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Passive Wetland Restoration Through Stream Restoration

Prepared for: National Stream Restoration Conference, August 2023

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Photos of Bacon Ridge Branch Stream Restoration
Annapolis, Anne Arundel County, MD

BACKGROUND

Bacon Ridge Branch (Elks Camp Barrett) Stream Restoration

- Full delivery project completed for Maryland State Highway Administration (SHA)
- TMDL stream restoration to meet MS4 permit requirements
- South River Watershed, Anne Arundel County, MD
- Atlantic Coastal Plain

Project Team

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

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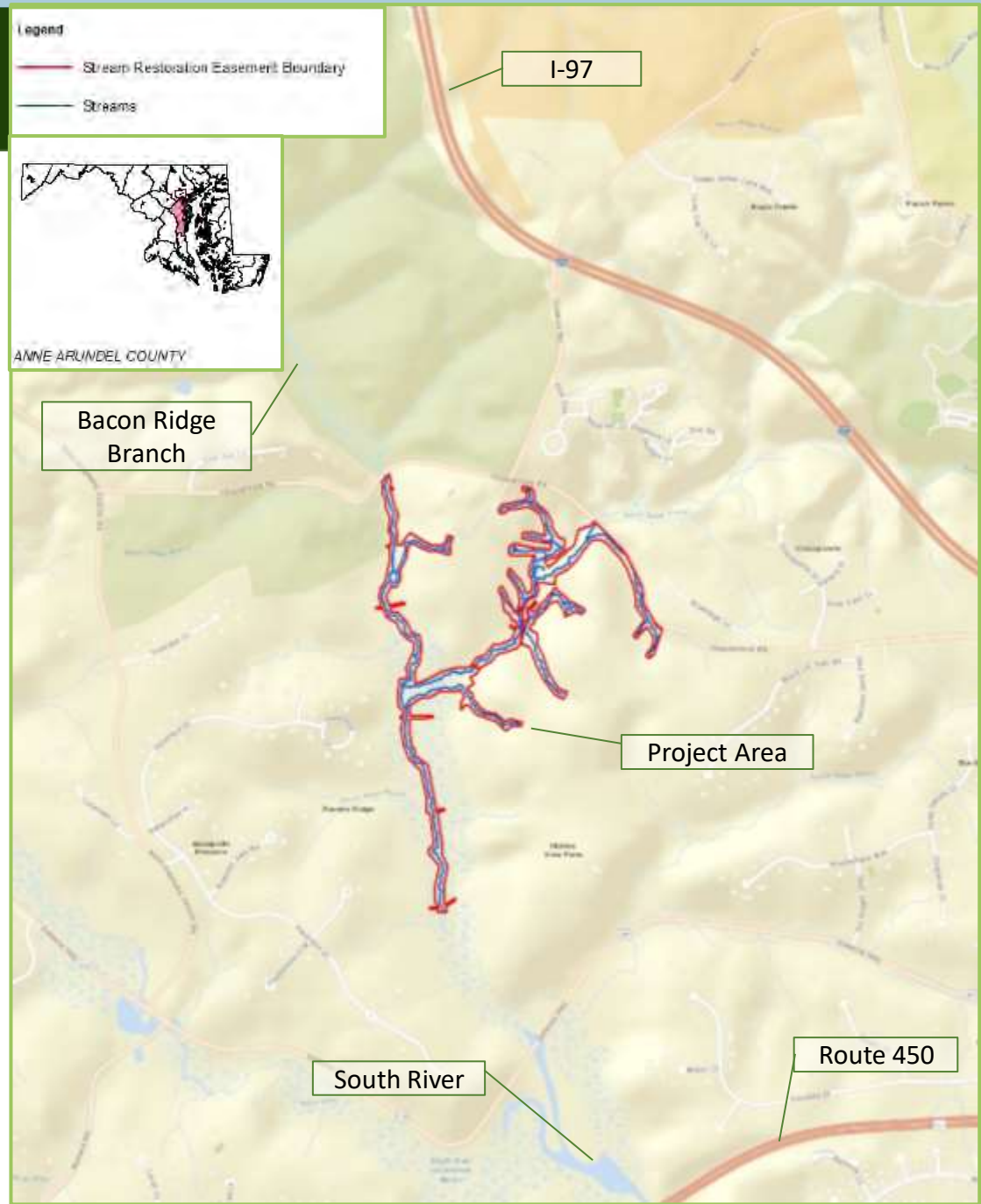
EQR

Biohabitats

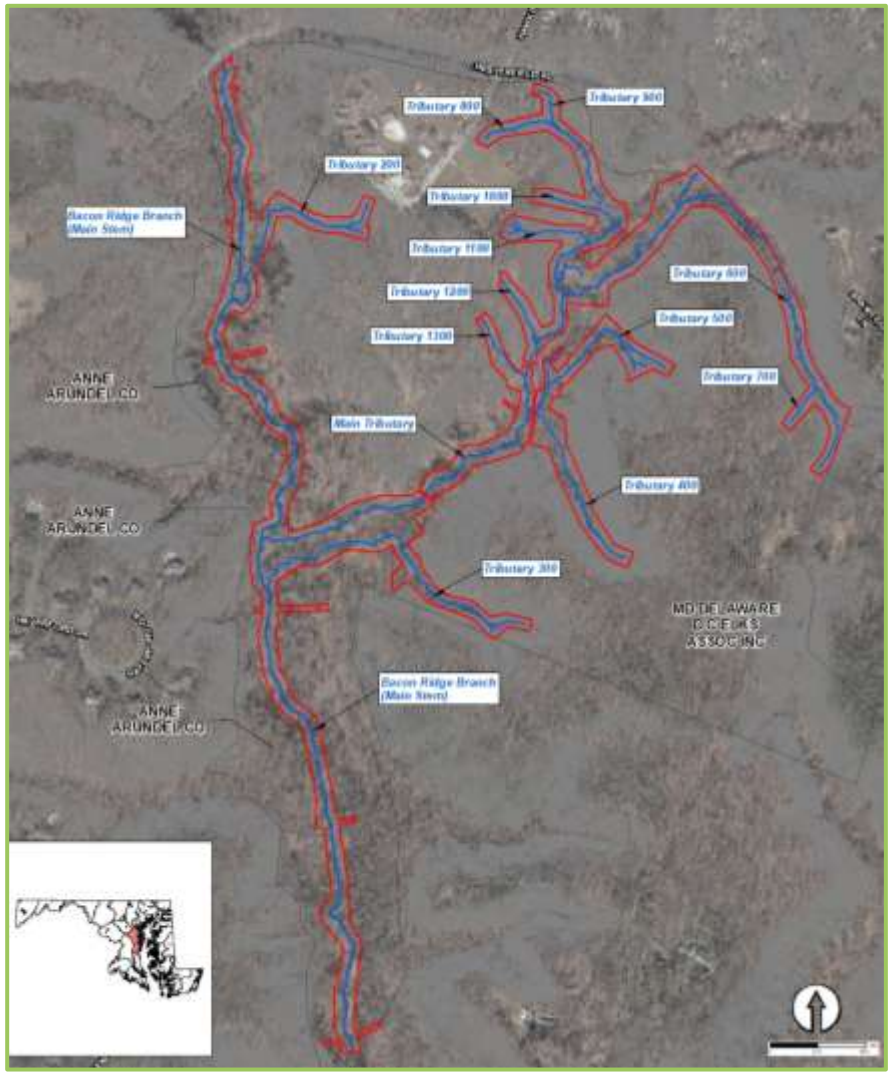
COASTAL RESOURCES INC.

The map to the right depicts the location of the Bacon Ridge Branch Stream Restoration, which flows into the South River.



BACKGROUND

- 17,970 LF total
  - Approx. 8,000 LF in two main perennial streams
  - Approx. 10,000 LF in headwater tributaries
- Land Uses
  - Current: Primarily forested, 10% impervious
  - Historic: ag (hog farming, row crops, pasture)
  - Elks Camp undeveloped for over 100 years
- Drainage Area
  - Main Stem: 4,495 acres (approx. 7 square miles)
  - Main Tributary: 631 acres (approx. 1 square miles)



The map to the right depicts the footprint of the Bacon Ridge Branch Stream Restoration in red.

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EXISTING CONDITIONS

- Streams incised, 3’ to 8’ deep
- Typical baseflow approx. 1-3 cfs in Main Stem and Main Tributary
- Stilt grass (*Microstegium vimineum)* dominated understory lacking smaller trees and shrubs
- Groundwater depth assessment
  - ➢ Groundwater depth sampled approx. 10’ and 70-100’ from edge of stream at multiple locations
  - ➢ Plots closer to the stream had greater depth to free water
    - ➢ Channel incision draining groundwater

The photographs to the right show preconstruction conditions along the project’s Main Tributary, including an understory dominated by stilt grass.

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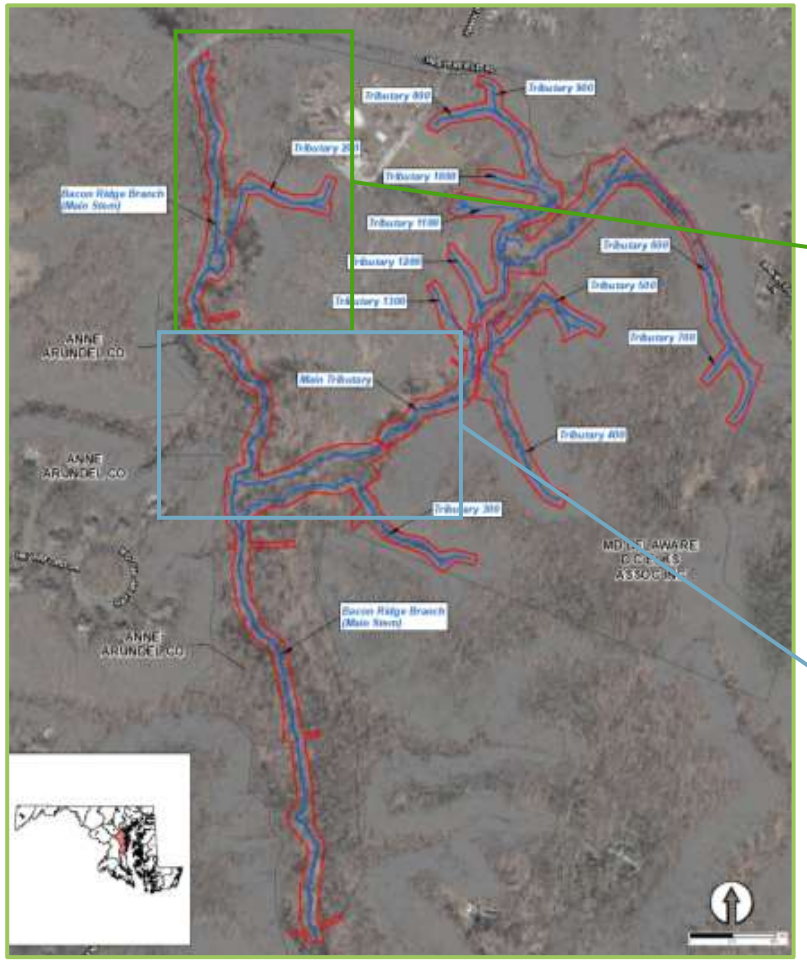
EXISTING CONDITIONS – Wetland Delineation

- Wetlands adjacent to streams in some areas, but not throughout floodplain
  - Patchy, not contiguous
- Some wetlands extending into headwater tributaries
- Primarily PFO wetlands, some PEM and PSS
- Regulatory tidal boundary is a few hundred feet downstream from the restoration area, but the downstream end of the restoration area is tidally influenced



The maps to the right show representative locations of delineated wetlands and a lack of wetlands in the existing/pre-construction condition.

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PROJECT GOALS

"Lighter touch" approach – no major stream channel realignment or large-scale grading, minimize imported materials

1. Optimize floodplain reconnection
2. Increase long-term bed and bank stability
3. Manage and slow stormwater flows throughout the full width of the valley bottom
4. Create and enhance the ecological functions of existing and historic non-tidal wetlands and stream habitats

The photograph shows preconstruction conditions along the project's Main Tributary.

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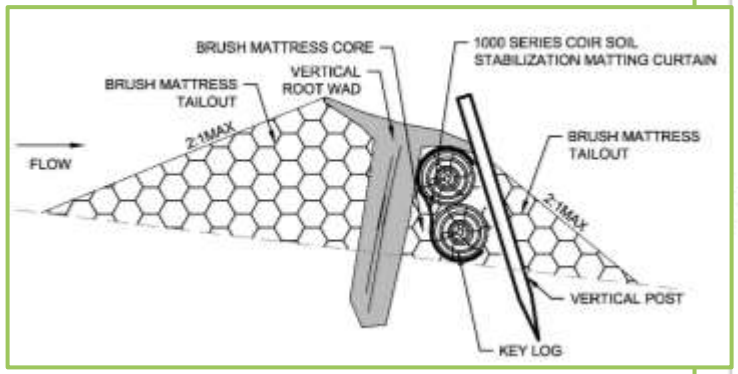
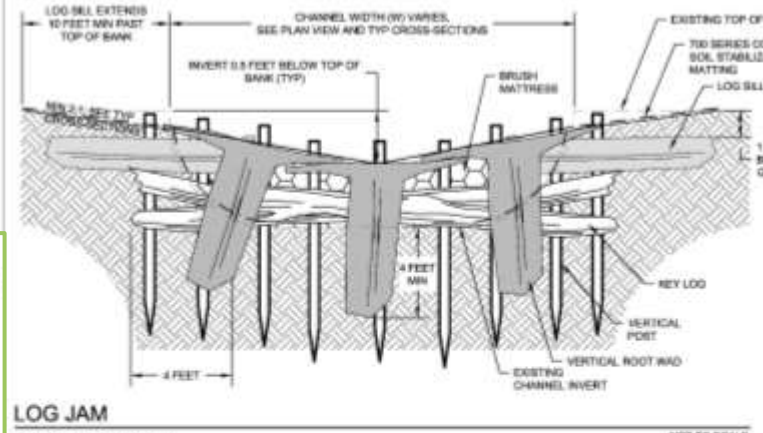
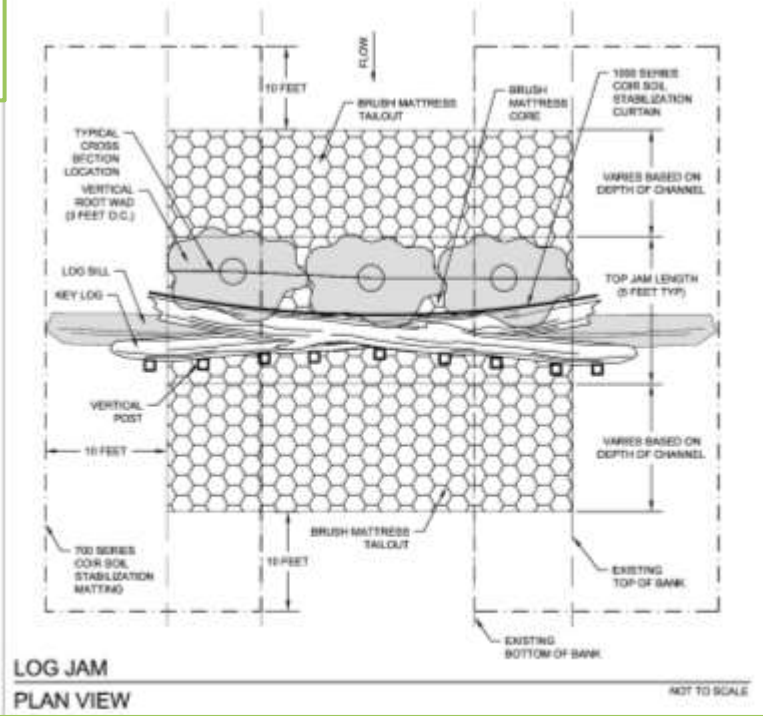
STREAM RESTORATION DESIGN – Engineered Wood Log Jams

- Primary restoration method
- Raise water surface elevation and reconnect floodplain
  - ➢ Baseflow channel
  - ➢ Multiple out-of-bank events per year
- Constructed with wood harvested on site
- Rootwads, trunks, treetops and branches
- Leaf litter, woody debris, and other organic matter replenish structures over time
- 61 log jams total, placed every 0.5’ of elevation drop for redundancy
- Woody debris in floodplain adds roughness and habitat
- Detail has evolved since this project – work in progress!







The log jams details were designed and engineered by Biohabitats.

MONITORING GROUNDWATER

- 3 transects installed on site pre-construction
  - 2 on Main Stem, 1 on Main Tributary
- Each has 3-4 groundwater loggers and an in-stream logger
  - 11 groundwater wells and 3 in-stream loggers total
- Wells installed 50’ to 300’ from top of bank
- Wetland delineation data sheet completed at each well upon install

Right: Map showing the locations of in-stream loggers and groundwater wells.
Above: An in-stream logger (left) and groundwater well (right).

MONITORING GROUNDWATER

Pre-Construction Groundwater Logger Installation

Logger ID	Hydric Soil Indicators?	Hydrophytic Vegetation?**	Wetland Hydrology?	Was it a Wetland?
T1-GW1	Yes	Yes	No	No*
T1-GW2	No	Yes	No	No
T1-GW3	Yes	Yes	No	No*
T1-GW4	No	Yes	No	No
T2-GW1	Yes	Yes	Yes	Yes
T2-GW2	No	Yes	No	No
T2-GW3	Yes	Yes	No	No*
T2-GW4	Yes	Yes	No	No*
T3-GW1	Yes	Yes	No	No*
T3-GW2	Yes	Yes	No	No*
T3-GW3	No	Yes	No	No

*These locations are remnant wetlands – they were previously wetlands, but not in August 2019 due to a lack of hydrology.

**While vegetation meets wetland criteria, most of the species are FAC.

STREAM RESTORATION CONSTRUCTION

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POST-CONSTRUCTION STREAM RESULTS

These photos show the increase in stream water surface elevation at the location of a constructed log jam pre- and post-construction.

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POST-CONSTRUCTION STREAM RESULTS

These photographs, taken by Biohabitats, show the increase in stream water surface elevation pre- and post-construction.

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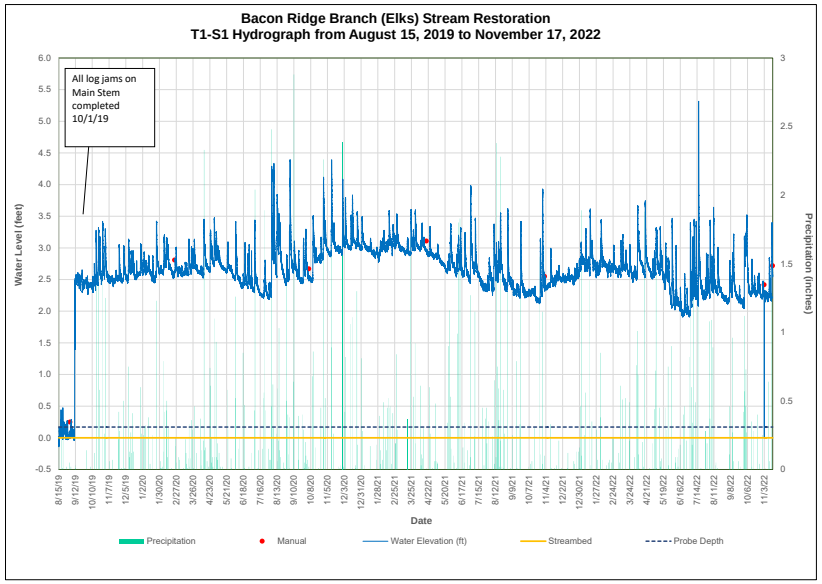
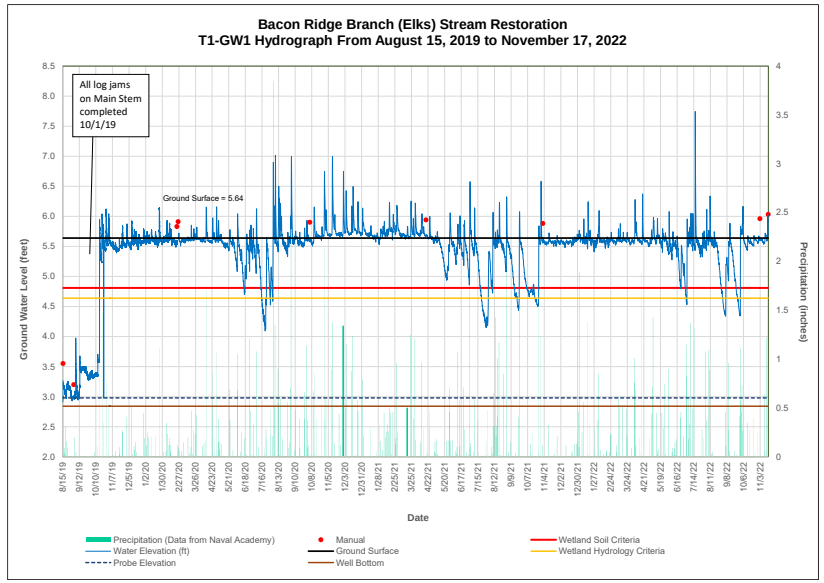
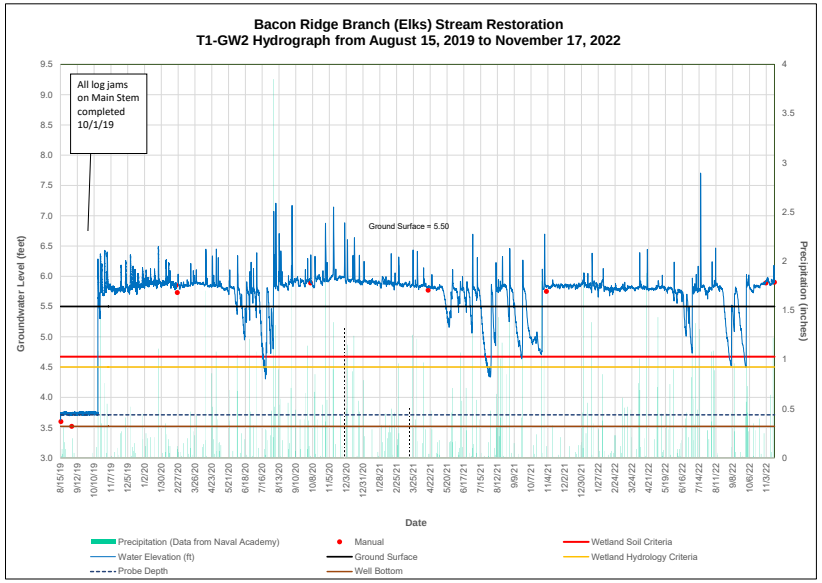
POST-CONSTRUCTION GROUNDWATER RESULTS

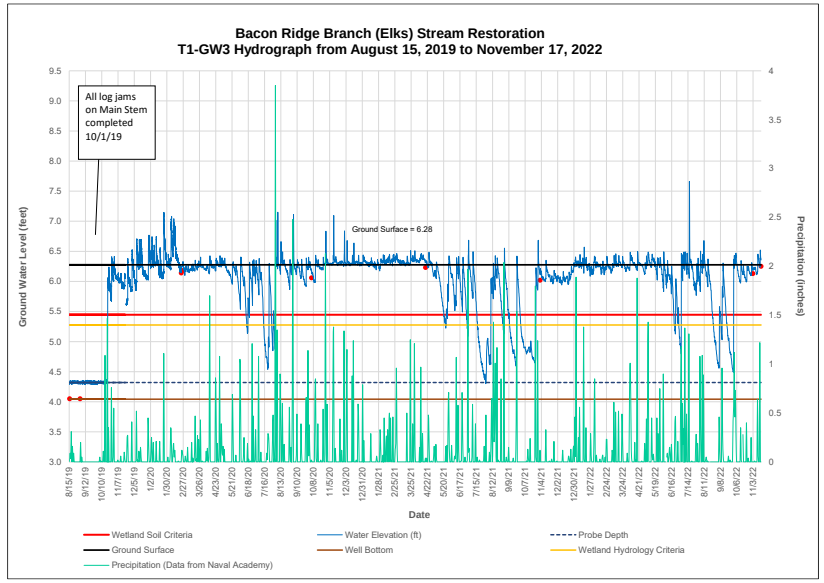


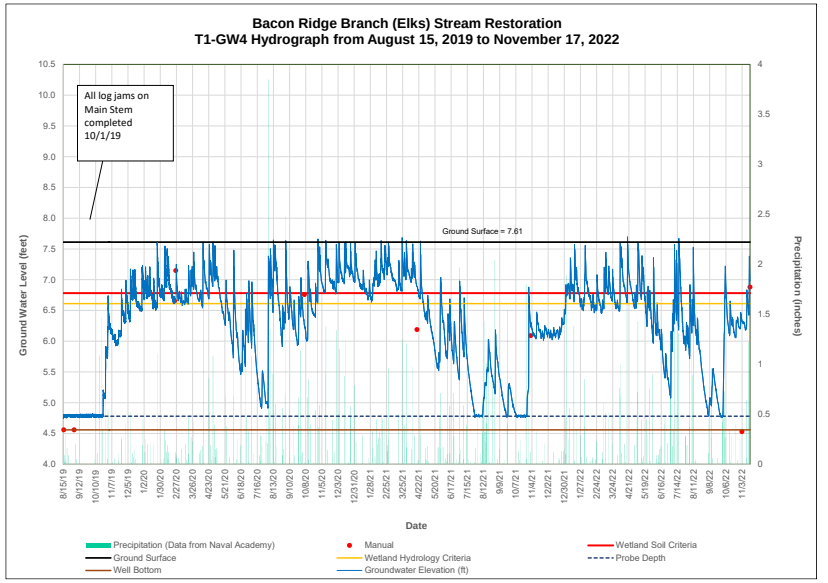


Transect T1 on the Main Stem

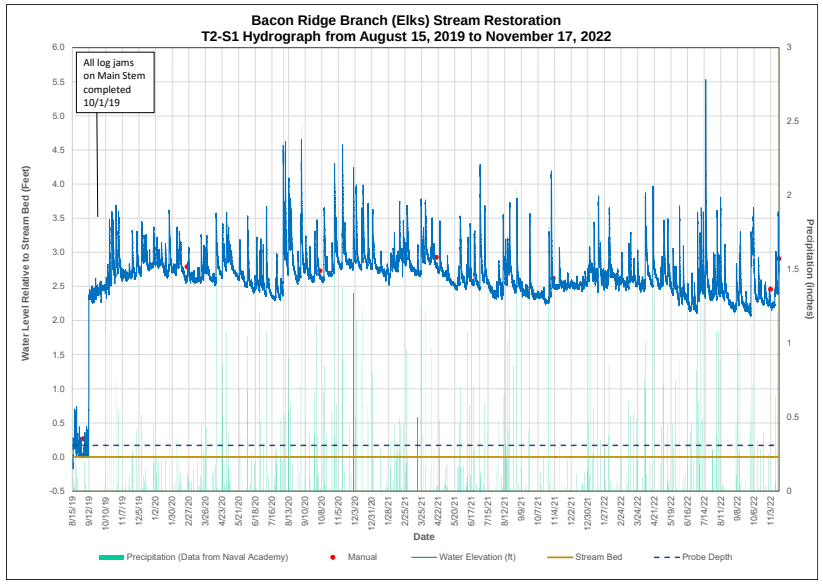
Logger ID	Approx. Distance from Stream (ft)
T1-S1	In-Stream
T1-GW1	50 feet
T1-GW2	100 feet
T1-GW3	200 feet
T1-GW4	300 feet

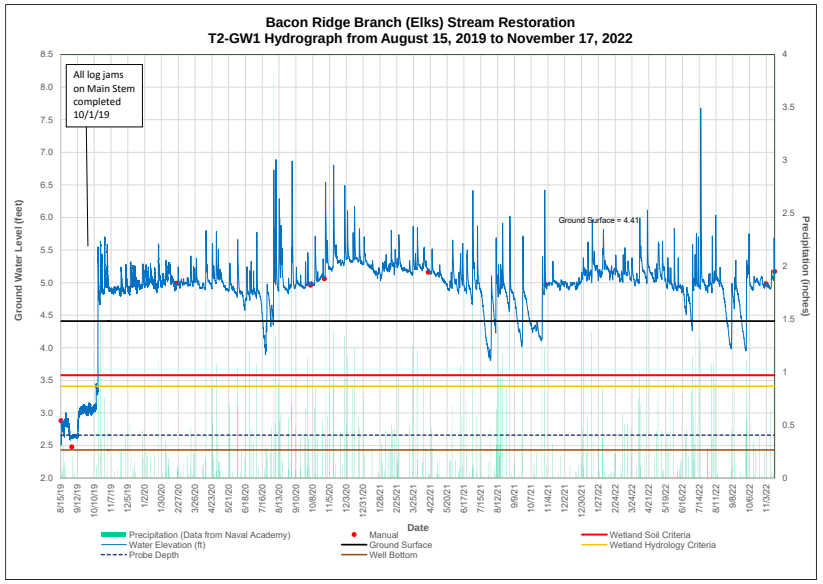






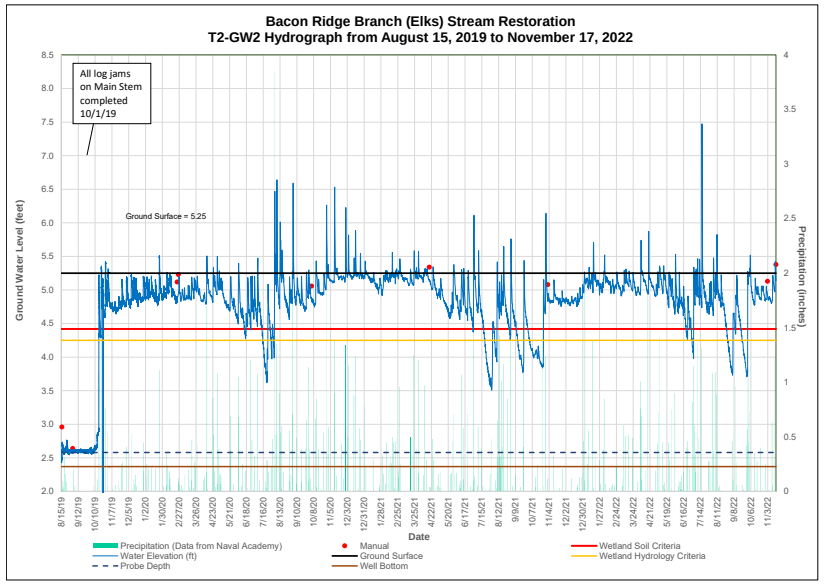
POST-CONSTRUCTION GROUNDWATER RESULTS

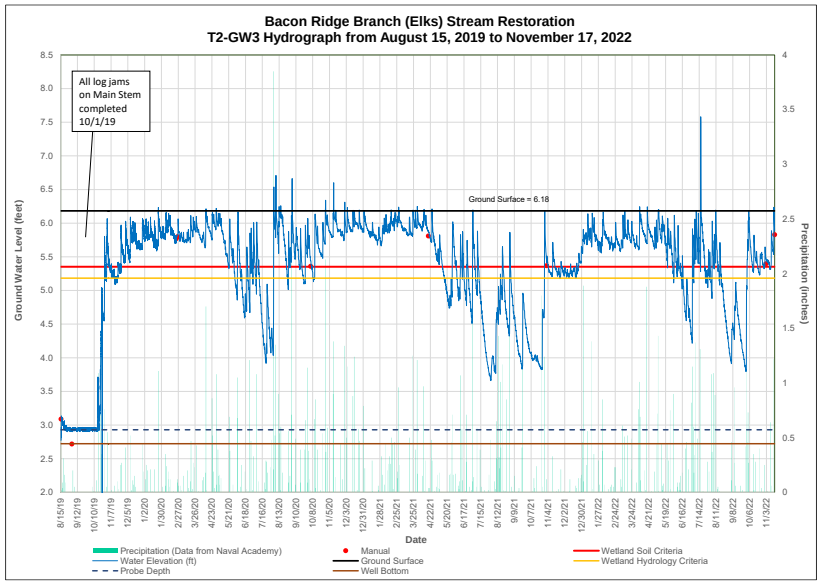


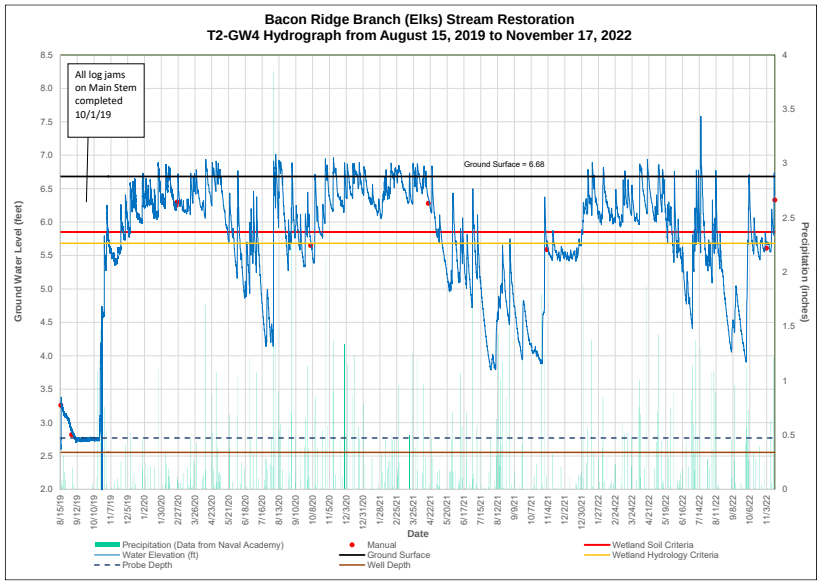


Transect T2 on the Main Tributary

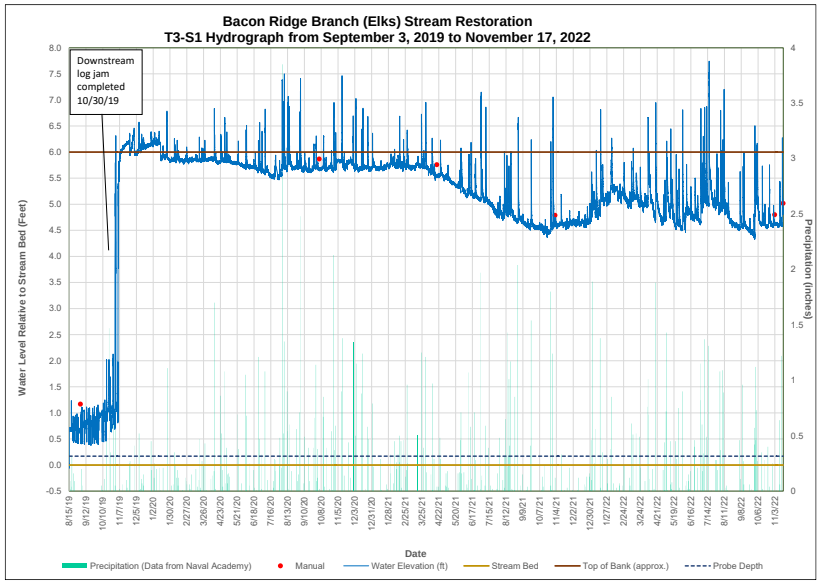
Logger ID	Approx. Distance from Stream (ft)
T2-S1	In-Stream
T2-GW1	50 feet
T2-GW2	100 feet
T2-GW3	200 feet
T2-GW4	270 feet

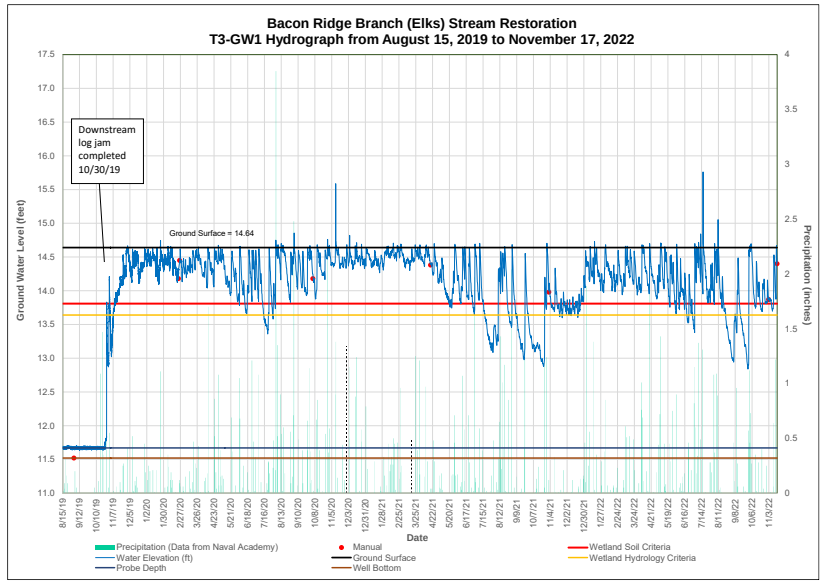


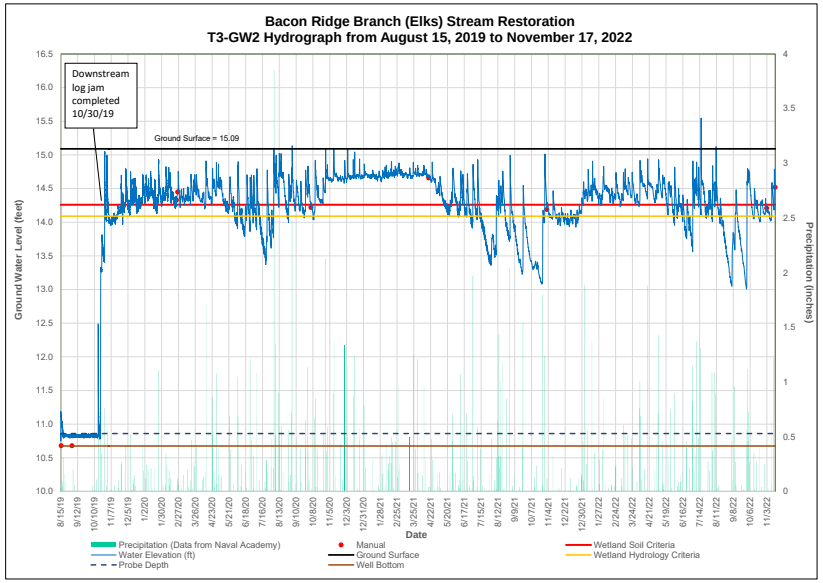


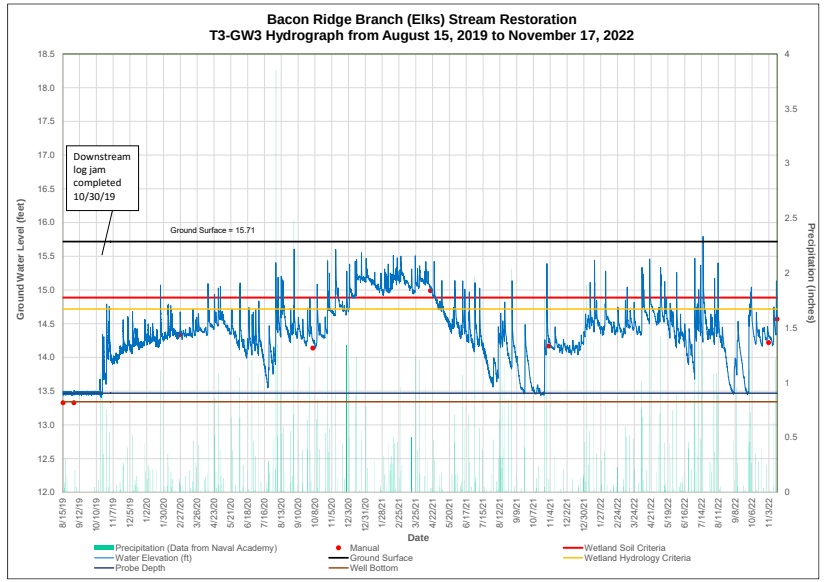


POST-CONSTRUCTION GROUNDWATER RESULTS









Transect T3 on the Main Tributary

Logger ID	Approx. Distance from Stream (ft)
T3-S1	In-Stream
T3-GW1	50 feet
T3-GW2	100 feet
T3-GW3	200 feet

- Groundwater elevation increased immediately ≥ 2’ at the majority of wells right after construction
- T3-GW3 only increased approx. 1’, but it’s 200’ from the stream channel
- The groundwater increase necessary to re-create hydric soil conditions has been sustained

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WETLAND RESULTS

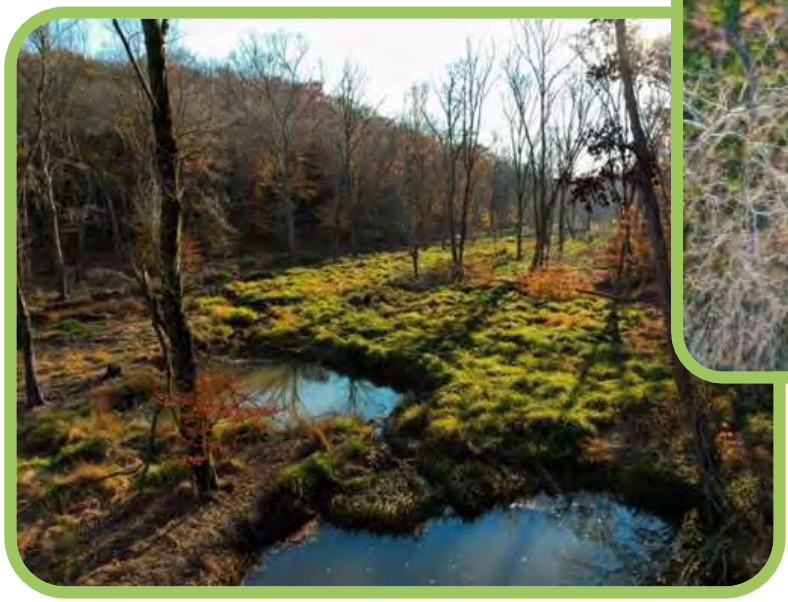
Year 2 (July 2021)

- Vegetation and hydrology indicators recorded at each groundwater well, soils not monitored
- All 11 well locations had wetland hydrology during monitoring or met criteria earlier in 2021 according to groundwater loggers
- All 11 well locations had hydrophytic vegetation
- This includes all 3 wells at the valley walls, T1-GW4 (300’ from stream), T2-GW4 (270’ from stream), and T3-GW3 (200’ from stream)

Year 3 (2022)

- Hydrographs show wetland hydrology at 9 out of 11 wells
    - All except T1-GW4 and T3-GW3

Above and Below: Vegetation along the Main Tributary.
Right: Aerial view of log jams and pools on the Main Tributary.



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PROJECT CHALLENGES AND ADAPTIVE MANAGEMENT

- Beaver
  - Eating some woody vegetation
  - Large (3' high) dam on first Main Tributary log jam retaining organic matter → less entering system
  - Adaptive Management: Managing beaver impacts if needed, not beaver presence
- Woody vegetation survival lower than anticipated
  - Deer, increased hydrology, beaver
  - Adaptive Management: Supplemental plantings
- Highly erodible soils coupled with hydrology contribute to more flow around and through log jams than anticipated
  - Adaptive Management: Filling voids in log jams where possible with a variety of material

A large beaver dam on the upstream end of the Main Tributary – facing upstream to the dam in December 2021 (above) and the adjacent right floodplain in April 2022 (left).

PROJECT CHALLENGES AND ADAPTIVE MANAGEMENT

- Decreased water surface elevations in some locations, particularly the Main Tributary
  - Potentially due to increased porosity, piping flows, precipitation
  - Some sediment in structures has likely washed away
  - Adaptive management: Filling voids in log jams where possible with a variety of material, supplemental planting including sod mats

- Log jam at downstream tie-in to unrestored, tidal channel was not holding upstream water surface elevation
  - Adaptive Management: Re-constructed 3 log jams and built 3 new log jams at the tidal interface to slowly decrease invert elevations and build a stronger tie-in
  - Tie-in now includes imported rock, and all new and re-constructed log jams include bentonite fabric

Above: A log jam that received adaptive management to encourage flows over the structure. **Left:** A new log jam under construction at the downstream end of the project. The white material in the photo is bentonite fabric.

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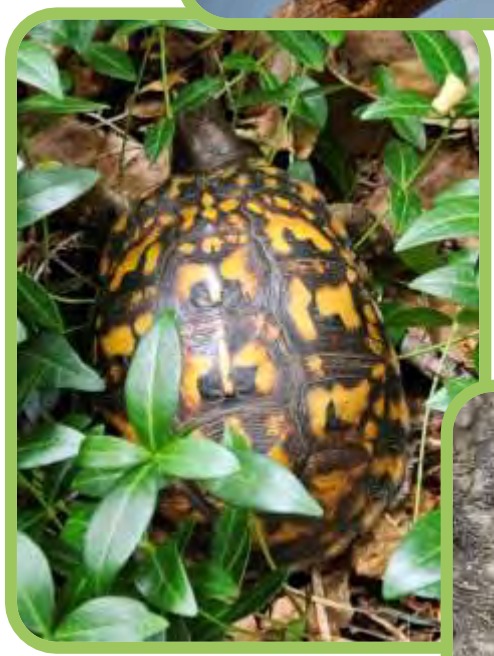
WILDLIFE OBSERVATIONS

Species Observed After Construction*

- Great blue heron
- Mallard and wood duck
- Blue-gray gnatcatcher
- Belted kingfisher
- Eastern phoebe
- Swamp sparrow
- Red-tailed hawk
- Wild turkey
- Bald eagle
- Spring peeper
- Wood frog
- American toad
- Eastern ratsnake
- Copperhead snake
- Snapping turtle
- Beaver
- Fox
- Two-lined salamander
- Fish throughout project area

Forest Interior Dwelling Species ("FIDS") Observed

- Barred owl
- Hairy woodpecker
- Pileated woodpecker
- Red-shouldered hawk
- Red-eyed vireo
- Northern parula
- Brown creeper
- Ovenbird
- Louisiana waterthrush
- Wood thrush



Clockwise from top left: White-breasted Nuthatch, Wood Thrush, Maintenance Crew (beaver), Raccoon prints, and Eastern Box Turtle.

*No formal wildlife monitoring has been conducted; this is a sampling of what has been casually observed since the completion of construction

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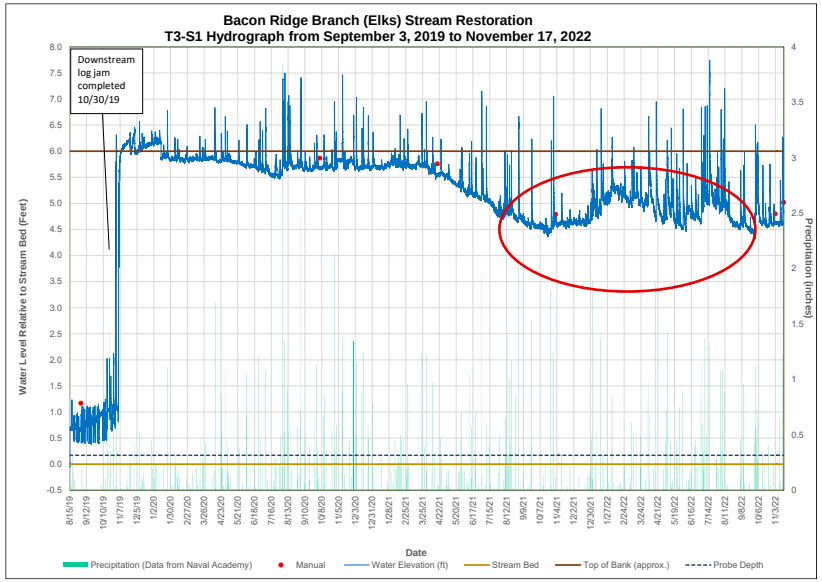
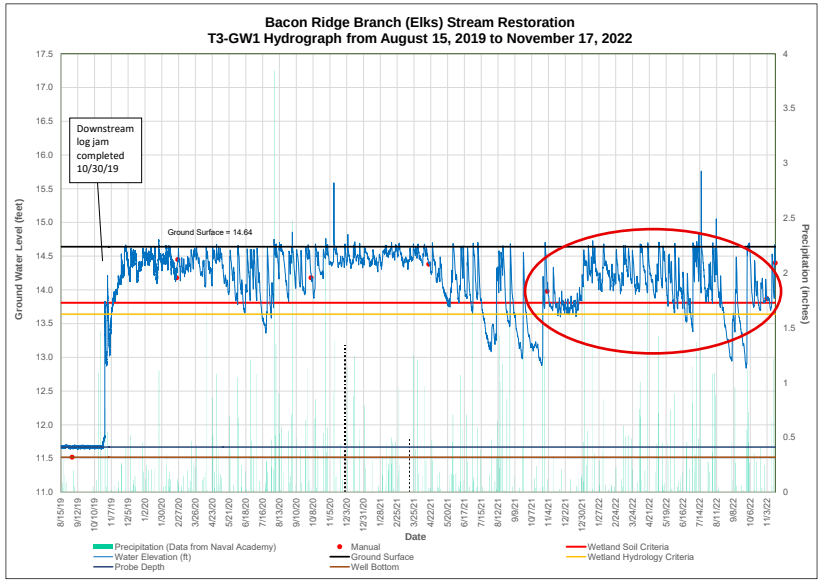
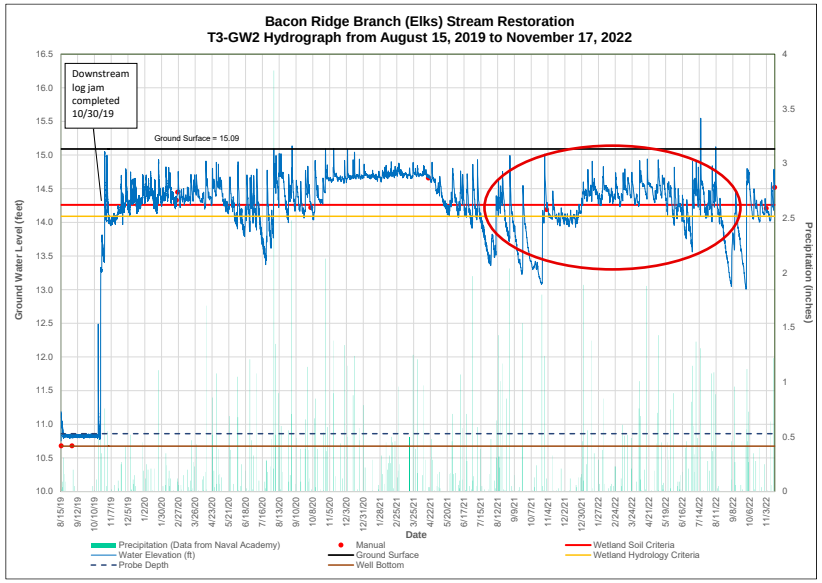
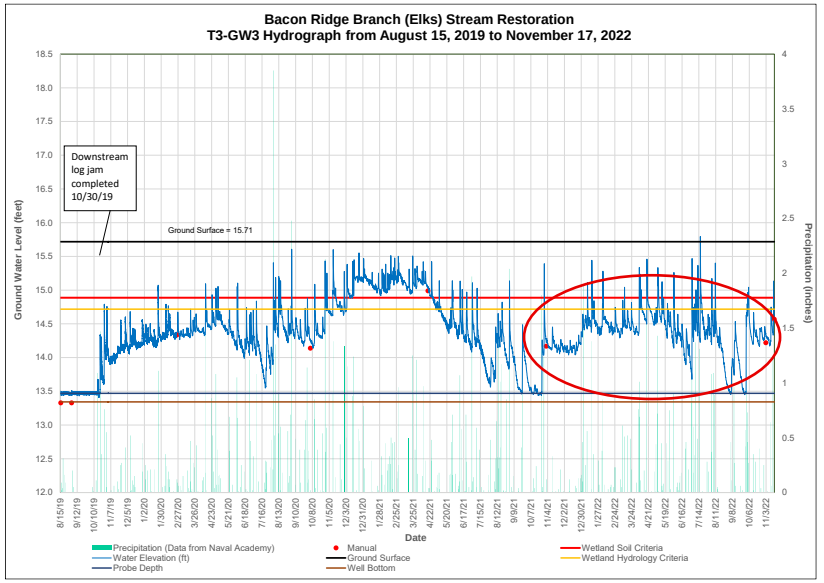
CURRENT STATUS

- Main Tributary in-stream logger shows decrease in water level, but not groundwater loggers (red circles)
  - Lower in-stream water level at some locations possibly due to piping flows and increased log jam porosity
  - Wetland hydrology maintained by saturation of floodplain soils
  - Role of precipitation/drought?
- Overall, site is performing well compared to pre-construction:
  - Reduced in-stream erosion
  - Trapping sediment in pools
  - Increased floodplain connectivity
  - Maximized ecological uplift
  - Increased wetland function, value, structure, and composition









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