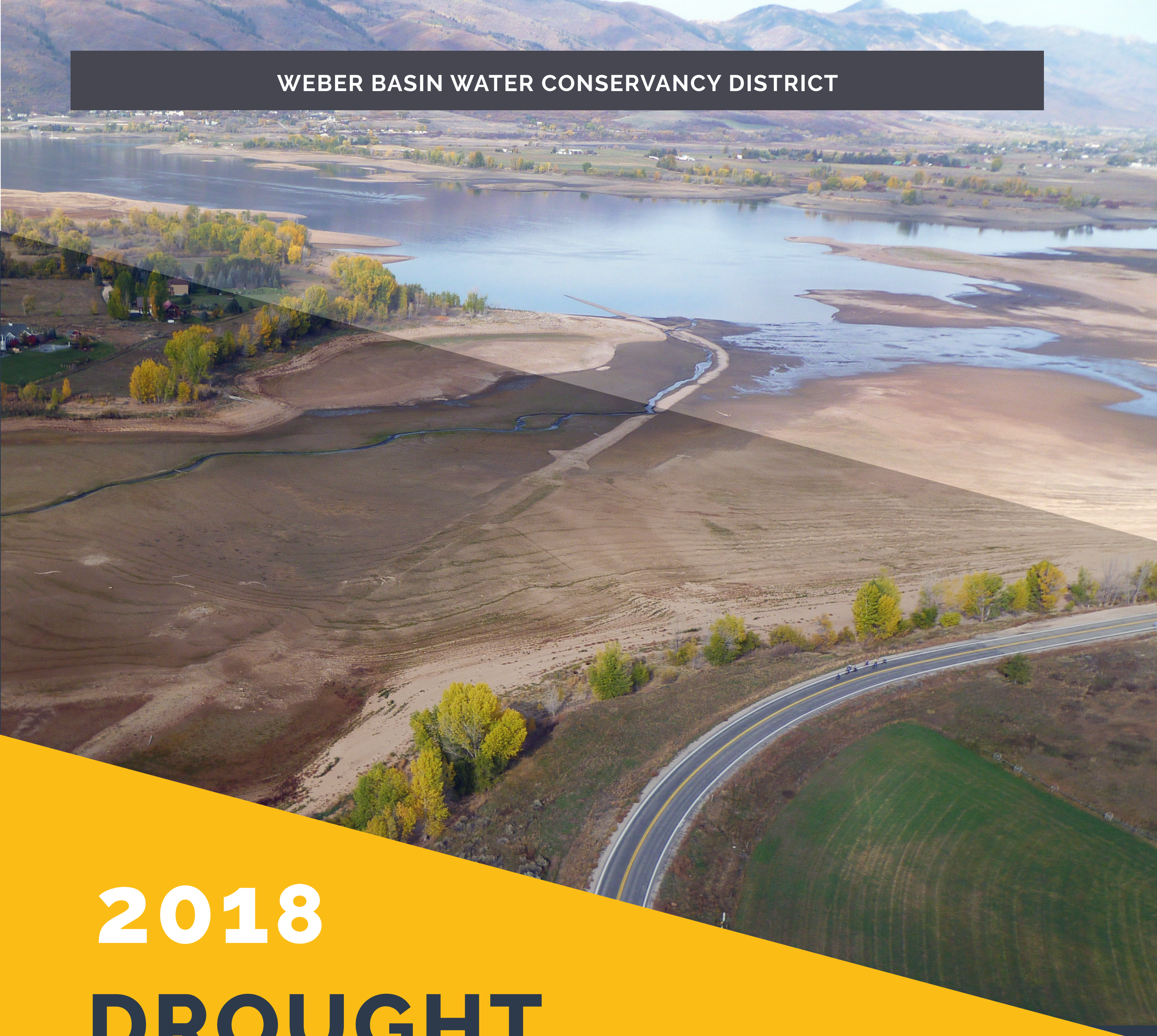
WEBER BASIN WATER CONSERVANCY DISTRICT



2018 DROUGHT CONTINGENCY PLAN

WEBER BASIN WATER CONSERVANCY DISTRICT

Prepared by:

J·U·B ENGINEERS, INC.

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UTAH DNR WATER RESOURCES

UTAH STATE UNIVERSITY 1888

WESTERN WATER ASSESSMENT A NOAA RISA TEAM

CONTENTS

PLAN GOALS

1. Evaluate and understand drought risks and vulnerabilities.
2. Establish drought levels and a process to monitor for drought events with specific triggering criteria.
3. Identify potential drought mitigation measures and create a mitigation plan.
4. Prepare an action plan to respond to various levels of drought.
5. Develop a process to implement, evaluate the effectiveness of, and update the drought plan.

EXECUTIVE SUMMARY

BACKGROUND

Utah has experienced periods of water shortages since the pioneers first settled in the Salt Lake Valley. The lengthy droughts of the 1930s and 1950s caused significant economic impacts and other problems for the state. While the drought of 1976-77 was not as long, the consequences were still intense and costly. Precipitation fluctuates greatly in Utah's relatively arid climate. As the demand for water continues to increase, even temporary shortages in supply can be disruptive to the normal process in urban and rural environments. Two or more consecutive years of significant reduction in precipitation — particularly snowfall in the mountains — may have serious and far-reaching impacts.

Weber Basin Water Conservancy District (WBWCD) is a junior water right holder, but also a major municipal water supplier. This combination of low-priority water rights and high-priority water delivery creates potential challenges during drought periods.

CONCLUSIONS AND RECOMMENDATIONS

This planning process has allowed Weber Basin to identify key insights and strategies to improve drought resiliency within the District boundary.

CONCLUSIONS

- Improved communication and cooperation between water users will improve drought resiliency and response.
- Multiple moderate droughts have occurred in the recent past and severe and extreme droughts have occurred in the last 400 years.
- Future climate changes will play a factor in available water supplies.
- The WBWCD water system is less resilient to drought periods that are longer than 1 to 2 years in duration.
- The projected maximum storage for each calendar year is a key indicator of drought status, especially following a poor water year.
- Water operations can impact the environment and should be coordinated between WBWCD and water users (Drought Plan Advisory Group) to minimize negative drought impacts.
- Maximizing the efficiency of the existing system will improve drought resiliency.

RECOMMENDATIONS

- Create and maintain an internet water supply dashboard to inform the public of the current drought status and conservation actions.
- Develop a WBWCD secondary water drought surcharge fee structure and inform other water suppliers about drought fee structures.
- Install flow meters on all WBWCD secondary water connections and promote metering on all secondary connections within District boundaries.
- Cooperate with irrigation water users and companies to establish short term water transfer agreements for future drought periods.
- Connect existing wells in Farmington to WBWCD culinary water system.
- Meet annually with Advisory Group stakeholders during drought conditions to consider strategies that benefit habitat and meet water deliveries.
- Develop Aquifer Storage and Recovery (ASR) sites to allow for storage of water during good water years for use in drought years.
- Present Drought Contingency Plan (DCP) findings and recommendations to cities and irrigation companies within WBWCD boundaries and follow up.
- Continue to investigate feasibility of water reuse and Willard Bay siphon improvements.
- Finish a climate change study specific to the WBWCD service area for better understanding on how storage levels may be impacted.
- Monitor how response actions help in maintaining storage volumes during droughts to determine if the target demand reductions should be adjusted.
- Update the DCP every 5 years

1950
Weber Basin Water Conservancy District created

2,500
square mile service area

5 counties
Davis
Weber
Morgan
Summit
Box Elder

INTRODUCTION

Weber Basin Background

Weber Basin Project

WBWCD covers over 2,500 square miles within five counties: Davis, Weber, Morgan, Summit and a part of Box Elder. Its jurisdiction covers all the unused stream flows in the natural drainage basin of the Weber River, including the Ogden River basin, which is the Weber River's principal tributary. The Weber Basin Project also includes areas lying between the west slope of the Wasatch Mountains and the east shore of the Great Salt Lake.

The Weber Basin Project was started in 1952 to regulate stream flow with four new reservoirs, two enlarged reservoirs, and the correlated operation of project reservoirs and Echo Reservoir (owned by the Weber River Project). Three of the six project reservoirs (Rockport, Lost Creek, and enlarged East Canyon), along with Echo Reservoir and Smith and Morehouse Reservoir (built by WBWCD in 1983) regulate the flow of the Weber River before it emerges from its mountain watershed to the Wasatch Front, where the principal water utilization occurs.

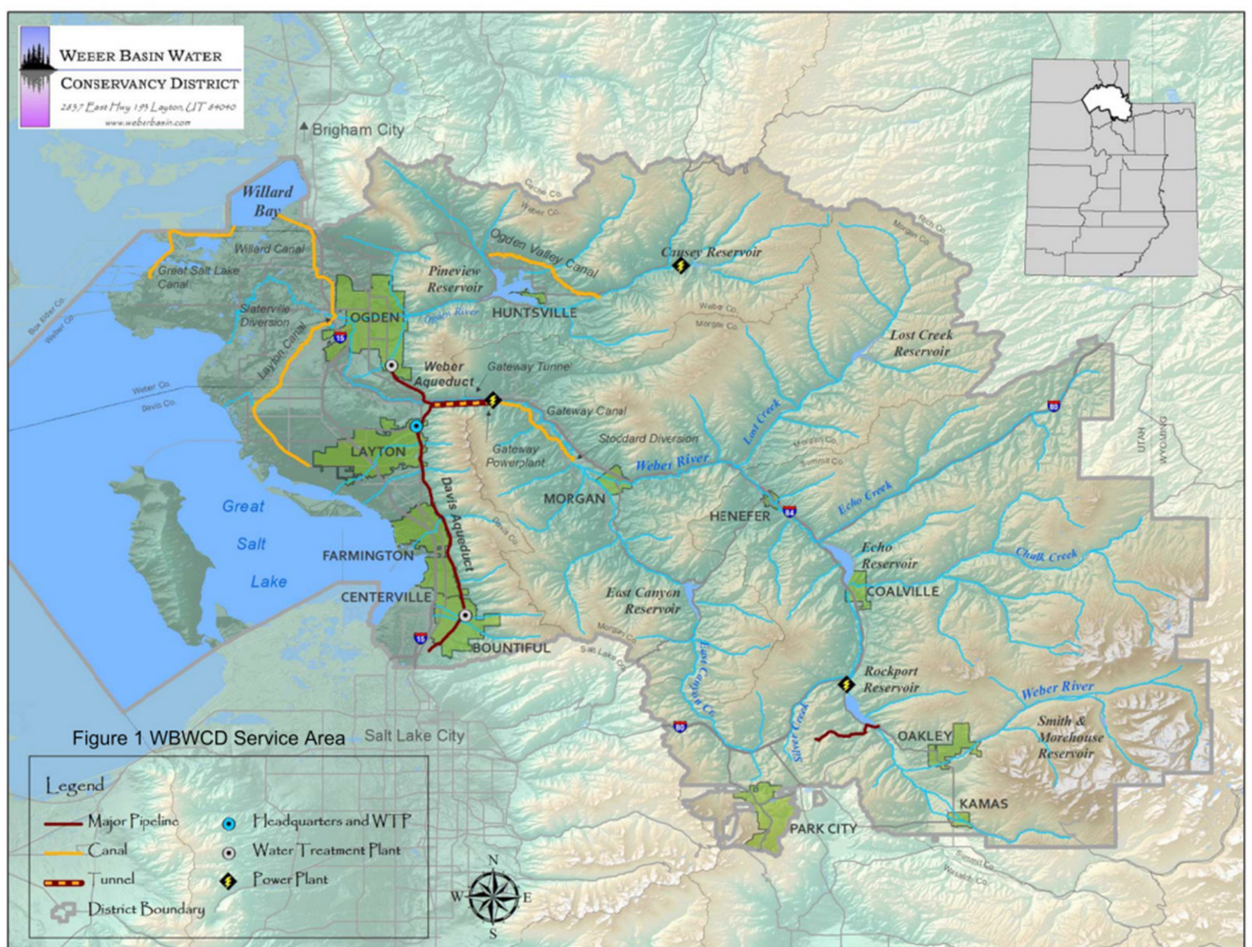


Figure 1 WBWCD Service Area

Pineview Reservoir

Two project reservoirs, Causey and Pineview (enlarged), regulate the flow of the Ogden River before it emerges from the mountains to join the Weber River just west of Ogden City. Willard Reservoir (off stream) is the lowest reservoir of the system and receives water from the Weber River that is diverted below the mouth of the Ogden River at Slaterville Diversion Dam and conveyed through the Willard Canal. If needed, water is returned to the Weber River from the Willard Reservoir over the same route facilitated by the two Willard pumping plants.

The reservoirs on the Weber River and its tributary creeks, Wanship, Lost Creek, East Canyon, and Smith and Morehouse, are operated to supply water for irrigation, municipal, and industrial purposes on the Wasatch Front and for power production at Gateway and Wanship Power Plants. Causey Reservoir on the Ogden River side has also been upgraded by WBWCD to produce power. In addition, the reservoirs are operated to provide supplemental irrigation water and replacement water for residential purposes in mountain valleys along the Weber River and its upper tributaries. The reservoirs are also used to provide flood control and for the maintenance of stream flows to support recreational fishing.

Causey Reservoir

Customers

WBWCD wholesales water and develops additional suppliers for cities, districts, and companies in five Utah counties.

WBWCD provides many categories of water including drinking water, urban secondary water, agricultural irrigation water, and industrial water.

DRINKING WATER

URBAN SECONDARY WATER

AGRICULTURAL IRRIGATION

INDUSTRIAL WATER

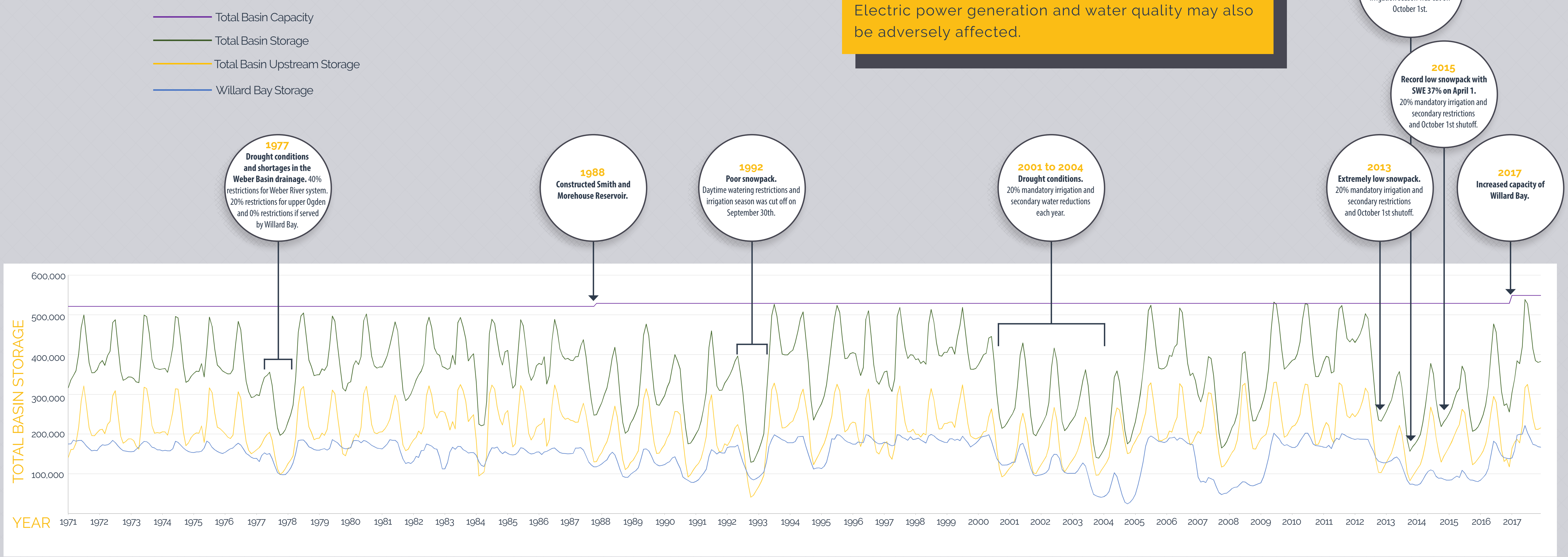
Drought History

Utah has experienced periods of water shortages since the pioneers first settled in the Salt Lake Valley. The lengthy droughts of the 1930s and 1950s caused significant economic problems for the state. While the drought of 1976-77 was not as long, the consequences were still intense and costly. Precipitation fluctuates greatly in Utah's relatively arid climate. As the demand for water continues to increase, even temporary shortages in supply can be disruptive to the normal process in urban and rural environments. Two or more consecutive years of significant reduction in precipitation—particularly snowfall in the mountains—may have serious and far-reaching impacts. A brief summary of historical events is shown below.

When droughts occur, the state and regional water suppliers, such as Weber Basin Water Conservancy District, could experience a variety of problems. If identified and evaluated, problems can be resolved in an organized and cost-efficient manner. The most significant impacts relate to agriculture, municipal water supplies, tourism, and wildlife preservation. Electric power generation and water quality may also be adversely affected.

Weber Basin Recorded Storage History (acre-feet)

1971 - 2017



Authorization & Construction

1949: Congress authorized Weber Basin Project

1952: Construction funds appropriated and contract awarded to the Utah Construction Company to build the Gateway Canal

1954: Construction started on the Davis Aqueduct, Wanship Dam, Gateway Canal, and the Weber Aqueduct

1955: Construction started on Willard Dam, Pineview Dam enlargement, and the Bountiful Drain

1956: Wanship and Gateway power plants and switch yards started

1957: Davis and Weber Aqueducts were completed and began delivering project water from the Weber River

Operating Agency

The Weber Basin Water Conservancy District is the legal agency representing the people of a five-county area: Davis, Morgan, Summit, Weber, and part of Box Elder. The District administers the sale and delivery of project water, operates and maintains the project facilities, and has contracted with the U.S. Government for repayment of reimbursable costs of the Weber Basin Project.

Plan Purpose

The Drought Contingency Plan (DCP) addresses drought related vulnerabilities through consideration of drought response actions and mitigation measures. The DCP is not a water supply master plan to accommodate growth. However, the strategies considered in this plan may provide ancillary benefits for emergency response, replacement or alternative supplies.

The DCP provides an effective and systematic means for WBWCD to manage emergency supply conditions within its service area. This plan is intended to augment and support the WBWCD's Water Conservation Plan and other District policies for the management of water supply and delivery in the event of severe or prolonged drought.

Technical Team

WEBER BASIN WATER CONSERVANCY DISTRICT

Owner/Data Collection and Drought Monitoring

- Derek Johnson
- Darren Hess
- Chris Hogge

J-U-B ENGINEERS, INC.

Stakeholder Involvement, Risk & Mitigation, Plan Development

- Chris Slater
- Cindy Gooch
- Josh King

WESTERN WATER ASSESSMENT

Climate Change Analysis

- Seth Arens

UTAH STATE UNIVERSITY

Historic Drought Analysis

- James Stagge
- David Rosenberg

DWRe

River Modeling

- Scott McGettigan
- Tony Melcher
- Candice Hasenyager

Plan Steps

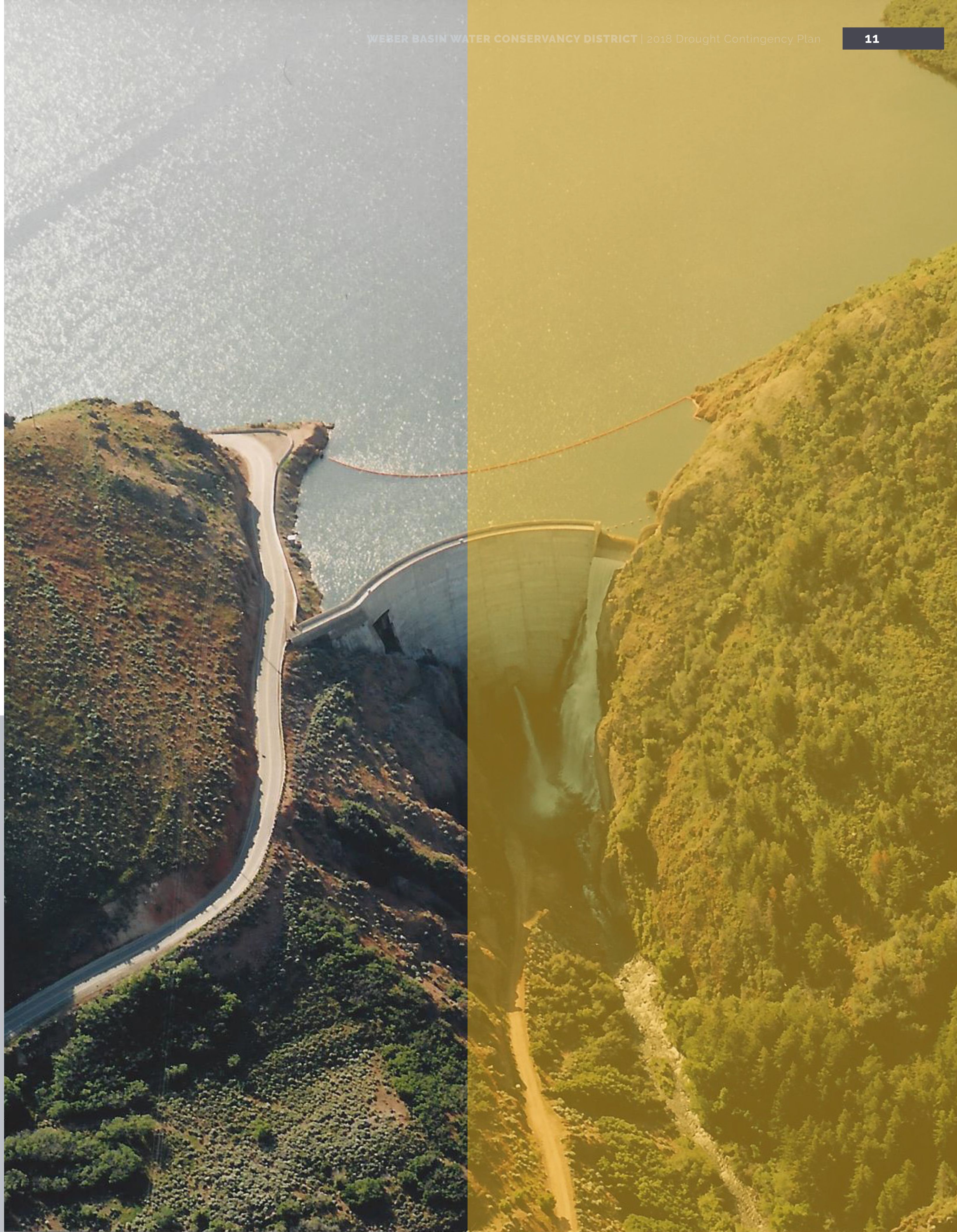
1. Gather stakeholder input/feedback throughout the plan creation
2. Identify historical drought from paleo records
3. Model historic water supplies based on records
4. Define drought levels
5. Project potential future climate scenarios
6. Model future climate scenarios
7. Assess risks
8. Formalize drought monitoring process
9. Identify mitigation measures
10. Create Drought Response Plan
11. Formalize administration of the plan

Plan **Objectives**

- Engage stakeholders throughout the process to inform the plan and meet objectives
- Understand past drought history and drought\vulnerabilities
  - Evaluate historic tree ring records and model past stream and reservoir levels
- Evaluate WBWCD drought vulnerabilities and risks
  - Identify potential future climate scenarios
  - Model river with future climate scenarios
  - Complete a risk evaluation
- Establish drought levels and their associated triggers
- Formalize the process used to monitor for drought
- Identify and prioritize drought mitigation measures
- Develop a drought response plan
- Formalize drought administrative framework

The intent of this plan is to reduce risks to public health from water shortages while also minimizing impacts to agricultural, industrial, and environmental water uses. Potential risks include issues of water quality, water quantity, sanitation, economic impacts, and environmental concerns.

If there is a temporary water shortage emergency as declared by the governor, the use of water for drinking, sanitation, and fire suppression has preferential right over any other water right for the duration of the temporary water shortage. A temporary water shortage emergency may not exceed in duration more than two consecutive calendar years (U.C.A. 73-3-21.1).



STAKEHOLDER INVOLVEMENT

WBWCD does not have control over how all of the water is managed within the district boundaries. As such, it is very important that irrigation companies, municipal water systems, industrial water users, environmental water user groups and other stakeholders participate in the creation and implementation of this plan.

The planning process included two levels of stakeholder involvement. Level one included a small group of stakeholders who were invited to be part of the "Task Force." Level two included a larger group called an "Advisory Group."

These two groups comprised of agriculture users, decision-makers, community residents, local businesses, environmental advocates, and other stakeholders. This extensive stakeholder involvement helped to provide an excellent foundation for the more in-depth work required to formulate an all-inclusive drought plan.

WBWCD understands the need for public involvement rather than merely conducting a public relations campaign. Public involvement is a process of including stakeholders in developing an array of alternatives and a decision-making process for selecting a solution. In contrast, public relations is the process of gaining public acceptance of a predetermined solution. Public involvement seeks to gain stronger support from stakeholders than mere public relations because stakeholders are part of the solution.

Key Stakeholder Interview Summary

Members of the Task Force and Advisory Groups were interviewed. Key themes and insights from these interviews are listed below. Key person interviews provided an understanding of the key drought concerns as well as potential strategies to mitigate the effects of drought and ways to respond to drought.

THEMES	INSIGHTS
INFRASTRUCTURE & OPERATIONS	Maximizing the efficiency and capacity of the existing system through strategies such as improved metering, canal lining, aquifer storage and recovery and wastewater reuse will improve drought resiliency.
ENVIRONMENT	Water operations strategies such as pulsing water through the system during wet years or improving the connectivity of fish habitats should be evaluated and coordinated to minimize negative environmental impacts during droughts.
DATA, COMMUNICATION & COLLABORATION	Improved communication and collaboration through strategies such as; public notification of current drought level status, delivery of water consumption reports to users, creation of water sharing agreements between water entities, interconnection agreements between cities and cooperation between all water users will improve drought resiliency and ability to respond to drought conditions.
DROUGHT WATER PRIORITIES & RESTRICTIONS	A detailed drought plan is needed to prioritize water restrictions for future drought periods, set expectations with water users for drought responses and develop drought messaging.

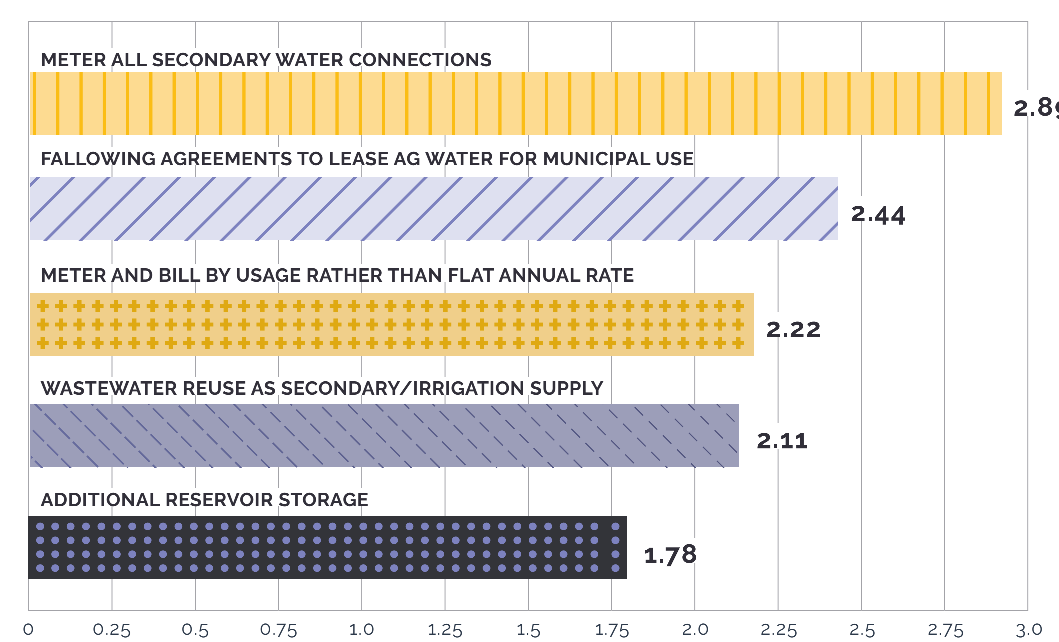
During the interviews, key stakeholders were asked to provide responses to a few key questions. Some potential mitigation actions were presented and stakeholders were asked:

"How would you prioritize the following drought mitigation actions?"

AVERAGE SCORE OF MITIGATION ACTIONS

The stakeholders responded **high**, **medium**, or **low**. The actions were then scored based on the following weighted average point system:

High Priority = 3
Medium Priority = 2
Low Priority=1



TASK FORCE

The Task Force consisted of the key stakeholders who represented the water sectors. The following are the Task Force members and the organizations and sectors that they represent:

ALL

- Cary Southworth - US Bureau of Reclamation
- Candice Hasenyager - DWRe
- Cole Panter - Weber River Commission
- Gary Henrie - US Bureau of Reclamation
- Justin Record - US Bureau of Reclamation
- Kent Kofford - US Bureau of Reclamation

MUNICIPAL

- Ben Quick - Pineview Water System
- Kenton Moffett - Ogden City
- Steve Jackson - Layton City

MUNICIPAL & AGRICULTURAL

- Grant Cooper - Davis & Weber Canal Board
- Rick Smith - Davis & Weber Counties Canal Co. and Weber River Water Users Assoc.
- Theo Cox - Weber River Water Users Assoc.

ENVIRONMENTAL

- Joe Havasi - Compass Minerals/Great Salt Lake Minerals
- Paul Thompson - Utah Division of Wildlife Resources
- Paul Burnett - Trout Unlimited

The purpose of the Task Force is to collaborate with WBWCD and the consulting team to develop the Drought Contingency Plan.

STAKEHOLDER MEETINGS

- Task Force Meeting #1: May 3, 2017
- Task Force/Advisory Meeting #2: August 29, 2017
- Municipal Subgroup Meeting: November 1, 2017
- Agriculture/Irrigation Subgroup: November 13, 2017
- Environmental and Industry Subgroup Meeting: November 16, 2017
- Task Force/Advisory Meeting #3: January 31, 2018
- Task Force/Advisory Meeting #4: June 20, 2018

Initially the Task Force and Advisory Groups met separately. As the project progressed, the Task Force and Advisory Groups began to meet together and all who wanted to participate were invited.

ADVISORY GROUP

The Advisory Group was made up of Task Force members and additional stakeholders from a diverse background, including each of the three major sectors - Agricultural, Municipal, and Environmental. The Advisory Group met together, collected data and research, learned different approaches, and collaborated with interested stakeholders. The following individuals participated in the Adviosry Group along with the Task Force members:

- Blake Carlin - Bona Vista Water District (Municipal)
- Bobby Boone - Trout Unlimited (Environmental)
- Clint Brunson - Utah Division of Wildlife Resources (Environmental)
- Clint McAffee - Park City (Municipal)
- Connely Baldwin - Pacificorp (Agricultural and Municipal)
- Craig Miller - DWRe (All)
- Derrick Radke - Summit County (Municipal)
- Holly Lopez - Park City Public Utilities (Municipal)
- Jamie Barnes - Utah Division of Forestry, Fire and State Land/DNR (Environmental)
- Jerry Allen - Bona Vista Water District (Municipal)
- Kamilla Schultz - Clearfield City (Municipal)
- Laura Ault - Utah Division of Forestry, Fire and State Lands (Environmental)
- Laura Vernon - Utah Division of Forestry, Fire and State Lands (Environmental)
- Lily Boone - Trout Unlimited (Environmental)
- Marcell Shoop - National Audubon Society (Environmental)
- Mark Slagowski - Bountiful City (Municipal)
- Rodney Banks - Roy Water Conservancy District (Municipal)
- Sam Christiansen - North Salt Lake City (Municipal)
- Scott Hodge - Clearfield City (Municipal)
- Skye Sieber - National Audubon Society (Environmental)
- Stacy Majewski - Layton City (Municipal)
- Tony Melcher - DWRe (All)
- Wes Adams - Layton City (Municipal)
- Wess Wight - Bountiful Irrigation District (Municipal and Agricultural)

Key Stakeholder Subgroup Meetings

The Task Force/Advisory group were split into three smaller sub-committees to focus on specific needs and drought response action strategies. The three subcommittees were:

MUNICIPAL **ENVIRONMENTAL** **AGRICULTURAL**

Each of the sub-committees discussed potential water use reduction goals as response actions for each stage of drought. Other key insights and discussion came as a result of the sub-committee meetings.

MUNICIPAL

November 1, 2017

Key Concerns & Issues

- Identified potential drought risks such as inability to provide the culinary water that city purchased from Weber Basin
- Potential health and sanitation issues
- The importance of public education and getting people in the habit of conserving water even on a good water year
- Making sure every city reduces water use equally in a drought situation
- Being proactive with mitigation actions, such as putting fallowing agreements in place, instead of being reactive if and when a drought hits
- Water share leasing

AGRICULTURAL

November 13, 2017

Key Concerns & Issues

- Potential for WBWCD to create agricultural agreements with compensation for farmers to water less or fallow for the season

ENVIRONMENTAL

November 16, 2017

Key Concerns & Issues

- Concern for agriculture not getting their share of water because it can negatively affect the Great Salt Lake and fisheries
- Water flushes in the river system would benefit fisheries and local economies during a drought
- Communication will be key during a drought, not just to fisheries but to everyone

Stakeholder Process

VULNERABILITY ASSESSMENT

An effective drought mitigation plan includes a vulnerability assessment evaluating the potential for drought based on historical data and future projections as well as an evaluation of potential risks and impacts of drought. The vulnerability assessment drives the development of potential mitigation and response actions.

This process included six major components:

1. Identification of Key Drought Vulnerabilities (Technical Team & Advisory Committee)
2. Paleohydrology Study (USU)
3. Hydrologic Model (DWRe)
4. Establishment of Drought Levels and Triggers (WBWCD)
5. Future Climate Change Scenarios (Western Water Assessment)
6. Drought Risks (Technical Team)

Key Drought Vulnerabilities Identified

Drought Vulnerabilities	Municipal	Agricultural	Environmental
Available Water Supply During Drought (Junior Water Rights)	X	X	X
Wasteful Watering	X	X	X
Inability to Operate and Maintain Water Systems	X	X	
Lack of Drought Information to Water Users	X	X	X
Environmental and Recreational Impacts			X
Agricultural Impacts		X	

Drought Impacts by Sector

Municipal

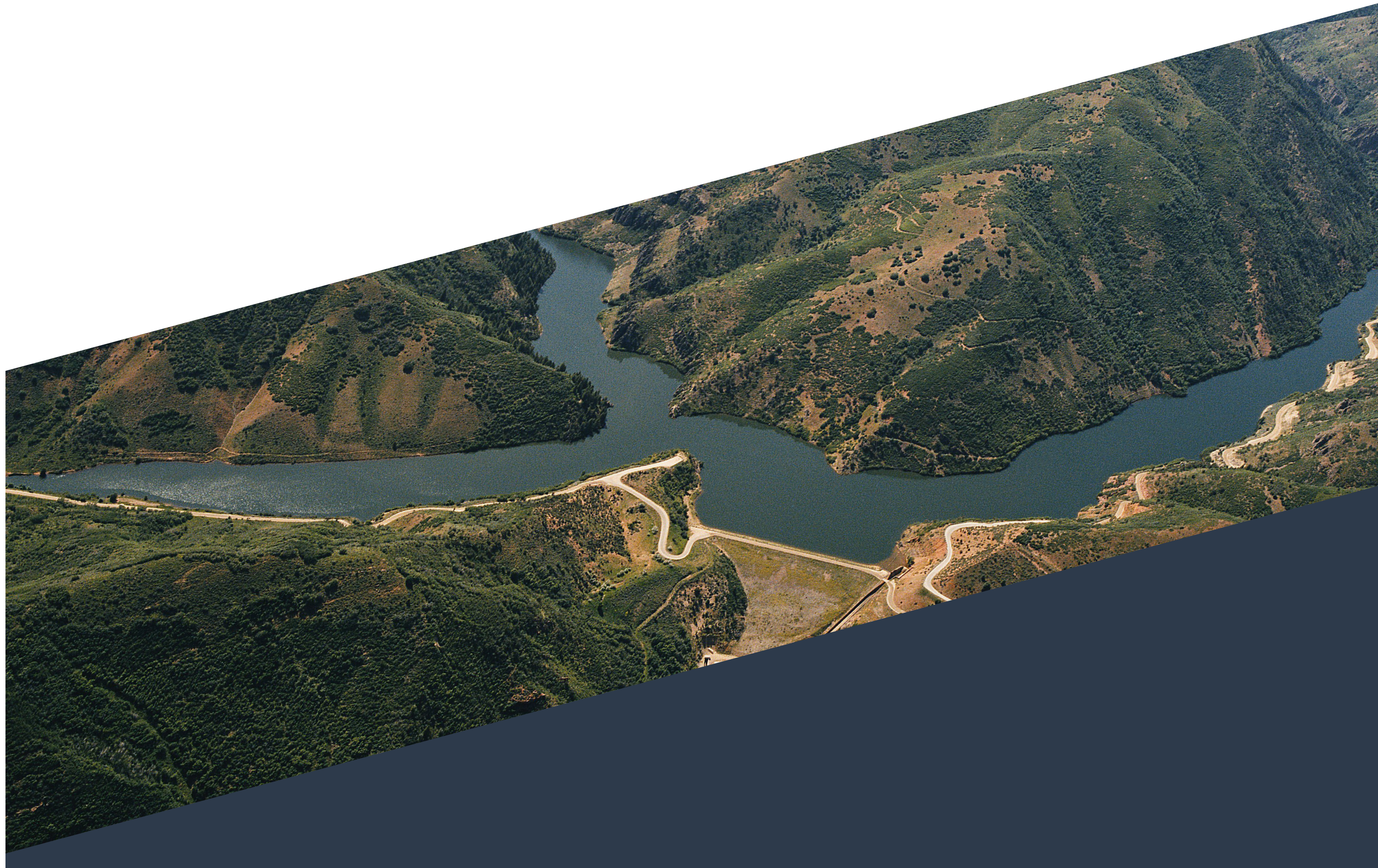
- Inability to collect fees due to inability to deliver water
- Lost revenue for industrial companies
- Loss of trees
- Drops in the aquifer levels/ increase well pumping costs
- Lost revenue for system operation and maintenance
- Growth and increased water demands
- Overuse of water for yards

Agricultural

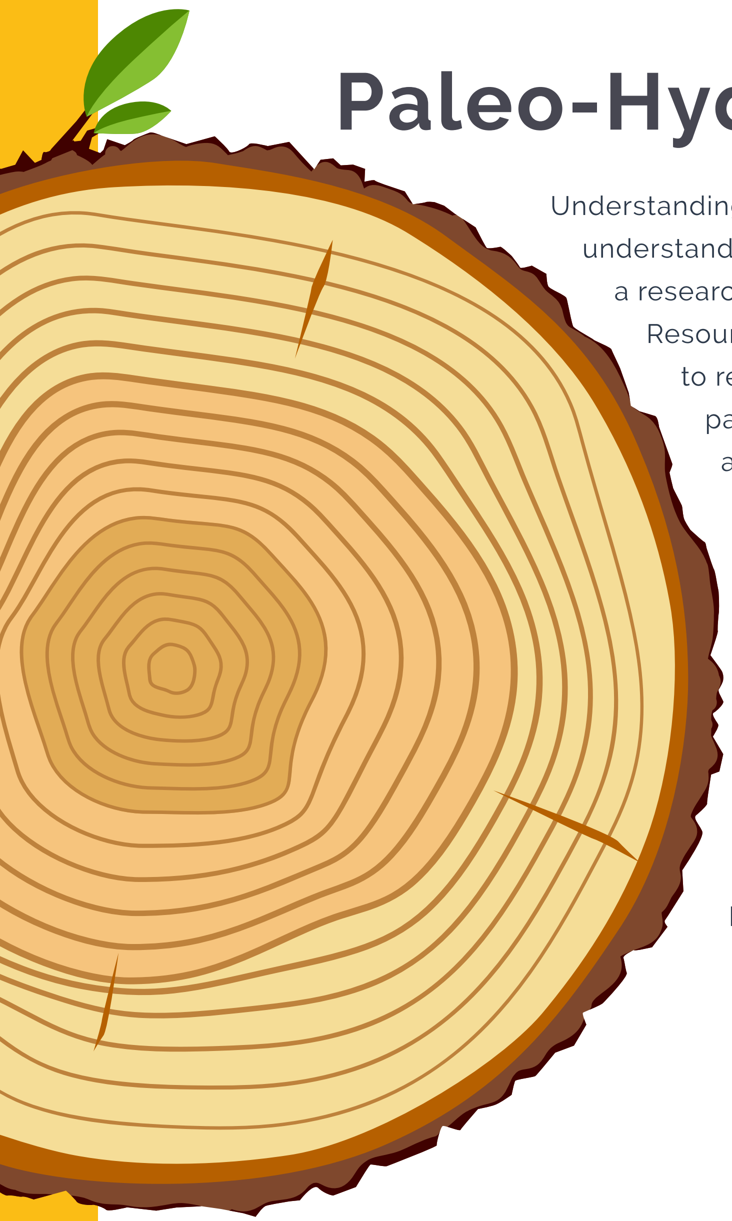
- Inability to deliver water to users
- Loss of crops or crop reductions
- Impacts to dairies
- Irrigation diversions may not work
- Loss of income
- Loss of clients

Environmental

- Impact to fisheries
- Bluehead sucker impacts
- Decline of native and wild trout
- Avian and brine shrimp issues
- Air quality
- Water quality
- GSL industry
- Recreation
- Skiing
- Boating
- Kayaking



Paleo-Hydrology Analysis



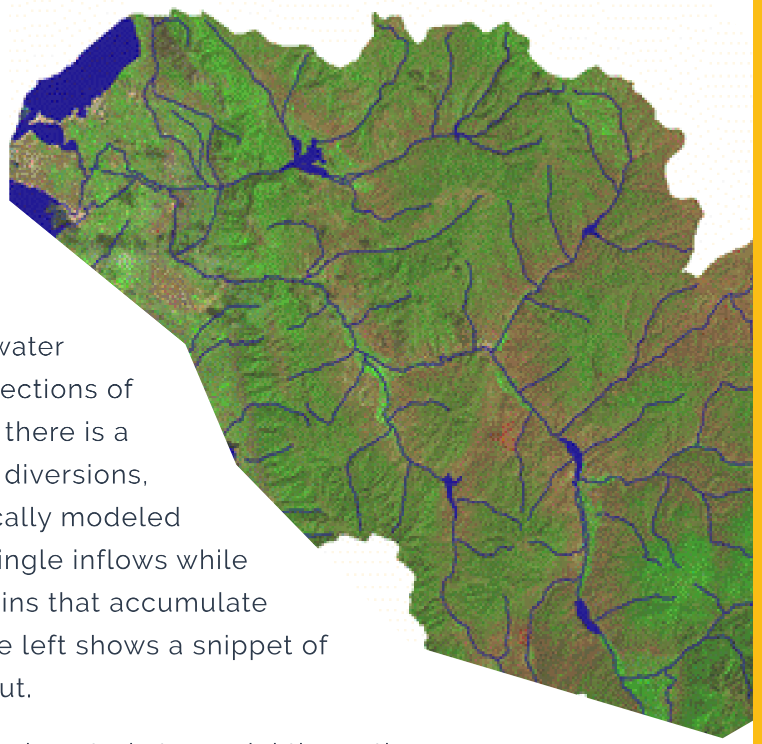
Understanding of the past flows in the Weber River is critical to understanding how vulnerable WBWCD is to future drought. In 2014, a research paper published in the Journal of American Water Resources Association used dendrochronology (tree ring studies) to reconstruct streamflow for the Weber River Basin. This paper provided valuable insight on the intensity, duration, and frequency of droughts and wet periods over the past 576 years in the Weber River Basin. USU utilized the annual data from the study and created a monthly record of stream flows back to the year 1429. The estimated historical flows from the tree ring study are referred to as paleo flows.

Plots of the Weber River paleo flows at Oakley can be viewed on line at http://www.paleoflow.org/. This website can be used to view monthly flow plots of both the observed flows from the USGS flow monitor and the paleo flows.

Utah State University completed a, first-of-its-kind statistical downscale of historic annual river flows to monthly flows based on a tree ring study.

Hydrologic Model

The Utah Division of Water Resources maintains a computer hydrologic model (Weber River Model) that is currently built with Riverware software. The model is mainly a water supply model with the intended purpose being to explore how different past and future scenarios may impact supply.

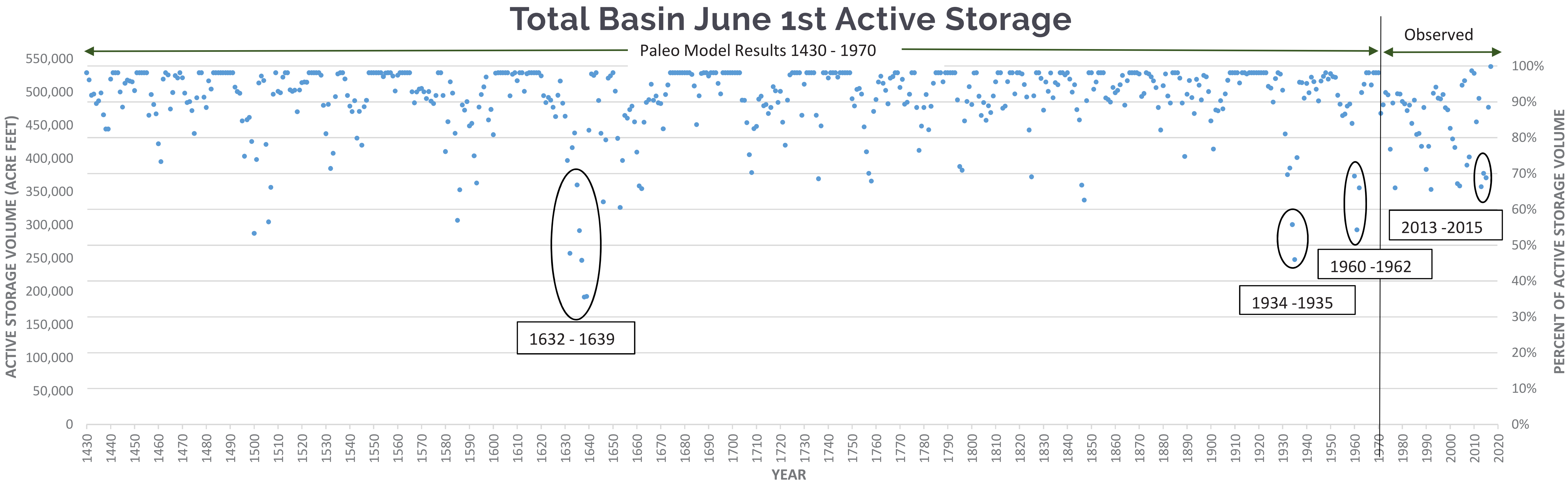


The entire river is modeled from top to bottom and is constructed with the major reservoirs, reaches, and water users on the system. Many water users are combined into aggregate groups on sections of the river, especially higher in the system where there is a greater number of individual users. Large canal diversions, most of which are lower in the system, are typically modeled individually. Major tributaries are identified as single inflows while smaller ones are combined into single reach gains that accumulate down-stream between gauges. The figure to the left shows a snippet of the model space illustrating the described layout.

DWRe utilized historic river flow data from the paleo study to model the entire system and identified the historic storage volume in the existing WBWCD reservoirs for each of the years in the paleo from 1429 up through 1970. WBWCD has records of observed storage from 1970 through the present. The model scenarios are based on total basin storage which includes all the stored water that WBWCD owns as well as water owned by irrigation companies and other water users.

Historic Total Basin Active Storage

The key indicator of the water supply for WBWCD is the projected June 1st storage each year. The maximum storage volume for each year will be reached near this date and varies depending on multiple factors. The total maximum active storage volume in the basin is approximately 529,000 acre feet. The chart below shows a single dot for each year that corresponds to the June 1st storage during that year.



A few notable multi-year periods of low storage are circled for reference. A very extreme and long duration drought occurred in the 1630's. The dust bowl drought of the 1930s is noted along with another drought of the 1960s. The period of 2013 through 2015 is a less severe period of drought, but provides a recent frame of reference to compare with droughts that occurred further back in history.

Establishment of Drought Levels

WBWCD completed an evaluation of the historic June 1st storage volumes from the observed storage record period and based on the paleo model results back to year 1430. WBWCD then established the total basin storage volumes that define a moderate, severe, or extreme drought based on the past recurrence intervals and water restrictions needed for recent moderate drought events.

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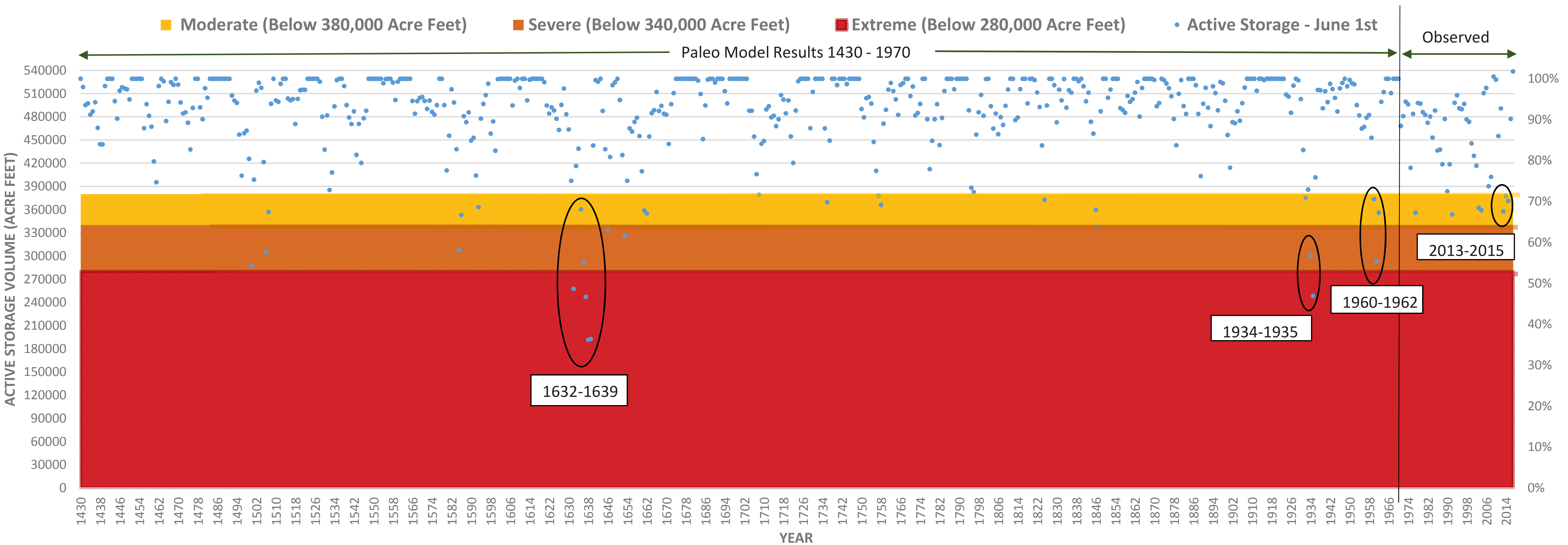
Historic Drought

	PROJECTED JUNE 1ST TOTAL BASIN STORAGE		AVERAGE NUMBER OF YEARS BETWEEN EVENTS	
Drought Level	Acre-Feet	% of Total Basin Storage Capacity	1430 - 1970	1971 - 2017
Moderate	340,000 to 380,000	64% - 72%	36	7
Severe	280,000 to 340,000	53% - 64%	60	No Events
Extreme	Less than 280,000	Less Than 53%	135	No Events

The average number of years between past droughts are tabulated in this table based on the identified drought levels.

Total Basin Storage Drought Levels



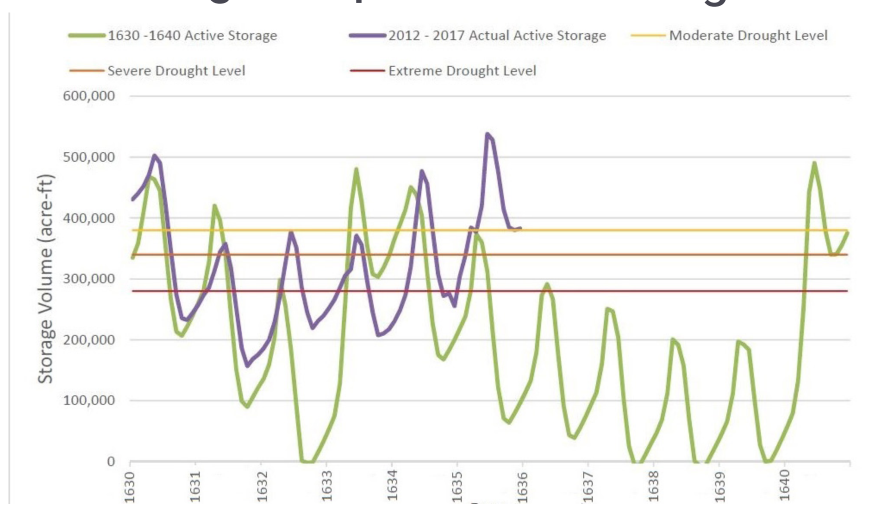
Evaluation of Past Droughts

The recent 2012 through 2015 drought is classified as a moderate drought. WBWCD implemented 20% reductions in irrigation water contracts in 2013 and 2015 and shortened the irrigation season by two weeks for years 2014 -2016 in response to this drought. Davis and Weber Counties Canal Company also had water supply reductions. With this drought in recent memory, it can be used as a baseline event to compare to past historic drought events.

The following graphs compare the active storage volumes recorded during the 2013 drought event with the other drought events that were identified through Riverware modeling using the tree ring data. The graphs provide a way to compare the droughts in terms of duration and intensity. The colored horizontal lines indicate the drought levels that were established and that are based on the June 1st active storage for each year. The peaks in the graphs indicate the June 1st active storage that was recorded or recreated based on the tree ring data.

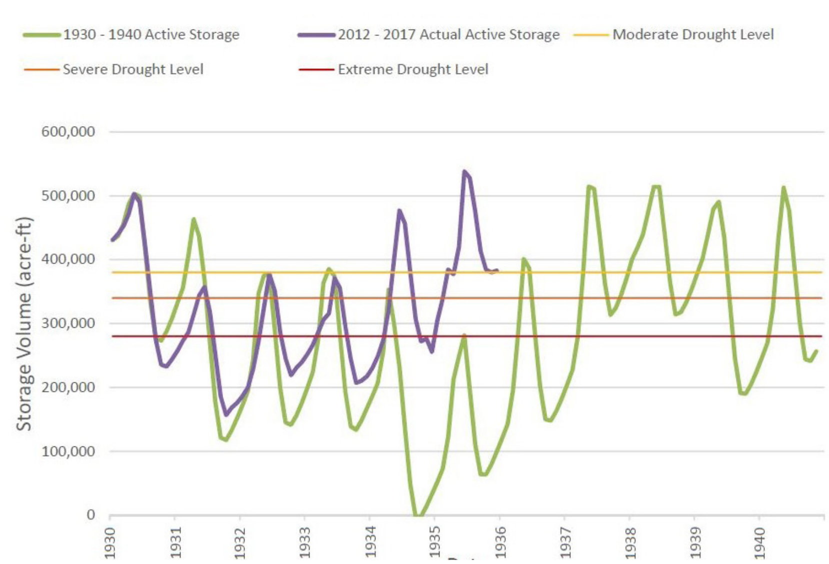
The drought from the 1630s was much longer and much more intense than the 2013 drought.

1630 - 1640 Historical Drought

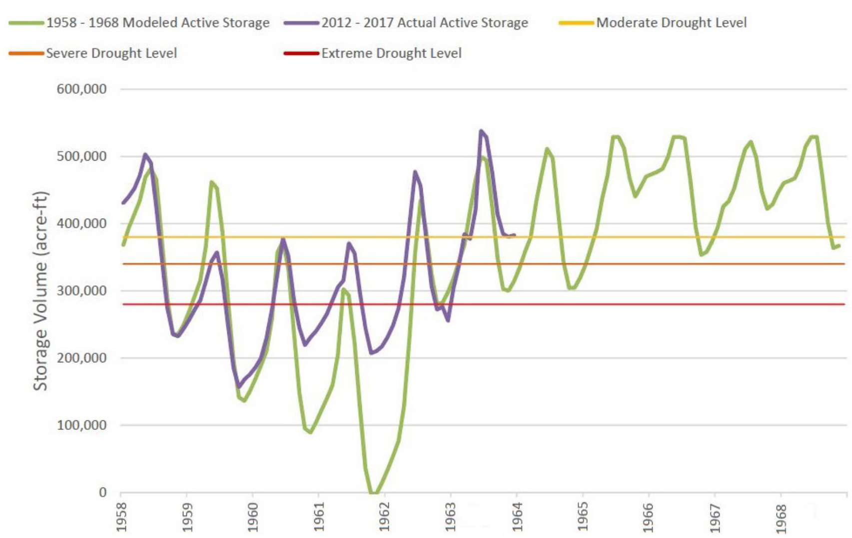


The drought from the 1930s was similar to the 2013 drought for the first few years, but then dropped into an extreme level for a year before improving.

1930 - 1940 Historical Drought

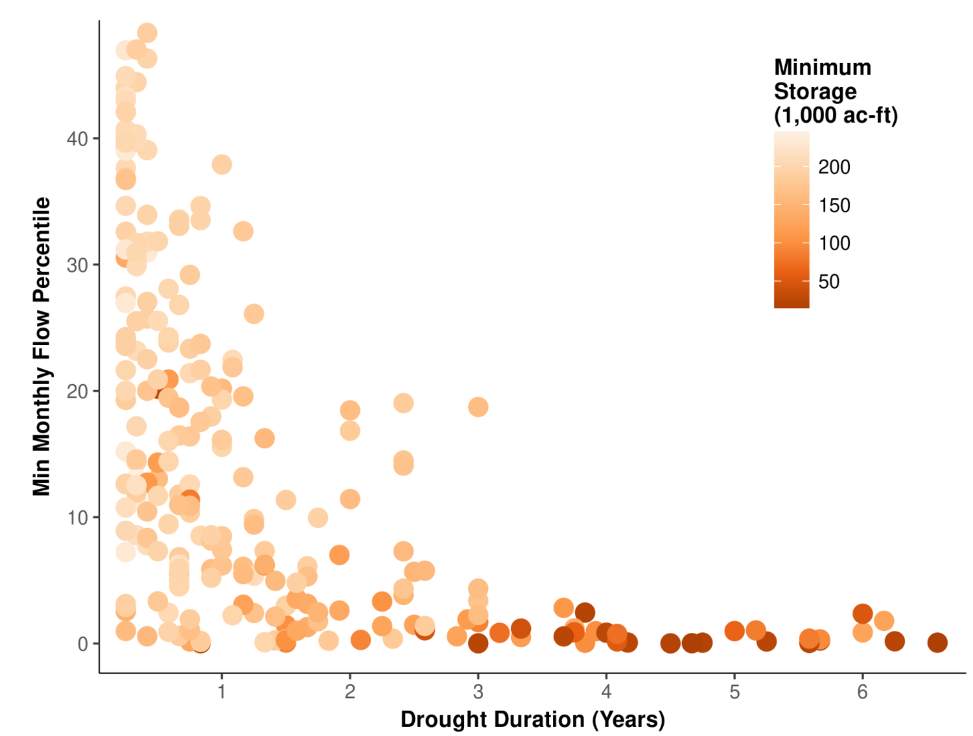


1958 - 1968 Historical Drought



The drought during the 1960s was similar in duration to the 2013 drought, but did have a year in the middle of the drought that dropped well into the severe drought level.

Drought Duration Impacts

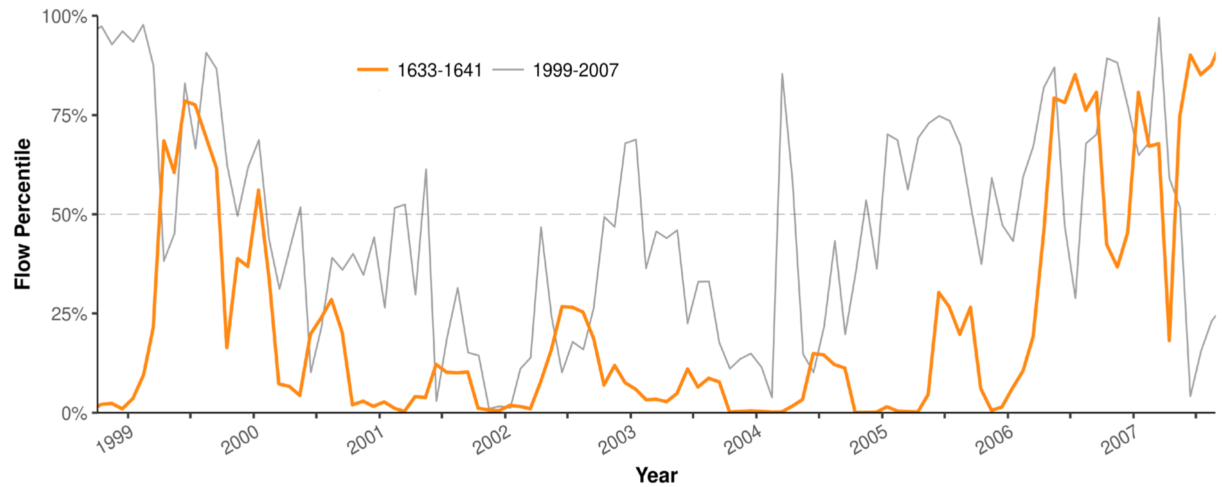


The WBWCD water storage supplies provide more than one year of storage. This is evident in this graph produced from the Riverware modeling results and based on the paleo records.

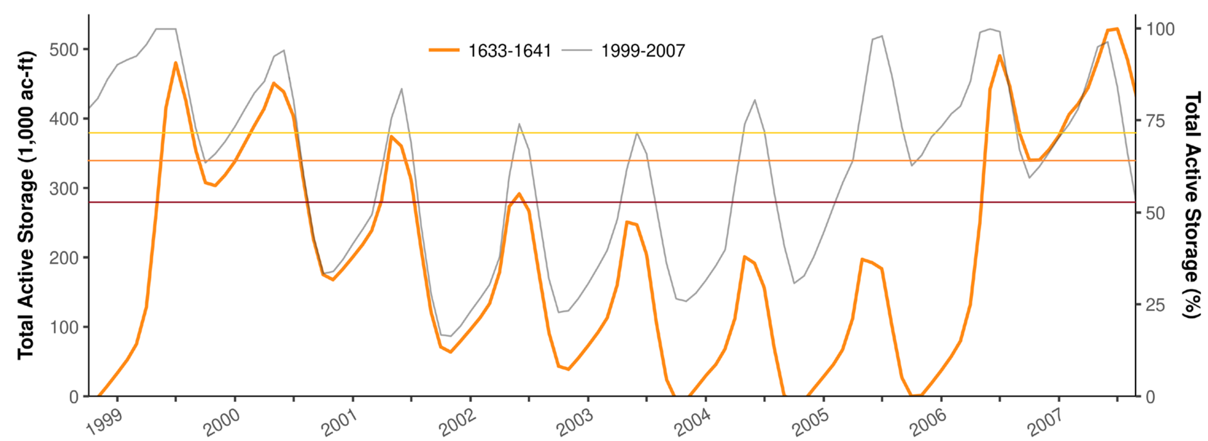
Storage levels hold well through one and two-year duration droughts; however, storage levels are typically very low for droughts that last three years or longer.

A key trend is observed based on the graphs below. During extended droughts, river flows may drop off first, followed by a drop in reservoir storage after the first couple of years. Demand shortages then begin multiple years into the actual drought. The large drought from the 1630s compared to the flows from 1999 to 2007 is used for this illustration.

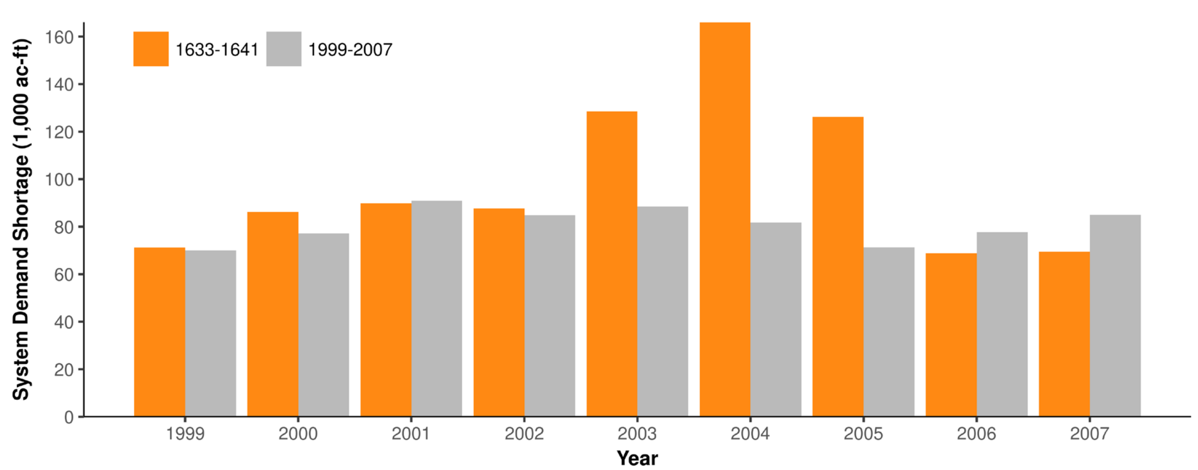
RIVER FLOWS OVER TIME



TOTAL ACTIVE STORAGE OVER TIME



ESTIMATED WATER SHORTAGE VOLUME BASED ON WATER DEMANDS



Climate Change Projections

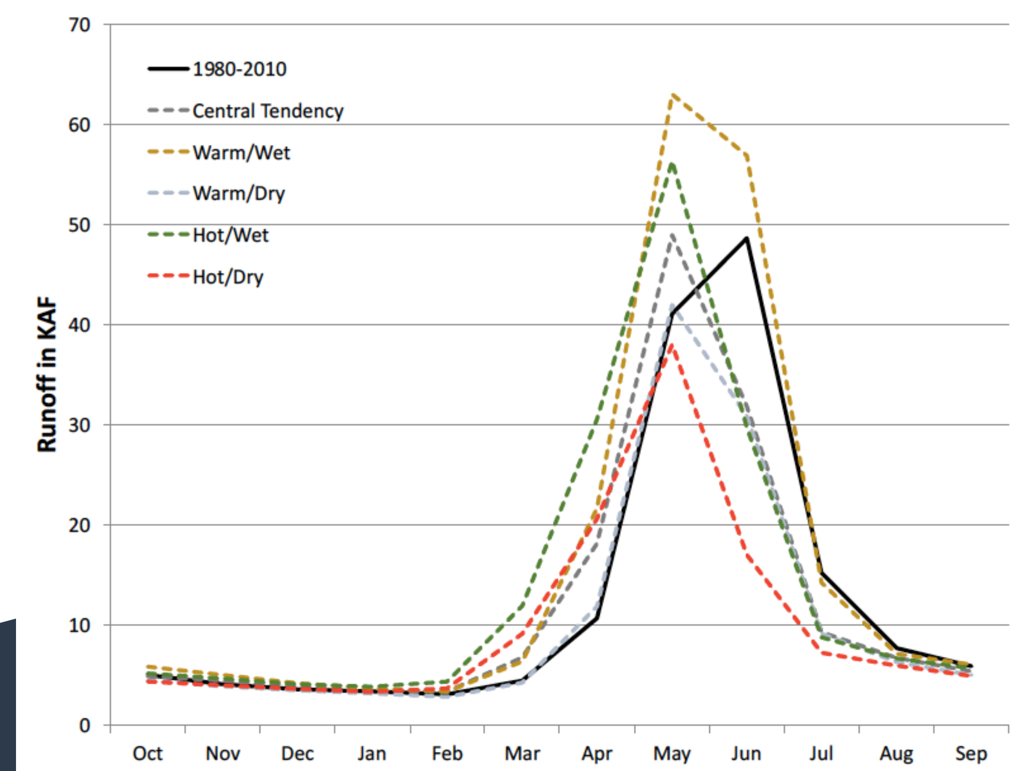
For this study, five future climate scenarios were evaluated based on potential future temperature and precipitation changes.

The climate change projections completed for this drought plan are based on phase 5 of the Wold Climate Research Programme Coupled Model Intercomparison Project (CMIP5). In the future, these projections will be updated to become more localized. WBWCD plans to complete a local climate change vulnerability study to downscale future climate scenarios to be more specific to Weber Basin. These scenarios take the 30-year period from 1980 to 2010 and project water conditions for future years 2034 to 2064.

CLIMATE CHANGE SCENARIOS

Scenario	Temperature Change (Fahrenheit)	Precipitation
Central Tendency	+4.1	+4%
Warm and Wet	+2.3	+12.7%
Warm and Dry	+2.2	-5.9%
Hot and Wet	+5.6	+10.2%
Hot and Dry	+5.8	-6.2%

Projected River Flows for Each Scenario



The projected river flows at the Oakley streamflow gauge vary for each of the projected climate change scenarios. Peak annual flows occur earlier in the year (May) for all future climate scenarios compared to historical peak flows (June). Peak Weber River monthly flows are higher in the warm/wet scenario and the hot/wet scenario compared to historical peak monthly flows while peak flows for the hot/dry and warm/dry scenarios are lower than historical peak flows.

Storage Projections

The hot/dry scenario is the worst-case scenario evaluated in terms of water supply (storage)

Projected monthly flows for each climate scenario were used as inputs in the Weber River model to assess the impact of future changes in climate on water availability, reservoir storage and the incidence and severity of drought in the Weber River Basin.

The hot/dry scenario is the worst-case scenario evaluated in terms of water supply (storage).

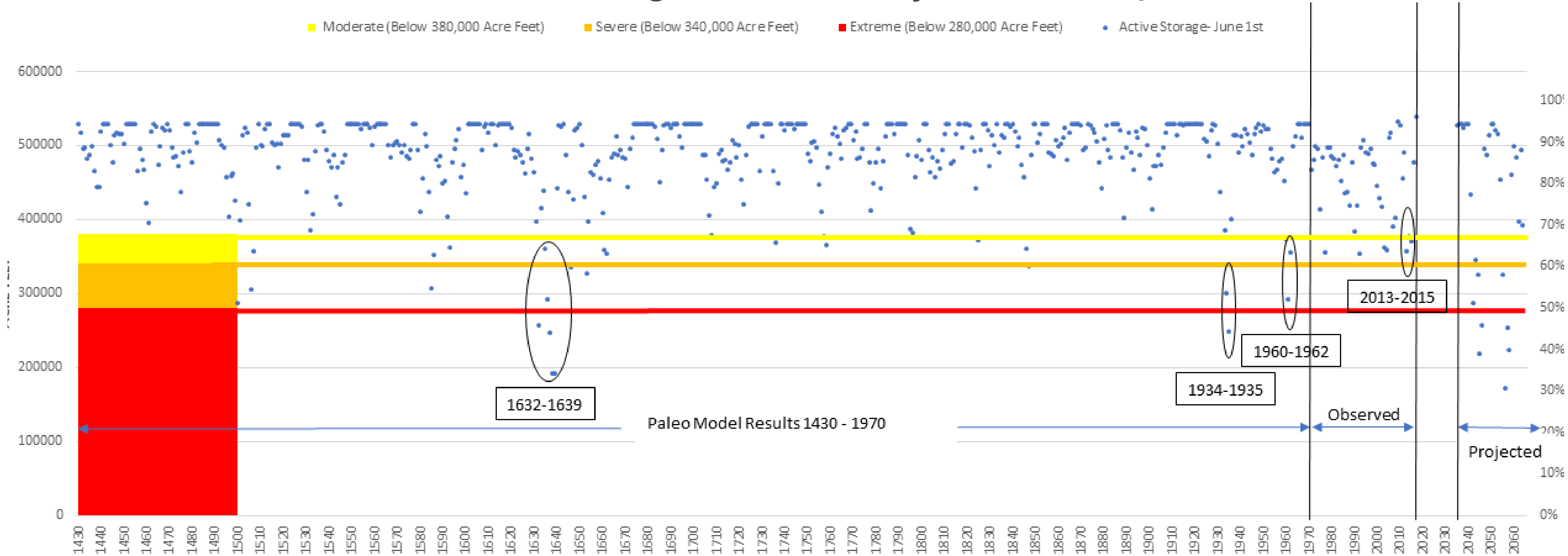
The central tendency scenario may be closer to what future conditions will be, but there are many variables and unknowns. The hot-dry scenario should be considered in order to be prepared for what the future may bring.

Under the hot-dry scenario, it appears that many of the moderate level droughts experienced since 1970 will happen again, but may be intensified to severe levels with three occurring in the future 30-year period. Under this scenario there are an estimated five extreme droughts projected during the future 30-year period.

Hot/Dry Projected Drought

	PROJECTED JUNE 1ST TOTAL BASIN STORAGE		AVERAGE NUMBER OF YEARS BETWEEN EVENTS		
			PAST		PROJECTED
Drought Level	Acre-Feet	% of Total Basin Storage Capacity	1430 - 1970	1971 - 2017	Future Hot-Dry Climate Scenario (2036 - 2065)
Moderate	340,000 to 380,000	64% - 72%	36	7	30
Severe	280,000 to 340,000	53% - 64%	60	No Events	10
Extreme	Less than 280,000	Less Than 53%	135	No Events	6

Total Basin Storage with Hot/Dry Climate Projection



Risk Evaluation

Unforeseen and unmitigated risks pose a threat to any organization and result in the loss of billions of dollars each year. Potential risks need to be identified and evaluated to develop a plan to mitigate those risks. One way to do this is through group risk assessment workshops. Risk assessment workshops:

- Provide a way to manage risks proactively
- Involve stakeholders (both internal and external) at a strategic business level
- Involve stakeholders at a programmatic operational level

Potential WBWCD drought related risks (or missed opportunities) were identified and assessed through workshops held with the WBWCD staff members and stakeholders. The workshops allowed for group brainstorming to think about potential risks to WBWCD as a result of drought. WBWCD staff members and the consultant team assigned a risk level to each identified risk based on a combination of the likelihood of the risk occurring and the potential impact or consequences of each risk occurring. The risks were categorized according to the Risk Level table shown below. The identified high risks are listed in the table to the right.

Risk Levels

Likelihood of Occurrence \ Impact of Consequence of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	LOW	MODERATE	HIGH	HIGH	HIGH
Likely	LOW	MODERATE	HIGH	HIGH	HIGH
Unlikely	LOW	LOW	MODERATE	MODERATE	HIGH
Very Unlikely	LOW	LOW	LOW	LOW	HIGH

Key Drought Vulneravilities and Risk Levels

KEY DROUGHT VULNERABILITY	POTENTIAL MITIGATION MEASURES	RISK LEVEL
Available Water Supply During Drought (Junior Water Rights)	Failure to enter into agreements	HIGH
	Loss of Echo holdover water	HIGH
	Failure to deliver culinary water	HIGH
	Increased wildfires	HIGH
	Hot-dry climate	HIGH
	Inability to utilize Larrabee water right	MODERATE
Wasteful Watering	Excessive use of water resources	HIGH
	Inability to deliver 50% of secondary water	MODERATE
	Inability to deliver 100% of secondary water	LOW
Inability to Operate and Maintain Water Systems	Failure to maintain existing storage and delivery facilities	MODERATE
	Loss of power generation at plant in Weber Canyon	MODERATE
Lack of Drought Information to the Water Users	Failure to collaborate and educate	HIGH
Environmental and Recreational Impacts	Decreases in stream flows and storage. Reduced GSL levels	HIGH
Agricultural Impacts	Inability to deliver 50% of agriculture water	HIGH
	Inability to deliver 100% of agriculture water	HIGH

DROUGHT MONITORING

Understanding how to measure and monitor key indicators of drought is critical to be prepared for future droughts.

Drought Levels

RESPONSE LEVEL	ADVISORY CODE	WATER SHORTAGE DESCRIPTION	GENERAL DESCRIPTION
1	Blue	Normal	Projected June 1st storage greater than 72% of total basin storage capacity, normal or better snowpack
2	Gray	Advisory	Projected June 1st storage greater than 72% of total basin storage capacity, low projected snow pack and low Colorado Basin River Forecast Center (CBRFC) flows
3	Yellow	Moderate	Projected June 1st storage is 64-72% of total basin storage capacity
4	Orange	Severe	Projected June 1st storage is 53-64% of total basin storage capacity
5	Red	Extreme	Projected June 1st storage is < 53% of total basin storage capacity

There are five water supply conditions or levels that are generally described in the table above. The first level is the blue level and is referred to as the normal level. The normal level is not a drought level, but indicates a state of adequate water supply. The advisory drought level is for situations when the reservoirs will be close to full on June 1st based on good snowpack and runoff from the previous years, but the current year has been a poor precipitation year. The advisory level allows WBWCD to begin taking actions to reduce water use in case a second poor precipitation year follows.

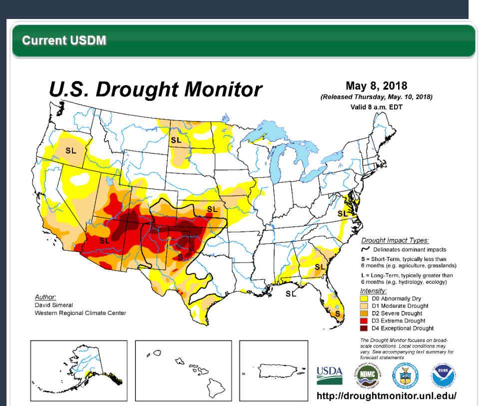
The yellow orange and red levels represent moderate, severe and extreme droughts respectively. Drought response actions to reduce water consumption will be needed during these droughts because of the dry conditions. Extreme and severe droughts will require greater response efforts than moderate droughts. WBWCD monitors water supply conditions throughout each year to assess and determine the current drought response level.

Drought levels are triggered through the monitoring of multiple key metrics throughout any given year.

DROUGHT INDICATORS

WBWCD uses other tools to actively project June 1st storage reservoir storage levels. These include:

- NRCS Snow Pack Forecasts
- Intermountain West Drought Early Warning System
- Colorado Basin River Forecast Center (CBRFC) Run-off and Snowpack Forecasts which gives outlook projections for:
  - Water supply
  - Reservoir conditions
  - Daily precipitation
  - Monthly precipitation
  - Soil moisture
  - Peak flood probability



Drought Triggers

The three primary triggers used to determine the drought level:

1 Projected June 1st Total Basin Active Storage (Maximum = 529,000 acre-feet)

Storage volumes fluctuate significantly within basin reservoirs during each calendar year. Storage volumes are at their maximum during the snow runoff period and are subsequently drawn down during the summer irrigation season.

WBWCD monitors storage levels regularly throughout the calendar year. However, the maximum storage achieved in any calendar year is the most critical in terms of water supply. The maximum total basin storage is 528,955 acre feet. The time that peak storage is achieved each year is typically around the month of June. Sometimes it occurs earlier and sometimes later. There are many years when the maximum storage is not reached. This June storage is a key indicator of how much water will be available for use through the summer and up to the next runoff season.

2 Projected June 1st Total Basin Upstream Active Storage (Maximum = 326,700 acre-feet)

WBWCD also monitors the amount of projected storage to be achieved in upstream reservoirs (all of its reservoirs excluding Willard Bay). The maximum upstream active storage that can be achieved in a given year is 326,679 acre feet. It is important to monitor this because the storage that is downstream of the mouth of Weber Canyon cannot be as easily treated or utilized to meet WBWCD needs throughout heavily populated areas of the District.

3 U.S. Drought Monitor Classification (only a trigger for the advisory level)

Another tool used only to help establish the normal and advisory drought levels is the U.S. Drought Monitor Intensity Classification. This tool was created by the National Drought Mitigation Center (University of Nebraska) and is found at http://drought.unl.edu/monitoringtools/usdroughtmonitor.aspx. It provides a summary of drought conditions across the United States and is updated weekly by combining a variety of data-based drought indices and indicators and input from local experts.

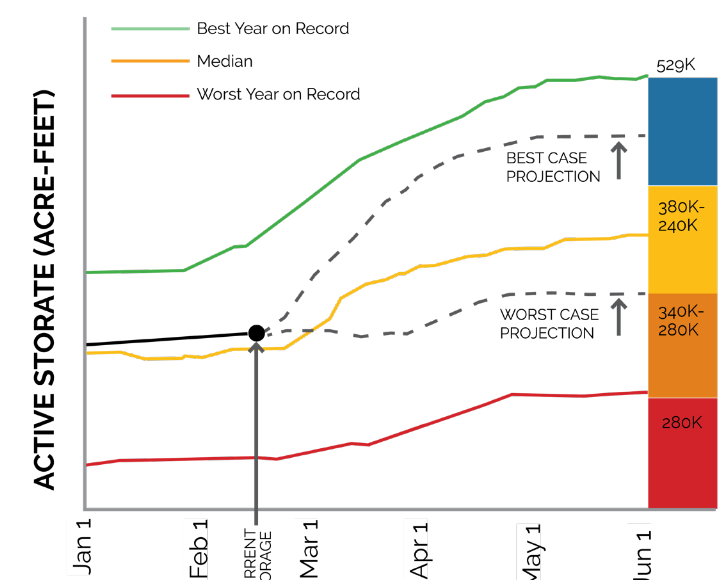
Drought Levels & Triggers

Drought Levels		Drought Level Triggers		
RESPONSE LEVEL	WATER SHORTAGE DESCRIPTION	PROJECTED JUNE 1ST TOTAL BASIN STORAGE [1]	PROJECTED JUNE 1ST TOTAL UPSTREAM BASIN STORAGE (ACRE-FEET)[2]	U.S. DROUGHT MONITOR INTENSITY CLASSIFICATION[3]
1	Normal	Greater than 380,000	Greater than 245,000	No Drought Intensity Classification to D1 (Abnormally Dry)
2	Advisory	Greater than 380,000	Greater than 245,000	D1 (Moderate Drought) or more severe
3	Moderate	340,000 to 380,000	200,000 to 245,000	U.S. Drought Monitor is not a trigger for this response level
4	Severe	280,000 to 340,000	160,000 to 200,000	U.S. Drought Monitor is not a trigger for this response level
5	Extreme	Less than 280,000	Less than 160,000	U.S. Drought Monitor is not a trigger for this response level

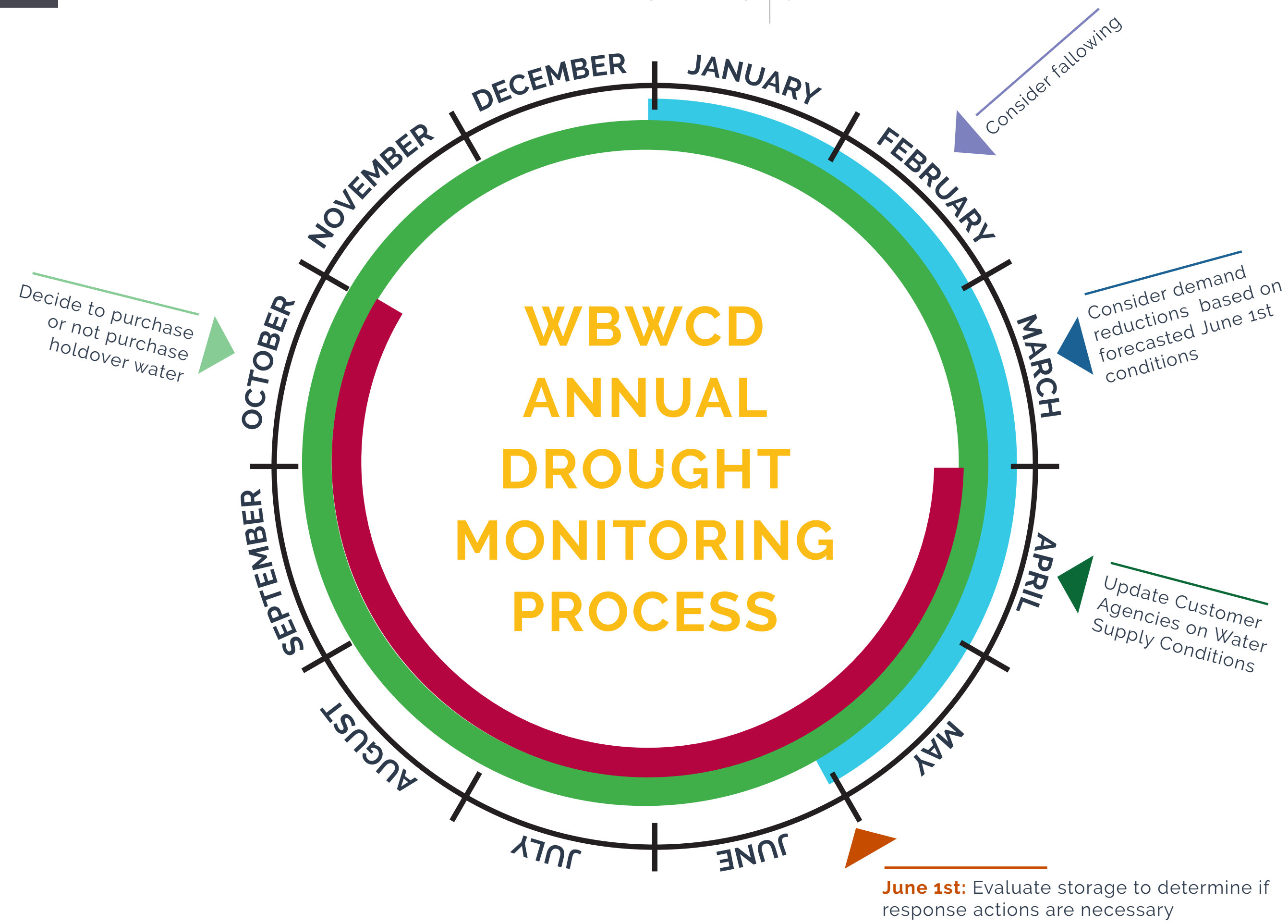
[1] Active storage
[2] Active storage excluding Willard Bay (Total Upstream Basin Storage)
[3] National Drought Mitigation Center: http://drought.unl.edu/monitoringtools/usdroughtmonitor.aspx

Annual Forecasting Tool

Over time, WBWCD will build the drought database, which will contain information that allows them to more accurately forecast the June 1st storage levels beginning in January of each year. WBWCD plans use the data to create a storage volume forecasting graph or graphs like this conceptual graph.



*Graph is an example only and not based on actual data



WBWCD follows an annual drought monitoring cycle to establish the current drought status in the District based on the drought level triggers. Monitoring actions are completed during the entire year to make decisions and to establish the current drought level based on the projections for June 1st. The annual process is based on past processes utilized by the District and includes proposed actions that have been identified in this drought plan.

EVERY MONTH

Water Manager prepares a water supply report including:

- Reservoir Levels: Percent of capacity compared to other years
- Groundwater levels
- Review historic storage graph

JANUARY - JUNE

- Gather runoff and snowpack forecasts from Natural Resource Conservation Service (NRCS)
- Gather runoff and snowpack forecasts from NOAA's Colorado Basin River Forecast Center (CBRFC)

FEBRUARY

- Decision for whether to initiate fallowing of agricultural lands
- Develop contact list of willing customers
- Execute agreements, as needed

MARCH

- Board of Trustees decides whether to initiate demand-reduction procedures.
- Issue press release and/or letter to wholesale customers
- Add notification to District website
- Notify retail customers
- Provide status report to irrigation companies & wholesale customers

APRIL - OCTOBER

Enforce restrictions as approved by the Board. Monitor usage and modify restrictions as needed.

APRIL

- If drought level is Moderate, Severe, or Extreme: Meet with advisory group stakeholders to discuss specific drought response actions

JUNE

- Evaluate storage in each of the reservoirs
- Final review of forecasts

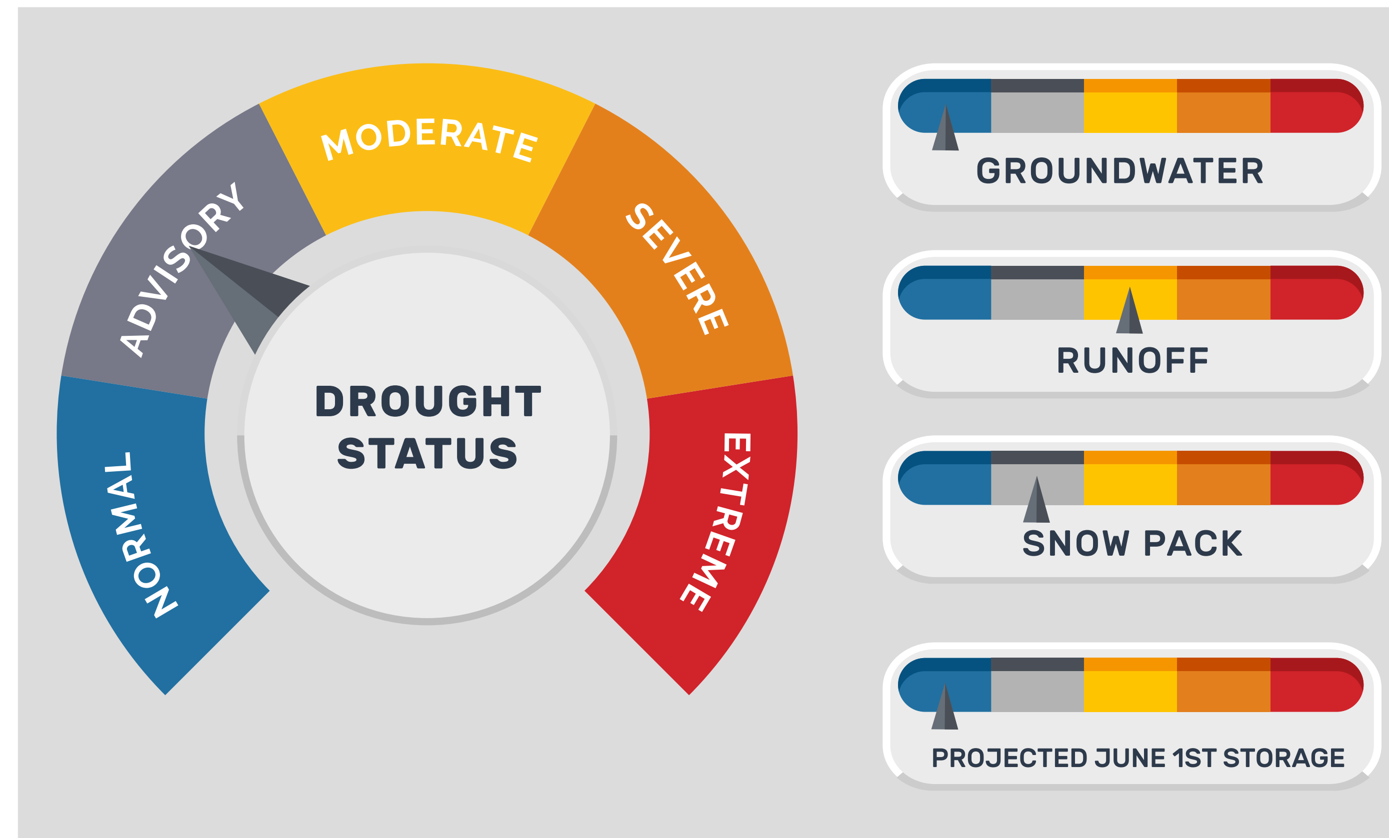
OCTOBER

- Determine whether holdover water is needed.
- If needed, execute purchase agreements

Drought Status Dashboard

After securing funding from Reclamation for the effort, WBWCD is planning to develop dial-indicators as measures for reporting each of the drought stages. As part of this effort, WBWCD is considering providing snapshot (static), dial indicator readings for the needle at various levels. Then, WBWCD could use logic-based inputs to select the correct snapshot, static reading (image) to display on its website to convey the current water conditions in WBWCD. WBWCD could provide a summary dial indicator with other dial indicators:

- Groundwater
- Runoff (April to July)
- Snow Pack
- Projected June 1st Storage



Public Update Process

MITIGATION MEASURES

Mitigation measures are actions taken prior to a drought to help lessen the impacts of drought within Weber Basin.

Mitigation Measure Objectives

SUPPLY	Increase WBWCD water supply available during drought years or reduce usage in drought years and/or reduce usage in drought years.
	Improve mobility of water supplies
FINANCIAL	Minimize costs
	Obtain funding assistance
	Maintain revenue during drought
IMPLEMENTATION & RISK REDUCTIONS	Reduce risks associated with drought
	Focus on actions that are easier to implement
	Prepare communities to respond quickly to drought
	Improve communication and available information
	Improve coordination with agricultural users
ENVIRONMENT	Minimize impacts to industry and the Great Salt Lake
	Minimize impacts to aquatic ecosystems, including wetlands
	Minimize impacts to recreation

Ranked Mitigation Measures

More than 30 specific mitigation measures were evaluated and ranked based on how well they meet the identified drought objectives. DWRe ran scenarios in the Riverware model to help identify which mitigation measures best meet the objectives. During the evaluation, the list of specific mitigation measures was reduced to 22 and then those were ranked. The top 10 mitigation measures identified through the evaluation are shown on the opposite page.

TYPES OF MEASURES EVALUATED

- STORAGE, SOURCE, DISTRIBUTION
- AGREEMENTS
- FLOW MEASUREMENT
- RATE STRUCTURES
- WATER REUSE
- EDUCATION
- HABITAT IMPROVEMENTS

Top 10 Mitigation Measures

1. **Internet Water Supply Dashboard** - Create a web-based system that reports current performance of system and drought levels and informs people what water conservation actions they should be implementing.
2. **Drought Surcharge Fees** - Study and develop a secondary water drought surcharge fee structure for Weber Basin to utilize during drought periods. Fee structures will provide revenue needed for system operation and maintenance and to fund response actions during droughts. (Assume all secondary connections are metered).
3. **WBWCD Secondary Water Metering** - Meter all secondary WBWCD water users and provide usage reports to the users. Save 35% average when going to meters. 11,000 services left to meter at a cost of $1,200 per service.
4. **Short-Term Transfer Agreements** - Create a program and get contracts in place to compensate large agricultural users to fallow land or plant drought tolerant crops when asked.
5. **Other Systems Secondary Water Metering** - Start a WBWCD program to provide secondary water metering technical assistance and meter installation assistance for secondary systems in the district boundaries, but not owned by the District. Assume 80,000 meters added.
6. **Drought Surcharge Fees Education** - Educate cities and the public about rate structures. Prepare a sample ordinance to provide for cities for drought water rate adjustments. Visit cities to explain the rate structures and the benefits (50 customer agencies).
7. **Connect Farmington Wells to Culinary System -** Install transmission lines to connect existing wells in Farmington to WBWCD culinary water transmission systems.
8. **Advisory Group Meetings -** Continue meetings with Advisory Group, Division of Wildlife Resources, Trout Unlimited, and other habitat stakeholders to better define strategies to make river habitat more drought resilient while still meeting water delivery requirements. Strategies may include stream connectivity improvements and water pulsing through the river to clean channels during wet years.
9. **Weber Canyon ASR** - Develop ASR near mouth of Weber Canyon. Use purchased Echo or East Canyon water in wet years to be used later during drought.
10. **Create New Tiered Rate Structure and Short Term Transfer Water Fund** - Create a fund prior to a drought to purchase water through short term transfer agreements during times of drought. Use overage fees from water users that exceed a certain level of water use in any given month.

RESPONSE ACTIONS

A planned action taken after a drought level trigger event occurs. The purpose of a response action is to manage the resulting impact of an adverse event.

Response actions should be monitored to evaluate the effectiveness of achieving the desired results. The demand reduction targets may need to be revised over time based on results.

A collaborative process with input from the Technical Team and the Advisory Group was used to develop a response plan that includes the establishment of target demand reductions (in terms of percentages) for each drought level.

Demand Reduction Targets

Drought Levels		Demand Reduction Targets				
RESPONSE LEVEL	WATER SHORTAGE DESCRIPTION	SECONDARY WATER[4]	AGRICULTURAL IRRIGATION[5]	M&I CULINARY OUTDOOR WATER[4]	M&I CULINARY INDOOR WATER[4]	TOTAL YEAR 2020 DEMAND REDUCTION (ACRE-FEET)[5]
1	Normal	0%	0%	0%	0%	0
2	Advisory	Reduce demands through messaging and general water conservation				0 to 43,000
3	Moderate	20%	20%	20%	0%	43,000
4	Severe	60%	40%	60%	10%	123,000
5	Extreme	95%	70%	95%	25%	206,000

[4]Assumed that water use reductions will be met across the entire WBWCD service area
[5]Assumed that only WBWCD agricultural supplies will be reduced. Does not include agricultural demands in the basin that are not managed by the District

WBWCD Drought Response Actions

Drought Levels		Response Actions
RESPONSE LEVEL	WATER SHORTAGE DESCRIPTION	
1	Normal	Continue current conservation efforts to meet statewide goal to reduce usage by 25% between year 2000 and 2025.
2	Advisory	Begin messaging to inform the public that water shortages are possible if drought conditions continue and that additional conservation efforts are needed.
3	Moderate	Increased messaging, implement yellow drought rates and shortened irrigation season, and increased advisory group meetings.
4	Severe	Increased messaging, implement orange drought rates, exercise fallowing agreements, cut watering of lawns in half, reduce agricultural water use, start indoor water reduction strategies, and increased advisory group meetings.
5	Extreme	Increased messaging, implement red drought rates, exercise fallowing agreements, no residential lawn watering (trees and gardens yes), and increased advisory group meetings.

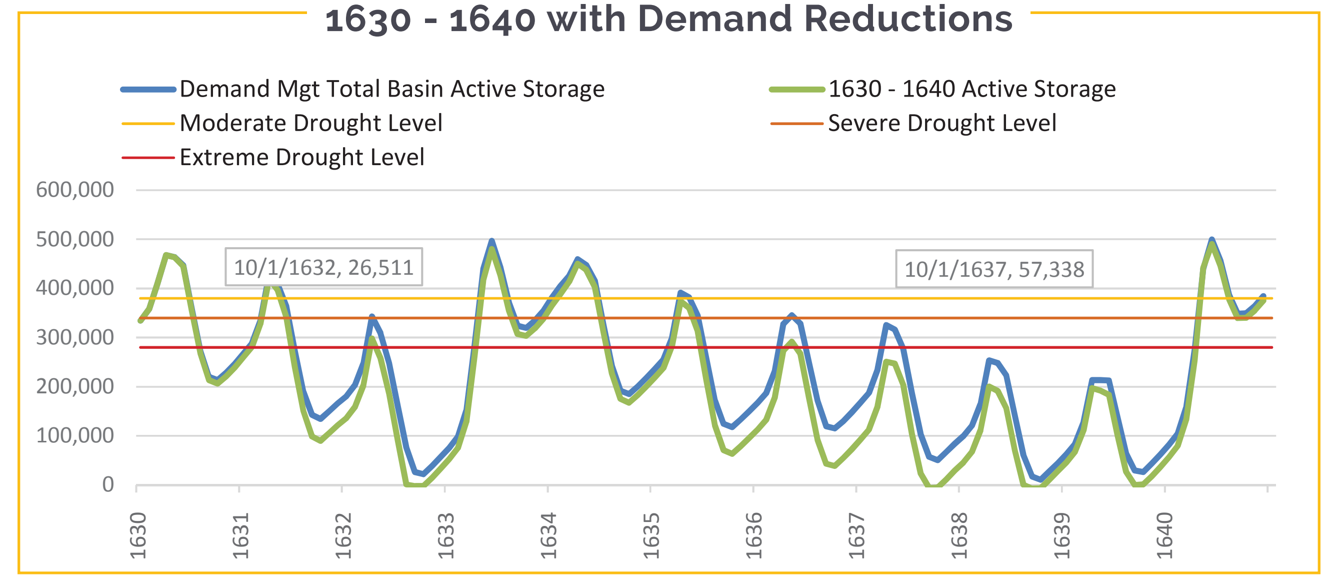
Effectiveness of Demand Reductions

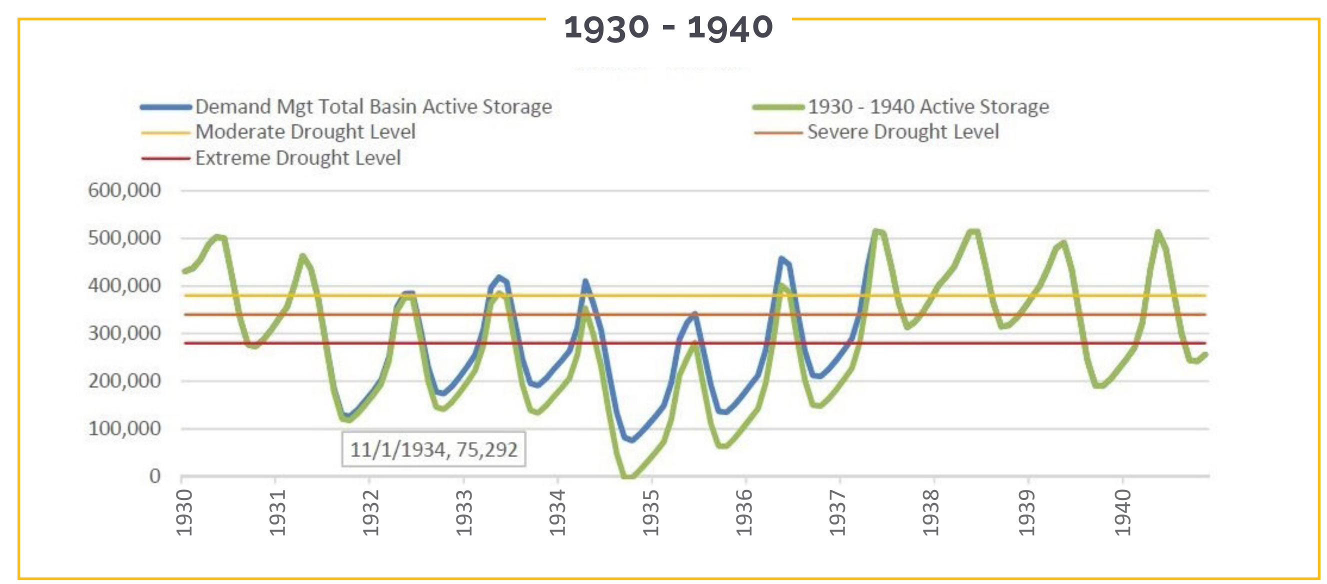
The total water demand reduction volume achieved by the targets for each drought level will help immensely during a drought. The following table lists the total demand reduction volumes compared to the estimated storage volume deficit during a moderate, severe, or extreme drought.

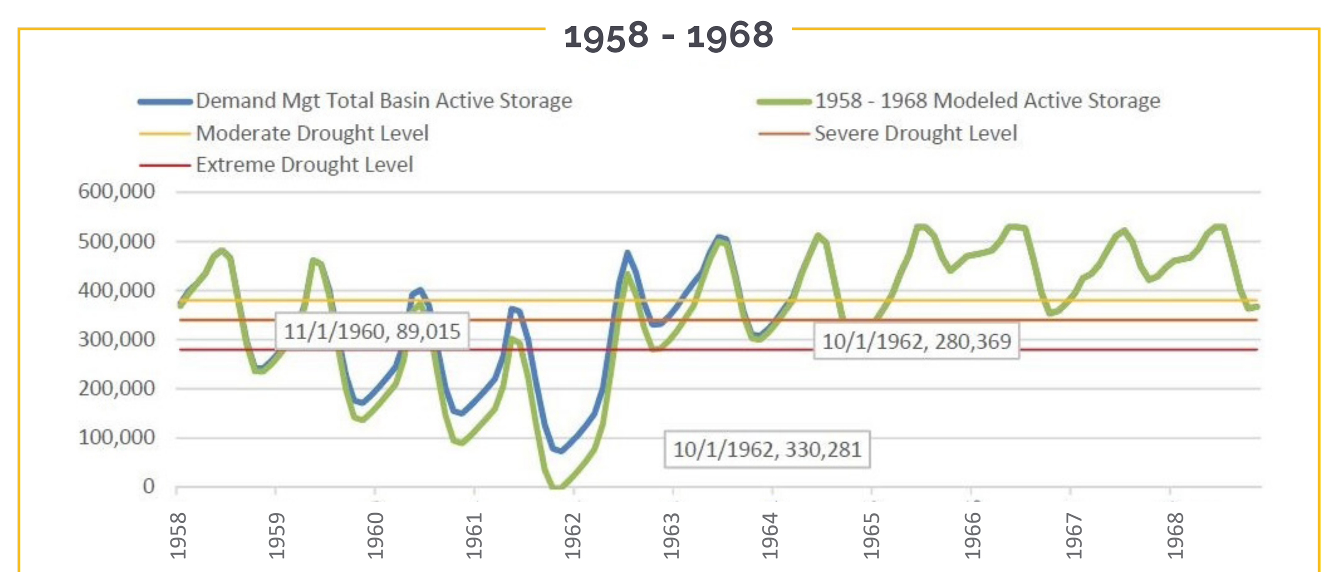
Drought Levels		Demand Reduction Targets					Theoretical Balance	
RESPONSE LEVEL	WATER SHORTAGE DESCRIPTION	SECONDARY WATER[4]	AGRICULTURAL IRRIGATION[5]	M&I CULINARY OUTDOOR WATER[4]	M&I CULINARY INDOOR WATER[4]	TOTAL YEAR 2020 DEMAND REDUCTION (ACRE-FEET)[5]	NORMAL STORAGE VOLUME DEFICIT (ACRE-FEET)[6]	NET WATER VOLUME DIFFERENCE (ACRE FEET)[7]
1	Normal	0%	0%	0%	0%	0		
2	Advisory	Reduce demands through messaging and general water conservation				0 to 43,000		
3	Moderate	20%	20%	20%	0%	43,000	40,000	3,000
4	Severe	60%	40%	60%	10%	123,000	100,000	23,000
5	Extreme	95%	70%	95%	25%	206,000	190,000	16,000

A model scenario was created to estimate how well the demand reductions would have improved the total basin storage over the modeled historic period during droughts. Most of the assumptions established for this scenario were derived based on the demand reductions required for each drought level.

The graphs on the following pages compare the the historical storage volumes during past drought periods with the reduced demand storage volumes during the same drought period. The reduced demand storage volumes are based on the assumption that the demand reductions established in this drought plan would have been implemented during the droughts.







OPERATIONAL AND ADMINISTRATIVE FRAMEWORK

The operational and administrative framework identifies the roles, responsibilities, and the procedures to:

- **Conduct drought monitoring.**
- **Implement drought mitigation measures.**
- **Initiate drought response actions.**

The implementation and update of the DCP will be led by WBWCD, which has an established administrative framework.

Operational & Administrative Responsibilities

DROUGHT MONITORING	MITIGATION MEASURES	DROUGHT RESPONSE INITIATION
• Monitor the current and projected water supply for the year to establish the drought level. Provide monthly reports to the Assistant General Manager. • Oversee water supply and drought level monitoring done by the Water Supply Manager and report monthly to the General Manager. • Report the drought level to the Board of Trustees monthly at the Board meetings. • Make water management decisions based on drought level reports from the General Manager.	• Implement the drought mitigation measures prioritized in the DCP. • Manage and lead the implementation of drought mitigation measures as coordinated with the General Manager. • Propose mitigation measures to the Board of Trustees. • Authorize implementation of specific mitigation measures.	• Notify customer agencies of drought status and implement restrictions on water deliveries as directed by the Assistant General Manager. • Assist with communication and implementation of drought response actions. Implement water restrictions with the Water Supply Manager and implement other response actions. • Manage public messaging and other response actions. • Approve implementation of responses actions.

Plan Update Process

WBWCD is currently implementing the recommendations found in this DCP. This DCP needs to be evaluated and monitored on a regular basis to integrate needed changes or updates that are identified based on data gathered in future droughts, or additional information that is gathered over time. New changes could come in the form of new technology, laws, or political leadership.

ONGOING DCP MONITORING

WBWCD will monitor and make minor adjustments periodically, as needed, based on new information or changes that occur related to droughts or drought monitoring in its boundaries. These changes will be made under supervision of the Assistant General Manager based on input from the Water Supply Manager.

POST-DROUGHT EVALUATIONS

The Water Supply Manager will meet with the Assistant General Manager and supporting WBWCD technical staff following any drought event. These meetings will be held to evaluate and asses the effectiveness of the DCP mitigation actions that were implemented prior to the drought, and to assess the effectiveness of the response actions implemented during the drought. These assessments will help identify if any adjustments are needed for the drought response levels or response actions, or if any additional mitigation actions should be implemented prior to future droughts. The Advisory Group will be involved when any significant changes are discussed or are made to the DCP.

DROUGHT CONTINGENCY PLAN UPDATES

Approximately every five years, WBWCD will evaluate the need for an update to the DCP, whether or not a drought has occurred. The Assistant General Manager, the Water Supply Manager (Operations), and WBWCD technical staff will decide if an update is needed under the direction of the General Manager. It is important to continually evaluate changing vulnerabilities and identify ways to reduce risks associated with drought. New information and technologies become available that can be integrated into the DCP. The Advisory Group will be included in the update process if a major DCP update is made.

Plan Update Process

CONCLUSIONS & RECOMMENDATIONS

This planning process has allowed Weber Basin to identify key insights and strategies to improve drought resiliency within the District boundary.

Conclusions

- Improved communication and cooperation between all water users will improve drought resiliency and the ability to respond to drought conditions.
- Multiple moderate droughts have occurred in the recent past, and severe and extreme droughts have occurred in the last 400 years.
- Future climate changes will play a factor in available water supplies. Currently, many of the climate change projections are on a larger scale and not specific to the Weber Basin area.
- The WBWCD water system is less resilient to drought periods that are longer than 1 to 2 years in duration.
- The projected maximum storage for each calendar year is a key indicator of the drought status, especially in the year following a poor water year.
- Water operations can impact the environment and should be coordinated between WBWCD and water users (DCP Advisory Group) to minimize negative drought impacts.
- Optimizing the existing system will improve drought resiliency.

Recommendations

- Create and maintain an internet water supply dashboard to inform the public of the current drought status and conservation actions to take.
- Develop a WBWCD secondary water drought surcharge fee structure and inform other water suppliers about drought fee structures.
- Install flow meters on all WBWCD secondary water connections and promote metering on all secondary connections within WBWCD boundaries.
- Cooperate with irrigation water users and companies to establish short term water transfer agreements for future drought periods.
- Connect existing wells in Farmington to WBWCD culinary water transmission system.
- Meet annually with Advisory Group stakeholders during drought conditions to consider operation strategies that benefit habitat while meeting water deliveries.
- Develop Aquifer Storage and Recovery (ASR) sites to allow for storage of water during good water years for utilization in drought years.
- Present DCP findings and recommendations to cities and irrigation companies within WBWCD boundaries and follow up.
- Continue to investigate feasibility of water re-use and Willard Bay siphon improvements.
- Finish a climate change study specific to the WBWCD service area to gain a better understanding on how storage levels may be impacted as a result of changes in the climate.
- Monitor how well response actions help in maintaining storage volumes during droughts to determine if the target demand reductions should be adjusted in the future.
- Update the DCP every 5 years.

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