CITY OF PITTSBURG, KANSAS

TECHNICAL ASSISTANCE PROJECT

SEPTEMBER 2022

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TABLE OF CONTENTS

1. INTRODUCTION

The Kansas Department of Agriculture (KDA) received funding from FEMA to complete a technical assistance project for the City of Pittsburg, Kansas. The goal being to determine potential mitigation methods to reduce the risk of flooding in the city and surrounding areas. There is no funding match requirement and no cost to the City of Pittsburg for this project.

WSP USA Environment & Infrastructure Inc. (formerly Wood) was retained by KDA to provide technical assistance to the City of Pittsburg. The City of Pittsburg wished to proactively consider the impact of future development and have a better understanding of the influences of mitigation techniques on the risk of flooding.

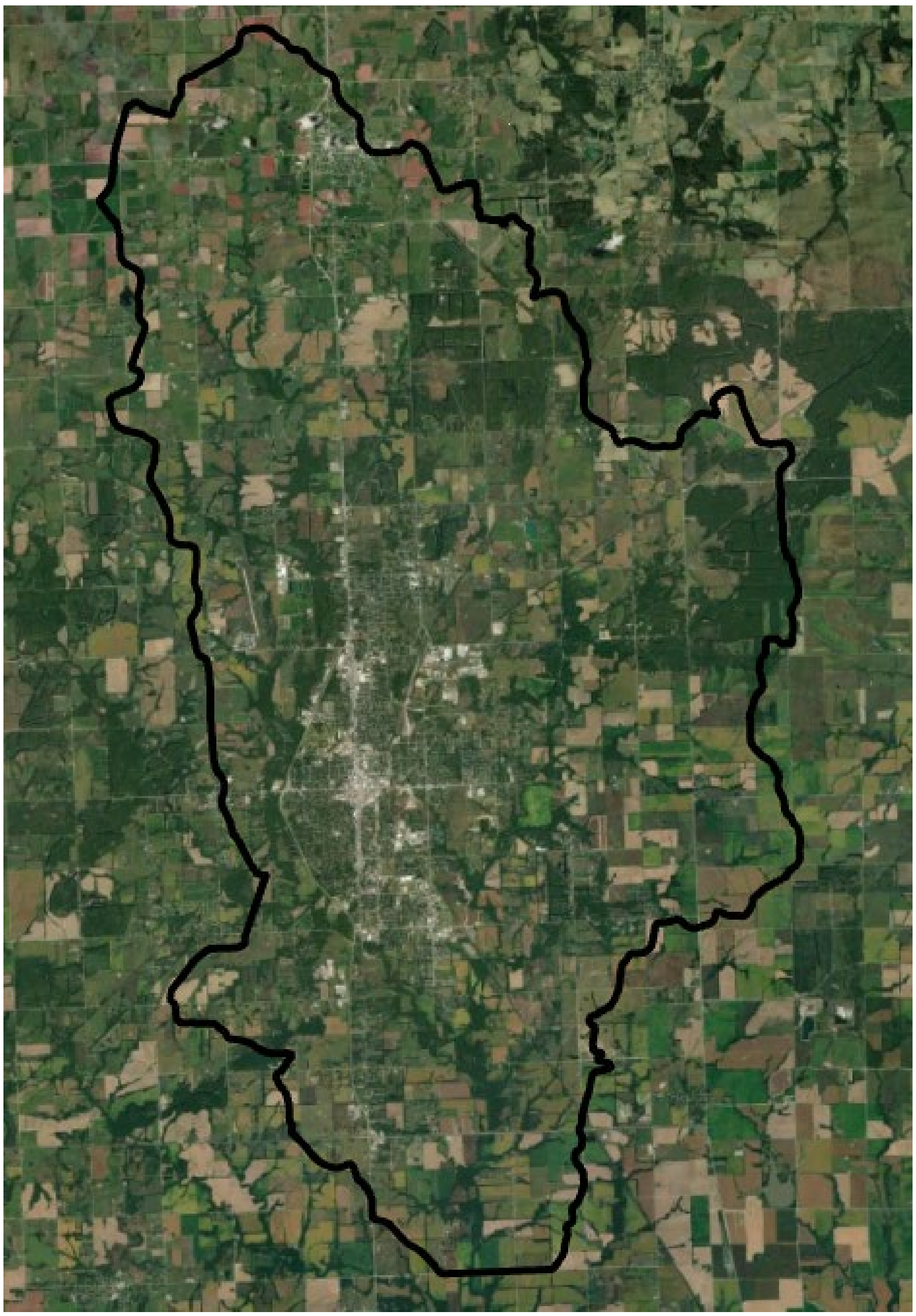
This report presents the alternative scenarios analyzed for three key areas throughout the City of Pittsburg as part of the technical assistance project. Each of these areas was identified by the stakeholders in the City of Pittsburg. The first of the key areas is the planned expansion of the existing water treatment plant to the Southwest of the city. The City of Pittsburg plans to extend the existing levee to protect the new addition. The second key area is an old mining pond along Free King Highway. The pond currently has no means of draining across Free King Highway and in large rainfall events, commonly overtops the highway causing road closures and safety concerns. The City of Pittsburg plans to add a drainage culvert across the highway, thus reducing the likelihood of the highway being overtopped. The third key area is a future housing development on the East side of Pittsburg. The site is contained by E 4th Street, S Free Kings Highway, E Quincy Street, and S Rouse Street. City stakeholders requested that techniques to shift the floodplain be considered. A map denoting the locations of the three key areas is shown in Figure 1.

Figure 1: Locations of the three key areas

2. MODEL DEVELOPMENT

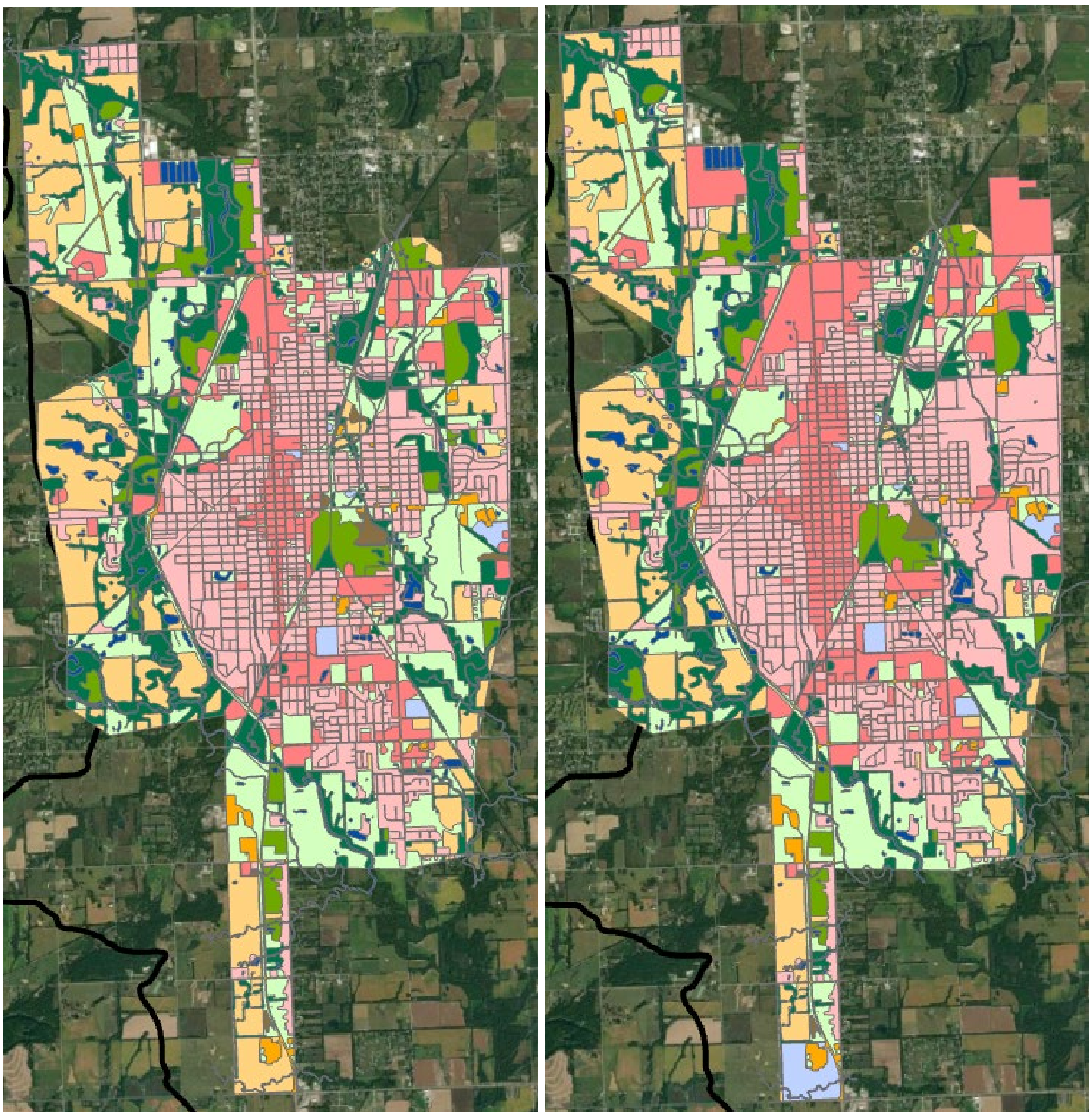
An unsteady state two-dimensional (2D) Hydrologic Engineering Center's River Analysis System (HEC-RAS), version 6.2 model was used to analyze the 1% annual chance storm event for the city of Pittsburg and surrounding watershed. Including the surrounding watershed in the model gave a more accurate representation of the flows coming near or through the city.

Figure 2: Model basin extents



Both the Current Conditions and Future Conditions models used a combination of detailed manual creation landcover grids throughout the city boundary and NLCD landcover grids for the area surrounding the city to develop both infiltration and Manning's 'n' values for the model. The Current Conditions detailed landcover grid was developed using aerial imagery to differentiate landcover types. The Future Conditions detailed landcover grid used the Current Conditions grid as a base and the Pittsburg Land Use Plan to determine any areas of development or change. Both the resulting Manning's 'n' grids had values that ranged from 0.015 to 0.24.

Figure 3: Current and Future Conditions detailed landcover grid



The detailed landcover grids were also used to develop infiltration grids that were incorporated into both models. Infiltration grids are created using landcover grids along with the underlying soil types to determine how much rainfall gets absorbed by the soil to then determine how much ends up as runoff. Including the detailed landcover grids in the infiltration grid development results in more accurate floodplain development.

The models do have one inflow from Second Cow Creek. The flows were taken from the Base Level Engineering (BLE) model previously completed for the Lower Neosho watershed. The BLE modeled the 1% annual chance storm event in HEC-RAS 5.0.7.

Structure data acquired for the Lower Neosho Data Development project was incorporated into both the Current and Future Conditions models. This included 60 bridges and culverts throughout Pittsburg, along with 3 GIS enabled culverts along Taylor Branch. Measured elevation data taken during the surveying process was used to modify the Digital Elevation Model (DEM) also known as the terrain. Predominantly, the DEM modifications were to burn a deeper channel into the DEM surrounding the structures. The DEM is created using lidar (laser imaging, detection, and ranging) which has difficulties piercing water, resulting in terrain readings being at the water surface elevation (WSEL) instead of the channel bottom for perennial streams.

Another important factor used was to arrange cells to align to elevation ridges. Cells grab terrain data along their perimeter to determine the direction of flow. So, the model implemented breaklines and refinement regions to align cells to so that they captured the desired elevations.

3. CONCEPTUAL MITIGATION TECHNIQUES

Three key areas of concern were identified through discussions with community stakeholders and evaluated for flood impact.

MITIGATION LOCATION ONE - WATER TREATMENT PLANT EXPANSION

The first identified area of concern is the planned expansion of the Water Treatment Plant Southwest of the city, along Cow Creek. The location of which is shown in Figure 4.

Figure 4: The current water treatment plant with boxed planned expansion

The treatment plant will be extending into the boxed area to the Northwest of the existing plant. To protect the area from flooding, the city of Pittsburg plans to extend the existing levee to run over then up the west side of the expansion.

The levee expansion was incorporated into the model by using a Terrain modification to alter the DEM by adding an embankment based on the design plans provided by the city of Pittsburg.

The existing levee is not accredited and at this time there are no plans to get it, or the extension accredited. For Flood Insurance Studies (FIS), this means that the water treatment plant would be modeled as a natural valley where the levee does not exist. For the purposes of this study, the existing levee and its extension are being treated as an accredited levee with the entire embankment being captured by the mesh in model.

Figure 5: Flooding levels without the levee expansion

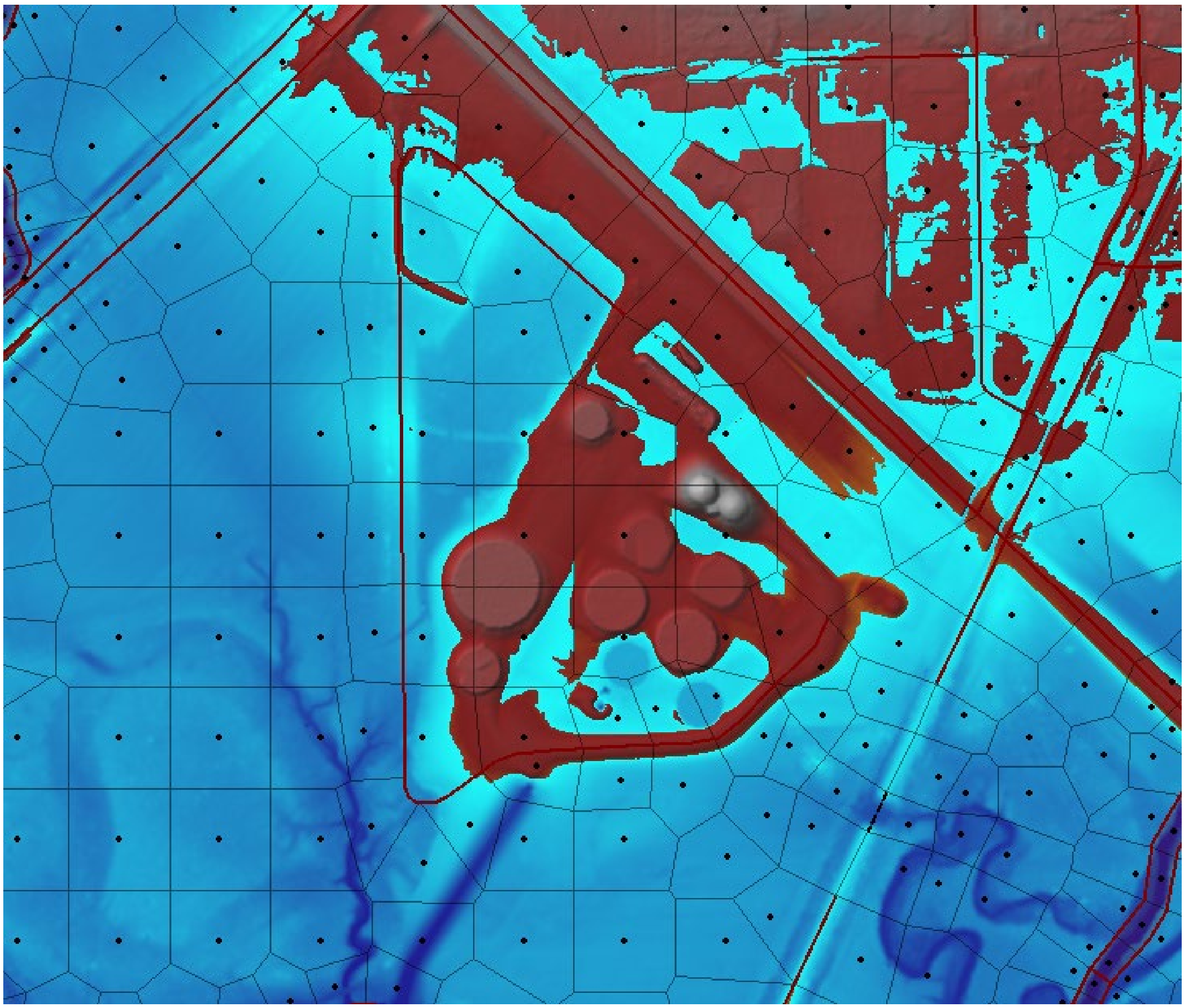
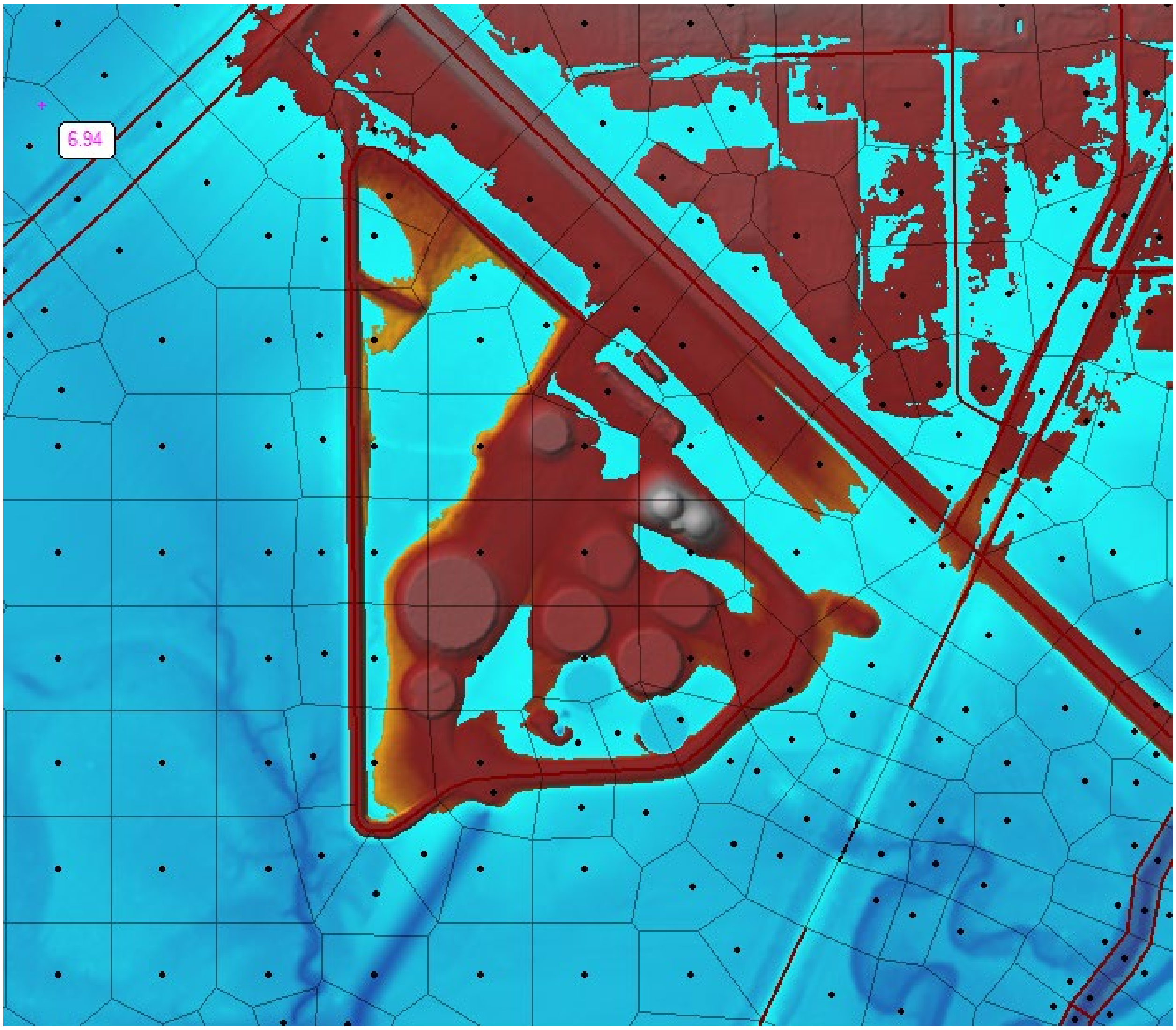


Figure 6: Flooding levels with the levee expansion



Unlike in Figure 5, Figure 6 shows that the flooding does not overtop the levee, thus protecting the water treatment plant addition. However, due to the it being an unaccredited levee, the regulatory floodplains will not account for the protection that it provides.

MITIGATION LOCATION TWO - OLD MINING POND DRAINAGE

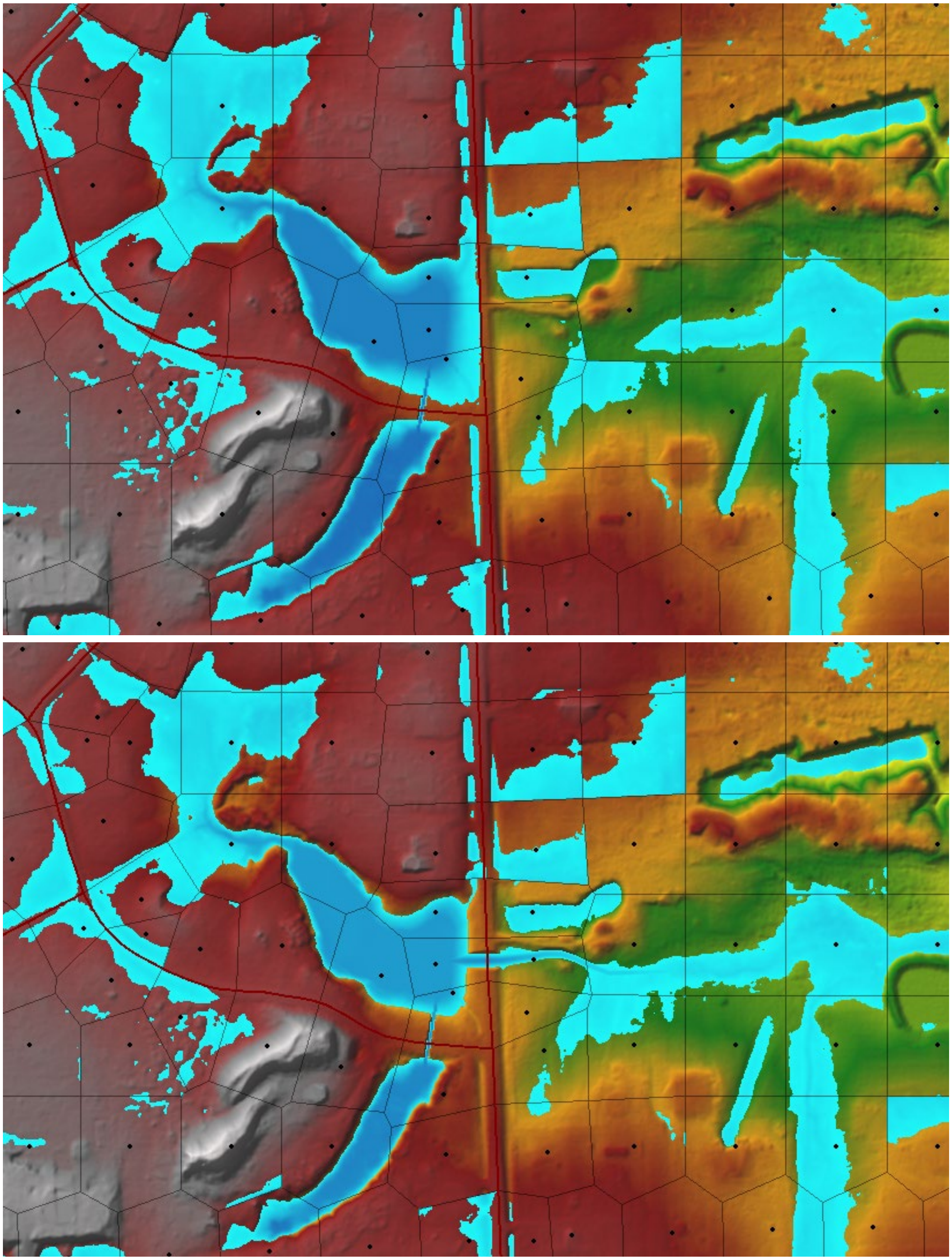
The second identified area of concern is an old mining pit and current pond west of Free Kings Highway and just North of E 20th Street. The location is shown in more detail in Figure 7.

Figure 7: Current overview of the pond

Free King Highway is a heavily used road and in large storm events the pond overfills and overtops the road. To help eliminate this hazard the city plans to add a drainage culvert that extends east across Free Kings Highway to drain into the tributary. Proposed design plans have already been created by an independent contractor and the city provided copies to be included in this project.

It was incorporated as a mitigation technique by adding a culvert across the road as per the design specifications. Additionally, the DEM was modified to include a channel from the pond downstream of the road where it meets up with an established drainage ditch. This was partially due to HEC-RAS not allowing any structure invert lower than the terrain elevation, but also because the proposed design for the culvert included establishing a drainage ditch through a permanent easement.

Figure 8: 1% storm event pooling, before and after adding drainage culvert



As shown in Figure 8, adding the drainage across the road significantly decreases the pooling on the East side, while not greatly impacting that which is seen on the right.

MITIGATION LOCATION THREE - FUTURE HOUSING DEVELOPMENT

The third identified area of concern is a future housing development adjacent to the confluence of Taylor Branch and East Fork Taylor Branch. The location and approximate shape of the new development is shown in Figure 9.

Figure 9: Overview of current conditions with an approximation of the future housing development outlined

During one of the meetings, the community requested to investigate shifting the floodplain away from the future development through channel and overbank modifications. The overall intent is to create a new channel that maintains a similar sinuosity as the existing as well as cut into the higher elevations on the western bank of the stream and using that material to raise the elevations on the eastern side of the stream. To represent this in the model terrain modifications were used to cut in a new channel, to lower the elevation along the western overbank, to raise it along the eastern, with a secondary embankment for the planned road, and to cut in two channels to allow for drainage across the embankments. Additionally, the manning's and infiltration grids were edited so the stream values follow the new channel. These changes resulted in the desired shift in the floodplain as shown in Figures 10 and 11. It should be noted that these terrain modifications were not completed at a level that would be required for design. This analysis was just a feasibility study. A more favorable floodplain could be generated with a better grading plan during design.

Figure 10: Flooding with existing channel

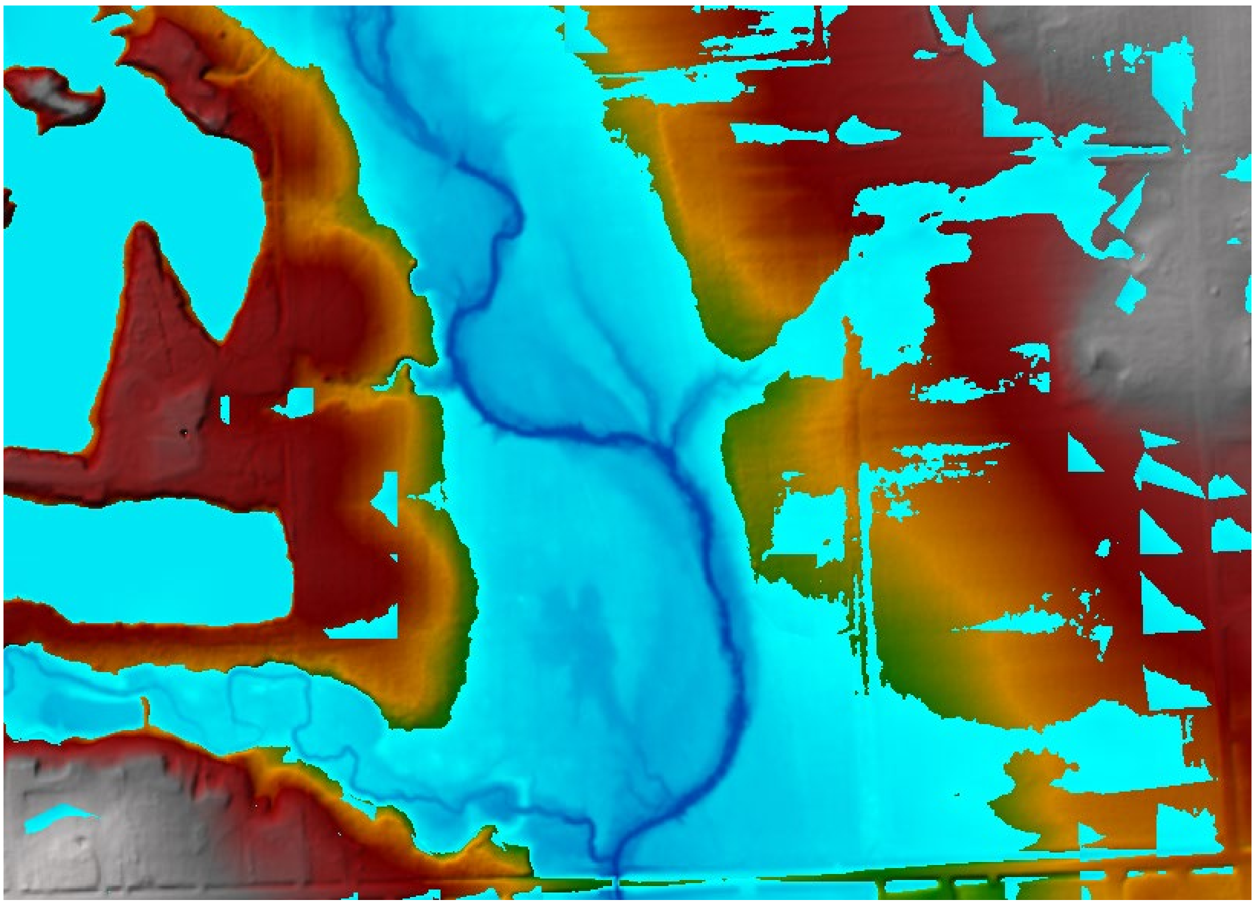
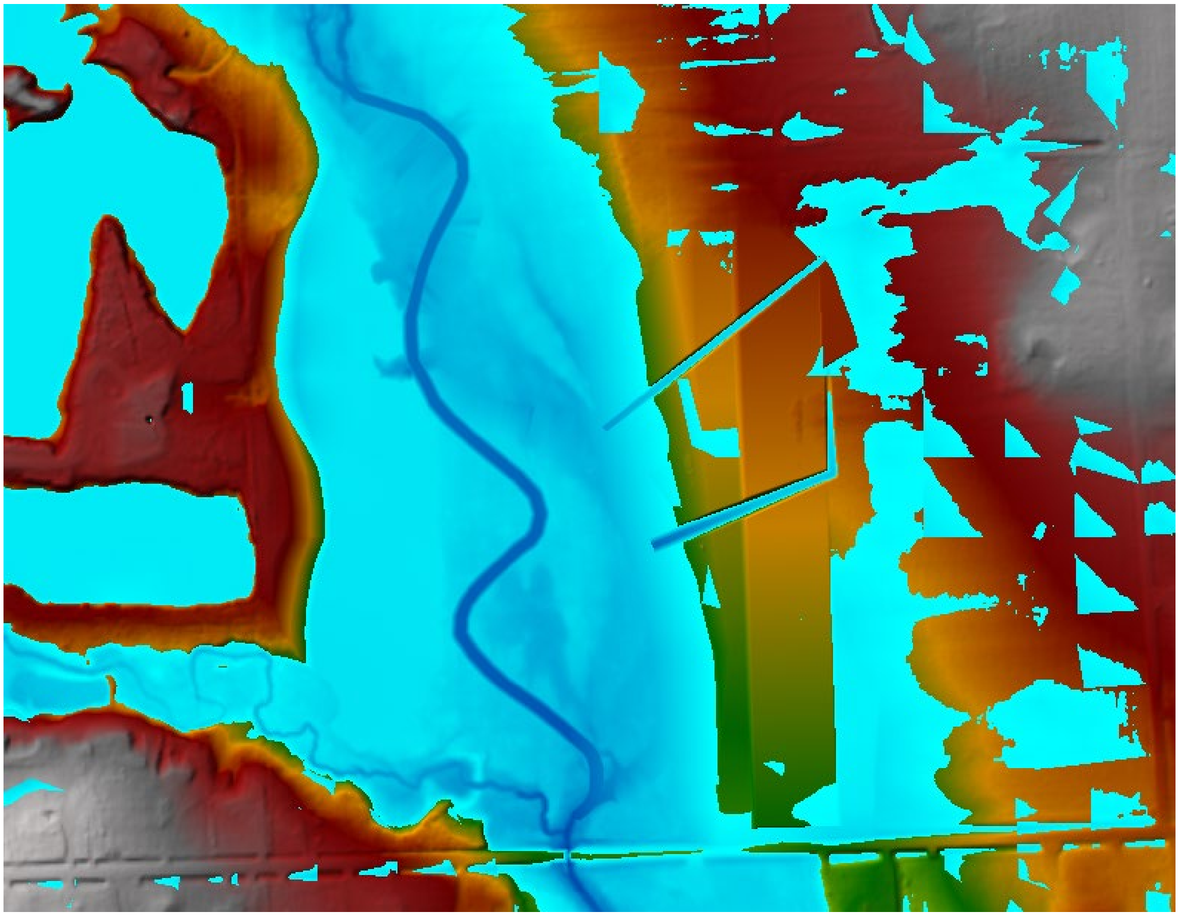


Figure 11: Flooding after floodplain modifications



4. COST ANALYSIS

Since two of the three identified areas of concern are already in the design stage of implementation, this report will not be including a cost analysis and instead is solely examining the impact on flooding.

A cost analysis was performed on the third mitigation location. A full itemized breakdown of the estimate is presented in Table 1. The total project cost includes construction cost, contingency cost, and project cost. This would include legal, fiscal, financing, engineering design, construction administration, inspection, and staking. Allowances based upon a percentage of the total capital or specifically defined portions of the capital work have been used for certain aspects of the work that are not yet well defined. This level of costing is consistent with industry standards and contains a contingency to cover unforeseen items that will develop during the engineering phase of the project.

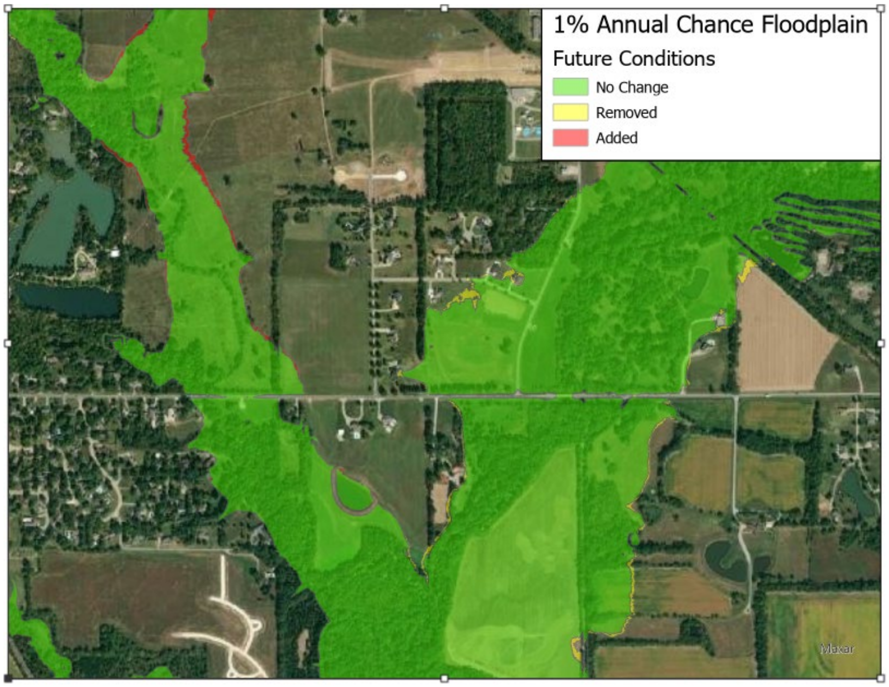
Table 1: Cost Analysis for Mitigation Location Three- Future Housing Development

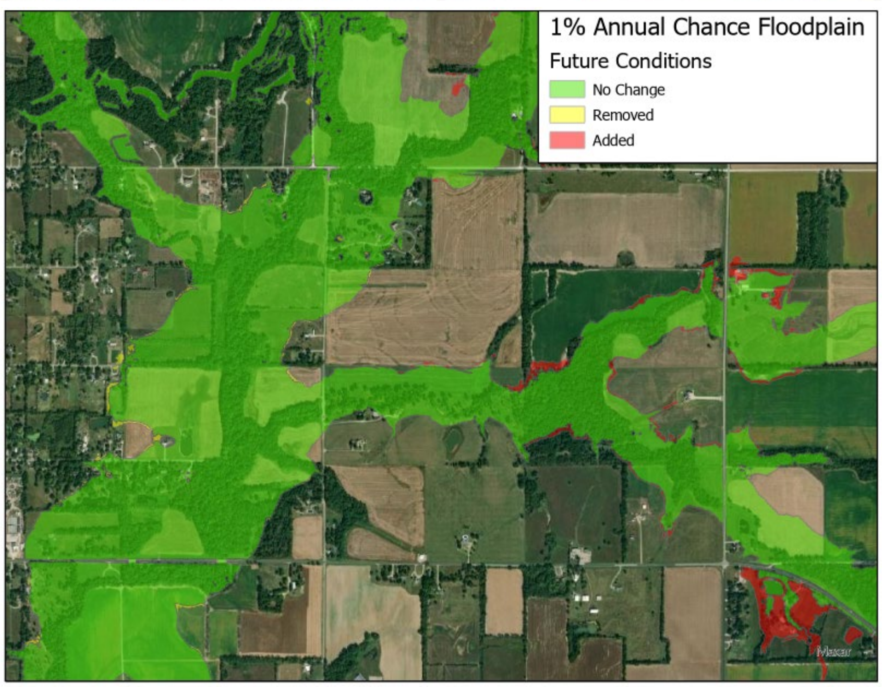
S. No.	Description	Quantity	Unit	Unit Costs	Total Costs
Channel and Overbank Excavation					
1	Excavation	96,000	Cubic Yard	$23.00	$2,208,000
Miscellaneous					
2	Erosion Control				$25,000
3	Site Cleaning and Restoration				$20,000
4	Permitting (LOMR, CLOMR, State and Federal)				$50,000
Preliminary Costs					**$2,303,000**
Design and Construction @ 30%					$690,900
Contingency @ 30%					$690,900
TOTAL PROBABLE COST					**$3,684,800**

5. MODELING RESULTS

There are not many areas that saw significant change between the Current and Future Conditions results. Most of the areas that saw considerable landcover change where outside of the floodplain. Some examples are shown in Figures 12 and 13, with yellow denoting areas no longer in the floodplain, green staying the same, and red being added with future conditions modeling.

Figures 12 and 13: Examples comparing Current and Future Conditions floodplains





The levee addition resulted in considerable change between the current/future conditions versus with mitigation. The results can be seen in Figure 14 with the yellow showing area removed from the floodplain and green showing areas with no change.

Figure 14: Current versus with mitigation floodplain plots

The second key area is not included in the 1% storm event plots and the added mitigation does not cause a significant impact to the floodplain.

The channel and floodplain modifications in the third key area have a significant impact on the floodplain. The modeling shows that it is possible to shift the floodplain for development, but it comes at a very high cost. Figure 15 shows the impact of the modifications on the floodplain with yellow denoting areas no longer in the floodplain, green staying the same, and red being added. As previously mentioned, a more detailed grading plan could be developed during design to generate a more favorable floodplain for development. This study shows that it is possible to shift the floodplain to the west with a significant amount of earthwork to reclaim area for development on the east side of the stream.

Figure 15: Floodplains before and after channel modifications