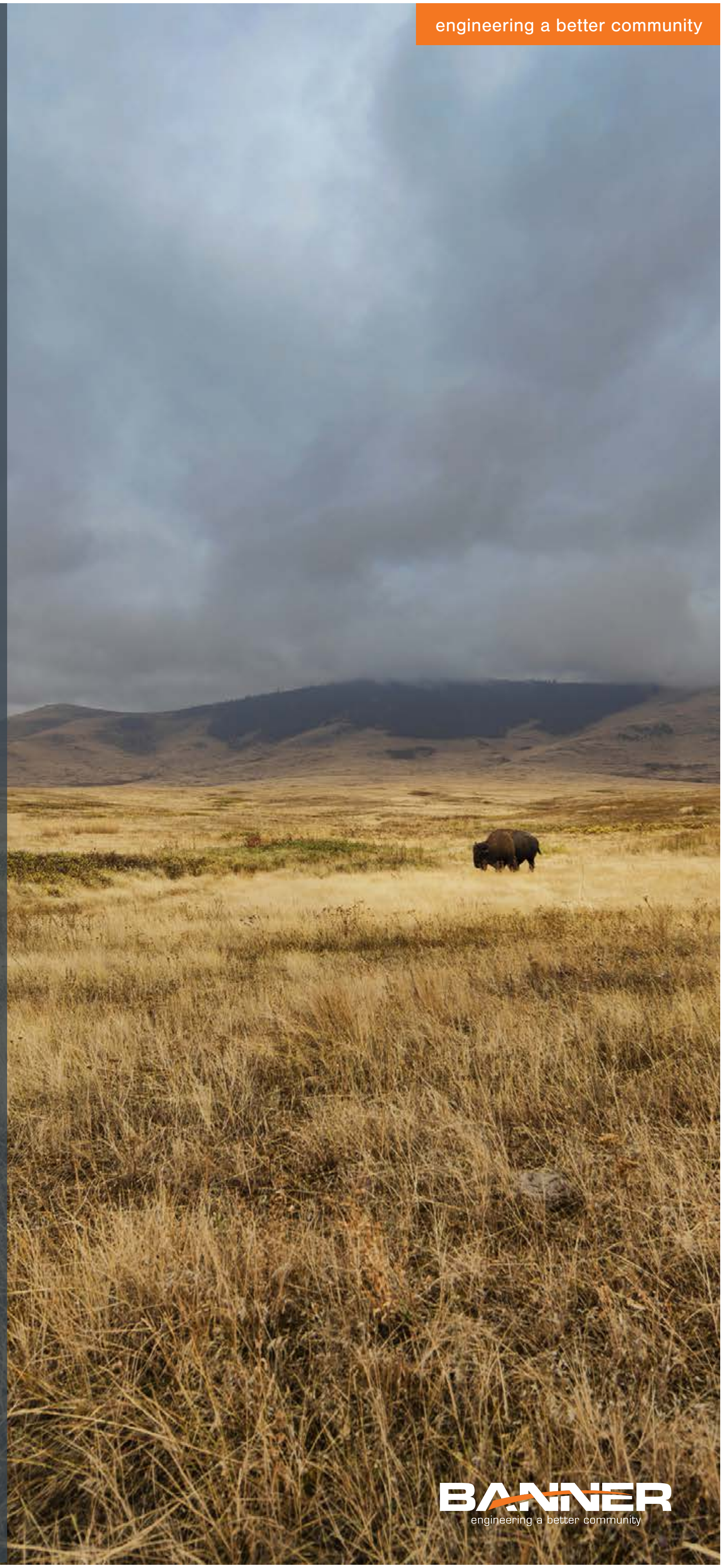
JUNE 2020

DROUGHT ADAPTATION PLAN



STANDING ROCK SIOUX TRIBE
JULY 1873

PREPARED FOR
The People of Standing Rock Sioux Tribe
Standing Rock Indian Reservation

PREPARED BY
Standing Rock Sioux Tribe
in collaboration with
Great Plains Tribal Water Alliance

Drought Adaptation Plan

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August 2020

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EXECUTIVE SUMMARY

The Great Plains Tribal Water Alliance (GPTWA) is a non-profit, whose members are Tribes in the Great Plains region of North Dakota, South Dakota, and Nebraska. On behalf of the Tribes, the GPTWA undertakes public outreach, research and education dedicated to the protection and preservation of Great Sioux Nation Indian Winter's Rights to the use of water in the Missouri River, tributaries and all aquifers and ground water sources located within the exterior boundaries of the Great Plains Region. It provides technical and policy recommendations for the protection of all water resources for the next seven generations.

The GPTWA serves as an advisory board to the Great Plains Tribal Chairmen's Association. The active Tribes in GPTWA include the Rosebud Sioux Tribe (RST), the Flandreau Santee Sioux Tribe (FSST), the Oglala Sioux Tribe (OST), and the Standing Rock Sioux Tribe (SRST). The GPTWA assisted in securing two Bureau of Indian Affairs (BIA) grants, one for FSST and SRST through FSST, and one for RST and OST, through OST. These grants were secured to develop a Drought Adaptation Plan (DAP) for each Tribe through the FY 17-18 Tribal Resilience Program, Adaptation Planning. Each grant was funded at $150,000. Through joint workshops and conferences, the Tribes collaborated on the development of the DAPs, however, each Tribe worked independently to identify unique opportunities for their reservation to adapt to drought.

This DAP will assist Standing Rock Sioux Tribe in developing drought resiliency and adaptation procedures. It is based on research, field visits to the Rosebud Reservation, questionnaires, surveys, and follow-up meetings with Technical Teams comprised of Tribal leadership, staff, and elders of the Tribe. Previously, the Drought Vulnerability Assessment (DVA) was created to identify sector specific vulnerabilities that are susceptible to drought. The sectors included: legal rights and infringements, Tribal lifeways, water, land, wildlife, agriculture, public health, and Tribal data monitoring.

In addition to the information developed in the DVA, research and field visits with Tribal leaders confirmed five specific vulnerabilities, including, 1) Contamination of Water Sources, 2) Water Use Conservation and Reliable Infrastructure 3) Agricultural Practices, 4) Fire Protection, and 5) Use and Preservation of Traditional Plants during Drought. Addressing the vulnerabilities resulted in identifying priorities for drought adaptation and mitigation strategies for the Tribe.

To address each vulnerability, corresponding Drought Adaptation Priorities were identified and mitigation projects to implement each priority were developed. The mitigation projects are meant to aid the Tribe in developing policy and infrastructure that will minimize the effects of drought. Some projects, like those dealing with water demand and restriction, require partnerships with private entities that are responsible for water distribution. Federal funding opportunities for each of the projects were also identified, detailing both the grant opportunity as well as the federal agency responsible for its distribution. The Drought Adaptation Priorities and associated Mitigation Strategies are shown in the following table.

Table 1: Drought Adaptation Priorities and Mitigation Strategies

Drought Adaptation Vulnerabilities	Mitigation Strategies
Vulnerability #1. Contamination of Water Source	Mitigation Strategy #1: Protection of Water Source
Vulnerability #2. Water Use Conservation and Reliable Infrastructure	Mitigation Strategy #2: Promote Water Conservation Practices Mitigation Strategy #3: Identify Existing Infrastructure and Future Improvements
Vulnerability #3. Agricultural Practices	Mitigation Strategy #4: Livestock Management Mitigation Strategy #5: Crop Mangement
Vulnerability #4. Fire Protection	Mitigation Strategy #6: Fire Protection
Vulnerability #5. Preservation of Traditional Plants	Mitigation Strategy #7: Preservation of Traditional Plants

The DAP relied on climate research and recommended actions during drought, based on the needs of each sector. The DAP requires diligent monthly monitoring of drought conditions using drought indices that track the severity of flash drought and long-term drought. Indices used include the U.S. Drought Monitor (USDM) and the Evaporative Demand Drought Index (EDDI) and the. The USDM uses a five-category system, labeled Abnormally Dry or D0, (a precursor to drought, not actually drought), and Moderate (D1), Severe (D2), Extreme (D3) and Exceptional (D4) Drought (NIDIS, 2020). Four categories triggering action from the Tribe include:

- Normal (No USDM rating)
- Alert (D0)
- Warning (D1-D2)
- Emergency (D3-D4)

Each category has a specified set of proactive and reactive actions for the Tribal government to take.

For each mitigation strategy, potential projects and funding for these projects were identified. The mitigation projects are meant to aid the Tribe in developing adequate infrastructure that will minimize the effects of drought. Some projects, like those dealing with water demand and restriction, require partnerships with private entities that are responsible for water distribution. Federal funding opportunities for each of the projects were also identified, detailing both the grant opportunity as well as the federal agency responsible for its distribution. These mitigations strategies, potential projects, and potential funding sources are described in ***Table 7. Summary of Vulnerabilities, Mitigation Strategies, Potential Projects, and Potential Funding.***

The success of this DAP depends on the current data and tools to track drought and adjustments to responses to drought. It is recommended that the DAP be updated every five years for successful and continued implementation.

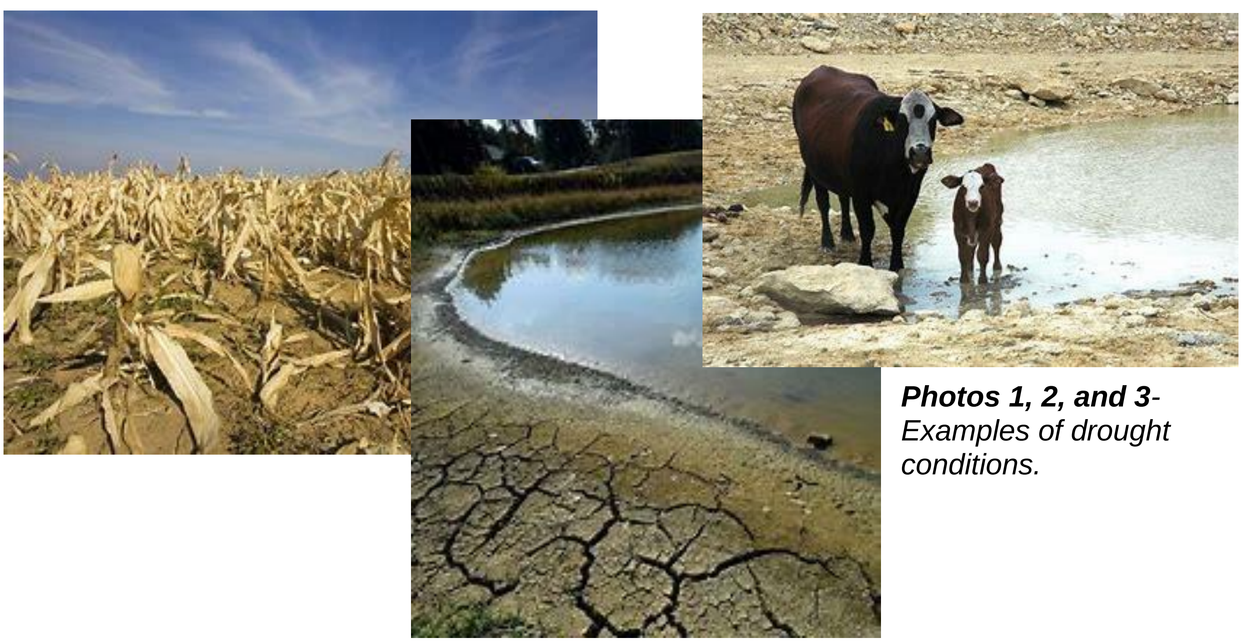
1.0 INTRODUCTION

The Drought Adaptation Plan (DAP) was developed as a planning tool to identify and prioritize Standing Rock Sioux Tribe (SRST) government responses before, during, and after drought. The recommendations in the DAP were created by understanding the important Tribal resources and the vulnerabilities of those resources to drought, combined with current scientific Standing Rock Sioux Tribe understanding of drought and climate resiliency. Key Tribal program directors, staff, council members, government officials, and members met to identify and prioritize strategies and plans most beneficial for the Tribe.

Three other Tribes, active in the Great Plains Tribal Water Alliance (GPTWA), worked collectively in developing the DAP. The GPTWA Tribes include Flandreau Santee Sioux Tribe (FSST), Oglala Sioux Tribe (OST), Rosebud Sioux Tribe (RST), and Standing Rock Sioux Tribe (SRST). The DAPs were funded by the Bureau of Indian Affairs (BIA) FY17 and FY18 Tribal Resilience Program, Category 2 Adaptation Planning Grant. The Tribes worked collectively in learning about drought adaptation through the joint water conferences and workshops. Although the Tribes worked together on overarching drought adaptation concepts, each Tribe has a unique DAP, tailored for their respective reservation.

The SRST DAP is the third resource document in a series documenting drought vulnerabilities and baseline resource conditions on the Standing Rock Reservation. Each report builds on information and data documented in the previous one. Previous resource documents include:

- *SRST Integrated Environmental Management Plan for Cultural, Natural, and Water Resources (IEMP)*
- *SRST Drought Vulnerability Assessment (DVA)*



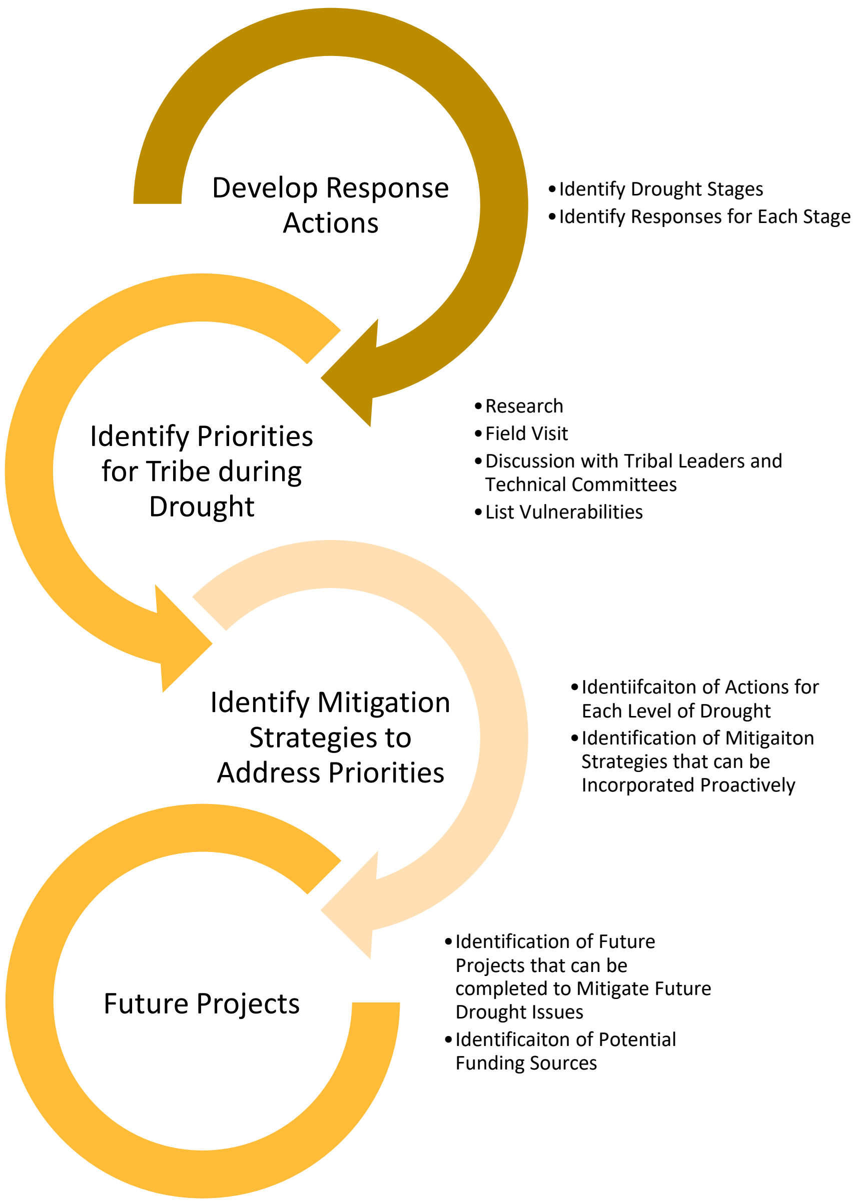
Photos 1, 2, and 3*- Examples of drought conditions.*

The objectives of this DAP are to develop an actionable plan that through policy adoption and infrastructure development enables the Tribe to become more resilient to drought and its effects. Specific steps in the development of the DAP include the following:

- Coordinate with Tribal leaders to develop a list of drought vulnerabilities, previously determined from the DVA, that need to be addressed immediately,
- Identify drought mitigation strategies that would best resolve the vulnerabilities, and
- Identify the projects that would meet the mitigation strategy and identify potential funding sources for the top two priority projects.

The process to achieve the objectives for this DAP is shown below in the flow chart.

Figure 1. Development of Drought Adaptation Actions

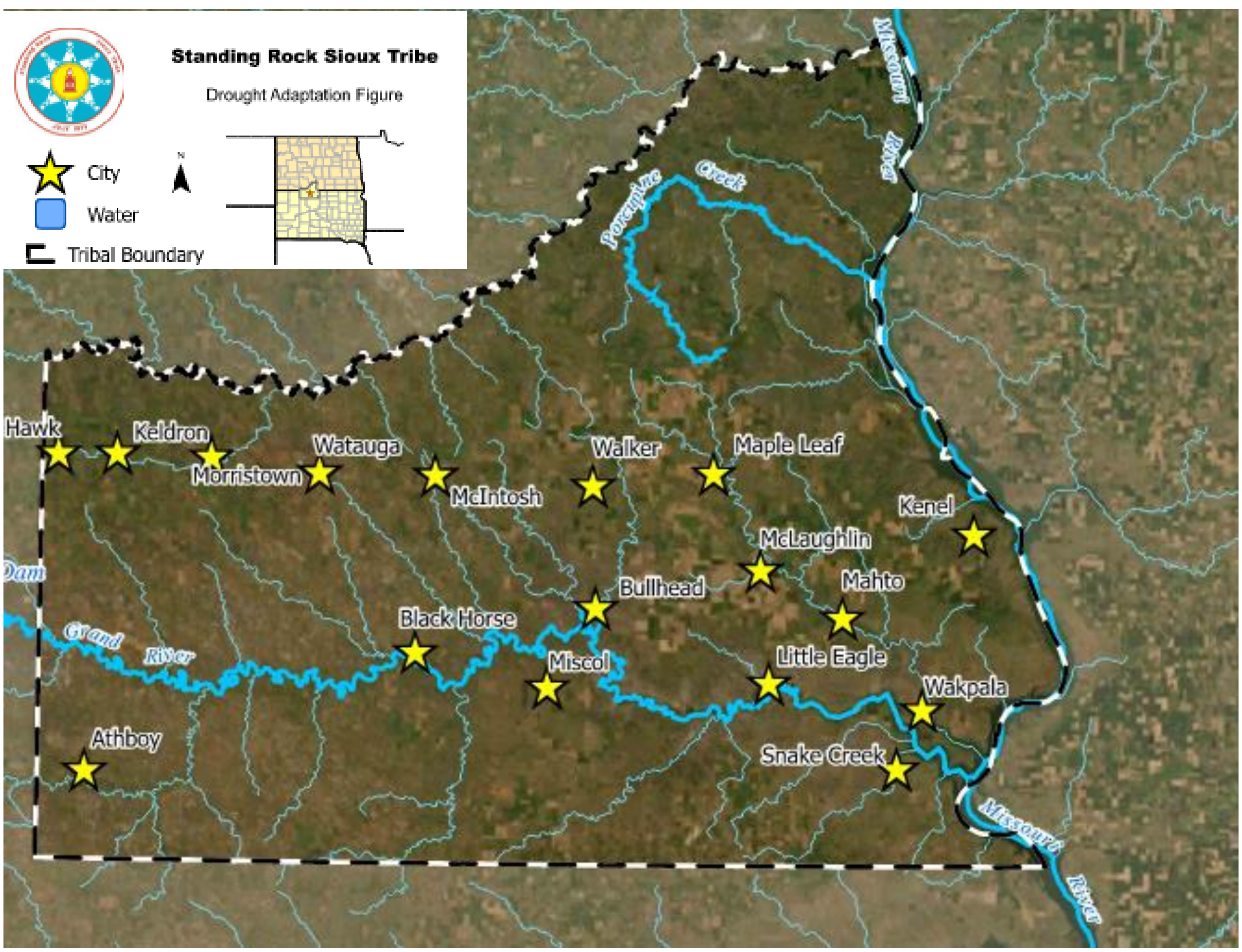


1.1 Standing Rock Sioux Tribe Reservation Location

The Standing Rock Sioux Tribe resides on the Standing Rock Indian Reservation (Reservation). The Reservation is located along the border of North Dakota and South Dakota, in Sioux County, ND and Corson County, SD. The Reservation encompasses an area of over 3,500 square miles, totaling over 2 million acres (SRST 2020). The Reservation is 34 miles south of Mandan, North Dakota. The Cannon Ball River and Cedar Creek are found on the north and northwest sides of the Reservation, respectively. The Reservation ends at the Perkins County and Adams County line in the west and the Missouri River on the east. The southern boundary of the Reservation ends with the Cheyenne River Reservation boundary as shown in ***Figure 2. Standing Rock Reservation Boundaries***.

The primary communities within the Reservation are Long Soldier, Rock Creek, Bear Soldier, Running Antelope, Porcupine, Kenel, Cannonball, and Wakpala. The Tribal Headquarters are located at Standing Rock Avenue, Fort Yates, ND, along the eastern border of the Reservation marked by the Missouri River.

Figure 2. Standing Rock Reservation Boundaries



1.2 Standing Rock Sioux Tribe Government

The Standing Rock Sioux Tribal Council consists of a Chairman, Vice-Chairman, Secretary, and 14 additional Councilmen who are elected by the Tribal members. Six of the 14 councilmen shall reside within reservation with no regard to any district or state, while the remaining eight must reside within their respective districts. The Council Chairman and Councilmen serve a term of four years between each election cycle.

1.3 Land Description

The total land area of the Reservation is 2.3 million acres with Tribally owned acres totaling 1,408,061 million.

The Reservation lies in the Northwestern Great Plains ecoregion (EPA 2020), which encompasses the Missouri Plateau section of the Great Plains. The Northwestern Great Plains ecoregion is a semiarid rolling plain of shale, siltstone, and sandstone, with occasional buttes and badlands. Native grasslands are found in areas of steep or broken topography but have been highly replaced by wheat and alfalfa over much of the ecoregion. The Reservation is dominated by rolling hills, woodlands, river valleys, and lakes. Of the 2,300,000 acres, approximately 76 percent is utilized for grazing (SRST 2020).

The land description focuses on Corson County, South Dakota, as this county lies entirely within the Reservation. Corson County is located in northwestern South Dakota and borders North Dakota and the Missouri River. The Grand River flows through the county from east to west and empties into the Missouri River. The Grand River and its tributaries drain the entire county. The topography of the area ranges from steep to undulating to rolling, with the steeper areas along the Grand River and its tributaries. The drainage of the area is from well to excessive. The clay loams and loams predominate with some sandy areas; and are primarily best suited for ranching and cash grain farming, with attention to wind and water erosion control. These areas are very susceptible to erosion. Corson County is in a low rainfall area where ranching is the leading enterprise. The land produces good grasses. Water is supplied by the river, creeks, springs, dams and wells, with the dams and wells being an important source of supply (Corson County Conservation District, 2012).

1.4 Climate

The western halves of North and South Dakota are semi-arid. Average rainfall on the Reservation is 16 to 17 inches during the summer season. The growing season lasts 3 months from June to August. The snowfall averages from moderate to heavy during the winter. The temperature in the winter is from 30 degrees Fahrenheit below zero to 17 degrees Fahrenheit above zero. The average temperature in the summer is 80 degrees Fahrenheit but usually ranges from 69 degrees to 110 degrees Fahrenheit from June to August. The area experiences occasional drought in the summer and severe blizzard in the winter. The spring and fall times are pleasant (SRST 2020).

1.5 Standing Rock Sioux Tribe Demographics

Because the Reservation lies in two states, demographics presented are a culmination of U.S. Census Bureau 2018 estimates for both Sioux and Corson Counties. There are approximately 8,523 people that reside on the Reservation, of which about 74 percent classify themselves as

Native American with about 4 percent identifying as two or more races (US Census 2019). Though census data is accurate and a valuable resource, Native Americans in the past have been undercounted. It is important to note that Tribal nations are regularly misrepresented or underrepresented by the Census due to multiple factors. The factors include residential mobility, language and literacy barriers, concealment of information because of a disbelief in census confidentiality, fear of retribution from authorities for violation of housing codes or other regulations, irregular and complex household arrangements, and resistance as a strategy for dealing with outsiders, particularly government representatives (NBC News 2019). Although this research was completed for the Rosebud Sioux Tribe, the same conclusions can apply to the Standing Rock Sioux Tribe as well. For example, in the 2010 Census, Native Americans living on reservations were undercounted by 4.9 percent (Kesslen 2019).

The average annual income on the Reservation is estimated at $36,000.00. South Dakota’s overall average annual income of $54,126, and North Dakota’s average income of $61,843.00 (Department of Numbers 2019). When comparing these average incomes, a majority of Standing Rock’s population is estimated to live below the poverty line as compared to South Dakota’s and North Dakota’s overall poverty percentage of 13.1% and 10.7% respectively (Talk Poverty 2019, 2018).

1.6 Drought Adaptation Plan Partners

The grant proposal that was submitted by the SRST had identified project partners that would be participating in the work. The partners included GPTWA and their interns, each Tribe, the National Drought Mitigation Center, and the National Oceanic and Atmospheric Administration. Banner Associates was hired as the consultant to complete this DAP. The partners and their specific roles are described below and can also be found in ***Table 2. Drought Adaptation Partners***.

- **Standing Rock Sioux Tribe -** The SRST is the project lead. The SRST team is led by Water Resources Water Administrator Errol “Doug” Crow Ghost. Doug has worked with the Tribe for numerous years not only as a Water Administrator, but also has served on the Tribal Council, bringing experience, knowledge, and personal contacts that have facilitated the gathering of feedback for the development of this document. The Tribe assisted in helping project participants coordinate field visits, interviews, and offering guidance and feedback on the DAP throughout the project, as well as providing input to the overall project to endure it met the goals and objectives of the Tribe.

- **Great Plains Tribal Water Alliance -** The Great Plains Tribal Water Alliance (GPTWA) is a non-profit, whose members are Tribes in the Great Plains region of North Dakota, South Dakota, and Nebraska. On behalf of the Tribes, it undertakes public outreach, research and education dedicated to the protection and preservation of Great Sioux Nation Indian Winter’s Rights to the use of water in the Missouri River, tributaries and all aquifers and ground water sources located within the exterior boundaries of the Great Plains Region. It provides technical and policy recommendations for the protection of all water resources for the next seven generations.

  The GPTWA serves as the organizing vehicle to collaborate with the Tribes, BIA, and relevant federal and state agencies to develop DAPs in a phased approach. This multi-Tribal approach follows the model for the Mni Wiconi Rural Water System (MWRWS), where federal and state governments worked with several Tribes to build, monitor, and maintain their water infrastructure. This partnership builds on historical and cultural networks to support and sustain water resource planning efforts after the grant period.

- **GPTWA Interns -** The project team worked with the South Dakota School of Mines and Technology and Oglala Lakota College in Rapid City, South Dakota, to identify two engineering or science students entering their upperclassmen years to work on this project. The students that were hired for the project are enrolled members of South Dakota Tribes. Their goal was to work with the Tribe's technical staff and other key resource personnel to assist in the development of a DAP for each Tribe. The interns acted as a team, sharing important methods and processes that helped them tailor plans for the Tribes. These students developed important skills and acquired knowledge about drought vulnerabilities and mitigation strategies to assist the Tribes in the future.

- **National Drought Mitigation Center -** The National Drought Mitigation Center (NDMC) helps people, organizations and institutions build resilience to drought through monitoring and planning, and it is the academic partner and web host of the U.S. Drought Monitor. Its capabilities include climatology, social science, and public engagement, and we work at all scales, from individual ranches to local, state, and tribal government, and countries around the world. NDMC's primary task was to offer professional and technical guidance.

- **National Oceanic and Atmospheric Administration -** the National Oceanic and Atmospheric Administration (NOAA) is an American scientific agency within the United States Department of Commerce that focuses on the conditions of the oceans, major waterways, and the atmosphere. NOAA has worked with GPTWA, assisting the Tribes in understanding current science findings that are beneficial to the Tribes. NOAA participated as a conference speaker and to offer information to the partnering Tribes of the GPTWA. Concurrently, two of their interns accompanied GPTWA Interns and Banner Associates on field visits.

- **Louis Berger, Inc. and Banner Associates, Inc.** - During the first phase of the development of the DAP, Louis Berger was the private partner, assisting GPTWA in the mentoring of the interns, coordination of the project, and overall technical assistance. As Louis Berger transitioned their work to Banner Associates, that role continued and was expanded to bring the partners together to develop the DAP document.

Table 2. Drought Adaptation Partners

Agency	Partners
Standing Rock Sioux Tribal Leaders	Doug Crow Ghost, Water Resources Megan Jones, Water Resources John Eagle, Tribal Historic Preservation Office Emmett "Suki" White Temple, Water Resources Control Board – Rock Creek District Kory McLaughlin, Water Resources Control Board – Porcupine District

Agency	Partners
	Celeste Long Elk, Water Resources Control Board – Long Soldier District
Great Plains Tribal Water Alliance	Standing Rock Sioux Tribe Oglala Sioux Tribe Rosebud Sioux Tribe Flandreau Santee Sioux Tribe
GPTWA Interns	Amanda Booton-Popken Elisha Yellow Thunder
National Oceanic and Atmospheric Administration	Doug Kluck, Central Region Climate Services Director Emily Bamford, Graduate Student Marianne Shiple, Graduate Student
National Drought Mitigation Center	Cody Knutson, Water Resource Scientist
Louis Berger/Banner Associates	Becky Baker, Environmental Manager Cheryl Chapman, PhD, PE Chance Knutson, EIT Logan Gayton, EIT Leslie Murphy

1.7 Methods to Identify Vulnerabilities and Mitigation Strategies

The development of the DAP is benefited by Standing Rock Sioux Tribe's active membership in the GPTWA. Since joining GPTWA, Standing Rock Sioux Tribe has produced its own Integrated Environmental Management Plan, Drought Vulnerability Assessments, and Quarterly Climate Summaries. The DAP is the latest in a series of projects assisting the Tribes in the GPTWA in developing both technical capacity and reports in the realm of climate resilience and drought assessments and leverages these previous efforts to build upon its knowledge and actions to assist Standing Rock Sioux Tribe in becoming resilient in the face of a drought.

The GPTWA serves as the organizing vehicle for the partnership of Tribes, BIA, and relevant Federal and state agencies. This multi-Tribal approach continues a model like the Mni Wiconi Rural Water System (MWRWS), where Federal agencies and the state partnered with multiple Tribes to increase capacity to build, monitor, and maintain their water infrastructure. By working with Tribes in South Dakota, this partnership builds upon historical and cultural networks to support and sustain water resource planning efforts after the grant period. This project provides opportunities for individual assessments of water resource vulnerabilities, adaptation strategies, and capacities for climate preparedness and incorporation of Traditional Knowledge of climate impacts to Tribes.

Although the deliverable of the project is a DAP, there are many outcomes and benefits that come with the development of the plan. Documentation of mitigation strategies will assist the Tribe in attaining further funding to accomplish drought adaptation goals. In working with the GPTWA and other project partners, the introduction of drought mitigation strategies was presented to Tribal members for comment and additional development of the strategies. Through the hands-on learning, Tribal program staff learned how plans are created and increased important professional relationships with national leaders in climate and drought planning. These relationships will lead to further projects in the drought and climate area that will continue to benefit all of the GPTWA Tribes for years to come.

The timeline for this project began with a kick-off meeting, public meetings, and working workshops. The Standing Rock Sioux Tribe action within this project was to hire two Tribal interns from the Oglala Lakota College and the South Dakota School of Mines and Technology. Their duties were to conduct field visits and assist in writing the draft mitigation plan. The kickoff meeting introduced the scope of the project, timeline, and the benefits of developing DAPs. To identify the vulnerabilities and mitigation measures, research, field visits, and coordination with Standing Rock Sioux Tribe and other identified experts and stakeholders was completed. The previous two DVAs were used to identify the vulnerabilities for the Tribe and reservation and the adaptation strategies were then tailored to address each vulnerability and potential projects identified to address each one. Overall, the project methodology is shown in ***Figure 1. DAP Project Management Methodology*** and described in the remainder of this section.

Figure 3. DAP Project Management Methodology

1.7.1 Kick-Off Meeting and Working Workshop

The development approach for the DAP was to include elders, leaders, and managers from the Standing Rock Sioux Tribe in each step of the plan. In addition to the field trip and individual meetings with Standing Rock Sioux Tribe, joint working workshops and sessions were scheduled as part of the regular GPTWA Board meetings and Bi-annual Water Conferences hosted by the alliance. The overall schedule for the project was, as follows:

- Spring 2019 Initial Kickoff Meeting in Rapid City
- Summer 2019 Field Visits to each reservation
- Winter 2019 Draft Drought Adaptation Plan
- Spring 2020 Public Review Meetings

- Summer 2020 Final Drought Adaptation Plan

1.7.2 Tribal-Member Student Intern Involvement

The GPTWA seeks ways in which to develop the next generation of leaders to work on protecting Tribal water resources. As part of that commitment, the GPTWA hired two interns, one a scientist from Oglala Lakota College and one an engineer from South Dakota School of Mines and Technology, to assist in the development of all the DAPs for each of the member Tribes. The duties of the interns over the course of the project was to attend all meetings, take notes of discussions, ideas, and findings, write field visits summaries, search and collect data for plans, and create the initial draft of the DAP for the Standing Rock Sioux Tribe. The student involvement added another dimension to capacity building and increased the individual understanding of climate and drought science, as well as cultural considerations of each Tribe in the development of the individual DAPs.

1.7.3 Research

Preliminary research was completed for the Standing Rock Sioux Tribe during the previous completion of the IEMP and DVA. The DVA utilized available research and became a guide on how to conduct adaptation planning for drought conditions. The work was funded by the BIA through their Climate Resiliency Program and BIA Tribal Water Program were used to serve as baselines for preliminary information for the DAP. The DVA utilized available research and became a guide on how to conduct adaptation planning for drought conditions. Extensive scholarly research was also completed using the databases ProQuest, EBSCO, and Google Scholar. Journals, publications, government documents, and articles regarding climate change, drought mitigation and planning, and Tribal, federal, and state political land interactions were read, notated, and cited in an annotated bibliography. This research was conducted to establish baseline information on types of drought adaptation and mitigation management practices that have been done in the past. This research allowed for specific practices and other methods to be considered for the Great Plains Tribes.

Climate change resilience and adaptation research were completed to establish base knowledge regarding how Tribal councils, programs, and members are building resilience and adapting to extreme weather events caused by current climate change trends. The drought mitigation and planning research was completed to obtain examples of how other areas, such as Tribal nations and states, are identifying drought vulnerabilities within their communities. It was also conducted to see how indigenous nations are using drought mitigation to prepare and alleviate potential threats to their ancestral territories and cultural resources. Land and legal interactions, both historical and current, were examined to better understand the environment Tribal nations must navigate to develop and implement a DAP.

1.7.4 Field Visits

Field visits were made to the Standing Rock Reservation to interview Tribal leaders and closely associated government officials. Interviews with key Tribal program directors, staff, Tribal council, government officials, and Tribal members were scheduled ahead of time, with confirmation calls and reminder emails made the week before appointments. The interviews were primarily conducted in the Tribe's Tribal Administration Building. If interviewees were not able to meet at the designated place, then the project team would accommodate them and meet them wherever was accessible. Field visits provided a working environment with the Standing Rock Sioux Tribe on location. A presentation was given to the Standing Rock Sioux Tribe Water Board to inform them of the work that has been conducted on the Drought Vulnerability Assessment and Drought Adaptation Plans. Information was disseminated to the board and they were asked to respond to surveys pertaining to the vulnerabilities and mitigation strategies specific to the Tribe.

2.0 STANDING ROCK SIOUX TRIBE DROUGHT ASSESSMENT

2.1 Drought Concern

The Standing Rock Sioux Tribe (SRST) often experiences issues with drought and experiences less precipitation than eastern North and South Dakota, as shown in ***Figure 4. Average Annual Precipitation for South Dakota*** and ***Figure 5. Average Annual Precipitation for North Dakota*** The SRST is in the northwest region of South Dakota and southwest region of North Dakota and receives approximately 15-20 inches of precipitation per year.

Figure 4. Average Annual Precipitation for South Dakota

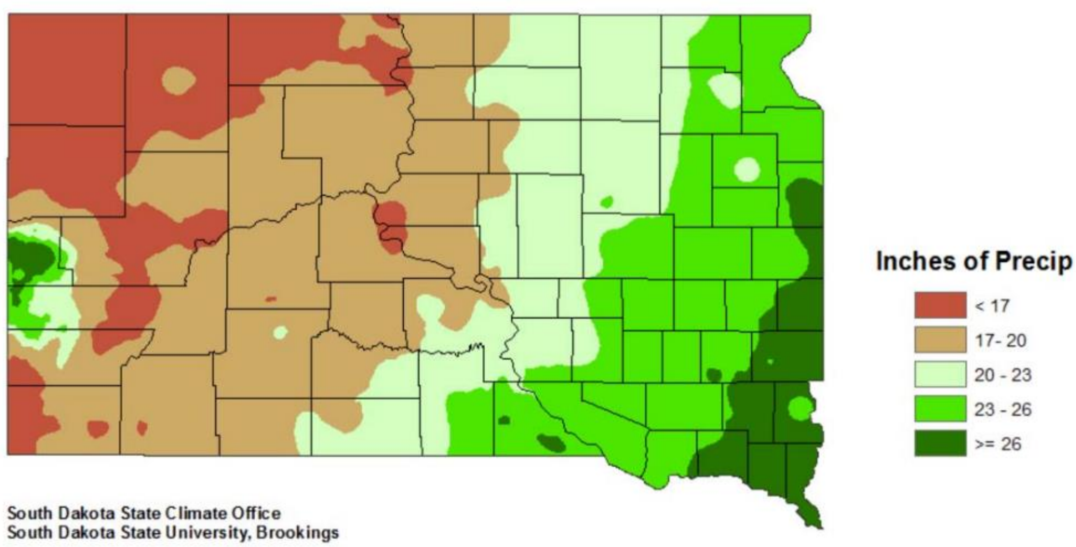
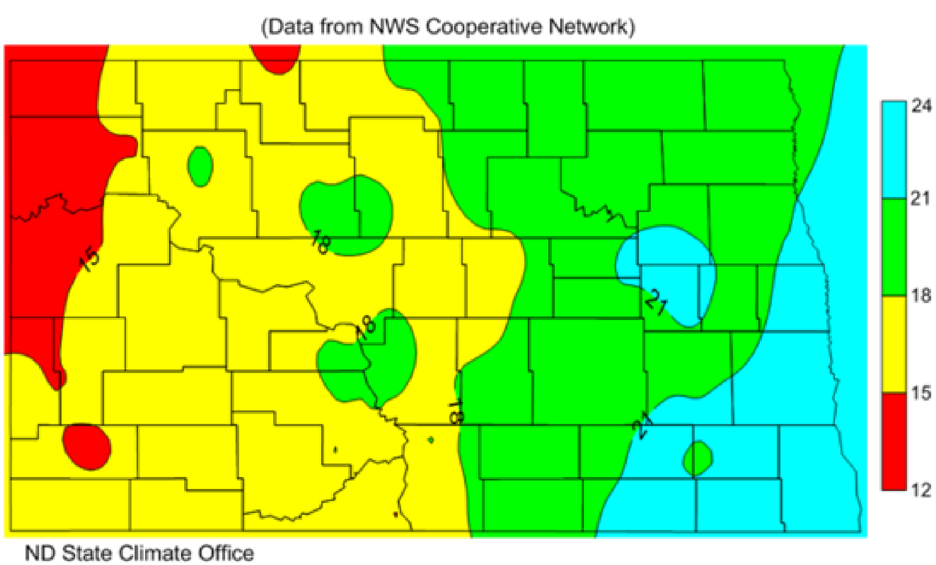
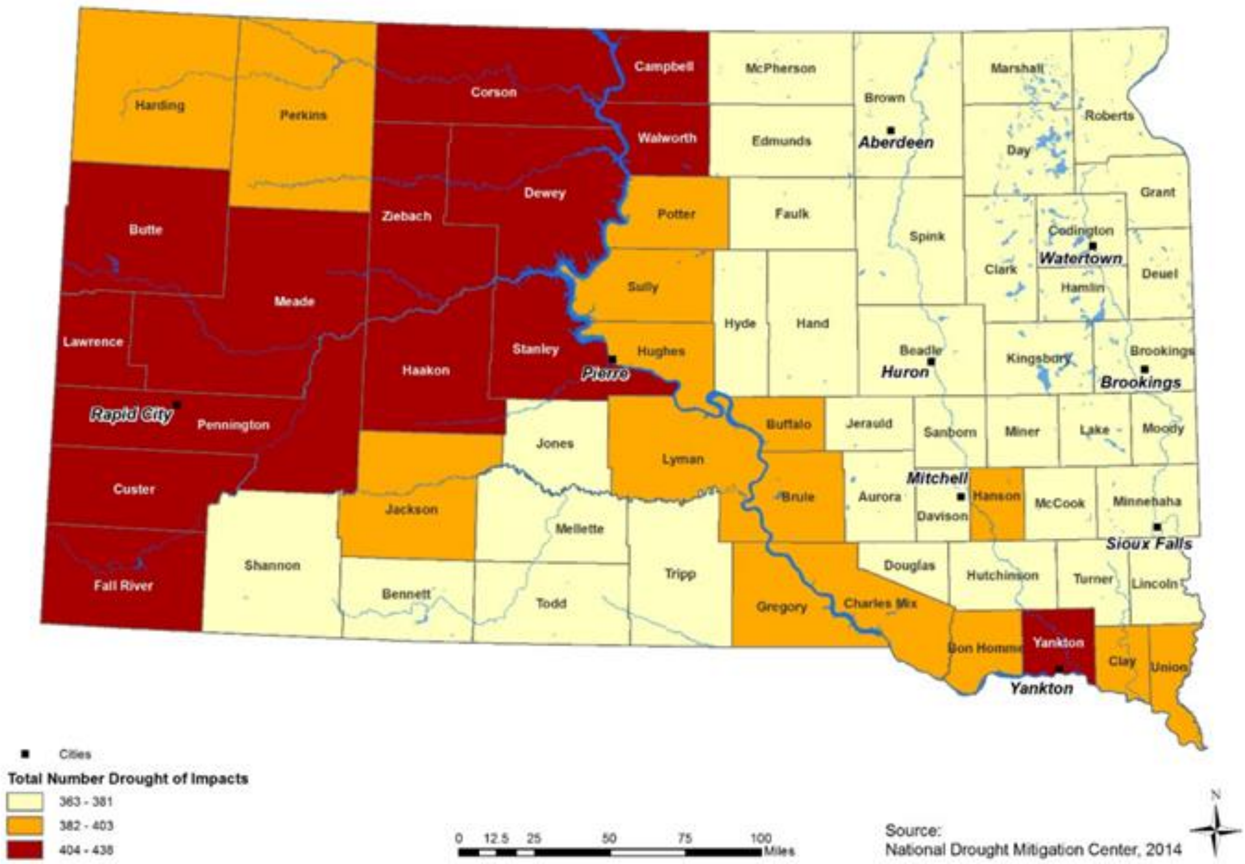


Figure 5. Average Annual Precipitation for North Dakota



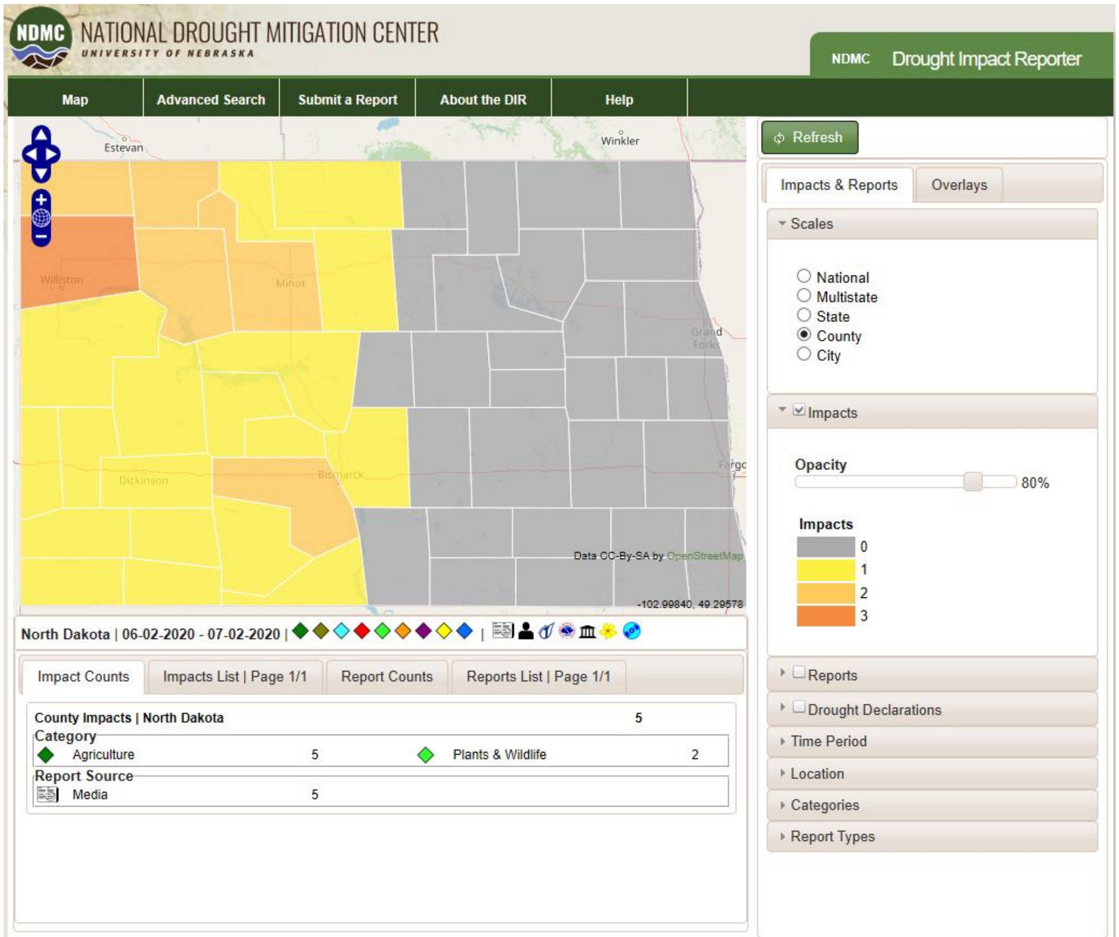
South Dakota's Drought Mitigation Plan also provides a Drought Impact Reporter, shown in ***Figure 6. Drought Impact Reporter For South Dakota.*** The Drought Impact Reporter indicates that Corson County experiences drought more frequently than other areas of the state. As seen in the figure below, there were somewhere between 404 and 438 incidents of drought recorded in Corson County from 1980 to 2015 (National Drought Mitigation Center 2020).

Figure 6. Drought Impact Reporter for South Dakota



A Drought Impact Reporter is also provided for North Dakota. Taken from the online interactive Drought Impact Reporter for North Dakota, ***Figure 7. Drought Impact Reporter for North Dakota*** below depicts information about what types of impacts were recorded for North Dakota. When Sioux County is selected on the online map, the specific county impacts are listed. At the time of the viewing, Sioux County had one reported drought related impact in 2020 (National Drought Mitigation Center 2020). Sioux County was reported to have 21-26 different impacts recorded from the time of May 1, 2006 through May 29, 2020. Surrounding counties such as Adams, Hettinger, Stark, Grant, Morton have all reported much more.

Figure 7. Drought Impact Reporter for North Dakota



2.2 Drought Prediction and Identification

Drought impacts are typically spread over large areas. There are many parameters and indices to choose from when predicting and identifying drought. Some measurable parameters include temperature, precipitation, soil moisture, reservoir/lake levels, streamflow, groundwater, snowpack, snow water equivalent, evapotranspiration, vegetation health/stress, and environmental and socioeconomic impacts. Indices exist that utilize the parameters noted to show the drought's severity. Common indices include the percent of normal precipitation, deciles, Standardized Precipitation Index (SPI/SPEI), Palmer Drought Severity Index (PDSI, SC-PDSI), and Aridity Index. Hydrologic drought indices include the Palmer Hydrological Drought Index (PHDI) and Surface Water Supply Index (SWSI) (World Meteorological Organization & Global Water Partnership, 2016).

Drought indices play an important role in understanding drought for the following reasons:

- Simplify complex relationships and provide good communication tools for diverse audiences/users.
- Provide a quantitative assessment of anomalous climatic conditions: intensity, duration, and spatial extent.
- Provide a historical reference showing the probability of recurrence, assisting in planning and design applications.

It is important to take careful consideration into choosing indicators and triggers for drought. Droughts are very dynamic and are not specific to one indicator. Precipitation alone is only part of the equation when assessing drought conditions. Soil moisture, humidity, and temperature also have a huge impact on drought and can exacerbate drought conditions. Indices, like the PDSI, estimate the movement of water in in the air, ground, and on the surface. However, calibrating a PDSI to a desired location is a process that requires extensive knowledge of soil properties and statistical analysis. Indices, like the PDSI, also come with a lag in data that could be weeks, or even months, meaning that actual notification of a drought may come too late. So, when choosing drought indices or indicators, it is imperative that its risk, lag, and ease of use are all considered.

For drought, it is important to start with creating adaptation plans. Once adaptation plans have been developed, the plan components should be followed and monitored to confirm an early warning system is initiated. Ideally, the early warning system is initiated before the drought occurs. After the drought occurs, an assessment should be done to develop the best response possible. The response initiated will eventually lead to a recovery of the situation. Reconstruction and mitigation follow recovery and allow for better preparation for the next situation. Once the cycle is complete, planning must start again to prepare for the next drought.

2.3 Drought Hazard Profile

A drought hazard profile is a way to analyze the various aspects of drought. For the drought hazard profile of the Standing Rock Sioux Tribe, the history of drought and related impacts were assessed, along with the probability of recurrent drought. Drought history (in the form of drought severity) can be obtained from the United States Drought Monitor (USDM). Drought severity is displayed on a scale of no drought, D0 (Abnormally Dry), D1 (Moderate Drought), D2 (Severe Drought), D3 (Extreme Drought), and D4 (Exceptional Drought). The data are also normalized by the percent area of the selected location that is affected by drought. For the Standing Rock Sioux Tribe, Corson County, South Dakota, and Sioux County, North Dakota were selected. The USDM has been made available on the internet on a weekly basis since January 4, 2000.

Along with the USDM, drought history can also be obtained using a PDSI and SC-PDSI. The PDSI is an effective index at determining long term drought. It uses precipitation, temperature, as well as evaporation and transpiration data to create an index that numerically represents the severity of a drought. However, when this index was created, soil conditions in Kansas and Iowa were utilized, which creates error for other parts of the country. The SC-PDSI corrects for different local conditions so values below -3, which represent extreme drought, occur roughly 10 percent of the time. SC-PDSI data is available for Sioux and Corson County from a period of 1950 to 2017.

Overall, western South Dakota and North Dakota are prone to experience frequent drought, though differing in length and severity depending upon location. Because almost all sectors of the SRST rely on the Missouri River as a water source, drought is an important issue that makes drought preparation and adaptation planning necessary.

2.4 Drought History

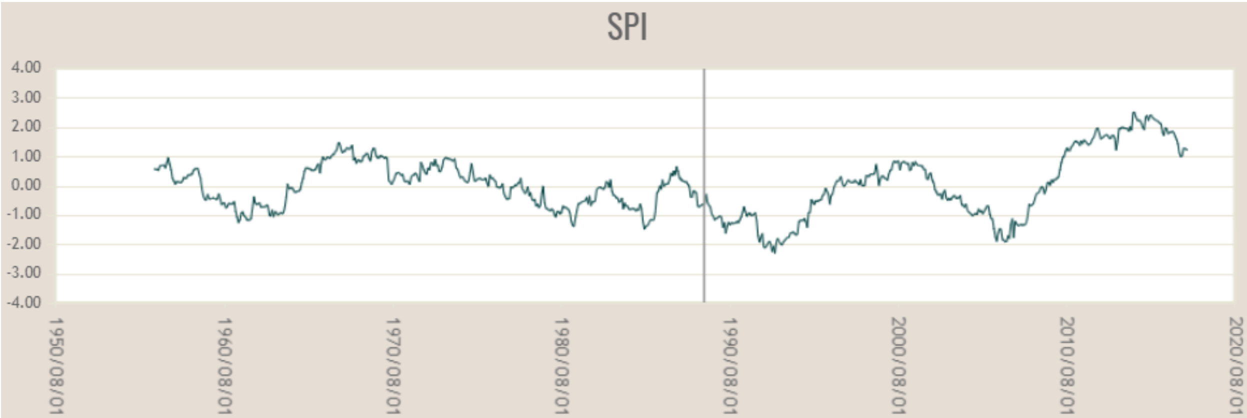
The drought history for the Standing Rock Sioux Tribe has been developed by using the USDM, Drought Risk Atlas' Standardized Precipitation Index, the Drought Impact Reporter, NOAA's Climate at a Glance Precipitation tool, and USGS Stream Gage Station 06357800 on the Grand River at Little Eagle, SD. The data used were from the weather station located in Watauga, North Dakota. Weather stations collect information needed to analyze drought history. ***Table 3. Drought Risk Atlas Station for Watauga, North Dakota*** shows the information from the weather station in Watauga.

Table 3. Drought Risk Atlas Station for Watauga, North Dakota

329219: WATAUGA S DAK 8 N	Latitude: 46.023	Longitude: -101.566
Elevation: 2070 ft.	State: North Dakota	County: Grant
Climate Division: 8	Time Period: 7/25/1950 – 11/1/2017	Years on Record: 67

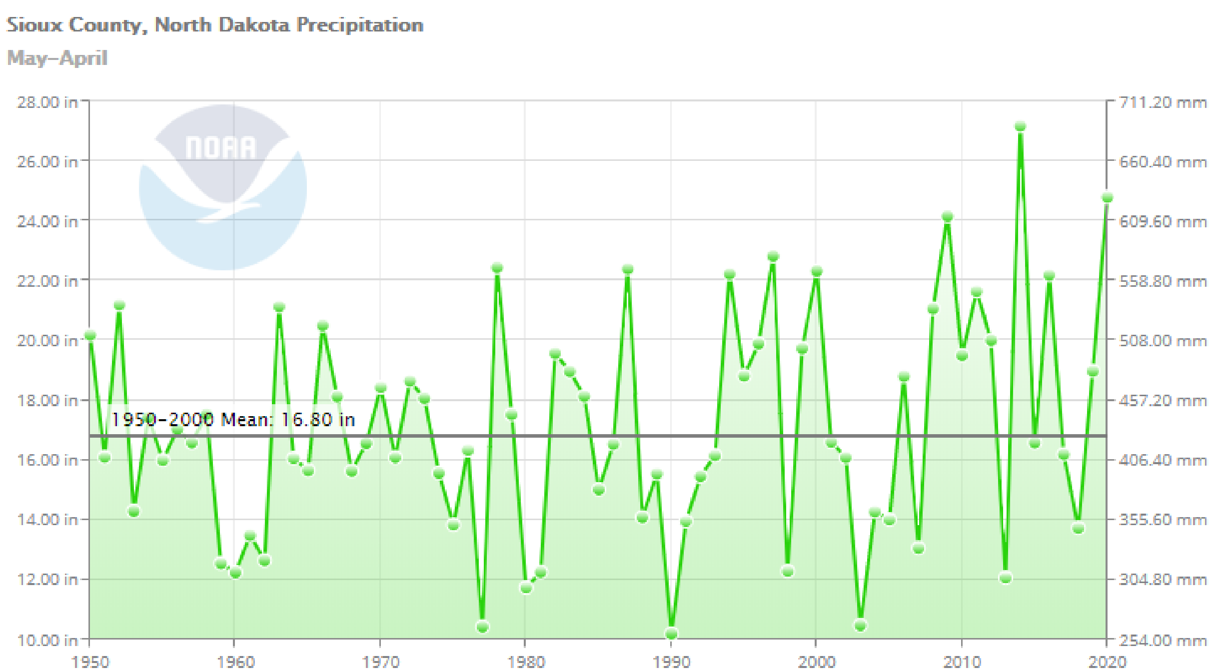
Information collected includes precipitation, temperature, relative humidity, and windspeed. The graph below shows SPI history calculations from 1950 to 2020 for Watauga from the Drought Risk Atlas. The sorting criteria for this was utilizing the period of record with a monthly aggregate filter applied with comparative timestep of 72 months. The aggregate and timestep allow for comparison of current data to the previous 72-months of data. The SPI is a statistical calculation that compares the years precipitation to the statistical average and typically uses a Pearson Type III distribution, comparing changes in standard deviations. Deviation from normal is expected, but the further from zero a number is the more significant that the precipitation recorded during that year is (Keyantash, 2018). SPI will be expanded upon for the Reservation in the respective drought history years below.

Graph 1. Drought Risk Atlas Standardized Precipitation Index (SPI) History for Watauga, North Dakota



NOAA provides a service called Climate at a Glance that allows quick data representation via graphs and tables. ***Graph 2. Sioux County, ND Annual Average Precipitation from 1950-2020*** shows the graphical representation of annual rainfall from 1950-2020 (National Oceanic and Atmospheric Administration, 2020), which will be further discussed in the upcoming drought history sections.

Graph 2. Sioux County, ND Annual Average Precipitation from 1950-2020

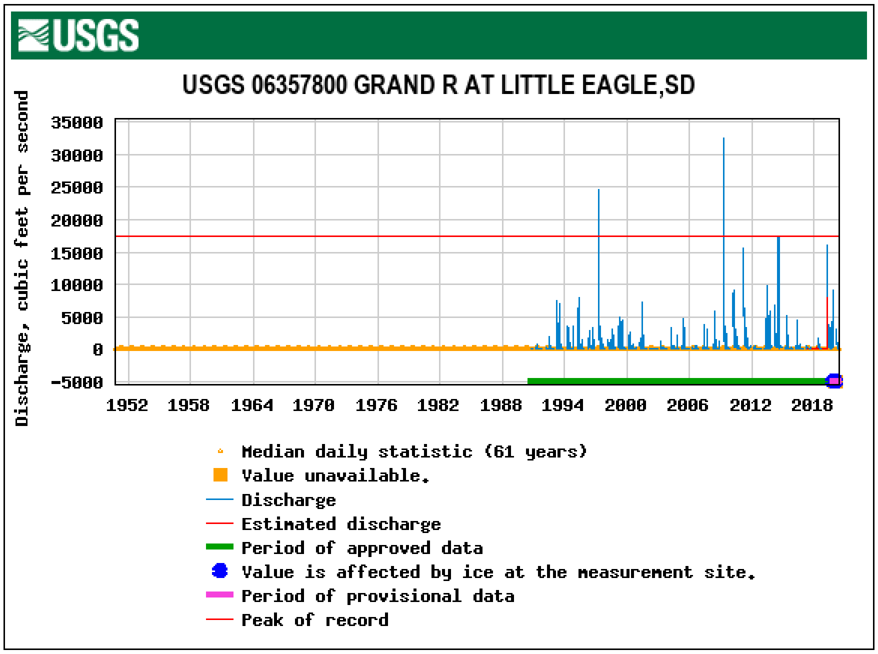


Graph 3. United States Drought Monitor SC-PDSI History for Corson and Sioux Counties shows the USDM percent area statistics for each category of the instances of recorded drought in Corson County, South Dakota, and Sioux County, North Dakota from 2000 to 2019. A description of the drought history from the United States Drought Monitor indicates that Sioux and Corson Counties often experience drought events simultaneously. The graph shows similar percent areas and drought severities between the two counties

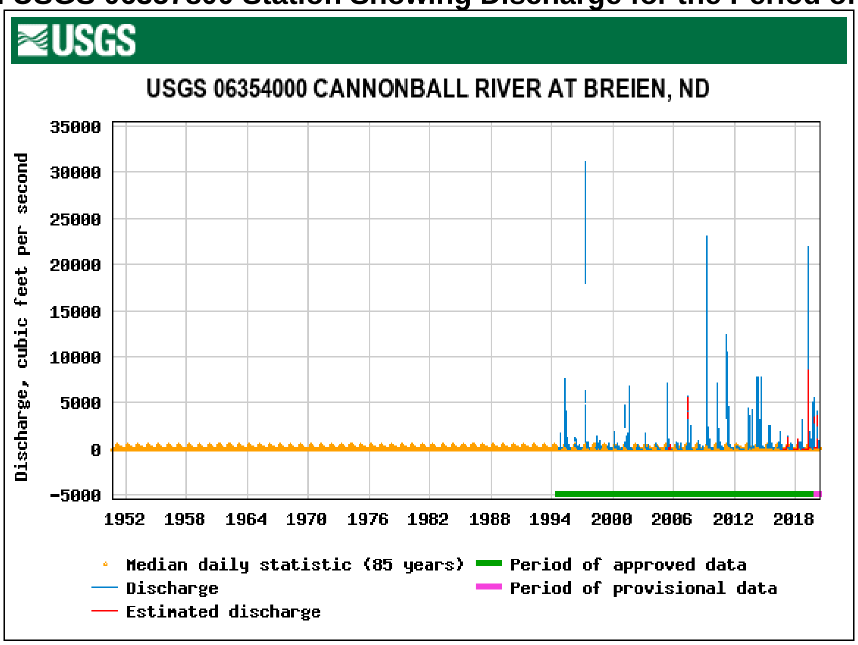
Graph 3. United States Drought Monitor SC-PDSI History for Corson and Sioux Counties

Two USGS gage stations were selected from USGS to represent discharge flows from the two counties of the Reservation. The two stations are shown in Graphs 4 and 5 below. Station 06357800 is located on the Grand River at Little Eagle, South Dakota, and Station 06354000 is located on the Cannonball River at Breien, ND. These stations were selected based upon their period of record. The Little Eagle station began recording data in 1990, and the station at Breien began recording in 1994. These flows will be compared to the droughts to add perspective to their environment.

Graph 4. USGS 06357800 Station Showing Discharge for the Period of Record



Graph 5. USGS 06357800 Station Showing Discharge for the Period of Record.



The primary purpose of the SPI and United States Drought Monitor (USDM) is to provide a means to understand the state of drought in a respective area. These tools utilize most of the contributing factors such as temperature, precipitation, and wind speed. The SPI primarily factors in precipitation, which is a main indicator of drought onset. The USDM is a multi-tiered warning system that notifies residents, departments, and program managers to which level of drought they are currently experiencing. This system performs well when the transition from the different levels of drought is gradual, but does not work well to signify flash drought events.

The following sections will discuss the type of climate that was experienced during respective droughts. For years between 1950-2000 the SPI will be the primary source of reference data. For years between 2000-2019, both USDM and SPI will be used. Droughts will be defined by the SPI as any event that negatively deviates from normal and/or has a marker on the USDM.

Historical drought events in Sioux and Corson Counties have also been documented in the following years:

Drought of 1955–1965- SPI's history of record for the weather station in Watauga, ND began in the 1950s. The SPI utilized the precipitation for the time frame of 1955-1960. Between these years a precipitation drought had begun taking effect, visible on the SPI with a standard deviation of 1.00, trending down, and reaching -1.00 in 1960. The SPI maintained -1.00 for a short period but quickly began ascending to 1.00 in 1965 effectively ending the precipitation drought in the area. During this time frame, comparisons of the SPI and the annual precipitation recorded by NOAA in the graphs above (Graph 2) show less rain received compared to the calculated average of 16.80 inches. In 1965, precipitation began to increase.

Droughts of 1976–1986- Between 1976 and 1986, the area experienced one long drought and a series of smaller droughts. In 1973, the precipitation began decreasing in quantity, showing a decline in the SPI. In 1976, the SPI fell below normal precipitation trends and the area entered the second recorded drought. This trend continued until 1981, with a SPI of approximately -1.22. During this period, the precipitation graph above (Graph 2) shows that moisture was variable from year to year. In 1976 the amount of moisture received was just above 10-inches; only 6-inches below the average. In the following year, the area experienced a significant increase in precipitation with over 22-inches of rain. Following this rise, the area experienced significantly less moisture over the following years, receiving approximately 12-inches of precipitation in each year. The area fluctuated in and out of two separate short-term droughts through 1981-1986 with another drought event occurring two years later.

Drought of 1988–1996- Beginning in 1988, the SPI had recorded a value of just under 1.00 and began descending, reaching -1.50 in 1989. For a short time, the area began experiencing more precipitation, but the SPI only recorded a rise to -0.75, which descended to -2.35 in 1993. This SPI reading is the lowest reading in the 43-year history of the area. Starting in 1993, the SPI began trending upward, reaching a normal level in 1996.

Drought of Early 2000- Although the SPI peaked at a value of 1.00, indicating adequate precipitation levels in the area, data from the USDM indicated that 100-percent of both Corson County and Sioux County began the year in an abnormally dry (D0) period. The year 2000 is the starting period of record for the USDM and when compared to SPI data, the USDM shows the likelihood of dry conditions in the late fall and early winter of 1999, which started the year 2000 in an abnormally dry status.

Drought of 2002–2008- This drought event had a recorded SPI of -2.00. Emergency programs were developed by the State of South Dakota, including the Drought Relief Hay Exchange. The exchange was developed to help farmers in need of hay locate farmers with available hay and accepted hay listings from across the state. The USDM ranked conditions as extreme drought

(D4), and the USGS stream gages verified low stream flows. NOAA's Climate at a Glance graph (Graph 2) also displays that precipitation decreased below normal to just over 10-inches of accumulation during this time.

During 2002, fireworks were banned over the Fourth of July weekend for much of western South Dakota because of the danger for drought-induced wildfires across the region. Also in 2002, Governor Bill Janklow requested a drought disaster designation for all but two South Dakota Counties, which created low-interest emergency loan opportunities for South Dakota farmers and ranchers affected by continued drought conditions (Plain Talk, 2002). USDA Secretary Mike Johanns declared a disaster for 24 counties in South Dakota because of drought, frost, high winds, insect damage, and hail. As a result, farmers and ranchers in those counties were eligible for low-interest emergency loans. In addition, 24 adjoining counties also qualified for relief. South Dakota received $4.3 million from the Livestock Assistance Grant Program to help producers who lost forage due to drought. Eligible producers that applied for the grant received $3 per head for cattle and about 50 cents per head for sheep (United States Department of Agriculture, 2006).

In 2003, Governor Mike Rounds announced that the USDA designated 55 South Dakota counties as primary or contiguous disaster areas because of persistent drought during 2003. The following counties were designated as primary disaster areas: Beadle, Bennett, Bon Homme, Brule, Buffalo, Butte, Campbell, Charles Mix, Corson, Deuel, Dewey, Grant, Gregory, Haakon, Hamlin, Hand, Harding, Hughes, Hyde, Jackson, Jones, Meade, Mellette, Perkins, Potter, Oglala Lakota, Spink, Stanley, Sully, Todd, Tripp, Walworth and Ziebach. The following counties were included as contiguous disaster areas: Aurora, Brookings, Brown, Clark, Codington, Custer, Day, Douglas, Edmunds, Fall River, Faulk, Hutchinson, Jerauld, Kingsbury, Lawrence, Lyman, McPherson, Miner, Pennington, Roberts, Sanborn, and Yankton.

Drought of 2012–2013- The data from the Drought Impact Reporter aligns directly with the data produced by the USDM and shows the severe, but short drought during 2013. Secondary impacts of this drought included many cattle being sold at auction when water supplies were low, and pastures were bare. The Drought Impact Reporter website showed that Sioux County, ND was in a disaster declaration in 2012. Stream gages indicate that river flows were high in 2011 for both counties, but rapidly declined in 2012.

Entering the 2013 growing season, the U.S. Department of Agriculture began declaring counties as primary and secondary disaster areas related to drought in January. Farmers in affected counties had eight months from the date of the declaration to apply for low-interest emergency loans. Laura Edwards, the State Climatologist, said that much of the southern South Dakota corn crop during these years was affected by drought, leading farmers to cut it for silage. A fall blizzard also caused hardship upon ranchers who were still trying to recover from the drought.

Drought of 2015- The drought of 2015 was mild with a ranking of D1-D2 throughout the duration. This drought minimally registers on the SPI and precipitation graphs, however low flows were observed at the two USGS stream gage sites.

The Drought Impact Reporter attributed many small fires occurring throughout Southwest North Dakota, including Sioux County, to the dry conditions. Additionally, 21 counties in North Dakota were designated as disaster areas, including Sioux County. The declaration had focus points on issues that exacerbated the drought during this time which were specifically effected by frost, a colder than average winter, cooler than normal spring temperatures, excessive rainfall, ground saturation, frost, severe thunderstorms, hail, high winds, and sprout damage (United Stated Department of Agriculture, 2015).

Drought of 2016-2018- In 2017, another severe drought occurred across the Reservation. On Friday June 16, 2017, Governor Dennis Daugaard announced a statewide drought emergency as crops and livestock continued to suffer without enough rain. Governor Daugaard activated the South Dakota Drought Task Force to monitor rapidly developing drought conditions in South Dakota. Task force members monitored drought information relating to agriculture, fire, and water supplies. Ponds and creeks were low, as was grass and crop production. USDA authorized early haying of Conservation Reserve Program acres beginning on July 16, 2017, to help farmers and ranchers in the Dakotas and Montana. Farmers and ranchers in counties experiencing drought severity of D2 or greater on the USDM or within 150 miles of a county in D2 were eligible for early haying. Conservation Reserve Program contract holders who hayed their acreage were able to donate their hay or take a 25 percent loss to their annual Conservation Reserve Program payment if they chose to sell it (United States Department of Agriculture, 2017). Transport restrictions were eased, allowing the movement of oversized loads of hay and feed with proper signage and reflectors. Landowners adjacent to highways were able to mow and bale hay along state highways. (South Dakota State News, 2017).

The sectors that demanded the largest uses of water were firefighting, human consumption, and agriculture. During this time, the Municipal, Industrial and Rural Water System (MR&I) serviced the Reservation and their communities. During the 2017 drought, water use restrictions for Tribal members were implemented for the first time. Restrictions included no watering of lawns, no filling of personal swimming pools, and no connecting directly to the water system for water needed for fire suppression.

2.5 Probability of Future Droughts

The National Climate Assessment of the Northern Great Plains includes Nebraska, South Dakota, North Dakota, Montana, and Wyoming. The basis of the assessment is to analyze current available resources and use modeled projections to determine what will happen to those resources over the next half century. The assessment is analyzed in various sections: water, agriculture, recreation and tourism, energy, as well as indigenous peoples. These analyses discuss the increased probability of extreme events, like flooding and drought, through 2050 (National Climate Assessment, 2014).

The National Climate Assessment states that changes in precipitation in the winter and spring months will have an impact on the current climate. In the winter and spring, more precipitation is projected, with an increase in extreme events in both volume and intensity. In the summer, no change precipitation is projected. Agriculturally, the growing season will be extended, and spring will begin earlier. However, higher temperatures are also projected for the region and more extreme daytime highs and nighttime lows will stress crops. Increased temperatures will result in higher evaporative demand, which is a measure of how thirsty the atmosphere is. This increase will result in more frequent drought and heatwaves across the region, which will reduce crop yields and quality of livestock forage. Additionally, increased temperatures will increase the range of pests within the region (National Climate Assessment, 2014).

The key message of the assessment is that rising temperatures are leading to increased demand for water and energy. In parts of the region, this increase in temperatures is expected to constrain development, stress natural resources, and increase competition for water among communities, agriculture, energy production, and ecological needs. Changes to crop growth cycles due to warmer winters, and alterations in the timing and magnitude of rainfall events have already been observed; as these trends continue, they will require new agriculture and livestock management practices.

Additionally, landscape fragmentation is increasing in the context of energy development activities in the northern Great Plains. A highly fragmented landscape will hinder adaptation of species as climate change alters habitat composition and timing of plant development cycles. Communities that are already the most vulnerable to weather and climate extremes will be stressed even further by more frequent extreme events occurring within an already highly variable climate system (National Climate Assessment, 2014).

The magnitude of expected changes will exceed those experienced in the last century, resulting increased strain on available water resources. This strain may signal increased competition for communities struggling to meet water demand. Existing adaptation and planning efforts are often inadequate to respond to these projected impacts. Although projections suggest more frequent and more intense droughts, heavy downpours, and heat waves, people can reduce vulnerabilities with new technologies, community-driven policies, and the judicious use of resources. Changing extremes in precipitation are projected across all seasons, including higher likelihoods of both increasing heavy rain and snow events and more intense droughts. Winter and spring precipitation and heavy downpours are both projected to increase in the north, leading to increased runoff and flooding that will reduce water quality and erode soils (National Climate Assessment, 2014).

Projected climate change will have both negative and positive consequences for agricultural productivity in the Northern Plains. Increases in winter and spring precipitation will benefit productivity by increasing water availability through soil moisture reserves during the early growing season; however, this can be offset by fields too wet to plant. Also, rising temperatures will lengthen the growing season, possibly allowing a second annual crop when and where feasible. A goal of planning will be to capitalize on positive aspects and minimize negative impacts of future climate variability.

3.0 DROUGHT VULNERABILITY ANALYSIS

The vulnerability, or risk, of a society to drought may be defined generally as the extent to which it will be affected by periods of natural water shortages. The DVA that was previously completed determined the drought vulnerabilities specific to Standing Rock Sioux Tribe (SRST). The DVA utilized a division of vulnerabilities regarding the following sectors: Legal Rights and Infringements, Tribal Lifeways, Water, Land, Wildlife, Agriculture, Public Health, and Data Monitoring. This information from the DVA and further coordination completed for this project was utilized to analyze the existing water sources and uses of water by the SRST. The following sections further discuss the water sources for the SRST and water uses of the SRST. This analysis is followed by the determination of the main drought vulnerabilities for the SRST. The drought risk for these water sources and corresponding water uses are summarized in ***Table 4. Drought Risk by Water Use Sector***.

3.1 Water Sources

The Standing Rock Rural Water System (SRRWS) was funded by the American Recovery Act in 2009 for the residents of the Reservation. Two intake valves for drinking water are utilized. One of the intake valves is in the shallow part of the Missouri River near Fort Yates, North Dakota, a location which causes issues with water supply. The second intake was brought online in 2016 to address the water supply issue and is located in Mobridge, South Dakota (Hurley, 2018). The SRRWS Water Treatment Plant, located approximately 14 miles north of the City of Mobridge, South Dakota along SD 1806, pumps raw water from Lake Oahe and treats the water to US EPA regulatory standards. The Fort Yates Water Treatment Plant (FYWTP), located on the east side of the community of Fort Yates, pumps raw water from Missouri River and treats the water to US EPA regulatory standards. Both surface water plants have flocculators, sedimentation basins, and multi-media filters. Following the treatment process, the finished water is injected with chlorine and fluoride prior to pumping to the distribution system (Bailey, 2017).

Photo 4. *Water Tower; Part of SRRWS*

Construction of the Oahe Dam started in 1948, reached full completion height in 1959, and was dedicated in 1962 (Gevik 2015). The United States Army Corps of Engineers (USACE) controls the flow of the upper Missouri River Basin through a series of dams, including the Oahe Dam. The SRST is dependent on the variable flow of the river, which has water levels that can fluctuate as much as thirty feet. In 2003, due to the low water level in the river, the water intake for the SRST was above the water's surface, creating issues in pumping water from the Missouri River. The intake at the Missouri River is at risk for sedimentation, movement, and build-up inside pipes, which can at times inhibit the ability of the intake to pull in water (Crow Ghost, 2017).

For groundwater on the Reservation, the possibility of obtaining adequate supplies of good quality water from surficial deposits generally is limited to three potential sources. These include either bedrock formations overlying the Pierre Shale, having a total thickness of at least 150 feet, four buried glacial valleys in eastern Sioux County, or alluvium along Cedar Creek and the Cannonball and Missouri Rivers. In a few places, adequate supplies of stock or domestic water may be found in alluvium along the Grand River and in terraces (USGS 2004).

The main surface water sources on the Reservation include the Missouri River, Grand River, and Porcupine River. The Missouri River runs north to south on the eastern boundary of the Reservation. The Grand River runs west to east and enters the Missouri River north of Mobridge. This segment of the Missouri River from North Dakota border to Oahe Dam does not meet the SD Department of Environment and Natural Resources (SDDENR) beneficial uses of cold water permanent fish life and fish and wildlife propagation (SDDENR 2020). Additional surface water sources include numerous impoundments and dugouts, which catch seasonal runoff and snow melt (Standing Rock Sioux Tribe, 2020).

3.2 Water Uses

3.2.1 Domestic and Municipal

The SRRWS provides water to approximately 10,000 residents of the Reservation (Scheyder 2016). During the drought of 2017, the Tribe implemented water use restrictions on Tribal members. Primary restrictions were enacted by restricting watering of lawns and the use of water for filling personal swimming pools. Responding fire departments were to not directly connect to the rural water system, and instead obtain water from nearby stock dams (Hodgekiss, 2017). The amount of water taken from the stock dams was measured, and the volunteer fire department was responsible for replenishing the amount of water used. Implementing stock dams as a reliable water supply to fight fires became a safety issue for residents as there might not be a stock dam or other reliable water supply in proximity.

3.2.2 Tribal Lifeways

The Tribal lifeways of the SRST include the practice of subsistence living, such as burning firewood for heat and using natural resources for food, ceremonies, arts and crafts, and barter systems. Tribal members have noticed a change in the traditional plants that are harvested in drought years. Invasive plant species are increasing under drought conditions, leading to the decrease of native plant species.

Native plants seem to be moving further north to evade the higher temperatures and dry conditions (Black Elk 2017). Timpsula (*Pediomelum esculenta*), also known as large breadroot in the area was observed growing at the end of May in 2017, but at the time of harvest was already dried out due to the drought conditions. It is believed that the plants and animals harvested during the drought of 2017 were significantly smaller compared to a non-drought year due to the lack of quality grass (Black Elk, 2017). During periods of drought, the quality of meat decreases and may even taste different due to the available food sources (Archambault 2017). It was observed that pest populations also increased during a drought, which decreased the number of chokecherries and buffalo berries (Black Elk 2017).

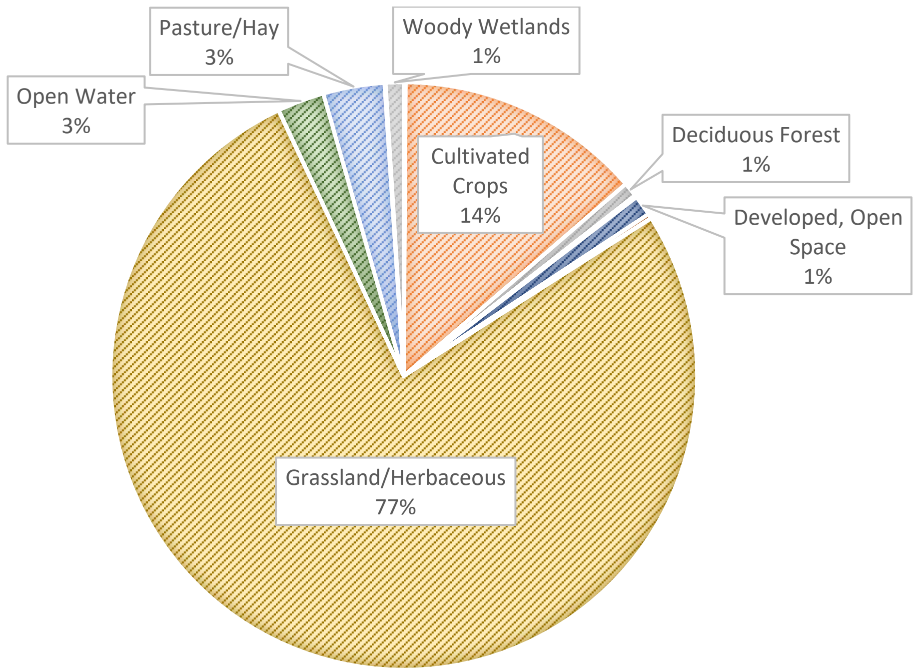
Photo 5. *Timpsula*

In the past, Tribal Elders were very active in the realm of gardening, but the population of Elders has decreased over time. During droughts, the ground is too hard to till, decreasing the amount of gardening on the Reservation. During drought years, more food is supplied from sources outside of the Reservation than what can be provided within the Reservation (Archambault Sr., 2017) (Black Elk, 2017).

3.2.3 Agriculture

The Reservation is primarily composed of herbaceous grassland and cultivated cropland. ***Graph 6. Land Use on the Reservation*** below shows a complete breakdown of the land cover from the National Land Cover Database (USGS 2020). From a historical perspective, it is believed by the Tribal members that the timing of the seasons has changed. The seasons have seemed to shift earlier by two weeks when compared to historical season changes. Tribal members believe that drought usually occurs on the Reservation every 7 years and lasts for a longer period (Archambault Sr., 2017, and Black Elk, 2017). These drought occurrences have affected plant growth and land quality.

Graph 6. Breakdown of Land Use on the Reservation



Numerous earth dams ranging in size from 3 acre-feet to approximately 300 acre-feet are the primary water source for livestock. In addition, an intake from the Missouri River is utilized for just agricultural purposes (Crow Ghost 2020). Shallow groundwater is not obtainable on much of the Standing Rock Indian Reservation, and where it is found, it is often of poor quality. Surface water, with the exception of the Missouri and Cannonball Rivers, though valuable and widely distributed resources, are undependable because of scanty and erratic precipitation. Artesian water from deeply buried bedrock aquifers underlies the entire Reservation. These aquifers are not, and probably will not become highly developed sources of water because of the high-to-very-high salinity of artesian water in most of the area (Standing Rock Sioux Tribe, 2020).

Surface water sources must be replenished by rain events and, if not replenished, ranchers must haul water to pastures for livestock consumption. During drought and drought-like conditions, there is a decrease in rainfall events and ranchers must purchase hay to supplement livestock food sources. In the case of extreme drought, ranchers may need to sell cattle to reduce the overall strain on pastures.

3.2.4 Fish and Wildlife/Recreation

Some of the big game animal species native to the Reservation include elk, mule and white-tailed deer, buffalo, wild turkeys, and antelope. Small game animal species include pheasants, prairie grouse, geese, prairie dog, and coyote. Fish species on the Reservation include minnows, trout, bass, crappie, walleye, perch, and paddlefish.

During drought on the Reservation, there is not as much stagnant water around, so there are significantly less insects such as butterflies and bees. There is also concern that on the

Reservation, fire flies are no longer seen very often (Archambault Sr., 2017). One of the primary issues during drought is the lack of resources to be utilized by both people and animal life. Animals rely on surrounding water sources as well as vegetation and other animals. When the ecosystem is strained, animals and vegetation do not grow to their full potential. For people who utilize animals as sustenance, adequate food sources for themselves and family members become concerning throughout a drought event. Lack of food causes malnourished animals, defects amongst young of the year animals, and animals unable to grow to full maturity later in life (Archambault Sr., 2017).

Drought impacts to wildlife on the reservation include Epizootic Hemorrhagic Disease (EHD) and bluetongue (BVD) in wildlife populations, increasing abundance of nonnative plants, reduced forage production and impacts to wildlife and buffalo, fire, plague in prairie dog towns, and degraded water quality leading to reduced fish populations. Additionally, mild winters may be increasing the risk of EHD and Bluetongue (Kelly, 2017). Drought alters plant communities and increases the abundance of non-native and invasive plant species to the detriment of environmentally and culturally significant plants. Drought also reduces plant growth, reducing forage production available to wildlife, buffalo, and livestock. Lower forage production often leads to buffalo and cattle sales, which reduce producer's incomes.

Invasive plants are an issue throughout the reservation. During drought, native plants struggle to absorb enough water to sustain themselves, while invasive species are often heartier in times of drought. On the Reservation, people have noticed that native plants are becoming more difficult to find. When found, native plants tend to be drastically smaller and less healthy than what they typically are. Invasive plants are a major issue for the reservation as they may outcompete and prevent culturally significant plants from growing.

South Dakota Department of Game, Fish and Parks (SDGFP) also manages fish and wildlife across South Dakota. The west river fishery management plan notes issues including 1) aging impoundments have decreased the ability to support fisheries, 2) remote locations mean habitat projects may be low statewide priority, 3) a lack of information on angler use and management preferences hinders management, and 4) angler access to larger western Missouri River tributaries is insufficient. The priority objectives in the plan noted improving angling access on small dams and to completely renovate one small dam (SDGFP 2020).

3.2.5 Fire Suppression

The Standing Rock Sioux Tribe believes that fire is a natural and necessary tool for renewal and rebirth of the earth. Fire plays an important role in nature, creating a healthier environment (Archambault Sr. 2017). Fires are occurring less often but are much more intense, resulting in more damage, requiring more resources to extinguish, and causing more economical strain (Hodgekiss 2017).

The Standing Rock Sioux Tribe (SRST) does not have their own structural fire department or structural fire trained team, but they have developed relationships with Volunteer Fire Departments in and around the Reservation (Hodgekiss, 2017). Although SRST is looking to increase their capacity to respond to structural fires by creating their own fire department, a Tribal fire department remains in the beginning phases of development. During the drought of 2017, a burn ban was implemented that prohibited BIA Fire from performing controlled burns, and this ban also prohibited the use of fireworks. In times of drought, the threat of wildland fires increases due to dry vegetation. Historically recorded years for high numbers of fire events were in 1988, 1990, 1991, 2002, 2006, and 2012 (Hodgekiss, 2017). ***Table 4: Drought Risk Assessment by Resource Sector*** shows the drought risks for various aspects of reservation, including fire suppression.

Table 4. Drought Risk Assessment by Resource Sector

Surface Water Supply	Groundwater Supply	Water Management	Drought Risk
Domestic and Municipal			
SRRWS utilizes Missouri River as water source. Two intake valves, one by Fort Yates, North Dakota and one by Mobridge, South Dakota (Standing Rock Sioux Tribe, 2020).	Groundwater not as abundant on the Reservation and where available is at a small scale (Standing Rock Sioux Tribe 2020).	SRRWS manages the water system.	**LOW RISK for quantity- one water source but source quantity appears to be reliable.** **HIGH RISK- Quality is a concern due to oil pipelines and other potential sources of pollution. If the Missouri River is affected, the groundwater cannot be relied upon due to quality.**
Tribal Lifeways			
Surface waters and precipitation provide water source to traditional plant communities. **Surface water provides water source to buffalo herds.**	N/A	SRST manages the water source to the buffalo herd.	**HIGH RISK- Droughts could affect the traditional plant community survival and cause concerns for water source to the buffalo herds. Drought can affect cultural resource sites.**
Agriculture			

Surface Water Supply	Groundwater Supply	Water Management	Drought Risk
Surface water in small streams, lakes, and dugouts are scattered throughout the area (Standing Rock Sioux Tribe 2020).	Shallow groundwater is scarce and unreliable. Deep groundwater is more plentiful but is highly mineralized and of poor quality (Standing Rock Sioux Tribe 2020).	Managed by individual ranchers.	**MEDIUM RISK for quantity- surface water is unreliable year-round supply and generally available only during wet periods in normal conditions.** **MEDIUM RISK- The quality if the groundwater makes it difficult to utilize and during drought would be difficult to use as an alternative source.**
Fish and Wildlife/Recreation			
Rivers, tributaries, lakes, stock ponds, oxbows and wetlands in the area.	N/A	Managed by SRST Game and Fish	**LOW RISK- water quantity is not as large of a concern with the surface water resources present.**
Fire Suppression			
Pull surface water when possible from stock dams during large fires.	N/A	Fire departments are managed by communities with volunteer departments. BIA is a non-structure fire department.	**HIGH RISK- Structural fire departments are no present on the Reservation and in some communities the department present does not have jurisdiction to fight structure fires for tribal housing.**

3.3 Priority Drought Vulnerabilities

Drought vulnerabilities were identified in the previous DVA. The results of the responses specify the rank of severity of the vulnerability; the lower scores represented the greatest vulnerabilities. In addition to this ranking process of the previous vulnerabilities, additional coordination occurred during the finalization of this report with the Technical Team of the Tribe. The information previously gathered in the DVA, research, and coordination for this project identified the following drought adaptation strategies. Although the priorities are numbered, each one represents an important priority and mitigation actions are recommended to achieve each one.

3.3.1 Vulnerability #1: Contamination of Water Source

Due to there being only one water source present on the Reservation, a major vulnerability of the water system is potential pollution to an extent that would render the source unusable for drinking water. The segment of the Missouri River at the SRRWS intake location is currently not meeting all the beneficial uses assigned to this reach of the Missouri River. According to the 2020 SDDENR Integrated Report for Surface Water Quality Assessment, the beneficial uses assigned to the section of the Missouri River from the North Dakota Border to Lake Oahe include domestic water supply, coldwater permanent fish life, immersion recreation, limited contact recreation, fish and wildlife propagation, recreation, and stock, irrigation waters, and commerce/industry. Currently, the requirements not being met for fish and wildlife propagation, recreation, and stock watering due to high levels of mercury found in fish tissue. The beneficial use requirements for coldwater permanent fish life use are also not consistently met. A significant temperature-depth gradient occurs on Lake Oahe in the near-dam (Pierre, SD) lacustrine area during summer months. This results in the development of a strong thermocline approximately 20-25 meters below the surface, with the longitudinal extent of the coldwater habitat dependent upon pool elevation and thermocline depth. The shallower upper reaches of the reservoir are well-mixed by late summer and do not display significant variations in temperature, however, still may provide some coldwater habitat based on pool elevation (SDDENR 2020).

Pipeline crossings of the Missouri River cause a potential threat to the water system, as pipeline leaks would affect the Reservation's drinking water supply which relies solely on the Missouri River. Groundwater sources are scarce and would not be able to provide an alternative drinking water source. In addition, the Standing Rock Sioux Tribe also has an intake on the Missouri River for agricultural purposes, and not being able to utilize this as a reliable source would have major effects to the Reservation's economy.

During times of drought, a pipeline leak could be exacerbated by a potentially reduced water resource. If the water source were to be disrupted and storage reservoirs were utilized until empty, most of the Reservation would be without water. Awareness of ways to prevent contamination from urban areas and agricultural practices will need to be a focus to preserve the water sources on the Reservation.

3.3.2 Vulnerability #2: Water Use Conservation and Reliable Infrastructure

The fluctuation of the water levels due to the Missouri River dam operations can cause issues for the SRRWS intakes. The intakes can be in shallow water, creating issues for adequately obtaining water, or the intakes can become blocked with sediment. These issues can affect the reliability of the existing infrastructure available for delivery of a consistent water source to the Tribe.

During times of drought, volunteer and non-volunteer restrictions may also need to be implemented. For example, in June 2020 the Standing Rock Sioux Tribe has a current burn ban due to drought conditions (Standing Rock Sioux Tribe 2020). Broad support of Tribal members to enact volunteer water use conservation practices and restrictions is essential. Education before drought can help deliver the message and prepare the Tribe for those times.

3.3.3 Vulnerability #3: Agricultural Practices

The Tribe depends on land leases for a large portion of its economy. Primarily the leases on land are for ranching. As of 2017, the Tribe does not have a required pre-mitigation plan for the lessees to follow during times of drought or resource hardship.

3.3.4 Vulnerability #4: Fire Protection

Non-structural fire protection is provided by the BIA and does not cover structural fire protection. In some cases, community volunteer fire departments that have structural fire training are not able to respond to structure fires in tribal housing. The Reservation lacks sufficient structural fire department response for all structural fires. Some agreements exist that allow fire departments to draw water from private dugouts or surface waters, but additional water sources, especially in times of drought, should be identified for fire departments, and agreements put in place for water use in firefighting.

3.3.5 Vulnerability #5: Preservation of Traditional Plants

Traditional plants are utilized for ceremonial and medicinal uses and are significant to the Tribe. The use and preservation of the plants needs to be considered as drought will affect the growth including inhibiting and stunting the growth of these plants.

4.0 DROUGHT MONITORING AND RESPONSE ACTIONS

Incorporating the science of drought and climate is an essential element of preparations for drought and adapting to its effects. NOAA and its affiliates, USGS, and other Federal agencies have taken a lead role in developing indicators that when used individually or combined provide early warning and current conditions for decisionmakers.

There are various methods and indices that track current drought conditions across the country. Many include different variables, like precipitation, soil moisture, and humidity. For Standing Rock Sioux Tribe, two monitoring indices will be reviewed for utilization, the U.S. Drought Monitor (USDM) and the Evaporation Demand Drought Index (EDDI). Each of these were developed using other indices. It is recommended that Standing Rock Sioux Tribe continue to expand their capabilities to obtain their own data and analyze it to tailor drought monitoring for the use of Tribal leadership.

4.1 Drought Monitoring

4.1.1 United States Drought Monitor (USDM)

The USDM is a semi-objective drought index that brings together several experts from the National Drought Mitigation Center, National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, and the National Integrated Drought Information System. Using a variety of different tools, including indices like the PDSI, they determine current drought conditions throughout the U.S. There are five levels of intensity to which they classify: D0 (abnormally dry), D1 (moderate drought), D2 (severe drought), D3 (extreme drought), and D4 (exceptional drought). These levels of drought intensity are further explained below in ***Table 5. Drought Severity Classifications***.

Some of the inputs into the USDM can be standalone indicators or combined to provide indicators for the USDM, including blended indicators. The inputs are as follows:

Palmer Drought Severity Index (PDSI)--calculated using monthly temperature and precipitation data along with information on the water-holding capacity of soils. It considers moisture received (precipitation) as well as moisture stored in the soil, accounting for the potential loss of moisture due to temperature influences (IDMP, 2020).

Climate Prediction Center—Soil Moisture (CPC Soil)—the CPC has developed a soil moisture tool for the next two weeks based on the National Weather Service Global Forecast System (GFS) model. Seasonal tools are based on the Constructed Analog on Soil Moisture (CAS) (National Weather Service, 2020).

U. S. Geological Survey Weekly Streamflow (USGS Weekly Streamflow)—reports in real-time the percentile of stream flow in key rivers/streams (USGS 2020).

<u>*Standardized Precipitation Index (SPI)*</u>—uses historical precipitation records for any location to develop a probability of precipitation that can be computed at any number of timescales, from 1 month to 48 months or longer. As with other climatic indicators, the time series of data used to calculate SPI does not need to be of a specific length. Guttman (1998, 1999) noted that if additional data are present in a long time series, the results of the probability distribution will be more robust because more samples of extreme wet and extreme dry events are included. SPI can be calculated on as little as 20 years' worth of data, but ideally the time series should have a minimum of 30 years of data.

SPI has an intensity scale in which both positive and negative values are calculated, which correlate directly to wet and dry events. For drought, there is great interest in the 'tails' of the precipitation distribution, and especially in the extreme dry events, which are the events considered to be rare based upon the climate of the region being investigated (IDMP, 2020).

<u>*Objective Drought Indicator Blends (Percentiles)*</u>—the Climate Prediction Center has been working on an experimental blend of indicators to develop short-term and long-term predictions (CPC, 2020). Sample maps of the United States showing both a short-term blend and long-term blend of drought indicators are shown in ***Figure 8. CPC Experimental Objective Short-Term Blend of Drought Indicators*** and ***Figure 9. CPC Experimental Objective Long-Term Blend of Drought Indicators***.

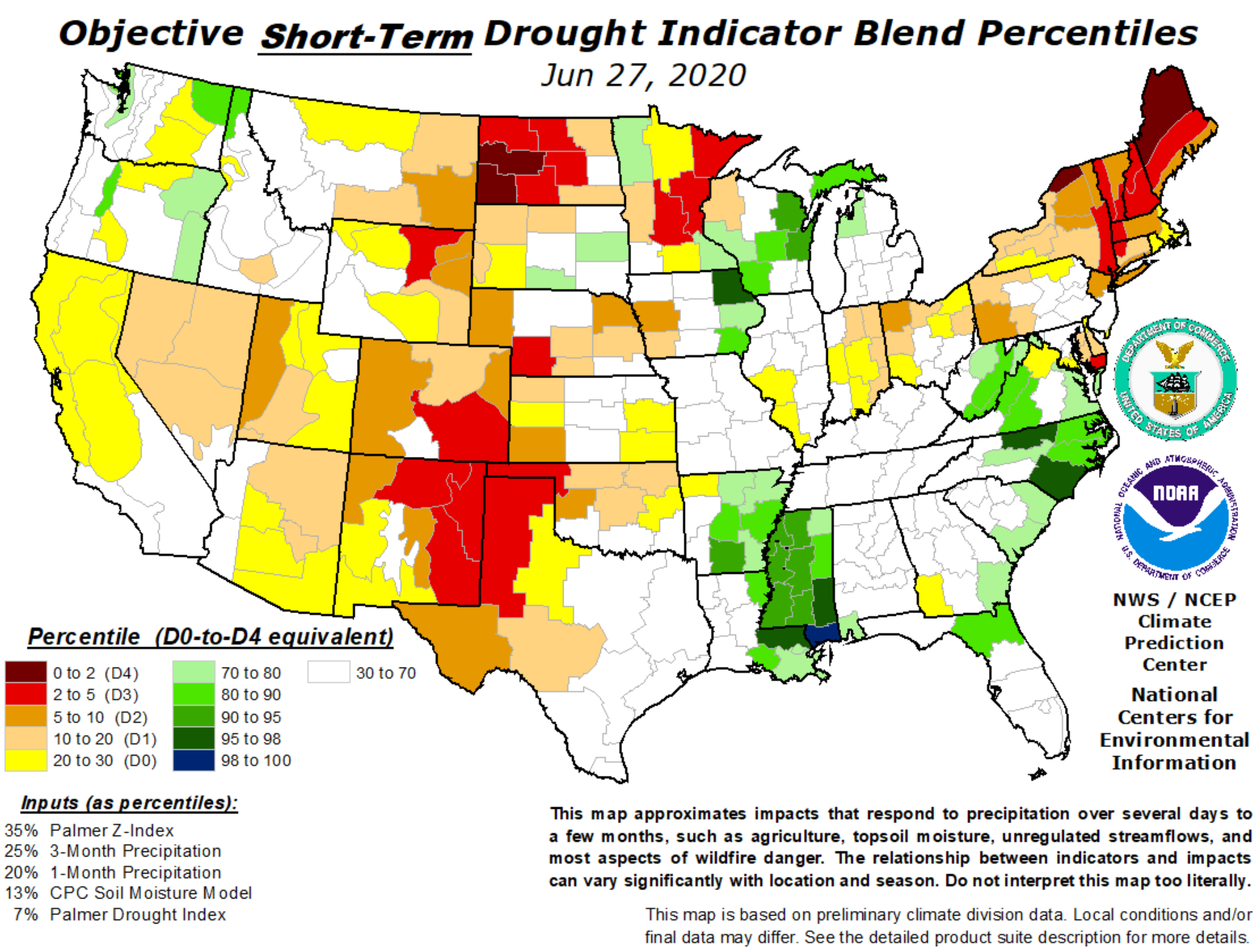
- The Short-Term Blend approximates drought-related impacts that respond to precipitation (and secondarily other factors) on time scales ranging from a few days to a few months, such as wildfire danger, non-irrigated agriculture, topsoil moisture, range and pasture conditions, and unregulated stream flows. The short-term inputs as a percentage include 35% Palmer Z-Index, 25% 3-Month Precipitation, 20% 1-Month Precipitation, 13% CPC Soil Moisture Model, and 7% Palmer Drought Index.
- The Long-Term Blend approximates drought-related impacts that respond to precipitation on time scales ranging from several months to a few years, such as reservoir stores, irrigated agriculture, groundwater levels, and well water depth. The long-term inputs as a percentage include 25% Palmer Hydrologic Index, 20% 24-Month Precipitation, 20% 12-Month Precipitation, 15% 6-Month Precipitation, 10% 60-Month Precipitation, and 10% CPC Soil Moisture Model.

Table 5. Drought Severity Classifications

Category	Description	Possible Impacts	Palmer Drought Severity Index (PDSI)	CPC Soil	USGS Weekly Streamflow	Standardized Precipitation Index (SPI)	Objective Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures coming out of drought some lingering water deficits pastures or crops not fully recovered	-1.0 to -1.9	21 to 30	21 to 30	-0.5 to -0.7	21 to 30
D1	Moderate Drought	Some damage to crops, pastures Streams, reservoirs, or wells low, some water shortages developing or imminent Voluntary water-use restrictions requested	-2.0 to -2.9	11 to 20	11 to 20	-0.8 to -1.2	11 to 20
D2	Severe Drought	Crop or pasture losses likely Water shortages common Water restrictions imposed	-3.0 to -3.9	6 to 10	6 to 10	-1.3 to -1.5	6 to 10
D3	Extreme Drought	Major crop/pasture losses Widespread water shortages or restrictions	-4.0 to -4.9	3 to 5	3 to 5	-1.6 to -1.9	3 to 5
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses Shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0 to 2	0 to 2	-2.0 or less	0 to 2

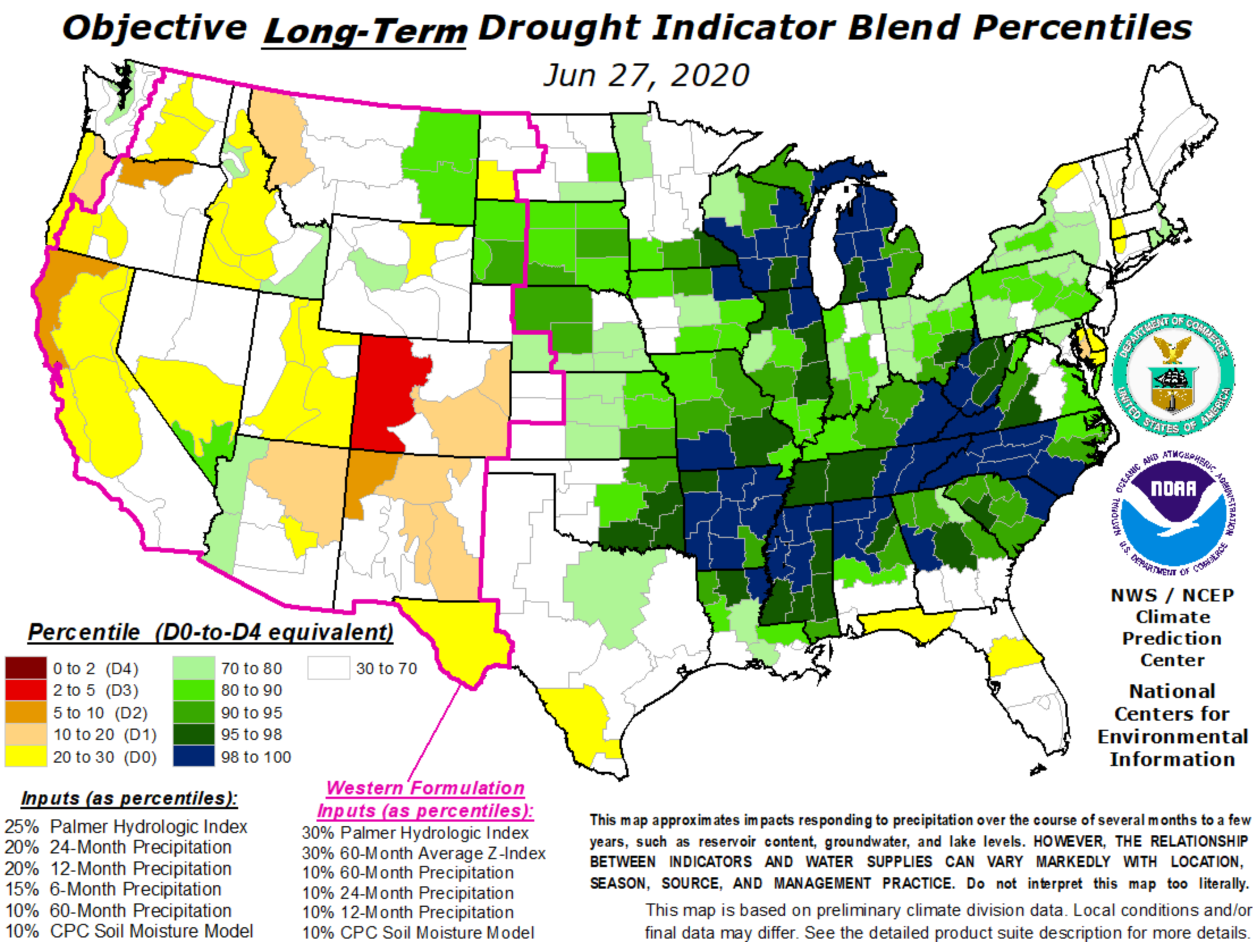
Source: Nation Drought Mitigation Center, University of Nebraska (https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx)

Figure 8. CPC Experimental Objective Short-Term Blend of Drought Indicators



Source : https://www.cpc.ncep.noaa.gov/products/predictions/tools/edb/droughtblends.php

Figure 9. CPC Experimental Objective Long-Term Blend of Drought Indicators



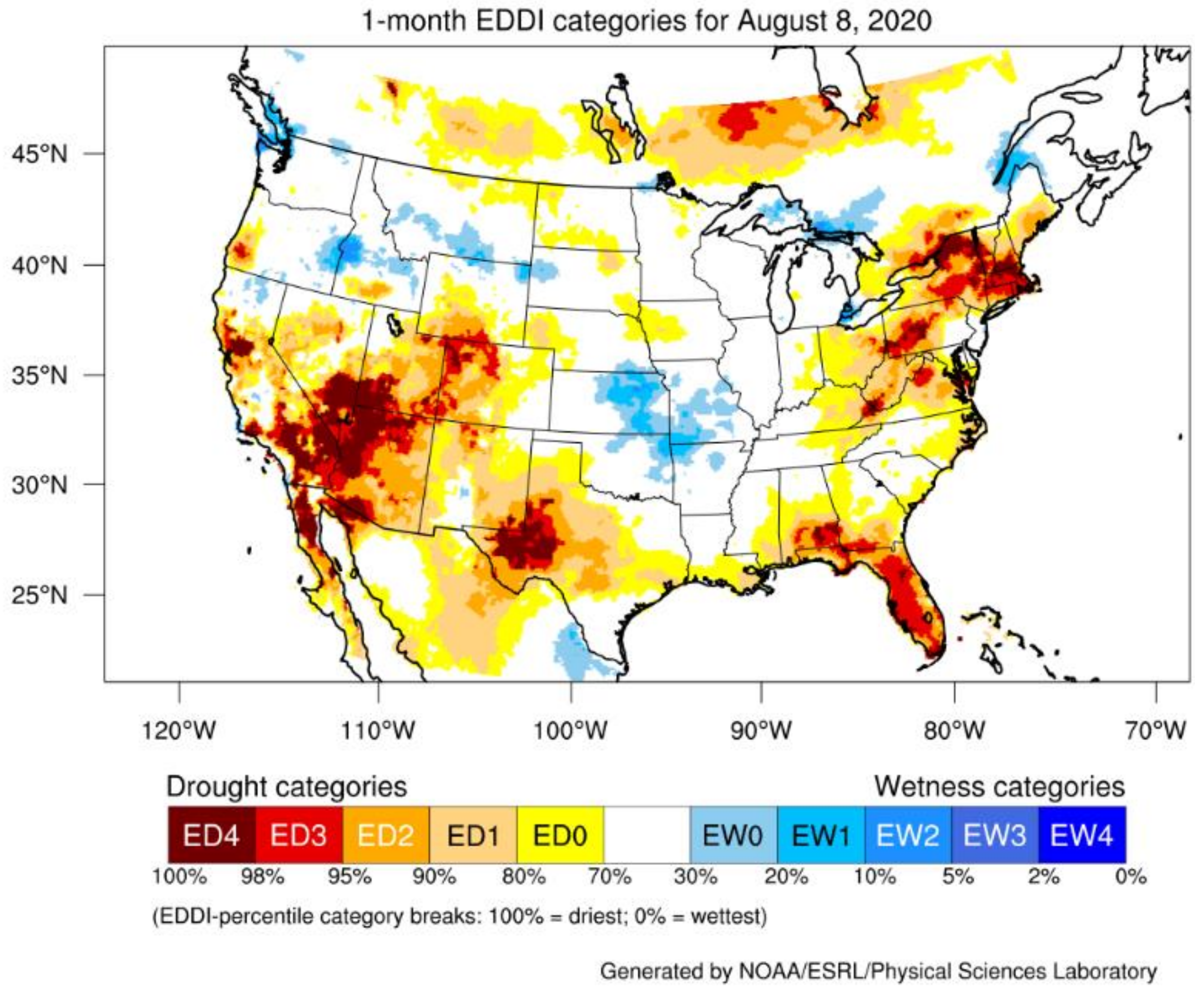
Source : https://www.cpc.ncep.noaa.gov/products/predictions/tools/edb/droughtblends.php

A potential downside to using the USDM is the lack of data in areas like Standing Rock Reservation. If there is little to no data recorded for Standing Rock, the USDM can interpolate data from surrounding areas, but this becomes an estimate rather than a recorded observation, leaving room for error in the interpolation. Because of this, it is important to take considerations beyond the USDM, whether it be self-observations by residents of the area, or using other available drought indices to determine the state of the region more accurately in question.

4.1.2 Evaporative Demand Drought Index (EDDI)

The EDDI is an experimental drought monitoring tool developed by climate scientists at NOAA. It is an index based on “evaporative demand”, which is basically a measure of how thirsty the atmosphere is. It uses measurements of temperature, humidity, windspeed, and solar radiation; all of which both contribute to and reflect the dying out of soil and vegetation. What makes EDDI unique compared to the USDM is that it can measure "flash droughts", which are short, intense periods of drying that can take a major toll on crop yields when they occur. EDDI can also show the early signs of a developing long-term drought. This is because EDDI only has a 5-day lag in data compared to the USDM, which has a lag of over a month. ***Figure 10. Evaporative Demand Drought Index Categories for the United States*** provides a sample map showing the drought versus wetness categories across the United States (NOAA 2020).

Figure 10. Evaporative Demand Drought Index Categories for the United States



EDDI can offer early warning of agricultural drought, hydrologic drought, and fire-weather risk by providing near-real-time information on the emergence or persistence of anomalous evaporative demand in a region. A strength of EDDI is in capturing the precursor signals of water stress at weekly to monthly timescales, which makes EDDI a strong tool for preparedness for both flash droughts and ongoing droughts.

4.1.3 Other Drought Indicators

In addition to the previously discussed drought indicators, the EDDI User Guide (Lukas, Hobbins, Rangwala, 2017) provides a useful comparison of the various drought indicators, prepared by and for NOAA, used in the preparation and prediction of drought:

ESI (Evaporative Stress Index)—anomaly in the ration of ET to E_0, where ET is calculated using leaf-area index (LAI) and land-surface temperature from satellite data, and E_0 is from a fully physical estimate, over a user-selected time window

SPEI (Standardized Precipitation-Evapotranspiration Index)—anomaly in the difference between observed precipitation (P) and estimated potential evapotranspiration (PET; equivalent to E_0) over a user-selected time window

VegDRI—blend of multiple drought indicators: 9-month SPI, Palmer Index, and satellite-sensed vegetation greenness and leaf-out anomaly; effective time window of several months

> ***"It's good practice to compare different drought indicators:"***
>
> EDDI and the other indicators capture different aspects of the moisture balance at the land surface; EDDI is unique in focusing on evaporative demand
>
> Different indicators can speak to some drought impacts better than others
>
> Different indicators also have different time windows over which conditions are aggregated—whether the window is user-selected or "baked into" that index
>
> Looking at multiple indicators provides a "convergence of evidence", e.g., to support a drought designation
>
> The differences between indicators can also provide insight into how drought conditions are emerging and causing impacts
>
> (Lukas, Hobbins, Rangwala, 2017)

4.2 Drought Conditions Monitoring

Drought monitoring should occur after the end of each month and should show both the final 1-month EDDI conditions and USDM conditions for that month. Current conditions should be classified in four different categories with the criteria shown in ***Table 6: Standing Rock Sioux Tribe Resources Affected by Drought and Response Actions***. Both current EDDI and USDM conditions can be found at the links below.

USDM: https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?SD

EDDI: https://www.esrl.noaa.gov/psd/eddi/

4.3 Drought Adaptation Actions

With each set of drought conditions, certain actions are suggested to be taken by local governments. Drought response actions are meant to allow local governments to adjust to the impacts of a drought. Even during a normal or wetter period, actions can be taken to further prepare for a potential drought. ***Table 6: Standing Rock Sioux Tribe Resources Affected by Drought and Response Actions*** shows recommended drought adaptation actions under normal, alert, warning, and emergency conditions. All actions are broken down into each water use sector. These suggested actions can be tailored for specific responses, depending on the time of year and the vulnerabilities and resources at stake.

Table 6. Standing Rock Sioux Tribe Resources Affected by Drought and Response Actions

	Normal (No Drought)	Alert (Mild Drought)	Warning (Moderate Drought)	Emergency (Severe to Extreme Drought)
Drought Stage Parameters	No USDM Classification	D0 USDM Classification	D1 and D2 USDM Classification	D3 and D4 USDM Classification
All Water Use Sectors	• Identify Tribal departments, communities, and agencies that will head and carry out actions outlined within this plan. • Review Tribal codes and policies and if needed, establish additional codes and policies for water use conservation. • Develop or review the existing plan for the water system about possible drought conditions and responses.	• Increase active enforcement of relevant Tribal codes and policies. • Monthly or quarterly report detailing current drought conditions to be made public.	• Prepare Drought Emergency Declaration. • Prepare letters to secretaries for drought determination. • Increase active enforcement of relevant Tribal codes and policies. • Monthly or quarterly report detailing current drought conditions to be made public.	• Declare Drought Emergency. • Send letters to secretaries for drought determination and assistance. • Support actions and resolutions for drought assistance funding. • Increase active enforcement of relevant Tribal codes and policies. • Monthly or quarterly report detailing current drought conditions to be made public.
Tribal Lifeways	• Identify methods to pass knowledge of traditional plants and ways for plants to be grown during drought. • Confirm alternative water sources during drought for buffalo herds. • Develop plans to minimize effects to cultural resources	• Begin to preserve as many traditional plants as possible through drying and canning processes. • Confirm alternative water sources for buffalo herds. • Enact plans to preserve cultural resources.	• Consider growing traditional plants in community gardens that can be watered regularly. • Utilize alternative water sources for buffalo herds. • Enact plans to preserve cultural resources.	• Consider growing traditional plants in community gardens that can be watered regularly. • Utilize alternative water sources for buffalo herds. • Enact plans to preserve cultural resources.
Domestic and Municipal Use	• Establish voluntary and required water use restrictions that will be utilized by drought stages. • Identify alternative intake locations for water system in the event issues occur with current intakes.	• Encourage voluntary water use conservation efforts. • Limit fireworks displays. • Encourage drought resistant landscaping.	• Apply pre-determined water use restrictions • No firework displays.	• Apply pre-determined water use restrictions • No fireworks displays.
Agriculture	• Develop grazing management plan. • Consider ways to enhance tribal agricultural. • Encourage practices to reduce erosion of topsoil.	• Encouragement of grasses in pastures that require less water. • Encourage row crops that need less water. • Encourage irrigation system efficiency checks and updates to improve efficiency. • Encourage practices to reduce erosion of topsoil. • Encourage pasture rotation for cattle.	• Encourage row crops that need less water. • Encourage drought resistant landscaping. • Encourage reduced irrigation practices. • Encourage practices to reduce erosion of topsoil. • Encourage pasture rotation for cattle. • Encourage voluntary livestock reduction.	• Encourage row crops that need less water. • Encourage drought resistant landscaping. • Encourage reduced irrigation practices. • Encourage practices to reduce erosion of topsoil. • Encourage pasture rotation for cattle. Encourage voluntary livestock reduction.
Fish and Wildlife/Recreation	• Develop wildlife habitat management plan. • Continue management of hunting and fishing licenses.	• Monitor conditions for fish and wildlife. • Monitor drought common disease outbreaks in big game. • Continue management of fishing and hunting licenses.	• Monitor conditions for fish and wildlife. • Monitor drought common disease outbreaks in big game. • Adjust hunting licenses to increase harvest, reducing impact on available forage.	• Monitor conditions for fish and wildlife. • Monitor drought common disease outbreaks in big game. • Adjust hunting licenses to increase harvest, reducing impact on available forage.
Fire Suppression	• Identify sources of water for structural fire and wildfire response. • Check availability of water carrying equipment.	• Coordinate with fire management regarding wildfire response.	• Coordinate with fire management regarding wildfire response.	• Coordinate with fire management regarding wildfire response.

5.0 Drought Mitigation Strategies and Potential Future Projects

The purpose of this plan component is to develop mitigation strategies for this implementing long-term measures to reduce drought risk. As in dealing with any type of disaster, this type of strategic approach is referred to as risk management. ***Table 7. Summary of Vulnerabilities, Mitigation Strategies, Potential Projects, and Potential Funding*** shows the vulnerabilities identified and the mitigation strategy that addresses those vulnerabilities to reduce the risk to the Standing Rock Sioux Tribe during drought. Several projects are identified for each mitigation strategy and potential project funding.

The following sections discuss the mitigation strategies and the potential projects identified.

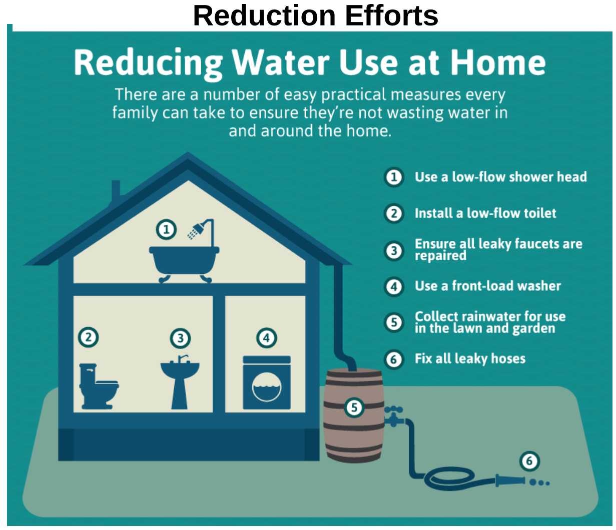
5.1 Mitigation Strategy #1: Protection of Water Sources

One protection instrument for water sources is permitting. Currently, any proposed infrastructure work (i.e. pipeline crossing) that is within the limits of a jurisdictional water of the US requires a Clean Water Act Section 404 permit. In addition to Section 404 permit, the Clean Water Act requires 401 Certification. A federal agency may not issue a permit or license to conduct any activity that may result in any discharge into waters of the United States unless a state or authorized tribe where the discharge would originate issues a Section 401 water quality certification verifying compliance with existing water quality requirements or waives the certification requirement. Currently, SDDENR has the 401 Certification responsibilities. This responsibility could be sought by the tribe to further protect the tribe's interest in protection surface water. In addition to Section 404 permits, Section 401 applies to: 1) Section 402 permit (non-delegated states), 2) Federal Energy Regulatory Commission (FERC) hydropower licenses, and 3) Rivers and Harbors Act Section 9 and 10 permits (USEPA 2020).

5.2 Mitigation Strategy #2: Promote Water Conservation Practices

Water use restrictions can also be utilized either through voluntary user efforts or enforced efforts. Voluntary efforts can include incorporating practical measures every family can incorporate such as low-flow shower heads and water efficient toilets. Education can be provided through social media to encourage these voluntary actions. Enforced restrictions can also be determined by the Standing Rock Sioux Tribe for water use such as lawn watering times. An example of promoting a reduction in personal water use can be seen in ***Figure 11. Example Voluntary Water Use Reduction Efforts.***

Figure 11. Example Voluntary Water Use Reduction Efforts



Reduction of water use for landscaping can also be incorporated, including timing and reduction of irrigation for traditional landscaping or even drought resistant landscaping. Drought resistant landscaping utilizes the growing of plants and grasses common to South Dakota or other similar drier climates. Prairie grasses and wildflowers offer an aesthetic alternative to traditional lawns that can be implemented and maintained using less water. Advertising campaigns can be used to spread information to residents about the individual aesthetic and economic benefits of drought resistant landscaping. Advertising campaigns can also serve as a how-to guide to implement drought resistant landscaping on their own property. The rise of social media has made it quick, easy, and inexpensive to spread information to local community members through various platforms.

Rainwater is an excellent source of non-potable water. Catching and using rainwater could be excellent for use in activities outside of the home, including watering a garden, grass, or for livestock use. Educational classes, brochures, posters, etc. would be recommended to encourage this practice. In addition, rain barrels to low income residents who are interested, as well as making rain catching methods available for government buildings to water and maintain their landscaping. There is potential conflict with capturing rainwater due to a lack of legislation stating that it is a tribe-endorsed activity. An alternative to capturing rainwater that does not interfere with legal rights is the reuse of gray water. Gray water is considered lightly used water that is not contaminated with potentially harmful or hazardous substances, such as urine or feces. Gray water may have been used to wash hands, wash dishes, bathe, etc. Learning how to capture and safely reuse this water in other applications such as wastewater systems, plant irrigation, and livestock watering can help reduce the overall demand of water across the reservation and may help reduce the impact of water restrictions during drought conditions.

5.3 Mitigation Strategy #3: Identify Existing Infrastructure and Future Improvements

In older water systems, leaks and breakdowns of the system can lead to loss of drinking water. Additional coordination could occur with the SRRWS to identify projects that would update or fix any segments of the system that are problematic. By completing these infrastructure updates, water would be conserved within the existing system, preparing the Tribe for drought events.

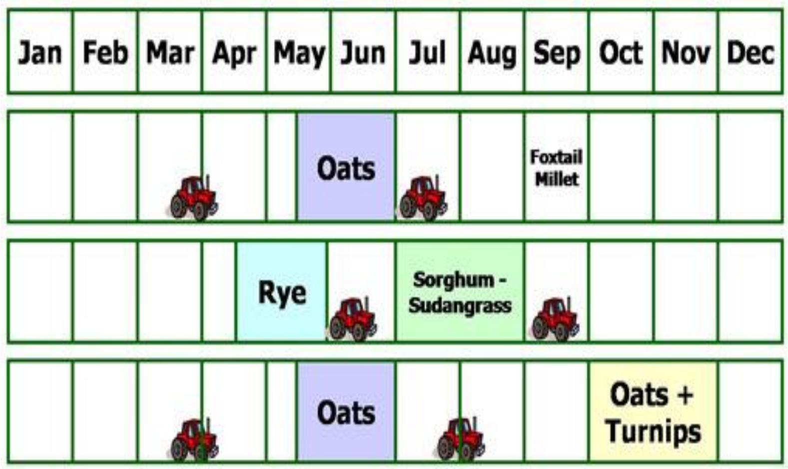
The SRRWS is the main supplier of drinking water to most residents within the Reservation. Before determining the demand of the system, identifying the current capacities of the distribution system must be completed. Identifying the system capacities involves looking at the technical, managerial, and financial components of the system. After all capacities have been determined, demands can be assessed, and the system losses and efficiencies can be determined. Though current demands of the water system are most likely known, reassessing demands for future scenarios and possibilities should be investigated. For example, one issue that should be addressed is the possibility of increasing output for irrigation. When making decisions about irrigation, SRRWS must consider if the system could support additional irrigation water, and if this additional output could be supported through a worst-case scenario drought. Possibilities such as this must be considered when discussing future mitigation plans.

An audit of the system must be completed to assess system capacities and demands. This project would seek to identify all demands and inefficiencies of the water collection, treatment, and pumping systems. This audit should also determine whether current capacities can support future demands, including proposed future additions.

5.4 Mitigation Strategy #4: Livestock Management

As noted earlier, drought can affect the amount of forage available. A few options are available for the Standing Rock Sioux Tribe to encourage or require leases to consider on their property. A pasture improvement assessment can be completed by local NRCS, Conservation District or Extension Office. Solutions such as working planted forage resources into the feeding strategy can be established. An example of a forage crop rotation that could be promoted during drought is shown in ***Figure 12. Example Planted Forage Schedule for Drought Conditions.***

Figure 12. Example Planted Forage Schedule for Drought Conditions (National Drought Mitigation Center 2020)



In addition, an evaluation of the reduction options to area livestock herds can also be considered. This might create a better balance of the forage available and keep the herd healthy. The herd reduction strategies can include: 1) Selling feeder animals early, 2) Selling replacement breeding animals, 3) Reduce breeding animal numbers, 4) Selling the herd and ceasing production, and 5) Selling the heard and restocking later (National Drought Mitigation Center 2020). In addition, water sources for the herd need to be considered. A private well or water line from SRRWS can also provide water to encourage options for watering. In addition, a review of any stock dams and maintenance activity (i.e. removing sedimentation) on stock dams could be completed. The Standing Rock Sioux Tribe can encourage or require ranchers to complete these pasture improvement assessments and analyze the different water sources available.

5.5 Mitigation Strategy #5: Crop Management

Although the Reservation is primarily rangeland, cultivated crops are present. Water efficient crops and grasses can serve as an important resource in mitigating the effects of drought. There are many avenues a community could take in promoting the use of water efficient crops. The education and encouragement of ranchers to produce water efficient crops could be done using both classes and advertising. The Standing Rock Sioux Tribe could also begin a program that would require the use of specific crops through funding. The funding could be used to subsidize crop seeds as well as provide resources for maintenance and harvest.

While the weather cannot be controlled, producers can manage for potential drought stress by using practices that conserve soil moisture and planting hybrids with a good overall stress tolerance. In some cases, planting early maturing hybrids may allow pollination and early development to take place prior to heat and drought conditions.

Drought tolerant corn and wheat are prevalent across the country. Drought tolerant corn varieties are genetically engineered strains of corn sold by companies throughout the US. As of 2016, only about 10 percent of irrigated corn in South Dakota was drought tolerant, and just over 20 percent of non-irrigated corn was drought tolerant. Since its commercial introduction in 2011 and in response to frequent droughts that plague regions from West Texas to North Dakota, drought tolerant corn has seen increases in use in the US (McFadden et al, 2019).

5.6 Mitigation Strategy #6: Fire Protection

As noted in the vulnerability assessment, structural fire response is lacking in some areas on the Reservation and back up water systems may or may not be in place. Water availability may be limited for the suppression of larger wildland fires. Retention basins, stock dams, and larger wetlands could potentially also be water sources for fire suppression. Typically, retention basins are located in urban settings. For rural settings, opportunities for additional sources could be stock dams or larger wetland complexes. The Standing Rock Sioux Tribe could identify these locations and work with landowners and/or lessees to put agreements in place allowing for water from these areas to be utilized in the event of a larger fire. Directions to access the supplemental sites can then be shared with the fire departments to obtain water from these areas for use in fire suppression activities.

5.7 Mitigation Strategy #7: Preservation of Traditional Plants

To preserve traditional plants includes two considerations, preservation of the knowledge of traditional plants and the continuation of growing traditional plants, even during drought. For the continuation of growing traditional plants, the communities could have gardens that are reserved for traditional plants so watering can be controlled. The gardens could be a learning tool for the elders to pass on the knowledge of the plants to younger generations and continue to provide the plants for medicinal purposes.

Table 7. Summary of Vulnerabilities, Mitigation Strategies, Potential Projects, and Potential Funding

Vulnerabilities	Mitigation Strategy	Potential Project	Potential Funding
#1: Contamination of Water Source	Protection of Water Source	Review and comment on proposed Missouri River crossings permits. Continue to bring awareness to protecting waterways on the Reservation.	US EPA Office of Water, Office of Wetlands, Oceans and Watersheds. Section 319 of the Clean Water Act (CWA). Opportunities for eligible Tribes and intertribal consortia to develop and implement watershed-based plans and implement watershed projects that will result in significant steps towards solving Nonpoint Source (NPS) impairments on a watershed-wide basis. US EPA Water Pollution Control Section 106 Supplemental Grant. Provides support for state, interstate and eligible tribal recipients of Section 106 grants for Water Pollution Control Programs. Covers activities such as water quality standards, water quality monitoring, impaired waters listing and total maximum daily loads development, National Pollutant Discharge Elimination System permitting and enforcement and compliance. US EPA Office of Brownfields and Land Revitalization. Section 128(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), authorizes a noncompetitive grant program to establish and enhance state and tribal response programs, by providing training, research, and technical assistance to individuals and organizations, as appropriate, to facilitate the inventory of brownfields sites, site assessments, remediation of brownfield sites, community involvement, or site preparation. Housing & Urban Development- Community Development Block Grant Program US Department of Agriculture- Rural Development Water & Waste Disposal Predevelopment Planning Grants; Rural Development Water and Waste Disposal Loan and grant Program; Water & Waste Disposal Grants to Alleviate Health Risks on Tribal Lands and Colonials
		Continue water quality monitoring and obtain TAS to be a part of permit approval as part of 401 Certification.	
		Continue to implement Brownfields program to prevent spills and illegal solid waste dumping.	
		Education on protection of water sources and issues with illegal solid waste dumping.	
#2: Water Use Conservation and Reliable Infrastructure	Promote Water Conservation Practices	Educate younger generations on water conservation.	DHHS Community Services Block Grant (CSBG) Rural Community Development Program (RCD) Water and Wastewater Treatment Systems Training and Technical Assistance Project. (HHS 2020) Rural Community Development (RCD) discretionary grant funds. RCD funds must be used to provide training and technical assistance to: Increase access for low-income families to water supply and waste disposal services, preserve affordable water and waste disposal services in low-income rural communities, increase local capacity and expertise to establish and maintain needed community facilities, increase economic opportunities for low-income rural communities by ensuring they have basic water and sanitation, utilize technical assistance to leverage additional public and private resources, and promote improved coordination of Federal, state, and local agencies and financing programs to benefit low-income communities.
		Encourage use of water efficient appliances in homes.	
	Identify Existing Infrastructure and Future Improvements	Identify all water pumping and reservoir capacities and how long a reservoir's supply can last during a drought without filling (worst case scenario).	US EPA – Office of Chemical Safety and Pollution Prevention, Office of Pollution Prevention and Toxics, EPA Regional Pollution Prevention Program Offices. Opportunities to fund two-year Pollution Prevention assistance agreements for projects that provide technical assistance (e.g., information, training, tools) to businesses and their facilities to help them develop and adopt source reduction practices (also known as "pollution prevention" or "P2"). P2 means reducing or eliminating pollutants from entering any waste stream or otherwise being released into the environment prior to recycling, treatment, or disposal.
		Identify all SRRWS losses and inefficiencies.	
		SRST to determine voluntary and non-voluntary restrictions.	
#3: Agricultural Practices	Livestock Management	Complete pasture improvement assessments. Consider additional requirements in lease agreements.	US Department of Agriculture - Farmers Market Promotion Program; Community Food Projects Competitive Grants Program; Conservation Innovation Grants; Conservation Stewardship Program; Environmental Quality Incentives Program USDA NRCS Community Compost and Food Waste Reduction (CCFWR) Project. This project provides assistance through a cooperative agreement to municipalities, counties, local governments, or city planners to develop and test strategies for planning and implementation that will 1) generate compost; 2) increase access to compost for agricultural producers; 3) reduce reliance on, and limit the use of, fertilizer; 4) improve soil quality; 5) encourage waste management and permaculture business development; 6) increase rainwater absorption; 7) reduce municipal food waste; and 8) divert food waste from landfills. USDA NRCS Urban Agriculture and Innovation Production (UAIP) Competitive Grants Program. UAIP supports the development of urban agriculture and innovative production activities by funding Planning Projects (PP) and Implementation Projects (IP). The purpose of PP is to support development of projects that will either initiate, build upon, or expand the efforts of farmers, gardeners, citizens, government officials, schools, and other stakeholders. Unites States Department of Agriculture-National Institute of Food and Agriculture (USDA-NIFA), Farm and Ranch Stress Assistance Network.
		Identify drought plans for buffalo herds.	
		Identify alternative water sources for livestock.	
	Crop Management	Educational programs on growing and maintaining water efficient crops.	
		Irrigation system efficiency updates.	

Table 7. Summary of Vulnerabilities, Mitigation Strategies, Potential Projects, and Potential Funding

Vulnerabilities	Mitigation Strategy	Potential Project	Potential Funding
			The purpose of the Farm and Ranch Stress Assistance Network (FRSAN) Program is to establish a network that connects individuals who are engaged in farming, ranching, and other agriculture-related occupations to stress assistance programs. The establishment of a network that assists farmers and ranchers in time of stress can offer a conduit to improving behavioral health awareness, literacy and outcomes for agricultural producers, workers and their families.
#4: Fire Protection	Fire Protection	Identification of further structural protection firefighting abilities on the Reservation.	United States Department of Agriculture-Rural Development (USDA-RD), Community Facilities Technical Assistance and Training Grant. Opportunity to provide associations Technical Assistance and/or training with respect to essential community facilities programs. The Technical Assistance and/or training will assist communities, Indian Tribes, and Nonprofit Corporations to identify and plan for community facility needs that exist in their area. Once those needs have been identified, the Grantee can assist in identifying public and private resources to finance those identified community facility needs. (USDA RD 2020)
		Identification of alternative sources for water during large fires. Ensure agreements with entities are obtained for those sources.	SD DENR Water and Waste Funding Program. Small Community Planning Grant. This program provides small communities with funds to hire an engineering consultant to develop a project specific engineering report. The engineering report's level of detail will be on par with the facilities plan required for SRF projects, The project sponsor must be an entity of government (county, municipality, or township), or a special purpose district with the authority to construct a water or wastewater project (sanitary, water user, watershed, or water project). Nonprofit organizations are also eligible provided they were formed for the primary purpose of supplying water or sanitary service. Nonprofit water systems applying for this grant must meet the definition of a community water system (a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents).
#5: Preservation of Traditional Plants	Preservation of Traditional Plants	Identify education pathways for elders to teach youth about traditional plants.	Department of Health and Human Services - Native American Language Preservation and Maintenance – Administration for Native Americans (HHS-ANA). The Native Language Preservation and Maintenance program provides funding for projects to support assessments of the status of the native languages in an established community, as well as the planning, designing, restoration, and implementing of native language curriculum and education projects to support a community's language preservation goals. Native American communities include American Indian tribes (federally-recognized and non-federally recognized), Native Hawaiians, Alaskan Natives, and Native American Pacific Islanders.(HHS-ANA 2020).
		Consider community gardens that traditional plants could be planted and utilized for education programs.	Department of Health and Human Services – Environmental Regulatory Enhancement – Administration for Native Americans (HHS-ANA). ANA provides discretionary grant funding, training, and technical assistance in support of community-based projects that address the current social and economic conditions in Native American communities. Second, ANA promotes social and economic self-sufficiency through advocacy and policy development on behalf of Native Americans. ANA's programmatic goals include: (1) fostering the development of stable, diversified local economies to encourage community partnerships and reduce dependency on public funds and social services; (2) supporting local access to, control of and coordination of services and programs that safeguard the health and well-being of Native children and families; (3) increasing the number of projects involving youth and intergenerational activities in Native American communities. (HHS-ANA 2020).
		Interview and record elders' knowledge of traditional plants.	Honor the Earth Native Food Security Grants, This program provides grants for Native organizations working to create food security utilizing traditional seeds, foods, and growing methods, as well as energy efficiency and renewable energy projects.

6.0 DROUGHT ADAPTATION PLAN MAINTENANCE

It is recommended that the Tribe continuously update the DAP. The updates should come every 5 years and it is recommended that the Standing Rock Sioux Tribe Natural Resources Department monitor the consistent updates. This will confirm that the DAP is consistently up-to-date and is beneficial during major droughts. To facilitate consistent updating on major plans, such as the DAP, the Federal Emergency Management Agency (FEMA) has funding sources available.

The DAP is written to be used to update the Tribe's Hazard or Multi-Hazard Mitigation Plan.

7.0 DATA/PROCESS GAPS AND NEEDS

The most important developmental tool for a DAP is a response from the affected people, the government leaders, and the experts of the area. To create a well-rounded plan, the differences in responses and professional opinions develop a solid understanding of the goals and needs of the Tribe. In a perfect scenario, all Tribal program directors, staff, Tribal council, government officials, and Tribal members invited would be able to attend and determine the exact projects and plans that the Tribe should pursue.

8.0 CONCLUSIONS AND NEXT STEPS

The information contained within this DAP should be implemented and used to seek funding for identified projects. The projects that are in this report were identified through the leadership of the Tribe. The future of the Tribe's resiliency to drought is dependent on the use of this report to work on the identified adaptation plan and projects. Subsequent action steps to the DAP should be seeking funding sources and pursuing the completion of each project outlined within.

In the future, attempts should be made to reach all Tribal leaders. In the next iteration of the DAP, it is recommended to have individual meetings with each Tribal leader to better understand every leader's perspective.

9.0 RESOURCES

Resources for information, outside of online sources, books, articles, and journals, were primarily from interviews and discussions with Tribal program directors, staff, Tribal council, government officials, and Tribal members.

9.1 Tribal Leaders Interviewed

SRST's field visit yielded excellent responses and had most of the invited tribal leaders in attendance who brought forth many ideas and thoughts on drought and drought mitigation strategies. The Tribal leaders that attended were: Doug Crow Ghost (Water Resources), Megan Jones (Water Resources), John Eagle (Tribal Historic Preservation Office), Emmett "Suki" White Temple (Water Resources Control Board – Rock Creek District), Kory McLaughlin (Water Resources Control Board – Porcupine District), and Celeste Long Elk (Water Resources Control Board – Long Soldier District). The surveys presented to participants may be found in Appendix A.

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APPENDIX A. FIELD VISIT HANDOUTS

Drought Vulnerability Survey

Vulnerabilities	Rank
Vulnerable to oil leak from DAPL.	
Decreased water and air quality.	
Invasive plant species are increasing, and natural plants are migrating north.	
Plant harvesting times are shifting	
Ground water sources are harsh and not economically feasible.	
Water intake in Missouri River is consistently at risk being exposed to surface due to USACE Control over River and possible sedimentation.	
No official structural fire protection on the Reservation.	
Pest population increases in drought.	
Drought occurs every 7 years but has had a much longer duration in recent years and affects vegetation and prime/choice land.	
Fireworks cause injuries (cause fires during dry years) – Public Health	
Pests eat an already low number of choke cherries and buffalo berries.	
Zebra Mussels blocking intake screen.	
Fire Departments (VFD) unable to connect to Water System to respond to fires.	
Leasers are not obligated to have a pre-management plan in case of issues coming from nature.	
Quality of animal meat declines due to ingestion of weeds and invasives.	
Plants and animals are smaller due to drought.	

Mitigation Strategy Survey

Mitigation Strategy	Rank
Identifying all water demands	
Grazing management plans	
Drip irrigation	
Encouragement of crops that need less water	
Encourage drought resistant landscaping	
Peer pressure (sending comparisons of water use)	
Irrigation scheduling	
Cross fencing	
Water use restrictions	
Weatherizing homes and buildings	
Stormwater management - retaining basin or dry basin	
Maintenance and repair programs on distribution infrastructure	
Improving efficiency standards in buildings	
Display water use to encourage low usage	
Composting	
Identifying new water sources before approving proposed development	
Catching and use of rainwater	
Encouraged use of water efficient appliances	
Putting wastewater into the ground to encourage GW replenishment	
Reservoir Augmentation	
Using cover crops (like Barley)	
Encourage dry land farming	
Reduce water use in food production (full washers, low flow)	
Updated the wastewater drinking plant	
Tal-Ya use	
Incentive pricing on water use	

SRST Drought Vulnerability Survey Results

Vulnerabilities	Total Score	Rank
Vulnerable to oil leak from DAPL.	8	**1**
Decreased water and air quality.	9	**2**
Invasive plant species are increasing, and natural plants are migrating north.	10	**3**
Plant harvesting times are shifting	11	**4**
Ground water sources are harsh and not economically feasible.	12	**5**
Water intake in Missouri River is consistently at risk being exposed to surface due to USACE Control over River and possible sedimentation.	13	**6**
No official structural fire protection on the Reservation.	13	**6**
Pest population increases in drought.	14	**8**
Drought occurs every 7 years but has had a much longer duration in recent years and affects vegetation and prime/choice land.	14	**8**
Fireworks cause injuries (cause fires during dry years) – Public Health	15	**10**
Pests eat an already low number of choke cherries and buffalo berries.	16	**11**
Zebra Mussels blocking intake screen.	17	**12**
Fire Departments (VFD) unable to connect to Water System to respond to fires.	17	**12**
Leasers are not obligated to have a pre-management plan in case of issues coming from nature.	17	**12**
Quality of animal meat declines due to ingestion of weeds and invasives.	18	**15**
Plants and animals are smaller due to drought.	20	**16**

SRST Mitigation Strategy Rankings

Mitigation Actions	Total	Rank
Identifying all water demands	8	1
Grazing management plans	11	2
Drip irrigation	12	3
Encouragement of crops that need less water	13	4
Encourage drought resistant landscaping	13	4
Peer pressure (sending comparisons of water use)	13	4
Irrigation scheduling	13	4
Cross fencing	13	4
Water use restrictions	14	9
Weatherizing homes and buildings	14	9
Stormwater management - retaining basin or dry basin	14	9
Maintenance and repair programs on distribution infrastructure	15	12
Improving efficiency standards in buildings	15	12
Display water use to encourage low usage	15	12
Composting	15	12
Identifying new water sources before approving proposed development	15	12
Catching and use of rainwater	16	17
Encouraged use of water efficient appliances	16	17
Putting wastewater into the ground to encourage GW replenishment	16	17
Reservoir Augmentation	16	17
Using cover crops (like Barley)	18	21
Encourage dry land farming	20	22
Reduce water use in food production (full washers, low flow)	20	22
Updated the wastewater drinking plant	20	22
Tal-Ya use	22	25
Incentive pricing on water use	25	26