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Innovative approaches
Practical results
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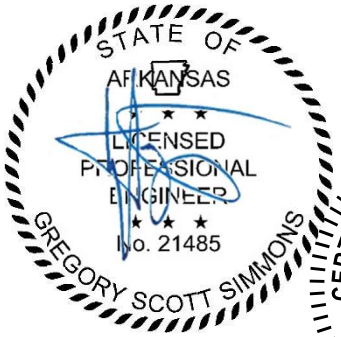
TO: Alan Pugh, PE, CFM, City of Fayetteville, Staff Engineer

FROM: Greg Simmons, PE, CFM
Central Plains Division Stormwater Lead

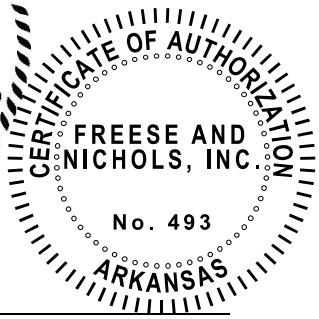
SUBJECT: Hamestring Creek Study Report

DATE: 12/11/2024

PROJECT: FYV23522



12/11/2024



In June 2023, the City of Fayetteville (City) engaged Freese and Nichols Inc. (FNI) to expand on previous modeling in the Hamestring Creek watershed to develop conceptual-level detention alternatives for reducing flood extents and depths throughout the watershed. The scope also included completing a Benefit/Cost Analysis (BCA) using the FEMA BCA toolkit to assess potential eligibility for grant funding for design and construction of a detention project for flood mitigation as well as development of conceptual Nature Based Solutions (NBS) features to be incorporated into the project.

As described later in this memo, in March 2024 the contract was amended to forego development of a grant application and NBS concepts in favor of more refined modeling on the conceptual flood mitigation project identified by the initial modeling that met FEMA BCA requirements. This memorandum summarizes the process and findings of the overall study and incorporates as attachments key documents created as a part of the project.

The overall conclusion of the complete effort is that it is feasible to develop a detention project in the Hamestring watershed that meets FEMA grant requirements. However, the project would be only minimally effective in lowering flood levels. In most of the flood prone parts of the watershed, the amount of reduction in water surface elevations (WSELs) tops out at a few inches so significant flood risk would remain even with a detention facility. Given these factors, the City may want to consider a buyout option. As explained in more detail later in this report, it appears that a voluntary buyout option for properties at risk of flooding would be eligible to apply for FEMA grant funding.

The balance of this cover memo presents an Executive Summary of the major elements of the overall effort. The attachments to the memo, as identified in the narrative below, provide a detailed description of each aspect of the study.

EXECUTIVE SUMMARY

Section 1: Initial Hydrologic and Hydraulic (H&H) Analysis

The full report for this modeling effort is **Attachment 1** to this memo.

H&H Methodology

The initial H&H modeling for this project was completed by FTN Associates, Ltd. (FTN) as a sub-consultant to FNI. FTN had previously studied the area in 2021 using HEC-HMS 4.8.0 for hydrology and FEMA effective models or HEC-RAS 5.0.7 for hydraulics. That modelling methodology did not indicate

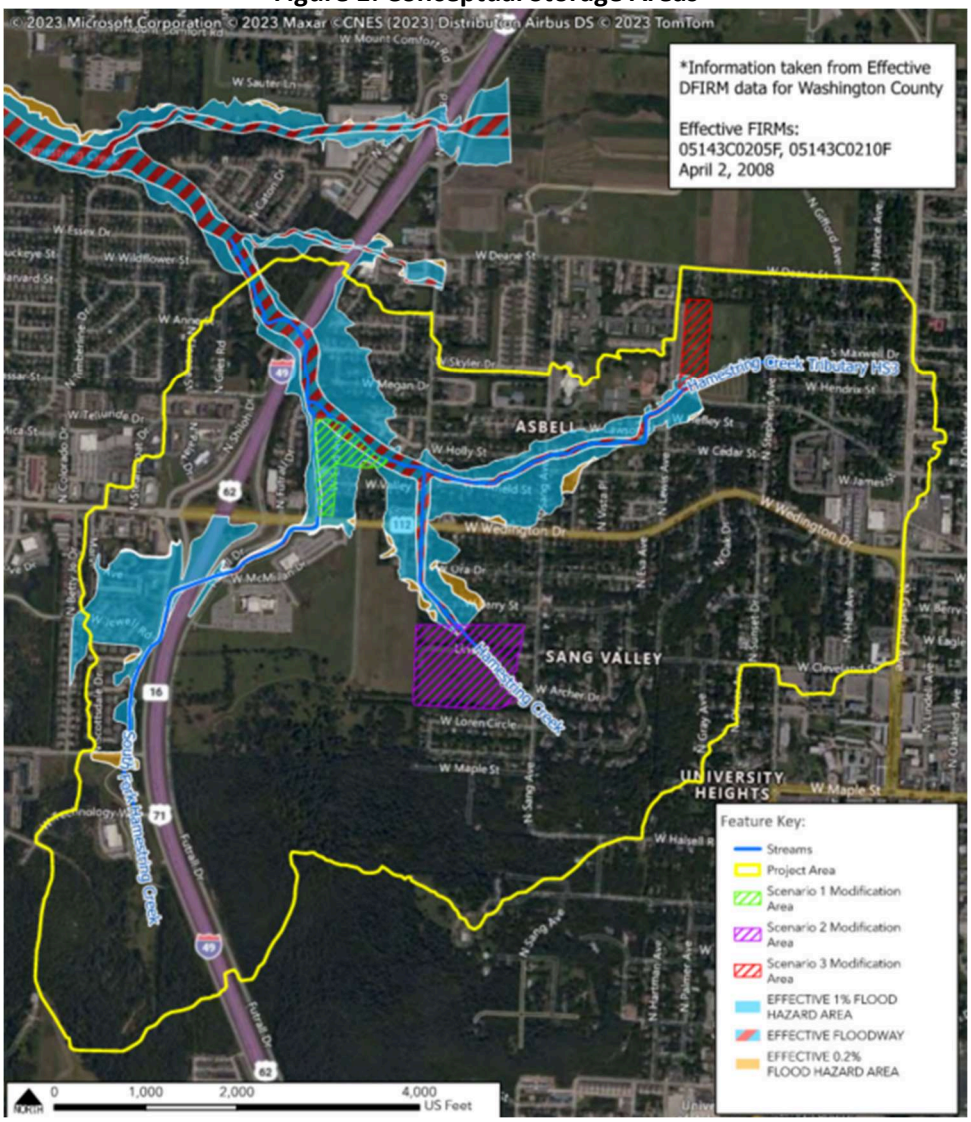
opportunities for significant flood mitigation projects. For this project FTN tried a rain-on-mesh 2-Dimensional model using HEC-RAS 6.3.1 that provided for hydrologic and hydraulic modeling to be completed in one model platform.

Mitigation Alternatives Evaluated

The modeling evaluated the following 4 flood mitigation scenarios (see **Figure 1**):

- **Scenario 1**: West End Apartment Storage (creating detention at the former site of the West End Apartments now owned by the City)
- **Scenario 2**: South Pond Storage (creating detention on a privately owned undeveloped piece of property southwest of the Lincoln/W. Wedington intersection)
- **Scenario 3**: Lewis Soccer Complex Storage (creating detention on the City-owned portion of the Lewis soccer complex)
- **Scenario 4**: Combining all 3 scenarios

Figure 1: Conceptual Storage Areas



In general, each of the scenarios showed some level of runoff and flood elevation reduction but none provided dramatic relief in the flood risk. The estimated cost of each scenario is as follows:

- West End Apartment Storage: $2.5 - $3.5 million
- South Pond Storage: $8 - $10 million
- Lewis Soccer Complex Storage: $1.5 - $2.5 million
- Combination: $12 - $16 million

The conceptual level Opinion of Probable Construction Cost (OPCC) calculated for these scenarios is **Attachment 2** to this memo. Given the highly conceptual nature of the scenarios, and to attempt to account to some degree for future cost inflation, the probable cost for each alternative is presented above as a range, with the calculated OPCC being toward the lower end of the range.

Benefit Cost Analysis

The Benefit Cost Ratios (BCR) calculated using FEMA methodology for the 3 detention areas are as follows:

- West End Apartment Storage: 0.54
- South Pond Storage: 0.61
- Lewis Soccer Complex Storage: 1.47

The data resulting in these BCRs is provided in **Attachment 3** to this memo. The project cost used in each calculation was the actual OPCC developed for the alternative being evaluated.

As shown in the **Attachment 3** data, the monetary benefits in each BCR calculation also included FEMA allowed factors for social and ecosystem benefits. The social benefits are calculated by the FEMA tool using U.S. Census Bureau data for the zip code of the benefitted properties. The tool takes the number of benefitted properties and estimates the number of residents and the number of workers represented by those properties. Those metrics determine the amount of social benefits that are included in the BCR calculation. Ecosystem benefits are calculated by the FEMA tool based on the percentage of the benefitted area that can be classified as “Urban Green Open Space”

A BCR for the combined option was not calculated since that option was known to be cost prohibitive and, based on the BCRs for each option, it could be confidently determined that the BCR for the combined option would be well below 1.0.

Lewis Soccer Complex additional evaluation

Since the Lewis Soccer Complex alternative was the only alternative meeting FEMA BCR requirements the modeling data was evaluated in more detail to further understand the nature and magnitude of the potential benefits. The data indicated that, though storage at the Lewis Soccer Complex could reduce flood depths for a significant portion of the watershed, in general, the amount of flood depth reduction was only a few inches.

It is noteworthy to point out that the driving factor for the much higher BCR for the Lewis Soccer Complex compared to the other scenarios is the amount of social benefits calculated by the FEMA BCA Toolkit for that option. Since the Lewis Soccer complex is at the upstream end of the watershed, storage at that location provides benefits for the majority of the flood prone area in the watershed. By contrast, the South Pond storage only provides benefits south of W. Washington Dr. The West End Apartment storage area, being at the far downstream end of the watershed, only provides benefits for a few

properties. The BCR for the Lewis Soccer complex storage based only on estimated flood damages avoided is 0.69. That BCR is reflective of the minimal level of flood depth reduction achievable for a detention facility at that location.

Conclusion and Next Steps

Given the relatively low level of benefit as compared to the estimated cost of the detention alternatives, the City opted to forego pursuing a grant application and the development of associated NBS concepts at that time. Instead, the contract was amended to add modeling effort to determine if it would be possible to increase the level of flood reduction benefit achievable through detention to the point where the City could justify the cost to proceed with a project.

Section 2: Supplemental H&H analysis

Details of the additional modeling effort are included as **Attachment 4** to this memo.

Additional brainstorming was conducted relative to the West End and South ponds to try and identify any possible revisions to the initial concepts that could significantly increase the benefits or reduce the costs of those ponds. That effort did not result in any ideas for overcoming the limited benefits of those 2 ponds. Therefore, the additional modeling focused on the Lewis Soccer complex storage area.

As outlined further in **Attachment 4**, the supplemental analysis sought to assess the possibility of significantly increased benefits from the Lewis Soccer complex storage area by:

- Supplementing the 2D HEC-RAS model created by FTN with an analysis of the area based on a previously created HEC-HMS model
- Additional berming
- Revision to the outfall condition/structure

Use of the additional modeling platform and revisions to the physical features of the conceptual detention area failed to significantly increase the level of flood depth reduction. The WSEL reductions in the floodplain projected by the model with these revisions were still a matter of inches.

Further, the additional berming and revised outfall structure for this option means that the construction cost would be higher than for the concept developed in the initial study. Given that the supplemental modeling effort also indicated that this alternative would still not achieve meaningful decreases in flood levels, this alternative has cost-to-flood-depth-reduction proportions generally similar to the initial Lewis Soccer Complex storage alternative. For these reasons, an OPCC and BCR were not developed for the revised concept.

Section 3: Public Meetings

Two public meetings were conducted in association with this project. Details of the meetings are documented below.

August 17, 2023
This meeting was to brief the community on the effort at the outset and receive input from them. **Attachment 5** to this memo is the sign-in sheet for that meeting. In addition to the seven (7) community members that signed-in, City of Fayetteville City Council Members Moore (Ward 2/Position

1) and Turk (Ward 4/Position 1) attended the meeting. **Attachment 6** to this memo is the PowerPoint presentation used to brief the community.

November 16, 2023

This meeting was to brief the community on the findings of the initial modeling and respond to any questions they had. **Attachment 7** to this memo is the sign-in sheet for that meeting showing the eight (8) community members that recorded their participation. **Attachment 8** to this memo is the PowerPoint presentation used to brief the community.

The bottom-line communicated to the stakeholders at this meeting was that, given the high cost and minimal level of benefit of even the most beneficial of the detention alternatives (Lewis Soccer Complex), home buyouts may be the best alternative and the City would be further evaluating the study findings and determining a direction.

Attachments:

1. FTN technical memo on initial modeling
2. Opinions of Probable Construction Cost
3. BCA calculation data on initial alternatives
4. FNI technical memo on supplemental modeling
5. Sign-in sheet for August 17, 2023 public meeting
6. PowerPoint presentation for August 17, 2023 meeting
7. Sign-in sheet for November 16, 2023 public meeting
8. PowerPoint presentation for November 16, 2023 meeting

Attachment 1

FTN Technical Memo on Initial Modeling

ftn Associates Ltd.
water resources / environmental consultants
124 W Sunbridge Drive, Suite 3 • Fayetteville, AR 72703 • (479) 571-3334 • FAX (479) 571-3338

TECHNICAL MEMORANDUM

DATE: November 30, 2023

TO: **Mr. Greg Simmons, PE, CFM**
Central Plains Stormwater Lead
Freese and Nichols, Inc.

FROM: **Mr. Lee Beshoner, PE, CFM**
FTN Associates, Ltd.

CERTIFICATE OF AUTHORIZATION FTN Associates, Ltd. No. 63 ARKANSAS - ENGINEER

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER No. 12942 LEE J. BESHONER 11/30/23

SUBJECT: REVISED: Result Summary for Fayetteville, AR Design & Grant Management for Hamestring Creek Watershed, Fayetteville, AR
FTN No. R16970-3093-001

1.0 PROJECT SCOPE & BACKGROUND

FTN Associates, Ltd. (FTN) on behalf of Freese and Nichols, Inc. (the Client), was tasked with performing hydrologic and hydraulic modeling, which expanded on previous Hamestring Creek Watershed analyses to evaluate conceptual-level alternatives to reduce flood extents and elevations throughout the Hamestring Creek Watershed in Fayetteville, Arkansas (Project area). The Project area, shown in Figure 1, is the watershed area to a point approximately 500-feet downstream of Interstate 49 and includes stream segments Hamestring Creek Tributary HS3, South Fork Hamestring Creek, and Hamestring Creek (approximately 2.1 sq. miles).

The Project area is generally bound by Deane Street to the north, State Highway 112 (Garland Avenue) to the east, Markham Road to the south and Betty Jo Drive to the west. It consists primarily of established residential neighborhoods with some open space and hilly forested areas in the southern parts of the Project area. Many locations throughout the Project area have historically experienced poor drainage, causing flooding that covers city streets and has impacted some single and multi-family residential properties.

FTN obtained existing hydraulic and hydrologic modeling developed as part of a previous floodplain analysis within Hamestring Creek Watershed. FTN also gathered information on the building type, parcel type, finished flood height, and foundation type for the existing structures in the Project area. In order to obtain finished floor elevations (FFE), FTN reviewed existing LiDAR

data for the Project area, gathered in 2015 as part of the Washington County Flood Insurance Restudy. FTN then performed field reconnaissance for all structures in the Project area to determine their foundation type and finished floor height above existing grade. Detailed notes were taken describing the foundation material, height, and if a crawlspace was present. The observed heights were then added to the LiDAR elevation, which was taken from the centroid of the building polygon for each structure, to calculate the FFE. The building polygon layer was taken from available City of Fayetteville GIS data.

2.0 HYDROLOGY & HYDRAULICS

The 10%-, 2%-, 1%-, and 0.2 %-annual-chance (10-, 50-, 100-, 500-year), 24-hour flood event hydrographs were taken from the previously developed hydrologic model for the Hamestring Creek Watershed. Hydrographs for the 20%- and 4%-annual-chance (5- and 25-year), 24-hour flood events were developed utilizing Design Rainfall Depths from the City of Fayetteville Drainage Criteria Manual for the Project area. As this analysis is built off of rain-on-mesh 2-Dimensional (2D) hydraulic modeling, FTN utilized the U.S. Army Corps of Engineers' HEC-RAS (version 6.3.1) software program. Use of this methodology allowed for the revision of the infiltration layer, which was updated using land cover data based on aerial imagery, taken from various sources, and soil data from the NRCS Soil Survey Geographic Database (SSURGO). The resultant precipitation for the new 20%- and 4%-annual-chance, 24-hour events were then applied to the 2D hydraulic model for the Hamestring Creek Watershed to establish the existing conditions scenario for each of the six (6) flood events modeled.

Once the existing conditions scenarios were established, FTN then modified the hydraulic models to evaluate conceptual-level alternatives to determine the potential for reducing the Base Flood Elevations (BFEs) and floodplain mapping extents in the Project area. A total of four (4) improvement alternatives were evaluated, with some alternatives being refined as the analysis progressed. The main scenario categories modeled are as follows:

1. Scenario 1: West End Apartment Storage
    - This scenario included the removal of the West End Apartment complex and included the addition of detention areas along South Fork Hamestring Creek and Hamestring Creek.
    - This scenario was modified to include one large detention area that included evaluation of the existing Niblock property and a portion of the existing Lindsey Management property in the Project area.
    - Storage consisted of a large irregular shaped basin with 3:1 (H:V) side slopes and minor channel and overbank invert sloping to promote drainage.
2. Scenario 2: South Pond Storage
    - Addition of a large detention pond along the upstream end of Hamestring Creek on the existing Heckathorn Property.

- Storage consisted of a large rectangular shaped basin with 3:1 (H:V) side slopes, minor channel and overbank invert sloping to promote drainage, and construction of 2 small weir outlets to assist with detaining surface flows.

3. Scenario 3: Lewis Soccer Complex Storage

- Addition of a large detention pond along the upstream reach of Hamestring Creek Tributary HS3 at the corner of Mt. Comfort Road and Lewis Avenue on the Lewis Soccer Complex.
- Storage consisted of a large rectangular shaped basin with 3:1 (H:V) side slopes and minor invert sloping to promote drainage.
- The scenario was also expanded to examine the impacts to overland flow by the addition of a small berm off of Lawson Avenue.

4. Scenario 4: Combination Storage

- Combination of previous scenarios and iterations to determine a cumulative impact.

The locations for these scenarios, displayed on Figure 1, were identified by the City of Fayetteville (the City) as properties either owned or having the potential to be purchased by the City to help address existing drainage issues. Conceptional Contour plans for the West End Apartments, South Pond, and Lewis Soccer Complex scenarios are shown on Figures 2, 3, and 4, respectively. The hydraulic analyses were performed by FTN for the models described above using HEC-RAS Version 6.3.1.

3.0 CONCLUSION

Based on the modeling scenarios completed, the simulations generally showed varying degrees of improvement in computed Water Surface Elevations (WSE) and flow discharges; however, most of the results did not reflect a large improvement in the resulting floodplain mapping due to the nature of the flooding and characteristics of the Hamestring Creek Watershed. In some instances, there are occurrences where the peak discharges do show increases in modeled storm events. After reviewing these occurrences, it is noted that the proposed improvement(s) alter the timing of the peak runoff condition. This change is enough to combine with other runoff to reflect increases in discharge at downstream locations.

A scenario-by-scenario synopsis is identified below.

3.1 Scenario 1: West End Apartment Storage

Prior to the project starting, the City of Fayetteville purchased the West End Apartment complex and tore down the buildings, as these locations were a source of repetitive flooding. Additionally, adjacent, vacant property owned by private landowners may be available to the City for purchase. With the removal of the West End Apartment complex and use of neighboring properties, the

addition of a large storage area option at the confluence of South Fork Hamestring Creek and Hamestring Creek displayed greater improvements in Hamestring Creek than South Fork Hamestring Creek. WSEs for both streams decreased. Changes in WSEs varied but were in the order of 0.1-ft, with the largest decrease being 0.15-ft (4% annual event) in Hamestring Creek. These results, which were taken from a point directly downstream of the West End Apartments on both streams, are displayed in Tables 1 and 2.

Table 1. Results taken downstream of West End Apartments on South Fork Hamestring Creek.

Event	Existing Conditions		Scenario 1	
	Discharges (cfs)	Water Surface Elevation (ft, NAVD88)	Discharges (cfs)	Water Surface Elevation (ft, NAVD88)
20% Annual Chance	419	1,229.0	515	1,229.0
10% Annual Chance	583	1,229.5	708	1,229.5
4% Annual Chance	939	1,230.2	994	1,230.2
2% Annual Chance	1,139	1,230.6	1,243	1,230.6
1% Annual Chance	1,282	1,231.0	1,374	1,231.0
0.2% Annual Chance	1,651	1,232.0	1,731	1,232.0

Table 2. Results taken downstream of West End Apartments on Hamestring Creek.

Event	Existing Conditions		Scenario 1	
	Discharges (cfs)	Water Surface Elevation (ft, NAVD88)	Discharges (cfs)	Water Surface Elevation (ft, NAVD88)
20% Annual Chance	585	1,229.3	446	1,229.2
10% Annual Chance	688	1,229.7	555	1,229.6
4% Annual Chance	857	1,230.2	747	1,230.1
2% Annual Chance	980	1,230.7	898	1,230.5
1% Annual Chance	1,124	1,231.1	1,050	1,231.0
0.2% Annual Chance	1,440	1,232.1	1,393	1,232.0

3.2 Scenario 2: South Pond Storage

With much of the Hamestring Creek Watershed populated with older neighborhoods, there are limited areas that are not developed for use of detention. One location that is open is a privately owned property upstream of Berry Street along Hamestring Creek. This storage pond location allows for storing discharges from the upper end of Hamestring Creek and an adjacent tributary. The addition of storage in this location shows improvements up to 0.2-ft for the more frequent and smaller annual-chance events; however, the results worsen for the larger annual-chance events. These results may be improved with the development of a weir outfall structure to assist in altering the release of flows. The results, taken from a point immediately downstream of the South Pond outlet, are shown in Table 3.

Table 3. Results taken downstream of the South Pond modification on Hamestring Creek.

Event	Existing Conditions		Scenario 2	
	Discharges (cfs)	Water Surface Elevation (ft, NAVD88)	Discharges (cfs)	Water Surface Elevation (ft, NAVD88)
20% Annual Chance	185	1,243.7	162	1,243.5
10% Annual Chance	208	1,243.9	204	1,243.8
4% Annual Chance	244	1,244.2	285	1,244.3
2% Annual Chance	277	1,244.3	354	1,244.5
1% Annual Chance	313	1,244.5	411	1,244.7
0.2% Annual Chance	400	1,244.8	571	1,245.2

3.3 Scenario 3: Lewis Soccer Complex Storage

With some of the most frequent flooding impacting homes along Hamestring Creek Tributary HS3, City of Fayetteville personnel have long considered the green space at the Lewis Soccer Complex as a possible location for stormwater storage. For this scenario, a large linear detention pond was added to the property currently owned by the City of Fayetteville. This scenario also included the addition of a small berm immediately upstream of Lawson Street in an attempt to keep flow in the Hamestring Creek Tributary HS3 channel. The addition of storage in this area provided improvements in the channel peak flows and showed reductions in WSEs for every event except the 1% annual event, which resulted in a negligible increase of 0. 04-ft. Results extracted for this scenario were taken from a point directly downstream of the Lewis Soccer Complex and are shown in Table 4, comparing the WSE and Peak Flows for the Existing Conditions Model and the Lewis Soccer Complex modifications.

Table 4. Results taken downstream of Lewis Soccer Complex on Hamestring Creek Tributary HS3.

Event	Existing Conditions		Scenario 3	
	Discharges (cfs)	Water Surface Elevation (ft, NAVD88)	Discharges (cfs)	Water Surface Elevation (ft, NAVD88)
20% Annual Chance	246	1,255.4	193	1,255.1
10% Annual Chance	324	1,255.8	276	1,255.6
4% Annual Chance	462	1,256.5	418	1,256.3
2% Annual Chance	561	1,257.0	521	1,256.8
1% Annual Chance	661	1,257.2	644	1,257.2
0.2% Annual Chance	873	1,257.4	852	1,257.4

3.4 Scenario 4: Combination of all scenarios

At the conclusion of the previous scenarios, each one was combined into a single model run to examine a potential cumulative condition and what impacts they may have on the Project area. Upon combining the West End Apartment, South Pond, and Lewis Soccer Complex storage scenarios, the modeled results produced slightly different results when compared to the individual scenarios. These discrepancies are attributed to differences in timing of peak flows being experienced throughout the Hamestring Creek Watershed. No summarized results have been included with this scenario due to varied locations of all the storage pond locations.

As the ultimate goal is to determine possible solutions to mitigate flooding in the Hamestring Creek Watershed, it is important to review the impact of each scenario at the confluence of Hamestring Creek and Hamestring Creek Tributary HS3 and the confluence of Hamestring Creek and South Fork Hamestring Creek. These comparison locations provide a better understanding of how the entire system works together to impact flooding throughout the Project area. Overall, the greatest improvements were produced by the combination scenario, which decreased peak flows by approximately 430 cfs for the 0.2%-annual-chance event at the confluence of South Fork Hamestring Creek and Hamestring Creek. This confluence, which is located downstream of all proposed storage areas, also contains the greatest decrease in WSE of approximately 0.5-ft for the 20%-annual-chance event. At the confluence of Hamestring Creek and Hamestring Creek Tributary HS3 there were reductions in WSEs for every storm event. Results taken from each scenario at the confluences are shown in Tables 5 and 6.

Table 5. Results at the confluence of Hamestring Creek and Hamestring Creek Tributary HS3.

Event	Existing Conditions		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)
20% Annual Chance	593	1,234.5	595	1,234.5	584	1,234.5	506	1,234.3	503	1,234.2
10% Annual Chance	689	1,234.8	695	1,234.8	684	1,234.8	608	1,234.6	613	1,234.5
4% Annual Chance	835	1,235.4	845	1,235.3	834	1,235.3	761	1,235.1	770	1,235.0
2% Annual Chance	957	1,235.7	971	1,235.6	957	1,235.7	889	1,235.5	902	1,235.4
1% Annual Chance	1,087	1,236.1	1,114	1,235.9	1,092	1,236.1	1,046	1,236.0	1,065	1,235.8
0.2% Annual Chance	1,358	1,236.8	1,400	1,236.6	1,359	1,236.9	1,328	1,236.8	1,165	1,237.1

Table 6. Results at the confluence of South Fork Hamestring Creek and Hamestring Creek.

	Existing Conditions		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
Event	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)	Discharge (cfs)	Water Surface Elevation (ft, NAVD88)
20% Annual Chance	961	1,228.7	944	1,228.7	852	1,228.4	906	1,228.6	753	1,228.2
10% Annual Chance	1,298	1,229.2	1,232	1,229.1	1,174	1,229.1	1,164	1,229.0	1,050	1,228.9
4% Annual Chance	1,637	1,229.9	1,637	1,229.8	1,607	1,229.8	1,537	1,229.7	1,511	1,229.6
2% Annual Chance	1,868	1,230.3	1,892	1,230.3	1,864	1,230.3	1,795	1,230.1	1,808	1,230.1
1% Annual Chance	2,078	1,230.8	2,120	1,230.7	2,083	1,230.7	2,027	1,230.6	2,065	1,230.6
0.2% Annual Chance	2,458	1,231.8	2,512	1,231.8	2,472	1,231.8	2,435	1,231.7	2,031	1,232.7

In addition to the repetitive flooding properties, the City of Fayetteville also experiences roadways that become inundated and impassable within the Project area. These occurrences require the City to allocate resources to close streets and monitor the road conditions. Tables 7 through 11 have been provided to summarize the depths experienced for each scenario at stream crossings.

We appreciate the opportunity to work with you on this project. If you have any questions or comments regarding this project, please do not hesitate to contact Lee Beshoner, PE, CFM, or McKenzie Taake, EI, at (479) 571-3334.

LJB/tas

Attachments

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Scenario: Existing Conditions

Table 7. Existing Conditions – water depths at roadways.

Location	Storm Event					
	20% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
	Water Depth Above Structure (ft)					
Interstate 49	-	-	-	-	-	-
Lawson Dr.	-	-	-	-	-	-
Lewis Ave.	-	-	-	-	-	-
Mt. Comfort Rd.	-	-	-	-	-	-
Newport Dr. – Hamestring Creek	2.7	3.2	3.8	4.2	4.5	5.4
Newport Dr. – SF Hamestring Creek	3.7	4.3	5.1	5.5	5.9	6.9
Persimmon St.	-	-	-	-	-	-
Porter Rd.	-	-	-	0.2	0.4	1.0
Sang Ave.	-	-	0.3	0.4	0.5	0.8
Shiloh Dr.	-	-	-	-	-	-
Stephens Dr.	-	-	-	-	-	-
Valley Dr.	-	-	-	-	-	-
Wedington Dr.	-	-	-	-	-	-

- No depth experienced.

Scenario 1: West End Apartment Storage

Table 8. Scenario 1 – water depths at roadways.

Location	Storm Event											
	20% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	20% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
	Water Depth Above Structure (ft)						Difference from Existing Conditions Model (ft)					
Interstate 49	-	-	-	-	-	-	-	-	-	-	-	-
Lawson Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Lewis Ave.	-	-	-	-	-	-	-	-	-	-	-	-
Mt. Comfort Rd.	-	-	-	-	-	-	-	-	-	-	-	-
Newport Dr. – Hamestring Creek	2.4	3.0	3.7	4.1	4.5	5.3	-0.3	-0.2	-0.1	-0.1	-0.1	-0.1
Newport Dr. – SF Hamestring Creek	3.8	4.4	5.1	5.5	6.0	6.9	0.1	0.1	0.1	0.0	0.0	0.0
Persimmon St.	-	-	-	-	-	-	-	-	-	-	-	-
Porter Rd.	-	-	-	0.2	0.4	0.9	-	-	-	0.0	0.0	-0.1
Sang Ave.	-	-	0.3	0.4	0.5	0.8	-	-	0.0	0.0	0.0	0.0
Shiloh Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Stephens Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Valley Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Wedington Dr.	-	-	-	-	-	-	-	-	-	-	-	-

- No depth experienced.
Negative Values = Reduction of Water Surface elevations

Scenario 2: South Pond Storage

Table 9. Scenario 2 – water depths at roadways.

Location	Storm Event											
	20% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	20% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
	Water Depth Above Structure (ft)						Difference from Existing Conditions Model (ft)					
Interstate 49	-	-	-	-	-	-	-	-	-	-	-	-
Lawson Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Lewis Ave.	-	-	-	-	-	-	-	-	-	-	-	-
Mt. Comfort Rd.	-	-	-	-	-	-	-	-	-	-	-	-
Newport Dr. – Hamestring Creek	2.5	3.1	3.7	4.1	4.5	5.4	-0.2	-0.1	-0.1	0.0	0.0	0.0
Newport Dr. – SF Hamestring Creek	3.4	4.2	5.0	5.5	5.9	6.9	-0.3	-0.2	-0.1	0.0	0.0	0.0
Persimmon St.	-	-	-	-	-	-	-	-	-	-	-	-
Porter Rd.	-	-	-	0.2	0.4	1.0	-	-	-	0.0	0.0	0.0
Sang Ave.	-	-	0.3	0.4	0.5	0.8	-	-	0.0	0.0	0.0	0.0
Shiloh Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Stephens Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Valley Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Wedington Dr.	-	-	-	-	-	-	-	-	-	-	-	-

- No depth experienced.

Negative Values = Reduction of Water Surface elevations

Scenario 3: Lewis Soccer Complex Storage

Table 10. Scenario 3 – water depths at roadways.

Location	Storm Event											
	20% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	20% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
	Water Depth Above Structure (ft)						Difference from Existing Conditions Model (ft)					
Interstate 49	-	-	-	-	-	-	-	-	-	-	-	-
Lawson Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Lewis Ave.	-	-	-	-	-	-	-	-	-	-	-	-
Mt. Comfort Rd.	-	-	-	-	-	-	-	-	-	-	-	-
Newport Dr. – Hamestring Creek	2.5	3.0	3.6	4.0	4.5	5.3	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1
Newport Dr. – SF Hamestring Creek	3.6	4.2	4.9	5.4	5.8	6.8	-0.1	-0.2	-0.2	-0.1	-0.1	-0.1
Persimmon St.	-	-	-	-	-	-	-	-	-	-	-	-
Porter Rd.	-	-	-	0.1	0.4	1.0	-	-	-	-0.1	-0.1	-0.1
Sang Ave.	-	-	0.2	0.3	0.5	0.7	-	-	-0.1	-0.1	0.0	0.0
Shiloh Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Stephens Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Valley Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Wedington Dr.	-	-	-	-	-	-	-	-	-	-	-	-

- No depth experienced.

Negative Values = Reduction of Water Surface elevations

Scenario 4: Combination of all scenarios

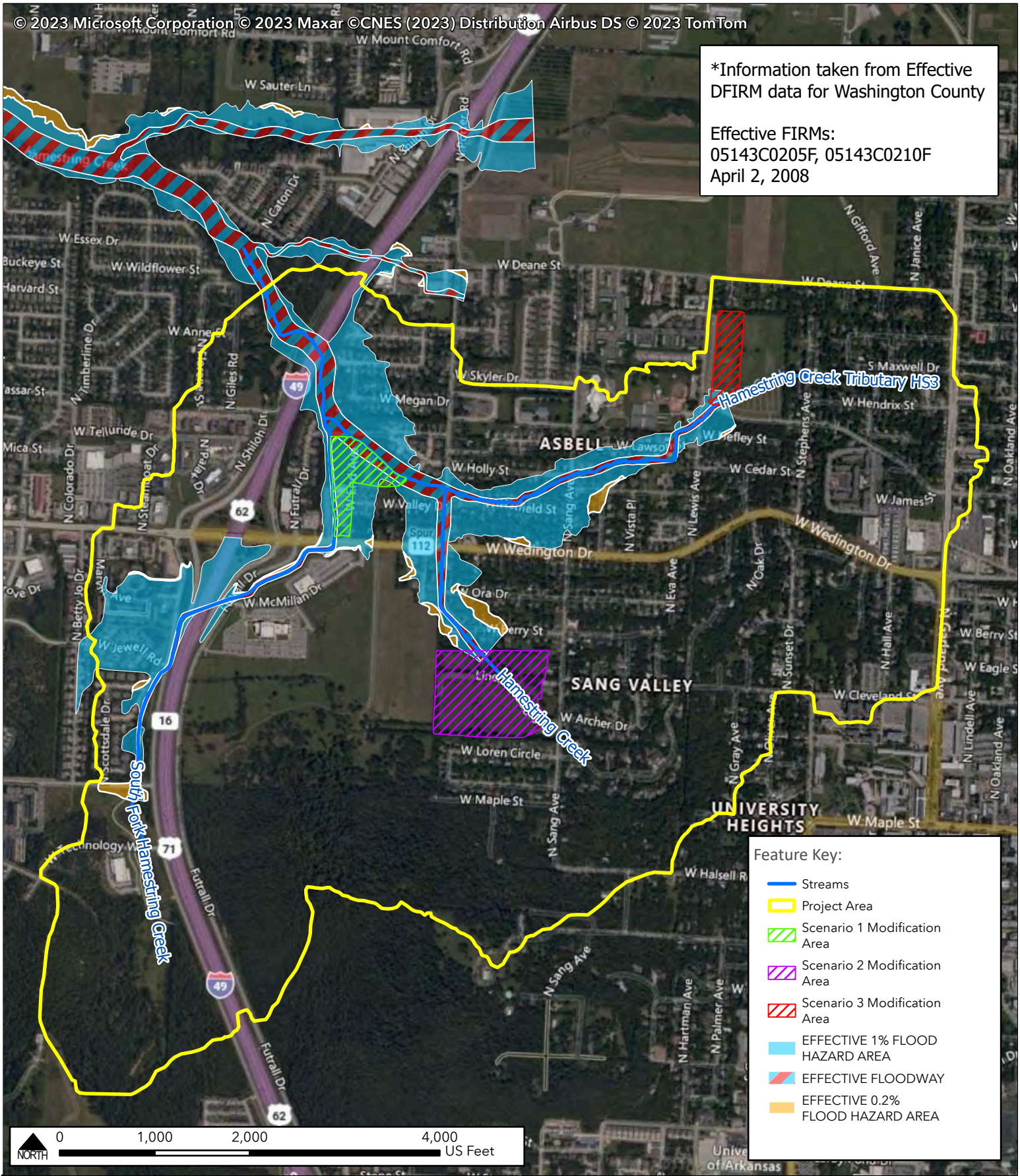
Table 11. Scenario 4 – water depths at roadways.

Location	Storm Event											
	20% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	20% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
	Water Depth Above Structure (ft)						Difference from Existing Conditions Model (ft)					
Interstate 49	-	-	-	-	-	-	-	-	-	-	-	-
Lawson Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Lewis Ave.	-	-	-	-	-	-	-	-	-	-	-	-
Mt. Comfort Rd.	-	-	-	-	-	-	-	-	-	-	-	-
Newport Dr. – Hamestring Creek	2.0	2.6	3.5	3.9	4.4	6.2	-0.7	-0.6	-0.3	-0.2	-0.2	0.8
Newport Dr. – SF Hamestring Creek	3.3	4.0	4.9	5.4	5.9	7.7	-0.4	-0.3	-0.2	-0.1	-0.1	0.8
Persimmon St.	-	-	-	-	-	-	-	-	-	-	-	-
Porter Rd.	-	-	-	0.1	0.3	1.4	-	-	-	-0.1	-0.1	0.4
Sang Ave.	-	-	0.2	0.3	0.5	1.1	-	-	-0.1	-0.1	0.0	0.3
Shiloh Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Stephens Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Valley Dr.	-	-	-	-	-	-	-	-	-	-	-	-
Wedington Dr.	-	-	-	-	-	-	-	-	-	-	-	-

- No depth experienced.

Negative Values = Reduction of Water Surface elevations

Figures



Client Name:
Freese and Nichols, Inc.

Project Title:
Hamestring Creek Watershed Analysis and Mitigation Alternatives

Project Location:
Hamestring Creek Watershed
Fayetteville, AR

Description:
Figure 1. Project Location

Date Exported:
11/1/2023 7:58 AM

Notice of Intent:
This map was created by FTN Associates Ltd. Geospatial Analytics unit to visualize general location(s) of subject property. Unless otherwise stated, features depicted herein do not represent legal or survey boundaries.

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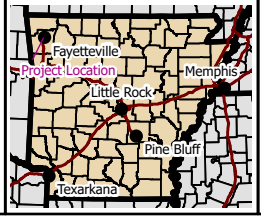
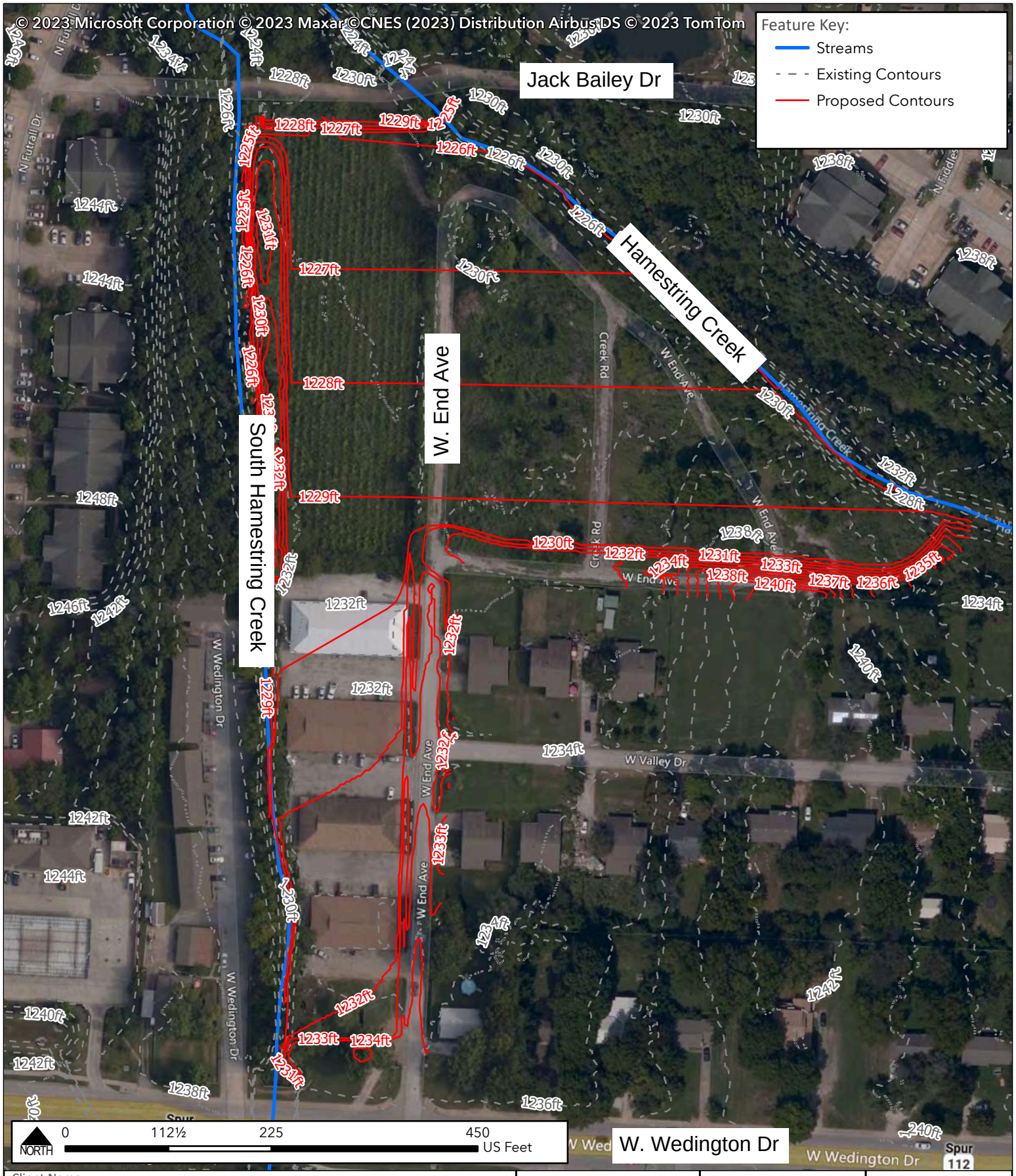


ftn Associates Ltd.



Client Name:
Freese and Nichols, Inc.

Project Title:
Hamestring Creek Watershed Analysis and Mitigation Alternatives

Project Location:
Hamestring Creek Watershed
Fayetteville, AR

Date Exported:
11/1/2023 8:05 AM

Description:
Figure 2.
West End Apartment Proposed Grading Contours

Notice of Intent:
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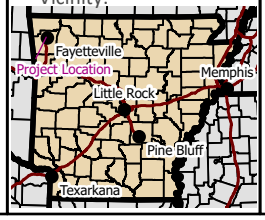

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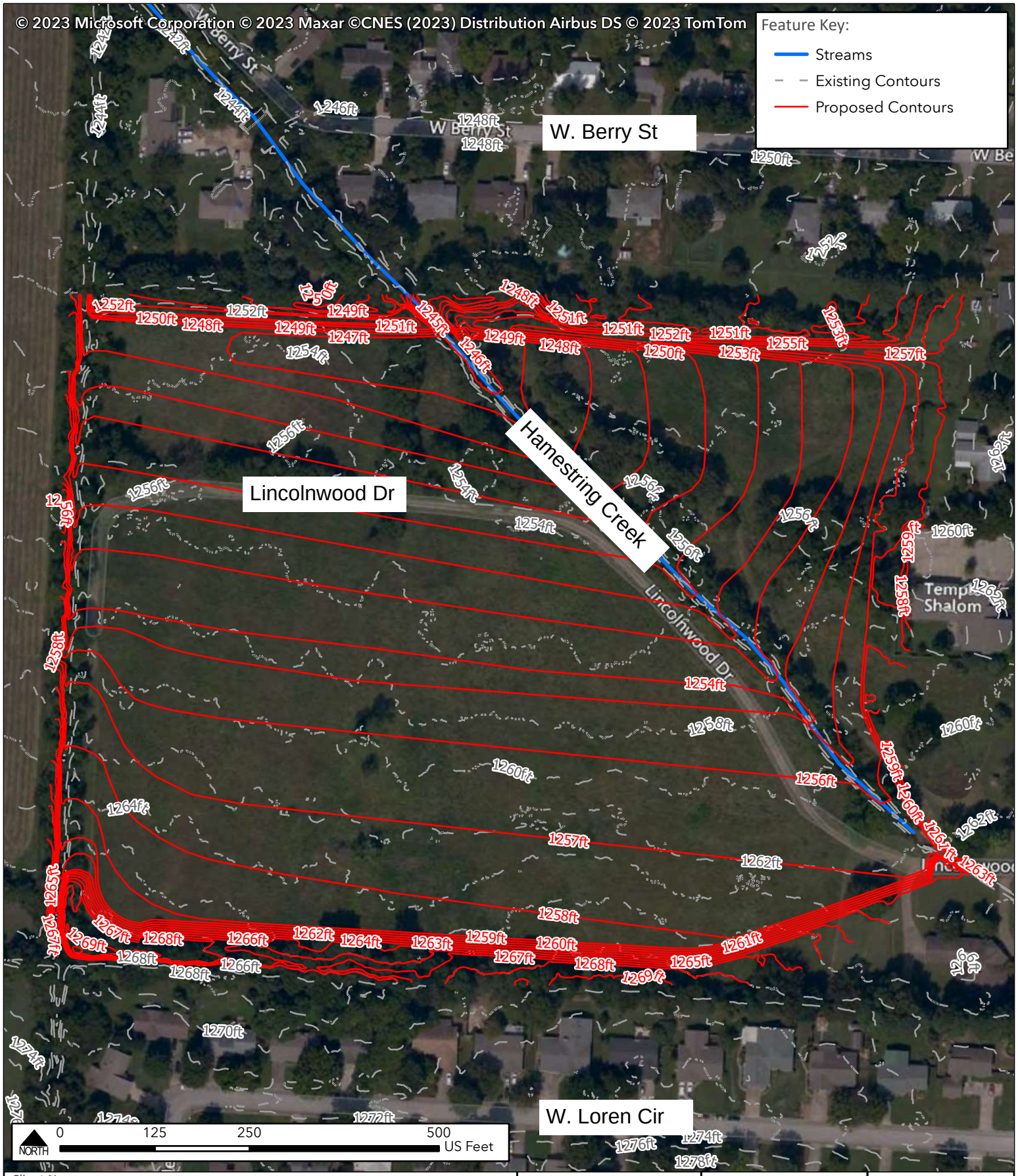

Client Name:	**Freese and Nichols, Inc.**
Project Title:	Hamestring Creek Watershed Analysis and Mitigation Alternatives
Project Location:	Hamestring Creek Watershed in Fayetteville, AR
Description:	Figure 3 South Pond Proposed Grading Contours
Date Exported:	11/1/2023 8:07 AM

Notice of Intent:
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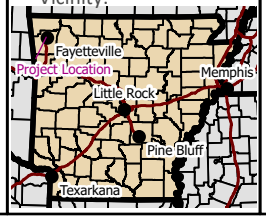
Vicinity:



ftn Associates Ltd.

Client Name:
Freese and Nichols, Inc.

Project Title:
Hamestring Creek Watershed Analysis and Mitigation Alternatives

Project Location:
Hamestring Creek Watershed
Fayetteville, AR

Description:
Figure 4
Lewis Soccer Field Proposed Grading Contours

Date Exported:
11/1/2023 8:10 AM

Notice of Intent:
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Vicinity:

ftn Associates Ltd.

Attachment 2

Opinions of Probable Construction Cost

West End Pond

Opinion of Probable Construction Cost

City of Fayetteville

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
FYV23552	JFS	JTO	October 6, 2023

ITEM		QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION					
	General				
1	Mobilization (10%)	1	LS	$ 184,350	$ 184,350
2	Site Clearing	7	AC	$ 10,000	$ 70,000
3	Development and Implement SWPPP	1	LS	$ 100,000	$ 100,000
4	Unclassified Channel Excavation	55,000	CY	$ 20	$ 1,100,000
5	Outlet Structure	1	LS	$ 250,000	$ 250,000
6	Hydromulch	7	AC	$ 10,500	$ 73,500
7	Trees	100	EA	$ 2,500	$ 250,000
				SUBTOTAL:	**$ 2,027,850**
				CONTINGENCY PERCENTAGE: 30%	$ 608,355
				PROJECT TOTAL:	**$ 2,637,000**

1. Assumed topsoil will be stockpiled and re-used on-site.

Disclaimer: The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.

South Pond

Opinion of Probable Construction Cost

City of Fayetteville

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
FYV23552	JFS	JTO	October 6, 2023

ITEM		QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION					
	General				
1	Mobilization (10%)	1	LS	$ 371,300	$ 371,300
2	Site Clearing	21	AC	$ 5,000	$ 105,000
3	Development and Implement SWPPP	1	LS	$ 100,000	$ 100,000
4	Excavation and Fill On-Site	2,500	CY	$ 15	$ 37,500
5	Unclassified Channel Excavation	135,000	CY	$ 20	$ 2,700,000
6	Outlet Structure	1	LS	$ 300,000	$ 300,000
7	Hydromulch	21	AC	$ 10,500	$ 220,500
8	Trees	100	EA	$ 2,500	$ 250,000
				SUBTOTAL:	**$ 4,084,300**
				CONTINGENCY PERCENTAGE: 30%	$ 1,225,290
				PROJECT TOTAL:	**$ 5,310,000**

1. Assumed topsoil will be stockpiled and re-used on-site.

Disclaimer: The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.

Lewis Soccer Complex Pond

Opinion of Probable Construction Cost

City of Fayetteville

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
FYV23552	JFS	JTO	October 6, 2023

ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION				
General				
1 Mobilization (10%)	1	LS	$ 126,975	$ 126,975
2 Site Clearing	4.5	AC	$ 5,000	$ 22,500
3 Development and Implement SWPPP	1	LS	$ 100,000	$ 100,000
4 Demolition	1	LS	$ 50,000	$ 50,000
5 Unclassified Channel Excavation	45,000	CY	$ 20	$ 900,000
6 Outlet Structure	1	LS	$ 150,000	$ 150,000
7 Hydromulch	4.5	AC	$ 10,500	$ 47,250
			SUBTOTAL:	**$ 1,396,725**
			CONTINGENCY PERCENTAGE: 30%	$ 419,018
			PROJECT TOTAL:	**$ 1,816,000**

1. Assumed topsoil will be stockpiled and re-used on-site.
2. Demolition assumes removal of portion of parking area and recreational building.

Disclaimer: The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.

Attachment 3

Benefit Cost Analysis Data on Initial Alternatives

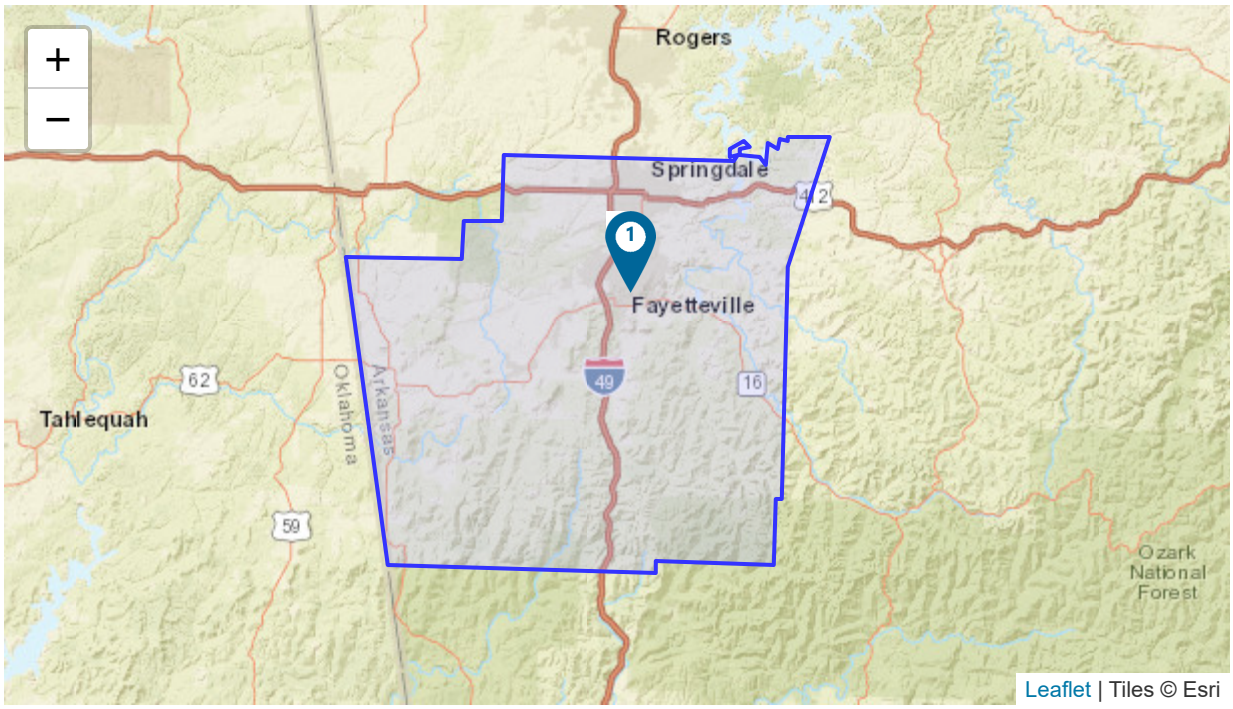
Attachment 3

FEMA Benefit-Cost Calculator

V.6.0 (Build 20241018.1218 | Release Notes)

Benefit-Cost Analysis

Project Name: West End Pond



Map Marker ▲	Mitigation Title	Property Type	Hazard	Discount Rate (%)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ Fayetteville, Arkansas		DFA - Riverine Flood	7.0	$ 1,427,584	$ 2,650,801	0.54
TOTAL (SELECTED)					**$ 0**	**$ 0**	**0.00**
TOTAL					**$ 0**	**$ 0**	**0.00**

Property Configuration

Property Title:	Drainage Improvement @ Fayetteville, Arkansas
Property Location:	72703, Washington, Arkansas
Property Coordinates:	36.062580000000025, -94.15742999999998
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Residential Building
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ Fayetteville, Arkansas

Discount Rate (%):	7.0% Use Default:Yes
Project Useful Life (years):	50
Project Cost:	$2,637,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ Fayetteville, Arkansas

Year of Analysis was Conducted:	2023
Year Property was Built:	1950
Analysis Duration:	74 Use Default:Yes

Professional Expected Damages Before Mitigation

Drainage Improvement @ Fayetteville, Arkansas

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
5	0	55,386	41,564	0	0	0	96,950
10	0	56,708	42,878	0	0	0	99,586
25	0	88,548	60,185	0	0	0	148,733
50	0	105,230	67,483	0	0	0	172,713
100	0	170,327	103,429	0	0	0	273,756
500	0	287,082	164,612	0	0	0	451,694

Annualized Damages Before Mitigation

Drainage Improvement @ Fayetteville, Arkansas

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
5	96,950	9,826
10	99,586	7,302
25	148,733	3,206
50	172,713	2,174
100	273,756	2,813
500	451,694	903
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,243,432	26,224

Professional Expected Damages After Mitigation

Drainage Improvement @ Fayetteville, Arkansas

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
5	0	55,386	41,561	0	0	0	96,947
10	0	56,708	42,425	0	0	0	99,133
25	0	78,486	54,923	0	0	0	133,409
50	0	115,184	74,292	0	0	0	189,476
100	0	158,890	97,430	0	0	0	256,320
500	0	276,771	159,215	0	0	0	435,986

Annualized Damages After Mitigation

Drainage Improvement @ Fayetteville, Arkansas

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
5	96,947	9,803
10	99,133	6,900
25	133,409	3,180
50	189,476	2,204
100	256,320	2,674
500	435,986	872
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,211,271	25,633

Standard Benefits - Ecosystem Services

Drainage Improvement @ Fayetteville, Arkansas

Total Project Area (acres):	6.3
Percentage of Urban Green Open Space:	99.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
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:	$96,929

Additional Benefits - Social

Drainage Improvement @ Fayetteville, Arkansas

Number of Workers:	6
Expected Annual Social Benefits:	$81,732

Benefits-Costs Summary

Drainage Improvement @ Fayetteville, Arkansas

Discount Rate (%):	7.0% Use Default:Yes
Total Standard Mitigation Benefits:	$1,345,852
Total Social Benefits:	$81,732
Total Mitigation Project Benefits:	$1,427,584
Total Mitigation Project Cost:	$2,650,801
Benefit Cost Ratio - Standard:	0.51
Benefit Cost Ratio - Standard + Social:	0.54

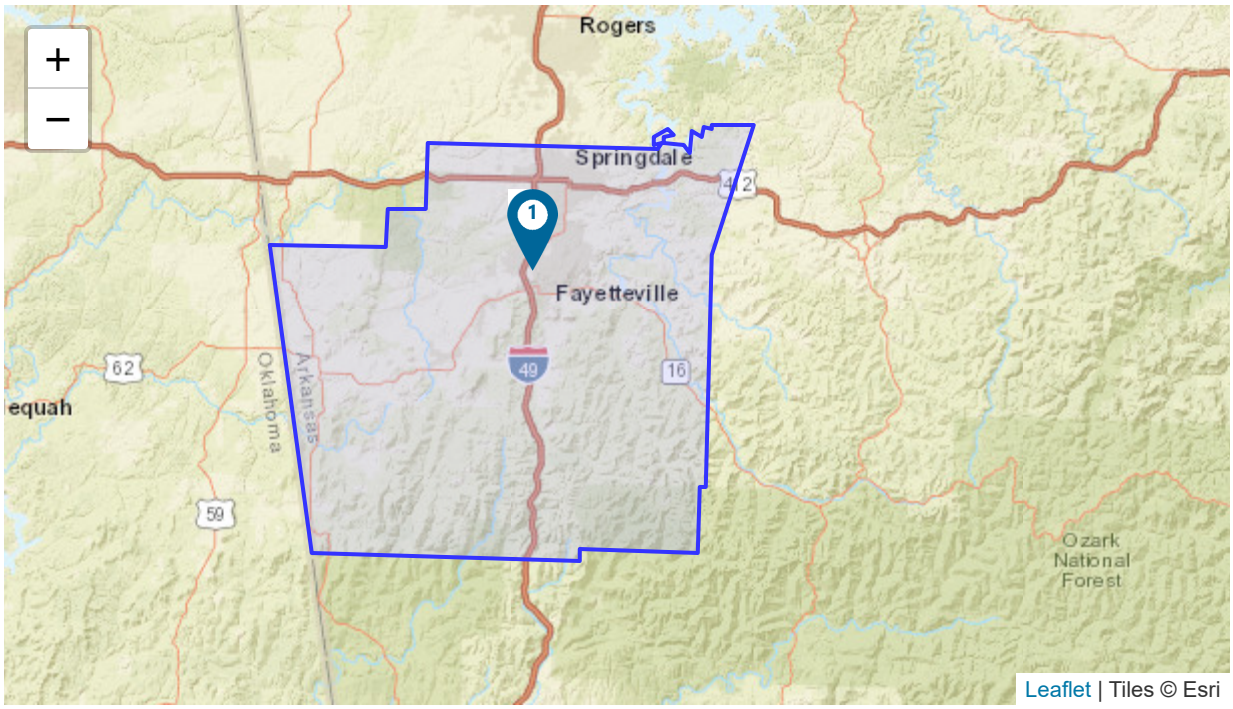
FEMA Benefit-Cost Calculator

V.6.0 (Build 20241018.1218 | Release Notes)

Attachment 3

Benefit-Cost Analysis

Project Name: South Pond



Map Marker ▲	Mitigation Title	Property Type	Hazard	Discount Rate (%)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701		DFA - Riverine Flood	7.0	$ 5,413,650	$ 8,860,401	0.61
TOTAL (SELECTED)					**$ 0**	**$ 0**	**0.00**
TOTAL					**$ 0**	**$ 0**	**0.00**

Property Configuration

Property Title:	Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701
Property Location:	72701, Washington, Arkansas
Property Coordinates:	36.07306499549796, -94.18917500143367
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Residential Building
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701

Discount Rate (%):	7.0% Use Default:Yes
Project Useful Life (years):	50
Project Cost:	$8,832,800
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$2,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701

Year of Analysis was Conducted:	2023
Year Property was Built:	1950
Analysis Duration:	74 Use Default:Yes

Professional Expected Damages Before Mitigation

Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
5	0	190,046	146,631	259	0	0	336,936
10	0	235,072	172,267	259	0	0	407,598
25	0	305,672	211,689	259	0	0	517,620
50	0	365,303	244,002	517	0	0	609,822
100	0	401,644	261,276	776	0	0	663,696
500	0	609,032	274,589	4,487	0	0	888,108

Annualized Damages Before Mitigation

Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
5	336,936	37,059
10	407,598	27,560
25	517,620	11,237
50	609,822	6,362
100	663,696	6,142
500	888,108	1,776
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	3,423,780	90,136

Professional Expected Damages After Mitigation

Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
5	0	169,090	134,183	259	0	0	303,532
10	0	214,890	160,729	259	0	0	375,878
25	0	281,299	198,416	259	0	0	479,974
50	0	339,430	230,014	375	0	0	569,819
100	0	413,270	269,770	776	0	0	683,816
500	0	569,756	352,104	4,112	0	0	925,972

Annualized Damages After Mitigation

Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
5	303,532	33,777
10	375,878	25,485
25	479,974	10,459
50	569,819	6,242
100	683,816	6,366
500	925,972	1,852
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	3,338,991	84,181

Standard Benefits - Ecosystem Services

Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701

Total Project Area (acres):	22
Percentage of Urban Green Open Space:	99.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
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:	$338,483

Additional Benefits - Social

Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701

Number of Workers:	49
Expected Annual Social Benefits:	$660,149

Benefits-Costs Summary

Drainage Improvement @ Lincolnwood Dr, Fayetteville, Arkansas, 72701

Discount Rate (%):	7.0% Use Default:Yes
Total Standard Mitigation Benefits:	$4,753,501
Total Social Benefits:	$660,149
Total Mitigation Project Benefits:	$5,413,650
Total Mitigation Project Cost:	$8,860,401
Benefit Cost Ratio - Standard:	0.54
Benefit Cost Ratio - Standard + Social:	0.61

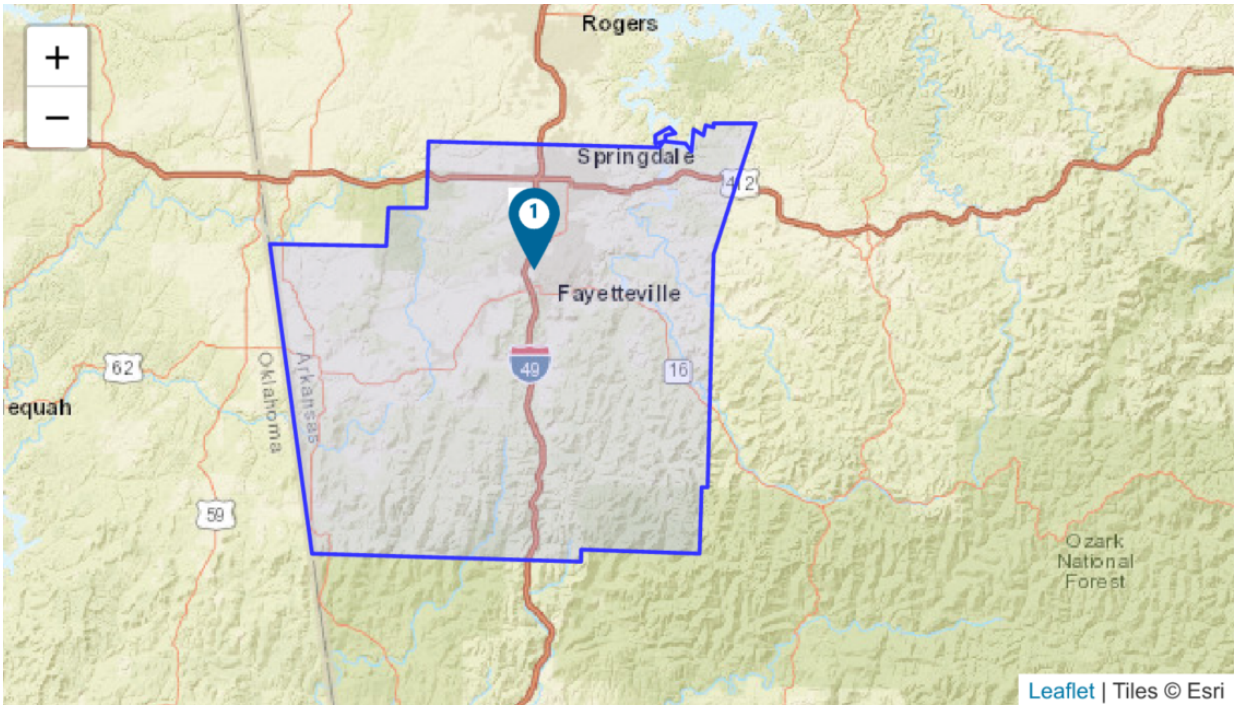
Attachment 3

FEMA Benefit-Cost Calculator

V.6.0 (Build 20241018.1218 | Release Notes)

Benefit-Cost Analysis

Project Name: Lewis Soccer Complex Pond



Map Marker ▲	Mitigation Title	Property Type	Hazard	Discount Rate (%)	Benefits (B)	Costs (C)	BCR (B/C)
1	Floodwater Diversion and Storage @ Fayetteville, Arkansas		DFA - Riverine Flood	7.0	$ 2,688,869	$ 1,829,801	1.47
TOTAL (SELECTED)					**$ 0**	**$ 0**	**0.00**
TOTAL					**$ 0**	**$ 0**	**0.00**

Property Configuration

Property Title:	Floodwater Diversion and Storage @ Fayetteville, Arkansas
Property Location:	72701, Washington, Arkansas
Property Coordinates:	36.062580000000025, -94.15742999999998
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodwater Diversion and Storage
Property Type:	Residential Building
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodwater Diversion and Storage @ Fayetteville, Arkansas

Discount Rate (%):	7.0% Use Default:Yes
Project Useful Life (years):	50
Project Cost:	$1,816,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Floodwater Diversion and Storage @ Fayetteville, Arkansas

Year of Analysis was Conducted:	2023
Year Property was Built:	1950
Analysis Duration:	74 Use Default:Yes

Professional Expected Damages Before Mitigation

Floodwater Diversion and Storage @ Fayetteville, Arkansas

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
5	0	412,787	298,661	517	0	0	711,965
10	0	443,181	316,545	517	0	0	760,243
25	0	583,624	396,930	1,267	0	0	981,821
50	0	669,265	442,274	2,586	0	0	1,114,125
100	0	795,869	510,672	3,737	0	0	1,310,278
500	0	1,124,059	687,349	8,367	0	0	1,819,775

Annualized Damages Before Mitigation

Floodwater Diversion and Storage @ Fayetteville, Arkansas

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
5	711,965	73,571
10	760,243	51,837
25	981,821	20,918
50	1,114,125	12,082
100	1,310,278	12,353
500	1,819,775	3,639
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	6,698,207	174,400

Professional Expected Damages After Mitigation

Floodwater Diversion and Storage @ Fayetteville, Arkansas

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
5	0	381,586	278,913	259	0	0	660,758
10	0	412,929	296,947	517	0	0	710,393
25	0	519,920	359,080	776	0	0	879,776
50	0	616,905	412,100	1,668	0	0	1,030,673
100	0	772,256	498,320	3,996	0	0	1,274,572
500	0	1,062,257	652,609	8,250	0	0	1,723,116

Annualized Damages After Mitigation

Floodwater Diversion and Storage @ Fayetteville, Arkansas

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
5	660,758	68,513
10	710,393	47,434
25	879,776	19,045
50	1,030,673	11,462
100	1,274,572	11,856
500	1,723,116	3,446
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	6,279,288	161,756

Standard Benefits - Ecosystem Services

Floodwater Diversion and Storage @ Fayetteville, Arkansas

Total Project Area (acres):	8.5
Percentage of Urban Green Open Space:	60.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
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:	$79,259

Additional Benefits - Social

Floodwater Diversion and Storage @ Fayetteville, Arkansas

Number of Workers:	105
Expected Annual Social Benefits:	$1,420,538

Benefits-Costs Summary

Floodwater Diversion and Storage @ Fayetteville, Arkansas

Discount Rate (%):	7.0% Use Default:Yes
Total Standard Mitigation Benefits:	$1,268,331
Total Social Benefits:	$1,420,538
Total Mitigation Project Benefits:	$2,688,869
Total Mitigation Project Cost:	$1,829,801
Benefit Cost Ratio - Standard:	0.69
Benefit Cost Ratio - Standard + Social:	1.47

Attachment 4

FNI Technical Memo on Supplemental Modeling

Attachment 4

TECHNICAL MEMORANDUM

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

www.freese.com

TO: Alan Pugh, PE, CFM, City of Fayetteville, Staff Engineer

FROM: Kale Farmer, PE, CFM
Central Plains Division,
Senior Stormwater Engineer

SUBJECT: Hamestring Creek Study Supplemental Report

DATE: 12/11/2024

PROJECT: FYV23522

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 14253
KENNETH LOYD FARMER III
12/11/2024

CERTIFICATE OF AUTHORIZATION
FREESE AND NICHOLS, INC.
No. 493
ARKANSAS

Given that the results of the initial modeling and BCA did not produce a potential mitigation project that significantly reduced flood levels in the watershed, the City decided not to move forward with a grant application and the associated Nature Based Solutions (NBS) concept development. In lieu of that effort, and to ensure that the flood mitigation opportunities were evaluated from every perspective, it was decided that further modeling would be conducted to determine whether a Lewis Pond detention project could be modified to provide more substantial WSEL improvements. FNI acquired previously developed HEC-HMS hydrologic modeling from the City to allow additional analysis of the Lewis Pond in the Hamestring Creek Watershed. Revisions to the HEC-HMS model allow more rapid alterations to be made to the pond outfall geometry and results in shorter model runtimes. The FTN analysis for the current project utilized a 2D, Rain-On-Mesh model using HEC-RAS (2D RAS), which provided a more detailed understanding of how rainfall runoff accumulates in the watershed, flows through the system, and locations where the runoff leaves the channel. The additional analysis prepared by FNI examined the detention volume and outfall in more detail using the HEC-HMS model but applied the results to the 2D RAS model to take advantage of the detailed hydraulic computations in the watershed downstream of Lewis Pond. Details of the additional modeling effort are summarized below.

H&H Methodology

The hydrologic modeling relied upon by FNI for this supplemental effort was originally developed by FTN Associates, Ltd. (FTN) as part of a watershed study completed in 2021. The goal of that study was to update the peak flows within the watershed and determine the drainage system's conveyance capabilities, at that time. The 2021 watershed study was not scoped to consider detention within the watershed, so FNI revised that model to incorporate detention at the site of the proposed Lewis Pond.

In order to take advantage of the more detailed detention analysis capabilities of HEC-HMS and further refine the WSEL reduction benefits of the proposed Lewis Pond, the existing conditions HEC-HMS model was revised to split the upstream drainage basin of Hamestring Creek Tributary HS3 near the intersection of Lewis Avenue and Mount Comfort Road. The Curve Number applied in the new basins was not changed from what was used in the original single basin defining the area because the land use and soil types within the divided basins are similar. Time of Concentration was updated for each of the divided basins and an updated hydraulic routing reach was added through the downstream subbasin. The peak flow results for the 1%-annual chance storm event were compared between the original model

and the revised existing conditions model at Mount Comfort Road, near the location of the Lewis Pond outfall. They were found to differ by less than 10%, a generally acceptable amount given standard engineering practice for hydrologic models.

A copy of the model was then updated to include an elevation-area curve, representing the maximum storage geometry available on the site owned by the City, and an estimated pond outfall structure. Using the HEC-HMS model allowed for an iterative design approach to develop sizing of the outfall structure components. The structure was sized to detain the storm flow to the extent possible while maintaining freeboard during the 1% annual chance (100-year) event and such that the pond berm was not overtopped during the 0.2% annual chance (500-year) event. The 2D RAS model developed by FTN considered additional detention volume which, after the results were incorporated into the FEMA Benefit-Cost Analysis Toolkit, proved that the Lewis Pond met the requirement of a Benefit-Cost Ratio (BCR) greater than one to be eligible for federal grant funding. This model relied on the existing roadway embankments of N Lewis Drive and W Mt Comfort Road, and the existing HS3 roadway crossing culvert to initiate backwater ponding. The supplemental modeling provided additional detailed analysis to further refine the detention potential of the conceptual Lewis Pond. Specifically, instead of having the road profile and existing culvert capacity be the factors that create the detention, FNI modeled the pond location, with a berm across the creek flowline, distinctly separate from the roadway, requiring all runoff to pass through an independent outfall structure that allows the system to take full advantage of the potential achievable volume of the pond footprint area.

After revised flows leaving the Lewis Pond were calculated, the 2D RAS model developed by FTN was modified by removing the portion of the 2D mesh east of N Lewis Ave and north of W Mt. Comfort Rd. A boundary condition was added to the remaining mesh, near the intersection of Lewis and Mt. Comfort, that allowed the application of the pond outfall hydrograph calculated in HEC-HMS. The Rain-On-Mesh hydrology for the remaining 2D mesh was not changed and the model was run to compute the anticipated WSELs throughout the watershed.

Findings

Based on the iterative design process, it was determined that the Lewis Pond with the added modifications had a greater impact on the peak flows that are able be captured than indicated by the initial 2D RAS model. **Table 1** below shows the relative change in the 1% annual chance event peak flows at several points within the watershed, starting at the outfall of the Lewis Pond, just upstream of W Mt. Comfort Road. Though the percentage reduction in flows is noteworthy, particularly at W. Mt. Comfort Rd., because of the conceptual pond's position relatively near the drainage basin divide, the portion of flow in the watershed that is un-detained quickly diminishes the flood mitigation benefit downstream of the Lewis Pond.

Table 1 – Flow Reduction

	1% Annual Chance Event			
Location	Existing Conditions Q (cfs)	Lewis Pond Q (cfs)	Q reduction (cfs)	% change
W Mt. Comfort Rd[1]	696	223	473	-68%
N Sang Ave[1]	1259	914	345	-27%
W Hatfield St[2]	1766	1370	396	-22%
W Newport Dr[2]	3873	3600	273	-7%

[1]Flows reported from HEC-HMS
[2]Flows reported from HEC-RAS

Attachment 4

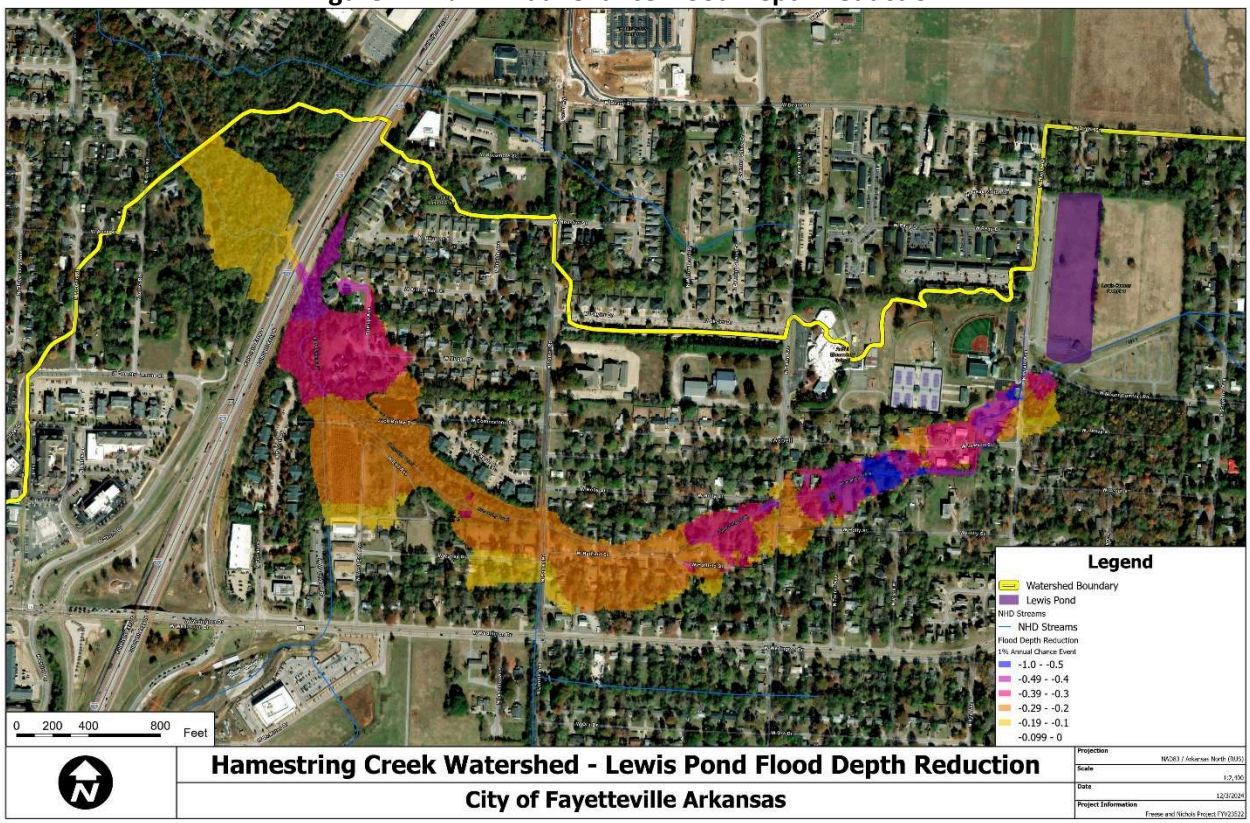
Table 2 below reports–WSEL reductions estimated by the revised modeling at the same locations referenced in **Table 1,** in the 1% chance annual event.

Table 2 – Water Surface Elevation Reduction

	1% Annual Chance Event			
Location	Existing Conditions WSEL (ft)	Lewis Pond WSEL (ft)	WSEL reduction (ft)	WSEL reduction (in)
W Mt. Comfort Rd	1257.96	1257.59	-0.37	-4.44
N Sang Ave	1246.25	1245.99	-0.26	-3.12
W Hatfield St	1238.77	1238.47	-0.3	-3.6
W Newport Dr	1231.90	1231.56	-0.34	-4.08

As indicated, the reduction in WSEL or, correspondingly, flood depth, was found to be minimal in most locations throughout the drainage basin. **Figure 1** below depicts estimated WSEL reductions in the 1% annual chance event that may be achieved if the Lewis Pond was constructed.

Figure 1 – 1% Annual Chance Flood Depth Reduction



The reductions indicated above do not dramatically reduce flood risk for most of the homes near the tributaries in the watershed in intense rain events.

Buyout Option

Given the relatively high cost of the alternatives evaluated, both in the initial and supplemental analyses, compared to the achievable level of flood depth/risk reduction, the City may want to consider a buyout of select properties, beginning with Repetitive or Severe Repetitive Loss (RL/SRL) structures. Potentially, if a significant number of properties are acquired by the City over time, and some of the residential area constraints are removed, the proposed mitigation alternatives of detention and channel capacity improvements may prove to be more effective in reducing hazards on the remaining residences. Any concepts evaluated involving channel capacity improvements, of course, would need to assess if increased conveyance upstream in the watershed can be achieved without adverse downstream impacts. Detention at the former West End Apartment property could be assessed for use in accommodating increased flows without adverse downstream impacts.

A simplified Benefit-Cost Ratio calculation is offered for the buyout of properties within the Special Flood Hazard Area (SFHA) identified on FEMA Flood Insurance Rate Maps (FIRMs). The standard benefit value for acquired properties is $ 775,411. Based on information from a variety of public and private sources, the average property value of residences within the SFHA in the study area, including the five (5) repetitive loss structures, appears to be in the $230,000 - $250,000 range. Even when considering the relocation costs required for tenants of rental properties, it is unlikely that the total acquisition cost of many, if any, of the properties eligible for voluntary acquisition would exceed $775,411. Therefore, a buyout option would have a BCR greater than one and be eligible for FEMA grant funding.

Attachment 5

Sign-in Sheet for August 17, 2023 Public Meeting

Attachment 5

Hamestring Creek Flood Mitigation Study Public Meeting

Aug 17, 2023

Sign-in sheet

Name	Address	Email or phone
[redacted]	92 Wesley Stevens Rd, Farmington	MarMacProperties@gmail.com
Alessandra Brown	2425 W Valley Drive	a[redacted]brown[redacted]l.com
Gayle		
MARTHA CLARK	2843 W. RIVERRIDGE DR	MJCCLARK@YAHOO.COM
TINA [redacted]	339 N. GREGG AVE,	[redacted]
Pamela Bowers	2400 W. Wedington Dr.	hhacu[redacted]

Hamestring Creek Flood Mitigation Study Public Meeting

Aug 17, 2023

Sign-in sheet

Name	Address	Email or phone
Andy Tarwater	2445 W Valley Dr	andy.tarwater24@gmail.com

Attachment 6

PowerPoint Presentation for August 17, 2023 Public Meeting

Attachment 6

CITY OF FAYETTEVILLE ARKANSAS

HAMESTRING CREEK WATERSHED FLOOD MITIGATION

ftn Associates Ltd.

FREESE AND NICHOLS

August 17, 2023

MEETING AGENDA

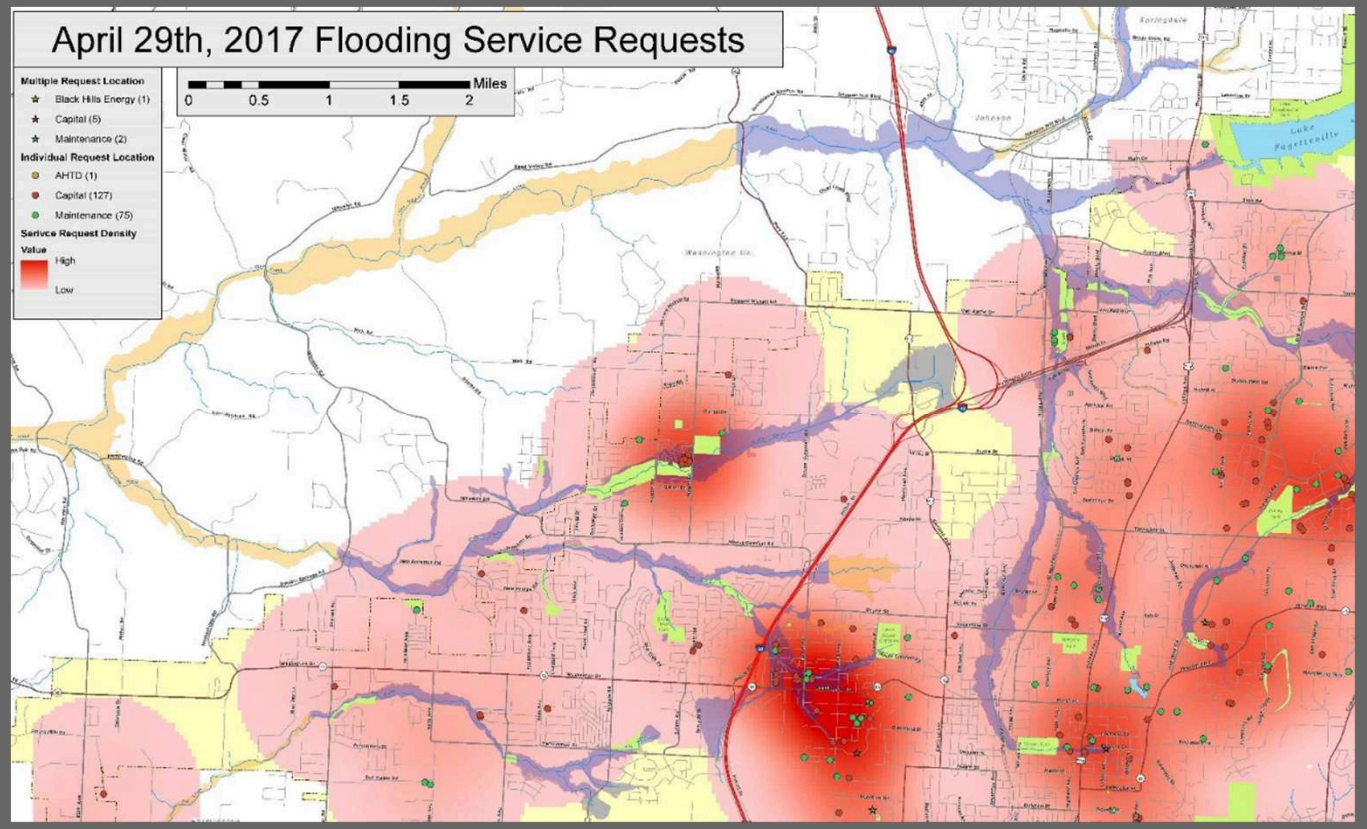
- Team members
- Meeting Purpose
- Nature of the problem
- Project Scope
- Project Timeline/Next Steps
- Q&A/Breakout tables

TEAM MEMBERS

- Community representatives
- City of Fayetteville
  - Alan Pugh, PE, CFM
  - Chris Brown, PE
- Freese and Nichols Inc.
  - Greg Simmons, PE, CFM
  - Annie Vest, CFM
  - Kale Farmer, PE, CFM
- FTN
  - Lee Beshoner, PE, CFM

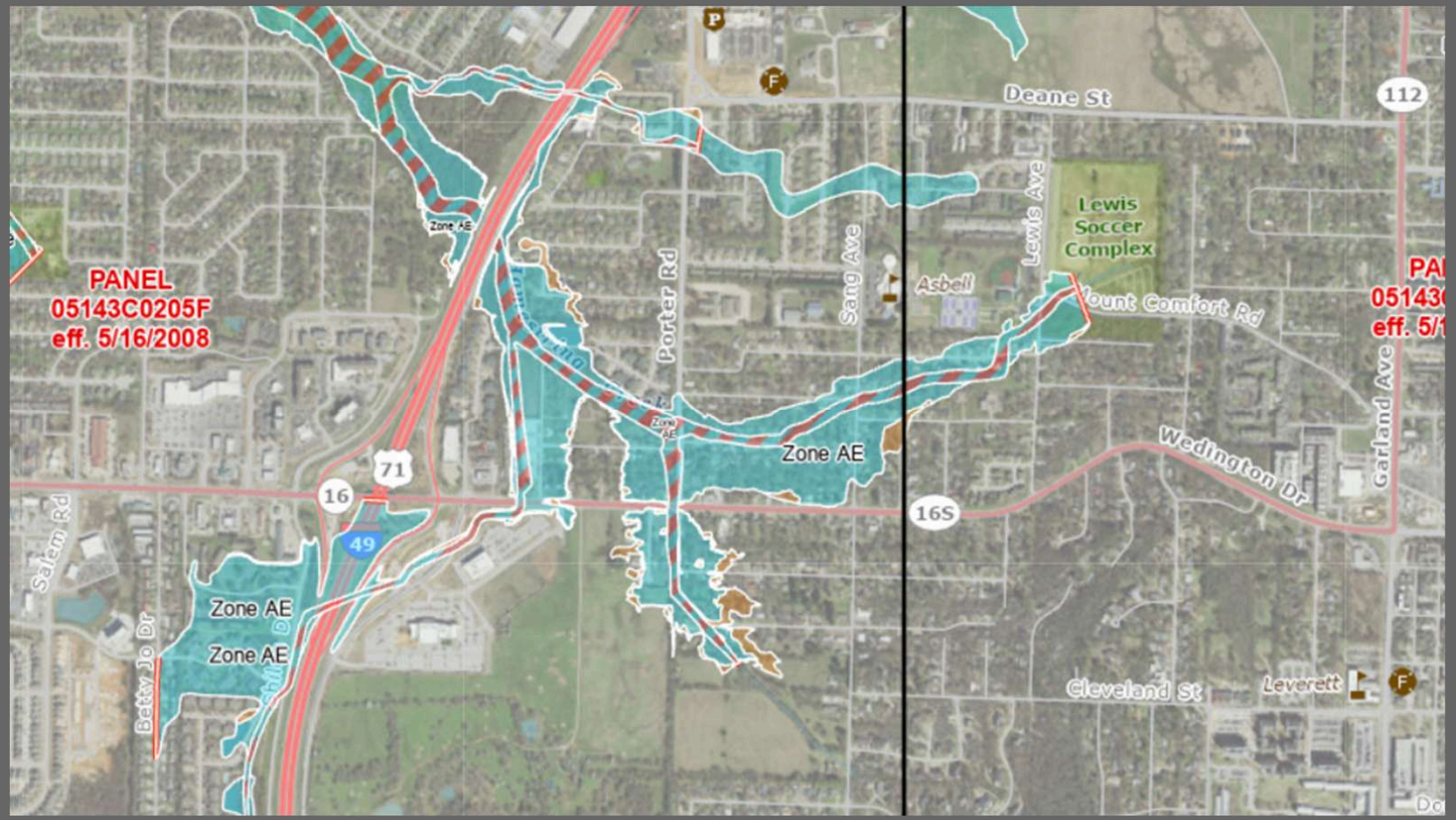
MEETING PURPOSE

- Inform community about the initiative
- Share current engineering assessment of flood risk
- Hear from community
  - Validate/refine engineering
  - Priorities
  - Ideas



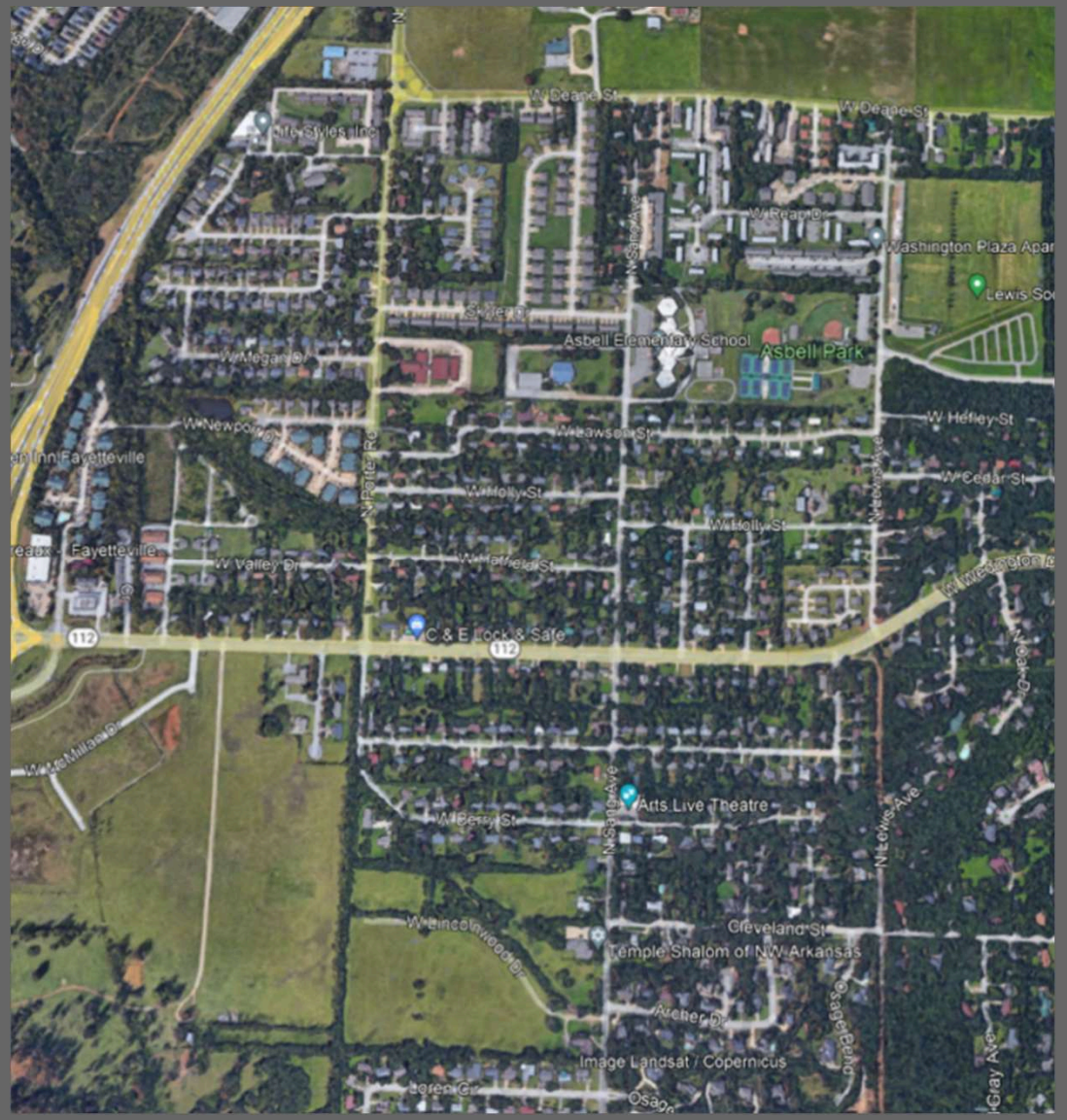
NATURE OF THE PROBLEM

- Wide floodplain
- Limited infrastructure
- Narrow ROW
- Constriction at IH49
- Downstream flooding
- Very expensive to mitigate



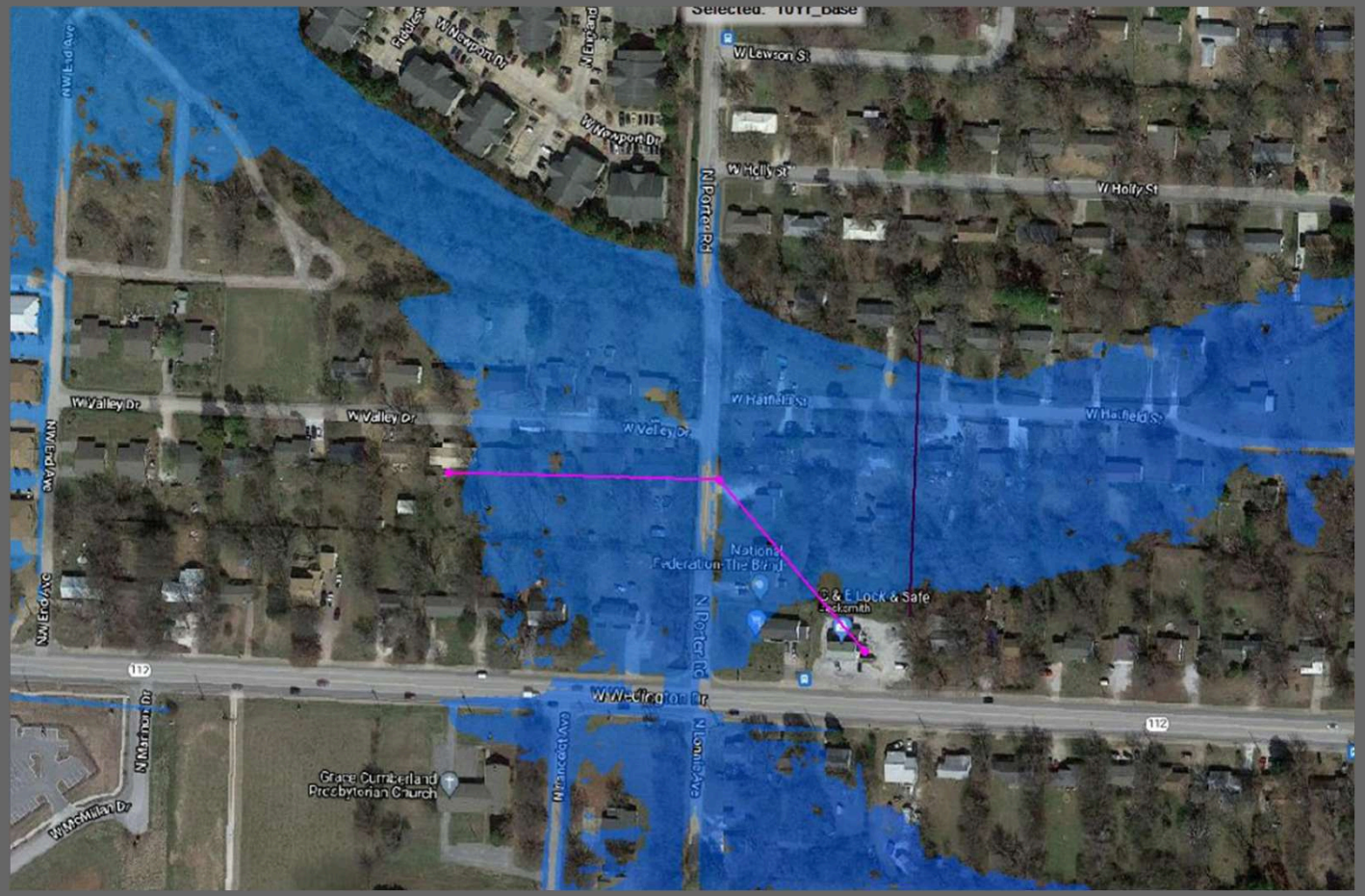
PROJECT SCOPE

- Assess existing flood risk
- Assess mitigation alternatives
  - Detention
  - Property acquisition
  - Combination
- FEMA Benefit Cost Analysis
- Submit grant application if criteria are met



PROJECT SCOPE

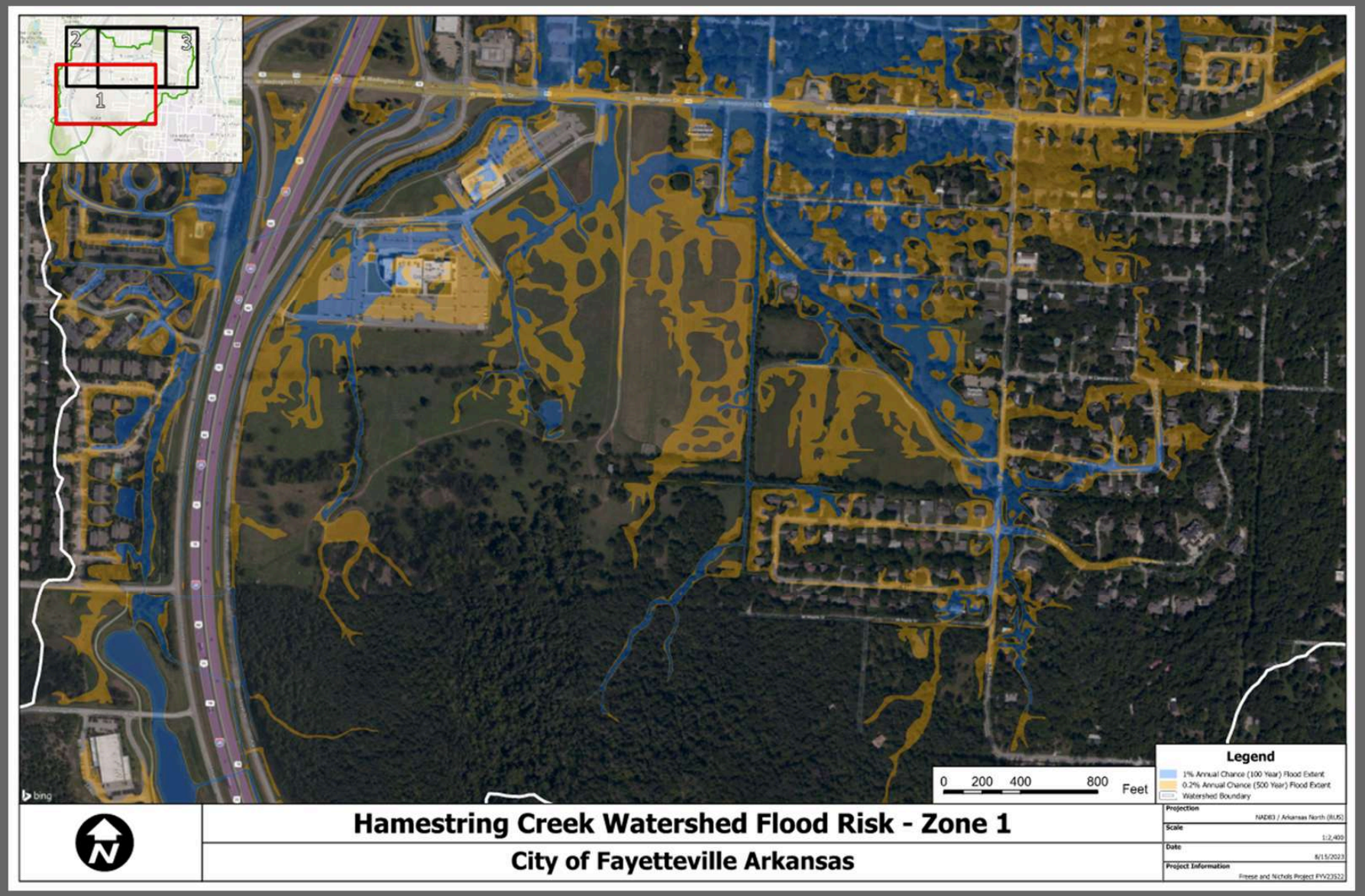
- Other Grant Application Factors
  - Road safety
  - First responder access
  - Nature Based Solutions
  - Equity



PROJECT TIMELINE

- End of Oct ‘23: Complete engineering
- Mid Nov ‘23: Public meeting to report findings
- End of Nov ‘23: Complete grant application
- Dec ‘23: Apply for grant(s)
- Early ‘24: Grant announcements
- Summer ‘24: Funding available for accepted projects

Q&A/BREAKOUT TABLES



Attachment 7

Sign-in Sheet for November 16, 2023 Public Meeting

Attachment 7

Hamestring Creek Flood Mitigation Study Public Meeting

November 16, 2023

Sign-in sheet

Name	Address	Email or phone
Allie Brown	2425 W Valley Drive	479 236 8716
MARTHA CLARK	2843 W. RIVERRIDGE DR	MSCLARK@YAHOO
Nathan Brown	2306 W. Ora Dr.	479-685-3522
Misty Grady	2558 W Valley Dr	918-801-3946
Becky Lynch	West End	479-466-718[illegible]
Pamela Bayers	2400 Wedington Dr.	hhack.bayers@gmail.com

Attachment 7

Hamestring Creek Flood Mitigation Study Public Meeting

November 16, 2023

Sign-in sheet

Name	Address	Email or phone
Scott Chamberlain	2547 W Arthur Hart	scott@teamdirectmgmt.com
Cameron Caja	1235 N. SANG Ave	caja.cameron@gmail.com

Attachment 8

PowerPoint Presentation for November 16, 2023 Public Meeting

Attachment 8

CITY OF FAYETTEVILLE ARKANSAS

HAMESTRING CREEK WATERSHED FLOOD MITIGATION

FREESE AND NICHOLS

November 16, 2023

MEETING AGENDA

- Team members
- Meeting Purpose
- Nature of the problem
- Scope of the study
- Study findings to date
- Project Timeline/Next Steps
- Q&A

TEAM MEMBERS

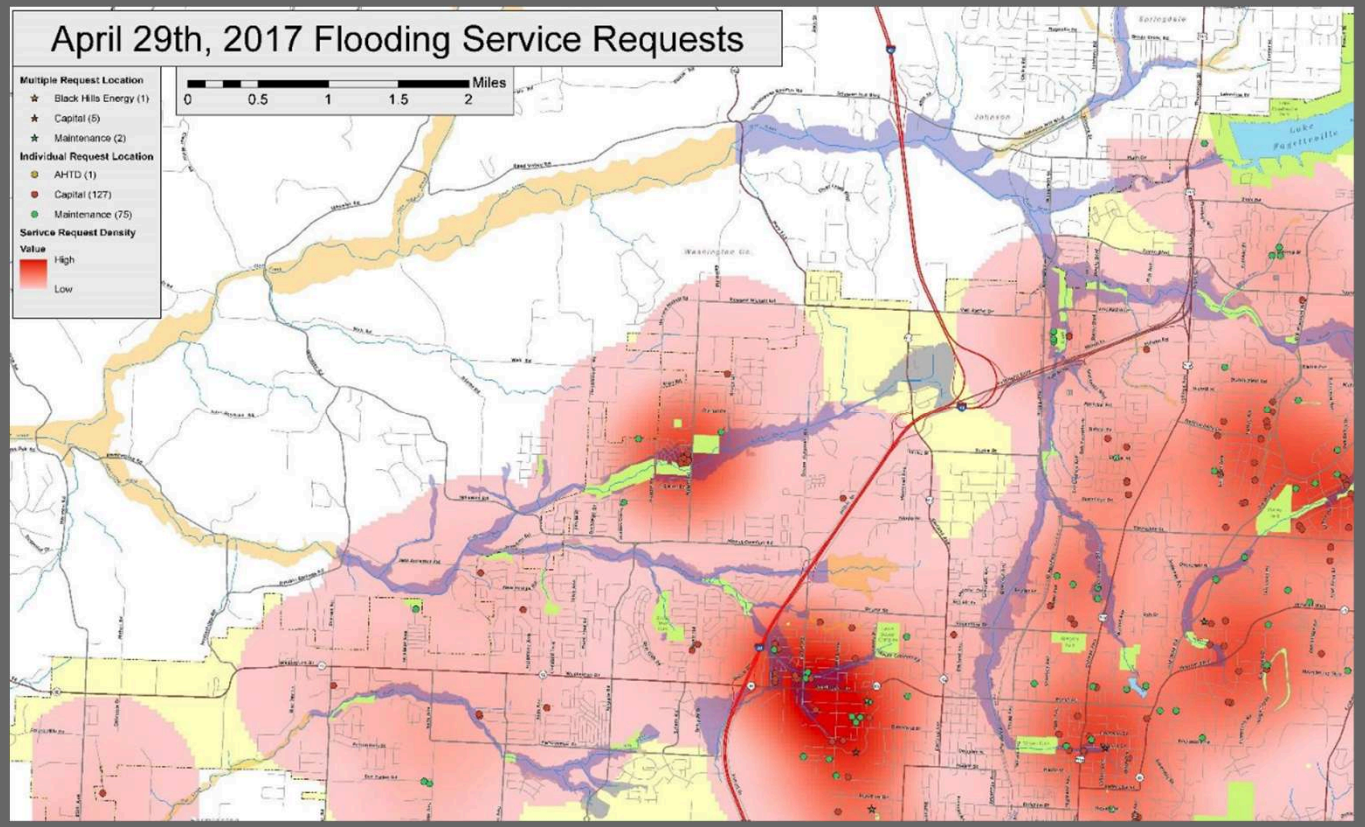
- Community representatives

- City of Fayetteville
  - Alan Pugh, PE, CFM
  - Chris Brown, PE

- Freese and Nichols Inc.
  - Greg Simmons, PE, CFM
  - Annie Vest, CFM
  - Kale Farmer, PE, CFM

MEETING PURPOSE

- Review the basic problem and study scope
- Share results of the study to date
- Discuss next steps
- Hear from community

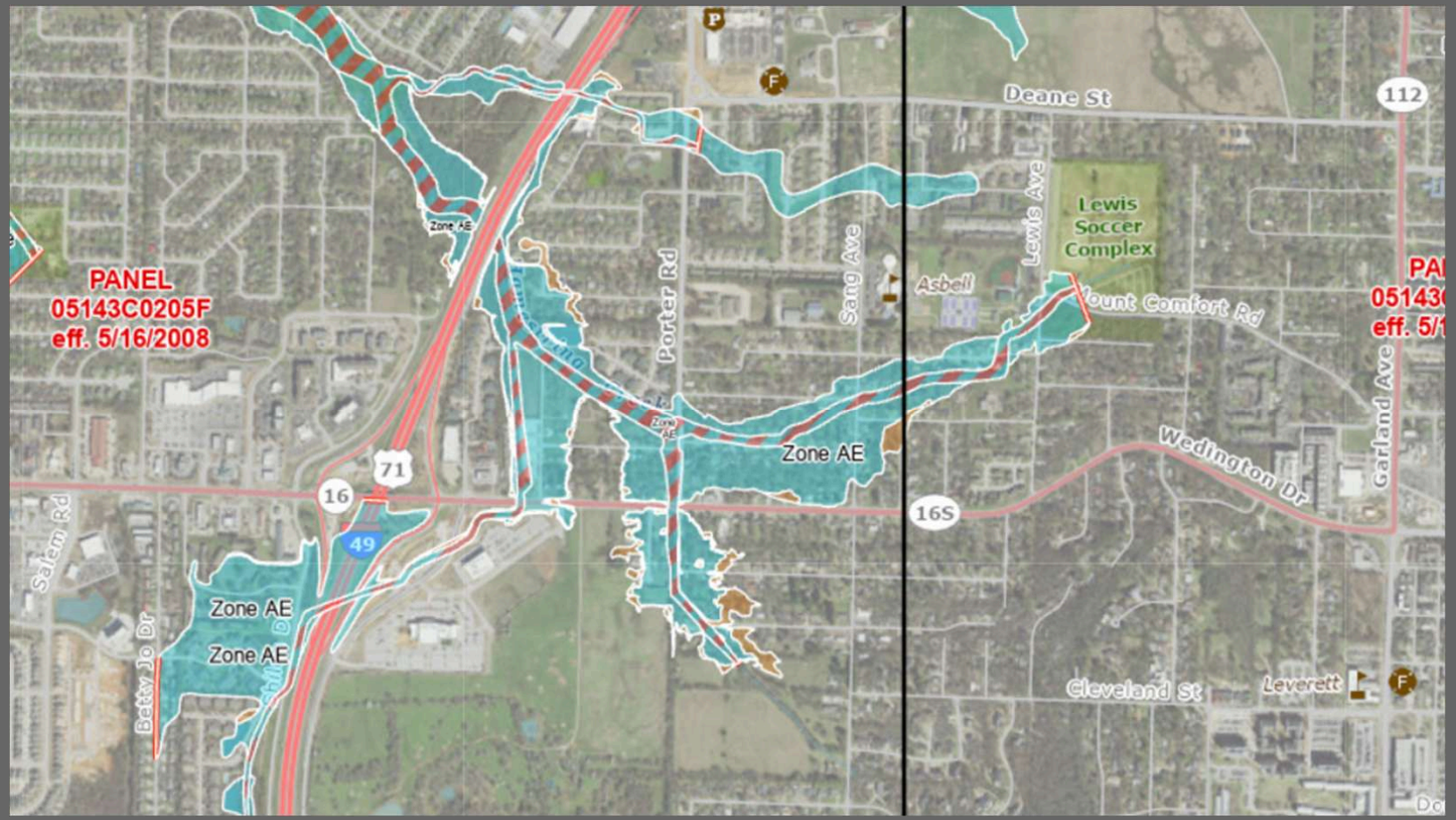


NATURE OF THE PROBLEM

FREESE AND NICHOLS

CITY OF FAYETTEVILLE ARKANSAS

- Wide floodplain
- Limited infrastructure
- Narrow ROW
- Constriction at IH49
- Downstream flooding
- Very expensive to mitigate

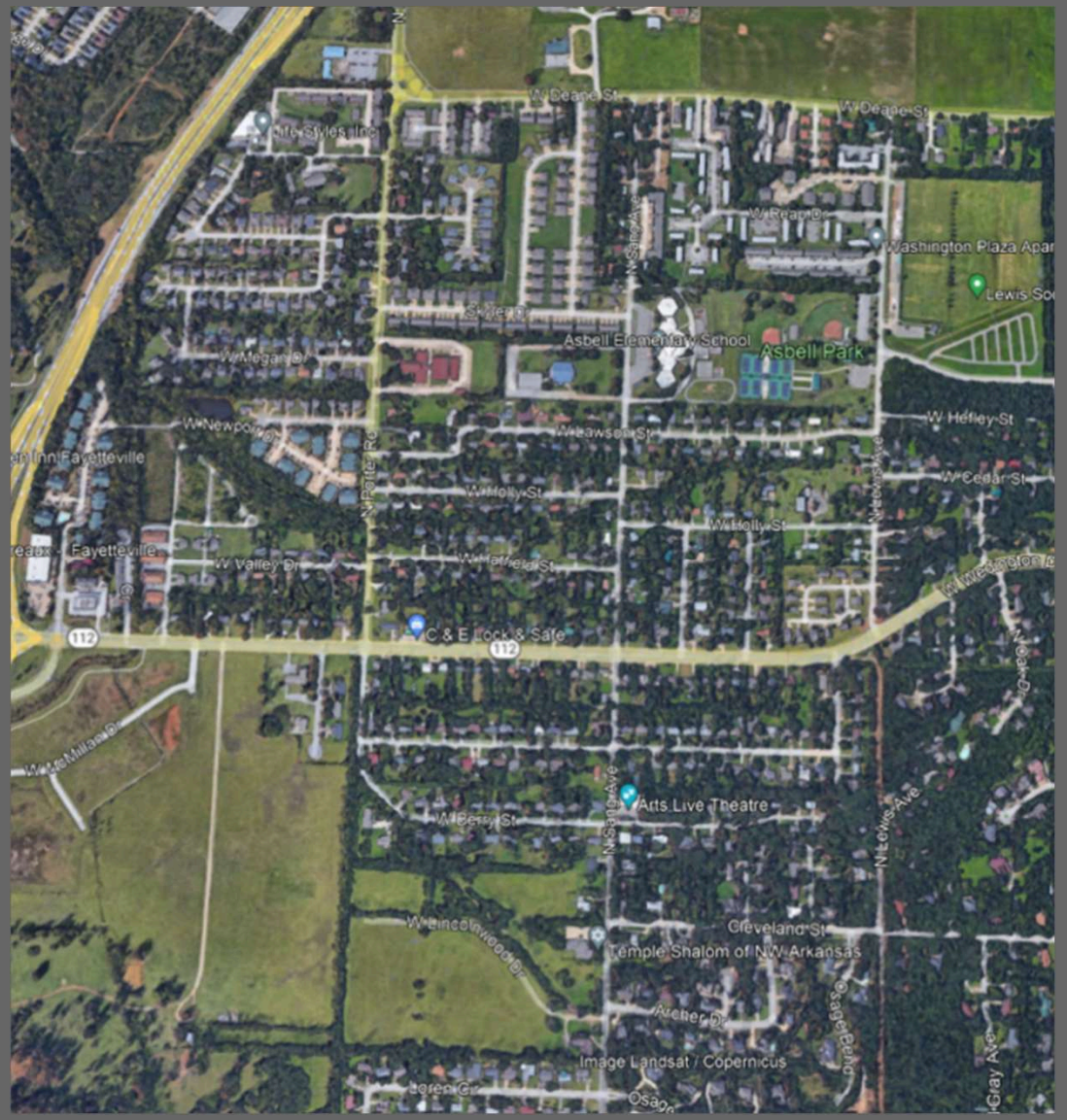


PROJECT SCOPE

FREESE AND NICHOLS

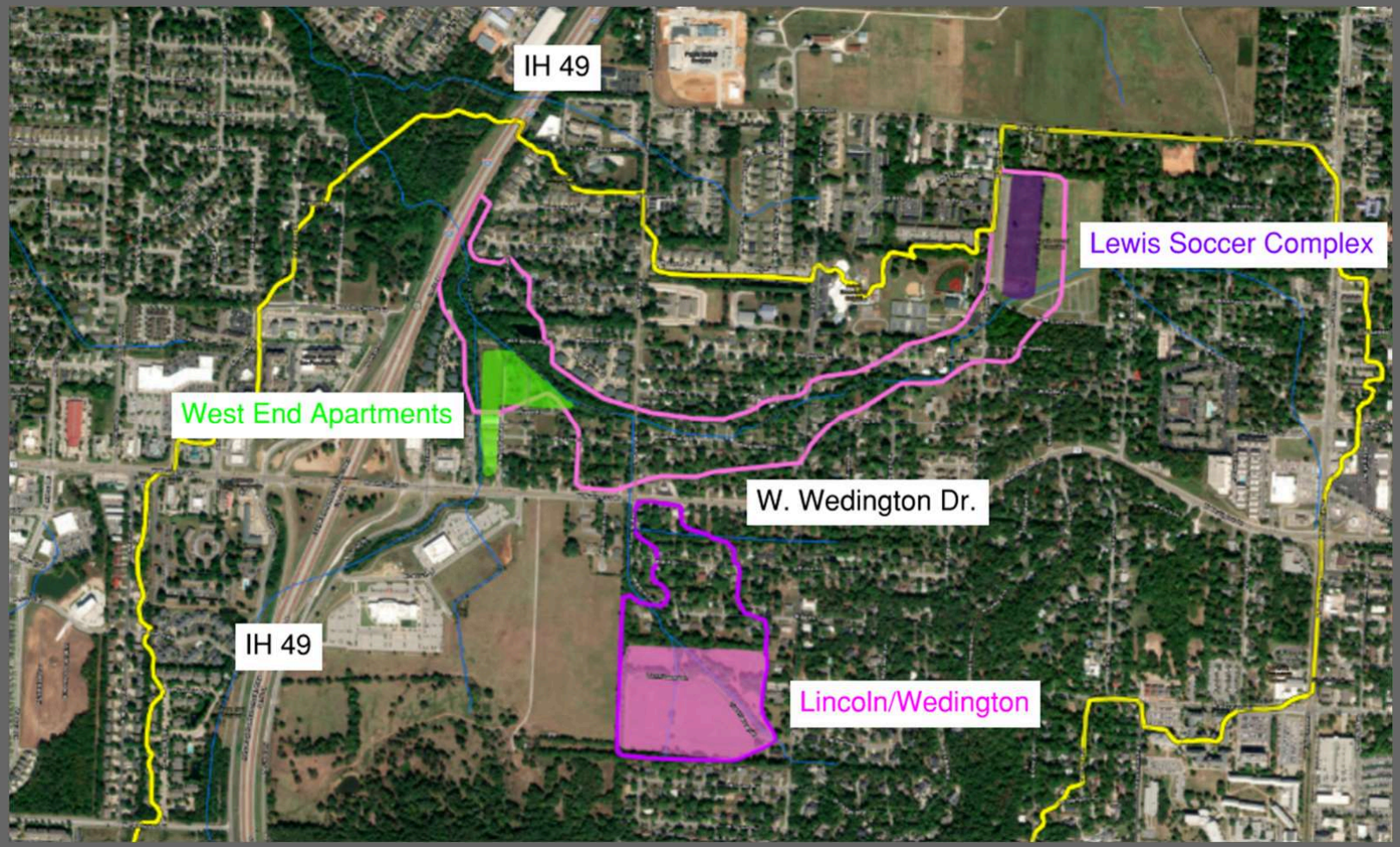
CITY OF FAYETTEVILLE ARKANSAS

- Refine assessment of existing flood risk
- Assess mitigation alternatives
  - Detention
  - Property acquisition
  - Combination
- FEMA Benefit Cost Analysis
- Submit grant application if appropriate
  - Meet FEMA requirements?
  - Realistic?

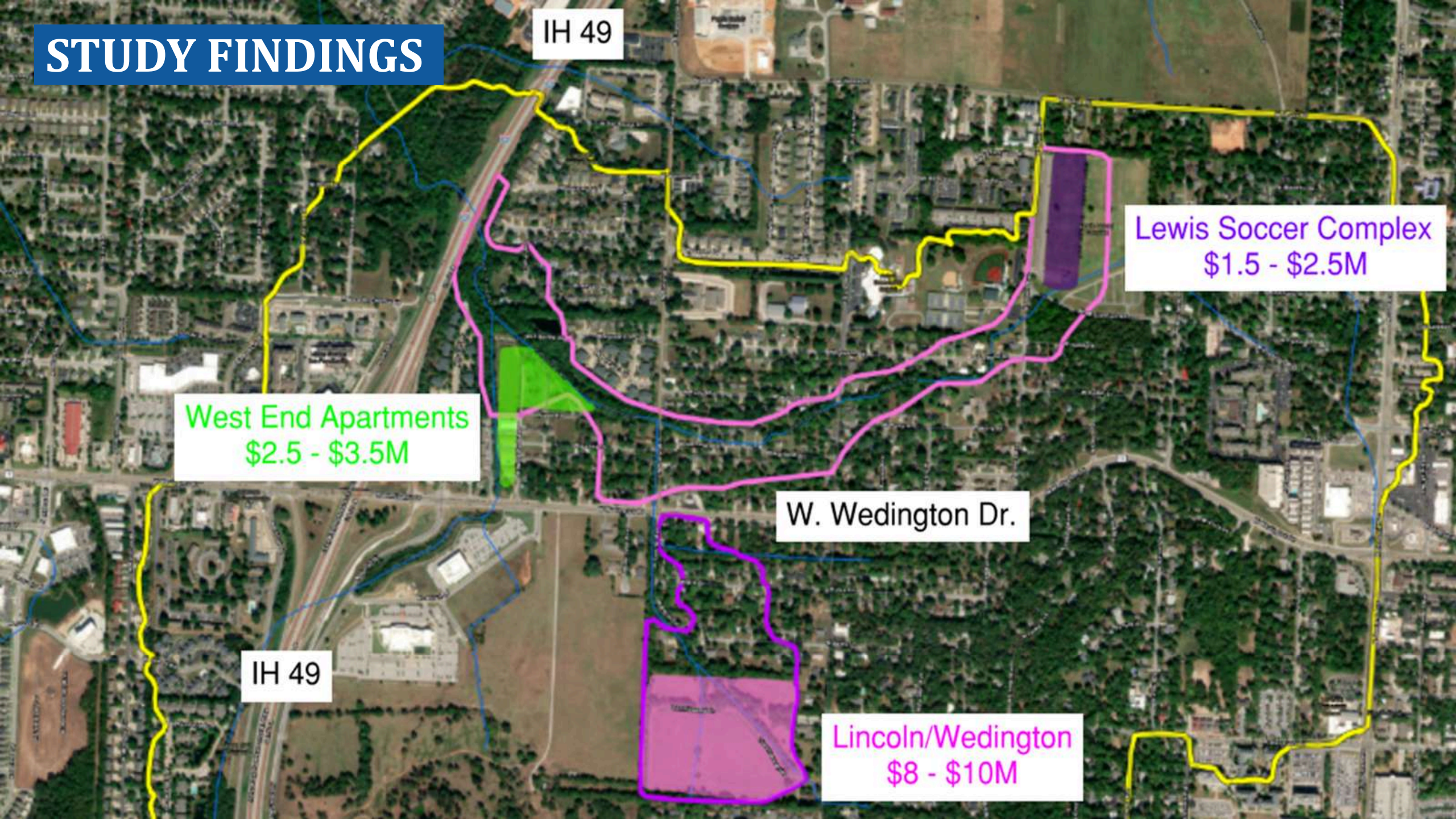


STUDY FINDINGS

- Three potential areas
  - Lewis soccer complex
  - Lincoln/Wedington
  - West End Apartments



STUDY FINDINGS



STUDY FINDINGS

FREESE AND NICHOLS

CITY OF FAYETTEVILLE ARKANSAS

Lewis Pond Benefits

	Current Flood Risk		Post-Project Flood Risk	
Annual Storm Probability	Lots at Risk	Structures at Risk	Lots With Reduced Risk	Structures at Risk
20%	51	2	26	1

STUDY FINDINGS

FREESE AND NICHOLS

CITY OF FAYETTEVILLE ARKANSAS

Lewis Pond Benefits

	Current Flood Risk		Post-Project Flood Risk	
Annual Storm Probability	Lots at Risk	Structures at Risk	Lots With Reduced Risk	Structures at Risk
20%	51	2	26	1
10%	54	2	30	2

STUDY FINDINGS

FREESE AND NICHOLS

CITY OF FAYETTEVILLE ARKANSAS

Lewis Pond Benefits

	Current Flood Risk		Post-Project Flood Risk	
Annual Storm Probability	Lots at Risk	Structures at Risk	Lots With Reduced Risk	Structures at Risk
20%	51	2	26	1
10%	54	2	30	2
4%	61	5	43	3

STUDY FINDINGS

FREESE AND NICHOLS

CITY OF FAYETTEVILLE ARKANSAS

Lewis Pond Benefits

	Current Flood Risk		Post-Project Flood Risk	
Annual Storm Probability	Lots at Risk	Structures at Risk	Lots With Reduced Risk	Structures at Risk
20%	51	2	26	1
10%	54	2	30	2
4%	61	5	43	3
2%	66	10	48	7

STUDY FINDINGS

FREESE AND NICHOLS

CITY OF FAYETTEVILLE ARKANSAS

Lewis Pond Benefits

	Current Flood Risk		Post-Project Flood Risk	
Annual Storm Probability	Lots at Risk	Structures at Risk	Lots With Reduced Risk	Structures at Risk
20%	51	2	26	1
10%	54	2	30	2
4%	61	5	43	3
2%	66	10	48	7
1%	69	15	48	15

STUDY FINDINGS

FREESE AND NICHOLS

CITY OF FAYETTEVILLE ARKANSAS

Lewis Pond Benefits

	Current Flood Risk		Post-Project Flood Risk	
Annual Storm Probability	Lots at Risk	Structures at Risk	Lots With Reduced Risk	Structures at Risk
20%	51	2	26	1
10%	54	2	30	2
4%	61	5	43	3
2%	66	10	48	7
1%	69	15	48	15
0.5%	72	33	54	33

STUDY FINDINGS

- Detention project
  - ✓ FEMA benefit/cost criteria
  - ? Acceptable level of benefit
  - ? City match (25%) realistic considering level of benefit
  - ? Additional benefits:
    - ? Channel improvements
    - ? Road flood mitigation
- Buyout of repetitive loss structures could be best path forward

PROJECT TIMELINE/NEXT STEPS

FREESE AND NICHOLS

CITY OF FAYETTEVILLE ARKANSAS

- Dec ‘23: Decision on Grant Application
- Early Jan ‘24: Communication to community

If moving forward with grant application

- Mid Jan ‘24: Submit grant application**
- Late Summer ‘24: FEMA announces grant selections

If grant approved

- Early ‘25: Funding available
- ‘26/’27: Complete project

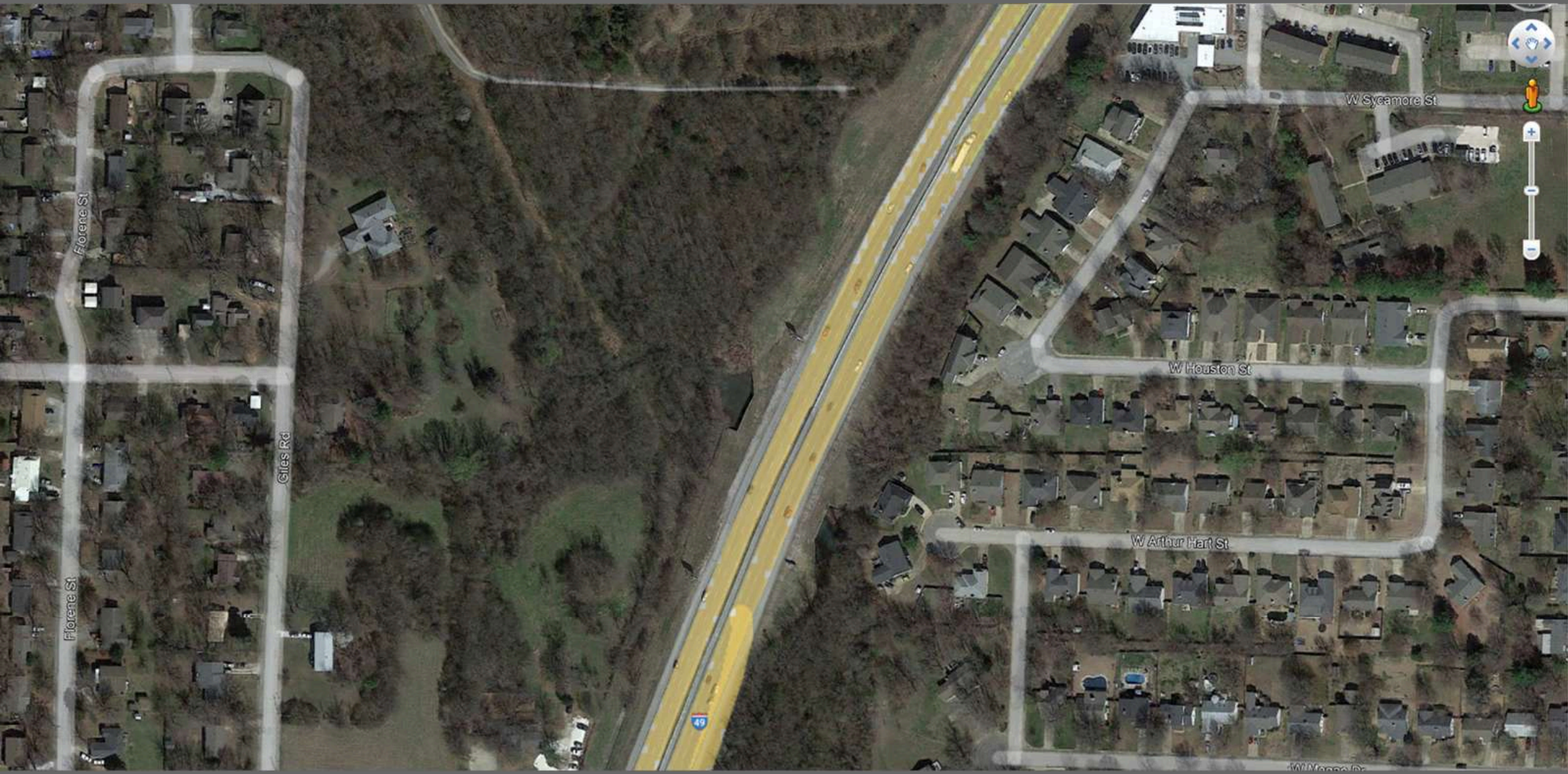
***NOTE: Assumes Washington County Hazard Mitigation Plan is approved*

Q&A

FREESE AND NICHOLS

CITY OF FAYETTEVILLE ARKANSAS

Questions?


W Sycamore St
W Houston St
W Arthur Hart St
Florene St
Florene St
Giles Rd
49