Study of Effects of Conservation on Streamflow

Supplemental Report

Findings Presented at the Basin-Wide Plan Annual Meeting, November 15, 2023

Jointly prepared by
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&
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Introduction

Neb. Rev. Stat. § 46-755(1) requires a basin-wide plan (Plan) for the Republican River Basin (Basin) jointly developed by the Nebraska Department of Natural Resources (NeDNR) and the Natural Resources Districts (NRDs) in the Basin. This Plan became effective on March 1, 2019. The approved Plan's Introduction section contains further information.

Neb. Rev. Stat. § 46-755(5)(d) requires NeDNR and the Basin NRDs to conduct a technical analysis within five years of the Plan's adoption and every five years thereafter. It identifies actions taken in the river basin that determine progress towards meeting the Plan's goals and objectives. The technical analysis includes an evaluation of the effects of conservation practices.

To study the effects of various conservation practices on streamflow, a literature review of academic and other publicly available sources was completed. In some cases, the sources will be specific to the Basin while others will have broader implications and applications. NeDNR and the Basin NRDs agreed to conduct this literature review one, as a first step in fulfilling requirements of Plan Action Item 2.5.1 and two, as a component of the evaluation of conservation practice effects for the First Five-Year Technical Analysis (Analysis) (analysis period 2019-2022). The Analysis is available in the "Plan Implementation" section of the Plan Website. To the extent practicable, NeDNR and the Basin NRDs will continue to work together to further fulfill Action Item 2.5.1 and improve the analysis of conservation practices in the Basin for subsequent five-year technical analyses.

Conservation Practices Overview

Our literature review focuses on select water and soil conservation practices. These practices are designed to reduce erosion and associated nutrient runoff, optimize the use of precipitation and irrigation water, and reduce non-beneficial water consumption (Flatwater, 2013; USDA, n.d.). The Natural Resources Conservation Service (NRCS) has a broad variety of conservation practice standards that may be beneficial to basin stakeholders. The beneficial effects of these practices do not necessarily equally impact groundwater and surface water. For example, some practices may protect groundwater quantity at the expense of surface water quantity, while simultaneously protecting water quality for both.

Categories of conservation practices in this review include improved irrigation efficiency, temporary production retirement (CREP/EQIP programs), conservation tillage, crop rotation, canal rehabilitation, and physical controls. Within each section, a general overview of the practice and associated benefits and costs is given. Benefits

may directly impact surface or groundwater as well as soil and crop health plus other associated natural resources conservation advantages.
Several of these practices have interrelated benefits and trade-offs that are compounded when the practices are conjunctively used. For example, conservation tillage, crop rotations, and cover crops are all associated with a reduction in evapotranspiration (ET), increased infiltration, and reduced irrigation water demand. These then engender increased groundwater storage and decreased runoff. Increased groundwater storage and decreased runoff are also associated with improved irrigation efficiency.

Balancing increased groundwater storage and decreased runoff is the primary challenge identified through this review relative to the Basin's overall water balance and associated increased conservation practices implementation. Decreased runoff may create short-term decreases to streamflow, while increased groundwater storage may lead to long-term streamflow baseflow in hydrologically connected areas. It is beyond the scope of this literature review, however, to assess or quantify the potential magnitude of such trade-offs or how they might differ based on factors associated with the Basin's varied geologic, hydrologic, and climactic conditions.

Irrigation Water Management

Basin Overview

The basin's topography consists primarily of flat to gently rolling upland plains and dissected plains, where streams have cut into former plains creating hilly land with steep slopes and sharp ridge crests. Plains remnants may be found on the hilltops. Several isolated sand hills areas are present with stabilized, grass covered sand dunes. Republican Basin valleys are flat-lying land along the major streams.

In small portions of the Republican Basin next to major streams, the available aquifers are found in recent unconsolidated alluvial deposits. Most of the basin, however, is underlain by aquifers in the Ogallala Formation. Those consist of poorly sorted, generally unconsolidated clay, silt, sand, and gravel. The Ogallala Formation is part of a vast system of related sediments that make up the High Plains Aquifer (HPA) within portions of six states in the central United States. In the Republican Basin, the HPA is underlain by Upper Cretaceous rocks. Large, saturated thicknesses, high porosity and yield, and high hydraulic conductivity are common in the basin.

Approximately half the Basin's land is tilled and half is used as pasture and rangeland. The primary crops grown are corn and soybeans along with wheat and other small grains. Alfalfa and potatoes are also grown here.

There are five major reservoirs in Nebraska's Republican Basin. Each hold more than 25,000 acre-feet of water, including the second largest reservoir in the state (Harlan County Lake). There are several active irrigation districts in the basin. The two largest are Frenchman-Cambridge Irrigation District (FCID) with more than 45,600 irrigated acres, and the Nebraska Bostwick Irrigation District (NBID) with more than 24,000 acres. Including irrigation districts, approximately 112,000 acres may be surface water irrigated in the basin along with over 1.2 million certified groundwater irrigated acres, as detailed in the Basin's annual reports (Republican River Basin-Wide Plan, n.d.).

Center Pivot Benefits and Trade-Offs

Center pivot irrigation systems are the primary irrigation method in the Basin (Alamosa Citizen, 2022). Nebraska's portion of the Basin saw pivot systems increase from 600 to 2,700 over a 12-year period beginning in 1973 (Szilágyi, 2001). Szilágyi (2001) concluded that these systems slightly increased the percentage of the Basin's ET, contributed to the decline in runoff, and may be the most important factor in changing the Basin's water balance. Additionally, increased ET rates can reduce streamflow rates over time under the same precipitation regime for an aquifer that has a strong hydrologic connection with the streams draining it (Szilágyi, 2014).

Figure 1: Center pivot irrigation system. (Rezak, 2014).

Water use efficiency and run-off rates vary for center pivot irrigation application depending on soil texture (Brown, 2008). Variable rate irrigation (VRI) is possible with center pivot irrigation systems. It allows water to be applied at variable rates to different areas of the field, thereby saving water and creating higher crop yields (Kranz et al., 2014; NRCS, n.d.; Peters & Flury, 2017). Generally, in comparison to alternative adopted methods like gravity systems, center pivot irrigation systems can be said to have the following benefits:

- improved efficiency,
- near 100% application uniformity and depth along the entire length of the center pivot based on space and position of the sprinkler,

- improved conditions for plant growth, and
- decreased nutrient runoff/leaching into surface water and groundwater (Kranz et al., 2014; NRCS, n.d.; Peters & Flury, 2017).

Irrigation Efficiency and Water Management

Irrigation water management is 'the process of determining and controlling the volume, frequency, and application rate of irrigation water'. It provides multiple benefits including improved plant growth, health, and productivity; minimized irrigation-induced erosion; optimized water use; and reduced surface and groundwater pollution. The most crucial component is irrigation scheduling: knowing when, how much, and where water should be applied (NRCS, n.d.).

Various technologies and strategies can be utilized for improved irrigation scheduling such as drones, remote sensing, wireless soil moisture sensors, yield monitoring, weather tracking, precision irrigation, and data logging. Improved irrigation efficiency results in reduced demand for groundwater pumping, and associated cost savings and increased groundwater storage (Hrozencki & Aillery, 2021; Noēl and Cai, 2017; NRCS, n.d.; West and Kovacs, 2017).

Figure 2: A completed telemetry flow meter system URNRD, left, and the meter installation process MRNRD, right. (URNRD, et.al., 2021).

Improved groundwater storage can be expected to result in increased streamflow in the long-term due to increased baseflow. However, the decreased runoff associated with lower pumping would result in decreased streamflow in the short-term. A long-term increased streamflow would likely improve water quality and riparian ecosystem health. Barriers that irrigation water managers may encounter are adoption costs, capital access/financing, and future water availability (Hrozencki & Aillery, 2021).

Cost-share programs for installation of telemetry-enabled flow meters and soil moisture probes were implemented in the Upper Republican and Middle Republican NRDs during the Analysis Period (see 'Improved Irrigation Efficiency' in 'Progress Made Under the Plan' in the Analysis). These projects will facilitate improved irrigation efficiency by providing near real-time pumping and soil moisture data to producers and allow for improved irrigation scheduling.

Conservation Reserve Enhancement Program (CREP)

In 1988 the Conservation Reserve Enhancement Program (CREP) was created as an expansion of the Conservation Reserve Program (CRP). It allows conservation partnerships between State, Federal, Tribal, non-profit, and private entities. These partnerships are agriculturally specific and target improved water quality, reduced soil erosion, and enhanced wildlife habitat at multiple scales. Benefits include improvement or enhancements to grasslands, air quality, forestry, critical threatened/endangered species habitat, increased critical invasive species control, and groundwater and/or surface water net savings along with energy conservation. Contracts usually run 10-15 years. Partners match USDA commitments with a variety of options (Farm Service Agency (FSA), 2021; NeDNR, n.d.; USDA, n.d.).

By 2007 CREP enrollment nationwide reached 1 million acres. That number declined to 862,173 acres enrolled by the end of November 2020 (USDA, n.d.). Because enrollment and acres vary by year and contract length, yearly acres vary, too. Colorado, Kansas, and Nebraska all have CREP participants in the Basin. Nebraska and Idaho were the first states to recognize how CREP could be used to address water supply conflicts (Patton and Miller, 2007).

Table 1: Nebraska Republican River Basin CREP Acres.

Conservation Reserve Enhancement Program (CREP) Republican River Basin Nebraska NRDs Enrolled Acres, 2014-2022 *data as of September 30 each year (water year end)					
Year	**Upper Republican**	**Middle Republican**	**Lower Republican**	**Tri-Basin (Republican)**	**Annual Basin Total**
2014	10,870	16,917	7,749	1,609	37,145
2015	10,847	16,739	7,754	1,602	36,942
2016	10,846	16,629	7,509	1,570	36,554
2017	10,566	15,550	7,551	1,752	35,419
2018	10,287	15,661	7,928	1,831	35,707
2019	10,499	12,310	6,444	2,329	31,582
2020	10,589	16,559	8,382	2,201	37,731
2021	8,790	14,842	6,724	1,911	32,267
2022	8,630	14,555	6,975	1,742	31,903
2023	8,630	14,552	6,975	1,742	31,900

*Data from the Republican River Basin Wide Annual Reports

Partnerships between NRDs, NeDNR, and the USDA's Farm Services Agency (FSS) are not uncommon. For example, landowners with areas that are in the proximity to the Republican River and its tributaries, where groundwater pumping has greater impacts on streamflow, have partnered with the Upper Republican Natural Resources District

(URNRD), NeDNR, and FSA to enroll irrigated acres in CREP in order to convert irrigated land to grassland (URNRD et al., 2016).

Established in 2005, the Nebraska Platte-Republican Resources Area CREP is a state-federal cooperative program. It removes land from agricultural production to improve environmental conditions and reduce the use of groundwater and surface water (Monger, 2016; NeDNR, n.d.).

Converting surface irrigated acres to dryland acres reduces surface water consumptive use, and thus can be anticipated to increase streamflow. Converting groundwater irrigated acres should reduce groundwater decline, raise the water table, and increase baseflow discharge to nearby streams raising their baseflow (Erickson & Stefan, 2007; Misra et al., 2011). Generally, the conversion of cropland to grassland reduces soil contamination (Diaz et al., 2012; Khalil et al., 2021).

In the Basin, CREP has been used to pay farmers for a period of 10-15 years to convert irrigated land to conservation uses that do not utilize dryland or irrigated crop production (Supalla & Thompson, 2010). Decertification efforts in the Republican are ongoing. According to the NeDNR CREP Database, as of October 1, 2023, there are 336 active CREP contracts in the Basin covering approximately 31,944 acres. The Middle Republican Natural Resources District (MRNRD) has the most active CREP contracts, 167 with 14,569.2 acres.

Environmental Quality Incentive Programs (EQIP)

The USDA/NRCS's Environmental Quality Incentives Program (EQIP) promotes and incentivizes voluntary agricultural and forestry producers to engage in conservation practices that improve:

- water quality and quantity,
- air quality,
- soil health,
- pest, invasive species, and nutrient management, and
- wildlife habitat (NRCS, n.d.).

EQIP is the USDA's primary program for irrigation water use efficiency, providing over 2,500 farms and over 500,000 irrigated acres with financial assistance (Hrozencik & Aillery, 2021).

These incentivized practices could be anything from drainage management and crop rotation to manure waste lagoons and irrigation equipment. The NRCS aids participants with technical and financial questions that may include labor, design, or training. Contracts range from 1-10 years (Richards, Krome, and Hernandez, 2020).

The EQIP Incentive Contracts introduced in the 2018 Farm Bill added more eligible practices such as cover crops, crop rotations, and precision agricultural technology.

Furthermore, it added qualifying water conservation projects for water delivery and management to eligible conservation lands. Water management entities could include irrigation or groundwater management districts, for example (Hrozencik & Aillery, 2021; Richards, Krome, and Hernandez, 2020).

Figure 3: Irrigation system efficiencies are supported by EQIP. (NRCS, n.d.)

Producer participation in the EQIP program is likely to have secondary benefits to surface water and groundwater supplies. For example, implementing practices such as cover crops might be expected to improve infiltration and thus groundwater supply. Trade-offs associated with these individual practices are described further in the corresponding sections throughout this report. During the Analysis Period, Basin NRDs worked with the NRCS to prioritize resource concerns in their districts through the EQIP program. See the Plan annual reports for further information.

Cover Crops

According to the NRCS, cover crops can be used for seasonal cover and other conservation purposes. They may be grasses, legumes and forbs. They are typically planted in the fall after regular crop harvesting, may or may not be harvested, incorporated into the soil, used as mulch in the spring, or terminated (Farmers.gov, Lee and McCann, 2019; NRCS n.d.; Padgitt et. al., 2000; Wallander, 2021).

Benefits vary and include practices such as erosion prevention, soil health and water quality improvement, to weed suppression, increased biodiversity, wildlife habitat, carbon sequestration, and increased farmer profits. Cover crops meet 3 of 4 principles for better soil health (Climate Hubs n.d.; Creech, 2018; Crowell, 2020; EA, 2017; Farmers.gov; Lee and McCann, 2019; Mohler and Johnson, 2009; NRCS, n.d.; Wallander, 2021). In addition to soil's increased organic matter with practices like cover crops, soil water holding capacity increases, too. About 27,000 gallons of water per acre can be retained by one percent of organic matter in the top six inches of soil (USDA, 2021). Practices that impact cover crop selection and management include crop rotation and frequency, type, purpose, and mixes of cover crop, termination methods, and seeding decisions. Increased costs over the short-term for implementation include time, seed costs, field operations, and costs for inputs like herbicides. Incentive programs are available (Climate Hubs (n.d.); Moore et.al, 2019; NRCS, n.d.).

A high residue cover cropping system, due to the increased biomass of the crop, can enhance the benefits of conservation tillage, such as reduced erosion, improved infiltration, and better nutrient cycling. The crop is managed more intensively than a traditional cover crop, and fertilizer is applied to maximize biomass production (Love et al., 2015). Increased crop residue increases soil moisture and crop yields (NRCS, n.d.).

Proper cover crop management requires selecting a water-efficient plant species to optimize the use of soil moisture and harvesting the cover crop before excessive transpiration. Additionally, utilizing a cover crop as a green manure crop to cycle nutrients will require harvesting the cover to match the release of nutrients with uptake by the subsequent cash crop (NRCS, n.d.). Dryland cropping systems have not seen undue losses to cash crops from cover crops for nutrients or water availability with appropriate management (Climate Hubs, n.d.).

Figure 4: A cereal rye is a common cover crop. (ARS, USDA, 2022).

Cover crops can increase infiltration, facilitate faster downward movement of water, enhance soil water storage capacity, and reduce runoff (Basche et al., 2016; Meyer et al., 2019). Enhanced soil water storage reduces irrigation needs that may decrease groundwater depletion and increase recharge, thereby raising the water table and increasing discharge to streams (Joyce et al., 2002; Nimmo, 2009).

Overall, cover crops with appropriate management can be anticipated to improve soil water storage and thus improve streamflow, along with numerous benefits to water quality and soil health. Improperly managed cover crops might result in increased ET and thus be a net detriment to water supplies in the Basin. Therefore, any successful promotional program to implement additional cover crops, particularly in high streamflow depletion areas of the Basin, should include a strong educational component to make producers aware of these trade-offs and appropriate management strategies to mitigate them.

Conservation Tillage

Agricultural tillage cropping practices can broadly be classified as conventional or conservation. Conventional tillage typically requires growers to use mechanical means to overturn soil, controlling for weeds and pests, disrupting harvested crops' roots, and increasing soil erosion, poor soil health, and runoff (ERS, n.d.; Mathew et al., 2012). It may cause erosion.

Conservation tillage typically is less disruptive to soil and leaves a minimum 30% plant residue on a field after crop harvesting (ERS, n.d.; Ni and Parajuli, 2018; Simmons and Nafziger, 2009; UC SAREP, 2017). Crops are planted and grown in narrow, tilled areas in the field's untilled seedbed of the harvested or previous crop.

A continuous no-till system with cover crops and crop rotation provides benefits that include the ability to: increase soil health, nutrient cycling, and organic matter, water holding capacity, retention, and infiltration, plant health, crop productivity, carbon sequestration, and resilience to growing conditions and disaster events. It can decrease water and nutrient run-off, soil erosion, and energy inputs and carbon dioxide emissions (Busari et al., 2015; Claassen et al., 2018; CTIC, 2023; ERS, n.d.; Farmers.gov; NRCS, 2007; NRCS, 2008; NRCS, n.d.; UC SAREP, 2017). In times of excess precipitation, no-till field practices can improve infiltration at the expense of reduced runoff and ponding (ERS, n.d.).

Figure 5: A no-till field showing residue and a later crop (USDA, Climate Hubs, n.d.).

Conservation tillage practices have contributed to the decline in surface water runoff in the Republican River Basin (HDR, 2006). In other US regions, SWAT (Soil Water Assessment Tool) has been used to demonstrate the effects of conservation tillage in northwest Mississippi's Big Sunflower River Watershed. Results there showed streamflow reductions up to 53% compared to conventional tillage, a likely significant decrease. Further, there was reduced sediment load and increased nutrient load on both field and watershed scales due to applied fertilizers, residual crops, and plant residues on soil surfaces (Ni and Parajuli, 2018; Risal and Parajuli, 2022). Implications for the Basin's streamflow may include decreased surface water quantities versus both positive and negative water quality impacts.

The historical increase in prevalence of conservation tillage practices in the Basin likely contributed to decreased runoff and reduced streamflow. However, the decreased ET and increased infiltration associated with conservation tillage could be expected to increase groundwater supplies over time due to enhanced recharge and reduced demand. The trade-off in increased prevalence of conservation tillage is thus between the short-term decrease in runoff and associated reduction in streamflow and the long-term increase in groundwater supply and associated increased streamflow from baseflow. Those would be most pronounced in areas of high hydrologic connectivity.

Crop Rotation

As early as 1926, the USDA documented the importance of crop rotation (Weir, 1926). Crop rotation involves planting a sequence of various crops that are rotated over time on the same field or piece of land. Crops are typically a combination of high- and low-residue species rotation that contributes to soil health and overall natural resources conservation. High residue crops include corn while low residue crops include soybeans. Small grains and corn can replace any low residue crop to improve erosion control. Residue crops may vary depending on the cash crop (NRCS, n.d.).

Rotations are especially important for fields that are subject to wind and water erosion and work best in conjunction with other conservation practices. It can decrease vulnerability to insect damage, diseases, and weeds, reduce sheet and rill erosion, and improve water quality, as well as increase farm diversity that reducing economic and environmental risks (Claassen et. al., 2018; NRCS, n.d.; USDA, n.d.).

Crop rotations can affect a river basin's surface water and groundwater relationship. Eco-hydrological models point towards how land use practices affect a river basin's water balance. Sietz et al. (2021) linked their Crop Gen model with the eco-hydrological Soil and Water Integrated Model (SWIM) to assess outputs (daily discharge, surface and sub-surface runoff, groundwater seepage, and ET) for a 30-year period with crop rotations for three simulations. Those that included crop rotations saw a 5%-9 increase in daily discharge, higher annual runoff (12%-13%), higher groundwater seepage (12%-16%), and lower ET (-5% to -7%). Seasonal patterns were evident.

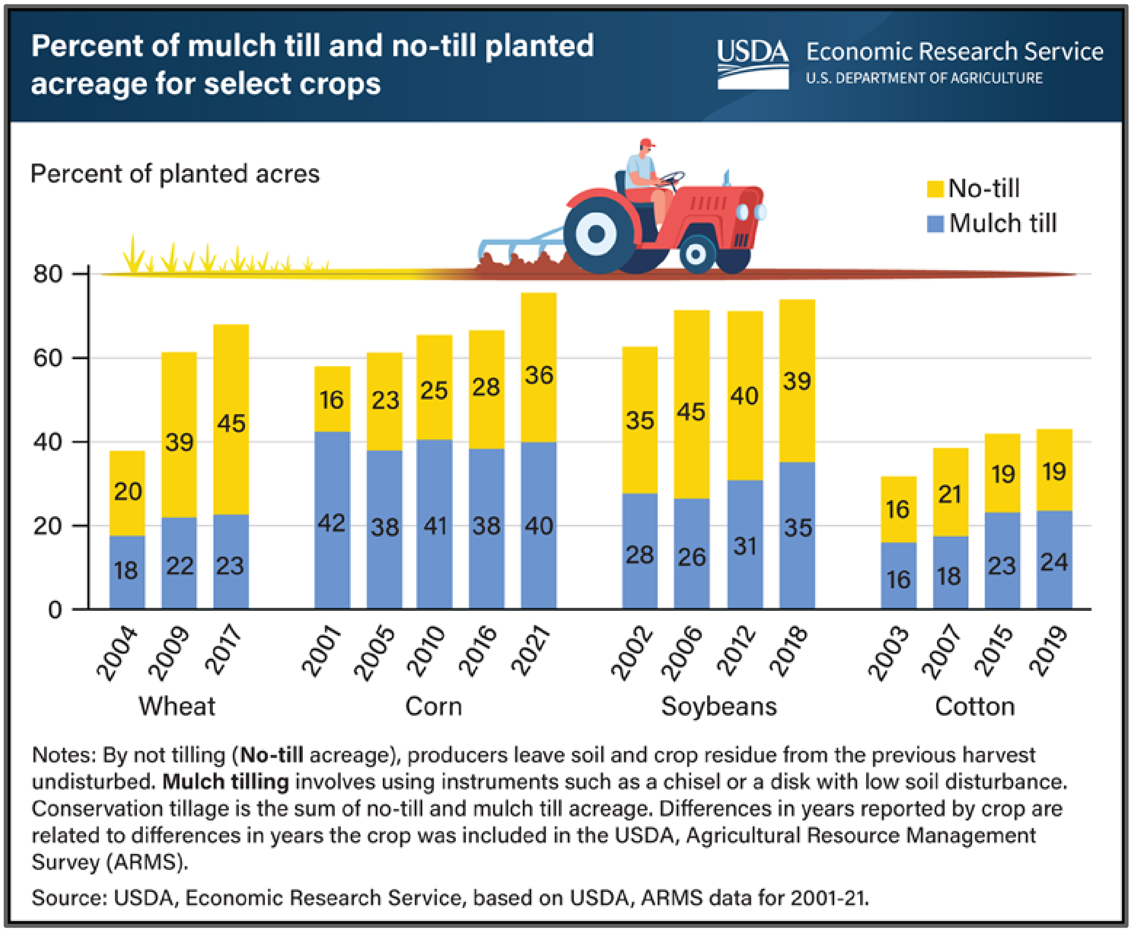

Figure 6: Mulch and till and no-till planted acreage for select crops. (ERS, 2022).

Irrigated cropping systems are typically a no-till or minimum till cropping system of crop rotation that use various row crops like corn, milo, and soybeans. Irrigated agriculture is the Basin's primary water use, specifically corn and soybeans, along with wheat and other small grains (NRCS, 2008; URNRD et al., 2019). Some irrigators use wheat in a cropping rotation since it requires less irrigation water.

Irrigation Canal Rehabilitation

Irrigation canal rehabilitation includes lining canals with impervious materials or chemical treatments and repairs and/or improvements to the canal system's infrastructure, such as automating gates and checks or converting open channels to pipelines (Bennett et al., 2015; Flatwater, 2013).

Canal lining benefits that improve streamflow include erosion prevention, reduced diversion needs, maintained water quality, and both reduced water and energy losses. Lining tradeoffs include reduced groundwater recharge, negative impacts to wetlands and other water-related habitats, and how dissolved substances are transported into groundwater and other downstream flows via canal seepage (Kendy & Bredehoeft, 2006; Lonsdale and Cross, 2020dale and Cross, 2020; NRCS, n.d.).

Automating gates help save water and improve irrigation delivery efficiency. Broadly, SCADA systems (Supervisory Control and Data Acquisition) involve electronic hardware, software, and communications equipment that create a platform for remote monitoring and control. Several control options and methods exist whose intent is to minimize manual adjustments, improve accuracy, timing, and routing for water delivery, and provide a quicker emergency response (Wahlin and Zimbelman, 2018 and Zimbelman, 2018).

Both the Nebraska Bostwick Irrigation District (NBID) and Frenchman-Cambridge Irrigation District (FCID) use automated gates in the Basin. FCID uses Total Channel Control (TCC) software to operate the gates (Harris, 2019; NBID, 2022). During the Analysis Period, NeDNR partnered with FCID and NBID on projects to install automated gates and complete other canal efficiency improvements. These projects also received United States Bureau of Reclamation (USBR) funding. For further details, see 'Improved Canal Efficiency' in the 'Progress Under the Plan' section of the Analysis full report and associated sections in Plan annual reports. Both are available here.

Figure 7: Nebraska Bostwick Irrigation District Franklin Canal. New automated gates with solar panels that power communication systems between the office and gates.

Terraces

Terraces are structures that transform long slopes into a series of shorter slopes. The practice can be divided into two types of infrastructure:

- storage terraces that collect and store water until it can infiltrate the soil or be released through a stable outlet, and
- gradient terraces that slow runoff and transport it to a stable outlet, such as a grassed waterway or through underground outlets (Deng et.al., 2021; IAWA, 2021; NRCS, n.d.; NRCS, 2021).

Terraces improve surface water quality and increase groundwater supply by reducing erosion, intercepting runoff (preventing sediment/nutrient pollution), increasing infiltration, and promoting water conservation through increased groundwater supply and reduced irrigation water demand (Deng et.al., 2021; IAWA, 2021; NRCS, n.d.; NRCS, 2021). They are typically one of four shapes depending on a field's slope with a 10-year minimum life expectancy (NRCS, n.d.; Soil Conservation Service (SCS), 1990). Streamflow is likely to be impacted because of reduced runoff at least in the short-term, but those losses may be offset over time by groundwater infiltration and increased baseflows.

Figure 8: Agricultural terraces in the Papio-Missouri NRD. (PMNRD, 2024).

Conservation tillage, contour strip cropping, crop rotations, or contouring between terraces help reduce soil movement between terraces, reduce erosion from 50%-90%, decrease maintenance costs, and lessen weeds (SCS, 1990). Dickey et al. (1985) noted that approximately 140 million tons of soil erode annually from fields in Nebraska. Terraces plus contour farming can reduce soil losses by 80% compared to non-terraced up-and-down fields. Additionally, temporary storage terraces or embankments act as a sediment trap.

The Republican River Compact Settlement Conservation Committee (RRCSCC) for the Republican River Compact Administration (RRCA) simulated the impacts of terraces across the Republican River Basin. That study concluded that land terracing reduced runoff from the areas above terraces by an average total of 71,000 acre-feet of water/year and provided protection for about 919,000 acres in Nebraska. Along with basin reservoirs, recharge from terrace installation may help increase surface streamflow and decrease groundwater use (RRCSCC for the RRCA, 2014).

Conclusion

This literature review was initiated and completed with a view to fulfill requirements of Plan Action Item 2.5.1. Further, it contributes to the progress made towards fulfilling the Plan's goals and objectives as they relate to the Analysis. In subsequent years and analysis periods, additional efforts may be made toward fulfilling these requirements to the extent deemed practicable by NeDNR and the Basin NRDs.

Common conservation practices' themes were identified as benefits and trade-offs associated with increased implementation. Practices such as cover crops and conservation tillage designed to improve soil health and reduce erosion have the potential to also increase infiltration, reduce runoff, and decrease ET. The result for those benefits is between a short-term decrease in surface water supply and a long-term increase in groundwater supply along with an associated baseflow increase to streamflow.

Practices that improve water management and efficiency have the potential to increase both groundwater and surface water supply if they contribute to decreasing overall water demand.
However, it is individual farmer decision-making whether to adopt conservation practices and the diffusion of those actions to other farmers that has the most local impact. Prokopy et al. (2019) analyzed 35-years of quantitative literature on agricultural conservation practices and their adoption. Overall, they concluded that farmers who use and seek out social networks, such as participating in a conservation program and consulting with natural resource professionals, are more likely to adopt soil and water conservation practices.

These select, reviewed conservation practices have numerous advantages and trade-offs. Many directly benefit surface water quality and have the potential to increase surface water supply in high hydrologic connectivity areas between surface water and groundwater. The potential increase in long-term surface water supply is in many cases balanced against decreased short-term streamflow supply due to runoff.

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