specify: ______________________________

____

NOTE: FOR QUESTION 3, ATTACH RESULTS.

4. Have you conducted any studies on water conservation measures that are <u>planned for future use</u> (but not now implemented)? Refer to Question 3 categories a, b, and c.:

   a. Reduction? ___Yes ___No. Specify: ____________________

   ____

   b. Coverage? ___Yes ___No. Specify: ____________________

   ____

   c. Public Acceptance? ___Yes ___No. Specify: ____________

   ____

NOTE: FOR QUESTION 4, ATTACH RESULTS.

5. Are the measures addressed in Questions 3 and 4 intended for long-term water conservation? ___Yes ___No, or for drought contingency ___Yes ___No. Specify: ________________________

   ____

6. Have previous water conservation efforts achieved expected results? ___Yes ___No. Specify goals (% reduction desired) and results: ____

   ____

7. If water use reduction data are not available by water user class, are they available by:

   a. Total Use, total pumped or total metered use.

   b. Customer meter size.

   c. Other.

   Specify: ____

8. How was water use reduction determined?

   a. Comparison with and without measure? ___Yes ___No

   ____

   b. Comparison before and after measure (over most recent years; between similar water years)? ___Yes ___No

   ____

9. Are reduction data for average daily flow, peak daily flow, other? Specify: ____

____

10. If public education is now used as a water conservation measure, describe the program: ____Minimal ____Moderate ____Maximum (Not used ____).

Direct Mail ____

____

News Media ____

____

Personal Contact ____

____

Special Events ____

____

Public Effort ____

____

Voluntary Effort ____

____

11. For measures of Pipeline Repair, Conservation Ordinances, Rationing, and Water Conservation pricing policy to be implemented. Please specify future water use reduction objectives:

a. Leak repair: % unaccounted for water to be reduced _____%.

b. Conservation Policy: % reduction wanted _______%.

c. Rationing: % reduction wanted ______%.

d. Pricing policy: % reduction wanted ______%.

12. Criteria for Drought/Emergency Water Rationing:

a. Specify Normal available water supply--when total available supply is ____________MGD.

b. Specify Drought Warning--when total available supply is less than ________MGD and voluntary conservation is requested. How often does this occur? 1 in ______years.

c. Specify Water Use Restriction/Rationing--when total available supply is less than ______MGD. How often does this occur? 1 in ______years.

d. Specify other contingency circumstances (ie., use of emergency water supply, selective industry closing, etc.,)

____

13. What time frame for Drought Emergency would be reasonable (ie., when water use restrictions/rationing would be implemented)?

____Less than 1 year ______________________________

____1-2 years

____Other ______________________________

APPENDIX D

BIBLIOGRAPHY

APPENDIX D

BIBLIOGRAPHY

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