State of Illinois
Drought Preparedness and Response Plan

Adopted by the State Water Plan Task Force
October 12, 2011

Illinois Department of Agriculture (IDOA)
Illinois Department of Commerce and Economic Opportunity (IDCEO)
Illinois Department of Natural Resources (IDNR)
Office of Mines and Minerals (OMM)
Office of Resource Conservation (ORC)
Office of Water Resources (OWR)
Illinois Department of Public Health (IDPH)
Illinois Environmental Protection Agency (IEPA)
Illinois Pollution Control Board (IPCB)
United States Geological Survey (USGS)
University of Illinois – Prairie Research Institute
Illinois State Geological Survey (ISGS)
Illinois State Water Survey (ISWS)
University of Illinois – Water Resource Center (WRC)

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Introduction

Need for a Drought Plan

Drought is a common natural phenomenon that can lead to a natural disaster. In many countries, famine occurs because of drought, often leading to a large number of casualties. Fortunately, for us living in this country at this time, famine is no longer a major concern of drought. However, there are still public health concerns with drought, primarily associated with water quality and proper disinfection as well as the effects of prolonged heat waves that commonly occur during severe drought periods. There are also serious economic impacts of drought with damages to crops or damages resulting from an interruption in available water supply. In addition, there are occasions when the interruption of water supply can lead to an emergency, such as for fire protection. Serious droughts can result in conflicts and competitions in water use, leading to difficult decisions and sacrifices. In addition to its effects on human activities, drought can have serious impacts on our fisheries, wildlife, and natural habitats as well as the threat of fires, which generally increases during periods of drought.

Every drought is different in its intensity, duration, timing, and impacts. Some droughts come on fast but do not last long. Others are slow to develop but persist for a long time. Thus, the response and issues concerning each drought are different. However, we typically do not know what kind of drought we're dealing with, or even if we are in a drought condition, until some time after it has started. With each drought, attention is focused on the further or additional needs for better drought preparedness and/or response, and plans are often made during or immediately after a drought to address a deficiency or need. We learn from droughts to better prepare ourselves to reduce the impacts of the next one. It is at this time that many communities reexamine or adopt new plans, make changes to their water supply systems, and enact ordinances for conservation measures as appropriate to respond to the next drought. For example, some communities have performed reservoir bathymetric surveys to determine their existing water storage capacity. Others have decided to interconnect to other systems, deepen or expand their well fields, or provide for additional reservoir storage.

State agencies also respond to the further needs for better preparedness during droughts. Following the 2005/2006 drought, the State Water Plan Task Force (SWPTF) decided that it was time to update the State's 1983 drought contingency plan. The SWPTF believed the drought plan should go beyond drought response, and also include drought preparedness. Since the 1980s, Illinois has made a number of advances in water supply planning and management, having conducted numerous studies, developed new tools and technologies, and prepared numerous reports concerning drought preparedness. This new information needs to be incorporated into the drought plan as a resource to assist communities in their drought planning. In doing so, the drought plan should address the need for communities to conduct risk management to assess the level of drought for which they are willing to prepare. The drought plan should also address the need to reassess the capacity of older reservoirs utilizing new measurement techniques and updated data and technical information. Lastly, the drought plan should emphasize <u>the need for conservation, water supply planning, and management efforts in the areas of drought</u>.

Illinois is a water-rich state and we are fortunate to have Lake Michigan, the Illinois River, and our bordering Mississippi, Wabash, and Ohio Rivers. Given certain legal constraints, these water supply sources are able to meet the current demands of over 60 percent of our population even during the worst of droughts. However, even these sources have limitations and issues that support the need for proper planning and conservation measures to meet the growing water supply demands for the regions in which they serve.

Our deep and shallow aquifer systems and our community surface water systems in central and southern Illinois are more vulnerable to drought in terms of their ability to provide the needed water supply, and in their impacts to other uses or users. Based on their limited water supply availability and substantial population and economic growth, four aquifer systems and five watersheds in Illinois have been identified as most in need of attention for water supply planning and management purposes (Wehrmann and Knapp, 2006). Improved water supply planning and management of these aquifers and watersheds will help ensure current and future water demands can be met and conflicts minimized. Aquifers and watersheds are listed in order of priority regarding the potential benefit and relative urgency of water supply planning. Studies and regional efforts on these systems are identified in this plan.

The following aquifer systems are recommended as most in need of study and planning:

- the deep bedrock aquifer system of northeastern Illinois,
- the sand and gravel and shallow bedrock aquifers of northeastern Illinois,
- the Mahomet Aquifer of east-central Illinois, and
- the American Bottoms of southwestern Illinois (MetroEast area).

The following watersheds are recommended for study and planning:

- the Fox River watershed,
- the Kaskaskia River watershed,
- the Sangamon River watershed,
- the Kishwaukee River watershed, and
- the Kankakee River watershed.

Besides the priority aquifers and watersheds, there are smaller systems that are just as susceptible to drought in their ability to provide water supply to the public and uses for which they serve. Many smaller systems are more susceptible to droughts of high intensity and short duration due to their limited capacity. Water hauling to replenish shallow wells is often one of the first signs of an extended dry period. In-stream reservoirs or side-channel reservoirs reliant on smaller streams also feel the early effects of drought. These systems are also often quicker to recover from drought.

Humans often postpone dealing with issues that are not a current problem, especially when there is a cost or effort involved. Time can slowly erase memories. It has been quite some time since the 1953-1955 drought and most of us have only read about the dust bowl era in the early 1930's. Probabilities would indicate that we are due for another drought of this magnitude.

> *The worst water-supply droughts in Illinois occurred in the 1930s and 1950s. Although selected communities have been impacted by more recent and less-severe droughts, such as droughts in the mid-1960s, 1976-1977, 1988-1989, 1999-2000, and 2005, none of these recent droughts had the same type of widespread impact as the droughts of the early and mid 20th Century. Such severe droughts will occur again in the future. Many communities that have not experienced water-supply concerns in decades may still be at risk of having water shortages during a severe drought.* (Winstanley, et al., 2006)

Goal and Framework of Illinois' Drought Preparedness and Response Plan

The goal of Illinois' Drought Preparedness and Response Plan is to assist community and state officials and the public with information and tools that promote better decision-making in water *supply planning and reduce drought-related impacts, water competition, and conflicts of use.* To enable meeting this goal, the SWPTF believes the drought plan should be a dynamic plan, able to be easily updated as new information becomes available.

> *Successful water supply planning depends on the availability and use of scientific data. …. a wealth of historical scientific data and resources on all components of the water cycle exists in Illinois. Analyzing and interpreting these data and incorporating them in mathematical models provide means to investigate possible variations and changes in future water availability, and to evaluate alternative strategies for providing adequate and safe supplies of clean water at reasonable cost.* (Winstanley, et al., 2006)

It is important to recognize that neither the SWPTF nor this drought plan is regulatory or required by law. The SWPTF is a forum of state agency representatives interested in keeping up-to-date with water issues and actions of other state agencies. For this same purpose, the SWPTF is updating the drought plan to provide state agencies, communities, and the public with a resource to stay updated on water supply issues, drought actions, and key considerations communities should make for drought preparedness. The framework proposed to accomplish this is as follows:

- **Web site-Driven —** with today's computer technology and web accessibility, a web site-driven state drought plan can contain the latest information.

- **Updates** — a section on current drought conditions, the status of existing state water planning activities, and considerations for additional studies will be included.

- **Contacts** — a list of State Agency Contacts and Drought Response Task Force members will be provided as a directory for coordination and assistance.

- **Links** — many publications and other sources of information were used in preparing this drought plan. In consideration of the wealth of information and publications available, the drought plan will only briefly describe the key subject areas but furnish links to detailed subject reports.

Role of the State Water Plan Task Force (SWPTF)

The State Water Plan Task Force (SWPTF) was created in 1980 to guide policy decisions regarding the adequacy of programs to deal with an increasing number of water issues and to prepare a State Water Plan for Illinois. The SWPTF is an interagency group composed of management-level representatives from state resource agencies, the University of Illinois, and the Governor's Office. The SWPTF is chaired by the Director of the IDNR Office of Water Resources. The following agencies are included on the SWPTF:

Illinois Department of Agriculture (IDOA)
Illinois Department of Commerce and Economic Opportunity (IDCEO)
Illinois Department of Natural Resources (IDNR)
- Office of Mines and Minerals (OMM)
- Office of Resource Conservation (ORC)
- Office of Water Resources (OWR)
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United States Geological Survey (USGS)
University of Illinois – Prairie Research Institute

- Illinois State Geological Survey (ISGS)
- Illinois State Water Survey (ISWS)

University of Illinois – Water Resource Center (WRC)

In consideration of public and advisory group views, the SWPTF originally identified ten critical issues upon which to proceed (Illinois State Water Plan, 1984):

1. Erosion and Sediment Control
2. Protection of Underground Water
3. Flood Damage Mitigation
4. Water Conservation
5. Competition for Water
6. Aquatic and Riparian Habitat
7. Water-Based Recreation
8. Atmospheric Changes and Management
9. Drought and Emergency Interruption of Supplies
10. Illinois Water Use Law

The Illinois State Water Plan also identified the need for integrated water management to develop methods and procedures to coordinate the application of various agency authorities toward emerging water resource issues facing the State.

One of the first reports of the SWPTF was the preparation of Special Report No. 3 in 1983, titled "Drought Contingency Planning," establishing the framework for the Drought Response Task Force and the state's drought contingency programs and options that are in place today. The present plan represents an update of that report.

The SWPTF meets quarterly and has its one hundred and forty-fifth (145) meeting on October 12, 2011. Over the course of its existence, the SWPTF has published the State Water Plan (in 1984) and 28 reports from 19 special work groups.

Defining Drought and Drought Impacts

Definition of Drought

A drought is a long-lasting weather pattern consisting of dry conditions with very little or no precipitation, usually lasting at least a season or more. Unlike other natural disasters, drought does not have a clearly defined beginning or end. Drought is a normal and recurrent feature of climate and can occur in all climatic zones, though its characteristics and impacts vary significantly from one region to another. The National Drought Mitigation Center web site @ http://www.drought.unl.edu/index.htm provides a thorough description of the various definitions used to define and describe drought. Below is a brief description of several commonly used definitions and methods to describe drought.

Drought is a deficiency of precipitation resulting in a water shortage for some activity or group over an extended period, having some social, environmental, or economic effect. Drought is considered relative to some long-term average or "normal" condition. It is also related to the timing and the effectiveness of the precipitation.

A *Conceptual Definition of Drought* is formulated in general terms to help people understand the concept of drought. It is often used in establishing drought policy, e.g., in instituting mandatory conservation measures under "severe drought conditions." The U.S. Drought Monitor uses easy to understand drought intensity levels, beginning with "abnormally dry" (DO), to "moderate" (D1), "severe" (D2), "extreme" (D3), up to "exceptional" (D4) and highlights these levels on a color map. (See U.S. Drought Monitor @ http://www.drought.unl.edu/dm/monitor.html) The U.S. Drought Monitor map indicates whether drought is affecting agriculture (A) or water supplies (as "H"- hydrological.).

An *Operational Definition of Drought* is used to help people identify the beginning, end, and degree of severity of a drought and is usually done by comparing the current situation to the historical average. Operational definitions specify the degree of departure from the average over some period and are used to analyze drought frequency, severity, and duration for a given historical period. Information of this type is extremely beneficial in the development of response and mitigation strategies and preparedness plans.

No single operational definition of drought works in all circumstances, and this is a big part of why policy makers, resource planners, and others have more trouble recognizing and planning for drought than they do for other natural disasters. In fact, most drought planners now rely on mathematic indices to decide when to start implementing water conservation or drought response measures (National Drought Mitigation Center, www.drought.unl.edu/index.htm).

The U.S. Drought Monitor map utilizes six key indicators of rainfall to produce the final drought intensity rating. Below are brief descriptions of three commonly used indicators. See indices link in previous paragraph for more detailed information.

Standardized Precipitation Index (SPI) The understanding that a deficit of precipitation has different impacts on groundwater, reservoir storage, soil moisture, snowpack, and streamflow led to the development of the SPI by T.B. McKee, N.J. Doesken, and J. Kleist, Colorado State University, in 1993. The SPI is an index based on the probability of precipitation for any time scale in order to reflect the impact of drought on the availability of the different water resources. It can provide early warning of drought and help assess drought severity.

Palmer Drought Severity Index (PDSI) The objective of the PDSI was to provide measurements of moisture conditions that were standardized so that comparisons using the index could be made between locations and between months. The PDSI is calculated based on precipitation and temperature data, as well as the local Available Water Content (AWC) of the soil. The Palmer Index is popular and has been widely used for a variety of applications across the United States. It is most effective measuring impacts sensitive to soil moisture conditions, such as agriculture (Willeke et al., 1994). It has also been useful as a monitoring tool to trigger actions associated with drought contingency plans and drought relief programs. It was developed by W.C. Palmer in 1965, being the first comprehensive drought index developed in the United States (National Drought Mitigation Center, www.drought.unl.edu/index.htm).

Percent of Normal relates the percentage of actual precipitation to normal precipitation over some period. A "precipitation drought" is defined by scientists at the Illinois State Water Survey (ISWS) as when one or more climatological districts in the state:

- average less than 60 percent of the normal precipitation over a 3-month period,
- average less than 70 percent of the normal precipitation over a 6-month period, or
- average less than 80 percent of the normal precipitation over a 12- month period.

As an example, using this definition during the five-month period from July through November 1999, nearly all of the state was experiencing precipitation drought conditions. Statistically, it was the fifth driest July-November period in Illinois since record keeping began in 1895.

Below are several operational definitions of drought that provide a disciplinary perspective.

Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or reservoir levels, and so forth. An operational definition for *agriculture* might compare daily precipitation values to evapotranspiration rates to determine the rate of soil moisture depletion. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil. A good definition of agricultural drought should be able to account for the variable susceptibility of crops during different stages of crop development, from emergence to maturity. Deficient topsoil moisture at planting may hinder germination, leading to low plant populations per hectare and a reduction of final yield. However, if topsoil moisture is sufficient for early growth requirements, deficiencies in subsoil moisture at this early stage may not affect final yield if subsoil moisture is replenished as the growing season progresses or if rainfall meets plant water needs (National Drought Mitigation Center, www.drought.unl.edu/index.htm).

Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (i.e., streamflow, reservoir and lake levels, groundwater). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with or lag the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, streamflow, and groundwater and reservoir levels. As a result, these impacts are out of phase with impacts in other economic sectors. For example, a precipitation deficiency may result in a rapid depletion of soil moisture that is almost immediately discernible to agriculturalists, but the impact of this deficiency on reservoir levels may not affect hydroelectric power production or recreational uses for many months. Also, water in hydrologic storage systems (e.g., reservoirs, rivers) is often used for multiple and competing purposes (e.g., flood control, irrigation, recreation, navigation, hydropower, wildlife habitat), further complicating the sequence and quantification of impacts. Competition for water in these storage systems escalates during drought and conflicts between water users increase significantly (National Drought Mitigation Center, www.drought.unl.edu/index.htm).

Understanding Drought in Illinois

Droughts are a common feature in the climate of Illinois. Over the past 115 years Illinois has experienced several serious droughts. While there are several ways to measure drought, one that is available back to 1895 is the Palmer Drought Severity Index (PDSI). This index uses precipitation deficits as well as temperature to identify periods of drought. Negative numbers mean dry conditions, and values below -2 are considered as some form of drought.

Figure 1 shows the statewide summer values of the PDSI since 1895.The outstanding statewide droughts since 1895 include 1902, 1915, 1931, 1934, 1936, 1954, 1964, and 1988. The 1930s were outstanding in both the frequency and severity of drought. The worst case was the summer of 1934 with a statewide PDSI of -6.48. In second place was the summer of 1931 with -6.39. In third place was 1954 with -6.09. All three of these events fall into the category of extreme drought. In recent times, the 1988 PDSI reached -4.17 and ranked as the eighth lowest on record.

Figure 1 reveals other features of drought in Illinois. One is that both dry and wet conditions tend to run in groups of two or more years. Another feature is that the occurrence of more serious droughts have decreased since 1965 and that exceptionally wet summers have become more common. The two outstanding droughts of the past 30 years have been the 1988 and 2005 droughts.

While the statewide PDSI can identify large-scale droughts, it is quite common for one part of Illinois to experience severe drought while other parts are experiencing adequate or even excessive precipitation. For example, the annual precipitation in southern Illinois in 1988 averaged 85 to 95 percent of normal compared to 60 to 85 percent of normal in central and northern Illinois. In addition, the timing of droughts can determine the types of impacts experienced. For example, an exceptionally dry July-August, combined with high temperatures, may have significant impacts on corn and soybean yields and thus qualify as an agricultural drought (such as 2011), while the same precipitation departures in winter might go unnoticed.

In Winstanley et al. (2006) the Illinois State Water Survey developed expected average precipitation at a given site for selected drought durations and return periods (Table 1). Precipitation deficits are most severe for shorter duration droughts . However, the precipitation deficits at the longer time scales generally prove to be more taxing on the water resources of the state because the accumulated shortfalls are larger.

Because multi-decadal shifts in Illinois precipitation have been recorded in the past, both towards wetter and drier conditions at various times in the record, it is reasonable to assume that similar shifts will occur in the future. Absent long-term climate change, it is expected that drought conditions similar to the worst historic droughts of the 1930s and 1950s will occur again, with the possibility that a more extreme drought might also occur on an infrequent basis. Given these expectations, it is sensible that Illinois water supply systems should plan for the recurrence of climatic conditions similar to those experienced in the early- to mid-1900s, with specific focus on the *drought of record*, that being the most severe of all the historical droughts for which there are hydrologic records available to evaluate each water supply system. Consideration may also be given to the possible outcome that long-term climate change may lead to warmer and drier conditions than those recorded in the past 150 years, although that particular scenario is not reflected in the climatic and hydrologic trends of recent decades.

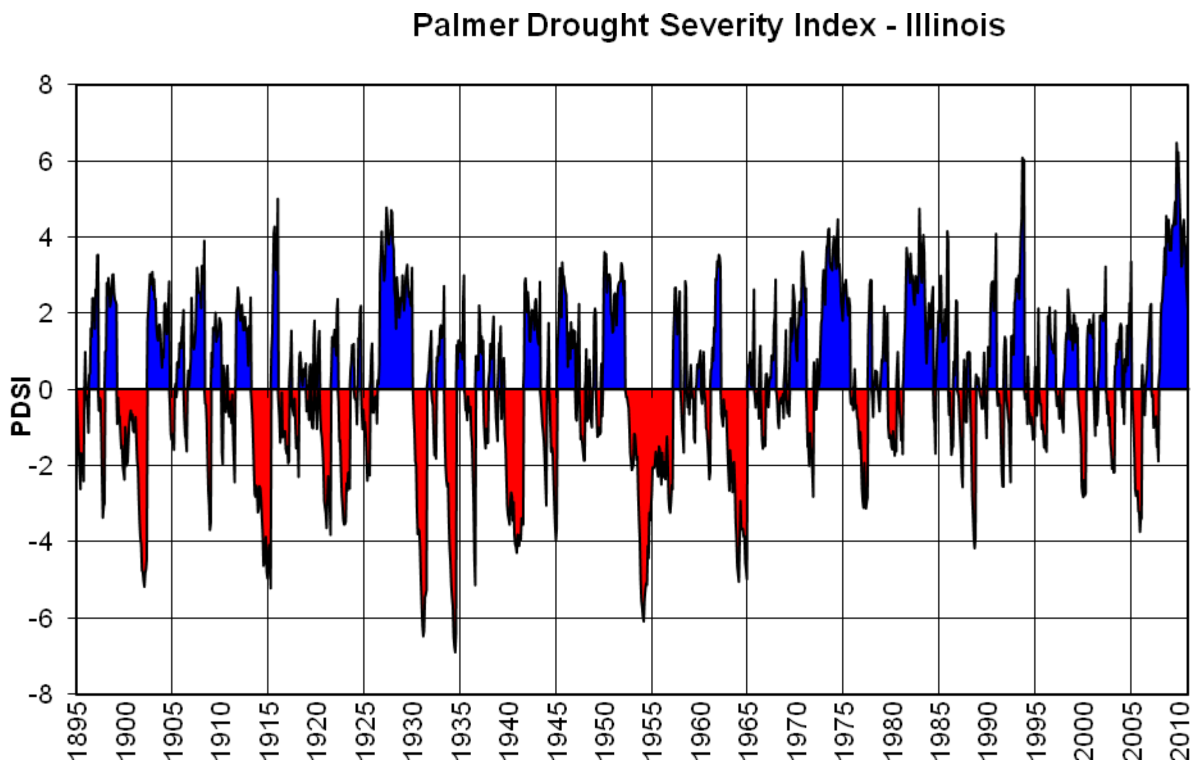


Figure 1. The Palmer Drought Severity Index (PDSI) from 1895 to present is shown with dry periods in red and wet periods in blue. Data provided by the National Climatic Data Center. Graph provided by the Illinois State Water Survey.

Table 1. Site-specific expected precipitation deficits, expressed as percent of the 1971-2000 average, for selected durations and return periods (from Winstanley et al., 2006, page 23).

Drought Duration	25-year return period	50-year return period	100-year return period	200-year return period
12 months	59.1%	52.5%	47.8%	44.0%
18 months	66.8%	60.1%	55.2%	51.3%
24 months	71.9%	64.8%	59.7%	55.5%
36 months	77.8%	71.1%	66.2%	62.2%
48 months	81.8%	75.0%	70.1%	66.1%
60 months	85.3%	78.3%	73.2%	69.0%

Effects of Drought

Rural Households (self-supply, e.g., wells, ponds)
Several hundred thousand people in Illinois depend on private wells for their water. Therefore, the sensitivity of private, domestic groundwater supplies to drought is important. Rural households are often affected first by droughts due to their reliance on shallow wells, which can be extremely sensitive to relatively small declines in the groundwater level. While many rural households have backup supply sources, many still have to haul water on a routine basis during dry summer months. For example, in

January 1977, in the 49 counties in Illinois considered to have potential disaster status by USDA standards, members of 24,123 households were hauling water from public supplies. The average monthly consumption was 3,408 gallons[3] or only about 110 gallons per day per household (as opposed to a typical per capita consumption of 90-100 gallons per day).

Additional analysis of the sensitivity of rural households to drought was completed in 2006 (Winstanley et al., 2006). A county-by-county summary of the prevalence of bored and dug wells, a Midwestern well-type particularly sensitive to drought, was conducted to highlight regions of the state where private wells will be most at-risk when drought occurs (Figure 2). It is readily apparent that, based on the number of records in the ISWS Wells Database, the greatest number of wells in Illinois occurs in northeastern Illinois. Many fewer wells exist in southeast Illinois and in a number of western Illinois counties. County populations aside, the number of wells clearly is influenced by the presence or absence of major aquifer systems. Northeastern Illinois is blessed with multiple aquifer systems, one lying over another; whereas, southern Illinois generally is groundwater poor, relying on alluvial aquifers within the major river valleys (Wabash, Illinois, Mississippi, and Kaskaskia).

Bored and dug wells are the principal well type in areas where no local aquifer exists. Water demands are met by the water in storage within the well bore (a typical 36-inch diameter well contains 53 gallons of water per foot of water depth). These wells rely on seepage from thin stringers of silts, sands, and gravels to replenish the water within the large bore during low demand periods (e.g., nighttime). As such, these wells are susceptible to dry conditions and, depending upon depth and water use demands, many go dry even during normal summers. Bored and dug wells, therefore, are extremely sensitive to drought. Examination of the ISWS private well database reveals the predominance of these well types across much of southern Illinois (Figure 2). In many cases, over 50 percent of the wells in these counties are bored or dug wells.

Public Water Supplies

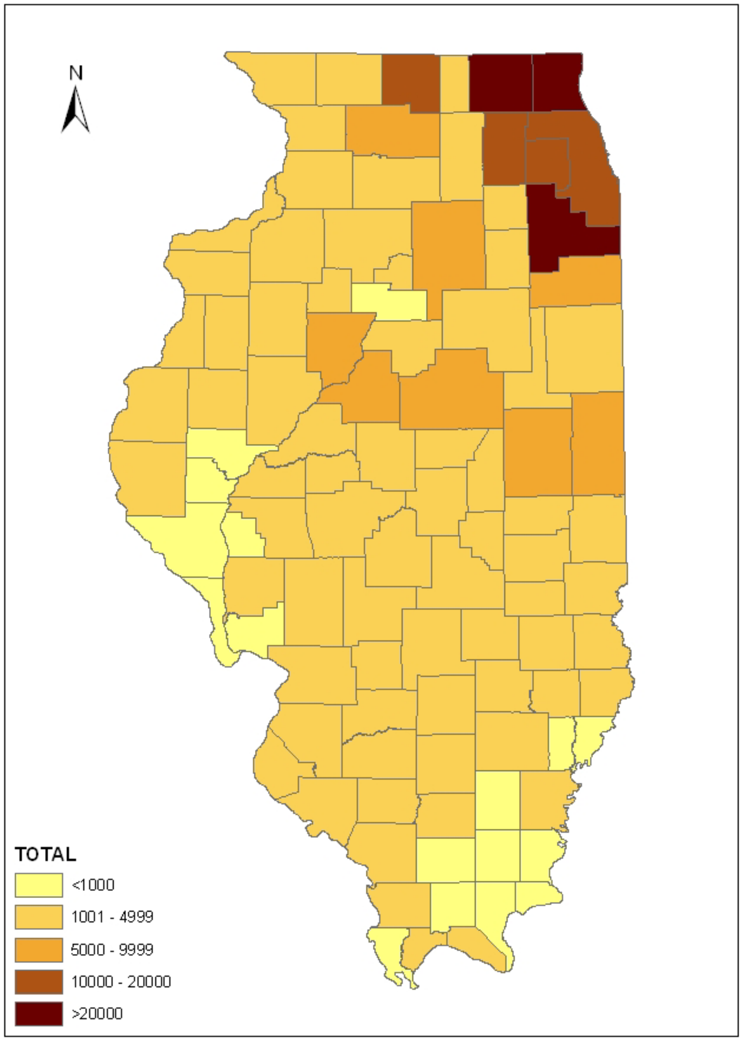
If water conservation measures or temporary assistance fails to carry a community through an extended drought, serious economic, sanitation, and fire protection problems could result (State Water Plan Task Force, 1983). In 1977, the Illinois Environmental Protection Agency compiled a partial list of communities that had drought-connected water supply problems. The communities were in 34 counties in central and southern Illinois.

The ISWS has completed a number of additional analyses on the sensitivity of community water supplies to drought (Winstanley et al., 2006; Knapp, 2010). More detailed discussion of these analyses is provided in the section on *Water Supply Planning and Drought Preparedness*.

Crops

In any drought during the growing season, the greatest economic loss in Illinois is likely to be the damage to crops, primarily corn and soybeans. At the beginning of the growing season, dry soils can reduce seed germination. As the season progresses, lack of rain can reduce the effectiveness of herbicides and fertilizers as well as reduce plant growth and interfere with successful pollination and grain filling. The response of crops to drought is a complex process that must take into account rapidly improving plant genetics, as well as cultivation practices, soil types, drainage, timing of rains during the growth cycle, etc. In addition, drought can help determine the presence or absence of plant diseases and pests in the field. For example, dry conditions may reduce populations of Japanese Beetles and aphids, while at the same time increase the vulnerability of corn to corn rootworm damage.

As a result, it is a challenge to accurately assess yield losses during the growing season. In recent years the estimates of yield losses during the growing season have typically been more pessimistic than the final harvests have shown.



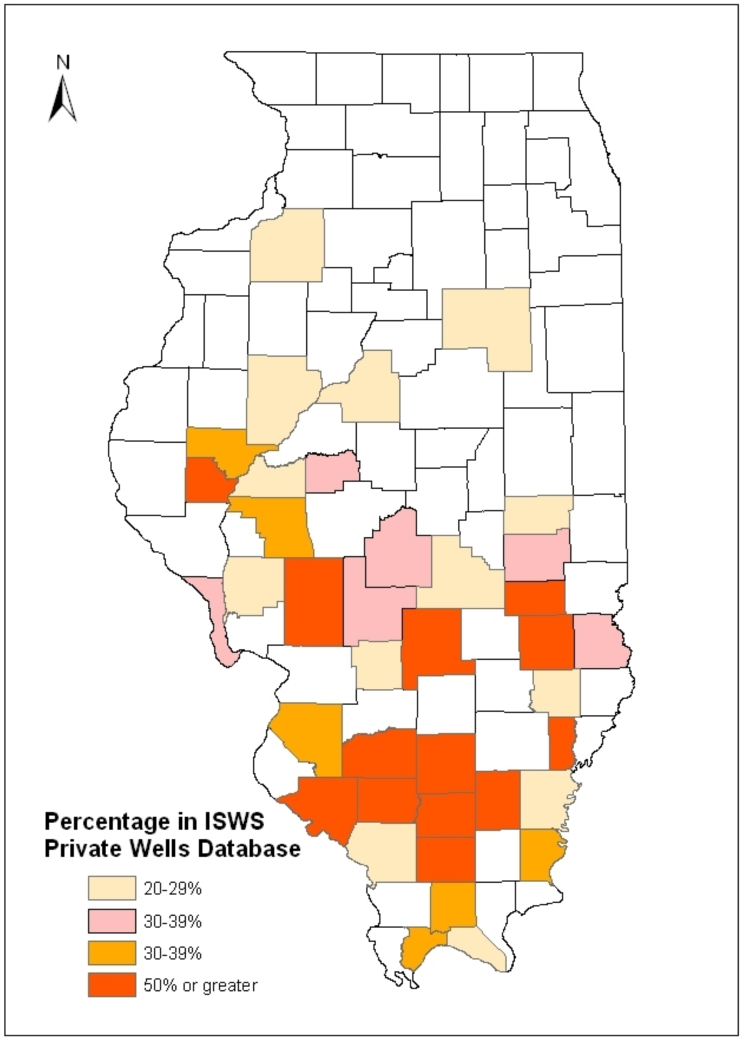


Figure 2. The number of rural wells in the ISWS Wells Database (left) and the predominance of dug and bored wells in Illinois, as a percent of total rural wells in the ISWS Wells Database (right), by county.

Livestock
During drought, livestock production can be hindered by poor pastures, low water supplies, and reduced feed consumption due to high temperatures usually associated with drought. This results in reduced weight gain in animals. Drought may also increase the cost of both grain and hay used for feed as supplies decrease and demand increases. Producers may also see reduced milk and egg production by dairy and poultry animals. It is common for producers to reduce the number of animals during drought due to the expense and difficulty in maintaining livestock.

Due to the daily water requirements of cattle and swine, the maintenance of even a modest size herd might require the daily hauling of water during a water shortage (State Water Plan Task Force, 1983).

Navigation
The flows in navigable rivers, such as the Illinois and Mississippi Rivers, may be lowered during extended drought conditions to the point where navigation, recreation, and water quality may be affected. Although the lock and dam system on the Illinois and Mississippi Rivers generally maintains sufficiently deep pool levels to avoid low flow impacts on navigation, occasional problems with shallow water levels can occur. Many of the navigation problems during the 1988 drought occurred on the Mississippi River downstream of the southernmost lock and dam near St. Louis. For example, south of St. Louis the barge traffic had to be halted so that bedrock could be removed to lower the bottom of the channel (Lamb et al., 1992). More commonly, barge traffic may be halted to allow dredging in locations where siltation has filled in part of the navigation channel. In other cases, the Corps of Engineers may direct barges to lighten their loads where navigation channel are too shallow.

Environment (water quality, fire, fish kills, habitat)
Surface water quality is more likely to be impaired during drought conditions, in particular affecting dissolved oxygen and temperatures in surface water bodies. This causes problems with the composition of fish communities and other aquatic organisms, as well as restricting human contact sports such as swimming and waterskiing. Numerous fish kills were reported, for example, during the 1988-1989 drought, in some cases from extremely high water temperatures in shallow ponds and lakes, and in other cases in major rivers from depressed concentrations of dissolved oxygen (Lamb et al., 1991).

Drought conditions also increase the probability of fires, may make forest trees susceptible to damage from insects and disease, causes problems for wildlife, and may affect the migratory behavior of waterfowl (State Water Plan Task Force, 1983).

Authorities and Regulations

Illinois Water Law

The laws regarding use and control of water in Illinois during drought conditions are expressed in many different statutes, regulations, and court cases. The primary laws are listed below. Please remember that the language of the laws must be understood within the context of judicial and administrative interpretations, only some of which are included here. Federal laws, such as the Clean Water Act (CWA), also affect the use of water in Illinois. Go to http://www.isws.illinois.edu/wsp/law.asp for information and links.

Authorities and Need for Emergency Powers during Drought Conditions

(Source – "Broad Based Changes to Illinois Water Law" Report to the Water Resources Advisory Committee, September 2000, IDNR Office of Water Resources)

The issue of drought response and management was reviewed extensively by the State Water Plan Task Force in 1983. The recommendations of the Water Plan Task Force for drought response have been followed by the State through the activation of the interagency Drought Response Task Force. Two activities in 1996 also reviewed the State's response to drought emergencies. The Global Climate Change Task Force published recommendations in January of 1996, which were updated in February of 1999, and the C-2000 consultant on water quantity issues published recommendations in July of 1996. The following description of the drought response and management issue by the Global Climate Change Task Force in their 1996 report summarizes current concerns regarding the need for improved state response.

> "Water supplies in Illinois are controlled by thousands of independent public water supply entities. There is no statutory authority for any state agency to intervene in disputes between those entities when conflicts arise over limited water resources. Thus, Illinois courts are called upon to settle disputes on piecemeal basis, with inadequate rules of law to guide them, often leading to undesirable outcomes. In recent years, the governor has activated the drought response task force as needed to settle conflicts during drought. Lacking regulatory powers, the task force relies on voluntary restrictions on users and arrangements between local water entities. These methods are useful and effective for moderate, short-term restrictions but insufficient in situations of chronic shortage. DNR's Division of Water Resources is best suited to settling water disputes. It has served as the lead state agency for water use administration allocating and regulating water supply from Lake Michigan through a permit system. It has also worked, statewide, in water supply planning and coordination of water supply users. State water law should be revised to give authority to the agency to settle water disputes. The Illinois Land and Water Use Task Force and the first Conservation Congress have already looked into this problem. Both concluded that the state does not have enough authority to deal with crises and that legislation is needed to fill the gap."

Options developed by the State Water Plan Task Force
(Source: Assessment of Illinois Water Quantity Law, July, 1996)

Option 1 - Seek a directive from the Governor to the Department of Natural Resources to prepare a drought response plan that would become part of a "comprehensive plan and program for the emergency management of the State. Estimated cost: $125,000.

Option 2 - Seek legislation that would mandate advance planning for drought conditions. One sub-option is to do the planning at the state level. A second option is to supervise the planning at the state level but require it to be done at the local level. This approach could require such a plan within a given period of time and provide that if none were forthcoming, the state would do it. Under this type of legislation, it would be determined in advance what emergency conservation measures would come into play, and what alternative sources, if any, of water supply are at hand. Furthermore, any necessary agreements or preconditions for tapping into the emergency supply could be entered into or taken care of in advance. (Source: Assessment of Illinois Water Quantity Law, July, 1996). Estimated cost: $500,000 for planning over three years.

Option 3 - Develop appropriate legislation to deal with water emergencies. (Source: The Illinois Response to Climate Change, Report of the Task force on Global Climate Change, January, 1996 and Climate Change Developments: Kyoto and Beyond, February, 1999). This recommendation was expanded in the C-2000 “Assessment of Illinois Water Quantity Law” report which stated; “seek more comprehensive legislation that would give a state water management agency authority to (1) declare the existence of a drought, (2) issue conservation and anti-waste measures that would apply during the emergency, and (3) expedite the location of, and access to, additional temporary supplies during the emergency. The statute could authorize general regulatory measures that would apply at times other than emergencies for areas that experience frequent drought problems. Estimated cost: $150,000 to draft rules and prepare initial response plan and program.

Suggested draft legislation for option number 3.

Option number 3 can be implemented by amending the water resources powers already exercised by the Department of Natural Resources Office of Water Resources. Amend Section 5-10 of the Department of Natural Resources Act of the Civil Administrative Code by adding at the end of Section 5-10e [20ILCS 801/5-10e] the following sections:

f) *To declare, following consultation with the Illinois Environmental Protection Agency, that a water shortage emergency exists when available sources of surface and groundwater in a watershed, aquifer, or urban county are insufficient to supply public water utilities, self-supplied commercial and industrial users, and self-supplied domestic users;*

g) *To restrict water withdrawals and water use within a region enclosing aquifers, watersheds, or urban counties affected by a water shortage emergency and authorize inter-basin or inter-system transfers of water;*

h) *To conduct rule making, investigation and adjudicative hearings, issue subpoenas and administrative orders, and seek judicial enforcement of orders for declaration, administration, and termination of a water shortage emergency.*

Rules to implement this authority must consider interagency input into the determination of facts supporting a water emergency declaration. Rules must also consider the significance of all water conservation activities and drought response activities, either authorized, approved and/or underway by all water users, and inter-system transfers of water can only be authorized under this legislation on a temporary basis and only during a water shortage emergency.

Option 3 is the preferred option by the Department of Natural Resources (in September 2000).

Instream Flow Protection

(Source – "Broad Based Changes to Illinois Water Law" Report to the Water Resources Advisory Committee, September 2000, IDNR Office of Water Resources)

The issue of instream flow protection has been investigated extensively by the State Water Plan Task Force (1983) and by the Interagency Instream Flow Protection Committee mandated under Public Act 86-191 (1991). The C-2000 consultant's report on water quantity issues also discussed the public concern for this issue, along with legal issues and legal options for further consideration. The issue of protecting critical flows in rivers and streams was the number three priority recommendation of the Land and Water Management Committee of Conservation Congress III.

The Interagency Instream Flow Protection Committee summarized the instream flow protection issue in its 1991 report as follows:

> "The protection of minimum instream flows within the rivers and streams of Illinois is a significant water resources management issue that has been widely recognized since the mid 1970's. With each new drought and burst of economic development and growth in Illinois, numerous additional demands for the offstream use of the State's surface water resources occur. The development of these resources occurs across the State and can cause significant negative impacts to streams of any size and at any location. Without the provision for the protection of some levels of minimum streamflows, the resource values, uses, and benefits of these aquatic resources are significantly impaired. In addition, it is now becoming recognized that most of the streams in Illinois cannot meet the demands of all users at all times. Therefore, developers of the surface water resources of the State of Illinois must recognize the need to cease withdrawals at various times to protect the values of instream uses. They must also recognize that most water supply developments in Illinois will require that additional storage or alternative sources of supply be developed as a necessary part of any secure water resources development project."

<u>Recommendations of the Water Plan Task Force</u>

<u>Option 1.</u> Seek legislation either that establishes minimum or required streamflows or that specifically authorizes an agency to establish such flows beyond the existing statutory law. (Reference to existing law is the Rivers, Lakes and Streams Act where DNR has "natural conditions" protection authority over the public waters of Illinois - 2,503 miles of streams out of a statewide total of 33,000 miles. Source: C-2000 Assessment of Illinois Water Quantity Law, July, 1996) The 18 key issues and questions identified in the Interagency Instream Flow Protection Committee report could be addressed in the rule-making process following passage of the recommended legislation. Cost: $125,000 to draft initial rules plus one new staff position.

> Suggested draft legislation for option number 1 would strike just two words in the existing Rivers, Lakes and Streams Act.
>
> Amendment to Section 23 of the Rivers, Lakes and Streams Act [615 ILCS 5/23] to Establish and Preserve Minimum Flows in Streams
>
> §23. It shall be the duty of the Department of Natural Resources to maintain stream gauge stations, **…** and to establish by regulations water levels below which water cannot be drawn down **~~behind dams~~** from any stream or river in the State of Illinois, in order to retain enough water in such streams to preserve the fish and other aquatic life in the stream, and to safeguard the health of the community.

Option 2. Draft a new instream flow protection act that will regulate downstream releases from new reservoirs as well as direct stream withdrawals by new users. Legislation to implement this regulatory program for new water users and impoundments will authorize the development of aquatic life protection rules for submittal and approval to the Illinois Pollution Control Board.

Option 1 was the preferred option by the Department of Natural Resources (in September 2000).

Groundwater Management and Regulation

(Source – "Broad Based Changes to Illinois Water Law" Report to the Water Resources Advisory Committee, September 2000, IDNR Office of Water Resources)

The issue of groundwater management and regulation was reviewed extensively by a subcommittee of the State Water Plan Task Force in 1989 and by the water law consultant in the C-2000 water law studies published in 1996. Draft legislation was introduced in 1989 and 1990 based on the recommendations of the State Water Plan Task Force, and although these legislative initiatives generated significant debate and issue resolution, the initiatives eventually failed when the Farm Bureau and Municipal League mutually agreed to lift their support from any administration bill for groundwater management. The groundwater regulatory and management issues defined by the Water Plan Task Force subcommittee and by the C-2000 water law consultant are basically identical, and are as follows:

1) Current state laws (Water Use Act of 1983 and the Water Authorities Act) do not provide for adequate or proper management of groundwater developments in Illinois.

2) A major issue in the development of groundwater resources is the resolution of well interference issues. This issue mainly occurs when the development of a high capacity well negatively impacts on the operation of a nearby smaller well, most generally in use by a rural household.

3) Political aspects of competition among and between urban and rural users of ground water. This issue was manifested in the drought of 1988 and 1989 between irrigators and rural homeowners in Kankakee County and between Municipalities and newly formed Water Authorities that were created to provide protection for rural areas located over the Mahomet aquifer system.

4) The level of government that should have the ultimate power to regulate groundwater resources. Rural areas and agricultural interests support local control based on the position that state government would tend to favor municipal and industrial users over rural interests.

The selected proposal for groundwater management that was ultimately developed by the State Water Plan Task Force involved a procedure for a locally developed groundwater management and regulatory program that would be implemented on a regional basis with state agency oversight and approval. This form of groundwater management program was also recommended as a legislative option in the ASCE Model Water Code published in 1997.

Interests in Northeastern Illinois such as Lake County, the Chicago Metropolitan Agency for Planning, the Metropolitan Planning Council, and the Barrington Area Council of Governments have recently expressed concerns regarding the inadequacy of current groundwater laws to deal with major development issues, which are now generating concern in the collar counties of the Chicago metropolitan area. The Department of Natural Resources proposes to work with these interests and others in Northeastern Illinois to develop needed and supportable revisions to Illinois groundwater law.

Public Water Supply Regulations

The following statutory and regulatory provisions require adequate quantity:

(415 ILCS 5/3)
Sec. 3.105. Agency. "Agency" is the Environmental Protection Agency established by this Act.
Sec. 3.365. Public water supply. "Public water supply" means all mains, pipes and structures through which water is obtained and distributed to the public, including wells and well structures, intakes and cribs, pumping stations, treatment plants, reservoirs, storage tanks and appurtenances, collectively or severally, actually used or intended for use for the purpose of furnishing water for drinking or general domestic use and which serve at least 15 service connections or which regularly serve at least 25 persons at least 60 days per year. A public water supply is either a "community water supply" or a "non-community water supply".

(415 ILCS 5/18)
Sec. 18. Prohibitions; plugging requirements.
(a) No person shall:
(1) Knowingly cause, threaten, or allow the distribution of water from any public water supply of such quality or **quantity** as to be injurious to human health; or
(2) Violate regulations or standards adopted by the Agency pursuant to Section 15(b) of this Act or by the Board under this Act; or
(3) Construct, install, or operate any public water supply without a permit granted by the Agency, or in violation of any condition imposed by such a permit.

(415 ILCS 5/19) (from Ch. 111 1/2, par. 1019)
Sec. 19. Owners or official custodians of public water supplies shall submit such samples of water for analysis and such reports of operation pertaining to the sanitary quality, mineral quality, **or adequacy** of such supplies as may be requested by the Agency. Such samples and reports shall be submitted within 15 days after demand by the Agency. (Source: P.A. 76-2429.)

In regard to regulatory requirements, first 35 Ill. Adm. Code 601.101:

Owners and official custodians of a public water supply in the State of Illinois shall provide pursuant to the Environmental Protection Act [415 ILCS 5] (Act), the Pollution Control Board (Board) Rules, and the Safe Drinking Water Act (42 U.S.C. 300f et seq.) continuous operation and maintenance of public water supply facilities so that the water shall be assuredly safe in quality, clean, **adequate in quantity**, and of satisfactory mineral characteristics for ordinary domestic consumption.

Secondly, under the Board's permit regulations:
Section 602.115 Design, Operation, and Maintenance Criteria
a) The Agency may adopt criteria in rules for the design, operation, and maintenance of public water supply facilities as necessary to insure safe, **adequate**, and clean water. These criteria shall be revised from time to time to reflect current engineering judgment and advances in the state of the art.

Third, under the Agency rules referenced above:
Section 652.101 Construction Permit Requirements
a) Construction permits shall be obtained by the official custodian of a community water supply prior to beginning construction of any proposed community water supply and prior to all alterations, changes or additions to an existing community water supply which may affect the sanitary quality, mineral quality, or **adequacy of the supply** including changes pursuant to 35 Ill. Adm. Code 653.115.

Further, State Standards include the following design provisions:

1.1.5 Water use data, including

- a. a description of the population trends as indicated by available records, and the estimated population which will be served by the proposed water supply system or expanded system 20 years in the future in five-year intervals or over the useful life of critical structures/equipment,
- b. present water consumption and the projected average and maximum daily demands, including fire flow demand (see Section 1.1.6),
- c. present and/or estimated yield of the sources of supply,
- d. unusual occurrences.

1.1.6 Flow requirements, including

- a. hydraulic analyses based on flow demands and pressure requirements (See Section 8.1.1)
- b. fire flows, when fire protection is provided, meeting the recommendations of the Insurance Services Office or other similar agency for the service area involved.

1.1.7 Sources of water supply

Describe the proposed source or sources of water supply to be developed, the reasons for their selection, and provide information as follows:

1.1.7.1 Surface water sources, including

- a. hydrological data, stream flow and weather records,
- b. safe yield, including all factors that may affect it,
- c. maximum flood flow, together with approval for safety features of the spillway and dam from the appropriate reviewing authority,
- d. description of the watershed, noting any existing or potential sources of contamination (such as highways, railroads, chemical facilities, etc.) that may affect water quality,
- e. summarized quality of the raw water with special reference to fluctuations in quality, changing meteorological conditions, etc.
- f. source water protection issues or measures that need to be considered or implemented.

Illinois Lake Michigan Water Allocation Program

Lake Michigan, the single largest source of water in Illinois, supplies Chicago and approximately 200 other public water supply systems in northeastern Illinois. On average, over 1 billion gallons of water are withdrawn from Lake Michigan each day for public water supply needs. However, the amount of water Illinois is allowed to divert from Lake Michigan for all purposes (public water supply, to operate and maintain the Chicago Waterway System, and stormwater runoff from the diverted watershed) is limited by a U.S. Supreme Court decree to 3200 cubic feet per second (cfs) or 2.1 billion gallons per day. This is a fixed amount and does not increase in the future. Illinois' diversion of water from Lake Michigan is the only major diversion out of the Great Lakes basin, and remains a contentious issue for Illinois, other lake states, and Canada.

Public water supply intakes along the Illinois shoreline of Lake Michigan have been designed to accommodate fluctuating water levels on Lake Michigan, which can vary by up to 6 feet. This fact, combined with the enormous storage volume of Lake Michigan, means that Lake Michigan is a very drought resistant source of public water supply.

In response to the 1967 U.S. Supreme Court Decree limiting Illinois' diversion of water from Lake Michigan, the General Assembly tasked the Illinois Department of Natural Resources (IDNR) with developing an ongoing program to equitably allocate Illinois' supply of Lake Michigan water. The importance of wise, long-term water resource planning and the large investments that must be made to secure new water supply sources requires that the objectives of an allocation program clearly address the problems to be solved. In Illinois' case, the objectives must also address the specific requirements of the U.S. Supreme Court Decree. The objectives, or goals, of Illinois' allocation program can be summarized as follows:

- To make the greatest amount of Lake Michigan water available for domestic water supply.
- To use Lake Michigan water allocations as a tool to preserve groundwater resources for communities in northeastern Illinois who will not have access to a Lake Michigan water supply.
- To make long-term allocations so that communities receiving an allocation for the first time can secure the needed financing to construct regional water distribution systems.
- To carefully consider the competing needs of all water users in the region so that allocations promote the efficient development of water supplies in the region in light of long-range needs and objectives.
- To require all users of Lake Michigan water to conserve and manage this resource.

Allocation Process - A successful water allocation program must combine a technically defensible methodology with an administrative process that follows legally defensible procedures and treats all applicants fairly. To achieve this goal, Illinois' allocation process consists of the following key elements:

- An active public participation program.
- An identification of available water supply sources.
- A long-range water demand forecasting methodology.
- Formal allocation hearings on all requests.
- Issuance of an Allocation Order.
- Ongoing monitoring of water use and consumption by all permittees.
- Formal process to make adjustments in allocations.

The "Rules and Regulations for the Allocation of Water from Lake Michigan" describe the allocation process and contain the criteria used to evaluate applications for a water allocation and water conservation practices and other permit conditions required of allocation permit holders http://www.dnr.illinois.gov/WaterResources/Pages/Permits.aspx. Water allocations are made through a hearing and order procedure. Entities receiving an allocation of Lake Michigan water receive an allocation permit.

Lake Michigan Diversion Status/Allocation Outlook

Illinois is currently in compliance with the Supreme Court Decree. As of Water Year 2007 (the latest year in which Illinois' diversion has been certified by the U.S. Army Corps of Engineers), Illinois' 40-year running average diversion is 3171 cubic feet per second (cfs), which is 29 cfs below the Court limit of 3200 cfs. The cumulative deviation (a water bank) is 774 cfs-years. Unofficial estimates of Illinois' diversion through Water Year 2010 continue the trend of staying below the Court limit and increasing the cumulative deviation.

The IDNR has noted an overall decrease in per capita use within the Lake Michigan service area. This is especially apparent in the City of Chicago, where water use has declined by over 200 million gallons per day over the past 15 to 20 years.

In 2008, the IDNR issued a new water allocation order extending water allocations out to the year 2030. With a continued emphasis on conservation and efficient use, there is reason to be optimistic that the future water supply needs within the Lake Michigan water service area can be met while staying in compliance with the Court Decree. The IDNR also anticipates that there will be some continued interest in expanding the Lake Michigan water service area where it can be shown to be cost effective. Lake

Michigan water will continue to play a very important role in ensuring that the entire northeastern Illinois region has an adequate supply of water.

Water Withdrawal Reporting

Illinois Water Inventory Program (IWIP). Documentation of annual water withdrawals (water use) for all of Illinois began in 1978 by the Illinois State Water Survey (ISWS) under a cooperative agreement with the U.S. Geological Survey (USGS). For each water-using facility inventoried, the database includes locations and amounts of water withdrawn from surface water and groundwater sources, as well as significant amounts of water purchased from other facilities. All public water supplies and major self-supplied industries, irrigation, fish and wildlife, and conservation uses (withdrawals ≥ 100,000 gallons per day) are inventoried. Data can be summarized geographically by county, township, and drainage basin, as well as by various water use and water source categories for inclusion in the National Water Use Data System.

Current uses of the data collected through the IWIP program include:

- Determination of community water supply usage
- Determination of aquifer-wide withdrawals
- Assessment of groundwater-level observations with respect to groundwater withdrawals (for example, comparisons of potentiometric surface maps of the Cambrian-Ordovician aquifer system and pumpage from that aquifer system)
- Water use projections
- Comparisons of aquifer withdrawals to estimated aquifer recharge
- Regional and site-specific groundwater flow modeling
- Determination of groundwater withdrawals for the U.S. Army Corps of Engineers' Lake Michigan Diversion Accounting Program
- Impact of high-capacity wells on neighboring wells

As of January 1, 2010, annual reporting of withdrawals from wells and surface water intakes that pump at a rate of 70 gallons per minute or greater (100,000 gallons per day) is mandatory in Illinois, according to Public Act 096-0222. A notable exception to the mandated reporting is the use of high-capacity well and intake use in agricultural irrigation. Agricultural irrigators are exempt from reporting for the first five years of the act (until January 1, 2015). However, individual farm irrigators with good records of irrigation water use are encouraged to report their annual water use prior to that date so their operations may serve as benchmark farms to aid in developing irrigation estimation coefficients. The Act may be viewed at http://www.ilga.gov/legislation/publicacts/fulltext.asp?Name=096-0222.

Water Supply Planning and Drought Preparedness in Illinois

Preparing for drought requires both planning and taking appropriate actions. Planning based on sound scientific analysis is essential to ensure adequate, reliable supplies of clean water at reasonable costs. Planning is needed to identify vulnerabilities to drought and characterize associated risks and potential impacts, including damages or threats related to agriculture, public water supply, health, environment, recreation, and navigation. It is important to know which water resources are subject to rising demand and which ones are most sensitive to drought as well as potential climate change. The ISWS (Winstanley et al., 2006) describes eight main components of water supply planning:

- Determine the capacity of existing water supply facilities
- Determine current water withdrawals, uses, and impacts
- Determine potential yields and water quality from surface waters and aquifers under variable climate conditions
- Construct future water demand scenarios
- Identify and evaluate drought, climate change, and other risks and uncertainties
- Present and compare water supply and demand scenarios (with uncertainties and risks)
- Evaluate the needs for increasing water supply and treatment and/or decreasing demand
- Identify and evaluate the risks and costs (including negative impacts) of options for increasing water withdrawals and/or decreasing water demand

The IDNR and ISWS have historically and continue to support water supply planning and analysis in Illinois, with particular emphasis on community water supply systems. Results of these efforts are available to communities and other water users to assist those entities in identifying drought risks and taking appropriate actions where needed. Large communities, industries, and the power sector typically also pursue their own planning efforts for determining needed actions.

Early History of Water Supply Planning in Illinois

For over a century, Illinois has been a leader in water supply planning and management. The Illinois State Water Survey (ISWS) was founded in 1895 with its original mission to trace the spread of waterborne disease, particularly typhoid, and to address the health and safety of public water supplies, water softening methods, sewage and wastewater treatment, and the establishment of sanitary standards for drinking water. In 1917, the ISWS published the state's first inventory of municipal groundwater supplies. Population growth in the late 1950s and 1960s created the need for expanded water resources, and the ISWS attempted to identify usable supplies for potential development. Studies were conducted to address potential reservoir sites and yields, to develop new methods for evaluating wells and aquifers, and to investigate the effects of future groundwater development. A statewide network of observation wells was also established, and investigations of groundwater resources in the Chicago and East St. Louis areas led to a comprehensive inventory of the state's principal groundwater formations.

Illinois first prepared a water plan in 1967 (Technical Advisory Committee on Water Resources, 1967). In 1980, a State Water Plan Task Force (SWPTF) was appointed by the governor to address emerging environmental issues, the energy crisis, potential new demands upon the water resources, and to coordinate the programs of existing agencies. SWPTF Special Report No. 3, “Drought Contingency Planning,” the predecessor to the present drought preparation and response plan, established the framework for the Drought Response Task Force and the state’s drought contingency programs and options that are in place today.

Recent History of Water Supply Planning in Illinois

In June of 2000, the DNR and the IEPA worked together toward formulation of a means and strategy to better identify, plan for, and address the numerous and diverse water quantity issues in the State. A Water Resources Advisory Committee (WRAC) was established to prepare a strategy to address water management in Illinois. The WRAC was composed of 27 individuals representing a cross-section of water users and water suppliers and was co-chaired by the DNR and the EPA. The WRAC Subcommittee on Integrated Water Planning and Management (2002) identified 12 consensus principles:

1. Better science and more funding for science is needed.
2. A system for identifying water resource problem areas is needed.
3. Water resource problem areas:
    - should not be too large,
    - could be based on ground or surface water sources or both,
    - should be based on supply and demand,
    - a drop below sustainable yield should be a criteria,
    - pollution could be a criteria.
4. Need to see details of how such areas will be identified both short-term, based on existing information, and long-term, as better data become available.
5. Emphasize regional water management authorities—boundary should have some relationship to scale of the water resource (watershed and/or aquifer boundary).
6. State's role:
    - for later resolution,
    - should support, provide science, and establish or appoint regional authorities.
7. Will existing water authorities established under the Water Authorities Act work?
8. Phased approach to implementation would be received better by a broader group of interests.
9. Immediately begin pilot programs in "willing" areas; pilots programs should be site-based and located in problem areas.
10. Sunsets should be established for #8 and #9.
11. There should be an ongoing role for the Water Resources Advisory Committee in developing the details associated with establishing regional water management authorities.
12. Both groundwater and surface water should be considered.

Signed on Earth Day 2002, Executive Order 2002-05 established a subcommittee of the Interagency Coordinating Committee on Groundwater (ICCG) to develop an integrated groundwater and surface-water assessment report. In December of 2002, the DNR-chaired Subcommittee on Integrated Water Planning and Management provided the Interagency Coordinating Committee on Groundwater (ICCG) and the Groundwater Advisory Council (GAC) with a comprehensive groundwater and surface-water assessment report with recommendations. This report included a draft strategic plan for water quantity planning and management, and a prioritized agenda and timetable for producing specific required scientific assessments. The report also included detailed information on key water resource concerns, critical water issues, needed water management powers, and the availability of water management tools and technologies.

In January 2006, Executive Order 2006-01 required the Illinois Department of Natural Resources (IDNR) to lead state and regional water supply planning activities. Within IDNR, the Office of Water Resources (OWR) was to coordinate with the ISWS to define a comprehensive program for state and regional water supply planning and management.

The OWR and the ISWS have prepared a draft "*Strategic Plan for a Statewide Water Supply Planning and Management Program*" to fulfill a requirement of Executive Order 2006-01. The draft Strategic Plan identifies eight conclusions and recommendations, which includes the recommendation that the SWPTF develop a WEB-based update of the State Drought Response Plan.

Priority Planning Areas

In July 2006, the identification and prioritization was completed by the ISWS with the assistance of the State Water Plan Task Force and reported in the ISWS publication, Prioritizing Illinois Aquifers and Watersheds for Water Supply Planning (Wehrmann and Knapp, 2006). Aquifers and watersheds in the state were identified and prioritized based on potentially limited water supply availability in the face of growing demand due to substantial population and economic growth and on the potential benefit from and relative urgency for water supply planning.

The following aquifer systems were recommended as most in need of study and planning:

- the deep bedrock aquifer system of northeastern Illinois,
- the sand and gravel and shallow bedrock aquifers of northeastern Illinois,
- the Mahomet Aquifer of east-central Illinois, and
- the American Bottoms of southwestern Illinois (MetroEast area).

The following watersheds were recommended for study and planning:

- the Fox River watershed,
- the Kaskaskia River watershed,
- the Sangamon River watershed,
- the Kishwaukee River watershed, and
- the Kankakee River watershed.

The draft *Strategic Plan for a Statewide Water Supply Planning and Management Program* identifies the state's Water Supply Planning Areas, based on a regional and phased approach to eventually cover the entire state. A map identifying the boundaries of the ten proposed planning regions is presented in Figure 3. For ease of mapping, the regions are primarily county-based, but are meant to include surface watersheds and underlying aquifers that often transcend political boundaries. Therefore, cooperation and communication across planning regions will be necessary to ensure consistent planning and management of common resources. While the Strategic Plan proposes a budget and timeline for completion, much will depend upon the availability of state resources to conduct the necessary studies and convene the meetings of local stakeholders.

The following section presents results of investigations that have been completed to date (circa 2011). These investigations include the top three priority aquifer systems and the top three watersheds. Analyses and plans for the Northeastern and East Central Illinois Planning Regions have been completed; the Kaskaskia River Basin Planning Region is ongoing.

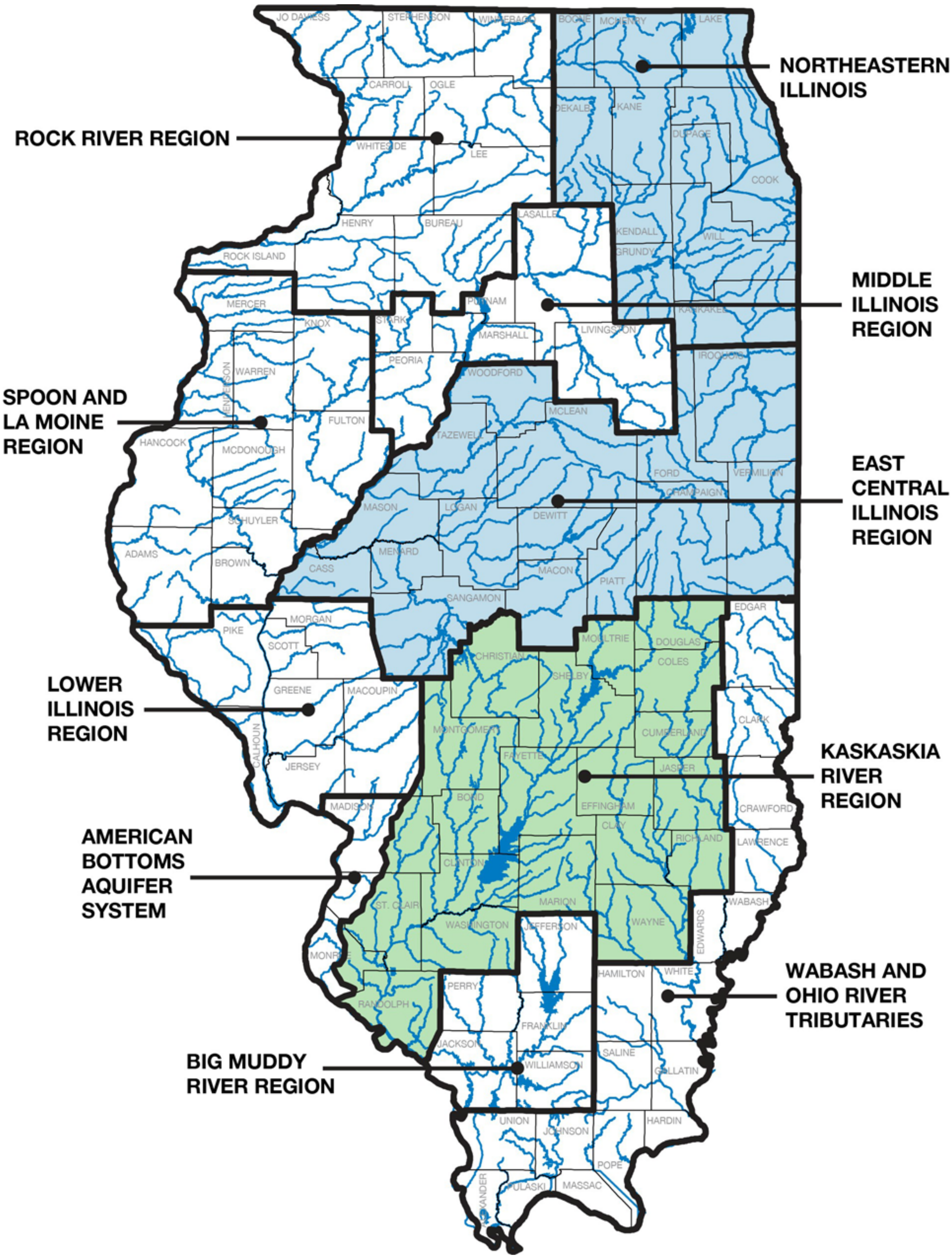


Figure 3. Designated Water Supply Planning Regions of Illinois

Completed and Ongoing Water Supply Planning Areas

To initiate water quantity planning activities as directed by Executive Order 2006-01, northeastern Illinois and east-central Illinois were selected for priority pilot studies. These priority-planning areas (map) included the top three prioritized aquifer systems and two of the top three prioritized watersheds. Water planning and study addressed groundwater, surface water, and climate variability and change. A Regional Water Supply Planning Group (RWSPG) was formed for each area with full representation of the stakeholders. The RWSPG duties included developing water supply/demand scenarios to 2050, and describing the nature of those scenarios and the importance of planning. The RWSPG also was to base planning efforts on evaluations of the impacts of withdrawing and allocating water to meet demand under drought and climate change scenarios to 2050, as provided by the State Surveys (ISWS and ISGS).

Northeastern Illinois. This planning area included 11 counties (Boone, Cook, DeKalb, DuPage, Grundy, Kane, Kankakee, Lake, McHenry, and Will). The planning effort was facilitated at the regional level by the Chicago Metropolitan Agency for Planning (CMAP). A Regional Water Supply Planning Group (RWSPG) was formed that included the following stakeholders: Academia & the Public Interest in Regional Planning, Agriculture, Business, Industry & Power, Conservation & Resource Management, County Government, Environmental Advocacy, Municipal Government, Real Estate & Development, and Wastewater & Non-municipal Utilities. The stakeholder plan was completed in 2010 (CMAP, 2010).

Regional water supply planning focused on three principal water sources available to the region: the deep bedrock aquifer system that underlies all of northeastern Illinois, sand and gravel and shallow bedrock aquifers underlying only the Fox River watershed, and the inland surface waters of the Fox River. The study also assessed the ability of Lake Michigan to meet future public water supply demand with the assistance of the IDNR-OWR Lake Michigan Allocation Program. A surface water accounting tool and a groundwater flow model were prepared specifically to examine the impacts of future demands on the Fox River and aquifers within the region. Due to time and budget limitations, shallow aquifers outside the Fox River watershed were not assessed, nor were other inland surface waters such as the Kankakee River. A brief summary of findings is provided below (from Meyer et al., 2011).

Regarding groundwater supplies, computer simulation of plausible scenarios of future pumping suggests significant additional drawdown, reduction in stream base flow, and changes in the quality of groundwater withdrawn from deep wells are all possible in parts of the 11-county study area before 2050. More work is needed to specifically assess how much of the future groundwater demand is not being met, which aquifers and wells will fail to meet demand, when, and where.

The Fox River currently supplies water to only two public water systems, at Elgin and Aurora. However, treated effluent discharges to the Fox River will continue to grow in proportion to community growth (and concomitant increases in water use) along the Fox. ISWS analyses suggest that, depending on demand scenario, from 14 to 58 mgd in additional withdrawals, or about 50 percent of projected new demand in major portions of the Fox River basin and above projected withdrawal increases by Elgin and Aurora, may be supported by Fox River withdrawals (assuming IDNR fixes the protected flow level to present day values for $Q_{7,10}$).

Lake Michigan is and will continue to be the major source of water to the region, currently providing approximately 85 percent (1,007 Mgd) of all water used for public supply in the 11-county region in 2005. Analysis using historical and assumed future values for Lake Michigan diversion components shows that those components must be managed collectively so that the decree limit is not exceeded while also accommodating domestic water demand growth. As such, with the understanding that the Lake Michigan water allocation program must remain in compliance with the Supreme Court Decree limiting Lake Michigan diversions, IDNR believes that a potential increase (on the order of 50-75 Mgd) in domestic water supply allocation can be accommodated without the need for major policy changes in diversion management (while also accommodating growth in water demand within the current Lake Michigan service area).

East-Central Illinois. Regional water supply planning focused on the Mahomet aquifer system and the Sangamon River watershed. This planning area included 15 counties (Champaign, Cass, DeWitt, Ford, Iroquois, Logan, McLean, Macon, Mason, Menard, Piatt, Sangamon, Tazewell, Vermilion, and Woodford Counties). The planning effort was facilitated by the Mahomet Aquifer Consortium (MAC). A RWSPG was formed that included the following stakeholders: Agriculture, County Government, Electric Generating Utilities, Environment, Industries, Municipal Government, the Public, Rural Water Districts, Small Business, Soil and Water Conservation, Water Authorities, and Water Utilities. Principal sources of water studied by the State Surveys included the Mahomet Aquifer and surface reservoirs supplying Bloomington, Danville, Decatur, and Springfield. A plan was completed by the RWSPG in 2009 (East Central Illinois RWSPC, 2009), and a brief summary is provided below.

Regarding groundwater supplies, withdrawing sufficient water from aquifers to meet demands to 2050 results in increasing drawdown of heads in wells finished in the aquifers, expanding cones of depression, a reversal of groundwater flow in some areas, and reduced baseflow in many streams. The bull's eye of concern is in Champaign County, where drawdown could lower head in some wells to less than 50 feet above the top of the Mahomet Aquifer in some scenarios. Some shallow aquifers increasingly are dewatered locally, wells finished in these aquifers go dry, and water levels in other wells drop below the pumps and will require pumps to be lowered to sustain yields.

With regard to surface reservoirs in the region, meeting future demand is much more problematic. Bloomington's current use is about 12 mgd and the 90 percent estimate of yield in a drought-of-record is 11.0 mgd. Decatur currently uses about 37 mgd and the 90 percent yield estimate is 34.6 mgd. Springfield uses about 32 mgd and its 90 percent yield estimate is 23.4 mgd. Due to increasing water demand and increasing sedimentation, all three cities will have increasing water supply deficits during droughts of record in the future, unless additional sources of supply are developed and/or demand is reduced. Decatur could face the possibility of water shortages within a single drought season.

Kaskaskia Region. In 2009, state funding allowed for the initiation of a third water planning area for study. The Kaskaskia Region was defined by the Illinois Department of Natural Resources (IDNR) to include the entire Illinois counties of Bond, Christian, Clay, Clinton, Coles, Cumberland, Douglas, Effingham, Fayette, Jasper, Marion, Montgomery, Moultrie, Randolph, Richland, Shelby, Washington, and Wayne and portions of Macoupin, Madison, Monroe, and St. Clair counties that are located within the Kaskaskia River watershed. Four of these counties (Clay, Cumberland, Jasper, and Richland) are located entirely outside of the Kaskaskia watershed; however, water from the Kaskaskia watershed is purveyed to portions of Clay County, and it was considered that potential exists that the other three counties might receive Kaskaskia water in the future. A RWSPG was formed in 2010 that includes the following stakeholders: Agriculture, County Government, Electric Utilities, Environment, Industry and Economic Development, the Kaskaskia Watershed Association, Municipal Government, the Public, Navigation, Recreation, Rural Water Districts, Small Business, Soil and Water Conservation, Water Authorities, and Water Utilities.

The first phase of the Kaskaskia study effort, funded by the Illinois Department of Commerce and Economic Opportunity through the Illinois Clean Coal Institute, produced the following two reports:

1. Future Water Demands and Coal Development Potential in Kaskaskia River Basin in Illinois
2. Water Supply Assessment for Kaskaskia River Watershed Development: Phase I Report

The second phase of the study effort (2011-2012), funded by the IDNR, supports additional water resource evaluations by the ISWS for meeting a range of 2050 water demand scenarios. The RWSPG is responsible for developing a water supply plan using these scenarios and the results of ISWS availability analyses.

Drought Vulnerability and Risk Assessment of Surface Water Systems

In 2010 the ISWS completed an evaluation of water supply yields and drought vulnerability of community water supply systems in Illinois that withdraw water from surface sources, including rivers, streams, and reservoir storage. Community systems that obtain water from Lake Michigan and the bordering Mississippi and Ohio Rivers were excluded from the analysis because these sources are, for practical purposes, drought resistant. Results of the analyses for each community system are provided in the ISWS web site on Illinois Drought (www.isws.illinois.edu/data/ilcws/drought.asp).

The yield analyses conducted for surface water supply systems examine the hydrologic and climatic records from the past 95 or more years for the purpose of identifying and simulating the water supply conditions that would be experienced if the worst droughts on record were to recur under present-day conditions. The analysis thus provides a juxtaposition of the historical drought periods with the existing water supply facilities and resources. For reservoirs, this is accomplished by creating water budget models of the existing systems that simulate expected gains in lake storage (stream inflows, precipitation, and diversions to the lake) and losses in lake storage (withdrawals and evaporation) during historical drought sequences and other selected drought scenarios. The analyses also introduce the application of data uncertainty in determining reservoir yields and evaluate how risk and uncertainty factor into the assessment of the drought vulnerability of each surface water supply system.

Risk and Uncertainty in Yield Analyses

The traditional method of estimating yield calculates drought recurrence intervals and the probability that a system may experience shortage in any given year. With a traditional yield estimate for a 100-year drought, for example, there is an estimated 1 percent chance that a drought may begin in any given year that would ultimately cause the system to experience water shortage in that year or subsequent years within the same multi-year drought period. Similarly, with a traditional 50-year drought yield, there is an estimated 2 percent chance that a drought may begin causing the system to experience water shortage. Unfortunately, most people incorrectly assume that if a community's water demand is less than the 50- or 100-year drought yield, then that system is "safe" from experiencing shortages during such severe droughts. In reality, by producing what is considered to be the "best" estimate of a 50- or 100-year drought, traditional methods produce a yield estimate that has roughly a 50/50 chance of being underestimated and overestimated. Thus, if a community's water demand is exactly equal to the traditional 100-year drought yield, there may be only a 50 percent chance that the system could safely provide the community's demand during a severe 100-year drought, as further explained in the next paragraph. For water supply planning, it is expected that most communities would want more than a 50 percent certainty that they would survive a severe drought without experiencing shortages.

The potential 50 percent chance of experiencing a water shortage associated with traditional yield estimates is caused by typical data uncertainties which are unavoidable given data availability and measurement methods. For most hydrologic and climate data sources there is roughly an equal chance that accepted data values are either underestimated or overestimated. When using water budget analyses, any underestimation or overestimation of data input is incorporated into the resulting yield estimate. Thus, there is roughly a 50 percent chance that the traditional best estimate of yield may be too high, such that during a severe drought the system may not be able to provide the stated yield. An alternative approach, which the ISWS has now adopted for its yield studies, is to explicitly identify and quantify the uncertainties in data and methods and use these uncertainties to provide confidence limits for yield values. The biggest concern in using uncertain data is that we may overestimate yield, resulting in less water being available than expected for use in a severe drought. For this reason, a 90 percent confidence yield estimate is also computed, such that there is 90 percent confidence that the "true" yield (an unknown amount) is greater than or equal to the computed 90 percent yield. This means that there is 90 percent confidence that there will be sufficient water during a severe drought and only a 10 percent chance that the "true" reservoir yield is less than the calculated amount. This also means, however, that the computed 90 percent confidence yield is a lower value than the traditional mid-estimate (50 percent) yield.

The selected 90 percent confidence value is a commonly used confidence limit. Similar estimates for other confidence levels, such as 70 percent, 80 percent or 95 percent could also be prepared using reservoir water budget modeling if desired. Communities should determine what level of confidence is appropriate for their system based on costs, the potential adverse consequences of having a water shortage, and to what degree emergency supplies not considered in the yield analysis would be available in the case of shortages.

Categories of Drought Vulnerability

The 2010 analysis of the water supply yield for all community surface water supplies in Illinois defines four categories of community drought vulnerability based on the uncertainty analysis of yield estimates:

> **Inadequate System** – There is greater than a 50 percent probability that the current system would not be able to provide the community's current rate of water demand through a severe drought similar to the drought of record.
>
> **At-Risk System** – There is greater than a 10 percent probability that the current system would not be able to provide the community's current rate of water demand through a severe drought similar to the drought of record.
>
> **Marginal System** – Although there is greater than a 90 percent probability that the current system would have sufficient water during a drought similar to the drought of record, the pending threat of potential shortages during the drought might still force the community to take extraordinary measures (enacting severe water use restrictions or development of alternative supply sources) to avoid shortages.
>
> **Adequate System** – There is greater than a 90 percent probability that the community will not experience any water shortages or threat thereof during a severe drought similar to the drought of record.

Based on the 2010 yield analyses, 23 community systems that obtain water directly from Illinois surface water sources were considered to be at risk or inadequate:

Inadequate	At Risk	
Altamont	Ashland	Macomb
Canton	Blandinsville	Mt. Olive
Coulterville	Bloomington	New Berlin
Farina	Breese	Palmyra-Modesto
Springfield	Carlinville	Pontiac
Wayne City	Carthage	Staunton
	Decatur	Vermont
	Gillespie	Vienna Correctional Center
	Greenfield	

It should be noted that a community's classification can change if supplemental supplies are developed, water demand is reduced, or if new data provide an improved risk assessment on the availability of water from the source of supply. It is recommended that a re-evaluation of the systems be performed every 10 years.

The surface water systems in Illinois that are most vulnerable are those that depend on man-made reservoirs for their supply, with over half of these systems considered to be at risk or inadequate. For many growing communities that use reservoirs, water demand has increased without an accompanying expansion in the source of water supply. Because there have been few severe droughts in Illinois since the 1950s, the public may not perceive the potential threat that severe droughts pose to their supply system. For some small systems, a community may also be considered to be at risk simply because insufficient data are available to define the capacity of its supply well enough to provide a confident yield estimate.

The potential for water shortage is the primary measure considered in determining drought vulnerability. However, what constitutes a water shortage or an adequate supply is not typically well-defined. In identifying water shortages following the 1952-1955 drought, Hudson and Roberts (1955) judged that a community had suffered a shortage if there was less than a six-month supply of water remaining in their reservoir at the end of the drought. We believe that their experience indicates that there can be substantial socio-economic stresses to a community well before it runs out of water. The definition of a marginal system presented above alludes to the potential problems and difficult decisions that a community may have to face as its water supply is running low.

Potential Effect of Conservation on a Community's Drought Vulnerability

All historical water supply droughts in Illinois have started during the summer, the season of highest water use. However, the impact of the drought on water supplies such as reservoirs is often not recognized until late summer or fall after a hot and dry summer that has already produced high water use and accelerated drawdown in reservoir levels.   Thus, voluntary and mandatory conservation measures, discussed in the chapter on *Drought Response*, are often not enacted until the fall season or later. Even when there is a noticeable drop in water use in subsequent stages in the drought, it may not make up the differential created by heavy use during the initial summer period, such that total water use over the entire course of a drought is typically expected to be 5 to 10 percent greater than the average annual water use.

It is noted that when their reservoir levels are approaching dangerously low water levels, communities and their citizens will almost certainly employ extraordinary water demand reduction measures, beyond those typically addressed in drought response plans, to prevent the depletion of their water supply. Even if such measures are successful in carrying the water supply through the drought, it is suggested that in such cases the supply system did not satisfactorily perform its function in providing a sustained water supply for the community, particularly if in the process there were noticeable adverse economic impacts to the community and its industries.

Long-term conservation measures (demand management) by a community, on the other hand, are a very cost effective way to reduce average annual water use and thereby lessen the vulnerability of the system to a severe drought. A 10 to 20 percent reduction in water use does not provide for a dramatic shift in the overall drought risk. Thus, conservation measures are most effective for systems that are only marginally vulnerable to drought, and should never be viewed as a substitute when an additional or augmented source of supply is needed. Of the 23 surface water systems classified inadequate or at-risk, only three systems would be reclassified if their communities' water use were reduced by 10 percent. Those three systems would be reclassified from at-risk to marginal, meaning that they would still experience some hardships during a drought similar to the historical drought of record. Thus, for most communities classified as inadequate or at-risk, the development of supplemental sources of water and interconnection with larger systems having surplus yield are seen as needed solutions to resolve drought vulnerability issues.

Drought Vulnerability of Groundwater Systems

The following discussion was presented in Winstanley et al. (2006). It is recommended interested readers review this report for a more detailed treatment.

The rate of groundwater recharge is one of the key variables influencing the amount of water that can be withdrawn from an aquifer over the long term. Groundwater recharge is arguably one of the least understood and quantified components of the hydrologic cycle. It cannot be measured directly, is highly variable in space and time, and must be inferred from measurements and determinations of related geologic and hydrologic properties.

> *"The major sources of recharge to aquifers in Illinois are direct precipitation on intake areas and downward percolation of stream runoff (induced infiltration)….Recharge from direct precipitation and by induced infiltration of surface water involves the vertical movement of water under the influence of vertical head differentials. Thus, recharge is vertical leakage of water through deposits. The quantity of vertical leakage varies from place to place and it is controlled by the vertical permeability and thickness of the deposits through which leakage occurs, the head differential between sources of water and the aquifer, and the area through which leakage occurs"* (Walton, 1965).

An analysis of the impact of the 1988-1989 drought on water resources was presented by Lamb (1992). A similar report on the drought of 1980-1981 was presented by Changnon et al. (1982). Both reports contain analyses of drought impacts on shallow groundwater conditions based on groundwater-level data from an ISWS-maintained shallow groundwater-level observation well network. This network consists of shallow water-table wells located in areas remote from pumping; the observation wells are shallow (mean depth = 28.5 feet) and, by design, were not completed in the state's major aquifers. While data from this network are useful for examining impacts of weather and climate on the water table, and thus are useful for extrapolating to impacts on shallow wells, the impacts of drought on recharge to the state's aquifers is less well documented, and therefore, less understood.

> *"... water stored in thick deposits of glacial drift is available to deeply buried aquifers so that drought periods have little influence on water levels in these aquifers. Ground-water storage in deposits above aquifers and in aquifers permits pumping for short periods of time at rates greater than recharge. However, many aquifers are greatly limited in areal extent and thickness, and pumping at rates much above recharge rates for extended periods results in rapid depletion of aquifers"* (Walton, 1965).

Perhaps the best way to assess drought sensitivity is through the use of groundwater flow models where the effects of reduced or no recharge can be examined. However, there are hundreds of Illinois community wells that would require modeling. Due to the intensive data requirements and time needed to develop groundwater flow models, it is simply not practical for the detailed flow models for each of these supplies to be developed. However, community supplies can be prioritized in terms of drought sensitivity and population served. Groundwater flow models have been developed for many communities as part of groundwater recharge area delineations for Illinois EPA's Source Water Assessment and Protection (SWAP) program. With time and resources, such models could be adapted to examine the groundwater resource and facility capability to respond to drought.

As a result, a different methodology to identify community wells potentially at-risk due to drought was devised. Digital databases were used to provide input to a geographical information system for display of selected well parameters that may suggest a community supply is drought-sensitive. A summary of the approach is presented below.

Well Depth. Community well data were segregated on the basis of well depth. Shallow wells are most likely to be affected by a lack of recharge resulting in lowered groundwater levels. Shallow wells also tend to have less available drawdown within which they can operate. Lower nonpumping water levels due to drought will further reduce available drawdown. Communities with wells less than 100 feet deep were deemed potentially sensitive, with wells less than 50 feet deep being most sensitive.

Proximity to Surface Waters. Shallow community wells were identified further on the basis of proximity to streams using a buffer of 1000 feet to highlight wells that receive potential recharge through streambed infiltration. These wells potentially could be affected by low streamflow during a drought or, conversely, could severely impact low streamflows during drought. Therefore, shallow community wells (wells <100' deep) in proximity to streams could be given higher priority.

Well Density. Community wells were examined on the basis of well density, that is, the number of wells within a defined area. Typically, communities that use areally-limited aquifers will have several low-capacity wells in a very confined area; for example, Lewiston has approximately 6 to 8 wells within a 10-acre area. During drought, water demand typically increases, causing wells to operate for longer periods and at higher rates, increasing the effects of mutual interference. For this analysis, shallow community wells within 1,000 feet of one another and within 1,000 feet of an identified stream were identified.

Population Served. Potentially drought-sensitive communities that serve larger populations than other potentially drought-sensitive communities also could be prioritized on the basis of risk to human health. Very few of the communities found through the screening process serve populations greater than 10,000 and most of those may not, in fact, be drought-sensitive for reasons discussed below.

Uncertainties. In some cases, community wells that were identified through the above process may not be drought-sensitive because the alluvial deposit in which those wells are completed is adjacent to a major river system (e.g., the Mississippi, Illinois, and Wabash River bottoms) or the aquifer is extensive and thick enough such that, even though shallow, is quite drought-resistant (e.g., western portions of the Mahomet Aquifer). Conversely, many drought-sensitive wells may not be identified by this methodology. Well depths of 100 feet and proximities of 1000 feet to other wells or streams were selected as methodological examples. Such an analysis ignores deeper wells that may have been completed in drought-sensitive aquifers and wells at greater distances from other wells that still could be affected by mutual interference. Nor did this analysis attempt to identify supplies that may be vulnerable due to facility deficiencies. Water demand often increases during drought and facility capability to meet increased demand is often a critical component of drought preparedness. Aquifer and well capabilities aside, a community also needs capacity to meet the maximum daily demands that occur during hot, dry weather often associated with droughts.

Summary. From a list of over 3000 community wells serving over 1100 community systems, this methodology pared the list to 208 wells, representing 82 communities (Figure 4). These community wells are deemed potentially vulnerable to drought conditions on the basis of their shallow depth, proximity to other shallow community wells, and proximity to identified streams. Examination of the map with respect to Illinois' major sand and gravel aquifers shows that most of the potentially drought-sensitive community wells are located in southern east-central Illinois, south of the Mahomet Aquifer and along minor river valleys, such as the upper reaches of the Kaskaskia, Embarras, and Little Wabash Rivers.

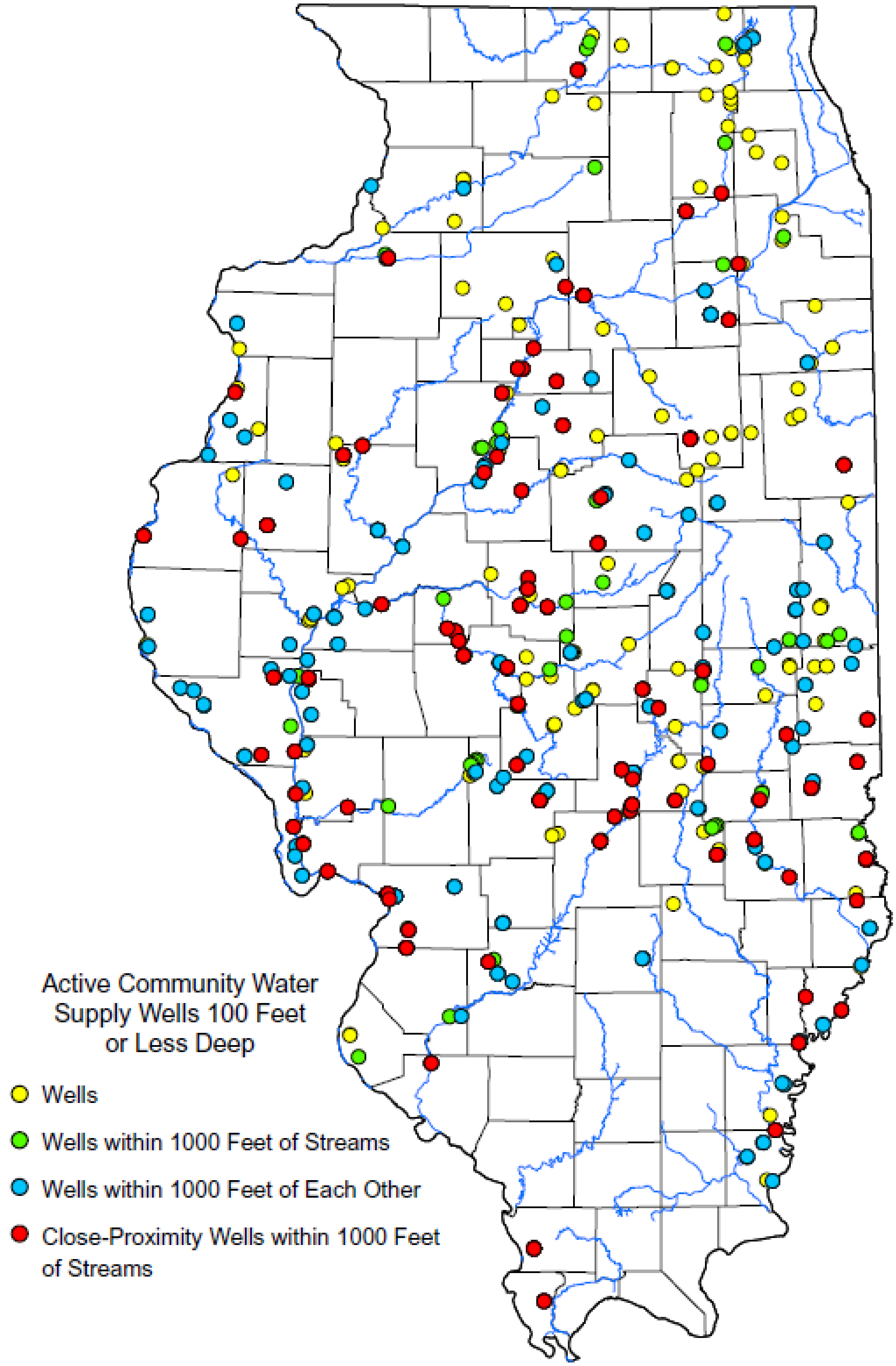


Figure 4. Community water supplies less than 100 feet deep, within 1000 feet of another community well, and within 1000 feet of a recognized stream (from Winstanley et al., 2006)

Follow-up analyses are needed with the intent of developing alternative water supplies for drought-sensitive communities. Alternatives include locating additional wells in the same aquifer or different aquifer; developing alternate water sources (e.g., surface water); deepening wells and/or lowering pumps; reducing or curtailing pumpage from other non-essential wells, such as irrigation and golf course wells; repairing system leaks; increasing storage; and instituting water conservation measures. Groundwater flow models can be developed for those community wells determined to be most drought sensitive. In some cases, advantage can be taken of groundwater flow models already developed for many community recharge area delineations as part of regulatory SWAP program.

Small Community Groundwater Resource Assessments. Over the past several years, the ISWS Center for Groundwater Science has assessed the groundwater resources for many small public water supply facilities (less than 2,000 individuals) through grants from the Midwest Technology Assistance Center. The project titled, *Groundwater Resource Assessment for Small Communities*, developed letter-type reports for 60 facilities that use shallow groundwater resources for their water supplies. The reports target those facilities that were determined to be potentially deficient or marginal in producing groundwater for their towns under certain well depth and facility operational criteria. A summary of available resources within five and ten miles of the facility was included as part of each report. The summaries typically include unexplored groundwater resources that would require further investigative study by the facility. Each community letter-report is available online and is intended as a means to start a more involved program of groundwater exploration.

Evaluating the Economic Risks and Costs in Determining Appropriate Action

There is the need for the State, its citizens, communities, and industries to assess the level of natural disaster that they are willing to prepare for in terms of cost, both with floods and droughts. With respect to drought, this involves determining potential damages and potential actions both in response to such damages during a drought and preparations that could mitigate damages from future droughts. For some water-use sectors (agriculture, recreation), there may be limited options for mitigating potential damages, whereas for other sectors (public water supply, industries), actions taken before the onset of drought have the potential to greatly alleviate damages.

For community surface water supply systems, the evaluation of drought vulnerability (presented earlier in this chapter) assumes that most communities should have a reasonable degree of confidence (90 percent) that their supply will be adequate during an extreme drought as represented by the historical drought of record. It is also recognized, however, that smaller at-risk communities could decide that they do not have the monetary resources to develop a sufficient supply to withstand an historical record drought condition; and thus, in their drought planning effort, could decide to haul water or interconnect with a nearby community during such an extreme drought condition. On the other hand, larger communities and industries that cannot afford to be without water–particularly those without an evident auxiliary supply in case of shortages–may decide that they need to develop a source of supply that is capable of providing sufficient water during a drought even more extreme or persistent than the historical drought of record. And there is always the potential that the next severe drought in Illinois may be worse than any drought of the past 100 years, requiring actions and decisions that most community drought plans are not designed to handle. The 2007-2008 Georgia drought is a clear example that new droughts of record can occur.

There is the need for community water systems to: 1) assess their drought vulnerability (or use available studies), 2) identify expected changes in future water needs, 3) adopt drought preparation plans to address vulnerabilities and potential damages, and 4) act on those plans. An awareness and compilation of material regarding state or regional drought plans, system behavior in previous extreme drought periods, and an assessment of current and near-future supply and demand will go a long way towards a functional plan. For some communities, the first step may be to better quantify their existing resources. For example, the capacity of many water supply reservoirs has never been measured; whereas in other cases, new measurement technology could provide greater certainty in the capacity estimate.

Considerations in Evaluating Local and Regional Water Supplies

The following check points, originally presented in Winstanley et al. (2006), provide a brief guide toward issues that should be considered in developing a drought preparedness plan.

1. Changes in Water Use (Past and Projected)
   - o What has been the community's growth in average water use over the past 10 to 15 years?
   - o What is the community's projected growth in water demand in the near future? Is the community attempting to attract new industries or commercial enterprises that will increase its water use?

     Reevaluation of system adequacy should be high priority for communities with a water use growth of more than 25 percent, particularly if the rate of growth is likely to continue into the near future.
   - o What is the community's water use during hot, dry periods?

     For many communities, water use during a drought period is significantly higher than the average annual rate (Chapter 2). An evaluation of system adequacy should be designed around expected use over the course of a drought.

2. Changes to the Water Supply System
   - o What is the current system capacity?

     Raw water ________________

     Treated water ______________
   - o How does this compare to the average daily water demand? Peak demand? Can the system meet peak demands routinely without additional infrastructure (e.g., the need for back-up or redundancy)?
   - o What is the community's water source capacity (be it river, lake, reservoir, or aquifer)?
   - o What changes or improvements to the water supply system have been made in the past 15 years?
   - o Is the community planning for any changes or improvements to the water supply system in the near future or in the upcoming decades? Do these plans involve incremental improvements in the current supply, or are substantial modifications being planned?

3. Uncertainties and Potential Decreases in the Capacity of the Current System
   - o If the community has a groundwater supply, have well capacities decreased with time (or have drawdowns increased to provide the same amount of water)? How do groundwater levels react to pumping stress in dry periods? Are the wells close together and do they interfere with one another? Are they close to a surface-water body and do they depend on that surface water for recharge? Is a record kept of pumping and nonpumping water levels in the wells? Is a water level trend apparent and, if so, how does it compare to trends in withdrawals?
   - o Could the community's future water source capacity be impacted adversely by additional withdrawals from other parts of the aquifer or watershed?
   - o If the community withdraws water from a reservoir, has the capacity of that reservoir been measured in the past 20 years? Has the rate of capacity loss from sedimentation been measured?

4. Problems Experienced in Past Drought Periods
   - o Has the community experienced concerns with inadequate water supply during drought since 1970? Ever?

     Supplemental sources and capacities added to the system since the last drought of major concern (addressed in item 2), minus potential losses due to reduction in pumping capacity or reservoir sedimentation (addressed in item 3) should have overcome not only the shortcomings in the *system as experienced in this past drought, but also offset coincident increases in water use (addressed in item 1).*

The worst water-supply droughts in Illinois occurred in the 1930s and 1950s. Although selected communities have been impacted by more recent and less-severe droughts, such as droughts in the mid-1960s, 1976-1977, 1988-1989, 1999-2000, and 2005, none of these recent droughts had the same type of widespread impact as the droughts of the early and mid 20th Century. Such severe droughts will occur again in the future. Many communities that have not experienced water supply concerns in decades may still be at risk of having water shortages during a severe drought.

Drought Response

State Agency Programs relating to Drought Response

Illinois has several ongoing programs that pertain to drought and drought contingency planning. The following is a brief description of these state agency programs:

Illinois Emergency Management Agency (IEMA) — IEMA is concerned with the emergency and short-term effects of a drought. In the event of a drought disaster, IEMA would coordinate the responses of all state agencies and would work with all the local IEMA units. A limited supply of pipe and pumps are available for a short-term loan to communities. IEMA also serves as the state coordinator for all federal disaster programs.

Illinois Environmental Protection Agency (IEPA) — The IEPA monitors public water supplies and maintains contact with the communities involved. The staff offers technical assistance and works with other state agencies in attempting to resolve water shortage problems. The IEPA has also prepared a list of sewage treatment plants with discharge effluent of sufficient quality to permit its use by farmers for stock watering in drought pressed areas.

Illinois Department of Agriculture (IDOA) — The IDOA assists farmers in water-short areas in obtaining water for livestock and performs other related supporting roles. The Department also monitors the impacts of drought on crops, soils, livestock, etc. and publishes findings in regularly issued reports.

Illinois Department of Public Health (IDPH) — The IDPH assesses the potability of water derived from privately owned sources and from sources shared by ten or fewer housing units. Water from these sources can be tested for potability by the department, at no cost.

Illinois Department of Natural Resources (IDNR) — The IDNR is the lead state agency governing water quantity planning and management decisions in Illinois. The IDNR Office of Water Resources'(OWR) key water quantity management and planning powers cited under 20 ILCS 801/5-10 are *(a) To study and investigate ways and means by which the various water uses may be coordinated to the end that the water resources of the State be put to their maximum beneficial use* . . . *(b) To coordinate, determine and provide ways and means for the equitable reconciliation and adjustment of the various conflicting claims and rights to water users and uses. (c) To recommend legislation for the most feasible method or methods of conserving water resources and putting them to the maximum possible use* . . . The IDNR has jurisdiction over all lakes and streams which the State has any rights or interests. Under the "Level of Lake Michigan Act" (615 ILCS 50) the IDNR is designated as the agency to control and regulate the diversion of Lake Michigan water and is responsible for apportionment of water diverted from the Lake Michigan watershed. The OWR manages the Lake Michigan Allocation Program, which provides water supply to approximately one-half of the state's population. It also owns and manages the state's water supply storage in the three federal surface water reservoirs in Illinois, being Shelbyville, Rend, and Carlyle Lakes. OWR concerns itself with water supply issues, as well as technical assistance in planning and water system design, special district organization, or the search for funding alternatives. Data and recommendations are provided to communities with water problems, which may result in state assistance for development of new supplies. OWR also promotes the siting of major consumptive users in water abundant areas. The IDNR Office of Resource Conservation (ORC) monitors and reports on the status of state-owned and public lakes and any observed impacts on fish, forestry, and wildlife.

Illinois State Geological Survey (ISGS) — The ISGS maintains information on the location of the more highly producing aquifers and assists with the exploration and mapping of smaller aquifer locations.

Illinois State Water Survey (ISWS) — The ISWS conducts scientific studies into measurement, utilization, and conservation of water, with emphasis on surface supplies and precipitation. This research is used in the ISWS's developmental projects to improve the quality and quantity of Illinois' water. The ISWS continually monitors water conditions in the state and issues detailed monthly reports containing information on surface water conditions, soil moisture, groundwater conditions, and precipitation. Of critical importance to drought contingency planning are the long-range monthly and seasonal precipitation outlooks issued by the ISWS for those parts of the state with water shortage problems.

Drought Response Task Force (DRTF)

The Drought Response Task Force (DRTF) was organized in 1983 under the recommendation of the State Water Plan Task Force — that *existing state and federal programs for drought and emergency interruption of supplies be organized and in a state of readiness*.

The DRTF is co-chaired by the Director of the IDNR Office of Water Resources and the Manager of the Public Water Supply Section of the IEPA. Other typically represented agencies include the Illinois State Water Survey, the Illinois Department of Agriculture, the Illinois Department of Public Health, the IDNR Division of Fisheries, the Illinois Emergency Management Agency, the Illinois Commerce Commission, the Illinois Department of Commerce and Economic Opportunity, and the Office of the Governor. Each agency has technical expertise and capabilities in specific areas of drought management and assistance.

DRTF Activation

The DRTF is convened either by the Governor or by the Director of the IDNR Office of Water Resources (OWR). The DRTF is co-chaired by the OWR Director and the Manager of the IEPA Public Water Supply Division. The ISWS issues a monthly summary report on the state's water and climate data, called the "Illinois Water and Climate Summary." The DRTF Co-Chairmen utilize this information in their decision of when to convene the DRTF, in addition to assessing the level of decline in water supplies and other resources being affected. Normally an update and assessment of the dry weather is provided at the quarterly SWPTF meeting preceding the decision to convene the DRTF, where agencies often report on the status and issues warranting attention. Upon the decision to convene, OWR makes the contacts and arrangements for the meeting, and serves as the focal point for the collection and dissemination of information.

Since 1983, the DRTF has been activated nine times, most recently during the period from June 2005 through May 2006.

DRTF Reporting and Actions

The OWR Director coordinates the meetings. The meeting structure provides for a "conditions" or problem report from each representative, and begins with an overview of the detailed *water and climate data monthly report* as prepared by the ISWS. Data on precipitation, soil moisture, river and reservoir levels, groundwater levels, and climate forecasts and projections are provided. Statistical data comparisons to historical records and water budget projections on certain water supply systems are also presented.

The IEPA normally follows with a detailed report on the status of the state's public water supply systems. This report provides water level and remaining water supply capacity information, highlighting the systems currently considered being at-risk. For those systems at-risk, the options identified for alternative water supply are presented. The Department of Public Health (IDPH) provides information on any specific health-related problems. Notice of any area increases in well drilling permits or water hauling activity is given, which generally indicates an impact on groundwater supplies. The Department of Agriculture (IDOA) provides data on weather and crop reports, soil moisture conditions, planting statistics, and notification of any sale of livestock due to the drought. The IDNR/Division of Fisheries reports on any problems with fisheries on any of the state's reservoirs and streams due to, for example, thermal or low-flow conditions. The Illinois Emergency Management Agency (IEMA) provides notice on any requests for assistance they have received and alerts the group of any specific community concerns. Each of the agencies also maintains staff in the field, and the awareness of real or potential impacts from precipitation deficiencies is frequently brought to the attention of the DRTF through staff contact with the public and local units of government.

Following these reports, the group discusses the information and establishes the areas of concern requiring further attention and close monitoring, with the course of action decided by the group. The IDNR Public Affairs Office serves to provide drought status information to the public and press releases as necessary. The Governor's Office (OG) representative provides drought status information and resource-related problems to the OG's Senior Advisor, allowing for timely intervention by the broad powers vested to the Governor during an emergency. The OWR prepares a summary report on each meeting.

Information on Current (and Historical) Drought Conditions

The Illinois State Water Survey hosts a web site (http://www.isws.illinois.edu/hilites/drought/) that includes information on current Illinois drought conditions and archived information on past droughts. This web site includes DRTF meeting summaries, ISWS updates on climatic and hydrologic conditions, periodic summaries of drought impacts as reported to the DRTF by various State agencies, press releases, and a list of agency contact persons for drought information.

Also included in the drought archives section of this web site are the following reports prepared following past Illinois droughts:

- The 2005 Illinois Drought
  http://www.isws.illinois.edu/pubdoc/IEM/ISWSIEM2006-03.pdf
- Illinois Drought of 1999-2000
  http://www.isws.illinois.edu/docs/reports/IllinoisDroughtof1999-2000.pdf
- The State of Illinois Response to the 1988-1990 Drought
  http://www.isws.illinois.edu/pubdoc/MP/ISWSMP-125.pdf
- The 1988-1989 Drought in Illinois: Causes, Dimensions, and Impacts
  http://www.isws.illinois.edu/pubdoc/RR/ISWSRR-121.pdf
- The 1980-1981 Drought in Illinois: Causes, Dimensions, and Impacts
  http://www.isws.illinois.edu/pubdoc/RI/ISWSRI-102.pdf
- 1952-1955 Illinois Drought with Special Reference to Impounding Reservoir Design
  http://www.isws.illinois.edu/pubdoc/B/ISWSB-43.pdf

Governor's Disaster Declaration and Emergency Powers

Under the Illinois Emergency Management Act [20 ILCS 3305/], the Governor is given broad powers to respond as necessary to an emergency. In the event of a disaster, such as a drought as defined in Section 4, the Governor may, by proclamation declare that a disaster exists. Upon such proclamation, the Governor shall have and may exercise emergency powers for a period not to exceed 30 days, which may be renewed. These powers include the ability to "*suspend the provisions of any regulatory statute prescribing procedures for conduct of State business, or the orders, rules and regulations of any State agency, if strict compliance with the provisions of any statute, order, rule, or regulation would in any way prevent, hinder or delay necessary action, including emergency purchases, by the Illinois Emergency Management Agency, in coping with the disaster.*" They also include the taking of real estate following certain provisions. The application of these powers is generally triggered by a request from a local unit of government. Local units of government generally make these requests when their local resources or authorities are insufficient to respond to an emergency. The DRTF and its member agencies continue to closely monitor the activities of all units of local government and are prepared to advise on the appropriateness of a request for a disaster declaration. In general, any emergency declaration sought through IEMA should be initiated or clearly supported by a local unit of government and concurred in by a lead state agency if the request demands actions outside of IEMA's capabilities or expertise.

<u>Example of Emergency Actions</u>. On November 6, 1999, the operator from Oakland contacted the IEPA Champaign Regional DPWS Manager with concerns about their low water conditions. Their reservoir was down 75 percent in volume and an estimated 35 to 40 days of supply remained at the present pumping rate of 140,000 gpd. The community (pop. 996) was asked to reduce water usage, and the Mayor was to approach every business and request a usage reduction. It was cited that, if this did not work, a rate surcharge and leak survey would be recommended. Oakland was a main topic of discussion at the November 23, 1999 SWPTF meeting. The village had contacted IEMA as it appeared that less than one month of water supply remained, even with usage having dropped to 120,000 gpd. A temporary solution of piping water from the 46-acre lake at Walnut Point State Park was being considered. The availability of pipe materials, assembly logistics, and freezing concerns were discussed. The IEPA recommended mandatory conservation measures. At the December 10, 1999 DRTF meeting, the IEPA reported that water restrictions had reduced usage to 99,000 gpd.

On December 2, Governor Ryan approved the plan to pipe water from Walnut Point State Park. OWR coordinated the emergency pipeline project. The water volume to be withdrawn from15 Walnut Point was to be limited to 1 foot of drawdown. This volume was estimated to provide about 2 feet of water to Oakland's reservoir and provide for another 120 days of supply. A total of 15,600 feet of pipe was delivered by IDOT and unloaded by a prison work crew. OWR obtained the pipe from the Fox Waterway Agency and the City of Havana. The pumps were furnished by the IDNR and IDOT. The OWR field crew began pumping on December 16. Pumping was completed on December 29, 1999. The project assured Oakland with water supply through the third week of April, barring any rainfall. Oakland has discussed their long-term plan options as either dredging their reservoir, connecting with an existing water district, or possibly joining a new water district being proposed for the area.

Federal Disaster Assistance

Federal disaster declarations qualify farmers for USDA assistance programs, including low-interest emergency loans and are quite common in Illinois. In January of 2004, the federal disaster declaration included 42 counties in southern Illinois that sustained losses to their soybean crops because of drought. In July 2005, the Governor requested federal disaster assistance from the USDA for drought-stricken Illinois farmers who have sustained substantial crop losses that year. The request was for all 102 Illinois counties to be declared natural disaster areas. In January 2007, the Governor announced that federal disaster assistance was available to help farmers in 44 Illinois counties who suffered crop losses because of drought. In order to qualify for federal disaster assistance, counties must experience at least a 30 percent decline in the production of any single crop. Assistance also can be obtained if farmers no longer qualify for commercial credit due to disaster-related losses.

Community Conservation Measures

During the onset of drought, many communities will send out an alert as to the drought situation and request voluntary conservation measures. These voluntary measures normally include common sense water usage practices to reduce water usage and waste. The DRTF has also typically provided conservation measures to the media for public awareness and education at the onset of drought. The Illinois Department of Public Health and the Illinois Environmental Protection Agency recommended the following conservation measures during the 2005/2006 drought:

- Don’t water vegetation during the heat of the day
- Use a broom, not a hose for outdoor cleaning
- Don’t play with the hose or sprinkler
- Check faucets and pipes for leaks
- Turn water off while shaving, brushing teeth, etc.
- Take shorter showers or take a bath in a partially filled tub
- Use dishwashers and washing machines only when full and don’t pre-rinse unless necessary
- When washing dishes by hand, don’t let the rinse water run
- Car washing should be kept to a minimum and water used only sparingly
- Cut lawns higher in hot months to conserve soil moisture

At later stages in a drought, conservation measures may be made mandatory. In examples from past Illinois droughts, mandatory conservation measures have typically not been substantially different from voluntary measures except that they are legally enforceable.

The following discussion on the effectiveness of conservation measures in drought response is taken from Knapp and Hecht (2009).

The timing of hydrologic droughts in Illinois typically limits the effectiveness of outdoor water use restrictions during the first year of a drought. All historical water supply droughts in Illinois have started during the summer, the season of highest water use. Community water use during a typical summer may often be 25 to 30 percent higher than the base water use throughout the rest of the year; but during hot and dry summer conditions (that have the potential to develop into droughts), communities typically experience very high levels of water use. At the start of the 2005 drought (June 2005), the water use for Bloomington was over 17 mgd, roughly 56 percent above its base water use and over 20 percent higher than the demand for a typical summer month. In July 1999 (the first month of its 1999-2000 drought), Springfield’s potable water demand exceeded 32 mgd, over 65 percent higher than the base use and 20 percent higher than that for a typical summer month. Even in Decatur, where the rise in summer water use is tempered by industrial use (which has little seasonal variation), the three months of June through August of 2005 had an average use of 45 mgd, or roughly 4 mgd higher than that a typical summer. Nearly all of the higher usage in summer is related to outdoor water uses.

Drought response plans for Bloomington and Springfield, for example, each identify various stages of drought based on abnormally low water levels in their reservoirs. Such low reservoir levels do not occur until many months into the drought, typically during the fall or winter season when outdoor water use restrictions have little or no direct impact. Even when there is a noticeable drop in water use in later stages in the drought, it may not make up the difference caused by heavy use during the initial summer period, such that total water use over the entire course of a drought is expected to be greater than the typical average annual water use. If the onset of droughts could be accurately forecasted, then a community would hypothetically be able to call for water use restrictions at the beginning of a drought. But in reality, there is little or no difference between the first months of a drought and many other dry periods that might occur once every several years. In order to reduce water use at the start of droughts, conservation measures would likely need to be placed on outdoor water use for all summers, i.e., permanent conservation measures, not just those related to drought response.

Most drought response plans focus on restricting outdoor water uses. These restrictions may work well in reducing water use during summer months, but have much less effect on water use from October through April, where their implementation relies upon mostly voluntary reductions in indoor water use via public awareness. The results of mandatory water restrictions implemented throughout northern Georgia in 2008, that region's worst drought on record, are provided here as an example of what might be expected during a similarly severe drought condition in Illinois. Water use in northern Georgia during the first summer of the drought (2007) was extraordinarily high. In October 2007, Governor Perdue of Georgia directed the state's Environmental Protection Division to modify water production permits for all community water supplies in northern Georgia. By that date, some of the major water supply reservoirs in northern Georgia, such as Lake Lanier, were already approaching record-low water levels. Mandatory restrictions were successful in reducing 2008 summertime (May–August) water use by more than 20 percent compared to the high 2007 values. In contrast, the reduction in total water use in the winter and early spring, presumed to result from indoor water conservation, was about 6 percent (data from the Georgia Department of Natural Resources, http://www.gaepd.org/Documents/news.html).

Although conservation measures are typically adopted only during drought conditions, long-term conservation measures as part of water demand management plan is expected to be more effective in reducing drought vulnerability. The 35-member regional water supply planning group that represented the 11 Northeastern Illinois county study area recommended the following demand management measures:

- Replacing old toilets and clothes washers with new, high-efficiency ones
- Prohibiting practices that waste water
- Metering water use
- Auditing water systems to detect leaks and other inefficiencies
- Retrofitting residential plumbing
- Finding alternatives to road salt to de-ice roads
- Charging the public for the full cost of delivering water instead of just for the water itself

They also recommended that municipal and regional conservation coordinators should be appointed to oversee water conservation programs.

In addition to the technological changes, such as installing more water-efficient fixtures in homes, conservation can be accomplished by encouraging behavioral changes in citizens and businesses. But in many ways, technological changes are more easily accomplished. Bringing about behavioral changes in the populace usually requires an acceptance that such changes are important to avoid a water crisis.

Citizens may be willing to sacrifice outdoor water use during periods of drought and potential shortage, for example, but not so willing to do so on a full-time basis.

The impact of conservation on a community's drought vulnerability may also depend on how the community responds to the reduction in water use. Successful long-term conservation programs can make municipal officials believe that their community has a water supply surplus that can be used to accommodate new industries or residential developments. If conservation savings are allocated to new customers, the system may become more vulnerable to droughts than before because there are fewer additional conservation measures that can be used to reduce demand during a drought.

A wide variety of publications and resources related to water conservation are available, from which two useful internet resources are listed. An American Water Works Association web site (www.waterwiser.org) provides a clearinghouse of information related to water use efficiency. Similarly, an Illinois State Water Survey web site provides links to water conservation web sites for various states across the nation (http://www.isws.illinois.edu/wsp/watermgmtoptns.asp).

References, Internet Links, and State Contacts

References

Illinois Department of Natural Resources, January 2004, Integrated Water Quantity Planning and Management.

Knapp, H. Vernon and Jory S. Hecht, July 2009, Evaluating Drought Vulnerability of Small Community Surface Water Supply Systems in the Midwest. Illinois State Water Survey Contract Report 2009-10.

Lamb, Peter J. (editor). 1992. The 1988-1989 Drought in Illinois: Causes, Dimensions, and Impacts. Illinois State Water Survey Research Report 121.

National Drought Mitigation Center web site @ http://www.drought.unl.edu/index.htm

State Water Plan Task Force (SWPTF), June 1983 Drought Contingency Planning, Special Report No. 3.

Subcommittee on Integrated Water Planning and Management, December 2002, Report to the Interagency Coordinating Committee on Groundwater with Recommendations Pursuant to Executive Order Number 5, 2002

Wehrmann, H. Allen and H. Vernon Knapp, July 2006, Prioritizing Illinois Aquifers and Watersheds for Water Supply Planning. Illinois State Water Survey Informational/Educational Material 2006-04.

Winstanley, Derek, James A. Angel, Stanley A. Changnon, H. Vernon Knapp, Kenneth E. Kunkel, Michael A. Palecki, Robert W. Scott, and H. Allen Wehrmann, June 2006, The Water Cycle and Water Budgets in Illinois: A Framework for Drought and Water-Supply Planning. Illinois State Water Survey Informational/Educational Material 2006-02.

Internet Links

Drought Assessment Tools

- Illinois Water and Climate Summary (monthly report - ISWS)
  http://www.isws.illinois.edu/warm/climate.asp

- U.S. Drought Monitor (National Drought Mitigation Center)
  http://www.drought.unl.edu/dm/monitor.html

- USGS Below Normal Streamflow Map (United States Geological Survey)

- Illinois Streamflow Assessment Model (flow estimates - ISWS)
  http://www.isws.illinois.edu/data/ilsam/

- Drought Vulnerability of Illinois' Community Surface Water Systems
  http://www.isws.illinois.edu/data/ilcws/drought.asp

Drought and Water Supply - Statewide Publications

- Link to ISWS Regional Water Supply Planning Reports http://www.isws.illinois.edu/wsp/
- Data for Assessing Drought Vulnerability of Illinois' Community Surface Water Systems (2008 ISWS) http://www.isws.illinois.edu/pubs/pubdetail.asp?CallNumber=ISWS+CR+2008%2D02
- Uncertainties and Data Needs in Evaluating the Adequacy of Community Surface Water Supply Systems in Illinois (2007 ISWS) http://www.isws.illinois.edu/pubs/pubdetail.asp?CallNumber=ISWS+CR+2007%2D08
- The Water Cycle and Water Budgets in Illinois: A Framework for Drought and Water-Supply Planning (June 2006 ISWS)
- State and Regional Water-Supply Planning in Illinois (2006 Brochure ISWS) http://www.isws.illinois.edu/iswsdocs/brochures/ISWSWaterPlanningBrochure.pdf
- Prioritizing Illinois Aquifers and Watersheds for Water Supply Planning (2006 ISWS) http://www.isws.illinois.edu/pubs/pubdetail.asp?CallNumber=ISWS+IEM+2006%2D04
- Drought Planning for Small Community Water Systems (2006 ISWS) http://www.isws.illinois.edu/pubdoc/CR/ISWSCR2006-01.pdf
- A Plan for Scientific Assessment of Water Supplies in Illinois (October 2001 ISWS) (http://www.isws.illinois.edu/pubdoc/IEM/ISWSIEM2001-03.pdf
- Integrated Water Quantity Planning and Management (link to access various reports) http://www.isws.illinois.edu/docs/iwqpm/
- Detecting Drought Conditions in Illinois (Changnon, Stanley A., Jr., 1987 ISWS) http://www.isws.illinois.edu/pubs/pubdetail.asp?CallNumber=ISWS+C%2D169
- Drought Contingency Planning (June 1983, Special Report No. 3 of the State Water Plan Task Force) 1983 Drought Plan.pdf.lnk

Drought and Water Supply Contacts

- State Agency Contacts
- Drought Response Task Force Representatives