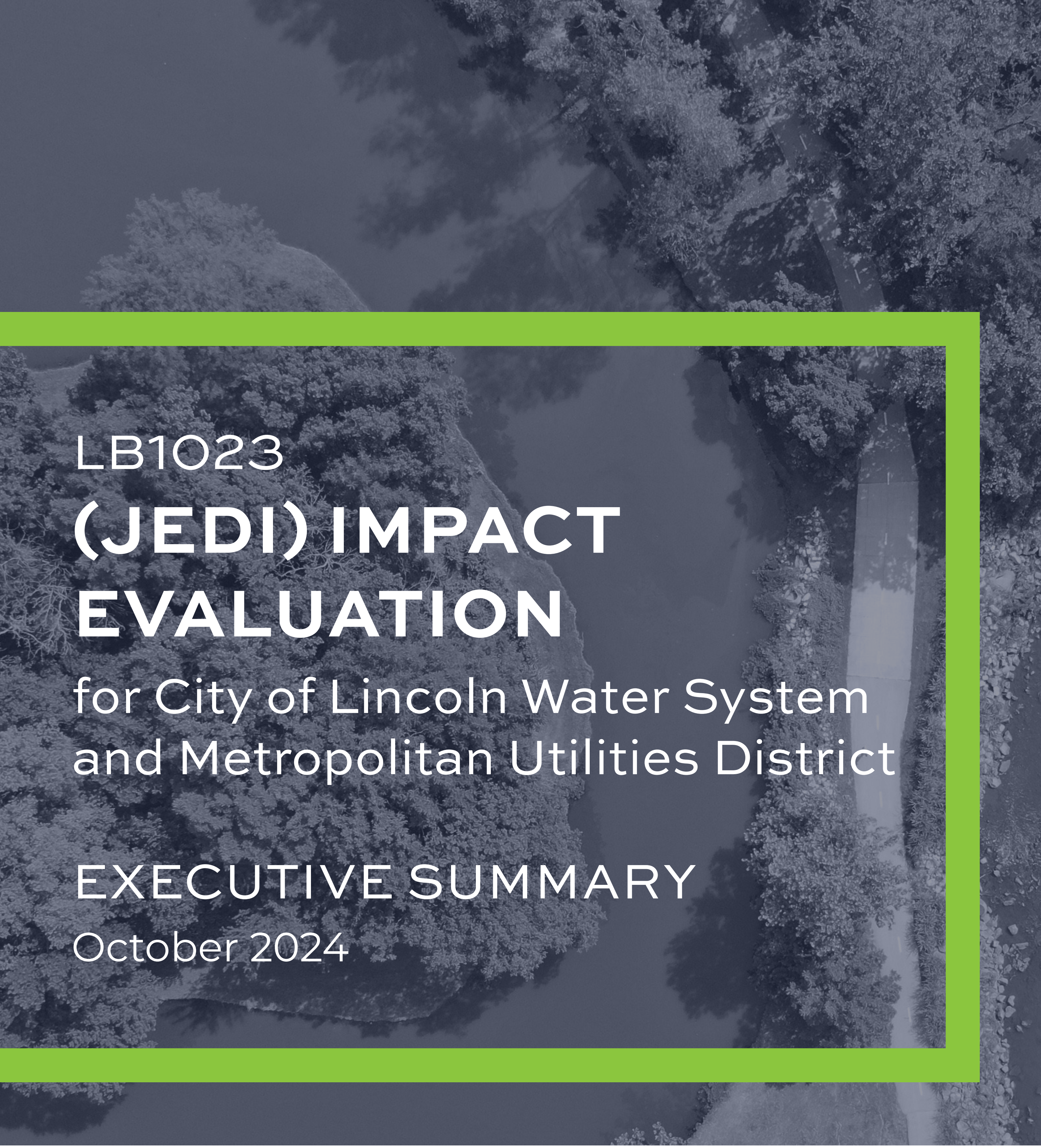

LB1023

(JEDI) IMPACT EVALUATION

for City of Lincoln Water System and Metropolitan Utilities District

EXECUTIVE SUMMARY

October 2024

olsson®

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Introduction

In 2021 and 2022, the Nebraska legislature enacted LB406 and LB1023, respectively, which first established the Statewide Tourism And Recreational Water Access and Resources Sustainability (STAR WARS) special committee, and then the Lake Development Act which was codified in statute as the Jobs and Economic Development Initiative (JEDI) Act (Neb. Rev. Stat. §61-401 to 61-404). In these pieces of legislation, the unicameral recognized the importance – in the wake of historic flooding in 2019 and the COVID-19 pandemic – for both flood control and major recreational opportunities in the state to attract and retain an increasingly remote workforce. The STARWARS committee envisioned, in the lower Platte River corridor, a lake that would rival Iowa's Lake Okoboji as a tourist destination and hub for public-private partnerships to develop lakeside communities, a community town center, and a major resort. As outlined in the STAR WARS committee's report, a lake location northeast of the city of Ashland was contemplated and this informed the committee's recommendation that further analysis be conducted to inform viable locations for a lake of at least 3,600 acres, located in or near Sarpy County, and adjacent to - but not impounding - the Platte River.

Recognizing the potential for impacts to public water system wellfields, the legislature also appropriated funds to be administered through the Nebraska Department of Natural Resources (NeDNR) for further study on possible lake sites. The City of Lincoln Water System (LWS) already had its Water 2.0 project – investigating possibilities for additional source(s) of drinking water – underway with Black & Veatch and Olsson, and recognized that these consultants have the necessary expertise regarding the water system as well as expertise in the types of technical analyses needed for possible lake sites. Thus, LWS amended its Water 2.0 contract to include this study and entered into a memorandum of understanding with Omaha's Metropolitan Utilities District (MUD) to allow for MUD's wellfields and concerns to also be considered. Monthly progress meetings and workshops were held between LWS, MUD, NeNDR, Olsson, and Black & Veatch to discuss the progress of the modeling and evaluations. In addition, LWS, MUD, and NeNDR provided direction and feedback on assumptions and decisions throughout the study.

The scope of this study, then, was to: (1) construct and calibrate a subregional groundwater model and run scenarios to help identify locations where a lake of this scale should not go while considering wellfields and their associated wellhead protection areas (WHPAs), and existing infrastructure; (2) develop and calibrate a two-dimensional surface water model of the Platte River and floodplain in the area of interest and use information from scenarios run with this model to identify possible lake locations and inform further groundwater modeling to determine impacts of potential lakes on wellfields operated by the LWS and MUD; (3) evaluate impacts to local water balance resulting from lakes constructed at the identified possible locations, specifically estimating evaporation and evapotranspiration; (4) perform seepage analysis of potential lakes; and (5) evaluate geomorphic impacts of potential lakes, including impacts from flood events on geomorphology of the lake itself as well as fluvial geomorphology resulting from existence of a lake.

Groundwater and Surface Water Modeling

The groundwater model, known as the JEDI model, was constructed with the existing Lower Platte Missouri Tributaries (LPMT) model as its basis. **Figure ES-1** shows the Nebraska counties included in the LPMT and JEDI groundwater models. The JEDI model comprises five layers, the uppermost of which has the greatest degree of refinement with the smallest cells measuring 82.5 by 82.5 feet; the bottom layer of the model's smallest cells measure 1,320 by 1,320 feet. **Figure ES-2** provides a visual representation of the five layers for the JEDI groundwater model layering within the Platte River alluvial valley. Cells representing and immediately adjacent to the Platte River are the smallest, with horizontal discretization of the model growing coarser as one moves further away from the river. **Figure ES-3** provides an illustration of the cells used for Layer 1, including enlarged detail demonstrating the smallest cells nearest the Platte River. The model was constructed with this level of refinement as the areas in and adjacent to the Platte River are those of greatest concern in terms of impacts.

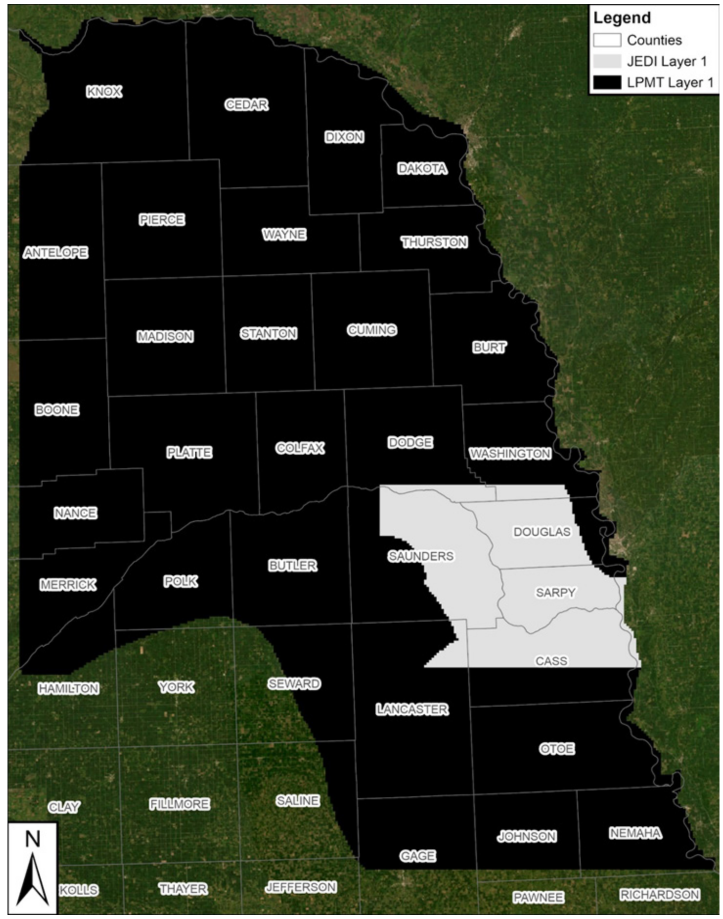

Figure ES-1: Nebraska Counties in the LPMT and JEDI Groundwater Models

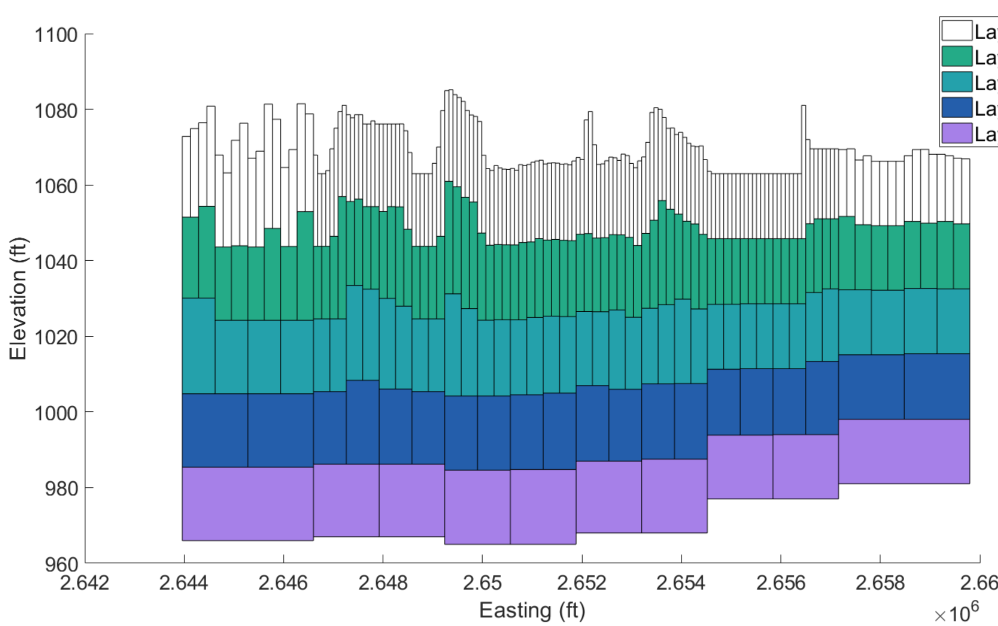

Figure ES-2: JEDI Groundwater Model Layering within the Platte River Alluvial Valley

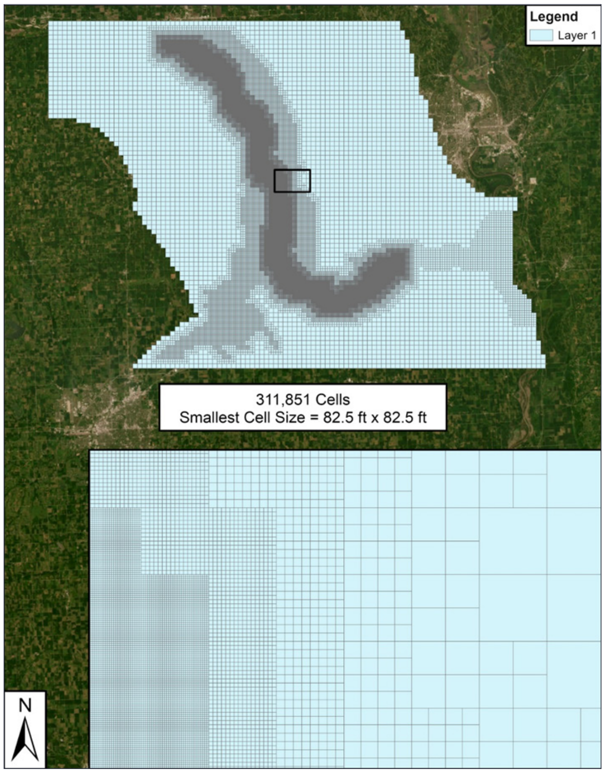

Figure ES-3: Illustration of the Layer 1 Cells for the Groundwater Model (Including Enlarged Detail)

Reverse particle tracking scenarios were conducted in wet, dry, and normal climatic and groundwater pumping conditions to determine times-of-travel for each of MUD's and LWS's wellfields; that is, the path and distance for a contaminant to reach each well in a set period of time (in this case, 50 years). These scenarios confirmed that previously delineated WHPAs for these wellfields were appropriate, and further demonstrated where a lake should not be located. Additionally, these scenarios showed clearly that each wellfield draws water not only from the local aquifer but also directly from the Platte River, with water being drawn from further away during drier periods. **Figure ES-4** provides an example of a reverse particle tracking scenario.

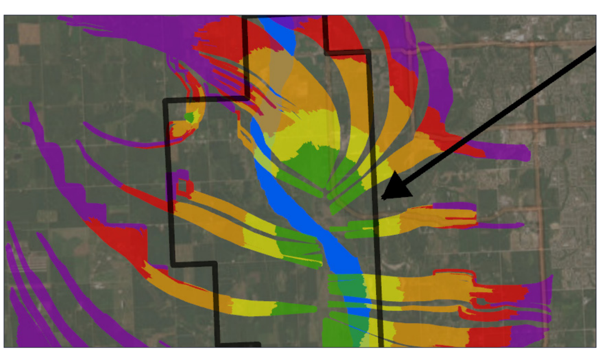

Figure ES-4: Example of Reverse Particle Tracking

From these results and the use of geospatial data and aerial imagery to identify locations of existing infrastructure, land use, and sandpit lakes, five possible lake locations were identified and three of these carried forward for further analysis (two were eliminated due to insufficient size or significant impacts to an existing road and proximity to existing high-density development). After reviewing the findings of this evaluation, the Nebraska Department of Economic Development asked whether a smaller Platte River lake (which was originally eliminated from further analysis) could be built in conjunction with the larger Platte River lake. The impacts of the two-lake scenario are generally the same as the (single) large-lake scenario and are discussed in the Conclusions section of this document. Each of the modeling summary reports - included as appendices to the final project report - discuss the two-lake impacts in greater detail.

A surface water model was developed for this study and consists of a model of the Platte River including the Elkhorn River and Salt Creek tributaries. The surface water model geometry is foundationally a digital elevation model (DEM) constructed from available topographic and bathymetric data from the U.S. Geological Survey (USGS), the Eastern Nebraska LiDAR Download Application, and the Headwaters Corporation. The DEM extends along the Platte River from North Bend to the confluence with the Missouri River and includes a portion of the Missouri River, Elkhorn River, and Salt Creek.

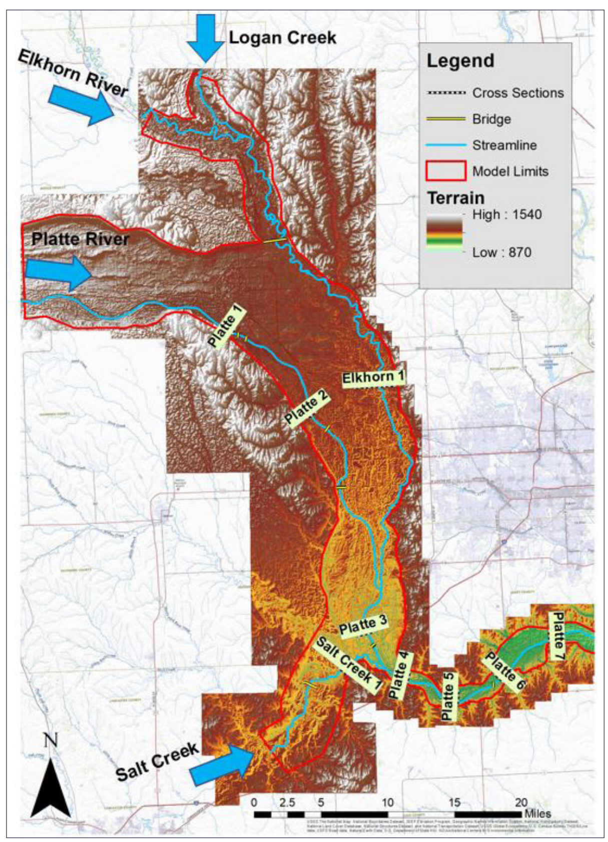

Figure ES-5 shows the boundaries for the surface water model.

Figure ES-5: Boundaries of the Surface Water Model

The surface water model was used to evaluate potential impacts of excavating a lake in the floodplain of the Platte River, or damming the Elkhorn River or Salt Creek. While a dammed lake was not necessarily envisioned by the legislature in LB1023, these locations were identified and further investigated as areas that could be considered in the future when initial analysis indicated few options in the Platte River floodplain.

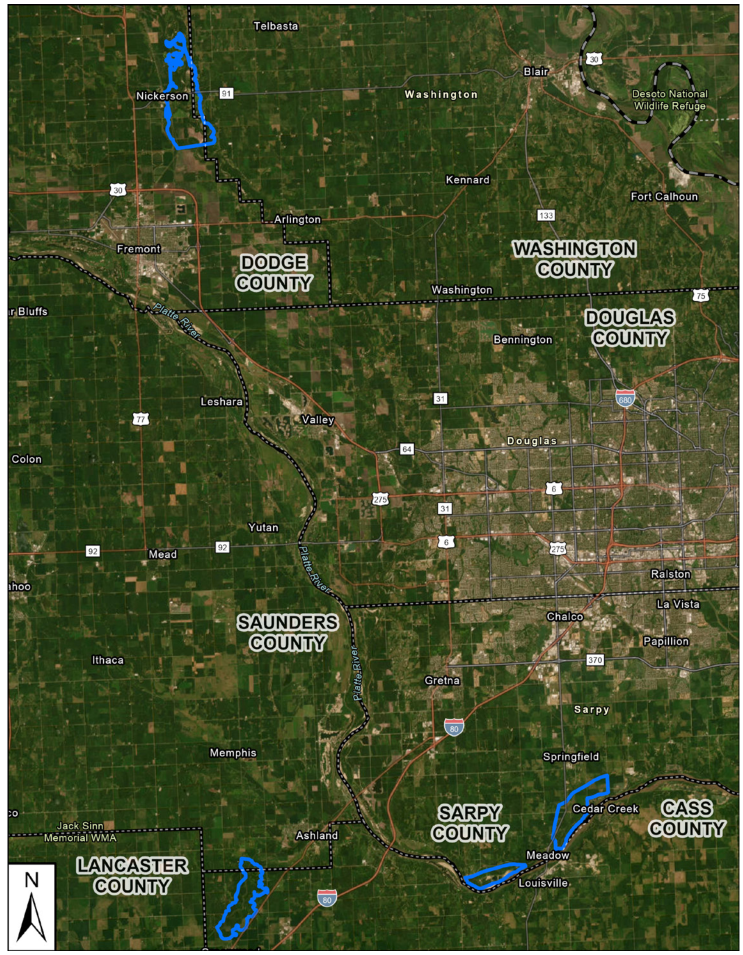

Figure ES-6: Analyzed Potential Lake Locations

The Platte River excavated lake is limited in spatial extent to roughly 2,100 acres because the area is confined by two WHPAs, the Platte River itself, and bluffs. The lake would likely need a berm – acting as a levee – constructed around it to prevent the entry of floodwaters. It is also notable that several small tributaries exist to the northwest of this lake, and flow from these would either have to be allowed to enter the lake or be routed around it. The berm would be approximately 10 feet high. The lake boundary was defined by attempting to limit increases in water surface elevation (WSE) during the 100-year flood event to no more than 1.0 feet, as required by Federal Emergency Management Agency (FEMA) regulations; however, final modeling results indicate the maximum increase in WSE during the 100-year flood event may be slightly above this threshold. This may require a reduction in the lake footprint. Alternatively, a letter of map revision (LOMR) or conditional letter of map revision (CLOMR) from FEMA could be sought, to update the regulatory flood map(s) and/or provide federal regulatory comment on whether changes in hydrology resulting from the lake's construction would be acceptable under the National Flood Insurance Program standards.

Both the Salt Creek and Elkhorn River dammed lakes, as analyzed, are approximately 4,100 acres in size. The conceptual Salt Creek dammed lake had a dam height of approximately 50 feet and a dam length of approximately 5,500 feet. For the Elkhorn River dammed lake, the conceptual dam height was approximately 36 feet with a dam length of 9,000 feet. Modeling results indicate that downstream reductions in WSE for the Salt Creek and Elkhorn River lakes would be relatively small; less than 0.1 foot and less than 0.01 foot, respectively.

From these lake footprints, then, additional groundwater modeling scenarios were carried out to evaluate the impacts of each lake on water table elevations. Modeling showed that each lake would locally produce both declines and rises in water tables. This information was used to inform the water balance analysis.

Forward particle tracking was also carried out with the groundwater model to examine times and paths of travel from the lakes and whether they would impact the existing municipal wellfields operated by MUD and LWS. These scenarios showed that the Platte River excavated lake would contribute water over short periods of time to the local aquifer and then to the river; note, again, that previously discussed model scenarios showed that all three municipal wellfields draw water from the Platte River, with more water drawn from the surrounding aquifer during dry periods. The conceptual Platte River excavated lake as analyzed is located upstream of the MUD Platte South wellfield.

Water Balance Modeling Analysis

This study also included a water balance analysis which includes water flowing into the lakes from upstream and rainfall, and outflow leaving the lake from evaporation, groundwater infiltration and downstream flows. **Figure ES-7** provides an example illustration of the mass balance for a water balance analysis. The purpose of the analysis was to estimate evaporation from the potential lakes, and the impacts of the lakes on changes in evapotranspiration within their footprints and evaporation from the river under low-flow conditions.

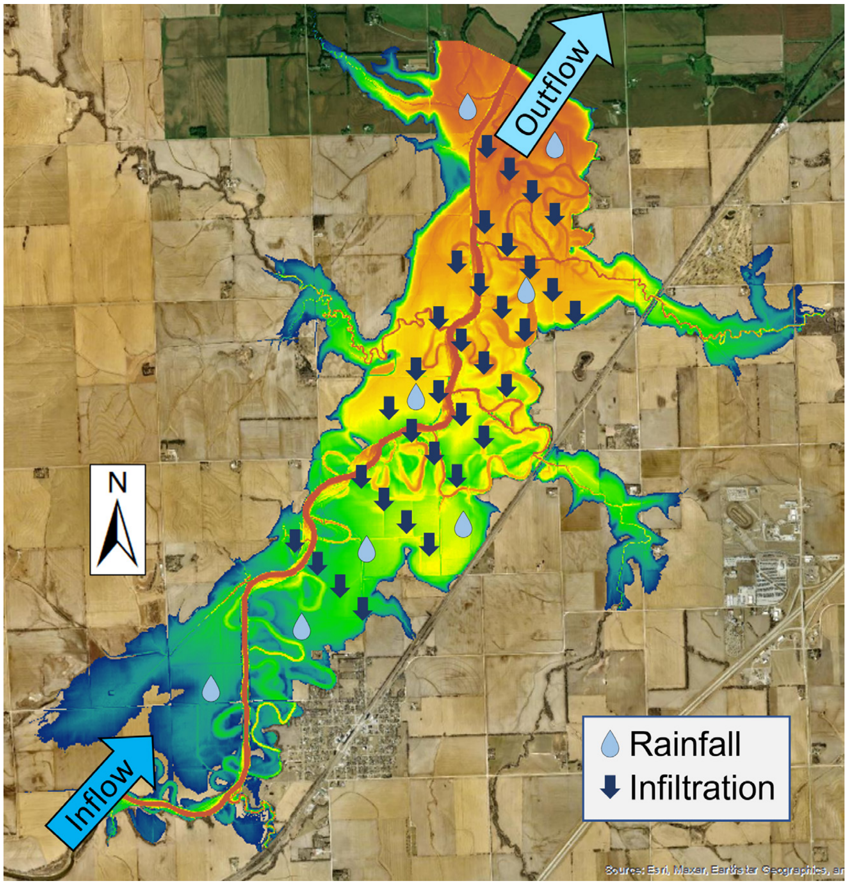

Figure ES-7: Example Illustration of Mass Balance for a Water Balance Analysis

The Platte River excavated lake would represent reduced loss of water to the atmosphere from groundwater, as the evapotranspiration conditions in the area currently are greater than would be the evaporative loss from the lake surface. In other words, the Platte River excavated lake would marginally increase the amount of groundwater retained in the local aquifer as compared to present conditions. Additionally, over half of the land within the footprint of the lake as modeled and analyzed is assumed to be irrigated, so conversion of these acres to permanent pool from irrigated row crops would reduce groundwater demand in the area.

For the two dammed lake locations, the Salt Creek lake would drain a much smaller land area compared to the Elkhorn River lake and would thus be more influenced by low-flow conditions. The Elkhorn River lake would drain an area of approximately 5,900 square miles, as compared to the Salt Creek lake's drainage area of approximately 1,050 square miles. As such, the relative impact of evaporative and groundwater losses would be less significant for the Elkhorn River lake. Results indicated that under average modeled conditions, the Salt Creek lake would result in passing approximately 99.0% of the upstream volume while Elkhorn River lake would pass approximately 99.7% of the volume. This analysis assumed downstream minimum flow requirements to maintain biological integrity equal to the monthly 10th percentile flows; wellfield water supply needs for LWS and/or MUD were not considered, nor were existing in-stream flow rights. During exceptionally dry periods, water surface elevation of either dammed lake would fluctuate significantly, but minimum downstream flow could be maintained. For the Salt Creek lake location, it is also noted that water surface elevation in the lake would frequently be controlled by minimum flows required downstream.

Desktop Geotechnical Analysis

A desktop geotechnical analysis was also performed to examine likely seepage at each of the three identified potential lake locations. This analysis involved research of each parcel, including: (1) identification of general soil formations and engineering parameters; (2) review of groundwater and soil information obtained from test hole logs; (3) review of soil information obtained from registered groundwater wells; and (4) review of readily available geotechnical exploration and engineering reports and/or soil test boring logs completed nearby. It is noted that full site-specific geotechnical exploration and laboratory testing would need to be performed for each of these sites to properly determine site feasibility, and the analysis described here was performed as an initial screening.

For the Elkhorn River dammed lake, on-site soils generally comprise four different complexes that vary from well/excessively drained to very poorly drained. Permeability rates in the upper five feet of soil could generally be between 0.039 to 0.000021 centimeters per second (cm/sec). On-site soils could include clay with varying silt or sand content overlying fine to coarse grained sands, with the possibility intermittent layers of fine to coarse grained gravels as well. Estimated seepage rates through the embankment and foundation of the embankment are calculated as less than 0.1 to 2.0 cubic feet per day per linear foot (cfd/lf), and less than 0.1 to 100 cfd/lf, respectively. Foundation seepage rates are expected to be highly variable, based on the likelihood of encountering intermittent layers of sands and gravels within the clay soil alluvial stratigraphy.

For the Salt Creek dammed lake, soils at the site generally include two different complexes that are also described with variable drainage, but the permeability rates in the upper five feet of soil are expected to be within a smaller range than for the dammed lake on the Elkhorn River, at 0.00092 to 0.000025 cm/sec. On-site soils could comprise clays with varying silt and sand content or fine to coarse grained sands with varying silt and clay content; it is also possible that intermittent layers of clay soils could be encountered within the sand. In general, seepage through the lakebed would not be expected to be as significant or variable as through the dammed lake on the Elkhorn River. Additionally, limestone bedrock is generally encountered at depths ranging from approximately 40 to 116 feet below the surface, and Dakota sandstone or shale may be encountered at greater depths. Estimated seepage rates through the embankment and foundation of the embankment are calculated as less than 0.1 to 4.0 cfd/lf, and less than 0.1 to 300 cfd/lf, respectively. It is anticipated that seepage rates may be variable, as with the dammed lake on the Elkhorn River, and also that limestone bedrock below a depth of about 40 feet could be encountered which could indicates existence or potential development of karst conditions.

For the Platte River excavated lake location, soils largely comprise two complexes, both of which are described as at least well drained (one is described as excessively drained). Permeability rates could generally be between 0.039 to 0.00014 cm/sec. Soils on the site could comprise clay with varying silt or sand content, and intermittent layers of fine to coarse grained sands and/or gravels could also be encountered. Sands and gravels may also be encountered with exposed sands more likely along the Platte River and near historic gravel pit areas. Layers of shale, sandstone, and ironstone were encountered in test holes in the area at depths as shallow as 125 feet and as deep as 205 feet below ground surface in the vicinity of this site. Estimated seepage rates through the embankment and foundation of the embankment are calculated as less than 0.1 to 0.3 cfd/lf, and less than 0.1 to 20 cfd/lf, respectively. Seepage rates may be high, based on the likelihood of encountering shallow sands and gravels associated with the Platte River and nearby quarries. Like the dammed lake on Salt Creek, the potential for existence or development of karst conditions exists at this location due to the variable depth of limestone bedrock.

Geomorphic Analysis

A geomorphic analysis was also conducted for each of the three potential lake locations. **Figure ES-8** provides an example of the channel and floodplain velocities along the Platte River. The purpose of this assessment is to consider the nature and magnitude of such changes in flood and erosion hazards in response to the scope and scale of different lake positions.

The Platte River excavated lake would require a berm isolating it from river floods. The lake would capture the river's normal flow and its sediment load would start filling the lake volume. The berm would displace natural floodplain surfaces where sediment normally is deposited and force that sediment downstream where it could have substantial unintended consequences and accumulations in areas that could acerbate downstream flooding. The narrowing of the floodplain would also accelerate flow during floods by constricting the floodplain, and the extra energy would increase erosion in the vicinity of the berm and beyond.

Two tributaries would be intercepted by the Platte River excavated lake, lowering their confluence elevation with the Platte floodplain by more than 10 feet. Without intervention, this lowering could lead to head cutting on those tributaries, leading to substantial bank failures and property loss well upstream of the lake boundary.

The two dammed lakes would produce different effects. The Elkhorn River dammed lake would trap a significant volume of sediment, preventing its normal delivery to the Platte River. This would require dredging upstream of the dam to maintain lake volume. Without intervention, the trapping of this sediment would facilitate riverbed and bank erosion downstream of the dam and would likely increase localized erosion on portions of the Platte and Elkhorn Rivers, especially near their confluence. The Salt Creek dammed lake would have less effect on the Platte River's stability because it normally delivers a less consequential sediment load to the Platte River. However, the dammed lake would increase erosivity of Salt Creek itself where it runs through an infrastructure-dense area of Ashland.

While various structural and other strategies could mitigate most of the erosion impacts, building and maintenance of any structures are costly. Further, such structures can displace energy and create their own downstream impacts.

Each of the lake positions contemplated would likely create a variety of complex upstream and/or downstream property instabilities and risk management scenarios to a greater extent or in different positions from which they currently occur, especially at the locations in closest proximity to the lakes. Fluvial geomorphic modeling, including detailed numerical modeling of sediment transport and erosive forces will be necessary to determine the specific locations of project impacts and the magnitude of those impacts on flood risks, habitat loss, and asset erosion.

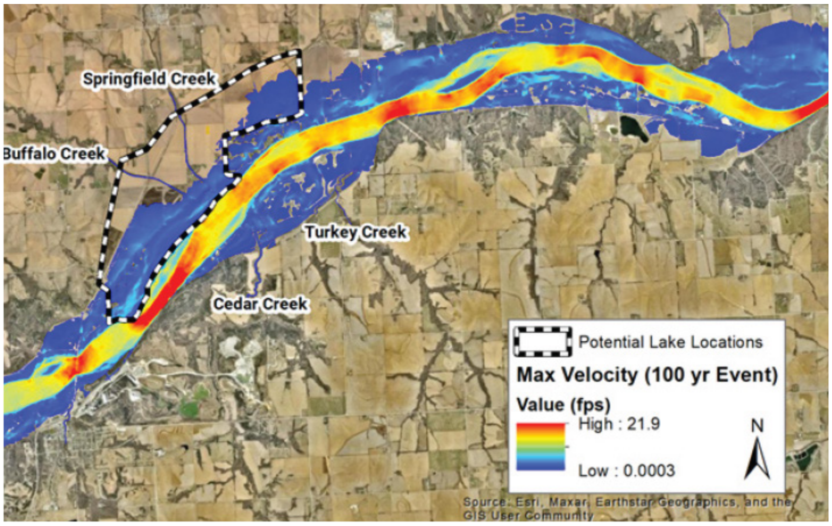

Figure ES-8: Example Image of Channel and Floodplain Velocities along the Platte River

Conclusion

While no fatal flaws were identified for the three potential lake locations analyzed in this study, challenges and possible adverse impacts were identified for each lake. More detailed analysis would be needed to identify the extent to which possible impacts could be mitigated. Therefore, it is recommended that a full feasibility study be conducted on any site(s) selected for further consideration for development.

Upon discussion of the groundwater and surface water flood modeling, water balance, and geomorphic analyses, the Nebraska Department of Economic Development asked whether both Platte River excavated lakes could be built to provide a total lake area (roughly 3,000 acres) closer to the targeted size in the legislation. Building both lakes would not significantly change the findings of the evaluation or the analyses that were completed. Impacts to the yield and water quality of the wellfields from the lakes would not change. The smaller lake is further away (upstream) from MUD's Platte South wellfield and several miles downstream of LWS's wellfield. Changes in flood elevations would be similar to those shown for the single-lake analyses and mitigation is likely to be required to limit the rise in the 100-year flood elevation to one foot or less. The extent of the mitigation is likely to be somewhat greater since more floodplain area would be taken by the second lake. The impacts to the geomorphology of the Platte River and its floodplain would increase; thus, careful consideration of the changes in sediment and erosion patterns in the Platte River as well as tributaries is needed. Finally, the water balance of the second lake would be same as the first, where there would be a slight reduction in evapotranspiration overall.

It is notable that, as demonstrated with particle tracking scenarios in the groundwater modeling analysis, there are relatively short times of travel - as little as 1 to 2 years - from the potential excavated lake sites to the Platte River, and that one of MUD's wellfields is located a short distance downstream. Because groundwater and surface water are so highly connected in this area, and a major municipal wellfield could experience impacts from the Platte River lakes within a short period of time, more extensive risk analysis is warranted.