

APPENDIX D: INVESTIGATION AND ANALYSIS

List of Figures	2
List of Tables.....	2
1. Introduction	5
2. Water Resources	5
2.1 History of Irrigation Districts and Canal Companies in the East Clear Creek Watershed	5
2.2 Conceptual Model of the System	5
2.3 Groundwater	10
2.4 Hydraulic Modeling.....	30
3. Preferred Analysis and Design.....	33
3.1 Existing Conditions and Operations	33
3.2 Recommended Improvements	36
3.3 Structure Improvements	38
3.4 Preferred Alternative—Combination of Improvements.....	39
3.5 Installation Costs	39
4. Economics.....	57
4.1 Introduction	57
4.2 Economic Analysis Parameters.....	59
4.3 NEE Costs.....	60
4.4 NEE Benefits	65
4.5 Benefits of the Modernization Alternative Over the No Action	70
4.6 NEE Benefits Compared to Costs	70
4.7 Incremental Analysis	71
4.8 Preferred Alternative	72
4.9 References	72
5. Cultural Resources.....	73
5.1 Post-Review Discovery Procedure.....	73
6. Environmental Resource Studies.....	75

6.1 Wetland Delineation	75
-------------------------------	----

List of Figures

Figure 2-1. Conceptual model of the Planning Area, with and without the Proposed Action.	7
Figure 2-2. Annual average reach gains for Keystone to Sutherland and Keystone to North Platte in acre-ft.	9
Figure 2-3. NPCM subregional model location map.	13
Figure 2-4. Refined grid of NPCM, with inset showing horizontal discretization in more detail. .	14
Figure 2-5. NPCM boundary conditions.	15
Figure 2-6. Hydraulic conductivity of NPCM.	16
Figure 2-7. NPCM specific storage.	17
Figure 2-8. NPCM Specific Yield.	18
Figure 2-9. Model boundary flow comparisons between regional and subregional model boundaries.	21
Figure 2-10. Evapotranspiration comparisons between regional and subregional models.	22
Figure 2-11. Recharge comparisons between regional and subregional models.	23
Figure 2-12. Stream leakage comparisons between regional and subregional models.	24
Figure 2-13. Storage comparisons between regional and subregional models.	25
Figure 2-14. Well pumping comparisons between regional and subregional models.	26
Figure 2-15. Example of a 2D model cross section illustrating the head distribution and the applied boundary conditions upstream and downstream of the proposed Platte Valley structure.	32
Figure 3-1. Map of Keith-Lincoln recommended improvements.	40
Figure 3-2. Map of Platte Valley recommended improvements.	41
Figure 3-3. Map of Paxton-Hershey recommended improvements.	42
Figure 3-4. Map of Birdwood recommended improvements.	43
Figure 3-5. Map of Suburban recommended improvements.	44
Figure 3-6. Map of Cody-Dillon recommended improvements.	45
Figure 3-7. Map of combined Platte Valley/Paxton-Hershey diversion.	46
Figure 4-1. Watershed Planning Area.	58

List of Tables

Table 2-1. Average annual reach gains for Keystone to Sutherland and Keystone to North Platte in acre-ft.	8
Table 2-2. MODFLOW 6 files that compose the refined NPCM groundwater model.	11
Table 2-3. NPCM run with no canal seepage.	28

Table 2-4. NPCM baseline run for each of the canals (cumulative volumes after 50 years).	28
Table 2-5. NPCM 1,000 acre-ft pulse model runs for each of the canals.	29
Table 2-6. Canal Diversion Structure Details.....	31
Table 2.7. Seepage modelling analysis assumptions and results	31
Table 3-1. Keith-Lincoln existing conditions summary.....	33
Table 3-2. Platte Valley existing conditions summary.....	33
Table 3-3. Paxton-Hershey existing conditions summary.....	34
Table 3-4. Birdwood existing conditions summary.....	34
Table 3-5. Suburban existing conditions summary.	35
Table 3-6. Cody-Dillon existing conditions summary.	35
Table 3-7. Keith-Lincoln recommended improvements.	36
Table 3-8. Platte Valley recommended improvements.	36
Table 3-9. Paxton-Hershey recommended improvements.	37
Table 3-10. Birdwood recommended improvements.	37
Table 3-11. Suburban recommended improvements.....	38
Table 3-12. Cody-Dillon recommended improvements.....	38
Table 3-13. Estimated Installation Costs for Keith-Lincoln Partial Replacement and Modernization	47
Table 3-14. Estimated Installation Costs for Birdwood Replacement and Modernization.....	49
Table 3-15. Estimated Installation Costs for Suburban Partial Replacement and Modernization	51
Table 3-16. Estimated Installation Costs for Cody-Dillon Replacement and Modernization.....	53
Table 3-17. Estimated Installation Costs for Platte Valley/Paxton-Hershey Combined Replacement and Modernization	55
Table 4-1. Implementation schedule and project life for Modernization with Partial Replacement and Combined Diversion Alternative.....	60
Table 4-2. Estimated installation cost, 2025 dollars. ¹	62
Table 4-3. Estimated cost distribution - water resources project measures, 2025 dollars. ¹	63
Table 4-4. OMRR costs by project component, 2025 dollars. ¹	64
Table 4-5. Estimated average annual NEE costs, 2025 dollars. ¹	65
Table 4-6. Change in annual net farm income under No Action Alternative relative to existing conditions.....	65
Table 4-7. Estimated average annual benefits, 2025 dollars. ¹	66
Table 4-8. Irrigated acreage for canals within the Planning Area.	67
Table 4-9. Estimated percentage of irrigated acres by crop type.	67
Table 4-10. Estimated irrigated acreage by crop type and canal.....	68
Table 4-11. Selected crop budget indicators for farmland in western Nebraska, 2025.....	69
Table 4-12. Average water storage volumes and cost (2001-2024).	70

Table 4-14. Incremental analysis of annual NEE costs and benefits under the Modernization with Partial Replacement and Combined Diversion Alternative, 2025 dollars. ¹	71
---	----

1. INTRODUCTION

This appendix presents information that supports the formulation, evaluation, and conclusions of the East Clear Creek Watershed Plan. The appendix is organized by major headings for ease of understanding for those not familiar with the details of the watershed and analyses leading up to the conclusions determined in the Plan. The goal of the appendix is to supplement the information provided in the Plan. This document follows USDA NRCS Watershed Program Manuals and guidance previously referenced in the Plan, and is intended to supplement information contained in the Plan.

2. WATER RESOURCES

Hydrologic data and models used to support the evaluation of the alternatives are summarized in this section. A description of the history of canal development within the watershed is presented, along with the surface water and groundwater models used to analyze alternatives. The models represent the best available science, and have been calibrated with historical observation data by registered professional engineers and/or geologists.

2.1 History of Irrigation Districts and Canal Companies in the East Clear Creek Watershed

A historical summary was created for the purpose of understanding the significance of the irrigation canals and districts. The content was summarized from the Nebraska Department of Natural Resources' Biennial Reports, found online at <https://dnr.nebraska.gov/surface-water/nednr-biennial-reports> and can be found in Appendix E as supporting information.

2.2 Conceptual Model of the System

Figure 2-1 depicts the canal system with and without the proposed project discussed throughout the Plan. The **"Without Project"** portion of the figure illustrates the water budget of the North Platte River in the absence of the Keith-Lincoln, Platte Valley, Paxton-Hershey, Suburban, Birdwood, and Cody-Dillon Canals. Under these conditions, all outflows from Lake McConaughy are discharged downstream to the South Platte River, through the Sutherland Canal at the Keystone Diversion Dam to the most senior water right holders, effectively removing them from the North Platte River system. This diverted water does not contribute to North Platte River streamflows nor the irrigation within the North Platte River canal network, does not support groundwater aquifer recharge, and does not augment streamflows in the North Platte River. The **"Without Project"** scenario results in a loss of beneficial water uses within the North Platte Basin. The **"With Project"** portion of the figure represents the water budget assuming the above-referenced canals are operating as proposed. In this scenario, outflows from Lake McConaughy are strategically allocated between the North Platte and South Platte Rivers according to priority dates of water rights. Water routed to the North Platte River supports many beneficial uses, including:

- Irrigation Supply for senior water rights holders via the canal system
- Streamflow augmentation within the North Platte River
- Groundwater recharge contributing to aquifer sustainability

The coordinated function of these canals, alongside the Keystone Diversion Dam, ensures a more resilient and efficient water management strategy across the North Platte River Basin.

Figure 2-2 and **Table 2-1** present the water budget for the existing North Platte River system, combining results from model simulations (reaches) with data from DWEE (stream gage and diversion). The segment identified as “Keystone to Sutherland” accounts for the net change in flow between the Keystone and Sutherland Gages on the North Platte River, adjusted for water diverted from the river for irrigation or other uses. The other segment called “Keystone to North Platte” accounts for net change in flow between the Keystone and North Platte Gages, subtracts inflow from Birdwood Creek, and adds back the volume of water diverted through canals to estimate actual gain or loss in the reach.

Positive reach gains would suggest additional inflow (e.g. groundwater or tributaries), whereas negative reach gains would indicate losses (e.g. seepage). For both segments, in the non-irrigated season (i.e. January to April and October to December), the average reach gains were positive (Figure 2-2). Both reaches recorded their highest reach gains in 2016, suggesting a system-wide hydrologic condition such as high precipitation or increased groundwater contributions. However, the lowest reach gains occurred in different years, 2003 for Keystone to Sutherland and 2005 for Keystone to North Platte, indicating spatial variability in groundwater-surface water interactions or localized hydrologic conditions within the planning area.

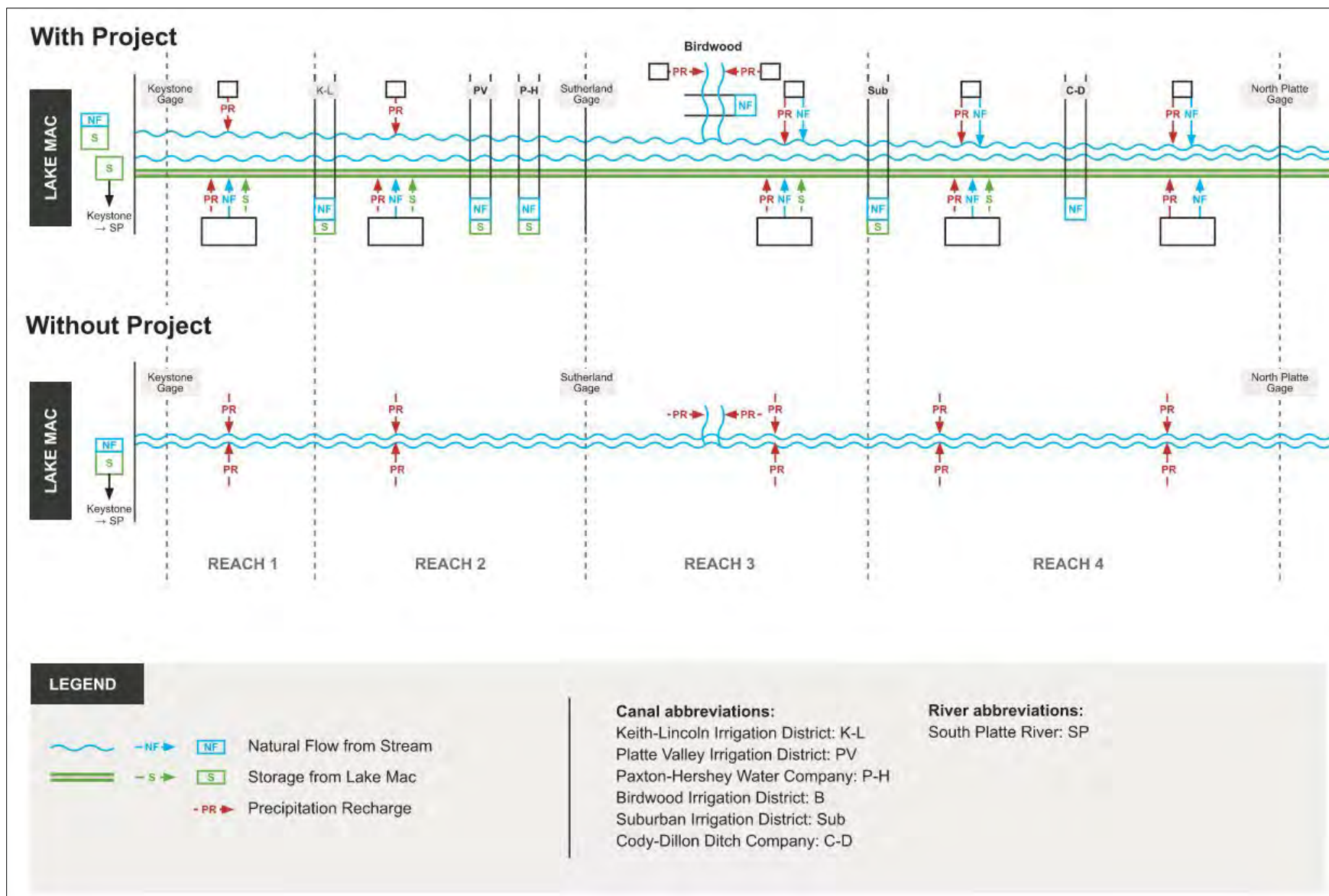


Figure 2-1. Conceptual model of the Planning Area, with and without the Proposed Action. Figure showing conceptual drawing of Planning Area, with and without Proposed Action.

Table 2-1. Average annual reach gains for Keystone to Sutherland and Keystone to North Platte in acre-ft.

Year	Keystone to Sutherland	Keystone to North Platte
2000	7,960	10,772
2001	6,692	9,544
2002	6,506	9,001
2003	6,002	8,702
2004	6,360	9,331
2005	6,287	8,473
2006	6,652	9,732
2007	7,486	12,372
2008	7,119	11,493
2009	7,690	13,169
2010	7,226	9,966
2011	8,489	12,345
2012	6,534	10,940
2013	6,699	9,758
2014	6,189	9,446
2015	7,585	12,941
2016	9,326	16,078
2017	7,811	13,253
2018	9,291	13,399
2019	7,898	14,104
2020	7,628	10,894

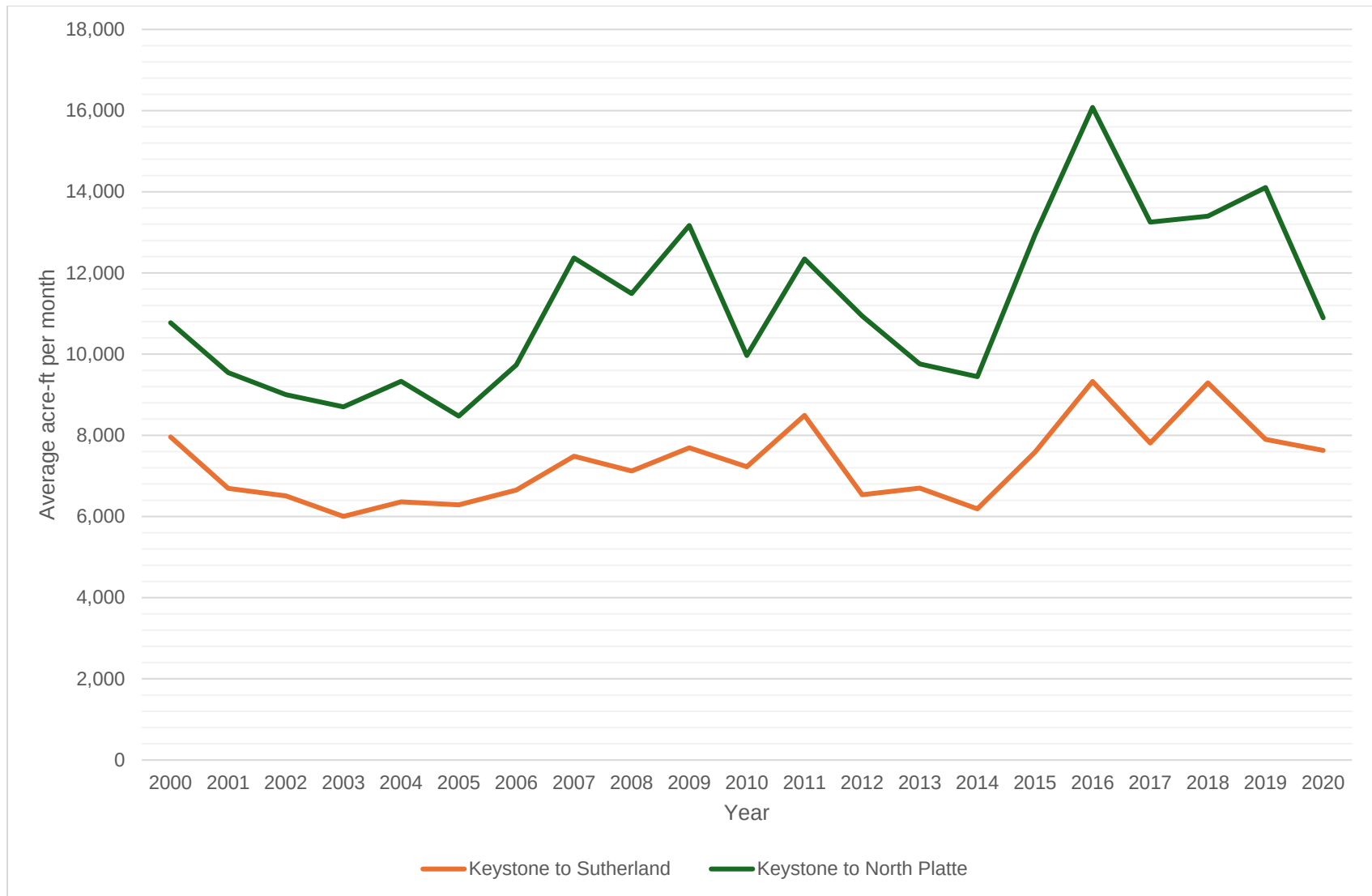


Figure 2-2. Annual average reach gains for Keystone to Sutherland and Keystone to North Platte in acre-ft. Graph of average reach gains for the Keystone-to-Sutherland and Keystone-to-North Platte reaches, showing similar trends for each reach with the Keystone to Sutherland reach attenuated as compared to the Keystone to North Platte reach.

2.3 Groundwater

Groundwater resources in the Planning Area have been heavily studied. Models representing the hydrogeologic system have been developed and used by DWEE to quantify the water budget and the effect of changes to the water budget. This section summarizes the groundwater models utilized as part of this Plan.

2.3.1 Background

Groundwater models are essential tools for quantifying changes in a hydrologic system. This Plan utilizes a groundwater model to represent the best available science for evaluating potential impacts within the Planning Area. One such model used in the Plan is the Cooperative Hydrology Study (COHYST) model. The COHYST model is a comprehensive, integrated hydrologic modeling framework composed of three primary components: a groundwater model, a watershed response model and a surface water operations model (McDonald Morrissey Associates, 2022). Designed to support regional-scale water resource analyses conducted by DWEE, the COHYST model covers a substantial portion of Nebraska and is well-suited for evaluating broad groundwater system dynamics. However, its spatial resolution limits its applicability for localized assessments, particularly those involving canal-specific hydrologic processes.

To address this limitation, the North Platte Canals Model (NPCM) was developed as a subregional refinement of the COHYST MODFLOW 6 groundwater model. The NPCM enables detailed hydrologic analysis within the NPCM domain, with a focus on canal recharge and groundwater interactions. The model utilizes calibrated aquifer properties and recharge inputs derived from the COHYST model, which underwent a major update and recalibration in 2022. This update included independent and conjunctive calibration of surface water and groundwater components, with aquifer parameters such as hydraulic conductivity and specific yield calibrated using pilot points informed by USGS observation data. Construction of the NPCM is detailed in the sections below.

2.3.2 Model Development

The NPCM subregional model was developed, based on the regional COHYST model, to support the Plan. The following sections detail the construction of the NPCM model.

2.3.2.1 Model Code and Applications

The regional COHYST and subregional NPCM models both utilize MODFLOW 6 software (Langevin et al., 2017), developed by the U.S. Geological Survey (USGS) as the industry standard software for groundwater modeling. MODFLOW 6 offers several key enhancements, including flexibility in grid discretization, improved representation of complex water table dynamics, enhanced control over hydrologic stress inputs, and an advanced numerical solver that provides faster performance and reduced mass balance errors compared to the traditional finite-difference approach (Langevin et al., 2017).

The COHYST model files served as the primary input for the development of the NPCM model files. **Table 2-2** outlines the MODFLOW 6 files used in the NPCM model. **Figure 2-3** illustrates the NPCM model domain in relation to the COHYST model and the Planning Area defined in the Plan.

Table 2-2. MODFLOW 6 files that compose the refined NPCM groundwater model.

MODFLOW File	Description
DISU	Unstructured Discretization File: this file is used to specify the model grid geometry, such as elevations of the vertical layers. Each grid cell is given a node number, and the ways each node is supposed to interact with other nodes is described.
EVT	Evapotranspiration Package: Simulates head-dependent evapotranspiration fluxes (e.g., riparian corridors). Specifies the evapotranspiration (ET) surface, extinction depth, and monthly ET rates.
IMS	Iterative Model Solution File: Configures linear and nonlinear solvers for matrix equation resolution, based on model complexity.
IC	Initial Conditions File: Provides starting water level elevations for each model cell.
NPF	Node Property Flow Package: Defines aquifer properties controlling flow between cells, such as hydraulic conductivity.
OC	Output Control Option: Specifies which head, drawdown, or budget outputs should be printed or saved.
RCH	Recharge Package: Defines the transient recharge fluxes for each cell.
STO	Storage Package: Specifies aquifer storage parameters, such as specific storage and specific yield.
SFR	Streamflow-Routing Package: Represents stream networks, including routing, inflows, stage, streambed conductance, elevations.
TDIS	Time Discretization Package: Establishes the time units and divides the model into stress periods.
WEL	Well Package: Simulates specified fluxes (e.g. pumping, inflows/outflows) at individual cells.

2.3.3 Model Discretization

The NPCM model encompasses about 1,324 square miles (847,360 acres) across portions of Keith, Lincoln, and McPherson counties. It extends about 50 miles east-west and 35 miles north-south. The largest grid cells in the NPCM model measure a quarter of a mile per side (40 acres), which is half the length and one fourth the area of the COHYST model cells.

The NPCM grid was refined using quadtree refinement - the most refined cells are located near streams and canals, the smallest cells measure 330 feet ($\frac{1}{16}$ mile) per side, with an area of 2.5 acres (See **Figure 2-4**). Quadtree refinement was created using Groundwater Vistas, enabling detailed results in the refined areas, while maintaining computational efficiency around the model boundaries. The NPCM grid was aligned with the DWEE statewide GIS dataset for constructing groundwater flow model grids, originating at Nebraska State Plane Coordinates $x = 1,181,400$ feet, $y = 425,040$ feet.

Vertically, the NPCM mirrors the COHYST structure as a single-layer model, built using the latest calibrated aquifer properties from the COHYST model (MMA, 2022). These aquifer properties have been updated, calibrated, and peer reviewed extensively over time. The top and bottom elevations of the NPCM model were derived from COHYST data, originally informed by UNL-CSD test hole data used to determine bedrock depth (Woodward et al., n.d.).

The NPCM has been discretized into 600 stress periods, representing the final 50 years (2021-2070) of the COHYST 2023 Robust Review simulation. This timeframe is appropriate for evaluating the impact of canal improvements, as it covers a broad range of dry, average, and wet conditions. This comprehensive coverage ensures an accurate assessment of the effects of canal improvements.

2.3.4 Boundary Conditions

Boundary conditions for the NPCM subregional model are shown in **Figure 2-5**. The North Platte River, South Platte River, and their tributaries are represented by the Streamflow Routing (SFR) package. The outer boundary of the model was simulated using a specified flux boundary, described in detail below.

The NPCM SFR package was derived from the COHYST SFR package and includes the same stream network. Stream locations were adjusted to reflect refinement made to the NPCM grid. Hydraulic properties, including streambed conductance, elevation and thickness, were adopted directly from the COHYST model. However, the stream length and slope were recalculated and reassigned for all NPCM SFR cells. A stream layer provided by DWEE was used to compute updated stream lengths within the refined cells using Groundwater Vistas. Inflow data for the NPCM SFR package were duplicated from the COHYST model, specifically for the North Platte River at Keystone and the South Platte River at Julesburg.

The outer boundaries of the NPCM did not correspond to surface water features or physical boundary conditions. Instead, the cell-by-cell flow data from the COHYST model were used to determine transient lateral flows at each boundary cell for each stress period. A well file was created to implement these flows, where inflows are represented as injection wells and outflows as extraction wells.

2.3.5 Aquifer Properties

Hydraulic conductivity and aquifer storage properties are foundational in a groundwater model's flow regime and water level changes. In the NPCM, two key aquifer parameters: hydraulic conductivity and storativity, were specified using data from the COHYST regional model.

Hydraulic conductivity refers to the ability of geologic material to transmit water. The values used in the COHYST model were established through calibration during model development. For the NPCM, hydraulic conductivity values were assigned directly from the calibrated COHYST data. The spatial distribution of hydraulic conductivity values in the NPCM are shown in **Figure 2-6**.

Aquifer storativity refers to the aquifer's ability to store and release water, and is composed of specific storage and specific yield (Woessner and Poeter, 2020). In an unconfined aquifer, storativity is dominated by specific yield – the volume of water that drains under gravity when the water table is lowered or fills with water when the water table is recharged (Woessner and Poeter, 2020). Specific storage is related to the compressibility of aquifer materials (Woessner and Poeter, 2020).

Both specific yield and specific storage terms for the NPCM are defined in the Storage (STO) package (Langevin et al., 2017) and were directly adopted from the regional COHYST model. In the NPCM, specific yield ranges from 0.14 to 0.28, while specific storage is assigned a constant value of 0.00005 ft^{-1} (see **Figures 2-7 and 2-8**).

Initial conditions, or starting water level elevation of the aquifer, are the last requirement for establishing aquifer properties. Initial conditions for the NPCM were established using COHYST resultant heads from stress period 862, which is one stress period before the NPCM simulation started. These heads were deemed suitable due to the model's rapid convergence and the parallelism of the water budget terms.

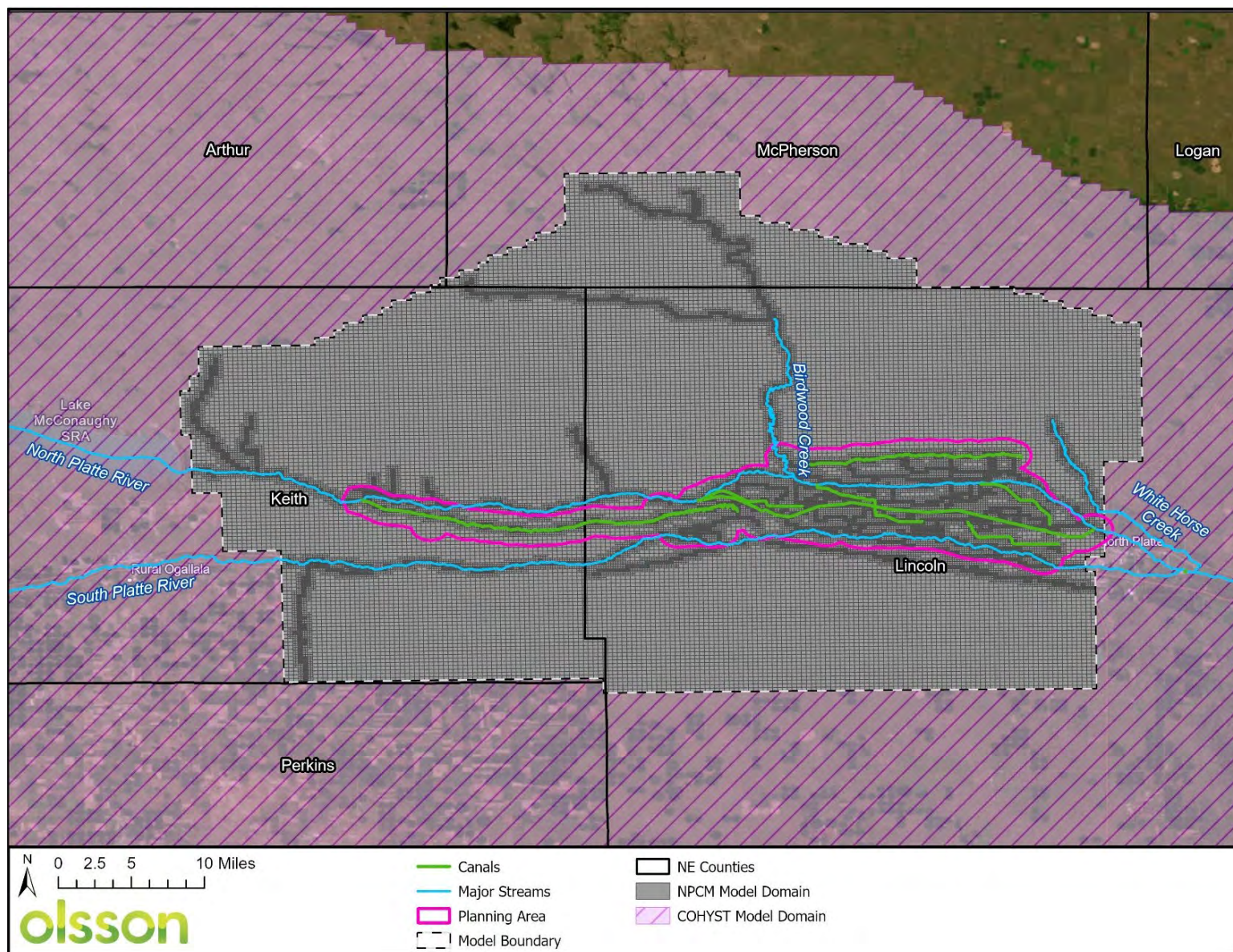


Figure 2-3. NPCM subregional model location map. Map of location for NPCM subregional model.

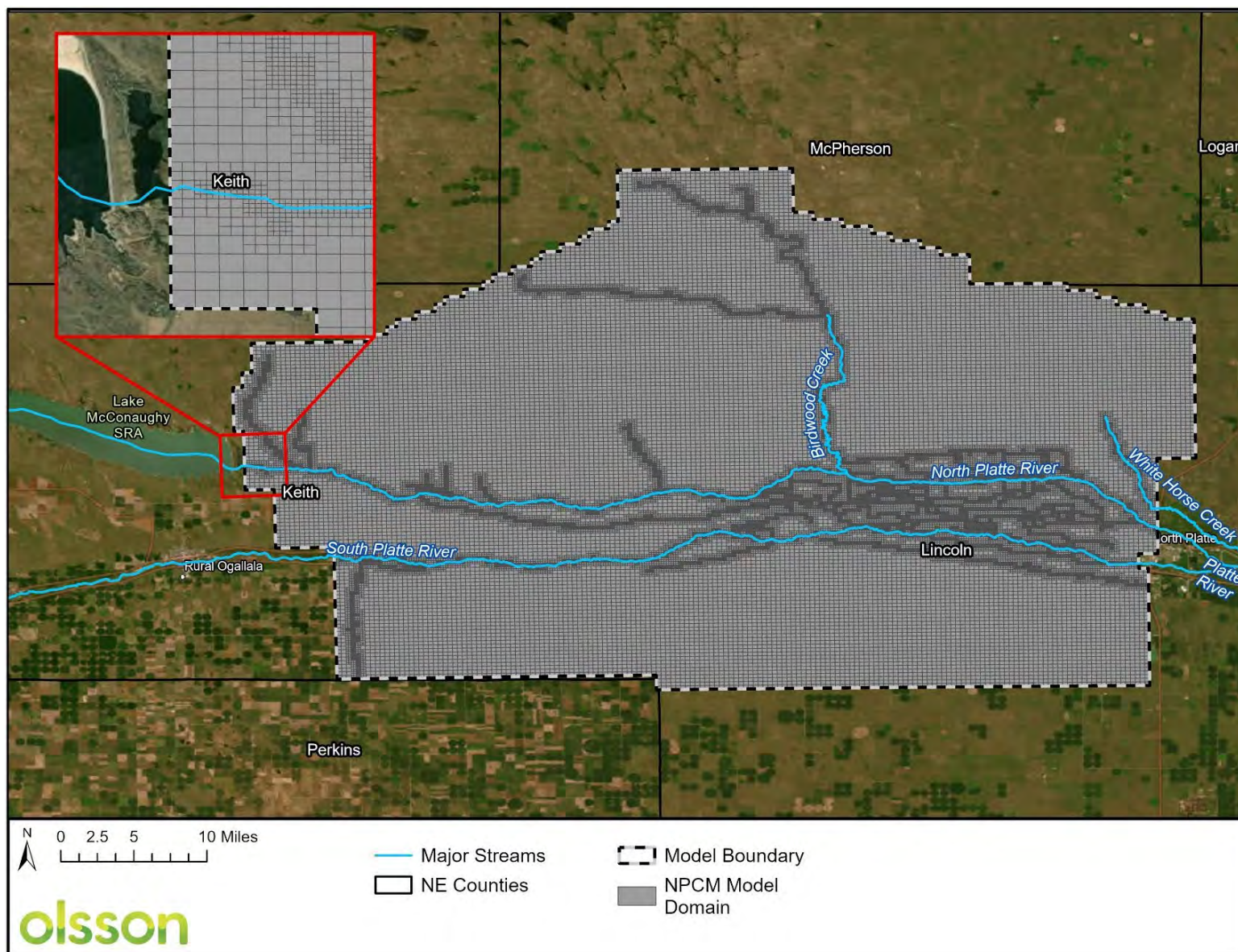


Figure 2-4. Refined grid of NPCM, with inset showing horizontal discretization in more detail. Map with inset detail of refined NPCM grid.

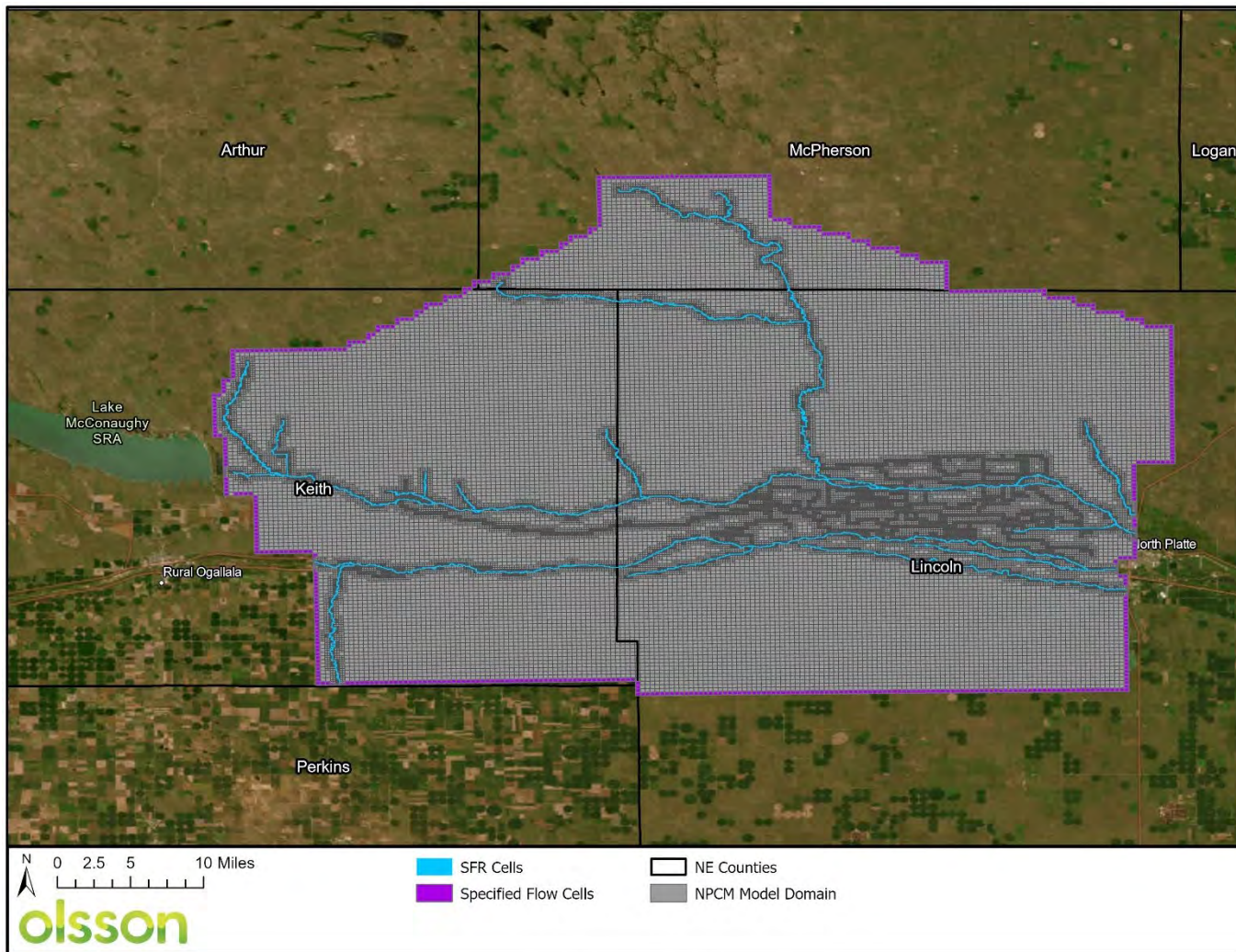


Figure 2-5. NPCM boundary conditions. Map of boundary conditions specified for NPCM.

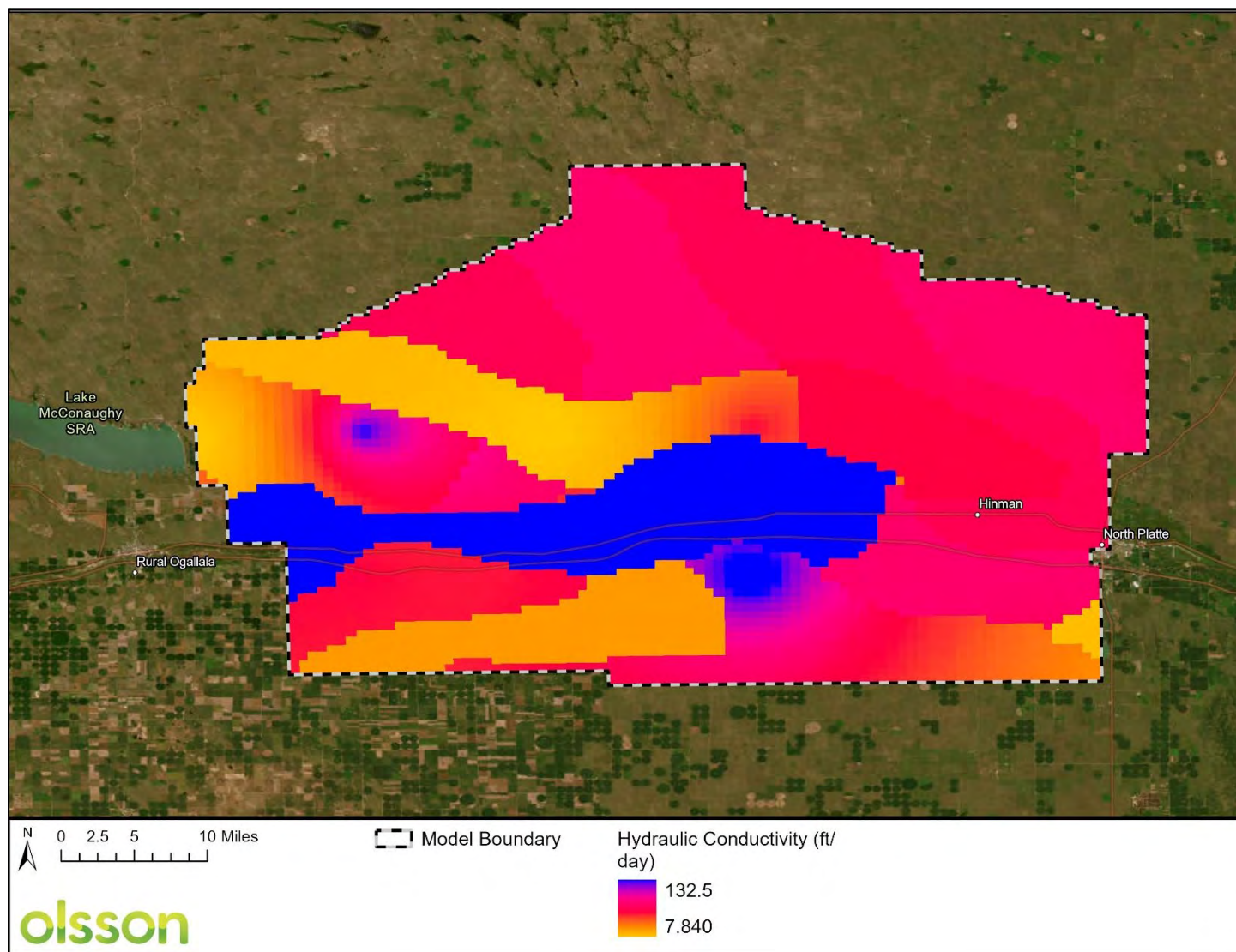


Figure 2-6. Hydraulic conductivity of NPCM. Map of hydraulic conductivity defined for NPCM.

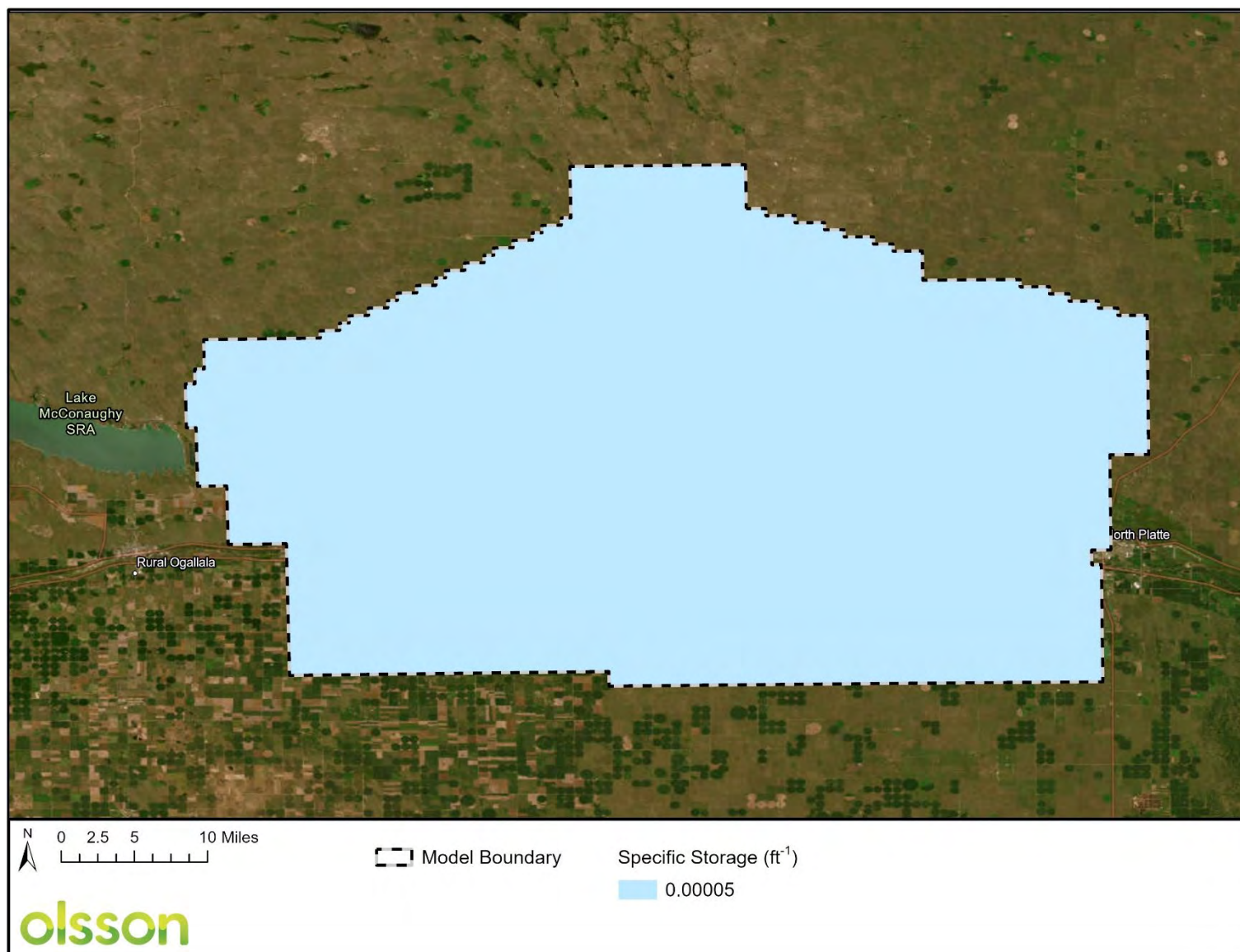


Figure 2-7. NPCM specific storage. Map of specific storage defined for NPCM.

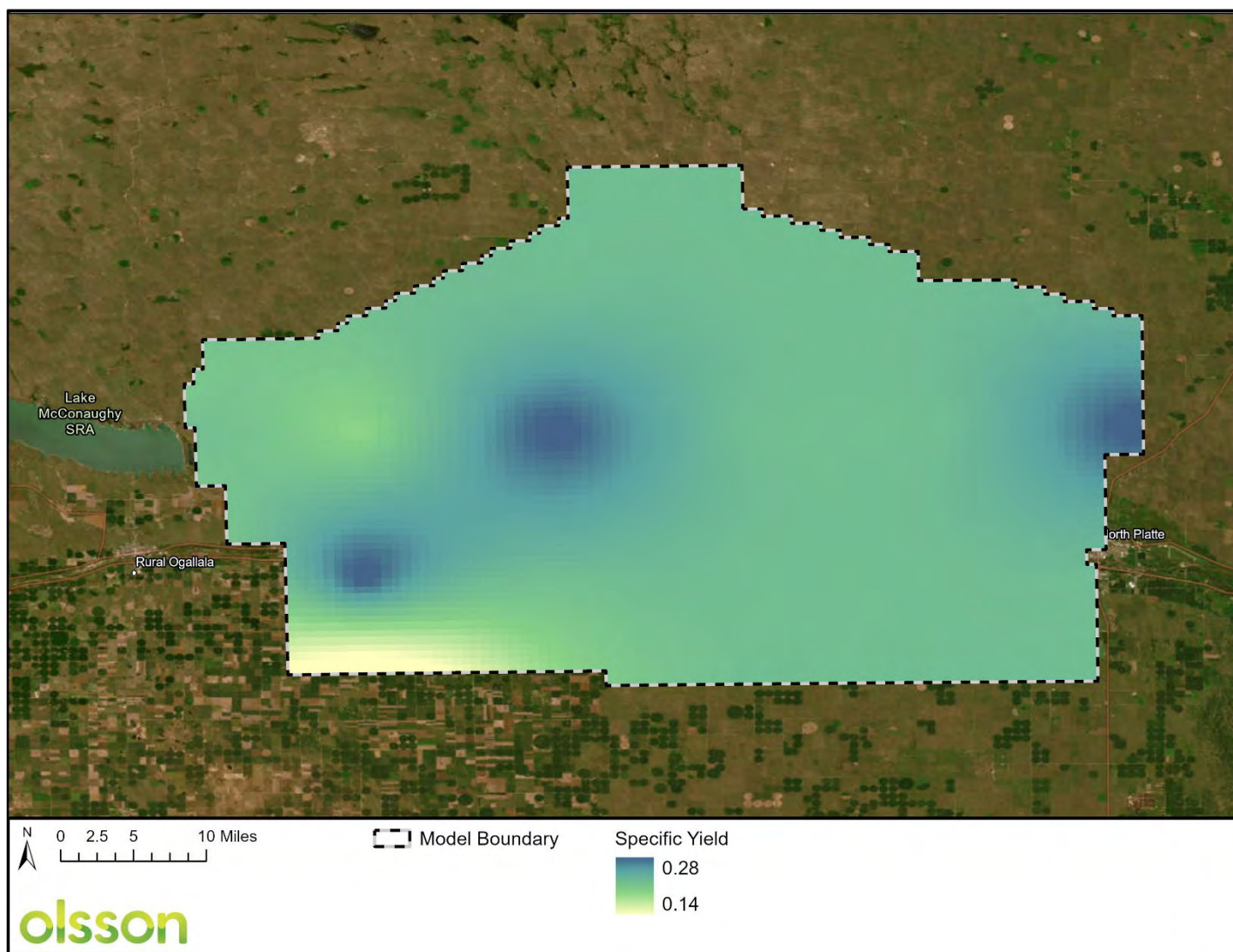


Figure 2-8. NPCM Specific Yield. Map of specific yield defined for NPCM.

2.3.6 Pumping Inputs

In the COHYST model, groundwater pumping was represented by the MODFLOW 6 Well (WEL) package. The WEL package was used to apply a specified-flow boundary condition to simulate the injection or extraction of water from the aquifer by assigning a volumetric pumping rate to model cells.

In the COHYST model, well locations were not explicitly defined, so values from the WEL package were distributed across multiple subregional NPCM cells. The volumetric pumping rate from the COHYST model was spread evenly across the refined subregional model cells, ensuring that the total groundwater pumping remains unchanged and the same volumetric flow rate is applied consistently across the same spatial area.

2.3.7 Recharge Inputs

Recharge inputs were implemented using the MODFLOW 6 Recharge (RCH) package in both the NPCM and COHYST models. This package simulates deep percolation of water through the groundwater system as a specified-flow boundary condition. A regional soil water balance (RSWB) model developed using CropSim was integrated into the COHYST surface water model (PRCS, 2017). A detailed description of the RSWB model can be found on the COHYST website. The RSWB model utilizes climate, soil, and land use data to produce recharge estimates.

COHYST model files include 61 RCH packages, categorized as follows:

- Watershed Recharge – Recharge resulting from precipitation and irrigation across the model domain.
- Excess Flow Recharge – Recharge induced from the portion of flow on a river or stream beyond what is required to support all existing water allocations, demands, and uses.
- Surface Water Canal and Reservoir Recharge – Recharge gained from Canals and Reservoirs (i.e., losing canals and reservoirs).

In the NPCM, Watershed, Excess Flow, and Reservoir Recharge inputs and spatial distributions were replicated from the COHYST model. The NPCM incorporated a refined canal recharge file from COHYST, which explicitly associates recharge rates with individual canals. For each canal, COHYST recharge rates were aggregated and spatially redistributed within the NPCM for each stress period. While the total recharge volume remained consistent with COHYST, the spatial distribution was refined in NPCM to more accurately reflect canal locations.

2.3.8 Model Calibration Assessment

In 2022, the COHYST regional model was updated to MODFLOW 6 and recalibrated in a process outlined in “COHYST Groundwater Model Update” prepared by McDonald Morrissey Associates. Calibration was performed independently for the surface water and groundwater models, followed by integrated calibration. As part of the groundwater calibration, the hydraulic conductivity and specific yield were adjusted using pilot points informed by observed water level elevations, primarily from USGS monitoring data (MMA, 2022). The NPCM was developed using aquifer properties calibrated in the COHYST model and therefore did not require additional calibration.

The differences in water budgets between the COHYST regional model and the NPCM by parameter are plotted in **Figures 2-9 to 2-14**. The water budget plots include rate and cumulative water budgets for both the COHYST and the NPCM model, as well as the difference between them. These plots confirm that the

NPCM water budget closely aligns with the COHYST model, further supporting the conclusion that additional calibration was not necessary.

Overall, the minimal differences between the COHYST regional model and the NPCM confirm that the NPCM maintains a consistent level of calibration in comparison to the COHYST regional model in representing the groundwater flow in the modeled area.

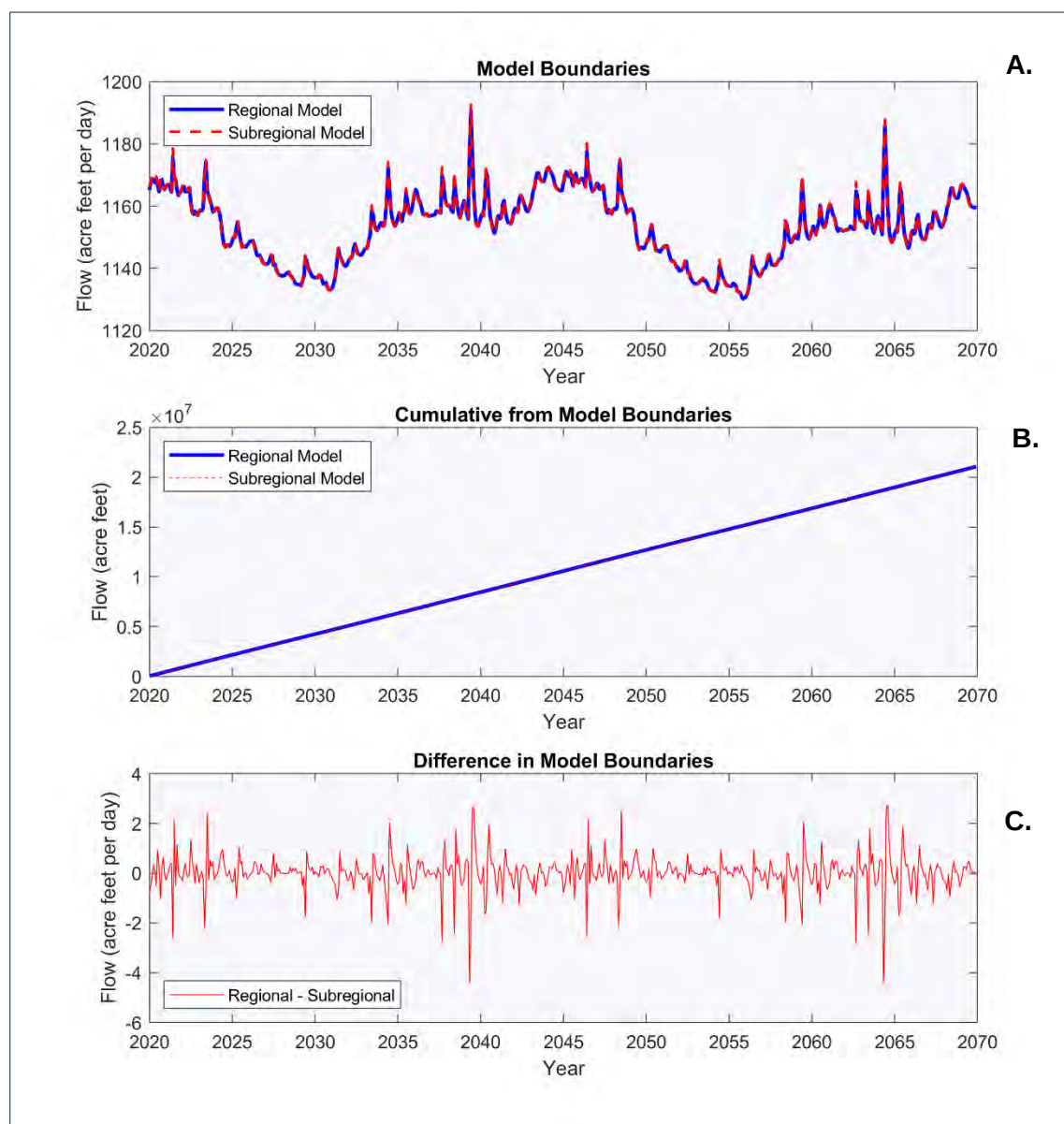


Figure 2-9. Model boundary flow comparisons between regional and subregional model boundaries. (A) Daily boundary flow from regional and subregional models (acre-ft/day); (B) Cumulative boundary flow from regional and subregional models over time (acre-feet); (C) Daily difference in boundary flow between regional and subregional models (Regional – Subregional, acre-feet/day). Graphs of model boundary flow comparisons between regional and subregional model boundaries showing strong overall agreement between the regional and subregional model boundaries.

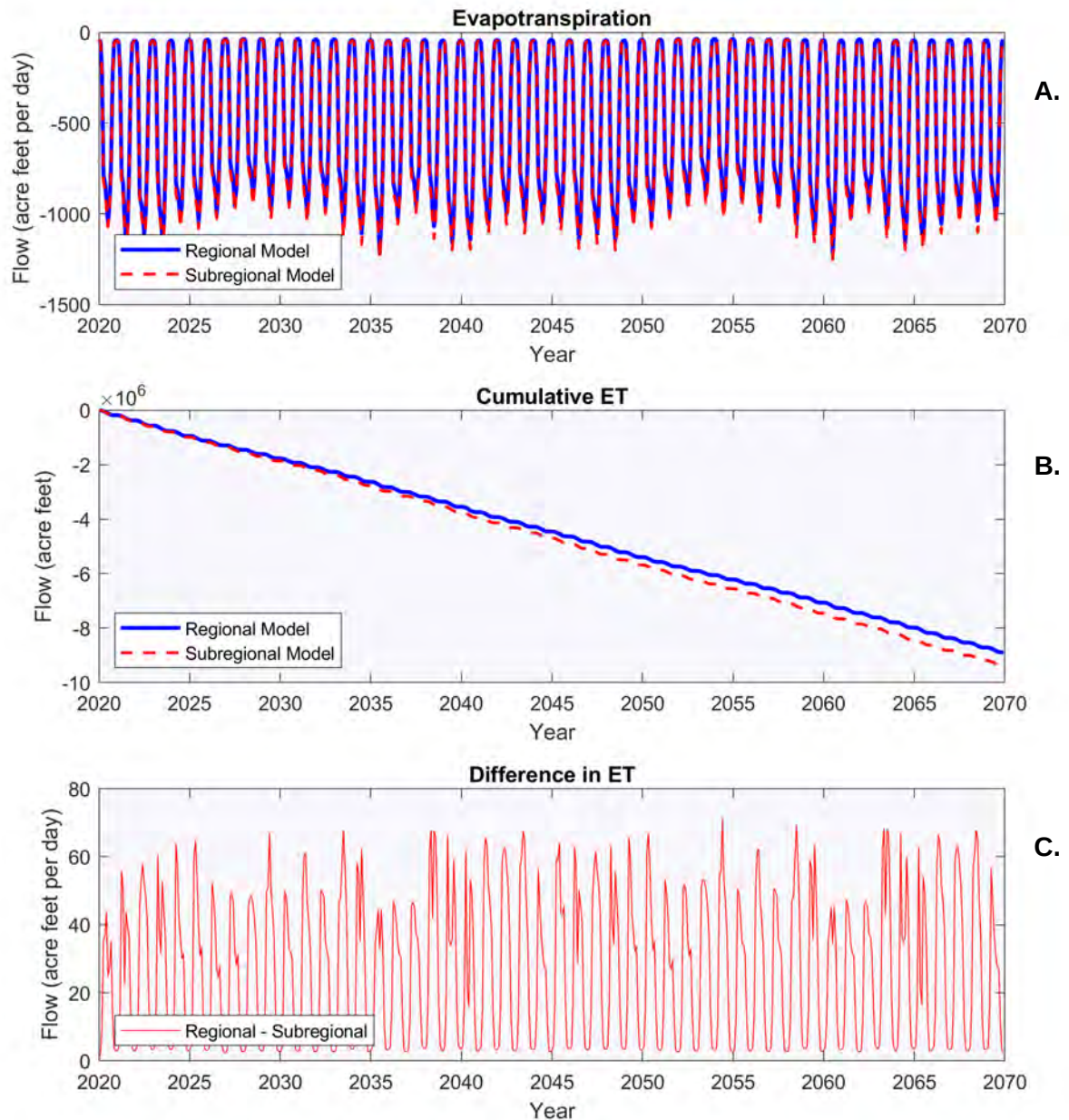


Figure 2-10. Evapotranspiration comparisons between regional and subregional models. (A) Daily evapotranspiration from regional and subregional models (acre-feet/day); (B) Cumulative evapotranspiration from regional and subregional models over time (acre-feet); (C) Daily difference in evapotranspiration between regional and subregional models (Regional – Subregional, acre-feet/day). Graphs of evapotranspiration comparisons between regional and subregional models showing strong overall agreement between the regional and subregional models.

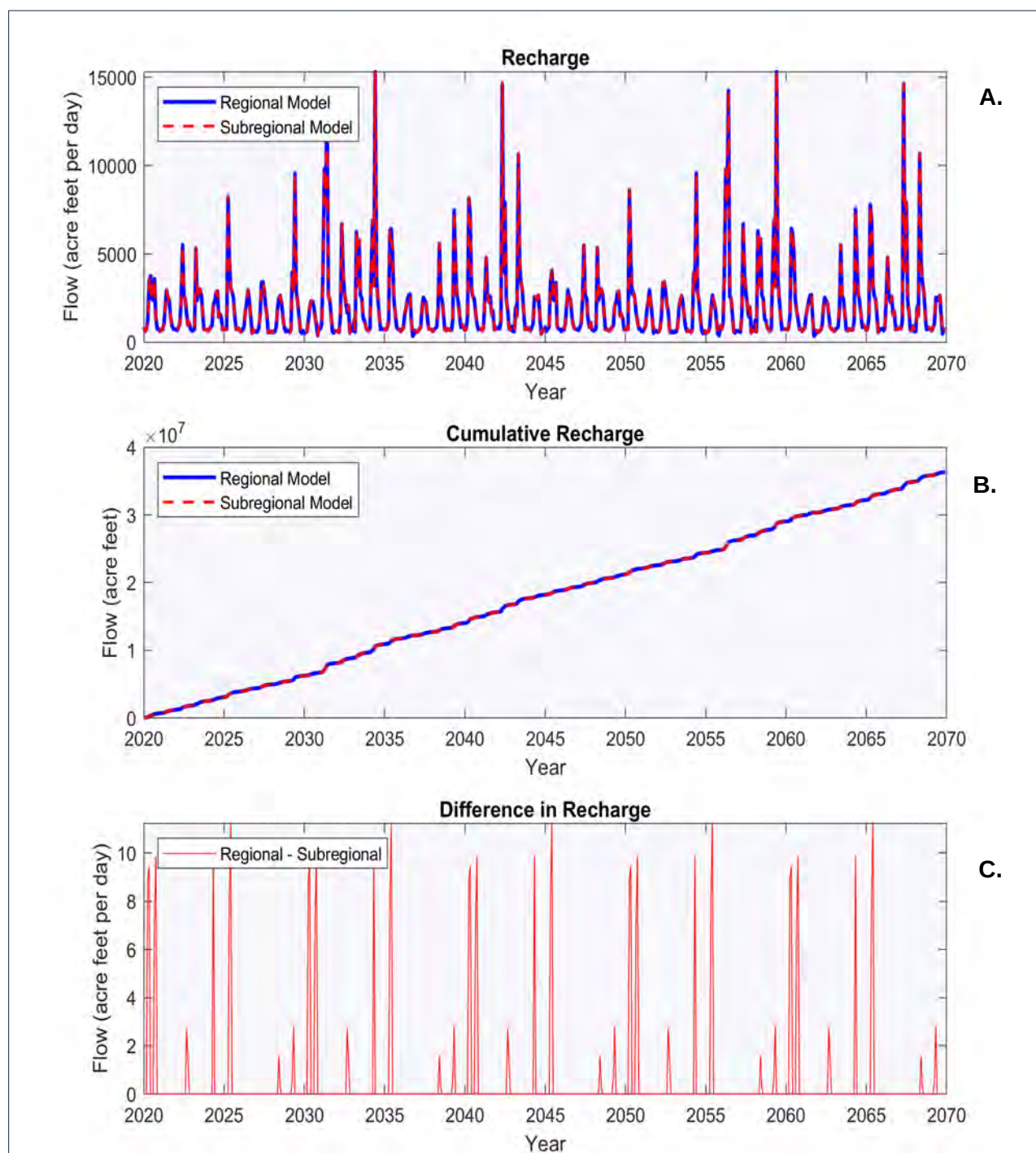


Figure 2-11. Recharge comparisons between regional and subregional models. (A) Daily recharge from regional and subregional models (acre-feet/day); (B) Cumulative recharge from regional and subregional models over time (acre-feet); (C) Daily difference in recharge between regional and subregional models (Regional – Subregional, acre-feet/day). Graphs of recharge comparisons between regional and subregional models showing strong overall agreement between the regional and subregional models.

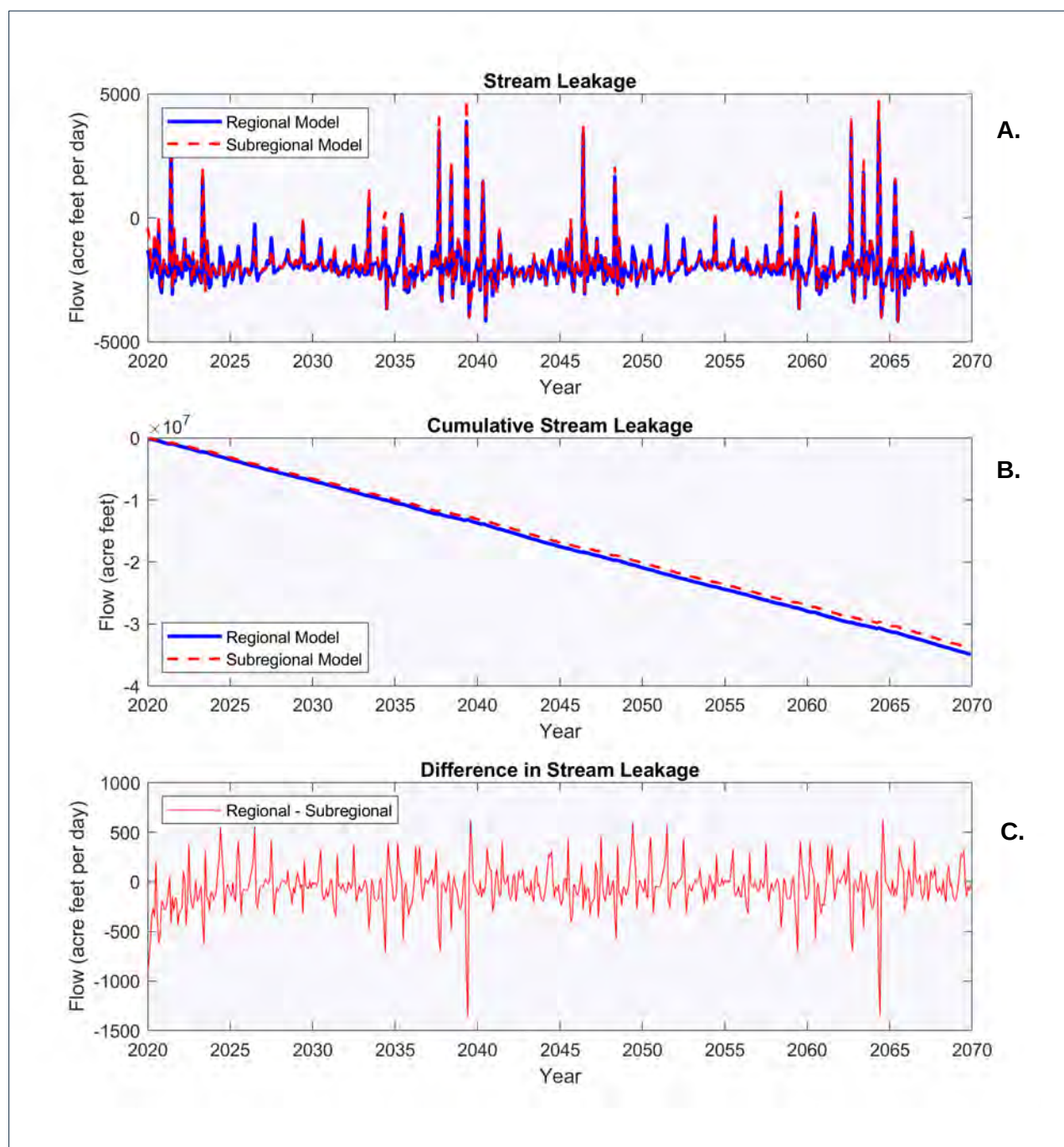


Figure 2-12. Stream leakage comparisons between regional and subregional models. (A) Daily stream leakage from regional and subregional models (acre-feet/day); (B) Cumulative stream leakage from regional and subregional models over time (acre-feet); (C) Daily difference in stream leakage between regional and subregional models (Regional – Subregional, acre-feet/day). Graphs of stream leakage comparison between regional and subregional models showing strong overall agreement between the regional and subregional models.

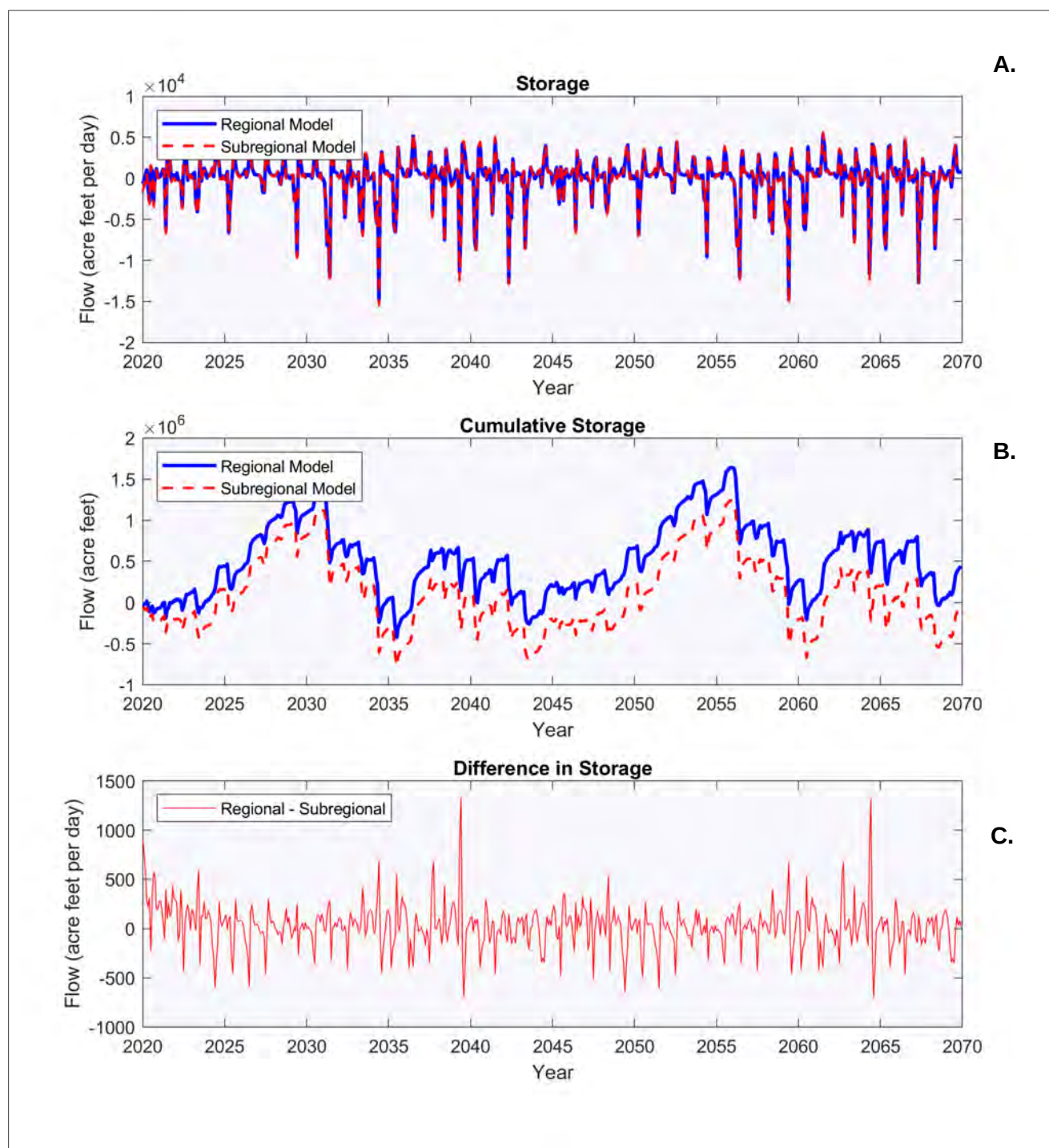


Figure 2-13. Storage comparisons between regional and subregional models. (A) Daily storage from regional and subregional models (acre-feet/day); (B) Cumulative storage from regional and subregional models over time (acre-feet); (C) Daily difference in storage between regional and subregional models (Regional – Subregional, acre-feet/day). Graphs of storage comparisons between regional and subregional models showing strong overall agreement between the regional and subregional models.

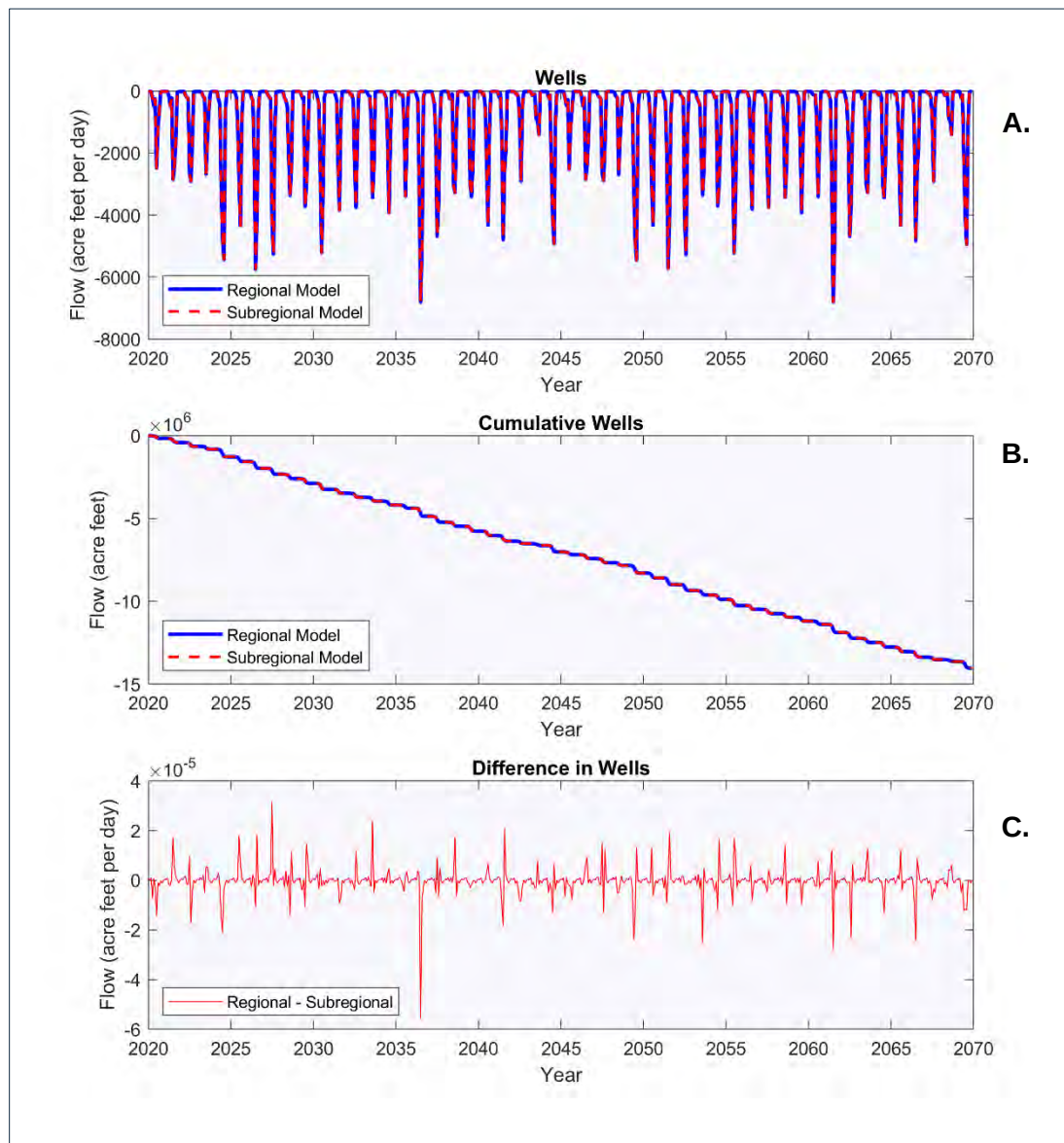


Figure 2-14. Well pumping comparisons between regional and subregional models. (A) Daily well pumping from regional and subregional models (acre-feet/day); (B) Cumulative well pumping from regional and subregional models over time (acre-feet); (C) Daily difference in well pumping between regional and subregional models (Regional - Subregional, acre-feet/day). Graphs of well pumping comparisons between regional and subregional models showing strong overall agreement between the regional and subregional models.

2.3.9 Model Use in the Plan

The East Clear Creek Watershed Plan outlines a closely connected hydrologic system of groundwater and surface water. The NPCM was applied across a variety of analyses, including quantifying interactions among canals, streams, and the aquifer. It also facilitated evaluation of changes in canal water delivery, the timing of canal recharge, and the broader significance of canal recharge for agricultural water management within the Planning Area. **Section 2.3.10** presents the results of canal recharge simulations resulting from the NPCM.

2.3.10 Canal Seepage Analysis

A series of canal recharge simulations were conducted using the NPCM and Olsson's Groundwater Evaluation Toolbox (GET). GET is an online platform where users can run groundwater models and view results in graphs and charts. A series of simulations were run to quantify the amount of seepage (recharge) provided by each canal individually and as an entire system over the 50-year model simulation. Additionally, a "pulse" of water (1,000 acre-feet [AF]) was simulated as seepage from each of the canals to understand the timing and amount of recharged water flowing to the stream.

The first scenario eliminated all canal seepage to evaluate its effect on the groundwater budget, specifically aquifer water level elevations. **Table 2-3** shows the model run for all canals with no canal seepage, showing a maximum water level decline of 12.25 feet. The baseline model was also run to trace the distribution of seepage – quantifying contributions to aquifer storage, streamflow, return flows and other water budget terms. **Table 2-4** shows the results of the baseline run for each of the canals.

Finally, a 1,000 AF seepage pulse was applied individually to each canal during the initial stress period to quantify its impact on the groundwater model's water budget. **Table 2-5** shows the results of the model runs with the 1,000 AF seepage pulse and the amount of recharged water returned to the stream. Within the NPCM, the streams are divided into reaches. The amount of recharged water returned to each specific reach is also provided.

Summary tables of the results are presented below.

Table 2-3. NPCM run with no canal seepage.

Canal Name	Maximum Decline (ft)
All canals	12.25

Table 2-4. NPCM baseline run for each of the canals (cumulative volumes after 50 years).

Canal Name	Total Seepage (AF)	Discharged to Stream (AF)	Change in Aquifer Storage (AF)	Evapotranspiration (AF)
Birdwood	172,000	127,500	37,500	7,000
Cody-Dillon	68,500	66,100	1,300	1,100
Keith-Lincoln	373,250	330,600	18,100	24,550
Paxton-Hershey	381,000	360,000	10,000	11,000
Platte Valley	1,037,400	989,000	22,300	26,100
Suburban	510,000	486,000	9,698	14,302

Table 2-5. NPCM 1,000 acre-ft pulse model runs for each of the canals.

Canal Name	Returned to Stream (AF)	% Returned to Stream	% Returned to Stream Within 1 Year	Return Distribution by Reach
Birdwood	855	85.5	29.2	Suburban to North Platte: 70.8%
				Sutherland to Suburban: 29.2%
Cody-Dillon	983	98.3	71.1	Suburban to North Platte: 98.5%
				To South Platte River: 1.5%
Keith-Lincoln	935	93.5	39.5	Keith Lincoln to Sutherland: 47%
				To South Platte River: 51%
				Sutherland to Suburban: 2%
Paxton-Hershey	970	97	50.1	Keith Lincoln to Sutherland: 14.5%
				To South Platte River: 33.8%
				Suburban to North Platte: 43.3%
				Sutherland to Suburban: 8.4%
Platte Valley	977	97.7	59.8	Keith Lincoln to Sutherland: 7.5%
				To South Platte River: 45.3%
				Suburban to North Platte: 43.1%
				Sutherland to Suburban: 4.1%
Suburban	975	97.5	64	Suburban to North Platte: 51%
				To South Platte River: 49%

2.3.11 References

COHYST, 2017. Appendix 5A: RSWB model construction. Cooperative Hydrology Study, May 30, 2017. <https://cohyst.nebraska.gov/pdf/appendix/05A-RSWBConstruction.pdf>

McDonald and Morrissey Associates LLC, 2022. COHYST groundwater model update version COHYST2010_29_16_29f. December 7, 2022.

2.4 Hydraulic Modeling

Existing HECRAS models of the study reach were obtained from Headwaters Corporation and used to evaluate the hydraulic impacts of the proposed structure replacements. The existing diversion structures were surveyed to obtain all key dimensions and elevations in order to develop preliminary size estimates for the proposed replacement structures. All structure dimensions and elevations that were specified in the existing models were cross validated with the as-built survey data to ensure the model was up to date and representative of current day conditions.

2.4.1 Models Used in Evaluation

Below is a list of models that were used to evaluate the hydraulic capacity of each diversion structure (NOTE: The FEMA regulatory model was not used in this Plan and additional coordination with the USACE will be needed for design and permitting):

- 1D Steady Flow Model of Keystone Dam to North Platte, NE (PRRIP, 2011)
- 1D Unsteady Flow Model of Keystone Dam to North Platte, NE (PRRIP, 2011)
- 2D Steady Flow Model of Choke Point Reach (Anderson Consulting Engineers, 2018)
- 2D Unsteady Flow Model of Choke Point Reach (Anderson Consulting Engineers, 2018)

The models did not require recalibration as their geometric parameters (i.e., cross-section bathymetry, Manning's n values, ineffective flow areas) were not modified. The 2D models developed by Anderson Consulting Engineers mainly focused on areas downstream of the irrigation diversions, therefore, it was only used as a reference to better understand downstream controls and sediment transport processes.

2.4.1.1 Analysis Within the Plan

The Keith-Lincoln, Platte Valley, Paxton-Hershey, and Suburban river gate structures were sized to be hydraulically equivalent to the existing structures (gate opening areas and overflow spillway areas were not changed). The Cody-Dillon and Birdwood creek structures were both modified to enhance their hydraulic efficiency and operability (radial gates and slide gates were added as the existing structures do not have gate control ability). All canal headgate structures were sized based upon the most recent current maximum permitted diversion under excess flow conditions (i.e., permitted diversion by DWEE) for that canal. This provides each irrigation district with the ability to divert the maximum amount of water permitted during any given year. It is not expected that all gates will be utilized during the entirety of the irrigation season. **Table 2-6** provides the most recent excess flow diversion grant for each irrigation district along with the number of proposed canal gates and total diversion capacity under typical flow conditions.

Table 2-6. Canal Diversion Structure Details

Canal Name	Max Permitted Diversion (cfs)	No. of Slide Gates (8.5')	Discharge Capacity (cfs)
Keith-Lincoln	80.56	3	89.75
Platte Valley	201	7	214.87
Paxton-Hershey	102.78	5	122.78
Suburban	77.47	5	81.53
Birdwood Creek	44.06	3	48.92
Cody-Dillion	58.08	4	65.23

2.4.2 River Structure Underseepage

This section details the seepage analysis of four of the proposed project diversion structures on the main channel of the North Platte River: Keith-Lincoln, Platte Valley, Paxton-Hershey, and Suburban. Birdwood and Cody-Dillion were not included because the small size of Birdwood's diversion structure would dictate that seepage modeling would produce only negligible differences in seepage quantities, and Cody-Dillion's orientation parallel to the river's flow would not produce seepage differences in the modeling. However, percentages of change in seepage as demonstrated by modeling the other four structures can be assumed to apply broadly to all six. The analysis was conducted using MODLFOW 6 to develop 2D cross section models for each structure. The aquifer properties at each structure were sourced from the COHYST groundwater model that also informed the canal seepage analysis outlined above. The hydraulic conductivity used in each model simulation and total length of the structure used to compute the total seepage rate are given in Table 2.7.

Table 2.7. Seepage modelling analysis assumptions and results

Canal	Hydraulic Conductivity (ft/day)	Structure Length (ft)	Seepage (ft ³ /day) Existing Conditions	Seepage (ft ³ /day) Proposed Conditions	Percent Change
Keith-Lincoln	74.37	130	24,488	20,498	-16.3%
Platte Valley	97.37	300	73,545	61,698	-16.1%
Paxton-Hershey	105.32	290	76,786	64,513	-16.0%
Suburban	86.38	130	28,343	23,718	-16.3%

The seepage analysis results are highly sensitive to the surrounding hydrogeologic environment, seasonal bank storage fluctuations, and the hydraulic head differential across the structure. New structural concrete and sheet piles are anticipated to significantly reduce the overall hydraulic conductivity of the structure; however, the total underseepage rates are mainly governed by the surrounding hydrogeologic environment. These localized seepage models incorporate several key assumptions:

- **Flow Confinement:** All seepage is assumed to flow directly underneath the structure due to cutoff walls and sheet piles along the channel banks near the canal headgate structure, eliminating lateral seepage around the structure sides.
- **Boundary Conditions:**
 - o A 5 ft head differential was applied across each structure, representing typical diversion conditions when head is generated upstream.
 - o The new concrete and sheet piles in the proposed structures are impervious and modeled as no-flow boundaries.

- o The existing structure/sheet pile system has a K-value of 0.1 ft/day (consistent with fractured-pervious concrete). This condition was imposed to simulate the impact of the deteriorated condition noted by the structural review.
- **Material Properties:** The stream-aquifer material is assumed to be homogenous in the immediate vicinity of the structure.
- **Sheetpile Depth:** The existing sheet pile walls extend approximately 18 ft into the alluvium (two sheet pile rows from historical drawings), while the proposed structures incorporate three sheet pile walls extending 25 ft beneath the concrete into the alluvial material.
 - o The models of the proposed structures incorporated an additional sheet pile wall in addition to extending the sheet piles deeper into the model domain. Both of these modifications are necessary in the structure design as they add stability to the structure by reducing the uplift forces acting on the structure base and provide greater stability to the structure toe by reducing the hydraulic gradient.
- **Model Extent:** The cross-section model extends 80 ft into the Platte River alluvium. The vertical cross-section is considered representative of the hydraulic conditions along the entire structure length.

The cross section in Figure 2-15 illustrates the head distribution across the Platte Valley structure, the applied boundary conditions, and the assumed proposed sheet pile configuration for a new river structure.

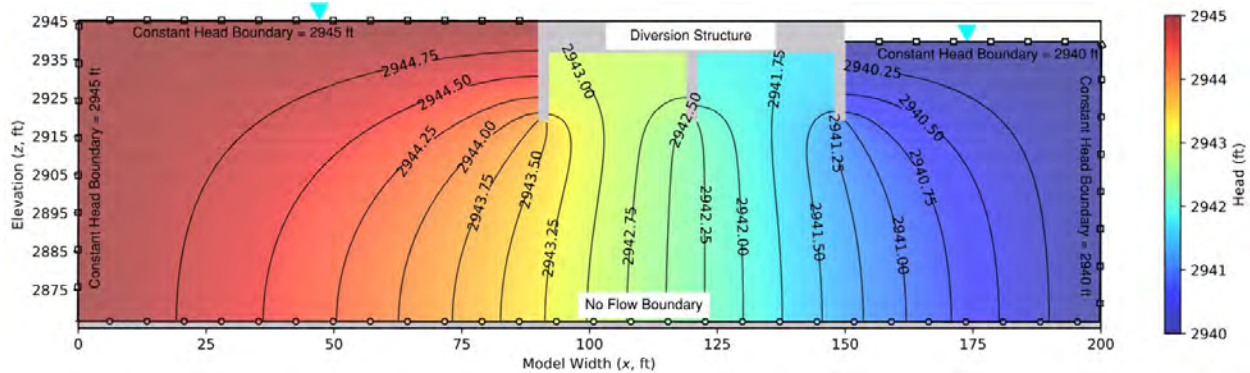


Figure 2-15. Example of a 2D model cross section illustrating the head distribution and the applied boundary conditions upstream and downstream of the proposed Platte Valley structure. Chart of example cross section of 2D model showing head distribution and applied boundary conditions upstream and downstream of proposed Platte Valley structure.

3. PREFERRED ANALYSIS AND DESIGN

Structural evaluations were performed at each canal diversion gate to better understand the existing conditions of each structure, and determine what improvements were needed.

3.1 Existing Conditions and Operations

The following information in **Tables 3-1 to 3-6** describe information provided in structural evaluation reports for the six canals in the Planning Area. More detailed information and pictures are available in the structural evaluation reports in Appendix E.

Table 3-1. Keith-Lincoln existing conditions summary.

Canal	Location	Structural Features	Description
Keith-Lincoln	~8 miles NW of Paxton, NE	General Configuration	Six river gates oriented perpendicular to the river
			Two-cell diversion structure along the south riverbank
		River Control Gates	Six cells with steel radial gates
			Operated via motorized cable and pulley systems
			Partial automation using retrofit equipment
		Canal Gate Structure	Concrete apron spans canal inlet and gate structure
			Two-cell box culvert with concrete-sealed river face
			Steel lift gates control flow through side openings
			Canal side includes splash basin, concrete baffles, and flared wing walls
			Apron slopes upward from downstream flowline

Canal personnel described challenges with the current gate operators - specifically that they are automated but not synchronized, limiting multi-gate operation. Concerns about excessive sand accumulation at the canal gate inlet were also expressed, requiring extensive dredging multiple times per year. The gate seals have deteriorated, with concrete patches as a temporary fix. However, the gates still leak - a deficiency that results in water loss.

Table 3-2. Platte Valley existing conditions summary.

Canal	Location	Structural Features	Description
Platte Valley	~2.5 miles NW of Sutherland, NE	General Configuration	Spillway structure to the north
			Six river gates toward the south riverbank
			90-degree diversion structure south of river gates
		Spillway Structure	Primary overflow weir with downstream concrete apron
			Secondary weir for additional energy dissipation and flow control
		River Control Gates	Six cells: two original and four newer cells built 4 feet lower
			All cells have manually operated steel radial gates
			Concrete aprons provide structural support and flow management
		Diversion Structure	Two-cell concrete inlet, each with five steel lift gates
			Gates divert water from below the checked river surface
			Canal turns 90-degrees south of the inlet, then continues east
			Concrete apron extends from the inlet through the original gate locations and across the structure

Canal personnel with Platte Valley expressed concerns about safety. Access to lower gate components is currently dangerous, and lighting at the site is not sufficient. Some erosion has occurred around the canal diversion gates that should be addressed. Canal operators also voiced interest in a combined diversion with Paxton-Hershey canal to improve operability. Automated gates were supported. Significant seepage underneath the structure was discovered in fall 2024, prompting emergency repairs that are temporary in nature.

Table 3-3. Paxton-Hershey existing conditions summary.

Canal	Location	Structural Features	Description
Paxton-Hershey	~2.5 miles NW of Sutherland, NE	General Configuration	Northern spillway structure
			Four river gates along the south riverbank
			90-degree diversion structure directly south of river gates
		Spillway Structure	Upstream weir with downstream concrete apron
		River Control Gates	Four cells with manually operated steel radial gates
		Canal Gate	Seven cells with manually operated steel lift gates
			Gates divert water from below the checked river surface
		Canal and Apron	Canal turns 90-degrees south of the inlet, then heads east
			Concrete apron present between river gates and canal inlet
			Apron formed with steel sheet piling, now serving as facing

Safety concerns were prevalent at the Paxton-Hershey diversion gates. Specifically, access to gate bays with ladders was suggested. Gates are functional, but steel is deteriorating and developing surface holes. Automated gates are desired by canal operators. Canal personnel expressed support for a combined Platte Valley/Paxton-Hershey diversion structure. Damage to the overflow spillway across the North Platte River was observed.

Table 3-4. Birdwood existing conditions summary.

Canal	Location	Structural Features	Description
Birdwood	~5.5 miles NE of Sutherland, NE	General Configuration	Two river control gates
			90-degree canal gate diversion structure adjacent to river gates
		River Control Gates	Two cells using stoplogs to manage river flows
		Canal Gate	Four-cell corrugated metal pipe inlet
			Each cell equipped with steel lift gates
			Gates divert water from below the checked river surface

At the Birdwood diversion structure, sand deposits are a major concern. Canal operators must clear the accumulated sand several multiple times per year to allow for continued operation. Compromised safety of canal personnel when crossing the canal gate structure was mentioned. Automated gate control was also supported.

Table 3-5. Suburban existing conditions summary.

Canal	Location	Structural Features	Description
Suburban	~3.5 miles NW of Hershey, NE	General Configuration	Southern spillway structure
			Two river gates along the northern riverbank
			90-degree canal gate structure directly west of spillway
			County bridge located upstream
		Spillway Structure	Primary overflow weir with downstream concrete apron
			Two permanently closed steel lift gates
			Original steel gates replaced with a concrete weir wall
		River Control Gates	Two cells with concrete side and intermediate walls
			Concrete apron spans the gate base
			Motorized steel radial gates manage river levels
			Concrete access platform mounted atop the structure
		Canal Gate Structure	Four-cell concrete inlet with end and intermediate walls
			Three cells have manually operated steel lift gates
			Easternmost cell permanently sealed with concrete
			Gates divert water from below the checked river surface
		Canal and Apron	Canal extends 900 feet south, then turns east
			Triangular concrete apron at southeast corner
			Apron extends 42 feet north along spillway and canal gate

A major concern of Suburban Canal operators was persistent erosion behind the west wall of the canal gate structure. Multiple mitigation measures have been attempted—but a long-term solution is desired. Additionally, fencing and safety improvements are needed to protect canal personnel.

Table 3-6. Cody-Dillon existing conditions summary.

Canal	Location	Structural Features	Description
Cody-Dillon	~7 miles NE of North Platte, NE	General Configuration	Return gate structure to the north
			90-degree canal gate structure directly east of return gate
			Feeder canal divers flow from the North Platte River using sand dams
		Canal Gate	Two-cell structure using stoplogs to regulate flow
			Excess flow returned to the river
		Return Gate	Four rectangular concrete cells with embedded steel channels
			Timber stoplogs used to dam flow from feeder canal
		Other Features	Concrete visible at gate face
			Supplemental concrete bases added to structure walls
			Modifications address abrasion-related degradation

The entirety of the Cody-Dillon diversion structure is unsafe for canal operators. Multiple structural deficiencies were identified. Canal personnel supported river gate automation.

3.2 Recommended Improvements

The following section describes the recommended improvements, outlined in structural reports about each of the six canals in the Planning Area. **Tables 3-7 to 3-12** provide details, but additional information is provided in the structural reports within Appendix E.

3.2.1 Keith-Lincoln

The diversion structures part of Keith-Lincoln were generally in good condition, with isolated structural fixes and recommended safety and operational upgrades. **Table 3-7** outlines the recommended improvements in more detail. Since structures were generally in good condition, only partial replacement of diversion gate components are recommended.

Table 3-7. Keith-Lincoln recommended improvements.

Structural Improvements	Safety & Operational Improvements
Restore grades behind river gate side walls (especially downstream) and add scour protection	Install 42" handrails on access platforms for river gate and canal structures
Fill scoured subgrade below south river gate side walls using flowable fill	Upgrade river gate automation for improved efficiency and safety
Install riprap basin at downstream edge of river gate structure to prevent undermining	Clean river gates, patch surface holes, and apply protective coating
Add steel sheet pile cut-off wall if not already present (presence not confirmed during site visit)	Replace river gate seals to minimize water loss through closed gates
	Clean canal gates and replace seals to reduce water loss

3.2.2 Platte Valley

Platte Valley structures were found to be in fair condition, with localized structural repairs and recommended safety and operational upgrades. **Table 3-8** outlines the recommended structural and safety and operational improvements.

Table 3-8. Platte Valley recommended improvements.

Structural Improvements	Safety & Operational Improvements
Repair/reconstruct north exterior wall of newer main channel gates for full gate operation	Install stairs or ladder between original and newer main channel gates for safer access
Reconstruct downstream retaining wall of the river channel	Add lighting to support nighttime operations
Replace temporary upstream apron repairs with a long-term solution	Upgrade gate systems for automated operation at river and canal gate structures
Repair western canal gate structure wall	Add 42" handrails to all access platforms
Replace intermediate and eastern canal structure walls	
Replace access platforms with steel or concrete catwalks	
Install scour mitigation sheet pile cut-off walls upstream and downstream, connecting to existing aprons or walls	
Perform concrete patching at spalled areas across walls and slabs	
Patch and seal construction joints in the spillway to prevent seepage	
Replace radial gate seals	
Backfill scoured region behind north retaining wall of overflow structure	
Restore downstream riprap basin at overflow weir	

3.2.3 Paxton-Hershey

River gates at the Paxton-Hershey Canal diversion were in fair condition, but need repairs to the steel radial gates, gate operators, and concrete. The overflow spillway was in poor condition, requiring significant concrete, joint, and scour repairs. Canal gates were in very poor condition and should be fully replaced. **Table 3-9** outlines the recommended improvements.

Table 3-9. Paxton-Hershey recommended improvements.

Structural Improvements	Safety & Operational Improvements
Reconstruct downstream retaining wall of the river channel	Install stairs or access ladders throughout the structure
Replace failed spillway section north of the river gates	Add lighting to support nighttime operations
Replace canal gate structure and reconnect to river gate structure	Upgrade gate systems at river gate structure for automated operation
Install scour mitigation sheet pile cut-off walls upstream and downstream, connecting to existing aprons or walls	Add 42" handrails to all access platforms
Perform concrete patching at spalled areas across walls and slabs	
Patch and seal construction joints in the spillway to prevent seepage	
Replace radial gate seals	
Patch and recoat radial gate surfaces with excessive section loss	
Restore downstream riprap basin at overflow weir	
Restore and armor eroded embankment areas to prevent future deterioration	

3.2.4 Birdwood

The river gate structure on Birdwood Canal appeared to be in good condition with minor maintenance needs. The canal gate structure was in poor condition, likely requiring costly repairs nearing replacement value, so no maintenance is recommended. Both structures were also in need of safety and operational upgrades. The following table addresses the recommended improvements (see **Table 3-10**). Due to the magnitude of improvements needed, a full replacement of the canal gate structure and partial replacement of river gate components is recommended.

Table 3-10. Birdwood recommended improvements.

Structural Improvements	Safety & Operational Improvements
Fully replace canal gate structure	Install a safer and more reliable method to dam flow through river control gates (replacing timber stop logs).
Replace or modify sand chute structure to improve sand removal effectiveness	Add a safer access platform for river control gates, including 42" handrails
	Install automated gates for the river gate structure
	Add structure lighting to support nighttime operations
	Raise canal gate structure elevation by 4–5 feet to maintain access during high-flow events
	Restore backfill grading behind the north sidewall of the river control gate structure

3.2.5 Suburban

The river gate at Suburban Canal was in good condition, while the spillway and canal structures need structural upgrades and some component replacements. Safety and operational improvements are also recommended. **Table 3-11** details the recommended improvements. Since structures were generally in good condition, only partial replacement of diversion gate components are recommended.

Table 3-11. Suburban recommended improvements.

Structural Improvements	Safety & Operational Improvements
Regrade embankment behind northern river gate wall to redirect drainage swale; restore and protect downstream northern riverbank	Install stairs or ladder for safer access to structure components.
Replace canal gate structure entirely, including end/interior walls, gates, access platform, and concrete apron—also includes adjacent river-parallel walls	Add lighting to support nighttime operations
Construct riprap scour basin beyond canal structure apron	Install 42" handrails along wall edges and walkways
Extend sheet pile walls across river channel upstream of spillway and river gates; retrofit concrete apron to connect with existing structure	Automate gate operations for river gate structure
Install downstream sheet pile wall for scour protection at spillway and river gates	

3.2.6 Cody-Dillon

Structures at the Cody-Dillon Canal were in fair condition, with some major upgrades required for continued operation. Safety and operational improvements are also recommended. **Table 3-12** provides details of the recommended improvements. Due to the magnitude of improvements needed, a full replacement of the structure is recommended.

Table 3-12. Cody-Dillon recommended improvements.

Structural Improvements	Safety & Operational Improvements
Replace western side wall of return gate structure; evaluate potential wall extension	Install safer access platform across both structures, including 42" handrails
Evaluate east side wall end of return gate structure for possible reconstruction	Add equipment crossing structure over canal with proper foundation design
Repair southern wall of canal gate structure: - Seal vertical crack between wall and canal gates. - Address vertical crack at wall bend.	Install automated gates for river return, operable wirelessly (replacing manual stop logs)
Seal minor cracks in concrete walls	Add lighting for nighttime operations
Seal gaps between base concrete repairs and upper wall sections as needed	Install access ladder or stairs into gate structures
Patch spalled concrete to maintain functionality	Extend concrete apron to fully cover area between return gate inlet and southern structure wall
Remove sediment from canal structure apron	
Restore grade at wall ends and implement erosion protection	

3.3 Structure Improvements

The following exhibits (**Figures 3-1 to 3-6**) detail the improvements to each of the six canals within the Planning Area. Through meetings with the irrigation districts and SLO, the combined Platte Valley/Paxton-Hershey diversion gate was conceptualized. An exhibit of the combined diversion is shown in **Figure 3-7**.

3.4 Preferred Alternative—Combination of Improvements

The Preferred Alternative, as discussed in Chapter 6 of the Plan, is a combination of the recommended improvements. Details of these improvements are discussed in Section 3.2 and depicted in Section 3.3 of Appendix D. This alternative was chosen because it meets the criteria of the purpose and need of the Plan and is the most cost-effective means of doing so.

3.5 Installation Costs

The following tables (**Table 3-13 to 3-17**) are the itemized installation cost breakdowns of each of the proposed improvements. These tables also include the base construction costs, contingencies, engineering costs, permitting costs, and administrative costs.

PROJECT NO.: 022-04855
DESIGN BY: EJS
DRAWN BY: EJS
DATE: 4/25/2025
CHK BY: BSR



PROJECT NO.: 022-04855
DATE: 4/25/2025

DESIGN BY: EJS
DRAWN BY: EJS
CHK BY: BSR

KIETH LINCOLN

olsson®

601 P Street, Suite 200
P.O. Box 84608
Lincoln, NE 68508
TEL 402.474.6311
FAX 402.474.5160

EXHIBIT
1

Figure 3-1. Map of Keith-Lincoln recommended improvements. Map of Keith-Lincoln structure with recommended improvements.

6/18/2025 11:28:05 AM
F:\3022\04855\04855\Map\Design\Microstation\022-04855.dgn, Reference\022-04855, Suburban_1.dgn



PROJECT NO.: 022-04855	DESIGN BY: EJS
	DRAWN BY: EJS
DATE: 4/25/2025	CHK BY: BSR

SUBURBAN

olsson®

601 P Street, Suite 200
P.O. Box 84608
Lincoln, NE 68508
TEL 402.474.6311
FAX 402.474.5160

EXHIBIT
1

Figure 3-5. Map of Suburban recommended improvements. Map of Suburban structure with recommended improvements.

Table 3-13. Estimated Installation Costs for Keith-Lincoln Partial Replacement and Modernization

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
1	Mobilization / Demobilization (8%)	LS	1	\$ 62,600.00	\$ 62,600.00
2	Coffer Dam (Includes temp. piling)	LS	1	\$ 80,000.00	\$ 80,000.00
3	Restore Grades Behind River Gate Side Walls and Place Riprap	LS	1	\$ 16,700.00	\$ 16,700.00
4	Place Flowable Fill Below South River Gate Sidewall	LS	1	\$ 9,000.00	\$ 9,000.00
5	Construct Downstream Rip-Rap Plunge Pool and Install Sheet Pile Cut Off Wall	LS	1	\$ 197,700.00	\$ 197,700.00
6	Install 42" Handrail to River and Canal Gate Walkways	LF	160	\$ 125.00	\$ 20,000.00
7	Repair and Repaint River Gates	LS	1	\$ 93,000.00	\$ 93,000.00
8	Replace River Gate Seals	LS	1	\$ 42,000.00	\$ 42,000.00
9	Clean Canal Gates and Replace Seals	LS	1	\$ 15,000.00	\$ 15,000.00
10	Update Gate Control System	LS	1	\$ 65,000.00	\$ 65,000.00
11	Replace River Gate Imbed Seal Plates	LS	1	\$ 45,000.00	\$ 45,000.00
12	Replace Gate Actuators	EA	6	\$ 25,000.00	\$ 150,000.00
13	6' Chain Link Fence	LF	245	\$ 95.00	\$ 23,275.00
14	5' Chain Link Gate (6' Height)	EA	2	\$ 750.00	\$ 1,500.00
15	10' Chain Link Gate (6' Height)	EA	2	\$ 2,000.00	\$ 4,000.00
16	Update / Add Lighting	LS	1	\$ 20,000.00	\$ 20,000.00
	Subtotal Construction Costs				\$ 844,775.00
	Contingency (25%)				\$ 211,200.00
	Engineering (15%)				\$ 126,700.00
	Project Administration (7%)				\$ 59,100.00
	Permitting (1%)				\$ 8,400.00
	Land Acquisition (Temp. Easements)				\$ 10,000.00
	NRCS Technical Assistance (7%)				\$ 52,800.00

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
	Total Installation Opinion of Costs - 2025				\$ 1,312,975.00
	Total Installation Opinion of Costs - 2027 (2 years @ 3%)				\$ 1,392,900.00

Table 3-14. Estimated Installation Costs for Birdwood Replacement and Modernization

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
1	Mobilization / Demobilization (5%)	LS	1	\$ 173,500.00	\$ 173,500.00
2	Demolition / Clearing & Grubbing	LS	1	\$ 200,000.00	\$ 200,000.00
3	Earthwork / Site Work / Erosion Control	LS	1	\$ 95,000.00	\$ 95,000.00
4	Coffer Dam (Includes temp. piling)	LS	1	\$ 350,000.00	\$ 350,000.00
5	Dewatering During Const.	LS	1	\$ 300,000.00	\$ 300,000.00
6	Sheet Piling - Main Structure	SF	4,175	\$ 40.00	\$ 167,000.00
7	Sheet Piling Joint Sealant (Main Structure)	VF	2,210	\$ 10.00	\$ 22,100.00
8	Sheet Piling (Canal)	SF	1,590	\$ 40.00	\$ 63,600.00
9	Sheet Piling Joint Sealant (Canal)	VF	1,060	\$ 10.00	\$ 10,600.00
10	Rip-Rap (w/ Geo Fabric) - Main Structure	TN	230	\$ 110.00	\$ 25,300.00
11	Rip-Rap (w/ Geo Fabric) - Canal	TN	35	\$ 110.00	\$ 3,850.00
12	Structural Concrete w/Reinforcement - Main Structure	LS	1	\$ 694,900.00	\$ 694,900.00
13	Structural Concrete w/Reinforcement - Canal Gate Structure	LS	1	\$ 247,040.00	\$ 247,040.00
14	16'x6' Radial Arm Gate w/ Electric Operator	EA	2	\$ 210,000.00	\$ 420,000.00
	10'x6' Radial Arm Gate w/ Electric Operator (Sand Chute)	EA	1	\$ 180,000.00	\$ 180,000.00
15	8'-6" S.S. Slide Gate w/ Manual Operator	EA	3	\$ 68,750.00	\$ 206,250.00
16	Level Control Manhole	LS	1	\$ 20,000.00	\$ 20,000.00
17	Pressure Transducer Stilling Well	LS	1	\$ 10,000.00	\$ 10,000.00
18	Galvanized Steel Hand Rail (Main Gate Structure)	LF	60	\$ 85.00	\$ 5,100.00
19	Galvanized Steel Hand Rail (Canal Gate Structure)	LF	96	\$ 85.00	\$ 8,160.00
20	6' Chain Link Fence (Main Gate Structure)	LF	86	\$ 95.00	\$ 8,170.00
21	6' Chain Link Fence (Canal Gate Structure)	LF	24	\$ 95.00	\$ 2,280.00

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
22	5' Chain Link Gate (6' Height) - Main Structure	EA	1	\$ 750.00	\$ 750.00
23	5' Chain Link Gate (6' Height) - Canal Gate Structre	EA	1	\$ 750.00	\$ 750.00
24	Diversion Dam Pressure Relief Piping & Gravel Underdrain	LS	1	\$ 131,250.00	\$ 131,250.00
25	Wall Nose Armoring & Erosion Plate	LS	1	\$ 59,060.00	\$ 59,060.00
26	Seeding	LS	1	\$ 5,000.00	\$ 5,000.00
27	5" Concrete Walks - Main Structure	SF	100	\$ 30.00	\$ 3,000.00
28	5" Concrete Walks - Canal Gate Structure	SF	50	\$ 30.00	\$ 1,500.00
29	Grating & Misc Metals	LS	1	\$ 20,000.00	\$ 20,000.00
30	Gate Control System	LS	1	\$ 65,000.00	\$ 65,000.00
31	Site Lighting	LS	1	\$ 20,000.00	\$ 20,000.00
32	Electrical	LS	1	\$ 55,000.00	\$ 55,000.00
33	Extending Power to Site	LS	1	\$ 70,000.00	\$ 70,000.00
	Subtotal Base Construction Costs				\$ 3,644,160.00
	Contingency (20%)				\$ 728,800.00
	Engineering (15%)				\$ 546,600.00
	Project Administration (7%)				\$ 255,100.00
	Permitting (1%)				\$ 36,400.00
	Land Acquisition (Temp. & Perm. Easements)				\$ 20,000.00
	NRCS Technical Assistance (5%)				\$ 218,600.00
	Total Installation Opinion of Costs - 2025				\$ 5,449,700.00
	Total Installation Opinion of Costs - 2027 (2 years @ 3%)				\$ 5,781,600.00

Table 3-15. Estimated Installation Costs for Suburban Partial Replacement and Modernization

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
1	Mobilization / Demobilization (8%)	LS	1	\$ 127,500.00	\$ 127,500.00
2	Earthwork / Site Work / Erosion Control	LS	1	\$ 25,000.00	\$ 25,000.00
3	Coffer Dam (Includes temp. piling)	LS	1	\$ 75,000.00	\$ 75,000.00
4	Dewatering During Const.	LS	1	\$ 100,000.00	\$ 100,000.00
5	Grading and Riprap on North River Bank	LS	1	\$ 75,000.00	\$ 75,000.00
6	Replace Canal Gate Structure	LS	1	\$ 841,700.00	\$ 841,700.00
7	Construct Downstream Rip-Rap Plunge Pool at Canal Structure	LS	1	\$ 22,100.00	\$ 22,100.00
8	Install Sheet Piling on Upstream Side of River Gates	LS	1	\$ 55,980.00	\$ 55,980.00
9	Install Sheet Piling on Downstream Side of River Gates and Spillway	LS	1	\$ 95,000.00	\$ 95,000.00
10	Install Access Ladder	LS	1	\$ 5,000.00	\$ 5,000.00
11	Install 42" Handrail to River Walkway	LF	50	\$ 125.00	\$ 6,250.00
12	Gate Control System	LS	1	\$ 65,000.00	\$ 65,000.00
13	Site Lighting	LS	1	\$ 15,000.00	\$ 15,000.00
14	Electrical	LS	1	\$ 65,000.00	\$ 65,000.00
15	Replace Gate Operators and Add Actuators	LS	1	\$ 110,000.00	\$ 110,000.00
16	6' Chain Link Fence	LF	130	\$ 95.00	\$ 12,350.00
17	5' Chain Link Gate (6' Height)	EA	3	\$ 750.00	\$ 2,250.00
18	Extending Power to Site	LS	1	\$ 22,500.00	\$ 22,500.00
	Subtotal Construction Costs				\$ 1,720,630.00
	Contingency (25%)				\$ 430,200.00
	Engineering (15%)				\$ 258,100.00
	Project Administration (7%)				\$ 120,400.00
	Permitting (1%)				\$ 17,200.00

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
	Land Acquisition (Temp. & Perm. Easements)				\$ 15,000.00
	NRCS Technical Assistance				\$ 107,500.00
	Total Installation Opinion of Costs - 2025				\$ 2,669,000.00
	Total Installation Opinion of Costs - 2027 (2 years @ 3%)				\$ 2,831,500.00

Table 3-16. Estimated Installation Costs for Cody-Dillon Replacement and Modernization

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
1	Mobilization / Demobilization (5%)	LS	1	\$ 78,400.00	\$ 78,400.00
2	Demolition / Clearing & Grubbing	LS	1	\$ 175,000.00	\$ 175,000.00
3	Earthwork / Site Work / Erosion Control	LS	1	\$ 70,000.00	\$ 70,000.00
4	Coffer Dam (Includes temp. piling)	LS	1	\$ 180,000.00	\$ 180,000.00
5	Dewatering During Const.	LS	1	\$ 120,000.00	\$ 120,000.00
6	Sheet Piling	SF	2,205	\$ 40.00	\$ 88,200.00
7	Sheet Piling Joint Sealant	VF	1,470	\$ 10.00	\$ 14,700.00
8	Rip-Rap (w/ Geo Fabric)	TN	115	\$ 110.00	\$ 12,650.00
9	Structural Concrete w/Reinforcement	LS	1	\$ 302,570.00	\$ 302,570.00
10	8'-6" S.S. Slide Gate w/ Manual Operator	EA	4	\$ 68,750.00	\$ 275,000.00
11	Gate Electric Actuators	EA	2	\$ 25,000.00	\$ 50,000.00
12	Level Control Manhole	LS	1	\$ 20,000.00	\$ 20,000.00
13	Pressure Transducer Stilling Well	LS	1	\$ 10,000.00	\$ 10,000.00
14	Galvanized Steel Hand Rail (3 rail)	LF	42	\$ 85.00	\$ 3,570.00
15	6' Chain Link Fence	LF	155	\$ 95.00	\$ 14,725.00
16	5' Chain Link Gate (6' Height)	EA	4	\$ 750.00	\$ 3,000.00
17	Wall Nose Armoring & Erosion Plate	LS	1	\$ 15,000.00	\$ 15,000.00
18	Seeding	LS	1	\$ 5,000.00	\$ 5,000.00
19	5" Concrete Walks	SF	150	\$ 30.00	\$ 4,500.00
20	Grating & Misc Metals	LS	1	\$ 10,000.00	\$ 10,000.00
21	Gate Control System	LS	1	\$ 65,000.00	\$ 65,000.00
22	Site Lighting	LS	1	\$ 15,000.00	\$ 15,000.00
23	Electrical	LS	1	\$ 45,000.00	\$ 45,000.00
24	Extending Power to Site	LS	1	\$ 70,000.00	\$ 70,000.00
	Subtotal Base Construction Costs				\$ 1,647,315.00

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
	Contingency (20%)				\$ 329,500.00
	Engineering (15%)				\$ 247,100.00
	Project Administration (7%)				\$ 115,300.00
	Permitting (1%)				\$ 16,500.00
	Land Acquisition (Temp. & Perm. Easements)				\$ 20,000.00
	NRCS Technical Assistance (5%)				\$ 98,800.00
	Total Installation Opinion of Costs - 2025				\$ 2,474,500.00
	Total Installation Opinion of Costs - 2027 (2 years @ 3%)				\$ 2,625,200.00

Table 3-17. Estimated Installation Costs for Platte Valley/Paxton-Hershey Combined Replacement and Modernization

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
1	Mobilization / Demobilization (5%)	LS	1	\$ 379,000.00	\$ 379,000.00
2	Demolition / Clearing & Grubbing	LS	1	\$ 350,000.00	\$ 350,000.00
3	Earthwork / Site Work / Erosion Control	LS	1	\$ 100,000.00	\$ 100,000.00
4	Coffer Dam (Includes temp. piling)	LS	1	\$ 450,000.00	\$ 450,000.00
5	Dewatering During Const.	LS	1	\$ 325,000.00	\$ 325,000.00
6	Sheet Piling	SF	14,240	\$ 40.00	\$ 569,600.00
7	Sheet Piling Joint Sealant	VF	4,110	\$ 10.00	\$ 41,100.00
8	Sheet Piling (Canal)	SF	3,335	\$ 40.00	\$ 133,400.00
9	Sheet Piling (Overflow Spillway)	SF	4,800	\$ 40.00	\$ 192,000.00
10	Rip-Rap (w/ Geo Fabric)	TN	2,370	\$ 110.00	\$ 260,700.00
11	Structural Concrete w/Reinforcement	LS	1	\$ 1,604,440.00	\$ 1,604,440.00
12	Canal Walls and Slab & Overflow Spillway Slab	LS	1	\$ 550,090.00	\$ 550,090.00
13	20'x6' Radial Arm Gate w/ Electric Operator	EA	3	\$ 250,000.00	\$ 750,000.00
14	16'x6' Radial Arm Gate w/ Electric Operator	EA	2	\$ 210,000.00	\$ 420,000.00
15	8'-6" S.S. Slide Gate w/ Manual Operator	EA	12	\$ 68,750.00	\$ 825,000.00
16	Level Control Manhole	LS	1	\$ 20,000.00	\$ 20,000.00
17	Pressure Transducer Stilling Well (2 total)	LS	1	\$ 20,000.00	\$ 20,000.00
18	Galvanized Steel Hand Rail (3 rail)	LF	100	\$ 85.00	\$ 8,500.00
19	Galvanized Steel Hand Rail (2 rail)	LF	125	\$ 75.00	\$ 9,375.00
20	6' Chain Link Fence	LF	313	\$ 95.00	\$ 29,735.00
21	5' Chain Link Gate (6' Height)	EA	3	\$ 750.00	\$ 2,250.00
22	Diversion Dam Pressure Relief Piping & Gravel Underdrain	LS	1	\$ 250,000.00	\$ 250,000.00
23	Wall Nose Armoring & Erosion Plate	LS	1	\$ 112,500.00	\$ 112,500.00
24	Seeding	LS	1	\$ 5,000.00	\$ 5,000.00

Item #	Description	Unit	Est. Qty.	Unit Cost	Cost
25	5" Concrete Walks	SF	100	\$ 30.00	\$ 3,000.00
26	Grating & Misc Metals	LS	1	\$ 20,000.00	\$ 20,000.00
27	New Paxton-Hershey Canal	LS	1	\$ 358,200.00	\$ 358,200.00
28	Gate Control System	LS	1	\$ 65,000.00	\$ 65,000.00
29	Site Lighting	LS	1	\$ 25,000.00	\$ 25,000.00
30	Electrical	LS	1	\$ 80,000.00	\$ 80,000.00
	Subtotal Base Construction Costs				\$ 7,958,890.00
	Contingency (20%)				\$ 1,591,800.00
	Engineering (15%)				\$ 1,193,800.00
	Project Administration (7%)				\$ 557,100.00
	Permitting (2%)				\$ 159,200.00
	Land Acquisition (Temp. & Perm. Easements)				\$ 10,000.00
	Land Acquisition (New Canal)				\$ 86,000.00
	NRCS Technical Assistance (5%)				\$ 477,500.00
	Total Installation Opinion of Costs - 2025				\$ 12,034,300.00
	Total Installation Opinion of Costs - 2027 (2 years @ 3%)				\$ 12,767,200.00

4. ECONOMICS

4.1 Introduction

This appendix outlines the costs and benefits of the Modernization with Partial Replacement and Combined Diversion (Preferred) Alternative and the No Action Alternative.

4.1.1 Project Overview

The authorized purpose of the proposed Watershed-Plan EA is to improve agricultural water management in the East Clear Creek watershed, specifically for the six canals operating in this area: Keith-Lincoln County Irrigation District, Paxton-Hershey Water Company, Platte Valley Irrigation District, Birdwood Irrigation District, Suburban Irrigation District, and Cody-Dillon Ditch Company. The canals have been in operation since the late 1800s and have some of the oldest (most senior) water rights in the state. The six canals within the project area all have severely aged diversion infrastructure, such that their ability to divert and deliver water to customers would likely be immediately halted with a single high-water event, or through regular ice breakup/flow cycles. Because the natural resources Twin Platte NRD is subject to moratoria on development of additional water rights/high-capacity groundwater wells in the watershed, the failure of the canals' ability to deliver water – namely, through failure of diversion structures – would mean that the currently irrigated, prime cropland in the watershed would not be able to be irrigated to its full needed extent to maintain or improve crop production, significantly altering not only the manner of agricultural production in the area but also its profitability. The proposed action is needed to ensure the canals' ability to reliably and efficiently deliver water into the future, protecting economic viability of the watershed. It is also needed to ensure the safety of canal operations, as the deteriorated condition of the present-day diversion structures do not have proper safety precautions (e.g. lighting, railings, ladders). Further, the deteriorated condition of these structures is such that about 16% less seepage would occur through them when improved as proposed, making diversions more efficient.

4.1.2 Planning Area

The project is in portions of Keith and Lincoln Counties in Nebraska and includes six canals and their diversion structures (Figure 4-1). These canals are owned and operated by: Keith-Lincoln Irrigation District, Platte Valley Irrigation District, Paxton-Hershey Water Company, Birdwood Irrigation District, Suburban Irrigation District, and Cody-Dillon Ditch Company. These six canals receive water from the North Platte River or Birdwood Creek. The Planning Area is the area that includes the portion of the North Platte River from which five of the canals receive water, a portion of the catchment from which the sixth canal (BID) receives water, and the benefitted areas of the canals which include all areas necessary for the implementation of potential measures to address the watershed problems. The Planning Area encompasses 111,604 acres and includes the canal diversions, lands served by the canals, and a one-mile buffer around the canals and laterals.

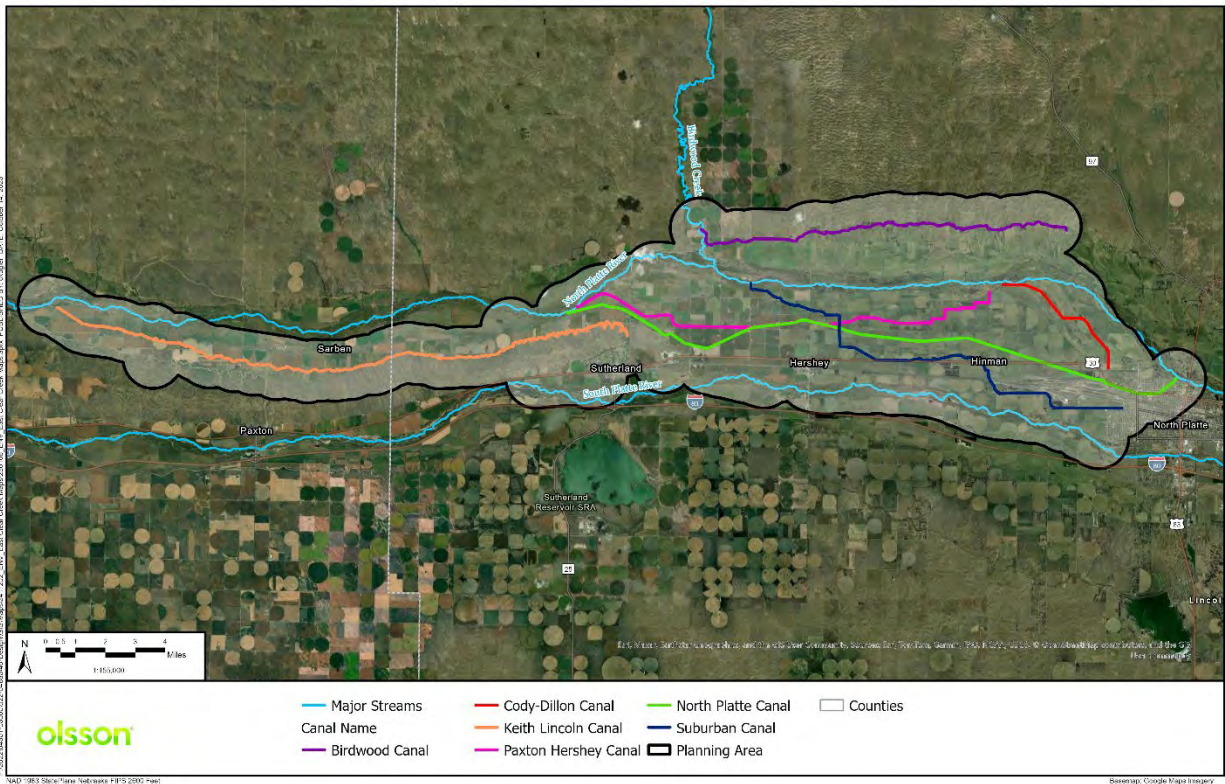


Figure 4-1. Watershed Planning Area. Map of portions of Keith and Lincoln Counties showing the Planning Area, between Lake McConaughy and the City of North Platte.

4.1.3 Project Purpose and Need

Within the PL-83-566 authorization, the purpose of the Watershed-Plan EA is to provide for long-term, sustainable agricultural water management within the East Clear Creek watershed. For the purposes of this Plan, “long-term” is defined as a period of 50 years. A 50-year period allows for sufficient simulation time to model the impacts from implementation options, evaluation of the long-term sustainability of water management, and adaptive management where needed. For the purposes of the Plan, “sustainable agricultural water management” is defined as surface and groundwater use that can be maintained consistent with water rights and the economic viability of the region’s agriculture.

4.1.4 Watershed Plan Alternatives

4.1.4.1 No Action Alternative

Under the No Action Alternative, federal funding through P.L. 83-566 would not be available for the project. The canals’ diversion structures would continue to be operated and maintained under current conditions, and this alternative assumes that modernization of the diversion structures would not be reasonably certain to occur. The No Action Alternative is a near-term continuation of the standard operating procedures.

This Alternative would not meet the Purpose and Need of the project. There would be no improvement to the diversions’ efficiency to meet the need of agricultural water management and improve the canals’ ability to efficiently deliver irrigation water at the correct time and in the correct amount to support optimal

crop yields. Due to the deteriorated state of each diversion structure, as detailed in the engineering assessment reports provided in Appendix E and discussed above, it is reasonable to assume that each diversion would fail within a short period of time – possibly within the next winter/ice season – and that irrigation water could not then be delivered to canal customers or provide recharge to the local aquifer and back to the stream.

4.1.4.2 Modernization with Partial Replacement and Combined Diversion (Preferred) Alternative

The Modernization with Partial Replacement Alternative includes replacing the structures on two of the diversions (Birdwood, Cody-Dillion), combining and replacing the diversion structures on the North Platte and Paxton-Hershey canals, and partial replacing and repairing structures on two of the diversions (Keith-Lincoln and Suburban). All the diversions would also be automated. The improvements and automation on the diversions would allow operations to continue while improving the efficiency of water diversion and delivery for irrigation; seepage under the structures would be lessened by about 16% and automation will allow for near-real-time adjustments in diversions as flows change on the river.

4.2 Economic Analysis Parameters

This section provides an overview of the economic analysis conducted on the alternatives proposed under the East Clear Creek Plan. First the analysis evaluates a change in net farm income estimated to occur under the No Action Alternative and under the preferred alternative. In this case, the No Action Alternative differs from existing conditions. Under existing conditions, all six of the canals are operational and continue to deliver surface water to irrigators within the Twin Platt NRD for the purposes of growing crops. As described above, under the No Action Alternative the canals would cease to operate, and irrigators would not have access to surface water to irrigate crops.

The National Economic Efficiency (NEE) analysis compares the economic benefits and costs of the Modernization with Partial Replacement and Combined Diversion Alternative (Modernization Alternative) with the benefits and costs of the No Action Alternative. This analysis allows for the determination of the net benefits of the Modernization Alternative. All economic values are expressed in 2025-year dollars and presented as average annual values, unless otherwise noted (as recommended by the Natural Resources Conservation Service (NRCS) Water Resources Handbook for Economics). The analysis utilizes a 3.0 discount rate for federal water projects for fiscal year 2025 (USDA, 2025). Under this method, all costs and benefits are evaluated in 2025-year dollars over the study period, then discounted to present value using the 3.0 percent discount rate. Finally, each present value is amortized to average annual values over the 50-year analysis period using the 3.0 percent rate.

4.2.1 Evaluation Units

The Modernization with Partial Replacement and Combined Diversion (Modernization) Alternative includes full replacement of two diversions (Birdwood and Cody-Dillon), combination of two diversions (Platte Valley and Paxton-Hershey), and partial replacement of two diversions (Keith-Lincoln and Suburban).

The analysis includes five evaluation units, one for each of the diversions and one combination diversion. The evaluation units include:

- Birdwood Canal
- Cody-Dillon Canal
- Keith-Lincoln

- Suburban Canal
- Platte Valley Paxton-Hershey Combined Canal

4.2.2 Project Implementation Timeline

Once the PL 83-566 funds are made available, the project team assumed that construction of all the five project components would be staggered occur over a four-year period, with construction overlapping for some of the components. The full benefits for each of the components are assumed to occur in the first year after construction is complete. The implementation timeline for each of the components is summarized in Table 4-1.

Table 4-1. Implementation schedule and project life for Modernization with Partial Replacement and Combined Diversion Alternative.

Canal	Construction Start Year	Construction End Year	Project Life Start Year	Project Life End Year
Keith-Lincoln	1	1	2	52
Suburban	1	1	2	52
North Platte-Paxton Hershey Combined	2	3	4	54
Birdwood	4	4	5	55
Cody-Dillion	4	4	5	55

4.2.3 Analysis Period

The analysis period was determined to be 50 years starting at the point when the project is implemented. A 50-year period of analysis considers that changes in water use may take years to take effect. A 50-year period allows for the evaluation of the long-term sustainability of water management, and adaptive management where needed.

4.3 NEE Costs

This section describes the NEE costs for both No Action and Modernization Alternatives. The No Action Alternative represents the most likely future condition if there is no federal funding available for the project. The Modernization Alternative represents the most likely future condition if federal funding is provided for the project.

4.3.1 Costs of No Action

Under the No Action Alternative, it is assumed that the existing diversions would fail and not be operational. Thus, operation, maintenance, repairs and replacement costs on the existing diversions would be zero under the No Action Alternative.

4.3.2 Costs of Modernization with Partial Replacement and Combined Diversion Alternative

The costs of the Modernization Alternative include construction and installation costs for each project component and other costs that are a direct result of project implementation and would occur periodically over the life of the project. These other direct costs include operations, maintenance, repairs and replacement (OMRR) for each of the diversions. All costs are in 2025 dollars and discounted to present value in the base year (2025) (not the construction year) and no inflation on construction costs has been included.

4.3.2.1 Project Implementation Costs

Project installation costs include mobilization and staging of construction or installation equipment, delivery of construction materials, replacements, improvements and repairs to diversion structures, safety and operational improvements, restoration and reseeded of disturbed areas, and any costs of obtaining easements or land acquisitions. In terms of automation, the project installation costs include the equipment, installation, power (solar or AC power), and setup of the systems.

The total installation cost of the Modernization Alternative is \$23.9 million. This includes costs of construction, engineering, construction management, and survey costs and contingency costs (20 to 25 percent of construction costs). This also includes the purchase of land rights.

The total costs of the project include project administration costs for TPNRD and NRCS (7 percent of the construction costs, 5 percent for Twin Platte NRD and 2 percent for NRCS). Permitting costs are estimated at 1 to 2 percent of construction costs. The cost of the project installation is provided in Table 4-2 and Table 4-3 below¹. The average annualized cost of installation and construction of the Modernization Alternative is \$858,335 (Table 4-5).

¹ These tables correspond with NWPM 506.11 Economic Table 1 and NWPM 506.12 Economic Table 2, respectively

Table 4-2. Estimated installation cost, 2025 dollars.¹

Works of Improvement	Unit	Federal land - Number	Non-Federal land - Number	Total - Number	Public Law 83-566 Federal land NRCS²	Public Law 83-566 Total	Other Funds Federal	Other Funds Non-Federal	Other Funds Total	Estimated Cost - Total
Birdwood	Acres	0	0.12	0.12	0	\$4,117,800	\$ -	\$1,331,800	\$1,331,800	\$5,449,600
Cody-Dillon	Acres	0	0.08	0.08	0	\$1,861,400	\$ -	\$613,100	\$613,100	\$2,474,500
Keith-Lincoln	Acres	0	0.32	0.32	0	\$988,400	\$ -	\$324,600	\$324,600	\$1,313,000
Suburban	Acres	0	0.32	0.32	0	\$2,013,100	\$ -	\$655,900	\$655,900	\$2,669,000
Platte Valley-Paxton-Hershey Combined	Acres	0	7.48	7.48	0	\$8,993,500	\$ -	\$3,040,800	\$3,040,800	\$12,034,300
Total	Acres	0	8.32	8.32	0	\$17,974,200	\$ -	\$5,966,200	\$5,966,200	\$23,940,400

¹ Price Base: 2025 Dollars.

Prepared August 2025

² Federal Agency responsible for assisting with works of improvement.

Table 4-3. Estimated cost distribution - water resources project measures, 2025 dollars.¹

Works of Improvement	Public Law 83-566 Construction	Public Law 83-566 Engineering	Public Law 83-566 Admin Subtotal²	Total Public Law 83-566	Other Funds - Construction	Other Funds Engineering	Other Funds - Project Admin Subtotal	Other Funds - Permitting	Total Other	Total Installation Costs
Birdwood	\$3,279,700	\$546,600	\$291,500	\$4,117,800	\$1,113,200	\$ -	\$182,200	\$36,400	\$1,331,800	\$5,449,600
Cody-Dillon	\$1,482,600	\$247,100	\$131,700	\$1,861,400	\$514,200	\$ -	\$82,400	\$16,500	\$613,100	\$2,474,500
Keith-Lincoln	\$792,000	\$126,700	\$69,700	\$988,400	\$274,000	\$ -	\$42,200	\$8,400	\$324,600	\$1,313,000
Suburban	\$1,613,100	\$258,100	\$141,900	\$2,013,100	\$552,700	\$ -	\$86,000	\$17,200	\$655,900	\$2,669,000
Platte Valley-Paxton-Hershey Combined	\$7,163,000	\$1,193,800	\$636,700	\$8,993,500	\$2,483,700	\$ -	\$397,900	\$159,200	\$3,040,800	\$12,034,300
Total Project	\$14,330,400	\$2,372,300	\$1,271,500	\$17,974,200	\$4,937,800	\$ -	\$790,700	\$237,700	\$5,966,200	\$23,940,400

¹ Price Base: 2025 Dollars.

Prepared August 2025

² Includes project administration costs and technical assistance.

4.3.2.2 Operation, Maintenance, Repair and Replacement

OMRR included in the estimate are those that are reoccurring during the life of the project and begin after the installation and construction of the project. They include operating costs such as electricity, maintenance and routine repairs. In addition, some of the components of each diversion structure (gates and actuators) have a useful life of 25 years. The cost of replacing these components has been included in the cost estimate during the life of the project.

Accounting for timing of costs, the average annual NEE cost of OMRR under the Modernization Alternative is approximately \$129,794 as summarized in Table 4-4.

Table 4-4. OMRR costs by project component, 2025 dollars.¹

Project Unit	Average Annual O&M Costs	Average Annual Replacement Costs	Average Annual OMRR Costs
Birdwood	\$11,660	\$6,996	\$18,656
Cody-Dillon	\$11,660	\$6,996	\$18,656
Keith-Lincoln	\$12,250	\$20,987	\$33,237
Suburban	\$11,660	\$6,996	\$18,656
Platte Valley-Paxton-Hershey Combined	\$23,100	\$17,489	\$40,589
Total	\$70,330	\$59,464	\$129,794

¹ Price base: 2025 dollars amortized over 50 years at a discount rate of 3.0 percent.

Prepared August 2025

4.3.3 Total Costs of Modernization with Partial Replacement and Combined Diversion Alternative Compared to No Action Alternative

Because costs under the No Action Alternative are expected to be zero, the NEE costs of the Modernization Alternative are equal to the estimate average annual installation costs and OMRR costs discussed in previous sections for each of the project components. The total average annual costs for all the project components are \$988,130. A summary of costs is provided in Table 4-5.²

² This table corresponds to NWPM 506.18 Economic Table 3.

Table 4-5. Estimated average annual NEE costs, 2025 dollars.¹

Project Unit	Project Outlays (Amortization of Installation Costs)	Project Outlays Operation, Maintenance, Repairs and Replacement Costs	Total Average Annual Costs
Birdwood	\$188,183	\$18,656	\$206,839
Cody-Dillon	\$85,448	\$18,656	\$104,104
Keith-Lincoln	\$49,544	\$33,237	\$82,781
Suburban	\$100,711	\$18,656	\$119,366
Platte Valley-Paxton- Hershey Combined	\$434,450	\$40,589	\$475,039
Total	\$858,335	\$129,794	\$988,130

¹Price Base: 2025 dollars amortized over 50 years
with a 3.0 percent discount rate.

Prepared August 2025

4.4 NEE Benefits

4.4.1 Benefits of No Action

Under the No Action Alternative, no PL 83-566 funding would be available to modernize the diversions. Given the current condition of the diversion structures, it is likely that they will fail to operate in the foreseeable future. If this were to occur irrigators would lose access to water and would be unable to irrigate crops. It was assumed that crops normally irrigated would now be grown using dryland farming practices resulting in lower yields and lower net farm income. Table 4-6 summarizes the reduction of net farm income of \$2.2 million per year if 39,056 acres of crops were switched from irrigated to dryland farming under the No Action Alternative.

Table 4-6. Change in annual net farm income under No Action Alternative relative to existing conditions.

Diversion/Canal	Change in Irrigated Acres (Surface Water and Commingled)	Change in Annual Net Farm Income (2025\$)¹
Birdwood	4,415	- \$323,690
Cody-Dillon	4,081	-\$260,876
Keith-Lincoln	6,062	-\$344,761
Suburban	4,226	-\$233,713
Platte Valley/Paxton-Hershey Combo	20,272	-\$1,075,894
Total	39,056	-\$2,238,934

¹ Price Base: 2025 Dollars.

Prepared August 2025

4.4.2 Benefits of Modernization with Partial Replacement and Combined Diversion Alternative

The benefits of the Modernization Alternative include those that can be quantified (e.g. avoided losses in net farm income) and others that are considered but not included in the analysis (e.g. public safety). The benefits of the Modernization Alternative compared to the No Action Alternative that are considered and quantified are summarized in Table 4-7³ below for each project component.

Table 4-7. Estimated average annual benefits, 2025 dollars.¹

Project Component	Agricultural-Related Benefits
Birdwood Diversion/Canal	
Avoided Loss in Net Farm Income	\$290,070
Cody-Dillon Diversion/Canal	
Avoided Loss in Net Farm Income	\$233,780
Keith-Lincoln Diversion/Canal	
Avoided Loss in Net Farm Income	\$340,637
Water Storage Savings	\$10,962
Suburban Diversion/Canal	
Avoided Loss in Net Farm Income	\$230,990
Water Storage Savings	\$10,781
Platte Valley/Paxton-Hershey Combination Diversion/Canals	
Avoided Loss in Net Farm Income	\$1,043,814
Water Storage Savings	\$61,263

¹Price Base: 2025-year dollars amortized over 50 years at a 3.0 percent discount rate.

Prepared August 2025

4.4.3 Avoided Losses in Net Farm Income Benefits

The analysis of benefits focused on the change in net farm income when access to water for irrigation is curtailed under the No Action Alternative. Under the No Action Alternative, it was assumed that deterioration of the diversions would no longer support access to water for irrigation. Under this scenario, the project team assumed that farmers would switch to dryland farming techniques for each of the crops currently irrigated. The analysis evaluated the difference in net farm income under dryland farming techniques and when irrigation techniques are utilized.

To complete the analysis, the project team started by evaluating the irrigated acres served by each of the diversions and canals in the study area. Table 4-8 summarizes the total irrigated acres by canal including acres irrigated by groundwater, surface water or commingled acres. The total irrigated acres for all the diversions and canals are 48,823. For the No Action Alternative, the analysis assumed that all acres irrigated by surface water and commingled acres would switch to dryland farming. Under the Modernization Alternative all crop acres would be irrigated.

³ This table corresponds with NWPM 506.20 Economic Table 4.

Table 4-8. Irrigated acreage for canals within the Planning Area.

Canal	Commingled	Groundwater	Surface Water	Total Irrigated Acres
Birdwood	70	113	4,345	4,528
Cody-Dillon	1,047	385	3,034	4,466
Keith-Lincoln	4,704	2,683	1,358	8,745
Suburban	1,464	1,880	2,762	6,106
Platte Valley	9,213	3,810	4,712	17,735
Paxton-Hershey	4,504	896	1,843	7,243
Total	21,002	9,767	18,054	48,823
Platte Valley/Paxton Hershey Combined	13,717	4,706	6,555	24,978

The project team then estimated the crop types being irrigated by each of the canals. The Twin Platte NRD tracks crop acres within the district and provided a summary for each of the canals as summarized in Table 4-9. These estimates represent the top four crops irrigated within the district.

Table 4-9. Estimated percentage of irrigated acres by crop type.

Canal	Crops			
	Corn	Soybeans	Alfalfa	Grass/Pasture
Birdwood	21%	0%	15%	64%
Cody-Dillon	13%	0%	48%	39%
Keith-Lincoln	62%	7%	6%	25%
Suburban	69%	6%	6%	19%
Platte Valley	70%	10%	5%	15%
Paxton-Hershey	61%	7%	7%	25%
Platte Valley/Paxton Hershey Combination ¹	66%	9%	6%	20%

¹ Average of the Platte Valley and Paxton-Hershey crop acreage percentages.
Source: Twin Platte NRD

The crop type percentages were used to estimate the number of acres by crop for each canal as summarized in Table 4-10. For all the canals, corn is the most widely grown crop followed by grass and hay.

Table 4-10. Estimated irrigated acreage by crop type and canal.

Canal	Corn	Soybeans	Alfalfa	Grass/Hay	Total
Birdwood	951	0	679	2,898	4,528
Cody-Dillon	581	0	2,144	1,742	4,466
Keith-Lincoln	5,422	612	525	2,186	8,745
North Platte	12,415	1,774	887	2,660	17,735
Paxton-Hershey	4,418	507	507	1,811	7,243
Suburban	4,213	366	366	1,160	6,106
Total	27,999	3,259	5,108	12,457	48,823

Crop budgets published by University of Nebraska Extension, Institute of Agriculture and Natural Resources for calendar year 2025 were used to estimate the yields and cost of production for each crop for both irrigated and dryland acres in Western Nebraska (University of Nebraska, 2025). These data are summarized in Table 4-11. Normalized crop prices were obtained from USDA Economic Research Service (USDA, 2023a). For crop prices, the state-level normalized prices from ERS, which are 3-year rolling averages were utilized (2021-2024) (ERS, 2024)⁴. For all three of four crops evaluated, irrigated production has a higher net return than dryland production as improved yields more than offset higher production costs.

⁴ USDA, Economic Research Service (ERS) annually calculates “normalized prices,” which smooth out the effects of short run seasonal or cyclical variation, for key agricultural inputs and outputs. These normalized prices are used by the U.S. Army Corps of Engineers, the Tennessee Valley Authority, USDA's Natural Resources Conservation Service, and other Federal agencies to evaluate the benefits of resource-related projects affecting agriculture.

Table 4-11. Selected crop budget indicators for farmland in western Nebraska, 2025.

Indicator	Corn	Soybeans	Alfalfa	Grass/Hay
Yield per Acre				
Dryland	110	45	2.8	3.3
Irrigation	185	70	3.8	4.5
Units	<i>bu/acre</i>	<i>bu/acre</i>	<i>Tons</i>	<i>Tons</i>
Cost per Acre				
Dryland	\$533.81	\$491.75	\$392.75	\$164.15
Irrigation	\$841.73	\$776.98	\$478.26	\$238.97
Cost per Unit				
Dryland	\$4.85	\$10.93	\$140.27	\$49.74
Irrigation	\$4.55	\$11.10	\$125.86	\$62.89
Normalized Price (2024)¹	\$4.88	\$10.72	\$134.74	\$134.74
Net Return per Unit*				
Dryland	\$0.03	-\$0.21	-\$5.53	\$85.00
Irrigation	\$0.33	-\$0.38	\$8.88	\$71.85
Net Return per Acre*				
Dryland	\$2.99	-\$9.35	-\$15.47	\$280.49
Irrigation	\$61.07	-\$26.58	\$33.75	\$364.45

Source: University of Nebraska, 2025 Crop Budgets.

*Calculations use crop budget data (e.g. price per unit minus cost per unit).

4.4.4 Water Storage Savings

Under existing conditions, some of the canals may need to purchase additional water for irrigation purposes during the irrigation season which is stored in Lake McConaughy. The Modernization Alternative will improve the operation and efficiency of the diversions and canals and thus eliminate the need to access water from storage. This benefit of the Modernization Alternative is the average annual avoided cost of water storage. To estimate the average annual benefit of water storage, the project team obtained the water storage volumes and costs for each of the canals during the years 2001 through 2024 as summarized in Table 4-12. Because water taken from storage varies by year, the project team estimated an average annual cost over this period. This is shown in the last column in Table 4-12. Note that the average cost for the Platte Valley/Paxton-Hershey Combined Diversion (\$65,827) was estimated by summing up the average cost for the two individual canals.

Table 4-12. Average water storage volumes and cost (2001-2024).

Canal	Total Storage Water Taken from 2001-2024 (AF)	Total Paid for Storage Water Taken from 2001-2024	Average Annual Volumes (ac-ft)	Average Cost per acre/foot	Average Storage Cost per Year
Birdwood	NA	NA			
Cody-Dillon	NA	NA			
Keith-Lincoln	13,734	\$260,937	597	\$19.00	\$11,345
Suburban	13,506	\$256,623	587	\$19.00	\$11,158
Platte Valley	52,495	\$997,404	2,282	\$19.00	\$43,365
Paxton-Hershey	27,190	\$516,611	1,182	\$19.00	\$22,461

4.5 Benefits of the Modernization Alternative Over the No Action

Net farm income under the No Action Alternative is expected to decrease from existing conditions with a loss in access to water for irrigation. The Modernization Alternative will restore the diversions and allow farmers to continue irrigating crops and avoid the loss in net farm income. These avoided losses are the benefits of the Modernization Alternative summarized in Table 4-7 above.

4.6 NEE Benefits Compared to Costs

The NEE benefits and costs for each of the project components are summarized in Table 4-13.⁵ The average annual benefit of the project is \$2.1 million. For all project components the benefits exceed the costs. In addition to the quantified benefits the project would improve public safety and groundwater recharge. The Modernization Alternative would improve the operation and efficiency of the irrigation infrastructure in the study area and help sustain agricultural operations in the future. This will help to sustain the rural way of life rooted in historical agricultural land uses throughout the region.

⁵ This table corresponds to NWPM 506.21 Economic Table 5

Table 4-13. NEE benefits and costs of the Preferred Alternative, 2025 dollars.¹

Works of Improvement	Agriculture-Related Increase in Net Farm Income	Agriculture-Related Water Storage Savings	Average Annual Benefits	Average Annual Cost²	Benefit-Cost Ratio
Birdwood	\$290,070		\$290,070	\$201,454	1.44
Cody-Dillon	\$233,780		\$233,780	\$98,720	2.37
Keith-Lincoln	\$340,637	\$10,962	\$351,599	\$67,398	5.22
Suburban	\$230,990	\$10,781	\$241,771	\$113,596	2.13
Platte Valley/Paston-Hershey Combo	\$1,043,814	\$61,263	\$1,105,077	\$460,349	2.40
Total	\$2,139,292	\$83,005	\$2,222,297	\$941,517	2.36

¹ Price base: 2025-year dollars amortized over 50 years

Prepared August 2025

² From Table 4-5.

4.7 Incremental Analysis

The Modernization Alternative is evaluated using an incremental analysis which describes how costs and benefits change as project components are added or removed. The design of each project component is independent of the number of project components included and the order in which they are implemented. The incremental analysis of the Modernization Alternative is summarized in Table 4-14 below.

Table 4-13. Incremental analysis of annual NEE costs and benefits under the Modernization with Partial Replacement and Combined Diversion Alternative, 2025 dollars.¹

Project Components	Total Annual Costs	Incremental Costs	Annual Benefits	Incremental Benefits	Net Benefits
Birdwood	\$201,454		\$290,070		\$88,615
Birdwood, Cody-Dillion	\$300,174	\$98,720	\$523,850	\$233,780	\$223,676
Birdwood, Cody-Dillion, Keith-Lincoln	\$367,572	\$67,398	\$862,404	\$351,599	\$507,877
Birdwood, Cody-Dillion, Keith-Lincoln, Suburban	\$481,168	\$113,595	\$1,095,204	\$241,771	\$636,052
Birdwood, Cody-Dillion, Keith-Lincoln, Suburban, Platte Valley/Paxton-Hershey	\$941,517	\$460,348	\$2,200,281	\$1,105,077	\$1,280,780

¹ Price Base: 2025 Dollars.

Prepared August 2025

4.8 Preferred Alternative

The No Action Alternative would provide no benefits relative to current conditions. The Modernization Alternative would generate \$1.3 million in annual net benefits in addition to other unquantified benefits. Thus, the Modernization Alternative is the Preferred Alternative.

4.9 References

Twin Platte NRD. Crop Acreage Percentages for Canals within the Study Area. July 2025.

University of Nebraska Extension, Institute of Agriculture and Natural Resources, 2025 Nebraska Crop Budgets. Available at: Nebraska Crop Budgets Updated for 2025 | Department of Agricultural Economics | Nebraska. Revised October 2024. Accessed May 15, 2025.

U.S. Department of Agriculture, Economic Research Service, 2024. Normalized Prices, Table 3. Available at: Normalized Prices | Economic Research Service. Accessed June 23, 2025.

U.S. Department of Agriculture, Natural Resource Conservation Service, 2024. National Bulletin 200-25-2, ECN-Discount Rate for Fiscal Year 2025 Water Resources Planning and Evaluation.

5. CULTURAL RESOURCES

Cultural Resources Analysts, Inc. (CRA), contracted by Olsson, completed the cultural resources inventory report (2025). The report details the methods and results of the cultural resources inventories of the area of potential effect (APE) for the alternatives outlined in the East Clear Creek Watershed Plan and can be found in Appendix E.

Information regarding the location of specific cultural resources has been removed from the report in accordance with Section 304 of the National Historic Preservation Act (54 U.S.C. §307103) and Nebraska Revised Statute 84-712.05. Complete copies of the cultural resource inventory reports may be available from History Nebraska (hn.hp@nebraska.gov) upon request.

5.1 Post-Review Discovery Procedure

Once NHPA Section 106 consultation is complete for this project, there is still potential for ground disturbance to expose cultural materials that were not identified by the cultural resources inventory. If any evidence of cultural resources is encountered during construction, all activities will be halted immediately and NRCS will proceed in accordance with the regulation on post-review discoveries (36 CFR § 800.13) by following the procedures outlined in the NRCS Cultural Resources Handbook (Title 190 Part 601.29). Those procedures are described below.

Where construction has not yet begun and a cultural resource is discovered after Section 106 review is complete, the NRCS shall seek avoidance or minimization strategies and/or resolution of adverse effects in accordance with 36 CFR Part 800.6 in consultation with the SHPO and consulting Tribes.

The NRCS shall ensure that every contract for this project includes provisions for halting work/construction in the area when potential historic properties are discovered or when unanticipated effects to historic properties are found after implementation, installation, or construction has begun. When such a discovery occurs, Twin Platte NRD or their contractor shall immediately notify the NRCS State Conservationist's Office, Cultural Resource Specialist (CRS), supervisory NRCS personnel for the area, and the landowner.

The NRCS CRS shall inspect the discovery within 24 hours if weather permits. The CRS shall establish a protective buffer zone surrounding the discovery in consultation with the local NRCS official (field office supervisor or District or Area Conservationist), concerned Indian tribes, the SHPO, the NRCS State engineering or program supervisor, as appropriate), and Twin Platte NRD. This action may require inspection by Tribal cultural resources experts in addition to the CRS.

All NRCS contact with media shall occur only under the direction of the NRCS Public Affairs Officer, as appropriate, and the State Conservationist. Security shall be established to protect the resources/historic properties, workers, and private property. Local law enforcement authorities will be notified in accordance with applicable State law and NRCS policy in order to protect the resources. Construction and/or work may resume outside the buffer only when the State Conservationist determines it is appropriate and safe for the resources and workers.

The NRCS CRS shall notify the SHPO, concerned Indian Tribes, and the Advisory Council on Historic Preservation no later than 48 hours after the discovery. The NRCS CRS will describe NRCS's assessment of the National Register eligibility of the property, as feasible, and the proposed actions to resolve any adverse effects to historic properties. The eligibility determination may require the assessment and advice of concerned Indian Tribes, the SHPO, and technical experts (such as historic landscape architects) not employed by NRCS. NRCS shall take any comments provided into account and

carry out appropriate actions to resolve any adverse effects. NRCS shall provide a report to the SHPO, Tribes, and the ACHP of the actions when they are completed.

5.1.1 Human Remains

When human remains are discovered, the NRCS shall follow all applicable federal, tribal, and state burial laws and ordinances, and related human rights and health statutes, where appropriate. NRCS shall refer to the ACHP's Policy Statement regarding Treatment of Burial Sites, Human Remains and Funerary Objects and the ACHP's Section 106 Archaeology Guidance. NRCS shall also follow USDA and NRCS policy on treatment of human remains and consultation.

All the measures proposed in the East Clear Creek Watershed Plan will be installed on non-federal, non-Tribal land. Therefore, any human remains discovered during construction will be subject to protection under the Unmarked Human Burial Sites and Skeletal Remains Protection Act (Nebraska Revised Statutes 12-1201 to 12-1212). Per Nebraska Revised Statute 12-1205, all ground disturbing activities in the area shall stop immediately. The remains shall be covered and/or protected in place in such a manner that minimizes further exposure of and damage to the remains. Twin Platte NRD or its contractor shall contact local law enforcement within 48 hours of the discovery. Per Nebraska Revised Statute 12-1207 and 12-1208, disposition of the human remains shall be the responsibility of the county attorney and/or History Nebraska. Construction may resume once all human remains and/or burial goods have been removed from the project area, and the State Conservationist determines it is appropriate and safe for the resources and workers.

6. ENVIRONMENTAL RESOURCE STUDIES

6.1 Wetland Delineation

A wetland and other water resources delineation was completed in July and September of 2025. Olsson reviewed publicly available information to identify areas with the potential to support wetlands, streams, and other aquatic resources within the Study Area. Olsson staff visited the Study Area from July 14-18 and September 3, 2025, to complete the wetland delineation field investigation. The wetland delineation followed methodology described in the U.S. Army Corps of Engineers Wetland Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region.

Six canals and two perennial streams were identified within the area surrounding the diversion structures. Perennial streams include the North Platte River and Birdwood Creek. The six canals include Keith-Lincoln, Platte Valley, Paxton-Hershey, Birdwood, Suburban, and Cody-Dillon. Additionally, a total of 81 wetlands and open water features were identified in the areas surrounding the diversions for a total of 10.6 acres. Wetlands were either Palustrine Emergent Temporarily / Seasonally Flooded (PEMA / C), Palustrine Scrub-Shrub Temporarily Flooded (PSSA), Palustrine Forested Temporarily Flooded (PFOA), and open waters were Palustrine Unconsolidated Bottom (PUB), or Palustrine Aquatic Bottom (PAB) according to the Cowardin classification. The wetlands and open waters are located abutting the North Platte River, Birdwood Creek, or one of the canals, as well as in floodplain depressions adjacent to these waterbodies. All identified wetlands are assumed federally jurisdictional.

6.1.1 Prime Farmland and Farmland of State Importance

During assessment of the affected environment, information was pulled from the USDA NRCS Web Soil Survey for Keith and Lincoln Counties, as it pertained to prime farmland, prime farmland if drained, and/or prime farmland if irrigated. This information is summarized in Table 7-1.

Table 7-1: Prime farmland and farmland of state importance within the Planning Area (USDA NRCS 2024a, 2024b).

Map Unit Symbol	Map Unit Name	Rating	Area (acres)
1020	Caruso loam	All areas are prime farmland	8,519
1075	Norwest loam, 0 to 2 percent slopes	Prime farmland if drained	1,389
1307	Bayard very fine sandy loam, 1 to 3 percent slopes	Prime farmland if irrigated	4,686
1351	Bridget loam, 1 to 3 percent slopes	Prime farmland if irrigated	11
1355	Bridget silt loam, 0 to 1 percent slopes	Prime farmland if irrigated	102
2302	McCook loam, rarely flooded	All areas are prime farmland	275
2596	Hersh fine sandy loam, 3 to 6 percent slopes	All areas are prime farmland	50
2668	Holdrege silt loam, 1 to 3 percent slopes	All areas are prime farmland	7
2670	Holdrege silt loam, 3 to 7 percent slopes	All areas are prime farmland	21
2671	Holdrege silt loam, 3 to 7 percent slopes, eroded	All areas are prime farmland	2
2818	Uly silt loam, 3 to 6 percent slopes, eroded	All areas are prime farmland	91
3571	Humbarger loam, gravelly substratum	All areas are prime farmland	6,856
3710	Cass fine sandy loam, rarely flooded	All areas are prime farmland	1,311
3755	Hord silt loam, rarely flooded	All areas are prime farmland	22.00

Map Unit Symbol	Map Unit Name	Rating	Area (acres)
5283	Vetal fine sandy loam, loamy substratum, 0 to 3 percent slopes	All areas are prime farmland	84
5288	Vetal loamy fine sand, 0 to 3 percent slopes	Farmland of statewide importance	12
5822	Duroc loam, terrace, 0 to 1 percent slopes	Prime farmland if irrigated	134
8401	Alda fine sandy loam, occasionally flooded	Prime farmland if drained	627
8406	Alda soils, occasionally flooded	Prime farmland if drained	1,342
8432	Cass fine sandy loam, calcareous variant, rarely flooded	All areas are prime farmland	1,554
8502	Lex loam, rarely flooded	Prime farmland if drained	1,448
8503	Lex loam, occasionally flooded	Prime farmland if drained	2,802
8581	Wann fine sandy loam, rarely flooded	Prime farmland if drained	847
8585	Wann loam, rarely flooded	Prime farmland if drained	834
8804	Anselmo sandy loam, terrace, 0 to 3 percent slopes	All areas are prime farmland	721
8805	Anselmo sandy loam, terrace, 3 to 6 percent slopes	All areas are prime farmland	719
8817	Cozad silt loam, 3 to 6 percent slopes	All areas are prime farmland	46
8867	Hord fine sandy loam, 1 to 3 percent slopes	All areas are prime farmland	44
9002	Anselmo fine sandy loam, 1 to 3 percent slopes	All areas are prime farmland	22
9004	Anselmo fine sandy loam, 3 to 6 percent slopes	All areas are prime farmland	14
9024	Anselmo-Holdrege fine sandy loams, 3 to 7 percent slopes	All areas are prime farmland	23
TOTAL			34,615