A COMPLETE PLAN "...EXPERIENCES FROM THE U.S."

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INTRODUCTION

A drought occurs when water supply is reduced to a level that cannot support existing demands. A drought may be caused by natural forces or system component failure and could last 2 to 3 months or extend over several seasons.

While many of you have not suffered a recent drought, the 1987-88 dust bowl conditions in other parts of the country have raised the question "Are we prepared for a drought?" This paper presents an overview of the necessary steps for completing a drought response plan. They reflect what has been done successfully throughout the country, especially in California.

Preparation of a drought response plan can be divided into four parts: inventorying existing supply, understanding demand, forecasting a supply shortfall, and analyzing supply augmentation and demand management measures.

INVENTORYING EXISTING SUPPLY

Decisions on how to mitigate a drought call for accurate knowledge of available and emergency supplies.

The first step is to collect existing supply information-facility data; stream flow data; readings of reservoir levels, groundwater table elevations, soil moisture, snowpack, and precipitation records. The reliable yield must be defined for each source, as must any weak links in getting water to customers such as limited pumping capacity.

The next step is to look at supply augmentation methods. These can be grouped into five categories: (1) increasing existing supplies, (2) drawing from reserve supplies, (3) increasing efficiency, (4) modifying operations, and (5) entering into cooperative efforts with other agencies. Specific measures include increasing use of reclaimed water, using reservoir dead storage, adding or deepening wells, and participating in water exchanges.

Agencies need to evaluate and document the efforts required for supply augmentation. Agreements or contracts should be written up ahead of time for such

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measures as water transfers. Costs and time requirements should also be determined.

UNDERSTANDING DEMAND

Understanding demand requires knowledge of existing and predicted future consumption patterns as well as a determination of realistic demand management opportunities.

Demand

Demand can be estimated from:

- Production records and forecasts.
- Water-use records and forecasts.
- Long-term weather forecasts.
- Precipitation records and forecasts.
- Service area population and growth projection.
- Customer class characteristics.

Demand Management

Efforts to reduce water demand are best directed at customer uses that are inefficient or wasteful or those that can be temporarily cut back or suspended. Techniques for reducing demand include restricting landscape irrigation and retrofitting plumbing fixtures with low-flow devices.

Two measures often imposed on all customer classes are rationing and restructuring of rates to encourage conservation (or discourage high water use).

Rationing: Consumer response to rationing programs, in the form of reduced water use, is more predictable than response to other measures. Thus these are generally the most effective programs for achieving significant demand reduction. In nearly every instance where mandatory rationing is implemented, consumers respond by reducing water use further than is requested.

A successful rationing program should be as equitable as possible, and customers should be kept informed about the status of the shortage. Pertinent information regarding water use and supply must be published and disseminated at least weekly if customer commitment is to be maintained.

Rationing programs are generally patterned after one of four basic allocation schemes: (1) percentage reduction, (2) seasonal allotment, (3) fixed allotment, and (4) specific use bans. A percentage reduction assigns each customer class a consumption reduction goal as a percentage of the consumption level in a similar billing period during a normal (nondrought) season. The fixed allotment is similar to the percentage reduction except the consumption reduction goal varies according to the time of year.

Rates: The ability of a price change to affect consumption is termed price elasticity. Price elasticity is a measure of the relative influence that a change in price of a given commodity (water) has on the demand for that commodity. Several variables effect price elasticity, such as whether the use is indoors or outdoors or whether use is in an affluent or depressed neighborhood. Using rates to encourage water conservation requires individual metering of customers.

Significant water conservation is unlikely to be achieved through the use of standard rate increases. However, there are several pricing structures that lend themselves to drought response plans. These include seasonal rates, excess-use charges, penalty charges, and drought surcharges.

Under a seasonal rate schedule, unit prices are higher during peak-use months. An excess-use charge (or inclining-block-rate structure) applies a higher unit price to the volume consumed above a set limit. Penalty charges are similar to excess-use charges except that the same unit price is charged for the entire volume consumed and a flat fee is assessed if total use exceeds a set ceiling. With either seasonal or excess use pricing structures, care must be taken in defining excess consumption for each of the customer classes. A drought surcharge, which is a percentage increase in user fees to pay the costs associated with the drought, may also cause reduction in water use.

FORECASTING A SUPPLY SHORTFALL

Accurate forecasting requires coordinated efforts between those at a water utility who understand demand and those who measure and predict state and local water supplies.

Supply Forecasting

Wholesalers will need to manage the allocation and delivery of source supplies or supplies from primary water suppliers such as the U.S. Bureau of Reclamation.

Water retailers will need to make their own findings and collect information from wholesalers, where appropriate. Supplies available from (1) snowpack, (2) groundwater, (3) storage, (4) exchanges, (5) etc., must be determined. They need to determine the total forecasted supply in each month for the coming 12 months as well as how much of the supply should be carried over as insurance against a possible subsequent drought year.

Demand Forecasting

Each agency should use its own forecasting method to predict demand. Various methods such as production records and weather forecasts were suggested earlier in this paper. The forecasts will need to be made for each month in the year to demonstrate the differences between summer and winter consumption.

Defining a Drought Shortfall

The agencies' next step is to compare the estimate of drought year water demand to available water supplies and identify those months, if any, during which a shortage is anticipated. This assessment will enable the utility to forecast what level of supply augmentation and/or demand reduction needs to be achieved.

Forecasted supply can be plotted on a graph and forecasted demand superimposed on it, as shown on Figure 1. This figure illustrates that a water shortage will occur by the end of February and that supply augmentation will be necessary in the beginning of May, as the drought worsens.

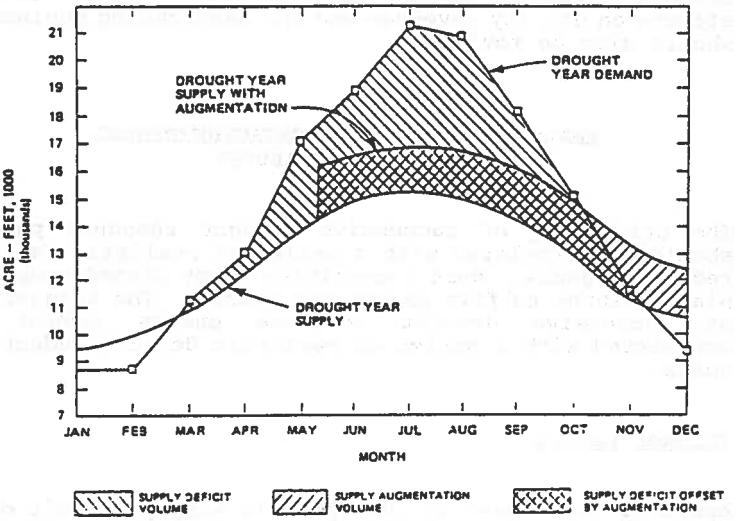

Figure 1 Projected Supply Deficit Conditions

To help motivate those who need to support the plan and to determine what level of effort and budget to apply during a drought, a preliminary drought impact assessment is important. What short and long-term impact would a drought have? Economic impacts, such as the likely effects on utility revenues and the landscaping business, should also be reviewed.

ANALYZING SUPPLY AUGMENTATION/DEMAND MANAGEMENT MEASURES

The triggering of successive drought response phases should be correlated with a series of realistic deficit reduction goals. Most communities adopt phased response plans. Three to five phases are common. The triggering of successive drought response phases should be correlated with a series of realistic deficit reduction goals.

Trigger Levels

Agencies must identify the specific supply deficit data they will use to "trigger" sequential drought response phases. Then they must quantify their deficit reduction goals and select the appropriate water-saving measures for the demand reduction phase. Comparison of forecasted supply and demand to the preestablished "trigger" levels provides the basis for initiating or upgrading a drought emergency.

A sliding scale for trigger values is often represented graphically. In the drought response plan for the Delaware River Basin, for example several stages of diversions, reservoir releases, emergency reservoir operations, and conservation measures are keyed to four drought conditions. The agency determines when it has reached these conditions according to a set of operation curves based on the total remaining available storage capacity in three reservoirs. Typical operation curves are shown on Figure 2.

Deficit reduction objectives for each drought phase are commonly expressed as a percentage of average demand levels or as a quantity (volume or rate) of water saved. A sample phased program has been developed as a guide:

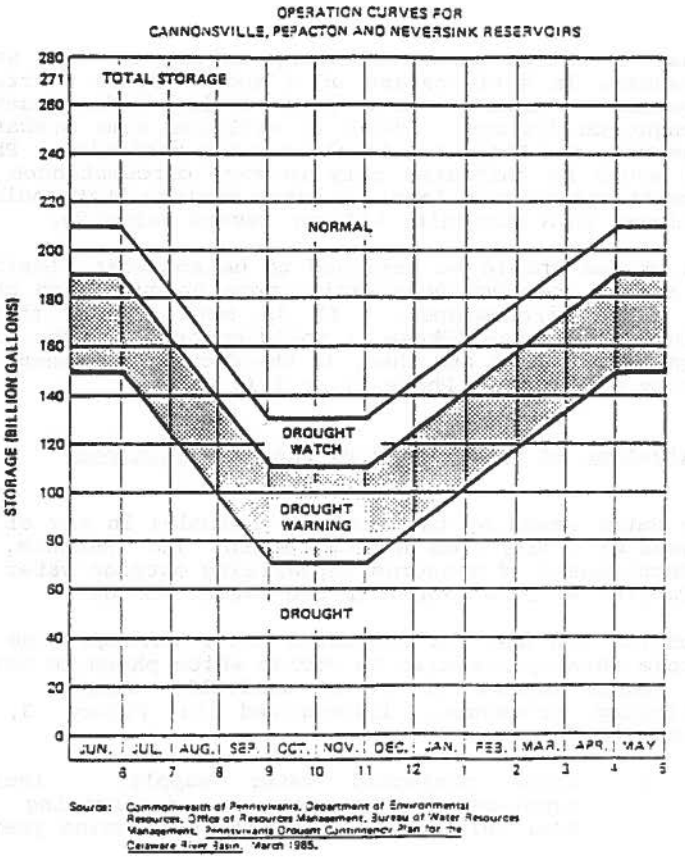

Figure 2 Graphic Method of Drought Staging Based on Reservoir Levels

Phase	Water Shortage	Target Water Savings, percent
I	Moderate	5 to 10
II	Severe	10 to 20
III	Critical	20 to 35

Phase I relies upon voluntary action by the water consumers in anticipation of a modest water shortage. Subsequent phases are in response to increasingly severe drought conditions. Phase II utilizes some mandatory measures, and Phase III involves water rationing. Phase III would be initiated only in rare circumstances and aims at the maximum level of water savings that could be achieved in a community without severe hardship.

The phases should be designed to be somewhat flexible. An agency does not necessarily move through each phase in every circumstance. It is more likely that a voluntary program (Phase I) would be tried at the first sign of a drought and then, if the drought worsened, the agency would begin Phase II or III.

Evaluation of Water Saved By Phased Reductions

The water saved by the measures included in any of the phases will vary from month to month. For instance, the effectiveness of measures emphasizing outside water use reduction will be higher in the warmer months.

Agencies can use the estimated water savings from the sample three-phase plan to decide which phase to select to reduce demand to match available supply. The following procedure, illustrated in Figure 3, is recommended.

1. Graph projected water supply. Include supplemental sources in determining the available water supply for the coming year.

2. Estimate dry year water demand. Apply the percent savings anticipated for each phase to the projected dry year demand (reduction) curve. Graph the results as a series of three adjusted demand curves together with the projected dry year demand.

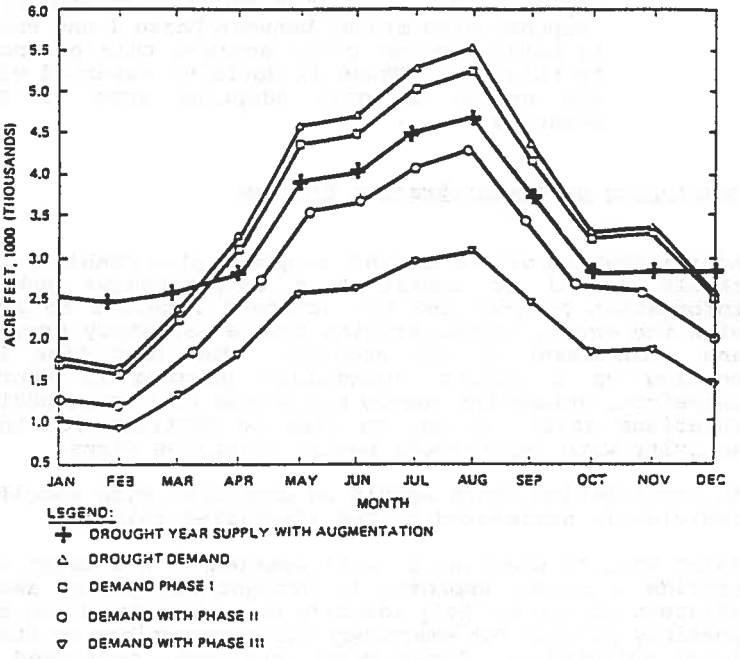

Figure 3 Projected Supply/Demand and Phased Reductions

3. Select the appropriate phase. Compare supply and demand curves to determine which drought phase will reduce demand to match the available supply. In the example shown on Figure 3, a response plan midway between Phase I and Phase II would theoretically achieve this balance. In this case, Phase II would be selected with the option of only adopting some of the measures.

Developing an Administration Program

Administration of the drought response plan combines the skills needed to undertake a comprehensive public information program and the judgment required to deal with the equity issues arising from a mandatory program and enforcement of the program. The lead time for setting up a public information program is short. Therefore, unless the agency has access to a large public relations staff, it may be wise to contract for this activity with experienced public relations firms.

An organization chart should be developed with specific individuals designated in the identified roles.

Joint utility planning in anticipation of a drought can provide a common approach to drought management among adjacent utilities, help identify emergency supplies, and possibly provide for emergency interconnections or other joint activities. Interagency agreements confirmed in advance will speed response to an emergency and help avoid hurried decisions on matters such as price and equity.

Ordinances restricting water use should be drafted in anticipation of potential emergencies. The ordinance should be adopted in response to an actual (and previously defined) emergency. An ordinance may contain various levels of mandatory restrictions and provisions that will go into effect when a state of emergency is declared by the governing body.

Preparing a Revenue Program

A reduction in water use without a rate change will mean a revenue shortfall for most utilities. This is especially true when the additional costs of dealing with a drought are brought in. There are two common ways of

balancing the budget: (1) raising water rates and (2) imposing a drought surcharge. Two additional possibilities are to use the financial reserves in the general or water revenue fund and to draw from a designated drought emergency account. Various combinations of these methods can be used to create a comprehensive revenue program.

Regardless of the method selected, it is necessary to do the following:

1. Estimate the amount of water use reduction that will be achieved and the associated lost revenue.

2. Design a rate adjustment or drought surcharge that will cover the anticipated revenue deficit.

3. Monitor actual revenue and compare with forecasted revenue; adjust drought surcharges as needed (but not too often).

Adopting the Drought Response Plan

Once it is decided that a drought plan is needed, the water agency should move quickly to adopt a plan. The process can usually be completed within 1 to 3 months. When all issues and procedures are defined as much as possible, the plan should undergo a formal public review process before the finalized document is adopted. This will help minimize surprises and future objections when mandatory provisions are called for.

Opposition to the plan should be anticipated from those involved with potentially affected business activities. The "green" industry--landscape contractors, nurseries, etc.--will probably suffer economic harm during a water shortage and can be expected to have concerns about certain elements of the plan. The best way to mitigate these objections is through communication and fairness. All concerned parties should be informed of the action plan well in advance of when it might be adopted. They should also be aware of the agency's efforts to make the plan as equitable as possible.

Monitoring Supply Versus Demand and Responding Accordingly

Implementation of a drought response plan includes ongoing monitoring of the effectiveness of the individual conservation measures, monitoring supply availability, and monitoring actual water use. The following procedure, illustrated by Figure 4, is suggested.

1. Overlay actual water supply and demand on the graph previously prepared (Figure 3). A 7-day average can be used to smooth out daily fluctuations. Update this graph weekly.

2. Compare actual demand and supply with projected demand and supply to determine if an adjustment within the phase is needed. Before moving to the next demand reduction phase, consider program adjustments such as raising the level of expenditure on public information and increasing enforcement efforts within the existing phase. If this does not achieve the required stabilization, then move into the next phase.

In the example on Figure 4, water supply is anticipated to be cut back. An appropriate response would be to implement Phase II in March. In this example, it would be advisable to implement Phase II early, and if the savings are not sufficient, initiate Phase III.

CONCLUSION

If water agencies have a complete understanding of supply and demand and a preplanned and carefully constructed drought management plan in place, the impact of a drought can be significantly reduced. Public relations of the responsible authorities will remain intact, and the economic impact on businesses and residential customers will be kept to a minimum. The main ingredients for success are good information, planning, and execution.

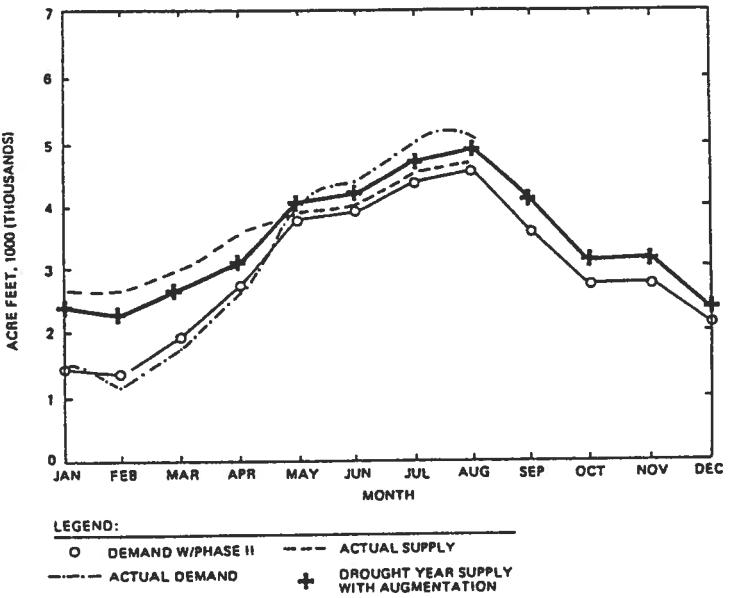

Figure 4 Available Supply/Actual Demand and Required Phase