Year 2 Monitoring Report

FINAL

LITTLE SEBASTIAN SITE

NCDMS Project # 100027 (Contract # 7187) | RFP 16-006993 (Issued 9/16/2016)
USACE Action ID: SAW-2017-01507 | DWR Project # 2017-1041

Surry County, North Carolina
Yadkin River Basin
HUC 03040101

Provided by:

Resource Environmental Solutions, LLC
For Environmental Banc & Exchange, LLC

Provided for:
NC Department of Environmental Quality
Division of Mitigation Services

January 2023

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January 16, 2023

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RE: Little Sebastian Mitigation Site: Year 2 Monitoring Report (NCDMS Project ID #100027)

Listed below are comments provided by DMS on December 1, 2022 regarding the Little Sebastian Mitigation Site: Year 2 Monitoring Report Draft and RES' responses.

General: At the April 19, 2022, IRT Credit Release meeting, the IRT asked about the project's rain gauge. RES reported that it was an off-site rain gauge and noted that the crest gauge reporting is conducted every 24-hours. Due to the lack of bankfull events reported, has RES considered installing an on-site rain gauge?
Rain data for this site is obtained from The Raven Knob CRONOS station, approximately 6 miles north of the site, and provides accurate daily rain data for the surrounding area. In the past, the use of on-site rain gauges has shown to be less reliable than data from established weather stations, due to battery life, water catchment issues, clogged gauges, and other general accuracy issues, and therefore, has not been considered for this site. In the future, the USACE's Antecedent Precipitation Tool (APT) may be utilized in conjunction with RES' current rain data retrieval method to better review climactic conditions.

General: The IRT also recommended more frequent (2-4 hour) crest gauge data recordation to confirm project bankfull events. In the revised report, please indicate the crest gauge recording frequency in MY2 (2022).
The recording frequency for both crest and flow gauges on the site is once per hour, 24 hours per day. This has been added to the report.

General: Please confirm that the entire project boundary was walked and assessed as part of the MY2 (2022) monitoring effort, and all conservation easement encroachment has been reported accordingly.
The entire project boundary was walked during MY2 monitoring. Encroachment issues have been noted in the report and will be addressed prior to MY3 monitoring efforts.

General: Please be sure to provide photo documentation of overbank events in MY3 (2023) and future monitoring reports. Is any photo documentation of the overbank event reported in MY2 (2022) available? If so, please include it in the revised monitoring report.
Flow cameras have not yet been installed on site but will be installed prior to the MY3 monitoring efforts to capture photo documentation of overbank events.

Section 1.7 Monitoring Performance (MY2): Thank you for relocating the fencing in May 2022 as discussed in the MY0 & MY1 (2021) reports. In the report text, please confirm that all project fencing is now located outside of the conservation easement or on the conservation easement line as required.
This has been confirmed in Section 1.7.

Section 1.7 Monitoring Performance (MY2) - Vegetation: In the report text, please further describe the total 0.83-acre encroachment areas observed on the site. Was the encroachment and project vegetation damage associated with livestock encroachment or landowner mowing? Please discuss how the encroachment was resolved with the landowner? The report notes that additional signage will be installed along the project boundary/conservation easement to prevent further encroachment. Please ensure that enough additional signage and horse tape are installed to clearly mark the conservation easement and establish an understandable mowing boundary for the landowner/s.
Further description regarding the encroachment and associated vegetation damage has been added to Section 1.7:

> *"Two areas of mowing encroachment along the eastern boundary of the Project, adjacent to BS1, were observed during Year 2 monitoring. The mowing has resulted in two areas of low stem density; one is 0.49 acres and the other is 0.34 acres. This roughly 0.83-acre area will be replanted with native container trees, chosen in reference to the original planting list (Appendix C) and based on supply availability, during this dormant season. Additional signage and horse tape (in areas where visibility between markers may be limited) will be installed along this side of the easement to mark a clear boundary to prevent further mowing."*

The encroachment will be resolved with the landowner by placing clear easement markers, signage, and horse tape where necessary, in the impacted areas. If further encroachment is observed in the future, a formal letter will be sent to the landowner.

Section 2.0 Methods: In this section, please provide the methodology for the flow gauges installed on the site and the associated data interpretation. How is the DS Riffle Elevation utilized in the flow gauge data interpretation?
Methodology regarding the project flow gauges has been added to Section 2.0. Flow detection is calculated by subtracting the water depth measurement at the flow gauge by the water depth measurement of the downstream riffle. Once this number is calculated, corrected HOBO readings can be used alongside the flow detection to quantify flow events, i.e., any readings greater than the flow detection equal stream flow.

CCPV Maps – Figure 2: Please add a callout to the map to clearly define the MY2 (2022) encroachment areas reported. The callout/s should also indicate that these areas will be replanted in the 2022/ 2023 dormant season as specified in the report.
These call outs have been added to the encroachment/low stem density areas in Figure 2.

CCPV Maps – Figure 2: A steep stream bank was observed on MC3-B/ MC3-C near the crossing during the last DMS monitoring site visit (2021). Please confirm that the bank continues to remain stable.
This bank continues to remain stable.

Visual Stream Stability Assessment Tables: Visual stream stability assessment tables should include Enhancement I reaches as well as Restoration reaches. Please update the monitoring report and digital support files accordingly.
Table 5 has been updated accordingly.

Little Sebastian Crossing Photos - July 12th, 2022: Please review and update the crossing photos provided. The photos for the crossing at JN2-D & JN3-B are the same photo sets. Additionally, the crossing name for MC3-B/C should be updated.
These duplicate crossing photos are accurate for the crossing on JN3-B; unfortunately, the MY2 crossing photo for JN2-D was lost during monitoring data download. Crossing photos from MY1 for JN2-D are included for reference and will be updated and included in the MY3 report. Crossing MC3-B/C caption has been revised.

Little Sebastian Crossing Photos - Please add upstream and downstream crossing photos for the crossing at MC1-A/B; the crossing at MC1-B; and the crossing at BS1-E. The IRT has requested supplemental photos of the all project culvert inlets and outlets to confirm crossing stability and sufficient organism passage.
The upstream and downstream crossing photos for BS1-E are included in the MY2 report. The crossing photos for MC1-A/B were lost during monitoring data download but will be updated and included in the MY3 report. MC1-B does not have a crossing, just an easement break, therefore, no photos were taken.

Appendix D – Cross Sections: Please review and QA/QC the cross-section data provided in Table 11 and the corresponding project cross-section graphs. Cross sections 1; 2; 3 and 11 show notable changes for Bankfull Bank Height Ratio between MY1 and MY2; however, these changes do not appear to be reflected in the cross-section graphs provided. Once reviewed, please discuss the individual cross-section Bankfull Bank Height Ratio changes in the revised report text.
Please see the reviewed cross section discussions below, and in the report.

Cross Section 1- because this is an Enhancement I section with steeper, uneven slopes, choosing the same location to call top of bank, year to year, is difficult; therefore, minor changes are expected in bank height ratios. Additionally, because the morphology tables are set to round numbers to one decimal place, the change from MY1 to MY2 may look more drastic than it is. MY1, cross section 1 had a bank height ratio of 1.380952381; MY2 cross section 1 had a bank height ratio of 1.467336683 (only 6% change). This is less than a 10% difference.

Cross Section 2- because this is an Enhancement I section with steeper, uneven slopes, choosing the same location to call top of bank, year to year, is difficult; therefore, minor changes are expected in bank height ratios. The left top of bank was called at 1211.91ft in the field, but upon desktop review, it is more likely that the top of bank is at 1211.66ft, as the low top of bank. This changes the bank height ratio to 1.577205882. This is a 4% change from the MY1 bank height ratio of 1.516791045.

Cross Section 3- because this is an Enhancement II section with steeper slopes, choosing the same location to call top of bank, year to year, is difficult; therefore, minor changes are expected in bank height ratios. The right top of bank was called at 1170.983ft in the field, but upon desktop review, it is more likely that the top of bank is at 1170.703ft, as the low top of bank. This changes the bank height ratio to 1.054081633. This is a 6% change from the MY1 bank height ratio of 1.127348643.

Cross Section 11 – this cross section is in a portion of the project that displays uneven slopes along both banks, and in this case, a very steep left bank; therefore, calling the same top of bank, year to year, is difficult. Minor changes are expected to occur, especially as the stream settles in the early stages of the project as this is a Restoration reach. The left top of bank was called at 1136.665ft in the field, but upon desktop review, it is more likely that the top of bank is at 1136.429ft, as the low top of bank. This changes the bank height ratio to 0.915041783. This is a 14% change from MY1 bank height ratio of 1.07194244604311; however, because this section has such uneven, sloped banks, the top of bank could have been miscalled

in MY1. MY2 more closely resembles as-built (MY0) conditions/numbers, which displayed a low bank height ratio of 1; this is only an 8% change between MY0 and MY2. This cross section and reach will continue to be monitored for changes that may impact the condition of the stream as a whole.

Appendix E – Hydrology Data - MY2 Little Sebastian GW1 graph: Please review and QA/QC to confirm that the 32 days (15%) reported is accurate. The groundwater level appears to drop below the 12-inch mark during the 32 days reported as "consecutive".
The groundwater level does drop below the 12-inch mark during the 32-day stretch; however, the groundwater gauge reads twice a day, and each of the instances where the level drops below 12 inches, it is only for one reading that day, not both. RES determines a consecutive streak by beginning with at least two days of readings above 12 inches, and then at least one reading a day above the 12-inch mark, until there are two readings in a row under 12-inches, ending the consecutive day count, which, in this case began on May 4, 2022, ending the 32-day stretch. Please reference the GW1 raw data in the digital files (5. Hydrology Data) to see where the determinations come from.

Digital Support File Comments:
Please revise the visual vegetation condition assessment table to reflect the areas of low stem or bare areas identified in the text and/or submitted with the digital data. All areas meet or exceed the minimum threshold of .10 acres. Please update the digital support files and MY2 report as necessary.
The encroachment area has now been duplicated as a low stem density area as well. Since they are linked issues, they share the same acreages. On Figure 2, the area is symbolized as red simple hatch since it is encroachment (additional orange simple hatch denoting low stem density would clutter the shapes and create symbology confusion). These were the only vegetation problem areas observed in MY2. The table and digital files have been updated.

Table of Contents

1.0 Project Summary 1
1.1 Project Location and Description 1
1.2 Project Goals and Objectives 1
1.3 Project Success Criteria 2
Stream Restoration Success Criteria 2
Vegetation Success Criteria 3
1.4 Project Components 4
1.5 Stream Mitigation Approach 4
1.6 Construction and As-Built Conditions 7
1.7 Monitoring Performance (MY2) 7
Vegetation 7
Stream Geomorphology 8
Stream Hydrology 9
Wetland Hydrology 9
2.0 Methods 10
3.0 References 11

Appendix A: Background Tables
Table 1. Project Mitigation Components
Table 2. Project Activity and Reporting History
Table 3. Project Contacts Table
Table 4. Project Background Information Table
Figure 1. Site Location Map

Appendix B: Visual Assessment Data
Figure 2. Current Conditions Plan View
Table 5. Visual Stream Morphology Stability Assessment
Table 6. Vegetation Condition Assessment
Vegetation Plot Photos
Monitoring Device and Crossing Photos

Appendix C: Vegetation Plot Data
Table 7. Planted Species Summary
Table 8. Vegetation Plot Mitigation Success Summary
Table 9. Stem Count Total and Planted by Plot Species

Appendix D: Stream Measurement and Geomorphology Data
Table 10. Baseline Stream Data Summary
Table 11. Cross Section Morphology Data Table
Cross Section Overlay Plots

Appendix E: Hydrology Data
Table 12. 2022 Rainfall Summary
Table 13. Documentation of Geomorphically Significant Flow Events
Table 14. 2022 Max Hydroperiod
Table 15. Summary of Groundwater Monitoring Results
Stream Flow Hydrographs
Groundwater Hydrographs

1.0 Project Summary

1.1 Project Location and Description

The Little Sebastian Mitigation Site ("the Project") is located in Surry County, approximately 10 miles north of Elkin. The Project presents 4,554.300 Cool Stream Mitigation Units (SMU) along Mill Creek and three unnamed tributaries.

The Project's total easement area is approximately 25.91 acres within the overall drainage area of 3,261 acres. The Project has two separate portions and in between those portions is the Gideon Mitigation Site. The Gideon Mitigation Site has a total easement area that is approximately 11.23 ac and presents 4,782 linear feet of stream restoration, enhancement, and preservation. Therefore, a total 37.14 ac and 12,887 LF of stream are protected in perpetuity. Grazing livestock historically had access to all stream reaches within the Project. The lack of riparian buffer vegetation, deep-rooted vegetation, and unstable channel characteristics contributed to the degradation of stream banks throughout the Project area.

The Project will be monitored on a regular basis throughout the seven-year post-construction monitoring period, or until performance standards are met. The Project will be transferred to the NCDEQ Stewardship Program. This party shall serve as conservation easement holder and long-term steward for the property and will conduct periodic inspection of the site to ensure that restrictions required in the conservation easement are upheld.

1.2 Project Goals and Objectives

Through the comprehensive analysis of the Project's maximum functional uplift using the Stream Functions Pyramid Framework, specific, attainable goals and objectives were realized by the Project. These goals clearly address the degraded water quality and nutrient input from farming that were identified as major watershed stressors in the 2009 Upper Yadkin Pee-Dee River RBRP. The Project will address outlined RBRP Goals 2, 4, and 6 (**Mitigation Plan**).

The Project goals are:

- Improve water transport from watershed to the channel in a non-erosive manner in a stable channel;
- Improve flood flow attenuation on site and downstream by allowing for overbanks flows and connection to the active floodplain;
- Improve instream habitat;
- Restore and enhance native floodplain vegetation; and
- Indirectly support the goals of the 2009 Upper Yadkin Pee-Dee RBRP to improve water quality and to reduce sediment and nutrient loads.

The Project objectives to address the goals are:

- Designed and reconstructed stream channels sized to convey bankfull flows that maintain a stable dimension, profile, and planform based on modeling, watershed conditions, and reference reach conditions;
- Permanently excluded livestock from stream channels and their associated buffers;
- Added in-stream structures and bank stabilization measures to protect restored and enhanced streams;
- Installed habitat features such as brush toes, constructed riffles, woody materials, and pools of varying depths to restored and enhanced streams;
- Reduced bank height ratios and increased entrenchment ratios to reference reach conditions.
- Increased forested riparian buffers to at least 30 feet on both sides of the channel along the Project reaches with a hardwood riparian plant community;
- Implemented one agricultural BMP in order to limit inputs of sediment, nutrients, and fecal coliform to streams from surrounding farming operations;
- Treated exotic invasive species; and
- Established a permanent conservation easement on the Project.

1.3 Project Success Criteria

The success criteria for the Project follows the 2016 USACE Wilmington District Stream and Wetland Compensatory Mitigation Update, the Little Sebastian Final Mitigation Plan, and subsequent agency guidance. Cross section and vegetation plot monitoring takes place in Years 0, 1, 2, 3, 5, and 7. Stream hydrology, wetland hydrology, and visual monitoring takes place annually. Specific success criteria components are presented below.

Stream Restoration Success Criteria

Four bankfull flow events must be documented within the seven-year monitoring period. The bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until four bankfull events have been documented in separate years.

There should be little change in as-built cross sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion) or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross sections shall be classified using the Rosgen stream classification method, and all monitored cross sections should fall within the quantitative parameters defined for channels of the design stream type. Bank height ratio shall not exceed 1.2, and the entrenchment ratio shall be above 1.4 within restored riffle cross sections. Channel stability should be demonstrated through a minimum of four bankfull events documented in the seven-year monitoring period.

Digital images are used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal images should not indicate the absence of developing bars within the channel or an

excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

Stream restoration reaches will be monitored to document intermittent or seasonal surface flow. This will be accomplished through direct observation and the use of hydraulic pressure transducers with data loggers. Reaches must demonstrate a minimum of 30 consecutive days of flow. Flow gauges will be installed on JN2-A and BS1-A. The flow gauge on BS1-A will also be capable of monitoring bankfull events.

Vegetation Success Criteria

Specific and measurable success criteria for plant density within the riparian buffers on the Project follow IRT Guidance. The interim measures of vegetative success for the Project is the survival of at least 320 planted three-year old trees per acre at the end of Year 3, 260 trees per acre with an average height of six feet at the end of Year 5, and the final vegetative success criteria is 210 trees per acre with an average height of eight feet at the end of Year 7. Volunteer trees are counted, identified to species, and included in the yearly monitoring reports, but are not counted towards the success criteria of total planted stems until they are present in the plot for greater than two seasons. Moreover, any single species can only account for up to 50 percent of the required number of stems within any vegetation plot. Any stems in excess of 50 percent will be shown in the monitoring table but will not be used to demonstrate success.

1.4 Project Components

The project streams were significantly impacted by livestock production, agricultural practices, and a lack of riparian buffer. Improvements to the Project help meet the river basin needs expressed in the 2009 Upper Yadkin Pee-Dee River Basin Restoration Priorities (RBRP) as well as ecological improvements to riparian corridor within the easement.

Through stream restoration, enhancement, and preservation, the Project presents 4,554.300 Cool Stream Mitigation Units (SMU) (**Table 1**).

Mitigation Approach	Linear Feet	Ratio	Cool Base SMU
Restoration	2,758	1	2,721
Enhancement I	597	1.5	398
Enhancement II	1,898	2.5	759.2
Enhancement II	1,372	5	274.4
Enhancement II	819	7.5	109.2
Enhancement II	243	10	24.3
Preservation	418	10	41.8
Total	**8,068**		**4,327.9**
		Credit Loss in Required Buffer	**-278.7**
		Credit Gain for Additional Buffer	**505.1**
		Total Adjusted SMUs	**4,554.300**

1.5 Stream Mitigation Approach

The Project includes priority I stream restoration, enhancement I, enhancement II, and preservation. Priority I stream restoration incorporates the design of a single thread meandering channel, with parameters based on data taken from reference sites, published empirical relationships, regional curves developed from existing project streams, and NC Regional Curves. Analytical design techniques also were a crucial element of the project and were used to determine the design discharge and to verify the design as a whole.

Reach JN2-A - Preservation activities included improving the existing livestock exclusion fencing and buffers greater than 30 feet. The easement was extended to provide preservation beyond the origin point of the stream as per the PJD.

Reach JN2-B - Enhancement activities included improving habitat through supplemental buffer plantings and livestock exclusion fencing. Minimal bank grading and buffer re-establishment was done along the downstream end. In-stream structures such as log sills and one log cross vane were installed for stability and to improve habitat. The restoration of the riparian areas at the downstream end filters runoff from adjacent pasture, reduce sediment loads, and provide wildlife corridors throughout the Project area.

Reach JN2-C - Enhancement activities included improving habitat through supplemental buffer plantings and livestock exclusion fencing. Minimal bank grading and buffer re-establishment were

done along the downstream end. The restoration of the riparian areas at the downstream end filters runoff from adjacent pasture, reduce sediment loads, and provide wildlife corridors throughout the Project area.

Reach JN2-D - Enhancement activities included some channel relocation, bed, and bank stabilization, removing an existing ford crossing and access road, improving habitat through supplemental buffer plantings, and livestock exclusion fencing. The restoration of the riparian areas at the downstream end filters runoff from adjacent pasture, reduce sediment loads, and provide wildlife corridors throughout the Project area.

Reach JN3-A –Enhancement II activities at a 7.5:1 ratio included improving habitat through supplemental buffer plantings and livestock exclusion fencing. The widening and restoration of the riparian areas along the right bank filters runoff from adjacent pasture and reduce sediment loads.

Reach JN3-B - Restoration activities included constructing a new channel within the natural valley to the north with appropriate dimensions and pattern and backfilling the abandoned channel. In-stream structures such as log sills, brush toes, and log vanes were installed for stability and to improve habitat. Habitat was further improved through buffer plantings and livestock exclusion. Buffer activities improved riparian areas that filter runoff from adjacent pastures, thereby reducing nutrient and sediment loads to the channel. Also, the reach was built through two small jurisdictional wetlands that are currently on the right bank floodplain and degraded from cattle access and pasture-use. While this project is not claiming any wetland credit, the raised channel bed enhances the wetlands' hydrology by reconnecting the floodplain wetlands to the stream. Two groundwater wells were installed on the right floodplain to monitor the wetland hydrology and will be reported in the yearly monitoring reports.

Reach MC1-A - Enhancement activities included improving habitat through supplemental buffer plantings and livestock exclusion fencing. The widening and restoration of the riparian areas along the right bank filters runoff from adjacent pasture and reduce sediment loads.

Reach MC1-B - Enhancement activities included improving habitat through supplemental buffer plantings and livestock exclusion fencing. The widening and restoration of the riparian areas along the left bank filters runoff from adjacent pasture, reduce sediment loads, and provide wildlife corridors throughout the Project area.

Reach MC1-C - Restoration activities included using log structures to provide vertical stability, assist in maintaining riffle, run and pool features and to provide habitat features. Cut and fill was balanced in an effort to raise the channel bed to provide regular inundation of the adjacent floodplain. Habitat was improved through supplemental buffer plantings and livestock exclusion fencing. The Gideon Mitigation Bank was constructed with the Project.

Reach MC3-A - Enhancement activities included improving habitat through supplemental buffer plantings and livestock exclusion fencing. The widening and restoration of the riparian areas along the right bank filters runoff from adjacent pasture and reduce sediment loads.

Reach MC3-B - Enhancement activities included reshaping the left bank, install coir matting and livestakes, and improving habitat through supplemental buffer plantings and livestock exclusion fencing. The widening and restoration of the riparian areas along the left bank filters runoff from adjacent pasture, reduce sediment loads, and provide wildlife corridors throughout the Project area. A ford crossing was installed on this reach.

Reach MC3-C - Enhancement activities included reshaping the left bank, install coir matting and livestakes, and improving habitat through supplemental buffer plantings and livestock exclusion fencing. The widening and restoration of the riparian areas along the left bank filters runoff from adjacent pasture, reduce sediment loads, and provide wildlife corridors throughout the project area.

Reach MC3-D - Enhancement activities includes improving habitat through supplemental buffer plantings and livestock exclusion fencing. The widening and restoration of the riparian areas along the left bank filters runoff from adjacent pasture, reduce sediment loads, and provide wildlife corridors throughout the Project area.

Reach BS1-A - Restoration activities included using log and rock structures to provide vertical stability, assist in maintaining riffle, run and pool features and to provide habitat features. Cut and fill were balanced in an effort to raise the channel bed to provide small floodplain benches where topography allows. Habitat was further improved through supplemental buffer plantings and livestock exclusion fencing. An engineered sediment pack was installed at the top of this reach.

Reach BS1-B - Enhancement activities included improving habitat through supplemental buffer plantings and livestock exclusion fencing. The widening and restoration of the riparian areas along the left bank filters runoff from adjacent pasture, reduce sediment loads, and provide wildlife corridors throughout the project area.

Reach BS1-C - Restoration activities included using log and rock structures to provide vertical stability, assist in maintaining riffle, run and pool features and to provide habitat features. Cut and fill was balanced in an effort to raise the channel bed to provide small floodplain benches where topography allows. Habitat was further improved through supplemental buffer plantings and livestock exclusion fencing.

Reach BS1-D - Enhancement activities included improving habitat through supplemental buffer plantings and livestock exclusion fencing. The widening and restoration of the riparian areas along the left bank filters runoff from adjacent pasture, reduce sediment loads, and provide wildlife corridors throughout the Project area.

Reach BS1-E - Restoration activities included using log structures to provide vertical stability, assist in maintaining riffle, run and pool features and to provide habitat features. Cut and fill were balanced in an effort to raise the channel bed to provide small floodplain benches where topography allows. Habitat was further improved through supplemental buffer plantings and livestock exclusion fencing.

1.6 Construction and As-Built Conditions

Stream construction was completed in February 2021 and planting was completed in March 2021. Additionally, five-strand high tensile electric fencing was installed for cattle exclusion. The Little Sebastian Site was built to design plans and guidelines. Two minor changes were made during construction: a log sill was added on JN2-B for extra grade control and log sills were removed from BS1 due to bedrock. Additionally, JN7 was added between Final Mitigation Plan approval and construction. This reach has a 30-acre drainage area and includes a pond located about 150 linear feet upstream of the easement area. Historically, this pond drained through a short ditch into JN3-B but due to the relocation of JN3-B, a channel was constructed in order to connect the pond back to JN3-B. The restored JN7 includes 37 linear feet within the easement. A photo of JN7 is in **Appendix B**. RES proposed the addition of JN7 for credit; however, this request was denied by IRT. A flow gauge was installed along JN7 in February 2022. RES will monitor the stability and hydrology of this reach and if back-up credits are needed at closeout there is the potential to use the 19.660 SMUs from JN7.

Planting plan changes included replacing blackgum (*Nyssa sylvatica*) and elderberry (*Sambucus canadensis*) with sugarberry (*Celtis laevigata*) and buttonbush (*Cephalanthus occidentalis*). These changes were based on bare root availability. A planted species summary is included in **Appendix C**. Minor monitoring device location changes were made during as-built installation due to site conditions. The only monitoring devices not installed were the stage recorders proposed for MC1-C and BS1-C due to the reach being less than 1,000 linear feet and there being two stage recorders proposed for the same reach, respectively.

1.7 Monitoring Performance (MY2)

The Little Sebastian Year 2 monitoring activities were performed in July and November 2022. All Year 2 monitoring data is present below and in the appendices. The Project is on track to meeting vegetation and stream interim success criteria.

Two areas of fencing inside the easement, adjacent to reach MC1, were relocated to the easement boundaries in May 2022. An additional area of fencing was relocated at the downstream side of fence at the crossing between MC1-A and MC1-B. Horse tape was strung along the upstream side of the crossing to reinforce the easement boundaries and prevent any driving through the far southwestern portion of the easement. All project fencing is now located outside of or on the conservation easement line. Approximate fence and horse tape locations can be found in **Figure 2**, **Appendix B.**

Vegetation

Monitoring of six fixed vegetation plots and three random vegetation plots was completed on November 2, 2022. Vegetation data can be found in **Appendix C**, associated photos are in **Appendix B,** and plot locations are in **Appendix B**. MY2 data indicates that all plots are exceeding the interim success criteria of 320 planted stems per acre. Planted stem densities ranged from 526

to 1,133 planted stems per acre with a mean of 823 planted stems per acre across all plots. A total of 10 species were documented within the plots. Volunteer species were not noted in any of the plots but are expected to establish in upcoming years. The average stem height in the plots was 3.0 feet.

Visual assessment of vegetation outside of the monitoring plots indicates that the herbaceous vegetation is becoming well established throughout the project. A few small areas of Chinese privet were treated in December 2021. No additional invasive species were observed during MY2. Two areas of mowing encroachment along the eastern boundary of the Project, adjacent to BS1, were observed during Year 2 monitoring. The mowing has resulted in two areas of low stem density; one is 0.49 acres and the other is 0.34 acres. This roughly 0.83-acre area will be replanted with native container trees, chosen in reference to the original planting list (**Appendix C**) and based on supply availability, during this dormant season. Additional signage and horse tape (in areas where visibility between markers may be limited) will be installed along this side of the easement to mark a clear boundary to prevent further mowing. If further encroachment is observed in the future, a formal letter will be sent to the landowner. All areas of proposed supplemental planting (as a result of the encroachment) can be seen in **Figure 2** as red simple hatch and are referenced in **Table 6**, **Appendix B**. The entire project boundary was walked, and no other problem areas were noted along the remainder of the easement boundary.

Stream Geomorphology

Cross section and geomorphology data collection for MY2 was collected on July 12, 2022. Summary tables and cross section plots are in **Appendix D**. Overall the MY2 cross sections and profile relatively match the proposed design. The current conditions show that shear stress and velocities have been reduced for all restoration/enhancement reaches. The reaches were designed as gravel/cobble bed channels and remain classified as gravel/cobble bed channels post-construction.

Four cross sections displayed notable changes for Bankfull Bank Height Ratio between MY1 and MY2 and are discussed below.

- Cross Section 1- because this is an Enhancement I section with steeper, uneven slopes, choosing the same location to call top of bank, year to year, is difficult; therefore, minor changes are expected in bank height ratios. Additionally, because the morphology tables are set to round numbers to one decimal place, the change from MY1 to MY2 may look more drastic than it is. MY1, cross section 1 had a bank height ratio of 1.380952381; MY2 cross section 1 had a bank height ratio of 1.467336683 (only 6% change). This is less than a 10% difference.
- Cross Section 2- because this is an Enhancement I section with steeper, uneven slopes, choosing the same location to call top of bank, year to year, is difficult; therefore, minor changes are expected in bank height ratios. The left top of bank was called at 1211.91ft in the field, but upon desktop review, it is more likely that the top of bank is at 1211.66ft, as the low top of bank. This changes the bank height ratio to 1.577205882. This is a 4% change from the MY1 bank height ratio of 1.516791045.

- Cross Section 3- because this is an Enhancement II section with steeper slopes, choosing the same location to call top of bank, year to year, is difficult; therefore, minor changes are expected in bank height ratios. The right top of bank was called at 1170.983ft in the field, but upon desktop review, it is more likely that the top of bank is at 1170.703ft, as the low top of bank. This changes the bank height ratio to 1.054081633. This is a 6% change from the MY1 bank height ratio of 1.127348643.
- Cross Section 11 – this cross section is in a portion of the project that displays uneven slopes along both banks, and in this case, a very steep left bank; therefore, calling the same top of bank, year to year, is difficult. Minor changes are expected to occur, especially as the stream settles in the early stages of the project as this is a Restoration reach. The left top of bank was called at 1136.665ft in the field, but upon desktop review, it is more likely that the top of bank is at 1136.429ft, as the low top of bank. This changes the bank height ratio to 0.915041783. This is a 14% change from MY1 bank height ratio of 1.07194244604311; however, because this section has such uneven, sloped banks, the top of bank could have been miscalled in MY1. MY2 more closely resembles as-built (MY0) conditions/numbers, which displayed a low bank height ratio of 1; this is only an 8% change between MY0 and MY2. This cross section and reach will continue to be monitored for changes that may impact the condition of the stream as a whole.

Visual assessment of the stream channel was performed to document signs of instability, such as eroding banks, structural instability, or excessive sedimentation (**Table 5**, **Appendix B**). The channel is transporting sediment as designed and will continue to be monitored for aggradation and degradation.

Stream Hydrology

Two stage recorders and two flow gauges were installed in March 2021 and document bankfull events and flow days, respectively. Both gauge types record readings at a frequency of once per hour, 24 hours per day. The stage recorder on JN3-B documented one bankfull event on July 9, 2022, measuring 0.02 feet above the top of bank. The stage recorder along BS1-E has yet to record any events; however, the highest recorded event was one inch away from receiving a bankfull event in July 2022. RES expects to see in increase in bankfull events in future monitoring years. Photo documentation of overbank events will be included in MY3 reports. The flow gauge on JN2-B recorded five flow events, with the longest lasting 119 consecutive days. The gauge on BS1-A recorded one flow event lasting 305 consecutive days. And the flow gauge on JN7, installed in February 2022, recorded one flow event, lasting 273 consecutive days. All recorded streams are on track to pass hydrology metrics. Stream hydrology data is included in **Appendix E**. Gauge locations can be found on **Figure 2** and photos are in **Appendix B**.

Wetland Hydrology

Two groundwater wells with automatic recording pressure transducers were installed in March 2021. The goal of the groundwater wells is to track the hydrology of the jurisdictional wetlands

on site post-stream construction. There is no hydroperiod success criteria for these groundwater wells. In MY2, GW1 recorded a consecutive hydroperiod of 15 percent of the growing season and GW2 recorded a consecutive hydroperiod of 100 percent of the growing season. Wetland hydrology data is included in **Appendix E**. Groundwater well locations can be found on **Figure 2**.

2.0 Methods

Stream cross section monitoring was conducted using a Topcon GTS-312 Total Station. Three-dimensional coordinates associated with cross-section data were collected in the field (NAD83 State Plane feet FIPS 3200). Morphological data were collected at 12 cross-sections. Survey data were imported into CAD, ArcGIS®, and Microsoft Excel® for data processing and analysis. The stage recorders include an automatic pressure transducer placed in PVC casing in a pool. The elevation of the bed and top of bank at each stage recorder are used to detect bankfull events. The flow gauges also include an automatic pressure transducer placed in a PVC casing in a pool. The elevations of the bed, water surface, and immediate downstream riffle are used to determine stream flow.

Vegetation success is being monitored at six fixed monitoring plots and three random monitoring plots. Vegetation plot monitoring follows the CVS-EEP Level 2 Protocol for Recording Vegetation, version 4.2 (Lee et al. 2008) and includes analysis of species composition and density of planted species. Data are processed using the CVS data entry tool. In the field, the four corners of each plot were permanently marked with PVC at the origin and metal conduit at the other corners. Photos of each plot are to be taken from the origin each monitoring year. The random plot is to be collected in locations where there are no permanent vegetation plots. Random plot will most likely be collected in the form of 100 square meter belt transects with variable dimensions. Tree species and height will be recorded for each planted stem and the transects will be mapped and new locations will be monitored in subsequent years.

Wetland hydrology is monitored to track the hydrology of the jurisdictional wetlands on site post-stream construction. This is accomplished with two automatic pressure transducer gauges (located in groundwater wells) that record daily groundwater levels. One automatic pressure transducer is installed above ground for use as a barometric reference. Gauges are downloaded quarterly and wetland hydroperiods are calculated during the growing season. Gauge installation followed current regulatory guidance. Visual observations of primary and secondary wetland hydrology indicators are also recorded during quarterly site visits.

Fixed digital image locations are established at each cross section, vegetation plot, stage recorder, flow gauge, and the upstream and downstream side of each crossing.

3.0 References

Griffith, G.E., J.M.Omernik, J.A. Comstock, M.P. Schafale, W.H.McNab, D.R.Lenat, T.F.MacPherson, J.B. Glover, and V.B. Shelburne. (2002). Ecoregions of North Carolina and South Carolina, (color Poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

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Peet, R.K., Wentworth, T.S., and White, P.S. (1998), *A flexible, multipurpose method for recording vegetation composition and structure*. Castanea 63:262-274

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Schafale, M.P. 2012. Guide to the Natural Communities of North Carolina, Fourth Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, NCDENR, Raleigh, NC.

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Appendix A

Background Tables

Table 1. Little Sebastian (ID-100027) - Mitigation Assets and Components

Project Segment	Existing Footage or Acreage	Mitigation Plan Footage or Acreage	Migitation Category	Restoration Level	Priority Level	Mitigation Ratio (X:1)	Mitigation Plan Credits		As-Built Footage or Acreage	Comments
JN2-A	418	418	Cool	P	NA	10.00000	41.800		418	Livestock exclusion
JN2-B	187	187	Cool	EI	NA	1.50000	124.667		187	Buffer planting and livestock exclusion
JN2-C	307	307	Cool	EII	NA	2.50000	122.800		307	Buffer planting and livestock exclusion; 31-foot crossing
JN2-C	837	837	Cool	EII	NA	2.50000	334.800		837	Buffer planting and livestock exclusion
JN2-D	39	43	Cool	EI	NA	1.50000	28.667		43	Channel relocation, bed and bank stabilization, crossing relocation, buffer plantings, and livestock exclusion; 62-foot crossing
JN2-D	150	153	Cool	EI	NA	1.50000	102.000		153	Channel relocation, bed and bank stabilization, crossing relocation, buffer plantings, and livestock exclusion
JN3-A	350	350	Cool	EII	NA	7.50000	46.667		350	Buffer planting and livestock exclusion
JN3-B	900	781	Cool	R	I	1.00000	781.000		781	Channel relocation in the natural valley, improved stream structures, buffer planting, and livestock exclusion; 43-foot crossing
JN3-B	224	262	Cool	R	I	1.00000	262.000		262	Channel relocation, bed and bank stabilization, crossing relocation, buffer plantings, and livestock exclusion
JN7*	0	0	Cool	R	I	1.00000	0.000		37	Channel construction, bed and bank stabilization, buffer plantings, and livestock exclusion; No Credit
MC1-A	469	469	Cool	EII	NA	7.50000	62.533		469	Buffer planting and livestock exclusion
MC1-B	717	717	Cool	EII	NA	5.00000	143.400		717	Buffer planting and livestock exclusion; 41-foot utility line crossing
MC1-B	260	260	Cool	EII	NA	5.00000	52.000		260	Buffer planting and livestock exclusion
MC1-C	545	555	Cool	R	I	1.00000	555.000		555	Channel bed raised, improved stream structures, buffer planting, and livestock exclusion
MC3-A	243	243	Cool	EII	NA	10.00000	24.300		243	Buffer planting and livestock exclusion
MC3-B	402	402	Cool	EII	NA	2.50000	160.800		402	Buffer planting and livestock exclusion; 41-foot crossing
MC3-C	214	214	Cool	EI	NA	1.50000	142.667		214	Bank stabilization, improved stream structures, buffer planting, and livestock exclusion
MC3-D	395	395	Cool	EII	NA	5.00000	79.000		395	Buffer planting and livestock exclusion
BS1-A	205	214	Cool	R	I	1.00000	214.000		214	Channel bed raised, improved stream structures, buffer planting, and livestock exclusion
BS1-B	190	175	Cool	EII	NA	2.50000	70.000		175	Buffer planting and livestock exclusion
BS1-C	580	541	Cool	R	I	1.00000	541.000		541	Channel bed raised, improved stream structures, buffer planting, and livestock exclusion
BS1-D	185	177	Cool	EII	NA	2.50000	70.800		177	Buffer planting and livestock exclusion
BS1-E	278	274	Cool	R	I	1.00000	274.000		274	Channel bed raised, improved stream structures, buffer planting, and livestock exclusion; 45-foot crossing
BS1-E	94	94	Cool	R	I	1.00000	94.000		94	Channel bed raised, improved stream structures, buffer planting, and livestock exclusion

*Added between Final Mitigation Plan and Construction; no credit but potential to add credits if reach meets success criteria and back-up credits are needed

Note: all crossings and utility easements have been removed from credit calculations.

Project Credits

Restoration Level	Stream			Riparian Wetland	Non-rip Wetland	Coastal Marsh
	Warm	Cool	Cold			
Restoration		2721.000				
Re-establishment						
Rehabilitation						
Enhancement						
Enhancement I		398.000				
Enhancement II		1167.100				
Creation						
Preservation		41.800				
NSBW		226.400				
TOTALS		**4,554.300**				

Table 2. Project Activity and Reporting History
Little Sebastian

Elapsed Time Since grading complete: **1 yr, 9 mo**
Elapsed Time Since planting complete: **1 yr, 8 mo**
Number of reporting Years[1]: **2**

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Mitigation Plan	NA	Nov-18
Final Design – Construction Plans	NA	Sep-20
Stream Construction	NA	Feb-21
Site Planting	NA	Mar-21
As-built (Year 0 Monitoring – VP, XS, Hydro, Visual)	Mar-21	Oct-21
Year 1 Monitoring	Stream: Nov-21 Vegetation: Nov-21	Dec-21
Invasive Treatment	NA	Dec-21
Fence Relocation	NA	May-22
Year 2 Monitoring	Stream: July-22 Vegetation: Nov-22	Nov-22
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		
Year 6 Monitoring		
Year 7 Monitoring		

1 = The number of reports or data points produced excluding the baseline

Table 3. Project Contacts Table Little Sebastian	
Designer	RES / 3600 Glenwood Ave., Suite 100, Raleigh, NC 27612
Primary project design POC	Frasier Mullen, PE
Construction Contractor	KBS Earthwork Inc. / 5616 Coble Church Rd., Julian, NC 27283
Construction contractor POC	Kory Strader
Survey Contractor	Acension Land Surveying, PC / 116 Williams Road, Mocksville, NC 27028
Survey contractor POC	Chris Cole, PLS
Planting Contractor	Shenandoah Habitats
Planting contractor POC	David Coleman
Monitoring Performers	RES / 3600 Glenwood Ave, Suite 100, Raleigh, NC 27612
Project Manager POC	Ryan Medric (703) 424-6313
Monitoring POC	Emily Ulman (910) 274-8231

Table 4. Project Background Information					
Project Name	Little Sebastian				
County	Surry				
Project Area (acres)	25.91				
Project Coordinates (latitude and longitude)	36.40, -80.86				
Planted Acreage (Acres of Woody Stems Planted)	10.7				
Project Watershed Summary Information					
Physiographic Province	45e - Northern Inner Piedmont				
River Basin	Yadkin				
USGS Hydrologic Unit 8-digit	03040101	USGS Hydrologic Unit 14-digit	03040101080020		
DWR Sub-basin	03-04-01				
Project Drainage Area (Acres and Square Miles)	3,261 acres (5.1 sq mi)				
Project Drainage Area Percentage of Impervious Area	<1%				
Reach Summary Information					
Parameters	**JN2-A**	**JN2-B**	**JN2-C**	**JN2-D**	**JN3-A**
Length of reach (linear feet)	418	187	1114	189	350
Valley confinement (Confined, moderately confined, unconfined)	UC	MC	MC	MC	UC
Drainage area (Acres)	10	17	37	38	956
Perennial, Intermittent, Ephemeral	I	P	P	P	P
Parameters	**JN3-B**	**MC1-A**	**MC1-B**	**MC1-C**	**MC3-A/B/C**
Length of reach (linear feet)	1043	469	977	555	859
Valley confinement (Confined, moderately confined, unconfined)	C	UC	UC	UC	UC
Drainage area (Acres)	999	1862	1915	2921	3225
Perennial, Intermittent, Ephemeral	P	P	P	P	P
Parameters	**MC3-D**	**BS1-A/C/E**	**BS1-B/D**	**JN7**	
Length of reach (linear feet)	395	1029	352	37	
Valley confinement (Confined, moderately confined, unconfined)	UC	C	C	UC	
Drainage area (Acres)	3262	12-29	14-28	30	
Perennial, Intermittent, Ephemeral	P	I/P	P	I	

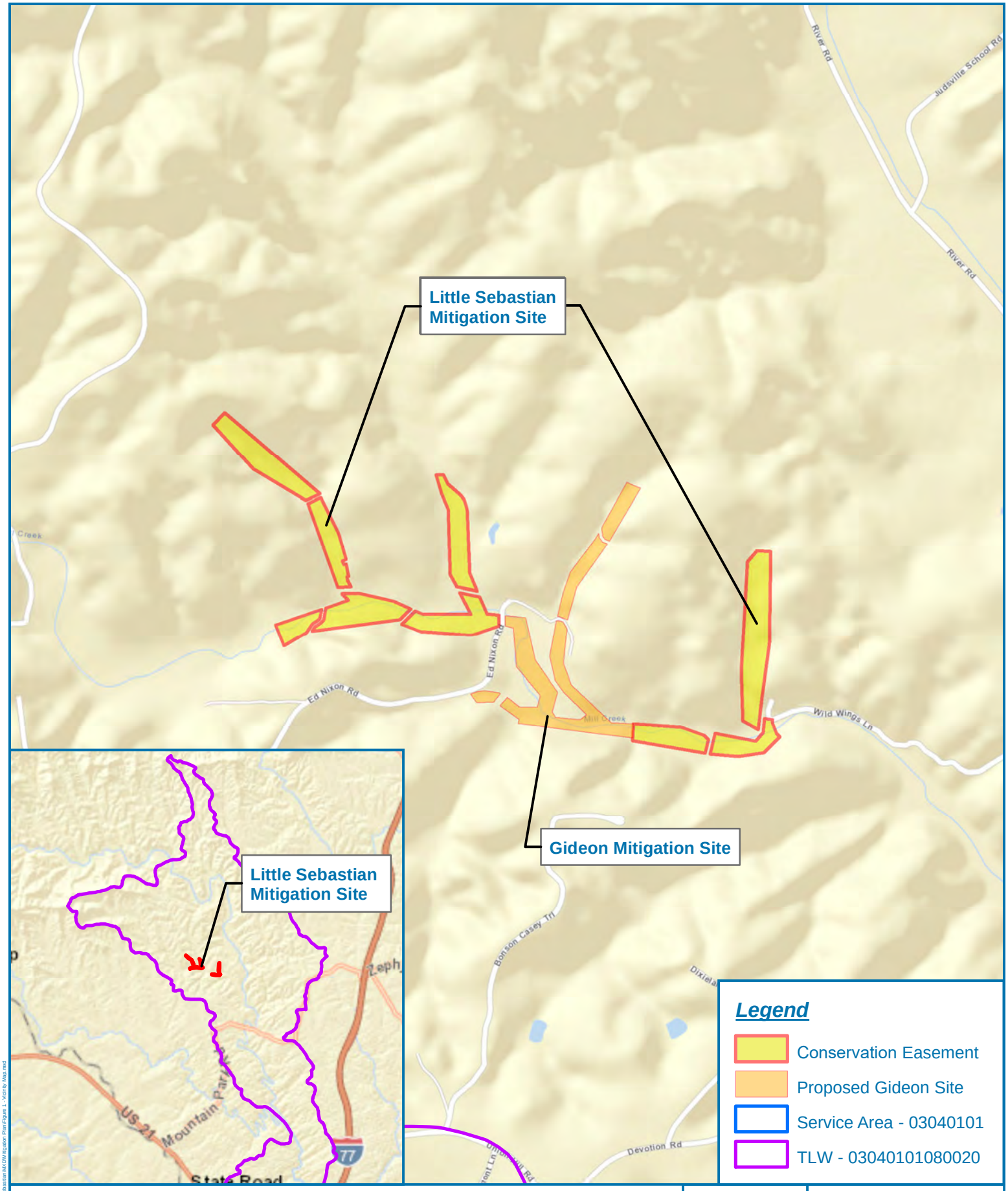


Figure 1 - Site Location Map

Little Sebastian Mitigation Site

Surry County, North Carolina

Date: 10/30/2018

Drawn by: MDE

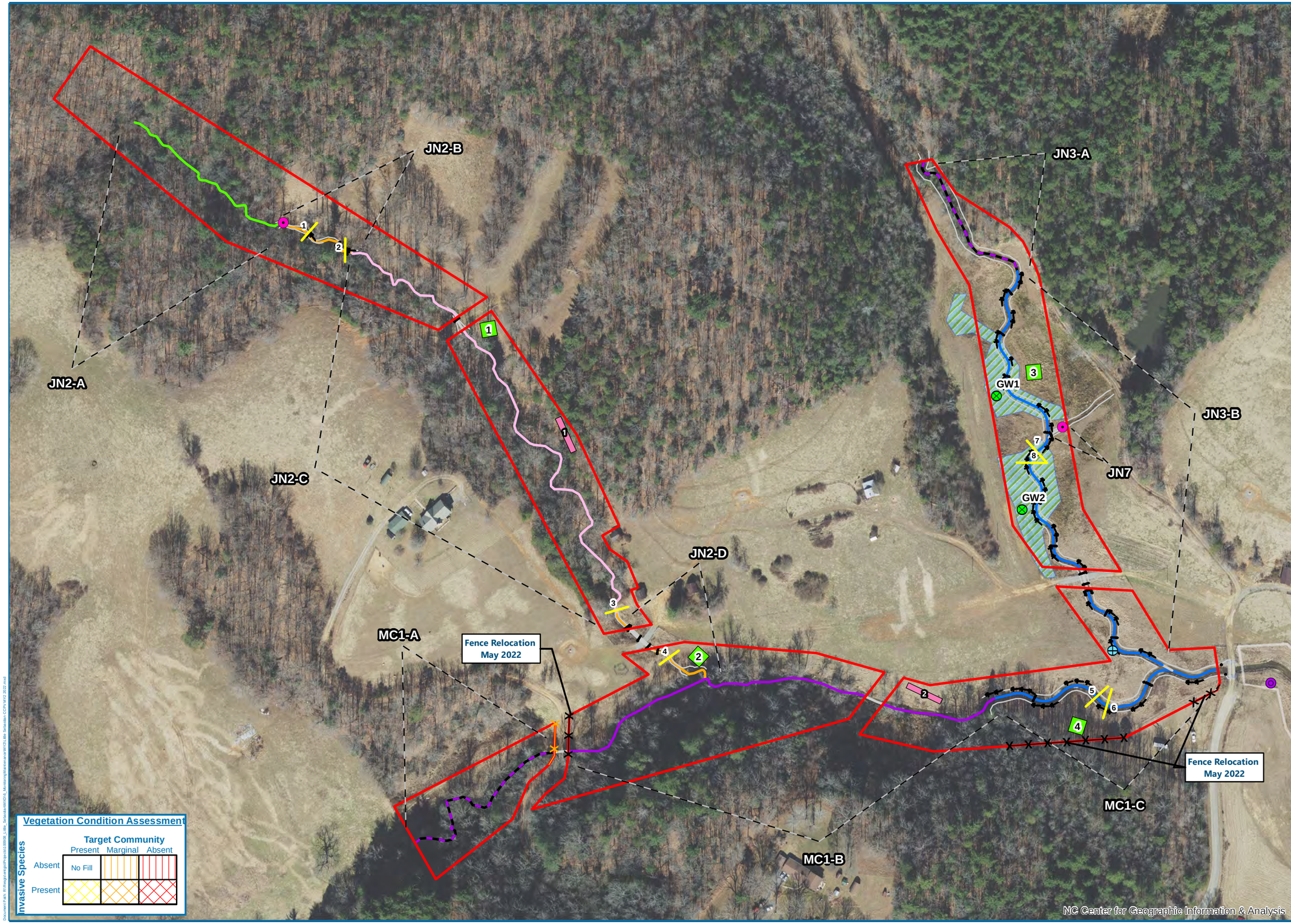
Checked by: ATP

res

Document Path: S:\IBRES GIS\Projects\NC\Little Sebastian\MXD\Mitigation Plan\Figure 1 - Vicinity Map.mxd

Appendix B

Visual Assessment Data



res

N
W
E
S

0 100 200
Feet

Figure 2

Current Conditions
Plan View

MY2 2022

Little Sebastian
Mitigation Site

Surry County, NC

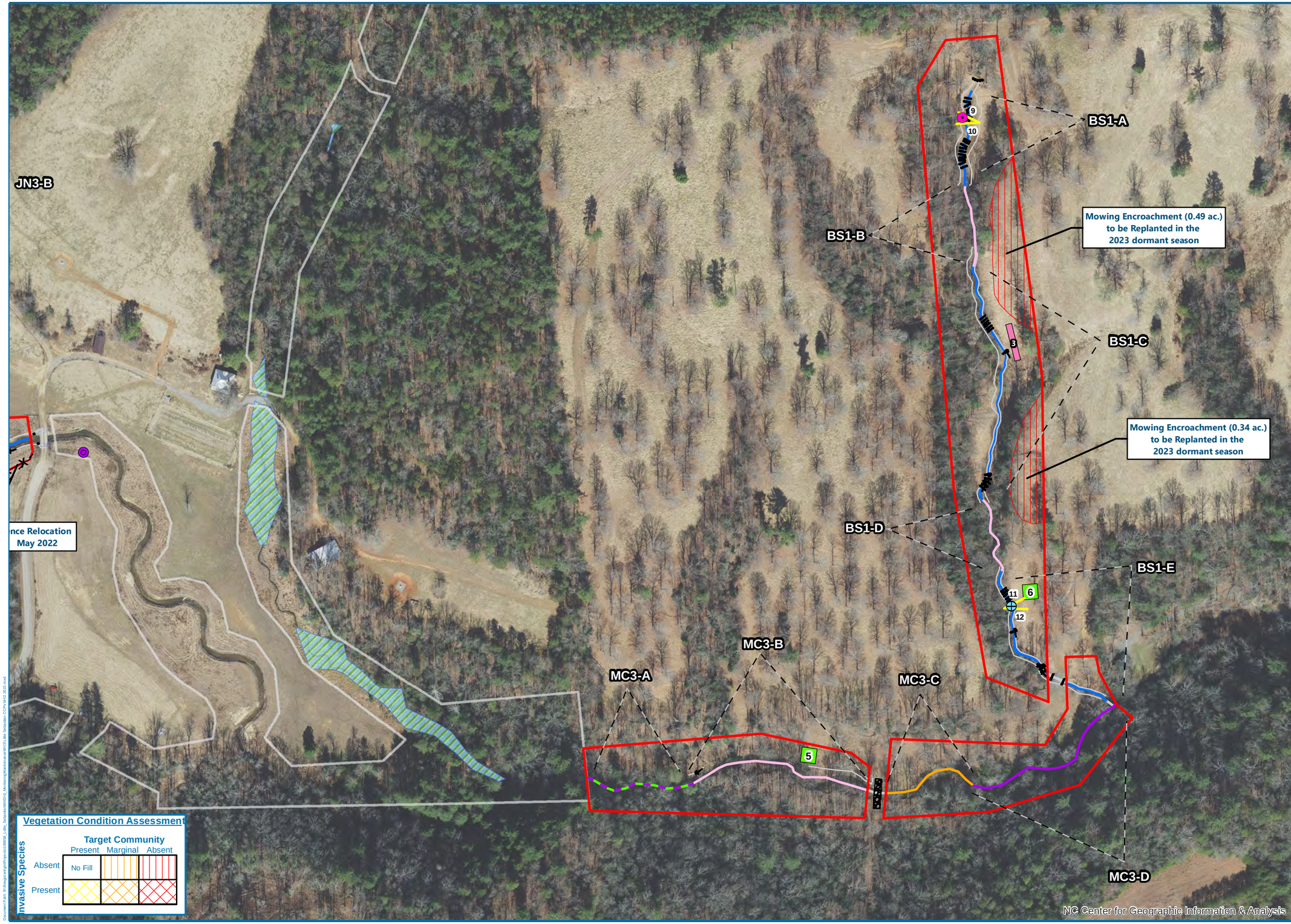
Date: 1/4/2023	Drawn by: EJU
Lat: 35.937509	Long: -81.234876

LEGEND

- Conservation Easement
- Gideon Bank Site
- Existing Wetland
- Fixed Veg Plot >320 Stems/Ac.
- Random Veg Plot >320 Stems/Ac.
- Fence Relocation
- Horse Tape Reinforcement
- Structure
- Top of Bank
- Cross Section

Stream Mitigation

- Restoration
- Enhancement I
- Enhancement II
- Enhancement II (5:1)
- Enhancement II (7.5:1)
- Enhancement II (10:1)
- Preservation
- No Credit
- Groundwater Well
- Stage Recorder
- Flow Gauge
- Ambient



res

N
W
E
S

0 100 200
Feet

Figure 2

Current Conditions
Plan View

MY2 2022

Little Sebastian
Mitigation Site

Surry County, NC

Date: 1/4/2023	Drawn by: EJU
Lat: 35.937509	Long: -81.234876

LEGEND

- Conservation Easement
- Gideon Bank Site
- Existing Wetland
- Fixed Veg Plot >320 Stems/Ac.
- Random Veg Plot >320 Stems/Ac.
- Fence Relocation
- Horse Tape Reinforcement
- Structure
- Top of Bank
- Cross Section

Stream Mitigation

- Restoration
- Enhancement I
- Enhancement II
- Enhancement II (5:1)
- Enhancement II (7.5:1)
- Enhancement II (10:1)
- Preservation
- No Credit
- Groundwater Well
- Stage Recorder
- Flow Gauge
- Ambient

Visual Stream Stability Assessment

Assessment Date: 11/2/2022

Reach JN3

Assessed Stream Length 1043

Assessed Bank Length 2086

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
Totals					0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	10	10		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	18	18		100%

Visual Stream Stability Assessment

Assessment Date: 11/2/2022

Reach MC1-C

Assessed Stream Length 555

Assessed Bank Length 1110

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
Totals					0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	2	2		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	7	7		100%

Visual Stream Stability Assessment

Assessment Date: 11/2/2022

Reach BS1

Assessed Stream Length 1123

Assessed Bank Length 2246

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
Totals					0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	8	8		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	3	3		100%

Visual Stream Stability Assessment

Assessment Date: 11/2/2022

Reach JN2

Assessed Stream Length 383

Assessed Bank Length 766

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
Totals					0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	9	9		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	2	2		100%

Visual Stream Stability Assessment

Assessment Date: 11/2/2022

Reach MC3

Assessed Stream Length 214

Assessed Bank Length 428

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
Totals					0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	0	0		NA
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	0	0		NA

Table 6 Vegetation Condition Assessment

Assessment Date: 11/2/2022

Planted Acreage[1] **10.7**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres	Red Simple Hatch	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Orange Simple Hatch	2	0.83	7.8%
			Total		0.83	7.8%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Orange Simple Hatch	0	0.00	0.0%
			Cumulative Total		0.83	7.8%

Easement Acreage[2] **25.91**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF	Yellow Crosshatch	0	0.00	0.0%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	Red Simple Hatch	2	0.83	3.2%

1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

2 = The acreage within the easement boundaries.

3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particulalry for situations where the conditon for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

Little Sebastian MY2 Vegetation Monitoring Plot Photos

Vegetation Plot 1 (11/2/2022)

Vegetation Plot 2 (11/2/2022)

Vegetation Plot 3 (11/2/2022)

Vegetation Plot 4 (11/2/2022)

Vegetation Plot 5 (11/2/2022)

Vegetation Plot 6 (11/17/2021)

Random Vegetation Plot 1 (11/2/2022)

Random Vegetation Plot 2 (11/2/2022)

Random Vegetation Plot 3 (11/2/2022)

Bare area along eastern side of BS1 (mowing/encroachment)

Little Sebastian Monitoring Device Photos - July 12th, 2022

Flow Gauge JN2-B

Flow Gauge JN7

Flow Gauge BS1-A

Stage Recorder BS1-E

Stage Recorder JN3-B

Groundwater Well 1

Groundwater Well 2

Little Sebastian Crossing Photos - July 12th, 2022

JN2-C (upstream)

JN2-C (downstream)

JN2-D (upstream) - Nov 2021

JN2-D (downstream) – Nov 2021

JN3-B (upstream)

JN3-B (downstream)

MC1-C (downstream)

MC3-B/C

BS1-E (upstream)

BS1-E (downstream)

Appendix C

Vegetation Plot Data

Table 7. Planted Species Summary

Common Name	Scientific Name	Mit Plan %	As-Built %	Total Stems Planted
Willow Oak	*Quercus phellos*	15	15	1,600
River Birch	*Betula nigra*	15	15	1,600
Sycamore	*Platanus occidentalis*	10	15	1,600
Water Oak	*Quercus nigra*	15	14	1,600
Northern Red Oak	*Quercus rubra*	10	11	1,200
Yellow Poplar	*Liriodendron tulipifera*	10	10	1,100
Green Ash	*Fraxinus pennsylvanica*	10	5	600
Persimmon	*Diospyros virginiana*	5	5	600
Buttonbush	*Cephalanthus occidentalis*	0	5	600
Sugarberry	*Celtis laevigata*	0	5	600
Elderberry	*Sambucus canadensis*	5	0	0
Nyssa sylvatica	*Blackgum*	5	0	0
			Total	11,100
			Planted Area	10.7
			As-built Planted Stems/Acre	1,037

Table 8. Vegetation Plot Mitigation Success Summary

Plot #	Planted Stems/Acre	Volunteer Stems/Acre	Total Stems/Acre	Success Criteria Met?	Averaged Planted Stem Height (ft)
1	769	0	769	Yes	2.7
2	1012	0	1012	Yes	2.9
3	1093	0	1093	Yes	3.9
4	1133	0	1133	Yes	1.9
5	769	0	769	Yes	3.8
6	607	0	607	Yes	2.2
R1	647	0	647	Yes	2.5
R2	850	0	850	Yes	4.3
R3	526	0	526	Yes	1.9
Project Avg	**823**	**0**	**823**	**Yes**	**3.0**

Table 9. Stem Count Total and Planted by Plot Species

Little Sebastian			Current Plot Data (MY2 2022)																												
			100027-01-0001			100027-01-0002			100027-01-0003			100027-01-0004			100027-01-0005			100027-01-0006			100027-01-R1			100027-01-R2			100027-01-R3		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Betula nigra	river birch	Tree	6	6	6				4	4	4				5	5	5				3	3	3				4	4	4
Celtis laevigata	sugarberry	Tree																1	1	1									
Cephalanthus occidentalis	common buttonbush	Shrub	5	5	5	5	5	5				1	1	1				1	1	1				1	1	1			
Diospyros virginiana	common persimmon	Tree																4	4	4									
Fraxinus pennsylvanica	green ash	Tree													2	2	2	1	1	1									
Liriodendron tulipifera	tuliptree	Tree	2	2	2				1	1	1	1	1	1							3	3	3				3	3	3
Platanus occidentalis	American sycamore	Tree	3	3	3	6	6	6	15	15	15	8	8	8	5	5	5	2	2	2	4	4	4	12	12	12	2	2	2
Quercus nigra	water oak	Tree	1	1	1	3	3	3	2	2	2	3	3	3	3	3	3	2	2	2				1	1	1			
Quercus phellos	willow oak	Tree				6	6	6	4	4	4	14	14	14	1	1	1	3	3	3	5	5	5	1	1	1	4	4	4
Quercus rubra	northern red oak	Tree	2	2	2	5	5	5	1	1	1	1	1	1	3	3	3	1	1	1	1	1	1	6	6	6			
		Stem count	19	19	19	25	25	25	27	27	27	28	28	28	19	19	19	15	15	15	16	16	16	21	21	21	13	13	13
		size (ares)	1			1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	6	6	6	5	5	5	6	6	6	6	6	6	6	6	6	8	8	8	5	5	5	5	5	5	4	4	4
		Stems per ACRE	769	769	769	1012	1012	1012	1093	1093	1093	1133	1133	1133	769	769	769	607	607	607	647	647	647	850	850	850	526	526	526

Little Sebastian			Annual Means								
			MY2 (2022)			MY1 (2021)			MY0 (2021)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Betula nigra	river birch	Tree	22	22	22	15	15	15	15	15	15
Celtis laevigata	sugarberry	Tree	1	1	1	3	3	3	4	4	4
Cephalanthus occidentalis	common buttonbush	Shrub	13	13	13	11	11	11	13	13	13
Diospyros virginiana	common persimmon	Tree	4	4	4	3	3	3	5	5	5
Fraxinus pennsylvanica	green ash	Tree	3	3	3	4	4	4	4	4	4
Liriodendron tulipifera	tuliptree	Tree	10	10	10	6	6	6	7	7	7
Platanus occidentalis	American sycamore	Tree	57	57	57	41	41	41	41	41	41
Quercus nigra	water oak	Tree	15	15	15	12	12	12	13	13	13
Quercus phellos	willow oak	Tree	38	38	38	31	31	31	32	32	32
Quercus rubra	northern red oak	Tree	20	20	20	17	17	17	22	22	22
		Stem count	183	183	183	143	143	143	156	156	156
		size (ares)	9			6			6		
		size (ACRES)	0.22			0.15			0.15		
		Species count	10	10	10	10	10	10	10	10	10
		Stems per ACRE	823	823	823	965	965	965	1052	1052	1052

Appendix D

Stream Measurement and Geomorphology Data

Table 10. Baseline Stream Data Summary
Little Sebastian Mitigation Site - Reach JN-3

Parameter	Gauge[2]	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline					
Dimension and Substrate - Riffle Only		LL	UL	Eq.	Min	Mean	Med	Max	SD[5]	n	Min	Mean	Med	Max	SD[5]	n	Min	Med	Max	Min	Mean	Med	Max	SD[5]	n
Bankfull Width (ft)		---	---	---	14.9	16.4	--	17.9	---	2	7.1	12.3	--	17.5	---	2	---	16.0	---	---	---	15.0	---	---	1
Floodprone Width (ft)					37.0	48.5	--	60.0	---	2	>30	51.3	--	72.5	---	2	---	>50	---	---	---	>64.4	---	---	1
Bankfull Mean Depth (ft)		---	---	---	1.6	1.7	--	1.6	---	2	1.0	1.3	--	1.6	---	2	---	2.2	---	---	---	---	---	---	---
[1]Bankfull Max Depth (ft)					2.1	3.0	--	3.9	---	2	1.2	1.9	--	2.6	---	2	---	2.9	---	---	---	2.2	---	---	1
Bankfull Cross Sectional Area (ft^2)		---	---	---	26.1	27.3	--	28.5	---	2	6.7	17.2	--	27.7	---	2	---	26.9	---	---	---	22.8	---	---	1
Width/Depth Ratio					8.5	9.9	--	11.2	---	2	7.4	9.3	--	11.1	---	2	---	9.5	---	---	---	---	---	---	---
Entrenchment Ratio					2.5	3.0	--	3.4	---	2	>4	4.2	--	4.3	---	2	---	>2.2	---	---	---	>4.3	---	---	1
[1]Bank Height Ratio					1.0	1.2	--	1.3	---	2	1.0	1.2	--	1.3	---	2	---	1.0	---	---	---	1.0	---	---	1
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	5.6	---	---	17	---	---	7	---	29	14	25	22	48	10	18
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.43	2.605	2.735	5.1	1.23176	18
Pool Length (ft)					---	---	---	---	---	---	4	---	---	16	---	---	4	---	18	19	35	34	55	10	17
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	26	---	---	68	---	---	29	---	75	38	59	59	78	11	15
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	20	---	---	85	---	---	39	---	94	39	---	---	94	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	7	---	---	54	---	---	14	---	60	14	---	---	60	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	0.9	---	---	3.7	---	---	0.9	---	3.7	0.9	---	---	3.7	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	33	---	---	105	---	---	74	---	116	74	---	---	116	---	---
Meander Width Ratio					---	---	---	---	---	---	2.4	---	---	5.9	---	---	2.4	---	5.9	2.4	---	---	5.9	---	---
Transport parameters																									
Reach Shear Stress (competency) lb/f^2					---												---			---					
Max part size (mm) mobilized at bankfull					---												---			---					
Stream Power (transport capacity) W/m^2					---												---			---					
Additional Reach Parameters																									
Rosgen Classification					E3						E3/E4b						E3			E3					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---												---			---					
Valley length (ft)					602						160						945			945					
Channel Thalweg length (ft)					772						189						1088			1088					
Sinuosity (ft)					1.225						1.195						1.15			1.15					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.0125						1.85						0.0085			0.0085					
[3]Bankfull Floodplain Area (acres)					---						---						---			---					
[4]% of Reach with Eroding Banks					---						---														
Channel Stability or Habitat Metric					---						---														
Biological or Other					---						---														

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section measurements and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing XS measurement data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

Table 10. Baseline Stream Data Summary
Little Sebastian Mitigation Site - Reach MC1-C

Parameter	Gauge[2]	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline					
		LL	UL	Eq.	Min	Mean	Med	Max	SD[5]	n	Min	Mean	Med	Max	SD[5]	n	Min	Med	Max	Min	Mean	Med	Max	SD[5]	n
Dimension and Substrate - Riffle Only																									
Bankfull Width (ft)		---	---	---	---	---	17.4	---	---	1	7.1	12.3	--	17.5	---	2	---	23.0	---	---	---	21.3	---	---	1
Floodprone Width (ft)					---	---	50.0	---	---	1	>30	51.3	--	72.5	---	2	---	>50	---	---	---	>64.9	---	---	1
Bankfull Mean Depth (ft)		---	---	---	---	---	1.8	---	---	1	1.0	1.3	--	1.6	---	2	---	2.4	---	---	---	---	---	---	---
[1]Bankfull Max Depth (ft)					---	---	2.9	---	---	1	1.2	1.9	--	2.6	---	2	---	3.2	---	---	---	3.2	---	---	1
Bankfull Cross Sectional Area (ft^2)		---	---	---	---	---	30.6	---	---	1	6.7	17.2	--	27.7	---	2	---	54.4	---	---	---	49.8	---	---	1
Width/Depth Ratio					---	---	10.0	---	---	1	7.4	9.3	--	11.1	---	2	---	9.7	---	---	---	---	---	---	---
Entrenchment Ratio					---	---	2.9	---	---	1	>4	4.2	--	4.3	---	2	---	>2.2	---	---	---	>3	---	---	1
[1]Bank Height Ratio					---	---	1.0	---	---	1	1.0	1.2	--	1.3	---	2	---	1.0	---	---	---	1.0	---	---	1
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	5.6	---	---	17	---	---	10	---	41	14	25	18	61	17	7
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.19	2.32	1.35	4.8	1.89753	7
Pool Length (ft)					---	---	---	---	---	---	4	---	---	16	---	---	6	---	25	36	51	48	73	12	6
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	26	---	---	68	---	---	41	---	108	65	81	73	109	19	5
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	20	---	---	85	---	---	56	---	135	56	---	---	135	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	7	---	---	54	---	---	21	---	86	21	---	---	86	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	0.9	---	---	3.7	---	---	1	---	4	1	---	---	4	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	33	---	---	105	---	---	106	---	167	106	---	---	167	---	---
Meander Width Ratio					---	---	---	---	---	---	2.4	---	---	5.9	---	---	2	---	6	2	---	---	6	---	---
Transport parameters																									
Reach Shear Stress (competency) lb/f^2					---												---			---					
Max part size (mm) mobilized at bankfull					---												---			---					
Stream Power (transport capacity) W/m^2					---												---			---					
Additional Reach Parameters																									
Rosgen Classification					E3						E3/E4b						E3			E3					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---												---			---					
Valley length (ft)					1109						160						478			478					
Channel Thalweg length (ft)					1288						189						542			542					
Sinuosity (ft)					1.16						1.195						1.13			1.13					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.008						1.85						0.0085			0.0085					
[3]Bankfull Floodplain Area (acres)					---						---						---			---					
[4]% of Reach with Eroding Banks					---						---														
Channel Stability or Habitat Metric					---						---														
Biological or Other					---						---														

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section measurements and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing XS measurement data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

Table 10. Baseline Stream Data Summary
Little Sebastian Mitigation Site - Reach BS-1

Parameter	Gauge[2]	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline					
Dimension and Substrate - Riffle Only		LL	UL	Eq.	Min	Mean	Med	Max	SD[5]	n	Min	Mean	Med	Max	SD[5]	n	Min	Med	Max	Min	Mean	Med	Max	SD[5]	n
Bankfull Width (ft)		---	---	---	---	---	3.2	---	---	1	7.1	12.3	--	17.5	---	2	---	4.5	---	5.7	6.0	---	6.3	---	2
Floodprone Width (ft)					---	---	60.0	---	---	1	>30	51.3	--	72.5	---	2	---	---	---	11.3	17.6	---	23.8	---	2
Bankfull Mean Depth (ft)		---	---	---	---	---	1.6	---	---	1	1.0	1.3	--	1.6	---	2	---	0.6	---	---	---	---	---	---	---
[1]Bankfull Max Depth (ft)					---	---	3.9	---	---	1	1.2	1.9	--	2.6	---	2	---	0.7	---	0.7	0.9	---	1.1	---	2
Bankfull Cross Sectional Area (ft^2)		---	---	---	---	---	2.4	---	---	1	6.7	17.2	--	27.7	---	2	---	2.7	---	2.6	3.3	---	4.0	---	2
Width/Depth Ratio					---	---	4.2	---	---	1	7.4	9.3	--	11.1	---	2	---	7.4	---	---	---	---	---	---	---
Entrenchment Ratio					---	---	3.4	---	---	1	>4	4.2	--	4.3	---	2	---	>1.4	---	2.0	2.9	---	3.8	---	2
[1]Bank Height Ratio					---	---	1.0	---	---	1	1.0	1.2	--	1.3	---	2	---	1.0	---	1.0	1.0	---	1.0	---	2
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	5.6	---	---	17	---	---	4.0	---	11	4	16	16	32	8	19
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.1	5.9	5.0	14.5	3.7	19
Pool Length (ft)					---	---	---	---	---	---	4	---	---	16	---	---	2.0	---	7	11	18	15	43	8	17
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	26	---	---	68	---	---	5.0	---	20	21	34	33	63	10	17
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	20	---	---	85	---	---	13.0	---	19.0	13.0	---	---	19.0	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	7	---	---	54	---	---	4.0	---	10.0	4.0	---	---	10.0	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	0.9	---	---	3.7	---	---	1.0	---	2.0	1.0	---	---	2.0	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	33	---	---	105	---	---	21.0	---	32.0	21.0	---	---	32.0	---	---
Meander Width Ratio					---	---	---	---	---	---	2.4	---	---	5.9	---	---	3.0	---	4.0	3.0	---	---	4.0	---	---
Transport parameters																									
Reach Shear Stress (competency) lb/f^2					---												---			---					
Max part size (mm) mobilized at bankfull					---												---			---					
Stream Power (transport capacity) W/m^2					---												---			---					
Additional Reach Parameters																									
Rosgen Classification					B4a						E3/E4b						B4/E4			B4/E4					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---												---			---					
Valley length (ft)					1508						160						1017			1017					
Channel Thalweg length (ft)					1703						189						1028			1028					
Sinuosity (ft)					1.13						1.195						1.01			1.01					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.049						1.85						0.025-0.035			0.025-0.035					
[3]Bankfull Floodplain Area (acres)					---						---						---			---					
[4]% of Reach with Eroding Banks					---						---														
Channel Stability or Habitat Metric					---						---														
Biological or Other					---						---														

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section measurements and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing XS measurement data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

Appendix D. Table 11 - Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

Project Name/Number: Little Sebastian #100027

	Cross Section 1 (Riffle)							Cross Section 2 (Riffle)							Cross Section 3 (Riffle)							Cross Section 4 (Riffle)							Cross Section 5 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1214.7	1214.8	1214.8					1211.2	1211.3	1211.4					1170.7	1170.7	1170.7					1165.0	1164.9	1165.0					1150.6	1150.7	1150.8				
Bankfull Width (ft)[1]	5.4	5.1	5.5					5.4	5.6	5.7					5.3	5.8	5.6					9.0	8.8	8.5					21.3	21.0	21.3				
Floodprone Width (ft)[1]	13.1	11.2	11.5					8.7	8.8	9.4					>34.8	>34.1	>33.5					>43.9	>43.2	>43.9					>64.9	>65.1	>65				
Bankfull Max Depth (ft)[2]	0.7	1.0	1.2					0.5	0.8	0.9					1.0	1.1	1.0					0.9	0.8	0.8					3.2	3.1	3.0				
Low Bank Elevation (ft)	1214.74	1215.0	1215.2					1211.2	1211.6	1211.7					1170.7	1170.8	1170.7					1165.0	1164.8	1164.9					1150.6	1150.6	1150.7				
Bankfull Cross Sectional Area (ft^2)[2]	2.4	4.1	4.9					2.3	4.1	4.3					3.5	4.3	3.8					3.5	2.6	2.4					49.8	48.2	47.2				
Bankfull Entrenchment Ratio[1]	2.4	2.2	2.1					1.6	1.6	1.7					>6.6	>5.9	>5.9					>4.9	>4.9	>5.2					>3.0	>3.1	>3.1				
Bankfull Bank Height Ratio[1]	1.0	1.4	1.5					1.0	1.5	1.6					1.0	1.1	1.1					1.0	0.9	0.9					1.0	1.0	1.0				

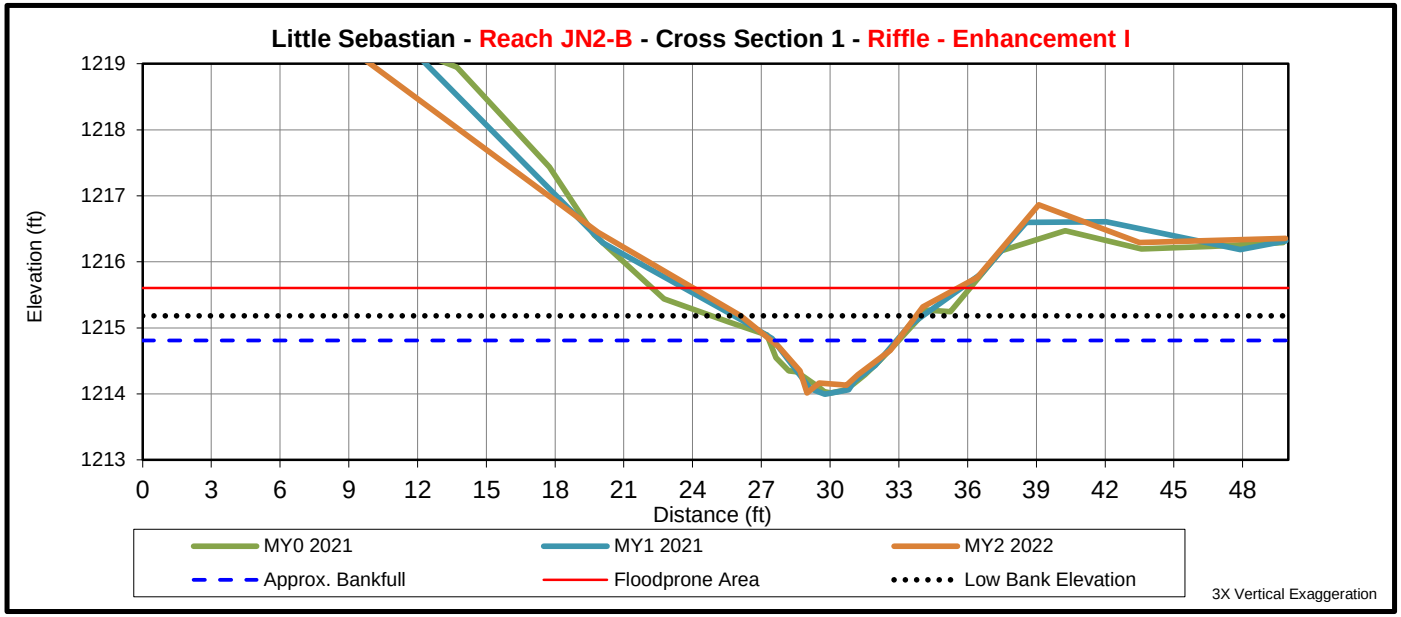
	Cross Section 6 (Pool)							Cross Section 7 (Riffle)							Cross Section 8 (Pool)							Cross Section 9 (Pool)							Cross Section 10 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1150.5	1150.6	1150.7					1157.4	1157.3	1157.4					1157.2	1157.2	1157.3					1188.3	1188.4	1188.4					1187.6	1187.6	1187.6				
Bankfull Width (ft)[1]	-	-	-					15.0	15.0	14.9					-	-	-					-	-	-					6.3	7.1	7.7				
Floodprone Width (ft)[1]	-	-	-					>64.4	>64.7	>64.3					-	-	-					-	-	-					23.8	23.5	23.3				
Bankfull Max Depth (ft)[2]	4.1	4.1	4.0					2.2	2.4	2.5					3.6	4.2	4.3					1.0	0.9	1.1					1.1	1.0	1.1				
Low Bank Elevation (ft)	-	-	-					1157.4	1157.4	1157.4					-	-	-					-	-	-					1187.6	1187.5	1187.6				
Bankfull Cross Sectional Area (ft^2)[2]	56.7	56.4	54.2					22.8	24.4	23.5					34.8	34.0	32.5					3.6	3.0	3.7					4.0	3.4	4.2				
Bankfull Entrenchment Ratio[1]	-	-	-					>4.3	>4.3	>4.3					-	-	-					-	-	-					3.8	3.3	3.0				
Bankfull Bank Height Ratio[1]	-	-	-					1.0	1.0	1.0					-	-	-					-	-	-					1.0	0.9	1.0				

	Cross Section 11 (Riffle)							Cross Section 12 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1136.4	1136.4	1136.5					1136.1	1136.2	1136.3				
Bankfull Width (ft)[1]	5.7	6.5	6.5					-	-	-				
Floodprone Width (ft)[1]	11.3	11.3	11.9					-	-	-				
Bankfull Max Depth (ft)[2]	0.7	0.7	0.7					1.2	0.9	1.0				
Low Bank Elevation (ft)	1136.4	1136.5	1136.4					-	-	-				
Bankfull Cross Sectional Area (ft^2)[2]	2.6	3.0	2.3					4.6	4.1	3.5				
Bankfull Entrenchment Ratio[1]	2.0	1.7	1.8					-	-	-				
Bankfull Bank Height Ratio[1]	1.0	1.1	0.9					-	-	-				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

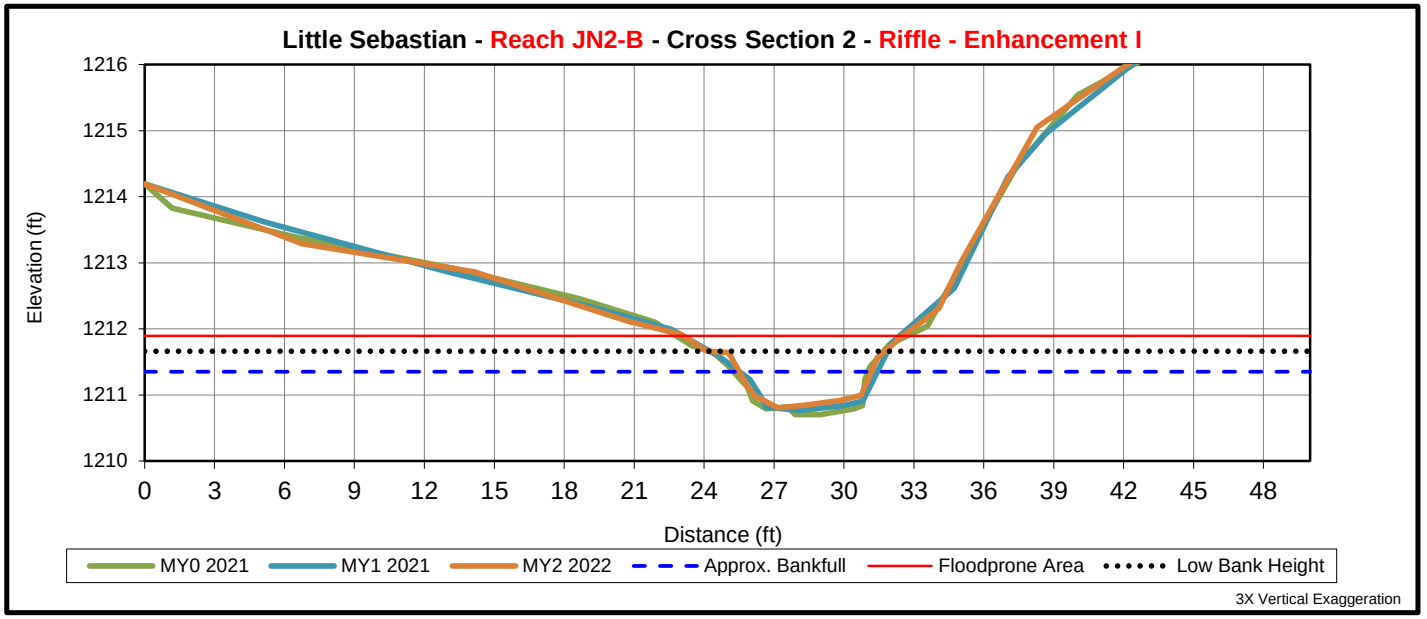


	Cross Section 1 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1214.7	1214.8	1214.8				
Bankfull Width (ft)[1]	5.4	5.1	5.5				
Floodprone Width (ft)[1]	13.1	11.2	11.5				
Bankfull Max Depth (ft)[2]	0.7	1.0	1.2				
Low Bank Elevation (ft)	1214.74	1215.0	1215.2				
Bankfull Cross Sectional Area (ft^2)[2]	2.4	4.1	4.9				
Bankfull Entrenchment Ratio[1]	2.4	2.2	2.1				
Bankfull Bank Height Ratio[1]	1.0	1.4	1.5				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

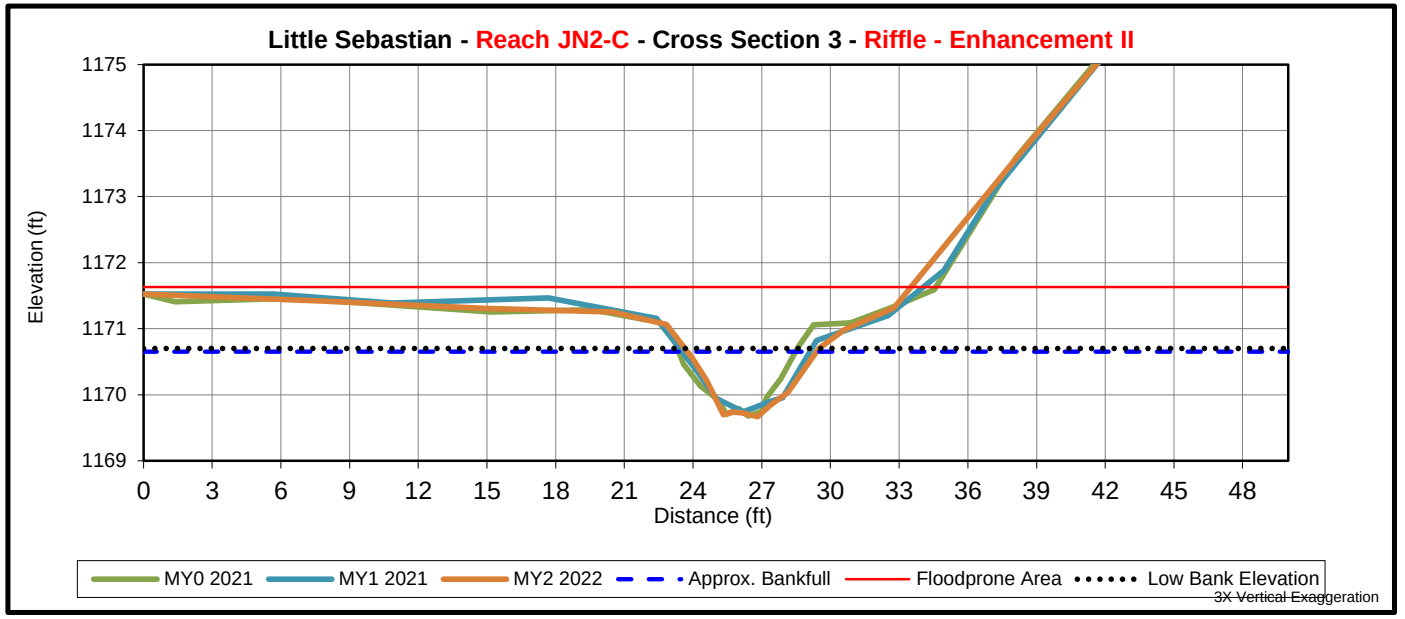


	Cross Section 2 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1211.2	1211.3	1211.4				
Bankfull Width (ft)[1]	5.4	5.6	5.7				
Floodprone Width (ft)[1]	8.7	8.8	9.4				
Bankfull Max Depth (ft)[2]	0.5	0.8	0.9				
Low Bank Elevation (ft)	1211.2	1211.6	1211.7				
Bankfull Cross Sectional Area (ft^2)[2]	2.3	4.1	4.3				
Bankfull Entrenchment Ratio[1]	1.6	1.6	1.7				
Bankfull Bank Height Ratio[1]	1.0	1.5	1.6				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

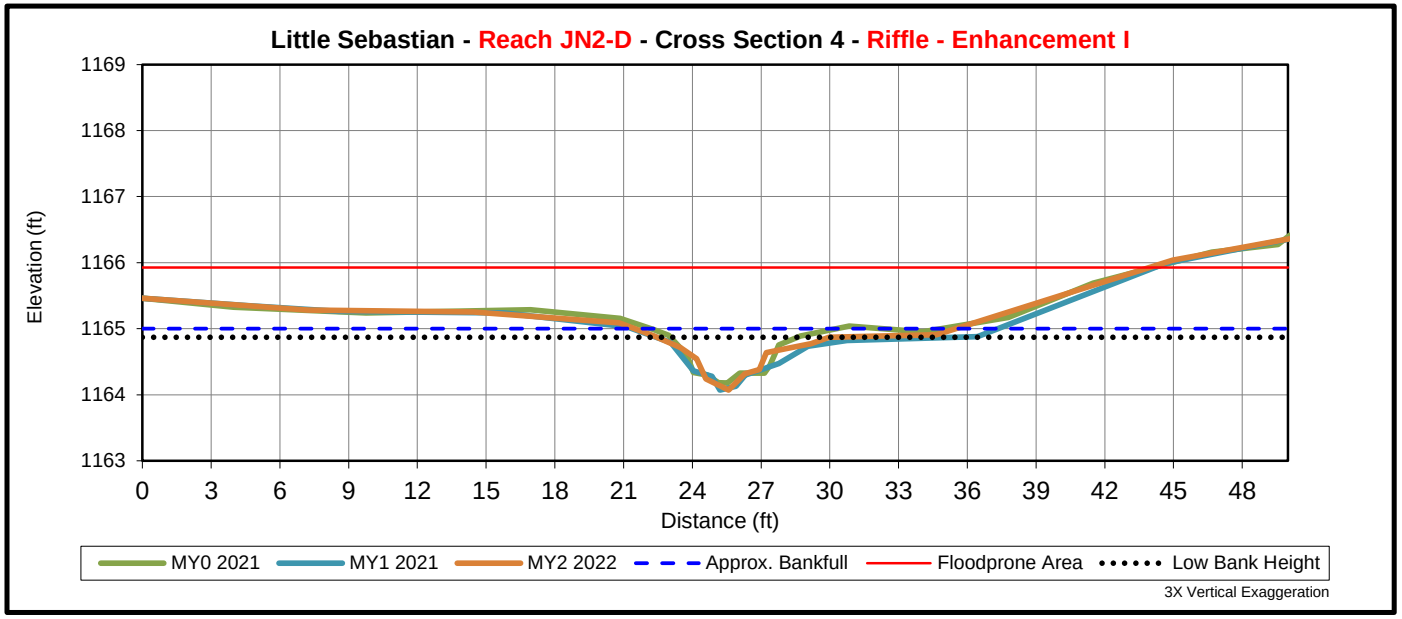


	Cross Section 3 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1170.7	1170.7	1170.7				
Bankfull Width (ft)[1]	5.3	5.8	5.6				
Floodprone Width (ft)[1]	>34.8	>34.1	>33.5				
Bankfull Max Depth (ft)[2]	1.0	1.1	1.0				
Low Bank Elevation (ft)	1170.7	1170.8	1170.7				
Bankfull Cross Sectional Area (ft^2)[2]	3.5	4.3	3.8				
Bankfull Entrenchment Ratio[1]	>6.6	>5.9	>5.9				
Bankfull Bank Height Ratio[1]	1.0	1.1	1.1				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

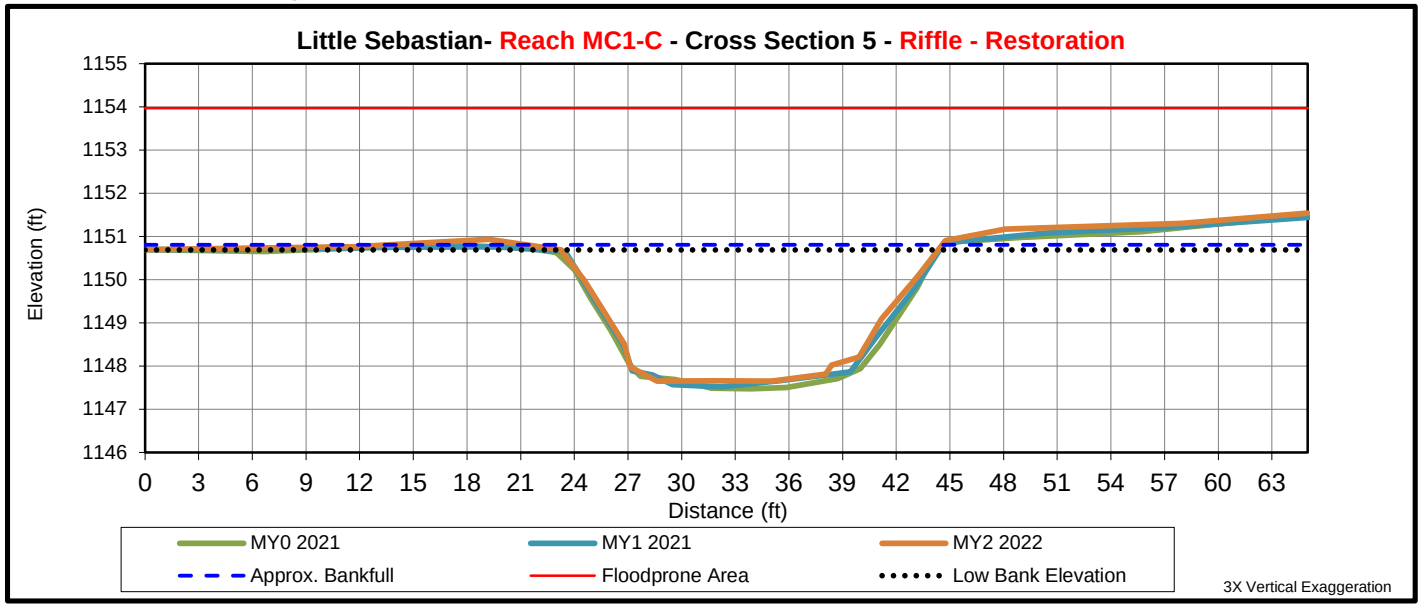


	Cross Section 4 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1165.0	1164.9	1165.0				
Bankfull Width (ft)[1]	9.0	8.8	8.5				
Floodprone Width (ft)[1]	>43.9	>43.2	>43.9				
Bankfull Max Depth (ft)[2]	0.9	0.8	0.8				
Low Bank Elevation (ft)	1165.0	1164.8	1164.9				
Bankfull Cross Sectional Area (ft^2)[2]	3.5	2.6	2.4				
Bankfull Entrenchment Ratio[1]	>4.9	>4.9	>5.2				
Bankfull Bank Height Ratio[1]	1.0	0.9	0.9				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

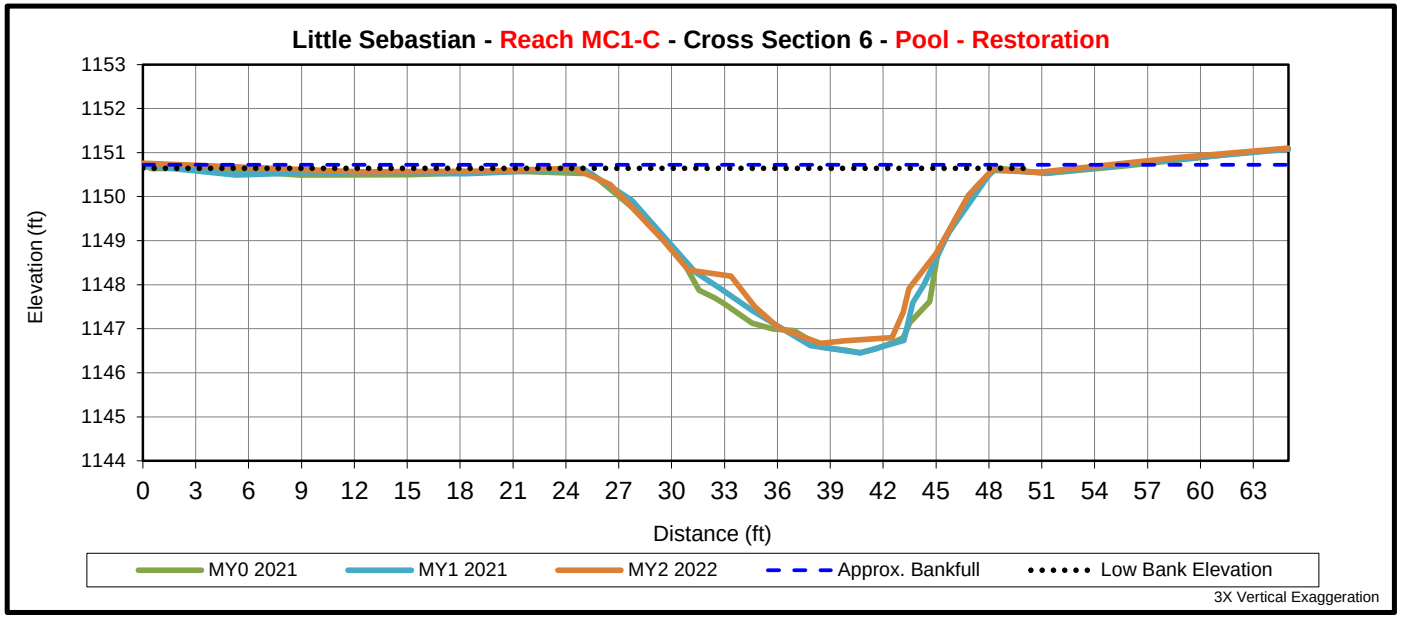


	Cross Section 5 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1150.6	1150.7	1150.8				
Bankfull Width (ft)[1]	21.3	21.0	21.3				
Floodprone Width (ft)[1]	>64.9	>65.1	>65				
Bankfull Max Depth (ft)[2]	3.2	3.1	3.0				
Low Bank Elevation (ft)	1150.6	1150.6	1150.7				
Bankfull Cross Sectional Area (ft^2)[2]	49.8	48.2	47.2				
Bankfull Entrenchment Ratio[1]	>3.0	>3.1	>3.1				
Bankfull Bank Height Ratio[1]	1.0	1.0	1.0				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

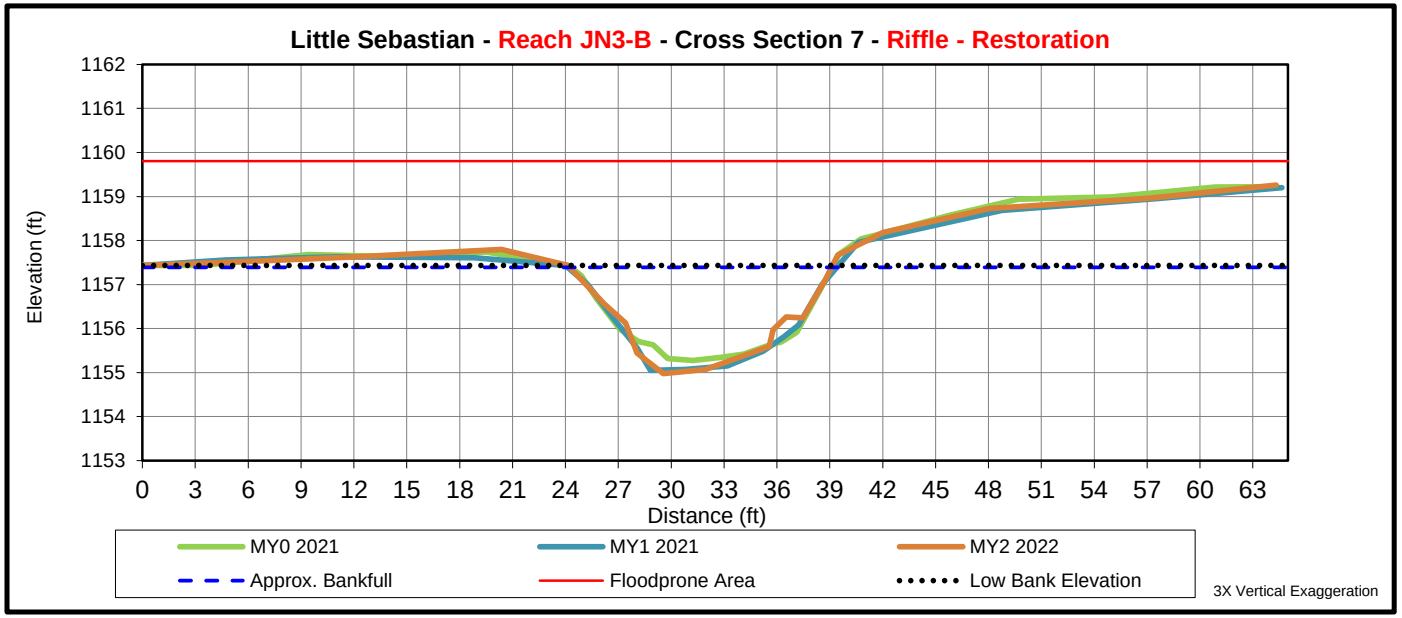


	Cross Section 6 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1150.5	1150.6	1150.7				
Bankfull Width (ft)[1]	-	-	-				
Floodprone Width (ft)[1]	-	-	-				
Bankfull Max Depth (ft)[2]	4.1	4.1	4.0				
Low Bank Elevation (ft)	-	-	-				
Bankfull Cross Sectional Area (ft^2)[2]	56.7	56.4	54.2				
Bankfull Entrenchment Ratio[1]	-	-	-				
Bankfull Bank Height Ratio[1]	-	-	-				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

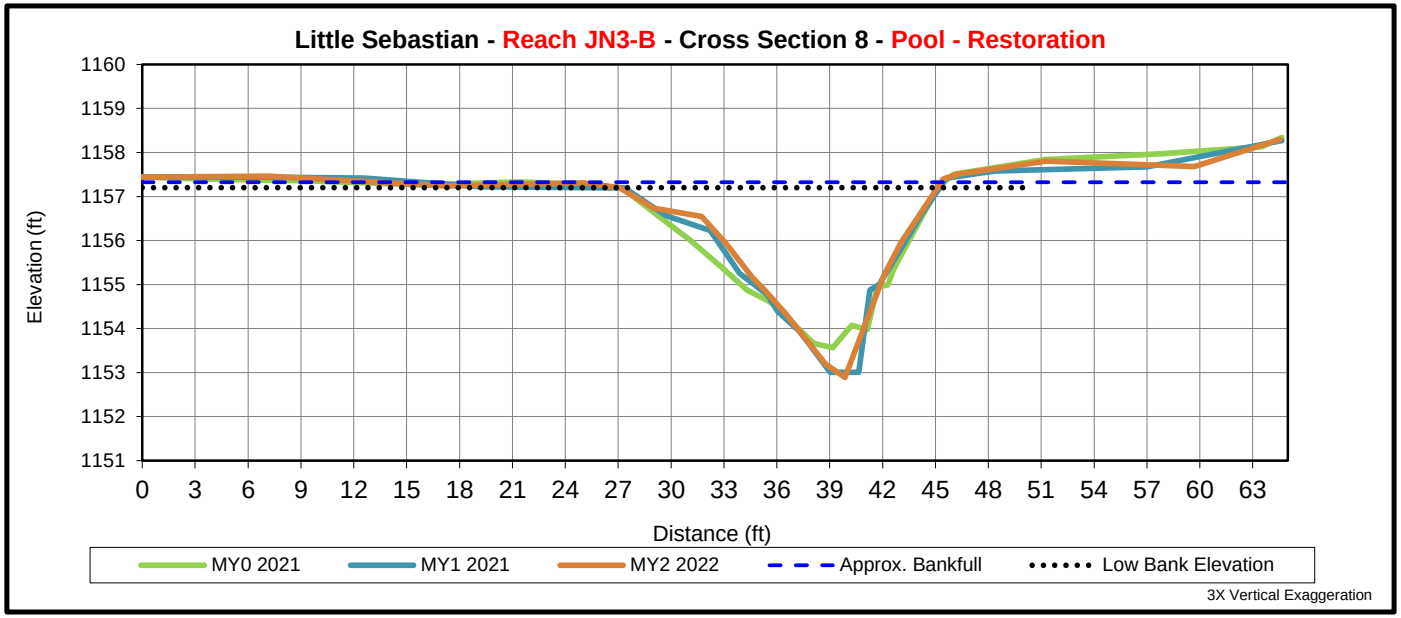


	Cross Section 7 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1157.4	1157.3	1157.4				
Bankfull Width (ft)[1]	15.0	15.0	14.9				
Floodprone Width (ft)[1]	>64.4	>64.7	>64.3				
Bankfull Max Depth (ft)[2]	2.2	2.4	2.5				
Low Bank Elevation (ft)	1157.4	1157.4	1157.4				
Bankfull Cross Sectional Area (ft^2)[2]	22.8	24.4	23.5				
Bankfull Entrenchment Ratio[1]	>4.3	>4.3	>4.3				
Bankfull Bank Height Ratio[1]	1.0	1.0	1.0				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

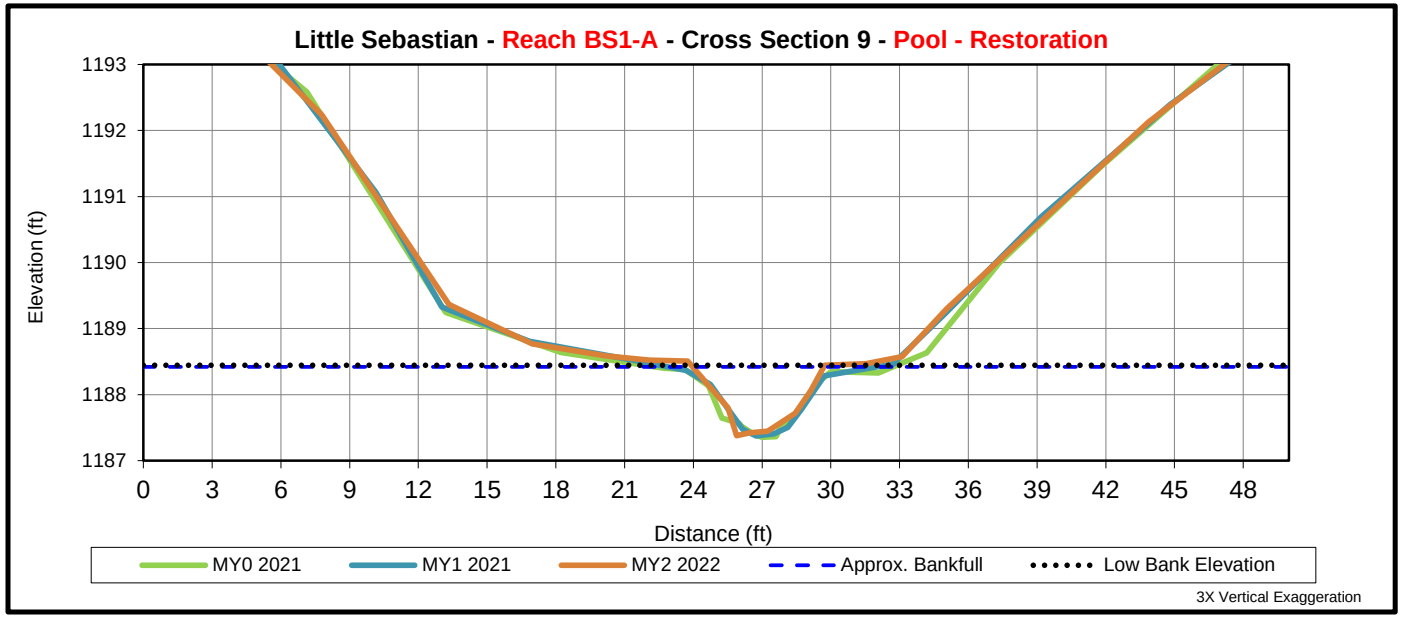


	Cross Section 8 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1157.2	1157.2	1157.3				
Bankfull Width (ft)[1]	-	-	-				
Floodprone Width (ft)[1]	-	-	-				
Bankfull Max Depth (ft)[2]	3.6	4.2	4.3				
Low Bank Elevation (ft)	-	-	-				
Bankfull Cross Sectional Area (ft^2)[2]	34.8	34.0	32.5				
Bankfull Entrenchment Ratio[1]	-	-	-				
Bankfull Bank Height Ratio[1]	-	-	-				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

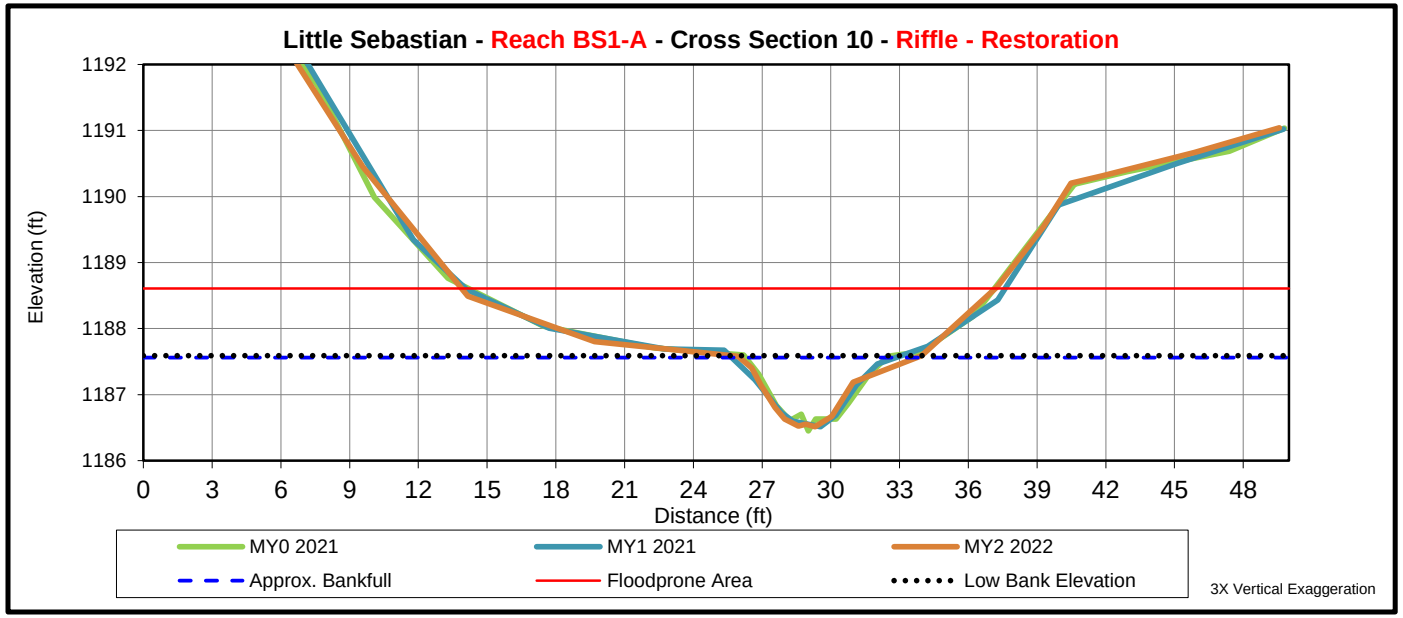


	Cross Section 9 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1188.3	1188.4	1188.4				
Bankfull Width (ft)[1]	-	-	-				
Floodprone Width (ft)[1]	-	-	-				
Bankfull Max Depth (ft)[2]	1.0	0.9	1.1				
Low Bank Elevation (ft)	-	-	-				
Bankfull Cross Sectional Area (ft^2)[2]	3.6	3.0	3.7				
Bankfull Entrenchment Ratio[1]	-	-	-				
Bankfull Bank Height Ratio[1]	-	-	-				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

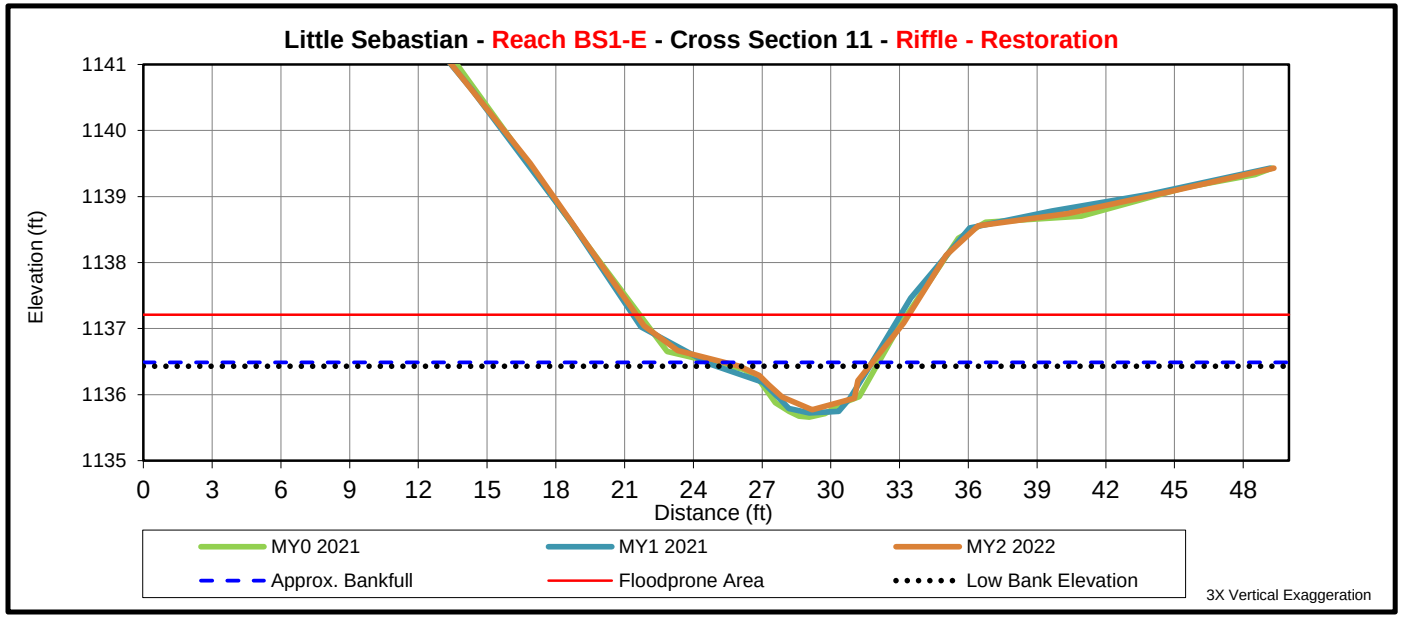


	Cross Section 10 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1187.6	1187.6	1187.6				
Bankfull Width (ft)[1]	6.3	7.1	7.7				
Floodprone Width (ft)[1]	23.8	23.5	23.3				
Bankfull Max Depth (ft)[2]	1.1	1.0	1.1				
Low Bank Elevation (ft)	1187.6	1187.5	1187.6				
Bankfull Cross Sectional Area (ft^2)[2]	4.0	3.4	4.2				
Bankfull Entrenchment Ratio[1]	3.8	3.3	3.0				
Bankfull Bank Height Ratio[1]	1.0	0.9	1.0				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

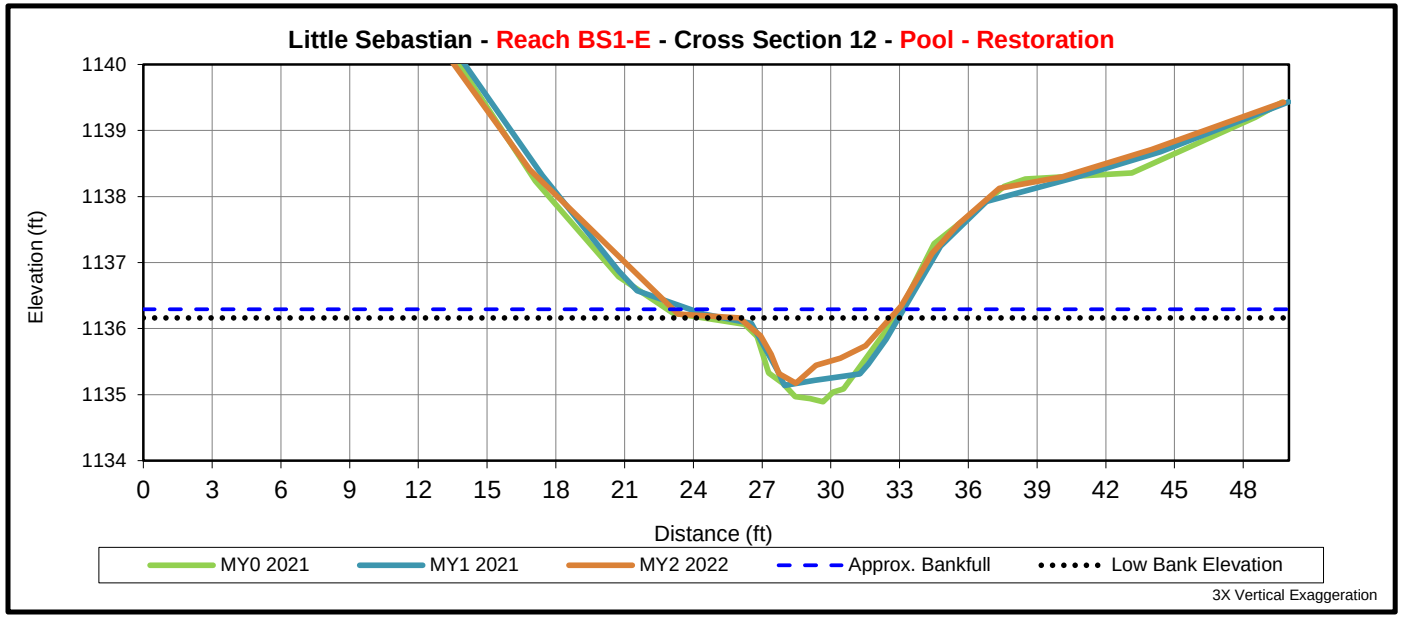


	Cross Section 11 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1136.4	1136.4	1136.5				
Bankfull Width (ft)[1]	5.7	6.5	6.5				
Floodprone Width (ft)[1]	11.3	11.3	11.9				
Bankfull Max Depth (ft)[2]	0.7	0.7	0.7				
Low Bank Elevation (ft)	1136.4	1136.5	1136.4				
Bankfull Cross Sectional Area (ft^2)[2]	2.6	3.0	2.3				
Bankfull Entrenchment Ratio[1]	2.0	1.7	1.8				
Bankfull Bank Height Ratio[1]	1.0	1.1	0.9				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



	Cross Section 12 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1136.1	1136.2	1136.3				
Bankfull Width (ft)[1]	-	-	-				
Floodprone Width (ft)[1]	-	-	-				
Bankfull Max Depth (ft)[2]	1.2	0.9	1.0				
Low Bank Elevation (ft)	-	-	-				
Bankfull Cross Sectional Area (ft^2)[2]	4.6	4.1	3.5				
Bankfull Entrenchment Ratio[1]	-	-	-				
Bankfull Bank Height Ratio[1]	-	-	-				

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Appendix E

Hydrology Data

Table 12. Rainfall Summary MY2 2022

Month	Average	Normal Limits		Raven Knob Station Precipitation
		30 Percent	70 Percent	
January	3.98	2.77	4.74	2.67
February	3.30	2.20	3.95	5.04
March	4.07	2.92	4.80	3.82
April	4.19	2.83	5.01	2.31
May	4.59	3.06	5.50	5.91
June	4.76	3.24	5.69	1.76
July	5.32	3.78	6.30	11.20
August	4.97	3.51	5.90	4.29
September	4.30	3.11	5.08	3.53
October	3.57	2.32	4.29	2.54
November	3.36	1.99	4.08	3.18
December	4.03	2.80	4.79	---
Total	50.44	34.53	60.13	46.25
Above Normal Limits	Below Normal Limits	Within Normal Limits		

Note: Raven Knob CRONOS Station is approximately 6 miles north of the site

Table 13. Documentation of Geomorphically Significant Flow Events

Year	Number of Bankfull Events	Maximum Bankfull Height (ft)	Date of Maximum Bankfull Event	
Stage Recorder JN3-B				
MY1 2021	0	N/A	N/A	
MY2 2022	1	0.02	7/9/2022	
Stage Recorder BS1-E				
MY1 2021	0	N/A	N/A	
MY2 2022	0	N/A	N/A	
Year	**Number of Flow Events**	**Maximum Consecutive Flow Days**	**Maximum Cummlative Flow Days**	**Maximum Consecutive Flow Date Range**
Flow Gauge JN2-B				
MY1 2021	1	243	243	3/19/2021 - 11/17/2021
MY2 2022	5	119	153	7/6/2022 - 11/2/2022
Flow Gauge BS1-A				
MY1 2021	1	243	243	3/19/2021 - 11/17/2021
MY2 2022	1	305	305	1/1/2022 - 11/2/2022
Flow Gauge JN7*				
MY2 2022	1	273	273	2/1/2022 - 11/2/2022

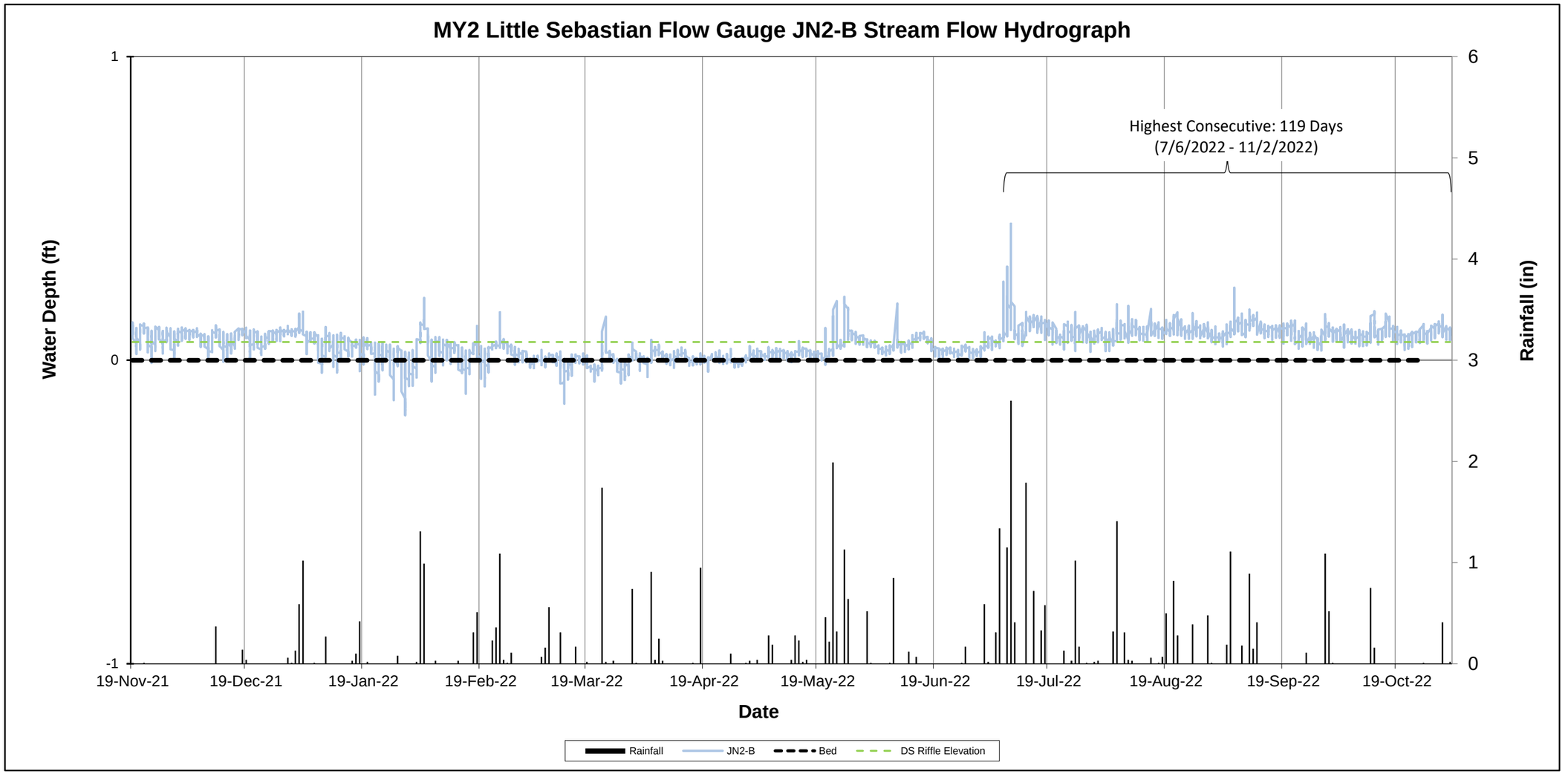
*Flow Gauge on JN7 was installed on February 1, 2022

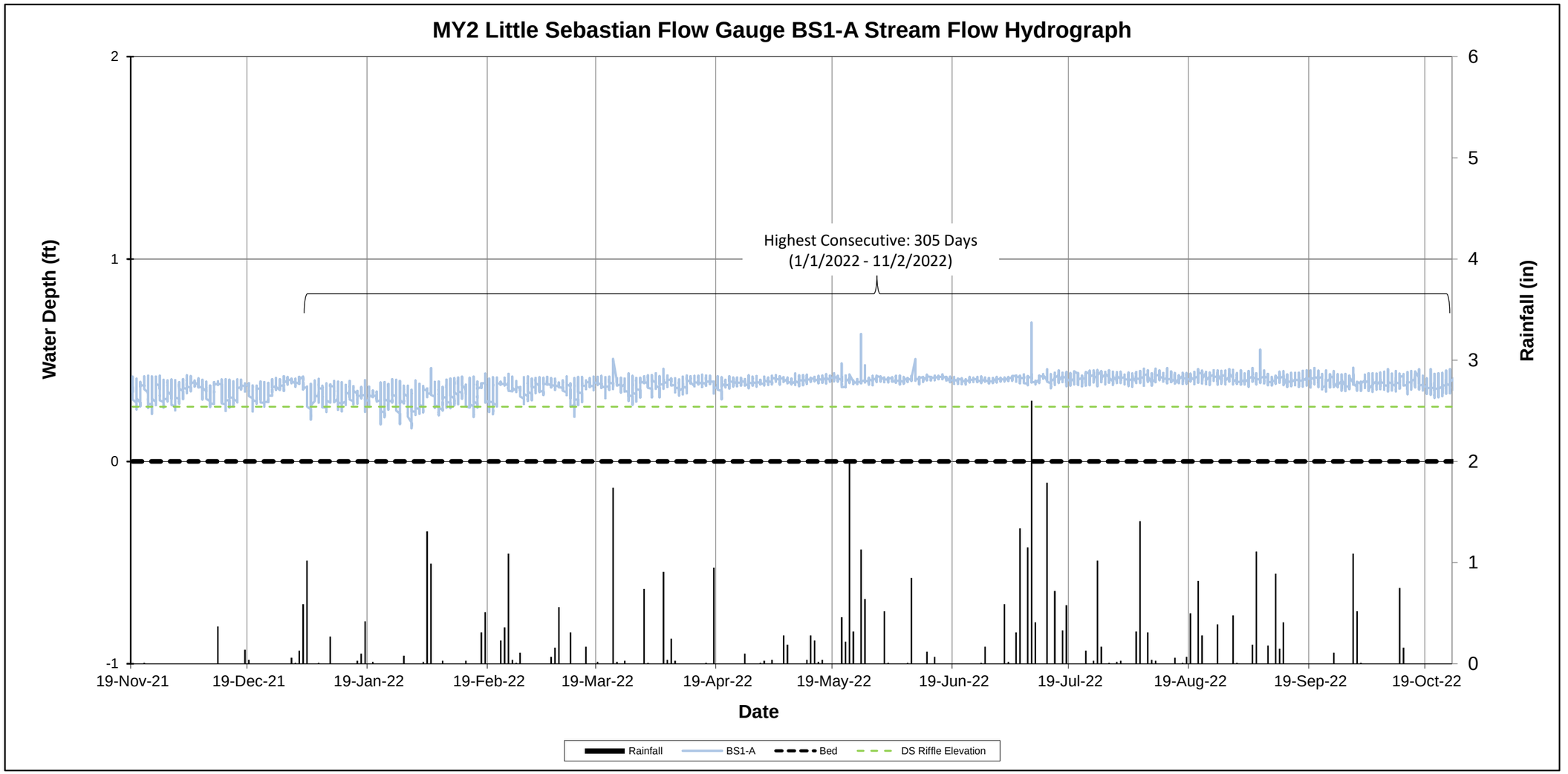
Table 14. 2022 Max Hydroperiod

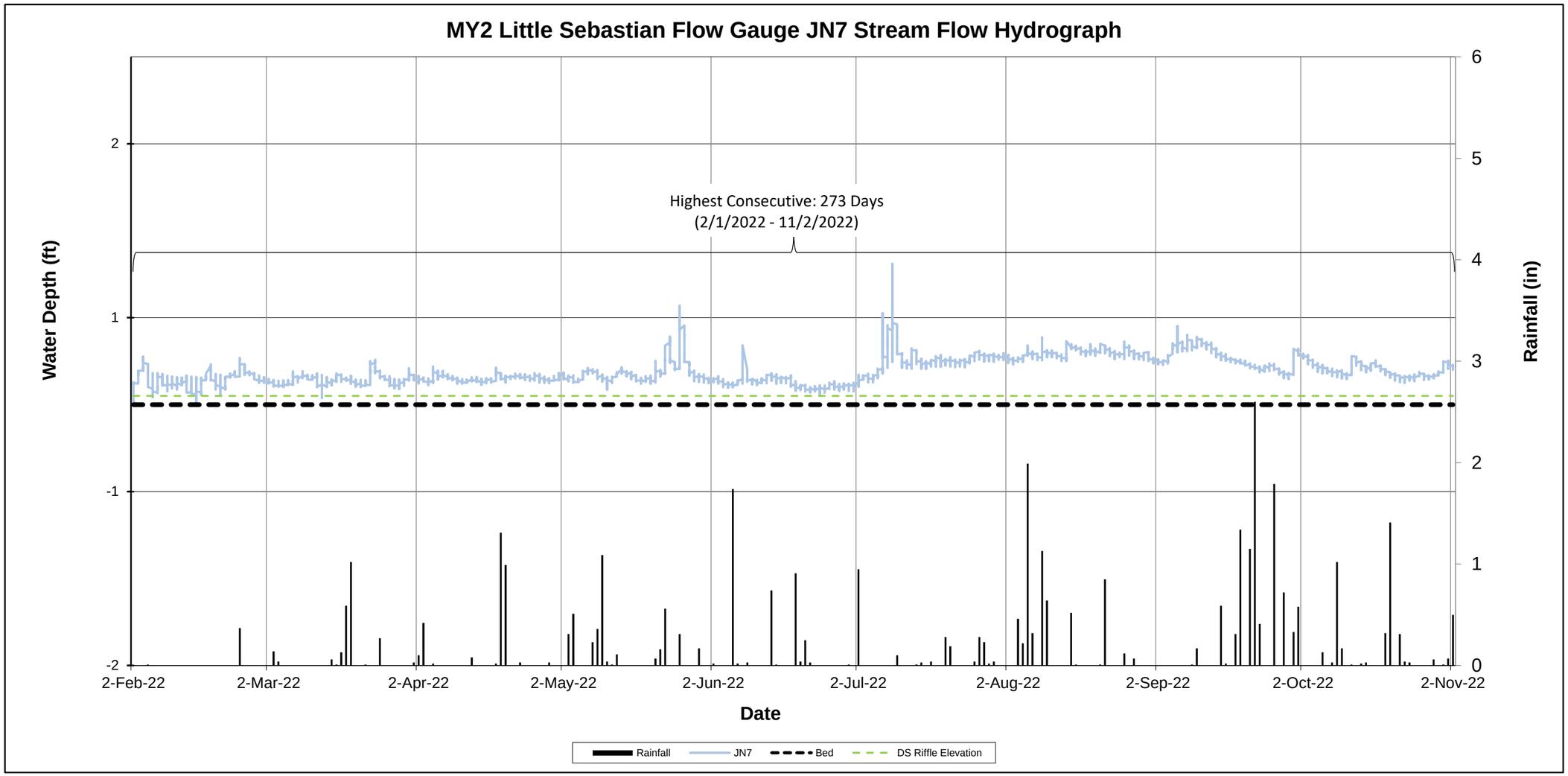
2022 Max Hydroperiod (Growing Season 3-Apr through 30-Oct, 210 days)					
Well ID	**Consecutive**		**Cumulative**		**Occurrences**
	Days	**Hydroperiod (%)**	**Days**	**Hydroperiod (%)**	
GW1	32	15	167	79	9
GW2	210	100	210	100	1

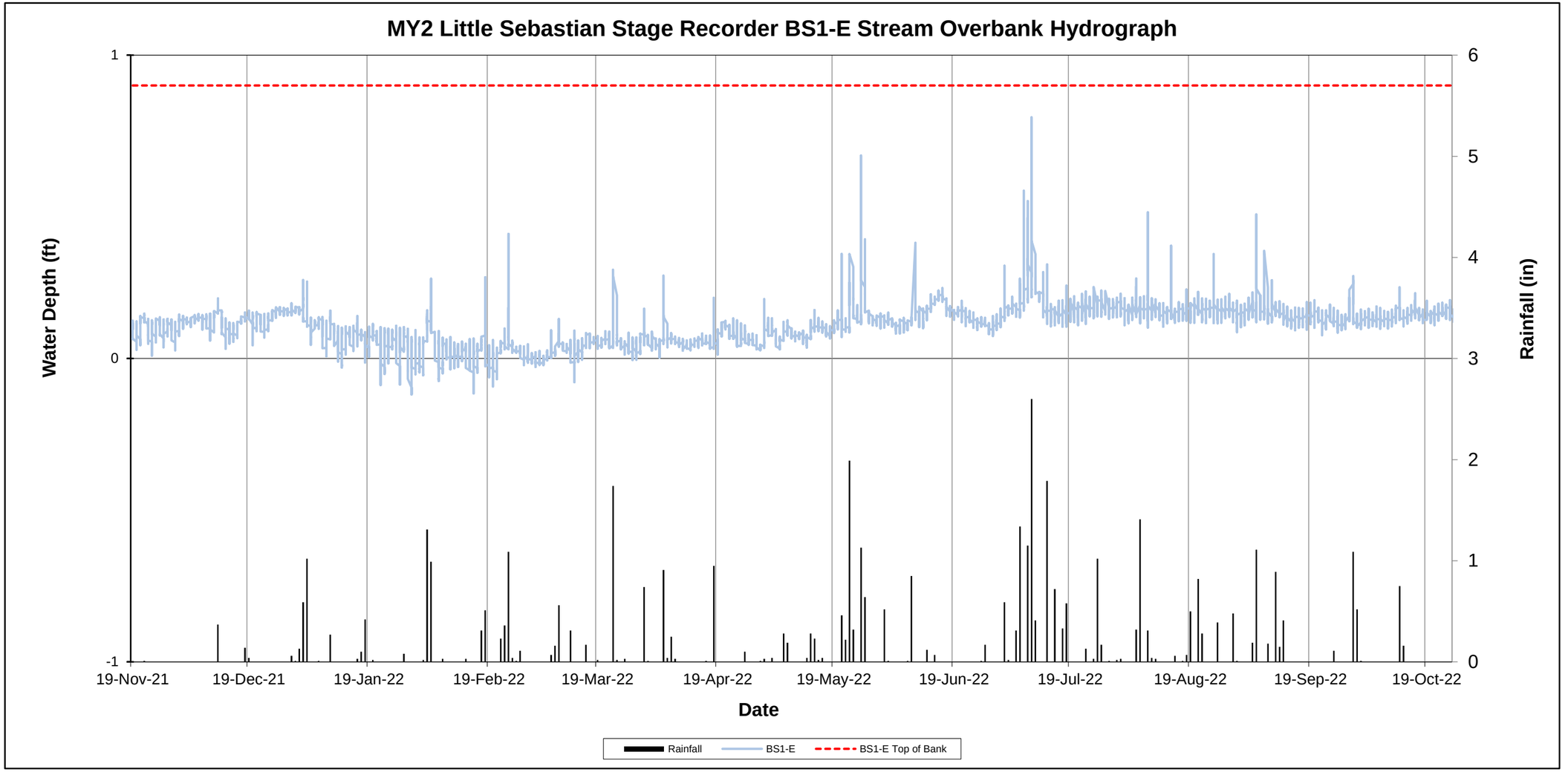
Table 15. Summary of Groundwater Monitoring Results

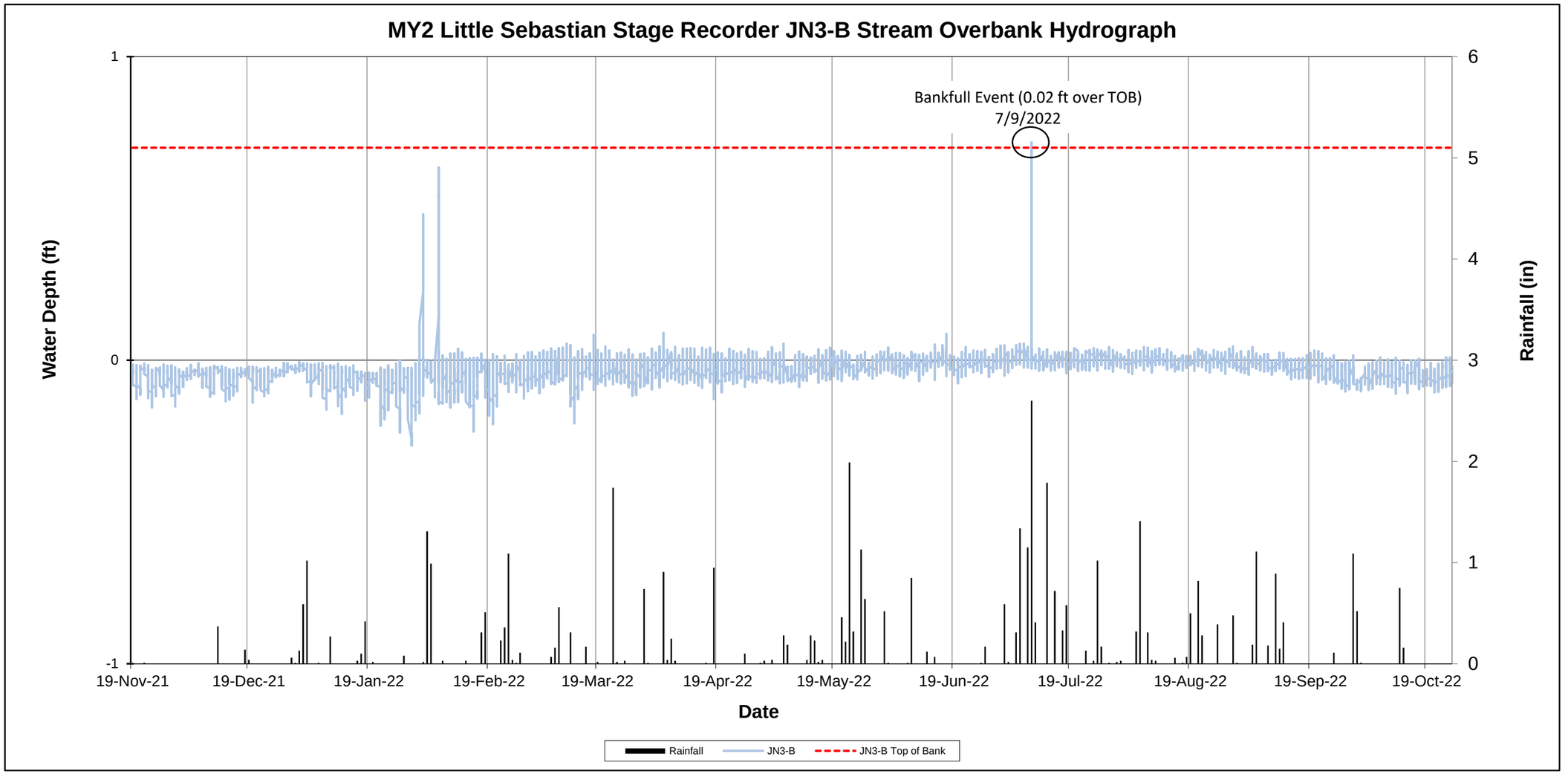
Summary of Groundwater Monitoring Results Little Sebastian							
Well ID	**Hydroperiod (%)**						
	Year 1 (2021)	**Year 2 (2022)**	**Year 3 (2023)**	**Year 4 (2024)**	**Year 5 (2025)**	**Year 6 (2026)**	**Year 7 (2027)**
GW1	41	15					
GW2	100	100					

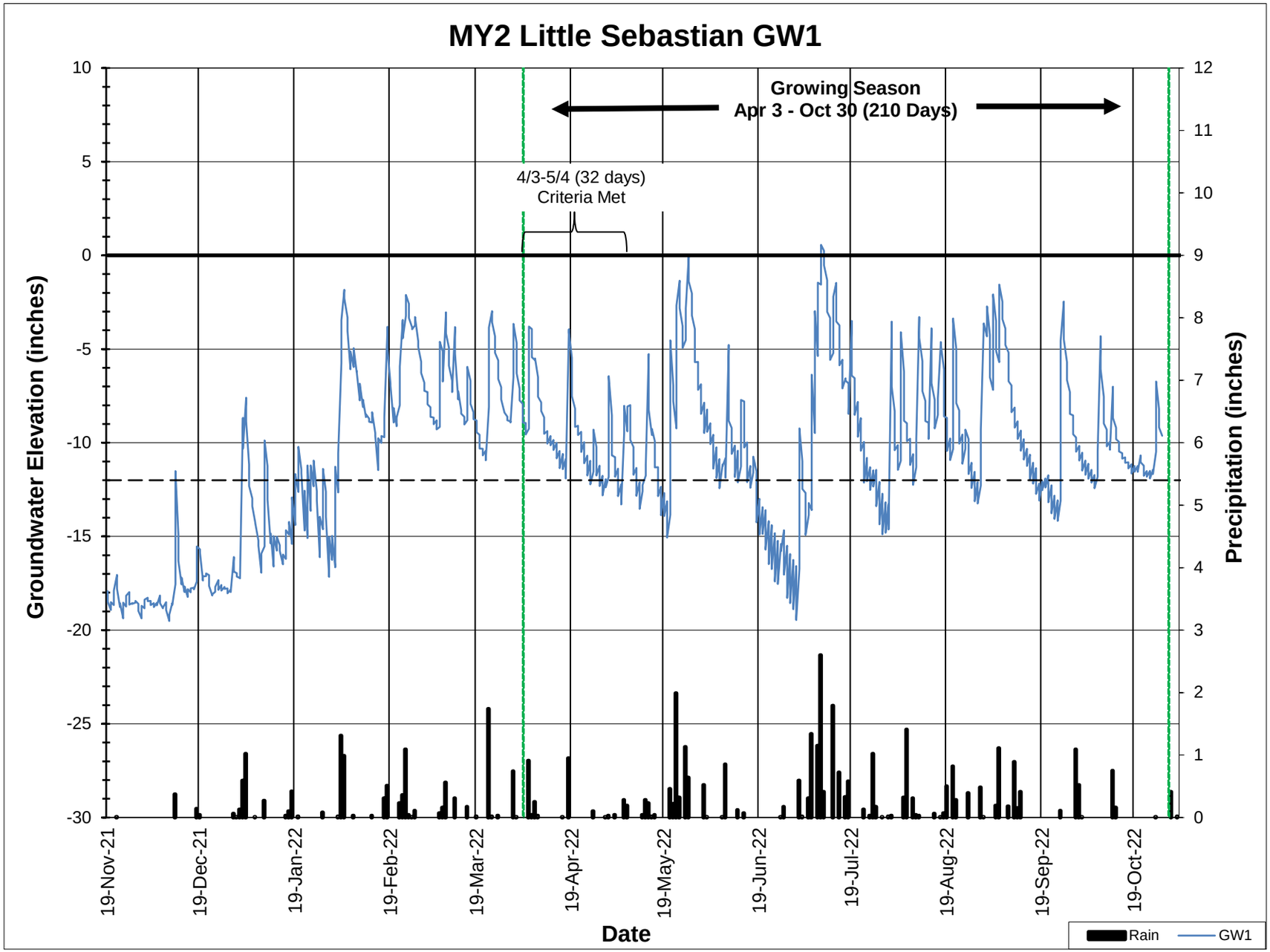

MY2 Little Sebastian Flow Gauge JN2-B Stream Flow Hydrograph
Water Depth (ft)
Rainfall (in)
1
0
-1
6
5
4
3
2
1
0
Highest Consecutive: 119 Days
(7/6/2022 - 11/2/2022)
19-Nov-21
19-Dec-21
19-Jan-22
19-Feb-22
19-Mar-22
19-Apr-22
19-May-22
19-Jun-22
19-Jul-22
19-Aug-22
19-Sep-22
19-Oct-22
Date
Rainfall
JN2-B
Bed
DS Riffle Elevation

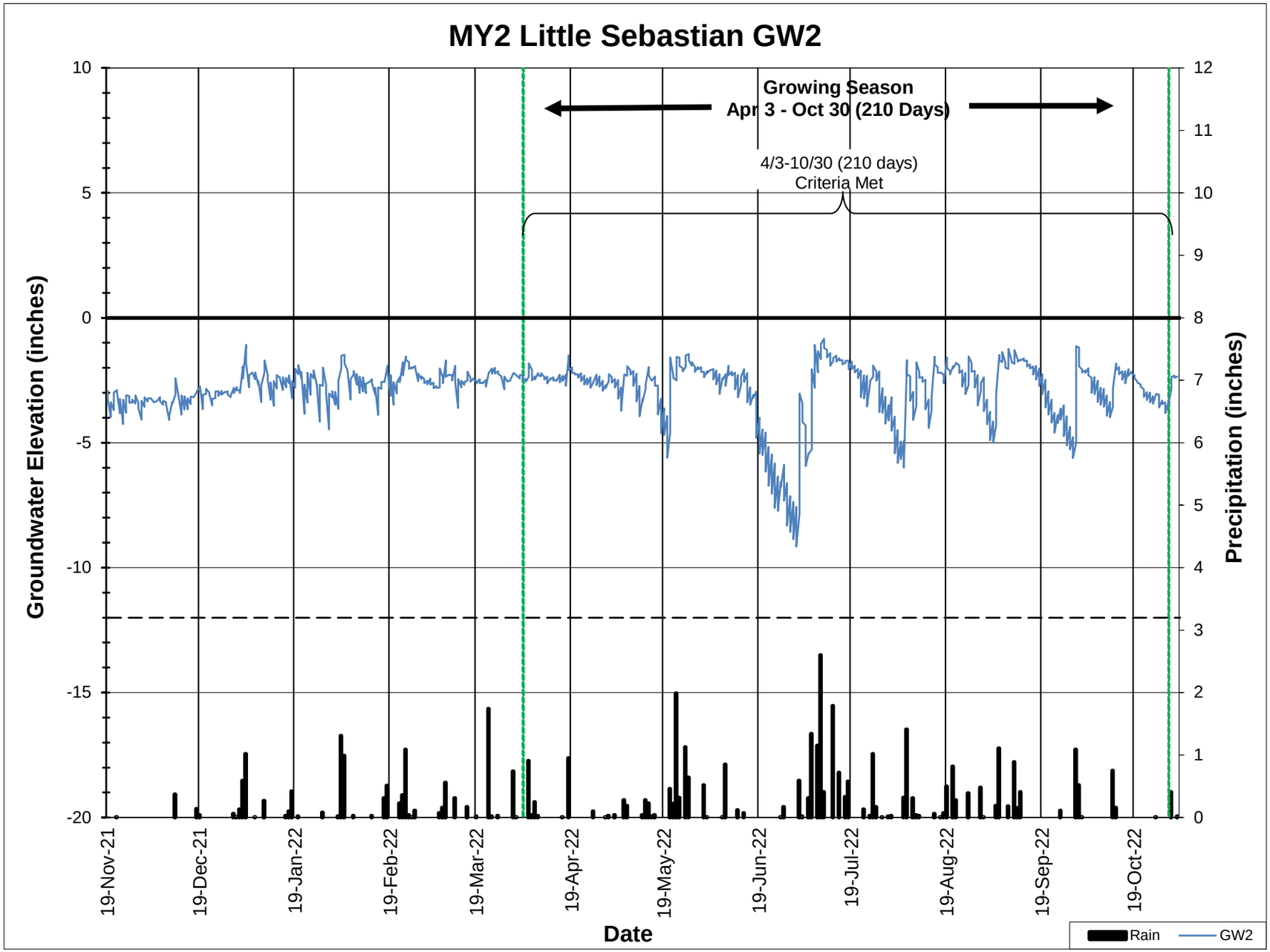

MY2 Little Sebastian Flow Gauge BS1-A Stream Flow Hydrograph
Water Depth (ft)
Rainfall (in)
Highest Consecutive: 305 Days
(1/1/2022 - 11/2/2022)
2
1
0
-1
6
5
4
3
2
1
0
19-Nov-21
19-Dec-21
19-Jan-22
19-Feb-22
19-Mar-22
19-Apr-22
19-May-22
19-Jun-22
19-Jul-22
19-Aug-22
19-Sep-22
19-Oct-22
Date
Rainfall
BS1-A
Bed
DS Riffle Elevation


MY2 Little Sebastian Flow Gauge JN7 Stream Flow Hydrograph
Water Depth (ft)
Rainfall (in)
Highest Consecutive: 273 Days
(2/1/2022 - 11/2/2022)
2
1
-1
-2
6
5
4
3
2
1
0
2-Feb-22
2-Mar-22
2-Apr-22
2-May-22
2-Jun-22
2-Jul-22
2-Aug-22
2-Sep-22
2-Oct-22
2-Nov-22
Date
Rainfall
JN7
Bed
DS Riffle Elevation


MY2 Little Sebastian Stage Recorder BS1-E Stream Overbank Hydrograph
Water Depth (ft)
Rainfall (in)
1
0
-1
6
5
4
3
2
1
0
19-Nov-21
19-Dec-21
19-Jan-22
19-Feb-22
19-Mar-22
19-Apr-22
19-May-22
19-Jun-22
19-Jul-22
19-Aug-22
19-Sep-22
19-Oct-22
Date
Rainfall
BS1-E
BS1-E Top of Bank


MY2 Little Sebastian Stage Recorder JN3-B Stream Overbank Hydrograph
Bankfull Event (0.02 ft over TOB)
7/9/2022
Water Depth (ft)
Rainfall (in)
1
0
-1
6
5
4
3
2
1
0
19-Nov-21
19-Dec-21
19-Jan-22
19-Feb-22
19-Mar-22
19-Apr-22
19-May-22
19-Jun-22
19-Jul-22
19-Aug-22
19-Sep-22
19-Oct-22
Date
Rainfall
JN3-B
JN3-B Top of Bank


MY2 Little Sebastian GW1
Growing Season
Apr 3 - Oct 30 (210 Days)
4/3-5/4 (32 days)
Criteria Met
Groundwater Elevation (inches)
Precipitation (inches)
Date
10
5
0
-5
-10
-15
-20
-25
-30
12
11
10
9
8
7
6
5
4
3
2
1
0
19-Nov-21
19-Dec-21
19-Jan-22
19-Feb-22
19-Mar-22
19-Apr-22
19-May-22
19-Jun-22
19-Jul-22
19-Aug-22
19-Sep-22
19-Oct-22
Rain
GW1


MY2 Little Sebastian GW2
Growing Season
Apr 3 - Oct 30 (210 Days)
4/3-10/30 (210 days)
Criteria Met
Groundwater Elevation (inches)
Precipitation (inches)
Date
10
5
0
-5
-10
-15
-20
12
11
10
9
8
7
6
5
4
3
2
1
0
19-Nov-21
19-Dec-21
19-Jan-22
19-Feb-22
19-Mar-22
19-Apr-22
19-May-22
19-Jun-22
19-Jul-22
19-Aug-22
19-Sep-22
19-Oct-22
Rain
GW2