January 1978

# Utah's 1977 Drought

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Water Resources Planning Series
UWRL/P-78/07

In cooperation with

Utah Division of Water Resources
and
Utah State University Extension Service

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Logan, Utah

December 1978

## ABSTRACT

The Utah Drought of 1976-77 has been characterized as the wettest drought in history. It was produced by the driest winter season of record followed by summer rains which were much wetter than normal in many regions of the state. Streamflow is highly correlated with winter rather than summer precipitation and therefore the most severe impacts of the drought were related to the record low streamflow during 1977 plus the ski industry impacts which were directly related to 1976-77 snowfall.

Drought impacts upon several sectors of the economy plus the extensive responses of all levels of government in the form of drought relief programs are described and quantified.

## ACKNOWLEDGMENTS

This report was funded jointly by the Utah Division of Water Resources, the Utah Water Research Laboratory, and the USU Extension Service. In addition to the listed authors, the report draws on material extracted from numerous agency reports. Special thanks is due the following individuals and agencies:

1. Jerry Williams, Hydrologist in charge of the River Forecast Center of the National Oceanic and Atmospheric Administration for the historic Utah streamflow report.

2. James D. Harvey, Executive Secretary of the Utah State Soil Conservation Commission for his report on the Portable Stockwater Tank Program.

3. Roger Hansen, Utah Water Research Laboratory, who produced the statewide municipal water survey analysis.

4. The U.S. Bureau of Reclamation provided both information on hydropower impacts and a report on drought impacts upon individual irrigation companies.

5. The Utah Department of Agriculture permitted extensive quoting from Utah Agricultural Statistics, 1978, particularly the data and analyses of Jack B. Goodwin and Dennis G. Schmidt.

6. Herbert Fullerton, USU Economist who helped gather and analyze agricultural statistics.

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# CHAPTER 1

# INTRODUCTION AND PHYSICAL DESCRIPTION OF DROUGHT

## Scope

The Utah drought of 1976-77 consisted of a peculiar sequence of fall and winter months which previously were unmatched for dryness followed by wetter than average summer season (1977). The principal negative impacts of the drought were experienced during the relatively wet summer months thereby causing considerable confusion among the general public and giving rise to the phrase "the wettest drought on record."

The 1976-77 drought affected the entire west and parts of the mid-west U.S. This report, however, is restricted to a description of the drought and its impact upon Utah, hence the phrase "Utah drought" is used. This chapter describes the drought, initially in terms of how 1976-77 precipitation compared with that during previous droughts. Similar comparison for streamflow follow. The final section in this chapter is an analysis of the impact upon water availability during 1976-77 of previously constructed water development projects (anti-drought measures) such as reservoirs and wells.

Subsequent chapters describe the drought impact upon people and the economy and the drought relief programs which were conducted by various federal, state, and local organizations during the drought.

## Precipitation During the Drought

### Annual precipitation as an index of severity

The climate of Utah is so varied that it is impossible to classify any particular period of time as the severest drought without specifying what portion of the state is being considered as well as the period of time. Table 1 shows the driest calendar year in each of the seven climatic divisions of the state shown on Figure 1. The driest year occurred in 1931 in the Northern Mountains, 1950 in the South East, 1956 in the Dixie and South Central divisions, 1966 in the Western and North Central divisions, and 1974 in the Uintah Basin. None of the divisions show 1976 or 1977 as the driest year. Accumulations during 1976 ranged from the third driest year of record in the South Central to the seventh driest year in the Western and North Central divisions. Yet when the individual division accumulations are averaged over the state, we find that on a statewide basis 1976 was the driest year since division records began in 1931 with 7.70 inches. The previous record dry year on a statewide basis was 1966 with an average of 8.10 inches. The calendar year 1977 was not particularly dry because of heavy summer rains in some regions; however, 1977 began with four extremely dry months.

Table 1. Record annual extreme precipitation for Utah's climate divisions.

| Division | Smallest Annual Precipitation | Calendar Year | 1976 Annual Precipitation | 1976 Ranking |
|---|---|---|---|---|
| Western | 3.38 | 1966 | 6.19 | 7th driest |
| Dixie | 4.52 | 1956 | 8.08 | 6th driest |
| North Central | 11.28 | 1966 | 12.06 | 7th driest |
| South Central | 6.87 | 1956 | 8.38 | 3rd driest |
| Northern Mountains | 10.15 | 1931 | 11.02 | 4th driest |
| Uintah Basin | 3.61 | 1974 | 5.27 | 6th driest |
| South East | 4.46 | 1950 | 6.38 | Tied for 6th driest |
| State Average | 7.70 | 1976 | 7.70 | Driest of Record |

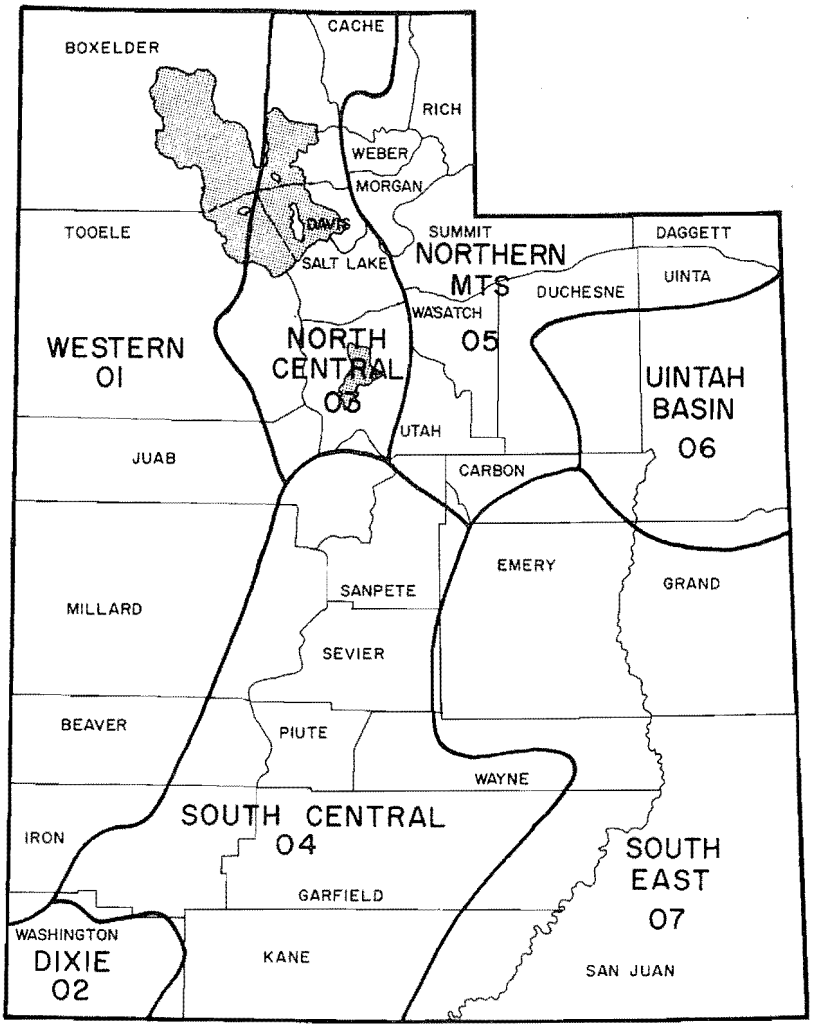


Figure 1. Location map for Utah's seven climatic divisions.

Palmer Drought Index of severity

As an index of drought severity, annual precipitation does not indicate the duration of any moisture deficit or how the situation worsens as a drought lengthens. An alternate which does index these properties as well is the moisture deficit represented by the Palmer Drought Index. This index treats drought severity as a function of accumulated weighted differences between actual precipitation and precipitation requirements in terms of evapotranspiration. The index values can be correlated with general crop conditions, forest fire danger, water supplies and economic disruption. Index values are summarized by large areal climatic division as follows:

Palmer Index Classes for Wet and Dry Periods

| Monthly Index Value | Class |
|---|---|
| ≥ 4.00 | extremely wet |
| 3.00 to 3.99 | very wet |
| 2.00 to 2.99 | moderately wet |
| 1.00 to 1.99 | slightly wet |
| 0.50 to 0.99 | incipient wet spell |
| 0.49 to -0.49 | near normal |
| -0.50 to -0.99 | incipient drought |
| -1.00 to -1.99 | mild drought |
| -2.00 to -2.99 | moderate drought |
| -3.00 to -3.99 | severe drought |
| ≤ -4.00 | extreme drought |

Table 2 tabulates the longest period of record with negative values of the Palmer index in each climatic division. The longest period with negative Palmer indexes in any division was the 112 months in the Western

Table 2. Comparison of record drought duration and 1975-77 period as defined by continuous below normal Palmer drought indexes.

| Division | Extremes for Entire Record | | | | | 1975-77 Drought | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Longest Subnormal Period (mo) | Begin | End | Lowest Index | Month | Duration Most Recent Period (mo) | Lowest Index | Month | Begin | End |
| Western | 112 | 4/52 | 7/61 | -5.68 | 8/60 | 34 | -4.65 | 4/77 | 8/75 | Pres.[a] |
| Dixie | 54 | 7/52 | 12/56 | -4.75 | 7/51 | 28 | -4.18 | 4/77 | 9/75 | 12/77 |
| North Central | 39 | 5/58 | 7/61 | -9.06 | 7/34 | 8 | -5.91 | 4/77 | 9/76 | 4/77 |
| South Central | 55 | 9/52 | 3/57 | -6.28 | 7/34 | 29 | -4.58 | 4/77 | 8/75 | 12/77 |
| Northern Mountains | 60 | 1/31 | 12/35 | -9.24 | 7/34 | 31 | -6/21 | 4/77 | 12/75 | Pres.[a] |
| Uintah Basin | 45 | 12/57 | 8/61 | -5.39 | 10/34 | 19 | -3/10 | 4/77 | 6/76 | 12/77 |
| South East | 51 | 10/52 | 12/56 | -4.83 | 6/77 | 29 | -4.83 | 6/76 | 8/75 | 12/77 |

[a]Calculated as of June 1978.

division from April 1952 through July 1961. The recent 1975-77 moisture deficit was much less with only 34 months in the Western division. The other divisions are shown in the table along with the lowest value of the index in each division and the month it occurred.

Precipitation pattern during the drought

The monthly pattern of precipitation totals which produced the most recent drought is presented in Tables 3 and 4 for each of the seven climate divisions for the calendar years 1976 and 1977. The deficit in accumulated rainfall actually began in August 1975 in the Western, Dixie, South Central, Uintah Basin, and South East sections of Utah. The subnormal moisture accumulations did not begin in the northern mountains until December 1975, and not along the Wasatch Front or North Central Divisions until May 1976.

In semiarid regions of the earth, a large degree of variability is characteristic of the precipitation. Hence, occasional months of above normal rainfall occur during the long periods of subnormal accumulations associated with severe drought, as shown in Tables 3 and 4. Moreover, moisture deficits like those reported during the latter part of 1975 and early 1976 are of frequent occurrence and caused no particular alarm to residents of the far west.

Table 3. Monthly accumulations of precipitation for calendar year 1976.

| Division | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Western | acc. pcpn. | 0.25 | 0.92 | 0.48 | 0.88 | 0.57 | 0.19 | 0.74 | 0.47 | 0.67 | 0.88 | 0.13 | 0.01 | 6.19 |
| | per. norm. | 42 | 156 | 64 | 101 | 68 | 23 | 121 | 62 | 134 | 116 | 19 | 1 | 73 |
| Dixie | acc. pcpn. | 0.02 | 2.69 | 0.46 | 1.14 | 0.19 | 0.01 | 0.89 | 0.23 | 0.72 | 1.44 | 0.25 | 0.04 | 8.08 |
| | per. norm. | 2 | 222 | 35 | 125 | 36 | 3 | 100 | 24 | 107 | 164 | 27 | 3 | 74 |
| North Central | acc. pcpn. | 0.73 | 2.20 | 1.36 | 2.12 | 0.85 | 1.15 | 1.05 | 0.83 | 0.60 | 0.91 | 0.18 | 0.08 | 12.06 |
| | per. norm. | 50 | 167 | 84 | 108 | 51 | 77 | 178 | 88 | 71 | 67 | 12 | 5 | 74 |
| South Central | acc. pcpn. | 0.24 | 1.72 | 0.88 | 1.27 | 0.76 | 0.09 | 1.17 | 0.33 | 0.88 | 0.73 | 0.26 | 0.07 | 8.40 |
| | per. norm. | 23 | 176 | 75 | 112 | 86 | 12 | 122 | 24 | 100 | 71 | 28 | 6 | 69 |
| Northern Mountains | acc. pcpn. | 0.90 | 2.20 | 1.20 | 1.52 | 1.42 | 0.90 | 0.74 | 0.58 | 0.87 | 0.57 | 0.07 | 0.06 | 11.03 |
| | per. norm. | 41 | 116 | 59 | 82 | 93 | 59 | 86 | 43 | 83 | 36 | 4 | 3 | 55 |
| Uintah Basin | acc. pcpn. | 0.04 | 0.65 | 0.53 | 1.00 | 0.91 | 0.42 | 0.33 | 0.44 | 0.79 | 0.15 | T | 0.02 | 5.28 |
| | per. norm. | 8 | 151 | 106 | 147 | 134 | 47 | 53 | 51 | 110 | 16 | 31 | 3 | 66 |
| South East | acc. pcpn. | 0.11 | 1.07 | 0.48 | 0.68 | 1.23 | 0.11 | 0.83 | 0.48 | 1.11 | 0.23 | 0.04 | 0.01 | 6.38 |
| | per. norm. | 18 | 191 | 80 | 100 | 208 | 20 | 112 | 39 | 144 | 21 | 7 | 1 | 73 |
| State Average | acc. pcpn. | 0.32 | 1.39 | 0.72 | 1.10 | 0.91 | 0.32 | 0.85 | 0.48 | 0.85 | 0.62 | 0.12 | 0.03 | 7.71 |
| | per. norm. | 33 | 158 | 71 | 103 | 99 | 36 | 113 | 44 | 112 | 59 | 13 | 3 | 68 |

Table 4. Monthly accumulations of precipitation for calendar year 1977.

| Division | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Western | acc. pcpn. | 0.26 | 0.09 | 0.51 | 0.13 | 2.88 | 0.46 | 0.89 | 1.47 | 0.49 | 0.21 | 0.34 | 0.52 | 8.25 |
| | per. norm. | 43 | 15 | 68 | 15 | 343 | 56 | 146 | 193 | 98 | 28 | 49 | 74 | 97 |
| Dixie | acc. pcpn. | 0.66 | 0.09 | 0.45 | 0.08 | 2.68 | 0.49 | 0.88 | 1.24 | 0.92 | 0.35 | 0.26 | 1.33 | 9.23 |
| | per. norm. | 57 | 7 | 35 | 9 | 506 | 129 | 99 | 131 | 137 | 40 | 29 | 141 | 84 |
| North Central | acc. pcpn. | 0.74 | 0.59 | 1.46 | 0.52 | 4.31 | 0.17 | 1.35 | 2.39 | 1.39 | 0.93 | 0.75 | 1.40 | 16.00 |
| | per. norm. | 50 | 45 | 90 | 27 | 258 | 11 | 229 | 254 | 164 | 68 | 50 | 90 | 98 |
| South Central | acc. pcpn. | 0.50 | 0.27 | 0.72 | 0.15 | 1.58 | 0.52 | 0.38 | 1.27 | 0.50 | 0.76 | 0.35 | 0.80 | 8.80 |
| | per. norm. | 49 | 28 | 61 | 13 | 180 | 68 | 144 | 91 | 57 | 74 | 38 | 74 | 72 |
| Northern Mountains | acc. pcpn. | 0.62 | 1.44 | 1.37 | 0.39 | 3.16 | 0.24 | 1.57 | 1.90 | 1.43 | 1.26 | 1.29 | 2.09 | 16.76 |
| | per. norm. | 28 | 76 | 67 | 21 | 208 | 16 | 183 | 142 | 136 | 80 | 71 | 93 | 84 |
| Uintah Basin | acc. pcpn. | 0.31 | 0.33 | 0.22 | 0.55 | 1.07 | 0.20 | 1.49 | 1.21 | 0.31 | 0.44 | 0.51 | 0.31 | 6.95 |
| | per. norm. | 61 | 77 | 44 | 81 | 157 | 22 | 240 | 139 | 43 | 47 | 100 | 45 | 86 |
| South East | acc. pcpn. | 0.63 | 0.14 | 0.14 | 0.19 | 0.64 | 0.16 | 1.61 | 0.95 | 0.52 | 0.55 | 0.45 | 0.47 | 6.45 |
| | per. norm. | 103 | 25 | 23 | 28 | 108 | 29 | 218 | 77 | 68 | 51 | 74 | 64 | 74 |
| State Average | acc. pcpn. | 0.49 | 0.36 | 0.62 | 0.24 | 2.10 | 0.33 | 1.32 | 1.41 | 0.68 | 0.61 | 0.53 | 0.83 | 9.52 |
| | per. norm. | 51 | 41 | 61 | 22 | 228 | 38 | 176 | 128 | 89 | 58 | 58 | 79 | 84 |

The extreme moisture deficits during the latter part of 1976, however, alerted growing numbers of people to the serious nature of what was occurring. The impact of the deficit on agriculture and streamflow is best represented by the Palmer Drought Index which has been summarized in Table 2. The lowest Palmer index in each division for this drought occurred in all but the South East section of the state during April 1977. The minimum indices all indicate an extreme drought except for the Uintah Basin which only reached the severe range.

Effective precipitation as an index of severity

By the end of April 1977 little soil moisture remained above the 5 or 6 foot depth except in land that has been summer fallowed the previous year. This was particularly bad because this 6 foot layer of soil supplies the moisture plants required during the growing season. Another important soil factor that contributed to an increase in the severity of the drought situation during the growing season of the year was the tendency under drought conditions of most desert soils to cake and form an almost impervious layer. As a result, little of the summer rainfall infiltrated to recharge the soil reservoir.

In total constrast to the cooler season, May, July, and August recorded very heavy precipitation in the western portion of Utah. For the period May through August, the Western division recorded 235 percent of normal and the Dixie and Wasatch Front areas, 185 percent. The remainder of the state ranged from 105 percent of normal in the South East section up to 135 percent in the northern mountains.

The heavy precipitation during May 1977 marked the end of the most severe stress on native vegetation in all but the South East section. However, the lack of water snowpack as a source of irrigation water was felt throughout most of the growing season. Recurring heavy thunderstorm activity during the latter part of the summer helped reduce the impact of restricted irrigation water supplies in the northern part of the state.

One factor which greatly increased the impact of this drought was the seasonal distribution of the limited precipitation which was received. The accumulated winter precipitation during the winter of 1976-77 was lowest ever recorded. Evaporation from fresh water surfaces is much greater during the warm season (May-October) than it is during the cool season (November-April) and amounts to 80 percent of the annual total. This pattern is important because cool season (November through April) precipitation is available for soil recharge, underground water aquifers, or runoff to refill lakes and reservoirs. Little of the warm season moisture contributes to the water supply in these ways.

By defining effective moisture as 80 percent of the accumulated cool season moisture and 20 percent of the accumulated warm season moisture, one obtains the results shown in Table 5. The table indicates the considerably smaller percentage of normal effective moisture for the 1976-77 water year than of percentage of total moisture. The effective cool season moisture averaged less than one-third of that normally available for soil recharge and streamflow. The warm season effective moisture, by contrast, was over 180 percent of the normal moisture accumulation in the western part

Table 5. Percentage of normal effective moisture during 1976-77 drought.

| Division | 80% of Cold Season Precipitation | | 20% of Warm Season Precipitation | | % of Effective Moisture 1976-77 Season | % of Water Year Moisture 1976-77 Season |
|---|---|---|---|---|---|---|
| Western | 0.91 | 3.36 | 1.43 | 0.61 | 59% | 114% |
| Dixie | 1.26 | 5.32 | 1.02 | 0.55 | 39% | 78% |
| North Central | 2.86 | 7.54 | 1.75 | 0.94 | 54% | 85% |
| South Central | 1.56 | 5.06 | 0.95 | 0.80 | 43% | 65% |
| Northern Mountains | 3.15 | 9.64 | 1.41 | 1.05 | 43% | 61% |
| Uintah Basin | 1.14 | 2.66 | 0.82 | 0.61 | 60% | 77% |
| South East | 0.92 | 3.03 | 0.66 | 0.62 | 43% | 58% |

of the state. This heavy precipitation, in spite of attrition by evaporation, was sufficient to allow near normal crop production in many sections of western Utah. The available irrigation water, however, which depends mostly on the winter precipitation, caused major stress on crops where summer moisture was not adequate.

Snowpack during the winter of 1976-77

Snow accumulation during the winter of 1976-77 was very low. Snow water equivalents on April 1, a date when snowpacks are normally near the seasonal maximum, were only 43 percent of average across Utah, shattering the previous record low for a statewide average. Record low water contents were established on 70 of the 160 snow courses. By May 1, only 27 percent of the courses had any snow remaining; only 2 of 134 stations recorded a water equivalent above previous minimums; and statewide only 9 percent of average snow remained. These statistics clearly foreshadowed alarmingly low streamflow levels during the summer of 1977.

Surface runoff conditions during 1977

Statewide summary. One of the most significant effects of a drought is to reduce the amount of surface runoff available for agricultural, municipal, and industrial uses. Surface runoff is highly correlated with effective precipitation as previously defined. Since effective precipitation reached record lows over most of the state during the winter of 1976-77, the 1977 streamflow could be expected to be similarly low, as indeed was the case. Record lows were established at several key stream gaging stations as shown in Table 6.

A previous discussion defined May to October as the period of low precipitation effectiveness. This was based upon the level of evaporation and therefore the accepted "evaporation season." Evaporation pans are often frozen and inoperative during portions of April. However, during some years, April is a relatively high streamflow month and the weather service defines April to September as the period during which the dominating fraction of streamflow occurs in this climate. Therefore Table 6 and the following discussion of streamflow during the drought is based upon an April through September period.

The most striking aspect of the data in Table 6 is that the April-September flow for the year 1977 on the Colorado River at Cisco, Utah, was 45 percent of the previous record low (18 percent of normal). The San

Table 6. April - September streamflow for four drought years (acre-feet) at key Utah gaging stations (preliminary USGS data).

| Stream | 1977 | % of Normal | 1934 | 1954 | 1961 |
|---|---|---|---|---|---|
| Big Cottonwood near Salt Lake City | 20,900 | 51 | 12,800 | 24,800 | 17,600 |
| Bear River at State Line | 43,000 | 35[a] | N.A. | 67,900 | 67,500 |
| Logan River at Logan | 45,000 | 33[a] | 50,700 | 86,200 | 59,800 |
| Weber River at Oakley | 42,700 | 33 | 39,600 | 82,300 | 51,100 |
| Pineview Reservoir Inflow | 21,000 | 18 | 10,000 | 53,300 | 24,700 |
| Colorado River at Cisco, Utah | 575,000 | 18[a] | 1,278,000 | 1,291,000 | 2,133,000 |
| San Juan River at Bluff | 155,000 | 15[a] | 375,400 | 725,500 | 909,400 |
| Bear River at Harer | 34,500 | 13 | 18,800 | 103,800 | 43,500 |

[a]New record low flows.

Juan River at Bluff was similarly dry, 41 percent of the previous record low flow in 1934 (15 percent of normal).

Streamflow continued below normal during the summer despite rains which greened the landscape. Nearly all stream gaging stations indicated 45 to 60 percent of normal runoff during September.

## Effectiveness of Water Development Projects

### Background

The storage facilities that are an essential part of most water supply projects are basic anti-drought measures as they provide the important capability of storing water during wetter periods for use during subsequent droughts. Storage of peak flow for subsequent seasonal withdrawals provides benefits during wet years, and additional benefit is added if more storage is available to hold water stored in wet years for later use in dry years. Water supply projects which provide large amounts of such carryover storage or take advantage of nature's storage by developing stable groundwater systems provide water users greater security against drought.

Many wells (particularly municipal and industrial) in Utah actually are operated as such a source of security. They are pumped only when low cost spring flow or other surface sources are inadequate. The lag time from the beginning of a drought to a significant drawdown or flow reduction from a well is at least several months and usually is measured in years. This time lag makes a well the ideal anti-drought facility (except for the resulting increased energy demand during a period when energy supply also is limited).

The importance placed on reservoirs and wells as anti-drought measures was demonstrated dramatically during 1977 by the remarkable political concensus which approved unprecedented levels of state funding for future reservoir construction (a $25-million water project bonding program for instance) and an equally unprecedented number of wells being drilled by private interests. Unfortunately, the lead time required for reservoir construction prevented installation of these facilities during 1977, and even if they had been completed, users would have to wait for subsequent runoff to fill them. Reservoirs consequently serve much better as insurance against future droughts than providing relief during current ones. In contrast, wells develop water that already has been stored by nature and thus can provide immediate relief. In 1977, many municipal wells were rushed into production. All of them and some of the new reservoirs will be available should a multiple year drought cycle occur soon as it did after 1931.

In view of the major investment in reservoirs and wells resulting from the 1977 drought and of the substantial historic investment of public and private dollars in reservoirs and wells, a reasonable question is: How effective were these in-place facilities during 1977? The remainder of this section will address that question.

### Use of surface storage reservoirs during 1977

The effectiveness of a reservoir may be measured by comparing inflow during a critical drought period with the outflow. Without the reservoir, the water users would have access only to the channel flow (the reservoir inflow) as depicted by Figure 2. A reservoir should be considered as a production function which transforms inputs (stream inflow plus capital investment) into a product (larger than the natural streamflow).

In addition to measuring reservoir impact in terms of increased availability of water during the high demand season, it is also helpful to compare reservoir yield during the drought with that during normal years.

Unfortunately, obtaining the data necessary to make these calculations individually for the more than 120 regulated reservoirs in Utah was beyond the scope of this report. A reasonably good estimate of these quantities, however, was produced in the following manner.

Storage levels in most of the major reservoirs in the state are measured by the U.S. Geological Survey. Levels in others are measured by various public and private agencies. The volumes in 30 key reservoirs are reported by the Soil Conservation Service in its regular Water Supply Outlook publications. Table 7 shows the storage in these 30 reservoirs at the beginning of the drought (October 1976), the beginning of the irrigation season (May 1977), and the end of the 1977 irrigation season. The four major Upper Colorado River Basin reservoir impoundments are not used for irrigation diversions within Utah and therefore storage totals are reported both with and without these quantities. The changes in storage from October 1976 to October 1977 reflect the volumes removed from carryover storage during the drought year while changes from May to October 1977 indicate the volumes used to supplement streamflow during the drought irrigation season. In addition to the 30 key reservoirs listed in Table 7. there are 92 other managed impoundments of significant size in Utah (Hughes et al., 1974). Volumes removed from these reservoirs during the drought are not available but have been estimated by assuming the average ratio to draw down to total storage measured for

## Table 7. Reservoir storage (thousand acre feet).

| Basin | Reservoir | Usable Capacity | Usable Storage Oct 1976 | Usable Storage May 1977 | Usable Storage Oct 1977 | Change in Storage May-Oct | Change in Storage May-Oct |
|---|---|---|---|---|---|---|---|
| GREAT BASIN | | | | | | | |
| Bear River | Bear Lake | 1,421.0 | 1,169.1 | 1,050.0 | 787.5 | 262.5 | 381.6 |
| | Woodruff Narrows | 26.5 | 0 | 8.6 | 0 | 8.6 | 0 |
| Beaver | Minersville | 23.3 | 2.8 | 9.4 | 0 | 9.4 | 2.8 |
| Little Bear | Hyrum | 15.3 | 7.7 | 14.9 | 3.8 | 11.1 | 3.9 |
| | Porcupine | 11.3 | 2.0 | 5.0 | 0.6 | 4.4 | 1.4 |
| Ogden | Causey | 6.9 | 1.1 | 4.6 | 1.0 | 3.6 | 0.1 |
| | Pineview | 110.1 | 53.8 | 59.3 | 32.9 | 26.4 | 20.9 |
| Provo | Deer Creek | 149.7 | 78.2 | 99.7 | 57.0 | 42.7 | 21.2 |
| Sevier | Gunnison | 18.2 | 0.3 | 3.2 | 0 | 3.2 | 0.3 |
| | Otter Creek | 52.5 | 16.4 | 34.1 | 6.2 | 27.9 | 10.2 |
| | Pinte | 71.8 | 3.1 | 25.1 | 4.7 | 20.4 | 1.6 |
| | Sevier Bridge | 236.0 | 65.0 | 113.9 | 37.7 | 76.2 | 27.3 |
| Spanish Fork | Strawberry | 270.0 | 203.4 | 211.1 | 136.6 | 74.5 | 70.8 |
| Utah Lake | Utah Lake | 883.9 | 632.6 | 797.6 | 505.6 | 292.0 | 127.0 |
| Weber | East Canyon | 48.1 | 27.7 | 45.6 | 15.7 | 29.9 | 12.0 |
| | Echo | 73.9 | 12.6 | 52.6 | 21.0 | 31.6 | - 8.4 |
| | Lost Creek | 20.0 | 12.9 | 13.9 | 8.6 | 5.3 | 4.3 |
| | Rockport | 60.9 | 43.0 | 33.5 | 19.6 | 13.9 | 23.8 |
| | Willard Bay | 193.3 | 147.3 | 149.0 | 100.5 | 48.5 | 46.8 |
| COLORADO RIVER BASIN | | | | | | | |
| Ashley Creek | Steinaker | 3.3 | 15.6 | 18.1 | 3.0 | 15.1 | 12.6 |
| Colorado | Blue Mesa* | 829.0 | 605.8 | 366.5 | 366.5 | 220.8 | 385.0 |
| | Lake Powell* | 25,002.0 | 19,641.0 | 18,127.0 | 16,144.0 | 1,983.0 | 3,497.0 |
| Green | Flaming Gorge* | 3,749.0 | 3,474.0 | 2,638.0 | 2,079.1 | 558.9 | 139.5 |
| Price River | Scofield | 65.8 | 31.0 | 30.7 | 17.1 | 13.0 | 13.4 |
| San Juan | Navajo* | 1,696.0 | 1,283.6 | 1,092.0 | 1,038.1 | 53.9 | 245.5 |
| San Rafael | Huntington North | 3.9 | 0.4 | 3.8 | 1.4 | 2.4 | - 1.0 |
| | Joe's Valley | 54.6 | 29.2 | 32.9 | 35.7 | - 2.8 | - 6.5 |
| | Mill Site | 16.7 | 0.0 | 3.6 | 3.0 | 0.6 | - 3.0 |
| Strawberry | Starvation | 165.3 | 121.8 | 165.0 | 103.3 | 61.7 | 18.5 |
| Uintah | Bottle Hollow | 11.3 | 10.0 | 10.8 | 9.7 | 1.1 | 0.3 |
| Totals for 30 key reservoirs | | | | | | 3,824.7 | 6,301.0 |
| Totals for 26 key reservoirs (4 Colorado River reservoirs* deleted) | | | | | | 1,083.2 | 778.7 |
| Estimated totals for 92 other reservoirs[1] | | | | | | 174.4 | 98.0 |
| State totals excluding 4 Colorado River reservoirs | | | | | | 1,258.6 | 876.7 |

[1]The 92 other reservoirs total 515,800 AF usable capacity of which 19 percent was estimated as carryover storage (Oct. to Oct.) used during drought and 34 percent of which was estimated May to October storage decrease during the drought irrigation season (based upon the same ratios for the 26 key reservoirs).

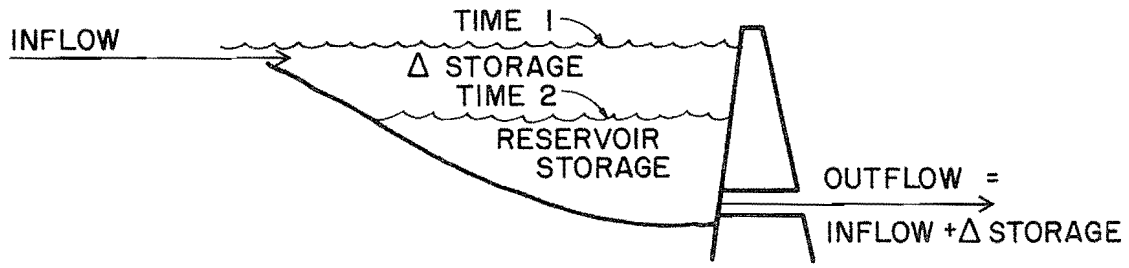


Figure 2. Storage reservoir as a production function

the 26 non-Colorado key reservoirs applied. The result of these calculations was the statewide total estimated at the bottom of Table 7.

Table 7 indicates the estimated withdrawal from reservoir carryover storage during the drought year was 876,700 ac ft. The total withdrawal from Utah Reservoirs during the 1977 irrigation season was 1,258,600 ac ft (excluding the four major Colorado River impoundments). One indication of the value of this supplement to natural streamflow during the drought can be obtained by comparing these figures with the total of 1,349,000 irrigated acres in the state estimated by the Utah Statistical Reporting Service. If the agricultural water requirement not satisfied by natural precipitation is estimated as 3 feet per acre, the 1977 May to October reservoir drawdown (1,258,600 ac ft) would have provided the complete seasonal requirement for 420,000 acres or 31 percent of the state's total irrigated acres.

Irrigation water from most reservoirs, however, supplements natural streamflow; therefore, a more realistic estimate may be that the reservoir draw down provided half the irrigation requirement for 840,000 acres or 62 percent of the total irrigated acres. Of course, not all of the Utah reservoir storage is used for agriculture, but the fraction is so high (over 90 percent) that these figures would be reduced very little if water used for industrial and municipal purposes were subtracted.

Clearly, carryover reservoir storage had a major role in holding drought-caused reductions in agricultural production (Chapter 2) to relatively minor amounts. The previous investment in reservoirs had saved the crops for the year on perhaps half of the state's irrigated acreage.

Use of groundwater during 1977

The estimated total 1977 withdrawal of water from wells in Utah was 947,000 ac ft. This was 10 percent greater than the 1976 total, however, the 1976 withdrawal was also unusually large. The 1977 total was 28 percent greater than the average annual withdrawal during the previous ten years. The geographic distribution of groundwater use over the state and the purpose of the withdrawals for 1977 are detailed in Table 8, which was taken from an annual groundwater report published jointly by the Utah Division of Water Resources and the United States Geological Survey (Gates et al., 1978).

An interesting situation in the Salt Lake County area (Jordan Valley) was that during 1977 the Salt Lake County Water Conservancy District (SLCWCD) pumped much more from their 15 wells than it ever had during previous years (70 percent more than in 1976), and yet groundwater levels in the area where their wells are located rose rather than lowered during 1977. This can be partially explained by the facts that, despite this major increase in withdrawals by SLCWCD, this utility pumps only a small fraction of the total withdrawal in the Jordan Valley (9,572 out of 119,000 ac ft during 1977) and total withdrawals for the Jordan Valley basin were down 4 percent in 1977 due to conservation measures by others.

Despite the heavy use of groundwater over the state relative to previous averages, the water levels generally declined only modestly or in some areas even rose. For example, in Cache Valley water table declines averaged 0 to 3 feet with local changes ranging from declines as much as 6 feet to rises as much as 6 feet. Along the east shore of the Great Salt Lake, where withdrawals increased by 25 percent, water levels declined 1 to 10 feet. In the Jordan Valley as a whole declines averaged 2.5 feet. In Utah Valley, withdrawals were 32 percent above average, but water levels generally declined less than 5 feet. A large increase in withdrawals from the Sevier Desert Basin caused only about a 2 foot decline in water table. In the Milford area, declines averaged less than 1 foot.

Several conclusions are suggested by this information. The groundwater resources of Utah proved extremely valuable in counteracting the drought in regions of the state where good aquifers exist. In other areas where only surface supplies were available,

the effect was much more adverse. Most of the larger population centers in Utah are underlain by large aquifers which were not strained by the extra demands caused by diminishing surface supplies during the drought. Where pumping during most years had been minor, water levels declined, but not very much because of the large amounts of water stored underground. Where major pumping had been the rule, water levels actually rose, probably because water use declined through the statewide water conservation effort.

In addition to increasing withdrawals from existing wells during 1977, the drought had a major impact in increasing the number of new wells drilled. As shown in Table 8, 1611 water wells were drilled during 1977. This compares with 746 during 1976, an increase of 116 percent. The number of small residential wells was up 268 percent from 104 to 383, and the number of large withdrawal wells (irrigation, industrial, and municipal supply) jumped 343 percent from 65 to 288. During most of 1977, drillers in the state had a backlog of customers that required several months wait for drilling a well. Clearly, the public as well as agricultural and utility managers recognized the value of access to groundwater during the drought. Although some of the wells drilled during 1977 were not equipped with pumps, controls, and an energy source in time for use during the 1977 summer peak demand period, these water development projects will be available in the future.

Table 8. Well construction and withdrawal of water from wells in Utah (from Gates et al., 1978).

| Area | Number of Wells Completed in 1977 | | | Estimated Withdrawal from Wells (acre-ft) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Diameter | | | | | | | | | |
| | Less Than 6 in. | 6 in. or more | Large-Withdrawal Wells[a] | Irrigation | Industry | 1977 Public Supply | Domestic and Stock | Total (rounded) | 1976 Total | 1967-76 Average Annual |
| Cache Valley | 29 | 35 | 4 | 17,600 | 8,800 | 3,800 | 2,100 | 32,000 | 27,000 | 24,000 |
| East Shore area | 35 | 20 | 5 | 15,800 | 6,700 | 29,300 | - | 52,000 | 41,000 | 43,000 |
| Jordan Valley | 9 | 97 | 24 | 5,500 | 33,000 | 47,300 | 33,000 | 119,000 | 124,000 | 117,000 |
| Tooele Valley | 1 | 27 | 6 | 23,200 | 500 | 4,300 | 151 | 28,000 | 30,000 | 27,000 |
| Utah and Goshen Valleys | 25 | 153 | 13 | 66,800 | 8,100 | 30,300 | 12,700 | 118,000 | 107,000 | 89,000 |
| Juab Valley | 0 | 10 | 3 | 28,500 | 50 | 200 | 200 | 29,000 | 29,000 | 23,000 |
| Sevier Desert | 4 | 19 | 0 | 46,800 | 2,000 | 600 | 900 | 50,000 | 33,000 | 26,000 |
| Sanpete Valley | 0 | 17 | 4 | 30,900 | 900 | 1,300 | 3,300 | 36,000 | 25,000 | 17,000 |
| Upper and Central Sevier and Upper Fremont River Valleys | 0 | 57 | 4 | 16,500 | 100 | 2,800 | 6,300 | 26,000 | 25,000 | 20,000 |
| Pavant Valley | 0 | 19 | 6 | 115,700 | 100 | 600 | 300 | 117,000 | 95,000 | 83,000 |
| Cedar City Valley | 0 | 19 | 8 | 37,100 | 1,000 | 1,900 | 200 | 40,000 | 37,000 | 32,000 |
| Parowan Valley | 0 | 11 | 6 | 32,800 | 100 | 250 | 150 | 33,000 | 34,000 | 26,000 |
| Escalante Valley | | | | | | | | | | |
| Milford area | 0 | 23 | 12 | 64,000 | 0 | 800 | 200 | 65,000 | 67,000 | 57,000 |
| Beryl-Enterprise area | 0 | 20 | 12 | 79,500 | 0 | 300 | 750 | 81,000 | 79,000 | 78,000 |
| Other Areas | 280 | 701 | 181 | 94,800 | 3,100 | 21,900 | 1,200 | 121,000 | 108,000 | 75,000 |
| Totals (rounded) | 383 | 1228 | 288 | 676,000 | 64,000 | 146,000 | 61,000 | 947,000 | 861,000 | 737,000 |

[a]Wells (6 inches or more in diameter) constructed for irrigation, industry, or public supply. Included under "6 inches or more."

CHAPTER 2

# DROUGHT IMPACT UPON PEOPLE AND THE ECONOMY

## Impact on Municipal Water Supply

### Introduction

The 1977 drought was felt in various ways in varying degrees by every municipal water utility in Utah and by the people they serve. Since complete documentation of all these impacts would be impractical, this report presents its overall assessment in two parts. The first summarizes effects on 154 water utilities scattered over the state, and the second analyzes the impact on Utah's second largest water utility, the Salt Lake County Water Conservancy District (SLCWCD). The first part surveys the breadth of the drought impact, and the second part looks into what happened in sufficient depth to provide some understanding of the principal interactions among drought conditions, water utilities, and water users.

Data on what happened to communities throughout the state were compiled from a statewide water use survey made jointly by the Utah Water Research Laboratory and the Utah League of Cities and Towns near the end of 1977 (Hansen et al., 1978). Because of the fortuitous timing of this survey, a section related specifically to impact of the 1977 drought was added to the questionnaire. Usable responses were obtained from 154 of the 450 municipal and rural domestic systems to whom the questionnaire was sent. Since virtually all of those not responding were very small rural systems and altogether they serve only a tiny fraction of the population, the results provide excellent population coverage.

Data on what happened in the Salt Lake County Water Conservancy District were obtained by analysis of water use data kept routinely by the district and from a special survey the district made of its customers following the drought.

### Statewide survey

Scope. The survey of municipal water utilities included drought related questions on three basic factors: 1) Water rate increases during the drought (usually to provide an economic incentive to reduce use), 2) emergency funding to supplement water supply, and 3) restrictions on water use. Appendix A details the survey results, including breakdowns of impacts by multi-county districts (Figure 3) and climatic districts (Figure 1), population, size of system, and type of water source.

Water rate increases. Statewide, 36.4 percent of the systems increased the price charged for water during 1977. Only one-third of these admitted that the rate increases were caused by the drought; however, it is likely that this report was influenced by a reluctance on the part of many utilities to go back to the old rates after having gone through the painful process of justifying a rate increase to their customers. Only 30 percent of the systems which increased their rates indicated an intention to reduce charges when the drought ended.

Geographically, very few utilities increased rates in the Mountain Lands district (an area of usually excess water) and in the Southwestern district (an area of perennial shortage where drought is the rule rather than the exception). About half of the systems along the Wasatch Front raised rates and 73 percent of Uintah Basin systems increased water charges.

There was no correlation between size of system and the number of systems which increased rates. There was, however, a strong correlation between types of water source and number of systems which increased rates; namely, 73 percent of those which use surface water as their supply increased their rates while only 30 to 32 percent of those using spring and well sources did so.

Emergency funding. Statewide, 16 percent of the systems reporting received drought emergency funding during 1977. Geographically, there was no correlation with distribution of drought funds (perhaps indicating a political reluctance to favor one region over another); however, there was a very strong correlation with the size of the system. None of the systems serving more than 5000 people reported receiving emergency funds. This likely reflects both a state policy (assistance is limited to small communities) and the importance of economies of scale in cost of water supply systems and the ability of larger systems to solve their own financial problems.

Restrictions on water use. On a statewide basis half of the water systems restricted water use by their customers during

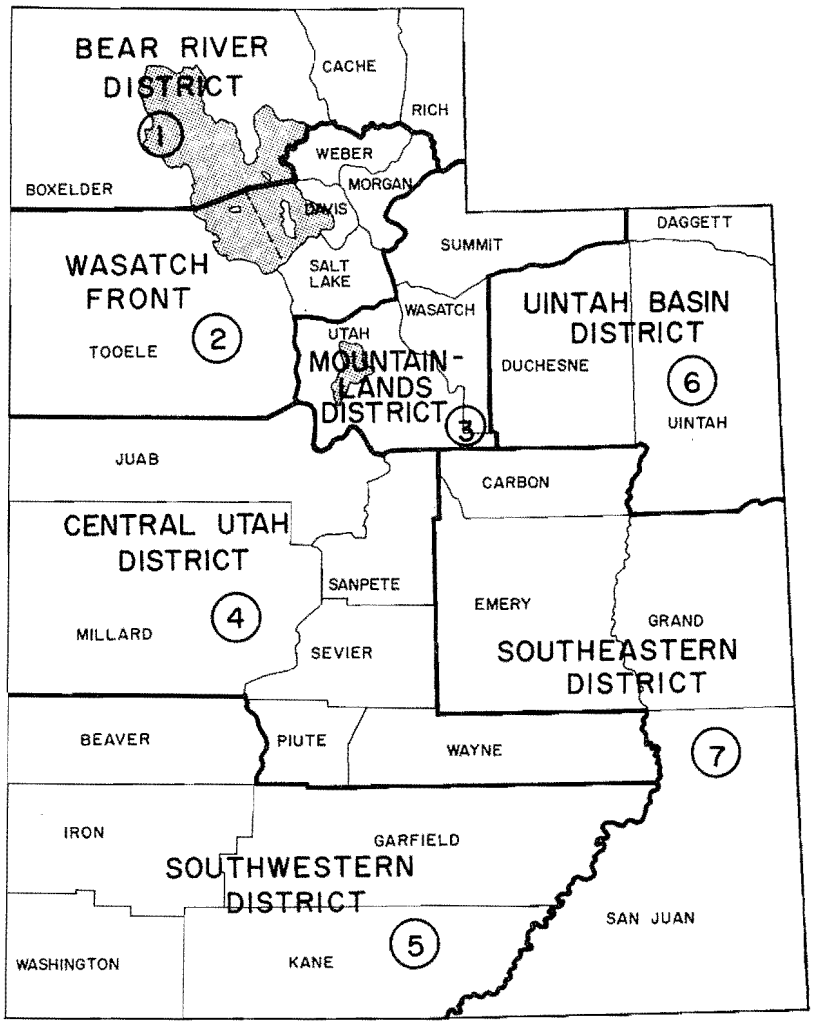


Figure 3. Location of Utah multi county districts.

the drought. Two thirds of these restrictions were initiated during the drought (one sixth of the systems in the state already had some form of restrictions). Of the systems with restrictions, half were mandatory and half were voluntary. Most restrictions were begun during May or June 1977 and ended in September or October at the close of the irrigation season. About 22 percent of the systems are continuing the restrictions.

The most common form of restriction was a limitation on both days of the week and hours of the day when individuals could sprinkle yards (44 percent), 16 percent of the systems limited days only, and 11 percent limited hours of the day only. Six systems went so far as to allow no outdoor use. The people those systems serve suffered substantial loss of landscaping.

Geographically, restrictions were most common in the Southeastern district (80 percent of the systems) and also occurred extensively in the Uintah Basin (71 percent). The Wasatch Front experienced restrictions in 61 percent of the systems while other districts varied from 33 to 45 percent.

The use of restriction was surprisingly correlated with population. Despite the extensive use of restrictions in the Southeast and Uintah Basin (areas with mostly small systems) the largest systems in the state were the most likely to restrict usage. Nine systems serve more than 25,000 people and seven of these (78 percent) used restrictions. This compares with use limitations by less than 40 percent of the systems serving less than 2,500 population. This can be at least partially explained by the fact that more of the larger systems use surface water sources and these were most impacted by the drought. Specifically, 86 percent of those systems which use surface water plus some other source also used

restrictions. This compares with 46 percent of systems which use springs only and 39 percent of systems which rely exclusively on wells.

## Impact on Salt Lake County Water Conservancy District

### Background

The SLCWCD is both a water wholesaler and retailer to a large population in rapidly growing areas of Salt Lake County. This district serves 6,627 retail customers in neighborhoods ranging from single family residential to a mixture of commercial establishments and multiple dwelling units. This utility was selected for detailed discussion not because it was impacted by the drought more severely than other utilities; but rather because it conducted a very extensive compaign to communicate information on the drought to its customers (including justification for its mandatory restrictions) and also obtained excellent feedback on drought experiences from a large fraction of its retail customers during the following winter.

### Communication with retail customers

As part of a planned program to communicate with its customers, the utility responded to telephone inquiries, granted interviews, and prepared media releases. However, the principal drought related communication was a planned series of written messages mailed with each water bill. These messages are summarized as follows:

Feb./March 1977. A rather lengthy bill stuffer stressed the apparent implications of the lowest snowpack on record, requested voluntary conservation wherever possible, and described ways to conserve in the home.

April 1977. The normal two-month billing period was reduced to monthly, and rules for voluntary water restrictions were put into effect. The goal of the voluntary program was to cut outdoor use by 50 percent. The rules were: 1) Water outside during only 4 hours per week; 2) limit outside use to the hours of 8 pm to 10 am; 3) even numbered houses water on Monday, Wednesday, and Friday; odd numbered houses water on Tuesday, Thursday, and Saturday (no watering on Sunday).

May 1977. Mandatory restrictions began in the form of a $10/kgal (thousand gallon) penalty for use over an allotted amount. The monthly allotments were determined from average meter readings in each neighborhood and were the same for each customer in the neighborhood. They were computed as average (1976) indoor use plus 50 percent of 1976 outdoor use for each neighborhood. Individual neighborhood figures varied widely (from 14,000 to 41,000 gallons). This $10 penalty compared to 25 cents as the normal unit cost of water.

June 1977. The message thanked the customers for almost universal cooperation with the conservation program, reviewed the restriction rules, and answered many telephone questions.

July 1977. The message informed customers of continuing drought conditions and described how a customer could allocate his water better within his restrictions by reading his meter frequently.

August 1977. Restrictions were relaxed by allowing a 50 percent increase in use without penalty and Sunday water was allowed.

Sept./Oct. 1977. All restrictions on days and hours were terminated, but voluntary conservation was still encouraged.

Nov./Dec. 1977. New drought information and a questionnaire including a series of questions on the drought experience was mailed to each retail customer.

Jan./Feb. 1978. A summary of the survey results was mailed to each customer.

### Results of the survey

The November-December questionnaire was answered and returned by 2,500 of the 6,657 customers. Many of the yes/no questions also invited individual comments on inequities and suggestions on how the restrictions could have been better handled. The wide variety of responses make fascinating reading but will be discussed here only to the extent that they can be categorized into significant group opinions.

Summary of questions and responses.

1. Do you feel that our water restrictions imposed an undue burden rather than an inconvenience on your household?

   10% said Yes, 84% No, 6% No response

2. If we must use water restrictions again in the coming year to control water use, what basis would you like to see us use to determine the amount of water you could use?

   48% said Same as Last Year, 35% Based on Size of Family, 35% Based on Size of Size of Yard, 5% each Household an Equal Amount, and 7% offered some other plan. A number of people indicated more than one choice on this question.

3. Do you feel that our $10 per 1,000 gallon surcharge on excessive water use was a reasonable and fair way to make water users aware of the need to conserve water?

   70% Yes, 22% No, 8% No response

4. Do you feel that it is reasonable for us to ask you to water before 10 am and after 8 pm and on every other day during the summer?

   72% Yes, 25% No, 3% No response

5. Do you have any suggestions for a better system of controlling water use?

   22% made some suggestions

6. Do you think you have good water service generally?

   51% said always, 45% usually, 1% half the time, 6 individuals said occasionally, 6 said never, 3% no response

## Conclusions

The striking conclusion from the survey was that, despite the rather severe restrictions (or at least the severe financial penalty for exceeding allotments) which were imposed, only 10 percent of the customers considered that they experienced an undue burden. About half agreed that the same system should be used in future droughts while one-third wanted the allotment based upon size of family and one-third based upon size of yard (some wanted both), rather than on previous use. The most common criticism of the percent-of-previous-use basis for the allotment was that those who conserved even during wet years (the group in which virtually all respondents included themselves) were penalized most while perennial wasters were given bigger allotments. Another area of complaint was that many believed the late night watering killed their lawns due to fungus growth.

Apparently, many customers eliminated lawn watering almost completely. This appeared to be due to fear of the large penalty for exceeding the allotment combined with lack of knowledge about how to read their meter and ration their water allotment properly.

Another common type of complaint was related to equity questions such as: Why are we restricted when Salt Lake City and Murray City are not? Why am I restricted more than my cousin in a different neighborhood? Why aren't you enforcing the penalties on my neighbor who is wasting water?

Despite the long list of complaints, only 22 percent thought the $10/kgal penalty was excessive and only 25 percent thought the night watering hours were unreasonable. In short, the large majority of water users accepted the District's approach to water management during the shortage. This has some important implications in regard to the system demand functions and hydraulic capacities which are discussed next.

## Impact on system demand

As described in a previous section, the SLCWCD restrictions during the summer of 1977 required that only half of the customers in any neighborhood use outside water on any given day and limited all outside watering to evening off-peak hours for domestic and commercial water uses. These voluntary restrictions were not universally followed, but the voluntary compliance which was achieved along with the large financial penalty on excessive monthly usage resulted in dramatic decreases in both summer monthly volumes and peak short term flow rates (see Table 9).

Table 9. Retail deliveries in thousand gallons per connection.

| Month | 1976 | 1977 | % Reduction |
|---|---|---|---|
| May | 18.4 | 17.8 | 3 |
| June | 36.4 | 23.5 | 35 |
| July | 49.9 | 31.5 | 37 |
| August | 59.5 | 29.7 | 50 |
| September | 20.2 | 29.2 | -49 (increase) |

The 1977 water volumes delivered to retail customers decreased from 35 to 50 percent from corresponding 1976 values for the three peak summer months. An interesting result of lifting the restrictions during September 1977 was that conservation not only stopped immediately, but demand actually increased 49 percent above the non-drought year. This was perhaps predictable since many customers probably attempted to revive brown lawns.

The overall deliveries for these two years (retail plus wholesale) showed a decreased of 28 percent from 26,000 ac ft in 1976 to 18,800 ac ft in 1977. This compares to a 25 percent reduction in retail only sales. The annual reduction is less than that during the three peak summer months because nonirrigation month deliveries were essentially equal for the two years.

The most dramatic reduction was in peak daily delivery rates caused by the combination of shifting outside watering to non-peak hours and reducing total water use by the penalty charge. For example, during 1976 the peak inflow to the total system which occurred during at least 3 days was 123 cfs (total spring, well, and treatment plant production). This peak was reduced to 72 cfs during 1977, a reduction of 42 percent. The decrease was about 50 percent on many summer days. Since 90 percent of the water users did not experience a serious burden, these figures suggest that this combination of shifting watering periods and surcharges and

penalty charges could be used routinely to reduce flow peaks, making it possible for a utility to serve considerable growth without additional capital investment in water mains and pumps. Considerable cost savings could be passed on to the customer, but water users may not be as responsive to continuing voluntary scheduling to cut utility costs as they were to the short-term drought emergency.

Even though the water volume delivered decreased by 28 percent, the district revenues decreased only 4 percent (from $2,462,150 to $2,360,820). This relatively small decrease in revenue can be explained by three factors, the least important of which is the revenue from the $10/kgal penalty. Only $6,500 in penalty revenue was collected (0.2 percent of the total) because allotments were set high enough that almost no one exceeded them. More important factors were 1) an increase in the price charged for wholesale water and 2) the higher units rates which result from spreading the minimum charge over fewer gallons. Rates remained the same (within the allotment) at $4/month minimum for 10 k gallons (40 cents/k gal) plus 25 cents/k gallons over 10 k. This meant that as monthly volumes decreased the average unit cost increased (from 30 to 34 cents/gal from 1976 to 1977).

Between 1976 and 1977, average monthly volumes decreased from 25.5 to 20 k gallons per month in the Granite Park (mixed commercial and residential) area and from 25.8 to 17.4 k gallons in the 1300 East residential area. This 33 percent decrease in annual water use in the residential area is very striking in view of the fact that during 8 months of the year the volumes were essentially the same. The fact that so much conservation could be achieved with so little negative impact on users suggests that the price of water in the SLCWCD (and in most other Utah systems) is so low in comparison to its value to the users that during normal years there is simply no incentive to conserve water.

## Impact on Agriculture

### Introduction

The unusual nature of the 1977 drought is graphically demonstrated by its impact, or in some cases its lack of impact, upon agriculture. The record low amounts of winter precipitation meant very low soil moisture levels for plant growth and low streamflows for irrigation during that water year. The extremely dry winter caused serious implications for irrigated agriculture and for some nonirrigated operations such as winter sheep grazing on desert ranges. However, the precipitation which occurred during the summer of 1977 seemed to come at optimum times for supplementing irrigation water for crop production and particularly for producing dryland crops and restoring grass on rangeland. Tables 10, 11, and 12 summarize the

Table 10. Crop acreage[a] for principal crops, UTAH 1972-77.

| Crop | Year | | | | | | Ratio (1977/Avg)[b] | |
|---|---|---|---|---|---|---|---|---|
| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | Acres Harvested | Acres Planted |
| | | | 1,000 acres | | | | | |
| Corn Silage | 69 | 74 | 78 | 80 | 80 | 62 | 0.78 | 0.81 |
| Corn for Grain | 8 | 13 | 14 | 15 | 15 | 13 | 0.89 | 0.81 |
| Winter Wheat | 205 | 207 | 243 | 238 | 222 | 180 | 0.77 | 0.89 |
| Spring Wheat | 16 | 47 | 52 | 44 | 42 | 24 | 0.52 | 0.48 |
| Oats | 13 | 14 | 12 | 13 | 12 | 10 | 0.81 | 0.92 |
| Barley | 132 | 135 | 131 | 135 | 126 | 115 | 0.88 | 0.98 |
| Alfalfa & Mixtures | 455 | 460 | 460 | 460 | 460 | 405 | 1.01 | |
| Other Hay | 131 | 124 | 118 | 124 | 120 | 119 | 0.97 | |
| All Hay | 586 | 584 | 578 | 584 | 580 | 584 | 1.00 | |
| Dry Beans | 13 | 15 | 14 | 15 | 13 | 1 | 0.06 | 0.32 |
| Potatoes | 4.3 | 5.0 | 6.3 | 5.8 | 5.2 | 5.4 | 0.94 | 0.94 |
| Sugar Beets | 22.0 | 18.4 | 17.0 | 22.5 | 18.0 | 11.1 | 0.58 | 0.65 |
| Alfalfa Seed | 9 | 10 | 17 | 13 | 11 | 13 | 0.95 | |
| Vegetables for Processing | 5.9 | 5.4 | 5.8 | 6.3 | 5.3 | 4.7 | 0.81 | 0.84 |
| Onions | NA | NA | NA | 1.3 | 1.5 | 1.4 | 1.00 | 1.00 |
| | 1083.2 | 1127.8 | 1168.1 | 1172.9 | 1131.0 | 1024.6 | 0.885 | |

[a]Harvested acres except for last column.

[b]1977 values divided by average of 1974, 75, and 76.

Source: Utah Agricultural Statistics, 1978.

Table 11. Crop production for principal crops, Utah, 1972-77.

| Crop | Unit | Year | | | | | | Ratio (1977/Avg)[a] |
|---|---|---|---|---|---|---|---|---|
| | | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | |
| Corn Silage | 1,000 Tons | 1,173 | 1,295 | 1,326 | 1,440 | 1,280 | 1,054 | 0.78 |
| Corn for Grain | 1,000 Bu. | 736 | 1,430 | 1,680 | 1,650 | 1,350 | 1,157 | 0.92 |
| Winter Wheat | 1,000 Bu. | 5,433 | 4,968 | 6,318 | 5,712 | 5,217 | 4,410 | 0.72 |
| Spring Wheat | 1,000 Bu. | 704 | 1,363 | 1,664 | 1,452 | 1,302 | 576 | 0.39 |
| Oats | 1,000 Bu. | 676 | 756 | 636 | 728 | 684 | 550 | 0.81 |
| Barley | 1,000 Bu. | 8,052 | 7,695 | 7,205 | 8,100 | 6,930 | 6,210 | 0.84 |
| Alfalfa & Mixtures | 1,000 Tons | 1,297 | 1,449 | 1,518 | 1,472 | 1,610 | 1,628 | 1.06 |
| Other Hay | 1,000 Tons | 216 | 211 | 177 | 198 | 210 | 214 | 1.04 |
| All Hay | 1,000 Tons | 1,513 | 1,660 | 1,695 | 1,670 | 1,820 | 1,842 | 1.06 |
| Dry Beans | 1,000 Cwt. | 52 | 68 | 46 | 63 | 51 | 2 | 0.03 |
| Potatoes | 1,000 Cwt. | 1,011 | 1,100 | 1,481 | 1,508 | 1,248 | 1,296 | 0.92 |
| Sugar Beets | 1,000 Tons | 431 | 322 | 296 | 353 | 317 | 198 | 0.61 |
| Alfalfa Seed | 1,000 Lbs. | 2,970 | 2,300 | 5,100 | 3,640 | 2,365 | 3,250 | 0.88 |
| Onions | 1,000 Cwt. | NA | NA | NA | 377 | 450 | 420 | 1.02 |

[a]1977 values divided by average of 1974, 75, and 76.

Source: Utah Agricultural Statistics, 1978.

acreage, production and yields per acre for principal Utah crops during 1977 and previous years.

In general, the weather during the growing season was excellent for plant growth. For some locations and crops yield per acre actually exceeded previous averages. In many locations the principal production decreases were caused by decisions by farmers to plant fewer acres (in the best soil) due to projected shortages of both reservoir storage and in-stream flows. Table 10, for example, shows that the number of acres planted for all crops (excluding hay) was about 22 percent less than the recent previous average. An interesting related statistic is that the total number of acres harvested was only 12 percent less than the previous average (including hay)--indicating both the favorable

Table 12. Crop yields per acre for principal crops, Utah, 1972-77.

| Crop | Unit | Year | | | | | Estimated | Ratio |
|---|---|---|---|---|---|---|---|---|
| | | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | (1977/Aug)[a] |
| Corn Silage | Ton | 17.0 | 17.0 | 17.0 | 18.0 | 16.0 | 17.0 | 1.00 |
| Corn for Grain | Bu. | 92.0 | 110.0 | 120.0 | 110.0 | 90.0 | 89.0 | 1.04 |
| Winter Wheat | Bu. | 26.5 | 24.0 | 26.0 | 24.0 | 23.5 | 23.0 | 0.94 |
| Spring Wheat | Bu | 44.0 | 29.0 | 32.0 | 33.0 | 31.0 | 24.0 | 0.75 |
| Oats | Bu | 52.0 | 54.0 | 53.0 | 56.0 | 57.0 | 55 | 0.99 |
| Barley | Bu. | 61.0 | 57.0 | 55.0 | 60.0 | 55.0 | 54 | 0.96 |
| Alfalfa & Mixtures | Ton | 2.85 | 3.15 | 3.3 | 3.2 | 3.5 | 3.5 | 1.05 |
| Other Hay | Ton | 1.65 | 1.7 | 1.5 | 1.6 | 1.75 | 1.8 | 1.07 |
| All Hay | Ton | 2.58 | 2.84 | 2.93 | 2.86 | 3.14 | 3.15 | 1.05 |
| Dry Beans | Lbs. | 400 | 450 | 330 | 420 | 390 | 200 | 0.54 |
| Potatoes | Cwt. | 235 | 220 | 235 | 260 | 240 | 240 | 0.98 |
| Sugar Beets | Ton | 19.6 | 17.5 | 17.4 | 15.7 | 17.6 | 17.8 | 1.05 |
| Alfalfa Seed | Lbs. | 330 | 230 | 300 | 280 | 215 | 250 | 0.94 |
| Onions | Cwt. | NA | NA | NA | 290 | 300 | 335 | 1.14 |

[a]1977 values divided by average of 1974, 75, and 76.

Source: Utah Agricultural Statistics, 1978.

summer climate and the fact that the irrigation water which was available was managed better than during an average year.

The discussion of particular agricultural product sectors which follows consists largely of quotations from "Utah Agricultural Statistics, 1978" plus some additional discussion of the drought impacts. The tables of agricultural product data also contain information extracted largely from the same publication but with the format modified to make 1977 comparison to previous production levels explicit.

Field crops

Summary. Where irrigation water was adequate, the season was very favorable for growth and harvesting of crops. Yields on grain and hay crops where water was adequate were unusually good with some farmers reporting that their alfalfa hay yields were the largest they had ever harvested. This did much to offset low yields or crop failures where irrigation water supplies were limited and where soil moisture was short to very short on nonirrigated cropland. Irrigated crops along the Wasatch Front were generally good and they varied from poor to good in other sections. Nonirrigated crops were fair to good in northern Utah, poor to fair in central, and very poor in southeast Utah.

Production of field and seed crops in 1977 was down 10 percent from a year earlier, down 12 percent from the large 1975 crop production, and the smallest since 1968 when acreage controls and conservation reserve programs were limiting crops grown. Production in 1977 compared with a year earlier was larger for potatoes, all hay, and alfalfa seed--smaller for corn, for grain and silage, wheat, oats, barley, dry beans, sugar beets, and sugar beet seed. Sharpest reductions were in dry beans and sugar beets.

The rains in north central Utah during August and September provided needed moisture for seeding fall grains. Moisture for fall planted wheat was poor to fair in central sections--fair in about half of San Juan County (southeastern Utah) and very poor in the remainder of that county.

Accurate measurement of the full impact of the drought upon Utah field crops would require a statewide survey of individual farmers including a comparison of anticipated 1977 production of various crops had the drought not occurred with actual production. Such a survey is beyond the scope of this study and a surrogate index of drought impact will be used. Major crop production and average unit price data for 1976 and 1977 are included in Utah Agriculture Statistics, 1978. Table 13 displays the difference between the production value of each crop for these two years. The net decrease in field crop production from 1976 to 1977 totals $13 million. Estimation of the drought impact in this manner probably understates the total figure because without the drought there would probably have been a production increase during 1977. Except for a few crops such as wheat and sugar beets, the recent trend in Utah has been a general increase in field crop production. $13 million is therefore considered to represent a very conservative estimate of the drought impact.

Corn. The acreage planted to corn was reduced 20 percent--from 100,000 acres in 1976 to 80,000 acres in 1977--because of drought conditions and expected water shortages. Production of corn silage in Utah was 1,054,000 tons, 18 percent less than a year earlier and 27 percent less than the record high 1,440,000 tons in 1975. Yield per acre was 17.0 tons in 1977, up 1.0 ton from 1976 and about average for the last 7 years. There were only 62,000 acres of silage harvested compared with 80,000 a year earlier. This

Table 13. Comparison of field crop production value--1976 and 1977.

| Crop | Production (1000 Units) | | | | | Total Value of Decrease ($ Million) |
|---|---|---|---|---|---|---|
| | Unit | 1976 | 1977 | Decrease | Avg. Price ($/Unit) | |
| Corn (Silage) | Bushel | 1280 | 1054 | 226 | 17.20 | 3.9 |
| Corn (Grain) | Bushel | 1350 | 1157 | 196 | 2.45 | 0.5 |
| All Wheat | Bushel | 6519 | 4716 | 1803 | 2.44 | 4.4 |
| Barley | Bushel | 6930 | 6210 | 720 | 1.85 | 1.3 |
| Oats | Bushel | 684 | 550 | 134 | 1.40 | 0.2 |
| Dry Beans | Cwt. | 51 | 2 | 49 | 22.90 | 1.1 |
| Potatoes | Cwt. | 1248 | 1296 | -48 | 3.13 | -0.1 |
| Sugar Beets | Ton | 317 | 173 | 144 | 19.40 | 2.8 |
| S. Beet Seed | Cwt. | 9.7 | 5.0 | 4.7 | 40.00 | 0.2 |
| All Hay | Ton | 1820 | 1842 | -22 | 58.00 | -1.3 |
| | | | | Total Decrease | | $13 Million |

was the smallest acreage since 1971, and the reduction occurred in those areas where irrigation water was expected to be short. Areas with adequate water had normal acreage and produced good crops. The value of corn silage production in Utah in 1977 amounted to $18.1 million. The only crop produced in the state with higher value in 1977 was hay. Corn for grain production in 1977 totaled 1,157,000 bushels--14 percent less than 1976. Yield at 89.0 bushels per acre from 13,000 acres compared with 90.0 bushels per acre from 15,000 acres in 1976. Nearly all corn in Utah is grown on irrigated land and in locations where the growing season is long enough for the crop to mature but the heaviest concentrations are in Utah County and north from there.

Wheat. Production of all wheat in 1977 amounted to 4,716,000 bushels, 28 percent less than 1976 and smallest since 1961. Acreage harvested was reduced by drought over much of the state. Winter wheat output totaled 4,140,000 bushels, 21 percent less than 1976 and smallest since 1964. Average yield per harvested acre at 23.0 bushels was 0.5 bushel below 1976 and, because of the dry weather, the lowest since 1964. There were 180,000 acres harvested, 19 percent less than 1976 and smallest since 1943.

Spring wheat production, at 576,000 bushels, was less than half that of a year earlier because of the drought. This was the smallest spring wheat crop of record. There were only 24,000 acres harvested for grain compared with 42,000 in 1976. This was still more than the 1970-72 level before high wheat prices in 1973 caused a sharp increase in acreage. About 40 percent of the state's spring wheat acreage was harvested in Box Elder and Cache Counties.

Most of Utah's winter wheat crop is grown on nonirrigated land (85 percent in 1969) and most of the spring wheat is grown on irrigated land (69 percent in 1969). Therefore, the pattern of drought impact on wheat production is apparent from the data presented in Tables 10, 11, and 12. The very large decrease in spring wheat (both acres planted and yield) reflects the shortages of irrigation water while the serious, but smaller decrease in winter (mostly dry land) wheat production was made possible by fortuitously timed summer rains.

Feed grains. Production of barley amounted to 6,210,000 bushels in 1977--10 percent below 1976 and smallest since 1964 as the drought reduced both acreage and yield. Yield, at 54.0 bushels, was 1.0 bushel below 1976. Area harvested for grain in 1977 amounted to 115,000 acres, 11,000 acres less than 1976, and lowest since 1946. Irrigated acreage of this crop, according to the 1974 Census, accounts for about 80 percent of the total. Major counties in barley production include Cache, Box Elder, Utah, and Millard where about 60 percent of the 1974 Census total barley acreage was harvested. Oat production, at 550,000 bushels in 1977, was 20 percent less than in 1976 and smallest since records started in 1909. Yield per acre at 55.0 bushels, was 2.0 bushels below 1976. The acreage harvested for oats, at 10,000, was down 2,000 from 1976 and lowest of record. While oats are primarily grown for grain, over a third of the acreage is planted for hay or pasture--a much higher portion than for either wheat or barley. Most of the state's oat acreage is grown on irrigated land. Production is spread throughout the state.

Dry beans. The 1977 drought was particularly bad in the dry bean area of southeastern Utah and only about 2,000 cwt. were harvested compared with the 1970-76 average of 64,000. Acreage planted was reduced to about 5,000 acres because of short moisture supplies. Continued dry weather resulted in only about 1,000 acres being harvested. Yields on the area harvested averaged only 200 pounds. In comparison, the 1970-76 averages were 16,000 acres harvested and 390 pounds per acre. Essentially all dry beans grown in Utah in recent years have been in San Juan County (southeast corner of Utah) on nonirrigated land.

Potatoes. Growers harvested 5,400 acres of potatoes in 1977, up 200 from 1976 and about average for the last 7 years. Yield per acre at 240 cwt. was the same as a year earlier. Production at 1,296,000 cwt. was up 4 percent.

Sugar beets. The 1977 sugar beet acreage was reduced in anticipation of water shortages in some sections and because of low prices. Production amounted to 173,000 tons, 45 percent less than 1976 and the smallest since records started in 1904. Only 9,800 acres of sugar beets were harvested in 1977, 46 percent less than 1976 and smallest on record. Yield averaged 17.7 tons per acre, slightly above 1976 and about average for recent years.

Hay crops. Production in 1977 totaled 1,842,000 tons, a record high and 1 percent above 1976. Hay (all classes) is the major crop grown in Utah. The 584,000 acres harvested in 1977 accounted for more than half of the total acreage of all crops harvested. Hay is grown throughout the state although its relative importance is lowest in nonirrigated grain farming sections. Alfalfa hay with a yield of 3.50 tons per acre accounted for most of the total hay with 1,628,000 tons, up 1 percent and a new record. Except for short irrigation water supplies in some sections, the 1977 season was very favorable for alfalfa hay with many reports of the largest yields ever harvested along the Wasatch Front. Quality was excellent. Other hay production at 214,000 tons was up 2 percent. Water shortages cut production substantially in some sections--particularly wild hay production in Rich County. However, in other areas, more grain

was cut for hay than usual and the drop in wild hay production was offset. Harvest weather was favorable and quality was good. Because of the limited feed supply on grazing lands there was considerable incentive to maximize hay production, and therefore limited water supplies were undoubtedly diverted from other uses to hay production during 1977.

Fruits

General. Fruit in Utah has a history dating back to the early pioneers. The acreage in fruit orchards reached a peak of about 20,000 acres in the mid-1940s. Since then the acreage has dropped to about 12,000 as a result of subdivisions taking orchard lands and competition from other states. Recently there has been some increase in apple and tart cherry plantings while apricot and pear tree numbers show a steady decline.

1977 production. The 1977 season was fair to good for Utah fruit crops in most areas. Spring frost damage was light and most fruits set good to heavy crops except tart cherries which were fairly light. Total fruit production, at 49,250 tons, was 3 percent less than in 1976 but still third largest in 15 years. It compared with 50,540 tons in 1976 and the very heavy crop of 55,350 tons in 1973. Utilized production of peaches at 8,750 tons was slightly less than the 8,900 tons in 1976, which was the largest since 1951. The apple crop totaling 23,500 tons was 18 percent larger than 1976 and second largest in recent years--following the 26,350 tons in 1973. Sweet cherry production dropped 22 percent from 1976--from 6,000 tons to 4,700 tons in 1977--with most of the drop (1,300 tons) occurring in production not harvested because of a shortage of labor. Tart cherry production amounted to 5,600 tons in 1977 compared with the record level of 8,500 tons in 1976. Pear production totaled 4,900 tons compared with 5,300 tons a year earlier and the large 1973 crop of 5,830 tons. A total of 1,800 tons of apricots were harvested compared with 1,840 tons a year earlier. The summer was dry and warm--favorable for development and harvest of fruit. Harvest was completed with very little loss except for the shortage of labor during the sweet cherry harvest.

Total value of 1977 fruit production, at $14.3 million, was 8 percent above 1976 and a record high. Record high average prices for apples, pears, and tart cherries plus relatively good prices for other fruits were responsible for pushing total value of all fruits to a record high even though total production was down from a year earlier. Clearly, the drought had little negative impact on fruit production. This was because most orchards are in areas where substantial reservoir storage provided adequate irrigation water.

Livestock

Beef cow numbers in Utah according to the Statistical Reporting Service, as of January 1, 1977, totaled 335,000 head. On January 1, 1978, beef cow numbers were 321,000 head, a reduction of approximately 4 percent.

Contacts with cattlemen, brand inspectors and extension livestock specialists suggest that the reduction in cattle numbers in Utah during 1977 was somewhat larger or closer to 10 - 15 percent of the breeding herd.

Sheep numbers as of January 1, 1977, were listed at 580,000 head. On January 1, 1978, the inventory for Utah showed 491,000 head a 15 percent reduction from a year earlier.

The 4 - 15 percent reduction in cattle numbers and 15 percent reduction in sheep numbers demonstrate that the drought had a significant impact upon the livestock industry in Utah during 1977. The drought was especially hard on livestock growers because it came at the end of a 3 year period when livestock prices and particularly beef cattle prices has been at a record low.

Drought conditions reduced feed production by 40 - 60 percent, making the purchase of supplemental feed necessary. Prices for these supplemental feeds (alfalfa and grass hay) ranged from $60 - $80 per ton, a near record for these types of feeds. Thus just at the time low livestock prices had ranchers financially squeezed, feed prices reached near record levels. It wsa this combined affect caused ranchers to reduce their herds.

Some hay and grain was made available to livestock producers through county drought relief programs. The grain was used in limited amounts because many livestock producers are not equipped to use supplemental feeds of this type. Livestock producers benefited more from the financial help given them in purchasing hay.

Range plant development was very slow and water supplies were inadequate on many range areas during the spring of 1977. Cattle and sheep were held off early spring and summer ranges for extended periods of time until enough feed grew to support grazing. When ranchers were finally allowed to utilize these range areas, conditions were still quite poor. Even when grass was available, it was necessary to haul water in many areas to utilize existing feed supplies. Fortunately, the rain that came to some areas of the state in August and September and caused growth to all forage plants. Range feed conditions were actually better in September and October when livestock were removed from range areas than they had been during any time of the entire season.

Accurate estimates could not be obtained on the actual loss experienced by Utah cattle and sheep ranchers due to the drought. Cattle and calf sales totaled $94.94 million

which was only 2 percent below 1976. Sheep receipts totaled $23.5 million which was up 42 percent over 1976. Many of these animals were sold at substantial losses due to: 1) sale forced forced by lack of feed during a period of very low cattle prices; 2) long term future losses due to 1977 loss of breeding stock; 3) extra cost of feeding high priced hay rather than grazing during portions of 1977.

The total value of the Utah beef cattle inventory on January 1, 1977, was $198.7 million (864,000 head at $210). Of this total inventory, if the 414,000 cows that have calved are considered to represent the breeding stock, and a 10 percent reduction in breeding stock is taken as a rough index of the drought loss, this suggests a minimum loss of $8.7 million.

Similarly the January 1977 sheep inventory of 580,000 (475,000 ewes) was valued at $51 each for a total value of $29.6 million. If the decrease in number of ewes is estimated at 15 percent of 475,000, this suggests a drought related loss of $3.6 million. Actual long term losses are likely to be substantially more than these figures.

## Local Agricultural Impacts

Much of the information presented in previous sections consisted of statewide average data. Such a format hides much of the severe impact experienced by individuals in particular locations. The statewide agricultural production data, for example, suggest a relatively minor impact compared to the unusual severity of streamflow reduction. There were, however, many areas of the state where farmers and ranchers lost entire crops, sold all their breeding stock, and in fact, were forced to sell their land. In an effort to describe some of these local situations, information from two sources is presented: (1) The U.S. Bureau of Reclamation developed a report on the drought experience of irrigation companies within the Colorado River Basin portion of Utah. It is reprinted here with permission of the Bureau of Reclamation. (2) USU extension agents throughout the state were interviewed concerning the drought experience in their county.

## Irrigation Company Impacts, Colorado River Basin Portion of Utah Only

The data are presented alphabetically by county and entities name. The data were collected by reconstructing past records and conducting interviews for general impressions of local River Commissioners, County Extension Agents, local Irrigation District officials, ditch riders, state colleges, and federal and state agencies.

### Daggett County

1. Sheep Creek Irrigation Co.
   Approximately 10,000 acres irrigated
   Sources of water: Sheep Creek, Spirit, Daggett, and Tamarack Lakes

The only information available is general impressions which lead to the conclusion that the availability of irrigation water was very limited, and at best, most crops received only partial irrigations. Most stockponds were dry by mid spring compared to July in a normal year.

### Duchesne County

1. Duchesne Irrigation Co., Bridgeland, Utah
   Approximately 1,500 acres irrigated
   Source of water: Duchesne River

Total water diversion in 1977 was 6585 ac ft, versus 7500 ac ft during normal years; 1269 ac ft of water was purchased from the Bureau of Reclamation Starvation Reservoir. Crop production was down 20 percent for small grains and 30 percent for alfalfa and grasses. Irrigation water was available until October 15, 1977. Most natural stockponds were dry by July 15, 1977, versus water available throughout the year under normal conditions.

2. Farm Creek Irrigation Co., Tabiona, Utah
   Approximately 1,500 acres irrigated
   Source of water: Duchesne River

There were 890 acres of alfalfa and grasshay in production during 1977 compared to 1500 acres during a normal water year. Total diversion for 1977 was 3177 ac ft versus 8940 ac ft for 1976. Actual crop production was down 5 to 10 percent on the 60 percent of irrigable lands in production. During 1977 some water was received up to the normal cutoff date of October 20. Stockponds in the area were dry by mid spring compared to mid July during a normal year.

3. Pioneer Canal Co., Utahn, Utah
   Approximately 1,250 acres irrigated
   Source of water: Duchesne River

Approximately 300 acres were in production during 1977. The availability of irrigation water was minimal, with farmers in the area receiving 20 to 40 percent of their normal water diversion (5,125 ac ft in 1976). Stock ponds were dry by mid spring compared to mid July in a normal year.

4. Red Creek Irrigation Co., Fruitland, Utah
   Approximately 1,200 acres irrigated
   Source of water: Red Creek

The irrigation water available during 1977 was used for gardens and watering cattle, with virtually no farmland in production. Natural stock ponds were dry by early spring compared to the end of July or mid August during a normal year.

5. Uintah Independent Ditch Co., Neola, Utah
   Approximately 4,000 acres irrigated
   Source of water: Uinta River

During 1977, 1600 acres were in usable production, with a total diversion of 2,400 ac ft of irrigation water, compared to 4,000 acres in production and 16,000 ac ft of water diverted during 1976. There was no water available after June 18, 1977, compared to August 20, 1976. Natural stock ponds were dry by early spring compared to late summer during a normal year.

Some ranchers dug wells, trying to find water for their cattle, while others made channels by which they could divert irrigation water to natural spring sites.

Emery County

1. Emery Muddy Creek Irrigation Co., Emery, Utah
   Approximately 16,000 acres irrigated
   Source of water: Muddy Creek

Information is limited in this area but the general concensus is about one-half of the land was in production during 1977 with irrigation water being very limited. Stockponds were dry by mid spring compared to seldom drying up in normal years.

Garfield County

1. Bench Irrigation Co., Antimony, Utah
   Approximately 1,500 acres irrigated
   Source of water: Antimony Creek

During 1977, 900 acres were in production versus 1,500 during a normal year. Since irrigation water is supplied by Antimony Creek and there are no measuring devices, it can only be estimated that 1977 flows were 65 percent of normal. Natural stockponds were dry by mid spring compared to mid July during a normal year.

2. Boulder Irrigation Co., Boulder, Utah
   Approximately 4,000 acres irrigated
   Sources of water: Boulder Creek, Deer Creek

There were 2,863 acres in production during 1977. Total diversion for 1977 was 6840 ac ft versus 7070 ac ft for 1976. Farm deliveries after convenance losses averaged 1.79 ac ft/acre during 1977 (2853 acres) versus 1.85 ac ft/acre (3817 acres) for 1976. Farmers in the area reported a very good growing season but an adverse situation with the availability of irrigation water.

3. Coyote, East Fork Irrigation Co., Antimony, Utah
   Approximately 1700 acres irrigated
   Source of water: East Fork Sevier River

All lands were in production during 1977. Total water diversion was 5100 ac ft which is comparable to 85 percent of normal water delivered to landowners up to the normal cutoff date of October 15. No known natural stockponds are in the area; however, the surrounding range area was adversely effected by the water shortage.

4. East Bench Irrigation Co., Panguitch, Utah
   Approximately 839 acres irrigated
   Source of water: West Fork Sevier River

During 1977, 277 acres were in production with 1943 ac ft of water diverted, versus 839 acres in production and 3759 ac ft of water diverted during 1976. Crop production was good due to the cutback of lands and a longer growing season.

No natural stockponds are in the area, however, rangelands were severely hurt by the lack of precipitation.

5. East Panguitch Irrigation Company, Panguitch, Utah
   Approximately 1510 acres irrigated
   Source of water: West Fork Sevier River

There were 906 acres in production with total diversion of 4415 ac ft versus 1510 acres in production and 7668 ac ft of water for 1976. Irrigation water was available through October 15, which is normal. Crop production was normal on the lesser amount of acreage. No natural stockponds are in the area.

6. Long Canal Co., Panguitch, Utah
   Approximately 2280 acres irrigated
   Source of water: West Fork Sevier River

There were 1367 acres in production during 1977 compared to 2280 acres during a normal year. Total diversion for 1977 was 5537 ac ft versus 11,903 ac ft for 1976. Actual crop production was down 5 to 10 percent on the 60 percent of irrigable lands in production. During 1977 water was available up to the normal cutoff date of October 15. No natural stockponds in the area.

7. Mc Ewan Canal Co., Panguitch, Utah
   Approximately 970 acres irrigated
   Source of water: West Fork Sevier River

All irrigated acreage was in production during 1977. Total water diversion for 1977 was 4,413 ac ft versus 5,743 ac ft for 1976. Crop production was down 15 to 20 percent with only one cutting in grasses and alfalfa fields.

8. New Escalante Irrigation Co., Escalante, Utah
   Approximately 2200 acres irrigated
   Source of water: Escalante River

There were 1650 acres in production during 1970 compared to 2200 acres during a normal year. Total water diversion for 1977 was 3869 ac ft (1.99 ac ft/acre) versus 8800 ac ft (3.40 ac ft/acre) for 1976. Crop production was down 20 percent on the 75 percent of irrigable lands in production. Some water was received up to two weeks of the normal cutoff date of October 31, 1977. Only 50 percent of the local stock ponds received water and the natural stock ponds in the area

were dry by mid spring. Water is stored in Wide Hollow Reservoir 1 mile northwest of Escalante, but no discharge records are available.

9. Tropic & East Fork Irrigation Co., Tropic, Utah
   Approximately 2200 acres irrigated
   Sources of water: West Fork Sevier River and the Tropic and East Fork Reservoir

There were 1200 acres in production during 1977, compared to 2200 acres during a normal year. Total diversion for 1977 was 2000 ac ft (estimate) versus 4400 ac ft for 1976. Actual crop production was down 15 percent on the 55 percent of irrigated lands in production. No water was delivered after August 21, 1977, compared to a normal cutoff date of October 15. Some water was used from the Tropic Reservoir and East Fork Reservoir; however, there are no records as to the actual dates and amounts.

10. West Panguitch Irrigation and Reservoir Co., Panguitch, Utah
    Approximately 2000 acres irrigated
    Sources of water: West Fork of Sevier River, Panguitch Creek, Panguitch Lake Reservoir

There were 1000 acres irrigated during 1977 compared to 2000 acres in a normal year. Total water diversion for 1977 was 2738 ac ft versus 15,175 during 1976. Actual crop production was down 40 percent on the 50 percent of irrigable lands in production.

No water was available after July 21, 1977, compared to September 15 during a normal water year.

Water was released from Panguitch Lake Reservoir 18 miles south of Panguitch; however, no records are available. Stockponds in the area were dry by mid July whereas these stockponds normally don't dry up.

| Stream | Avg. Normal Flow (CFS) | 1977 Flow (CFS) | Flow Stop 1977 | When Flow Usually Stops |
|---|---|---|---|---|
| Blue Spring Creek | 8 | 4 | N/A | N/A |
| Clear Creek | 2 | 1 | July 1 | N/A |
| Ispen Creek (Bunker) | 2 | 1 | July 10 | N/A |
| Deer Creek | 2 | 1 | July 1 | N/A |

Grand County

1. Moab Irrigation Co., Moab, Utah
   Approximately 600 acres irrigated
   Source of water: Mill Creek

There were 420 acres irrigated during 1977 compared to 600 acres in a normal year. Total water diversion for 1977 was 1400 ac ft versus 3200 ac ft for 1976.

Actual crop production was down 60 percent in small grains (fall 76 plant dates) and 50 percent in grasses and alfalfa. All natural stockponds were dry by early summer compared to seldom during a normal water year.

San Juan County

1. Blanding Irrigation Co., Blanding, Utah
   Approximately 2500 acres irrigated
   Sources of water: Johnson and Recapture Creeks

All water sources were totally dry during 1977. Usually there are 2500 acres in production receiving 8100 ac ft of irrigation water. For 1977, no lands were irrigated and crop yields in grasses and alfalfa would total at the best 1 1/2 A.U. per acre. Dry Wash Reservoir is 15 miles north of Blanding (300 ac ft capacity) and received no inflow and released no outflow during 1977. All natural stockponds were dry by early spring compared to early August during a normal year.

2. Blue Mountain Irrigation Company, Monticello, Utah
   Approximately 1200 acres irrigated
   Source of water: South Creek

During 1977 no lands were in production due to the lack of irrigation water. Normally there is 1200 acres irrigated with a water diversion of 1000 ac ft (0.67 ac ft/acre). Crop production was at best minimal, with production measured at approximately 1 1/2 A.U. per acre. Natural stockponds were dry by mid spring compared to August 1 during a normal water year.

3. Lasal Irrigation Co., Lasal, Utah
   Approximately 1800 acres irrigated
   Sources of water: Lasal, Beaver, Two Mile, and Indian Creeks

Normally 1800 acres are irrigated with a water diversion of 5400 ac ft. During 1977, no lands were irrigated, and crop production, at best, was approximately 1 1/2 A.U. per acre. Natural stockponds were dry by early spring compared to early fall and then usually replenished by storm runoff.

4. Lasal Livestock Co., Lasal, Utah
   Approximately 400 acres irrigated
   Source of water: Lasal Creek

There were 120 acres in production during 1977 compared to 400 acres during a normal year. Total water diversion for 1977 was 300 ac ft versus 1620 ac ft during 1976. Actual crop production was down 30 percent on the 30 percent of irrigable lands in production. Some water was received up to September 10, 1977, compared to October 15 during a normal year. Natural stockponds

were dry by April 1, 1977, compared to mid June during a good year.

5. Spring Creek and North Creek Water Users, Monticello, Utah
   Approximately 660 acres irrigated
   Sources of water: Spring Creek and North Creek

Due to dry streambeds no land was irrigated during 1977. There were 660 acres irrigated with 2420 ac ft (3.12 ac ft/acre) until July 1 of 1976. Crop production was at best minimal with most areas using animal units as measurements.

6. Verdure Irrigation Co., Monticello, Utah
   Approximately 172 acres irrigated
   Source of water: Montezuma Creek

No lands were irrigated during 1977. Compared to 172 acres with 360 ac ft (1.78 ac ft/acre) during 1976. Most natural stockponds were dry by early spring compared to mid July during a normal water year.

Uintah County

1. Whiterocks Irrigation Co., Lapoint, Utah
   Approximately 6500 acres irrigated
   Sources of water: Whiterocks River, Paradise Park, and Chapeta Lakes

There were 1750 acres in production during 1977 compared to 6500 acres during a normal water year. Total water diversion for 1977 was 5200 ac ft versus 19,500 ac ft for 1976. Crop production was down 30 percent on the 27 percent of irrigable lands in production. Some water was received up to two weeks of the normal last irrigation date of October 15. Natural stockponds were dry by mid spring compared to a continuous flow during a normal year. Tridell City diverted 70 gallons per minute from a spring north of the city.

Wayne County

1. Fremont Irrigation Co., Loa, Utah
   Approximately 10,468 acres irrigated
   Sources of water: Fremont River, Spring Creek, and Forsyth, Johnson, and Fish Lake Reservoirs

There were 8,898 acres in production during 1977 compared to 10,468 acres during a normal year. Total water diversion for 1977 was 17,800 ac ft (1.80 ac ft/acre) versus 31,400 ac ft (2.70 ac ft/acre) during 1976. Actual crop production was down 15 percent on the 85 percent of irrigable lands in production. Some farmers received water up to the normal cutoff date of November 1. Reservoirs have no records; however, reservoirs were full at the beginning of the irrigation season and empty about one-half way through the season. Comments were made that if it had not been for sprinkler irrigation, the losses would have been devastating.

Report of County Extension Agents

The following is summarized from county agent responses to specific questions:

1. How did the drought generally affect individual families?

Many county agents reported that in general there were no great ill effects, but that crops were not as good as expected. In some areas of the state, vegetable gardens were curtailed, and the lawns were left dry because of water shortage. Some families were affected in that they planted smaller gardens and some gardens which were planted were of poor quality because of lack of water, but overall the people who had lawns and gardens managed their water better. This was also true in irrigated agriculture. The water was managed better and more crops were produced with a given amount of water than perhaps in any other year. In many areas of the state the ranges dried up and this affected families and people who were in the livestock business as explained below.

On Indian reservations in southeastern Utah the drought had little effect on Indian agriculture. Farming there is booming. Indians are developing the Colorado and San Juan Rivers for agricultural production. There was some crop failure, but this was due as much to poor management as to the drought. The project to provide more irrigation water is moving ahead and water conservation does not seem to be an important part of the program.

Many farm and ranch families incurred more indebtedness during the drought year than had ordinarily been the case. Reports from Box Elder County state that families were affected quite differently. Nearly all farmers who received irrigation water from the Bear River Canal System owned by the Utah-Idaho Sugar Company received a normal supply and crops were not affected greatly. However, in west Box Elder and a few other areas where the irrigation depends on streamflow, there were shortages. Most of the dryland farms and range lands suffered.

During the drought, extension personnel received many more requests for information than normal on water storage and how to conserve water both in and around the home. People became more mindful of keeping a supply of water in the home for emergency conditions.

In some areas of the state, particularly along the Wasatch Front, home owners and backyard gardeners faced the dilemma of reduced amounts of water for yards, plus an increase in water rates. However, curtailment programs instituted by some water agencies were less often a limitation on the amount of water than on the amount of time water could be used. Thus, a homeowner with many valves, sprinklers, etc.,

could apply a normal amount of water in the short time allowed and could even over-irrigate. He had an incentive to apply as much water as he could if the water was not measured to him, which was the case in many areas.

Many people benefited from the drought by learning more about proper irrigation techniques for gardens and lawns through the programs of government agencies and Extension Service. They learned how and when to apply the right amount of water. Home agents also conducted many short courses before civic and religious organizations on water conservation.

In Rich County the drought looked especially bad in the spring of 1977. There was very little moisture in the ground or snow in the hills. The May rains gave some relief. In the north end of the county, the effect of the drought was not too great and crops continued to grow as summer storms came, especially in August, and many of the crops did quite well. In the south end of the county, summer rains were not as intensive and the ranges became quite dry. Water was hauled to livestock in watering tanks made available from government agencies.

In some communities, residents rearranged their plumbing to drain wastewater from their washing machines and bathtubs to irrigate lawns and shrubs. This practice is against the Utah plumbing code, but there was not sufficient factual information on the dangers of disease or on potential salt buildup in the soil to stop people from using this water.

In some communities water restrictions were imposed and fines assessed for excessive water use. Perhaps the situation was best described by Ralph Horne, Utah County Agent, who said, "Generally speaking, there were two divisions of thinking, those that were very concerned and those that were not concerned at all. Most people compared it with the gasoline shortage in that we really don't have a shortage, while on the other hand there were those that really tried to get it in and do something about it." The latter were mainly the older people in the county. In Utah County, the average household use is 285 gallons of water per day per person. Educational programs, news articles, radio programs, and other types of mass media release were able to reduce water use by only 8 percent. Many individuals reduced their use by more than this amount thereby making up for those who paid no attention to conservation and went on as usual, using whatever water they felt they needed.

2. Did farmers have short term damages occur to annual crops such as wheat, etc.?

The general opinion of the county agents is there were short term damages. Exact figures are not available, just reports of decreased production. Many farmers knew that one or two irrigations would be about the extent of their supply for the season and planned accordingly. However, summer rains in May and August helped to alleviate that situation. The first crop alfalfa hay was about normal, grass hay production was down and second crop alfalfa hay was somewhat below normal. The third crop was better than normal in some areas because of the rains in late August. Grain production was spotty due to lack of early moisture and irrigation water, and many farmers chose not to plant spring grain or corn because of dry springtime conditions.

In Salt Lake County short range effects were quite critical in some areas because water supply in canals was reduced considerably. One canal with only secondary rights received no water after June. Decreased yields of alfalfa, grain, etc., were considerable.

County agents reported that perhaps the greatest loss to farmers occurred because of low livestock prices, especially beef and feeder cattle. Drought and low prices caused a few families to sell their cattle. Some did not plant corn and grain, but used their limited supply of water to maintain their perennial crops such as alfalfa.

In Juab County much of the dryland wheat was not harvested at all, just plowed under, and a lot of what was harvested produced low yields. Farmers on irrigated land planted fewer acres than in other years. Another major affect in the southern part of the state was a bad frost on June 14, 1976, that took 85 percent of the small grain production and about 35 percent of the alfalfa and made feed very scarce going into the drought.

In Utah County special effort was made to provide enough water to fruit trees to keep them alive regardless of whether fruit was produced. In fact, conditions did not prove that bad. Not only was there no known fruit tree loss because of the drought but total production turned out to be very good. Again it was good management and people doing a better job of irrigating. There was the highest irrigation efficiency ever in the region.

In San Juan County, production of grain and forage for livestock was reduced 50 or 60 percent (mostly dryland wheat). The mountain streams were mostly dry and very little irrigated forage was produced.

3. Did farmers have long term damage because of loss of such crops as fruit trees?

Generally the answer was no except in San Juan County where fruit trees and ornamental shrubs died as a result of moisture stress during the drought. Generally, however, priority given to watering fruit trees prevented such losses.

One of the big affects of the drought was that many springs which were used for stock watering dried up. In some areas of the state, feed on ranges was good, but there was no water for the cattle to drink. In the emergency trucks and trailers were provided by the army and other government agencies for farmers to haul water. Many artsian wells also dried up or became unusable. Because of the lag time between the rainfall and the flow from springs and wells, the full impact of this effect is not yet known.

4. Did stockmen sell their breeding stock and/or other cattle?

Several county agents reported that many cattle were sold in the spring of 1977 due to the impending drought and the lack of feed on the ranges. Alfalfa hay was expensive during the early part of the year, especially for beef cattle feeders. However, the rains which came during the latter part of the year produced more feed. This together with the low cost of grain caused many dairymen to feed more grain and less alfalfa. By fall, alfalfa prices had decreased considerably, and hay was available for cattlemen to feed. In the southwest portion of the state, the livestock industry was severely effected. Some animals died on the range because of lack of feed and water. The Navajo Indians, who have good grazing rights, did not suffer much damage and their livestock, including horse, sheep, and goat populations were not affected greatly.

In Wayne County it was reported that approximately 3,000 acres of established alfalfa was lost during the drought and about 1500 acres of mature and seeded pasture lost up to 25 percent of the grass composition. One ranch sold its entire cow herd as well as three sheep flocks. Some beef cow herds were reduced by 50 percent, other cattlemen sold only a few. Three farm families sold their operation. The decision to sell was influenced by the drought. One 300-cow unit was being sold in 1978 as a direct result of the 1977 drought and two farms reported total crop failure because of the drought. It is estimated that 75 percent of the cropland was left idle during 1977. But several drought grant-in-aid projects through state and local government agencies helped. A few families and farmers produced normal or above normal crops. The shortage of water and grass on the range also caused many cattle to be thin and in poor condition, and this reduced the calf crop. In the Uintah Basin, it was reported that about 30 percent of the cattlemen reduced their breeding stock due to the drought. Some didn't keep their replacement heifers, and others sold some of their cows. Three farmers in the Uintah Basin sold all of their cows due to debts and the prospect of being unable to feed them. In Juab County, it was reported that practically every livestock man was hit hard by the drought and nearly all of them qualified under the Emergency Feed and Grain program. The program was given credit for them being able to stay in business.

In San Juan County about 50 percent of breeding herds were sold due to the drought. Some ranchers sold all of their cattle. The drought was reported to have caused some insects to move off range lands much earlier than usual. As a result, several growers found themselves trying to control grasshoppers and other pest insects several weeks earlier than normal. This probably increased the use of pesticides in some areas. However, a more important factor was that the crops the drought prevented from growing to maturity, did not need to be treated. Overall, less pesticides were used on feed crops during the drought period than normal. Some agents reported less weed and insect problems than during normal years.

In the Wayne-Piute area, the county agent reported that grasshopper damage on forest lands was quite severe, available forage was reduced but permanent damage did not occur.

6. Miscellaneous comment on programs

In Iron County, the most visible drought relief programs were those administered by the Agricultural Stabilization and Conservation Service (ASCS). Many water development cost-share type projects were completed because of the availability of matching money. Nearly $1 million was spent in Beaver County on drought-related irrigation water projects. This included the farmers share of ASCS payments and grants for major projects such as lining ditches, installing pipelines and concrete canals. One rancher drilled two successful horizontal wells for livestock that were very beneficial. Providing tanks and trucks for hauling water to cattle was effective in Beaver County. In Wayne and Piute Counties, it was reported that several ASCS drought aid projects assisted families in producing normal or above normal crops. But most projects funded by ASCS to combat drought were completed only after the growing season was over. Many farmers purchased sprinkler irrigation systems under government drought related programs, but their effectiveness in combating the drought is in doubt. One agent reported that he felt there were very few if any government programs that were effective in assisting the farmers to solve the drought related problems.

In Juab County, in contrast, the agent felt that all of the programs were successful to some degree. Over $500,000 were spent in that county under the various emergency funds to provide drought relief to farmers.

Water conditions in Iron County turned out much better than expected. Low flow in springs and creeks caused a stock water problem but feed on summer ranges was much better than normal. Crop yields, especially alfalfa hay, were higher in 1977 than in

other years, probably because of summer rains and good wells.

In the eastern part of the state a number of forest fires were reported and some recreational camps were closed because of both lack of culinary water and fire danger. In Beaver County, nearly $1 million was spent on drought-related irrigation water projects. One comment from the agent was that "Southern Utah is more subject to drought problems than northern, where most of the population is located. The fact that the drought did affect northern Utah in 1977 caused much more action on drought programs therefore helping southern Utah more than in many other drought years."

Some agents reported concern over the big impact of government programs to aid installation of sprinkler systems, especially those where pumping is required. Because of higher energy costs it was questioned whether a farmer could afford to use his sprinkler system even if it had been given to him. Most agents felt that more emphasis needs to be given in the state towards construction of reservoirs for times of shortage.

## Impact on Recreation

### State parks operation

The Utah State Park System experienced only minor negative impact from the drought. One well became inoperable at Rockport Reservoir, but it is not clear whether this was due to the drought or to underground explosions for seismic testing in the area. There were no recreation areas closed nor landscaping destroyed due to lack of water.

The most significant drought impact was a temporary inability to launch boats at several ramps due to low lake and reservoir levels. This, however, resulted in a benefit for future years as the low water levels plus emergency funding which became available allowed the extension of many boat ramps.

### Ski industry

One recreation sector which did experience an extremely severe impact was the ski industry. In fact, the ski business probably experienced a more severe percentage reduction in business than any other sector of the economy. This loss was also the first to occur since it began early in the drought period (November 1976) and emergency loan programs which were available later for agriculture and other sectors were not available to ski resort operators.

The ski industry is a major Utah business which generates from $25 to $40 million annually and attracts approximately 2,000,000 skier-days. At least two thirds of the money is spent by out-of-state visitors at resorts directly and at other locations such as restaurants and hotels. The following historic and estimated 1977 quantities developed by the Utah Travel Council suggest a loss of $25 million (excluding air fare losses to the air lines) by the ski industry during 1977.

| Season | Total Revenue | Non-Resident Revenue | Percent Increase From Previous Year |
|---|---|---|---|
| 1974-75 | 21,800,000 | 15,200,000 | |
| 1975-76 | 29,430,000 | 20,500,000 | +35% |
| 1976-77 | 38,000,000[a] | | +30% |
| | 13,000,000[b] | | -56% |

[a]Projected

[b]Actual

Ski resorts normally open during November, and Thanksgiving weekend is usually one of the busier periods. During 1977, however, there was virtually no snow until Christmas weekend. Most resorts opened for Christmas week, but the snowpack was simply not skiable and almost all of them closed after Christmas. Some additional snow fell during January and some resorts reopened during the last half of January and remained open through February. But skiing conditions were never better than fair and only a small fraction of the runs were skiable.

In efforts to overcome the bad situation, some resorts invested in artificial snow devices. Park City resort, for instance, spent over $1 million for equipment and water transmission lines used in producing artificial snow. Ironically, they were unable produce snow because winter temperatures were so high that the air/water mixture blown on the ski runs would not freeze. In summary, the 1976-77 ski season was a disaster.

## Impact on Energy Production

### Background

The demand for electrical energy in the entire Western United States was critically close to generating capacity during portions of 1977. The drought extended over the entire region, reducing water supplies to the point that major power production cutbacks were required in the Pacific Northwest where hydroelectric power predominates. As the states to the north imported power, little was left to purchase to meet demand peaks in Utah. Electricity had to be generated by or purchased from expensive standby plants. As the cost of generating power increased, rates were raised accordingly.

During normal years, most western utilities buy peaking power during part of the year (some states peak in summer and

others in winter) from the Bonneville Power Administration (BPA) because the Pacific Northwest usually produces a surplus of very inexpensive hydropower at Columbia River Dams. The cost of this power during 1976, for instance, was 4 mills per kwh. During 1977, however, the Columbia River flowed at approximately half its normal volume, and no power was available for sale outside the region. In fact, interruptible power was cut back from many industrial users, such as aluminum producers in the northwest. At least 400 jobs were lost and some abandoned fossil fuel generating plants were reactivated to meet peak demands. It was estimated that an additional 5 percent curtailment of capacity in the BPA system would have resulted in a loss of 12,000 jobs. The 1977 loss of revenue to BPA was estimated at $89 million, 90 percent of which was attributed to the drought (Federal Power Commission, 1977).

Most electrical energy in Utah is obtained from two electricity suppliers--Utah Power and Light (UPL) and the federally operated Colorado River Storage Project (CRSP). These systems will be discussed individually. Other minor sources of energy are several municipally owned hydro or thermal generating plants.

Utah Power and Light

The drought impacted Utah's largest energy supplier more in 1977 than it would have during almost any other year because of other factors which simultaneously reduced UPL's generating capacity. The large Huntington coal-fired plant was down completely during half of the year because the first unit was destroyed by a switching accident and the second unit was not yet in service. Also, a subsidence problem in the dam at Electric Lake (which stores cooling water for the Huntington Plant) required the release of much of the stored water while repairs were made. The drought in Utah caused some direct reductions in UPL's hydropower production, but hydropower represents a very small fraction (3 percent of kwh during 1977) of the total UPL operation which consists primarily of thermal plants.

The economics of electricity production in the Western United States are such that hydropower is by far the lowest cost source, coal-fired plants normally produce at the next lowest cost, and natural gas and oil are at the high end of the 4 to 35 mill range of production costs. During 1977, hydropower and coal-fired plant capacities combined were inadequate to meet demands and many expensive oil-fired plants (which are normally shut down during most of the year) had to be operated at capacity.

The major impact upon UPL was related to the drought in the Pacific Northwest. Despite the difficulties at the Huntington Plant, during a normal year, UPL could have purchased most of what it needed to meet peak demands from Bonneville at 4 to 6 mills per kwh. During 1977, however, UPL was forced to pay 30 mills for power from gas and oil fired plants in Arizona. UPL estimates that its operating costs were increased by $4 million due to these purchases at a rate six times the normal cost.

Another impact of the drought resulted from UPL's decision to lease cooling water for 1978. During 1977, enough water was available in Emery County because the Huntington plant was down half of the year. However, release of 10,000 acre feet of water prior to repairs at Electric Lake caused doubt that the reservoir would refill for 1978. The company decided to protect against this contingency by leasing additional water from irrigators, who have water rights to flows from Huntington and Cottonwood Creeks in Emery County. In view of the uncertain drought duration and a potential shortage for the irrigators themselves, these purchases had to be made at a price high enough to motivate irrigators to take some of their lands out of production for the year. UPL paid $2 million to irrigators for this one year's supplemental water supply and an additional $400,000 was spent to construct a pumping station to allow trades of water between Huntington and Cottonwood Creek canals. Adding these two amounts to the $4 million increase in operating cost to purchase power, the total drought impact upon UPL costs (which will be recouped by future rate increases to Utah customers) appears to be at least $6.4 million.

Colorado River Storage Project

The federally owned and operated CRSP system supplies electricity to 30 Utah municipalities plus 6 rural electric cooperatives. The sources of energy production which are owned by CRSP consist of five hydro plants at Upper Colorado River dams. Flows through these turbines are determined by the operating rules for these multi-purpose reservoirs and are constrained by such factors as irrigation demands, relative levels of Lake Mead and Lake Powell, and the Colorado River Compact. The existing generating capacities total 1250 megawatts (950 of which is at Glen Canyon), but the operating constraints force purchase of additional energy to meet contractual obligations even during average years. This energy is normally purchased from various other hydro-power utilities at costs under 6 mills per kwh.

Because of the drought, it was necessary for CRSP to purchase very expensive energy from oil-fired plants during 1977. Figure 4 shows the history of energy purchases for resale by CRSP along with the total and unit costs of such purchases. The average cost of power purchased by CRSP (18 percent of their total demand) jumped from 5.5 mills in 1976 to 22 mills during the drought period (1977). Some power was purchased at unit costs as high as 36 mills. Despite only half as much

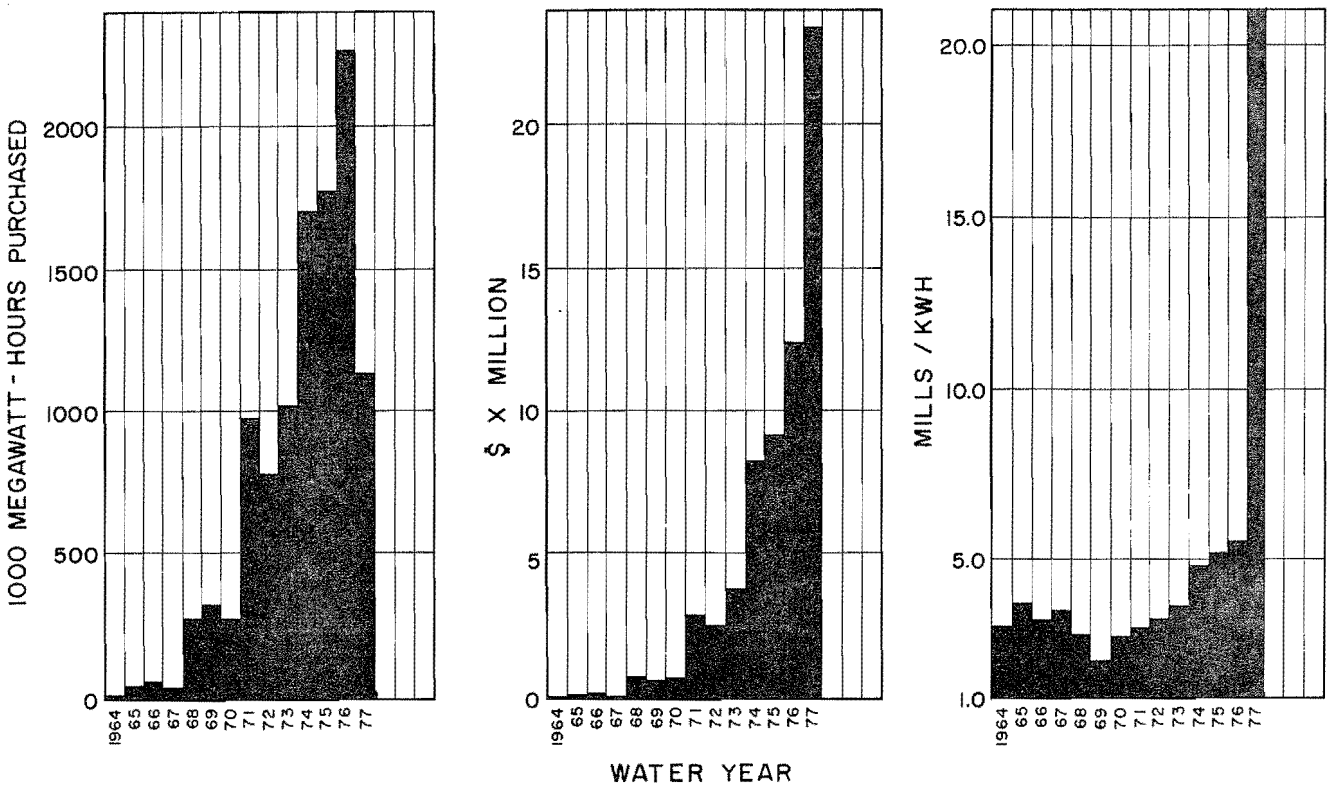


Figure 4. CRSP energy purchases by fiscal (water) years.

power being purchased during 1977 as during 1976, the total cost doubled (from 12.4 to 24.0 for a net increase of $11.6 million). The amount purchased was held down by limiting municipalities to their minimum contractual obligations. The additional expenses incurred by CRSP during 1977 were handled as a temporary operating deficit which will be recouped by future rate increases. The current cost of power to Utah municipalities is 6.3 mills (including demand charges), and CRSP is preparing a request for a 40 percent increase in this rate.

The economic impact of CRSP purchasing this additional power can be estimated by examining the fraction of CRSP's contracts which serve Utah customers. The Utah contracts represent 25 percent of the summer peak obligations and 33 percent of the winter peak obligations for an average of 29 percent. The Utah drought impact directly attributable to the 1977 water year is 29 percent of $11.6 million or $3.4 million; however, the low reservoir carryover storage levels into 1978 undoubtedly added to the impact by requiring additional purchases.

## Impact on Forest and Range Fires

Because of the unusual timing of the precipitation that did fall, losses from forest and range fires actually were lower than average in Utah. The dry winter and spring caused dry conditions to develop earlier than normal but also greatly reduced the growth of annual species that later dry and fuel range fires. Lightning storms, mostly in July, resulted in 1217 total fires within the United States Forest Service Region 4 area (which includes Utah). This was about the average number for the last four years; however, the number of fires within the Utah portion of Region 4 was lower than normal. The rains produced by the summer storms left conditions wetter than normal during the remainder of what is usually the driest part of the summer.

## Impact on Water Rights Administration

The 1976-77 drought had a significant impact on water rights administration. The major areas in which problems developed were with the distribution of available water among parties with established water rights and the increased number of water right applications received by the Division of Water Rights. Low flows during the spring created a number of allocation issues that the near record-breaking rains much of Utah received during May and later in the summer alleviated.

In Utah, as in most western states, water rights are distributed based on priority with first in time, first in right. Thus water distribution requires cutting off junior appropriators with later priorities in order to satisfy rights of senior appriators with earlier priorities. Distribution problems varied throughout the state depending on the water rights and water supply situation in each area. There were a number of disputes between irrigation companies and/or individuals. Still, there were not as many disputes as anticipated. Perhaps the reason for this was that water users were made aware of the severity of the drought early in the year and many expecting water shortages made the best use of what water was available or greatly reduced their planted crop acreage.

Some of the general water distribution problems encountered in addition to a shortage of irrigation water was a lack of stockwater, inadequate storage water, reduced spring flow (principally for culinary use) and in some areas a lack of adequate measuring devices to help in proper water distribution.

In Cache Valley several irrigation companies have water rights with priorities dating back to the 1870s were cut off. This was the first time this had occurred since establishment of those rights.

On the Provo River system several problems required emergency measures. The lack of stock water was critical in some areas along the Provo River because water to some irrigation companies was shut off early in the year. These irrigation companies historically have used their canals for stockwatering purposes but since their water rights were cut off there was no water available for stockwatering. Therefore, small temporary dams were placed in those canals and water was intermittently diverted to fill the canals for stockwater purposes. In addition, the Provo River Water Users Association stored about 35,000 ac ft of natural flow from the Provo River in Deer Creek Reservoir during early 1977 under an arangement made with the State Engineer and Utah Lake Water Users. Water stored in Deer Creek was then available under the rights of Utah Lake Water Users. In May 1977 a Memorandum of Understanding was negotiated to resolve the disputes over the water and in the interest of alleviating the severe impact of the prevailing drought on the municipal and domestic water supplies of Salt Lake County. A portion of the stored water was delivered to supply municipal and domestic water in Salt Lake County and compensation was paid to Utah Lake Water Users.

The Division of Water Rights received over three times the normal number of right applications. Most were for small domestic, stockwatering and/or irrigation wells. In the Blanding-Monticello area, which experienced shortages of culinary water, there were about 300 requests for domestic and/or stockwatering wells. The Ashley Valley area municipalities placed restrictions on outside watering. As a result about 400 residents filed applications for small irrigation wells.

Federal and state drought programs provided financial assistance to both municipalities and irrigation water users. There were numerous water right filings associated with these programs. Many of these requests had to be expedited so applicants could utilize the drought assistance moneys. This, combined with the many requests for small domestic, stockwatering and/or irrigation wells greatly increased the work load of the Division of Water Rights in a way that will be felt for years to come.

In those areas where the surface water and groundwater are closely connected and supplementally used, an above normal decline was noticed in the groundwater table. This made it necessary for many water users to either deepen their wells or lower their pump bowls to obtain adequate water.

Because many of the shortage reservoirs were emptied during the drought, the structures were dry most of the year. As a result tension cracks developed as the embankment dried on some dams. As the spring runoff occurred in 1978 it was necessary to pay close attention to these dams to make sure the damage did not increase the risk of failure.

The effects of the drought regarding water rights will be felt for many years in Utah. While the drought was regarded as an adversity it did bring into focus the value of good management and development of water resources so as to better survive future drought conditions.

CHAPTER 3

DROUGHT ASSISTANCE PROGRAMS

## Federal and Multi-State Programs

### Introduction

The geographic extent of the 1977 drought was unprecedented. Over 2,200 counties in the United States--over 80 percent of the nation's total--were eventually designated as "drought emergency areas" for purposes of federal relief. As the impacts of the drought spread to more states and to more sectors of the economy, the level of public concern rose accordingly and the responses by local, state, multi-state, and federal organizations proliferated.

The federal and multi-state responses will be discussed here under two headings. First a summary of the legislative and executive actions which affected the entire drought area will be described. This will be followed by a more detailed description of the type and level of use of various federal programs specifically in Utah.

### Summary of federal and multi-state actions

Most of the material presented here is taken from a paper entitled "State and Federal Responses to the 1977 Drought" by Berry Crawford[1] which was published in a volume entitled, North American Droughts (Rosenberg Ed., 1978). The political atmosphere early in 1977 is described by Crawford as follows:

> As the drought became more and more evident during the winter months of 1977 and dire predictions were being sounded, the level of private and public concern rose sharply and led to remarkable state and federal responses. Front page newspaper accounts, featured articles in leading news-magazines, TV documentaries, and drought conferences and meetings became commonplace. Over 60 drought-related bills were introduced in Congress, including those which made up the President's $844 million "drought package," and many existing federal programs were re-tooled and mobilized to deal with the drought's impending problems. The result was the most expensive and one of the most rapidly mounted and best coordinated relief efforts in the nation's history. The states responses were no less impressive, with emergency powers being given to governors, scores of drought-related bills being introduced in state legislatures, and local, state, and multi-state task forces being formed to develop plans and programs for dealing with the expected problems.

Meetings in January of the Western States Water and the Western Governors Task Force on Regional Policy Management resulted in confusion over the federal preparedness for dealing with the drought and led to a February meeting of the governors of 14 western states and the Interior Secretary Andrus. This meeting resulted in three agreements, described by Crawford (Rosenberg, 1978) as follows:

> The first was that the Secretary would seek the appointment of a White House - level drought coordinator to be located in the Executive Office of the President. The second was that each governor would appoint a state drought coordinator. The third was that the governors would meet one week later at the annual meeting of the National Governors Conference in Washington, D.C. to consider taking concrete steps for dealing with the drought and its impacts on a cooperative multi-lateral basis.
>
> All three of these agreements led to early and effective actions. On February 22, the President appointed Jack Watson, Cabinet Secretary and Special Assistant for Intergovernmental Relations, as the Federal Drought Coordinator. The meeting of the western governors on February 27 at the annual National Governors Conference resulted in the formation of the twenty-one state Western Regional Drought

[1]The Crawford paper is in "North American Droughts" published by the American Association for the Advancement of Science, 1978 and is quoted here by permission of Westview Press, Boulder, Colorado.

Action Task Force (WRDATF),[1] chaired by Governor Lamm and staffed by the Western States Water Council and the Institute for Policy Research. The state drought coordinators, appointed by the governors following the February 20 meeting in Denver, were designated as the governors' alternates on the WRDATF.

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The WRDATF has played a significant role in helping effect cooperative federal-state relations, providing information to the states on the status of new and existing federal programs, representing states' interests before Congress and the Administration, coordinating and exchanging information of state actions, and organizing special studies related to drought problems. Principal milestones and achievements in the work of the WRDATF are noted below:

Weekly publication of Western Drought Conditions: 1977 by the Western States Water Council. (Beginning February 1)

WRDATF staff work with four federal agency personnel (representing the Federal Disaster Assistance Administration, the Bureau of Reclamation, the Department of Agriculture, and the Corps of Engineers) dispatched by Jack Watson to the office of the Western States Water Council in Salt Lake City to provide early federal-state coordination. (March 15-24)

Meeting of the WRDATF staff and alternates in Salt Lake City to review the proposed $844 million White House "drought package," exchange information on problems and actions of the individual states, and refine the mission of the WRDATF.

Assignment of the Director of the Institute for Policy Research to Jack Watson's office to monitor and report on Administration and Congressional drought initiatives and to prepare a "directory of federal drought assistance." (March 29-May 13)

Meeting of the WRDATF staff and alternates in Denver to review status of the White House "drought package" and form working groups to deal with issues and problems in the areas of crops and irrigation; livestock and rangeland; fish, wildlife and recreation; energy, business, and industry; and Task Force Management. (April 27)

Publication and distribution of 6,000 copies of the Directory of Federal Drought Assistance: 1977 by the Department of Agriculture for the WRDATF. (June 3)

Assignment of a member of the Utah Department of Agriculture to USDA on a temporary duty assignment. (month of July)

Initiation and organization of efforts leading to the passage and signing of S. 1935 which gives the Secretary of the Interior authority to reallocate funds from the "water bank" program to other programs (e.g., states grants) as authorized by S. 925. (S. 1935 signed by the President on August 17)

Organization by the Institute for Policy Research of invitational workshops on drought research needs (in cooperation with the National Science Foundation and Corps of Engineers' Institute for Water Research), drought economic impacts (in cooperation with the Economic Development Administration and the Economic Research Service), and emergency preparedness (in cooperation with the National Science Foundation, the National Governors Conference, and the Council of State Planning Agencies) scheduled for October 14-15, December 1-2, and December 8-9, respectively.

The President's $844 million "drought package" was transmitted to the Congress on March 23, 1977, and contained only a small part of the proposed new and expanded federal programs that in total greatly exceeded the $844 million level. The Directory of Federal Assistance (WRDATF, 1977), for example, described 42 separate drought relief programs (only nine of which were included in the new

[1]The states participating in the Western Regional Drought Action Task Force are: California, Oregon, Washington, Hawaii, Idaho, Montana, Utah, Nevada, Arizona, New Mexico, Colorado, Wyoming, South Dakota, North Dakota, Kansas, Nebraska, Illinois, Iowa, Minnesota, Oklahoma, and Texas.

drought package). It includes a table listing 81 types of drought related problems, the federal programs that respond to each problem, and the 16 federal agencies which administered them.

## Federal programs and their use within Utah

The federal government introduced several new drought assistance programs designed to provide assistance to ranchers, farmers, and businesses that had suffered financial hardships as a result of the drought. In addition to this they offered assistance to communities which experienced water supply problems.

The 844 million-dollar Comprehensive Drought Assistance Program contained nine elements. Some of the proposed programs required only modifications of existing programs or additional funding. Others required totally new legislation. All nine were established, with the exception of the Emergency Drought Disaster Loan Program of the Small Business Administration (SBA). Table 14 lists the programs announced by the White House which were established.

In addition to those programs listed on Table 14 there were a number of other existing and on-going federal programs that could provide various types of drought assistance. Information regarding these programs is available in the Directory of Federal Drought Assistance (Institute for Policy Research, 1977).

There were essentially two ways that a state and/or county could become eligible for federal drought assistance. The first was to be declared a disaster area by the President through the Federal Disaster Assistance Administration (FDAA). The second was to be declared an Emergency Drought Impact Area by Interagency Drought Emergency Coordinating Committee comprised of the Departments of

Table 14. Federal drought assistance programs established to deal with the 1976-77 drought.

| Agency | White House/Administration Package | | Program Name |
|---|---|---|---|
| Department of Agriculture | | $100 million for emergency low interest loans to cover prospective losses to farmers and ranchers | Emergency Loan Program |
| | Farmers Home Administration (FmHA) | $225 million loan and grant program ($150 million in 5% interest loans; $75 million in grants) for short-term water supply assistance to communities less than 10,000 population | Community Facilities Program |
| | Agriculture Stabilization & Conservation Service (ASCS) | $100 million for soil & water conservation cost-sharing grants | Agricultural Conservation Program |
| | Federal Crop Insurance Corp. (FCIC) | $50 million to increase FCIC capital stock | Federal Crop Insurance |
| Department of the Interior | Bureau of Reclamation | $100 million for increasing water supply, making loans (5% interest) for water supply and conservation measures and establishing a water bank of available water for redistribution | Drought Emergency Program (new authority) |
| | | $30 million for emergency irrigation loans | Emergency Fund |
| | Southwestern Power Administration (SWPA) | $13.8 million for purchase of emergency power supplies | Emergency Electric Fund |
| Economic Development Administration (EDA), Dept. of Commerce | | $175 million loan and grant program for short-term water supply assistance to communities over 10,000 population | Community Emergency Drought Relief |

Agriculture, Commerce, Interior, and the Small Business Administration.

If a state or a county were declared a disaster area, individuals within that state or county became eligible to apply for assistance under the Emergency Livestock Feed Program. The designation of an Emergency Drought Impact Area generally made available most of the other federal drought assistance programs.

On January 24, 1977, seven counties in Utah were declared disaster areas due to the drought. On March 23, 1977, four additional counties were added, and on June 1, 1977, the remaining counties, with the exceptions of Salt Lake and Utah, were included in the disaster area declaration. Originally, the disaster assistance was to remain in effect until September 1, 1977, however, it was extended at various times, finally to May 31, 1978.

The entire State of Utah was designated an "Emergency Drought Impact Area" by the Interagency Drought Emergy Coordinating Committee on April 25, 1977. Many of the programs were required to obligate their funds by September 30, 1977, and projects were to be completed by November 30, 1977. However, extensions on the obligation, completion, and/or expiration dates were necessary for many of the programs.

## Agricultural Stabilization and Conservation Service (ASCS)

Emergency Conservation Measures Program. This provided grants for up to 80 percent of project costs for soil and water conservation. This $11.8 million allocated to Utah provided assistance to over 6,000 farmers. The primary types of projects supported were: 1) improvements to irrigation systems, such as canal linings, installation of pipelines and drilling wells; and 2) developing livestock water through construction of ponds, pipelines and wells.

Emergency Feed Program. Known originally as the Emergency Livestock Feed Program, this began under the Federal Disaster Assistance Administration (FDAA). Later, the program was transferred to the Agricultural Stabilization and Conservation Service (ASCS) with the funding still being provided by FDAA. On September 30, 1977, the FDAA Emergency Livestock Feed Program was terminated.

On October 1, 1977, the ASCS implemented an Emergency Feed Program that provided up to 2 cents per pound not exceeding 50 percent of the cost on eligible livestock feed. With this program, the Secretary of Agriculture could declare an area eligible for emergency feed without an official declaration from the President, as required under the FDAA program.

Nearly $1.4 million was distributed in Utah from January through September 1977 while the program was under FDAA. From October 1, 1977, to May 31, 1978, the ASCS program paid about $5.1 million in Utah.

## Farmers Home Administration (FHA)

Emergency loans to farmers and ranchers. This program made available to farmers and ranchers low interest loans for actual losses or anticipated losses suffered as a result of the drought. The original interest rate for these loans of 5 percent was later reduced to 3 percent. This program was in effect in all counties of the state up to December 2, 1977, and continued in 16 counties until March 6, 1978. The 564 loans made in Utah totaled nearly $14.5 million.

Community Facilities Program. This made available loans at 5 percent interest and grants (not to exceed 50 percent of project costs) to communities with less than 10,000 population who suffered water supply problems. The deadline for obligation of funds was September 30, 1977, and the deadline for project completion was April 30, 1978. However, because of construction delays it was necessary to extend some completion dates.

This program assisted the six Utah communities of Lewiston, Wellsville, and Millville, Cache County; Aurora, Sevier County; Virgin, Washington County; and South Jordan, Salt Lake County. A total of $1,190,700 was authorized in loans and grants. In addition, funds from the Utah Board of Water Resources and the Four Corners Commission also were available to these communities.

Soil and Water Loans. On June 29, 1977, the Bureau of Reclamation transferred $3 million under the Emergency Drought Act of 1977 to FmHA for use in making and securing loans to individual irrigators under federal reclamation projects. The reason for the transfer was that the Bureau of Reclamation could not provide low interest loans to individual irrigators and FmHA had an existing program and authority to accomplish this. Seven loans were made in Utah under this program totaling $95,430.

## Economic Development Administration (EDA)

Community Emergency Drought Relief Program. This program provided loans at 5 percent interest and grants (not to exceed 50 percent projected cost) to communities with populations of 10,000 or more, that were experiencing water supply problems. Funds under this program were to be obligated by September 30, 1977, and projects completed by April 30, 1978. The two projects approved in Utah are described below:

EDA COMMUNITY EMERGENCY DROUGHT RELIEF PROJECTS IN UTAH

| Project | EDA Financing | Project Description |
|---|---|---|
| Brigham City, Utah | $ 375,000 Grant<br>638,000 Loan<br>$1,013,000 Total | Repair and replace leaking lines and storage facilities |
| Salt Lake County Water Cons. Dist., Utah | $ 337,000 Loan<br>$ 337,000 Total | Replace leaking water lines, meter replacement and water use education and restriction program |
| TOTALS FOR UTAH | $ 375,000 Grant<br>975,000 Loan<br>$1,350,000 Total | |

Bureau of Reclamation

Emergency Drought Act of 1977 (P.L. 95-18). This act provided funds to be used to 1) establish a "water bank"; 2) permit water user organizations to augment water supplies by undertaking construction, develop wells, build pipelines, and pump water; 3) permit state water resource agencies to obtain emergency funds for their drought emergency programs to provide benefits of a widespread nature; 4) assist Indians; and 5) mitigate damages to fish and wildlife resources.

Funds under this program were to be obligated by September 30, 1977, and projects were to be completed by January 31, 1978. In Utah, 11 projects were approved as follows:

PROJECTS APPROVED IN UTAH UNDER THE BUREAU OF RECLAMATION EMERGENCY DROUGHT ACT OF 1977

| Applicant | Amount Authorized | Project Description |
|---|---|---|
| Weber Basin Water Con. Dist. | $4,310,460 | Pumping plant and pipeline construction |
| Uintah Mountain Stream Irr. Co. | 14,272 | Piping and ditches |
| So. Davis Water Improve. Dist. | 85,000 | Drilling wells |
| Newton Water Users Association | 65,000 | Lining ditches |
| American Fork Irrigation Co. | 50,000 | Well pumping |
| Muddy Creek Irrigation Co. | 600,000 | Canal lining & reservoir repair |
| Wilson Irrigation Company | 50,000 | Canal lining |
| Springville Irrigation Co. | 40,000 | Construct pipeline |
| Utah Div. of Wildlife Resources | 133,480 | Fish & Wildlife Mitigation |
| U.S. Fish & Wildlife Service | 20,000 | Fish & Wildlife Mitigation |
| Utah Division of Water Resources | 553,500 | Cloud seeding, public awareness drought administration |
| | $5,921,712 | |

Evaluation of federal drought assistance programs in Utah

The federal drought assistance programs were of great benefit to the State of Utah in providing assistance to farmers, ranchers, businesses and communities adversely impacted by the drought. While there were problems with some of the programs, the administrators generally felt that they experienced minimal delay and red tape and met their objectives.

Those programs which appeared to be best received were the ASCS - Emergency Conservation Measures Program and Emergency Feed Program; Bureau of Reclamation - Emergency Drought Program; - and FmHA - Emergency loans to farmers and ranchers. One reason for the success of the ASCS - Emergency Conservation Measures Program and Emergency Feed Program was that they were grant programs. The Emergency Feed Program received some complaints because of the short period of time for which applicants could receive assistance. But when the program was transferred completely to ASCS on October 1, 1977, this problem was corrected.

Under the Bureau of Reclamation program the Weber Basin Water Conservancy District project accounted for about 70 percent of the funds authorized. Response to the FmHA - Emergency Loans Programs was slow at first, but requests greatly increased in the late summer and early fall.

The FmHA - Community Facilities Program and Economic Development Administration (EDA) - Community Emergency Drought Relief Program were not widely used in Utah. Perhaps, the reasons for this may have been that the state, through the Governor's Emergency Fund, provided grants to those communities with severe water supply problems and was able to provide the funds much more quickly than could the federal programs. The large communities which would have been eligible for the EDA program generally had sufficient water supplies to get through the summer months with conservation measures.

The total financial assistance provided by the federal drought assistance programs in Utah during the 1976-77 drought exceeded $40 million.

## State of Utah Drought Relief Programs

### Introduction

State government's battle against the drought - existing programs utilized and new programs devised to help Utahns cope with a situation ranging from inconvenience to major hardship is outlined below in chronological form. The major state sponsored drought relief programs were administered by the Division of Water Resources except for the Portable Stockwater Tank Program of the Department of Agriculture.

### Drought threat

A fear that the state might face a serious drought was growing into a stark reality when the 42nd Utah Legislature convened its Regular Session January 10, 1977, in the Capitol.

Governor Scott M. Matheson had been concerned with reports of scant or no precipitation through the early stages of the 1976-77 winter. Executive Director Gordon Harmston of the Department of Natural Resources was watching the weather as were two of his top aides, Directors Daniel F. Lawrence of the Division of Water Resources and Dee C. Hansen of the Division of Water Rights.

The January issue of "Water Supply Outlook for Utah" documented record low snowpacks throughout the state. Mountains east of Salt Lake City, for example, were dusted with a sheet of only 0.3 of an inch thick, compared to an average blanket of 9.9 inches that early in the season. The Soil Conservation Service also warned carryover storage in many of Utah's small reservoirs was dangerously low.

### Legislative support

Deeply concerned about the possible drought, Director Lawrence and the Division's Assistant Director, Paul L. Gillette, developed a precisely detailed presentation to the 42nd Legislature accurately depicting the need for additional financing for the 30-year old Revolving Construction Fund. That money over three decades had been responsible for in excess of 400 water conservation and development projects constructed in cooperation with water companies throughout Utah.

Legislative committees quickly saw justification for greater funding for the Division of Water Resources. While the session was still young, a $1.5 million supplemental appropriation was made to the revolving construction fund. Two factors which helped the legislators reach a speedy decision were the threatened drought and the fact the division had plans completed for several projects ready to go to construction as soon as needed funding was available so sponsor companies could advertise for bids.

In an effort to determine the effectiveness of the Revolving Construction Fund, the Division mailed 372 questionnaires to irrigation and culinary companies at midspring in 1977. Of the 83 returned, only 44 contained firm figures as to the amount of water expected from projects financed in part from the fund. The amount totaled 52,855 ac ft.

The Governor and the lawmakers early in 1977 probably were more concerned about adverse drought impacts on domestic water systems in Utah than the affect on irrigation supplies. Governor Matheson expressed strong support for programs to help culinary water systems in danger because of reduced flow or outright failure of springs, wells and surface supplies.

### Culinary Grant Fund

Legislators promptly created and appropriated $500,000 to the Governor's Emergency (drought relief) Culinary Grant Fund. Mr. Gillette was named by Director Lawrence to chair the Governor's Drought Relief Committee.

Eligibility for assistance under this program was determined by a three-step investigative process. Pleas for aid first went to the Division of Water Resources whose personnel conducted a telephone interview with community representatives prior to an actual field inspection of the proposed relief project. A recommendation then went from the State Drought Relief Coordinator to the State Drought Executive Committee composed of Executive Director Harmston; Director Lawrence; Lynn Thatcher, Division of Health; Beth Jarman, Department of Community Affairs and Micky Galivan, Department of Development Services. Requests able to clear that group were forwarded to the Governor for his final decision.

The half million dollars was exhausted by late May. But town and city officials were assured more help was coming to the most threatened of the state's communities. Before adjourning the regular session, legislators set aside $5 million for drought relief. Exactly how that money was to be spent would be determined in June after lawmakers had a better opportunity to assess the severity of the situation.

Generosity of the legislators in the face of the drought threat was felt beneficially in other established programs and new methods were devised to get assistance to those desperately in need. Lawmakers loosened the purse strings when the 1977 General Appropriations Act was adopted and allocated another $1.5 million to the Revolving Construction Fund.

## Special Legislative Session

Two weeks after the regular session ended, a Special Session was reconvened, and drought legislation was adopted on July 12.

One bill appropriated another $500,000 to the Governor's Emergency Culinary Grant Fund, poured an additional $2 million into the Revolving Construction Fund, and added $1 million to the Cities Water Loan Fund. The other measure created an Emergency Water Resources Project Fund of $2 million to finance interest-free loans to stockmen who earned more than half of their income from their farm or ranch operations. The State Agricultural Advisory Board was delegated the responsibility of determining whether applicants actually were bona fide stockmen. This legislation, dubbed the stockwater program, attracted a number of applications.

The Division processed and the Board approved applications to finance wells, pipelines, or watering troughs submitted by more than 50 stockmen. Slightly less than 40 of those actually signed contracts and obtained the money.

Some stockmen later opted to ride out the drought on their own. Other applicants sought assistance under the assumption it was a grant program. A few decided not to take advantage of the interest-free money because they felt the state demanded too much security. Still others were reluctant to pledge their water rights during the period they purchased projects from the state on installment payment contracts.

When it became apparent there would not be sufficient projects to use the $2 million, the Legislature transferred $1.5 million of the stockwater appropriation to the Revolving Construction Fund and stipulated that the remainder not used by stockmen would lapse to that fund effective December 31, 1978.

Some $303,000 worth of projects were constructed for stockmen under the program. The remaining $197,000 was transferred to the Revolving Construction Fund at the end of 1978. Loans made under this program are listed in Table 15.

## Additional culinary grants

A total of 33 cities, towns, and small mutually owned culinary water systems received money from the Governor's Emergency Culinary Grant Fund. The Governor approved grants amounting to $855,000. Three cities did not use the full amount of their grants, leaving actual expenditure from the fund of $851,147.16.

Those grants enabled 21 communities to drill and equip wells, five others to develop springs, one to pump mine water to augment culinary supplies, one to construct a river pump station, two towns to lease agricultural water for diversion to their domestic systems, another two bought or repaired pump motors and one city drilled test wells. Grants made under this program are detailed in Table 16.

## State-federal cooperation

Allocation of the State Board of Water Resources Revolving Construction Fund money enabled certain irrigation companies to take advantage of $1.7 million in federal drought grants to help pay for water conservation projects costing $4.9 million.

Funds amounting to $1,733,777 were distributed to companies desperately in need of help so they could supply water to their stockholders during the 1977 irrigation season. The ASCS grants were on a matching basis. Twenty-five eligible companies were unable to find all the additional money needed to pay their share of projects partially funded with ASCS grants. Most financed what they could, then looked to the Board of Water Resources and its Revolving Construction Fund for the remainder needed to assure that conservation work could be funded entirely.

The Board bought $2,166,978 worth of the projects. Participating irrigation companies are buying back the state's investment under long-term installment payment contracts. Total initial expenditure of the companies was $985,407.

In some cases the Board juggled its priority list in order to aid companies which were eligible for ASCS drought grants. This was done carefully so no other company which had an approved project ready to go to construction was denied money it had been promised by the Board. The loans made under this program are detailed in Table 17.

## Cloud seeding

The continuing State/County Cloud Seeding Program began as usual in 1976 on November 15, but growing pressure from ski resorts convinced the Legislature of the need to do more in the face of the growing drought threat. The lawmakers approved the Division of Water Resources' request for $390,000 to help pay for continuation of cloud seeding operation and research projects.

Farmers and ranchers in areas of the state not served by the ongoing cloud seeding program were successful in persuading the Board of Water Resources to set aside up to $300,000 from the Revolving Construction Fund for possible financing of emergency cloud seeding projects. The Bureau of Reclamation made several million dollars available for states to use in cloud seeding programs. The Division of Water Resources received a grant of $500,000 from that fund.

Table 15. Stockwatering loan program.

| Name of Project | County | Description | Amount |
|---|---|---|---|
| Thornley Swan | Box Elder | Spring Dev. & Pipeline | $ 48,000 |
| Harvey K. Ross | Millard | Well | 8,200 |
| Paul K. Cahoon | Millard | Well | 7,800 |
| Ray Finlinson & Sons | Millard | Spring Dev. & Pipeline | 10,000 |
| Clayton Jeffery | Millard | Well | 7,600 |
| Harold Taylor | Millard | Well | 3,500 |
| Dalley Brothers | Sanpete | Equip Well | 4,000 |
| Irish Anderson | Millard | Well | 4,140 |
| Monte C. Nielson | Millard | Well | 3,800 |
| Ronald H. Webb | Millard | Well | 3,370 |
| Vincent Cropper | Millard | Well | 3,730 |
| Douglas Turner | Millard | Well | 4,243 |
| Earl F. Holman | Millard | Well | 6,000 |
| Grayson Roper | Millard | Well | 8,000 |
| Eldon P. Nielson | Millard | Well | 8,000 |
| Oren L. Kimber Enterprises, Inc. | Box Elder | Well | 3,387 |
| Robert G. Stevens | Millard | Well | 5,450 |
| Carl M. & Jay E. Pace | Millard | Well | 5,600 |
| O. Reed Jeffery | Millard | Well | 4,000 |
| Donald A. Paulsen | Millard | Well | 5,000 |
| Boyd M. Louder | Millard | Well | 5,500 |
| Saint John Group | Tooele | Spring Dev. & Pipeline | 22,000 |
| Ralph E. Nichols | Millard | Well | 4,800 |
| Howard Roundy | Millard | Well | 3,127 |
| Donald R. Peterson | Millard | Well | 4,500 |
| Bryant M. Stevens | Millard | Well | 5,800 |
| Norman Nielson | San Juan | Wells & Pipeline | 33,000 |
| Carl Webb | Millard | Well | 4,500 |
| Faun Staples | Millard | Well | 4,750 |
| Arapian Valley Livestock Co. | Sanpete | Well | 6,100 |
| Eldon Money | Utah | Well | 8,400 |
| Alvin Anderson | Weber | Well | 4,950 |
| Ray Hoelzle | Millard | Well | 4,700 |
| Paul Finlinson | Millard | Well | 6,300 |
| Anderson Farm Enterprises | Millard | Well & Pipeline | 6,500 |
| Johnson Brothers | Millard | Well | 4,600 |
| Gearld Rose | Box Elder | Two Wells | 9,600 |
| Sherril Tolbert | Millard | Well | 5,000 |
| James D. Nickle | Millard | Well & Pipeline | 5,000 |
| | | Total | $302,947 |

Although $300,000 had been allocated for the emergency cloud seeding projects, only $200,000 of that could be utilized during the remainder of the normal cloud seeding season; $100,000 was returned to the Revolving Construction Fund. Most of the remainder of the grant was spent to organize and operate cloud seeding projects in virtually every Utah county from January 1 to June 1, 1977.

Despite the increased cloud seeding effort, success was limited by weather patterns that failed to produce seedable clouds. But early in May, the persistent high pressure ridge which had been preventing almost all storm activity from moving across the Western States finally broke down. This permitted an increase in cloud seeding flights, and the effort possibly contributed to heavier spring precipitation than otherwise would have occurred.

Stockwater hauling program

In addition to the emergency stockwater loan program administered by the Division of Water Resources, the Utah Department of Agriculture organized a program to assist ranchers in hauling water to stock in grazing areas where streams and springs simply had stopped flowing. As coordinator of the program. James D. Harvey contacted many organizations, including military bases, and was successful in acquiring and placing with ranchers a total of 689 portable water tanks and/or motorized water hauling vehicles. The types of equipment included engine containers, water trailers, jet fuel tanks, rubber water storge tanks, tank trucks, and eight-wheel trucks. The equipment was acquired on loan from Tooele Ordinance Depot, Hill Air Force Base, the State Office of Emergency Services, the Utah National Guard and the Bureau of Land Manage-

ment. A complete list of the number and type of equipment placed in each county is given in Table 18.

The objective of this program was to help ranchers save their breeding stock, and it appears to have been very successful. A very critical situation faced cattle ranchers in several areas. In some instances, cattle were actually sent to the summer ranges where there was little or no water. As cattle began to die, the full impact of the seriousness of the water situation became apparent.

The cooperation of the loaning agencies, county commissioners, and the speedy coordination action by the Department of Agriculture were credited with saving the cattle industry in Sevier, Juab, Sanpete, Beaver, Piute, and Garfield Counties. Speedy action early in the drought resulted in its success

Drought Information Center

A Drought Information Center was established in what had been a broom closet in the Capitol. It was the focal point for gather-

Table 16. Governor's emergency (drought relief) culinary grant fund. (As of July 31, 1978.)

| Project | County | Description | Authorized | Unused Balance |
|---|---|---|---|---|
| Manderfield | Beaver | Drill & equip well | $ 32,000.00 | $ -- |
| East Grouse Creek Pipeline Company | Box Elder | Drill & equip well | 18,000.00 | -- |
| Elwood | Box Elder | Drill & equip well | 10,000.00 | -- |
| West Tremonton | Box Elder | Drill & equip well | 30,000.00 | -- |
| East Carbon | Carbon | Develop springs | 25,000.00 | -- |
| Sunnyside | Carbon | Pump mine water | 35,000.00 | 1,808.74 |
| Helper | Carbon | Develop springs, replace pipe | 50,000.00 | -- |
| Scofield | Carbon | Develop springs | 25,000.00 | -- |
| Manila | Daggett | Drill & equip well | 30,000.00 | -- |
| Myton | Duchesne | River pump station | 13,000.00 | -- |
| Huntington | Emery | Lease water | 10,000.00 | -- |
| North Emery Water Users Association | Emery | Lease water | 10,000.00 | -- |
| Henrieville | Garfield | Spring development | 18,000.00 | -- |
| Eureka | Juab | Drill & equip well | 40,000.00 | 1,121.72 |
| Levan | Juab | Develop springs, repair pump | 14,000.00 | 922.38 |
| Alton | Kane | Drill & equip well | 15,000.00 | -- |
| Kanab | Kane | Drill & equip well | 40,000.00 | -- |
| Mt. Carmel | Kane | Drill & equip well | 33,000.00 | -- |
| Circleville | Piute | Buy pump motor | 5,000.00 | -- |
| Woodruff | Rich | Drill & equip well | 5,000.00 | -- |
| Blanding | San Juan | Drill & equip well | 50,000.00 | -- |
| Monticello | San Juan | Drill & equip well | 73,000.00 | -- |
| Mexican Hat | San Juan | Drill & equip well | 6,000.00 | -- |
| Fairview | Sanpete | Drill & equip well | 5,000.00 | -- |
| Mayfield | Sanpete | Drill & equip well | 55,000.00 | -- |
| Spring City | Sanpete | Drill & equip well | 15,000.00 | -- |
| Tooele | Tooele | Repair pump motor | 15,000.00 | -- |
| U.S. Geol. Survey | Tooele | Test wells | 50,000.00 | -- |
| Central | Washington | Drill & equip well | 11,000.00 | -- |
| Enterprise | Washington | Drill & equip well | 6,000.00 | -- |
| Springdale | Washington | Drill & equip well | 25,000.00 | -- |
| Virgin | Washington | Drill & equip well | 56,000.00 | -- |
| Uintah Highlands Improvement Dist. | Weber | Drill & equip well | 30,000.00 | -- |
| | | TOTAL | $ 855,000.00 | $3,852.84 |
| | | Total Unused Balance | $ 3,852.94 | |
| | | Total Spent | $ 851,147.16 | |
| | | Amount Set Aside by Legislature | $1,000,000.00 | |
| | | Amount Spent | 851,147.16 | |
| | | Balance Not Used | $ 148,852.84 | |

Table 17. ASCS - Board of Water Resources projects.

| Company | County | Total Cost | Board Share | ASCS Share | Company Share |
|---|---|---|---|---|---|
| Fisher Creek Irr. Co. | Box Elder | $ 214,000 | $ 126,000 | $ 37,500 | $ 50,500 |
| Marble Creek Irr. | Box Elder | 200,000 | 104,000 | 56,273 | 39,727 |
| Cub River Irr. | Cache | 127,000 | 39,000 | 47,055 | 40,945 |
| Wellington Canal Co. | Carbon | 102,000 | 13,000 | 74,255 | 14,745 |
| Cottonwood Creek Con. | Emery | 366,000 | 115,478 | 231,000 | 19,522 |
| Chalk Creek Irr. | Millard | 169,000 | 100,000 | 36,000 | 33,000 |
| Deseret Irr. | Millard | 86,000 | 42,000 | 23,918 | 20,082 |
| Holden Irr. Co. | Millard | 140,000 | 65,000 | 47,000 | 28,000 |
| West Holden Irr. | Millard | 105,000 | 64,000 | 15,000 | 26,000 |
| West Porterville Irr. | Morgan | 383,162 | 144,000 | 201,037 | 38,125 |
| Cottonwood-Gooseberry | Sanpete | 200,000 | 125,000 | 52,591 | 22,409 |
| Fountain Green Irr. | Sanpete | 206,000 | 139,500 | 22,500 | 44,000 |
| George Sorenson Well | Sanpete | 60,000 | 26,500 | 10,142 | 23,358 |
| Manti Irr. & Res. Co. | Sanpete | 242,000 | 116,500 | 71,283 | 54,217 |
| Pleasant Creek Irr. | Sanpete | 115,000 | 55,000 | 36,262 | 23,738 |
| Sterling Irr. Co. | Sanpete | 440,000 | 235,000 | 112,495 | 92,505 |
| Middle Canyon Irr. | Tooele | 114,000 | 62,000 | 38,357 | 13,643 |
| Soldier Canyon Irr. | Tooele | 232,000 | 160,000 | 36,407 | 35,593 |
| Upper Clover Irr. | Tooele | 120,000 | 44,000 | 66,403 | 9,597 |
| Mosby Irr. Co. | Uintah | 101,000 | 16,000 | 77,282 | 7,718 |
| Cedar Fort Irr. | Utah | 200,000 | 26,000 | 151,282 | 22,718 |
| Sand Creek Irr. | Wayne | 76,000 | 17,000 | 40,000 | 19,000 |
| Teasdale Irr. Co. (Blueberry) | Wayne | 117,000 | 47,000 | 40,735 | 29,265 |
| Daniel Irr. Co. | Wasatch | 466,000 | 190,000 | 176,000 | 100,000 |
| Ivin Irr. Co. | Washington | 305,000 | 95,000 | 33,000 | 177,000 |
| | TOTALS | $4,886,162 | $2,166,978 | $1,733,777 | $985,407 |

Table 18. Emergency stockwater hauling equipment.

| County | Material | Loaning Agency |
|---|---|---|
| Beaver | 6 - 3,000 Gal. Collapsible Tanks | Tooele Ordinance Depot |
| | 1 - 6,000 Gal. Tanker Trailer | Hill Air Force Base |
| Box Elder | 3 - 3,000 Gal. Tanks | Tooele Ordinance Depot |
| | 2 - 400 Gal. Trailers | Tooele Ordinance Depot |
| | 28 - Engine Cases | Tooele Ordinance Depot |
| Cache | 20 - Engine Cases | St. Office of Emergency Services |
| Carbon | 20 - Engine Cases | St. Office of Emergency Services |
| Daggett | | |
| Davis | | |
| Duchesne | 1 - 3,000 Gal. Collapsible Tank | Tooele Ordinance Depot |
| Emery | 14 - 450 Gal. Jet Fuel Tanks | St. Office of Emergency Services |
| | 4 - 3,000 Gal. Collapsible Tanks | Tooele Ordinance Depot |
| | 4 - 1,500 Gal. Collapsible Tanks | Tooele Ordinance Depot |
| | 1 - 1,200 Tanker Truck | Utah National Guard |
| | 4 - 120 Gal. Trailers | Utah National Guard |
| Garfield | 2 - 3,000 Gal. Collapsible Tanks | Tooele Ordinance Depot |
| Grand | 1 - 1,500 Gal. Collapsible Tank | Tooele Ordinance Depot |
| Iron | 4 - 3,000 Gal. Collapsible Tanks | St. Office of Emergency Services |
| Juab | 2 - 1,500 Gal. Collapsible Tanks | St. Office of Emergency Services |
| | 3 - 3,000 Gal. Collapsible Tanks | St. Office of Emergency Services |
| | 14 - 120 Gal. Trailers | Utah National Guard |
| | 1 - 1,200 Gal. Tanker Truck | Utah National Guard |
| Kane | 4 - 1,500 Gal. Tanks | Tooele Ordinance Depot |
| | 1 - 3,000 Gal. Tank | Tooele Ordinance Depot |

Table 18. Continued.

| County | Material | Loaning Agency |
|---|---|---|
| Millard | 2 - 1,500 Gal. Tanks | Tooele Ordinance Depot |
| | 3 - 3,000 Gal. Tanks | Tooele Ordinance Depot |
| | 1 - 1,400 Gal. Tanker Truck (Diesel) | Utah National Guard |
| Morgan | 15 - 3,000 Gal. Collapsible Tanks | St. Office of Emergency Services |
| | 6 - Engine Cases | Tooele Ordinance Depot |
| Piute | 2 - 1,500 Gal. Tanks | St. Office of Emergency Services |
| | 1 - 3,000 Gal. Tank | St. Office of Emergency Services |
| | 20 - 400 Gal. Trailers | Utah National Guard |
| Rich | 1 - 1,500 Gal. Tank | St. Office of Emergency Services |
| | 15 - 400 Gal. Trailers | Utah National Guard |
| | 54 - Engine Cases | Tooele Ordinance Depot |
| Salt Lake | 4 - 400 Gal. Trailers | Utah National Guard |
| San Juan | 1 - 1,500 Gal. Water Tank | Tooele Ordinance Depot |
| | 2 - 3,000 Gal. Water Tank | Tooele Ordinance Depot |
| Sanpete | 2 - 1,500 Gal. Tanks | St. Office of Emergency Services |
| | 3 - 3,000 Gal. Tanks | St. Office of Emergency Services |
| | 13 - 400 Gal. Water Trailers | Utah National Guard |
| | 46 - Engine Cases | Tooele Ordinance Depot |
| Sevier | 2 - 1,500 Gal. Water Tanks | St. Office of Emergency Services |
| | 2 - 3,000 Gal. Water Tanks | St. Office of Emergency Services |
| | 34 - 400 Gal. Trailers | Utah National Guard |
| | 198 - Engine Cases | Tooele Ordinance Depot |
| | 1 - 1,200 Gal. Tanker Trucks | Utah National Guard |
| Summit | 17 - 400 Gal. Trailers | Utah National Guard |
| | 57 - Engine Cases | Tooele Ordinance Depot |
| Tooele | 1 - 1,200 Gal. Tank | B.L.M. |
| | 1 - 1,500 Gal. Tank | St. Office of Emergency Services |
| | 1 - 3,000 Gal. Tank | St. Office of Emergency Services |
| Utah | 2 - 400 Gal. Trailers | Utah National Guard |
| Wasatch | 2 - 3,000 Gal. Tanks | St. Office of Emergency Services |
| Washington | 2 - 3,000 Gal. Tanks | St. Office of Emergency Services |
| Wayne | 1 - 6,000 Gal. Trailer | Hill Air Force Base |
| | 1 - 10 ton Semi-Truck | Utah National Guard |
| | 32 - Engine Cases | Tooele Ordinance Depot |
| | 3 - 3,000 Tanks | St. Office of Emergency Services |

ing, processing and disseminating public information regarding the situation which in some localities reached near emergency proportions. The center was charged with furthering these objectives:

A. To convince the general populace that the drought situation did in fact exist, that it was not fabricated by public officials.

B. To educate the public on the actual facts of the drought (statistics, effects, relief efforts, status of the various water companies and restrictions, etc.).

C. To motivate the public to actually make the sacrifices necessary for conservation.

D. To inform the people of what they could do to conserve water.

E. To provide a central place where people could telephone or call in person to receive needed information.

F. To stimulate positive attitudes and emphasize the fact that even though a drought is a negative experience, conservation measures learned can have a positive impact on the future of the state.

At its closure amid humorous festivities following what appeared to be the end of the drought late in the summer of 1977, the center staff compiled an impressive scrapbook of the information placed before the public. That document is available for inspection at the Division of Water Resources.

## Utah State University Programs

### Information dissemination on water conservation practices

The severe drought conditions experienced during 1977 in Utah were also experienced in the other western states and in many areas to the east as well. Many states inaugurated a variety of programs to help their citizens better cope with drought conditions. The programs fell into the general categories of 1) financial assistance to water users to alleviate the economic impact of reduced water supply, 2) financial assistance to water utilities and individuals who develop their own sources to expand their system by providing new wells or storage facilities, and 3) collection and dissemination of information on how water users could better manage available supplies. The first two efforts were largely handled by the various state and federal agencies based on independent evaluations of individual situations. The third largely was centered at the land grant universities in the respective states and coordinated through a Technology Transfer Project funded in part by the Office of Water Research and Technology, U.S. Department of the Interior.

The study was organized to provide a forum for the exchange of information among the respective states that could reduce duplication. The project collected information on: A) Water-user conservation practices, 1) domestic use, a) inside use, b) outside use, 2) industrial, 3) commercial, and 4) irrigation; B) Water-supplier management practices, 1) water conservation inducements, 2) emergency supply augmentation, a) groundwater mining, b) water harvesting, c) water reuse, 3) reallocation among uses or users; C) Dealing with special drought problems, 1) livestock and range management, 2) effects on fish and wildlife, 3) fire danger, 4) effects on recreation, 5) energy effects (reduced generation and additional use), 6) effects of resulting changes in water quality including salinity, and 7) wind erosion. Types of information included: 1) research results contributing to dealing more effectively with emergency drought situations, 2) research currently underway, 3) brochures or other material prepared for public distribution, 4) reports of extension agents or other technical personnel working with the public to solve drought problems, and 5) user or expert statements recommending supplementing or revising any of the above. Lists that eventually covered 667 abstracted items were distributed to 1,717 subscribers, 785 orders requested information direclty from the program, and many other requests went directly to the primary information sources. All the abstracts and a synthesis of the information obtained on each topic were published by the Utah Water Research Laboratory as Report P-78-002, June 1978.

Altogether, 711 items of information were obtained on 667 abstracts and distributed in drought-impacted areas throughout the country in a newsletter called The Western Water Stretcher published every three weeks. Agricultural water conservation (irrigation practices, irrigated land management, and dry farming adjustments) proved to be the topic generating the most interest followed by manager water conservation inducements (drought publicity, financial incentives, water management research, and financial aid to drought victims), livestock and range management, and water conservation practices outside the home. About 75 percent of the items were for popular distribution and about 25 percent were research studies. A relatively high number of new studies suggests that the drought was inspiring a great deal or new research.

A total of 785 copies of abstracts were requested with the same topics proving most popular except that livestock and range management information did not get an amount of attention proportional to the number of items obtained. Analysis of data on requests showed greater interest in popular than in research items and a decreasing interest from the water users to the water manager to the drought problem items. These trends are at least in part associated with the greater effort to get the Stretcher to people dealing with the water-using public. The responses also reflect a greater desire to obtain information on water management research than to obtain more press releases designed to spread awareness of the drought conditions. The people responding were already well aware that a drought existed and were more interested in specific help on what they could do to alleviate the problem. Water reuse proved the most popular single topic with respect to the number of items received.

Utah proved to be the state originating the greatest number of abstracted items (126) as well as the state from which the greatest number of requests for more information were received (233). Colorado and California had the second and third most active participation respectively in both categories.

After the project, a number of water managers were interviewed on how they felt about the results of this effort as well as other programs (extension service, publicity in public media, etc.) to disseminate information on the drought and on water conservation practices. Only two listed more than three sources of information. The Salt Lake County Water Conservancy District reported almost all of the information they disseminated to their customers was developed internally from within their own office. The single external source of information listed was the Western Water Stretcher. Sevier County residents were also looking for more drought related information. An extension agent explained that many people are not familiar with the extension program and the services and information available.

Others indicated that many people were not getting accurate information. These comments show that although there was a high degree of awareness of the drought, the flow of information was quite uneven; and many residents did not know where to turn for usable drought information.

USU Extension Service

In early 1977 it became apparent that rainfall was well below normal and unless weather conditions changed dramatically, Utah would experience a severe drought. In response to a letter from Dr. A. A. Bishop, Head of the Agricultural Engineering Department, USU President Glen Taggart appointed a campus drought committee to organize university resources to help the people of the state. Shortly thereafter, the Governor appointed a drought committee (Dr. Bishop was a member) and the committee provided what help it could. Richard E. Griffin began assembling information for a public awareness program. The first step was to present a half hour television program on the drought situation and what could be done to combat the drought.

The television program emphasized agriculture (management of crops and irrigation water in a drought) and conservation of water in and around the home. The latter was in two parts: saving water in the home, and outside the home in the garden, on the lawn, shrubs and trees. The program was designed to appeal to all water users. Although directed to the general public, it was presented in a manner so as to provide the USU extension personnel with information to help them develop programs to aid the people of the state in water conservation.

The specifics given in the television show are included in the Utah State University Extension Leaflet 83, "Management of Crops and Irrigation Water in a Drought," and Leaflet 84, "How to Save Water In and Around the Home." The first TV program was presented in February of 1977 and was followed up by the second TV presentation in late summer. The purpose of the July television program was to pass on hints and ideas of those who were using water saving techniques, encourage people to save water and also to pass on information showing how many people were able to get along with less water. A third was planned for December if the drought continued. Winter rains, however, caused cancellation of the December program.

The extension service also cooperated with the State School Board sponsoring a water conservation program for 4th, 5th and 6th grade students. Over 100,000 copies of the little comic book entitled, "Captain Hydro," together with the Teacher's Supplement, were printed. These personally were presented to each school district in the state by Richard Griffin, Tagg Hundrup and Dorothy Wardrop of the State School Board. To introduce the program, a 35 mm slide presentation adapted from Bulletin #84. "How to Save Water In and Around Home," was shown and made available to each school. Copies of a second slide presentation, "Management of Crops and Irrigation Water in the Drought," were distributed to county agents throughout the state for their use in water conservation programs

In December of 1977 a sampling of the schools throughout the state was surveyed to see how effective this program had been. The questions were intended to determine the value of the booklet, whether it was geared to the level of the students, and if parents and families became involved in water conservation. The teachers indicated that families had become involved and that in most cases the Captain Hydro booklet was geared to their needs and understanding. One teacher reported in her survey, "We as a class were amazed at the total amounts of water used each day in regular households. It was a challenge to everyone to fix leaky water faucets and pipes. We learned a lot from the program." Another teacher reported, "It was an excellent booklet, written in a form which interested the students and received positive reaction from students."

The Captain Hydro program was undertaken because it was felt that getting the youngsters in the 4th, 5th, and 6th grades involved in water conservation in and around the home was the best way to get the parents and in many cases the entire family, involved in water conservation.

Weekly Drought Update Program

As the impact of the moisture deficit on Utah's economy became more severe, officials in the state recognized the importance of a routine update on the moisture situation about the state. The Climatologist for the State Department of Agriculture was asked by the Governor to provide this information on a weekly basis.

It was recognized that accumulations of moisture at individual sites might be misleading due to local amounts being appreciably different from the average values in the area. Salt Lake City is a typical example of such a situation. Due to several very heavy storms, accumulations at the Salt Lake City Airport were much above those anywhere else along the Wasatch Front or in the adjacent mountains. A method of estimating accumulations for each of the seven climate divisions in the state was therefore developed. Weekly reports from 40 to 50 weather stations from all areas of the state were provided the State Climatologist by the National Weather Service in Salt Lake City. By means of a weighting technique, accumulations at these stations were used to estimate totals for each of the climate divisions (Figure 1). Weighted division averages were then used to calculate an average value for the entire state.

Normal values for each of the seven climate divisions based upon the period 1941-70 were used for comparison and to determine departures. The first issue of the update was released on January 31, 1977, and subsequent updates have been provided on a weekly basis since that time. The Extension Service at Utah State University has paid for printing and distribution of this service.

Two sample publications follow. The first, dated February 18, 1977, was the period of the year when departures from normal in most areas of the state were the lowest of the drought period. The second, dated June 10, 1977, shows the beneficial effect of the much above normal May rainfall.

Irrigation company responses

Nearly all irrigation companies in Utah took action to help alleviate drought impacts. Some irrigation companies (such as some in San Juan County) had little or no water to distribute and thus could do nothing to help their situation. The general practice of the irrigation companies which had water was to assess their water supply situation to determine the quantity of water that would be available. Then an examination of their distribution system was made to see what if any measures could be taken to reduce irrigation losses, such as canal lining, installing pipelines, and drilling wells to supplement their water supply. The irrigation companies either undertook these projects under their annual operation and maintenance funds or obtained financial assistance. While some of the measurements were completed in time to assist with water shortages during the drought, all of the improvements will be of benefit in future years.

With the early notice and warning of the severity of the drought, farmers in many areas did not plant crops because water would not be available to irrigate them. This helped free water to irrigate perennial crops and also minimized conflicts over the limited water supplies.

Those irrigation companies with direct flow rights generally distributed the water based on shares of stock, as in other years. The time for which a water user could divert and use the water remained the same as other years but the flow of water was geatly reduced. Those irrigators near the end of canals usually experience difficulty in any kind of water shortage. Because seepage greatly reduces the flow rate by the time water has travelled several miles in unlined canals, it is necessary for such canals to be almost full initially for adequate delivery to distanct users. Since many canals were only one-third or one-fourth full by July and August of 1977 it was necessary to cut off deliveries to closer users completely during water turns to distant users. This was true not only in very arid parts of the state but also in normally water surplus areas such as irrigation systems diverting from the Logan River.

Irrigation companies with storage water generally prorated the available supply based on shares of stock and delivered the water at the same flow rate as usual, but the time of delivery was reduced. In Emery County, for instance, the canal system which diverts water from Cottonwood Creek and from Joe's Valley Reservoir reduced flows initially to 50 percent of normal deliveries and by August shares were reduced to 25 percent of normal.

Irrigation water users perhaps were the most severely impacted group by the drought. They knew that their water supply would be limited and by implementing conservation measures and utilizing the water to gain the maximum benefit they were at least able to minimize some of the drought impacts.

DROUTH UPDATE FOR WEEK ENDING FEBRUARY 18, 1977

The past week was again dry in all sections of the state. Departures from normal again increased slightly in most divisions. The drouth conditions are becomming more and more serious as the season progresses.

The storm which moved across much of the state Monday and Tuesday of this week brought light to moderate amounts of moisture with 6 inches to 14 inches of snow to higher mountain ski areas. While this moisture is of course very helpful, it is only a drop in the bucket to what is needed to overcome the moisture deficit. The largest amount reported Tuesday morning was only a little over an inch in the higher mountains of northern Utah and nearly 15 inches is needed during the next 3 or 4 weeks to bring us up to normal for the season. Such an amount is nearly impossible since it would exceed anything previosuly recorded for the period.

| Division | Current Week | * Water Year Accumulation | Departure From Normal | **Percentage of Normal |
|---|---|---|---|---|
| Western | 0 | 1.10 | -2.03 | 35% |
| Dixie | 0 | 1.78 | -3.11 | 36% |
| North Central | 0 | 1.88 | -4.85 | 28% |
| South Central | 0 | 1.58 | -3.12 | 34% |
| Northern Mountains | 0 | 1.40 | -7.64 | 15% |
| Uinta Basin | 0 | 1.12 | -1.81 | 38% |
| South Central | 0 | .85 | -2.53 | 27% |
| State Average | 0 | 1.24 | -3.30 | 27% |

* Values are based upon preliminary reports from about 50 reporting stations scattered about the state.

** Values may have changed from last week due to receipt of additional weather stations for January.

This report was prepared by: E. Arlo Richardson
Utah State Department of
Agriculture Climatologist



DROUTH UPDATE FOR WEEK ENDING JUNE 10, 1977

Scattered shower and thunderstorm activity dominated the weather pattern over the Intermountain area during the past week. Moisture accumulations for the period were extremely variable ranging from little or none to locally very heavy accumulations with local flash flooding. Average temperatures for the period ranged between 4 and 12 degrees above normal.

These above normal temperatures combined with considerable local wind to reduce the effectiveness of the moisture received in so far as relieving the impact of drouth conditions. If temperatures had been cooler, the precipitation less intense, and the duration longer but with equivalent amounts, the infiltration into the soil would have been much greater than actually occurred.

This moisture, however, was very adequate to further support growth of range grasses, forbes, shrubs, and dryland crops which was initiated by the much above normal moisture received during the month of May. Crops at the present time look very good in most sections of the State. If moisture continues to occur during the next two months, the crop picture on both dryland and irrigation crops will be much brighter.

| Division | Current Week | * Water Year Accumulation | Departure From Normal | ** Percentage of Normal |
|---|---|---|---|---|
| Western | .38 | 4.87 | -1.20 | 80% |
| Dixie | .57 | 6.24 | -1.95 | 76% |
| North Central | .13 | 8.87 | -4.08 | 68% |
| South Central | .31 | 4.60 | -3.89 | 54% |
| Northern Mountains | .35 | 8.32 | -7.31 | 53% |
| Uinta Basin | .09 | 2.71 | -2.53 | 52% |
| South East | .25 | 2.70 | -2.94 | 48% |
| State Average | .30 | 4.91 | -3.25 | 60% |

* Values are based upon preliminary reports from about 50 reporting stations scattered about the State.

** Values may have changed from last week due to receipt of additional weather stations.

This report was prepared by: E. Arlo Richardson
Utah State Department of
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## CHAPTER 4

## SUMMARY

The Utah drought of 1976-77 included the driest fall and winter seasons on record followed by a wetter than average summer in most regions. Reservoir storage of snow runoff as well as natural summer streamflow are highly correlated with amount of winter precipitation. The principal impacts of the drought therefore, were those related to the record low streamflows throughout 1977, plus the ski industry impacts which were caused directly by the dry, warm winter of 1976-77.

Despite the extremely low winter precipitation and resulting lack of spring runoff, the impacts of this drought upon the residents of Utah did not appear to be nearly so severe as those attributed to the previous record Utah drought which occurred in 1934. There appear to be at least three reasons for the decreased impact during 1977: (1) The 1977 drought had essentially a one year duration while the 1934 drought was preceded by several years of below normal precipitation beginning in 1931. (2) Since 1934 a continuing water development effort has resulted in construction of many storage reservoirs, thousands of wells and numerous systems to convey water to users. These "anti-drought" measures had a major benefit in that without them the demand for water, which was much larger in 1977 than it had been in 1934, would have fallen far more short of being met by the supply and the impact would have been much more severe than it had been in 1934. The much larger 1977 demand for water would have caused impacts much more severe than those in 1931. (3) Both state and federal agency responses in the form of major drought relief programs were timely and extensive during 1977.

Table 19 summarizes some of the economic losses caused by the drought. There were many losses such as shrubbery and trees which died during or following the drought which are not accounted for in Table 19. Also there were losses within the agriculture and other industries which were not quantifiable within the scope of this study and therefore are not included in the loss summary. There were many severe local agricultural impacts which were balanced by production increases in other regions of Utah where fortuitous timing of summer rains occurred. Overall, many individual losses are not reflected in Table 19, and the figures given there must be regarded as rather rough minimal estimates.

Table 19. Estimated statewide 1977 economic losses attributed directly to the drought.

| Industry | Loss ($ Million) |
|---|---|
| Field Crops | 13.0 |
| Cattle | 8.7 |
| Sheep | 3.6 |
| Ski | 26.0 |
| Utah Power and Light | 6.4 |
| Colorado River Storage Project | 3.4 |
| Total | 60.1 |

The geographic extent of the drought was unprecedented. Over 80 percent of the counties in the U.S. were eventually designated as "drought emergency areas" for purposes of federal relief. As the level of public concern rose a drought relief oriented political concensus developed and responses by all levels of government soon followed. The President's $844 million "drought package" resulted in a proliferation of new and expanded programs. A Directory of Federal Assistance was published to acquaint drought relief seekers with available programs. It listed 42 separate drought programs and 81 types of drought problems which were cross referenced to relief programs.

In Utah several state programs were also available. A summary of actual expenditures from both federal and state loan and grant programs is listed in Table 20.

Most of the expenditures produced long term improvements such as wells and improved conveyance systems which will continue to yield benefits in future years long after the immediate affects of the 1977 drought are over.

Table 20. Drought relief program expenditures in Utah.

| Program | Amount ($ Million) | Type (Loan/Grant) |
|---|---|---|
| FEDERAL | | |
| ASCS Conservation Projects | 11.8 | G |
| ASCS Emergency Stock Feed | 6.5 | G |
| FmHA Emergency Loans (Farmers) | 14.5 | L |
| FmHA Public Water Systems | 1.2 | Both |
| EDA Municipal Water Loans | 1.4 | Both |
| USBR Irrigation Loans and Cloud Seeding | 5.9 | Both |
| SUBTOTAL | 41.3 | |
| STATE | | |
| Emergency Stockwater | 0.30 | L |
| Municipal Water | 0.85 | G |
| Revolving Fund (Irrigation) | 2.10 | L |
| SUBTOTAL | 3.25 | |

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