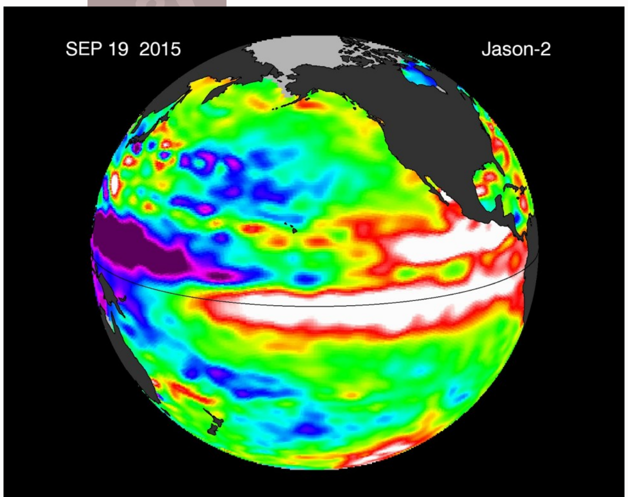
Appendix A

El Niño Fact Sheet

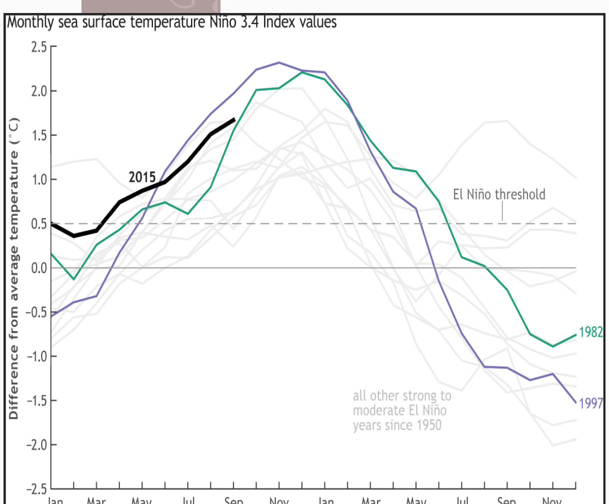
2015-2016

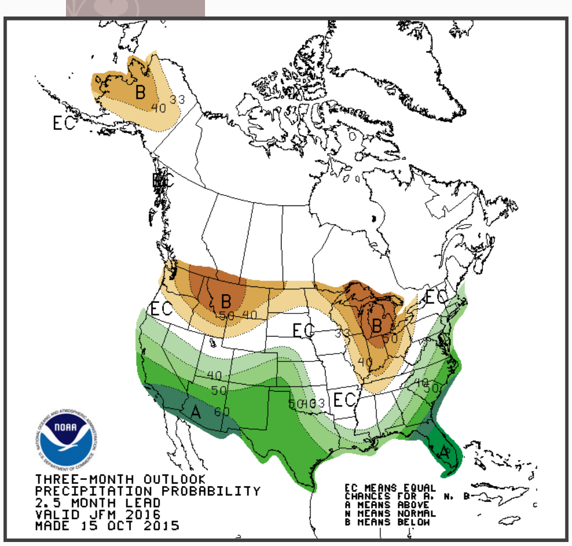
El Niño Fact Sheet

Weather.gov/Phoenix @NWSPhoenix



El Niño is a prolonged period of unusually warm Pacific waters that influence weather patterns





What we know:

- Strong El Niño conditions will exist through winter 2015-16
- This will be one of the strongest recorded El Niño episodes since 1950
- Strong El Niño's lead to the most predictable outcomes of increased rainfall in AZ and SoCal
- Odds clearly point towards a wetter than average winter - especially the latter part of the season

Uncertainties:

- Each El Niño is slightly different and there are other weather influences to consider
- There have only been 6 recorded strong El Niño events and only 3 as strong as this year since 1950
- The small sample size of comparative El Niño events limits more certainty in specific winter predictions

What we don't know:

- Even though odds strongly point towards a wet winter, we do not know whether it will be just above average or much above average
- Mountain snowfall may or may not be above average depending on snow levels during the winter

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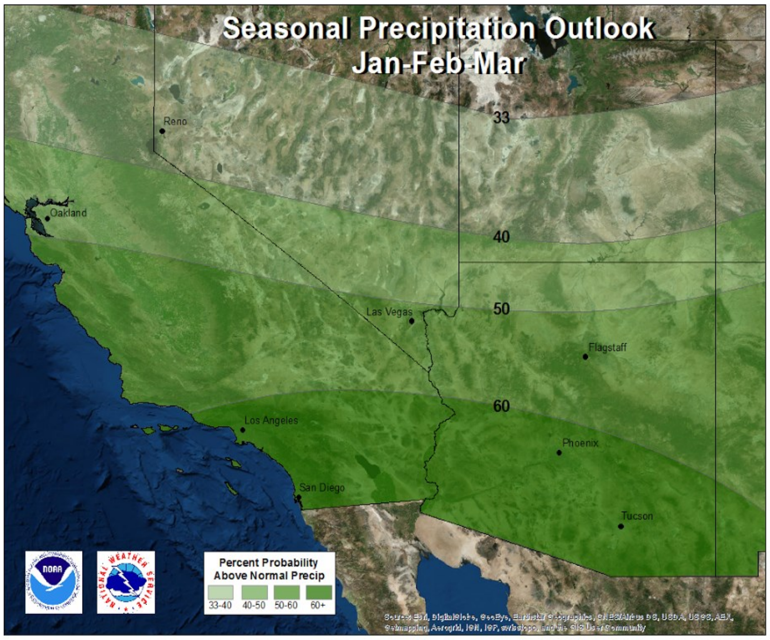
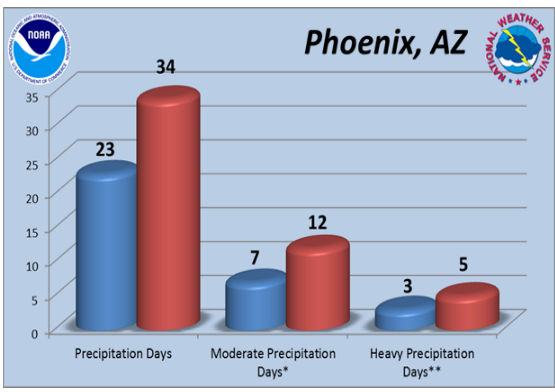
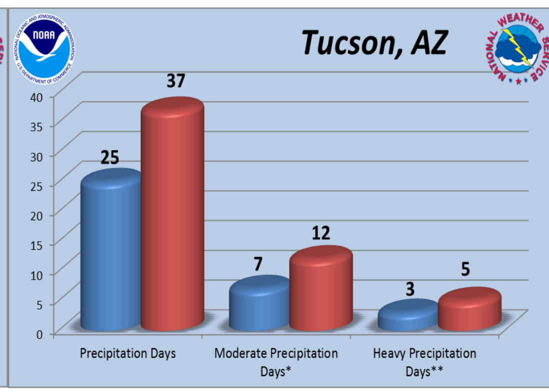
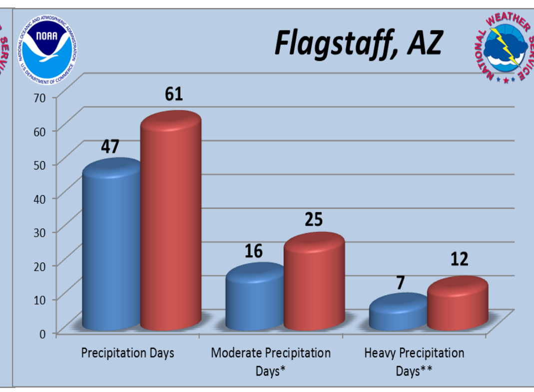


While strong El Niño's provide little predictive skill regarding temperatures, there is an excellent correlation to wetter than normal winters in Arizona and southern California—particularly later in the winter (Jan-Apr). The Climate Prediction Center forecasts better than a 60% chance of a wetter than normal Jan-Mar (leaving only a 5% chance of below normal).

However, each El Niño has a somewhat different "flavor" and even among the strongest episodes, there are notable differences in precipitation amounts and placement . Fortunately, despite typical greater than average precipitation, past strong El Niño events have not produced significant flooding events in Arizona and Southeast California (not saying that it couldn't happen this year). Seasonal mountain snowfall also carries considerable uncertainty, though all the 3 strongest events led to above average snow in Arizona (not shown).



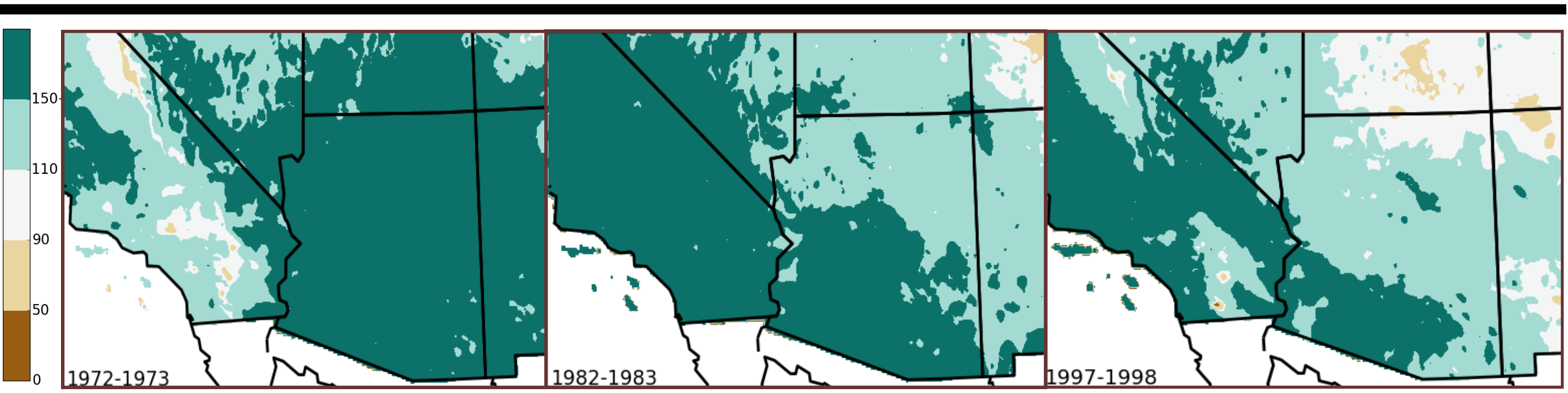




Average Winter   Strong El Nino Winters

Number of rainfall days during an average winter (Oct-Apr) versus the average during 6 strong El Niños

(* Moderate = 0.25 inches   ** Heavy = 0.50 inches)



October-April Percent Normal Precipitation from last 3 Strongest El Niño Episodes (1972-73, 1982-83, and 1997-98)

Appendix B

Mohave County Local Drought Impact Group (LDIG)

2015 Annual Report

Mohave County Local Drought Impact Group
Annual Report 2015

Introduction. This report summarizes the Local Drought Impact Group activities conducted in Mohave County in 2015. The established drought monitoring network continued to function efficiently with monitors providing monthly impact information to the County Emergency Management Technician, who compiles and files the report information. The LDIG continues to function as an informal advisory body to the Mohave County Division of Emergency Manager and the County Extension Office.

Status of Drought. As of the time of this report (mid-October, 2015), all of Mohave County is experiencing moderate drought conditions. For the most part, conditions this year have been in the moderate range.

Drought Impacts. No severe impacts have been reported from the agriculture sector.
Drought conditions in some areas of the county were edging more toward the severe range in early spring after several small precipitation events earlier in the year. However, the county experienced several periodic rounds of isolated rainfall events that moderated conditions enough that implementation of fire restrictions were never seriously considered. This was in contrast to 2013 and 2014, where extreme fire hazard conditions caused restrictions to be imposed.

Monsoon rainfall, although spotty as usual, impacted widespread areas in August and September. This was a mixed blessing, because lightning caused several small snag fires in the Hualapai Mountains, and the Willow Fire in Mohave Valley, which destroyed 11 homes and forced the temporary evacuation of 900 residences. This fire rapidly spread due to thick salt cedar fuels, dry conditions, and a 25 mph wind. In addition, an extremely intense but isolated thunderstorm created flash flooding on September 14, 2015, in Hildale, Utah, and Colorado City, Arizona, twin cities that straddle the Mohave County/Washington County (Utah) line. Fourteen lives were lost, and infrastructure damage in Colorado City was estimated at $490,000.

Due to continued low snowpacks in the Rocky Mountains, the Colorado River has experienced no recovery in streamflow volume. Lake Mead water levels at one point this year approached the level for mandatory implementation of water conservation measures for jurisdictions that tap into the river. However, the Bureau of Reclamation released upstream water that brought the lake level to a point that the mandatory conservation implementation level will likely not be reached in 2015. Mandatory conservation measures would potentially impact Lake Havasu City, Bullhead City, and unincorporated areas south of Bullhead City, although much of the water supply in these areas comes from wells in aquifers fed by the river rather than the river itself. The populated areas from Wikieup north through Kingman and the Hualapai Mountains and extending northwards to the Arizona Strip and Colorado City are dependent on monsoon and winter rainfall and aquifers generally not associated with the Colorado River.

Drought Related Actions. No drought response or mitigation measures are currently in effect. The Mohave County Alert Flood Warning System, which has expanded to 177 weather stations across the county, continues to provide near real time precipitation and stream flow information. Valuable impact information continues to be provided by the BLM, State Game and Fish, and other agencies, as well as ranchers.

Work continues on developing trigger points for implementing the general mitigation and conservation measures identified for a countywide Mitigation Plan. Distinct population density/elevation zones and maps delineating these zones along with vegetative overlays were developed in 2012 to assist monitoring efforts. Specific impact indicators, particularly regarding vegetation impacts, have been difficult to directly associate with activation of specific mitigation measures in rural areas.

Appendix C

Pima County Local Drought Impact Group (LDIG)

2015 Annual Report

Pima County Local Drought Impact Group (LDIG)
2015 Annual Report

The Pima County Local Drought Impact Group (LDIG) has been an active component of county operations since 2006 when the Board of Supervisors adopted *the Drought Response Plan and Water Wasting Ordinance* (Chapter 8.70).

LDIG consists of water providers and local, state and federal agencies that have an interest in the cause and effect of drought conditions in Pima County. LDIG meets bimonthly to monitor the short-term and long-term drought status, discuss drought impacts and coordinate drought declarations and responses.

The County's *Drought Response Plan and Water Wasting Ordinance* established a four stage trigger category that corresponds to the Arizona Drought Monitor Report and their declaration of a watershed drought conditions. Each "Stage" declaration within the county triggers drought stage reduction measures.

LDIG explores the impacts of drought on various sectors in Pima County including agricultural water use, ranching, wildfire, hydrology, and flooding. Because many water providers depend on Central Arizona Project water, LDIG also monitors the status of the Colorado River, the El Niño Southern Oscillation (ENSO) and other climate weather patterns in relation to their effect on drought conditions and climate variability in the southwest. LDIG also monitors the status of the summer monsoon season and convenes roundtable discussions of drought and water conservation outreach programs. For a list of presentations and agendas, please visit Pima County's LDIG website[1].

DROUGHT STATUS

- Weather (NWS Data)

In Tucson, the first half of the 2015 calendar year (January 2015 to June 2015) was the 2nd warmest on record with an average yearly temperature to date of 3.0°F above normal.[2] The summer of 2015 was the 2nd warmest on record (tied with 2013) with an average temperature of 88.3°F, 2.6°F above normal (85.7°F).

January through April was the warmest quarter on record, surpassing the same period in 2014; 4.3°F above normal. February was easily recorded as the hottest documented with 6.8°F above normal February temperatures. The warm quarter of 2015 was compounded by a very warm end of the year 2014 winter season; average low winter temperatures were 4.5°F above normal.

A cooling period began in April (18th warmest) and continued in May, which was the coolest May since 1998 accompanied by the longest stretch of recorded below normal highs and lows since the 1970's. In May, average high temperatures were 3.9°F below normal and average temperature down 2.6°F. The reprieve from record warm months proved temporary- despite a tropical moisture surge and early start to the monsoon, heat waves in June pressed that month to the 4th warmest. While July's monsoon pattern brought temperatures down to near normal, August was the 3rd warmest (+3.7°F) and contributed to another record warm summer, 2nd warmest, while pushing 2015 to the warmest year to date on record, tied with 2014.

While January through April was only an average wet period, the 2014-2015 winter season was the wettest since a strong El Niňo event in 1997-1998 and the 14th wettest overall with 5.12" of rain, 2.39" above normal. In terms of the 2015 water year, February was the wettest since 2000-2001 with 6.45". Drier conditions set in as spring was the 10th straight spring with below normal rainfall.

In June, Pacific storm systems began pushing tropical moisture into southern Arizona jumpstarting an early monsoon season mixed with high pressure heat waves. However, local storms were sporadic and precipitation for the summer remained just below average, 60th driest on record. The monsoon season, continuing into a wet September with 2.40" rain (+1.11"), concluded just above normal with 6.63" of rain (normal is 6.08").

In summary, Pima County has experienced record above average temperatures and mixed rainfall with strong single storm events able to push precipitation just above average.

[1] LDIG website: http://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=70243

[2] http://www.wrh.noaa.gov/twc/climate/monthly/jun15.php

- Drought (NDMC and Arizona MTC Data)

Pima County benefitted from a wet 2014-2015 winter season and an average 2014 monsoon season that brought some strong storm events. Prior to last year's monsoon, the majority of Pima County was in severe drought (moderate in western portions, extreme in the northeast corner). Conditions eased to the majority of the county being in moderate drought (abnormally dry in the west, and severe drought in the northeast) and remained going into the winter season. A wet December brought the January 2015 status of moderate drought in eastern Pima County and no drought to abnormally dry in the western half. The January status remained unchanged into September, which then improved in the eastern portion of the county to abnormally dry leaving a central ribbon of moderate drought, a result of the strengthening El Niño and southeastern rainfall.

Pima County's long term drought status improved during last year's winter season following the monsoon, from severe to moderate drought in the Santa Cruz and San Simon watersheds and from abnormally dry to no drought in the Lower Gila River watershed Winter and spring precipitation slowly improved conditions in eastern Arizona and by July Pima County recovered to abnormally dry in the Santa Cruz and San Simon watersheds; no drought in the Lower Gila.

In summary, drought in Pima County has improved beginning with an adequate 2014 monsoon and following a wet winter. Drought conditions remained stable, moderate, through much of 2015 with incremental improvement through the monsoon season to an increasingly abnormally dry condition.

- Colorado River Basin & Central Arizona Project (CAP)

Several water providers are taking delivery of water from the Central Arizona Project. Tucson Water has the largest CAP annual municipal allocation in the state: 144,172 acre-feet. Metropolitan Domestic Water Improvement District, the Town of Oro Valley and others have smaller CAP allocations. Agricultural users and the Tohono O'Odham Nation in Pima County also have access to and use CAP water. Consequently, the drought status of the Colorado River and the potential for a shortage declaration is of interest to these sectors.

Unregulated inflow into Lake Powell for water year 2015 was just below average, at 95% or 10.34 million acre feet; water year 2015 precipitation for the Upper Colorado Basin was just below average as well, at 92%.

Every month the Bureau of Reclamation releases their 24-Month Study which provides operational announcements and near-term projections. The study released in August 2015 stated, most importantly, that there will be no shortage in 2016 and that the water release from Lake Powell to Lake Mead for water year 2016 (October 2015 to September 2016) will be 9.0 million acre feet.

Lake Mead elevation is projected to be just above 1075' in both 2016 (1083.92') and 2017 (1081.09') though a 15% chance of shortage is forecast at this time. A significant probability exists for shortage in 2018.

Significant uncertainty of future snowpack and inflow to Powell is evident in the minimum and maximum probable projections. Next year's inflow could be as high as 16.9 million acre feet (maf) or as low as 6.4 maf. The most probable is 9.54 maf, or 88% of average. Should minimum inflow occur, release to Lake Mead would be reduced and storage in Powell would decline to 43%. In the event of maximum inflow, release to Mead would increase to 11.4 maf and storage in Powell would rise to 70%. Upper Basin reservoirs are mostly full, able to send substantial river flows to Powell.

On June 26, 2015, the water level elevation of Lake Mead was at its lowest (1,074.71') since being filled in the 1930s. Even with the increased water releases from Lake Powell, the Lake Mead water level is projected to decline in 2016. Based on the Bureau of Reclamation's projections the most probable (50th percentile) Lake Mead inflows and resulting water levels in January 2017 are six feet above the first shortage trigger of 1075'; the minimum probable (10th percentile) projected water level is three feet above 1075'. The earliest likelihood of a shortage declaration is 2018. This shortage declaration is not expected to reduce deliveries of CAP water to Native American or municipal and industrial users.

Outflow from Lake Mead has been exceeding the inflow since 2000, except in 2004 and 2010 when there was significant snowpack in the Colorado River Basin. The flow imbalance, referred to as a structural deficit, is lowering the elevation of Lake Mead. At the current rate of decline, Lake Mead's elevation could fall below

1000 feet in five to eight years unless equalization or corrective action is taken. The consequences could reduce diversions of CAP water to municipal and industrial users and Indian users. The CAP, Arizona Department of Water Resources and Colorado River basins states are evaluating options for corrective action to reduce the declining water elevation in Lake Mead.

- El Niňo

The current El Niňo advisory predicts a greater than 95% chance El Niňo will continue through the 2015-2016 winter season and an 85% chance it will last into early spring 2016. The Climate Prediction Center has repeatedly forecast chances for above average precipitation for Pima County; a 40-50% chance exists for September through October. While indication is of a strengthening El Niňo, any probable impact to Lake Mead and Colorado River water supply is guarded. CAP officials warn El Niňo is a poor predictor of streamflow conditions in the Colorado River Basin and correlations between El Niňo and inflow to Lake Powell are weak. Past instances have contributed to local reservoir replenishment (Salt River system). A possible indirect benefit to Pima County could be reduced demand as increased rainfall might result in less CAP ordered, for the agriculture sector as an example, stalling a shortage.

- "Miracle" May

Upper Colorado River Basin precipitation in May was 205% of average with some sub-basins inundated with 230-330% of average rainfall. This unexpected reversal of the normal precipitation pattern provided sufficient inflow to forestall shortages perhaps for two years, eliminating increasing chance of shortage in 2016 and 2017, though concern remains for 2018. The weather pattern did not impact Pima County, rainfall was 0.14" below average with 0.09" received during this typically dry month.

IMPACTS IN PIMA COUNTY

The 32 shallow groundwater areas in Pima County are important for riparian areas that are dependent on groundwater. Sustained drought conditions can adversely impact groundwater levels if nearby well owners pump more groundwater to mitigate drought effects on their property. Invasive species like buffel grass and tamarisk and fewer birds, Gila Topminnows and aerial arthropods are still being observed in Pima County. There is also a significant decrease in ephemeral stream flows.

Agua Caliente Park, located northeast of Tucson has historic and cultural significance. The park's focal point is a natural artesian spring that feeds a creek and produces an abundant variety of oasis vegetation and a habitat for native species. The natural spring has been historically pumped to feed a pond which produces a recreational element for neighborhood residents and park visitors. Over the last several years, water levels have decreased to levels where pumping was ineffective, and eventually failed, to keep the pond filled. Summer and winter rains replenished groundwater, allowing sufficient pumping to replenish the pond, though this is not a sustainable source. However, the natural spring flow has not recovered and managers stress short term precipitation gains cannot reverse multi-year drought.
Pima County continues to investigate measures to maintain the health and vigor of Agua Caliente Park.

Cienega Creek, in eastern Pima County, continues to show the impacts of sustained drought though some improvement has occurred this year. Pima Association of Governments' (PAG) drought reporting uniquely depicts the localized drought impacts on a shallow groundwater dependent system, important for habitat and rural residents dependent on this water source. Streams and rivers are rare exceptionally productive systems in the arid landscape of Arizona that are especially sensitive to changes in water availability. With long term support and interest from its member jurisdictions, PAG has consistently monitored the shallow groundwater-dependent riparian area of Cienega Creek Preserve on a monthly and quarterly basis since 1989 and reported the findings to ADWR for compilation into state records. This rich dataset is used by numerous entities to track and evaluate the seasonal, annual and cumulative impacts of drought. This Preserve, located outside of Tucson, AZ, is the site of a rare, low-elevation perennial stream that is of regional importance for its environmental and recreational value and has been designated as an "Outstanding Water" by the State of Arizona.

In 2015, PAG's analysis documented water level trends that indicate marginal improvement. June 2015 showed only 0.88 miles of flow, an increase of 0.02 miles from last year, but still just nine percent of the full 9.5 miles of flow extent observed in June of the mid-1980s. In addition, 2015 records showed increases in average annual stream flow, volume not recorded since the wet 2008-2009 period, and a slight rise in average groundwater well levels. Because surface water base flows and groundwater are strongly correlated, these trends parallel each other.

Annual reports and studies can be found on PAG's Cienega Creek web pages. Based on a 2014 Pima County report, precipitation in the Cienega Watershed has been declining in the winter but shows no trend in the summer. PAG's Cienega Creek monitoring data reflects the lack of winter rains as found in June, which is the season with the most significant decline in stream flow. This delayed seasonal impact can only be recognized by monitoring the creek and tracking long term response in addition to precipitation

Erosion is another result of drought in this system. PAG has tracked a major erosion head-cut in the streambed that progressively erodes after major flood events, if those floods are preceded by dry periods. Head cutting in the Cienega Creek watershed is a dramatic demonstration of sediment fluctuation within the stream system. PAG continues to note erosion and sedimentation patterns along the watercourse, but the change of form of erosion makes continued analysis difficult. The head cut has changed from being a nick point with a steep drop in elevation within the three stream channels to a more gradual incline and a destabilized flood plain as it continues to move upstream.

PAG recommends further ecological study to track species habitats and water needs in Cienega Creek Preserve in order to establish critical thresholds. Pima County's preserve has heretofore been a successful safe harbor for threatened and endangered species with few invasive species issues. The impacts of drought – coupled with increased temperatures and groundwater pumping – pose an unprecedented and increasingly serious threat, causing land managers in the region to be concerned about the prospects for long term health of the aquatic and riparian system of Cienega Creek. Ranked conservation strategies from watershed assessments should be considered in the prioritization of management goals and strategies throughout the watershed. Pima County's current threat assessment process for the watershed will be a key planning effort that will address key data needs and conservation strategies. Data from PAG's field effort are an invaluable source of information for the threat assessment.

Increased coordination with land use planners and well owners to encourage conservation strategies near vulnerable riparian areas is recommended. Monitoring is recommended where groundwater restoration methods are applied to increase stormwater infiltration. PAG's 2012 report on groundwater use near shallow groundwater areas showed a steady increase of wells drilled near Cienega-Davidson since 1990. Strategic additions of land through open space acquisition and Pima County's conservation land system should be considered as a means to reduce additional groundwater withdrawals.

Outreach, training, and engagement of water users in the Cienega Watershed to conserve, share information, and increase infiltration of stormwater will help create a more resilient landscape. Drought information is primarily disseminated by large municipal water providers in urban areas, and private wells are exempt from coordinated water use tracking requirements. These well owners may not be receiving conservation messaging even though their water use impacts the system and may increase to compensate for the lack of rainfall.

DROUGHT RESPONSE ACTIONS

Pima County continues its efforts to respond to drought conditions. Several organizations, such as Conserve to Enhance (C2E), urge water conservation that translates into donations to support environmental enhancement. C2E participants have saved 6.9 million gallons (21.35 acre-feet) of water since the program inception in 2011, average gallons per capita savings of approximately 11,474 gallons. C2E has awarded funding to 10 local neighborhood projects totaling $67,000 in investment. School projects offer an opportunity to engage students in continuing water conservation education.

The Conservation Effluent Pool (CEP) is an effluent allocation set aside pursuant to intergovernmental agreements between the City of Tucson and Pima County for use in riparian restoration projects. In previous years, a CEP taskforce, coordinated by the Community Water Coalition, identified thirteen candidate projects for CEP effluent allocations. The projects are prioritized into three groups: immediate potential, strong potential, and long-term potential. Three of the projects have been recommended for implementation that all have immediate potential.

The first proposed project is a request for several thousand acre feet of reclaimed water to be reserved within the Santa Cruz River along the existing streamflow extent in order to safeguard existing habitat. Both

County and City administrations are reviewing the proposal; the request may require some amendment in order to execute within the operational constraints of multiple systems.

In 2010, Pima County and the City of Tucson completed the Water & Wastewater Infrastructure, Supply and Planning Study. An important outcome of the study was the 2011-2015 Action Plan for Sustainability. This year is the fifth and final year of the action plan implementation, a final report card itemizing successful completion toward shared goals and recommendations is underway.

In addition to the Water & Wastewater Infrastructure, Supply and Planning Study, Pima County adopted the Water Resources Asset Management Plan (WRAMP), a distinct water resource planning process to guide the County in maximizing all its water assets. WRAMP, drafted by the County's Water Management Committee, is designed to provide direction in executing County Board of Supervisor Policy F 54.9 Water Rights Acquisition, Protection and Management. WRAMP includes directives to maintain an up to date central database of all water rights and wells, map and inspect wells and develop strategic plans for the County's reclaimed water, long term storage credits and surface and groundwater rights. The County has implemented the following:

- The Strategic Plan for Use of Reclaimed Water (SPUR) has been developed and accepted by County Administrator and Board of Supervisors; multiple recommendations supporting the objective of maximize the County's water resources asset value and the production and use of reclaimed water to sustain and protect the natural environment.
- Underground Storage Facility (USF) applications have been submitted for two County Water Reclamation Facilities (WRF), Avra Valley and Green Valley, to maximize long term storage credits. Both applications deemed complete, Green Valley process completed, accruing credits.
- County Regional Wastewater Reclamation Department (RWRD) is cooperating with CMID, Metropolitan Domestic Water Improvement District and the U.S. Bureau of Reclamation to deliver effluent from Tres Rios WRF to CMID agriculture in a Groundwater Savings Facility project.
- RWRD is partnering with Tucson Water to deliver effluent to a newly constructed USF, the County has 2,000 acre-feet capacity at the South Houghton Area Recharge Project Underground Storage Facility to earn credits.
- Building an accurate baseline of potable and reclaimed water using EnergyCap (after correction of database) and other methods. Devising methods for flagging high consumption buildings for individual water audits. Preliminary effort underway for formulation of an Energy/Water Master Plan for county operations, building upon the County's Sustainability program.
- A well and water rights database has been linked with County GIS mapping and migrated to GIS servers. A database of springs (with points of diversion) links ADWR and County springs.
- The Lower Santa Cruz Living River Project, funded by an EPA grant, is a monitoring strategy and reporting tool evaluating water quality and environmental improvement along the effluent dependent habitat and wetlands, providing better understanding of beneficial impact from upgraded effluent production. Second year report indicates WRF improvements have had the effect of an increase of 12,000 acre-feet infiltration, with a decrease in flow extent and habitat. A large reduction in ammonia has removed a barrier to increased aquatic life. These benefits and impacts are a result of ROMP project upgrade to metropolitan WRF's. The Living River report will help inform a Lower Santa Cruz River Management Plan.

In August, Pima County approved a new comprehensive plan, *Pima Prospers*, which includes goals and policies for water resources, including policy and implementation related to the Action Plan for Water Sustainability, water supply including for economic development and conservation, demand management, and groundwater quality.

The County continues to enhance Low Impact Development/Green Infrastructure (LIDGI) within the region's built environment. LIDGI utilizes stormwater as a renewable water resource to irrigate native vegetation, which has an added benefit of providing shade during the higher temperatures associated with drought conditions. The Pima County Regional Flood Control District coordinated the publication of the Low Impact Development and Green Infrastructure Guidance Manual describing stormwater harvesting features effective in a semi-arid climate. The Pima County Board of Supervisors unanimously passed an update to Title 18 (Zoning) to incentivize building stormwater harvesting features and green infrastructure. The newly updated Design Standards for Stormwater Detention and Retention Basins requires the retention of firstflush waters within stormwater harvesting features. A 2015 Low Impact Development (LID) Workshop was organized by the Pima County Regional Flood Control District's collaborative LID Working Group and Pima Association of Governments. The group held discussions on the future of LID in the Tucson region, field visit experience covered best practices in LID, methods of measuring the economic benefits of LID and strategies for minimizing maintenance issues, among other insights for both public and private sector professionals. The PAG Regional Council passed a LIDGI Resolution in 2015, reaffirming the importance of encouraging stormwater harvesting to reduce irrigation needs and enhance drought resiliency.[3]

As of now, the region's water providers and other entities with established drought plans are at Drought Stage 1 or its equivalent (voluntary reductions). Given some incongruity among the various drought plans, Pima Association of Governments has undertaken a local drought plan comparison effort, documenting variances among the plans and issuing a report and recommendations to aid in a more coordinated response and mitigation approach to drought in Pima County. An early draft was presented at the County's LDIG and a stakeholder comment period is underway.

RECOMMENDATIONS

In 2015, Pima County recorded some improving conditions as drought impacts eased, a result of last year's monsoon, a wet winter and a strengthening El Niño effect that has brought slightly above normal precipitation for the calendar year (and water year). However, the cumulative effect of multi-year drought and inherent climate variability require the County to maintain a diligent assessment and response posture; severe and extreme drought conditions could return.

As Pima County LDIG monitors local drought, concern remains for the Colorado River Basin water supply. The Tucson Metro region's past reliance on and overdraft of the groundwater supply has been reined by the importation of CAP water. Pima County's large municipal & industrial (M&I) sector is reliant on continued delivery of this renewable supply in order to maintain progress toward safe yield and consistency with AMA management goals. Lacking any surface water supply, the only alternative for Pima County is optimizing reuse. In an effort to relieve dependence on CAP supply, the region's largest water provider has initiated a recycled water plan that includes indirect potable reuse. Pima County's Strategic Plan for Reclaimed Water supports maximizing the direct reuse of reclaimed supply.

In addition to continuing recommendations from last year's annual report, discussion among Pima County LDIG included the following:

- Given increasing demand for long term storage credits (LTSCs) and large reserve deficits of the Arizona Water Banking Authority (AWBA) and the Groundwater Replenishment District (GRD), LDIG supports the development of new "wet" water delivery to the Tucson AMA (TAMA) rather than "paper" water accounting of traded credits. The AMWUA/SAWUA inter-AMA storage agreement is an example of increasing the physical water supply within the TAMA. Regardless, AWBA and GRD efforts to close large gaps in their reserve of LTSCs should be supported but development of physical supplies and recharge of renewable water is more beneficial.

M&I Firming by the AWBA for the TAMA is "farther behind than the other AMAs", with just half of necessary credits accrued to achieve Planning goal (864,000 acre-feet). After AWBA ten year planning period, in 2025, TAMA firming goal will only be 69% completed (596,000 acre-feet). AWBA has given direction to develop as many credits as possible in the Tucson area. Additionally, AWBA staff recommends continued evaluation of the AMWUA/SAWUA inter-AMA storage proposal. AMWUA's Executive Director has mentioned that "Tucson-area cities are more vulnerable to a water bank supply cutoff because the bank hasn't met its goal for recharging water to back up this area's CAP supplies."

GRD has established a Replenishment Reserve subaccount for each AMA to accrue LTSCs that can be applied to replenishment obligations; a "savings account" GRD will use during water supply shortage or infrastructure failure to offset obligations rather than buying "spot-market water". A full Reserve Target

[3] http://www.pagnet.org/tabid/189/default.aspx

volume must be maintained over time, any Replenishment Reserve credits used are to be replaced. The Reserve Target is unique to each AMA based upon projected obligations and available supplies.

The target reserve for the TAMA is 112,600 acre-feet but GRD has only 34,818 acre-feet in reserve leaving a deficit of 77,782 acre-feet or 70% of its target reserve unfulfilled. GRD proposes to meet their obligation and the reserve by recharging excess CAP water and purchasing long term storage credits. Another consideration is the growing replenishment obligation. Within the TAMA, GRD supplied 3,000 acre-feet of water to replenish excessive groundwater pumping in 2013. Increasing demand from growth and future enrollment will require an additional 9,700 acre-feet per year by 2034.

- Review Arizona Drought Preparedness Plan (ADPP) for update given approaching shortage, determination of Lake Mead structural deficit and to include shortage sharing agreement and its impact to Colorado River water users, information not available at the time of ADPP drafting. Original ADPP tasks included the development of risk-based vulnerability assessments for each basin/watershed. An update to the ADPP could expand risk assessment by providing analysis of the economic impact at each Shortage Tier and CAP reduction. Moreover, a statewide vulnerability assessment could define the potential impacts within all water use sectors of the state's economy and provide a better understanding of differing mitigation and response needs of each county. Additionally, ADWR could explore options that encourage LDIG formation in non-active counties. LDIG's serve a key function within the ADPP; inquiring other entities to serve in an LDIG function (i.e., non-profits) could assist in reporting local impacts to the MTC.
- Rural areas rely on domestic wells and Pima County residents have reported the loss of production from their exempt wells. The private well owner needs tools to assess water availability and make such determinations as to drill deeper or add a new well to supply their property, or reallocate the expense if availability is severely limited to transporting water and haul water. With accurate information of local aquifers and water tables available to this vulnerable sector, the best strategy for water provision can be devised and public health impacts from a sudden lack of water can be avoided. California's drought experience has necessitated an interim emergency drinking water program providing information and funding of bottled water and water hauling provision. A planning document guiding affected well owners in water hauling practices may be beneficial. At the same time, well owners could be advised of the best conservation strategies and the impact of groundwater pumping to the local environment surrounding their property.

The following are continuing recommendations regarding ADWR's Drought Program:

- Arizona and ADWR, in particular, must continue to monitor the status of the Colorado River and work with the Basin States and the Bureau of Reclamation to address the structural deficit in Lake Mead. Failure to take corrective action could have impacts to both agricultural, municipal and industrial CAP deliveries in Southern Arizona in the future
- Water providers in Pima County have made significant water infrastructure investment to increase the use of renewable water supplies to achieve the groundwater management goal of safe yield. ADWR's and ADEQ's regulatory setting should be supportive of adaptive management strategies to develop new and renewable water supplies and innovative demand management
- ADWR's Drought Management Program should continue to monitor the status of drought and report statewide drought conditions through the Drought Monitoring Technical Committee and the Interagency Coordinating Group.
- ADWR should incorporate environmental benefits from recharging and/or reducing groundwater pumping near shallow groundwater dependent ecosystems when designing and developing criteria for special enhancements areas and similar efforts.
- ADWR should encourage and promote a study evaluating the effectiveness of managed stormwater recharge throughout Arizona, as recommended by the Blue Ribbon Panel, and evaluate potential for recharge credits.
- Monitoring of riparian areas in other regions for localized drought impact reporting should be encouraged.
- Drought response resources should be disseminated to exempt well owners not receiving drought alerts from water providers

- Unique drought response resources should be disseminated to areas of shallow groundwater dependent ecosystems that are sensitive to well impacts and drought.
- ADWR should improve statewide coordination and information sharing of local drought responses by posting water providers' drought response plans to ADWR's Drought Program website. This could assist communities that wish to prepare or update their drought program
- ADWR should maintain on its website a list of cities and towns where water restrictions are in place. Doing so illustrates the extent and severity of drought on water supplies
- An annual statewide roundtable of county agencies might reinvigorate the establishment of local drought impact groups. These groups can provide valuable input to the ADWR on drought conditions. They can provide a forum for sharing drought impacts, adaptive management strategies and successful drought preparedness measures for their constituencies.
- ADWR should encourage coordinated shortage outreach where shared messaging is appropriate across regions as well as continued press releases to national media about Arizona's preparedness efforts.
- ADWR should continue to explore ways to account for riparian areas as well as cumulative impacts of exempt wells within groundwater models and water accounting areas efforts to plan for sub-regional groundwater balance.
- Due to the history of efforts in our region, to fully utilize reclaimed water and community desire to preserve environmental flows, ADWR should consider special exemptions for full credits for instream recharge of effluent where appropriate.
- ADWR should provide protocols and criteria for applying for pump tax funds for conservation and drought programs.

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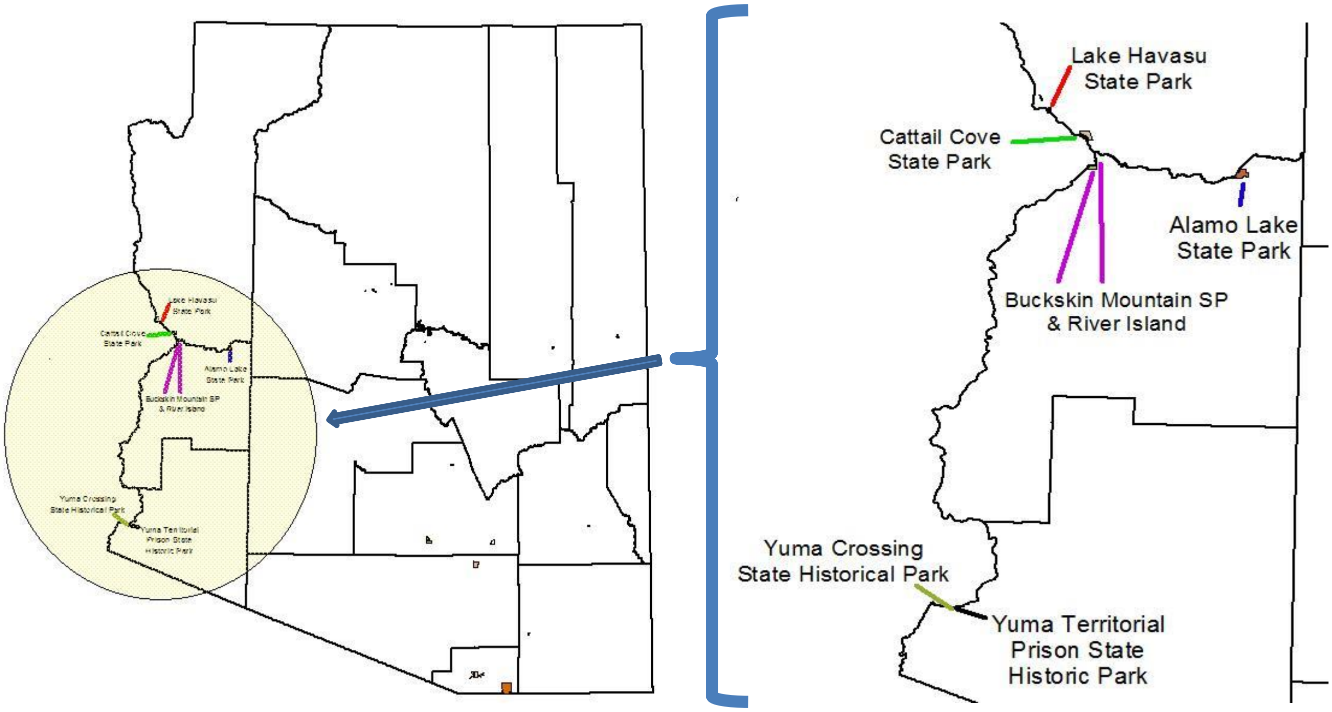
Appendix D

Drought Ratings by Arizona State Park Managers

Arizona State Parks -- Western Arizona



PARK/DATE	Nov-13	May-14	Aug-14	Nov-14	May-15	Nov-15	Graph Over Assessment Period *
ALAMO – nr Parker AZ	10	10	10	10	10	10	Alamo has been ALL 10s since Nov 2013
BUCKSKIN – nr Parker AZ	0	3	3	2	0	0	
CATTAIL - nr Parker AZ	0	0	1	0	0	5	
LAKE HAVASU at Lake Havasu AZ	0	0	3	0	0	0	
RIVER ISLAND – nr Parker AZ	0	3	3	2	0	0	
YUMA QUARTERMASTER DEPOT	0	3	2	2	1	0	
YUMA TERRITORIAL PRISON	0	3	1	2	1	0	

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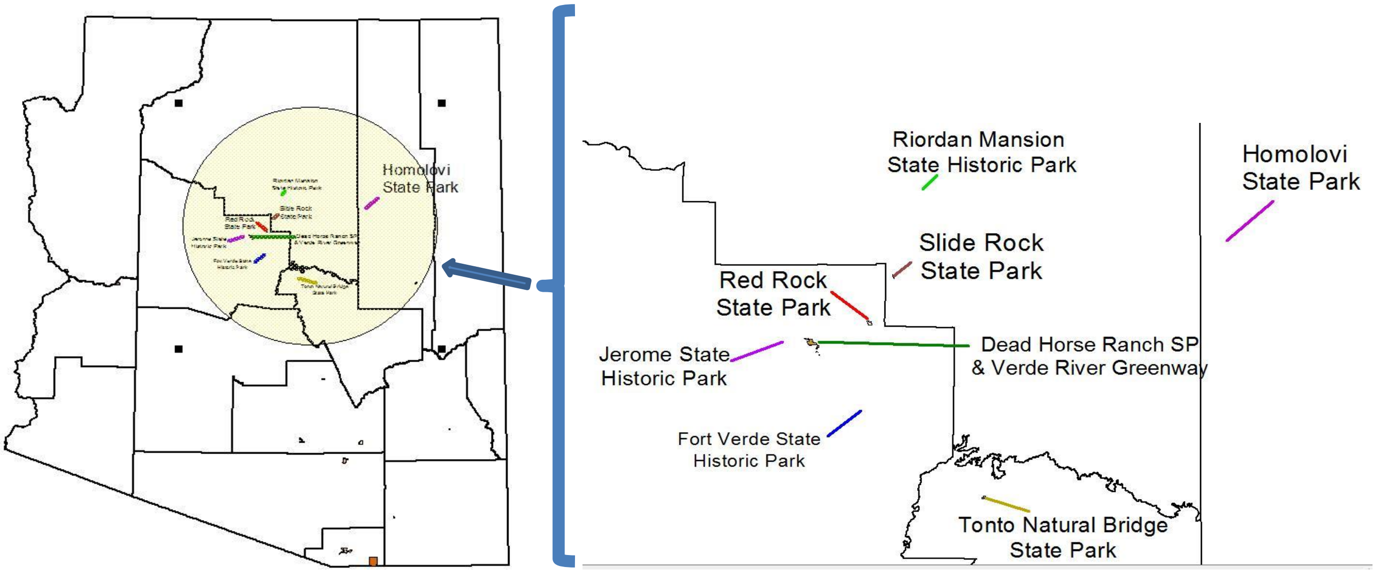
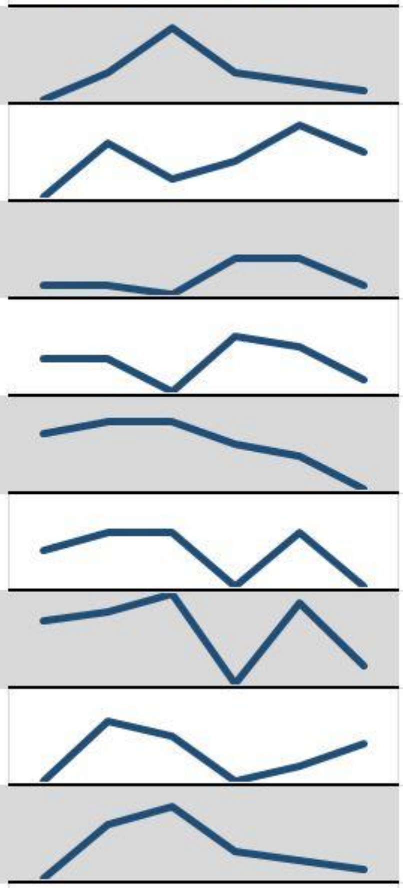
* 0 - 10 Scale =
0=no drought impact; 10=extreme

Arizona State Parks -- North-Central Arizona

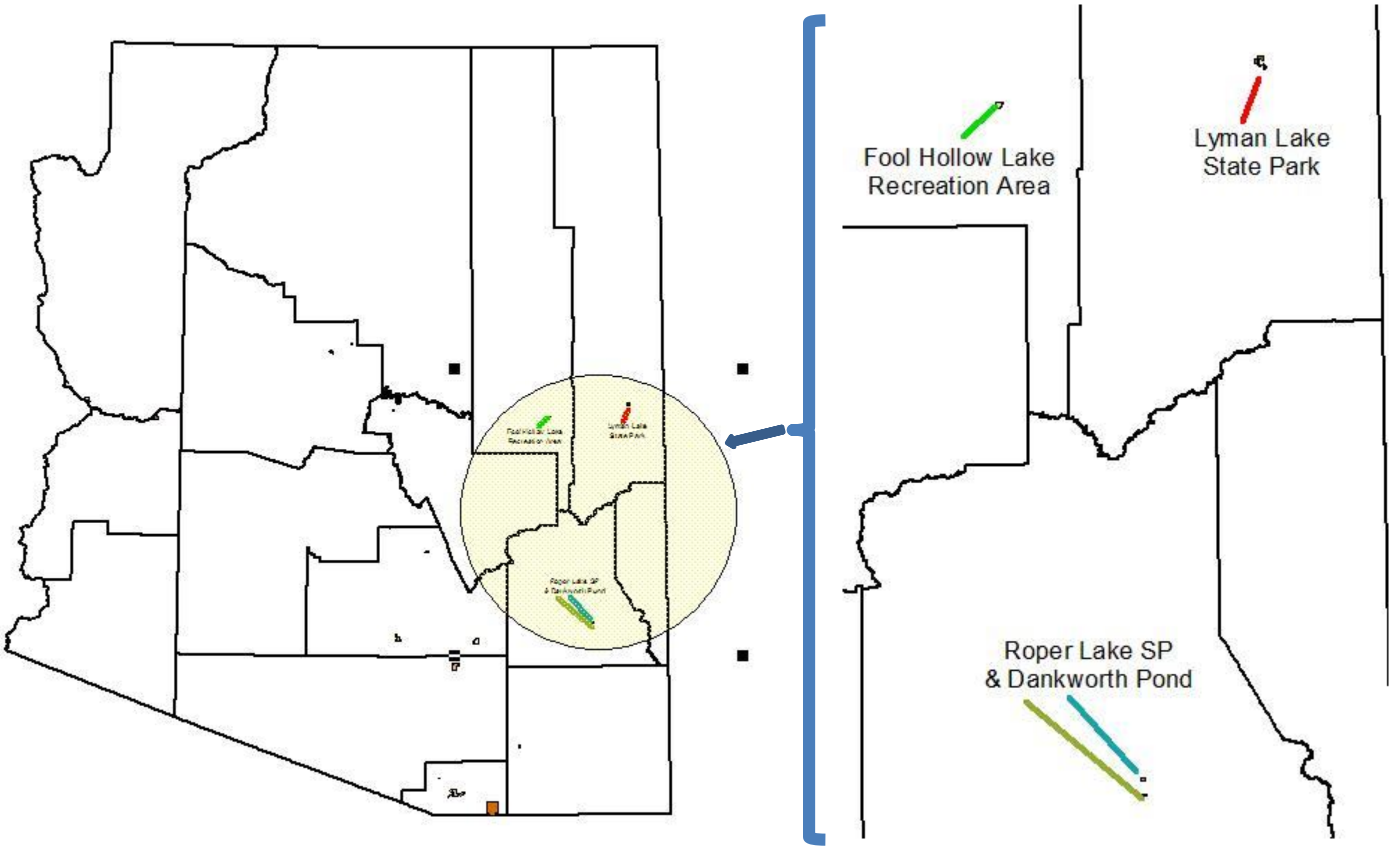


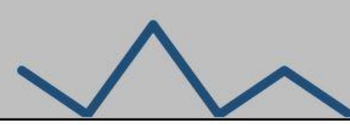
PARK/DATE	Nov-13	May-14	Aug-14	Nov-14	May-15	Nov-15	Graph Over Assessment Period *
DEAD HORSE – at Cottonwood AZ	0	3	8	3	2	1	
FT VERDE – at Camp Verde AZ	5	8	6	7	9	7.5	
HOMOLOVI – nr Winslow AZ	1	1	0	4	4	1	
JEROME – at Jerome AZ	5	5	2	7	6	3	
RED ROCK – nr Sedona AZ	7	8	8	6	5	2	
RIORDAN MANSION – in Flagstaff	7	8	8	5	8	5	
SLIDE ROCK – nr Sedona AZ	7	8	10	0	9	2	
TONTO NATURAL BRIDGE – nr Payson	4	8	7	4	5	6.5	
VERDE RIVER GREENWAY – nr Cottonwood	0	6	8	3	2	1	



* 0 - 10 Scale =
0=no drought impact; 10=extreme

Arizona State Parks -- Eastern Arizona

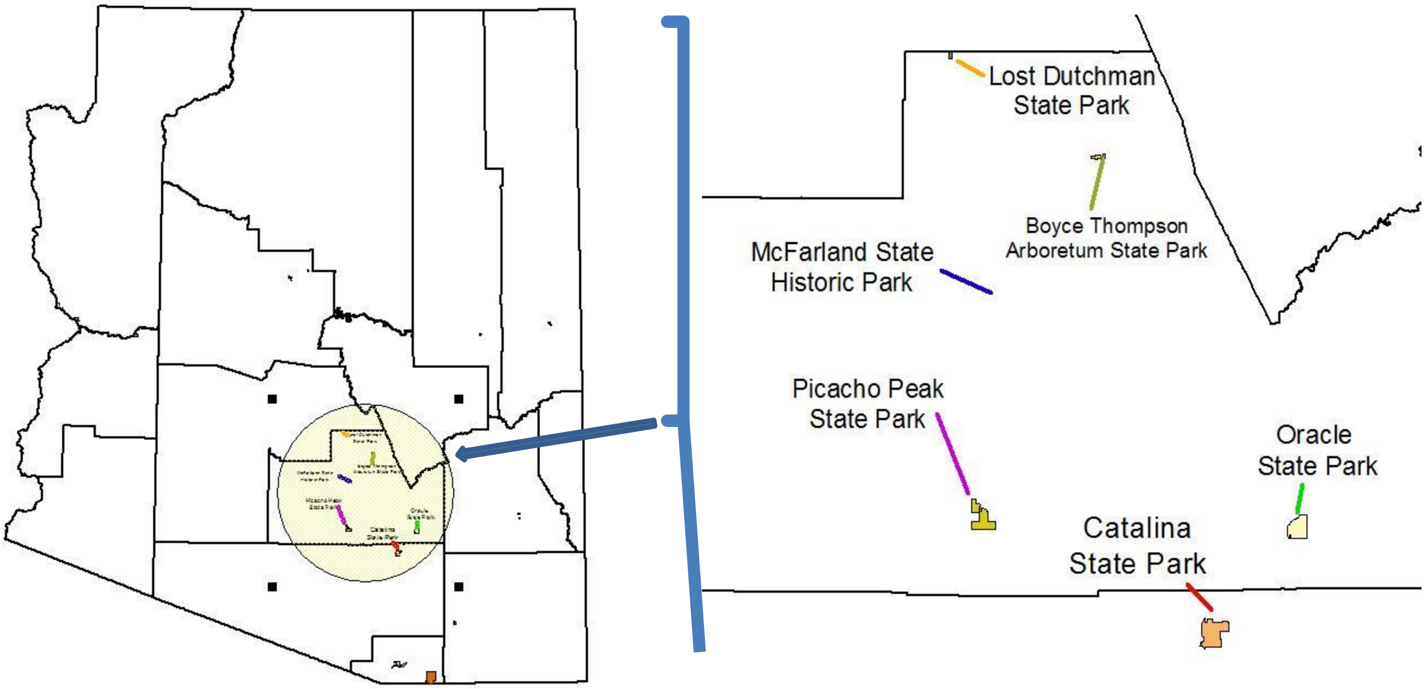


PARK/DATE	Nov-13	May-14	Aug-14	Nov-14	May-15	15-Nov	Graph Over Assessment Period *
FOOL HOLLOW – Show Low AZ	8	7	9	7	8	7	
LYMAN – nr St Johns AZ	8	8	7	6	7	5	
Roper/Dankworth–nr Safford AZ	9	8	3	5	3	5	

* 0 - 10 Scale =

0=no drought impact; 10=extreme

Arizona State Parks -- South-Central Arizona



PARK/DATE	Nov-13	May-14	Aug-14	Nov-14	May-15	Nov-15	Graph Over Assessment Period *
BTA – nr Superior AZ	8	7	7	6	7	8	
CATALINA – nr Tucson AZ	7	8	6	4	7	5	
LOST DUTCHMAN – nr Apache Junction	3	4	5	2	3	3	
McFARLAND – in Florence AZ	8	7	4	5	7	5	
ORACLE – nr Oracle AZ	7	8	5	3	8	1	
PICACHO PEAK – nr Eloy AZ	4	1	10	0	0	0	

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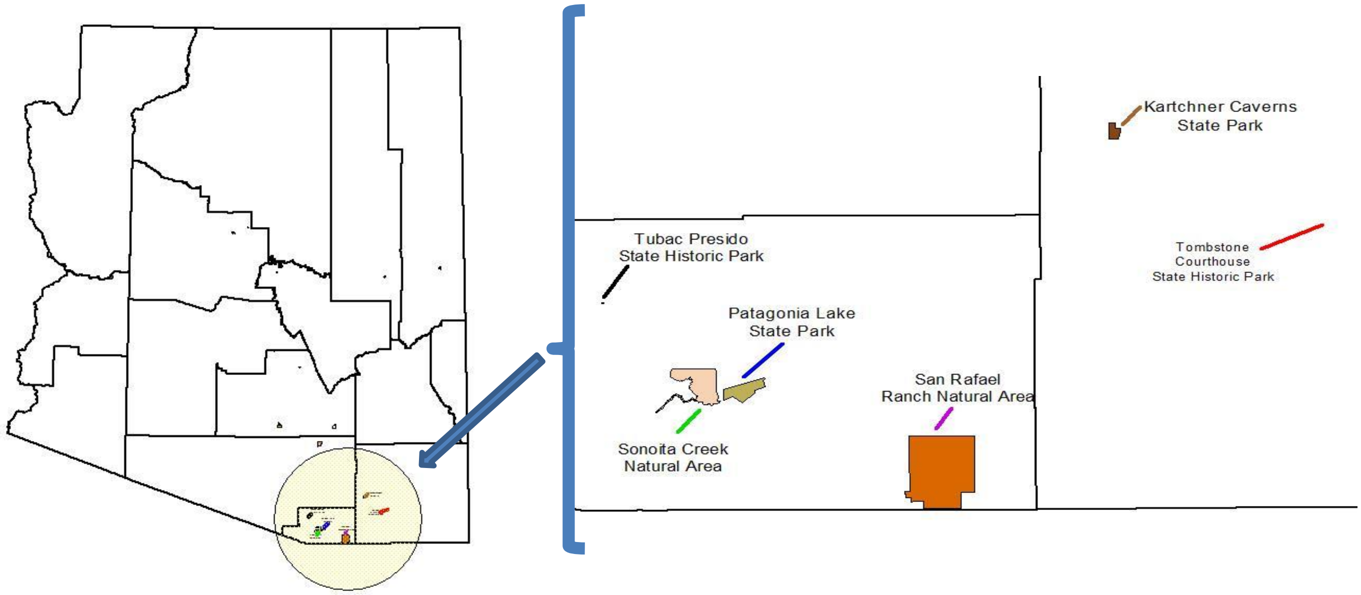
* 0 - 10 Scale =
0=no drought impact; 10=extreme

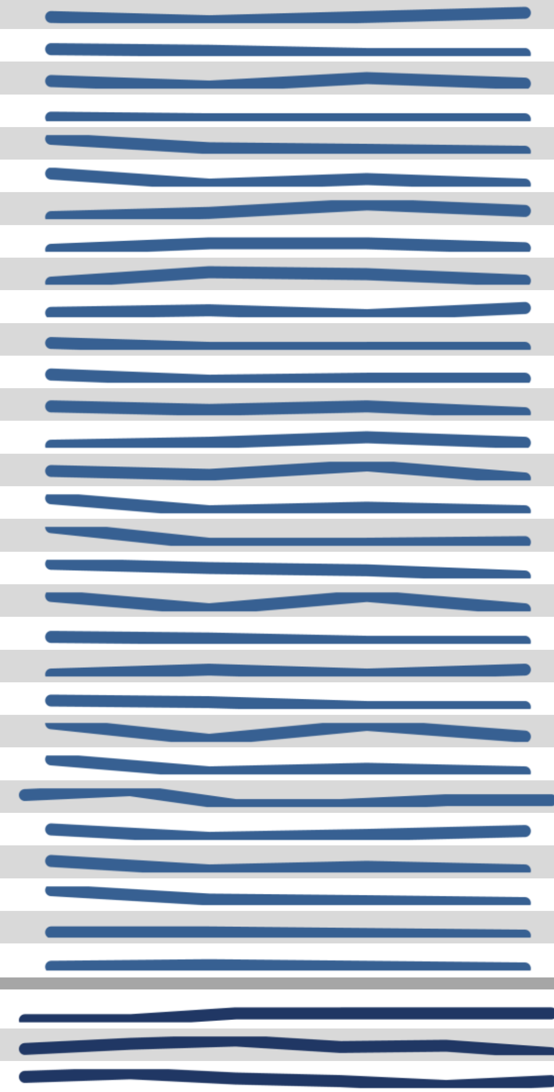
Arizona State Parks -- Far-South Arizona



PARK/DATE	Nov-13	May-14	Aug-14	Nov-14	May-15	Nov-15	Graph Over Assessment Period *
KARTCHNER – nr Benson AZ	6	9	4	5	3	6	
PATAGONIA LAKE – nr Nogales AZ	5	5	8	1	3	1	
SAN RAFAEL – nr Lochiel AZ	6	9	4	3	0	0	
SONOITA CREEK – nr Nogales AZ	5	5	8	1	3	1	
TOMBSTONE – in Tombstone AZ	2	7	0	0	1	3	
TUBAC – in Tubac AZ	4	4	6	1	3	3	

* 0 - 10 Scale =
0=no drought impact; 10=extreme

PARK / DATE	Nov-13	May-14	Aug-14	Nov-14	May-15	15-Nov	Graph Over Assessment Period: 0 to 10 Scale*	
ALAMO – nr Parker AZ	10	10	10	10	10	10	Alamo has been ALL 10s since Nov 2013	ALSP
BTA – nr Superior AZ	8	7	7	6	7	8		BTA
BUCKSKIN – nr Parker AZ	0	3	3	2	0	0		BMSP
CATALINA – nr Tucson AZ	7	8	6	4	7	5		CSP
CATTAIL - nr Parker AZ	0	0	1	0	0	0		CCSP
DEAD HORSE – at Cottonwood AZ	0	3	8	3	2	1		DHRSP
FOOL HOLLOW – Show Low AZ	8	7	9	7	8	7		FHLSP
FT VERDE – at Camp Verde AZ	5	8	6	7	9	7.5		FVSHP
HOMOLOVI – nr Winslow AZ	1	1	0	4	4	1		HSHP
JEROME – at Jerome AZ	5	5	2	7	6	3		JSHP
KARTCHNER – nr Benson AZ	6	9	4	5	3	6		KCSP
LAKE HAVASU at Lake Havasu AZ	0	0	3	0	0	0		LHSP
LOST DUTCHMAN–nr Apache Jctn	3	4	5	2	3	3		LDSP
LYMAN – nr St Johns AZ	8	8	7	6	7	5		LLSP
McFARLAND – in Florence AZ	8	7	4	5	7	5		MSHP*
ORACLE – nr Oracle AZ	7	8	5	3	8	1		OSP
PATAGONIA LAKE – nr Nogales AZ	5	5	8	1	3	1		PLSP
PICACHO PEAK – nr Eloy AZ	4	1	10	0	0	1		PPSP
RED ROCK – nr Sedona AZ	7	8	8	6	5	2		RRSP
RIORDAN MANSION – in Flagstaff	7	8	8	0	8	0		RMSHP*
RIVER ISLAND – nr Parker AZ	0	3	3	2	0	0		RISP
Roper / Dankworth – nr Safford AZ	9	8	3	5	3	5		RLSP
SAN RAFAEL – nr Lochiel AZ	6	9	4	3	0	0		SR-SNA
SLIDE ROCK – nr Sedona AZ	7	8	10	0	9	2		SRSP
SONOITA CREEK – nr Nogales AZ	5	5	8	1	3	1		SCr-SNA
TOMBSTONE – in Tombstone AZ	6	9	0	0	3	3		TSHP*
TONTO NATURAL BRIDGE –nr Payson	4	8	7	4	5	6.5		TNB
TUBAC PRESIDIO– in Tubac AZ	5	5	6	1	3	1		TPSHP*
VERDE Riv GREENWAY–nr Cottonwood	0	6	8	3	2	1		VRG-SNA
YUMA QUARTERMASTER DEPOT	0	0	2	2	1	0		YQSHP*
YUMA TERRITORIAL PRISON	0	0	1	2	1	0		YTPSHP*
WESTERN REGION	0	0	3	3	3	3		W.REG*
NORTHERN REGION	4	6.5	8	5	5.5	2		N.REG*
SOUTHERN REGION	5.5	7.5	4.5	3	0	3		S.REG*



* 0 - 10 Scale = 0=no drought impact; 10=extreme

Appendix E

Arizona Natural Resources Conservation Services (NRCS) Drought Report

NRCS 2015 DROUGHT REPORT

SUMMARY OF SURVEY PROVIDED BY NRCS FIELD OFFICE'S

Prepared by E. Carrillo – Acting State Rangeland Specialist

General

A survey was sent out in late Sept. 2015 to all NRCS Field Office's in Arizona soliciting feedback on drought conditions in their respective work areas. Responses were gathered and summarized in early October. Results are summarized below.

Survey questions were broad and focused on drought conditions relating to;

1) Dryland Farming
2) Irrigation Water Supply
3) Rangeland Water Supply
4) Rangeland Forage Supply
5) Rangeland Precipitation data

See attachment 1 for survey questions.

Results

Of the 24 NRCS Field Office's (FO's) in Arizona 16 (67%) responded to the survey.

Figure 1 depicts FO's and the work area they cover that responded (in green) to survey. Although not all offices responded, statewide coverage was attained. All counties at a minimum had some, if not all, portions included in the survey.

Of the offices that participated in the survey 25% reported their work areas experiencing drought conditions. Those offices are;

- Avondale
- Casa Grande
- Dilkon
- Fredonia
- Keams Canyon
- Prescott
- Safford
- Springerville
- Tucson
- Whiteriver
- Willcox

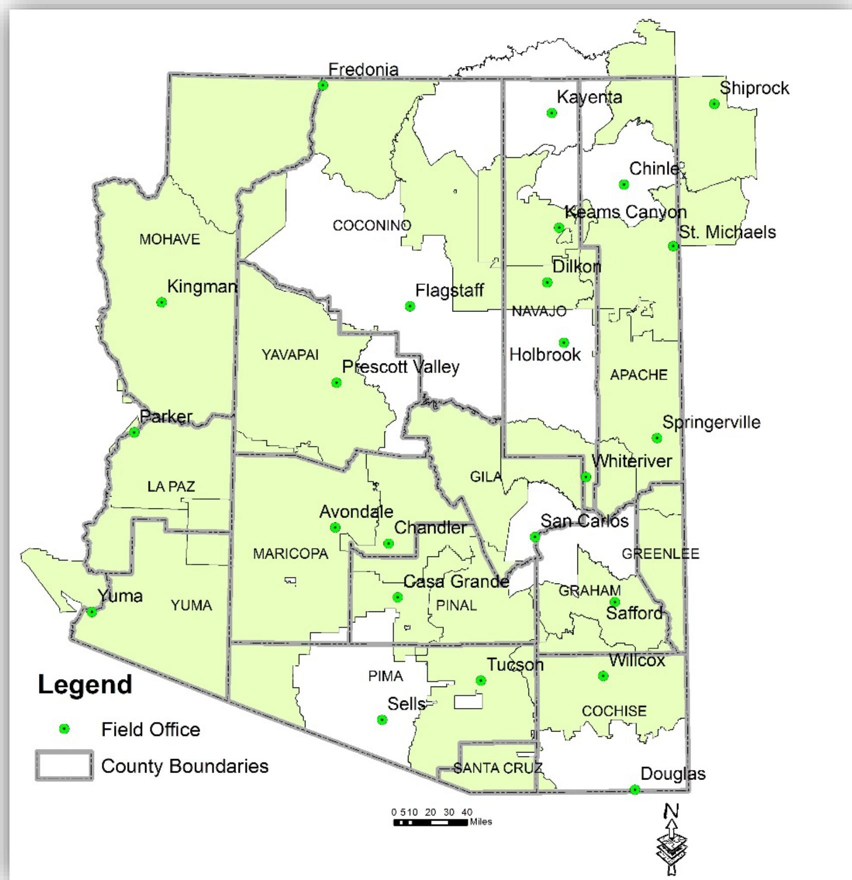


Figure 1. Map of FO's responded. Green = responded.

Table 1 NRCS Field Office's and counties in work area.

Field Office	Reported drought	County(ies) covered
Avondale	Yes	La Paz, Maricopa, Yavapai
Casa Grande	Yes	Pima, Pinal
Chandler	Yes	Gila, Maricopa, Pinal
Dilkon	Yes	Coconino, Navajo
Fredonia	Yes	Coconino, Mohave
Keams Canyon	Yes	Apache, Coconino, Navajo
Kingman	No	Coconino, Mohave
Parker	No	La Paz

Field Office	Reported drought	County(ies) covered
Prescott	Yes	Yavapai
Safford	Yes	Graham, Greenlee
Shiprock	No	Apache
Springerville	Yes	Apache, Greenlee
Tucson	Yes	Cochise, Gila, Pima, Pinal, Santa Cruz
Whiteriver	Yes	Apache, Gila, Navajo
Willcox	Yes	Cochise, Graham, Pima
Yuma	No	La Paz, Yuma

Dryland Farming

Three Office's with land in dryland farming reported effects of drought. These offices are located on Indian Reservations. Crops reported to be affected are; corn, sorghum, squash, melons and fruit trees.

Table 2 - Dryland Farm FO's

Field Office	**Dilkon**	**Keams Canyon**	**Whiteriver**
Acres of cropland affected	500	5,000	200
% loss of crop production expected	50%	30%	40%

Irrigation Water Supply

Four Office's reported water supply shortages. Water sources affected are; wells, surface diversions and the Colorado River diversion. Crops affected are; alfalfa, cotton, tame pasture, corn, beans and milo.

Table 3 - Crops affected & acres by FO.

Field Office	**Casa Grande**	**Parker**	**Springerville**	**Willcox**
Acres of cropland affected	324,243	4,000	All acres	20,000
% loss of crop production expected	10%	<1%	40-50%	25%

Rangeland Water Supply

Twelve Office's reported water supply shortage on rangelands. Sources that were affected are; wells, ponds, springs and creeks.

Table 4 - Rangeland Water Supply by FO

Field Office	**Avondale**	**Casa Grande**	**Chandler**	**Dilkon**
% of area out of water	60%	90%	35-45%	50%
% of ranchers hauling water	5%	25-30%	35-45%	25%
% of wells dry	0%	25-30%	30%	25%
% of ponds dry	50%	35-40%	40%	25%
% of springs dry	0%	30%	40%	25%
% capacity of all ponds	50%	30%	5%	75%
Field Office	**Fredonia**	**Keams Canyon**	**Prescott**	**Safford**
% of area out of water	25%	60%	35%	10%
% of ranchers hauling water	5%	35%	35%	5%
% of wells dry	0%	50%	5%	0%
% of ponds dry	40%	75%	35%	8%
% of springs dry	0%	65%	5%	0%
% capacity of all ponds	50%	15%	0%	0%
Field Office	**Springerville**	**Tucson**	**Whiteriver**	**Willcox**
% of area out of water	50%	10%	35%	25%
% of ranchers hauling water	40%	5%	0%	5%
% of wells dry	10%	10%	33%	20%
% of ponds dry	65%	15%	35%	35%
% of springs dry	50%	50%	20%	15%
% capacity of all ponds	50%	50%	50%	40%

Rangeland Forage Supply

Nine Office's reported shortage of forage for livestock on rangelands. Although rain's to date are at normal or above average, rains did not occur at the opportune time for forage growth. Many offices across the state reported good rains starting in the spring, but through the months of June and July the rains had stopped. This caused the forage to initiate growth in the spring as normal, but production slowed or ceased when the rains stopped. Rain did not resume until August, which is close to the end of the growing season. Forage growth did resume as well for the months of August and September, however, not enough to make average annual production. Forage capacity is considerably low because of prolonged drought and die off of sod base. Rains have been good the last two summers and have grown excellent grass but, the production is not there as large amounts of perennial forage have died. Most livestock reductions are not necessarily due to this year's lack of forage production, but are carry over from the long term drought.

Table 5 - Forage production by FO

Field Office	**Avondale**	**Casa Grande**	**Chandler**
% of normal year production at spring	30%	40%	35%
% of normal year expected at end of growing season	25%	45%	35%
% of normal livestock numbers being grazed	60%	Decreased by 25%	35%
% of ranchers feeding supplemental forage	65%	40%	35-45%

Field Office	**Dilkon**	**Keams Canyon**	**Prescott**
% of normal year production at spring	60%	90%	100%
% of normal year expected at end of growing season	75%	65%	50-75%
% of normal livestock numbers being grazed	60%	85%	50%
% of ranchers feeding supplemental forage	0%	15%	20%

Field Office	**Safford**	**Springerville**	**Tucson**
% of normal year production at spring	100%	60%	40%
% of normal year expected at end of growing season	75-80%	60%	80%
% of normal livestock numbers being grazed	100%	60%	70%

% of ranchers feeding supplemental forage	5%	0%	1%

Ranch Precipitation

This year an additional question regarding ranch precipitation was added to the survey completed by the FO's. More and more ranchers are installing rain gauges across their ranches and many are coupled with monitoring sites. This information gives us a better picture of spatial variability of rainfall events and amounts. Seven Offices reported their ranchers keeping rainfall data.

Table 6 - Ranch precip. by FO

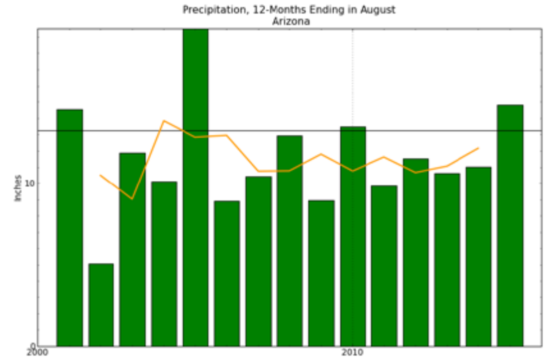
Field Office	**Chandler**	**Dilkon**	**Fredonia**	**Prescott**
% of ranchers that keep rainfall data	95%	50%	15%	10%
% below average precipitation	65%	50%	1%	50%
Did rain occur at the right time and amount for forage growth?	yes	yes	yes	no

Field Office	**Safford**	**Tucson**	**Willcox**
% of ranchers that keep rainfall data	65%	100%	80%
% below average precipitation	25%	40%	50%
Did rain occur at the right time and amount for forage growth?	yes	yes	yes

Note – Many FO's reported June and July as below average precipitation. April, May and August, September reported as good rain's.

2015 NRCS Field Office Drought Report

September 2015



FIELD OFFICE: CLICK HERE TO ENTER TEXT. **CONSERVATIONIST:** CLICK HERE TO ENTER TEXT.

GENERAL

Is the Field Office work area experiencing any drought conditions? ☐YES ☐ NO

If yes, answer the following questions. Discuss with some key producers before responding.

DRYLAND FARMING

Is there dryland cropland in the work area being affected by the drought? ☐YES ☐ NO

If yes, answer the following questions.

What crops are affected?

How many acres of cropland are being affected?

What % loss of crop production is expected?

IRRIGATION WATER SUPPLY

Are there irrigation water shortages in the Field Office work area? ☐YES ☐ NO

If yes, answer the following questions.

What water source is affected (well, surface diversion etc)?

What crops are being affected?

How many acres of cropland are being affected?

What % loss of crop production is expected?

RANGELAND WATER SUPPLY		
Is there a shortage of livestock water in the Field Office work area?	☐YES	☐ NO
If yes, answer the following questions.		
What % of the work area is out of livestock water?		
What water sources are affected (well, dirt ponds, etc)?		
What % of ranchers are hauling water?		
What % of livestock wells are dry?		
What % of dirt ponds are dry?		
What % of springs are dry?		
What % of capacity is available in all ponds?		
RANGELAND FORAGE SUPPLY		
Is there a shortage of livestock forage in the Field Office work area?	☐YES	☐ NO
If yes, answer the following questions.		
What % of normal year forage production was available this past spring?		
What % of normal forage production is expected by the end of this year's growing season?		
What % of normal livestock numbers are currently being grazed?		
What percent of ranchers are feeding supplemental forage (due to forage loss)?		
RANCH PRECIPITATION DATA		
Do key producers keep rain gauge data?	☐YES	☐ NO
If yes, answer the following questions.		
What % of producers keep precipitation records?		
What % of producers recorded below average precipitation?		
Did precipitation occur during the opportune time and at sufficient amounts for forage production? (i.e. avg. precip for the growing season)	☐YES	☐ NO
MORE COMMENTS?		
Please expand upon your assessment. Add any additional information you feel is pertinent to drought conditions in your work area.		

Appendix F

ADWR Testimony to the U.S. Senate Committee of Energy and Natural Resources

Testimony of Thomas Buschatzke
Director
Arizona Department of Water Resources

COMMITTEE ON ENERGY AND NATURAL RESOURCES
United States Senate
June 2, 2015

Chairman Murkowski, Ranking Member Cantwell and members of the Committee:

I. Introduction

My name is Tom Buschatzke and I am the Director of the Arizona Department of Water Resources. Thank you for providing me an opportunity to present testimony on behalf of the State of Arizona regarding the on-going drought in the western United States, how it is impacting my state, how we have prepared to offset or mitigate those impacts and how the United States may help Arizona meet the challenges presented by continued drought.

II. Background

The State of Arizona and its water users have a long history of developing water supplies and the necessary infrastructure to deploy those supplies to maximize their benefit to the citizens and businesses in our State. Sound management of those supplies has been a primary focus in our State and the arid nature of Arizona is a constant reminder of the value of every drop of water available to us. Arizona is fortunate to have a diverse portfolio of water supplies. Arizona currently uses about seven million Acre-feet of water per year statewide which comes from the following sources: the Colorado River-40%; Groundwater-40%; in state rivers-17%; and reclaimed water reuse-3%.

Arizona has a long history of collaboration and innovation to manage our water supplies. We have participated in interstate and international agreements to protect our Colorado River water supplies, beginning with the Colorado River Compact to recent agreements with Mexico through Minute 319. Arizona has created institutions over many decades that provide certainty for our water users. Some of those success stories include the Salt River Project, the Gila Project, the Wellton-Mohawk Irrigation and Drainage District, the Yuma County Water Users' Association, the Yuma Mesa Irrigation District, the North Gila Valley Irrigation and Drainage District, the Yuma Auxiliary Project-Unit B, the Central Arizona Project, the 1980 Groundwater Management Act, the Underground Storage and Recovery Act and the Arizona Water Banking Authority. Arizona and its water users have taken proactive measures and made hard choices over many decades to insure a high quality of life for our citizens and a vibrant economy and will continue to do so in the face of the on-going drought in the west.

Despite the actions and choices made by Arizona uncertainty remains and the vulnerability of our water supplies to drought is the subject of constant attention among water providers, water users and water managers around the state. Flexibility to manage water supplies and adaptation to drought conditions are part of Arizona's history and will continue to be a key management strategy now and in the future.

III. Challenges Imposed by the On-Going Drought

Arizona continues to experience drought and more than 85% of the State falls within "Abnormally Dry" to "Severe Drought" conditions. The Salt and Verde River watersheds are in the fifth consecutive year of drought which has reduced the surface water supplies that are used in the Phoenix metropolitan area by municipal water providers and agriculture. That has resulted in an increase in groundwater pumping to backfill the reduction in those surface water supplies. The Salt and Verde River watersheds are also at increased risk to wildfires, as is the Gila River watershed, the other main source of Arizona's in-state river supplies. Allocations of surface water from the Gila River have also been reduced as a result of the drought. To address drought conditions and the impact on our water supplies and water users the Governor's Drought Interagency Coordinating Group has recommended that a Drought Declaration be adopted by Governor Ducey. That Declaration will allow aid to flow to farmers and ranchers from the United States Department of Agriculture for loss of production and it also raises public awareness regarding drought conditions affecting the State.

The west-wide drought presents some unique challenges for all Colorado River users and the State of Arizona. The Colorado River watershed is entering its 16^{th} year of below average runoff due to drought. Arizona stands to lose 320,000 Acre-feet of its 2.8 Million Acre-feet Colorado River allocation when a Tier 1 shortage is triggered by Secretarial order pursuant to the 2007 Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Mead. Under the Interim Guidelines a projection of the elevation of Lake Mead is made in mid-August for the first day of the next calendar year. If that projection shows Lake Mead falling below elevation 1,075 feet then a Tier 1 shortage is put into place starting on January 1 of that year. Today, Lake Mead is at elevation 1,076[1] feet. The probability of a shortage declaration in the Lower Basin of the Colorado River has been steadily increasing over the past few years. The probability of a shortage in calendar year 2016 is 33% and that increases to 75 %[2] for 2017. It is important to note that a Tier 1 shortage triggers reductions for Arizona, Nevada and the Republic of Mexico but not for California. Arizona shoulders the brunt of the shortage among the three states and Mexico, about 84% of the total.

Deeper shortages will occur if Lake Mead's elevation continues to decline. Between elevation 1,050 feet and 1,025 feet a Tier 2 shortage results in Arizona suffering a reduction of 400,000 Acre-feet and at elevation 1,025 feet Arizona loses 480,000 Acre-feet, a Tier 3 shortage. The probabilities of Tier 2 and 3 occurring have also been increasing as the drought continues. If Lake Mead's elevation continues to drop and falls below elevation 1,025 feet, the volume of shortage to Arizona is unknown at this time. This uncertainty creates a difficult task for Arizona: how to plan for a shortage that is unquantified but will undoubtedly be greater than 480,000 Acre-feet. As Lake Mead approaches elevation 1,000 feet, the near-term limit for diversions by Las Vegas, or continues to decline to dead pool at elevation 895 feet draconian shortages are likely to occur.

Low reservoir conditions in the Colorado River system impact not only water users, but directly impact the production of hydroelectric power from major dams on the River. For example, if Lake Mead falls below elevation 1,000 feet, the hydropower production from Hoover Dam will be cut in half. Glen Canyon Dam hydropower production is eliminated if Lake Powell falls below elevation 3,490 feet, and United States Bureau of Reclamation has indicated that impacts to power production could occur at elevation 3,525 feet.

Lake Mead's falling elevations are not tied strictly to reductions in flow of the Colorado River due to drought. A "structural deficit" in the water supplies available from Lake Mead to California, Nevada,

[1] Based on USBR Lower Colorado River Region's weekly Colorado River water supply report for May 18, 2015.
[2] Based on USBR Lower Colorado River Region's Colorado River April 24 Month Study and resulting projections of Lake Mead elevations.

Arizona and Mexico exists as an artifact of the “Law of the River”, the complex set of laws, agreements, rules, regulations and operating criteria that govern the storage, use and delivery of Colorado River water. In short, in a normal year a set amount of water flows into Lake Mead but it is not enough water to cover releases for use, evaporation and delivery losses. That structural deficit results in an annual drop of about 12 feet in the elevation of Lake Mead. In wet years high flow in the Colorado River allows more than the normal amount of water to flow into Lake Mead so the elevation of the lake can rise and recover. The drought has limited high flows in the Colorado River so that Lake Mead is not receiving more than its normal annual inflow and water elevations do not have a chance to rebound.

The drought also causes other impacts indirectly related to reduced precipitation. The health of the watersheds of the Colorado, Salt, Verde and Gila Rivers is an increasingly important issue in the region. A number of national forests in Arizona were created primarily for watershed protection and are indicative of the fact that forest health and water supply are closely connected. The drought has exacerbated issues associated with poor forest management including fuels and timber management so that the risk to our forests from catastrophic wildfires is increasing.

IV. How Arizona Has Prepared For Drought

The water development projects put in place over the last century to utilize Colorado River water and in state rivers have created a solid foundation for meeting water demand with renewable water supplies. Yet, Arizona also recognized that reliance upon those renewable supplies made us vulnerable to potential shortages during drought.

To address that vulnerability Arizona took a giant leap forward in 1980 with the passage of the Groundwater Management Act. The Act was a hard fought compromise between agriculture, industry, mining interest and municipalities. It established a policy direction for the protection of central and southern Arizona’s abundant groundwater supplies that were being mined at the time at an unsustainable rate.

Mandatory water conservation requirements for municipal, industrial and agricultural water users in that part of the state, termed “Active Management Areas” were elements of the Act. Agricultural acreage was capped and no new agricultural land was allowed to be put into production after 1980. New golf courses were limited in size and the amount of water they could use. New housing was required to show that it has a 100-year renewable water supply before it can be built. Community water systems, i.e., municipal providers, are required to have conservation and drought management plans in place. These aggressive water management actions reduced Arizona’s water use over time while its population and economic output have increased. One result is that Arizona’s dependence on groundwater has decreased from 53% in 1980 to 40% today. In addition, case studies included in the Colorado River Basin Study Phase 1 Moving Forward Report prepared by the United States Bureau of Reclamation show agricultural and municipal users in Arizona are some of the most efficient in the West. Arizona irrigation users in central Arizona and the Yuma area, average 80 - 85% on farm irrigation efficiency, while municipal water users in central Arizona have reduced per capita consumption by more than 20% since 2000.

The 1980 Groundwater Management Act incentivizes the conservation and conjunctive use of Arizona’s surface water, Colorado River water, reclaimed water and groundwater and helps to protect water levels in aquifers in central and southern Arizona. To accomplish that goal, the Underground Storage and Recovery program was originally added to the Act in 1986 and later restructured in 1996. This suite of statutes allows for water to be stored underground and recovered at a later point in time. The program has resulted in the storage of 9 million Acre-feet of water in our aquifers for Arizona. The Arizona Water

Banking Authority, the Arizona Department of Water Resources, and the Central Arizona Project have prepared a plan to recover the water stored underground to further protect Arizona water users from the impact of shortage. The Arizona Water Banking Authority (AWBA), a state agency, was created in 1996 to allow for underground water storage for the specific purposes of supplementing Colorado River water supplies when shortages reduce supplies for tribal, municipal and industrial water users. The Arizona Water Banking Authority has stored 3.4 million Acre-feet of the 9 million Acre-feet total stored in Arizona. The value of underground storage was recognized by other States in the Colorado River Basin through the creation of interstate water banking agreements. Arizona stored 80,000 Acre-feet for California in a pilot program in the 1990's. That water has been recovered and delivered to California. Arizona stored another 600,000 Acre-feet for Nevada in the 2000's but that water has yet to be recovered and delivered to Nevada.

Arizona's history also includes a strong commitment to recycling and reuse of reclaimed water. One example of a major reuse program is the Palo Verde Nuclear Generating Station in the Phoenix metropolitan area. The Nuclear Generating Station contracts for 60,000 Acre-feet per year of treated municipal wastewater from the 91st Ave Wastewater Treatment Plant which serves five cities in the region. The 2010 agreement is for a 40 year term and replaces an earlier agreement from 1973.

To better monitor and adapt to drought conditions the State created the "*Arizona Drought Preparedness Plan, Operational Drought Plan*," in 2004. The plan provides information on drought contingency actions, ways to reduce water use during droughts and is designed to achieve more aggressive water savings as drought persists or worsens. It created a State Drought Monitoring Technical Committee that meets monthly to determine the drought status in Arizona. Local Drought Impact Groups feed information into that Committee. The Drought Interagency Coordinating Group reports annually to the Governor and makes recommendations for a drought declaration to be adopted. The Arizona Department of Water Resources publishes the "*Arizona Drought Preparedness Annual Report,"* that summarizes drought conditions and drought preparedness activities for the water year.

A holistic approach to water management was necessary to create the level of resiliency Arizona enjoys today. The programs authorized under the 1980 Groundwater Management Act and its progeny have left Arizona in a strong position to deal with the on-going drought at this moment in time. However, Arizona must continue to be proactive to insure that its resiliency will continue into the future. That will be a challenge for the State of Arizona.

V. The Role of the Federal Government

The Secretary of the Interior is the water master in the Lower Basin of the Colorado River and operates the entire Colorado River system pursuant to the "Law of the River" including the decree in *Arizona v. California.* The Secretary, through the Bureau of Reclamation, has taken preliminary steps to begin to address the Colorado River drought by participating in conservation efforts such as those included in the WaterSmart programs, Pilot System Conservation Agreement, and the Lower Basin Pilot Drought Response Actions Memorandum of Understanding. It is imperative that any actions of the Secretary of the Interior or the United States to aid drought stricken California be consistent with the Law of the River and not reduce the flexibility or impinge on Arizona's efforts to deal with the drought. Arizona already takes the lion's share of shortages and it is clear there is an increasing risk of deeper shortages on the River. Secretarial actions that might further impact Arizona are not warranted and would not be equitable.

Furthermore, the reliability and sustainability of the Colorado River system is critical to many Arizona Indian tribes and to the United States as trustee for those tribes. In partnership with the United States the tribes, and others, Arizona has settled 13 of 22 tribal water rights claims, in whole or in part. Central Arizona Project water from the Colorado River has been a key component of the water budgets for many of those tribal water rights settlements. Additional Central Arizona Project water is set aside for use in the settlement of the remaining tribal water right claims in Arizona. Insuring that Colorado River water is reliable is a necessity for the successful implementation of exiting settlements and for settling the remaining tribal claims in Arizona.

Augmentation of water supplies continues to be a key component for the future of Arizona. The need for augmentation to benefit Arizona was identified in the report entitled "*Arizona's Next Century: A Strategic Vision for Water Supply Sustainability,* January 2014." The December 2012 Colorado River Basin Water Supply and Demand Study, a joint effort by the seven Colorado River Basin States and the Bureau of Reclamation, identified augmentation as a potential solution to close a water supply and demand imbalance projected for 2060 in the Colorado River Basin study area. The importance of augmentation for the Colorado River has been recognized for many decades. In the Colorado River Basin Project Act the benefit of augmenting the supply of the Colorado River below Lee Ferry in the amount of 2.5 million Acre-feet was documented. (Public Law 90-537 90th Congress, S. 1004 September 30, 1968.)

In summary, Arizona would like to see additional opportunities for federal support of programs to conserve water that will benefit the entire Colorado River system rather than any one particular Colorado River water user.

Appendix G

ADWR Monitoring Well Network Optimization Plan

Monitoring Well Network Optimization Plan

Well Matching

Determine what well identifiers match between multiple databases: WELLS55, GWSI, and WELLS35

Construct Central Well Table by Well Matching

Outsource: Phase 1 – 3.5 months; Phase 2- 4 months; Phase 3 - 13 months

DB Modify Simultaneously

GWSI Database Structural Modifications

Develop GWSI ORACLE lithology, geologic, aquifer, and hydrogeologic unit tables and populate from existing ACCESS database structures

Modify GWSI Database Structure for Lithologic, Geologic, Aquifer, Hydrogeologic Unit Tables

ADWR IT & Hydrology staff: 2- 4 months, 3FTE

Correlate & Assign Aquifer(s) to Wells

Determine what aquifer(s) or hydrogeologic unit(s) each well monitors

Populate GWSI tables with Aquifer(s) & Hydrogeologic Unit(s) Correlations to Monitoring Well Construction

ADWR Hydrology staff: 3 months, 2FTE

Relate Programs & Statutes to Wells

Determine what wells support what programs or statutes

Populate Monitoring Well Table by relating what wells support what programs &

ADWR Hydrology staff: 2 months, 2FTE

Optimize ADWR's Monitoring Well Network

Does the current network of monitoring wells adequately provide data needed for water management decisions?

Optimize Monitoring Well Network by utilizing GIS & database techniques

Outsource or ADWR Hydrology staff: 3 months, 2FTE

Monitoring Well Network Optimization Plan

Tasks

The following work flow identifies specific tasks to optimize the statewide monitoring well network.

- Construct Central Well Table by Well Matching – (Determine what well identifiers match between multiple databases: WELLS55, GWSI, and WELLS35)

- Modify GWSI Database Structure for Geologic, Hydrogeologic, Aquifer Tables – (Lithologic data, geologic contacts, and aquifer/ hydrogeologic units contacts will be populated into existing database structures from ACCESS into ORACLE GWSI)

- Correlate Aquifer/Hydrogeologic Units to Monitoring Wells Construction - (What aquifer or hydrogeologic unit does each well monitor?)

- Relate Programs and Statutes to Wells - (What wells support what programs or statutes)

After the above work flow (process, system) is established and complete an optimization of the network can be conducted.

- Optimize ADWR's Monitoring Well Network – (Does the current network of monitoring wells adequately provide data needed for water management decisions?)

Monitoring Well Network Optimization Plan

Background

ADWR currently measures the depth to water (DTW) statewide in approximately 1,600 wells annually. Groundwater level (WL) measurements are used by a multitude of water resource managers, planners, researchers, government entities, well drillers; real estate industry, and private land owners just to name a few.

Of the 1600 wells measured, some are measured on an annual frequency, some semi-annual, some quarterly, and others on a continuous basis by automated monitoring equipment maintained by the Department. Monitoring well objectives include the ability to obtain long-term records of ground water level fluctuations while monitoring specific hydrologic factors statewide.

Problem

It is uncertain what the current well network monitors with regard to aquifer(s)/hydrogeologic unit(s) and, or regulatory program(s)/statute(s). A comprehensive statewide monitoring well analysis is needed to best optimization a statewide network that would consider what aquifer(s) or hydrogeologic unit(s) each well monitors and the purpose of that monitoring; factors to consider are listed below (see GWSI Index Well Siting Criteria). A critical evaluation of the current monitoring well network is needed to understand the purpose of monitoring the existing network and to identify gaps in the network that additional monitoring maybe needed and, or identify monitoring well sites that are either redundant, ambiguous or fluctuate too widely to discern static conditions.

The first step however towards a comprehensive monitoring well analysis is the resolution of well identification and well location discrepancies between the Department's databases, specifically, WELLS55 and GWSI and to some extent WELLS35. Without proper well matching between databases, well construction and driller log information is unknown and thus it is uncertain what each well is monitoring in terms of aquifer(s) or hydrogeologic unit(s).

Currently there are approximately 201,620 well registry IDs in WELLS55. There are 43,181 sites in GWSI of which 20,028 have no registry ID. The need exists to match wells in GWSI without a WELLS55 number. Identification of various multiple well names and locations for the same well listed in both databases is essential to eliminate confusion and uncertainty in using well information. Common links or well ids between GWSI and WELLS55 are needed for the management of well data and to ensure no duplication or redundant wells sites between databases. The need to reference all wells by a single well identifier prompts the need to match wells between databases and develop a central table that links all well IDs.

Proposal

<u>Well Matching</u>

Through well matching techniques, matches can be determined by comparing all records against each other for key fields such as location, well owner, casing depth, hole depth, date drilled, completed water level, casing diameter, well elevation, top of perforations, bottom of perforations, and etc. Drillers/geologic logs are reviewed to substantiate matches found by database informational comparisons. Once wells are matched between and or within databases, the well registration number, WELLS55, will serve will serve as a common link.

If it is determined that a GWSI well is not registered and has no WELLS55 number, then a well registry number will be generated by the "Administrative Late Registration" process. The goal is to assure that every well within the state has a 55 number – a single identifier available to link the many databases that exist. The time savings realized from data compilation for any hydrologic project requiring groundwater level data within Arizona will be of immediate notice once the well matching is complete between the WELLS55 and GWSI databases and a central well table is developed.

ADWR has conducted numerous well inventories and developed well matching techniques that can be used as examples for outside parties for well matching projects. It is recommended based on the number wells needed to be matched and ADWR current FTE resources that this task be considered for outsourcing. It is also recommended that the project be scoped as one comprehensive (statewide) project to make use of the learning curve necessary to conduct well matching.

The length of time estimated to complete the entire project with ten (10) FTE is ten (10) months or approximately 50 wells per week per FTE. A phased approach may be more desirable to adjust the number of FTE and timeframes to accomplished priority well matches. Priority could be given to wells with previous water levels and well matching being focused on those first. The following is a time estimate and recommendation of each phase.

First priority would be for those wells with water levels since 2000 of which there are approximately 3,500 GWSI wells without a registry number. With five (5) FTE in 3.5 months approximately 50 wells per week per FTE can be reviewed and Phase 1 completed. Second priority would be those GWSI wells with water levels since 1980 of which there are approximately 4,000 GWSI wells without a registry number. With five (5) FTE in 4 months approximately 50 wells per week per FTE can be reviewed and Phase 2 completed. Third priority would be those GWSI wells with water levels before 1980 of which there are approximately 13,000 GWSI wells without a registry number. With five (5) FTE in 13 months approximately 50 wells per week per FTE can be reviewed and Phase 3 and entire project completed.

It should be noted that the administrative late registration process will be handled by ADWR once the well matching is complete. Also, a business process will be developed and implemented in-house to ensure new GWSI Site IDs will not be created without a WELLS55 match or registry number.

GWSI Database Modifications (Lithologic/Aquifer/Hydrogeologic Tables)

Simultaneously with well matching, the ADWR GWSI database structure will need to be modified to store and manage well lithologic data as well as primary, secondary, and local aquifer or hydrogeologic unit information. As a part of the 3rd Party Water Level Portal, GWSI database modification is already planned but without a specific timeframe for completion. For a comprehensive review of the ADWR Monitoring Well Network, this phase of the GWSI database structure will need increased agency priority and resources to be concurrent with this proposal. Lithologic, geologic, aquifer and hydrogeologic unit code and data tables have already been developed for numerous projects including SRV geology update, Big Chino hydrogeologic conceptual model, WELLS35 database, and WELLS55 WQARF Well inventories all with the same database structure in Microsoft Access databases. Both the database structure and data tables can be transferred into the ORACLE environment for this purpose.

It is recommend that this task be conduct by ADWR staff given the expertise needed to be familiar with ADWR ORACLE environment and ADWR lithologic, geologic, aquifer and hydrogeologic unit code and data tables in numerous Access databases on currently stored on multiple ADWR networks/servers. Agency resources would need to be given to the IT Division for the modification of GWSI database structure. Estimates of time required would best be provided by the IT Division. IT has developed much of this in the past and therefore would be a time savings from previous efforts. Previous estimates of time to complete this project have ranged from 2 to 4 months.

Correlate Aquifers/Hydrogeologic Units to Monitoring Wells

Once well matching and administrative late registration is complete and the central well hub table is integrated into ADWR ORACLE databases, and the database structure has been modified in GWSI for the capture of lithologic, geologic, aquifer, and hydrogeologic data, an evaluation of what wells are constructed within what aquifer(s) or hydrogeologic unit (s) can be conducted. This evaluation can be accomplished through GIS and database techniques utilizing the newly developed central well hub and modified GWSI database tables. An assignment of wells that correlate to specific aquifer or hydrogeologic units will be made and documented within GWSI.

It is also recommended that this task be conducted by ADWR staff given the expertise needed to be familiar with ADWR GWSI and Access databases as well as Hydrology Division projects. The length of time to complete this task is estimated to be three (3) months with two (2) FTE.

Relate Programs/Statutes to Monitor Wells

Once it is known what wells monitor what aquifer(s) or hydrogeologic unit(s) then a relationship can be made between monitoring wells and program or statue support. GWSI already has a data and code table, "GWSI MONITORING", that begins to document what wells support what programs or statute. The results of the evaluation above regarding what each monitor well monitors with respect to primary, secondary, or local aquifer will populate the GWSI Monitoring table.

It is recommended that this task be conduct by ADWR staff given the expertise needed to be familiar with ADWR programs and statutes as well as institutional knowledge of current monitoring well locations and GWSI database familiarity. The length of time to complete this task is estimated to be two (2) months with two (2) FTE.

Optimize ADWR's Monitoring Well Network

ADWR's monitoring well network can begin to be optimized by use of the newly developed central well hub table and GWSI lithologic/geologic/aquifer/hydrogeologic tables and monitoring tables.

This task could be conducted by ADWR staff or outsourced for a separate opinion. It is recommended to complete the above tasks before determining the best resources to complete this task. The length of time to complete this task is estimated to be three (3) months with two (2) FTE.

Tasks

The following work flow identifies specific tasks to optimize the statewide monitoring well network.

- Construct Central Well Table by Well Matching – (Determine what well identifiers match between multiple databases: WELLS55, GWSI, and WELLS35)

- Modify GWSI Database Structure for Geologic, Hydrogeologic, Aquifer Tables – (Lithologic data, geologic contacts, and aquifer/ hydrogeologic units contacts will be populated into existing database structures in ACESS into ORACLE GWSI)

- Correlate Aquifer/Hydrogeologic Units to Monitoring Wells Construction - (What aquifer or hydrogeologic unit does each well monitor?)

- Relate Programs and Statutes to Wells - (What wells support what programs or statutes)

- Optimize ADWR's Monitoring Well Network – (Does the current network of monitoring wells adequately provide data needed for water management decisions?)

After this work flow (process, system) is established and complete an optimization of the network can be conducted. Optimization techniques can include, contouring of basin sweep water level elevations and comparison with existing index well water level elevation contouring for identification of general pattern differences or spatial gaps in monitoring. Groundwater modeling techniques such as those in PEST can best optimize monitoring locations based on hydrologic conditions within existing models. Other techniques can include GIS/database techniques that consider areas within the state that need monitoring based on critical areas such as Basins with large WL changes (especially those with significantly declining groundwater levels) and Sub-basins with no or low well counts will be considered for additional or increased monitoring.

Adequate spatial coverage of basins is only one factor for selecting additional monitoring locations. Understanding what aquifer or hydrogeologic unit a well is monitoring (knowing what intervals are screened) is another critical factor in siting additional monitoring wells. In addition to the data presented in this report, the following criteria are also considered when selecting new monitoring sites:

- areas showing an increase in water demand or a decrease in recharge,
- areas where wells can be co-located with pre-existing stream and/or precipitation gages,
- areas with significant on-going or projected population growth,
- areas with land subsidence,
- safe yield considerations,
- water quality concerns,
- riparian and other environmental considerations, and
- drought considerations.

Monitoring sites may be discontinued if analysis of the existing network reveals that data are either redundant, ambiguous or fluctuate too widely to discern static conditions. For example, several wells may be monitored in the same general area, or wells screened over multiple hydrogeologic units or aquifer systems can exhibit groundwater levels that are not representative of any one particular system. Also, WLs obtained from actively pumping wells may be of marginal value, even if pumping cycles are known. Groundwater levels collected from "static" groundwater conditions (conditions where groundwater is not being stressed by pumpage or artificial influences) provide data that can assist with understanding the nature of aquifer systems. Evaluating WL change data presented in this report with respect to screened intervals in wells and hydrogeologic units or aquifers, along with the other factors described above, would be the next step in improving and optimizing the statewide groundwater monitoring network.

GWSI Index Well Siting Criteria

Field Services Section Hydrology Division ADWR

7/21/2008

In general, ADWR Index wells historically have been selected to provide good spatial distribution or coverage within a groundwater basin and to assess vertical gradients if possible. ADWR GWSI Index wells are selected based on guidelines developed by the USGS Office of Ground Water for the Collection of Basic Records (CBR) Program: http://water.usgs.gov/ogw/CBR/Guidelns.html

Specific criteria for Index well selection can include at a minimum the following:

- Open to a single, known hydrogeologic unit
- Known well construction that allows good water-level measurements
- Located in unconfined aquifers or near-surface confined aquifers that respond to climatic fluctuations
- Minimally affected by pumpage and likely to remain so
- Essentially unaffected by irrigation, canals, and other potential sources of artificial recharge
- Long-term accessibility
- Well has never gone dry (not susceptible to going dry)

Additional desired characteristics:

- Representative of broad area (e.g., a regional aquifer)
- Complete characterization of the site is available
- A long record of water-level measurements exists
- Lithologic and geophysical logs available

Please note that selection criteria may vary for GWSI Index wells depending on area specific monitoring objectives. For example, wells may be selected that are located in confined conditions versus unconfined for specific regional data needs.