

Water Resources Planning

Third Edition



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Water Resources Planning

Third Edition



American Water Works
Association

Manual of Water Supply Practices—M50, Third Edition

Water Resources Planning

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Preface



This publication is the third edition of the American Water Works Association (AWWA) Manual M50, *Water Resources Planning*, originally published in 2001, with a second edition released in 2007. The manual presents information on how to develop a plan for new water supplies to accommodate projected future water demands and provides an effective framework for water resources planning for the 21st century.

Water resources planning for potable water supplies is a very broad topic. Issues range from estimating future water demand to evaluating possible new sources of water, protecting water sources, and addressing expanding environmental regulations. One method for preparing a water resources plan is integrated resource planning (IRP). Developed in the 1990s, IRP is a way to bring together myriad issues, interests, and stakeholders through a planning process that can result in a reason-based, cost-effective, and environmentally sound plan the public can support.

This third edition significantly enhances the basis of water resources planning provided in prior editions. Additions and improvements include the following:

- Organization of the manual around the planning process
- Inclusion of stakeholder involvement at various steps throughout the process
- Inclusion of reclaimed water and other source water alternatives in the portfolio of solutions, recognizing the Total Water Solutions planning perspective
- References to AWWA standards and manuals of water supply practices for more details on specific topics
- Expanded emphasis on the evaluation of alternatives
- A new, award-winning case study that illustrates the concepts presented in the manual
- Inclusion of the AWWA policy statement on water resources planning

This manual was prepared by AWWA's Water Resources Planning and Management Committee and associated volunteer authors to help water resources planners meet the challenge of accommodating a growing demand for water, while complying with myriad regulations that govern the development and use of new water supplies.

No two water resources plans are alike, and planning is an ever-changing process. The issues discussed in this manual should allow the planner to develop and implement a comprehensive work plan that responds to technical and institutional questions that must be addressed before deciding how to develop new water supplies.

The AWWA Water Resources Planning and Management Committee welcomes your input and comments on the content and usefulness of this manual.

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Chapter **1**

Introduction to Water Resources Planning

A number of years ago, archeologist Bryan Fagan addressed attendees at the American Water Works Association's (AWWA's) Sustainable Water Sources Conference. Dr. Fagan has traveled all over the world to study ancient ruins. He likened his career to "50 years of studying drainage ditches," and explained that through studying drainage ditches he could provide the audience with an understanding of the rise and fall of civilizations through history. His book *Elixir* outlines a number of these civilizations: Egypt, Babylonia, Southeast Asia, and even the American West (Fagan 2012). He found that a civilization could develop to the extent that infrastructure could be constructed to allow water to flow to where it was needed for agricultural purposes, whether that was Alexandria or Ur. If the water stopped flowing, there was trouble.

As a result, later civilizations expanded and developed as technology allowed water to flow farther to protect themselves from drought or other outages. Rome demonstrated that water could be moved with more than ditches, which would have been a severe limitation. The Romans constructed extensive tunnels and aqueducts to supply Rome with water from mountains to the east and north, some of which are still in operation. Some people have estimated that we know perhaps only about 20 percent of the Roman tunnel system in that we keep discovering more of it each year—the location of many of the tunnels in the system were lost in the Dark Ages after the fall of Rome.

Dr. Fagan demonstrated that it was access to water that allowed human civilizations to develop and evolve. It is why a number of engineering organizations like Water For People and Engineers Without Borders focus their efforts on providing access to clean water to people in Third World countries. It is critical for people to remain healthy enough to be productive in the modern world. Other infrastructure (roads, major buildings, etc.) also depends in part on people having access to adequate clean water supplies, allowing our communities and economies to thrive.

Water availability, however, can be a limiting factor. Although 70 percent of the earth's surface is covered by water (mostly in oceans), only about 3 percent of all water on earth is freshwater (USGS 2015). Because much of this freshwater is locked up in ice caps and glaciers, only about 1 percent of all freshwater is reasonably accessible for use.

Far less than 1 percent of the world's total supply of water is considered easily accessible for human use.

While supplies of freshwater are finite, its uses are not. Now estimated at more than 7 billion, the world's population is increasing by some 70 to 80 million people per year. By 2025, the number will exceed 8 billion. Hundreds of millions of people around the world already face critical water shortages. Some areas of the United States also face shortages, and other areas are at risk of future shortages. That is where water resource management and the concept of sustainability come into play. The concept of sustainability reflects water consumption at a rate that can be maintained in perpetuity, while maintaining water quality.

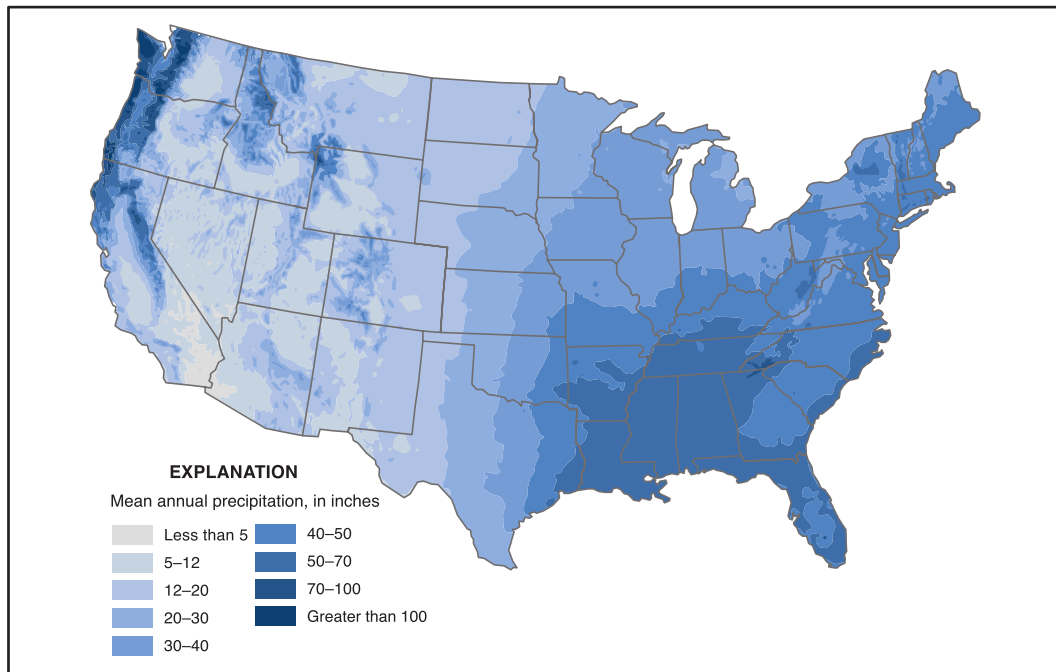
But the concept is not that simple, and buy-in to the concept of "sustainable water" depends on the profession or perspective of the person defining it (Bloetscher 2010). A sustainable world is not a rigid one where population or productivity is constant. Instead, the concept of sustainability must adapt to constant change. The concept of sustainability requires rules, laws, and social constraints that are recognized and adhered to by all (Meadows, Randers, and Meadows 2004). From a hydrologic perspective, the term "sustainable yield" is the amount of water that can be withdrawn from a source at rates that are less than their recharge potential and that do not deteriorate the source or basin. While many areas attempt to develop and use water sustainably, not all do. Even within regionally sustainable situations, unsustainable use can occur locally.

A key component of water resource management is planning the utilization of water supplies, which requires some means to determine how the hydrologic cycle provides water to the area (e.g., recharge basin), in what quantities, and with what reliability. Ultimately, reliability is a risk issue—precipitation can be consistent or can have significant fluctuations that disrupt ongoing basin development (Molak 1997). In any given basin, there are typically a variety of uses competing for water resources, and each basin has unique characteristics (Bloetscher and Muniz 2008). Major uses of water can include

- agriculture,
- ecosystems,
- recreation,
- urban and domestic use, and
- industrial and power generation use.

All these users depend on—and in many cases can compete for—reliable water supplies. From a practical perspective, sustainable development of a region depends on the appropriate management of water resources. Managing water resources requires decision-making that addresses the environmental, economic, and social concerns of the community, which may extend far beyond the community borders. The result is that researchers can define the concept of sustainability, but practitioners emphasize feasibility and limitation to sustainability of the ecosystem (Starkl and Brunner 2004).

Water quantity and quality issues have significant fiscal effect on the potential users in the basin, while there are unrealized costs and benefits that are often ignored in the current water management framework (Bloetscher and Muniz 2008). There are two categories of water supplies: surface systems and underground systems, which are described in the following sections.



Source: Reilly *et al.* 2009

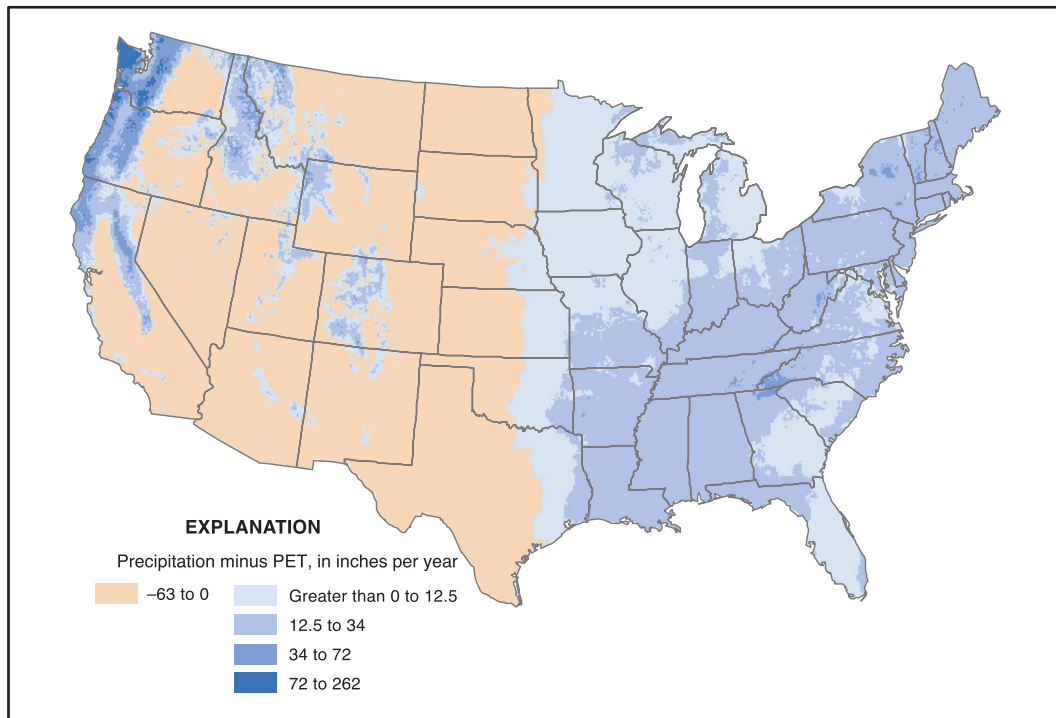
Figure 1-1 Average annual precipitation (inches) in the United States (1961–1990)

SURFACE WATER

Surface water is precipitation that runs off the land, reaching streams, rivers, or lakes, or groundwater that discharges into these water bodies. Surface water bodies that mix with saltwater bodies along the coast are called estuaries (e.g., where a river meets the ocean in a delta). Surface water flow is controlled by topography because water on the surface flows downward by gravity, which means it generally flows toward the oceans. Figure 1-1 outlines precipitation throughout the continental United States. Annual rainfall is generally much higher in the eastern United States than in the west, except in the Pacific Northwest region.

Figure 1-2 shows the difference between precipitation and potential evapotranspiration (PET). The tan areas illustrate where the PET rate is higher than precipitation, meaning net water availability (precipitation minus PET) for crops and other purposes is negative. In these areas, high levels of crop irrigation may not be sustainable, depending on local conditions and sources of supply. In many of these areas, streamflows are variable and limited, so surface water storage and groundwater are often used to ensure adequate water supplies for crops and people.

Surface waters are recharged by precipitation and sometimes by groundwater. When there is limited rain, surface waters can diminish significantly and leave users at risk. The construction of reservoirs can reduce the potential for this risk, but prolonged droughts may have severe effects on supplies in surface storage (e.g., shortages experienced in and around Atlanta in 2008). Surface water quality can also be affected by adjacent or upstream land-use activities. As a result, source water protection measures are often employed to avoid detrimental surface water quality effects from point and nonpoint sources.



Source: Reilly *et al.* 2009

Figure 1-2 Difference between average annual precipitation and PET rates

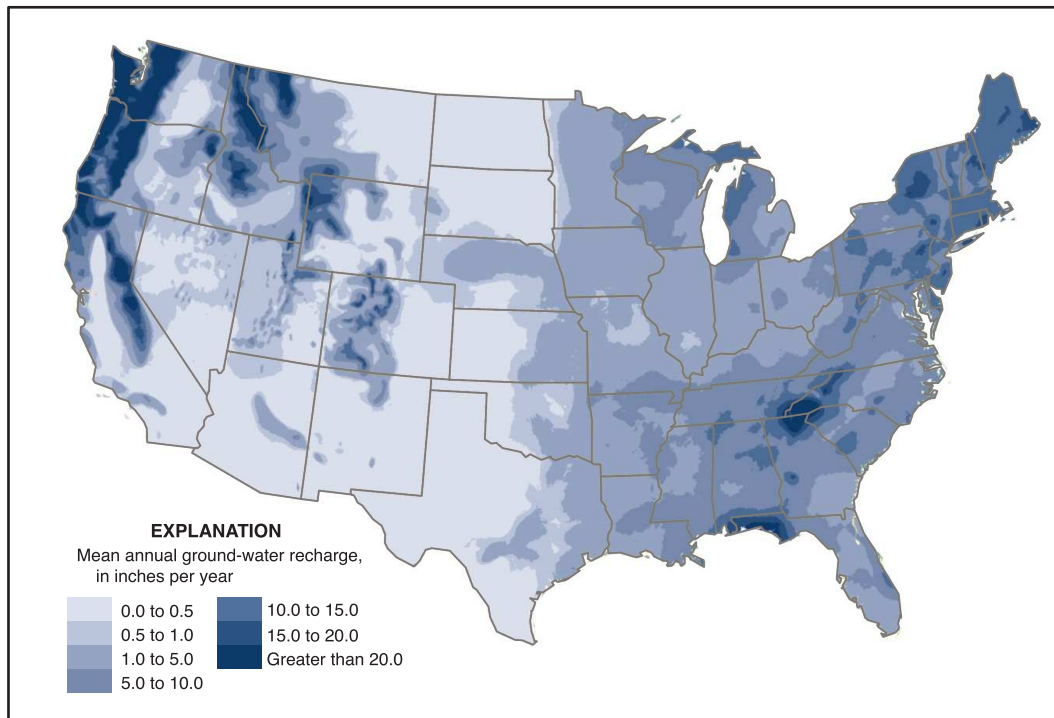
GROUNDWATER

Groundwater is stored and flows beneath the land surface. Groundwater may be recharged by infiltration of rain and melting snow, surface waters (including streams, rivers, and lakes), and other groundwater flows. Formations that transmit groundwater are termed “aquifers.” Deeper aquifers are generally recharged at slower rates relative to shallow aquifers, which are more likely to be in direct hydrologic “communication” with surface water supplies. As a result, withdrawals from deep aquifers may be more likely to be unsustainable (i.e., when withdrawals exceed recharge rates), depending on local hydrogeology, recharge rates, and patterns of use.

Ideally, planning and design of well fields should assume the wells could be pumped continuously at a rate that allows the wells to fully recharge locally. The more common practice is to pump wells that have a significant drawdown seasonally or for only a few hours each day, allowing time for the aquifer to recover. Even this is difficult, however, because the long-term capacity of an aquifer is usually determined by short-term tests and study of the geology of the area. Ultimately, using groundwater unsustainably reduces the water in aquifer storage, lowers the water table, and requires drilling and pumping from lower levels, which in turn increases capital and operating costs.

In many areas, deeper groundwater tends to have worse water quality (e.g., high total dissolved solids) as a result of having been in contact with the geologic formation longer and dissolving minerals into the water. Therefore, while some deep aquifers may be prolific, the quality of water obtained from a well may not be desirable or even usable for drinking water without substantial treatment. In addition, many deep aquifers are confined and local recharge is therefore limited. The result is the potential for aquifer drawdown that is accompanied by aquifer mining—and in extreme situations, land subsidence.

Figure 1-3 shows that the rate of groundwater recharge is very limited in much of the United States. Figure 1-4 illustrates where groundwater levels declined over the



Source: Reilly *et al.* 2009

Figure 1-3 Mean annual groundwater recharge

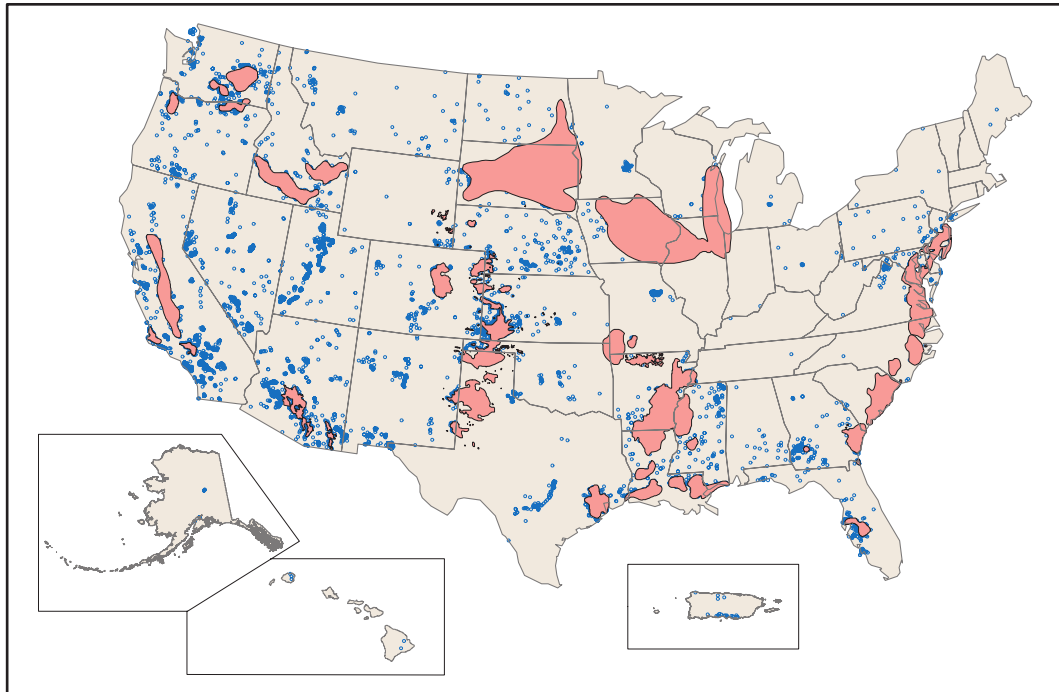
last 40 years throughout the United States. Eastern coastal areas, the Lower Mississippi Basin states, the Great Plains states, Texas, and the West are particularly affected. Red regions indicate areas in excess of 500 mi² (1,295 km²) that have water-level decline in excess of 40 ft (12 m) in at least one confined aquifer since predevelopment, or in excess of 25 ft (7.6 m) of decline in unconfined aquifers since predevelopment. Blue dots are wells in the US Geological Survey National Water Information System database where the measured water-level difference over time is equal to or greater than 40 ft (12 m). The confined aquifers recharge at very low rates, meaning that in most cases, these aquifers are being mined (overdrafted).

THE WATER RESOURCES PLANNING PROCESS

The issues discussed in this manual should allow the planner to develop and implement a comprehensive work plan that responds to technical and institutional questions that must be addressed before deciding how to develop new water supplies. However, planners are expected to use the parts of the manual that apply to their situations. Regulations and planning requirements discussed in this manual are for the United States. Specific regulations and reporting requirements of other countries should be adhered to, and the planning concepts presented in this manual adjusted accordingly.

Each chapter deals with different issues. Chapter 2 starts with the impetus for preparing a water resources plan, which can involve a variety of issues including the following:

- Changes in demand
- Changes in supply
- Raw and treated water quality
- Aging water supply infrastructure



Source: Reilly et al. 2009

Figure 1-4 Groundwater level declines

- Implementation of conservation and reuse programs
- Instream flow and water quality requirements
- Operational changes
- Capital improvement planning

A preliminary assessment is often needed to identify issues, validate the need for the plan or a new supply, and prepare a work plan. Often, a white paper or scoping paper is needed to define the issues surrounding planning for a new source. Nearly every plan is a significant undertaking and requires approval from appointed or elected officials. The process should be thought through in advance, so decision makers have timely information to guide the process along the way and the information for selecting the best plan.

Water resources planning is ultimately a local exercise that has regional effects. The decisions associated with the planning process are critically important to the community and the community's unique local conditions because the characteristics of supply and demand are unique to each locale. The goals, values, and priorities of the end users of the water can only be coordinated through local planning processes; but because local planning is likely to have effects beyond the borders of the utility, it is important to involve other stakeholders that may affect or be affected by the plan. Active engagement by local planners in regional, watershed, and statewide planning processes is key to the success of those efforts in terms of coordinating water supply planning and heading off conflicts between competing uses of shared resources. As a result, there should be a strong and beneficial linkage between local, regional, and state planning efforts.

Chapter 2 provides an understanding of public participation techniques and the important role it can play in water resources planning. It covers the process of setting goals and developing work plans to involve the public in the water resources planning

process. It also describes the key elements of plan implementation that include chartering the project team, and monitoring and managing change in the process.

Chapter 3 discusses the role of water rights in water resource management. Two distinct systems of water rights are defined and described: riparian rights, used primarily in the eastern United States; and prior appropriation doctrine, predominantly used in the western United States. Water rights systems for groundwater include absolute ownership, reasonable use, correlative rights, and appropriation permit systems. Federal and Tribal rights also are described, including federal reserved rights, water rights for water not reserved, rights of navigable water, and federal contract rights. A discussion of the water quality effects of all of these water rights doctrines is also included because this is an emerging area of interest.

Chapter 4 identifies alternatives for developing, expanding, or maximizing a water resource portfolio, including

- surface water, including source identification, screening, and site selection for direct river withdrawals, onstream reservoirs, and pumped-storage reservoirs;
- groundwater, including confined and unconfined aquifers; and
- conjunctive use of surface water and groundwater.

Chapter 4 also describes other water resources alternatives that might be available to a given community, including

- reclaimed water,
- desalination,
- demand management,
- water marketing and transfers, and
- nontraditional sources.

Chapter 4 does not necessarily present a comprehensive list of options, nor does it require evaluation of all options. Local conditions will govern the options available to the water utilities. The key is to identify feasible new sources that, individually or combined, make up the identified supply deficit for an estimated future time period.

Chapter 5 begins by summarizing common water demand forecasting methods ranging from simple per capita models to more complex statistical forecasting methods. It then describes types of data normally used for forecasting, including water billing data, weather data, demographic and economic data, and other explanatory variables, and provides examples of forecasting with per capita coefficients, land-use water factors, and regression analysis of disaggregated demand data. Uncertainty analyses and probability methods conclude the chapter.

Chapter 6 explains water quality interactions and the hydrologic cycle, including physical, chemical, and biological components. This chapter defines various measures of water quality and describes the relationships between water uses and water quality. In addition, effects of natural influences, point sources, and nonpoint sources on water quality are defined, as are the major factors affecting quality of various types of surface water. Similarly, the major factors affecting groundwater quality include common contaminants and transport considerations.

Chapter 7 addresses source water protection. Source water protection has long been promoted and used by water systems, local governments, and states as a part of a multiple-barrier approach to ensure that drinking water for public water systems is high quality and meets drinking water standards for public health protection. Source protection essentially

makes treatment easier by minimizing the contaminants that must be removed. Chapter 7 includes sections on

- source water protection programs,
- groundwater protection, and
- surface water source protection.

The above protections include the following elements:

- Identification of potential contaminant sources
- Assessing vulnerability and determining susceptibility
- Making source water assessments available to the public
- Development of a source water protection plan and program

AWWA's Utility Management Standards program (also known as the G Series) is designed to cover the principal activities of a typical water and/or wastewater system. It provides a means to assess service quality and management efficiency based on recognized standards for best available practices. American National Standards Institute (ANSI)/AWWA Standard G300-14 (AWWA 2014) and the associated operational guidebook (Sham et al. 2010) are valuable resources that complement the content of chapter 7.

Chapters 8 and 9 are intrinsically linked. Chapter 8 describes water supply assessments and is designed to help the reader identify the fatally flawed options and the most likely portfolio of solutions. The solutions are compared to a baseline of performance, while risks and benefits are assessed. Infrastructure, water quality and treatment of supplies, water source reliability, environmental impacts, implementation considerations, and costs should be taken into account. The evaluation criteria should be defined in conjunction with the goals of the utility.

Chapter 9 identifies the means for assessing the evaluation criteria and utility goals through a rigorous evaluation process, reflecting the nature of the new alternative sources identified. All relevant issues regarding alternative analysis should be addressed, including

- water quality of new sources,
- protection of current and new sources,
- regulations,
- water rights and policies,
- yield of new sources and effects on other sources (assessed through modeling)
- environmental impact assessments,
- economic feasibility and financing considerations, and
- long-term viability (design life).

These evaluations are intended to identify a preferred plan that balances conflicting factors. Criteria will generally include

- cost-effectiveness,
- financial feasibility,
- public acceptability, and
- environmental issues.

Chapter 10 ties all prior chapters together by outlining the planning process and planning tools. Examples are provided to illustrate the planning process and strategies. What is not discussed in detail in chapter 10, because of constantly changing rules, are regulatory requirements. Water resource projects are subject to varying degrees of regulatory approval. Developing new sources or expanding withdrawals may require permits. Examples of such permits are a state water allocation permit or a federal Section 404 permit, often requiring a long and involved approval process.

Planners should address permit requirements in the water resources plan through consultation with state and federal regulatory officials so that likely permits are identified, and the considerations required or implied are included in the alternatives analyses. However, detailed aspects of the permit approval, such as detailed environmental impact analyses, will occur after the plan is approved. Each state or locale has its own framework for assessing the environmental impacts of water resource projects. The state's water allocation agency can identify the lead permitting agency and help identify the types of environmental work that will likely need to be performed. Detailed environmental assessments or impact statements are not usually undertaken until after the preferred alternative source is identified. However, the planning process leading to that selection should include preliminary consideration of all issues likely to require detailed assessment.

Preliminary environmental screening needs to be integrated with the alternative assessment process. This will help justify the alternative selection and reduce the time required to complete environmental assessments or an environmental impact analysis for the recommended project and needed permits due to "false starts" and missing the obvious.

SELECTING THE PROJECT TEAM

One of the most important issues a water resources planner faces is who should be involved in the planning process. Those involved are called "stakeholders" because they have a vested interest in how the process turns out and which alternative is selected. No longer are plans prepared in a vacuum, released for approval after all the technical work is completed, and the alternatives evaluated. Planners have found that this closed-door approach necessitates starting over when opposition to the proposed project surfaces, possibly more than once. An open approach requires a slower, more deliberate process. Although involving all stakeholders may slow down the technical work, the final decision and project approval are invariably reached sooner and more amicably. This critical element is discussed in more detail in chapter 2.

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Chapter **2**

Planning Policies

Reliable water supplies are vital to the growth, development, and long-term prosperity of any community. Water supply reliability depends directly on planning and foresight in securing and maintaining water supply sources. To set the foundation for a solid water supply plan, water managers should consider how previous planning efforts, regional or statewide plans, and other related planning work can be integrated into a local water supply plan. A variety of drivers can affect when and how a water supply is developed.

These factors should be considered as part of initial activities in developing a water resources plan, because they directly affect the outcome and long-term value of the plan. Upfront planning, in terms of establishing the audiences and means that the plan will be used to secure water supplies, is key to setting a firm foundation for the plan. Outreach to public stakeholders and integrating public input into the plan are key elements for community buy-in to identify the future water supply needs and priorities that are inherently unique to each community. These foundational aspects of water supply planning are discussed in this chapter.

LOCAL PLANNING HISTORY

Planning for future water needs is an ongoing process—not a one-time event. Yet many communities and utilities have never initiated a formal water resources or water supply plan. Some may have had a plan generated by their predecessors but may or may not have access to the basis or findings of those previous water-planning efforts. Other water providers have institutionalized a formal process with defined intervals between updates.

Those who have initiated planning processes often find that the foundational elements of a plan evolve over time. Underlying assumptions change, such as the local industrial and commercial bases, population dynamics, social values, or the priorities placed on water resources. Each underlying assumption can alter the criteria for evaluating and comparing supply sources. Such changes manifest themselves in both the demand and supply sides of the equation. For example, a source of supply that was not used because it was cost prohibitive becomes more attractive for use because less-expensive alternatives have become more costly or are no longer available. Each of these changes can be cause for updating a plan.

Drivers for Planning

Often there are multiple drivers for initiating and updating water resources plans, starting with the initial assumptions and projections from prior plans. Observed growth in number of customers and trends in demands tend to vary from projections. As a result, new plans need to update projections in light of a series of potential drivers. These drivers generally fall into one of the following categories, as detailed in Table 2-1:

- Changes in demand
- Changes in supply
- Raw and treated water quality
- Aging water supply infrastructure
- Implementation of conservation and reuse programs
- Instream flow, groundwater management, and source water quality requirements
- Effects of climate change
- Operational changes
- Capital improvement planning

In some cases, other governmental permitting or regulatory agencies may require that water resources plans be developed or updated on a recurring basis, or when triggered by certain permitting or regulatory actions. Because those situations are unique to local rules and requirements, they are not discussed in detail here, but the remaining items are more fully discussed below.

COORDINATION OF UTILITY-LEVEL PLANS WITH STATE AND REGIONAL WATER RESOURCES PLANS

Identification of Relevant Plans

Water resources planning is ultimately a local exercise with regional effects. The planning analyses and decisions are critically important to the future vitality of a community and must reflect unique local conditions. The characteristics of supply and demand unique to each locale—and the values and priorities of the end users of the water—can only be coordinated through local processes. However, there should be a strong and beneficial linkage between local and regional planning efforts.

Regional planning is often organized by political entity or boundaries (e.g., counties or joint powers authority), watershed, state level, or interstate basin level. First and foremost, regional planning serves a coordination role. Watersheds and aquifers transcend political boundaries and provider service areas, and in most cases, utilities share sources of supply with their neighbors to at least some degree.

Statewide and regional planning spans those boundaries and allows for coordinating plans between local entities. Such planning efforts can help identify situations where multiple providers are planning to use the same source in the future—and thereby head off conflicts that might otherwise occur between competing users and uses. Statewide and regional plans can also serve as a vital information resource to local planners. By providing the higher-altitude view—albeit with less detail than local plans—statewide and regional plans can be used by local planners as a resource for surface water and groundwater physical and legal availability, current and projected demands on supply sources, and projections of potential future shortages in terms of magnitude and frequency.

Table 2-1 Summary of drivers for integrated resource planning

Drivers for Planning	Primary Causes	Description of Drivers
Changes in demand	General	Water resources plans are founded on projections of future demand. Annual demands drive decisions and investments in water supply sources, while peak-day demands can dictate the sizing of water diversion, transmission, storage, treatment, and distribution infrastructure to match customers' daily and seasonal use patterns.
	Growth in service area	Growth in demand driven by population and employment growth is a fundamental element of traditional water supply planning. Perhaps more than any other factor, anticipated growth in a provider's customer base is a call to action to plan ahead to ensure continued reliable water service for all customers. Many providers choose to plan for anticipated demands 50 years or more into the future to secure long-term reliable supplies. In some cases, obtaining permits and approvals for implementing water supply projects can take decades.
	New or expanded service areas	From time to time, changes in a provider's service area boundaries may occur, driven by land-use planning decisions, annexations, or intergovernmental agreements. The newly included service areas may be fully built out and developed, partially built out, redeveloped, or undeveloped lands. Portions of the new service areas may also be on domestic wells—not connected to any provider's treated water distribution network—and may be candidates for conversion to water service from the provider. "Wholesale" water transactions, where one provider sells water to another provider on an ongoing, intermittent, or emergency basis, can also directly affect the planning of both the seller's and the buyer's water supply portfolios. The buyer may purchase all or a portion of its water needs as raw or treated water from one or more sellers. Benefit-cost analyses for both the seller and the buyer should be conducted before entering into such agreements, but often there are economies of scale and operational benefits to creating regionalized systems involving partnerships between two or more communities, districts, or water providers. Each of these factors affects the amount of water needed and the timing and phasing for its implementation. Adding service areas that are already developed and served by an existing water system can add demand to a provider's supply system and treatment and distribution infrastructure gradually or literally overnight—requiring inter-local agreements, adequate planning, and the capacity to be identified and secured in advance.
	Uncertainty in long-range planning	There are many challenges in projecting service area demands far into the future. One particularly challenging aspect of long-range planning is the availability of population and employment projections that reach as far into the future as the water supply plan seeks to project. For example, many local land-use and population planning documents only project conditions 10 or 20 years out. Extrapolating from those projections for water supply planning, while often necessary, causes further uncertainty in the accuracy of long-range water demands.
	Variation from previous projections	In water planning, projections will almost certainly be more accurate in the first 5 years than they will be 50 years out. The assumptions and data used to make projections are often based in system-specific empirical data, observations, and trends. Actual demands almost always vary from projections—the question, then, is to what degree they might diverge. Water utilities can expect to see changes in annual and/or peak demands relative to previously projected values. This is often driven by deviation from the foundational assumptions in previous plans, such as • service area population and employment growth, • per capita demand, • new or modified inter-provider arrangements to buy or sell water, and • climate change. Per capita demands can be affected by changes in the nature of demands in the service area (e.g., a new major industrial water demand), the effectiveness and pace of adopting conservation programs or drought management measures, and short- and long-term trends in climate. Because these factors can trend upward or downward over time—and in many cases are difficult to predict with accuracy more than 5 or 10 years in advance—regular updates to the water supply plan are valuable in refining projections of per capita demands and the resulting implications on the source of supply investment and operational decisions.

Table continues next page

Table 2-1 Summary of drivers for integrated resource planning (continued)

Drivers for Planning	Primary Causes	Description of Drivers
Changes in supply	General	The traditional norm is that new or expanded sources of supply are prompted by growth in demand—and successful planning provides sufficient time for identifying and comparing new source options and to demand capacity measures, decision making, securing new sources for long-term use, and implementing the infrastructure needed to deliver reliable supplies. However, this may not hold true because needs for power, competing utilities, or industrial uses may quickly limit the access a utility has to its planned-for long-term water supplies.
	Climate change and surface water supply availability	Changes in supply availability or reliability can prompt a new or updated water supply plan. Adapting to climate change is at the forefront of many water providers' concerns, with the potential for significant changes in yields, water quality, and the timing of supply availability. In many cases, supply availability projections are indicating trends contrary to traditional assumptions, and historical data and observations. Projections in some areas call for wetter or drier conditions, more intensive precipitation events, or changes in snowpack and snowmelt patterns that can alter the supply picture and management approach. The Water Utility Climate Alliance (WUCA) produced a white paper in 2010 that discussed the use of multiple climate scenarios in water utility planning (WUCA 2010). The US Environmental Protection Agency (USEPA) developed a range of adaptive planning tools and resources for water providers' use in planning for climate change, embodied in the Climate Ready Water Utilities initiative (USEPA 2012a). A joint publication by the American Water Works Association (AWWA) and the International Water Association also provides insights into the future of water management under evolving climate conditions (Smith, Howe, and Henderson 2010). AWWA also established a policy regarding climate change (AWWA 2014a). Climate can affect water supplies in a variety of ways. In the northwestern United States, glacial melt continues to decrease stored water supplies, while in low-lying coastal areas, rising sea levels may encourage salt water intrusion into coastal aquifers. The variability and intensity of storms are changing in other locations. Utilities relying on snowpack for seasonal storage should assess the effects of projected changes in snowpack and runoff patterns. Long-term planning should include understanding the effects of climate as they affect water supply availability.
	Groundwater yield	The US Geological Survey Circular 1323 (USGS 2008) identifies much of the United States as having overdrafted aquifers. Many of these aquifers will not recharge anytime in the relative future. Much of the United States continues to pump these aquifers despite suggestions that water supplies will no longer be physically or economically viable in the next 30–100 years. Many of these areas lack major surface supplies, so the loss of groundwater may create significant water supply challenges for affected groundwater utilities. Because many communities, especially smaller communities with limited resources, built their water supplies around a network of groundwater wells, the challenge is daunting. Ultimately, in the long term, a supply that is not used sustainably will eventually become unreliable. Thus, an understanding of the supply/demand balance for any given aquifer, and the potential for regulatory limitations, can prompt the need to initiate or adapt water supply planning activities. Many providers find that no single source of supply is optimal. Groundwater is typically much more reliable than surface water supplies in times of drought, but it may be possible to overdraft aquifers beyond their rate of recharge. Surface water is renewable but subject to hydrologic variability. Both groundwater and surface water supplies can be affected by others' use of the same source of supply. In some cases, this has caused utilities to not only modify their plans for future supply additions but to initiate plans to transition to a more diversified water supply to develop a sustainable and reliable water supply network. All utilities should have sufficient capacity and redundancy to meet at least the basic indoor domestic water needs under any foreseeable supply conditions. All utilities should have drought response plans.
	Environmental flows	Environmental concerns related to river flows or water quality can also alter the supply picture. Minimum flow requirements may change or be newly promulgated. Impacts to endangered or threatened species could affect supply availability. Furthermore, surface water diversions can affect a variety of riverine water quality parameters, such as salinity and dissolved oxygen. New or existing water quality requirements can also affect a water provider's supply portfolio.

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Table 2-1 Summary of drivers for integrated resource planning (continued)

Drivers for Planning	Primary Causes	Description of Drivers
Raw and treated water quality	General	Water quality is integral to any water planning exercise and can directly or indirectly affect the decisions made in planning future water supplies. Much like water quantity—where changes in either demand or supply assumptions can affect the need for, and timing of, planning and implementation—water quality can be affected by both the end users' needs and the source of supply. There is a direct link between drinking water regulations, water quality, and public health protection. Additional information is provided in chapter 6 of this manual.
	Drinking water regulations	Ever-evolving drinking water regulations are perhaps the most significant driver for treated water quality. Faced with limits on new parameters or more stringent limits on parameters that are already regulated, water providers must balance the costs of treatment versus the choice of supply sources and the raw water quality characteristics inherent to each. For example, when the USEPA set new national standards for arsenic in drinking water in 2001, many communities faced a decision between implementing treatment for arsenic removal and abandoning existing water supply wells. Abandoning wells, in turn, would prompt the need to accelerate implementing alternative sources.
	Aesthetics of treated water	Users' preferences and provider goals for treated water aesthetics play a role in supply planning. While virtually any goal can be achieved through selecting the right treatment technologies, the costs of achieving those goals will vary with the quality of the source of raw water supplies.
	Cost of various sources	The quality of raw water supplies directly affects the costs needed to achieve regulatory compliance and user preferences for treated water quality. This is an important consideration when comparing the costs and operational implications of one source to another. In the United States, the Safe Drinking Water Act requires compliance with public health standards regardless of the costs. This creates significant challenges in some communities.
Aging water supply infrastructure	General	Water supply systems are a complex network of diversion, pumping, transmission, storage, treatment, and distribution infrastructure. Elements include structural components; electrical, instrumentation, and controls systems; piping; and equipment—each of which has a unique service life that depends on its use and ambient conditions.
	Incremental funding and replacement	Water systems are typically expanded and updated incrementally over time as needs and funding sources dictate. This translates to a situation where each year, different components of water supply systems are coming to the end of their useful service life. Decisions on rehabilitating and replacing existing infrastructure should be weighed in the context of considering alternative sources of supply or alternative means of diverting, conveying, storing, and treating the existing sources of supply.
	Maintenance	Preventive maintenance is key to reduce the potential for infrastructure and equipment failures, and the associated potential for supply interruption. Now more than ever, water providers are turning to asset management strategies and programs to forecast rehabilitation and replacement needs using data-driven analyses to target the financial needs without prematurely replacing equipment or relying excessively on reactive repairs.
	System reliability	Aging water supply infrastructure must be considered when assessing the reliability of water supply systems. Simply assuming that today's sources of supply can be used indefinitely without major investment within the planning period is unrealistic. Decisions integral to the water supply planning process include assessing the condition of existing infrastructure, considering its anticipated service life, and integrating these decisions with a robust asset management plan.
Implementation of conservation and reuse programs	General	Managing a water portfolio is a dynamic process, reacting to daily, seasonal, and year-to-year variability in supplies and demands. Some of this variability is driven by programs under the control of water supply planners, while others are driven by factors well outside of water supply planners' control. The components of the urban water cycle are increasingly recognized by planners and the public as being interconnected—and highly interdependent. Water conservation programs and water reuse systems affect this balance via two very distinct pathways.

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Table 2-1 Summary of drivers for integrated resource planning (continued)

Drivers for Planning	Primary Causes	Description of Drivers
	Water conservation	Water conservation is often considered in terms of reduction of water use or waste, and increased efficiency—using less water to achieve a given purpose. Often considered a component of a water <i>supply</i> portfolio, conservation <i>reduces demands</i> and can affect both annual and peak-day demands. Reducing demands has the potential to affect utility revenues, but conservation typically increases gradually over time, providing time for utilities to modify rate structures if needed.
	Water reuse	Water reuse does not reduce demands. Rather, it replaces traditional raw or treated water supplies with an alternative source of supply (typically highly treated water from a water reclamation facility) to help satisfy demands. Water reuse within a community can reduce or defer the need for developing additional new water supplies. This holds true whether the reuse system is directly or indirectly connected to beneficial uses, serving nonpotable uses, or supplying water for potable treatment and use. Water reuse decisions are often prompted by the economics of supply options or regulatory requirements. The economics can include the availability and reliability of the supply, the costs to implement alternative raw water supplies, and the economics of meeting increasingly stringent wastewater discharge permit conditions. Water reuse in upstream communities, in contrast, can affect the availability of surface water supplies for a downstream community, subject to water rights and permit constraints. To the extent that those factors drive additional water reuse, they also need to be included in water supply planning.
	Overall demand reductions	The degree to which a provider relies on conservation and reuse—and the degree and pace they are adopted and implemented in the community—can affect the water supply/demand balance. Part of a community’s planning process might include an analysis of demand management measures, including their cost-effectiveness and water savings efficiency. Significant reductions in demand can defer the need for new water supplies, thus deferring capital expenditures, and operation and maintenance costs. Deviations from previous planning values in any of these factors affect the timing and amount of need for additional water supply solutions. One approach that many providers have found effective is the use of demand-based triggers for water supply capital projects, in tandem with the use of conservation and reuse programs. The timing of those demands and projects can be estimated based on demand projections, then updated over time—adjusting <i>when</i> the actions will be taken, while maintaining consistency in <i>what</i> actions will be taken to meet demands.
Instream flow, groundwater management, and source water quality requirements	General	For water managers overseeing portions, or all, of the urban water cycle, it is well understood that water quality standards drive nearly continuous investments and improvements in water reclamation facilities. At the same time, as users of water resources for potable supply, it is important to recognize the value that those water quality standards provide in terms of suitable source water quality for treatment and delivery to customers. In the water environment, the connection works both ways.
	Source water quality	While seeking source water quality for potable treatment and supply, the source of that supply and its quality will also affect the quality of the wastewater that is returned to the water reclamation facility for treatment and discharge. In some cases, standards for specific constituents (e.g., certain metals) may have discharge standards that are more stringent than those for drinking water. For example, metals standards for instream aquatic life beneficial uses may be an order of magnitude lower than the maximum contaminant level set by the US Safe Drinking Water Act standards. In that event, choices between sources of supply and operation of the water supply system can be driven in part by discharge standards at the water reclamation facility. These considerations should be screened as part of evaluating existing and potential future sources of supply—and investigated in more detail if warranted, based on the findings of the screening evaluation before making long-term decisions on water supply sources and their operation.
	Groundwater management	Voluntary or mandated restrictions on the rate of groundwater use can drive water supply planning efforts. For example, the 2014 Sustainable Groundwater Management Act in California requires the development of groundwater sustainability plans for overdrafted aquifers. The act is administered by the state on a groundwater basin basis in areas where there is no local or regional agency sustainably managing its groundwater levels.

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Table 2-1 Summary of drivers for integrated resource planning (continued)

Drivers for Planning	Primary Causes	Description of Drivers
	Instream flow requirements	Water planning by municipal water providers and water authorities has historically focused on the needs of their customers—water diverted or pumped, stored, treated, and conveyed through distribution systems to the end user. Today’s planning often considers the implications of such diversions and uses on streamflows and nonconsumptive instream flow uses for recreational and environmental purposes. Those drivers—whether considering the effects of additional changes to instream flows or contemplating alternate water management methods—are key elements of an integrated water resources management approach to planning. Such considerations can affect when a new or updated plan is needed, what supply options and management methods are considered, and ultimately, the decisions that result in implementing new water supply, conservation, and reuse programs.
Operational changes	General	Managing a water supply system requires consideration of operational costs and implications.
	Operational cost impacts	Costs are driven by a range of factors, but only portions of those are within a water provider’s direct control. Operational changes might consist of reversing the roles of sources used for peaking and baseload. Those decisions can be founded on changes in operational costs (such as energy costs, capital costs, or labor costs) or on physical supply availability, or water rights, or permit constraints. Operational drivers should be fully characterized—and forecasted to the extent practical—to allow operational costs and preferences to be integrated into decisions between alternative source options and strategies for how those sources will be used on an annual and seasonal basis.
	Energy demands	A water provider with deep groundwater wells in an aquifer with limited natural recharge may be physically capable of pumping those wells to produce a given yield but may find that the available supply continues to diminish. Groundwater modeling techniques can be used to project future water-table levels and aquifer yields. Over time, in this situation, the model may predict a need to pump water from the aquifer at lower per-well yields. The increased energy cost to pump that water—with unit energy costs increasing at the same time—may make that source economically unattractive on a life-cycle cost basis, prompting a decision to accelerate the implementation of alternative sources even though the wells could continue to produce water. Conversely, pumping energy costs for a regional surface water supply project could escalate to a point where that source is less attractive than others. Oftentimes, planners are faced with a decision between locally available—but expensive to pump and treat because of aquifer levels or local water quality—and more distant regional supplies that have higher water quality but higher transmission costs.
Capital improvement planning	General	Water resources plans can also be initiated as part of a utility’s regular cycle of capital improvement planning. Because it can take decades to obtain permit approvals and funding for major projects, water supply plans often look well beyond the typical time frame of a utility’s typical capital improvement plan time horizon. Nevertheless, near-term costs can be estimated for inclusion in capital improvement plans, and longer-term cost ranges can be used to help the utility assess longer-term rate structures and system development fees.

Local planners should be aware of regional or statewide water planning efforts because they have been engaged in those planning processes. As a result, local planners understand the types of information made available by the state or regional process, and the constraints and limits of those processes.

Statewide planning varies widely from state to state. Some states have never undertaken a statewide planning effort. Some have initiated statewide planning processes in the last decade. Others have been conducting planning and periodic plan updates for decades. The US Army Corps of Engineers (USACE) conducted an assessment of statewide planning efforts, culminating in the 2010 report titled “Responding to National Water Resources Challenges” (USACE 2010). That report provides a list of lead state agencies for water planning in each state.

Regional efforts can be identified through a variety of avenues, such as professional associations, state and federal water agency contacts, and regional political organizations and venues.

Planning Data Resources and Tools

Previous plans can serve as a key foundation for updates. Professional and industry associations (e.g., AWWA, American Water Resources Association, WaterReuse Association) also offer a wide range of resources—including this manual—for water supply planning. Related tools for developing plans and conducting analyses for water conservation programs, water reuse systems, and other facets of integrated water management are also available.

Water demand projections may be available from regional or statewide plans. Similarly, foundational data for demand projections, such as population and employment projections, may be available from sources such as city planning departments, the United States Census, state demographers, economic development organizations, transportation planning agencies, or state universities. These data may or may not be on the same scale as the local plan. For example, population or demand projections may be forecasted by others on a city, county, or watershed basis. Those boundaries—and the resulting projections—may not match with those of the local planner’s service area. Many water providers’ service areas do not directly coincide with other political or watershed boundaries. Even within a community, some of the residents may not be served by municipal or rural water systems (e.g., individual wells), or there may be service outside the community’s boundaries. This may require using geographical information systems or other tools for manipulating the forecasts to reflect the local agency’s planning boundaries. Local planning numbers from more detailed local studies may also be available for use as foundational data. State and regional planning should generally not supersede local plans but rather can serve as a resource for local plans and can be used for comparisons between areas by applying consistent methods and sources of data. Careful attention needs to be paid when combining plans, because population estimates may be higher or lower due to overlapping boundaries of the planning agencies or estimating methods for the population or employment. For example, for a census tract that spans across two water agency boundaries, both agencies would need to agree on the proportion of the population that belongs in each service area, especially if regional or state planning estimates are being used based on local plans.

Supply data may also be available from other sources. The US Geological Survey (USGS) maintains a nationwide network of streamflow gauging stations and groundwater-level monitoring wells, and makes those data publicly available through its online National Water Information System (USGS 2012). Other streamflow data from state or federal agencies may be available in the watershed of interest. Groundwater aquifer data may be available from the USGS, state sources, and local or site-specific studies.

Water quality data should also be sought as part of planning and anticipating potential water treatment needs, using federal sources such as the nationwide Storage and Retrieval of US Waterways Parametric Data (STORET) database.

Coordination of Results

Active engagement by local planners in regional, watershed, and statewide planning processes is key to the success of those efforts in terms of coordinating water supply planning and heading off conflicts between competing uses before they occur. Participation by local planners in such processes is important, regardless of what stage of their planning they may be conducting or implementing at the time.

INITIAL SCOPING

Clearly scoping the effort and end products for a water resources plan will focus the planning team's efforts from the outset, resulting in a targeted plan that meets established objectives and is most useful to the target audiences and users of the plan. Initial scoping includes taking into consideration who the primary and secondary "audiences" or users of the plan will be; clearly setting goals, objectives, and outcomes for the plan; assessing what is and is not within the scope of the planning effort; and setting a timeline for planning.

Audiences

Each water resources plan should focus on its users and uses as part of early efforts to organize and "plan the plan." By understanding how the plan will be used and when it will be updated, each of the plan's elements can be targeted at meeting those goals. Examples of the factors that should be considered as part of early planning efforts are the following:

- Who has authority to approve or modify the plan?
- Who will be responsible for implementing the plan?
- Who might be affected by the plan—both within and outside the local provider's organization, and over the near- and long-term time frames as it is implemented?
- Who will monitor implementation progress and adapt the plan as implementation proceeds?
- Who will be responsible for updating the plan, and when will that update be initiated?
- How will customers benefit from the plan?

If the answers to these questions are not immediately clear, the planning team should work with internal and external stakeholders to resolve and clarify the role of the plan in addressing future water needs and water management strategies. Ultimately, the plan has limited value if the stakeholders, especially the users, do not buy into and implement the proposed plan.

Priority Goals, Objectives, and Outcomes

Initial planning activities should focus on the end goals in terms of the priority outcomes from the planning process. What will the organization know at the end of the plan that it does not know now? What do planners and managers need to know to continue to have a safe and reliable water supply portfolio decades from now? What specific information

and direction will the implementation team need to know to put implementation of the plan into motion? A major priority should include matching demand patterns with water supply options. The critical juncture for any water supply plan is when the current supply availability is exceeded by the projected demands. Securing a new supply is often a difficult task and will require significant financial investment and commitment on the part of the stakeholders.

Planning Boundaries—What Is On and Off the Table?

The planning team should take a deliberate approach to setting boundaries for planning, once the primary and secondary audiences are identified and the priority outcomes have been established. The following are examples of the types of questions that should be answered:

- What is the planning horizon (e.g., 50 years)?
- How much detail will be included in near-term years versus longer-term planning years?
- Will the plan consider meeting nonpotable demands through water reuse or raw water supply options?
- Is indirect potable reuse (supply augmentation with highly treated water from a water reclamation facility) a potential consideration? Is direct potable reuse a potential consideration? Why or why not?
- Should the plan include developing a conservation plan? Is there already a conservation program whose goals should be assumed as part of basic demand projection work? Does the conservation plan contemplate efficient, cost-effective measures that could extend supplies and/or reduce capital outlay?
- Are there any specific supply sources that must be included or are definitely excluded? Why?

By clearly delineating the uses and boundaries of the plan—envisioning the end product and its users before developing the plan—planners can focus their efforts on the elements that most directly benefit the intended audience and users of the plan. This will likely include both internal stakeholders such as a city council, authority board of directors, and the provider's staff charged with implementing the plan, and external stakeholders such as the provider's customers, neighboring communities, and water-related interest groups.

Timeline for Planning

When considering sources of supply, many plans take a 50-year or longer outlook. It is often difficult for stakeholders, and especially elected officials, to embrace long-term plans. They often ask, "Why so long, when the accuracy will be diminished the further out demands and supplies are forecasted?" The answer is that developing new supplies may take 15 to 20 years, and understanding how growth might occur in the 50- to 100-year period will provide justification for acquiring appropriate allocations of those new supplies. Most stakeholders understand the importance of a permanent—and permanently reliable—water supply system. Too often, permitting and regulatory processes create significant time delays in the implementation process. Major projects, such as new reservoir storage, can trigger a decades-long regulatory process. Thus, it is also important to project long-term needs and phasing schedules to fully understand when supplies might be at risk for not meeting demands. As competition grows for finite resources, so grows the potential for conflicts and shortages. A solid look ahead in light of shared use of water

resources can head off problems before they materialize. It is also important to project longer time horizons to take into account incremental changes (such as loss of storage capacity) or the increase of frequency and intensity of extreme climate change events, which are small shifts on a near-term basis, but when aggregated over a longer time horizon can have a significant effect on planning assumptions for the permanence of supplies and planning outcomes.

PROCESS AND ROAD MAP FOR PLAN DEVELOPMENT

AWWA Policy

Water rights and allocation of water supplies is fundamental to any water supply planning process. Water rights are described in detail in chapter 3 of this manual. AWWA has developed the following policy regarding developing and managing water resources (AWWA 2014b):

The American Water Works Association (AWWA) supports and promotes the integrated use of adaptive water resources planning processes and effective management practices to provide for reliable, sustainable, and cost-effective supplies of appropriate quality water for customers.

Freshwater sources are increasingly at risk from a variety of natural and human-induced stressors, including population increase, climate change, land-use changes, and pollution. Additionally, water system reliability is increasingly at risk due to aging infrastructure that is in need of replacement or renewal.

In order to assure current and future water supply reliability, it is essential that water managers use iterative and adaptive long-range planning processes that encourage consideration of local and regional water supply options, including demand management. These efforts should be comprehensive in approach, include the participation of local and regional partners, and explicitly evaluate water resource conditions under a variety of scenarios. Additionally, water managers should routinely review their water management practices and consider all opportunities for incorporating operational efficiencies that result in water supply, water quality and cost benefits.

Water agencies should consider all water supply options that are potentially viable. Surface and groundwater storage should be considered, when and where feasible, as an effective approach to managing and augmenting local water supplies. In addition to freshwater sources, potable options include treating brackish groundwater, seawater or reclaimed water to drinking water standards. Nonpotable supply options such as reclaimed/recycled water, decentralized rainwater and greywater collection systems, along with stormwater capture, are all effective options for reducing demands on potable supplies and should be considered in the planning process. These options should be evaluated with consideration of life-cycle costs at local and regional levels to optimize the long-term value of investments in utility infrastructure.

Planning Team

The planning team should include a core group of water professionals at its foundation. In smaller communities, this may include one or two lead staff, while larger utilities may

have several key staff from their management, planning, operations, conservation, or engineering groups. Depending on the level of detail and effort targeted for the plan, and the provider's in-house staff availability and qualifications, the provider may elect to engage the services of consultants, university staff, or other supplemental resources.

The planning team should include, or have direct access to, a broad set of viewpoints. For example, the planning team should actively seek and address input from operational, financial, engineering, management, and council or board representatives. It should also reflect public input and involvement through a strategic effort of the utility's public information officer or consultant. Some providers also seek out advisory panels or steering committees to bring representative viewpoints for various interests in the community. In establishing the planning team, consideration should be given to including representatives from organizations that could affect—or be affected by—the outcome of the plan. Examples might include key permitting agencies, public interest groups, or other neighboring water providers.

Identifying and communicating each team member's specific role, responsibilities, and expectations in the planning process should be clearly established at the outset of the project.

Defining Timelines and Responsibilities

Organizational planning for developing the water supply plan should include documenting key timelines and the roles and responsibilities of each team member—both on an individual and organizational level. Identifying the critical path for plan development activities can be a useful tool in focusing the team's efforts. Often, maintaining a decision log, an action item tracking log, and similar project management tools can be helpful in establishing and maintaining a path toward timely completion of the plan. Sufficient time should be built into the schedule to obtain necessary internal team reviews, and for meaningful public involvement and input. Given the importance and long-term ramifications of the decisions made in a water supply plan, adequate time for deliberation and decision-making is crucial to a successful plan that sets a course for a long-term reliable water supply.

Organization of the Plan

No single outline exists that is best for all planning processes. The organization of the plan will in many ways depend on the goals and intended audiences for the plan.

That said, many plans include the following basic elements:

- Introduction and drivers for planning
- Basis of planning (demand projections, anticipated regulations, etc.)
- Water supply options
- Screening of viable options
- Developing and evaluating “portfolios” of supply
- Public involvement process
- Recommendations and capital improvement plan data

The process outlined in this AWWA manual provides detail on the development of each of these aspects of planning, with suggestions on organization and content for each.

Planning Process and Decision Making

Deliberate consideration of how decisions will be made—the criteria and process that will be used to compare and select alternatives—should be conducted well in advance. In many cases, participants and stakeholders will be much more willing to accept and constructively improve the results of a plan if they “buy in” to the methods that will be used in the planning process. Decision making can use simplified pro/con methods or more advanced multicriteria decision support methods. While each provider will have its own drivers for selecting planning process and decision making methods, using multicriteria decision support methods can be useful in documenting to other stakeholders (including city councils, boards, etc.) the rationale and basis for the decisions that are made in the planning process.

In some cases, internal and external stakeholders can participate in the decision making process. For example, when considering a seawater desalination plant for Florida’s east coast, project team members held workshops with internal stakeholders to determine and define evaluation criteria. Once each criterion was defined, it was presented to the community for review and input. Additionally, internal and external stakeholders provided input on the evaluation criteria weighting. Multiple weighting scenarios were developed and applied to help make the decision makers’ selection.

PUBLIC INVOLVEMENT

Public involvement has become an essential step in the planning process. Stakeholder and interest groups are more sophisticated in their communication skills and are more apt to understand and use the power of mass and social media to marshal political and voter forces.

Whether it is required by statute or simply a commitment on behalf of the utility, public involvement provides water managers with a broader community context as they consider demand, supply, regulatory, economic, environmental, and other technical aspects of identifying new water supplies. Public involvement is more than just a public meeting—it is a strategic process to engage stakeholders early in the planning process so that they may contribute to and influence decision making. An open, transparent decision-making process can lead to an informed, consensus-based decision that reflects community values and minimizes public opposition.

AWWA’s policy statement on public involvement and customer communication states, “Opportunities for input and involvement are essential to public understanding and acceptance of utility programs and projects. The format and depth of involvement will vary according to individual suppliers, communities, and issues. Opportunities for involvement must, however, be meaningful, inclusive, and clearly linked to the decision-making process” (AWWA 2013).

Benefits of Effective Public Involvement in Resource Planning

Today’s water suppliers must balance multiple, often competing organizational and political demands while also providing safe, high-quality drinking water to their customers. The water resources planning process seeks to frame resource decision making in terms of community values, as well as technical and cost criteria. Therefore, the planning process should be designed to not only solicit community input but also use that input in a meaningful way during decision making. There are numerous benefits of meaningful public involvement:

- Aligning the utility's projects and plans with its constituents' long-term plans and priorities
- Listening to, and learning from, the public to develop and implement projects that incorporate community values and priorities
- Increasing public access to accurate information about current water quality and quantity, and other affected water resources, thereby increasing trust in the utility and providing a counterbalance to misinformation that may be communicated through other avenues
- Increasing the public's baseline understanding of water permitting and water quality regulations that have dramatically increased the need for more costly advanced treatment technologies
- Increasing public support for balancing development of limited water resources and increasing need for water use efficiency and emphasis on environmental stewardship
- Demonstrating the utility's commitment to efficient and effective use of public dollars
- Providing more and better information that is otherwise unavailable
- Increasing elected officials' comfort level with complex decisions about long-term investments in a community's future by building a public mandate for sustainable, high-quality water
- Reducing the potential for protracted win/lose battles with project opponents, lawsuits, and the odds that needed permits may be denied

Integrating water resources planning and public participation can add credibility to a project and can improve public trust in government/institutions. Public involvement can help utilities garner the support necessary to move a project forward. Furthermore, public involvement can help projects succeed by reducing the risk of failure, ensuring compliance with regulatory agencies, and gaining acceptance with the public and elected officials.

Planning for Public Involvement

The International Association for Public Participation (IAP2) states that public participation means to involve those who are affected by a decision in the decision-making process (IAP2 2012). Integrating public participation into the planning process requires a concerted, strategic effort to identify and engage stakeholders to build understanding and incorporate public input into decision making.

Stakeholder groups include many parties; consideration of local and regional stakeholders is imperative. Such groups might include local economic development interests, business leaders, ratepayers, environmental groups, and regulatory agencies, while regional groups might include upstream and downstream users, agricultural interests, industries, and other government agencies. As a part of the process, some effort should be undertaken toward a risk communications framework, if there are perceived health risks, potential controversy, or low levels of trust.

Truly involving the public in identifying, prioritizing, and assessing the value of resources will require a strategically planned process for reaching interested members of the public, educating them on the issues, and providing a meaningful way for them to express their opinions and influence the decision making, enabling them to be effective participants in the decisions that are made.

Planning for public involvement should be integrated with the overall water resources planning process, beginning in the conceptual planning phase. The decision to include the stakeholders requires that an honest assessment of water supply

alternatives and benefits will be the basis for the planning effort, and that the public's input will have a bearing on the final decision-making process. Assuming that the planning process will be collaborative, the development of an effective public involvement program should begin with careful, thoughtful planning. Essential elements to successful planning include the following:

- Defining the project and assessing potential risks to the successful completion of the project
- Assessing the "owner's" (utility or decision-making entity) readiness for public involvement and ensuring that adequate budget and staff are allocated to the effort
- Conducting a preliminary assessment of potential stakeholders and their concerns and expectations for involvement
- Identifying techniques for informing and involving stakeholders
- Developing, implementing, and monitoring the public involvement work plan

Special planning considerations. Public involvement becomes a regulatory requirement under certain conditions. Some states require review of projects affecting large areas. The National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) require public involvement when there is the potential to impact environmental, historic, or cultural resources where a federally permitted project is being considered.

Additionally, USEPA has an environmental justice mandate that extends to all of the agency's work, including permitting facilities, awarding grants, and reviewing proposed actions by federal agencies. USEPA's website defines *environmental justice* as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (USEPA 2012b).

If a proposed project or planning effort affects a recognized Native American tribe, consultation is taken to another level. Federally recognized tribes are recognized under law as sovereign nations. Within the United States, there are about 570 federally recognized Native American tribes or governments. NEPA and NHPA require that consultation and collaboration with affected tribes be conducted in a formal government-to-government manner. Additional information on public involvement and NEPA, NHPA, environmental justice, and Native American tribes can be found online at the following links:

- USEPA National Environmental Policy Act—www.epa.gov/compliance/nepa/
- National Historic Preservation Act—www.achp.gov/about.html
- Environmental justice—www.epa.gov/environmentaljustice/
- Native American tribes—www.epa.gov/sites/production/files/2015-03/documents/ips-consultation-guide_0.pdf

A team approach. Effective public information planning and implementation requires input from, and coordination with, the water resources planning team. Ideally, the public involvement task leader should be a key member of the project management team to ensure collaboration, alignment with the overall planning process, and improved communication between stakeholders and the project team or utility. This also ensures that stakeholders are involved at strategic opportunities within the project schedule, so that input can influence decisions before they are made.

The project team members ranging from senior project management to planning, permitting, funding, and design can play a role in public involvement planning and

implementation. During the public involvement planning stage, it is helpful to identify an internal project champion. The champion is the designated senior-level manager who is visible in the community, has access to political decision makers, and has a passion for the project to succeed.

Champions have a big-picture view and are able to accommodate temporary setbacks; they consistently communicate both internally and externally about the progress being made; and they are able to maintain project momentum during controversy. External champions are also essential project team members. They are typically allies in the community who act as a conduit about public sentiments. They often serve as contacts and symbols for elected officials, especially during controversial projects, because they demonstrate knowledge of community values, understand project priorities, and illustrate sensitivity to local politics. They can be important local opinion leaders who speak on the team's behalf.

Laying the foundation. The public involvement planning process starts with the water resources planning team. Input from the team is necessary to lay a foundation for the overall process, help define goals, and manage expectations. Key foundation elements include the following points.

Framing the project. Determining the specific problems that will be solved, and identifying the boundaries of those problems, helps to frame the project in terms that both internal and external interests can understand. Facts that establish the need and scope of the process are clearly defined, and assumptions used in the process are identified. Once these boundaries are understood, it will be easier to establish achievable goals and expectations.

Distinguishing facts from assumptions. Water supply alternatives are more clearly defined when facts are distinguished from assumptions. Facts are limited to what is known about an option: they can be readily agreed upon. Project facts may focus on water supply capacity or permitting constraints. Assumptions often form the basis for disagreement, so it is important to uncover differing opinions about data sources, uncertainties, regulatory projections, and planning horizons—first within the sponsoring organization and then among key members of the public. During this planning phase, facts and assumptions should be listed separately as distinct line items to ensure that all potential obstacles are anticipated.

Developing a need statement. One of the most important components of the public involvement planning process is developing a clearly defined water supply need statement. The need statement consists of a few sentences describing why the utility must resolve particular problems. Developing a concise, easy-to-understand need statement will foster internal alignment among project team members but also clearly convey the need with staff, the media, elected officials, and the public. Sharing the need statement outside of the utility will foster internal alignment, gain the attention of the public, and lay the groundwork for consensus-based solutions. Sometimes needs can be defined jointly between the utility and the stakeholders.

Planners should resist the temptation to develop solutions to problems too early in the process. It is natural to want to present solutions when describing a problem to the public rather than just communicating about the problem. Instead of bolstering credibility, this position can alienate the public, forcing the utility to try to sell the project, while pushing the public into positions of support or opposition. At this stage, it is essential that a public forum be established for discussing problems. In this way, managers can resolve public concerns rather than brokering positions on a project. In the field of mediation, this approach is referred to as “interest-based negotiation” rather than “position-based negotiation.”

Determine the Process and Opportunities for Public Involvement

For public involvement to be meaningful to both the participants and the decision makers, the public's input should feed into the process at logical points. Once the opportunities for public involvement are identified, planning can take place for appropriate activities or venues.

To gain public confidence, utilities look for external champions among stakeholder groups. This is best accomplished by identifying interested members of the public who have the knowledge and background to understand most of the full range of decisions that must be made during the water resources planning process.

The following questions may be helpful in identifying when the public should be involved:

- Do opportunities exist for informing the public about the issues and challenges?
- Do project alternatives exist? If so, how can the public participate in developing or ranking alternatives?
- Do opportunities exist for public input into selection criteria or criteria weighting that will be used to rank alternatives?
- Does an opportunity exist for the public to participate in some aspect of water supply development, particularly location of facilities, site configuration, aesthetics, and timing?
- How much could and/or should alternative strategies, such as water conservation and water reuse, contribute to meeting future demands?
- Are there opportunities to create other community benefits, such as parks or environmental centers, related to this project?

Determine Public Involvement Priorities and Develop Budget

Public involvement is typically linked with project implementation. However, budgeting for public involvement activities should be aligned with each phase of water resources planning activities. This will ensure that resources and staff are available during the planning process. Implementation of a public involvement plan is typically front-end loaded with the bulk of the planning and public involvement activities taking place early in the water resources planning process.

Planners should begin by focusing on the overall plan, then considering each project and any special project-specific needs. Project issues raised in the past by customers, activists, elected officials, other communities, or the media should be factored into the process.

Securing the resources necessary to implement meaningful public involvement programs is a fundamental challenge. Because staff and financial resources are limited, the focus should target future projects with the greatest risk of opposition, delay, or failure. Examining future projects with public involvement will prompt a series of questions about the nature of the challenges a project might face and will assist in developing a strategy on how to allocate resources to each water resources project.

Assess risks and priority for each resource being evaluated. Project risk is the potential impact on the organization for the failure to develop or complete the project or program. Types of risk to water resource projects may not be inherently clear. Not developing a plan at all, or failure to develop a plan in a timely fashion, can be risky in terms of lost opportunities to secure a water supply option, a delay in the supply coming online that may lead to local moratoriums on development, or the inability to secure supplies in the face of a sudden change to, or loss of, a current supply that creates large, unanticipated financial losses. The investment in public involvement should be proportional to the

risk posed to the organization, although with even a low-risk project, some minimal level of public involvement is always needed. Public involvement should not be viewed as an insurance policy against project failure. However, projects that include high risks or significant controversy should include robust public involvement programs. When assessing a project's risk, these variables should be considered:

- Consequences of not developing a feasible water resources plan
- Risks that eliminate water supply options
- Effects that the lack of public involvement may have on internal and external plan approval

After assessing risk, focus can be shifted to resources and projects that are more controversial than others, those that require public support, and whose success is key to the water resources plan as a whole.

Assign Responsibilities

To ensure a credible and sustainable public involvement plan, it is important to assign responsibility for individual public involvement activities, determine who has lead responsibility, and what support will be needed to provide the appropriate technical input, logistical support, and production assistance for public involvement materials. A well-planned public involvement initiative will include both labor and expense budgets for each task. The number of professional hours for each person and all expenses should be budgeted for each task. Senior management should evaluate the workload and determine whether outside consultants will be needed to provide staff support. Consultants can help balance workload without the time or expense of hiring full-time staff, and they offer expertise that may not be available in-house. They usually cannot substitute for staff, because internal staff typically has a far deeper understanding of the system, its ratepayers, and its challenges than consultants.

A strategic planning process will ensure that all alternatives have the appropriate level of public involvement, can help the utility garner internal and external support for public involvement, and will guide the development of a strategic, implementable public involvement work plan.

Prepare the Public Involvement Work Plan

After determining the elements of the planning process that will need to interface with public involvement activities, a work plan should be prepared. The work plan will outline specific tasks to be performed in concert with the water resources planning process. These activities include

- identifying stakeholders,
- identifying public involvement techniques,
- considering a professional facilitator, and
- matching public involvement activities with water resources planning elements.

Identify stakeholders. The public is not one group but many groups or individuals—each with different viewpoints about the utility, its problems, and potential solutions. These interested groups or individuals are called “stakeholders” because they have a stake in the outcome of the decision. It is important to remember that stakeholders are not limited to groups or individuals in favor of the water resources planning process.

Stakeholders often include opposition groups and vocal detractors. The following questions will help identify key stakeholders:

- Who has information?
- Who is likely to be concerned about the problem?
- Who will benefit by potential solutions?
- Who will be affected by potential solutions?
- Whose support is needed to implement the plan?

Project managers often think they know and understand stakeholder concerns, but these perceptions are sometimes wrong or have changed over time. To ensure that stakeholder views are clearly understood, one-on-one interviews should be scheduled with the people who are likely to shape opinions about the project. Interviews with these opinion leaders often correct assumptions about stakeholder opinion and provide valuable insights. These interviews are an opportunity to measure the credibility of the organization, further expand the network of project stakeholders, plan for information dissemination, and identify potential avenues for stakeholder input. To conduct a successful interview, a list of questions can be prepared that are designed to achieve the following objectives:

- Understand a group or individual's specific concerns about a particular problem or set of solutions.
- Determine which interests will be satisfied with receiving timely, appropriate information and which interests will seek to influence the decision-making process.
- Identify other stakeholders to interview.
- Determine if any of the stakeholder values are contradictory.
- Identify where and how interested groups or individuals are likely to find their information.

Stakeholders will have varying levels of interest and expectations on any given project. Typically they will fall into one of three groups:

1. **Group A** expects to be informed but not involved.
2. **Group B** expects to be able to exchange ideas with the project team.
3. **Group C** expects to be able to influence the outcome of the project.

Understanding the stakeholders and their level of expectations will help in determining which techniques will work best and how to link public involvement activities to project tasks. Table 2-2 is an example of how to organize information gained from stakeholder interviews.

Identify techniques. When selecting public involvement techniques, project needs must be linked with stakeholder expectations, the owner organization's culture, and the time and money available to devote to public involvement. Some techniques are suitable for informing the public, others are better suited to consulting with stakeholders, while others enable stakeholders to participate in some aspect of project decision making (see IAP2 Spectrum of Public Participation, IAP2 2012).

Internet-based tools, websites, and social media facilitate information and idea sharing and can play a part in any public involvement effort. Providing information via the Internet is expected in the current environment, but care should be taken when deciding the best method for exchanging information with stakeholders. Technology-based

Table 2-2 Organization of information from stakeholder interviews

Stakeholder	Issues and Concerns	Expectations for Involvement (A, B, or C)
Resident	Cost and effect on property values	A + B
Local elected official	Effect on constituents, effects to water rates	B + C
Environmental	Compliance with regulations, environmental impacts	B + C

techniques can supplement traditional efforts to increase public participation but cannot replace the intangible benefits of meeting face-to-face with the community.

Water resources projects most likely will use some techniques from all three categories. Efforts should focus on the most critical tasks associated with the water supply alternatives. A few common techniques are listed in Table 2-3.

Consider a professional facilitator. A professional facilitator can play a vital role when involving or collaborating with stakeholders in the decision-making process. A facilitator is a neutral third party that develops and implements a process to help a group provide focused input, reach consensus, or make decisions. Another definition is a person whose selection is acceptable to all the members of the group, who is substantively neutral, and who has no substantive decision-making authority but is someone who diagnoses and intervenes to help a group improve how it identifies and solves problems, and makes decisions to increase the group's effectiveness (Schwartz 2002).

A facilitator is particularly helpful when dealing with larger groups, such as in a workshop setting. A professional facilitator can help run the meeting or workshop, help develop ground rules, call on participants, manage the agenda, and more. More importantly, a professional facilitator's role is to understand the project owner's goals and develop and implement a framework for effective input to help achieve that goal.

An effective facilitator ensures that everyone is involved in the process and encourages open discussion. Because the facilitator is also impartial, this means he or she can help groups name problems and identify options, help avoid or resolve disputes, and work to maximize joint gains (Field 2010).

Match public involvement needs and opportunities with each planning process element. Identifying opportunities for incorporating public involvement includes combining what is known—about stakeholder interests and expectations for involvement—with what can be done to include the stakeholders in the decision-making process. One way to identify strategies for linking stakeholders to a project is to evaluate the project's task schedule.

A task schedule is a common project management tool often developed as a Gantt chart using Microsoft Project, Oracle's Primavera, or some other type of project planning software. Project management software illustrates the relationship of one task element to another over time. This is the project manager's road map and the key to understanding how to incorporate public interests into the decision-making process. Public input can only help shape the project if it is obtained before key decision points, so understanding the schedule is vital.

To enhance support for, and implementation of, a public involvement work plan, all public involvement activities should be displayed graphically on the project schedule. The goal is to link public involvement tactics with the other project tasks so that public involvement becomes an integral part of the project delivery process.

Understanding the relationship of the project tasks with the concerns of stakeholders is critical to the success of a public involvement program. An effective public involvement program can be crafted once the stakeholder concerns are linked to specific project decisions. The information gathered from stakeholder contact will help link the project tasks with public concerns.

Table 2-3 Informing the public

Getting Information to the Public	Getting Information From the Public	Exchanging Information With the Public
Internet (email, websites, social media, blogs, microblogs, etc.)	Internet (email, websites, social media, microblogs, etc.)	Internet (social media, microblogs, etc.)
Direct mail/bill stuffers	Questionnaires or surveys (telephone, Internet, direct mail)	Information line telephone number
Newspaper advertisements	Focus groups	Storefront, trailer, street kiosk
Door hangers	Small group meetings/interviews	Talk shows
Newsletters	Informational workshops	Speakers bureau
Displays	Public comment period	Door-to-door canvassing
Local media via news releases	Agenda items at local public meetings (councils, boards, or commissions)	Advisory groups
Articles in existing publications		Public meetings (open houses, presentation/Q&A, workshops)
Legal notices		Telephone town hall meetings
Cable TV		Web-based meetings

One vitally important step in the public involvement process is gaining and utilizing feedback from stakeholders, then conveying how that feedback was used. If stakeholders are uninformed how their input was used, it can harm credibility and confidence. Communicating back to stakeholders throughout a public involvement process is required to realize the benefits of early and inclusive public participation.

Implement and Monitor the Plan

Public involvement, like any other project component, requires focused, strategic implementation of the work plan. If the organization already has established project management processes, they should be used. While it may be necessary to modify the processes to address both the needs of the public involvement program and technical aspects of the project, existing tools are a good starting point.

Monitor the project. Predicting and managing project changes involves monitoring the status of a public involvement work plan almost daily. Regular communication with project team members and advisory bodies facilitates this process. During the monitoring phase of plan implementation, the project manager must be aware of the interrelationships between the project's public involvement activities and schedule of technical tasks to ensure a consistent workflow. Understanding the sequencing of tasks is also important because the plan must build on the successful completion of a preceding task before the next one can be implemented.

Active monitoring of the project will indicate where the public involvement program is working and where it needs improvement. The plan should be assessed to determine how effectively the individual tactics are meeting the intended goals. Assessments should focus on the most critical issues or stakeholder groups, because these have the potential to stop or significantly delay the planning process. The means of making these assessments include the following:

- Tracking social media for opinions, volume, and other parameters
- Asking key stakeholders their opinions
- Conducting public surveys to measure change in attitude or position

- Tracking media coverage
- Monitoring attendance at public meetings

When developing assessment tools, planners choose the methods that best meet the needs of the project. Their scientific defensibility may not be as important as their ability to gauge how targeted stakeholders feel. The feedback should be used to correct previous assumptions about opinions on proposed projects.

Manage change. Change on any project is inevitable. Public involvement programs must address public concerns and perceptions, which are often in flux and can be hard to predict. Even the most subtle change in public sentiment can cause a shift in the public involvement strategy, timing of program elements, and program goals. Public involvement programs must be flexible to respond to events such as election results, pending rules, evolving community issues, and changing stakeholder needs as awareness grows.

Because some changes in public opinion can be anticipated, it may be valuable to assign monitoring responsibility to the most probable risk-related changes. For example, the team member assigned to address political issues should also monitor local elections, candidates, and platforms. Ideally, the public involvement team should develop a change management plan that identifies potential changes in project parameters and public opinion, and methods for addressing them. Creating a flowchart that maps out hypothetical scenarios will help to display the plan. Sometimes public information committees have been used to guide needed mid-course corrections so that the goals of the public involvement plan are met.

Case Study: Norman, Oklahoma, 2060 Strategic Water Supply Plan

The City of Norman, Oklahoma, acting through the Norman Utilities Authority (NUA), provides a case study that exhibits many of the key drivers and elements for water supply planning. Located in central Oklahoma, on the southern edge of the Oklahoma City metropolitan area and home to the University of Oklahoma, Norman's service area, which included about 94,000 people in 2010, is projected to grow to a population of nearly 200,000 in 2060. NUA serves about 85 percent of the overall population of Norman, with the remainder on private domestic groundwater wells.

NUA draws on local groundwater supplies from the Garber-Wellington bedrock aquifer to meet about one-third of current demands, surface water from nearby Lake Thunderbird for about two-thirds of current demands, and intermittent use of treated water from an interconnection with the City of Oklahoma City to meet peak-day demands on an as-needed basis. The NUA *2040 Strategic Water Supply Plan* (SWSP) was developed in 2001, and updated in 2014 as the 2060 SWSP (NUA 2001, 2014).

Promulgation of significantly lower arsenic standards for potable water in the early 2000s led NUA to make an economic decision to shut down a significant number of its existing groundwater wells, rather than implement arsenic removal treatment. Potential future hexavalent chromium standards could prompt a similar future decision for NUA.

Drivers for initiating the 2060 SWSP included the following:

- Projections for significant growth in service area population, and associated increases in demand
- Potential conversion of a portion of the existing domestic well users to NUA water service, and potential future wholesale water sales to neighboring water providers
- Challenges with existing groundwater sources meeting more stringent Safe Drinking Water Act standards (e.g., more stringent arsenic standard promulgated in 2001, and potential new hexavalent chromium regulations in the coming years)

- Anticipated reductions in the estimated firm yield of Lake Thunderbird that will result in a reduction in the permitted amount of annual reservoir supply to Norman
- Potential climate change implications on supply and demand, ranging from projections that suggest that conditions could trend toward warmer and wetter, to hotter and drier for central Oklahoma and its upstream watersheds to the northwest
- Recent years' conservation successes and implementation of Norman's 2011 Water Conservation Plan, as well as implementation of water reuse for irrigation and conversion of certain groundwater wells to nonpotable service, all contributed to downward trends in per capita water use in Norman and in peak-day demand ratio (calculated as peak-day demand divided by annual average demand for a given calendar year)

The development of the 2060 SWSP drew on a range of sources, starting with the previously developed 2040 SWSP. Having already implemented many of the previous SWSP recommendations, NUA built on the 2040 SWSP. It also leveraged data and resources made available by the Oklahoma Water Resources Board's statewide water plan, the 2012 *Oklahoma Comprehensive Water Plan* (OCWP), providing insights into regional supplies and anticipated competition for supplies between multiple future users of each. The OCWP was also used in estimating passive and active conservation savings potential.

Development of the 2060 SWSP was guided by significant public input, and was actively solicited and brought forth at three levels:

1. Public meetings and Web-site materials (general public)
2. Ad Hoc Committee, appointed by City Council to represent key interests in a steering committee role for the SWSP planning team
3. City Council input and approvals.

The 2060 SWSP included supply option identification, screening, and packaging into supply "portfolios" for characterization and ranking. Supply options ranged from existing and new local sources, to additional water reuse for nonpotable demands, to augmenting Lake Thunderbird with highly treated water from Norman's Water Reclamation Facility as indirect potable reuse, to water conservation and new sources of supply, to new regional partnerships for regional supplies. With significant public input, the supply options were screened to those that passed fatal-flaw criteria and were the most cost-effective. Those options were then packaged into water supply portfolios for meeting the annual and peak-day demands through 2060, and evaluated relative to detailed criteria that were reviewed and modified through the public involvement process. The culmination of the 2060 SWSP is a phased, adaptive, water supply implementation plan.

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Chapter **3**

Legal Issues With Water Supplies

WATER RIGHTS IN GENERAL

Water is among the most fundamental concerns of any society. It is, therefore, unsurprising that the regulation of water and water rights has a long and tortuous history as governments decide whether and how to regulate this essential resource. In addition to natural concerns over water quantity and quality, policy judgments also play a role in this decision. Across the United States and throughout history, water law and policy have created a dynamic, continually evolving area of law.

Water rights are defined by statute, by regulation, and by common-law or other tradition. Current water rights and allocation methods reflect the differing conditions and historical influences that are present in different areas of the country. This chapter focuses on three distinct sources of water rights: common law rights, state rights, and federal statutory rights. The appropriation doctrine present in the western United States and the riparian system in the eastern United States illustrate how different approaches to water management are adapted to distinct environments and reflect historic influences.

From a scientific perspective, groundwater and surface water are not distinct resources but are interconnected pieces of the same hydrologic cycle. Traditionally, however, state water laws have addressed groundwater and surface water rights as though the two were separate sources of freshwater. Although this view has changed in some jurisdictions, the law in most states still fails to reflect the hydraulic connectivity of ground water and surface water. This disconnect creates conflicts among water rights holders and the regulators who are confronted with fairly allocating limited resources. It also creates the potential for over-allocation of water supplies in many jurisdictions, which is recognized as a current problem by the US Geological Survey (USGS).

Reflecting the range of influences that shape water allocation methods, water rights programs have long been the province of state—not federal—government. Some states delegate responsibility for water management to local governments, acknowledging that the

nuances of water management may be best served at the local level. At each level of water management, a regulatory body may rely on common law doctrines or court decisions to resolve private disputes. Other state governments may develop sophisticated statutory and administrative arrangements to define individual water rights and to allocate limited water resources.

Ideally, water rights and management systems should be designed to avoid and resolve conflicts between competing uses of water as they occur. To accomplish this, water rights should be

- clearly defined and quantified,
- applied consistently to prospective and current water rights holders, and
- assigned to maximize the benefit of the resource.

The problem is how to define what “maximizes the benefit of the resource.” What constitutes maximal benefit often depends on an individual’s viewpoint. Regardless of the mechanism of determining maximal benefit, a water use allocation method that creates predictability allows water managers to rely on water rights when planning for future demands. By contrast, water rights systems without clearly defined allocation methods, predictability of use, or protection from use or waste by others tend to fail to meet societal demands.

Changing the structure of a state’s water rights system can often be a long and complex process. However, when considering how to structure a water rights method, it is important to consider the underlying and sometimes competing interests of consumptive use, efficiency, conservation, historical allocation, and environmental needs. While no state’s allocation system perfectly balances all these competing interests, water managers should be alert to opportunities to further align a state’s water rights system with the ever-increasing demands for freshwater.

This chapter offers an overview of the existing water rights methods in the United States. It is by no means a detailed study but is designed to provide the reader with a basic background in the fundamental tenants of water law.

SURFACE WATER RIGHTS

Surface water rights in the United States were traditionally divided into two distinct systems: riparian rights in the East and the appropriation doctrine in the West. A more modern picture presents three systems of water rights: (1) riparian* rights, (2) regulated riparianism (which projects a system of permits and government regulation on top of the traditional court-made riparian doctrine), and (3) the appropriation doctrine (also called “prior appropriation”). A comparison of state surface water systems is presented in Table 3-1.

Riparian Rights

Overwhelmingly, riparian rights are used to allocate water in the eastern United States, roughly east of the Mississippi River. Riparian policies evolved naturally in an environment where water was generally plentiful and excessive government involvement was unwanted. The riparian doctrine, sometimes called the “rule of reasonable use,” is patterned after water policy in England, where water resources look much like those of the eastern United States.

* *Ripa* means “riverbank” in Latin.

Table 3-1 Comparison of state surface water systems

State	Riparian	Regulated Riparian	Prior Appropriation
Alabama		X	
Alaska			X
Arizona			X
Arkansas		X	
California			X
Colorado			X
Connecticut		X	
Delaware		X	
Florida		X	
Georgia		X	
Hawaii		X	
Idaho			X
Illinois	X		
Indiana		X	
Iowa		X	
Kansas			X
Kentucky		X	
Louisiana	X		
Maine	X		
Maryland		X	
Massachusetts		X	
Michigan	X		
Minnesota		X	
Mississippi		X	
Missouri	X		
Montana			X
Nebraska			X
Nevada			X
New Hampshire	X		
New Jersey		X	
New Mexico			X
New York		X	
North Carolina		X	
North Dakota			X
Ohio	X		
Oklahoma			X
Oregon			X
Pennsylvania	X		
Rhode Island	X		
South Carolina	X		
South Dakota	X		
Tennessee	X		
Texas			X
Utah			X
Vermont	X		
Virginia		X	
Washington			X
West Virginia	X		
Wisconsin		X	
Wyoming			X