

Minimum standards of the FMP has components that comply with the U. S. Army Corps of Engineers (USACE) planning guidance for floodplain management plans (USACE 2), as required when a cost share construction project using USACE funding is proposed for flood risk management projects. In this case, the project is the Manhattan Levee project site. A recently completed USACE feasibility study, called the *Manhattan, Kansas Local Protection Project Section 216 Feasibility Study* (2015), documents a federal interest in assisting Manhattan with improving its existing levee system. This FMP also meets the minimum standards for two Federal Emergency Management Agency's (FEMA) programs. The first is Section 510 of the Community Rating System (CRS), as described in the CRS coordinator's manual (FEMA 1), and secondly, the FMP complements the local hazard mitigation plan for Region I of Kansas.

II. DEVELOPMENT PROCESS OF THE FLOODPLAIN MANAGEMENT PLAN

This section includes the documentation of the process used to develop the floodplain management plan (FMP). The process begins with a thorough assessment of flood hazards, whether for loss of life or property damage. Additional steps include the detailing of records of meetings and public involvement activities, which appears below in this FMP.

Future Conditions Flows

The flood hazard area will be altered over time as changes occur in impervious areas in the basin, in the location and "morphology" of river channels or with stormwater infrastructure and flood protection measures, such as stormwater sewers, detention basins and levee systems. The creation of future condition flood models and stream flow models are designed to account for these changes. The USACE Manhattan Levee feasibility study (*Manhattan, Kansas Local Protection Project Section 216 Feasibility Study*, 2015), has selected final alternatives that could be funded by Federal dollars to improve the flood protection functions of the Manhattan Levee System. These proposed levee improvements can affect flows on the Big Blue and Kansas Rivers for less frequent events or higher flood elevations, which may affect more upstream land owners. During the USACE study, analysis indicated effects were minimal, less than 0.4-foot of a rise of the flood waters, for these less frequent events would possibly occur (2015).

Floodplain Hazard Assessment

Numerous reports and studies exist that describe the problems associated with flooding along the Big Blue and Kansas Rivers. The References section presents a bibliography of these resources. The following sub-sections describe the flood hazards for different reaches along the Big Blue River. The reaches begin at the downstream end and work sequentially toward upstream. The left bank (looking upstream) floodplains are listed first, then the right bank floodplains.

HISTORY

AMEC's Levee Certification Report for the Manhattan Levee System (January 4, 2013) states 43 flood events occurred between 1904 and 1951. The most historic flood occurred in 1951, which led to the decision to build the Tuttle Creek Reservoir for flood control of the area and the Kansas River Basin. The Manhattan Levee System was also built to protect the City of Manhattan and surrounding areas. The dam was completed in 1962 and the levee was completed in 1963.

Tuttle Creek Reservoir Flood Control

One of the authorized purposes for Tuttle Creek Reservoir is flood control. The term “flood control” is used to describe the U.S. Army Corps of Engineers (USACE) efforts to reduce flood damages from the more frequent, less intense flood events that occur in the river valley. The reservoir is not designed to prevent all floods. *Larger, infrequent storm events will occur that exceed the capacity of reservoir, requiring water to be released from the reservoir, impacting homes and businesses downstream.*

According to the USACE, since the construction of Tuttle Creek Reservoir in 1962, eighty-five (85) individual storms created runoff that would have exceeded the capacity of the Big Blue River channel near Manhattan. These storm events would most likely have caused flooding in the areas described in the following sections. Several of these storms occurred in a single year. Of the eighty-five (85) storm events described, six (6) storms (1973, 1983, 1984, 1987, 1990, 1992, & 2008) had flows entering into Tuttle Creek Reservoir that were larger than the flood event that caused the 1993 flood and would have likely caused substantial damage in the Manhattan area. The storm event in 1973 was so intense that, if Tuttle Creek Reservoir was not in place, the flood waters would have overtopped the Manhattan Levee System. Fortunately, the reservoir had enough capacity to contain the flood events so the flood waters could be released from the reservoir at a controlled rate. According to USACE economists, Tuttle Creek Reservoir has provided over \$6.5 billion in cumulative flood damage protection since it was constructed. As previously mentioned, the dam structure and reservoir is not designed to prevent flooding, but to minimize potential risks.

1993 Flood Event

Conditions were right in 1993, to cause significant flooding on the Big Blue River, Kansas River and other river basins in the Upper Mississippi River Valley. The flood in the summer of 1993 was a historic event that impacted nine (9) states in the Upper Mississippi River Valley, including Kansas. Starting in January, snow and rain storms filled ponds and lakes and saturated the ground in the region. The rain did not stop until the end of July. According to the U.S. Geological Survey (Wahl et al., 1993), the Manhattan area had over five (5) times its normal amount of rain in July alone. From July 22nd to 24th, two (2) to thirteen (13) inches of rain fell in parts of Kansas and Nebraska alone. On July 23rd, USACE officials were forced to open the flood gates to 58,800 cfs to control the capacity of the reservoir based on the amount of water flowing into the already full reservoir. This release from Tuttle Creek Reservoir caused significant flooding to residences and businesses in rural Riley County, the Dix Addition in the City of Manhattan, the Fairmont neighborhood south of the Kansas River and the Blue Township area of Pottawatomie County.

Month	Year	Name of Water Body	Estimated Probability of Occurrence in Each Year <i>(limited by uncertainty in period of record, also uncertainty varies depending on year)</i>
June	1903	Kansas River and Big Blue River	Not Available
June	1935	Kansas River and Big Blue River	Not Available
July	1951	Kansas River and Big Blue River	0.2% (500-year return frequency)
	1962	Tuttle Creek Reservoir Construction Completed	
	1963	Manhattan Levee System Construction Completed	
July	1993	Kansas River and Missouri River	1.4% (about 70-year return frequency)

TABLE 1: BIG BLUE RIVER FLOOD HISTORY (SOURCE: POTTAWATOIME COUNTY FLOOD INSURANCE STUDY, 2015 AND RILEY COUNTY FLOOD INSURANCE STUDY, 2015)

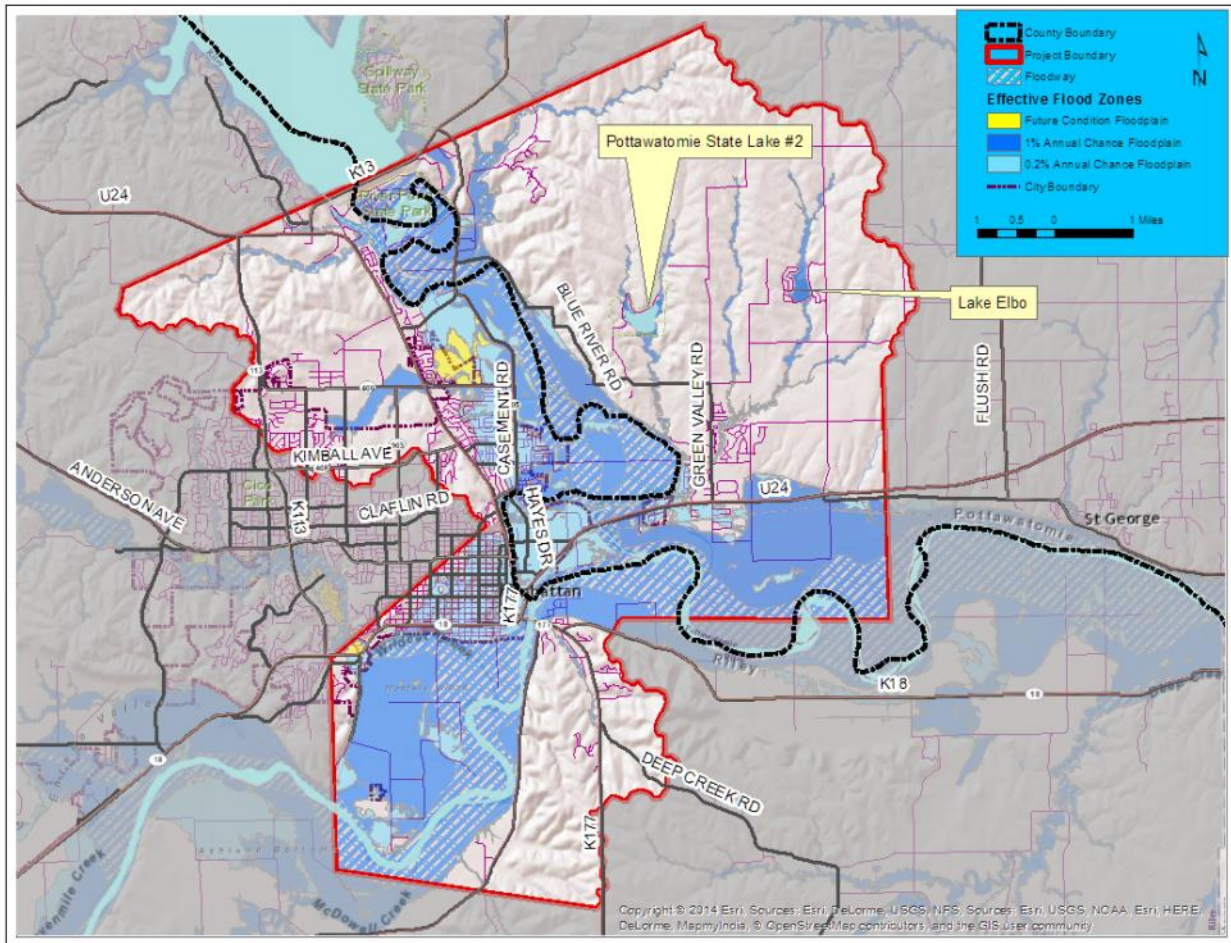


FIGURE 6: THE PROJECT AREA

REACH 1 FLOOD HAZARDS: KANSAS RIVER (UNPROTECTED SIDE OF LEVEE)

1. Identification of the Area. This area is west and south of the Manhattan Levee alignment outside of its protection area. This includes the Kansas River area west and upstream of the confluence with the Big Blue River. Hunter's Island is within this reach. Wildcat Creek is adjacent to the northwest side of this area (see Wildcat Creek Floodplain Management Plan, separate document).

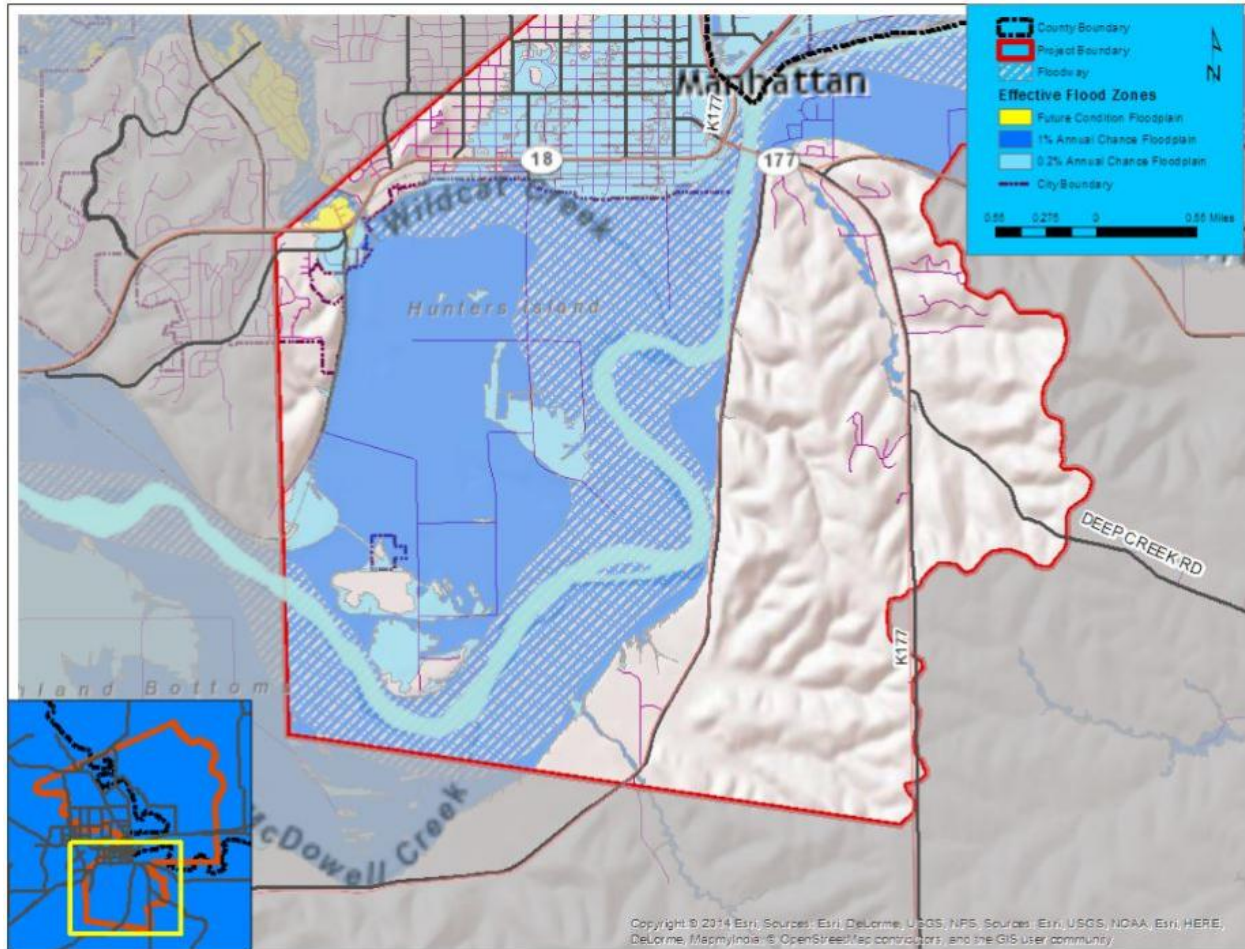


FIGURE 7: KANSAS RIVER (UNPROTECTED SIDE OF LEVEE)

2. Source of the Problem. The main source of the flood risk for this reach is the Kansas River and its interaction with the Big Blue River and Wildcat Creek. As previously mentioned, both the Kansas River and the Big Blue River are controlled waterways, which diminish the potential for flash floods. Wildcat Creek is uncontrolled and creates flash flood conditions in this reach. The extent of Wildcat Creek's flooding can be impacted by the flows in the Kansas River. When the Kansas River's stream flows are high, Wildcat Creek has limited abilities to drain, causing a backwater effect into Hunter's Island and other areas upstream along Wildcat Creek. This same backwater effect occurs on the Big Blue River at the confluence with the Kansas River.
3. Flood Data. The vast majority of this reach is within a mapped floodplain or floodway. The Summary of Discharge table from the 2015 Riley County Flood Insurance Study (FEMA, 2015) lists the peak discharge at the confluence with the Big Blue River during the 1% Annual Chance Flood event (100-year flood) as 177,300 cfs. The 2015 flood model shows the flood elevation of the 1% Annual Chance Flood elevation at the K-177 Bridge to be 1017.1 feet. At the intersection of S. Manhattan Avenue and Collins Lane, the 1% Annual Chance Flood elevation is 1020.8 feet.

4. Recent Flood History. As described above, the Kansas River and the Big Blue River experienced frequent flooding during the early to mid-1900, the worst event being in 1951. Since the construction of Tuttle Creek Reservoir and the Manhattan Levee System, the largest flood of record was in 1993. This flood threatened to overtop and/or breach the levee system, inundating the City of Manhattan. Fortunately, the flood waters receded and the levee system remained intact; protecting the City from catastrophic flooding.

Although 1993 is the major flood of record since the 1960's, there has been flooding in this reach of the study area in recent years. This has primarily been the result of flash flooding along Wildcat Creek. These flood events have occurred in 2007, 2010 and 2011. During a flood on Wildcat Creek, the floodwater inundates this portion of Riley County and spreads out in the low, flat areas adjacent to the Kansas River. Homes and businesses along S. Manhattan Avenue were significantly impacted by these floods.

5. Land Use & Building Data. The area can be classified as predominately agricultural, with a few farm houses, large lot, single-family residences and a few businesses. The businesses include, but not limited to, a sand and gravel dredging operation, a contractor business and Riley County's solid waste facility. The businesses are approximately 20 to 30 years old.

Most of the homes within this reach of the study were built from the 1930's through the 1960's. A number of homes were purchased by Riley County, using Federal Disaster Grant funds, following the 1993 flood event. These tracts of land are vacant and held by Riley County as open space, with development controlled by deed restrictions.

6. Development Trends. The Hunter's Island area has remained relatively agricultural and largely undeveloped. Because of the risk of flooding from the floodway and the 1% Annual Chance Floodplain, this area is projected to remain relatively undeveloped.
7. Development Constraints. The majority of this reach is either in the Floodway or in the 1% Annual Chance Floodplain. The risk of flooding is the largest constraint towards development. Essentially no development can occur in the Floodway. Development in 1% Annual Chance Floodplain requires at least one (1)-foot of freeboard above the base flood elevation. This would require fill or floodproofing of approximately 2 - 5 feet throughout much of the area.
8. Critical Facilities. Riley County Rural Fire Department's Hunter's Island fire station and Riley County's solid waste facility are located within this reach. Manhattan Township's maintenance facility is also located within this reach.

REACH 2 FLOOD HAZARDS: BLUE TOWNSHIP

Identification of the Area. This reach is the suburban and highway commercial area of Pottawatomie County on the east bank (left bank looking downstream). The area includes community commercial, industrial, and agricultural land uses. U.S. 24 Highway, including the properties north and south are part of this reach.

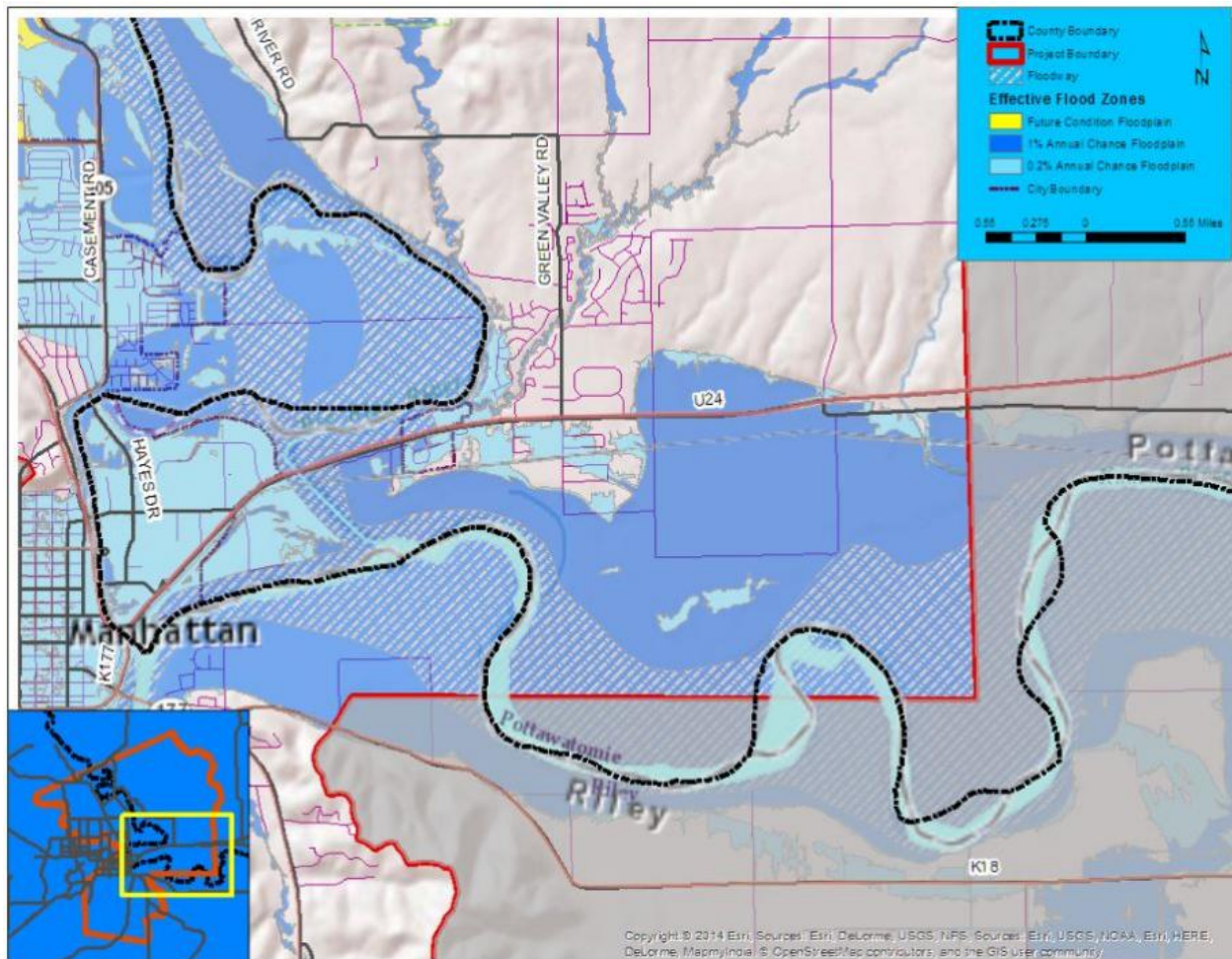


FIGURE 8: BLUE TOWNSHIP

1. Source of the Problem. The flood risk associated with this reach is from the Big Blue River and the backwater effect at the confluence of the Big Blue River and Kansas River. The flood risk is also caused by two constrictions: the U.S. Highway 24 Bridges and the Union Pacific railroad bridge. As with other ravine flooding conditions, unmonitored and controlled vegetation in the stream channel can adversely impact flooding.

Near the confluence with the Kansas River, much of the flood risk is due to property being in the floodway of the Big Blue or backwater effects created by the confluence of the two major rivers. Both of these scenarios significantly impact the commercial and agricultural uses in this reach of the study.

During an event at or larger than a 1% Annual Chance Flood event, floodwaters will overtop U.S. Highway 24, which increases the flood risks in this reach by allowing more floodwaters to flow freely throughout the area.

In addition, of the flood risks associated with the Big Blue River, Elbo Creek flows into the Big Blue River. This small creek is the outflow of Lake Elbo to the north and creates a flood risk for several single-family homes adjacent to the creek. Elbo Creek does have steep banks, so the flood risk is largely contain within those banks. However, the creek is extremely windy; with several, nearly 90 degree turns. Because of the creek form, severe erosion can be a concern for landowners adjacent to Creek.

2. Flood Data. The significant portion of this reach is within a mapped floodplain or floodway. The Summary of Discharge table from the 2015 Riley County Flood Insurance Study (FEMA, 2015) lists the peak discharge at the mouth of the Big Blue River at the during the 1% Annual Chance Flood event (100-year flood) is 71,600 cfs. The 2015 flood model shows the flood elevation of the 1% Annual Chance Flood elevation at the US-24 bridge to be 1013.9 feet.

At the Green Valley Road Bridge, near Elk Creek Road, the 1% Annual Chance Floodplain is 1026 feet.

3. Recent Flood History. The Kansas River and the Big Blue River saw frequent flooding in the early to mid-1900. The 1908 flood event on the Big Blue River altered the river channel, moving it to the east and generally way from the City of Manhattan. The most damaging event being in 1951. This flood event was caused by significant rains in the region in both the Kansas River and Blue River Valley. The result was massive flooding in Manhattan's older neighborhoods, central business district and industrial areas along the rivers, as well as the rural areas throughout the region. Since the construction of Tuttle Creek Reservoir and the Manhattan Levee System, the largest flood of record was in 1993.

At the time, the 1993 flood was assumed to be larger than the 1% Annual Chance Flood event, as shown in the Flood Insurance Study (FIS) and the Flood Insurance Rate Maps (FIRMs) at that time. The current FIS and FIRMs have studied the flood situation, in part, using the 1993 flood event, and have concluded the event was more likely a "75-year storm" and not as intense as originally assumed. The 1993 caused significant damage to the homes and businesses in this reach.

4. Land Use & Building Data. This reach has a mix of agricultural uses near the Big Blue River, commercial and industrial uses along U.S. Highway 24 and single-family homes to the north and south of U.S. Highway 24. The commercial and industrial areas along the highway range from 20 – 30 year old developments to new developments. The residential uses in the reach are similar in age. This area has been a major residential growth area for the region over the past several years.
5. Development Trends. Blue Township is a growth corridor for Pottawatomie County and the region. Several new commercial areas have been developed in recent years along the highway corridor. To the north and south the of highway corridor, a large number of single-

family residential neighborhoods have been developed. This trend will continue for the unforeseeable future, as the region continues to grow. Areas along U.S. Highway 24 will continue to develop or re-develop as commercial space.

6. Development Constraints. To the north and west side of the Blue Township is floodway and floodplain of the Big Blue River. The floodway will be a significant constraint to development, as development or re-development is largely prohibited. Development in the floodplain will require new commercial or industrial development be elevated or floodproofed to one (1)-foot above the base flood elevation, which is roughly 1015 feet along the highway.
7. Critical Facilities. A number of critical facilities are located in Blue Township, including a fire station, a sheriff's department sub-station office and a parochial school. However, none of these facilities are located in a high risk flood zone.

There are a number of businesses in this reach of the Big Blue River that sell, store and/or produce hazardous materials above the Tier II threshold that are considered critical facilities. Because of the need to keep these critical facilities confidential, the exact location has not been provided; however, officials of Pottawatomie County, Riley County, the City of Manhattan and the State of Kansas have the location and information regarding these facilities.

REACH 3A-D FLOOD HAZARDS: URBAN MANHATTAN, VARIOUS SUB-WATERSHEDS

Reach 3a: City of Manhattan Protected by Levee System

1. Identification of the Area. The Manhattan Levee System protects a large portion of the originally platted land of Manhattan and all of the commercial and industrial areas along Tuttle Creek Boulevard and McCall Road.

The older portion of the City protected by the levee system includes Manhattan's Central Business District, the commercial and industrial areas along Ft. Riley Boulevard and the original Ward District neighborhoods of Manhattan. Specifically, the area impacted by the 1% Annual Chance Floodplain or 0.2% Annual Chance *Floodplain if the levee was not present* would generally be a diagonal line starting near the intersection of S. 17th Street and Ft. Riley Boulevard and ending near the corner of Bertrand Street and N. 5th Street. Everything to the east of this approximate line is at an elevation, which if the levee was not constructed, would be impacted by a 1% Annual Chance Flood or a larger flood event.

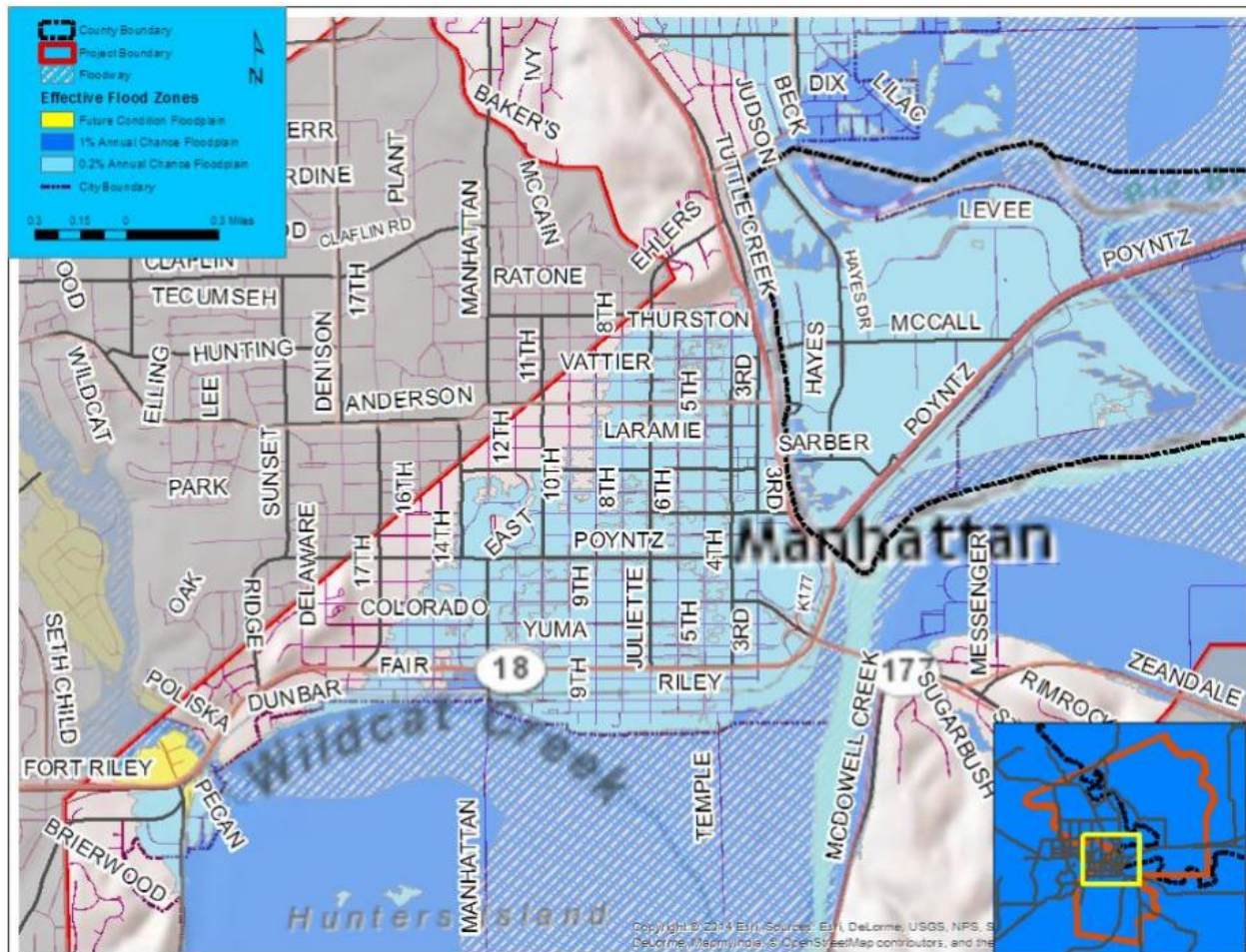


FIGURE 9: CITY OF MANHATTAN PROTECTED BY LEVEE

2. Source of the Problem. The existing Manhattan Levee System protects a large majority of the area described above from the 1% Annual Chance Flood event. The levee system was certified by FEMA on February 3, 2013 to protect against at least the 1% Annual Chance Flood elevation event plus three (3) feet.

The March 16, 2015 Flood Insurance Study and corresponding Flood Insurance Rate Maps shows ponding affects for some of the commercial and industrial properties along Tuttle Creek Boulevard, particularly the large drainage ditch, and low lying areas near the Big Blue River Levee segment. This area along McCall Road and Hayes Drive has experienced rapid redevelopment. The redevelopment activity has added substantial fill in the area to improve site drainage and prevent flood risks from shallow ponding. Generally speaking, the mapped flooding related to ponding is a function of the stormwater runoff being “trapped” behind the levee system when drainage gates are closed due to high water stages on the Big Blue River and the Kansas River. In these situations, pump systems are required to move the water up and over the levee system to reduce the flooding impacts behind the levee.

Localized flooding can also occur due to minor changes to the local terrain, drainage channels or failures of private or public infrastructure, such as plugged rain spouts, street inlets or culverts.

3. Flood Data. As previously described, the Manhattan Levee System protects a vast majority of this reach from at least the 1% Annual Chance Flood event. The portion of the reach that is in a mapped 1% Annual Chance Floodplain is the result of shallow flooding that ponds behind the levee and collects in the roadway, in various roadside ditches and the large drainage structures along Tuttle Creek Boulevard, commonly referred to as the “Pretty Ditch”. The Base Flood Elevation for this area is a static 1008 feet.
4. Recent Flood History. As described above, the Kansas River and the Big Blue River experienced frequent flooding in the early to mid-1900. The worst event being in 1951. Since the construction of Tuttle Creek Reservoir and the Manhattan Levee System, the largest flood of record was in 1993. This flood threatened to overtop and/or breach the levee system, inundating this area. Fortunately, the flood waters receded and the levee system remained intact; protecting this area from catastrophic flooding.

Although 1993 was the only major flood since the 1960's, there has been flooding on the dry side of the levee that has impacted several properties. This localized flood risk has been a result of the relatively flat land in the area, undersized and/or lack of stormwater infrastructure in the residential and commercial areas of the Ward Districts and the limited points for the stormwater to drain towards the river. A number of stormwater infrastructure improvement projects were outlined in the Eastside Drainage Report (BG Consultants, 2006) to improve drainage to the east of Tuttle Creek Boulevard. A number of these projects were completed with the McCall Road improvements in 2013. However, localized flooding still remains an issue in this reach.

5. Land Use & Building Data. The Manhattan Levee System protects over \$1 billion dollars of existing development. This includes a mix of residential, commercial, industrial land uses, schools and public infrastructure.

The residential land uses comprise a mix of single-family and multiple-family development ranging in age from the early Manhattan homes, some of which have been designated as historic properties or districts, to newly renovated, and brand new residential structures, most of which are multiple-family apartment buildings.

The commercial properties include the historical Central Business District, Manhattan Town Center Mall, and the new redevelopment areas situated to the north and south of the Central Business District. The area to the east of Tuttle Creek Boulevard is a mix of commercial and industrial uses. The properties along McCall Road and the Tuttle Creek Boulevard Frontage Road have experienced a recent trend to redevelopment the properties to big box commercial stores, drive-thru restaurants and similar highway commercial uses.

Industrial uses, such as manufacturing, warehouses, trades offices; and service commercial uses, like auto mechanics and self-storage are present in the McCall Road area and along Ft. Riley Boulevard.

6. Development Trends. This reach has experienced area of preservation of historic structures and neighborhoods, including the Central Business District, as well as large areas of redevelopment. The areas to the north and south of Poyntz Avenue have had a significant amount of both public and private redevelopment activity. The areas along McCall Road and Tuttle Creek Boulevard have also had a number of redevelopment projects that has shifted the area along the major arterial roadways from industrial uses to highway commercial uses. Additional redevelopment can be expected in this reach for residential, commercial and industrial uses.
7. Development Constraints. With the protection of flooding by the Manhattan Levee System, there are no significant constraints on development or redevelopment.
8. Critical Facilities. A number of critical facilities are located in this reach that service the entire City, suburbanized and rural areas of Pottawatomie County and Riley County (Executive Order 11988).

The City's Water Treatment Plant, including some of the raw water wells and the Waste Water Treatment Plant are located on the protected side of the Manhattan Levee System. Through inter-local agreements, the City wholesales water and in some situations, sanitary sewer services to the suburbanized and rural areas of the two (2) aforementioned counties.

Manhattan City Hall, a number of the City's department buildings, the Riley County Courthouse and administrative buildings are located behind the Manhattan Levee System.

Three (3) USD 383 Manhattan/Ogden elementary schools, the 9th Grade Center and the Manhattan Catholic School are protected by the levee system. There are also a number of businesses and residential uses that cater to the young or elderly (i.e. childcare centers & assisted living centers) in this area that are also behind the Manhattan Levee System.

There are a number of businesses in this reach of the Big Blue River which sell, store and/or produce hazardous materials above the Tier II threshold and are therefore considered critical facilities. Because of the need to keep these critical facilities confidential, the exact location has not been provided; however, officials of Pottawatomie County, Riley County, the City of Manhattan and the State of Kansas have the location and information regarding these facilities.

Reach 3b: City of Manhattan – Northeast Park Area (Unprotected)

1. Identification of the Area. This area is generally located to the north of the Manhattan Levee System – Big Blue River Segment, east of Casement Road and along Knox Lane. This area historically was the old river channel of the Big Blue River until the flood of 1908, which moved the portion of the Big Blue River to the east, away from the City of Manhattan (“Riley County,” n.d.). This area of the City was most impacted by the 1993 flood event.

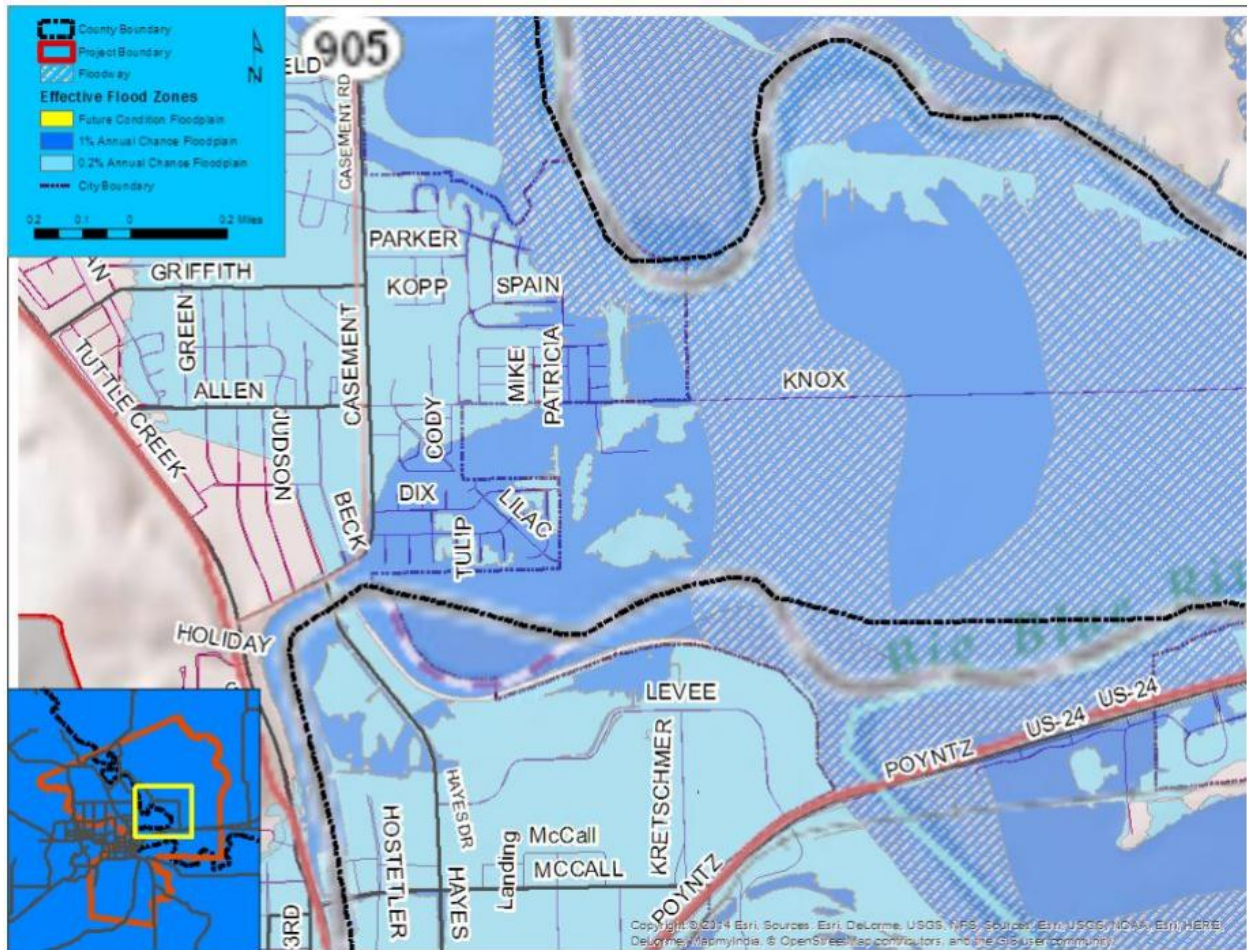


FIGURE 10: CITY OF MANHATTAN – NORTHEAST PARK AREA

2. Source of the Problem. The source of the flooding problem is when the Big Blue River is at or above the flood stage for the 1% Annual Chance Floodplain (100-year floodplain). The Summary of Discharge table from the 2015 Riley County Flood Insurance Study (FEMA, 2015) lists the peak discharge for the Big Blue River at the mouth of the river during the 1% Annual Chance Flood event (100-year flood) is 71,600 cfs. During this size of a storm, the Big Blue River leaves the confines of its banks and impacts the area in a variety of ways. A wide, natural overflow channel is created, causing an oxbow in the river. This overflow channel directs the flood waters immediately to the south towards the confluence with the

Kansas River. Due to the relatively flat ground in the area, the flood waters spread out from this natural overflow channel and impacts the immediate area.

During this size of flood event, the river follows the former river channel that was altered during the 1908 flood (Riley County, n.d.) The old river channel generally runs in a diagonal line from the intersection of Spruce Street and Knox Lane to the intersection of Hayes Drive and Casement Road. The flood water then meets the Manhattan Levee System and is diverted back to the natural overflow channel via a drainage ditch on the west side of the levee.

Localized flooding can also occur due to minor changes to the local terrain, drainage channels or failures of private or public infrastructure, such as plugged rain spots, street inlets or culverts.

3. Flood Data. The Summary of Discharge table from the 2015 Riley County Flood Insurance Study (FEMA, 2015) lists the peak discharge for the Big Blue River at the mouth of the river during the 1% Annual Chance Flood event (100-year flood) is 71,600 cfs. The 2015 flood model shows the flood elevation of the 1% Annual Chance Flood elevation for the Dix Addition, generally south of Knox Lane and east of Casement Road ranged from 1015.7 feet on the northern edge of the residential neighborhood to 1015.2 feet on the southern edge of the area. The 1% Annual Chance Flood elevation in the Countryside Manufactured Home Community to the south of Knox Lane is 1016.0 feet. The Countryside Manufactured Home Community to the north of Knox Lane has a flood elevation ranging from 1016.5 feet on the north to 1016.1 feet to the south.
4. Recent Flood History. The Kansas River and the Big Blue River experienced frequent flooding in the early to mid-1900's. The 1908 flood event on the Big Blue River altered the river channel, moving it to the east and generally away from the City of Manhattan. The most damaging event being in 1951. This flood event was caused by significant rains in the region in both the Kansas River and Blue River Valley. The result was massive flooding in Manhattan's older neighborhoods, central business district and industrial areas along the rivers, as well as the rural areas throughout the region. Since the construction of Tuttle Creek Reservoir and the Manhattan Levee System, the largest flood of record was in 1993.

At the time, the 1993 flood was assumed to be larger than the 1% Annual Chance Flood event, as shown in the Flood Insurance Study (FIS) and the Flood Insurance Rate Maps (FIRMs) at that time. The current FIS and FIRMs have studied the flood situation, in part, using the 1993 flood event, and have concluded the event was more likely a "75-year storm" and not as intense as originally assumed. The 1993 flood caused significant damage to the homes in this reach.

5. Land Use & Building Data. This reach is predominately single-family homes, some of which are manufactured homes. The Manufactured Home Parks were established in the 1960's. The Dix Addition was built in the 1970's and the Knoxberry Addition began developing in the 1980's.

6. Development Trends. The area is almost completely built out. Single-family homes are built on moderately sized lots (7,500 square feet to 10,000 square feet). The home designs are generally ranch style, some with basements or walkout basements. Other homes are built with slab on grade foundations. The manufactured homes in the area are part of a large manufactured home park, Countryside Estates. The layout of the residential neighborhoods is a function of the subdivision design. No significant terrain elements dictated how the homes were developed.
7. Development Constraints. The reach is almost completely built out. Vacant land located to the east towards the Big Blue River has been designated as Flood Hazard Area on the Future Land Use map of the 2015 Manhattan Urban Area Comprehensive Plan. This designation corresponds to the effective Flood Insurance Rate Maps (March 16, 2015) or the vacant land inundated by the 1993 flood event. Through the Comprehensive Plan process, the community has determined that development should be prohibited in the Flood Hazard Area because of the “potential to endanger life, resources, and property.”
8. Critical Facilities. There are no critical facilities due to the small size of the reach.

Reach 3c: City of Manhattan – Prairie Lakes Area (Unprotected)

1. Identification of the Area. The residential area is defined by the manmade lake, Prairie Lakes and its manmade and natural drainage channel that drains into the Big Blue River. The reach includes the residential properties in the Knoxberry and Hackberry Subdivisions to the east of Casement Road, as they are adjacent to the confluence of the Prairie Lakes drainage channel with the Big Blue River.

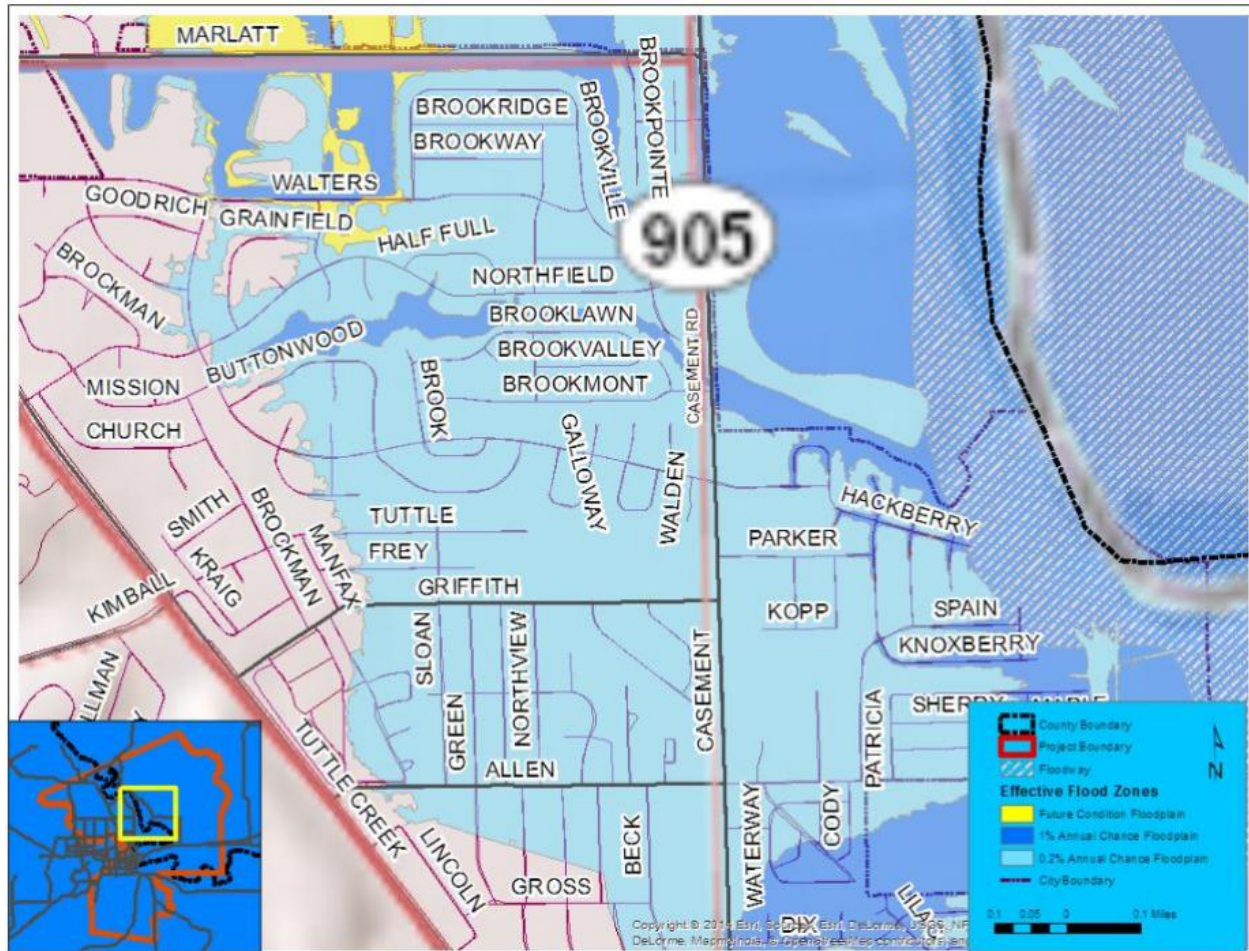


FIGURE 11: CITY OF MANHATTAN – PRAIRIE LAKE AREA

2. Source of the Problem. The source of flooding is both from the drainage of Prairie Lakes, a small lake designed to handle the stormwater runoff from the surrounding residential neighborhoods and from the effects of the Big Blue River.

Prairie Lakes is an approximately eleven (11) acre body of water that is approximately 10 – 15 feet deep. The wet basin is on a separate tract of land and is owned and maintained by the home owners association. The separate tract is adjacent to the rear yards of several homes in the neighborhood. Near the intersection of Brookhaven Drive and Brooklawn Drive, the basin drains to a concrete lined drainage channel that directs the overflow from the lake to the Big Blue River. The channel is in the rear of many homes. The channel crosses under Casement Road, where the channel becomes unimproved and is in its “natural state”. The channel then flows to the southeast, adjacent to the Hackberry & Knoxberry Subdivisions until it reaches the Big Blue River.

In addition to the flood risks associated with Prairie Lakes, the Big Blue River impacts these areas by inundating low lying areas associated with the old river channel. The low lying areas, including some residential areas in the Knoxberry subdivision are in the mapped

floodway. There is also a risk of flood waters backing up into the drainage channel of Prairie Lakes.

3. Flood Data. The entire area is relatively flat. The mapped 1% Annual Chance Floodplain generally follows the natural and manmade channel and the low lying areas, as described above. The elevation of the 1% Annual Chance Floodplain throughout the reach is approximately 1018 feet.
4. Recent Flood History. As previously described, the last major flood event on the Big Blue River was in 1993. The only developments in this reach that existed at the time of the 1993 flood were in the Knoxberry Addition on the extreme eastern edge of the City, adjacent to the Big Blue River. These homes were impacted by the flooding in 1993.

All other existing developments in this reach were constructed after 2002. Before these neighborhoods were constructed, it was farmland within the Big Blue River Valley. The developer of these newer homes took additional measures to minimize the risk of flooding by increasing the ground or building elevation above the flood elevations known at that time. However, as previously discussed, the FEMA and USACE mapping products at the time underestimated the base flood elevations, as they are related to the USACE operation of Tuttle Creek Reservoir.

5. Building Data. The reach consists of single-family, single-family attached, and two-family homes built from 1990's to present. The foundations of the homes range from full basements to slab-on-grade.
6. Development Trends. The area is almost completely built out. A small area on the east side of Prairie Lakes is currently under construction. This is the last remaining vacant area of residential land.

Single-family homes are built on moderately sized lots (7,500 square feet to 10,000 square feet). The home designs are generally ranch style homes with slab on grade foundations. The layout of the residential neighborhoods is a function of the subdivision design. Other than the location of the retention basin, no significant terrain elements dictated how the homes were developed.

7. Development Constraints. The reach is almost completely built out. Vacant land located to the east towards the Big Blue River has been designated as Flood Hazard Area on the Future Land Use map of the 2015 Manhattan Urban Area Comprehensive Plan. This designation corresponds to the effective Flood Insurance Rate Maps (March 16, 2015) or the vacant land inundated by the 1993 flood event. Through the Comprehensive Plan process, the community has determined that development should be prohibited in the Flood Hazard Area because of the "potential to endanger life, resources, and property."
8. Critical Facilities. Due to the small size of the reach there are no critical facilities.

Reach 3d: City of Manhattan – Marlatt Avenue Area (Unprotected)

1. Identification of the Area. This reach of the unprotected areas of the City of Manhattan is along the Marlatt Ditch. The headwaters of the small watershed are generally on the Kansas State University property to the west. This land is currently used for row crop agricultural research. The flood hazard analysis was focused on the area east of Tuttle Creek Boulevard to the Big Blue River.

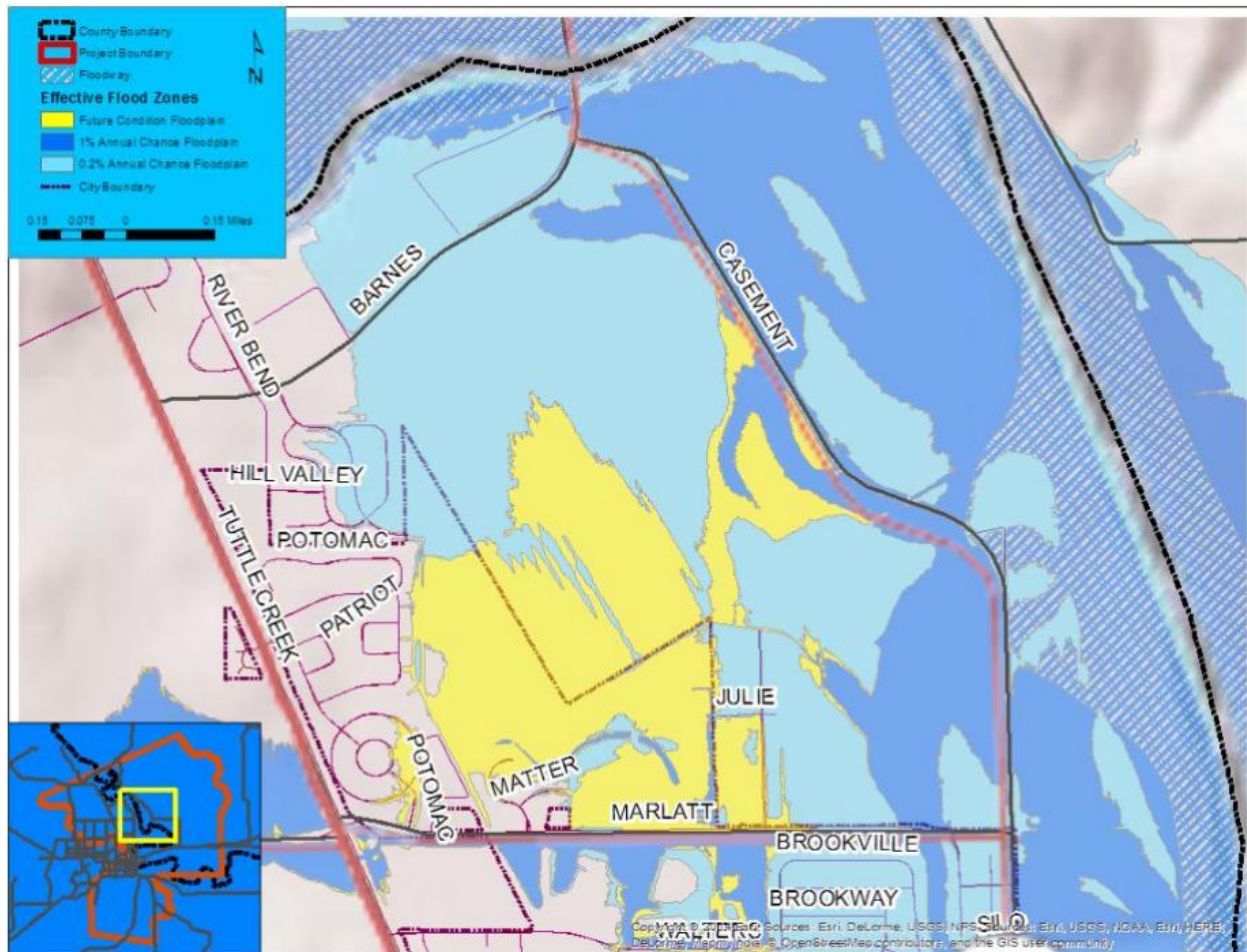


FIGURE 12: CITY OF MANHATTAN – MARLATT AVENUE AREA

2. Source of the Problem. The main source of flooding issues for the reach is due to backwater effects from the Big Blue River during significant storm events. The flood waters on the Big Blue River would travel upstream in the ditch and inundate affected areas. The potential exists for stormwater runoff from developments in the upper reaches of the drainage basin to impact properties downstream. This could be exacerbated during flood stages on the Big Blue River.

The City of Manhattan hired AMEC Foster Wheeler to conduct a study to determine if placing flap gates or other structures on existing culverts along Marlatt Ditch would lessen the backwater effects on properties to the north of Marlatt Avenue, while not increasing the

flooding impacts on the properties to the south of the roadway. The study determined that placing a flap gate on two (2) culverts along Marlatt Avenue could reduce the flood elevation of a 1% Annual Chance Storm by as much as 0.4 feet (AMEC, 2013). These two (2) culverts are adjacent to a rural Riley County residential neighborhood.

3. Flood Data. The entire area is relatively flat. The mapped 1% Annual Chance Floodplain generally follows the natural and manmade channel and the low lying areas, as described above. The elevation of the 1% Annual Chance Floodplain throughout the reach is approximately 1019 feet to the south of the Marlatt Ditch and 1020 feet to the north of Marlatt Ditch.

This area is considered a growth corridor of Manhattan, primarily to the north of Marlatt Avenue. Because of this, the City had the Future Conditions Flood Study done for this area. The Future Conditions Flood Study was done by Foster Wheeler, using the base FEMA Flood Model used for the 2015 Riley County Flood Insurance Study Update (FEMA, 2015) and used the runoff values based on a complete build out of the watershed, as shown on Future Land Use Map of the 2003 Manhattan Urban Area Comprehensive Plan (City of Manhattan, 2005). The Future Conditions Flood Study predicts the 1% Annual Chance Flood area and elevations for future floods without stormwater management measures taken into account. The flood model predicts the most conservative future floodplain. The Future Conditions Flood Study is shown on the Flood Insurance Rate Maps (FIRM) as “Zone X Future Base Flood.” The base flood elevation for the Future Conditions Floodplain is approximately 1022 feet.

4. Recent Flood History. As previously described, the last major flood event on the Big Blue River was in 1993. The majority of the new homes in this area were built after 2005. The residential developments outside of Manhattan City limits were built around 1980’s. Older farmstead homes in the area were built in the early 1900’s.

The Brookfield Neighborhood began developing in 2005. Before these neighborhoods were constructed, the land use was farmland. The developer of these newer homes took additional measures to minimize the risk of flooding by increasing the ground or building elevation above the flood elevations known at that time. However, as previously discussed, the FEMA and USACE mapping products at the time underestimated the base flood elevations, as they are related to the USACE operation of Tuttle Creek Reservoir.

5. Building Data. The reach consists of single-family, single-family attached, two-family homes and a few apartment buildings constructed from the 1990’s to present. The foundation construction of the homes consists of mostly slab-on-grade designs.
6. Development Trends. The area to the south of Marlatt Avenue is generally built out with single-family, single-family attached, two-family dwellings and a few apartments. The area to the north of Marlatt Avenue is a growth area of the City. This area is also where a number of existing single-family homes in rural Riley County are located. Recent developments include the Northwing Neighborhood, a single-family development and The Links at Manhattan apartment complex. The 2015 Manhattan Urban Area Comprehensive Plan shows this as

Low to Medium Residential, which generally equates to a residential density of less than 1 – 11 dwelling units per net acre.

7. Development Constraints. The largest development constraint to the undeveloped areas and future redevelopment areas is adequately managing stormwater runoff and protecting against floodwaters. Because of relatively flat grades, creating adequate slopes to drain stormwater runoff from a site to Marlatt Ditch and/or Casement Road is challenging. Unique stormwater management designs and construction has been developed for the Northwing Neighborhood and The Links at Manhattan apartment complex. These unique stormwater management designs also incorporated measures to protect against flood damages.
8. Critical Facilities. The only critical facility in the reach study area is a USD 383 Middle School site.

REACH 4 FLOOD HAZARDS: RURAL RILEY COUNTY, BIG BLUE RIVER

1. Identification of the Area. This reach of the study is the unincorporated, rural areas of Riley County north of the City of Manhattan, within the immediate Blue River Valley. This reach includes private property bordered by the Big Blue River to the east, U.S. Highway 24 to the west, the city limits of Manhattan to the south and the State of Kansas and Army Corps of Engineers land associated with Tuttle Creek Reservoir to the north.

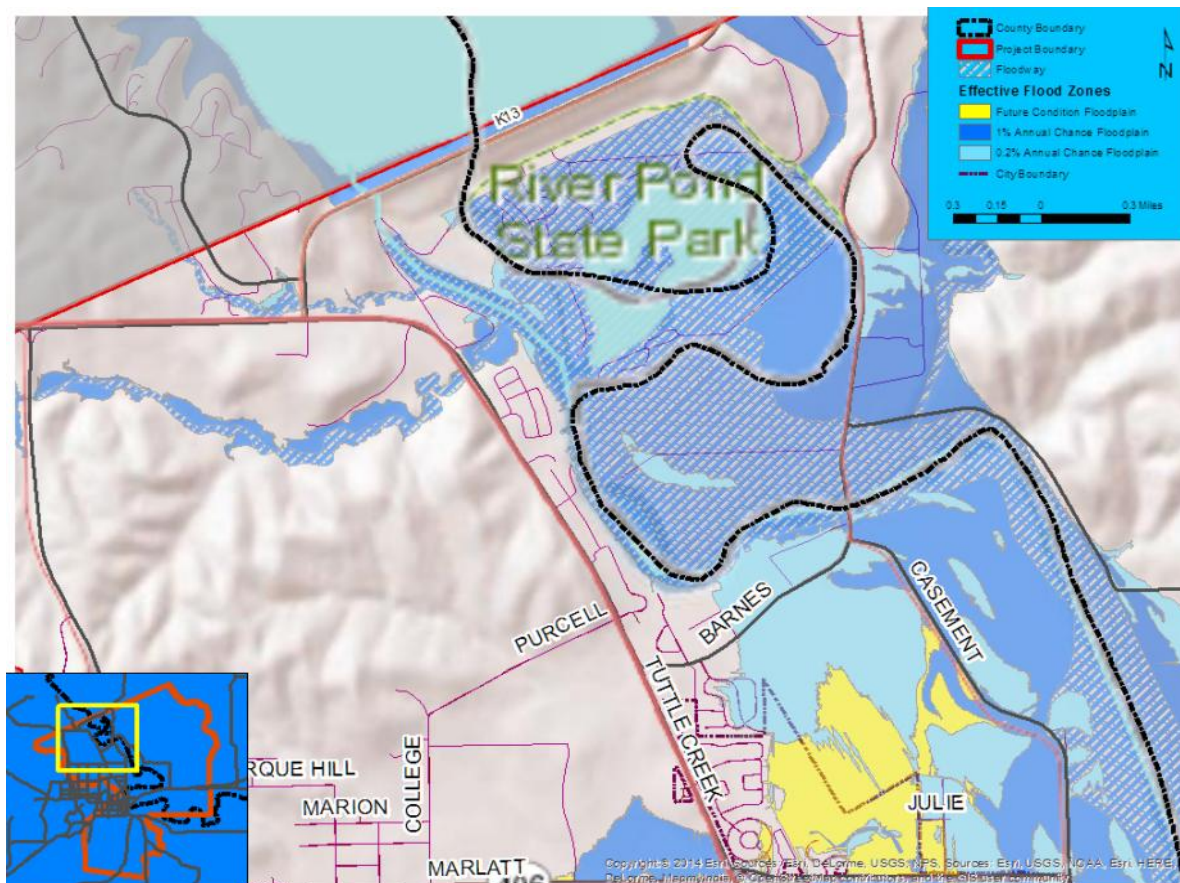


FIGURE 13: RURAL RILEY COUNTY – BIG BLUE RIVER

2. Source of the Problem. The main source of flooding for this reach of the study is the Big Blue River. However, localized flooding in low-lying areas can occur due to the relatively flat grade of the reach and possible poor drainage throughout the area. The areas of concern for flooding are primarily along Casement Road and from Casement Road to the east towards the Big Blue River. Areas along road ditches and drainage channels are also susceptible to flooding due to backflow of floodwaters from the Big Blue River.
3. Flood Data. The entire area is relatively flat. The mapped 1% Annual Chance Floodplain generally follows the natural and manmade channel and the low lying areas, as described above. The elevation of the 1% Annual Chance Floodplain throughout the reach is approximately 1020 feet to the north of Marlatt Ditch and 1023 feet at the northern edge of the reach.
4. Recent Flood History. As described above, the Kansas River and the Big Blue River experienced frequent flooding in the early to mid-1900's. The worst event being in 1951. Since the construction of Tuttle Creek Reservoir and the Manhattan Levee System, the largest flood of record was in 1993. This flood event adversely impacted several of the farm houses, buildings, equipment, agricultural lands and livestock throughout the area.
5. Building Data. The area is mostly agricultural, with row crops and small livestock operations. There are a few single-family homes associated with the farms and "outbuildings" for equipment and livestock. The single-family subdivision on Nelson's Landing is located in this reach. This subdivision was developed in the mid- to late-1980's with slab-on grade homes and manufactured homes.
6. Development Trends. This area is considered a growth area for Manhattan and the region. The Manhattan Urban Area Comprehensive Plan, adopted in March 2015, shows this area low to medium residential density on the Future Land Use Map. A large apartment complex was approved by the City in 2015 on the southern edge of this reach. Development in this reach can be expected in the future if Manhattan and the region continue to grow.
7. Development Constraints. The largest development constraint to the undeveloped areas and future redevelopment areas is adequately managing stormwater runoff and protecting against floodwaters. Because of relatively flat grades, creating adequate slopes to drain stormwater runoff from a site to Barnes Road, the Marlatt Ditch and/or Casement Road is challenging. Unique stormwater management designs and construction have been developed for the recent developments in the City. These unique stormwater management designs also incorporated measures to protect against flood damages.
8. Critical Facilities. There are no critical facilities in this reach of the study area.

REACH 5 FLOOD HAZARDS: RURAL POTTAWATOMIE COUNTY, BIG BLUE RIVER

1. Identification of the Area. This is the unincorporated, rural areas of Pottawatomie County outside of the commercial and suburban residential areas of Blue Township. This reach would be the east bank of the Blue River, bordered by Blue River Road to the east.

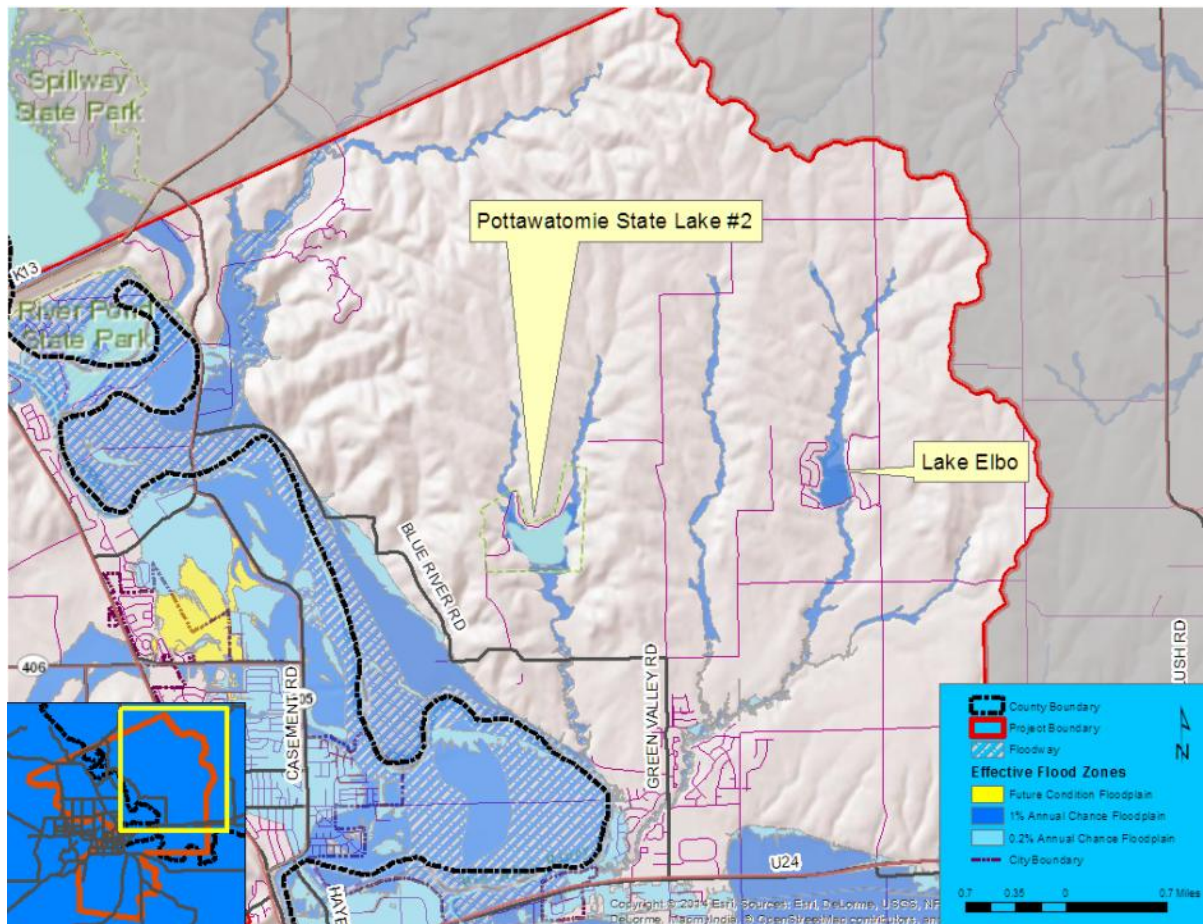


FIGURE 14: BIG BLUE RIVER – RURAL POTTAWATOMIE COUNTY

2. Source of the Problem. The main source of flooding for this reach of the study is the Big Blue River. The risk of flooding also occurs on the smaller, unnamed streams and dry water courses found draining from the Flint Hills to the east in Pottawatomie County.
3. Flood Data. The landforms found in this reach of the study include relatively flat lands adjacent to the Big Blue River and steep ravines to the east, which are typically found in the Flint Hills. The mapped 1% Annual Chance Floodplain generally follows the natural and manmade channels and the low lying areas along the river, as described above.

The elevation of the 1% Annual Chance Floodplain throughout the reach is approximately 1017 feet to the north of Marlatt Ditch and 1023 feet at the northern edge of the reach.

Lake Elbo is a man-made lake with a surface area of approximately 30 acres. The Big Blue River Tributary that flows out of Lake Elbo has a steep grade and the elevations of the 1% Annual Chance Floodplain range from 1058 feet near the lake to 1016 feet near its confluence with the Big Blue River. Because of the size of the lake, this would generally be considered a high-risk dam.

Many of the unnamed streams and ravines found in the Flint Hills do not meet FEMA's mapping standards because of the low density of development within these minor watersheds, thus there is not a mapped floodplain for these areas.

4. Recent Flood History. As described in other parts of the section, flooding of the Kansas and Big Blue Rivers impacted the region through the early and mid-1990's. Since the construction of Tuttle Creek Reservoir, the largest flood of record was in 1993. This flood event adversely impacted several farm houses, buildings, equipment, agricultural lands and livestock throughout the area.
5. Building Data. Outside of the residential and commercial properties that were previously described in the Blue Township Reach, few residential and commercial developments exist in the reach. There are several large lot, single-family homes found in the upper sections of the Flint Hills. The lower areas of the reach adjacent to the Big Blue River consist of primarily row crop agricultural.
6. Development Trends. Currently, it is envisioned that development patterns for this reach would remain similar to what has been developed, open rangeland associated with the Flint Hills or large lot, single-family residential homes.

There is discussion and research being conducted by officials with Pottawatomie County and Riley County on the viability of a major road improvement in this reach to connect northern Manhattan and adjacent rural Riley County to Blue Township and U.S. Highway 24. This major transportation project is a long range planning project, so the development impacts in this reach are currently unknown.

7. Development Constraints. As with other reaches, the floodway and floodplain along the Big Blue River is the major constraint to developing near the river. Development either is prohibited in the floodway by local regulations or is cost prohibitive due to required fill or floodproofing to protect against the flood risks. No significant constraints on development are known for the land in the Flint Hills portion of this reach.
8. Critical Facilities. There are no critical facilities in this reach of the study area.

Public Involvement Process

Three public meetings have been held regarding how to manage flood risks along the rivers.

Meeting Name	Location	Date
Technical Advisory Group	City Hall	November 13, 2013
Technical Advisory Group	City Hall	November 21, 2013
Technical Advisory Group	City Hall	December 12, 2013
Technical Advisory Group	City Hall	January 30, 2014
Technical Advisory Group	City Hall	February 20, 2014
Technical Advisory Group	City Hall	February 27, 2014
Public Open House	County Commission Room	March 11, 2014
Technical Advisory Group	City Hall	March 27, 2014
Public Open House	Denison Fire Station	April 16, 2014
Public Action Working-group	County Commission Room	June 10, 2014
Public Action Working-group	County Commission Room	September 23, 2014
Public Action Working-group	County Commission Room	October 28, 2014
Public Open House	Denison Fire Station	November 5, 2014

TABLE 2: RECORD OF PUBLIC MEETINGS

The public meeting in November 2014 discussed the following issues:

1. Causes and extent of flooding
2. What is being done about flooding
3. What to do during a flood
4. How people can protect their homes
5. Flood insurance
6. Maintaining drainage ways
7. Status of implementing this FMP and the development of the FMP goals

Public outreach is a continual process by all parties involved. This includes implementing annual awareness campaigns that should be done by the City and the counties. The local authorities can use these public outreach efforts for credits in the CRS program as defined in Strategies and Tools section.

Through the public meetings in 2014, a documented interest from stakeholders was identified for taking steps to reduce flood damages on an individual basis. Individual businesses and residents

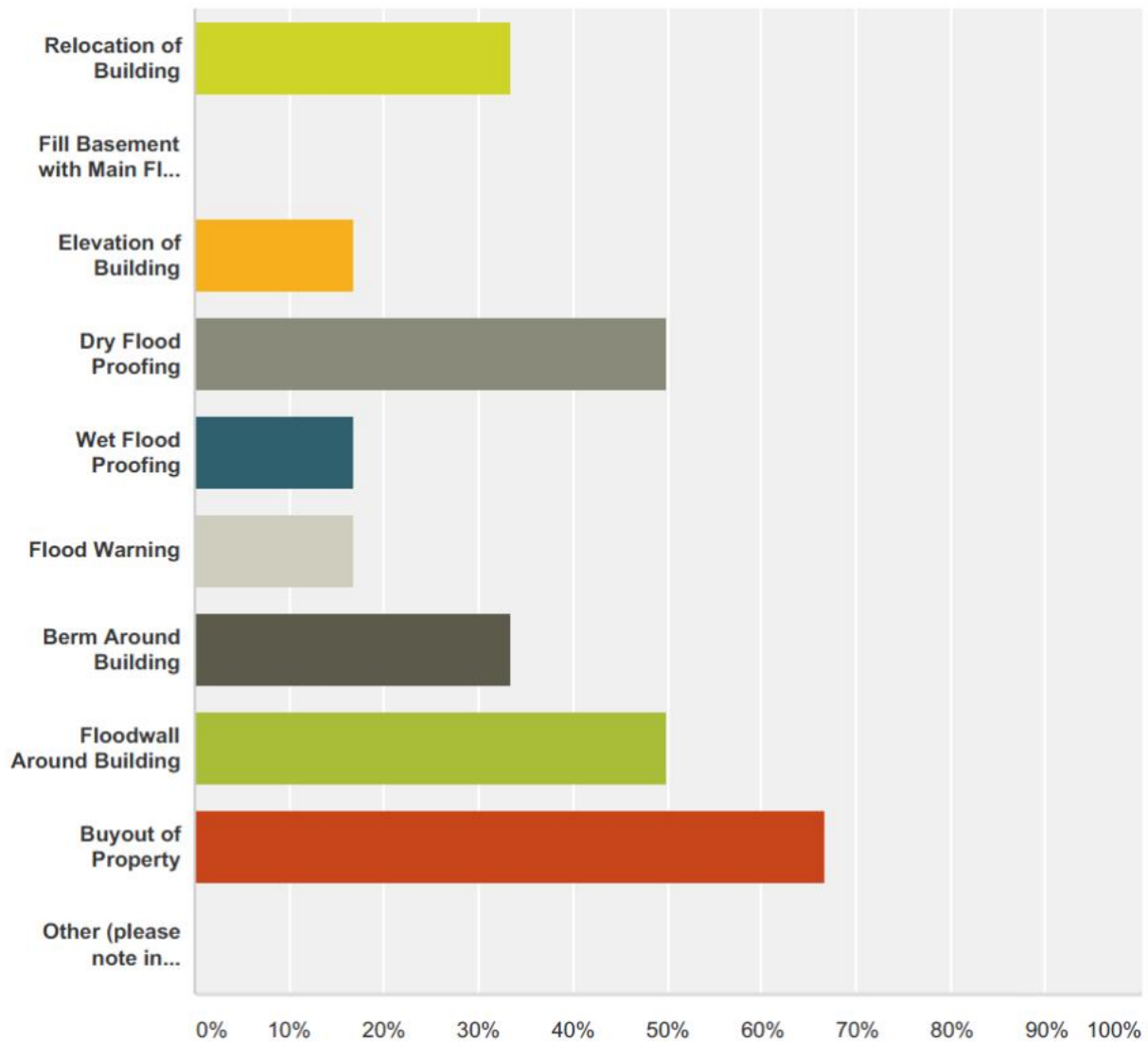


FIGURE 15: SURVEY RESPONSES SHOW INTEREST IN TOOLS INDIVIDUALS CAN PURSUE FOR THEIR HOME OR BUSINESS

can take various steps to reduce flood damages, which are outlined in this plan. A survey from November 5, 2014 indicated several tools for addressing flood damage are of interest (Figure 16).

The tools from Figure 15 are discussed in detail in the Strategies and Tools section of this document.

Public Involvement Plan

A separate plan developed to engage the public better was created. It includes findings by the Technical Advisory Group (TAG) and the temporary Public Action Working-group (PAW).

BIG BLUE RIVER TECHNICAL ADVISORY GROUP

The Technical Advisory Group (TAG) is a planning group established by the City and counties. This group includes planners, Certified Floodplain Managers (CFMs), engineers and emergency managers dedicated to this project. The TAG helped guide the development of the floodplain management plan and was responsible for the completion of the FMP.

BIG BLUE RIVER PUBLIC ACTION WORKING GROUP

The Public Action Working-group (PAW) was envisioned to consist of various people living, working or otherwise related to the Big Blue River Valley, which could provide guidance to the TAG in developing the project elements and informing the public. It was envisioned the PAW would be active for a shorter amount of time than the TAG. The PAW would provide more targeted outreach than a public meeting, where only a select few might attend. The PAW was expected to meet 3 - 4 times throughout the year and help to advance the community's interest in public meetings.