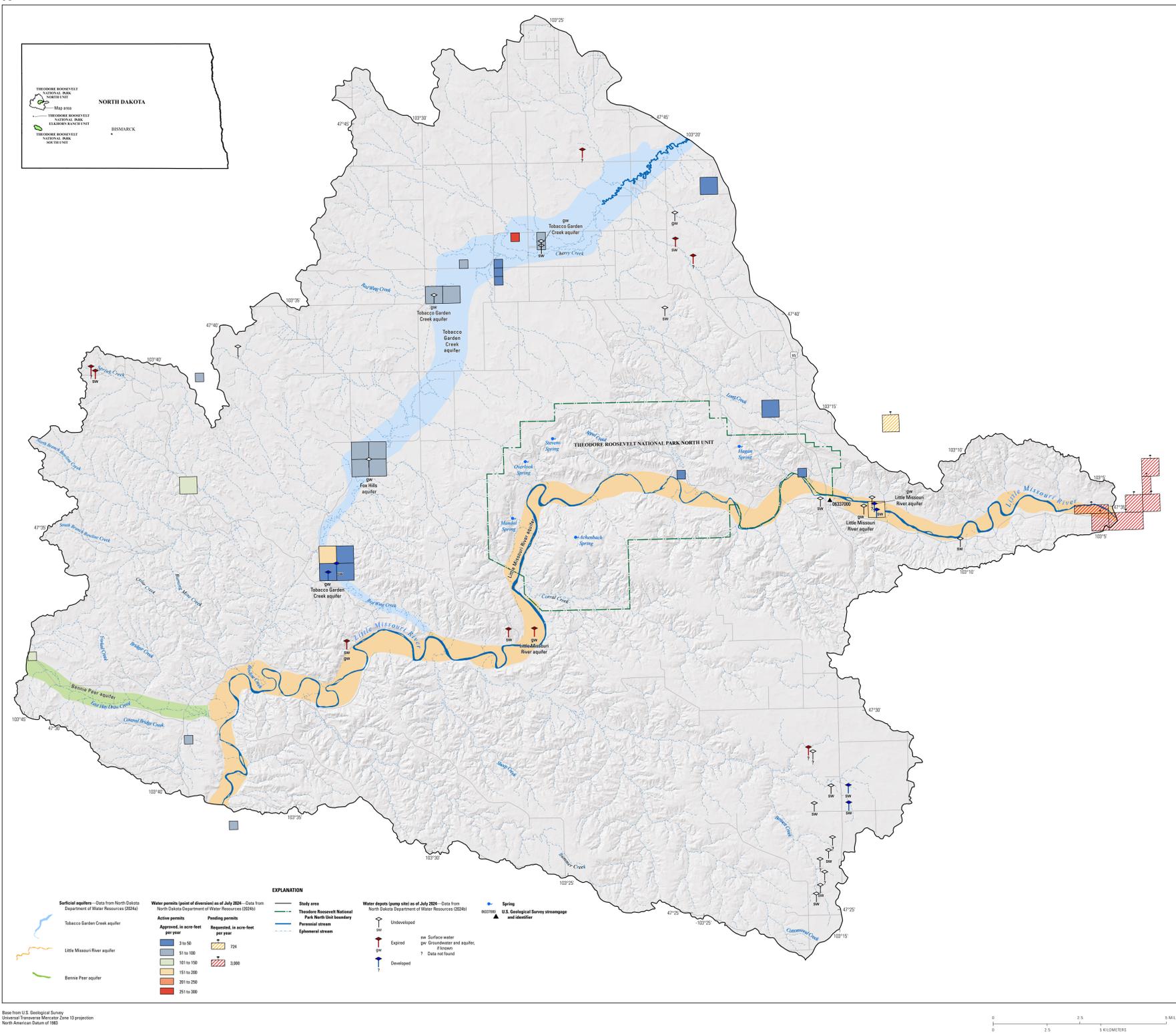


A



Plain Language Summary

This map shows the location of water permits and graphs of the reported amount of water used from these permits from rivers, streams, and wells as of July 2024, near Theodore Roosevelt National Park in North Dakota. Total water use in the map area more than doubled from 2020 to 2023. From 1980 through 2023, water from rivers and streams was used more than water from wells, but water use from wells began to increase starting in 2011. From 1980 through 2015, most water was used for irrigation, but after 2015, most water was used for industrial purposes.

Abstract

Starting in the early 2000s, increasing oil and gas development in western North Dakota created a need for additional water resources from surface-water and groundwater sources near the North Unit of Theodore Roosevelt National Park. To summarize the use of water in that area, the U.S. Geological Survey, in cooperation with the National Park Service, developed a map of surface-water and groundwater resources, aquifers, and water-use diversions, and plotted water-use trends from 1980 to 2023. Reported water used from permits in the map area has more than doubled since 2020, increasing from about 750 acre-feet in 2020 to about 2,300 acre-feet in 2022 and 2,000 acre-feet in 2023. Surface water provided the primary source of reported water used for the study period with an average of about 410 acre-feet per year from 1980 through 2017 and about 1,330 acre-feet per year from 2018 through 2023. After 2011, groundwater sourced from the Little Missouri River, Tobacco Garden Creek, Fox Hills, Fort Union, and Dakota aquifers became a larger portion of total annual reported water use from permits in the map area. From 1980 through 2015, water use for irrigation averaged 86 percent of the total annual reported surface-water and groundwater use in the map area. Starting in 2011, however, industrial uses became a proportionally larger total use of water, and in 2015, became the highest reported volume of water use in the map area. From 2011 to 2023, industrial use designated for water depths increased from 50 acre-feet to about 1,200 acre-feet, accounting for about 70 percent of total reported water use in the map area in 2023.

Introduction

The North Unit of Theodore Roosevelt National Park includes about 24,000 acres of land in McKenzie County of west-central North Dakota (Amberg and others, 2014, sheet 1A). Starting in the early 2000s, increasing oil and gas development in western North Dakota created a need for additional water resources (Eldridge and Medler, 2021). Some of the water used to support oil and gas development was sourced from surface water and groundwater near the North Unit of Theodore Roosevelt National Park. Mapping the location of surface-water and groundwater resources, aquifers, water-use diversions, and water-use permits as of July 2024 with historic reported water use from 1980 to 2023 provides National Park Service staff information about the natural resources of Theodore Roosevelt National Park.

The purpose of this report is to document the basic hydrology and water use near the North Unit of Theodore Roosevelt National Park, North Dakota, as of July 2024. The mapped area includes major surficial aquifers, stream locations, water depths, surface topography, and permitted water withdrawal locations (sheet 1A). The report also includes a simplified stratigraphic column modified from Croft (1985) and Murphy and others (2009, sheet 1B), and reported water use by type and source plotted from 1980 through 2023 (sheets 1C, D).

Hydrologic Setting

The hydrologic setting of the North Unit of Theodore Roosevelt National Park includes surface water and groundwater, and both provide sources for water withdrawal near the park. Surface waters are used by wildlife and for recreation in Theodore Roosevelt National Park (Amberg and others, 2014). Several perennial and ephemeral streams flow through or near the North Unit of the park (sheet 1A). The perennial Little Missouri River flows through 14 miles of the north unit and is the primary surface-water resource for the park. The river flows from the southwest to the east in the map area. At U.S. Geological Survey streamgage 06337000 (sheet 1A), the mean annual discharge from October year 1935 through 2023 was 541 cubic feet per second (ft³/s), and the peak discharge during the same period was 110,000 ft³/s on March 25, 1947 (U.S. Geological Survey, 2025). Minimum daily flows at the streamgage have been recorded at 0 ft³/s typically during winter months (U.S. Geological Survey, 2025). Ephemeral tributaries that flow into the Little Missouri River in the map area include the East Hat Drain Creek, which flows over the Bennie Peer aquifer, and Red Wing Creek, which flows over the western part of the Tobacco Garden Creek aquifer. Coral Creek and Apple Creek also are ephemeral tributaries partly in the north unit that flow into the Little Missouri River. Numerous other ephemeral streams are in the map area and discharge either to the Little Missouri River or to Cherry Creek.

Geologic systems commonly used for permitted withdrawals of groundwater in the map area include Cretaceous, Tertiary, and Quaternary Systems (sheet 1B). The geologically oldest aquifer used for groundwater withdrawals in the map area is the Early Cretaceous Dakota Group and includes units of shale and sandstone underlying the map area (not shown; Medler and Eldridge, 2021). The upper Fort Union aquifer typically includes the Bullion Creek and Sentinel Butte Formations which are exposed at the land surface in much of the map area (not shown). Groundwater use estimates from the lower and upper Fort Union aquifers were combined into a single Fort Union aquifer in this report.

Several aquifers of the Quaternary Coloharbor Group overly the deposits of the Fort Union Group in the map area. These aquifers are classified as surficial glacial-drift or glacial/alluvial and are a major source of groundwater withdrawal in North Dakota (North Dakota Department of Water Resources, 2024a, sheet 1B). The Bennie Peer aquifer consists of glacial/alluvial deposits of sand and gravel and averages 100 feet thick in the map area (sheet 1A). Only a small part of the Bennie Peer aquifer is shown on the map and the aquifer extends west past the map border (not shown). The Tobacco Garden Creek aquifer in the north-central part of the map area averages 70 feet thick and consists of sand and gravel overlain with clay and lakebed deposits (sheet 1B). The aquifer extends north past the map boundary. The Little Missouri River aquifer is in the central part of the map area (sheet 1A) and averages 150 feet thick with a maximum thickness of 176 feet. The aquifer is described as glacial drifts consisting of clay, silt, sand, and gravel and extends to the east past the eastern map boundary.

Springs and seeps are common in the map area and as early as 1929, the hydrogeology in this region and Theodore Roosevelt National Park was noted for its ability to form springs and seeps because of the steep topography and the presence of permeable and impermeable geologic units (Medler and Eldridge, 2021). Many of the seeps and springs provide water for wildlife in the backcountry of the park (Amberg and others, 2014). The North Unit of Theodore Roosevelt National Park contains five documented springs (sheet 1A): Stevens, Hagan, Overlook, Mandall, and Achenbach Springs. All the springs are sourced partly from groundwater from the Sentinel Butte Formation of the Fort Union aquifer (Medler and Eldridge, 2021).

Sources of Water

The Water Appropriation Division of the North Dakota Department of Water Resources manages the use of the North Dakota waters. All water use, except for domestic, livestock, fish, wildlife, and other recreational uses (unless greater than 12.5 acre-feet per year), requires a categorized water permit (conditional or temporary) before using the water for beneficial use (North Dakota Department of Water Resources, 2025). Conditional permit categories for all water-use types include active (perfected, approved, or in abeyance), in-processing, cancelled, conditionally approved, deferred, denied, pending review, under review, void, or withdrawn. Temporary permits are issued for a defined time (usually as many as 12 months) and for a specific use, such as industrial, irrigation, or firefighting (North Dakota Department of Water Resources, 2025). Permits shown on the map area were active, pending review, or under review as of July 2024, and temporary permits are not shown.

Each permit specifies a point-of-diversion, either a surface-water location or a well, defined by square acre corresponding to the section, township, and range of the permit (sheet 1A). Industrial and municipal permits require that the well or pump site be specified within the point of diversion, if applicable. The map shows the point-of-diversion square area, and for water depths the map shows the well or pump site.

Water used in the map area is from surface-water and groundwater sources but some sources are undefined (sheet 1C). North Dakota Department of Water Resources, 2024b). Since 1980, surface water provided the primary source of reported water use from permits in the map area and averaged about 410 acre-feet per year through 2017. From 2018 through 2023, the reported use from permits for surface water increased to an average of about 1,330 acre-feet per year. Total water use also increased after 2017 from a mean annual rate of 440 acre-feet per year from 1980 through 2017 to a mean annual rate of about 1,600 acre-feet per year from 2018 through 2023.

Starting in 2011, groundwater began to become a larger portion of reported water use from permits in the map area (sheet 1C). North Dakota Department of Water Resources, 2024b). Reported groundwater use from the Little Missouri River aquifer started in 2019 and increased from 4 acre-feet per year in 2021, then decreased to 11 acre-feet in 2023. Reported groundwater use for the Tobacco Garden Creek aquifer began in 2014 at 109 acre-feet and in 2023 increased to 349 acre-feet per year. Reported groundwater use from permits from the Fort Union aquifer started in the early 1980s and was typically less than 1.3 acre-feet per year through 2015, averaged 1.4 acre-feet per year from 2016 through 2021, and was 0 acre-feet in 2022 and 2023. Total reported water use from permits from the Fox Hills aquifer from 1980 through 2011 were on average 12 acre-feet per year, but starting in 2012, declined to a mean annual rate of 2.7 acre-feet per year from 2012 through 2023. Reported groundwater use from permits from the Dakota aquifer started in 2011 at 24 acre-feet per year but decreased to 18 acre-feet per year in 2023. The mean annual rate of water use categorized by the North Dakota Department of Water Resources as undefined (surface water or groundwater) from 1980 through 2023 was 2.6 acre-feet per year (North Dakota Department of Water Resources, 2024b).

Water Uses

The North Dakota Department of Water Resources currently (2024) categorizes water-use permits as domestic, municipal, livestock, irrigation, industrial, and fish, wildlife, and other outdoor recreational uses but these categories have changed with time (North Dakota Department of Water Resources, 2025). The map area contained permit information from 1980 through 2023, and during those years permits were categorized as domestic, rural water, livestock, irrigation, industrial (water depth and other), construction, and resource planning uses (sheet 1D). Water depths are a category of industrial-use permits with the beneficial use of the permit typically supporting oil and gas development. The North Dakota Department of Water Resources maintains a database of water depths (North Dakota Department of Water Resources, 2024b), and the map displays the locations of the permitted water depths within the map extent as of July 2024 (sheet 1A).

Most permitted water uses, specifically municipal, irrigation, and industrial uses with conditional or temporary permits, report water use quarterly or annually to the North Dakota Department of Water Resources. Data displayed on sheets 1C and 1D were compiled from annual reported use (North Dakota Department of Water Resources, 2025). From 1980 through 2015, irrigation averaged 86 percent of the total groundwater and surface water use in the map area with a mean annual reported water-use rate of 390 acre-feet per year. The highest reported annual irrigation water use was 994 acre-feet in 2011. Starting in 2011, industrial uses of groundwater and surface water became proportionally larger, and in 2015, industrial uses of groundwater and surface water were the highest reported category in the map area at 260 acre-feet. Industrial use for water depths increased from 50 acre-feet per year in 2011 to 1,370 acre-feet per year in 2022, which was about 70 percent of total water use in the map area in 2023. Since 1980, domestic, construction, rural water, and resources planning and livestock uses have remained a relatively small proportion of total water use in the map area with mean annual rates of 2.8, 8.5, 0.2, and 1.5 acre-feet per year (North Dakota Department of Water Resources, 2025).

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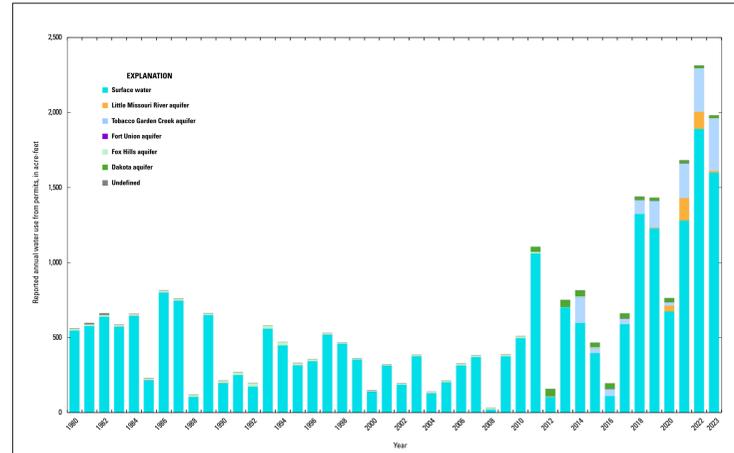
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B (—, not applicable)

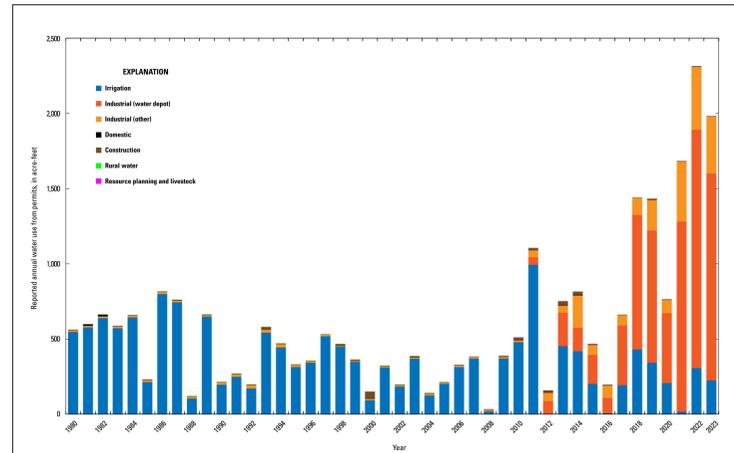
Epoch	System	Series	Group	Geologic unit	Approximate thickness (feet)	Aquifer	Aquifer description				
Quaternary	Holocene	—	—	Undifferentiated	Variable	Undifferentiated surficial aquifers	Alluvium (floor plain) and undifferentiated coluvial deposits of sand, gravel, silt, and clay.				
				190 (average) but up to 176	Little Missouri River aquifer	Glacial drifts consisting of clay, silt, sand, and gravel.					
				70 (average)	Tobacco Garden Creek aquifer	Glacial drifts consisting of sand and gravel overlain with clay and lakebed deposits.					
				100 (average)	Bennie Peer aquifer	Glaciofluvial deposits of sand and gravel.					
Cenozoic	—	—	—	Pliocene	—	Unnamed units	Not used in study area as a source of groundwater				
				Miocene	—	Arkansas Formation	Not used in study area as a source of groundwater				
				Oligocene	White River	Bulle Formation	Not used in study area as a source of groundwater				
				Eocene	—	Golden Valley Formation	Not used in study area as a source of groundwater				
				Tertiary	—	—	—	Sentinel Butte Formation	650 (maximum)	Fort Union	Units of saturated sandstone, siltstone, claystone, mudstone, silt-clay, and lignite.
								Bullion Creek Formation	650 (maximum)	Fort Union	Units of saturated sandstone, siltstone, claystone, mudstone, silt-clay, and lignite.
								Canonball Formation	255 (maximum)	Fort Union	Units of saturated sandstone, siltstone, claystone, mudstone, silt-clay, and lignite.
								Ludlow Formation	300 (maximum)	Fort Union	Units of saturated sandstone, siltstone, claystone, and mudstone.
				Montana	—	—	—	Hell Creek Formation	400	Hell Creek	Saturated units of sandstone, siltstone, claystone, and mudstone.
								Fox Hills Formation	400	Fox Hills	Saturated units of mudstone, siltstone, cemented to poorly cemented sandstone.
Pierre Shale	—	—	—								
Niobrara Shale	—	—	—								
Mesozoic	Cretaceous	—	—	Colorado	—	—	Not used in study area as a source of groundwater				
				Graneros Limestone	—	—	—				
				Ball's Bluff Shale	—	—	—				
				Mossy Shale	200	—	Saturated units of shale and sandstone.				
				Newcastle Formation	100	Dakota	Newcastle, Sual Creek, and Ryan Raas are primary water producers. Brackish waters.				
				Hyban Kara Formation	800	Dakota	Saturated units of shale and sandstone.				

Modified from Croft (1985) and Murphy and others (2009)

C



D



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Water Use Permits as of July 2024 and Reported Water Use Near the North Unit of Theodore Roosevelt National Park, North Dakota, 1980–2023

By
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2026