Section 9: Common Management Challenges and Questions

While prairie streams may hold great potential, they also have experienced significant change and disturbance over hundreds of years. This section describes a few of the most common challenges seen in prairie streams across western South Dakota.

Overview of Common Riparian Management Challenges
A healthy, well-managed riparian area can provide many benefits to the landscape. These include water storage and retention high in the landscape, quality grazing forage production, flood protection during high flows, water quality protection, and habitat for wildlife (including game species, beneficial birds, insects, and pollinators). Loss of stream function however, either in terms of stream health or grazing value, is common across western South Dakota. Streams are affected by both upstream watershed conditions and local management practices.

For many landowners and managers, common stream and riparian management issues and challenges often center around the following issues (not in order of importance):

1) Active channel incision, bank erosion, and streambank instability
2) Overwidening
3) Inadequate low flows
4) Lack of adequate riparian vegetation, low-quality vegetation, and invasive plants
5) Poor water quality
6) Poor soil conditions, including salinization and sodification (an accumulation of water-soluble salts and/or sodium in the soil that leads to structural decline of soil)
7) Highly altered streams: impoundments, road crossings, and culverts

Due to the dynamic action of water in streams and riparian areas, these issues are often interrelated. This section will describe each of these challenges and possible causes in further detail. Later sections of the guide will then describe management options that can be used to help heal or recover prairie streams experiencing challenges such as these.

Active Channel Incision, Bank Erosion, and Streambank Instability
Active channel incision and headcutting are indicators of stream channel instability that leads to entrenchment. These downcutting sites often start with a single “knickpoint” (or headcut), as shown in Figures 80 and 81. Headcuts are commonly formed or originate at places of high disturbance, such as livestock trails, road crossings, etc. Culverts and road crossings can have particularly severe impacts on streams because they concentrate flow and contribute to downstream scouring. Headcutting and undersized or improperly designed culverts accelerate water and erode its channel. The downcutting of the stream channel causes vegetation to dry out, increasing erosion and sediment loss. This allows a headcut to migrate farther up the channel as well.
Figure 80: A headcut is forming in an upper headwater system. The area above this headcut is not incised. Below the headcut, the channel is downcutting and incising. Photo © Corissa Busse, TNC

Figure 81: When headcuts occur below water, they may not be easily visible—but they often can be heard. Here, the knickpoint where a headcut is forming underwater causes the water level to drop. The rush of water flowing down is audible. Photo © Corissa Busse, TNC
As downcutting and incision persist, a stream and its channel will begin to drop along with the water table below ground. This will create multiple management challenges, as shown in Figure 82, including difficulty accessing the water for livestock and wildlife, inability of managers to easily cross streams, and loss of riparian zones and the beneficial vegetation they provide.

Many of the problems associated with channel erosion, downcutting, or high bank instability are also caused by increased streamflow after large storm events, which erode and transport sediment. This problem has become more pronounced in western South Dakota in recent years due to the increased frequency of large precipitation and runoff events; it is not uncommon to now receive several inches of rainfall in under an hour. This has led to very high streamflow levels and flooding; accelerated erosion; and damage to roads, culverts, and other streamside infrastructure (Wienhold et al. 2018). These large rainfall events also trigger headcuts, which as noted can instigate problems both up and downstream.

Loss of infiltration and soil water-holding capacity across watershed areas frequently leads to excess runoff and creates increased peak flow and downstream flooding that can cause channel erosion problems. Altered hydrology and loss of infiltration across large portions of the watershed can be the result of recent changes in climate or land use, or they can be the cumulative effect of multiple changes in land use and management extending back many decades. If land-use or climate changes (such as new land conversion or increased precipitation in storm events) happened abruptly and recently, there may be an abrupt increase in channel erosion.

In more urbanized or intensive crop production regions of the United States, loss of water storage and infiltration is often related to draining wetlands and/or an increase in impervious surfaces, such as paved roads and parking lots. However, in western South Dakota, widespread soil compaction, reduced plant cover and loss of soil organic matter can occur across large areas due to extended drought, a long history of overutilization, and the loss of the historic plant community. Channel responses to these alterations may take many decades to adjust throughout the system, meaning that a stream that is currently actively downcutting or incising may be responding to management or environmental changes that occurred from historic events.

When the stream reach is at the downstream end of a relatively large watershed, and/or the landowner owns only a small portion of the overall watershed, an integrated approach of best management practices and tools will be needed to address stream health issues.

It is often possible, however, to heal or prevent the further spread of headcuts into a pasture at the local level by using site-specific management interventions. Similarly, it may be possible to rebuild a stream that has recently incised if the incision level is not too dramatic. Improved grazing management can positively impact riparian vegetation, which slows and traps sediment. In addition, in-stream installations such as Zeedyk structures and beaver dam analogs can be used to slow water and help trap sediment in the channel, which can then begin the stream’s natural rebuilding process. These management interventions are described further in the following section.

**Sensitivity to Downcutting**

Certain stream types are more sensitive to disturbances, such as flood events, prolonged drought, channelization, and/or grazing pressure. As streams change over time, they often follow a pattern or cycle, as described in earlier sections. This cycle is influenced by the stream’s position in the watershed, the slope, and the soil type. Many of the headwater streams and woody draws in western South Dakota are highly sensitive to disturbance because they run through soils composed of highly erodible fine sediments (clay and silt) and thus are prone to rapid channel adjustment. Streams with larger drainage areas are also sensitive to disturbance and likely to downcut because the larger volume of water exerts greater force on the banks.

The controlling influence of vegetation is very high in the slightly entrenched channel types. This means that if vegetation is removed by disturbance, streams are more likely to erode downward and/or widen, as shown in the Channel Evolution Cycle. Streams that are more entrenched have increased stream power and velocity, which will make restoration more challenging as the banks continue to erode.

Active channel incision is related to or plays a role in many of the challenges listed below in this section. It is the precursor event that contributes to bank erosion, degrading plant communities, and reduced flows.
Incision Leads to Excessive Bank Erosion and Streambank Instability

Streambank erosion is a natural process, but it is often accelerated by human activities that alter the plant community or increase flow and slope. Excessive bank erosion is a warning sign that a stream has limited ability to dissipate its energy and could result in additional riparian health problems. These issues tend to occur when there is a loss of deep-rooted plants. As streams lose bank stability, they become wider and water moves faster; over time their length shortens, and they become straighter as the water cuts through collapsing banks. Streambank instability is often closely related to channel incision. When channels are eroding laterally, it can cause problems for human structures such as fences and buildings. It also can make streams less accessible to livestock and more difficult to cross and may degrade water quality due to excess inputs of sediment.

Figure 82: This stream has incised nearly 10–15 feet. It is no longer easily crossed or accessible to livestock and wildlife. The surrounding meadow area will lose vegetation productivity due to the drop in the water table. Photo © Kristen Blann, TNC
Overwidening
Channel widening can occur when the stream bed hits a resistant soil layer such as claypan or bedrock, creating resistance to channel incision. In this case, bank erosion leads to channel widening rather than incision, and stream depth decreases. This can have significant impacts on the floodplain ecosystem and cause stream temperature to rise, drying out ephemeral or intermittent reaches earlier in the season. Typically, little water is retained in the streambanks for use by vegetation or delayed release back into the stream (Wyman et al. 2006).

Figure 83: This channel has widened considerably in recent years due to streambank collapse, leading to shallower flow with little vegetative overhang to provide shade and habitat for aquatic life. Photo © Corissa Busse, TNC

Inadequate Low Flows
Increased peak flows caused by excess runoff and reduced infiltration are frequently associated with extreme low flow periods. This indicates poor storage and capture of water in the watershed during wet periods and could be a warning sign of a falling water table as a stream downcuts and hydrology is lost. Low flow may create stressful conditions for the riparian plant community, wildlife, and aquatic life. While low-flow conditions are normal for streams in the region (by definition, intermittent streams go dry part of the year), channel incision and inadequate vegetation cover throughout the upland landscape contribute to excess runoff and poor soil infiltration. This worsens low-flow conditions because less water is being held in the soil profile throughout the watershed. Local flow and/or water levels can also be impacted by local impoundments and/or groundwater pumping, reducing baseflow and connectivity of streams during the late summer or fall, when water levels are typically at a low point for the year.
Lack of Adequate Riparian Vegetation, Low-quality Vegetation, and Invasive Plants
A common problem in riparian areas is poor quality or inadequate riparian vegetation, often associated with bare exposed soil in the channel and banks, leaving the stream vulnerable to water and wind erosion. The plants present in these degraded buffers are often weedy pioneer species, annuals, unpalatable salt-tolerant species, or invasive species that have little value as forage or wildlife habitat and that provide little streambank protection against high flows.

Poor quality riparian vegetation is often a vicious cycle. A period of high flows, drought, or other disturbance may trigger the original decline in vegetation. This decline can continue if disturbance continues, preventing plants from re-establishing. Scouring from high flows causes banks to dry out and the water table to lower as the channel begins to downcut. This lowering of the water table in the adjacent floodplain or terrace caused by channel incision is a subtle impact that dries out riparian soils and adjacent meadows (Chambers et al. 2004, 2016).

Drier conditions support less productive grasses and forbs and reduce the potential for desirable or woody riparian species to establish. As the riparian water table drops from ~3 inches in depth to greater than 60 inches in depth, the landscape changes. Channel incision greater than 3 feet can move the riparian zone from a wet meadow to a dry meadow or upland community. This is less desirable from both an ecological viewpoint and from a grazing standpoint, as there is less desirable forage and reduced water-holding capacity in the uplands.
Figure 85: As banks erode, the plant roots are exposed, which causes them to dry out and die. As the roots die, they are no longer able to hold soil. This creates a negative feedback loop of erosion and drying. This photo also demonstrates the lack of deep fibrous root systems in degraded areas that lack strong riparian vegetation. Photo © Joe Dickie, Generation Photography, Inc.

In comparison, strong riparian vegetation such as prairie cord grass and willow can help protect banks and capture sediment; they provide roughness that reduces stream velocity and its erosive power. As mentioned previously, some stream systems neither require nor have the potential to support woody vegetation, but a diverse herbaceous plant community can be equally effective at providing protection. Some systems need woody vegetation to function properly, but others do not. For that reason, it is important to understand the stream type that you are working with.
Figure 86: Small headwater streams, as shown in the photo on the left, may have some potential to support woody shrubs and small trees. The top right photo is an example of a mid-size prairie stream system that can support woody species, but because of loss of floodplain connectivity, trees are rare and struggling to survive. Larger systems like the one shown in the bottom right have more potential to support woody species. Photos © Joe Dickie, Generation Photography, Inc.

Larger prairie streams are more likely to support woody species than headwater meadow streams, which historically were subject to frequent fire and grazing. However, we surveyed many headwater streams in 2018–19 where infrequent, large mature cottonwoods were present, suggesting that riparian conditions even in these areas supported cottonwood establishment and persistence at some point in recent history. The presence of mature cottonwoods does not mean that the area is currently suitable for the establishment of young cottonwood seedlings. Cottonwood recruitment is influenced by access to shallow groundwater and sustained moist soil conditions throughout the growing season, as well as the occurrence of small flood events that deposit new sediment and seeds. As channel incision and dams have altered the hydrology of streams, favorable growing conditions are less likely to occur.
Poor Water Quality

Poor-quality water can have a negative effect on growth, reproduction, and general productivity of livestock and wildlife. In some cases, animals can die within days or hours after drinking low-quality water. Salinity is one of the most common water quality issues. Animals that have an increased requirement for water (e.g., during lactation or pregnancy) are the most susceptible to salinity. High salinity has been an increasingly common problem in South Dakota in past years. Limited snow run-off and dry conditions, along with evaporation, contribute to increased salinity concentration and should be a warning to producers that possible water problems may exist under these conditions. It is important to understand that limited run-off and drought increase the risk of poor-quality water; however, some water sources are “bad” regardless of environmental conditions.

The most widespread water quality issues for aquatic life in South Dakota streams are low dissolved oxygen, high temperature, and excessive nutrients (mainly nitrogen and phosphorus) from runoff. As stream levels recede and temperatures increase in the summer, low oxygen levels make it difficult for fish and aquatic life to survive (Dodds et al. 2004). Although these conditions are part of the natural pattern of intermittent prairie stream hydrology, they can be worsened by water withdrawals, farming practices, the alteration of riparian vegetation, and impoundments. Manure and/or farm runoff can add nutrients to streams and ponds, causing excessive algal growth that further worsens water quality in the form of blue-green algae (cyanobacteria) blooms.

Figure 87: Algae blooms and poor water quality may occur in heavily used, low-flowing streams. Photo © Corissa Busse, TNC
Poor Soil Conditions, Including Salinization and Sodification
Challenging soil characteristics occur across rangelands in the Northern Great Plains (Letey 2000). Typically, soils derived from marine sediments have high concentrations of sodium and other salts. Salts are leached out of soils into runoff and shallow groundwater seepage and tend to accumulate along the flowpaths of water at discharge points (as shown in Figure 88). Salts also accumulate where evaporation and evapotranspiration exceed inflows, such as in poorly drained footslope areas or along the margins of streams, wetlands, and impoundments (as shown in Figures 89 and 90). Frequently, evaporation and seepage from stock dam impoundments and even natural wetlands can exacerbate conditions that lead to saline and sodic conditions. Irrigation of hay, pasture, and cropland, both current and in the past, can also contribute to increased salts and overall changes in soil chemistry.

These soils are toxic to many plants and limit the growth of most species. The presence of salt-tolerant plants such as kochia (*Kochia scoparia*) and foxtail barley (*Hordeum jubatum*) indicate conditions where salt concentrations may be high. In extreme cases, there may be no vegetation. In the worst cases of soil salinization, streams contain barren exposed flats of varying sizes. Salinization can also lead to poor water quality for livestock in streams and stock ponds.

Salts and salinity are a natural component of the system in parts of western South Dakota, and plant communities have evolved to tolerate saline conditions. However, in some riparian areas or along the margins of stock dams and impoundments, salt accumulation exceeds the natural balance due to human-made disturbances of the landscape. Unlike historic beaver dams, which allowed slow but continuous flows of water through a system over greater areas, stock dams are designed to be impermeable and concentrate water, holding it in a confined area where it experiences greater stagnation and evaporation once inflows dry up. These water sources have an increased risk of salinity and other water quality issues.

At the time of this guide’s publication, increasing attention is being given to salinity, and research is being conducted around how to address this difficult challenge, especially related to stock dams and impoundments. We recommend that you contact your local NRCS or SDSU Extension office for technical assistance and the most up-to-date guidance on how to address salinity issues.

*Figure 88:* Salinity accumulation causes loss of vegetation in riparian areas. Photo © Corissa Busse, TNC
Figure 89: At this poorly drained foot slope, intermittent/ephemeral hydrology has created salt accumulation due to evaporation. Photo © Lori Brown, TNC
Highly Altered Streams: Impoundments, Road Crossings, and Culverts

As mentioned earlier in the guide, many of our stream systems are highly altered. Some of the alternation is minor and has minimal effect on the overall health of the system; some alterations are drastic and directly impact the connectivity and integrity of a stream. We are just beginning to see and understand the full effect that alterations can have on stream health. The most common alterations to stream connectivity in our landscape are small impoundments, road crossings, and culverts.

Small impoundments and cattle stock ponds are intended to capture and store runoff, provide livestock with water later into the season, and attract wildlife. The storage of spring runoff water through the season is vital for livestock managers. Often, these stock dams and impoundments may be the only source of water available in large summer pastures to sustain livestock and other wildlife. However, impoundments can also create challenges on the landscape. In addition to capturing and storing water, they also capture and store sediment and, in some watersheds, accumulate salts. The sediment fills the ponds over time, which decreases the water storage capacity and starves the stream of sediment that would have helped build point bars and sinuosity. As a result, the erosive power of the water is increased and contributes to downcutting of the stream. The salts that are accumulated can cause water quality issues as they slowly leach out and concentrate downstream.

Furthermore, many riparian species like cottonwoods are dependent on natural flood events that deposit sediment, create scouring, and open soil for seeds to germinate, recruit, and establish (NRCS 2002). Unlike historic beaver dams, impoundments do not allow a continuous flow or trickle of water through them. We are still learning about how impoundments and dams influence and affect the landscape; more research is needed to help find solutions to balance the need for livestock water.

Figure 90: This small stock pond has a distinct ring of salt accumulation. In some situations, salt accumulation can create toxic conditions for livestock and wildlife. Photo © Lori Brown, TNC
Road and road berms can also function as impoundments, causing similar challenges and issues. Poorly designed water infrastructure such as perched or undersized culverts can create management issues and block movement of aquatic life, reducing connectivity of the aquatic habitat. This can permanently fragment populations and eventually eliminate those species from upstream reaches (Hernick et al. 2019). Undersized or poorly designed culverts may also be washed out or undermined during high flows, creating maintenance needs and raising costs for local government and ranch owners. Poorly designed road crossings can often trigger channel instability and headcuts that can migrate upstream or downstream. For example, during high flows, bridges or culverts that constrict the channel can cause a “fire hose” effect downstream or erode on the upstream side where flows are held back.

Figure 91: Culverts and road crossings can significantly constrict the flow of water in a stream during flood events. This constriction point can then intensify the force of waters, creating headcut and incision challenges, which not only create challenges for the stream but also compromise the road over time. Photo © Christian Lenhart, TNC
Holistic Plan Revives Ranch Springs and Soils

“A shift to bison, strategic grazing, and proper grass rest and recovery yields success in partnership with nature.”

The adage ‘time heals all wounds’ is appropriate for the 777 Bison Ranch, thanks to holistic management practices implemented by owner Mimi Hillenbrand over 30 years ago.

“By capturing water, controlling grazing to rest and recover grass, and building healthy soils, we have restored our prairie using bison, in partnership with nature,” she says. “It’s an ongoing journey that takes time, trial and error, and constant monitoring—but it works to produce more grass and increase water infiltration to feed the many springs this practice has created.”

Her journey began in 1970, when she was a child and her family bought a ranch near Hermosa, east of Custer State Park in South Dakota. The ranch had a traditional, cow–calf Angus/Hereford herd and the family used the same pastures for calving, spring, summer, and winter. They also employed tillage and seeding of crested wheatgrass and smooth bromegrass—initially thought to be an ideal remedy for overgrazed rangeland.

An aha moment

Hillenbrand’s passion for holistic practices was born during high school when she heard Allan Savory speak on the value of working with natural soil systems to graze and rest grass. “It just made sense to me and helped me determine what I wanted to do with my life,” she shares.

She saw how previous pasture management had degraded the ground and eroded the creek beds, and how repeated grazing caused the creek areas to lose vital vegetation. “If we had a heavy rain back then, it would wash right through and be gone because the land was so degraded, so I knew we had to change,” Hillenbrand says.
The ranch had very few seasonal springs, and Dry Creek, which ran through the ranch, lived up to its name. “I remember when we moved cattle, the creek was so dry you could easily drive a four-wheeler over it in certain parts where it wasn't steeply eroded.”

**Enter the bison**

In the early 1980s, the ranch began incorporating bison into the beef herd. A nasty spring blizzard during calving season changed the ranch philosophy forever, prompting a shift away from beef to 100% bison.

“We were pulling calves from our beef cows and trying to keep them warm in the middle of a blizzard. Yet, all the bison waited to have their babies until after the storm had passed,” Hillenbrand says. “It was the coolest thing to see how bison adapted to nature. They are survivalists.”

That reevaluation helped spark a prairie regeneration journey for Hillenbrand. She adopted what was then known as the Savory System—wagon wheel paddock pastures around a central watering point. But the survivor characteristics of the bison also led to some teachable moments, including a disregard for electric fences, which made it difficult to contain them.

“We've learned a lot from the bison over the years,” Hillenbrand laughs. “We've put up fence, added electric fence, taken down fence, taken out all electric fence, and redone pasture shape and size. At one point, we had 36 pastures, and now we're down to about 25 pastures, which seems to work for us.”

Being flexible and writing spring and fall grazing plans in pencil are key to their grazing success. In addition, over the years, they have extended their two pasture recovery periods during the growing season. “It used to be between 40 and 100 days, but now we have more success with 60 to 120 days of rest and recovery.”

To judge forage quality, quantity, and recovery, Hillenbrand must do daily monitoring. She and her team check the grass and herd daily to move the animals while maintaining healthy grass. “We move the bison anywhere from after a couple of days to after a week in a fast-growing smaller pasture. Or it can be seven days to three weeks in a larger pasture,” she says. “It's daily decisions, and you have to be on the land all the time to know what's happening.”

**Dry Creek becomes a plant and wildlife haven**

More than anything, Hillenbrand wanted to bring back native grasses and keep water on the land. During the past eight years, more sections of Dry Creek have had constant water, due to more springs running year-round.

“By planning our grazing, I've noticed over the years that our creek has more willows and young cottonwood trees, and more groups of prairie bulrush and other aquatic vegetation filling in, which is super exciting,” she says. “And our bird and wildlife habitat increase every year, bringing in flocks of bobolinks and dickcissel, ducks, cranes, trumpeter swans, shorebirds, deer, mountain lions, coyotes and more.”

When big rain events happen now, the water no longer runs fast and disappears. Instead, it soaks into the soil. A study conducted on the ranch confirmed that infiltration rates have vastly improved.

**Research proves holistic benefits**

Five years ago, Hillenbrand hired the company Applied Ecological Services to conduct an overall ranch health assessment. Over the course of a year, they mapped soils and plant species, examined water infiltration, and measured soil carbon, then compared these values with those of area ranches that were still practicing traditional grazing.

“We learned that we have two to three times more native grass species and fewer invasive species, and our water infiltration rates were dramatically higher,” she says. “I'm so proud of my team, because achieving those two goals means we're doing things right.”

Hillenbrand firmly believes that if you graze correctly and take care of the land, everything else falls into place. However, she describes her ranch as a work in progress, since there are always areas to improve. “That's why we're always learning, attending conferences, remaining open to new ideas, and doing things better—knowing that improvements take time.”
Figure 1. Ranch owner Mimi Hillenbrand with ranch manager Moritz Espy. The 777 Bison Ranch team practices holistic grazing practices on the operation. Photos © Joe Dickie, Generation Photography, Inc.

Figure 2. The 777 Ranch works with bison as grazers, moving them rotationally over the land to mimic the historic movement of the herds. Photos © Joe Dickie, Generation Photography, Inc.
Figure 3. The 777 Ranch has seen many springs reappear across the ranch over the years as they continue to increase their soil profile. Photos © Joe Dickie, Generation Photography, Inc.

Figure 4. Willows, young cottonwood trees, and more groups of prairie bulrush and other aquatic vegetation are filling in along Dry Creek on the ranch. Photos © Joe Dickie, Generation Photography, Inc.