To: Kansas Department of Agriculture – Division of Water Resources
City of Hutchinson, KS

From: Jeff Brislawn, CFM, Hazard Mitigation Lead/Sr Associate
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Date: 9-26-2022

Re: Technical Assistance Project - Benefit Cost Analysis of Cow Creek Channel Expansion, City of Hutchinson, KS

1.1 Benefit Cost Analysis Overview

WSP E&I performed a FEMA benefit cost analysis (BCA) including standard FEMA compliant depth-damage estimates, ecological benefits, and social benefits. Appendix A summarizes our assumptions and Appendix B includes the output report from the FEMA BCA Tool. The BCA resulted in a benefit cost ratio (BCR) of 3.30. This indicates that the cost of the proposed improvements would be very cost beneficial.

The following is a description of the data input sources and methods used for a BCA associated with the selected flood mitigation improvements.

1.1.1 Pre and Post Project Drainage Improvement Depth Grids

WSP E&I utilized hydrology and hydraulic models from the FEMA approved Lower Middle Arkansas HUC and recent stormwater planning models from the City of Hutchinson to determine the expected floodplain extents in Hutchinson. These floodplain extents represent the existing conditions that will likely be mapped in the new Reno County Flood Insurance Study currently underway and likely to go effective by 2025. The models were updated based on proposed conditions in which the flood reduction benefits were then estimated.

Water surface elevation grids were derived from the hydraulic models. Geographic information systems (GIS) was used to develop depth grid for the 25, 50, 100 and 500-year events for both existing conditions and proposed flood mitigation scenarios. This resulted in a total of eight grids for all flooding events (two for the 25-year, two for the 50-year, two for the 100-year, and two for the 500-year events).

1.1.2 Structure Analysis

WSP E&I identified a total of 206 structures within the project area effected by flooding. WSP E&I utilized Microsoft Footprint data to obtain building footprints and building square footage and the parcel data was provided Reno County Assessor's office. The

parcel data included necessary attribute data such as structure value, type of structure, number of stories and multi-family unit counts. The assessor's data did not contain basement or foundation type and an assumption was made that all structures had no basement and slab on grade.

Maximum flood elevations for each structure during the different flood events were calculated with the Zonal Statistics tool from ArcMap. The structure layer was used as the zone data feature (meaning, the polygon layer with the zones/areas for which the summaries should be derived), and each flood depth grid with the Mean Sea Level (MSL) elevations built-in was used as the raster layer containing the information to be used in the zonal calculation (i.e. elevation values). So, this function derived the maximum flood elevation for each polygon in the zonal feature layer (structures).

1.1.3 Spreadsheet Tool

A BCA spreadsheet developed by FEMA Region VIII to capture property data for large drainage improvement projects was used to capture data on each structure and analyze damages from the various flood recurrence intervals. Structure data and maximum flood elevations were obtained for each structure and captured in the BCA spreadsheet. The spreadsheet already contained the proper functions to calculate outputs (loss estimates) from inputs (e.g. elevations, building square footage) and flood depth. With the calculated flood elevation maximums from the zonal statistics too and the base/first floor elevations from the survey points, the spreadsheet derived: building depth damage functions (DDF) damage percentages, content DDF damage percentages, days of displacement based on the DDF values, and monetary values for the building damages, content damages, and displacement costs. The sum of all the damage categories provided the flood event totals to be used in the FEMA BCA Tool, for each flood recurrence interval. Spreadsheets for existing conditions (EC) and proposed condition (PC) with flood mitigation were used to assess damages for the 25, 50, 100 and 500-year events. Note: the spreadsheet tool DDF curves are the US Army Corp of Engineers curves for residential buildings.

1.1.4 FEMA BCA Tool

FEMA's BCA Tool V 6.0.0 Damage Frequency Assessment module was utilized to calculate the Benefit Cost Ratio (BCR). Various details and assumptions (see Appendix A) including project cost and maintenance costs, and damages were incorporated into the tool. Finally, the damages calculated from each flood recurrence interval derived from the spreadsheet were inserted, along with the "damages after mitigation" calculated in the PC spreadsheet Structural damages and displacement costs are accounted for in the spreadsheet calculations. Social benefits including reduced mental stress/anxiety and lost productivity estimates were input into the tool based on the population affected and an estimated number of workers. In addition, it is anticipated that 280 acres would be acquired and

converted to urban green open space, which was counted as an ecosystem services benefit in the tool. Finally, additional economic disruption benefits as a result of flooding of the access road to Cargill plant was counted in the "Optional Damages" category. The tool calculated the BCR to be 3.30, meaning that for every dollar invested in the project will return 3.3 in benefits, demonstrating cost effectiveness.

1.1.5 Benefits Not Counted

Other projects not accounted for include costs associated with emergency responders needed to evacuate residents and close streets. These benefits could be quantified based on hourly rates and manpower estimates needed during past and projected future flood events. While social equity benefits are difficult to quantify, it is assumed that there are many households with low to moderate income that will benefit from the project, based on the housing stock in the project area.

Appendix A - BCA Assumptions
Appendix B - BCA Report from FEMA Benefit Cost Analysis tool
Appendix C – Flooding Extents

Digital Data Included as Supplemental Data:

1. BCA calculation spreadsheets
2. FEMA BCA Tool V. 6.0.0 input files
3. GIS shapefiles
4. 1D/2D 5.7 HEC-RAS models

Appendix A BCA Assumptions

Square Footage

- A Microsoft building footprints GIS layer was used to obtain Living Space SqFt and Basement SqFt.

FFE – First Floor Elevations approximations

- Foundation type was assumed to be slab on grade with no basement across the project area.
- Initial FFE was derived from recently obtained/updated 2018 LiDAR based on average elevation in footprint polygon; survey data was not available.
- Average FFE's were used in the calculator.

Building Costs

- Initially we utilized the FEMA standard of $100 times total sqft to obtained Building Replacement Value.
    - Calculator's estimated total value $72,217,789
- WSP Topeka Office provided Final Project Cost: $20,662,641
- Final Annual O&M Cost: $15,000 per year per WSP Topeka
- Life of Project: 50 yrs
    - Supported by FEMA BCA Checklist
        - Drainage Improvement

Ecological Benefit acreage

- Total Project Area (acres): 1,075
- 26% of that is green open space, per WSP Topeka office
- 1% of that is Riparian

Social Benefits (Number of residents and workers)

- The number of residents and workers is based on the number of residential dwellings in the project area
- South Hutchinson Average Household Size (AHH) is 1.96 and the Unemployment Rate for Reno County is 2.6% according to Census American Community Survey.
- 206 total buildings; 152 are residential which contains 13 Multi-Family Dwellings with 36 units
    - 139 Single Family Homes and 36 units with families
        - 175 residential dwellings * 1.96 AHH = 343 total population
- Workers: Assumes 1 worker in each household x 2.6% unemployment rate for Reno County
    - 175*0.026 unemployment rate = 5 (4.55) Unemployed
    - 175-5 = 170 Employed

Optional Damages

- Optional damages capture downtime at the Cargill plant when floods inundate the plant's access road and were based off of a Daily / Annual operation cost for the Cargill Plant: $62,000/day. This information was provided by WSP's Alex Roe based on data from Cargill. The

Appendix A BCA Assumptions

estimated flood overtopping duration for the 25 year, 50 year, 100 year and 500 year events were anticipated to be:

- 25yr- Overtopping 3 hrs
- 50yr- Overtopping 4 hrs
- 100yr- Overtopping 5 hrs
- 500yr- Overtopping 6 hrs

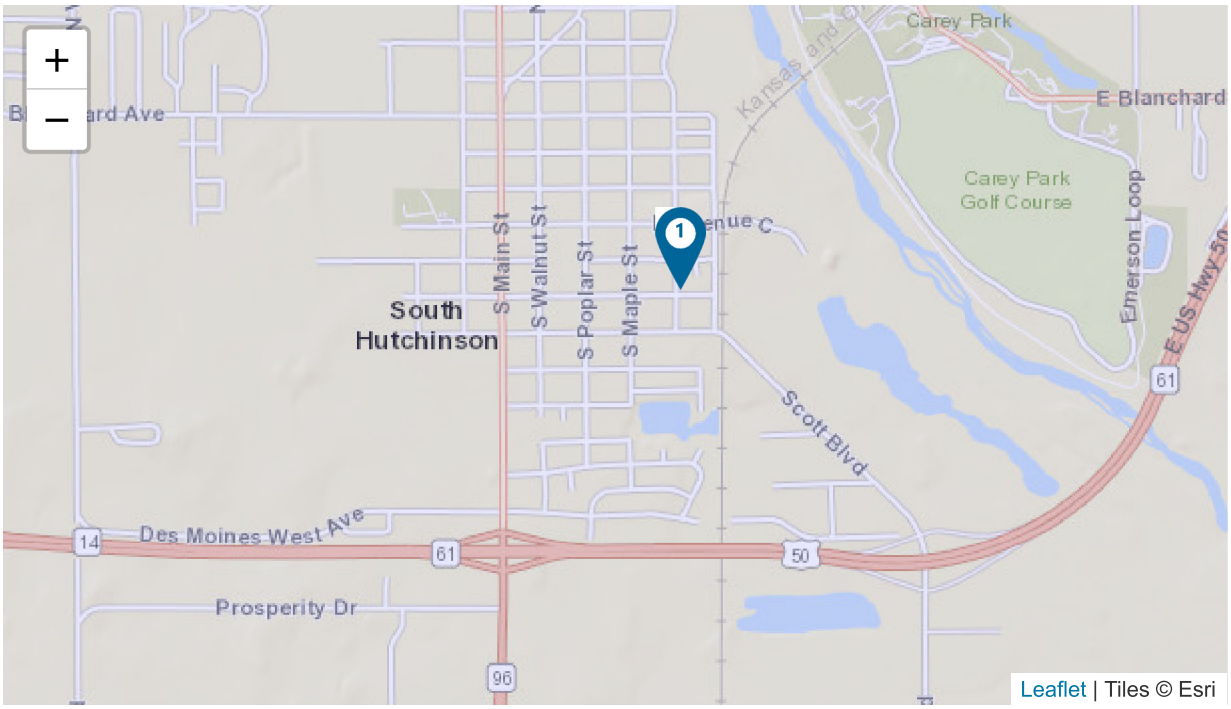
- It is assumed a full day of disruption would occur up through the 50 year event, and 2 days for the 100 and 500 year events to account for public safety and debris clearance. Therefore $62,000 was used for the 25 year and 50 year valuations and for the 100 year and 500 year $124,000 was used due to the number of hours of overtopping.

Benefit-Cost Calculator

V.6.0 (Build 20220831.1934 | Release Notes)

Benefit-Cost Analysis

Project Name: Hutchinson BCA FFE $100 Sq. Ft



Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 38.0220660; -97.9325110		DFA - Riverine Flood	$ 68,950,734	$ 20,869,652	3.30
TOTAL (SELECTED)				**$ 68,950,734**	**$ 20,869,652**	**3.30**
TOTAL				**$ 68,950,734**	**$ 20,869,652**	**3.30**

Property Configuration

Property Title:	Drainage Improvement @ 38.0220660; -97.9325110
Property Location:	67505, Reno, Kansas
Property Coordinates:	38.0220660, -97.9325110
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Residential Building
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 38.0220660; -97.9325110

Project Useful Life (years):	50
Project Cost:	$20,662,641
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$15,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 38.0220660; -97.9325110

Year of Analysis was Conducted:	2022
Year Property was Built:	1919
Analysis Duration:	104 Use Default:Yes

Professional Expected Damages Before Mitigation

Drainage Improvement @ 38.0220660; -97.9325110

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	1,494,875	62,000	0	0	0	0	1,556,875
50	2,224,606	62,000	0	0	0	0	2,286,606
100	10,199,320	124,000	0	0	0	0	10,323,320
500	15,173,486	124,000	0	0	0	0	15,297,486

Annualized Damages Before Mitigation

Drainage Improvement @ 38.0220660; -97.9325110

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	1,556,875	37,736
50	2,286,606	48,585
100	10,323,320	100,533
500	15,297,486	30,593
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	29,464,287	217,447

Professional Expected Damages After Mitigation

Drainage Improvement @ 38.0220660; -97.9325110

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	246,197	0	0	0	0	0	246,197
50	771,908	0	0	0	0	0	771,908
100	8,629,781	0	0	0	0	0	8,629,781
500	10,489,522	0	0	0	0	0	10,489,522

Annualized Damages After Mitigation

Drainage Improvement @ 38.0220660; -97.9325110

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	246,197	8,719
50	771,908	25,810
100	8,629,781	76,115
500	10,489,522	20,978
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	20,137,408	131,622

Standard Benefits - Ecosystem Services

Drainage Improvement @ 38.0220660; -97.9325110

Total Project Area (acres):	1,075
Percentage of Urban Green Open Space:	26.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	1.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$4,743,599

Additional Benefits - Social

Drainage Improvement @ 38.0220660; -97.9325110

Number of Workers:	170
Expected Annual Social Benefits:	$2,301,082

Benefits-Costs Summary

Drainage Improvement @ 38.0220660; -97.9325110

Total Standard Mitigation Benefits:	$66,649,652
Total Social Benefits:	$2,301,082
Total Mitigation Project Benefits:	$68,950,734
Total Mitigation Project Cost:	$20,869,652
Benefit Cost Ratio - Standard:	3.19
Benefit Cost Ratio - Standard + Social:	3.30

Appendix C – FLOODING EXTENTS

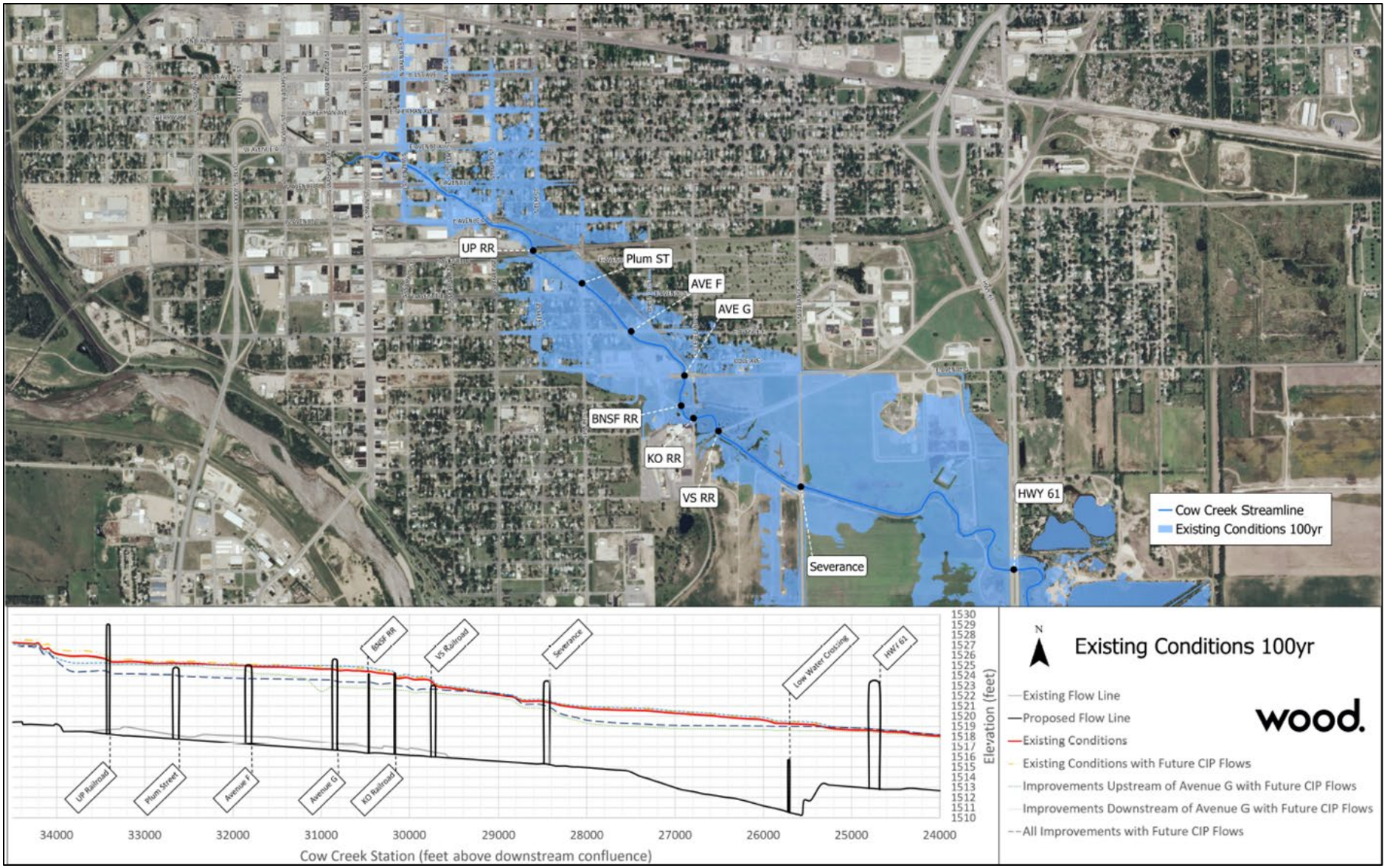


Figure showing 1% frequency flooding extents based on existing conditions.

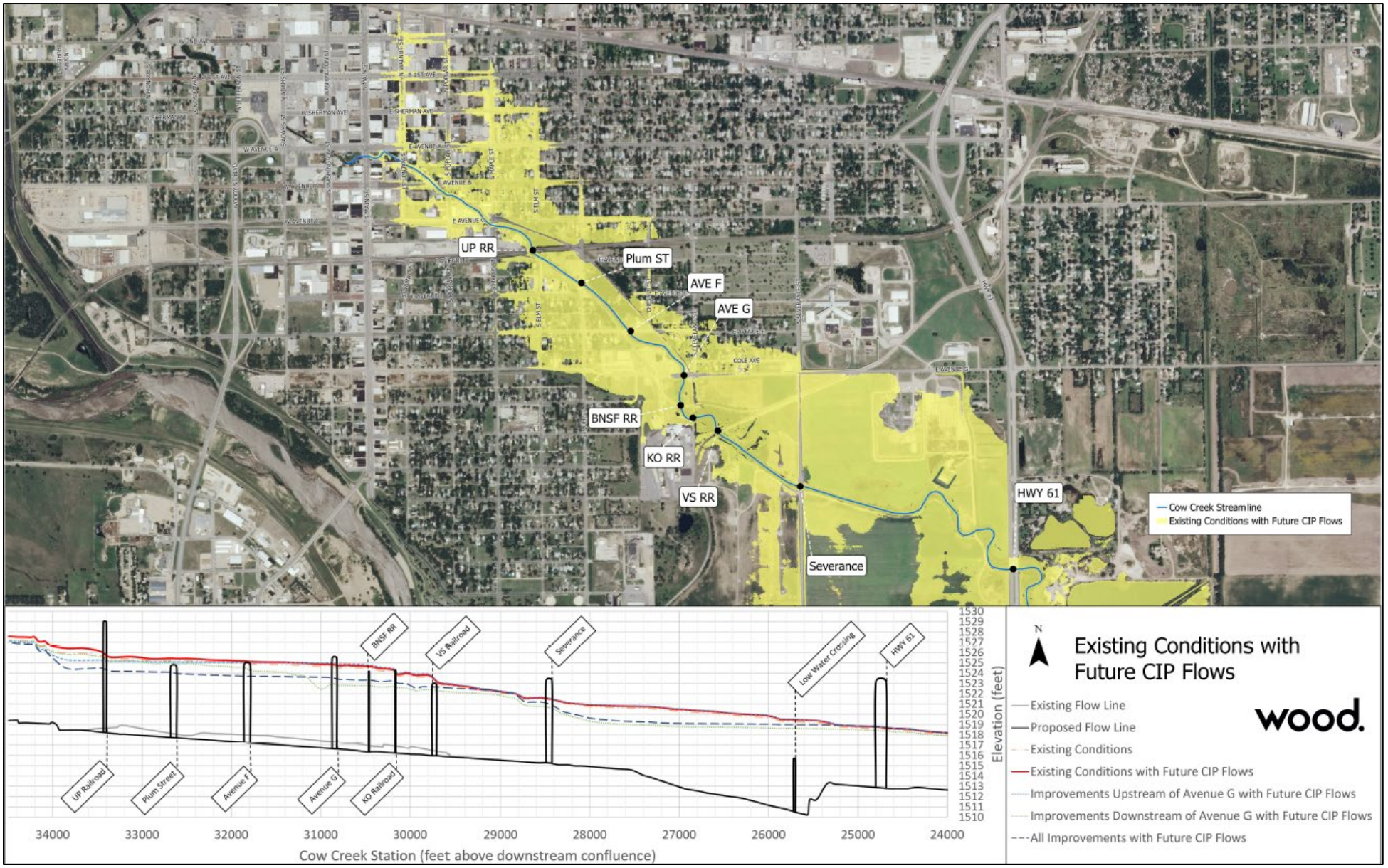


Figure showing 1% frequency flooding extents with future CIP stormwater project implemented upstream

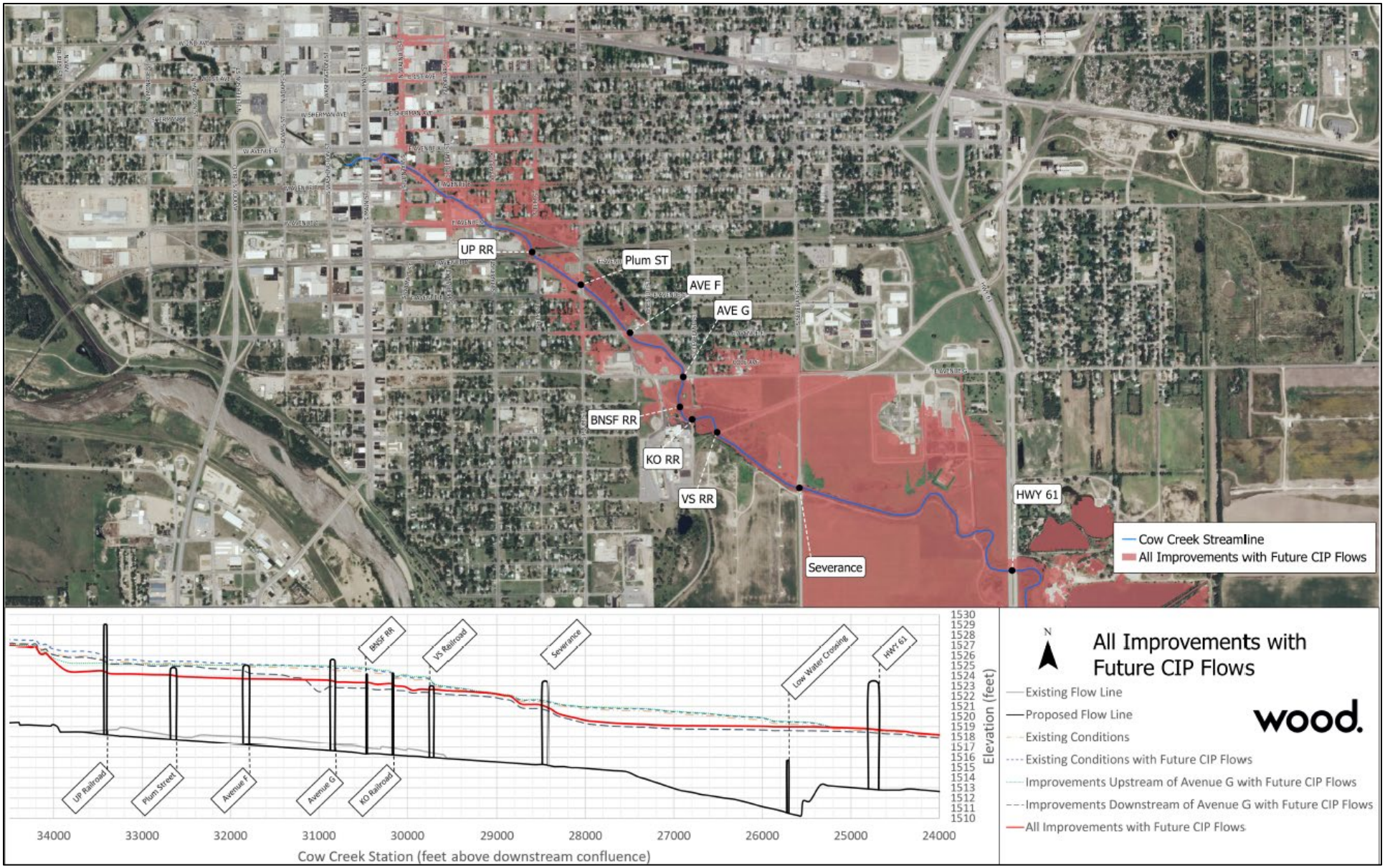


Figure showing 1% frequency flooding extents with future CIP stormwater projects implemented and the Cow Creek Improvement project implemented.