As-Built Baseline Monitoring Report

FINAL

GROUNDHOG HOLLOW PROJECT

NCDMS Project #100049 (Contract #7417) | RFP 16-007277 (Issued 6/21/2017)

USACE Action ID: SAW-2018-00450 | DWR Project #20180666

Alexander County, North Carolina
Catawba River Basin
HUC 03050101

Provided by:

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

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

June 2021

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June 9, 2021

Paul Wiesner
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RE: Groundhog Hollow Mitigation Site: Baseline Report and As-Built Drawings (NCDMS Project ID #100049)

Listed below are comments provided by DMS on May 26, 2021 regarding the Ground Hollow Mitigation Site: Baseline Report and As-Built Drawings and RES' responses.

Report Cover: Please also include the RFP # and issuance date of the RFP on the report cover: RFP 16-007277 (Issued 6/21/2017).
Done.

Section 1.5 Stream Design/ Approach: In the report text, please also note the type of fencing installed to exclude livestock from the project conservation easement.
Done.

Section 1.6 Construction and As-Built Conditions: This section notes that minor repairs will be conducted during the summer of MY1 (2021) due to a significant post construction storm event. DMS understands that these minor storm repairs were completed in May 2021. Please update the report text and discuss the minor repairs implemented. DMS recommends quantifying the total length of the stream repairs completed and noting the overall percentage of project streams repaired.
"In May 2021, approximately 200 linear feet of channel (three percent of the total stream length) and 10 structures underwent repairs. Generally, the problem areas were step pools, sills, banks, and old channel erosion that failed during extreme high flows that occurred before vegetation could be established. Banks were regraded and matting was added, sills were replaced, repaired, or added to reestablish proposed bed elevations, and check dams were installed in the old channel to discourage concentrated flow. Repair areas were livestaked in May 2021 and will be livestaked again if needed during the next dormant season. Additionally, bareroot supplemental planting will be performed next dormant season in the areas affected by the repairs." This was added to Section 1.6.

Section 1.6 Construction and As-Built Conditions: In the report text, please briefly discuss any monitoring feature updates or locations that have changed from what was presented in the IRT approved mitigation plan.
No significant monitoring feature updates or location changes were made at as-built. This was discussed in the second paragraph of Section 1.6.

Appendix A – Table 1: DMS recommends adding a note to Table 1 indicating that all crossings and utility easements have been removed from the credit calculations.
Done.

Appendix A – Table 2: In the table, please update the elapsed time since grading and planting.
Done.

Appendix D – Table 11: Cross section 17 is identified as a Pool in Table 11; however, it is identified as a Riffle on the cross sections provide. Please QA/QC the data and tables and update as necessary.
This error has been corrected and the data and tables have been QA/QC.

General; Monitoring; Monitoring Photo Points: As noted in the IRT approved mitigation plan, fixed digital image locations have been established at each cross section, vegetation plot, stage recorder, and flow gauge. Per recent IRT discussion, DMS recommends adding photo points in the MY1 (2021) report at each project crossing location to document crossing stability and function during the monitoring term.
RES will add photographs of the crossings to the MY1 (2021) report.

Record Drawings:

• The project conservation easement shown on the draft record drawings is identified as the Limits of Proposed Conservation Easement (LCE). The final recorded conservation easement (approved by the NC SPO) should be utilized for the record drawings. Please update the record drawings and legend accordingly. Once updated, please confirm that no additional areas of fencing or project crossings are located within the recorded conservation easement.
Done – there are no additional areas of fencing or project crossings in the recorded conservation easement.

• As noted in the draft MY0 report, please make sure the minor fencing areas currently installed inside of the conservation easement (Sheet 1, Sheet 2, and Sheet 12) are relocated to the recorded conservation easement line or outside of the recorded conservation easement in MY1 (2021). Please document that the fencing relocation was completed in the MY1 (2021) report.

• Sheet 6: The downstream Enhancement (Level 2) portion of GF 1-B is labeled as GF1-C on the record drawings. Please QA/QC and update the report and record drawings so all project reach labeling and stationing is consistent with Table 1 (Mitigation Assets and Components).
Done.

• Please show the utility lines/ utility easements on the record drawings.
Done.

Digital Support File Comments:

• If available, please include existing conditions features in the revised final digital submittal.
Existing streams, top of bank, and wetlands were added to the digital submittal.

• Please provide PDFs of any permits or associated permit correspondence acquired during design development that wasn't submitted during the Mitigation Plan development (i.e. FEMA Floodplain Compliance permit; DEQ Land Quality permit; etc.). This should be included in a separate "Project Permits" folder in the final digital submittal.
Done.

• Please provide the stand alone as-built .pdf and .dwg files with the final digital submittal. The .pdf with a Professional Land Surveyor (PLS) seal is included; however, the .dwg file/s are missing. Please review and update as necessary.
Done.

• Please provide the final standalone RES design plan (.pdf and .dwg files) with the final digital submittal. The design plan should bear a Professional Engineer's seal.
The sealed design plan PDF is included, however, the DWG files are not standalone so were not included.

Table of Contents

1.0 Project Summary

1.1 Project Location and Description

The Groundhog Hollow Project ("Project") is located within a rural watershed in Alexander County, North Carolina approximately three and a half miles northwest of Taylorsville. Water quality stressors affecting the Project included livestock production, agricultural production, and lack of riparian buffer. The Project presents stream restoration and enhancement generating 4,093.95 Warm Stream Mitigation Units (SMU).

The Project's total easement area is 20.58 acres within the overall drainage area of 156 acres. Grazing livestock historically had access to all the 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 stream design approach for the Project was to combine the analog method of natural channel design with analytical methods to evaluate stream flows and hydraulic performance of the channel and floodplain. The analog method involved the use of a reference reach, or "template" stream, adjacent to, nearby, or previously in the same location as the design reach. The template parameters of the analog reach were replicated to create the features of the design reach. The analog approach is useful when watershed and boundary conditions are similar between the design and analog reaches. Hydraulic geometry was developed using analytical methods to identify the design discharge.

The Project has been constructed and planted and 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. Funding will be supplied by the responsible party on a yearly basis until such time an endowment is established.

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 will be 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 (amended 2018) Upper Catawba River Basin Restoration Priorities (RBRP). These goals and objectives reflect those stated in the Groundhog Hollow Project Final 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 overbank flows and connection to the floodplain;
- Improve instream habitat;
- Reduce sediment, nutrient, and fecal coliform inputs into stream system;
- Restore and enhance native floodplain vegetation; and
- Indirectly support the goals of the 2009 Upper Catawba RBRP to improve water quality and to reduce sediment and nutrient loads

The Project goals were addressed through the following project objectives:

- Designed and reconstructed stream channels that convey bankfull flows while maintaining stable dimension, profile, and planform;
- Added in-stream structures and bank stabilization measures to protect restored streams;
- Installed habitat features such as brush toes, constructed riffles, woody materials, and pools of varying depths to restored streams;
- Increased forested riparian buffers to at least 50 feet on both sides of the channel along the Project reaches with a hardwood riparian plant community;
- Installed approximately 12,000 linear feet of livestock exclusion fencing along the easement boundary to ensure livestock will no longer have stream access;
- Treated exotic invasive species; and
- Established a permanent conservation easement on the Project that will exclude future livestock from stream channels and their associated buffers and prevent future landuse changes.

Functional uplift, benefits, and improvements within the Project area, as based on the Function Based Framework, are outlined in the Mitigation Plan**.**

1.3 Project Success Criteria

The success criteria for the Project follows the 2016 USACE Wilmington District Stream and Wetland Compensatory Mitigation Update, the Groundhog Hollow Project 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 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.

Specific Project reaches will be monitored to document intermittent or seasonal surface flow. Intermittent reaches must demonstrate a minimum of 30 consecutive days of flow.

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 seven feet at the end of Year 5, and the final vegetative success criteria is 210 trees per acre with an average height of ten feet at the end of Year 7. Volunteer trees are counted, identified to species, and included in the yearly monitoring reports, but are not be counted towards the success criteria of total planted stems until present 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.

Level	Treatment	Objective	Monitoring Metric	Performance Standard
1 ***Hydrology***	Convert land-use of Project reaches from pasture to riparian forest	Improve the transport of water from the watershed to the Project reaches in a non-erosive way	NA	NA
2 ***Hydraulic***	Reduce bank height ratios and increase entrenchment ratios by reconstructing channels to mimic reference reach conditions	Improve flood bank connectivity by reducing bank height ratios and increase entrenchment ratios	Stage recorders: Inspected quarterly	Four bankfull events occurring in separate years
			Flow gauge: Inspected quarterly	At least 30 days of continuous flow each year
			Cross sections: Surveyed in Years 1, 2, 3, 5 and 7	Entrenchment ratio shall be no less than 1.4 within restored reaches
				Bank height ratio shall not exceed 1.2
3 ***Geomorphology***	Establish a riparian buffer to reduce erosion and sediment transport into project streams. Establish stable banks with livestakes, erosion control matting, and other in stream structures.	Limit erosion rates and maintain channel stability Improve bedform diversity (pool spacing, percent riffles, etc. Increase buffer width to 50 feet	As-built stream profile	NA
			Cross sections: Surveyed in Years 1, 2, 3, 5 and 7	Entrenchment ratio shall be no less than 1.4 within restored reaches
			Visual monitoring	Bank height ratio shall not exceed 1.2
			Visual monitoring: Performed at least semiannually	Identify and document significant stream problem areas; i.e. erosion, degradation, aggradation, etc.
			Vegetation plots: Surveyed in Years 1, 2, 3, 5 and 7	MY 1-3: 320 trees/acre MY 5: 260 trees/acre (7 ft. tall) MY 7: 210 trees/acre (10 ft. tall)
4 ***Physicochemical***	Exclude livestock from riparian areas with exclusion fence, conservation easement, and plant a riparian buffer	*Unmeasurable Objective/Expected Benefit* Establish native hardwood riparian buffer and exclude livestock.	Vegetation plots: Surveyed in Years 1, 2, 3, 5 and 7 (*indirect measurement*)	MY 1-3: 320 trees/acre MY 5: 260 trees/acre (7 ft. tall) MY 7: 210 trees/acre (10 ft. tall)
			Visual assessment of established fencing and conservation signage: Performed at least semiannually (*indirect measurement*)	Inspect fencing and signage. Identify and document any damaged or missing fencing and/or signs

1.4 Project Components

The Project area is comprised of a 20.58-acre easement involving four unnamed tributaries which drain directly into the Lower Little River which eventually drains into the Catawba River. These four Project streams are split into nine reaches based on treatment type and/or changes in flow: GF1-A, GF1-B, GF2-A, GF2-B, GF3-A, GF3-B, GF4-A, GF4-B, and GF5.

Due to landowner and utility requirements, there are four easement breaks within the project. One break is for an existing utility easement; fencing was installed across the utility easement in order to provide contiguous livestock exclusion to the stream. The other three are locations for current agricultural crossings. These easement breaks will allow landowners to continue current land-use and access throughout the property as needed.

Through stream restoration and enhancement, the Project presents 6,129 LF of stream, generating 4,093.95 Warm Stream Mitigation Units (SMU). The stream mitigation components are summarized below. Mitigation credits presented below are based upon the Approved Mitigation Plan. To account for areas of more or less than minimum 50-foot buffer widths, credits were adjusted using the USACE Wilmington District Stream Buffer Credit Calculator.

Mitigation Approach	Linear Feet	Ratio	Warm SMU
Restoration	2,851	1	2,851.00
Enhancement I	306	1.5	204.00
Enhancement II	2,338	2.5	935.20
Enhancement II	253	5	5060
Enhancement II	381	7.5	50.80
Total	**6,129**		**4,091.60**
		Non-standard Buffer Width Adjustment	**+2.35***
		Total Adjusted SMUs	**4,093.95**

* Credit adjustment for Non-standard Buffer Width calculation using the Wilmington District Stream Buffer Credit Calculator issued by the USACE in January 2018.

1.5 Stream Design/Approach

The Project includes Priority I and II Restoration and Enhancement Levels I and II. 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 were also a crucial element of the project and were used to determine the design discharge and to verify the design as a whole. For livestock exclusion, woven wire fencing with one strand of barbed wire at the top was installed.

The following treatments were performed on the Project reaches:

Reach GF1-A
An Enhancement Level II approach was performed for this reach to address areas of bed instability, bank erosion, and buffer impacts. Enhancement activities included:

- Stabilizing a 2-foot knick-point located near station 00+70 by installing two rock sills,
- Removal and regrading of an existing culvert crossing near station 03+50,
- Bank stabilization beginning near station 05+75 by installing a log vane and brush toe,
- Stabilizing a 5-foot headcut located near station 07+10 by installing a rock step-pool,
- Livestock exclusion,
- Riparian planting,

- Invasive vegetation treatment.

Reach GF1-B

An inline restoration approach was used for the upstream portion of the reach to address eroding banks, channel entrenchment, and buffer impacts. Restoration activities included:

- Raising the channel bed with a mix of log sill, log vanes, riffle grade controls, and clay plugs,
- Normalizing the existing channel alignment to reduce channel stress,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Transitioning existing vertical channel banks to a minimum 5:1 floodplain slope,
- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

An offline priority I restoration approach was performed for the middle portion of the reach to address, eroding banks, channel entrenchment, and channel braiding. Restoration activities included:

- Regrading a new single thread channel in the existing floodplain,
- Installing log and rock structures to provide grade control and habitat,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Filling the existing channel,
- Replacing an existing ford crossing with a culvert crossing,
- Livestock exclusion,
- Riparian planting.

An offline priority II restoration approach was performed for the downstream potion of the reach to address, eroding banks, channel entrenchment, and channel braiding. Restoration activities included:

- Regrading a new single thread channel and floodplain,
- Installing log and rock structures to provide grade control and habitat,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Filling the existing channel,
- Livestock exclusion,
- Riparian planting.

Enhancement Level II was performed along the portion of the reach that ties into the Lower Little River and is within its non-encroachment area. Enhancement activities included:

- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

Reach GF2-A

An Enhancement Level II approach was perfomed for this reach to address areas of bed instability, bank erosion, and buffer impacts. Enhancement activities included:

- Stabilizing a 9-foot headcut located near station 01+30 by installing log sills and a log step pool,
- Bed stabilization beginning near station 05+00 by installing a double log drop,
- Bank stabilization beginning near station 07+50 by installing a log vane and brush toe,
- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

Reach GF2-B
A mix of offline and inline restoration was performed for this portion of the reach to address eroding banks, channel entrenchment, historic impoundment, and buffer impacts. Restoration activities included:

- Regrading a new single thread channel in the existing floodplain,
- Installing log and rock structures to provide grade control and habitat,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Removing the relic earthen dam and relic pond,
- Filling the existing channel,
- Replacing an existing ford crossing with a culvert crossing,
- Livestock exclusion,
- Riparian planting.

Reach GF3-A
An Enhancement Level I approach was performed for this reach to address areas of bank erosion, and buffer impacts. Enhancement activities included:

- Stabilizing the left bank near station 08+75 by installing a brush toe,
- Stabilizing the left bank near station 10+25 by installing a brush toe,
- Bank stabilization beginning near station 09+40 and 09+80 by installing a log vane,
- Floodplain grading,
- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

Reach GF3-B
An offline restoration approach was performed for this portion of the reach to address eroding banks, channel entrenchment, and buffer impacts. Restoration activities included:

- Regrading a new single thread channel in the existing floodplain,
- Installing log and rock structures to provide grade control and habitat,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Filling the existing channel,
- Replacing an existing ford crossing with a culvert crossing,
- Livestock exclusion,
- Riparian planting.

Reach GF4-A
An Enhancement Level II approach was performed for this reach to address areas of bed instability, bank erosion, and buffer impacts. Enhancement activities included:

- Stabilizing head cut near station 00+50 by grading a vegetated swale,
- Stabilizing banks near station 01+50 by grading back channel banks,
- Bed stabilization beginning near station 03+30 by installing a rock step-pool,
- Removing and replacing the two existing 24” Corrugated Metal Pipes,
- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

Reach GF4-B
A limited Enhancement Level II approach was performed for this reach at a reduced credit ratio. Enhancement activities included:

- Livestock exclusion,
- Riparian planting,
- Trash removal,
- Invasive vegetation treatment.
    - To ensure bank stability, Chinese privet was flush cut and sprayed; therefore, subsoil was not disturbed. Roots will remain intact while plantings establish roots.

Reach GF5
An Enhancement Level II approach was performed for this reach to address buffer impacts and protect multiple spring heads. Enhancement activities included:

- Livestock exclusion,
- Riparian planting,
- Removal of existing concrete tank,
- Invasive vegetation treatment.

1.6 Construction and As-Built Conditions

Stream construction was completed in September 2020 and planting was completed in December 2020. The Groundhog Hollow Project was built to design plans and guidelines. However, in May 2021, approximately 200 linear feet of channel (three percent of the total stream length) and 10 structures underwent repairs. Generally, the problem areas were step pools, sills, banks, and old channel erosion that failed during extreme high flows that occurred before vegetation could be established. Banks were regraded and matting was added, sills were replaced, repaired, or added to reestablish proposed bed elevations, and check dams were installed in the old channel to discourage concentrated flow. Repair areas were livestaked in May 2021 and will be livestaked again if needed during the next dormant season. Additionally, bareroot supplemental planting will be performed next dormant season in the areas affected by the repairs. The record drawings are included in **Appendix E**.

Planting plan changes included the removal of black gum (*Nyssa sylvatica*) and hackberry (*Celtis occidentalis*). Hackberry was replaced with sugarberry (*Celtis laevigata*) and the quantities of the other planted species were increased to compensate for not planting black gum. These changes were based on bare root availability. Minor monitoring device location changes were made during as-built installation; however, the quantities remained as proposed in the Final Mitigation Plan.

1.7 Baseline Monitoring Performance (MY0)

The Groundhog Hollow Baseline Monitoring activities were performed in January and February 2021. All Baseline Monitoring data is present below and in the appendices. The Project is on track to meeting interim success criteria.

Vegetation

Setup and monitoring of nine fixed vegetation plots and three random vegetation plots was completed after planting and stream construction on February 4, 2021. Vegetation data are in **Appendix C**, associated photos are in **Appendix B,** and plot locations are in **Appendix B**. MY0 monitoring data indicates that all plots are exceeding the interim success criteria of 320 planted stems per acre. Planted stem densities ranged from 526 to 850 planted stems per acre with a mean of 667 planted stems per acre across all plots. A total of seven species were documented within the plots. Volunteer species were not noted at baseline monitoring but are expected to establish in upcoming years. The average planted stem height in the vegetation plots was 1.6 feet.

Visual assessment of vegetation outside of the monitoring plots indicates that the herbaceous vegetation is becoming well established throughout the project.

Stream Geomorphology

A total of 22 cross sections were installed and geomorphology data collection for MY0 was conducted on January 27, 2021. Summary tables and cross section plots are in **Appendix D**. Overall the baseline cross sections and profile relatively match the proposed design. The as-built conditions show that shear stress and velocities have been reduced for all restoration/enhancement reaches. All reaches were designed as gravel bed channels and remain classified as gravel bed channels post-construction.

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

Stream Hydrology

Three stage recorders and one flow gauge were installed on February 4, 2021: one stage recorder on GF1-B, one stage recorder on GF2-B, one stage recorder on GF3-B, and one flow gauge on GF4-A. The stage recorders are in place to document bankfull events and the flow gauge to document at least intermittent flow. Stream hydrology data will be included in the Monitoring Year 1 Report in this section and in the appendices. Gauge locations can be found on **Figure 2** and photos are in **Appendix B**.

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 22 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 gauge was also installed in a pool and records flow conditions at an hourly interval. Water level data from the flow gauge is corrected using the height of the downstream riffle to detect stream flow events.

Vegetation success is being monitored at nine fixed monitoring plots and three random monitoring plot. 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 plots are to be collected in locations where there are no permanent vegetation plots. Random plots 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.

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).

Lee Michael T., Peet Robert K., Roberts Steven D., and Wentworth Thomas R., 2008. *CVS-EEP Protocol for Recording Vegetation Level*. Version 4.2

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

Resource Environmental Solutions (2019). Groundhog Hollow Project Final Mitigation Plan.

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.

USACE. (2016). Wilmington District Stream and Wetland Compensatory Mitigation Update. NC: Interagency Review Team (IRT).

Appendix A

Background Tables

Table 1. Groundhog Hollow (100049) - Mitigation Assets and Components

Project Segment	Existing Footage or Acreage	Mitigation Plan Footage or Acreage	Mitigation Category	Restoration Level	Priority Level	Mitigation Ratio (X:1)	Mitigation Plan Credits		As-Built Footage or Acreage	Comments
GF1-A	1,192	1,206	Warm	EII	N/A	2.50000	482.400		1202	Bed and bank stabilization, riparian planting, livestock exclusion (Powerline easement: STA 12+34 to 12+70)
GF1-A	62	62	Warm	EII	N/A	2.50000	24.800		63	Bed and bank stabilization, riparian planting, livestock exclusion
GF1-B	1034	1,020	Warm	R	P1/P2	1.00000	1020.000		1031	Channel restoration, riparian planting, livestock exclusion (Stream crossing: STA 23+52 to STA 24+12)
GF1-B	936	986	Warm	R	P1/P2	1.00000	986.000		994	Channel restoration, riparian planting, livestock exclusion
GF1-B	130	130	Warm	EII	N/A	2.50000	52.000		133	Riparian planting, livestock exclusion
GF2-A	642	642	Warm	EII	N/A	2.50000	256.800		636	Bed and bank stabilization, riparian planting, livestock exclusion
GF2-B	442	451	Warm	R	P1/P2	1.00000	451.000		459	Channel restoration, riparian planting, livestock exclusion (Stream crossing: STA 12+80 to STA 13+10)
GF2-B	167	83	Warm	R	P1/P2	1.00000	83.000		84	Channel restoration, riparian planting, livestock exclusion
GF3-A	311	306	Warm	EI	N/A	1.50000	204.000		306	Bed and bank stabilization, riparian planting, livestock exclusion (Stream crossing: STA 10+75 to STA 11+07)
GF3-B	270	311	Warm	R	P1	1.00000	311.000		311	Channel restoration, riparian planting, livestock exclusion
GF4-A	283*	298	Warm	EII	N/A	2.50000	119.200		283	Bed and bank stabilization, riparian planting, livestock exclusion (Stream crossing: STA 3+54 to STA 3+88)
GF4-B	381	381	Warm	EII	N/A	7.50000	50.800		383	Riparian planting, livestock exclusion
GF5	253	253	Warm	EII	N/A	5.00000	50.600		249	Riparian planting, livestock exclusion

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	Riverine	Non-Riv		
Restoration	2851.000						
Re-establishment							
Rehabilitation							
Enhancement							
Enhancement I	204.000						
Enhancement II	935.200						
Enhancement II (5:1)	50.600						
Enhancement II (7.5:1)	50.800						
Creation							
Preservation							
NSBW	2.350						
Total	**4093.950**						

Table 2. Project Activity and Reporting History
Groundhog Hollow Mitigation Project

Elapsed Time Since grading complete: **8 months**
Elapsed Time Since planting complete: **5 months**
Number of reporting Years[1]: **0**

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Restoration Plan	NA	Dec-19
Final Design – Construction Plans	NA	Jun-20
Stream Construction	NA	Sep-20
Site Planting	NA	Dec-20
As-built (Year 0 Monitoring – baseline)	Feb-21	Jun-21
Year 1 Monitoring		
Year 2 Monitoring		
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 Groundhog Hollow Mitigation Project	
Designer Primary project design POC	RES / 3600 Glenwood Ave., Suite 100, Raleigh, NC 27612 Ben Carroll, PE
Construction Contractor Construction contractor POC	Carolina Environmental Contracting Inc. / PO Box 1905 Mount Airy, NC 27030 James Poe
Survey Contractor Survey contractor POC	WSP USA / 434 Fayetteville St, Suite 1500, Raleigh, NC 27601 Barry Creed, PLS
Planting Contractor Planting contractor POC	Shenandoah Habitats David Coleman
Monitoring Performers Monitoring POC	RES / 3600 Glenwood Ave, Suite 100, Raleigh, NC 27612 Ryan Medric (919) 741-6268

Table 4. Project Background Information										
Project Name	Groundhog Hollow									
County	Alexander									
Project Area (acres)	20.58									
Project Coordinates (latitude and longitude)	35.937201° N, -81.237783° W									
Planted Acreage (Acres of Woody Stems Planted)	14.42									
Project Watershed Summary Information										
Physiographic Province	Northern Inner Piedmont									
River Basin	Catawba									
USGS Hydrologic Unit 8-digit	3050101	USGS Hydrologic Unit 14-digit	3050101120030							
DWR Sub-basin	03-08-32									
Project Drainage Area (Acres and Square Miles)	156 (0.24)									
Project Drainage Area Percentage of Impervious Area	<1%									
CGIA Land Use Classification	Managed Herbaceous Cover, Mixed Upland Hardwoods									
Reach Summary Information										
Parameters	**Reach GF1-A**	**Reach GF1-B**	**Reach GF2-A**	**Reach GF2-B**	**Reach GF3-A**	**Reach GF3-B**	**Reach GF4-A**	**Reach GF4-B**	**Reach GF5**	
Length of reach (linear feet)	1,254	2,100	642	609	311	270	283	381	253	
Valley confinement (Confined, moderately confined, unconfined)	Moderately confined	Moderately confined/Unconfined	Confined	Moderately confined	Moderately confined	Unconfined	Moderately confined/Unconfined	Confined	Moderately confined	
Drainage area (Acres and Square Miles)	42 (0.07)	156 (0.24)	35 (0.05)	45 (0.07)	36 (0.06)	39 (0.06)	16 (0.02)	23 (0.04)	9 (0.01)	
Perennial, Intermittent, Ephemeral	Perennial	Perennial	Perennial	Perennial	Perennial	Perennial	Intermittent	Intermittent	Perennial	
NCDWR Water Quality Classification	C	C	C	C	C	C	C	C	C	
Stream Classification (existing)	F4b	G4c/C4	F4b	F4b	G4	G5/6	G4	F4b	C4/5a	
Stream Classification (proposed)	F4b	C4/E4	F4b	C4/E4	G4	C4/E4	G4	F4b	C4/5a	
Evolutionary trend (Simon)	III / IV	II / III	IV	III	III / IV	III	IV / V	IV	I	
FEMA classification	Zone X	Zone X and Zone AE	Zone X	Zone X	Zone X	Zone X	Zone X	Zone X	Zone X	

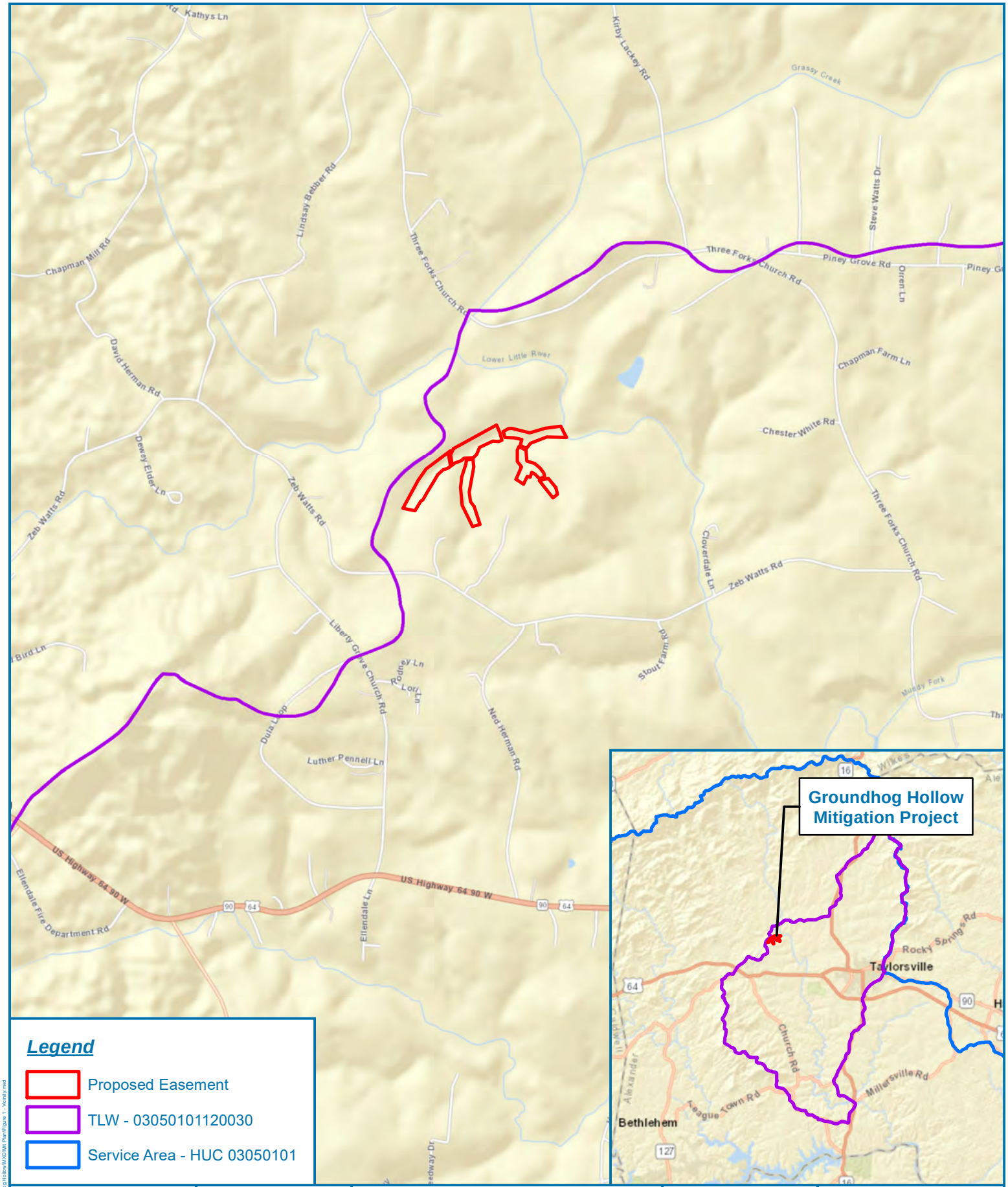


Figure 1 - Site Location Map

Groundhog Hollow Mitigation Project

Alexander County, North Carolina

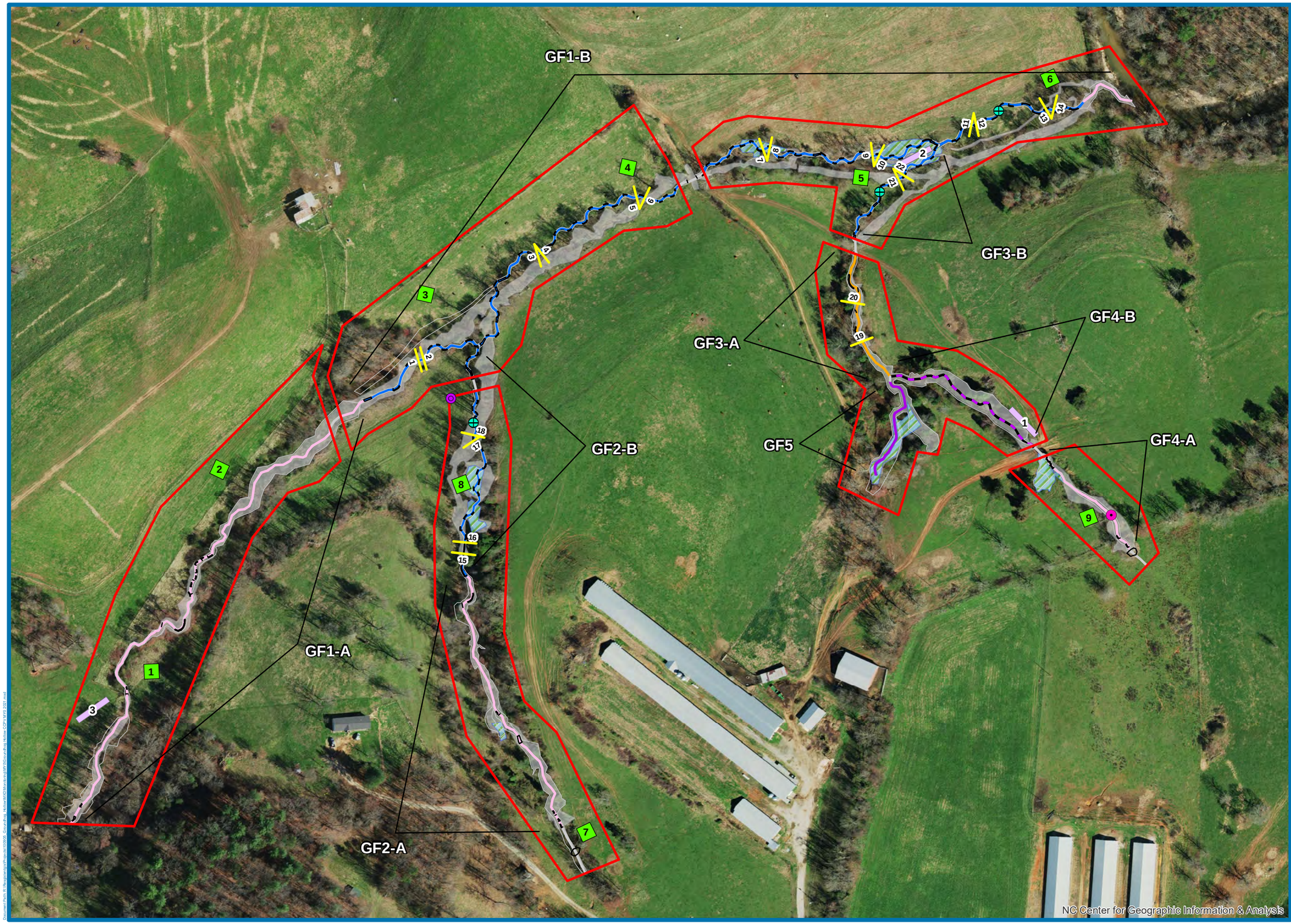
Date:	9/17/2020
Drawn by:	MDD
Checked by:	BPB
	1 inch = 2,000 feet

res

Document Path: S:\@RES GIS\Projects\NC\Groundhog Hollow\MXD\Mit Plan\Figure 1 - Vicinity.mxd

Appendix B

Visual Assessment Data



res

N
W E
S
0 100 200
Feet

Figure 2

Current Conditions
Plan View

MY0 2021

Groundhog Hollow
Mitigation Site

Alexander County, NC

Date: 6/9/2021	Drawn by: RTM
Lat: 35.937509	Long: -81.234876

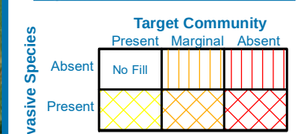
LEGEND

- Conservation Easement
- Cross Section
- Fixed Veg Plot
- Random Veg Plot
- As-Built Top of Bank
- Existing Top of Bank
- Existing Wetland

Stream Mitigation

- Restoration
- Enhancement I
- Enhancement II
- Enhancement II (5:1)
- Enhancement II (7.5:1)
- No Credit
- Stream Structure
- Flow Gauge
- Stage Recorder
- Ambient

Vegetation Condition Assessment



Visual Stream Stability Assessment

Reach GF1-B

Assessed Stream Length 2006

Assessed Bank Length 4012

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.	32	32		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)	60	60		100%

Visual Stream Stability Assessment

Reach GF2-B

Assessed Stream Length 534

Assessed Bank Length 1068

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.	15	15		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

Reach GF3-B

Assessed Stream Length 311

Assessed Bank Length 622

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.	6	6		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)	12	12		100%

Table 6 Vegetation Condition Assessment

Planted Acreage[1] **14.42**

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	0	0.00	0.0%
			Total			0.0%
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			0.0%

Easement Acreage[2] **20.66**

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	0	0.00	0.0%

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.

Groundhog Hollow MY0 Vegetation Monitoring Plot Photos

Vegetation Plot 1 (2/4/2021)

Vegetation Plot 2 (2/4/2021)

Vegetation Plot 3 (2/4/2021)

Vegetation Plot 4 (2/4/2021)

Vegetation Plot 5 (2/4/2021)

Vegetation Plot 6 (2/4/2021)

Vegetation Plot 7 (2/4/2021)

Vegetation Plot 8 (2/4/2021)

Vegetation Plot 9 (2/4/2021)

Random Vegetation Plot 1 (2/4/2021)

Random Vegetation Plot 2 (2/4/2021)

Random Vegetation Plot 3 (2/4/2021)

Groundhog Hollow Monitoring Device Photos

Stage Recorder GF1-B

Stage Recorder GF2-B

Stage Recorder GF3-B

Flow Gauge GF4-A

Appendix C

Vegetation Plot Data

Table 7. Planted Species Summary

Common Name	Scientific Name	Mit Plan %	As-Built %	Total Stems Planted
White Oak	*Quercus alba*	15	15	2,100
River Birch	*Betula nigra*	15	15	2,100
Sycamore	*Platanus occidentalis*	15	15	2,100
Willow Oak	*Quercus phellos*	15	15	2,100
Persimmon	*Diospyros virginiana*	5	10	1,500
Northern Red Oak	*Quercus rubra*	10	10	1,500
Yellow Poplar	*Liriodendron tulipifera*	10	10	1,500
Sugarberry	*Celtis laevigata*	0	10	1,500
Hackberry	*Celtis occidentalis*	10	0	0
Blackgum	*Nyssa sylvatica*	5	0	0
			Total	14,400
			Planted Area	14.42
			As-built Planted Stems/Acre	999

Table 8. Vegetation Plot Mitigation Success Summary

Plot #	Planted Stems/Acre	Volunteer Stems/Acre	Total Stems/Acre	Success Criteria Met?	Average Planted Stem Height (ft)
1	728	0	728	Yes	1.7
2	526	0	526	Yes	1.3
3	526	0	526	Yes	1.7
4	607	0	607	Yes	1.9
5	688	0	688	Yes	1.9
6	688	0	688	Yes	1.4
7	769	0	769	Yes	1.3
8	850	0	850	Yes	1.8
9	809	0	809	Yes	1.8
R1	526	0	526	Yes	1.3
R2	728	0	728	Yes	1.9
R3	567	0	567	Yes	1.4
Project Avg	**667**	**0**	**667**	**Yes**	1.6

Table 9. Stem Count Total and Planted by Plot Species

Groundhog Hollow			Current Plot Data (MY0 2021)																									Annual Means		
			100049-01-0001			100049-01-0002			100049-01-0003			100049-01-0004			100049-01-0005			100049-01-0006			100049-01-0007			100049-01-0008			100049-01-0009			MY0 (2021)		
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	PnoLS	P-all	T
Betula nigra	river birch	Tree	7	7	7							4	4	4	6	6	6							6	6	6	10	10	10	40	40	40
Celtis laevigata	sugarberry	Tree	2	2	2				2	2	2				1	1	1	4	4	4	8	8	8	1	1	1				21	21	21
Diospyros virginiana	common persimmon	Tree										1	1	1																3	3	3
Platanus occidentalis	American sycamore	Tree							2	2	2	2	2	2	4	4	4				1	1	1	6	6	6	7	7	7	35	35	35
Quercus alba	white oak	Tree				3	3	3	2	2	2	1	1	1				2	2	2	3	3	3	1	1	1				15	15	15
Quercus phellos	willow oak	Tree	9	9	9	1	1	1				3	3	3	6	6	6	1	1	1				5	5	5	1	1	1	29	29	29
Quercus rubra	northern red oak	Tree				9	9	9	7	7	7	4	4	4				10	10	10	7	7	7	2	2	2	2	2	2	55	55	55
Stem count			18	18	18	13	13	13	13	13	13	15	15	15	17	17	17	17	17	17	19	19	19	21	21	21	20	20	20	198	198	198
size (ares)			1			1			1			1			1			1			1			1			1			12		
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.30		
Species count			3	3	3	3	3	3	4	4	4	6	6	6	4	4	4	4	4	4	4	4	4	6	6	6	4	4	4	7	7	7
Stems per ACRE			728	728	728	526	526	526	526	526	526	607	607	607	688	688	688	688	688	688	769	769	769	850	850	850	809	809	809	667	667	667

Groundhog Hollow			Current Plot Data (MY0 2021)									Annual Means		
			100049-01-R1			100049-01-R2			100049-01-R3			MY0 (2021)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Betula nigra	river birch	Tree				7	7	7				40	40	40
Celtis laevigata	sugarberry	Tree							3	3	3	21	21	21
Diospyros virginiana	common persimmon	Tree				1	1	1	1	1	1	3	3	3
Platanus occidentalis	American sycamore	Tree	3	3	3	8	8	8	2	2	2	35	35	35
Quercus alba	white oak	Tree	1	1	1				2	2	2	15	15	15
Quercus phellos	willow oak	Tree	1	1	1	2	2	2				29	29	29
Quercus rubra	northern red oak	Tree	8	8	8				6	6	6	55	55	55
Stem count			13	13	13	18	18	18	14	14	14	198	198	198
size (ares)			1			1			1			12		
size (ACRES)			0.02			0.02			0.02			0.30		
Species count			4	4	4	4	4	4	5	5	5	7	7	7
Stems per ACRE			526	526	526	728	728	728	567	567	567	667	667	667

Appendix D

Stream Measurement and Geomorphology Data

Table 10. Baseline Stream Data Summary
Groundhog Hollow Mitigation Site - Reach GF1-B

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)		---	---	---	4.4	--	6.3	8.3	---	3	4.4	---	---	---	---	1	5.2	5.3	6.8	6.2	6.8	6.4	8.3	0.8	7
Floodprone Width (ft)					6.5	---	8.3	22.5	---	3	12.0	---	---	20.0	---	1	19.2	19.3	20.8	44.8	47.6	47.0	50.6	2.5	7
Bankfull Mean Depth (ft)		---	---	---	0.5	---	0.6	1.1	---	3	0.5	---	---	0.6	---	1	0.5	0.5	0.7	---	---	---	---	---	---
[1]Bankfull Max Depth (ft)					0.9	---	0.9	1.3	---	3	0.8	---	---	0.9	---	1	0.7	0.7	1.0	0.6	1.0	1.0	1.4	0.2	7
Bankfull Cross Sectional Area (ft^2)		---	---	---	2.6	---	4.5	6.8	---	3	2.1	---	---	2.8	---	1	2.5	2.7	5.0	1.9	3.8	3.4	6.2	1.4	7
Width/Depth Ratio					5.9	---	7.6	15.2	---	3	6.9	---	---	9.2	---	1	9.2	10.3	10.7	---	---	---	---	---	---
Entrenchment Ratio					1.3	---	1.5	2.9	---	3	2.7	---	---	4.5	---	1	3.6	3.7	3.9	5.5	7.1	7.3	8.2	1.0	7
[1]Bank Height Ratio					1.3	---	2.3	2.8	---	3	1.0	---	---	2.5	---	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	7
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	4	---	---	18	---	---	3.9	---	19.8	2	8	7	18	3	84
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.0	3.1	2.5	11.4	2.3	84.0
Pool Length (ft)					---	---	---	---	---	---	3	---	---	8	---	---	3.2	---	9	3	16	14	87	10	83
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	12	---	---	35	---	---	13.1	---	38.8	9	24	22	92	11	83
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	15	---	---	35	---	---	16.7	---	39	16.7	---	---	39	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	6	---	---	17	---	---	6.7	---	18.7	6.7	---	---	18.7	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	1.4	---	---	3.9	---	---	1.2	---	3.3	1.2	---	---	3.3	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	23	---	---	43	---	---	25.3	---	47.7	25.3	---	---	47.7	---	---
Meander Width Ratio					---	---	---	---	---	---	3.4	---	---	8	---	---	4.4	---	8.3	4.4	---	---	8.3	---	---
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					F4b						E4/5						C4/E4			C4/E4					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---						---						---			---					
Valley length (ft)					1168						842						1535			1535					
Channel Thalweg length (ft)					1350						995						689			689					
Sinuosity (ft)					1.16						1.18						1.17			1.17					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.024						0.0033						0.011			0.011					
[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 (continued)
Groundhog Hollow Mitigation Site - Reach GF2-B

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)		---	---	---	---	---	7.7	---	---	1	---	---	4.4	---	---	1	---	4.9	---	5.5	6.6	6.8	7.5	1.0	3
Floodprone Width (ft)					---	---	8.1	---	---	1	---	---	12.0	20.0	---	1	---	16.9	---	38.6	44.9	45.4	50.8	6.1	3
Bankfull Mean Depth (ft)		---	---	---	---	---	0.5	---	---	1	---	---	0.5	0.6	---	1	---	0.4	---	---	---	---	---	---	---
[1]Bankfull Max Depth (ft)					---	---	0.8	---	---	1	---	---	0.8	0.9	---	1	---	0.6	---	1.0	1.1	1.1	1.2	0.1	3
Bankfull Cross Sectional Area (ft^2)		---	---	---	---	---	4.0	---	---	1	---	---	2.1	2.8	---	1	---	2.2	---	3.0	3.8	3.7	4.8	0.9	3
Width/Depth Ratio					---	---	14.8	---	---	1	---	---	6.9	9.2	---	1	---	11.1	---	---	---	---	---	---	---
Entrenchment Ratio					---	---	1.1	---	---	1	---	---	2.7	4.5	---	1	---	3.4	---	5.7	6.9	6.8	8.3	1.3	3
[1]Bank Height Ratio					---	---	2.1	---	---	1	---	---	1.0	2.5	---	1	---	1.0	---	1.0	1.0	1.0	1.0	0.0	3
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	4	---	---	18	---	---	3.3	---	16.9	3	9	6	48	9	27
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.5	3.4	2.5	16.3	3.2	27.0
Pool Length (ft)					---	---	---	---	---	---	3	---	---	8	---	---	2.7	---	7.6	6	12	11	22	4	26
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	12	---	---	35	---	---	11.1	---	33	12	21	19	65	11	25
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	15	---	---	35	---	---	14	---	33	14	---	---	33	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	6	---	---	17	---	---	6	---	16	6	---	---	16	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	1.4	---	---	3.9	---	---	1.2	---	3.3	1.2	---	---	3.3	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	23	---	---	43	---	---	30	---	56	30	---	---	56	---	---
Meander Width Ratio					---	---	---	---	---	---	3.4	---	---	8	---	---	6.1	---	11.5	6.1	---	---	11.5	---	---
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					F4b						E4/5						C4/E4			C4/E4					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---												---			---					
Valley length (ft)					573						842						492			492					
Channel Thalweg length (ft)					680						995						53			53					
Sinuosity (ft)					1.19						1.18						1.14			1.14					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.031						0.0033						0.02			0.02					
[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 (continued)
Groundhog Hollow Mitigation Site - Reach GF3-B

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)		---	---	---	---	---	4.1	---	---	1	---	---	4.4	---	---	1	---	5.3	---	---	---	7.6	---	---	1
Floodprone Width (ft)					---	---	6.2	---	---	1	---	---	12.0	20.0	---	1	---	19.3	---	---	---	25.6	---	---	1
Bankfull Mean Depth (ft)		---	---	---	---	---	0.7	---	---	1	---	---	0.5	0.6	---	1	---	0.5	---	---	---	---	---	---	1
[1]Bankfull Max Depth (ft)					---	---	1.0	---	---	1	---	---	0.8	0.9	---	1	---	0.7	---	---	---	0.9	---	---	1
Bankfull Cross Sectional Area (ft^2)		---	---	---	---	---	2.9	---	---	1	---	---	2.1	2.8	---	1	---	2.7	---	---	---	2.9	---	---	1
Width/Depth Ratio					---	---	5.8	---	---	1	---	---	6.9	9.2	---	1	---	10.3	---	---	---	---	---	---	1
Entrenchment Ratio					---	---	1.5	---	---	1	---	---	2.7	4.5	---	1	---	3.6	---	---	---	3.4	---	---	1
[1]Bank Height Ratio					---	---	1.6	---	---	1	---	---	1.0	2.5	---	1	---	1.0	---	---	---	1.0	---	---	1
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	4	---	---	18	---	---	3.1	---	15.8	3	7	6	12	2	16
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.1	4.6	4.2	11.8	3.2	16.0
Pool Length (ft)					---	---	---	---	---	---	3	---	---	8	---	---	2.6	---	7.2	7	12	11	23	4	15
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	12	---	---	35	---	---	3.8	---	31	10	18	18	27	4	14
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	15	---	---	35	---	---	13	---	31	13	---	---	31	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	6	---	---	17	---	---	5	---	15	5	---	---	15	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	1.4	---	---	3.9	---	---	1	---	2.8	1	---	---	2.8	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	23	---	---	43	---	---	20	---	38	20	---	---	38	---	---
Meander Width Ratio					---	---	---	---	---	---	3.4	---	---	8	---	---	3.8	---	7.2	3.8	---	---	7.2	---	---
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					G5/6						E4/5						C4/E4			C4/E4					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---												---			---					
Valley length (ft)					253						842						294			294					
Channel Thalweg length (ft)					272						995						343			343					
Sinuosity (ft)					1.08						1.18						1.17			1.17					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.021						0.0033						0.013			0.013					
[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: Groundhog Hollow #100049

	Cross Section 1 (Riffle)							Cross Section 2 (Pool)							Cross Section 3 (Pool)							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]	1103.8							1103.5							1097.9							1097.5							1092.7						
Bankfull Width (ft)[1]	6.3							6.4							8.5							6.2							6.3						
Floodprone Width (ft)[1]	50.0							-							-							>50.6							45						
Bankfull Max Depth (ft)[2]	0.6							0.7							1.6							1.0							0.9						
Low Bank Elevation (ft)	1103.77							1103.5							1097.9							1097.5							1092.7						
Bankfull Cross Sectional Area (ft^2)[2]	1.9							2.3							6.1							3.3							2.6						
Bankfull Entrenchment Ratio[1]	7.9							-							-							8.2							7.1						
Bankfull Bank Height Ratio[1]	1.0							-							-							1.0							1.0						

	Cross Section 6 (Pool)							Cross Section 7 (Riffle)							Cross Section 8 (Pool)							Cross Section 9 (Riffle)							Cross Section 10 (Pool)						
	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]	1092.2							1085.5							1085.2							1081.3							1081.0						
Bankfull Width (ft)[1]	7.9							6.4							6.5							7.6							6.6						
Floodprone Width (ft)[1]	-							>49.8							-							>44.8							-						
Bankfull Max Depth (ft)[2]	1.2							1.0							1.0							1.1							1.2						
Low Bank Elevation (ft)	1092.2							1085.5							1085.2							1081.3							1081.00						
Bankfull Cross Sectional Area (ft^2)[2]	5.0							4.7							4.1							4.5							4.7						
Bankfull Entrenchment Ratio[1]	-							7.8							-							5.9							-						
Bankfull Bank Height Ratio[1]	-							1.0							-							1.0							-						

	Cross Section 11 (Riffle)							Cross Section 12 (Pool)							Cross Section 13 (Pool)							Cross Section 14 (Riffle)							Cross Section 15 (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]	1076.2							1076.3							1071.6							1071.0							1119.1						
Bankfull Width (ft)[1]	6.4							5.5							7.8							8.3							6.8						
Floodprone Width (ft)[1]	>47							-							-							46.1							>38.6						
Bankfull Max Depth (ft)[2]	0.9							1.6							2.5							1.4							1.2						
Low Bank Elevation (ft)	1076.24							1076.3							1071.6							1071.0							1119.1						
Bankfull Cross Sectional Area (ft^2)[2]	3.4							5.4							9.9							6.2							4.8						
Bankfull Entrenchment Ratio[1]	7.3							-							-							5.5							5.7						
Bankfull Bank Height Ratio[1]	1.0							-							-							1.0							1.0						

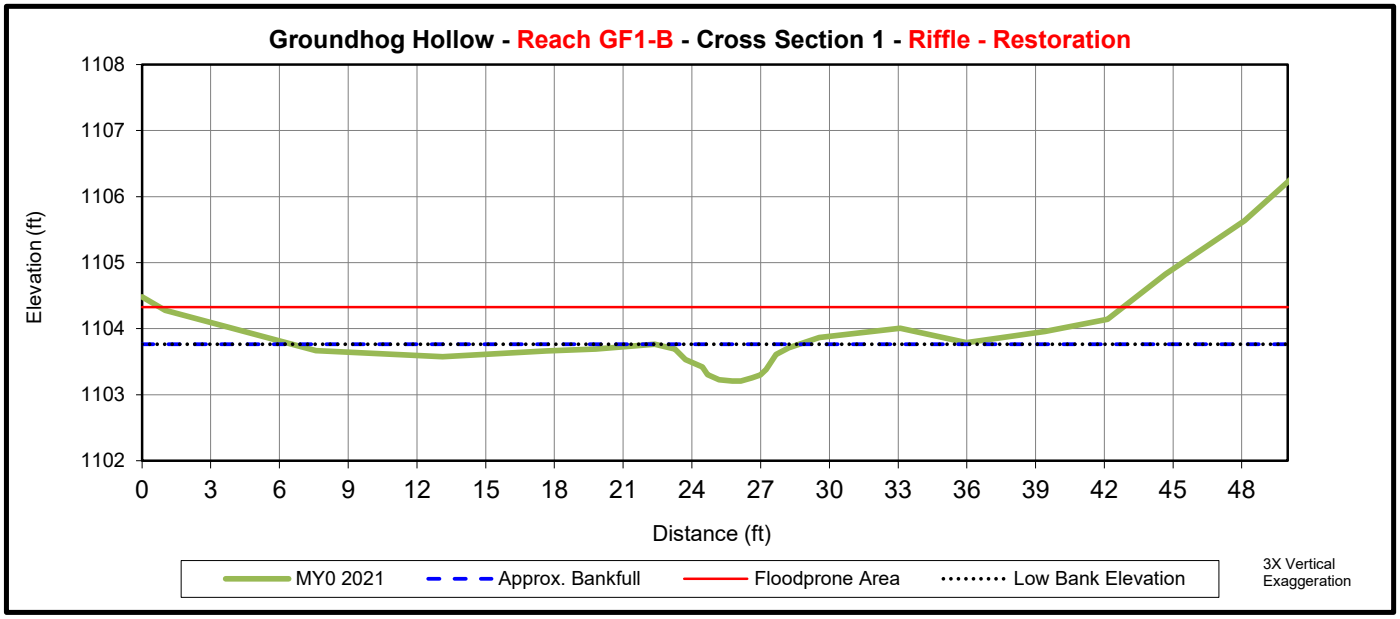
	Cross Section 16 (Pool)							Cross Section 17 (Pool)							Cross Section 18 (Riffle)							Cross Section 19 (Riffle)							Cross Section 20 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1118.6							1111.0							1110.6							1087.0							1084.8						
Bankfull Width (ft)[1]	8.0							7.5							5.5							4.9							6.2						
Floodprone Width (ft)[1]	-							-							>45.4							6.3							9.6						
Bankfull Max Depth (ft)[2]	2.3							1.1							1.0							0.8							0.8						
Low Bank Elevation (ft)	1118.63							1111.0							1110.6							1089.2							1086.2						
Bankfull Cross Sectional Area (ft^2)[2]	8.3							3.7							3.0							3.0							3.0						
Bankfull Entrenchment Ratio[1]	-							-							8.3							1.3							1.5						
Bankfull Bank Height Ratio[1]	-							-							1.0							3.6							2.9						

	Cross Section 21 (Riffle)							Cross Section 22 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1079.8							1079.6						
Bankfull Width (ft)[1]	7.6							6.2						
Floodprone Width (ft)[1]	25.6							-						
Bankfull Max Depth (ft)[2]	0.9							1.0						
Low Bank Elevation (ft)	1079.84							1079.6						
Bankfull Cross Sectional Area (ft^2)[2]	2.9							3.1						
Bankfull Entrenchment Ratio[1]	3.4							-						
Bankfull Bank Height Ratio[1]	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

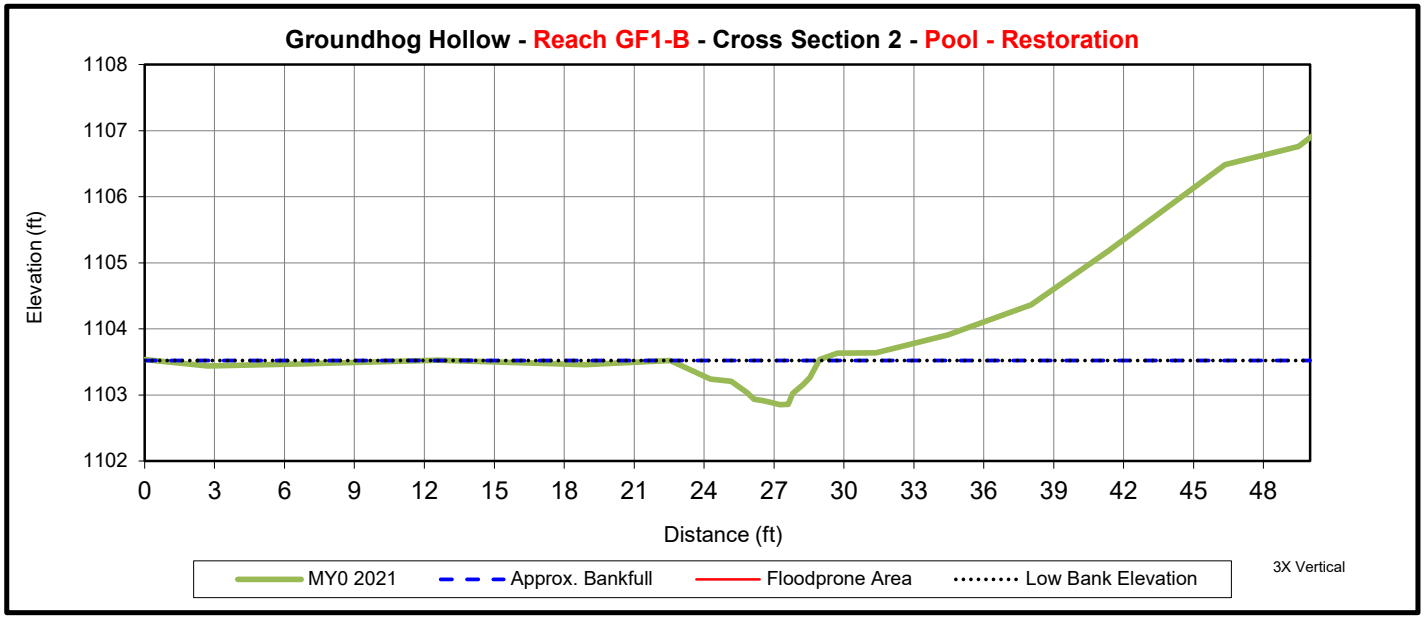


	Cross Section 1 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1103.77						
Bankfull Width (ft)[1]	6.3						
Floodprone Width (ft)[1]	50.0						
Bankfull Max Depth (ft)[2]	0.6						
Low Bank Elevation (ft)	1103.77						
Bankfull Cross Sectional Area (ft^2)[2]	1.9						
Bankfull Entrenchment Ratio[1]	7.9						
Bankfull Bank Height Ratio[1]	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

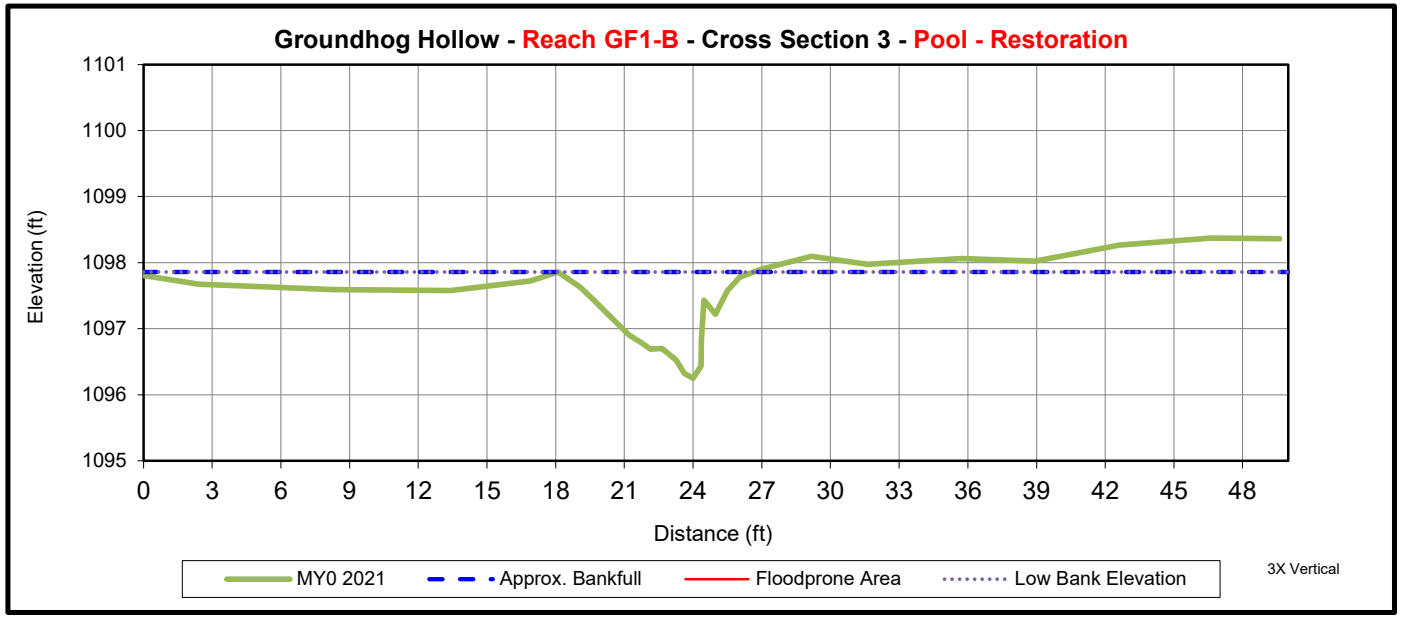


	Cross Section 2 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1103.52						
Bankfull Width (ft)[1]	6.4						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	0.7						
Low Bank Elevation (ft)	1103.52						
Bankfull Cross Sectional Area (ft^2)[2]	2.3						
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

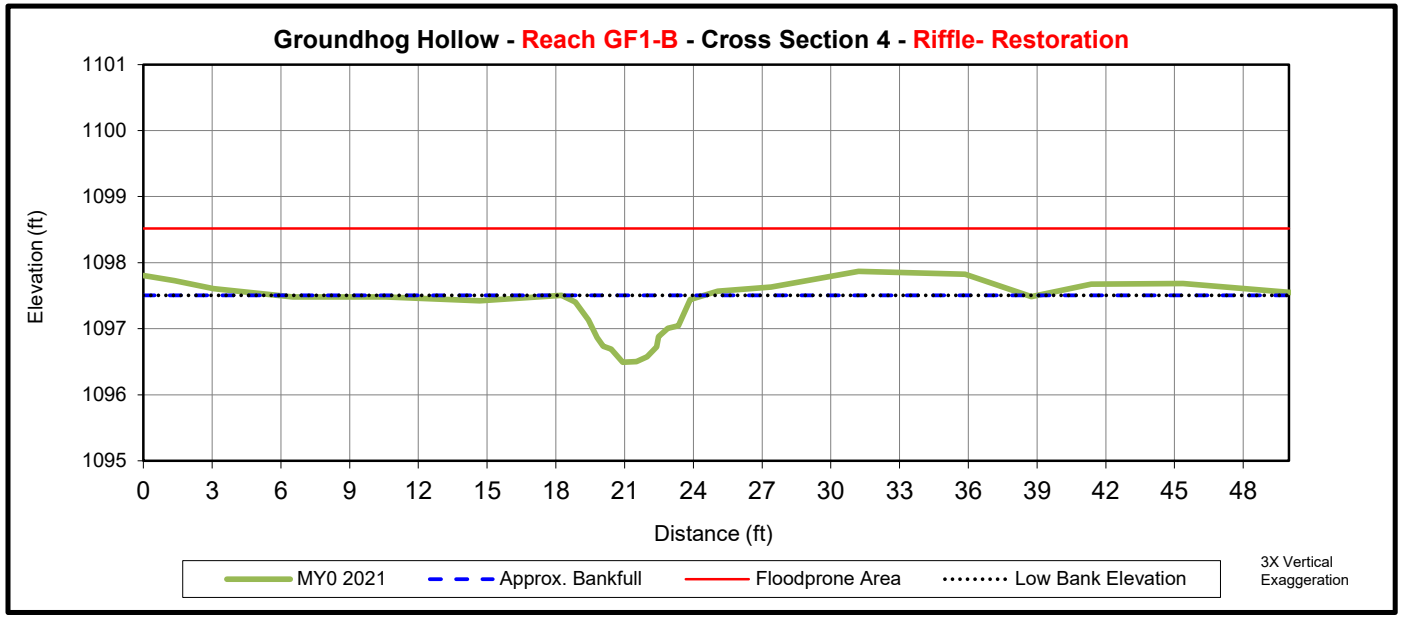


	Cross Section 3 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1097.86						
Bankfull Width (ft)[1]	8.5						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	1.6						
Low Bank Elevation (ft)	1097.86						
Bankfull Cross Sectional Area (ft^2)[2]	6.1						
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

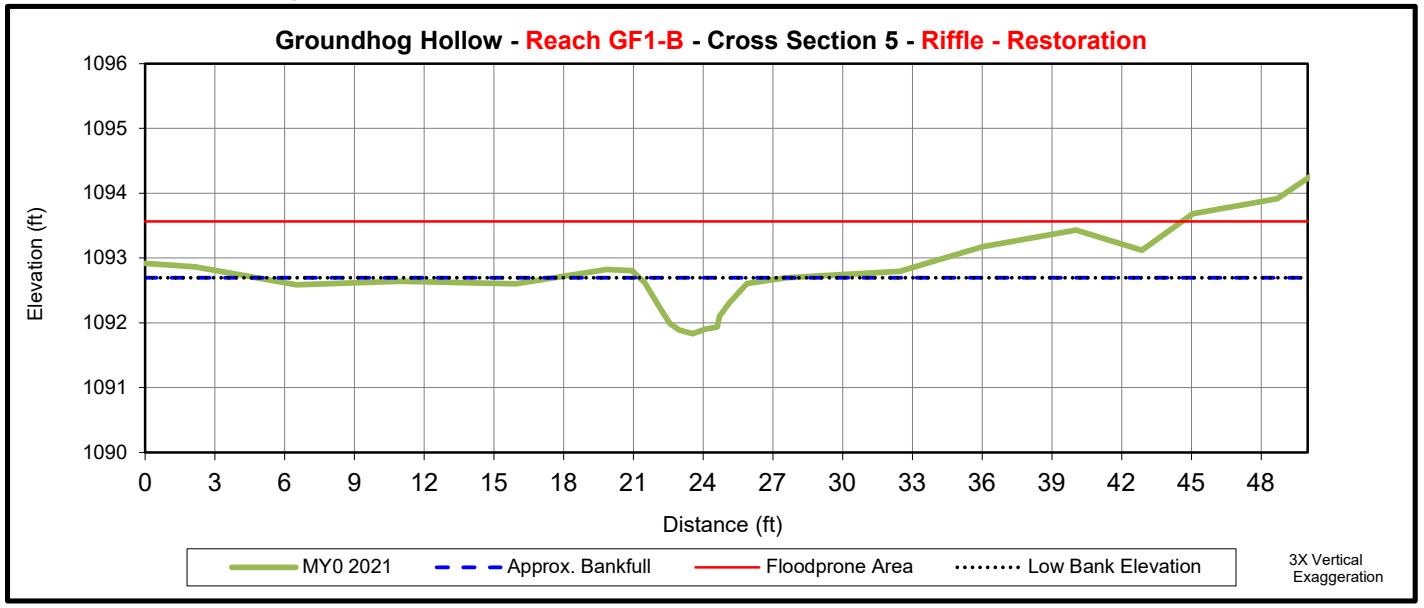


	Cross Section 4 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1097.50						
Bankfull Width (ft)[1]	6.2						
Floodprone Width (ft)[1]	>50.6						
Bankfull Max Depth (ft)[2]	1.0						
Low Bank Elevation (ft)	1097.50						
Bankfull Cross Sectional Area (ft^2)[2]	3.3						
Bankfull Entrenchment Ratio[1]	8.2						
Bankfull Bank Height Ratio[1]	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

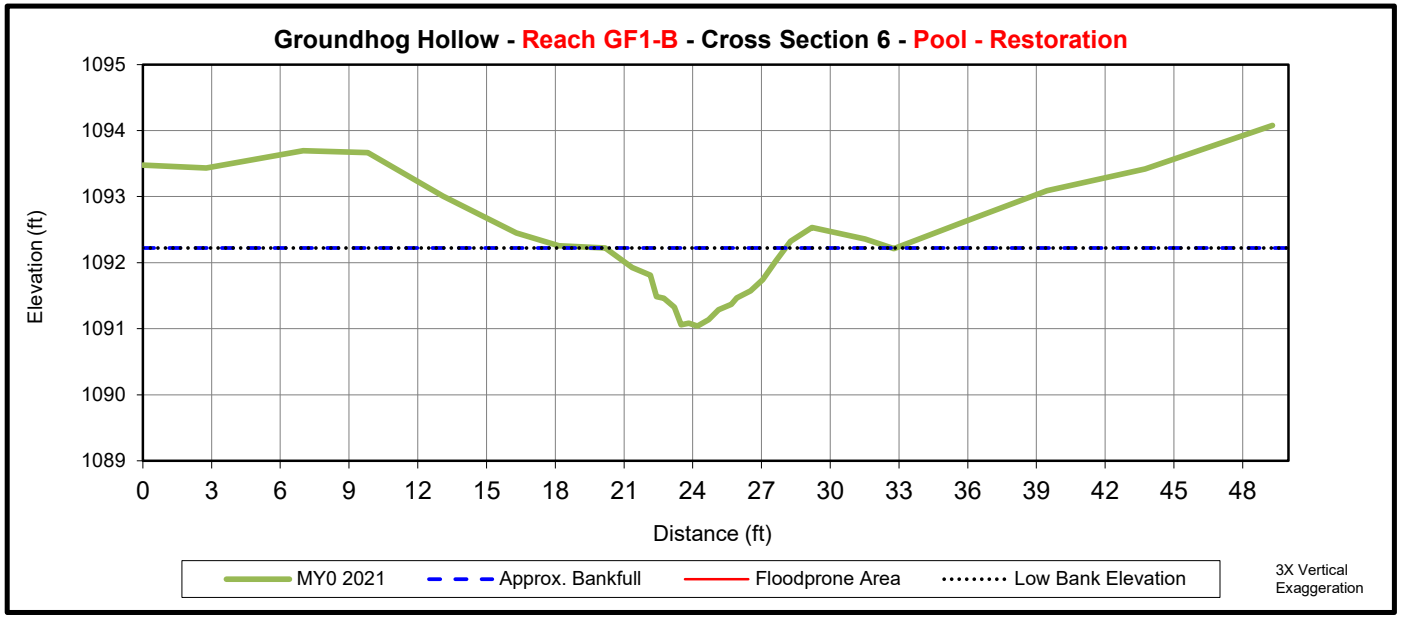


	Cross Section 5 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1092.70						
Bankfull Width (ft)[1]	6.3						
Floodprone Width (ft)[1]	45						
Bankfull Max Depth (ft)[2]	0.9						
Low Bank Elevation (ft)	1092.70						
Bankfull Cross Sectional Area (ft^2)[2]	2.6						
Bankfull Entrenchment Ratio[1]	7.1						
Bankfull Bank Height Ratio[1]	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

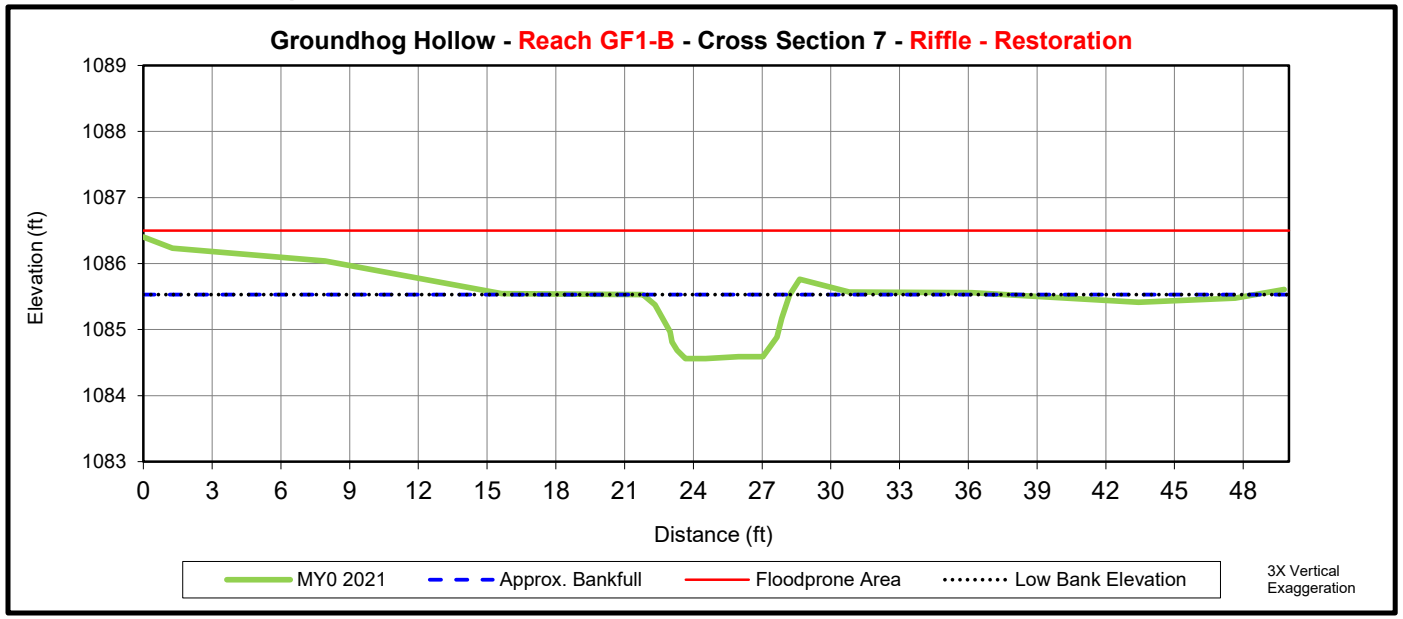


	Cross Section 6 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1092.22						
Bankfull Width (ft)[1]	7.9						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	1.2						
Low Bank Elevation (ft)	1092.22						
Bankfull Cross Sectional Area (ft^2)[2]	5.0						
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

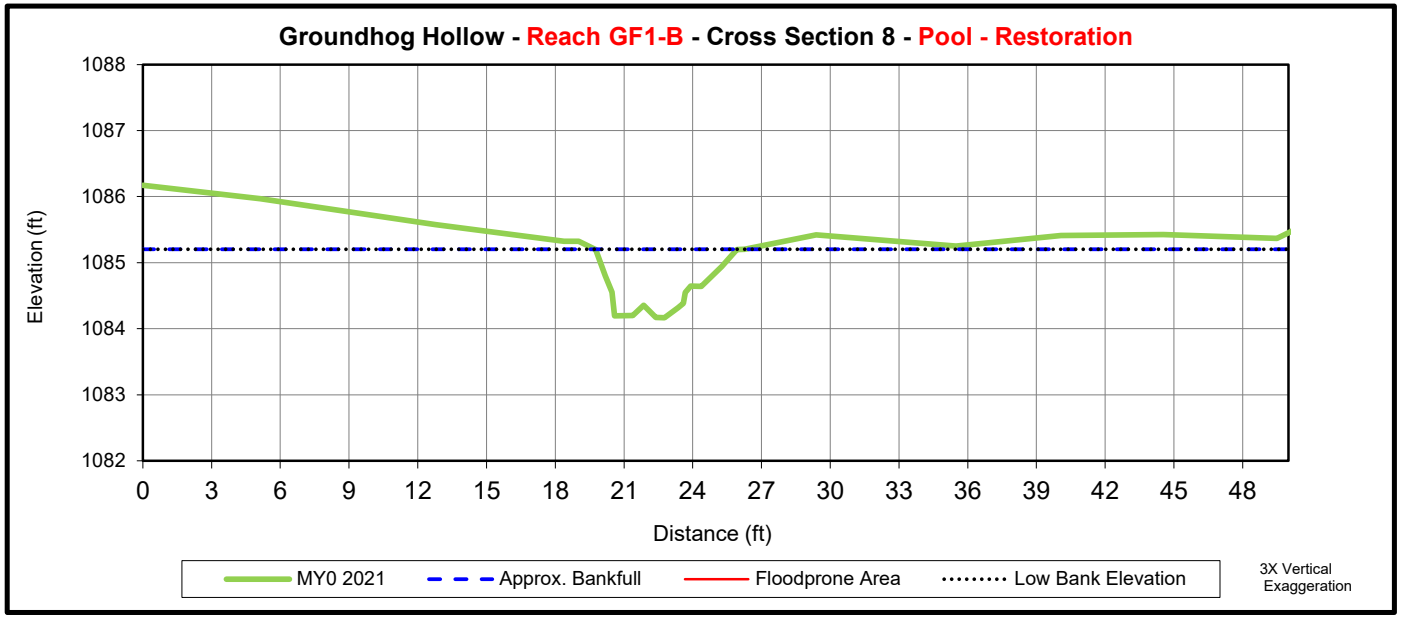


	Cross Section 7 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1085.53						
Bankfull Width (ft)[1]	6.4						
Floodprone Width (ft)[1]	>49.8						
Bankfull Max Depth (ft)[2]	1.0						
Low Bank Elevation (ft)	1085.53						
Bankfull Cross Sectional Area (ft^2)[2]	4.7						
Bankfull Entrenchment Ratio[1]	7.8						
Bankfull Bank Height Ratio[1]	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

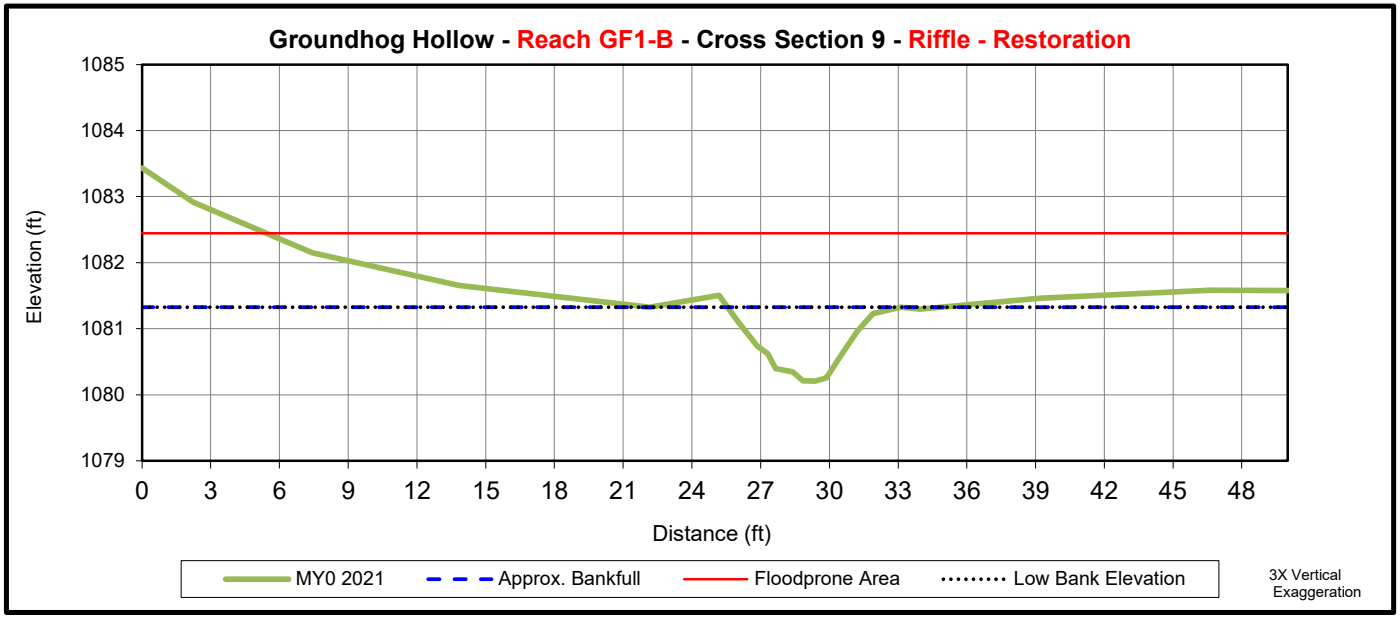


	Cross Section 8 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1085.20						
Bankfull Width (ft)[1]	6.5						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	1.0						
Low Bank Elevation (ft)	1085.20						
Bankfull Cross Sectional Area (ft^2)[2]	4.1						
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

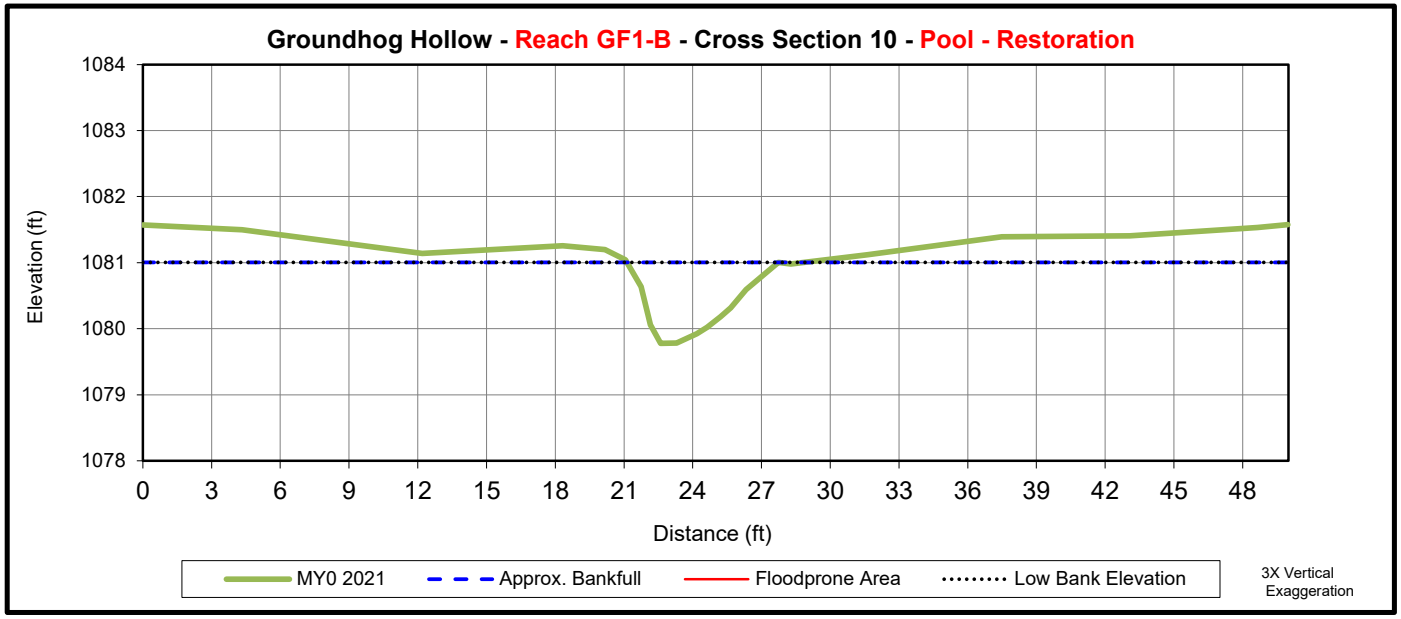


	Cross Section 9 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1081.33						
Bankfull Width (ft)[1]	7.6						
Floodprone Width (ft)[1]	>44.8						
Bankfull Max Depth (ft)[2]	1.1						
Low Bank Elevation (ft)	1081.33						
Bankfull Cross Sectional Area (ft^2)[2]	4.5						
Bankfull Entrenchment Ratio[1]	5.9						
Bankfull Bank Height Ratio[1]	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

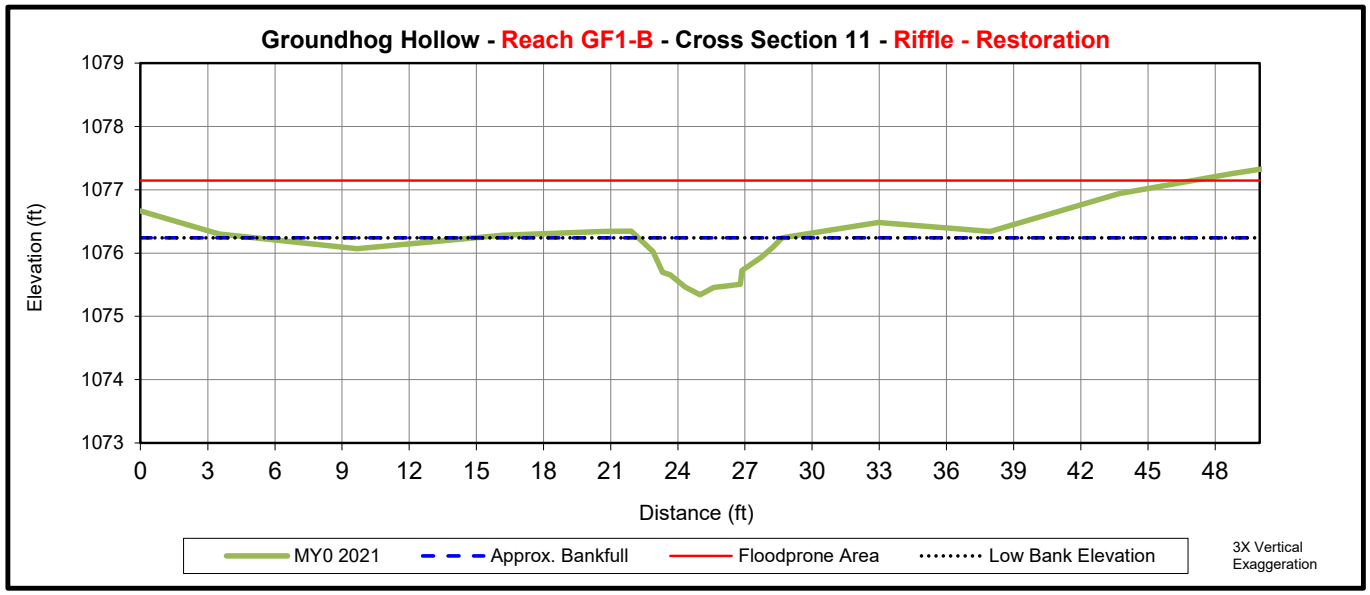


	Cross Section 10 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1081.00						
Bankfull Width (ft)[1]	6.6						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	1.2						
Low Bank Elevation (ft)	1081.00						
Bankfull Cross Sectional Area (ft^2)[2]	4.7						
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

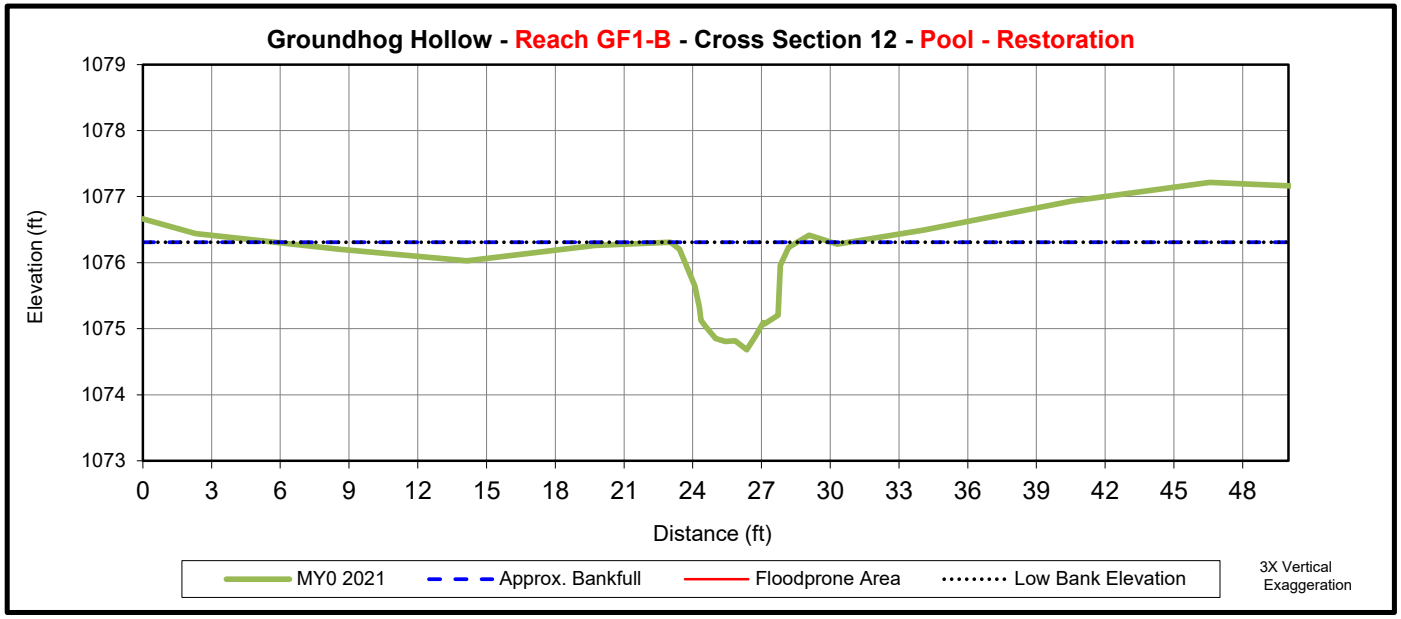


	Cross Section 11 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1076.24						
Bankfull Width (ft)[1]	6.4						
Floodprone Width (ft)[1]	>47						
Bankfull Max Depth (ft)[2]	0.9						
Low Bank Elevation (ft)	1076.24						
Bankfull Cross Sectional Area (ft^2)[2]	3.4						
Bankfull Entrenchment Ratio[1]	7.3						
Bankfull Bank Height Ratio[1]	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

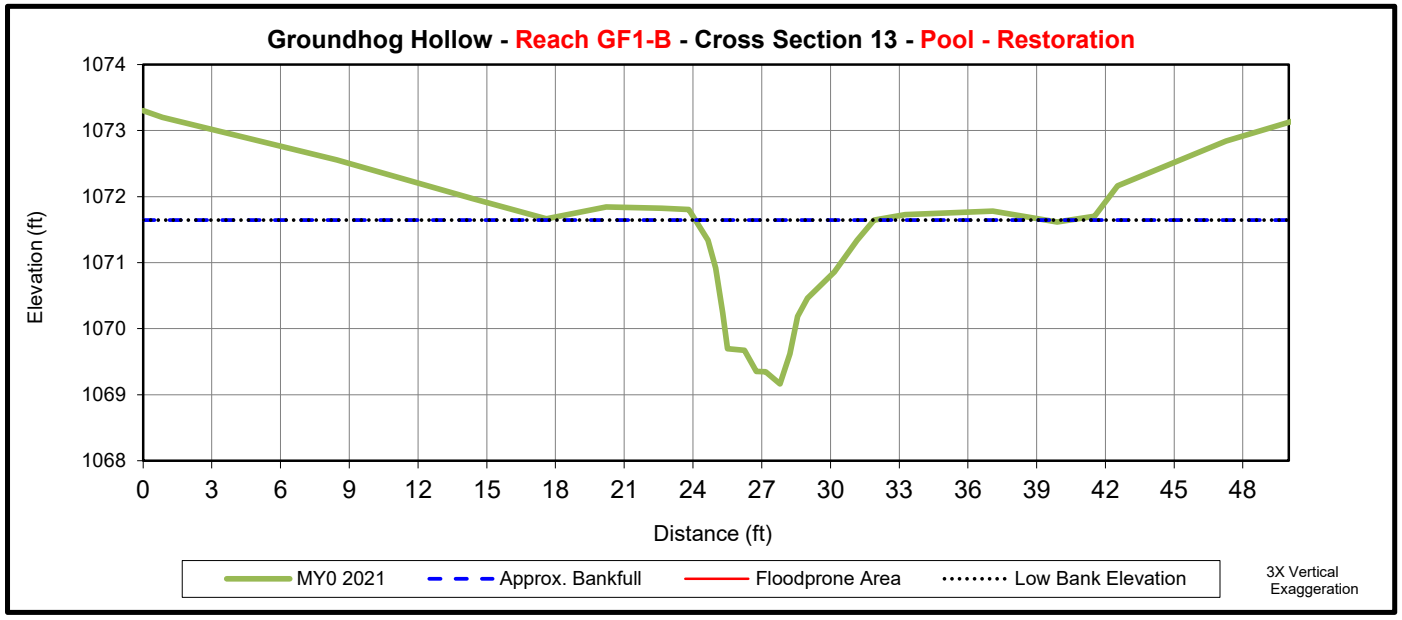


	Cross Section 12 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1076.31						
Bankfull Width (ft)[1]	5.5						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	1.6						
Low Bank Elevation (ft)	1076.31						
Bankfull Cross Sectional Area (ft^2)[2]	5.4						
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

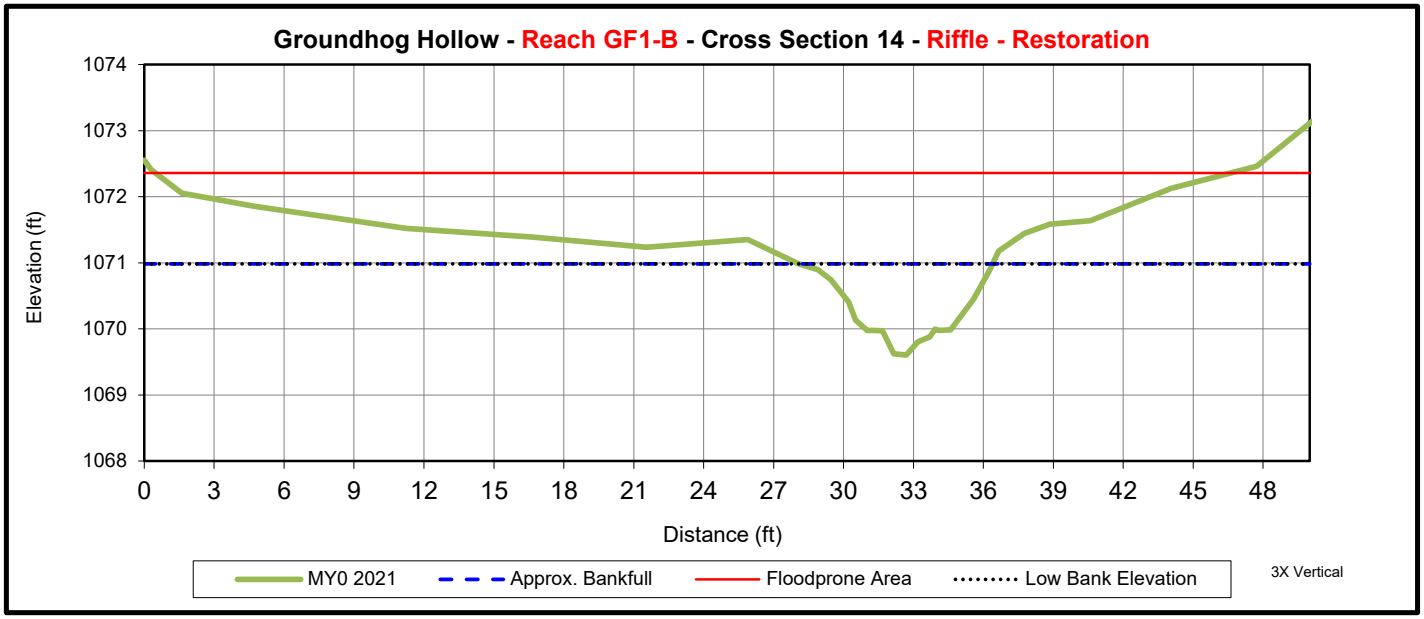


	Cross Section 13 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1071.64						
Bankfull Width (ft)[1]	7.8						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	2.5						
Low Bank Elevation (ft)	1071.64						
Bankfull Cross Sectional Area (ft^2)[2]	9.9						
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

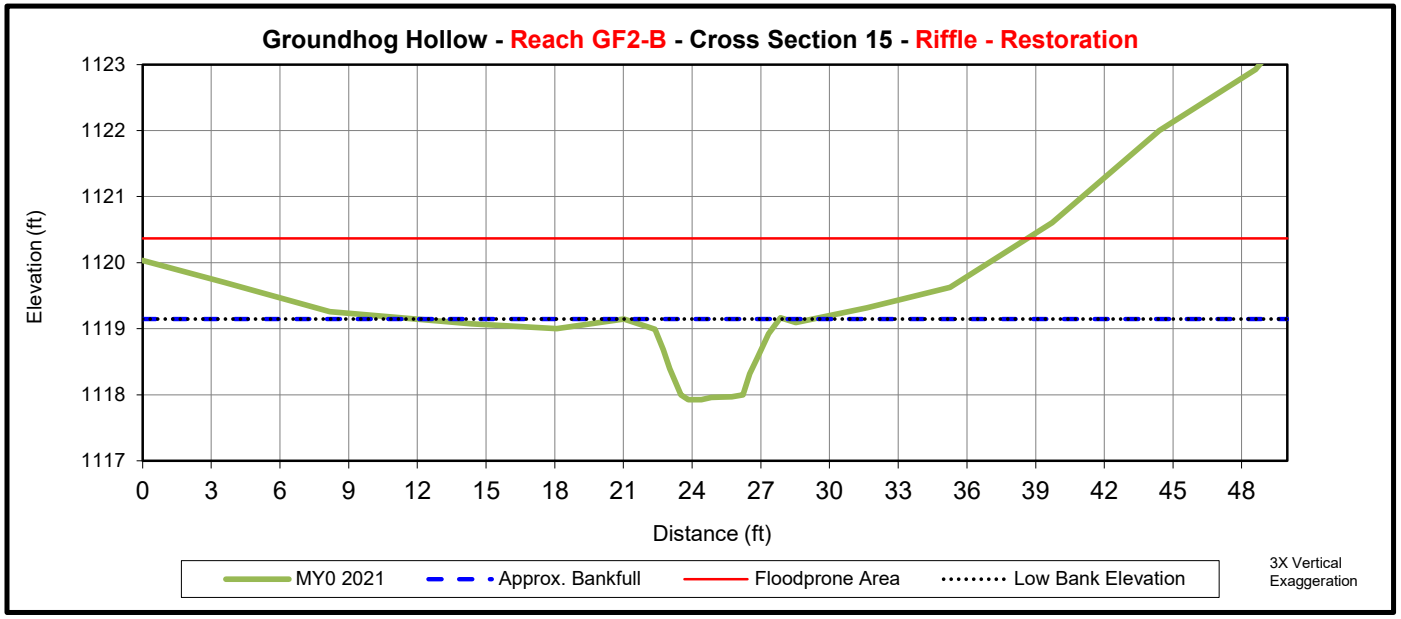


	Cross Section 14 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1070.98						
Bankfull Width (ft)[1]	8.3						
Floodprone Width (ft)[1]	46.1						
Bankfull Max Depth (ft)[2]	1.4						
Low Bank Elevation (ft)	1070.98						
Bankfull Cross Sectional Area (ft^2)[2]	6.2						
Bankfull Entrenchment Ratio[1]	5.5						
Bankfull Bank Height Ratio[1]	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

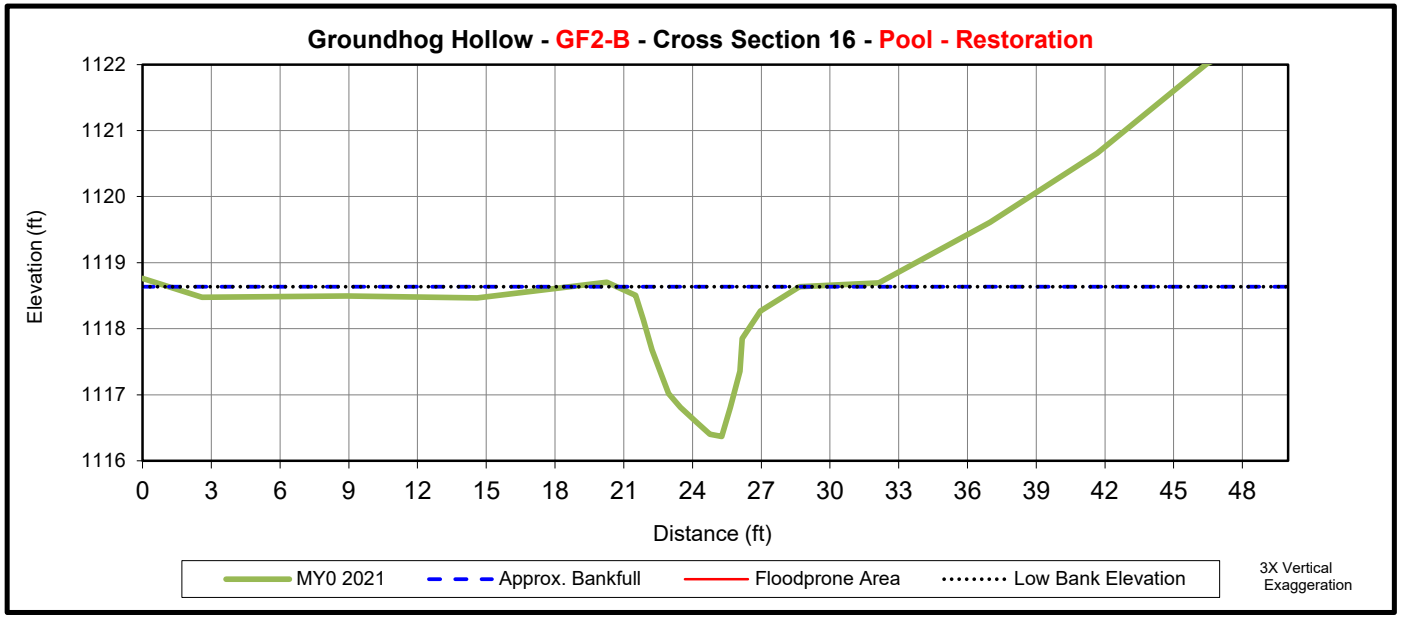


	Cross Section 15 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1119.15						
Bankfull Width (ft)[1]	6.8						
Floodprone Width (ft)[1]	>38.6						
Bankfull Max Depth (ft)[2]	1.2						
Low Bank Elevation (ft)	1119.15						
Bankfull Cross Sectional Area (ft^2)[2]	4.8						
Bankfull Entrenchment Ratio[1]	5.7						
Bankfull Bank Height Ratio[1]	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

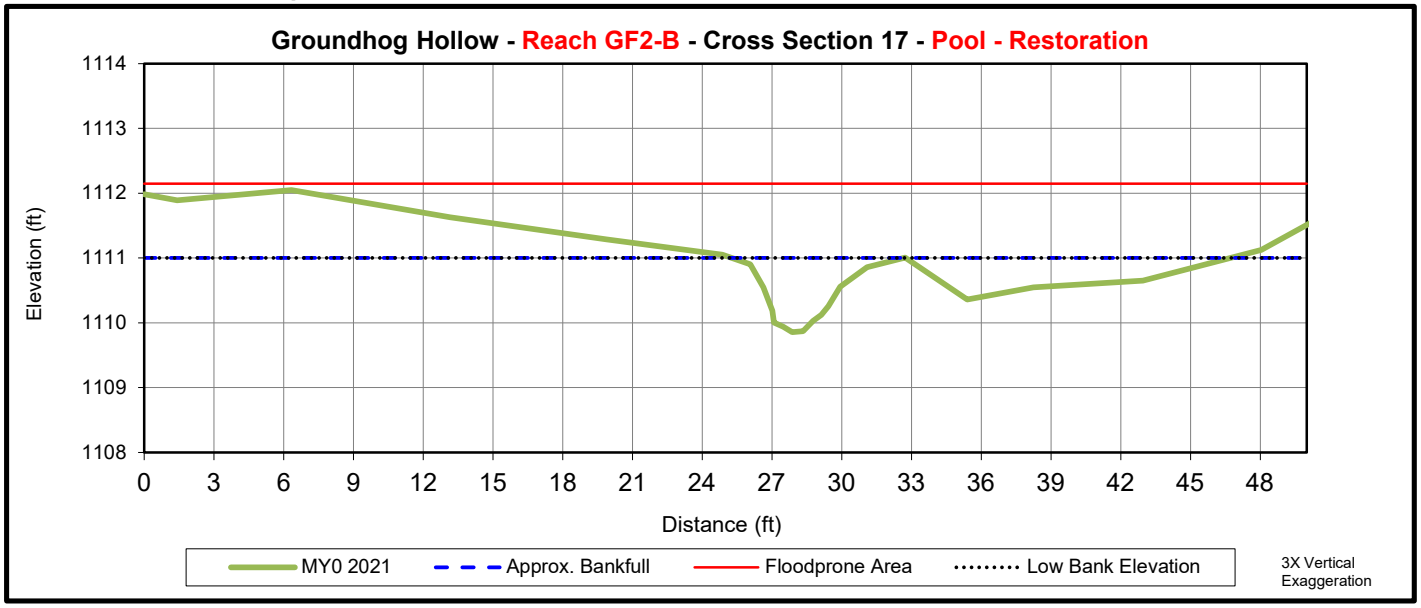


	Cross Section 16 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1118.63						
Bankfull Width (ft)[1]	8.0						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	2.3						
Low Bank Elevation (ft)	1118.63						
Bankfull Cross Sectional Area (ft^2)[2]	8.3						
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

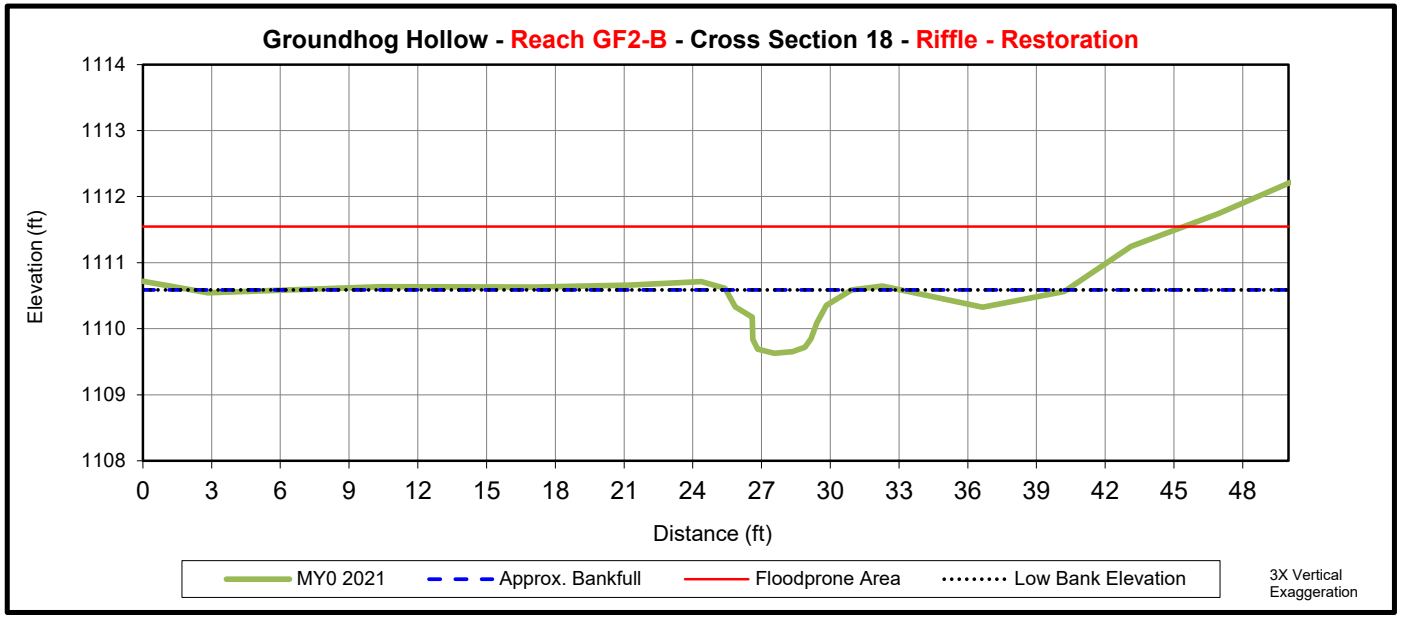


	Cross Section 17 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1111.00						
Bankfull Width (ft)[1]	7.5						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	1.1						
Low Bank Elevation (ft)	1111.00						
Bankfull Cross Sectional Area (ft^2)[2]	3.7						
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

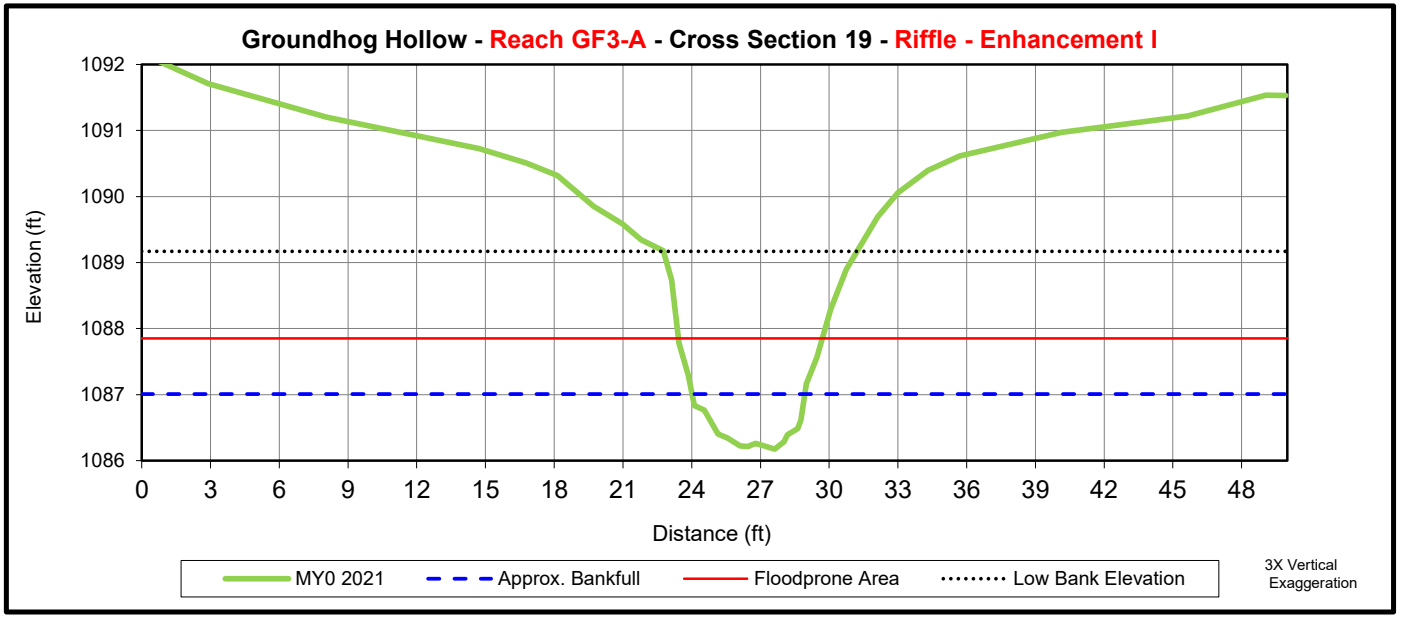


	Cross Section 18 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1110.59						
Bankfull Width (ft)[1]	5.5						
Floodprone Width (ft)[1]	>45.4						
Bankfull Max Depth (ft)[2]	1.0						
Low Bank Elevation (ft)	1110.59						
Bankfull Cross Sectional Area (ft^2)[2]	3.0						
Bankfull Entrenchment Ratio[1]	8.3						
Bankfull Bank Height Ratio[1]	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

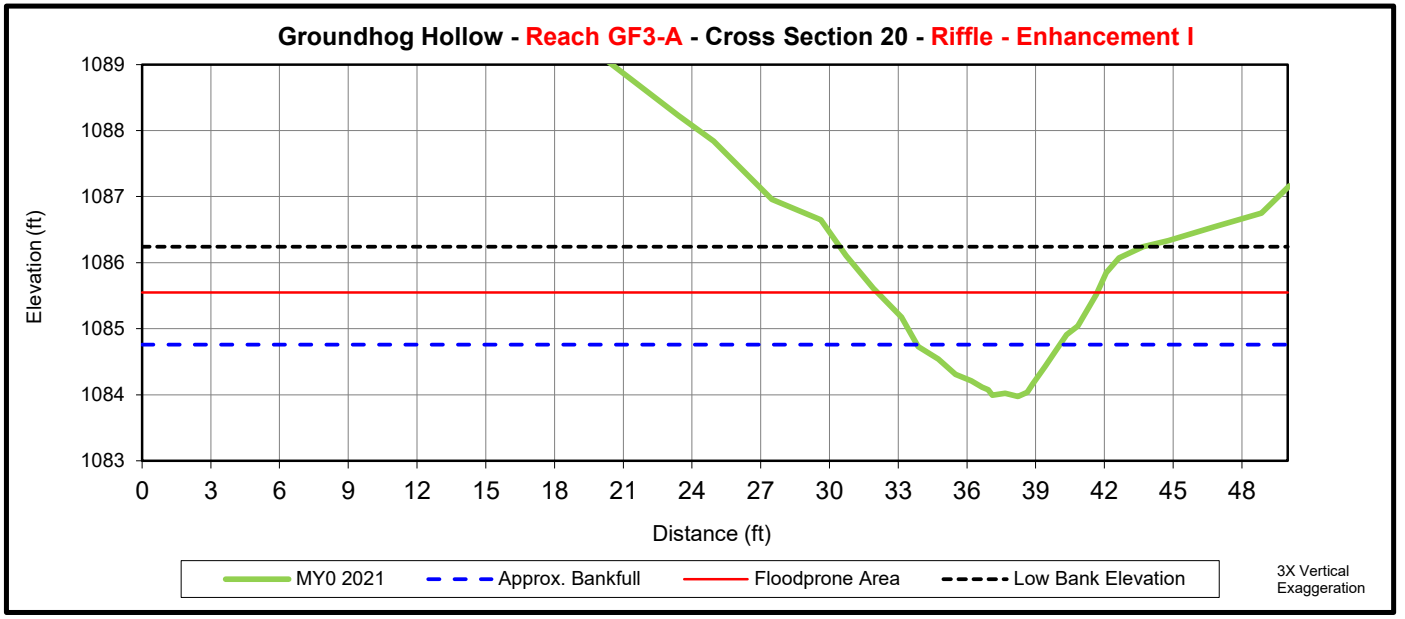


	Cross Section 19 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1087.00						
Bankfull Width (ft)[1]	4.9						
Floodprone Width (ft)[1]	6.3						
Bankfull Max Depth (ft)[2]	0.8						
Low Bank Elevation (ft)	1089.20						
Bankfull Cross Sectional Area (ft^2)[2]	3.0						
Bankfull Entrenchment Ratio[1]	1.3						
Bankfull Bank Height Ratio[1]	3.6						

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

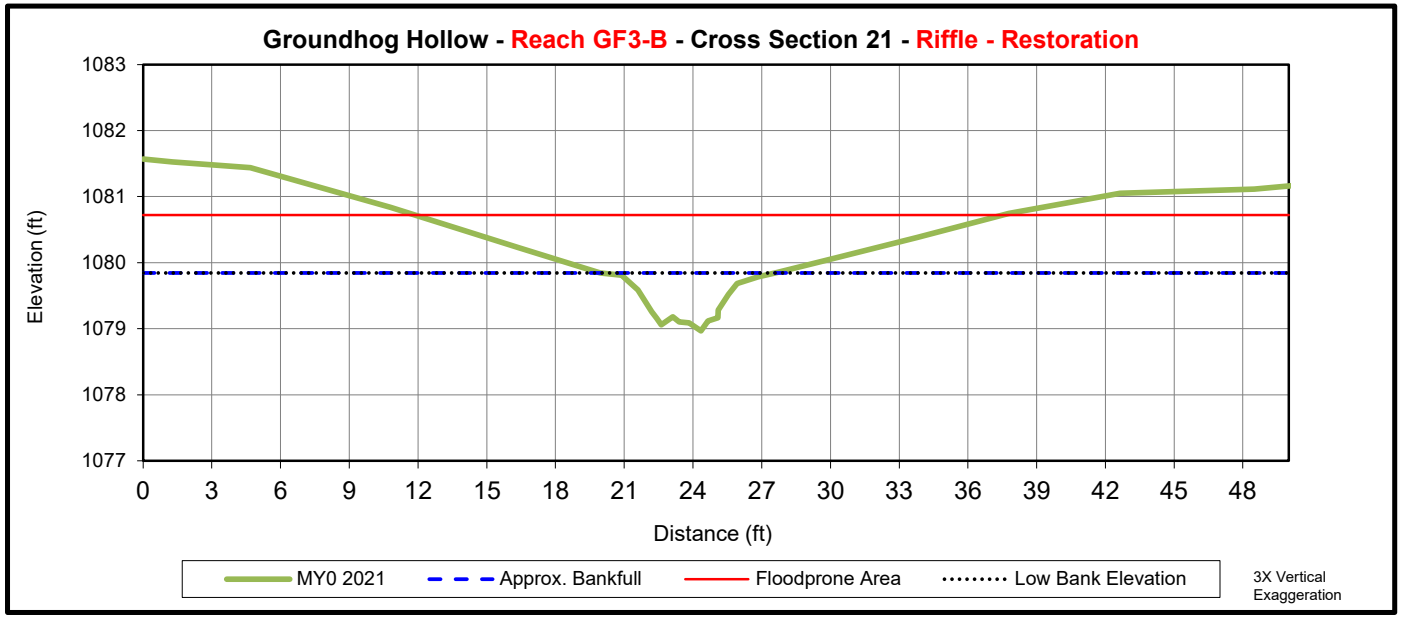


	Cross Section 20 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1084.80						
Bankfull Width (ft)[1]	6.2						
Floodprone Width (ft)[1]	9.6						
Bankfull Max Depth (ft)[2]	0.8						
Low Bank Elevation (ft)	1086.20						
Bankfull Cross Sectional Area (ft^2)[2]	3.0						
Bankfull Entrenchment Ratio[1]	1.5						
Bankfull Bank Height Ratio[1]	2.9						

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

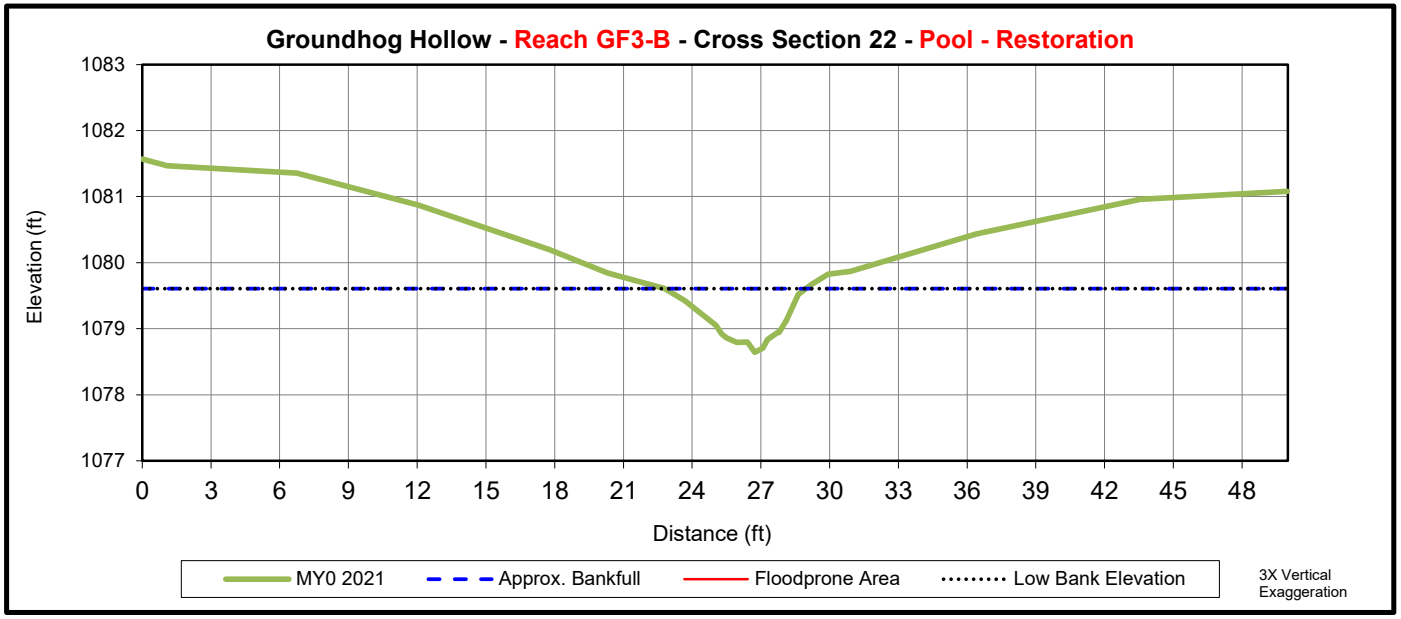


	Cross Section 21 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1079.84						
Bankfull Width (ft)[1]	7.6						
Floodprone Width (ft)[1]	25.6						
Bankfull Max Depth (ft)[2]	0.9						
Low Bank Elevation (ft)	1079.84						
Bankfull Cross Sectional Area (ft^2)[2]	2.9						
Bankfull Entrenchment Ratio[1]	3.4						
Bankfull Bank Height Ratio[1]	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 22 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1079.61						
Bankfull Width (ft)[1]	6.2						
Floodprone Width (ft)[1]	-						
Bankfull Max Depth (ft)[2]	1.0						
Low Bank Elevation (ft)	1079.61						
Bankfull Cross Sectional Area (ft^2)[2]	3.1						
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

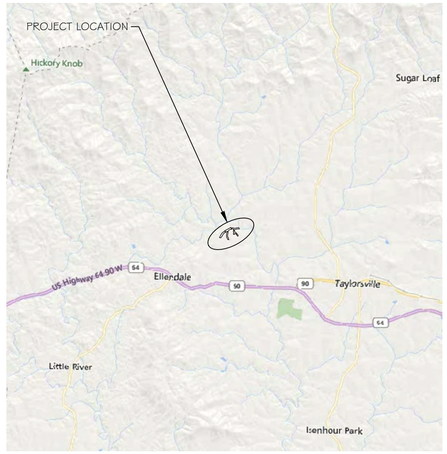
Record Drawings

GROUNDHOG HOLLOW RECORD DRAWINGS

ALEXANDER COUNTY, NORTH CAROLINA
35.937201° N, 81.237783° W

CATAWBA RIVER BASIN: HUC 03050101
JUNE 2021

RESOURCE ENVIRONMENTAL SOLUTIONS, LLC
3600 GLENWOOD AVE, SUITE 100
RALEIGH, NC 27612



VICINITY MAP
NTS

Know what's below.
Call before you dig

NOTICE TO CONTRACTOR

PRIOR TO CONSTRUCTION, DIGGING, OR EXCAVATION THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UNDERGROUND UTILITIES (PUBLIC OR PRIVATE) THAT MAY EXIST AND CROSS THROUGH THE AREA(S) OF CONSTRUCTION, WHETHER INDICATED ON THE PLANS OR NOT. CALL "811" A MINIMUM OF 72 HOURS PRIOR TO DIGGING OR EXCAVATING. REPAIRS TO ANY UTILITY DAMAGED RESULTING FROM CONSTRUCTION ACTIVITIES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

PROJECT DIRECTORY

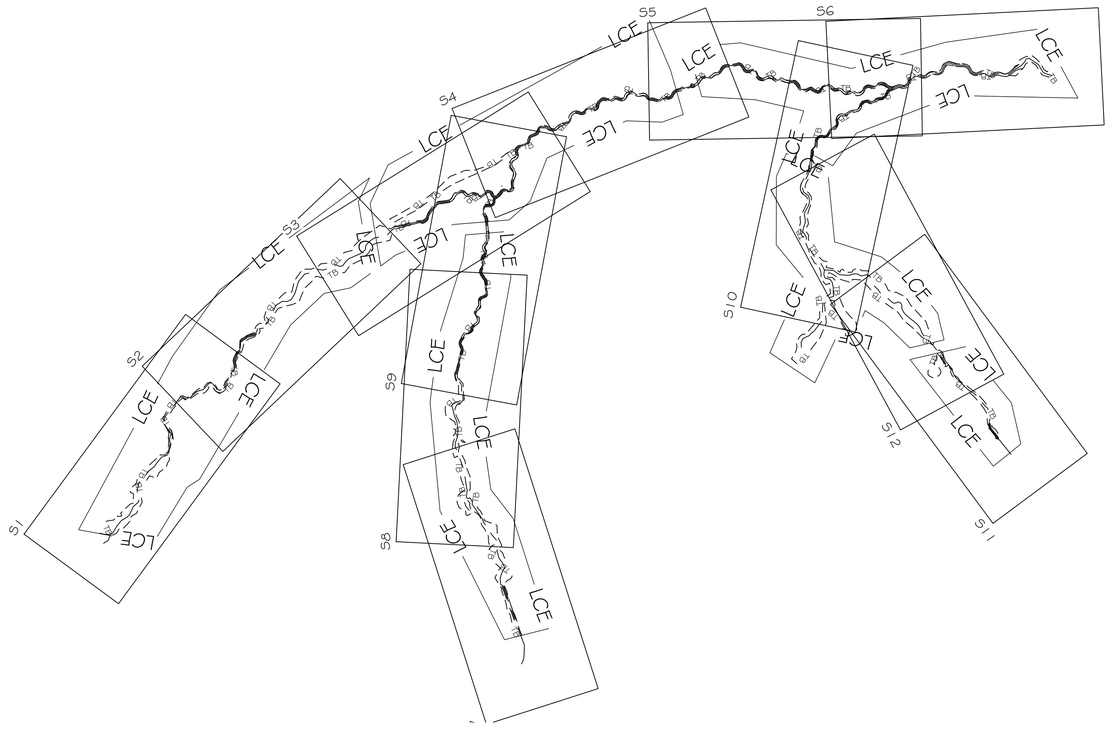
DESIGNED BY:
RESOURCE ENVIRONMENTAL SOLUTIONS, LLC
3600 GLENWOOD AVE, SUITE 100
RALEIGH, NC 27612

DESIGNED FOR:
PAUL WIESNER
NC DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
217 WEST JONES ST., SUITE 300A
RALEIGH, NC 27603

SURVEYED BY:
WSP USA INC.
128 TALBERT RD, SUITE A
MOORESVILLE, NC 28117

DMS PROJECT #: 100049
CONTRACT #: 7417
USACE ACTION ID #: SAW-2018-00450
RFP #: 16-007277

PROJECT TOPOGRAPHY AND AS-BUILT PLANIMETRICS SURVEY WAS PROVIDED BY WSP USA INC. (NC FIRM LICENSE NUMBER F-0165, BARRY W. CREEK, NC PLS L-4776), DATED APRIL 22, 2021



SITE MAP
NTS

Sheet List Table	
Sheet Number	Sheet Title
-	COVER
S1	REACH GF1
S2	REACH GF1
S3	REACH GF1
S4	REACH GF1
S5	REACH GF1
S6	REACH GF1
S7	REACH GF2
S8	REACH GF2
S9	REACH GF2
S10	REACH GF3
S11	REACH GF4
S12	REACH GF4
P1	PLANTING PLAN

res
3600 Glenwood Ave, Suite 100
Raleigh, NC 27612
Main: 919.829.9909
www.res.us

Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BENJAMIN R. CARROLL

PLOT DATE: 3/16/2021

REVISIONS:

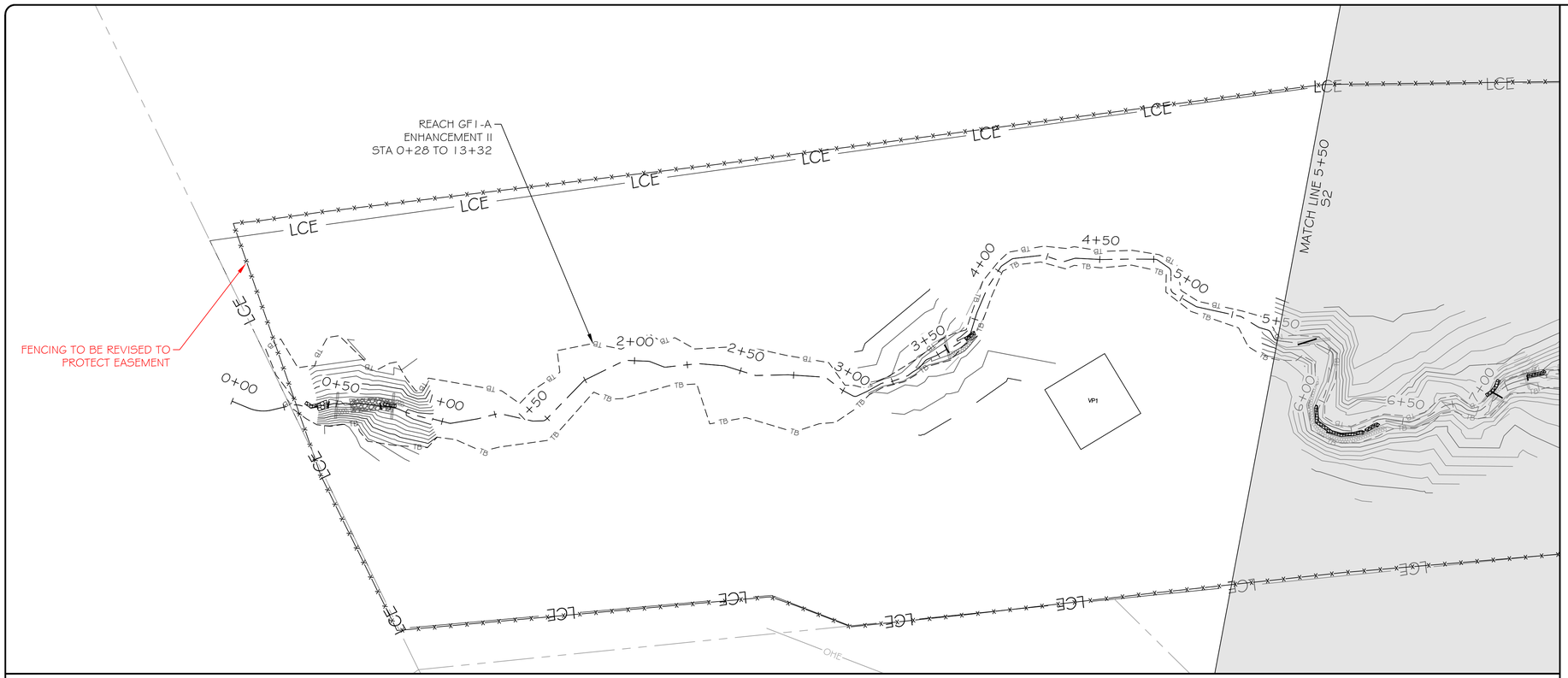
RELEASED FOR: RECORD DRAWINGS

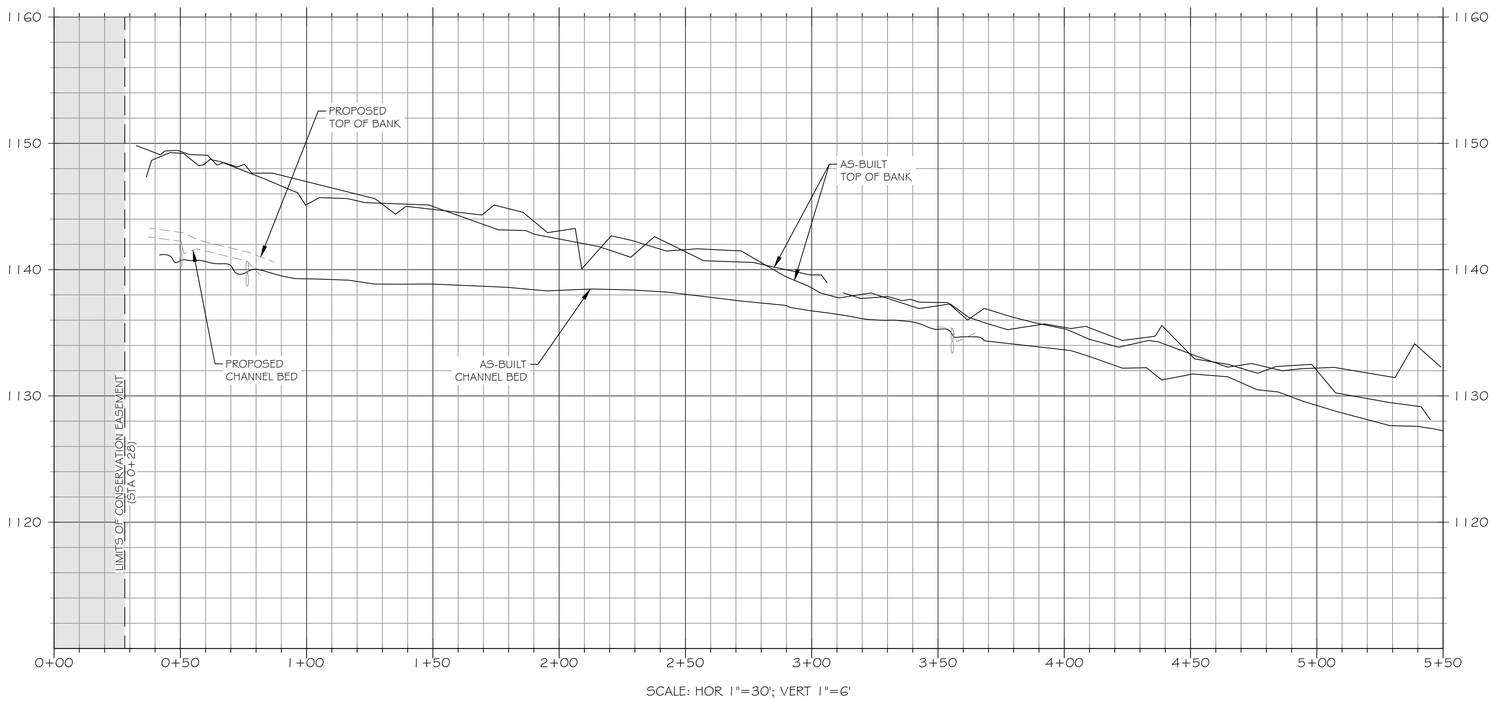
PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

-

FILE NAME:R:\Resced\Projects\100905-Groundhog Hollow\ABRL\100905_ABRL_COVER.dwg SAVED BY: Stasking





SCALE: HOR 1"=30'; VERT 1"=6'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
- AS-BUILT BRUSH TOE
- AS-BUILT LOG STRUCTURE
- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

res
3600 Glenwood Ave, Suite 100
Raleigh, NC 27612
Main: 919.829.9909
www.res.us

Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BRANDON P. CARROLL
6/1/21

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

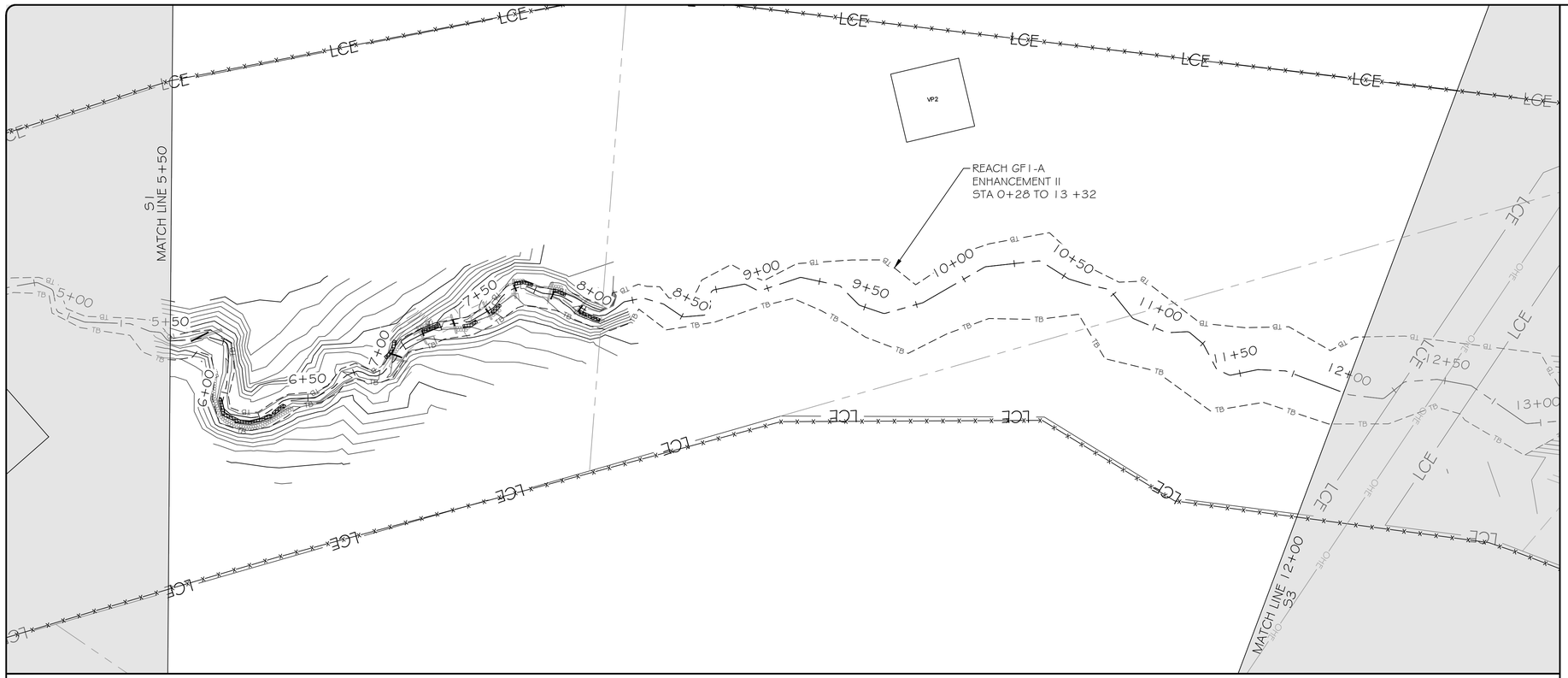
PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

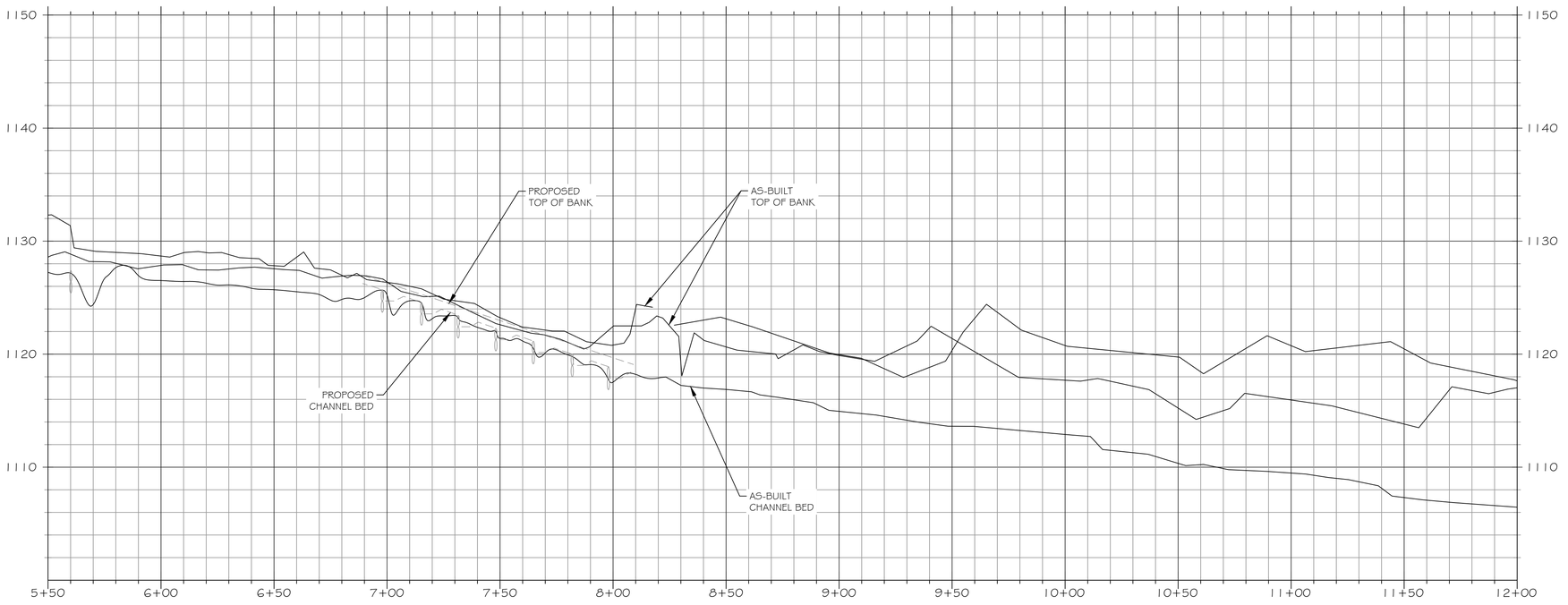
DRAWING TITLE: REACH GF1

PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER: S1

FILE NAME:R:\Resad\Projects\100905-Groundhog Hollow\ABRL\100905_ABRL_GF1_N.dwg SAVED BY: Stasking





SCALE: HOR 1"=30'; VERT 1"=6'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE Ø)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
- AS-BUILT BRUSH TOE
- AS-BUILT LOG STRUCTURE
- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

res
3600 Glenwood Ave, Suite 100
Raleigh, NC 27612
Main: 919.829.9909
www.res.us

Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BRANDON R. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: REACH GF1

PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER: S2

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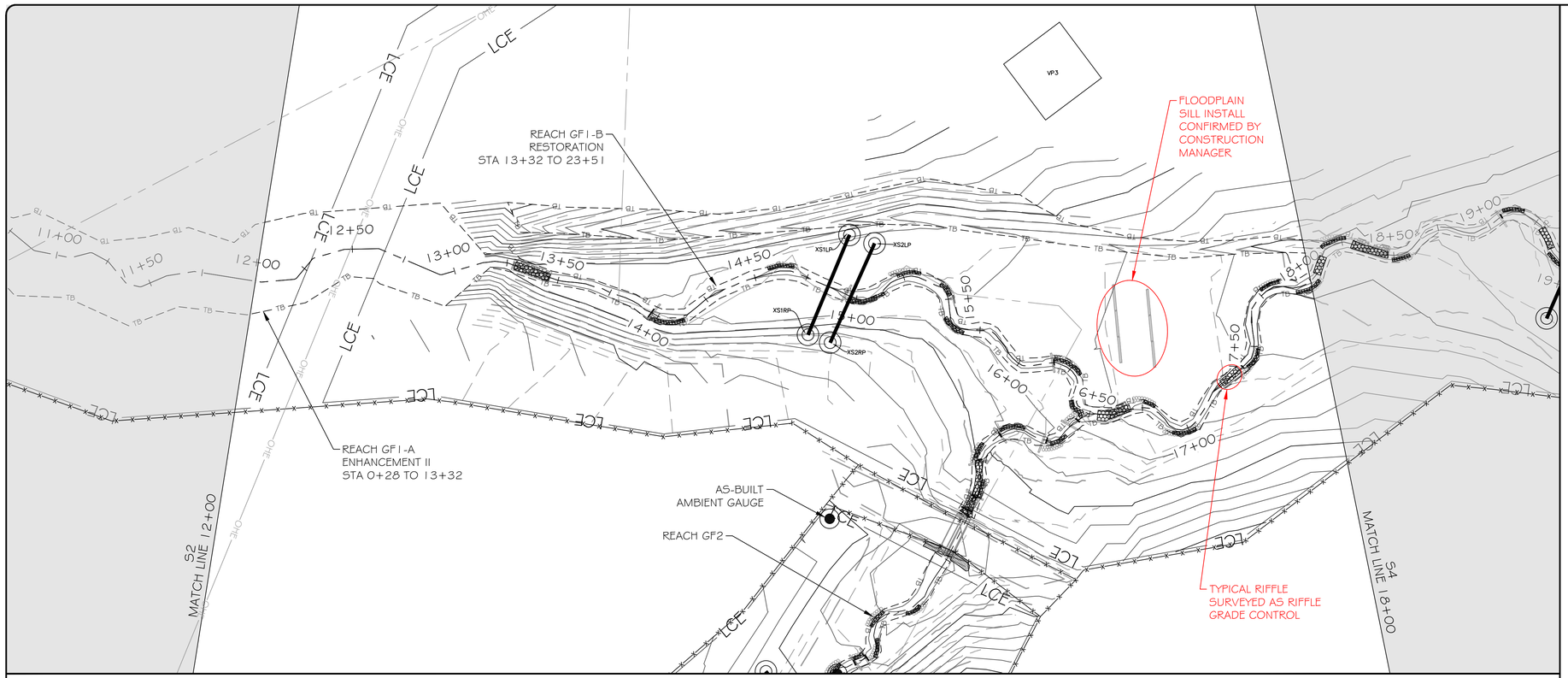

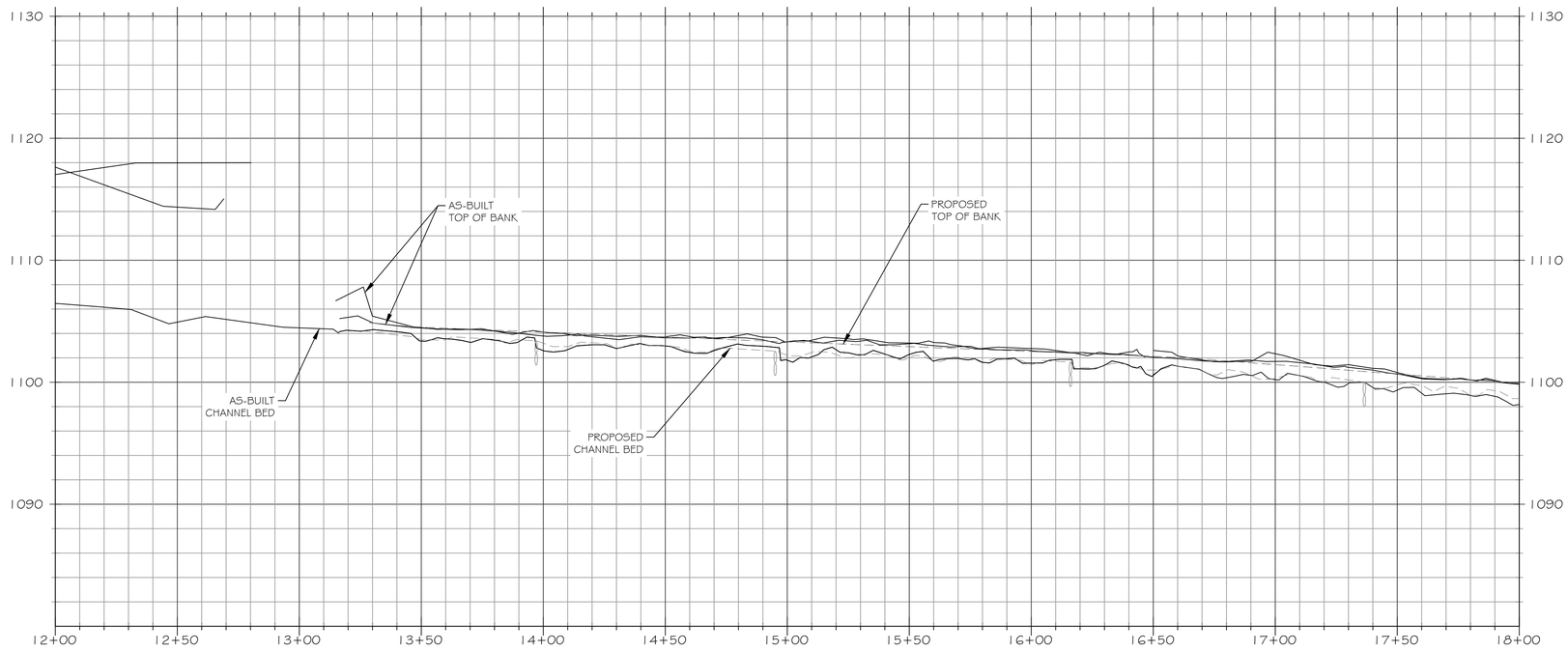

SCALE: HOR 1"=30'; VERT 1"=6'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
- AS-BUILT BRUSH TOE
- AS-BUILT LOG STRUCTURE
- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

res
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Main: 919.829.9909
www.res.us

Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042590 ENGINEER BENJAMIN R. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

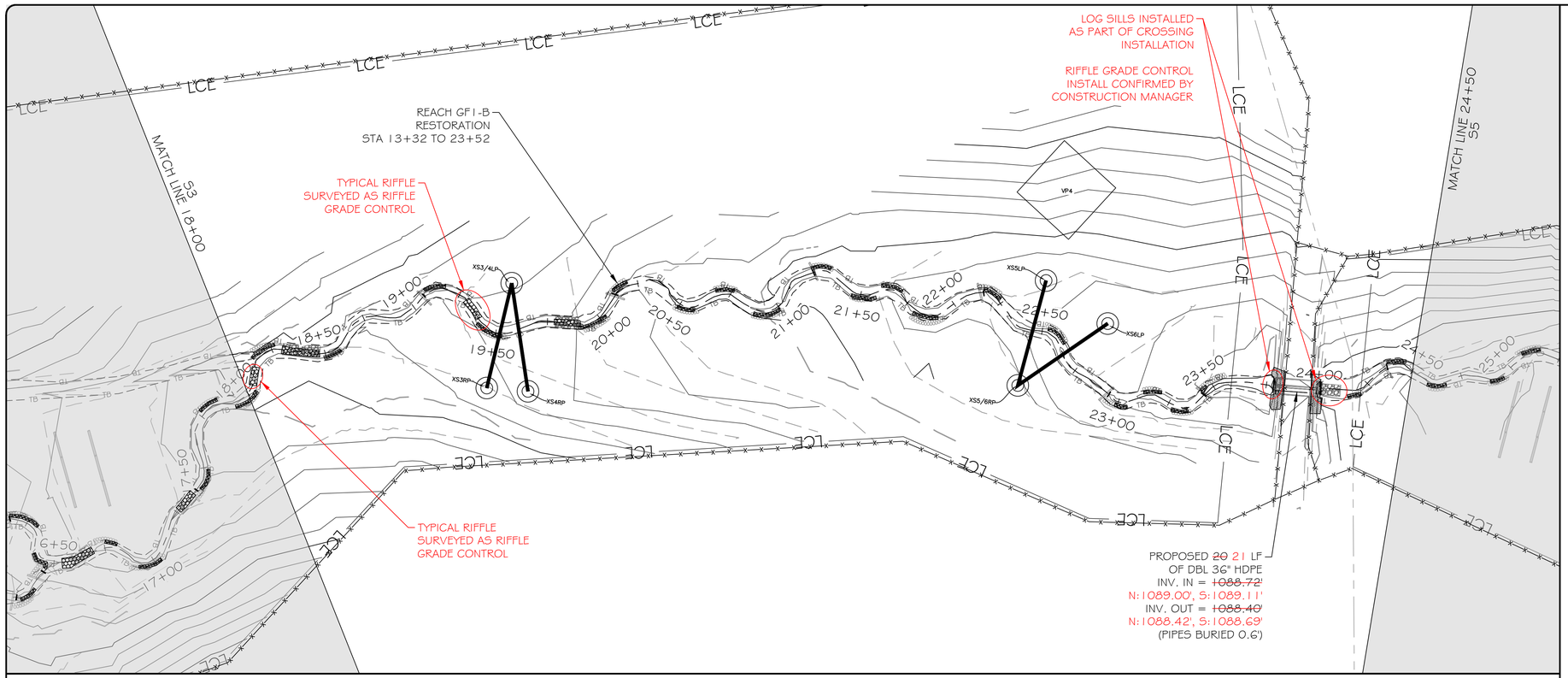
DRAWING TITLE: REACH GF1

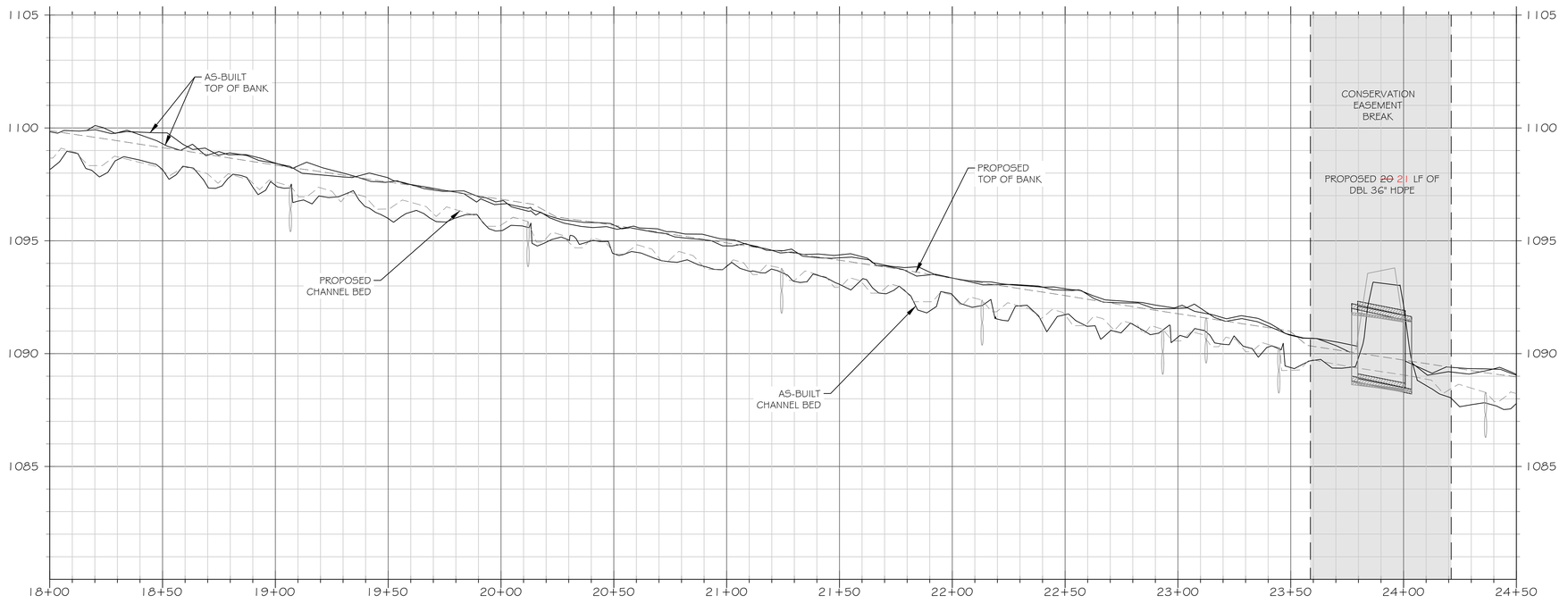
PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

S3

FILE NAME:R:\Resad\Projects\100905-Groundhog Hollow\ABRL\100905_ABRL_GF1_N.dwg SAVED BY: Stasking





SCALE: HOR 1"=30'; VERT 1"=3'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE Ø)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
- AS-BUILT BRUSH TOE
- AS-BUILT LOG STRUCTURE
- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

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Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042590 ENGINEER BENTON R. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME:
GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

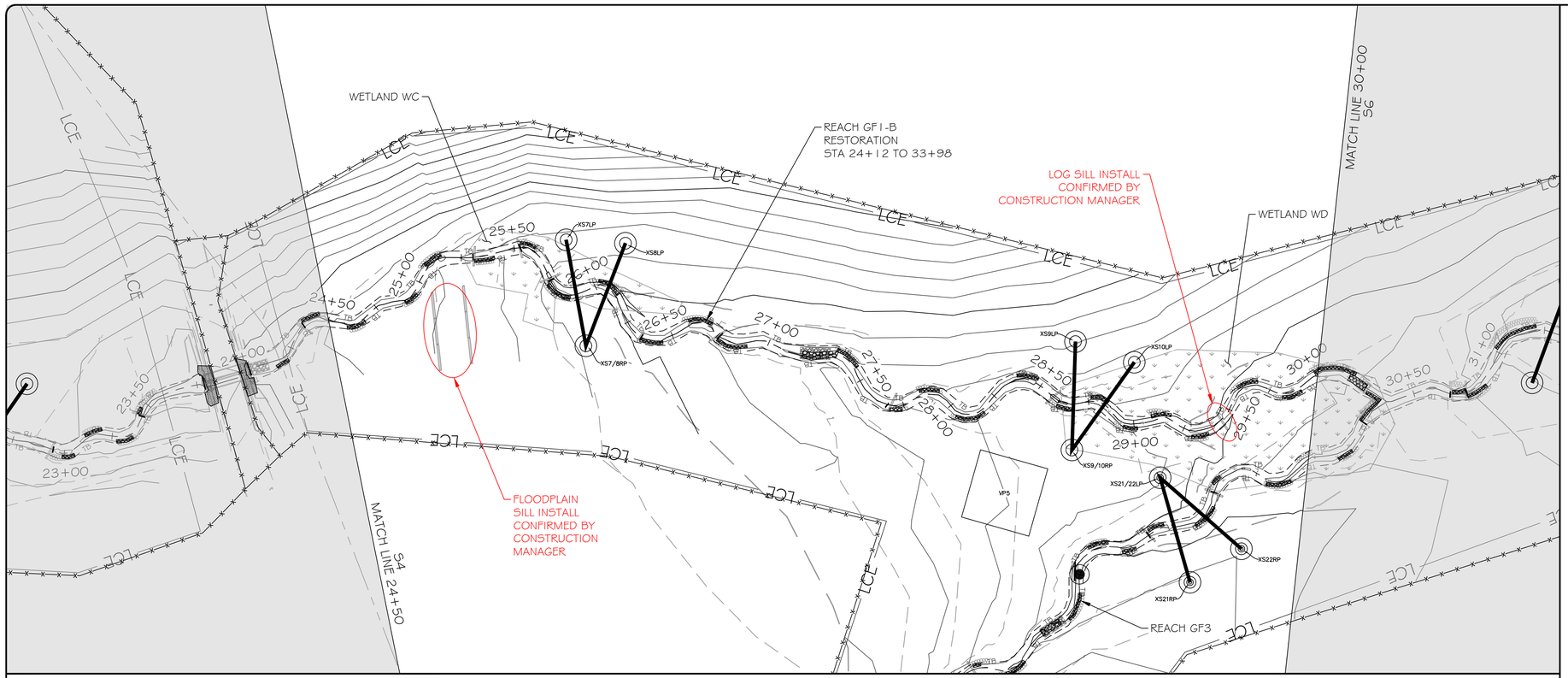
DRAWING TITLE:
REACH GF1

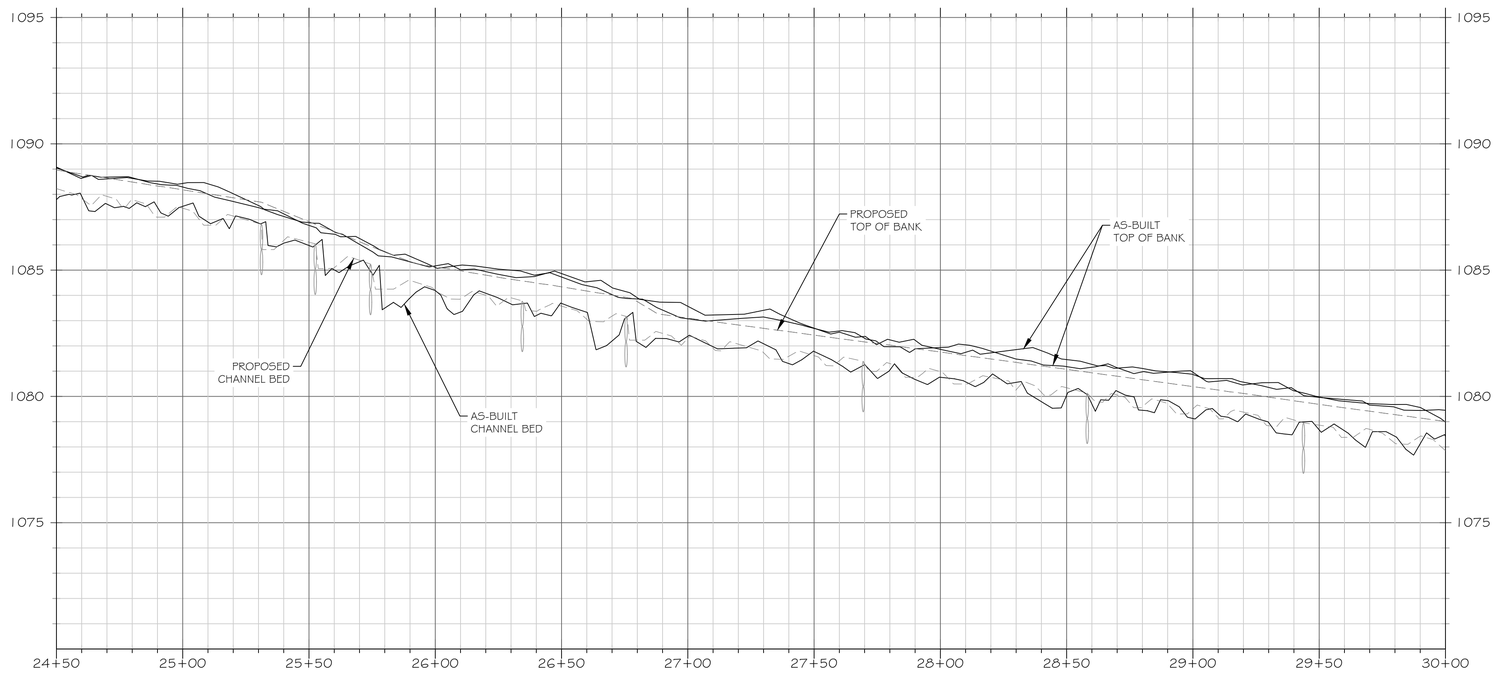
PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

S4

FILE NAME:R:\Recad\Projects\100905-Groundhog Hollow\ABRL\100905_ABRL_GF1_N.dwg SAVED BY: Stasking





SCALE: HOR 1"=30'; VERT 1"=3'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
- AS-BUILT BRUSH TOE
- AS-BUILT LOG STRUCTURE
- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

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Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BENTON R. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

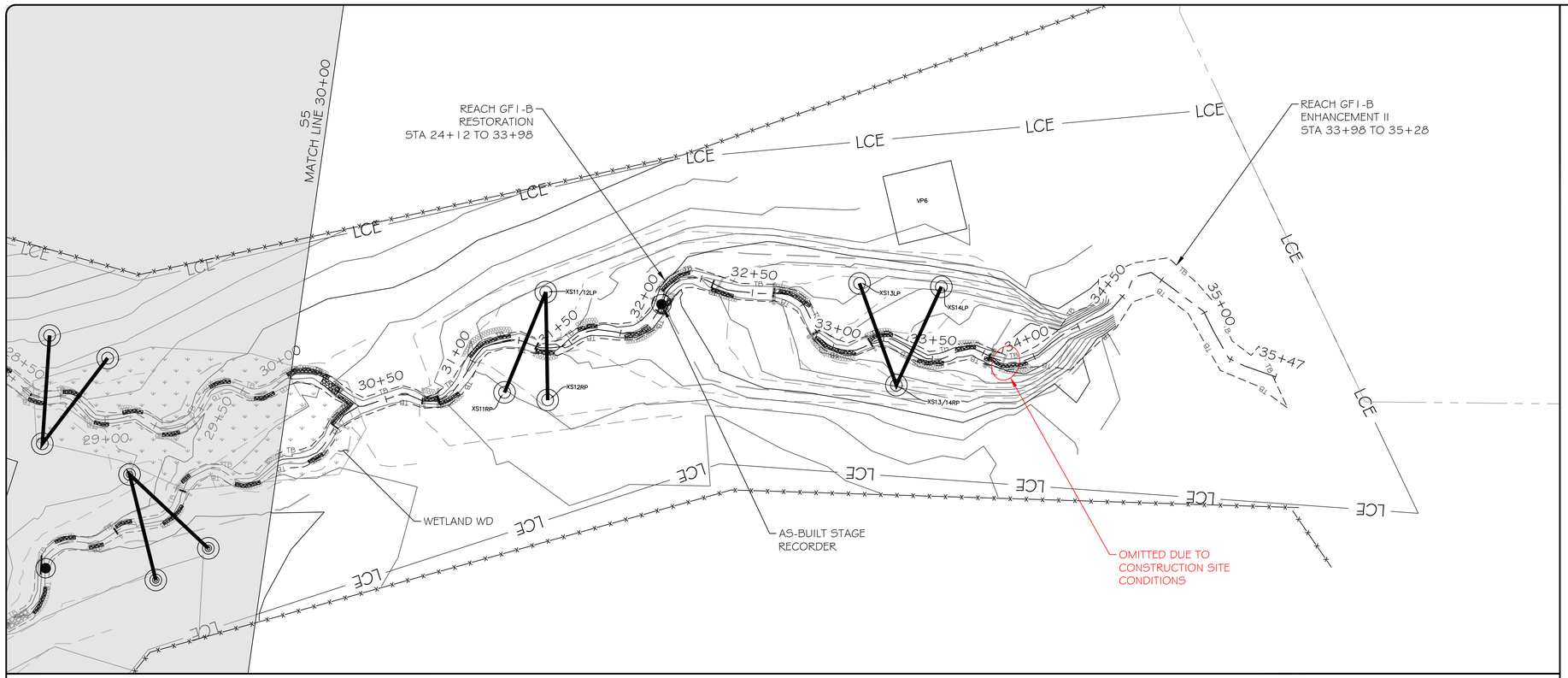
DRAWING TITLE: REACH GF1

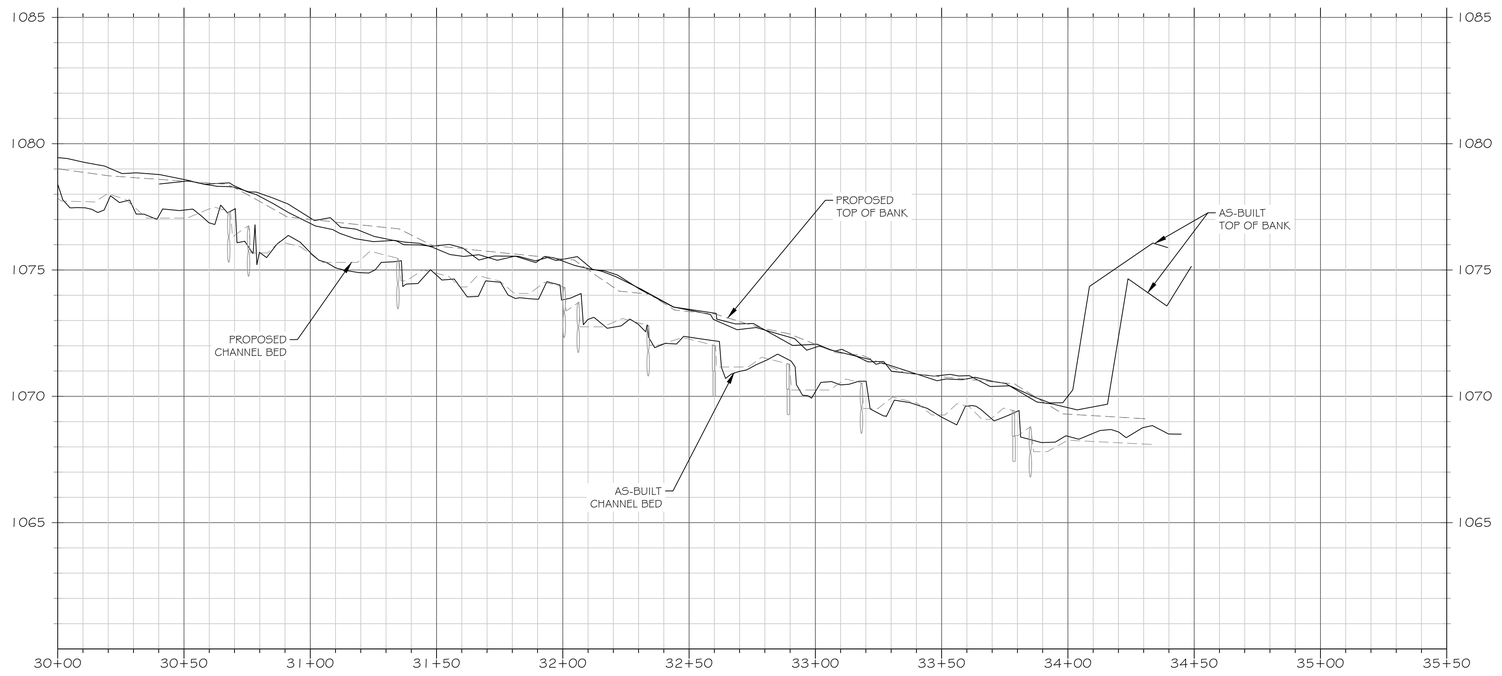
PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

S5

FILE NAME:R:\Resad\Projects\100905-Groundhog Hollow\ABRL\100905_ABRL_GF1_N.dwg SAVED BY: Stasking





SCALE: HOR 1"=30'; VERT 1"=3'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE — OHE
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR — 50
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR — 50
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK — TB
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
- AS-BUILT BRUSH TOE
- AS-BUILT LOG STRUCTURE
- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT — VP#
- LIMITS OF RECORDED CONSERVATION EASEMENT — LCE

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

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Engineering Services Provided By:
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License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BENJAMIN R. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

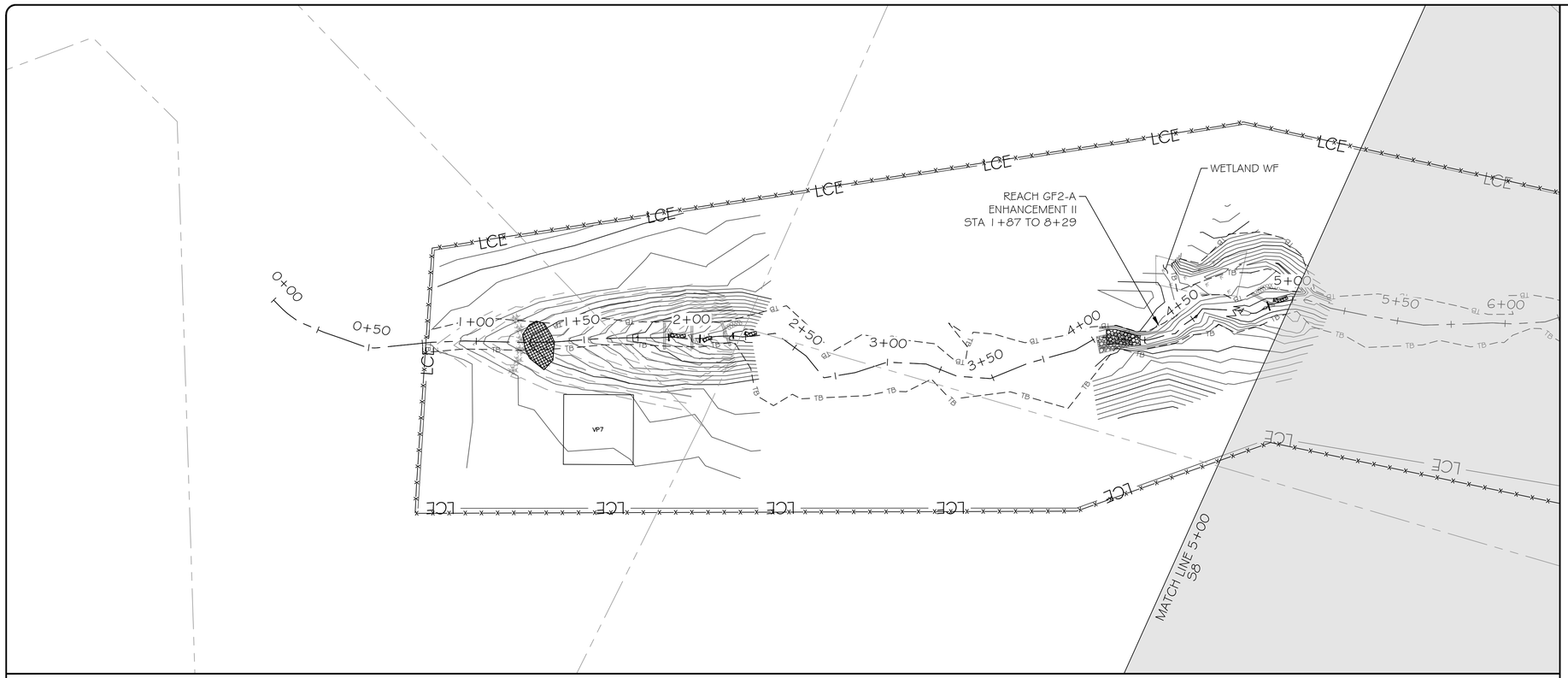
DRAWING TITLE: REACH GF1

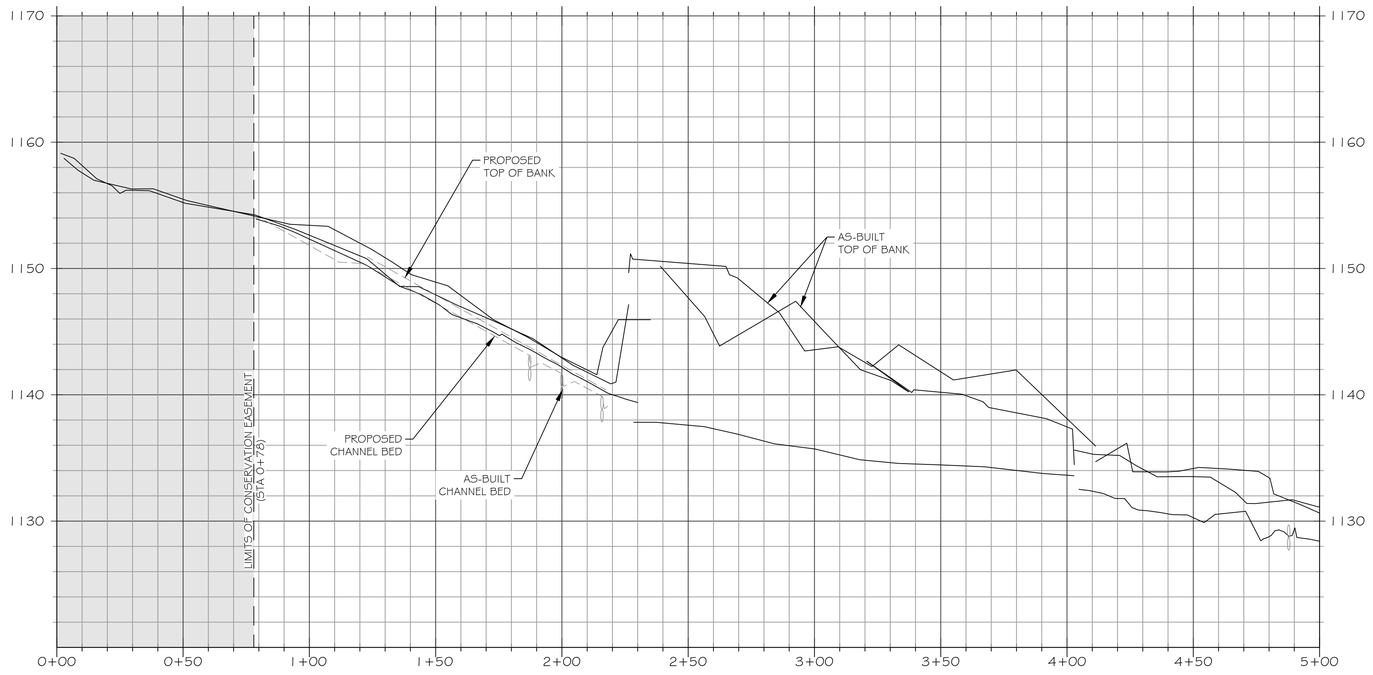
PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

S6

FILE NAME:R:\Resad\Projects\100905-Groundhog Hollow\ABRL\100905_ABRL_GF1_N.dwg SAVED BY: Stasking





SCALE: HOR 1"=30'; VERT 1"=6'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
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- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

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Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BRANDON R. CAUDILL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: REACH GF2

PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

S7

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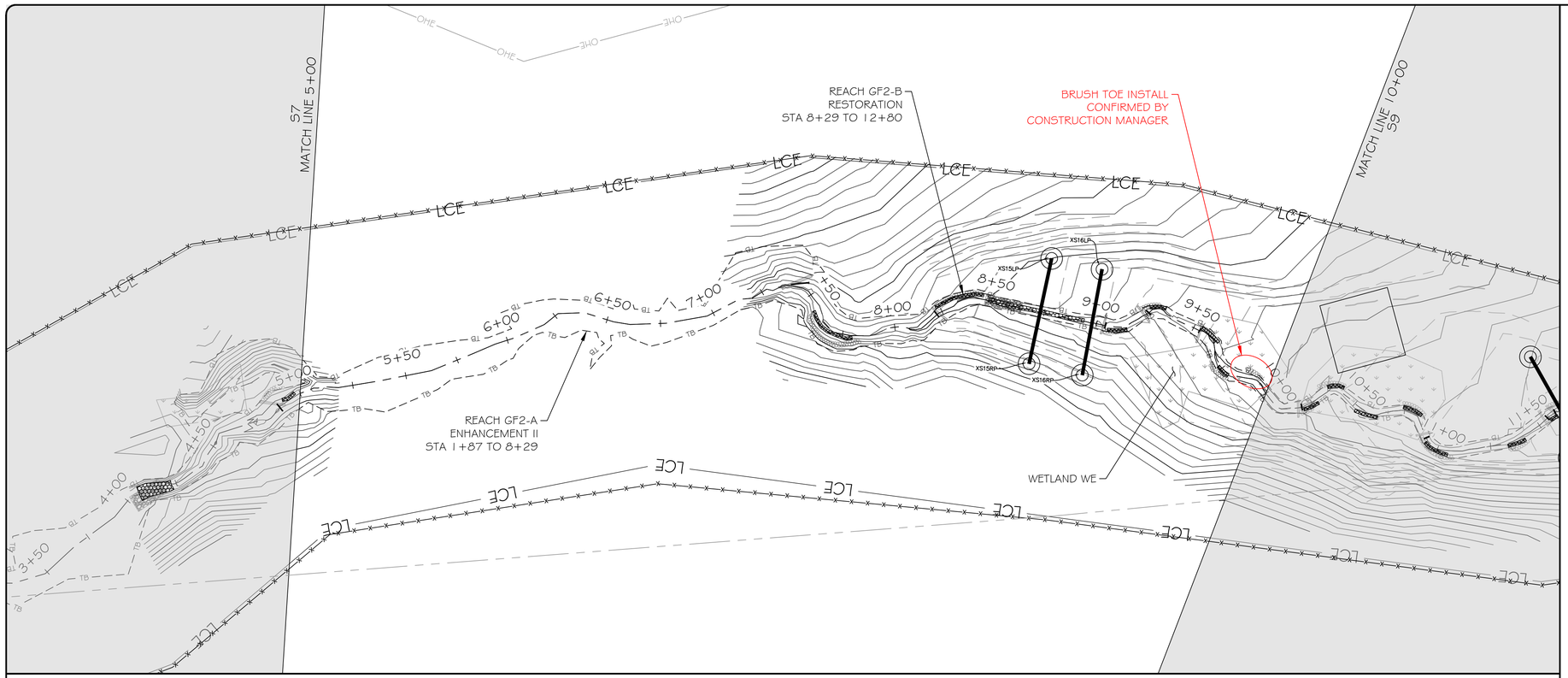

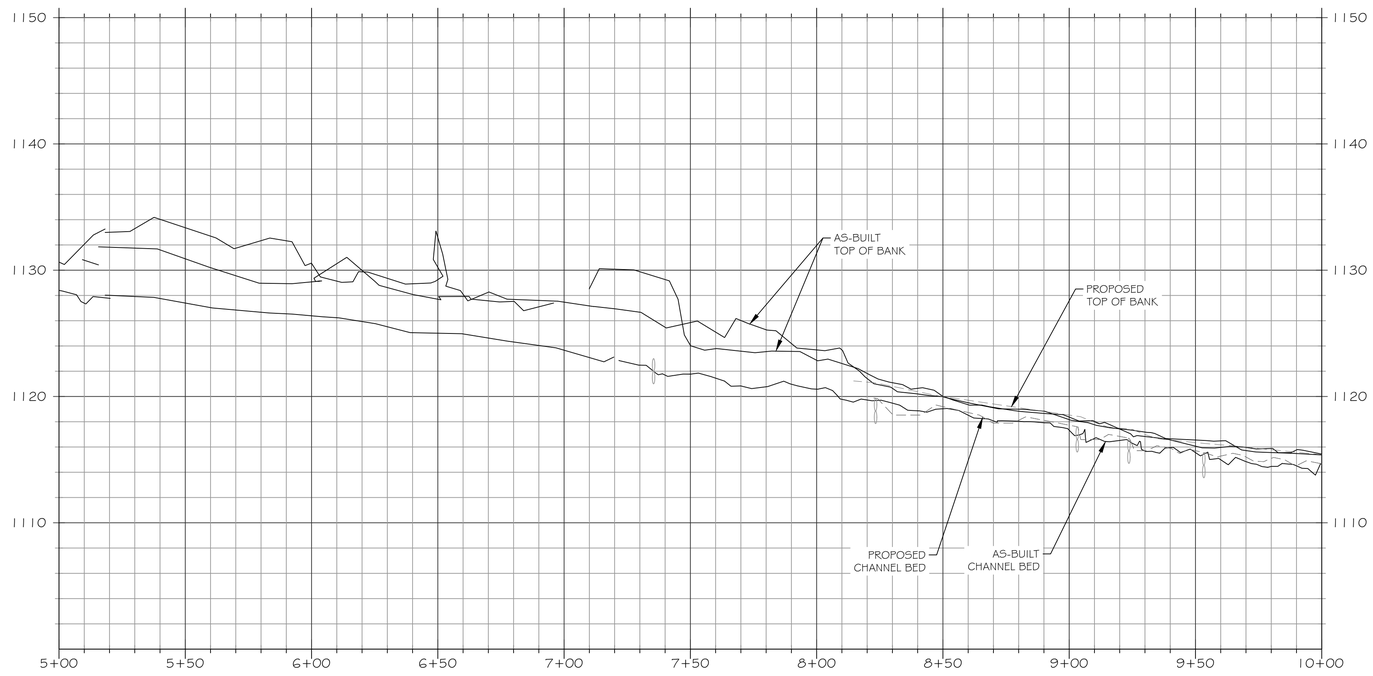

SCALE: HOR 1"=30'; VERT 1"=6'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
- AS-BUILT BRUSH TOE
- AS-BUILT LOG STRUCTURE
- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

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Engineering Services Provided By:
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License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BENJAMIN R. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

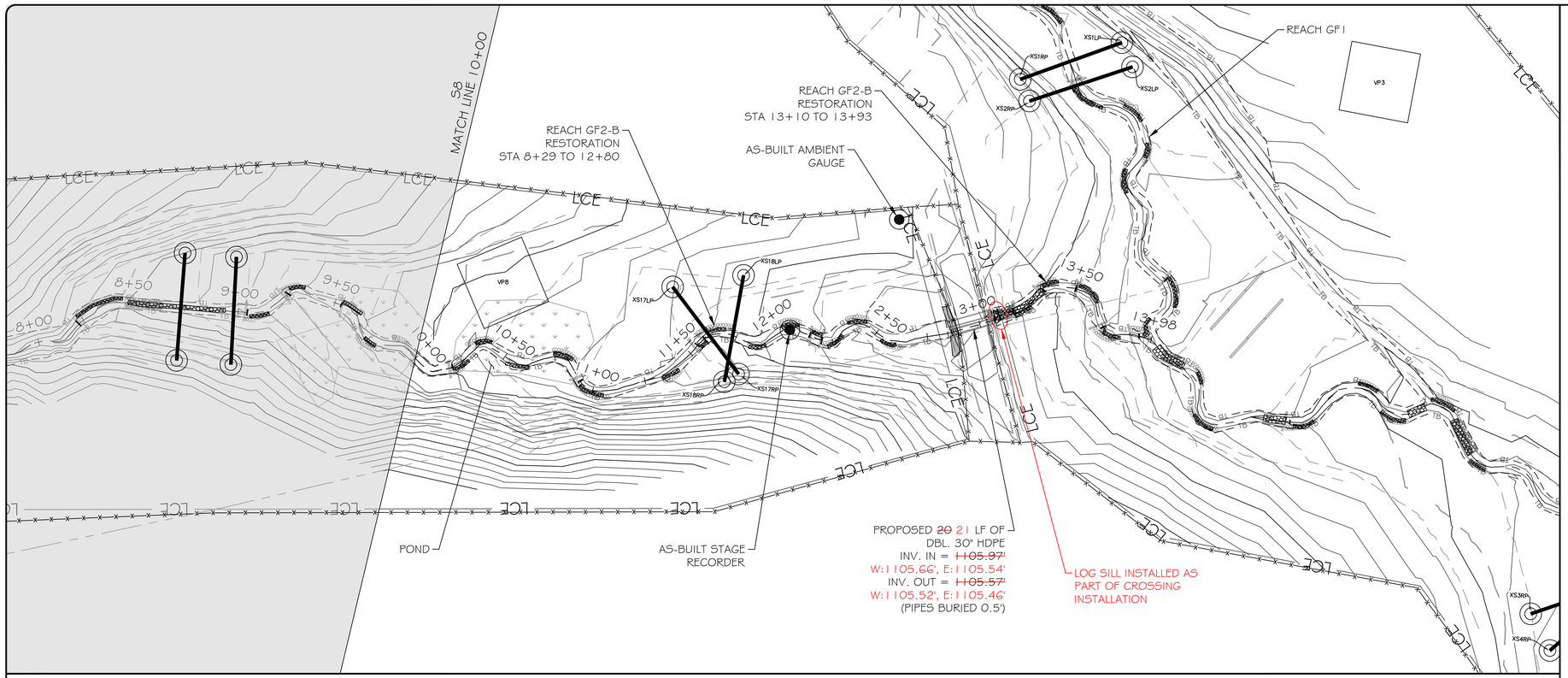
DRAWING TITLE: REACH GF2

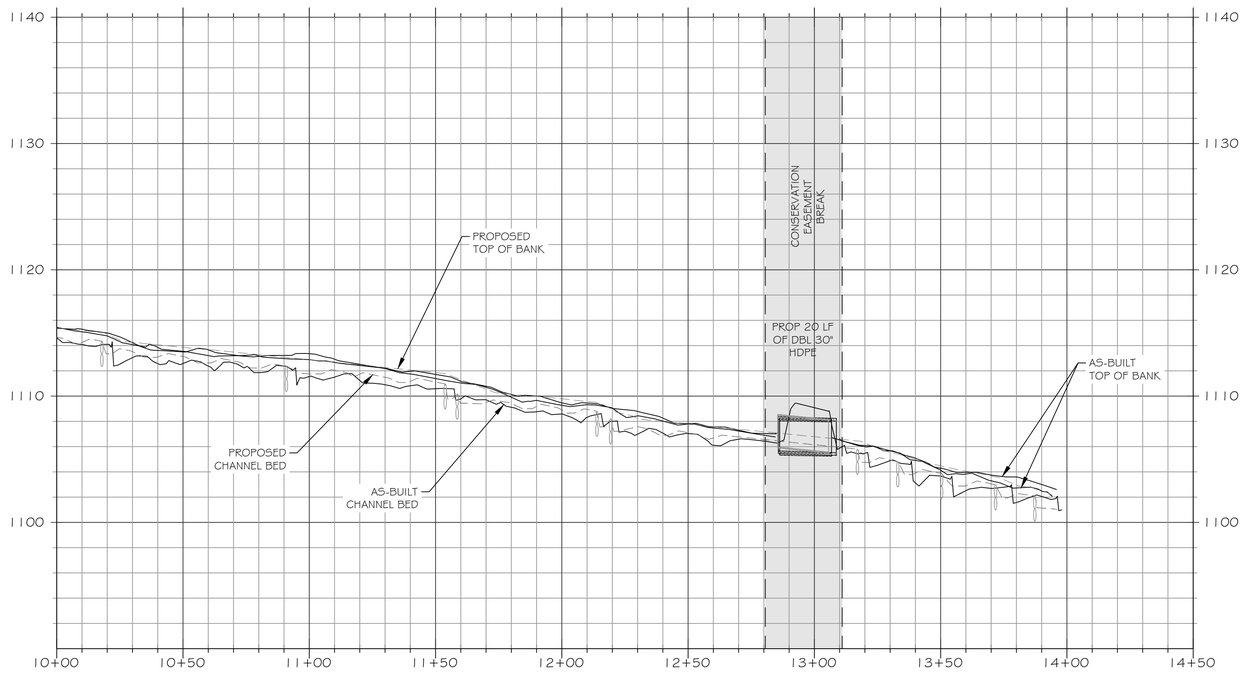
PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

S8

FILE NAME:R:\Resad\Projects\100905-Groundhog Hollow\ABRL\100905_ABRL_GF2_N.dwg SAVED BY: Stasking





SCALE: HOR 1"=30'; VERT 1"=6'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE Ø)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
- AS-BUILT BRUSH TOE
- AS-BUILT LOG STRUCTURE
- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

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Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BENTON R. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

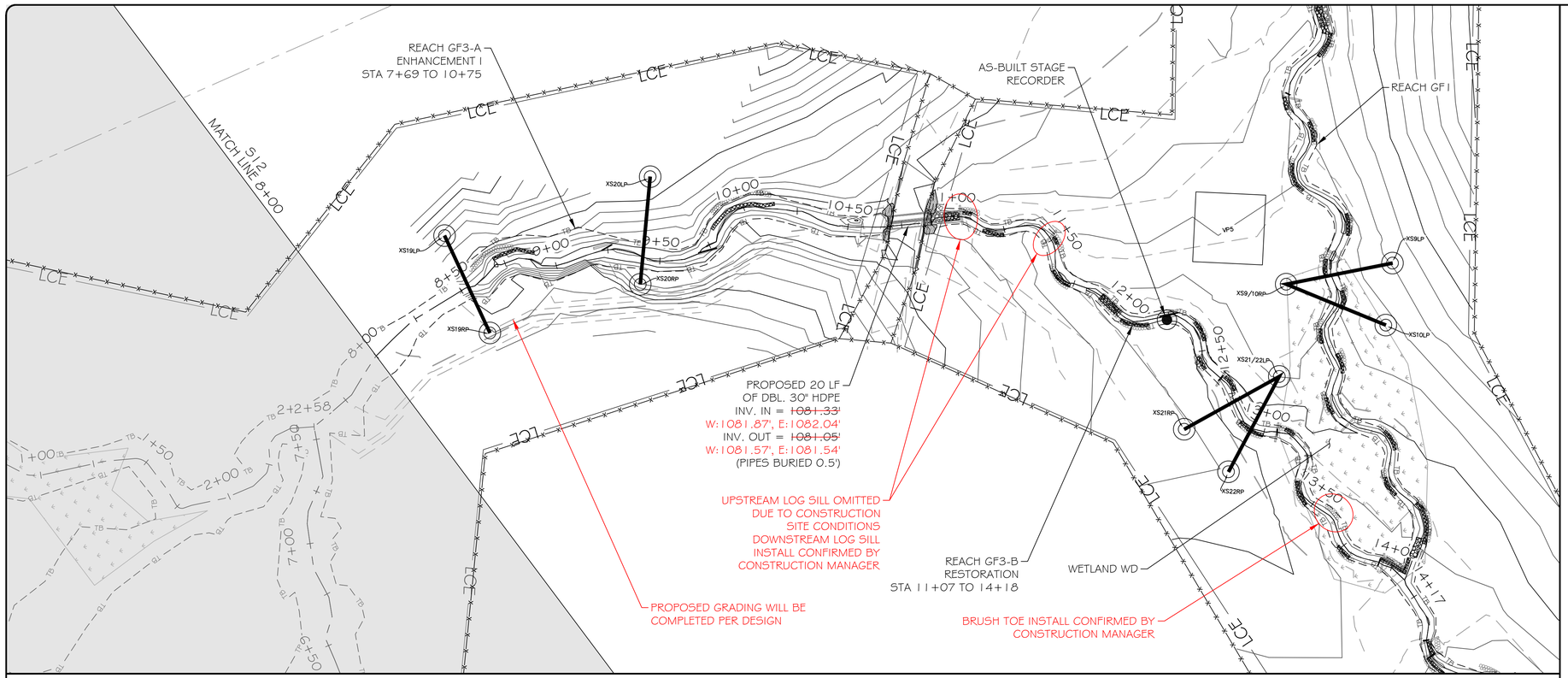
PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

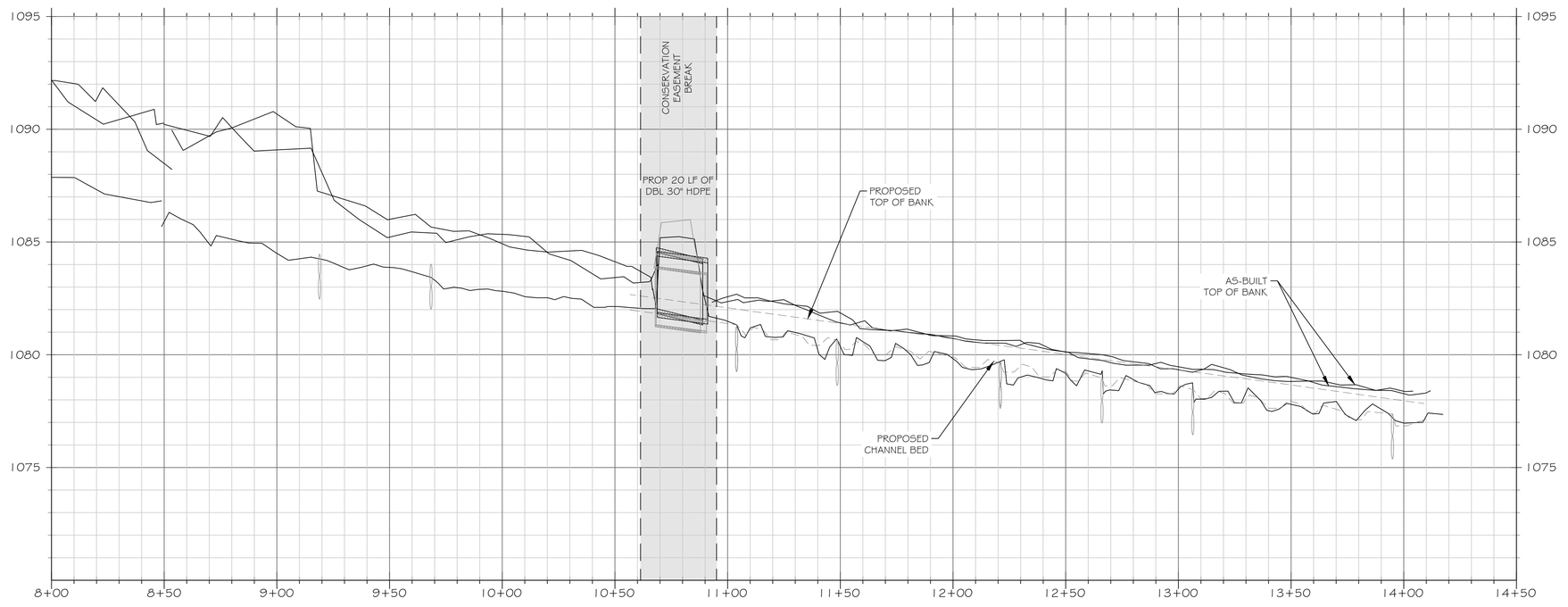
DRAWING TITLE: REACH GF2

PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

S9





SCALE: HOR 1"=30'; VERT 1"=3'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
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- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
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- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

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Raleigh, NC 27612
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Engineering Services Provided By:
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License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042589 ENGINEER BENJAMIN R. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

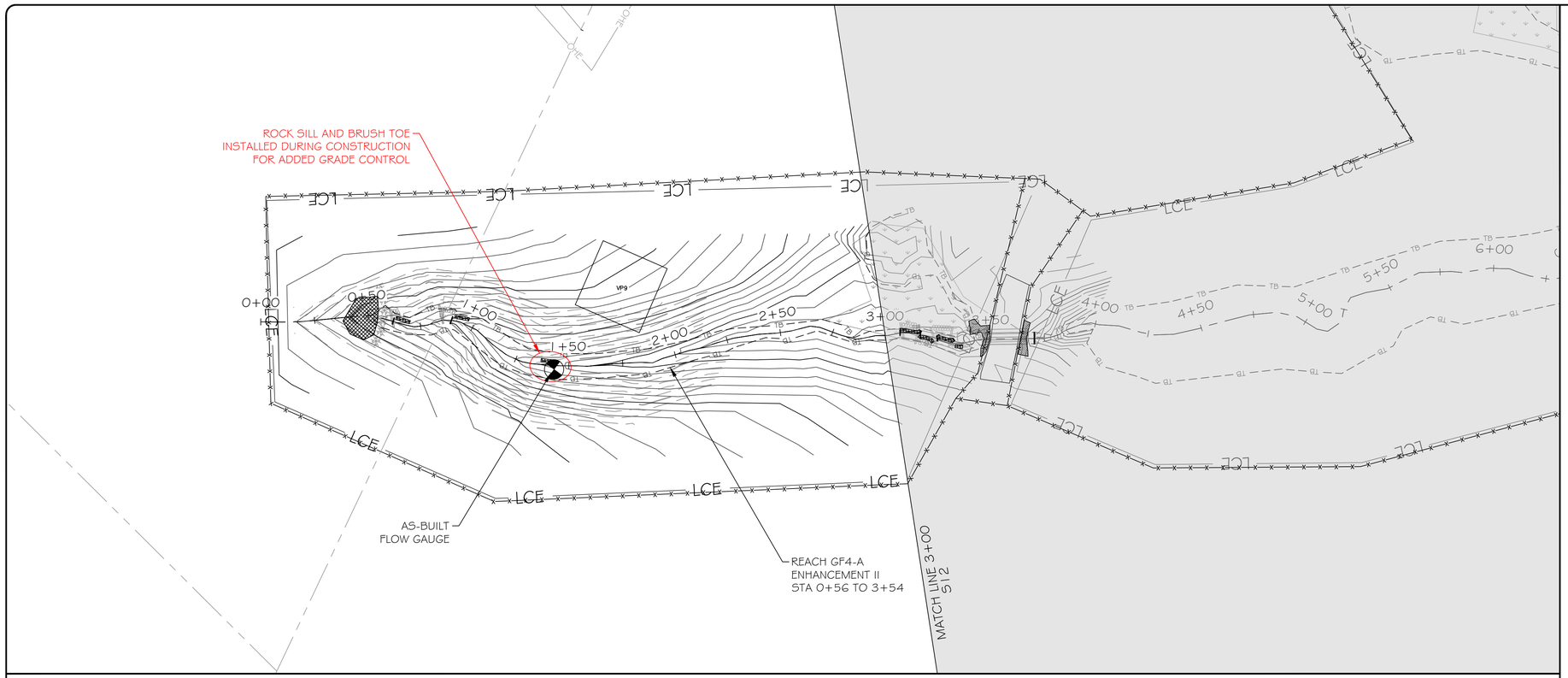
PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

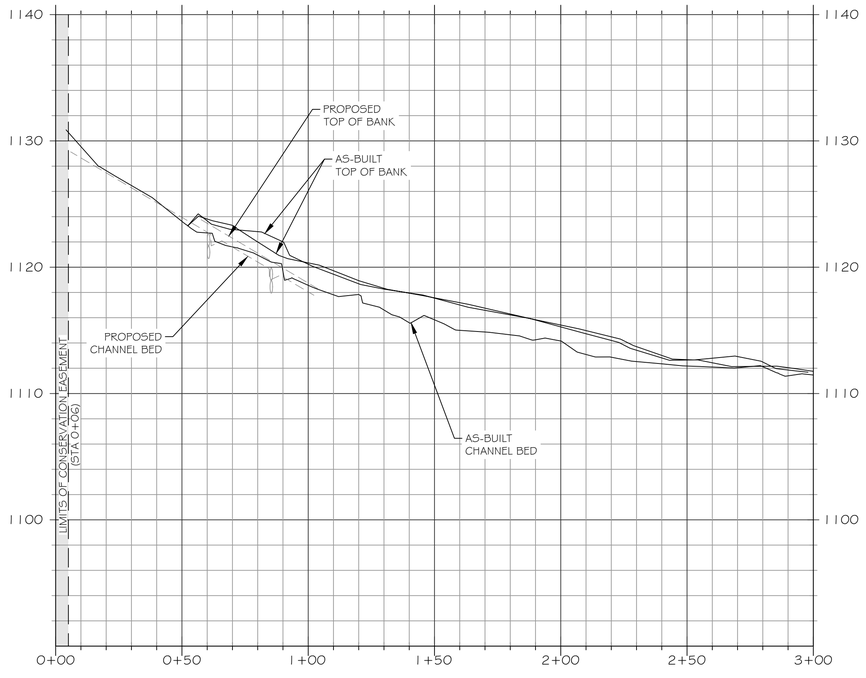
DRAWING TITLE: REACH GF3

PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER: S10

FILE NAME:R:\Resad\Projects\100905-Groundhog Hollow\ABRL\100905_ABRL_GF3_N.dwg SAVED BY: Stasking





SCALE: HOR 1"=30'; VERT 1"=6'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
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- AS-BUILT BRUSH TOE
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- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

res
3600 Glenwood Ave, Suite 100
Raleigh, NC 27612
Main: 919.829.9909
www.res.us

Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BENTON P. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: REACH GF4

PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

S11

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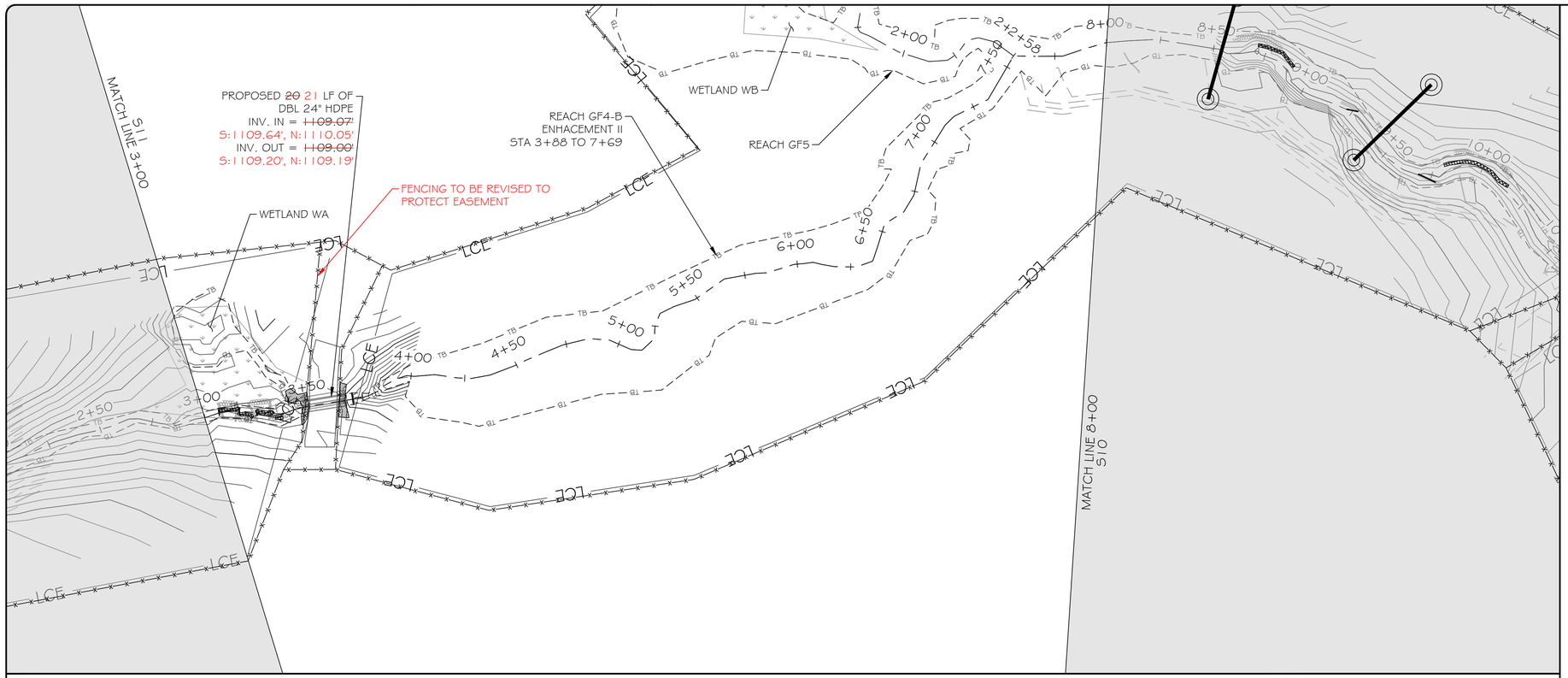

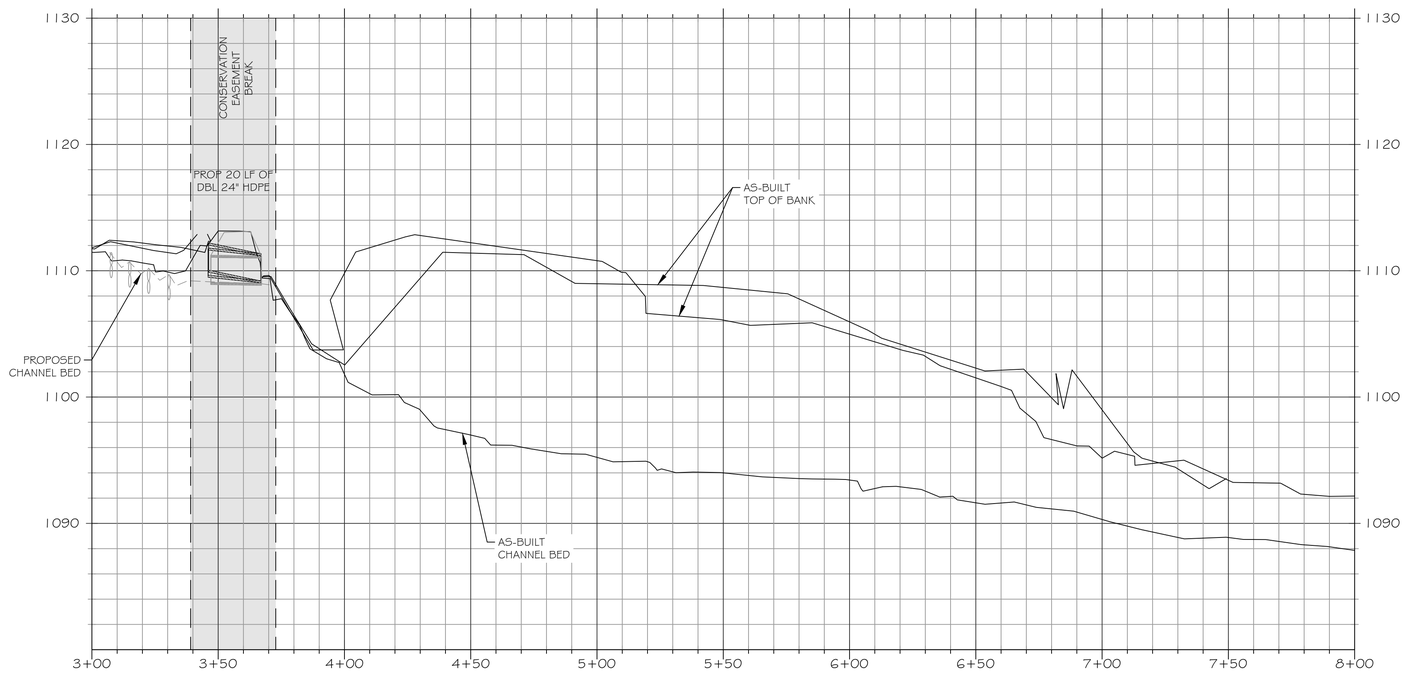

SCALE: HOR 1"=30'; VERT 1"=6'

LEGEND

- EXISTING WETLAND
- EXISTING OVERHEAD ELECTRIC UTILITY LINE (OHE)
- PROPERTY LINE
- PROPOSED CONTOUR MAJOR (50)
- PROPOSED CONTOUR MINOR
- PROPOSED TOP OF BANK
- PROPOSED CHANNEL CENTERLINE
- AS-BUILT CONTOUR MAJOR (50)
- AS-BUILT CONTOUR MINOR
- AS-BUILT TOP OF BANK (TB)
- AS-BUILT CHANNEL CENTERLINE
- BRUSH TOE PROTECTION
- LOG STRUCTURE
- ROCK SILL
- RIFFLE GRADE CONTROL
- ENGINEERED SEDIMENT PACK
- AS-BUILT BRUSH TOE
- AS-BUILT LOG STRUCTURE
- AS-BUILT ROCK SILL
- AS-BUILT RIFFLE GRADE CONTROL
- AS-BUILT ENGINEERED SEDIMENT PACK
- AS-BUILT CROSS-SECTION
- AS-BUILT STAGE RECORDER
- AS-BUILT FLOW GAUGE
- AS-BUILT VEGETATION MONITORING PLOT (VP#)
- LIMITS OF RECORDED CONSERVATION EASEMENT (LCE)

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

DMS PROJECT #: 100049

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Engineering Services Provided By:
RES Environmental Operating Company, LLC
License: F-1428

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042690 ENGINEER BRYTON R. CARROLL

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: REACH GF4

PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER:

S12

FILE NAME:R:\Resad\Projects\100905-Groundhog Hollow\ABRL\100905_ABRL_GF3_N.dwg SAVED BY: Stasking

PLANTING LEGEND

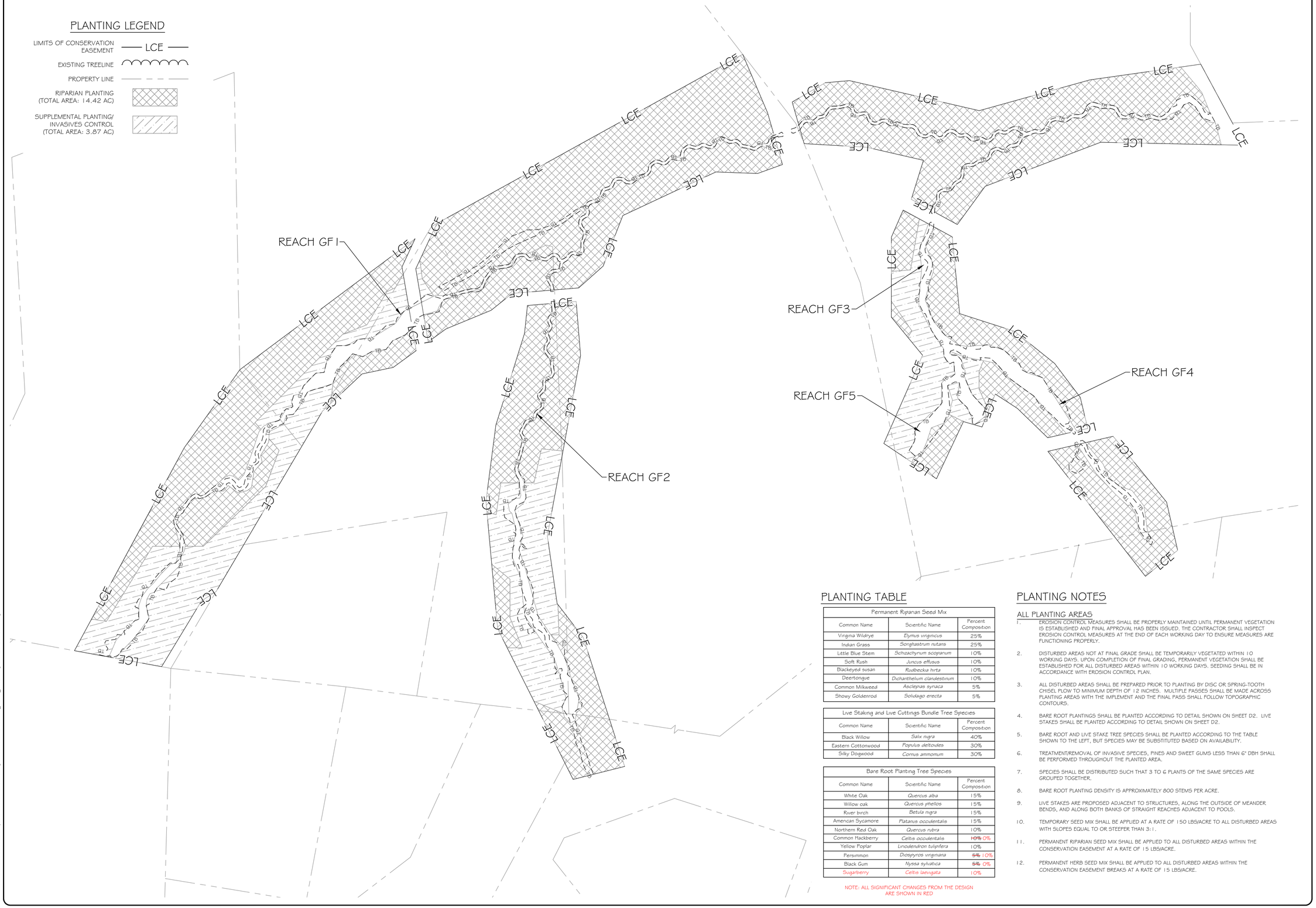
LIMITS OF CONSERVATION EASEMENT — LCE —

EXISTING TREELINE

PROPERTY LINE

RIPARIAN PLANTING (TOTAL AREA: 14.42 AC)

SUPPLEMENTAL PLANTING/ INVASIVES CONTROL (TOTAL AREA: 3.87 AC)



PLANTING TABLE

Permanent Riparian Seed Mix		
Common Name	Scientific Name	Percent Composition
Virginia Wildrye	*Elymus virginicus*	25%
Indian Grass	*Sorghastrum nutans*	25%
Little Blue Stem	*Schizachyrium scoparium*	10%
Soft Rush	*Juncus effusus*	10%
Blackeyed susan	*Rudbeckia hirta*	10%
Deertongue	*Dichanthelium clandestinum*	10%
Common Milkweed	*Asclepias syriaca*	5%
Showy Goldenrod	*Solidago erecta*	5%

Live Staking and Live Cuttings Bundle Tree Species		
Common Name	Scientific Name	Percent Composition
Black Willow	*Salix nigra*	40%
Eastern Cottonwood	*Populus deltoides*	30%
Silky Dogwood	*Cornus ammomum*	30%

Bare Root Planting Tree Species		
Common Name	Scientific Name	Percent Composition
White Oak	*Quercus alba*	15%
Willow oak	*Quercus phellos*	15%
River birch	*Betula nigra*	15%
American Sycamore	*Platanus occidentalis*	15%
Northern Red Oak	*Quercus rubra*	10%
Common Hackberry	*Celtis occidentalis*	~~10%~~ 0%
Yellow Poplar	*Liriodendron tulipifera*	10%
Persimmon	*Diospyros virginiana*	~~5%~~ 10%
Black Gum	*Nyssa sylvatica*	~~5%~~ 0%
Sugarberry	*Celtis laevigata*	10%

NOTE: ALL SIGNIFICANT CHANGES FROM THE DESIGN ARE SHOWN IN RED

PLANTING NOTES

ALL PLANTING AREAS

1. EROSION CONTROL MEASURES SHALL BE PROPERLY MAINTAINED UNTIL PERMANENT VEGETATION IS ESTABLISHED AND FINAL APPROVAL HAS BEEN ISSUED. THE CONTRACTOR SHALL INSPECT EROSION CONTROL MEASURES AT THE END OF EACH WORKING DAY TO ENSURE MEASURES ARE FUNCTIONING PROPERLY.
2. DISTURBED AREAS NOT AT FINAL GRADE SHALL BE TEMPORARILY VEGETATED WITHIN 10 WORKING DAYS. UPON COMPLETION OF FINAL GRADING, PERMANENT VEGETATION SHALL BE ESTABLISHED FOR ALL DISTURBED AREAS WITHIN 10 WORKING DAYS. SEEDING SHALL BE IN ACCORDANCE WITH EROSION CONTROL PLAN.
3. ALL DISTURBED AREAS SHALL BE PREPARED PRIOR TO PLANTING BY DISC OR SPRING-TOOTH CHISEL PLOW TO MINIMUM DEPTH OF 12 INCHES. MULTIPLE PASSES SHALL BE MADE ACROSS PLANTING AREAS WITH THE IMPLEMENT AND THE FINAL PASS SHALL FOLLOW TOPOGRAPHIC CONTOURS.
4. BARE ROOT PLANTINGS SHALL BE PLANTED ACCORDING TO DETAIL SHOWN ON SHEET D2. LIVE STAKES SHALL BE PLANTED ACCORDING TO DETAIL SHOWN ON SHEET D2.
5. BARE ROOT AND LIVE STAKE TREE SPECIES SHALL BE PLANTED ACCORDING TO THE TABLE SHOWN TO THE LEFT, BUT SPECIES MAY BE SUBSTITUTED BASED ON AVAILABILITY.
6. TREATMENT/REMOVAL OF INVASIVE SPECIES, PINES AND SWEET GUMS LESS THAN 6" DBH SHALL BE PERFORMED THROUGHOUT THE PLANTED AREA.
7. SPECIES SHALL BE DISTRIBUTED SUCH THAT 3 TO 6 PLANTS OF THE SAME SPECIES ARE GROUPED TOGETHER.
8. BARE ROOT PLANTING DENSITY IS APPROXIMATELY 800 STEMS PER ACRE.
9. LIVE STAKES ARE PROPOSED ADJACENT TO STRUCTURES, ALONG THE OUTSIDE OF MEANDER BENDS, AND ALONG BOTH BANKS OF STRAIGHT REACHES ADJACENT TO POOLS.
10. TEMPORARY SEED MIX SHALL BE APPLIED AT A RATE OF 150 LBS/ACRE TO ALL DISTURBED AREAS WITH SLOPES EQUAL TO OR STEEPER THAN 3:1.
11. PERMANENT RIPARIAN SEED MIX SHALL BE APPLIED TO ALL DISTURBED AREAS WITHIN THE CONSERVATION EASEMENT AT A RATE OF 15 LBS/ACRE.
12. PERMANENT HERB SEED MIX SHALL BE APPLIED TO ALL DISTURBED AREAS WITHIN THE CONSERVATION EASEMENT BREAKS AT A RATE OF 15 LBS/ACRE.

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SEAL

FULL SCALE: 1"=100

0 100 200

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/1/2021

REVISIONS:

RELEASED FOR: RECORD DRAWINGS

PROJECT NAME: GROUNDHOG HOLLOW RECORD DRAWINGS
ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: PLANTING PLAN

PROJECT NUMBER:	100905
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	SCF
CHECKED:	BRC

SHEET NUMBER: P1

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