2049 E. Joyce Boulevard, Suite 400
Fayetteville, AR 72703

TEL 479.527.9100
FAX 479.527.9101

www.GarverUSA.com

TECHNICAL MEMORANDUM

Date: 4/13/2018

To: James Clark-Public Works Director

From: Zach Moore, PE and Chris Buntin, PE

RE: Pianalto Drive - Drainage Analysis

Garver performed a hydrologic and hydraulic analysis on Wildcat Creek as it crosses S. Pianalto Road in Tontitown, Arkansas. The analysis was requested as result of recent flooding of a house immediately downstream of the double 6'X4' box culvert crossing of S. Pianalto Road.

Hydrologic Analysis

The watershed was delineated from data obtained from USGS Stream Stats, USGS topographic maps, and recent aerial photography from Washington County, Arkansas. Drainage basin characteristics such as soil types, percentage of drainage area urbanized and impervious, length of longest flow path, and average slopes were determined. The drainage basin at the Pianalto Road culverts was determined to be 1.4 square miles or 877 acres. The delineated area is shown in **Appendix A**. The drainage basin is largely undeveloped.

The multiple regression analysis approach was used to determine the peak flows for each storm event. An applicable regression equation for each storm frequency event was utilized as provided by the USGS published report "Methods for Estimating Annual Exceedance Probability Discharges for Streams in Arkansas, Based on Data Through Water Year 2013". The regression equations provided in this USGS report are based on a minimum of ten years of annual peak discharge records from 2003 to 2013. The peak flows determined with each regression equation are summarized below in **Table 1.**

Table 1 – Summary of Peak Flow Rates (cubic feet per second)

Q (10)	Q (25)	Q (50)	Q (100)	Q (500)
879	1,350	1,760	2,220	3,540

Hydraulic Analysis

A HEC-RAS model of Wildcat Creek was created starting approximately 1,060' upstream of the S. Pianalto Road double 6'X4' box culvert and continuing approximately 1,330' downstream. Attached Exhibit 1 shows the model limits and cross section locations. An existing conditions model was developed utilizing LiDAR contours and previous construction drawings of the box culvert. The existing conditions model shows that the 100 year storm event is approximately 1.83' above the finished floor elevation (FFE) of the house immediately downstream of the Pianalto Road crossing. Based upon discussions with adjacent property owners, the existing hydraulic model is consistent with observed water surface flooding levels. Additional models were developed to examine options to reduce the flooding.

The first option, Option A, examined utilizing the existing culverts and constructing a 12' trapezoidal channel at 1.52% upstream approximately 170' of culverts and widening by approximately 30' the right side of channel downstream of the culverts about 150'. The results of Option A showed a minimal decrease in the upstream water surface elevation (WSE) of 0.08' and 0.44' decrease in the downstream WSE when compared to existing conditions model for the 100 year storm event. For Option A, all storm events above the 10 year storm event have WSE's above house FFE.

The second option, Option B, utilized the same channel grading as Option A but with a proposed additional 6'x4' culvert. The results of Option B showed a 0.24' decrease in the upstream WSE compared to the existing conditions model and no effect on the downstream WSE when compared to Option A for the 100 year storm event. For Option B, all storm events above the 10 year storm event have WSE's above house FFE.

The third option, Option C, utilized the same channel grading as Option A but with two proposed additional 6'x4' culverts. The results of Option C showed a 0.41' decrease in the upstream WSE when compared to the existing conditions model and no effect on the downstream WSE when compared to Option A for the 100 year storm event. For Option C, all storm events above the 10 year storm event have WSE's above house FFE.

The fourth option, Option D, utilized the same channel grading upstream as Option A but with channel widening on both sides of channel for approximately 300' downstream of the existing culverts. The right side of the downstream channel was widened approximately 30' and the left side widened approximately 12'. Option D did not include any additional proposed culverts from the double 6'x4' box culverts. The results of Option D showed a 0.13' decrease in the upstream WSE and 1.34' decrease on the downstream WSE when compared to the existing conditions model for the 100 year storm event. For Option D, only storm events greater than the 50 year event have WSE's above house FFE.

The fifth option, Option E, examined placing a 265' long earthen berm on the east and south side of the property with the house downstream of the culvert crossing. The results showed that this option was not feasible as the water surface was raised several feet upstream and flow velocity increased significantly downstream.

See **Table 2** for comparison of WSE's between options for the 100 year storm event.

Table 2 – Comparison of WSE's for 100 Year Storm Event

Option	Upstream WSE	Downstream WSE	US Difference from Existing Model	DS Difference from Existing Model
Existing	1234.06	1232.83	n/a	n/a
A	1233.98	1232.39	0.08'	0.44'
B	1233.82	1232.39	0.24'	0.44'
C	1233.65	1232.39	0.41'	0.44'
D	1233.93	1231.49	0.13'	1.34'

Note: FFE of the house immediately downstream is estimated to be 1231.00

Analysis of Results

The various options examined indicate that channel grading upstream of the box culverts and/or additional box culverts have minimal effect on the water surface downstream of the box culverts as long as the box culverts are undersized resulting in overtopping of the roadway. Further analysis shows that at least ten 6'x4' box culverts (or the equivalent culvert opening area) would be required to keep the 100 year storm from overtopping the road, eight 6'x4' culverts to accommodate the 50 year storm, and seven 6'x4' box culverts to accommodate the 25 year storm. Installing this many culverts with the necessary associated channel widening to accommodate the culverts becomes unfeasible from a cost and practical perspective.

It should also be noted that an analysis was performed without the 6'x4' culverts to simulate conditions prior to their installation (essentially having S. Pianalto Road function as a low water crossing only). The analysis showed that the installation of the culverts did not have any negative effects to the flooding of the downstream property. Specifically, the house would flood if the road and culvert did not exist.

As shown in Option D, the most significant decrease in the downstream water surface elevation occurs when the downstream channel is widened. Option D widened the channel as much as the adjacent residential structures would reasonably allow and for a length of the channel that would not require a Corps of Engineer's Individual 404 permit. However, Option D would result in thousands of cubic yards of channel excavation, several trees being removed, and the reduction of useable yard space for both properties downstream on the north and south sides of the creek.

In conclusion, Options A through D would all improve by varying extents the flooding at the downstream house. However, there is not an inexpensive option that eliminates flooding for the downstream house due to the house's proximity to the channel and the volume of water in the channel during significant rain events. The most cost effective way to eliminate the house (adjacent to and downstream of Pianalto Road) flooding is to either demolish the house or raise the house above the floodplain elevation. In addition, new developments should continue to be required to implement stormwater detention, insuring the development does not worsen existing flooding.