

# INDUSTRIAL PARK DRAINAGE STUDY

## AUGUSTA, KANSAS

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### I. INTRODUCTION:

The City of Augusta has experienced flooding in recent years in an industrial park north of US-400 and south of the BNSF railroad tracks, between Ohio Street and Industrial Rd. at the southeast edge of town. The City has requested a drainage study to analyze the question of whether or not an existing 2-cell 7'x7' box culvert under US-400 is adequately sized and what options exist for mitigation of said flooding in the industrial park. Schwab Eaton has conducted the following study in which the existing conditions of the US-400 box and contributing watershed were analyzed, and potential options for detention within the watershed were evaluated.

### II. METHODOLOGY:

The SCS Curve Number Method was used to determine peak storm water discharge rates. This study analyzed the 2, 5, 10, 25, and 100-Year storm events. Terminology related to the SCS Curve Number Method is as follows:

“Q” represents the peak discharge rate at a given point in the watershed for the respective design storm and is measured in cubic feet per second (cfs).

The Type II, 24-hour storm represents the SCS hydrograph type selected in this study for the region in which the project site is located.

Rainfall Depth: a total rainfall depth was determined from the KDOT rainfall depth table for Butler County, Kansas for a 24-hour storm. The total 24-hour rainfall depth from the table for the design storms are as follows:

**TABLE 01**

<b>Type-2, 24-hour Storm Rainfall Depths</b>	
<b>Storm Year</b>	<b>Depth (in)</b>
2-Year	3.6
5-Year	4.5
10-Year	5.3
25-Year	6.6
50-Year	7.6
100-Year	8.7

“CN” represents the SCS Curve Number. CN values were chosen based on the weighted average of CN values per hydrologic soil group and ground cover type from Table 2-2a of the 1986 Urban Hydrology for Small Watersheds (Technical Release 55).

“Tc” represents the time of concentration of a given watershed. The Tc values in this study were determined per Section 11.2.2 in the KDOT Design Manual, Vol. 1, Part C.

“A” represents the watershed area in acres. Watershed areas were mapped out and measured on topographic drawings created in AutoCAD Civil 3D 2023. Existing topographic information within the industrial park and surrounding watershed area was obtained from Lidar data provided by the Kansas Data Access and Support Center. Watershed Maps for existing and proposed conditions are included in the Appendix.

PondPack CONNECT Edition, a Bentley software, was used to model the watersheds and the runoff from the site in both the existing and proposed conditions and to design storm water detention facilities. See Appendix for additional data generated from the PondPack model.

### **III. EXISTING CONDITIONS**

The existing conditions of the US-400 2-cell 7'x7' reinforced concrete box culvert (RCB) was analyzed to determine whether the culvert was sized adequately for the current amount of upstream development. The watershed from which runoff concentrates at the US-400 RCB includes an area of approximately 509 acres. The watershed extends north from the RCB to E Belmont Ave. The watershed extends west to Larry Street and east to Custer Lane. See existing conditions drainage map in the appendix. The time of concentration of said watershed is 62 minutes and the Curve Number (CN) is 82.9.

A major leg of the BNSF Railroad bisects the south portion of the watershed. Runoff flows underneath the tracks at three bridges located at the south end, the middle, and the north end of the section of tracks within the watershed. These three bridges were analyzed to determine their impact on the overall peak runoff and headwater elevations at the US-400 RCB. However, the results of this analysis were of no consequence to the overall conclusions. The final results of the existing conditions analysis includes the watershed of the US-400 as a whole.

The ditch into which the RCB discharges (south of US-400) is spanned by another RCB serving as an entrance to a crop field. This RCB is approximately 150 feet south of the US-400 RCB. The field entrance RCB has the potential to impact the discharge capacity of the US-400 RCB and the resulting water surface elevation upstream of the RCB. The field entrance was included in the existing conditions analysis. A sanitary sewer main crosses the same ditch further south.

The above watershed data, the US-400 RCB characteristics, and the tailwater condition created by the field entrance, were modeled together in PondPack. Table 03 shows the total discharge rates through the US-400 RCB and the resulting water surface elevations immediately upstream of the RCB for each design storm.

**TABLE 03**

<b>Augusta Industrial Park Drainage Analysis</b>						
<b>US 400 RCB Analysis (w/ Tailwater Condition)</b>						
<b>Pond Pack Results</b>						
<b>Design Storm</b>	<b>2-Year</b>	<b>5-Year</b>	<b>10-Year</b>	<b>25-Year</b>	<b>50-Year</b>	<b>100-Year</b>
<b>Peak Flow (IN)(cfs)</b>	502.4	716.2	909.3	1204	1449.6	1707.5
<b>Maximum Water Elev.</b>	1226.6	1227.63	1228.26	1229.03	1229.38	1229.77

The resulting water surface elevations (WSEL) at US-400 indicate that in the 25-Year and higher, flooding occurs in the Global Parts Buildings (South Building FFE=1229.70; North Building FFE=1229.03).

The conclusions stated in the preliminary drainage summary letter (dated 09/29/2022) remain consistent with the data generated in this study regarding KDOT sizing of the US-400 RCB

The results of the existing conditions analysis indicate the field entrance south of the US-400 RCB has an insignificant effect on the hydraulic performance of the US-400 RCB. Stormwater overflows and bypasses the box culvert under the field entrance even in the 2-year storm. In each design storm, results indicate the US-400 RCB operates under inlet control which means the dimensions and characteristics of the RCB itself are the controlling factor in determining the resulting upstream water surface elevations. This being the case, the sanitary sewer main which crosses the ditch further downstream of the field entrance has no effect on the performance of the US-400 RCB.

**IV. PROPOSED CONDITIONS**

The existing conditions analysis results indicate flooding in the industrial park occurs due to amount of runoff concentrating at the US-400 RCB and the RCB’s limited capacity to convey said runoff to the south. Therefore, channel and/or storm sewer pipe network improvements involving increasing the capacity of stormwater conveyance upstream of the US-400 RCB would only result in higher peak flows at the US-400 and potentially higher water surface elevations. Viable options for flood mitigation will include upstream detention of runoff and increased capacity of the US-400 RCB.

***US-400 RCB improvements***

Using the existing conditions model, improvements to the US-400 RCB were analyzed to determine how much its capacity would need to be increased to decrease the risk of flooding in the Industrial Park. Typically, buildings are constructed with an FFE of at least 1-ft above the 100-Year flood elevation. Several iterations were analyzed in the model to determine the structure size that would decrease the WSEL in the industrial park to 1228.03 (1-ft below lowest existing building). Replacing the existing RCB in the model with the final improved RCB yielded the following results in the 100-Year storm.

**TABLE 04**

<b>Improved US-400 RCB Results (Triple-Cell 11.25'x6' RCB)</b>	
US-400 RCB Peak Flow (IN):	1,707.5 cfs
US-400 RCB Peak Flow (Out):	1,573.0 cfs
US-400 RCB WSEL (Upstream):	1,227.99 ft
WSEL Delta:	-1.78 ft

The results in Table 04 above indicate a significant reduction in the 100-Year WSEL at the RCB. The lowest building in the industrial park has an FFE of 1229.03. Thus, by increase the RCB size to a triple-cell 11.25'x6' structure, the 100-Year flood elevation will be reduced to at least 1-ft below the lowest existing building in the industrial park under the above-described parameters.

***Upstream Detention of Runoff***

In terms of upstream detention, several locations for potential detention pond construction were discussed with the City. The list of potential sites was narrowed down to four, and an analysis of each was conducted to determine their potential feasibility. Each pond site was conceptually graded. A preliminary outlet structure was identified for each pond. The four pond sites were individually analyzed for the 100-Year storm. Ponds were not analyzed in combination with one another. See Proposed Conditions Drainage Map attached showing locations of potential detention pond sites and their potential drainage impact.

**A. Pond Option #1 – Electrical Distribution Plant**

Pond Option #1 is located just north of the BNSF railroad at the City’s electrical distribution facility. It has a contributing area of 274.26 acres, a maximum storage volume of 4.57 ac-ft, a depth of 5.16 feet, and an overflow elevation of 1236.00. The pond was added to the existing conditions model and analyzed for the 100-year storm. Outlet structures as large as the existing railroad bridge in that location were analyzed in the model. See model results in Table 05 below.

**TABLE 05**

<b>Option #1 Results Summary</b>				
<b>Pond Peak (IN) (cfs)</b>	<b>Pond Peak (OUT)(cfs)</b>	<b>Pond Max Storage (ac-ft)</b>	<b>US-400 RCB Peak (IN)(cfs)</b>	<b>US-400 RCB WSEL Delta (ft)</b>
920.2	890.9	3.73	1669.7	No Change

**B. Pond Option #2 – East Storage Unit Pond**

Pond Option #2 is located just north of DT’s U-store storage buildings, north and east of the intersection of Hooper Dr. and 12<sup>th</sup> Ave. It has a contributing area of 199.15 acres, a maximum storage volume of 6.39 ac-ft, a depth of 4 feet, and an overflow elevation of 1238.00. The pond was added to the existing conditions model and analyzed for the 100-year storm. Various outlet structures were analyzed in the model. Adding a 3-cell, 10-ft x 3-ft box culvert allowed the water surface elevation in the proposed pond to remain just below the overflow elevation, thus maximizing the potential benefit of the pond storage. See model results in Table 06 below.

**TABLE 06**

<b>Option #2 Results Summary</b>				
<b>Pond Peak (IN) (cfs)</b>	<b>Pond Peak (OUT)(cfs)</b>	<b>Pond Max Storage (ac-ft)</b>	<b>US-400 RCB Peak (IN)(cfs)</b>	<b>US-400 RCB WSEL (ft)</b>
668.1	641.5	5.879	1669.8	-0.02

**C. Pond Option #3 – West Storage Unit Pond**

Pond Option #3 is located just north of Space Station Storage, between Ohio St. and Elmwood Cemetery. It has a contributing area of 95.74, a maximum storage volume of 6.95 ac-ft, a depth of 5 feet and an overflow elevation of 1244.00. The pond was added to the existing conditions model and analyzed for the 100-year storm. Various outlet structures were analyzed in the model. Adding a 1-cell, 9-ft x 3.5-ft box culvert allowed the water surface elevation in the proposed pond to remain just below the overflow elevation, thus maximizing the potential benefit of the pond storage. See model results in Table 07 below.

**TABLE 07**

<b>Option #3 Results Summary</b>				
<b>Pond Peak (IN) (cfs)</b>	<b>Pond Peak (OUT)(cfs)</b>	<b>Pond Max Storage (ac-ft)</b>	<b>US-400 RCB Peak (IN)(cfs)</b>	<b>US-400 RCB WSEL (ft)</b>
321.2	268.6	6.467	1625.05	-0.08

**D. Pond Option #4 – Golf Course Pond**

Pond Option #4 is located in the golf course just northeast of the large existing pond. The pond was modeled with the assumption that the bottom 5 feet would not drain down after a rain event but would retain water as a feature of the golf course. The pond has a contributing area of 9.63 acres, a maximum storage volume (above retention) of 3.98 ac-ft, a detention depth of 5 feet, and an overflow elevation of 1265.00. The pond was added to the existing conditions model and analyzed for the 100-year storm. Various outlet structures were analyzed in the model. Adding a single 6-inch diameter outlet orifice allowed the water surface elevation in the proposed pond to remain 1.7-ft below the overflow elevation. See model results in Table 08 below.

**TABLE 08**

<b>Option #4 Results Summary</b>				
<b>Pond Peak (IN) (cfs)</b>	<b>Pond Peak (OUT)(cfs)</b>	<b>Pond Max Storage (ac-ft)</b>	<b>US-400 RCB Peak (IN)(cfs)</b>	<b>US-400 RCB WSEL (ft)</b>
32.3	1.7	3.8	1676.29	-0.04

Although additional pond volume was left un-used, the outlet orifice size was not reduced any further due to clogging concerns.

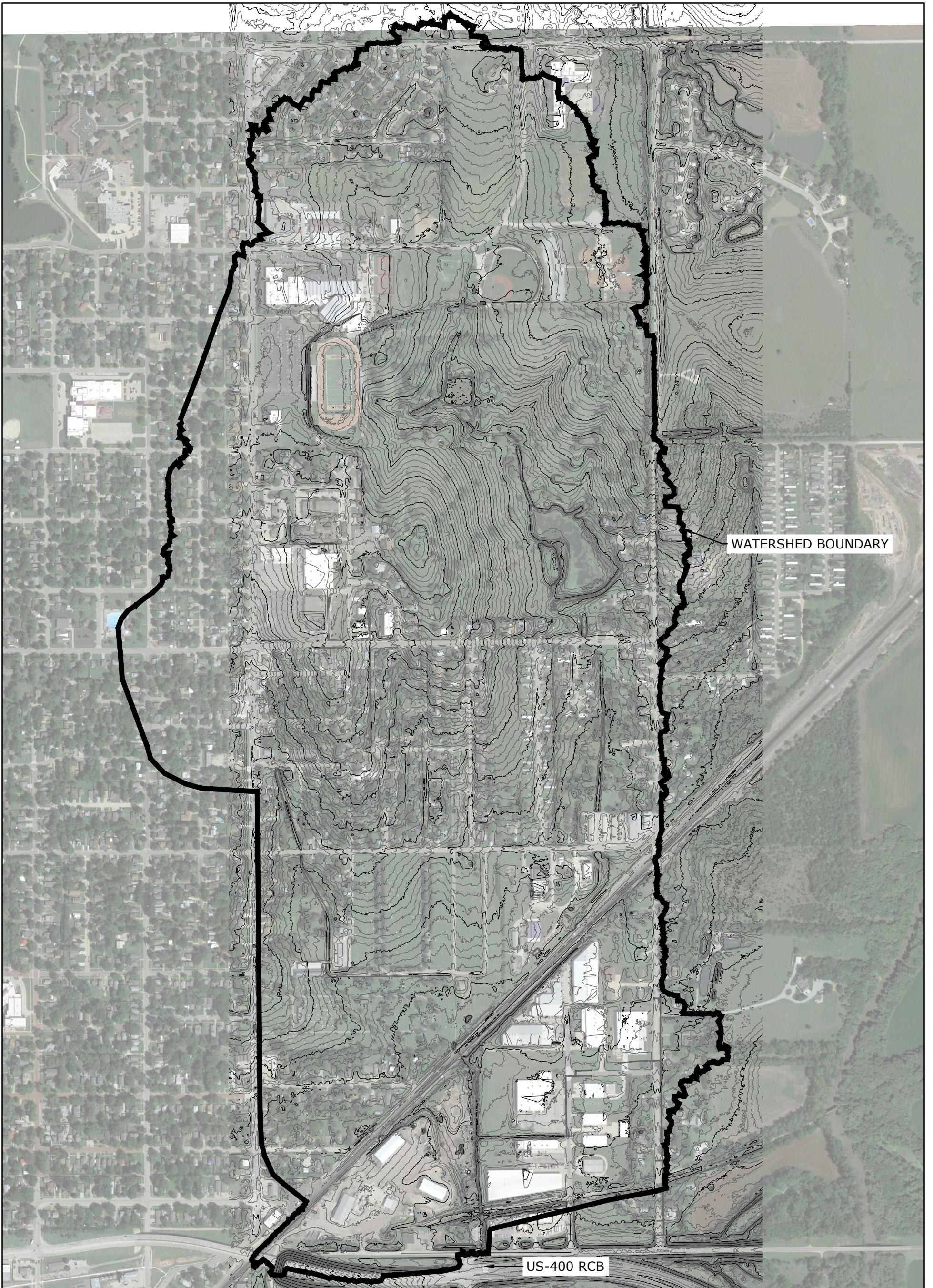
## **V. CONCLUSIONS**

Increasing the size of the US-400 RCB to a triple-cell 12'x6' box culvert has a significant impact on the upstream WSEL and can significantly reduce the risk of flooding in the industrial park in the 100-year storm.

The above analysis of Pond Options 1-4 indicates only a slight benefit to the system as a whole. Pond Option 1 results in no change in the WSEL at US-400. Options 2-3 lower the WSEL at US-400 by only a few hundredths of a foot each. Thus, constructing ponds in the locations identified would have minimal impact on the present drainage concerns. Either larger areas with more available storage volume should be considered, or other solutions altogether.

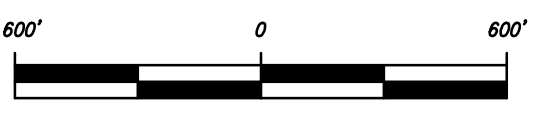
## **VI. RECOMMENDATIONS:**

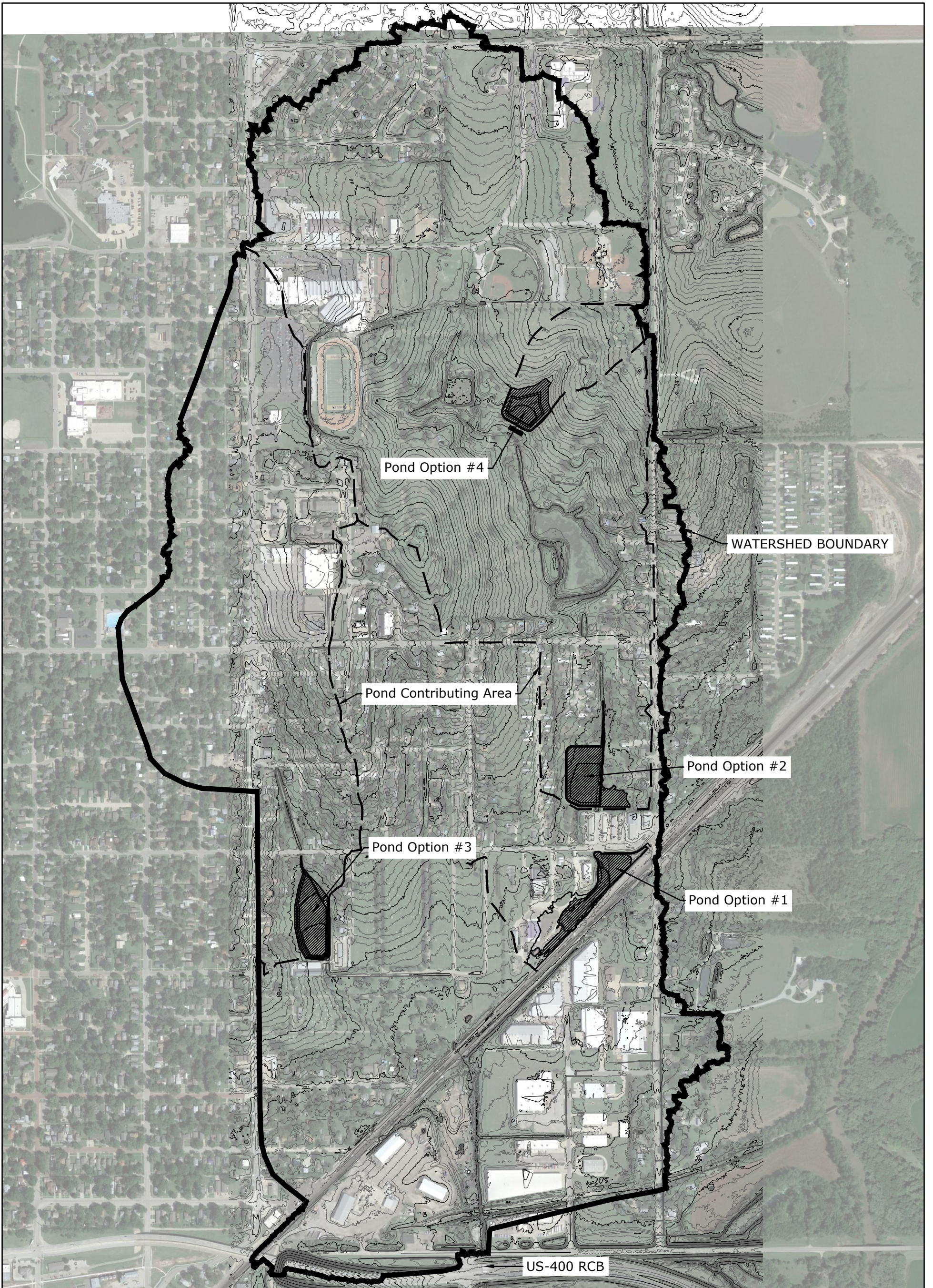
It is recommended that avenues for increasing the size of the US-400 RCB be pursued. An improved US-400 RCB scenario provides the most significant mitigation of flood risk in the industrial park.



# EXISTING CONDITIONS MAP

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# PROPOSED CONDITIONS MAP

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