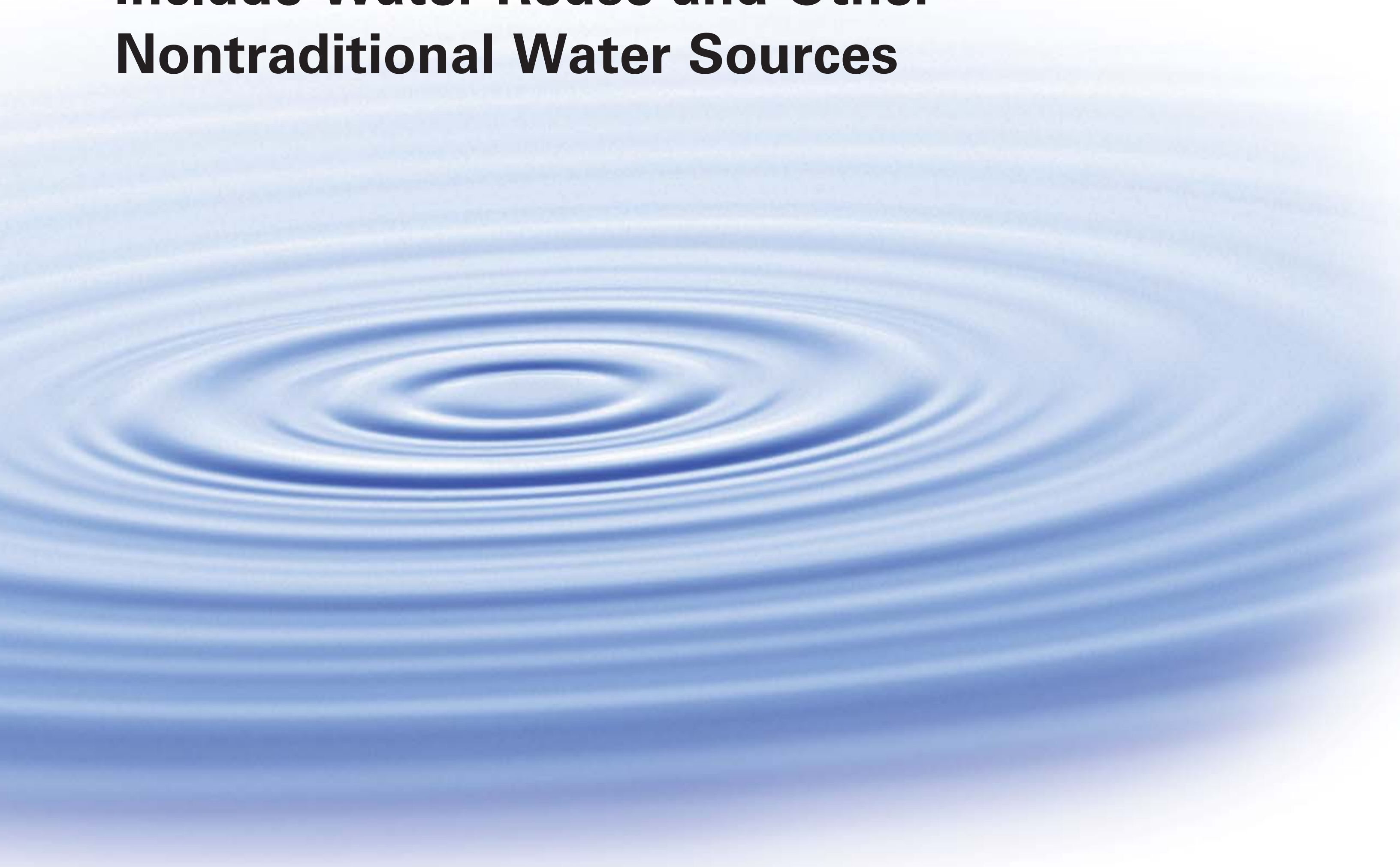
Extending the Integrated Resource Planning Process to Include Water Reuse and Other Nontraditional Water Sources



WateReuse Foundation

Extending the Integrated Resource Planning Process to Include Water Reuse and Other Nontraditional Water Sources

About the WateReuse Foundation

The mission of the WateReuse Foundation is to conduct and promote applied research on the reclamation, recycling, reuse, and desalination of water. The Foundation's research advances the science of water reuse and supports communities across the United States and abroad in their efforts to create new sources of high quality water through reclamation, recycling, reuse, and desalination while protecting public health and the environment.

The Foundation sponsors research on all aspects of water reuse, including emerging chemical contaminants, microbiological agents, treatment technologies, salinity management and desalination, public perception and acceptance, economics, and marketing. The Foundation's research informs the public of the safety of reclaimed water and provides water professionals with the tools and knowledge to meet their commitment of increasing reliability and quality.

The Foundation's funding partners include the U.S. Bureau of Reclamation, the California State Water Resources Control Board, the Southwest Florida Water Management District, and the California Department of Water Resources. Funding is also provided by the Foundation's Subscribers, water and wastewater agencies, and other interested organizations. The Foundation also conducts research in cooperation with the Global Water Research Coalition.

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LIST OF ACRONYMS

ACE	U.S. Army Corps of Engineers
BCA	benefit–cost analysis
CCC	California Coastal Commission
CDS	Coastal Distribution System
CSO	combined sewer overflow
CUWA	California Urban Water Agencies
CWA	Clean Water Act
CWQCA	Colorado Water Quality Control Act
DEQ	Department of Environmental Quality
DHS	Department of Health Services
DO	dissolved oxygen
DSS	Decision Support System
EA	environmental assessment
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
GHG	greenhouse gas
I&E	impingement and entrainment
IRP	Integrated Resource Planning
IRWMP	Integrated Regional Water Management Planning
IWP	Integrated Water Plan
IWPC	Integrated Water Plan Committee
MWDSC	Metropolitan Water District of Southern California
NCWRP	North City Water Reclamation Plant
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	U.S. National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTWS	nontraditional water supply
O&M	operations and maintenance
PV	present value
RHA	Rivers and Harbors Act
RWQCB	Regional Water Quality Control Board
SDWA	Safe Drinking Water Act
SFWMD	South Florida Water Management District
SROG	Sub-Regional Operating Group
SWFWMD	Southwest Florida Water Management District
TDS	total dissolved solids
T&E	threatened and endangered
TMDLs	total maximum daily loads

USFWS	U.S. Fish and Wildlife Service
WBMWD	West Basin Municipal Water District
WCS	Water Curtailment Study
WEAP	Water Evaluation and Planning System
WMDs	Water Management Districts
WRWTF	Watsonville Recycled Water Treatment Facility
WTP	willingness to pay
WWTP	wastewater treatment plant

FOREWORD

The WateReuse Foundation, a nonprofit corporation, sponsors research that advances the science of water reclamation, recycling, reuse, and desalination. The Foundation funds projects that meet the water reuse and desalination research needs of water and wastewater agencies and the public. The goal of the Foundation's research is to ensure that water reuse and desalination projects provide high-quality water, protect public health, and improve the environment.

A Research Plan guides the Foundation's research program. Under the plan, a research agenda of high-priority topics is maintained. The agenda is developed in cooperation with the water reuse and desalination communities, including water professionals, academics, and Foundation Subscribers. The Foundation's research focuses on a broad range of water reuse research topics, including the following:

- Defining and addressing emerging contaminants
- Public perceptions of the benefits and risks of water reuse
- Management practices related to indirect potable reuse
- Groundwater recharge and aquifer storage and recovery
- Evaluating methods for managing salinity and desalination
- Economics and marketing of water reuse

The Research Plan outlines the role of the Foundation's Research Advisory Committee (RAC), Project Advisory Committees (PACs), and Foundation staff. The RAC sets priorities, recommends projects for funding, and provides advice and recommendations on the Foundation's research agenda and other related efforts. PACs are convened for each project and provide technical review and oversight. The Foundation's RAC and PACs consist of experts in their fields and provide the Foundation with an independent review, which ensures the credibility of the Foundation's research results. The Foundation's Project Managers facilitate the efforts of the RAC and PACs and provide overall management of projects.

The Foundation's primary funding partner is the U.S. Bureau of Reclamation. Other funding partners include the California State Water Resources Control Board, the Southwest Florida Water Management District, Foundation Subscribers, water and wastewater agencies, and other interested organizations. The Foundation leverages its financial and intellectual capital through these partnerships and funding relationships. The Foundation is also a member of the Global Water Research Coalition.

This publication is the result of a study sponsored by the Foundation and is intended to communicate the results of this research project. The goals of this project were to explore how the useful aspects of Integrated Resource Planning (IRP) could be extended to help integrate nontraditional water supply (NTWS) options—including reclamation and desalination—into water supply portfolios.

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EXECUTIVE SUMMARY

OBJECTIVE OF THIS REPORT

This report provides guidance and examples of how water planners and managers can use the Integrated Resource Planning (IRP) process as an objective and balanced way to explore the relative merits of considering nontraditional water supply (NTWS) options alongside their suite of more typical water supply and demand-side alternatives. IRP is a planning approach that water resource agencies have been using with growing frequency as a way of evaluating and balancing their water supply and water demand management options. NTWS options include reclamation (i.e., water recycling), desalination (coastal or groundwater), and stormwater use.

Increasing use of NTWS options is seen as a viable complement to—and in some instances, a substitute for—investments in more traditional long-term water supplies and infrastructure. Several factors are driving water managers and planners to seriously consider reuse and other NTWS within their long-term supply planning. Most notable is the need to meet increasing water demands at the same time as there are increasing constraints on extracting more water from traditional sources such as freshwater river flows and aquifers. In addition to IRP, this report addresses how water and wastewater utilities in California are being challenged to integrate water management activities regionally through integrated regional water management planning (IRWMP). Integrated regional water management plans are required of utilities seeking funding through the State's Propositions 50 and 84 and will be used by the state's Department of Water Resources as it promotes future statewide water supply planning.

A BRIEF HISTORY OF IRP

IRP has its roots in the electric power industry, where it emerged in the late 1980s. As the power sector looked to stabilize costs and minimize adverse environmental impacts, demand-side management (e.g., energy conservation and peak-load shifting) emerged as an important strategy to be considered concurrently with a range of alternative supply options.

In the water sector, IRP has largely been used over the past decade to integrate water conservation into utilities' planning processes. Significantly less attention has been paid to date on integrating water reuse or other NTWS options into those plans. The focus of this report is to identify the opportunities and challenges for extending the IRP process to NTWS. The goal is to help local and regional water planners and utilities make (and implement) better-informed decisions regarding their mix of NTWS and traditional water supply options. IRWMP will address NTWS options as a natural extension of water supply alternatives, and will address the impacts and benefits of NTWS regionally on watersheds, ecosystems, and critical habitats.

CHALLENGES IN INCORPORATING NTWS INTO IRP

Many IRP principles can readily be extended to NTWS. However, NTWS options create some unique challenges that need to be addressed. Primary among these are:

1. ***The nexus between water quantity and water quality.*** There may be restrictions on some types of NTWS uses (e.g., reclaimed water is not typically viewed as a full substitute for all uses of "potable" water). In addition, reuse may have both quantity and quality impacts on water supply extraction streams and on wastewater receiving streams, which must also be carefully considered. These types of constraints may limit the value of some NTWS options.

2. ***Institutional issues.*** Water utilities and wastewater utilities often are not part of the same organization, and their service area boundaries may not correspond. In such cases, the development of reclaimed water can raise complex institutional, legal, and financial considerations.

3. ***Types and distribution of benefits and costs.*** NTWS options can have different types of benefits from—and a more diverse and dispersed set of beneficiaries than—some traditional options. For example, an NTWS option may enhance instream conditions that benefit people and entities downstream of the utility's service area boundaries. Generating benefits for those outside the rate base can raise equity concerns and financing opportunities or challenges.

The IRP approach provides a useful context for addressing these issues. The key is in identifying and understanding the relative benefits and costs of NTWS options and placing these alternatives within the context of the other options available to water supply agencies and the communities they serve. For example, an NTWS may provide considerable environmental benefits if used in lieu of extracting more surface waters from rivers and streams that are already impaired by low flows. In general, evaluations of these NTWS options must compare their impacts to the outcomes that might arise if other water supply options are pursued instead. Alternatively, these NTWS options should be compared to a baseline in which no new traditional water supply is developed and the community faces the possibility of severe water shortages in the future.

ELEMENTS OF THE IRP PROCESS

Although the term IRP has been defined in different ways in different applications, it usually incorporates the following four features:

1. ***Multiple resource strategies.*** The original concept of IRP was rooted in a need to place demand-side and supply-side alternatives on a level playing field. Integrated resource plans develop and evaluate alternative resource strategies, each of which consists of different combinations of those alternatives. The performance of those strategies against a variety of evaluation criteria (see below) is then assessed. Among the supply options that should be considered for inclusion in the resource strategies are NTWS.

2. ***Multiple participating agencies.*** Often integrated plans are sponsored and/or funded by several agencies, not all of which are necessarily water utilities. Wastewater, stormwater, energy (e.g., hydroelectric), and other utilities with interests in water

resources may be integral participants. Federal, state, or county/local agencies—potentially including land use planning entities—and public interest groups may also be full-scale participants.

3. ***Multiple stakeholders.*** One of the key attributes of integrated plans is that they make great efforts to integrate the public and diverse stakeholder groups into the planning process. Public participation has thus become a common and often very significant component of the IRP process.

4. ***Multiple evaluation criteria.*** IRP incorporates multiple criteria in evaluating alternative water resource strategies. Such criteria can, for example, be associated with costs, water supply reliability, water quality, environmental impacts, public acceptability, ease of implementation, and other factors. Integrated plans also tend to consider future uncertainties in a more explicit fashion than do traditional analyses.

Most utilities doing significant water resource planning are now incorporating some or all of these four elements of IRP, even if called by another name. When planning involves NTWS, these elements tend to become more relevant and vital to the process.

STEPS OF THE IRP PROCESS

Every IRP application faces a different set of circumstances. Hence, no single process or formula is appropriate for all applications of IRP. IRP does, however, generally include four steps.

Step 1: Define Scope

This is a critical step in the IRP process. At this stage, planners must define the appropriate geographic area, plan participants, stakeholders, decision-making framework, project objectives, and logistics.

Currently, most integrated resource plans are done by individual water agencies. This is often the easiest logistically to administer and implement, and is consistent with historical water resource planning efforts. There is often merit, however, in expanding the geographic and organizational scope to incorporate the goals of and synergies among the multiple agencies involved with regional water resources. Expanding the geographic and institutional scope to include, for example, a county, river basin, or larger region affords the opportunity for a richer and more complete analysis. However, such a broad scope also can complicate the planning process and increase its cost (in part, because water, wastewater, and stormwater service area boundaries often differ and overlap).

In general, when defining the scope of an integrated resource plan, utilities should neither over-analyze nor under-analyze. Utilities need to think hard about the potential payoff to alternative analytical investments. This is difficult to discern and apply with perfect foresight, yet it is important for utilities as they determine the appropriate level of integration and the associated analytical requirements.

Step 2: Identify Alternatives

This step entails defining the appropriate baseline and then defining the set of alternative supply and demand options that will be incorporated into strategies and evaluated to improve upon baseline conditions.

Baseline conditions are typically seen as the "do nothing different" or "status quo" scenario. This does not mean "no projects," as there may well be future projects that will go forward in any event, regardless of the outcome of the IRP. Those projects should be included in the base case. Defining the proper baseline sounds simple, but it is often a considerable challenge because it entails projecting into the future.

Supply alternatives could be projects to develop or access new conventional or nontraditional water supplies. Alternatives may also include a variety of operational and strategic collaborations to optimize existing resources. For example, this could include conjunctive use of surface and groundwater, rapid infiltration ponds for stormwater, drought-year purchase options, among many others. Typically, in addition to these supply-side alternatives, demand management programs, which reduce future water use by customers, should also be considered. Then, depending on the number and complexity of the alternatives, they can be combined into a set of resource strategies.

Step 3: Evaluate Alternative Strategies

Once strategies are developed, they can be evaluated against a set of carefully crafted criteria. Some of these criteria will be easily quantifiable, while others will not. Some of the benefits can be expressed in dollars, but it is likely that others (especially environmental outcomes as may be associated with NTWS) may be especially difficult to monetize. Moreover, it is almost certain that not all plan participants and stakeholders will agree on all the evaluation approaches and findings. Thus, there must be a well-thought-out process to resolve differences and end up with useful evaluations of each of the alternatives against all of the criteria.

IRP is not simply least-cost planning. The essence of IRP is to compare alternatives using multiple criteria, not just costs. For example, decision-makers may prefer to see how alternatives compare against supply reliability, water quality, and environmental metrics. The "best" strategy may not be the least expensive. Also, when the analysis for IRP is treated as an iterative and interactive process, then the quantification and monetization of benefits can be illustrative and help establish common ground among stakeholders. That common ground may potentially lead to bases for cost-sharing arrangements.

Step 4: Select Strategy

Based on the results of the prior IRP steps, decision-makers will select a strategy to pursue. Once choices have been made and the "formal" IRP is concluded, other tasks then face plan participants. Implementation plans must be developed, funding must be sought, and financial responsibility assigned. Likewise, political support must be garnered, environmental documentation must be developed, and monitoring procedures must be designed and put in place. As conditions change, the plan itself must be periodically re-examined, and modified as necessary. Thus, IRP should be viewed as a continuing process.

ISSUES AND OPPORTUNITIES FOR EXTENDING IRP TO NTWS

Several key issues are often encountered when integrating NTWS into the IRP process. While including NTWS does not change the conceptual underpinnings of IRP, it often requires that IRP practices be expanded to address new and different NTWS issues. Key issues discussed in this report illustrate how the IRP paradigm must grow to accommodate increasingly complicated challenges in water resource planning.

Nontraditional IRP Leadership and Participants

Water IRP has commonly been conducted by individual water utilities. As alluded to above, the benefits—and potentially the costs—of IRP can, however, be expanded in some applications if multiple water, wastewater, and other water-related utilities and agencies engage in a joint planning exercise.

When IRP includes multiple players, the question arises of how to best organize the effort. Given that NTWS options are more likely to involve multiple agencies, this is a particularly important issue to address in this context. In some cases, a clear regional or basin-wide agency exists to take on a coordinative role. In other cases, a new or nontraditional player can provide this leadership function. In still other cases, no single agency takes leadership, but some partnering arrangement is struck among existing agencies.

Ultimately, IRP leadership can come in many shapes and forms. In order to incorporate more overarching regional objectives and synergies, there may be value in being more expansive in terms of both participants and geographic scope. This may introduce additional organizational and institutional complexities as the IRP expands beyond the direction and control of a single water agency. A balance must be struck between the added value and added complexity. Three case studies are provided to offer illustrations of a range of organizational possibilities. IRWMP leadership is by necessity expansive regionally and may involve leadership by stormwater, flood control, and watershed management agencies in addition to water and wastewater agencies.

Water Supply Reliability

Some key NTWS options, such as reclaimed wastewater and desalination, are generally considered to be "drought-resistant" supplies, meaning that the expected water yields tend not to be appreciably impacted by weather conditions such as prolonged drought. There is evidence—from empirical research and from casual observation of political impacts—that water users place a fairly high value on having a water supply that reliably provides them the quantity and quality of water they desire, on an uninterrupted basis. Hence, the inclusion of such NTWS options can generate significant economic and societal benefits.

Water supply reliability is a key decision variable for water managers. In a traditional water utility planning exercise, reliability often is treated as a fixed value or constraint, with the goal being to identify the combination of supply and infrastructure investments that will maintain a predetermined level of reliability at the lowest cost. In IRP, reliability is a variable, and maximizing reliability is one of many objectives among which trade-offs must be made. Thus, there is not a predetermined level of reliability; rather, the best level of reliability is determined along with the best levels of costs, environmental impact, water quality, public acceptability, etc. Two case studies are provided that illustrate some of the ways in which NTWS reliability has been considered in an IRP context.

Stakeholder and Public Input

The overall objective of IRP is not to necessarily persuade communities to use NTWS options. Rather IRP is about getting communities to explicitly, systematically, and objectively consider all relevant options, including NTWS, so that they can select the best mix of options for solving their problems. To accomplish this, a distinguishing feature of IRP is its explicit inclusion and integration of stakeholder and public input.

In traditional water resource planning, stakeholders often had limited or no involvement in the process. Today, it is hard to imagine developing NTWS options without explicit and involved coordination with stakeholders. There are many advantages to taking an open and proactive approach to identifying and engaging with stakeholders. Of key importance are the potential improvements in the planning, development, and implementation of the options that may result from the collaboration. Moreover, having a strong relationship with stakeholders can save utilities considerable time and effort and might possibly help garner the level of public support that is needed for an agency to move ahead and successfully implement an NTWS option.

Stakeholder involvement is not without its costs and challenges. Agencies need to recognize and plan for a considerable investment of staff and calendar time, as well as the possibility of contentious meetings. Accordingly, a key to successful stakeholder involvement is to make sound choices about whom to engage, when to engage them, and how to integrate stakeholder input into the process. Other keys to success are to clearly lay out and agree on roles and expectations from the outset.

Regulatory and Institutional Issues

Planners and managers who are contemplating the addition of NTWS into their regional water supply portfolio should be aware that they probably will face permitting and other institutional issues that could complicate and delay the process. These issues are defined here as nontechnical barriers that may impede the implementation of desalination, reuse, or other NTWS options. These are barriers in the sense that these issues may impede the effective inclusion of NTWS options in a region's water supply portfolio, because they increase uncertainty, add costs, and/or create delays. In sum, these barriers may adversely affect the ability of a water or other IRP-engaged utility to obtain needed permits, gain support from citizens and governing officials, get an NTWS facility built, and/or successfully operate a facility.

Institutional and regulatory barriers often will be specific to the type of NTWS option being considered within an integrated resource plan. For example, desalination of coastal waters typically will require a daunting array of regulatory reviews and approvals that cover the full range of desalination-related activities, including obtaining feedwater, blending and distributing product water, and disposing the brine concentrate and other byproducts. One California utility has worked with 25 different permitting entities in an effort to secure over 50 different permits deemed necessary for proceeding with a coastal desalination facility that the utility wishes to colocate with an existing power plant. The number and types of permits required for a desalination project may vary from state to state and also will depend on the feedwater source. Desalting high-total-dissolved-solids groundwaters will typically raise far fewer permitting and other institutional issues than will the tapping of coastal waters.

Water reclamation and stormwater harvesting raise their own sets of institutional issues. In some locations, public opposition to reusing wastewater has emerged as a critical issue for some reclaimed water applications (e.g., “toilet to tap” misconceptions and/or other perceived public health or aesthetic concerns). There also can be a more generic opposition to any NTWS option by antigrowth advocates who perceive new water supply options as encouraging or enabling growth.

Water and Wastewater Utility Collaboration

In many areas, water and wastewater services are provided by different utilities. Commonly, a wastewater utility provides service for customers served by multiple water utilities. This or other similar disjoints can cause significant institutional barriers in implementing reuse or other NTWS projects. This problem may arise, for example, where the water supplier views the emergence of a reuse program by the regional wastewater entity as a competing source, possibly leading to revenue shortfalls and stranded assets for the water utility.

These differences can be magnified by the inherent uncertainties that surround many of the assumptions that underlie the IRP process, such as the region’s projected demand growth and water supply needs into the future, and/or the impact of changing climate on long-term supplies and demands. Different stakeholders may have diverging opinions on these and other factors. These differences also can be compounded by issues outside the normal IRP process, such as political disputes and competition between the various levels of government or between neighboring jurisdictions that manage the utilities.

Ultimately, resolving these differences can be a complex exercise, but using the IRP process can be useful in helping to identify the factors that underlie the differences (e.g., disagreements may be pinpointed over the long-term supply and demand forecast). Further, the IRP process can provide a mechanism for proceeding despite these differences (e.g., by running sensitivity analyses based on different scenarios). The IRP process also can be a useful way to examine or reveal a legitimate basis and need for revenue sharing across utilities (e.g., where the wastewater entity shares revenues with the water supply utility to compensate for the latter’s loss of peak summer outdoor irrigation revenues).

The primary job of staff and decision-makers at each agency is to look out for the interests of their particular customers and/or constituents. These local and utility-centric concerns are very important but, by their nature, often pose a challenge to regional planning. What is perceived as best by one agency does not necessarily match the perception of another agency; what is best for either of them is not necessarily what is best for the region as a whole.

IRP practitioners need to foster “big picture” perspectives in order for the benefits of regional resources to be realized. The success of an integrated resource plan often depends on the ability to stay above purely local or utility-centric concerns. The question becomes how to meet current and future demands throughout the region in a manner that best meets regional objectives. An integrated resource plan can all too easily be taken over by individual agency concerns, and the regional focus can be quickly lost. One of the critical functions of an integrated resource plan may be to help ensure that the focus remains regional.

Among other things, this means that the evaluation criteria should be developed in terms of regional and subregional, rather than purely local or utility-specific, needs. This emphasis will greatly increase the likelihood of a successful and useful product. In addition, and perhaps most important, by consciously deferring discussion of inherently contentious local- or utility-level issues, participants get the opportunity to work together and reach mutual understandings before dealing with those issues.

A truly regional deliberation about supply alternatives will provide a region with the highest probability of ultimate success. The IRWMP extension of the IRP process will foster regionalism as well, along with an emphasis on water management strategies that touch on stormwater management, flood control, and other NTWS options and the benefits and impacts they may have on regional watersheds and ecosystems.

Incorporating Environmental Externalities

Many NTWS projects may generate benefits (and/or costs) that are "external" to the water or wastewater utility developing these options. These external benefits—environmental or otherwise—often can have substantial value to a range of stakeholders outside the water utility and to society as a whole. Recognizing external benefits may often reveal that NTWS options which do not appear favorable for the utilities themselves may, in fact, have much more favorable benefit–cost results when evaluated for the broader region and society.

What is important for the IRP process (or any sound planning approach) is that the full range of benefits, and the full range of beneficiaries, is identified and valued to the extent feasible. Likewise, external costs (such as possible adverse impacts on marine ecosystems from the intake coastal waters to feed desalination facilities) also need to be accounted for in an objective and sound manner.

By developing and using broadly scoped criteria as part of the evaluation step in the IRP process, a more balanced assessment can be developed of the relative pros and cons of NTWS options as compared to more conventional supply alternatives. Identifying the entities to whom benefits and costs accrue may also help identify a useful basis for cost-sharing arrangements with neighboring jurisdictions (e.g., when they benefit from but otherwise do not pay for an NTWS option). Likewise, identifying benefits and beneficiaries that are external to the sponsoring utility and community may provide a rationale for state or federal subsidies to help cover a portion of the costs of an NTWS option (e.g., where there are appreciable external benefits to the broader region or state).

IRP ANALYTICAL TOOLS AND MODELS

Computer applications addressing water resources are becoming more expansive, sophisticated, and widely used. IRP models can facilitate the appropriate use of NTWS in the water resource big picture. Models can help decision-makers understand and better fit NTWS into their water supply portfolios. Using IRP models, however, has challenges that practitioners need to recognize and address.

IRP practitioners need to opportunistically make use of a variety of models applicable to their situation. The level of coordination among models, the regional scope of models, and the level of decision-making guided by models are particularly important issues. Each utility will have different needs, resources, and challenges. Common issues to address in the model consolidation process can include geographic scope, time horizons, level of detail, and the handling of uncertainty. Ideally, IRP practitioners will be able to identify, coordinate, and obtain modeling results for all components relevant to the scope of their resource planning efforts. In reality, however, this is rarely the case. IRP practitioners must often patch together results from assorted sources, often with gaps that need to be filled or improved upon at a later date. Thus, like the rest of the IRP process, computational modeling is more a continuing process than a quest for a single static outcome.

CHAPTER 1

INTRODUCTION AND OVERVIEW

1.1 OBJECTIVE OF THIS REPORT

This report is intended to provide guidance and illustrative examples to water supply and wastewater managers—and other relevant planning and regulatory entities—as they consider how to meet increasing local and regional water demands while they concurrently face more constraints on developing new potable supplies. Because traditional sources of potable water are increasingly limited by numerous factors (including environmental, hydrologic, and economic constraints), there is heightened interest in considering as well as a need to consider if and how nontraditional water supply (NTWS) options can help meet the challenge of satisfying increased water demands. For the purpose of this report, NTWS includes wastewater reclamation, desalination of seawater or brackish groundwater, and various forms of rainwater harvesting including stormwater use (and most of the discussion focuses on reclamation and desalination). This report examines how water planners and managers can use the Integrated Resource Planning (IRP) process as an objective and balanced way to explore the relative merits of considering NTWS options alongside their suite of more traditional water supply alternatives.

1.2 BACKGROUND AND MOTIVATION

Increasingly, water managers have come to appreciate the value of nontraditional sources for accomplishing their long-term mission of providing a safe and reliable water supply. Increasing use of reclaimed water, desalination, and other nontraditional water source options is seen as a viable complement to—and in some instances, a substitute for—investments in more-traditional long-term water supplies and infrastructure.

There are several factors driving water managers and planners to seriously consider NTWS within their long-term supply planning, most notably the need to meet increasing water demands at the same time that there are increasingly evident constraints on extracting more water from traditional sources such as freshwater river flows and aquifers. A key challenge, however, is having a fair and balanced approach to evaluate the NTWS options within the context of traditional water sources and other alternatives.

Specifically, a suitable process is needed to help fully identify, weigh, and compare the benefits and costs of all water supply options. The potential direct and indirect benefits of reuse, desalination, and other nontraditional water source options range far beyond the cost savings associated with an offset in supply requirements and often include a range of important ecological, social, and economic considerations. Unfortunately, these wide-ranging benefits (and/or costs) often go unrecognized by the average citizen or policymaker, and NTWS options may remain undervalued and underutilized unless all benefits (and costs) are thoroughly understood and carefully valued.

1.3 A BRIEF INTRODUCTION TO IRP

Determining the most appropriate mix of water reuse and other supply-side and demand-side investments is a difficult challenge for many utilities. IRP is a planning approach that water resource agencies have been turning to more and more over the past decade to address this challenge. The goal of an integrated resource plan (or, for that matter, any water resources planning effort) is to provide, at a reasonable cost, information that helps policymakers make better decisions. In this context, "better decisions" are those that are likelier to result in actions that meet multiple utility objectives. A plan that considers a wide array of options and applies integrated planning techniques is more likely to result in this type of "better decision."

IRP has its roots in the electric power industry, where it emerged in the late 1980s in response to a fundamental shift in the cost structure of the industry. Increasing fuel and construction costs caused the economies of scale to bottom out, and electricity rates began a marked increase. As utilities, regulators, and consumers sought ways to stabilize costs and minimize adverse environmental impacts, demand-side management (e.g., energy conservation and peak-load shifting) emerged as an important strategy to be considered concurrently with a range of alternative supply options.

In the water sector, IRP has largely been used over the past decade to integrate water conservation into utilities' planning processes. Significantly less attention has been paid to date to integrating water reuse or other NTWS options into those plans. The focus of this report is to identify the opportunities and challenges for extending the IRP process to NTWS. The goal is to help local and regional water planners and utilities make (and implement) better-informed decisions regarding their mix of NTWS and traditional water supply options.

1.4 CHALLENGES IN INCORPORATING NTWS INTO IRP

Many of the IRP principles that guide the traditional IRP process can readily be extended to NTWS. However, NTWS options create some unique challenges that need to be addressed. Primary among these are:

- ***Quantity–quality nexus.*** There may be restrictions on some types of NTWS uses (e.g., reclaimed water is not typically viewed as a full substitute for all uses of "potable" water).Thus, in assessing potential water reuse programs, utilities must carefully consider water quality as well as water quantity effects.

- ***Instream considerations.*** In addition to concerns about finished water quality, water reuse may have both quantity and quality impacts on water supply extraction streams and wastewater receiving streams; they must also be carefully considered.

- ***Institutional issues.*** In most cases, water utilities and wastewater utilities are not part of the same organization. Water utilities may not own the wastewater, making for much more complex institutional, legal, and financial transactions, which also must be considered.

- ***Types and distribution of benefits and costs.*** NTWS options can have different types of benefits from—and a more diverse and dispersed set of beneficiaries than—some traditional options. For example, an NTWS option may enhance instream conditions that benefit people and entities downstream of the utility's service area boundaries.

Generating benefits for those outside the rate base can raise equity concerns and financing opportunities or challenges.

At the heart of the integration of nontraditional resources into water utility planning lies an economic standard: a viable reuse or other NTWS program is one that (at a minimum) produces benefits that exceed the costs required to undertake the program. Reuse and other NTWS programs for which this is not the case are questionable undertakings for water utilities. Thus, a key challenge is to understand all the benefits and costs of these options. The IRP approach provides a useful context for addressing these issues. The key to identifying and understanding the relative benefits and costs of reuse and other NTWS options is to place these alternatives within the context of the other options available to water supply agencies and the communities they serve. For example, reuse or desalination may provide considerable environmental benefits if it is used in lieu of extracting more surface waters from rivers and streams that are already impaired by low flows. In general, evaluations of these NTWS options must compare their impact to the outcomes that might arise if other water supply options are pursued instead. Alternatively, these NTWS options should be compared to a baseline in which no new traditional water supply is developed and the community faces the possibility of severe water shortages in the future. Moreover, these impacts must be readily communicated to stakeholders and policymakers, so that the process of making decisions that affect the community is open, transparent, and informed.

1.5 RELATIONSHIP OF IRP TO INTEGRATED REGIONAL WATER MANAGEMENT PLANNING

Integrated Regional Water Management Planning (IRWMP) is a practice that is being encouraged in California through the use of grants funded by the state. In essence, IRWMP applies the concepts of IRP with an additional emphasis on integrating the various water resource planning activities across a broad regional landscape. It also encourages greater inclusion of nontraditional water-related entities.

The regional emphasis embodied in IRWMP has encouraged agencies to coordinate and integrate plans beyond the service areas of single wastewater and water supply entities or a single political jurisdiction such as a county. It has expanded the geographic scope to embody multiple water supply and wastewater agencies across a physical area that more closely approximates water resource boundaries (e.g., major watershed areas). One of the advantages of the IRWMP-style application of IRP is that the broader geographic scope enables entities to more readily consider projects (NTWS or otherwise) that are more regional in scope.

The IRWMP approach also enables and encourages greater inclusion of more entities and beneficiaries in the IRP process. For example, the approach can promote including stormwater management agencies, flood control organizations, and habitat protection and restoration entities (among others) in the regional water resource management planning process. This action provides greater opportunities for integrated solutions and better utilization of all the region’s water resources.

1.6 AN OVERVIEW OF THIS REPORT

Chapter 2 provides a working definition of IRP and summarizes the major components of the IRP process. Its purpose is to establish a common basis for understanding IRP, so that the rest of the report can build on this foundation and incorporate NTWS into the IRP process.

The objective of Chapters 3 through 9 is to describe key issues commonly encountered when integrating NTWS into the IRP process. Including NTWS does not change the conceptual underpinnings of IRP but requires that the IRP paradigm grow and IRP practices expand to address the new and complicated challenges posed by adding NTWS to water resources planning.

The chapters are organized as follows:

- Chapter 3: Nontraditional IRP Leadership
- Chapter 4: Water Supply Reliability
- Chapter 5: Stakeholder and Public Input
- Chapter 6: Regulatory and Institutional Issues
- Chapter 7: Incorporating Environmental Externalities: Benefit–Cost Analysis and Its Relationship to IRP
- Chapter 8: Water and Wastewater Utility Collaboration with Reuse
- Chapter 9: Computer Models for IRP
- Chapter 10: Agenda for Future Research

These seven issues are not exhaustive, but they target areas likely to be of most importance in this context. They reflect how IRP must expand in several dimensions in order for NTWS to be fully considered and evaluated along with traditional water supplies and water demand management measures. Although each chapter is meant to stand alone for selective readers, we also point out and describe important overlaps and interactions among the key issues. We conclude the report with a chapter identifying an agenda for future research, and we also provide a references section that includes materials that can be consulted for additional insights.

In each chapter, we weave in case studies illustrating how the key issue has been dealt with in different contexts. Although we incorporate the case experience from many IRP projects, this project concentrates on six in-depth case studies in the United States:

1. Broward County, FL
2. City of Santa Cruz, CA
3. City of Phoenix, AZ
4. San Diego County Water Authority, CA
5. Tampa Bay region, FL
6. California IRWMP

We contacted and interviewed individuals involved with each case to better understand and learn about their experiences in applying IRP to their circumstances. Each case dealt with each of the key issues to some degree, but we use the cases selectively to illustrate the key issues of most relevance. This results in a matrix showing the intersections among the key issues and case studies as shown in Table 1.1.

Table 1.1. Intersection of Key Issues with Case Studies

Key Issue	Case Study					
	Broward County	**Santa Cruz**	**Phoenix**	**San Diego**	**Tampa Bay**	**California IRWMP**
Nontraditional IRP Leadership	X				X	X
Water Supply Reliability		X		X		
Stakeholder and Public Input		X		X		
Regulatory and Institutional Issues (Various Cases Included)						
Incorporating Environmental Externalities: BCA[a] and Its Relationship to IRP			X			X
Water and Wastewater Utility Collaboration with Reuse			X		X	
Computer Models for IRP	X	X	X			

[a]BCA, benefit–cost analysis.

CHAPTER 2

OVERVIEW OF IRP

This chapter provides a working definition of IRP and summarizes the major components of the IRP process. It provides an introduction to readers not familiar with IRP as well as a common basis and understanding of the IRP process, because IRP can mean different things to different people.

The purpose of this project is not to provide a detailed discussion of the foundations of IRP. There are many documents covering this topic, as summarized in the bibliography provided in Appendix A. Instead, the purpose of this project is to express and document how NTWS can be incorporated into the IRP process and also how IRP practices may need to expand and refocus to address key issues encountered when including NTWS in an integrated resource plan.

2.1 BACKGROUND AND DEFINITION OF IRP

Water resource planning has been advancing, by necessity, to meet greater challenges. A review of the literature on water utility planning shows it has gone through three general stages.

- ***Utility-centric least-cost planning for water supplies.*** Traditionally, water planning tended to be utility-centric and focused only on traditional water supply alternatives. The general process was for a utility to forecast water demands and invest in water supplies and infrastructure to meet those demands with a high degree of reliability. Decisions were made by the utility, without major input from impacted stakeholders and in isolation from other water resource agencies. The primary evaluation criterion was minimizing costs, which is why this form of planning was called least-cost planning.

- ***Utility-centric least-cost planning: supply-side and demand-side resources.*** Starting in the 1980s, utilities began to analyze and include demand management elements in the planning process. A major driver for this shift came from higher costs associated with new supplies. This type of planning emphasizes the optimization of supply and demand projects to minimize overall costs. The main decision criterion continues to be cost, although here the costs of demand-side resources are compared to the supply-side costs to determine the least costly combination of supply-side and demand-side resources to meet future demands. Thus, while the basic decision criterion remains the same (least-cost), the range of alternatives considered expanded considerably.

- ***IRP.*** In the 1990s, water planners started using the term IRP. Although the term IRP has been defined in different ways in different applications, it usually incorporates the following four features:

1. ***Multiple resource strategies.*** The original concept of IRP was rooted in a perceived need to somehow place demand and supply alternatives on a level playing field. In fact, much of the impetus for advancing IRP came from water conservation professionals. IRP develops and evaluates alternative resource strategies, each of which consists of different combinations of demand-side and supply-side alternatives. The performance of those strategies against a variety of evaluation criteria (see below) is then assessed. Among the supply options that should be considered for inclusion in the resource strategies is NTWS.

2. ***Multiple agencies as participants.*** Often integrated plans are sponsored and/or funded by several agencies, not all of which are necessarily water utilities. Wastewater, stormwater, flood management, energy (e.g., hydroelectric), and other utilities with interests in water resources may be integral participants. Other federal and state agencies and public interest groups may also be full-scale participants.

3. ***Multiple stakeholders.*** One of the key attributes of integrated plans is that they make great efforts to integrate the public and diverse stakeholder groups into the planning process. Public participation has thus become a common and often very significant (and costly) component of integrated plans. To the extent that they are not full-scale plan participants (and many will be), common stakeholders can include, among others, the following:

    - Water utilities
    - Wastewater utilities
    - Stormwater utilities
    - Flood management districts
    - Energy utilities (hydroelectric)
    - Regulatory agencies (local, state, federal)
    - Environmental groups
    - Business groups
    - Ratepayer representatives

4. ***Multiple evaluation criteria.*** IRP incorporates multiple criteria in evaluating alternative water resource strategies. Such criteria can, for example, be associated with costs, water supply reliability, water quality, environmental impacts, public acceptability, ease of implementation, and other factors. Integrated plans also tend to consider future uncertainties in a more explicit fashion.

    Note that policymakers must ultimately make trade-offs among all of these criteria. One of the implications of this truth is that the evaluation criteria are treated as decision variables rather than as constraints. Water supply reliability, for example, has traditionally been treated as an assumed engineering target which new supplies and infrastructure must meet. IRP changes this paradigm.

Most utilities doing significant water resource planning are now incorporating some of these four elements of IRP, even if the planning process is called by another name. When planning involves NTWS, these elements tend to become more relevant and vital to the process.

2.2 THE IRP PROCESS

Every IRP application faces a different set of circumstances. Hence, no single process or formula is appropriate for all. IRP does, however, follows four general planning steps:

1. Define scope
2. Identify alternatives
3. Evaluate alternative strategies
4. Select alternative(s)

Here we summarize these four steps, a framework we use throughout this report when addressing key issues related to incorporating NTWS in the IRP process. Figure 2.1 shows a basic flow chart of the IRP process.

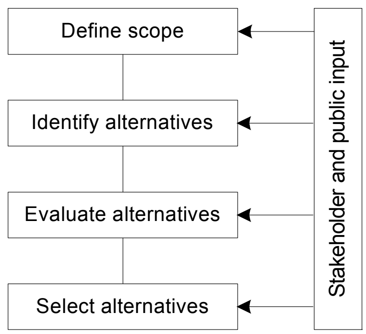

Figure 2.1. IRP process.

2.2.1 Step 1: Define Scope

This is a critical first step in the IRP process. The first place to start in framing an IRP project is to define its scope. This is usually one of the most important steps in the IRP process. The major elements to consider include

- Geographic area
- Plan participants
- Stakeholders
- Decision-making framework
- Project objectives
- Logistics

When one is considering these elements, there is often merit to expanding the scope of the project, as doing so affords the opportunity for a richer and more complete analysis. Such expansion can, however, make the IRP process more difficult and costly. Increasing the number of participants, stakeholders, objectives, and alternatives can rapidly add to the complexity of the IRP process. Hence, the framers of the IRP process need to carefully consider the trade-offs in determining the best level of complexity for their circumstances.

In general, when defining the scope of an IRP process, utilities should neither overanalyze nor underanalyze. Both are possible, and utilities need to think hard about the potential payoff to alternative analytical investments. Conceptually, underanalysis occurs when the cost of the next level of analytical sophistication is less than the expected value of the added information that would be generated. Under such conditions, it is in the utility's interest to perform the additional analysis. Conversely, overanalysis occurs when the cost of the last level of analysis exceeds the value of the added information developed by that analysis.

While these concepts are difficult to discern and apply with perfect foresight, they are nevertheless important for utilities to bear in mind as they determine the appropriate level of integration and the associated analytical requirements. The correct level of analysis will differ for different utilities. Each agency must determine that level for itself, based on at least a "thought experiment" that compares the costs of the additional complexity to the value of the additional information generated by that complexity. This thought experiment, which is illustrated in Figure 2.2, must consider the tools available to the utility to perform different levels of analysis.

Figure 2.2. Cost versus value of information.

2.2.1.1 Geographic Area

IRP can cover a range of geographic areas, including but not limited to the boundaries of utility service areas, territories of adjacent agencies, political jurisdictions, metropolitan areas, or watersheds. Currently, most IRP projects occur at the individual water agency level. It is often the easiest logistically to administer and implement. It is also consistent with historical water resource planning efforts.

There is often merit, however, in expanding the geographic and organizational scope to incorporate the goals of and synergies among the multiple agencies involved with regional water resources. Water, wastewater, and stormwater service area boundaries often differ and overlap with multiple agencies. It is common, for example, for a wastewater agency to serve customers served by multiple water utilities. Hence, conducting IRP at the individual water utility level may overlook the best reuse sites from a regional perspective. Expanding the geographic and institutional scope to include, for example, a county, river basin, or larger region, affords the opportunity for a richer and more complete analysis. This is the intent of the IRWMP process. However, increasing the geographic scope can also complicate the difficulty of the planning process and, as described above, increase its cost.

2.2.1.2 Plan Participants

Participants are those involved with the design, funding, and administration of the IRP steps. The number and variety of agencies actively participating in the plan are a scope variable that must be determined early on. This decision will be guided by many financial, political, geographic, logistical, and institutional considerations.

By bringing NTWS options into the picture, a number of entities that in the past may have been only stakeholders or entirely outside the IRP process are now likely to be engaged directly as IRP participants (e.g., a stormwater management agency). This expansion of the number and types of participants will add complexity but also create opportunities for more-prudent overall management of the region's water resource management challenges.

2.2.1.3 Stakeholders

A key element of the IRP process is to identify the key stakeholders from whom input will be sought. In NTWS applications, the number and type of stakeholders tend to be larger and more diverse than are typical for conventional supply development. Hence, addressing stakeholder issues tends to become even difficult and more important. Once the stakeholders are identified, organizers must carefully lay out the process by which stakeholder input (and the input of the public at large) will be solicited. Expectations of the role of the stakeholders must be clearly specified and communicated. Stakeholder involvement processes often succeed or fail based on how realistic these expectations are.

2.2.1.4 Decision-Making Framework

In a planning effort with multiple participants and a variety of stakeholders, an interested public, concerned regulators, and numerous decision-making bodies, it is important for the framers of the integrated resource plan to clearly lay out the manner in which decisions will ultimately be made. The roles of all parties, the process of soliciting and using input, the questions for which staff and policymakers will and will not concede authority to stakeholder groups, and the expectations of advisory groups or task forces are all issues that must be clarified and communicated at the front end of the process. In some cases, particularly multi-agency planning efforts, some issues (e.g., funding of projects) will be excluded from the IRP process. This reality too must be made explicit.

The desired outcome of the process must also be defined. What will the "bottom line" of the integrated resource plan be, and what future investment or operational decisions will be affected by the planning exercise?

2.2.1.5 Project Objectives

The framers of an IRP process need to identify the key objectives that the process will seek to achieve. Some possible objectives include the following:

- Provide water quantity to meet current and future needs
- Ensure water supply reliability
- Maximize quality of raw and/or treated water
- Minimize negative environmental impacts (and/or enhance positive impacts)
- Provide flood protection
- Provide recreation opportunities
- Minimize customer costs
- Manage resources for sustainability
- Improve equity among stakeholders
- Meet existing and future regulatory requirements

The objectives will differ in each IRP setting. It is critical, however, that plan participants spend sufficient time at the beginning of the process to carefully define these objectives.

2.2.1.6 Logistics

Logistics of any planning effort include the common elements of staffing, funding, scheduling, and interagency coordination. Logistics will be determined in large part by the scope of the components, as defined above. In general, for NTWS applications, the logistics tend to be more complicated because of broader groups of participants and stakeholders, more difficult issues to resolve, and associated institutional challenges that must be overcome.

2.2.2 Step 2: Identify Alternatives

After establishment of the scope of the plan, the next planning step is to identify alternative options to improve upon baseline conditions.

Baseline conditions are a predetermined set of future conditions against which to compare strategies. They are typically seen as the "do nothing different" or "status quo" scenario. This does not mean "no projects," as there may well be future projects that will go forward in any event, regardless of the outcome of the integrated resource plan. Those projects should be included in the base case.

Defining the proper baseline sounds simple, but it is often a considerable challenge because it entails projecting into the future. This deed in turn becomes a focal point for many assumptions that will underlie the analysis of options, and these assumptions may reveal core differences in opinion or philosophy across stakeholders (e.g., a potentially controversial baseline assumption may be projected growth in local population and water demand).

Alternative options could be projects to develop or access new conventional or nontraditional water supplies. Typically, alternatives should also include demand management programs to reduce future water use by customers.

Supply alternatives could be projects to develop or access new conventional or nontraditional water supplies. Alternatives may also include a variety of operational and strategic collaborations to optimize existing resources. For example, they could include conjunctive use of surface and groundwater, rapid infiltration ponds for stormwater, and drought-year purchase options, among many others. In addition to these supply-side alternatives, demand management programs, which reduce future water use by customers, should also be considered. Then, depending on the number and complexity of the alternatives, they can be combined into a set of resource strategies.

2.2.3 Step 3: Evaluate Alternative Strategies

Once strategies are developed, they can be evaluated against a set of carefully crafted criteria. Some of these criteria will be easily quantifiable, while others will not. Some of the benefits can be expressed in dollars, but it is likely that others (especially some environmental outcomes, as may be associated with NTWS) may be especially difficult to monetize. Moreover, it is almost certain that not all plan participants and stakeholders will agree on all the evaluation approaches and findings. Thus, there must be a well-thought-out process to resolve differences and end up with useful evaluations of each of the alternatives against all of the criteria.

It must be kept in mind that IRP is not simply least-cost planning. The essence of IRP is to compare alternatives by using multiple criteria, not just costs. For example, decision-makers may prefer to see how alternatives compare against supply reliability, water quality, and environmental metrics. The “best” strategy may not be the least expensive. Also, when the analysis for IRP is treated as an iterative and interactive process, then the quantification and monetization of benefits can be illustrative and help establish common ground among stakeholders. That common ground may potentially lead to bases for cost-sharing arrangements.

2.2.4 Step 4: Select Alternatives

Based on the results of the prior tasks, decision-makers will select a strategy to pursue. As alluded to earlier, the process by which this selection will be made must be carefully laid out.

Once choices have been made and the “formal” IRP is concluded, other tasks then face plan participants. Implementation plans must be developed. Funding must be sought and financial responsibility assigned. Political support must be garnered. Environmental documentation must be developed. Monitoring procedures must be designed and put in place. As conditions change, the plan itself must be periodically reexamined and modified as necessary.

Thus, the integrated resource plan is the beginning of a continuing process in which all plan participants and stakeholders must engage. If done correctly, the openness and transparency of the planning process will set the stage for ongoing cooperation among all parties. At the very least, the parties will develop a mutual trust and respect that will set the stage for essential long-term dialogue.

2.3 CONCLUSIONS

IRP raises the bar when compared to traditional planning by incorporating multiple resources, agencies, stakeholders, and evaluation criteria into the water resources planning process. This added complexity can be daunting and certainly adds to the cost and time needed to accomplish water planning.

IRP is, however, becoming increasingly necessary to adequately address greater challenges. In particular, IRP can be very useful in providing a better environment in which to evaluate NTWS alternatives. NTWS alternatives tend to involve multiple resources, multiple agencies, multiple stakeholders, and multiple evaluation criteria. Hence, a clear nexus between IRP and NTWS exists. The remaining chapters of this report present and address a number of key issues that may arise as NTWS is incorporated into IRP.

CHAPTER 3

NONTRADITIONAL IRP LEADERSHIP

Water IRP has traditionally been conducted by individual water utilities. The benefits of IRP, however, can be greatly enhanced in some applications by expanding both the jurisdictional and geographic boundaries and including multiple water, wastewater, and other water-related utilities and agencies (as per the IRWMP approach).

When IRP includes multiple players, the question arises of how to best organize the planning effort. This issue is particularly important to address in the context of NTWS options, which are likelier to involve multiple agencies (e.g., when reclaimed water is produced by the regional wastewater agency). In some cases, a clear regional or basin-wide agency exists to take on a coordinative role. In other cases, a new or nontraditional player can provide this leadership function. In still other cases, no single agency takes leadership, but some partnering arrangement is struck among existing agencies.

This chapter explores different IRP organizational arrangements. In doing so, it is important to distinguish between IRP participants—those who design, fund, and administer the IRP components—and stakeholders. Participants typically include an array of water, wastewater, and stormwater agencies. Although the line between participants and stakeholders can blur in some applications, the distinction can be useful in getting the IRP process rolling. Chapter 5 specifically addresses stakeholders and their role.

3.1 OVERVIEW OF CASE STUDIES

This chapter presents three case studies illustrating the changing nature of the IRP organizational structure with respect to NTWS applications. The case studies do not exhaust the possibilities but show some nontraditional and emerging trends associated with IRP and NTWS.

In the first case, we look at how a county government can lead in the stewardship of water resources within its political boundaries. Although county boundaries do not commonly match those of hydrologic watersheds, they often have an established political structure that can be utilized for IRP organization. We selected Broward County, Florida, as a case study because it coordinates, through an IRP process, a large and diverse community with an interest in water resources. The community consists of 31 water utilities, 23 drainage control/water control districts, 31 municipalities, and state and federal entities. This case illustrates a recent trend of IRP to seek and forge broader coalitions in water resource planning.

The second case illustrates an entirely different leadership direction. In this case, a consortium of water and wastewater utilities, along with a regulatory entity, collaborated to improve regional water resource management in the Tampa Bay region of Florida. The consortium is a team-based effort, not centered on a single political (e.g., county) or organizational entity to perform the IRP steps. Instead, the participating agencies came together in a communal spirit to communally address specific issues of mutual concern and benefit. Organizing such communal groups into an IRP process has its own challenges. We look at how three water utilities, a wholesale water producer, and a water regulatory agency joined in water reuse planning efforts. Financial assistance provided by the regulatory agency catalyzed and facilitated the process.

The third case study documents statewide efforts in California to facilitate regional water IRP via an incentive-based approach of providing grants for IRP and implementation. The state recognizes the immense potential gain from and also traditional barriers to cooperating in regional water operation. By providing significant financial resources distributed through a competitive process, the state's intent is to stimulate effective regional solutions by using a carrot instead of a stick. In applying for grant monies, water and water-related agencies are allowed to form their own coalitions and create planning and implementation proposals that generate regional benefits. The specific IRP organizational structure is left up to the applicants to best serve the regional circumstances in each application.

3.2 BROWARD COUNTY INTEGRATED WATER RESOURCE PLAN

Rapid population and economic growth in Broward County, Florida, is threatening the integrity of its water resource systems to provide potable water (e.g., Biscayne aquifer) and maintain the health of its remaining natural ecosystems. Population has grown from 83,933 in 1950 to 1.7 million in 2005 to a projected 2.4 million in 2025. Broward County also has significantly transformed its water resources through primary and secondary canals, largely implemented between 1952 and 1962 in efforts to drain regions of the Everglades for development. Figure 3.1 shows the location of Broward County.

Prior to the mid-1990s, no attempts were made to coordinate water planning on a county-wide basis. Given significant future challenges, Broward County, with support from the South Florida Water Management District (SFWMD), began to take steps to support regional planning and solutions.

A product of these efforts was the Broward County Integrated Water Resource Plan of 2005 (Broward County, 2005). Using a 10-year planning horizon, its goals were to

1. Coordinate the sources and users of water for effective and efficient local water management

2. Work with water producers to meet the county's present and future urban water needs

To accomplish these goals, Broward County identified four plan components, including the following:

- Natural system integration
- Canal system integration
- Utility system integration
- Policy integration

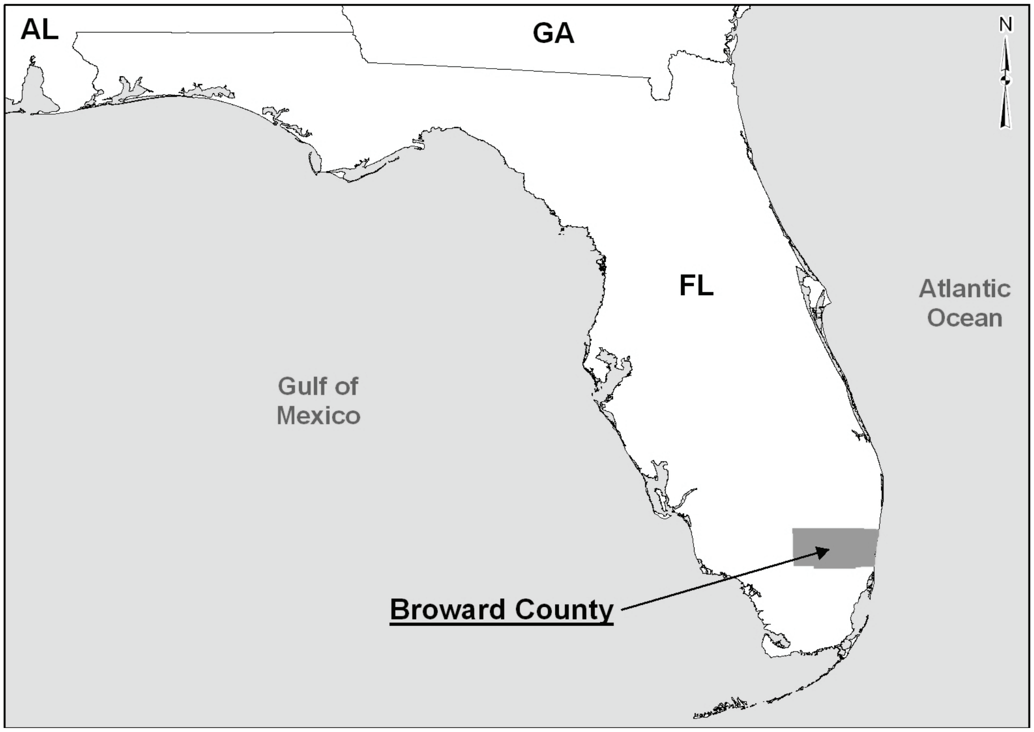

Figure 3.1. Broward County, Florida.

Broward County is implementing or coordinating the implementation of numerous activities to foster its goals within each component, including the following:

- Compiling a county-wide inventory of water attributes and assets, including wetlands, surface water, and water management infrastructure
- Developing and making available hydrologic models to quantify the water needs of the natural system and urban population
- Funding feasibility studies and design of individual projects that support regional goals
- Funding individual projects that support regional goals
- Supporting and administering regional water conservation programs

Broward County serves as the focal point in governing a large and diverse water management community. The community consists of 31 water utilities, 23 drainage control/water control districts with water management functions, 31 municipalities, and state and federal entities. It also interfaces on issues associated with the Comprehensive Everglades Restoration Plan and the Lower East Coast Regional Water Supply Plan. Hence, it can be characterized as a true multi-agency integrated resource plan.

The IRP project is headed by elected members of the Water Advisory Board of Broward County. The board gets input from a Technical Advisory Committee comprised of water utility managers, drainage district engineers, consultants, SFWMD staff, and a variety of stakeholders representing environmental and business organizations, and Native American tribes. Broward County staffers perform various analytical and administrative tasks for the committee.

The designers of the IRP process recognized from the outset that coordination and consensus from a diverse water management community, governed by multiple political bodies, were essential to successful implementation of IRP. They also recognized that water must be viewed from a regional perspective, ignoring municipal or service area boundaries.

In this case, the county governmental body was judged to be the best entity to organize and administer such a diverse set of participants and stakeholders. No single water or wastewater agency could provide such leadership.

3.3 TAMPA BAY REGIONAL RECLAIMED WATER AND DOWNSTREAM AUGMENTATION PROJECT

In 2004, an innovative partnership agreement was reached with five entities in the Tampa Bay region of Florida. The purpose of the partnership is to maximize the beneficial use of reclaimed water in the Hillsborough River, Alafia River, and Palm River watersheds. Figure 3.2 shows a map of the region. The partners include:

- City of Tampa
- Hillsborough County
- Pasco County
- Tampa Bay Water
- Southwest Florida Water Management District (SWFWMD)

The benefits derived from the partnership would result from the development of a multidimensional set of reclaimed water use projects that would provide for

- An increase in surface water withdrawals as a potable water source that would be offset by augmenting downstream river flows with reclaimed water

- New reclaimed water customers for the City of Tampa, Hillsborough County, and Pasco County

- The ability to meet mandated minimum flows in the lower Hillsborough River during low-flow conditions

- Restoration of water dependent-systems in the Hillsborough and Alafia River watersheds, from which most of the regional drinking water supply is taken

- Creation of a wet season storage system that will allow for the beneficial use of additional water made available during seasonal rains, which is currently discharged to Tampa Bay

- Further expansion of the beneficial use of reclaimed water during the dry season and an increase in the overall efficiency of reclaimed water use in southwest Florida

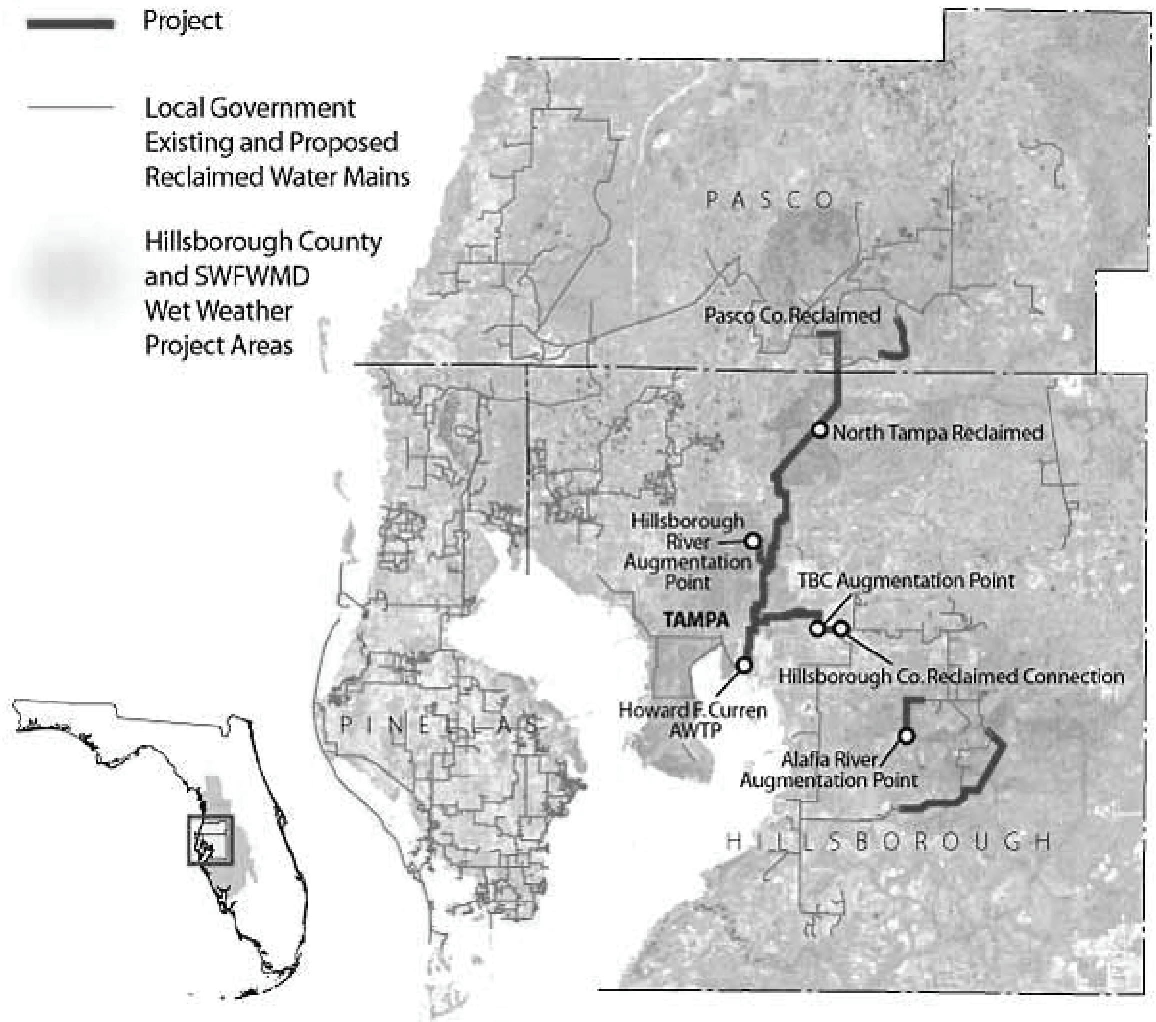

Figure 3.2. Tampa Bay Regional Project.

A major factor in this project is a large wastewater treatment plant (WWTP; the Howard F. Curren Advanced WWTP, owned by the City of Tampa) that currently discharges most of its treated effluent to Tampa Bay. As the above list shows, this highly treated effluent can be used in the region in numerous beneficial ways.

The catalyst behind the planning of this project is SWFWMD. SWFWMD is one of five state water-management districts in Florida tasked with managing water and related natural resources to ensure their continued availability while maximizing environmental, economic, and recreational benefits.

To foster regional participation in the project, SWFWMD provides funding for planning and construction. Between 1987 and 2006, SWFWMD provided $225 million in funding to 257 reclaimed water projects. For some elements of this regional plan, those directly related to restoration of wetland systems, SWFWMD pays all costs. For most other elements, SWFWMD funds 50% of costs.

SWFWMD staff, participating utility staff, and consultants are developing the regional plan. No separate entity exists to coordinate the planning and construction; rather, it is a cooperative arrangement of existing entities, each taking the lead on key elements most relevant to their jurisdiction.

The success of this process rests in the mutual benefits perceived by each participant in the regional project. SWFWMD financial assistance also facilitates the process.

3.4 CALIFORNIA'S PROPOSITION 50 AND IRWMP

Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002, was passed by California voters in November 2002. It amended the California Water Code to add, among other articles, Section 79560 et seq., authorizing the Legislature to appropriate $500 million for projects. The intent of the IRWMP Grant Program is to encourage integrated regional strategies for management of water resources and to provide funding, through competitive grants, for projects that protect communities from drought, protect and improve water quality, and improve local water security by reducing dependence on imported water.

Proposition 50 allows for up to $500,000 per planning grant and $50 million per implementation grant. Successful applicants must provide matching funds of at least 50% for planning grants and 10% for implementation grants.

For the first round of funding in fiscal year 2005–2006, the state received 54 planning grant proposals requesting approximately $22 million in grant funds for projects totaling approximately $38.5 million. The state awarded approximately $12.6 million in grants to 28 agencies for projects totaling approximately $21.6 million. The successful applicants are located throughout the state, as shown in Figure 3.3, and address a variety of important and regional water resource issues. Most successful grants included multiple agencies, provided a description of regional benefits derived from their coordination and described their process for obtaining stakeholder input.

3.5 OBSERVATIONS AND CONCLUSIONS

IRP leadership can come in many shapes and forms. To tap more synergies, many IRPs are becoming more expansive in participants and geographic scope. This evolution complicates the leadership issue as IRP expands beyond the direction and control of a single water agency and may thereby make the planning effort costlier and more time intensive.

IRP leadership can be structured in the following three ways:

1. Water agency leadership
2. Leadership by other agencies
3. Shared leadership

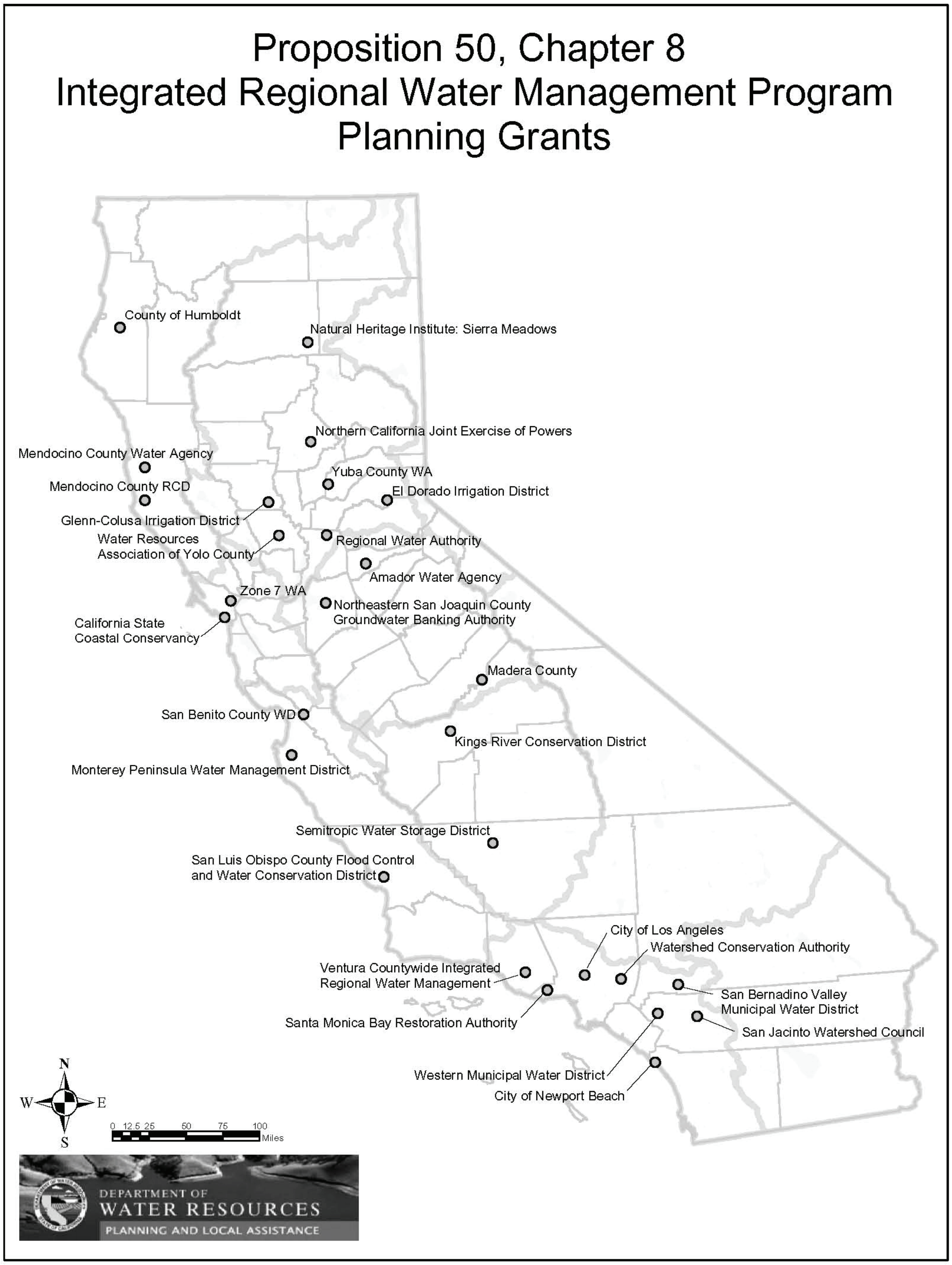

Figure 3.3. California Proposition 50 grant locations (fiscal year 2005–2006).

Water agency leadership of planning efforts means that the IRP will be led by entities whose mission goes to the heart of the IRP scope. Such leadership can be provided by local water retailers. Regional water wholesalers, such as the Metropolitan Water District of Southern California (MWDSC), also are natural candidates to lead IRP projects. In some regions, agencies responsible for regulating regional water resources can serve as obvious leaders. For example, in Florida, the state regulatory regional Water Management Districts (WMDs) exemplify this course. In both the Broward County and Tampa Bay cases presented in this chapter, while the regional WMDs were not the titular plan leaders, they provided major facilitation and funding for the IRP efforts and were clearly integral to the success of the planning efforts. Another class of natural IRP leaders is the myriad of agencies responsible for managing groundwater or river basins.

In some cases, local or regional institutional relationships call for leadership from a nonwater agency, such as a county, city, or regional planning agency. The case study of Broward County shows how a county government organized a large and diverse set of IRP participants and stakeholders.

There are some inherent difficulties in such a leadership arrangement. For one thing, counties do not historically have the mission, staff, and resources to conduct water planning. In addition, county boundaries frequently do not coincide with watershed or water agency boundaries. Hence, nonwater entities such as counties are not usually natural leaders for IRP but can be used opportunistically when they are the best choice available.

Shared IRP leadership occurs when no single entity leads the IRP process. Instead, multiple water, wastewater, and/or other water-related agencies form consortia and enter into cooperative IRP arrangements. An advantage of these arrangements is that the IRP consortia can be structured to focus solely on the critical water issues. The consortium described in the Tampa Bay case serves as an example—it tackled a regional reuse issue. Agencies have the flexibility to become IRP participants depending on their mission and interests. The California Proposition 50 IRWMP case study shows that many different types of consortia can be created depending on local conditions. However, the political and institutional difficulties of forming such a quasigovernmental entity and sustaining it in a productive manner should not be underestimated. Shared leadership generally requires a higher degree of agreement, vision, and trust among the participants.

Each region needs to develop the IRP leadership that best coincides with its unique circumstances. Given the many layers and dimensions of water management, this is a challenging and evolving task. With the emergence of NTWS options, however, it becomes even more important to carefully consider leadership arrangements before embarking on an integrated resource plan.

CHAPTER 4

WATER SUPPLY RELIABILITY

This chapter addresses the important connection between NTWS and water supply reliability. Many NTWS projects—such as reclaimed water, desalination, or seasonal recharge of the groundwater basin with stormwater—are generally considered to be more “drought proof” than are more-conventional supplies. Other NTWS options—such as extraction of lower-quality groundwater in times of need—provide opportunities to provide “lesser-quality” water to customers in years when the preferred higher-quality sources are not available in the quantities usually tapped. Hence, the inclusion of NTWS options in a utility’s supply portfolio can greatly improve the overall ability of a water provider to meet its customers’ demands during times of drought. This situation can generate significant economic and societal benefits.[1]

Section 4.1 of this chapter cites studies that indicate that water customers value supply reliability quite highly. There is evidence—from empirical research and from casual observation of political impacts—that water users place a fairly high value on having a water supply that reliably provides them the quantity and quality of water they desire on an uninterrupted basis. The challenge is to interpret the existing evidence, so that one can reasonably deduce the monetary value that added reliability generates for water users.

Section 4.2 discusses water reliability as a decision variable for water managers. The trade-off between cost and reliability is a familiar one and one that the IRP process can explicitly address.

Section 4.3 uses the Integrated Water Plan (IWP) of the City of Santa Cruz, California, to illustrate the trade-off between cost and reliability. in order to determine the appropriate size of a desalination plant to be used during droughts to reduce customers’ shortages. In this case, decision-makers determined that customers were willing to accept some chance of shortages in return for reducing the costs and other impacts of the plant.

Section 4.4 looks at San Diego, a location that has offered preferential reliability to specific commercial customers hooking up to their reclaimed water systems. During droughts, these customers will be protected from water cutbacks—a circumstance that offers significant financial benefits to both existing businesses and businesses considering locating in San Diego.

1. The degree to which reclaimed water is drought resistant may vary across regions and circumstances. While reclaimed water is generally less drought impacted than are most traditional source water supplies, reuse water can nonetheless be impacted by drought conditions. For example, in west-central Florida, there have been reductions in wastewater availability during drought due to less inflow into the system. Drought periods also tend to bring about higher outdoor demand, which also can lead to shortfalls between reclaim supply and the amount demanded.

Section 4.5 provides observations and conclusions summarizing key issues commonly encountered with water reliability in the nexus between IRP and NTWS.

4.1 QUANTIFYING THE VALUE OF WATER RELIABILITY

The literature contains several studies that attempt to quantify the value of reliability to water customers. These studies have used both "stated preference" and "revealed preference" methods to examine reliability values for residential customers. Stated preference methods determine estimates for reliability on the analysis of responses to hypothetical choices in surveys, yielding household willingness-to-pay (WTP) values. Revealed preference infers the value of reliability from data obtained from choices and decisions made in the marketplace. For example, expenditures made to obtain higher levels of reliability (i.e., to avert potential shortages) sometimes can be used to infer the value of reliability.

The reliability values derived from stated preference studies need to be interpreted with caution. There are several reasons why the estimates may be under- or overstated relative to the true WTP of households for utility-supplied water (e.g., see Raucher et al., 2006a). With these caveats in mind, if one applies the general assumptions and procedures described above to the applicable reliability value estimates, the following illustrative WTP estimates for reliability of residential water are inferred (all monetary figures are in year 2003 U.S. dollars, unless otherwise specified):

- Griffin and Mjelde's (2000) "current shortfall" scenario implies a WTP for residential water on the order of $4005 per acre-foot or nearly $12.30 per thousand gallons[2]

- Carson and Mitchell's (1987) scenarios for the MWDSC imply a possible WTP for residential water of between $4675 and $7714 per acre-foot (up to $23.68 per thousand gallons)

- The Barakat and Chamberlin study for the California Urban Water Agencies (Barakat and Chamberlin, 1994) implies a possible WTP of over $14,500 per acre-foot (up to $44.52 per thousand gallons)

These value estimates may be overstated for water use at the margin (i.e., for modest cutbacks in current outdoor uses). In particular, the results based on Carson and Mitchell (1987) and Barakat and Chamberlin (1994) may be overstated because they are based on certainty equivalents of eliminating future shortfalls. However, these estimates may be on target, or possibly understated, for more essential water uses.

Of the revealed preference studies, the most NTWS-applicable may be the work by Thomas and Rodrigo (1996), who measured the benefits of nontraditional water resource investments. The focus of the study was on the MWDSC and its member agencies. They investigated the benefits (expected yields and cost savings) of developing additional resources in the region through several alternatives: increased imported supplies (base case), the addition of significant conjunctive storage of local groundwater basins (groundwater case), and the

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2. An acre-foot of water consists of 325,850 gallons and is a unit of measurement often applied in the western United States. Each $1000 per acre-foot is equivalent to $3.07 per thousand gallons.

implementation of reclaimed water and groundwater recovery projects (preferred case). To determine the value of reclaimed water and conjunctive use storage, the savings attributable to each of these resources were compared to the yield associated with the resource.

The Thomas and Rodrigo (1996) results suggest a $353-per-acre-foot reliability value for an approach in which conjunctive use storage was used to ensure greater reliability. These reliability value results are considerably lower than those based on WTP from the stated preference studies (where the results imply values of perhaps $4000 per acre-foot and up). This situation may demonstrate that the results reflect artificial measures such as costs incurred or rate structures applied by water agencies. Thus, the stated preference results are designed to reflect the real *value* (i.e., WTP) of water supply reliability, whereas the Thomas and Rodrigo *cost*-differential-based results are simply reflective of agency pricing decisions that are not likely to reflect any value (WTP) considerations. Also, the economies of scale that can be realized in the reliability programs undertaken by an entity of MWDSC's size may result in implied reliability values that are considerably lower than may be obtained by most other agencies.

4.2 WATER RELIABILITY AS A DECISION VARIABLE

Water supply reliability can be defined as the degree to which water consumers receive the quantity of water desired within acceptable quality and service standards. Since the provision of a reliable supply of water to customers is the *raison d'etre* of most water utilities, maintaining or improving water supply reliability is a key consideration in most, if not all, water integrated resource plans. The manner in which this key objective is handled illustrates a key difference between traditional planning and IRP.

In a traditional water utility planning exercise, reliability is treated as a *constraint*. That is, the goal of the plan is to identify the combination of supply and infrastructure investments that will maintain a predetermined (often perfect) level of reliability. A typical question that a traditional plan seeks to answer may therefore be, "What is the least costly set of investments that will maintain 100% reliable service under all hydrologic conditions?"

In IRP, reliability is a *variable*. Maximizing reliability is one of many objectives among which *trade-offs* must be made. Thus, there is not a predetermined level of reliability; rather, the "best" level of reliability is determined along with the best levels of costs, environmental impact, water quality, public acceptability, etc. For example, increases in reliability (i.e., water quantity) might be traded off against consumer preferences for perceived "pristine" water quality.

The IRP process recognizes that increased levels of reliability may be costly, both in monetary terms and in terms of other important objectives. Thus, the decisions that must be made in an integrated resource plan are generally multidimensional, rather than unidimensional.

NTWS can have important ramifications on the ability of a water agency to reliably supply water to its customers. This truth is illustrated in the Santa Cruz case study described below.

4.3 CITY OF SANTA CRUZ

The City of Santa Cruz (California) relies primarily on surface water supplies that are highly variable. Generally speaking, in most years there is more than sufficient supply to meet demand. However, in drought years, this is not currently the case, and as future demand increases, the range of hydrologic conditions under which there will be water shortages will expand.

Santa Cruz had been considering new water supplies, using a “traditional” planning paradigm, for decades and was unable to assemble the necessary political and financial support to proceed with any major projects. The situation was becoming more acute in that, if the worst historical hydrological event (the drought of 1976–1977) were to reoccur, customers would face serious shortages and the attendant hardships. So the city decided to embark on a different kind of planning process.

The city began an IRP process that it called the IWP and recognized from the outset that the level of reliability was a decision variable and that 100% reliability was not necessarily the right answer. Thus, a key issue addressed in the integrated resource plan was defining the “right” level of water supply reliability. Each water supply scenario was examined under three different reliability levels or curtailment profiles. The profiles resulted in 0, 15, and 25% shortages in the second year of a 1976–1977 drought event, as shown in Table 4.1.

Table 4.1. Alternative Curtailment Profiles for Santa Cruz

	Probability of:			
Curtailment Profile	**< 10% Peak-Season Shortage**	**10–20% Peak-Season Shortage**	**20–30% Peak-Season Shortage**	**Worst-Year Peak-Season Shortage (%)**
1 (perfect)	0	0	0	0%
2	6–9 in 59[a] (1 in 7–10)	1 in 59	0	15%
3	10–15 in 59 (1 in 4–6)	0–1 in 59	1 in 59	25%

[a]The historical hydrologic record includes 59 years of data.

The integrated resource plan began with the following three separate studies:

- A water supply study examined a variety of alternative water supplies
- A water conservation study recommended a set of water conservation programs for the city to undertake
- A water curtailment study reported on the impacts on different classes of customers of drought-induced curtailments of different magnitudes (i.e., different levels of water supply reliability)

The integrated resource plan viewed each of these three options—supply, conservation, and curtailment—as the underpinnings of a three-legged stool. Each was an alternative way of bringing supply and demand into balance. The task of the plan was to determine the best combination of these options for the citizens of Santa Cruz. Because of a very strong conservation ethic in the community, it was decided to implement all of the programs that emerged from the conservation planning effort. Once that decision was made, the remaining two dimensions between which trade-offs needed to be made were supply and curtailment.

The water curtailment study was a ground-breaking effort, the results of which were integral to the city's decision-making process. It was a careful attempt to obtain input from Santa Cruz water customers on the manner in which potential future peak-season water shortages would affect different classes of water consumers in the Santa Cruz Water Department service area. The intent of this study was not to quantify these impacts but rather to describe the steps that different customer classes are likely to take to reduce water consumption by specified amounts and the economic and noneconomic hardships that these actions would impose on customers.

As mentioned above, the curtailment study was conducted because the city wished to actively consider the trade-offs between different levels of water supply reliability and the costs required to achieve those levels. A prerequisite to this process was to first achieve a solid understanding of what actions members of different customer classes would take in response to various curtailment levels and what hardships these actions would impose on these customers. In addition to relying on evidence from past California droughts, a horticultural study of shortage impacts on Santa Cruz residential landscapes, and an extensive literature review, the study also included focus groups with residential customers and a mail survey and set of interviews with key representatives of each business sector. Shortage impacts on large landscape and golf course irrigation customers, the University of California, and municipal government agencies were based on meetings held with representatives of each of those classes.

The study assumed that shortages would be allocated to classes of service based on the classification of end uses into the following three priorities:

1. Health and safety
2. Business
3. Outdoor irrigation

Under this priority scheme, end uses related to health and safety were assumed to be cut back the least in a water shortage, while irrigation would be cut back the most. The prioritization recognized the critical importance to the city's economic well-being and the well-being of its citizens of business activities. While these uses are of a lower priority than health and safety uses, the ranking attempted to shield them from the full brunt of a water shortage.

Based on these priorities, the amounts by which each class of service would be cut back were estimated for six peak-season shortage conditions, ranging from mild (10%) to extreme (60%). The necessary actions to achieve these cutbacks and the associated hardships were then described in detail based on the historical data and literature review and, most important, on the survey and interviews of, and focus groups with, Santa Cruz customers. Table 4.2, from the water curtailment study, shows the anticipated class cutbacks and a summary of the level of customer impacts associated with these cutbacks.

Table 4.2. Estimated Relative Customer Class Peak-Season Shortage Impacts

Shortage Condition	Peak-Season System Shortage	Single-Family		Multi-Family		Business		Industrial		Golf	
		Shortage	Impact[a]	Shortage	Impact[a]	Shortage	Impact[a]	Shortage	Impact[a]	Shortage	Impact[a]
Mild	10%	11%	1	9%	1	4%	1	5%	2	5%	1
Moderate	20%	22%	1	19%	1	13%	2	15%	3	15%	2–3
Serious	30%	31%	3	27%	3	22%	4	25%	5	25%	4
Severe	40%	41%	4	37%	4	27%	4–5	30%	5	30%	4–5
Critical	50%	54%	5–6	48%	5–6	33%	6	35%	6	35%	5
Extreme	60%	63%	6	56%	6	48%	6	50%	6	50%	6

[a]Key to shortage impacts:

1. Little or none
2. Some
3. Intermediate
4. Considerable
5. Major
6. Catastrophic

Based on the information in this study, decision-makers were able to better understand what each of the curtailment profiles referenced above actually meant to water customers. Rather than being described merely by a number (e.g., 15% shortage) or a set of numbers, each level of reliability was described by a set of expected actions to be taken and hardships to be experienced by each customer class.

The integrated resource plan considered three primary water supply options:

1. Seawater desalination
2. An exchange of reclaimed water for groundwater currently used for irrigation by farmers in the coastal region north of the city
3. Groundwater from a fairly deep aquifer currently not used by the city

Based on a variety of criteria, a decision was made to pursue the desalination option. The *Confluence*® simulation model (see Chapter 9) was used to determine the desalination capacity and the necessary infrastructure that would be required to achieve each of the three curtailment profiles.[3] For example, the simulations revealed that to maintain Profile 1 (no shortages) between now and 2030, a total of 8.0 million gallons per day of desalination capacity would have to be installed over that period. The corresponding capacities to maintain shortages to less than 15% (Profile 2) or 25% (Profile 3) were 4.5 and 4.0 million gallons per day, respectively.

Decision-makers were then able to make the trade-off between the costs required to develop each level of capacity and the level of water curtailment the community would be willing to bear.[4] It turned out that the present value of the cost associated with Profile 2 was only slightly higher than that associated with Profile 3. Profile 1, however, was significantly more expensive. While the cost differences between Profiles 2 and 3 were small, the customer impacts, as described in the curtailment study, for Profile 2 were significantly smaller than those associated with Profile 3. Thus, it became apparent to decision-makers that Profile 2, corresponding to a 15% worst-year peak-season system shortage, was the best choice.

Because of the integrated nature of the Santa Cruz planning effort and particularly the manner in which the reliability variable was addressed, this choice was informed by much more complete information than is generally available to policymakers who face these types of decisions. Perhaps due in part to that, the city is moving forward in the process of acting on the plan recommendations and developing the desalination plant. In November 2005, the City Council certified the Program Environmental Impact Report and adopted the IWP. The city immediately began planning a desalination pilot plant to be located at the University of California, Santa Cruz Marine Science Campus. The pilot study was awarded a $1.9 million grant from the California Department of Water Resources. The city is currently in the process of securing the appropriate permits for the pilot plant. Plant construction is slated to begin this year (2007). The pilot plant will operate for 12 months.

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3. In addition, for each supply option, ratings were developed for a variety of other evaluation criteria.

4. The only criterion for which the reliability level (i.e., curtailment profile) made a significant difference was cost.

4.4 CITY OF SAN DIEGO

A study of water shortages in California (CUWA, 1991) shows that in response to a hypothetical 30% water supply reduction, about half of high-technology firms surveyed would consider locating plant expansions and new plant production facilities outside California. This study also documented a direct link between water shortages and job and production losses. In other words, water supply reliability is a valuable commodity for these firms.

In response to this situation, the City of San Diego developed its "Guaranteed Water for Industry Program." The program provides a higher level of water supply reliability to those research-and-development or industrial manufacturing firms that enroll in the program. To qualify for the program, a business must be located in an area where reclaimed (nonpotable reuse) water is available, and it must use reclaimed water on its premises to the fullest extent possible (in addition, the business must participate in all applicable city water conservation programs). In return, in times of drought, these firms will be exempt from mandatory water restrictions that would otherwise apply. Participating firms also receive the financial benefit of being able to purchase reclaimed water at half the cost of potable supplies.

The Torrey Pines area near the North City Water Reclamation Plant (NCWRP) in San Diego has been dubbed "Biotech Hill" and has over 2.7 million square feet of office and laboratory space. The NCWRP is a state-of-the-art facility that can treat up to 30 million gallons of wastewater per day generated by northern San Diego communities. It has over 45 miles of distribution pipelines for reclaimed water. Firms in this area are beginning to ensure reliable water supplies by taking advantage of this program.

The first participant in the Guaranteed Water for Industry Program was R.W. Johnson Pharmaceutical Research Institute, a member of the Johnson & Johnson family of companies. The facility was completed in 1999 and uses an average of 22 acre-feet per year of reclaimed water for landscape irrigation and its cooling system. Another participant is PharMingen, a biotechnology company built on a diversified technology base covering immunology, cell biology, neurosciences, molecular biology, and protein expression systems. PharMingen is the fourth largest biotechnology employer in the City of San Diego. Reclaimed water is used for irrigation and cooling at an 80,000-square-foot facility on a six-acre campus. It is also used for irrigation and indoor plumbing (toilet flushing, urinal flushing, and priming of floor drain traps) at another 58,000-square-foot facility containing office space and custom-designed, state-of-the-art laboratories. This PharMingen site is the first in San Diego to be dually plumbed to use reclaimed water.

The strategy used in San Diego to address the objective of water supply reliability differs from that used in Santa Cruz. In Santa Cruz, the water utility gathered information on the negative impacts of unreliable supplies on customers and, based on the trade-off between these impacts and the costs of developing new supplies to alleviate them, made the decision on the appropriate system-wide level of reliability and the associated level of source and facility investment.

In contrast, San Diego has chosen, to some extent, to let the individual customer choose its preferred level of reliability. By agreeing to use reclaimed water and incurring the associated capital and operating costs, the customer can "purchase" a higher level of reliability. This more market-based approach also benefits the water utility in its efforts to supplement and diversify its water supplies and the region as a whole by reducing ocean discharges.[5]

4.5 OBSERVATIONS AND SUMMARY

A useful feature of IRP is that policymakers can treat water reliability as a decision variable, not a constraint. Making the trade-off between reliability and other key objectives can have important societal, environmental, and financial ramifications. The City of Santa Cruz and City of San Diego case studies illustrate this point.

Water supply options that are drought resistant (such as desalination or water reclamation) may provide a special type of reliability-based added value, compared to other, more traditional (and drought-sensitive) water supply options. Recent work sponsored by the federal Bureau of Reclamation and also explored elsewhere has helped explain how the concept of "portfolio theory"—as originally devised and applied to financial assets by Nobel Prize winner Harry Markowitz—can be constructively applied to water supply portfolio choices (Markowitz, 1952).

The central goal, long recognized and applied by financial managers, is to maximize expected returns (water yields) while also reducing the overall variance in portfolio yield. This feat can be accomplished by minimizing the covariance in yield risks across the assets held in a portfolio. As shown by Kasower et al. (2007, to be submitted for peer review), a simple and plausible numeric illustration reveals that a manager should be willing to pay a premium for drought-resistant supply options (perhaps justifying paying more per unit of water for a reuse or desalination option than on expanding the reliance on a more traditional surface water supply). The drought-resistant supply will be available precisely at the times (i.e., during droughts) when the water supply system is under the most stress.

This lesson points out the necessity of careful system modeling. A traditional supply and a nontraditional supply, both of which have the same average "yield," will have markedly different value in terms of their contributions to water supply reliability. The models described in Chapter 9 show that supplies for which yields are less dependent on weather or hydrology will result in higher levels of water supply reliability than will supplies whose yields vary substantially with weather and hydrology.

5. The city's water utility and wastewater agency are integrated within the same municipal organization, an arrangement that can help lead to more coordinated NTWS planning efforts.

CHAPTER 5

STAKEHOLDER AND PUBLIC INPUT

A distinguishing feature of IRP is its inclusion and integration of stakeholder and public input. In traditional water resource planning, stakeholders had limited or no involvement in the process. Today, it is hard to imagine developing NTWS options without explicit and involved coordination with stakeholders.

Much has been written on incorporating stakeholders into IRP. The objective of this chapter is to highlight points especially relevant to NTWS options. In particular, a number of utilities throughout the United States are advancing from nonpotable reuse to indirect potable reuse via groundwater recharge or reservoir augmentation. In some communities, direct potable reuse is now even being considered. Desalination projects also are becoming more common. These types of NTWS projects often generate a whole new set of public issues, generally not associated with traditional water supplies or water demand management options. Hence, IRP needs to expand and refocus its direction to accommodate these issues.

People's attitudes, opinions, and beliefs can have significant impacts on the ultimate outcome of proposed NTWS options. Decision-makers need to look beyond usual economic and engineering considerations. Perceptions, accurate or not, need to be factored into the decision-making process. "Toilet-to-tap" misperceptions associated with indirect or direct potable reuse, for example, illustrate the importance of water resource managers working with the community to develop the best overall portfolio of water supplies. This point highlights the need for multiple agencies to consider multiple resources, factoring in multiple stakeholders and using multiple evaluation metrics—the traits of IRP.

The overall objective of IRP is not to persuade communities to use NTWS options. Rather, IRP is about getting communities to explicitly, systematically, and objectively consider all relevant options, including NTWS, to best meet their objectives. NTWS options can offer compelling and relatively attractive benefits, and it is important that such benefits (as well as any drawbacks) be properly articulated and communicated to stakeholders so that informed public discourse can be promoted.

This chapter provides guidance on working with stakeholders in an NTWS/IRP context. It includes two case studies illustrating different approaches and applications in working with stakeholders. The first case includes Santa Cruz, California, and looks at the multiple ways public input can be collected and integrated throughout an IRP process. The second case study shows how stakeholders and their concerns can lead to project rejection, based on experiences with an indirect potable reuse project in San Diego, California.

5.1 STAKEHOLDER INVOLVEMENT: PROS AND CONS

The advantages of water and wastewater agencies working with stakeholders in an NTWS/IRP context can be significant and diverse. Effective incorporation of stakeholder input can:

- Avoid contentious litigation
- Avoid costly delays and uncertainties
- Avoid stranded or underutilized assets caused by loss of public support
- Improve the quality of a utility's decision-making by broadening the perspectives of the planning process
- Expedite planning, permitting, and implementation of new NTWS options
- Increase the likelihood that NTWS options will get a "fair" assessment by including all beneficiaries to such projects
- Decrease the likelihood of damage to a water agency's reputation that could interfere with future water planning dialogue and activities
- Create a positive image for NTWS options, to foster their contribution in meeting future water supply needs

It is undeniable that working with stakeholders takes money and time. In addition, it can result in some loss of control. In traditional water resource planning, the water utility traditionally had complete control over its internal decision process. Stakeholder involvement forces a utility to share that control. If stakeholders are not involved, they are likely to eventually make their voices heard anyway, such as though the ballot box for Board or other elected positions that relate to utility operations or for ballot initiatives related to rate or assessment changes associated with the utility-desired project.

Every IRP project will need to determine the appropriate scope of stakeholder input sought and carefully lay out the expectations of the stakeholder process (see below). Although there can be significant short-run costs, the long-run costs of not integrating stakeholders early and proactively can be significantly higher. Excluding stakeholders, especially in the context of NTWS, can lead to total project rejection, including stranded assets. To optimize project development, the issue is how to best manage and integrate stakeholders into IRP.

5.2 IDENTIFYING STAKEHOLDERS

At the outset, plan managers must identify key stakeholders with an interest in local water resource issues. The types of stakeholders can vary widely among applications. In the context of NTWS options, the list of stakeholders will likely expand. The following series of questions can help identify the key stakeholders.

- What groups of water users would benefit most from or most strenuously object to new water supplies?
- Who are the water and wastewater utilities in the region?
- What local, state, and Federal government agencies regulate impacted water resources?

- What government agencies might be involved with permitting of projects?
- What environmental groups have an interest in potential project externalities (positive or negative)?
- What groups have an interest in water quality impacts on public health?
- What political entities are involved?
- Who are the large water users impacting the local economy?
- What entities have an ownership or water right for waters in impacted watersheds?
- Are there ratepayer groups that should be contacted?
- Which key business representatives are interested in the potential projects?
- Are there downstream users (e.g., agriculture or industry) who might wish to participate?

These and similar types of questions will help identify key stakeholders. Experienced public outreach experts and utility managers suggest that early, proactive engagement can be relatively beneficial (Raucher et al., 2001).

5.3 WORKING WITH STAKEHOLDERS

Framing the stakeholder process is a challenging and important IRP task. Stakeholder input can vary from minimal to extensive. Stakeholders can be involved at various stages of the planning process and can take on roles that range from simply providing information to participating directly in the decision-making process.

There are several published reports and other documents that provide very detailed and constructive guidance to utilities on how to initiate, structure, and manage a stakeholder process. We encourage interested readers to refer to this existing and useful body of literature, which includes the following Awwa Research Foundation reports as a starting point: Nero (1995), Nero et al. (2001), and Raucher et al. (2001). Below, we provide a brief overview of some of the key themes that come from this literature.

One of the key aspects of working with stakeholders is to set up a suitable organizational structure. Stakeholder alliances come in many possible shapes and sizes. Some involve limited duration interactions, and some entail ongoing standing committees. Some are large and some are small. A key is to set up a structure that best suits the needs of the utility and its fellow IRP participants.

It is not easy to effectively integrate outside groups into the planning process. One of the keys is to set clear expectations of how the input of the outside groups is going to be solicited, gathered, recorded, and used. That is not to say that, within a single planning effort, all public and stakeholder input must be dealt with similarly. There may well be different groups for whom different approaches are appropriate. IRP participants must, however, identify those stakeholder groups and carefully lay out the process that will be used to garner input from each of them.

As part of this process, IRP participants (e.g., the lead utilities) need to identify the types of outcomes to be obtained from and with stakeholders. This arrangement in turn needs to reflect what type of authority the IRP-leading participants want to vest in the stakeholders. It also clearly establishes for stakeholders how the utility intends to use their input. Hence, the IRP leading utility needs to determine whether it is seeking simply to build relationships and exchange information or elicit advice or receive formal recommendations or try to reach consensus with the stakeholders.

The types of outcomes that utilities may seek thus might include any or all of the following:

- ***Exchange information.*** Stakeholders assist in gathering information, responding to questions, and providing input on community values and perspectives.
- ***Elicit comments and advice.*** Stakeholders provide comments during various IRP stages, including the identification and evaluation of alternatives.
- ***Receive recommendations.*** Stakeholders review or make recommendations on selected IRP elements. The elements on which recommendations are received may or may not include the selection of preferred alternatives.
- ***Reach consensus.*** Stakeholders are fully engaged in the process and have a voice in the final decision-making process.

Each of these different outcomes has implications for (1) what the stakeholders believe to be their role in the process and authority in forming the outcomes and (2) what type of structure the utility establishes with its stakeholders and the utility's role in the stakeholder alliance. Table 5.1 provides an overview of how different types of outcomes imply the type of roles the utility needs to establish for itself in the process and what its duties will be in that role.

Table 5.1. Matching Utility Roles in Stakeholder Alliance with Suitable Outcomes

Outcome Models	Utility Role	Utility Duties in this Role
Advisory or recommendation alliance.	Administrative	Provide logistical support, perhaps hire facilitator. No active role, strictly observer.
Information exchange mode.	Direct management	Convene and directly manage the group.
Advisory or recommendation panel. Most appropriate when utility wants input from stakeholders to factor into its decision or in addressing complex political issues.	Indirect management	Convene group and use an outside or neutral facilitator to manage it. Role may involve providing information, assisting in information gathering, responding to questions, bringing issues to group and receiving a recommendation but not directly participating.
When trying to achieve consensus with stakeholders.	Full participation	Participate fully and candidly in the discussions and have a voice in final decision-making process.

Source: Raucher et al., 2001.

An important point is that different circumstances require different stakeholder approaches; there is no single, universal approach to be used in every case. IRP participants that scope the process must consider a variety of approaches and the degree to which an approach is implemented. Each approach should be viewed as evolving; each will need to be adapted to best fit the particular circumstances. Also, as a general practice, running a transparent public process will ultimately increase trust in the process and help build comfort with and support for the final outcome.

5.4 WORKING WITH POLICYMAKERS

NTWS options can introduce or touch on issues of significant importance to particular stakeholders. Some of these issues might revolve around specific project impacts related to public health or cost. Others may extend to larger issues such as environmental improvements, land use development (e.g., "no growth" advocates), concepts of sustainability and local control, and business climate. Identifying the stakeholders and their issues will vary with each case. Stakeholders will almost always have some competing and conflicting interests.

Water resource policymakers are responsible for identifying, evaluating, and ultimately selecting actions to best meet the overall needs of their constituents. IRP is a process of making this happen. IRP participants (e.g., water utilities) can facilitate the process by understanding and addressing the issues and risks facing policymakers.

The following are several ways that IRP participants (practitioners) can support policymakers, based on a recent WateReuse Foundation project (Kavanaugh and Sedlak, 2004; WateReuse Association, 2007).

- ***Develop a positive attitude about policymakers.*** Assume policymakers are ethical and want to protect the interests of their constituents. Be willing to understand their motivations and concerns. Do not judge their actions and decisions as "politics" without careful consideration and attempting to understand their motivations.

- ***Develop a foundation of written support.*** "Cover" and help policymakers by developing a strong foundation of written support from respected individuals (e.g., technical experts) and organizations. Asking for written support encourages a deeper, stronger relationship.

- ***Develop political champions.*** Developing champions within governing bodies, especially if multiple governing bodies have jurisdiction or influence on outcomes, can help carry a process or project forward.

- ***Define priority relationships.*** You cannot reach everyone. Prioritize people that policymakers listen to, represent a larger group, have been involved in past conflicts, or are likely to energize conflict.

- ***Identify early supporters.*** Early in the outreach process, identify and seek out "early adopters" who are willing to give written support without having to see a long list of other supporters.

- ***Keep the relationships going.*** Maintain a database of key audiences/relationships and periodically send them information updates. Keep it simple and relevant to motivations, value, and investment.

- ***Create water quality confidence.*** Create water quality confidence by becoming the trusted source of quality. Emphasize your water quality ethics and actions.

- ***Turn conflict and opposition into assets.*** Seek out and embrace conflict and opposition as a path to stronger relationships, more committed supporters, and better outcomes. Create events designed to find opponents early. Finding opponents after significant capital has been committed to a specific project can be very expensive.

- ***Adopt a collaborative communication style.*** Do not waste your audience's time by not listening and learning. Seek to understand people's motivations, and ask "why" a lot. Your audience has valid inputs.

- ***Lead a meaningful dialogue.*** Lead a meaningful dialogue about water supply reliability, the need for new water supply, and the options for creating new supply. Make sure your communications emphasize the problem and your commitment to solving the problem, reinforcing that this is not a pet project.

- ***Pay attention to the media.*** Reach out and develop ongoing relationships with the media. Do not just show up when you need something from them. Help them by being a good source of information and stories.

- ***Understand public sentiments.*** Document feedback and collect information from your audiences during all meetings. Compile and use this information to improve your message and help policymakers be more confident.

- ***Provide information for participation and sound decisions.*** Meaningful public participation requires timely and full access to information about proposals, problems, impacts, and alternatives. Those with the resources must produce this information and share it. Make sure that there are widely announced opportunities for comment on all documents and that people receive the documents well in advance of meetings.

- ***Understand the motivations and needs of opponents.*** In order to foster a relationship, you have to listen. Seriously try to understand the motivations of opponents. Sometimes people just want to be heard. Listening also allows you to improve your messages and uncover flaws with your current proposal.

- ***Ensure opponents understand your constraints.*** In developing relationships, both parties must come to understand the other's situation. Make sure that opponents understand the constraints that the utility is working under or assuming. This behavior helps them better understand your motivations. Working together, you may be able to remove constraints or secure more investment.

- ***Articulate water quality risks.*** Define the issues and risks that need to be addressed in simple and meaningful terms. Describe the different types of contaminants, from where they come, and why they are a problem. People who are paying attention will not buy that there are no risks.

- ***Describe general treatment capabilities.*** First, let people know that we can make the water as pure as we want. Describe in simple and meaningful terms the operations of separation, destruction, and disinfection. Being simple, yet meaningful, will increase trust. Technical information without meaning erodes trust. For example, relate treatment processes to familiar things—such as kidney dialysis or bottled water treatment.

- ***Define the local problem.*** Often utilities focus on the proposed project before the problem it is intended to address is clearly defined or accepted by the audience. Focusing on the problem to be solved establishes the fundamental motivations and answers why the utility is reaching out to the community in the first place.

5.5 CITY OF SANTA CRUZ, CALIFORNIA

The City of Santa Cruz integrated resource plan provides a good example of the variety of techniques that can be used to elicit input from stakeholders. What is exemplary about the Santa Cruz plan is the variety of public and stakeholder involvement techniques used throughout the planning process, which allowed each stakeholder to make important and useful contributions to the plan.

The city currently relies primarily on surface supplies that are highly variable. Generally speaking, in most years there is more than sufficient supply to meet demand. However, in drought years, this is not currently the case, and, as future demands increase, the range of hydrologic conditions under which there will be water shortages expands.

The city had been considering new water supplies, using a more traditional planning paradigm, for decades and was unable to assemble the necessary political and financial support to proceed with any major projects. The situation was becoming more acute in that, if the worst historical hydrological event (the drought of 1976–1977) were to reoccur, customers would face serious shortages and the attendant hardships. So the city decided to embark on a different kind of planning process.

Among other innovations, the integrated resource plan included a variety of modes of public and stakeholder involvement. Water Department staff and the consultant worked closely and on an ongoing basis with an Integrated Water Plan Committee (IWPC), which was appointed by the City's Water Commission. The seven-member IWPC consisted of members of the Water Commission, members of the City Council, and persons with prior experience and expertise in Santa Cruz water supply issues. The committee took a very active role in plan development and met frequently with the staff and consultant. These meetings were open to the public.

The IWPC had a distinctive responsibility as a buffer between the technical information being developed by staff and consultants and the needs and concerns of decision-makers. Due to its composition, the IWPC members possessed skills and expertise in both of these areas and so made this committee uniquely positioned to assume this dual function.

Of the roles described above, the IWPC assumed the role of evaluating and exercising veto power over any proposed recommendations made to the Water Commission and, ultimately, to the City Council. No recommendations were forwarded to which the IWPC did not agree.

In addition to the ongoing involvement of the IWPC, two well-attended evening public workshops were held to seek input from the interested public at large. These workshops included formal presentations, responses to questions, maps, charts, and other visual aids, and multiple stations where attendees could speak one-on-one to staff or consultant team members about particular issues. Finally, the full Water Commission and the City Council held several meetings at which the IWP was discussed. At these meetings, comments were taken from the public.

Perhaps the most innovative form of public involvement in the Santa Cruz plan was the determination of the appropriate level of system reliability alluded to above. The Water Curtailment Study (WCS; Gary Fiske and Associates, 2001), which preceded the IWP and was a key input to it, was predicated on a careful attempt to obtain input from Santa Cruz water customers on the manner in which potential future peak-season water shortages would affect different classes of water consumers in the Santa Cruz Water Department service area. The intent of this study was not to quantify these impacts but rather to describe the actions that different customer classes are likely to take to reduce water consumption by specified amounts and the economic and noneconomic hardships that these actions would impose on customers.

The curtailment study was conducted to allow the city to actively consider the trade-offs between different levels of water supply reliability and the costs required to achieve those levels. A prerequisite is to first achieve a good understanding of what actions members of different customer classes would have to take in response to various curtailment levels and what hardships these actions would impose on these customers. In addition to relying on evidence from past California droughts, a horticultural study of shortage impacts on Santa Cruz residential landscapes, and an extensive literature review, the study also included focus groups with residential customers and a mail survey and set of interviews with key representatives of each business sector. Shortage impacts on large landscape and golf course irrigation customers, the University of California, and municipal government agencies were based on meetings held with representatives of each of those classes. The role of the focus groups and the interview and survey respondents was to provide critical input to the study to make the study's conclusions more robust. Neither group was accorded any further role in the WCS.

The residential focus groups resulted in some key findings, including the following:

- The common wisdom in shortage management in California and elsewhere has been that outdoor watering will take the lion's share of a shortage. The single-family focus group participants reported that, in mild shortages (requiring a 10% usage reduction), they would rely more heavily on behavioral changes, such as shorter or less frequent showers and reductions in toilet flushing, clothes washing, dishwashing, faucet use, and washing of outdoor surfaces. For more severe shortages, changes in outdoor irrigation are reported more frequently, as are substitution activities and capital replacement.

- Not unexpectedly, participants report increasing hardship as the magnitude of the shortage increases. Perhaps more surprisingly, even at a 50% shortage level, only about one-fourth of single-family and 40% of multi-family participants reported that expected actions would result in "considerable" hardship. However, the comments of single-family participants appear to indicate a much higher level of concern and, in some cases, anger, at the prospect of having to endure large future shortages.

- Milder shortages are expected to result primarily in inconvenience, while more severe shortages are expected to result in many more economic, aesthetic, or health and safety impacts.

- Several single-family participants articulated a concern that, since they have already “hardened” their demand by adopting water-conserving behaviors or technologies, they would be unfairly burdened if asked to reduce their demand by the same percentage as their nonconserving neighbors.

- It appears that the provision of the basic water usage information allayed some of the concern of participants and resulted in reduced hardship expectations. Moreover, participants uniformly felt that the information was useful and would help customers respond to a shortage.

The curtailment study served as a critical market research vehicle to gather information from both primary customer sources and secondary sources on one of the key parameters of the IWP, namely, the effects of differing reliability levels on Santa Cruz water customers.

Finally, the IRP included two public workshops to educate interested members of the public, answer their questions, and receive their input. These workshops were held at critical points of the planning process, at which public feedback was deemed particularly important. The purpose of the first meeting was to provide information to the public on the evaluation criteria selected by the IWPC and accept public input on the evaluation criteria and on the various supply components to be evaluated. The second workshop was held after the consultant and the IWPC had gone through much of the evaluation process and had narrowed the number of strategies still under consideration. Its purpose was to provide information to the public on the results of the evaluation process and accept public input on the results and on the supply strategies that were still being considered.

Both workshops included a combination of formal presentations by staff, consultants, and IWPC members and responses to questions from the public. The second workshop also included informal “breakout” tables for each major supply technology (e.g., a table for desalination, a table for reclamation, a table for groundwater, and a table for conservation). A block of time was set aside for attendees to visit these tables, each of which was manned by a staff member or consultant. In both workshops, public comments were recorded and incorporated into the planning process. The primary role of the public workshop participants was thus to comment on tentative conclusions and recommendations that had already been developed by staff and consultants. A simplified schematic of the Santa Cruz stakeholder involvement process is shown in Figure 5.1.

5.6 SAN DIEGO, CALIFORNIA

In June 1993, San Diego began a feasibility study of an indirect potable reuse project within the City of San Diego. The project consisted of creating facilities for advanced (tertiary) treatment of wastewater at the NCWRP and transmitting product water to a local reservoir (San Vicente) for subsequent indirect potable reuse. The intended project size of 30 million gallons per day would produce about 33,000 acre-feet per year, increasing local water supplies by about 40%.

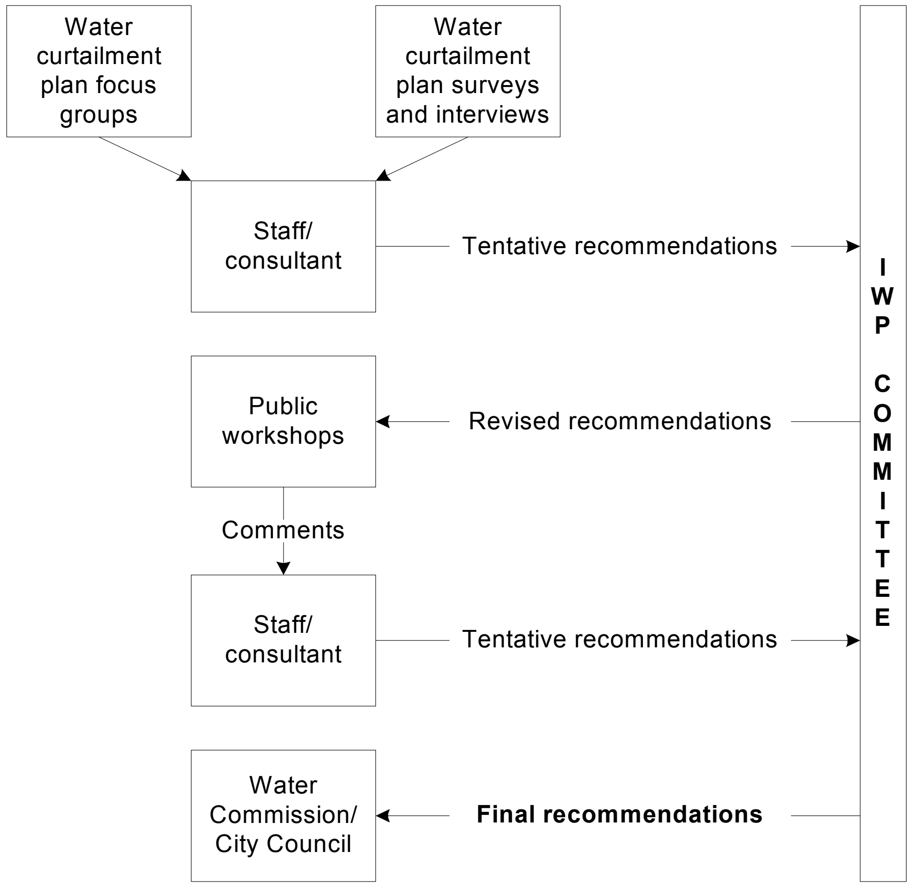

Figure 5.1. City of Santa Cruz Integrated Water Plan—public and stakeholder group participation.

Between 1993 and 1997, the project proceeded through the planning and regulatory approval stages. A first step was to conduct market research to gauge public perception of the project via telephone surveys, focus groups, and community leader interviews; based on the results, it was concluded that the community supported the project. In 1994, the California Department of Health Services (DHS) put together an Independent Advisory Panel of nationally recognized experts in water treatment and public health to advise on the project. In August 1994, DHS granted conditional project approval. A variety of public education activities occurred over the planning period, including a media education campaign, development of education materials, and educational presentations. Selected stakeholders formed a Repurified Water Review Committee that met five times in 1994 and issued a report supportive of the project.

In 1998, the project went to the San Diego City Council for final approval and funding. The project was rejected and terminated from further consideration. Regardless of the merits of this specific project, it is interesting to review some of the circumstances that converged to diminish public support. There are multiple lessons learned that can be shared with other communities in their planning of NTWS options.

- ***Environmental justice.*** The wastewater collected for this project would come from affluent neighborhoods and businesses in north San Diego. Potable water derived from the San Vicente Reservoir largely serves less-affluent areas, with significant Asian, Hispanic, and African American neighborhoods, in west central San Diego. The city council representative from the west central area (4th District) became a strong and vocal opponent of the project. The project was perceived as creating water quality risks, with no tangible benefits. One possible approach that may have helped alleviate some of this line of opposition would have been to more actively engage the relevant stakeholders in discussions about the advantages for using reclaimed water, such as enhanced reliability and, perhaps, lower water rates. Nonetheless, overcoming the "yuck factor" associated with linking reclaimed water with potable supplies, even if indirectly, is not a simple matter.

- ***Need for the project.*** A hallmark of IRP is considering multiple resource issues—this project had both water and wastewater motivations. In 1993, when project planning started, California was in a severe drought, and water supply reliability was a major community issue. The drought ended, and heavy rains in 1997, an El Niño year, took drought off the list of pressing public issues. In addition, at this time the San Diego County Water Authority was seeking to secure a large water transfer of Colorado River water from the Imperial Irrigation District. This created uncertainty about the future need for indirect potable reuse.

  On the wastewater side, the City of San Diego operates a large regional wastewater plant (Point Loma) with outfall to the Pacific Ocean. This plant has been in violation of U.S. Environmental Protection Agency (EPA) standards in its discharge of "advanced primary" treated wastewater into the ocean. As part of a continuance of an ocean discharge waiver, the city agreed to progressively divert and reuse more of its wastewater flows over time. EPA provided significant co-funding to projects serving this end. This particular project would largely serve this purpose.

  The plant, however, was not necessarily an important issue to the community. Many stakeholders began to see this project not as the best way to improve water quality and secure future water supply reliability but more as an "experimental" project forced on the community by the federal government.

- ***Stakeholder support.*** Opposition to this project grew over time. It included one journalist from San Diego's major daily newspaper (Union-Tribune) who repeatedly provided negative coverage on the project. Opposition expanded to include a local, and very visible, state senator and filmmaker, who made opposition to the project one of his campaign issues in 1998. The major water agencies in the county also did not provide strong, unified support.

It is interesting to consider how employing different IRP strategies and tactics might have changed the situation. One possibility is that too little was done to reach out and develop relationships with opponents. Better communication might have identified the environmental justice issue, remaining public concerns about water quality, or the diminished perception of the need for water reliability improvements due, for example, to negotiations that were ongoing with the Imperial Irrigation District. It remains a matter of conjecture whether, with these critical issues identified, planners might have been able to alter the process, project design, and timetable in numerous ways that may have improved the odds of success.

Unsuccessful projects can be costly and tarnish the reputations of participating agencies and of NTWS. A lingering question is, given the history, when can another indirect potable reuse project be brought forth for objective consideration in this community?

Indirect potable reuse is employed in many regions of the world, including within the United States. It commonly occurs as “unplanned” indirect potable reuse, when upstream communities discharge treated wastewater into surface waters that ultimately are sources of drinking water for downstream communities. This practice has existed as long as people have drawn water downstream of other human settlements. However, planned potable reuse, using methods such as groundwater recharge using reclaimed wastewater, also has been in practice for many years in some locations. Planned indirect potable reuse is being practiced with increasing frequency as communities use their highly treated wastewater to replenish their traditional source waters. The Orange County Water District and the West Basin Municipal Water District (WBMWD) are two examples located just north of San Diego, whose communities have provided wide support over several years for ongoing indirect potable reuse via groundwater recharge. Future work with stakeholders in other communities may benefit from a discussion of both planned and unplanned indirect potable reuse.

CHAPTER 6

REGULATORY AND INSTITUTIONAL ISSUES

While, based on both engineering and economics, desalination, reuse, and other forms of NTWS have become more attractive, several potential obstacles to more widespread application may arise due to real or perceived "institutional" issues. These institutional issues may include regulatory and related permitting requirements, concerns from some local citizens over growth, and other "nontechnical" matters.

Ultimately, planners and managers who are contemplating the inclusion of NTWS in their regional water supply portfolio should be aware that they probably will face permitting and other institutional issues that could complicate and delay the process. This chapter provides an overview of these institutional issues, so that practitioners can be more informed and better prepared to address them.

We define institutional issues generically as nontechnical barriers to the implementation of desalination, reuse, or other NTWS options. These issues may impede the effective inclusion of NTWS in a region's water supply portfolio, because they increase uncertainty, add costs, create delays, or in other ways pose "barriers." These barriers, in turn, may adversely affect the ability of a water or other utility to obtain needed permits, gain support from citizens and governing officials, get a facility built, and/or successfully operate a desalination or other NTWS facility.

This chapter is presented in three sections, which respectively lay out the institutional and regulatory issues that may be confronted for desalination, reclamation, and stormwater projects. In addition, brief case studies are included to help reveal some of the practical issues utilities may face.

The issues explored consist primarily of the following:

- ***Permitting issues***. In some states (e.g., California), as many as seven major state or federal permits are needed before final permission is granted to begin the planning, design, and construction of a desalination facility. Often many more permits and permissions may be required from federal, state, and/or local government entities. It can become a lengthy, uncertain, and arduous process; we explore how and why the process may be so difficult.

- ***Government issues***. Related to permitting, some government entities may greatly influence whether an NTWS project is feasible or not. For example, the State of California Coastal Commission (CCC) has jurisdiction over development along the coast and may require proposed desalination plants to evaluate whether subsurface intakes are feasible (Tom Luster, California Coastal Commission, personal communication, Nov 9, 2006). In addition, the California State Lands Commission's requirements for facilities using once-through cooling may make the colocation of desalination plants with, and use of cooling waters from, coastal power plants more difficult.

- ***Public perceptions and attitudes***. As discussed in Chapter 5 concerning stakeholders, there can be a range of "hot button" issues and concerns held by some organizations and individual citizens over the use of NTWS as part of the local water supply portfolio. These issues may include concerns over potential risks to health (real or perceived) associated with NTWS, implications for how much local population growth may be facilitated by expanding the community's source water options, the role of the private sector in water provision, and others.

In discussions of permitting and related government issues, a central theme that has emerged in our interviews with numerous water utility officials and other relevant parties is the need to have support—or at least understanding and suitable flexibility—from the various regulators who need to issue permits or otherwise provide necessary approvals for a desalination or other NTWS project. The nature of the relationship with regulators will naturally vary from state to state, from region to region within a state, and from agency to agency. However, there are some common elements and concerns, and they point to potential strategies that may be broadly useful to agencies seeking to implement an NTWS project.

6.1 DESALINATION

6.1.1 Permit Requirements and Issues

Permits and approvals can become a potential bottleneck for desalination projects. The number and types of permits vary by project location and other specifics but generally fall into three broad categories: (1) where and how the source water is obtained; (2) how the desalination-generated water will be used; and (3) how the brine concentrates will be managed. Each of these is addressed in turn below. A more extensive discussion of these and related issues can be found in Institutional Issues in *Desalination and Water Purification Technologies*, a report prepared for the Joint Water Reuse & Desalination Task Force (Raucher et al., 2006b).

6.1.1.1 Source Water (Feedwater) Permits

The source of water feeding the desalination process and the manner in which these waters are obtained are major determinants of the types and numbers of state and federal permits and approvals required.

6.1.1.2 Coastal Desalination Facilities Colocated with Power Plants

In coastal waters, institutional issues are affected by whether the desalination plant is colocated with a power plant or is a stand-alone facility. In colocated approaches, the desalination plant takes a portion of the power plant's once-through cooling water, which creates several technical and regulatory advantages, including the following:

- There is no need for a new water intake pipe or any increase in the volume of coastal waters taken in. This characteristic eliminates the need for permitting of new intakes and avoids any associated ecosystem disruption from placing such new intake pipes in the coastal environment.

- With this approach, there would be no added impingement and entrainment (I&E) of aquatic species, beyond that which is already occurring due to preexisting power plant operations. This property means that the desalination facility's use of coastal waters is unlikely to cause any ecosystem impacts beyond the baseline of what is already associated with the power plant.

- The higher temperature attained by the once-through cooling water makes the desalination process more efficient, saving fuel and perhaps other costly inputs.

While colocation of desalination with coastal power plants offers several advantages, there are also some problems that may arise because coastal power plants are often the target of strong opposition by many parties. Concerns with coastal power plants tend to focus on ecosystem impacts (e.g., I&E from the use of once-through cooling processes), potential thermal impacts, aesthetic concerns, barriers to beach access, and other issues. In some locations (especially in California), there is strong sentiment in some circles that coastal power plants should be phased out.

Colocating desalination facilities with power plants thus creates guilt by association. Power plant opponents worry that colocating desalination plants with power plants along the coast will make it harder to phase out the power plants. In fact, the California State Lands Commission, which has jurisdiction over the state's intertidal lands, adopted a resolution in April 2006 limiting approval of new leases and expansions of existing leases for power facilities that utilize once-through cooling to those plants that are in full compliance with California water quality law and Clean Water Act (CWA) Section 316(b) (California State Lands Commission, 2006).

6.1.1.3 Coastal Stand-Alone Desalination Facilities

Utilities seeking to build a stand-alone desalination plant in coastal waters will need to develop and obtain a permit for an intake structure, develop beach wells, or use horizontal directional drilling to develop undersea well intakes some distance from the shore.

For desalination facilities that develop their own intake structure, this process is likely to entail several major permits and approvals:

- A CWA Section 404 permit for the intake pipe (one is also needed for any new discharge pipe), since placing a pipe in the water is considered "fill." It is administered by the U.S. Army Corps of Engineers (ACE), but the ACE typically requires buy-in and approval from other agencies, such as the U.S. National Oceanic and Atmospheric Administration (NOAA) and/or relevant state or regional bodies that have jurisdiction over fisheries and other coastal resources and impacts.

- A Rivers and Harbors Act (RHA) Section 10 permit for the intake pipe (again, a separate permit will also be required for a discharge pipe). It too is administered by the ACE, and again the ACE typically will not issue such a permit unless other agencies (e.g., NOAA) are consulted and sign off.

- In some states, a permit will be required from the state coastal authority (e.g., the CCC).

A prime concern with developing an independent desalination intake is the potential I&E and its impact on marine species and the associated coastal ecosystem. I&E impacts from desalination plant intakes probably are very minor compared to those from power plants using once-through cooling. Compared to power plants, desalination facilities use feedwater intake pipes that are considerably smaller in diameter, apply much lower intake velocity (allowing more fish to swim away rather than getting impinged in the screen), and take in a much smaller volume of water. Nonetheless, citizens and regulators are likely to have concerns that water agencies need to accommodate.

6.1.1.4 Inland Groundwater Desalination Facilities

Inland groundwater is easily accessed through wells, and, thus, groundwater desalination facilities may not require any significant regulatory review and approval (unless the water rights and/or pumping permits are an issue).

In addition, because desalting groundwater may be pursued in concert with an environmental restoration effort (e.g., where total dissolved solids [TDS] and other contaminant levels in the aquifer are elevated by irrigation, agricultural runoff, or other activities), it can be viewed as part of an environmental improvement regimen (e.g., making contaminated waters usable and/or creating a barrier to limit the intrusion of lower-quality water into other systems).

Therefore, desalting inland groundwater can be relatively easy to arrange with regulators, is less likely to engender public concerns, and may be seen as an environmental plus. Permitting and public perception, however, may present challenges for the management of concentrate from inland desalination facilities, as discussed below.

6.1.1.5 Potable Water Permits

Most desalination-generated waters are expected to provide water to enhance potable supplies, and as such the operating utilities will probably require permitting as a drinking water treatment plant (i.e., require a potable water permit from the Safe Drinking Water Act [SDWA] primacy agent, typically the state public health or environmental protection agency). This process should not pose any unusual challenges for water suppliers.

There may be ways to avoid the need for a potable water permit in some settings. For example, if the desalted water is for irrigation or other nonpotable uses, then a potable water supply permit is not necessary. In the Coachella Valley Water District in California, for example, the plan is that desalted water will be used for irrigation only. However, by developing a desalted source for irrigation, the water district can exchange some other waters currently diverted to irrigation and make those other water sources part of its potable portfolio.

6.1.1.6 Permits for Discharge of Brine Concentrates and Associated Wastes

Concentrate disposal is a major financial and regulatory issue, and the options and issues depend on the setting and disposal approach applied.

6.1.1.7 Coastal Colocated Desalination Facilities

In coastal settings with desalination colocated with power plants, the concentrate would typically be discharged with the cooling water return flows from the power plant. This arrangement would provide considerable dilution of the brine wastes in the discharge line (i.e., before the point of discharge into coastal waters) and may even serve to slightly cool the thermal power plant discharge. Presumably, the discharge to a dynamic marine setting (e.g., subject to currents, waves, and tidal influences) would be promptly and highly dispersed and diluted in the ocean setting.

Nonetheless, there are environmental concerns with the discharge of brine concentrates to coastal waters. Although the brine concentrates are essentially the same compounds found in the coastal waters drawn as the desalination source, they will have been concentrated to levels that could pose environmental risk to aquatic organisms if they are not adequately diluted and dispersed. Another concern is that the discharge may contain antiscaling or other cleaning agents and other compounds used in the desalination process.

State primacy or federal regulators will impose federal CWA National Pollutant Discharge Elimination System (NPDES) permits on desalination facility discharges (even when the wastewater is released through a power plant discharge line, with its own permit). Key issues will be levels of local mixing, dispersion, and dilution, as well as the potential presence of any special status species. Presumably, reasonable pilot testing and periodic monitoring should identify any impacts of concern. However, a potential hurdle for desalination facilities may arise when concentration-based limits (or biomonitoring) are set and measured at challenging compliance locations that do not reflect coastal conditions (e.g., inside the discharge pipe).

6.1.1.8 Coastal Stand-Alone Desalination Facilities

Coastal desalination plants that are not colocated with power plants are required to have the following permits for their discharge pipes:

- A CWA Section 404 permit for the outfall, since placing a pipe in the water is considered "fill." This permit is administered by the ACE but typically requires buy-in and approval from other agencies, such as NOAA, which have jurisdiction over fisheries and other coastal resource impacts.

- An RHA Section 10 permit for the outfall pipe. This permit too is administered by the ACE, but it will typically not issue such a permit unless other agencies (e.g., NOAA) are consulted and sign off.

- In some states, a permit will be required from the state coastal authority (e.g., the CCC).

In some instances, coastal stand-alone desalination plants may have other options for brine concentrate disposal. For example, it may be feasible to mix the discharge with the outfall from another facility such as a power plant or wastewater treatment facility. This arrangement would provide dilution and avoid the need to develop and permit a new outfall. Nonetheless, the desalination facility would need an NPDES permit for the portion of the discharge for which it is responsible.

6.1.1.9 Inland Groundwater Desalination Facilities

Most inland desalination facilities will probably rely on deepwell injection of concentrates, if geologic conditions are such that regulators will permit such an approach under the federal SDWA's underground injection control program. Regulators seek hydrogeologic evidence that the injected wastes will remain physically isolated from other groundwater systems.

Questions may also arise about whether the concentrate is a hazardous waste (or perhaps whether drinking water standards may apply to the waste to be injected). Water supply agencies will want assurance that the concentrate will not reduce the porosity of the target underground system, thus limiting the volume of concentrate that can be injected over time.

Inland desalting operations may also seek discharge permits to surface waters (i.e., NPDES permits), though this process may prove challenging depending on the nature of the concentrate and the targeted receiving waters. In some locations, however, agencies may have circumstances that allow for innovative approaches that eliminate the need for a discharge permit. For example, in Coachella Valley, California, the desalter is planned to feed a constructed salt marsh, and then the outflow from the marsh will flow to the Salton Sea—thus providing environmental benefits (and, possibly, eliminating the need or basis for an NPDES permit).

Finally, evaporation ponds may be an option for managing concentrate disposal. However, the area of land required (600 acres was the estimated land area needed for the El Paso desalting plant) and the likely requirement for lining (and probably double-lining) such large-scale facilities make such an option unlikely at this time. There also are concerns over windblown transport of potentially hazardous concentrated materials in the dried-out brines.

6.1.1.10 Conclusions

The number and types of major permits needed to build and operate a desalination facility will depend on the source water, end use, and disposal regimen pursued by a water agency. However, for a coastal stand-alone facility in California, there are likely to be seven major federal or state permits required. Several of these permits may, in turn, entail several consultations and approvals from numerous other state, local, or federal entities before the issuing agency signs off. A number of local agency permits also are typically required (although some are construction and land use permits that would typically be required for any project, not just for desalination).

For example, California American Water reports that it has to obtain over 50 different permits in total—from a variety of federal, state, and local entities—if it is to proceed with its efforts to develop a coastal desalination facility in conjunction with the Moss Landing power plant in Monterey, CA (Turner, 2006). So far, the California-American utility in Monterey has worked with 25 different permitting agencies (including 7 federal and 11 state) in pursuit of 41 of the permits it needs to pursue the facility. In contrast, through some creativity and favorable local circumstances, the Coachella Valley Water District is pursuing a groundwater desalting program that would have two (at most) major permits, and if it proceeds according to its plan, the program may not require any major permit.

6.1.2 Other Institutional Issues Affecting Desalination

This section discusses numerous other institutional issues that can have an impact on desalination implementation.

6.1.2.1 Ocean versus Estuarine Waters

There are often important differences between a desalination facility that is located along the coast and that takes in ocean water and discharges it to the ocean and desalination facilities that rely on estuarine water bodies. Both types of facilities may be considered “coastal,” but they may face different physical and institutional issues, and in some instances, planners will need to work with different permitting agencies.

6.1.2.2 Private Sector Involvement

Some members of the public, and some public officials, have expressed concerns over having private sector entities involved in desalination projects. This anxiety stems from a deeper philosophical issue about what role (if any) the private sector should play in the provision of water as an essential good and public service (i.e., critical to life, health, safety, and welfare).

Beyond the philosophical debate, which at some level may not be resolved to the satisfaction of either side, there may need to be important distinctions drawn between *“merchant” desalination facilities* (plants developed by private entities, with the intent of selling their product to water utilities) and *investor-owned water utilities* (private sector entities that are publicly regulated utilities and have a contractual obligation to serve the public). In the case of merchant plants, the owner is providing water as a commodity. In the case of an investor-owned utility, water—and water distribution and delivery services—is provided with public sector oversight and pricing control.

6.1.2.3 Foreign Ownership

Similar to the opposition in some circles to private sector desalination provision, there is a related concern over foreign ownership of desalination facilities. This concern too stems from philosophical beliefs about control over water as an essential good. While contracts can be drawn that assure protections for both parties to an agreement—regardless of owner type or point of origin—the aversion to foreign ownership may impede some desalination projects where the merchant vendor, or the investor-owned utility, has foreign ties.

There have even been some concerns aired regarding international trading and investment agreements such as the North American Free Trade Agreement and General Agreement on Tariffs and Trade. The CCC has raised “. . . concerns about potential conflicts between trade rules and state regulatory authority.”[6] The subject of ownership by a multinational private company raises additional concerns regarding potential challenges to U.S. laws that a multinational corporation might regard as restrictions on “free trade” or an “undue limitation on their [sic] ability to make a profit” (Surfrider Foundation, 2006).

6.1.2.4 Asserted Jurisdictional Control

In some instances, utility professionals believe state or local agencies established conditions (i.e., requirements or restrictions) on desalination activities that were not within the government entity’s legal jurisdiction or authority. In these cases, the utility was forced to either test the legality of the asserted authority by filing a legal challenge (implying long delays and high costs) or adhere to the asserted (but probably unauthorized) demands. The typical choice is to bow to the demands and consider the imposed conditions to be part of the cost of getting needed approvals.

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6. This issue is addressed in a March 2004 document (Harrison Institute for Public Law and Georgetown University Law Center, 2004).

Making concessions to appease an overreaching regulatory body may simply be a practical reality in some instances, but in other circumstances the impediments created may warrant a challenge to the legality or constitutionality of such actions. Asserted (versus actual or tested) permitting jurisdiction may be used in attempts to limit the types of entities that can be involved in a desalination project (e.g., precluding private entities or organizations with foreign ownership, as has been explored by some local political bodies in the Monterey region of California), or such efforts may impose other conditions on a local water supply agency (e.g., demanding more public access or changes in design or processes).

Finally, some utility professionals noted that it is not always clear when a state agency staff member comment reflects an official policy position of the agency or when it is simply a personal observation. Casual or unofficial statements, especially when captured by the news media, can morph (intentionally or not) into apparent policy positions that may be difficult to reverse.

6.1.2.5 Growth and the "Sociology of Water"

In many communities, there is considerable concern about the potential magnitude and pace of population growth and its associated impacts on the local "quality of life." Water supply provision serves as one convenient point of leverage with which parties can limit growth. This issue does not necessarily concern desalination or other NTWS; rather, it is about expanding the local water supply in general regardless of the source or method. However, because desalination is the promising new alternative that is emerging as the potential solution to growing water scarcity, it has become a primary target of no- or slow-growth advocates.

Ideally, local citizens and public officials concerned about how to manage growth would rely on policy tools directly aimed at the problem, such as local zoning requirements. However, there is a long tradition through much of North America of "zoning by infrastructure." This term implies that by directing the location and pace of expanded local water and/or wastewater infrastructure, interested parties (developers included) have been able to impact property values, traffic patterns, and the general level and location of population growth in localities.

6.1.2.6 Water Rights for the Ocean

Currently, the ocean's water is a common property resource, and no water rights are required to divert such waters. There has been discussion in some circles about the possible need or merit of considering near-shore waters as part of the public trust and, therefore, making them subject to some regulatory control for desalination extractions or other uses. It is not evident that this issue of establishing ocean water rights (or some similar mechanism through which a government establishes authority and management over the quantities of ocean withdrawals) is likely to have much impact or traction in the near term.

One water rights complication that may arise in the case of estuarine desalination is the interaction of tidal influences with flows from inland rivers. It may be the case that an estuarine intake might capture ocean water at some times, river water at other times, and, perhaps most often, some indeterminate blend of both. To the extent that river waters are part of the feedwater, a water rights issue might arise for the desalting agency.

6.1.2.7 The Energy-Desalination Nexus: Cost, Reliability, and Global Warming

The water supply sector is a large consumer of electrical power in general. Current desalination technologies require a relatively large amount of energy, even compared to other water sources imported over great distances. For example, Bob Wilkinson, from the University of California at Santa Barbara, has examined the energy cost embedded in a wide range of supply options used or considered by the Inland Empire Utilities Agency (located east of Los Angeles in the Chino Basin). The results, in kilowatt-hours per acre-foot of water, show reclaimed water at 400, groundwater pumping at 950, the local groundwater desalter at 1700, imported surface waters at between 2000 and 3200, and ocean desalting at 4400.

There are concerns that expanded application of desalination will increase the overall demands for energy, especially where grid capacity is already strained by current demands (as in California). The issue is not just about the high and potentially volatile cost of energy as an input to desalting water but also the strain on the overall power grid system and its reliability and sustainability. Thus, one concern is that broader application of desalination could push the electrical transmission grid, and the region's power generating capacity, into heightened vulnerability to massive blackouts and other failures.

In addition, there is considerable concern in some circles over the greenhouse gas (GHG) emissions—and air pollution emissions in general—associated with the presumed need to expand fossil fuel use to power desalination facilities. GHG emissions are linked with global climate change, and other air pollutants pose risks to human health, vegetation and other resources and/or impair visibility. The link between the energy needs for desalination and increased air pollutant emissions and global warming creates another basis for concern about (and for some people, opposition to) desalination.

One avenue to address this concern is to explore alternative (green) energy options for desalination facilities and/or for water agencies in general. As one expert phrased it, "We need to decouple tomorrow's water from yesterday's energy." The technical feasibility and economic practicality of this view need to be further investigated, but the concept (i.e., the "greening of desalination") could have considerable intuitive appeal in many circles.

6.2 WATER RECLAMATION AND REUSE

Reclaimed water can comprise treated domestic wastewater or a combination of treated domestic and industrial wastewater. Such "recycled" water can be used for three purposes: nonpotable, indirect potable, or direct potable reuse. Nonpotable reuse refers to water used for nondrinking purposes and includes applications such as agriculture, landscape, public parks, and golf course irrigation. This type of reuse can also be used as cooling water for power plants and oil refineries and industrial process water (e.g., paper mills and carpet dryers, toilet flushing, and dust control). Indirect potable reuse water can be used to augment surface water sources that are used, or will be used, for public water supplies or to recharge aquifers that may be used as a source of domestic water supply (U.S. EPA, 2004). Direct potable reuse—one of the more controversial uses of reclaimed water—refers to the use of reclaimed water for drinking directly after treatment (U.S. EPA, 2006) and has not been pursued to date in the United States, although it is practiced in Singapore.

Regulatory and institutional issues for water reclamation arise throughout all of the planning phases of a reclaimed-water project, including end use. The Reclamation Wastewater and Groundwater Study and Facilities Act (Title XVI) of 1992 (amended in 1996) authorizes the federal Bureau of Reclamation to conduct appraisal and feasibility studies on water reclamation and reuse projects, as well as to conduct research and demonstrate programs to test water reclamation and reuse technologies. This Act represents the federal government's primary jurisdiction over water reclamation and reuse issues. Federal agencies may also claim jurisdiction when water reuse conflicts with water rights law, water quality standards, discharge into surface waters, wetlands, or other waters of the United States, and takings of endangered or threatened species. State agencies also have jurisdiction over reclaimed water projects, but the permitting procedures and regulations generally differ by state.

The following section provides an overview of the relevant permitting issues, which may arise during the planning, construction, or monitoring phases of a water reuse project.

6.2.1 Permit Requirements and Issues

The permitting and approval process for water reuse projects can be time-consuming and can delay or deny a project's progress, especially when federal or state regulations do not specify time limitations for the permitting process. Many of the permits related to reclaimed water projects deal with water quality standards and the discharge of effluent into waters of the state and waters of the United States, including wetlands. The following sections describe these permitting issues.

6.2.1.1 Discharges into Waters of the State

States may issue their own permits to protect waters of the state. Waters of the state refer to all surface and groundwaters within the state boundary. These waters can include streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, reservoirs, aquifers, irrigation systems, drainage systems, and all other bodies or accumulations of water, including natural or artificial and public or private waters.

Protection of these waters include the prevention of streambed alterations and the prevention of water quality degradation. Water quality permits for the discharge of effluent from reclaimed water facilities can also vary from state to state. Some states have standards that can differ across their regions (e.g., different lakes may have different standards). The CWA requires states to develop water quality standards, which apply to wastewater discharges. Some states or municipalities may require additional discharge permits. These permits may limit the amount of water a facility can discharge, a requirement that has implications for the amount of water available for reuse. The following are examples of water quality (of discharged effluent) permit requirements for California, Washington, and Arizona:

- California's Department of Fish and Game issues a 1600 permit for any projects that may alter the streambed of waters of the state. Alterations may include pipes crossing under a drainage or crossings under dry, ephemeral streams. This permit requires the facility operator to submit an Environmental Impact Report, as governed by the California Environmental Quality Act.

- Washington State's Reclaimed Water Reuse Act of 1992 allows the state to issue a reclaimed-water permit for discharging effluent to waters of the state. These permits contain requirements for treatment, public health protection, water quality, monitoring, distribution, and use of reclaimed water.

- In Arizona, all owners and operators of facilities discharging either directly to an aquifer or to the land surface or to the vadose zone[7] must obtain either an individual or general Aquifer Protection Permit. This permit requires facilities to monitor and report the quality of the reclaimed water, ensuring that effluent limitations for reclaimed-water quality classes are met.

6.2.1.2 Discharges into Waters of the United States

Waters of the United States are defined in the CWA as navigable waters; tributaries of navigable waters; interstate waters; and interstate lakes, rivers, and streams. The interstate lakes, rivers, and streams must be used by interstate travelers for recreation or other purposes, serve as sources of fish or shellfish sold in interstate commerce, or be utilized for industrial purposes by industries engaged in interstate commerce. Discharges to waters of the United States also include discharges into wetlands.

Most water reuse projects require storage ponds to hold the treated reclaim water until it is needed for potable or nonpotable uses. Many reuse projects use wetlands as their storage container. Vernal pools, a type of seasonal wetland, are ideal for water reuse projects because of their clay-like soils, which reduce the rate of flow into the groundwater system. Project managers must also consider the appropriate size for the storage ponds to avoid overflow during rain events.

In general, any new or proposed water reuse facility that discharges effluent into waters of the United States may need to obtain several federal permits: a CWA Section 404 permit, a CWA Section 401 permit, an RHA Section 10 permit, an Endangered Species Act (ESA) Section 7 or Section 10 incidental take permit, and an NPDES permit.

CWA Section 404 Permit

A facility will need to acquire a CWA Section 404 permit if it discharges any dredged or fill material into the waters of the United States, including wetlands. The ACE issues Section 404 permits, which fall into two categories: a general permit or an individual permit. Facilities qualify for a general permit if the area of the affected wetland is less than 0.5 acres. If the affected wetland is greater than 0.5 acres, facilities will need to acquire an individual permit. For all individual permits, facilities must complete a 404(b)(1) alternatives analysis to demonstrate that there are no feasible or practical alternatives to filling the particular wetland(s). These 404(b)(1) permits are the driving force of the ACE’s permitting process.

In addition to the alternatives analysis, the ACE must consult with several agencies, such as the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and other state resource agencies, to ensure that the proposed project is in compliance with the ESA, the Coastal Zone Management Act, the National Historic Preservation Act, the CWA, and the National Environmental Policy Act (NEPA).[8] To comply with the 404 permit,

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7. The vadose zone is the area between the land surface and the water table where the moisture content is less than saturation.

8. NEPA requires all federal projects, projects receiving federal funding, or projects involving federal permittees to complete an environmental assessment (EA). If the EA demonstrates that the project will cause significant harm to the environment, the agency must prepare an environmental impact statement.

the NEPA alternatives should also show no feasible alternative to filling in a wetland for a storage pond. Projects will fail to receive a 404 permit if the alternatives assessment and the NEPA assessment do not focus almost exclusively on the wetlands issue.

CWA Section 401 Permit

Facilities should also be aware of the CWA's Section 401 water quality certification, which requires facilities to demonstrate the steps they will take to reduce harm and avoid water quality problems. The states have different agencies that issue 401 water quality permits. In some states (e.g., California), the regional water boards issue this permit.

RHA Section 10 Permit

When constructing a new treatment facility (or modifying an existing facility), operators need to be aware of several construction permits, which address pipeline and conveyance issues. Most of these permits fall under the jurisdiction of the RHA of 1989. This act prohibits any construction activity in or near or altering any navigable water of the United States. The ACE needs to issue Section 10 permits if a facility needs an outtake pipe to discharge effluent. If a reclaimed water facility also requires a Section 404 permit (in addition to the Section 10 permit of the RHA), the facility must submit the applications simultaneously, so the ACE can issue a joint permit.

ESA Incidental Take Permit

Facility managers or operators will need to consult with the USFWS and/or the NMFS to determine whether any endangered or threatened species exist in the proposed project area. If endangered or threatened species are present in the area, the facility needs to obtain a Section 7 incidental take permit or a Section 10 incidental take permit. A Section 7 incidental take permit is required if a facility operates under the nexus of a federal agency (e.g., if any action is authorized, funded, or carried out by a federal agency). If so, the facility will enter a Section 7 consultation, which requires the USFWS and/or the NMFS to issue a biological opinion. The biological opinion states whether the proposed action is likely to jeopardize the continued existence of the endangered or threatened species.

The ESA Section 10 permit is required if a facility does not operate under the nexus of a federal agency. In this case, the facility would need to prepare a habitat conservation plan for any affected species. Unlike Section 7 permits, Section 10 permits do not require the USFWS and/or the NMFS to adhere to any schedule, so project delays are typical.

NPDES Permits

The CWA established the NPDES permitting process, which regulates point source discharges into the waters of the United States. Most states have adopted an NPDES permitting program. In Colorado, a water or wastewater agency must obtain a Colorado Discharge Permit System permit for any land application of the reuse water (e.g., landscape irrigation). This permit falls under the jurisdiction of the NPDES permit.

6.2.2 End-Use Issues

Most states require a permit to apply reclaimed water or other NTWS option for any use, such as irrigation or landscaping. The permitting process becomes more complicated when the reclaimed or other NTWS water is intended for potable uses (direct or indirect). Depending on how the water will be used, facilities might have to increase their treatment to meet higher water quality standards. Many states also have guidelines for pipeline conveyances to ensure that reclaimed water does not become confused with potable drinking water.

6.2.3 Other Institutional Issues

Issues that managers should consider during the planning phase for water reuse projects include water rights laws, water use, and wastewater discharge regulations, as well as laws that restrict land use and protect the environment. For the implementation phase of a water reuse project, managers need to be aware of policies that guide the development of reclaimed water rates and agreements between reclaimed water producers, wholesalers, retailers, and customers, as well as rules affecting system construction and liability for water use (U.S. EPA, 2004).

6.2.3.1 Water Quality Regulations

EPA Guidelines

No federal regulations directly govern water reuse practices in the United States, although EPA has developed a set of guidelines for water reuse projects. EPA's guidelines are specifically directed at states that have not yet developed their own regulations or guidelines for water reuse projects. The EPA established guidelines based on the states that have established guidelines in place (e.g., Arizona, California, Florida, and Texas). Suggested guidelines for wastewater treatment processes, reclaimed-water quality, monitoring, and setback distances are provided for the following types of water reuse: urban reuse, restricted-access-area irrigation, agricultural reuse (for food crops and nonfood crops), recreational impoundments, landscape impoundments, environmental reuse, groundwater recharge, and indirect potable reuse. Regardless of the type of reclaimed water use, these guidelines recommend that some level of disinfection be provided to avoid adverse health consequences from inadvertent contact or accidental or intentional misuse of a water reuse system (U.S. EPA, 2004).

State Standards

Many states have adopted their own set of regulations, guidelines, or design standards for implementing reuse projects. These regulations typically include standards for water quality (e.g., turbidity and fecal coliform).

- In Colorado, the Colorado Water Quality Control Act (CWQCA) establishes requirements, prohibitions, standards, and concentration limits for the use of reclaimed water. The intent of these regulations is to encourage the use of reclaimed water *and* promote the protection of public health and the environment. The CWQCA further establishes three categories for reclaimed water standards and describes reclaimed water uses, conditions for use of reclaimed water, and methods for monitoring, record-keeping, and reporting (5 CCR 1002-84).

- The Arizona Department of Environmental Quality establishes water quality standards for the level of treatment for water reuse projects (e.g., primary treatment, secondary treatment, and filtration), turbidity (for unrestricted urban use, agricultural reuse [food crops], and restricted recreational use), and total fecal coliform counts. Unlike other states, Arizona does not regulate biochemical oxygen demand or total suspended solids. Additional detail can be found in *Guidelines for Water Reuse* (U.S. EPA, 2004).

6.2.3.2 Water Rights

The right to use water (i.e., a water right) does not entitle any ownership over the resource. A water right simply allows water to be diverted at one or more particular points and a portion of the water to be used for one or more particular purposes (U.S. EPA, 2004). Water rights can complicate or simplify a water reuse project's progress, depending on a state's water right law. State laws allocate water based on two types of rights: the appropriative doctrine and the riparian doctrine.

The prior appropriative doctrine—a first-in-time, first-in-right doctrine — governs western states that are water limited (e.g., California, Colorado, or Arizona). This doctrine is based on the first-come, first-served principle, rather than from the property's proximity to the water source or the value of the water use. During a period of drought, for example, the state guarantees high-seniority water users first-priority access to the native water, possibly denying low-seniority water users the right to the water. For low-seniority water users, reclaimed water provides a more predictable supply of water. Reclaimed water is the largest block of unappropriated water in the west (U.S. EPA, 2004).

In many eastern states, which typically have been relatively water abundant, water use and allocations are governed by the riparian doctrine, which is based on the proximity to water and is acquired by the purchase of land. Under riparian water law, those who hold the water right can use the water only on the riparian land and are not allowed to store the water during times of drought.[9]

Limitations for Reclamation

Water rights can impose complications on reclamation projects for several reasons: (1) uncertainty regarding who retains control of the reclaimed water—the discharger, the water supplier, other appropriators, or environmental interests; (2) uncertainty regarding the downstream water user's right to reclaimed water (e.g., as return flows); and (3) federal water rights issues.

9. Florida uses a model water law, which is a combination of both the water rights and riparian doctrines.

Case Study: West Basin Municipal Water District
Carson, California

California, like many western states, has been facing water shortages as a result of limited supplies and growing populations. The WBMWD, a water wholesaler in Carson, California, depends on imported water from northern California and the Colorado River—as well as a few groundwater reserves—to provide water to retail water supplies who provide service to over 800,000 people in the greater Los Angeles region. In response to the increased demand for water, the WBMWD built a water reuse plant in the early 1990s and began distributing reclaimed water in 1995.

One of the recipients of the reuse water was the West Coast Seawater Barrier Program. This program uses recycled water to replenish the aquifer and avoid seawater intrusion. The WBMWD has decided to expand the barrier program to include 100% recycled water. Initially, the program used only 75% reclaimed water and 25% potable water. The process to obtain permits for this project has taken nearly four years and has tied up 60% of a key WBMWD staff person's time. The following section highlights some of the barriers for the expansion program (Daniel, 2006):

- The WBMWD first had to request the California Department of Health Services Drinking Water Division (i.e., the agency responsible for writing recharge regulations) to submit a Finding of Facts and letter of recommendation to the Regional Water Quality Control Board (RWQCB) (i.e., the department responsible for issuing a recharge permit). This additional step had to be completed before the RWQCB would review the project's Waste Discharge Requirement permit.
- The WBMWD had to obtain a NPDES permit (issued by the RWQCB) for the discharge of brine concentrate resulting from the use of reverse osmosis technology to treat the reclaimed water before it was injected into the groundwater. The WBMWD discharges the brine into the City of Los Angeles' Hyperion Outfall, which discharges wastewater five miles out to sea—an area under federal jurisdiction. As a result, the WBMWD submitted an application for a NPDES permit from the federal government (i.e., EPA) in November 2004. As of June 2006, neither EPA nor the RWQCB had yet granted the permit.
- The WBMWD was required to obtain operating permits from the Air Quality Management District, a primacy agency responsible for air pollution control in Orange County. However, the WBMWD did not realize the permits needed to be obtained prior to construction—the result of a miscommunication between WBMWD and its construction contractor.
- All new projects, regardless of size, must pass the requirements of the California Environmental Quality Act. If the project receives any funding from the federal government, it is subject to the NEPA process. The WBMWD had no problem with these processes because they were considered from the project's planning phase.

For more specifics, refer to *Clearing the Hoops: Regulatory Approval for 100% Reclaimed Water Aquifer Injection Project*, a report presented at the 21st Annual WaterReuse Symposium (Daniel, 2006).

Trying to determine who retains control of the reclaimed water may lead to unwanted litigation. In Washington State, for example, reclaimed water is considered a new water supply and the owner of the reclaimed water facility receives exclusive rights to the use, distribution, and exemption of appropriative water right permitting requirements. The owner cannot, however, divert reclaimed water from existing effluent discharge locations if diversion would impair existing downstream water rights without any compensation or mitigation. A local irrigation district in Washington State took the municipal corporation of the City of Walla Walla to court because the former wanted the city to continue discharging wastewater effluent into Mill Creek (a natural channel) for irrigation use (U.S. EPA, 2004). The court sided with the local irrigation district on two occasions, forcing the city to discharge all of its wastewater effluent into the creek all year long.

Whether the downstream user has a right to the reclaimed water depends on the state's water rights law. Typically, the owner of a wastewater facility producing effluent will have the right to use it and is not required to continue discharging the effluent, but the threat of litigation may still linger. If the facility reduces discharge (e.g., for evaporative cooling or groundwater infiltration), downstream users may claim damages against the owner of the facility.

In Colorado (and perhaps other prior appropriation states), water rights for downstream users may preclude the development of reclaimed water by an upstream wastewater plant when the original source water was drawn from the same river basin. If a facility imports water from one location and typically returns discharge to another river basin—as is the case for Denver Water, which imports water from the western slope and discharges to the eastern slope—then the facility can reclaim water because the possibility of returning water to the original location is negligible. If, however, the water discharged to another location can be returned to the original location, the water may not be reclaimed under Colorado water law. The exception is for potable water that results from the transfer of agriculturally decreed water rights and nontributary groundwater. This water can be reclaimed even if a path exists back to the origin of the discharge water (for more information on Colorado water law as it applies to water reuse, refer to Colorado Revised Statutes, 1996).

When a project increases, reduces, or affects in any other way the supply of water to more than one state, to protected Native American tribes, or to other countries, federal water laws will become relevant for water reuse projects. The allocation of water from the Colorado River to Arizona, California, Colorado, Nevada, and Utah causes disputes between states, especially during years of low flow. In this instance, the federal government might claim jurisdiction in disputes between states. It is possible that such federal involvement might arise in the context of reclamation or other NTWS options, to the extent that a state argues that the use of the NTWS option limits Colorado River flows in a manner that reduces how much Colorado River water the state can extract.

Public Acceptance

The public's perception of reclaimed water can create a bottleneck for water reuse projects if the project manager does not involve all stakeholders from the beginning of the project. The City of Los Angeles learned this lesson the hard way. After 10 years of development of the East Valley Water Recycling Project, which was designed to use recycled water for groundwater recharge in the San Fernando Valley and cost $55 million, the project came to a sudden end after delivering only 62 acre-feet of recycled water. A large segment of the general public would not accept that water from their toilets would end up in their drinking water—the "Toilet to Tap" controversy.

From this experience, the City of Los Angeles learned that an intensive public information and education campaign and a participatory approach from the beginning of the process are critical for the success of a recycled-water project. A successful project also requires strong and continuous political support, open dialogue with stakeholders, and transparency throughout the process to ensure that the public understands the benefits associated with recycled water (Van Wagoner and Lynch, 2006). Additional discussion of the public acceptance issue and working with stakeholders is provided in Chapter 5 of this report.

6.3 STORMWATER USE

Stormwater runoff is regulated as a point source discharge, which requires an NPDES permit under the CWA. Primacy agents already require entities to try to collect and manage stormwater in their jurisdiction, increasing the feasibility of using stormwater as an NTWS option (e.g., to percolate to recharge groundwater; to use in saltwater barrier injection wells; or to harvest, treat, and use more directly as a source water). Using stormwater becomes easier because the waters already have to be collected in some fashion under the water pollution mandates. As a result, facilities can collect the stormwater more systematically, making the process more centralized and the resource more available for possible use.

Our research has not uncovered many regulations that pertain specifically to the manner in which stormwater may be used. The following are examples of regulations or guidelines for stormwater use in Los Angeles and in Florida:

- Los Angeles County's DHS is in the process of developing guidelines for the use of stormwater, which will likely include provisions for pipeline construction, installation, and safe use to protect domestic water supplies and public health.

- The State of Florida requires a permit for supplemental water supplies, which includes treated stormwater, groundwater, and drinking water to augment the reclaimed water supply. Even if the reclaimed water is not intended for potable use, it still must meet many of the primary and secondary drinking water standards.[10]

For other areas of the country, we presume that if a utility (or any other entity) decided to use stormwater for any direct use purposes (other than for discharge to a stream or other surface water body), then it would have to abide by the rules and regulations, including permitting processes, relevant for the specific intended use (e.g., potable supply, groundwater recharge).

Other components of stormwater regulations deal with pollution abatement measures, which facilities may have to incorporate into their project's design. More information, including different programs, can be found in Appendix B of this document.

10. Interested readers may wish to see the State of Florida rules for water reuse (62-610, FAC), which are very specific about the requirements for various types of reuse projects.

CHAPTER 7

INCORPORATING ENVIRONMENTAL EXTERNALITIES: BCA AND ITS RELATIONSHIP TO IRP

Many water supply projects, and many NTWS projects in particular, generate benefits (and in some cases, costs) that are external to the water or wastewater utility. These external benefits and costs often can have substantial value to a range of stakeholders outside the water utility. Recognizing these external benefits may reveal that projects for which revenues do not appear to cover costs from the narrow financial (cash flow) perspective of a utility may, in fact, be economically warranted from a broader societal benefit–cost perspective. That is, some NTWS projects may provide values to the region as a whole that outweigh the costs, once the full range of external benefits is identified and valued.

To account for these external benefits and costs, economists typically apply benefit–cost analysis (BCA). BCA is a technique that enables program planners to undertake structured comparative analyses of alternative approaches to achieve similar goals. It is widely used, familiar to many, and in some cases federally mandated in evaluating complex projects that have substantial environmental and social impacts.

In broad terms, a BCA compares the benefits of a project—or a set of projects—to its costs. As discussed more fully below, the question of to whom the benefits and costs accrue is a critical one that can greatly affect the results of the analysis. However, in the context of this report, the larger question is how BCA fits into an IRP process, particularly one that is considering NTWS alternatives. This chapter provides a brief overview of BCA and addresses these questions. It includes an illustration of the application of BCA to NTWS projects in the Phoenix, Arizona, area and an application to an IRWMP effort that includes NTWS alternatives in the Pajaro region of central California. Since the field of BCA has been documented extensively elsewhere, we do not provide a detailed description here. Readers interested in more detail can refer to many other publications, including Raucher et al. (2006a).

7.1 BCA OVERVIEW

BCA is one of several tools that water managers and public officials need to have in their “decision support toolbox” to help them make well-informed choices between different water supply options. While BCA can be very informative and useful, BCA is not an exact science and should not be seen as providing a firm “rule” to determine what alternatives (e.g., reuse project options) should be pursued. Rather, BCA is simply a way to help systematically organize information and illustrate suitable comparisons across options. A good BCA alone is unlikely to carry the day for a manager or public official attempting to expand water reuse or other NTWS applications. Instead, BCA is one of a suite of tools and can be used to complement other types of analyses, perspectives, and communication approaches that comprise an integrated plan. Thus, for example, a BCA is unlikely to overcome opposition to a project from those who perceive potential health risks due to a proposed reuse application.

In those cases, complementary approaches in risk communication and public dialogue will be needed.

A BCA is fundamentally an economic analysis. As such, it attempts to monetize the benefit and cost components so that they can be directly compared. This monetization must account for timing differences, so that benefits realized or costs incurred today can be properly compared to future costs and benefits. Typically, present values or annualized values of benefits are compared to present or annualized values of costs. The present or annualized value of a time series of values uses a suitable discount rate to reflect the lesser value of future cash flows.

7.2 THE PERSPECTIVES OF BCA

A taxonomy of benefits and costs is helpful in understanding the full social cost accounting approach associated with a particular project. In particular, it is useful to distinguish between utility and nonutility benefits and costs. The critical distinction that we wish to make here is between benefits and costs that accrue to the water utility and its customers and those that are external to the utility.[11] A majority of the benefits and costs that accrue to the utility are those that affect a utility's revenue requirements (and are therefore passed through to ratepayers). The most prominent utility cost is the direct financial costs borne by a utility for a project. A critical component of utility benefits is the water supply and/or wastewater costs that would have been incurred in the absence of the proposed project and that can be avoided (or postponed) by implementing the project. These cost savings, or "avoided costs," are commonly encountered with NTWS projects.

There are other utility benefits that are not as readily monetized, including such things as increased water supply reliability, drought relief, and increased local control of water resources. Planners must take care not to double-count benefits. For example, avoided supply costs and increased water supply reliability can be "two sides of the same coin." In such a case, the project(s) being considered will either avoid other supply costs or enhance reliability but not both and therefore both should not be accounted for as separate benefits.

Many water supply projects, and many NTWS projects in particular, generate benefits and costs that are external to the water utility. Projects can generate external ecological benefits; recreational benefits; public health benefits; and economic, social, and equity impacts. These external benefits and costs, while often difficult to quantify, often can have substantial value to a range of stakeholders outside the water utility.

Which of the benefits and costs listed above are counted in a BCA depends on the analysis perspective used. In general, from a narrow or "internal" utility perspective, only benefits and costs that accrue to the utility are counted, while nonutility benefits and costs are ignored. From a societal perspective, both utility and nonutility benefits and costs are counted. Recognition of benefits and costs external to the utility in the societal perspective can often

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11. Depending on the specific NTWS project(s) being considered, the "utility" may include several water and/or wastewater providers.

result in projects for which, while benefits do not appear to cover costs from the utility perspective, benefits in fact outweigh costs from the societal perspective.[12]

These perspectives, and which benefits and costs are counted in them, have been defined in a variety of ways. For the purposes of this discussion, we will not go into great detail on all of the perspectives, but the interested reader can refer to the definitions offered in the *California Standard Practice Manual* (CPUC, 2001).

Utilities and others often ask which perspective is the “right” one for deciding among water resource options. The answer, of course, is that there is no single “right” perspective. Each provides potentially useful information to answer different questions. If the question that is of most interest is which option(s) does the best job of minimizing utility revenue requirements and/or maximizing utility service levels, the planner should focus on the utility perspective. If, on the other hand, the question is which option(s) does the best job of maximizing total utility and external benefits, the focus should be on the societal perspective.

Whichever perspective is taken, it is critical to value benefits and costs relative to a consistent baseline. The baseline should represent what the utility would do in the absence of the project(s) being considered. Thus, for example, avoided costs should reflect those components of the baseline scenario that would be avoided, downsized, deferred, reoperated, etc., as a result of the project(s). A clear and consistent definition of the base case is critical to a BCA.

7.3 THE RELATIONSHIP BETWEEN BCA AND IRP

At this point, the reader may be asking how BCA fits into IRP. BCA provides a framework within which the economic values of project benefits and project costs can be compared. IRP recognizes that there can be many criteria that are important in making a decision about whether to proceed with a project, some of which are economic criteria but some of which are not. The noneconomic criteria may be of importance equal to or greater than that of the economic criteria and may include political considerations, project feasibility, or social or environmental considerations. However, it must be pointed out that the distinction between economic and noneconomic criteria is fluid. Many of the so-called “noneconomic” criteria can, under some circumstances, be quantified and incorporated into the economic analysis of a well-done BCA. Thus, for example, the value of environmental “externalities” might be translated into reduced mitigation costs or estimated by using one of a variety of economic analysis approaches. To the extent that all of the evaluation criteria can be satisfactorily monetized, BCA and IRP are very similar.

But generally, not all criteria can be monetized. There will doubtless remain some criteria that are important to the utility and the broader community that cannot be (or, by choice, are not) reflected in the economic analysis. Indeed, the recognition that BCA often did not adequately consider critical objectives was a key reason for planners to look for alternatives to BCA, which led to the broader and more inclusive IRP structure.

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12. It should, however, be noted that there may be instances where the external costs outweigh the external benefits, thereby worsening the overall benefit–cost comparison.

Thus, BCA should be thought of as an important constituent of IRP but one which typically must be complemented by other analytical techniques. One possible way to use BCA within an IRP is described in a recent Awwa Research Foundation report (Awwa Research Foundation, 2007). That report describes a typical analytical sequence designed to reach a decision on individual- or multiple-water-use efficiency options, while minimizing the unnecessary use of analytical resources. The sequence, which is illustrated in Figure 7.1, is equally applicable to water supply options. The steps that are described in the Awwa Research Foundation report are as follows:

- Determine whether there are compelling reasons either to implement or not implement the project(s). “Compelling reasons” could result from political/regulatory, environmental, customer service, or other such concerns. If such factors are truly compelling, no further analysis is necessary. The go/no-go decision should be made based on these factors.

- If no such compelling reasons exist, then perform a BCA as described above. For purposes of discussion, the results of that analysis are assumed to fall into one of three categories:

  1. ***Clearly economic.*** The economic results are very favorable (i.e., high benefit–cost ratio or net benefits). There is a high return on the utility’s investment in this project(s).

  2. ***Clearly uneconomic.*** The economic results are very unfavorable (i.e., low benefit–cost ratio or net benefits). Investing in this project(s) would clearly be a poor allocation of resources.

  3. ***Borderline.*** The economic results are inconclusive; they may be favorable or unfavorable but not overwhelmingly so.

This “triage” approach ensures that analytical resources will be expended only as necessary. In either of the first two cases, no additional analysis is necessary, and the project(s) should be undertaken or not according to the economic results. Only in the third case should an effort be made to carefully evaluate noneconomic criteria and a decision made based on the results of the economic and noneconomic analyses.

7.4 CASE STUDY: TRES RIOS AND RIO SALADO PROJECTS

7.4.1 Background

Historically, the Lower Salt River, located in the vicinity of Phoenix, Tempe, and Scottsdale, Arizona, was a perennial stream (flowing year-round). The river was characterized by many channel meanders, sand bars, and backwater areas, which were conducive to riparian growth and wildlife habitat. However, beginning in the late 1800s and over the next 100 years, the river environment changed dramatically. Upstream diversions and dams removed water from the river system and prevented the perennial and high winter flows. Consequently, the lower portion of the Salt River became an ephemeral system (flowing only at certain times of the year).

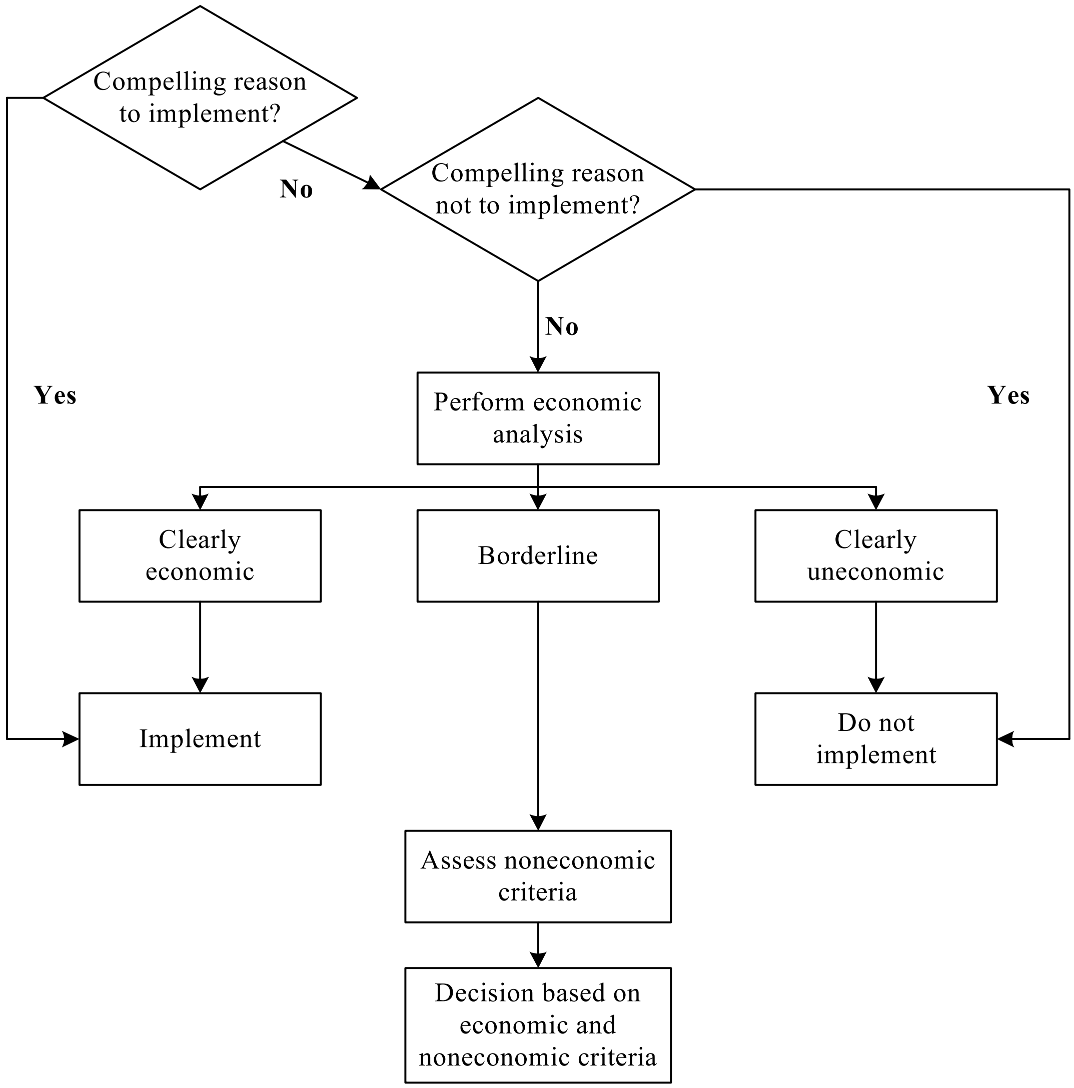

Figure 7.1. Possible integrated planning sequence.

In 1958, the cities of Phoenix and Glendale constructed the original 91st Avenue WWTP and began discharging 5 million gallons per day of treated wastewater into the Salt River. This plant was replaced with a 45-million-gallon-per-day plant that was subsequently expanded over the years. The capacity of the 91st Avenue WWTP currently has reached 180 million gallons per day and is in construction to expand to 205 million gallons per day (Paul Kinshella, City of Phoenix Water Service Department, personal communication, May 7, 2007). With the construction of the WWTP, the river once again became perennial. The 91st Avenue WWTP discharge into the lower river channel provided an artificial flow and, while not of optimal water quality, supplied the water needed for habitat along the banks of the Lower Salt River (Paul Kinshella, City of Phoenix Water Service Department, personal communication, Aug 15, 2005). The 23rd Avenue WWTP also contributes to providing year-round flows to the Salt River (Paul Kinshella, City of Phoenix Water Service Department, personal communication, Dec 4, 2006).

In 1990, the Arizona Department of Environmental Quality (DEQ) released new water quality standards for wastewater discharges into Arizona waterways. To meet the new stringent standards, the City of Phoenix estimated that upgrades totaling $600 million would need to be made to the 91st Avenue WWTP (Paul Kinshella, City of Phoenix Water Service Department, personal communication, Aug 15, 2005). Similar costs were to be expected at the 23rd Avenue plant. However, the proposed upgrades would not give the plants additional treatment capacity, and the city decided to seek an alternative solution. The city had two options:

- ***Option 1.*** The city could move to a zero-discharge scenario at the WWTPs. If no water was discharged, the new regulation would have no impact. Zero discharge would be attained through the 100% reclamation and reuse of the wastewater effluent from the WWTPs. While this option solved the problem of meeting water quality standards, the action also would have resulted in the river drying up, causing the loss of riparian habitat and downstream water availability to irrigators.

- ***Option 2.*** The city would construct a wetland project near the WWTPs to meet the more-stringent discharge standards. Water from the 91st Avenue plant would be discharged into the Tres Rios wetland. When secondary treated effluent is discharged into a wetland system, the wetland reduces the effluent toxicity of the water (Paul Kinshella, City of Phoenix Water Service Department, personal communication, Aug 15, 2005). Concentrations of nitrogen, other nutrients, and metals are reduced dramatically, and the water is naturally "polished." The polished water draining from the wetland into Salt River would meet the new standards.

  Water from the 23rd Avenue Plant would be used by exchange in the Rio Salado Project. The Rio Salado Project consists of 5 miles of riparian habitat restoration along the Salt River from 19th Avenue on the west to just west of the I-10 bridge on the east. Rio Salado indirectly makes use of treated effluent produced at the 23rd Avenue WWTP. The treated wastewater currently goes to the Roosevelt Irrigation District. The Roosevelt Irrigation District does not have to pump groundwater because of the discharge. Phoenix gets in-lieu groundwater credits for the groundwater that Roosevelt Irrigation District does not pump. In the long term, the water will go to the Roosevelt Irrigation District, which will use the water in place of pumping groundwater. Credits from the use of effluent instead of groundwater pumping are then used to provide groundwater to Rio Salado.

The second option was selected, and in 1995, under a cooperative partnership among the cities of Phoenix, Tempe, Mesa, Scottsdale, and Glendale (which make up partners in the Sub-Regional Operating Group or SROG), and the Bureau of Reclamation, construction began on the Tres Rios Demonstration Project. Today, the $3.6 million, 12-acre demonstration project consists of three operational wetlands: the Hayfield site (6 acres), the Cobble site (4 acres), and the Research Cell (1 acre) (U.S. EPA, 2005a). The flow of water from the wetlands has helped sustain a 1-mile corridor of riparian habitat below the project site. The goal by 2012, using the design criteria developed in the demonstration project, is to increase the size of the Tres Rios wetland project to 800 acres, creating up to 10 miles of riparian habitat along the river corridor (City of Phoenix, 2005a). The 800-acre, full-scale project will be capable of receiving the 91st Avenue WWTP's entire outfall of secondary treated effluent (City of Phoenix, 2005a).

The Rio Salado Project received funding from federal and local resources in 1999. Construction started in 2000, and Rio Salado opened to the public in 2005. The Tres Rios and Rio Salado projects make up part of a regional effort at river redevelopment that includes the Tempe Town Lake and may include the proposed Rio Salado Oeste project.

7.4.2 Cost Sharing

It is estimated that the total cost of the full-scale Tres Rios Project will be approximately $140 million, with an estimated annualized capital and operating cost of approximately $10 million (Megdal, 2005; Paul Kinshella, City of Phoenix Water Service Department, personal communication, May 7, 2007). The ACE will pay 65% of total full-scale wetland project costs, with the remaining 35% of costs covered by local sources—primarily the SROG cities of Phoenix, Glendale, Tempe, Mesa, and Scottsdale. The cost-sharing agreement within SROG has been based on the flow of the WWTP, with Phoenix paying 54% and the other cities paying 46%.

The idea for the Rio Salado Project originated in 1966 with students at the Arizona State University College of Architecture. The idea was forwarded by a public interest organization of business and civic leaders later in the 1960s and was promoted by creation of the Rio Salado Development District in 1980. Federal interest in Rio Salado increased in the 1990s with county flood control projects and a newly expanded mission for the ACE. Once an agreement was reached, the ACE designed the project in cooperation with the City of Phoenix. The project received funding from federal and local sources in 1999.

Two-thirds of the $100 million cost for Rio Salado was paid by the ACE. SROG cities bear a majority of the rest of the Rio Salado cost. The cost-sharing formula for shares within SROG has been changed from a flow-based formula to a formula based on the share of constituents. Other contributions came from Phoenix taxpayers in the form of $16 million for bond funding for cleanup and habitat restoration, $1 million from the Arizona Water Protection Fund, $1.5 million from the Phoenix Parks and Preserve Initiative, and a Heritage Fund construction grant for $250,000.

7.5 ESTIMATING BENEFITS OF THE TRES RIOS PROJECT

7.5.1 Cost Offsets

The city realized significant cost avoidance benefits through the construction of the Tres Rios Project. The $600 million upgrade was avoided, and with the completion of the full-scale project, the city will be able to treat 100% of its wastewater to Arizona DEQ standards by using the wetland technique. This ability translates to a net savings in capital outlays of about $500 million (and probably also would include operations and maintenance [O&M] cost savings).

While the direct cost savings are appreciable in their own right, there are also numerous wider-range benefits associated with the Tres Rios Demonstration Project that will grow as the full-scale project is completed, such as habitat creation, aesthetic improvements, and recreation. In order to evaluate the full benefit of wetland creation, we must not only consider the local benefits but also the broader regional benefits. There are clear local benefits to the Tres Rios Project, but benefits such as habitat creation for threatened and endangered (T&E)

species hold value not only to those who live within walking distance of the Salt River. These various benefits are described in the following sections.

7.5.2 Habitat Creation

The Tres Rios Project is restoring critical riparian and wetland habitats that have been lost to the region as a result of water resource development in the Phoenix metropolitan area. The design phase of the demonstration project targeted improving aquatic and riparian habitats for T&E species that have habitat ranges that overlap the metropolitan area. Specifically targeted T&E species include the Yuma clapper rail, the south western willow flycatcher, the yellow-billed cuckoo, and the lesser long-nosed bat (City of Phoenix, 1997, 2005b). There are also a number of species that receive or are candidates for state protection that inhabit the project area, such as the lowland leopard frog, the desert tortoise, and the Mexican garter snake (City of Phoenix, 1997).

There have been a number of studies on the value of instream flows on ecological systems and the public's WTP to protect instream flows and the riparian habitat created. Studies have estimated the value of instream flows for protecting T&E fish species. Values ranged from $7 to $112 per household for various specific aquatic T&E species. A meta-analysis (Loomis and White, 1996) of studies covering 18 different T&E species resulted in similar annual WTP results ($6 to $95 per household).[13] The majority of T&E species in the Tres Rios area are birds. Therefore, using a 1999 study (Reaves et al., 1999) from the meta-analysis is appropriate. This study evaluated households' WTP for the protection of an endangered species' habitat that had been severely decimated by a hurricane. Reaves et al. (1999) estimated that households are willing to pay $8–$16 per year to protect the red-cockaded woodpecker habitat. More specifically, the study indicates that households are willing to pay $8–$16 per year to increase the woodpecker's chance of survival from 0 to 50%, a significant change in the probability of survival.

In order to estimate the benefits of the Tres Rios Project, it is necessary to estimate how the project might increase the target species' prospects for continued survival. Unfortunately, this information is not readily available. Therefore, to cite the Yuma clapper rail as an example, it is known that approximately 400–750 pairs of Yuma clapper rails exist in the United States (California and Arizona) and another 450–970 inhabit Mexico (Arizona Game and Fish Department, 2001). Studies show that the year-round home ranges of rail pairs average approximately 18.5 acres (Arizona Game and Fish Department, 2001). Thus, we can estimate that, at best, the Tres Rios Project may support an additional 45 breeding pairs of rails, increasing the total population of rails by at least 2.5% (45 additional pairs with a current estimated maximum population of 1750 in the United States and Mexico). Using a scaling factor of 2.5% and the Reaves et al. (1999) original WTP values, we estimate a WTP of $0.20–$0.40 per household for habitat creation. This figure is very conservative, given that there are a number of species other than the Yuma clapper rail that also will benefit from the project.

We conservatively assume that only those residents of the immediate Phoenix metropolitan area have a positive WTP for T&E habitat creation in the river corridor. This assumption

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13. A meta-analysis is used to combine the strengths of many different studies that use different valuation methods to try to ensure that a single outlier study does not mislead the valuation result.

most likely results in an underestimate because it is highly probable that people outside the Phoenix metropolitan area have a WTP for the protection of the T&E species living along the Salt River corridor. Currently, there are approximately 1.1 million households in the metropolitan area (based on 3.1 million residents and 2.6 people per household; U.S. EPA, 2005b).

Using annual WTP values of $0.20–$0.40 per household, we estimate an annual net benefit for habitat creation for T&E species of approximately $220,000 to $440,000 per year. Again, this range is likely to be a conservative (i.e., low) estimate, because multiple T&E and other potentially special status species are likely to be supported by the enhanced habitat and also because households outside the Phoenix metropolitan area are also likely to value enhancing the habitat for these species.

7.5.3 Aesthetic Improvements

Where the river was once fed by a WWTP outfall pipe, now wetlands will feed the river system. The entry of wastewater into the river channel through an artificially created "natural" system has important implications on the public perception of the river below 91st Avenue. The wetlands are an aesthetic improvement over an outfall pipe, and this improvement is valued by residents. However, as Paul Kinshella of the City of Phoenix's Water Service Department notes, the public perception of the project may be even more complex than simply that of an aesthetic improvement. The wetland may be seen as a buffer. Treated wastewater is converted back to source water in the minds of the public if it is filtered through a natural system, such as a wetland (Paul Kinshella, City of Phoenix Water Service Department, personal communication, Aug 15, 2005).

It is difficult to quantify aesthetic attributes, and we do not attempt to estimate their values estimated here. However, the aesthetic improvements to the river corridor may be able to be assessed through a hedonic analysis of property values in the vicinity of the river or through a valuation of recreational amenities that increase with improvements in aesthetics.

7.5.4 Recreation

The creation of open space for recreation and wildlife habitat is often a top priority in creating livable, people-friendly communities. The Tres Rios Project has the opportunity to provide significant educational and recreational benefits to the Phoenix metropolitan area. Wetland habitats attract diverse wildlife, making them an appealing destination to bird watchers, photographers, and day hikers. However, up to this point, the demonstration project sites have provided very little recreation benefit because public access is very limited. Security concerns after September 11, 2001, coupled with the proximity of one of the demonstration wetland sites to the WWTP, have prevented public access (Paul Kinshella, City of Phoenix Water Service Department, personal communication, Aug 15, 2005). The other existing reuse-based wetland site has been receiving negative use from late-night "partiers," and their presence has been destructive (Paul Kinshella, City of Phoenix Water Service Department, personal communication, Aug 15, 2005). While recreational opportunities have been limited to date at the Tres Rios demonstration site, it has been successful in providing educational opportunities. For example, the site is the focus of investigation at both state universities, as well as at several high schools in the area.

The future goal is that a significant portion of the full-scale wetlands project will contain trails tied into the Sun Circle trial system, and they will be monitored by the parks department, which will take some of the monitoring burden off the WWTP staff (Paul Kinshella, City of Phoenix Water Service Department, personal communication, Aug 15, 2005). Although it is uncertain what the annual number of visits will be to the completed 800-acre Tres Rios site, the site will potentially provide considerable opportunities for the public to come to view wildlife, picnic, hike, etc. A 1996 meta-analysis of near water recreational activities demonstrates that the public places significant values on these types of activities. For example, the average value per adult user day for wildlife viewing, picnicking, and hiking across numerous studies ranges from $32.00 to $44.02 per person per outing.

Since estimates of the number of visits are unavailable, we assume that user days at the Tres Rios site will be compatible to those at the Urban Wetland Project in the Las Vegas Wash. The Las Vegas wetland is larger than the Tres Rios Project; however, the 8-mile, 2700-acre Las Vegas wetland is in less of a residential area than the Tres Rios site. The Las Vegas wetland project contains 45 miles of trails and has parking for 90 cars. A detailed count of visitor use has not been conducted at the time of this report, but the Parks and Recreation Department roughly estimates that at least 15,000 user days occurred in 2004 (Karen Esteen, Las Vegas Parks and Recreation Department, personal communication, Dec 6, 2005). If one applies the Las Vegas Wetland Project annual use number, annual recreational benefits at the Tres Rios site might range from $480,000 to $660,000 per year.

7.6 RIO SALADO BENEFITS

The Rio Salado Project is part of a regional effort aimed at economic revitalization of areas adjacent to restored riparian habitat. It is designed to provide many of the same benefits as Tres Rios. Rio Salado is designed to provide flood control benefits; habitat restoration; opportunities for residential and commercial development; and links to parks, trails, and transportation systems. What makes Rio Salado benefits somewhat different is that the project is specifically designed to encourage investment in development closer to the river.

Rio Salado is specifically designed to encourage businesses to locate close to the Salt River channel. The “Beyond the Banks” land use plan, which pulls together the riparian habitat-based redevelopment efforts in the area, specifically discusses development near the river. Infill development incentive districts have been created to enhance the redevelopment effort. Redevelopment recommendations have included golf course development and provision of quality housing for ownership, recreational opportunities, and institutional facilities. To the extent that Rio Salado development encourages additional business development rather than shifting planned development from elsewhere in the Phoenix area, Rio Salado can provide real economic development benefits.

7.6.1 Conclusions

The Tres Rios and Rio Salado projects in Phoenix are prime examples of how water reuse-based wetland creation can generate significant benefits, both directly to the utility (i.e., financial savings) and also to the broader community. Given the emergence of more-stringent wastewater discharge regulations, the wetlands provide an effective polishing step for wastewater effort that can provide significant cost savings. However, cost savings should not be the only rationale for wetlands projects; this example reveals that considerable economic value can be linked to the habitat creation and recreational and aesthetic improvements that wetlands provide. And in the case of Rio Salado, river and wetland redevelopment is being used to attract economic development. Tables 7.1 through 7.4 (drawn from Raucher et al., 2006a) demonstrate the benefit values calculated for Tres Rios and their derivation.

Table 7.1. Summary Screening Analysis for Tres Rios Project

Benefits and costs receiving full or partial economic valuation
❍ Habitat creation (T&E species) (+)
❍ Recreation (+)
❍ Avoided expansion of treatment capacity (+)
❍ Capital costs of Tres Rios Project (-)
❍ Operation and maintenance costs (-)
Benefits and costs requiring qualitative assessment[a]
(+) Water quality (regulatory compliance)
(+) Aesthetic improvements
Impacts deleted from further analysis: impacts that are relatively small or mitigated
❍ None

[a]Place "+" or "-" in parentheses for positive benefits or costs (negative benefits), respectively.

Table 7.2. Detail on Benefit Value Derivation for Tres Rios Project

Benefit Category	Annual Quantity	Unit Value Used	Comments
Habitat creation/ T&E species	1.1 million households in the Phoenix metropolitan area	$8–$16 per year/household, scaled to $0.20–$0.40 per household to reflect the level of impact that this project might have on the total species survival (a possible 2.5% increase in habitat for the Yuma clapper rail population)	WTP values for protection of T&E species range from ten to hundreds of dollars per household per year. However, these estimates are based on scenarios that result in a significant change in the probability of survival of a species. Such a formula is not appropriate for the Tres Rios Project example. We use WTP values from Reaves et al. (1999) because the types of species evaluated in the study (birds) were generally consistent with those found in the region of Tres Rios.
Recreation	Estimated that the 800-acre site might receive 15,000 user days per year, based on visitation rates to the Las Vegas Wash Wetland Nature Preserve	$32–$44 per user day	A 1996 meta-analysis (Rosenberger and Loomis, 2001) found that average WTP values per user day for near-water recreational activities ranged from $32 to $44 per day.

Table 7.3. Costs and Benefits of Tres Rios Project (2003 USD per Year)

Cost or Benefit	Dollar Amount	Stakeholder Accruing Cost or Benefit
Cost components		
Total capital and operating cost (annualized) for full-scale wetlands construction (Megdal, 2005)	$10,000,000	Phoenix, Tempe, Mesa, Scottsdale, Glendale, and the Bureau of Reclamation
Total annual costs	***$10 million***	
Benefit components		
Habitat creation/T&E species protection	$220,000–$440,000	Public
Recreation at the Tres Rios site	$480,000 to $660,000	Public
Avoided expansion of WWTP treatment capacity (annualized capital cost avoided)	$50,000,000	WWTP (cities) and customers
Total annual monetized benefits	***$50.7 to $51.1 million***	
Benefits requiring qualitative assessment[a]		
Aesthetic improvement of wetland areas	+	*General public*
Monetized net benefits (monetized benefits minus costs)	***~$41 million per year***	

[a](+) indicates positive benefits anticipated but not monetizable with readily available data, and (-) indicates costs anticipated but not monetizable with readily available data.

Table 7.4. Omissions, Biases, and Uncertainties and Their Effect on the Tres Rios Project

Benefit or Cost Category	Likely Impact on Net Benefits[a]	Comment
Recreation	U (+ or -)	It is unclear what the use level at the full-scale project site will be. We assumed it would be similar to the user-day-per-acre data found in the Las Vegas Wetland Project, given their similar size and scope. However, the Tres Rios site may receive more use because of its proximity to residential areas. Additionally, the records of use estimate for the Las Vegas Wetland Project are imprecise.
Habitat creation/T&E species	U (+ or -)	The WTP value used in our calculation may be an overestimate or underestimate of the WTP that households possess for habitat creation for T&E species. The Reaves et al. (1999) study calculates WTP values for habitat creation that results in a significant probability increase of species survival. A project of the Tres Rios scale would most likely not result in significant changes in species survival probability. We have attempted to correct this overestimate. It is unclear if our 0.025 scaling factor is too high or too conservative, resulting in a WTP range that might overstate or understate benefits.
Habitat creation/T&E species	++	We conservatively assume that only those residents in the immediate Phoenix metropolitan area have a positive WTP for T&E habitat creation in the river corridor. This assumption most likely results in an underestimate because it is highly probable that people outside the Phoenix metropolitan area do have a positive WTP for the protection of T&E species living along the Salt River corridor within which habitat will be improved.
WWTP: O&M costs saved	+	The costs avoided from not having to expand and upgrade the WWTP reflect only capital outlays. O&M savings are also likely but are not included in the cost savings estimate used here (data not available).

[a]Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
- = Likely to decrease benefits.
-- = Likely to decrease net benefits significantly.
U = Uncertain, could be + or -.

7.7 CASE STUDY: ASSESSING NTWS WITHIN AN IRWMP CONTEXT FOR THE PAJARO REGION

The Pajaro River Basin, in the central coastal region of California, provides another example of an analysis of a more complete range of the benefits and costs associated with an NTWS project. In this case, a water reclamation project is an integral part of an overall regional water supply management solution to alleviate pressure on a highly stressed groundwater system. The BCA described here was part of a broader IRWMP process to determine whether it made economic sense to develop the NTWS option as part of this regional solution. In this case, the wastewater agency developing the NTWS would not obtain much value internally (i.e., in terms of revenues accrued or avoided costs) as a result of developing a reclaimed water resource. However, the BCA reveals that there will be a considerable level of external benefits realized region-wide from the development and use of the NTWS. These external benefits not only provide a sound economic rationale for proceeding with the project but also provide a justification for eliciting state grant funds under California's Proposition 50 to support the effort as well as a basis for exploring intraregional cost-sharing approaches.

The proposed Watsonville Recycled Water Treatment Facility (WRWTF) Project, a joint effort developed by the Pajaro Valley Water Management Agency and the City of Watsonville, entails the design and construction of tertiary treatment facilities adjacent to the existing City of Watsonville WWTP as well as a pipeline to transmit the tertiary effluent from the treatment plant to a blending facility. The WRWTF will produce 4000 acre-feet per year of recycled water that will be blended with local groundwater initially (and with imported Central Valley Project water after 2012) to decrease the salinity to levels acceptable for agricultural use. The WRWTF Project is linked to a proposed Coastal Distribution System (CDS); together, they are part of the Pajaro River Watershed Integrated Regional Water Management Plan. The CDS entails the construction of the roughly 30 miles of pipeline that will convey the blended recycled water from the WRWTF to coastal irrigators to offset their demands on the highly stressed regional aquifer. In total, this project will enable 7000 acre-feet per year of water to be delivered to coastal growers for irrigation on 2000 acres of prime agricultural land (4000 acre-feet per year from the recycling plant blended with 3000 acre-feet per year from other sources).

Pajaro River Basin communities and agricultural water users currently rely exclusively on local waters to meet their growing demands. Of the 71,000 acre-feet per year of local water used, virtually all 69,000 acre-feet per year (over 97%) is drawn from a highly stressed groundwater system. The current levels and patterns of groundwater use are associated with declining groundwater levels, saltwater intrusion, and the associated loss of coastal area wells that are used for agricultural production of high-value crops (e.g., strawberries).

Absent better efforts to manage the groundwater system, the region will continue to suffer additional losses of usable low-TDS groundwater and, thus, endure a reduction in the quality of water for municipal use and a decline in crop production and agricultural land values. The latter will arise through a pattern in which increasingly saline agricultural wells will force a transition from high-value crops with low salt tolerance to lower-value crops that can tolerate higher-TDS waters. Ultimately, many currently productive irrigated agricultural lands will likely transition to dry-land pasture, when the salt levels in local groundwaters can no longer profitably support even salt-tolerant crop irrigation.

By curtailing and replacing groundwater extraction in coastal areas where well pumping promotes saltwater intrusion, the CDS and the blended reclaimed water it delivers will approximately double the total regional sustainable yield of the local aquifer system (from approximately 24,000 acre-feet per year to 48,000 acre-feet per year). The WRWTF will provide over 20% of the total water distributed via the CDS and, therefore, contributes to the overall benefits of the CDS.

The BCA of the reclaimed water project and associated CDS reflects how, by developing an NTWS at an inland location and transmitting the water to coastal agricultural areas, there would be considerable water-related benefits realized for the region as a whole. The results of the BCA are summarized in Tables 7.5 and 7.6. The combined monetized benefit of the CDS and related projects is on the order of $301.5 million in present value (PV) terms. To obtain an estimate of the benefits suitably associated with the WRWTF alone, the total benefits are apportioned based on the relative costs of the broader project's elements. Since the cost of the WRWTF (PV cost of $34 million) contributes to 18% of the total cost of the suite of CDS project (PV cost of $185.3 million), 18% of the benefits created by the CDS can be apportioned to the WRWTF. The total present value of the avoided water supply costs attributable to this project is, therefore, over $35 million. In addition to its share of the CDS benefits, the project avoids some agricultural costs. When combined, total benefits from the WRWTF total approximately $59 million in present value. After netting out of PV costs, the present value net benefits of the WRWTF are approximately $25 million.

Table 7.5. Benefits Summary for Pajaro NTWS Option

Type of Benefit	Assessment Level	Beneficiaries
Water supply and water quality		
Water supply avoided costs (~20% of the avoided costs associated with the CDS)	Monetization	Local
Other benefits		
Avoided agricultural costs	Monetization	Local
Recreation and public access	Qualitative	Local, regional
Habitat preservation (Monterey Bay National Marine Sanctuary & Bay-Delta system)	Qualitative	Local, regional, statewide

Table 7.6. BCA Overview for Pajaro NTWS Option

Cost or Benefit	Annualized	Present Value
Costs—Total capital and O&M		$34,172,290
Quantifiable benefits		
Water supply (avoided costs)		$35,463,202
Other benefits (avoided agricultural losses)		$23,796,772
Total monetized benefits		$59,259,974
	Qualitative Indicator[a]	
Qualitative benefits		
Recreation and public access	+	
Habitat preservation (Monterey Bay National Marine Sanctuary & Bay-Delta system)	+	

[a](+) indicates positive benefits anticipated but not monetizable with readily available data, and (-) indicates costs anticipated but not monetizable with readily available data.

CHAPTER 8

WATER AND WASTEWATER UTILITY COLLABORATION WITH REUSE

In many areas, water and wastewater services are provided by different utilities. While, in some cases, a water service area boundary is served by two or more wastewater utilities, it is more common for a wastewater utility to provide service for customers served by multiple water utilities. In either case, this disjunction can cause significant institutional barriers in implementing reuse projects. And, even if water and wastewater services are provided by the same utility, institutional barriers can still exist between departments.

The first part of this chapter discusses the case where water and wastewater interests in reuse are not aligned. In such cases, IRP practitioners need to foster "big picture" perspectives in order for the net benefits of regional reuse to be realized. We also look at institutional barriers that can arise when reuse occurs in a region different from the one where wastewater collection occurs (i.e., the "duplication of service" issue). Lastly we look at how regulatory barriers can block water and wastewater utilities from collaborating on regional reuse projects.

Finally, while this chapter focuses on the challenges of improved collaboration between water and wastewater agencies, the issues also extend to other entities that may be associated with the provision of forms of NTWS. For example, the harvesting and use of stormwater would entail more communication and coordination between the stormwater management agency and the regional wastewater and water utilities. Likewise, if an entity emerges to offer desalinated water to the region (as in the case of a merchant developer of a desalination facility), issues of coordination and duplication of service (among others) would need to be addressed by all the parties in the region.

8.1 NONALIGNED UTILITY MANDATES AND OBJECTIVES

When the IRP process includes both water and wastewater utilities (as is often the case when forms of NTWS are incorporated in the IRP process), then various conflicts may arise from the different perspectives, mandates, and objectives of the utilities involved. These conflicts can be exacerbated when the water and wastewater utilities are operated by different entities (e.g., where a county is responsible for wastewater collection and management but the city governments purvey water supplies).

For example, objectives may not be well aligned in a location where water reclamation is under consideration by the primary wastewater utility but where the water supply utility does not necessarily see the need or value of developing a new source of water to compete with its own services. This conflict may arise in an area where there are differences of opinion about the scarcity of source water over the long term.

In such a setting, the wastewater agency may be motivated to pursue reclamation to promote water resource sustainability and make productive use of a resource that otherwise would be discharged as wastewater. The wastewater agency may be further motivated by state wastewater permitting regulations that create pressure (or uncertainty) about how much wastewater can be discharged in the future to a sensitive receiving waterbody. Thus, to the wastewater agency, reclamation might look like a smart and environmentally enlightened approach that reduces regulatory uncertainty and provides a drought-resistant supply to the regional portfolio.

From the perspective of the water supply utility, however, reclamation may look like a pathway to stranded assets and revenue shortfalls. If reclaimed water is intended for outdoor irrigation (e.g., public green spaces and golf courses), demand will exist for it during the dry season. However, reclaimed water will be substituted for what currently is provided as part of the potable supply. Typically, the local water supply agencies have already invested in the infrastructure and source waters that meet current outdoor irrigation demand. To compound the problem, the revenues needed to pay for these fixed assets are generated by the high water sales arising from the demands for outdoor irrigation waters in the dry season. Thus, in a setting where there is disagreement over the short- or long-term scarcity of source waters, a water reclamation program may be viewed as a competing supply that will eliminate (or significantly reduce) a major source of revenue that the water supply utility relies on to cover its fixed costs. To the water supplier, reuse water may be seen as burdening it with stranded assets and a loss of significant revenues; the reuse program looks fiscally irresponsible and unnecessary. In contrast, to the wastewater agency, reclamation appears like a prudent and forward-thinking approach to enhance sustainability. These differences arise because each entity has its own objectives and mandates. Disagreements may also arise because of other concerns, such as water quality implications and who pays for what. For example, a wastewater agency may see the application of reclaimed water to outdoor irrigation as a prudent and sustainability-enhancing activity. In contrast, a water supply utility in the region may be concerned about the possible degradation of local groundwater supplies from infiltration of irrigation waters. This situation may lead to conflicts about whether it makes sense to require that reclaimed water be treated to potable standards in order to apply it to nonpotable uses such as turf irrigation. These types of disputes tend to arise because each agency involved in the process has its own mandates, perspectives, and cost-containment directives.

These differences can be magnified by differences in opinion about several factors that are part of the IRP process (e.g., different perspectives on the region's demand growth and water supply needs into the future and/or the impact of changing climate on long-term supplies). These differences also can be compounded by other factors (e.g., political disputes and competition between the various levels of government, or between neighboring jurisdictions, that manage the utilities).

Ultimately, resolving these differences can be a complex exercise, but using the IRP process can be useful in helping to identify the factors that underlie the differences (e.g., disagreements may be pinpointed over the long-term supply-and-demand forecast). Further, the IRP process can provide a mechanism for proceeding despite these differences (e.g., by stepping back and taking a broader regional perspective and/or by running sensitivity analyses based on different scenarios). The IRP process can also be a useful way to examine or reveal a legitimate basis and need for revenue sharing across utilities (e.g., where the wastewater entity shares reclaim water revenues with the water supply utility to compensate for the latter's loss of peak summer outdoor irrigation revenues).

8.2 BARRIERS CREATED BY DUPLICATION-OF-SERVICE PROHIBITIONS

Some states or local jurisdictions apply duplication-of-service prohibitions. Their general intent is to preserve economies of scale and avoid administrative challenges and conflicts that might otherwise arise if service territories were divided into smaller or overlapping areas served by multiple entities. The idea is to preclude the development of duplicative infrastructure such that the same homes or commercial entities could be served by two or more water suppliers.

Adding reuse or other forms of NTWS to the local or regional water supply portfolio could result in conflicts with duplication-of-service provisions. Where they apply, these provisions are institutional constraints that require some effort and cooperation to overcome. For example, if a wastewater agency produces reclaimed water and wishes to transmit and sell it, such action may be construed in some areas as entering the realm of services provided by the local water supply agency that serves the same area. The situation will depend on whether providing reclaimed water is viewed under applicable prohibition language as the same service as providing potable water. Initial investigation suggests that this understanding is not often the case, as reuse and potable supplies may often be viewed as distinct service offerings.[14] But if providing an NTWS is considered a duplication of potable services, then the relevant agencies need to negotiate and sign a suitable agreement to allow for the sale of reuse water by the wastewater agency.

Another situation in which duplication-of-service issues may arise is in the context of the physical proximity of treatment facilities and how they are located relative to service area boundaries. For example, two wastewater agencies may be producing reclaimed water suitable for golf course irrigation. If Utility A's reclamation facility is located near the border to Agency B's service area and if there is a golf course in B's territory that is very near A's plant (but far removed from B's plant or existing transmission lines), then providing reclaimed water from Utility A to the golf course would make good economic and engineering sense. However, this arrangement would be prohibited by a duplication-of-service provision (because the golf course is located within the service area designated to Utility B). This situation typically can be resolved so that Utility A can indeed serve the golf course located in service area B but only if all relevant parties can forge a suitable written agreement and get any necessary approvals. This requirement can become an institutional barrier to broader use of reclaimed water.

These duplication-of-service complications also may arise in the context of other NTWS options. For example, the introduction of harvested stormwater, desalinated water, or untreated surface waters into the area's total water supply portfolio may give rise to the same issues noted above for reclaimed water. Where they do arise, it will require the various agencies involved to develop suitable written agreements. The IRP process is likely to help the various relevant agencies develop better communication and recognition of the mutual benefits of forging such agreements.

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14. Preliminary research shows that currently, in states such as California, Washington, Arizona, Texas, and Florida, potable water and reclaimed water typically are regarded as separate products; the two sources of water must have separate infrastructures and are regulated separately. However, as reuse becomes more widespread, duplication-of-service problems may become increasingly relevant.

8.3 REGULATORY CONSTRAINTS TO WATER AND WASTEWATER COLLABORATION

Reuse projects rely on a good working relationship among the applicable water and wastewater utilities. When one or the other is uninterested or opposed, it is difficult to bring reuse projects to fruition. Even if water and wastewater agencies are motivated, they must collaborate to overcome multiple barriers.

One of the most difficult barriers to overcome can be associated with regulatory constraints. To illustrate, the following case highlights how a collaborative reuse project among multiple water and wastewater agencies in the Tampa Bay area of Florida can be altered by environmental considerations.

The Tampa Bay Downstream Augmentation Project is part of an innovative partnership to increase the use of reclaimed water throughout the Tampa Bay region. The proposed Downstream Augmentation Project would exchange surplus reclaimed water for a like amount of water from the Tampa Bypass Canal and Hillsborough River. This arrangement allows more water to be withdrawn for public supply upstream of the supplement point. In essence, more river water can be withdrawn and placed in the regional public water system, because highly treated reclaimed water from Tampa's Howard F. Curren Advanced Wastewater Treatment Plant (located at the Port of Tampa) is added back to the river downstream. If approved, the Downstream Augmentation Project could add over 13 million gallons of drinking water per day to the regional system.

A major project issue results from a difference in water quality between the water withdrawn and the water replaced. One original issue was the level of chlorine added to the reclaimed water for disinfection. This problem could be overcome via an engineering solution, by having the reclaimed water undergo ultraviolet light disinfection instead of chlorine disinfection. This remedy would be more expensive but would remove the chlorine residual discharge issue.

Another water quality issue is that the downstream augmentation project could increase nutrient loadings in the lower Hillsborough River, potentially allowing the proliferation of algae and stressing marine life (especially in summer months). The reclaimed water would be released into the lower Hillsborough River, which functions as an estuary for Tampa Bay. As a consequence, the project could require a change in water quality standards to lower dissolved-oxygen (DO) criteria for the river. DO, which is necessary for a healthy aquatic environment, typically decreases with increased nutrient loading. The lower Hillsborough River is already considered impaired for both nutrients and DO, so no additional loading is allowable without revising state standards or getting an exemption, according to the Florida Department of Environmental Protection.

The Downstream Augmentation Project is still in the planning phase, and it will likely take many years and design changes before it is built, if indeed it is ever built. The regulatory challenges are formidable. However, it is the regional collaboration among agencies that makes even consideration of this project possible. The same regional entities (City of Tampa, Hillsborough County, Pasco County, Tampa Bay Water, and SWFWMD) are already collaborating and implementing a number of other reuse projects.

CHAPTER 9

COMPUTER MODELS FOR IRP

Over the last 30 years, computer technology has greatly expanded the analytic capabilities of water resource planners. Computer applications addressing water resources are becoming more expansive, sophisticated, and widely used. In fact, it would be hard to imagine conducting water resource planning without some use of computer models.

Computer models allow planners to gain a better understanding of the future impacts of different resource decisions, thus enabling better decisions. The types of models that are useful to different utilities vary widely and depend on many factors, including but not limited to the important questions that need to be answered, the level of staff sophistication, and the available time and financial resources. While IRP models can facilitate the appropriate incorporation of NTWS in water resource strategies and can help decision-makers understand and better fit NTWS into their water supply portfolios, IRP practitioners must exercise due diligence in their use of such models.

This chapter addresses some common issues encountered in using computer applications in an IRP/NTWS context. IRP practitioners need to opportunistically make use of a variety of models applicable to their situation. The level of coordination among models, the regional scope of models, and the level of decision-making guided by models are particularly important issues.

Models can roughly be divided into those that are component specific and those that are integrative. The next two sections will address each of these categories.

9.1 INTEGRATING COMPONENT-SPECIFIC MODELS

As the name suggests, these models are those that address discrete analytical components of the integrated planning process. Since a distinguishing feature of IRP is to expand the planning scope to consider multiple components, these models, which can be, and often have been, applied independently of an IRP process, can also be very useful within such a process. Examples of such component-specific models include the following:

- Water demand
- Water conservation
- Groundwater hydrogeology
- Surface water hydrology
- Reservoir design and operation
- Reuse, desalination, or other NTWS options
- Water treatment and transmission and distribution hydraulics
- Wastewater collection, treatment, and outfall
- Water rights and contracts
- Water quality
- Temperature and precipitation
- Ecosystems

In many of these cases, it is critical to account for future uncertainty. This can be done through examining multiple scenarios or through some type of probabilistic analysis. For example, point estimates of future water demands are often inadequate. Stream flows, temperature, and rainfall will also vary considerably from year to year, with historical records typically being used to predict future variability.[15]

Utilities[16] may base their planning on the results from several such models and assimilate those results manually. For example, the City of Phoenix used several of its existing models as part of the development of its long-range water resources plan. Phoenix combined its existing hydrologic model with its water budget model, which includes water rights and contracts. To better define the possibility of future shortages of the water sources upon which Phoenix depends, planners used output from existing models detailing availability projections of those sources into the future. These models were combined with demand projections based on demographic data from the Maricopa Association of Governments, and conservation projections for Phoenix, to examine overall reliability of the system over time under different demand and supply scenarios.

Not only might IRP practitioners have to deal with multiple component-specific models. They might also have to consolidate models from multiple sources, utility or otherwise. Common issues to address in the consolidation process can include the following:

- ***Geographic scope.*** Each IRP participant may have developed its models independently of the others. Planners may need to stitch together models from a variety of sources to get regional results.

- ***Time horizons.*** The multiple model components may have different planning time horizons (e.g., 5, 10, 20, and 50 years). Differences in time horizon can vary both among utility participants and among model components at a specific utility. Time resolution (hourly, daily, weekly, monthly, seasonally, and annually) of results can also be an important issue.

- ***Level of detail.*** Some utilities may have spent considerable time and resources on modeling, while others have not.

- ***Risk and uncertainty.*** Some utilities may have simulated model results for a range of possible future outcomes, while others have not.

Ideally, IRP practitioners will be able to identify, coordinate, and obtain modeling results for all components and all participants in accordance with the IRP scope. In reality, however, this completeness is rarely likely to be the case. IRP practitioners must often patch together results from assorted sources, often with gaps that need to be filled or improved upon at a later date.

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15. Note that global climate change and other plausible future scenarios may cause one to examine futures that differ in important ways from the past.

16. Planning models may be owned and/or developed by a single utility. However, it is sometimes the case that regional entities take on that role. For instance, in Broward County, Florida, the county itself purchased a detailed hydrologic model. Thus, the term "utilities" can also refer to regional agencies.

9.2 USING MODELS TO FACILITATE IRP DECISION-MAKING

Alternatively, utilities can use models specifically designed to "bring the pieces together." These integrative models are in no way intended to replace the component models. Rather, they are designed to use the results of the other models in some fashion that facilitates understanding of the overall performance of integrated resource alternatives/strategies against multiple criteria.

It can be useful for IRP practitioners to note the differences between *simulation* and *optimization* models to facilitate decision-making.

- ***Simulation models*** attempt to replicate the operation of a water system under a specific set of supply-side and demand-side resource and operational assumptions. Simulation models evaluate a set of strategy alternatives. These evaluations then can be presented to decision-makers for deliberation. These deliberations typically occur outside the modeling process and rely on the model results as inputs to the decision-making process. The comparison of alternatives can assist decision-makers as they attempt to understand the trade-offs that inevitably must be made. The trade-offs are made by decision-makers and not by the model itself.

- ***Optimization models*** attempt to rank strategies, based on performance against a set of criteria. Such models may include a simulation component, may be applied to results generated from a separate simulation model, or may not rely at all on system simulation. For decision processes requiring multiple criteria, an optimization model must implicitly or explicitly apply weights to the estimated performance against each individual criterion. These models should be designed to reflect the fact that different stakeholders generally weigh evaluation criteria differently.

The decision whether to use simulation or optimization models, or neither, depends in part on the manner in which IRP participants prefer to make their decisions and the circumstances at hand. Some decision-makers prefer an explicit model-generated ranking, while others see it as too much of a "black box" and instead prefer receiving well-packaged, user-friendly information from a simulation model that they can then use in their own decision-making. Political and institutional opportunities and constraints sometimes render one or the other alternative more feasible.

The example models presented below are presented for different reasons. The simulation model example from Tampa Bay Water is presented because it represents a modeling system custom-built for a utility. Simulation model examples 2 and 3 represent generic integrative simulation modeling packages that utilities have used to bring their data together into one framework. Other modeling software packages that might be considered in this category include Riverware, OASIS, and Stella. The fourth example represents an optimization model software package that has been used for multi-objective decision-making by several water utilities. Other similar modeling packages include Logical Decisions, Expert Choice, and GeNIe.

9.2.1 Simulation Model Example 1: Tampa Bay Water DSS

Tampa Bay Water developed a Decision Support System (DSS) to assist with its water resource planning. The model has a custom-developed user interface (referred to as the DSS

Manager) that provides access into the agency's database, allowing users to query data, extract data, conduct analyses, and generate reports. The DSS integrates forecasting and other model results used by the agency. Tampa Bay Water benefits from the DSS in multiple ways, including increasing the agency's efficiency in operating the new supply sources; enhancing effective management of Tampa Bay Water's complex water supply/resource systems; improving the agency's data collection, storage, and retrieval process to maximize environmental and cost benefits; facilitating regulatory compliance; and providing for consistent and uniform decision-making in a complex and dynamic water supply environment.

9.2.2 Simulation Model Example 2: Confluence®

Confluence® is a simulation model that uses a map-based interface to define the physical system infrastructure, including reservoirs and transmission links, water supply sources, water demands, water treatment plants, and other system components. The model is populated by the user with data on these components. The model simulation dispatches the system in each user-specified time step to minimize "costs" represented by user-defined shadow prices. In this way, different approaches to jointly operating reservoirs and other surface water and groundwater supplies can be modeled.

Demand projections can either be created within the model, or the model can be linked to an external text file. Separate demands can be created for each class of service, and demands can be varied according to precipitation and temperature data. Demand forecasts can be either deterministic or stochastic. Using Monte Carlo simulation, the model can vary the way it samples from historical weather and flow data, as well as stochastic demand data, to evaluate the performance of a scenario under a variety of conditions. The user can also enter information on water rights and priorities for specific water sources. The model includes a complete conservation module, which permits detailed definition of conservation programs based on their participation rates, savings, and costs. The model also has a detailed financial model, which tracks categories of costs through time. Model output charts provide information on future water supply reliability, costs and customer bill impacts, demands, supply utilization, conservation savings, reservoir operations, transmission and treatment plant loadings, and performance against various user-defined qualitative criteria.

9.2.3 Simulation Model Example 3: WEAP

The ***Water Evaluation and Planning System (WEAP)*** uses a map-based interface to define the physical system infrastructure, including reservoirs and transmission pipes, water supply sources, water demands, water treatment plants, and other system components. This user-created system schematic can overlie an underlying map to give a better geographic sense of the hydrologic system. The model is populated by the user with data regarding the system components. Operation of the model is controlled through priorities assigned to each component. The model allows for both groundwater and surface water sources. Demand projections can either be created within the model, or the model can be linked to an external spreadsheet file. Separate demands can be created for each class of service. Conservation programs can be defined according to their participation rates, savings, and costs. The model has a financial planning module, which allows input of revenues and costs for individual elements and includes a loan payment function to calculate potential loan payments. Model outputs can help assess water system operation, water system reliability, and costs of capital expenditures for different scenario alternatives.

9.2.4 Optimization Model Example 4: Criterium Decision Plus

Criterium Decision Plus is an optimization model that facilitates multiple-criterion decision-making. This software package has been used by several water utilities to aid their planning processes. For example, in the Silicon Valley of California, this software was used to calculate the relative ranking of project alternatives based on the weighting assigned to multiple objectives by the collective agreement of the stakeholders. Once these weights were agreed upon and the results examined, the stakeholders changed the weighting to understand their influence on the ranking results. The model allowed this process to occur during a group session where all stakeholders could see the results of real-time analysis. This process encouraged adaptation and compromise in reaching better solutions.

9.3 CONCLUSION

Computer models are tools, no more and no less. Different types of processes and different groups of participants may have vastly different modeling needs and capabilities. The degree and manner in which models are to be used in a water resource planning process must be driven by the needs of the participants in the process, rather than the reverse. Tools should be found or created that suit the questions to be addressed and the decision preferences, expertise, and resource limitations of the plan participants.

IRP practitioners considering developing or purchasing one or more models to support an integrated planning process should contemplate the following issues:

- ***Geographic, political scope.*** Will the plan focus on a single utility or a multi-utility region? If the latter, will the questions the plan is asking be solely regional or will the financial and institutional implications for individual agencies be important? Is the model expected to provide information regarding impacts that extend beyond the combined service areas of the agencies participating in the planning process?

- ***Key objectives.*** What are the objectives against which resource strategies will be evaluated? What role, if any, will the model(s) play in each of these evaluations? For example, a simulation model may be critical in estimating the impact of each strategy on future water supply reliability. Financial models (or financial modules of more general integration models) can provide important information on the cost and rate implications of each strategy. For such qualitative criteria as public acceptability, an integration model can be designed to calculate and compare indices for each strategy based on user-input ratings for each strategy component. Other objectives, including, for example, minimizing impacts on wetlands or fisheries, or maximizing raw water quality, can likewise be handled as user-provided inputs. But they can also be estimated in a more rigorous fashion by using their own component-specific models. The results of these models may then be transferred to an integration model.

- ***Types of resources.*** What types of traditional and nontraditional supplies are being assessed? The analytical requirements for surface water diversions, surface storage, groundwater, desalination, reclamation, conservation, and other types of supplies differ from one another. Utilities considering different modeling alternatives must ensure that the modeling algorithms are appropriate to the types of supply and infrastructure alternatives that are being evaluated. Moreover, the manner in which particular objectives are measured for traditional versus nontraditional resources may differ; the integration modeling must change these "apples to oranges" comparisons to "apples to apples."

- ***Decision-making framework.*** What is the expected type of outcome from an IRP process? How is stakeholder input going to be utilized? How explicit are participants going to be on weighing evaluation criteria?

In conclusion, there is no single right or wrong modeling configuration for an integrated plan. Each agency or group of agencies undertaking an integrated plan must determine which model(s) best serves their needs. This assessment must take place before the actual planning activities begin. Because of some of the unique features of NTWS options, this assessment is likely to be more difficult, but more crucial, when the plan simultaneously evaluates traditional and nontraditional resources.

CHAPTER 10

AGENDA FOR FUTURE RESEARCH

This report has described the IRP process, indicated ways in which it can be especially useful for factoring NTWS options into water supply planning, and identified various challenges and potential opportunities for applying IRP to these options. We have also addressed how IRWMP can extend the IRP process by analyzing NTWS options regionally and by considering how the NTWS options might affect the watersheds, ecosystems, and critical habitats. Along the way, several areas emerge as topics that may warrant additional research, with the objective of helping attain broader and improved application of the IRP and IRWMP processes to NTWS options. An agenda for future research is thus described below.

10.1 HOW CAN IRWMP MORE THOROUGHLY ADDRESS NTWS?

The IRP process can be extended to examine a broader-than-usual regional area, as is done in the IRWMP form of IRP. The broader geographic scope of the IRWMP perspective enables greater opportunity to tap into the valuable NTWS options that may exist in the larger regional context. At the same time, given the broadening of the IRP process in both geographic scale and number of agencies involved as participants, its cost and complexity will increase. Further research will be useful on how the IRWMP process can be developed and managed so that it can effectively enhance opportunities to recognize regional benefits, including how NTWS options may benefit in stream flows, groundwater resources, and broader ecosystems.

10.2 CLIMATE CHANGE IMPLICATIONS FOR NTWS AND IRP

Changing global climate is likely to have important impacts on water supply planning and related water resource conditions. It will increase some challenges for water supply managers and planners (e.g., reducing yields and/or the quality from some traditional water sources), but it also may create some opportunities for IRP processes and NTWS options to assist communities. For example, precipitation is expected to occur in more-intense storm events, resulting in increased runoff, turbidity, and sedimentation. It will increase the challenge of meeting potable standards from surface waters and also will increase stormwater management problems.

The additional stormwater flows and their flood management implications will need to be addressed and will also create larger opportunities for the harvest and use of these flows. Some investigation of these types of scenarios—and their implications on watersheds, ecosystems, and critical habitat—will help agencies be forward-looking as they contemplate NTWS options within the modified operating environments posed by changing climate.

10.3 RELIABILITY ENHANCEMENT AND VALUES WITH NTWS IN THE SUPPLY PORTFOLIO

Adding NTWS into a region's water supply portfolio increases diversification. This adjustment ultimately increases the overall yield reliability of the portfolio in times of drought or other adverse events. The enhanced reliability needs to be better quantified. In addition, the monetary value of increased reliability needs to be better understood and estimated. These steps will help systems determine if relatively expensive investments in NTWS options may be worth the added expense, where these NTWS options provide added yield reliability. Research that moves the reliability literature forward toward practical quantification, measurement, and valuation will be very useful for water managers and planners.

10.4 EMERGENCY RESPONSE AND BUSINESS CONTINUITY IMPLICATIONS FOR NTWS INTEGRATED RESOURCE PLANS

As integrated resource plans begin to take on larger regional scopes and include multiple utilities and water sources, the added supply diversity, physical interconnections, and operating relationships can help regions become more capable of addressing emergency events (e.g., earthquakes, hurricanes, terrorism, or other adverse events that impact the ability to deliver safe water to customers). Business continuity and service restoration may be facilitated through the establishment of an IRP process, especially when NTWS options are factored into the overall supply mix. However, adding these elements to the IRP process creates several additional planning tasks and challenges. A guide and case studies that reveal some valuable lessons and opportunities in the area of emergency response and business continuity, and the role that NTWS options and the IRP process can play in enhancing them, would be useful to many regions and agencies.

10.5 CASE STUDIES TO REVEAL NTWS BENEFITS AND COSTS AND THEIR DISTRIBUTION

In order to help demonstrate the types and levels of some of the hard-to-quantify external benefits of NTWS options, it will be useful to develop specific case studies that demonstrate how some real projects using NTWS have created specific types and levels of benefits. This work will move the benefit–cost discussion from the conceptual and hypothetical level to a realm based on real projects with real benefits and identified real beneficiaries. These real-world illustrations will help agencies think about their own circumstances and help them discern what added benefits may be likely with their own NTWS options. These case illustrations also will help convince local governing officials and other stakeholders that the value of NTWS options is more than hypothetical or conceptual and can in fact be quite large in real cases.

10.6 HELP RESOLVE OR AVOID REGULATORY AND OTHER INSTITUTIONAL BARRIERS TO NTWS USE

Many NTWS options are very difficult to implement due to various regulatory and other institutional constraints. While permitting requirements are generally well intentioned and motivated by real concern over adverse environmental or other consequences, they also can be ill suited for application to the development of an NTWS option. NTWS options may be square pegs in a regulatory regimen set up with round holes. For example, permits for seawater intakes for coastal desalination facilities may be very difficult to obtain, in part because regulatory regimens may be designed to address the significantly larger-flow and higher-velocity intakes of cooling water intakes for power plants. Research that helps reveal suitable degrees of regulatory flexibility or adjustment to NTWS-specific circumstances may be of considerable value. The goal is to help align regulatory approaches and the protections they afford society with NTWS-specific circumstances and impacts.

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APPENDIX A

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APPENDIX B

STORMWATER REGULATIONS AND POLLUTION ABATEMENT

Some states have established water quality standards that apply to stormwater discharge. All watersheds with established total maximum daily loads (TMDLs) are subject to stormwater discharge limits for the pollutant or pollutants. All point source discharges are subject to water quality standards, and stormwater is considered a point source discharge as it enters a pipe. The following is a description of the water quality or performance standards for California and Florida:

- California has established and proposed TMDLs: a calculation of the maximum amount of a pollutant that a water body can receive and still meet the EPA's water quality standards and an allocation of that amount to the pollutant's sources. The state has not, however, established numeric treatment requirements at the state or regional level.

- The State of Florida established a performance standard for erosion and sediment control during construction so that no discharge will violate the state's water quality standard for turbidity. The state further requires the removal of 80% of the annual pollutant load for stormwater discharges to Class III (recreational) waters and the removal of 95% of the annual pollutant load for stormwater discharges to Class I (potable supply) waters, Class II (shellfish harvesting) waters, and outstanding Florida waters. Finally, the WMDs established performance standards to minimize flooding by limiting the postdevelopment stormwater peak discharge rate and stormwater volume.

Other stormwater regulations may limit the activities of a treatment facility to discharge stormwater. In California, the Orange County Sanitation District (a large wastewater collection and treatment agency) initiated an urban runoff program in 1999. The program resulted from a major closure of Huntington State Beach due to high levels of bacteria that violated beach standards. As a result of the closure, the district agreed to reroute the runoff that flowed into existing stormwater pump stations and storm channels into its sanitary sewer system for treatment and proper disposal. Before the urban runoff discharges to the sewer system, an applicant must obtain a Wastewater Discharge Permit from the district.

Stormwater may also be captured by combined sewer overflows (CSOs), sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. During times of excessive precipitation (from rain or snowmelt), the wastewater volume may exceed the CSO's holding capacity, resulting in discharges of untreated water into streams and rivers. Currently, state and NPDES permitting authorities are trying to incorporate CSO conditions into the NPDES permitting process. EPA now requires CSO to implement minimum technology-based controls to reduce the impacts of CSOs and to develop long-term CSO control plans. These plans will eventually ensure full compliance with the CWA's water quality standards. For further information on EPA's policy on CSOs, refer to EPA's website, www.epa.gov.

Advancing the Science of Water Reuse and Desalination



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