

# DROUGHT CONTINGENCY PLANNING IN ACTION

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**Abstract.** Much of the eastern United States experienced an intense drought in 1998 and again in 1999, as levels of precipitation were some of the lowest in over a century. The Delaware River Basin Commission, the state of Maryland, and the state of Pennsylvania were among those declaring a drought emergency. In Northern Virginia, conditions were extremely dry – precipitation recorded from July through December of 1998 was 13 inches below the normal of 20 inches. According to the Palmer Drought Severity Index, the regional drought was classified as “extreme,” the most serious category.

Reservoir supplies throughout the Mid-Atlantic region were negatively affected by this intense drought. Lake Manassas in Prince William County, Virginia, reached its lowest level, 8.6 feet below the spillway, in late December 1998. Fortunately, the City of Manassas was prepared to address the extreme conditions due to drought contingency planning that was initiated as part of a comprehensive water system optimization strategy.

Typical Lake Manassas operation includes a refill period beginning in November, when seasonal water demands begin to diminish. When reservoir levels continued to fall in November of 1998, the City initiated the first stages of public awareness and education. Intense monitoring of reservoir level and inflow by the City’s Department of Utilities was coupled with implementation of a number of measures to conserve the water in Lake Manassas. Due to regional cooperation with other large-volume water customers, the City was able to stabilize the previously rapid drop in lake level.

A Water Supply Advisory Task Force was created to assist with development and implementation of fair and equitable restrictions that would accompany more restrictive drought stages. Task Force members include community and industry representatives, City Council and administrative members, the Occoquan Watershed Monitoring Laboratory, and Department of Utilities. The Task Force will have an ongoing role in updating and refining the Drought Contingency Plan.

## BACKGROUND INFORMATION

Lake Manassas was created in 1970 by impoundment of Broad Run near the mouth of North Fork in the Occoquan Watershed. The drainage basin area is 46,500 acres (72.65 square miles) and constitutes approximately 21 percent of the Occoquan Creek sub-basin that lies within the Occoquan Watershed. The lake covers 771 acres (1.2 square miles) and impounds approximately 5.1 billion gallons at full pool elevation, 290 ft mean sea level (msl). The volume of the reservoir which can be withdrawn through the screened intake is defined as usable. The top of the lowest intake screen is at elevation 257 ft msl, and at full pool, 4.76 billion gallons are usable.

Occoquan Basin rainfall records are compiled by the Occoquan Watershed Monitoring Laboratory (OWML) from gages at Dulles Airport, the Fairfax County Water Authority (FCWA) Plant at Lorton, the Manassas Water Treatment Plant (MWTP) on Lake Manassas, and at the Occoquan Watershed Monitoring Laboratory. The OWML also maintains a continuous stream gage, located at the U.S. Highway 29 Bridge over Broad Run near Buckland. This gage has been in operation since 1951, except for the period from September 1979 to October 1980 during highway construction at the site. Broad Run is the largest stream that flows into Lake Manassas.

The annual cycle of Lake Manassas inflow, which correlates with lake level is typical for reservoirs in the region: the reservoir generally refills in winter, with peak levels occurring in the spring, then level slowly declines through the summer with minimum flows observed in the early fall. The annual pattern for water demand grows to a peak during the summer with more modest demands in the spring and fall, and the lowest demands (reflecting minimum outdoor water use) in the winter.

**Table 1. Precipitation at Dulles National Weather Station**

	Total Precip Inches	Normal Precip, Inches	Difference, Inches
Total 1998	37.45	40.24	-2.79
Jan-Jun 1998	30.18	19.73	+10.45
July-Dec 1998	7.27	20.51	-13.24

**Drought Conditions**

During the last half of 1998, the levels of precipitation in the Lake Manassas watershed were the second driest 6 months on record. Precipitation recorded from July through December of 1998 was approximately 13 inches below the normal 20 inches. According to the Palmer Drought Severity Index, the regional drought was classified as “extreme”, the most serious category.

**Immediate Response**

Recognizing the significance of the drought conditions, the City initiated a number of response actions. These measures included education efforts, conservation efforts, and investigation of alternate water supplies.

Education efforts included preparing bill stuffers that advised water system customers of current conditions and offered water conservation tips, interviews with the local media informing them of current conditions, and meeting with the largest system water users, including wholesale water customers.

The City also focused on water conservation. Internal city efforts included eliminating water main flushing and increased sewer flow monitoring to enhance leak identification. Water flow to customers was also reduced; flow to golf courses was restricted. The City also coordinated with the wholesale customers; due to this cooperation, several of the wholesale customers were able to reduce demand by using alternative supplies such as wells or interconnections with other jurisdictions. Another conservation effort was limiting the dam flowby to match the inflow.

Alternative water supplies were also considered. The City had already begun participation in an interagency pipeline construction project to interconnect several municipal supplies. This pipeline interconnection, however, was more than a year from completion. The City did investigate the condition of several wells that

had been abandoned for some time with the thinking that this well water could be used for nonpotable water uses such as landscape irrigation. However, due to the condition of the mechanical equipment, use of these wells was postponed.

As a result of these immediate response activities, the rate of lake level reduction slowed. Lake Manassas reached its lowest level, 8.6 feet below the spillway, in late December 1998. The Manassas City Council was briefed on the serious drought conditions and the immediate response activities that had been undertaken to stabilize the situation. Given the significance of this issue, the City of Manassas then formed a Water Supply Advisory Task Force (WSATF) to develop and implement drought contingency measures.

**Water Supply Advisory Task Force**

During years of drought, and in communities that regularly experience water shortages, a local water shortage management team is important to successful response. If a water shortage occurs, difficult decisions must be made. In the case of the City of Manassas, the WSATF was assigned the responsibility of providing support for making and implementing decisions during a water shortage and participating in ensuring an appropriate and effective community response. If the assessment of reservoir condition, meteorological predictions, and system demand shows the potential for a water shortage, then City staff and the Task Force will begin planning to take action. If a determination is made that the potential for a water shortage is diminished, then City staff should continue to monitor the supply and be prepared to notify the Task Force, if the situation changes.

The membership of a Water Supply Advisory Task Force should include representatives of major water users, officials responsible for health and safety, water system operations personnel, and other persons who can help design and implement an effective program, including residential customers of the water system. Additional members may be called to serve during a water shortage. In Manassas, a diverse group of stakeholders was assembled to serve on the Task Force, including City staff, Utilities Department personnel, major water users, and citizens. The initial focus of the WSATF was developing a Drought Contingency Plan.

A Drought Contingency Plan serves as a framework for effective and systematic assessment of drought condition. Additionally, the Plan specifies risk management measures and response options that minimize economic and public health impacts and ensures the best use of available water resources.

Recognizing that the Drought Contingency Plan may not be implemented on a regular basis, it is important to provide a mechanism for updating and ensuring that assessment and response measures reflect current conditions. The Drought Contingency Plan should be reviewed for adequacy, and an update should be prepared on a periodic basis.

Water use restrictions are an integral component of the Drought Contingency Plan. Restrictions should become progressively more severe as drought conditions increase in severity. One important responsibility of a Task Force is to assist in enforcing drought restrictions. Another responsibility of a Water Supply Advisory Task Force is to perform a Post-Drought Evaluation, if the Drought Contingency plan is activated.

### DROUGHT CONTINGENCY PLAN DEVELOPMENT

As part of developing a drought contingency plan, drought indicator criteria (triggers) must be set which will identify the onset of drought occurrences. The criteria or triggers must give sufficient warning for adequate drought response but not trigger these actions so prematurely or so frequently that the public becomes complacent and does not respond. Drought triggers and responses should be progressively staged, with the most severe response measures reserved for truly emergency situations. The initial triggers allow for early response actions while there is still water in existing supplies to conserve. Subsequent triggers generally indicate the

onset of a severe water shortage emergency and water rationing may eventually be necessary. Good drought management can make a difference in the levels of curtailment required, and can provide greater water supply reliability to all customers, including local business and industry.

The Manassas Plan describes a series of staged water supply extension and water demand reduction measures which will be triggered by monitoring Lake Manassas and other key parameters. Four stages are identified, each triggered by a progressive decline of the reservoir pool elevation, relative to month of the year. Part of the drought monitoring program is a planned public education and awareness program to inform the public of the problem and instruct them in the actions or responses which are needed.

A number of drought indicator parameters are available for monitoring and triggering drought stages, including reservoir storage levels, streamflows, rainfall and soil moisture. From a water supply perspective, the single most important indicator is reservoir storage level. In a community such as Manassas that is primarily dependent on a single reservoir or lake for its water supply, measurements of the impoundment water level provide an adequate indication of drought status. Normal variations in storage must be taken into account, since there is a seasonal pattern. In the eastern United States, reservoir storage is usually at maximum in May or June and at a minimum in October or November. The storage declines during the summer because of low inflow and high water demands and recovers during the winter and spring when inflow is higher and demand is less.

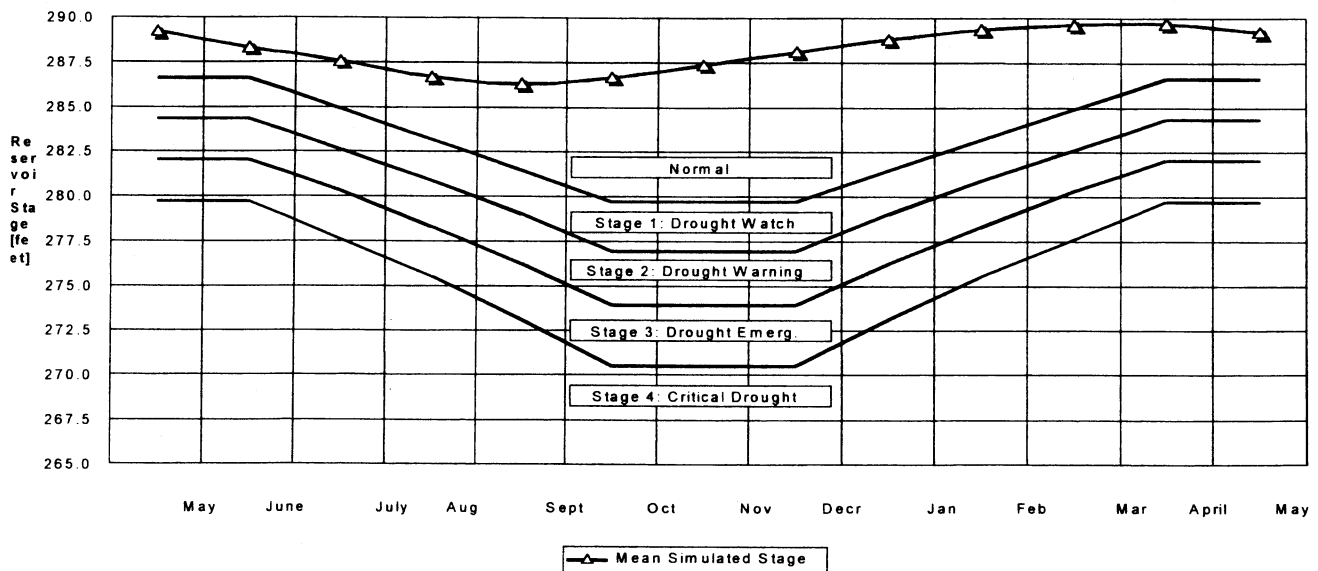


Figure 1. Manassas Drought Operation Curves.

**Table 2. Manassas Drought Plan Provisions**

Stage 1 – Drought Watch	Stage 2 – Drought Warning	Stage 3 – Drought Emergency	Stage 4 – Critical Drought
Reservoir Level of 85% to 55% of total usable volume	Reservoir Level of 75% to 45% of total usable volume	Reservoir Level of 65% to 35% of total usable volume	Reservoir Level of 55% to 25% of total usable volume
Voluntary Conservation Measures	Specific Water Uses Prohibited; Increased	Mandatory Water Use Allocations Established	Mandatory Water Rationing
Target 15% Reduction in System Demands	Voluntary Conservation Encouraged	Target 35% Reduction in System Demands	Target 45% Reduction in System Demands
Focus on Public Education	Target 25% Reduction in System Demands Focus on Eliminating Non-Essential Water Uses	Focus on Preparing for Water Rationing	Focus on Water Rationing

**Demand Management Stages**

The purpose of identifying multiple drought stages is to differentiate between appropriate response actions at various risk stages. The demand reduction measures should follow a logical progression from voluntary water use restrictions, to a mandatory ban of nonessential uses, and finally, under severe water shortage conditions, to water rationing. The demand reduction measures will correspond to the drought stages identified. Measures are selected to reduce water usage within residential dwellings, commercial and industrial establishments and institutions in addition to the continued reduction of nonessential water uses. During drought emergencies, large customers can be encouraged to use alternative supplies, where possible.

Ongoing efforts to educate water customers about water conservation practices should be increased during early drought conditions. Customers should be alerted to drought conditions and informed of actions required to respond to water shortages. This may be accomplished through local newspaper articles and news broadcasts, and through presentations on water conservation and drought response activities to local organizations. Water conservation literature should be distributed to residential customers to discourage wasteful habits and to encourage the installation of water-saving plumbing fixtures in homes that are not already so equipped. Household leak detection programs should also be instituted during early drought conditions and meter readers should inform customers with unusually high readings. The municipality or WSATF should also meet with major commercial and industrial users to plan strategies for demand reduction in these facilities.

An important aspect of implementing a drought contingency plan is the early notification to appropriate municipal officials and employees of the plan provisions they will be called upon to implement and enforce. The municipality should also have the enabling legislation in place to specifically allow implementation of the plan.

For the City of Manassas, a four-stage plan was developed by the WSATF. When water supplies are below the level necessary to meet normal needs or other emergencies, the City Council may declare that a Water Shortage Emergency exists. This declaration triggers implementation of the Drought Contingency Plan. The drought plan consists of four stages, with each stage having an indication trigger and targeted water-use reduction. The reservoir stage indicator varies by month of the year, based primarily on percent of stored volume remaining.

**Drought Plan Provisions**

A drought contingency plan, in addition to prescribing appropriate response actions, should be developed to allow flexible implementation. For Manassas, an Appeals Board Process was developed. The Appeals Board reviews customer applications for exemptions from mandatory conservation or rationing by specific allotments on a case-by-case basis, and if warranted, to make equitable adjustments to such provisions.

Successful implementation of a Drought Contingency Plan is dependent on the cooperation of all system customers. To this end, the Plan must include appropriate penalties for noncompliance. Penalties should be set with the goal of encouraging compliance.

A prolonged drought will affect the financial operation of the utility; as water demand is reduced through conservation, utility revenue decrease proportionately. The Drought Contingency Plan should also include specific provisions to adopt drought surcharge water rates, reconnection fees, and excess usage charges to address this situation. Rate changes in the form of excess use charges can also provide an additional conservation incentive.

Residential and non-residential water customers are expected to share the burdens and sacrifices associated with water use reduction when a water supply shortage is identified. However, it is recognized that some customers, particularly non-residential entities, may already operate in a water conservation mode, and that additional reductions may result in an extraordinary hardship. Additionally, the objective of the plan is to achieve system-wide reductions in water demand, in the most efficient manner possible. To accomplish this objective, the Drought Contingency Plan should include provisions to adjust the plan for specific individual circumstances.

In the Manassas Drought Plan, an individual Drought Contingency Plan provision was included for flexibility. If an enterprise believes that prescribed levels of water demand reduction cannot be attained without extraordinary hardship, an individual drought contingency plan may be prepared and a variance may be requested. The individual drought plan would include documentation of facility water usage and justification for waiving the overall plan targets.

### SUMMARY

In Manassas, implementation of Stage I voluntary water use restrictions and public education was successful in reducing water demands approximately 15%. In conjunction with other drought management actions, this effort was successful in stabilizing lake level and conserving the water supply. In addition, the reservoir refilled much quicker during precipitation in early 1999 since water conservation had helped sustain the lake level.

All municipal water supplies are at risk of facing a drought situation. The risk level for a particular watershed varies based on geography, geology, meteorological patterns, water demand magnitude, and numerous other factors. Formal drought contingency planning offers the municipality an opportunity to educate the public and governing bodies to the issues and considerations for a particular watershed. This

process works well with a multi-faceted approach including the establishment of an appointed task force representing appropriate stakeholders, and the development of a specific plan. The plan must be developed to establish agreed upon drought criteria, appropriate response activities, and penalties for noncompliance. However, the plan must also be developed with the flexibility to address particular unforeseen extenuating circumstances. The plan must also be developed in conjunction with enabling legislation.

A formal plan can also assist municipalities in developing action plans for coordination in time of need, which can enhance interjurisdictional working relationships. In addition, a well-conceived drought contingency plan can greatly enhance a municipality's ability to provide adequate potable water for the health and safety of its customers, even during moderate to severe drought events.

### REFERENCES

- American Water Works Association (AWWA), "Drought Management Planning," Prepared for the American Water Works Association Water Conservation Committee by the Water Shortage Subcommittee.
- Truby, J., Bouloulas, L., and Kisterner, R., Colorado State Drought Response Plan, Prepared by the Colorado Division of Disaster Emergency Services, 1990.
- Miller, Don E., and Hays, Charles R., Missouri Drought Response Plan: Mo. Dept. Of Natural Resources' Division of Geology and Land Survey, Water Resources Report No. 44, 1995.
- Montana Drought Response Plan, Prepared by the Montana Drought Advisory Committee, 1995.
- Walker, William R., Hrezo, Margaret S., and Haley, Carl J., "Management of Water Resources for Drought Conditions," U.S. Geological Survey Water-Supply Paper 2375, 1988-89.
- "Guidelines for the Development of a Local Water Rationing Plan," September 25, 1995 Edition, Pennsylvania Department of Environmental Protection.
- "Emergency Water Use", Prince William County, Virginia, January 1981.
- "Emergency Water Use Ordinance of 1981," Prince William County, Virginia.
- Virginia Drought Contingency Plan, 1987