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Johnson Creek, DeSoto County, MS: FluvialGeomorph Level I Channel Stability Assessment & Reconnaissance Report

Appendix C. Memphis Metropolitan Stormwater – North DeSoto Count Feasibility Study

Christopher P. Haring and David S. Biedenharn

March 2021

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Christopher P. Haring and David S. Biedenharn

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Final report

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Abstract

DeSoto County in north-central Mississippi requested a study initiative to assess Flood Risk Management and Ecosystem Restoration Alternatives for a series of watersheds including Johnson Creek. The USACE-Memphis District is the lead for the study and requested CHL's assistance in developing a rapid geomorphic assessment approach to develop a reconnaissance level of details. With severely limited funding and time constraints, CHL used a newly developed rapid watershed assessment toolkit-FluvialGeomorph, to assess Johnson Creek and other watersheds. The analysis uses existing off-the-shelf LiDAR, channel surveys and any other detailed information to provide a basis for restoration and stabilization alternatives. FG is being used in multiple District's as a tool to provide a rapid assessment approach for limited funding and time constrained studies. The results of the analysis are contained in this document.

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Preface

This study was conducted for the Memphis District General Investigation Feasibility Study-Memphis Metropolitan Stormwater-DeSoto County, Mississippi. The Project Lead for coordination with CHL was Andrea Carpenter Crowther.

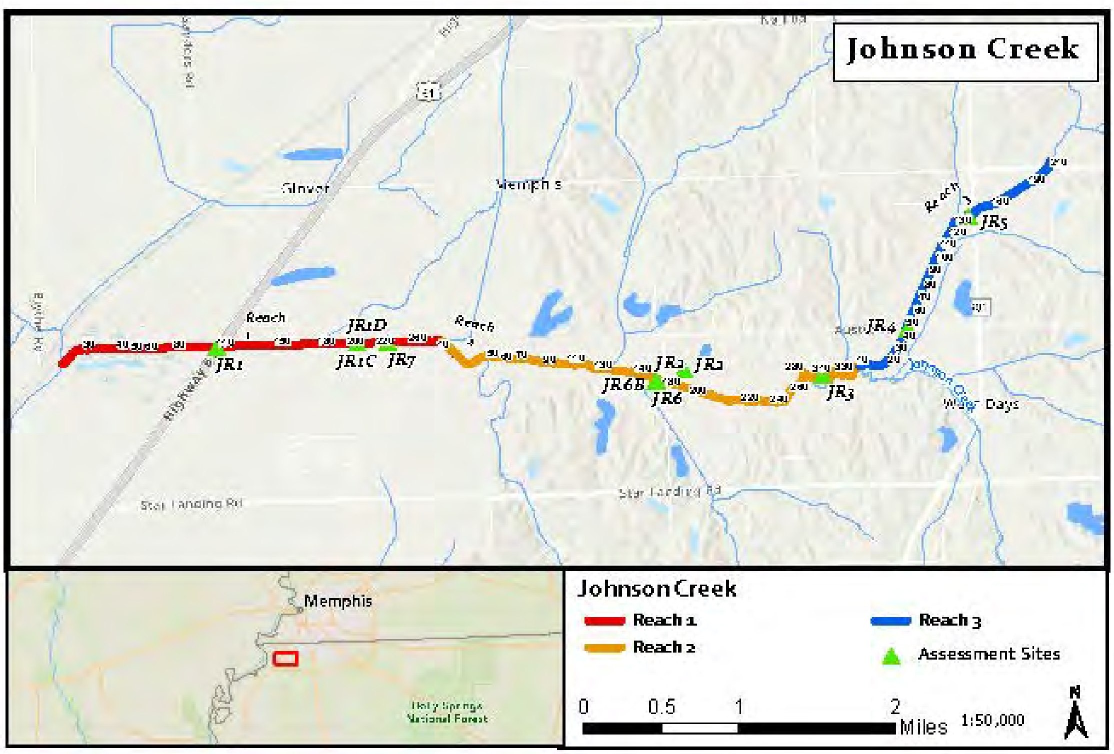
The work was performed by the River and Estuarine Branch of the Flood and Storm Protection Division, U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory (ERDC-CHL). At the time of publication, David P. May was Chief; Cary Talbot was Chief; and Julie Rosati was the Technical Director for Flood and Storm Technical Programs. The Acting Deputy Director of ERDC-CHL was Keith Flowers, and the Director was Ty Wamsley.

The Commander of ERDC was COL Teresa A. Schlosser, and the Director was Dr. David W. Pittman.

1 Introduction

The following is an abbreviated FluvialGeomorph (FG) Level I-Channel Stability Assessment for Johnson Creek. The FG analysis is based on LiDAR data for Johnson Creek in Desoto County, MS that was downloaded from the USGS National Map, and limited field site visits completed on November 4, 2020. The FG study reaches are defined in Figure 1. The best available LiDAR for the area was Mississippi Delta Yazoo Phase 1 data flown between February 19, 2009 and August 2, 2020. The data was collected at 1-meter pulse spacing. The vertical accuracy is 15 cm RMSE or better. The coordinate system is State Plane 1983in NAD 83.

Figure 1. Johnson Creek Watershed, De Soto County, MS FG Reaches illustrating cross-section locations and biological sampling sites (JR).



1.1 Background

Johnson Creek is a small approximately 35 square mile watershed that is mostly rural with some urbanization in the upper watershed areas. The creek is locating in western De Soto County, north central Mississippi, immediately south of the Memphis, TN (Figure 1). The watershed is largely agricultural and has been extensively channelized with only minor meandering patterns reforming in the middle-forested reaches. Channelization has led to channel degradation is the primary cause of channel instability within the watershed. As illustrated in Figure 1, Reach 1, 2 and 3 have relatively straight channel alignments that were likely straightened for drainage and agricultural production.

To identify potential locations of Johnson Creek channel instability, LiDAR water surface profiles and cross-sections were analyzed. The existing LiDAR (2009-2010) can be used to identify locations of channel slope change-identifying potential nick points or existing grade control structures. There were minor grade control structures (GCS) identified from the LiDAR or during the site visit. Typically, the primary channel stability points are either bridge locations or road culverts. Austin Road bridge (Figure 2) with minor riprap and State Route 301 culvert (Figure 3) illustrate some bed control points within the watershed that were identified. The bridge and culvert(s) have helped stabilize the channel in some locations but there are not many other locations where they are present in the watershed.

Figure 2. Johnson Creek at Austin Road Bridge showing minimal riprap protection under the bridge.

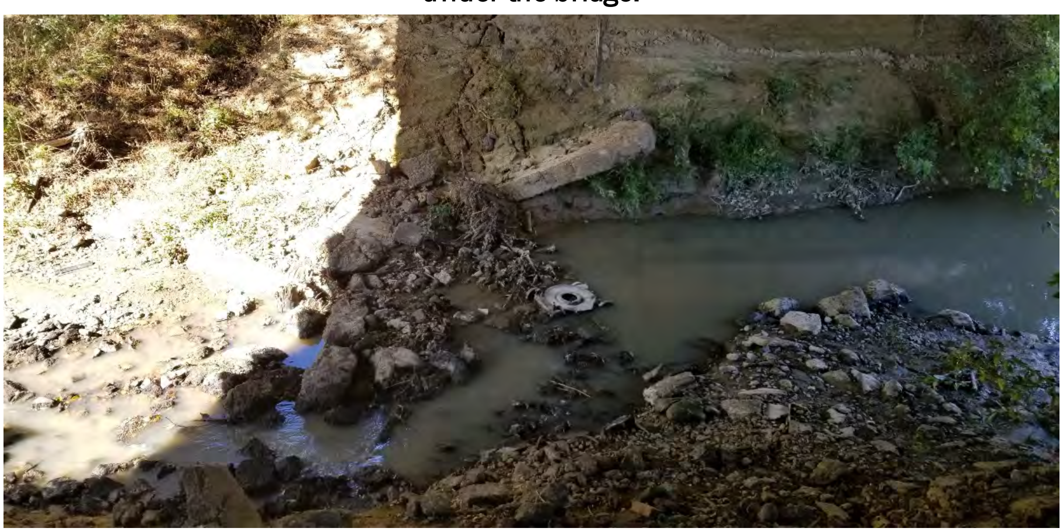
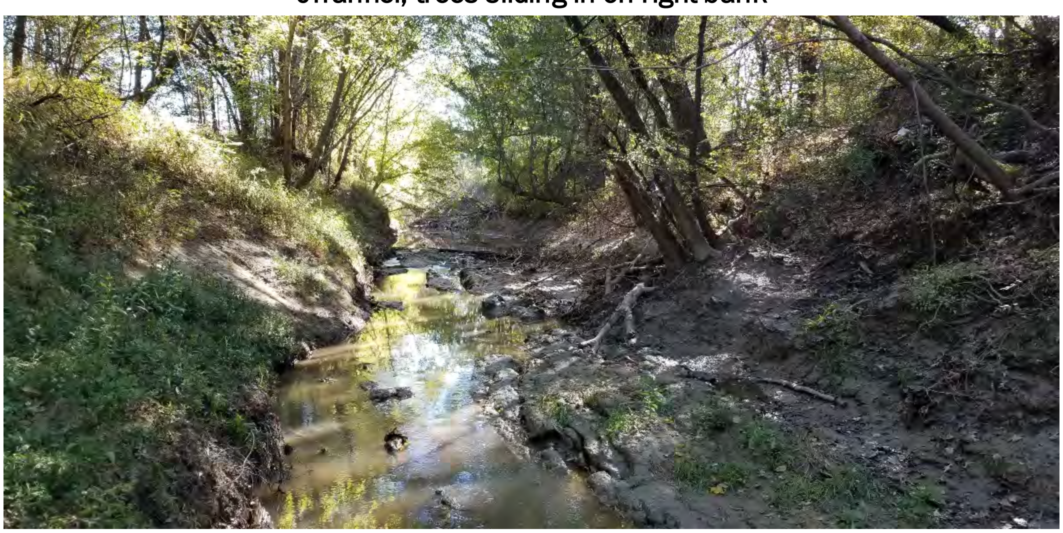


Figure 3. Johnson Creek at State Route 301 Culvert providing grade control.

During the site visit on November 4, 2020, the channel sections in proximity to the Baldwin Road Bridge were investigated (Figures 4 and 5). Downstream of the bridge is where the channel slope changes from the low channel slope Mississippi River floodplain materials (Reach 1) to clay, silts and higher channel slope gravel deposits in the upland steeper sloped watershed areas (Reach 2 and 3). Figure 4 illustrates channel degradation that has eroded through some of the less erosion resistant clay bed.

Figure 4. Johnson Creek-Baldwin Road Bridge-looking upstream at degrading channel, trees sliding in on right bank



Vegetation is also sloughing in from the channel margins as the channel continues to degrade lowering the base level of the channel. Also illustrated (Figure 5) is the tributary channel that enters Johnson Creek on the left bank upstream of the bridge. The top of the degradation can be viewed approximately 100 feet upstream of the confluence with Johnson Creek (Figure 6). If the degradation continues upstream the base level continues to lower and the channel widens. Upstream of this location the tributary is no longer degrading and is relatively stable.

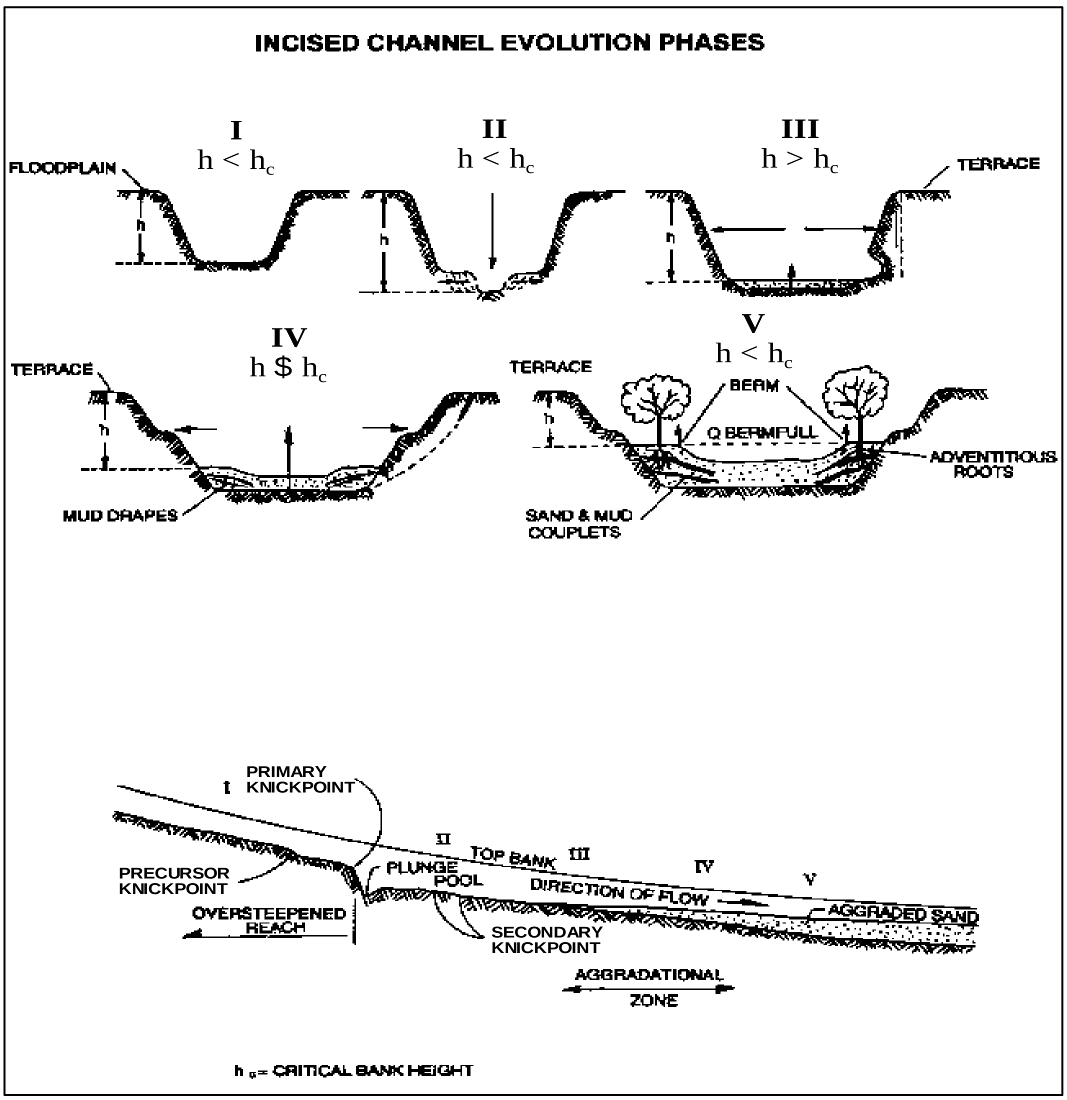
Figure 5. Johnson Creek-Baldwin Road Bridge-looking upstream at channel degradation in a tributary immediately upstream of bridge

Figure 6. Johnson Creek-Baldwin Road Bridge-looking upstream at channel degradation in a tributary immediately upstream of bridge

1.1.1 Channel Evolution Model:

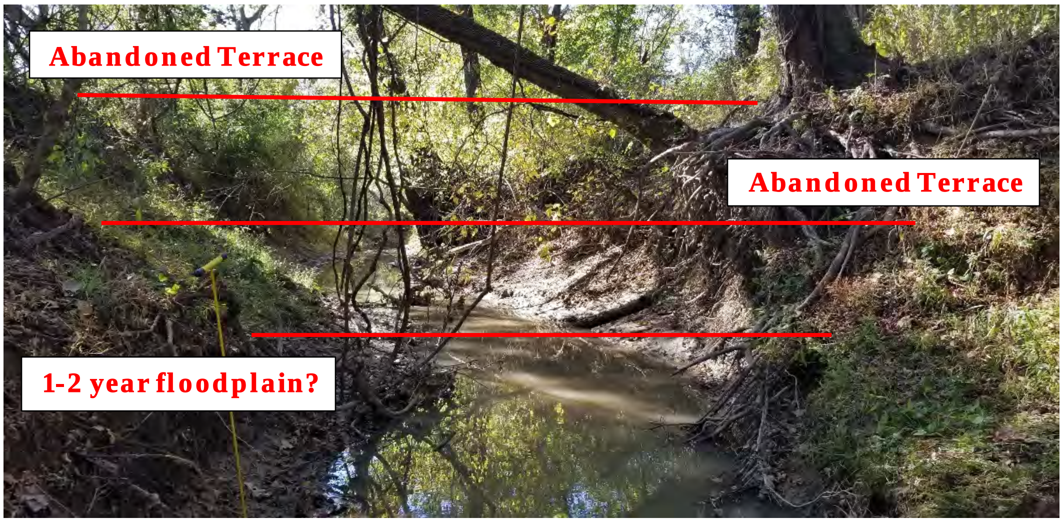
The five-stage Channel Evolution Model (CEM) developed by Schumm et al., (1984) was used to provide qualitative discussion on the condition of the channel reaches (Figure 7). There are not widespread watershed development changes occurring as is the situation with the Johnson Creek watershed. Stability issues within Johnson Creek center around past channelization and how the stream channels continue to adjust. Channelization paired with public infrastructure encroachments in the form of bridges, roadways and utilities all affect the channel development and stability. The process of channelization has decreased channel length with the same elevation difference prior to the changes. This process severely increases channel slope thereby promoting channel degradation caused from steeper slopes and greater channel velocities.

Figure 7. The 5-stage Channel Evolution Model (Schumm et al., 1984)



As channel degradation continues, Johnson Creek stream channels continue to adjust width and depth and characteristic delivery of sediment and hydrologic discharge regimes throughout the watershed. If not mitigated with some type of channel bed-grade control, continued degradation leads to a process of channel bed incision followed by widening and floodplain re-development. The process is outlined in the CEM diagram in Figure 7 and the multiple floodplain terraces defined in Figure 8 provide evidence for the process.

Figure 8. Johnson Creek Cross-section illustrating abandoned terraces and possible 1-2year floodplain berm development.



1.1.2 Local Geology.

The local surficial geology of the study area is mapped as Eocene age deposits from the Claiborne Group and Kosciusko formation. Reach 1 has developed through an old Mississippi River meander scar that consists of Collins Silty Clay Loam floodplain deposits (USDSW, 1994). The Kosciusko formation is classified as irregularly bedded sand, clay, and some quartzite deposits (Bicker, 1969). Field observations of the surficial geologic materials are presented in Figures 7 through 10.

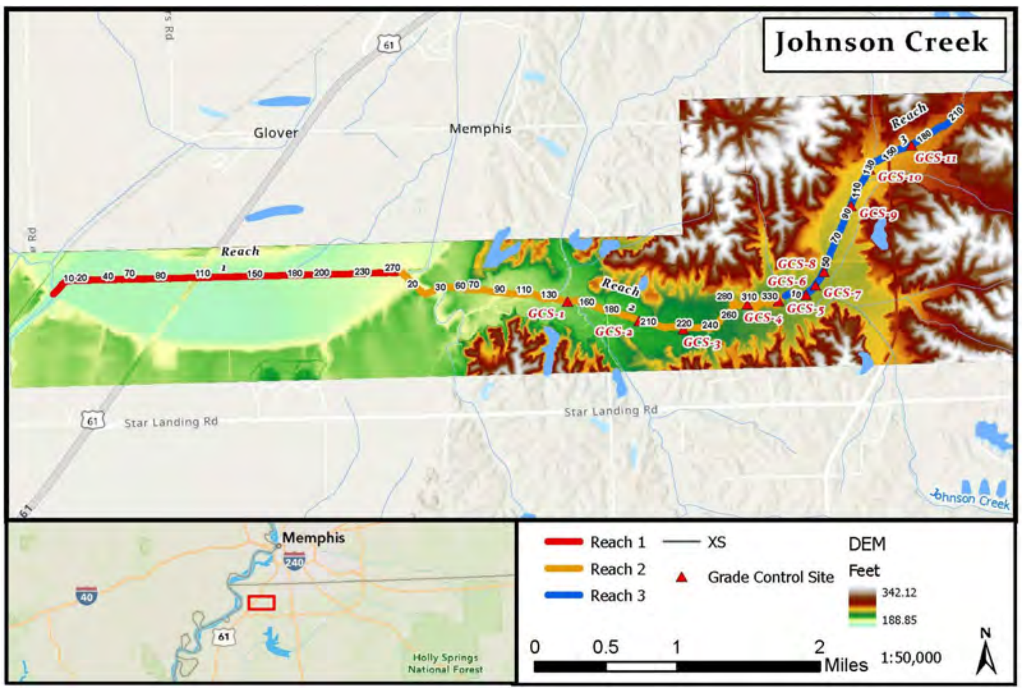
Figure 9. Johnson Creek upstream of Austin Road (Reach 2) showing clay bed with silty and clay loam banks.

Figure 10. Johnson Creek upstream of State Route 301 culver with point bar material-small gravel to sand in Reach 3

1.2 Objective(s)

Johnson Creek (Figure 11) as well as other watersheds within the greater DeSoto County area have problems with channel erosion that threaten private and public properties. The objective of this study is to use the FG geomorphic watershed assessment approach to assess and identify locations that are susceptible to further channel erosion and determine what areas would benefit greatest from restoration and stabilization measures. Once the areas are identified and mapped then further field validation will occur to define the stabilization and restoration needs within the watershed. This allows for limited funding resources to be targeted to treat the most severe prioritized areas.

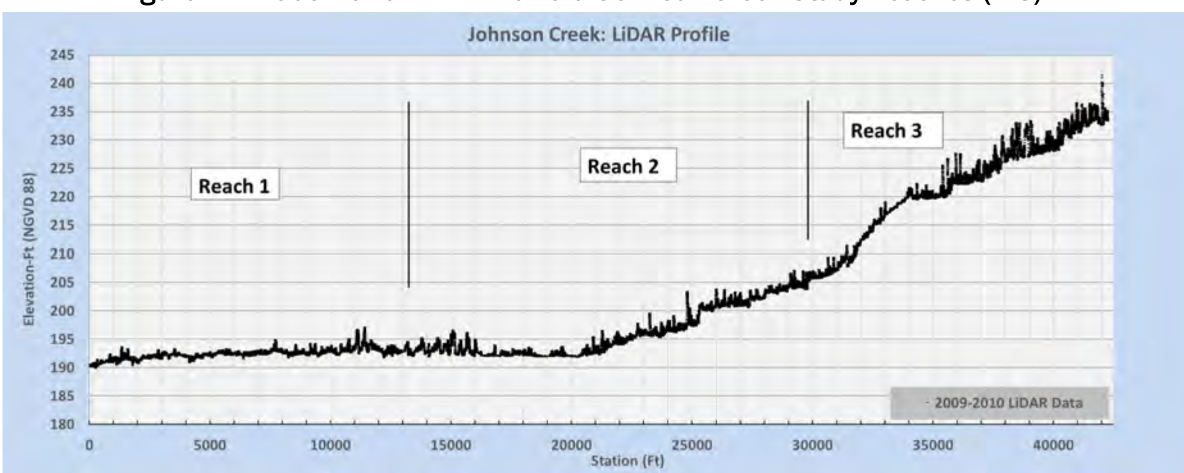
Figure 11. Johnson Creek Study Reaches (1-3)



This report provides a preliminary assessment for Johnson Creek based on limited field investigations and FG analysis of the 2009-2010 Lidar. Figure 12 shows the LiDAR profile for Johnson Creek. One of the primary goals of this project is to minimize channel degradation, channel erosion, and sedimentation to support aquatic ecosystem form and function. This report is a preliminary assessment for identifying areas in need of channel stabilization, erosion control and possibly identify sedimentation issues within the watershed. Two equilibrium slope curves were available to assess the vertical stability of the channel. The first was developed early in the DHP program in the late 1980s for watersheds that were mostly south of Johnson Creek. There was also an equilibrium slope curve that had been developed specifically for the Coldwater streams in the mid-1990s. Comparing these two curves against streams in this area suggested that the Coldwater curve might be overly steep while the older DHP curve was viewed as being more conservative.

For the FG assessment, Johnson Creek was divided into three reaches: Reach 1 is from Route 61 (~5500 ft downstream) to right bank Canal Creek (~500 ft upstream); Reach 2 extends from the Right bank Canal Creek (~500 ft upstream) to confluence of Johnson and Tributary; and Reach 3 starts confluence with Johnson Creek tributary and terminates 500 ft upstream of Church Road (Figures 11 & 12).

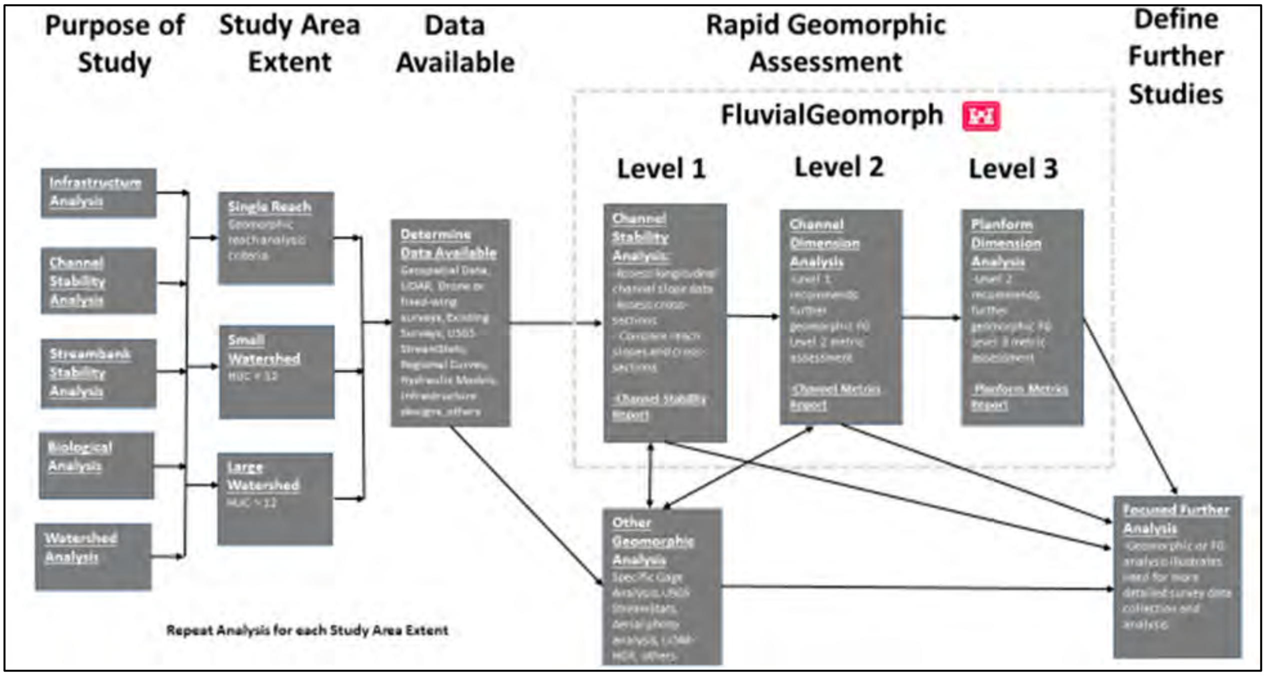
Figure 12. 2009-2010 LiDAR Profile of Johnson Creek Study Reaches (1-3)



1.3 Approach to Watershed Assessments using FluvialGeomorph (FG)

The FG watershed assessment approach was developed to provide a relatively rapid method for evaluating stream channel stability based on existing LiDAR-high resolution terrain data. There are five categories identified in completing typical geomorphic studies outlined for the FG toolkit analysis and they are illustrated in Figure 13. FG-Level 1 defines the Channel Stability Analysis (CSA) for stream channel reaches or watersheds. The rapid assessment analyzes the longitudinal water surface slope profiles and cross-sectional analysis. This provides a reconnaissance level of detail to identify potential areas of concern based on simple slope and cross-sectional area comparative analysis. The CSA provides a basis for identifying potential areas of interest where channel degradation, aggradation, or widespread channel changes are observed. The first FG workflow is described in more detail in Haring et al. (in-draft 2020).

Figure 13. FluvialGeomorph Watershed Assessment Workflow



1.3.1 LiDAR Data and Resolution:

LiDAR data for Johnson Creek in Desoto County, MS was downloaded from the NOAA Data Access Viewer, https://coast.noaa.gov/dataviewer/#/lidar/search/where:projectid=25.

The data set was extracted from a larger classified data set and only includes points classified as Ground within the requested geographic bounds. The best available LiDAR for the area was Mississippi Delta Yazoo Phase 1 data flown between February 19, 2009 and August 2, 2010. The data was collected at 1-meter pulse spacing. The vertical accuracy is 15 cm RMSE or better. The coordinate system is State Plane Mississippi West 1983 in NAVD 88.

The ground classified points were combined into a LAS dataset and then transformed into a DEM. The DEM was hydro-modified to allow flow through areas where bridges crossed the creek.

1.3.2 Analysis Assumptions and Limitations:

FG is not a model, so stating and understanding the limitations of this and other geomorphic and hydraulic data is of utmost importance. Assumptions include:

- The LiDAR data used in the analysis does not penetrate the water surface so true channel depth is not directly measurable. However, if LiDAR is collected during low-water conditions then the least amount of water depth is lost. Riffle cross-over locations in smaller stream systems provide the least amount of depth loss as the water surface to the bottom of the channel can be minimal (Haring et al., 2019).

- Any identified geomorphic metrics for FG Level II analysis are based on the depth captured between the water surface and the bankfull indicators.

- Based on assessing the LiDAR water surface profile, it also appears that LiDAR was collected during low water conditions. Comparison of the 2010 LiDAR profile with the 2011 surveyed thalweg from the Vicksburg District showed that the two surveys matched closely.

- The interpretation of the LiDAR data needs to be completed in an objective consistent manner. Depending on the year of collection there are differing levels of accuracy that can be expected and should be considered when assessing and making recommendations from interpreting the data.

- The LiDAR water surface slope trends are only representing the range of points that the LiDAR collected. Vegetation can affect LiDAR coverage and can have major impacts on the assessment abilities using LiDAR. When assessing the slope trends or cross-sections, aerial photos should be reviewed to determine level of potential vegetation interference.

- The FG program is meant to be used to assess stream channel conditions and provide an assessment of where system instability exists. Field site visits are recommended to validate the information.

2 Interpretation of Geomorphic Data-Level I FG Analysis

The cross-sections for all the reaches were spaced at 50 feet apart. The individual lateral cross-section stationing across the channel cross-sections were spaced at 1-foot increments. The longitudinal water surface profiles were plotted using approximately 3 foot spacing. The Level 1-CSA uses a combination of cross-sections and the longitudinal profile to assess channel stability reach trends.

2.1 Reach 1: Route 61 (~5500 ft downstream) to right bank Canal Creek (~500 ft upstream)

The Reach 1 site map is illustrated in Figure 14 and the water surface profile from 2009 is plotted in Figure 15. Reach 1 ends at the edge of a previous Mississippi River meander and the bank heights increase immediately upstream. The LiDAR water surface slope in this reach is 0.0002 ft/ft. Based on the LiDAR cut cross-sections, channel bank

Figure 14. Johnson Creek Reach 1: Cross-section Location Map

heights vary throughout from 12 to 18 feet in lower reach and 8-12 feet in the upper reach. The bank heights are based above the existing water surface and majority of the reach has deep water with little or no riffle cross-over locations so there is more bank height lost below the water surface in the LiDAR cut cross-sections. The lower and middle sections of the reach have relatively vertical banks with little or no sediment deposits visible along the channel margins or as bars in the center of the channel (Figures 16-18). Toward the upper end of the reach, the channel has locations that are actively building floodplain berms within the channel margins (Figures 19 and 20). Sinuosity within the reach ranges from 1 to 1.15 so the reach has no discernable meandering pattern. With the flat slope and likely floodplain connections the channel is a CEM type IV-V. This channel reach appears to be relatively stable based on the slope and cross-sectional analysis. However, there are pockets of local erosion as noted during the field reconnaissance.

Figure 15. FG level 1-Johnson Creek Reach 1: LiDAR water-surface profile with cross-section locations

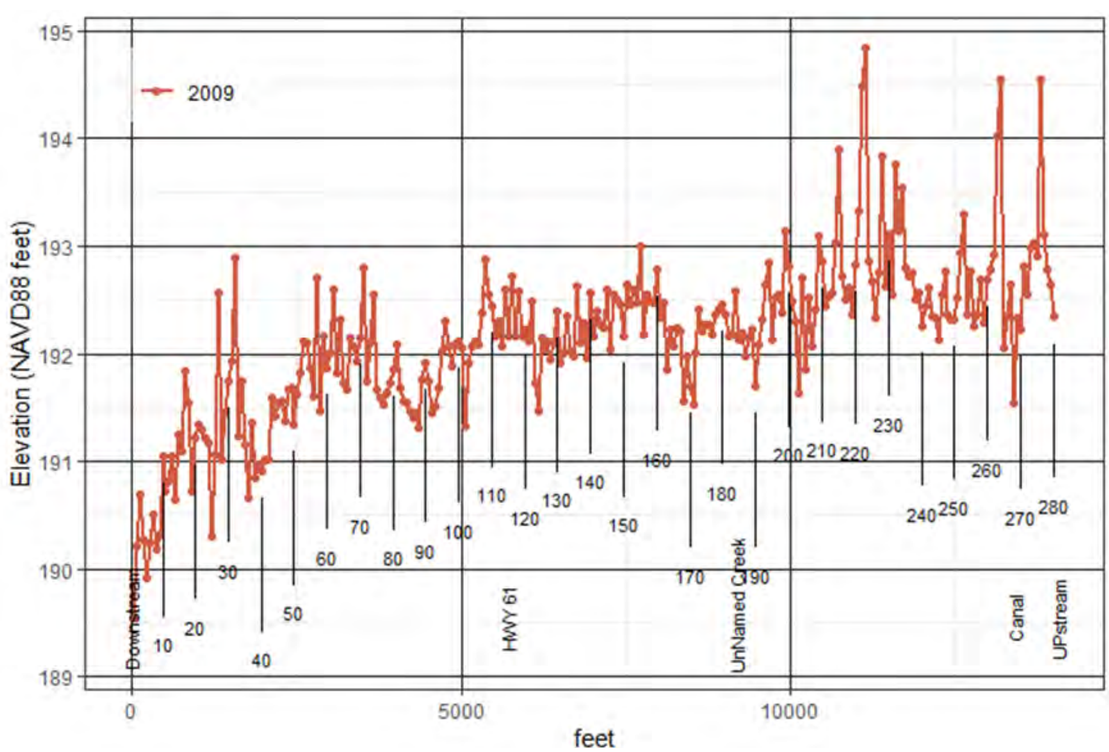


Figure 16. Cross-section 22, illustrating high banks in Lower Reach 1.

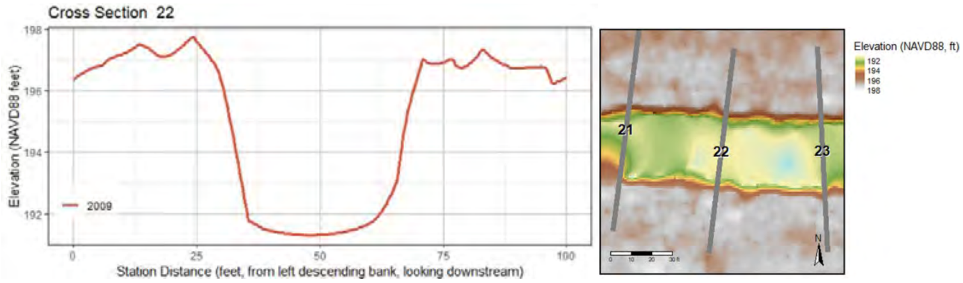


Figure 17. Cross-section 96, illustrating high banks in Lower Reach 1.

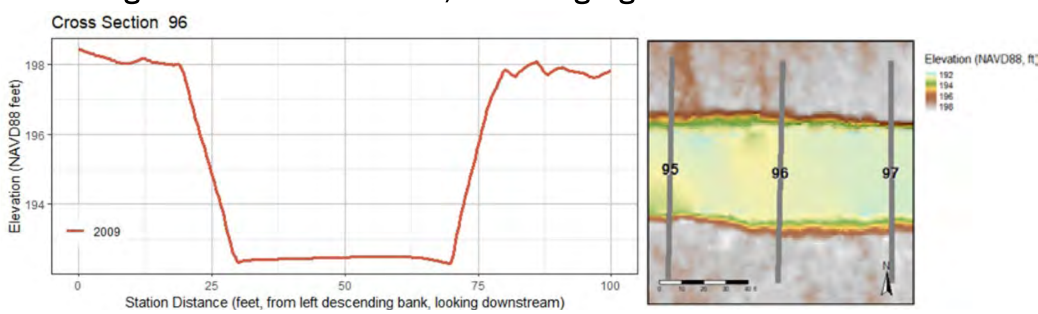


Figure 18. Cross-section 167, illustrating high banks in Middle Reach 1.

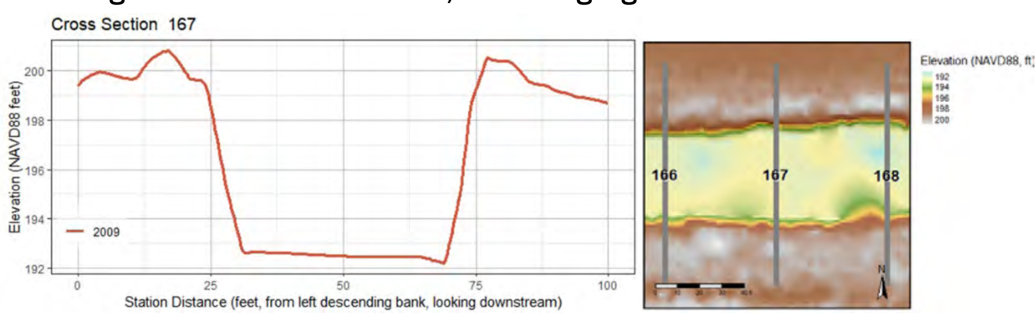
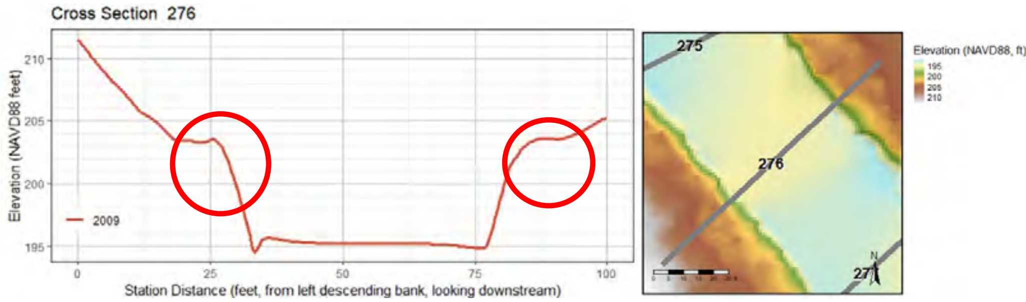


Figure 19. Cross-section 186, illustrating right floodplain berm development.

Figure 20. Cross-section 276, illustrating right & left bank floodplain berms



2.2 Reach 2 – Right bank Canal Creek (~500 ft upstream) to confluence of Johnson and Tributary

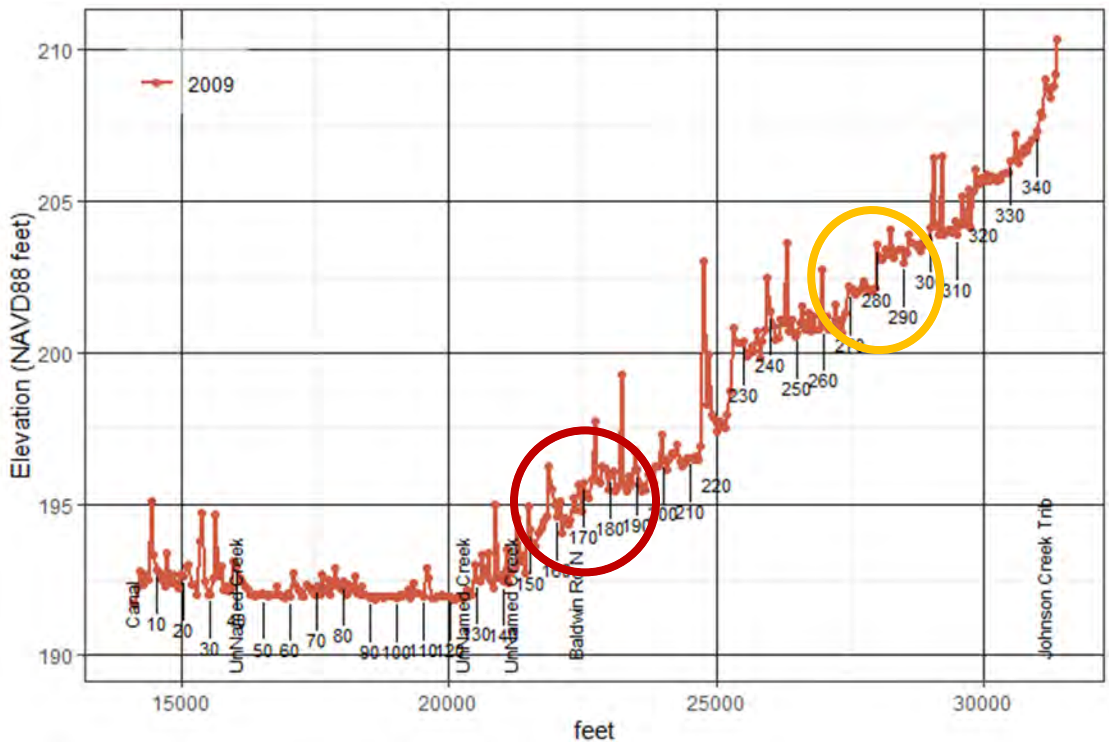
This reach is a transitional zone where Johnson Creek is in old Mississippi River alluvial deposits at the downstream beginning of this reach and transitions into silt and clay materials overlain with loess deposits.

Figure 21. Johnson Creek Reach 2: Cross-section Location Map

The Reach 2 site map is illustrated in Figure 21 and the water surface profile from 2009 plotted in Figure 22. There is one main road crossing within this reach at the Baldwin Road Bridge (Red Circle in Figures 21 and

22). There is also a new subdivision that installed revetment materials at another location upstream just south of Odums Crossings Road (Orange Circle in Figures 21 and 22). Johnson Creek at the Odums Crossing subdivision has an extensive amount of concrete and other rubble that has been added to protect right bank erosion (Figure 23). There are also active nick points partially buried by concrete and a visible nick zone downstream of the concrete revetment (Figure 24).

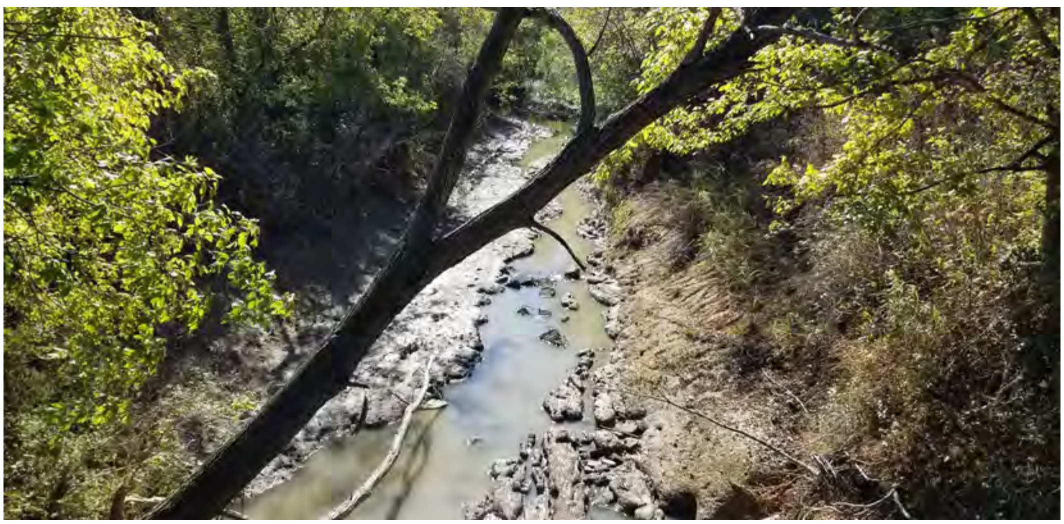
Figure 22. FG level 1-Johnson Creek Reach 2: LiDAR water-surface profile with cross-section locations



The same LiDAR surface slope (0.0002 ft/ft) was collected from the start of the downstream end of the reach to approximate station 20,500 (ft.) identified as lower Reach 2. The slope then increases significantly with a steep transition at station 25000 (ft.) and then again at approximate station 31,000 (ft.), identified as upper Reach 2. The slope of the upper Reach 2 is 0.0016 ft/ft. The high potential for nick points and zones were discovered during FG LiDAR analysis and verified during the site visits to the Baldwin Road Bridge and Odums Crossing subdivision (Figures 4-6). Sinuosity within the lower Reach 2 is relatively straight with a value of 1. Sinuosity ranges 1.1 to 2.1 so there is some meandering occurring within the incised channel.

Figure 23. Johnson Creek Reach 2: Concrete bank revetment at Odums Crossings Subdivision

Figure 24. Johnson Creek Reach 2 nick zone located at Odums Crossings Subdivision



Based on cross-section analysis, as expected a similar range of average channel bank heights were found in downstream Reach 2 as in upper Reach 1. The lower Johnson Creek is actively building floodplain berms that are about 5-8 ft. with bank heights ranging from 8 to 12 ft. Lower Reach 2 has experienced channel degradation and is progressing through a recovery phase with the flat channel slopes and relative access to floodplain berms. The lower Reach 2 channel is a CEM type IV-V.

Figure 25. Cross-section 8, illustrating floodplain berm building in lower Reach 2.

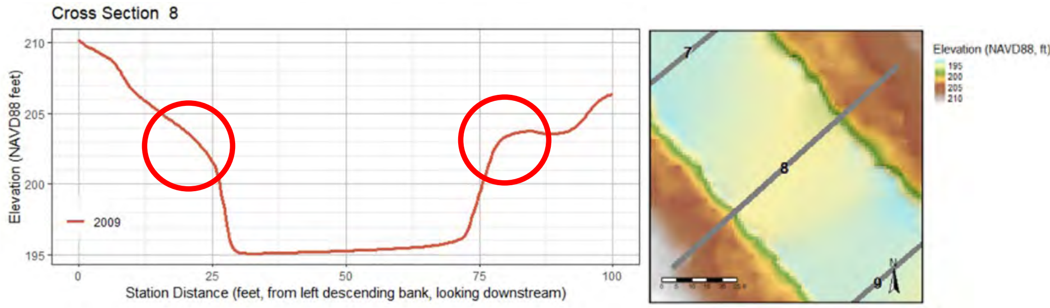
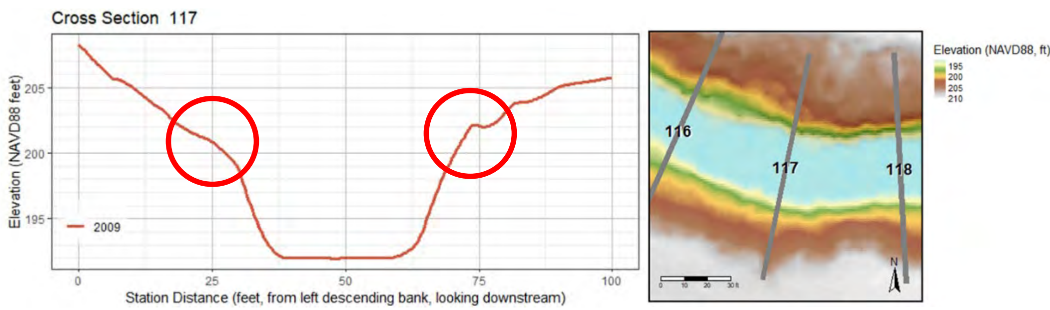


Figure 26. Cross-section 117, illustrating floodplain berm building in lower Reach 2.



The upper Reach 2 has a significantly steeper slope and the main channel trends are not actively building floodplain berms but are progressing through a series of channel degradation areas. Nick points and zones are developed on areas where erosion resistant materials (Figure 24). There is a noticeable change in bank heights (channel type) from downstream Reach 1 and lower Reach 2 with bank heights at 15 to 20 ft. (Figures 25-27). The steeper slope paired with incised channel form and steep side-banks with little or no floodplain berms or access to an active floodplain represents typical degrading channel locations. With the steep slope and lack of active floodplain connections the upper Reach 2 channel is a CEM type III.

Figure 27. Cross-section 192, illustrating lack of floodplain berm building with abandoned floodplain terraces in upper Reach 2 (see Figure 8).

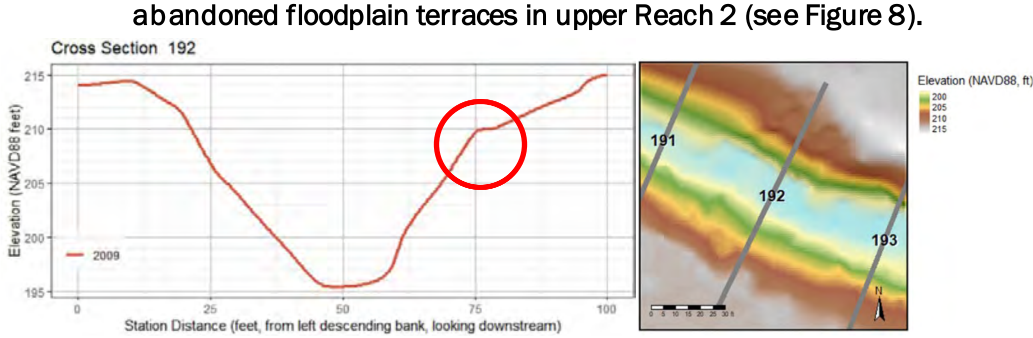


Figure 28. Cross-section 242, illustrating lack of floodplain berm development in upper Reach 2

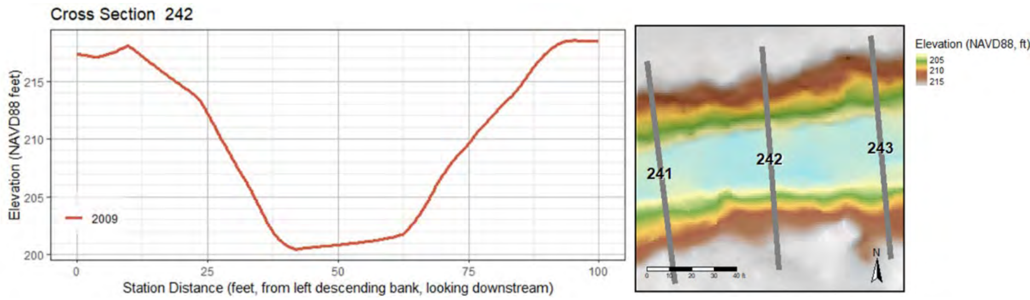
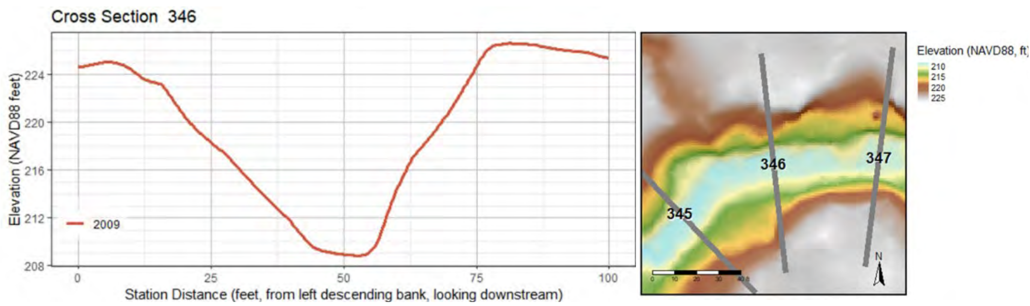


Figure 29. Cross-section 346, illustrating no active floodplain berm building in upper Reach 2

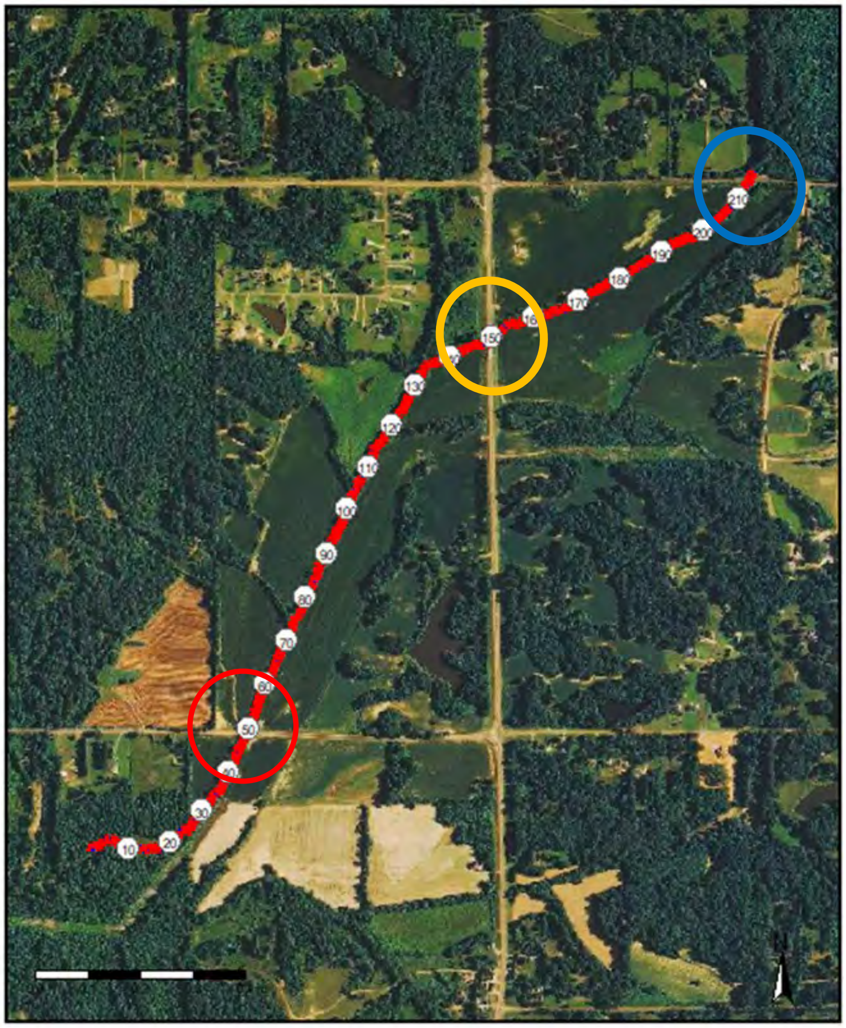


The character of this reach changes dramatically from Reach 1 at approximate station 21500 (ft). Upstream of station 21500 (ft), the channel bed is comprised of a somewhat resistant clay that limits the rate of channel degradation. However, the clay has not stopped active channel degradation from continuing to work upstream. This reach does have a well-established woody riparian vegetation. Comparison of the DHP equilibrium slope curve suggest that the upper Reach 2 is degradational. The limited field investigations indicated that the channel bed was comprised predominantly of a semi-resistant clay material, with little to no sediment accumulation in the bed.

2.3 Reach 3 – Confluence with Johnson Creek tributary and terminates 500 ft upstream of Church Road

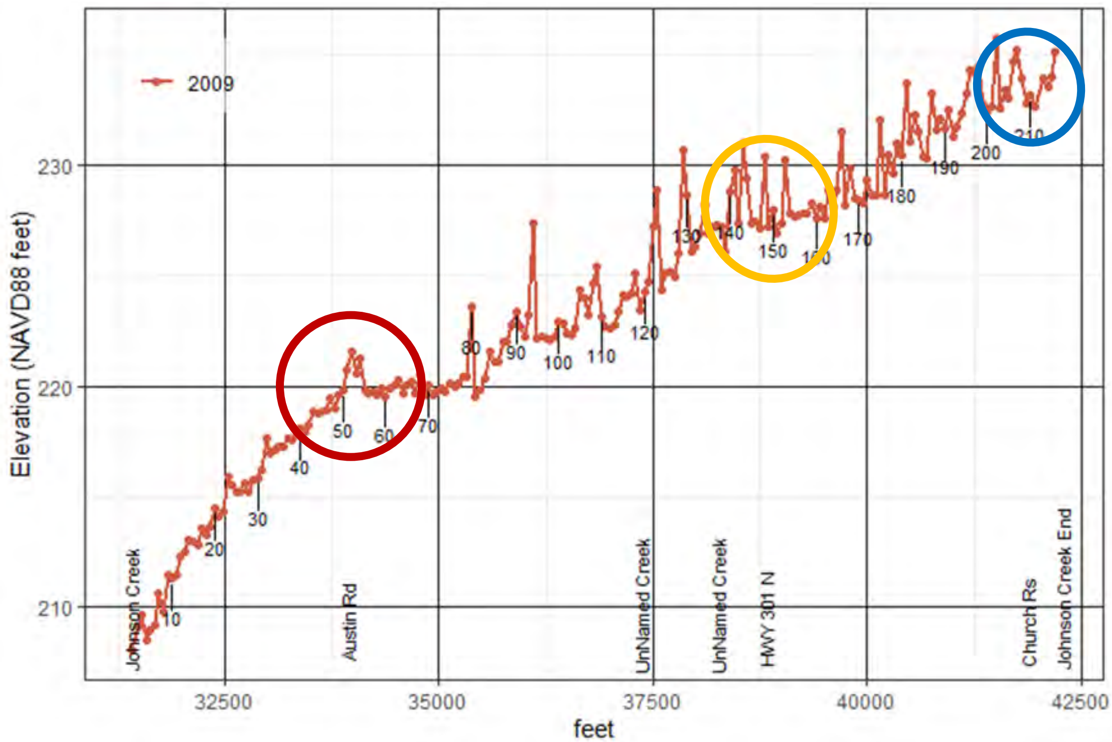
This reach is a strictly upland reach where Johnson Creek channel is entrenched into clay bed materials overlain with loess deposits. The Reach 3 site map is illustrated in Figure 30 and the water surface profile from 2009 is plotted in Figure 31. There are three main road crossings within this reach at the Austin Road Bridge, State Route 301 Road Bridge and Church Road Culverts (Red, Yellow, Blue circles respectively in Figures 30 and 31).

Figure 30. Johnson Creek Reach 3: Cross-section Location Map



There is also a new subdivision that installed revetment materials at another location upstream just south of Odums Crossings Road (Orange Circle in Figures 21 and 22). Johnson Creek at the Odums Crossing subdivision has an extensive amount of concrete and other rubble that has been added to protect right bank erosion (Figure 23). There are also active nick points partially buried by concrete and a visible nick zone downstream of the concrete revetment (Figure 24).

Figure 31. FG level 1-Johnson Creek Reach 3: LiDAR water-surface profile with cross-section locations



The LiDAR water surface slope of 0.0024 (ft/ft) is significantly steeper than Reach 2. The downstream 2000 ft of Reach 3 is the steepest at 0.007 (ft/ft). The slope then decreases significantly upstream of the Austin Road Bridge which appears to be providing some form of limited grade control (Figure 31). The old bridge piles, riprap and concrete are providing limited bed protection (Figure 32). Field verification of the FG data found nick zones upstream (Figure 33). Sinuosity within lower Reach 3 had the highest values from 1 to 1.25. The rest of the reach had values less than 1.15 and most were around 1.

Figure 32. Johnson Creek Reach 3: Limited riprap and concrete bank revetment at the Austin Road Bridge.

Figure 33. Johnson Creek Reach 3 nick zone located upstream of Austin Road Bridge

The lower Johnson Creek Reach 3 has bank heights ranging from 10-12 ft. and variable channel widths depending on where nick points or nick zones are located. Qualitatively, visually comparing the cross-sections (Figures 34 and 35) illustrates the variability in cross-sectional area and bed levels. There is approximately 1550 ft. between cross-sections 30 and 61 but there is a larger cross-sectional area in the downstream cross-section and is also 4 ft lower in bed elevation. This information coupled with the field identification of nick points likely shows a degraded downstream cross-section with continued degradation occurring up to the upstream cross-section. Paired with oversteepened channel slopes and relatively straight sinuosity, channel incision will continue to lower the bed elevation as it works upstream and widens and increases cross-sectional area. There are relatively no floodplain berms being formed in any of Reach 3, this also being an indicator of channel degradation and an entrenched channel. The lower Reach 3 channel is a CEM type III.

Figure 34. Cross-section 30, illustrating entrenched channel with no access to active floodplain-lower Reach 3.

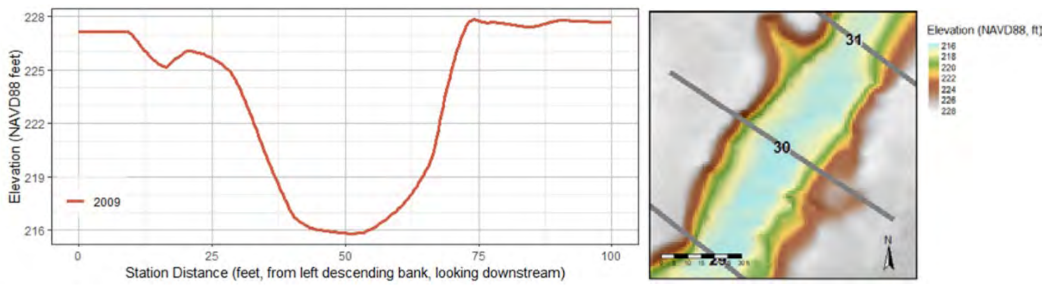


Figure 35.Cross-section 61, upstream of Austin Road Bridge-illustrating entrenched channel with no access to active floodplain (Figure 33).

The mid and upper Reach 3 has a flatter slope than the lower section of the reach but again shows all the signs of a typical degrading channel system. Low sinuosity, steep channel slopes, and relatively no floodplain berms or connections to an active floodplain are qualitative signs that a channel is in a degrading condition. A similar progression of cross-sectional area and channel bed elevations can be illustrated between cross-section plots (Figures 36-38). In the field, nick points and zones were identified. Bank heights ranged from 8 to 10 ft. with channel widths from 10 to greater than 25 ft. The mid and upper Reach 3 channel is also a CEM type III.

Figure 36. Cross-section 120, illustrating lack of floodplain berm building with abandoned floodplain terraces in upper Reach 3 (see Figure 8).

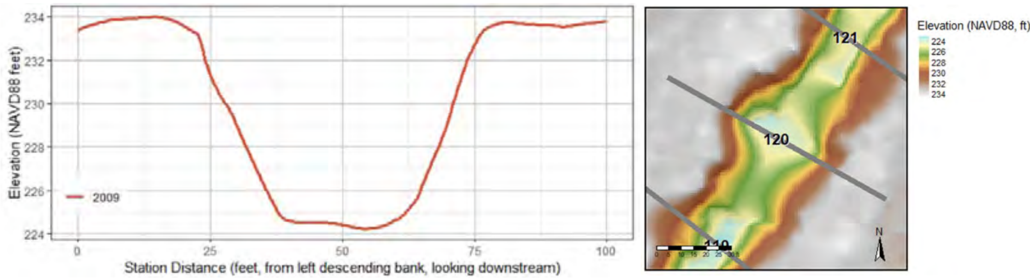


Figure 37. Cross-section 160, upstream of Highway 301 Bridge illustrating lack of floodplain berm development in upper Reach 3

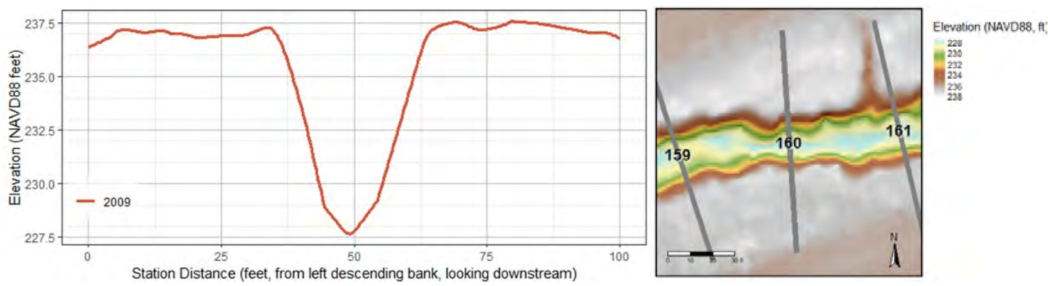
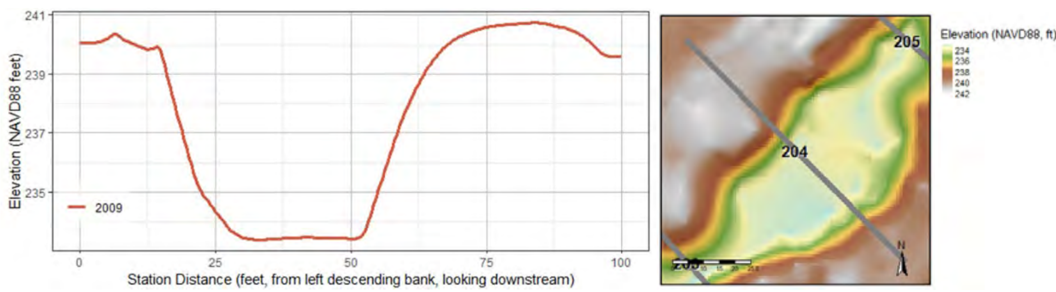


Figure 38. Cross-section 204, upstream of Church Road Culverts illustrating no active floodplain berm building in upper Reach 3



The character of this reach contrasts sharply to Reach 1 but is similar to Reach 2. Like Reach, the channel bed is comprised of a somewhat resistant clay that potentially limits the rate of channel degradation. However, the clay has not stopped active channel degradation from continuing to work upstream and will continue to migrate in an upstream direction. This reach does have a well-established woody riparian vegetation. The limited field investigations indicated that the channel bed was comprised predominantly of a semi-resistant clay material, with little to no sediment accumulation in the bed. Comparison of the DHP equilibrium slope curve suggest that Reach 3 is degradational.

3 Summary of Findings

Based on the FG analysis and the limited field assessments the following reconnaissance level geomorphic information is provided as summaries of each reach.

3.1 Reach 1 Summary

Based on the FG Level 1 and field site analysis:

- Reach 1 appears to be stabile with a relatively flat slope and possible access to floodplain berms. Based on the field site visit, this reach is relatively stable with some local bank erosion. The reach would be good for implementing habitat enhancement projects to include Engineering With Nature approaches to stabilize eroding banks and also provide enhanced aquatic habitat. The section is likely in a late CEM Stage IV or Stage V.

Figure 39. Johnson Creek-Reach 1 illustrating f

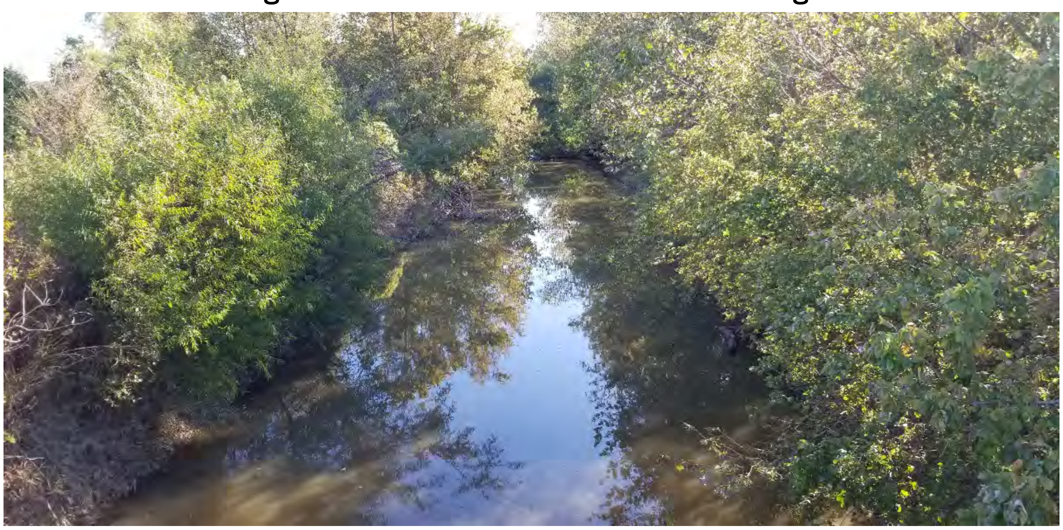


Figure 40. Nolehoe Creek right bank erosion site with large point bar

- Reach 1 may also good site for expanding riparian corridor habitats. There is a well established corridor on both sides of the channel and there may be opportunities through programs from the Natural Resources Conservation Service (NRCS) to provide incentives to plant and expand the riparian corridor if landowners are willing participants.

3.2 Reach 2 Summary

Based on the FG Level 1 and field site analysis:

- The lower section of Reach 2 has alluvial channel characteristics similar to Reach 1, with flat slopes and stable banks. There are in-channel floodplain berms that illustrate a trend of stabilization (Figure 23-24). Based on the field site visit, the lower Reach 2 is an extension of Reach 1, eroding and reworking through Mississippi River alluvial deposits. There is some localized bank erosion but is trending toward stability. Lower Reach 2 is a CEM Stage IV.

- For the mid and upper sections of Reach 2, FG Level 1 CSA analysis shows low sinuosity with widespread signs of degradation in cross-section analysis and over-steepened profile sections.

- Baldwin Road Bridge is not providing any grade control and was visually investigated and verified during the field site visit.

- There is widespread tributary and small drainage channel instability along the margins, adjacent to the stream channel (Figure 41). As part of the Johnson Creek restoration and stabilization plan, additional analysis is required to treat the areas throughout the watershed.

- Based on the field site visit, there is conclusive evidence of bed degradation upstream of the Baldwin Road Bridge. Based on the profile information there is likely more degradation that will work upstream into the bridge area causing further channel instability. The mid and upper Reach 2 is in a CEM Stage II-III. The section has a degradational trend (CEM II & III) but does have some cohesive, limited erosion resistant clay bed and lower banks that may be effectively locking the channel in place in certain areas within the reach. Some form of grade stabilization is required before bank stabilization should be attempted.

Figure 41. Johnson Creek upstream of Baldwin Road Bridge illustrating tributary erosion.

3.3 Reach 3 Summary

- Austin Road Bridge appears to be providing very limited protection with debris present in the channel bottom and margins.

- Limited grade control is provided in the reach by the Highway 301 Road Bridge and the Church Road Culverts. There are no distinct differences between channel stability upstream of Highway 301 and downstream. The Church Road Culverts show signs of channel degradation at the downstream concrete aprons and should be monitored for further degradation and potential undermining.

- There is widespread tributary and small drainage channel instability along the margins, adjacent to the stream channel form the continued degradation of the main Johnson Creek channel (Figure 42). As the channel continues to degrade the tributaries and drainage ditches will adjust to a new base level and erode deeper and widen out as par to the continued channel evolution process. As part of the Johnson Creek restoration and stabilization plan, additional analysis is required to treat the areas throughout the watershed.

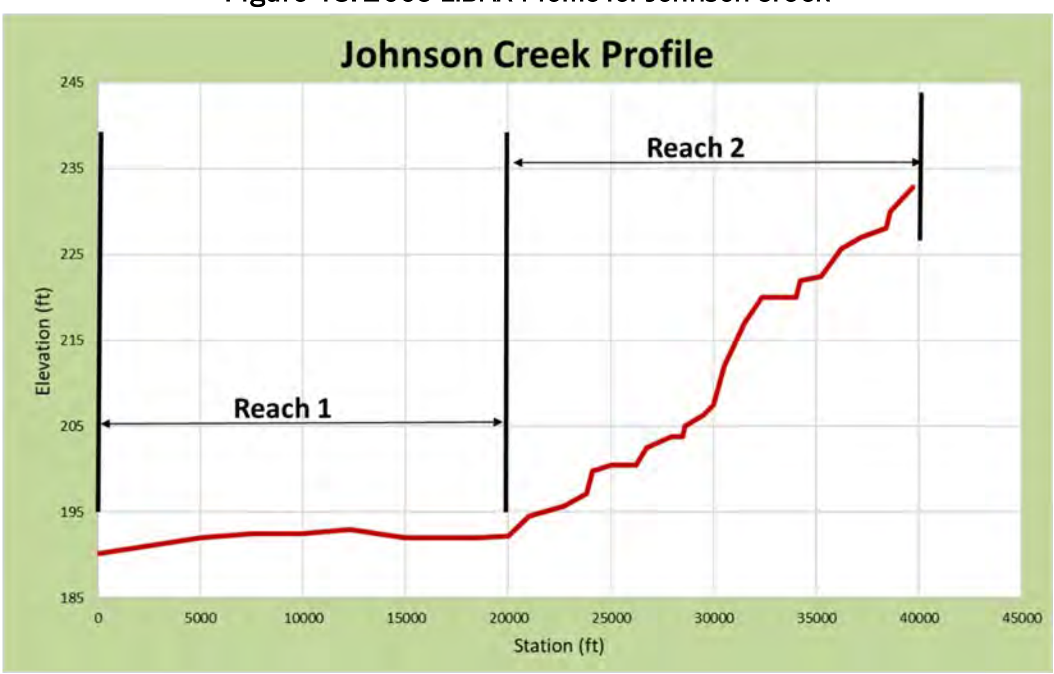
- Based on the field site visit, there is conclusive evidence of bed degradation upstream of the Austin Road Bridge. Reach 2 has a degradational trend (CEM II & III) but does have some cohesive, limited erosion resistant clay bed and lower banks that may be effectively locking the channel in place in certain areas within the reach. Some form of grade stabilization is required before bank stabilization should be attempted.

Figure 42. Johnson Creek upstream of Austin Road Bridge illustrating gully formation from agricultural field runoff.

4 Recommendations: Johnson Creek Stabilization Plan

The following is a very preliminary assessment with recommendations for Johnson Creek based on limited field investigations and analysis of the 2009 Lidar surveys using the FG Level 1 Channel Stability Assessment approach. One of the primary goals of this project is to minimize channel degradation, channel erosion, and sedimentation to support aquatic ecosystem form and function. This assessment addresses the channel stabilization, erosion control and sedimentation aspects of these goals. Base on additional reach valuations, the FG Reaches 1, 2 and 3 were changed into two reaches for this Recommendations Section (Figure 43). The new break for defined Reaches 1 and 2, is in the profile slope break located at approximately the same location as the Mississippi River alluvial materials and just downstream of the Baldwin Road Bridge.

Figure 43. 2009 LiDAR Profile for Johnson Creek



4.1.1 Reach 1 Plan

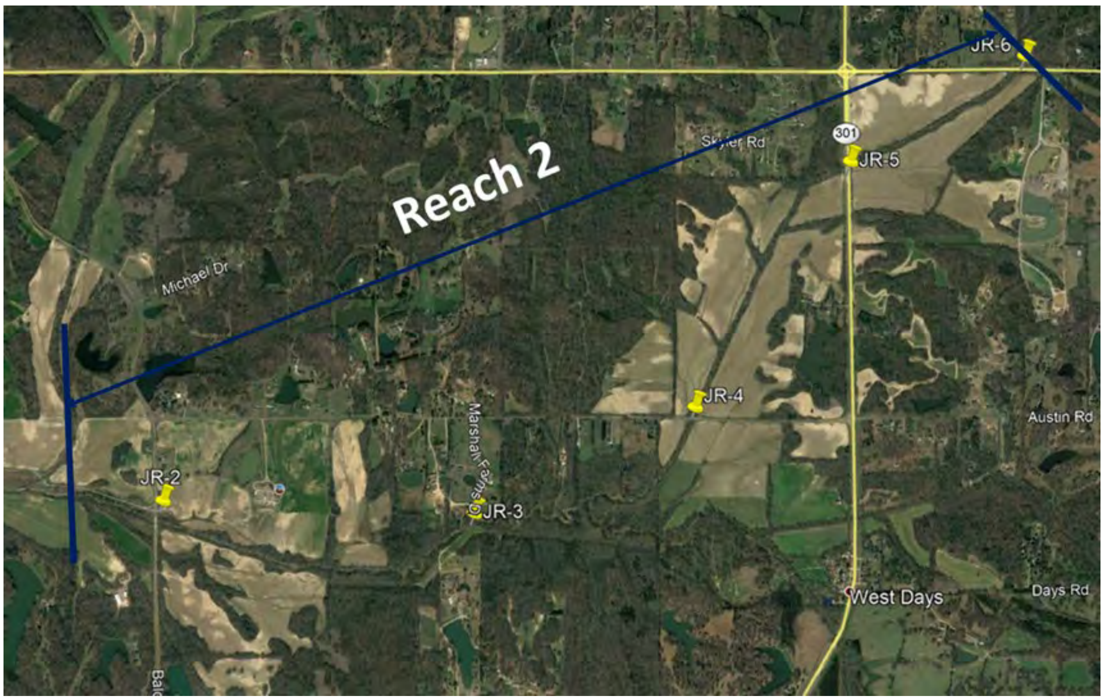
Reach 1 extends from about a mile downstream of Hwy 61 to approximate Sta 20,000 just downstream of Baldwin Road (Figures 1 and 2). Based on the limited field investigations and examination of the Lidar surveys, it appears that this reach of Johnson Creek is relatively stable vertically, with bank erosion only occurring in isolated locations. This would roughly correspond to CEM Types IV –V. Therefore, grade control would not be required in this reach. Additionally, bank stabilization should only be considered if critical locations are identified that must be stabilized to protect some valuable riparian features. It was observed that downstream of about Sta 13,960 (Figure 44), there was a significant riparian zone consisting of woody vegetation. However, upstream of about Sta 13,960 the was a noticeable lack of established riparian vegetation. Therefore, consideration should be given to the establishment of a woody riparian zone upstream of Sta 13,960.

Figure 44. Johnson Creek Reach 1

4.1.2 Reach 2 Plan

Reach 2 extends from approximate Sta 20,000 (downstream of Baldwin Rd) to just upstream of Church Rd (approximate Sta 40,000). The limits of this reach are shown in Figure 45. The field investigations confirmed that this entire reach was subject to degradation, albeit, at a relatively slow rate due to the hard clay throughout the bed. Although the degradation rate appears to be relatively slow, this continued incision will contribute to the long-term deterioration of the channel system, inducing accelerated bed and bank erosion and sediment supply to downstream reaches. Therefore, for this preliminary assessment, a conservative plan of a series of sloping rock grade control structures is recommended. For this plan it was simply assumed that each structure would have a 3.5-foot drop with a flat pool upstream which would provide a tailwater for the next upstream structure. Figures 46 and 47 show the tentative locations of these 11 proposed structures proposed. Again, it must be emphasized that this is a conservative assessment and that the final locations, heights and number of structures could vary considerable after a more thorough analysis.

Figure 45. Johnson Creek Reach 2



With respect to bank instability, the field investigations were too limited to provide a complete assessment of the degree of erosion in this reach. However, the preliminary observations suggest that localized areas of bank erosion exist, but they may be more localized than systematic. Therefore, bank stabilization is only included as needed to protect the proposed grade control structures. Table 1 provides a preliminary and conservative estimate of the linear feet of bank stabilization that will be required for each grade control structure. In total, approximately 6,300 feet of bank stabilization may be required.

Figure 46. Grade Control Plan for Johnson Creek-Reach 2 Profile Plot

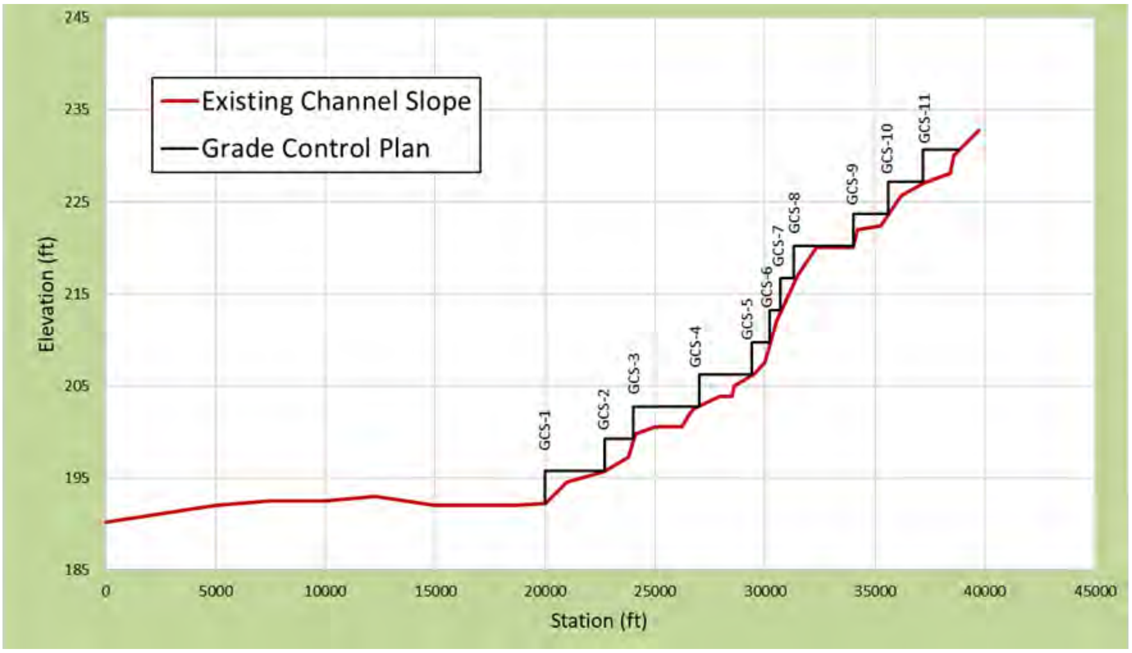


Figure 47. Grade Control Plan for Johnson Creek-Reach 2 Planview Map

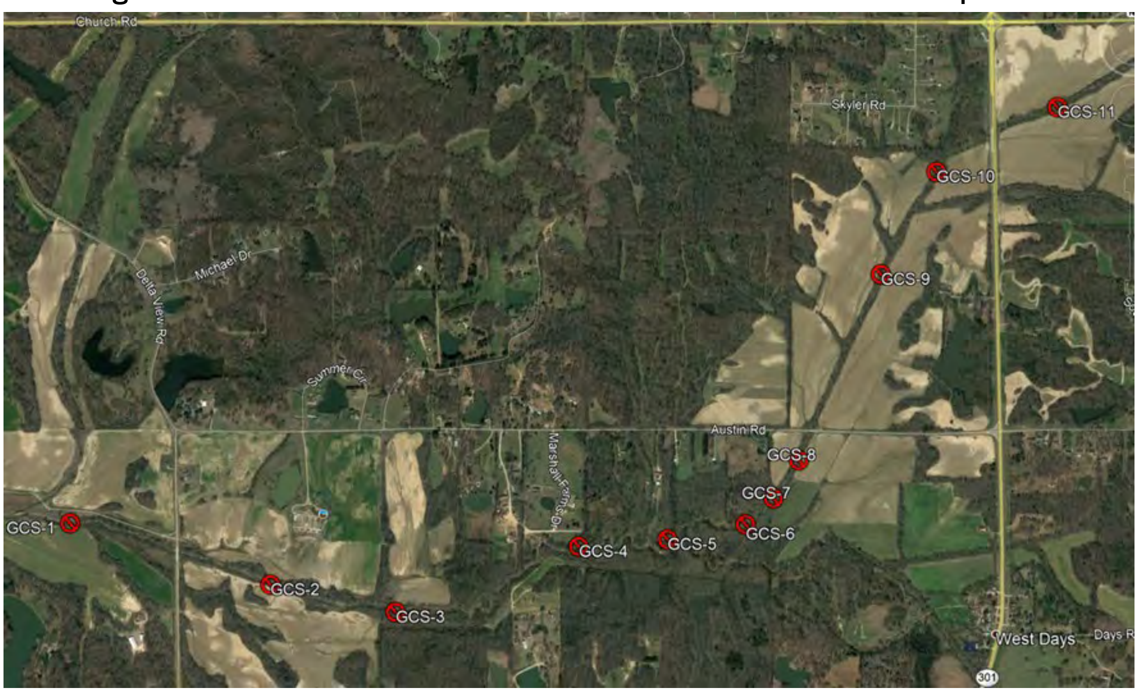


Table 1. Bank Stabilization Associated with Each Grade Control Structure

Grade Control Site	Linear feet of bank stabilization
GCS-1	500

GCS-2	400
GCS-3	600
GCS-4	1000
GCS-5	1000
GCS-6	600
GCS-7	400
GCS-8	400
GCS-9	400
GCS-10	600
GCS-11	400
Total Linear Feet	6,300

4.1.3 Summary of the Johnson Creek Stabilization Plan

A total of 11 new grade control structures and approximately 6,300 feet of bank stabilization are recommended (Table 1). In addition, a woody riparian zone of approximately 6,000 feet is proposed. Grade control structures described in this report are sloping loose rock riprap structures, and bank stabilization structures will be assumed to longitudinal stone toe protection with tiebacks.

5 Conclusions

Based on the limited amount of time and funding available to complete the geomorphic assessments, using existing tools such as the FG Level I Channel Stability Assessment are extremely important to provide the best available information. The FG Level-CSA combined with geomorphic field assessments provide critical baseline information that was used for the DeSoto County Watershed studies for reconnaissance level details in which preliminary restoration alternatives are developed. Continued refinement and development of the FG toolkit for rapid watershed assessment is of utmost importance.

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