Upper Joachim Creek

Floodplain Management Plan

For the City of De Soto & Jefferson County, Missouri

Prepared by the Upper Joachim Creek Floodplain Management Planning Partners

September 2019

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Executive Summary

The Upper Joachim Creek Floodplain Management Plan (FMP) was developed as an interagency Flood Risk Management (FRM) study via the Silver Jackets team funded under the Flood Plain Management Services (FPMS) program.

The purpose of developing the FMP is to enhance the community's flood resilience. An effective FMP offers options to lessen the impacts of flooding to the community's economy and the lives of those living near the many waterways. Once adopted, the FMP, maintained as a living document, is continually updated as new information arises, or as additional goals and strategies are developed.

The goals of an FMP include:

- Reducing loss of life, injury, and hardship due to floods;
- Reducing flood-related damages;
- Reducing public expenditures for construction of additional flood damage reduction measures, emergency response actions, and post-disaster assistance; and,
- Preserving and enhancing natural floodplain values for fish and wildlife habitat along with their attendant benefits of groundwater recharge, moderation of floods, water quality improvement, and reduced erosion and sedimentation.

The City of De Soto, in Jefferson County, Missouri has historically been prone to flash flooding but has experienced an increase in both frequency and intensity in recent years. Flood depths and the rate of flood-waters inundating the community have increased over time. The city has experienced 5 flood events in the last 4 years and has had fatalities associated with flooding as emergency services were unable to reach those in need due to inundated roads. In addition to residential and commercial structures located in the 1-percent annual chance of exceedance (ACE) floodplain, the De Soto Rural Fire Station #1 and public library are also located in the floodway and floodplain, respectively. The fire station has been impacted by recent flood events, and one of the flood-related fatalities occurred when a vehicle was swept away down the street from the fire station.

The FMP focuses on the 1-percent ACE event, which refers to flood events that have a one percent probability of occurring in any given year, using previous Flood Insurance Rate Maps (FIRMS) from 2006 and recently published FIRMS from 2019. The hydraulic model used throughout the study is the same model used for the Federal Emergency Management Agency's (FEMA) Flood Insurance Study. The FMP considered the many ways (referred to as "tools") to reduce flood risk. The U.S. Army Corps of Engineers – St. Louis District (USACE) performed an analysis using the National Nonstructural Committee's assessment of 10 representative structures within De Soto and Jefferson County and applied the Committee's findings to all of the structures in the 1-percent ACE flood event. USACE also performed hydraulic modeling of sediment deposit removal in seven specific locations within the creek.

Both Jefferson County and the City of De Soto's goals and objectives were used to form broad strategies with specific implementable tools within each strategy. Table 1 below lists the various tools and evaluates each as either effective or ineffective and either recommends the tool, does not recommend the tool, or suggests that further evaluation is needed before considering the tool. Several of the tools were considered because the members of the community referenced the tools during the public comment period or during the public workshop.

Table 1. Summary of Tools

TOOLS		
Land Use Policies and Regulations	EFFECTIVE	RECOMMENDED
Public Alert Flood Warning System	EFFECTIVE	RECOMMENDED
Warning Dissemination, Multi-Media	EFFECTIVE	RECOMMENDED
Flood Emergency Preparedness Plans (or EAP)	EFFECTIVE	RECOMMENDED
Development Policies – Moratorium	EFFECTIVE	NOT RECOMMENDED
Structure Elevations	EFFECTIVE	RECOMMENDED
Buyouts (Structure and Land Acquisition)	EFFECTIVE	RECOMMENDED
Flood proofing (Wet & Dry)	EFFECTIVE	RECOMMENDED
Community Education and Advocacy	EFFECTIVE	RECOMMENDED
Temporary Flood Risk Adaptive Measures	EFFECTIVE	RECOMMENDED
Information and Education	EFFECTIVE	RECOMMENDED
Flood Insurance	EFFECTIVE	RECOMMENDED
Community Rating System (CRS)	EFFECTIVE	RECOMMENDED
Local Drainage and Utility Protection	EFFECTIVE	FURTHER EVALUATION NEEDED
Tax Adjustments	EFFECTIVE	FURTHER EVALUATION NEEDED
Post-Flood Recovery Processes	EFFECTIVE	RECOMMENDED
Wetlands, Stream, and Riparian Protection and Restoration	EFFECTIVE	RECOMMENDED
Enhancement of Recreation and Education Opportunities	EFFECTIVE	RECOMMENDED
Dredging of Joachim Creek to Increase Channel Capacity	NOT EFFECTIVE	NOT RECOMMENDED
Accumulated Sediment Deposit/Debris Removal from Joachim Creek	EFFECTIVE	FURTHER EVALUATION NEEDED
National Guard Involvement	EFFECTIVE	FURTHER EVALUATION NEEDED
Bridge and Highway (re) Construction	-----	ANALYSIS NOT PERFORMED
Detention/Retention Basins	EFFECTIVE	FURTHER EVALUATION NEEDED
Levees and Floodwalls	EFFECTIVE	FURTHER EVALUATION NEEDED

The FMP concludes with the Action Plan, which provides a path forward for the City of De Soto and Jefferson County for both the short term and the long term. The Action Plan can be implemented as one package or in phases based upon the goals of the community and available funding. Potential funding sources have been included in an appendix to the FMP.

The Upper Joachim Creek Floodplain Management Plan Action Plan includes the following actions:

1) Adopt the Upper Joachim Creek FMP

2) Develop a comprehensive public outreach plan

3) Adopt higher regulatory floodplain management standards

4) Maintain and expand the existing flood warning systems

5) Join the Community Rating System (CRS)

6) Implement nonstructural recommendations in Appendix G

1 Introduction

1.1 Study Authority

This Floodplain Management Plan was developed as an interagency Flood Risk Management (FRM) study via the Silver Jackets program. Silver Jackets is funded under the USACE Flood Plain Management Services (FPMS) program and is authorized by Section 206 of the 1960 Flood Control Act (P.L. 86-645), as amended. The program allows the U.S. Army Corps of Engineers to conduct small, conceptual studies for local communities with the objective of fostering public understanding of the options available to manage flood hazards and to promote prudent use and management of the Nation's floodplains. The Silver Jackets team bring together multiple state, federal and local agencies, as well as non-governmental agencies, to leverage resources, learn from one another and apply trans-disciplinary knowledge to reduce the risk of flooding as well as enhance response and recovery efforts when such events do occur.

1.2 Description of the Area

The City of De Soto is situated in Jefferson County, Missouri, approximately 45 miles south of St. Louis in the Upper Joachim Creek watershed (HUC12). The watershed has a total drainage area of 39,154 acres, and the City of De Soto, at the downstream end, is the only incorporated city in the watershed. Figure 1 (below) depicts the Upper Joachim Creek Watershed, the City of De Soto and Jefferson County Missouri, and its proximity to St. Louis, Missouri.

The city has historically been prone to flash flooding but has experienced an increase in both frequency and intensity in recent years. Flood depths and the rate of flood-waters inundating the community have increased over time. The city has experienced 5 flood events in the last 4 years and has had fatalities associated with flooding, and emergency services were unable to reach those in need due to inundated roads. In addition to residential and commercial structures located in the 1-percent annual chance of exceedance (ACE) floodplain, the De Soto Rural Fire Station #1 and public library are also located in the floodway and floodplain, respectively. This fire station has been impacted by recent flood events, and one of the flood related fatalities occurred when a vehicle was swept away near the DeWitt Street Bridge on Veterans Drive.

The State of Missouri Emergency Management Agency (SEMA) prepared the Missouri State Hazard Mitigation Plan in 2013, which was recently updated in 2018. The plan identifies riverine flooding (major and flash) as having a high probability of occurring and a high severity statewide. Missouri has had 42 flooding-related presidential disasters in the 44 years since 1975. Jefferson County is specifically called out in the plan as being heavily affected by flooding and has more presidentially-declared, flooding-related disasters in the state than any other county (1975-2017).

More specifically, 2006 Flood Insurance Rate Maps (FIRMs) for the Upper Joachim Creek watershed show approximately 1,642 acres subject to inundation by the 1-percent ACE flood event: 524 acres were mapped as *AE flood zone*, meaning base flood elevations are known, and 1,118 acres were mapped as *A flood zone,* meaning no depths or base flood elevations are shown due to a lack of detailed analyses performed for the area. The updated 2019 FIRMs show approximately 2,127 acres subject to inundation by the 1-percent ACE flood event: 1,930 acres were mapped as *AE flood zone* and 197 acres were mapped as *A flood zone*. When comparing 2006 FIRMs and 2019 FIRMs, the overall watershed shows nearly 30% increase in 1-percent ACE flooding. Of the total 2,127 acres (2019 FIRMs), 375 acres (17.6%) are within the De Soto city limits. This increase can be the result of multiple factors occurring between 2006 and 2019: increase in rainfall, increase in development causing more runoff, tools used for analysis providing more accurate answers, among many others.

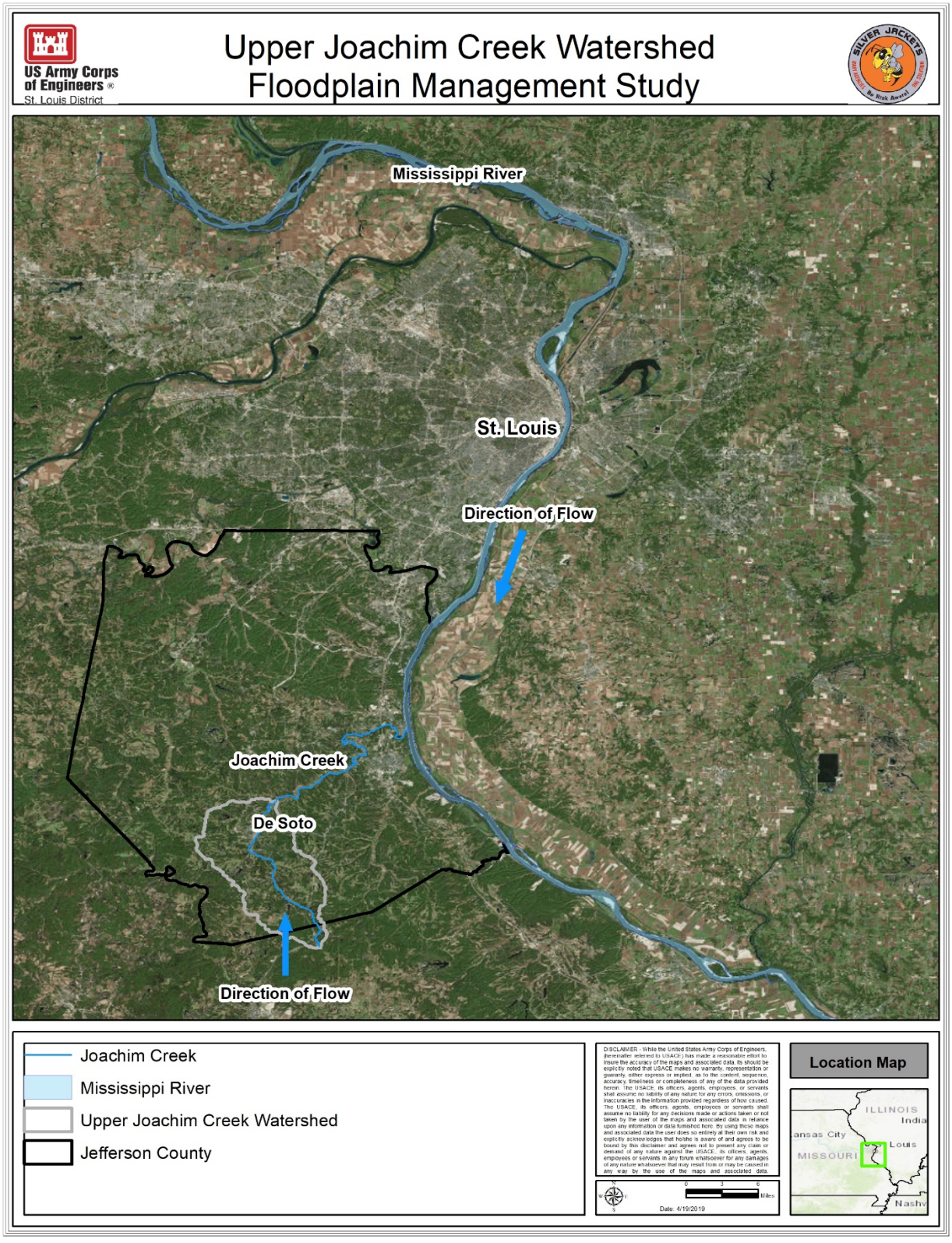

Figure 1. Location Map

1.3 Previous Studies

Numerous reports and studies exist that describe the problems associated with flooding along the Upper Joachim Creek. *Section 9- References* presents a bibliography of these resources.

Table 2 displays the most recent flood events and the approximate annual chance of exceedance (ACE) for the rainfall of each event. It also indicates which events resulted in federal disaster declarations.

Table 2. Recent Upper Joachim Creek Flood History

Month	Year	Approximate Precipitation Annual Chance of Exceedance[1]	Common "year" Event Terminology	Federal Disaster Declaration[2]
April	2013	99%	1-year event	
June	2015	50%	2-year event	
December	2015	10-20%	5-year to 10-year event	Disaster Recovery (DR)-4250; IA & PA
May	2016	50-20%	2-year to 5-year event	
August	2016	20%	5-year event	
April	2017	4%	25-year event	DR-4317; IA & PA

[1] Annual Chance of Exceedance (%ACE) is commonly referred to as x-year flood or y-year event. For example: a 1-percent ACE is commonly referred to as the 100-year flood or 100-year event. The approximations in this table are based on rainfall data, not flood heights.

[2] Declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121-5207). FEMA has codified the declaration process at 44 C.F.R. Part §206.

Between 2005 and 2014, 3% of the land area in Jefferson County was affected by riverine flash flooding according to the National Climactic Data Center. The media has also reported on a number of flooding events in the watershed in recent years. As of the date of this Floodplain Management Plan, there have been 11 reported events over a 32-year period and six of those events have occurred in the last six years. There may be flood events in the watershed that were not covered by local media or did not result in a flood insurance claim on a repetitive loss property.

1.4 Disaster Recovery Flood Events

1.4.1 December 2015 Flood Event

Severe storms producing tornadoes, straight-line winds and heavy rainfall swept across the State of Missouri the last week in December 2015, prompting widespread flooding along the Missouri and Mississippi Rivers and their tributaries. Locations across the state, from southwest Missouri Ozarks towards the east to St. Louis received 10-12 inches of rainfall, resulting in flash flooding and historic river flooding. On December 27, 2015, the Governor of Missouri declared a state of emergency. The President of the United States (POTUS), subsequently approved a major disaster declaration, FEMA-4250-DR-MO, for 33 counties for Individual Assistance (IA). On February 10, 2016 the declaration was amended to include 37 counties for Public Assistance (PA) for permanent work categories. While flood damages occurred along Joachim Creek, unfortunately, there was no stream gage installed or information available for the 2015 winter flood. Since then, a stream gage has been installed on Joachim Creek and started collecting readings on July 17, 2018. The stream gage is located at DeWitt Street and Route E, and it is operated by the United States Geological Survey (USGS), in partnership with the City and County. This will provide valuable information for monitoring water levels on the Creek and for future study purposes.

1.4.2 2017 Flood Event

On May 24, 2017, the Governor requested a major disaster declaration due to severe storms, tornadoes, straight-line winds, and flooding during the period of April 28 to May 11, 2017. The Governor requested a declaration for Individual Assistance for 37 counties, Public Assistance for 46 counties, and Hazard Mitigation statewide. On June 2, 2017, POTUS declared that a major disaster exists in the State of Missouri. This declaration made Individual Assistance requested by the Governor available to affected individuals and households to include Jefferson County. While flood damages occurred along Joachim Creek, unfortunately, there was no stream gage installed or information available for the 2017 spring flood.

2 Floodplain Management Plan Development

2.1 Purpose

The purpose of a Floodplain Management Plan (FMP) is to enhance a community's flood resilience. Flood resilience refers to the ability of a community to withstand a flooding event, minimize damages, and rapidly recover. An effective FMP offers options to lessen the impacts of flooding to the community's economy and the lives of those living near areas prone to flooding. Once adopted, the FMP should be maintained as a living document that is continually updated as new information arises or as additional goals and strategies are developed. The goals of an FMP include:

- Reducing loss of life, injury and hardship due to floods;
- Reducing flood-related damages;
- Reducing public expenditures for construction of additional flood damage reduction measures, emergency response actions and post-disaster assistance; and,
- Preserving and enhancing natural floodplain values for fish and wildlife habitat along with their attendant benefits of groundwater recharge, moderation of floods, water quality improvement and reduced erosion and sedimentation.

A FMP attempts to balance benefits obtained from use of the floodplain with potential losses arising from such use. The comprehensive nature of such a plan stresses consideration of the full range of structural and non-structural measures potentially useful in achieving these objectives. The concepts contained in this Floodplain Management Plan were developed to closely follow the 1994 Unified National Program for Floodplain Management.

Effective management of both floodplains and floodwaters, with sound policies, using appropriate physical features, allows those living and working in and around the floodplain to break the cycle of damage, rebuild, and repeat. Breaking this cycle achieves a sustainable flood risk management cycle (Figure 2).

Figure 2. Disaster Cycle

The FMP was prepared in accordance with federal standards originating from Executive Order (EO) 11988. EO 11988 requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Additionally, this FMP meets the minimum standards for the Federal Emergency Management Agency's (FEMA) Community Rating System (CRS), Section 510 as described in the CRS coordinator's manual (FEMA, 2007).

2.2 Participants

Both the City of De Soto and Jefferson County are integral participants in the Floodplain Management Planning process because they have the statutory authority to carry out or implement the major elements (primarily the tools described in Section 7) of this FMP. Other partners, listed in Section 2.5, have supported the effort in terms of technical expertise, public outreach, as well as other support.

The De Soto City Council adopted a resolution agreeing to participate in the Floodplain Management Planning effort on 18 December 2017 (Figure 3).

Although the Jefferson County Council did not adopt a resolution agreeing to participate in the Floodplain Management Planning effort, County officials have provided input and have participated throughout the process.

Both the City and County Floodplain and Emergency Managers were actively involved in the planning process. Table 3 is a list of the City and County's respective departments who have participated in the planning process.

Table 3. City and County Participants

Name	Department
David Dews	City Manager/Floodplain Manager/City Planner
Ann Baker	De Soto City Clerk/Acting City Manager/Acting Floodplain Manager/ Acting City Planner
Todd Melkus	City Manager/Floodplain Manager/City Planner
Kevin Warden	Public Works Director
Clayton Henry	De Soto City Councilman
Roger Charleville	De Soto City Councilman
Charles Roop	De Soto City Councilman
Craig Block	De Soto Fire Chief/Building Inspector
Tasha Dennis	De Soto Finance Manager
Warren Robinson	Jefferson County Director of the Office of Emergency Management
Eric Larson	Jefferson County Director of County Services and Code Enforcement/ Community Planning/Floodplain Administrator/

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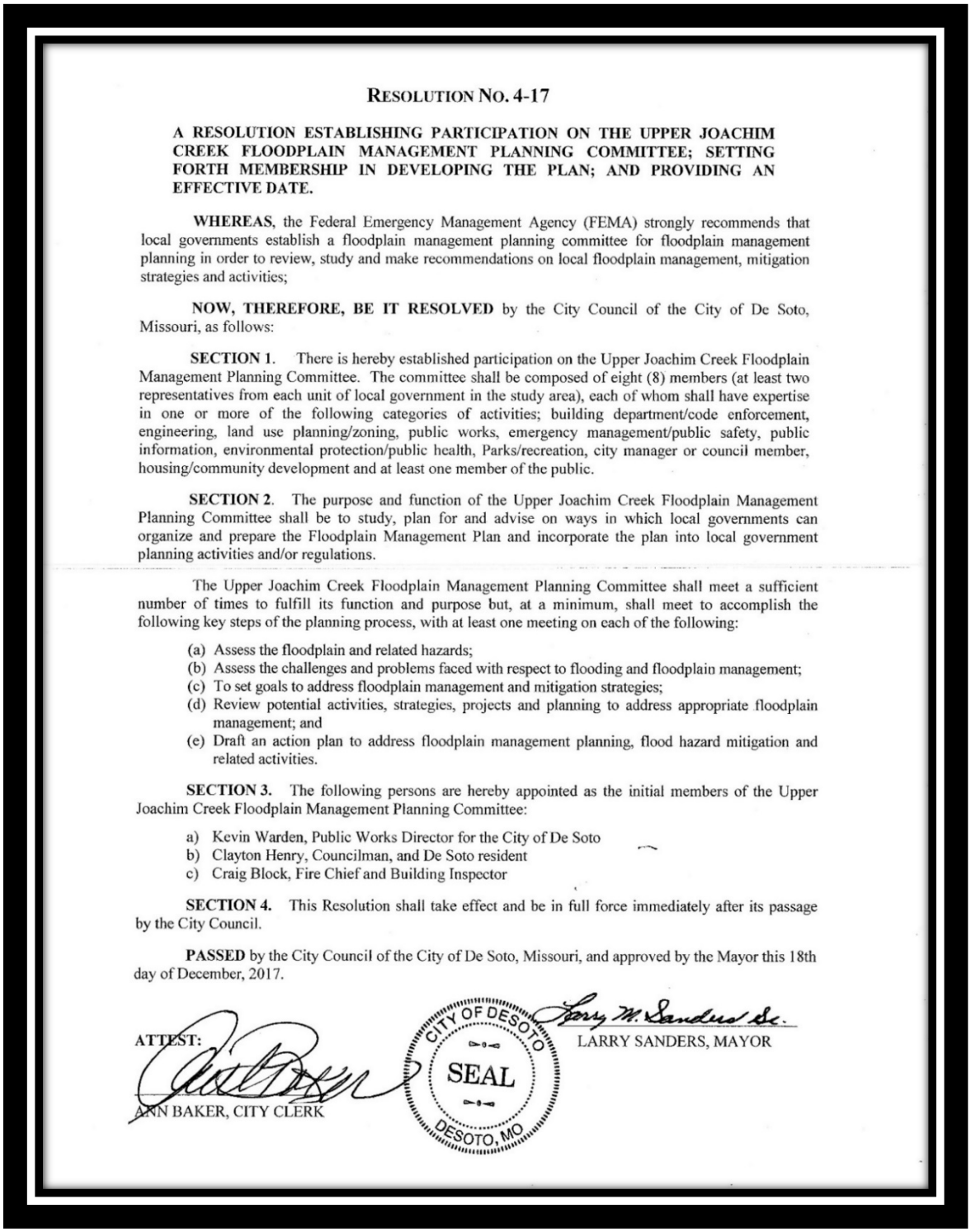

RESOLUTION NO. 4-17

A RESOLUTION ESTABLISHING PARTICIPATION ON THE UPPER JOACHIM CREEK FLOODPLAIN MANAGEMENT PLANNING COMMITTEE; SETTING FORTH MEMBERSHIP IN DEVELOPING THE PLAN; AND PROVIDING AN EFFECTIVE DATE.

WHEREAS, the Federal Emergency Management Agency (FEMA) strongly recommends that local governments establish a floodplain management planning committee for floodplain management planning in order to review, study and make recommendations on local floodplain management, mitigation strategies and activities;

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of De Soto, Missouri, as follows:

SECTION 1. There is hereby established participation on the Upper Joachim Creek Floodplain Management Planning Committee. The committee shall be composed of eight (8) members (at least two representatives from each unit of local government in the study area), each of whom shall have expertise in one or more of the following categories of activities; building department/code enforcement, engineering, land use planning/zoning, public works, emergency management/public safety, public information, environmental protection/public health, Parks/recreation, city manager or council member, housing/community development and at least one member of the public.

SECTION 2. The purpose and function of the Upper Joachim Creek Floodplain Management Planning Committee shall be to study, plan for and advise on ways in which local governments can organize and prepare the Floodplain Management Plan and incorporate the plan into local government planning activities and/or regulations.

The Upper Joachim Creek Floodplain Management Planning Committee shall meet a sufficient number of times to fulfill its function and purpose but, at a minimum, shall meet to accomplish the following key steps of the planning process, with at least one meeting on each of the following:

(a) Assess the floodplain and related hazards;
(b) Assess the challenges and problems faced with respect to flooding and floodplain management;
(c) To set goals to address floodplain management and mitigation strategies;
(d) Review potential activities, strategies, projects and planning to address appropriate floodplain management; and
(e) Draft an action plan to address floodplain management planning, flood hazard mitigation and related activities.

SECTION 3. The following persons are hereby appointed as the initial members of the Upper Joachim Creek Floodplain Management Planning Committee:

a) Kevin Warden, Public Works Director for the City of De Soto
b) Clayton Henry, Councilman, and De Soto resident
c) Craig Block, Fire Chief and Building Inspector

SECTION 4. This Resolution shall take effect and be in full force immediately after its passage by the City Council.

PASSED by the City Council of the City of De Soto, Missouri, and approved by the Mayor this 18th day of December, 2017.

ATTEST:

ANN BAKER, CITY CLERK

CITY OF DESOTO SEAL DESOTO, MO

LARRY SANDERS, MAYOR

Figure 3. Resolution Adopted by City of De Soto to Participate in FMP

2.3 Project Study Outcomes

This Floodplain Management Plan (FMP) serves as a blueprint that can be implemented by the City of De Soto and Jefferson County, Missouri.

The FMP will include and foster:

- Flood risk reduction strategies that are current, technically sound, and consider all possible mitigation alternatives and the consequences of those alternatives.
- Prioritization of resources to reduce risk to the furthest extent and minimizes effect on natural floodplain functions.
- Public and political support for activities and projects and a constituency that wants to see the plan's recommendations implemented.

The FMP documents all meetings and public involvement activities, lists goals and objectives, identifies strategies and tools considered as well as reasons for inclusion or rejection, and details the action plan for implementation. The plan addresses primary strategies to modify human susceptibility to flood hazards, modify the impact of flooding, preserving and restoring the floodplain's Environmental Quality and other publically-referenced tools.

2.4 Public Involvement Process

For the purpose of this FMP, the term "public" includes residents, businesses, property owners, and tenants in the floodplain and other known hazard areas as well as other stakeholders in the community, such as developers and contractors, civic groups, environmental organizations, academia, non-profit organizations, private companies, and staff from governmental agencies, such as a housing authority and other federal agencies. See Table 5 in Section 2.5 for a complete partner list.

Public involvement was vital during the development of the Upper Joachim FMP. During the scoping phase, a private group of citizens known collectively as the Citizens' Committee for Flood Relief contributed time and effort by contacting property-owners to allow USACE's National Nonstructural Committee to visit their homes/businesses, reserving the venue for the public workshops, promoting the public comment opportunity, taking USACE staff on a site visit, and providing data.

In addition, USACE introduced the Floodplain Management Planning effort to the public by hosting a public workshop at the De Soto Community Center on 28 February 2018. The purpose of the meeting was to gather information on historic and existing conditions, flooding locations, local opinion on possible solutions, and community flood procedures. Table 4 shows the attendance and demographic of the workshop attendees.

Table 4. De Soto, MO Public Workshop Attendance on February 28, 2018

Workshop Location	Public	Partners	Congressional	Media	Total
De Soto Community Center	47	13	3	4	**67**

The public was given approximately 30 days to respond with comments via email or regular mail. Based on some late public interest to submit comments, the comment period was extended to a total of 45 days. USACE received a total of 29 responses, which were then compiled. A detailed breakdown of public involvement feedback (Public Involvement Results) can be found in Appendix A of this FMP.

In late August of 2018, the USACE National Nonstructural Committee (NNC) sent two of its staff to De Soto, Missouri in order to perform nonstructural assessments on 10 homes and businesses whose owners volunteered to have Committee members enter their properties, take pictures, and collect data about flood depths and damages. The NNC's report can be found in Appendix D. The objective of the assessments was to identify potential opportunities for flood risk adaptive measures, generally referred to as nonstructural mitigation measures.

USACE was also given a tour of the project area by two members of the Citizens' Committee for Flood Relief, which allowed USACE staff to see locations that have experienced past and recent flooding and to hear from these two members, who are civic leaders from the area. This site visit occurred on September 26, 2018.

From the initial public workshop in February of 2018, the U.S. Army Corps of Engineers-St. Louis District has maintained a live website with information for the public including the Information Paper, Public Comment Periods results, relevant contact information for federal, state, and local officials, the draft Floodplain Management Plan, and the public meeting presentation. USACE-St. Louis District has also posted on its social media page about the public workshop and the public meeting. The City of De Soto also used its website to spread information about the public meeting and to gather public feedback. Figure 4 is a clip of USACE's webpage and Figure 5 is a clip of the City of De Soto's webpage.

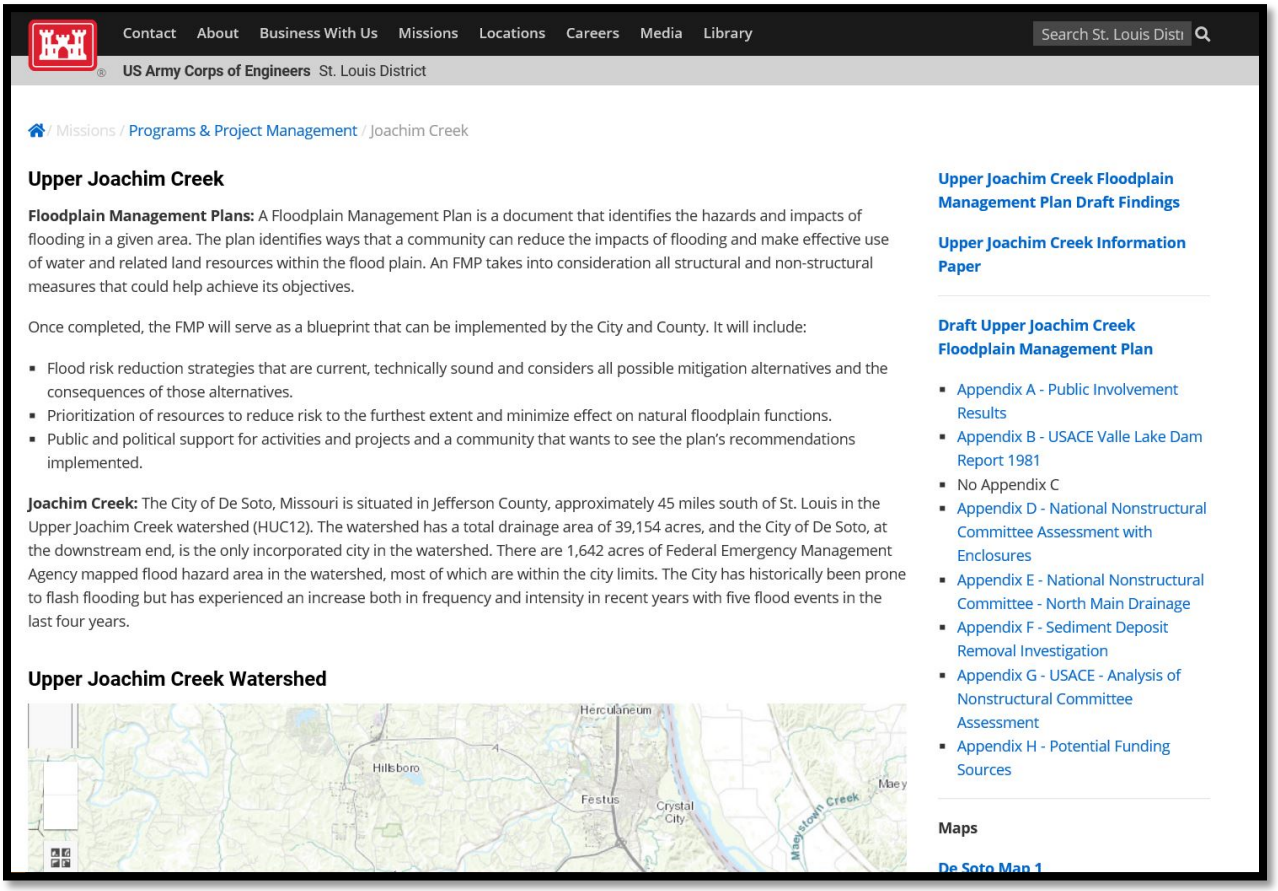

Figure 4. USACE's Public Webpage

Figure 5. City of De Soto's Public Webpage

The City of De Soto hosted an additional public meeting to present the Floodplain Management Plan to the public with recommendations. USACE gave the presentation, and partners were in attendance to communicate with the public. News media and congressional representatives were also in attendance. The objective of the meeting was to share the findings of the FMP, to educate the public on the Action Plan, and to gather any additional feedback from the public before finalizing the FMP.

2.5 Partner Coordination and Communication

There has been significant and continuous coordination and communication between the various partners throughout the development of the Upper Joachim Creek Floodplain Management Plan. The list of official Partners can be found in Table 5.

Table 5. Upper Joachim Creek FMP Partners

Federal	State	Local	Non-Governmental
U.S. Army Corps of Engineers (USACE)	Missouri State Emergency Management Agency (SEMA)	City of De Soto, Missouri	Citizens' Committee for Flood Relief
U.S. Geological Survey (USGS)	Missouri Department of Transportation (MoDOT)	Jefferson County, Missouri	East-West Gateway Council of Governments (EWG)
Federal Emergency Management Agency – Region VII (FEMA)	Missouri Department of Natural Resources (MoDNR)		Thriving Earth Exchange, American Geophysical Union (TEX-AGU)
Congressional Staff	Legislative Staff		Public

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Several partner meetings took place in-person, via webinar, phone, and email. Table 6 is a list of the formal partner meetings.

Table 6. Coordination Meetings

Meeting #	Meeting Name	Date	Communication Medium	Partners Involved
1.	Kick-Off Meeting	January 24, 2018	In-Person (De Soto City Hall)	All
2.	Public Workshop	February 28, 2018	In-Person (De Soto Community Center)	All
3.	Partner Update Meeting	July 11, 2018	In-Person (De Soto City Hall)	All
4.	Pre-Nonstructural Meeting	August 15, 2018	Webinar	USACE National Nonstructural Committee
5.	Nonstructural Assessments	August 27-30, 2018	In-Person (De Soto, Missouri)	USACE National Nonstructural Committee
6.	Goals & Objectives Setting Call #1	August 21, 2018	Teleconference	USACE, De Soto, Jefferson County
7.	Goals & Objectives Setting Call #2	September 7, 2018	Teleconference	USACE, De Soto, Jefferson County
8.	De Soto Site Visit	September 26, 2018	In-Person (De Soto, Missouri)	USACE, Citizens' Committee for Flood Relief
9.	Goals and Objectives Finalization Meeting	October 25, 2018	In-Person (De Soto City Hall)	USACE, De Soto (Todd Melkus)
10.	Partner Update Call	February 27, 2019	Teleconference	All
11.	Presentation of Draft Report to Partners	May 9, 2019	Webinar	All
12.	Presentation of Findings to the Public	June 20, 2019	In-Person (De Soto High School)	All

3 Future Conditions

3.1 Land Use and Population

The state hazard mitigation plan anticipates the largest population growth in the region will be in Jefferson and St. Charles Counties over the next 30 years; however, the plan anticipates most of that growth to be in the northeast portion of the County near I-55. Based on this information, this study assumes that no substantial growth will occur in the Upper Joachim Creek watershed in the near future. Development plays a critical role in the amount and timing of runoff which can impact flood heights and velocities.

3.2 Climate Change

Climate change, as it relates to extreme precipitation events, has been the focus of numerous studies in recent years. Figure 6 shows percent change based on linear trends in annual precipitation, 1895-2009, shown as a percent change per century. The Upper Joachim Creek watershed is included in the dark green category which shows an increase in annual precipitation of 5%-10%, change per century.

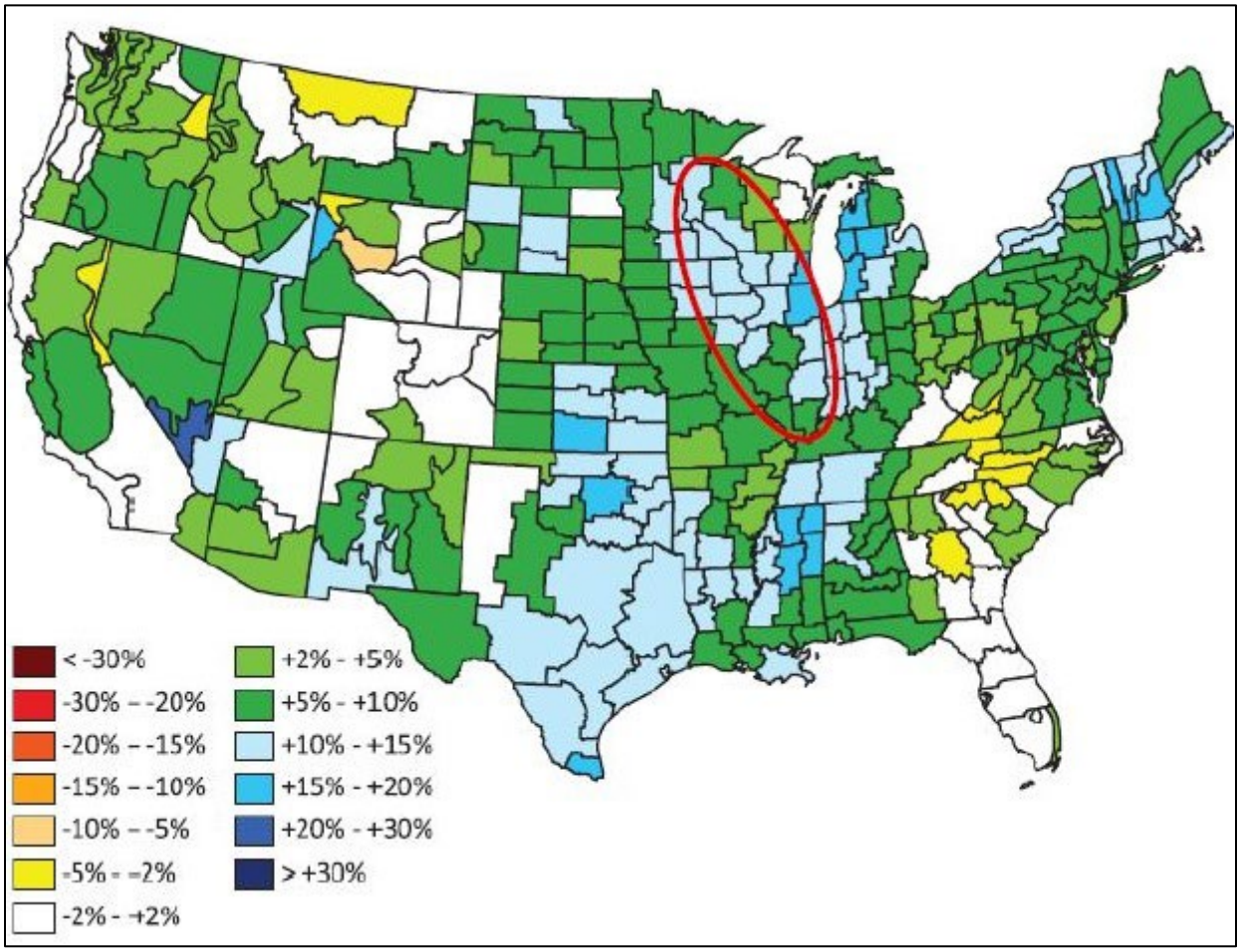

Figure 6: Linear trends in annual precipitation, 1895-2009, percent change per century. The red oval indicates the Upper Mississippi River Region (McRoberts and Nielsen-Gammon, 2011)

Figure 7, comes from the U.S. Army Corps of Engineers (USACE) Institute for Water Resources publication titled "Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions - Upper Mississippi Region 07", published in June 2015. The figure shows the observed and projected trends and literature consensus for environmental factors such as temperature, precipitation and hydrology/streamflow. Observations have shown a large increase in precipitation, while a small increase is projected for the future. When it comes to extreme precipitation, trends have shown a small increase, which is also projected for the future. The observed and projected trends indicate increased average and extreme precipitation and a variable trend in hydrology and streamflow.

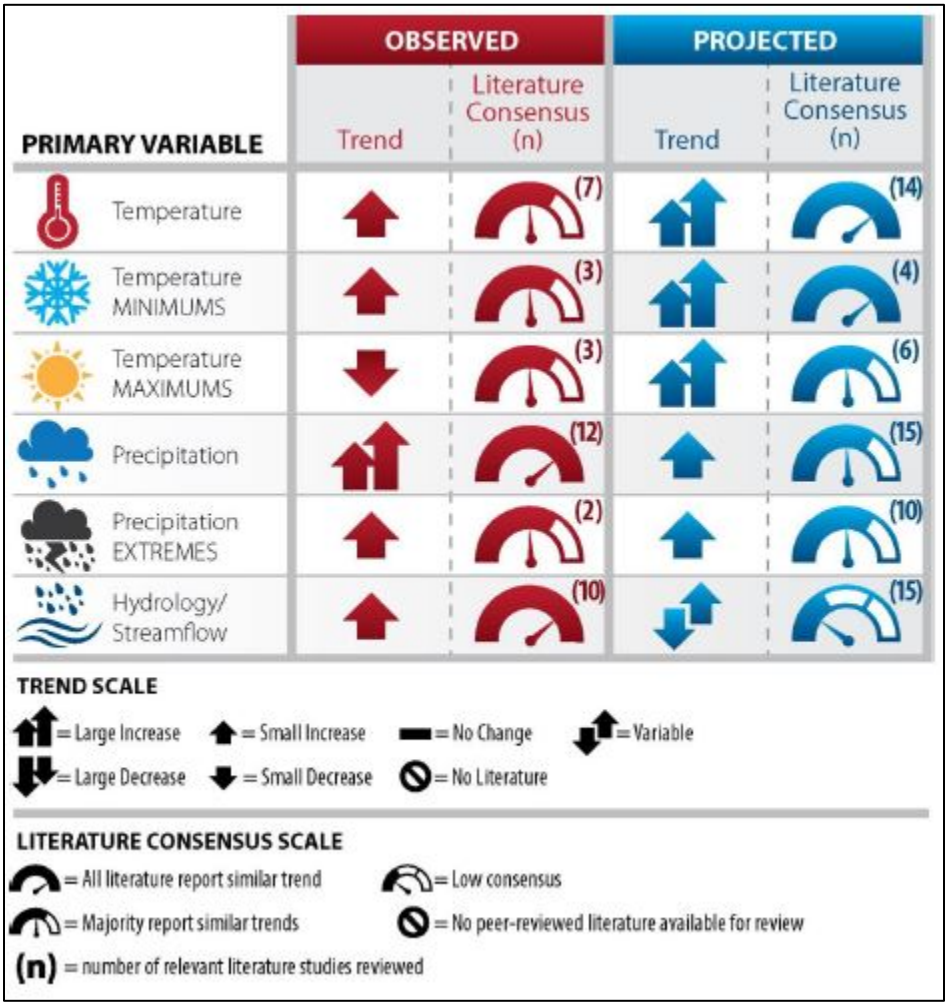

Figure 7: Summary matrix of observed and projected climate trends and literary consensus (USACE Institute for Water Resources)

This study considered the potential flood extent of a hypothetical 10% increase to 1-percent ACE flow, to determine potential future flood conditions. FEMA's calibrated HEC-RAS model and 1-percent ACE flow (used to develop 2019 FIS) were used for this effort.

For hypothetical purposes, "Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions - Upper Mississippi Region 07", published in June 2015, was used, as the report noted 5-10% increase in annual precipitation, percent change per century. For the purpose of this FMP, this annual precipitation increase was directly related to 10% increase in flows (runoff). Note, this is a hypothetical assumption and 10% increase in precipitation does not directly relate to 10% increase in flows.

Assuming a 10% increase to FEMA's 2019 FIS 100-year flow, the average depth of flooding in a majority of the City of De Soto was increased by approximately 1 foot. These potential future increases in flooded footprint and depth are presented for consideration only and are not utilized in any of the FMP's other analyses or recommendations. Figure 8 demonstrates the flood footprint of the City of De Soto with an estimated 10% increase in flows, which shows wider and/or deeper flooding levels in some areas.

Figure 9 demonstrates the change in depths (in feet) with the City of De Soto specifically outlined in black.

If trends and literature studies are accurate, the watershed will see increased precipitation in the coming decades, likely worsening the flooding conditions. The structures will continue to regularly flood and annual damages will continue to put a strain on the City and County residents and businesses. In addition to the economic damages, there will continue to be a risk to the health and safety of De Soto and Jefferson County residents.

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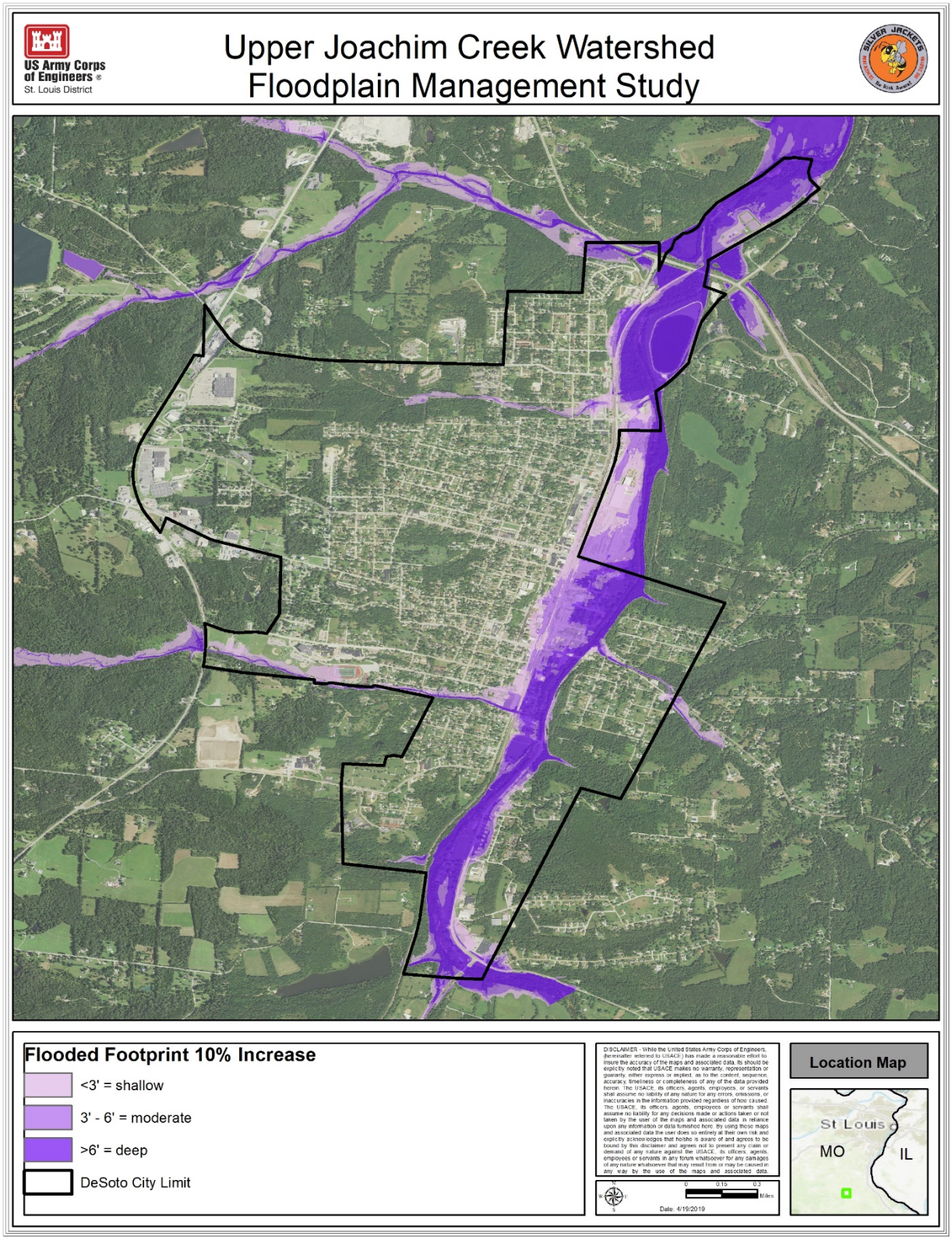


Figure 8. Flooded footprint in the City of De Soto with a 10% increase in flows when compared to the 2018/2019 FEMA FIS flows

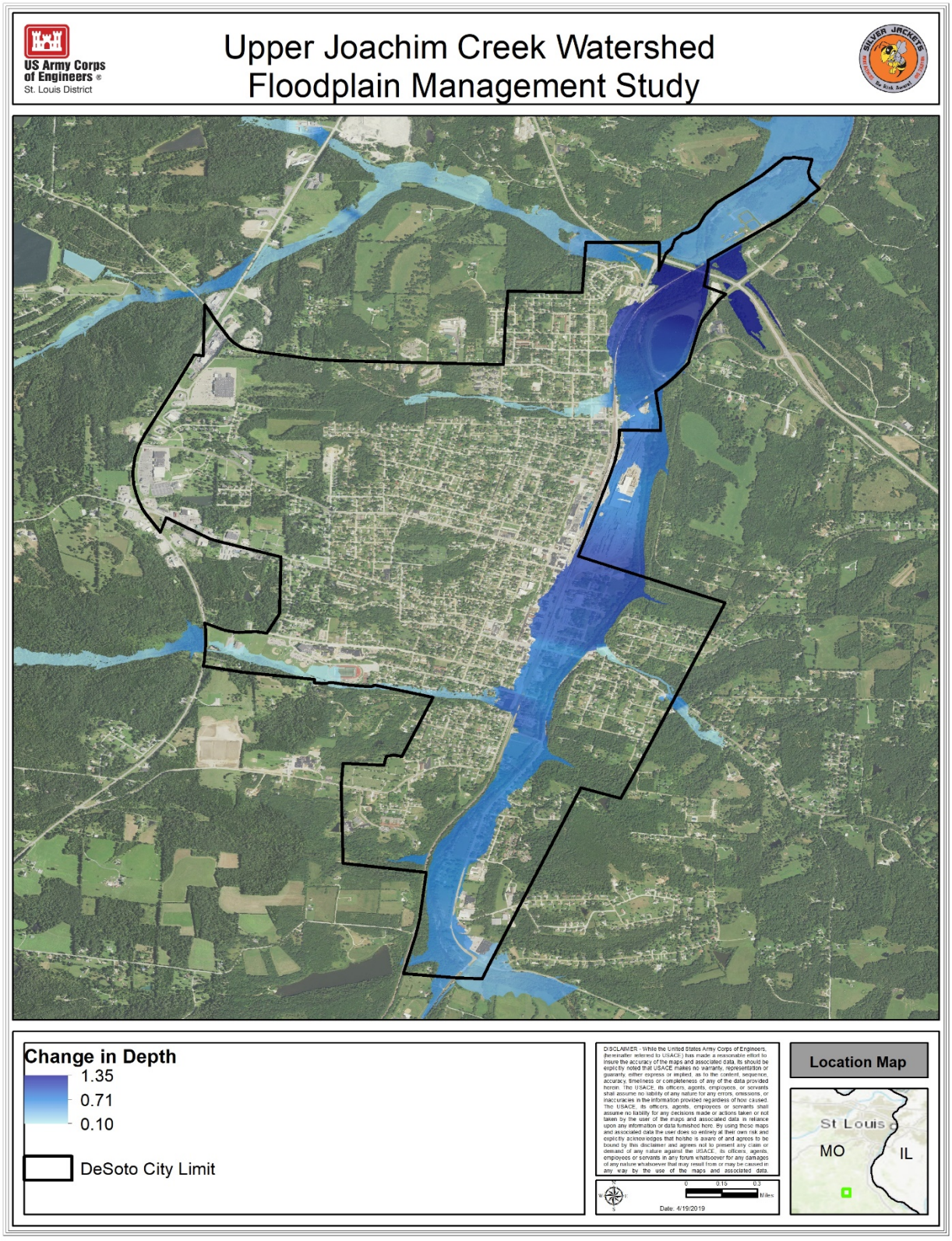


Figure 9. Change in depth of flooding in the City of De Soto with a 10% increase in flows when compared to the 2018-2019 FEMA FIS flows

4 Floodplain Hazard Assessment

Flooding is defined by the rising and overflowing of a body of water onto normally dry land. As defined by FEMA, a flood is a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties. Flooding can result from an overflow of inland waters or an unusual accumulation or runoff of surface waters from any source.

Certain health hazards are also common to flood events. While such problems are often not reported, three general types of health hazards accompany floods. The first comes from the water itself. Floodwaters carry anything that was on the ground that the upstream runoff picked up, including dirt, oil, animal waste, and lawn, farm and industrial chemicals. Pastures and areas where farm animals are kept or their wastes are stored can contribute polluted waters to the receiving streams.

Floodwaters also saturate the ground, which leads to infiltration into sanitary sewer lines. When wastewater treatment plants are flooded, there is nowhere for the sewage to flow. Infiltration and lack of treatment can lead to overloaded sewer lines that can back up into low-lying areas and homes. Even when it is diluted by flood waters, raw sewage can be a breeding ground for bacteria such as e.coli and other disease causing agents.

The second type of health problem arises after most of the water has gone. Stagnant pools can become breeding grounds for mosquitoes, and wet areas of a building that have not been properly cleaned breed mold and mildew. A building that is not thoroughly cleaned becomes a health hazard, especially for small children and the elderly.

Another health hazard occurs when heating ducts in a forced air system are not properly cleaned after inundation. When the furnace or air conditioner is turned on, the sediments left in the ducts are circulated throughout the building and breathed in by the occupants. If the local water system loses pressure, a boil order may be issued to protect people and animals from contaminated water.

The third problem is the long-term psychological impact of having been through a flood and seeing one's home damaged and personal belongings destroyed. The cost and labor needed to repair a flood-damaged home puts a severe strain on people, especially the unprepared and uninsured. There is also a long-term problem for those who know that their homes can be flooded again. The resulting stress on floodplain residents takes its toll in the form of aggravated physical and mental health problems.

4.1 FEMA Flood Insurance Study

The largest source of flood hazard information in the Upper Joachim Creek watershed comes from FEMA products such as Flood Insurance Studies (FIS) and Flood Insurance Rate Maps (FIRMs). FEMA conducted a Flood Insurance Study for Jefferson County in April 5, 2006 and recently completed a county-wide update with maps effective 20 June 2019. The data acquired from the FIS and FIRMs informed this FMP. This FMP includes both the previous information (floodplain as of 2006) and the effective (2019 floodplain footprint) updates for the watershed. Figures 10 and 11 (below) show the previous and effective Flood Insurance Rate Maps (FIRMs) in the Upper Joachim Creek Watershed and the City of De Soto, respectively. Figures 12 and 13 (also below) show flood water velocities and depths (respectively) in the Joachim Watershed during a 1-percent ACE event. The city limits of De Soto are outlined in black.

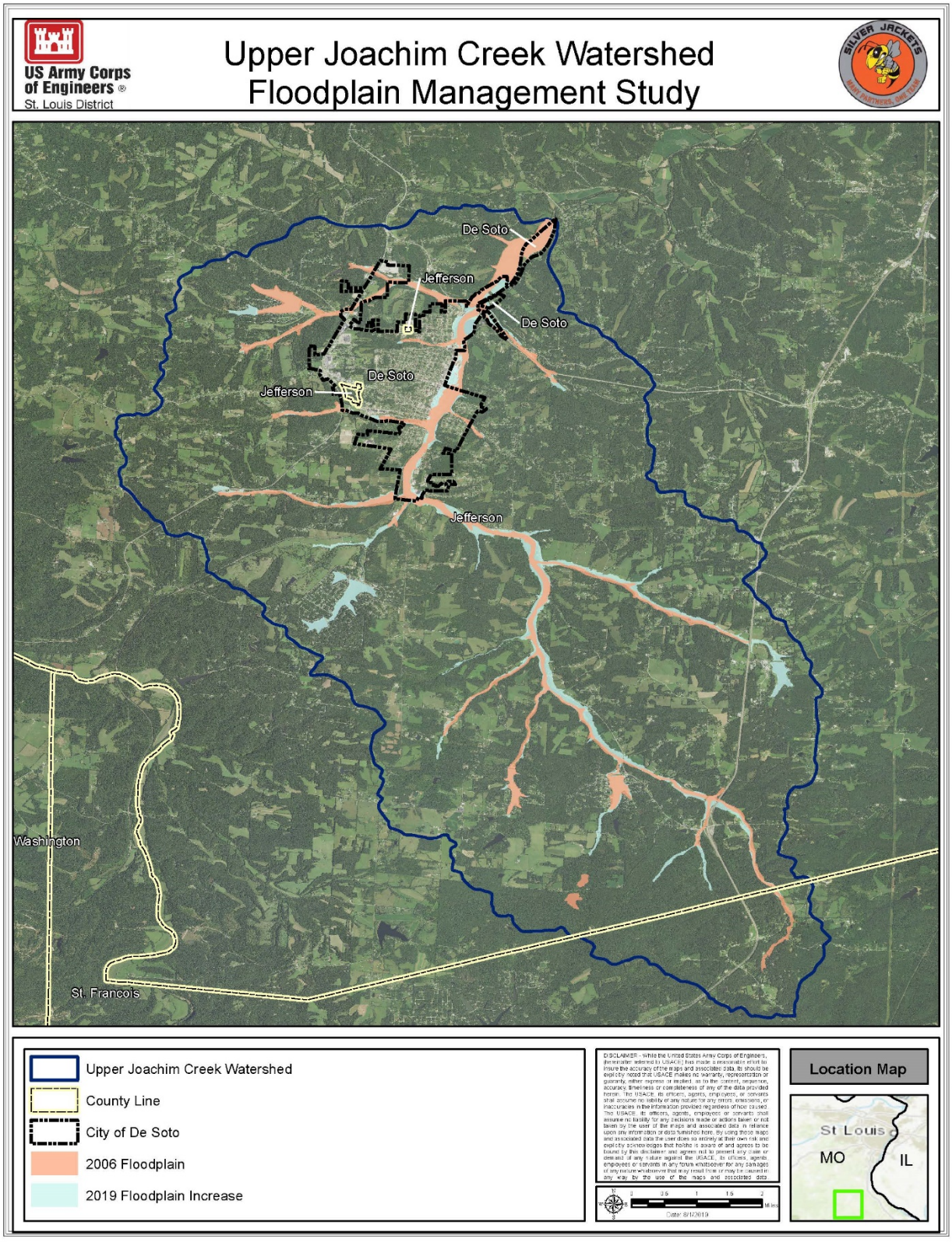


Figure 10. Upper Joachim Creek Watershed Flood Insurance Rate Map (FIRM)

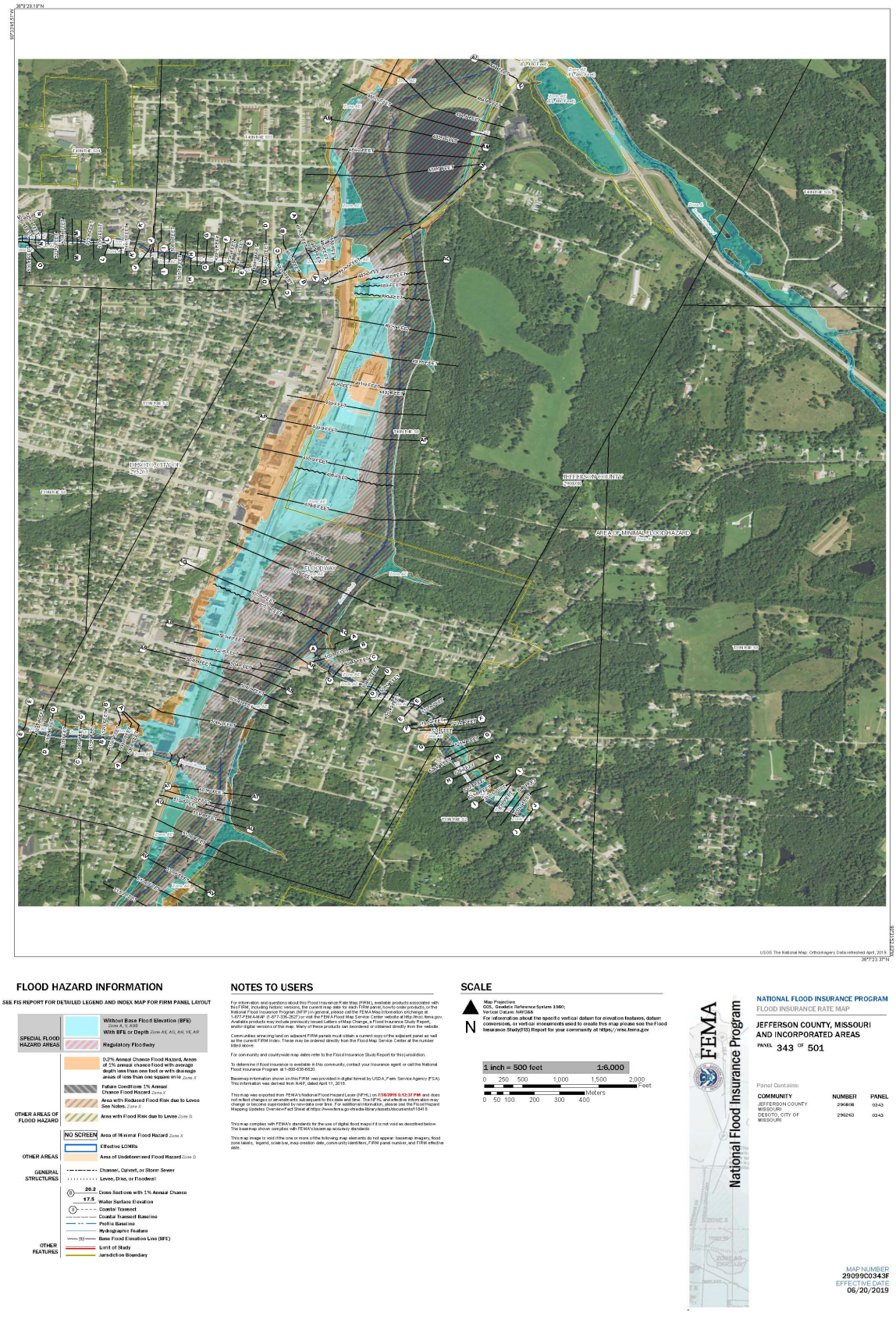


Figure 11. De Soto, Missouri Flood Insurance Rate Map (FIRM)

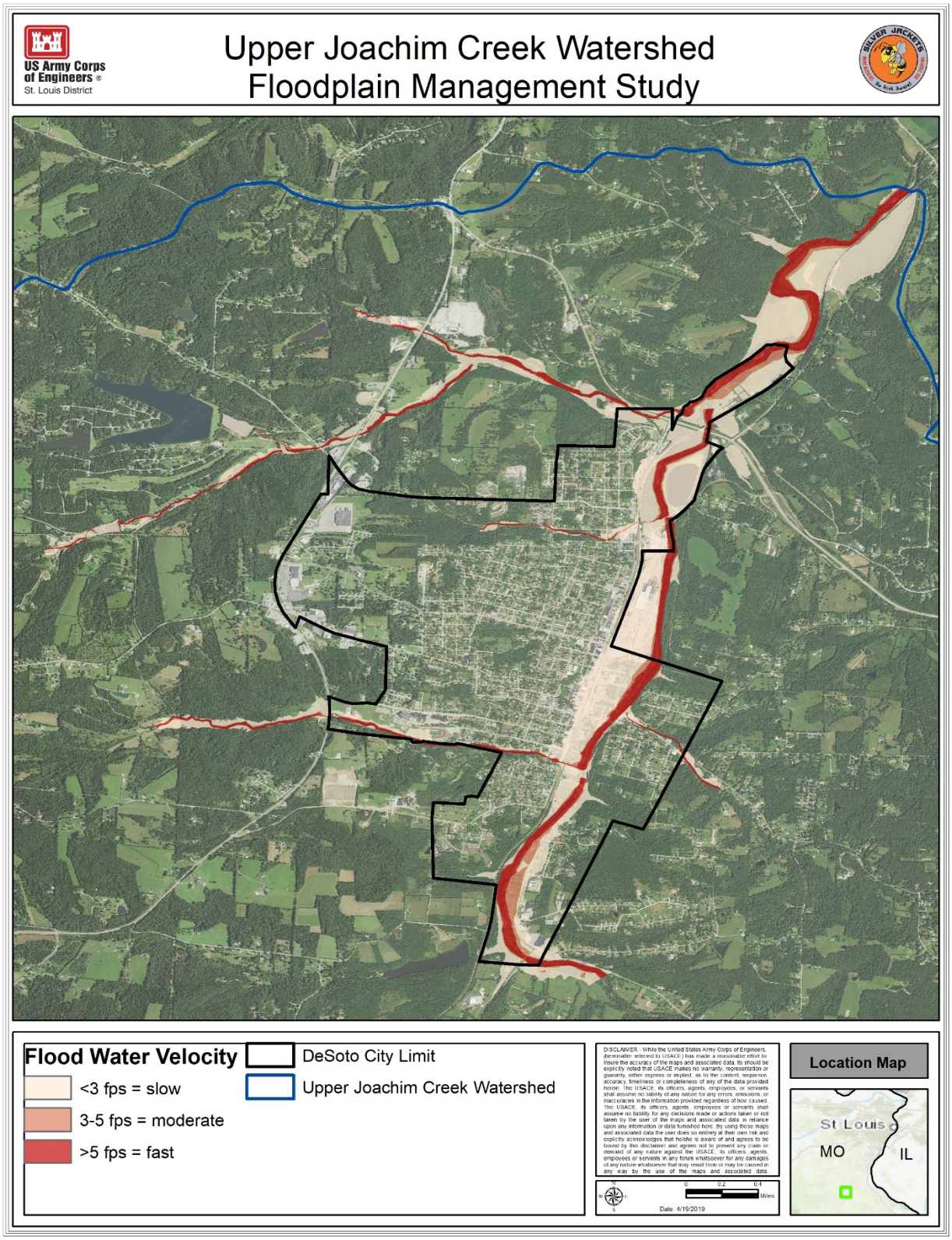


Figure 12. City of De Soto, Missouri: Joachim Creek Flood Water Velocities (1-percent ACE event)

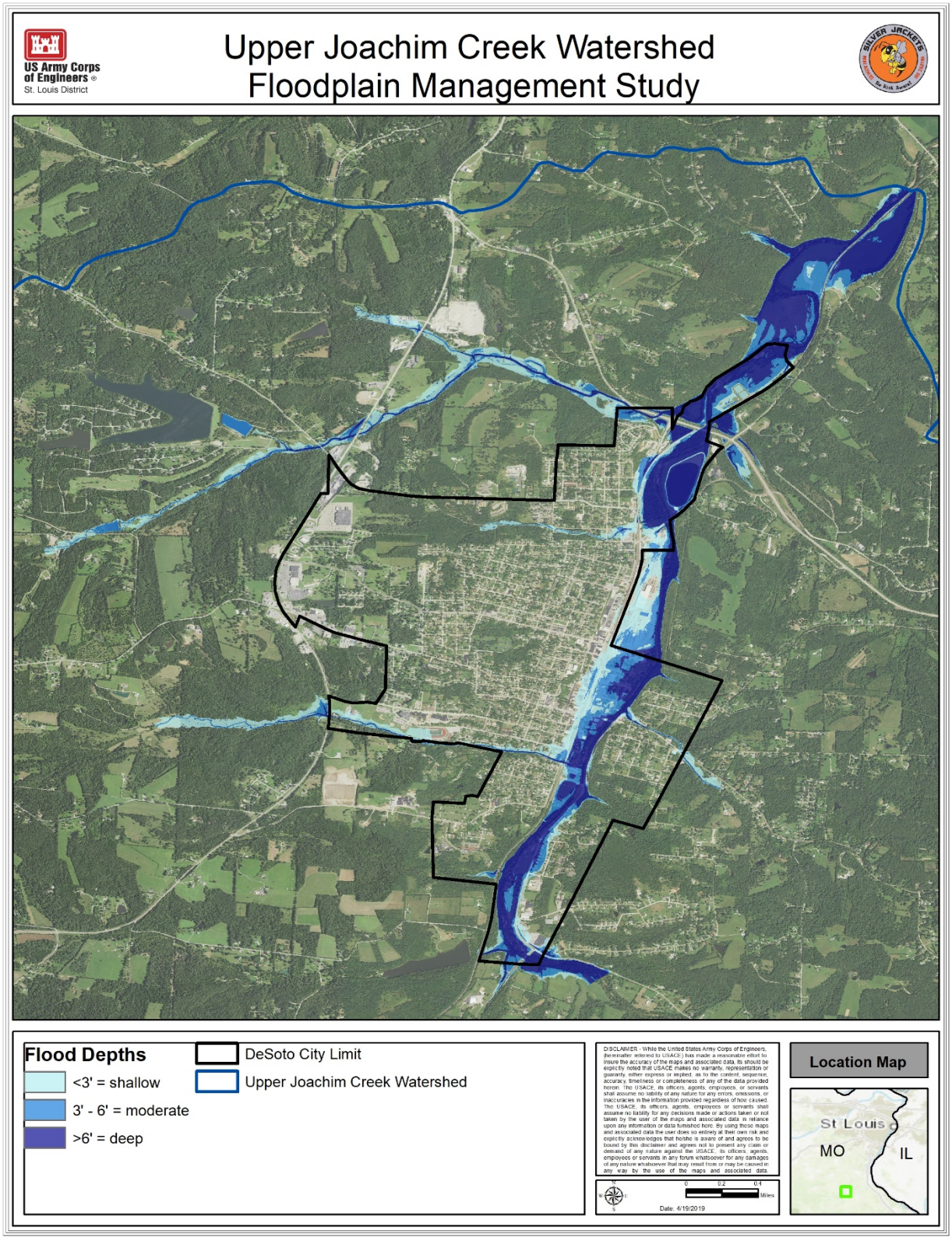


Figure 13. City of De Soto, Missouri: Joachim Creek Flood Water Depths (1-percent ACE event)

4.2 East-West Gateway Hazard Mitigation Plan

Jefferson County falls under the St. Louis Regional Hazard Mitigation Plan (HMP), which was originally developed by the East-West Gateway Council of Governments (East-West Gateway) in 2004. The HMP was developed with funding from Missouri's State Emergency Management Agency (SEMA) and is revised every 5 years. The current plan is in effect for 2015-2020 and covers the Missouri portion of the St. Louis region, including St. Louis City, Franklin, Jefferson, St. Charles and St. Louis Counties, 135 municipalities and 50 school districts. The purpose of the HMP according to East-West Gateway's website is to "present information about natural disasters, levels of risk, and strategies for local governments and school districts to take to reduce the adverse effects of natural disasters including tornadoes, severe thunderstorms, severe winter or summer weather, drought, flood, earthquake, dam failure, or wild fire".

The HMP identifies that a significant portion of the county is subject to flooding and that the overall risk of flooding is high. The HMP further identifies in Section B that the risk assessment and vulnerability analysis for De Soto lists the community as a high flood risk and a medium risk for dams in the watershed. Vulnerability is based on exposure to hazards, socio-economic information, location of community or school district, repetitive loss claims and hazard event history. The primary flood mitigation programs in Jefferson County are floodplain management regulations and participation in and administration of the National Flood Insurance Program (NFIP). Additional programs identified in the County include the following:

- The County's floodplain regulations are aimed at restricting any new development in the floodplain. The current ordinance requires three feet of additional freeboard for new structures and requires an increase, if necessary, to that elevation when structures are significantly reconstructed within the floodplain. Minimum elevation is one foot above for structures in the identified regional floodplains. See Section 7.1.1 for additional information on land use policies and regulations.

- The County has participated in floodplain property acquisition, funded through FEMA's Hazard Mitigation Program.

- Stormwater management and sedimentation and erosion control standards that comply with Phase II Federal Stormwater Regulations were implemented in 2004.

- Development is prohibited in identified floodways through floodplain regulations.

- The County is able to receive National Weather Service warnings and disseminate those warning to emergency responders, key executive officials and the public.

4.3 Jefferson County Floodplain Management

The County's floodplain regulations aim at managing and/or restricting floodplain development by requiring three feet of freeboard above FEMAs 1-percent base flood elevation for new structures as well as prohibiting development in identified floodways where an increase in flood heights of more than one (1) foot would occur at any point.

For emergency notifications, many municipalities (not including the City of De Soto) within the County have sirens that are radio-activated to provide National Weather Service (NWS) warnings. Jefferson County 911 dispatch also has a CodeRed warning system, which automatically calls everyone in the

affected area if they have signed up with CodeRed. In addition to NWS emergency notifications, CodeRed can be used for other emergencies as well.

In the event of an emergency, the County also has a variety of authorities it can exercise to assist with disasters and to bring order in a timely manner. These authorities include:

- Order an evacuation
- Redirecting funds for emergency use
- Ordering a curfew
- Authorize lines of succession to carry out emergency activities
- Safeguard records to conduct emergency operations
- Commandeering facilities, equipment and materials

In addition to these authorities, the County has a system to safeguard vital records, has developed an all-hazards vulnerabilities analysis, has a multi-hazard emergency operations plan and mutual aid compacts with other jurisdictions and the county's Emergency Operations Plan (EOP) addresses the protection of people with special needs. Of the hazards that the residents and businesses of Jefferson County are exposed to, riverine and flash flooding hazards are most frequently seen with the greatest potential magnitude in loss of lives and property.

4.4 FEMA Hazard Mitigation Program

The Missouri State Emergency Management Agency (SEMA) and FEMA keep track of properties that have been acquired due to repeated flooding as well as those that are considered "repetitive loss" properties. FEMA defines a repetitive loss property as "any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program within any rolling 10-year period since 1978".

There are 9 properties in the Upper Joachim Creek Watershed that are designated as repetitive loss structures, 8 of which are within the De Soto city limits, and no parcels in the watershed have been acquired under FEMA's Hazard Mitigation Grant Program (HMGP). Jefferson County has participated in floodplain property acquisition through FEMA's Hazard Mitigation Program, though not within in the Upper Joachim Creek watershed.

In addition to information found in media reports, USACE solicited public input for flood prone areas during a public meeting held on February 28, 2018. The results of that input are shown below, in Figure 14. Some of these flood prone areas are within a special flood hazard area, which is an area where the National Flood Insurance Program's (NFIP's) floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies.

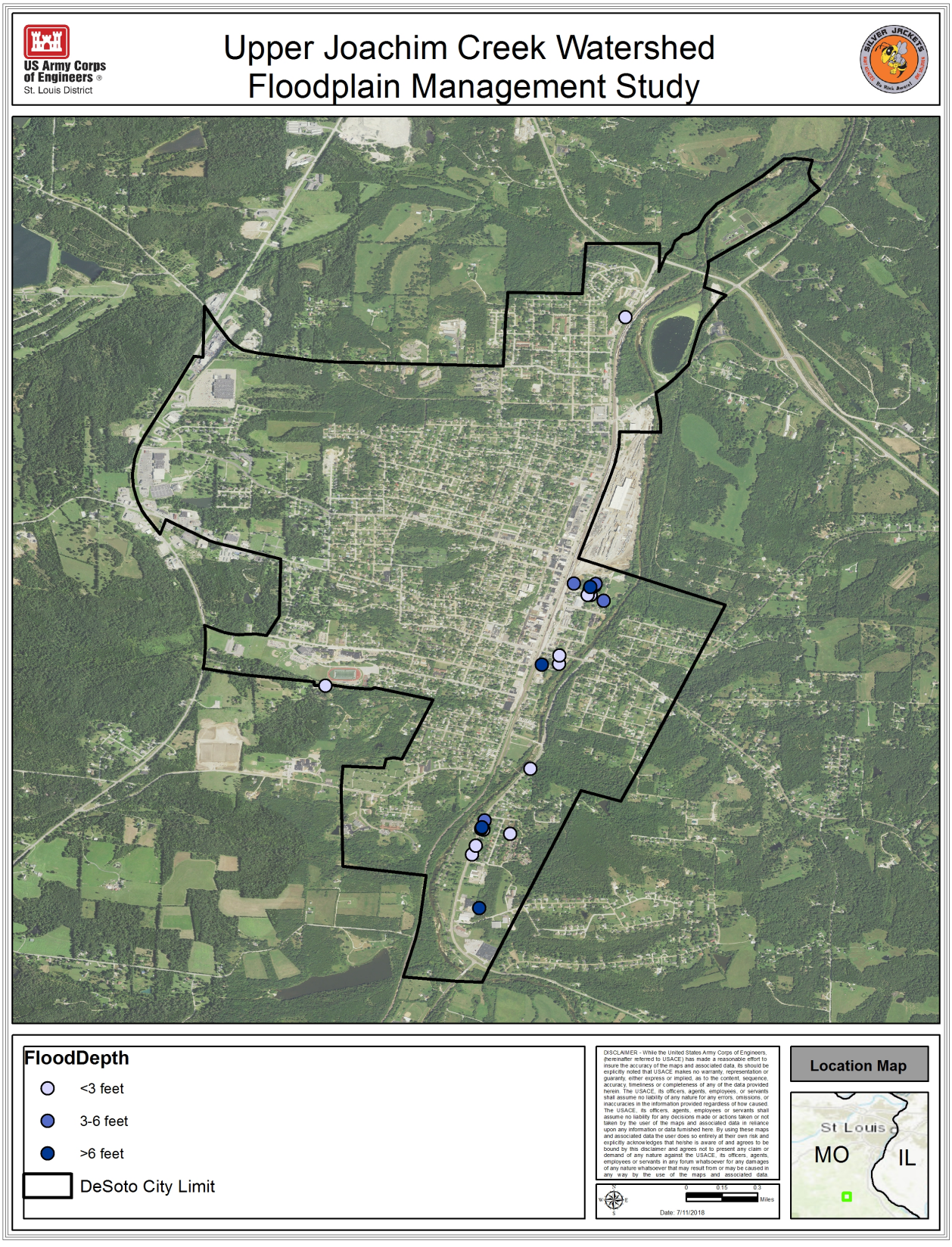


Figure 14. Flood prone areas as identified by the public at February 28, 2018 public meeting held in De Soto

4.5 Joachim Creek Watershed

There are no known levees within the Upper Joachim Creek Watershed; however, there are 19 dams in the watershed (Table 7), 15 of which are upstream of the City of De Soto. These dams were mostly constructed in the 1950s through the 1970s with one outlier built in the early 1990s.

One of the missions of the Missouri Department of Natural Resources -Water Resources Center is to ensure that dams in the state are constructed, maintained and operated in a safe manner through its Dam and Reservoir Safety Program. This Program is accomplished by regulation (10 CSR 22-1.020 (13)) of all non-agricultural, non-federal dams 35 feet or more in height and by providing technical assistance and informational resources to all dam owners.

Table 7. Inventory of Dams in the Upper Joachim Creek Watershed

Dam Name	NID ID (MO)	River	Year Completed	State Regulated Dam
Clear Lake Dam	3043	Tributary to Joachim Creek	1961	No
Dierberg Lake Dam	3044	Tributary to McMullen Branch	1968	No
Fisherman's Lake Dam	3103	Tributary to Ball Branch	1970	No
Kearbey Dam	3197	Tributary to Fletcher Branch	1991	No
Lake Briarwood Dam	3040	Ball Branch	1970	Yes
Lembeck Lake Dam	3036	Whitehead Creek	1958	No
Little Lake Dam	3045	Tributary to Joachim Creek	1961	No
Lower Valle Mines Dam	3043	Tributary to Joachim Creek	1952	No
Lucas Lake Dam	3045	Tributary to Joachim Creek	1960	No
Rustic Hills Resort Lake Dam	3045	Tributary to Joachim Creek	1957	No
Siesta Lake Dam	3119	Tributary to Fitz Creek	1957	No
Spring Lake Dam	3119	Tributary to Falling Rock Branch	1976	No
Spring Lake Dam (2)	3040	Tributary to Ball Branch	1970	No
Summer Set Lake Dam	3045	Falling Rock Branch	1974	Yes
Sunrise Big Lake Dam	3045	Tributary to Joachim Creek	1961	Yes
Sunrise Lake Upper Dam	3119	Tributary to Joachim Creek	1961	Yes
Upper Valle Mines Dam	3037	Tributary to Joachim Creek	1958	No
Valle Lake Dam	3043	Tributary to Joachim Creek	1955	Yes
Winter Haven Lake Dam	3119	Falling Rock Branch	1978	Yes

Figure 15 shows the location of dams in the watershed as identified by the National Inventory of Dams (NID). They are all classified as high hazard dams, due to a probable loss of human life if the dam fails or is operated inappropriately. They are all privately owned and range in height from 20 to 59 feet.

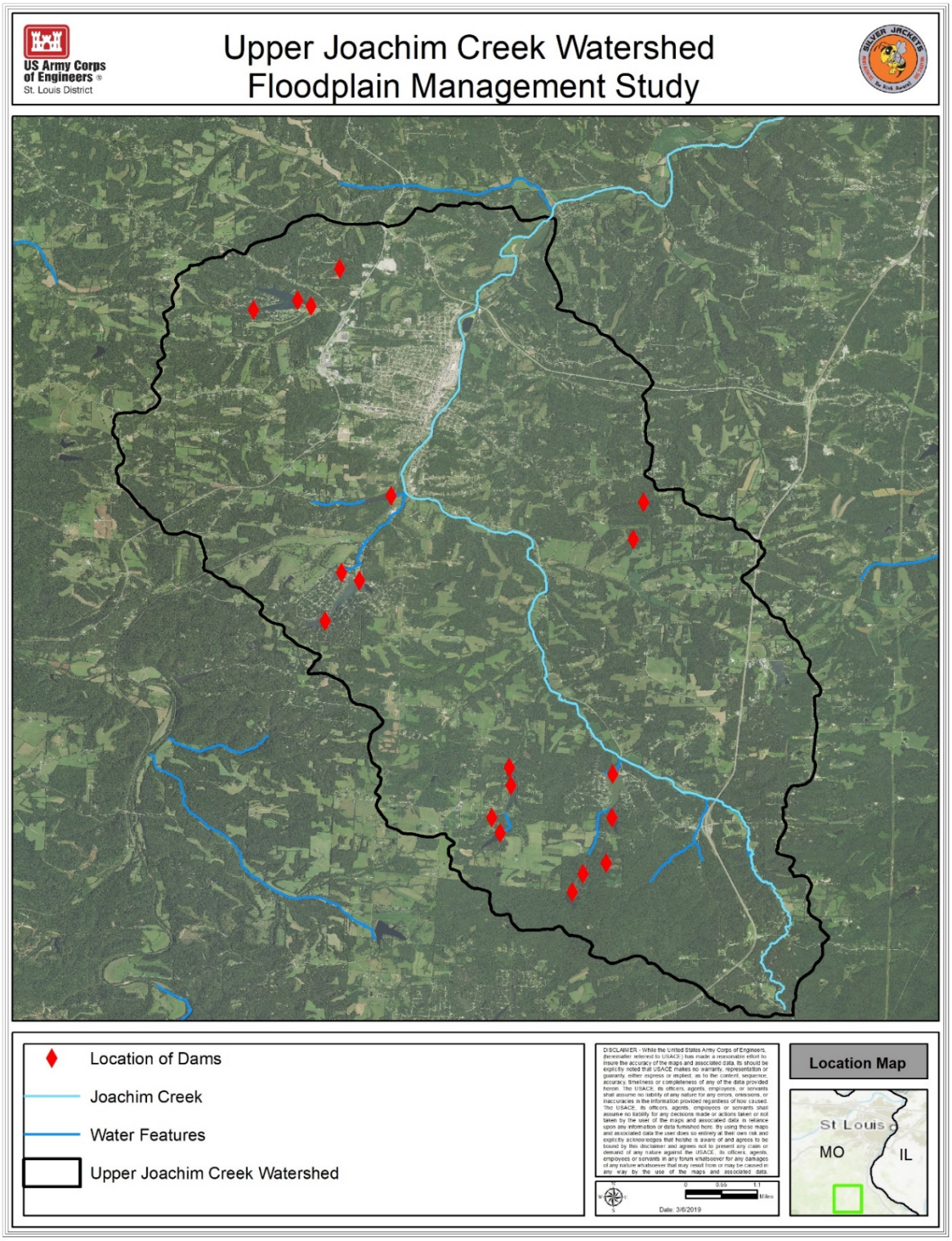


Figure 15. Location of dams in the Upper Joachim Creek Watershed

Valle Lake Dam is 39 feet tall and is identified as a State Regulated Dam (Permit Number R-381) and has a hazard class 2. Hazard class 2 dams are considered by the State to be significant risk structures based on downstream consequences of the dam should it fail. By State regulation Missouri dam owners are required to complete and have an emergency action plan that is coordinated between the MDNR - Dam

and Reservoir Safety Program, County Emergency Management Director and other state and federal agencies.

In 1981, the USACE St. Louis District performed a field inspection and evaluation of the Valle Lake Dam, one of the largest lakes which drains into Joachim Creek because it was identified as a concern by De Soto residents. The 1981 report determined that the combined capacity of the spillways will not pass 50% of the Probable Maximum Flood without overtopping the dam. This means the dam has limited flood storage function and is susceptible to overtopping during heavy precipitation events. The USACE's 1981 Valle Lake Dam Report is attached as Appendix B.

Figure 16 contains photographs of Valle Lake Dam and Spillway taken in August of 2018 during a USACE site visit.

Figure 16. Valle Lake Dam and Spillway Photos, 2018

Other flood related special hazards in the watershed include the potential for landslides, liquefaction and collapse. These hazards were assessed by the Missouri Department of Natural Resources, but they have not been included in this Floodplain Management Plan as they are not floodplain-related.

In addition to the previously discussed hazards, there are also critical facilities within the watershed that are vulnerable to flooding, potentially causing life-safety issues if inundated with flood water. One such facility is the De Soto Rural fire station in De Soto, which was inundated during several flood events and prevented emergency personnel from performing their duties. Due to security issues, the exact location of these facilities are not included in the report, but the number of each type of facility located within the watershed and within 500 feet of the 1-percent ACE floodplain is included in Table 8 below (EPA Facility Registry, 2012).

Table 8. Critical and Hazardous Facilities in the Upper Joachim Creek Watershed

Facility Type	Upper Joachim Creek Watershed Totals	Within 500 feet of a mapped floodplain in the Upper Joachim Creek Watershed
Chemical industry	1	0
EPA FRS Facility[1]	25	7
Cellular Towers	2	0
Day care centers	3	0
Schools (K-12)	1	0
Emergency Medical Services	5	2
Law enforcement	1	1
Cemeteries & crematories	4	3
Nursing homes	3	0
Pharmacies	4	1
Veterinarian	3	1
Wastewater treatment plant	1	1

[1]EPA Facility Registry Service (FRS) Facility identifies facilities, sites or places subject to environmental regulations or environmental interests.

5 Consequence Assessment

5.1 Consequence Elevation Analysis

Figure 17 below shows a topography map of the Upper Joachim Creek Watershed and relies on Light Detection and Ranging (LiDAR) data. LiDAR data displays the ground surface elevation across a spatial map and is a critical assumption of the consequence assessment. It shows 3-meter resolution LiDAR data for the City of De Soto. The floodplain with the lowest elevation is in green. The areas with the highest elevation are shown red and orange.

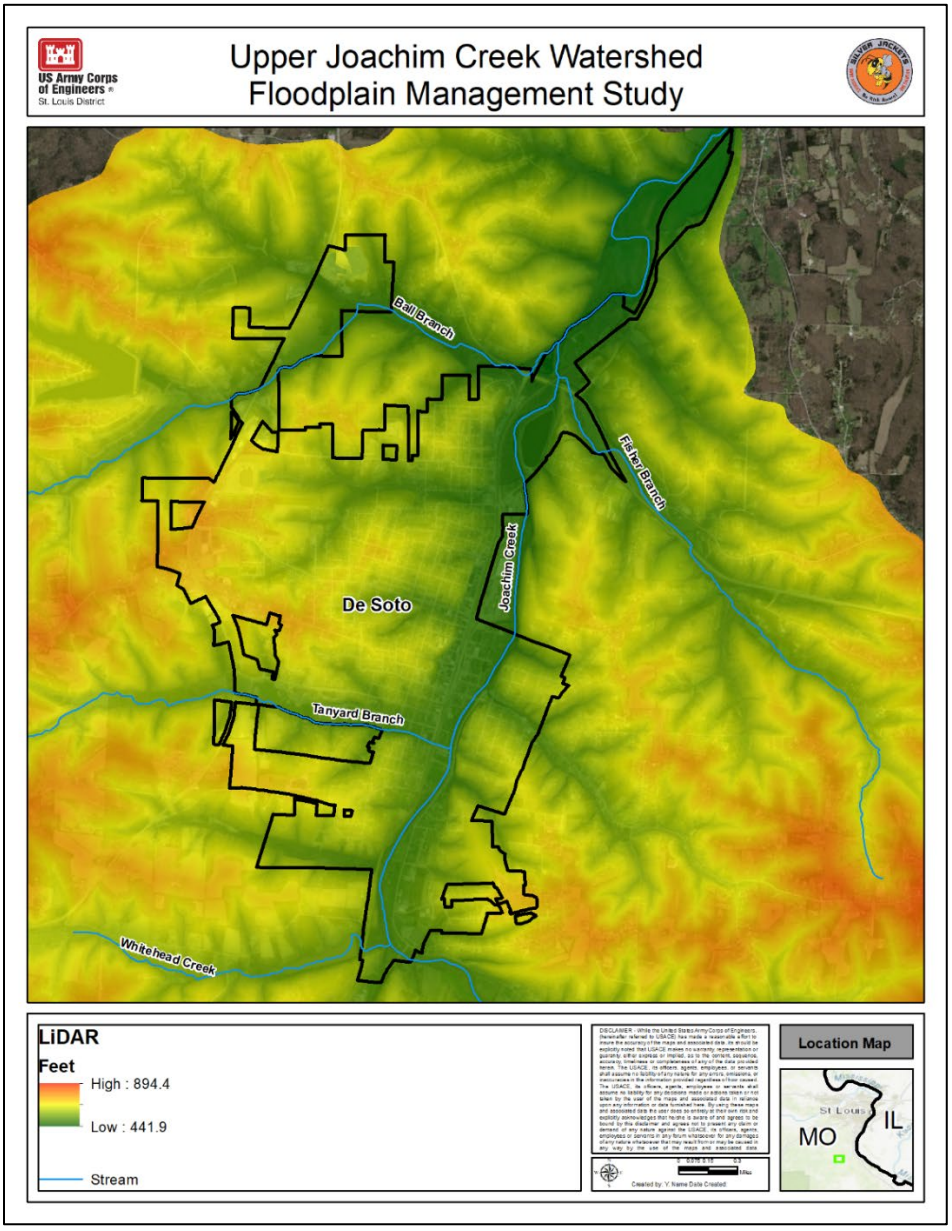


Figure 17. De Soto LiDAR Ground Surface Elevation Map

There are three primary ways to measure flood susceptibility in structures:

1) First Floor Elevation
2) Beginning Damage Elevation
3) Depth of Flooding Relative to First Floor

For this study, structures' first floor elevations were not surveyed. Instead, first floor elevation was defined as the ground surface elevation plus the foundation height, which was estimated by utilizing a Google Street View windshield survey for each structure. This kind of survey consists of using existing street view software from applications such as Google or Bing to approximate the first floor elevation of a structure in lieu of an in-person, on-site survey. First floor elevation can be used to quickly identify structures that are more likely to be flood-prone, relative to neighboring structures. Additionally, the first floor elevation signifies where the majority of damages to contents and the building envelope, or the outer shell of a structure (walls, roof, etc.), begin. While first floor elevation measurements provide an assessment of the elevation at which significant damages will begin, they do not properly illustrate where water enters the building or the depths of flooding given a particular flood event.

Beginning damage elevation is defined as the lowest point at which water begins to enter the building and is dependent on the building's foundation type. Beginning damage elevation is measured as ground surface elevation plus any distance up to a basement window, crawl-space vent, or door or window leading into the structure. Beginning damage elevation improves on the first floor elevation statistic because it takes into account each of the different kinds of foundations that a structure could have.

Depth of flooding relative to the first floor is the most precise indicator of flood susceptibility and goes beyond the normal measure of first floor elevation by indicating how high flood depths are expected to rise on a structure for a given flood event. A depth of flooding measurement of two feet would indicate that a given flood event would be expected to flood the structure two feet above the first floor. A depth of flooding measurement of negative two feet would indicate that flooding is not anticipated to reach the first floor but instead could cause damage in a subfloor space such as the basement or crawlspace. Since the ground surface elevation changes spatially, the depth of flooding estimate provides the best overall characterization of flood susceptibility by being able to compare flood prone structures across a floodplain or even separate studies.

A table of summary statistics for each of the elevation categories is shown in Table 9. A detailed list of individual structure elevations can be found in Appendix G, the USACE Analysis of the National Nonstructural Committee Assessment. Within the De Soto city limits, 12% of the structures had basements, meaning damage may begin at elevations below the first floor due to sub-graded garage openings, basement windows, sewer backups or seepage through foundation cracks.

Table 9. De Soto Elevation Statistics (feet, NAVD)

	10-percent ACE	4-percent ACE	2-percent ACE	1-percent ACE	.2-percent ACE
Structure Count	49	128	202	229	332
Average Ground Surface Elevation	499.0	499.8	499.6	500.6	502.8
Average Foundation Height	2.6	2.1	1.8	1.7	1.5
Average First Floor Elevation	501.6	501.9	501.4	502.3	504.3
Average Beginning Damage Elevation	499.7	500.3	500.2	501.1	503.1

5.2 Consequence Flood Depths & Velocities

As previously described in Section 4, flood depths and velocities were estimated utilizing a riverine hydraulic model. Flood velocities for each structure were generated, but, given the dissipating effects of vegetation covering most banks in combination with slow rising rivers, concerns about structural integrity due to water velocity was not an issue for the average structure in the City of De Soto. Of the 332 structures, less than 10 experience velocities greater than three feet per second during the 1-percent ACE flood event. Flood velocities less than three feet per second are considered relatively slow by the U.S. Army Corps of Engineers National Nonstructural Committee and should only be mitigated if flood depths are the primary driver of damages.

Table 10 shows the average depths (relative to ground surface elevation) and velocities for each flood event in De Soto.

Table 10. De Soto Flood Depths & Velocities

	10-percent ACE	4-percent ACE	2-percent ACE	1-percent ACE	.2-percent ACE
Structure Count	49	128	202	229	332
Average Depth of Flooding (ft)	0.7	1.9	2.7	3.8	6.1
Average Velocity of Flooding (ft/sec)	1.0	1.2	1.3	1.5	1.6

Figure 18 provides a graphical representation of how flood depths for four flood frequency events are distributed among the structures in De Soto. It shows the frequency distribution for each of the events and illustrates that while most inundation is less than three feet during the 4-percent ACE and 2-percent ACE flood events, there are a considerable number of structures that receive flood depths greater than three feet during the 1-percent (1/100) ACE and .2-percent (1/500) ACE flood events, which limits recommended nonstructural mitigation approaches.

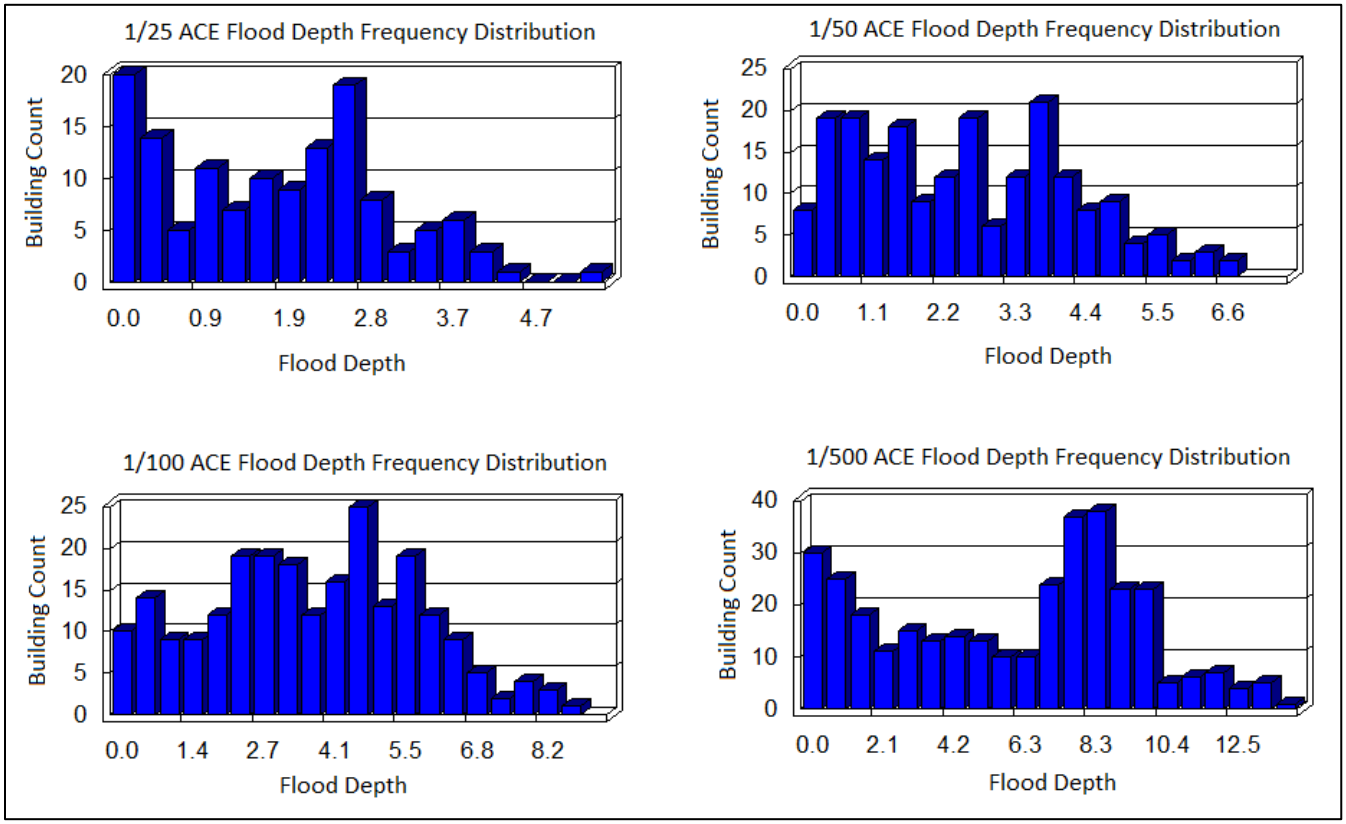


Figure 18. De Soto Flood Depth Frequency Distributions

Once each structure in the floodplain was assigned a flood elevation for each frequency, it was related to the first floor elevation to determine the depth of flooding relative to the first floor, as shown in Table 11. For example, during the 1-percent (1/100) ACE flood event, 105 structures have flood depths above three feet, 106 structures have flood depths between zero and three feet and 20 structures have flood depths less than zero feet (flooding below the first floor). Since flood waters can enter basements and crawlspaces, flooding below the first floor is still a significant consideration during the analysis to determine flood mitigation approaches.

Flood mitigation approaches are based on the statistics in Table 11 since the depths of flooding are now related to the first floor elevation. For structures with flooding that exceeds three feet, the mitigation approaches are expected to be limited to elevation, relocation, or acquisition due to hydrostatic pressures.

Table 11. De Soto First Floor Flood Depth Statistics

	10-percent ACE	4-percent ACE	2-percent ACE	1-percent ACE	.2-percent ACE
Flood Depths Above 3 Ft	0	3	30	105	225
Flood Depths Between 0 and 3 Ft	7	77	140	106	62
Flood Depths Below 0 Ft	42	55	32	20	45
Unaffected	283	197	130	101	0

Figure 19 shows the 1-percent (1/100) ACE depth of flooding in De Soto by structure. In the figure, structures not colored are not estimated to be flood-prone or may be vacant land. The majority of flood-prone buildings are located near the remapped floodway along Main Street, which is a known location for high inundation during flood events.

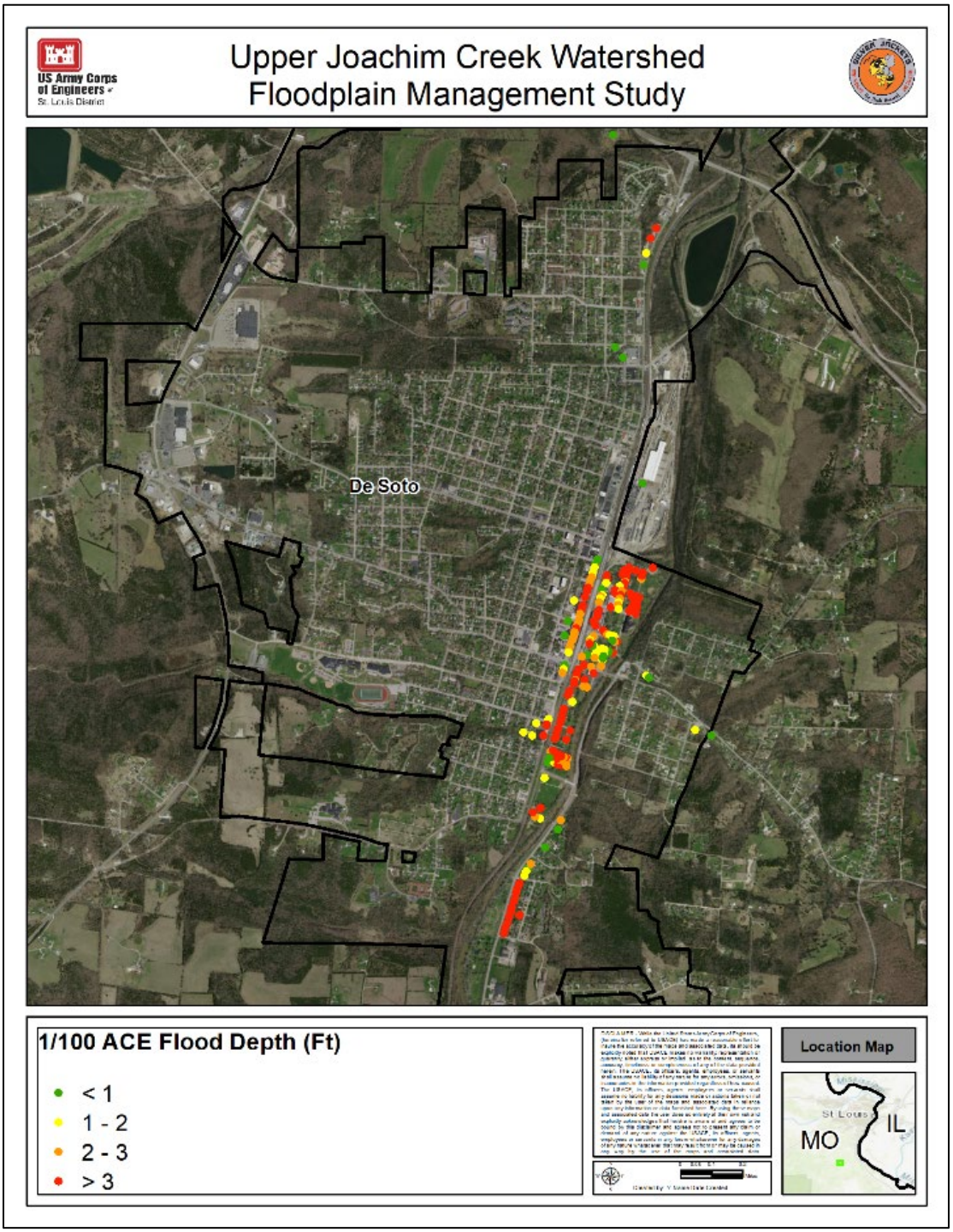


Figure 19. De Soto Depth of Flooding Relative to 1st Floor Elevation

5.3 Structure Valuation

The De Soto city limits encompass 332 flood-prone structures spread over 2,750 acres. A windshield survey in combination with Google Street View were utilized to view all flood-prone structures in De Soto. A windshield survey involves USACE staff driving to each structure in the inventory and recording structural attributes such as foundation type and foundation height. The accuracy of determining foundation types (slab, crawlspace, or basement) and foundation heights may vary due to building setbacks, large vegetation, or general inaccessibility. Structure square footage and the year the structure was built was gathered using Jefferson County Tax Assessor data. The assessor valuations provided by the county assessor's office were multiplied by three (per county assessor policy) to determine the appraised (market) value.

Figure 20 shows the distribution of structures by occupancy type, with close to 60% of the structures in the study area being either one or two-story residential (RES) buildings. The rest of the structures are either mobile homes (37%), apartment complexes (2%) or commercial or public buildings (1%). The appraised values of mobile homes were computed using Jefferson County averages from the tax assessor database.

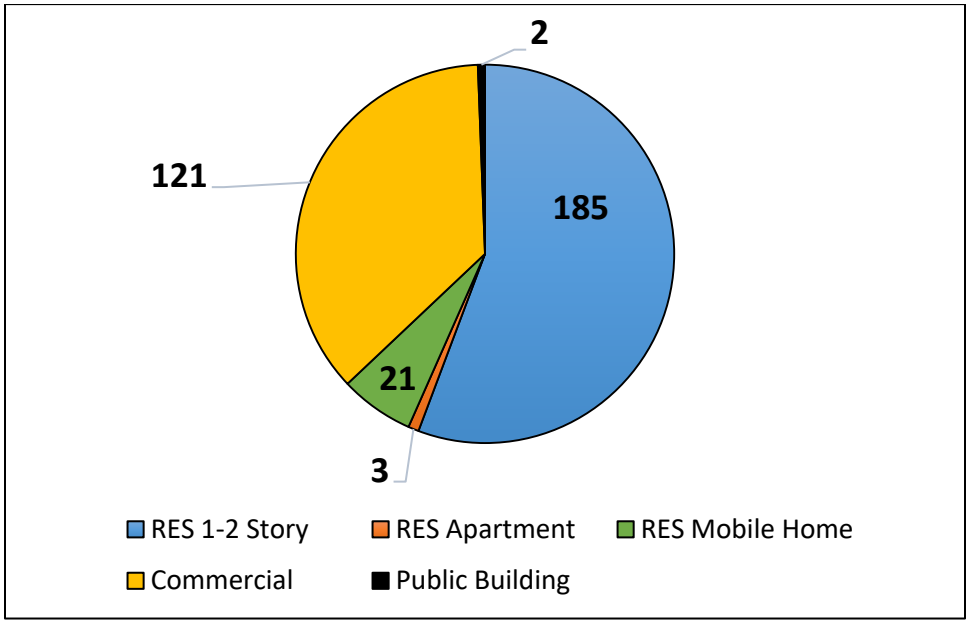


Figure 20. De Soto Structures by Occupancy Type

The structure inventory in De Soto can be further sorted by foundation type to generalize structural attributes such as square footage, year built and structure value, as shown in Table 12. The table shows that the average structure in De Soto is over 50 years old and may not be a viable candidate for traditional nonstructural mitigation measure such as elevation or relocation. The slab foundation type is an outlier in the table as the majority of commercial structures in De Soto rest on a slab, giving the foundation height a higher than average appraised value and square footage relative to the other foundation types.

Table 12. De Soto Structural Attributes by Foundation Type

Residential by Foundation Type	Average Foundation Height	Average Square Footage	Average Year Built	Average Appraised Value
Mobile Home	2.50 ft.	938	N/A	$17,155
Basement	1.90 ft.	1,120	1947	$59,200
Crawlspace	1.53 ft.	936	1941	$49,493
Slab	0.65 ft.	3,993	1959	$109,360

6 Goals and Objectives

Defining goals, objectives, and mitigation actions is an essential step in this planning process to establish and achieve a community's vision of what it wishes to accomplish as a result of the FMP effort.

- Goals are general guidelines and usually broad policy-type statements, long-term in nature, and represent the vision of the local jurisdictions. Goals guide decisions to address floodplain management and mitigation actions in the focus area.
- Objective(s) accompany goals and provide a more specific intent of the goal.
- Mitigation actions are specific efforts to implement any measure(s) (physical or non-physical) to mitigate flood hazards and help jurisdictions achieve goals and objectives.

This effort develops into an action plan that prioritizes the objectives and mitigation actions as well as guides the implementation of the FMP; including the responsible departments for each activity, timeframe for implementation, budget for the activity (if appropriate), and how it might be funded.

The goals address all flood-related problems, set the context for the subsequent review of floodplain management activities and drafting of the action plan and are consistent with other regional and community goals for the affected areas.

During the development of the Upper Joachim Creek Floodplain Management Plan, the local governing bodies in the watershed were responsible for identifying and refining their goals and objectives. These communities included the City of De Soto (the City) and Jefferson County (the County). Both the City and the County are partners in this FMP and are responsible for ultimately implementing the FMP. Each have elected officials who ultimately make decision on altering city/county codes, expending resources, and voting on many actions that the FMP recommends.

6.1 Goal Identification

After a series of three calls with the City of De Soto and Jefferson County, the following five goals and objectives were established (listed in no particular order):

1. Develop a collaborative multi-jurisdictional approach towards floodplain management to address the flooding concerns and impacts in the Joachim Creek Watershed.
2. Coordinate, integrate and balance flood management activities, water quality improvement strategies, recreational improvements, sediment management and ecological restoration activities.
3. Obtain a balance between development needs and the proper functions of the floodplain within the Upper Joachim Creek Watershed.
4. Proactively manage and reduce flood risk along Joachim Creek and its tributaries to protect life and property.

5. Develop a comprehensive public education, advocacy and outreach program to increase public awareness about, understanding of, and involvement in protecting and enhancing our natural and built environment; improve public understanding of flood risks within the Joachim Creek Watershed.

For each goal, the City and County identified corresponding objectives that can be met in order to achieve those goals. Note: There are some objectives that the respective governments have already met in order to meet its goals.

GOAL 1: DEVELOP A COLLABORATIVE MULTI-JURISDICTIONAL APPROACH TOWARDS FLOODPLAIN MANAGEMENT TO ADDRESS THE FLOODING CONCERNS AND IMPACTS IN THE JOACHIM CREEK WATERSHED.

Objective 1: Adopt and implement an Upper Joachim Creek Floodplain Management Plan by Jefferson County and the City of De Soto.

GOAL 2: COORDINATE, INTEGRATE AND BALANCE FLOOD MANAGEMENT ACTIVITIES, WATER QUALITY IMPROVEMENT STRATEGIES, RECREATIONAL IMPROVEMENTS, SEDIMENT MANAGEMENT AND ECOLOGICAL RESTORATION ACTIVITIES.

Objective 1: Establish an entity to address flood risks.

Objective 2: Establish organization structure including representatives from diverse interests and city departments.

Objective 3: Identify/create sustainable funding mechanism to coordinate efforts with other agencies and stakeholders in planning, design, development and implementation of projects.

Objective 4: Provide for watershed maintenance (ownership/easement, access, resources, staff, equipment, etc.).

GOAL 3: OBTAIN A BALANCE BETWEEN DEVELOPMENT NEEDS AND THE PROPER FUNCTIONS OF THE FLOODPLAIN WITHIN THE UPPER JOACHIM CREEK WATERSHED.

Objective 1: Implement appropriate policies and regulations that address needs of existing properties.

GOAL 4: PROACTIVELY MANAGE AND REDUCE FLOOD RISK ALONG JOACHIM CREEK AND ITS TRIBUTARIES TO PROTECT LIFE AND PROPERTY.

Objective 1: Compile known flood risks in the watershed from local stakeholders and characterize the flood risks in terms of public safety (depth, velocity, population-at-risk, warning time and rate-of-rise).

Objective 2: Evaluate and implement flood warning systems and response plans.

Objective 3: Use a multipurpose stream corridor approach to manage flood risks (flood proofing, building elevation, buyouts, etc.).

Objective 4: Identify and mitigate repetitive loss areas.

Objective 5: Revise Floodplain and Subdivision policies and regulations.

GOAL 5: DEVELOP A COMPREHENSIVE PUBLIC EDUCATION, ADVOCACY AND OUTREACH PROGRAM TO INCREASE PUBLIC AWARENESS ABOUT, UNDERSTANDING OF, AND INVOLVEMENT IN PROTECTING AND ENHANCING OUR NATURAL AND BUILT ENVIRONMENT; IMPROVE PUBLIC UNDERSTANDING OF FLOOD RISKS WITHIN THE JOACHIM CREEK WATERSHED.

Objective 1: Increase awareness and appreciation of natural resource conservation and water quality through public surveys, educational programs watershed signage.

Objective 2: Create interactive, educational opportunities for the community that promote good stewardship ethic, connect citizens to the water resource, encourage participation in recreational activities and develop neighborhood and community pride.

Objective 3: Develop focused advocacy program to build support for a watershed approach from public officials and the private community.

Objective 4: Develop a range of educational tools to inform the general public, elected officials and interested parties (i.e., realtors, property owners, tenants and developers) of the flood risks, promote floodplain stewardship, connect citizens to the riparian environment, encourage appropriate recreational activities and develop a sense of watershed ownership along Joachim Creek.

Objective 5: Implement an Early Warning System that incorporates multiple media tools that are tied to the National Weather Service

7 Strategies and Tools

Elected officials should work collaboratively with the staff in the City and County in order to prioritize risk management actions. The Floodplain Management Plan helps staff articulate or make the case for these decisions which, in turn, assists elected officials to focus expending limited resources on problem areas that are driving the flood risk.

The USACE, in consultation with various partners and stakeholders, considered a long list of strategies and tools and has made recommendations and provided rationale for inclusion or exclusion of each tool. Later, the plan bases prioritized actions on this evaluation. This section serves to describe the reasons for inclusion or rejection of those tools.

The Upper Joachim Creek Floodplain Management Plan includes tools in four strategy categories:

- Modifying Human Susceptibility to Flood Hazards
- Modifying the Impact of Flooding
- Preserving and Restoring Floodplains' Environmental Quality
- Other Publically-Referenced Strategies/Tools

The four strategy categories and corresponding tools are the "measures" that the flood risk management professional refers to with very deliberate terminology, because these will lead to the eventual action items in the floodplain management plan. That terminology serves to clarify that the measures fall under the category of either

- an "**activity**" or
- a "**feature**."

An “activity” is an effort done by the City, Counties, or partnering State and Federal agencies to better understand the flood risks, to reduce the risk and to manage risk in the long-term. Activities involve little to no construction actions. Examples of an activity could be an informational outreach program, an updated study of a flood-prone area, or an emergency action plan.

“Features” are actual construction projects to a property or properties that an individual can undertake, or the City, County, or partnering agencies can perform. Features can include major civil works projects such as levees, or smaller “flood risk adaptive measure,” such as elevating an existing home or business. USACE typically calls these smaller features “nonstructural measures.” This term originates from FEMA policy, but the term can be confusing. For the sake of this Floodplain Management Plan, the term “nonstructural” refers to a measure that does not include a large structural project such as a levee, floodwall, floodgate, etc., which is traditionally what the public thinks of when referring to USACE projects. This FMP does consider some structural measures that were proposed by the public during the public workshop, during nonstructural assessment home/business visits or in the public survey.

Table 13 presents a list of various structural (physical) and nonstructural (physical and/or non-physical) measures (or features) which can be implemented independently or in combination with others to reduce the overall risk to flood damages in the given study area.

Table 13. List of Potential Structural and Nonstructural Measures

Structural Measures	Nonstructural measures	Nonstructural and Nonphysical Measures
Levees	Elevation	Flood Warning Systems
Large Floodwalls*	Relocation	Flood Insurance
Large Berms*	Buyout/Acquisition	Floodplain Mapping (FIRM)
Flood Gates	Dry Floodproofing**	Flood Emergency Preparedness Plans
	Wet Floodproofing**	Land Use Regulations
	Small Berms*	Evacuation Plans
	Small Floodwalls*	Risk Communication

*The terms “large” and “small” are used only to differentiate between structures that reduce risk to a widespread area (large) versus one or two structures (small).

**Wet floodproofing cannot be used to bring a residential structure into compliance with the community’s floodplain management ordinance. Dry floodproofing cannot be used to bring any structure into compliance with a community’s floodplain management ordinance.

The USACE evaluated each of the possible tools and, after involving the stakeholders through public involvement in the decision process, each tool was categorized as:

- **Effective or Not Effective**; and
- **Not Recommended or Recommended**; or
- **Further Evaluation Needed**

These specific terms will appear with each tool, leading the discussion but also in the body text in bold format, because these represent important supporting information to the action items later in the floodplain management plan. The expanded meanings are below:

- “**Not Recommended**”. The tool was evaluated and determined to not be appropriate for reasons explained.

- "**Further Evaluation Needed**". The tool is likely appropriate, but additional efforts are needed to collect and study the facts of the situation before a decision can be made for the evaluation.
- "**Recommended**". The tool has been evaluated and is a good solution in the community, although the community has yet to begin the effort. This could be a *feature* awaiting construction funding or an *activity* like building codes / inspection or zoning requirements, where guidance is developing with the city or county, for example.
- "**Effective**" (or "Highly Effective"). A tool evaluated with this term is one that has proven to manage the flood risks well. As an example, this could be either an activity, like land use regulation or a stream setback ordinance, or even green space requirement that is proven and will require continuous staff support (including funding) to continue being effective. Another example, a constructed feature that has costs for upkeep. Upkeep costs must consider operation and maintenance (for example, costs for mowing grass around the feature), as well as repair (for example, erosion damage from flooding), rehabilitation and replacement (like a failing or old pump that eventually is surpassed by new technology). Without the upkeep, the feature will not have effective performance as originally intended.

7.1 Strategy: Modifying Human Susceptibility to Flood Hazards

This strategy and set of tools includes measures directed toward managing the floodplain. These measures include these specific activities: land use regulations, public redevelopment policies, flood warning systems and flood emergency preparedness plans (including emergency action plans and flood fighting plans). These measures include these features: flood proofing buildings in the floodplain, berms and floodwalls for buildings, elevation of buildings, fill basement with main floor addition for buildings, acquisition of buildings (for demolition) and relocation of buildings. With this deliberate referencing to terminology under both activities and features, the reader will begin to see that floodplain management plans, emergency action plans and flood fighting plans are not the same.

7.1.1 Tool: Land Use Policies and Regulations

ACTIVITY: EFFECTIVE ✓ RECOMMENDED ✓

Included under land use regulations are the following potential actions:

- Regulatory NFIP floodplain management ordinance
- Regulatory NFIP flood maps and floodways
- Development permitting
- Zoning Maps
- Building codes
- Critical structure development practices
- Redevelopment processes
- Freeboard or stream setback ordinances
- Comprehensive plans

This tool covers both development policies and land use regulations. Development policies could be found in the various community-wide plans for the City and the County (i.e., comprehensive plans,

master plans, economic development strategic plans, etc.). These policies help guide the community decisions of where new development or redevelopment should occur.

Land use regulations can be used to implement a wide variety of site and building requirements, restrictions and prohibitions to protect new developments as well as existing developments. A minimum standard of floodplain regulations has been established by the National Flood Insurance Program.

The City has integrated some of these actions into various policies in the community's efforts to manage flood risk. The City of De Soto adopted a revised floodplain management ordinance on 15 April 2019 which included FEMA's revised maps. It includes requirements for building in FEMA zones A and AE. One such requirement is that any residential construction in these zones must be elevated to 2 feet above the base flood elevation (BFE) (i.e., have 2 feet of freeboard), which is a higher standard than the original 1-foot freeboard requirement. Another provision of the ordinance is that the community should identify a regulatory floodway and prohibit any new development unless it has been demonstrated through a hydraulic analysis that the development would not cause any increase in flood levels during the occurrence of the base flood discharge.

Jefferson County adopted a revised floodplain ordinance on May 28, 2019 in order to better manage floodplains within its jurisdiction. The revised ordinance includes requirements for building in Special Flood Hazard Areas (SFHAs). One such requirement is that residential and non-residential construction in a SFHA shall be elevated to 3 feet above the base flood elevation (BFE).

These tools are readily acceptable as an effective measure to reduce the risk of flood damages to existing homes and businesses, additions to these existing structures, and new developments. The tool is **recommended** to be included in the Action Plan of the FMP.

7.1.2 Tool: Public Alert Flood Warning System

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

Any flood risk management plan should consider the development and implementation of flood warning systems and emergency preparedness planning. The development of such plans and the installation of pertinent equipment such as data collection devices (rain gages, stream gages) and data processing equipment can become an integral feature of a project. Evacuation planning should consider vertical evacuation as well as lateral evacuation. Reunification sites should be a featured component of any evacuation plan.

Both Jefferson County and the City of De Soto participate in and promote the CodeRED system, each municipality administering its own system. It is a reverse 911 system that informs the public of weather conditions and weather watches and warnings via phone call or text. Citizens may sign up at no cost to them by calling 9-1-1 Dispatch. In addition, other medium forums are used such as social media sites Twitter and Facebook. These various mediums can be promoted more to reach a broader audience and provide high quality emergency notification.

A flood risk communication tool such as flood warning lights on roadways can also serve to notify traffic to turn around to avoid high water on roadways. This warning system can help avoid motorists from being trapped in moving water, or worse, a drowning. A set of flood warning lights tied to a USGS stream gage (USGS 07019500 Joachim Creek at De Soto, MO) is recommended to be located near the

areas in De Soto and Jefferson County that experience the most severe flooding in a short amount of time.

7.1.3 Tool: Warning Dissemination, Multi-Media

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

As a flood risk communication tool, multi-media approaches have considerably advanced technologically, although other more traditional means are also still very much relevant. Another suggestion noted during public involvement work with the City of De Soto was to use newer public warning systems via multi-media outlets.

While the City of De Soto including the fire department and the police department are all active on social media outlets, one **recommended** step is to further promote use of social media and website announcements. In addition, during major flooding events similar to 2017, daily status updates could be channeled through newer multi-media outlets used by a demographically diverse group of residents. Pre-identified roles could be established to present daily updates based on reality during the flood to local "traditional" media outlets, as well as through the newer outlets.

Another **recommended** step is to formalize this public media engagement in a new emergency action plan. This may include predefined messages that correspond to action stages identified with the NOAA National Weather Service or with the USGS development of the Flood Inundation Mapper (FIM) for the Upper Joachim Creek, based on the existing creek gages in the area. The public can subscribe to the USGS WaterAlert to receive water information texted directly to their cell phones for personal evacuation planning and awareness.

7.1.4 Tool: Flood Emergency Preparedness Plans (or Emergency Action Plan)

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

Inter-related to the flood warning system is an emergency preparedness plan for flooding. Generally speaking, emergency preparedness plans include several topics related to identifying the risk:

- Emergency operation plans based on indicators or stages of the magnitude of the risk;
- Emergency communication plans;
- Emergency evacuation plans;
- After action plans.

Each of these is relevant, but all have a unique focus and/or audience.

<u>Emergency Operation Plan:</u>

An emergency operation plan is the core of the emergency preparedness plan. The flood emergency operation plan is designed to provide needed actions based on existing or forecasted water levels. Using the FIM described above, Emergency Managers for the City and County can define action stages when certain emergency response actions should be initiated. These action stages could be the activation of an Emergency Operation Center, the signaling of emergency sirens, warning lights and multi-media warnings, mobilization of emergency personnel, closing of roads at risk of flooding and evacuation of impacted areas.

Jefferson County, Missouri has an Emergency Operations Plan. It provides a framework for response to disasters of any type or magnitude within the County's borders. Not a tactical response plan, the EOP

identifies areas of responsibility and methods of coordination to ensure that local responders will have the resources they need to efficiently respond when day-to-day resources have been stretched thin.

It is **recommended** that De Soto adopt an Emergency Operations Plan at the local level.

Emergency Communication Plan:

As with any emergency situation, communicating to the public is key to describe the event, discuss what risks are associated with the event and explain what actions should be taken to lessen the impacts of the event. An emergency can be chaotic and sometimes communicating the risk and other needed information is not always adequately done. An emergency communication plan can create a framework to establish who will provide the needed communication to the public, what communication media will be used and generally what the message will be. The added benefit to a detailed emergency communication plan is the effective use of emergency personnel, the timely flow of information about the risk and the establishment of a dedicated and reliable source of information which will reduce the duplication of messages and/or confusion and rumors.

It is **recommended** that De Soto adopt an Emergency Communication Plan at the local level.

Emergency Evacuation Plan:

By their very nature, emergencies are not predictable and can occur anytime and anywhere. The timing of flood emergencies is generally unpredictable, but the location of a flood event is well known. With modern flood models and mapping software, the location, depth and even velocity of a ravine flood event can be provided to emergency response professionals. Armed with this information and the FIM, it can readily be shown what areas of the community will flood first and how large the impact from the flooding will be. This information is invaluable to determining how many people will be impacted, social characteristics that may create unique circumstances or challenges in evacuating an area (i.e., low car ownership population, English as a second language population) and what routes will be available to get the impacted people out of harm's way. This information can also assist in determining short and long term emergency shelter needs and locations of these shelters.

Appendix 9 of Jefferson County's Emergency Operations Plan, describes the process whereby residents will evacuate or shelter in place during emergencies.

The City of De Soto has no formalized emergency evacuation plan; however, the City does follow a procedure when heavy rainfall is forecasted and uses USGS stream gage (USGS 07019500 Joachim Creek at De Soto, MO) to determine when to contact the public to encourage evacuation.

It is **recommended** that De Soto adopt an Emergency Evacuation Plan at the local level.

After Action Plans:

A later step in the flood emergency preparedness plan is the after action plans. This planning phase covers all of the steps for recovering from the flood event. Items that can be included in this plan include damage assessment, material disposal, clean-up and recovery communication, and economic recovery. Although this step of the emergency preparedness process is sometimes overlooked, a dedicated plan to help a community recover from a disaster will be extremely beneficial to both the individual and the community as a whole.

This is a **recommended** activity to create a prepared and resilient community in the face of the flood risk. These plans should be periodically practiced and vetted via table top exercises and small scale simulated drills to ensure the variety of plans are up to date and accurate.

7.1.5 Tool: Development Policies – Moratorium

ACTIVITY: **EFFECTIVE** ✓ **NOT RECOMMENDED** X

A moratorium on development in the floodplain would prohibit any building in the floodplain by law until a specified time when solutions could be created to reduce the flooding impacts from Upper Joachim Creek. In researching the moratorium, it was determined that such a measure would only impact a very small number of vacant properties in the City and County and might be considered a "taking" if implemented. These factors do not lend to this tool being considered moving forward.

7.1.6 Tool: Structure Elevations

FEATURE: **EFFECTIVE** ✓ **RECOMMENDED** ✓

As a nonstructural technique, elevating structures involves raising the structure in place to reduce frequency and/or depth of flooding during high-water events. Elevation can be completed on fill, foundation walls, piers, piles, posts, or columns. Selection of proper elevation method depends on flood characteristics such as flood depth or velocity and condition of the structure and site. See Section 8.1.6 as well as Appendices D and G for additional information on nonstructural flood risk measures.

7.1.7 Tool: Buyouts (Structure and Land Acquisition)

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

As a nonstructural technique, buyouts remove flood-prone structures and maintain the purchased land as open space. Land acquisition can be in the form of fee title or permanent easement with fee title. Land use after acquisition is open space use via deed restriction that prohibits any type of development that can sustain flood damages or restrict flood flows. Land acquired as part of a nonstructural project can be converted to a new use such as ecosystem restoration and/or recreation that is open space based such as trails with interpretive markers, shoreline access and limited recreation fields. Conversion of previously developed land to open space means there is no longer the need for utilities, streets.and sidewalks which can be removed as part of the project.

One consideration that is a concern of local units of governments as well as citizens is the potential impact of acquisition to the local economy. The recommendations of this FMP do **not** take into consideration the culturally and/or locally significant areas and neighborhoods nor does it consider the economic impacts associated with acquisitions to the housing market, opportunities for employment, impacts to businesses, etc. The FMP makes recommendations based on flood depths, property value versus the cost of mitigation, engineering judgment, and other factors in order to reduce the overall risk to health and life safety and economic damages to structures. See Section 8.1.6 as well as Appendices D and G for additional information on nonstructural flood risk measures.

7.1.8 Tool: Flood proofing (Wet & Dry)

FEATURE: **EFFECTIVE** ✓ **RECOMMENDED** ✓

Dry flood proofing involves temporarily or permanently sealing exterior building walls with water proofing compounds, impermeable sheeting, or other water resistant materials to prevent the entry of floodwaters into structures. Temporary dry flood proofing measures, such as installing door barriers, require some early warning for the owner/tenant to be able to install the closure(s) and safely evacuate the premises prior to the arrival of floodwaters. Note: Dry floodproofing cannot be used to bring any structure into compliance with a community's floodplain management ordinance.

Wet flood proofing includes measures that allow floodwater to enter the structure without significant consequence. Vulnerable items such as utilities, appliances, and furnaces are waterproofed or relocated to higher elevations. Basements are abandoned and filled, in order to prevent placement of damageable items in the space. By allowing floodwater to enter the structure, hydrostatic forces on the inside and outside of the structure can be equalized, thereby reducing the risk of structural damage. See Section 8.1.6 as well as Appendices D and G for additional information on nonstructural flood risk measures. Note: Wet floodproofing cannot be used to bring a residential structure into compliance with the community's floodplain management ordinance.

7.1.9 Tool: Community Education and Advocacy

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

Community Education and Advocacy is a key component to a healthy and vibrant community. Communication between a unit of government and its constituents, at any and all levels, creates trust and a sense of shared responsibility for the citizens. In terms of reducing flood risk, educating the public on the risks of living in or near a floodplain can and does reduce the risk that lives will be lost or property damaged during a flood event. There must be a balance between community activism and governance, and this balance can be accomplished by sharing the goals and objectives of the unit of government and the citizens whether they are shared individually or as formal or informal groups.

It is **recommended** for the City to form an official committee or group that has representatives from the city government, private citizens, and any other county or municipal representatives deemed beneficial to the committee. The mission of this committee will be to openly communicate the risk of living in or near a floodplain and to host public meetings, both formal and informal, to help citizen and business owners prepare for and respond to all types of natural disasters (including flooding). This will allow the various governmental and nongovernmental groups of city employees and private citizens to pool their efforts and their resources to understand, communicate, and ultimately reduce the risk of flooding in the De Soto community.

7.1.10 Tool: Temporary Flood Risk Adaptive Measures

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

The most common temporary measures that are recommended for at-risk structures along the Upper Joachim Creek floodplain are: 1) polyethylene sheeting attached or hung onto the structure exterior (usually to a height of 3 feet above the first floor elevation and continued on the ground surface 4 feet out from the structure exterior), in combination with door and window closures, 2) clear liquid sealant applied to the structure exterior in combination with caulking of large cracks in the exterior and placement of door and window closures, 3) sandbag berms located around all or a portion of the

structure, and 4) any of the barriers certified through the National Flood Barrier Testing and Certification Program [see http://nationalfloodbarrier.org/].

See Appendix D (National Nonstructural Committee Assessment with Enclosures) of this report for more information on temporary flood risk adaptive measures.

7.2 Strategy: Modifying the Impact of Flooding

7.2.1 Tool: Information and Education

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

City and County officials should, through a variety of methods and media, inform the general public and residents within the floodplain of specific flood hazards, how to prevent and/or prepare for a flood event, and what to do after a flood event.

A number of local, state, and federal agencies, such as the Missouri State Emergency Management Agency (SEMA), have prepared detailed pamphlets, books, and other informational pieces on how to prevent and prepare for a flood event. Similar information about how to recover from a flood event has been created by these agencies and others. City and County officials should continue to collect, review, and maintain a sufficient library of information to assist residents with these topics, with an online database with easy access for residents. In addition to notifying the public about this resource library, the information should be catalogued at public libraries in Jefferson County and the City of De Soto.

Information on other topics related to flooding, such as water quality and water conservation, should be collected and made public in similar fashion as the flood hazard and prevention information. This information can be provided at City and County offices and/or the public libraries. A variety of media types can be used to inform residents and other interested parties about these flood related topics. Both the City of De Soto and Jefferson County maintain informative websites where this information can be displayed. Newsletters, newspaper advertisements, press releases, notices on utility bills, other government notices, social media and direct mailings should also be used. Both entities should be creative as to how these messages are relayed to the public both broadly and specifically in an effort to have a well-informed community on the hazards of flooding in the area.

In terms of participating in the FEMA's Community Rating System (CRS), credit points can be earned for a comprehensive approach to informing the general public and residents living and working in the floodplain of the potential hazards of flooding in the community. De Soto and Jefferson County should set a goal to create a comprehensive public outreach and educational plan that targets a variety of topics and groups of residents to inform as many people as possible and potentially earn greater reductions in flood insurance premiums through the CRS program (if the City or County chooses to participate in the program in the future).

7.2.2 Tool: Flood Insurance

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

The National Flood Insurance Program (NFIP) contains 3 basic parts: flood insurance, flood mitigation, and floodplain regulation. In terms of reducing flood risk, only flood mitigation and floodplain management regulations are believed to have a direct impact. In regards to the flood insurance part of the NFIP, flood insurance does not reduce flood risk. It simply spreads the flood risk across multiple public and private structures as does any insurance program - it shares flood risk.

Homes and businesses in high-risk flood areas with mortgages from federally regulated or insured lenders are required to have flood insurance. If residents live or own a business in a high-risk flood zone and received federal disaster assistance in the form of grants from FEMA or low-interest disaster loans from the U.S. Small Business Administration (SBA) following a Presidential Disaster Declaration, they must maintain flood insurance in order to be considered for any future federal disaster aid. Disaster assistance comes in two forms: an SBA loan, which must be paid back with interest, or a FEMA disaster grant, which is about $5,000 on average per household. By comparison, the average flood insurance claim is nearly $30,000 and does not have to be repaid.

Increased Cost of Compliance (ICC) coverage is one of several resources for flood insurance policyholders who need additional help rebuilding after a flood. ICC provides up to $30,000 to help cover the cost of mitigation measures that will reduce flood risk. ICC coverage is a part of most Standard Flood Insurance Policies available under the FEMA's NFIP. When a building insured by a Standard Flood Insurance Policy under the NFIP sustains a flood loss and the community declares the building to be substantially or repetitively damaged, ICC coverage helps pay for the cost to elevate, floodproof (nonresidential only), demolish or relocate the building to meet certain building requirements in the community . ICC coverage is available on residential and non-residential buildings (this category includes public or government buildings, such as schools, libraries and municipal buildings) insured under the NFIP's flood insurance policy. It must be noted that wet floodproofing cannot be used to bring a residential structure into compliance with the community's floodplain management ordinance and dry floodproofing cannot be used to bring any structure into compliance with a community's floodplain management ordinance.

Five flood mitigation programs exist within the NFIP. They are the hazard mitigation grant program, pre-disaster mitigation grant program, flood mitigation assistance program, repetitive loss program, and severe repetitive loss program.

7.2.3 Tool: Community Rating System

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

The Community Rating System (CRS) is a national program through FEMA and the NFIP that evaluates a community's floodplain management efforts and rewards those efforts with reductions on National Flood Insurance premiums based on the community's floodplain management performance. Neither the City of De Soto nor Jefferson County participate in FEMA's CRS. This Floodplain Management Plan (FMP) is an element that, if adopted, can lead to the community's participation in the CRS, which can increase the flood insurance premium discounts. Other activities, such as higher floodplain regulations (Section 7.1.1), dedication of open space in the floodplain (Sections 7.1.7 and 7.3.2), and the outreach of information related to flood risk (Section 7.1.9), can also further the community's participation in CRS. Several manuals on this topic are listed in the Reference section (Section 9) of this FMP, as well as the Missouri State Floodplain Coordinator's Manual and examples of several applicable activities.

7.2.4 Tool: Local Drainage and Utility Protection

ACTIVITY: **EFFECTIVE** ✓ **FURTHER EVALUATION NEEDED** ✓

During the USACE National Nonstructural Committee's assessment of residential and commercial structures in Upper Joachim Creek watershed, several property owners brought the issue of local storm water run-off to the attention of USACE personnel. Storm water run-off, especially for a community that is vulnerable to flash flooding, can, in combination with main channel flooding, have damaging

consequences for property owners. The USACE National Nonstructural Committee drafted a report titled "North Main Street at De Soto Interior Drainage", and it has been attached to this Floodplain Management Plan as Appendix E.

Based on the report, further evaluation is needed. Table 14 is a list of each flood source associated with local drainage issues and what analysis is needed in order to further recommended solutions.

Table 14. Sources and Recommendations for local drainage issues in the vicinity of 1800 N. Main Street

Flood Source	Recommendation
Joachim Creek	Consider installation of flap gate or slide gate on outlet of concrete box culvert.
Storm Water System	Interior drainage issue. Analyze system capacity at railroad box culvert.
Overland Flow	Interior drainage issue. Consider analysis of redirecting runoff into storm water system.

7.2.5 Tool: Tax Adjustments

ACTIVITY: EFFECTIVE ✓ FURTHER EVALUATION NEEDED ✓

The use of tax adjustments and tax rebates could be a tool to incentivize the establishment of more open space and/or encourage the construction and renovations of homes and businesses that are better protected from the risk of flooding.

A tax incentive program could provide a reduction of the property tax in exchange for the dedication of the open space area on a parcel through conservation and drainage easements.

Tax rebates could be made available to home and business owners for a portion of the cost of materials and labor to build a new structure to a higher degree of flood protection or renovate an existing structure to mitigate the flood risk. As an example, the tax credits could be used to offset the cost to increase the elevation of a new home above what would typically be required. During the renovations to an existing home, tax credits could be used to cover the cost engineered opening in the foundation, relocation and elevation of utility equipment or the use of flood resistant materials over traditional materials.

More research is needed to determine if this tool would be a substantial benefit to both the property owners and the community and what mechanisms need to be put into place to make these tax adjustment and tax rebate programs successful.

7.2.6 Tool: Post-Flood Recovery Processes

ACTIVITY: EFFECTIVE ✓ RECOMMENDED ✓

The City of De Soto, Jefferson County, and the citizens in the region have significant training and real-life experience in their roles and responsibilities in post-flood events in their jurisdictions.

It is **recommended** that the entities along the Upper Joachim Creek continue to inspect damaged homes and businesses after flood events to ensure they comply with all regulations. In addition, the local entities should become a repository of post-flood disaster information on flood safety, clean up and mitigation options for impacted property owners and their tenants. Documenting post-flood lessons learned and developing recovery plans helps to keep all community members aware of the processes and procedures used to recover from varying levels of flood damage after events.

Jefferson County and the City of De Soto officials should also focus their post-flood recovery efforts on long term needs for a neighborhood or the region. These efforts could include economic recovery and infrastructure recovery plans. A significant portion of the region's commercial and industrial uses are located in the Upper Joachim Creek basin. More research is needed on this topic to develop this information.

7.3 Strategy: Preserving and Restoring Environmental Quality

While most people view a river or stream only as the place where there is regularly flowing water, the reality is that the river and floodplain are one integrated system that has evolved over time to convey water and sediment downstream. The floodplain functions to both store water and to slowly release it back into the main channel of the river as the floodwaters recede. This strategy and set of tools has to do with managing the floodplain with nature based conservation measures for habitat protection and restoration, erosion and sediment control, water quality enhancement, enhancement of recreation and educational opportunities, and preservation of cultural resources.

7.3.1 Tool: Wetlands, Stream, and Riparian Protection and Restoration

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

Reducing flood risk through open space preservation and habitat restoration is a large scale proposition based on watershed size, topography and rainfall intensity. At the very least, this tool would require that protection and restoration of significant acreage to realize the benefits of any flood attenuation. In general, an effectively applied tool requires: (1) identification or mapping of available open space, (2) prioritization of parcels, (3) acquisition of property or educate/inform landowners about available incentivized conservation programs and (4) restoration of habitat types that attenuate or reduce the floodwater velocities. Nature based conservation measures of wetland restoration, riparian restoration or preservation and floodplain forest restoration have co-benefits of erosion reduction, reduced sediment accretion and improved water quality. USDA Programs and In-Lieu Fee Compensatory Mitigation Programs cited in Appendix H offer financial incentives to landowners who are interested in preserving and/or restoring the habitat types identified above.

7.3.2 Tool: Enhancement of Recreation and Education Opportunities

ACTIVITY: **EFFECTIVE** ✓ **RECOMMENDED** ✓

The City Public Works Department oversees and manages more than 56 acres of parks and recreational facilities for the general public. The City parks and recreation system includes ten park sites, including general parkland, sports fields and courts, picnic facilities, natural resource areas and related support facilities. These facilities provide valuable recreation resources for the residents of De Soto and surrounding community. A variety of recreation amenities exist along the Upper Joachim Creek. Open space along a stream provides for an area that is free and clear of man-made structures to allow stormwater runoff and flood waters to flow unobstructed, as nature intended.

As these open public spaces attract residents from within the City and adjoining areas, coupled with the fact some of these parks are within a flood hazard area makes them likely candidates for participation in a joint project between the U.S. Army Corps of Engineers, Kansas City District and the State Emergency Management Agency (SEMA). Widespread flooding in 2017 is pushing the state to increase public awareness of flood risks. This project encourages communities to make a sign or signs which capture the flood story. The project creates public historic flooding signs to raise awareness of past severe flood

disasters in Missouri. The sign will describe impacts of past events and may include use of:

- any past high water elevations,
- flood damage costs, and
- loss of life data.

All participating communities will be required to document the posting of the sign(s) by providing a photo of the mounted sign(s). The communities are responsible for the cost of materials to mount the sign(s).

7.4 Other Publically-Referenced Strategies/Tools

At several points during the development of the Upper Joachim Creek Floodplain Management Plan, members of the public have identified other potential solutions to flooding. During the public workshop and during the public comment period, De Soto citizens suggested dredging Joachim Creek as a way to contain more water thereby reducing the amount of water that would flood homes and businesses. One variation of this suggestion also included calling in the National Guard to help with this effort because the 735th Field Support Command unit of the Missouri Army National Guard is located in De Soto, Missouri. Another variation of this suggestion included removing debris from the creek including rock, trees, gravel and other vegetation. Several members of the public suggested that recent bridge and highway construction had induced flooding on the Upper Joachim Creek. Several others proposed retention or detention basins, with some offering their property as potential sites. Finally, several citizens mentioned potential levees and flood walls to protect the city from flooding. The next several sections will describe the actions (or tools) and forecasted conditions if each proposal would be implemented.

7.4.1 Tool: Dredging of Joachim Creek to Increase Channel Capacity

ACTIVITY: **NOT EFFECTIVE** **X** **NOT RECOMMENDED** **X**

This tool considers dredging of the channel within a hypothetical linear reach of the creek. While there are some instances where dredging (deepening of the channel) can be used to reduce flooding, it is not in wide practice due to the significant environmental impacts and likelihood of destabilizing the channel, thereby creating channel problems such as bank failures and head-cutting within and outside of the dredged reach. Additionally, while no geotechnical analysis was performed during the development of this FMP, the team did visit Joachim Creek and assessed that the bottom of the creek appears to largely be bedrock. Excavating the bedrock for the purpose of increasing channel capacity (by increasing depth) would not yield the necessary storage capacity to reduce flooding in an effective and efficient way. It would also require legal permits from the required state and federal agencies.
Other dredging considerations include:

1. Dredging is expensive and includes complete removal of the dredged material from the creek, hauling and disposal of the dredged material and long-term maintenance to remove future accumulated sediment.
2. Dredging rarely reduces water levels in any significant way.
3. Dredging in one part of the channel can induce flooding in other areas.
4. Dredging can impact the environment often requiring compensatory mitigation.
5. Maintaining the dredged channel requires both operational and financial resources on a regular basis.

Based on these considerations, dredging the Upper Joachim Creek for the purpose of reducing flood heights is not effective and, therefore, **not recommended**.

7.4.2 Tool: Accumulated Sediment Deposit and Debris Removal from Joachim Creek (Seven Areas)

ACTIVITY: **EFFECTIVE** ✓ **FURTHER EVALUATION NEEDED** ✓

Several community members have recommended removing debris including sediment and vegetation from Upper Joachim Creek as a means of allowing more water to drain into the creek and keeping more water within the banks of the creek. This tool differs from the dredging tool in that the removal of sediment and vegetation would be performed as-needed in small localized areas. The USACE conducted site visits to De Soto and did witness several areas of the creek where sediment had developed in the form of gravel bars or islands, many of which were covered in dense vegetation.

Appendix F is a report from the USACE Hydrology & Hydraulics Branch where engineers performed preliminary modeling of removal of sediment deposits at seven different locations in one reach of the Upper Joachim Creek within the De Soto city limits. The results of the analysis demonstrate that during a 10-percent ACE flood event, there could be approximately 0.1 to 0.6 feet reduction in flood depths within this reach with removal of all seven deposits. For a 1-percent ACE flood event, there could be approximately 0.1 to 0.5 feet reduction in flood depths with removal of the seven deposits. It is vital to mention that by removing just two of the seven deposits that were analyzed, flooding was induced downstream. Removing the sediment deposits allowed more water to flow downstream; therefore, approximately 0.1 to 0.9 feet of induced flooding was computed in areas downstream of the removed sediment deposit. Based on this preliminary analysis, it appears that sediment removal would be minimally effective for reducing localized flood depths and can also have the negative effect of increasing downstream flood depths. For the detailed analysis, see Appendix F – USACE Sediment Deposit Removal Investigation.

Further hydraulic modeling analysis should be performed before any implementation of this tool occurs.

7.4.3 Tool: National Guard Involvement

ACTIVITY: **EFFECTIVE** ✓ **FURTHER EVALUATION NEEDED** ✓

De Soto, Missouri is home to the Missouri National Guard Armory, which houses the 735th Forward Support Company (FSC) Missouri Army National Guard. This unit is an integral part of helping to support the City and the County during authorized periods (Governor State of Emergency, etc.). It is **recommended** to continue communication between this and other National Guard Unit(s) and the City/County/State governments to ensure that the residents are aware of the National Guard's role in emergency situations.

7.4.4 Tool: Bridge and Highway (re) Construction

FEATURE: **N/A**

Due to ongoing litigation, further analysis of this feature was not performed by USACE. It is recommended to communicate with the Missouri Department of Transportation regarding any past or future construction.

7.4.5 Tool: Detention/Retention Basins

FEATURE: **EFFECTIVE** ✓ **FURTHER EVALUATION NEEDED** ✓

There are over ten tributary creeks that drain into Joachim Creek, upstream of Desoto, Missouri. All are similar in drainage area; therefore, creating similar amount of runoff. Five of the tributaries have reservoirs: Fletcher Branch has Valle Lake, an unknown creek has Clear Lake/Sunrise Lake/Big Lake, Falling Rock Branch has Summerset Lake/Fisherman's Lake, Whitehead Creek has Lembeck Lake, Ball Branch has Lake Briarwood/Spring Lake. These reservoirs were designed for recreational purpose only and not for flood control. When recreational purpose reservoirs experience high water, they become run-of-the-river reservoirs and pass flow downstream. Flood control reservoirs retain water and release flow downstream in a controlled manner; therefore, reducing flooding downstream.

Due to the number of tributaries to Joachim Creek, the most optimum flood control reservoir location would be on the Joachim Creek mainstem, upstream of the City of De Soto. This would require significant financial resources to fund planning, design, construction, operation and maintenance for the life-cycle delivery of a project of this magnitude; therefore, further evaluation of this feature is needed.

7.4.6 Tool: Levees and Floodwalls

ACTIVITY: **EFFECTIVE** ✓ **FURTHER EVALUATION NEEDED** ✓

Levees are earthen structures, typically 10 foot top width, and typically 1 on 3 slopes. Levee height determines the levee's base width; for a 10-foot high levee with a 12-foot crown, the base of the levee would be approximately 72 feet wide when taking into consideration the 15-foot vegetation buffer on each side. Levees also require regular inspections and have annual operation/maintenance costs. Due to the lack of real estate and large footprint needed, the preliminary assessment is that a levee option is not feasible.

Floodwalls are utilized for urban settings and where real estate is limited for flood protection. Floodwalls are typically built of concrete and typically one width top to bottom. Depending on the height of the floodwall, the width can be 12 inches to 36 inches.

One option for De Soto, Missouri is to build a floodwall parallel to Main Street/Railroad, which would protect against flooding from Joachim Creek. The floodwall would need to be continuous and continue upstream Tanyard Branch and upstream Ball Branch, to protect against backwater from Joachim Creek. How far upstream to extend the flood risk reduction measure along each creek would need to be further investigated. Interior drainage would be needed to be evaluated for pump station(s), as building the floodwall would block drainage to Joachim Creek during high water. Pump station(s) would pump interior drainage up and over the floodwall into Joachim Creek. Closure structures would need to be evaluated, closed during high water and open during low water to allow pedestrian/vehicle traffic in and out. Floodwalls require regular inspections and have annual operation/maintenance costs. This measure would leave many homes and public infrastructure vulnerable to overbank flooding.

Two potential floodwall and/or levee alignments can be seen below in Figures 21 and 22. Figure 22 includes the rail yard and is approximately 1,400 feet longer in length. The heights would vary based upon flood depths and elevations. Beyond the flood height, the wall would also be required to maintain 3 feet of freeboard for the 1-percent ACE event. It is estimated that the cost of a floodwall the length of Figures 21 and 22 would be approximately $66M-$86M for just the wall with additional costs for other features as well as operations and maintenance.

If the City of De Soto is interested in additional evaluation of structural alternatives, there are other USACE programs that could be explored (see Appendix H).

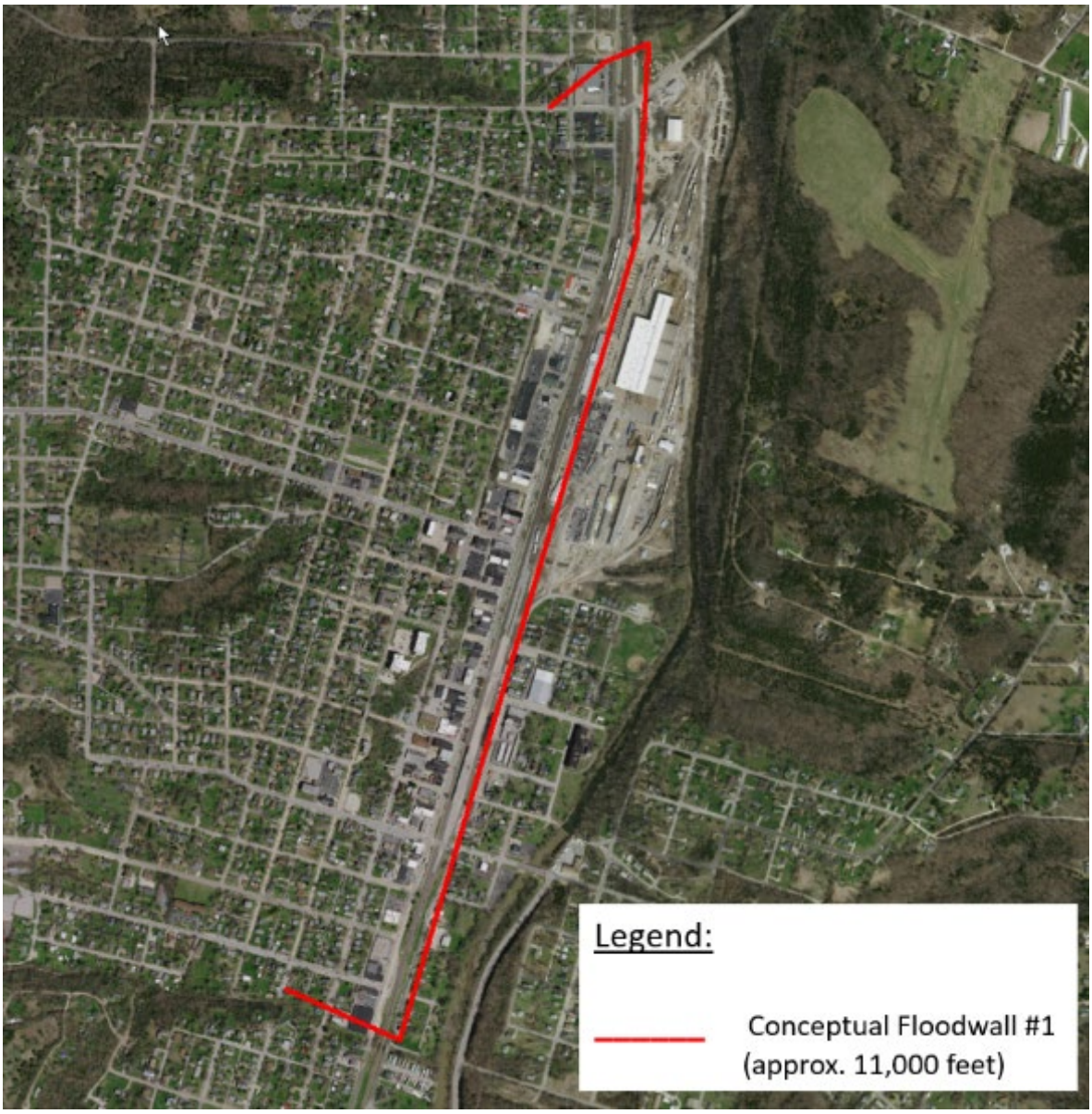


Figure 21. Example Upper Joachim Creek Floodwall Alignment #1

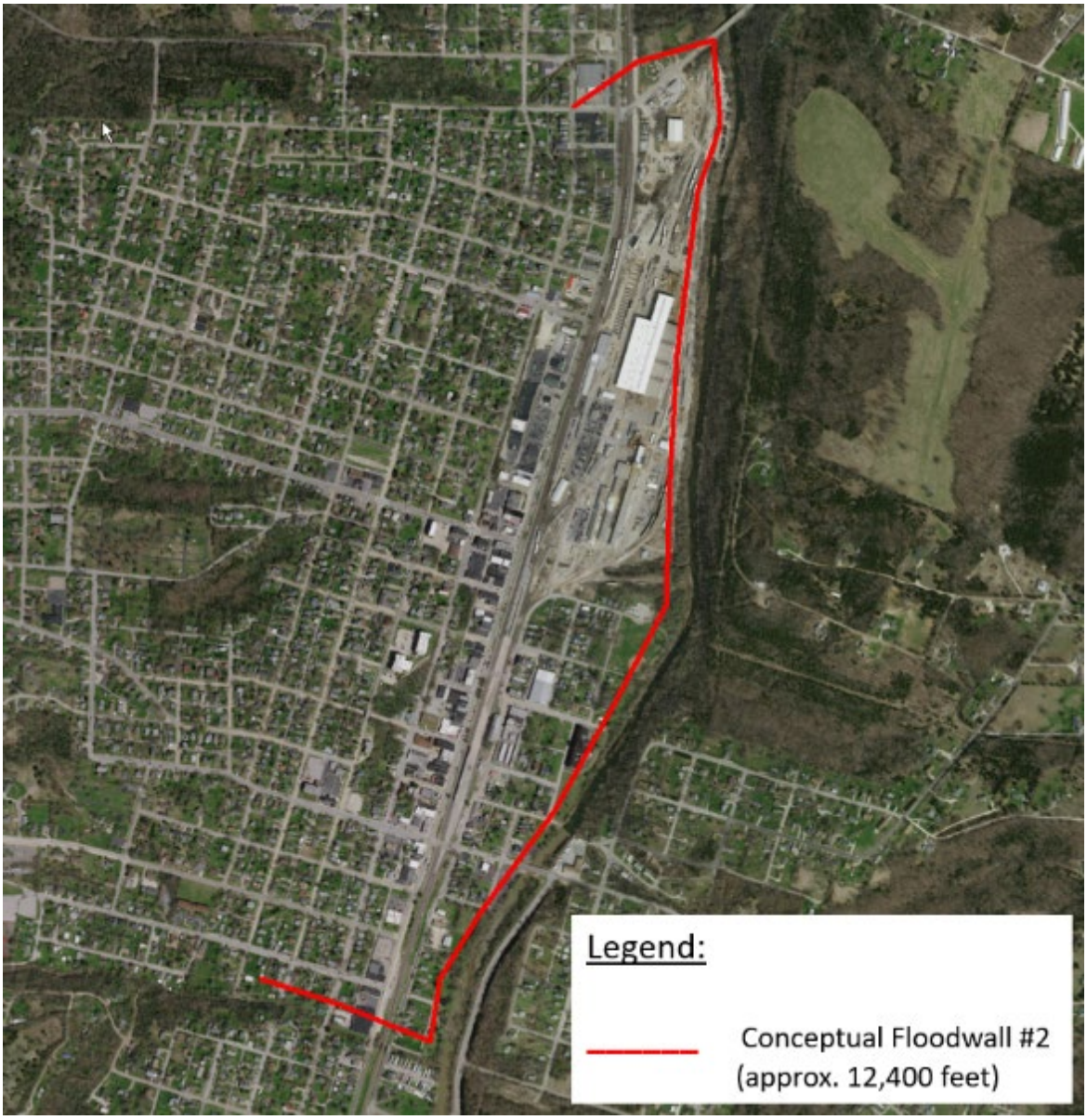


Figure 22. Example Upper Joachim Creek Floodwall Alignment #2

8 Action Plan

This is the very heart of the Floodplain Management Plan (FMP). The action plan is a blueprint for implementation of the FMP. This action plan is based on the recommendations developed throughout the FMP process, as presented in the earlier sections of the FMP. Possible strategies and tools of the action plan were evaluated for their relationship to the FMP's goals and objectives (Section 6) and their feasibility to be completed.

Having vital information included in this FMP creates the opportunity to equip city and county floodplain administrators and elected officials with the actions necessary to reduce future flood risk and resources necessary to accomplish the action to achieve the goal.

Based upon the goals and objectives identified by the City of De Soto and Jefferson County staff, this FMP recommends the following actions (in no particular order), which are further described in subsequent paragraphs:

1) Adopt the Upper Joachim Creek FMP
2) Develop a comprehensive public outreach plan
3) Adopt higher regulatory floodplain management standards
4) Maintain and expand the existing flood warning systems
5) Join the Community Rating System
6) Implement Nonstructural Recommendations

8.1 Action Items

8.1.1 Adopt the Upper Joachim Creek Floodplain Management Plan

The Upper Joachim Creek Floodplain Management Plan (FMP) is over a year culmination of participation and work by federal and state agencies, concerned citizens, City and County staff members, and public and private groups. The FMP documents these efforts and creates an action plan to implement strategies and tools to promote mitigation of flooding along the Upper Joachim Creek. Adoption of the plan will support future decisions regarding allocation of scarce resources to best reduce the risks of to life and property from flood events in the Upper Joachim Creek watershed. Adoption of the FMP can also count as points toward participation in the Community Rating System, which can ultimately reduce flood insurance premiums.

8.1.2 Develop a Comprehensive Public Outreach Plan

The De Soto community is rich with history, culture and pride, and it is for those reasons that the City of De Soto, the Citizens' Committee for Flood Relief and Jefferson County are partners in this FMP. Under the City's leadership, it should create a Public Outreach Plan that includes the formation of a committee whose mission is community education and advocacy.

8.1.3 Adopt Higher Regulatory Floodplain Management Standards

The City of De Soto should continue to adopt higher floodplain regulations to discourage development in the floodplain and to reduce the economic and life safety risks associated with flooding. It is **not recommended** to encourage development in the floodplain; however, it is important to adopt higher freeboard standards, for example, to reduce the risk of those currently living or working in the floodplain. It is also **recommended** to incorporate any current and/or proposed revisions to floodplain regulations into the community education and advocacy piece of the Floodplain Management Plan so that residents and business-owners are aware that any new developments in the floodplain can impact their existing development.

The existing floodplain management ordinance has been determined compliant by SEMA in meeting the provisions for participation in the NFIP as outlined in 44 CFR 60.3. It is **recommended** that the County and City update its current floodplain management ordinance to reflect the most current Flood Insurance Rate Maps (FIRMs). SEMA has provided the jurisdictions with a FEMA model 60.3(d), along with standards that meet or exceed minimum NFIP regulations for adoption prior to the June 20, 2019 effective date. The City and County have adopted a stricter floodplain management ordinance, and a cursory review of the model ordinance provided appears to satisfy that recommendation. It is **recommended** to adopt and submit a signed, sealed and dated copy of its new floodplain management

ordinance that includes the new FIRM panels and FIS to the Missouri State Emergency Management Agency.

8.1.4 Maintain and Expand the Existing Flood Warning Systems

The USGS has partnered with the City of De Soto and Jefferson County in the Joachim Creek Basin by installing USGS stream gage (USGS 07019500 Joachim Creek at De Soto, MO) operational beginning July 17, 2018. The gage provides river level information and basis for future flood warning protocols. See the following link for website access.
https://waterdata.usgs.gov/mo/nwis/uv/?site_no=07019500&PARAmeter_cd=00065,63160,00060

Stream forecast information is being developed at this location. A stage-discharge (rating) relation is defined for bank full conditions; however, discharge is not disseminated on the web until overbank flows are measured to help define the shape of the rating from the channel to the overbank.

The National Weather Service (NWS) has completed small-scale hydrologic model of the basin defined by the USGS stream gage at Joachim Creek at De Soto, Missouri. The model is called the Site Specific Headwater Program, and is used at numerous small basin gages throughout the country. NWS is currently testing the results of this modeling and plans to begin forecast services for Joachim Creek at De Soto Spring 2019. The NWS will issue a Public Information Statement within the next few weeks giving a 30-day notice of this service beginning in May or June.

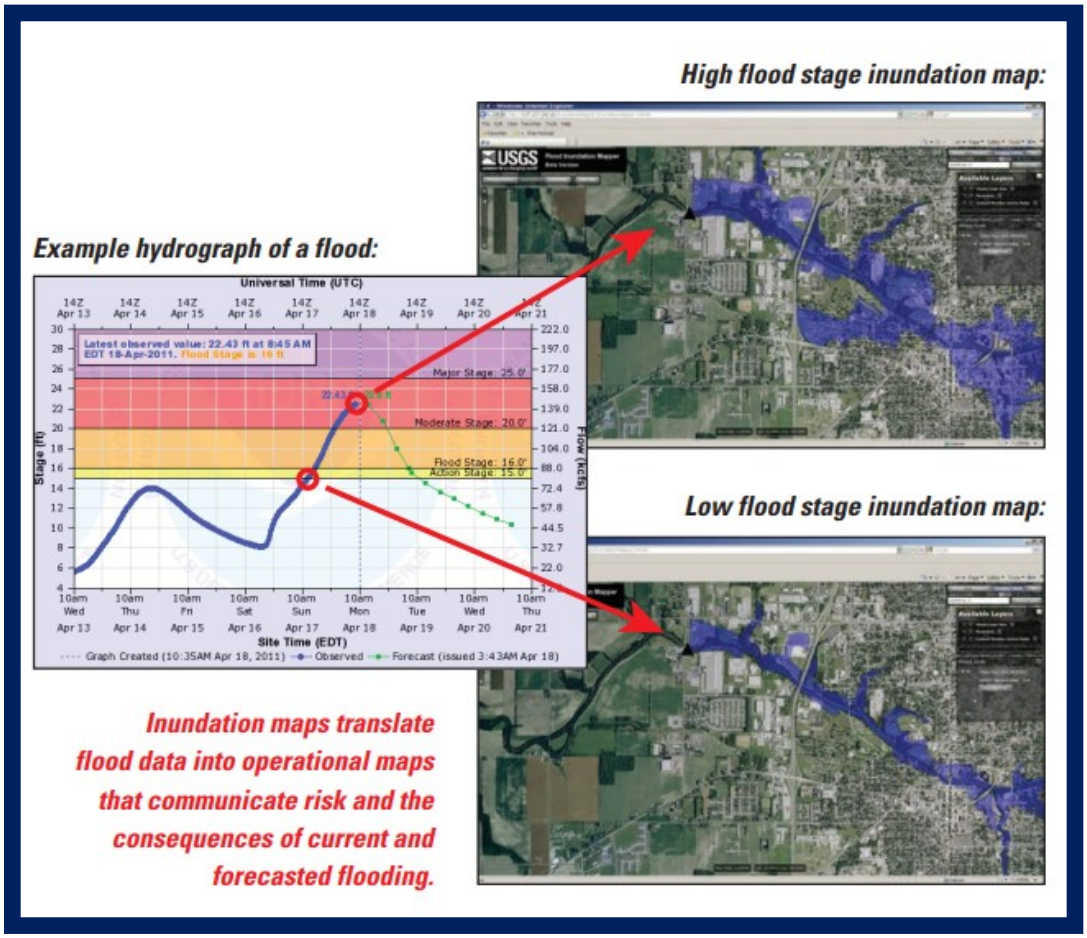
When forecast service begins, users will not notice much change to the website hosting these forecasts. During normal flows with little significant precipitation forecast, users will only see the latest stage, flow and impact data available, similar to what is currently available; however, when the model indicates forecast stages higher than action stage (8 ft.), these forecast time series will then appear on the site until these forecasts drop below 8 ft. or the observed stages drop below this level.

When the NWS gains sufficient (80%) confidence that Joachim Creek will exceed flood stage, the NWS will issue a Flood Warning for this site. These warnings will include the expected magnitude and timing of the crest along with any anticipated impacts. These warnings are intended to give local emergency managers, officials, and residents the necessary lead time to take appropriate protective action of life and property.

From a flood-warning perspective, the use of USGS WaterAlert service (which utilizes gage parameters/information) to provide a text or email message is beneficial to public users where user-

defined river level thresholds are exceeded. See the following link for website access.
https://water.usgs.gov/wateralert/subscribe2/index.html?site_no=07019500&type_cd=sw

To further enhance flood-warning, USGS has developed a series of concentric inundation maps that correlate to increments of stage disseminated from the USGS stream gage. These Flood Inundation Maps (FIMs) are developed from the NWS "Action Stage" near the top of the bank to the location of the 0.2% Annual Exceedance Probability (AEP) or 500-year flood. Essentially residents of De Soto and emergency management personnel will be able to access these flood inundation maps in all four (4) phases of the life cycle of emergency management: (1) Mitigation, (2) Preparedness, (3) Response and (4) Recovery. In addition to defined flooding extents, maps provide depths at user-defined locations along with other value-added information such as census-block loss-estimate models (HAZUS-MH), gage



statistics correlated to NWS flood categories and published documentation. Ultimately, with proper community administration and regulation of the National Flood Insurance Program (NFIP), the USGS FIM product is applicable to the Community Rating System (CRS) 600-series (Warning and Response), which provides credit toward reducing insurance premiums.

8.1.5 Join the Community Rating System

The National Flood Insurance Program's (NFIP's) Community Rating System (CRS) is a voluntary incentive program that recognizes communities for implementing floodplain management practices that exceed the Federal minimum requirements of the NFIP. Any community in full compliance with the minimum NFIP floodplain management requirements may apply to join the CRS. CRS uses a Class rating system that is similar to fire insurance ratings to determine flood insurance premium reductions for residents.

CRS Classes are rated from 9 to 1. Each CRS Class improvement produces a 5 percent greater discount on flood insurance premiums for properties in the Special Flood Hazard Areas (SFHAs).

Most communities enter the program at a CRS Class 9 rating, which entitles residents in SFHAs to a 5 percent discount on their flood insurance premiums. As a community engages in additional mitigation activities, its residents become eligible for increased NFIP policy premium discounts. Class 1 is the highest level of CRS and provides the largest flood insurance premium reduction (45 percent), The CRS Classes are based on completion of 19 creditable activities organized into 4 categories:

1. Public Information
2. Mapping and Regulations
3. Flood Damage Reduction
4. Warning and Response

In exchange for a community's proactive efforts to reduce flood risk, policyholders can receive reduced flood insurance premiums for buildings in the community. These reduced premiums reflect the reduced flood risk resulting from community efforts toward achieving the three (3) CRS goals:

1. Reduce flood damage to insurable property
2. Strengthen and support the insurance aspects of the NFIP
3. Encourage a comprehensive approach to floodplain management

During the development of this Floodplain Management Plan, the Federal Emergency Management Agency reviewed it for preliminary credit. In doing so, USACE completed the CRS Planning Credit Activity Checklist, and updated it for the Final Plan transmittal to the City and County. The Checklist is attached to this FMP as Appendix J.

8.1.6 Implement Nonstructural Recommendations in Appendix G

After the USACE's National Nonstructural Committee visited De Soto and Jefferson County and performed visual assessments of the properties and structures, the Committee wrote a Nonstructural Flood Mitigation Assessment Report with data sheets for each property. That Report with data sheets is attached as Appendix D. The findings in that report are preliminary and were further analyzed, which is described below.

USACE – St. Louis District performed a detailed analysis of the Report as well as the properties that were not part of the assessment. That analysis was a consideration of how the recommendation from the ten (10) assessed properties could be expanded to include all 229 structures that are expected to be damaged in a 1-percent ACE flood event. The full property list with the property-specific recommendations can be found in Appendix G (USACE Analysis of National Nonstructural Committee Assessment). Of the 229 structures located within the 1-percent ACE floodplain in De Soto, 41% are recommended to be elevated, 31% are recommended to be acquired, 17% are recommended to be floodproofed, and the rest (11%) had inundation below the first floor, and therefore only required either a sewer check valve or relocation of utilities. The analysis, Appendix G, supersedes the National Nonstructural Committee's original assessment (Appendix D). Figures 23 and 24 are maps of Main Street and just upstream of Main Street in De Soto, which show the nonstructural recommendations outlined in Appendix G with individual parcels outlined in white.

One structure of note is the De Soto Rural Fire Station at E. 201 Miller Street, which was assessed by the National Nonstructural Committee and the St. Louis District. The Fire Station's location in the floodway and the fact that fire trucks must be deployed from a flooded structure to save others during a flood event creates a safety and social impact on the community. Therefore, it is **recommended** to acquire and relocate the De Soto Rural Fire Station. Further explanation and analysis can be found in Appendix G.

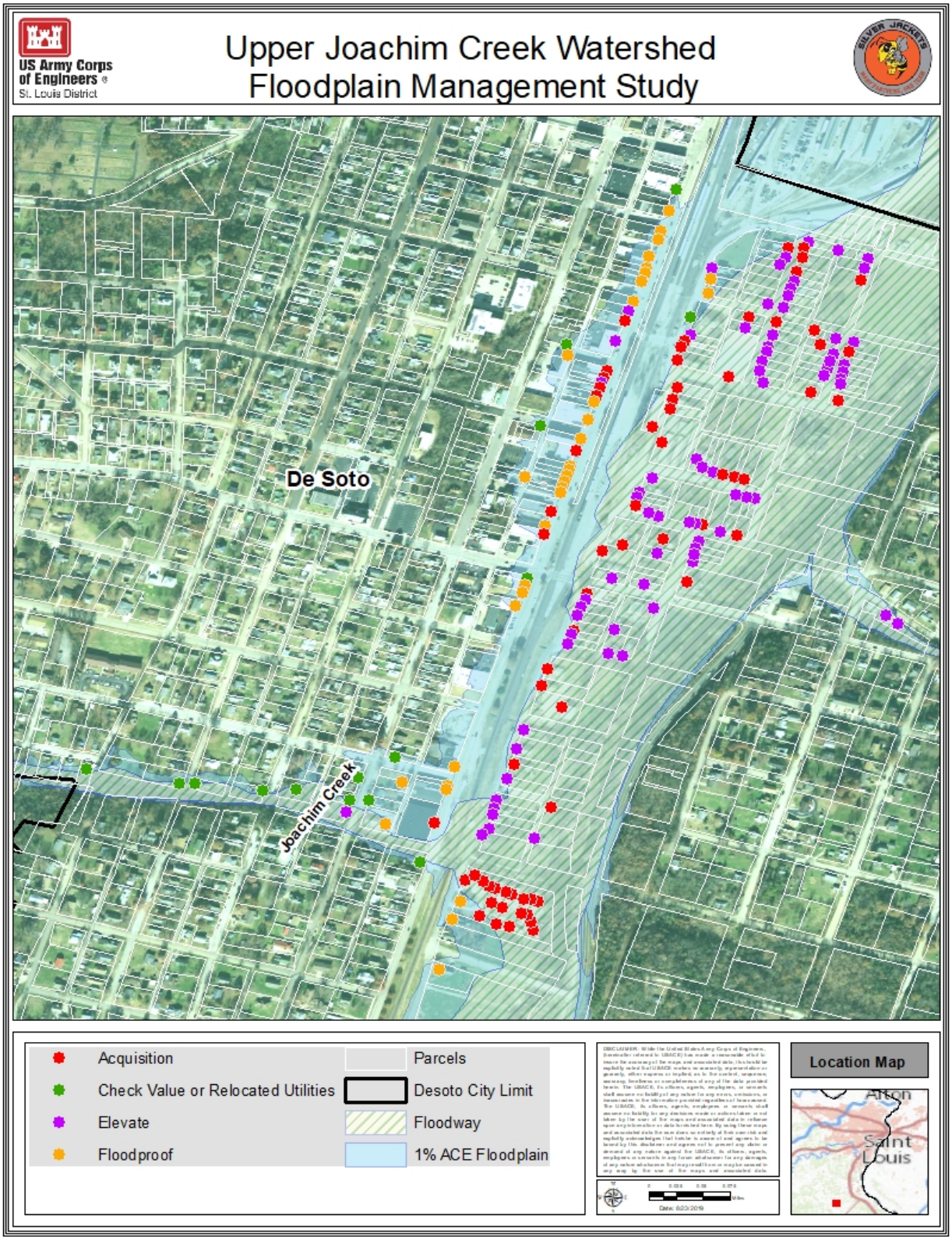


Figure 23. Nonstructural Recommendations with Parcel Lines - Main Street

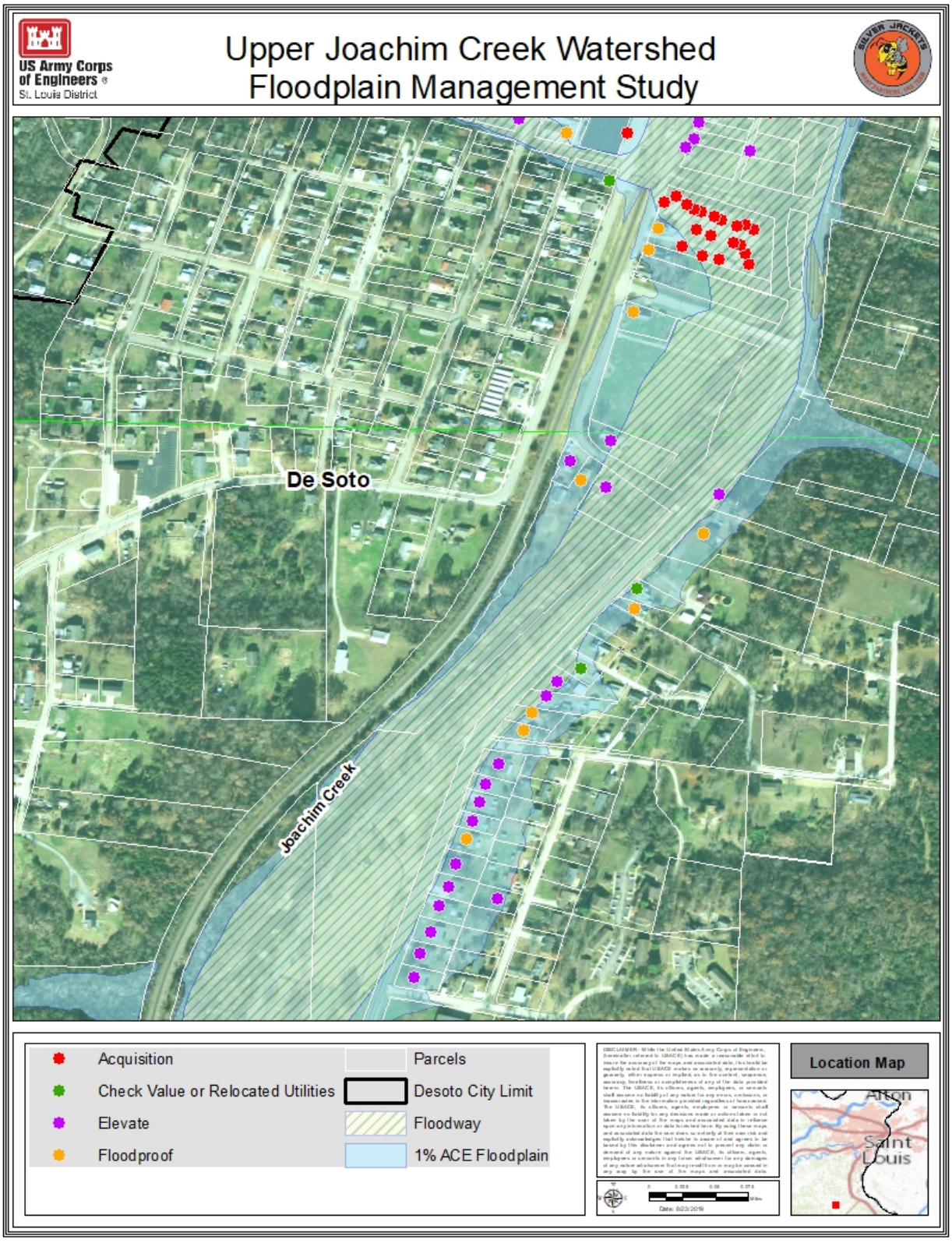


Figure 24. Nonstructural Recommendations with Parcel Lines - Upstream of Main Street

8.2 Potential Funding Sources

There are several programs available to assist the City and County with financial resources to implement action items and recommendations of the floodplain management plan. Advancing mitigation action is not easy and requires significant, varying resources. These resources may include grants, loans, technical assistance and in-kind services, among others. Recognizing the many funding programs that currently exist across various Federal departments and agencies, the State and non-governmental organizations compiled a list of programs to make it accessible to those who want to advance mitigation action in their communities. Table 15 provides local officials with a spectrum of potential mitigation funding sources. This guide will assist officials in determining the best source(s) of funding and technical assistance for potential mitigation projects.

Table 15. Potential Funding Sources

State Funding Sources	Federal Funding Sources	Federal Funding Sources
Missouri DNR: Soil and Water Conservation Program	FEMA: Hazard Mitigation Grant Program, Public Assistance Program, Pre-Disaster Mitigation (PDM) Grant Program, Flood Mitigation Assistance Program,	EPA: Clean Water State Revolving Loan Fund
	Internal Revenue Service: Disaster Assistance and Emergency Relief for Individuals and Businesses	USACE: In-Lieu Fee Compensatory Mitigation Program, Continuing Authorities Program (CAP)
	Small Business Administration (SBA): Disaster Loan Program	National Park Service: Rivers, Trails, and Conservation Assistance Program
	HUD: Community Development Block Grant State Program (CDBG), CDBG Disaster Program, Section 108 Guarantee Program	USDA: Water and Waste Disposal Loan & Grant Program, Emergency Watershed Protection (EWP) Program, Rural Housing Service Housing Preservation Grants, Emergency Conservation Program, Farm Service Agency Conservation Reserve Program (CRP)
	Department of Commerce: Economic Development Administration Disaster Recovery	

The full list and the requirements for each source can be found in Appendix H - Potential Funding Sources.

8.3 Communications Plan

As part of the public release of the Upper Joachim Creek Floodplain Management Plan, the U.S. Army Corps of Engineers-St. Louis District, along with the interagency partnership are developing a communication plan. The communication plan will be used at a public workshop that will be held to communicate the FMP to the public and any stakeholders who did not participate in the partner and agency review of the FMP. Once the final version of the FMP is transmitted to the City of De Soto and Jefferson County, it will be posted to the U.S. Army Corps of Engineers-St. Louis District website. It is also **recommended** for the City of De Soto and Jefferson County to post the Floodplain Management Plan to their respective websites to allow for more community-based involvement before any implementation of the Plan will occur by each community's officials or governing boards. Also, the Citizens' Committee for Flood Relief working with the Thriving Earth Exchange, American Geophysical Union are planning communication efforts to take elements of the plan and communicate them with the public.

8.4 Monitor, Evaluation, and Changes to the Floodplain Management Plan

The City of De Soto and Jefferson County, in partnership with other local, state, and federal agencies and nonfederal organizations as well as the public will initiate quarterly meetings to review the status of the FMP's implementation. There will also be an annual review of the Upper Joachim Creek Floodplain Management Plan with technical staff members who will monitor and evaluate activities related to the aforementioned Action Plan.

The annual review will discuss effectiveness of the following items and provide any recommendations or changes:

- Adopted policies and regulations
- Public outreach projects conducted and what products were produced
- Infrastructure improvements completed.

An annual report outlining discussion and identifying issues by technical staff members will be made to the respective Boards and, if necessary, to the municipal boards.

Substantial changes to the Action Plan or other parts of the Floodplain Management Plan will be made through a formal public hearing or similar public outreach process.

Every five (5) years following the initial adoption of the Upper Joachim Creek Floodplain Management Plan, a formal review and update will be conducted to include changes in the watershed, risk assessment, and needed updates to the strategies, tools, and Action Plan.

9 References

FEMA has a series of "how-to guides" on planning, to help communities meet the multi-hazard mitigation planning criteria. They can be found at www.fema.gov/hazard-mitigation-planning-resources#1.

Getting Started: Building Support for Mitigation Planning (FEMA-386-1) covers planning Phase I and CRS planning Steps 1-3.

Understanding Your Risks: Identifying Hazards and Estimating Losses (FEMA-386-2) covers planning Phase II and CRS planning Steps 4-5.

Developing the Mitigation Plan: Identifying Mitigation Actions and Implementation Strategies (FEMA-386-3) covers planning Phase III and CRS planning Steps 6-8.

Bringing the Plan to Life: Implementing the Hazard Mitigation Plan (FEMA-386-4) covers planning Phase IV and CRS planning Steps 9-10.

Integrating Manmade Hazards into Mitigation Planning, FEMA-386-7.

Reducing Damage from Localized Flooding: A Guide for Communities, FEMA-511 (2005). Also available at www.fema.gov/library/viewRecord.do?id=1448**.**

Planning for Post Disaster Recovery and Reconstruction, American Planning Association (APA) Planning Advisory Service, 346 pages, APA Report # 483/484, FEMA-421 (1998). www.fema.gov/library/viewRecord.do?id=1558.

Planning for a Sustainable Future: The Link Between Hazard Mitigation and Livability, 43 pages, FEMA-364, 2000. Also available for downloading at http://www.fema.gov/media-library/assets/documents/2110?id=1541.

Reducing Losses in High Risk Flood Hazard Areas-A Guidebook for Local Officials, FEMA-116, 1987. Also available for downloading at www.fema.gov/library/viewRecord.do?id=1508.

"Mitigation Benefit Cost (BCA) Toolkit Compact Disc." This CD includes all the FEMA BCA software, technical manuals, BCA training course documentation, and other supporting material and BCA guidance. Copies can be obtained by calling FEMA's toll- free BC Hotline at 1-866-222-3580

10 Appendices

Appendix A	Public Involvement Results, June 2018
Appendix B	USACE Valle Lake Dam Report, July 1981
Appendix C	Deleted
Appendix D	National Nonstructural Committee Assessment with Enclosures, January 2019
Appendix E	National Nonstructural Committee - North Main Street at De Soto Interior Drainage
Appendix F	USACE Sediment Deposit Removal Investigation
Appendix G	USACE Analysis of National Nonstructural Committee Assessment
Appendix H	Potential Funding Sources
Appendix I	Not Used
Appendix J	CRS Planning Credit Activity Checklist
Appendix K	2019 FIRMettes for Upper Joachim Creek