



The influence of  
**LANDSCAPE  
FACTORS**  
on transportation systems

prepared by Iowa State University



# Overview



Image Credit: Instagram

This presentation explores the relationship between the landscape and built systems in your community. Specifically, we will examine:

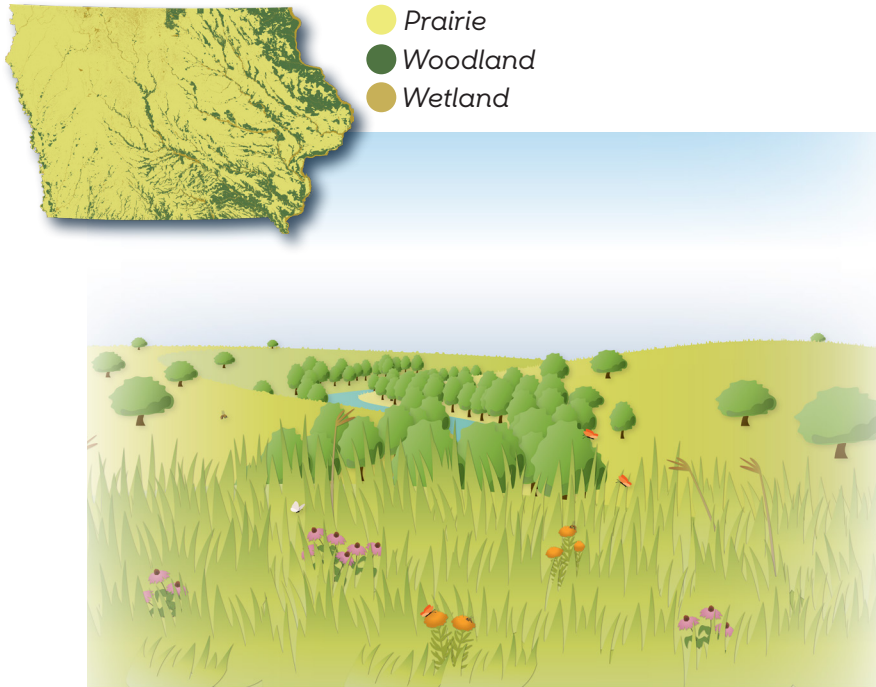
- The development of transportation systems and community land use over time
- How surface water and topography affect where communities and transportation systems develop
- The impact of groundwater (when present) on transportation and land use
- Benefits of trees and other vegetation and how trees in towns fit with transportation networks, main streets, and neighborhoods

Keokuk is the southernmost city in Iowa, located at the confluence of the Des Moines and Mississippi Rivers, as well as the tri-point of the states of Iowa, Illinois, and Missouri. The town is situated within the Loess Flats and Till Plains ecoregion, which is characterized by irregular plains and low, open hills.

The community was incorporated in 1847 and in its early days was a hub for trade because of its location on the Mississippi River. It is one of two county seats in Lee County, with Fort Madison being the other. The community's population peaked in 1930s at more than 15,000 people; today it is home to approximately 9,900 residents. Keokuk is named for the Sauk Chief Keokuk, who is buried in Rand Park on the east side of town.

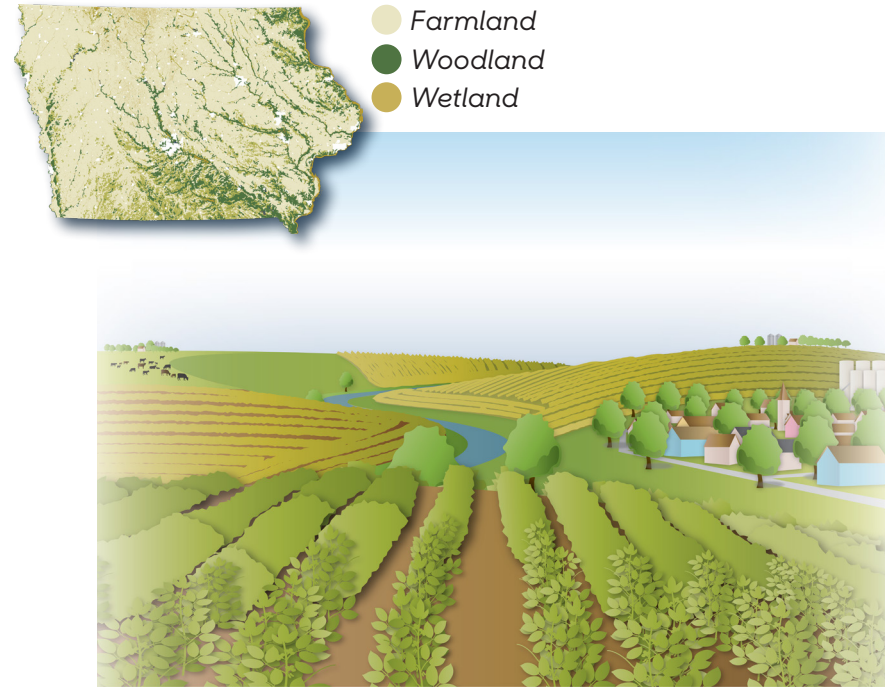
Keokuk is fed by three major highways in the area. Highways 218, 61, and 136 are the main corridors for transportation within the region.

# Land Cover Changes Over Time



**Historical Landscape**

The historical landscape of Iowa was dominated by prairie and savannas. Tree canopy was typically found in valleys along river corridors adjacent to scattered savannas, because the fires that maintained the prairies could not spread as easily in those places. Native plants such as switchgrass, little bluestem, coneflower, and milkweed are some of the more recognizable plants found in the diverse prairie landscape.



**19th Century Landscape**

The once-dominant prairie has been replaced by agricultural fields, pasture lands, and small towns in the post-settlement Iowa landscape. Fire suppression and development have allowed for greater growth of wooded areas among the rural landscape and in town. At the same time, many wooded river corridors have narrowed to make more room for cropland.

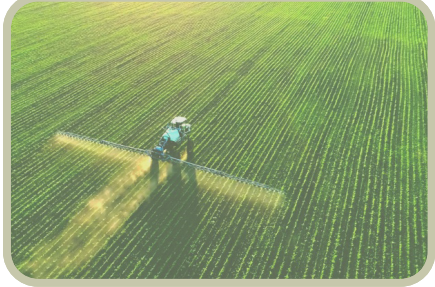


# Land Cover

## Impervious Surfaces



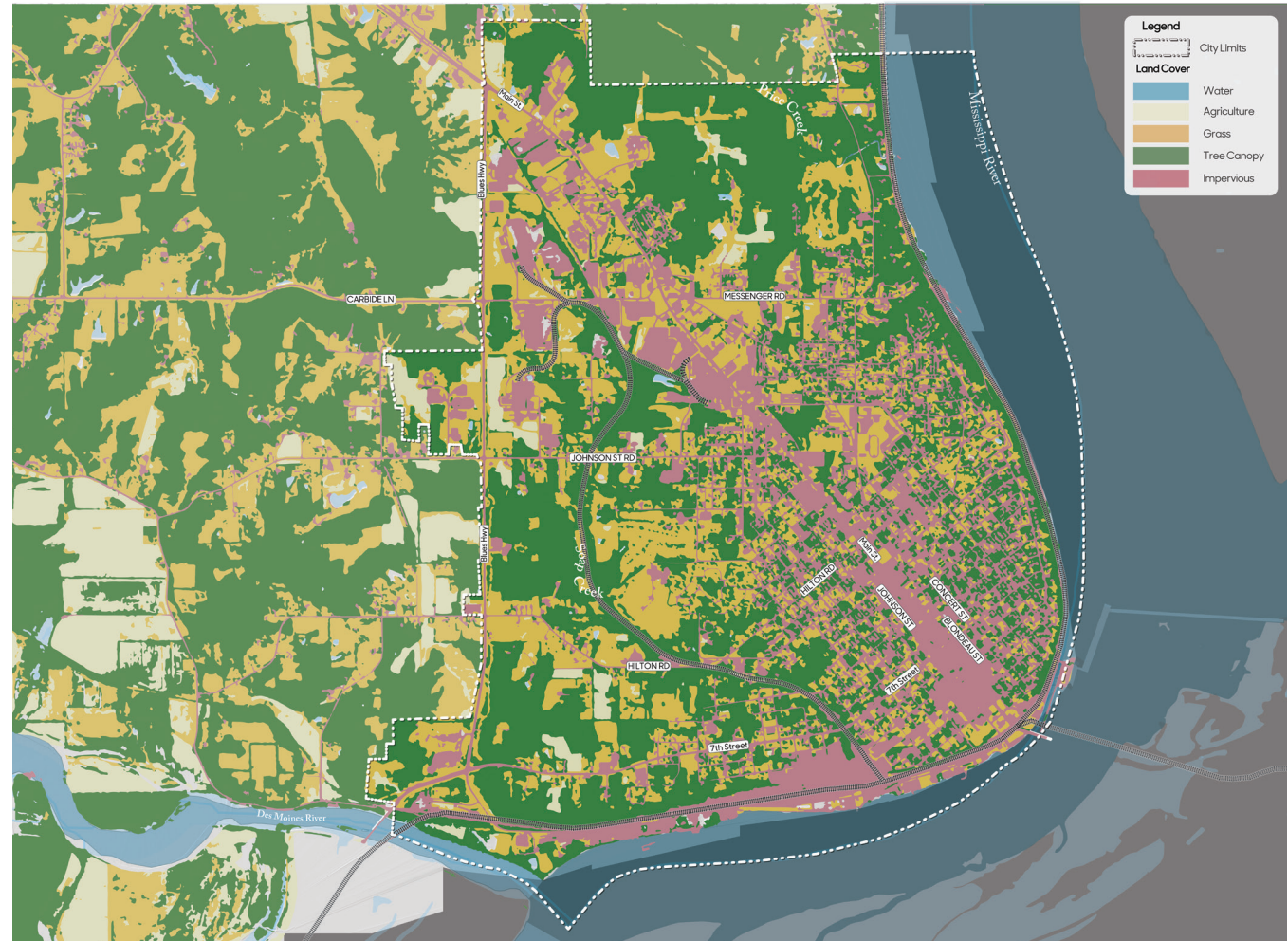
## Agricultural Land



## Grassland/Lawn



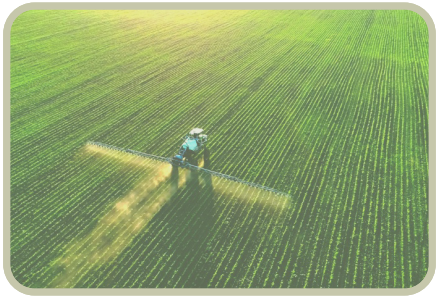
## Tree Canopy



The land cover in most of Iowa's small towns today is a mix of residential lawns or neighborhood spaces dotted by trees. Streets and parking are paved and are sometimes flanked by sidewalks. Commercial and industrial zones are typically dominated by impervious surfaces.

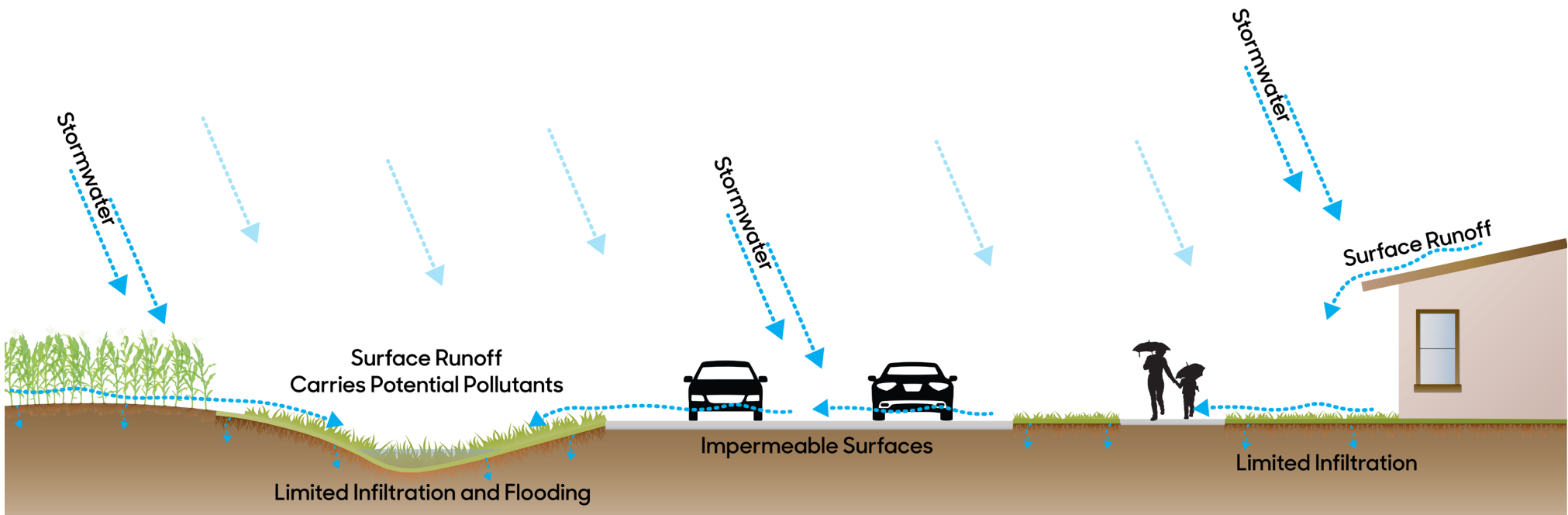
Because of its location at the confluence of the Des Moines and Mississippi Rivers, Keokuk's story has been largely shaped by water. The early landscapes of oak hickory forest and bluestem prairie have given way to more community-driven developments in the downtown area.





## Impervious Surfaces, Agricultural Land, & Lawns

Impervious surfaces limit or prevent stormwater from infiltrating the ground and, in expansive areas, can create heat-island effects through stored and reflected heat. Agricultural land that is in annual crops and tilled provides limited infiltration, which can contribute to local flooding. Lawns can also limit infiltration, especially over compacted soil. All of these factors contribute to stormwater runoff and localized flooding, especially during intense rainfall.



# Groundwater Concerns

The depth to the water table refers to the distance from the surface that groundwater fully saturates soil. In places with a high water table (zero or only a few feet below the surface), groundwater can well up and cause localized flooding. Rivers and natural lakes are generally areas where the water table is above the ground. These rivers and lakes receive most of their water from groundwater with some surface-water runoff from rain or snowmelt. This is why rivers can still be seen even if it hasn't rained in a while.

High water tables can have effects beyond just surface pooling, such as in the case of "frost boils." Frost boils result from groundwater freezing during winter and forming bubbles of ice called "ice lenses" that expand and push up from the ground. When the ice thaws, the frost boils collapse, leaving a divot in the surface. With certain kinds of flexible pavement, such as asphalt or gravel, these frost boils form potholes.

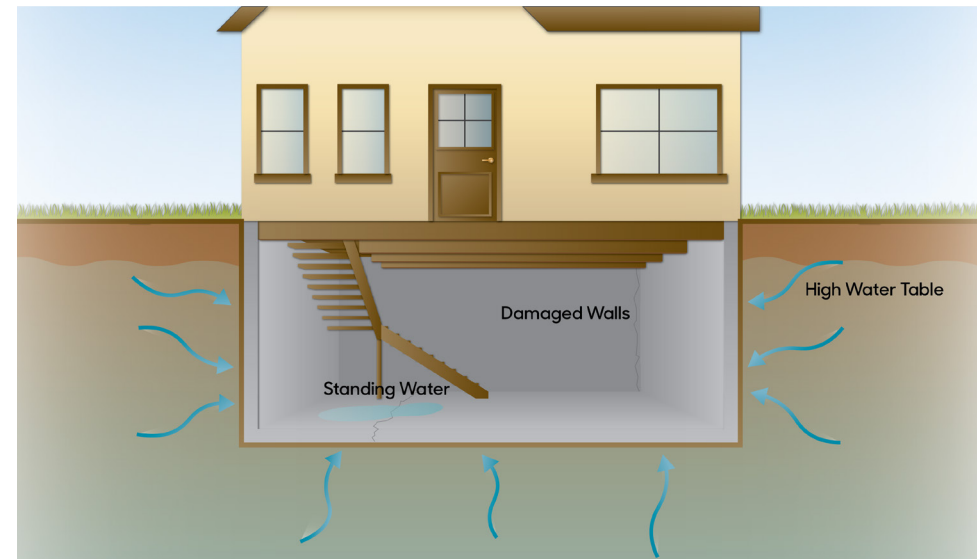
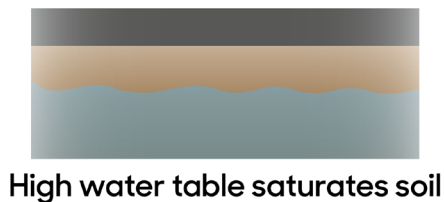
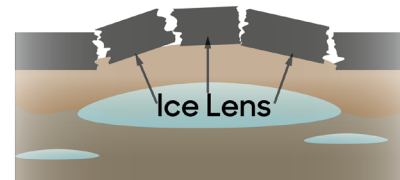


Diagram of the effects of a high water table on foundations and basements.

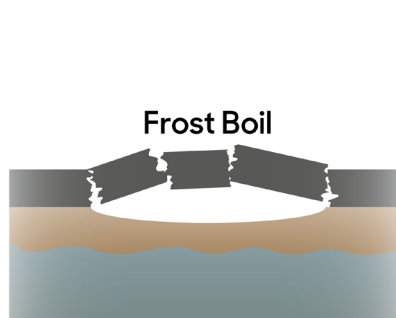
High groundwater tables can also have detrimental effects on one's home. Houses with basements surrounded by a high water table develop cracks or damaged walls due to water pressure. Typically a tile drain mitigates some of these effects, but wet foundations can require "dewatering," which can be expensive. Developing landscapes with high water tables requires more expensive maintenance, construction, and paving. Creating public spaces or parks in these areas makes good sense.



High water table saturates soil



Water freezes and expands



Ice thaws and saturated soil collapses



Traffic breaks bubble and wears surface

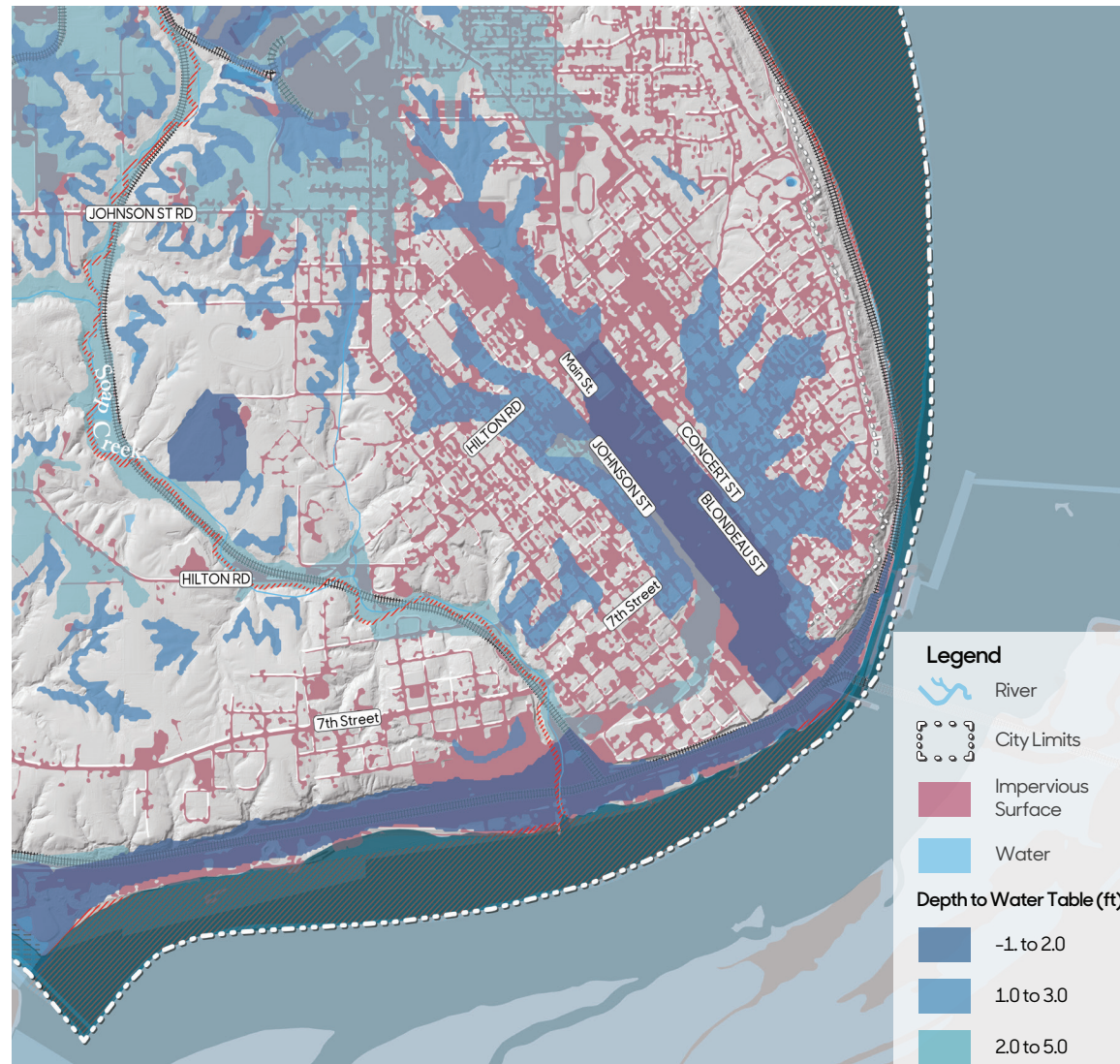
Diagram of the process by which frost boils affect roadways.



## Example Community



Emmetsburg's high water table has caused repeated damage on streets and parking lots. The highway shows signs of continual repairs.



Groundwater and impervious surface map of Keokuk, IA  
 In Keokuk, the highest water table is located in the downtown, along with the majority of impervious surfaces. Moving away from the downtown, occurrences of high water table decrease.

Looking at your town map, are there areas where the high water table and impervious surfaces overlap? Next time you are in this part of town, note local pavement conditions. Do you see signs of cracks or buckling? Has the surface been patched multiple times?



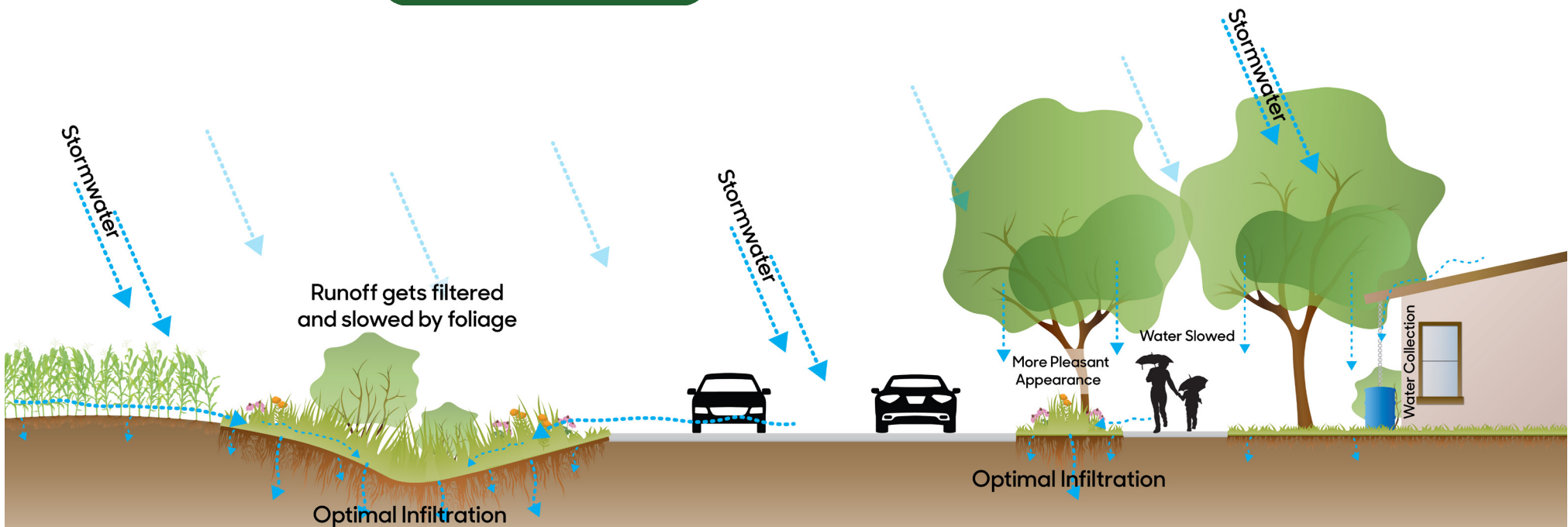
# Vegetation Benefits



## Grasslands & Tree Canopy

Native grasslands with deep-rooted plants aid in infiltrating stormwater, while dense foliage slows and filters stormwater from other areas. Practices such as bioswales and natural roadsides capitalize on these benefits to improve water quality.

Trees offer many advantages. They clean the air, create shade, and cool the atmosphere. Trees also intercept rainfall, which helps mitigate stormwater runoff and flooding. They consume groundwater, which lowers the water table and makes space for water storage below ground. Carefully chosen and placed trees create community identity and make spaces comfortable for residents. Grasslands and trees provide habitat for pollinators and birds, which provides enjoyment for residents.



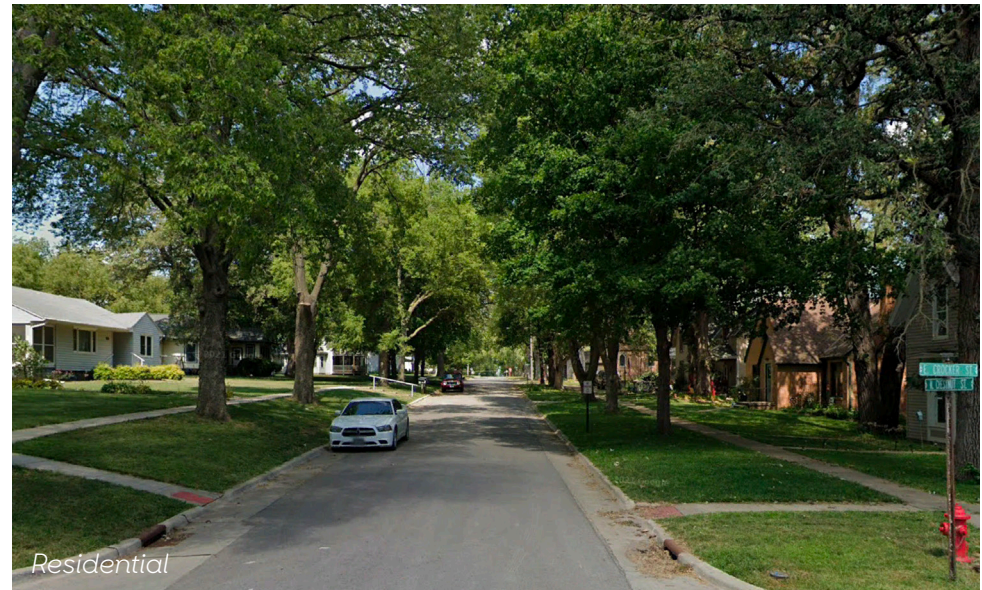




## Example Streetscapes with Minimal Vegetation



## Example of Vegetated Streetscapes



Lack of street trees creates uncomfortable spaces that feel unwelcoming and exposed to the elements.

Street trees, shrubs, and planters along a roadway offer shade and protection from the elements, while also enhancing the experience of the street.



# Vegetation Benefits



Land Use Map of Keokuk, IA

The pie chart to the right summarizes the variety of Keokuk's land cover. However, the downtown area is dominated by impervious surfaces in comparison to the rest of the community.

Looking at the heart of your community, does your downtown core have trees?

How does this change as you move from the downtown into residential areas of town?

Reflecting on your own experiences, where do you feel most comfortable on a hot summer day?

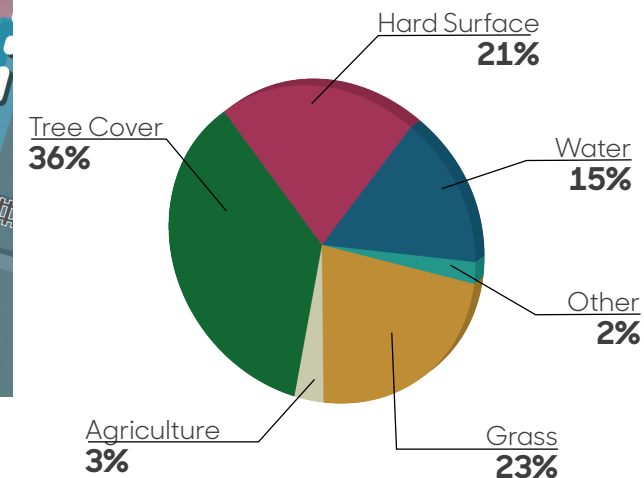
How do you think visitors see this space?

## Legend

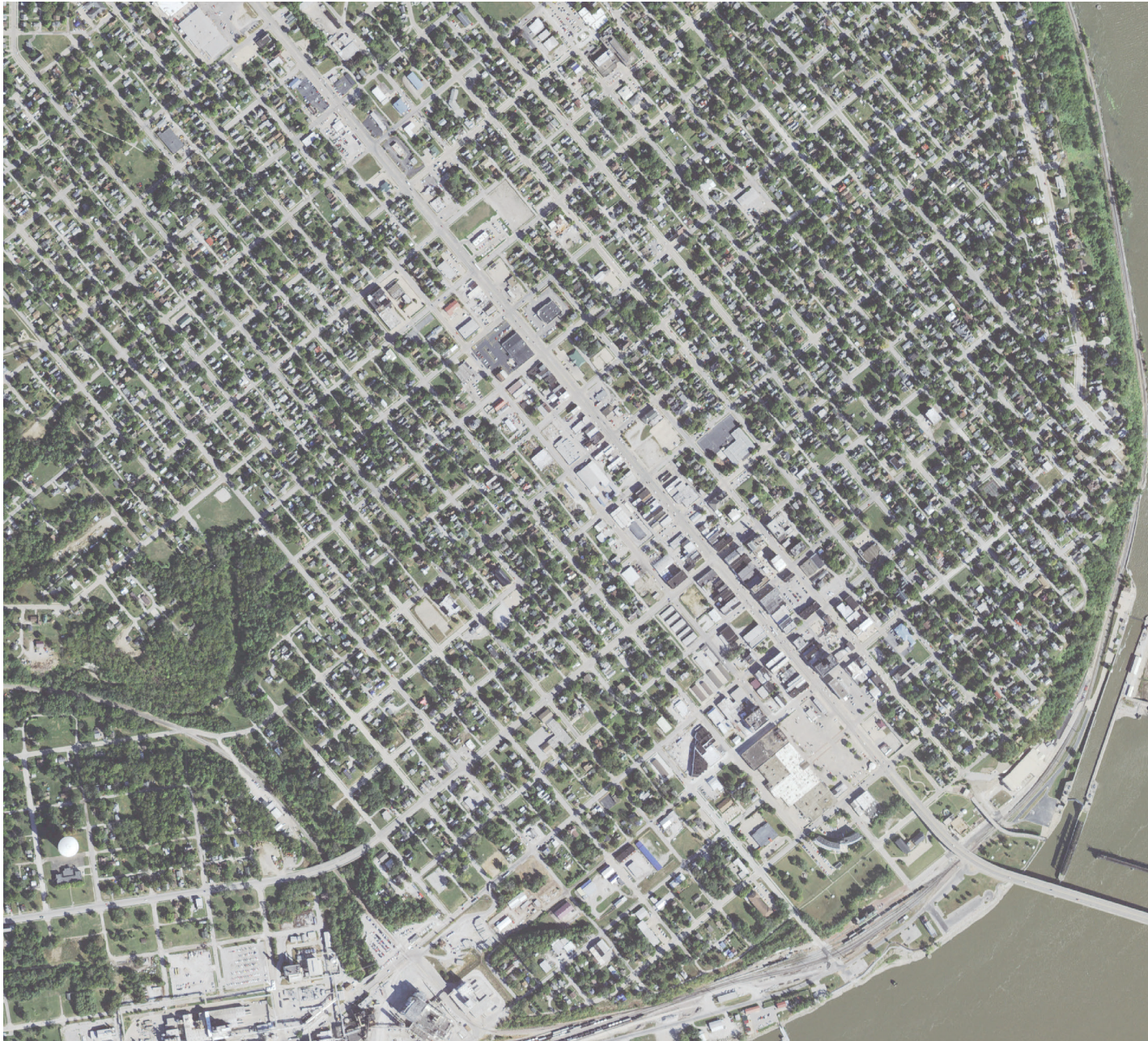
City Limits

## Land Cover

- Water
- Agriculture
- Grass
- Tree Canopy
- Impervious







*Aerial photograph of Keokuk, IA*

*In Keokuk's downtown area, the tree canopy is almost nonexistent. The absence of trees causes a lack of shade, which creates an unwelcoming environment in the hotter months. The tree canopy is more substantial in residential areas.*

Next time you are out in town, note what it feels like to be in areas where there are more trees and vegetated areas.

How does it feel to be in areas mostly dominated by impervious surfaces with minimal vegetation?

Do you notice a difference in how many people pause or gather in those spaces?



# Surface Water Conditions

A watershed is an area defined by elevated boundaries that separate water flowing toward different rivers and creeks. These basins show the extent of a drainage area flowing to a single outlet point.

Where a community is located within its watershed(s) determines how much water flows into or through it. Location also influences the town's capacity to manage flooding issues. For example, a community located near the end of a watershed (close to the outlet point) will have little capacity for reducing the amount of water draining toward it from upland areas, and will receive greater volumes of water during flooding seasons than other communities located higher in the same watershed.

Development of channelized waterways, drainage tiles, and impervious surfaces also leads to increased quantities and speed of the water headed downstream; while a community located near the top of its watershed may not experience flooding, how it manages water will have a greater effect on neighboring communities downstream.

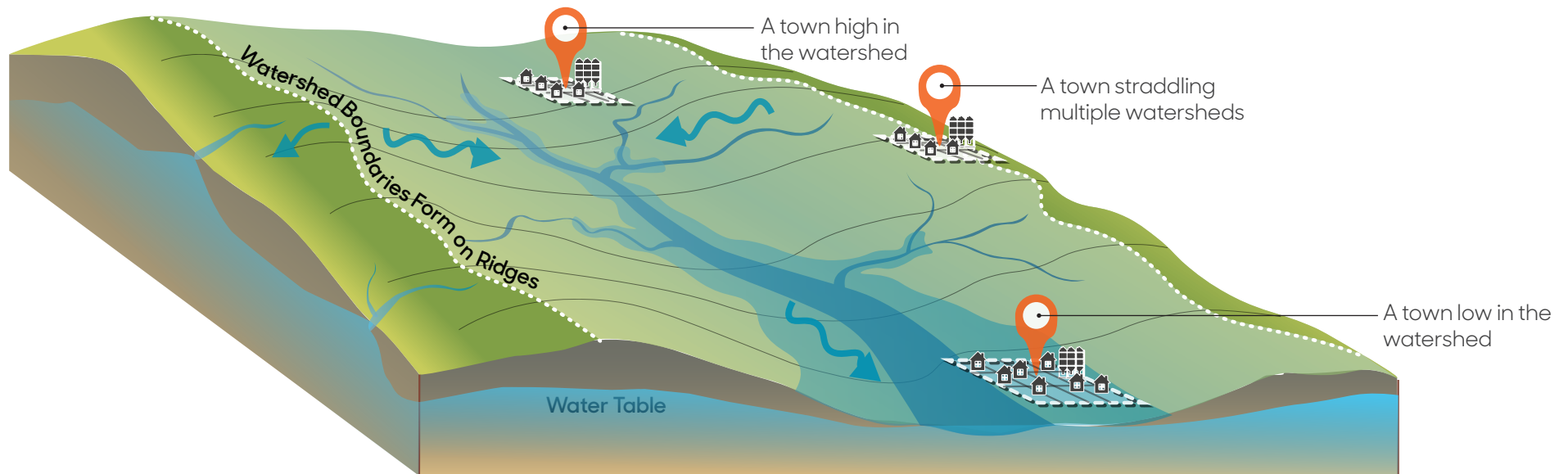
The map on the following page highlights your community within its surrounding watershed(s).

Where is your community located within the watershed(s)? Is water flowing to your community or away from it?

Is flooding an issue in your community?

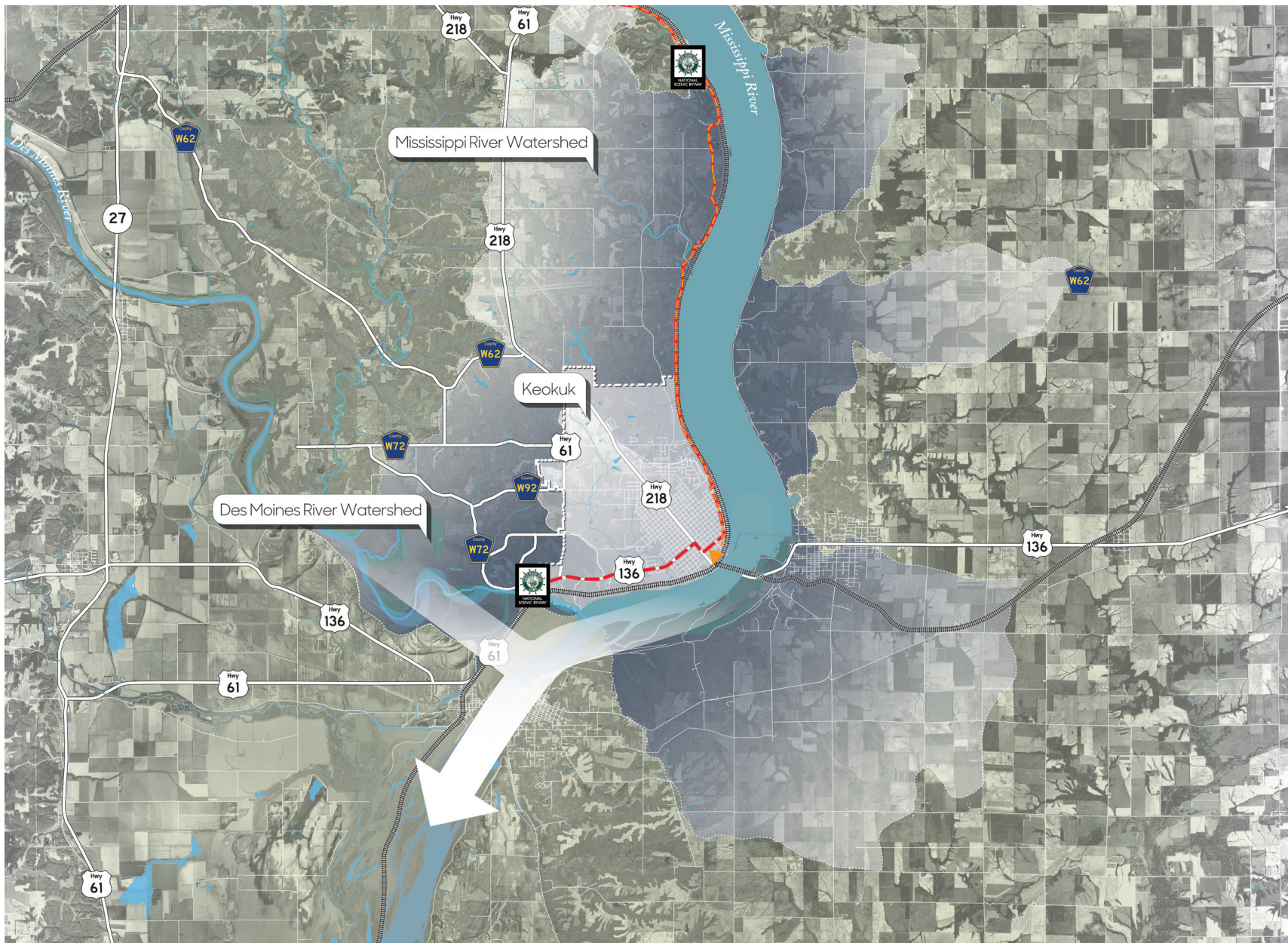
How big is the watershed above your town? What conditions might increase or reduce flooding?











Are there conditions or practices happening in your community that could be creating risk for communities downstream from you?



*Axonometric diagram of the physical characteristics of a watershed.*





- Legend**
-  Trail
  -  River
  -  Railroad
  -  Scenic Byway
  -  Highway
  -  City Limits
  -  [Native Tribe] Settlement
  -  Water
  -  Watershed
  -  Watershed Flow

Watershed map of Keokuk, IA  
 Keokuk is located at the base of two major watersheds; therefore, all of the water in the area will flow toward Keokuk and eventually downriver.



# Surface Water Conditions

The elevation and flow map displays differences in elevation. A combination of contour lines and the color gradient depicted in the legend show which areas are highest and which are lowest in the landscape.

If your community lies within or near a floodplain or floodway, the map on the following page reflects these features. Not all communities will have all of these elements; if they are absent on this map, none are present.

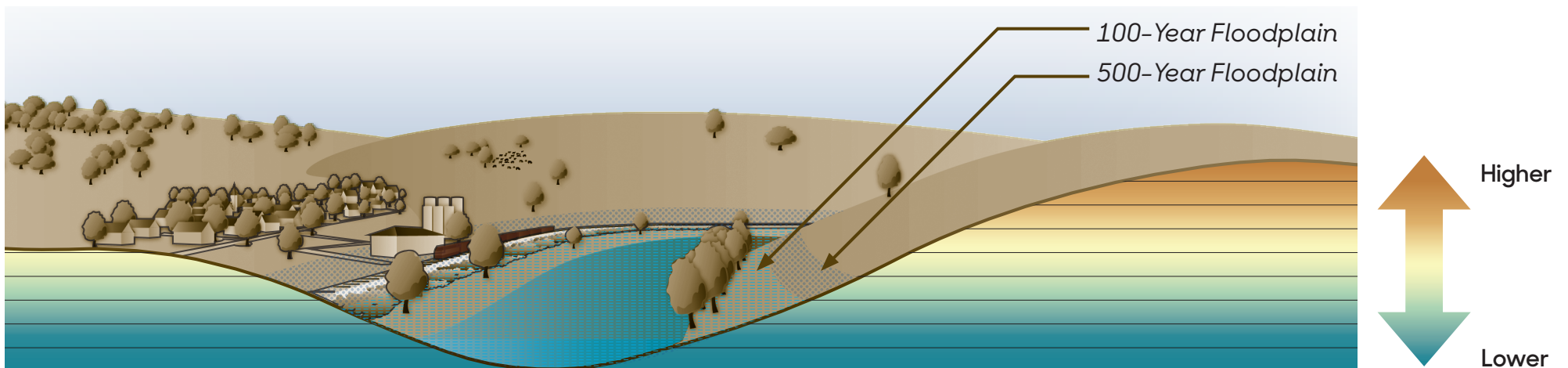
Flood risk is correlated to low-lying land. This map shows your community's 100- and 500-year flood risk as defined by the Federal Emergency Management Agency (FEMA) Flood Map Service Center. A floodway may also be shown, which signifies the greatest flow during a flood and is a zone that cannot be developed.

Note the position of your community in this landscape: is it located in a valley, on high ground, or between the two?

What parts of the community are in the floodplain or are at risk of flooding?

Why do you think these areas have developed in this location?

As the town grew historically, at what elevation did development happen? Has this changed over time?



Sectional diagram depicting the scale of elevation in relation to topographic features and development patterns.





**Legend**

- ○ ○ ○ ○ Trail
- ~ River
- □ □ □ City Limits
- ▭ Road
- ▬▬▬ Railroad
- Water
- 〰 2ft Contours
- ▨ 100-Year Flood
- ▩ 500-Year Flood
- ⊙ Water Well
- ⬆ Higher Elevation  
↓  
Lower Elevation

*Elevation and flow map of Keokuk, IA  
Keokuk was initially settled in the low part of the region along the Mississippi River, which facilitated the development of the railroad. As Keokuk continued to grow, it expanded into the higher areas of the region.*



