

The Cache la Poudre River: From Snow to Flow



The Cache la Poudre River is located in northern Colorado. It spans nearly 130 miles in length and drops over 6,100 feet (1860 meters) in elevation. The river is a popular destination for rafting and fishing, two activities that rely on continuing flow of water. But where is this water coming from and where does it go? Let's find out.

Activity Introduction

This activity uses a series of interactive web maps, embedded videos, and printable worksheets to help you learn about watershed hydrology.

Want to test your watershed knowledge? Click [here](#) to take a pre-test. (We'll compare your answers with a post-test later to see how much you've learned!)

Note, there are two types of links throughout this story:

- Links in [green](#) will open a new tab and direct you to a different site
- Links in [blue](#) are locations highlighted on our map, click on them to explore the map content

Teachers

These online activities support an in-depth curriculum module for middle school students and beyond. This module can be used for education on hydrologic processes within the Cache la Poudre Watershed, in Northern Colorado. To access additional resources, visit our [research website](#). There you can find lesson plans, student worksheets, and additional materials.

Vocabulary

Hydrology - the science involving the presence, distribution, movement, and properties of water on land

Hydrologic Cycle - the circulation of water as it moves between the land, oceans, and atmosphere. Main components include: precipitation, evaporation, soil water, groundwater, and streamflow.

Watershed - an area of land in which all of the incoming precipitation drains to the same place. A watershed's boundary is determined by its topographic high points. Smaller watersheds can be nested within larger watersheds. The Cache la Poudre Watershed is outlined in grey on the main map.

Headwaters - the smaller streams that drain the upper portions of a watershed.

Mouth - the larger stream where water flows out of the watershed.

Snow Zone - region with similar snow cover patterns. Persistent snow zones are regions with deep snowpack where snow stays on the ground all winter. Transitional snow zones are below the persistent snow areas, where snow melts earlier in the winter. Intermittent snow zones are regions where snow falls and melts multiple times through the winter.

Precipitation - input of water to the watershed from the atmosphere, in the form of rain, snow, sleet, or hail.

Evaporation - a loss of water from a watershed into the atmosphere. Water can be evaporated from any surface (plants, water bodies, soil surface, roads, etc.).

Infiltration - the process in which water on the ground surface enters the soil.

Soil Moisture / Soil Water - water contained in the soil, reported as the percent of the soil volume that is water.

Discharge - the flow in a channel. This is sometimes called streamflow, which is the volume of water flowing through the stream over time. Discharge is reported in units of volume per time. Common units are cfs (cubic feet per second) or cms (cubic meters per second). Sometimes the volume of discharge is divided by the area of the watershed, so it can be presented in units of length per time.

Hydrograph - graphical display of discharge in streams or rivers over time.

Water Year - the 12 month period from October 1 to September 30, used in place of the calendar year so that cycles of snow accumulation and melt are contained within the same year.

Groundwater - water underground in areas where all of the rock or sediments are completely filled with water.

Storage - water that is naturally or artificially stored in soil water, groundwater, snowpack, lakes, and reservoirs.

Fort Collins, Colorado

Welcome to Fort Collins, Colorado!



The city of Fort Collins is located in Northern Colorado

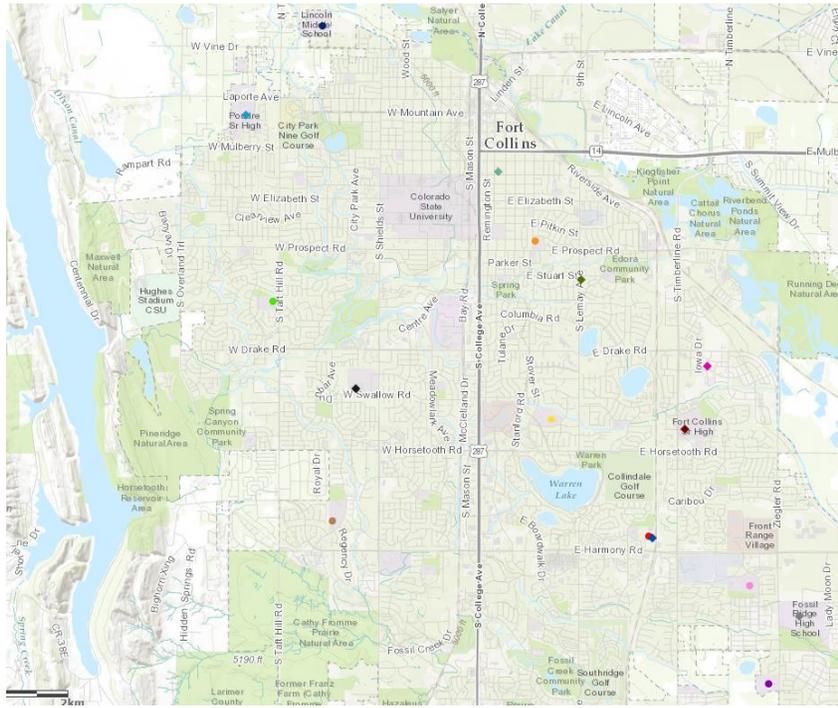
Let's take a moment to orient ourselves. Fort Collins is located at the base of the Rocky Mountains in Northern Colorado and is situated along the Cache la Poudre River. It was founded as a military outpost back in 1864 but has since grown to a population of about 164,000. In fact, it is the 4th largest city in Colorado and is home to Colorado State University.

Use the Legend to explore the map below and locate your school.

Legend

Schools

- Blevins Middle School
- Boltz Middle School
- Colorado Early Colleges Middle School
- Kinard Core Knowledge Middle School
- Leshler Middle School
- Lincoln IB World Middle School
- Preston Middle School
- Webber Middle School
- ◆ Centennial High School
- ◆ Colorado Early Colleges High School
- ◆ Fort Collins High School
- ◆ Fossil Ridge High School
- ◆ Liberty Common High School
- ◆ Poudre High School
- ◆ Ridgeview Classical Schools
- ◆ Rocky Mountain High School



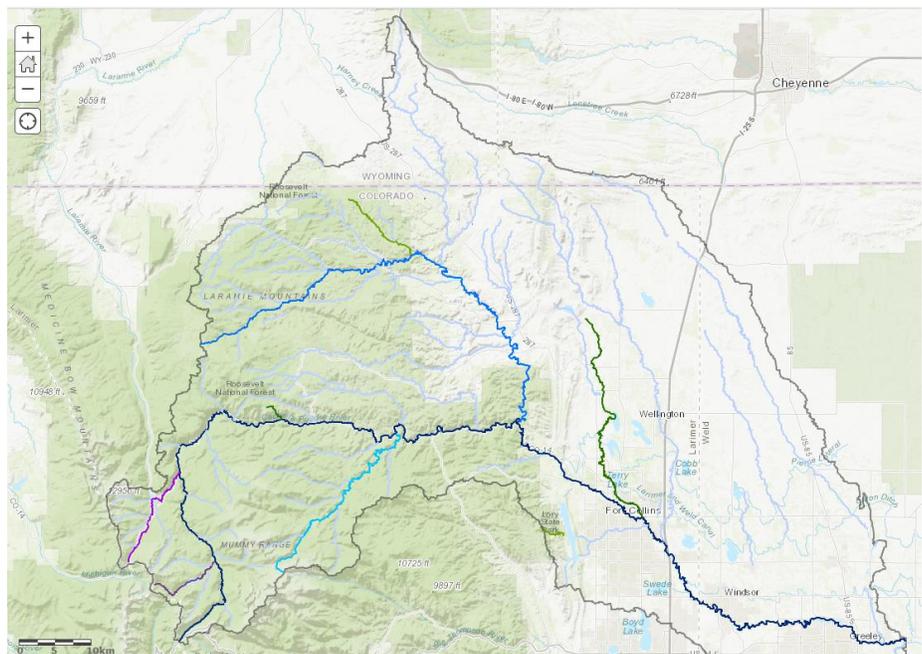
Cache la Poudre Watershed

A watershed is an area of land where all of the water drains toward a common outlet, often a stream or a river. These watersheds consist of surface water, such as lakes, streams, reservoirs, and wetlands, and the underlying soil and groundwater. Fort Collins lies within the Cache la Poudre Watershed, which includes small streams that drain into the Cache la Poudre River, and ultimately the larger South Platte Watershed. Explore the map and discover some of the main streams and rivers within the Cache la Poudre Watershed.

Legend

Rivers within the Cache la Poudre Watershed

- Cache la Poudre River
- North Fork Cache La Poudre River
- South Fork Cache la Poudre River
- La Poudre Pass Creek
- Joe Wright Creek
- Dry Creek
- Mill Creek
- Other

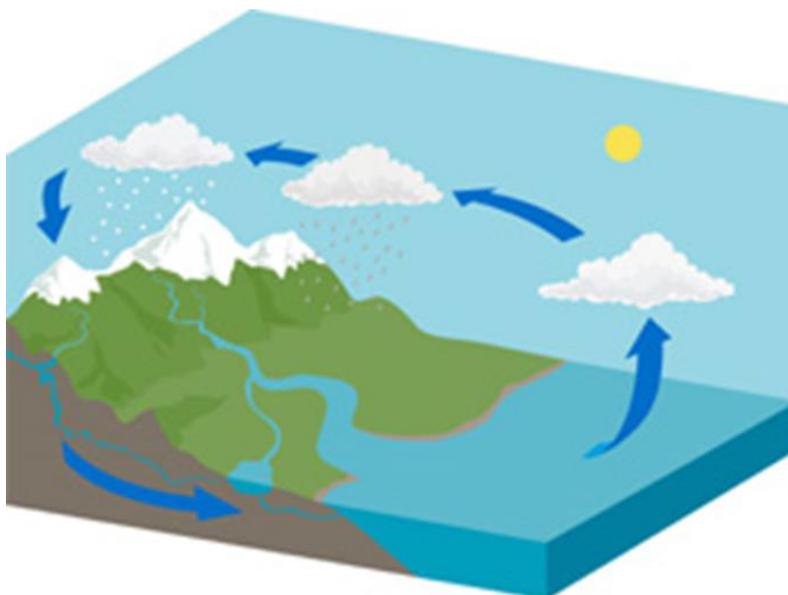


In Colorado, 50-90% of stream water comes from snowmelt, so it is important to understand the snow systems that feed this watershed. The Cache la Poudre Watershed can be broken down into three snow zones: intermittent snow zone (ISZ), transitional snow zone (TSZ), and persistent snow zone (PSZ). These snow zones all receive different patterns of snowfall and snow persistence. Variables such as temperature, elevation, and vegetation all help to shape and define these zones. We'll explore each of these snow zones in more depth.



The Cache la Poudre River in its canyon, upstream from Fort Collins

Before we move on, let's take a moment to learn about the water cycle and what we study in Watershed Science here at Colorado State University.



The Water Cycle (image source: US EPA Water Sense)

The water cycle describes how Earth's water moves and changes. Water exists in the atmosphere as water vapor, which is gas. When the vapor gets cold enough, it turns into tiny liquid droplets through the process of condensation. In cold clouds, these droplets freeze into ice crystals. The small water droplets and/or ice crystals are what we see as clouds. If the particles in clouds get large enough, they fall out as precipitation, in the form of rain or snow. Precipitation can be stored in lakes or snowpack, soak into the ground, or flow on the land surface into rivers and streams.

The Headwaters



Poudre Lake, Rocky Mountain National Park, Colorado (*image source: MaidinSun Photography*)

The headwaters of a watershed contain the smallest streams or lakes in the higher elevations. One of the contributing headwaters of the Cache la Poudre River is Poudre Lake, located in Rocky Mountain National Park. Poudre Lake is located in the persistent snow zone. Let's learn more about the hydrology in this zone.

The Persistent Snow Zone

The persistent snow zone is an area that consistently maintains a high snow cover throughout the winter. The high elevations of the Rocky Mountains lie within this zone, where you can find snow most of the year.



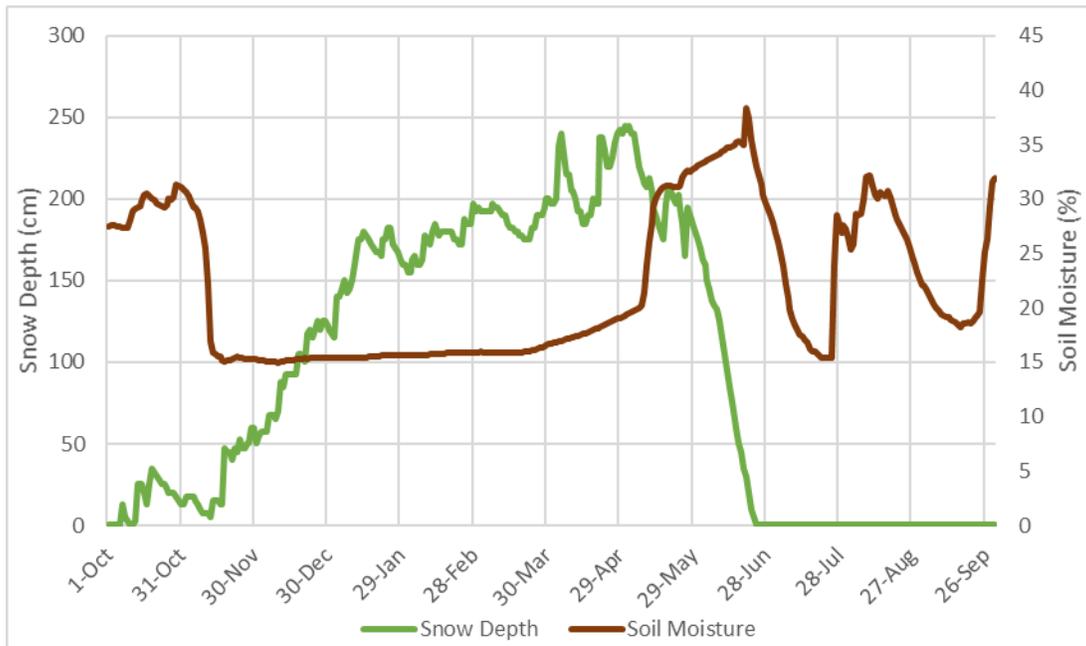
Never Summer Mountains, Colorado (*image source: John C. Hammond*)

CSU researchers monitor several locations in different snow zones in and near the Cache la Poudre Watershed. One of the persistent snow zone research sites is located at Michigan River. Here, student researchers monitor snow depth, soil moisture, and stream flow.



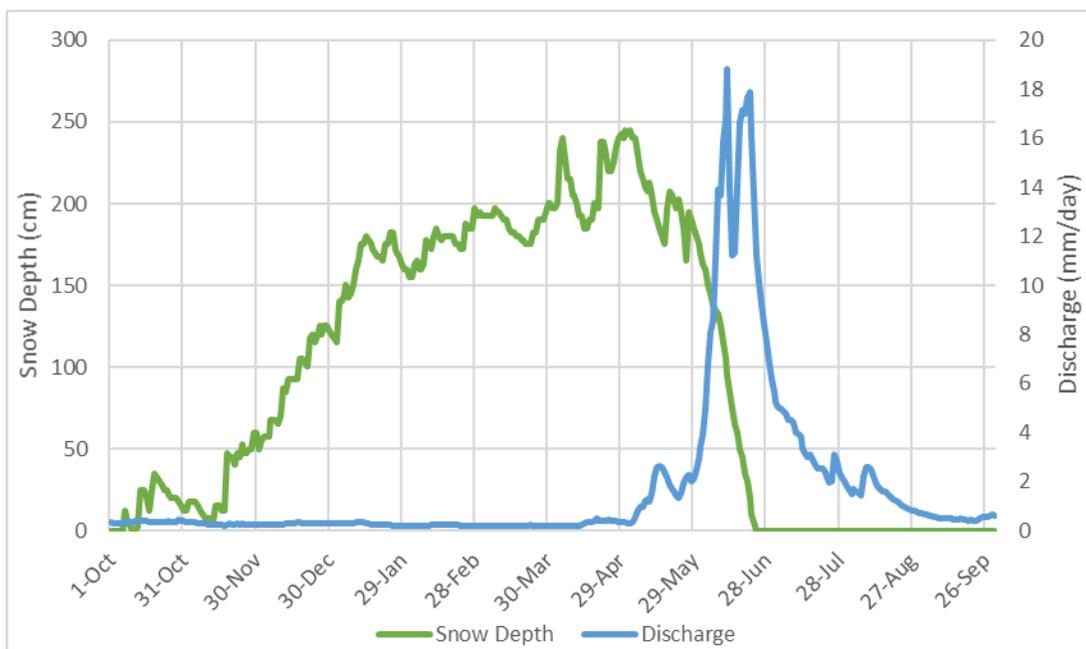
Snow monitoring at the CSU research site near Michigan River

Data from these sites help researchers understand how melting snow relates to soil water and stream flow. The first graph below illustrates the relationship between snow depth and soil moisture during the 2017 water year. In Colorado, a water year starts on October 1 because that is around the time when snow starts to accumulate in the mountains.



Snow Depth and Soil Moisture for Water Year 2016

As snow accumulates throughout the winter and early spring, soil moisture remains relatively constant. In late spring and early summer, soil moisture increases as a result of snow melt. The graph below depicts the relationship between snow depth and discharge (streamflow) during the 2017 water year. A graph that shows discharge over time is also known as a hydrograph. This shows the direct effect that snow melt has on streamflow generation. As shown in the figure below, in dry mountain regions, as snow melts, the streamflow rises. Once the snow is gone, streamflow declines, except during brief summer rains.



Snow Depth and Discharge for Water Year 2016

Snowmelt supplies water to cities and farms downstream in the watershed, and it provides water and habitat for plants and animals in mountain regions. Long term monitoring of snowpack, soil moisture, and streamflow in the persistent snow zone is important for understanding climate-related shifts and how this affects water resources and ecosystems.



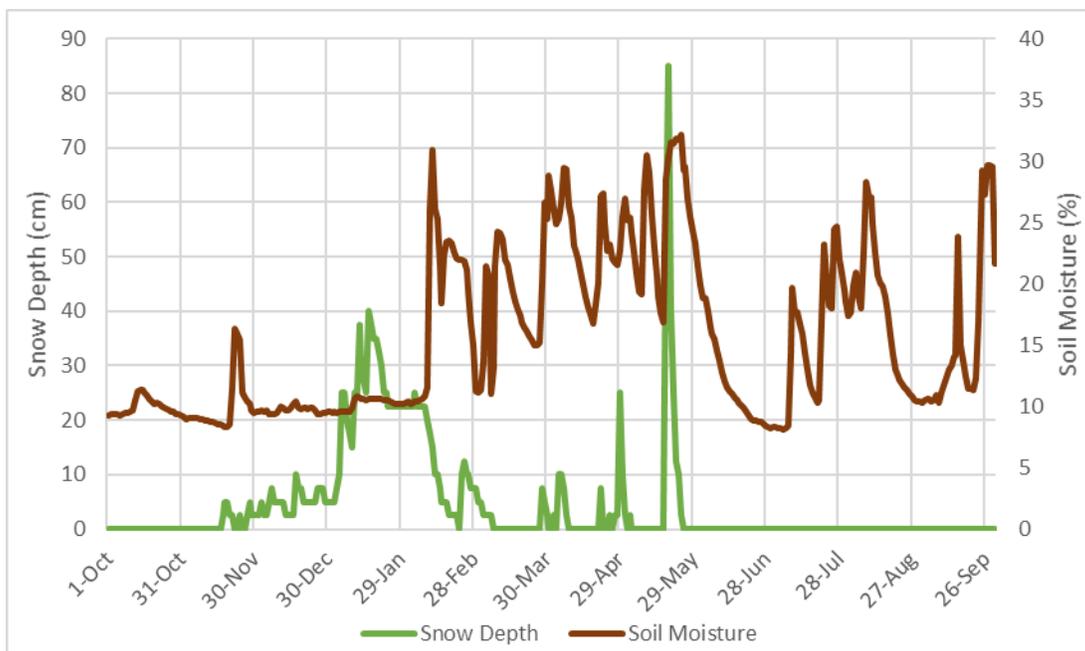
American Lakes in July (top) and January (bottom), located in State Forest State Park and the Never Summer Mountain Range. (*image source: John C. Hammond*)

The Transitional Snow Zone

The transitional snow zone is lower in elevation than the persistent snow zone, and it has higher temperature and lower precipitation. This means that the snow does not stay on the ground as long, and the snowpack does not get as deep as in the persistent snow zone. Small increases in

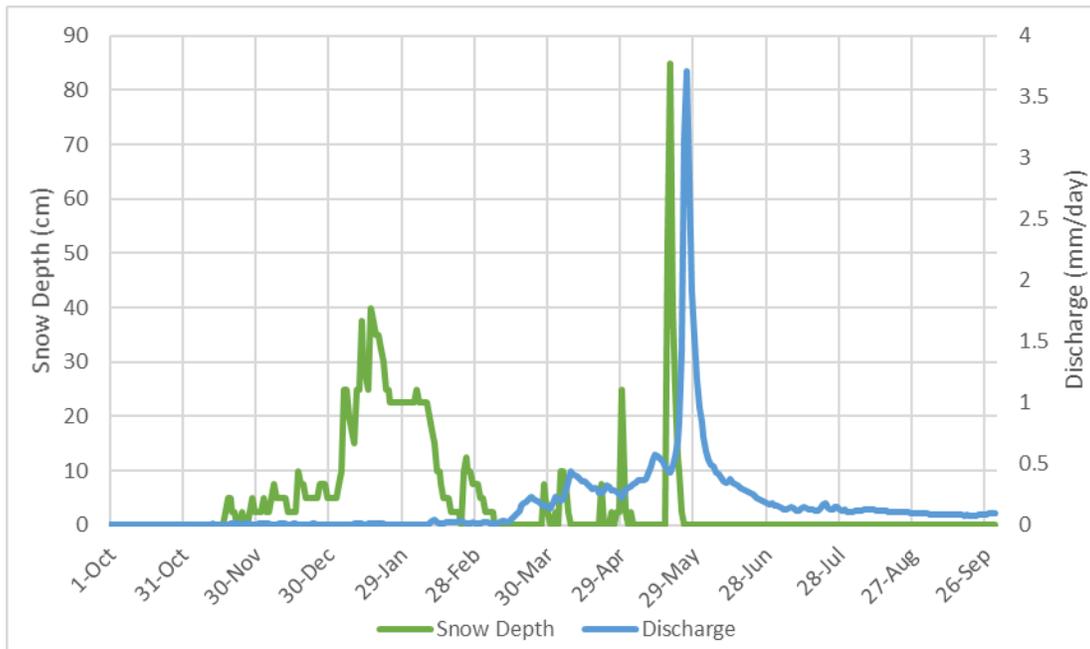
temperature in this zone can cause precipitation to fall as rain instead of snow, making this zone sensitive to climate warming. Therefore, monitoring of the transitional snow zone is important for understanding how a warmer climate may affect our water systems. One of the implications of a warming climate is that warmer temperatures may delay snow accumulation and cause snow to melt much quicker. If snow accumulation and melt are significantly altered, this can affect the reliability of water supply in the future.

Another CSU research site is located at Dry Creek in the transitional snow zone. This research site has less snow accumulation than in the persistent snow zone, and earlier snow melt. The first graph depicts snow depth and soil moisture at Dry Creek during the 2017 water year. Notice how soil moisture increases each time the snow melts.



Snow Depth and Soil Moisture for Water Year 2016

Stream discharge also increases after each period of snow melt, and reaches its maximum after the longest lasting snowpack melts in February.



Snow Depth and Discharge for Water Year 2016

Stream discharge is measured at Dry Creek by releasing a known volume of salt in solution upstream and measuring the electrical conductivity of the water downstream. Electrical conductivity rises as the salt passes by the conductivity sensor, and researchers can relate this to the amount of water in the stream. They can also visually measure the height of the water in the stream by referencing a staff gauge, which is similar to a large ruler installed in the stream.



A staff gauge is used to measure the height of the stream water at the CSU stream monitoring site at Dry Creek

Another familiar location in the transitional snow zone is the CSU Mountain Campus. Here students can attend classes, workshops, and retreats while being fully immersed in the natural world. CSU Mountain Campus also hosts Eco-Week, an opportunity for 5th and 6th graders to learn all about the Rocky Mountain ecosystem.

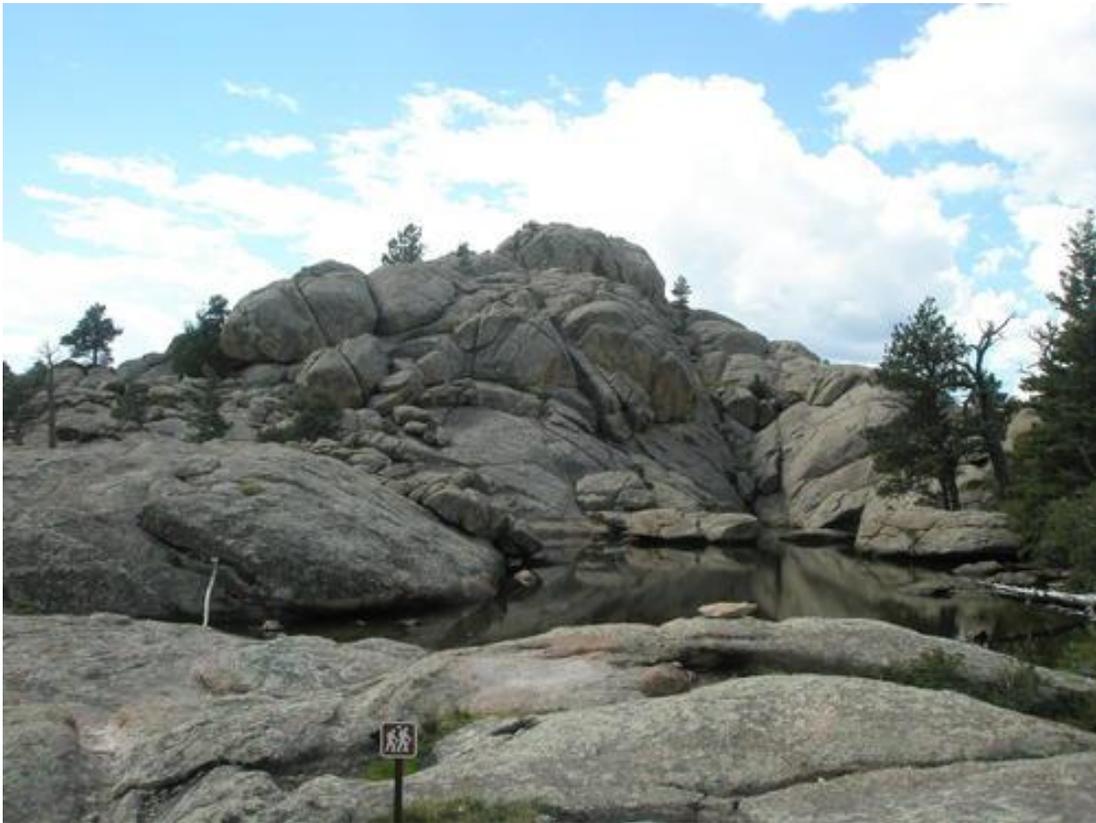


Colorado State University Mountain Campus (*image source: Rebecca Mezoff*)

The Intermittent Snow Zone

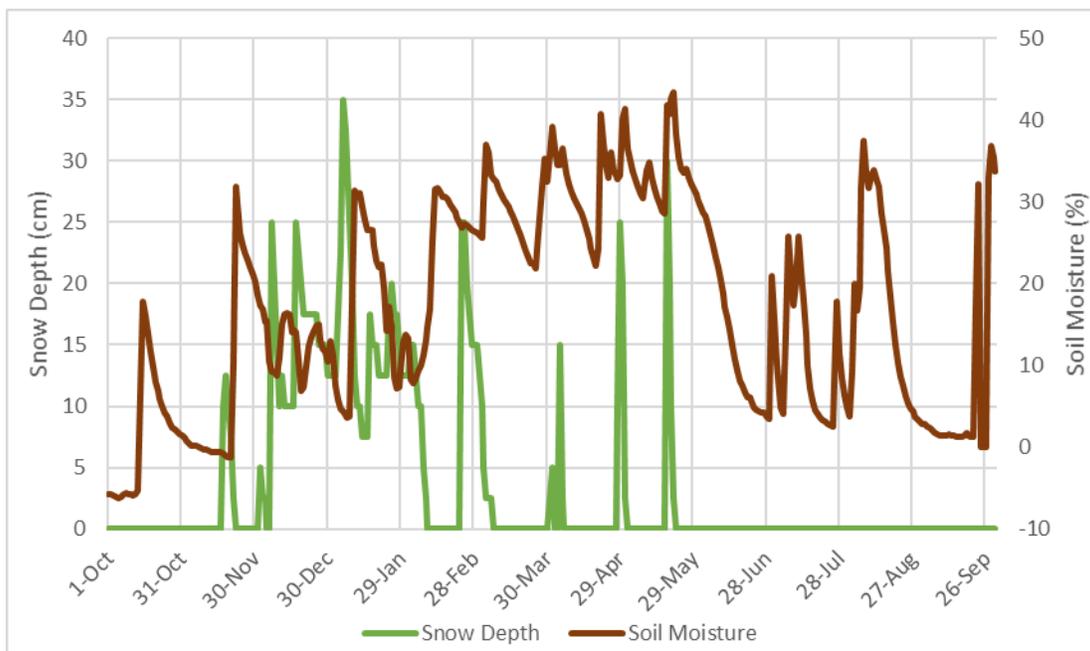
The intermittent snow zone does not maintain consistent snow cover throughout the winter, and it covers the foothills areas at the lower elevations of the mountains. Here, north-facing slopes are more likely to maintain snow cover than south-facing slopes that face the sun and melt sooner. Snow accumulation and persistence is most variable across the intermittent snow zone, emphasizing the sensitivity of this zone to changes in temperature, precipitation, and sunlight.

A notable location within the intermittent snow zone is Grey Rock Mountain, a popular hiking location for Fort Collins residents. Small tributaries follow the Grey Rock Trail, eventually joining the Cache la Poudre River.



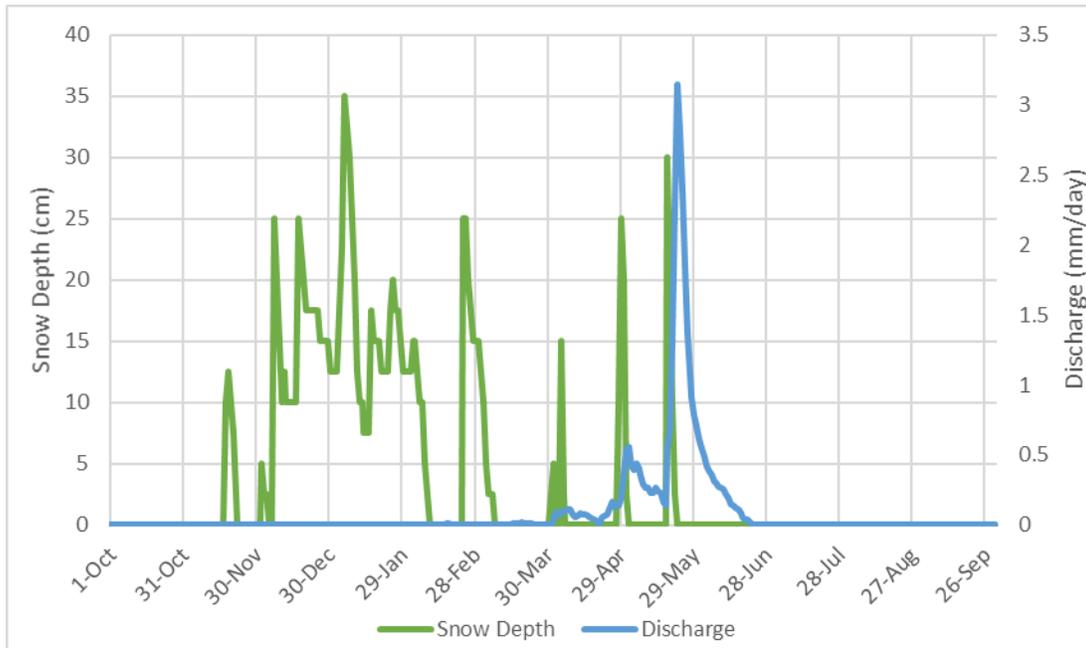
A small pool at the summit of Grey Rock Mountain (*image source: SummitPost.org*)

Another CSU research site is Mill Creek, located in Horsetooth Mountain Park. In the graph below, snow cover persisted from December 2016 through February 2017, but after that the snow accumulated and melted quickly. Each time the snow melted in the winter, the soil moisture increased.



Snow Depth and Soil Moisture for Water Year 2016

Mill Creek is considered an intermittent stream because it only flows after periods of snow melt or heavy rain. The second figure shows the response of discharge to snow depth. From October through February, discharge was negligible. However around late-February discharge at Mill Creek began to increase, reaching peak discharge in April, corresponding to substantial snow melt, then gradually decreased from April through July.



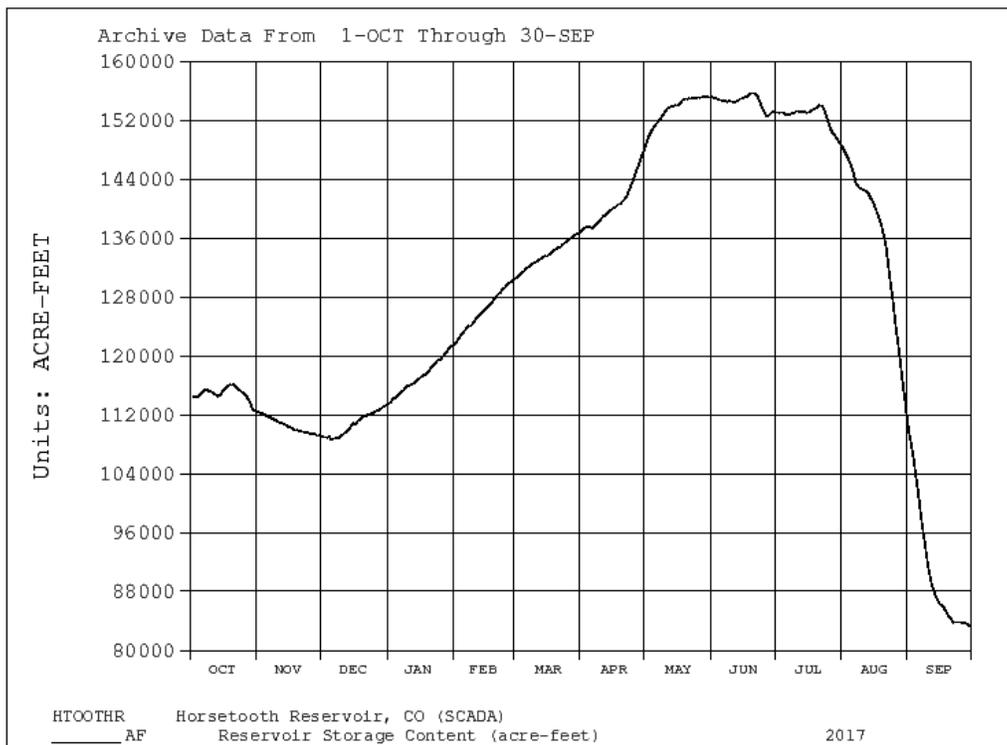
Snow Depth and Discharge for Water Year 2016

Nearby is Horsetooth Reservoir, a popular location for water activities but also one of the sources of water for the residents of Fort Collins. Four earthen dams were constructed in 1949 to create Horsetooth Reservoir, which can hold over 193,000,000 cubic meters of water! (1) The water that fills the reservoir is pumped up the west side of the Rocky Mountains, sent through a tunnel under Rocky Mountain National Park, then piped down the east side of the mountains to reach Horsetooth. Fort Collins Utilities monitors the water quality of Horsetooth Reservoir to support the protection of the City's drinking water sources. Monitoring includes routine sampling of the reservoir, determining turnover rates and storage, creating temperature profiles, and minimizing contaminants (2).



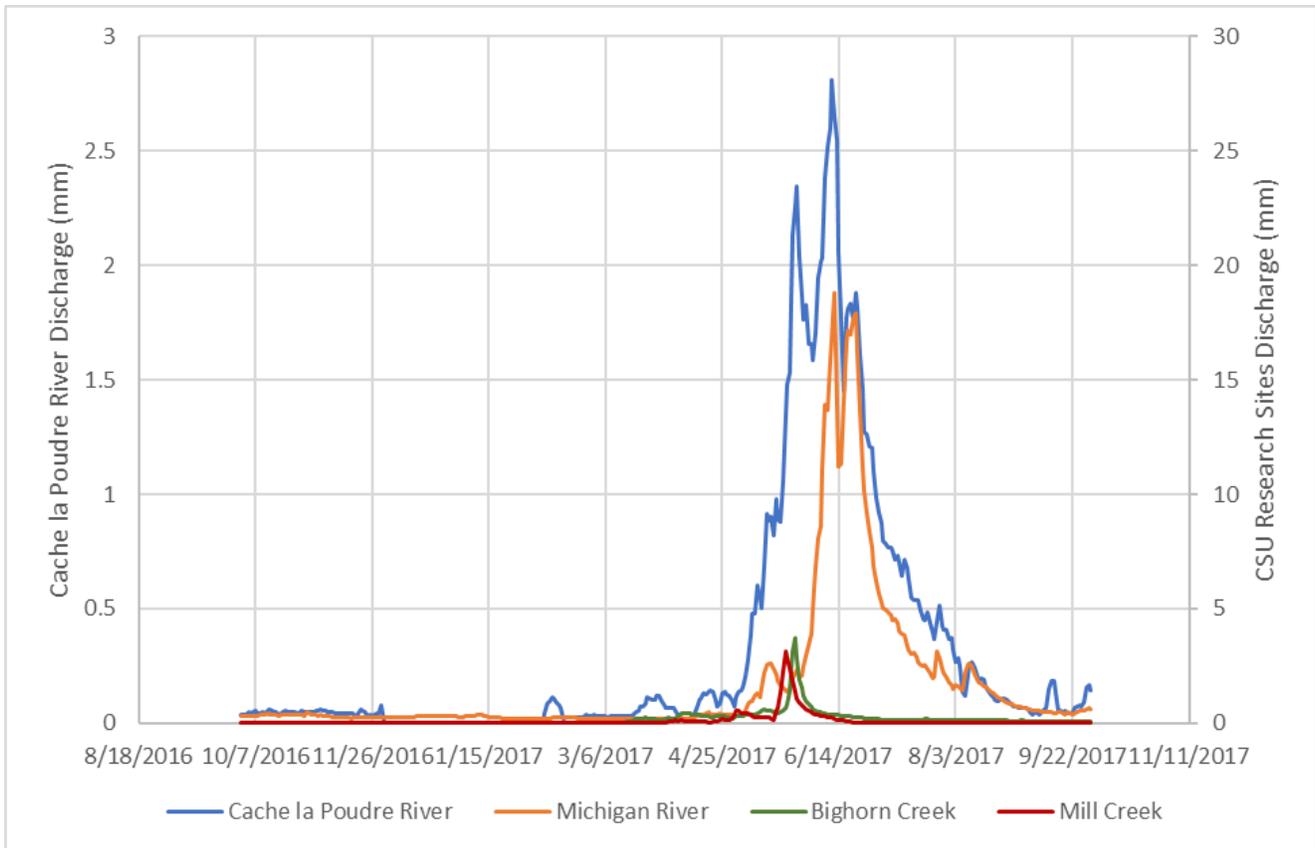
Horsetooth Reservoir, Fort Collins, CO (*image source: Laura Lee Carter*)

The following graph illustrates water storage in Horsetooth Reservoir during the 2017 water year. Storage increases in the spring, as snowmelt water from the Rocky Mountains enters the system. Water users take water from the reservoir during the summer to irrigate farms, lawns, and gardens. Fort Collins also gets water supply directly from the Cache la Poudre River in Gateway Canyon.



Water storage in Horsetooth Reservoir during the 2017 water year (*data accessed from USBR*)

Just downstream from Fort Collins' water intake on the river, another point of interest in the intermittent snow zone is the streamflow gauging station, Cache la Poudre River at Canyon Mouth. Near this point the river shifts from a high-slope, high-velocity mountain river to a lower slope meandering channel as it exits the canyon and flows across the plains to its confluence with the South Platte River. The hydrograph below shows the discharge from the Cache la Poudre River during the 2017 water year. The river receives flow from low elevation snowmelt (intermittent and transitional snow zones) early in the season (April through May) and from high elevation snowmelt (persistent snow zone) mainly during peak flow (June and July), as shown in the figure below.

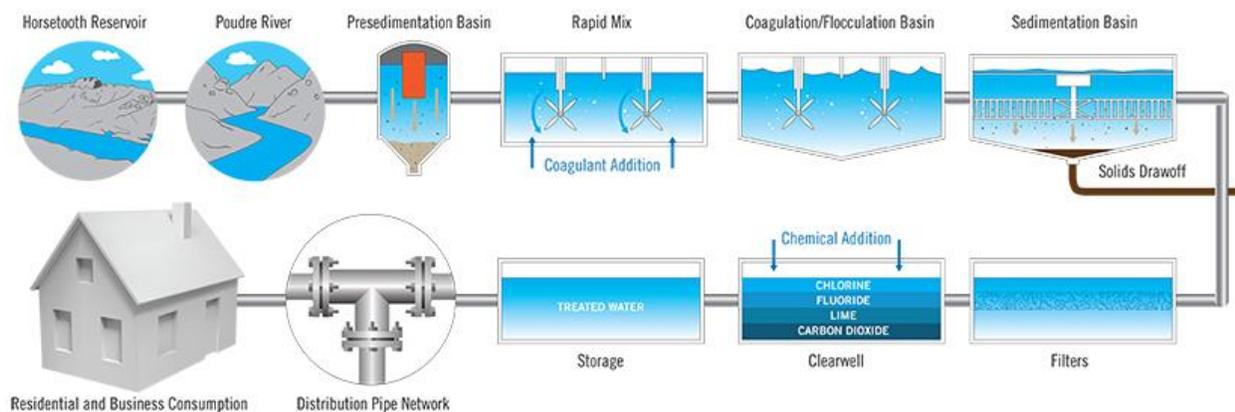


Hydrograph of the Cache la Poudre River at Canyon Mouth and CSU Research Sites for the 2017 water year (CLP data accessed from Colorado Department of Water Resources. Visit the [CDWR](#) website to view current flow conditions)

Fort Collins Water Treatment

As water travels through the watershed it interacts with contaminants and soil, and must be purified before reaching our taps. The Fort Collins Water Treatment Facility purifies the water we receive to ensure that it is safe for drinking purposes. Water collected from the Cache la Poudre River and Horsetooth Reservoir first passes through a basin where debris, sand, and silt settle out of the water.

The water then goes through a process of rapid mixing, flocculation, and sedimentation to remove any additional particles and contaminants. Lastly, it moves through a series of filters to remove impurities and a clearwell holding tank where chlorine, fluoride, lime, and carbon dioxide are added. The water is then safe to be distributed to the public. You can learn more about Fort Collins' water treatment [here](#).



The Water Treatment Process

From Snow to Flow

From the atmosphere to the mountains, to rivers and into our homes, water travels a long way! Maintaining ongoing research and monitoring will allow us to predict patterns and understand the effects of short- and long-term climate change on our water resources. This places a responsibility on us as citizens to appreciate and understand the importance of water resources to our environment and to our lives here in the Front Range.



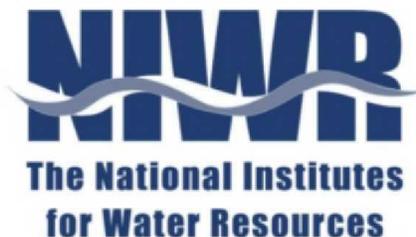
Now that you've learned about the Cache la Poudre Watershed, click [here](#) to a post-test.

Interested in helping learn more about streams in our watershed? Join **Stream Tracker**, a community powered stream monitoring project. Stream Tracker's goal is to improve the mapping and monitoring of smaller, intermittent streams through crowd sourced on-the-ground observations of streamflow. To learn more and get involved, [click here](#).



If you have any questions or would like to provide feedback, please use this [form](#).

Research supported by the National Science Foundation and the National Institutes for Water Resources.



Field photography: John Hammond, Alyssa Anenberg