

Drought Contingency Plan 2025

Prepared by the City of Roswell



ROSWELL

New Mexico

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DRAFT

LIST OF ABBREVIATIONS

BOR	Bureau of Reclamation
DRAP	Drought Response Action Plan
DTF	Drought Task Force
ERP	Emergency Response Plan
GPCD	Gallons Per Capita Per Day
M	Mitigation
NDMC	National Drought Mitigation Center
NOAA	National Oceanic and Atmospheric Administration
NM	New Mexico
OMP	Operation and Maintenance Plan
PWS	Public Water Systems
RCC	City of Roswell's City Council
RDCP	Roswell Drought Contingency Plan
USDM	U.S. Drought Monitor
USDA	U.S. Department of Agriculture
WCS	Water Conservation Specialist

I. EXECUTIVE SUMMARY (Quoted text from *New Mexico Drought Plan: 2018* p 1)

“Drought is a common occurrence and has had acute impacts on New Mexico communities, industry, agriculture, and ecosystems.” Developing a “drought response system that is adaptive to changing needs and conditions and capable of being continually upgraded through the incorporation of new information” is essential to the sustainability of the community. “The plan specifies that subsequent updates should be made every five years.”

The purpose of the Roswell Drought Contingency Plan is as follows:

- To conserve the available water supply in times of drought and emergency
- To maintain supplies for domestic water use, sanitation, and fire protection
- To protect and preserve public health, welfare, and safety
- To minimize the adverse impacts of water supply shortages
- To minimize the adverse impacts of emergency water supply conditions

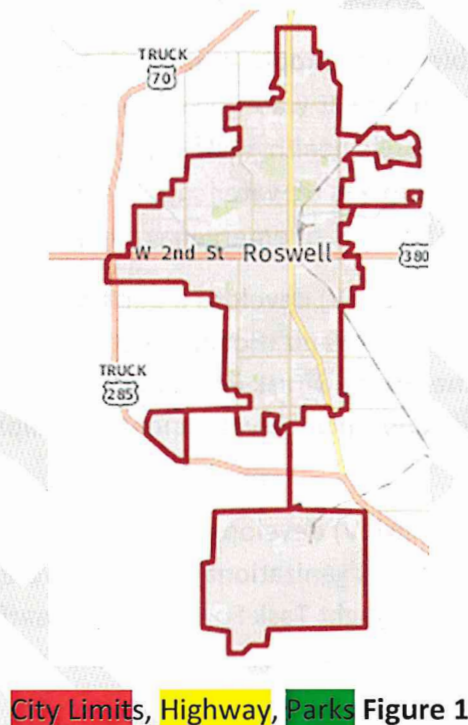
“The Operational Framework (Section IV) develops a decision support system and communication plan by defining the organizational structure, roles, and individuals responsible for implementing the (plan.) The Drought Task Force (DTF) is reaffirmed as the sole official point of contact between the drought plan development and implementation process and the (City of Roswell City Council.)”

The Operational Framework (Section IV) develops a decision support system and communication plan by defining the organizational structure, roles, and individuals responsible for implementing the (plan.) The Drought Task Force (DTF) is reaffirmed as the sole official point of contact between the drought plan development and implementation process and the (City of Roswell City Council.)

The plan coincides with and is consistent with the framework and drought stages established in the New Mexico Drought Plan: 2018. “The three drought stages are: Drought Watch Stage, Emergency Drought Stage, and Exceptional Drought Stage.... These triggers will be constantly evaluated based on the analysis of current drought conditions. Response actions include DTF meetings, as well as agency-specific responses.”

“Section VIII describes recommended mitigation actions for drought impacts within the following sectors: agriculture, drinking water, water quantity, wildfire and wildland fire, and watersheds. (Section XI) -Future Work, discusses steps and strategies that can be explored to further refine (the City of Roswell’s) drought response system. These include communication and collaboration with stakeholders, improvements to impact and vulnerability assessments, and evaluating/developing additional data for use as drought triggers.”

The City of Roswell (Roswell), located in Chaves County, New Mexico, provides water and wastewater services to 48,422 people within Roswell and surrounding county shown in **Figure 1**. The area is predominately reliant on groundwater and has experienced increasing water demands while experiencing multi-year drought conditions. At the time of adoption of this plan, Roswell is and has experienced exceptional drought conditions since 2018. This has resulted in increased groundwater pumping. Water demands in the area is among cities, agriculture, industry, recreation, and environmental uses. Roswell will use the Roswell Drought Contingency Plan (RDCP) to increase their water reliability and improve water management through conservation, expanded technologies, and improved modeling capabilities. This planning effort will work in tandem with Roswell's 2021 Water Conservation Plan.



II. HISTORY AND PURPOSE (Quoted text from *New Mexico Drought Plan: 2018* p 2)

"Drought is a common occurrence in New Mexico, having impacted the Land of Enchantment since prehistoric times. During the more recent historical period, drought has had particularly acute impacts during the years 1900-1910, 1932-1937, 1945-1956, 1974-1977, 2002-2004, and 2011-2013 shown in **Figure 2** (Palmer Drought Index). Since 1998, New Mexico governors have issued seven emergency drought declarations in the form of executive orders. Drawing on work done by various state agencies and other southwestern states, the first New Mexico Drought Plan was introduced and implemented in 2002. Since then, the state drought plan has been updated five times in conjunction with drought declarations. On July 11, 2018, Governor Susana Martinez signed Executive Order 2018-031, ordering another update of the existing (New

Mexico Drought Plan). The New Mexico Drought Task Force (DTF) met on September 24, 2018, and approved an expedited process to update the drought plan.”

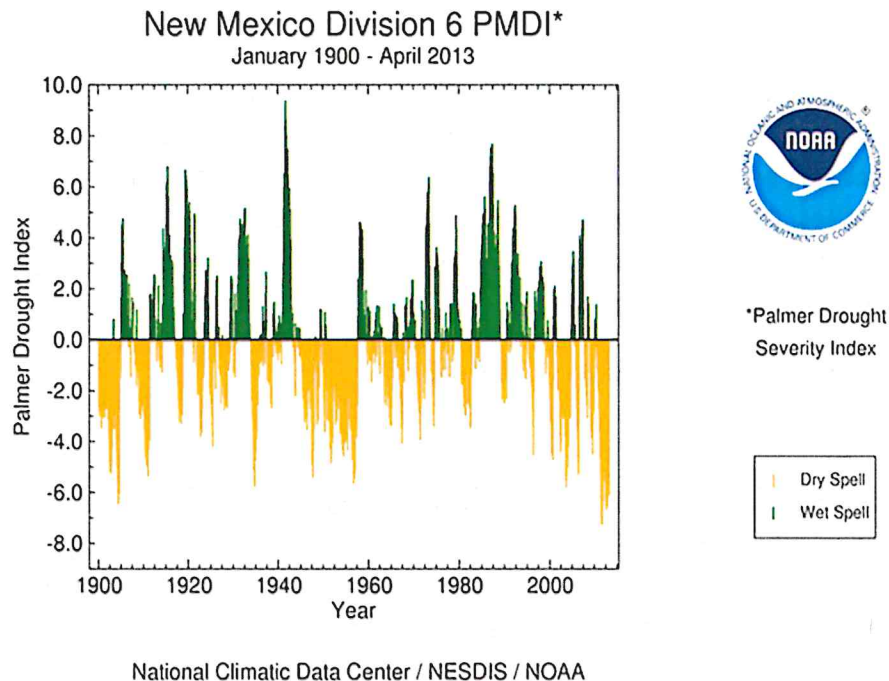


Figure 2

Summaries of Executive Orders Related to Drought (Excerpts in quotes from *New Mexico Drought Plan: 2018* pages 3-4)

“Term of Governor Gary Johnson (1995-2002)

Executive Order 1998-041

In October 1998, Governor Gary Johnson directed New Mexico to create a drought plan. The Governor described the behavior of drought in New Mexico as normal and periodic, triggering natural disturbances that negatively impact agricultural production and quality of the land, air, biomass, and water. These issues are difficult to respond to as drought evolves slowly, which presents challenges for efficient response.

This Order declared New Mexico to be in a state of drought whenever the continuation of rising temperatures and decreasing amounts of precipitation and snowpack prolong the dry conditions and harm surface water availability. The DTF was established to review and edit the drought plan that had been drafted by the New Mexico Office of the State Engineer (NMOSE). State agencies were directed to identify specific vulnerabilities within their jurisdictions to

provide mitigation strategies to the DTF. Agencies were also asked to make recommendations to the Governor on how to respond efficiently to drought. Governor Johnson encouraged individuals to identify drought vulnerabilities within their communities and take conservation actions when possible.

Executive Order 2002-019

In April 2002, an Executive Order was issued by Governor Johnson in response to a drought that intensified during the dry winter of 2001-2002. At that time, reservoirs were at their lowest points in two decades, and the snowmelt runoff forecast was one of the five lowest in the previous five decades. Drought conditions were expected to worsen, increasing fire danger and reducing stream runoff levels, potentially impacting compliance with the Endangered Species Act (ESA) and interstate compact deliveries.

Term of Governor Bill Richardson (2003-2010)

Executive Order 2003-019

In May 2003, Governor Bill Richardson declared an emergency drought condition for the state. Per Executive Order 2003-019, the extremely dry winters during the preceding seven years contributed to altered ecological regimes in which snowpack, runoff, streamflow, reservoir storage, and soil moisture were at their lowest levels since 1978.

The Order stated that the restoration of surface and subsurface flow to streams and reservoirs would take years of high precipitation. The Order outlined the purpose, tasks, and membership of the DTF. Additionally, the Order identified the need for funding assistance to alleviate the deterioration of natural resources and environmental conditions, and stated that the funds would be released by the Office of the Governor upon the recommendation of the DTF.

The Order directed the DTF to continuously examine and monitor statewide drought conditions and recommend appropriate response measures to be implemented to mitigate drought impacts. The DTF was chaired by the State Engineer and included cabinet secretaries from various state agencies.

Executive Order 2006-012

In March 2006, Governor Richardson once again declared a state of drought emergency in New Mexico, and directed state agencies to implement water-savings strategies and begin preparations to assist in drought relief efforts across the state. The Governor instructed the DTF to prepare recommendations on additional water conservation and drought mitigation strategies that could be implemented. He also ordered all executive branches of state government to apply for emergency funds to carry out the existing drought plan.

Executive Order 2009-025

In June 2009, Governor Richardson issued a disaster declaration for the state due to drought. The Order directed the New Mexico Department of Finance and Administration (NMDFA) to make emergency financial resources available, the New Mexico Department of Homeland Security and Emergency Management (NMDHSEM) to coordinate all drought responses and requests for assistance, and the New Mexico National Guard to provide military support to civil authorities as needed.

Term of Governor Susana Martinez (2011-2018)

Executive Order 2012-006

In May 2012, Governor Martinez declared New Mexico to be in an emergency state of drought and called for additional resources for mitigation due to its severity. This drought was compared to those of 1955 and 2011, then the driest years on record. The DTF was directed to continue to convene quarterly for two years to assess the impacts of drought severity on the state's resources and economy, and make recommendations to the governor of intermediate actions and long-term mitigation strategies that could help stabilize environmental and economic conditions. The Governor also ordered a review of the existing drought plan, and revision as necessary.

Executive Order 2018-031

In July 2018, Governor Martinez ordered the DTF to review and revise the drought plan with a focus on drought planning, mitigation, and response. Executive Order 2018-031 stated that as of July 11, 2018, New Mexico had received less than half of the average precipitation for the water year, resulting in record low snowpack and spring runoff. Drought impacts are described as being beyond the response capability of local communities."

Drought in the City of Roswell, NM

The City of Roswell serves a community of 48,422 people. The City of Roswell Utilities Department serves an area of approximately 29.9 square miles. The system serves at total of 20,347 accounts, of which 18,049 are residential connections and 2,298 are commercial connections. The COR system is supplied by 24 wells used for domestic demands and 11 wells available for providing irrigation water to the golf course, farmland, and some park lands. The domestic wells can provide between 800 and 2650 gpm according to current well statistics

The planning area has experienced a multi-year drought from 2018-present. As the population, business, and industry increases, the need to change water use practices has become more urgent. This plan will work in tandem with the Roswell's overall Water Conservation Plan. The Roswell Drought Contingency Plan will increase Roswell's water reliability and improve water management through conservation, expanded technologies, improved modeling capabilities.

Roswell's Drought Contingency Task Force (DCTF) was created on May 12, 2023 and held its first meeting on May 18, 2023.

Purpose of the Roswell Drought Contingency Plan (Based on the *New Mexico Drought Plan: 2018* p 1)

The purpose of this document, *Roswell Drought Contingency Plan: 2025* (RDCP), is to provide the City of Roswell with an updated approach to address drought as well as support and encourage water conservation to protect the population, cultural and natural resources through: a) synthesizing previous drought plan efforts and streamlining the content; b) making strategic adjustments to the previous conservation efforts; and c) laying a foundation for future collaborative improvements. To accomplish these objectives the RDCP:

- defines an updated drought operational framework to be followed in addressing drought and drought-related activities (Section IV)
- explains monitoring activities to identify drought status and triggers for the different stages of drought (Section V)
- describes impact and vulnerability assessment (Section VI)
- outlines the responses to drought based on triggers and impact conditions, identifies long- and short-term mitigation activities that can be implemented to prepare for drought and to minimize the impacts of future droughts (Section VII)
- identifies enforcement action that can be taken during a drought including communication with the public (Section VIII)
- acts as a catalyst for the creation and implementation of local drought planning and response efforts, including the drought plan update process (Section IX)
- includes a future work section describing potential work that is outside of the scope of this plan (Section X)

In designing the content of the RDCP, every effort was made to use existing partnerships and the input of various stakeholders from local agencies to provide feedback on the effectiveness of planned or implemented responses and mitigation measures.

The RDCP is intended to complement the ongoing water resource planning efforts of regional water planners. The New Mexico Regional Water Planning Guidelines and the New Mexico State Water Plan clearly identify drought planning as an important item of discussion in any water planning effort. It is anticipated that the measures and actions outlined in the RDCP will be incorporated into existing and future water planning efforts.

Summaries and web links have been used to streamline the contents of the plan. To allow access to The RDCP by the largest possible audience without the need for high document publication costs, the entire online document has been placed uploaded to the City of Roswell's website. In addition to hosting the RDCP, the website includes links to current drought conditions and updates by the Drought Monitoring Work Group (DMWG).

The RDCP should be considered a document to which continual review, evaluation, and revision must be made to reflect successes, failures, and changes.

Value of Drought Planning (Quoted text from *New Mexico Drought Plan: 2018* pages 5 & 6)

“Drought planning develops an integrated drought response system identifying vulnerabilities, impacts, and responses. Documenting initiatives and programs in a drought plan can improve the potential to obtain public financing.

In 1998, New Mexico initiated planning efforts to be more proactive and anticipate drought impacts. Those efforts...resulted in a comprehensive drought plan that addresses drought response and potential vulnerabilities in advance of drought.

New Mexico drought impacts can be severe and recovery can be challenging. Historically impacts have included:

- early and severe wildfire seasons
- adverse effects on agriculture
- loss of tourism resulting from reduced snowpack, streamflow's, and recreational opportunities
- low reservoir levels
- shortages in municipal water supplies
- reduce rangeland and forest health
- potential health problems for humans
- other meteorological, agricultural, hydrological, socioeconomic, and ecological consequences

This plan benefits drought assessment and response efforts in the city by developing an adaptive organizational infrastructure that improves systems monitoring as needs and impacts change, supporting collaboration among stakeholders, and integrating these efforts with policy experts and decision-makers. These components are further described in the subsequent sections.”

III. DEFINITION OF DROUGHT (Quoted text from *New Mexico Drought Plan: 2018* pages 6 & 7)

“Drought is a normal characteristic of the climate in New Mexico, and unlike most natural disasters, occurs slowly and persistently. Due to this, government response to drought has typically been slow and fragmented, with little focus on preparedness and mitigation.

Drought is a complex time-dependent physical process that can adversely impact regions on both the macro and micro scales. Drought is difficult to define succinctly, and there is no universally accepted definition. Drought has the following characteristics:

- unlike floods and other natural disasters, it is not a discrete event
- it is often the result of many complex factors, and may not have a well-defined beginning or end, and

- its impacts vary by geographic location and/or economic sector, making the definition of drought specific to each affected group or location.

Definitions of Drought

The most commonly used drought definitions are based on meteorological, agricultural, hydrological, socioeconomic, and ecological impacts.

Meteorological

Meteorological drought is a period of substantially reduced precipitation. It is commonly defined as an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatic average moisture supply.

Agricultural

Agricultural drought occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought commonly occurs after or during meteorological drought, but before hydrological drought. Agricultural drought can also adversely impact livestock and other dry-land agricultural operations.

Hydrological

Hydrological drought occurs when there are deficiencies in surface and subsurface water supplies. It is measured as reduced streamflow, snowpack, reservoir, and groundwater levels. A delay usually occurs between the lack of precipitation and later deficits observed in water measurements. Due to this, hydrological response tends to lag behind other drought indicators.

Socioeconomic

Socioeconomic drought occurs when physical water shortages affect the health, well-being, and quality of life of people, or when the water shortages adversely impact economic activity.

Ecological

Ecological drought occurs when there is a prolonged and widespread deficit in naturally available water supplies, creating stresses across ecosystems."

IV. OPERATIONAL FRAMEWORK (Quoted text from *New Mexico Drought Plan: 2018* p 7)

"This section documents the operational framework of the RDCP. It designates the individuals tasked with implementing the plan and includes steps to communicate the drought response actions to the public.

The operational framework, based on National Drought Mitigation Center (NDMC) planning guidelines, outlines the organizational structures and membership necessary to carry out the various aspects of the drought plan including:

- conducting drought monitoring
- developing an adaptive drought response system
- initiating mitigation actions
- updating the drought plan”

City of Roswell’s City Council (Text based on *New Mexico Drought Plan: 2018 p 9*)

The City of Roswell’s City Council (RCC) calls upon the DTF to provide drought updates and recommendations. The RCC has the final authority in declaring drought emergencies. The DTF shall, on a yearly basis and as needed, update Roswell City Council on drought conditions, status, and recommended actions.

Water Conservation Specialist (Text based on *New Mexico Drought Plan: 2018 p 9*)

The Water Conservation Specialist (WCS) will be the centralized point of contact for drought planning, coordination, and response efforts in the City. The primary role of the WCS will be to facilitate information sharing to the DTF, RCC, and the general public. This position will have the following responsibilities:

- provide regular updates to the DTF
- serve as a community liaison and information facilitator
- facilitate agency work groups and other community partnerships
- establish priorities and meeting schedules for the DTF
- engage with agencies and community drought groups to compile impacts and needs
- maintain RDCP continuity by serving as the point of contact for plan activity and updates

Drought Task Force (Quoted text from *New Mexico Drought Plan: 2018 p 9*)

“The DTF oversees the implementation of drought-preparedness activities in the (City of Roswell). Additionally, the DTF plays major roles in intergovernmental drought preparedness, response coordination, agency collaboration, and media information releases. The DTF is the singular official channel to the (RCC) for drought plan activities in the (City).... The DTF has submitted reports that review current and ongoing drought mitigation activities. This plan maintains the DTF’s roles, and schedules future meetings based on drought severity in the (City).”

The Drought Task Force (DTF) maintains, updates, and communicates the drought plan to support the planning process. The DTF will work with the WCS to summarize impact

assessments from various agencies, compile lists of drought impact specific to each agency, communicate drought plan activities to different audiences, and conduct other activities as directed. The DTF meets as needed in response to elevated drought stages and to address specific issues that require targeted action

DTF Members in 2023

Judy Stubbs	Residential Customer
Tom Jennings	Residential Customer
Rose Duran	Commercial Customer
Cameron Grimm	Commercial Customer
Aron Balok	Pecos Valley Artesian Conservancy District
Sean Benedict	Roswell Independent School District
Jonathan McGary	Supervising Ranger, Bottomless Lakes State Park (Ex Officio Member)
Cristina Arnold	City Councilor
Chantel Longway	Water Conservation Specialist (Staff Liason)

DTF Member in 2024 and Final

Judy Stubbs	Residential Customer
Tom Jennings	Residential Customer
Todd DeKay	Commercial Customer
Nathan Cobb	Commercial Customer
Aron Balok	Pecos Valley Artesian Conservancy District
Sean Benedict	Roswell Independent School District
Jonathan McGary	Supervising Ranger, Bottomless Lakes State Park (Ex Officio Member)
Darrell Johnson	City Councilor
Chantel Longway	Water Conservation Specialist (Staff Liaison)
Merideth Hildreth, AICP Planning & Zoning Administrator (Staff in Advisory Capacity)	

Drought Related Funding

A number of drought-related funding sources exist including, but not limited to:

- City of Roswell
Bureau of Reclamation (BOR)

V. COORDINATED DROUGHT MONITORING (Quoted text from *New Mexico Drought Plan: 2018 p 12 - 14*)

“Drought monitoring, assessing current conditions, and predicting future drought development are key to implementing and updating the (RDCP). The U.S. Drought Monitor (USDM) is used by the (DTF) to monitor drought in the (city). The USDM analyzes and maps...current drought conditions using five drought intensity categories. It is produced weekly through the joint efforts of the National Drought Mitigation Center (NDMC), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of Agriculture (USDA).”

In the City of Roswell, the DTF meets on a quarterly basis, to discuss current drought conditions that the USDM (Figure V.1 and V.2) provides. The DTF also tracks rainfall and seasonal; snow amounts using local weather stations, to predict such water accumulation in the aquifers.

U.S. Drought Monitor: New Mexico

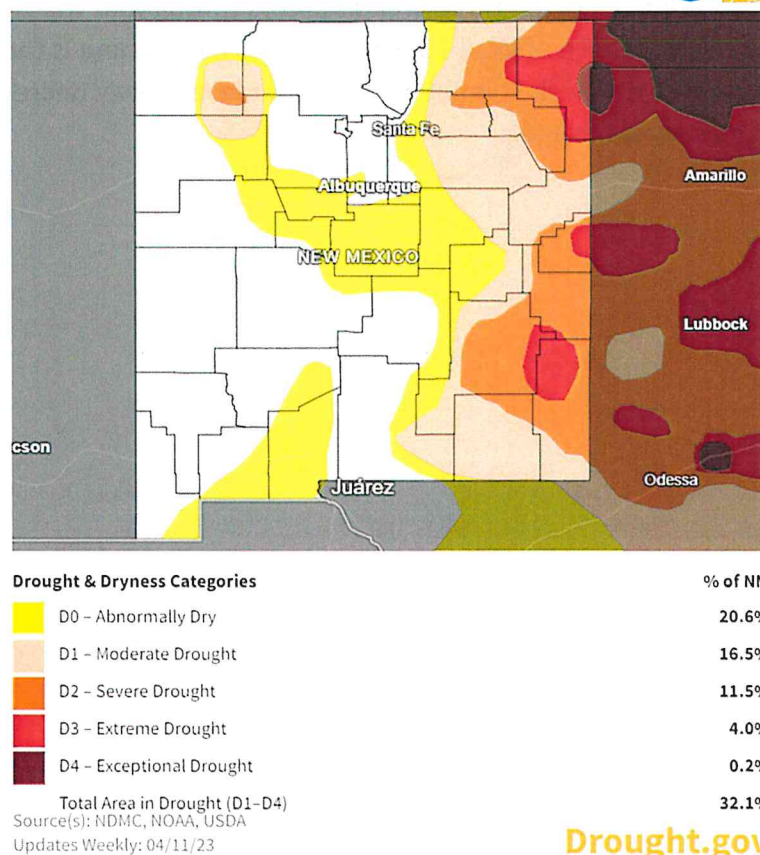


Figure V.1

(Source - *New Mexico Drought Plan: 2018 p 13*)

Week	Date	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	4/25/2023	0	100	87.87	58.05	8.58	0
Last Week	4/18/2023	0	100	87.87	58.05	8.58	0
3 Months Ago	1/24/2023	0	100	93.84	58.17	8.58	0
Start of Calendar Year	12/27/2022	0	100	84.8	58.17	8.58	0
Start of Water Year	9/27/2022	0	100	100	61.97	9.63	0
One Year Ago	4/26/2022	0	100	100	100	94.16	58.25

Figure V.2

“A network of data gathering sites, operated by various state and federal agencies, provide the most current climate, streamflow, and reservoir information for review by the (DTF). Data from these sites are reviewed as either raw data, or more refined indices of drought-related conditions. Additionally, field observations made by (DTF) participants are incorporated into the discussions. Any changes to the current city drought classifications are then recommended to the (RCC). The USDM is an analysis of drought conditions and does not include any forecast information.”

The City of Roswell purchased and installed three well monitors throughout the city. Below is a photograph depicting the recharge rate of Well 18 (Figure V.3). The blue line is the water level and the red line is the bottom of the well. This shows the water level slowly decreasing over the summer of 2024 and the high-water usage.



Figure V.3

VI. IMPACT AND VULNERABILITY ASSESSMENT (Quoted text from New Mexico Drought Plan: 2018 pages 14-15)

“Vulnerabilities are increased susceptibilities to drought impacts, and are understood by identifying and assessing impacts (UNCCD, 2016). Drought impacts are the consequences of physical drought, including but not limited to crop yield losses, reservoir depletions, and loss of vegetation in rangelands.

The first step in assessing vulnerability is an identification of the impact, which is a measure of the effects that have already occurred. The assessment of vulnerability determines the structure of underlying systems and identifies how the systems will be impacted by drought. Impact and vulnerability assessments provide the basis for drought response and mitigation planning.”

The DTF identified the following major vulnerabilities for the City of Roswell:

- Drought contributes to lower water table level that impact the agricultural economy when wells go dry
- Drought stress the urban forest causing distressed trees to die or become diseased throughout the municipal area. A distressed urban forest has an aesthetic and an economic impact. Mature trees store carbon and provide shade thereby reducing the heat island affect in urban environments. Removal of mature tree canopy increases heat captured and released in the urban environment and therefore increases ambient temperature.
- Increased fire risk due to accumulation of dry grass, weeds, and vegetation, possibly enhanced by dead and/or dying trees.
- Increased risk of negative wildlife encounters in the city due to lack of forage.
- Excess stress on athletic facilities, parks, school grounds, and private facilities, resulting in economic loss and reduced opportunity for children and adults to exercise and compete.
- Disadvantageous to the local economy in competition for tourist dollars, new move-ins, and economic development.
- The overall rising temperatures in this area contribute to public and animal health and well-being concerns such as dehydration. With record-breaking high nighttime temperatures, houses and bodies are unable to cool off at night. Source: Duke University Nicholas Institute for Energy, Environment & Sustainability (Heat Policy Innovation Hub).
- Drought conditions contribute to habitat degradation and loss for fish and wildlife. Roswell is surrounded by state and federal public lands which harbor threatened and endangered species.
- Increased expenditures for energy and air conditioning across the board for public and private entities and potential impacts to the energy grid.
- Increased use of water to produce energy for cooling. In 2012, The Department of Energy has initiated policy and established a Water-Energy Tech Team that published *The Water-Energy Nexus: Challenges and Opportunities*. Source: 2014 U.S. Department

of Energy The Water-Energy Nexus: Challenges and Opportunities Overview and Summary.

VII. TRIGGERS AND RESPONSE (Text based on *New Mexico Drought Plan: 2018* pages 16 & 17)

Triggers

The city of Roswell will use three drought phases: Drought Watch Stage, Emergency Drought Stage, and Exceptional Drought Stage. The city of Roswell will use a combination of Well Monitors via the Pecos Valley Artesian Conservancy District and Roswell Well Bubblers and the U.S Drought Monitor. The well monitors will use data from 1970 until further data is received from both well monitoring systems. The base line to be used is -120 from the 1970 data seen in Pecos Valley Artesian Conservancy District in **Figure VII.1**. This graph is a sobering snapshot showing the decline of the water table and reduced recharge rate over the past 50 years.

Figure VII.2, the USDM graph shows the drought conditions in New Mexico from 1969 to 1971, which was part of the 1931-1979 major drought in New Mexico that occurred in intervals throughout the years.

The triggers and restrictions are shown in **Figure VII.3**.

Figure VII.1

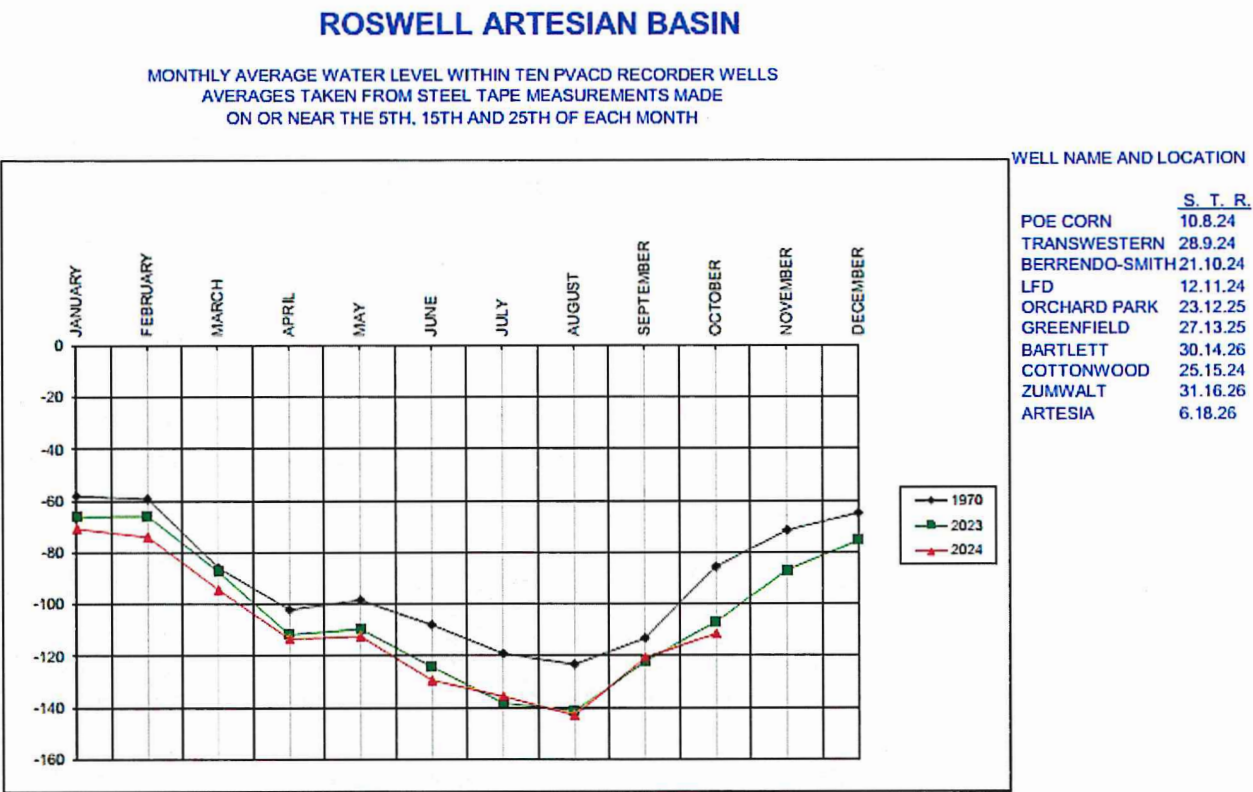


Figure VII.2

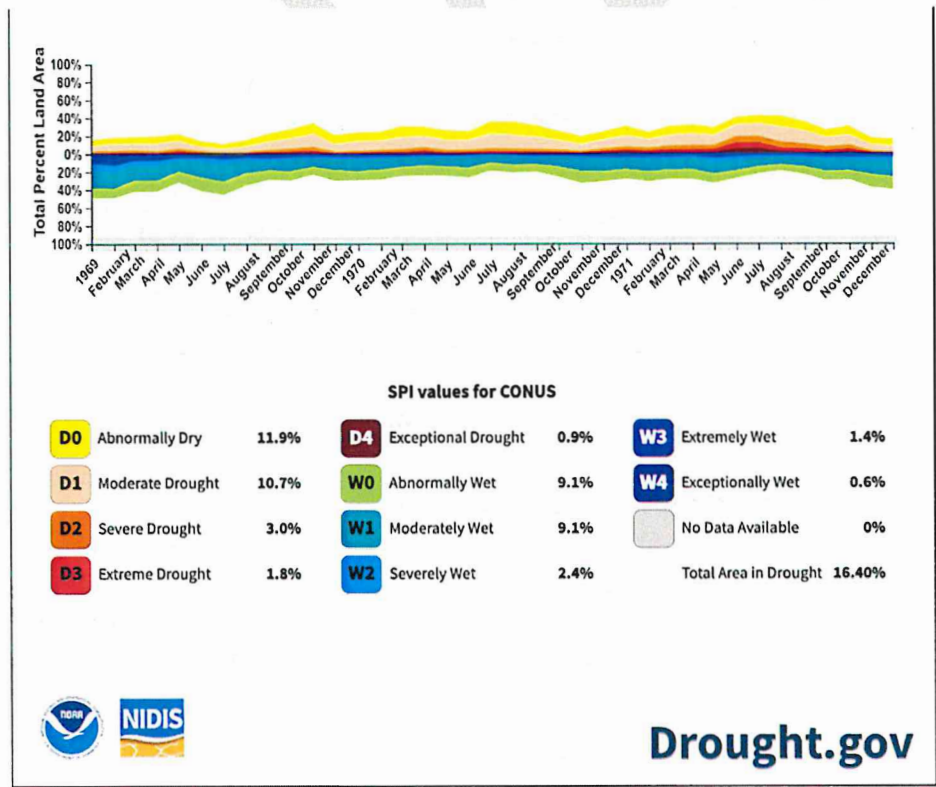


Figure VII.3 Three Triggers for Drought Response

(Framework for Table information based on *New Mexico Drought Plan: 2018* p 17)

Pre-Drought	Initiation	Pre-Stage is the continued observation of Water Conservation Ordinances throughout the year.
	Conditions	These are steps the city of Roswell's water supply is taking to help ensure the continued stability of our water resources.
	Termination	This stage is not entered into or out of; instead, it is a constant reminder to remain vigilant about water usage and conduct public education and water conservation activities.
	Restrictions	Enforce the rules and restrictions laid out in the City of Roswell Municipal Code Water Conservation Ordinance Chapter 26.

Drought Watch	Initiation	10 feet deviation of water level and a D3, D4, D5 drought severity via the U.S Drought Monitor
	Conditions	All Roswell Water customers shall be requested to reduce consumption through voluntary measures described in this stage.
	Termination	When water level is above the base line, the City of Roswell will return into the Pre-Drought Stage.
	Restrictions	Target: Achieve a voluntary 10% reduction in total gallons per capita per day (GPCD). Water Utility Measures: • Increase public education and outreach regarding water use reduction • Reduce landscape water consumption at all city facilities by 10% • Cease routine line flushing and testing • Cease routine fire hydrant flushing and testing • Increase targeted outreach to high consumption customers to urge water use reductions Voluntary Water Use Restrictions: • Request residential customers reduce consumption by 10% • Request all Industrial, Commercial, and Institutional customers reduce consumption by 10% Mandatory Water Use Restrictions:

		No outside watering between 10 am – 6 pm during the summer for all customers, with exemption request to be reviewed by WCS.
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Emergency Drought	Initiation	15 feet deviation of water level and a D4 or D5 drought severity via the U.S Drought Monitor
	Conditions	All customers shall be required to comply with the requirements and mandatory restrictions on certain non-essential water uses provided in this stage.
	Termination	When water level is above the -130 base line, the City of Roswell will return into the Drought Watch Stage.
	Restrictions	Target: Achieve a 15% reduction goal in total GPCD. Water Utility Measures: - Increase public education and outreach regarding water use reduction - Facilities landscape watering shall be reduced to 2 days a week - Cease routine line flushing and testing - Cease routine fire hydrant flushing and testing - Increase targeted outreach to high consumption customers to urge water use reductions Mandatory Water Use Restrictions: - Splash pads are prohibited to be in use - All customers are required to reduce non-essential water consumption by 15% - Landscape watering limited to 2 days a week - No at home washing of cars, trailers, or trucks - No draining or filling pools (except to maintain levels for filter function) - Restaurants may only serve water upon request - No use of ornamental fountains - Businesses that derive 75% of their income from watered plants (such as nurseries) shall be exempt from watering restrictions - The City of Roswell may also authorize additional personnel to issue notices of violation to enforce the Water Conservation Ordinance and the Drought Contingency Plan as well as increase public education and outreach regarding water use reduction.

		No outside watering between 10 am – 6 pm during the summer for all outside water consumers. <table><tr><th>Property Type</th><th>Twice Per Week Schedule</th></tr><tr><td>Residential – EVEN</td><td>Tuesday/Saturday</td></tr><tr><td>Residential – ODD</td><td>Wednesday/Sunday</td></tr><tr><td>Commercial/Multifamily</td><td>Tuesday/Friday</td></tr><tr><td>Schools/Parks</td><td>Monday/Thursday</td></tr></table>	Property Type	Twice Per Week Schedule	Residential – EVEN	Tuesday/Saturday	Residential – ODD	Wednesday/Sunday	Commercial/Multifamily	Tuesday/Friday	Schools/Parks	Monday/Thursday
Property Type	Twice Per Week Schedule											
Residential – EVEN	Tuesday/Saturday											
Residential – ODD	Wednesday/Sunday											
Commercial/Multifamily	Tuesday/Friday											
Schools/Parks	Monday/Thursday											

Exceptional Drought	Initiation	20 feet deviation of water level and a D4 or D5 drought severity via the U.S Drought Monitor
	Conditions	All customers shall be required to comply with the requirements and mandatory restrictions on certain non-essential water uses provided in this stage.
	Termination	When water level is above the -135 base line, the City of Roswell will return into the Drought Emergency.
	Restrictions	Target: Reduce water consumption goal will be determined by the City of Roswell based upon the nature of the emergency to increase Roswell Aquifers replenishment. Mandatory Water Use Restrictions: All requirements of previous stages shall remain in effect during the Emergency Stage, to also include: - Landscape irrigation is prohibited - Use of water to wash any vehicle or part of property is prohibited - Fines for violation of any of the aforementioned restrictions will triple while in the Emergency Stage - All previous restrictions are enforced

The RCC may declare the drought stage, upon being notified of conditions from the DTF. After such declaration, the conditions will continue to be monitored weekly to ensure descending into the lowest drought stage in an efficient and quick manner. The mayor may declare an emergency and implement a drought stage, after which the RCC shall met within five days to vote on the issue. The City Manager may enhance any drought stage restrictions subjected to Chapter 26: Water Conservation.

*Notification

Notification of the Public:

The Public Affairs Office or designee shall notify the public with voluntary actions requested or mandatory actions needed according to given drought stages by using any combination of the following:

- public service announcements (radio/TV)

- social media announcements
- news media (online/print)
- digital public service messages on public and private digital billboards, digital signs, and electronic message centers
- Continuous bill inserts showing the current water restriction until the water system is at a Pre-Drought Stage condition.
- Customer notification via mail

This notification shall take place within 48 hours and mandatory enforcement will begin within five business days since the first notification. This will allow customers to be informed of the drought stage via a broad range of notification systems and make arraignments to adhere to all restrictions.

Additional Notification:

The Utilities Director or designee shall directly notify the following individuals and entities:

- City Manager
- Mayor
- City and/or County Emergency Management Coordinator(s)
- Wholesale Customers
- Critical water users, i.e. hospitals
- Parks/street superintendents & public facilities managers

This notification shall take place within 24 hours and mandatory enforcement will begin within five business days since the first notification. This will allow customers to be informed of the drought stage via a broad range of notification systems and make arraignments to adhere to all restrictions.

Mitigation (Quoted text from *New Mexico Drought Plan: 2018* pages 20)

“In addition to planning for triggering emergency responses, mitigation planning helps communities and agencies proactively prepare for the next drought. For example, a mitigation strategy for (the City of Roswell) would be enhancing supply through aquifer recharge. Other mitigation strategy examples include demand management through reducing losses, reducing use, and employing economic incentives. The goal of mitigation planning is often defined as supporting communities to become resilient in the face of drought by reducing vulnerabilities to impacts in the underlying social, economic, and environmental systems. (Wilhite et al., 2014).”

The overall mitigation actions for drought management in Roswell are as follows:

Turf Management Education

Water Step Cost Education and Evaluation of a Person Using More than Average

Reduce Water Use

Outdoor Water Rotation

Reducing Watering days

Turf Removal

Enforcement

Abstract of Water Right Contracts

Outreach education on water and energy conservation through a coordinated public information and public service announcement communication guide and policy

Hold local and regional water conservation summits

Replace failing infrastructure

Encourage water reuse and recycling

Hold Fix a Leak Weeks (EPA)

Plan for, design, and fund water reclamation infrastructure such as "purple pipe" technologies to water public, institutional, and private vegetation, turf, golf courses, cemeteries, and recreational facilities

Draft and adopt Water wise vegetation and landscaping policies and ordinances

Use of Hydro Delta to detect water leaks in both public and private infrastructure through a satellite imagery system. Source: New Mexico Environment Department.

Use of tools and technologies such as NO-DES™ to filter water that would otherwise be wasted when flushing fire hydrants.

VIII. ENFORCEMENT ACTIONS

Division IV – Service: Water Conservation

Sec. 26-230 - Definitions.

All definitions contained in Section 26, Definitions, of Chapter 26 "Roswell Utility Ordinance" are incorporated into this chapter by reference.

Sec. 26-231 Purpose and Scope of Ordinances

This ordinance is intended to set forth the rules under which the City of Roswell provides services to the City's property owners and ratepayers with conservation efforts in mind and when mandatory restrictions are in place.

- A. The governing body finds and determines that encouraging and requiring the adoption of water conservation strategies is an effective and low cost means to balance water demands with limited available water supplies and production capabilities. The governing body further recognizes that as a consequence of implementing water conservation regulations, reduction in water use provides the following benefits to the city and its citizens:
- Potential for reduction of individual residential and commercial customers' water and sewer bills.
 - Serves as a critical interim source of supply while additional supply sources are being brought on line.
 - Reduces peak summer demands thereby reducing short and long-term system costs.
 - Enhances the local environment by minimizing transport of fertilizer, pesticide, and other contaminants from runoff to deep percolation to ground waters. Enhances the global environment by reducing energy consumption associated with water production, treatment, and distribution.
- B. It is hereby declared, because of the city's immediate and long-term limited water supplies and the overall benefits of water conservation, that the city promotes and require water use efficiency strategies for the public health, safety, and general welfare of its citizens.

Sec 26-232 - Water conservation compliance.

No person who uses water from the city water supply system, shall make, cause, use or permit the use of water received from Roswell Utilities for residential, commercial, industrial, agricultural, governmental or any other purposes in a manner contrary to any provisions of this chapter. Provided further, that no person shall make, cause, use or permit the use of water in a manner contrary to Chapter 26 of the city code.

Sec. 26-233 - Mandatory compliance—Lawn and landscape watering.

The following mandatory restrictions shall apply to all customers of, or persons who use or receive water from Roswell Utilities:

- A. All outdoor irrigation of grass, trees, plants or other vegetation on residential and commercial property shall not water more than three times a week between April 1st and September 30th, unless exempted due to new turf or reseeded.
- B. All outdoor irrigation of grass, trees, plants or other vegetation on industrial properties, parks, golf courses, schools and cemeteries shall not water more than three times a week between April 1st and September 30th, unless exempted due to new turf or reseeded.

- C. Outdoor irrigation of grass, trees, plants or other vegetation on City of Roswell parks (with such meter/account under the control and management of the City of Roswell Parks and Recreation Department) may be permitted for more than three days April 1st and September 30th, subject to the submission and approval of an annual Conservation Plan. The City of Roswell Parks and Recreation Department will submit the annual conservation plan to the City Manager by end-of-January each year. The plan will consist of:
- Conservation goals and targets; total annual water consumption, volume per developed acre, and any other agreed upon metric;
 - Conservation improvements implemented in prior year; improvements planned for year ahead,
 - Policy statement that any new city parks have been designed to irrigation efficiently; and
 - Special variances needed for the year (watering days, new parks, turf renovation, seeding, etc.).

The plan will be considered and approved on an annual basis with previous year compliance taken into account as part of the approval process. All outdoor irrigation shall be subject to the drought and water emergency management response plans adopted by City of Roswell.

- D. From April 1st to September 30th, all outdoor irrigation of vegetation is prohibited between the hours of ten a.m. and six p.m.
- E. The City of Roswell shall have the authority to review special situations and hardship cases upon application of any person.

Sec. 26-234 - Nonessential water use restrictions.

The following restrictions shall apply to all customers of or persons who use or receive water from the City of Roswell:

- A. The washing of vehicles
1. Automobiles, trucks, trailers, boats, airplanes and other types of mobile equipment shall be done only with a hand-held bucket or a hand-held hose equipped with a shut-off nozzle that completely shuts off the flow of water, even if left unattended. This restriction does not apply to the washing of the above-listed vehicles or mobile equipment when conducted on the premises of a commercial car wash or a commercial service station. When used in this chapter, "bucket" means a bucket or other container holding five gallons or less;
 2. The washing of automobiles, trucks, trailers, boats, and other types of mobile equipment for fund-raising purposes must be conducted at a commercial car wash.

3. Prior to connection of water service to any commercial car wash issued building permits for construction after June 1, 2025, a certification shall be provided to Roswell Utilities that the car wash uses no more than fifty gallons of water per vehicle washed. Absent such certification, no water service will be provided.
- B. The following uses of water are defined as "wasting water" and are absolutely prohibited:
1. Irrigating any turf grass, tree, plant, or other vegetation, or otherwise utilizing the city water supply system to permit or cause water to pond, or to flow, spray or otherwise move or be discharged from the premises of any person responsible for any property within the corporate limits of the city, or which receives water from Roswell Utilities to or upon any street, alley, gutter or ditch, or other public right-of-way, or into a storm water drainage system or facility;
 2. Failing to repair a leak to be used in conjunction with **Sec. 26-162 Notification.**
 3. Washing sidewalks, driveways, parking areas, tennis courts, patios or other impervious surface areas with a hose, except in emergencies to remove spills of hazardous materials or to eliminate dangerous conditions which threaten the public health, safety, or welfare. "Impervious surface area" means any structure, street, driveway, sidewalk, patio or other surface area covered with brick, paving, tile or other impervious or nonporous material.
- C. When referred to in this subsection, "swimming pool" shall mean any portable or permanent structure containing a body of water twenty-four inches or more in depth and containing one thousand one hundred twenty-two gallons or more of water and intended for recreational purposes, including a wading pool. All swimming pools, which are constructed after the effective date of the ordinance codified in this chapter, must be equipped with filtration, pumping and recirculation systems. All existing swimming pools not equipped with such shall, within five years of the effective date of this chapter, shall be converted to filtration, pumping and recirculation systems, unless the City of Roswell, grants such a variance or extension of time.
1. It is unlawful to drain swimming pools into the street, alley, gutter or other public right-of-way, ditch, or storm water drainage system or facility. Swimming pools may be drained into the sanitary sewer system only in coordination with the Roswell Water Utilities' Wastewater System Division.
 2. New or replacement bleeder lines from evaporative coolers shall not be larger than one eighth-inch inside diameter. Bleeder lines shall be conducted outside and discharged so that the effluent can be used for water landscaping and other outdoor vegetation, except where this would be impractical or unfeasible.

3. No person shall use water for non-residential single pass cooling or heating purposes unless the water is reused for other purposes. "Single pass cooling or heating" means the use of water without recirculation to increase or decrease the temperature of equipment, a stored liquid or a confined airspace.

Sec. 26-235 - Declaring of nuisance of exist.

The flow of produced water from property into streets, alleys, gutters, and other public rights-of-way, ditches, or into a stormwater drainage system or facility is contrary to the public health, safety and welfare of the citizens of Roswell and is therefore declared to be a nuisance. This authorization to seek relief, or other legal action to abate such a nuisance shall not preclude prosecution for a violation of this chapter.

Sec. 26-236 - Penalty.

Any person who violates any of the provisions of this chapter shall be deemed guilty and a fine imposed of the following:

- \$0, warning first offence in 30 days
- \$75, second offence in 30 days
- \$150, third offence in 30 days
- \$250, fourth offence in 30 days
- Termination of water service, fifth offence in 30 days

The customer will receive a copy. The enforcement will be tracked by the Water Conservation Specialist, who keep a copy and submit the original to Water billing. Water billing will retain the original infraction and make a note in the billing system.

Sec. 26-237 - Variances and permits.

- A. Owners of newly seeded or sodded turf grass and landscaping and new residential and commercial developments may receive a landscape watering permit upon application and approval by the City of Roswell allowing for daily watering of the same until the turf grass and landscaping are established, which shall not exceed thirty days.
- B. The planning and Zoning Department, Utilities Director, and City Manager, or his designee, shall be immediately established as a review board to review hardship and special cases which cannot fully comply with the provisions of this chapter. The review board will review hardship or special cases to determine whether a particular case warrants a variance or permit and shall hear appeals from any person. The review board shall consider the facts of each case separately and decide whether to grant a variance or permit within ten working days of the receipt of a properly completed "Application for Variance/Permit" form. A variance shall be granted only for reasons of economic hardship, medical hardship, or if there is a legitimate public health or safety concern that will be promoted or fulfilled as a result of granting the permit or variance.

- An "economic hardship" is defined as a threat to an individual's or business' primary source of income, and where not granting the variance would result in material structural damage to the person's property. Examples are as follows:
 - i. Tree or plant farm
- A "medical hardship" is defined as a situation where it is determined that a person's ill health or medical condition requires a dependency upon others to water or irrigate. Examples are as follows:
 - i. A doctors note for asthmatics and/or respiratory issues, to which letting a yard turn into dirt for lack of water will increase the irritates inside the residence. In turn increasing the number of "attacks" to the lungs and puts the person at risk.

Under no circumstances shall inconvenience or the potential for damages of landscaping be considered an economic hardship or significant damage to property which justifies a variance. Any special water uses restrictions authorized by the review board in each hardship or special case shall be set forth on the face of the variance or the permit. A fee of fifty dollars shall be assessed per application to defray administrative costs. The fee may be waived upon the execution of an affidavit stating that applicant for the variance is unable to pay the fee and such affidavit shall be sworn before a notary public. Final determination of an applicant's inability to pay shall be made by the City Manager.

- C. A variance or permit issued under this section expires under its own terms and conditions, but in no event shall a variance or permit be issued for a period of more than five years from the date of issuance. Any person issued a variance or permit must fully comply with all the provisions of this chapter as an express condition of that person's variance or permit.

Any person who is issued a variance or permit and uses water supplied or delivered by the Roswell Utilities shall provide proof of such variance or permit upon demand by any person authorized to enforce this chapter. Upon conviction of violating any provision of this chapter, the review board may revoke or suspend any permit or variance previously granted. Provided, however, the review board shall notify the permittee of the proposed revocation five working days before taking such action, and if within that time the permittee requests a hearing in writing, the permittee shall be given an opportunity to be heard by the review board prior to taking such action.

Sec. 26-238- Appeal

- A. Any person who applies for a permit or variance under Section 26-237 or and is denied such permit or variance by the review board, or whose permit or variance is revoked or suspended by the review board, or issued a monetary fee Section 26- 236, may appeal the decision. Any person(s) filing an intention to appeal in writing with the City Manager within five working days of the review board's decision. If a proper appeal is timely filed,

the public service board will hear the appeal within thirty days of the time the appeal is filed with the City Manager. The public service board may take any action it deems necessary with regard to the appeal including denying same, granting same, or granting the requested permit or variance with conditions, or suspending the imposed fee. The decision of the review board shall be final and binding if there is no timely filing of an appeal in accordance with this section.

- B. Any person, whose appeal to the public service board is denied, may appeal the decision of the public service board by filing an intention to appeal in writing with the city clerk within five working days of the public service board's decision. If a proper appeal is timely filed, the city council will hear the appeal within thirty days of the time the appeal is filed with the city clerk. The city council may take any action it deems necessary with regard to the appeal including denying same, granting same or granting the requested permit or variance with conditions, or suspending the imposed fee. The decision of the city council shall be final and binding. The decision of the public service board shall be final and binding if there is no timely filing of an appeal in accordance with this section.

Sec. 26-239 - Other enforcement action.

Nothing contained in Section 26-236, or any other provision of this chapter, shall prevent the city from seeking compliance with or enforcement of this chapter.

Sec. 26-240 - Exceptions to enforcement.

The following shall constitute exceptions from compliance with the provisions of this chapter:

- A. The water is a result of natural events such as rain or snow;
- B. The flow is a result of temporary failures or malfunctions of the water supply system;
- C. The flow is a result of water used for firefighting purposes including the inspection and pressure testing of fire hydrants or the use of water for firefighting training activities;
- D. The use of water is required for the control of dust or the compaction of soil;
- E. The water is used to wash down areas where flammable or otherwise hazardous material has been spilled and creates a dangerous condition;
- F. The water is used to prevent or abate public health, safety or accident hazards when alternate methods are not available;
- G. The water is used for routine inspection or maintenance of the water supply system;
- H. The water is used to facilitate construction within public right-of-way in accordance with the requirements of the city and good construction practices;
- I. The use of water is permitted under the terms of a variance, permit or compliance agreement granted by the review board
- J. The water that is used for street sweeping, sewer maintenance or other established utility and public works practices;

- K. Watering contrary to the even/odd watering requirements, under Sections 26-233, may be permissible for one day only where application of chemicals requires immediate watering to preserve an existing lawn. In cases of commercial application, a receipt from a commercial lawn treatment company indicating the date of treatment, the address of the property treated, the name and address of the commercial contractor, and the chemical treatment required shall constitute evidence that the owner or person responsible for the property is entitled to this exception. Where treatment with a noncommercial application of chemicals requires immediate watering to preserve an existing lawn, the owner or person responsible for the property must contact the Water Conservation Specialist prior to the application of chemicals and provide evidence satisfactory to the Utilities Director for approval of this exception;
- L. Outdoor irrigation necessary for the establishment of newly seeded or sodded turf grass and landscaping in new residential and commercial developments;
- M. Plants which cannot be kept alive without daily watering may be permitted to be watered from a bucket but not from the use of a hose on the days when watering is prohibited.

Sec 26-241 - Water emergency—Restriction of water use.

The City Manager may implement the following additional restrictions and regulations curtailing water use upon the declaration of a water emergency by the mayor:

- A. Prohibit all restaurants from serving water to their customers except when specifically requested by the customer;
- B. Prohibit the operation of any ornamental fountain or similar structure;
- C. Suspend the issuance of all variances or permits hereunder;
- D. Prohibit the filling, refilling or adding of water to all swimming pools;
- E. Prohibit the washing of all vehicles and equipment except upon the premises of a commercial car wash;

The mayor may declare a water emergency in case of a severe drought, in the event of any condition which interrupts the ability of the Roswell Utilities to supply water, where curtailment of the use of water is necessary due to war, a natural disaster, to protect the public health, safety or welfare, or to preserve the water supply. In the event such water emergency is to continue for more than five days, such measures must be passed by resolution by majority of city council in order for the declaration of emergency to continue beyond the initial five-day period. During such a water emergency, the City Manager may impose any additional restrictions on the use of water from the city's water supply system in all or in any part of the city as the city council may authorize.

Sec 26-242 - Drought and water emergency management response plan.

It shall be unlawful to violate the imposed provisions of the drought and water emergency management response plan, dated April 2025, after the declaration of a drought or water emergency and imposition of restrictions in accordance with the plan.

IX. DROUGHT PLAN UPDATE PROCESS (Quoted text from *New Mexico*

Drought Plan: 2018 p 29)

“There are not any previously established guidelines for drought contingency plan content and updates. Moving forward, the drought contingency plan should be updated every five years for the purpose of keeping the document current.” After drought emergencies, the DTF and WCS shall meet and evaluate the current plan and make proposed modifications to the RCC.

X. FUTURE WORK

Water Conservation

The City of Roswell has adopted the following goals for the water conservation program:

- Reduce nonrevenue water to below 10% by 2024
- Track billed vs. produced water more closely
- Reduce outdoor water use by 30%
- Reduce water waste
- Reduce peak summer demands for more efficient system operation and reduced energy use
- Reduce pumping and treatment costs
- Educate the public about water conservation
- Increase the water audit data validity score from 67 to 80 by 2024

To see the full City of Roswell Water Conservation Plan, go to the provided link

<https://www.roswell-nm.gov/DocumentCenter/View/20084/Water-Conservation-Plan---Dec-2021?bidId=>.

The Water Conservation Plan is to be used with the Communication and Outreach Plan developed by the DTF to educate the community stakeholders in conserving water and fixing unchecked leaks.

Performance Measures

To ensure the RDCP is effective, performance metrics should be used to track positive change. The following is a list of performance metrics:

- A survey can be submitted to customers to gauge their perception of current drought conditions
- Track monthly GPCD in relation to how many active connects are currently used. This will give the average GPCD for consumers. This can be breaking down by commercial, city, and residential use.
- Quarterly track the number of leaks the city repairs, to ensure the line replacement plan is effective at reducing water loss.

XI. REFERENCES

Duke University Nicholas Institute for Energy, Environment & Sustainability (Heat Policy Innovation Hub). <https://nicholasinstitute.duke.edu/project/heat-policy-innovation-hub>

Fix a Leak Week. U.S. Environmental Protection Agency. <https://www.epa.gov/watersense/fix-leak-week>

Hydro Delta. New Mexico Environment Department. <https://www.env.nm.gov/hydro-delta/>

New Mexico Drought Plan: 2018. New Mexico Office of the State Engineer and New Mexico Water Resources Research Institute.
https://api.realfile.rtsclients.com/PublicFiles/5f809ddfc9864dad89f9d03375144a14/e4330c9e-dc1b-4177-9f86-2d5135ec050f/NMDP_2018_01092019_Final.pdf

NO-DES™ System. <https://www.hydrologics.com/>

Roswell, New Mexico – Code of Ordinances, Chapter 26: Water, Sewers and Sewage Disposal
https://library.municode.com/nm/roswell/codes/code_of_ordinances?nodeId=COOR_CH26WASESED

Roswell Water Conservation Plan (2021). Roswell Utilities Department - Roswell Water Maintenance <https://www.roswell-nm.gov/DocumentCenter/View/20084/Water-Conservation-Plan---Dec-2021?bidId=>

The Water-Energy Nexus: Challenges and Opportunities (2014). U.S. Department of Energy.
<https://www.energy.gov/sites/prod/files/2014/07/f17/Water%20Energy%20Nexus%20Full%20Report%20July%202014.pdf>

UNCCD. 2016. Drought: reducing impacts and building resilience. Knowledge Hub. Retrieved from <https://knowledge.unccd.int/topics/drought-reducing-impacts-and-building-resilience>

XII. APPENDICES