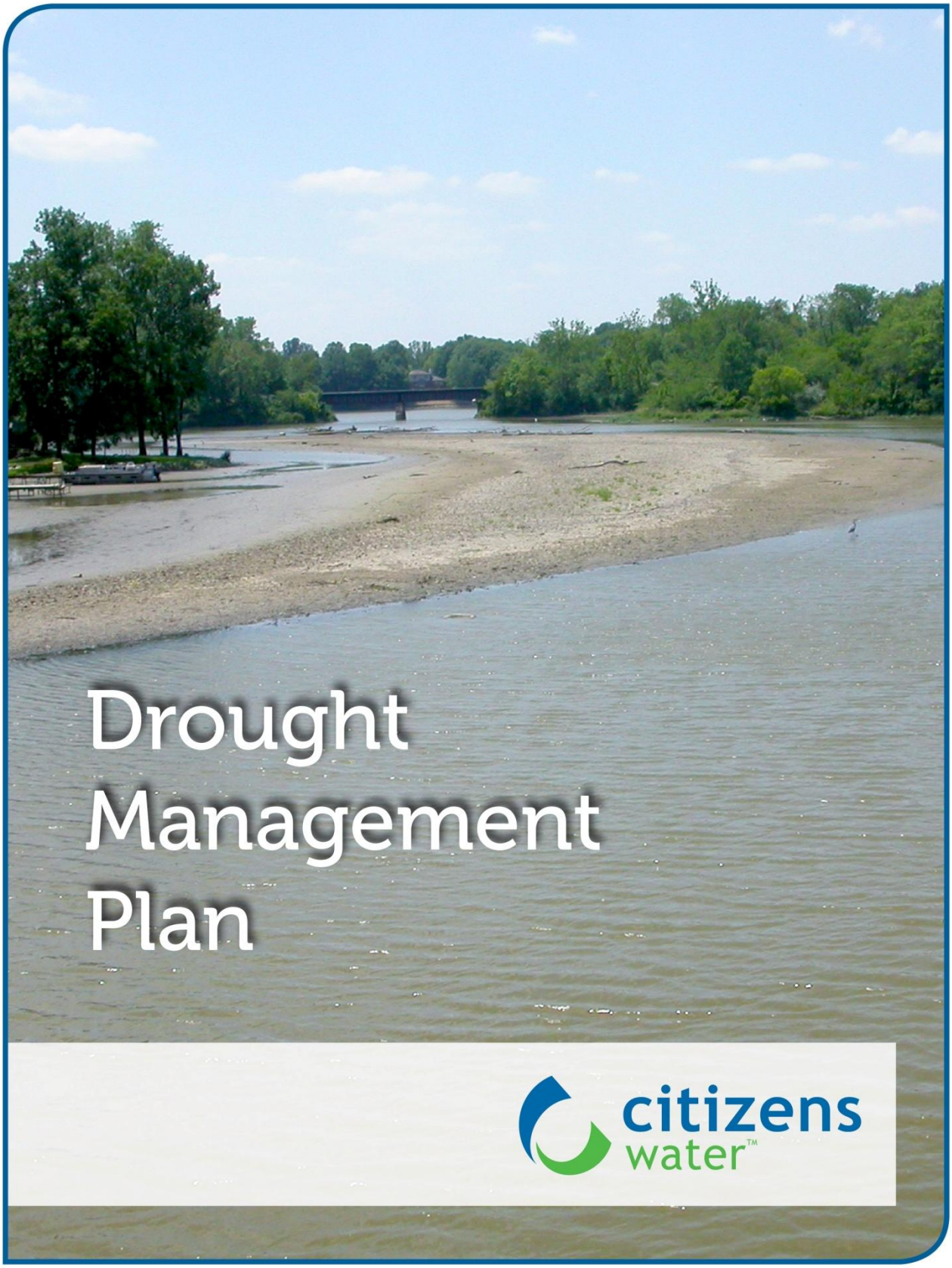


Drought Management Plan

citizens water™

TABLE OF CONTENTS

SECTION **PAGE**

1. INTRODUCTION 1
   - Plan Goals and Description 1
   - Historical Droughts 2
   - Other Water Shortage Conditions 3
2. WATER SUPPLY AND DEMAND 4
   - Water Supply Availability 4
   - Water Demand 9
3. DEVELOPMENT OF WATER SHORTAGE TIERS 11
4. DROUGHT INDICATORS AND TRIGGER LEVELS 11
   - US Drought Monitor 12
   - White River Streamflow at Noblesville 13
   - Morse and Geist Reservoir Levels 14
   - Groundwater Levels 17
   - Water Deficit Forecast Tool 18
   - System Pressure Maintenance Risk 19
5. DROUGHT RESPONSE ACTIONS 20
   - Supply Management 20
   - Demand Management 21
6. DROUGHT MANAGEMENT GUIDELINES 23
7. WATER SHORTAGE RESPONSE TEAM 24
8. REVENUE IMPACTS 25
9. CONCLUSIONS 25

REFERENCE CITED 25

ATTACHMENT A: Drought Management Guidelines 26

FIGURES

FIGURE TITLE **PAGE**

Figure 1-1: Drought Severity Based on White River Flow Deficit at Noblesville 3
Figure 2-1: White River Watershed Land Use Map 5
Figure 2-2: Surface Water Supplies and Treatment Facilities 6
Figure 2-3: White River Streamflow at Noblesville, IN 7
Figure 2-4: Citizens Water Service Area 9
Figure 2-5: Monthly Pumpage: 2007 - 2013 10
Figure 4-1: U.S. Drought Monitor Map for Indiana 13
Figure 4-2: White River Streamflow at Noblesville Trigger Conditions 14
Figure 4-3: Morse Reservoir Design Drawdown Curve 145
Figure 4-4: Morse Reservoir Water Level Trigger Conditions 166
Figure 4-5: Geist Reservoir Water Level Trigger Conditions 167
Figure 5-1: Estimated 2012 Demand Reductions Realized by Drought Management Actions 22

1. INTRODUCTION

Generally, Central Indiana is not considered lacking in water resources. The average annual precipitation of approximately 42-inches provides ample water to meet the areas water supply needs on an average annual basis. However, Indianapolis is the largest city in the Midwest that is not situated on a major navigable waterway. It does not possess a single large source of surface water supply that can be tapped as needed, such as the Wabash River or the Ohio River. Rather, Indianapolis is situated near the upper end of a relatively small watershed with limited storage capabilities. This geography requires the annual average precipitation to be spread relatively evenly throughout the year to be used most efficiently. During time periods with heavy precipitation, the excess water immediately flows downstream and cannot be utilized. During time periods with no or low precipitation, water supplies available in streams and reservoirs can be quickly depleted, resulting in water supply shortages.

A water shortage occurs anytime water supply is reduced to a level that cannot support existing demands (AWWA, 2011). The inability to predict either the start or the end of a drought makes these events particularly challenging for water supply management. However, droughts are not the only causes of water shortages. Water shortages can also be caused as a result of infrastructure failures or regulatory actions. The supply-management actions described in this plan were formulated primarily to respond to drought conditions, but they can be utilized for any type of water shortage event.

Plan Goals and Description

The goal of this Drought Management Plan is to provide a framework for taking appropriate actions to manage both the water supply and the water demand during periods of water shortages or periods when conditions are present that pose a heightened risk of future water shortages.

The Plan provides the following information in an effort to achieve this goal:

- Background information on past droughts and other water shortages to provide context to the Plan and identify some of the obstacles caused by droughts;
- A description of water supplies available to Citizens Water and a description of service area and customer demand patterns;
- Description of four water shortage tier levels that have been established to assist with drought management and customer communications;
- Identification of various drought indicators relevant to the Citizens Water supply;
- Establishment of triggers for the four water shortage tier levels based on the various drought indicators;

- Description of response actions to be taken that are associated with each of the four water shortage tier levels;
- A set of Drought Management Guidelines that summarize the four water shortage tier levels, the trigger indicators associated with each tier level, and the corresponding response actions to be taken at each level;
- Description of the roles and responsibilities for implementation of the actions described in the Plan;
- Comments related to revenue impacts from a severe drought and possible future mitigation strategies.

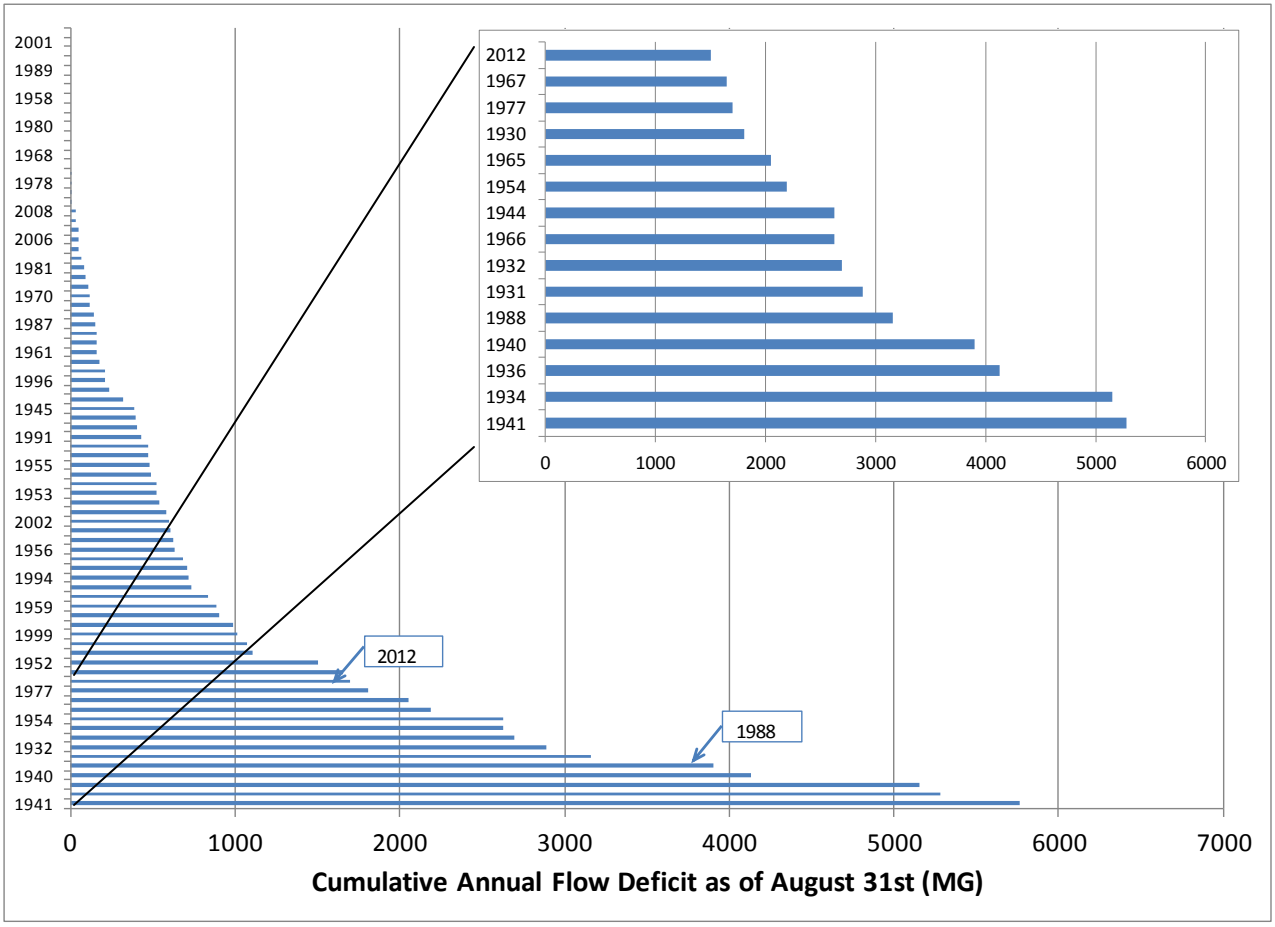
The most complicating factors in achieving the goal of this plan are related to the complexity of the water supply system for Citizens Water. The combination of surface water supplies from multiple streams and storage reservoirs, and groundwater supplies from multiple well fields provides some positive redundancy of supply characteristics, but also creates challenges in drought planning in that each supply has unique characteristics in response to drought conditions. The complexity of the water supply is addressed in this Plan by the inclusion of a set of drought indicators and trigger levels that capture the unique characteristics of the various water supplies. However, implementation will require evaluation of these indicators and trigger levels on the overall water supply situation.

Historical Droughts

Droughts can be classified into three types: meteorological, agricultural, and hydrological. A meteorological drought is defined as an extended period of below average precipitation. An agricultural drought is a drought that negatively affects crop production and other vegetation. A hydrological drought is manifested by a decline in water resources that are available in aquifers, streams and reservoirs to levels below normal. For the purposes of the water supply system, hydrologic droughts are the most significant because measures of the water resources available in aquifers, streams and reservoirs are direct measures of the resources available for water supply. The significance of these distinctions is that a drought severity measured purely by the amount of precipitation or by the impact on agriculture may be greater or lower than if measured based on streamflow and reservoir levels.

Indiana experiences short periods of dry weather on a regular basis. However, significant droughts that pose concerns to the water supply are less common. The worst drought on record for Central Indiana spanned two years, from 1940 through 1941. The White River experienced extremely low streamflows from June of 1940 through January of 1942. A drought of this duration can be particularly problematic because of the need to rely on limited storage resources available in reservoirs for such a long duration without an opportunity for replenishment. Other significant droughts occurred in 1934, 1936, and more recently in 1988 and 2012. The ranking of drought severity based on cumulative flow deficits below 120 MGD in the White River at Noblesville is provided in Figure 1-1.

Figure 1-1: Drought Severity Based on White River Flow Deficit at Noblesville



The drought of 2012 resulted from a period of extremely low precipitation for the period from early May through mid July. Precipitation at the Indianapolis airport during the month of June in 2012 was less than ever in recorded history. While this represented a period of extremely low precipitation, the duration was not as significant as some other droughts due to the occurrence of heavy rain events during the month of August. The net result was, that while streamflows and reservoir levels dropped quickly due to the extremely dry weather and high water demands, the streamflows in the White River did not get as low as they did in 1988, nor nearly as low as in 1940 and 1941.

Other Water Shortage Conditions

Water shortages can also occur due to infrastructure or system component failure. Infrastructure failures have the potential to result in short term water shortages in events such as main breaks, or longer term shortages in the event of major damage during a natural disaster.

The most significant event of this type occurring in Indianapolis was the breach of the canal in 1992. The breach occurred following heavy rains when a tree on the side of the bank between the canal and the White River toppled, pulling up its root ball and causing the bank to collapse. The breach interrupted the supply of raw water to the White River treatment plant, which provides approximately 55% of the water supply for the Indianapolis system. This interruption impacted residents and business until it was repaired and placed back in service 2 days later.

These types of events can occur with little to no notice. In July 2013, the Washington Suburban Sanitation District announced that an emergency repair on a 54-inch water main was going to cause a complete water outage for 150,000 residents in the suburban Washington D.C. area, with the outage expected to last for up to 4 days. This was expected to have an enormous impact on residents and business and prompted emergency plans for water distribution. Fortunately an alternative solution was identified that allowed pressure to be maintained in the system with the help of significant water use reductions by customers.

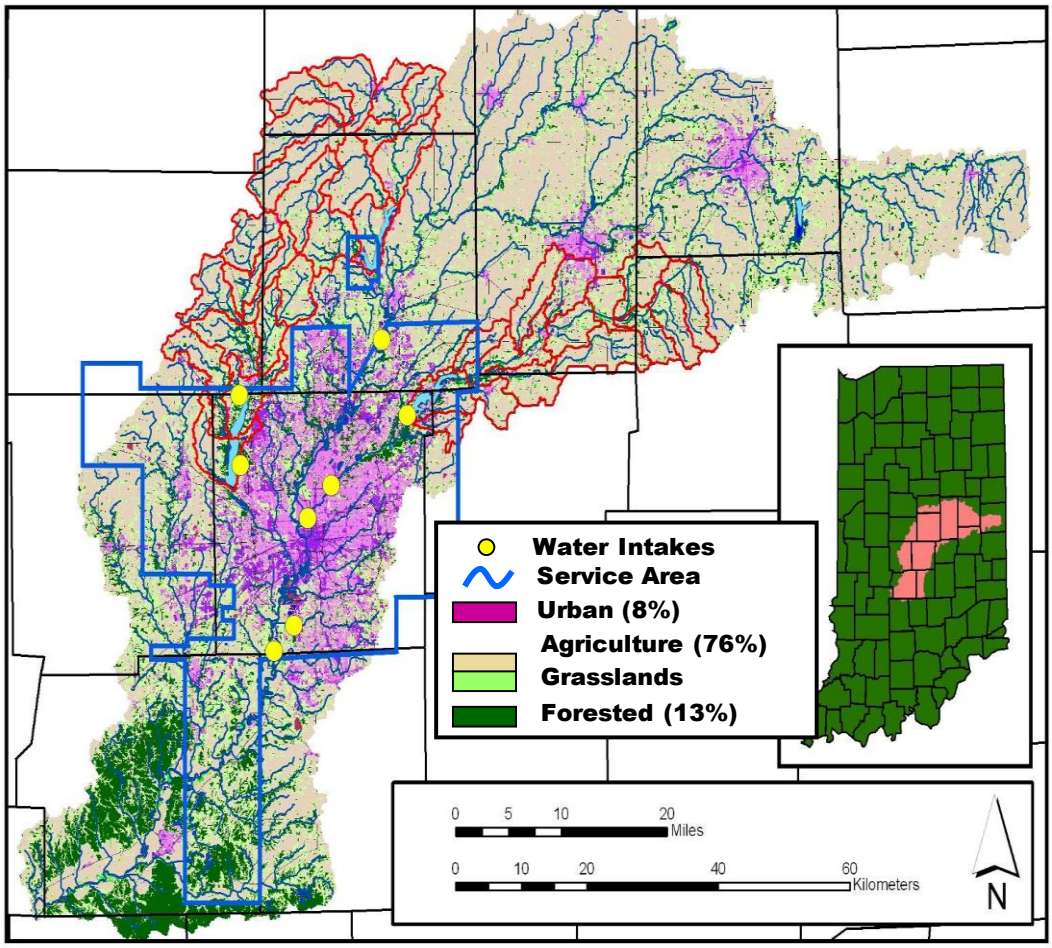
2. WATER SUPPLY AND DEMAND

The need to develop a Drought Management Plan and the mitigation steps included in the plan are largely driven by the overall water supply and demand profile of the utility. Some water supplies can be considered drought-proof for practical purposes due to their large size relative to the demand. However, this is far from the case for Indianapolis and Central Indiana in general. Indianapolis is located at the upper end of the White River watershed and taps several relatively small water resources to satisfy the demand of the growing Indianapolis area. A map of the watershed and corresponding land uses is provided as Figure 2-1.

Water Supply Availability

Current water resources available to Citizens Water fall into four categories: Natural river streamflows, surface water storage in water supply reservoirs, ground water resources, and purchased water resources. Supply management consists of balancing these resources to ensure that supply is available at all times. Essentially, the management strategy is to conserve storage resources during periods of adequate natural streamflows as much as possible to ensure that the storage is available during dry periods when natural streamflows are not sufficient to satisfy system demands. Conservation of reservoir storage volumes is important because if natural streamflows do not recover before storage is depleted, it is likely that more serious water use restrictions and curtailments will be necessary than if actions are taken earlier.

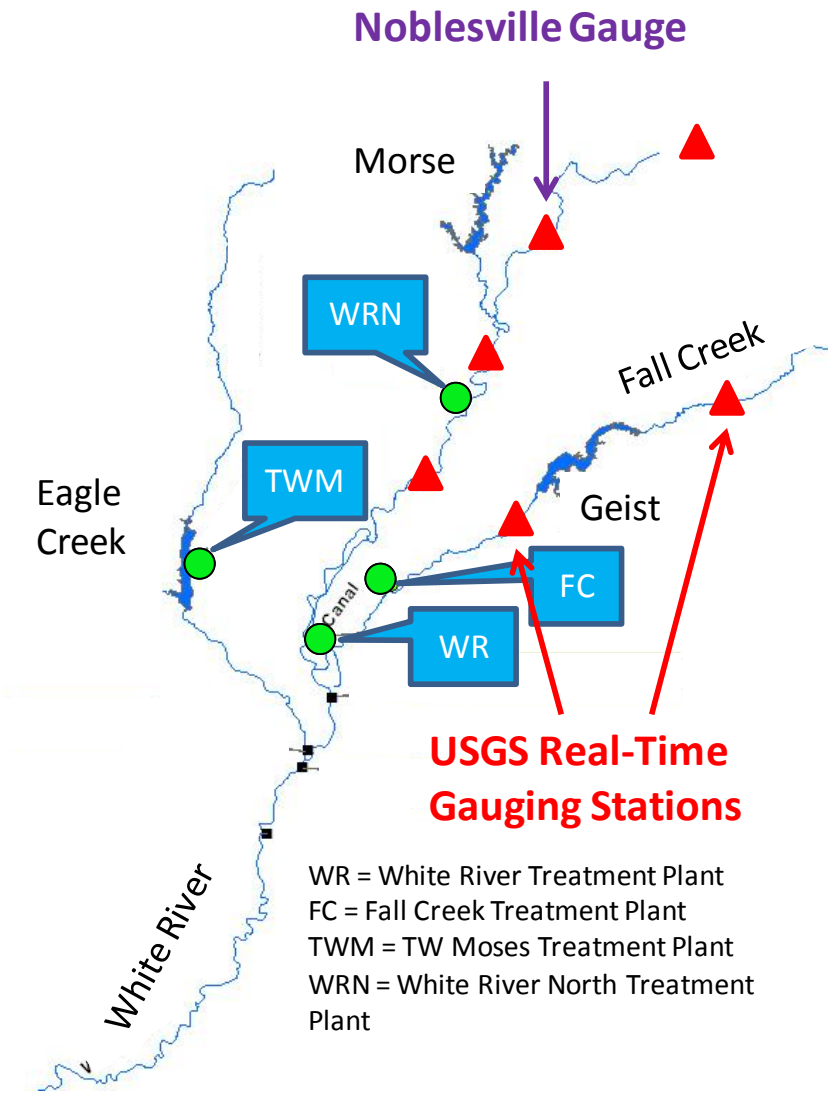
Figure 2-1: White River Watershed Land Use Map



Source: Center for Earth and Environmental Science, IUPUI

Approximately 60% of the water supply for Citizens Water originates from the White River system. This includes water treated at the White River treatment plant in the center of Indianapolis and the White River North treatment plant in Carmel as shown in Figure 2-2. During the majority of the year, the natural streamflow in the White River is sufficient to meet the production demands placed on the two White River treatment plants. However, as streamflows decline during summer months and demands increase, streamflows commonly reduce to levels below those needed to meet customer demands while maintaining downstream flows sufficient for ecological health of the stream. During these periods, water is released from Morse Reservoir to supplement flow in the White River, ensuring that adequate flow is available at the downstream treatment facilities to meet customer demand.

Figure 2-2: Surface Water Supplies and Treatment Facilities

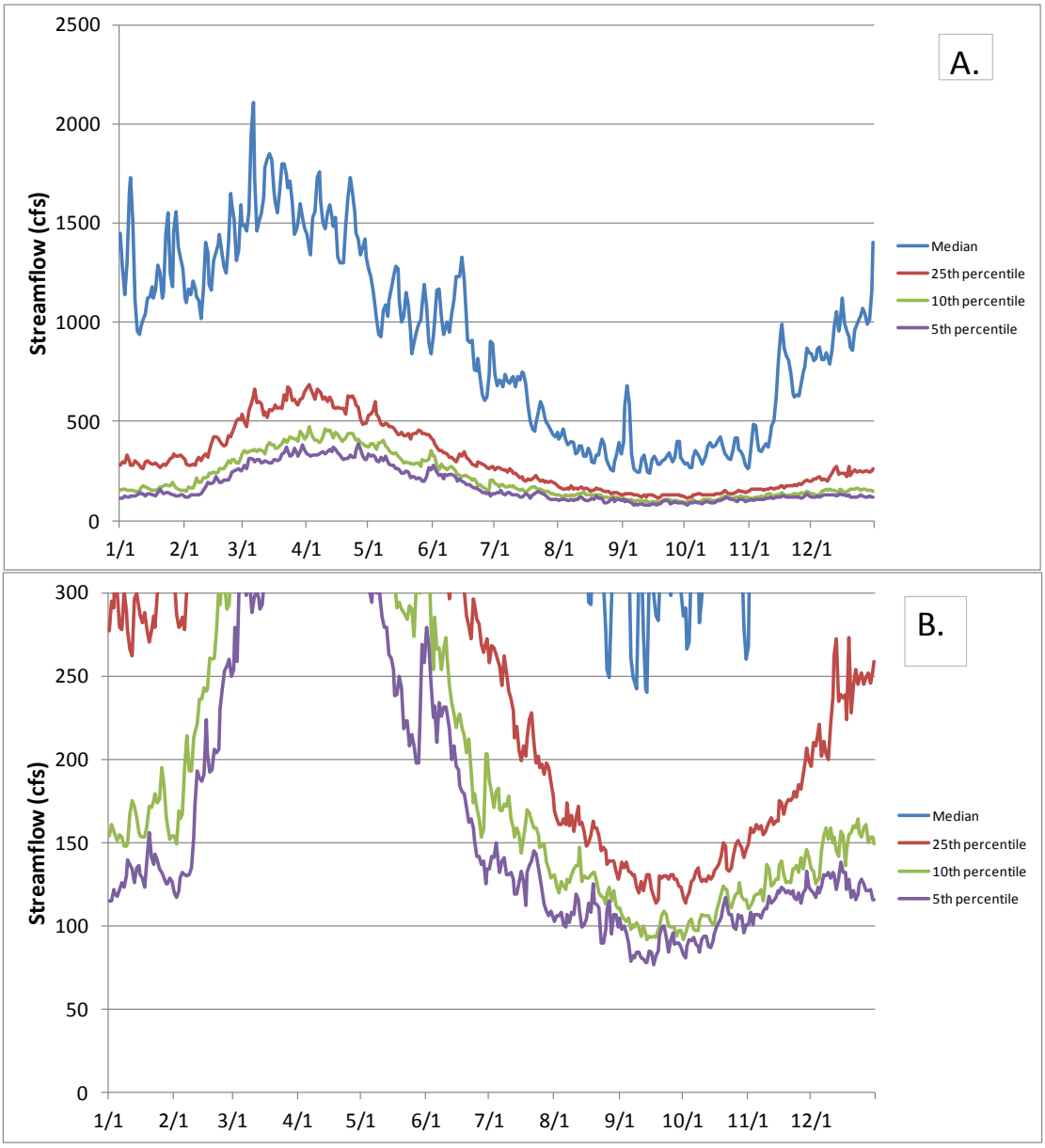


The USGS maintains several streamflow gauging stations along the White River, some of which are funded by Citizens Energy Group. Real-time data from these gauges are used by Citizens to manage releases from Morse Reservoir and balance the water supply availability with customer demands. The stream gauge at Noblesville is also useful for planning purposes as this gauge represents the White River flow prior to any impact from water releases from Morse Reservoir, and therefore represents the natural streamflow entering the area. The water supply system for Indianapolis has been developed over the years based on the natural flow patterns of the White River. Flows in the White River are typically relatively high in the winter and spring, with much lower flows in the summer and fall. The basis for construction of Morse Reservoir was to provide a water source to supplement the White River during the period of time when river flows can be low.

While the Indianapolis water supply system was developed to account for these seasonal fluctuations, deviations from the normal pattern can cause water supply challenges.

Extreme high flow conditions are the basis for flood control design and planning. Extreme low flow conditions can pose water supply challenges and are relevant in drought planning. For locations with a long historical record of flow data, the extreme low flow conditions can be illustrated by evaluating the flow percentiles over the recorded period. Figure 2-3A and 2-3B illustrate the median, 25th percentile, 10th percentile and 5th percentile flows in the White River at Noblesville over the course of the year based on 66 years worth of recorded data. The two figures contain the same data, but the scales are different to illustrate the annual trends (Figure 2-3A) and the low flow levels (Figure 2-3B).

Figure 2-3: White River Streamflow at Noblesville, IN
Basis: USGS Gauge 03349000; 66 years of data (1946 – 2012)



The need to supplement flow in the White River with releases from Morse Reservoir typically occurs when the Noblesville streamflow decreases to a flow between 160 and 200 cubic feet per second (cfs), depending on demand patterns. As illustrated in Figure 2-3A, median flows remain above these values for the entire year. However, 25th percentile flow values decrease below 200 cfs for a period of approximately four months between July and December. However, during drought periods (as represented by the 10th and 5th percentile curves) this time period can be extended and the magnitude of the streamflow deficit can be increased. An increased streamflow deficit requires increased daily releases from Morse Reservoir to make up the supply-demand gap. The finite ability for Morse Reservoir storage to supplement this supply-demand gap and the high percentage of the Citizens Water supply that is dependent upon it makes the White River system the most critical supply system during drought conditions.

Fall Creek and Geist Reservoir provide 15% of the water supply for the Citizens Water system via the Fall Creek treatment plant. Geist Reservoir is an in-line reservoir on Fall Creek. During wet periods when Geist Reservoir is full, flow from Fall Creek enters the headwaters of Geist Reservoir, passes through the reservoir, and flows over the spillway at the dam. During dry periods, inflows decline and the water level in the reservoir can drop below the spillway level. When this occurs, a release valve in the Geist Reservoir dam must be opened in order to prevent the streamflow below the dam from dropping to zero.

The final surface water supply to the Citizens Water system is Eagle Creek Reservoir. While Morse and Geist reservoirs are owned by Citizens, Eagle Creek Reservoir is owned by the City of Indianapolis and was originally constructed primarily for flood control. Citizens withdraws water from this reservoir under a contract with the City of Indianapolis and treats this water at the T.W. Moses water treatment plant. The contract contains stipulations for maximum average withdrawal rates based on the calculated sustainable yield of the reservoir. Withdrawals from Eagle Creek Reservoir typically amount to approximately 9% of the water supply for the Citizens Water system.

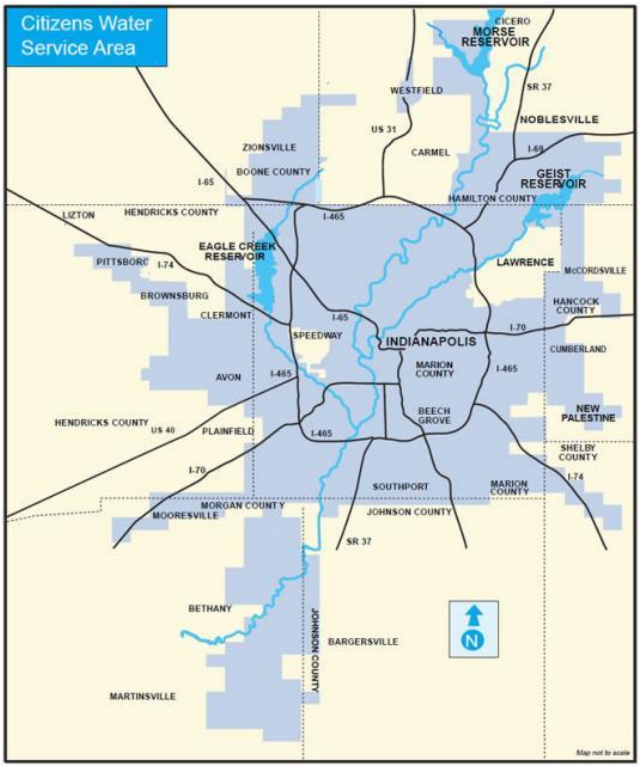
Groundwater resources available to the system include water from 7 well fields that account for approximately 12% of water supply for Citizens Water. These wellfields are located in relatively shallow sand and gravel aquifers along the various waterways, with typical screen depths in the range of 80 to 120 feet. Several of these wellfields are located along the White River, others along Fall Creek and one small wellfield exists along Eagle Creek. The aquifers are essentially river outwash aquifers that follow the river systems. Due to their relatively small size, these aquifers are susceptible to declining water levels during dry periods when recharge rates cannot support increased pumping rates.

Finally, Citizens obtains approximately 4% of its supply through purchased water agreements with neighboring communities. This includes the purchase of both finished water and raw water that Citizens then treats. In all cases the source for this purchased water is groundwater.

Water Demand

Citizens Water provides water service to most of Marion County and portions of Morgan, Hendricks, Boone, Hamilton, Hancock, Johnson, and Shelby Counties, as shown in Figure 2-4. This represents a large majority of the water service to the entire Indianapolis metropolitan area as well as some of the surrounding rural areas. Assurance of water supply is critical for economic development and quality of life needs of the area.

Figure 2-4: Citizens Water Service Area



Customer demands for water vary seasonally during the year. These demands can be divided into two classifications: baseload demands primarily associated with indoor water use; and seasonal demands primarily associated with lawn irrigation but also including other outdoor uses such as car washing and the filling and maintenance of swimming pools.

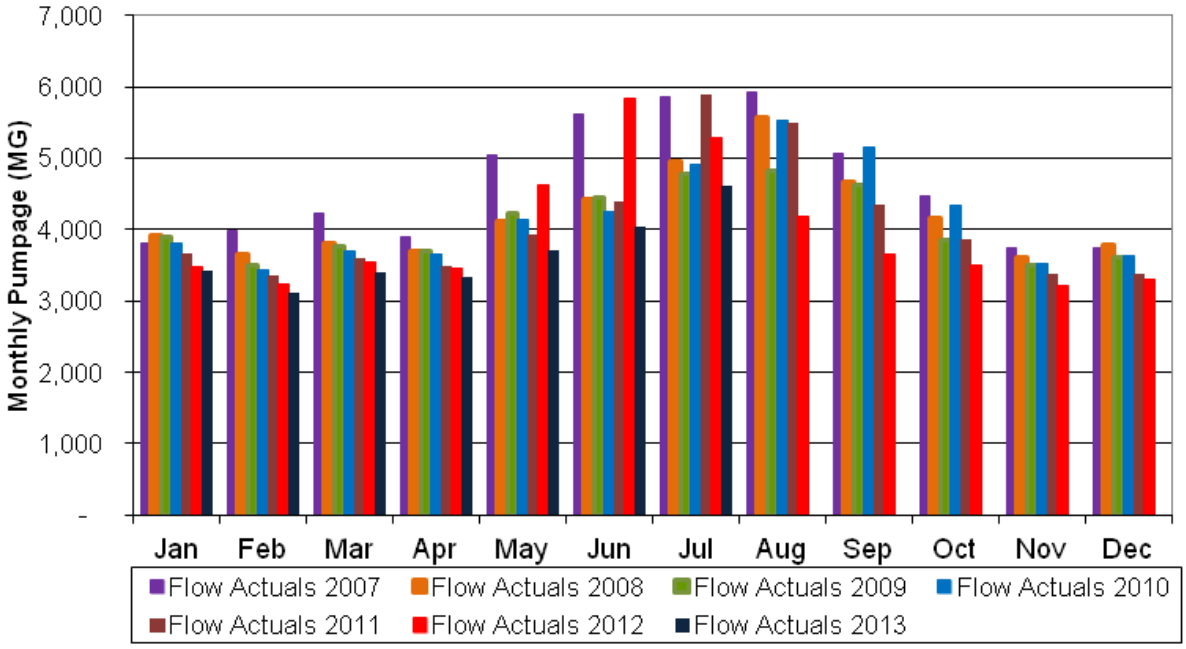
Baseload demands typically follow fairly stable trends. These trends vary from year to year, but are fairly stable on a day to day basis. Changes in the average baseload from year to year represent a composite of economic and demographic trends, and water conservation trends in water-using appliances and in customer behavior.

Seasonal demands can vary significantly from year to year and even week to week or day-to-day within an irrigation season. These demands are highly dependent on weather

conditions, with demands increasing significantly during extended periods of hot and dry weather.

The variability in customer demands are illustrated by the monthly pumpage volumes provided in Figure 2-5. The baseload demand for the Citizens Water system has exhibited a declining trend in recent years, as indicated by the monthly production trends during the cooler weather months of January through April and November and December. For many years prior to 2007, Indianapolis experienced a fairly consistent trend of increasing baseload water demand typical of system growth. The decline in baseload demand in Indianapolis in recent years is consistent with demand patterns observed in cities throughout the U.S. Much of this decline has been attributed to a decline in indoor water use on a per household and a per capita basis due to increased market penetration of water efficient toilets and appliances (Deoreo and Mayer, 2012). Additional factors impacting baseload demands in Indianapolis include the transfer of Citizens Water customers in Carmel to the Carmel water system per earlier agreements and a declining trend by some wholesale water customers.

Figure 2-5: Monthly Pumpage: 2007 - 2013



While baseload demands, represented by demand patterns during cooler weather months, are shown to follow fairly stable trends, the same cannot be said for demand trends during warm weather months. The pumpage volumes during May through September are shown to vary significantly and somewhat randomly from year-to-year. Prior to the issuance of an outdoor lawn watering ban in July of 2012, pumpage volumes were on a pace to exceed 6,500 million gallons (MG) for the month.

The weather patterns that result in high customer water demands typically correspond to patterns that can result in shortages in water supply availability—both are driven by a lack of rainfall. For this reason, it is particularly important to monitor for early indicators of drought development since customer demands are typically increasing at the same time that supply limitations are developing.

3. DEVELOPMENT OF WATER SHORTAGE TIERS

Prior to the drought of 2012, Citizens Water developed a four tier approach for tracking drought severity and managing response as part of its Drought Management Guidelines that were posted on the Citizens Water website. These tiers were developed to provide a framework for elevating response actions as drought conditions increased in severity. The four tier levels proved to be very effective in assisting with drought management and communicating to the public.

The specific trigger levels and response actions associated with the tier level used in 2012 have been updated and refined herein based on lessons learned from the 2012 drought and based on more detailed analysis of water supply and demand relationships. However, the basic tier levels remain unchanged. The tier levels are:

- No Shortage
- Tier 1 – Water Shortage Watch
- Tier 2 – Water Shortage Alert
- Tier 3 – Water Shortage Warning
- Tier 4 – Water Shortage Emergency

These tier levels will be discussed in relation to trigger levels and response actions in the following sections.

4. DROUGHT INDICATORS AND TRIGGER LEVELS

The establishment of specific water supply shortage conditions that will trigger specific mitigating actions is a critical aspect of drought management planning. Trigger levels should be designed to allow adequate time to make necessary operational and/or demand management adjustments to ensure that available resources will be sufficient to meet modified demand levels should the drought conditions continue. With this objective, Citizens has identified key indicators for tracking the onset and progress of drought conditions. These indicators include drought monitoring data compiled by various federal and state agencies, as well as specific parameters associated with the Citizen Water supplies. Finally, in collaboration with the Citizens Service Advisory Board and their consultant, Citizens has developed a water supply deficit forecasting tool for the White River System.

Specific trigger conditions for designation of the water shortage tiers have been developed based on the drought indicators. Due to the complexity of the Citizens Water supply system and its dependence on streamflows, reservoir volumes, groundwater levels, and customer demands, trigger levels have been established for each of these indicators:

- US Drought Monitor
- White River Streamflow at Noblesville
- Morse and Geist Reservoir Levels
- Groundwater Levels
- Water Deficit Forecast Tool
- System Pressure Maintenance Risk

The indices and associated trigger levels provide measurable metrics to monitor drought status. Typically declining streamflows will be an early indication of the onset of drought conditions, with declining reservoir levels being a later indication of worsening conditions. However, because of the complexity of the water supply system, no single metric can capture the entire water supply picture. For this reason, Citizens will use a triggering condition with one metric as a prompt to review the status of all trigger metrics and make a determination on whether to make a change to the current drought tier status. These indicators and trigger levels are described in the following paragraphs.

US Drought Monitor

The US Drought Monitor is a conglomeration and blending of numeric measures of drought and the best judgments of national experts into a single map of national drought conditions that is updated weekly. The monitor can found at droughtmonitor.unl.edu. It is produced in partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. An example of the U.S. Drought Monitor map for Indiana is provided in Figure 4-1.

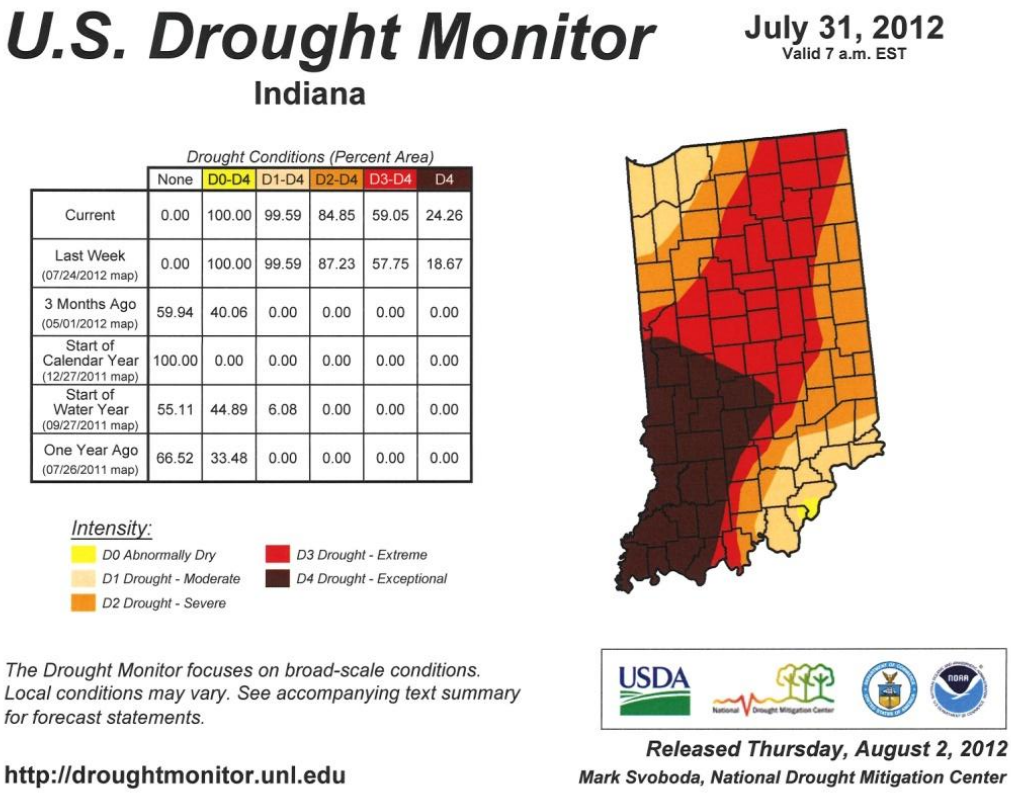
U.S. Drought monitor conditions are most helpful in early stages of drought response and can be helpful in supporting communication messaging to the public. Citizens has identified the US Drought Monitor designations of drought status in Central Indiana as a trigger event for considering modification of the drought tier status as follows:

- Tier 1, Water Shortage Watch: U.S. Drought Monitor designation of D1: moderate drought.
- Tier 2, Water Shortage Alert: U.S. Drought Monitor designation of D2: severe drought.

The US Drought Monitor is not used as a trigger for higher tier designations as these are driven by specific water supply conditions associated with the drinking water supply system. However, the US Drought Monitor status can still be used as an aid in

communicating drought severity and the needs for conservation to the general public and stakeholders.

Figure 4-1: U.S. Drought Monitor Map for Indiana
Map courtesy of NDMC-UNL



White River Streamflow at Noblesville

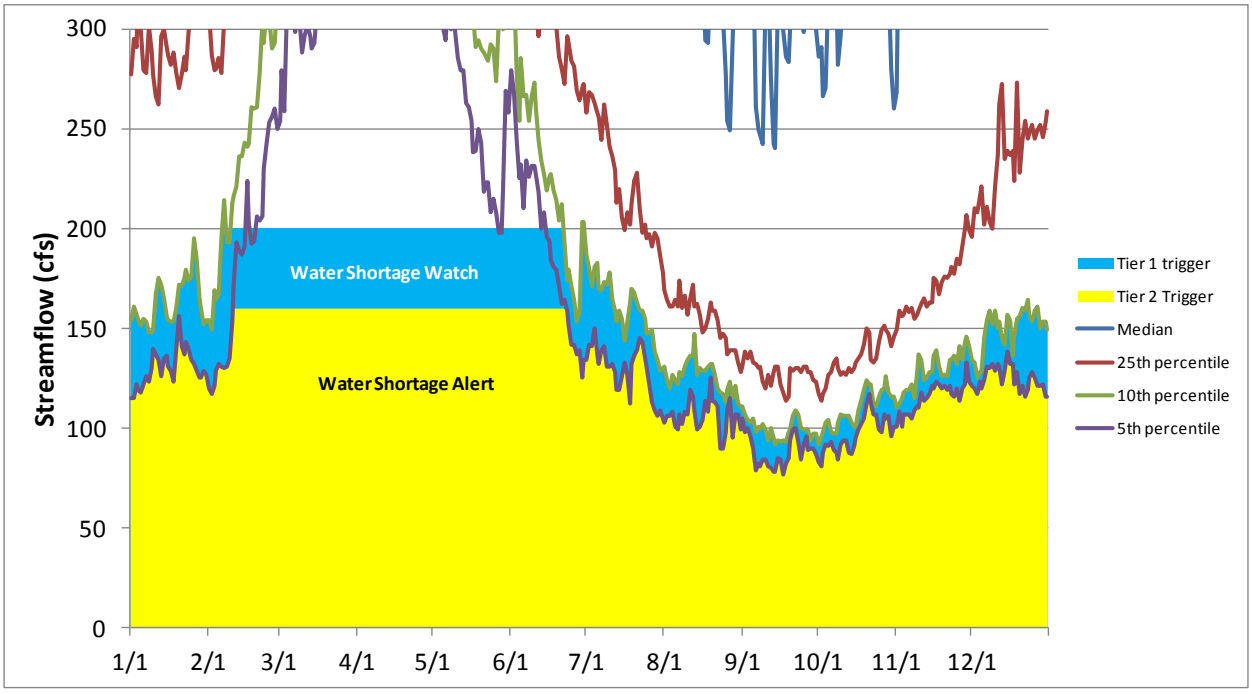
The USGS gauging stations on the White River near Noblesville provides an excellent indication of water supply conditions in the entire White River watershed prior to any flow augmentation from Morse Reservoir releases. Typical streamflow values are illustrated in Figure 2-3 in Section 2 of this plan. During the low flow months for June through December, a decline in streamflows to 10th percentile and 5th percentile values are indicative of streamflow conditions that may pose water supply challenges, as these values will likely require large releases from Morse Reservoir if stream conditions do not recover. The White River streamflow value at Noblesville provides an earlier indication of potential water supply challenges than reservoir levels because declining streamflows can be monitored prior to the need to release water from Morse Reservoir to meet supply needs.

Citizens has identified the following trigger conditions associated with streamflows at Noblesville:

- Tier 1, Water Shortage Watch: White River Stream flow at Noblesville less than 200cfs and less than 10th percentile flow for the day of year.
- Tier 2, Water Shortage Alert: White River Stream flow at Noblesville less than 160 cfs and less than 5th percentile flow for the day of year.

Streamflows representing these trigger conditions are illustrated in Figure 4-2.

Figure 4-2: White River Streamflow at Noblesville Trigger Conditions



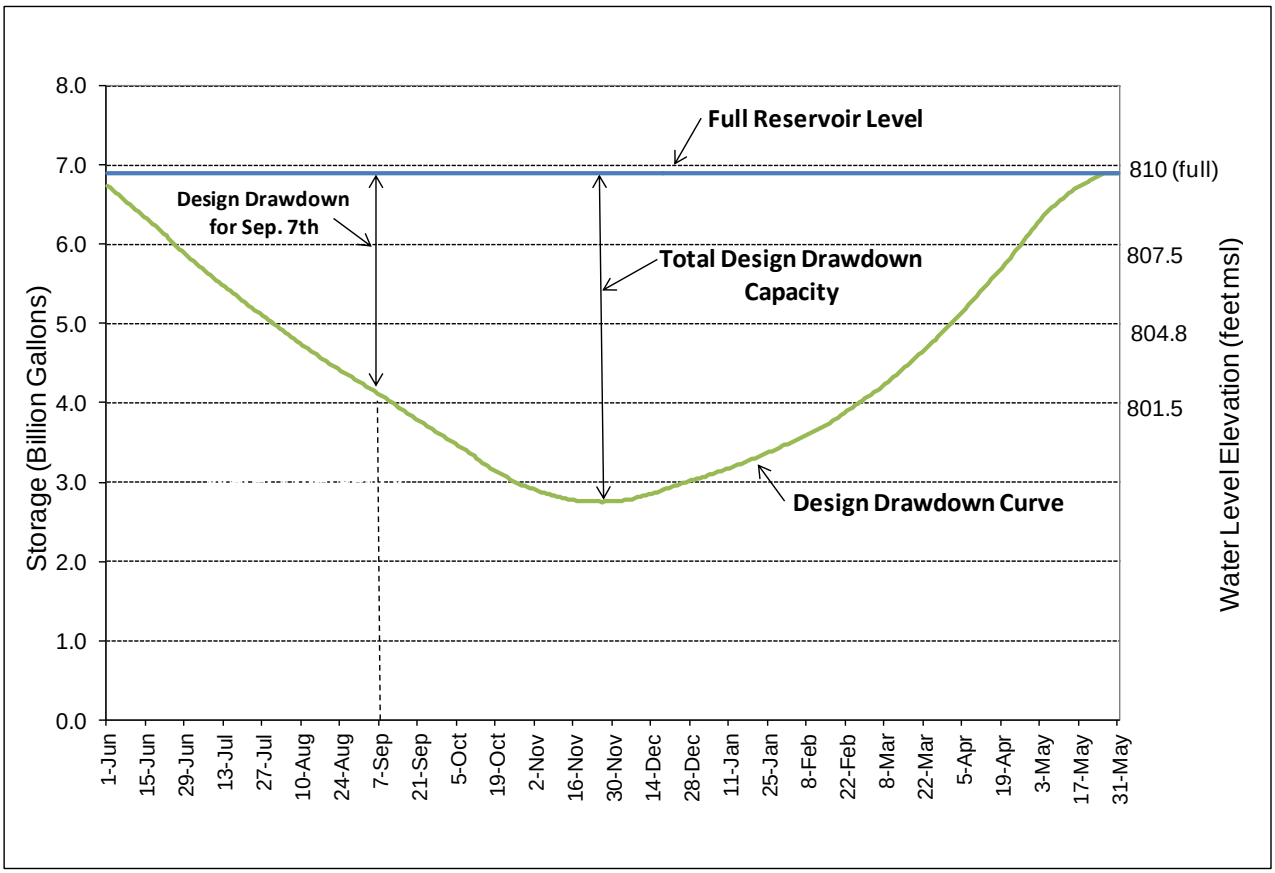
Morse and Geist Reservoir Levels

Morse and Geist Reservoir were constructed as water supply reservoirs. The primary usage of these reservoirs was to supplement streamflows during dry weather periods when natural streamflows were less than the supply needs for Indianapolis. Given that these reservoirs contain a finite volume of water, operational procedures are designed to conserve these resources controlling outlet valve to release the minimum volumes necessary to ensure adequate supply is available at downstream treatment facilities.

Based on normal streamflow levels and typical demands, drought design drawdown curves were developed for each reservoir. The design drawdown curve for Morse Reservoir is provided in Figure 4-3. This curve provides an operational guideline for the reservoir level that can be expected under a significant drought condition with a high likelihood that the reservoir will fully recover in volume before the end of the season. If the reservoir level is below the design drawdown curve, the stored water volume available

is less than the operational design level and the reservoir supply is at increased risk to being depleted. The curves do not represent an absolute limit in capacity, but do provide a basis for monitoring the criticality of water supplies and the need to take mitigating actions to conserve supplies.

Figure 4-3: Morse Reservoir Design Drawdown Curve



Citizens has used the design drawdown curves as a basis for evaluating trigger conditions for all four drought tier levels. These trigger conditions are described below and provided graphically for Morse and Geist reservoirs in Figures 4-4 and 4-5, respectively.

- Tier 1, Water Shortage Watch: Reservoir Level below design drawdown curve for the date but above 75% above the total design drawdown capacity.
- Tier 2,Water Shortage Alert: Reservoir Level below lower of:
  - 75% above the total design drawdown capacity, or
  - 50% above the design drawdown capacity for the date.
- Tier 3, Water Shortage Warning: Reservoir level below lower of:
  - 50% above the total design drawdown capacity, or
  - 25% above the design drawdown capacity for the date.

- Tier 4, Water Shortage Emergency: Reservoir level below lower of:
  - 25% above the total design drawdown capacity, or
  - Design drawdown capacity for the date.

Figure 4-4: Morse Reservoir Water Level Trigger Conditions

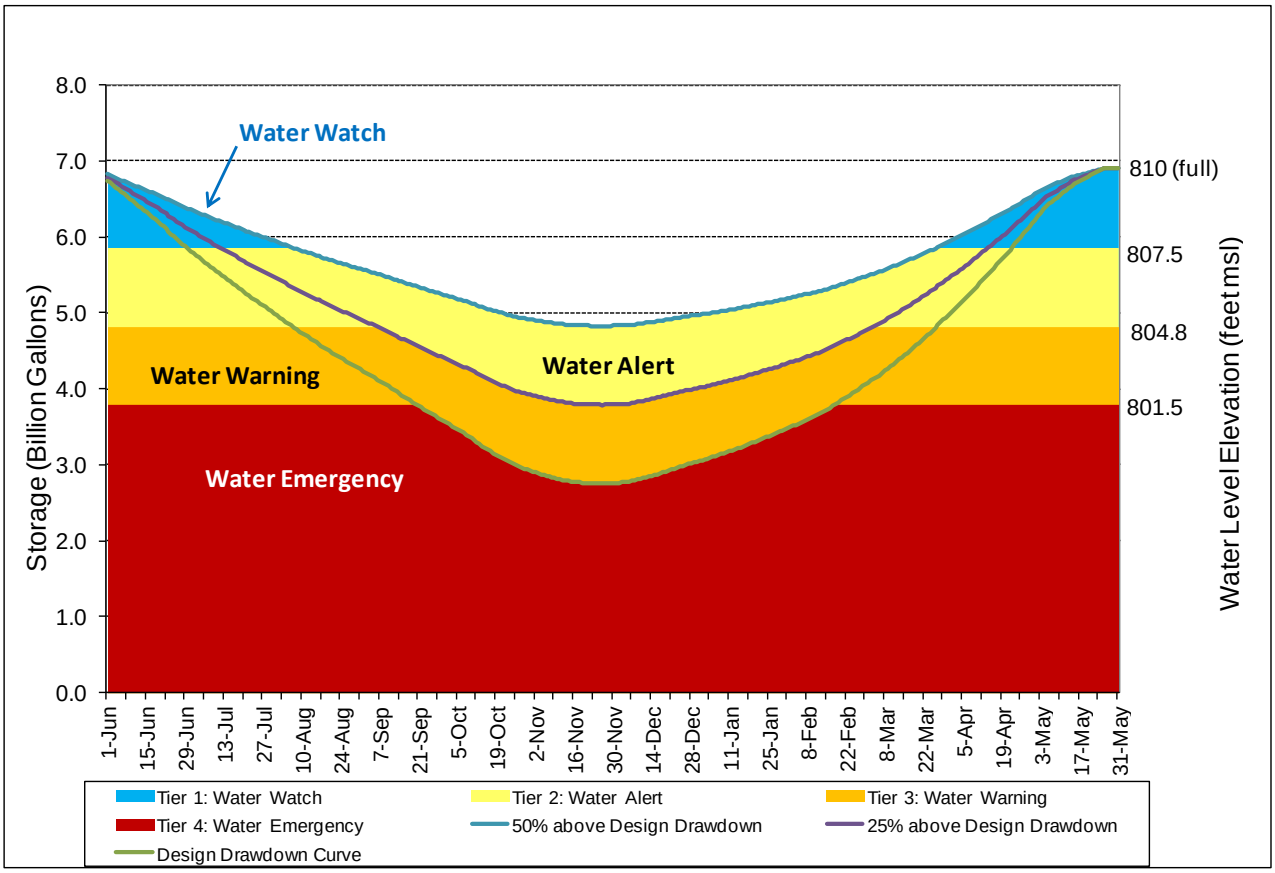
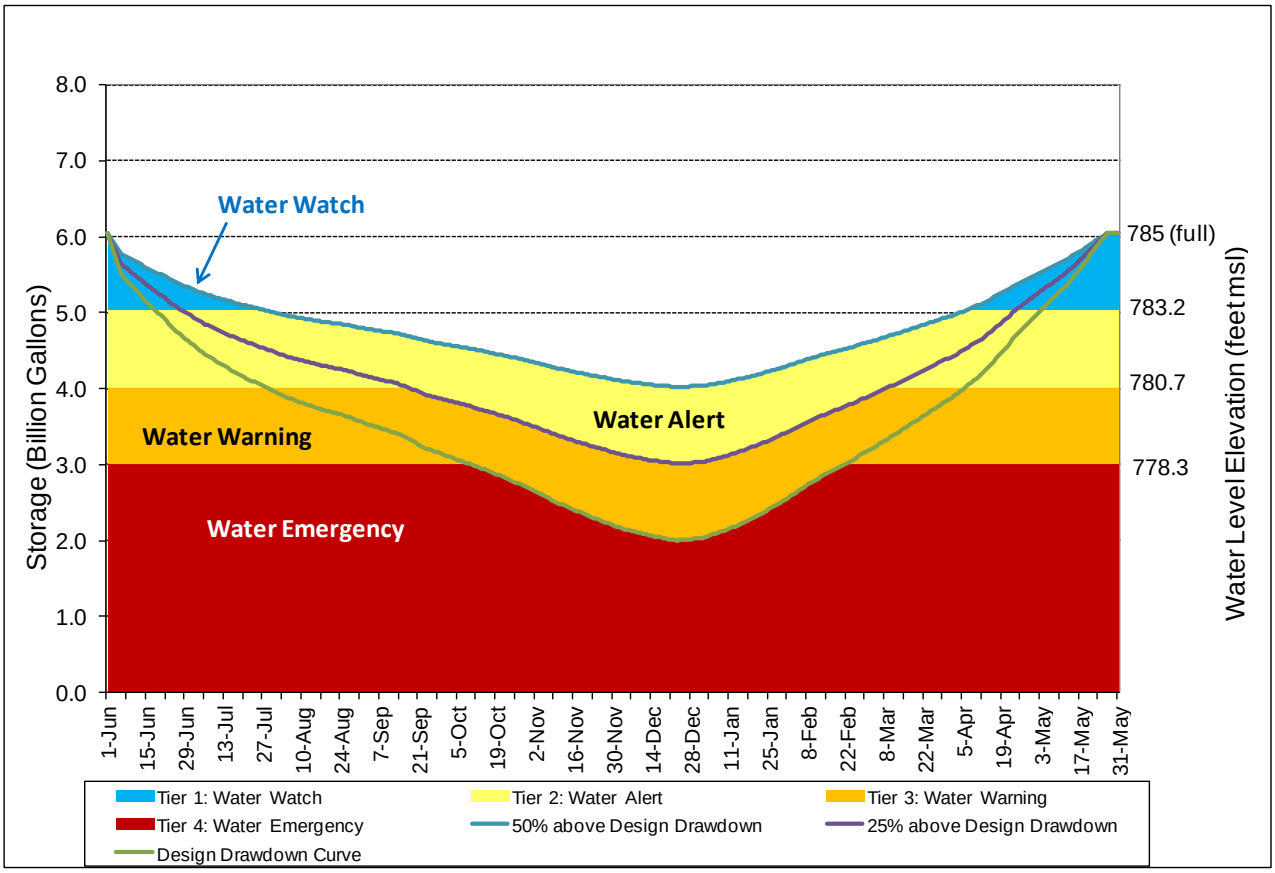


Figure 4-5: Geist Reservoir Water Level Trigger Conditions



Groundwater Levels

Groundwater resources in Central Indiana primarily consist of aquifers located in the sand and gravel outwash of streambeds. The primary groundwater well fields operated by Citizens are located along the White River from 146th Street in the north to Waverly, Indiana in the south, and along Fall Creek near Geist Reservoir and near the State Fair Grounds. These resources are unconfined aquifers with relatively shallow depths typically in the range of 100 to 140 feet. As with a surface water reservoir, aquifers are essentially water storage resources. If pumping is greater than recharge rates, water levels in the aquifer will drop. During extended drought conditions, typically demands for pumping increase while recharge rates decrease, resulting in a draining of the aquifer storage. The net effect is that over pumping during dry periods can result in decreased supplies available in the future until adequate recharge has occurred to replenish water levels.

Another complicating factor in managing groundwater levels is that these levels are impacted not only by wells operated by Citizens, but also by wells in the area that are operated by other utilities, businesses, or individuals. This is particularly evident in the

River Road area along the White River where Citizens, Westfield, and Carmel all have wells, and several gravel pit operations exist that also dewater areas at times.

Due to the variability of specific conditions in the various wellfields operated by Citizens, the trigger levels established are based on general impacts of lower water levels on water production wells. These trigger levels are outlined below:

- Tier 1, Water Shortage Watch: Groundwater levels approaching critical operating levels of some water production wells, resulting in the need to limit withdrawal capacities of individual wells to conserve resources.
- Tier 2, Water Shortage Alert: Groundwater levels approaching critical operating levels of several water production wells, resulting in the need to limit withdrawal capacities from some wellfields to conserve resources.
- Tier 3, Water Shortage Warning: Groundwater levels below critical operating levels of some water production wells, resulting in restricted withdrawal capacities from some individual wells.
- Tier 4, Water Shortage Emergency: Groundwater levels below critical operating levels of several water production wells, resulting in restricted withdrawal capacities from some wellfields.

Water Deficit Forecast Tool

The Water Deficit Forecast Tool was developed through a collaborative effort between the Citizens Service Advisory Board, their consultant, and Citizens Water. The tool development was based on an extensive analysis of streamflow data for the White River, with specific emphasis on the Noblesville gauging station. The data analysis was conducted to evaluate potential statistical or probabilistic trends that could be used to forecast the deficit in supply that would be expected in the White River by the end of summer from trends observed in spring and early summer. White River flow deficit is a significant concept in that this provides an indication of the flow supplementation that would be required from Morse Reservoir to satisfy customer demands on this resource.

The analysis included data from the White River Noblesville gauge from 1930 through 2012, an 83 year record. Correlating data from this gauge is meaningful because the streamflow at Noblesville provides an indication of soil moisture conditions and drainage in the entire watershed above Noblesville. Higher flows at Noblesville in the spring and early summer are generally an indication that levels are not likely to decrease to extremely low levels for long periods during the summer months. Conversely, low streamflow levels in the spring and early summer are indicative of a higher risk of sustained low flows throughout the summer.

The tool works by tracking the progress of two parameters daily: the cumulative Noblesville streamflow for the year, and the cumulative deficit in streamflow based on an assumed daily flow need of 120 MGD. Depending on the time and year and the value of these parameters, these data are compared to probability prediction curves or deficit correlation curves to forecast the expected cumulative deficit that will occur on August

31st of the year. August 31st is relevant in that this is the general time frame when customer demands typically begin to decrease.

The total volume of Morse Reservoir is approximately 7 billion gallons (BG). However, the design drawdown curve is based on a maximum drawdown of approximately 4 BG. Therefore, forecast deficits greater than 3 or 4 BG provide an indication that there is a potential for heavy drawdown of Morse Reservoir and potential supply limitations in the future. Using this guide, the following triggers were established for use with this forecasting tool:

- Tier 1, Water Shortage Watch: White River flow deficit forecast of greater than 2 BG using 50% non-exceedence curve and deficit correlation curves.
- Tier 2, Water Shortage Alert: White River flow deficit forecast of greater than 3 BG using 50% non-exceedence curve and deficit correlation curves.
- Tier 3, Water Shortage Warning: White River flow deficit forecast of greater than 4 BG using 50% non-exceedence curve and deficit correlation curves.

As this tool is a statistically based tool using the past 83 years of data, it provides a good basis for forecasting, but it ultimately is only valid if future years follow patterns observed in the 82 years evaluated. Nevertheless, it is expected to be a valuable tool in providing some quantitative guidance on expected potential severity of a water supply shortage.

System Pressure Maintenance Risk

The maintenance of system pressure is extremely critical in operation of drinking water system. Positive pressure is required to provide fire protection services and is needed to ensure confidence in water quality. Maintenance of appropriate system pressures is a daily operational task for water system operators and managers. While this is an extremely important operating parameter, system operators only have direct control of one half of the pressure equation: the volume of water pumped into the distribution network. The other half of the pressure equation is based on customer usage. Essentially maintaining system pressure entails balancing the flow pumped into the distribution network with the usage by customers. Elevated tanks in the network help to buffer differences that occur throughout the day, but these differences ultimately need to balance out or the elevated tanks will either spill over or run dry, resulting in a loss of system pressure.

Drought conditions can cause risks to maintaining system pressure if supply resources for treatment drop below customer demands. In addition, customer demands can increase to levels that approach infrastructure capabilities during dry weather conditions. Infrastructure limitations can have a similar result as inadequate supply. If customer demands exceed the capacity to treat and distribute water, system pressures can drop. In addition, critical infrastructure failures, such as the 1993 canal breach or a critical transmission main failure can cause system pressure risks for large areas of the Citizens Water system.

The number of possible scenarios that could result in heightened system pressure risk is impossible to quantify. Citizens has therefore developed the following general guidelines as trigger levels related to maintenance of system pressure.

- Tier 1, Water Shortage Watch: Water supply or delivery limitation resulting in expectation that continuing demand increases will limit ability to maintain distribution pressures at levels required to provide adequate fire protection and public safety.
- Tier 2, Water Shortage Alert: Water supply or delivery limitation resulting in inability to maintain distribution pressures at levels required to provide adequate fire protection and public safety.
- Tier 3, Water Shortage Warning: Other water supply warning condition that limits ability to supply volumes required to meet customer demand and that jeopardizes fire protection or public safety.

5. DROUGHT RESPONSE ACTIONS

Drought response actions include a combination of supply management contingencies and customer demand management measures. Supply management contingencies typically consist of actions internal to Citizens operations and capital programs to optimize the supply available to meet customer demands. Customer demand management consists of voluntary conservation requests and mandatory water use restrictions aimed at limiting water use while minimizing adverse impacts on quality of life and the economy.

Supply Management

Supplies are managed on a daily basis to conserve supplies where possible so that Citizens is in the best position possible in the event of the start of a drought. Normal daily supply management consists of the following:

- Maintaining reservoir release valves closed except when supplemental supplies are needed to conserve storage volumes in Morse and Geist Reservoirs.
- Reduction in groundwater pumpage during periods of high surface water flow and no other needs for groundwater blending (such as for water quality benefits or water temperature benefits for the prevention of main breaks in the winter).
- Balancing of water supplies between production facilities as possible to distribute supply load in proportion to available resources

In addition to the daily supply management tasks described above, there are typically various additional supply contingencies that can be implemented. These contingencies may change year to year based on the status of various infrastructure and capital improvement projects. As an example, some of the contingencies implemented during the 2012 drought included the following:

- Expediting appropriate permits to allow dredging of surface water plant intake areas to increase functionality under very low river conditions.
- Contracting additional aquatic weed harvesting equipment and initiation of dredging in the canal to improve canal hydraulics.
- Expediting groundwater well maintenance work to increase well efficiency.
- Shifting load from the White River treatment plant to the Fall Creek treatment plant to reduce reliance on Morse Reservoir.
- Developing contingency plans for transferring water from Fall Creek to the White River treatment plant to better balance supply resources.
- Developing contingency plans for recovering water from inactive wells that were part of the former Harbour Water system in Noblesville for supply to the White River North surface water treatment plant.

These contingencies were developed by convening appropriate knowledgeable operations, engineering and environmental personnel to evaluate status of activities and projects that could be expedited or initiated. The options available in a different drought year would likely be different than those outlined above, depending on the particular situation and project status. Development of contingencies for a given year should begin at the first indications of a potential drought when a Tier 1 Water Shortage Watch is triggered.

Demand Management

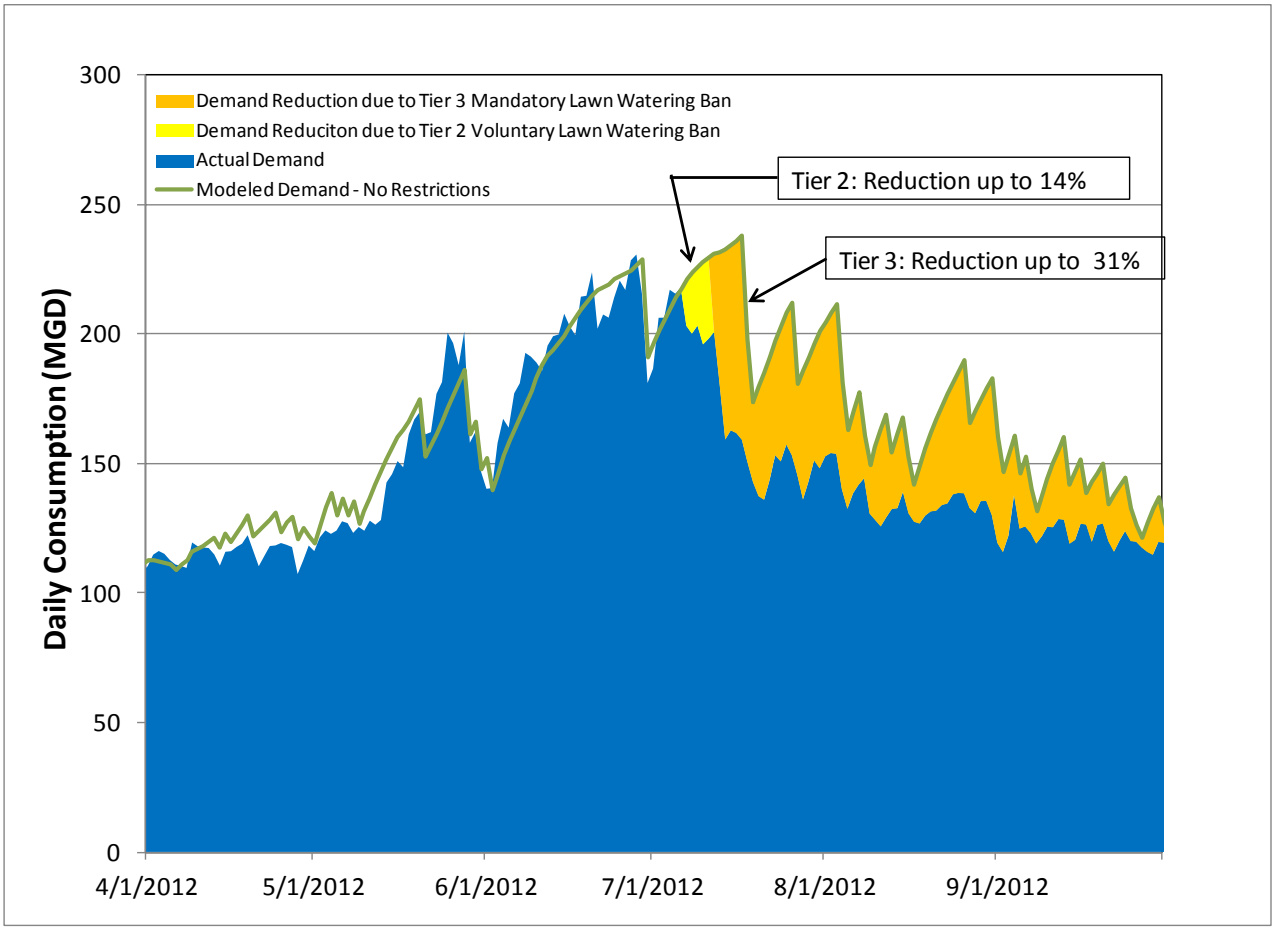
Demand management consists of a combination of voluntary requests and mandatory restrictions aimed at achieving certain levels of reduction in overall customer demands. Citizens has identified the following water reduction goals associated with the four water shortage tiers:

Tier 1, Water Shortage Watch	5% reduction
Tier 2, Water Shortage Alert	15% reduction during irrigation months; 5% reduction during non-irrigation months
Tier 3, Water Shortage Warning	30% reduction during irrigation months; 10% reduction during non-irrigation months.
Tier 4, Water Shortage Emergency	40% reduction during irrigation months; 20% reduction during non-irrigation months.

The development and refinement of these goals was largely influenced by the lessons learned during the drought of 2012. It can be extremely difficult to predict the potential water demand reductions achievable without having some history in implementation of the steps. In 2012, various demand management strategies were implemented ranging from voluntary requests for conservation under Tier 1 to the mandatory lawn watering ban under Tier 3. The customer response and the steps implemented proved quite effective and in line with the goals provided above.

The demand reductions achieved in 2012 are illustrated in Figure 5-1. These reductions were determined by modeling the expected demand that would have occurred without issuing the Tier 2 voluntary lawn watering ban or the Tier 3 mandatory lawn watering ban.

Figure 5-1: Estimated 2012 Demand Reductions Realized by Drought Management Actions



The specific actions intended to achieve the demand reduction goals provided above are as follows:

- No shortage:
  - Normal water wise messaging per Water Conservation Plan
- Tier 1, Water Shortage Watch: Voluntary Reductions.
  - Communication and media requests for voluntary reduction in water use;
  - Requests to limit discretionary use including reduction in lawn watering to no more than two days per week, consistent with water wise use messaging.
- Tier 2, Water Shortage Alert: Mandatory restrictions and voluntary reductions.
  - Declaration of "Water Alert" per Marion County Water Conservation ordinance. Mandatory limit on lawn watering to 2 days per week. Odd addresses allowed to water on Mondays and Thursdays, even numbered

addresses allowed to water on Tuesdays and Fridays. No lawn watering allowed on Sundays, Wednesdays, or Saturdays.
    - Declaration must be acknowledged by Mayor's office to trigger enforcement through the City's Department of Code Enforcement.
    - Notification of declaration to communities outside of Marion County served by Citizens Water with recommendation for enactment of similar local restrictions.
    - Communication and media requests for customers to take voluntarily steps to reduce peak demand, including reductions in outdoor lawn watering;
    - Direct contact with large customers to request voluntary reductions particularly with any discretionary water use per Large Customer Voluntary Reduction measure in Water Conservation Plan
- Tier 3, Water Shortage Warning: Implementation of lawn watering ban.
    - Declaration of "Water Warning" per Marion County Water Conservation ordinance. Bans lawn irrigation, with certain exceptions such as watering of vegetable gardens.
    - Declaration must be acknowledged by Mayor's office to trigger enforcement through the City's Department of Code Enforcement.
    - Notification of declaration to communities outside of Marion County served by Citizens Water with recommendation for enactment of similar local restrictions.
    - Direct contact with large customers to emphasize needs for voluntary reductions particularly with any discretionary water use per Large Customer Voluntary Reduction measure in Water Conservation Plan
- Tier 4, Water Shortage Emergency: Implementation of additional restrictions.
    - Declaration of "Water Emergency" per Marion County Water Conservation ordinance. Bans outdoor water uses, including lawn irrigation, washing cars, and filling swimming pools, with certain exceptions such as watering of vegetable gardens.
    - Declaration must be acknowledged by Mayor's office to trigger enforcement through the City's Department of Code Enforcement.
    - Notification of declaration to communities outside of Marion County served by Citizens Water with recommendation for enactment of similar local restrictions.
    - Direct contact with large customers to explore potential emergency curtailment possibilities.

6. DROUGHT MANAGEMENT GUIDELINES

Effective communication with the public is extremely important in drought management if the targeted water-use reductions are to be achieved. While transparent and accurate information is required, it is also important to provide concise information that is easily understood. In an effort to achieve this goal, the water shortage tier levels, triggers and corresponding actions are summarized in the Drought Management Guidelines provided as Attachment A to this plan.

These guidelines provide a complete summary of the actions and triggers described in the previous sections. These guidelines may be updated periodically as deemed necessary to improve response and communication of these issues.

7. WATER SHORTAGE RESPONSE TEAM

The occurrence of significant water shortage events can be irregular and rare. As such, Citizens does not anticipate constant maintenance of a water shortage response team. However, the water supply and demand situation is constantly monitored by Water Production personnel and in the event that a trigger event is reached the Director of Production is responsible for notifying appropriate internal staff to coordinate response.

In the event of a significant water shortage, response team members will include representatives from the following departments:

- Water Production – overall monitoring of supply and demand situation; management of supply resources to optimize yield; management of pumping stations to distribute water as necessary
- Water Distribution – mitigation of water losses by rapid repair of main breaks
- Environmental Stewardship – coordination with environmental regulatory agencies on local, regional and statewide responses
- Corporate Communications – development of communication plans and messages; media relations
- Government Relations – coordination with governmental officials in all areas served by Citizens Water and at State level if necessary; coordination specifically associated with implementation of water restriction ordinances
- Customer Relations – Direct communication with large water users on conservation needs; managing the call center and responding to customer inquiries.
- Capital Programs and Engineering – Facilitation of projects to increase water supply yield.

The Director of Production or his/her designee will function as Team Leader and coordinate the response activities between the various functional areas. The Team Leader will be responsible for evaluating the various trigger conditions and making any change in the tier level designation. This determination will be made based on evaluation of the various trigger conditions specified in Section 4 of this plan and consideration of any unique issues pertinent to the situation at hand.

8. REVENUE IMPACTS

A severe drought, particularly one that continues into a second year, has the potential to have a dramatic impact on utility revenues. This decrease in revenue can come at a time when certain utility costs actually increase due to implementation of actions required in response to the drought conditions. To mitigate this impact of the revenue decrease on utility financial health, and to further encourage water use reductions during drought conditions, some utilities have established temporary rate surcharges that only apply in the event that a drought occurs. As an example, Denver Water has developed drought pricing principles that provide surcharges in proportion to the severity of drought (AWWA, 2011). No such surcharge capability is currently available in the Citizens Water rate structure, but should be considered as a potential future tool for both aiding in demand management during a severe drought and ensuring utility remains financially stable during extreme events.

9. CONCLUSIONS

This Drought Management Plan provides a detailed framework for Citizens Water to manage the supply and demand balance during drought or other water shortage conditions. The Plan provides a description of water supply triggers for the designation of four water shortage tier levels and actions to be taken at each tier level to mitigate supply shortfalls. In addition, the Plan provides demand reduction goals for each tier level and describes roles for Plan implementation. Enactment of this Plan is expected to allow Citizens Water to ensure delivery of vital water supplies while minimizing negative impacts to the economy and quality of life during drought conditions.

REFERENCE CITED

AWWA, 2011. Manual of Water Supply Practices M60. *Drought Preparedness and Response*. First edition. American Water Works Association, Denver, Colorado.

Deoreo, W.B. and Mayer, P.W., 2012. *Insights into Declining Single-Family Residential Water Demands*. Journal AWWA, 104:6:E383

ATTACHMENT A: Drought Management Guidelines

Water Shortage Levels and Triggers: A key component of water shortage response is the establishment of trigger levels for taking specific actions oriented at reducing system demands in order to conserve available resources. Citizens anticipates using the following trigger levels as guides for implementation of the corresponding demand management actions. Implementation of specific response actions will be based on review of all factors available at the time. Consecutive system wholesale customers will be notified of each tiered response action and requested to implement similar actions in their service territory.

No Shortage

Normal demand; continued general wise-water use messaging per Conservation Plan.

Tier 1 - Water Shortage Watch

Goal: 5% reduction in water demand.

External Actions: Voluntary Reductions. Communication and media requests for voluntary reduction in water use; particularly to limit discretionary use including reduction in lawn watering to no more than two days per week, consistent with wise-water use messaging.

Internal Actions: Formation of Water Shortage Response Team for internal communications and coordination. Evaluation of status of capital and maintenance projects that may influence water supply availability and evaluate possibilities to expedite. Evaluation of operational factors and implementation of any that could preserve water supplies.

Triggers:

- Water supply or delivery limitation resulting in expectation that continuing demand increases will limit ability to maintain distribution pressures at levels required to provide adequate fire protection and public safety.
- White River Stream flow at Noblesville less than 10th percentile flow for day of year and less than 200 cfs. (Figure 4-2 of Drought Management Plan)
- Volume of storage in Morse or Geist reservoir declines to below the design drawdown curve for the date but above 75% above total design drawdown capacity. (Figures 4-4 and 4-5 of Drought Management Plan)
- Groundwater levels approaching critical operating levels of some water production wells, resulting in the need to limit withdrawal capacities of individual wells to conserve resources.
- White River flow deficit forecast of greater than 2 BG.
- US Drought Monitor (sponsored by NOAA, USDA and others) indicates that Central Indiana is in a moderate drought.

Tier 2 - Water Shortage Alert

Goal: 15% reduction in demand during irrigation months; 5% reduction during non-irrigation months.

External Actions: Mandatory lawn watering restriction to 2 days per week and voluntary reductions. Communication and media requests for customers to take voluntarily steps to reduce peak demand, including halting outdoor lawn watering for a specific period of time.

Internal Actions: Implementation of any operational adjustments to improve water supply conditions. Coordination with Water Shortage Response Team and development of contingency plans for improving water supply availability based on the specific water supply situation. Coordination with local authorities related to implementation and enforcement of water conservation ordinances. Initiate communications with large water-use customers related to water conservation.

Triggers:

- Water supply or delivery limitation resulting in inability to maintain distribution pressures at levels required to provide adequate fire protection and public safety.

- White River Stream flow at Noblesville less than 5th percentile flow for day of year and less than 160 cfs. (Figure 4-2 of Drought Management Plan)
- Volume of storage in Morse or Geist reservoir declines to below the lower of 75% above the total design drawdown capacity or 50% above the design drawdown capacity for the date. (Figures 4-4 and 4-5 of Drought Management Plan)
- Groundwater levels approaching critical operating levels of several water production wells, resulting in the need to limit withdrawal capacities from some wellfields to conserve resources.
- White River flow deficit forecast of greater than 3 BG
- US Drought monitor indicates that Central Indiana is in a severe drought.

Tier 3 - Water Shortage Warning

Goal: 30% reduction in demand during irrigation months; 10% reduction during non-irrigation months.

External Actions: Mandatory restrictions via Water Conservation Ordinance. Bans lawn irrigation, with certain exceptions such as watering of vegetable gardens. Must be acknowledged by Mayor's office to trigger enforcement through the City's Department of Code Enforcement.

Internal Actions: Implementation of contingency plans to improve water supply conditions. Coordination with local authorities related to implementation and enforcement of water conservation ordinances. Increased coordination with large water-use customers related to water conservation.

Triggers:

- Volume of storage in Morse Reservoir or Geist Reservoir declines to below the lower of 50% above the total design drawdown capacity or 25% above the design drawdown capacity for the date. (Figures 4-4 and 4-5 of Drought Management Plan)
- Groundwater levels below critical operating levels of some water production wells, resulting in restricted withdrawal capacities from some individual wells.
- White River flow deficit forecast of greater than 4 BG.
- Other water supply warning condition that limits ability to supply volumes required to meet customer demands and that jeopardizes public safety or fire protection.

Tier 4 - Water Shortage Emergency

Goal: 40% reduction in demand during irrigation months; 20% reduction during non-irrigation months.

External Actions: Mandatory restrictions via Water Conservation Ordinance. Bans outdoor water uses, including lawn irrigation, washing cars, and filling swimming pools, with certain exceptions such as watering of vegetable gardens. Implement emergency actions to arrange for alternative supplies as necessary.

Internal Actions: Implementation of additional contingency plans to improve water supply conditions. Coordination with local authorities related to implementation and enforcement of water conservation ordinances and other potential emergency orders. Increased coordination with large water-use customers related to potential water rationing.

Triggers:

- Volume of storage in Morse Reservoir or Geist Reservoir declines to below the lower of 25% above the total design drawdown capacity or the design drawdown curve volume for the date. (Figures 4-4 and 4-5 of Drought Management Plan)
- Groundwater levels below critical operating levels of several water production wells, resulting in restricted withdrawal capacities from some wellfields.

Other water supply emergency condition that limits ability to supply volumes required to meet customer demands and that jeopardizes public safety or fire protection.