Manual of Water Supply Practices

M50

Water Resources Planning

Third Edition

American Water Works Association

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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.