IV. Strategies and Tools

The Technical Advisory Group considered a long list of strategies and tools that could address the flood risk on the Big Blue River. This section serves to describe the reasons for inclusion or rejection of those tools. The Big Blue and Kansas Rivers Floodplain Management Plan categorize the list of strategies and tools as follows:

- Modifying Human Susceptibility to Flood Hazards
  - Flood Risk Adaptive Measure
- Modifying the Impact of Flooding
- Preserving and Restoring the Environmental Quality of Floodplains
- Modifying Floodwaters

The Actions, the Tools, the Measures.

The tools are in fact the "measures" the planning community refers to with very deliberate terminology, because these will lead to the eventual action items in the floodplain management plan.

These four categories of strategies and tools were created by the Federal Interagency Floodplain Management Task Force (FIFM-TF) during the formation of a Unified National Program for Floodplain Management. The four categories and corresponding tools are the "measures" the flood risk management professional refers to with very deliberate terminology, as they lead to the eventual action items in the floodplain management plan. This terminology serves to clarify 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 study, inform or react to a flood risk. 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 on a property or properties that an individual, the city, counties or partnering agencies can perform. Features can include major civic 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," which originates from FEMA policy. This plan will refer to these types of features as "flood risk adaptive measures."

Stakeholders will view each tool differently and a consensus will be established over time. The city and counties evaluated and designated each of the possible tools using one of the following terms after involving the stakeholders through public involvement in the decision process:

- **Not Advisable**
- **Further Evaluation Needed**
- **Advisable**

These specific terms will appear with each tool prior to the discussion section, and also in the body text in bold format, because these represent important supporting information to the action items later in the floodplain management plan. These terms help stakeholders to

Decision History

This decision history is an important part of the floodplain management plan because a community's unique story is made up of a risk assessment followed by years of decisions about how to manage floodwaters and the floodplain.

better understand the decision history for flood risk management along the rivers and their tributaries. This decision history is an important part of the floodplain management plan, as a region's unique story is made up of a risk assessment followed by years of decisions about how to manage floodwaters and the floodplain. The specific terms also help improve public involvement and can be applied to specific reaches of a river or a tributary. Since the public needs to be involved with defining their individual acceptable level of risk, these terms facilitate buy-in and get the community focused on the actual action items identified later in this plan. These action items eventually lead to more effective hazard mitigation by the City, the Counties and State and Federal agencies, whom are all partners sharing the responsibility of reducing the risks from flooding and other natural disasters.

This input based approach allows an FMP to be established and work to begin on realizing the goals of the plan. Communities can work on annual revisions to the FMP and update evaluations on the tools' effectiveness.

Over a period of several years, consensus will be established and a collaborative approach to building projects can be done, effectively leveraging the invested infrastructure dollars in the City and Counties. This can assist with implementing various tools in the Action Plan.

Strategy 1: Modifying Human Susceptibility to Flood Hazards

This strategy and set of tools relates to measures directed toward managing the floodplain. These measures include specific activities and features. Activities include land use regulations, public redevelopment policies, flood warning systems and flood emergency preparedness plans (including emergency action plans and flood fighting plans). Features include flood-proofing buildings in the floodplain, berms and floodwalls for buildings, elevation of buildings, filling basements, acquisition of buildings (for demolition), and relocation of buildings. This deliberate terminology distinguishing between activities and features, will help the reader understand that floodplain management plans, emergency action plans, flood fighting plans and hazard mitigation plans are not the same.

Tool: Development Policies and Land Use Regulations

Advisable

In several meetings of the TAG and PAW, land use policies and regulations were at the top of the list of objectives. Topics that are more specific included:

- Prohibit development in the:
  - Floodway
  - Historical flood areas
  - 1% Annual Chance Floodplain
  - Future Conditions Floodplain
- Establish higher standard floodplain regulations
- Limit repair/improvements of existing structures in the floodplain
- Establish Comprehensive Plan policies identifying appropriate development/redevelopment areas outside of floodplain.
- Compensatory Storage

This tool covers both development policies and land use regulations. Development policies can be found in the Comprehensive Plans for the City and the two counties. These policies help guide the

community's decisions of where new development or redevelopment should occur. An example of this tool put into practice, is the Manhattan Urban Area Comprehensive Plan documenting the area inundated by the 1993 flood, designating this area as environmentally sensitive, and implementing policies to adequately protect this area.

Land use regulations can be used to implement a wide variety of site and building requirements, restrictions, and prohibitions to protect new and existing developments. The National Flood Insurance Program (NFIP) and the State of Kansas have established a minimum standard of floodplain regulations. Some of these minimum standards may not be appropriate for a growing community like Manhattan and the surrounding areas in Pottawatomie and Riley counties, or for places located directly below a major dam and reservoir.

This tool is readily acceptable as an effective measure to protect existing homes, businesses and new developments from flooding. This tool is **advisable** to be included in the Action Plan of the FMP to invoke changes to development practices to better protect existing and future development from flood damages.

Tool: Flood Warning Systems

Advisable

Flood warning systems are a flood risk adaptive measure and are categorized as both an activity and a feature. Flood warning systems include several components and are usually part of a process written into an emergency response plan (not to be confused with this floodplain management plan). The first component is a flood threat recognition system. The next component is a warning dissemination system for risk communication. Emergency response follows and should be integrated through use of an emergency response plan. This means collaborative involvement across several professional groups, including emergency responders, public works, and staff charged with operation and maintenance of flood features like levees or dams. Because a flood warning system is inter-related with an emergency action plan, the tool is not simply a feature. Maintaining the system and integrating it with the emergency action plan make this an on-going activity.

Flood Forecast Inundation Map

Advisable

Through an interagency project, a tool has been developed for the Big Blue River known as a Flood Forecast Inundation Map (FFIM). The FFIM is tied to the USACE flow releases from Tuttle Creek Reservoir. This tool was of high importance during the TAG and the PAW meetings to visually communicate special impacts of flooding. The FFIM is similar to the Wildcat Creek FFIM located near Scenic Drive. Agencies involved in creating the FFIM are the Kansas Hazard Mitigation Team, the KDA Division of Water Resources, the USACE, KDEM, the NOAA National Weather Service (NWS), and USGS. The system is hosted on the NWS Advanced Hydrologic Prediction Service (AHPS) and is operated by NWS in perpetuity. The system includes a set of static map books tied to the USGS gage (#06887000) near Rocky Ford on Barnes Road. This system provides valuable information to the public and to emergency responders. As an example of the effectiveness of this tool, during a series of rain events in June, 2014, the Wildcat Creek AHPS site received over 600 unique visits. This website activity during storm events shows the public and those responsible to

act in an emergency are using the FFIM to make decisions in response to the elevation of Wildcat Creek, before the creek reaches flood stages. It is further **advisable** the FFIM be tied to emergency action plans, since the action stages developed with the NWS are thresholds for specific response tasks.

Warning Dissemination, Flood Warning Lights & Sirens

Advisable

A flood risk communication tool, such as flood warning lights on roadways, can notify travelers of high water on roadways and can help motorists from being trapped in moving water or worse, drowning, by warning of the dangers and the need to turn around. During the Manhattan Levee study, the hydraulic engineers noted the U.S. Hwy 24 Bridge and the associated roadway will overtop for the 0.5% annual exceedance probability (a 200-year storm). This highway corridor is the most direct evacuation route for some people living and working in the area. A set of flood warning lights tied to the Flood Forecast Inundation Map and the associated NWS forecast point and USGS gage is recommended to be located near the U.S. Hwy 24 Bridge that crosses the Big Blue River. Other areas along the Big Blue River may benefit from a flood warning light system for motorists. Similar warning lights that are tied to action stages have been established by a joint City/Counties emergency preparedness plan for Wildcat Creek (includes emergency action plan and flood fighting emergency operation plan). It is **advisable** that this general system be provided along the Big Blue and Kansas Rivers.

Warning Dissemination, Multi-Media

Advisable

As a flood risk communication tool, multi-media approaches, such as Instant Messaging and Short Message Services (SMS), have advanced considerably, although other traditional means, such as radio and television, are also still relevant. An objective noted during public involvement work with the TAG and the PAW was to use public warning systems via multi-media outlets. One **advisable** step is to further promote the region's use of the Northeast Kansas Notification system and website announcements. During major flooding events similar to 1993, daily status updates could be channeled through the local television and radio stations, and social-media outlets, such as Twitter and Facebook. Pre-identified roles could be established to present daily updates during the flood to local "traditional" media outlets, as well as through the newer outlets. Another **advisable** step is to formalize public media engagement through a section in a new emergency action plan. This may include predefined messages that correspond to action stages identified with the NOAA NWS for the FFIM for the Big Blue Kansas Rivers, based on existing river gauges in the area.

TOOL: EMERGENCY OPERATIONS PLANS

Advisable

Corresponding with the previously mentioned flood warning system is an emergency operations plan (EOP) for flooding. Generally speaking, emergency operations plans include several topics related to preparing for, responding to, and mitigating against the risk:

- Flood risk management;
- Emergency communications;
- Emergency response; and
- After event actions.

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

Flood Risk Management: Flood risk management is an element of every EOP. The plan is designed to provide necessary actions based on water levels released from Tuttle Creek Reservoir or the water elevations on the Big Blue River. Using the FFIM described above, Emergency Managers for Manhattan, Riley County and Pottawatomie County can outline when certain actions should be initiated. These action stages could be the activation of the Emergency Operation Center, the activation of outdoor warning sirens, mobilization of emergency personnel, closure of roads at risk of flooding and the evacuation of impacted areas.

Pottawatomie County and Riley County are part of the Regional I Hazard Mitigation Plan. Each county has an EOP, which is based on all-hazards planning. These emergency plans support functions rather than individual hazards for planning and guidance during an event.

Emergency Communication: As with any emergency situation, communicating to the public is key to describe the event, discuss the risks, and explain appropriate actions to be taken. An emergency situation is often chaotic and sometimes communicating the risk and other necessary information is not always done adequately. An emergency communication guide can create a framework of roles and responsibilities, templates, and suggested media outlets. This would then cause the release of effective information, timely flow of information, and reduce the duplication of messages and/or conflicting messages from different sources.

Pottawatomie County and Riley County participate in and promote the Northeast Kansas Notification system. This is a subscription based service that provides emergency notifications such as storm warnings, road closures, and other emergency information via text message, telephone call, or email. This system can be promoted more effectively to reach a broader audience and provide more timely emergency notification.

Emergency Response: Riley County and Pottawatomie County have Emergency Operations Plans (EOP). Riley County has several documents attached to their EOP which pertain to evacuation procedures for known flood-prone locations in the county, as well as action stages for several rivers/creeks in the area.

After Event Action Plans: After an event, items such as damage assessment, material disposal, clean up, recovery communications, and economic recovery need to be addressed. These are completed using the Emergency Support Functions in the EOP or referring to the Debris Management Plan.

This is an **advisable** activity to create a prepared and resilient community in the face of the flood risk along the Big Blue River. 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.

Flood Risk Adaptive Measure

Flood risk adaptive measures are construction projects and/or operational actions that can be taken to lessen the likelihood of damages from flooding. Careful consideration needs to be made before selecting the appropriate flood risk adaptive measure. Items to consider are:

- The probability/frequency of flooding
- The depth of flood waters
- The velocity of flood waters
- The duration of the flood event
- The cost of the construction project or actions
- The financial benefits from the measures taken, including
  - Reduction in flood insurance costs
  - Reduction in structural and content damage costs

These tools can be applied to several of the reaches defined in the study area. Figure 17 helps illustrate some of the subdivisions that should consider nonstructural measures.

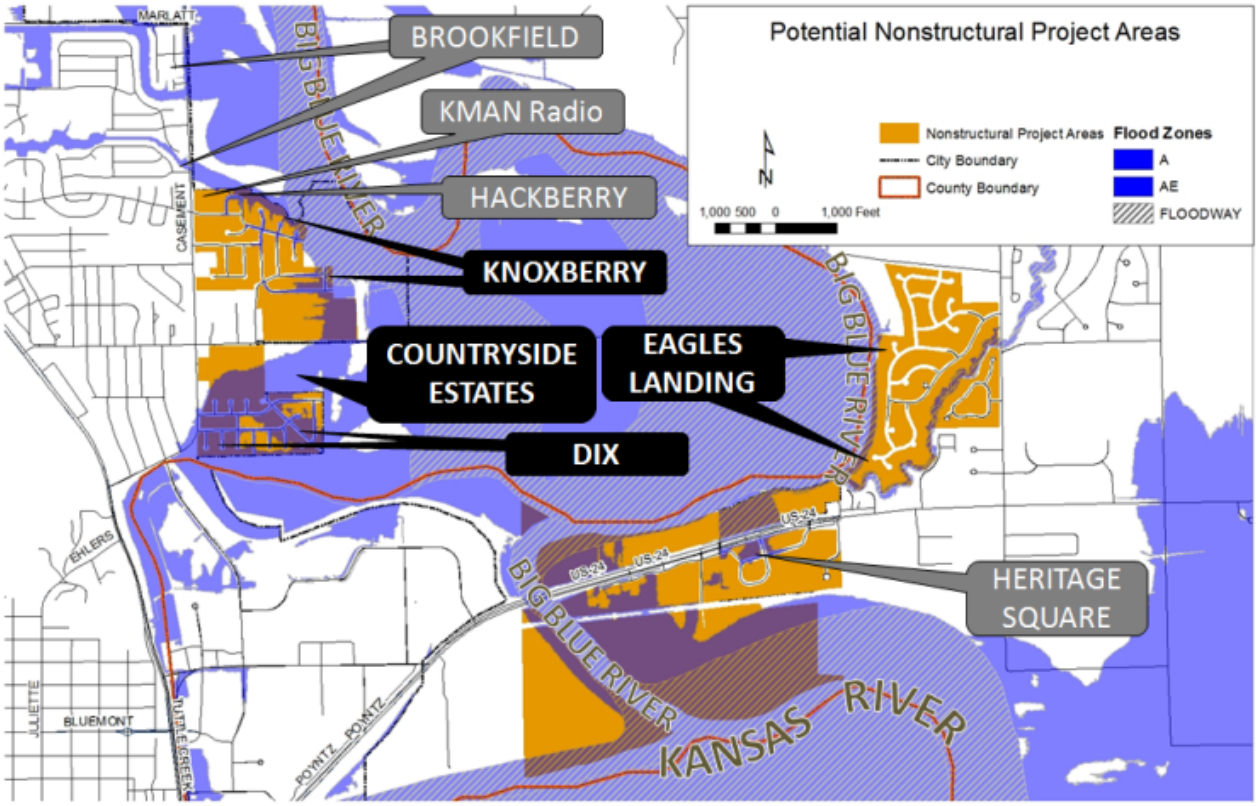


FIGURE 16: SUBDIVISIONS IDENTIFIED FOR CONSIDERING NONSTRUCTUAL MEASURES

Tool: Elevation of Buildings

Advisable

This flood risk adaptive measure lifts an existing building to an elevation that is greater than the elevation of the 1% annual chance flood. The elevation of buildings is a tool that can be used with several approaches. The most common approach in this region is to elevate a building on earthen fill material. For structures with poured concrete foundation walls, extending the stem walls is possible. Elevation of slab-on-grade foundations can be elevated in a similar fashion. In some cases, the structure may be elevated on piles. In others cases, pillars or columns could be used. These last two cases are not frequently used in the region, but are accepted methods to meet the objective of protecting a home from the flood risk.

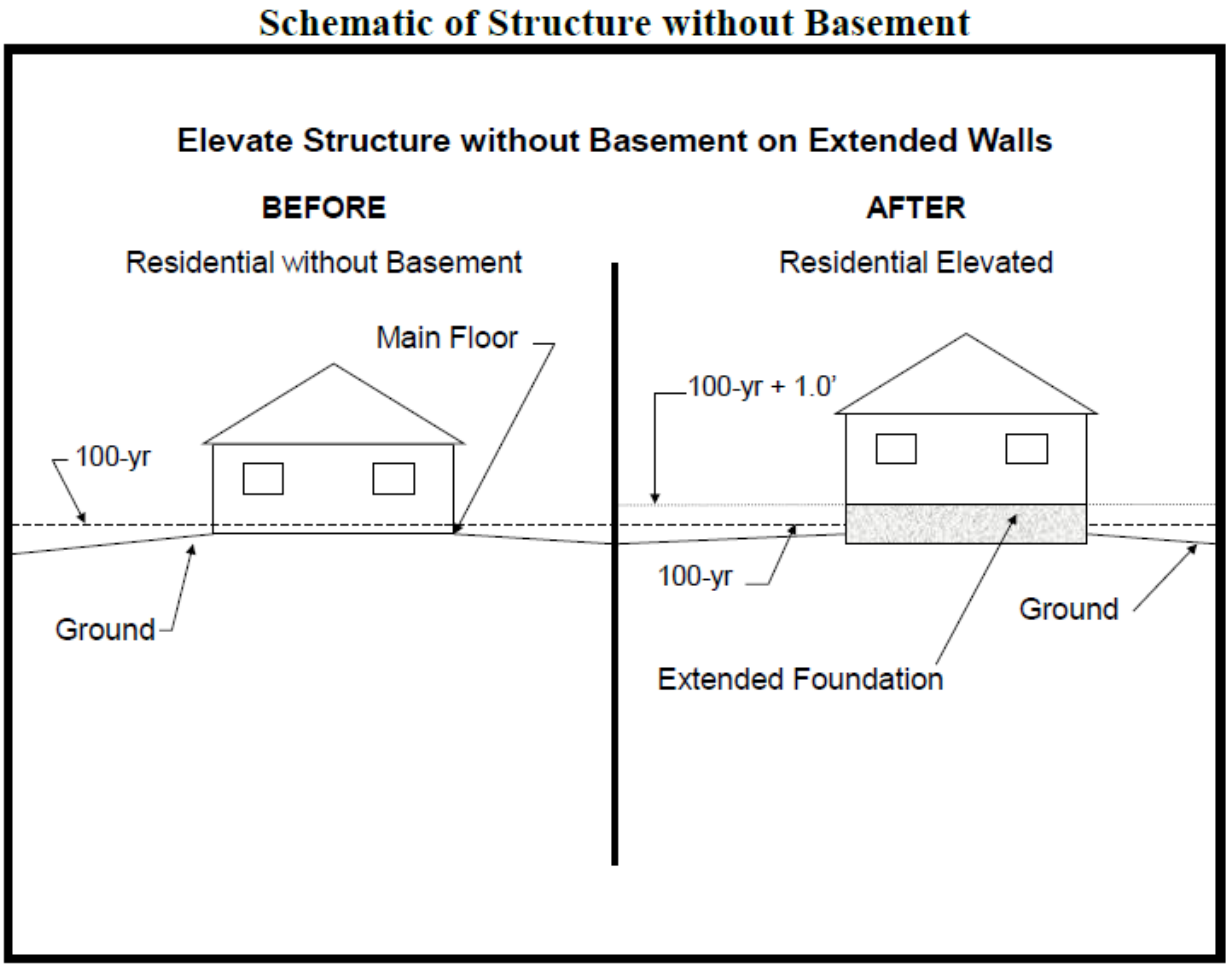


Figure 17: Elevation buildings to minimize flood risk

Individuals need to remember the challenge of accessing an elevated home or business when a flood occurs. The effect of an elevated building could be the creation of an island within the floodplain. Considering the type of flood risk for the Big Blue and Kansas Rivers, the island effect could last for an extended period. The challenge could be evacuating from the elevated structure or

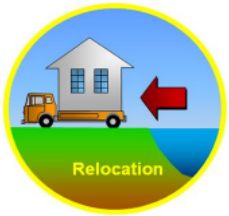
the ability of emergency service personnel to reach the building during a flood event. The elderly or disabled should take this challenge into consideration.

This tool is generally accepted as a mitigation option for new and existing structures at risk of flooding. Through the public involvement process and surveys gathered in 2014, 16% of respondents indicated interest in elevating their home. This tool is **advisable** for its effectiveness and the interest expressed.

Further research and evaluations are required to understand better cost-engineering aspects of the tool for the variety of structures in the Big Blue and Kansas River floodplains. Several federal programs are available to assist in mitigating the flood risk in the area. Because of the federal funds available, a comprehensive flood hazard mitigation study should be considered. This study could be created across the Big Blue and Kansas River floodplains, and even throughout the two (2) counties. For each mitigation area, off-the-shelf projects should include groupings of structures which may be tied to subdivisions, types of flood risk (considering flood depth, velocity, rate-of-rise and duration of inundation), and population at risk. Groupings may also be tied to the type of structure and common elements, as this may lead to a more effective future construction contract. This approach could assist in developing a prioritization list and increase the benefit-to-cost ratio to meet federal grant program requirements. By evaluating this tool for specific properties and developing a prioritized list of projects, these projects can be mobilized when the next round of hazard mitigation funds become available.

Tool: Relocation of Buildings

Advisable



This flood risk adaptive measure requires physically moving the at-risk structure away from the floodplain area. In some cases, relocation of a structure can occur on the same property where it is currently located, but is safely away from the high-risk flood area. In other situations, the structure is moved entirely away from the property on which it is currently located because there is no viable location where the structure would be safe from flooding. When the structure is moved away from the property, the land is typically purchased and future development is prohibited.

This tool is generally accepted as a flood risk adaptive measure for existing structures at risk of flooding. The public involvement process and the 2014 survey indicated 33% of the respondents were interested is this tool. This tool is an **advisable** feature. Once again, further research and evaluations are required to better understand cost-engineering aspects of the tool for the variety of structures in the Big Blue and Kansas River floodplains. As discussed above in the Building Elevation tool, opportunities exist to study this tool in a comprehensive manner to create a list of -projects that would be prioritized and ready to submit for federal grant funding.

Figure 18: Example post-project aerial view of a site where residences were relocated

Tool: Floodproofing Buildings in the Floodplain

Floodproofing is a possible approach to defending against rising floodwaters outside a residential home or commercial building. Two approaches are wet or dry floodproofing measures (explained below). *It should be noted these tools may not reduce the cost of flood insurance for residential structures.* Only commercial, industrial and accessory structures are allowed to be floodproofed according to the National Flood Insurance Program (NFIP). Residential structures could benefit from floodproofing measures in certain situations; however, the effort will not reduce the cost of the flood insurance premium for the residential structure.

Tool: Wet Flood Proofing

Further evaluation needed

Dependent on its application, this tool was found to be acceptable. The evaluation is supported by public involvement and surveys gathered in 2014, where 16% of respondents indicated interest in wet floodproofing.

Wet floodproofing is defined as permanent or temporary/contingent measures applied to a structure and/or its contents to prevent or provide resistance to damage by allowing floodwaters to enter the structure. This flood adaptive measure is applicable either as a stand-alone measure or as a measure combined with other measures, such as elevation.

As a stand-alone measure, all construction materials and finishing materials need to be water resistant and all utilities must be elevated above the design flood elevation. Wet floodproofing is quite applicable and generally **advisable** for commercial and industrial structures when combined with a flood warning and flood preparedness plan. This measure is generally not applicable to deep flood waters and/or high velocity flows.

Due to the structural and health risks associated with allowing flood waters to inundate a dwelling, wet floodproofing is generally **not advisable** as a mitigation option for residential applications. The one exception is the use of engineered openings in an elevated or "crawl space" foundation of a

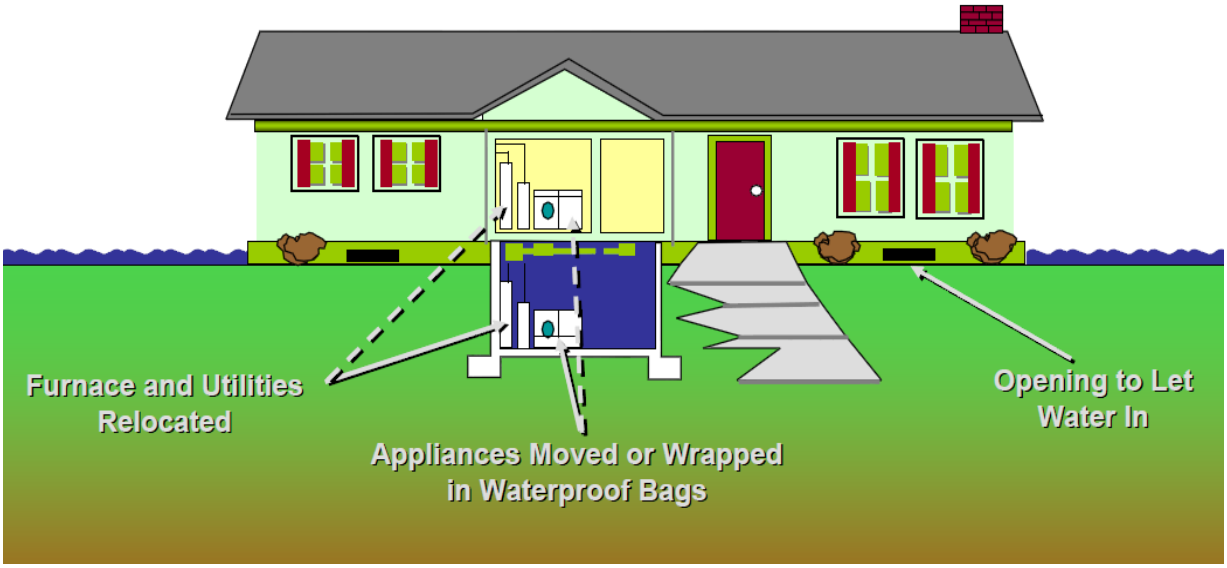


Figure 19: Wet Flood Proofing

home. In this application, openings or vents of a specific size are installed in a new or existing foundation to allow flood waters to enter the elevated foundation and equalize the hydrostatic pressure of the flood waters. Without these vents, the force of the flood waters could be enough to damage or destroy the foundation. The specific requirements of FEMA (FEMA, August 2008) and local floodplain regulations require permits and oversight by local officials. The installation of this type of wet floodproofing could reduce the cost of flood insurance premiums for a home if installed appropriately. Property owners wishing to utilize this method should contact their local Floodplain Administrator.

Dry Flood Proofing

Further evaluation needed

Dependent on its application, this tool was found to be **Acceptable**. The evaluation is supported by public involvement and surveys gathered in 2014, where 50% of respondents indicated interest in dry floodproofing.

Dry floodproofing is defined as a measure involving sealing the walls of a structure with water-proofing compounds, impermeable sheeting or other materials and using closures for covering and sealing openings from floodwaters.

This tool is **Acceptable** for commercial and industrial structures and can be used in residential homes in specific circumstances, such as when flood waters are not anticipated to be deep or move at fast speeds. This tool achieves flood risk reduction, but is not recognized by the NFIP for any flood insurance premium rate reduction if applied to a residential structure. Commercial and industrial structures can use this tool and realize an improved flood insurance premium. Based on laboratory tests, a “conventional” built structure can generally only be dry floodproofed up to 3-feet in elevation. A structural analysis of the wall strength would be required for higher protection. Openings into the structure, such as doors and windows below the base flood elevation, would need watertight closures to achieve the desired results. Sump pumps and French drain systems should be installed as part of the measure. For buildings with basements and/or crawlspaces, the only way dry floodproofing could be effective is for the first floor to be made impermeable from inundation of floodwaters.

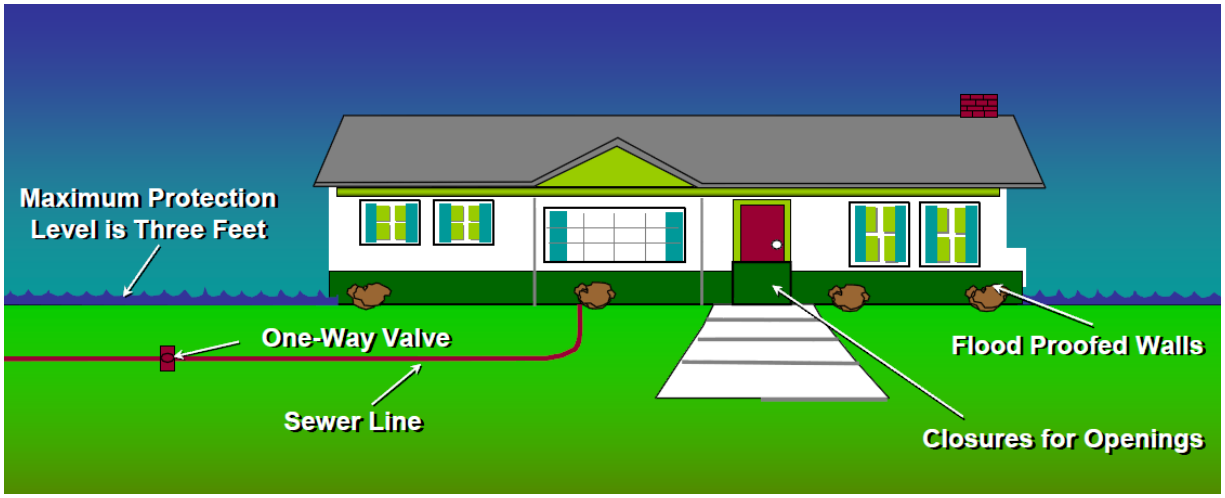


FIGURE 20: DRY FLOOD PROOFING

As discussed, dry flood proofing for residential structures may be applicable in limited situations, but is not an eligible measure to reduce the cost of flood insurance premiums. This tool would be an acceptable application for homes on the outer fringe of the area of the base flood, and/or within the 0.2% annual chance floodplain (500-year floodplain). These areas are generally impacted by shallow, low velocity floodwaters that cause damage to flooring, HVAC and other utility equipment low to the floor. In these situations, temporary water-proof barriers to building openings, such as doors, could be installed and foundations could be sealed to prevent infiltration into the home. This would not be an acceptable solution for deep or fast moving floodwaters. This tool would also not be acceptable to a homeowner seeking to lower their flood insurance premiums, as these flood damage reduction measures do not qualify under the NFIP.

TOOL: BERMS AND FLOODWALLS FOR BUILDINGS

Further evaluation needed

This tool could be **advisable** if certain measures are undertaken to limit or prevent adverse impacts on adjacent properties. The evaluation was supported by public involvement and surveys gathered in 2014, where 33% of respondents indicated interest in installing a berm or a floodwall around their building.

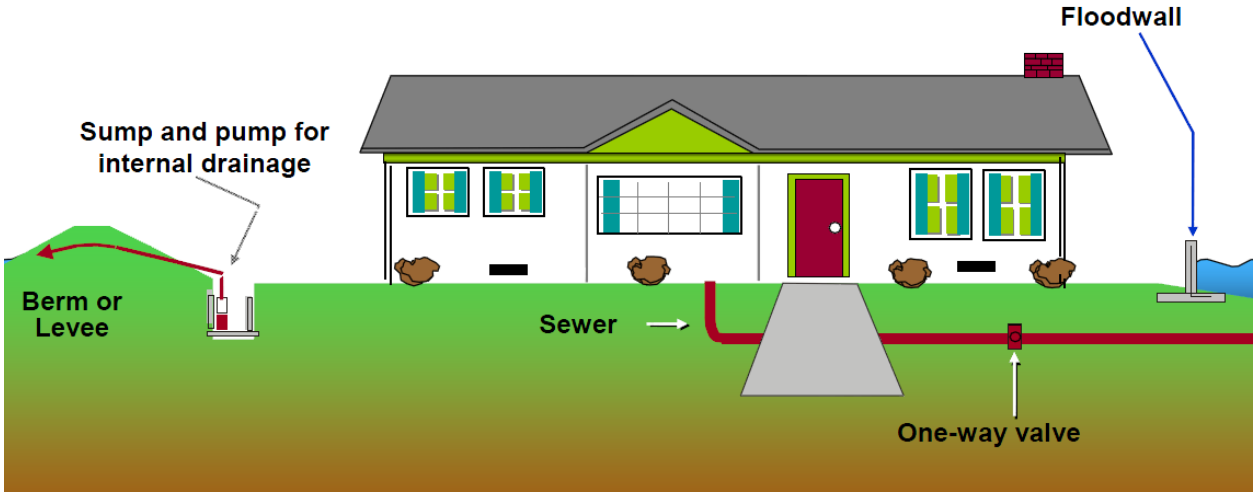


FIGURE 21: BERMS AND FLOODWALLS

This flood adaptive measure is applicable on a small-scale basis. It is intended to reduce the frequency of flooding, but currently would not eliminate floodplain regulation and flood insurance requirements. These measures can be placed around a single structure or a small group of structures. As a flood-adaptive measure, berms and floodwalls should be constructed to no higher than six (6) feet above grade and generally cannot raise the elevation of the floodwaters. The "No Rise" requirement is to ensure the berm or floodwall will not displace the floodwaters onto an adjacent property and increase their risk and cost of flooding.

In order to eliminate the need for flood insurance and floodplain regulations, the berm or floodwall would need to be substantially built to the level of a major civic works project, such as a levee, which would generally not be financially feasible for most property owners and neighborhoods.

Berms and floodwalls for buildings would be a tool for a smaller number of the homeowners in the Big Blue and Kansas River floodplains. This tool requires a larger effort and engineering cost to ensure it will not adversely impact adjacent properties and is designed to withstand the forces of floodwaters. Also, space constraints between structures can be a significant issue, requiring floodwalls instead of berms to be installed, which may be more expensive. Businesses may find this the best approach for their property. Further evaluation is needed to study applicability of this measure and outreach to stakeholders is needed to identify local interest. This could be organized through a workshop with homeowners associations or neighborhood groups. Cost engineering is needed to help individuals understand what the estimated cost and benefits would be to implement berms or floodwalls. For the most part, individual property owners need to pursue implementation of this tool.

Tool: Fill or Conversion of a Basement with Main Floor Addition for Buildings

Further Evaluation Needed

This nonstructural technique consists of filling in the existing basement or converting the basement space to an uninhabitable crawl space, without elevating the remainder of the structure. The measure is applicable only if the 1st floor of the structure that is above grade is higher than the base flood elevation. In addition to filling in an existing basement, homeowners may also consider placing an addition onto the side of the structure or add an additional floor above to compensate for the lost living space. In rare cases, the former basement area could become space for storage; however, this is generally discouraged because of the possibility of the space being converted back to living space. New owners may wish to "re-purpose" the storage area as a basement again and since inspections for compliance would be difficult, use of this area for storage is not recommended.

As this measure results in the reduction of living space and the loss of the primary area for protection against tornadoes, the survey participants did not openly accept this measure. There were zero respondents that indicated interest in this tool. However, it still is an acceptable tool to minimize the risk of flooding and can substantially decrease the cost of flood insurance. This tool is listed as **further evaluation needed** to better understand the cost of this tool and determine whether or not some property owners may be interested.

Schematic of Structure with Basement Filled in and Addition on Main Floor

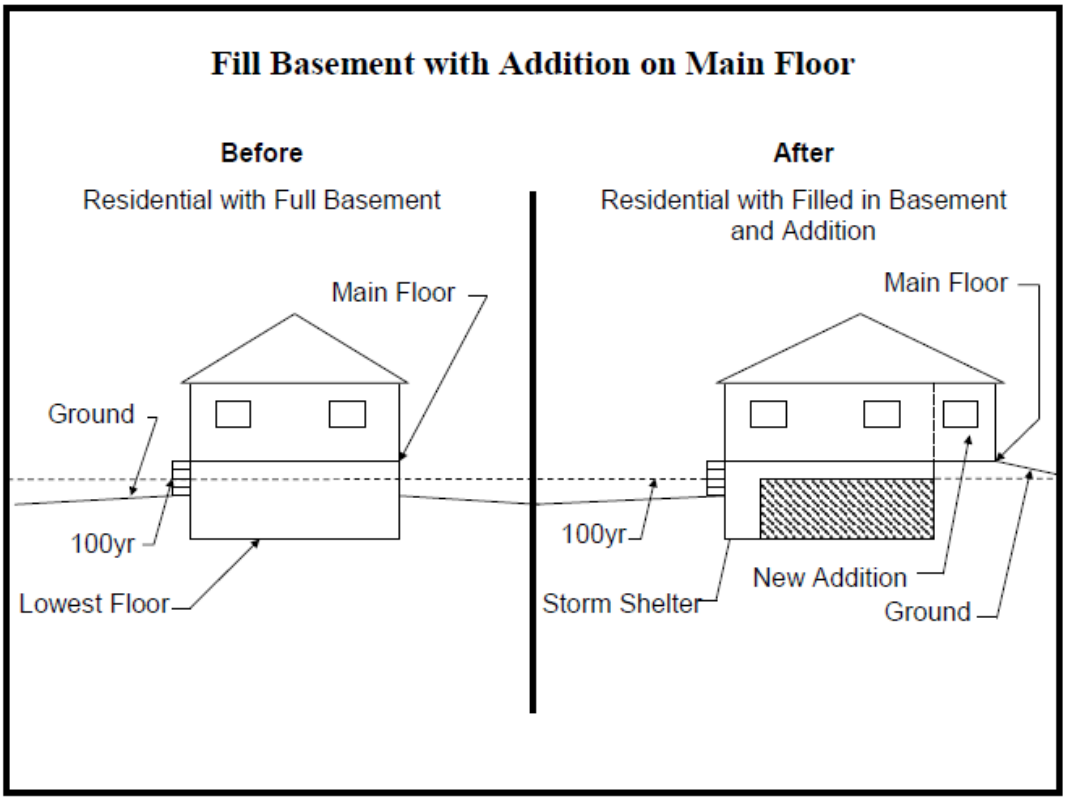


Figure 22: Filled Basement

Tool: Acquisition of Buildings

Advisable

This tool was found to be acceptable. The evaluation was supported by public involvement and surveys gathered in 2014, where 66% of respondents indicated interest in being bought out or selected the tool Acquisition of Buildings on the survey.

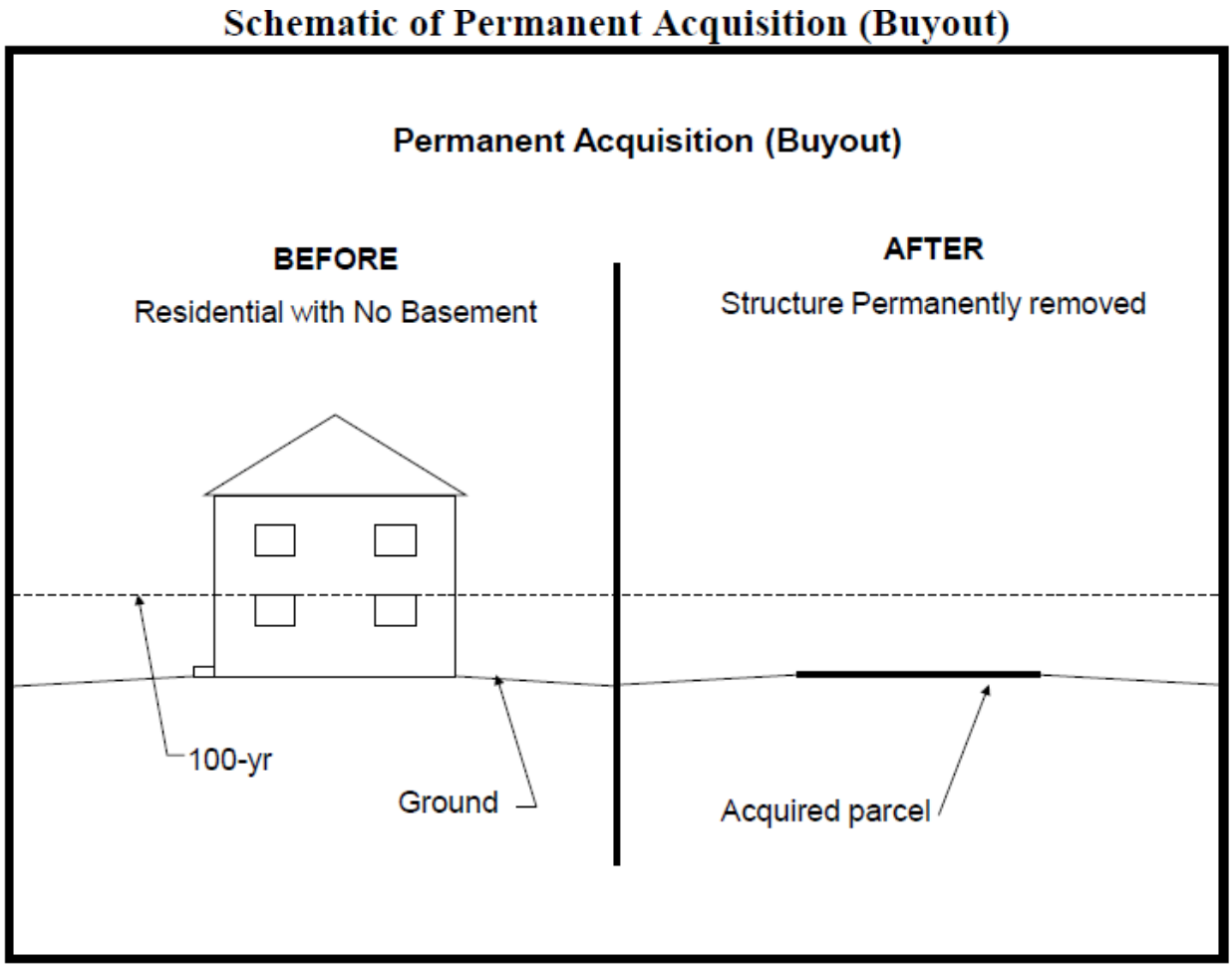


Figure 23: Permanent Acquisition

This flood adaptive measure consists of buying the structure and the parcel of land. The structure is either demolished or is sold and relocated to a site outside of the high risk floodplain. The purchased land is then converted to passive open space, used for recreational purposes or allowed to be reclaimed by the river. Part of a proposed project could be the development of adequate and comparable home sites outside of the floodplain in order to provide locations where displaced persons may build new homes within an established community.

This tool's feasibility will depend heavily on a funding mechanism. Federal, state and local resources exist. The most likely funding source is federal grants from Housing and Urban Development, FEMA, or USACE. In all of these cases, the new use of the land would be required to

be undeveloped in perpetuity or could be used for recreation, such as a playing field, environmental enhancement, ecosystem restoration, or a combination of these. Concept projects should be studied and developed and leverage as many opportunities as possible. The creation of open space, public involvement processes and other similar activities could provide eligible credit for the communities in the FEMA Community Rating System.

Groupings of structures in each impacted area may be conceptualized to create a list of potential projects should funding become available. Groupings may be tied to subdivisions or neighborhoods, types of flood risk (considering flood depth, velocity, rate-of-rise, duration of inundation and population at risk). Groupings may also be tied to the type of structure and common elements, which may lead to a more effective future construction contract.

Strategy 2: Modifying the Impact of Flooding

This strategy and set of tools has to do with managing the floodplain with the following specific activities: information and education, flood insurance, tax adjustments, emergency relief, and post-flood recovery processes.

Tool: Information and Education

Advisable

A primary purpose of the FMP is communicating flood risks and increasing the public understanding of flood hazards. City and County officials should, through a variety of methods and media, further inform residents, business owners and the general public of the flood risks present on the Big Blue and Kansas Rivers

Flood Risk Mapping: Both the City and the two Counties have a wealth of flood risk information available for the public in the form of FEMA flood studies, local flood studies, as well as "non-regulatory" flood maps provided with these studies, and other flood risk efforts. Providing this information, or at least advertising that this information is available to the public, is highly effective.

The standard way for a community to express the risk of flooding is through the FEMA Flood Insurance Rate Maps (FIRMs). These floodplain maps were recently updated using the most up to date information for both Counties and the City. In addition to the traditional paper floodplain maps, this information is made available digitally for web maps through FEMA. The City of Manhattan, Pottawatomie County and Riley County have all incorporated this digital information into their existing web maps on their respective websites.

In addition to the FEMA floodplain maps, other information on flooding in the area, such as historic floodplain maps, localized flood studies and "non-regulatory" flood maps, should be provided to the residents, businesses and property owners in an easy to acquire manner. An example of a "non-regulatory" flood map is depth grid maps representing not only the location of the floodplain for a particular storm event, but also the depth of the floodwater. The City of Manhattan facilitated the creation of depth grid maps for the floodplains in the City and the rural areas surrounding the City. These maps provide valuable information to the impacted resident or business owner, as well as to City and County officials for flood preparedness. Other non-regulatory maps, such as flood risk probability maps and floodwater velocity maps, could also be created to further explain the risk of flooding for an area. The City and Counties should look to expand these map products and share them with the residents and business owners, where available.

As a part of the USACE Silver Jacket Project Big Blue and Kansas River Flood Planning Project, NOAA and the National Weather Service (NWS) has created Advanced Hydrologic Prediction Service (AHPS) web pages for the Big Blue River, from the face of the Tuttle Creek Dam to the confluence with the Kansas River. The core of the AHPS web pages is the flood forecast inundation maps (FFIMs). The FFIM on the Big Blue River helps to correlate flow releases from Tuttle Creek Dam and visualize the extent of flooding. It should be noted that because of the multitudes of variables and complexities associated with the different water elevations on the two rivers, the Big Blue FFIM ties to one specific water elevation on the Kansas River. The water elevations of the Big Blue River are adjustable to represent the releases from Tuttle Creek Reservoir. Because of these variables and limitations of the AHPS webpage, the flood information is for planning and

preparedness efforts and should not be relied upon as exact locations of floodwaters on the Big Blue or Kansas River.

The true benefit of the AHPS service is to provide individuals a mapping tool that can be used during flood events as well as information to prepare for future floods. Property owners can reference the AHPS services to plan for future development. Residents, business owners and community emergency planners can develop accurate contingency plans ahead of flood events.

During major flood events, the NWS will also provide a forecast of stages, which is valuable information to those needing to know the anticipated peak flood stage. Projecting the various stages of the river will provide several hours of advanced warning for emergency management personnel and impacted residents and business owners.

Information to Prepare and Recover: A number of local, state and federal agencies, such as the Kansas Division of Water Resources, American Red Cross, FEMA and the National Flood Insurance Program, have prepared detailed pamphlets, books and other informational pieces on how to prevent, prepare for and recover from a flood event. Officials from the City and Counties should continue to collect, review and maintain a sufficient library of information to assist residents with these topics. This information should be readily available to residents and business owners via the internet and also local libraries in the two counties.

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 the City and County offices and/or the public libraries in the two counties. A variety of media types can be used to inform residents and other interested parties about these flood related topics. The City of Manhattan, Pottawatomie County and Riley County maintain informative websites where this information can be displayed. Newsletters, newspaper advertisements, press releases, notices on utility bills and other government notices, social media and direct mailings, could be used. The 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 regarding the hazards of flooding.

During the distribution of these preventative, preparedness and recovery messages, it is recommended to more actively address vulnerable population groups. During the 2014 public involvement process, including the Public Action Working Group (PAW) meetings and the open houses, two vulnerable populations were identified and discussed. Students and soldiers, who are transient and may only be in the community for a short time, may unknowingly rent structures in the floodplain. Being new to the community, these individuals often do not know of the risks associated with flooding or how to prevent, prepare for and recover from a flood event. Specialized information techniques are **advisable** to inform these vulnerable populations. Points of contact for living arrangements at Kansas State University and at the Army garrison at Fort Riley should be utilized to inform these new residents of the flooding risks in the area. Additionally, providing the information in multiple languages is also **advisable**.

FIGURE 24: EXAMPLE STEPS, INCLUDING OUTREACH, FOR REDUCING FLOOD RISK TO ACCEPTABLE LEVELS

TOOL: FLOOD INSURANCE

Advisable

Pottawatomie County, Riley County and the City of Manhattan are participating communities in the National Flood Insurance Program (NFIP) by the Federal Emergency Management Agency (FEMA). The NFIP is similar to most other types of insurance; however, it is controlled by the Federal Government and managed by FEMA. As the City and Counties participate in the NFIP, flood insurance is available to home and business owners and tenants of the properties. If an insurable structure is located in a high risk floodplain and a federally backed loan is involved, flood insurance is mandatory. For properties not in a high risk floodplain or when federally backed loans are not involved, flood insurance is optional.

Flood Insurance is one means of establishing a resilient community. Similarly to other types of insurance, flood insurance transfers the financial risk of being impacted by a flood to a broader population, even during a catastrophic event. This tool is considered to be highly effective. Depending on the disaster and the situations, funds become available in the form insurance claims or through low-interest loans and grants to recover from a flood event and to mitigate against future flood risks. It is the individual property owners as well as the community who share the responsibility of managing flood risks by having flood insurance that will cover damages. Therefore, this evaluation lists this tool as **advisable** for the property owner to get flood insurance.

Tool: Community Rating System

Advisable

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. Riley County and the City of Manhattan are participants of CRS. To get the reduced premiums, a variety of proactive steps can be done. This floodplain management plan (FMP) is an element that can improve the community's performance in the program and increase the premium discounts. Other activities, such as higher floodplain regulations, dedication of open space in the floodplain and the outreach of information related to flood risk, can qualify for premium discounts. Several manuals on this topic are listed in the Reference section of this FMP.

Tool: Tax Adjustments and Rebates

Further Evaluation Needed

The use of tax adjustments and tax rebates are potential tools 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.

Open space along a stream provides for an area free and clear of man-made structures to allow stormwater runoff and flood waters to flow unobstructed, as nature intended. 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.

With the exception of US Army Corps of Engineers and State of Kansas land near Tuttle Creek Reservoir, the majority of the property along the Big Blue River is privately owned. As a result, the tax adjustment strategy may be effective.

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 elevate the new home above what would typically be required. During the renovations to an existing home, tax credits could be used to cover the cost of engineered openings in the foundation, relocation & elevation of utility equipment or the use of flood resistant materials instead of 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 would be needed to make these tax adjustment and tax rebate programs successful.

Tool: Emergency Relief

Advisable

Thanks to the efforts of the Big Blue River Silver Jacket project, the FEMA Flood Insurance Study update for Riley County and Pottawatomie County, efforts by the State of Kansas, USACE and the local communities, a wealth of information is available to local emergency planners, responders, and impacted residents and business owners, to provide accurate and timely information and to devise specific planning efforts for flood events on the Big Blue and Kansas Rivers.

This information can be included in the region's Multi-jurisdictional Hazard Mitigation Plan. Having this vital information included in the region's hazard mitigation plan creates the opportunity to use emergency relief funds and hazard mitigation grants when they become available through a Presidential Disaster Declaration, or other avenues from the State of Kansas and other federal agencies. These funds can address property owners' needs after an event and reduce or remove the impacts of the flood hazards.

Tool: Post-Flood Recovery Processes

Advisable

The City of Manhattan, Riley County and Pottawatomie County have significant training and real-life experience in post-flood events in their jurisdictions. Both the Manhattan Building Codes and the Floodplain Regulations for the City and the two Counties require homes and businesses impacted by flood waters be inspected to ensure they are habitable and meet all regulations and standards.

It is **advisable** that the entities along the Big Blue and Kansas Rivers will 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.

Manhattan, Riley County and Pottawatomie County officials should also focus their post-flood recovery efforts on long-term needs for a neighborhood and/or the region. These efforts could include economic recovery and infrastructure recovery plans. A significant portion of the region's commercial and industrial uses is located along the Kansas and Big Blue Rivers. Likewise, a substantial portion of the City and the rural areas source of potable water and sanitary sewer service are located along these rivers. Fortunately, the Manhattan Levee System protects many of these regionally vital amenities. However, the levee system does not eliminate the risk of flooding for these areas, and contingency plans should be in place if the worst case scenario occurs. More research is needed on this topic to develop this information.

Strategy 3: Preserving and Restoring the Environmental Quality of Floodplains

This strategy and set of tools refers to managing the floodplain with the following specific activities and environmental features: wetlands protection and restoration, erosion and sediment control, water quality enhancement, enhancement of recreation and educational opportunities, and preservation of cultural resources.

Tool: Wetlands Protection and Restoration

Advisable

Wetlands play an important role in reducing sediment and other pollutants from entering a stream channel and can reduce flood waters in small intensity storms. The City has a number of known and mapped wetlands within the city limits and there are several within the Big Blue and Kansas River Watersheds. Federal and State regulations dictate the protection, restoration and creation of wetlands. The continued protection of established wetlands in the City, Pottawatomie County and Riley County is a priority of all entities.

Where feasible, the restoration of wetlands should be considered in mitigation measures along the Big Blue and Kansas Rivers and their tributaries.

Tool: Erosion and Sediment Control

Advisable

The City of Manhattan is required to follow the Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES), Phase II program to prevent polluted storm water runoff from entering U.S. water bodies. As part of NPDES, Phase II, the City requires Notice of Intent Permits for construction projects that will disturb an acre or more of ground. The City also has adopted best management practices (BMPs) for construction sites to prevent sediment from reaching the stormwater system and staffs a full-time employee to enforce the BMP construction requirements (City of Manhattan, 2012).

Riley County has adopted riparian buffer regulations requiring specific buffer zones based on the order of the stream (Riley County, 2012).

These policies should be continued within the City and Riley County. A similar policy is encouraged to be adopted in rural Pottawatomie County to reduce erosion of stream banks and improve water quality of stormwater runoff entering tributaries of the Big Blue and Kansas Rivers.

Other agencies, such as the Riley County and Pottawatomie County Conservation Districts, provide educational and technical support and possible funding sources to preserve natural resources in the two counties.

The City has also adopted policies and procedures for post-construction BMPs, which through structural and non-structural measures, are intended to provide for long-term water quality improvement for individual lots and/or entire subdivisions (City of Manhattan, Kansas, 2012).

The City and Counties should continue to participate in these types of programs and projects to protect existing homes and businesses.

Tool: Water Quality Enhancement

Advisable

As described above in Tool: Erosion and Sediment Control, the City, Counties and other agencies have plans, policies, and regulations in place to begin addressing water quality issues. These items include pre- and post-construction BMPs and riparian buffer regulations. However, more can and should be done, where feasible. A variety of local groups and organizations can partner to address both water quality issues and other environmental concerns along the Big Blue and Kansas Rivers and in other parts of the City and the two counties. These groups include classes and organizations at Kansas State University. Collaboration and cooperation projects, such as rain barrel giveaways which have been done in the past at Sunset Zoo, can be accomplished. A number of classes at Kansas State University can assist government entities in developing educational programs and assist private property owners with technical assistance to address water quality concerns. More collaboration and cooperative endeavors should be explored to tackle these needs.

Tool: Enhancement of Recreation and Educational Opportunities

Advisable

A variety of recreation amenities exist along the Big Blue and Kansas Rivers, including the Linear Trail, Rocky Ford Recreational Area and the trails and recreational amenities in the Tuttle Creek River Pond Area (*see map below)*. Currently, there is no direct connection via a recreation trail between all of these amenities. To date, no specific master plan has been created to study and expand on this concept, however an opportunity exists. A trail network is established from the Tuttle Creek River Pond area, to the Rocky Ford Recreation Area and Dyer Road. This trail network could be extended to the city limits to connect to the Linear Trail network and area parks, making this a regional park and trail network along the rivers. An update to the Manhattan Urban Area Comprehensive Plan, jointly developed and adopted by the City, Pottawatomie County and Riley County in 2012, includes applicable policies in Chapter 5 – Natural Resources and Environment that promote the creation of trails and connected open space areas along riparian stream corridors, including the Big Blue and Kansas Rivers.

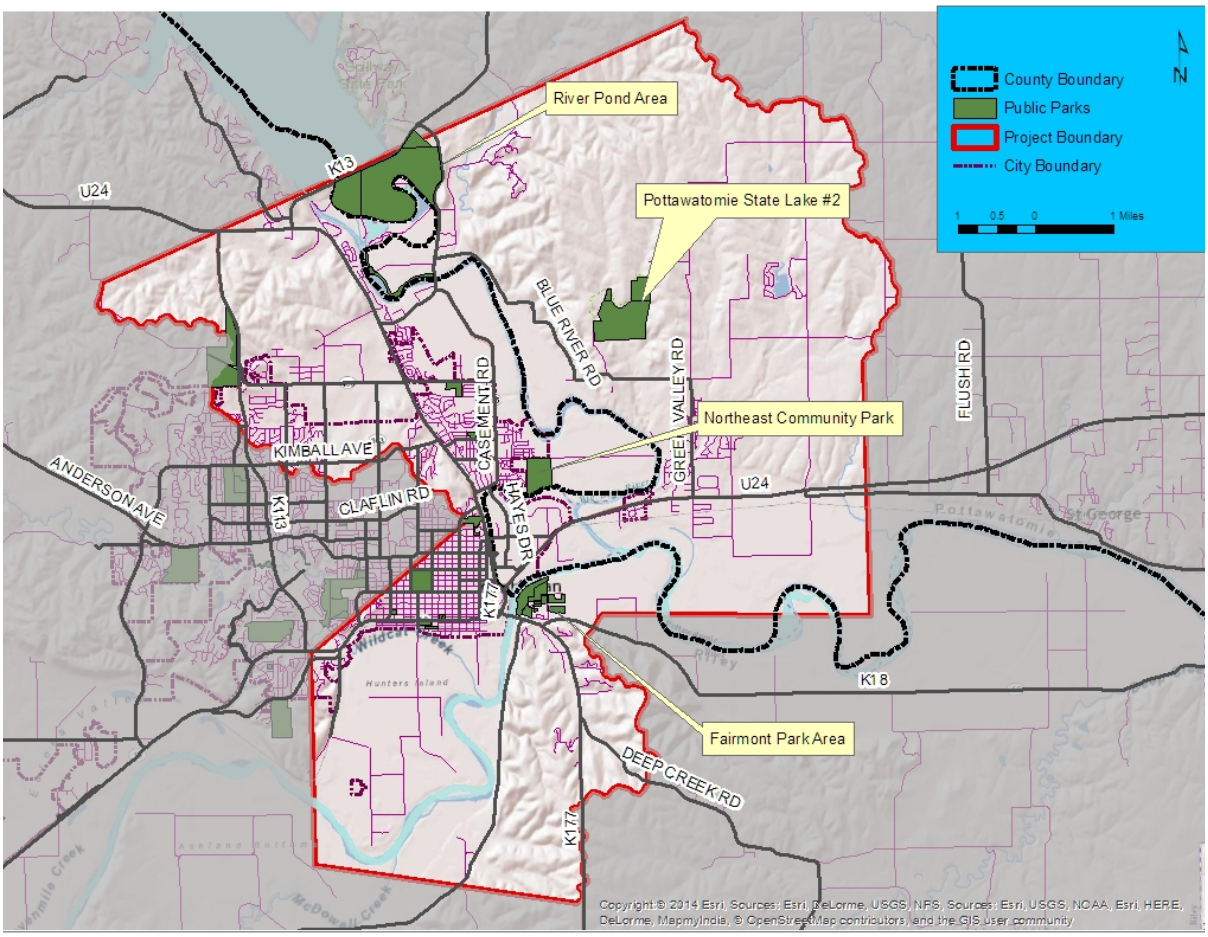


Figure 25: Permanent Acquisition

In addition to the expansion of recreation along the Big Blue and Kansas Rivers, a regional trail and park network, if done correctly, could also be used to preserve more open space in the floodplains, which will assist in improving erosion and water quality and potentially reduce flooding in their tributaries. This concept could also include an educational component to describe a variety of functions and topics related to natural and cultural resources found in the watersheds. A joint venture between the City and the two counties will most likely be needed to study the preferred route, purchase easements and property, and work with the USACE and the State of Kansas Department of Wildlife, Parks and Tourism. A funding source will need to be established to make this trail network a reality.

Tool: Preservation of Cultural Resources

Advisable

The Big Blue and Kansas River watersheds hold a plethora of cultural resources. Artifacts of pre-historic nomadic tribes, American Indian tribes, the Oregon Trail and early settlers can be found in these watersheds. These watersheds also contain an excellent example of today's agrarian lifestyle, characteristic of the Flint Hills.

The City of Manhattan and Manhattan Historic Resources Board, in conjunction with the State Historic Preservation Office, Riley County Historical Society and the History Department at Kansas State University have done both a Phase I and Phase II Archeological Resource Study for the area within the boundaries of the Manhattan Area Urban Area Comprehensive Plan, including some of the Big Blue River Watershed. As structural projects are proposed that are related to this Floodplain Management Plan, these cultural resources must be considered and protected when discovered.

Strategy 4: Modifying Floodwaters

This strategy and set of tools focuses on managing the floodwaters with the following specific features: the dam, stormwater detention basins, levees and floodwalls, landforms, channel alterations, diversions, and pump stations.

Since the late 1950s, communities have considered structural features to bring acceptable solutions for the flood hazards. Several of these structures are currently in place along the Big Blue and Kansas Rivers, including Tuttle Creek Dam and the Manhattan Levee System.

Tool: A Dam and Reservoir

Advisable and Further Evaluation Needed

The Tuttle Creek Dam and Reservoir was built in 1962 and is managed by the USACE. The dam is six miles north of Manhattan. The reservoir is a multipurpose project with the following authorized purposes: Flood Control, Low Flow Supplementation (Big Blue and Kansas Rivers), Navigation Supplementation (Missouri River), Water Quality, Water Supply, Recreation, and Fish and Wildlife. The structure has been a highly effective tool for managing floodwaters on a regional basis, as supported by the estimated $6.5 billion in flood damages prevented as of 2012. On a local basis, the dam is effective at managing floods for the community, working in tandem with other measures such as the Manhattan Levee and floodplain management measures required under the FEMA National Flood Insurance Program. The dam is designed to prevent flooding, but the reservoir operation can be very limited in water release flexibility in times of extreme drought and extreme

flood. Therefore, public understanding of this is important and was the subject of public involvement efforts in 2014 and 2015 as the Flood Insurance Rate Maps were updated.

Sedimentation. The USACE anticipated that Tuttle Creek Reservoir would gradually silt in as soil washed out of the land upstream. Despite land use practices encouraged by the Natural Resource Conservation Service (NRCS), sedimentation has occurred slightly faster than originally projected. However, the Flood Control Capacity does not face as much risk of being adversely affected as the Multipurpose Pool. At some point, perhaps 10 to 20 years from now, **Further Evaluation Is Needed** for studying the effectiveness of managing the sediment accumulated in the reservoir. A future action item could be pursued with USACE, although a local sponsor for the study would have to step forward.

As described, the Tuttle Creek Dam has been successful protecting property downstream from significant, repetitive flooding in most situations and the support of the structure is **advisable.** Additional structures of similar size and scale in the immediate area is unfeasible and is **not advisable.**

Tool: Stormwater Detention Basins

Advisable

In 2009, the City of Manhattan updated its Design and Construction Standard Specifications and Policies to require new subdivisions and infill projects that are 0.5 acres or larger to have stormwater release rates equal to or less than the pre-developed condition for the 2-year, 10-year, and 100-year storms. When the pre- vs. post-development stormwater releases are not achievable, stormwater detention measures are required on the site, in an appropriate location. This stormwater requirement has been implemented in new developments and redevelopment areas in the City. A detention structure would typically be inappropriate near a stream and/or in the floodplain, because the release of the stormwater from the detention basin could coincide with stormwater flowing into the area from upstream, which would compound the amount of stormwater in the area; possibly worsening the flood risks. The most appropriate location for stormwater detention structures in the middle and upper reaches of watershed.

Few examples exist in the Big Blue and Kansas River Watershed, but examples of detention basins in the Wildcat Creek Watershed on the west side of Manhattan have proven to be beneficial in decreasing the risk of flooding as well as improving sedimentation control. These new basins have significantly reduced the rate of runoff from these developments and the surrounding areas to the point they have lessened the base flood elevation and shrunk the mapped floodplain boundaries below these basins, when comparing the 2010 and 2015 flood studies for Riley County.

In addition to requiring detention basins where appropriate, the City of Manhattan has also implemented the practice of requiring restrictive covenants, running with the property, to identify who will own and maintain the basins and what measures will be taken by the City in the event a detention basin is not maintained. These measures may include the City doing the required maintenance of the detention basin and assessing the property for the cost of the work.

Because of the dynamics of the Big Blue Watershed below Tuttle Creek Reservoir, detention basins will not make any meaningful difference to the flood risks along the main stem of the river. However, these basins can decrease localized flooding along tributaries of the Big Blue River to lessen the flood risk and improve sediment and erosion control.

This policy should be continued within the City. A similar policy is encouraged to be adopted in rural Pottawatomie County and Riley County to reduce the rate of runoff from new developments that could go into tributaries of the Big Blue River and effect properties downstream.

Tool: Levees and Floodwalls

Advisable (current structure) and Not Advisable (new structure)

The Manhattan Levee System on the Big Blue and Kansas Rivers was constructed in 1964 by the USACE. Since the completion of the levee system, the City of Manhattan has maintained the structure and its accessory systems. The levee system protects a number of the region's commercial centers, including Manhattan's Central Business District, industrial areas, the City's wastewater treatment plant and fresh water supply, as well as a number of homes in the older part of Manhattan, totaling over $1 billion dollars of public and private investment.

The USACE Manhattan Levee Feasibility Report (2015) documented the opportunities for reducing the flood risk behind the levee in the vicinity of the confluence of the Big Blue and Kansas Rivers. The Big Blue River is the largest tributary of the Kansas River. The feasibility report clarified that a federal interest exists in increasing the level of protection currently offered.

With the completion of the USACE feasibility report, federal funding is pending authorization for a design and construction project. Federal funding appropriations for construction of improvements will eventually follow. A recommended step is for the City to begin budgeting dollars towards the City's portion of property acquisition and construction.

Through the USACE feasibility report, analysis was made to determine if extending the levee system to the north from the intersection of Casement Road and Hayes Road to Barnes /Dyer Road was feasible. Although a new levee system would protect a number of homes and public infrastructure in the northeast part of Manhattan, the initial cost-to-benefit analysis of such a levee did not meet the parameters set forth by the USACE to justify it as a recommended civil works project. The rough estimated price of the new levee was over $65 million, making it unfeasible for the local jurisdictions to fund such a major structure. Because of the cost, a new levee is **not advisable** at this time.

Tool: Landforms

Further Evaluation Needed

The City of Manhattan and Riley County recognize that some areas of the Big Blue and Kansas River floodplains may benefit from structural measures that are less substantial than a levee, but could direct floodwaters away from structures. A landform or training dikes have been used in situations around the country to better manage flows and reduce the adverse effect upon land owners. Analysis of a training dike that may help the land owners around the Dix Subdivision and other subdivisions nearby could be done at a later date. During the development and plan formulation for the USACE Manhattan Levee Feasibility Report (2015), this analysis was initially examined for possible inclusion in the federal project. Although a federal interest was not justified through the report, enough research was done to show some merits in a training dike or other similar landforms to divert floodwaters away from existing structures. The feasibility report also pointed to the need for flood risk adaptive measures, as described in the Modifying Human Susceptibility to Flood Hazards and also Modifying the Impact of Flooding. **Further Evaluation is Needed** to determine if a training dike or other kind of landforms are possible to reduce the risk of flooding in the watershed.

TOOL: CHANNEL ALTERATIONS, DIVERSIONS, AND BYPASSES

Further Evaluation Needed

The USACE Manhattan Levee Feasibility Report (2015) documented the levee system is an integral component for achieving successful flood risk management for the communities. Two key elements were discussed during the plan formulation work in regards to the channel adjacent to the levee and the diversion nearby in the commercial area on U.S. 24 Highway. The first element relates to constriction points at the U.S. 24 Highway Bridge and the Union Pacific Railroad Bridge, which creates a series of bottle necks to the flow of floodwater in this area. This bottleneck does not allow the floodwaters to flow freely and causes the water to back up further into the Big Blue River floodplain. The second element is the protection against encroaching into the floodway to the north of these two bridges. These issues relate to managing the flow of the floodwaters and the feasibility of a channel alteration that may help by widening the river channel, as opposed to deepening. Another measure would be managing the roughness of the channel, or more specifically how unmanaged vegetation may adversely affect the performance of other vital structural features, namely the Manhattan Levee.

Further Evaluation is Needed by KDOT and Union Pacific Railroad (UPRR) regarding the replacement or major rehabilitation on the two bridges. City-county-county initiatives should collaborate to engage both KDOT and UPRR to address the bridge improvement simultaneously. An upstream conveyance improvement may put the downstream structure at risk for some higher flood events, which is the reason to make future studies coincide.

During significant flood events, the floodway expands beyond the river channel and impacts a number of private property owners and their structures. Because of the impact of these flood waters on private property, as well as the potential impacts on adjacent property if the floodway is encroached upon or obstructed, special floodplain management oversight should be implemented. Although developing in the floodway is strictly discouraged, all three entities allow for development in this high risk flood area, if it can be proven the development will not raise the elevation of the base flood. To mitigate this potential issue, changes to the floodplain regulations for the City and two Counties should be made to prohibit development in the floodway, or the communities should attempt to purchase the properties to control the area and maintain the land in a condition suitable for the conveyance of floodwaters. An alternative approach to purchasing the land could be to purchase the development rights to building structures, etc. on the property.

An important recommendation is to keep a well maintained channel that limits the potential for obstructions caused by debris. Trees represent the highest vegetative restriction to the flood flows. The bridge's structural members will also be a place for flood borne debris to catch, causing an increase in flooding as well as damages to the bridge. The action of debris management could be a collaborative effort by the City of Manhattan, Riley County and Pottawatomie County and could be described in detail as part of a future emergency action plan.

Tool: Pump Stations

Advisable

The USACE Manhattan Levee Feasibility Report (2015) documented how pump stations for managing floodwaters are important to the function of the levee along both the Big Blue and Kansas Rivers. These facilities are aging and, in order to address flood risks, were evaluated as to whether or not there was a federal interest in future improvements.

This tool is an important piece of the Floodplain Management Plan, and several aspects of the tool are effective and have sub-elements or associated elements that are recommended. These pumps stations are **advisable** to be addressed as the USACE feasibility report describes. In addition, the City will need to continue the operation and maintenance in the manner required in the Operation and Maintenance Plan for the Manhattan Levee System. It is **advisable** the City periodically review the requirements of the Public Law 84-99 and ensure the Floodplain Management Plan, the Emergency Action Plan, and any flood fighting plan are in harmony with the requirements for USACE assistance.