# *Upper Platte River*
# *Drought Contingency Plan*

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# Acronyms and Abbreviations

| | |
|---|---|
| °F | degrees Fahrenheit |
| AF | acre-foot/feet |
| Basin Plan | *Second Increment (2019–2029) Basin-Wide Plan for Joint Integrated Water Resources Management of Overappropriated Portions of the Platte River Basin, Nebraska* |
| BOR | United States Bureau of Reclamation |
| CDC | Centers for Disease Control and Prevention |
| CMOR | Condition Monitoring Observer Report |
| CNPPID | Central Nebraska Public Power and Irrigation District |
| Coalition | Platte Basin Coalition |
| COHYST | Platte River Cooperative Hydrology Study |
| CPC | Climate Prediction Center |
| CPNRD | Central Platte Natural Resources District |
| Crop-CASMA | Crop Condition and Soil Moisture Analytics |
| CRP | Conservation Reserve Program |
| CSD | Conservation and Survey Division |
| CWA | Federal Clean Water Act |
| DEWS | Drought Early Warning System |
| Drought Plan | *Upper Platte River Drought Contingency Plan* |
| Department | [Nebraska] Department of Water, Energy, and Environment |
| EAP | Emergency Action Plan |
| EDDI | Evaporative Demand Drought Index |
| EPA | United States Environmental Protection Agency |
| ET or $ET_p$ | Evapotranspiration |
| FSA | Farm Service Agency |
| GC | Governance Committee |
| GWMP | Groundwater Management Plan |
| HEFS | Hydrologic Ensemble Forecast Service |
| IMP | Integrated Management Plan |
| INSIGHT | Integrated Network of Scientific Information and GeoHydrologic Tools |
| LB | Legislative Bill |
| LFP | Livestock Forage Disaster Program |

| | |
|---|---|
| LPD | Loup Power District |
| MAF | Million Acre-Feet |
| MRB | Missouri River Basin |
| MBRFC | Missouri Basin River Forecast Center |
| MW | Megawatt(s) |
| NARD | Nebraska Association of Resource Districts |
| NASS | National Agriculture Statistical Service |
| N-CORPE | Nebraska Cooperative Republican Platte Enhancement |
| NDHHS | Nebraska Department of Health and Human Services |
| NDWEE | Nebraska Department of Water, Energy, and Environment |
| NDMC | National Drought Mitigation Center |
| NeDNR | Nebraska Department of Natural Resources |
| NEMA | Nebraska Emergency Management Agency |
| NGPC | Nebraska Game and Parks Commission |
| NHPRCC | Nebraska High Plains Regional Climate Center |
| NIDIS | National Integrated Drought Information System |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDC | North Platte Decree Committee |
| NPNRD | North Platte Natural Resources District |
| NPPD | Nebraska Public Power District |
| NRCS | Natural Resources Conservation Service |
| NRD | Natural Resources District |
| NWS | National Weather Service |
| P | Precipitation |
| PDSI | Palmer Drought Severity Index |
| PIO | Public Information Office |
| POAC | Platte Overappropriated Area Committee |
| PRRIP | Platte River Recovery Implementation Program |
| SAFE | State Acres for Wildlife Enhancement |
| SNOTEL | Snow Telemetry [NRCS Program] |
| SPC | Storm Prediction Center |
| SPEI | Standard Precipitation Evaporation Index |
| SPI | Standard Precipitation Index |
| SPNRD | South Platte Natural Resources District |
| SRA | State Recreation Areas |

| | |
|---|---|
| STAR WARS | Statewide Tourism and Recreational Water Access and Resource Sustainability |
| SWE | Snow Water Equivalent |
| T | Temperature |
| Task Force | Drought Planning Task Force |
| T&E | Threatened and/or Endangered |
| TBNRD | Tri-Basin Natural Resources District |
| TPNRD | Twin Platte Natural Resources District |
| UNL | University of Nebraska-Lincoln |
| UPRB | Upper Platte River Basin |
| USDA | United States Department of Agriculture |
| USDM | United States Drought Monitor |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| WDP | Water Data Program |
| WMA | Wildlife Management Area |
| WWUM | Western Water Use Model |

## Preface

During the timeframe for which this current version of the Upper Platte River Drought Contingency Plan was developed, the Nebraska Department of Natural Resources (NeDNR) was merged into the Department of Environment and Energy, creating a single agency called the Nebraska Department of Water, Energy, and Environment (NDWEE). To avoid confusion, this document will refer to both as "**the Department**" (NeDNR prior to July 1, 2025; NDWEE thereafter).[1]

## 1.0 Introduction and Plan Implementation

The Platte Basin Coalition (Coalition) is an Interlocal Cooperative Agreement pursuant to Neb. Rev. Stat. Section 13-804, which consists of five Natural Resources Districts (NRDs) in the Upper Platte River Basin (UPRB) and the Department. The five UPRB NRDs include the Central Platte NRD (CPNRD), Tri-Basin NRD (TBNRD), Twin Platte NRD (TPNRD), South Platte NRD (SPNRD), and North Platte NRD (NPNRD). The Coalition recognizes the interrelation of water resources within the UPRB and has committed to sustaining the long-term balance between water uses and water supplies throughout the UPRB.

In September 2019, the Department and the UPRB NRDs adopted the *Second Increment (2019–2029) Basin-Wide Plan for Joint Integrated Water Resources Management of Overappropriated Portions of the Platte River Basin, Nebraska* (Basin Plan). The Basin Plan sets a framework for collaboration of each NRD's Integrated Management Plan (IMP) to ensure coordinated management of the hydrologically connected surface water and groundwater supplies. The primary goal of the Basin Plan is to mitigate the effect of water uses initiated after July 1, 1997, on stream baseflows and interconnected groundwater supplies. The Basin Plan recommends the development and implementation of a drought contingency plan as part of the continuing efforts to balance water supplies and demands by addressing shortages caused by short-term and long-term drought conditions.

The Coalition received a WaterSMART Planning Grant in 2022 from the United States Bureau of Reclamation (BOR) to develop a drought contingency plan for the UPRB in Nebraska. This Upper Platte River Drought Contingency Plan (Drought Plan) was developed following the guidelines of BOR's drought plan development process (Guidance Regarding the Drought Contingency Planning Process – Appendix A 2019) and is intended to address action items of the *Basin Plan*, particularly Action Item 1.3.4, which states:

> *"The Basin drought contingency plan is part of the continuing efforts to reach fully appropriated conditions by addressing those shortages caused by short- and long-term drought conditions. The* [drought] *contingency plan discussed herein is to be completed within the first 3 to 5 years of this increment and address conditions under a basin-wide or regional drought condition, not a local (county or NRD level) drought condition.*

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1 2025 Neb. Laws, LB 317, passed on May 6, 2025, provides that on or after July 1, 2025, the Department of Natural Resources shall be merged into the Department of Environment and Energy, which shall be renamed the Department of Water, Energy, and Environment and that the Director of Natural Resources shall be renamed the Chief Water Officer of the Department of Water, Energy, and Environment and shall retain authorities previously prescribed for the administration of duties of the Department of Natural Resources, except as otherwise provided by law.

*The Basin drought contingency plan will focus on vulnerabilities identified through coordination with Basin water users in Action Item 1.3.1, and developing a monitoring and communication protocol for consistency across the Basin. The Basin drought contingency plan will serve as a guide for plans to be developed by each individual NRD as a part of this action item. District-level mitigation measures and response actions corresponding to the drought conditions will be identified and implemented at the individual NRD level. Elements of a drought contingency plan include:*

1. *Vulnerabilities (Action Item 1.3.1)*
2. *Monitoring Protocols (Basin-Wide Plan)*
3. *Triggers (individual NRD plans)*[2]
4. *Mitigation Actions (individual NRD plans – potentially basin-wide activities)*
5. *Response Actions (individual NRD plans - potentially basin-wide activities)*
6. *Plan administration (individual NRD plans and Basin-Wide Plan)"*

Table 1 identifies the required elements of the BOR WaterSMART agreement and the associated actions in the Basin Plan and documents where each are addressed in this Drought Plan.

**Table 1. Upper Platte River Drought Contingency Plan Requirements**

| | BOR WaterSMART Agreement | Upper Platte Basin-Wide Plan | Location in Drought Plan |
|---|---|---|---|
| **Plan Administration, Implementation, and Updates** | **5.2.5 Operational and Administrative Framework:** identify who is responsible for undertaking the actions necessary to implement each element of the drought contingency plan, including communicating with the public about those actions. The framework should identify roles, responsibilities, and procedures necessary to: conduct drought monitoring; initiate response actions; initiate mitigation actions; update the Drought Plan.<br><br>**5.2.6 Plan Development and Update Process:** describe the process to develop the plan, including how stakeholders were engaged and how input was considered, and the process and schedule for monitoring, evaluating, and updating the plan. | **Action Item 1.3.4.4:** Identify roles for administering and implementing the Basin Drought Contingency Plan.<br><br>The administration of the Basin Drought Contingency Plan requires defining specific roles and responsibilities for monitoring, communication, and implementation activities at the Basin level. In addition, protocols for updating the plan need to be developed for inclusion in the plan administration. | **Section 3.0**<br><br>(p.31-34) |

[2] This *Drought Plan*, as a condition of the WaterSMART grant, must include basin-wide triggers. Additionally, this *Drought Plan* includes subarea water supply triggers.

| | BOR WaterSMART Agreement | Upper Platte Basin-Wide Plan | Location in Drought Plan |
|---|---|---|---|
| **Vulnerability Assessment** | **5.2.2 Vulnerability Assessment:** evaluation of the risks to critical resources within the planning area and the factors contributing to those risks. Assessments will drive the development of potential mitigation and response actions. | **From Action Item 1.3.4:** Elements of a drought contingency plan include: Vulnerabilities (Action Item 1.3.1).<br>**Action Item 1.3.1:** Understand the economic impacts of supply variability on water users. Through the planning process conducted for the second increment, extensive discussion centered on vulnerabilities of stakeholders to the variable water supply. The action items related to this objective are geared toward developing a fundamental and quantitative understanding of the economic impacts on Basin water users from variability in water supply.<br>**1.3.1.1:** Identify who is affected (hydrologically and economically), and to what extent, by water supply variability.<br>**1.3.1.2:** Partner with impacted water users and other entities to gather data and study economic impacts of supply variability as well as regulatory and management actions. | **Section 4.0**<br>(p.34-51) |
| **Drought Monitoring** | **5.2.1 Drought Monitoring:** process for monitoring near- and long-term water availability and a framework for predicting probability of future droughts or confirming an existing drought. | **Action Item 1.3.4.1:** Develop a Basin drought monitoring protocol for defining and determining drought conditions.<br>This effort will focus on defining the severity of drought conditions (including identifying trigger points that will be linked to response actions) and determining the protocols for monitoring drought conditions at a basin level. The result of this effort is intended to be consistency in communicating drought conditions to users across the Basin. | **Section 5.0**<br>(p. 56-81) |

| | BOR WaterSMART Agreement | Upper Platte Basin-Wide Plan | Location in Drought Plan |
|---|---|---|---|
| **Mitigation and Response Actions** | **5.2.3 Mitigation Actions:** identify, evaluate, and prioritize mitigation actions and activities that will build long-term resiliency to drought and mitigate the risks posed by drought.<br>**5.2.4 Response Actions:** identify, evaluate, and prioritize response actions and activities that can be implemented during drought to decrease the severity of drought impacts. | **Action Item 1.3.4.2:** Identify potential Basin-wide mitigation and response actions to drought conditions and opportunities for cooperation across the Basin (for example, management of storage water).<br>Each NRD will develop individual drought contingency plans. The NRD drought plans will include mitigation and response actions specific to each NRD. The responsibility for implementation of those activities will lie with each NRD. | **Section 6.0**<br>(p.83-106) |

## 1.1 Plan Purpose

The focus of this first phase of the Basin-wide Drought Plan is to establish a framework for coordination and communication among Coalition members to address droughts in the UPRB. The purpose of the Drought Plan is to document a collective understanding of drought vulnerabilities and to identify monitoring and forecasting tools, new mitigation strategies, and response actions to create a sound operational framework. The Drought Plan will also serve as a framework and "menu of options" for each UPRB NRD to select from while developing their individual drought plans. The individual NRD drought plans will contain more information about individual mitigation and response implementation activities for each NRD.

As described in the Basin Plan, the time frame to implement the Basin-wide Drought Plan and individual NRD drought plans is 10 years, spanning from the effective date of the Basin Plan to no later than September 11, 2029. The individual drought plans will be appended to the Basin-wide Drought Plan, at which time the Basin-wide Drought Plan will be considered complete.

This Basin-wide Drought Plan supplements the current authorities and activities of the Coalition members and is not intended to replace or duplicate efforts (e.g., NRDs address water conservation through their individual groundwater management plans). With the framework established by this Basin-wide Drought Plan, Coalition members will continue to evaluate monitoring and communication protocols, mitigation measures, and response actions and will revise the Drought Plan as necessary.

## 1.2 Plan Implementation

The Coalition currently convenes on a regular basis throughout the year—typically every 2 months—with an annual meeting in the summer. This Drought Plan and drought conditions will be a standing agenda item for these meetings. The Coalition will coordinate drought mitigation measures as they are initiated and implemented throughout the year.

Unless otherwise noted, responsibilities of the Department shall be implemented by the Water Planning Division Manager and other Water Planning staff as assigned. Responsibilities of the NRDs shall be implemented each NRD's General Manager and other NRD staff as assigned. Responsibilities of the Coalition shall be agreed upon by each party's voting member.

### 1.2.1 Drought Monitoring

Numerous drought monitoring indicators were considered during the development of this Drought Plan based on their effectiveness at forecasting or determining the onset of drought conditions and impacts. Additionally, the Coalition reviewed and selected several surface water supply indicators to supplement drought monitoring, as surface water supply issues may persist after other drought indices return to normal or may occur entirely separate from other drought conditions.

The Coalition has determined that some indicators best represent the forecast or existing drought conditions on a Basin-wide level or reflect existing or forecast water supplies within applicable subareas (Figure 2).

Table 2 provides a summary of the drought monitoring roles and responsibilities of each Coalition member.

**Table 2. Drought Monitoring Roles/Responsibilities**

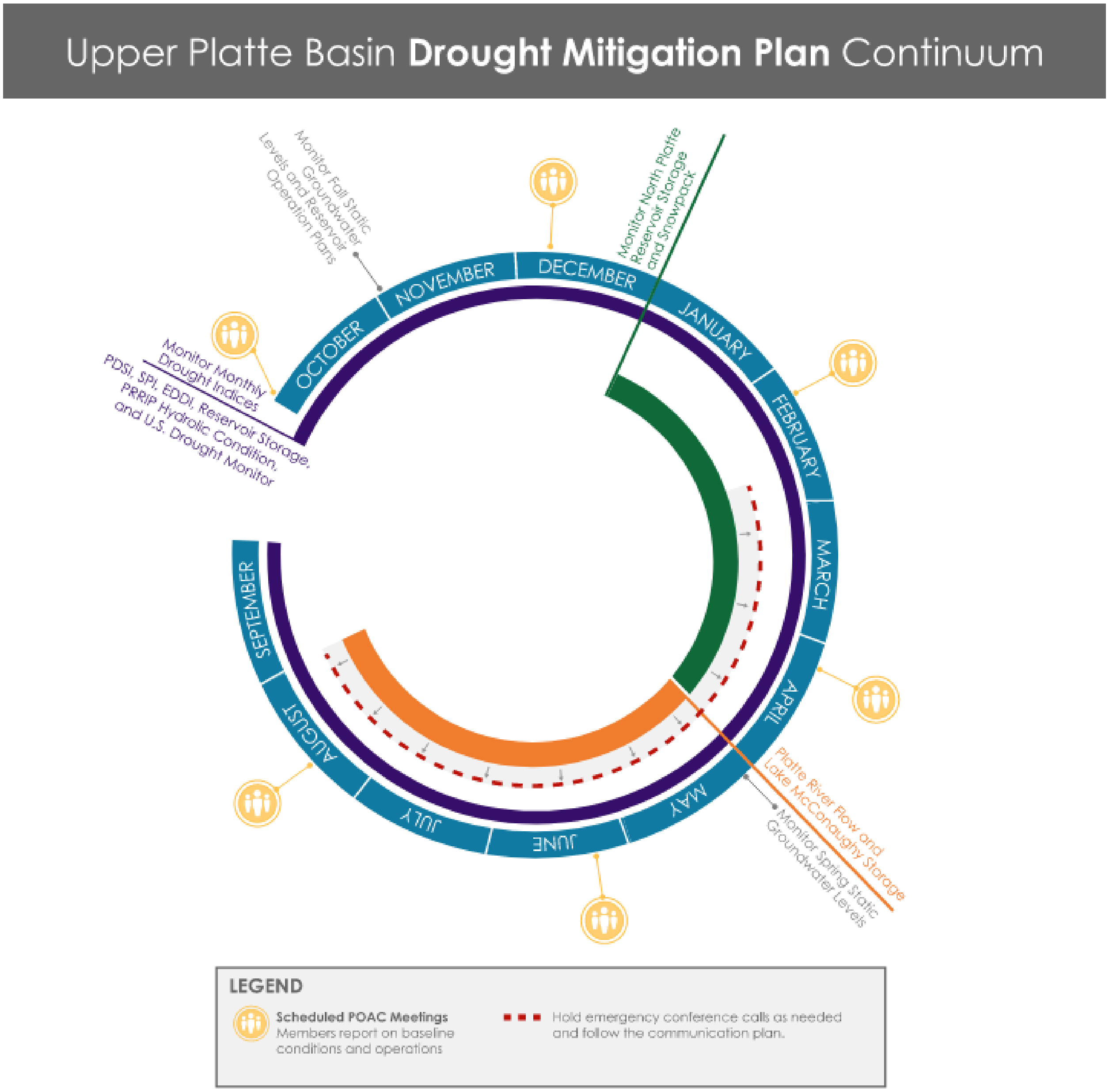
| Drought Monitoring Element | Coalition Member | Contact |
|---|---|---|
| Drought Dashboard Website Hosting/Maintenance | The Department | Water Planning Division Manager |
| Drought Indices EDDI/PDSI/ SPI/SPEI | The Department | Water Planning Division Manager |
| Streamflow | The Department | Water Planning Division Manager |
| Snowpack/Reservoir levels | The Department | Water Planning Division Manager |
| Groundwater levels | Each NRD in accordance with their groundwater management plans | NRDs' General Managers |
| Allocation status | Each NRD with allocations in place for its users and monitoring producer status relative to allowable allocation | NRDs' General Managers |
| Notification drought triggers reached | The Department will notify Coalition members when drought triggers have been reached.<br>Coalition will initiate response actions according to drought level. | Water Planning Division Manager |

EDDI = Evaporative Demand Drought Index; PDSI = Palmer Drought Severity Index; SPEI = Standard Precipitation Evaporation Index; SPI = Standard Precipitation Index; USDM = United States Drought Monitor

#### 1.2.1.1 Indices for Drought Monitoring

The relative significance of drought indicators varies seasonally. When evaluating drought conditions, more weight should be given to indicators with increased significance at the time of the evaluation. The seasonal times to observe monitoring data are highlighted in Figure 1. Reporting and review of drought conditions is scheduled to occur at bimonthly meetings throughout the year as indicated in Figure 1.

**Figure 1. Drought Monitoring Continuum**




Notices of "Drought Advisory" and "Drought Alert" are based on relationships between drought indices and indicators as described in Section 5.0 of this plan. A "Drought Advisory" indicates that conditions are favorable for a drought to start or worsen. Table 3 lists Drought Advisory conditions. Higher Evaporative Demand Drought Index (EDDI) values lead to quicker drying if precipitation decreases and indicates the potential for a severe drought to develop quickly. This was the case for the 2012 drought. The prior years were normal to above-normal conditions but had very high EDDI conditions. When precipitation dwindled, conditions quickly worsened into a severe single-year drought.

Drought Alerts will be issued when there is high confidence that drought impacts will occur, are occurring, or have occurred. Table 3 lists triggers for Drought Alert conditions. One type of alert during the growing season is when dryland crop yields are likely to significantly decrease. Some drought indices during summer become high confidence predictors of yield declines. Drought Alert triggers were selected to provide a response to drought conditions both within the UPRB and upstream.

The USDM was selected as a trigger because it is widely relied upon by the agricultural industry and it displays drought data at various geographic scales (watershed, regional, state, county, and local). The drought dashboard will measure and report the percentage of the UPRB and each subarea reporting D0, D1, D2, D3, and D4 drought conditions. Those percentages will be used to determine if the Advisory or Alert triggers reported in Table 3 are being met or exceeded.

**Table 3. Drought Advisory and Alert Triggers**

| Drought Indicator | Advisory Trigger | Alert Trigger | Applicable Areas |
|---|---|---|---|
| United States Drought Monitor (USDM) | D0+D1 > 75% area<br>OR<br>D1 > 50% area | D2 or worse > 50% area | Basin-wide and all subareas |
| Evaporative Demand Drought Index (EDDI) (1-month) | ED0+ED1 > 75% area<br>OR<br>ED1 > 50% area | ED2 or worse > 50% area | Basin-wide and all subareas |

### 1.2.1.2 Surface Water Supply Monitoring

Data that best indicate forecast or current water supplies were selected for specific subareas of the UPRB as shown in Figure 2. The subareas include the North Platte River drainage upstream of Lake McConaughy, the South Platte River drainage upstream of the confluence at North Platte, Nebraska, and the remaining drainage area from Lake McConaughy and the South and North Platte River confluence downstream to the Loup River and Platte River confluence. For this reason, spring and summer Drought Alert triggers include reservoir storage levels and the effect of hydrologic conditions on the Platte River. The surface water supply triggers are listed in Table 4.

**Figure 2. Surface Water Supply Monitoring Subareas**

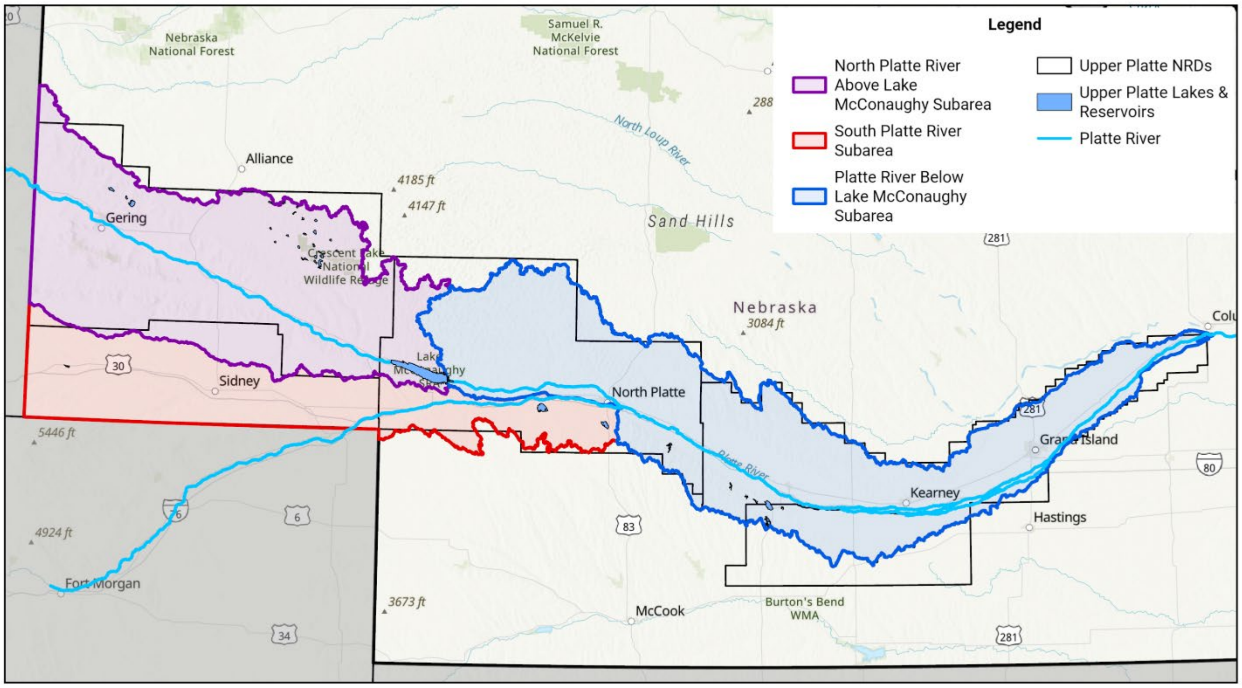



**Table 4. Surface Water Supply Subarea Advisory and Alert Conditions**

| Water Supply Indicator | Advisory Trigger | Alert Trigger | Applicable Areas |
|---|---|---|---|
| South Platte River streamflow at Julesburg | N/A | Mean daily discharge < 120 cfs (April 1 through October 15) | South Platte River to the North Platte River Confluence |
| BOR Forecast North Platte Supply | Forecast supply < 1.1 MAF (October, February, March) | Forecast supply < 1.1 MAF (April, May, June) | North Platte River above Lake McConaughy |
| Lake McConaughy Storage | <70% of average monthly storage (1991–2020 average) | <60% of average monthly storage (1991–2020 average) | Lake McConaughy to the Loup River Confluence |

BOR = Bureau of Reclamation; cfs = cubic feet per second; MAF = Million Acre-Feet; N/A = Not Applicable

The drought monitoring data selected for triggers in Table 3 and Table 4 are described in more detail in Section 5.0. Drought monitoring data not selected for triggers but selected as supplemental data for decision-making when triggers are met are described in Section 5.4.

The Department, on behalf of the Coalition, will maintain a public drought monitoring dashboard. The dashboard will automate drought data collection and display trigger statuses for the Basin and for each subarea. Once available, the dashboard link will be available on the Department's website and shared with stakeholders.

Drought response actions by the Coalition will vary between Drought Advisory and Drought Alert triggers. The procedures and roles for providing public information and outreach are outlined Communication and Outreach Plan in Section 1.2.2. The historical relevance of drought monitoring triggers and the past occurrences when a drought alert would have been issued are documented in Appendix A.

### 1.2.2 Communication and Outreach Plan

It is important that the Coalition maintains a relationship with basin water users and serves as a resource to those users. The Coalition has identified the following communication and outreach activities as priorities for building and maintaining relationships with basin stakeholders before, during, and after drought.

Generally, during a Drought Advisory, the Coalition will increase the frequency of internal communication and coordination. Some external public communication actions will take place to encourage the public to use and learn about the online drought dashboard. During a Drought Alert, more robust public communications will be implemented to provide public information about ongoing drought conditions, potential impacts, and potential actions that may reduce the severity of impacts.

#### 1.2.2.1 Year-Round Efforts

The Department, on behalf of the Coalition, will maintain the project website to update interested stakeholders on Drought Plan implementation activities. Additionally, the Department shall maintain a public drought monitoring dashboard. The purpose of the dashboard is to automate drought monitoring and trigger status determinations throughout the UPRB and for each water supply subarea. The dashboard will also be a "one-stop shop" for hydrologic data in the UPRB (i.e. will provide data on snowpack and other elements to be tracked and stored). The dashboard link will be available on the project website and shared with stakeholders.

The Platte Overappropriated Area Committee (POAC)[3] will include an agenda item to discuss drought conditions and plan implementation activities at each regularly scheduled meeting. Topics shall include, but not be limited to, the following:

- Current drought and water supply conditions, including triggers and supplemental monitoring;
- Ongoing and planned mitigation and/or response activities;
- Internal (within POAC) communication needs; and
- Education and outreach needs.

When Drought Advisory or Drought Alert conditions are met, POAC will discuss the necessary frequency of internal communications, including email updates. POAC will develop messaging as part of Drought Plan implementation.

#### 1.2.2.2 Stakeholder Engagement

The Coalition will present updates on drought conditions in the UPRB and Drought Plan implementation activities at the annual Basin-wide meeting. The Coalition shall include interested Drought Plan stakeholders in the annual Basin-wide meeting invitation list.

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[3] POAC is the administrative arm of the Coalition. It is a collaboration among the UPRB NRDs and the Department to review IMP activities while the Coalition is the public facing/funding arm, responsible for maintaining a budget and adopting policies and procedures.

Stakeholders will be able to provide feedback on Drought Plan implementation during the public comment portion of the annual meeting.

The Coalition will also promote Condition Monitoring Observer Reports (CMORs), a nationwide public resource for reporting drought-related conditions and impacts, as an opportunity for stakeholder engagement. CMORs are used as supporting evidence in the development of the weekly United States Drought Monitor (USDM). People are encouraged to submit CMORs year-round to capture wet, dry, and normal conditions. The USDM is used by the United States Department of Agriculture (USDA) to trigger disaster declarations and eligibility for low-interest loans and assistance programs. By providing regular reports, stakeholders can highlight the impacts of drought within the UPRB and help improve the accuracy of the USDM maps. CMOR is available on the University of Nebraska-Lincoln's (UNL) Drought Impacts Toolkit website at https://droughtimpacts.unl.edu/tools/conditionmonitoringobservations.aspx. The CMOR website also provides customizable outreach language for recruiting CMOR participants at https://droughtimpacts.unl.edu/tools/ConditionMonitoringObservations/Recruit.aspx.

#### 1.2.2.3 Public Education and Outreach

Drought preparedness education will occur during times of no drought and Drought Advisory conditions. The Department's Public Information Office (PIO) and the NRDs' Information and Education staff will collaborate to identify outreach opportunities (conferences, events, etc.) and implement outreach strategies during Drought Plan implementation. NRDs will collaborate with UNL Extension to connect producers to existing resources and develop new outreach materials as desired. Educational opportunities and materials to be considered include, but are not limited to, booths at conferences, activities at educational events, flyers, newsletters, podcasts, and social media posts.

When Drought Advisory or Drought Alert conditions are met, POAC will discuss public communication strategies and methods. Public communication should include descriptions of how POAC members are responding to drought conditions, how the public can become involved in drought response, and where to find additional information. POAC shall apply the following process for developing outreach:

1. Assess triggers:
    - What is the current drought status of the Basin and each water supply subarea?
2. Review supplemental data:
    - What are the primary impacts?
3. Determine audience:
    - Who is being impacted (or at the risk of being impacted)?
4. Determine partners/collaborators (as needed):
    - Who is the best entity to engage with the target audience? (such as Nebraska Association of Resource Districts [NARD], UNL, other State agencies, Farm Bureau, etc.)
5. Determine message:
    - What does the audience need to know?
    - What messaging already exists that could be promoted?
6. Determine media:

- What is the best way to reach the target audience?

7. Finalize and publish message.

POAC will develop standard language and templates as part of Drought Plan implementation. Types of communication to consider include press releases, articles or stories on local news outlets, and social media posts. Communication templates shall include POAC-approved language while allowing each entity to customize details to their area and audience. Table 5 summarizes the communication plan.

**Table 5. Communication Plan Summary**

| Drought Conditions | Internal (POAC) Communications | Public Education and Outreach Activities |
|---|---|---|
| No Drought | • POAC meetings will discuss the need for any additional internal communications.<br>• Gather data from stakeholders (other than dashboard information). | • Promote the drought monitoring dashboard.<br>• Education campaign (via existing NRD or UNL education events, email blasts, newsletters, etc.).<br>• Promote CMOR. |
| Drought Advisory | • Email monitoring reports sent by the Department.<br>• Teleconferences as needed.<br>• Share and review ongoing drought mitigation actions and potential response actions. | • Social media posts pointing to dashboard for reference.<br>• Updates on local NRD websites regarding conditions in their area.<br>• Promote CMOR.<br>• Implement outreach process (as needed). |
| Drought Alert | • Each member prepares/updates communication tree of municipalities, emergency managers (county officials) and emergency responders (fire departments).<br>• Develop/update shared messaging. | • Promote CMOR.<br>• Coordinate with local emergency managers, responders, and rural fire departments.<br>• Implement outreach process. |

CMOR = Condition Monitoring Observer Report; NRD = Natural Resources District; POAC = Platte Overappropriated Area Committee; UNL = University of Nebraska-Lincoln

#### 1.2.2.4 Drought Emergency Communication

Extended periods of drought may result in elevated fire risk. Each NRD shall prepare for this risk by developing and maintaining resources for collaborating with local emergency managers and responders. These resources shall include, but not be limited to, the following:

A contact list of county emergency managers, responders, and rural fire departments;

A list of active emergency action plans and ongoing management activities; and

A list of ready and available wells for rural fire departments to utilize for firefighting.

Each NRD shall keep these resources up to date to ensure seamless coordination during wildfire events, as summarized in Table 5.

### 1.2.3 Additional Mitigation and Response Actions

The Communication Plan described in Section 1.2.2 is the only mitigation and response action required as part of this increment of the Drought Plan. However, the Department and NRDs may collectively or individually decide to implement additional mitigation or response actions and incorporate them into their own plans. Table 6 describes additional mitigation and response actions considered as part of the development of the Drought Plan and are available as a "menu of options" for the Coalition NRDs in development of their individual drought plans.

**Table 6. Drought Mitigation and Response Actions by Type Considered in this Plan**

| Action | Vulnerability Addressed | Type (Mitigation, Response, or Both) | Priority | Trigger (Response) | Primary Implementation Responsibility |
|---|---|---|---|---|---|
| ***Water Supply Actions: Increase availability of groundwater and streamflow supplies, including, but not limited to, hydropower, and irrigation*** | | | | | |
| Enhance Surface Water Storage and Delivery | Groundwater and streamflow supplies | Mitigation | High | — | Both |
| Groundwater recharge projects | Groundwater and streamflow supplies | Mitigation | High | — | NRDs in coordination with the Department |
| Irrigation efficiency and water use monitoring | Groundwater and streamflow supplies | Mitigation | High | — | NRDs in coordination with the Department |
| Promote use of surface water/conjunctive management | Surface water irrigation/conjunctive management, groundwater and streamflow supplies, crop yield reduction | Mitigation | High | — | Both |
| Coordinate and support development of emergency action plans for water shortage (communities/municipalities) | Decreased source water quantity, fire/emergency threats | Mitigation | Medium | — | NRDs |
| ***Drought-Resilient Agriculture: Decrease the demand for groundwater and streamflow supplies*** | | | | | |
| Promote crop variety and seed spacing | Crop yield reduction | Response/Both | Medium | Drought Advisory (fall/winter) | NRDs |
| Livestock protection, shade, and water | Livestock feed/water shortage | Response | Medium | Drought Alert | NRDs |
| Irrigation scheduling | Groundwater/aquifer depletion | Response | High | Drought Alert | NRDs |
| Erosion conservation measures | Erosion, soil health | Mitigation | High | — | NRDs |
| ***Drought Resilient Habitat Projects: Ecosystem function/biodiversity, habitat, ecotourism, and recreation*** | | | | | |
| Promote drought-resilient habitat | Ecosystem function/biodiversity, Threatened and Endangered (T&E) species critical habitat | Mitigation | Medium | — | Department |
| Promote riparian buffer zones | Terrestrial and aquatic habitat, surface water quality | Mitigation | Medium | — | NRDs |
| Controlled (prescribed) burns | Fire threat | Mitigation | High | — | NRDs |
| Lake dredging and aquatic habitat restoration | Aquatic restoration, ecotourism | Mitigation | Medium | — | NRDs; Department coordination |
| Watershed water quality management | Aquatic recreation, game/fish disease, ecotourism | Mitigation | Low | — | Both (NRDs and the Department) |
| Drought-resilient recreational facilities | Aquatic recreation, ecotourism | Mitigation | Medium | — | Department |
| Promote awareness of fish and game regulations during drought | Game/fish disease, aquatic recreation, upland game | Response | Medium | Drought Alert | Department coordination with Nebraska Game and Parks Commission |
| ***Outreach Activities*** | | | | | |
| Promote available drought-related financial assistance | Public services, economic development | Response | Medium | Drought Alert | Both |
| Promote lawn irrigation efficiency, scheduling, and reduction | Decreased source water quantity | Response | Medium | Drought Advisory | NRDs/Both |
| ***Emergency Response Activities*** | | | | | |
| Water supply for rural fire departments/districts | Power infrastructure stress and maintenance | Mitigation | Medium | — | NRDs |

| Action | Vulnerability Addressed | Type (Mitigation, Response, or Both) | Priority | Trigger (Response) | Primary Implementation Responsibility |
|---|---|---|---|---|---|
| Emergency potable water | Fire/emergency threats, public health (drinking water) | Response | Low | Drought Alert | NRDs |
| Promote wildfire suppression and fire weather awareness | Fire threat/impact | Response | Medium | Drought Alert | Both |
| Promote air quality monitoring | Public health | Response | Low | Drought Advisory and Drought Alert | Department |
| ***Additional Monitoring Activities*** | | | | | |
| Groundwater quantity and quality monitoring | Decreased source water quantity and quality, public health (drinking water) | Both | High | Drought Advisory and Drought Alert | NRDs |
| Municipal infrastructure monitoring and maintenance | Decreased source water quantity, infrastructure stress and maintenance | Mitigation | High | — | NRDs |

# 2.0 Background and Basin Information

## 2.1 Legal/Administrative Framework

### 2.1.1 North Platte Decree

To resolve a dispute among Nebraska, Wyoming, Colorado, and the United States (which operates federal dams and reservoirs) over water rights to the North Platte River, the United States Supreme Court issued a decree in 1945 imposing restrictions on storage and diversion by Colorado and Wyoming; establishing priorities among federal reservoirs and certain Nebraska canals; and apportioning 75 percent of the natural flow of the river's so-called "pivotal reach" during the irrigation season to Nebraska and 25 percent to Wyoming (*Nebraska v. Wyoming*, 325 U.S. 589). This case arose due to the over appropriation of the North Platte River for irrigation purposes, leading to significant water shortages in Nebraska.

Nebraska petitioned to reopen proceedings in 1986. (*Nebraska v. Wyoming*, 483 U.S. 1002). A Special Master was appointed and submitted three interim reports to the Supreme Court between 1989 and 1995. The Supreme Court issued opinions in 1993 and 1995 following the second and third interim reports and those opinions established the framework for the Final Settlement Stipulation, which the parties agreed to and entered a Modified Decree in 2001.

The settlement agreed upon specified and secure upstream irrigated acreage and consumptive use rights for Wyoming in exchange for more far-reaching and more comprehensive injunctions protecting Nebraska from uses exceeding Wyoming's specified entitlements. The settlement includes Wyoming's hydrologically connected groundwater pumping into the settlement on par with other irrigation sources.

Claims asserted by Wyoming and Nebraska against the United States were resolved by agreements to make substantial adjustments in BOR storage water contracting and deliveries. Those changes included a new regime for allocating storage water between two States' contractors during periods of shortage. To settlement also established the North Platte Decree Committee (NPDC), which assists the parties in decree administration.

#### 2.1.1.1 Platte River Recovery Implementation Program (PRRIP)

In 1997, the governors of Nebraska, Colorado, and Wyoming and the Secretary of the Interior (the Signatories) entered into a Cooperative Agreement to address the needs of four target Threatened or Endangered (T&E) species[4] using the Platte River system. Between 1997 and 2006, the Signatories negotiated and authorized the First Increment of the PRRIP for 13 years, from 2007 to 2019. In 2019, the Signatories enacted a First Increment Extension through December 31, 2032. The PRRIP is led by a Governance Committee (GC) consisting of representatives of Colorado, Wyoming, Nebraska, BOR, the United States Fish and Wildlife Service (USFWS), South Platte River water users, upstream (North Platte River) water users, downstream water users, and environmental groups.

The long-term goal of the PRRIP is to maintain and enhance the associated habitats, which includes the following:

---

[4] The four T&E species are the least tern, piping plover, whooping crane, and pallid sturgeon.

1. Improving and maintaining migration habitat for whooping cranes and reproductive habitat for least terns and piping plovers;
2. Reducing the likelihood of other species found in the area being listed under the Endangered Species Act; and
3. Testing the assumption that managing water flow in the central Platte River also improves the pallid sturgeon's Lower Platte River habitat.

The PRRIP's objective is to use incentive-based water projects to provide sufficient water to and through the central Platte River habitat area to assist in improving and maintaining habitat for the target species. During the First Increment, the PRRIP focus was on retiming and improving flows to reduce target flow shortages by an average of 130,000 to 150,000 acre-feet per year. During the First Increment Extension, the PRRIP will reduce target flow shortages by an average of 120,000 acre-feet per year while studying the feasibility and necessity of acquiring an additional 10,000 acre-feet per year.

Flow retiming is accomplished in part by releases from the Environmental Account in Lake McConaughy. The Environmental Account is a portion of the water stored in Lake McConaughy that is set aside and managed by USFWS for the benefit of the target species. Other actions include revised operations of other water systems; general retiming of Platte River system water projects and other project management actions; and implementation of new water supply and conservation projects in the UPRB. Success of the PRRIP relies on implementation of agreed-upon New Depletions Plans in Colorado, Wyoming, and Nebraska and by the federal government in accordance with the PRRIP goal of offsetting new depletions to the Platte River that occurred after July 1997 (PRRIP 2018).

#### 2.1.1.2 LB 962

The Nebraska Legislature passed Nebraska Legislative Bill 962 (LB 962) on July 16, 2004, to address conflicts between surface water and groundwater users and to provide a framework for joint management of water resources. As required under LB 962, the Department must evaluate the expected long-term availability of hydrologically connected water supplies each year to meet both existing and new surface water and groundwater uses for each river basin in the state.

Under *Nebraska Revised Statute* Section 46-713(3), a basin is considered fully appropriated when certain conditions for hydrologically connected surface water and groundwater are met, namely the following:

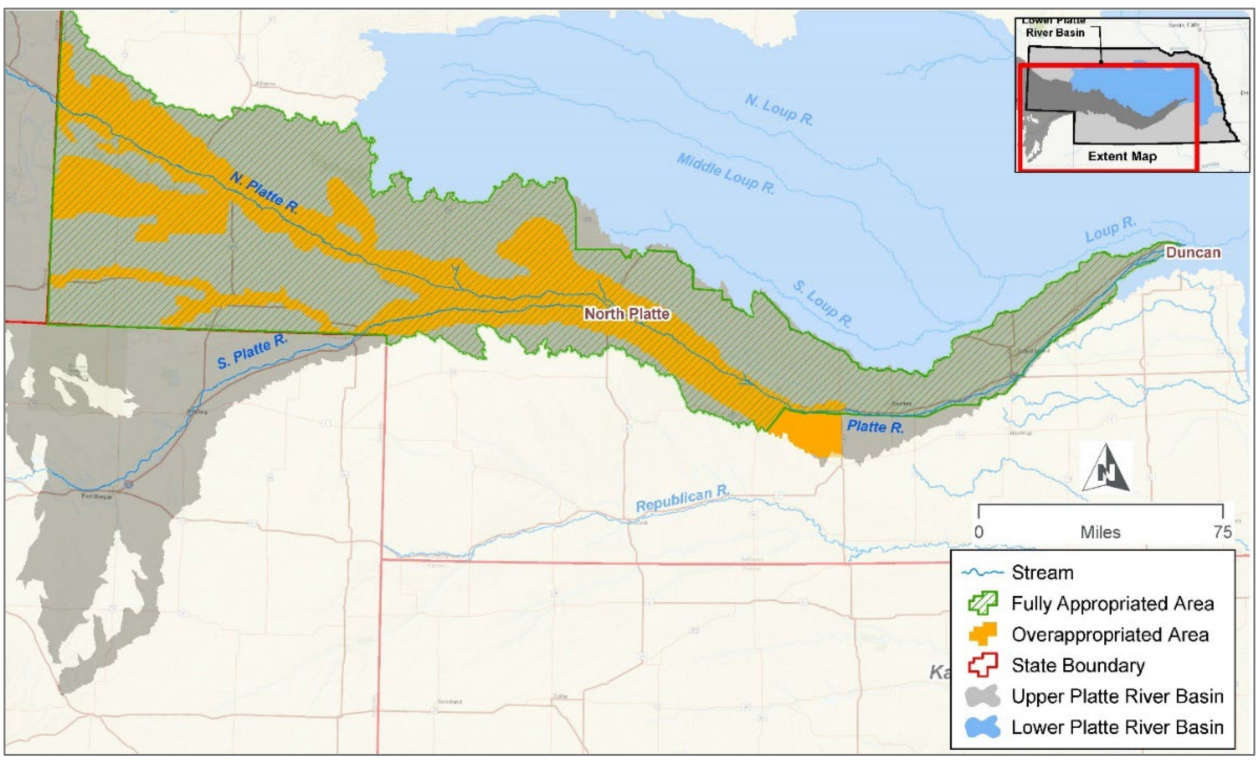
> [When] *then-current uses of hydrologically connected surface water and groundwater* […] *will in the reasonably foreseeable future cause:*
>
> *(a) the surface water supply to be insufficient to sustain over the long term, the beneficial or useful purposes for which existing natural-flow or storage appropriations were granted and the beneficial or useful purposes for which, at the time of approval, any existing instream appropriation was granted.*
>
> *(b) the streamflow to be insufficient to sustain over the long term the beneficial uses from wells constructed in aquifers dependent on recharge from the river or stream involved.*
>
> *(c) reduction in the flow of a river or stream sufficient to cause noncompliance by Nebraska with an interstate compact or decree, other formal state contract or agreement, or applicable state or federal laws.*

According to *Nebraska Revised Statute* Section 46-713(4)(a), a basin is deemed overappropriated if, on July 16, 2004, it is subject to an interstate cooperative agreement among three or more states and if, prior to such date, the Department has declared a moratorium on the issuance of new surface water appropriations and has requested each NRD with jurisdiction in the affected basin to place a moratorium on the issuance of additional water well permits.

On September 15, 2004, the Department designated the Platte River Basin upstream of the Kearney Canal diversion, the North Platte River Basin including Pumpkinseed Creek, and the South Platte River Basin including Lodgepole Creek as overappropriated. This area is defined in the 2004 Order, which also defines the area in which groundwater is hydrologically connected to the overappropriated surface water basin (see Figure 3). Subsequently, the Department made a final determination on September 30, 2004, that all surface water and tributaries of the Platte River within the five NRDs and upstream of the Loup River confluence were fully appropriated.

Since the UPRB above Elm Creek, Nebraska, was designated overappropriated and the area from Columbus to Elm Creek was determined to be fully appropriated, any additional uses would cause water supply to be out of balance with demand. With those designations, the NRDs and the Department developed IMPs calling for no new uses in the UPRB that would adversely affect an existing surface water right or groundwater use. Changes to existing uses are allowed, but any depletion of existing rights and uses must be directly offset.

**Figure 3. Upper Platte River Basin Hydrologically Connected, Fully Appropriated, and Overappropriated Areas**

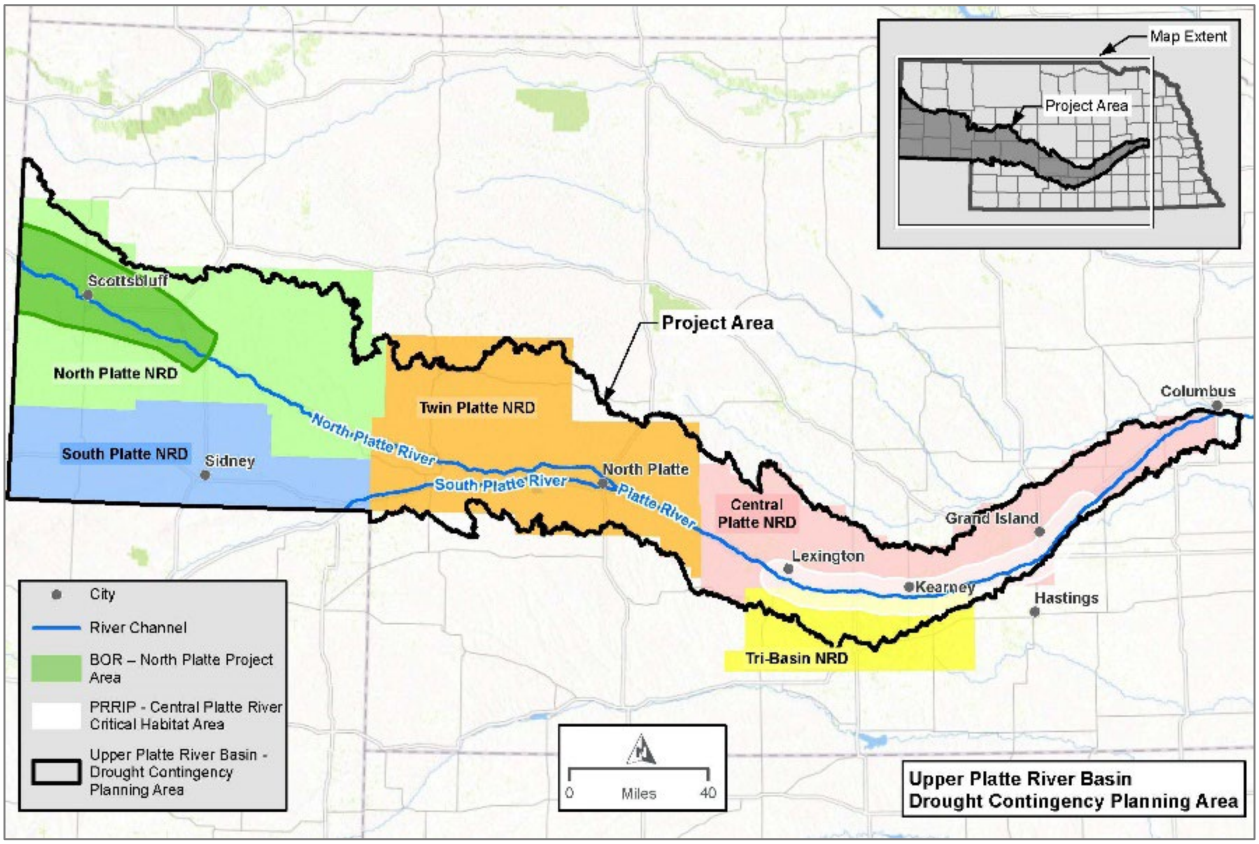



## 2.2 Project Area

The UPRB is defined as all surface areas that drain into the Platte River upstream of its confluence with the Loup River near Columbus. The total area of the UPRB in Nebraska is approximately 15,170 square miles, and includes the North Platte River, South Platte River, and Central Platte River watersheds. This area in Nebraska is considered the planning area for this

Drought Plan and is illustrated in Figure 4. NRDs within the Basin include the NPNRD, SPNRD, TPNRD, TBNRD, and CPNRD.

**Figure 4. Map of Upper Platte River Basin**




The UPRB upstream of its confluence with the Loup River near Columbus, Nebraska, encompasses a watershed that is over 60,000 square miles in Colorado, Wyoming, and Nebraska (see Figure 5). Of this watershed area, just over 51 percent (about 31,000 square miles) is drained by the North Platte River and 40 percent (about 24,200 square miles) lies within the South Platte watershed. The remaining area (below the confluence near North Platte, Nebraska) is about 9 percent (about 5,200 square miles) and includes tributaries to the Platte River between North Platte and Columbus.

The annual supply of water is highly variable across the UPRB and relies heavily on weather patterns and precipitation across this region of the Great Plains and eastern Rocky Mountains. Average annual precipitation across the UPRB ranges from 12 inches in the high semi-arid regions at the base of the Rocky Mountains to approximately 48 inches of mainly snowfall in the highest elevations of the contributing Rocky Mountain areas (Nebraska High Plains Regional Climate Center [NHPRCC] 2020). Annual average precipitation across the Nebraska portion of the UPRB ranges from 28 inches at Grand Island to 16 inches around Scottsbluff. Table 7 illustrates the variability in the amount of water that makes its way into various rivers in the UPRB in Nebraska.

**Figure 5. Upper Platte River Watershed**

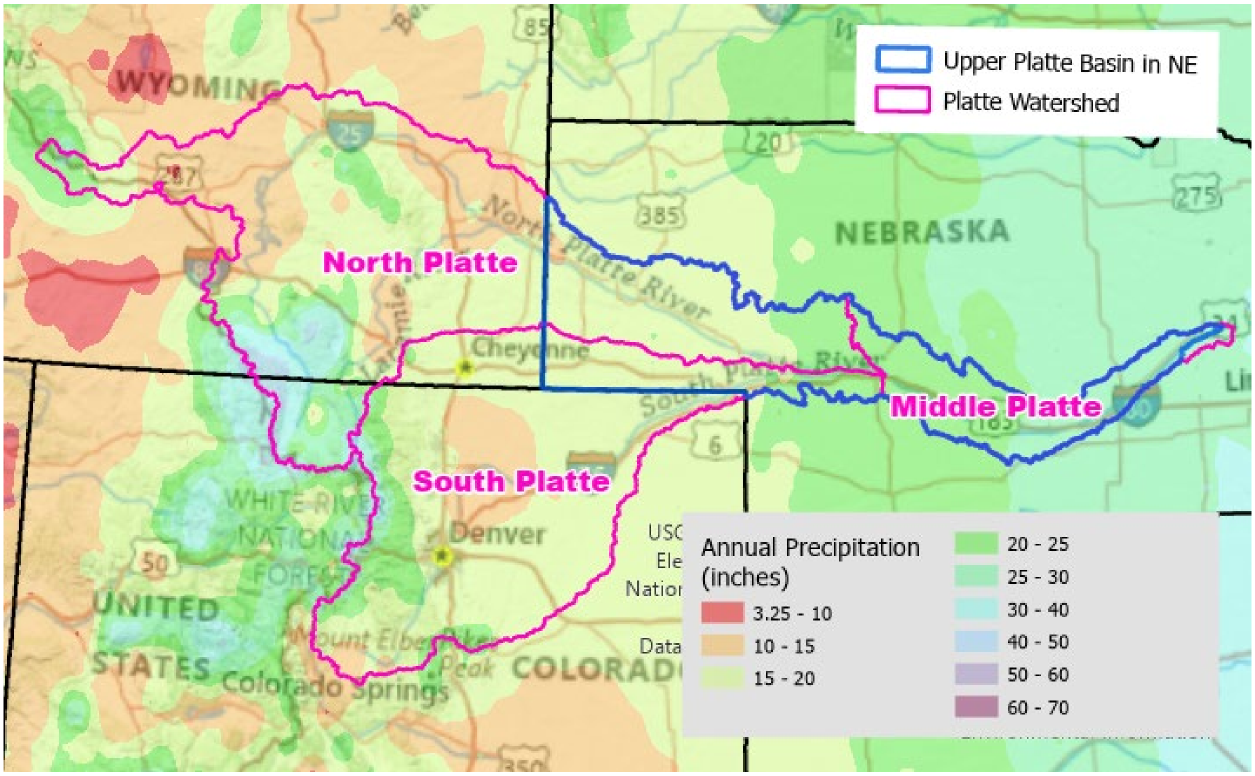



**Table 7. Measured Annual Volume of Water at Various River Gages**

| Location | Drainage Area (square miles) | Lowest Annual Total Volume (acre-feet) | Average Annual Total Volume (acre-feet) | Highest Annual Total Volume (acre-feet) | Year of Lowest Annual Total Volume |
|---|---|---|---|---|---|
| North Platte River at Wyoming-Nebraska State Line (USGS 06674500)<br>Calendar Year 1930 to 2023 | 22,218 | 201,520 | 564,380 | 2,191,771 | 2004 |
| South Platte River at Roscoe, Nebr. (USGS 06764880)<br>Calendar Year 1983 to 2023 | 29,300 | 11,431 | 490,289 | 2,237,970 | 2004 |
| Platte River near Grand Island, Nebr. (USGS 06770500)<br>Calendar Year 1939 to 2023 | 57,650 | 111,658 | 1,138,162 | 4,239,279 | 1941 (2004 second lowest) |

USGS = United States Geological Survey

One commonality among all the river gage locations in Table 7 is that they each experienced their lowest or second lowest annual volume of water in 2004 (with some records dating back to

1929). This points to the extreme impact a long-term drought (greater than 6 months, in this case 2002 through 2006) can have in the UPRB as the vast majority of water in 2004 came from reservoir storage in the North Platte River system. Some NRDs benefit from storage available in Lake McConaughy. Others, especially on the South Platte River, have limited surface water storage. Instead, these areas rely primarily on groundwater storage to meet demand.

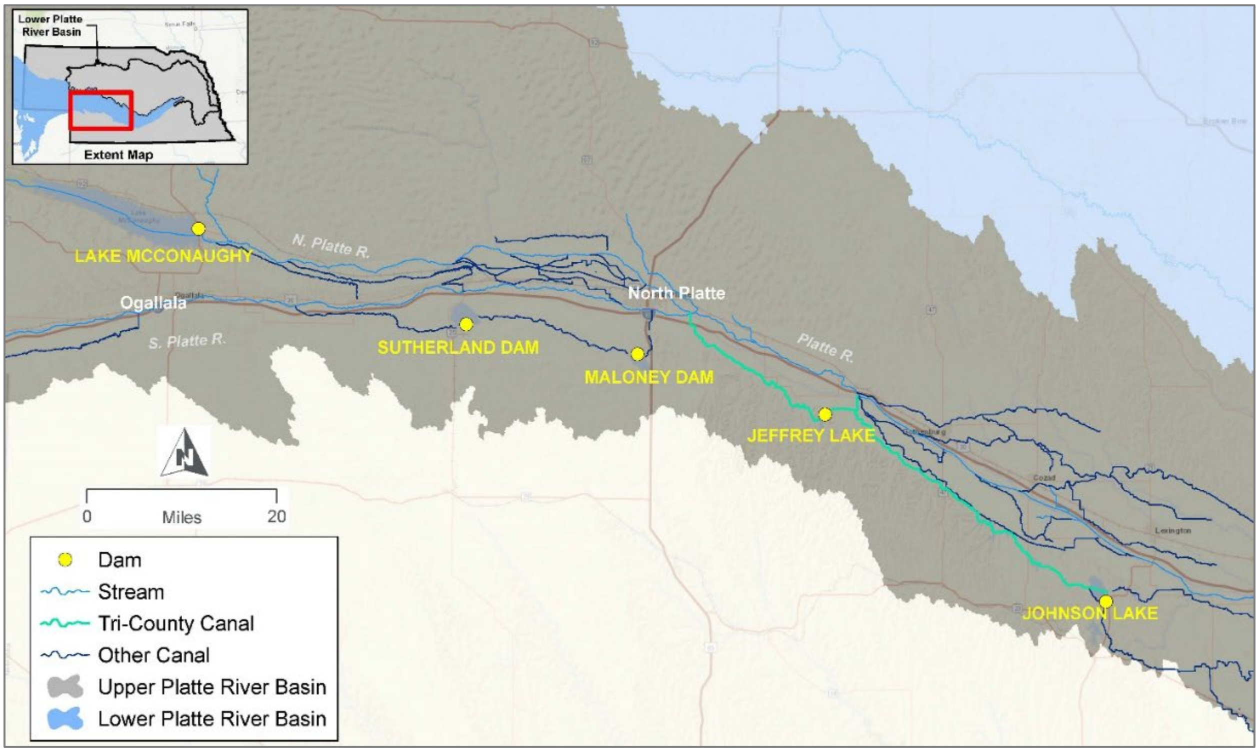
Not only does the supply of water decrease during a drought, but the demand for water proportionally increases. In the agricultural sector, for example, water is used for irrigation to offset the soil moisture deficit required to sustain commercial crops, forage, livestock feed, and landscapes. In the UPRB in Nebraska, total corn water use ranges from about 26 inches per year near Grand Island to 28 inches per year in the west (Kranz et al. 2008). As the deficit between crop water needs and growing season precipitation increases during drought, more surface water and groundwater irrigation is required to meet these demands.

### 2.2.1 Lake McConaughy – CNPPID and NPPD

The Central Nebraska Public Power and Irrigation District (CNPPID) owns and operates multiple hydropower facilities in the UPRB. CNPPID diverts water released from Nebraska's largest reservoir, Lake McConaughy (35,700 surface acres when full), into the Tri-County Canal, directs the water through Jeffrey Lake and Johnson Lake (regulating reservoirs), through three hydroelectric plants (Jeffrey, J-1, and J-2), and then delivers it to the irrigation system (during the irrigation season) or back to the Platte River (Figure 6).

Nebraska Public Power District (NPPD) also operates multiple hydropower facilities in the UPRB, in addition to the Canaday Power Station (a gas-fired plant) and Gerald Gentleman Station (a coal-fired power plant), both which utilize surface water as a cooling water source. NPPD operates diversions on the South Platte River (Korty Diversion) and the North Platte River (Keystone Diversion). Flows are conveyed through their supply canal to Gerald Gentleman Station or into Sutherland Reservoir (a cooling water source for the Gerald Gentleman Station), then through Lake Maloney near North Platte, which serves as a regulating reservoir for NPPD's North Platte hydropower facility. The hydropower returns flows to the South Platte River just above the confluence with the North Platte River and CNPPID's Tri-County diversion (see Figure 6). NPPD's Canaday Power Station is located on CNPPID's Tri-County Canal. NPPD also has a hydropower facility in Kearney, served by the Kearney Canal Diversion.

**Figure 6. Upper Platte Hydropower and Canal Operation**




## 2.2.2 Existing Integrated Water Management

The Department is responsible for permitting and administering surface water rights for beneficial uses including, but not limited to, storage, irrigation, hydropower, and instream flows. Among its duties, the Department registers wells, delineates hydrologically connected aquifers and flowing water, regulates dams, delineates floodplains, and provides technical and policy assistance. The Department also collaborates with all 23 NRDs in the State of Nebraska to develop and manage integrated water management plans and Basin-wide plans.

Among their other statutory authorities, NRDs are responsible for local development, management, utilization, and conservation of groundwater and surface water resources. NRDs manage groundwater use permitting and monitor and regulate groundwater quality. The NRDs have the legal authority to regulate groundwater use within their boundaries to ensure that irrigated agriculture remains an important industry to Nebraska in accordance with *Neb. Rev. Stat.* Sections 46-701 and 46-703(3). Additionally, NRDs are authorized, along with the Nebraska Game and Parks Commission (NGPC) to hold instream water rights for fish, wildlife, and recreation. The NRDs collaborate with the Department to develop and implement integrated water management plans and Basin-wide plans.

The initial *Basin Plan for Joint Integrated Water Resources Management of Overappropriated Portions of the Platte River Basin* was adopted in August 2009. Following the completion of this Basin Plan, UPRB NRDs jointly adopted IMPs with the Department (see Table 8).

**Table 8. Department and NRD Integrated Management Plan Effective Dates**

| Natural Resources District | First Increment IMP | Revision | Second Increment IMP |
|---|---|---|---|
| NPNRD | 9/14/2009 | 5/11/2013 | 9/11/2019 |

| Natural Resources District | First Increment IMP | Revision | Second Increment IMP |
|---|---|---|---|
| SPNRD | 6/20/2008 | 9/14/2009 | 9/11/2019 |
| TPNRD | 8/13/2009 | 3/14/2013 | 9/11/2019 |
| TBNRD | 9/15/2009 | — | 9/11/2019 |
| CPNRD | 9/15/2009 | 5/21/2012 | 9/11/2019 |

The Second Increment Basin Plan, adopted in 2019, outlines what accomplishments have previously been made to reduce UPBR depletions back to pre-1997 levels and what future efforts are necessary to continue progress towards fully appropriated status in the overappropriated area. Subsequent to the new Second Increment Basin Plan, the Department and each NRD adopted a new joint IMP as dated in Table 8. Existing provisions of these IMPs or groundwater management rules and regulations from each of the NRDs are highlighted in the following sections.

#### 2.2.2.1 North Platte NRD

The NPNRD began to take steps in 2002 to manage groundwater pumping in some regions of the NRD to address declining groundwater levels and protect water resources. These actions prepared the NPNRD for different management decisions that would result from the passage of LB 962 in 2004. As part of its 2002 management actions, the NPNRD had already placed a moratorium on issuing permits for new well construction throughout the entire NPNRD. The 2004 designations and the 2009 IMP put a moratorium on expanding irrigated acres in the NPNRD. This moratorium prohibits using existing wells to increase the number of acres historically irrigated before July 16, 2004.

The NPNRD requires the installation and use of approved flow meters on all regulated wells within the overappropriated and fully appropriated areas of the NPNRD.

In June 2007, the NPNRD Board of Directors voted to set an allocation on groundwater irrigation wells in the overappropriated area of the NPNRD and the Pumpkin Creek Management Area. This decision was spurred by the ongoing drought and increasing use of wells to supplement the limited surface water supplies at that time. Irrigators within the overappropriated area of the NPNRD, with the exception of the Pumpkin Creek Management Area, are allowed 70 acre-inches of groundwater per certified irrigated acre over a 5-year allocation period beginning with Water Year 2015. This amount can be applied at any rate on certified irrigated acres within the 5-year allocation period but must not exceed 70 acre-inches during this period. This results in a yearly average allocation of 14 acre-inches per certified irrigated acre over the allocation period. Irrigators in the Pumpkin Creek Management Area are allowed 60 acre-inches of groundwater per certified irrigated acre per allocation period. The base allocation for each certified irrigated acre is 12 acre-inches per certified irrigated acre per water year.

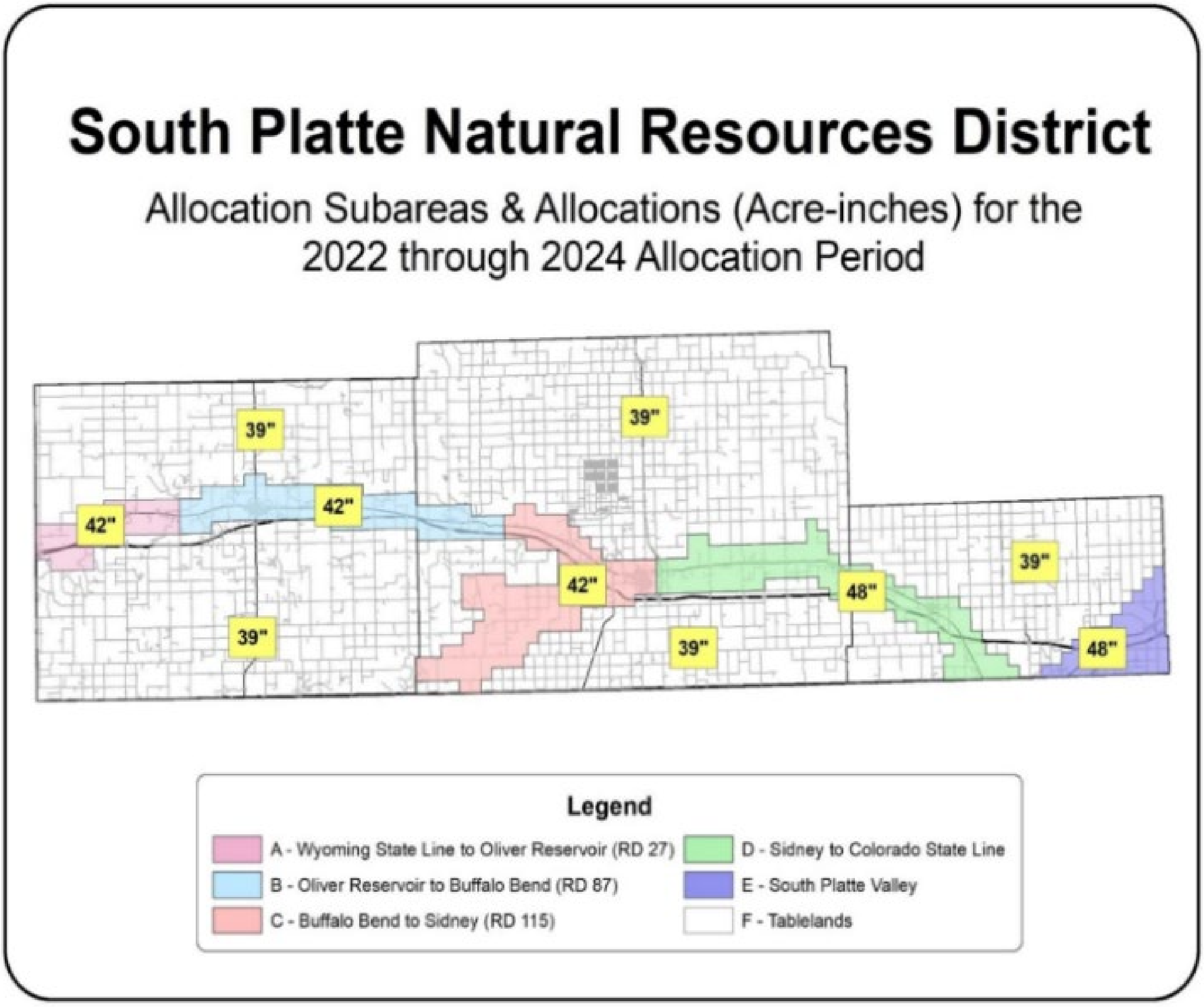
#### 2.2.2.2 South Platte NRD

In 2002, the SPNRD established a Districtwide Groundwater Management Area to manage groundwater for concerns of quantity, integrated management, and quality. In January 2004, a temporary stay was initiated on new water well construction for all areas of the SPNRD not already in a moratorium.

The SPNRD required the installation and use of approved flow meters on all irrigation wells within the SPNRD by March 2009.

The first SPNRD-required allocations went into effect during the 2007 growing season in certain subareas of the SPNRD. Subsequently, additional areas of the SPNRD were restricted under water allocation periods. The latest allocations for subareas within the SPNRD are shown in Figure 7.

**Figure 7. South Platte NRD Allocation Subareas (Allocations are for 3 growing seasons)**




#### 2.2.2.3 Twin Platte NRD

In 2004, the TPNRD approved a moratorium for new irrigated acres within the District. This moratorium has continued.

The TPNRD's IMP First 10-Year Increment from 2009 to 2019 target was -7,700 acre-feet and required the TPNRD provide an annual delivery of 7,700 acre-feet of water to the Platte River in 2019, or begin management (regulations) for all groundwater users. The TPNRD succeeded in securing 7,700 acre-feet in 2019 for the Platte River.

For the TPNRD IMP Second 10-Year Increment, the TPNRD Board of Directors and the Department approved the stakeholder's recommendation that the TPNRD begin a Water Data Program (WDP). This WDP provides growers in the TPNRD real-time daily information of their water use on the grower's computer or cell phone app. This WDP also provides accurate information for the TPNRD groundwater models used by the Department to determine the water requirements for each NRD in the UPRB. Visit https://www.gisc.coop/nebraska-tpnrd/ for more information.

#### 2.2.2.4 Tri-Basin NRD

The TBNRD includes portions of the Platte, Republican, and Little Blue River Basins in south-central Nebraska. All irrigated land in the District has been certified. No additional irrigated acres can be developed within the TBNRD. Flowmeters are in place on all wells in the Republican Basin portion of the TBNRD and are required on all conditional replacement wells NRD-wide. Transfers of groundwater and certified irrigated acres are regulated under TBNRD rules. TBNRD does not implement any water allocations within the UPRB.

#### 2.2.2.5 Central Platte NRD

CPNRD's Groundwater Management Plan (GWMP) established 24 groundwater supply management areas that are similar in aquifer conditions, soils, and topographic characteristics. The GWMP uses a phased approach to implement controls when needed with maximum acceptable declines ranging from 10 feet in the eastern part of the CPNRD to 30 feet in portions of the western end. All irrigated acres in CPNRD are certified, including variances and water bank transactions. The CPNRD does not require flow meters on registered irrigation wells or to implement water use allocations.

CPNRD canal rehabs were developed as result of the CPNRD's Water Banking Program, which began in January 2007 to try to reduce the need to regulate irrigators within the CPNRD. As part of the program, CPNRD purchases water rights as a solution to balance water demands with water supplies. CPNRD's water bank is the first to be implemented in Nebraska. The CPNRD Water Banking Policy was implemented in May 2007, which defines the process of how the water bank works.

CPNRD, along with the other UPRB NRDs, are partners in the PRRIP's goal to improve and conserve habitat for T&E species (see Section 2.1.2). Other Partners include USFWS and the States of Nebraska, Colorado, and Wyoming.

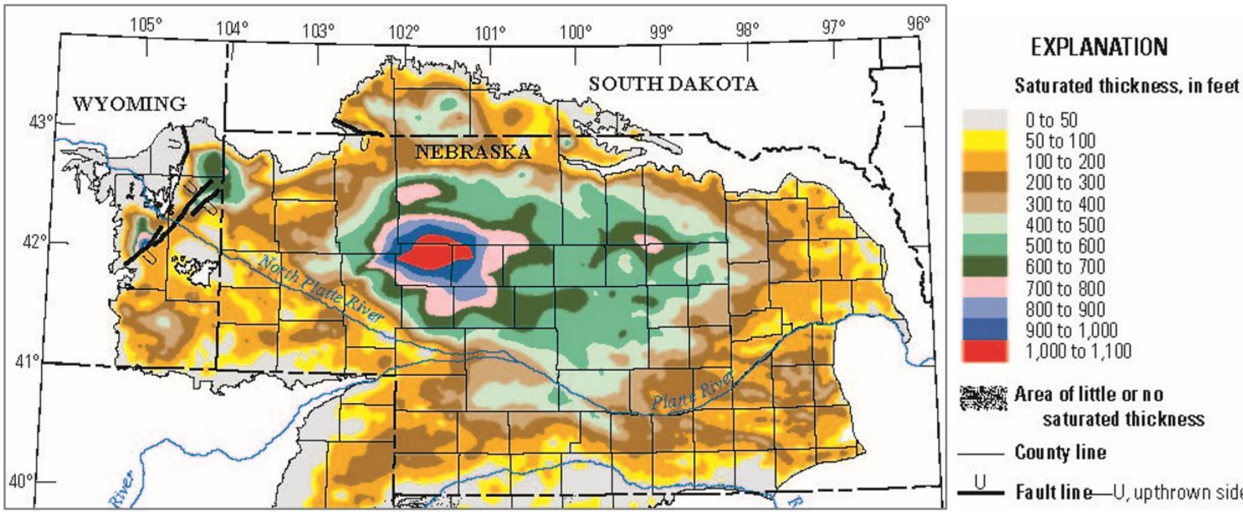
## 2.3 Water Supply and Demand

### 2.3.1 Surface Water and Groundwater Interaction

Many of the municipal, industrial, and domestic wells in the UPRB draw water from an alluvial aquifer or the High Plains aquifer. In the Platte River Valley and its tributaries, the alluvial aquifers are highly connected to the streams, resulting in gaining and losing reaches dependent on whether groundwater levels are at or above the elevation of the riverbed.

The High Plains Aquifer underlies the entire UPRB at varying depths and thicknesses (Figure 8). Precipitation infiltrates and recharges the aquifers that provide baseflow to the Platte River. The Platte River and its tributaries in western and central Nebraska have a close hydrologic connection to the alluvial and underlying aquifers, with groundwater baseflow depletions and accretions playing a significant role in the available water supply. Aquifer recharge has also been enhanced due to the development and use of surface water canals throughout the Platte River valley, where a portion of flows conveyed through the canals seep into the aquifer.

**Figure 8. Saturated Thickness of the High Plains Aquifer, 2009**




Source: USGS 2012.

### 2.3.2 Water Supply

The UPRB includes the North Platte River, South Platte River, and Platte River from the Wyoming and Colorado State boundaries to Columbus. For purposes of this Drought Plan, the UPRB was divided into specific subareas based primarily on watersheds. The subareas include the North Platte River drainage upstream of Lake McConaughy, the South Platte River drainage upstream of the confluence at North Platte, Nebraska, and the remaining drainage area from Lake McConaughy and the South and North Platte River confluence downstream to the Loup River and Platte River confluence, as seen in Figure 9.

The primary source of water in the UPRB is precipitation, which varies spatially and temporally across the region. In the mountains of Wyoming and Colorado, much of the precipitation falls as snow, which serves as a seasonal, natural reservoir, releasing water when snow melts in the late spring and summer. This natural, seasonal reservoir is supplemented across the UPRB with human-made structures, such as Seminoe and Pathfinder Reservoirs and Lake McConaughy.

Through a combination of natural and human-made influences, three distinct time scales exist for precipitation contributions to the Platte River. Natural runoff from rainfall feeds river flows in a matter of hours to days. Runoff from snowfall and storage/releases from human-made surface water reservoirs typically occur on a seasonal scale. Finally, aquifer recharge and baseflow accretions to the Platte River occur over a period of months to years.

Water supplies of the UPRB are highly variable, with annual streamflows ranging from 100,000 acre-feet per year to nearly 4 million acre-feet per year. Recent data indicate that this variability is increasing due to greater extremes in the intensity and duration of precipitation events in the Basin and shifts in precipitation patterns that have resulted in a greater proportion of precipitation in the upper portion of the UPRB occurring as rainfall, negating the beneficial impacts of natural snowpack storage on basin water supplies (United States Environmental Protection Agency [EPA] 2022). Figure 10 illustrates the variability in water supplies in the UPRB, as well as the proclivity of extended drought periods (2002–2006).

**Figure 9. Surface Water Supply Monitoring Subareas**

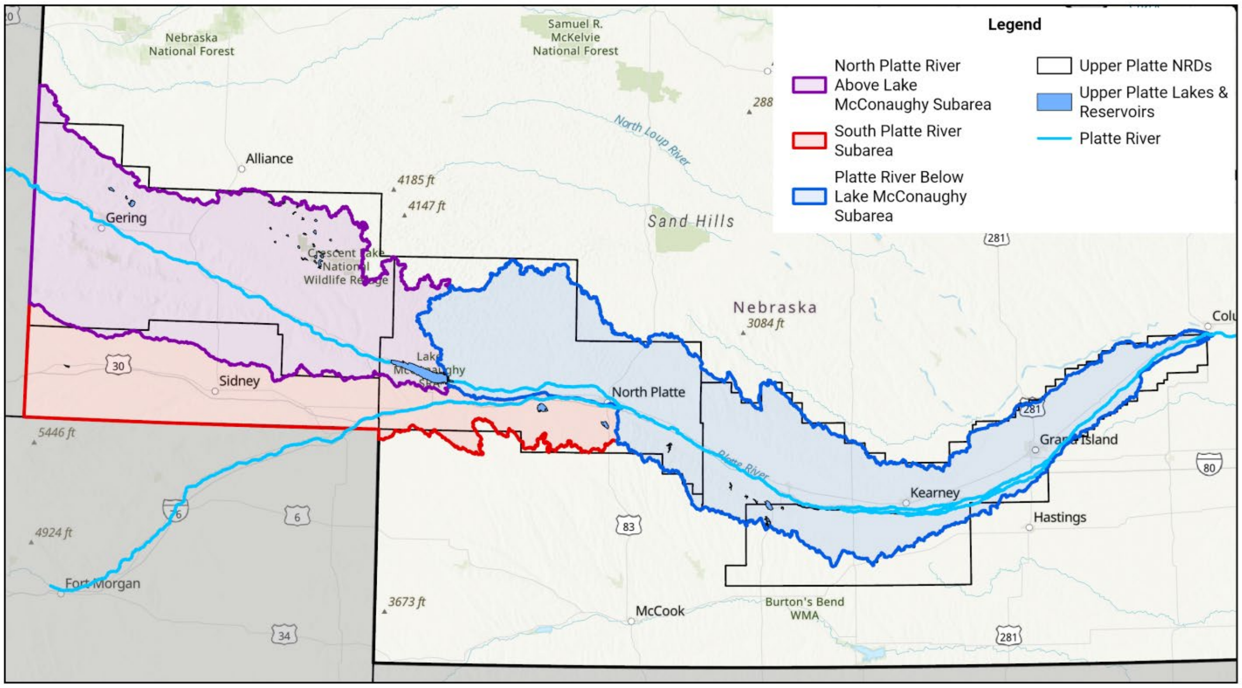
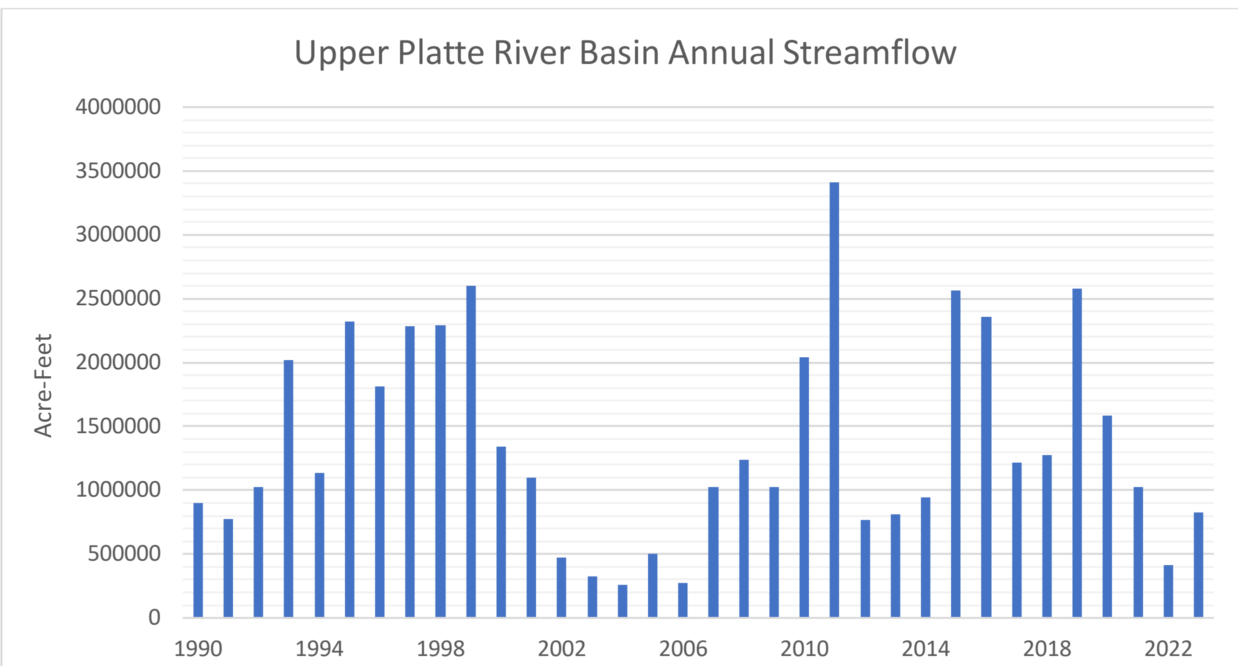



**Figure 10. Annual Streamflow for the Upper Platte River above Duncan, NE**




### 2.3.3 Water Demand

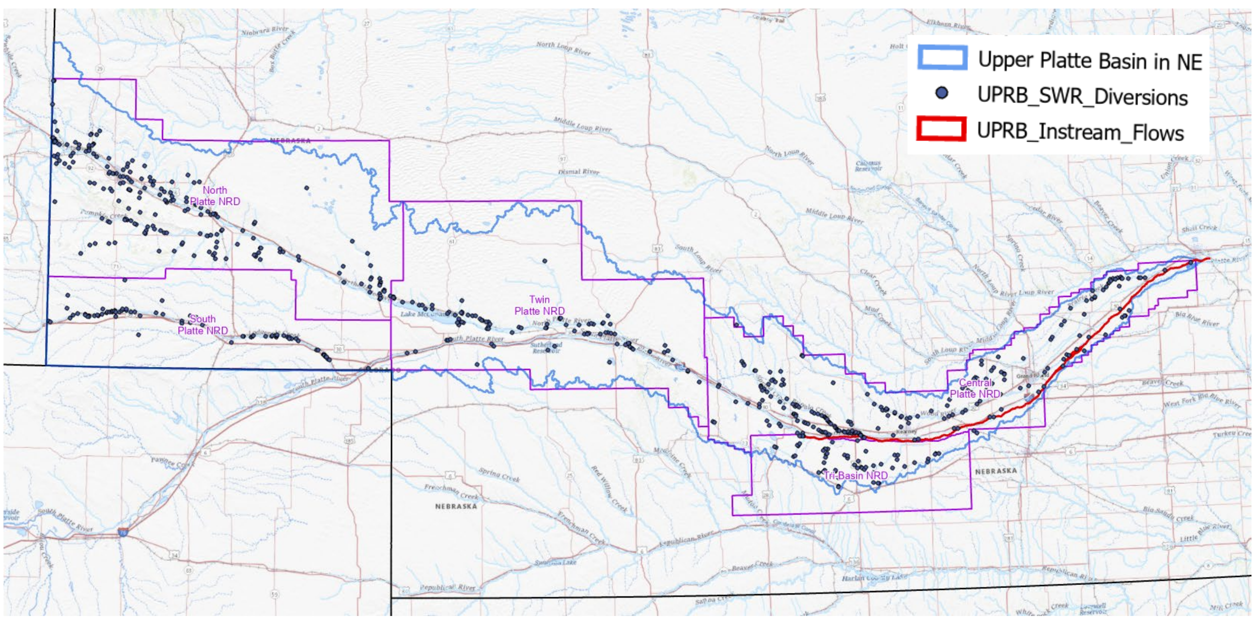
The water demands and uses in the UPRB in Nebraska are diverse and variable in timing and amounts. Major water uses within the UPRB include municipal/domestic, agriculture, instream flows, recreation, powerplant cooling water, and hydropower. Communities throughout the UPRB rely upon the Platte River, its tributaries, and its underlying aquifers as the source for meeting municipal and industrial needs, serving over 258,000 Nebraskans (NeDNR 2020). The UPRB includes over 2.4 million acres of irrigated cropland, utilizing water from both surface water and hydrologically connected groundwater sources. Instream flow appropriations are in place throughout the associated habitat reach of the central Platte River Valley to maintain historic flow patterns and preserve native habitats.

Recreation usage of the Platte River, its tributaries, and the many multi-purpose reservoirs, including Nebraska's largest reservoir—CNPPID's Lake McConaughy—are a primary economic driver throughout the Basin and Nebraska. Platte River flows provide the cooling water source for NPPD's Gerald Gentleman Station near Sutherland, which is Nebraska's largest electric generation facility, supplying enough electricity to serve 600,000 Nebraskans. Finally, both CNPPID and NPPD have multiple hydropower generation facilities reliant upon Platte River flows.

#### 2.3.3.1 Surface Water Demands

There are over 1,200 surface water appropriation points of diversion in the UPRB. Most of the surface water appropriations are for irrigation use and tend to be located on major streams (see Figure 11). Instream flow appropriations exist in the Platte River from North Platte (at the confluence of the North and South Platte Rivers) to Odessa, Odessa to Grand Island, and Grand Island to Duncan reaches for the purpose of fish and wildlife needs. Like hydropower uses, instream flows are a non-consumptive use demand.

**Figure 11. Surface Water Point of Diversions and Instream Flows**




Source: NeDNR Map layer (obtained 2023)

#### 2.3.3.2 Groundwater Demands

Groundwater in the UPRB is used for a variety of purposes: domestic, commercial/industrial, livestock, irrigation, and other uses (Table 9). As of July 2023, 39,773 groundwater wells are registered as active for irrigation, domestic, livestock, and commercial/industrial use within the UPRB (NeDNR 2023a). Nebraska is second in the nation for irrigated acres, accounting for about 1 acre of every 7 acres of irrigated land in the U.S. in 2022 (USDA 2022).

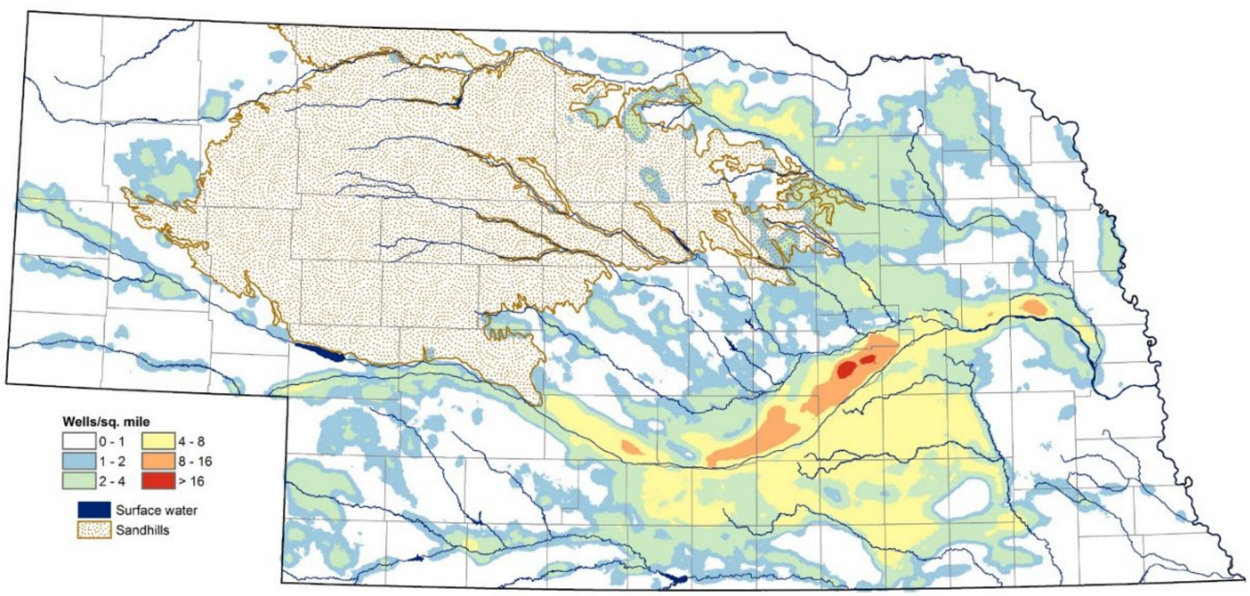
**Table 9. Current Groundwater Well Development by Number of Registered Groundwater Wells, Upper Platte River Basin**

| Type | Percentage of Wells |
|---|---|
| Irrigation | 64.4 |
| Domestic | 22.3 |
| Livestock | 12.2 |
| Commercial/Industrial | 0.1 |

Source: NeDNR 2023a.

Figure 12 displays the density of irrigation wells across the state and Table 10 documents the latest reported number of irrigated acres by NRD.

**Figure 12. Density of Active Irrigation Groundwater Wells**




Source: Young et al. 2022.

**Table 10. Number of Irrigated Acres by NRD**

| NRD | Total | Groundwater Only | Surface Water Only | Comingled |
|---|---|---|---|---|
| CPNRD | 950,949 | 870,044 | 39,273 | 41,632 |
| TBNRD | 573,463 | 457,571 | 25,265 | 90,627 |
| TPNRD | 308,474 | 263,261 | 13,425 | 31,788 |
| NPNRD | 441,158 | 134,885 | 190,862 | 115,411 |
| SPNRD | 123,777 | 122,187 | 40 | 1,551 |
| TOTAL | 2,397,821 | 1,847,948 | 268,865 | 281,009 |

Source: USDA 2020; Western Water Use Model (WWUM) Irrigated Acres Summaries for 2023 Robust Review; Adaptive Resources, Inc. 2016; and SPNRD 2022.

### 2.3.4 Consideration of Future Demands

Several factors influence future water demands. Population changes can affect domestic use, commercial and industrial use, and ultimately agricultural use when trying to provide an adequate food supply for areas far beyond the UPRB. In addition, climate change over the next century is projected to increase demand for both existing and future uses.

Future demands were addressed in the Basin Plan. Based on the Basin Plan accounting methodologies, no new or increased demands from future population growth are allowed without offsetting Basin depletions back to pre-1997 levels. As such, future growth in demand is not explicitly incorporated into the development of mitigation or response actions as part of this Drought Plan.

Additional demands due to climate change are addressed in Section 4.8.

### 2.3.5 Water Supply and Demand Conclusions

The balance of water supply and uses across the UPRB is highly variable both seasonally and year to year. Results of the Department Integrated Network of Scientific Information and GeoHydrologic Tools (INSIGHT) Methodology for the UPRB show that demand exceeds total supplies across much of the UPRB on an average annual basis evaluated from 1988 to 2012. It should be noted that this INSIGHT Methodology considers demand in its entirety (all surface and groundwater acres irrigated at full net irrigation requirement). The intent of this methodology is to understand demands of the total surface water appropriations and groundwater permitted acres existing within the Basin; not to imply that all water demand would, could, or should be satisfied. Additionally, it should be noted that while the non-consumptive uses (hydropower and instream flow) are capped based on historically available flow, surface water uses, downstream demands, and required inflows are not.

Drought periods decrease water supplies and exacerbate water demand beyond what is seen in average annual calculations. Storage of water (in snowpack, reservoirs, and groundwater aquifers) is essential to meet demand and/or retime the availability of water supplies. Because of water storage, the UPRB east of Lake McConaughy is better equipped to withstand short-term drought conditions due to groundwater reserves and surface water stored in Lake McConaughy. The areas west of Lake McConaughy are primarily irrigated by runoff or water stored in reservoirs from winter snow accumulation in the Rocky Mountains. Even groundwater irrigation, where available, in this western area of Nebraska is more heavily reliant on snowmelt runoff and recharge from streamflows. This makes the area west of Lake McConaughy more susceptible to both short-term and long-term drought impacts on both dryland and irrigated cropland and pastures.

Future changes in climate and direct human water use may have impacts during drought periods across the UPRB in Nebraska, including:

- Increased extremes in temperatures and precipitation—resulting in extremes in both supply and demand—and ultimately imbalances between the two.
- More precipitation as rain rather than snow reduces snowpack natural storage and necessitates retiming water supplies with manmade storage.
- Increased evapotranspiration (ET) in the Basin due to a longer growing season and higher temperatures, particularly overnight temperatures.

# 3.0 Operational and Administrative Framework

The Coalition currently convenes on a regular basis throughout the year—typically every two months—with an annual meeting in the summer where members present reports on their activities, actions, and accomplishments over the past year in implementing their Basin Plan and individual IMPs. This Drought Plan and drought conditions will be a standing agenda item for these meetings. Specifically, standing agenda items will include:

- Review current drought conditions within the UPRB.
- Discuss current and ongoing drought monitoring efforts.
- Discuss actions to be taken by the Coalition pursuant to the Drought Plan.

Additional agenda items, on an as-needed basis, may include:

- Evolving needs in the region and issues to be addressed;
- Additional evaluation and prioritization of identified mitigation and response projects to implement as future funding opportunities arise;
- Funding needs and sources for the following year's activities and development of plans to pursue identified funds; and
- Progress, efficacy, and results of the Drought Plan monitoring and evaluation efforts.

## 3.1 Plan Update Process

The Drought Plan and associated planning efforts are meant to be part of an adaptive process that is routinely updated to reflect the needs of the UPRB and its water users. As described in the Basin Plan, the time frame to develop and adopt the Basin-wide Drought Plan and individual NRD drought plans is 10 years, spanning from the effective date of the Basin Plan to no later than September 11, 2029. The Coalition will update the Drought Plan at least every 10 years and as conditions warrant (such as availability of new indicators or monitoring data products, or implementation of a mitigation or response action project).

On an annual basis:

The Coalition will review the Vulnerability Assessment and make any necessary updates. Updates may be necessary when new vulnerabilities emerge and existing vulnerabilities are addressed through infrastructure improvements and resiliency projects.

The Coalition will determine the need for new and/or revised mitigation and response actions, update the status of existing mitigation and response actions, and add new actions as needed. Conditions that may warrant updating the mitigation and response actions include project funding availability and new/updated Basin Plan action items related to drought.

On an as-needed basis:

The Coalition may identify and incorporate additional planning and technical efforts outside those anticipated, based on need.

The Coalition may conduct a post-drought workshop following completion of a drought cycle to evaluate plan effectiveness and modify plan elements, as necessary.

Once at least every 10 years:

The Coalition will review and update the Drought Plan. Subsequently, the Department and the UPRBs will review the associated NRD drought plans and determine whether updates are warranted. This update interval allows the Department and UPRB NRDs sufficient time to implement the Drought Plan and NRD drought plans and learn what works and what needs adjustment. This timeframe also prevents conflicts with Basin Plan and IMP increment updates.

The Coalition will update the Drought Plan if there are substantial changes to the drought planning action items contained in the Basin Plan.

When the Coalition determines that updates to the Drought Plan are necessary, the group will collectively decide which members are responsible for collecting the necessary information, making Plan revisions, and reviewing updates. Once updates to the Drought Plan are complete, the Coalition shall finalize and implement the updated Plan.

## 3.2 Upper Platte River Drought Contingency Plan Development and Public Outreach Efforts

Development of the Drought Plan was directed by the following:

1. **Development of a Detailed Work Plan.** The Work Plan, developed for the WaterSMART Planning Grant, guided the Drought Plan development process. It described the specific planning tasks and the manner in which each would be completed, the associated schedule, and the roles and responsibilities. The Work Plan included four sections:
    a. **Section A: Introduction.** Description of the scope and purpose of the Drought Plan, the planning area, and background information.
    b. **Section B: Planning Approach.** Description of the project budget and schedule for Drought Plan development, scope of work to complete the six required Drought Plan elements, planning oversight structure, decision-making process, roles and responsibilities, and coordination.
    c. **Section C: Documentation and Reporting.** Description of deliverables and documentation requirements, reporting requirements and responsibilities, and review process.
    d. **Section D: Communication and Outreach Plan.** Description of anticipated stakeholder and public involvement and schedule.

    The Drought Plan Work Plan was submitted and accepted by BOR in June 2022.
2. **Establishment of a Drought Planning Task Force (Task Force).** The Task Force consisted of Coalition members and a diverse group of stakeholders representing different water-related interests (agriculture, environmental, groundwater and surface water irrigators, groundwater users, surface water users, recreation users, irrigation districts, municipalities, and public power districts). NRD representatives provided local input on a variety of water-related issues.
3. **Development of a Communication and Outreach Plan.** The Coalition prepared a Communication and Outreach plan geared to maximize stakeholder involvement in the development of the Drought Plan. This Communication and Outreach Plan targeted stakeholder participation at multiple levels during the Drought Plan development:

- Coalition members from the NRDs and DNR guided the Drought Plan development. The primary stakeholder group members have the appropriate expertise and authority to provide guidance and oversight on plan development, background information, review, and the staff to support analyses developed as part of the Drought Plan. This group also has the authority and ultimate responsibility for plan content and approval (through their boards/directors).
- Other stakeholders provided critical input through several workshops. This group also included the designated representative from BOR. Stakeholders represented a wide range of water users, including municipal/domestic, irrigation, environmental, recreation, business, and industries.
- The Technical Work Group consisted of members representing entities with ground and surface water management responsibilities in the UPRB. This group has extensive experience and understanding of the ground and surface water resources of the UPRB, their interaction—particularly during drought conditions—and the infrastructure and framework in which the ground and surface water resources are managed within the Basin. The Technical Working Group provided technical guidance during plan development based on their working knowledge of the UPRB water systems, in addition to assisting in the development and evaluation of potential mitigation and response actions.
- The fourth group engaged during the Drought Plan development was the general public. This was facilitated through opportunities to participate at each of the Task Force meetings. In addition, each of the Task Force meetings was complemented with an online meeting resource that contains meeting content and an opportunity for public comment. Each of the NRDs has monthly board meetings open to the public. Primary stakeholder members are responsible for keeping their board and constituents of the NRD updated on the planning process through regular updates in this public forum. A website was developed and maintained throughout the planning process to provide information on the Drought Plan and provide a forum for the public to comment online.

### 3.2.1 Primary Stakeholder Group

The primary stakeholder group provided direction and guidance through plan development as part of its regularly scheduled, bimonthly meetings. As part of the regular agenda, Drought Plan development progress, past and upcoming activities, and plan elements were discussed.

### 3.2.2 Drought Planning Task Force

The following is a list of Task Force meetings and dates those meetings were held. Public notice was given for all meetings.

**Task Force Meeting #1, July 21, 2022.** The meeting focused on the plan purpose and development process, and discussed drought vulnerabilities in the Basin.

**Task Force Meeting #2, March 29, 2023.** The meeting focused on results of the vulnerability assessment, monitoring protocols, and potential mitigation and response actions.

**Task Force Meeting #3 and Drought Tabletop Exercise, May 23, 2023.** Meeting topics included discussion of monitoring protocols and potential triggers, followed by a drought tabletop exercise where historic short-term and long-term drought conditions were used to test monitoring protocols and assess potential mitigation and response action effectiveness.

**Task Force Meeting #4, June 27, 2023.** Discussion topics included the results of the tabletop exercise, further discussion of potential monitoring triggers, and plan content.

### 3.2.3 Technical Work Group

Engagement of technical work group members was achieved through individual conversations with the group members. These discussions focused on their specific jurisdiction/infrastructure, activities, and vulnerabilities to drought within the Basin. As an example, interviews with municipal water superintendents in October 2023 from Sidney, Scottsbluff, North Platte, and Grand Island concluded that long-term drought was not likely to reduce access to an adequate groundwater supply when needed to meet their Cities' needs.

### 3.2.4 Public Outreach Efforts

Several activities were undertaken to encourage and provide opportunities for participation by the general public and included the following:

**Task Force Meetings.** All Task Force meetings were open to the public and provided opportunity for public comment.

**Public Website.** The Department established a website to track the development of the Upper Platte River Drought Contingency Plan. The website included notice of the Task Force meetings, meeting materials and summaries, and GIS-based tools to help with collecting drought-related information from the public. Sections of the draft plan and an online comment form were also posted to the website to allow for public and stakeholder review and input.

**NRD Briefings.** Elements for the draft plan were provided to the participating NRDs and were reviewed and approved by each district. Opportunity for public comment was provided at each NRD's monthly board meeting.

**Platte Basin Coalition Meetings.** Opportunity for public comment was provided at bimonthly Coalition meetings.

The Coalition's stakeholder and public outreach efforts continued throughout the development of the Drought Plan. All Task Force meetings were publicly noticed, posted publicly on the Department's Upper Platte River Drought Contingency Plan website, and were held in Ogallala, Nebraska—a central location within the plan area of the UPRB.

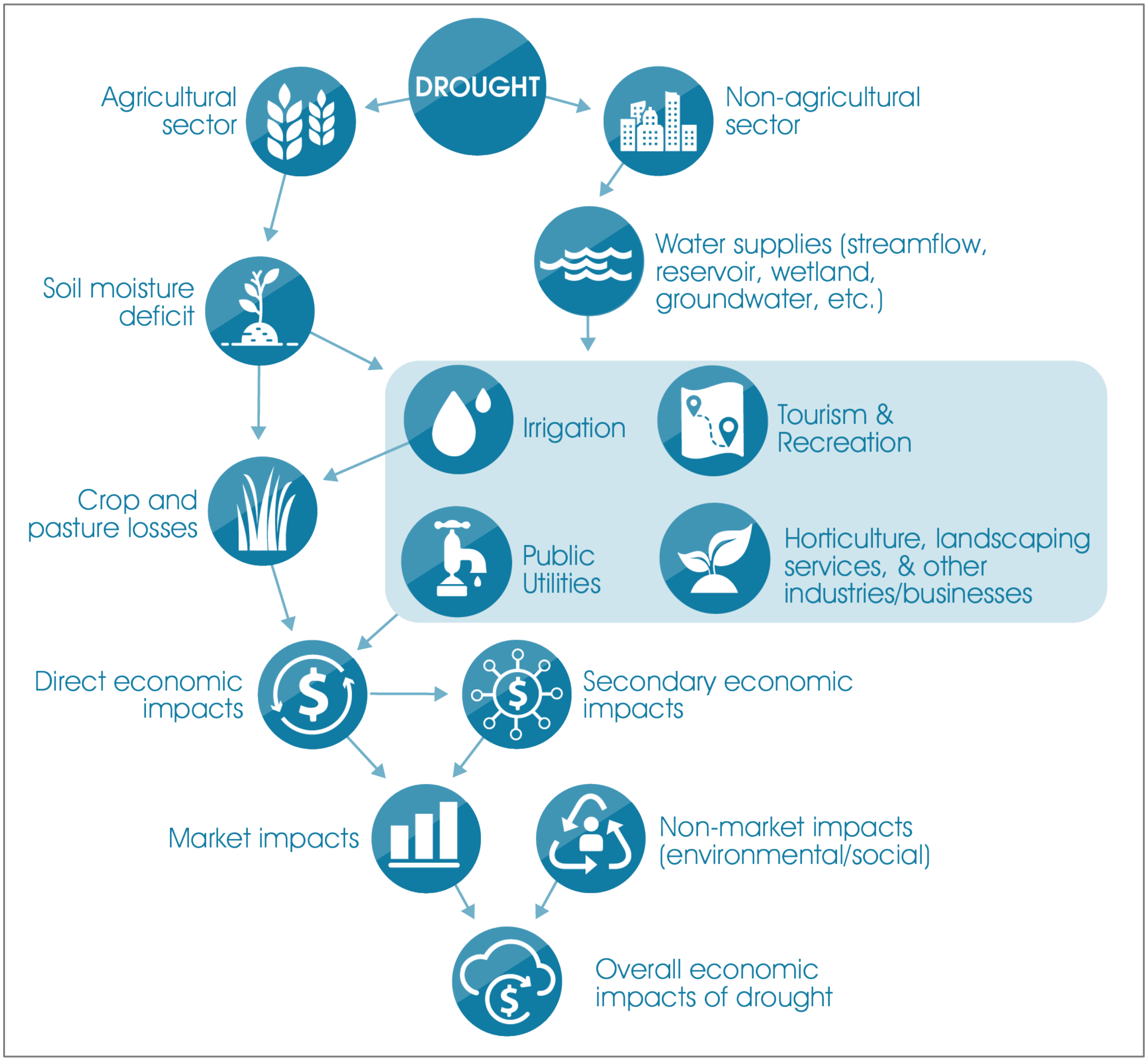
## 4.0 Vulnerability Assessment

A vulnerability assessment is an evaluation of the risks to critical resources within a planning area and the factors contributing to those risks. For the purposes of this assessment, the risk of vulnerability should be viewed as a combination of the frequency of occurrence, magnitude and severity, and consequences (Bureau of Reclamation [BOR] 2019). "The degree to which a population is vulnerable hinges on the ability to anticipate, to deal with, resist, and [fully] recover from the drought" (Commission on Water Resource Management 2003).

The impacts from drought can be classified as direct and indirect. Direct impacts include physical destruction of property, crops, natural resources, as well as public health and safety.

Indirect impacts are consequences of that destruction, such as temporary unemployment and business interruption (National Academy of Sciences 1999). "The most vulnerable portions of the state in terms of economic impact are cropland, pastureland for animals, recreational areas, and businesses that depend on agricultural industries for the bulk of their business. However, all areas of the state can be impacted by drought events" (Nebraska Emergency Management Agency [NEMA] 2021). Figure 13 summarizes sectors, resources, and economic impacts that are affected by drought (both agriculture and non-agriculture).

**Figure 13. An Overview of Drought Economic Effects**




Source: Adapted from Ding, Hayes, and Widhalm 2010.

For this assessment, drought impacts are divided among the following six sectors, with several impacts and vulnerabilities considered and ranked within each sector:

- Agriculture;
- Energy;

Municipal and Industrial Supply;

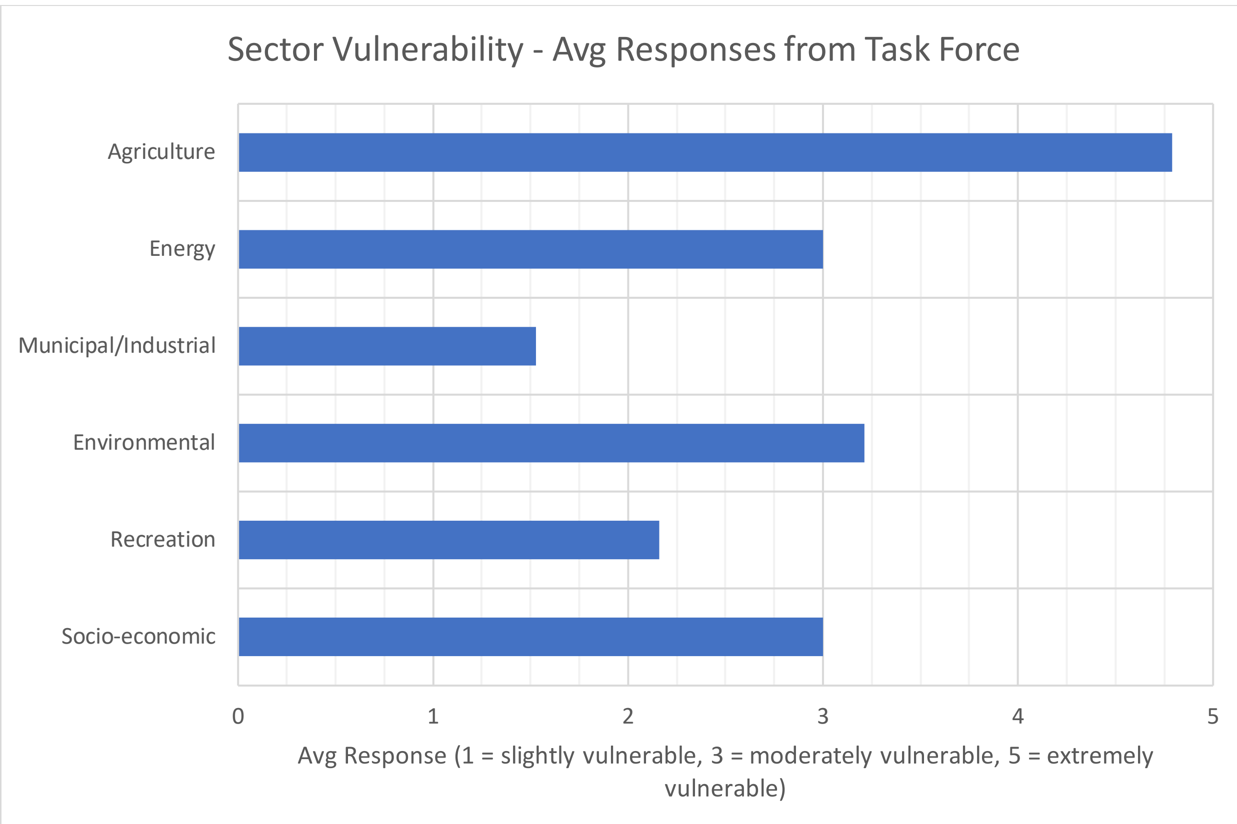
Environmental;

Recreation; and

Socioeconomic.

The Task Force provided a comparison of the overall vulnerability in each of the six sectors. During its first Public Meeting on July 21, 2022, Task Force members provided ratings from 1 to 5 for "how vulnerable each sector is to drought in their area" and those ratings were averaged to provide the composite vulnerability for long-term drought impacts. Short-term drought is defined by the National Oceanic and Atmospheric Administration's (NOAA) National Integrated Drought Information System (NIDIS) as a weather pattern that results in a precipitation deficit for up to or less than 6 months. A long-term drought typically lasts longer than 6 months. Overall, the composite vulnerability to impacts in each sector is indicated in Figure 14.

**Figure 14. Priority of Drought Vulnerabilities Across the Six Sectors Based on Input by Drought Task Force Members During the Second Drought Task Force Meeting in July 2022**

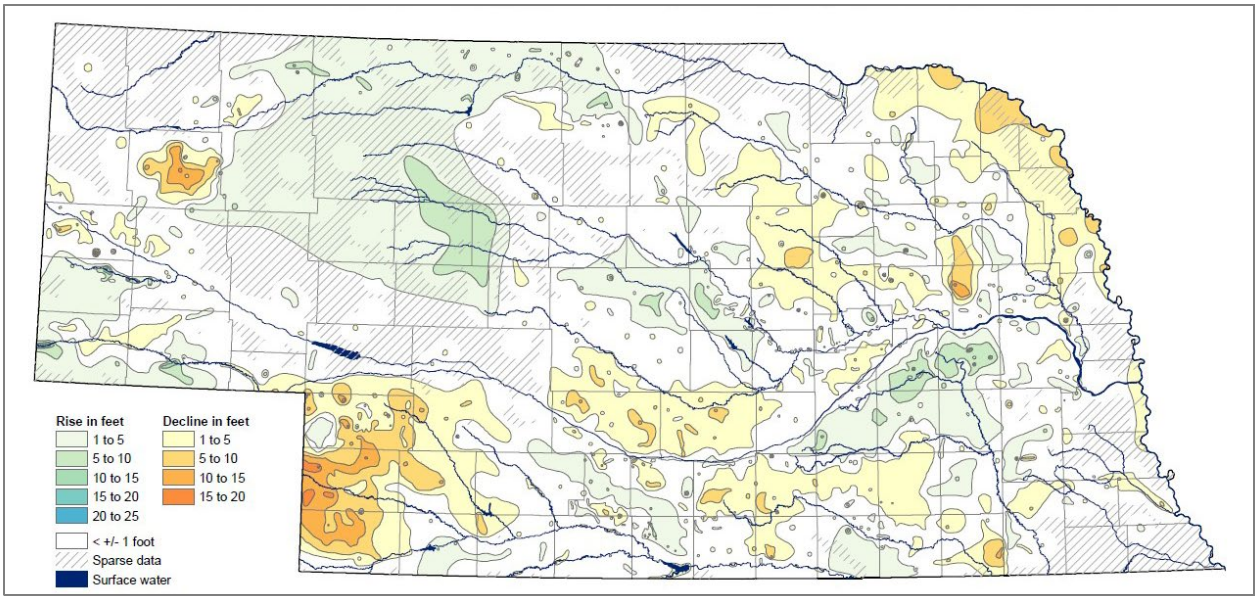



## 4.1 Historic Impacts of Short-Term and Long-Term Droughts

The drought of 2012 was considered the most severe single-year drought on record for Nebraska, with the driest May-to-September on record coupled with extreme heat. From the spring of 2012 to the spring of 2013, most wells in Nebraska experienced declines ranging from 1 foot to more than 20 feet. The increased demand for irrigation water combined with slower rates of recharge resulted in some of the greatest recorded 1-year water-level declines in Nebraska (Young, Burbach, and Howard 2013).

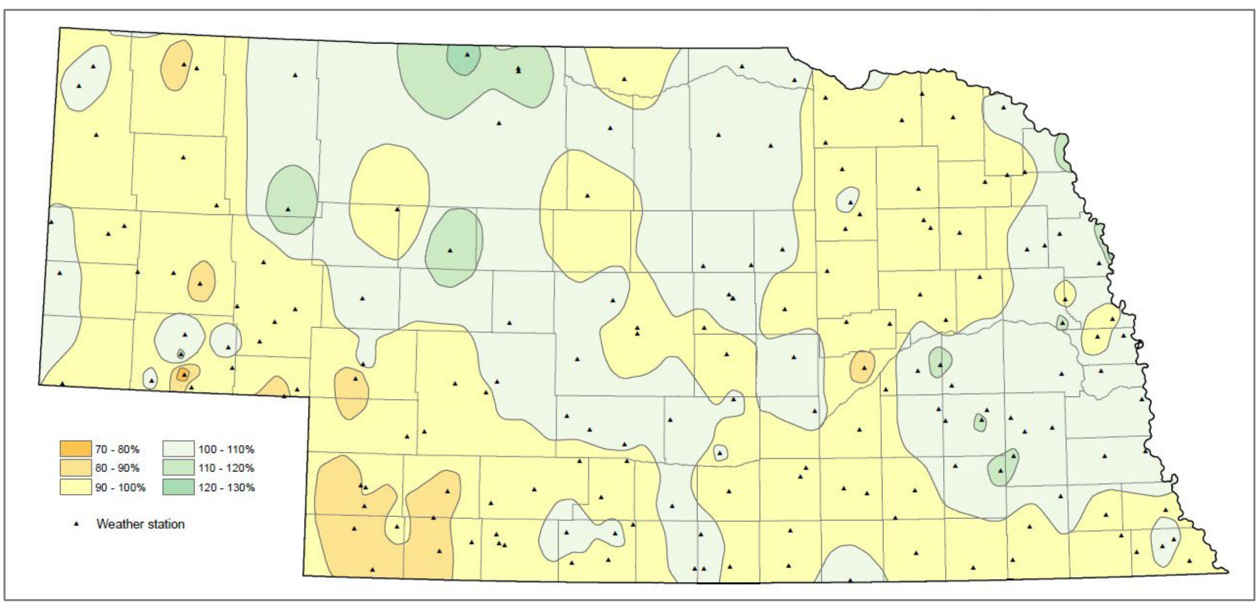
Streamflows respond more quickly to drought than groundwater. "[T]he lag time between the beginning of a drought and the start of declining ground-water levels is longer than for streamflows. This time-lag pattern continues following the end of a drought when streamflows are returning to normal and ground-water levels may still be declining" (United States Geological Survey [USGS] 2005). Figure 15 shows the groundwater-level changes between 2012 and 2022. Groundwater levels in portions of the UPRB have not yet fully recovered with groundwater levels 1 to 10 feet below 2012 levels. Figure 16 shows that precipitation for the same period was 80 to 110 percent of normal across the Basin.

**Figure 15. Groundwater Level Changes in Nebraska – Spring 2012 to Spring 2022**




Source: Young et al. 2022.

**Figure 16. Percent of Normal Precipitation – January 2012 to January 2022**

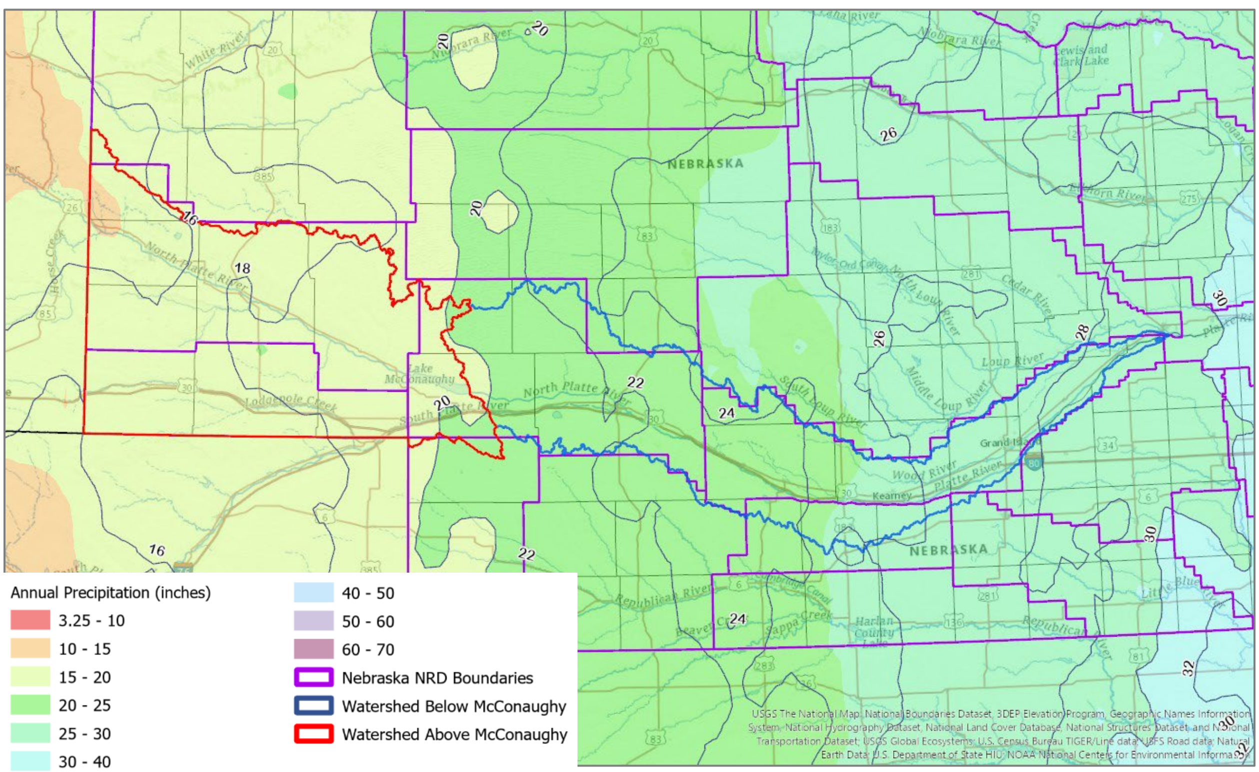


Source: Young et al. 2022.

Relief from the drought of 2012 began in most parts of Nebraska as early as 2013. As such, 2012 is considered a short-term drought in the context of this vulnerability assessment as the actual drought conditions persisted from approximately June until December. In contrast, the drought from 2002 through 2006 across Nebraska resulted in a variety of different impacts and is considered a multi-year, or long-term, drought.

Comparing these two differing drought scenarios highlights how vulnerabilities often change based on the duration of the drought as well as the geographic diversity of drought impacts across the UPRB. Irrigation of cropland and some pastures is used across the Basin as a tool to mitigate against years of normal precipitation, not just droughts. Sources of irrigation water differ from west to east throughout the plan area which is a driver of drought vulnerability. The areas west of Lake McConaughy, shown in Figure 17 are primarily irrigated by runoff or water stored in reservoirs from winter snow accumulation in the Rocky Mountains. Even groundwater irrigation, where available, in this western area of the Basin is more heavily reliant on snowmelt runoff and recharge from streamflows. This makes the area west of Lake McConaughy more susceptible to both short-term and long-term drought impacts on both dryland and irrigated cropland and pastures. This means drought conditions in this portion of the plan area are dependent on both the amount of snowfall in the Platte River watershed in Wyoming and Colorado as well as the actual amount of precipitation received in the Basin in Nebraska.

**Figure 17. Watershed Area Above Lake McConaughy and Annual Average Precipitation Across Upper Platte River Basin**




Source: NHPRCC 2020

In contrast, the UPRB east of Lake McConaughy, shown in Figure 17, is better equipped to withstand short-term drought conditions due to groundwater reserves and surface water stored in Lake McConaughy. For this area of the UPRB, the short-term drought of 2012 had very little impact on cropland irrigated with either surface water or groundwater. This shows that the main vulnerability of land uses in this portion of the UPRB is to non-irrigated crop or grasslands. Multi-year drought conditions east of Lake McConaughy result in depletions of water stored and used each year from Lake McConaughy as well as the depletion of groundwater storage. As such, irrigated lands east of Lake McConaughy can become more vulnerable as local and upstream drought conditions persist, especially to irrigated lands that rely on surface water irrigation supplies from Lake McConaughy.

## 4.2 Agricultural Sector

Nebraska is the nation's third largest producer of corn (USDA National Agriculture Statistical Service [NASS] 2021). The critical impacts to the agricultural sector during drought include crop yield reduction (caused by a soil moisture deficit), feed/water shortage for livestock, erosion and topsoil loss, soil health/nutrient depletion, and increased use of groundwater for irrigation (causing aquifer depletion).

In 2012, Nebraska was the fourth largest consumer of crop insurance and the fifth largest recipient of indemnity payments (Reed 2015). During the drought of 2012, the total Nebraska indemnities were at $544 million, with $502 million due to drought, heat, and dry wind on more than 2 million acres of cropland (Reed 2015). "Crop failures and pasture losses are the primary direct economic impact of drought within the agricultural sector. Drought-induced production losses cause negative food supply shocks, but the amount of incurred economic impacts and distribution of losses depends on the market structure and interaction between the supply and demand of agricultural products" (Ding, Hayes, and Widhalm 2010).

"Drought causes plant stress and crop losses, plant diseases, insect infestation, and reduced biomass causing damage to grazing lands" (NEMA 2021). Drought causes long-term impacts on perennial crops and livestock productions that can last for years.

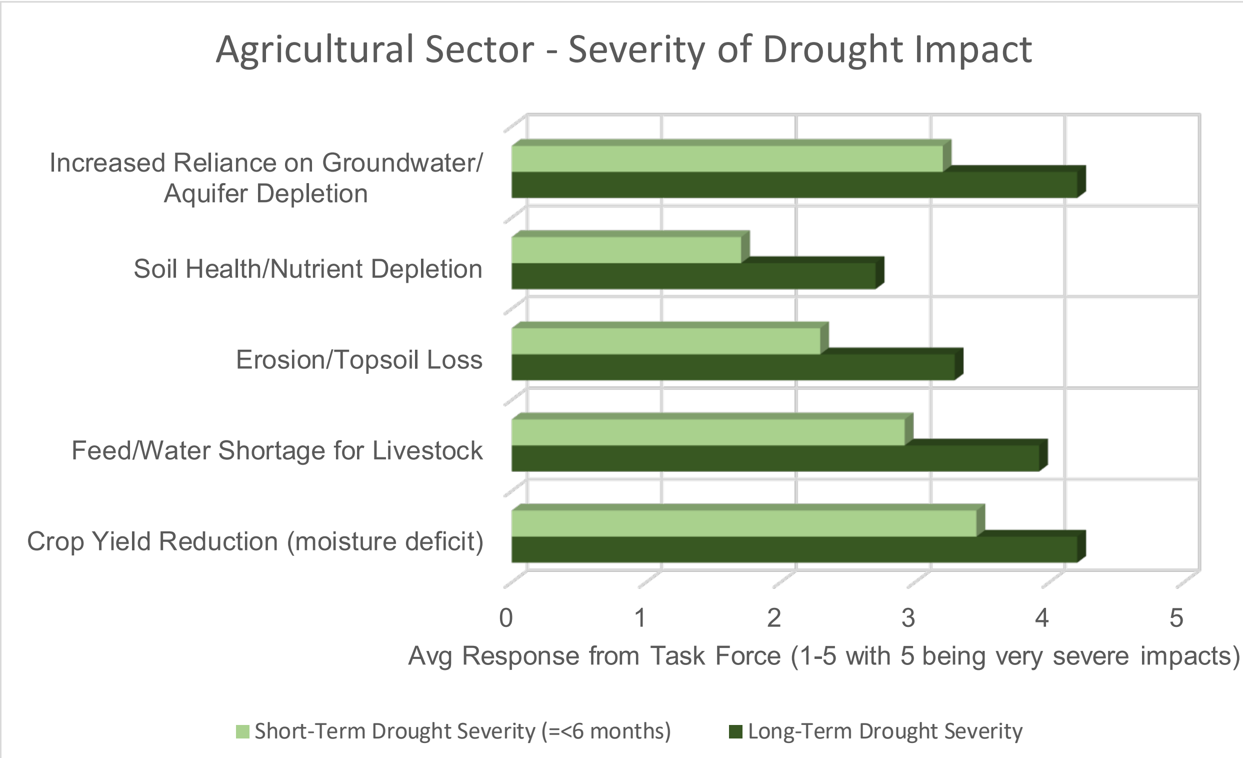
"During the long-term and/or severe droughts, farmers may have a higher cost of crop production because of increased water and energy cost for irrigation. In some cases, farms may temporarily lose water rights because of seniority, and this could result in reduced crop yields. However, in most cases, and especially, during a short-term drought, irrigated farming provides more security for crop growers" (Wilhelmi and Wilhite 2002) "[W]here available, irrigation was effectively used as a tool for creating agricultural drought resistance. Taken in aggregate, [this] point[s] to an "all eggs in one basket" approach: irrigating as the sole means of agricultural drought resistance. [Continued] reliance on agricultural irrigation as a drought mitigation measure may leave the Basin vulnerable to future multiyear drought" (Zipper et al. 2017).

"Drought-induced losses are not completely borne by farmers; instead, a portion of the losses [are] passed on to consumers through increased prices. […] Additionally, farmers purchasing crop insurance will get part of their losses compensated by insurance companies, and some eligible farmers may receive direct disaster aid from the government" (Ding, Hayes, and Widhalm 2010). Additional indirect effects include reduced supplies to downstream industries, reduced fertilizer sales, and diminished expenditures.

Task Force members provided ratings for the severity of each of these impacts and those ratings were averaged to provide the composite vulnerability for short-term and long-term drought impacts as indicated in Figure 18. For each impact, long-term drought is assumed to have a more severe risk than short-term drought due to the compounding effect of a multi-year drought.

Quantifiable measurements of agricultural impacts often imply how severe the drought was or is, not necessarily how severe it might become. Direct measurements of agricultural sector impacts include, but are not limited to, crop yield, commodity prices, livestock production, soil moisture, surface water irrigation use, and groundwater irrigation use.

**Figure 18. Priority of Short-Term and Long-Term Drought Vulnerabilities in the Agricultural Sector Based on Input by Task Force Members During the Second Task Force Meeting in March 2023**




## 4.3 Energy Sector

Power delivery throughout the UPRB is handled by over 60 Public Power and Rural Electric Districts. The primary driver of the peak power demand each summer is power for electric motors used to withdraw groundwater from irrigation wells. As demand for irrigation increases during drought, so does the demand for affordable power supplies.

NPPD owns and operates two hydroelectric generating facilities at North Platte and Kearney on the Platte River, receives 100 percent of the energy output from the Kingsley Hydropower facility and purchases 100 percent of the hydropower energy produced by the Loup Power District (LPD). At each plant, water passes through turbines, generates electricity and continues unchanged. In total, the hydropower generators in the UPRB can supply 130 megawatts (MW).

Nebraska's largest generating facility, NPPD's Gerald Gentleman Station, is located south of the South Platte River at Sutherland, Nebraska, and can generate 1,365 MW of power. The cooling process at this coal-fueled power plant relies on water delivered in the Sutherland Canal, which can be supplied by both the North Platte River from Lake McConaughy and South Platte flow from the Korty Diversion Dam just upstream of Paxton, Nebraska. Periods of drought can reduce the reliability of available water supplies into Sutherland Canal and put stress on the water supply and temperature of the water that is stored in Sutherland Reservoir.

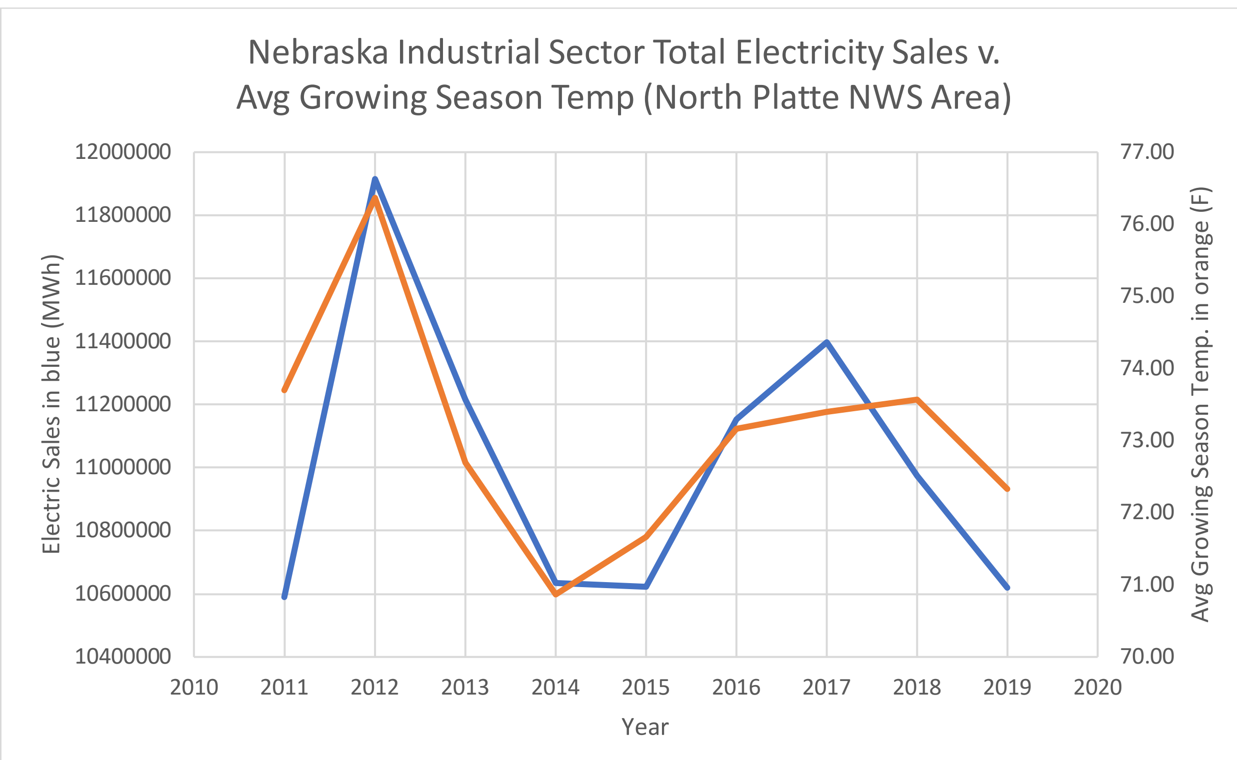
Electrical power usage is heavily influenced by extreme temperatures, which can be experienced during drought in the UPRB as there is a lack of frontal systems that produce precipitation and briefly cool the near-surface atmosphere. This correlation is shown in the recorded electrical usage for industry, heavily influenced by agricultural irrigation, across Nebraska versus the average recorded temperatures (graphed in Figure 19 from the North Platte National Weather Service [NWS] Area). The increase of electrical power usage during drought is also supported by the recorded number of cooling degree days since 1975 in North Platte with 2012 being the highest followed recently by 2022 (see Figure 20).

All of these factors that lead to increased electrical usage put stress on not only power production, but also on transmission and electrical distribution systems. Nebraska's all-time high electricity expenditure in the Agricultural Sector was recorded in 2012 at just over $312 million (Nebraska Department of Environment and Energy [NDEE] 2022a).

The primary drought impacts to the energy sector include insufficient cooling water, increased power costs, power infrastructure maintenance, increased energy demand, and the decreased availability of hydropower production. Of these, the Drought Task Force rated insufficient cooling water as the most severe long-term impact with decreased hydropower, infrastructure stress and maintenance, and increased power cost and energy demand close behind (see Figure 21).

Monitoring electrical usage is not readily available for the Drought Plan area on a real-time basis. However, past data indicate that even without stresses caused by drought, electrical usage will continue to increase as more energy-consuming appliances and equipment are transitioned over to electricity. This includes heating and cooling systems as well as the conversion of power for irrigation wells from fossil fuels to electricity (NDEE 2022b).

**Figure 19. Nebraska Industrial Sector Total Electricity Sales, Including Agriculture and Average Growing Season Temperature (°F) from North Platte NWS area**




Source: NDEE 2022b. and NWS n.d.

**Figure 20. Increasing Trend of Cooling Degree Days During Summer Months in North Platte**

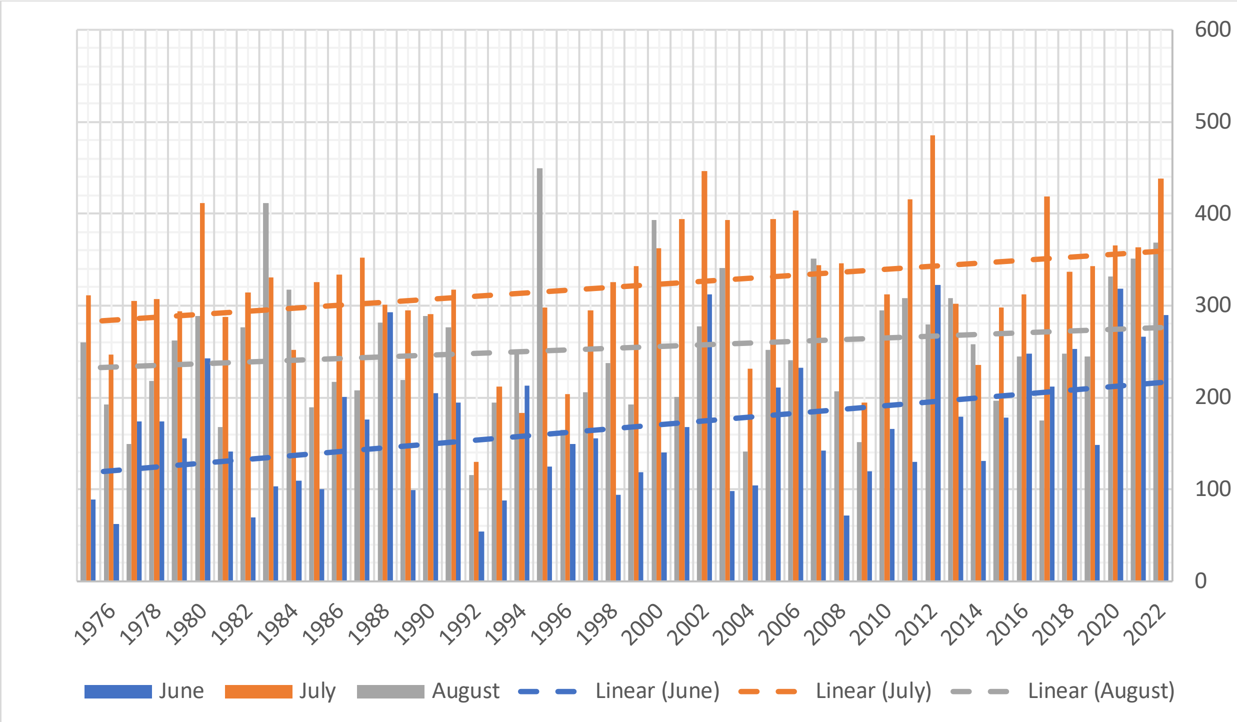
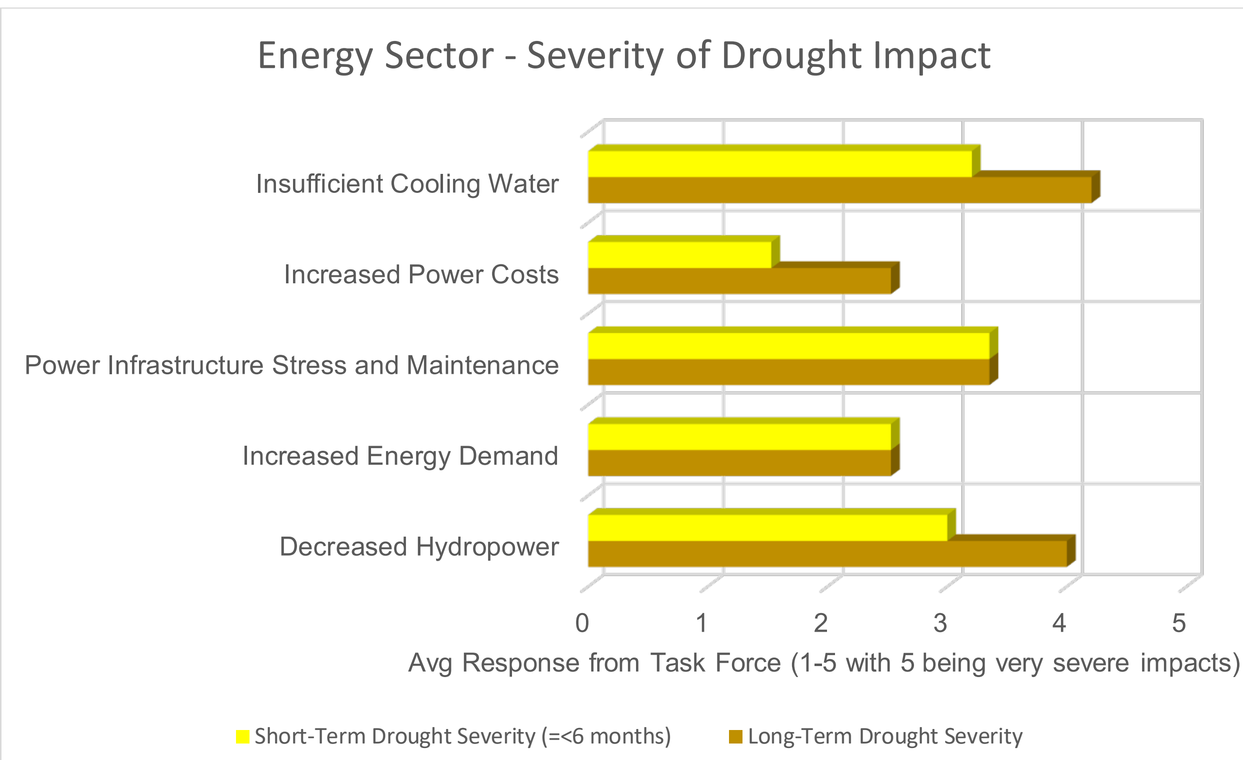



**Figure 21. Priority of Short-Term and Long-Term Drought Vulnerabilities in the Energy Sector Based on Input by Task Force Members During the Second Task Force Meeting in March 2023**

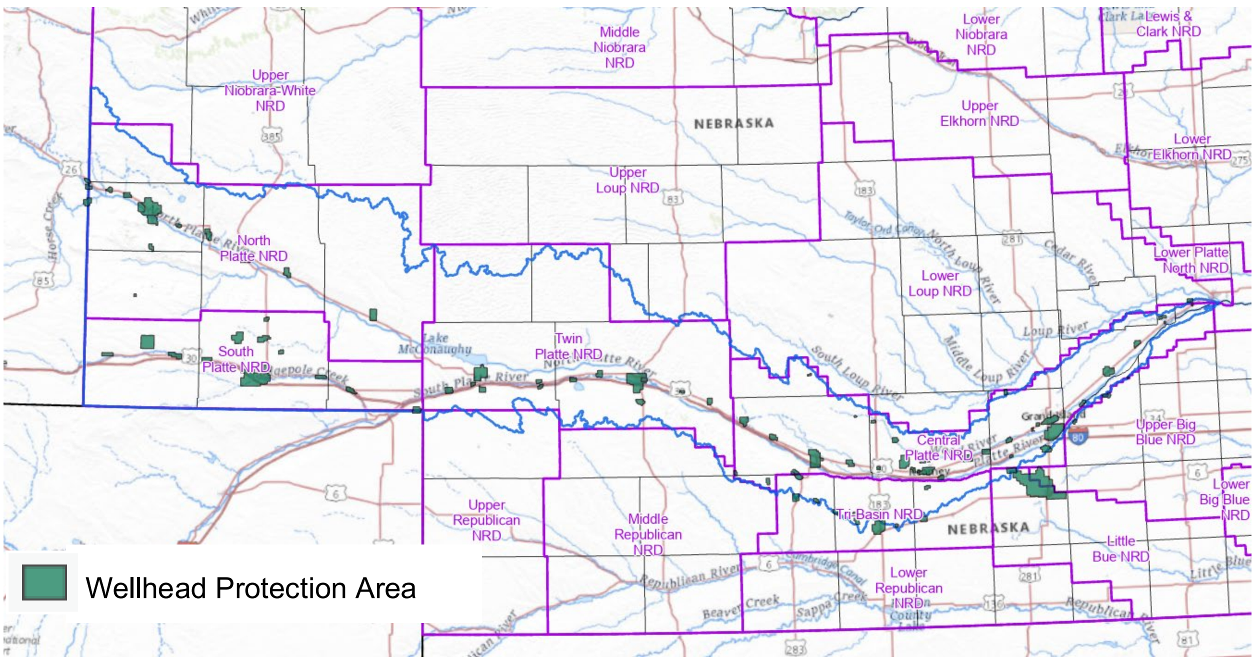


## 4.4 Municipal and Industrial Water Supply

In addition to irrigation, groundwater supplies homes, businesses, and industries. The effect of drought on municipal and industrial water supplies depends on the importance of water for operations. Businesses such as grocers and food production, nurseries, car washes, and construction can be especially hit hard. For industries, key components of operations are dependent on water at a specific time. Droughts affect production, sales, and operations of these industries. Drought can lead to lost production, lost revenue, and increased costs for consumers.

All of the municipal water systems within the UPRB are dependent on groundwater aquifers for their water supply. Additionally, many of the public water supply wellhead areas are within the Platte River Valley or its tributaries and are connected to surface water via recharge from streamflow (see Figure 22). This interconnection to rivers and streams means that times of drought will likely result in groundwater level declines and less efficient pumping operations for many public water supply systems.

**Figure 22. Wellhead Protection Areas of Municipal Groundwater Supplies in the Upper Platte River Basin**




Based on a review of the geologic logs for municipal wells across the UPRB, it is estimated that nearly 50 of the approximately 70 municipal systems operate within an alluvial aquifer that is geologically tied to the High Plains Aquifer. Many of these municipal systems have installed wells that are greater than 100 feet deep. This has made most of the municipalities more resilient and less vulnerable to groundwater level declines during drought conditions, as compared to historically relying on shallower production wells. So, while most municipal water supplies are subject to groundwater level declines during drought, their water supply storage and pumping capabilities are not as vulnerable. Interviews with municipal water superintendents in October 2023 from Sidney, Scottsbluff, North Platte, and Grand Island all agreed with this assessment, concluding that drought conditions should be actively monitored but were not likely to pose an overall threat to having access to an adequate groundwater supply when needed to meet their cities' needs.

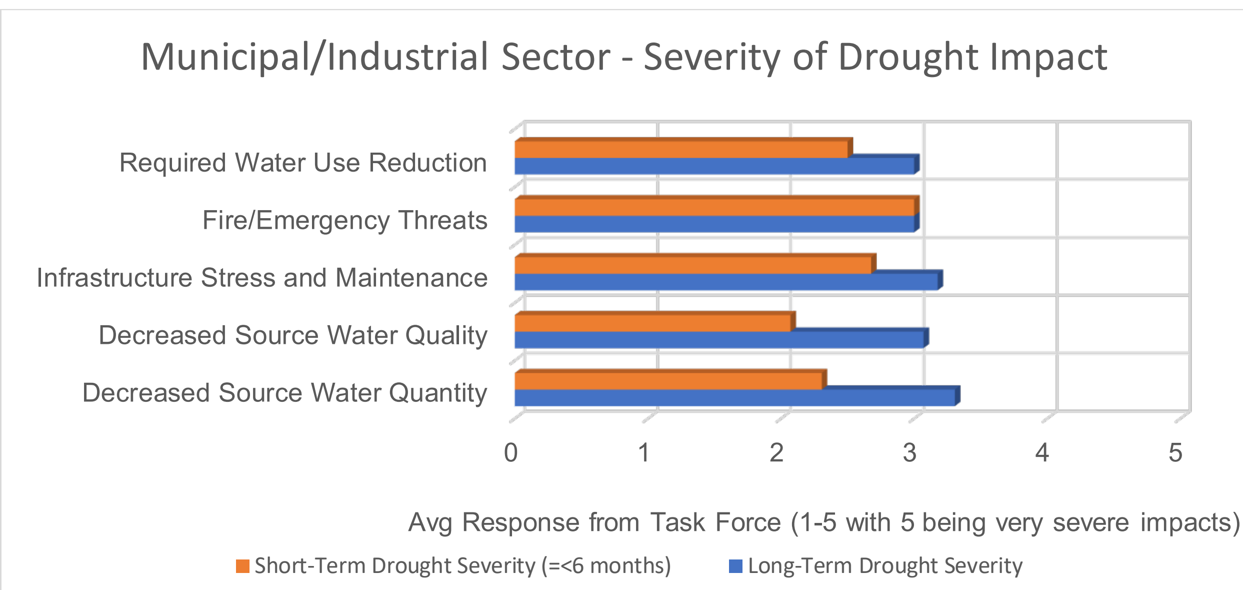
However, municipal water use during drought is a double-edged sword because of supply and demand dynamics. Peak water demand can place greater stress on the groundwater supplies that are already dwindling due to a lack of recharge from local precipitation or connected surface water supplies. This is largely due to the increased water demand during the summer months from irrigation of urban landscapes. Drought can also cause increased water main breaks due to extreme heat, dry soil conditions, and higher water volumes being pumped through the distribution system. This stress placed on the infrastructure of public water supply systems increases vulnerability to disruptions during drought.

Drought conditions that result in significant declines in groundwater elevations also have the potential to negatively affect water quality, specifically related to iron, manganese, nitrate, and uranium. Any drought conditions that would result in lower groundwater levels may affect the concentration of contaminants and, depending on the natural influence of these contaminants on water chemistry, could result in groundwater quality deterioration in a few public water systems. These changes can influence requirements for potable water treatment or put water systems into non-compliance with Safe Drinking Water regulations through the NDWEE. According to NDWEE, as of 2019, eight community water systems in the UPRB were required to monitor drinking water quarterly because of increasing nitrate-nitrite contamination.

Ultimately, most of the vulnerability of municipal water supplies is dependent on groundwater level declines. Monitoring of groundwater levels is completed on a semi-annual basis or on a continuous basis for a limited number of wells by Nebraska NRDs. Many municipalities may also take static or pumping water levels in their groundwater supply wells. Monitoring these levels and making comparisons may also provide information about groundwater decline and drought conditions.

While evaluating the vulnerability of the potential impacts to the municipal/industrial sector, the Task Force prioritized infrastructure stress and maintenance, decreased source water quantity, and reduced revenue as the highest impacts. Priorities during short-term drought are fire/emergency threats, infrastructure stress and maintenance, and required water use reduction (see Figure 23).

**Figure 23. Priority of Short-Term and Long-Term Drought Vulnerabilities in the Municipal/Industrial Sector Based on Input by Drought Task Force Members During the Second Drought Task Force Meeting in March 2023**



## 4.5 Environmental Sector

Droughts can be detrimental to the environmental sector. The result of sustained drought conditions is decreased streamflow and reduced vegetation. Streamflows support T&E species that can become vulnerable during drought periods. The T&E species that could be the most affected by drought in the UPRB are the interior least tern, piping plover, whooping crane, and pallid sturgeon. Instream-flow targets represent discharge conditions that are intended to result in favorable habitat for these species in the Central Platte River. For the whooping crane, USFWS has designated the reach of the Central Platte River from Lexington to Chapman, Nebraska, as critical habitat. Favorable habitat conditions for the whooping crane include an unobstructed river channel with open sand bars and an unforested corridor of at least 1,100 feet as a safe boundary from predators (PRRIP n.d.).

"The piping plover is endangered due to the loss of suitable nesting areas. During prolonged droughts, grasses and vegetation can begin growing on the beaches and sandbars along the Platte River making these areas unsuitable for plover nesting. The interior least tern prefers the sandbars along the Platte River for nesting. The same issue that causes a problem for the plover may also present a problem for the least tern" (Ehrman et al. 2015).

Low streamflows are associated with higher water temperatures and degraded water quality that can lead to fish kills and increased water treatment costs. The 2012 drought and extended high air temperatures caused a number of Nebraska's rivers and streams baseflows to decline and, in some instances, to dry up. As a result, a large number of fish kills in streams and rivers was caused by thermal stress.

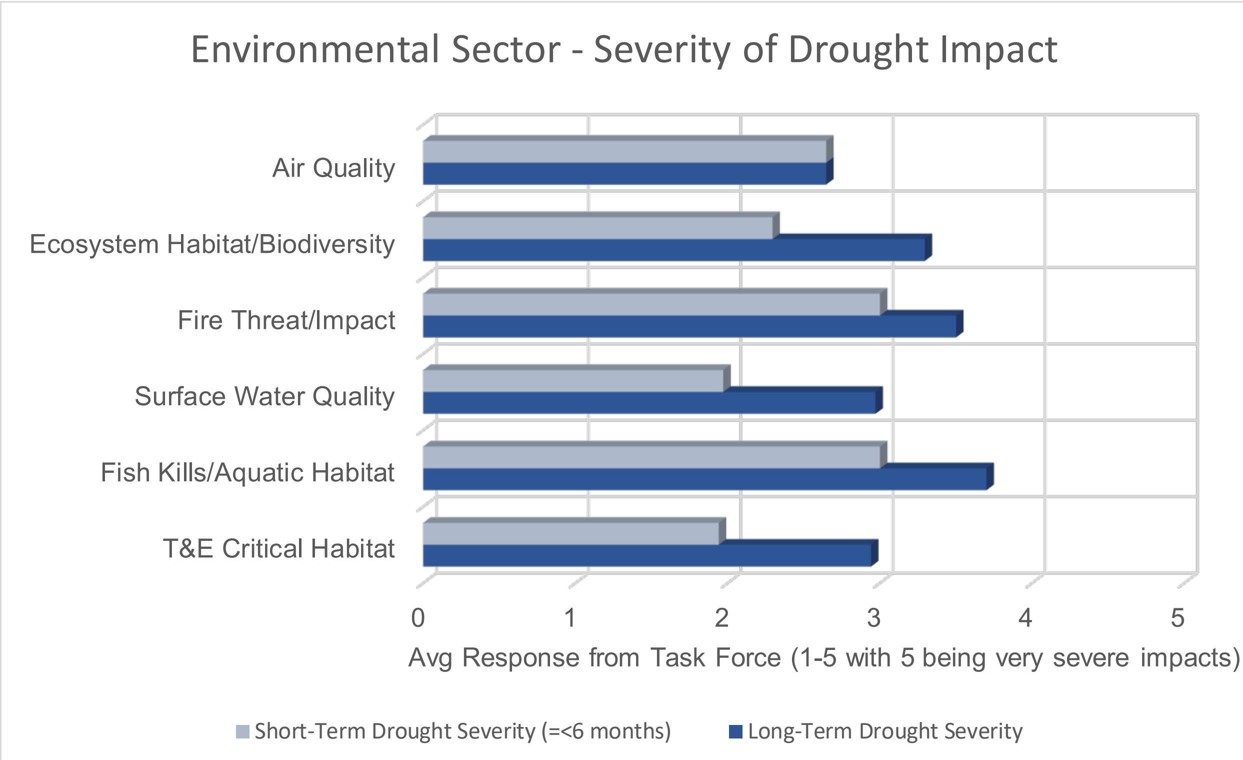
These same weather conditions likely caused many of the "low dissolved oxygen" fish kills that were reported in ponds, lakes, and reservoirs. Lower lake levels lead to higher than optimum water temperatures and are correlated with blue-green algae blooms. Fish kills in lakes are typically caused by low dissolved oxygen concentrations stemming from eutrophic conditions. Eutrophication is a term that describes water quality conditions in a lake or reservoir with high levels of nutrients and aquatic vegetation, which is common during droughts when fresh inflows into the lake or reservoir are limited or nonexistent. Lakes or reservoirs that are eutrophic tend to exhibit frequent algae blooms, warmer water temperatures, and lower dissolved oxygen concentrations. "As water warms, its ability to retain dissolved oxygen is lessened. If warm water conditions persist, eventually the demand for oxygen will surpass the supply and a fish kill will occur" (NDEE 2013).

Drought also has a direct impact on non-agricultural vegetation including grasslands and forests. Drier and hotter conditions lead to a greater risk of wildfire and the encroachment of non-native species and invasive vegetation. According to USDA NASS Cropland Data Layer (2019), nearly 54 percent of the UPRB is grassland or pasture while another 11 percent is also non-agricultural including forests, wetlands, developed and fallow lands. This amounts to a total grassland and forest area of approximately 6.65 million acres. A study by University of Nebraska researchers shows that the average area of land annually burned by wildfire in the Great Plains has grown by more than 400 percent between 1985 and 2014 (Reed 2017).

Wildfires resulting from widespread drought also can threaten air quality. Large plumes of smoke and particulates can travel across continents under certain weather conditions. Satellites are used to forecast and track these air quality impacts, but since there is no abatement possible, the impacts lead to alerts for people to stay inside and avoid inhaling the hazardous air.

The environmental sector impacts from drought include air quality, ecosystem function and habitat, wildfires, surface water quality, aquatic habitat (fish kills), and T&E critical habitat. The severity of impacts for short-term and long-term drought, shown in Figure 24, were derived from responses by the Task Force on July 21, 2022, and March 29, 2023.

**Figure 24. Priority of Short-Term and Long-Term Drought Vulnerabilities in the Environmental Sector Based on Input by Task Force Members During the Second Task Force Meeting in March 2023**




Monitoring environmental sector impacts includes streamflow and lake levels and may also include measurements of relative humidity, water quality, and water temperature. Water temperature readings can be tracked at Lake McConaughy (CNPPID 2023a) and in the Platte River at Overton, Nebraska (USGS 2023).

## 4.6 Recreational Sector

The UPRB is home to about 75 state recreational properties managed by the NGPC (see Figure 25). Together these State Recreation Areas (SRAs) and Wildlife Management Areas (WMAs) comprise almost 69,000 acres. Lakes at these recreation areas along with other lakes in the UPRB provide a total of approximately 37,700 acres of water surface area.

Lake McConaughy is the largest recreation area and lake in Nebraska with a recreation area of nearly 37,000 acres and a lake area (including Lake Ogallala) of over 30,600 acres. Lake McConaughy was the most visited attraction in Nebraska (in 2018) with nearly 2 million visitors.

Drought conditions reduce water-based recreational opportunities, including boating, swimming, and fishing. Drought reduces the surface water and groundwater supplies that feed lakes, leading to lower lake levels and reduced open water surface area. Fishing, primarily, is also impacted by potential eutrophication and fish kills as discussed in Section 4.5.

Drought also has a severe impact on upland habitats, including grassland and forested areas for wildlife. Impacts on these habitats put stress on the availability of food, insects, pollination, and cover. These impacts can increase the threat of plant- and animal-borne diseases both increasing wildlife death rates and reducing birth rates. These impacts on wildlife and habitat result in less wildlife viewing, hunting, and trapping activities throughout the drought-affected area.

The primary drought impacts of recreational opportunities are ranked in Figure 26 and include increases in game and fish disease, decreased upland habitat, less water-based recreation, and less ecotourism.

**Figure 25. Public Recreational Properties Managed by NGPC in the Upper Platte River Basin**

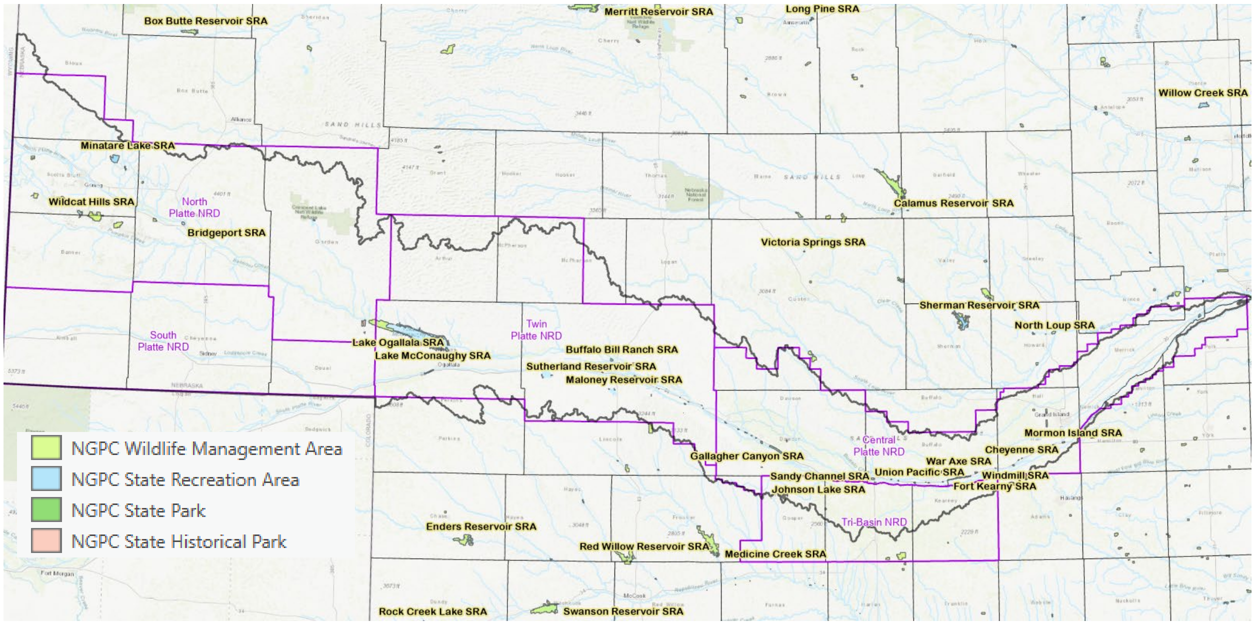
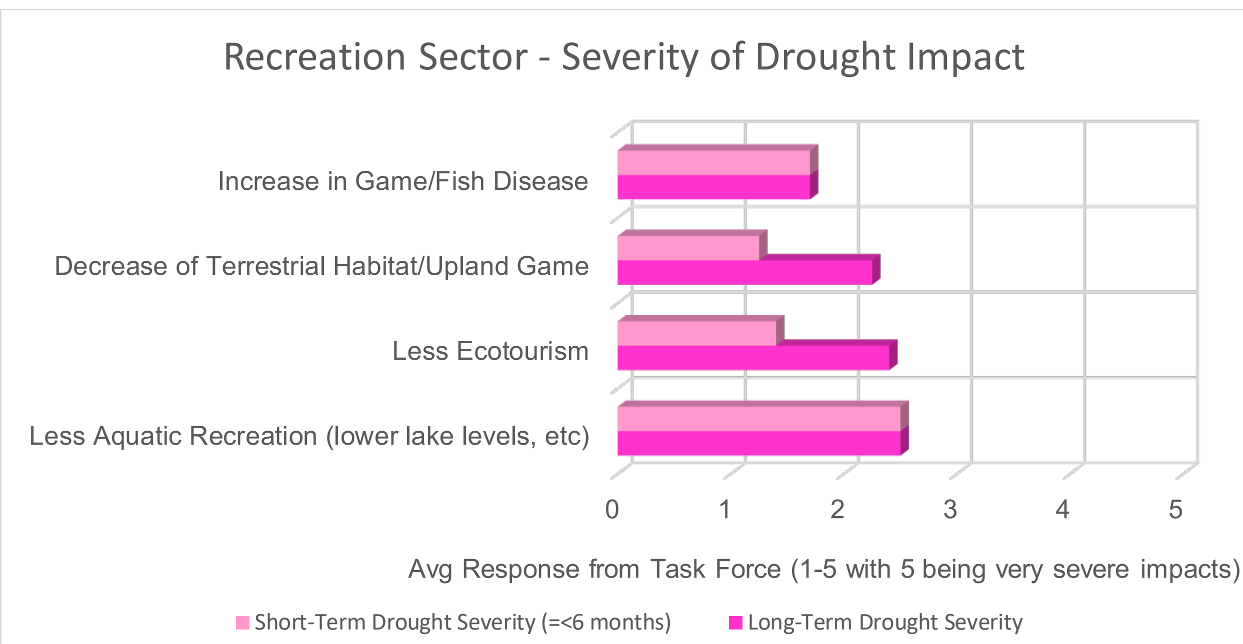



**Figure 26. Priority of Short-Term and Long-Term Drought Vulnerabilities in the Recreation Sector Based on Input by Task Force Members During the Second Task Force Meeting in March 2023**



Monitoring of recreation sector impacts could include number of recreational visitors, campsite reservations, streamflows, and lake levels, as well as measurements of water quality and water temperature. Historic lake elevations at Lake McConaughy are available dating back to 1941 (CNPPID 2023b).

## 4.7 Socioeconomic Sector

The socioeconomic sector includes impacts on human health and the economy. Public health is adversely affected by drought through soil erosion and wildfire smoke, which degrade air quality; result in toxins in water bodies; increase the presence of mosquitos, rodents, and other nuisance insects; and adversely affect public mental health. The Centers for Disease Control and Prevention (CDC) has assessed previous droughts and identified the following possible public health implications due to drought (2023):

> "Compromised quantity and quality of drinking water;
>
> Increased recreational risks;
>
> Effects on air quality;
>
> Diminished living conditions related to energy, air quality, and sanitation and hygiene;
>
> Mental health effects related to economic and job losses;
>
> Compromised food and nutrition; and
>
> Increased incidence of illness and disease."

When drought reduces the size of water bodies, it can also cause open water to become more stagnant, providing additional breeding grounds for certain types of mosquitoes, which can carry West Nile virus. Additionally, smaller water bodies with higher water temperatures can lead to reduced oxygen levels in lakes and reservoirs as well as increased eutrophication in area lakes that can result in blue-green algae cyanotoxins, which can be harmful to animals and humans if ingested. "Toxins originating from freshwater blooms of cyanobacteria … can become airborne and have been associated with lung irritation, which can lead to adverse health effects in certain populations" (CDC 2020a).

"The dusty, dry conditions and wildfires that often accompany drought can harm health. Fire and dry soil and vegetation increase the number of particulates that are suspended in the air, such as pollen, smoke, and fluorocarbons. These substances can irritate the bronchial passages and lungs, making chronic respiratory illnesses like asthma worse. This can also increase the risk for acute respiratory infections like bronchitis and bacterial pneumonia" (CDC 2020a).

Sustained heat and heat waves during drought can result in dehydration, heat exhaustion, or heat stroke for humans who are overly exposed outdoors or are already vulnerable. Heat-related illnesses can be from both short-term exposure and chronic exposure over longer periods of weeks or even months.

Economic impacts from drought are far reaching and may persist long after the actual drought conditions have passed. "In 2012, the most geographically extensive drought to affect the U.S. since the 1930s covered 50% of the county and cost $31 billion" in economic losses (CDC 2020b). Economic impacts extend from direct losses to indirect impacts that affect supporting businesses and government. Long-term drought impacts can affect income and property values which, in turn, have long-lasting impacts throughout an entire community, including schools, banking, businesses, and public infrastructure.

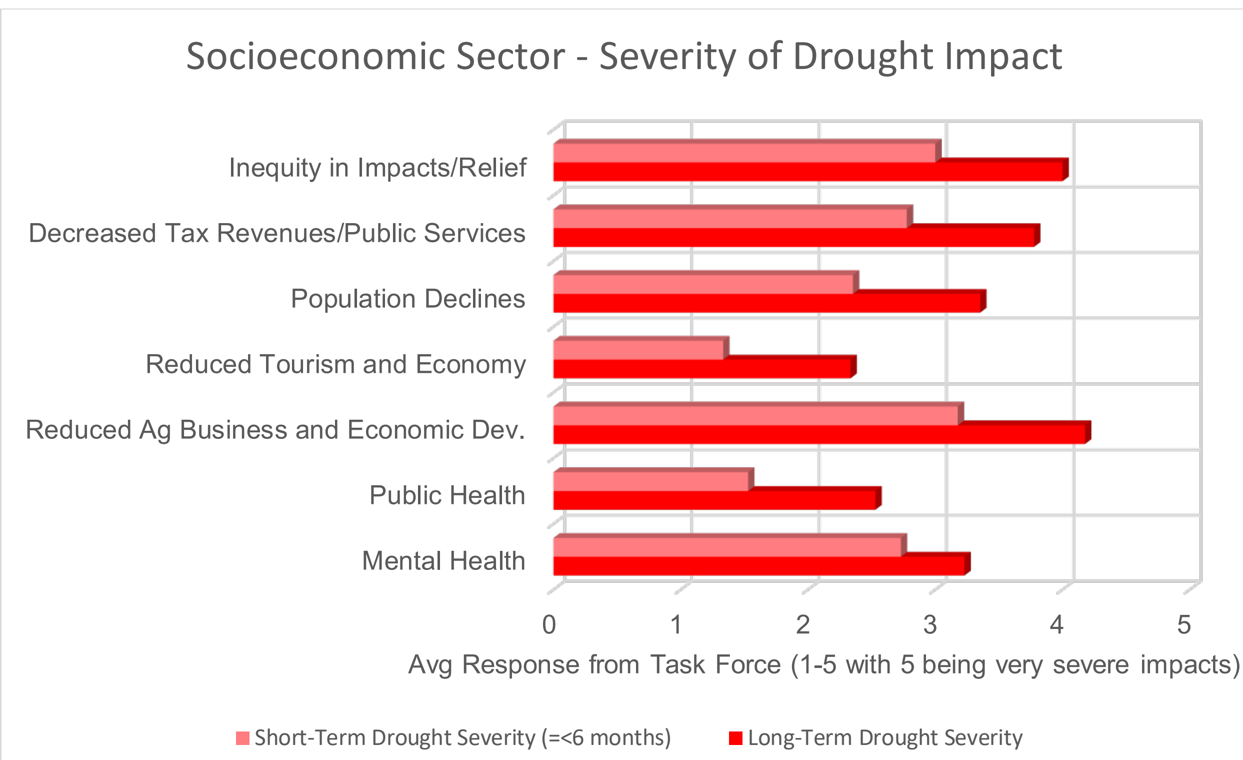
Together, health and economic impacts from drought can lead to mental health impacts, including mood disorders, substance abuse, domestic violence, and suicide (NOAA n.d.a). Mental health effects are often compounded and increase the longer a drought persists. A 2015 literature review in the *International Journal of Environmental Research and Public Health* (Vins et al.) resulted in the identification of major pathways through which drought has been linked with mental health outcomes.

Many drought-related factors or outcomes can induce human stress, anxiety, or social isolation. These factors can include increased workloads, disruption of children's education, shame and humiliation over financial struggles, household or family tension, and even migration of people away from the drought-stricken area. Additionally, the Vins et al. 2015 publication, co-authored by Jesse Bell (now at the University of Nebraska Medical Center College of Public Health), noted that rural and remote populations face a unique set of challenges that increase their vulnerability during drought. These challenges include a reluctance to seek assistance for mental health problems due to a culture of self-reliance, the social visibility present in small, rural communities, and the lack, or perceived lack, of resources available.

The presence of government initiatives to provide financial assistance during times of drought may serve as mitigation against mental health impacts for those eligible for such assistance. It is noted, however, that many people affected by indirect economic impacts do not receive financial relief and this may cause stress or tension within a local community as well.

Of all the socioeconomic impacts, the Task Force prioritized reduced agricultural business and economic development along with inequity of impacts and relief as the most severe with relatively high long-term drought implications (see Figure 27). For each impact, long-term drought poses a more severe risk than short-term drought due to the compounding effect of a multi-year drought.

**Figure 27. Priority of Short-Term and Long-Term Drought Vulnerabilities in the Socioeconomic Sector Based on Input by Task Force Members During the Second Task Force Meeting in March 2023**



Measurement of public health and economic impacts is typically reactive or historic rather than real-time or forecast. The best indicators to monitor for socioeconomic impacts include weather measurements and forecasts (specifically temperature and humidity) as well as air quality measurements and forecasts. The NDWEE also provides a public beach monitoring program that provides weekly tests for bacteria and microcystin at over 50 sites (NDWEE n.d.).

## 4.8 Potential Future Vulnerabilities Attributable to Climate Change and Population Growth

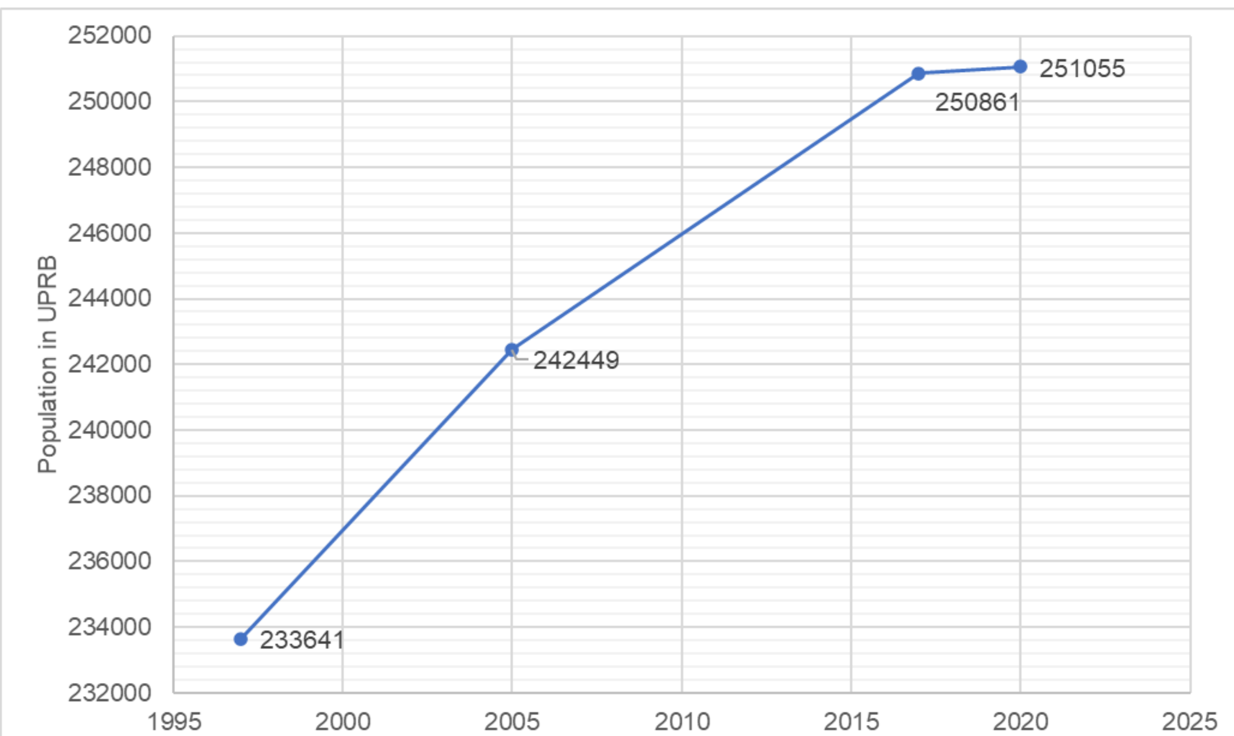
Several factors influence future water demands. Population changes can affect domestic use, commercial and industrial use, and ultimately agricultural use related to providing an adequate food supply for areas far beyond the UPRB. In addition, climate change over the next century is projected to increase demand for both existing and future uses.

Future demands were addressed in the Basin Plan. Based on the Basin Plan accounting methodologies, no new or increased demands from future population growth are allowed without offsetting basin depletions back to pre-1997 levels. As such, future growth in demand is not explicitly incorporated into the development of mitigation or response actions as part of this Drought Plan.

### 4.8.1 Population Growth

Figure 28 shows the population change within the UPRB since 1997. This data is available from the Platte River Cooperative Hydrology Study (COHYST) Population Change Analysis Report (NeDNR 2023b).

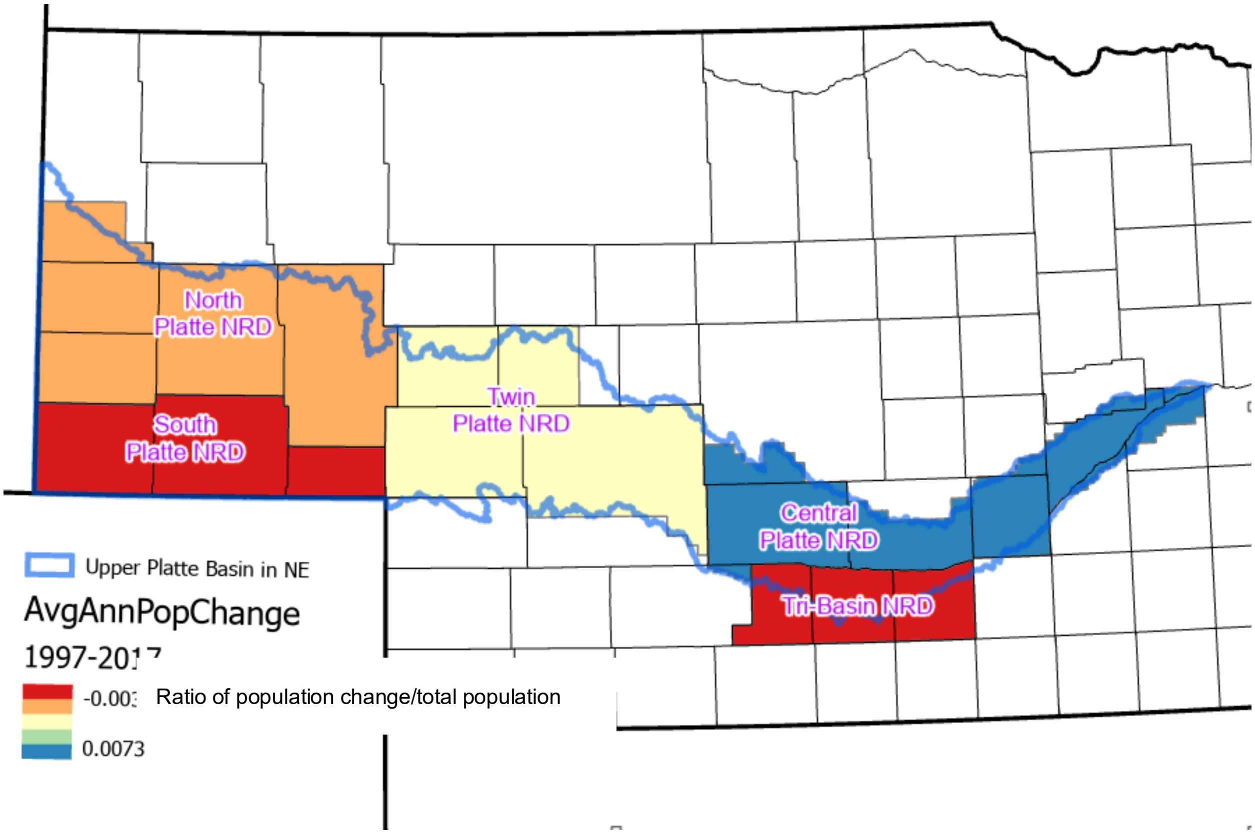
**Figure 28. Population in the UPRB since 1997–2020**




It is important to investigate population trends to understand where growth is occurring and, consequently, where increased water demand may occur. The largest population centers in the

UPRB are in Hall County, followed by Buffalo and Scotts Bluff Counties. Figure 29 shows the annual average population change across the five NRDs as either decreasing (orange and red), neutral (yellow), or increasing (blue).

**Figure 29. 1997 to 2017 Population Change by NRD**




Average annual population change is presented as the ratio of population change to the total population. Positive values indicate an increase in population from 1997–2017, whereas negative values indicate a decrease in population. Source: NeDNR 2017.

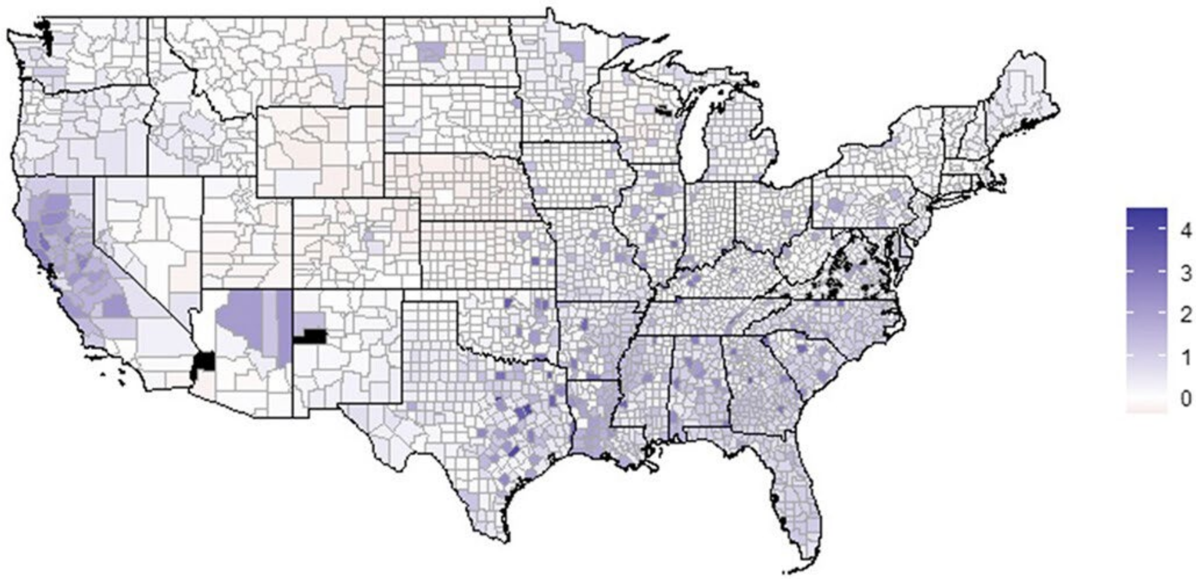
### 4.8.2 Projected Future Water Demand Due to Climate Change

"Projections of Freshwater Use in the United States under Climate Change" (Warziniack et al. 2022) examines recent trends in water use and makes projections for future water use. The projections are based on socioeconomic and climate scenarios from the Intergovernmental Panel on Climate Change's Fifth Assessment Report. This 2022 article found that climate models show a wide range of futures for the United States. Under dry climate models, the South, Southeast, and Great Plains show decreases in water yield. Those same regions, however, see increases in water yield under wet scenarios.-For the drier areas, farmers and households will have to increase their water use to maintain crops and lawns (Warziniack et al. 2022).

This projection assumes "future gains in water use efficiency and reductions in irrigated area in the west" (Warziniack et al. 2022). However, when climate change is considered, significant increases in water demand can occur.

Because there is such a large amount of uncertainty in climate change projections related to uncertainty of future drivers of water use (e.g., climate, population) and rapid changes in the way Americans use water, projections for total consumptive use are averaged together for all uses and climate change scenarios. Figure 30 shows the geographic distribution of the projected change in consumptive use based on multiple climate change scenarios. It is shown that most of Nebraska would have less than a 1 percent increase in total consumptive use.

**Figure 30. Mean Percent Change in Total Consumptive Use Across Climate Change Scenarios**




Source: Warziniack et al. 2022.

An earlier 2013 study (Brown, Foti, and Ramirez 2013) analyzed the increases isolated to climate change by evaluating effects of increasing temperature (T), decreasing precipitation (P), and increased evapotranspiration ($ET_p$). A decrease in precipitation results in increases in agricultural irrigation and landscape watering. “Although specific regions of the U.S. are projected to experience either increases or decreases in precipitation, at the national scale, little change in precipitation is projected” (Brown, Foti, and Ramirez 2013). As temperatures increase, there is an “increasing water use at thermoelectric plants to accommodate the electricity needed to satisfy increasing space cooling demands that occur with rising temperatures” (Brown, Foti, and Ramirez 2013). Increasing $ET_p$ (corresponding to increased temperatures) results in increased agricultural irrigation and landscape watering “as plant water use responds to changes in atmospheric demand” (Brown, Foti, and Ramirez 2013).

“The temperature effect is slightly larger than the precipitation effect, reaching a 3 percent increase in water use by 2060 and 5 percent increase in 2090” (Brown, Foti, and Ramirez 2013). “The $ET_p$ effect is [much larger], reaching 16 percent in 2055 and 23 percent in 2090” (Brown, Foti, and Ramirez 2013). “The combined (temperature, precipitation, $ET_p$) effect of a changing climate is to increase total withdrawal in the U.S. by about 20 percent in 2060 and by about 30 percent in 2090, as compared to a future without climate change” (Brown, Foti, and Ramirez 2013).

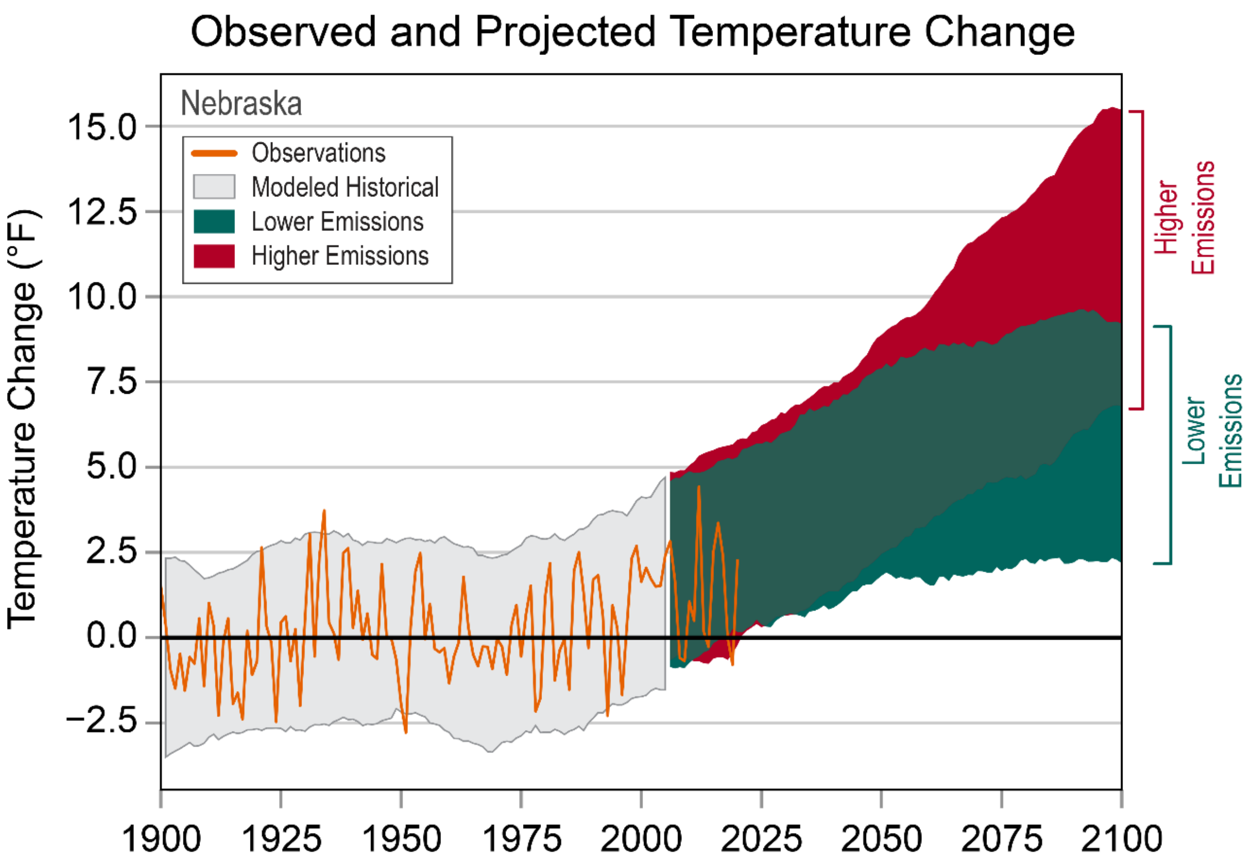
#### 4.8.2.1 Temperature Increase

Changes in extreme weather and climate events, such as heat waves and droughts, are the primary way that most people experience climate change. Human-induced climate change has already increased the number and strength of some of these extreme events. Over the last 50 years, much of the U.S. has seen increases in prolonged periods of excessively high temperatures, heavy downpours, and in some regions, severe floods and droughts (Melilo, Richmond, and Yohe 2014).

Nebraska has experienced an overall warming of about 1 degree Fahrenheit (°F) since 1895 (Bathke et al. 2014). Nine of the warmest years on record have occurred during the past 20 years, since 2004 (NOAA 2024).

Figure 31 shows observed and projected changes (compared to 1901–1960 average) in near-surface air temperature in Nebraska. Unprecedented warming is projected during the twenty-first century. Less warming is expected under lower emissions future (the coldest years being about as warm as the warmest years in the historical record; shown in green in Figure 31) and more warming under a higher emissions future.

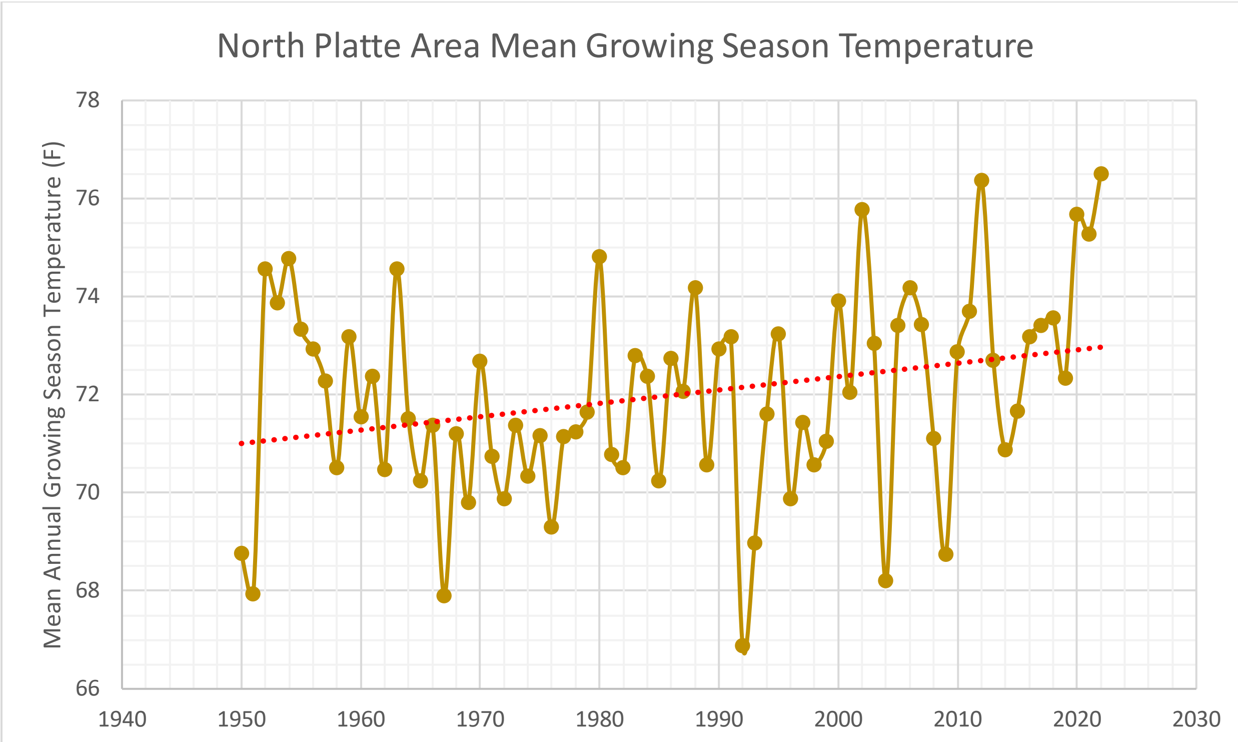
**Figure 31. Observed and Projected Temperature Change in Nebraska**




Source: NOAA 2022.

Local climate results for the UPRB are no exception. According to NWS data for the North Platte area, mean monthly temperatures experienced during the summer growing season (June to August) have experienced an increasing trend from approximately 71°F in 1950 to 73°F in 2022, a rate of about 2.7 percent or approximately 0.3°F each decade (see Figure 32).

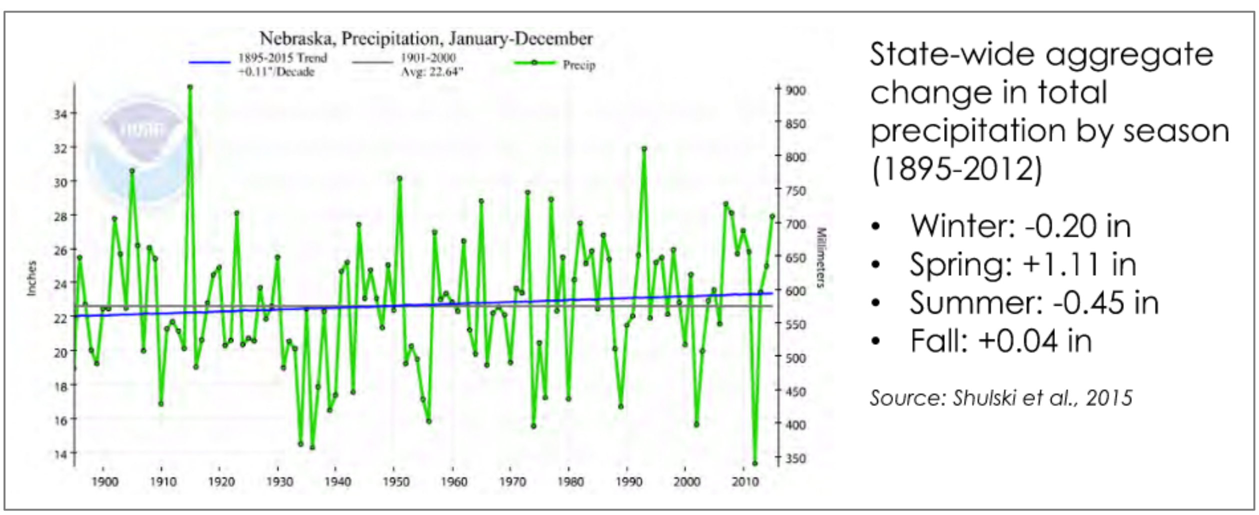
**Figure 32. Increasing Trend of Mean Growing Season Temperature in the North Platte Area**




#### 4.8.2.2 Precipitation Changes

According to the UNL report *Understanding and Assessing Climate Change: Implications for Nebraska* (Bathke et al. 2014), climate change may impact the hydrologic system across the state in several ways. Overall, Nebraska has observed an uptick in average annual precipitation since 1895. However, these changes have also fluctuated between seasons with increases in spring precipitation and decreases in winter and summer (see Figure 33).

**Figure 33. Fluctuations in Statewide Precipitation Between Annual Seasons**




Source: Shulski et al., 2015.

### 4.8.2.3 Reduction in Snowpack

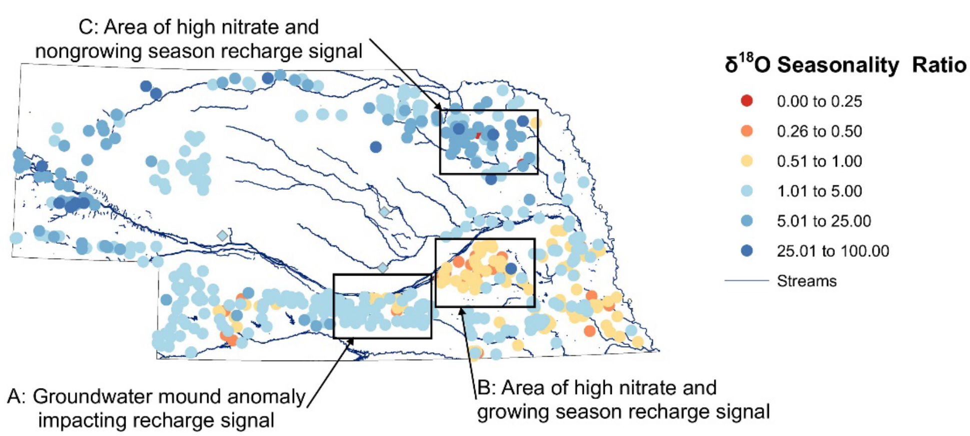
This long-term change in precipitation patterns points to more rain and less snow. A major concern for Nebraska and other central Great Plains states is the projected reduction in snowpack for the central and northern Rocky Mountains. “Reduced snow and a change in the melting regimen both result in a change in the quantity and timing of runoff that may lead to greater water stress during the summer months and increased challenges for water management” (Bathke et al. 2014).

The EPA’s analysis of snowpack as a climate change indicator is based on data from the USDA Natural Resources Conservation Service (NRCS) Water and Climate Center. This analysis indicates that the snow water equivalent (SWE) as of April each year has declined at over 90 percent of the Snow Telemetry (SNOTEL) sites measured with an average decline of about 23 percent from 1955 to 2022.

### 4.8.2.4 Implications Related to Groundwater Recharge

Long term, this temporal change in precipitation by seasons will likely have implications for groundwater recharge as well as streamflow, ultimately having the potential to reduce baseflow discharges to streams and rivers and/or reduce groundwater levels and storage. First, heavier, more intense rainfall will result in more runoff and ultimately less soil moisture, leading to less groundwater recharge. Also, because of the high transpiration demands of crops and vegetation in the late spring and summer, little groundwater recharge occurs during this time of year. This conclusion that a majority of groundwater recharge occurs during the non-growing season is supported by 2020 research from UNL (see Figure 34) (Matteson 2020). If groundwater recharge is primarily supported by soil moisture remaining after the growing season and what precipitation is available in the fall and winter, then it can be inferred that less available water will result in less recharge.

**Figure 34. Seasonality of Groundwater Recharge**




Based on groundwater recharge ratios the majority of Nebraska shows a modest bias toward nongrowing season recharge (ratio >1). Human activities such as irrigation can alter recharge seasonality (A and B). Areas with high nitrate but different recharge seasonality may respond differently to groundwater quality management strategies (B and C).

Source: Matteson 2020.

The study presented in “Why Do Different Drought Indices Show Distinct Future Drought Risk Outcomes in the U.S. Great Plains?” suggests potential for chronic drought across the Great Plains in the future (Feng et al. 2017). Of particular concern is the potential for climate change to increase the severity, frequency, and duration of future droughts, presenting greater challenges for managing Basin water resources and mitigating drought impacts. These potential future drought conditions were considered in developing and evaluating the drought mitigation and response actions.

# 5.0 Drought Monitoring

Drought monitoring provides a means of measuring drought, such as when a drought starts and ends, how severe it is, and the degree to which various sectors are impacted. Monitoring provides a framework to predict the probability of drought or to confirm an existing drought. Drought monitoring includes collection and analysis of items such as water availability, precipitation, and other data.

Drought monitoring for this Drought Plan is intended to provide Basin-wide coverage and set “Advisory” and “Alert” status for Basin-wide response actions as indicated in Section 1.0. Future NRD-level drought plans may use the monitoring data described in this Drought Plan as triggers for individual NRD response actions.

## 5.1 Monitoring Plan

Numerous drought monitoring indicators were considered during the development of this Drought Plan based on their effectiveness at forecasting or determining the onset of drought conditions and impacts. Because the UPRB across Nebraska is extensive, the effectiveness of various indicators varied by geographic location and distribution.

Results of an evaluation of drought impacts as correlated to drought monitoring indicators and a review of drought monitoring data and historic droughts are included in Appendix A.

Based on this evaluation and review, the Coalition has determined that some indicators best represent the forecast or existing drought conditions on a Basin-wide level or reflect existing or forecast water supplies within applicable subareas (Figure 35). Trigger levels selected for Basin-wide drought monitoring indicators are presented in Table 11.

**Table 11. Basin-Wide Drought Advisory and Alert Triggers**

| Drought Indicator | Advisory Trigger | Alert Trigger | Applicable Areas |
|---|---|---|---|
| U.S. Drought Monitor (USDM) | D0+D1 > 75% area<br>OR<br>D1 > 50% area | D2 or worse > 50% area | Basin-wide and all subareas |
| Evaporative Demand Drought Index (EDDI) (1-month) | ED0+ED1 > 75% area<br>OR<br>ED1 > 50% area | ED2 or worse > 50% area | Basin-wide and all subareas |

Drought monitoring data that best indicate the forecast or current water supplies were selected for specific subareas of the UPRB as shown in Figure 35. The subareas include the North Platte

River drainage upstream of Lake McConaughy, the South Platte River drainage upstream of the confluence at North Platte, Nebraska, and the remaining drainage area from Lake McConaughy and the South and North Platte River confluence downstream to the Loup River and Platte River confluence. The triggers selected for these water supply subarea drought indicators are listed in Table 12.

**Figure 35. Surface Water Supply Monitoring Subareas**

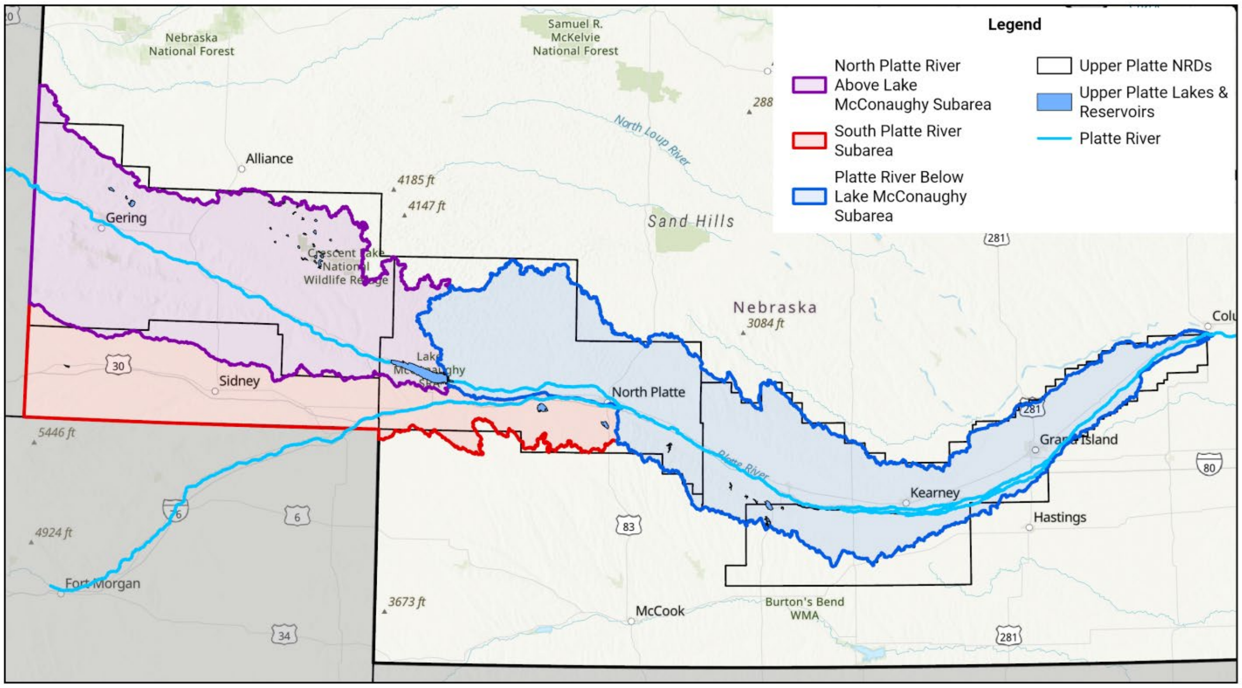



**Table 12. Surface Water Supply Subarea Advisory and Alert Conditions**

| Water Supply Indicator | Advisory Trigger | Alert Trigger | Applicable Areas |
|---|---|---|---|
| South Platte River streamflow at Julesburg | N/A | Mean daily discharge < 120 cfs (April 1–October 15) | South Platte River to the North Platte River Confluence |
| Bureau of Reclamation Forecast North Platte Supply | Forecast supply < 1.1 MAF (October, February, March) | Forecasted supply < 1.1 MAF (April, May, June) | North Platte River above Lake McConaughy |
| Lake McConaughy Storage | <70% of average monthly storage (1991–2020 average) | <60% of average monthly storage (1991–2020 avg) | Lake McConaughy to the Loup River Confluence |

cfs = Cubic Feet per Second; MAF = Million Acre-Feet; N/A = Not Applicable

The drought monitoring data selected for triggers in Table 11 and Table 12 are described in more detail in Section 5.3. Drought monitoring data not selected for triggers but selected as supplemental data for decision-making when triggers are met, are described in Section 5.4.

The Department, on behalf of the Coalition, will maintain a public drought monitoring dashboard. The dashboard will automate drought data collection and display trigger statuses for the Basin and for each subarea. Once available, the dashboard link will be available on the Department's website and shared with stakeholders.

## 5.2 Drought Types

Determining the start, end, and severity of drought is complex, so scientists have described different types of drought based on impacts and timing. A reduction in the amount of precipitation received over time is referred to as a "meteorological drought." A meteorological drought can occur without immediately impacting streamflow, groundwater amounts, or people's lifestyles. If a meteorological drought continues, it will eventually begin to affect other water resources.

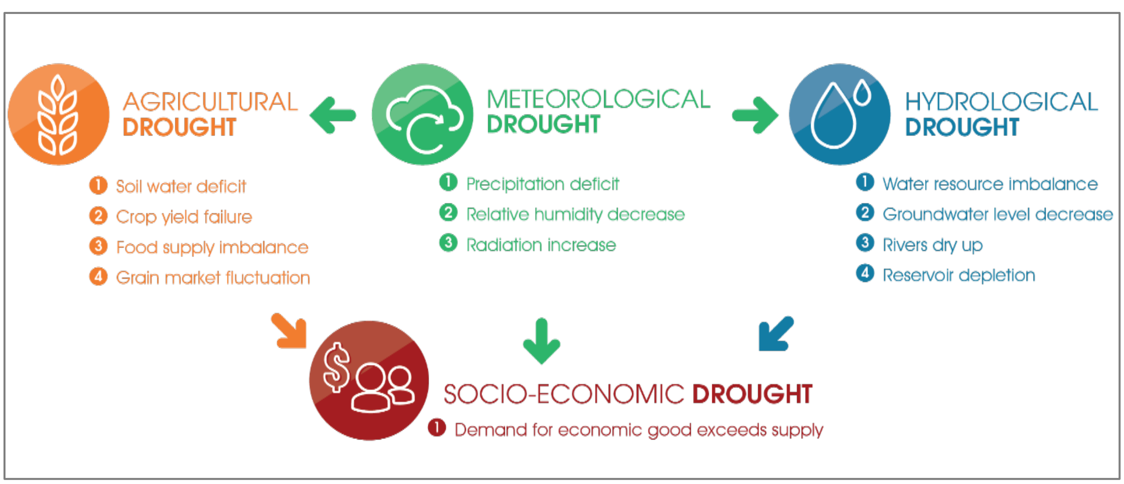
Evaporation is continually taking place from soil, provided it is not frozen. Some of this evaporation is generated as plants take in moisture through roots and transpire through leaves. This process, called "evapotranspiration," is critical to keep plants alive and growing. Soil moisture will become depleted due to a reduction in precipitation and continued or increased consumptive use from evapotranspiration. This type of drought is referred to as an "agricultural drought." If an agricultural drought continues, plants will begin to protect themselves by reducing their water use, which can potentially reduce crop yields, reduce grazing forage, and deteriorate wildlife habitat.

Rainfall recharges groundwater aquifers through infiltration of the soil and runoff into streams and rivers. Once groundwater and surface waters are significantly impacted by lack of precipitation, a "hydrologic drought" occurs. A minor drought may affect small streams, causing low flows or drying. A major drought could impact surface storage, lakes, and reservoirs, affecting water quality and causing municipal and agricultural water supply problems. Aquifer declines can range from a quick response (shallow sand) to impacts extending over multiple years. Impacts can include depletion of shallow depth wells, drying of farm ponds, and changes to groundwater quality. The surface water and groundwater processes are generally not influenced as easily as with an agricultural drought, but impacts will appear over time.

At any time during these types of droughts, a "socioeconomic drought" can occur. Deficits of precipitation impacting agricultural, industrial, commercial, municipal, and other sectors generate a reduction in economic output, restrictions to lifestyles, or effects noticeable to the public. Mandatory water conservation measures may come into effect, which can alter lifestyles.

Figure 36 shows the interactions among different types of droughts. Drought has its origin in meteorological drought, which then affects agricultural and hydrologic sectors leading to socioeconomic impacts.

**Figure 36. Drought Transfer Process and Interactions**




Source: Adapted from National Drought Mitigation Center (NDMC) 2018.

## 5.3 Drought Monitoring Trigger Data

Drought monitoring can include numerous indicators and indices. Drought indicators are measurements such as precipitation, streamflow, reservoir storage or soil moisture. Indicators are useful in directly measuring an element of concern. The disadvantage is that indicators often cannot be directly compared between areas and possibly over time. For example, 1 inch below average precipitation in Scottsbluff, where average annual rainfall is about 15.8 inches per year, is more significant than the same change in Grand Island, where the average is above 25 inches per year.

In comparison, drought indices are measures of anomalies, ideally comparable across a large area and over a long period. A precipitation index, therefore, takes the area average into account and conveys above and below average information. Neither drought indices nor indicators are forecasts. These are current and past measurements that can show possible impacts based on previous drought examples.

For the purposes of this monitoring plan, indices and indicators that were considered need the following characteristics:

- A history of use in the UPRB. This history allows evaluation of an index or indicators in the context of previous droughts and demonstrates usefulness of measurements.
- Widely collected throughout the UPRB. Differences in typical precipitation, weather patterns, soils, geology, and landforms throughout the area require widespread area-specific measurements.
- Likelihood that it will continue to be collected. If climate stations or other measurement sites become unavailable in the future, the monitoring plan will need to be revised to account for the loss of data. While future funding is not always known, the percent completeness of data and length of time that data was collected can be an indicator of the interest in continued operation of data collection sites.
- Authoritative and readily available data. One goal of the Drought Plan is the production of an online drought dashboard that presents pertinent drought information. Automation to link with other existing databases will assist in the development of this dashboard.
- Be updated in a timely fashion. Drought information that requires a great deal of effort to collect and process may not be available when decisions on mitigation or response actions are needed. For purposes of this monitoring plan, drought monitoring items should ideally be available within 1 month of collection.

The Department is responsible for collecting and assimilating the drought monitoring data selected for triggers in the online drought dashboard described in Section 1.0. Table 13 lists the indices and indicators selected for use as triggers in this Drought Plan. Each index or indicator selected is described in further detail below.

**Table 13. Monitoring Data Selected for Drought and Surface Water Supply Triggers**

| Index or Indicator | Description | Monitoring Timeframe | Collection Responsibility |
|---|---|---|---|
| USDM jointly produced by NOAA, the USDA, and NDMC | Multiple drought indicators, including various indices, outlooks, field reports, and news accounts are reviewed and synthesized to develop a consensus assessment presented as the USDM map. | Weekly Updates | Dashboard |

| Index or Indicator | Description | Monitoring Timeframe | Collection Responsibility |
|---|---|---|---|
| EDDI (NOAA Physical Sciences Laboratory) | Tracks atmospheric evaporation demand, often described as the "thirst of the atmosphere." Produced daily and available in 1-to-12-month timeframes. | Weekly Updates | Dashboard |
| Streamflow in the South Platte River @ Julesburg | Measures and records stream discharge. Data available from USGS and the Department. | Daily Updates | Dashboard |
| BOR Forecast North Platte Supply | See Great Plains Region Water Supply Report at https://www.usbr.gov/gp/lakes_reservoirs/wareprts/wsrp.html. | Monthly Updates | Department |
| Reservoir Storage in Lake McConaughy | Current and projected Lake McConaughy reservoir storage provided by CNPPID. | Monthly Updates | Dashboard |

BOR = United States Bureau of Reclamation; CNPPID = Central Nebraska Public Power and Irrigation District; EDDI = Evaporative Demand Drought Index; NDMC = National Drought Mitigation Center; NOAA = National Oceanic and Atmospheric Administration; USDA = United States Department of Agriculture; USDM = United States Drought Monitor; USGS = United States Geological Survey

Based on this evaluation and review, the Coalition has determined that some indicators best represent the forecast or existing drought conditions on a Basin-wide level or reflect existing or forecast water supplies within applicable subareas. Trigger levels selected for Basin-wide drought monitoring indicators are presented in Section 5.1 and Table 11.

### 5.3.1 United States Drought Monitor (USDM)

The USDM is a component of the National Integrated Drought Information System and produced jointly by NOAA, the USDA, and the National Drought Mitigation Center (NDMC). The USDM is a weekly product that provides a general summary of current drought conditions.

Multiple drought indicators, including various indices, outlooks, field reports, and news accounts are reviewed and synthesized. In addition, numerous experts from agencies and offices across the country are consulted. The result is the consensus assessment presented on the USDM map. The USDM information is usually summarized in the North Central and U.S. Monthly Climate and Drought Summary Outlooks.

Figure 37 shows an example of drought conditions. Conditions are assessed on a scale from D0 (abnormally dry) to D4 (exceptional drought). Links between drought conditions and possible impacts are provided within the USDM. For example, D1 droughts begin to show surface water impacts and D2 impacts are associated with reduced crop yields. The USDM also compiles outlooks and reports from other sources, such as the NOAA Climate Prediction Center (CPC). Figure 38 is an assessment of future drought conditions, which indicates chances of drought improving, worsening, or staying the same.

The USDM was selected as a trigger because it is widely relied upon by the agricultural industry and it displays drought data at various geographic scales (watershed, regional, state, county, and local). The drought dashboard will measure and report the percentage of the UPRB and each subarea reporting D0, D1, D2, D3, and D4 drought conditions. Those percentages will be used to determine if the Advisory or Alert triggers reported in Table 13 are being met or exceeded.

**Figure 37. Example USDM Condition Map**

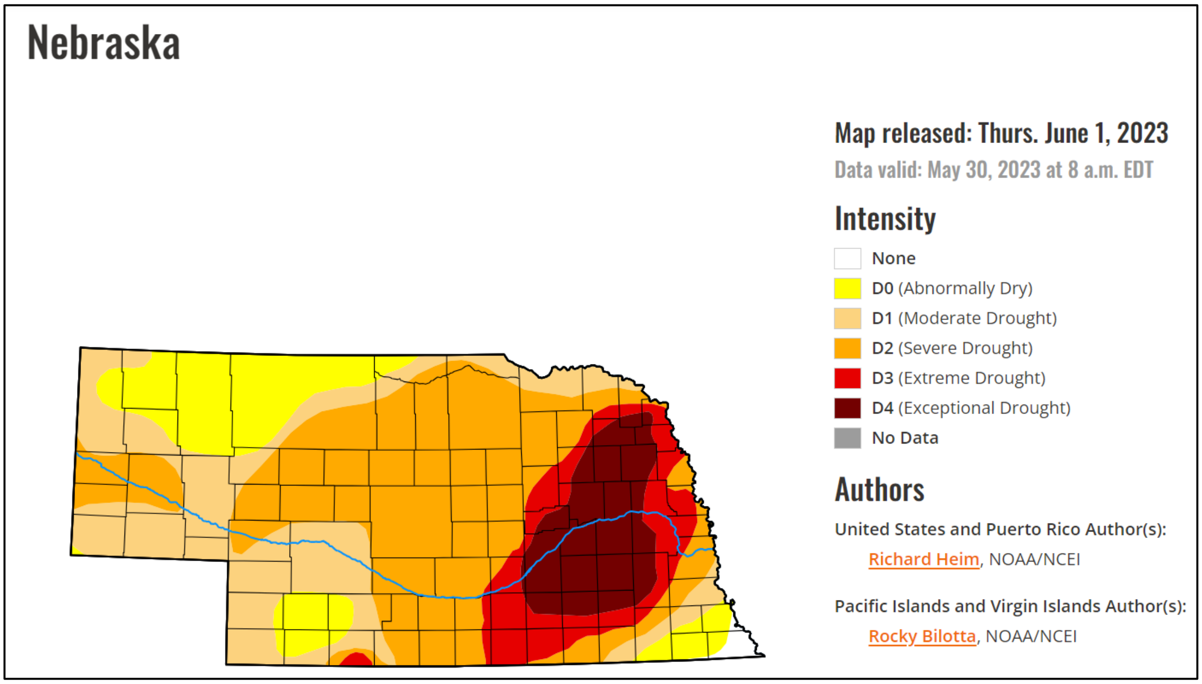
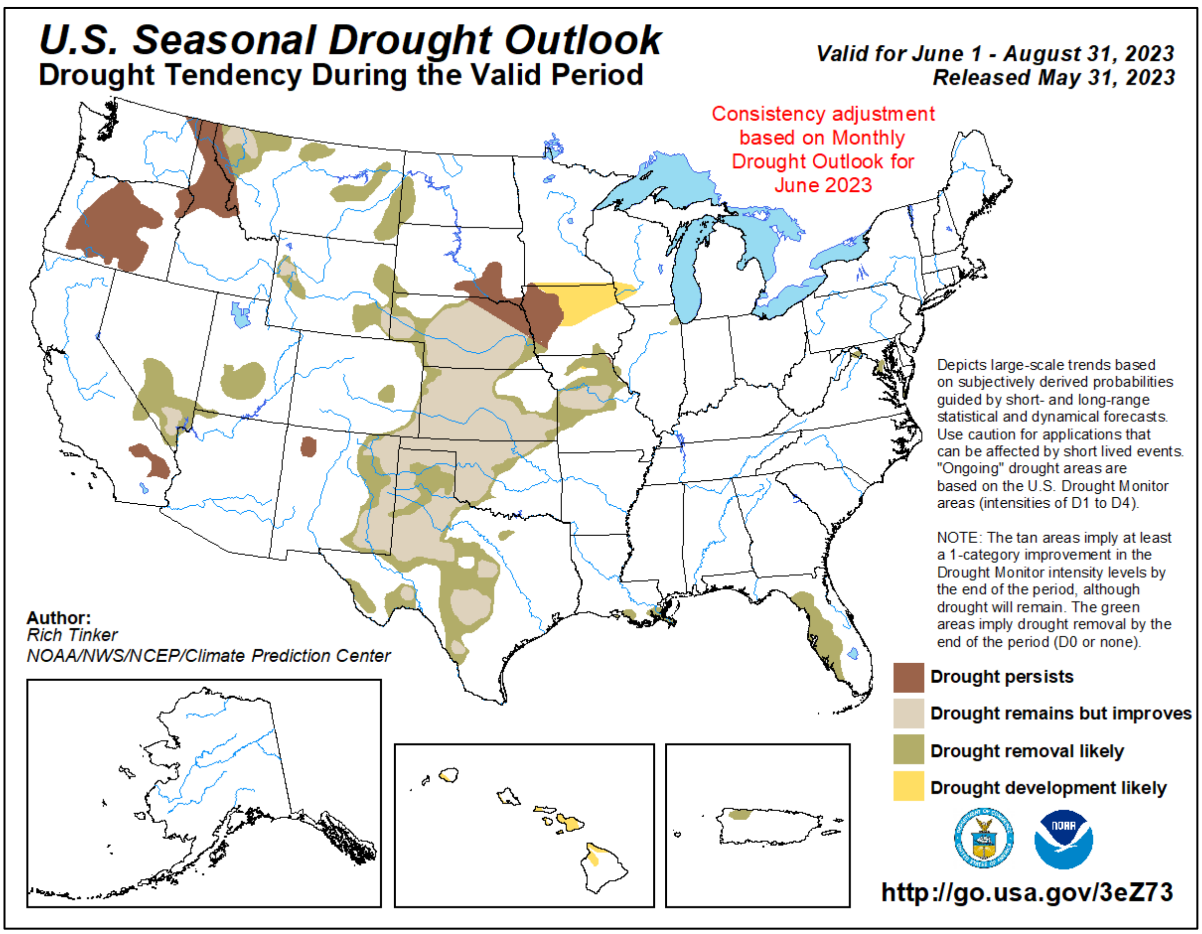



**Figure 38. Example Seasonal Drought Outlook Map from the Climate Prediction Center**



### 5.3.2 Evaporative Demand Drought Index (EDDI)

The EDDI is a newer, experimental index developed by the NOAA Physical Sciences Laboratory. EDDI is unique compared to other drought indicators in that it focuses on evaporative demand, which is estimated from observed temperature, humidity, wind speed, and solar radiation. EDDI is not a direct measurement of evapotranspiration or drought conditions. Rather, EDDI is a drought index based on the "thirst" of the atmosphere, or evaporative demand. The EDDI is not a drought prediction but, at short timescales, indicates the potential for drought emergence.

Positive values of EDDI indicate greater than normal evaporation, or drought conditions. Negative values of EDDI indicate lower than normal evaporation, or wetter conditions. EDDI is expressed in different timeframes ranging from 1 week to 12 months. The EDDI generated for the drought dashboard will be aggregated over a one-month period so it can provide an early alert of *flash drought* or rapid-onset drought that develops over several weeks.

The EDDI developers provide a classification scheme like that used in the USDM. These classifications are shown in Table 14. The percentile breaks for the EDDI drought categories are analogous to those for the USDM.

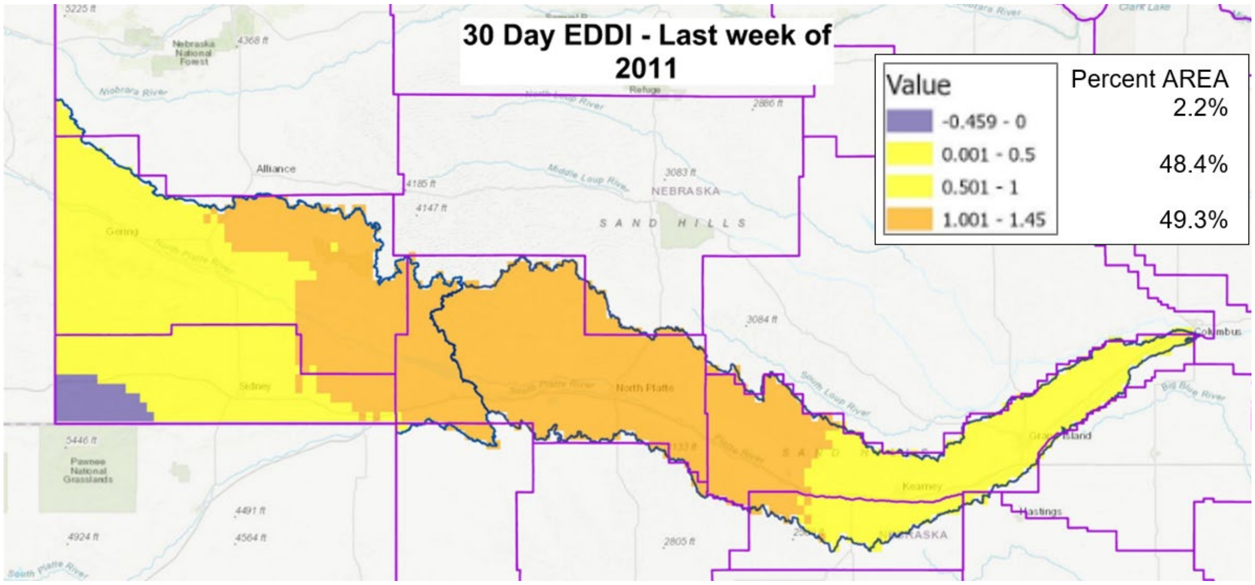
**Table 14. EDDI Classifications**

| Description | Category | Percentiles (0% = wettest; 100% = driest) | EDDI Numeric Values |
|---|---|---|---|
| Wetness Categories | EW4 | 0–2 | -2.5 to -2.0 |
| | EW3 | 2–5 | -2.0 to -1.5 |
| | EW2 | 5–10 | -1.5 to -1.2 |
| | EW1 | 10–20 | -1.2 to -0.7 |
| | EW0 | 20–30 | -0.7 to -0.5 |
| Near Normal | — | 30–70 | -0.5 to 0.5 |
| Drought Categories | ED0 | 70–80 | 0.5 to 0.7 |
| | ED1 | 80–90 | 0.7 to 1.2 |
| | ED2 | 90–95 | 1.2 to 1.5 |
| | ED3 | 95–98 | 1.5 to 2.0 |
| | ED4 | 98–100 | 2.0 to 2.5 |

Source: Lukas et al. 2017.

The 2-month EDDI in December, with a value of +1 or greater, has in the past anticipated the onset of drought. Higher EDDI values lead to quicker drying if precipitation decreases and indicates the potential for a severe drought to develop quickly. This was the case for the 2012 drought. The prior years were normal to above-normal conditions but had very high EDDI conditions. When precipitation dwindled, conditions quickly worsened into a severe single-year drought. For example, EDDI 1-month in December 2011 was +1.2, as shown in Figure 39, which preceded the 2012 growing season. An EDDI greater than zero but less than +1 in the November/December timeframe is less reliable at indicating drought onset.

**Figure 39. 30-day EDDI Ending the Last Week of December 2011**




The Coalition has determined that the EDDI best represents the forecast or existing drought conditions on a Basin-wide level. Trigger levels selected for Basin-wide drought monitoring indicators are presented in Section 5.1 and Table 11.

### 5.3.3 South Platte River Streamflow

Flow quantities are a combination of contributions from precipitation (runoff) and groundwater (baseflow). Streamflows can be affected by losses from evapotranspiration and withdrawals, among other factors. Low-flow conditions in winter and spring can affect the ability of reservoirs to refill sufficiently to provide adequate water for intended uses, typically including surface water irrigation. Low-flow conditions in summer can result in more demand on these reservoirs, reduced hydropower production, and water quality and temperature impacts on streams. Below-average streamflow is a drought impact. Seasonal low streamflow in winter or spring might be an indicator of future low streamflow later in the year.

Streamflow in the South Platte River at Julesburg, CO, was selected as a trigger to indicate low water supplies coming from the South Platte River basin in Colorado. The drainage area to Julesburg is 22,824 square miles. USGS daily discharge data at Julesburg (USGS 2025) exists from April 1902 until September 2018. The two gages at Julesburg, one for Channel 1 and one for right Channel 2, are operated and maintained by the Colorado Division of Water Resources and jointly funded by the States of Colorado and Nebraska.

The alert trigger of 120 cfs coincides with the minimum mean daily flow required between April 1 and October 15 each year under the *1923 South Platte River Compact between the States of Colorado and Nebraska*.

Monitoring additional stream gages in the UPRB can provide a more comprehensive picture of how droughts are developing across the UPRB. Additional stream gages that may be considered are discussed in more detail in Section 5.4.2.

### 5.3.4 Reservoir Storage

Several large reservoirs on the North Platte River regulate and store flows for irrigated agriculture, hydropower generation, and environmental purposes. Monitoring storage levels in these reservoirs throughout the year can inform water managers about the likelihood of reservoir releases and, ultimately, potential downstream flow contributions.

Four of the reservoirs along the North Platte in Wyoming are the Seminoe, Pathfinder, Glendo, and Guernsey Reservoirs. Release quantities from these reservoirs are controlled by BOR. Generally, releases are very low in the winter (October through March) with higher releases in the summer (April through September). Winter releases are calculated to meet requirements for water rights, fish and wildlife habitat needs, and power plant operations. All three reservoirs operate downstream power plants.

Additionally, in accordance with the *North Platte Decree Final Settlement Stipulation Appendix E*, BOR forecasts the volume of available water supply for irrigation. At the beginning of each water year, BOR completes an initial assessment of the likelihood of the need to allocate storage during the subsequent irrigation season by comparing the forecast available supply to an approximate irrigation demand of 1.1 million acre-feet (MAF). BOR further assesses the need to allocate storage during the first week of February, March, April, May, and June. If the forecast supply is less than 1.1 MAF, there may be a need for an allocation.

BOR forecast water supply for the North Platte River was selected as a trigger representing water supply for the subarea upstream of Lake McConaughy in the North Platte River drainage. A forecast supply of less than 1.1 MAF in October, February, or March (outside the irrigation season) triggers a water supply Advisory, while a forecast supply of less than 1.1 MAF in April, May, or June (within the irrigation season) triggers a water supply Alert.

Reservoir storage in Lake McConaughy is considered a primary driver of water supply on the Platte River downstream of Lake McConaughy to the Loup River confluence. Storage values at the end of each month were averaged for Lake McConaughy based on historical data from 1991 through 2020. Figure 40 illustrates these 30-year average storage volumes for Lake McConaughy.

Additional reservoir monitoring products exist and can provide a more comprehensive picture of how droughts are developing across the UPRB. Additional reservoir monitoring producents that may be considered are discussed in more detail in Section 5.4.3.

CNPPID reviews the operational plan released by BOR for the upstream reservoirs on the North Platte River, along with their historic operations, and develops an annual operating plan for downstream irrigation deliveries, which drives the storage and releases in Lake McConaughy. This plan is generally prepared by October of each year, allowing CNPPID to budget for future irrigation deliveries and power production.

Actual percent of monthly average reservoir storage was selected as a Drought Plan trigger for the best indicator of water supply in the Central Platte River. Figure 41 displays the percent average monthly storage in Lake McConaughy over the 30-year period from 1991 to 2020 along with the 70 percent Advisory level and 60 percent Alert level.

**Figure 40. 30-year Normal Average Storage Volumes for Lake McConaughy**

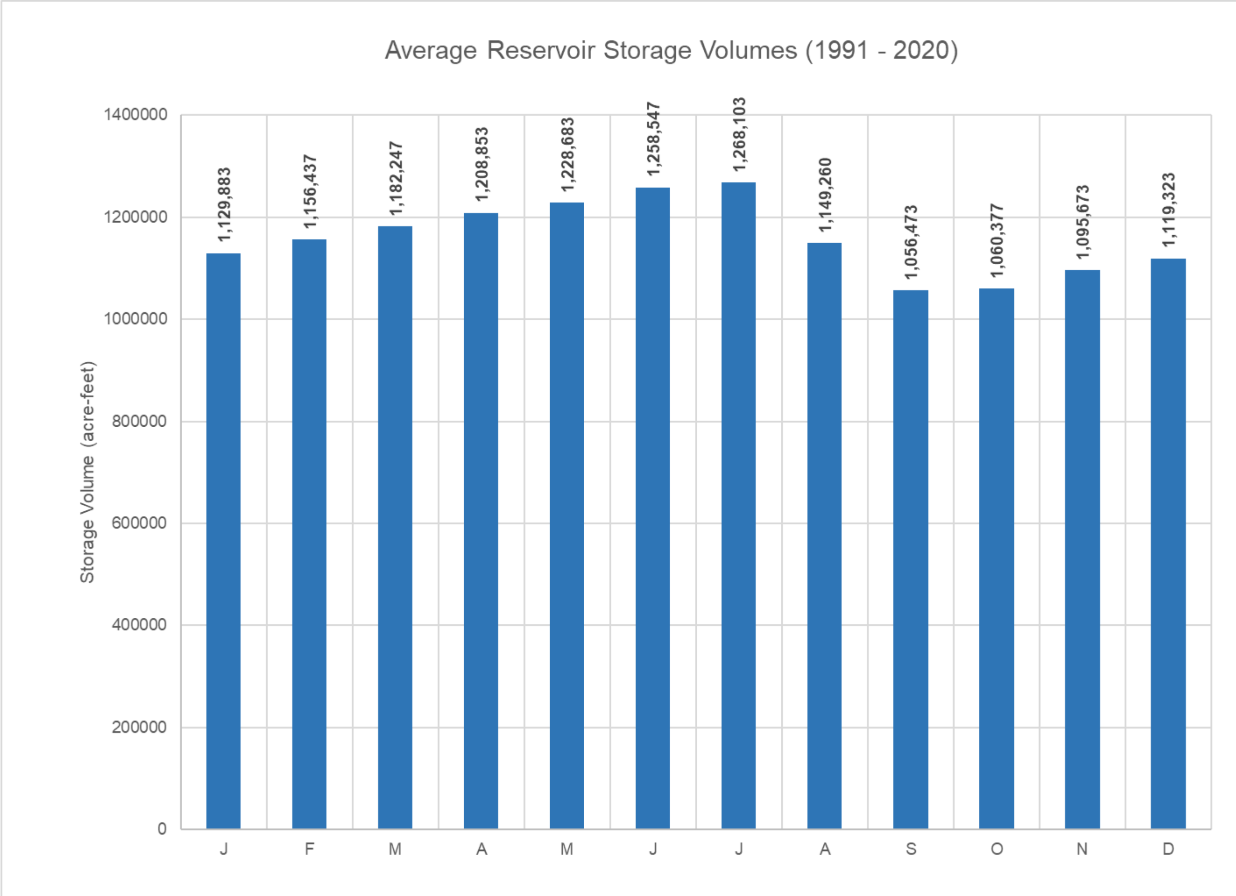
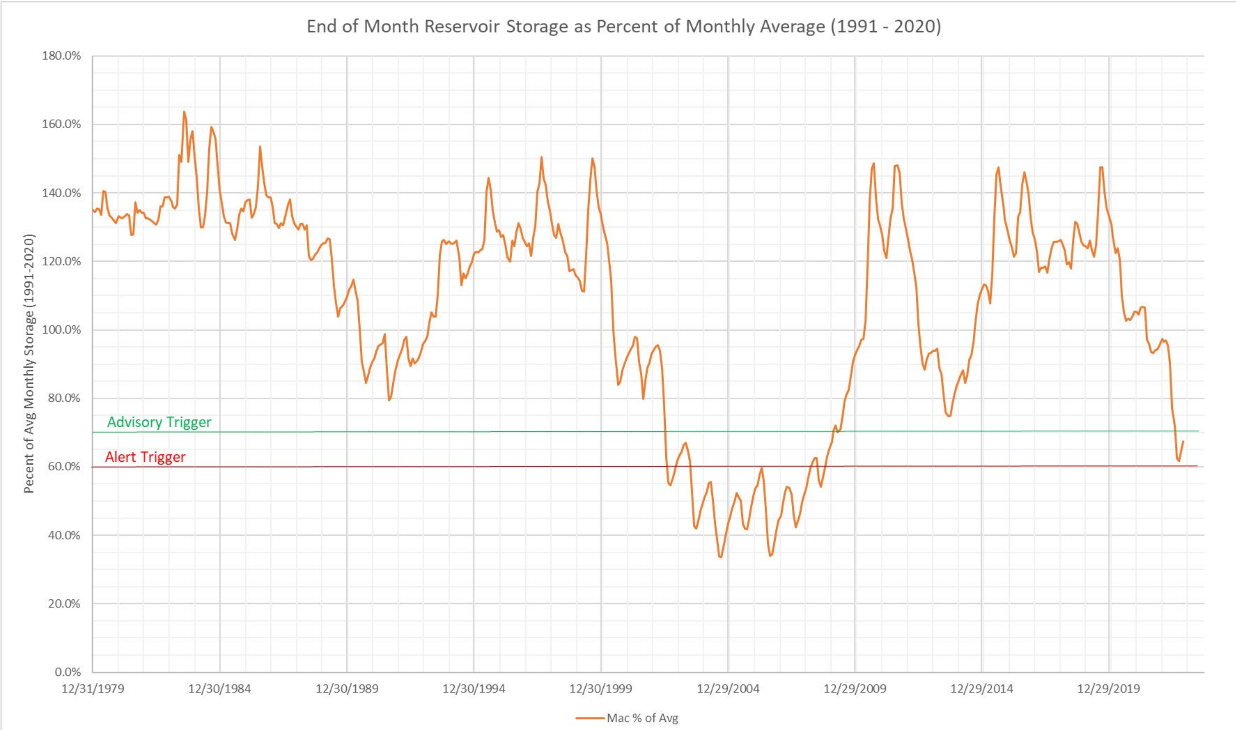


**Figure 41. Percent of Monthly Average Lake McConaughy Reservoir Storage 1991–2020**




## 5.4 Supplemental Drought Monitoring Data

Monitoring additional drought indicators gives the Coalition a more comprehensive picture of what types of droughts are occurring and who is being impacted. The Coalition will assess the supplemental indicators, as described in Table 15, as needed when Drought Advisory and Alert conditions are met. This information will inform Basin-wide communication and outreach activities during drought. Where feasible, the drought dashboard will automate the collection and summarization of supplemental indicators or provide links to data sources.

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## Table 15. Supplemental Drought Monitoring Data

| Index or Indicator | Description or Link | Timeframe | Data Source | Collection Responsibility |
|---|---|---|---|---|
| Snowpack | North Platte and South Platte Basins percent of median Snow Water Equivalent (SWE) | Weekly | NRCS | Department |
| Streamflow | Measures and records the amount of water flowing in a river or stream, or its discharge. | Daily | USGS and the Department | Dashboard |
| Reservoir Storage | Current and projected system storage in Glendo, Seminoe, Pathfinder, and McConaughy. | Daily | USGS and BOR | Department |
| Standardized Precipitation Index (SPI) | Characterizes precipitation on a range of timescales by determining the probability of recording a given amount compared to the historical record. | 1 to 96 months | National Drought Mitigation Center (UNL) | Department |
| Standard Precipitation Evapotranspiration Index (SPEI) | Considers both precipitation and potential evapotranspiration in determining drought; an extension of the SPI. | 1 to 96 months | National Drought Mitigation Center (UNL) | Department |
| Palmer Drought Severity Index (PDSI) | Estimate relative dryness using precipitation and temperature and estimate of soil moisture. | Varies depending on soil | National Drought Mitigation Center (UNL) | Dashboard |
| Static Groundwater Levels and Changes (spring to spring) | Measure depth to static groundwater levels | Annual or semi-annual | Nebraska NRDs, UNL, CSD, and USGS | NRDs |
| Grassland Productivity Forecast | Grass-Cast (2025) provides an indication of grassland productivity in the upcoming season relative to an area's precipitation history. | Monthly | UNL | Department |
| Monthly and Seasonal Temperature and Precipitation Outlooks | NOAA NWS Climate Prediction Center (https://www.cpc.ncep.noaa.gov/) | Monthly | NOAA | Department |

| Index or Indicator | Description or Link | Timeframe | Data Source | Collection Responsibility |
|---|---|---|---|---|
| Missouri Basin River Forecast Center | MBRFC and NIDIS (https://www.drought.gov/dews/missouri-river-basin) | Daily | Drought.gov | Department |
| Wildfire Outlooks | National Interagency Fire Center (https://www.nifc.gov/) | Monthly | National Interagency Fire Center | Department |

BOR = Bureau of Reclamation; Department = Nebraska Department of Water, Energy, and Environment; CSD = ; MBRFC = Missouri Basin River Forecast Center; NIDIS = National Integrated Drought Information System; NOAA = National Oceanic and Atmospheric Administration; NRCS = Natural Resources Conservation Service; NRDs = Natural Resources Districts; NWS = National Weather Service; UNL = University of Nebraska-Lincoln; USGS = United States Geological Survey

### 5.4.1 Snowpack

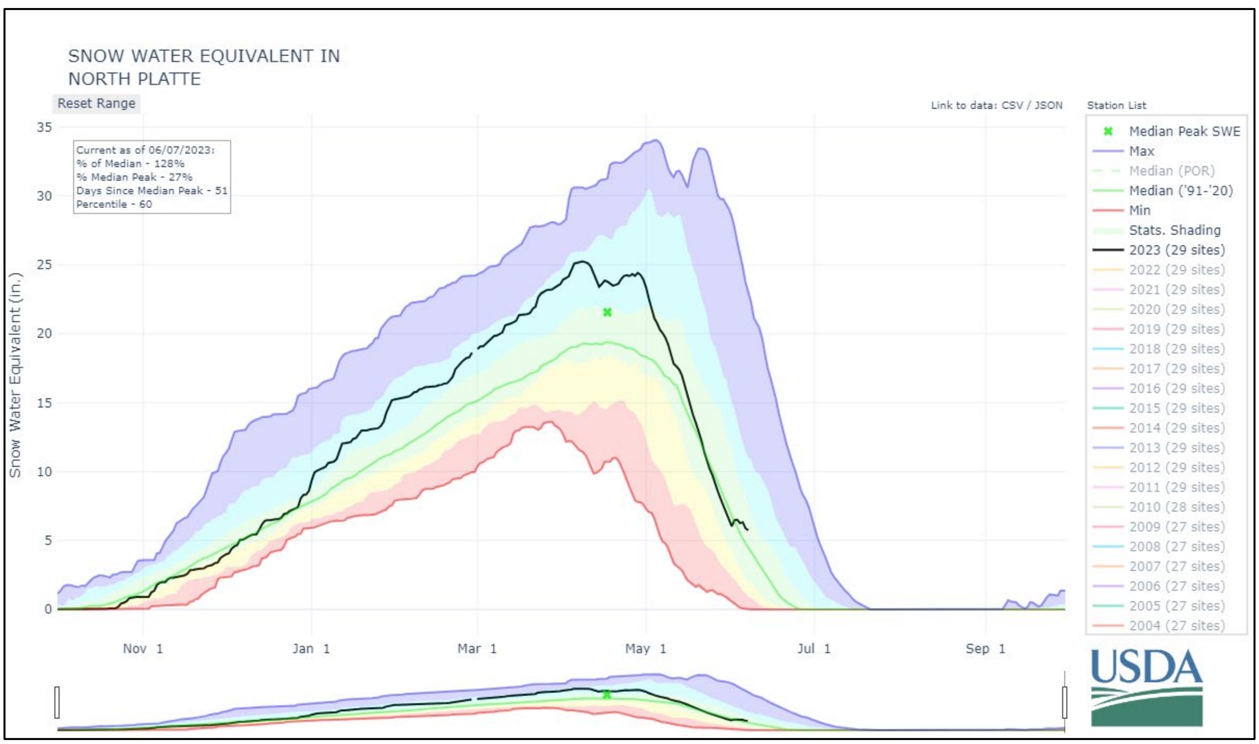
Snowpack can provide insight into the likelihood of Platte River flow contributions from the UPRB being maintained into July. This is particularly true for the South Platte River Basin snowpack, where flows are largely unregulated by reservoirs. Plains snowpack in the Platte River Basin can be used to anticipate soil moisture conditions for the coming growing season, particularly in areas of irrigated agriculture where the initiation of crop irrigation early in the growing season can affect streamflows later in the growing season.

SWE is a measurement of snow depth in inches of water. Variations in snow/ice density and structure can affect the total height of accumulated snow so this measurement normalizes the variation across years and areas. The NRCS's National Water and Climate Center operates SNOTEL stations which measure the SWE at remote sites. In the North Platte River Basin, which is 31,070 square miles, there are 30 stations in the SNOTEL network. The South Platte River Basin is 23,163 square miles and has 23 SNOTEL stations.

The NRCS calculates Basin-wide SWE for both the North and South Platte Basins. The meltwater from snowpack in the mountains is a major contributor to streamflow in the North and South Platte Rivers. Snowpack in Nebraska generally lacks SWE measurements. Local climate stations can provide snow depth.

The National Water and Climate Center maintains SNOTEL stations in the North and South Platte watersheds. As part of this monitoring, the NRCS produces plots of current SWE data for each basin. The current year's data are also shown against historic snowpack data in the Basin. Figure 42 shows an example of these data for the North Platte basin with water year 2023 in black. The shape of the curve illustrates both existing snowpack compared to past years of accumulation and melting.

**Figure 42. USDA NRCS Snow Water Equivalent in North Platte Basin (June 7, 2023)**




Source: USDA NRCS 2023.

### 5.4.2 Streamflow

Streamflow in the South Platte River at Julesburg, CO, was selected as a trigger to indicate low water supplies coming from the South Platte River basin in Colorado, as discussed in Section 5.3.3. However, monitoring additional stream gages in the UPRB can provide a more comprehensive picture of how droughts develop across the UPRB.

The USGS and the Department maintain streamflow gages at several sites in the UPRB. The gages at the Wyoming-Nebraska state line, Roscoe and Grand Island, Nebraska, have long periods of record, with measurements since at least 1983 and can be used to study historic drought impacts on streamflow in addition to future monitoring. The Wyoming-Nebraska State Line Gage (USGS 06674500) has been in operation since 1930, providing daily streamflow value along the North Platte River. The Roscoe gage (USGS 06764880) has been operating since 1983 along the South Platte River. The Grand Island gage (USGS 06770500), below the confluence of the North and South Platte Rivers, has been in operation since 1939.

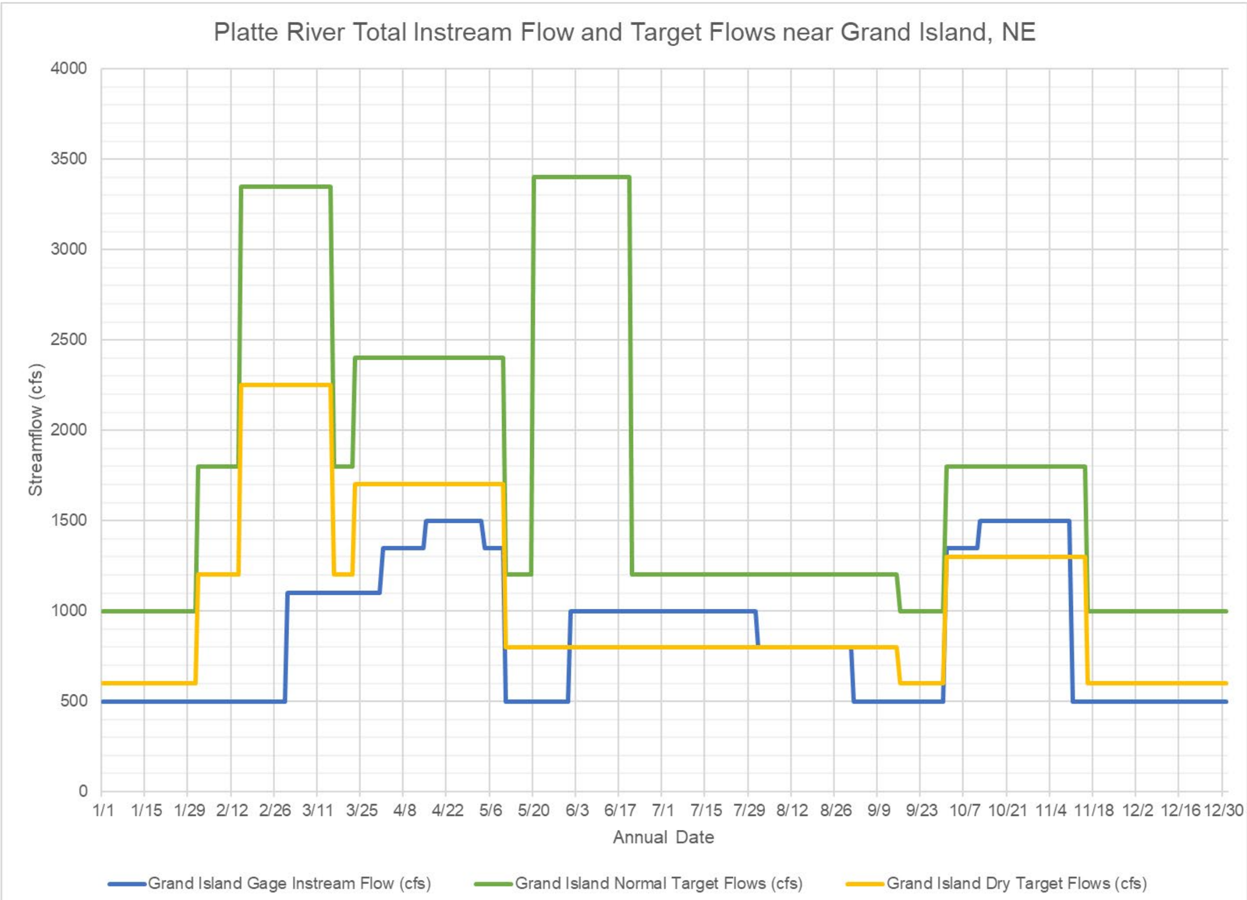
Real-time information can be presented as percent of normal for consistent times of the year. For example, percentiles can help provide context for wet or dry conditions from river discharge and streamflow information. The Department already provides real-time streamflow data in relation to the historic 25th to 75th percentile data for several gages.

Instream flow appropriations exist on the Central Platte River in Nebraska from the North and South Platte Confluence to Odessa, Odessa to Grand Island, and Grand Island to Duncan for the purpose of fish and wildlife conservation. The instream flow volumes vary throughout the year and comprise water rights granted to the CPNRD and NGPC with priority dates of July 25, 1990, and November 30, 1993, respectively. Instream flows throughout the calendar year at Grand Island are shown in Figure 43 and are actively used to administer water rights within the UPRB.

Target flows were also developed by USFWS as species and annual pulse flow recommendations for the Platte River at Grand Island. Values for these recommended flows also vary during the year and are shown graphically in Figure 43.

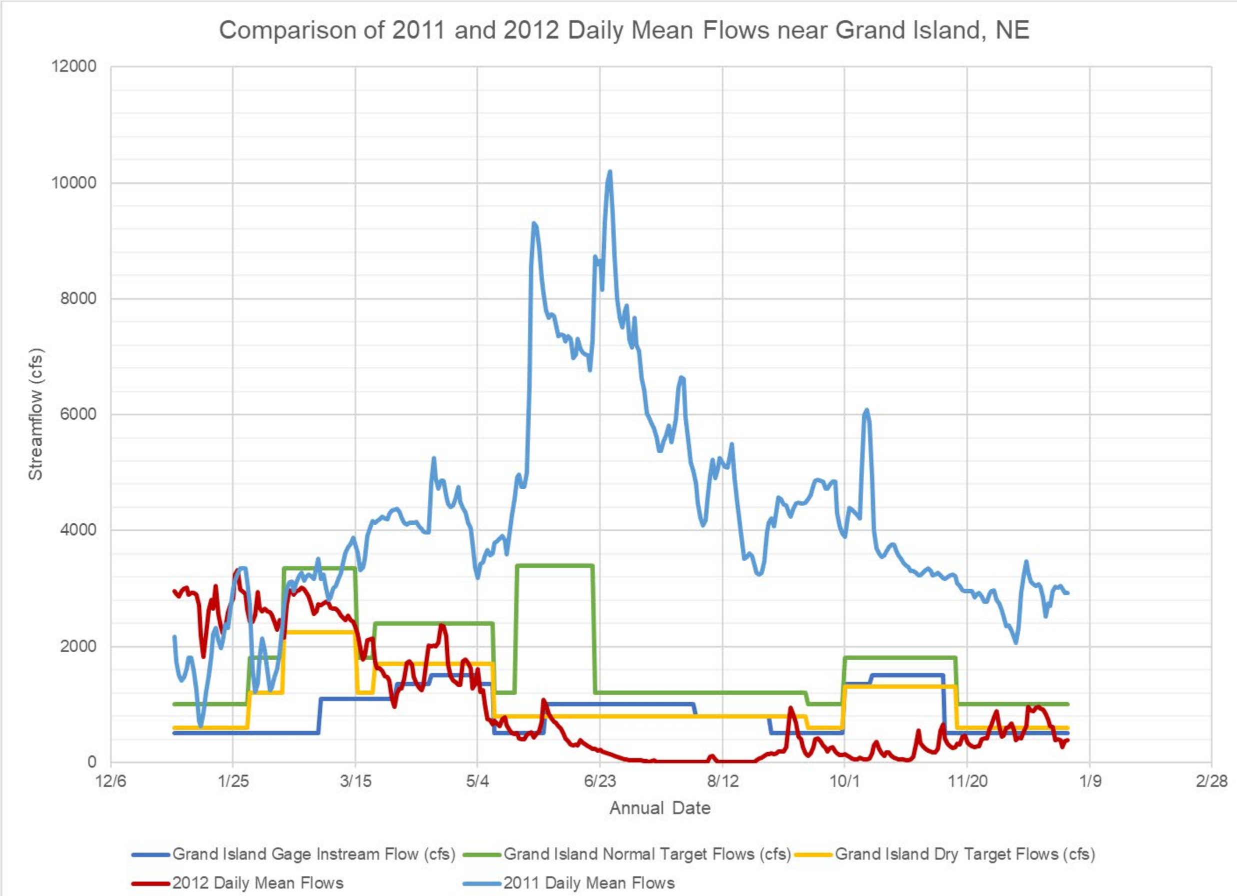
A goal of the PRRIP is to reduce shortages to target flows by assessing current, periodic and annual hydrologic conditions for the Platte River. This hydrologic condition is calculated using a formula developed by USFWS that includes variables such as streamflow at Grand Island and on the South Platte at Julesburg, Colorado (Anderson and Rodney 2006). Extreme variation in streamflow across the UPRB leads to designations of “wet,” “normal,” or “dry” hydrologic conditions. Daily mean streamflows are shown in Figure 44 for calendar years 2011 and 2012 as an example of these extreme variations in streamflow.

## Figure 43. Platte River Annual Instream Flows and Annual Target Flows




Sources: Total Instream Flow based on CPNRD and NGPC Instream Flow Rights with priority dates of 7-25-1990 and 11-30-1993, respectively; PRRIP Water Plan Appendix A-5 of Program Attachment 5, Section 11 shows the wet, average, and dry target flows expressed on a weighted monthly basis. Wet Year annual flow at the USGS gage near Grand Island, NE is above 1,140,265 acre-feet (AF), Dry Year is below 679,815 AF, and Normal Years fall in between.

**Figure 44. Comparison of 2011 and 2012 Daily Mean Flows with Total Instream and Target Flows**



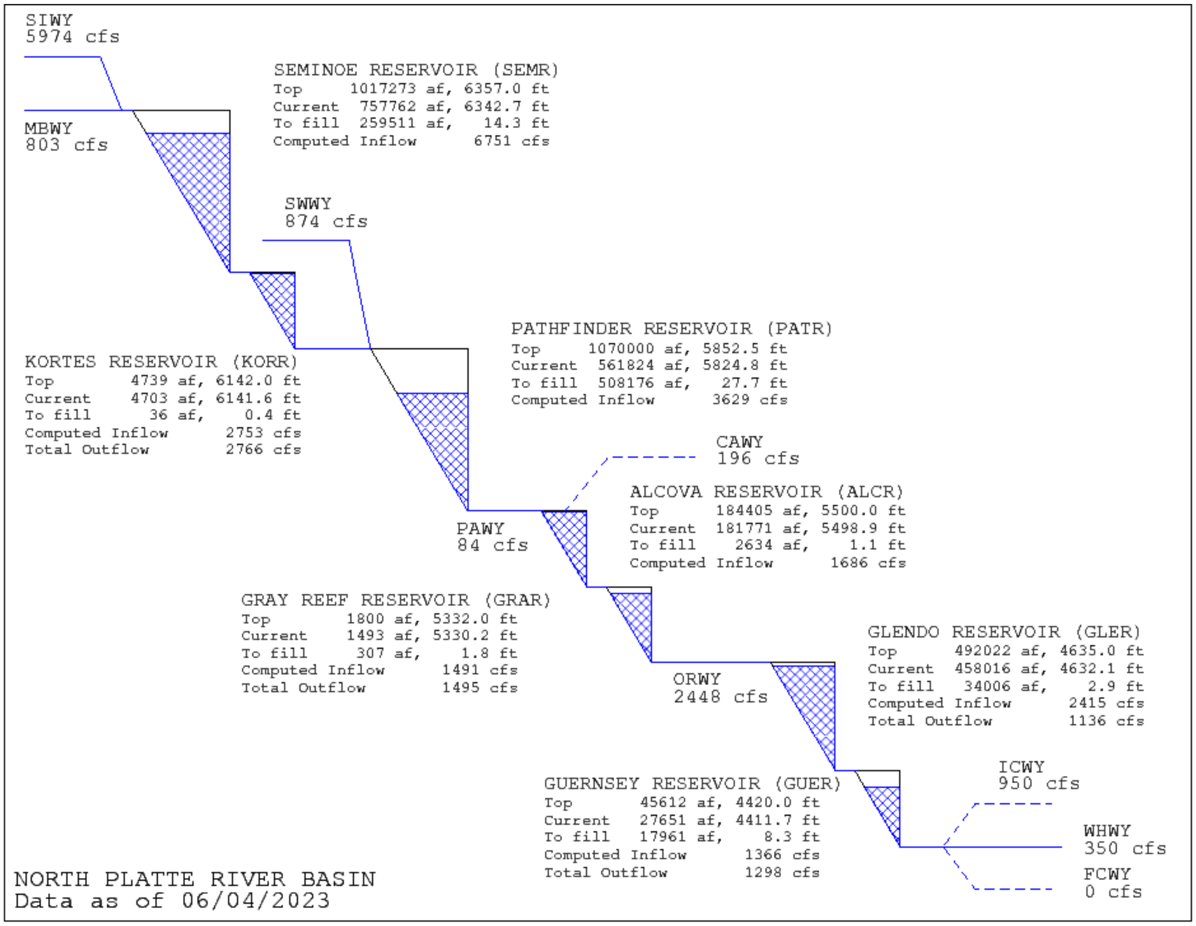

### 5.4.3 Reservoir Storage

BOR forecast water supply for the North Platte River was selected as a trigger representing water supply for the subarea upstream of Lake McConaughy in the North Platte River drainage, as described in Section 5.3.4.

Reservoir storage in Lake McConaughy is considered a primary driver of water supply on the Platte River downstream of Lake McConaughy to the Loup River confluence. However, additional reservoir monitoring products exist and can provide a more comprehensive picture of how droughts develop across the UPRB.

BOR operates Glendo, Seminoe, and Pathfinder reservoirs on the North Platte River. Monitoring products from BOR include real-time reservoir storage information and probabilistic projections of future reservoir storage and releases. The Great Plains Hydromet system provides real-time reservoir storage and release information. A “tea-cup” diagram (Figure 45) graphically displays some of this information. The diagram is a schematic of the North Platte reservoir system. Reservoirs are shown from upstream to downstream along with not-to-scale elevation differences. The hatched portions show the portion of each reservoir that is filled, with notations showing the remaining space that could store water.

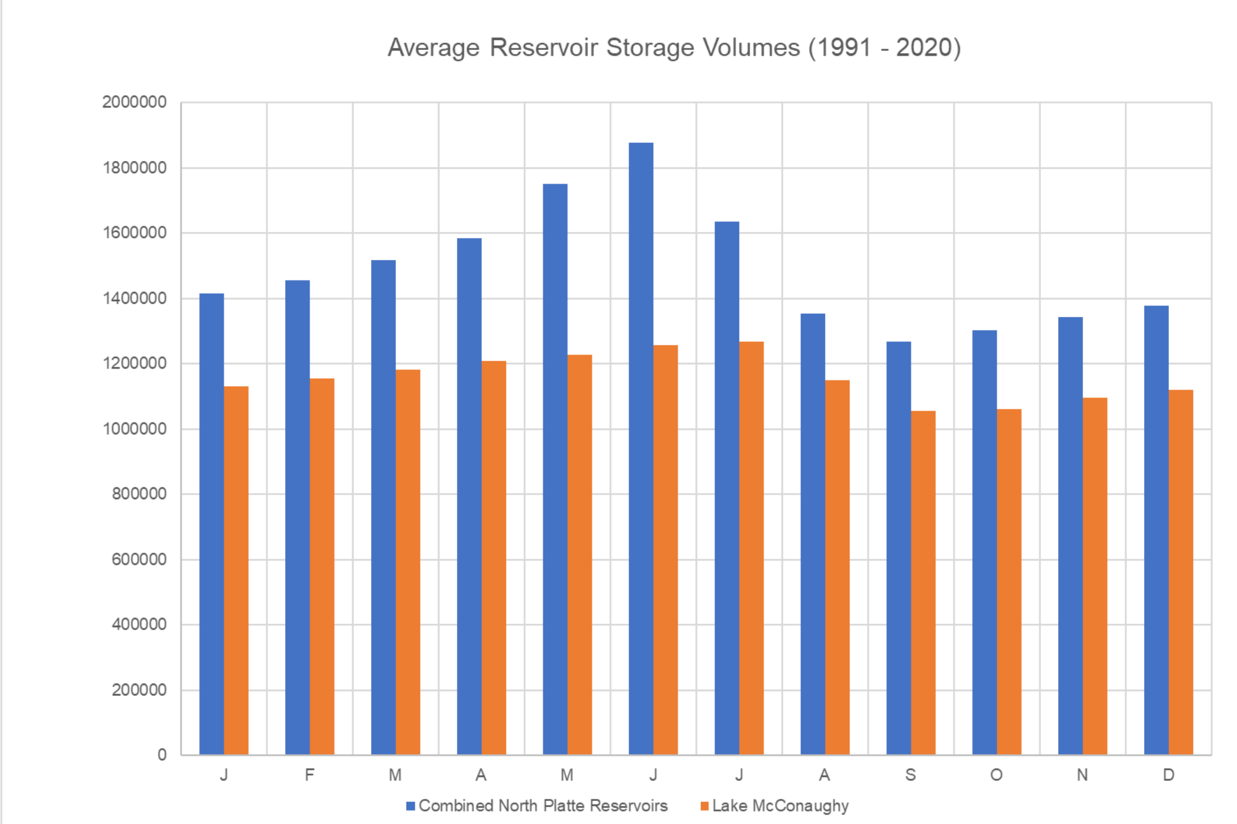
**Figure 45. Example BOR Tea-Cup Diagram**




Source: BOR 2023.

The NRCS's National Water and Climate Center has developed 30-year normal values for reservoir storage in each of the North Platte River reservoirs based on average values at the end of each month. The latest averages are from 1991 through 2020. Similarly, storage values at the end of each month were averaged for Lake McConaughy based on historic data from 1991 through 2020. Figure 46 illustrates these 30-year average storage volumes for the combined North Platte Reservoirs (Seminoe, Pathfinder, and Glendo) as well as Lake McConaughy.

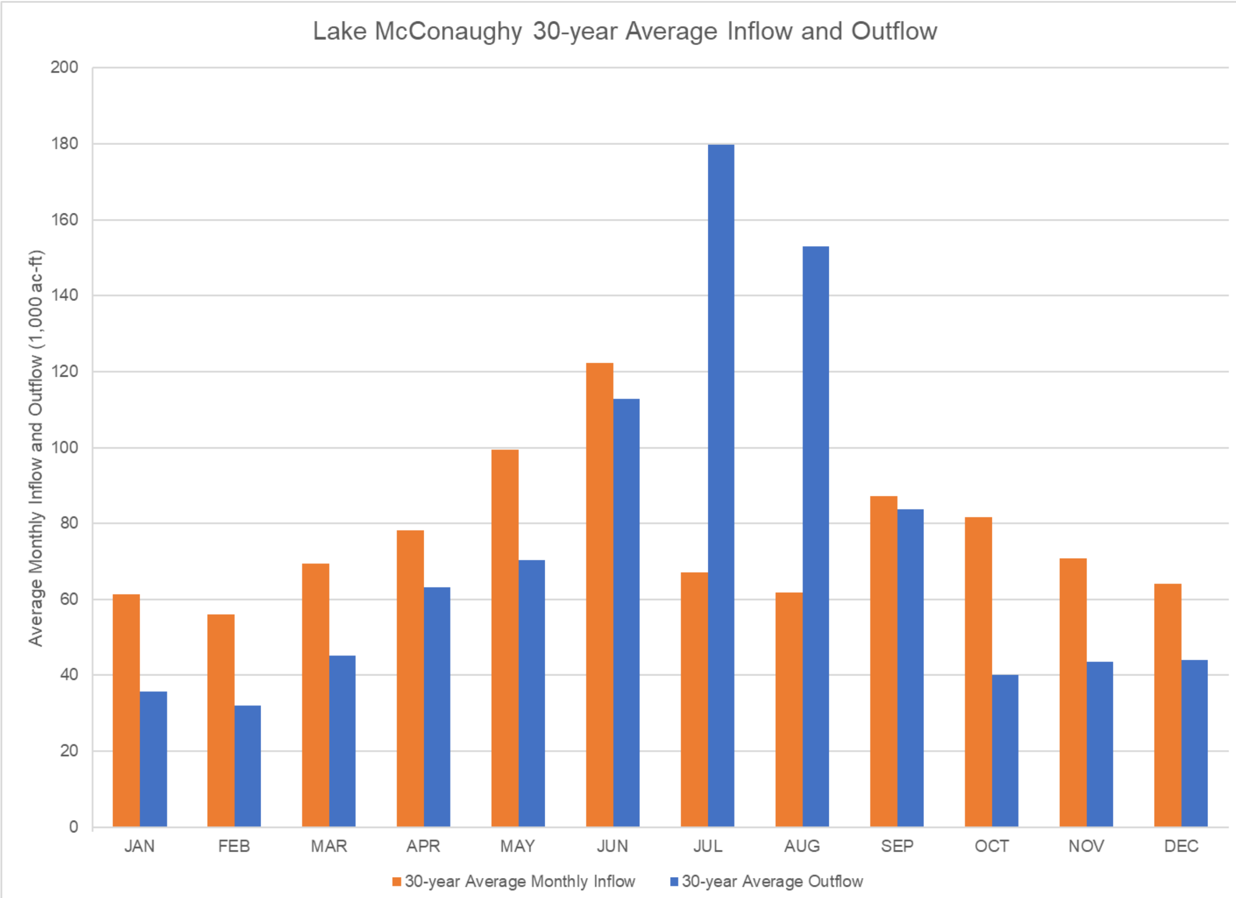
**Figure 46. 30-year Normal Average Storage Volumes for Major BOR North Platte Reservoirs and Lake McConaughy**




The releases from these reservoirs differ year to year based on reservoir recharge and downstream habitat, power, and irrigation needs. Reservoirs also must be operated to maintain additional storage in case of flood in a year with excess precipitation. After August 1 each year, BOR releases a monthly operating plan for the North Platte River Basin reservoirs. This plan reports the actual inflows during the past 12 months and the storage in each reservoir as a percent of the 30-year normal. The operating plan then projects a reasonable minimum, reasonable maximum, and most probable reservoir inflow and releases schedule for the next water year, beginning in August and ending in July. These calculations project end-of-month storage content in each reservoir and estimated power production. The operating plan also accounts for contractual water delivery obligations, record of decisions, water rights, and maintenance issues.

Similarly, the CNPPID reviews the operational plan released by BOR for the upstream reservoirs on the North Platte River, along with their historic operations, and develops an annual operating plan for downstream irrigation deliveries, which drives the storage and releases in Lake McConaughy. This plan is generally prepared by October of each year, allowing CNPPID to budget for future irrigation deliveries and power production. Figure 47 displays the average monthly inflow and outflow in Lake McConaughy over the 30-year normal period from 1992 to 2023.

**Figure 47. 30-year Normal Lake McConaughy Monthly Inflow and Outflow**




### 5.4.4 Standardized Precipitation Index (SPI), Standard Precipitation Evapotranspiration Index (SPEI), and Palmer Drought Severity Index (PDSI)

There are different hydrologic drought indices for monitoring drought including the SPI, SPEI, and the PDSI. One study provided a global assessment of the performance of these indices for monitoring drought impacts on several hydrological, agricultural, and ecological response variables. The study found:

> *"a superior capability of the SPEI and the SPI drought indices, which are calculated on different time scales than the Palmer indices to capture the drought impacts on the hydrological, agricultural, and ecological variables. They detected small differences in the comparative performance of the SPI and the SPEI indices, but the SPEI was the drought index that best captured the responses of the assessed variables to drought in summer, the season in which more drought-related impacts are recorded and in which drought monitoring is critical. Hence, the SPEI shows improved capability to identify drought impacts as compared with the SPI. In conclusion, it seems reasonable to recommend the use of the SPEI if the responses of the variables of interest to drought are not known a priori."*
> (Vicente-Serrano et al., 2012)

### 5.4.4.1 Standardized Precipitation Index

The SPI tracks precipitation anomalies, that is, the degree to which precipitation is above or below normal. For this index, zero or near zero SPI values indicate normal conditions, a negative SPI indicates drought, and a positive value indicates wet conditions. SPI is expressed in different timeframes. A 1-month SPI evaluates just the previous 1-month period. This tracks a short-term trend. A longer timeframe, such as a 12-month SPI, evaluates the previous year. A negative 1-month SPI and positive 12-month SPI, for example, indicate long-term wet conditions and short-term dry conditions. This condition could indicate the beginnings of drought. The opposite, a 1-month wet condition and 12-month dry condition could indicate that drought is subsiding. The various timeframes can also be linked to different impacts. Short-duration SPI can illustrate soil moisture impacts, longer durations can be related to streamflow impacts, and the longest durations are linked to groundwater impacts. Table 16 lists the SPI classification for drought.

**Table 16. SPI Classifications**

| Index Value | Description |
|---|---|
| 2.0 or greater | Extremely Wet |
| 1.50 to 1.99 | Severely Wet |
| 1.00 to 1.49 | Moderately Wet |
| -0.99 to 0.99 | Near Normal |
| -1.49 to -1.00 | Moderate Drought |
| -1.99 to -1.50 | Severe Drought |
| -2.0 or less | Extreme Drought |

Source: NOAA National Weather Service Climate Prediction Center 2023

### 5.4.4.2 Standard Precipitation Evapotranspiration Index

The SPEI is based on the SPI and incorporates evaporation potentials. A positive SPEI indicates a combination of either above-normal precipitation and/or below-normal evaporation. A negative SPEI indicates below-normal precipitation and/or above-normal evaporation. Similar to SPI, SPEI is expressed in different timeframes that express short-term to long-term conditions.

### 5.4.4.3 Palmer Drought Severity Index

The PDSI is one of the oldest drought indices in use. PDSI can be thought of as a means of tracking soil moisture deficits. Like SPEI, the index weighs both precipitation and evaporation rates. PDSI also considers local soil properties, namely the ability of a soil's porosity to store soil moisture. A positive PDSI value indicates above-normal potential for soil moisture; that is, precipitation exceeds evaporation enough to maintain soil moisture. Negative PDSI indicates a potential soil moisture deficit. Unlike SPI, SPEI, and EDDI, there are no direct timeframes for PDSI. That is, there is no 1-, 6-, or 12-month PDSI value. Instead, the capacity of soil to store moisture is the effective timeframe. Soils that have high porosity can be more resistant to drought. It takes longer for PDSI to change from positive to negative compared to soils with low porosity. PDSI is provided as uncalibrated (which uses literature values for weightings of precipitation and evaporation) or calibrated to local conditions. Table 17 lists the PDSI classifications for drought.

**Table 17. Palmer Drought Severity Index Classifications**

| Index Value | Description | Index Value | Description |
|---|---|---|---|
| 4.0 or above | Extremely Wet | -0.99 to -0.5 | Incipient Dry Spell |
| 3.00 to 3.99 | Very Wet | -1.99 to -1.00 | Mild Drought |
| 2.00 to 2.99 | Moderately Wet | -2.99 to -2.00 | Moderate Drought |
| 1.00 to 1.99 | Slightly Wet | -3.00 to -3.99 | Severe Drought |
| 0.5 to 0.99 | Incipient Wet Spell | -4.00 or less | Extreme Drought |
| -0.49 to 0.49 | Near Normal | — | — |

Source: NOAA National Weather Service Climate Prediction Center 2005.

Note: The USDM includes one additional category "exceptional drought" for index values less than -5.

### 5.4.5 Static Groundwater Levels and Changes (Spring to Spring)

Fall and spring static aquifer levels provide insight into the cyclical aquifer drawdown and recovery due to irrigation during the peak season. Monitoring these levels can assist in anticipating potential conflicts and well interference that may occur due to groundwater pumping in the coming irrigation season. Additionally, static water levels can inform estimates of drought effects on anticipated baseflow gains and recharge. Selection of groundwater monitoring sites is complex as each location has different finished depths, geological conditions, and influences from nearby surface and groundwater features. Due to this complexity, static groundwater levels were not directly considered as a trigger. Individual NRDs and other water management organizations are best suited to identify and monitor groundwater conditions.

### 5.4.6 Grassland Productivity Forecast

The Grassland Productivity Forecast, also known as Grass-Cast, is a tool designed to help ranchers and rangeland managers in the Great Plains and Southwest regions reduce uncertainty about grassland productivity. It provides predictions for the upcoming growing season based on historic weather data and precipitation outlooks from the Climate Prediction Center. Grass-Cast uses data from almost 40 years of weather and vegetation growth history to estimate if rangelands in individual grid cells are likely to produce above-normal, near-normal, or below-normal amounts of vegetation.

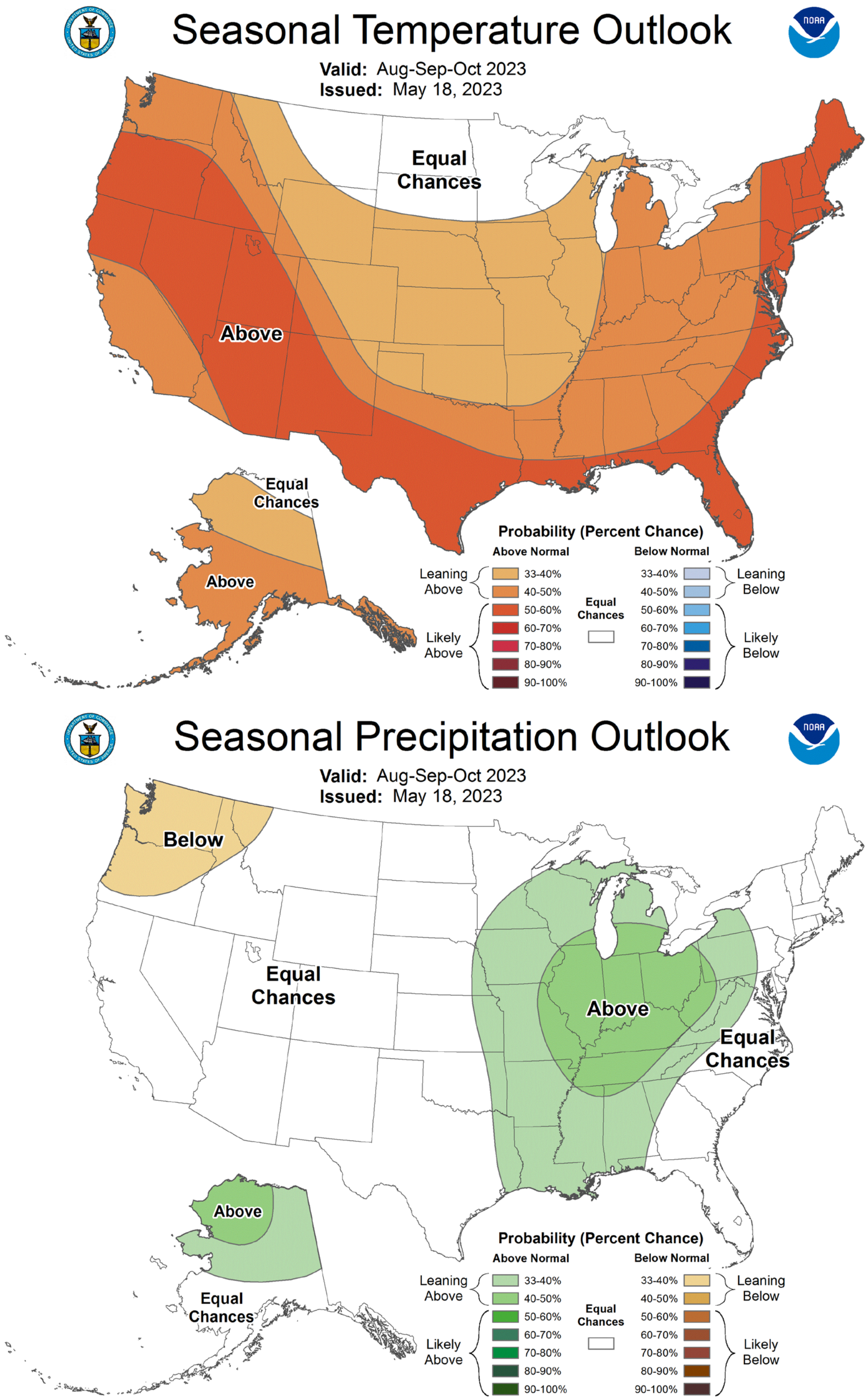
Below-normal amounts of vegetation indicate that vegetation is stressed and more likely to present fire hazards.

### 5.4.7 Climate Prediction Center Monthly and Seasonal Outlooks

The NWS CPC publishes monthly and seasonal drought outlooks that combine their temperature and precipitation forecasts with the USDM (NOAA 2025). Outlooks indicate if a drought is likely to persist, remain but improve, develop, or subside. The outlooks incorporate a variety of climate signals, including El Niño-La Niña, constructed soil moisture, and long-term regressions. Figure 48 shows examples of outlook products for temperature and precipitation.

The maps show if temperature and precipitation are likely to be above or below normal for the time of year. Equal chances indicate an uncertainty that the forecast could either be above, below, or near normal.

**Figure 48. Example of Climate Prediction Center Outlooks**



### 5.4.8 Missouri Basin Drought Early Warning System

The UPRB is included in the Missouri River Basin (MRB) Drought Early Warning System (DEWS) Strategic Action Plan updated for 2021–2023 (NIDIS 2023). The first MRB DEWS Strategic Plan was developed for 2015–2016. The activities for the 2021–2023 Strategic Plan include:

- Network Coordination and Integration;
- Predictions and Forecasting;
- Observations and Monitoring;
- Planning and Preparedness;
- Communication and Outreach; and
- Interdisciplinary Research and Applications.

Work from the network coordination and integration and observations and monitoring have resulted in a Missouri Region Watershed Drought Information website (https://www.drought.gov/watersheds/missouri) that presents current conditions including the USDM, precipitation as percent of normal, temperature, and soil moisture. It also relates the USDM map to current agricultural production statistics and water supply data.

Current soil moisture percentiles, the soil moisture anomaly, and the fractional available water represent some of the most useful data provided by the DEWS. The Crop Condition and Soil Moisture Analytics tool (Crop-CASMA) is extremely helpful in understanding current soil moisture conditions and their comparison against historic averages. Maps can be viewed at https://nassgeo.csiss.gmu.edu/CropCASMA/.

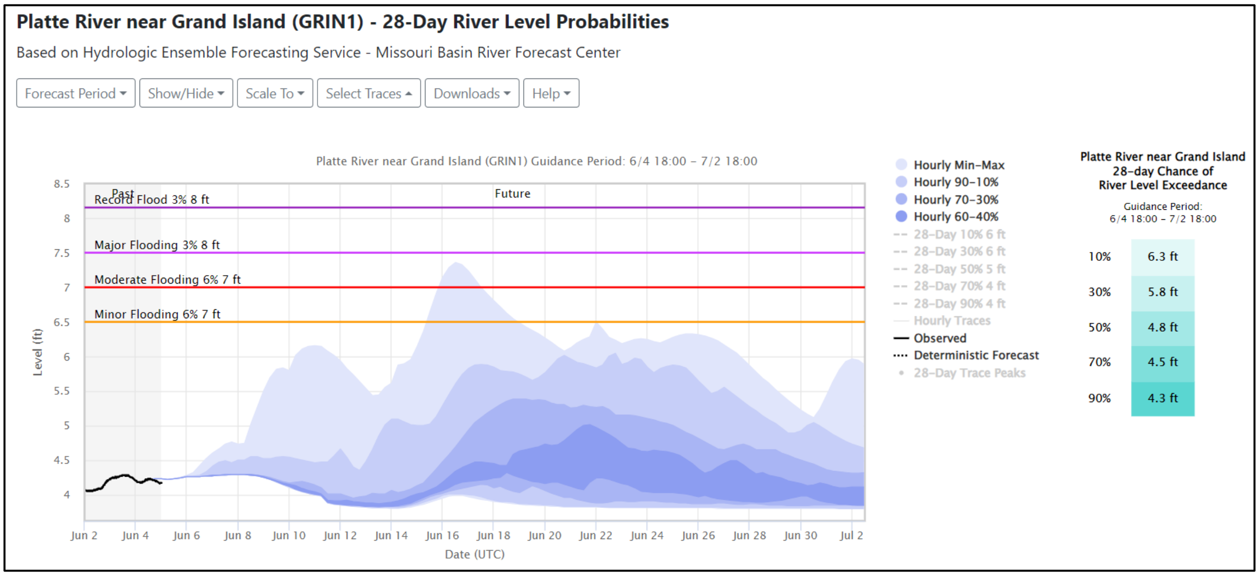
### 5.4.9 Missouri River Basin Forecast Center

The Missouri Basin River Forecast Center (MBRFC) provides river forecasts for river gages in the UPRB from the headwaters in Colorado and Wyoming, into Nebraska (NOAA NWS CPC 2023). One application of MBRFC products has been flood management, where future forecasts of peak river stages can guide flood-fighting efforts. Similar information can also be applied for water supply forecasts.

The Hydrologic Ensemble Forecast Service (HEFS) combines probabilistic forecasts of precipitation, temperature, and snowpack to forecast river flows up to 28 days into the future. The ensemble is a collection of traces of river flows. Each trace is a possible single future of river flows based on when and how much precipitation may occur and how quickly snow may melt. The collection of traces may point to a likely river flow outcome, although there will always be outliers to reflect the range of low or high flows that could occur.

Figure 49 shows an example 28-day river forecast at Grand Island. The black line represents the most recent measured river flow data while the blue bands are projected future flows. The darker blue band is the most likely river flows. The probability of these river flows is 40 to 60 percent chance, with the middle of the band representing a 50 percent chance. The lighter blue bands are less likely chances of river flows, for example a 10 percent chance. The HEFS ensembles are available for 14 locations on the North Platte, South Platte, and Platte River.

**Figure 49. Example River Ensemble Forecast**

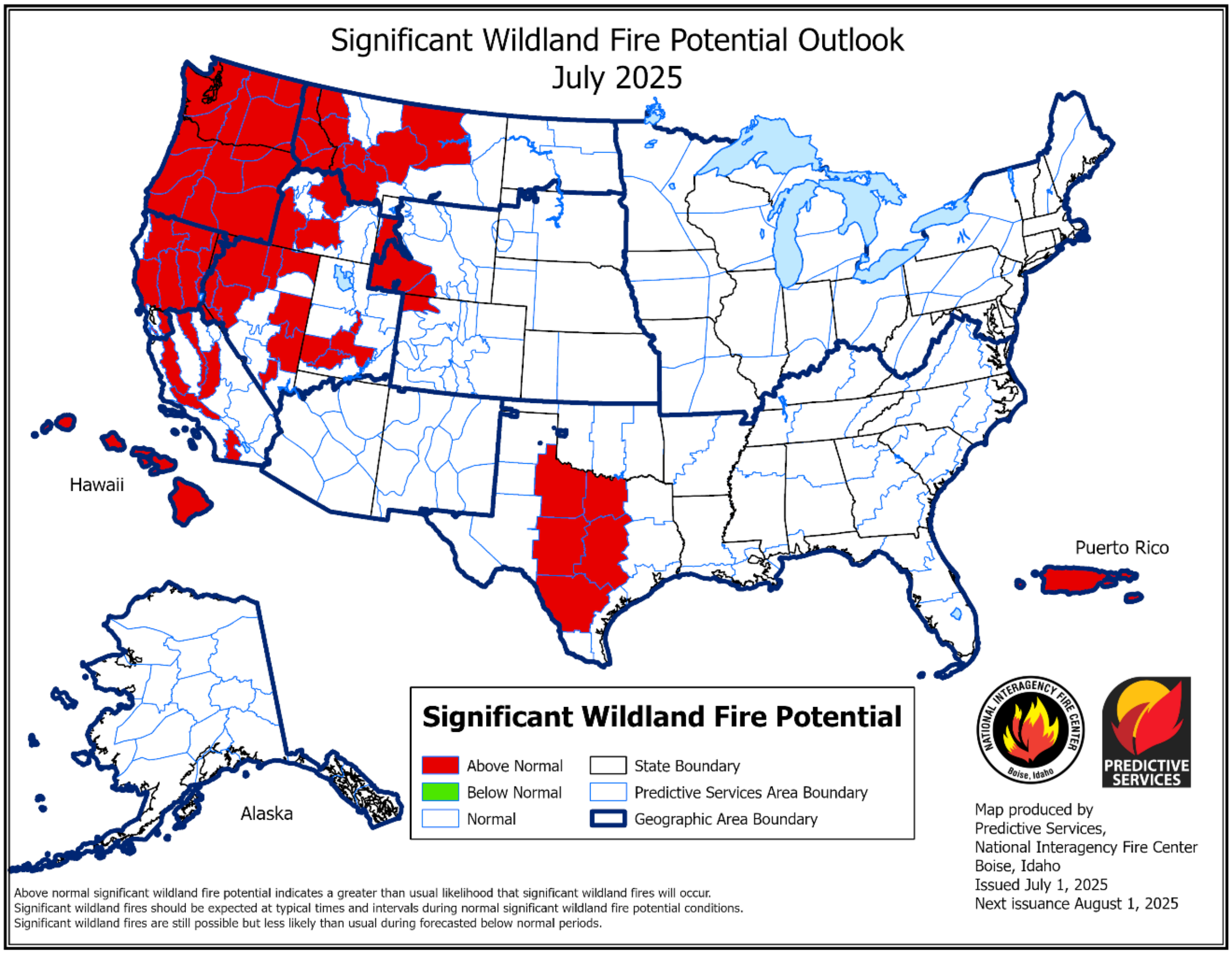



Source: NOAA NWS River Forecast Centers 2023.

### 5.4.10 Wildfire Outlooks

The National Interagency Coordination Center for Wildland Fire evaluates current conditions and climate outlooks to examine seasonal fire risks on a monthly basis. The source data include current drought conditions, including temperature and precipitation, and climate projections. Figure 50 provides an example of a fire potential outlook map. For reference, the Federal Emergency Management Agency also produces a National Wildfire Risk Index (https://hazards.fema.gov/nri/wildfire).

**Figure 50. Wildland Fire Potential Outlook Example**




## 6.0 Drought Management

Drought management includes actions taken before and in response to drought conditions to reduce potential risks and effects associated with drought. Currently, drought mitigation and response actions are taken by members of the Coalition independently to address various drought impacts. Drought mitigation measures are actions, programs, and strategies implemented during non-drought periods to address potential risks and effects and reduce the need for response actions; implementation of drought mitigation measures improves long-term resilience. Drought response involves actions or assistance to provide relief of drought impacts during or immediately after a drought.

### 6.1 Basin-Wide Actions

#### 6.1.1 Communication Plan

The Communication Plan described in Section 1.0 is the only mitigation and response action required as part of this increment of the Drought Plan. Table 18 shows a summary of communication plan actions. However, the Department and NRDs may collectively or individually decide to implement additional mitigation or response actions and incorporate them into their own plans. Table 19 describes additional mitigation and response actions considered as part of the development of the Drought Plan and are available as a “menu of options” for the Coalition NRDs in development of their individual drought plans.

**Table 18. Communication Plan Summary**

| Drought Conditions | Internal (POAC) Communications | Public Education and Outreach Activities |
|---|---|---|
| No Drought | • POAC Meetings will discuss the need for any additional internal communications.<br>• Gather data from stakeholders (other than dashboard information). | • Promote the drought monitoring dashboard.<br>• Education campaign (via existing NRD or UNL education events, email blasts, newsletters, etc.).<br>• Promote CMOR. |
| Drought Advisory | • Email monitoring reports sent by the Department.<br>• Teleconferences as needed.<br>• Share and review ongoing drought mitigation actions and potential response actions. | • Social media posts pointing to dashboard for reference.<br>• Updates on local NRD websites regarding conditions in their area.<br>• Promote CMOR.<br>• Implement outreach process (as needed). |
| Drought Alert | • Each member prepares/updates communication tree of municipalities, emergency managers (county officials) and emergency responders (fire departments).<br>• Develop/update shared messaging. | • Promote CMOR.<br>• Coordinate with local emergency managers, responders, and rural fire departments.<br>• Implement outreach process. |

CMOR = Condition Monitoring Observer Report; NRD = Natural Resources District; POAC = Platte Overappropriated Area Committee; UNL = University of Nebraska-Lincoln

The following sections describe additional mitigation and response actions considered as part of the development of the Drought Plan and are available as a “menu of options” for the Coalition NRDs in development of their individual drought plans.

## 6.2 Drought Mitigation and Response Action Priorities

The mitigation and response actions included in this portion of the Drought Plan are intended to help reduce drought impacts. Each action is categorized based on the desired outcome of the action.

Direct benefits and costs are not specifically evaluated for the actions within this Drought Plan. Rather, each action is prioritized based the Department’s and the NRDs’ ease of implementation and likelihood of success.

**High** priority actions are those that fulfill the statutory obligations of the Department and the NRDs. These actions have the potential to serve multiple purposes and may be similar to other projects or programs already being implemented, making these actions most likely to be successfully implemented.

**Medium** priority actions are those that build upon the Department’s and the NRDs’ existing relationships, including (but not limited to) partnerships with other State agencies and UNL Extension. Actions in this priority category require buy-in and additional coordination with partners to ensure successful implementation.

**Low** priority actions are those that require the Department and the NRDs to build new partnerships. These activities will take the most time to develop and have the most uncertain future.

Input on the perceived effectiveness of each mitigation and response action was solicited from members of the Task Force at the June 27, 2023, meeting in Ogallala. Results from the polls, as shown in Appendix B, provide a comparison of perceptions of how effective mitigation and response actions might be. The Coalition considered the results of these polls when finalizing the mitigation and response actions contained in this Drought Plan.

Actions with higher ratings will be prioritized by the Coalition in the future for further studies, modeling, or funding. However, all actions discussed in the Drought Plan are considered implementable.

**Table 19: Drought Response Actions by Type Considered in this Plan**

| Action | Vulnerability Addressed | Type (Mitigation, Response, or Both) | Priority | Trigger (Response) | Primary Implementation Responsibility |
|---|---|---|---|---|---|
| ***Water Supply Actions: Increase availability of groundwater and streamflow supplies, including, but not limited to, hydropower, and irrigation*** | | | | | |
| Enhance Surface Water Storage and Delivery | Groundwater and streamflow supplies | Mitigation | High | — | Both |
| Groundwater recharge projects | Groundwater and streamflow supplies | Mitigation | High | — | NRDs in coordination with the Department |
| Irrigation efficiency and water use monitoring | Groundwater and streamflow supplies | Mitigation | High | — | NRDs in coordination with the Department |
| Promote use of surface water/conjunctive management | Surface water irrigation/conjunctive management, groundwater and streamflow supplies, crop yield reduction | Mitigation | High | — | Both |
| Coordinate and support development of emergency action plans for water shortage (communities/municipalities) | Decreased source water quantity, fire/emergency threats | Mitigation | Medium | — | NRDs |
| ***Drought-Resilient Agriculture: Decrease the demand for groundwater and streamflow supplies*** | | | | | |
| Promote crop variety and seed spacing | Crop yield reduction | Response/Both | Medium | Drought Advisory (fall/winter) | NRDs |
| Livestock protection, shade, and water | Livestock feed/water shortage | Response | Medium | Drought Alert | NRDs |
| Irrigation scheduling | Groundwater/aquifer depletion | Response | High | Drought Alert | NRDs |
| Erosion conservation measures | Erosion, soil health | Mitigation | High | — | NRDs |
| ***Drought Resilient Habitat Projects: Ecosystem function/biodiversity, habitat, ecotourism, and recreation*** | | | | | |
| Promote drought-resilient habitat | Ecosystem function/biodiversity, Threatened and Endangered (T&E) species critical habitat | Mitigation | Medium | — | Department |
| Promote riparian buffer zones | Terrestrial and aquatic habitat, surface water quality | Mitigation | Medium | — | NRDs |
| Controlled (prescribed) burns | Fire threat | Mitigation | High | — | NRDs |
| Lake dredging and aquatic habitat restoration | Aquatic restoration, ecotourism | Mitigation | Medium | — | NRDs; Department coordination |
| Watershed water quality management | Aquatic recreation, game/fish disease, ecotourism | Mitigation | Low | — | Both (NRDs and the Department) |
| Drought-resilient recreational facilities | Aquatic recreation, ecotourism | Mitigation | Medium | — | Department |
| Promote awareness of fish and game regulations during drought | Game/fish disease, aquatic recreation, upland game | Response | Medium | Drought Alert | Department coordination with Nebraska Game and Parks Commission |
| ***Outreach Activities*** | | | | | |
| Public Outreach – available drought-related financial assistance | Public services, economic development | Response | Medium | Drought Alert | Both |
| Outreach – lawn irrigation efficiency, scheduling, and reduction | Decreased source water quantity | Response | Medium | Drought Advisory | NRDs/Both |
| ***Emergency Response Activities*** | | | | | |
| Water supply for rural fire departments/districts | Power infrastructure stress and maintenance | Mitigation | Medium | — | NRDs |

| Action | Vulnerability Addressed | Type (Mitigation, Response, or Both) | Priority | Trigger (Response) | Primary Implementation Responsibility |
|---|---|---|---|---|---|
| Emergency potable water | Fire/emergency threats, public health (drinking water) | Response | Low | Drought Alert | NRDs |
| Promote wildfire suppression and fire weather awareness | Fire threat/impact | Response | Medium | Drought Alert | Both |
| Promote air quality monitoring | Public health | Response | Low | Drought Advisory and Drought Alert | Department |
| ***Additional Monitoring Activities*** | | | | | |
| Groundwater quantity and quality monitoring | Decreased source water quantity and quality, public health (drinking water) | Both | High | Drought Advisory and Drought Alert | NRDs |
| Municipal infrastructure monitoring and maintenance | Decreased source water quantity, infrastructure stress and maintenance | Mitigation | High | — | NRDs |

## 6.3 Drought Water Supply Actions

Drought water supply actions increase the availability of water for both surface water and groundwater users dependent on streamflows (including, but not limited to, hydropower and irrigation). Mitigation actions to increase supplies will also address shortages that cause non-compliance with interstate agreements.

Projects aimed at storing excess water when available to provide offset water during dry periods are a predicted and proven approach in the UPRB. These projects can include both surface water storage reservoirs and groundwater recharge projects. The UPRB NRDs, with the support of the Department, have included groundwater recharge projects as implementable actions in their IMPs. In addition, objectives and action items identified to achieve goals in the Second Increment Basin Plan call for the continued identification and use of conjunctive management opportunities.

### 6.3.1 Enhance Surface Water Delivery and Storage (Mitigation)

Dams and reservoirs in the UPRB are often located in the upland drainage areas just beyond the Platte River floodplain, as depicted in Figure 51 and Figure 52. Several of these reservoirs are connected to canal systems that allow the various irrigation districts to store water during the non-irrigation season for use during the irrigation season.

**Figure 51. UPRB Canals, Diversions, and Reservoirs (West)**

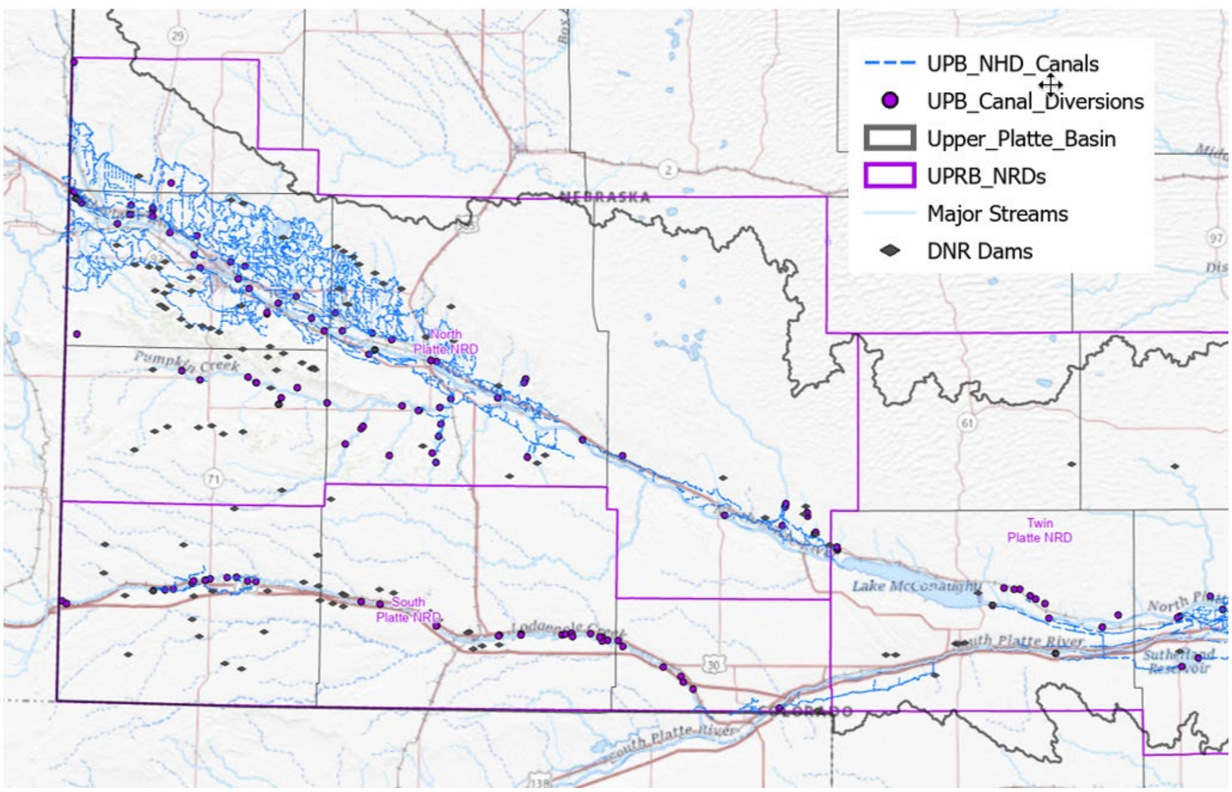
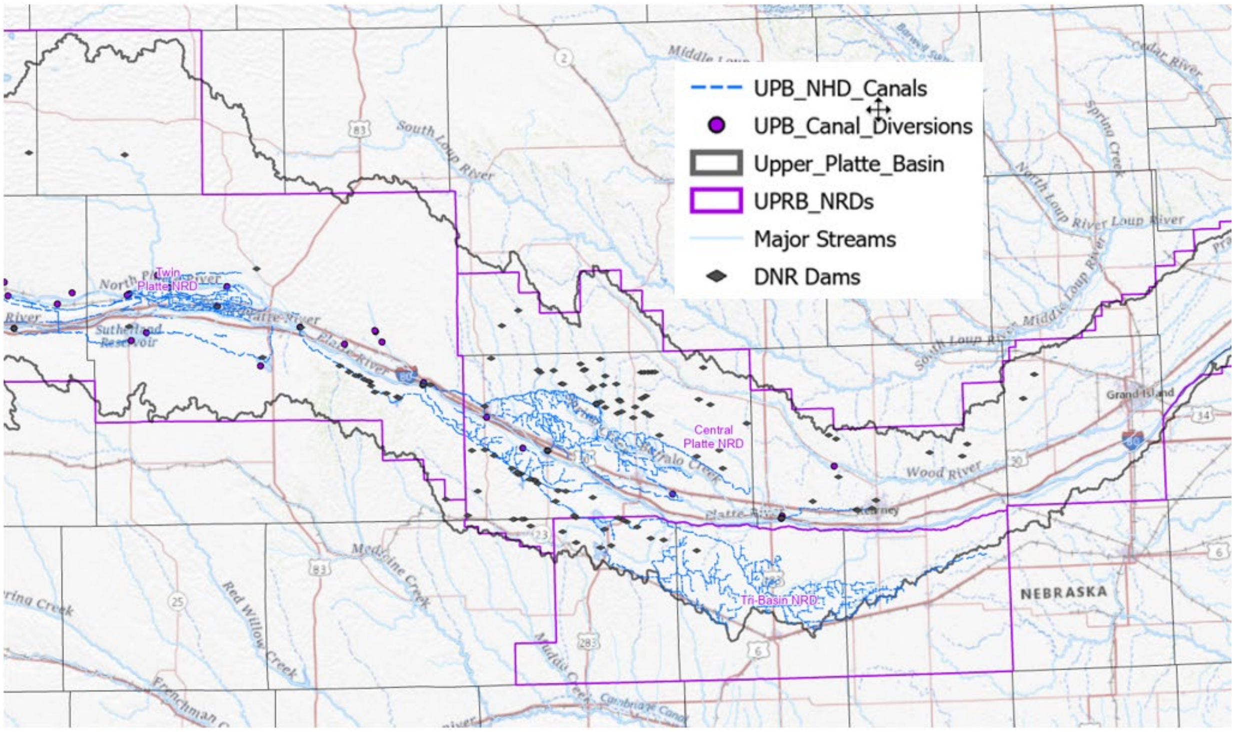


**Figure 52. UPRB Canals, Diversions, and Reservoirs (East)**




Opportunities still exist within the UPRB NRDs to add surface water storage with or without supplemental water supplied by other reservoirs or rivers and streams outside the impoundment's natural drainage area. Several of these additional reservoir sites have been or are actively being studied as part of the Nebraska Watershed and Flood Prevention Program with the USDA NRCS. Some of these tributary watersheds include Spring Creek, Buffalo Creek, Wood River, Brule Canyon, Gering Valley, and Birdwood Creek.

Additional storage projects that can retain water and then release it during periods of drought should be considered beneficial as they provide options for irrigation districts or NRDs to potentially leave natural flow in rivers or streams or directly release stored water to rivers or streams. New surface water impoundments within the UPRB must comply with prior surface water appropriations, each NRD's IMP, and the Nebraska New Depletion Plan for the Platte River Recovery Implementation Program.

Drought mitigation projects can improve the delivery of water for irrigation and power production needs by reducing losses in canals and reservoirs. Projects can be implemented to mitigate seepage losses from surface water reservoirs or impoundments. However, mitigation or offsets may be necessary to compensate for the reduced groundwater recharge that can result from more efficient surface water storage and delivery systems. Other water delivery efficiency projects can include the construction or repair of headgates, flumes, diversion structures, check valves, etc.

#### 6.3.1.1 Increase Availability of Water for Cooling and Hydropower (Mitigation)

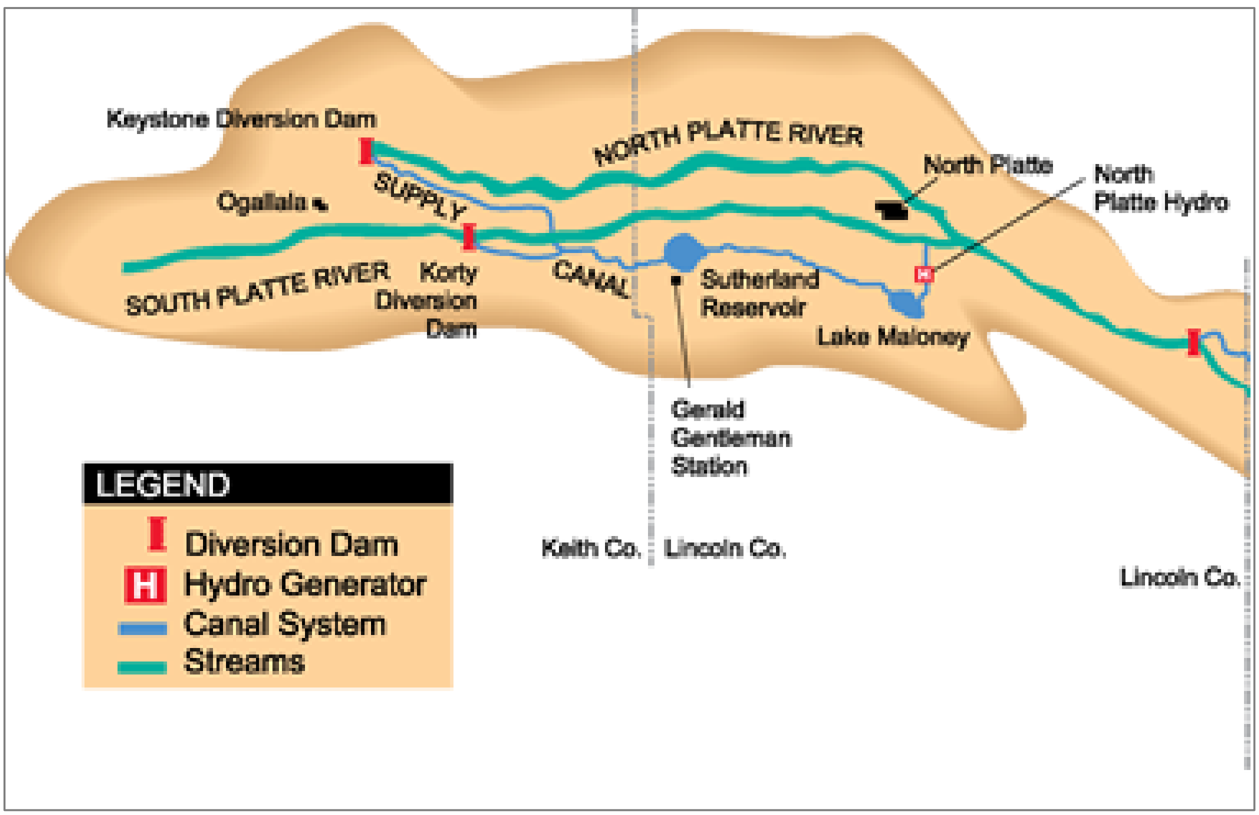
Cooling water is constantly required for the operation of coal-fired power plants. In the UPRB, NPPD's Gerald Gentleman Station is Nebraska's largest electric generating facility at 1,365 MW and primarily relies on cooling water supplied by canals from Lake McConaughy or diverted from the South Platte River into Sutherland Reservoir, which is adjacent to the power station (see Figure 53). A series of groundwater wells owned and operated by NPPD was constructed in response to the 2002 to 2004 drought and can supplement the surface water source and maintain an appropriate water temperature in Sutherland Reservoir.

From Sutherland Reservoir, water is routed through Sutherland Canal to Lake Maloney before it is released through the North Platte Hydropower turbines back into the South Platte River. Opportunities exist to enhance water availability, water delivery efficiency, and water temperature regulation on this system. Mitigation actions that allow more water to be stored in Sutherland Reservoir can have benefits throughout the UPRB system.

Projects to control seepage from Sutherland Reservoir would allow it to store additional water for longer periods. This would help keep the temperature of water held in the reservoir lower and allow for greater operational flexibility in maintaining hydropower production downstream.

Augmenting surface water with groundwater is also a potential mitigation action to improve the availability of water for thermoelectric power production and hydropower. NPPD's existing backup wellfield around Sutherland Reservoir included the installation of 38 drilled wells; however, only 27 of those wells are currently equipped with pumps and connected by pipelines. If the remaining wells are needed in the future to address more severe drought conditions, then a new project may be necessary to complete these wells with required pumps and piping. It is also possible for the Nebraska Cooperative Republican Platte Enhancement (N-CORPE) Project to help supplement surface water with pumped groundwater into Sutherland Canal downstream of Sutherland Reservoir. This augmentation of groundwater can help maintain the water supply in Lake Maloney to be used for hydropower and downstream releases while leaving water stored at Sutherland Reservoir. Any new groundwater depletions not already accounted for must comply with each NRD's IMP and the Nebraska New Depletion Plan.

**Figure 53. NPPD's Cooling Water and Hydropower System**



### 6.3.2 Groundwater Recharge Projects (Mitigation)

Induced groundwater recharge occurs when excess surface water is diverted or stored and allowed to infiltrate into groundwater aquifers. From there, the timing of that groundwater being used or returning to streams or rivers as accretion is variable and dependent on rates of water infiltration through the vadose zone and lateral groundwater flow. As a result, benefits from groundwater recharge projects occur over a broad range of time, both in wet periods and in dry periods.

Implementation of the first increment of the Basin Plan (2009–2019) demonstrated the value of intentional recharge to retime and augment baseflows. Each NRD in association with numerous surface water irrigation districts, power districts, private conservation entities, federal agencies, and Nebraska state government worked together to utilize and retime excess flows that occurred along the Platte River. In 2011, the Upper Platte River Recharge and Flood Mitigation Demonstration Project was carried out with the participation of 21 irrigation districts (NeDNR 2013). The project capitalized on flooding originating from the upper North Platte and South Platte River basins in Colorado and Wyoming. Results from the demonstration project show that 65,000 acre-feet (AF) of the 140,000 AF diverted was estimated to have seeped into groundwater storage. Of this 65,000 AF, a total of 36,000 AF is calculated to benefit streamflow within a 50-year timeframe.

Numerous other groundwater recharge projects across the UPRB have been successfully implemented and remain ready to provide intentional recharge to sustain aquifers and augment stream baseflows. Surface water features used for intentional recharge are typically existing surface water irrigation infrastructure repurposed or modified to enhance recharge. Some entities have also created entirely new projects. Existing and new surface water features that can be utilized to induce groundwater recharge include canals, wetlands, ponds, or reservoirs. A key aspect of these projects is the ability to predict and measure water diverted and delivered to enable documentation and modeling of actual accretion to aquifers, streams and rivers.

Future opportunities exist to repurpose or create additional surface water features that can serve as intentional recharge projects. A 2019 report based on 2010 aerial imagery reported that over 53,500 acres of open water existed across the UPRB including sandpit lakes and both permitted and unpermitted reservoirs (Zoller, Ajaere, and Pedley 2019). Permitted reservoirs within the Basin are regulated through surface water storage permits from the Department. There are 236 dams in the UPRB based on the Nebraska Dams Inventory. See Department permitted dams shown in Figure 51 and Figure 52.

Approximately 2,700 miles of canals and 400 diversion points shown in Figure 51 and Figure 52 highlight the extent of additional induced groundwater recharge project opportunities. New projects can enhance or expand upon existing infrastructure. Planning for new groundwater recharge projects has distinct advantages of capitalizing on new and improved geologic or groundwater modeling data, which show recharge hot spots, optimizing the delivery of excess flows to avoid potential losses, and maximizing surface water right availability. It should be noted that new groundwater recharge projects within the UPRB must comply with prior surface water appropriations, each NRD’s IMP, and the Nebraska New Depletion Plan for the Platte River Recovery Implementation Program.

### 6.3.3 Irrigation Efficiency and Water Use Monitoring (Mitigation)

Improving the efficiency of water applied for irrigation as well as monitoring the amount of water used are effective ways to reduce the amount of water applied for irrigated crop production. Techniques employed to improve irrigation efficiency include soil and yield mapping, conversion from furrow irrigation to center-pivots or subsurface drip irrigation systems, improved irrigation controls, low-pressure or low-flow nozzles, soil-moisture monitoring, and enhanced dissemination of weather and ET data via the internet, cellphone texts, and social media. Methods adopted or adapted to measure the amount of irrigation water applied include flow meters, calibration of electrical usage to pump and well performance, and direct measurement of water applied in portions of the field.

Implementation of these mitigation measures before drought allows for water savings to occur leading up to and during drought. Programs and funding to support irrigation efficiency enhancements include NRD programs, USDA NRCS conservation programs, and locally led initiatives by irrigation manufacturers, technology proponents, and conservation organizations such as The Nature Conservancy. Several programs also exist to support irrigation research, water use data collection, and data analysis. They include programs and initiatives sponsored by UNL, NRDs, and the Nebraska Water Balance Alliance. Flow meters or other irrigation water measurement methods are required in some portions of the UPRB. In many areas, implementation of monitoring has been supported by local initiatives, including NRD and grant funding.

### 6.3.4 Promote Use of Surface Water/Conjunctive Management (Mitigation)

Conjunctive management is the planned use and management of both surface water and groundwater resources to maximize water availability and reliability. It aims to optimize the use of both surface and groundwater to ensure sustainable and reliable water supplies. Commingled acres and groundwater controls are examples of conjunctive management.

#### 6.3.4.1 Commingled Irrigation (Mitigation)

Commingled irrigated acres are those lands that can be irrigated using either groundwater or surface water, or a combination of both. The advantage of commingled irrigation during drought is the flexibility to receive water from surface water when it is available while having groundwater as a secondary supply for when surface water may not be available.

The current UPRB technical guidance recommends procedures for estimating surface water depletion from groundwater irrigation on commingled irrigated acres. Adding groundwater pumping to create commingled irrigated acres within the UPRB must comply with each NRD’s IMP and the Nebraska New Depletion Plan for the Platte River Recovery Implementation Program.

#### 6.3.4.2 Groundwater Management Controls (Mitigation)

The Nebraska Legislature, under Nebraska Revised Statutes Section 46-701 to Section 46-754 of the Nebraska Groundwater Management and Protection Act, grants NRDs authority to protect the quantity and quality of water, and to resolve conflicts between surface water and groundwater users. The NRD may adopt one or more controls, which may include the following:

- Allocations of the amount of groundwater users may withdraw.
- System of rotation of irrigation water use.
- Well spacing requirements.
- Well metering requirements.
- Reduction of irrigated acres.

- Limits on or prevention of expansion of irrigated acres or beneficial use of water.
- NRD approval of transfer of groundwater off overlying land.
- NRD approval of transfer of rights to use groundwater that result from NRD-imposed allocations or other NRD restrictions.
- Prevention of adverse effects on other groundwater or surface water users.

Each NRD maintains a Groundwater Management Plan with water quality area designation criteria and water quantity area designation criteria, which can include regulation of well spacing, allocations, and stays on new development depending on which phase is triggered.

#### 6.3.5 Coordinate and Support Development of Emergency Action Plans for Water Shortage (Communities/Municipalities) (Mitigation)

NRDs will build upon existing relationships with municipalities within their districts by encouraging the development of Emergency Action Plans (EAPs) for water shortage. The EPA provides guidance on planning for an emergency drinking water supply for public water supplies and municipalities (2011). Recommended approaches include cross-coordination, interdependence on neighboring water utilities, bottled water supplied locally or regionally, or regionally supplying a community storage tank or reservoir. EAPs should include general contact information for potential supplies of safe fresh water.

### 6.4 Drought-Resilient Agriculture

NRDs will work with the identified groups as appropriate to ensure producers are planning for the potential for drought to impact their operations. These groups could include local agronomists, co-ops, or the UNL Extension.

#### 6.4.1 Promote Crop Variety and Seed Spacing (Mitigation and Response) (Trigger: Drought Advisory (Fall/Winter))

NRDs should work with local agronomists, co-ops, and the UNL Extension to assist with crop selection and seed spacing in both preparation and response to drought conditions.

Drought-tolerant crops are plants that can survive and produce yields under low-water conditions. These plants optimize water uptake and reduce water loss through physiological adaptations, such as deeper root systems that tap into underground water sources and stomatal regulation that limits transpiration (Ameer 2024).

Reduced tillage ahead of seeding can also help conserve moisture. Single-disc drills disturb and move less soil, which means opening less soil and allowing less moisture to escape (Bayer 2024).

Varying inter-row and intra-row seed spacing can improve plant physiological traits and overall yield. Increased row spacing maximizes water distribution while minimizing interplant competition (Frantova et al. 2024).

In dry soil conditions, fields should not be overworked to help maintain topsoil moisture. Additionally, timely planting is key to helping provide the best chances for germination before the topsoil profile dries out (Bayer 2025).

Crop rotation has been used by farmers for generations to improve grain yields by regenerating the soil and breaking the cycles of weeds, diseases, and insect damage to crops. One long-term study (Wagner 2021) in eastern Nebraska showed that:

1. *"More diverse rotations improved yield and yield sustainability*
   - *Under no fertilization (0N), yield for corn or grain sorghum rotated with soybean was similar to grain yield in fertilized continuous cropping systems.*
   - *Compared to continuous cropping, fertilized corn yield improved 29% and fertilized grain sorghum yield improved 20% when grown in two-year rotations, and up to 48% (corn) and 29% (grain sorghum) when grown in four-year rotations that included a legume winter cover crop in just one of four of those years.*
   - *Soybean yield was stable regardless of N application and tended to improve with rotation complexity.*
   - *Rotating crops increased long-term yield stability and decreased crop losses during drought by 14–90% compared to continuous cropping.*
2. *Yield benefits from crop rotations are similar to N fertilizer, but more stable over time.*
   - *Yield responses for corn and grain sorghum were similar at low N (80 lb N/ac) and high N (160 lb N/ac), suggesting that crop N demands were met at the low N rate.*
   - *Adding fertilizer-N to the most diverse rotations (CSGO, COGS) did not increase yield.*
   - *Fertilizer-N responses decreased over time, but crop rotation benefits were maintained (grain sorghum) or increased (corn) over time. This suggests that the benefits of rotation on crop N nutrition increasingly displaced the effect of fertilizer N over time.*
   - *Rotating crops increased yields similar to fertilizer-N even with no fertilizer use (0N).*
   - *The sequence of crops in rotation also affected yield outcomes (COGS vs CSGO).*
3. *More diverse crop rotations had more soil organic C (SOC) than fertilizer-N.*
   - *The SOC increased with rotation diversity down to 5 feet deep.*
   - *The grain sorghum/soybean rotation had the lowest SOC content to 5 feet depth due to lower root mass and length in both crop types.*
   - *The effect of crop rotation effects on SOC were equal to or greater than the effect of fertilizer-N.*
   - *Clover cover crops added N to the soil for crop and microbial uptake.*
   - *Crop rotation and cover crops can build soil organic matter and improve soil water retention, likely contributing to more stable yields and greater resilience to adverse weather."*

### 6.4.2 Livestock Protection, Shade, and Water (Response) (Trigger: Drought Alert)

Heat stress can adversely affect livestock. The use of shade has been used as a mitigation strategy to improve animal comfort and growth performance, with positive outcomes (Blasi and Tarpoff 2025).

A study by the Kansas Agricultural Experimentation Station during the summers of 2021 and 2022 investigated four treatments of 852 heifers: limit-fed, high-energy ration or high-roughage ration fed for *ad libitum* intake with or without access to shade. Growth performance and water usage were measured during a 90-day growing period. Calves were fed a gut equilibration diet for 7 days to account for gut fill. The results indicate that limit-feeding a high-energy ration at 2.2 percent of body weight daily on a dry matter basis in combination with shade can improve animal efficiency, reduce water consumption, and improve animal comfort during periods of heat stress (DeBord et al. 2023).

During Drought Alert conditions and as needed, NRDs will identify producer needs and help connect producers to available resources, such as USDA Farm Service Agency (FSA) Emergency Livestock Relief Program. See Section 6.6.3 for more information about USDA Disaster Assistance Programs.

### 6.4.3 Irrigation Scheduling (Response) (Trigger: Drought Alert)

Many irrigation and high-capacity wells (greater than 50 gallons per minute) are driven by electrical motors using electricity provided by NPPD and Rural Electric Districts. Scheduling irrigation or high-capacity well water use in certain areas during certain times, dates, or days of the week can help moderate peak electrical demand throughout a service area. This same practice can help reduce maximum groundwater drawdown in areas by preventing many large-capacity wells from operating at the same time. While this response action will not necessarily reduce total water use, it can alleviate well interference issues and help protect domestic groundwater supplies from experiencing temporary water availability issues.

Even if irrigation scheduling is not a requirement of power districts or NRDs, voluntary efforts can be coordinated among various governmental agencies and promoted as part of an information and education campaign. This can also help inform well owners who use combustion engines to power their wells. Scheduling rotations by even- or odd-numbered sections can help geographically distribute well pumping and well drawdown.

### 6.4.4 Erosion and Conservation Measures (Mitigation)

The Nebraska Soil and Water Conservation Program, established in 1977, provides state financial assistance to Nebraska landowners for the installation of soil and water conservation measures that improve water quality, conserve soil moisture, and help control erosion and sedimentation. Among the eligible practices for cost-share assistance are terraces, terrace outlets (grassed or mechanical), irrigation reuse pits, grade stabilization structures, dams, diversions, grassed waterways, control basins, pasture and range seeding, planned grazing systems, irrigation water management, windbreaks, and windbreak renovations. See Table 20.

The Nebraska Natural Resources Commission determines the list of eligible practices, establishes operating procedures for the fund, and allocates the funds annually among the State's 23 NRDs. The USDA NRCS provides the technical assistance needed in planning and installing the approved conservation measures. Each NRD is responsible for the administration of the program at the local level including accepting applications from landowners, setting priorities, and working with the landowners and contractors to complete the practices.

### Table 20. Nebraska Soil and Water Conservation Program Drought-Relevant Practices

| Practice ID | Practice Name | Purpose |
|---|---|---|
| NC-1 | Constructing Terrace Systems | To control erosion on cropland, to conserve water and to reduce pollution. |
| NC-3 | Constructing Water Impoundment Dams | To impound runoff, conserve water, prevent erosion, prevent pollution, and to enhance groundwater recharge. |
| NC-5 | Constructing Irrigation Tailwater Recovery Pits with or without Underground Return Pipe | To impound runoff from irrigated fields for reuse and conserve groundwater. |
| NC-6 | Constructing Diversions | To divert water from areas where it is in excess to sites where it can be used or disposed of safely. |
| NC-8 | Constructing Water-and-Sediment-Control Basins | To reduce on-site erosion, reduce sediment, reduce sediment content in water, intercept and conduct surface runoff through subsurface conduits to stable outlets, reduce peak rate or volume of flow at downslope locations, reform the land surface, and improve farmability. |
| NC-9 | Constructing Dugouts for Livestock Water (runoff collection only) | To create an impoundment for livestock water use by excavating to collect runoff in grassland. |
| NC-10 | Pasture Planting or Range Seeding (land use conversions) | To establish grass on land being converted from other uses or the renovation of existing pasture or range. |
| NC-11 | Critical Area Planting (grass) | To stabilize the soil, reduce damage from sediment and runoff to downstream areas. |
| NC-12 | Windbreaks | To establish stands of trees to conserve soil and moisture and to prevent erosion. |
| NC-13 | Constructing Underground Return Pipe from Irrigation Tailwater Recovery Pits | To provide permanent conveyance facilities for water impounded by approved tailwater recovery pits to the water supplies that created the tailwaters. |
| NC-14 | Planned Grazing Systems | To reduce erosion and improve water quality by maintaining or improving plant cover for increased forage production, enhanced wildlife habitat, grazing uniformity, and water use efficiency. |
| NC-16 | Windbreak Renovation | To provide for the restoration of farmstead or field windbreaks that have been rendered substantially ineffective due to the death of trees or other windbreak plantings as a result of weather, disease, or other natural causes. |
| NC-17 | Irrigation Water Management | To conserve groundwater and surface water by improving water use efficiency on irrigated lands. |

| Practice ID | Practice Name | Purpose |
|---|---|---|
| NC-19 | Repair of Practices | To repair the following practices or practice elements when the damage to the practice is due to natural cause(s) rather than improper or inadequate maintenance: Terraces, dams, diversions, grade stabilization structures, and livestock water supply pipelines. Any repair work must return the practice to a condition that meets technical specifications of the NRCS. |

## 6.5 Drought-Resilient Habitat

Drought can shift the ecological balance of natural systems and harm fish, wildlife, and plant species. Ecological drought is defined as "an episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability, impacts ecosystem services, and triggers feedbacks in natural and/or human systems" (Crausbay et al. 2017).

Currently, the best practice for addressing ecological drought is to link the important drivers of drought to both ecological impacts and ecosystem service impacts. Together, these impacts relate to how much changes in the natural environment will cause changes in humans' uses of natural resources. In turn, the need to share water and other natural resources during drought between direct human needs and ecological needs can be better understood and better implemented.

Research suggests that additional monitoring and documentation is needed to relate drought conditions to ecosystem and wildlife impacts. This monitoring should include increased hydrological measurements, as well as water temperature measurements, in sensitive stream, wetland, and lake habitats. Even increased monitoring by cameras helps provide long-term documentation and assists future research and study efforts. In the UPRB, this effort has started with the Platte Basin Timelapse Project (Platte Basin Timelapse 2023).

### 6.5.1 Promote Drought-Resilient Habitats (Mitigation)

Planning ahead and establishing upland wildlife and pollinator habitat is an important action to complete ahead of drought conditions. Many of the counties in the UPRB are part of a special Conservation Reserve Program (CRP) initiative in Nebraska known as the State Acres for Wildlife Enhancement (SAFE) program (USDA FSA 2022).

Planting trees and shrubs can enhance wildlife habitats and pastures. Shade from trees and shrubs protects soil and helps curb heat and reduce evaporation. Trees also mitigate the forces of wind and water on the landscape, helping to prevent or slow down erosion. The Nebraska Forest Service (2022a) recommends that efforts to sustain trees and shrubs be prioritized during drought as they are more difficult and time-demanding to replace than grasses or other landscape plants.

Maintenance of grasslands and native habitats and the removal of invasive species should also be a priority mitigation action. Removal and continuous suppression of invasive species, such as eastern red cedar, not only help native habitats thrive, but reduce wildfire threats and fuel that is especially dangerous during drought.

The Department will coordinate with the NGPC and other applicable federal, state, and local agencies to identify project and outreach opportunities.

### 6.5.2 Promote Riparian Buffer Zones (Mitigation)

Riparian buffers surrounding streams and rivers are vital habitat and wildlife corridors during drought. Being the closest to remaining sources of water during drought, these grass and forested areas help maintain habitat, natural migration, and protected sources of water for wildlife. Riparian areas also protect surface water from contamination and erosion.

Nebraska maintains a buffer strip program administered from fees assessed on registered pesticides. This program is targeted at protection areas adjacent to perennial and seasonal streams, ponds, and wetlands.

Selecting native plants for riparian buffers can enhance their durability during drought. Recommended species for various areas of the state are identified in UNL Extension NebGuide G1557 (Fox et al. 2005).

NRDs will coordinate with the Department on the buffer strip program and the UNL Extension for plant selection.

### 6.5.3 Controlled (Prescribed) Burns (Mitigation)

Prescribed fire is a very valuable practice for rangeland and prairies that can reduce wildfire hazards by encouraging native grass species and suppressing invasive species. Prescribed burns should be properly planned and carried out by a trained and qualified team. An open burn permit is required from the Nebraska State Fire Marshal per State Statute 81-520.02.

Many organizations across Nebraska support controlled burns including USDA NRCS (2008), NRDs, NGPC, Nebraska Forest Service, USFWS, and private organizations such as Nature Conservancy (2020), and Pheasants Forever. The Nebraska Prescribed Fire Council is also a resource formed by landowners for the purpose of educating, training, and practicing safe prescribed burn techniques that remove invasive species and fuel buildup as protection from wildfires (Nebraska Prescribed Fire Council n.d.).

### 6.5.4 Lake Dredging and Aquatic Habitat Restoration (Mitigation)

Dredging and in-lake aquatic habitat improvements have numerous advantages during drought. First, deepening lakes allow aquatic organisms to survive the large lake level fluctuations that can be experienced during drought, especially in reservoirs used to supply surface water irrigation. Second, dredged lakes can help maintain cooler water temperature during severe heat as compared to the same impoundment without dredging. Removing accumulated sediment from lakes and reservoirs increases the life and function of the lake. Coincidentally, adding aquatic habitat improvements to dredged or new lakes improves water quality, promotes fish diversity, and helps utilize nutrients that otherwise could cause harmful algae blooms.

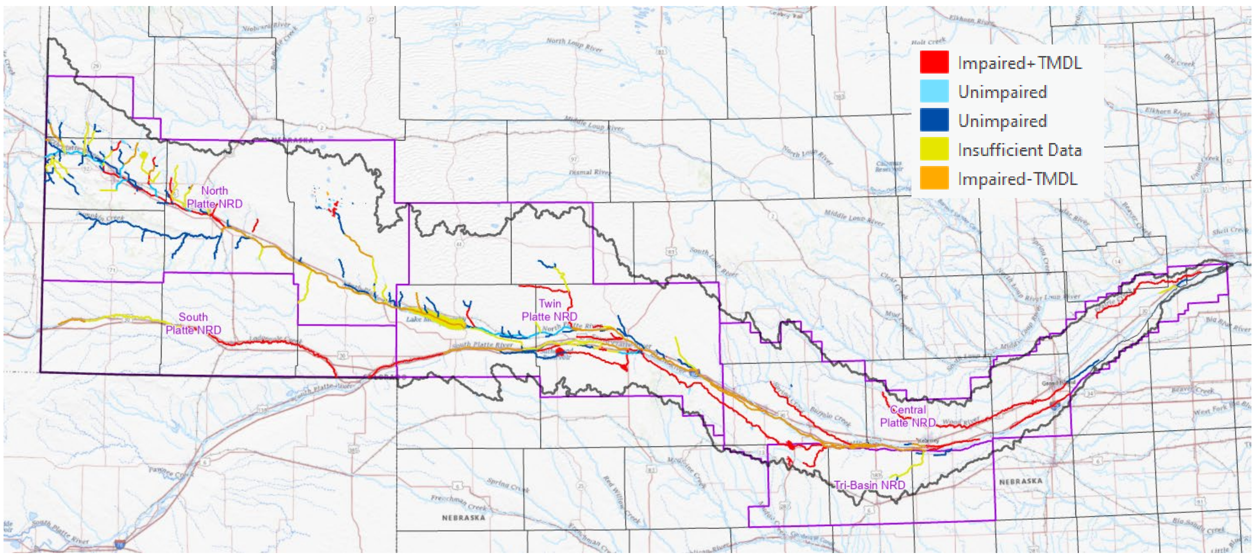
Several agencies and partners help promote lake dredging and aquatic habitat restoration. The Aquatic Habitat Program from the NGPC aims to improve conditions for aquatic life through waterbody rehabilitation and improved management (NGPC n.d.). This program can be combined with other federal and state funding programs, including Section 319 non-point source pollution management projects.

The Department will coordinate with NGPC and NRDs to identify opportunities for aquatic habitat restoration within the UPRB.

### 6.5.5 Watershed Water Quality Management (Mitigation)

The *Nebraska Nonpoint Source Management Plan* (NDEE 2021a) lays out a process for developing Basin Management Plans for each NRD or smaller watershed management plans for local, specific surface water quality problems. Each type of plan qualifies actions identified within each plan for project implementation and funding under Section 319 of the Clean Water Act (CWA). Approximately 30 percent of the stream reaches, around 1,100 miles, in the UPRB are listed as impaired (Category 4 or 5) in the 2020 Water Quality Integrated Report (NDEE 2021b). Similarly, about 32 percent of the 214 lakes monitored in the 2020 Water Quality Integrated Report were found to be impaired (Category 4 or 5; NDEE, 2021b), see Figure 54.

**Figure 54. Stream and Lake Water Quality Designations from the 2020 Water Quality Integrated Report**




Source: NDEE 2021b.

If Basin or Watershed Management Plans were developed to address contamination issues facing these lakes and streams, then measures could be implemented within contributing watersheds or within the streams and lakes themselves to help resolve or reduce water quality issues. Potential mitigation actions for water quality improvement have already been discussed above as riparian buffer zones, lake dredging, and aquatic habitat restoration or erosion and conservation measures. Surface water quality improvements implemented within a watershed or directly within the surface water body will help reduce the risk of water quality impairments increasing during drought.

Each NRD maintains a Groundwater Management Plan with water quality area designation criteria and water quantity area designation criteria, which can include regulation of well spacing, allocations, and stays on new development depending on which phase is triggered.

The Department will coordinate with NRDs to identify opportunities for water quality planning.

### 6.5.6 Drought-Resilient Recreational Facilities (Mitigation)

A draft report of the Statewide Tourism and Recreational Water Access and Resource Sustainability (STAR WARS) Special Committee (May 2022) specifically evaluated and recommended a permanent marina at Lake McConaughy that can withstand water level fluctuations experienced during droughts. This type of drought-resilient feature continues to allow boat access even during extremely low lake levels and helps sustain the tourism economy during drought.

Similar drought mitigation opportunities exist for other lakes and reservoirs in the UPRB. Installing drought-compatible boat ramps, docks, and fishing piers promotes continued water and angler access. Such improvements can be constructed along with in-lake improvements as discussed above.

The Department will coordinate with the NGPC for state lakes while NRDs will coordinate with local jurisdictions for lakes they own and operate.

#### 6.5.6.1 Fish and Game Regulations During Drought (Response)

Analysis of impacts to fish and wildlife habitats and populations during drought may lead wildlife managers to scale back or change hunting and fishing seasons and bag limit regulations. This approach may provide more flexibility for reproduction or adaptation by species that are struggling with habitat impacts, disease, or increased predation. It may also help balance the strengths and weaknesses of different species as drought continues or intensifies (Bureau of Land Management n.d.). The Department will coordinate with NGPC to stay aware of imminent or active fish and game regulations during drought in the UPRB.

## 6.6 Outreach Activities

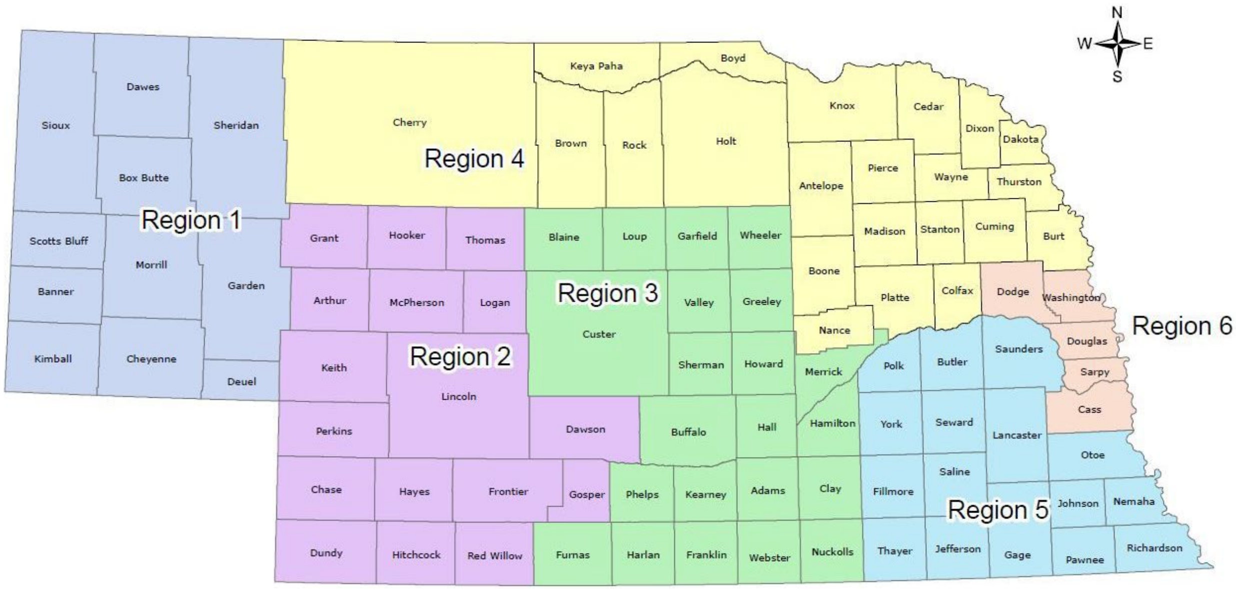
Numerous resources exist for public outreach and drought education. However, it takes local programs and local organizations to make outreach and education a successful reality. Outreach and education conducted when the UPRB is not experiencing a drought will prepare the public for increased and more specific public information during a drought (see Table 19).

UPRB NRDs participate in school outreach programs to help teach children about the importance of conserving natural resources, including water, and ways they can contribute to a safe, clean environment. Elementary students attend water and natural resources festivals across the Basin, while older students benefit from outdoor classroom development; contests for land, range, and soil judging; Envirothon; and other activities. Many NRDs help teachers develop tools to pass the conservation message on to the next generation. NRDs assist universities and colleges in developing natural resources opportunities. Workshops for farmers and urban landowners provide practical information on a variety of ways to care for natural resources. As a result of drought planning, NRDs can develop drought mitigation information and education to disseminate throughout each NRD.

### 6.6.1 Promote Mental Health Resources

When appropriate, public outreach will include promoting mental health resources when they are needed during a drought. Access to many different mental health resources is already available through local healthcare facilities, state and local health departments, and local municipal facilities such as libraries. The Nebraska Department of Health and Human Services (NDHHS) Division of Behavioral Health has a network of care website (https://portal.networkofcare.org/NebraskaBehavioralHealth) and three regions that cover the UPRB as shown in Figure 55. Public outreach and education for mental health ahead of drought helps break down barriers and improve community perception about seeking information and help.

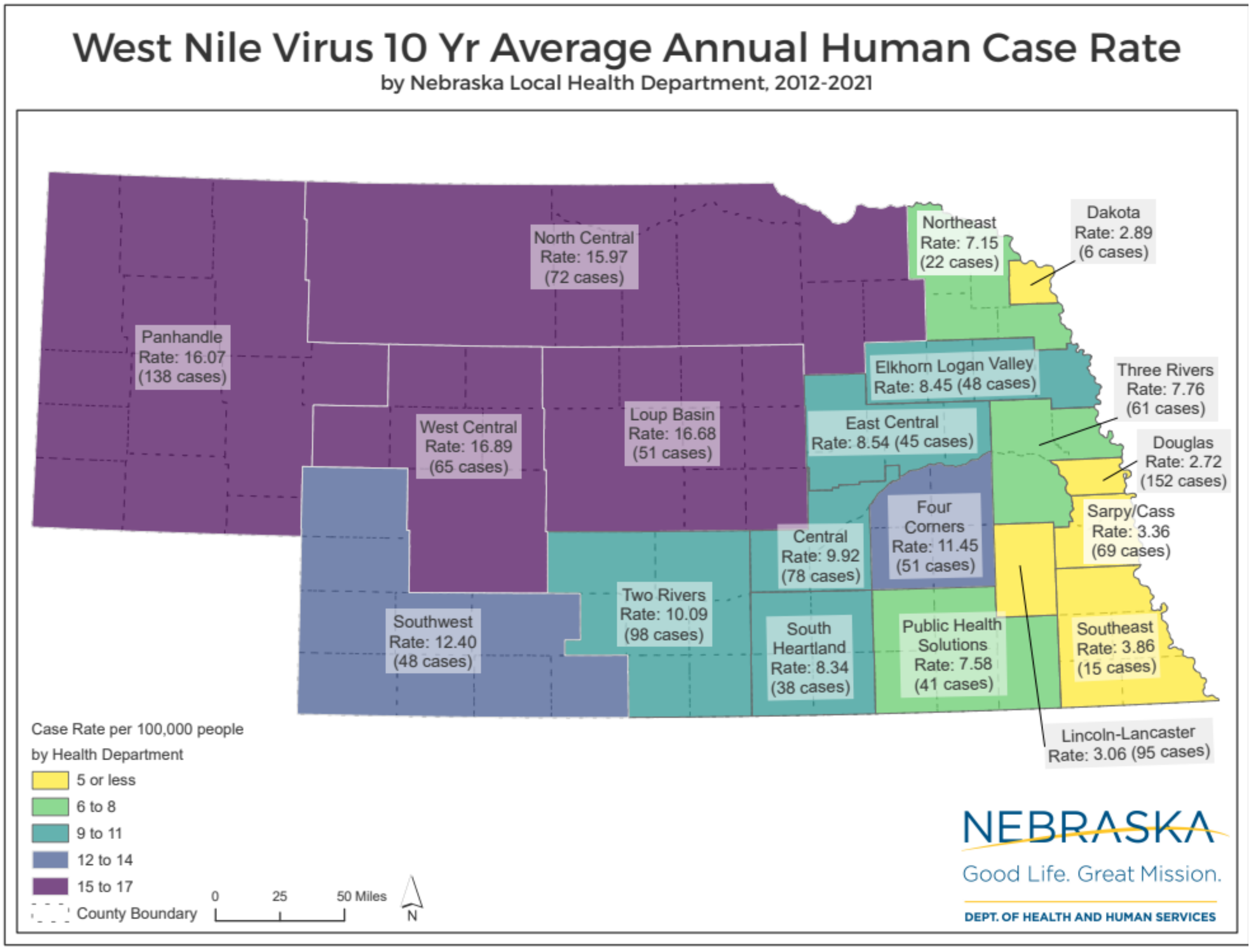
**Figure 55. NDHHS Behavioral Health Regions**




## 6.6.2 Promote Awareness of Disease Outbreaks

Education and training for potential diseases enhanced during the presence of drought and extreme heat, including vector-borne diseases from animals and insects, are available from local health departments across Nebraska. Primarily five health departments cover the UPRB and their contact information is updated and available at https://dhhs.ne.gov/CHPM%20Maps/LHDcontactMaster.pdf. NDHHS tracks reported cases of West Nile Virus across Nebraska each year by health department (see Figure 56). A weekly vector-borne report is also available at https://dhhs.ne.gov/WNV%20Documents/Vector-Borne-Report.pdf.

**Figure 56. 10-year Average Annual West Nile Virus Case Rate Indicating How Drier Conditions Can Increase Vector-Borne Diseases**




As needed during Drought Alert conditions, the Department and NRDs will promote these existing resources to promote public awareness of the impacts of drought on vector-borne diseases.

### 6.6.3 Available Financial Assistance

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas for the purpose of making emergency loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. Additionally, other emergency assistance programs have historically used disaster designations as an eligibility trigger.

The USDA-FSA has several disaster assistance programs available during drought conditions as described on the Disaster Assistance Programs at a Glance brochure, available online at https://www.farmers.gov/sites/default/files/2022-07/farmersgov-disaster-assistance-brochure-07-21-2022.pdf (USDA FSA 2022). Grazing land or pastureland physically located in a county rated by the USDM as D2 though D4 may qualify for and receive compensation for grazing losses for covered livestock. This program is administered by the FSA and is known as the Livestock Forage Disaster Program (LFP).

Economic injury disaster loans also exist to help small businesses, small agricultural cooperatives, and most private nonprofit organizations located in a declared disaster area. The

U.S. Small Business Administration website (https://www.sba.gov/funding-programs/disaster-assistance/economic-injury-disaster-loans) provides guidance on eligibility and application for such assistance. The Department and NRDs will promote the availability of drought disaster assistance programs as they become available.

#### 6.6.4 Lawn Irrigation Efficiency, Scheduling, and Reduction (Response) (Drought Advisory)

Many water utilities implement voluntary or mandatory water use restrictions during various stages of drought. The UPRB NRDs, in coordination with the Department, will work with municipalities in each NRD to develop and/or promote information and education programs that share the intended benefits of these restrictions both to the overall water supply as well as to each community's water infrastructure and level of service costs.

### 6.7 Emergency Response Actions

Emergency response actions focus on threats from fire during drought and threats to public health. Emergency responses generally result during or after a natural disaster. Drought itself is a large scale and long-lasting natural hazard. Quantifying the impacts and providing disaster relief are far more difficult tasks for drought than for other natural hazards since these impacts can filter through economies and the environment for months, years, and even decades (NEMA 2021).

However, programs aimed at providing disaster relief to agricultural producers most often exclude any disaster relief to communities, public services, or other independent businesses who also suffer economic losses. It usually takes a natural disaster, such as fire, resulting from a drought before an area may be declared an emergency disaster area by the Governor or U.S. President. The President can declare an emergency for any occasion or instance when federal assistance is necessary to supplement state and local services or resources.

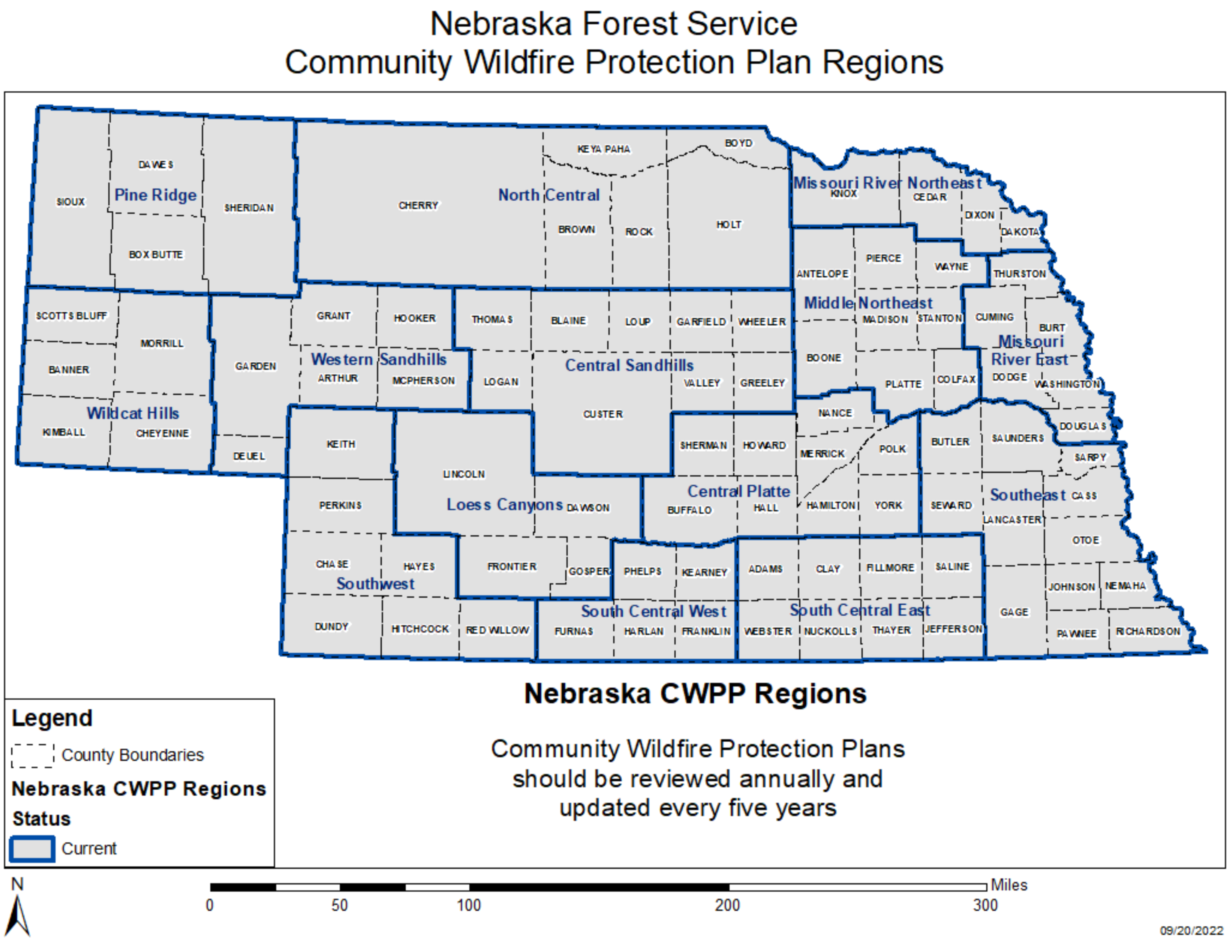
#### 6.7.1 Emergency Potable Water Supply (Response) (Trigger: Drought Alert)

As needed during drought conditions, NDWEE Water Planning and Drinking Water Divisions will monitor and communicate with potentially vulnerable communities. During drought-related emergencies, the Department and NRDs may coordinate the provision of or cost-share for emergency drinking water supplies.

#### 6.7.2 Promote Wildfire Suppression and Fire Weather Awareness (Response) (Trigger: Drought Alert)

Response actions to wildfire often involve coordinated responses from multiple local fire districts. Since these emergency responses to wildfire typically involve communication, coordinated Community Wildfire Protection Plans have been developed and implemented across numerous regions in Nebraska (see Figure 57). Each plan provides specific details on areas at risk from wildfire, emergency operations and capacity, risk reduction measures, preparedness, training and education, mitigation strategies, and monitoring. These plans often treat communities as Wildland Urban Interfaces where wildfire can potentially move into urban areas. Of these regions in the UPRB shown in Figure 57, all but the Western Sandhills Region have a Community Wildfire Plan as of the preparation of this report (Nebraska Forest Service 2022b).

**Figure 57. Community Wildfire Protection Plan Regions**




Source: Nebraska Forest Service 2022b.

### 6.7.2.1 Water Supply for Rural Fire Departments/Districts (Mitigation)

Each NRD shall, as part of its individual drought plan development and implementation, coordinate with producers and rural fire departments to develop (or update) a list of available wells to support firefighting efforts. The list will include information such as well locations, types of connections available and required equipment, and relevant contact information. The lists shall be updated regularly to promote efficient wildfire response.

### 6.7.2.2 Protect Power Infrastructure from Fire Threats (Mitigation)

Electrical power usage is heavily influenced by extreme temperatures, which can be experienced during drought in the UPRB. Increased electrical usage for cooling and irrigation during drought puts stress on not only power production, but also on transmission and electrical distribution systems. This stress, coupled with extreme temperatures and dry conditions, can lead to fires caused by electrical systems or fires from other causes that can directly damage power infrastructure. Potential drought mitigation actions to protect power infrastructure from fire threats include:

Maintain non-vegetated area around electrical utilities that can potentially ignite fires.

Replace wooden poles or use a fire-resistant coating.

Prevent wildlife contact (i.e., birds) from igniting wildfire.

Improve grid monitoring to detect outages possibly caused by or that could cause wildfire.

#### 6.7.2.3 Promote Fire Weather Monitoring Resources (Mitigation)

During drought alert conditions, the Department and NRDs will monitor and promote awareness of fire weather conditions. The NWS Storm Prediction Center (SPC) publishes Day 1, 2, and 3–8 Fire Weather Outlooks at https://www.spc.noaa.gov/products/fire_wx/overview.html. These outlooks categorize wildfire threat as Elevated, Critical, or Extreme based on the concurrence of warm temperatures, low relative humidity, sustained winds, and dry fuels https://www.spc.noaa.gov/misc/about.html#FireWx. Depending on these conditions, NWS may also issue a Red Flag Advisory, Watch, or Warning.

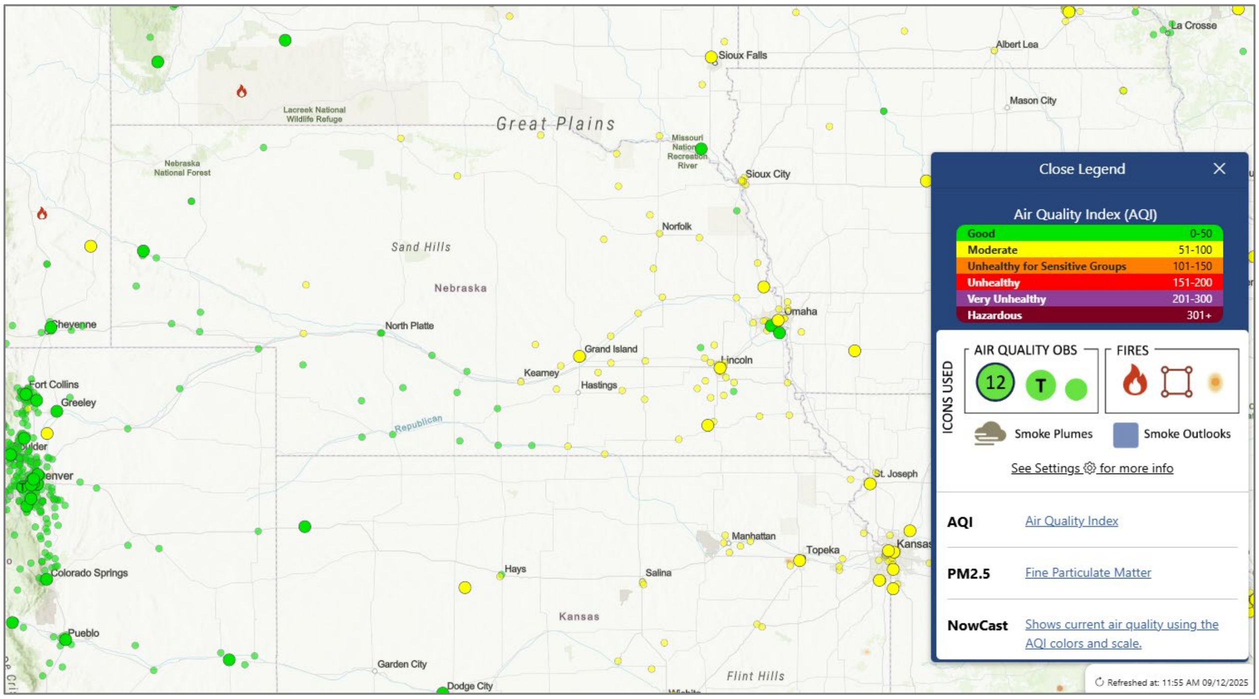
When applicable, the Department and NRDs shall promote fire weather awareness and share additional resources on how to prevent the ignition and spread of wildfires.

### 6.7.3 Promote Air Quality Monitoring (Response) (Trigger: Drought Alert)

Increasing the geographical coverage and capability of air quality monitoring can help warn and protect vulnerable portions of the public from the health impacts of poor air quality. Resources such as AirNow (https://www.airnow.gov/) rely on monitoring stations that are often grouped close to dense population areas and, as such, may not provide adequate rural coverage or alert.

During Drought Alert conditions and as needed, the Coalition will promote the Fire and Smoke Interactive Map, available at https://fire.airnow.gov, as shown in Figure 58. Department Water Planning and Air Quality Divisions will also collaborate as needed to identify additional opportunities to enhance and promote air quality monitoring before, during, and after wildfires.

**Figure 58. Fire and Smoke Interactive Map**




Source: AirNow n.d. (https://fire.airnow.gov)

### 6.7.4 Participate In/Assist with Disaster Relief (Response) (Trigger: Drought Alert; Advisory when Applicable)

Disaster relief during a drought can occur in different ways, from various sources, and with varying levels of effectiveness for different recipients. Many of the USDA's drought relief programs (NOAA n.d.b) are triggered by the USDM map and are primarily focused on mitigating losses in agricultural production as incurred by producers. These programs include crop insurance, emergency loans, haying and grazing assistance, and environmental protection and are coordinated by the FSA with private producers.

Other disaster relief programs through non-profit organizations, such as the Red Cross, may be more focused on providing community services and local funding. Many of these private programs are funded nationally with the intent of delivering local aid to impacted areas. As part of the Drought Contingency Plan, members of the Task Force may work together to develop an organized inventory and usage of disaster relief programs. The intent of this inventory would be to help inform potential relief program recipients of programs that could help them and to help highlight gaps in the equity of relief programs across a community or the Basin. Inequities in disaster relief are often experienced by those who do not qualify for insurance or disaster programs but are still burdened with economic losses. An example of this would be small local businesses that provide agricultural services or products that experience a downturn due to drought impacts.

## 6.8 Additional Monitoring Activities

### 6.8.1 Groundwater Quality and Quantity Monitoring (Mitigation and Response) (Trigger: Drought Advisory and Alert)

Groundwater levels in irrigation or municipal production wells can be monitored multiple times each day using pressure transducers and water level loggers. These data can provide an indication of swell drawdowns over time, stress that the well is placing on the aquifer, and recovery time. Monitoring wells can be strategically installed in areas of groundwater quantity concern, such as municipal wellhead protection areas or areas with domestic wells that may encounter well interference. Recording groundwater levels from dedicated monitoring wells can inform groundwater users and managers about changes in static water levels or impacts from well drawdown and interference.

Increasing groundwater quality monitoring can also be implemented as a response to drought conditions. This may not require continuous monitoring, but even increasing sampling from yearly to quarterly would provide greater assurance of safe drinking water during the drought. Installing monitoring wells in wellhead protection areas or near domestic wells provides access to aquifers for monitoring groundwater quality during a drought. Changes in water quality parameters may indicate impacts of aquifer depletion and/or changes in groundwater chemistry.

### 6.8.2 Municipal Infrastructure Monitoring and Maintenance (Mitigation)

Wells for drinking water supplies should be maintained to maximize efficiency during drought, but more may need to be done to ensure wells and the pipes that deliver the water can remain effective during extremely dry periods. If existing public drinking water or private domestic wells are screened at shallow depths within the groundwater aquifer, it may be possible to drill new, deeper wells that can maintain water supply during times of groundwater level decline and surrounding well interference.

Monitoring municipal water pumping, groundwater levels, and deliveries is an effective approach to determine what influences withdrawals have on the aquifer, what losses may be occurring in the City’s system, and what benefit conservation makes in people’s daily and seasonal usage.

It is also advantageous to assess the water supply infrastructure connected to drinking water supply wells and determine if pipes, fittings, valves, etc., may need to be replaced before the extreme stress of extended peak water demand during drought occurs. Assessing the need to repair or replace infrastructure may be based on age, past performance (breaks), known high pressure zone issues, or physical inspections.

Another well maintenance or modification action may be to install enhanced well seals to better maintain water quality during drought. Well seals outside of the well casing at a known aquitard layer above the production zone or just above the well screen are required on all new wells drilled in Nebraska since 2014. It is possible to install these enhanced well seals on existing wells by pulling the pump, creating penetrations in the well casing, and pumping a grout slurry just outside of the casing. This is most effective when the sand filter pack installed around the casing is not the same as the sand and gravel found in the aquifer.

Drought may also impact a community’s wastewater system and discharge. During drought, decreases of influent flows can cause increases of influent pollution concentrations, particularly salinity. Decreased flow in receiving rivers and streams may also cause concern depending on the allowable concentration of pollutants and water temperature.

Where appropriate, the NRDs shall monitor and coordinate with municipal water and wastewater systems to address these potential impacts. Additionally, Department Water Planning and Drinking Water Divisions will coordinate to identify additional project and outreach opportunities.

The U.S. Cybersecurity and Infrastructure Security Agency recommends a planning process to assess and address drought impacts on infrastructure, including water and wastewater, transportation, and energy (2021).

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# APPENDIX A – Historical Drought Warning Triggers

The usefulness of various drought indices and indicators was evaluated against past drought impacts. These impacts were selected from drought impact rankings from the Drought Task Force (Appendix B). Basin Drought Task Force members provided ratings for the severity of each impact and those ratings were averaged providing a composite vulnerability ranking. The rankings were evaluated separately for a short-term (e.g., single year) drought and long-term (multiple years) drought. The surveys considered agriculture, energy, municipal and industrial (M&I), environmental, recreational, and socio-economic impacts.

For agriculture, the Basin Drought Task Force ranked “Crop Yield Reduction” from lack of soil moisture as the highest long- and short-term drought concern. The USDA NASS conducts annual surveys of acreages planted, harvested, and yield per acre for each county. A tabulation of acres by crop type within the study area as a percentage of the overall land area is provided in Table A-1. Most of the area is pasture, followed by corn. The eastern portion of the UPRB has higher corn and soybean production (such as Kearney County with 55 percent of the area in corn and 23 percent in soybeans in 2019) and the western portion is predominantly pasture.

**Table A-1: Crop Types in Upper Platte River Basin**

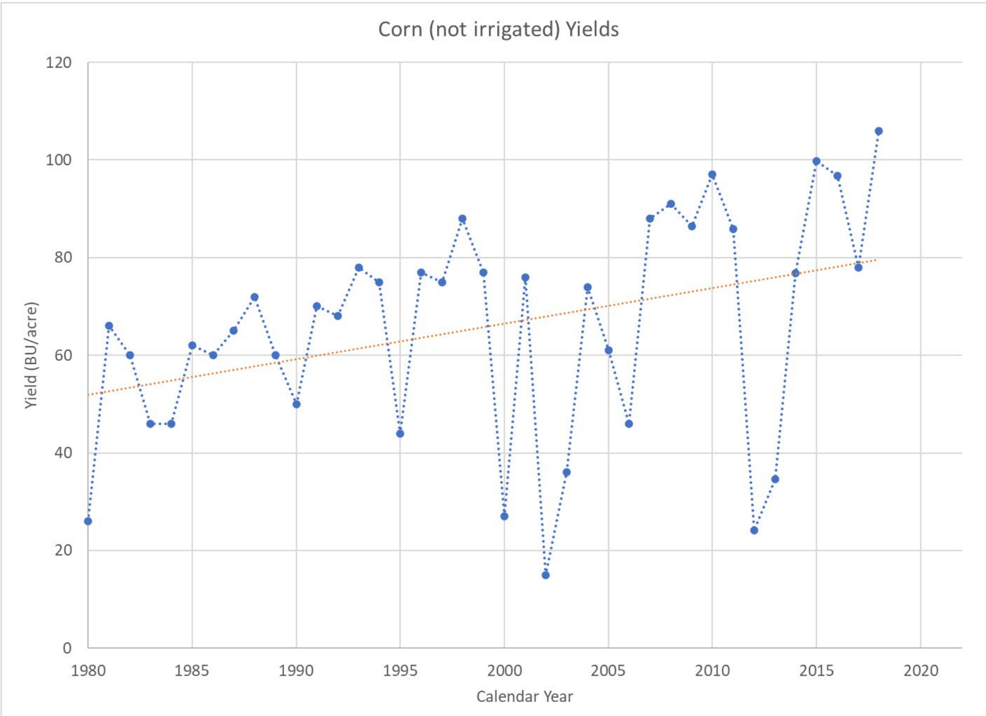
| Crop Type | Percent of Upper Platte River Basin |
|---|---|
| Alfalfa | 2 |
| Corn | 22 |
| Pasture | 54 |
| Millet | 1 |
| Sorghum | 1 |
| Soybeans | 5 |
| Wheat | 4 |
| Other | 11 |

*Source: USDA NASS 2019.*

HDR collected non-irrigated (dryland) crop yield information from years 1980 to 2020 for the predominant crops listed in Table A-1. The information was available on a county-level. Pasture information was only available on a state-level and could not be isolated solely to the Upper Platte River area. Pasture was reported as condition assessments of “excellent,” “fair,” “good,” “poor,” and “very poor” instead of yield. Alfalfa and hay yields were used as a substitute for pastures. These yields were reported as tons per acre from the various cuttings over the growing season and assumed to be linked to the health of grazed pasture lands.

Crop yields have changed over time due to improvements in farming practices such as improved mechanization, hybrid plants, chemical applications, and precision farming techniques. Figure A-1 provides an example of non-irrigated corn yields in Lincoln County. Corn yields in 1980 averaged about 50 bushels per acre which rose to an average of 80 bushels per acre by 2020. To account for crop yield changes over time, a long-term trend was applied to each crop type. Drought impacts are evaluated based on changes from this average. For example, during the 2000s drought corn yields were about 50 bushels per acre below average. In the wet years in the late 2010s, crop yields were about 20 bushels per acre above average.

**Figure A-1: Historical Non-Irrigated Corn Yields in Lincoln County**




Irrigators have the ability to offset drought crop yield impacts by applying a net irrigation requirement (NIR) to replace the lack of soil moisture. A portion of rainfall reaches a crop root zone; this is called the effective rainfall. If the effective rainfall is insufficient, then additional NIR water is applied through irrigation. Additional irrigation water beyond NIR is needed for other operational aspects, such as irrigation method inefficiency, canal seepage losses, and canal system operations. However, NIR represents a theoretical minimum amount of irrigation water needed to replace rainfall deficits. As natural rainfall decreases in a drought, the NIR will proportionally increase. Therefore, while non-irrigated crop yields were used in evaluating drought monitoring needs this can be assumed to also represent basic drought irrigation requirement trends as well.

For energy needs, the Basin Drought Task Force equally ranked decreased hydropower production, increased energy demand, and insufficient cooling water as long-term drought concerns. Increased energy demand was the highest ranked short-term drought concern. The energy demand was evaluated using a "cooling degree day" statistic. Average daily temperatures were obtained from 1980 to 2020 from the long-term climate stations in the Upper Platte River area. Each day when the average air temperature exceeded 65°F was counted as a degree day. For example, a day with an average air temperature of 66°F was one-degree day (1 day and 1 degree above 65°F). A day with an air temperature of 75°F was ten-degree days (1 day of 10 degrees above 65°F). The total cooling degree days in a year is related to the overall residential summer energy needs (National Centers for Environmental Information 2023).

For municipal, industrial, and environmental sectors, the Basin Drought Task Force ranked fire threats and impacts as the highest long- and short-term drought impacts. Information from wildland fires were obtained from the National Interagency Coordination Center for Wildland

Fire. Data is available on a state-level and generally from years 2002 to 2020. The number of separate wildland fires and the total acres burned for each year was available.

Overall, the Basin Drought Task Force ranked recreation as a lower level concern during both short-term and long-term drought. While this concern entails a range of impacts, for purposes of drought impact evaluation, lake storage and surface area was considered.

Multiple drought indices and indicators were compared against selected drought impacts. The evaluation assessed how often a candidate indicator/index predicted future drought impacts. For example, the evaluation sought to determine what drought indicators and indices known in October have historically predicted changes in non-irrigated crop yields harvested in the following year. This process produces items useful in determining when a drought starts or ends (leading indices and indicators) and gauging drought severity when a drought has developed.

The evaluation used a time period from calendar years 1980 to 2020 (40 years). This was a long enough timeframe to evaluate several droughts of varying severity and duration while also being recent enough that the drought impacts should remain relevant in the future. Key droughts in this timeframe include 1989 to 1992, 2002 to 2006, and 2012 to 2014. A total of 57 drought indices and indicators were evaluated. This includes 20 versions (timeframes) each of SPI and SPEI, 11 versions of EDDI, both calibrated and uncalibrated PDSI, aggregate averages of SWE for the North Platte (Wyoming) and South Platte (Colorado) basins, and average and maximum snow depths in Nebraska.

Correlations were calculated for each indicator/index and drought impact. Correlations show how closely a given indicator or index relates to an impact. That is, as the value of an indicator or index increases or decreases then the drought impact may change by a similar degree. A 70 percent correlation, for example, would suggest that 70 percent of a drought impact could be explained by a given indicator or index while 30 percent is attributed to something else. A significance test was also applied, and correlations were considered only if there was a 95 percent confidence in a statistically significant correlation.

Separate evaluations were conducted for each county and drought impact within the UPRB for crop yield reductions and cooling degree days. Impacts to seasonal streamflows were evaluated at the Wyoming-Nebraska Stateline (North Platte River), at Roscoe (South Platte River), and at Grand Island (Platte River).

For crop yields and potential NIR, examples of drought indices for monitoring are shown in Figure A-2 to Figure A-7 and Table A-2. Some indices may work better in some counties than in others. Overall, these indices appear more frequently over all counties for the various crop types.

Custer County is shown as an example of drought impacts to pasture. This county has a high portion of pastures, about 70 percent of the county. It also has about 4,000 acres of alfalfa production, which is used as a proxy for overall pasture health. Alfalfa production averages about 3.5 tons per acre, although there had been a long-term trend from around 2.5 tons per acre in the 1980s to nearly 4 tons per acre in 2010s. The drought in the early 2000s had around a 0.9 tons per acre decline from average production. The drought of 2012 has a 0.7 ton per acre decline, a similar decline as well for 1989.

The 2-month EDDI in December, with a value of +1 or greater, has in the past anticipated the decline in production of these drought years. For example, EDDI 2-month in November to December 2011 was +1.2 which preceded a production decline of alfalfa cuttings taken in the 2012 growing season. An EDDI greater than zero but less than +1 in the November/December timeframe is less reliable at indicating production declines. There were 7 years of production declines but also 10 years of average or above alfalfa average production in succeeding years.

EDDI in December of less than zero generally indicated the potential of above average production in the upcoming growing season. The overall correlation between November/December 2-month EDDI to alfalfa production in the following year was 59 percent.

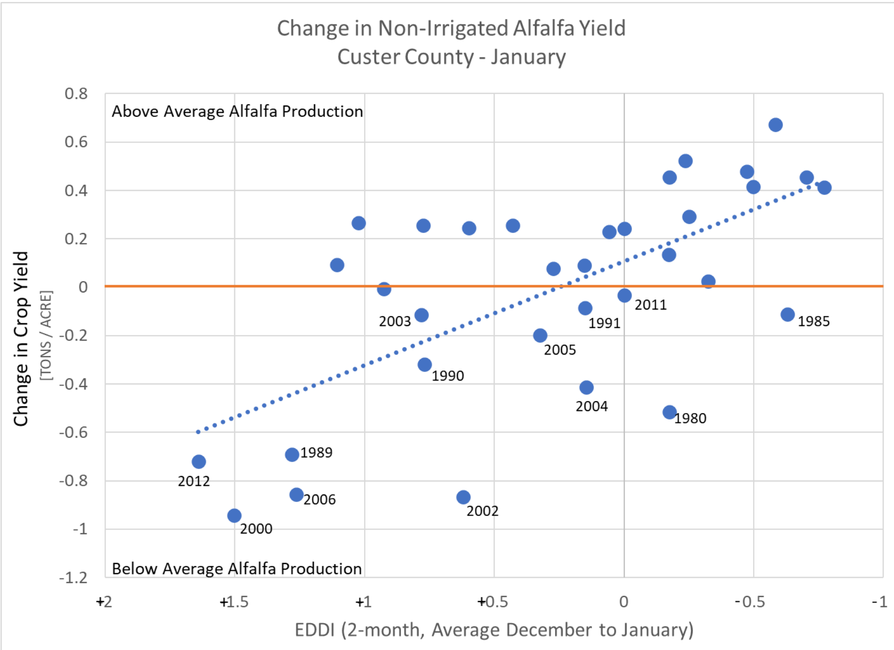
The correlation shows the overall ability of an index to explain a drought impact over a range of wet to dry conditions. An index does not forecast drought impacts; it just shows the degree and extent of past drought impacts and suggests the impacts that could be expected in the current year. For this index, there are several examples of past years when the EDDI the previous fall was greater than +1.2 and a drought impact occurred, but no examples when this impact did not occur. EDDI values between 0 and +1 had examples of years when the drought impact occurred and other years when it did not. Negative EDDI had examples of years when the drought impact did not occur and no example when it did. The correlation nearing the start of the growing season did not improve until May, when drought indices started to explain more of the production potential.

A similar example for corn yields is demonstrated for Phelps County, where 58 percent of the county is typically corn. Non-irrigated corn production averages about 89 bushels per acre, which has increased over time from around 50 bushels per acre in the 1980s to over 120 bushels per acre in the 2010s. The 2002 drought year saw 66 bushels per acre of below average production and the year 2012 to 2013 drought caused about a 60 bushels per acre yield decline. Other drought impacted years included year 2003 (about 50 bushels per acre below average) and 1980 (about 24 bushels per acre below average).

The 11-month SPEI in January was the leading index for two of these drought years. Values of -1 or less occurred in 2002 and 2012, which saw larger declines in the respective growing seasons of 2003 and 2013. Values below 0 saw an equal chance of above or below average production. The correlation between this index and corn production was 57 percent. The ability of indices to predict corn production improved after May. The June/July SPEI 10-month index had an 83 percent correlation to production. Values of -0.5 or less indicated some level of below average production. Value of -1 or less indicated more severe production declines. Mild drought (above -0.5) may not result in production declines. The 5-month SPEI in August was linked to corn crop yields, where positive values indicate above average yields and negative values below average yields. Values between 0 and -1 indicated around a 20 bushels per acre decline in production while larger values indicated up to 60 bushels per acre decline.

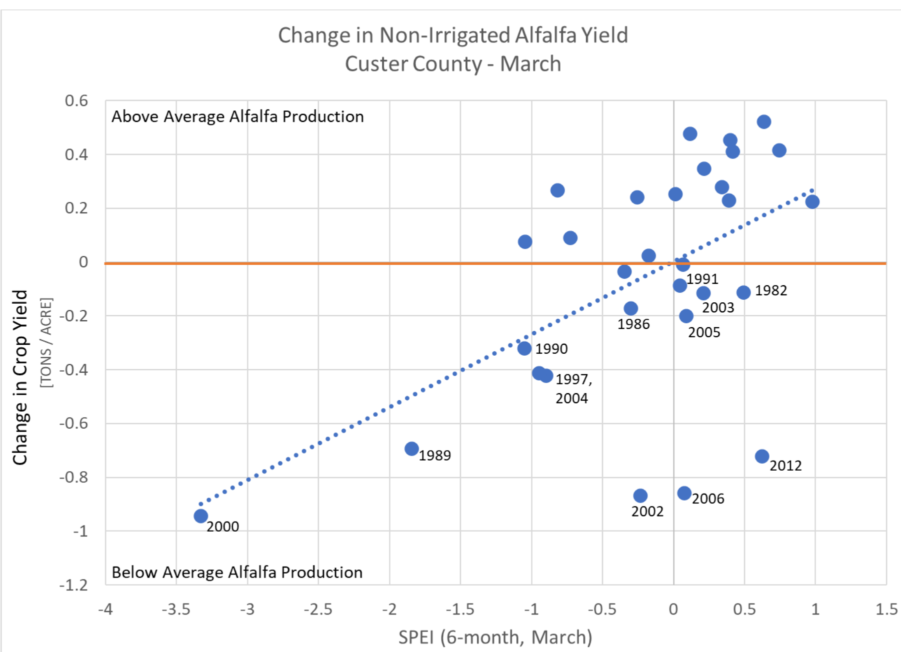
Generally, it is more difficult to estimate in winter what the crop drought impacts might be in the upcoming growing season. Better estimates are available usually by May, although this is generally too late in advising growers on planting recommendations. Longer timeframes, up to 8-months, are called on in winter to estimate upcoming growing season impacts while shorter timeframes (such as 1 to 3 months) are useful during the growing season. Most drought indices require the incorporation of evaporative demand.

## Figure A-2: Example Alfalfa Yield using January Index (r= 66%)

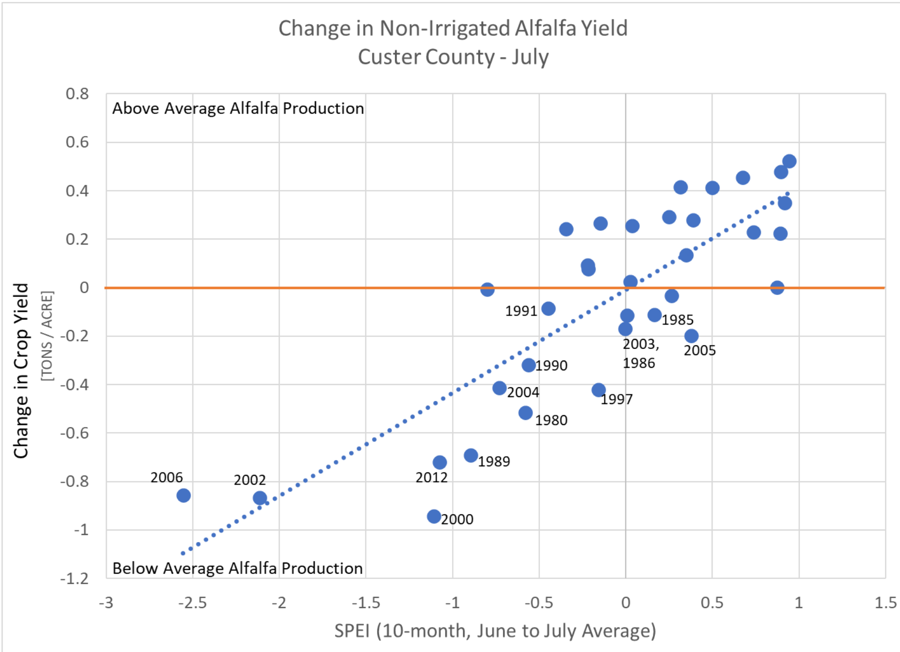



*Note: EDDI axis are reversed for consistency with other drought indices. Positive EDDI values indicate above normal evaporative demand, more linked to drought conditions. In other indices, negative values indicate drought conditions.*

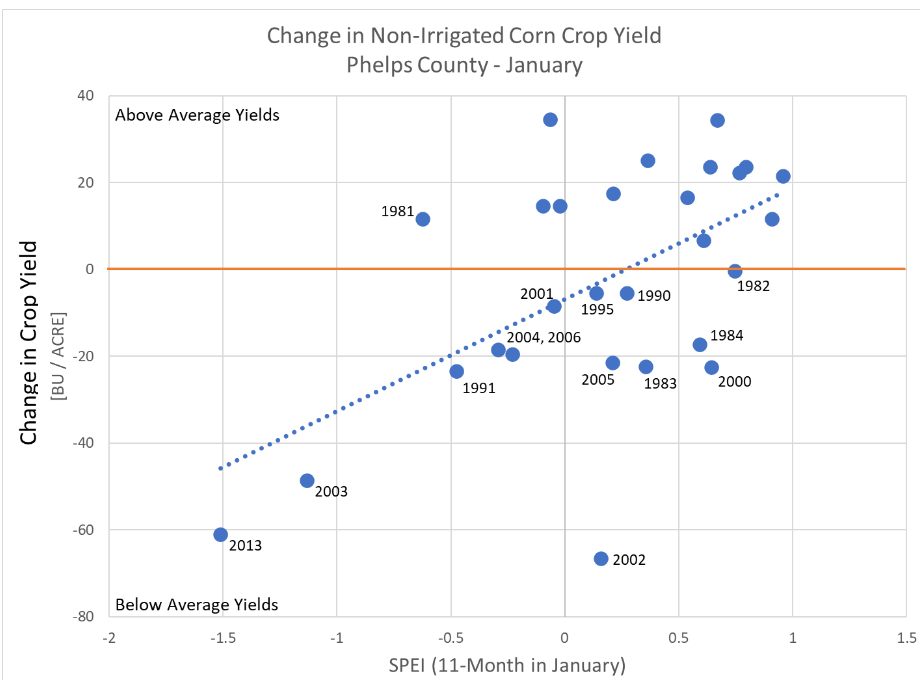
## Figure A-3: Example Alfalfa Yield using March Index (r= 55%)



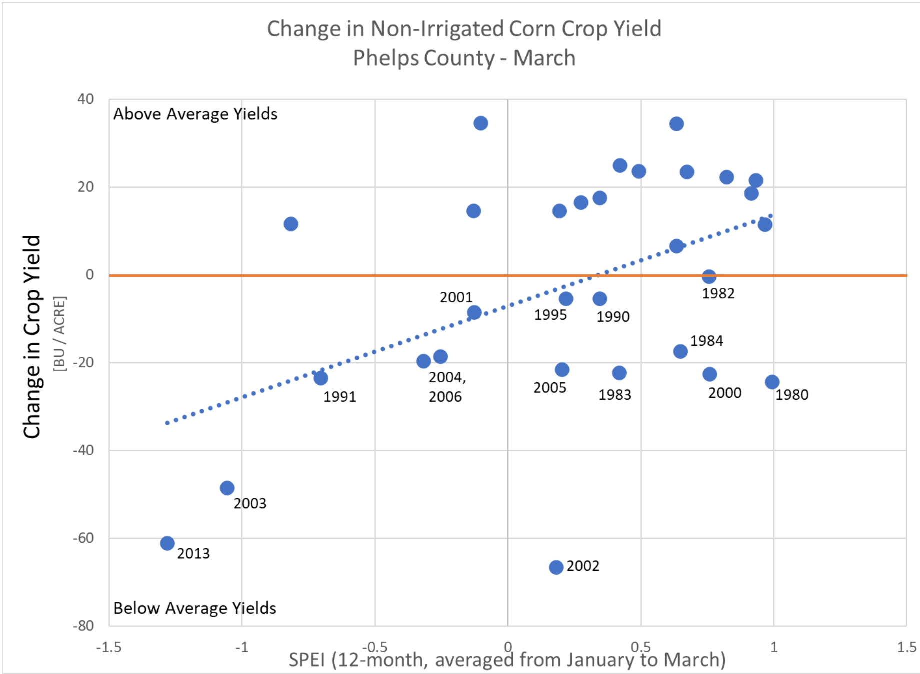
## Figure A-4: Example Alfalfa Yield using July Index (r= 83%)




## Figure A-5: Example Corn Yield using January Index (r= 57%)



## Figure A-6: Example Corn Yield using March Index (r= 47%)




## Figure A-7: Example Corn Yield using August Index (r= 84%)

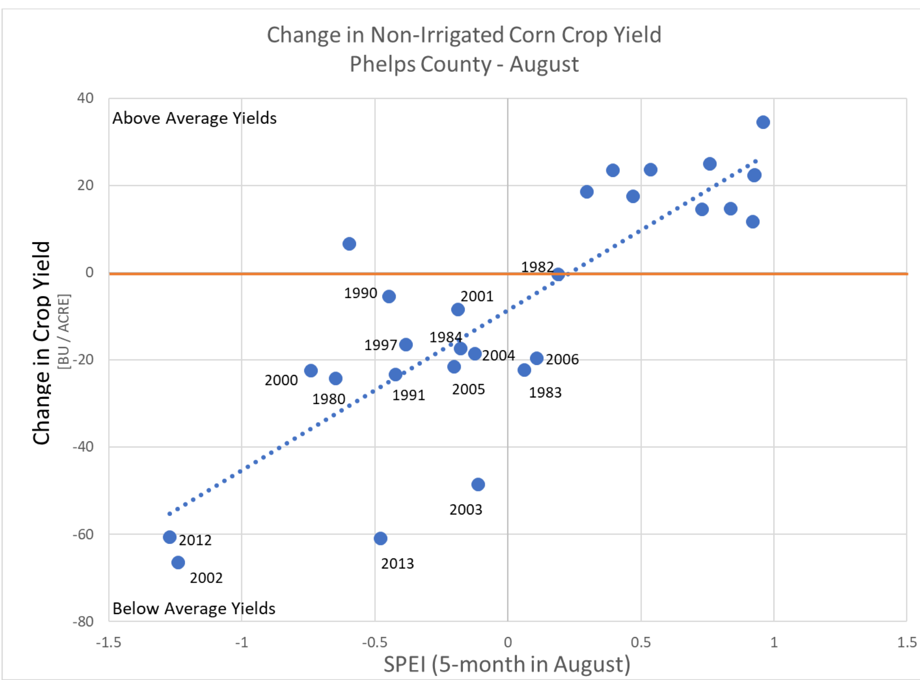


**Table A-2: Key Drought Indicators/Indices for Crop Yields**

| Month | Alfalfa | | Hay | | Corn | | Sorghum | | Soybeans | | Wheat | | Winter Wheat | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Indicator/Index | Correlation | Indicator/Index | Correlation | Indicator/Index | Correlation | Indicator/Index | Correlation | Indicator/Index | Correlation | Indicator/Index | Correlation | Indicator/Index | Correlation |
| October | SPEI/EDDI (1- to 8-month) | 45% | SPEI (1- to 6-month) | 48% | EDDI/SPI (6- to 8-month) | 45% | SPEI (1- to 8-month) | 48% | SPI/SPEI (6- to 8-month) | 51% | EDDI/SPI (1- to 4-month) | 43% | EDDI (1- to 4-month) | 41% |
| November | SPEI/EDDI (1- to 8-month) | 46% | SPEI/EDDI (1- to 2-month) | 47% | SPI/SPEI (1- to 8-month) | 46% | SPEI/EDDI (1- to 6-month) | 52% | SPI (6- to 7-month) | 53% | EDDI (1- to 4-month) | 53% | EDDI/SPEI (1- to 4-month) | 50% |
| December | SPEI (1- to 8-month) | 44% | EDDI (2- to 3-month) | 50% | EDDI/SPI (1- to 8-month) | 51% | SPEI/EDDI (1- to 6-month) | 53% | SPI (1- to 7-month) | 57% | EDDI (1- to 5-month) | 51% | EDDI/SPEI (1- to 5-month) | 50% |
| January | SPEI/SPI (1- to 8-month) | 49% | EDDI (1- to 4-month) | 54% | EDDI (1- to 4-month) | 50% | SPEI/EDDI (1- to 8-month) | 55% | SPEI/SPI (1- to 8-month) | 58% | EDDI (4- to 6-month) | 54% | EDDI/SPEI (4- to 6-month) | 52% |
| February | SPEI/EDDI/SPI (8-month) | 46% | EDDI (1- to 5-month) | 51% | EDDI (1- to 4-month) | 49% | SPEI/EDDI (1- to 6-month) | 53% | EDDI/SPI (1- to 8-month) | 57% | EDDI (4- to 7-month) | 55% | EDDI/SPEI (4- to 7-month) | 53% |
| March | SPEI/SPI (8-month) | 46% | EDDI (1- to 5-month) | 50% | EDDI (1- to 4-month) | 48% | SPEI/EDDI (1- to 5-month) | 54% | EDDI/SPI (1- to 6-month) | 56% | EDDI (5- to 6-month) | 54% | EDDI (4- to 6-month) | 53% |
| April | SPI/SPEI (2-month) | 46% | EDDI (1- to 6-month) | 52% | EDDI/SPEI (1- to 4-month) | 49% | SPEI/EDDI (1- to 6-month) | 54% | EDDI (1- to 6-month) | 57% | EDDI (1-month) | 63% | EDDI/SPEI (1-month) | 61% |
| May | SPEI/SPI (2-month) | 51% | EDDI/SPEI (5- to 6-month) | 52% | EDDI (1- to 2-month) | 54% | SPEI/EDDI (1- to 6-month) | 55% | EDDI (1- to 5-month) | 58% | EDDI (1- to 3-month) | 68% | EDDI/SPI (1- to 2-month) | 67% |
| June | SPEI/SPI (1- to 2-month) | 56% | SPI/EDDI (6- to 8-month) | 58% | EDDI (1-month) | 64% | SPEI/EDDI (1-month) | 59% | EDDI (1- to 2-month) | 63% | EDDI (1- to 3-month) | 67% | EDDI/SPI (1- to 3-month) | 64% |
| July | SPEI/SPI (1- to 2-month) | 59% | EDDI/SPEI (1-month) | 61% | SPEI (1-month) | 72% | SPEI/SPI (1- to 2-month) | 64% | SPEI/SPI (1- to 2-month) | 70% | EDDI (1- to 4-month) | 64% | EDDI/SPI (1- to 3-month) | 60% |
| August | SPEI/SPI (1- to 2-month) | 59% | EDDI (1-month) | 61% | SPEI (1- to 3-month) | 76% | SPEI (1- to 3-month) | 66% | SPI (1-month) | 75% | SPEI/EDDI (1- to 6-month) | 62% | SPEI/EDDI (1-month) | 59% |
| September | SPEI/SPI (1- to 2-month) | 59% | EDDI (1-month) | 59% | SPEI (1- to 3-month) | 76% | SPEI/EDDI (1- to 3-month) | 67% | SPI (1- to 4-month) | 76% | SPEI/EDDI (1- to 6-month) | 59% | SPEI/EDDI (6- to 8-month) | 57% |

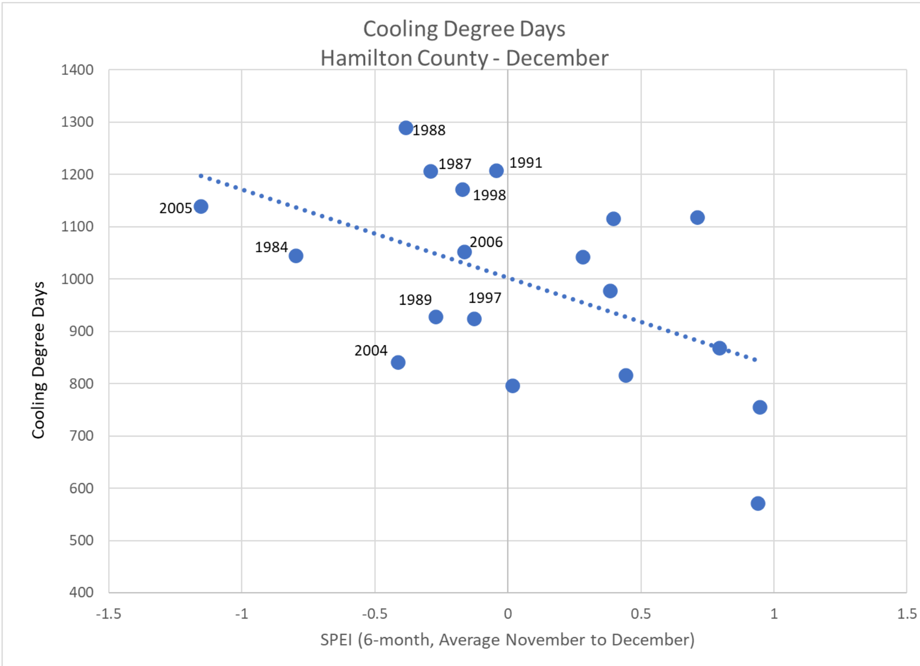
*Note: The indicator and index for each month with the highest correlation to the following harvest production is shown. Light red < 50%, Gold is 50% to 60%, Light Blue is 60% to 70%, Light Green is > 70%.*

The ability of drought indices to predict summer energy needs (via cooling degree days) was generally less consistent. Hamilton County is shown as an example in Table A-3 and Figure A-8 through Figure A-10 as it provides a better link between indices and energy demand. In November/December, a negative 6-month SPEI indicated the potential of above-normal cooling degree days in the upcoming summer. This correlation was 52 percent. Between an index value of 0 and -0.5 about half of the years were above normal and half below normal. Index values of -0.5 and less had above normal cooling degree days. The ability to predict cooling degree days improved starting in June, where 1-month EDDI of more than +0.5 were more often above average cooling degree days. By September, the 1-month SPEI had a 75 percent correlation. Negative values of SPEI indicated above average cooling degree days.

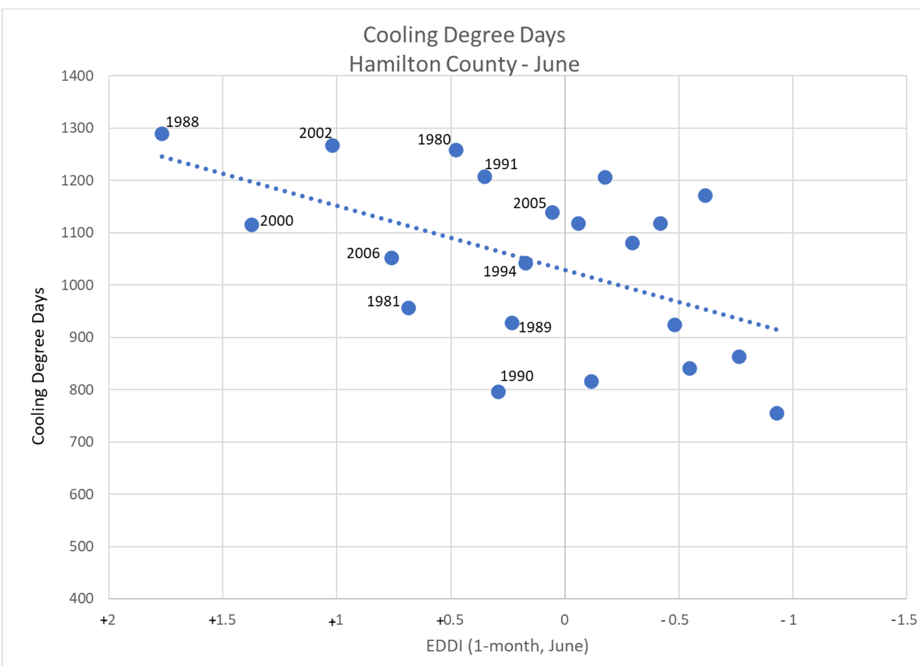
**Table A-3: Key Drought Indicators/Indices for Cooling Degree Days**

| Month | Indicator/Index | Correlation |
|---|---|---|
| October | EDDI (3- to 8-month) | 34% |
| November | EDDI (1- to 4-month) | 38% |
| December | EDDI (1- to 2-month) | 38% |
| January | SPEI (1- to 3-month) | 40% |
| February | SPEI/EDDI (1- to 2-month) | 42% |
| March | SPEI (1-month) | 39% |
| April | SPEI (1- to 3-month) | 39% |
| May | EDDI (1- to 4-month) | 36% |
| June | EDDI/SPEI (1-month) | 62% |
| July | SPEI (1- to 2-month) | 68% |
| August | SPEI (1- to 3-month) | 72% |
| September | SPEI (1- to 4-month) | 75% |

## Figure A-8: Example Cooling Degree Days using December Index (r= 52%)




## Figure A-9: Example Cooling Degree Days using June Index (r= 52%)




*Note: EDDI axis are reversed for consistency with other drought indices. Positive EDDI values indicate above normal evaporative demand, more linked to drought conditions. In other indices, negative values indicate drought conditions.*

**Figure A-10: Example Cooling Degree Days using September Index (r= 75%)**

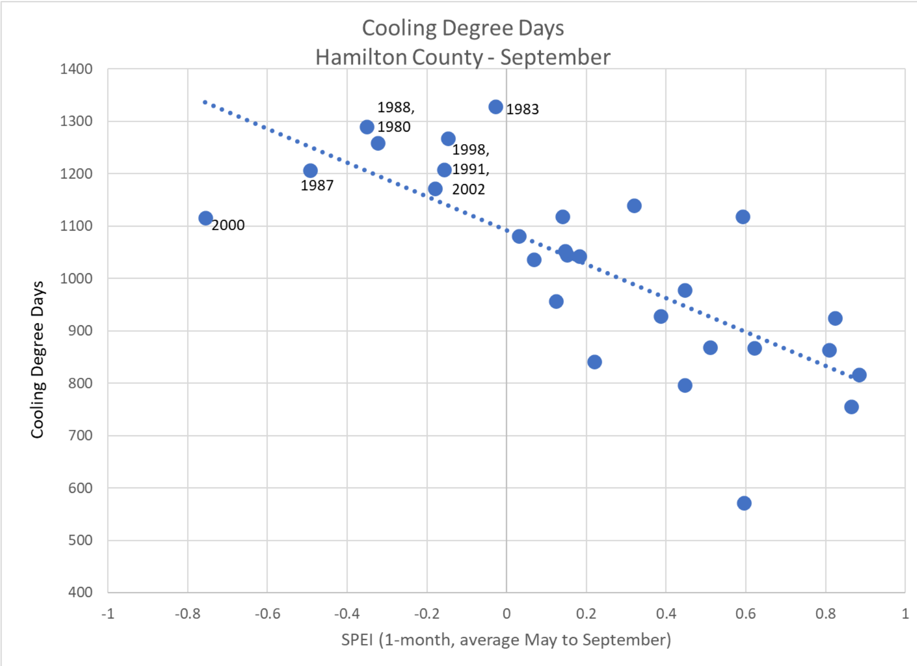


Table A-4 to Table A-7 show the correlations between potential drought indicators including SNOTEL snowpack data and river flows at Roscoe, Grand Island, and the Wyoming-Nebraska State Line. Correlations were calculated for the annual flow values (summed by year), the winter flows (October to February), spring flows (March to June), and summer flows (July to September). The tables show the correlations by month, with the strongest drought indicator in each month listed along with its correlation value to seasonal streamflow. For example, the 70 percent correlation between PDSI and summer volume at Grand Island in May is the strongest correlation across the potential indicator values. By September there is an 82 percent correlation between SNOTEL data in the South Platte Basin and the summer flows at Grand Island.

All three streamflow gages show weaker correlations at the beginning of the water year with stronger correlations by the end of the year. The winter period (October to February) of the water year is generally a period of accumulation of snow in the basin, with runoff and rainfall occurring during the spring period (March to June). Summer (July to September) has a return to lower flows, affected by regional storms and reservoir releases. Correlation strength increases at the end of the water year, unfortunately this is largely after planting decisions need to be made.

The Wyoming-Nebraska state line gage along the North Platte River correlates well with the SNOTEL Data for the North Platte River basin beginning in January for annual and summer flows. At Roscoe, on the South Platte, the flows are mainly correlated with PDSI. The Grand Island gage is downstream of the confluence of the North and South Platte rivers and correlates most closely with the SNOTEL South Platte basin values for the summer flow predictions in June through September. Otherwise, Grand Island is most closely correlated with PDSI values.

Summer and annual flow correlation values improve around May for each gage, with the strongest predictors at the end of the water year. It is difficult to predict spring and summer flows during the winter months. Snowpack can be a strong predictor but evaporation and melting rates higher in the watershed can greatly impact the percentage of flows that reach the gages. PDSI and SNOTEL data cannot predict potential rainfall and flooding events so correlations may be diminished in wet years.

The river flows include regulation by upstream reservoirs, which contributes to uncertainty in the use of drought indices alone. Refilling of the reservoirs will affect spring runoff flows while releases from reservoirs affect summer flows. Projections by BOR and the Missouri River Basin River Forecast Center are discussed later which can provide improved river flow outlooks.

Comparing drought indices and indicators to the historical number or area of wildfires did not produce reliable relationships. There could be several reasons for this. The period of record collected by National Interagency Coordination Center for Wildland Fire starts in year 2002, which limits the number of comparisons to past droughts. Wildfires are discrete events, started either by humans or lightning strikes. Some of the randomness of these events means that conditions may be favorable to wildfires, but no fires may erupt. Also, prescribed burns may take place to remove fuel for wildfires. These prescribed burns are mitigations intended to reduce wildfires despite unfavorable drought conditions.

**Table A-4: Key Drought Indicators/Indices for Winter River Flows (October to February)**

| Month | North Platte River at Wyoming-Nebraska State Line | | South Platte River at Roscoe | | Platte River near Grand Island | |
|---|---|---|---|---|---|---|
| | Indicator/ Index | Correlation | Indicator/ Index | Correlation | Indicator/ Index | Correlation |
| March | EDDI (1-month) | 58% | EDDI (11-month) | 57% | PDSI | 60% |
| April | EDDI (2-month) | 59% | EDDI (11-month) | 55% | PDSI (self-corrected) | 60% |
| May | EDDI (1-month) | 57% | EDDI (7-month) | 56% | PDSI | 69% |
| June | SNOTEL (Nplatte) | 55% | SNOTEL (Splatte) | 66% | PDSI | 68% |
| July | SNOTEL (Nplatte) | 55% | SNOTEL (Splatte) | 65% | PDSI | 67% |
| August | SNOTEL (Nplatte) | 55% | SNOTEL (Splatte) | 65% | PDSI | 69% |
| September | SNOTEL (Nplatte) | 55% | SNOTEL (Splatte) | 65% | PDSI | 71% |
| October | EDDI (6-month) | 40% | EDDI (6-month) | 60% | SPEI (36-month) | 63% |
| November | EDDI (7-month) | 47% | EDDI (8-month) | 62% | SPEI (36-month) | 66% |
| December | EDDI (7-month) | 51% | EDDI (7-month) | 60% | SPEI (36-month) | 66% |
| January | EDDI (7-month) | 49% | EDDI (7-month) | 62% | SPEI (36-month) | 64% |
| February | EDDI (6-month) | 48% | EDDI (7-month) | 61% | SPEI (36-month) | 67% |

**Table A-5: Key Drought Indicators/Indices for Spring River Flows (March to June)**

| Month | North Platte River at Wyoming-Nebraska State Line | | South Platte River at Roscoe | | Platte River near Grand Island | |
|---|---|---|---|---|---|---|
| | Indicator/ Index | Correlation | Indicator/ Index | Correlation | Indicator/ Index | Correlation |
| July | EDDI (10-month) | 52% | EDDI (10-month) | 48% | PDSI | 57% |
| August | EDDI (11-month) | 52% | PDSI | 51% | PDSI | 60% |
| September | SPEI (18-month) | 53% | PDSI (self-corrected) | 51% | PDSI | 61% |

| Month | North Platte River at Wyoming-Nebraska State Line | | South Platte River at Roscoe | | Platte River near Grand Island | |
|---|---|---|---|---|---|---|
| | Indicator/ Index | Correlation | Indicator/ Index | Correlation | Indicator/ Index | Correlation |
| October | SPEI (18-month) | 47% | PDSI (self-corrected) | 47% | SPEI (18-month) | 54% |
| November | PDSI (self-corrected) | 53% | SPEI (18-month) | 53% | PDSI (self-corrected) | 55% |
| December | SPEI (24-month) | 54% | SPEI (18-month) | 52% | PDSI (self-corrected) | 57% |
| January | SNOTEL (Nplatte) | 60% | SPEI (24-month) | 50% | PDSI | 58% |
| February | SNOTEL (Nplatte) | 66% | SPEI (24-month) | 49% | PDSI | 64% |
| March | SNOTEL (Nplatte) | 63% | PDSI (self-corrected) | 54% | PDSI | 61% |
| April | SNOTEL (Nplatte) | 63% | PDSI (self-corrected) | 61% | PDSI (self-corrected) | 69% |
| May | SNOTEL (Nplatte) | 69% | PDSI | 66% | PDSI | 73% |
| June | SNOTEL (Nplatte) | 73% | PDSI | 61% | SNOTEL (Splatte) | 72% |

## Table A-6: Key Drought Indicators/Indices for Summer River Flows (July to September)

| Month | North Platte River at Wyoming-Nebraska State Line | | South Platte River at Roscoe | | Platte River near Grand Island | |
|---|---|---|---|---|---|---|
| | Indicator/ Index | Correlation | Indicator/ Index | Correlation | Indicator/ Index | Correlation |
| October | SPEI (8-month) | 32% | SPEI (60-month) | 33% | PDSI | 57% |
| November | SPEI (10-month) | 37% | SPEI (60-month) | 38% | PDSI | 55% |
| December | PDSI (self-corrected) | 40% | SPEI (60-month) | 37% | PDSI | 58% |
| January | SNOTEL (Nplatte) | 50% | SPEI (60-month) | 37% | PDSI | 58% |
| February | SNOTEL (Nplatte) | 50% | SPEI (60-month) | 36% | PDSI | 52% |
| March | SNOTEL (Nplatte) | 48% | SPEI (60-month) | 35% | PDSI | 54% |
| April | SNOTEL (Nplatte) | 55% | SPEI (3-month) | 40% | PDSI | 52% |
| May | SNOTEL (Nplatte) | 63% | SPEI (1-month) | 47% | PDSI (self-corrected) | 70% |

| Month | North Platte River at Wyoming-Nebraska State Line | | South Platte River at Roscoe | | Platte River near Grand Island | |
|---|---|---|---|---|---|---|
| | Indicator/ Index | Correlation | Indicator/ Index | Correlation | Indicator/ Index | Correlation |
| June | SNOTEL (Nplatte) | 75% | SNOTEL (Splatte) | 60% | SNOTEL (Splatte) | 86% |
| July | SNOTEL (Nplatte) | 77% | SNOTEL (Splatte) | 60% | SNOTEL (Splatte) | 86% |
| August | SNOTEL (Nplatte) | 77% | SNOTEL (Splatte) | 60% | SNOTEL (Splatte) | 86% |
| September | SNOTEL (Nplatte) | 77% | SNOTEL (Splatte) | 60% | SNOTEL (Splatte) | 86% |

## Table A-7: Key Drought Indicators/Indices for Annual River Flows

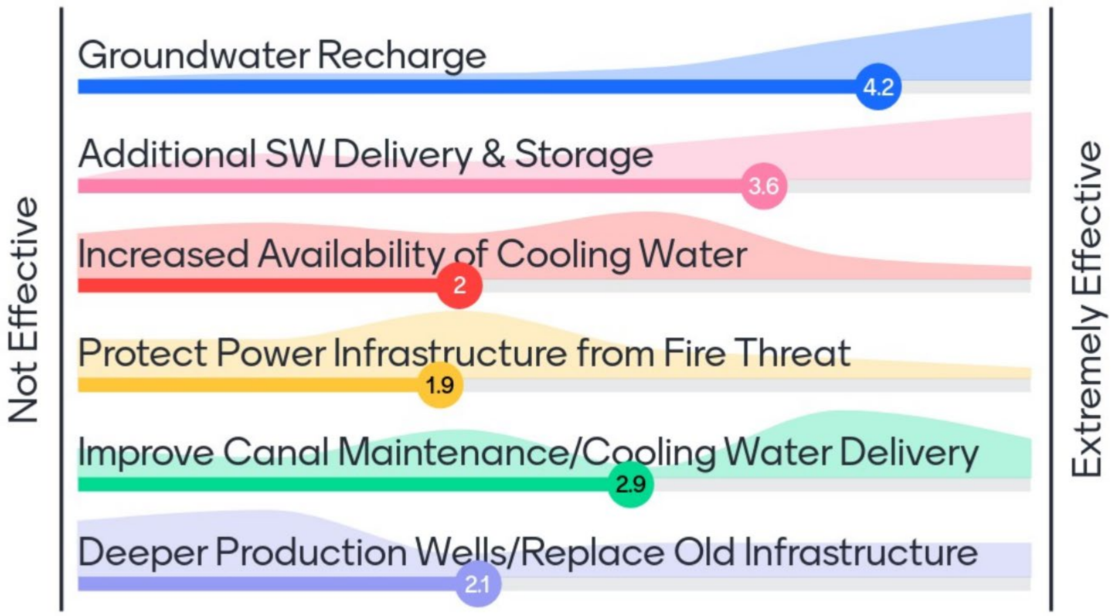
| Month | North Platte River at Wyoming-Nebraska State Line | | South Platte River at Roscoe | | Platte River near Grand Island | |
|---|---|---|---|---|---|---|
| | Indicator/ Index | Correlation | Indicator/ Index | Correlation | Indicator/ Index | Correlation |
| October | SPI (18-month) | 46% | PDSI (self-corrected) | 51% | PDSI (self-corrected) | 54% |
| November | PDSI (self-corrected) | 51% | PDSI (self-corrected) | 51% | PDSI (self-corrected) | 56% |
| December | PDSI (self-corrected) | 52% | PDSI | 54% | PDSI (self-corrected) | 57% |
| January | SNOTEL (Nplatte) | 65% | PDSI | 56% | PDSI | 59% |
| February | SNOTEL (Nplatte) | 63% | PDSI | 59% | PDSI | 56% |
| March | SNOTEL (Nplatte) | 60% | PDSI | 54% | PDSI | 57% |
| April | SNOTEL (Nplatte) | 62% | PDSI (self-corrected) | 58% | PDSI (self-corrected) | 65% |
| May | SNOTEL (Nplatte) | 69% | PDSI | 66% | PDSI | 70% |
| June | SNOTEL (Splatte) | 75% | PDSI | 71% | PDSI | 82% |
| July | SNOTEL (Splatte) | 76% | PDSI | 68% | PDSI (self-corrected) | 82% |
| August | SNOTEL (Splatte) | 76% | PDSI | 67% | PDSI (self-corrected) | 82% |
| September | SNOTEL (Splatte) | 76% | PDSI | 72% | PDSI | 82% |

# Appendix B – Stakeholder Meeting Material

Basin Drought Task Force members provided ratings for the severity of each impact and those ratings were averaged providing a composite vulnerability ranking. The rankings were evaluated separately for a short-term (e.g., single year) drought and long-term (multiple years) drought. The surveys considered agriculture, energy, municipal and industrial (M&I), environmental, recreational, and socio-economic impacts.

For agriculture, the Basin Drought Task Force ranked “Crop Yield Reduction” from lack of soil moisture as the highest long- and short-term drought concern.

**Figure B-1: Drought mitigation action projects’ potential effectiveness (1 of 2)**



**<u>Figure B-2: Drought mitigation action projects' potential effectiveness (2 of 2)</u>**


Figure B-3 shows the potential effectiveness of drought mitigation action programs.

**<u>Figure B-3: Drought mitigation action programs' potential effectiveness (1 of 1)</u>**

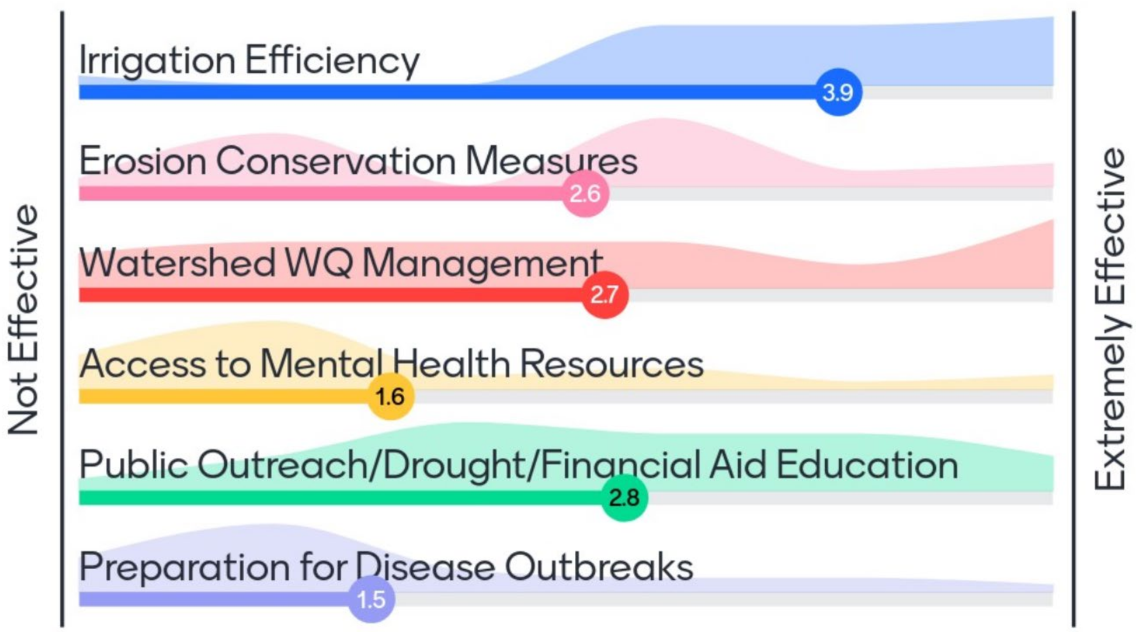



Figure B-4 shows the potential effectiveness of drought mitigation action policies.

**Figure B-4: Drought mitigation action policies' potential effectiveness (1 of 1)**


Similarly, the Drought Task Force rated the potential effectiveness of drought response actions. Figure B-5 and Figure B-6 show the potential effectiveness of administrative and operational drought response actions.

**Figure B-5: Drought response administrative and operational actions' potential effectiveness (1 of 2)**

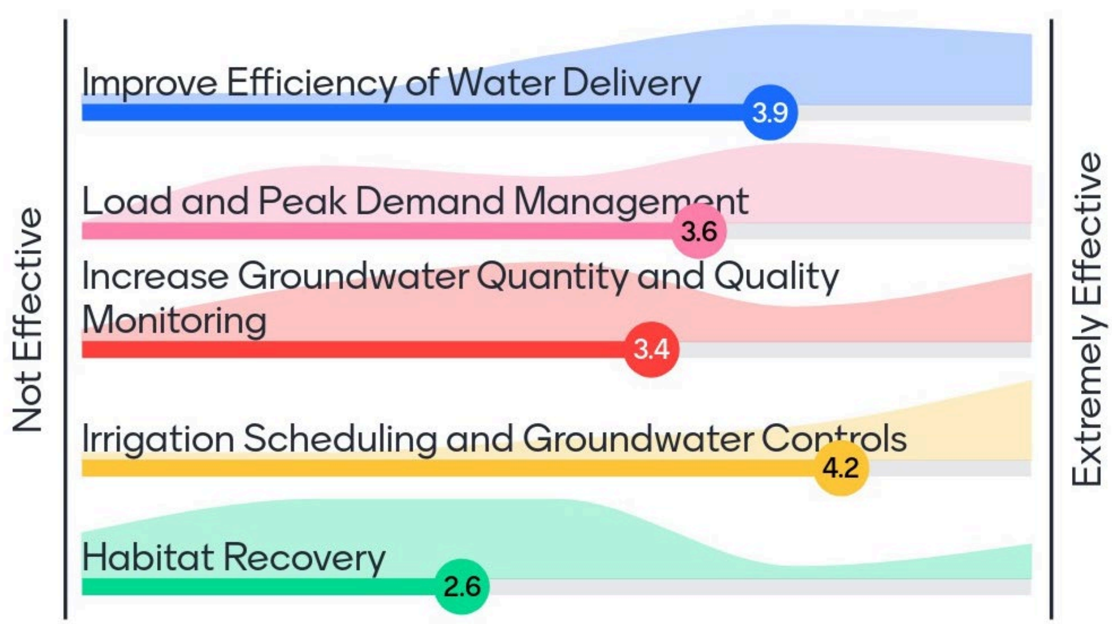


**Figure B-6: Drought response administrative and operational actions' potential effectiveness (2 of 2)**

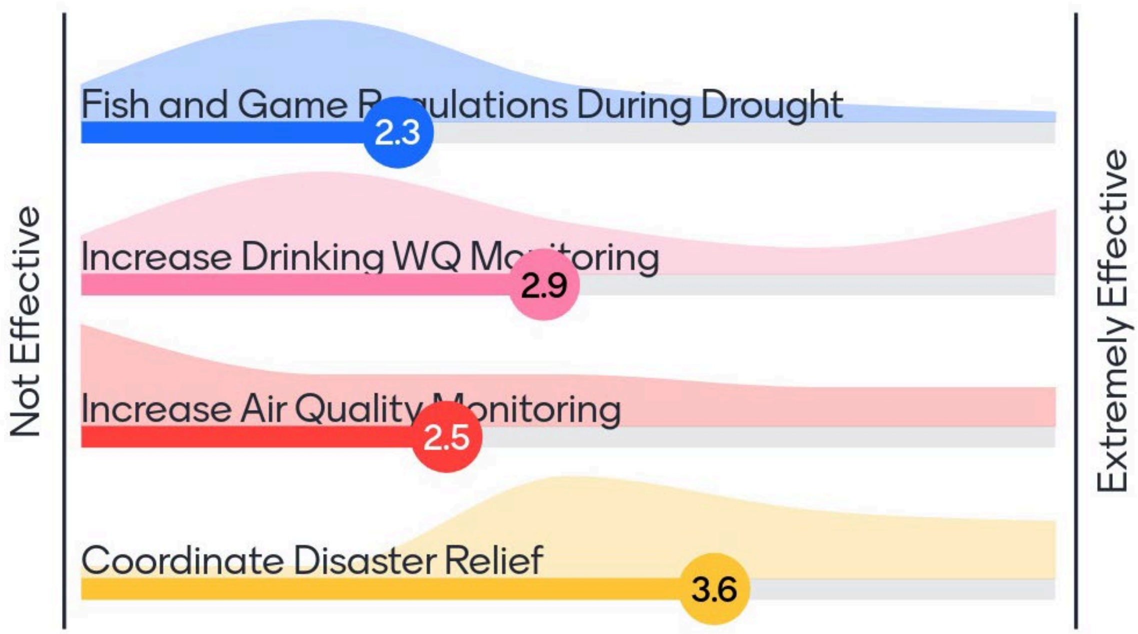



Figure B-7 shows the potential effectiveness of emergency response drought response actions.

**Figure B-7: Drought response emergency actions' potential effectiveness (1 of 1)**

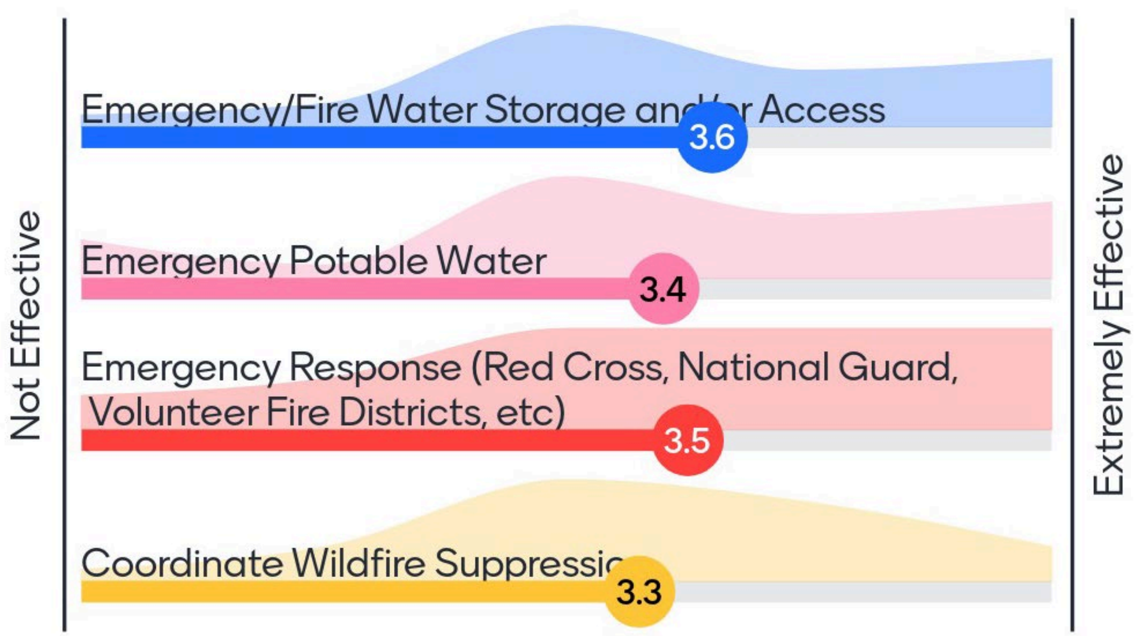
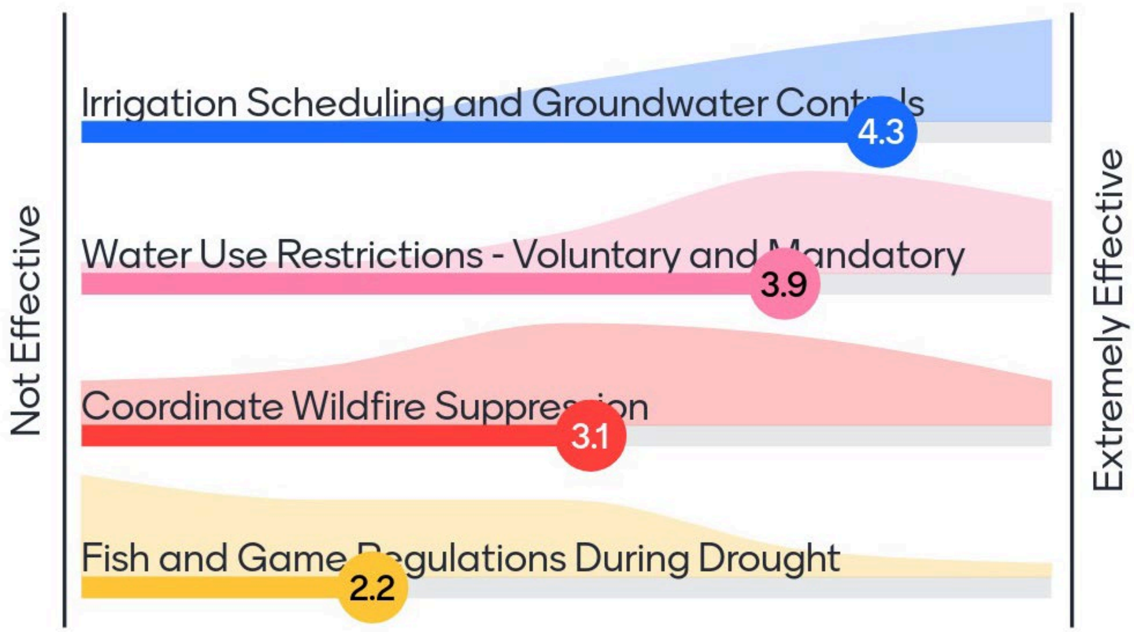



Figure B-8 shows the potential effectiveness of policy drought response actions.

**<u>FigureB-8: Drought response information and education actions' potential effectiveness (1 of 1)</u>**



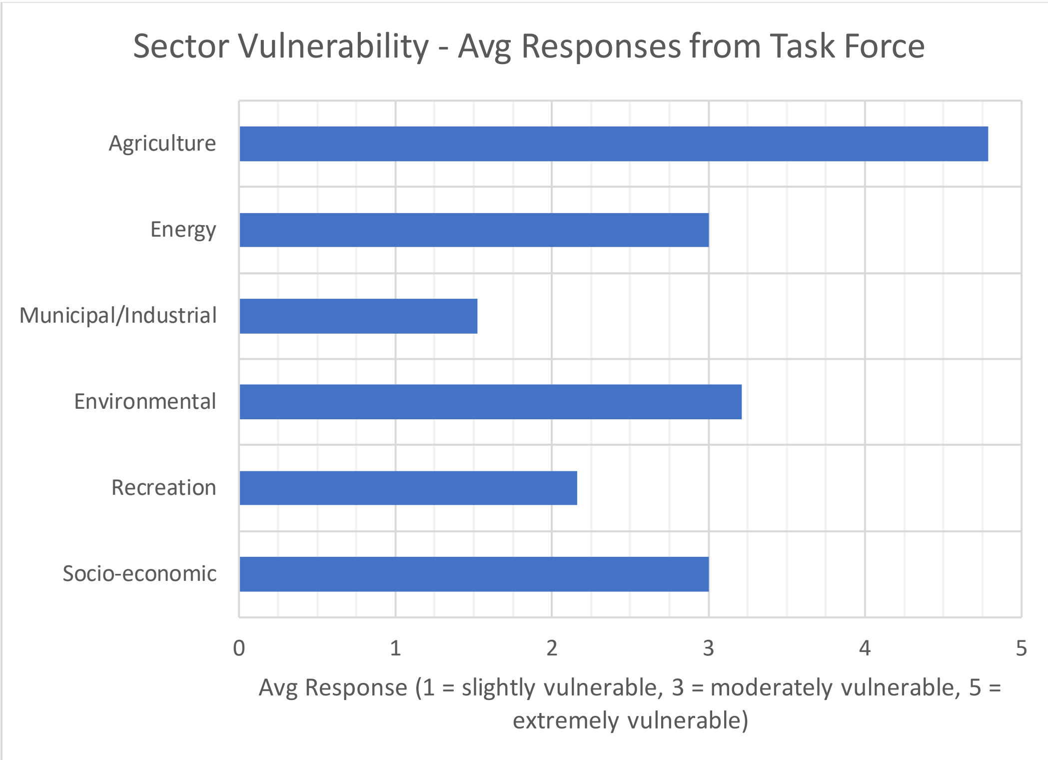

## Vulnerability Assessment

"The degree to which a population is vulnerable hinges on the ability to anticipate, to deal with, resist, and recover from drought" (Commission on Water Resource Management 2003). The risk of vulnerability to drought should be viewed as a combination of the frequency of occurrence, magnitude and severity, and consequences (<u>Guidance Regarding the Drought Contingency Planning Process – Appendix A 2019</u>)

For this drought contingency plan, drought impacts are divided among the following six sectors, with several impacts and vulnerabilities considered within each sector. The six sectors include agriculture, energy, municipal and industrial supply, environmental, recreation, and socio-economic.

The Drought Task Force provided ratings for "how vulnerable each sector is to drought in their area" and those ratings were averaged providing a comparison for long-term drought impacts between sectors (Figure B-9).

**<u>Figure B-9: Priority of Drought Vulnerabilities Across the Six Sectors Based on Input by Drought Task Force Members During the Second Drought Task Force Meeting in July 2022</u>**



# Appendix C– INSIGHT Methodology

INSIGHT (Integrated Network of Scientific Information and GeoHydrologic Tools) is a web-based, interactive tool[5] developed by the Department in support of required and voluntary integrated water management planning efforts pursuant to Neb. Rev. Stat. § 46-715. INSIGHT consolidates data from several sources, including the Department, the United States Geological Survey (USGS), BOR, and local NRDs. The Department uses that hydrologic data to conduct an analysis of the following items at the basin- and subbasin-level: (1) streamflow water supplies available for use; (2) the current amount of demand on these supplies; (3) the long-term demand on these water supplies due to current uses; (4) the projected long-term demand on these water supplies due to 5 percent growth in total use;[6] and (5) the balance between these water supplies and demands.

INSIGHT uses groundwater and surface water models to determine intrinsic water supply in a basin as well as water demands. In the UPRB, the Western Water Use Model (WWUM) covers the central and southern panhandle in Western Nebraska and extends east to include Lake McConaughy and a small portion of the South Platte River, see Figure C-1. The model is an integrated tool consisting of a surface water operations model, groundwater flow model, and soil-water balance model.[7]

The Platte River Cooperative Hydrology Study (COHYST) model covers the Platte River Basin from Lake McConaughy downstream to Columbus and takes into account surface water as well as groundwater, see Figure C-1. COHYST 2010 consists of three integrated modeling tools—watershed model for partition of rainfall/applied water, surface water model for the river and canal systems (STELLA), and a groundwater model for the aquifer processes. Groundwater depletion, groundwater consumptive use, surface water demand, and seepage data are available from COHYST.[8]

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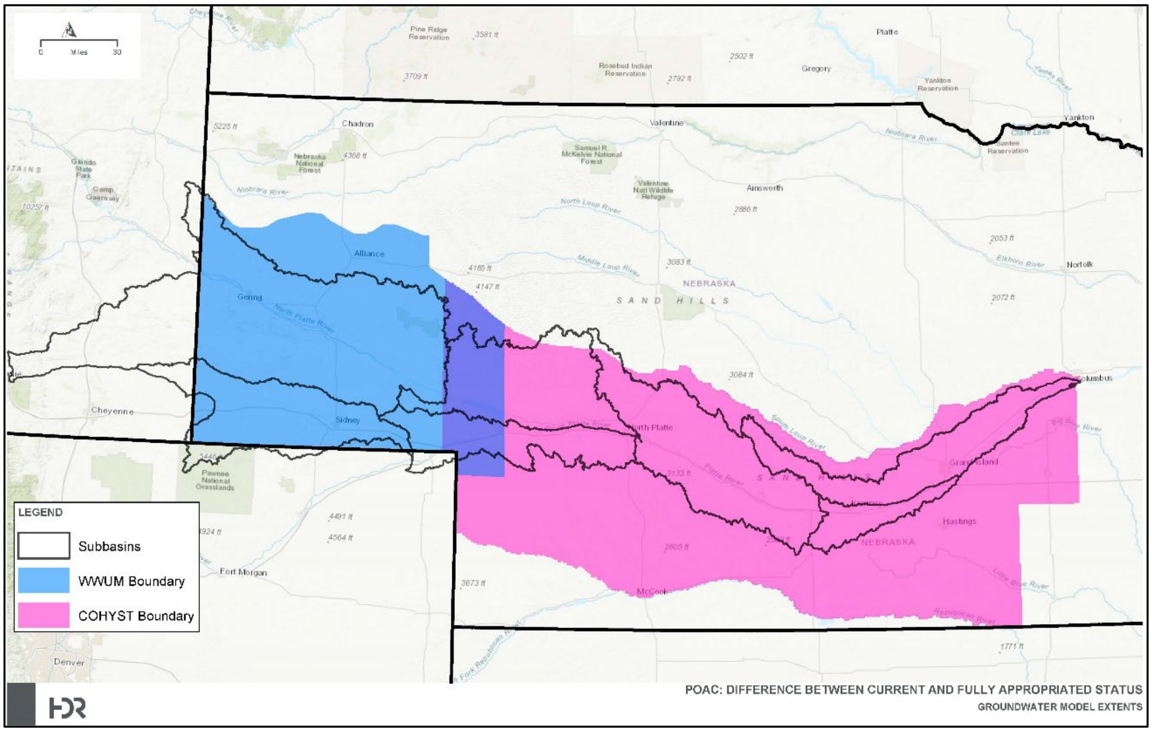
[5] The INSIGHT interactive tool is available at https://nednr.nebraska.gov/INSIGHT/.

[6] The projected growth in long-term demand was not applied in the Upper Platte River basin analysis as new uses are regulated

[7] Visit https://dnr.nebraska.gov/Western-Water-Use-Conjunctive-Use-Model for more information on the Western Water Use Model.

[8] Visit https://dnr.nebraska.gov/COHYST-Conjunctive-Use-Model for more information on the COHYST Model.

**Figure C-1: Groundwater Model Extents**

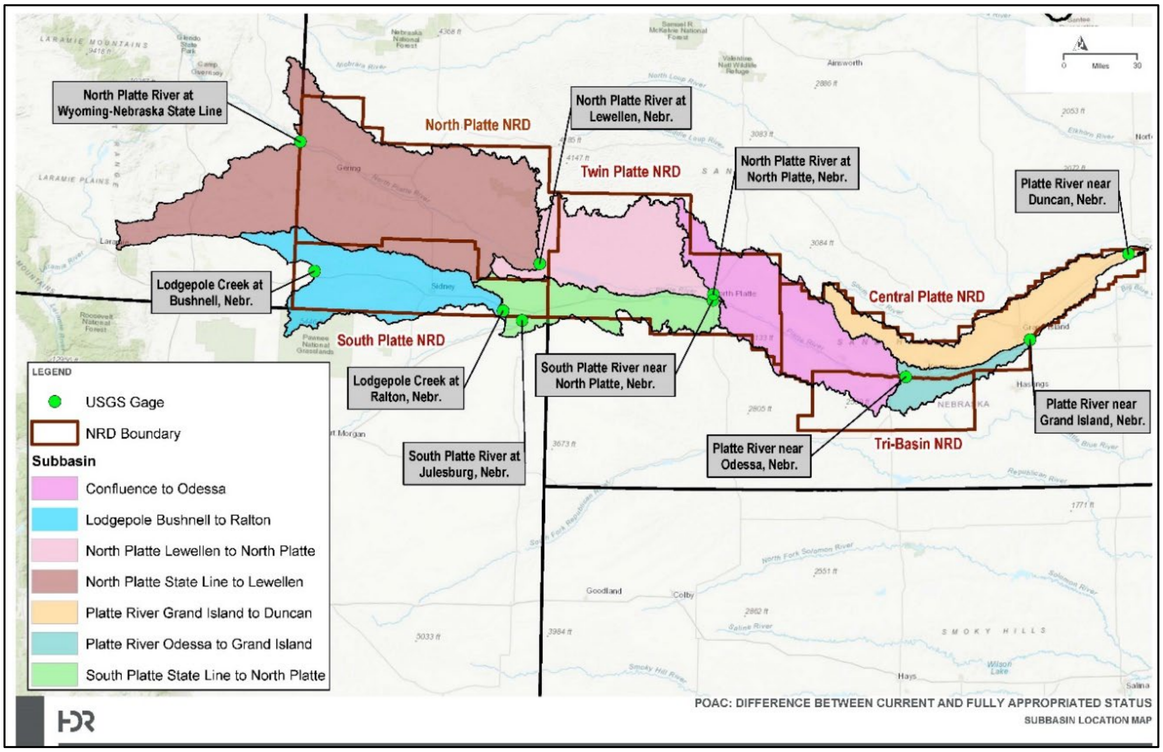



## 1.0 Water Supply

The UPRB includes the North Platte River, South Platte River, and Platte River from the Wyoming and Colorado state boundaries to Columbus, as shown in Figure C-2. The primary source of water in the UPRB is precipitation, which varies spatially and temporally across the region. In the mountains of Wyoming and Colorado, much of the precipitation falls as snow, which serves as a seasonal, natural reservoir, releasing water when snow melts in the late spring and summer. This natural, seasonal reservoir is supplemented across the UPRB with human-made structures, such as Seminoe and Pathfinder Reservoirs and Lake McConaughy.

Through a combination of natural and human-made influences, three distinct time scales exist for precipitation contributions to the Platte River. Natural runoff from rainfall feeds river flows in a matter of hours to days. Runoff from snowfall and storage/releases from human-made surface water reservoirs typically occur on a seasonal scale. Finally, aquifer recharge and baseflow accretions to the Platte River occur over a period of months to years.

**Figure C-2: Subbasins in the Upper Platte River Basin Overlaid by NRD Boundaries**




Water supplies of the UPRB are highly variable, with annual streamflows ranging from 100,000 acre-feet per year to nearly 4 million acre-feet per year. Recent data indicates that this variability is increasing due to greater extremes in the intensity and duration of precipitation events in the basin and shifts in precipitation patterns that have resulted in a greater proportion of precipitation in the upper portion of the UPRB occurring as rainfall, negating the beneficial impacts of natural snowpack storage on basin water supplies (EPA 2022). Figure C-3 illustrates the variability in water supplies in the UPRB, as well as the proclivity of extended drought periods (2002–2006).

**Figure C-3: Annual Streamflow for the Upper Platte River above Duncan, NE**

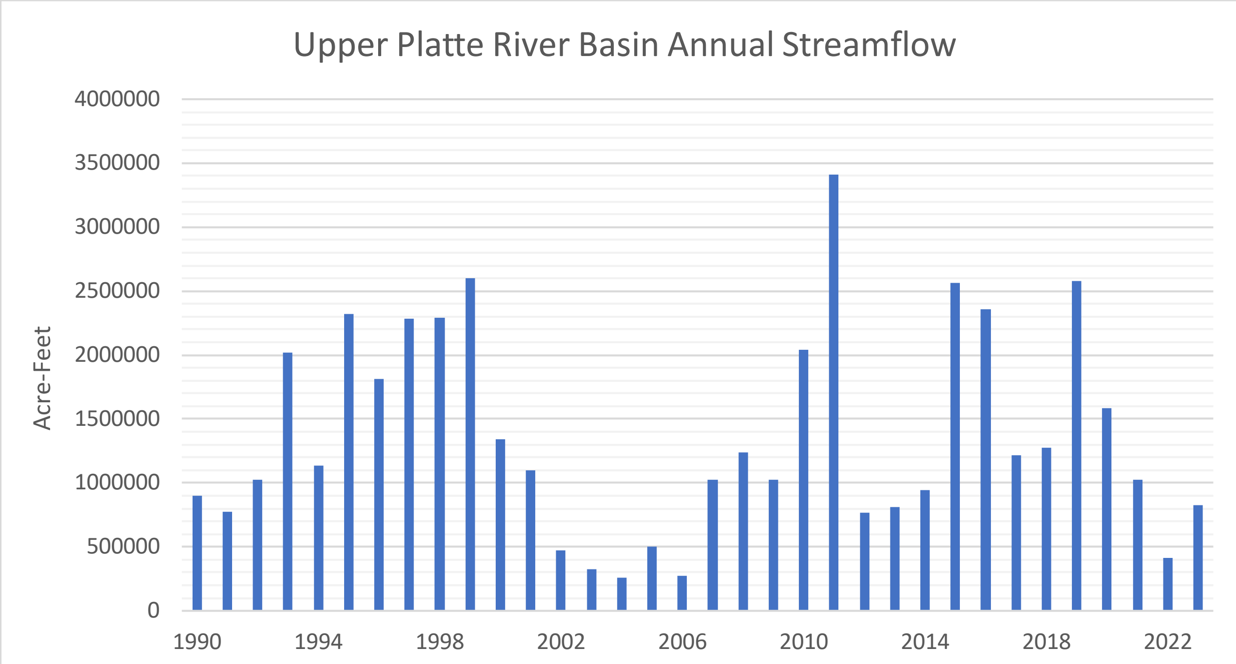
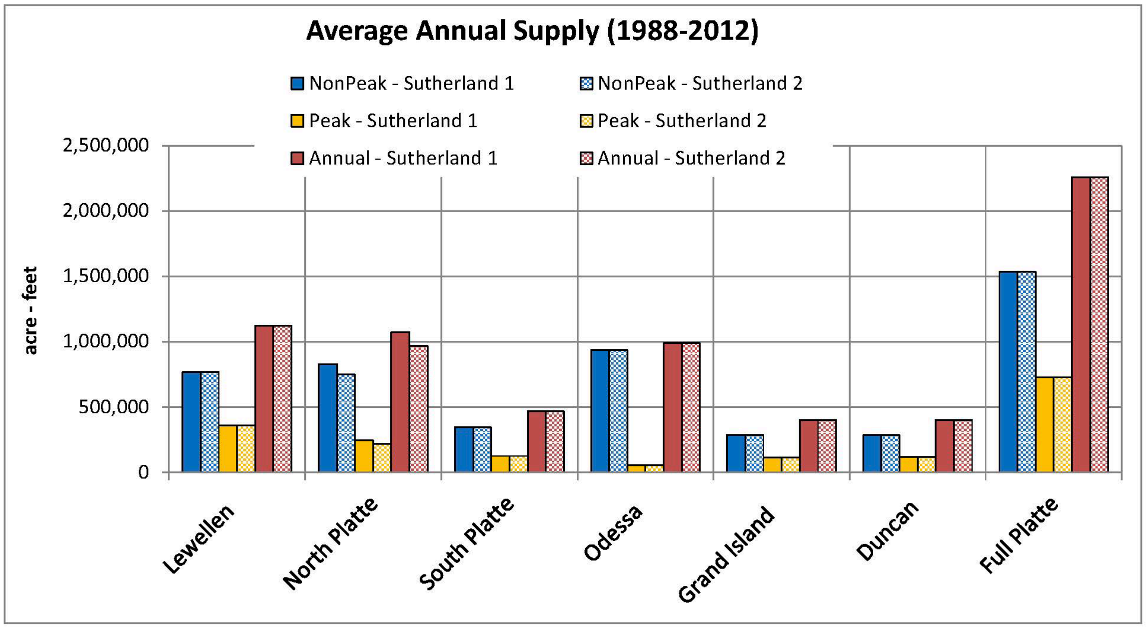



Figure C-4 from the UPRB INSIGHT Analysis shows the 25-year average (1988–2012) calculated supplies in the UPRB based on the INSIGHT subbasins, shown in Figure C-2. Note that the supply only changes by Sutherland demand scenario for the Lewellen to North Platte subbasin. This is because the required inflow term for the Lewellen to North Platte subbasin changes based on which Sutherland demand scenario is applied to the subbasin. The demand associated with Sutherland is unique in that the water right exceeds canal capacity. Therefore, two demand scenarios were evaluated for purposes of the INSIGHT analysis. The first scenario maximizes the contribution of the Sutherland demand from the South Platte River, Julesburg to North Platte subbasin by placing the 850 cfs Korty canal capacity capped to historic undepleted flow at Roscoe and assigning the remainder to the North Platte subbasin. The second demand scenario places a 1,750 cfs demand on the North Platte Lewellen to North Platte subbasin (the capacity of the Keystone Canal) capped to the undepleted historic streamflow at Lewellen and assigning the remainder of the Sutherland demand to the South Platte Julesburg to North Platte subbasin. In actuality, the demands assigned to these two subbasins will likely be somewhere in-between these two scenarios.

**Figure C-4: Annual Supply Plot for the Upper Platte River Basin**




## 2.0 Water Demand

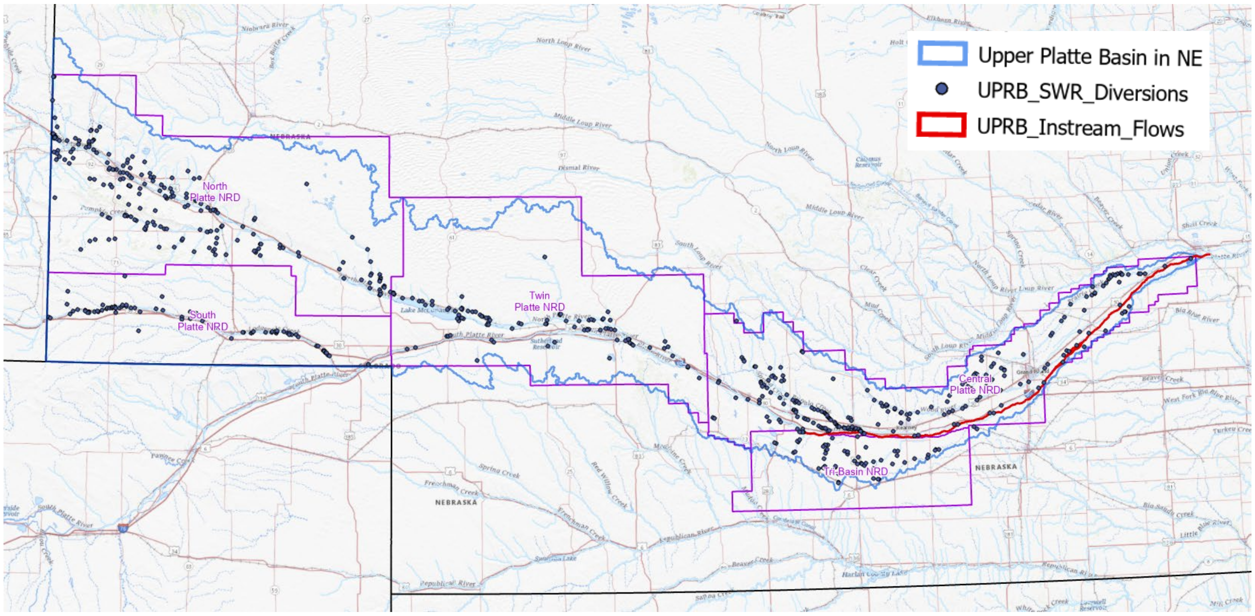
The water demands and uses in the UPRB in Nebraska are diverse and variable in timing and amount. Major water uses within the UPRB include municipal/domestic, agriculture, instream flows, recreation, powerplant cooling water, and hydropower. Communities throughout the UPRB rely upon the Platte River, its tributaries, and its underlying aquifers as the source for meeting municipal and industrial needs, serving over 258,000 Nebraskans (2020, COHYST Population Change Analysis Report). The UPRB includes over 2.4 million acres of irrigated cropland, utilizing water from both surface water and hydrologically connected groundwater sources. Instream flow appropriations are in place throughout the associated habitat reach of the central Platte River valley to maintain historic flow patterns and preserve native habitats.

Recreation usage of the Platte River, its tributaries and the many multi-purpose reservoirs, including Nebraska's largest reservoir—CNPPID's Lake McConaughy—are a primary economic driver throughout the basin and Nebraska. Platte River flows provide the cooling water source for NPPD's Gerald Gentleman Station near Sutherland, which is Nebraska's largest electric generation facility, supplying enough electricity to serve 600,000 Nebraskans. Finally, both CNPPID and NPPD have multiple hydropower generation facilities reliant upon Platte River flows.

## 3.0 Surface Water Demands

There are over 1,200 surface water appropriation points of diversion in the UPRB. Most of the surface water appropriations are for irrigation use and tend to be located on major streams (see Figure C-5). Instream flow appropriations exist in the Platte River from North Platte (at the confluence of the North and South Platte Rivers) to Odessa, Odessa to Grand Island, and Grand Island to Duncan reaches for the purpose of fish and wildlife needs. Like hydropower uses, instream flows are a non-consumptive use demand.

**Figure C-5: Surface Water Point of Diversions and Instream Flows**




*Source: NeDNR Map layer (obtained 2023)*

## 4.0 Groundwater Demands

Groundwater in the UPRB is used for a variety of purposes: domestic, commercial/industrial, livestock, irrigation, and other uses (Table C-1). As of July 2023, 39,773 groundwater wells are registered as active for irrigation, domestic, livestock, and commercial/industrial use within the UPRB (NeDNR 2023a). Nebraska is second in the nation for irrigated acres, accounting for about 1 acre of every 7 acres of irrigated land in the U.S. in 2022 (USDA NASS 2022 Irrigation and Water Management Survey).

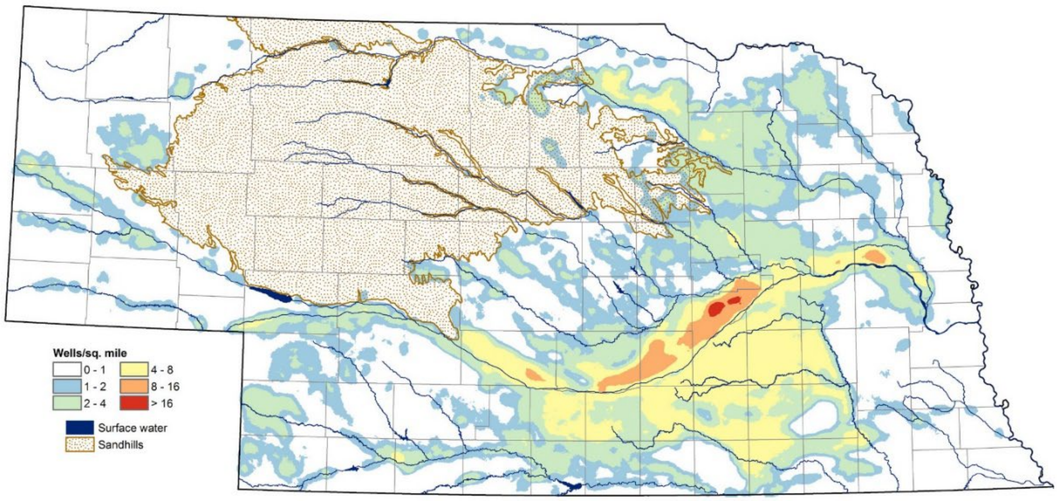
**Table C-1: Current Groundwater Well Development by Number of Registered Groundwater Wells, Upper Platte River Basin**

| Type | Percentage of Wells |
|---|---|
| Irrigation | 64.4 |
| Domestic | 22.3 |
| Livestock | 12.2 |
| Commercial/Industrial | 0.1 |

*Source: NeDNR 2023a.*

Figure C-6 displays the density of irrigation wells across the state, and Table C-2 documents the latest reported number of irrigated acres by NRD.

**Figure C-6: Density of Active Irrigation Groundwater Wells**




*Source: Young et al. 2022.*

**Table C-2: Number of Irrigated Acres by NRD**

| NRD | Total | Groundwater Only | Surface Water Only | Comingled |
|---|---|---|---|---|
| CPNRD | 950,949 | 870,044 | 39,273 | 41,632 |
| TBNRD | 573,463 | 457,571 | 25,265 | 90,627 |
| TPNRD | 308,474 | 263,261 | 13,425 | 31,788 |
| NPNRD | 441,158 | 134,885 | 190,862 | 115,411 |
| SPNRD | 123,777 | 122,187 | 40 | 1,551 |
| **TOTAL** | **2,397,821** | **1,847,948** | **268,865** | **281,009** |

*Source: 2020 COHYST and WWUM Irrigated Acres Summaries for 2023 Robust Review*

## 5.0 Total Calculated Demands

Figure C-7 shows the 1988 to 2012 25-year average calculated near-term demands by INSIGHT subbasin and in the full UPRB. Note that the demand only changes by Sutherland demand scenario (described in Section 2.0).

**Figure C-7: Annual* Near-Term Demand Plot for the Upper Platte River Basin**

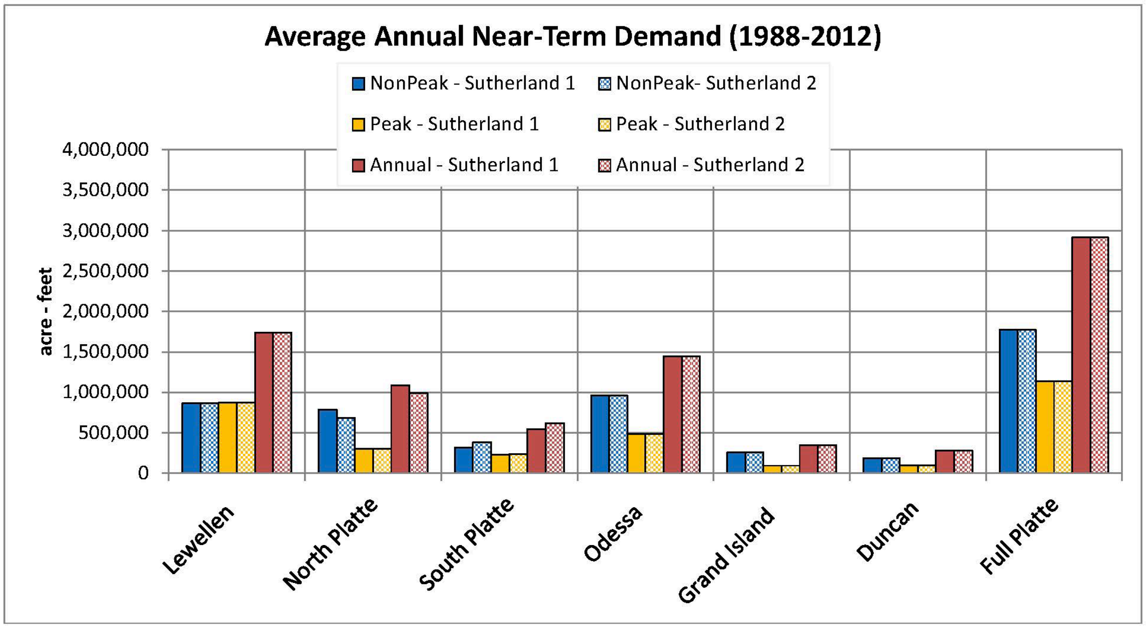
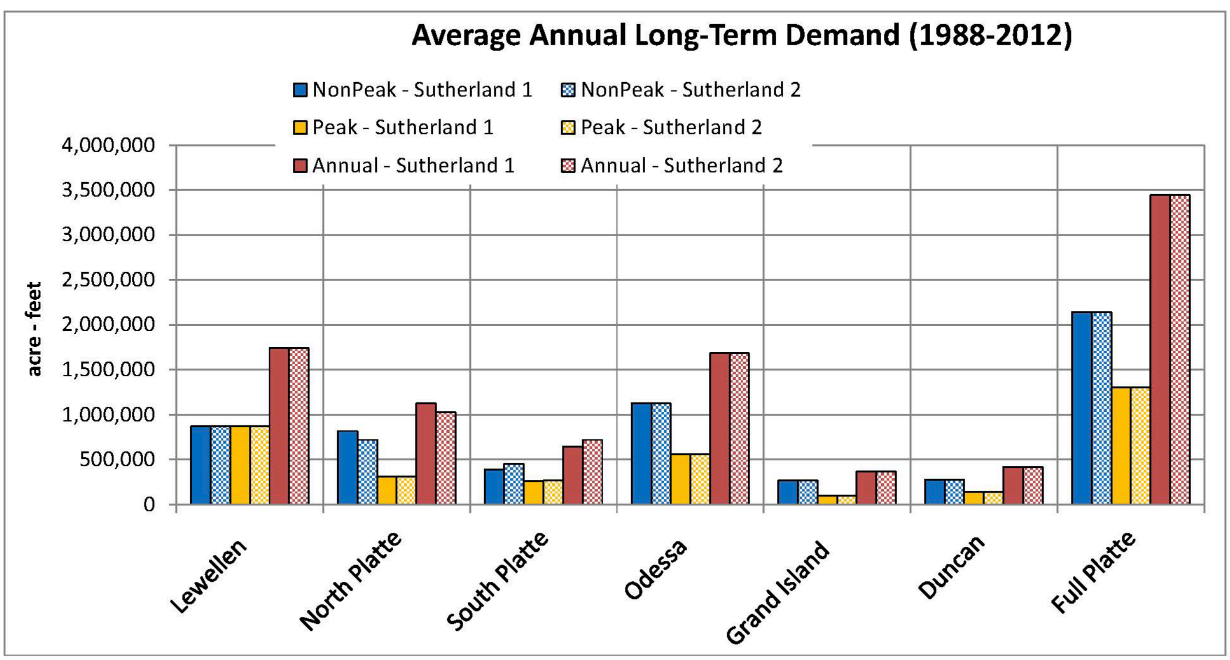



Figure C-8 shows the 1988 to 2012 25-year average calculated long-term demands by INSIGHT subbasins and by aggregate in the full UPRB. The difference between the near-term and long-term demands is that the near-term demand calculation considers the groundwater depletion (current effect of wells on the stream) while the long-term calculation considers the groundwater consumption (full impact of wells on a hydrologically connected stream). Note that the demand only changes by Sutherland demand scenario (described in Section 2.0).

**Figure C-8: Annual Long-Term Demand Plot for the Upper Platte River Basin**



## 6.0 Supplies versus Demands

The latest INSIGHT analysis quantified basin supplies and basin demands by subbasins and cumulatively across the full UPRB. Section 1.0 described the sources of water supply in the Basin while Sections 2.0 discussed the demand components. This section evaluates the comparison of basin supplies versus demands.

With the supplies and demands calculated, the difference was determined to be either excess supplies or supply deficits. Figure C-9 shows the 1988 to 2012 25-year average calculated annual excess supply for the UPRB based on near-term demand while Figure C-10 shows the 1988 to 2012 25-year average calculated annual excess supply for the UPRB based on long-term demand.

**Figure C-9: Annual Excess Supply (Based on Near-Term Demand) for the Upper Platte River Basin**

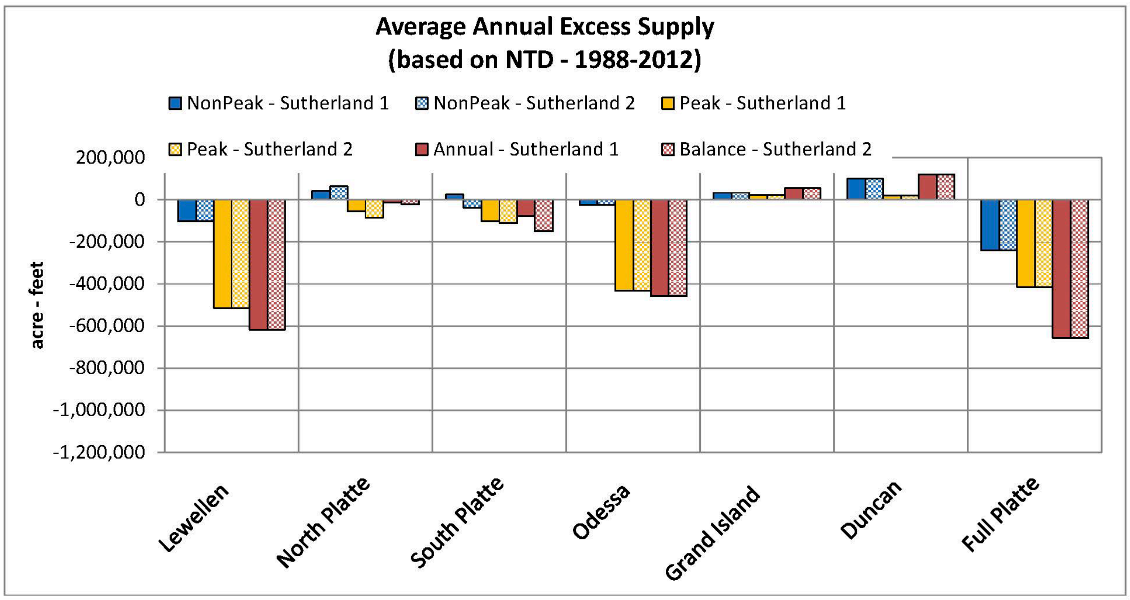


**Figure C-10: Annual Excess Supply (Based on Long-Term Demand) for the Upper Platte River Basin**