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Laura Kelly, Governor

April 23, 2024

To: Senator Rick Billinger, Chairperson, Senate Committee on Ways and Means &
Representative Troy Waymaster, Chairperson, House Committee on Appropriations

From: Greg Schieber, P.E. State Transportation Engineer and Deputy Secretary

RE: City of Augusta Drainage issue at the Industrial Park just north of US-54/US-400

The City of Augusta industrial park is located on the southeast side of the city, north of US-400 and southeast of the BNSF Railway line. The Walnut River is located just east of the industrial park. The drainage for the eastern third of Augusta flows generally south and east towards the Walnut River through the industrial park. The drainage crosses US-400 just east of Lunger Road through a reinforced concrete box culvert (RCB) which was placed in 1975.

The City of Augusta has experienced increased frequency of flooding events within the industrial park in recent years. Because of this, in 2022 the City of Augusta hired an engineering consultant to perform an "Industrial Park Drainage Study" (attached for reference). The study evaluated the current conditions at the site and proposed solutions to mitigate the flooding. The proposed solutions included several options for upstream detention as well as increasing the size of the RCB under US-400. The recommended alternative was to pursue increasing the size of the RCB.

US-400 is owned and maintained by the Kansas Department of Transportation (KDOT). Any improvements to the culvert need to be coordinated with KDOT. In February of 2023, The KDOT Division of Engineering and Design reviewed the City's drainage study and provided a "Drainage Study Review" memo (attached for reference). The conclusion was that the RCB design was adequate for the original undeveloped conditions. However, as the City and industrial park have developed in the past 40+ years, the addition of impervious area (buildings and paved lots) has created unmitigated runoff resulting in flooding. KDOT staff did not dispute the conclusion in the City's report that increasing the size of the RCB would improve this flooding condition.

For the past year KDOT and City staff have been working together to find a solution. KDOT has initiated a project to design a solution including performing a more detailed analysis to understand downstream impacts of replacing the existing RCB with a larger structure. As the design progresses, construction estimates will be generated. Construction estimates will allow the City and KDOT to identify and pursue potential funding sources (local, state and federal). KDOT estimates the development of this project will take up to three years. This includes time for right-of-way acquisitions and utility relocations prior to construction. Through the design process, if there are reasonable opportunities to accelerate the schedule KDOT will pursue them.

Should you have any questions regarding the content of this memo, please contact me at 785-296-3285 or Greg.Schieber@ks.gov

INDUSTRIAL PARK DRAINAGE STUDY
AUGUSTA, KANSAS

Prepared by Schwab Eaton P.A.
November 1st, 2022

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

Type-2, 24-hour Storm Rainfall Depths	
Storm Year	Depth (in)
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

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

Improved US-400 RCB Results (Triple-Cell 11.25'x6' RCB)	
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

Option #1 Results Summary				
Pond Peak (IN) (cfs)	**Pond Peak (OUT)(cfs)**	**Pond Max Storage (ac-ft)**	**US-400 RCB Peak (IN)(cfs)**	**US-400 RCB WSEL Delta (ft)**
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 12th 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

Option #2 Results Summary				
Pond Peak (IN) (cfs)	Pond Peak (OUT)(cfs)	Pond Max Storage (ac-ft)	US-400 RCB Peak (IN)(cfs)	US-400 RCB WSEL (ft)
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

Option #3 Results Summary				
Pond Peak (IN) (cfs)	Pond Peak (OUT)(cfs)	Pond Max Storage (ac-ft)	US-400 RCB Peak (IN)(cfs)	US-400 RCB WSEL (ft)
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

Option #4 Results Summary				
Pond Peak (IN) (cfs)	Pond Peak (OUT)(cfs)	Pond Max Storage (ac-ft)	US-400 RCB Peak (IN)(cfs)	US-400 RCB WSEL (ft)
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.

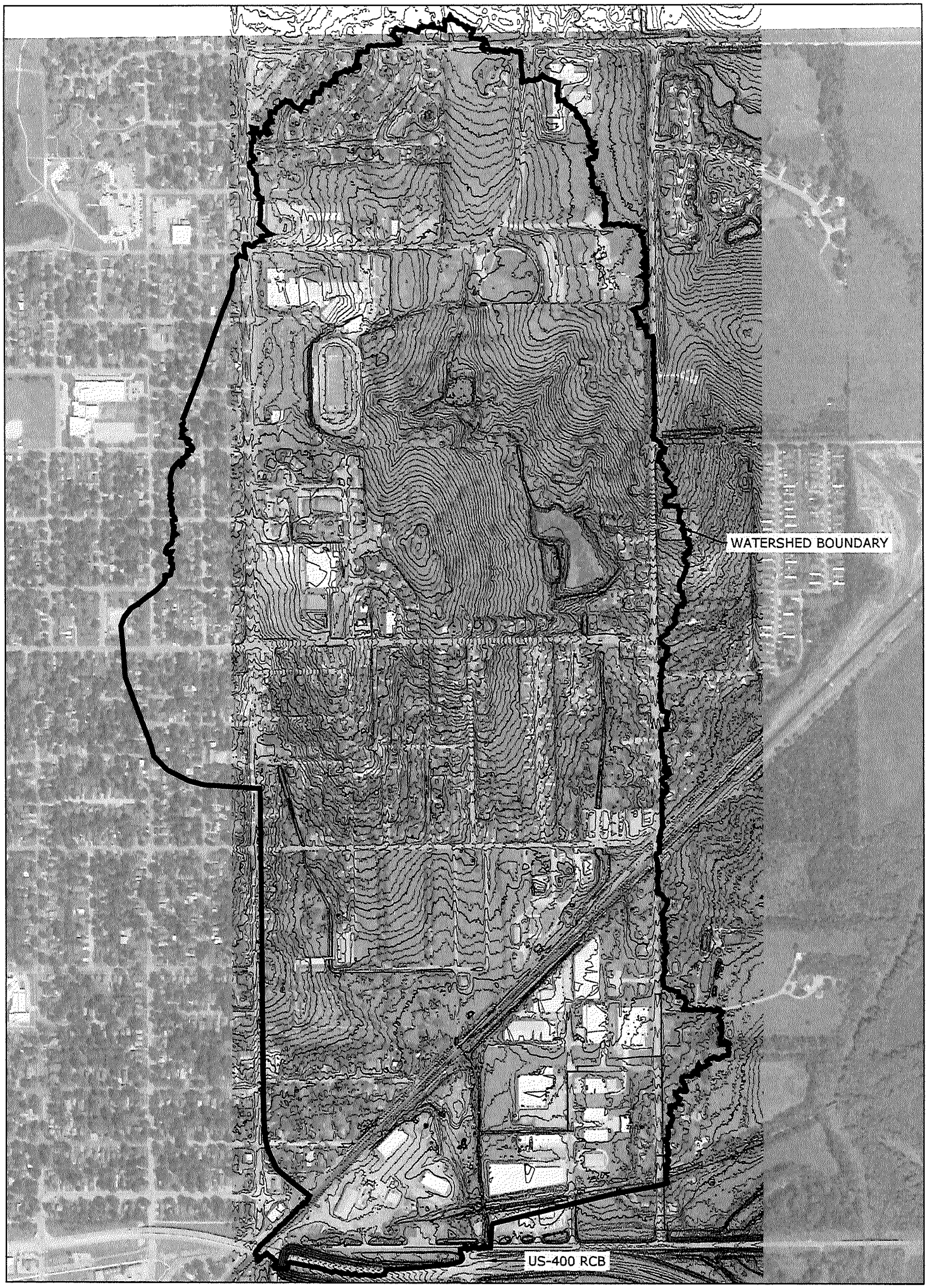
V. CONCLUSIONS

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:

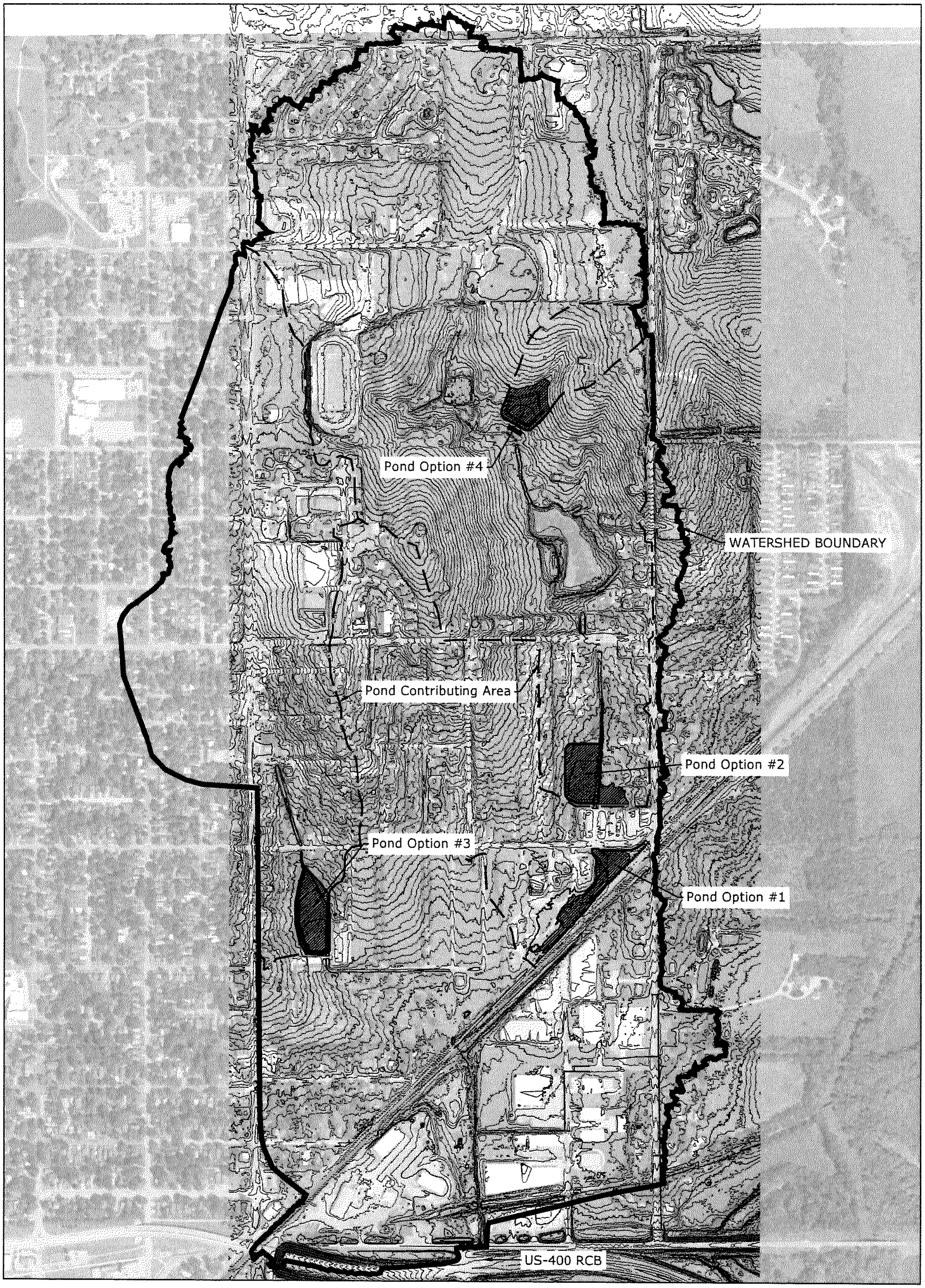
It is recommended that avenues for increasing the size of the US-400 RCB be pursued. An improved US-400 RCB scenario provides the most significant mitigation of flood risk in the industrial park.



EXISTING CONDITIONS MAP

Industrial Park Drainage Study
Augusta, KS

Schwab Eaton



PROPOSED CONDITIONS MAP

Industrial Park Drainage Study
Augusta, KS

Schwab Eaton

600' 0 600'

MEMO

Kansas
Department of Transportation
Bureau of Road Design

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DATE: February 17, 2023

TO: Nick Squires, P.E.
District V Engineer

ATTENTION: Scott Koopmann, P.E.
Area II Engineer (El Dorado)

FROM: Debbie Tanking, P.E., Chief
Bureau of Road Design

BY: Steven Cross, P.E. SPC
Road Design Leader

REFERENCE: US-54/400 in Butler County

SUBJECT: Drainage Study Review

We have reviewed the drainage study sent from the City Manager of Augusta, Josh Shaw. The culvert in questions is an existing 2-7'x7'x175'-11" reinforced concrete box (RCB) constructed in an unknown year, before 1975, and extended in 1975. The original box culvert construction plans could not be located nor any historic drainage calculations for this structure. Rough calculations were done based on the 1975 estimated conditions and the existing 2-7'x7' RCB seems to have been properly sized for that time period.

There have been some developments in this drainage basin since 1985, as seen on the below Google Aerial photos. It is unknown what developments were in this basin in 1975. The approximately 77 acres in the triangular area bound by the railroad, 7th Avenue, and Custer Lane in 1985, see Google Earth aerial below, only shows minimal development as compared to the development shown in the 2021 Google Earth aerial below. Several smaller developments can also be seen in the below aerials. It is unknown if these developments had any drainage requirements associated with their building permits.

The drainage study does provide a recommendation to increase the size of the structure to a 3-12'x6' RCB, which takes it to a bridge size structure. This size structure, or something similar, would lower the inlet water depth. The curve number of 82.9 in the drainage study appears to be based on the current year (2022) and not the 1975 conditions. If a curve number was developed for the 1975 condition, it would be lower and would produce a low water volume.

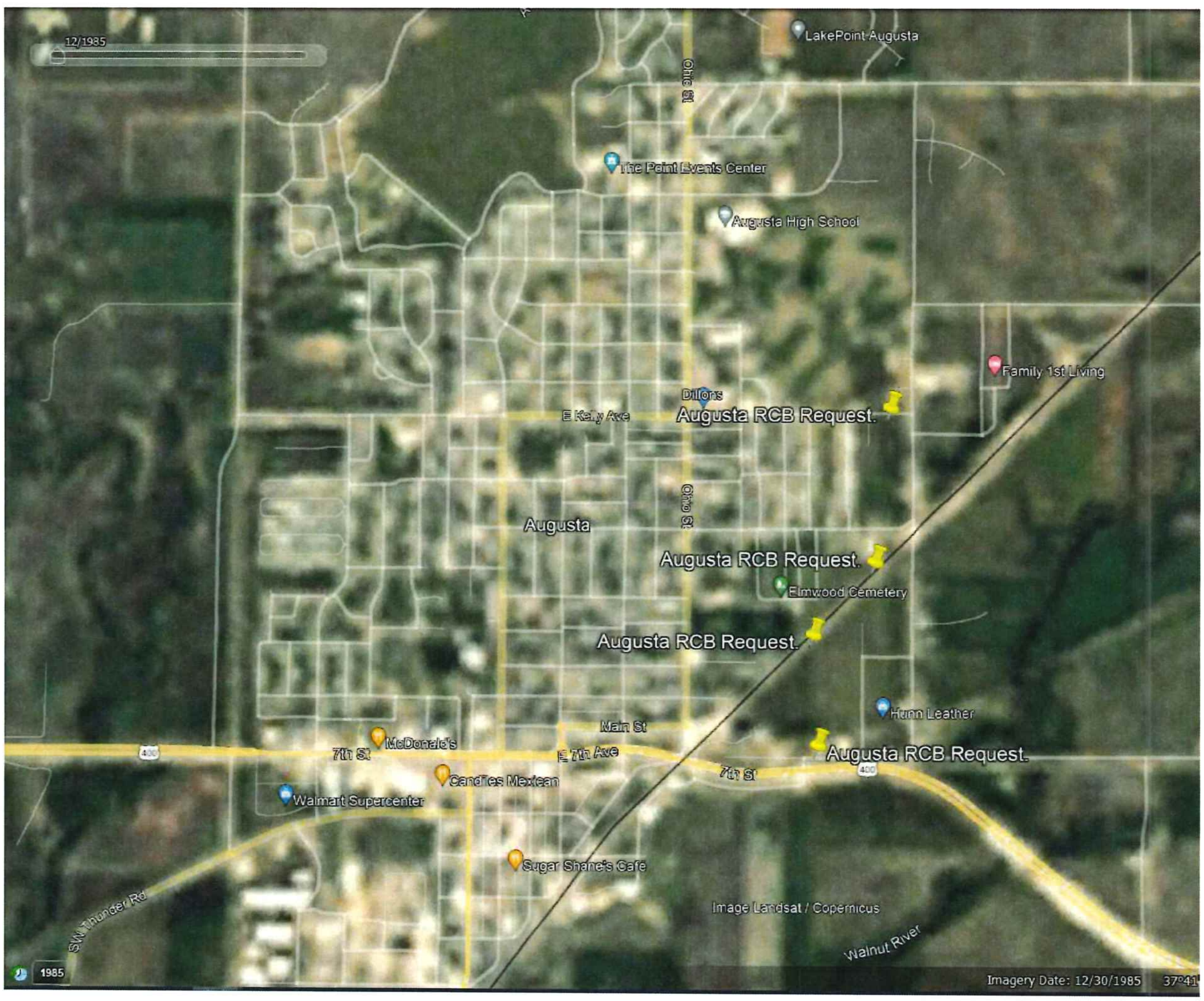
Since the existing drainage patterns have remained the same and this structure has been in place since the 1970's with no historical issues related to US-54/400, KDOT would not typically change the configuration due to the belief that the flooding issue is caused by developments.

KDOT requires any development to address their outflow and not increase the existing flows to KDOT maintain structures and ditches.

It is KDOT's conclusion that the developments in this drainage basin should have been required to regulate their runoff and should have been required to set building elevation to avoided being flooded. If additional information is available showing that the developments in this drainage basin were required to regulate their runoff, KDOT would re-evaluate this location and issue a new conclusion based on the new information.

If you have any questions pertaining to this review, please contact me at (785) 221-6441

Google Earth aerial from 1985



Google Earth aerial from 1991

Google Earth aerial from 2021