

**An Assessment of  
Municipal Drought Contingency Planning  
in Texas**

by

Bill G. Billingsley

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Dr. Patricia M. Shields

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# ABSTRACT

## An Assessment of Municipal Drought Contingency Planning in Texas

Water availability is an important environmental issue in the United States. Since water is becoming more a limited natural resource, water policy will be a primary source of controversy, specifically during periods of drought. Recent widespread droughts have raised concerns about our nation's vulnerability to periods of water shortages. It is imperative that public administrators of municipal water supply systems develop drought contingency plans that deal with water shortages in a timely and systematic manner because droughts are a normal part of the climate for most regions, especially for Texas.

The purpose of this research is twofold. The first purpose is to explain the ideal components of a municipal drought contingency plan. The elements include public involvement, drought response triggering criteria, successive stages of response, drought response management measures, enforcement and plan adoption. The next objective is to assess the drought contingency plans of retail public water suppliers submitted to the Texas Commission on Environmental Quality (TCEQ) to determine which retail public water suppliers utilized the model drought contingency plan and how close all the plans met the ideal components. The overall assumption of this research is that the model drought contingency plan developed by the TCEQ is an effective tool for retail public water suppliers in Texas to aid them in meeting the regulatory components of drought contingency plans.

The first portion of this research examines, from a national level, the concept of drought, drought impacts, future impacts facing municipal public water suppliers, problems with traditional drought planning, drought policy, and lessons learned from previous droughts. A conceptual framework for a municipal drought contingency plan is developed from the review of available literature. The purpose of the review is to explain the components of an ideal plan.

The paper later focuses on Texas, the setting for this research. A brief overview of Texas droughts and projections are presented. A description is provided for both the model drought contingency plan and the municipal drought contingency plans selected for assessment.

The later part of the paper discusses the methodology used to assess the municipal drought contingency plans submitted to the TCEQ by retail public water suppliers in Texas. Content analysis is used to determine which municipal public water suppliers utilized the TCEQ model drought contingency plan in developing their plans and which did not. After determining which suppliers utilized the model, content analysis is further used for each of the drought contingency plans to determine which ideal components are included in all of the plans. A discussion of how the practical ideal type of a municipal drought contingency plan is operationalized into measurable items for assessment is provided. The findings of the analysis confirm that the model plan in Texas is an effective tool for retail public water suppliers in meeting the required components of drought contingency plans.

The paper concludes with a summary of the research findings in relation to the practical ideal type of the model drought contingency plan in Texas and concludes with recommendations and suggestions for additional research.

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“When the well’s run dry, we know the worth of water.”

- 18<sup>th</sup> Century Scottish Proverb

“The test of progress is not whether we add more to the abundance of those who have much; it is whether we provide enough for those who have little.”

- Franklin Delano Roosevelt

## Chapter 1

### INTRODUCTION

Water availability is an important environmental issue in the United States. Many regions throughout the nation are characterized by increasing populations, increasing water demand, changing

trends and patterns of water use, changes in social behavior, and growing environmental awareness. Water availability is becoming more limited and water policy will continue to be a primary source of controversy, especially during periods of drought conditions. Droughts are a normal part of the climate for most regions. Recent widespread periods of drought conditions, such as in the East and West portions of the United States, have lead to many communities issuing mandatory water restrictions. The nation has also been plagued with the impacts associated with drought. For Texas alone, drought-related losses from the 1996 drought have been estimated at nearly \$5 billion (Wilhite 2000, p 697).

These issues have raised concern about our vulnerability to periods of water shortages and have captured national attention. To reduce the nation's vulnerability, developing drought contingency plans that deal with water shortages in a timely and systematic manner is imperative for public administrators of municipal water supply systems.

## What is a Drought Contingency Plan?

Because widespread periods of drought conditions emphasize vulnerability, there is a need for a proactive approach to drought management that places emphasis on preparedness planning. Drought contingency planning is a principal tool to improve responses to drought (Wilhite, et al 2000, p. 697).

A distinction must be made between water conservation planning and drought contingency planning. The goal of water conservation planning is to achieve lasting, year-round water use efficiency improvements for the purpose of extending existing water supplies. By contrast, a drought contingency plan is focused on a temporary supply management and demand management response to temporary and potentially recurring water supply shortages and other water supply emergencies (TC&B 1998, p. 2).

Title 30 of the Texas Administrative Code (TAC) Chapter 288 directed all retail public water suppliers in Texas to develop drought contingency plans meeting all of the mandated plan components. The Texas Commission on Environmental Quality (TCEQ) developed a model drought contingency plan to aid water suppliers in plan development to construct plans that would meet all of the plan elements as mandated by Title 30 TAC Chapter 288. The TCEQ made the model available to all of the retail public water suppliers in Texas. The water suppliers were given the option of either utilizing the model to create their drought contingency plans or to develop a plan on their own. Retail pubic water suppliers that provide

water service to 3,300 or more connections were specifically required to submit their completed drought contingency plans to the TCEQ.

## Research Purpose

The purpose of this research is twofold. The first purpose is to explain the ideal components of a municipal drought contingency plan. The next objective is to assess the drought contingency plans of retail public water suppliers submitted to the TCEQ to determine which retail public water suppliers in Texas utilized the model drought contingency plan and how close all the plans met the ideal components. The working hypothesis of this research is that the TCEQ's model drought contingency plan serves as an effective tool for retail public water suppliers in Texas to meet the required components of drought contingency plans in accordance with the mandates of Title 30 TAC Chapter 288.

## Chapter Summaries

Chapter Two examines national drought concerns. These concerns include the ambiguous concept of drought, drought impacts, lack of a comprehensive definition of drought, problems with traditional drought planning, drought policy, and lessons learned from previous droughts.

Chapter Three provides an explanation of the ideal components of a municipal drought contingency plan. The first purpose of this research is fulfilled in this chapter.

Chapter Four explains the setting for the research. A brief overview of Texas droughts and projections for water availability in the State is provided. The chapter discusses the mandatory drought contingency plan required in Texas and concludes with a description of the plans required to be submitted to the TCEQ.

The focus of Chapter Five is on the Texas model drought contingency plan. An overview is provided of the development of the model plan and publicizing of the model to the water community in Texas. The working hypothesis of the research is introduced in this chapter.

Chapter Six discusses the methodology (content analysis) used to assess the municipal drought contingency plans submitted to the TCEQ by retail public water suppliers. More specifically, this chapter

discusses the data collection methods and statistics used to develop the findings of the research. A brief overview of the data collection is provided. This chapter concludes with a discussion of how the practical ideal type of a municipal drought contingency plan is operationalized into measurable items for assessment.

Chapter Seven presents the findings of the content analysis. The water suppliers that utilized the model drought contingency plan, as well as those that did not, are identified. The remainder of the findings are organized by the categories as identified in the conceptual framework of a drought contingency plan. The results reveal the percentages of each component that was included in the plans for both the water suppliers that utilized the model drought contingency plan and those suppliers that did not. The second purpose is achieved in this chapter.

Finally, Chapter Eight summarizes the research findings in relation to the use of the practical ideal type of the model drought contingency plan. The chapter provides the evidence to confirm that the TCEQ's model drought contingency plan is an effective tool for retail public water suppliers in meeting the required components of drought contingency plans in accordance with the mandates of Title 30 TAC Chapter 288. The chapter concludes with recommendations and provides suggestions for additional research.

## Chapter 2

# NATIONAL DROUGHT CONCERNS

### Purpose

The primary function of drought contingency planning is to ensure the uninterrupted supply of water in an amount sufficient to satisfy essential human needs. The purpose of this chapter is to explore, from a national level, the concept of drought, drought impacts, the lack of a comprehensive definition of drought, problems with traditional drought planning, national drought policy, and lessons learned from previous droughts.

### Concept of Drought

Water availability is a meaningful environmental concern in the United States. Many regions throughout the Nation are marked by “increasing and shifting population, increasing urbanization, changing trends and patterns of water use, changes in social behavior, and growing environmental awareness and concern” (Wilhite 1997a, p. 2). Municipal use is also the fastest growing sector of water use (USACE 1998, p. 7.9). Because water is a limited natural resource, water policy will be a primary source of controversy, especially during periods of drought.

While drought conditions can severely disrupt the normal availability of water, drought is a normal part of the climate for virtually all areas of the United States. Drought, like many natural disasters, can cover large regions of the United States. Wilhite (1997a, p. 4) argues that drought differs from other natural hazards in many ways. First, he asserts that it is a “creeping phenomenon” that makes its onset and end difficult to determine. The effects of drought accumulate slowly over a considerable period of time and may linger for years after the termination of the event. Second, he maintains that the absence of a precise and universally accepted definition of drought adds to the confusion about whether or not a drought exists and, if it does, to what severity. Third, Wilhite (1997b, p. 6) notes that drought impacts are less obvious and spread over a larger geographical area than the damages that result from other natural hazards. Additionally, drought seldom results in structural damage. For these reasons, Wilhite finds that the

quantification of impacts and provisions of disaster relief is a far more difficult task for drought than it is for other hazards.

Woodhouse and Overpeck (1998, p. 2693) reviewed data regarding the frequency and severity of drought in the central United States over the last two thousand years. Based upon empirical evidence of drought from various proxy data indicators, they discovered the presence of numerous "multidecadal to centuryscale droughts," which lead them to conclude that twentiethcentury droughts are not representative of the full range of drought variability that has occurred over the last 2000 years. In addition, the authors noted that the most recent century has been characterized by droughts of "moderate severity and comparatively short duration, relative to the full range of past drought variability" (Woodhouse and Overpeck 1998, p. 2712).

With respect to the causes of drought, Woodhouse and Overpeck suggest a number of different possibilities that either directly or indirectly induce changes in atmospheric circulation and moisture transport, causing drought conditions. They caution, however, that the causes of droughts with durations of years (i.e., the 1930's) to decades or centuries are poorly understood (Woodhouse and Overpeck 1998, p. 2711).

What this suggests for the future is that "droughts more severe than those of the 1930's and 1950's are likely to occur in the future." Because severe and longlasting droughts for the central United States have been shown to be more normal than conditions of the past century, Woodhouse and Overpeck (1998, p. 2711) argue that any intensification of droughts that might occur in the future may not be caused by global warming, especially in light of society's ignorance of the causes of extremely long droughts experienced in this region of the Unites States centuries ago.

## Drought Impacts

During the past century, the United States has been plagued by numerous major droughts. In fact, it is unusual for drought not to occur somewhere in the nation each year. Droughts of both long and short duration produce significant impacts (Wilhite 1991, p. 29). After a major drought, it is common for researchers and economists to study the impacts of the drought. The impacts, however, can be difficult to

measure. The primary impact of drought is a shortage of water whereas the secondary impacts are the indirect effects of the shortage. Table 2.1 is a comprehensive list of the secondary impacts associated with drought-related conditions (Yevjevich, et al 1978, pp. 55-58). The table is categorized into three types of drought-related impacts. They are economic, environmental, and social repercussions.

Each of these drought-related impact types have increased significantly in recent decades (Wilhite, et al 2000, p. 709). Wilhite (1991, p. 32) also notes that “economic, environmental, and social impacts and values often clash as competition for scarce water resources intensifies.” Fortunately, as Cunh (1983, p. 10) points out, drought is a slow evolution that seldom causes drastic losses to human life, except through famine.

According to Water Management During Drought, impacts caused by drought are difficult to separate from impacts that occur coincidentally during a drought (USACE 1995, p. v). Because droughts continue for much longer than floods, earthquakes, or wind storms, external factors (such as land management and fish practices) may also contribute to, or mitigate, the impacts associated with drought (USACE 1995, p. v).

While measuring a specific secondary drought impact is difficult, if not impossible, some historical studies estimate that the federal government spent \$3.3 billion responding to the 1953-1956 drought, at least \$6.5 billion during the 1976-1977 drought, and about \$6 billion during the 1988-1989 drought (NDPC 2000, p. 1). More recently, drought-related losses from the 1996 drought have been estimated at nearly \$5 billion just for Texas alone (Wilhite, et al 2000, p. 697).



Table 2.1 - Secondary Drought-Related Impacts

Economic Impacts  
 Economic loss from drought-impacted dairy and beef production  
 Economic loss from drought-impacted crop production  
 Economic loss from drought-impacted timber production  
 Economic loss from drought-impacted fishery production  
 Economic loss from drought-impacted recreational businesses  
 Economic loss to manufacturers and sellers of recreational equipment  
 Economic loss to industries impacted by drought-related power curtailment  
 Economic loss to industries directly dependent on agricultural production  
 Unemployment from drought-related production declines  
 Strain on financial institutions (foreclosures, greater credit risks, capital shortfalls, etc.)  
 Revenue loss to state and local government (reduced tax base, hunting and fishing license fees, etc.)  
 Revenue to water supply firms  
 Economic loss from impaired navigability of streams and rivers  
 Cost of water transport or transfer  
 Cost of new or supplemental water source development  
 Environmental Impacts  
 Soil erosion and resulting dust storms  
 Forest fires  
 Increased concentration of pollutants  
 Damage to animal & plant species  
 Water quality effects (salt concentration)  
 Visual and landscape quality  
 Social Impacts  
 Public safety from forest and range fires  
 Health-related low flow problems (diminished sewage flows, increased pollutant concentrations)  
 Inequity in the distribution of drought impacts/relief  
 Lifestyle impacts (unemployment, loss of savings, uncertainty, recreation, personal hygiene)

Wilhite and his research associates (1987, p. 582) point out that measuring first-order impacts (e.g., water shortages) is easier than assessing second-to-nth order impacts such as economic losses in local and regional economies (e.g., unemployment). The problem of measuring secondary impacts is heightened by the fuzzy concept of drought. While researchers may link indirect impacts like mortgage default to other natural disasters such as floods or tornadoes, the creeping and pervasive nature of drought make such linkages less clear. The next portion of this section briefly discusses additional economic, environmental, and social repercussions to drought.

Economic Impacts. Specific economic impacts caused by drought are difficult to measure due to “agitating elements, such as an overlapping recession” (USACE 1998, p. 7.9). Of all the drought impacts in Table 2.1, the economic effects are usually the most important because they are essential in adequately assessing the repercussions (Cunh 1983, p. 6). As indicated in Table 2.1, economic impacts can range anywhere from agricultural and recreational losses to the cost of transporting water or developing new water sources (Yevjevich, Hall, and Salas 1997, p. 55). Economic losses caused by drought are, however, found mainly in the production of crops, cattle, industrial goods, and hydro-power (Cunh 1983, p. 6).

Environmental Impacts. Drought impacts include more than just monetary losses. Significant environmental impacts are also experienced. As exhibited in Table 2.1, drought effects usually produce secondary environmental percussions. Important impacts include soil erosion and resulting dust storms, forest fires, plant diseases, insect plagues, increased concentration of pollutants, and the consequent degradation of water quality (Cunh 1983, p. 6). Equally significant are the environmental impacts that threaten endangered or sensitive species (Young 1995, p. 785) and the deterioration in the quality of visual landscapes (Cunh 1983, p. 6). Droughts, together with floods, tropical cyclones, and earthquakes, are considered responsible for more than “90 percent of all the losses” caused to the environment by natural

forces (Cunh 1983, p. 8). Other natural hazards, such as volcanoes, landslides, avalanches, tornadoes, tsunamis, and fires, although of significant local importance, are of much smaller global significance. Furthermore, the impacts of drought on the environment and society often linger for years after the drought has passed.

Social Impacts. Social impacts, as listed in Table 2.1, can range anywhere from stress-related illnesses such as public safety from forest fires to lifestyle impacts such as unemployment, loss of recreational activities, and personal hygiene (Yevjevich, et al 1997, p. 58). The final two portions of this section discuss recent effects and future impacts facing municipal water suppliers.

Recent Impacts. Some recent concerns from drought-related conditions in the United States (Western Governor's Association letter to Congress, August 5, 2002) include:

1. low water supplies from East to West leading to many localities requesting voluntary or issuing mandatory water restrictions,
2. low well levels or dried up wells (with water hauling in some communities), and
3. widespread record or near-record low streamflows in many areas of the U.S.

It is important to note that policies designed to minimizing drought impacts are faced with a “moving target” because water demands can increase and diversify (USACE 1998, p. 7.10). As with all issues surrounding the adaptation of the world to natural disasters, policies that produce success for one water supplier may be unsuccessful in another due to the uniqueness of every water system and community. An equally important point, according to Wilhite and his research associates (2000, p. 582), is to avoid the pitfall of focusing only on the impacts of drought and ignoring the effects and interrelationships of decisions made and actions taken by public officials and administrators during non-drought periods. Future impacts confronting municipal water suppliers must be looked at as well.

Future Impacts Facing Municipal Water Suppliers. Public water use is the fastest growing category among major users (Young 1995, p. 1) and future strategies for satisfying needs for public water systems in the United States today are much different from those a few decades ago. While the price of water to homeowners may be relatively inexpensive when supplies are ample, during periods of acute water shortages, the value of water may increase substantially. The presence of drought is usually manifested

when dwindling water supplies necessitate emergency procedures by the water supplier. Examples of emergency procedures can include mandatory water restrictions, hauling of water, installing of emergency pipelines to new water sources, or securing emergency water releases from upstream dams (Riggio, et al 1987, p. 63).

According to Moreau (1991, p. 117), certain issues are driving water suppliers to seek more efficient uses of existing sources as an alternative to expanding supplies. These concerns include increased worries about the public-health aspects of drinking water, declining number of water sources, consideration of environmental consequences resulting from new impoundments, and greater competition for water resources. Wilhite (1997a, p. 5) predicts that future droughts will produce greater impacts because the demand for water increases the vulnerability of society to drought-related water supply interruptions, with or without any increase in the frequency and intensity of drought. He further notes that “it must be accepted that the importance of drought relies in its impacts” (Wilhite 1997a, p. 4).

Water supply depletion during drought could ultimately result in future financial constraints on public water suppliers. This depletion could materialize into added financial burdens by securing additional water sources and developing the necessary infrastructure for the system. These financial strains are ultimately paid for by the citizens that the water suppliers serve. Wilhite (1991, p. 33) argues that these costs must be weighed against the losses that may result in the absence of a contingency plan for drought. The potential impacts to municipal public water suppliers further support the need for a timely and systematic approach to drought contingency planning by every municipal water supplier.

## Lack of a Comprehensive Drought Definition

Because drought affects many economic and social sectors, scores of drought definitions have been developed by a variety of disciplines. There is, however, no universally accepted or comprehensive definition of drought (Wilhite 1997a, p. 4). For example, the National Drought Policy Commission (NDPC) provides a generic definition of drought as a starting point: “Drought is a persistent and abnormal moisture deficiency having adverse impacts on vegetation, animals, or people” (NDPC 2000, p. 3). The NDPC suggests that the definition of what drought is and what drought is not has profound implications for

the environment and all segments of society, yet it may be different for each.

The National Oceanic and Atmospheric Administration (NOAA), on the other hand, defines drought as a “period of abnormally dry weather which persists long enough to produce a serious hydrologic imbalance (for example crop damage, water supply shortage, etc.).” NOAA asserts that the severity of drought depends upon the degree of moisture deficiency, the duration of the condition, and the size of the affected area. NOAA uses four different operational definitions of drought. They are meteorological, agricultural, hydrological, and socioeconomic. A meteorological drought is “a measure of the departure of precipitation from normal.” Due to climatic differences, what is considered a drought in one location may not be a drought in another. An agricultural drought refers to “a situation when the amount of moisture in the soil no longer meets the needs of a particular crop.” A Hydrological drought “occurs when surface and subsurface water supplies are below normal.” And finally, a socioeconomic drought refers to “the situation that occurs when a physical water shortage begins to affect people” (NOAA, 2000).

Droughts, as defined in the Water Management During Drought, are “periods of time when natural or managed water systems do not provide enough water to meet established human and environmental uses because of natural shortfalls in precipitation or streamflow” (USACE 1995, p. 1).

Obviously a universally accepted definition of drought does not exist. Since drought occurs with varying frequency in nearly all regions of the globe and in all types of economic systems, Wilhite suggests that the approaches taken to define drought should be impact and region specific. He maintains that the “lack of a precise and objective definition in specific situations has been an obstacle to understand drought, which has led to indecisions and inaction on the part of managers, policy makers, and others” (USACE 1995, p. 4). Therefore, it is imperative for individual water suppliers to draw upon past and current conditions to develop their own definitions and concepts of drought. Specific definitions will facilitate the preparation of contingency plans for future drought conditions.

## Problems with Traditional Drought Planning

Aside from the impacts associated with drought and the lack of a universally accepted drought definition, additional problems exist. The General Accounting Office (GAO) first reported in 1979 that the

traditional mind set of government in the United States was to react to drought through emergency assistance to affected areas of the nation. However, by following this approach, drought only received the attention of decision makers during peak drought conditions and when options for administrators managers were limited. The GAO characterized this approach as ineffective and poorly coordinated (GAO 1979, p. 11). This strategy was not only costly but relief was usually misdirected and driven by politicians rather than by public administrators. This “crisis management” approach, as concluded by the GAO, was poor policy and needed to be replaced by a preventive design that reduced risk through the management of water with appropriate policies and planning. According to Wilhite (1997, p. 951), crisis management responses were hastily prepared and executed during the peak of drought severity and usually did little to lessen the impacts.

The U.S. Army Corps of Engineer (USACE 1991, p. v) further reported that the problems in water management during droughts were manifestations of water management difficulties in general. They found

five typical problems with traditional drought plans. These plans:

1. did not recognize newer uses of water;
2. were usually designed for the drought of record and were not understood or endorsed by the public;
3. did not sufficiently address equity issues or economic differences in the use of water;
4. were often triggered by indicators not related in a known way to impacts; and
5. were better characterized as documents rather than ways of behaving, and their effectiveness diminished as staff changes occurred and as time passed between plan preparation and drought.

In the 1995 revision to the Water Management During Drought, the U.S. Army Corps of Engineers indicated that “just as recessions may reveal weaknesses in management practices of a company that made money when business was good, these droughts revealed weaknesses in water management systems which were hidden in the years when water was plentiful” (USACE 1995, p. v). Technology and social change are improving our nation’s ability to manage water and other shared natural resources more effectively during periods of drought shortages. These changes are anticipated in non-drought times due to growing population, water pollution, and leaks in distribution systems (USACE 1998, p. 7.9).

More recently, Wilhite and his group of research colleagues (2000, p. 582) reported that actions taken during non-drought periods often determined the level of vulnerability to future droughts. Overall,

the public water suppliers that did nothing during periods when water was plentiful were also those systems that later experienced drought-related impacts to their communities when water was more scarce.

## National Drought Policy

In 1998, Congress created the National Drought Policy Commission (NDPC) and challenged them to recommend improvements to national policy. The NDPC developed a national drought policy statement with preparedness as its foundation and outlined a course of action that included a preparedness initiative to help reduce the damages and costs of drought. The statement used as the basis of national drought policy was: “National drought policy should use the resources of the federal government to support but not supplant nor interfere with state, regional, local, tribal, and personal efforts to reduce drought impacts” (NDPC 2000, p. 1).

This policy required a shift from the previous emphasis on drought relief. It required the NDPC to adopt a forward-looking stance to reduce the nation’s vulnerability to the impacts of drought. More specifically, it stated that “drought planning, plan implementation, proactive mitigation, risk management, resource stewardship, consideration of environmental concerns, and public education—must become the cornerstone of national drought policy” (NDPC 2000, p. 2).

The NDPC found that drought preparedness (including drought planning, plan implementation, proactive mitigation measures, and public education) may “reduce the social, economic, and environmental impacts of drought and the need for federal emergency relief expenditures in drought-stricken areas” (NDPC 2000, p. 2). Wilhite (NDPC 2000, p. 9) further suggests that water policies must be flexible so that changes in water demand and social priorities can be incorporated with relative ease.

While the national drought policy has been under discussion for some time, it took another series of severe droughts to remind states and localities that the crisis management approach was not effective (Wilhite, et al 2000, p. 698). This was significant enough that federal legislation was recently proposed. The legislation would create the National Drought Preparedness Act of 2002. The passage of the bill would:

1. put in place a comprehensive national drought policy that statutorily authorizes a lead federal agency for drought, and delineates the roles and responsibilities for coordinating and integrating federal assistance for droughts;
2. move the country away from the costly and response-oriented approach to drought, similar to what the nation has in place for other natural disasters such as hurricanes, floods, and tornadoes;
3. improve forecasting and monitoring; and
4. provide new tools for drought preparedness planning.

As emphasized in the proposed bill above, providing new tools for drought preparedness planning is an area necessitating action in national water policy. This proposed legislation provides additional rationale for this research.

## Lessons Learned from Previous Droughts

Efforts have been made to reduce the nationwide vulnerability to drought. Unfortunately, droughts are often dealt with poorly. They are “too rarely documented, critically analyzed, and shared with other regions” (USACE 1995, p. xv). For the most part, previous responses to drought in the United States have been reactive, representing the crisis management approach. This reactive approach, as characterized by Wilhite and his research associates (2000, p. 709), has been “ineffective, poorly coordinated, and untimely; more important, it has done little to reduce the risks associated with drought.” Lessons of the past strongly suggest that a proactive approach to drought management is a more effective mitigation tool than the reactive approach (Wilhite 1991, p. 29).

Moreau and Little (1989, p. 3) conducted a study of experiences in the United States of public water suppliers during the 1986-1989 nationwide drought. They estimated that half of all the water supply utilities in the United States were adversely affected by drought conditions and had asked their customers to reduce water consumption. More important, they reported that less than 30 percent of all water suppliers in the United States who served more than 10,000 connections did not have a quantitative decision support system (i.e., criteria for initiation of response stages and action measures) in place (Moreau and Little 1989, p. 1). Furthermore, the existence of a decision support system had a positive effect on the level of satisfaction among water managers with their decisions. They also reported that the existence of a drought policy had a favorable effect on the effectiveness of water conserving programs.

Another notable study, commissioned as part of the U.S. Army Corps of Engineers (USACE, 1993), examined a broad range of issues associated with the experiences of water suppliers during drought.

Three relevant conclusions are of particular interest. They are:

1. careful and more realistic drought planning is needed;
2. urban water users will reduce water use if they believe that the water supply problem is real, the drought contingency plan is fair, hardships associated with reducing water use are manageable, and their individual actions to reduce water use will make a difference; and
3. early response to drought conditions and the proper timing of drought response measures are essential in short-term drought management.

To better prepare for future droughts, the public administrators of the water resource community should include drought planning as an essential component of water policy. Most experts, such as the U.S. Corps of Engineers, agree that “better planning, better data, better analytical techniques, and a more coordinated, cooperative and communicative response” would greatly improve water management during drought (USACE 1998, p. 7.10). Lessons learned from drought allow society to adjust and adapt to the increasing demand and competition for water. Learning from past experiences allows the public administrator to develop a comprehensive and realistic drought contingency plan that is based on a timely and systematic approach to planning. Additionally, sharply focused drought contingency plans, prepared in advance, could greatly assist the government and public water suppliers in the early identification of drought and “lessen personal hardship, improve the economic efficiency of resource allocation, and ultimately reduce drought-related impacts” (Wilhite 1991, p. 29).

## Moving Towards a Proactive Approach

Drought contingency planning is a proactive approach that addresses one area of disaster preparedness. As previously stated, the primary purpose of drought contingency planning is to ensure an uninterrupted supply of water in an amount sufficient to satisfy essential human needs. Another purpose of the drought contingency plan development process, as identified by Wilhite (1991, p. 29), is to “improve mitigation efforts through more timely, effective, and efficient assessment and response activities.” Wilhite also stresses that experience, the expectation of future droughts, and the desire to improve future response



efforts are also key factors in the decision to pursue plan development (1991, p. 30).

McEntire (2002, p. 274) acknowledges that preparedness and planning measures are “strong determinants of whether a community will reduce its future vulnerability during a disaster” and asserts that the lack of preparation may increase the vulnerability of communities to a disaster. Wilhite (1997a, p. 16) further states that drought plans are the “foundation for improved drought management in the United States.” Moreau (1989, p. 3) reports that for water suppliers during the droughts of 1986 and 1988, less than half of the water utilities had a drought contingency plan in place. He also discovered that the suppliers that had a drought contingency plan in place improved the effectiveness of water demand management measures.

A proactive approach to drought is obviously crucial for a water supplier to remain viable. Improving future drought response efforts is achievable through the development of a drought contingency plan that includes meaningful elements.

## Conclusion

There is not a clear-cut definition of what a drought is. The definition depends greatly on the individual water supplier. This places the responsibility on the water supplier to determine if they are in a drought. Therefore, the individual municipal water supplier must draw upon past and future conditions in developing their own definition or concept of drought. Drought conditions affect individual water suppliers in differing degrees. The secondary impacts, as a result of a water shortage, are economic, environmental, and social. Water suppliers must ultimately develop their own operational definition based upon their specific system and their water supply and demand issues. They must also draw upon lessons learned from previous experiences throughout the nation to reduce their own vulnerabilities. This process is accomplished through comprehensive drought contingency planning.

## Chapter 3

# FRAMEWORK FOR A MUNICIPAL DROUGHT CONTINGENCY PLAN

### Purpose

The purpose of this chapter is to explain the conceptual framework for a municipal drought contingency plan through the careful review of available literature. Because drought contingency planning is so important, the State of Texas contracted with Turner, Collie, & Braden Inc. (TC&B) to develop an ideal model that could be used by municipalities to develop their own plan. Appendix A is the model drought contingency plan for retail public water suppliers in Texas.

The model includes the quintessential components that are to be expected in an ideal municipal drought contingency plan. These elements include public involvement, drought response triggering criteria, successive stages of response, drought response management measures, enforcement and plan adoption. This chapter describes the ideal components of a plan. Each element is described in more detail and additionally supported by the study of available literature. The first component described is public involvement.

### Public Involvement

Citizens unfortunately feel that they have little impact on what government does. According to King and Stivers (1998, p. 12), the perception of government by the public is that government exercises too much power and in the wrong ways, is inefficient and wasteful, and appears to care little about ordinary citizens, their lives, and their problems. They contend that when citizens voice anti-government feelings, what they mean is that “government is remote and disconnected from ordinary life” (1998, p. 11). The only way to overcome this perception, as determined by King and Stivers, is to “invite the public into the process and give government back to its rightful owners” (1998, p. 100).

By attempting to overcome negative perceptions, decision makers in government are becoming more compelled to seek citizen input in determinations that affect the public, not only because it may be a

legislative mandate, but also because it is “good business” (Glicken 1999, p. 298). Glicken asserts that decisions affecting the public, particularly technical determinations, have historically been made with input from “selected stakeholders only, primarily those with public responsibility for the decisions and those with applicable technical expertise in the appropriate area” (1999, p. 298). King and Stivers (1998, p. 99) insist that it is necessary for public administration to abandon the expectation that the administrator should be the sole expert in the policy implementation process. They further argue that public administrators must have the “courage to step away from the comfortable identity as managers and neutral efficiency experts and be open to the knowledge that ordinary lived experience provides.” King and Stivers also believe that administrators should become “facilitators and partners with citizens” (1998, p. 110) and should leave behind any “arrogance of expertise” (1998, p. 100). They further contend that in order for truly effective long-term solutions to contentious political problems to occur, what must develop is “an open, inclusive process where administrators welcome citizen participation as essential to their work rather than as a challenge of their own expertise.” After all, it is the public who must live with the consequences of policy decisions.

To that end, the broader public is demanding more “direct involvement in decisions that will affect their lives” (Glicken 1999, p. 298). Campbell and Marshall (2000, p. 339) reiterate the need for a more “sophisticated approach to thinking about the role and purpose of public involvement in contemporary planning practice.” If planning is to include concerns of the collective good, particularly in social justice and environmental responsibility, “extreme care will need to be taken in the role conceived for public participation” (Campbell and Marshall 2000, p. 340).

What exactly is the role for public involvement in plan making? King and Stivers (1998, p. 157) suggest that the challenge is to develop structures and processes that will “value technical and professional knowledge and integrate citizens into the governance process.” This involves a more collaborative relationships and partnerships between citizens and public administrators. This partnership role, accordance to King and Stivers (1998, p. 157), emphasizes “civic problem solving and civic capacity building with government increasingly acting as the facilitator of problem-solving processes rather than the problem solver.”

Campbell and Marshall (2000, p. 341) state that given the multifaceted nature of the problems which policy makers deal with, public administrators need help in “making connections between the social, economic and political, and perhaps most importantly questioning their own assumptions and taken-for-granted preconceptions.” Additionally, King and Stivers (1998, p. 151) contend that policy makers must have the skills to “promote consensus building and collaborative problem solving.”

Why encourage public participation? The justification for public involvement rests on the very fundamental premises of democracy. The relation between democracy and bureaucracy, as indicated by King and Stivers (1998, p. 71), is “enacted in the daily lives of bureaucrats and citizens and in their interactions with one another.” The fundamental justification for public involvement, according to Creighton (1980, p. 3), is that basic axiom of democratic society that the government derives “from the consent of the governed.” Furthermore, the public interest in a democracy is whatever people can agree upon. The agreement of the people is accepted as the final arbiter because, as Creighton confirms, any claims to the “absolute knowledge of the public interest based on religious truth, divine right, or technical expertise potentially from the basis from for the claims of a theological, aristocratic, or scientific elite and are a threat to democratic society” (Creighton 1980, p 15). In the words of Thomas Jefferson (1820):  
I know of no safe depository of the ultimate powers of the society but the people themselves.  
And if we think them not enlightened to exercise their control with wholesome discretion, the remedy is not to take it from them but to inform their discretion.

Additionally, Glicken (1999, p. 302) asserts that “[public participation] contributes to the competence of decision makers through the generation of better decisions, provides greater “legitimacy” to those decisions through greater accountability on the part of the decision maker, and constitutes part of the proper conduct of a democratic society.” It is in this manner, according to Glicken, that the public can hold the government accountable for its actions, and thereby both protect the rights of the citizenry and ensure the support of the citizenry for governmental actions.

King and Stivers (1998, p. 100) further maintain that “recognition of legitimacy and acceptability of administrative discretion provides the foundation for transformative action.” In the long run, building a consensus on policy is better than the ongoing conflict that can result from decisions made solely by

government. An important ingredient in building a consensus, as argued by King and Stivers (1998, p. 153), is the “sharing of power between government and citizen groups at all stages — from the problem-setting stage to taking credit for the success.”

Creighton (1980, p. 3) also attests that government must have “legitimacy” and believes that without it, every action of government would be “questioned and resolved only through the use of force.” He believes that no agency can survive if every action it takes is challenged or questioned. But to achieve this legitimacy, as Creighton maintains, an agency’s decision-making process must have a visibility and credibility that creates legitimacy.

By providing input directly to a decision maker on a specific issue, according to Glicken (1999, p. 304), citizens feel their views are “directly represented in the decision-making process, and so they believe they have a part in crafting the decision itself.” This buy-in or “ownership” of the decision through participation produces a greater commitment to the decision and increases the likelihood that it will be honored through social action. In the decision-making process, Campbell and Marshall (2000, p. 341) point out that it is important to keep in mind that the purpose of public involvement in this process is not, however, to move from a system of representative democracy to participatory democracy; rather, it is to “inform the process of plan making.”

\_\_\_\_\_Public participation also contributes to vulnerability reduction through the process of plan making. McEntire and his colleagues (2002, p. 275) note that legislators pass laws to encourage the enactment of preparedness measures but the citizenry play the crucial role when it comes to actual vulnerability reduction. The public’s vulnerability is often determined by their “values, attitudes, and practices.” McEntire also asserts that apathy shown toward disaster and the environment, as well as the defiance of disaster legislation, are major explanations for increased vulnerability. The low degree of personal responsibility often shifts vulnerability to other people or the government. Comprehensive management of vulnerabilities is particularly important for citizens in order to reduce the impacts of disasters. Therefore, McEntire maintains that it is imperative for government and the community to work together to diminish risk and build resistance and resilience (McEntire, et al 2002, p. 275).

\_\_\_\_\_King and Stivers (1998, p. 151) indicate that one of the concerns often voiced by public officials is

that the “issues are too technical for citizens to grasp all the implications of the various issues.” A particular issue facing public administrators and citizens is the concern for our water resources.

Public Involvement in Water Resources. Thomas (1993, p. 444) contends that the desirable degree of public involvement in decision-making varies depending on the issue. Specific to issues encompassing water policy, Pierce and Doerksen (1976, p. v) noted as early as 1976 that public involvement is “central to water resource politics.” Creighton (1980, p. 1) defines public involvement in water resource services as a “process, or processes, by which interested and affected individuals, organizations, agencies and governmental entities are consulted and included in Water Resources Service decision-making.” Pierce and Doerksen (1976, p. 17) maintain that the role of the public, in making decisions about water policy, “rests on the assumption that in fact there exists real policy alternatives.” To lessen conflicts rising from policy alternatives, in an effort to develop satisfactory solutions specific to drought contingency planning, it is essential that “the views of citizens and environmental interest groups are considered” at an early stage of the planning process (Wilhite 1991, p. 29).

There are three aspects of public involvement in drought contingency planning that are further discussed in this section. The aspects are public involvement in drought contingency plan preparation, notification to water users when the plan is implemented and terminated, and a program of continuing public education and information.

Plan Preparation. The first aspect of public involvement is citizen participation in the development of the drought contingency plan. As reported in TC&B’s survey and evaluation, the starting point for the development of a plan is to “provide the public with an opportunity to participate directly in the planning process” (TC&B 1998, p. 16). Once a drought contingency plan is implemented, the success of the plan depends heavily upon how well the “public understands the need for and goals of the plan, as well as the degree to which the public complies with the drought response measures called for by the plan.” Therefore, it is important for water suppliers to provide their customers with a say in how the plan is “designed and how and under what conditions it will be implemented” (TC&B 1998, p 16).

There are several ways for water suppliers to involve their water customers in the planning process. Common methods include “providing public notice that a drought plan is being prepared, forming

a citizen's advisory committee or task force, holding public meetings, conducting customer surveys, and distributing the draft plan for public review and comment prior to adoption" (TC&B 1998, p. 16).

Campbell and Marshall (2000, p. 321) emphasize that increasing the effectiveness of the public sector is dependent upon "greater engagement than at present between those that inhabit town halls and the populations that they serve."

The U.S. Army Corps of Engineers (USACE) supports this plan development process and believes that collaboration between water suppliers and their stakeholders can make planning more effective (USACE 1995, p. xv). This collaboration can harness knowledge near the beginning of the problem solving efforts and can make it more likely that stakeholders will take action when necessary (USACE 1995, p. xv). The USACE states that "like other plans, drought plans are largely behavioral, and their success depends on people understanding their role, and knowing how their actions fit into the larger response" (USACE 1995, p. 36). Creighton (1980, p. 2) professes that the final measure of the effectiveness of a public involvement program is not just that the public has been informed, but that the public comment has been "solicited in such a manner that it has contributed to making a decision which is feasible, environmentally sound, and enjoys the support of a significant segment of the public."

Notification of Implementation and Termination. The second aspect of public involvement is notification to the water users by the water supplier once the drought contingency plan is implemented and terminated. An ideal plan should provide "specific procedures for notifying the public once a triggering condition has been reached and a corresponding drought response stage that is being implemented" (TC&B 1998, p. 16). The notification procedure to the public should include an explanation of the restrictions to be implemented along with the consequences for violations. Notification procedures should also specify the manner of informing the public that the response stages are terminated. Examples of means of public notification include "direct mail, announcements through local media, messages on marquees, or by other means" (TC&B 1998, p. 16).

Program of Continuing Education. The final aspect of public involvement in drought contingency planning is a program to educate and inform the water users within the service area of the supplier about the plan. McEntire (2002, p. 274) asserts that the success of vulnerability preparedness to disasters relates

to how well local community education reduces disaster liabilities. At times, vulnerabilities to drought conditions can cause conflict. To reduce the risk of conflict between water users during periods of water shortages, it is essential for the public to “receive a balanced interpretation of changing conditions through public information” (Wilhite 1991, p. 32). Therefore, a continuous effort to educate the public about the drought contingency plan is imperative, “particularly prior to and during the actual implementation of the plan” (TC&B 1998 p. 16).

A well-informed public is generally more willing to adhere to requests to alter their water use if they are fully informed about the plan. The information that is provided to the public should include a description of the conditions that will trigger implementation of the plan and a description of what can be expected once the drought contingency plan is in effect. Common approaches to educating the public about the utility’s drought contingency plan include “utility bill inserts, articles in local newspapers, public service announcements, and advertisements in the local media” (TC&B 1998, p. 16). Wilhite (1991, p. 33) states that through leadership, water suppliers should ensure that “frequent, thorough, and accurate news releases are issued to explain changing conditions and complex problem areas.”



## Drought Response Trigger Criteria

The next component of the ideal drought contingency plan is drought response trigger criteria. There are several aspects to triggering criteria. These include monitoring of drought indicators and triggering criteria for the initiation and termination of response stages.

Monitoring of Drought Indicators. The first facet of drought response triggering criteria is the monitoring of drought indicators. The ideal drought contingency plan should include a description of the drought indicators to be monitored. McEntire (2002, p. 274) asserts that when it comes to vulnerability, there are many unique triggering criteria and combinations which have an impact on all types of disasters. TC&B further emphasizes that drought triggering criteria should be “specific to each water supplier and should be based on an assessment of each water system’s vulnerability” (TC&B 1998, p. 12). This should include an assessment of “both the adequacy and reliability of the water supply itself, as well as a determination of the conditions under which a water shortage can be said to exist.” TC&B also stresses that it is equally important to “evaluate the adequacy and reliability of water production, storage, and distribution facilities under drought conditions” (TC&B 1998, p. 12). Whatever indicators are used as triggering criteria, they should be based upon information that can be readily monitored and understood by the customers of the water supplier.

Prasifka (1988, p. 217) indicates that planning should be focused on drought indicators to establish values for drought thresholds such as “precipitation measurement; stream flow for drought thresholds such as precipitation measurement; stream flow; reservoir, natural surface, and groundwater storage; soil moisture; temperature; and geographic characteristics.”

Triggering Criteria for the Initiation. The next aspect of the drought response triggering criteria is in relation to the initiation of the response stages. The drought contingency plan should specify the criteria for initiating response stages. Triggering criteria, based on indicators that are water system-specific, have been shown to improve drought response effectiveness (TC&B 1998, p. 12). With such triggers, decisions about when to implement drought response measures are not made “arbitrarily or on an ad hoc basis.” The purpose of triggering criteria, according to TC&B, is to ensure that action is taken in response to a developing drought situation and that the response is appropriate to the level of severity.

Triggering Criteria for the Termination. The final aspect of the drought response triggering criteria is in relation to the termination of the response stages. The drought contingency plan should also specify the criteria for the termination of each response stage. These criteria are usually based on a “lessening of the severity of the conditions that triggered implementation of a response stage, or the return to “normal” supply or demand conditions” (TC&B 1998, p. 12).

## Successive Stages of Response

Another component of the ideal drought contingency plan is the successive stages of response in managing vulnerability to the water supplier. In managing vulnerability for disaster preparation, McEntire (2002, p. 273) suggests that this should be accomplished through “activities directed toward the reduction of emergencies and disasters by diminishing risk and susceptibility and building of resistance and resilience.” This approach can also be utilized in drought contingency planning, specifically when determining stages of response.

The ideal drought contingency plan should provide for the integration of drought response measures in successive stages. This is accomplished by a “structure that allows increasingly stringent drought response measures to be implemented in successive stages as water supply or water demand conditions worsen” (TC&B 1998, p. 11). This gradual approach allows for a timely and appropriate action as a water shortage or other condition develops. This can also minimize the possibility of overreacting to a drought situation. The purpose is to “implement response measures that are geared to the severity of the situation with the hope that actions taken in one stage will be sufficient to stabilize conditions and avoid the need to progress to another response stage with more stringent measures” (TC&B 1998, p. 13).

The drought contingency plan should include stages of response to drought and other uncontrollable circumstances that can severely disrupt “normal” water availability and quality. To that end, TC&B states that the ideal drought contingency plan should provide responses to four components. The four elements of successive stages of response are the reduction in available water supply, production or distribution system limitations, supply source contamination, and system outage. Each facet is described in greater detail below.

Reduction in Available Water Supply. The first facet in successive stages of response is the reduction in available water supply. A water shortage occurs when there is “an imbalance between the supply of water and the demand for water over some period of time” (TC&B 1998, p 12). Short-term drought-related water shortages are often the “result of both decreased water supply due to below normal rainfall and increased water demands, which can speed the depletion of water supplies” (TC&B 1998, p 12).

Production or Distribution Limitations. The next element in successive stages of response is related to production or distribution limitations of the water system. Even where the water supply itself is adequate, a water system may not have enough capacity to treat water in order to meet the higher than normal peak water demands that typically occur during drought. In such situations, there is often a significantly higher risk of water system outages due to equipment failures.

Supply Source Contamination. The third element is a response to contamination of the water supply. During peak water demand periods, inadequate system capacity may also result in low water pressure. This can increase the risk of contamination due to back-flow and may impair fire fighting capabilities.

System Outage. The final element to successive stages of response is system outage. Natural and man-made disasters can damage water facilities or cause prolonged power outages creating short-term water supply emergencies. Therefore, the water supplier must prepare in advance the actions the supplier will take to ensure an uninterrupted supply of water to satisfy essential human needs in the event of a disaster.

## Drought Response Management Measures

This section discusses the drought response management measures and includes two facets. The two elements include both the water supply and water demand management measures. The ideal drought contingency plan should “specify the response measures or actions that will be implemented when predetermined triggering criteria are met” (TC&B 1998, p. 14). The response measures that are implemented for each response stage should be related to the severity of the water supply or water demand conditions. Water demand management measures are designed to reduce water use while water supply

management measures typically are designed to better manage the available water supply, as well as the use of backup or alternative water sources.

Prasifka (1988, p. 221) acknowledges that the mandate of a water supplier is to supply water according to demand but “managing demand before developing all supply options leaves suppliers open to the charge of mismanagement.” He also indicates that suppliers may be just as equally open to the charge of mismanagement if they allow all water supplies to be exhausted. Therefore, water supply mandates are “not simply to deliver water, but to deliver it from an assured supply” (Prasifka 1988, p. 221). Viewed in this light, the water supplier must include management of both water supply and demand measures in their drought contingency plans. Examples of the measures are listed below.

Water Supply Management Measures. TC&B provides examples of water supply management measures (TC&B 1998, p. 15). These examples include:

1. Modification of water utility operating (e.g., leak detection and repair);
2. Use of water supply reserves (e.g., dead storage of a reservoir, use of back up groundwater supplies);
3. Use of reclaimed water (e.g., landscape irrigation, wastewater treatment plant filter backwash); and
4. Acquisition of alternative water supplies (e.g., interconnection with a neighboring water supplier, temporary water purchases, emergency water rights transfer)

Water Demand Management Measures. TC&B also provides examples of water demand management measures (TC&B 1998, p. 15). These examples include:

1. Restrictions or bans on nonessential water use such as lawn watering, car washing, hosing down pavement, use of non-recirculating ornamental fountains, swimming pool filling;
2. General prohibitions on water waste (e.g., allowing water to run down a gutter, failure to repair leaks);
3. Use of water rate incentives or penalties (e.g., surcharges for excess water use; and

4. Water rationing (e.g., water allocation on a per capita or per household basis)

## Enforcement and Plan Adoption

The final component of the ideal drought contingency plan is enforcement and plan adoption. These elements include procedures for the enforcement of any mandatory restrictions in water use, procedures for granting exceptions to the plan, and official adoption of the plan by the governing body of the water supplier to ensure that the plan is a legal and enforceable document.

Enforcement of Mandatory Restrictions. The first element discussed in this section is the procedure for the enforcement of mandatory water use restrictions. A drought contingency plan should include “explicit provisions for enforcement of any mandatory drought response measures” (TC&B 1998, p. 16). These provisions include procedures for monitoring water user compliance with mandatory measures and penalties for violations. The TC&B survey and evaluation suggest that penalties for noncompliance should include fines, the installation of a flow restrictor on a customer’s water service line, a water rate structure that includes surcharges for excessive water use, or discontinuation of service for repeat violations.

Procedures for Granting Exceptions. The next facet of enforcement and plan adoption is the development of procedures for granting exceptions to the plan. A drought contingency plan must include a procedure for granting exceptions (variances) to measures prescribed by the plan. For example, the water supplier might determine that an allowance is provided for more frequent watering of newly installed lawns. TC&B suggests that the water supplier must “retain discretion to approve or disapprove any request for a variance” and include a written procedure in the drought contingency plan that describes how a customer might request an exception (TC&B 1998, p. 15).

Official Plan Adoption. The final element of the drought contingency plan is the official adoption of the plan. For the drought contingency plan to be considered complete and enforceable, water suppliers must formally adopt their plans by their governing body. For municipal water systems, adoption must be by the city council as an ordinance. For other types of publicly-owned water systems, such as utility districts, the plan adoption must be by a resolution of the entity’s board of directors adopting the plan as an administrative rule. For privately investor-owned utilities, the drought contingency plan must be incorporated into the utility’s rate tariff (TC&B 1998, p. 16).

## Conceptual Framework

This research uses practical ideal type as the conceptual framework. The TCEQ model drought contingency plan for retail public water suppliers and the additional supporting literature previously discussed in this chapter explain the components that are to be expected in an ideal municipal drought contingency plan. This model, discussed further in Chapter 5, serves as the practical ideal type. Table 3.1 summarizes the material discussed early.

Table 3.1 - Conceptual Framework Sources for a Practical Ideal Type  
 Conceptual Framework  
 Ideal ComponentSourcePublic Involvement

! Public involvement in plan preparation		
! Notification to water users of plan initiation and termination		
! Program of continuing public education and information		
Campbell & Marshall (2000)		
Creighton (1980)		
Glicken (1999)		
King & Stivers (1998)		
McEntire, Fuller, Johnson, & Weber (2002)		
Pierce & Doerksen (1976)		
TC&B (1998)		
Thomas (1993)		
USACE (1995)		
Willhite (1991) Drought Response Triggering Criteria		
! Monitoring of drought indicators		
! Triggering criteria for the initiation of response stages		
! Triggering criteria for the termination of response stages		
McEntire, Fuller, Johnson, & Weber (2002)		
Prasifka (1988)		
TC&B (1998)		
Successive Stages of Response		
! Reduction in available water supply		
! Production or distribution system limitations		
! Supply source contamination		
! System outage		
McEntire, Fuller, Johnson, & Weber (2002)		
TC&B (1998)		
Drought Response Management Measures		
! Water Supply Management Measures		
! Water Demand Management Measures		
McEntire, Fuller, Johnson, & Weber (2002)		
Prasifka (1988)		
TC&B (1998) Enforcement & Plan Adoption		
! Procedures for enforcement of any mandatory water use restrictions		
! Procedures for granting variances (exceptions) to the plan		
! Official adoption of the plan by the governing body		
TC&B (1998)		
Willhite (1997a)		



## Conclusion

The first purpose of this research, to explain the ideal components of a municipal drought contingency plan, was achieved in this chapter. The essential elements of a drought contingency plan were described in detail. The identified elements link to the second purpose, to assess the drought contingency plans of retail public water suppliers submitted to the TCEQ to determine which retail public water suppliers utilized the model drought contingency plan and how close all the plans met the ideal components. This assessment will ultimately connect to the overall objective of this research, to affirm that the model drought contingency plan in Texas is an effective tool for meeting state-mandated plan components by individual retail public water suppliers. In order to achieve this objective, the setting for this research is identified and discussed in the forthcoming chapter.

## Chapter 4

### TEXAS SETTING

#### Purpose

This chapter explains the setting for the research. A brief overview of Texas droughts and projections for water availability in the State is provided. The chapter discusses the mandatory drought contingency plans in Texas and concludes with a description of the plans that were required to be submitted to the State. This section of the research establishes the context for which the plan reviews are conducted in upcoming chapters.

#### Texas Droughts

The setting for this research is the state of Texas. At least one serious drought has plagued parts of Texas in every decade in the 20th century. Since every decade has been marred by at least one severe drought, the phenomenon of drought is hardly cyclic in nature and makes predictability a “formidable chore” (Riggio, et al 1987, p. 61). As a subtle phenomenon characterized by too little rain for too long a period of time, fewer severe droughts manifest in “varying intensities in some parts of Texas virtually every year” (Riggio, et al 1987, p. 61).

The most catastrophic drought to strike Texas was the mammoth dry spell that afflicted every sector of the State in the 1950's (Riggio, et al 1987, p. 1). Near the drought's end in 1957, all but ten of Texas' 254 counties were declared federal drought disaster areas (Texas A&M University Report 1996, p. 4). Many other droughts, some lasting only a few months and others continuing for several years, have dealt harshly with Texas during the 20<sup>th</sup> century (Riggio, et al 1987, p. 61).

In the late 1980s, Riggio, Bomar, and Larkin conducted a comprehensive study of droughts in Texas. They collected monthly National Weather Service rainfall data at many sites from 1931 to 1980. They defined droughts by the “quantity and duration of rainfall events.” Precipitation data was normalized to account for differences in rainfall between arid West Texas and humid East Texas. Droughts covering three, six, and twelve months were identified and classified by their severity, duration, and location. Their results revealed that it was more likely that a sixmonth or yearlong drought would occur somewhere in

Texas than a nearnormal or wetweather spell for the same period. Additionally, drought that lasted at least sixmonths were expected once every sixteen months, while droughts covering more than a year were likely to visit Texas once every three years. Droughts lasting six months occurred more frequently in West Texas, while longer droughts were found most often in the North Texas (Riggio, et al 1987, p. 61).

Clearly, drought is a perpetual antagonist for the State. Therefore, it is crucial that drought is fully understood and anticipated if Texas is to ensure that its citizens will have an adequate supply of water in the future.

## Texas Projections

Unfortunately, drought is not just a condition of rainfall levels, but it is also greatly influenced by water demands. A relatively minor drought (in terms of low rainfall) becomes a major concern as the population and water use increase. For Texas, the population is expected to almost double in the next fifty years, from nearly 21 million in 2000 to about 40 million in 2050 (Texas Water Plan 2002, p. 25). Additionally, municipal water demand is projected to increase by 67 percent while serving a population that is projected to double (Texas Water Plan 2002, p. 34). Hence, drought seems certain to impact municipal water users in the coming years.

By 2050, the Texas Water Plan predicts that almost 900 cities in Texas will either need to reduce water demand through conservation and drought management or develop additional sources of water to meet their water needs during droughts (Texas Water Plan 2002, p. 2). It is evident from these projections that drought contingency planning in Texas is imperative.

## Mandatory Planning in Texas

Because drought is such a frequent event in Texas and population and water demand projections are less than appealing, drought contingency plans are required of all retail public water suppliers by Title 30 Texas Administrative Code (TAC) Chapter 288. Each ideal component of a drought contingency plan, as described in Chapter 3, is also required to be included in drought contingency plans developed by retail public water suppliers in Texas. Title 30 TAC §288.20 mandates that the drought contingency plans for

retail public water suppliers in Texas incorporate provisions that include public involvement, drought response triggering criteria, successive stages of response criteria, drought response management measures, enforcement and plan adoption. Appendix B is Title 30 TAC §288.20.

## Required Plan Submittals

As previously stated, Title 30 TAC Chapter 288 directed all retail public water suppliers in Texas to develop drought contingency plans meeting all of the required components as mandated. Retail public water suppliers that provide water service to 3,300 or more connections were specifically required to submit their drought contingency plans to the TCEQ. For the other retail public water suppliers in Texas with less than 3,300 connections, they were not required to submit their plans but were, however, required to make the plans available to the TCEQ if they are ever requested by the executive director of the agency.

## Chapter 5

# TEXAS MODEL DROUGHT CONTINGENCY PLAN

### Purpose

While the previous chapter established the setting for this research, this chapter focuses specifically on the model drought contingency plan. An overview is provided for the development of the model plan as well as the outreach education of the plan to public administrators and the water professionals in Texas. The overall hypothesis of this research, that the TCEQ model drought contingency plan is an effective tool for meeting mandated plan components in Texas, is also introduced in this chapter.

### Model Plan Development

In an effort to assist retail public water suppliers in Texas in developing drought contingency plans, the TCEQ developed a model plan for drought contingency planning. As previously mentioned, the TCEQ contracted with Turner, Collie, and Braden Inc. (TC&B) to develop the model. Appendix A is the Model Drought Contingency Plan. As the research supported in Chapter 3, this model serves as the practical ideal type.

The development of the model was not a legislative mandate. The model was developed, however, to serve as a tool to assist public administrators of retail public water suppliers in designing their required drought contingency plans so that each component of the plan would meet the requirements of Title 30 TAC Chapter 288. By fully completing the model plan with the water system-specific data, a municipal public water supplier would ideally meet all of the required components of a drought contingency plan for a retail public water supplier in accordance with Title 30 TAC Chapter 288.

### Outreach Education on the Model

After the model plan was developed, the water supply community was notified about the existence of the model. All of the retail public water suppliers in Texas were mailed a postcard informing them about the availability of the model. Depending on the preference of a supplier, the model was provided to them

either by direct mail, electronic mail, or by download from the TCEQ Internet Website.

The TCEQ also conducted a series of drought contingency planning workshops throughout Texas. The model was made available to each workshop participant. The purpose of the workshops was to educate public administrators of water supply systems about the regulatory requirements of drought contingency plans and to instruct them on the use of the model plan. The workshops reached more than 1,200 individuals representing approximately 800 retail public water suppliers in Texas. The workshops specifically provided information about public involvement, drought response triggering criteria, successive stages of response, drought response management measures, enforcement and plan adoption.

## Working Hypothesis

The working hypothesis concept is used to develop the possible solutions through an ideal plan because, “it is not a guess at the riddle, a hunch as to what the answer might be. It is an idea . . . about the next steps that may be worthy of taking” (Kaplan 1964, p. 88). For the water suppliers in Texas that utilized the model drought contingency plan developed by the TCEQ, the assumption is that the model was an effective tool for ensuring inclusion of all the ideal plan components. The specific working hypothesis of this research is:

WH: The model drought contingency plan developed by the Texas Commission on Environmental Quality is a valuable instrument for retail public water suppliers in Texas to meet the ideal components for a drought contingency plan as mandated by Title 30 Texas Administrative Code Chapter 288.

Before this conclusion can be reached, the drought contingency plans are first assessed. The next chapter discusses the methodology used to analyze the plans in order to confirm the working hypothesis.

## Chapter 6

# METHODOLOGY

### Purpose

The purpose of this chapter is to discuss the methodology used to assess the municipal drought contingency plans submitted to the TCEQ by retail public water suppliers. The chapter first discusses the plans selected for content analysis and then addresses the data collection methods used to determine the findings of the research and provides an overview of the data collection. A discussion of how the practical ideal type of a municipal drought contingency plan is operationalized into measurable items for assessment is presented. The statistics used in the assessment conclude the chapter.

### Population

All of the two hundred and thirty-six municipal drought contingency plans submitted to the TCEQ by retail public water suppliers providing water service to 3,300 or more connections will be analyzed. Appendix C lists the two hundred and thirty-six drought contingency plans for analysis of the retail public water suppliers in Texas with 3,300 or more connections that were submitted to the TCEQ.

### Content Analysis

In order to complete the next objective of this research, to assess the drought contingency plans of retail public water suppliers submitted to the TCEQ to confirm that the model drought contingency is an effective tool for meeting the ideal plan components, two undertakings must occur. First, the retail public water suppliers that utilized the model drought contingency plan, as well as those that did not, are determined. Content analysis is used to identify which municipal water suppliers utilized the TCEQ model drought contingency plan in developing their plans in addition to those that did not use the model.

After determining which suppliers utilized the model and which did not, content analysis is further used for each of the drought contingency plans to determine which components of Title 30 TAC Chapter 288 are included in all of the plans. This analysis is conducted for both the suppliers that utilized the model

plan and for the suppliers that did not utilize the model plan. The working hypothesis will be confirmed by a positive difference in percentages for the presence of the ideal components between these two groups.

The ideal components and working hypothesis are operationalized in Table 6.1. Again, the operationalization of the ideal components was carefully developed from the literature review.



Table 6.1 - Operationalizing the Conceptual Framework

Content Analysis of Plans for Presence of Ideal Components	Category	Component	Example	Public Involvement
opportunity for the public to provide input into the preparation of the drought contingency plan	public meeting, survey to customers, or utility bill insert	inviting comment	written procedure for providing notice to customers of plan initiation and termination	date of restrictions, circumstances triggering the restrictions, stages of response and explanation of restrictions to be implemented, and explanation of the consequences for violations
periodically provide customers with information about the plan	information through public meetings, public events, press releases, or utility bill inserts	Drought Response Triggering Criteria	monitoring of drought indicator	triggering criteria/trigger levels based on a statistical analysis of the vulnerability of the water source under drought of record conditions or based on known system capacity limit
triggering criteria for the initiation of response stages	well level, overnight recovery rate, reservoir elevation, stream flows, or as identified by their wholesale supplier	triggering criteria for the termination of response stage	treatment plant capacity, total daily demand of pumping capacity, total daily demand as of storage capacity, pump hours per day, or production/distribution limitations	Successive Stages of Response
response to reduction in available water supply	stages established (mild, moderate, severe, critical, or emergency stage)	with implementation of measures listed below	response to production or distribution system limitations	stages established (mild, moderate, severe, critical, or emergency stage)
with implementation of measures from list below	response to supply source contamination	emergency stage established with implementation of measures (boil water notice, alternative water source)	response to system outage	emergency stage established with implementation of measures (alternative water source, emergency interconnect)

Drought Response Management Measures water supply management measures modification of water utility operating, use of water supply reserves, use of reclaimed water, acquisition of alternative water supplies water demand management measures restrictions or bans on nonessential water uses, general prohibitions on water waste, use of water rate incentives or surcharges, water allocation Enforcement & Plan Adoption procedures for enforcement of any mandatory water use restrictions fines, installation of flow restrictor on customer's water service line, discontinuation of service for repeat violations, or water rate structure surcharges procedures for granting variances (exceptions) to the plan temporary variance for existing water uses otherwise prohibited under their plan if it is determined that failure to grant such a variance would cause an emergency condition adversely affecting the health, sanitation, or fire protection for the public or the person requesting such variance official adoption of the plan by the governing body municipalities (adoption by the city council as an ordinance), publicly-owned water systems (adoption by resolution of the entity's board of directors adopting the plan as administrative rules), private investor-owned utilities (adoption by incorporation into the utility's approved rate tariff) Working Hypothesis WH Research Method Evidence The model drought contingency plan developed by the TCEQ is an effective tool for retail public water suppliers in Texas for meeting the ideal drought contingency plan components as mandated by Title 30 TAC Chapter 288. Content analysis of all of the drought contingency plans submitted to the TCEQ is used to determine the presence of each ideal component. This is conducted for both the suppliers that utilized the model plan and for the suppliers that did not utilize the model plan. positive difference in percentages for the presence of the ideal components between the systems that utilized the model versus the systems that did not

Content analysis is useful in this research as a method because it allows for a systematic approach to each drought contingency plan. By using content analysis, it is possible to gauge how each water supplier's drought contingency plan compares to the ideal model. Content analysis, nevertheless, has limitations that need to be kept in mind. Babbie states that "[content analysis is] limited to the examination of recorded communications" (1999, p. 296). Hence, this technique does not allow the researcher to determine how successfully the drought contingency plans were implemented or the quality that is associated with the plans contents.

## Data Collection

A coding sheet (Figure 6.1) was developed to add validity to the data collection of the drought contingency plans. Since the framework was constructed through a careful review of the literature and regulatory requirements, it is perhaps the best available tool for reviewing each drought contingency plan.

The coding sheet was used to determine if the model plan was utilized by the water supplier and to determine which required components are present in the drought contingency plan. In each case, the plans are scored with either a "yes" or "no" response.

The limitations associated with this data collection method are that no two reviewers may interpret

the drought contingency plans in the same manner. Coding, therefore, may vary depending on the reviewer of the plan. To limit variations, the reviewers exchanged plans with each other to ensure that the same results were determined. This exchange occurred for approximately the first twenty-five plans that were reviewed. At that point, the author of this research supervised the reviewers closely to determine if they were consistent in their analysis. Once consistency was ensured, the exchange did not occur any further. For the remainder of the review process, however, if a reviewer had difficulty in determining the presence of a particular component, the team of reviewers would collectively look at the plan and develop a consensus.

Figure 6.1 - Coding Sheet for Content Analysis

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Name of Municipal Public Water Supplier \_\_\_\_\_

Did the water supplier utilize the model? Yes / No

	Ideal Type Component	Present in the Plan
(Yes/No)	Public Involvement	Public involvement in plan preparation
	Notification	Notification to water users of plan initiation and termination
	Program of continuing public education and information	Drought Response
	Triggering Criteria	Monitoring of drought indicators
	Triggering criteria for the initiation of response	Triggering criteria for the termination of response
	stages	Successive Stages of Response
	Reduction in available water supply	Production or distribution system limitations
	Supply source contamination	System outage
	Drought Response Management Measures	Water Supply Management Measures
	Water Demand Management Measures	Enforcement & Plan Adoption
	Procedures for enforcement of any mandatory water use restrictions	Procedures for granting variances (exceptions) to the plan
	Official adoption of the plan by the governing body	

## Statistics

Descriptive summary statistics and percentages are utilized in this research. After the plans are analyzed, they are classified into two groups, the water suppliers in Texas that employed the model drought contingency plan and the suppliers that did not utilize the model plan. Descriptive summary statistics are used for both groups. The percentages of the components that are included in the drought contingency plans are presented for each category of the drought contingency plans for the two groups. Percentages are used to determine the overall number of water suppliers that meet all of the required elements of a drought contingency plan for the suppliers who both utilized and did not utilize the model plan.

## Chapter 7

# RESULTS

### Purpose

This chapter presents the findings from the content analysis of the municipal drought contingency plans. The results in this chapter are reflective of all the two hundred and thirty-six municipal drought contingency plans reviewed. The water suppliers that utilized the TCEQ model drought contingency approach are identified first. The results of each category for the ideal model drought contingency plan are presented separately. A summary of the results is developed for each category to explain the extent to which the retail public water suppliers in Texas followed the practical ideal type of the model drought contingency plan as compared to the suppliers who did not utilize the model plan. The results are organized by the categories identified in the conceptual framework. The categories are public involvement, drought response triggering criteria, successive stages of response, drought response management measures, enforcement and plan adoption. A summary, supporting the working hypothesis, of the overall results of the content analysis of the municipal drought contingency plans is presented.

### Model Plan Use

To determine which systems utilized the TCEQ model drought contingency plan, careful review was conducted of the 236 drought contingency plans of the retail public water suppliers in Texas with 3,300 or more connections. Again, Appendix C is the list of 236 water systems with plans that were submitted to the TCEQ and analyzed in this research. The analysis determined that 102 water suppliers utilized the model and 134 water suppliers developed their drought contingency plans without the model. These figures are presented in Table 7.1.

Table 7.1 - Model Drought Contingency Plan Use

Model Drought Contingency Plan	Number Used by Water Suppliers	102 NOT Used by Water Suppliers
134	Total Drought Contingency Plans Analyzed	236

## Public Involvement

Public involvement in drought contingency planning, as discussed extensively in this paper, is important because the success of a plan depends heavily on how well customers are informed. A well-informed public is generally more willing to adhere to requests to alter their water use if they are fully informed. Additionally, Title 30 TAC Chapter 288, mandated that a drought contingency plan for a retail public water supplier in Texas shall include provisions to actively provide an opportunity for public input into the plan development, provide public notification of plan implementation and termination, and include a program of continuing public education and information regarding the drought contingency plan.

Table 7.2 shows the percentage of the water suppliers, both if the model plan was used and if the model not used in plan development, meeting the requirements related to public involvement as required by Texas regulations. The table represents all 236 drought contingency plans reviewed for retail public water suppliers in Texas with 3,300 or more water connections.

Table 7.2 - Public Involvement Compliance

Public Involvement	Used Model	Model NOT Used	Percent Included	Percent Included	Public involvement in plan preparation
Notification to water users of plan initiation and termination	100%	84%	94%	31%	
Program of continuing public education and information	98%	62%	94%	29%	
Used All Components	94%	29%			
Number of Drought Contingency Plans Reviewed	102	134			

\* The table represents all 236 Drought Contingency Plans reviewed for retail public water suppliers in Texas with 3,300 or more connections.

The majority of the 102 water suppliers that used the model drought contingency plan met all the required components for public involvement. However, for the 134 water suppliers that did not use the model, only 41 suppliers (31%) included public involvement in the drought contingency plan preparation, 112 suppliers (84%) incorporated public notification to water users of plan initiation or termination, and just 83 suppliers (62%) included a program of continuing public education and information regarding the plan.

Unfortunately for those systems with plans that did not meet the requirements for public participation, more than likely, their customers will not be well-informed and will be less willing to adhere

to requests to alter their water use when they are called upon to do so in periods of drought.

## Drought Response Triggering Criteria

This paper pointed out that the purpose of triggering criteria for the drought contingency plan is to ensure that action is taken in response to a developing drought situation and that the response is appropriate for the level of severity. Additionally, Texas regulations mandate that a drought contingency plan for a retail public water supplier in Texas include both a description of the drought indicators to be monitored and the triggering criteria for response stages.

Table 7.3 illustrates the percentage of the water suppliers, both if model was used and not used in plan development, that met the requirements related to drought response triggering criteria. The table represents all 236 drought contingency plans reviewed for retail public water suppliers in Texas with 3,300 or more water connections.

All of the 102 water suppliers that utilized the model plan overwhelmingly included monitoring of drought indicators as part of drought contingency planning. On the other hand, only 108 of the 134 water suppliers (81%) that did not use the model had plans that met the requirements for this component.

Regarding the elements for triggering criteria for both the initiation and termination of response states, all but two of the 102 water suppliers that used the model (99%) had these elements present in the plans. Whereas, only 110 of the 134 water suppliers that did not use the model plan (82%) included these components.

Table 7.3 - Drought Response Triggering Criteria Compliance  
Drought Response

Triggering Criteria	Used Model	Model NOT Used	Percent Included	Percent Included	Monitoring of drought indicators
Triggering criteria for the initiation of response stages	100%	81%	99%	82%	Triggering criteria for the termination of response stages
Used All Components	98%	80%	98%	80%	Number of Drought Contingency Plans Reviewed
	102	134			

\* The table represents all 236 Drought Contingency Plans reviewed for retail public water suppliers in Texas with 3,300 or more connections.

Unfortunately for those water systems that do not have drought response triggering criteria identified in their plans, there is no assurance that any response actions will occur. If the criterion that triggers a response stage is not identified by the retail public water supplier, it is not reasonable to expect a response to drought conditions to occur.

## Successive Stages of Response

The drought contingency plan, as discussed previously, should include stages of response to drought and other uncontrollable circumstances that can severely disrupt “normal” water availability and quality. Title 30 TAC Chapter 288 mandates that, at a minimum, a drought contingency plan for a Texas retail public water supplier shall include response stages to address a reduction in the available water supply, water production or distribution system limitations, supply source contamination, and system outages.

Table 7.4 lists the percentage of the water suppliers, both if model was used and not used in the plan development, that met the requirements related to successive stages of response. Again, almost all of the water suppliers that utilized the model plan met all the required components for successive stages of response. For the water suppliers that did not use the model, only a portion addressed how their systems would respond to a reduction in the amount of water (84%), production or distribution limitations (79%), contamination of the water (61%), or failure of their systems to operate (67%).



Table 7.4 - Successive Stages of Response Compliance

Successive Stages of Response	Used Model	Model NOT Used	Percent Included	Percent Included	Reduction
in available water supply	99%	84%	Production or distribution system limitations	98%	79%
contamination	98%	61%	System outage	99%	67%
Used All Components	96%	58%	Number of Drought Contingency Plans Reviewed	102	134

\* The table represents all 236 Drought Contingency Plans reviewed for retail public water suppliers in Texas with 3,300 or more connections.

## Drought Response Management Measures

The drought contingency plan should specify the actions that will be implemented when triggering criteria are met. As a minimum requirement, Title 30 TAC Chapter 288 mandates that a drought contingency plan for a retail public water supplier shall include supply or demand management measures that are to be implemented during each stage.

Table 7.5 shows the percentage of the water suppliers, both when the model drought contingency plan was used and not used, that met the requirements related to drought response management measures.

Table 7.5 - Drought Response Management Measures Compliance

Management Measures	Used Model	Model NOT Used	Percent Included	Percent Included	Water Supply
Management Measures	92%	50%	Water Demand Management Measures	92%	50%
Components	92%	48%	Number of Drought Contingency Plans Reviewed	102	134

\* The table represents all 236 Drought Contingency Plans reviewed for retail public water suppliers in Texas with 3,300 or more connections.

Ninety-four of the 102 water suppliers that used the model approach to drought contingency planning (92%) met the required components for drought response management measures as required by Texas regulations. For those water suppliers that did not use the model plan, only half of these suppliers met the required elements for this category. Again, almost all of the water suppliers that utilized the model plan met all the required components for successive stages of response. For the water suppliers that did not use the model, only a portion addressed how their systems would respond to a reduction in the amount of water (84%), production or distribution limitations (79%), contamination of the water (61%), or failure of

their systems to operate (67%).

## Enforcement and Plan Adoption

A drought contingency plan, as previously presented, should include the enforcement of mandatory drought response measures to ensure compliance with the plan. Additionally, a procedure is necessary in the drought contingency plan for granting variances to measures prescribed by the plan. Finally, the plan must be formally adopted by the governing body of the water supplier for the plan to be considered complete and enforceable. As mandated by Title 30 TAC Chapter 288, a drought contingency plan for a retail public water supplier in Texas shall include these components.

Table 7.6 illustrates the percentage of the water suppliers, both if the model was utilized and not utilized in plan development, that met the Texas requirements related to enforcement and plan adoption. All but one of the water suppliers that utilized the model plan met the requirement for a procedure for enforcement of mandatory water use restrictions, where as only 68% of the suppliers that did not use the model, included the enforcement protocol. Regarding the procedure for granting variances to the plan, the majority of the suppliers that used the model included this component. For the systems that did not use the model, less than half (40%) met this requirement.

Table 7.6 - Enforcement and Plan Adoption Compliance

Enforcement & Plan Adoption	Used Model	Model NOT Used	Percent Included	Percent Included	Procedures
for enforcement of any mandatory water use restrictions	99%	69%	99%	69%	Procedures for granting variances
(exceptions) to the plan	95%	40%	95%	40%	Official adoption of the plan by the governing body
Components	90%	18%	89%	33%	Used All
					Number of Drought Contingency Plans Reviewed
					102134

\* The table represents all 236 Drought Contingency Plans reviewed for retail public water suppliers in Texas with 3,300 or more connections.

Ninety-one of the 102 water suppliers (89%) using the model provided evidence of official adoption of the drought contingency plan by the governing body of the water system. A mere 33% of the suppliers that did not use the model plan submitted evidence of adoption of the plan. Again, almost all of the water suppliers that utilized the model plan met all the required components for successive stages of response. For the water suppliers that did not use the model, only a portion addressed how their systems would respond to a reduction in water supply (84%), production or distribution limitations (79%), water contamination (61%), or system failure (67%).

## Conclusion

Content analysis of each of the drought contingency plans was beneficial in this research because it allowed for a systematic approach. By using content analysis, it was possible to gauge how close each water supplier's drought contingency plan came to the ideal model. The evidence of this analysis supports the working hypothesis. The TCEQ's model drought contingency plan serves as an effective tool for retail public water suppliers to meet the ideal components of drought contingency plans as required by Title 30 TAC Chapter 288.

## Chapter 8

# CONCLUSION

### Purpose

The purpose of this chapter is to summarize the research findings in relation to the practical ideal type of the model drought contingency plan. The chapter provides the evidence to confirm that the TCEQ's model drought contingency plan is an effective tool for retail public water suppliers to meet the required components of drought contingency plans in accordance with the mandates of Title 30 TAC Chapter 288. The chapter concludes with recommendations and provides suggestions for additional research.

As this research emphasized, water availability is a meaningful environmental issue in the United States that has captured national attention. Since water is becoming a more limited natural resource in Texas, water policy will be a primary source of controversy, particularly during periods of drought conditions. Recent widespread periods of drought have raised concerns about vulnerabilities to periods of water shortages. It is imperative that administrators of public water supply systems develop drought contingency plans that deal with water shortages in a timely and systematic manner.

The purpose of this research was twofold. The first purpose explained the ideal components of a municipal drought contingency plan as developed through an extensive review of available literature. The second objective assessed the drought contingency plans of retail public water suppliers submitted to the TCEQ to determine which retail public water suppliers utilized the model drought contingency plan and how close all the plans met the ideal components.

### Summary of Findings

All of the two hundred and thirty-six municipal drought contingency plans submitted to the TCEQ by retail public water suppliers were analyzed. Content analysis was used to determine which municipal water supply systems utilized the TCEQ model drought contingency plan in developing their plans and which did not. The coding sheet was developed to add validity to the data collection. Since the framework was constructed from the 1) TCEQ model drought contingency plan 2) careful review of available literature

supporting the model, and 3) and regulatory requirements for plan components in Texas, the coding sheet was the best available tool for reviewing each drought contingency plan.

After determining that 102 water suppliers utilized the model and 134 did not, content analysis was utilized on each of the drought contingency plans to determine which components of Title 30 TAC Chapter 288 were included in the plans. In relationship to the municipal public water suppliers that utilized the model plan versus the suppliers that did not, the research revealed the ideal components that were present in the plans for both groups.

Content analysis was useful in this research because it allowed for a systematic approach to each drought contingency plan. By using content analysis, it was possible to gauge how each water supplier's drought contingency plan compared to the ideal model. The percentages of all ideal components included in the plans by each category for both groups (use of the model and non use of the model) are summarized in Table 8.1. In each category, the percentages for all components included in the plans for the two groups are undeniably higher for the water suppliers that used of the model.

Table 8.1 - Summary of Categories

Category	Used Model	Model NOT Used	Percent of All Components Included	Percent of All Components Included
Public Involvement	94%	29%	Drought Response Triggering Criteria	98%80%
Successive Stages of Response	96%	58%	Drought Response Management Measures	92%48%
Enforcement & Plan Adoption	90%	18%	Number of Drought Contingency Plans Reviewed	102134

\* The table represents all 236 Drought Contingency Plans reviewed for retail public water suppliers in Texas with 3,300 or more connections.

The overall findings of this research are summarized in Table 8.2. Eighty-four of the 102 entities (82%) that utilized the model plan also successfully developed plans that met all of the required components for every element. Whereas only eight of the 134 entities (6%) that did not utilize the model plan developed complete plans for all components. The evidence of this analysis supports the working hypothesis. The TCEQ's model drought contingency plan serves as an effective tool for retail public water suppliers to meet the ideal components of drought contingency plans as required by Title 30 TAC Chapter

Table 8.2 - Summary of Research Findings

Levels of Compliance	Used Model	Model NOT Used	Percent of All Components Included	Percent of All Components Included
100% Compliance	826	99-80% Compliance	111	279-60% Compliance
328	59-40% Compliance	019	39-1% Compliance	323
019	39-1% Compliance	323	0% Compliance	113

\* The table represents all 236 Drought Contingency Plans reviewed for retail public water suppliers in Texas with 3,300 or more connections.

## Recommendations

Based on the findings, it is obvious that the model drought contingency plan in Texas is an effective tool for administrators of municipal public water suppliers to use in to comply with the ideal and required plan components. Based on this analysis, recommendations are:

- All administrators of municipal public water suppliers in Texas should utilize the TCEQ model drought contingency plan to successfully meet the ideal components as identified in this research and as required by Texas regulation.
- For those water suppliers that did not use the model plan, as evidenced by flaws in their plans, they must amend their plans to include the ideal components in their plans. More importantly, administrators should encourage public involvement.
- The model drought contingency plan in Texas is a tool for administrators of other municipal public water suppliers outside of the State that seek to develop an ideal municipal drought contingency plan.

## Future Research Needs

This scope of this research included an analysis of the municipal public water suppliers in Texas that utilized the TCEQ model drought contingency plan in the plan development. This research further illustrated the ideal component findings in relationship to the municipal public water suppliers that utilized the model approach versus the suppliers that did not. The scope of this research, however, did not measure drought contingency plan effectiveness.

Future research is needed to determine how effective the drought contingency plans are for municipal public water suppliers once the plans have been implemented. A future comparison could be made to evaluate the effectiveness of the plans for those water suppliers that utilized the model drought contingency plan versus those suppliers that did not.

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## Appendix A

# Model Drought Contingency Plan

## DROUGHT CONTINGENCY PLAN FOR THE (Name of public water supplier) (Date)

### Section I: Declaration of Policy, Purpose, and Intent

In order to conserve the available water supply and protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the \_\_\_\_\_ (name of water supplier) hereby adopts the following regulations and restrictions on the delivery and consumption of water.

Water uses regulated or prohibited under this Drought Contingency Plan (the Plan) are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply condition are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in Section XI of this Plan.

### Section II: Public Involvement

Opportunity for the public to provide input into the preparation of the Plan was provided by the \_\_\_\_\_ (name of water supplier) by means of \_\_\_\_\_ (describe methods used to inform the public about the preparation of the plan and provide opportunities for input; for example, scheduling and providing public notice of a public meeting to accept input on the Plan ).

### Section III: Public Education

The \_\_\_\_\_ (name of water supplier) will periodically provide the public with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided by means of \_\_\_\_\_ (describe methods to be used to provide information to the public about the Plan; for example, public events, press releases or utility bill inserts).

### Section IV: Coordination with Regional Water Planning Groups

The service area of the \_\_\_\_\_ (name of water supplier) is located within the \_\_\_\_\_ (name of regional water planning area or areas) and \_\_\_\_\_ (name of water supplier) has provided a copy of this Plan to the \_\_\_\_\_ (name of regional water planning group or groups).

### Section V: Authorization

The \_\_\_\_\_ (designated official; for example, the mayor, city manager, utility director, general manager, etc.), or his/her designee is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is necessary to protect public health,

safety, and welfare. The \_\_\_\_\_, (designated official) or his/her designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in this Plan.

#### Section VI: Application

The provisions of this Plan shall apply to all persons, customers, and property utilizing water provided by the \_\_\_\_\_ (name of supplier). The terms "person" and "customer" as used in the Plan include individuals, corporations, partnerships, associations, and all other legal entities.

#### Section VII: Definitions

For the purposes of this Plan, the following definitions shall apply:

Aesthetic water use: water use for ornamental or decorative purposes such as fountains, reflecting pools, and water gardens.

Commercial and institutional water use: water use which is integral to the operations of commercial and non-profit establishments and governmental entities such as retail establishments, hotels and motels, restaurants, and office buildings.

Conservation: those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water or increase the recycling and reuse of water so that a supply is conserved and made available for future or alternative uses.

Customer: any person, company, or organization using water supplied by \_\_\_\_\_ (name of water supplier).

Domestic water use: water use for personal needs or for household or sanitary purposes such as drinking, bathing, heating, cooking, sanitation, or for cleaning a residence, business, industry, or institution.

Even number address: street addresses, box numbers, or rural postal route numbers ending in 0, 2, 4, 6, or 8 and locations without addresses.

Industrial water use: the use of water in processes designed to convert materials of lower value into forms having greater usability and value.

Landscape irrigation use: water used for the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf courses, parks, and rights-of-way and medians.

Non-essential water use: water uses that are not essential nor required for the protection of public, health, safety, and welfare, including:

- (a) irrigation of landscape areas, including parks, athletic fields, and golf courses, except otherwise provided under this Plan;
- (b) use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle;
- (c) use of water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
- (d) use of water to wash down buildings or structures for purposes other than immediate fire protection;
- (e) flushing gutters or permitting water to run or accumulate in any gutter or street;
- (f) use of water to fill, refill, or add to any indoor or outdoor swimming pools or jacuzzi-type pools;
- (g) use of water in a fountain or pond for aesthetic or scenic purposes except where necessary to

support aquatic life;

(h) failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s); and

(i) use of water from hydrants for construction purposes or any other purposes other than fire fighting.

Odd numbered address: street addresses, box numbers, or rural postal route numbers ending in 1, 3, 5, 7, or 9.

#### Section VIII: Criteria for Initiation and Termination of Drought Response Stages

The \_\_\_\_\_ (designated official) or his/her designee shall monitor water supply and/or demand conditions on a \_\_\_\_\_ (e.g., daily, weekly, monthly) basis and shall determine when conditions warrant initiation or termination of each stage of the Plan, that is, when the specified “triggers” are reached.

The triggering criteria described below are based on:

\_\_\_\_\_

(provide a brief description of the rationale for the triggering criteria; for example, triggering criteria / trigger levels based on a statistical analysis of the vulnerability of the water source under drought of record conditions, or based on known system capacity limits,).

#### Stage 1 Triggers -- MILD Water Shortage Conditions

##### Requirements for initiation

Customers shall be requested to voluntarily conserve water and adhere to the prescribed restrictions on certain water uses, defined in Section VII – Definitions, when

\_\_\_\_\_ (describe triggering criteria / trigger levels; see examples below).

Following are examples of the types of triggering criteria that might be used in one or more successive stages of a drought contingency plan. One or a combination of such criteria must be defined for each drought response stage, but usually not all will apply. Select those appropriate to your system:

Example 1: Annually, beginning on May 1 through September 30.

Example 2: When the water supply available to the \_\_\_\_\_ (name of water supplier) is equal to or less than \_\_\_\_\_ (acre-feet, percentage of storage, etc.).

Example 3: When, pursuant to requirements specified in the \_\_\_\_\_ (name of water supplier) wholesale water purchase contract with \_\_\_\_\_ (name of wholesale water supplier), notification is received requesting initiation of Stage 1 of the Drought Contingency Plan.

Example 4: When flows in the \_\_\_\_\_ (name of stream or river) are equal to or less than \_\_\_\_\_ cubic feet per second.

Example 5: When the static water level in the \_\_\_\_\_ (name of water supplier) well(s) is equal to or less than \_\_\_\_\_ feet above/below mean sea level.

Example 6: When the specific capacity of the \_\_\_\_\_ (name of water supplier) well(s) is equal to or less than \_\_\_\_\_ percent of the well’s original specific capacity.

Example 7: When total daily water demand equals or exceeds \_\_\_\_\_ million gallons for \_\_\_\_\_ consecutive days of \_\_\_\_\_ million gallons on a single day (e.g., based on the “safe” operating capacity of water supply facilities).

Example 8: Continually falling treated water reservoir levels which do not refill above \_\_\_\_ percent overnight (e.g., based on an evaluation of minimum treated water storage required to avoid system outage).

The public water supplier may devise other triggering criteria which are tailored to its system.

Requirements for termination

Stage 1 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of \_\_\_\_ (e.g. 3) consecutive days.

Stage 2 Triggers -- MODERATE Water Shortage Conditions

Requirements for initiation

Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses provided in Section IX of this Plan when \_\_\_\_\_ (describe triggering criteria; see examples in Stage 1).

Requirements for termination

Stage 2 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of \_\_\_\_ (e.g., 3) consecutive days. Upon termination of Stage 2, Stage 1 becomes operative.

Stage 3 Triggers -- SEVERE Water Shortage Conditions

Requirements for initiation

Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 3 of this Plan when \_\_\_\_\_ (describe triggering criteria; see examples in Stage 1).

Requirements for termination

Stage 3 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of \_\_\_\_ (e.g., 3) consecutive days. Upon termination of Stage 3, Stage 2 becomes operative.

Stage 4 Triggers -- CRITICAL Water Shortage Conditions

Requirements for initiation

Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 4 of this Plan when \_\_\_\_\_ (describe triggering criteria; see examples in Stage 1).

Requirements for termination

Stage 4 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of \_\_\_\_ (e.g., 3) consecutive days. Upon termination of Stage 4, Stage 3 becomes operative.

Stage 5 Triggers -- EMERGENCY Water Shortage Conditions

Requirements for initiation

Customers shall be required to comply with the requirements and restrictions for Stage 5 of this Plan when \_\_\_\_\_ (designated official), or his/her designee, determines that a water supply emergency exists based on:

1. Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service; or
2. Natural or man-made contamination of the water supply source(s).

Requirements for termination

Stage 5 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of \_\_\_\_ (e.g., 3) consecutive days.

Stage 6 Triggers -- WATER ALLOCATION

Requirements for initiation

Customers shall be required to comply with the water allocation plan prescribed in Section IX of this Plan and comply with the requirements and restrictions for Stage 5 of this Plan when \_\_\_\_\_ (describe triggering criteria, see examples in Stage 1).

Requirements for termination – Water allocation may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of \_\_\_\_ (e.g., 3) consecutive days.

Note: The inclusion of WATER ALLOCATION as part of a drought contingency plan may not be required in all cases. For example, for a given water supplier, an analysis of water supply availability under drought of record conditions may indicate that there is essentially no risk of water supply shortage. Hence, a drought contingency plan for such a water supplier might only address facility capacity limitations and emergency conditions (e.g., supply source contamination and system capacity limitations).

Section IX: Drought Response Stages

The \_\_\_\_\_ (designated official), or his/her designee, shall monitor water supply and/or demand conditions on a daily basis and, in accordance with the triggering criteria set forth in Section VIII of this Plan, shall determine that a mild, moderate, severe, critical, emergency or water shortage condition exists and shall implement the following notification procedures:

Notification

Notification of the Public:

The \_\_\_\_\_ (designated official) or his/ here designee shall notify the public by means of:

Examples:  
publication in a newspaper of general circulation,  
direct mail to each customer,  
public service announcements,  
signs posted in public places  
take-home fliers at schools.

Additional Notification:

The \_\_\_\_\_ (designated official) or his/ her designee shall notify directly, or cause to be notified directly, the following individuals and entities:

Examples:  
Mayor / Chairman and members of the City Council / Utility Board



Fire Chief(s)  
City and/or County Emergency Management Coordinator(s)  
County Judge & Commissioner(s)  
State Disaster District / Department of Public Safety  
TCEQ (required when mandatory restrictions are imposed)  
Major water users  
Critical water users, i.e. hospitals  
Parks / street superintendents & public facilities managers

Note: The plan should specify direct notice only as appropriate to respective drought stages.

#### Stage 1 Response -- MILD Water Shortage Conditions

Goal: Achieve a voluntary \_\_\_\_ percent reduction in \_\_\_\_\_ (e.g., total water use, daily water demand, etc.).

##### Supply Management Measures:

Describe measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, activation and use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

##### Voluntary Water Use Restrictions:

- (a) Water customers are requested to voluntarily limit the irrigation of landscaped areas to Sundays and Thursdays for customers with a street address ending in an even number (0, 2, 4, 6 or 8), and Saturdays and Wednesdays for water customers with a street address ending in an odd number (1, 3, 5, 7 or 9), and to irrigate landscapes only between the hours of midnight and 10:00 a.m. and 8:00 p.m to midnight on designated watering days.
- (b) All operations of the \_\_\_\_\_ (name of water supplier) shall adhere to water use restrictions prescribed for Stage 2 of the Plan.
- (c) Water customers are requested to practice water conservation and to minimize or discontinue water use for non-essential purposes.

#### Stage 2 Response -- MODERATE Water Shortage Conditions

Goal: Achieve a \_\_\_\_ percent reduction in \_\_\_\_\_ (e.g., total water use, daily water demand, etc.).

##### Supply Management Measures:

Describe measures, if any, to be implemented directly by \_\_\_\_\_ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

Water Use Restrictions. Under threat of penalty for violation, the following water use restrictions shall apply to all persons:

(a) Irrigation of landscaped areas with hose-end sprinklers or automatic irrigation systems shall be limited to Sundays and Thursdays for customers with a street address ending in an even number (0, 2, 4, 6 or 8), and Saturdays and Wednesdays for water customers with a street address ending in an odd number (1, 3, 5, 7 or 9), and irrigation of landscaped areas is further limited to the hours of 12:00 midnight until 10:00 a.m. and between 8:00 p.m. and 12:00 midnight on designated watering days. However, irrigation of landscaped areas is permitted at anytime if it is by means of a hand-held hose, a faucet filled bucket or watering can of five (5) gallons or less, or drip irrigation system.

(a) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight. Such washing, when allowed, shall be done with a hand-held bucket or a hand-held hose equipped with a positive shutoff nozzle for quick rises. Vehicle washing may be done at any time on the immediate premises of a commercial car wash or commercial service station. Further, such washing may be exempted from these regulations if the health, safety, and welfare of the public is contingent upon frequent vehicle cleansing, such as garbage trucks and vehicles used to transport food and perishables.

(a) Use of water to fill, refill, or add to any indoor or outdoor swimming pools, wading pools, or jacuzzi-type pools is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 a.m. and between 8 p.m. and 12:00 midnight.

(a) Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountains or ponds are equipped with a recirculation system.

(a) Use of water from hydrants shall be limited to fire fighting, related activities, or other activities necessary to maintain public health, safety, and welfare, except that use of water from designated fire hydrants for construction purposes may be allowed under special permit from the \_\_\_\_\_ (name of water supplier).

(a) Use of water for the irrigation of golf course greens, tees, and fairways is prohibited except on designated watering days between the hours 12:00 midnight and 10:00 a.m. and between 8 p.m. and 12:00 midnight. However, if the golf course utilizes a water source other than that provided by the \_\_\_\_\_ (name of water supplier), the facility shall not be subject to these regulations.

(a) All restaurants are prohibited from serving water to patrons except upon request of the patron.

(a) The following uses of water are defined as non-essential and are prohibited:

1. wash down of any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
2. use of water to wash down buildings or structures for purposes other than immediate fire protection;
3. use of water for dust control;
4. flushing gutters or permitting water to run or accumulate in any gutter or street; and
5. failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s).

#### Stage 3 Response -- SEVERE Water Shortage Conditions

Goal: Achieve a \_\_\_\_ percent reduction in \_\_\_\_\_ (e.g., total water use, daily water demand, etc.).

Supply Management Measures:

Describe measures, if any, to be implemented directly by \_\_\_\_\_ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

Water Use Restrictions. All requirements of Stage 2 shall remain in effect during Stage 3 except:

(a) Irrigation of landscaped areas shall be limited to designated watering days between the hours of 12:00 midnight and 10:00 a.m. and between 8 p.m. and 12:00 midnight and shall be by means of hand-held hoses, hand-held buckets, drip irrigation, or permanently installed automatic sprinkler system only. The use of hose-end sprinklers is prohibited at all times.

(a) The watering of golf course tees is prohibited unless the golf course utilizes a water source other than that provided by the \_\_\_\_\_ (name of water supplier).

(a) The use of water for construction purposes from designated fire hydrants under special permit is to be discontinued.

#### Stage 4 Response -- CRITICAL Water Shortage Conditions

Goal: Achieve a \_\_\_\_ percent reduction in \_\_\_\_\_ (e.g., total water use, daily water demand, etc.).

#### Supply Management Measures:

Describe measures, if any, to be implemented directly by \_\_\_\_\_ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

Water Use Restrictions. All requirements of Stage 2 and 3 shall remain in effect during Stage 4 except:

(a) Irrigation of landscaped areas shall be limited to designated watering days between the hours of 6:00 a.m. and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight and shall be by means of hand-held hoses, hand-held buckets, or drip irrigation only. The use of hose-end sprinklers or permanently installed automatic sprinkler systems are prohibited at all times.

(a) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle not occurring on the premises of a commercial car wash and commercial service stations and not in the immediate interest of public health, safety, and welfare is prohibited. Further, such vehicle washing at commercial car washes and commercial service stations shall occur only between the hours of 6:00 a.m. and 10:00 a.m. and between 6:00 p.m. and 10 p.m.

(a) The filling, refilling, or adding of water to swimming pools, wading pools, and jacuzzi-type pools is prohibited.

(a) Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountains or ponds are equipped with a recirculation system.

(a) No application for new, additional, expanded, or increased-in-size water service connections, meters, service lines, pipeline extensions, mains, or water service facilities of any kind shall be approved,

and time limits for approval of such applications are hereby suspended for such time as this drought response stage or a higher-numbered stage shall be in effect.

#### Stage 5 Response -- EMERGENCY Water Shortage Conditions

Goal: Achieve a \_\_\_\_ percent reduction in \_\_\_\_\_ (e.g., total water use, daily water demand, etc.).

#### Supply Management Measures:

Describe measures, if any, to be implemented directly by \_\_\_\_\_ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

Water Use Restrictions. All requirements of Stage 2, 3, and 4 shall remain in effect during Stage 5 except:

- (a) Irrigation of landscaped areas is absolutely prohibited.
- (a) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle is absolutely prohibited.

#### Stage 6 Response -- WATER ALLOCATION

In the event that water shortage conditions threaten public health, safety, and welfare, the \_\_\_\_\_ (designated official) is hereby authorized to allocate water according to the following water allocation plan:

##### Single-Family Residential Customers

The allocation to residential water customers residing in a single-family dwelling shall be as follows:

Persons per Household	Gallons per Month
1 or 2	6,000
3 or 4	7,000
5 or 6	8,000
7 or 8	9,000
9 or 10	10,000
11 or more	12,000

“Household” means the residential premises served by the customer’s meter. “Persons per household” includes only those persons currently physically residing at the premises and expected to reside there for the entire billing period. It shall be assumed that a particular customer’s household is comprised of two (2) persons unless the customer notifies the \_\_\_\_\_ (name of water supplier) of a greater number of persons per household on a form prescribed by the \_\_\_\_\_ (designated official). The \_\_\_\_\_ (designated official) shall give his/her best effort to see that such forms are mailed, otherwise provided, or made available to every residential customer. If, however, a customer does not receive such a form, it shall be the customer’s responsibility to go to the \_\_\_\_\_ (name of water supplier) offices to complete and sign the form claiming more than two (2) persons per household. New customers may claim more persons per household at the time of applying for water service on the form prescribed by the \_\_\_\_\_ (designated official). When the number of persons per household increases so as to place the customer in a different allocation category, the customer may notify the \_\_\_\_\_ (name of water supplier) on such form and the change will be implemented in the next practicable billing

period. If the number of persons in a household is reduced, the customer shall notify the \_\_\_\_\_ (name of water supplier) in writing within two (2) days. In prescribing the method for claiming more than two (2) persons per household, the \_\_\_\_\_ (designated official) shall adopt methods to insure the accuracy of the claim. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of persons in a household or fails to timely notify the \_\_\_\_\_ (name of water supplier) of a reduction in the number of person in a household shall be fined not less than \$ \_\_\_\_\_.

Residential water customers shall pay the following surcharges:

\$ \_\_\_\_\_ for the first 1,000 gallons over allocation.  
\$ \_\_\_\_\_ for the second 1,000 gallons over allocation.  
\$ \_\_\_\_\_ for the third 1,000 gallons over allocation.  
\$ \_\_\_\_\_ for each additional 1,000 gallons over allocation.

Surcharges shall be cumulative.

#### Master-Metered Multi-Family Residential Customers

The allocation to a customer billed from a master meter which jointly measures water to multiple permanent residential dwelling units (e.g., apartments, mobile homes) shall be allocated 6,000 gallons per month for each dwelling unit. It shall be assumed that such a customer's meter serves two dwelling units unless the customer notifies the \_\_\_\_\_ (name of water supplier) of a greater number on a form prescribed by the \_\_\_\_\_ (designated official). The \_\_\_\_\_ (designated official) shall give his/her best effort to see that such forms are mailed, otherwise provided, or made available to every such customer. If, however, a customer does not receive such a form, it shall be the customer's responsibility to go to the \_\_\_\_\_ (name of water supplier) offices to complete and sign the form claiming more than two (2) dwellings. A dwelling unit may be claimed under this provision whether it is occupied or not. New customers may claim more dwelling units at the time of applying for water service on the form prescribed by the \_\_\_\_\_ (designated official). If the number of dwelling units served by a master meter is reduced, the customer shall notify the \_\_\_\_\_ (name of water supplier) in writing within two (2) days. In prescribing the method for claiming more than two (2) dwelling units, the \_\_\_\_\_ (designated official) shall adopt methods to insure the accuracy of the claim. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of dwelling units served by a master meter or fails to timely notify the \_\_\_\_\_ (name of water supplier) of a reduction in the number of person in a household shall be fined not less than \$ \_\_\_\_\_. Customers billed from a master meter under this provision shall pay the following monthly surcharges:

\$ \_\_\_\_\_ for 1,000 gallons over allocation up through 1,000 gallons for each dwelling unit.  
\$ \_\_\_\_\_, thereafter, for each additional 1,000 gallons over allocation up through a second 1,000 gallons for each dwelling unit.  
\$ \_\_\_\_\_, thereafter, for each additional 1,000 gallons over allocation up through a third 1,000 gallons for each dwelling unit.  
\$ \_\_\_\_\_, thereafter for each additional 1,000 gallons over allocation.

Surcharges shall be cumulative.

#### Commercial Customers

A monthly water allocation shall be established by the \_\_\_\_\_ (designated official), or his/her designee, for each nonresidential commercial customer other than an industrial customer who uses water for processing purposes. The non-residential customer's allocation shall be approximately \_\_\_\_ (e.g. 75%) percent of the customer's usage for corresponding month's billing period for the previous 12 months. If the customer's billing history is shorter than 12 months, the

monthly average for the period for which there is a record shall be used for any monthly period for which no history exists. Provided, however, a customer, \_\_\_ percent of whose monthly usage is less than \_\_\_ gallons, shall be allocated \_\_\_ gallons. The \_\_\_\_\_ (designated official) shall give his/her best effort to see that notice of each non-residential customer's allocation is mailed to such customer. If, however, a customer does not receive such notice, it shall be the customer's responsibility to contact the \_\_\_\_\_ (name of water supplier) to determine the allocation. Upon request of the customer or at the initiative of the \_\_\_\_\_ (designated official), the allocation may be reduced or increased if, (1) the designated period does not accurately reflect the customer's normal water usage, (2) one nonresidential customer agrees to transfer part of its allocation to another nonresidential customer, or (3) other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the \_\_\_\_\_ (designated official or alternatively, a special water allocation review committee). Nonresidential commercial customers shall pay the following surcharges:

Customers whose allocation is \_\_\_ gallons through \_\_\_ gallons per month:

- \$ \_\_\_ per thousand gallons for the first 1,000 gallons over allocation.
- \$ \_\_\_ per thousand gallons for the second 1,000 gallons over allocation.
- \$ \_\_\_ per thousand gallons for the third 1,000 gallons over allocation.
- \$ \_\_\_ per thousand gallons for each additional 1,000 gallons over allocation.

Customers whose allocation is \_\_\_ gallons per month or more:

- \_\_\_ times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation.
- \_\_\_ times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation.
- \_\_\_ times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation.
- \_\_\_ times the block rate for each 1,000 gallons more than 15 percent above allocation.

The surcharges shall be cumulative. As used herein, "block rate" means the charge to the customer per 1,000 gallons at the regular water rate schedule at the level of the customer's allocation.

#### Industrial Customers

A monthly water allocation shall be established by the \_\_\_\_\_ (designated official), or his/her designee, for each industrial customer, which uses water for processing purposes. The industrial customer's allocation shall be approximately \_\_\_ (e.g., 90%) percent of the customer's water usage baseline. Ninety (90) days after the initial imposition of the allocation for industrial customers, the industrial customer's allocation shall be further reduced to \_\_\_ (e.g., 85%) percent of the customer's water usage baseline. The industrial customer's water use baseline will be computed on the average water use for the \_\_\_\_\_ month period ending prior to the date of implementation of Stage 2 of the Plan. If the industrial water customer's billing history is shorter than \_\_\_ months, the monthly average for the period for which there is a record shall be used for any monthly period for which no billing history exists. The \_\_\_\_\_ (designated official) shall give his/her best effort to see that notice of each industrial customer's allocation is mailed to such customer. If, however, a customer does not receive such notice, it shall be the customer's responsibility to contact the \_\_\_\_\_ (name of water supplier) to determine the allocation, and the allocation shall be fully effective notwithstanding the lack of receipt of written notice. Upon request of the customer or at the initiative of the \_\_\_\_\_ (designated official), the allocation may be reduced or increased, (1) if the designated period does not accurately reflect the customer's normal water use because the customer had shutdown a major processing unit for

repair or overhaul during the period, (2) the customer has added or is in the process of adding significant additional processing capacity, (3) the customer has shutdown or significantly reduced the production of a major processing unit, (4) the customer has previously implemented significant permanent water conservation measures such that the ability to further reduce water use is limited, (5) the customer agrees to transfer part of its allocation to another industrial customer, or (6) if other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the \_\_\_\_\_ (designated official or alternatively, a special water allocation review committee). Industrial customers shall pay the following surcharges:

Customers whose allocation is \_\_\_\_\_ gallons through \_\_\_\_\_ gallons per month:

- \$\_\_\_\_\_ per thousand gallons for the first 1,000 gallons over allocation.
- \$\_\_\_\_\_ per thousand gallons for the second 1,000 gallons over allocation.
- \$\_\_\_\_\_ per thousand gallons for the third 1,000 gallons over allocation.
- \$\_\_\_\_\_ per thousand gallons for each additional 1,000 gallons over allocation.

Customers whose allocation is \_\_\_\_\_ gallons per month or more:

- \_\_\_\_\_ times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation.
- \_\_\_\_\_ times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation.

\_\_\_\_\_ times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation.

\_\_\_\_\_ times the block rate for each 1,000 gallons more than 15 percent above allocation.

The surcharges shall be cumulative. As used herein, "block rate" means the charge to the customer per 1,000 gallons at the regular water rate schedule at the level of the customer's allocation.

#### Section X: Enforcement

- (a) No person shall knowingly or intentionally allow the use of water from the \_\_\_\_\_ (name of water supplier) for residential, commercial, industrial, agricultural, governmental, or any other purpose in a manner contrary to any provision of this Plan, or in an amount in excess of that permitted by the drought response stage in effect at the time pursuant to action taken by \_\_\_\_\_ (designated official), or his/her designee, in accordance with provisions of this Plan.
- (b) Any person who violates this Plan is guilty of a misdemeanor and, upon conviction shall be punished by a fine of not less than \_\_\_\_\_ dollars (\$\_\_\_\_) and not more than \_\_\_\_\_ dollars (\$\_\_\_\_). Each day that one or more of the provisions in this Plan is violated shall constitute a separate offense. If a person is convicted of three or more distinct violations of this Plan, the \_\_\_\_\_ (designated official) shall, upon due notice to the customer, be authorized to discontinue water service to the premises where such violations occur. Services discontinued under such circumstances shall be restored only upon payment of a re-connection charge, hereby established at \$\_\_\_\_\_, and any other costs incurred by the \_\_\_\_\_ (name of water supplier) in discontinuing service. In addition, suitable assurance must be given to the \_\_\_\_\_ (designated official) that the same action shall not be repeated while the Plan is in effect. Compliance with this plan may also be sought through injunctive relief in the district court.

(c) Any person, including a person classified as a water customer of the \_\_\_\_\_ (name of water supplier), in apparent control of the property where a violation occurs or originates shall be presumed to be the violator, and proof that the violation occurred on the person's property shall constitute a rebuttable presumption that the person in apparent control of the property committed the violation, but any such person shall have the right to show that he/she did not commit the violation. Parents shall be presumed to be responsible for violations of their minor children and proof that a violation, committed by a child, occurred on property within the parents' control shall constitute a rebuttable presumption that the parent committed the violation, but any such parent may be excused if he/she proves that he/she had previously directed the child not to use the water as it was used in violation of this Plan and that the parent could not have reasonably known of the violation.

(d) Any employee of the \_\_\_\_\_ (name of water supplier), police officer, or other \_\_\_\_\_ employee designated by the \_\_\_\_\_ (designated official), may issue a citation to a person he/she reasonably believes to be in violation of this Ordinance. The citation shall be prepared in duplicate and shall contain the name and addresses of the alleged violator, if known, the offense charged, and shall direct him/her to appear in the \_\_\_\_\_ (e.g., municipal court) on the date shown on the citation for which the date shall not be less than 3 days nor more than 5 days from the date the citation was issued. The alleged violator shall be served a copy of the citation. Service of the citation shall be complete upon delivery of the citation to the alleged violator, to an agent or employee of a violator, or to a person over 14 years of age who is a member of the violator's immediate family or is a resident of the violator's residence. The alleged violator shall appear in \_\_\_\_\_ (e.g., municipal court) to enter a plea of guilty or not guilty for the violation of this Plan. If the alleged violator fails to appear in \_\_\_\_\_ (e.g., municipal court), a warrant for his/her arrest may be issued. A summons to appear may be issued in lieu of an arrest warrant. These cases shall be expedited and given preferential setting in \_\_\_\_\_ (e.g., municipal court) before all other cases.

#### Section XI: Variances

The \_\_\_\_\_ (designated official), or his/her designee, may, in writing, grant temporary variance for existing water uses otherwise prohibited under this Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the health, sanitation, or fire protection for the public or the person requesting such variance and if one or more of the following conditions are met:

- (a) Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.
- (b) Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of this Ordinance shall file a petition for variance with the \_\_\_\_\_ (name of water supplier) within 5 days after the Plan or a particular drought response stage has been invoked. All petitions for variances shall be reviewed by the \_\_\_\_\_ (designated official), or his/her designee, and shall include the following:

- (a) Name and address of the petitioner(s).
- (b) Purpose of water use.
- (c) Specific provision(s) of the Plan from which the petitioner is requesting relief.
- (d) Detailed statement as to how the specific provision of the Plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance.
- (e) Description of the relief requested.
- (f) Period of time for which the variance is sought.
- (g) Alternative water use restrictions or other measures the petitioner is taking or proposes



- to take to meet the intent of this Plan and the compliance date.
- (h) Other pertinent information.

Variances granted by the \_\_\_\_\_ (name of water supplier) shall be subject to the following conditions, unless waived or modified by the \_\_\_\_\_ (designated official) or his/her designee:

- (a) Variances granted shall include a timetable for compliance.
- (b) Variances granted shall expire when the Plan is no longer in effect, unless the petitioner has failed to meet specified requirements.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

## Appendix B

### Title 30 Texas Administrative Code Chapter 288

#### **§288.20. Drought Contingency Plans for Municipal Uses by Public Water Suppliers.**

- (a) A drought contingency plan for a retail public water supplier, where applicable, shall provide information in response to each of the following.
  - (1) Minimum requirements. Drought contingency plans shall include the following minimum elements.
    - (A) Preparation of the plan shall include provisions to actively inform the public and affirmatively provide opportunity for public input. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.
    - (B) Provisions shall be made for a program of continuing public education and information regarding the drought contingency plan.
    - (C) The drought contingency plan must document coordination with the Regional Water Planning Groups for the service area of the retail public water supplier to insure consistency with the appropriate approved regional water plans.
    - (D) The drought contingency plan shall include a description of the information to be monitored by the water supplier, and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.
    - (E) The drought contingency plan must include drought or emergency response stages providing for the implementation of measures in response to at least the following situations:
      - (i) reduction in available water supply up to a repeat of the drought of record;
      - (ii) water production or distribution system limitations;

- (iii) supply source contamination; or
    - (iv) system outage due to the failure or damage of major water system components (e.g., pumps).
  - (F) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:
    - (i) curtailment of non-essential water uses; and
    - (ii) utilization of alternative water sources and/or alternative delivery mechanisms with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).
  - (G) The drought contingency plan must include the procedures to be followed for the initiation or termination of each drought response stage, including procedures for notification of the public.
  - (H) The drought contingency plan must include procedures for granting variances to the plan.
  - (I) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions, including specification of penalties (e.g., fines, water rate surcharges, discontinuation of service) for violations of such restrictions.
- (2) Privately-owned water utilities. Privately-owned water utilities shall prepare a drought contingency plan in accordance with this section and shall incorporate such plan into their tariff.
- (3) Wholesale water customers. Any water supplier that receives all or a portion of its water supply from another water supplier shall consult with that supplier and shall include in the drought contingency plan appropriate provisions for responding to reductions in that water supply.
- (b) A wholesale or retail water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

- (c) The retail public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as the adoption or revision of the regional water plan.

## Appendix C

### Drought Contingency Plans for Analysis: Retail Public Water Suppliers in Texas with 3,300 or More Connections

ABILENE, CITY OF  
ACTON MUNICIPAL UTILITY DISTRICT  
ADDISON, CITY OF  
ALAMO, CITY OF  
ALICE, CITY OF  
ALLEN, CITY OF  
ALVIN, CITY OF  
AMARILLO MUNICIPAL WATER  
SYSTEM  
ANDERSON MILL MUD  
ANDREWS, CITY OF  
ANGLETON, CITY OF  
AQUA WATER  
SUPPLY CORPORATION  
ARLINGTON, CITY OF  
ATHENS CITY, OF  
AUSTIN, CITY OF  
AZLE, CITY OF  
BAY CITY, CITY OF  
BAYTOWN, CITY OF  
BEAUMONT, CITY OF  
BEDFORD, CITY OF  
BEEVILLE, CITY OF  
BELLARE, CITY OF  
BELTON, CITY OF  
BENBROOK WATER & SEWER  
AUTHORITY  
BETHESDA WATER SUPPLY CORPORATION  
BEXAR MET WDBIG SPRING, CITY OF  
BOLIVAR PENINSULA WATER SUPPLY CORP  
BONHAM, CITY OF  
BORGER MUNICIPAL  
WATER SYSTEM  
BRENHAM, CITY OF  
BRIDGE CITY, CITY OF  
BROWNFIELD, CITY OF  
BROWNSVILLE PUBLIC UTILITY BOARD  
BROWNWOOD, CITY OF  
BRUSHY CREEK  
MUD  
BRYAN, CITY OF  
BURKBURNETT, CITY OF  
BURLESON, CITY OF  
C N P UTILITY  
DISTRICT  
CANYON MUNICIPAL WATER SYSTEM  
CARROLLTON, CITY OF  
CASH WATER  
SUPPLY CORPORATION  
CEDAR HILL, CITY OF  
CEDAR PARK, CITY OF  
CLEAR LAKE CITY  
WATER AUTHORITY  
CLEBURNE, CITY OF  
COLLEGE STATION WATER  
COLLEYVILLE, CITY OF  
COLONY, CITY OF  
THE CONROE, CITY OF  
CONSOLIDATED WATER SUPPLY  
CORP  
CONVERSE, CITY OF  
COPPELL, CITY OF  
COPPERAS COVE, CITY OF  
CORPUS CHRISTI, CITY OF  
CORSICANA, CITY OF  
CRYSTAL CLEAR WATER SUPPLY CORP  
DALLAS COUNTY  
WCID NO 6  
DALLAS WATER UTILITY  
DEER PARK, CITY OF  
DEL RIO UTILITIES  
COMMISSION  
DENISON, CITY OF  
DENTON, CITY OF  
DESOTO, CITY OF  
DONNA, CITY OF  
DUMAS MUNICIPAL UTILITY DISTRICT  
DUNCANVILLE, CITY OF  
EAGLE PASS, CITY OF  
EAST CENTRAL WS  
EAST RIO HONDO WATER SUPPLY CORP  
EDINBURG, CITY OF  
EL CAMPO, CITY OF  
EL PASO COUNTY WATER AUTHEL PASO  
WATER UTILITIES  
PUB SERV  
BENNIS, CITY OF  
EULESS, CITY OF  
FARMERS BRANCH, CITY OF  
FLOWER MOUND, TOWN OF  
FOREST HILL, CITY OF  
FREDERICKSBURG, CITY OF  
FREEPORT, CITY OF  
FRIENDSWOOD, CITY OF  
FRISCO, CITY OF  
FT BEND WCID NO 2  
FT WORTH, CITY OF  
GAINESVILLE, CITY OF  
GALENA PARK, CITY OF  
GALVESTON, CITY OF  
GALVESTON COUNTY WCID NO 1  
GARLAND, CITY OF  
GEORGETOWN, CITY OF  
GRAHAM, CITY OF  
GRAND PRAIRIE, CITY OF  
GRAPEVINE, CITY OF  
GREEN VALLEY SPECIAL UTILITY DIST  
GREENVILLE, CITY OF  
GROVES, CITY OF  
HALTOM CITY, CITY OF  
HARKER HEIGHTS, CITY OF  
HARLINGEN  
WATER WORKS SYSTEM  
HCO FWSD NO 51  
HCO FWSD NO 61  
HCO MUD NO 173  
HCO MUD NO 200  
HCO MUD NO 53  
HCO MUD NO 55  
HCO WCID NO 21  
HENDERSON, CITY OF  
HEREFORD  
MUNICIPAL WATER SUPPLY  
HEWITT, CITY OF  
HIGHLAND PARK, CITY OF  
HIGHLAND  
VILLAGE, CITY OF  
HOUSTON, CITY OF  
HUMBLE, CITY OF  
HUNTSVILLE, CITY OF  
HURST, CITY OF  
IRVING, CITY OF  
JACKSONVILLE, CITY OF  
JASPER, CITY OF  
JOHNSON COUNTY RURAL  
WATER SUPPLY  
KELLER, CITY OF  
KERRVILLE, CITY OF  
KILGORE, CITY OF  
KILLEEN, CITY OF  
KINGSVILLE, CITY OF  
LA JOYA WATER SUPPLY CORPORATION  
LA MARQUE, CITY OF  
LAGUNA MADRE WATER DISTRICT  
LAKE JACKSON, CITY OF  
LAMAR COUNTY  
WSD  
LAMESA, CITY OF  
LANCASTER, CITY OF  
LAPORTE, CITY OF  
LAREDO, CITY OF  
LEAGUE  
CITY, CITY OF  
LEVELLAND, CITY OF  
LEWISVILLE ,CITY OF  
LONGVIEW, CITY OF  
FLOWER  
VALLEY WATER DISTRICT  
LUBBOCK PUBLIC WATER SYSTEM  
LUFKIN, CITY OF  
LUMBERTON MUNICIPAL UTILITY DIST  
MANSFIELD, CITY OF  
MANVILLE WATER SUPPLY  
CORPORATION  
MARSHALL, CITY OF  
MCALLEN, CITY OF  
MCKINNEY, CITY OF  
MERCEDES, CITY OF  
MESQUITE, CITY OF  
MIDLAND, CITY OF  
MILITARY HWY WSC PROGRESS  
MINERAL

WELLS, CITY OF MISSION, CITY OF MONTGOMERY COUNTY MUD NO 47 MOUNT PLEASANT,  
CITY OF NACOGDOCHES, CITY OF NEDERLAND, CITY OF NEW BRAUNFELS UTILITIES NORTH  
ALAMO WATER SUPPLY CORP NORTH RICHLAND HILLS CITY OF NORTHAMPTON  
MUD NUECES COUNTY WCID NO 30 DESSA, CITY OF ORANGE, CITY OF PALESTINE, CITY  
OF PAMPA MUNICIPAL WATER SYSTEM PARIS, CITY OF PASADENA, CITY OF PEARLAND,  
CITY OF PECAN GROVE MUD NO 1 PECOS, CITY OF PFLUGERVILLE, CITY OF PHARR, CITY  
OF PLAINVIEW MUNICIPAL WATER SYSTEM PLANO, CITY OF PLEASANTON, CITY OF PORT  
ARTHUR, CITY OF PORT LAVACA, CITY OF PORT NECHES, CITY OF PORTER WSC PORTLAND,  
CITY OF QUAIL VALLEY UTILITY DISTRICT RICHARDSON, CITY OF RIO GRANDE, CITY  
OF ROCKETT SPECIAL UTILITY DISTRICT ROCKPORT, CITY OF ROCKWALL, CITY OF ROMA,  
CITY OF ROSENBERG, CITY OF ROUND ROCK, CITY OF ROWLETT, CITY OF SAGINAW, CITY  
OF SAN ANGELO, CITY OF SAN ANTONIO WATER SYSTEMS SAN BENITO, CITY OF SAN JUAN,  
CITY OF SAN MARCOS, CITY OF SCHERTZ, CITY OF SEGUIN, CITY OF SHARYLAND WATER  
SUPPLY CORPORATION SHERMAN, CITY OF SNYDER, CITY OF SOUTH HOUSTON, CITY  
OF SOUTHERN UTILITIES SOUTHLAKE, CITY OF SPRINGS HILL WATER SUPPLY  
CORP STEPHENVILLE, CITY OF SUGARLAND, CITY OF SULPHUR SPRINGS, CITY  
OF SWEETWATER, CITY OF TAYLOR, CITY OF TEMPLE, CITY OF TERRELL, CITY  
OF TEXARKANA WATER UTILITIES TEXAS CITY, CITY OF TIMBERLANE UTILITY  
DISTRICT TOMBALL, CITY OF TRAVIS CO WCID 17 TRI WATER SUPPLY  
CORPORATION TYLER, CITY OF UNIVERSAL CITY, CITY OF UNIVERSITY PARK, CITY  
OF UVALDE, CITY OF VERNON, CITY OF VICTORIA, CITY OF WACO, CITY OF WAXAHACHIE,  
CITY OF WEATHERFORD, CITY OF WESLACO, CITY OF WEST CEDAR CREEK MUNICIPAL  
UTILITY WHARTON, CITY OF WHITE SETTLEMENT, CITY OF WICHITA FALLS, CITY  
OF WOODWAY, CITY OF WYLIE, CITY OF