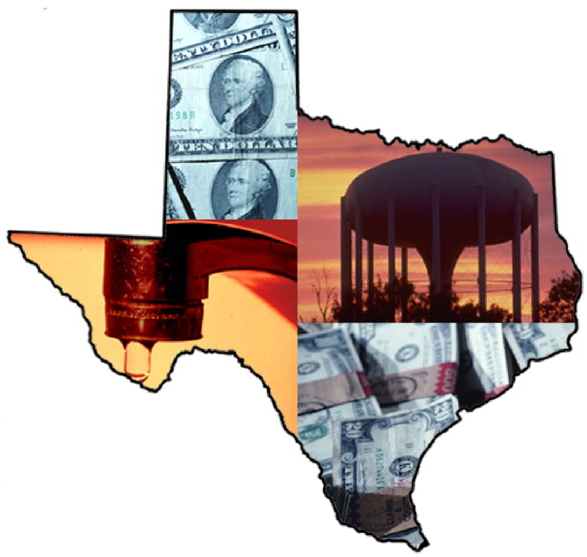
Economic Principles for Sound Water Planning



An Introduction for Regional Water Planning Groups in Texas

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Authors

Mark MacLeod
Director, Special Projects
Environmental Defense

Elta Smith
PhD. Candidate
Kennedy School of Government, Harvard University

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For more information on the activities of the Austin office of Environmental Defense, contact us at 512-478-5161 or at 44 East Avenue, Suite 304, Austin, Texas 78701.

For more information on Texas water issues visit www.texaswatermatters.org.

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Introduction

This report provides Regional Water Planning Group members and other interested citizens with an introduction and guide to the use of sound economic principles in water planning. Economic principles can assist regional planners both in the process of accurately forecasting future water demand, and the evaluation and selection of projects to meet that demand. By following the principles outlined in this report, state and regional planners can meet Texas water needs while avoiding costly mistakes.

In 1997, the Texas Legislature adopted Senate Bill 1, instituting a new model of water planning for the State of Texas. Senate Bill 1 charged Regional Water Planning Groups (RWPGs), made up of local officials, stakeholders, and interested citizens, with developing regional plans to meet water supply needs. These regional water plans would ultimately be integrated into the 2002 State Water Plan. In the first round of regional planning, the RWPGs, under the guidance of the Texas Water Development Board (TWDB), made a heroic effort under a short timeline to gather information about existing water supplies, future water demands, and potential projects that could meet any predicted shortfalls.

Unfortunately, RWPGs received relatively little guidance in this first round on the appropriate use of economic principles as a tool that could be used to forecast water demand accurately and then evaluate and rank potential solutions to meet that demand. For example, some adjustments to water demand forecasts provided by the TWDB to the RWPGs, such as the impact of water conservation practices on agricultural demand, came from old models where it was impossible for RWPG members to examine the assumptions being made. Cost estimates for major water projects did not incorporate "discounting" as a means of comparing projects that occur over different time horizons. RWPGs were not given guidance on how to evaluate the non-market impacts of proposed water projects on water quality or the environment. And even major projects, with potential price tags in the hundreds of millions of dollars or more, were not required to undergo a benefit-cost analysis before being included in the regional plan.

For these reasons, many greeted the 2002 State Water Plan's $18 billion dollar cost estimate to meet future water needs in the 2002 State Water Plan with considerable skepticism. Subsequently, proposals in the 2001 Texas Legislature to fund Senate Bill 1 water projects failed. Unless the Texas Water Development Board improves its assistance to RWPGs with respect to economic analysis of water demand and the evaluation of potential water supply projects, Texas decision-makers, taxpayers and ratepayers will continue to cast a suspicious eye on any cost estimates in future regional and state water plans.

In this second round of regional planning, RWPGs have a new opportunity to incorporate economic principles from the start. Assisted with the tools of economics, water plans built upon accurate demand forecasts and careful selection among proposed projects will safeguard two precious Texas assets - water and money.

Why Economic Principles are Critical to Sound Water Planning

In recent years, the importance of water planning has become evident to the citizens of Texas. As the state's population grows, the need for water resources to meet that growth increases as well. And, as natural water resources become scarcer, it becomes critical to protect the sources we have. Water is an essential resource that is a basic ingredient to life and the environment. The means by which water supplies are developed and delivered has a broad range of impacts on our quality of life, and economy, as well as streams, riparian areas and wildlife. To meet future demand in a sustainable manner, water planners must understand all of these impacts and help ensure that they are accounted for in the selection of new water projects. In this manner, water planners can act as good stewards of water resources both for society and the environment.

Economic principles are important in evaluating (1) whether new infrastructure is needed to meet a region's needs, and (2) if so, what type of project(s) best meets the needs. To evaluate whether new infrastructure is needed, planners must accurately project future water demand. Overestimating and underestimating future demand both have economic consequences. Overestimating demand can result in scarce financial resources being directed to unnecessary water projects when the money could be better spent elsewhere. On the other hand, a lack of water in critical periods due to underestimating demand could impose costs on the economy and the environment.

Once future demand has been forecasted as accurately as possible, the task of evaluating and selecting among alternative water projects begins. Choices among alternatives require careful and systematic analysis of the advantages and disadvantages of each potential project both individually and compared to all other alternatives. Above some threshold amount ($10 million dollars or other appropriate amount), RWPGs should select among projects that will demonstrate greater benefits to society than their costs will impose.

Basic economic principles can assist in the accurate forecasting of future demand, the determination of whether a project's benefits exceed their costs, and the ranking among alternative projects. Ignoring economic principles can be costly. As a Technical Report from the Texas Water Resources Institute at Texas A & M University warns, "The result of not incorporating valid economic theory into water resources planning assessments is that some projects may appear to be the best choice on the surface, but in reality may not be optimal once all the economic realities are considered."

Organization of the Discussion

This report is designed to give Regional Water Planning Group members and interested citizens an introduction to basic economic principles and methods required for sound water planning. It defines the essential procedures for determining the future demand for water and for systematically comparing alternative strategies and projects for meeting that demand.

One of the most important requirements for sound water planning is transparency: i.e. can any member of the RWPG or interested citizen see how data has been derived and follow the steps themselves? If not, then regional water planning is not really a citizen driven process. This report also provides a checklist of economic questions RWPG members and interested citizens can ask of the consultants and TWDB representatives helping to prepare the plan. The checklist can serve as a barometer of how effectively the region is incorporating sound economic principles in its current planning process.

The remaining sections of the report are organized as follows:

<u>Forecasting Demand</u>

- Accurately forecasting base water demand
- Conservation as an adjustment to water demand
- Drought management as an adjustment to water demand

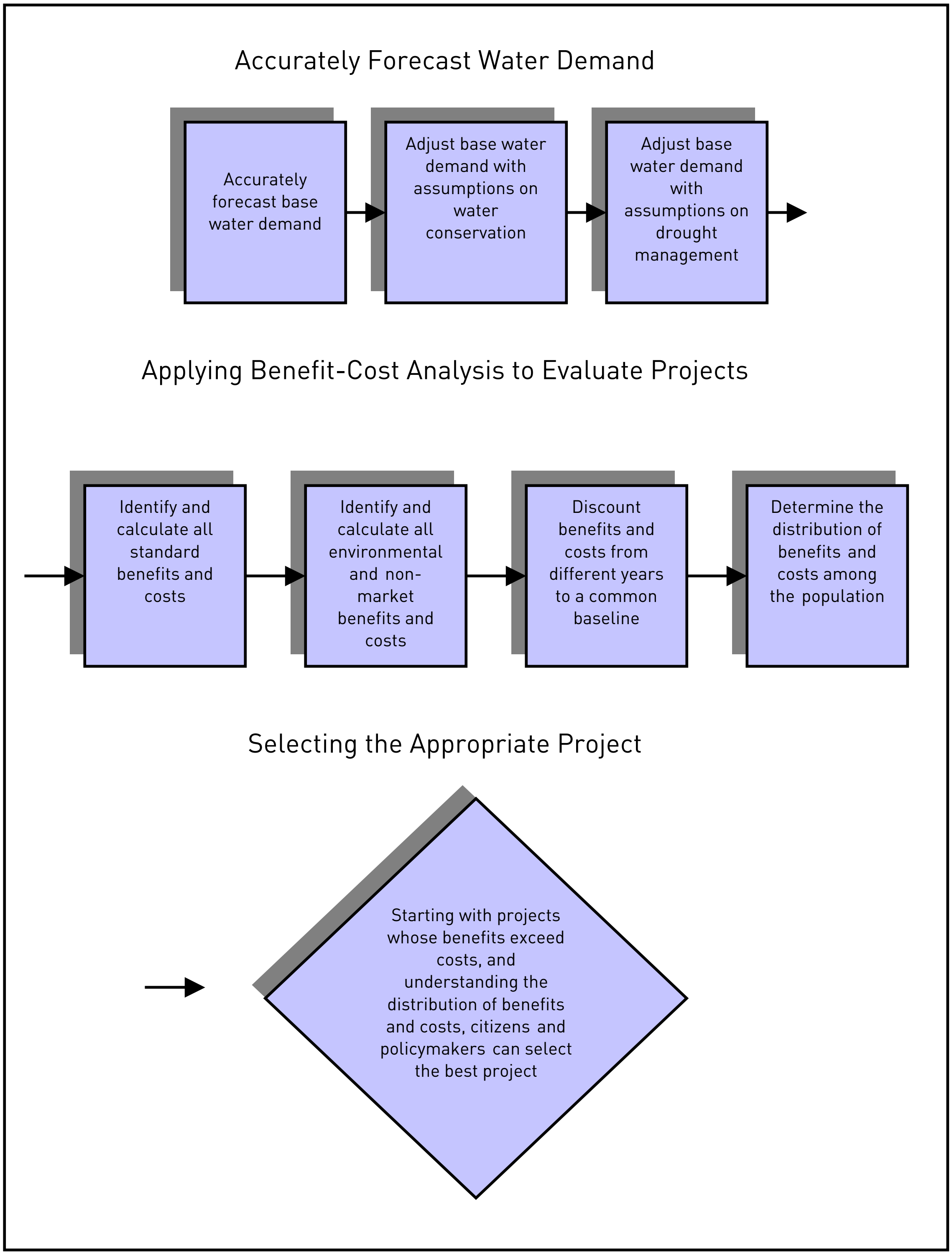
Once the amount of water that the region is planning for is known, water planners need to be able to analyze potential projects to make sure each project's net benefits are greater than its costs. Further, regions need to compare projects against each other in a systematic manner that incorporates the fact that projects have different time horizons, impacts on the environment, and impacts on the different subgroups of the population. To address these issues, part three of the report includes:

<u>Applying Benefit-Cost Analysis to Select and Rank Alternative Projects</u>

- Introduction to Benefit-Cost Analysis
- Environmental and Non-market Benefits and Costs
- Discounting over different time horizons
- Examining the distribution of benefits and costs

The diagram on the following page provides a graphic illustration of the water planning process.

The Steps to Effective Water Planning



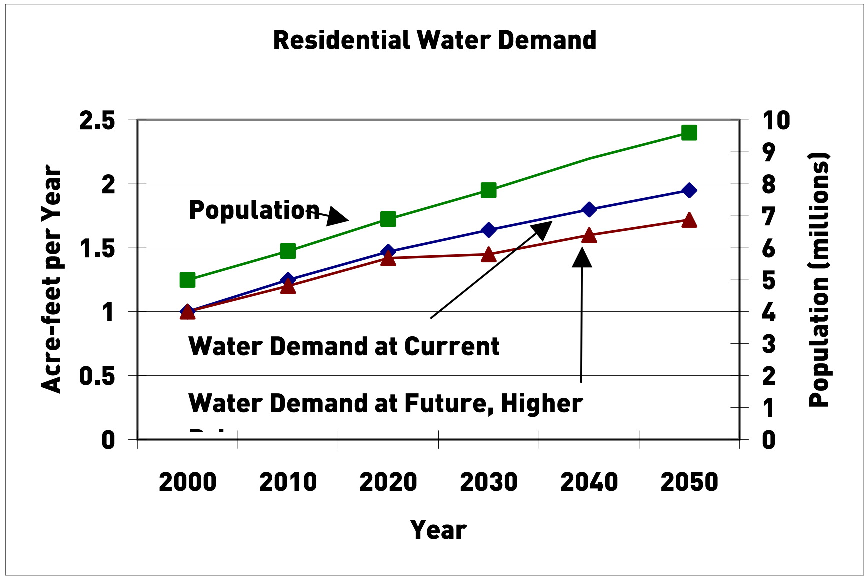
Forecasting Demand

Future water demand is a key concern for water planners: they must make decisions on the design, permitting and construction or implementation of large-scale projects that will take years to plan and complete in order to meet needs that stretch decades into the future. Furthermore, water planners must consider the needs of several classes of users, such as residential, commercial, industrial, and agricultural. Properly assessing future demand can both avoid costly shortages of water and ensure that taxpayer dollars are utilized efficiently by avoiding construction of unnecessary projects.

Demand is defined as a relationship between the price of water and the resulting quantity of water used by consumers during a given time period.[1] Demand schedules (that is, a listing of prices and the corresponding water consumption associated with that price) can be constructed to illustrate seasonal changes, income differences, conservation effects, or variations across users (such as commercial or residential).[2] For municipal users (primarily residential), demand is determined by estimating daily average, per person (per capita) water consumption based on the expected price in the planning period and then multiplying by the number of persons estimated to require service in the area. For example, for an expected price of $3 per 1,000 gallons, per person demand would be approximately 174 gallons per day.[3] For a population of approximately five million in the Dallas-Fort Worth area, this equals 870 million gallons per day of municipal water demand.

Accurately predicting future demand requires careful consideration of four major factors: economic influences, demographic changes, technological changes, and conservation. Of the four main influences on water demand, **economic influences** are perhaps the most easily quantifiable. Most people simply think of demand as "how much water I need," but it is more complicated than that because the determination of "how much water I need" is affected by the price of water. Since the price of water will likely rise over the next 50 years as it becomes more scarce, when calculating demand, planners must account for the *price effect* on water consumption.

Basically, as the price of water increases, demand decreases. A simple and reasonably accurate method of assessing the price effect is to estimate the "price elasticity of demand." Briefly defined, this is the percent change in consumption resulting from a percent change in price. For Texas, a recent estimate is -0.32. That is, per capita water consumption will decline by 3.2% for every 10% rise in the price of water to a given municipal user.[4] The following example illustrates this concept:



In the figure above, the residential demand in a large metropolitan area is estimated through the year 2050. Without accounting for the effect of higher water prices, water demand is expected to grow by 920 thousand acre-feet per year by the end of 2050. However, when a price elasticity of -0.32 is used in calculating per capita demand, and consumer water prices increase by about 40%, the resulting demand is only 740 thousand acre-feet per year by 2050, a difference of 180 thousand acre-feet. This difference could mean that, if demand is properly forecast, the region could avoid planning for, financing and building an unnecessary reservoir or well field.

Economic influences also affect non-residential water demand. Businesses are "price sensitive" and thus may decrease their water use when prices increase to minimize costs. For example, agricultural users may change to more efficient drip irrigation if water costs increase substantially. Thus, like the example above for municipal demand, there are price elasticities of demand that approximate a particular (agricultural, commercial, or industrial) sector's consumption response to increased water prices. Different sectors might respond differently depending on their willingness and ability to adopt water re-use or other conservation methods.[5]

Water planners should also consider **demographic influences** when determining future water demand. Population growth is the most obvious demographic influence and the one that is having the most effect on the future water needs of Texas. But other factors, such as trends in living arrangements can help predict water consumption.

For example, over time the size of households has decreased, which results in decreased consumption. Additionally, some living arrangements, such as multi-family housing, consume less water. Cities with higher concentrations of young people tend to have higher numbers of multi-family housing. Conversely, areas with more single-family residences consume greater amounts of water. Demographic projections can aid predictions of future water demand.

Third, **technological innovations** such as low-flow toilets and showerheads, automatic sprinklers and drip irrigation can help decrease future water demand. For instance, residential adaptations (e.g. low-flow toilets) can be thought of as a substitute for high-cost new water supplies. Technological innovations are a form of **conservation** that can be included in forecasting demand. Forecasting demand requires an assessment of current and potential conservation programs and their estimated water savings over time. Water planners should then assume a certain amount of water savings due to these technological improvements.

Checklist One – Accurately Forecasting Base Water Demand

1. Is the model being used to forecast demand available to the RWPG members and interested citizens?
2. Are the assumptions and inputs to the model listed and described?
3. Can RWPG members and interested citizens run the model or request the model be run with alternative assumptions and input values?
4. Do the beginning population and water use inputs match actual current data? (That is: is the model being run from an accurate baseline?)
5. Are assumptions about changes in water use over time for different user groups, i.e. agriculture, consistent with changing land use and demographics?
6. Does the forecast include different price elasticities of demand for different water user groups? Does the forecast explain the source or derivation of these elasticity estimates?

Conservation as an Adjustment to Water Demand

Because of their influence on water demand, conservation measures should not just be viewed as a water supply strategy. The opportunity for more efficient use of water is a water planning input - one that has the ability to significantly reduce future infrastructure needs and costs. Conservation approaches aim to reduce water consumption while maintaining levels of service and enjoyment similar to non-conservation situations. Conservation measures generally fall into two categories: price and non-price programs.

While design and implementation of conservation measures may take some time, they usually can be developed much faster than infrastructure projects, cost less and can be highly effective. Water managers traditionally focus on the supply side of water development, but conservation approaches that affect demand may be of great help in reducing water consumption and consumer costs. Both price and non-price approaches can help reach this goal.

Non-price conservation programs

- Education for public schools
- Public information (e.g. public service announcements)
- Retrofitting (distribution and installation of low-flow devices)
- Water conservation ordinances (e.g. building codes)
- Mandatory, but temporary water use restrictions

Non-price programs include public education, retrofitting, and conservation ordinances, to name a few (see box on non-price programs). Education programs, which encourage people to use water more efficiently, are often used in water management programs, especially for drought contingency plans.[6] Additionally, many water utilities have begun to encourage the use of technological innovations such as soaker hoses for lawn irrigation, toilet dams and low-flow showerheads for residential and other low-volume consumers.[7] In agricultural areas, managers focus attention on repairing canal leaks, leveling irrigation lands, and installing low-evaporation sprinkler systems.[8] The economics of such programs can be evaluated by use of benefit-cost analyses in the same way supply-side projects are evaluated.

Conservation Rate Types (Price Programs)

- *Increasing (or inverted) block*: Rates increase at set usage level intervals
- *Seasonal block*: Two different rate structures are set (one in the summer and one in the winter)
- *Baseline block*: A baseline usage water usage amount is set based on a customer's winter use and a surcharge is then imposed for any use over the baseline during the summertime

Utilities may also introduce price-based programs for conservation. These programs include changing rate structures during times of drought. Water suppliers should eliminate "declining block rates." These rate structures discourage conservation because the more water a customer uses, the lower the price for the last units of use. Instead suppliers should adopt one of three alternative rate-types (see box to side[9]). These alternative rate structures encourage users to reduce their consumption. Whatever alternative water managers choose, most utility managers conclude that to protect low income water users the first low-cost block must be large enough to include all of the water consumption for basic household users (such as drinking water, cooking, laundry and sanitation).[10]

One report analyzing the long-term effectiveness of conservation programs relative to the effects of price incentives found that both price and non-price programs were effective in reducing water consumption in the cities studied, but that both required a major commitment to implementation.[11] Non-price programs are most effective when a substantial number of them are conducted over long periods of time.[12] Consumers tend to respond to price increases by reducing consumption, but as predicted by the price-elasticity of demand, the percent decline is smaller than the percent increase in price.[13]

Though demand for water is slightly inelastic, even price elasticities of less than one can be significant: a 10% price increase that results in a 7% water usage decrease can be a substantial water savings.[14] In 1991, El Paso Water Utilities adopted conservation water pricing policies. The adoption of these policies reduced water consumption by 17 percent. At the same time, El Paso continues to have low average water bills relative to other southwestern cities.[15]

Checklist Two – Conservation as an Adjustment to Water Demand

1. **Is the forecast of water demand adjusted by a base case level, mid level, and high level of water conservation measures?**

2. **Are these adjustments broken down by sector: e.g. agriculture, municipal, industrial?**

3. **Do adjustments include items such as:**
   - **aggressive leak detection and repair?**
   - **move towards low water landscaping?**
   - **more efficient water pricing regimes?**
   - **accelerated application of readily available conservation technology?**

Drought Management as an Adjustment to Water Demand

Droughts are periods of time when water systems "do not provide enough water to meet established human and environmental uses (due to) natural shortfalls in precipitation or stream flow."[16] Historically, much of the water planning done in Texas has been designed to ensure adequate water supplies during a time of drought as severe as the worst drought on record.

The time, duration and severity of droughts in Texas are uncertain events. Past experience, however, provides data with which to determine the probabilities of such future events. The data clearly shows that severe droughts of long duration occur infrequently; therefore, only planning for supply side approaches to drought is expensive and wasteful. Responsible drought planning can be an important mechanism to lower projected water demand and its related infrastructure costs.

Though droughts can be difficult to predict, management concepts can be utilized to plan for low-water conditions and enable the state and regions to provide for the needs of the citizens. The Texas Commission on Environmental Quality (TCEQ) defines a drought contingency plan as follows.

> *"A strategy or combination of strategies for temporary supply and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies."*[17]

A drought contingency plan can contain both regulatory and economic approaches to help reduce the severity and cost of managing water systems during droughts. Typical regulatory drought contingency plans for municipalities specify increasingly stringent measures in response to predetermined trigger conditions such as groundwater levels or daily pumping rates. For instance, Stage 1 conditions may limit outdoor irrigation to early morning and evening hours, Stage 2 might restrict irrigation to certain days of the week, and Stage 3 may prohibit outdoor irrigation altogether.

On a broader scale, there is great potential for market-based approaches to drought management such as Irrigation Suspension and Dry Year Options.

Irrigation suspension, for example, provides a means for cities to meet their water needs with short-term transfers from farmers.[18] These short-term transfers provide benefits to farmers on marginal lands who voluntarily choose cash payment for water rather than take the uncertain expectation of earnings from the use of water for irrigating crops.

A similar type of market-based incentive is **dry year option**. Farmers are compensated for not irrigating crops during dry years and they then have several options: early in the season, crop mixes may be changed to more drought-tolerant varieties; later, crops can either be abandoned or farmed using deficit irrigation or dry land farming techniques.[19]

A major advantage of drought management options is that they only incur costs during actual drought years. In this way, they avoid the costs to society of carrying excess water capacity for all of the years where drought conditions do not occur. Structural approaches, such as the construction of new water supply reservoirs, incur a cost every year even though they are of little or no use during normal years.

Checklist Three – Drought Management as an Adjustment to Water Demand

1. Is the forecast of peak water demand adjusted by a base case level, mid level and high level of drought management practices?

2. Are the drought management practices listed specifically? Such as the following:
   - reduction in municipal use due to lawn water reductions
   - short-term lease of water from agriculture to municipal

3. Does the water plan incorporate scenarios if even more aggressive water conservation or drought management practices are called for in future years?

Applying Benefit-Cost Analysis to Select and Rank Alternative Projects

Once demand has been accurately forecasted, then various water supply projects - ranging from advanced conservation, to new supply reservoirs or increased groundwater pumping, to desalination - will be proposed to meet any shortfall. The first step in the selection of the best water supply alternatives to meet demand is to account for and analyze the economic, social and environmental benefits and costs of each project.

The basic concept of benefit-cost analysis (BCA) is intuitively simple and is a conscious or unconscious factor in all individual and business decision-making. Benefit-cost analysis for public water projects is just a substitute for the type of business case analysis that would be conducted if the development and delivery of water supplies were a solely private enterprise. Formal benefit-cost analysis for public water projects was first mandated in the Flood Control Act of 1936 (PL 74-738) to analyze water resource projects, and became a widely employed tool after World War II.[20] In 1981, President Reagan issued an Executive Order requiring BCA on all major federal projects. BCA is now regularly employed by policymakers to determine the advisability of making investments of public funds in public works projects.

The goals of a BCA are three-fold: (1) ensuring that a potential project (including conservation programs) makes the most efficient use of capital, (2) providing a framework for comparing alternative projects, and (3) estimating the impacts of regulatory changes. The basic principle of a BCA is that the benefits of a water project must exceed the costs. While BCA is not a perfect tool, it is less susceptible to error and manipulation than more informal decision-making approaches because each element in the project is laid out in the BCA process.[21]

To perform a benefit-cost analysis, the following procedure is usually employed: the potential project or projects are identified; positive and negative impacts for affected population groups are determined; values are assigned to each impact (typically in dollars); net benefit is calculated; and a choice is made.[22] The final decision hinges upon a fundamental rule of a BCA: select the project that produces the greatest net benefit.

Benefit-Cost Analysis Steps

- Project(s) identified
- Impacts determined (costs and benefits)
- Values assigned to impacts
- Net benefit calculated
- Decision made

Once the potential project (or projects) has been determined, the next step is to predict the costs and benefits of each proposal. Direct costs include *capital costs*, such as the acquisition of land and materials, construction costs, and *maintenance and operating costs*.[23] The capitol costs also include the cost of investment returns foregone (interest) by not using the funds in an alternative investment. Indirect costs include those imposed on society or the environment. For example, a new reservoir may displace landowners or result in lost wetland recreational value. Benefits of a new reservoir include increased water supplies for residential and commercial users (direct) and developed recreational opportunities (indirect).

Each cost and benefit must then be valued in monetary units. The most obvious valuation technique is to use a resource's market value: capital costs and maintenance and operating costs are readily determined through an engineering company's bid in a competitive market. A great portion of benefits can be calculated from the expected revenues from future sales of water. However, not all inputs and outputs have a readily assigned market value. In this case, other means are necessary to develop a valuation (these methods are discussed in the following section).

Understanding the difference between the market costs (or accounting costs) and the true costs of a particular project is very important to a benefit-cost analysis. The true cost of a new reservoir is not just the cost of the land and labor or even the current market value for these inputs, but rather, the value of the land if put to its best alternative use--that is, its *opportunity cost*.[24] For example, decision-makers may not consider the value of bay and estuary inflows that may be restricted by a new reservoir, though the value of those inflows to shrimp industry may exceed the value of the reservoir. Opportunity costs are not considered in the accounting scheme of a particular project, but should be assessed during the decision-making process and benefit-cost analysis provides the method for considering them.

After all market and non-market costs and benefits have been estimated, the total net benefit is determined by summing the individual benefit and cost values (e.g., irrigation, municipal water, and recreation benefits minus project costs allocated to each). When the resulting new benefit calculation is positive, then benefits exceed costs and economic efficiency indicates that the project should be developed. When comparing multiple projects - projects should initially be ranked according to highest net benefit.

The following table is a hypothetical example of the benefits and costs that would be identified and calculated for a typical water project. The exact set of benefits and costs will depend on the particular project. For instance, this example project provides electric power but not navigation services. In this example, the net benefit is a negative $0.5 million dollars annually so the project would not be selected. Note that the net benefits are equal to or greater than zero for irrigation, municipal, and industrial, but the electric power purpose has a negative net benefit of -$0.5

million. The total project has a net benefit of -$0.5 million per year, so the project should not be accepted in its current state. Note also that if the electric power purpose with negative net benefits is eliminated from the project, the net benefits of the over-all project would be zero--the benefits would just equal the costs. The example therefore illustrates two important principles of benefit-cost analysis. First, benefits should equal or exceed costs for each project considered. Second, each project purpose needs to pass the benefit-cost test or else the over-all project may fail to meet the economic criteria, and even if it should still pass the test, the project would be put at a disadvantage when ranked along side of other projects.

Example of a Benefit - Cost Analysis

To simplify, figures are presented as annualized costs/benefits

Irrigation Benefit	$1.5 million
Municipal Benefit	$2.0 million
Industrial Benefit	$1.5 million
Electric Power Benefit	$.5 million
Navigation	$0
Flood Control	$0
Recreation Impact (+/-)	$0.2 million
Environmental Impact (+/-)	(1.0 million)
- Land & Capital Costs	($4.2 million)
- Irrigation	($1.3 million)
- Municipal	($1.8 million)
- Industrial	($0.3 million)
- Electric Power	($0.8 million)
- O&M Costs	($ 0.5 million)
- Irrigation	($0.1 million)
- Municipal	($0.1 million)
- Industrial	($0.1 million)
- Electric Power	($0.2 million)
= Net Benefits*	($0.5 million)

* Net Benefits must be positive, or at least zero.

Benefit-cost analysis is an important tool for determining the economic efficiency of a particular project or projects and it creates a framework for comparing and selecting among alternatives. It is not a precise formula, but rather an *approach* to decision-making that discredits projects that are ultimately more costly than worthwhile. Using benefit-cost analysis also helps identify those projects that best utilize our finite resources, after considering all affected social, economic and environmental effects.

Checklist Four – Beginning the Benefit-Cost Analysis

1. Has the RWPG established a decision rule to subject large, expensive, high impact projects (over $10 million or some other appropriate threshold) to a BCA prior to being included in the plan? (The threshold reduces the administrative burden of doing BCA for smaller, lower cost, and less impacting projects.)

2. Are cost estimates for proposed projects up-to-date?

3. Are all of the underlying components (sub costs) for the cost estimates adequately described and available for citizen review?

4. Does the analysis estimate all costs and benefits associated with the projects?

5. Does the measure of benefits from sales of water fully describe the amount of water purchased by each user group and its price?

6. Is the analysis consistent across all proposed projects? (e.g. uses same assumptions, discount rates, etc.)?

Environmental and Non-Market Benefits and Costs

Determining the costs and benefits of water use for irrigation, municipal consumption, manufacturing, mining and power generation is far easier than calculating the costs and benefits of, for example, ecosystem protection, recreation, species diversity and water quality.[25] The table below describes some commonly accepted environmental and non-market values that need to be addressed in water planning.

Description of Environmental and Non-market Values

Water Quality	Decreased water flows can adversely impact water quality, which can increase treatment costs to municipal and industrial dischargers. Impacts of increased groundwater pumping may also include salinization of the water table.
Recreation Values	Water-based recreation can include activities such as hunting, fishing, boating and other water sports as well as such passive activities as viewing water, and the nature and wildlife in and around water sources.
Environmental Flows	Environmental flows are important for preserving habitat, species diversity and wildlife resources including commercial activities such as fishing, shrimping, hunting, and wildlife viewing.
Ecosystem Protection	A well-functioning ecosystem depends on the biological integrity and plant and animal viability of wetlands, marshes, estuaries and riparian corridors.[26] When reservoirs are created, the reduced flow may impair estuary productivity and alter downstream ecosystems.
Species Diversity	Species diversity is closely related to ecosystem protection. The impact of water development and diversions on species diversity has been a central issue in water conflicts in Texas during the last two decades.[27] Maintaining proper water conditions (such as: temperatures, depth, speed, and wet and dry periods) can help preserve sensitive species.
Existence Values	This includes a sense of place, heritage, and community identity in seeing public resources utilized responsibly and protected for the use of future generations.

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Determining Values for Environmental Flows

The six benefits mentioned above should be considered in the water planning process. However, the lack of market (dollar) values for these benefits and costs creates impediments to their inclusion. Several different techniques have been developed by economists to help assign value.

First, indirect valuation techniques seek to examine people's behavior and relate it to their willingness to pay for increased benefits or harm avoidance. There are two main indirect valuation techniques: *hedonic pricing* (based on person's observed behavior, assuming they are acting to enhance their pleasure) and the *travel cost model*. Hedonic pricing can be used to estimate economic benefits and costs associated with environmental quality such as water pollution and environmental amenities, including aesthetic views or proximity to recreational opportunities. The travel cost model measures the costs of travel to and from a recreational site to determine the (minimum) value of the site to a visitor. Such a measure is usually an under estimate of value because people must value the experience at least as much as the travel cost of going to the site, or else they would not go, and would usually pay more if required.

Direct valuation techniques do not assess actual behavior, but rather ask people to value environmental uses through hypothetical questions about their willingness-to-pay for such uses. This method is called *contingent valuation*: it can be used for both use and non-use value estimates.

Finally, valuation can be achieved by determining how much it would cost to replace a resource if it were damaged or lost or for a substitute to a lost resource. Insurance companies perform a similar function when they provide replacement cost coverage for loss of property.[28]

Though valuing nonmarket goods can be difficult, using these indirect, direct and replacement cost techniques can help ensure that environmental flow benefits are considered in the evaluation of various water supply alternatives. Incorporating these values in a benefit-cost assessment can help water planners achieve balanced judgment in their decisions.

Two examples of estimates for environmental and non-market benefits and costs are provided in the following tables. The first is a study of economic values associated with the natural functions of the Rhine River in Germany. The second is a selection of recreation values calculated by the U.S. Forest Service pursuant to the Renewable Resource Planning Act. The recreation values are expressed in dollars per recreation visitor day, which can easily be converted to annual benefits by determining the number of visitor days to a site during the year.

Economic Value of Natural Rhine River Functions

Rhine Function	Value (in million $ per year)
Clean Drinking Water	663
Fish Production	1.7
Existence Value of Nature	640
Natural Retention Capacity	500
TOTAL	1,800

Source: Bouma, Jan-Jaap, and Kirsten Schuijt. Ecosystem Valuation and Cost-Benefit Analysis as Tools in Integrated Water Management. Erasmus University of Rotterdam. The Netherlands.

A Selection of Recreation Values from the U.S. Forest Service

Activity	Value ($ per RVD, Southwest Region)
Swimming	$18.92
Scenery	$14.35
Hunting	$72.59
Fishing	$134.47
Wildlife Viewing	$95.00

Source: Resource Pricing and Valuation Procedures for the Recommended 1990 RPA Program. U. S. Forest Service.

Even the best benefit cost analysis is unlikely to correctly value all of the nonmarket impacts of a proposed water supply project however. In that case, some qualitative analysis can provide assistance. For instance, projects that have demonstrated a positive net benefit can be further ranked by nonmarket criteria such as impact on rural communities or environmental impact. Those projects with the highest net benefit and lowest impact would be selected first.

Checklist Five – Environmental and Non-Market Benefits and Costs

1. Have all of the potential environmental and non-market impacts been identified?

2. Have the environmental and non-market impacts been initially ranked in order of importance?

3. For those non-market impacts that are higher in importance, have appropriate methods been identified to estimate their value as costs or benefits?

4. Are cost and benefit estimates presented along with any description of uncertainties in their calculation?

5. If quantitative valuation processes are not available, has a comprehensive qualitative evaluation of the impacts been conducted? (Qualitative evaluations must be conducted using a consistent measuring device for the area of choice - region or state.)

Discounting over Different Time Horizons

Most large-scale infrastructure projects have effects that occur over long periods of time. A method called *discounting* helps water planners compare the desirability of alternatives, including their future consequences.[29] Discounting is used to adjust monetary values to account for the time value of money: it is widely accepted by government agencies, financial institutions and private industry as the appropriate method for comparing benefits and costs that occur at different times.

Most people are intuitively familiar with the principle underlying discounting. For example, if given the choice, would a person offered $100 today or $100 one year from now (from a reliable source) take the money now or later? Most people would take the $100 today because it is obvious that the $100 would decline in value over the year. Another way of looking at it is to consider what $100 would be worth one year from now if taken today and placed in a bank to earn interest. This is a form of everyday discounting. Now, think about two water supply projects under consideration for development. Each project has different initial costs and different streams of costs and benefits over its life span. Discounting helps to combine these streams into a single present value for each project, thus making it possible to compare them on an equivalent basis. For public water supply projects, planners must consider the present value of projected costs and benefits that accrue over each project's time horizons to better choose among different projects.

The following example demonstrates how failure to use discounting is likely to result in inappropriate project planning and selection for water development projects.

In the following example, three different water supply projects are being analyzed over a fifteen-year period: a new reservoir, wet wells, and a conservation program. These projects are fictional and created for the purpose of illustration only. For simplification purposes, the project costs and benefits are estimated at five-year intervals though, in a real-life analysis, each year would be evaluated. The following table illustrates the benefits and costs of the three projects using undiscounted values:

Project Costs and Benefits Without Discounting ($ millions)

	Reservoir (Infrastructure) Without Discounting		Wet Wells (Alternative A: Structural) Without Discounting		Conservation (Alternative B: Non-Structural) Without Discounting	
Year	Cost	Benefit	Cost	Benefit	Cost	Benefit
0 (today)	500		300		275	
5		350	5	275	2	200
10		350	5	275	2	250
15		350	5	275	2	300
Total:	500	1050	315	825	281	750
Net Benefit:	550		510		469	

Without discounting, it appears that the reservoir would be the best project because it has the greatest net benefit over time (benefits ($350 million x 3) - costs ($500 million) = $550 million net benefit). The wet wells ($510 million) would be ranked second and the conservation program ($469 million), third. Now consider the same three projects with discounting principles utilized:

Project Costs and Benefits With Discounting ($ millions)

	Reservoir (Infrastructure) Discounted		Wet Wells (Alternative A: Structural) Discounted		Conservation (Alternative B: Non-Structural) Discounted	
Year	Cost	Benefit	Cost	Benefit	Cost	Benefit
0 (today)	500		300		275	
5	0.0	217.3	3.1	170.8	1.2	124.2
10	0.0	134.9	1.9	106.0	0.8	96.4
15	0.0	83.8	1.2	65.8	0.5	71.8
Total:	500.0	436.0	306.2	342.6	277.5	292.4
Net Benefit:	-64.0		36.4		14.9	

Discounting drastically changes the results of the analysis. Now the wet wells project has the greatest net benefit ($36.4 million) and is the best choice for policymakers. The conservation approach also has a positive net benefit and would be the second-best choice. The reservoir returns a negative net benefit over time and is therefore not economically desirable. Since it would cost more than it would return in benefits over time, it should not be selected as part of the water development plan. The following table illustrates the results of the analysis with and without discounting:

Comparison of Project Selection With and Without Discounting ($ millions)

Water Development Project	Without Discounting		Discounted	
	Net Benefit	Choice	Net Benefit	Choice
Reservoir	550	1	-64.0	No
Wet Wells	510	3	36.4	1
Conservation	544	2	14.9	2

This example reveals the difference discounting makes when it is used to analyze projects to which benefits and costs accrue over time. When the projects are considered without regard to the value of time, the reservoir would have been the best choice. But, time does have a value and, by using discounting, it become apparent that the reservoir has negative returns and should not be considered.

Choosing a Discount Rate

How does a water planner choose an appropriate discount rate for potential projects? Conceptually, the answer is simple: choose a rate that corresponds to the opportunity cost (or time value) of capital. However, individuals have different opportunity costs and the market interest rate that we observe for individuals or industry includes factors such as risks of repayment and inflation.

The risk of repayment for the government is rather small and inflation is accounted for in the evaluation process, meaning that it should not be part of the discount rate. The EPA suggests a 10% discount rate for environmental projects with a relatively short lifespan (on the order of a few years). For projects with a longer time-horizon (decades for example), procedures for determining discount rates and changes in these rates have already been established and the appropriate discount rates for government-supported projects can be found on the Internet (e.g. U.S. Office of Management and Budget, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs). Adopting one of the published Federal government rates for discounting would be a relatively easy and reliable process to ensure that Texas water development projects are evaluated on a financially sound and consistent basis.

Checklist Six – Discounting Over Different Time Horizons

1. Does the water plan incorporate discounting as a means to compare water projects that occur over different time horizons?

2. Has a reasonable discount rate been selected? (Current guidance from the TWDB calls for a discount rate of 6.5%, which is reasonable).

3. Has sensitivity analysis been performed to determine how sensitive the results are to modest changes in the discount rate? (This is more likely when the majority of benefits occur in out-years of the project. If this is the case, it argues that the project decision be delayed until those out-year benefits are more certain.)

Distributional Issues

The net benefit measure produced by a benefit-cost analysis is invaluable in determining the efficient allocation of scarce water supplies, but it is an incomplete measure of social benefit because it ignores the distribution of project costs and benefits among individuals and/or groups. A water project may provide a large overall net economic benefit to society, but it is not certain that all individuals and/or groups will be better off after the project is constructed. For example, individuals residing in one area of the state may be made worse off if they pay taxes to finance a project that will primarily benefit individuals residing in another area of the state. Individuals that do not directly pay for a water project may also be damaged if the project prevents these individuals from accessing a resource they currently utilize. For example, residents in a rural Texas county would lose valuable farmland if their land were flooded by a reservoir for storing water for later delivery to an urban population area.

A simple example in the table below illustrates the concept. Imagine a plan for a new reservoir that will meet some municipal and agricultural water need for a growing population, but its greatest benefit is its use as a cooling pond for a new power plant. With higher water rates to help pay for the reservoir, it passes a simple benefit cost test. But looking closer, because the power plant pays less for water (nonconsumptive use that is returned to the reservoir after cooling), municipal water users end up subsidizing much of the benefit for the power plant. Citizens may support or oppose this plan depending on the circumstances - does the plant mean that electricity rates will be lower (thus their total water and electricity rates do not go up) - or does the power plant sell its electricity out of the area? The main point is that distributional analysis lets water planners and interested citizens know how the benefits and costs of a proposed project are allocated among different groups: i.e. who pays and who benefits?

User Group	Benefits from new reservoir	Costs (from new water rates)	Result
Municipal	$1 million	$2 million	Cost is $1 million above benefits
Power Plant	$2 million	$1 million	Benefits are $1 million above costs
Agriculture	$ 0.5 million	$0.5 million	Benefits equal costs
Total	$3.5 million	$3.5 million	While total benefits equal total costs, citizens may still object to project on grounds they are subsidizing power plant

How the costs and benefits of water projects are actually distributed among individuals is a social issue normally resolved by political processes and not applied economic analysis. However, economics is not completely silent in the distributional debate. In fact, they can be used to provide water planners with estimates of the distributional consequences of a particular project.

Accurately analyzing the specific economic impacts of a proposed water project on various water users and other interested parties can help water planners make informed decisions regarding the selection of superior alternatives and the possible need to compensate damaged parties.

Checklist Seven – Distributional Issues

1. Are the benefits of a proposed project to each population group (agriculture, municipal, industrial, electric power) listed individually? (It may be important to break this down into further subgroups; a proposed water project may offer different benefits to different crop types within the agricultural sector or different businesses within the industry sector.)

2. Are the specific costs that each of the population group or subgroups are going to contribute to the water project described? (Costs may be borne by water rates, taxes and fees, or third party impacts such as reduced tourism revenue or lost farm income.)

3. Are the cost and benefits to each group "netted out" (benefit minus cost)?

4. Is there any description of compensation from "net winners" to "net losers"?

Conclusions and Recommendations

Where Do We Go From Here?

Using the Checklist as an initial guide, members of RWPGs and interested citizens should demand that the Texas Water Development Board, as the lead state agency charged with implementing the State Water Planning Process, assist them in better incorporating sound economics into the regional planning process.

RWPG members should also ask agencies and the Legislature to ensure that reasonable funds are allocated to economic analysis in water planning. With an initial bill for water supply projects totaling close to $18 billion dollars identified in the first round of regional planning, a relatively small amount of money that can be used to screen out wasteful projects and appropriately rank beneficial projects is a good use of taxpayers' money.

Most importantly, RWPGs and the TWDB, through the work of their own consultants, and through the Board's guidance, should insure that the planning process - including all models, inputs and assumptions - is transparent, user-friendly, and subject to public review. Only this standard can assure against “black box modeling” where even the RWPG members are unclear about how results have been obtained.

If RWPGs and the TWDB make the planning process, models, inputs and assumptions transparent subject to public review, and available for operation, then members of RWPGs and interested citizens working with local experts such as professors from local universities, professionals from trade organizations, civic leaders, and other public interest organizations will be able to weed out costly or unnecessary projects and have increased confidence in their regional water plan.

Appendix - Checklists

Checklist One – Accurately Forecasting Base Water Demand

1. Is the model being used to forecast demand available to the RWPG members and interested citizens?
2. Are the assumptions and inputs to the model listed and described?
3. Can RWPG members and interested citizens run the model or request the model be run with alternative assumptions and input values?
4. Do the beginning population and water use inputs match actual current data? (That is: is the model being run from an accurate baseline?)
5. Are assumptions about changes in water use over time for different user groups, i.e. agriculture, consistent with changing land use and demographics?
6. Does the forecast include different price elasticities of demand for different water user groups? Does the forecast explain the source or derivation of these elasticity estimates?

Checklist Two – Conservation as an Adjustment to Water Demand

1. Is the forecast of water demand adjusted by a base case level, mid level, and high level of water conservation measures?
2. Are these adjustments broken down by sector: e.g. agriculture, municipal, industrial?
3. Do adjustments include items such as:
   - aggressive leak detection and repair?
   - move towards low water landscaping?
   - more efficient water pricing regimes?
   - accelerated application of readily available conservation technology?

Checklist Three – Drought Management as an Adjustment to Water Demand

1. Is the forecast of peak water demand adjusted by a base case level, mid level and high level of drought management practices?
2. Are the drought management practices listed specifically? Such as the following:
   - reduction in municipal use due to lawn water reductions
   - short-term lease of water from agriculture to municipal
3. Does the water plan incorporate scenarios if even more aggressive water conservation or drought management practices are called for in future years?

Checklist Four – Beginning the Benefit-Cost Analysis

1. Has the RWPG established a decision rule to subject large, expensive, high impact projects (over $10 million or some other appropriate threshold) to a BCA prior to being included in the plan? (The threshold reduces the administrative burden of doing BCA for smaller, lower cost, and less impacting projects.)
2. Are cost estimates for proposed projects up-to-date?
3. Are all of the underlying components (sub costs) for the cost estimates adequately described and available for citizen review?
4. Does the analysis estimate all costs and benefits associated with the projects?
5. Does the measure of benefits from sales of water fully describe the amount of water purchased by each user group and its price?
6. Is the analysis consistent across all proposed projects? (e.g. uses same assumptions, discount rates, etc.).

Checklist Five – Environmental and Non-Market Benefits and Costs

1. Have all of the potential environmental and non-market impacts been identified?
2. Have the environmental and non-market impacts been initially ranked in order of importance?
3. For those non-market impacts that are higher in importance, have appropriate methods been identified to estimate their value as costs or benefits?
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Checklist Seven – Distributional Issues

1. Are the benefits of a proposed project to each population group (agriculture, municipal, industrial, electric power) listed individually? (It may be important to break this down into further subgroups; a proposed water project may offer different benefits to different crop types within the agricultural sector or different businesses within the industry sector.)
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3. Are the cost and benefits to each group "netted out" (benefit minus cost)?
4. Is there any description of compensation from "net winners" to "net losers"?

End Notes

[1] Holloway and Michelsen, "Forecasting Demand and Evaluating Conservation," p. 2

[2] For more information on demand schedules and elasticity estimates by class of user;

a) Gibbons, Diana C., The Economic Value of Water: A Study from Resources for the Future, Resources for the Future, Washington D.C., 1986.

b) Michelsen, A.M., T. McGuckin and D.M. Stumpf. Effectiveness of Residential Water Conservation Price and Nonprice Programs. American Water Works Association Research Foundation. ISBN 0-89867-954-0. 1998).

c) Holloway, Milton L. and Bob S. Ball, Understanding Trends in Texas Per Capita Water Consumption, prepared for Texas Water Development Board, July 1991.

[3] Griffin, Ronald and Chan Chang, Community Water Demand in Texas, Texas Water Resources Institute, Texas A&M University, April 1989, p. 46.

[4] Holloway *supra* n 1, p. 4.

[5] A compendium of studies to predict water use, including various estimates of elasticity can be found in "Predictive Models of Water Use: An Analytical Biography" Research Report of the Departments of Geography and Economics. Southern Illinois University. Carbondale, IL. February 2002.

[6] Holloway, "Optimal Drought Planning," p. 16.

[7] *Ibid*, p. 16.

[8] Ibid.

[9] Information from: Gerston, Jan, "Conservation rates affect demand management," Texas Water Resources Institute, Texas Water Savers Newsletter, v3n4, Fall 1997 http://twri.tamu.edu/twripubs/WtrSavrs/v3n4/article-2.html, viewed 8/22/02.

[10] Ibid.

[11] Holloway "Optimal Drought Planning," p. 16-17, from Michelsen, Ari M, J. Thomas McGuckin and Donna M. Stumpf, "Effectiveness of Residential Water Conservation Price and Nonprice Programs," AWWA Research Foundation and American Water Works Association, Denver, Colorado: 1998.

[12] Holloway and Michelsen, "Forecasting Demand and Evaluating Conservation," p. 4, from Michelsen, Ari M, J. Thomas McGuckin and Donna M. Stumpf, "Effectiveness of Residential Water Conservation Price and Nonprice Programs," AWWA Research Foundation and American Water Works Association, Denver, Colorado: 1998.

[13] Holloway *supra* n 10, p. 17.

[14] Gerston *supra* n 8.

[15] Archuleta, Edmund G. and Anai J. Padilla, 1998 Conference Proceedings. 25th Water for Texas Conference. Texas Water Resources Institute.

[16] Holloway, "Optimal Drought Planning," p. 1; U.S. Army Corp of Engineers, "National Study of Water Management During Drought," IWR Report 94-NDS-12, September 1995, p.4.

[17] Texas Water Development Board. Stakeholder Report, Stakeholder Policy Issues and Recommendations, Draft September 19, 2001, p. 30.

[18] Gerston, Jan, et al, "Efficient Water Use for Texas: Policies, Tools, and Management Strategies," Texas Agricultural Experiment Station, September 2002, p. 28.

[19] Ibid.

[20] Stokey, Edith and Richard Zeckhauser, A Primer for Policy Analysis, New York: W.W. Norton & Co., 1978, p. 134.

[21] *Ibid*, p. 135.

[22] *Ibid*, p. 136.

[23] Starling, Grover, "The politics and economics of public policy: An introductory analysis with cases," Illinois: The Dorsey Press, 1979, p. 256.

[24] Stokey *supra* n 19, p. 151.

[25] Kaiser, Ron "Benefits and Economic Values of Environmental Water Use," p. 1.

[26] *Ibid*, p. 6.

[27] *Ibid*, p. 6.

[28] *Ibid*, p. 11.

[29] Stokey *supra* n 19, p. 159.