

EXECUTIVE SUMMARY

The City of Lincoln and the Lower Platte South Natural Resources District (LPSNRD) have addressed flood control and floodplain management in a variety of ways in the Salt Creek watershed over the last century. It is important to understand the history of the watershed and how flooding has been addressed in the past. It is also important to look at how national floodplain best management practices (BMPs) and state-of-the-art climate science may effectively be used to address watershed resiliency in the future.

The primary focus of this study is to illuminate how existing non-structural and structural floodplain management measures can be strengthened to further reduce flooding impacts to existing infrastructure, local businesses, residences, and future developments and to enhance the floodplain resiliency of Salt Creek.

For this study, the city and LPSNRD determined a public education plan would be beneficial to improve public awareness about floodplain management and resiliency. To develop a dynamic education plan, a diverse stakeholder group was assembled to help guide the education process. The stakeholder group was comprised of individuals with an interest in the Salt Creek floodplain area. Stakeholders were invited to participate in three stakeholder meetings during the study to review study content and outcomes. Stakeholders were provided tools and information through a project website to share information about floodplain management and the resiliency study with their communities.

The study examines the following eight subject areas:

1. National floodplain BMPs
2. Floodplain BMPs from communities across the country
3. Lincoln's current floodplain management practices
4. A review of floodplain studies involving Salt Creek
5. A rigorous climate evaluation of past, current, and future conditions
6. Potential flood resiliency measures and recommendations
7. A review of potential funding sources
8. Recommendations

National Floodplain Best Management Practices (BMPs)

The study team examined national BMPs for relevant and critical guidance and strategies from six organizations that are leaders in the field of floodplain management. These organizations offer expertise and insight into national trends and include the Federal Emergency Management Agency (FEMA); the National Oceanic and Atmospheric Administration (NOAA); the Pew Charitable Trust; Resilient Nation Partnership Network (RNPN); the Technical Mapping Advisory Council (TMAC); and the National Academy of Sciences (NAS). Each organization brings a unique mission and perspective to how floodplain management is evolving in the United States. Selected BMPs that each organization is implementing and their relevance to Lincoln and Salt Creek are evaluated.

Community Floodplain BMPs

Eight communities from across the county that stand out in the Community Rating System (CRS) program; have done a notable job of implementing a proactive floodplain management strategy or strategies; and have elements of their communities, geography, or risk that are relatable to Lincoln were selected for review. The communities include Beatrice, Nebraska; Boulder County, Colorado; Cedar Falls, Iowa; Fort Collins, Colorado; Mecklenburg County, North Carolina;

Papillion, Nebraska; Platte County, Missouri; and Shawnee, Kansas. The summary and analysis of each community's BMPs include benefits and drawbacks of the strategies and how they may relate to Lincoln's floodplain program.

Lincoln's Floodplain Management Practices

The city and the LPSNRD have partnered together to reduce flooding and to protect the citizens of Lincoln from the hazards associated with flooding. The many successes of this partnership are the result of a blended approach to floodplain management. A summary of current floodplain management practices is provided in Section 3 along with an evaluation of the pros and cons of each practice. The practices include education and outreach; policies; local detention requirements; post-construction stormwater BMPs; Salt Creek flood storage areas (SCFSA); freeboard requirements; FEMA's CRS; floodplain preservation; flood protection and buyouts; flood risk reduction projects; and a no adverse impact policy in new growth areas.

Floodplain Studies Involving Salt Creek

Twenty-one flood studies involving Salt Creek, from 1954 thru 2016, are referenced in this report. Participants in the studies included the city, LPSNRD, FEMA, the University of Nebraska-Lincoln, and U.S. Army Corps of Engineers.

Local Climate Evaluation

Optimal resiliency planning requires a forward-looking approach: Planners must consider not just events and hazards that may occur in the present day, but they must also account for future hazards and how those hazards may evolve over time. The study evaluated local historical and existing precipitation patterns, developed probable future storm magnitudes, and developed future flood discharges that can be used for future conditions flood hazard analysis. The results of the study indicate that flood hazards on Salt Creek and its tributaries can be expected to increase in the future. The degree of increase is uncertain, but generally Lincoln should expect floodwater surface elevations multiple feet higher than the existing flood hazard data. When considering resiliency and potential flood hazard reductions measures, it is critical to allow for these increases.

Potential Flood Resiliency Measures and Recommendations

A resilient flood management plan requires a comprehensive flood impact reduction strategy that takes both structural and non-structural measures into consideration. The foundation of a flood resiliency plan includes robust non-structural measures such as floodplain management policy, buyouts, relocations, floodproofing, and preservation of open space. These non-structural measures may be complemented by structural flood risk impact reduction measures. The proposed measures must be designed to manage the events and hazards that may occur in the present day, but they must also account for future hazards and how those hazards may evolve over time.

Non-structural Measures

The study recommends the city and LPSNRD take six nonstructural flood resiliency measures under further consideration. The non-structural strategies include cluster subdivisions regulations; overlay zoning; voluntary buy program; setbacks and riparian preservation; low-impact development regulations; and higher floodplain management standards. The strategies selected were evaluated based on conversations with the project team, the review of comparative regulatory levels from other communities, feedback from the stakeholder group, and anticipated benefits associated with their implementation. Each recommendation includes a reference to the

BMP in which it was first identified; a description of the recommendation; an overview of why the recommendation is beneficial to the Salt Creek watershed; evaluation of potential CRS points; and identified next steps.

For the nonstructural flood resiliency measures recommendations, the City of Lincoln, in partnership with LPSNRD, should do the following:

1. Identify the recommendations that are top priorities and chart a path to implementation.
2. Evaluate the cost to implement the identified recommendations.
3. Identify local funding sources that are sufficient to match potential federal funding sources.
4. Position projects for potential grant funding.

Structural Measures

A conceptual system of structural flood management measures was evaluated based on the three conditions described below:

Existing Conditions

The **existing conditions** precipitation is derived from the U.S. Weather Bureau's Technical Paper 40 (TP40) (U.S. Department of Commerce 1961). The flood flows and flood elevations provided in the Flood Insurance Study (FIS) for Lancaster County, Nebraska, and Incorporated Areas (NFIP 2013) are based on the TP40 precipitation amounts and are referred to as the **existing conditions**. One goal of the study was to analyze a conceptual system of flood management measures to bring the 1 percent annual chance flood elevations to a level below the top of levee and low enough to provide the 3 feet of freeboard required to accredit a levee system, where possible.

Updated Conditions

Updated precipitation values are provided in the National Oceanic and Atmospheric Administration's Atlas 14 (NOAA 2013) Precipitation Analysis (Atlas 14). The Atlas 14 precipitation values, developed for Nebraska in 2013, are used to develop the **updated conditions** flood flows. The conceptual system of flood management measures was intended to show a reduction in the increased 1 percent annual chance flood elevations associated with **updated conditions** flood events to a level equal to or below the **existing conditions** flood elevations (as shown in the FIS) for a majority of the Salt Creek levee segments.

Future Conditions

A detailed climate modeling effort was performed as part of this study to determine potential future precipitation values for the year 2100. The precipitation values that were derived from the climate modeling effort, which assumed greenhouse emissions trends would continue to increase, were used as the basis for computing the **future conditions** flood flows for Salt Creek. The conceptual system of flood management measures was also intended to show a reduction in the increased 1 percent annual chance flood elevations associated with **future conditions** flood events to a level equal to or below the **existing conditions** flood elevations (as shown in the FIS) for a majority of the Salt Creek levee segments.

The conceptual system of structural flood management measures analyzed 16 dams within the Salt Creek tributary subbasins. The study concluded that the conceptual system of flood management measures analyzed reduce flood elevations for the 1 percent annual chance flood

event for the existing conditions flood (as shown in the FIS) below the top of levee throughout the levee system, and provides the necessary freeboard at most locations.

The conceptual system of flood management measures analyzed also reduce flood elevations for the 1 percent annual chance flood event for the updated and proposed conditions to a level below the existing conditions flood elevations (as shown in the FIS) throughout most of the Salt Creek levee system. At a conceptual level, the structural flood management measures do not provide the necessary amount of freeboard to remove areas outside of the levees from the floodplain.

Funding Sources

The study shows that actual flood risks and potential flood damages in Lincoln are greater than depicted in the current regulatory models, maps, and public information. And, as the climate models illustrate, the flood hazards on Salt Creek are expected to increase in the future. Both structural and nonstructural solutions to reduce the flood risks along Salt Creek and its tributaries are presented. The solutions for structural controls are multimillion-dollar projects. Several of the primary options for funding through federal, state, and local agencies are presented along with options to partner with private enterprises in public-private partnerships. As the preferred solution is selected, the appropriate funding strategy will be identified based on the details of the proposed project(s).

Recommendations

Six recommendations for the city and LPSNRD to consider are presented below:

- Continue active participation in the CRS program to continue to qualify for reduced flood insurance rates.
- Adopt higher floodplain regulatory standards to mitigate higher flood elevations in the future.
- Initiate the development of new floodplain maps to incorporate up-to-date precipitation information.
- Use the national BMPs identified to guide planning objectives.
- Consider implementation of six additional nonstructural flood resiliency strategies that include:
 - Cluster subdivisions
 - Overlay zoning
 - Voluntary buyouts
 - Setbacks and riparian preservation
 - Low-impact development regulations
 - Higher floodplain management standards
- Continue with the development of a comprehensive flood resiliency strategy for Salt Creek and the City of Lincoln.