# Advancing Green Infrastructure in Coastal Georgia through Monitoring and a Case Study

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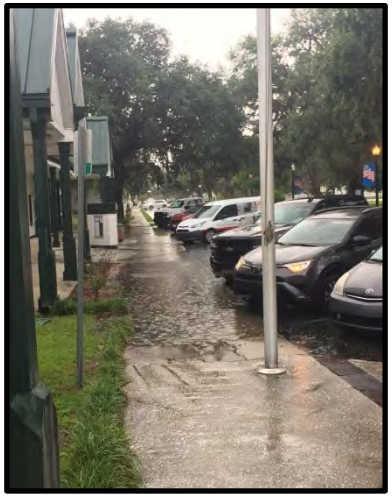
**Building Communities**

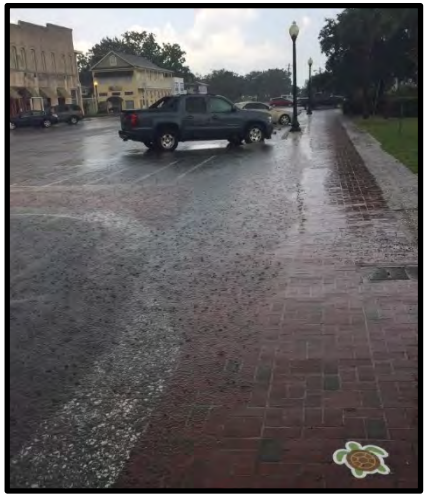
# Project Background & Case Study,

St. Marys, GA

# DOWNTOWN ST. MARYS, GA: PRE-GI/LID

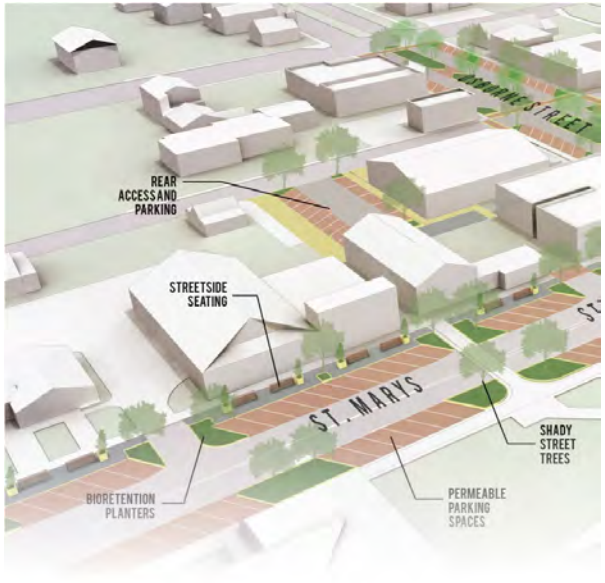
- Site Conditions
  - –Flat topography
  - –Lack of drainage infrastructure
  - –Narrow sidewalks
  - –Limited pedestrian facilities
  - –Large impervious surfaces





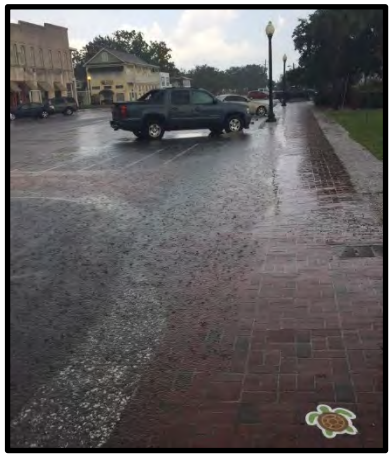
# WHEN THERE'S A PLAN…

- 2008 Stormwater Masterplan
  - –Drainage deficiencies & high priority sites
  - –Gray approach
- 2014 St. Marys Watershed Management Plan
  - –Impaired waterway & recommended BMPs for GI/LID
    - ***Eligibility for Section 319(h) funding from GAEPD***
- 2014 St. Marys Flood Resiliency Plan
  - –Downtown core is vulnerable to flooding (now and in future); recommended stormwater improvements
- 2016 Downtown St. Marys Strategic Vision & Plan
  - –Recommended green infrastructure practices as part of streetscape enhancements



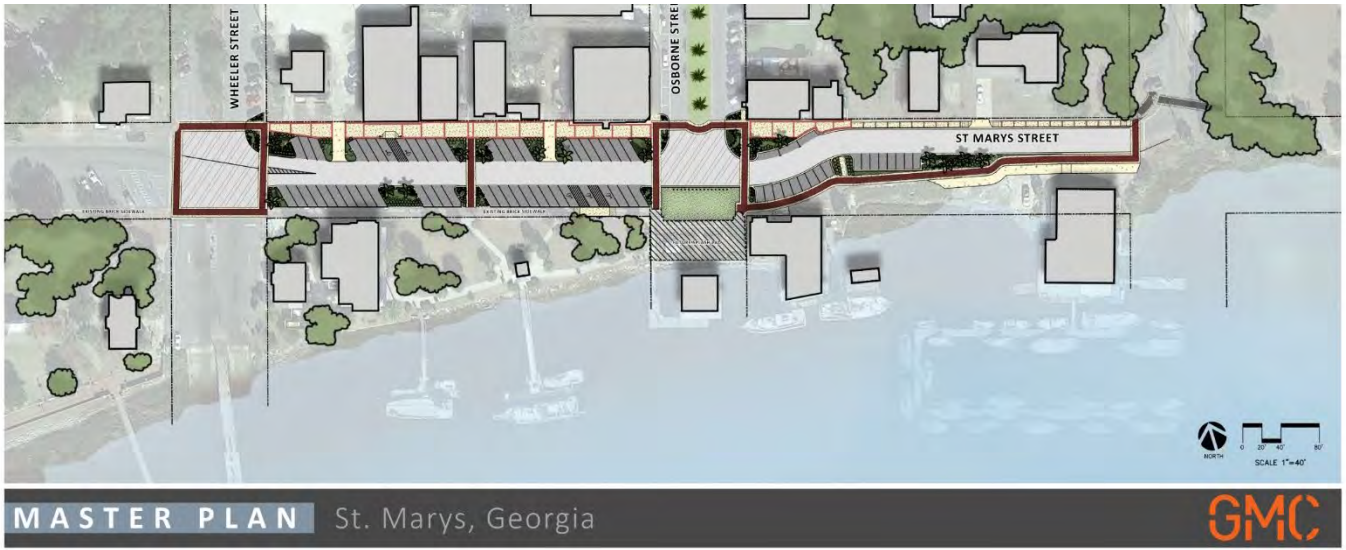
# PROJECT GOALS

- Enhance roadway and pedestrian access
- Address nuisance flooding
- Grant funding to expand footprint
  - –GDOT LMIG & GAEPD Section 319(h)
  - –Phase 1: St. Marys Street; Phase 2: City Hall



# SECTION 319(h) GRANT COMPONENTS

- Two project phases; ~$500K grant funds
- Most of grant funds paid for green infrastructure elements
  - –19,300 SF perm. pave. & 7,600 SF bioretention
- Monitoring & outreach/education components

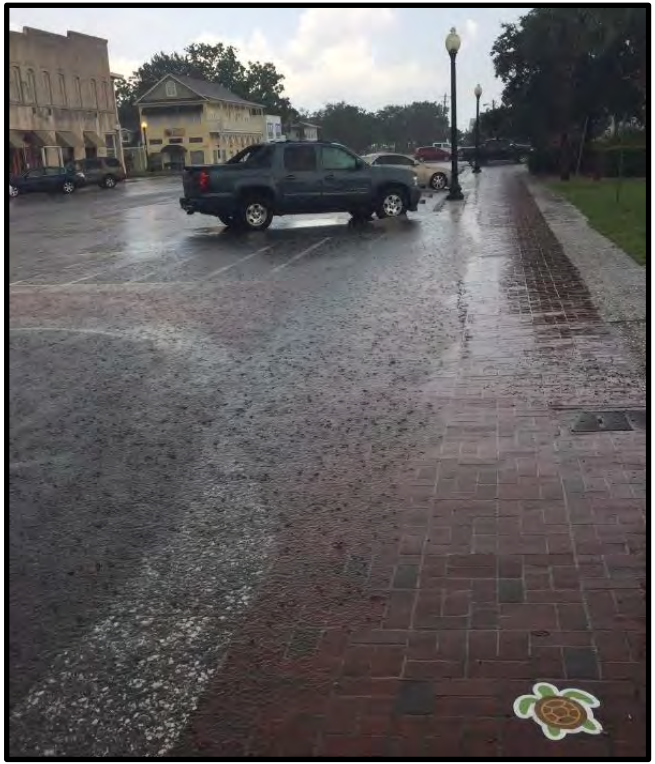


# PHASE 1 RIBBON CUTTING – OCTOBER 18, 2019

# LOOKING WEST ON ST. MARYS STREET (FROM OSBORNE STREET)


# PHASE 1 – ST. MARYS STREET

**Before: 6/12/2018**



**After: 8/19/2020**

# PHASE 2 – CITY HALL (OSBORNE STREET)

**Before: 6/12/2018**

**After: 8/19/2020**

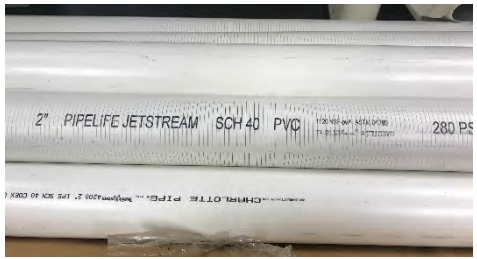
# ADDITIONAL PHOTOS – SPRING 2020

# FINISHED SITE – IN ACTION

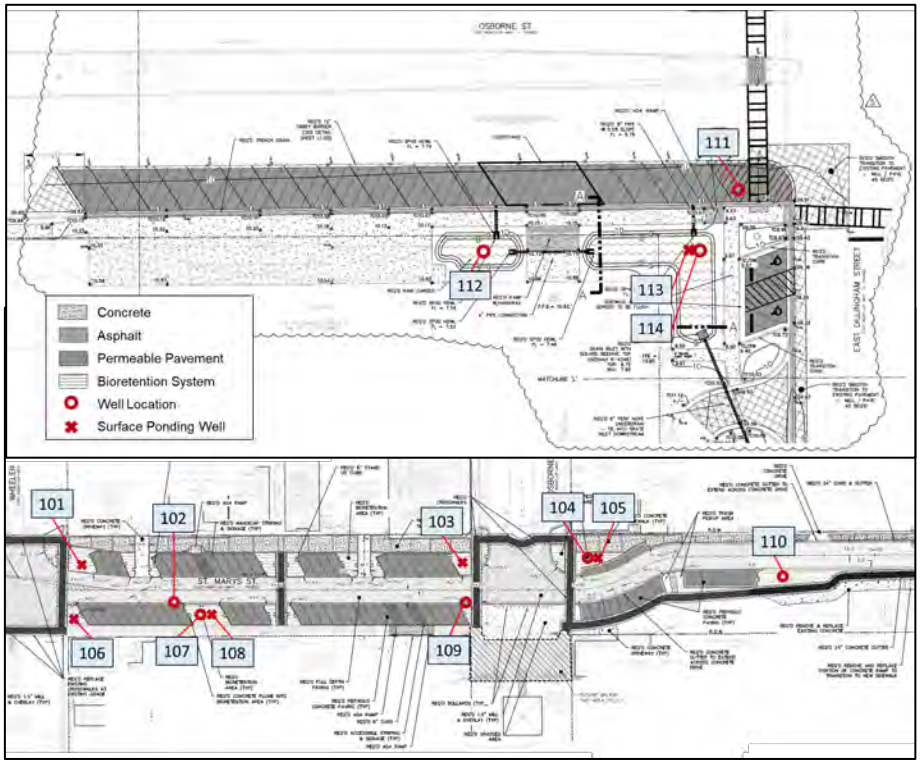
# Research Program & Monitoring Results: Hydrologic

# HYDROLOGIC MONITORING EQUIPMENT

- 14 Shallow Wells
  - –Solinst Levelogger Edge
    - Non-vented water level datalogger
    - Extra barometric pressure logger
  - –Measure infiltration & exfiltration
- Tipping Bucket Rain Gauge
  - –Model runoff/inflow

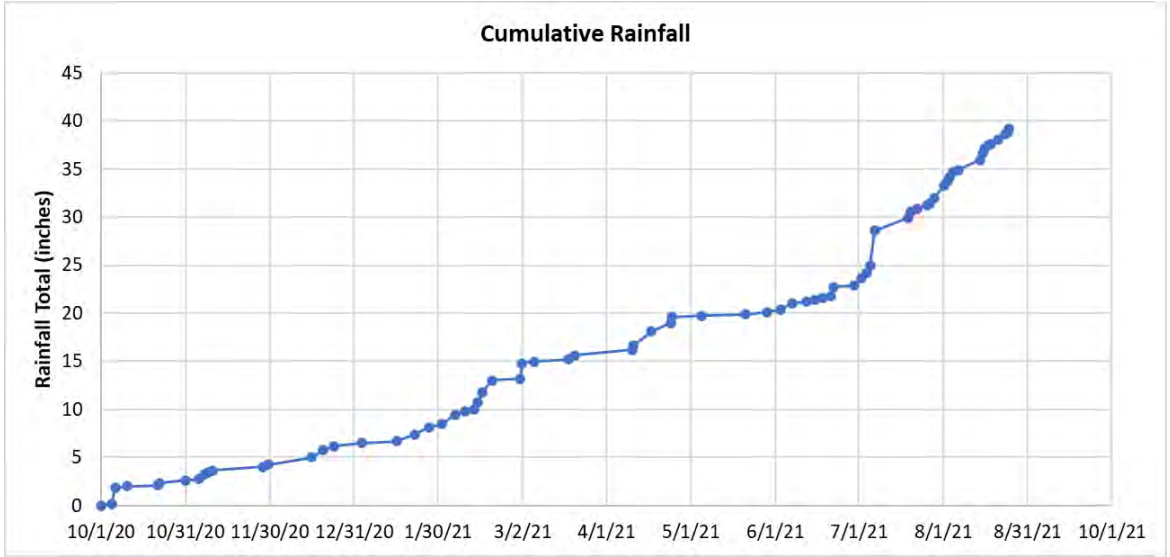






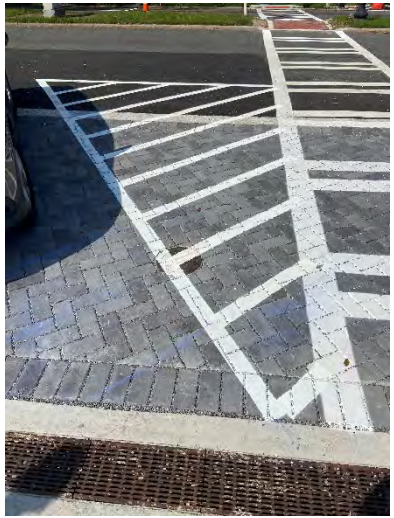
# RAINFALL SUMMARY

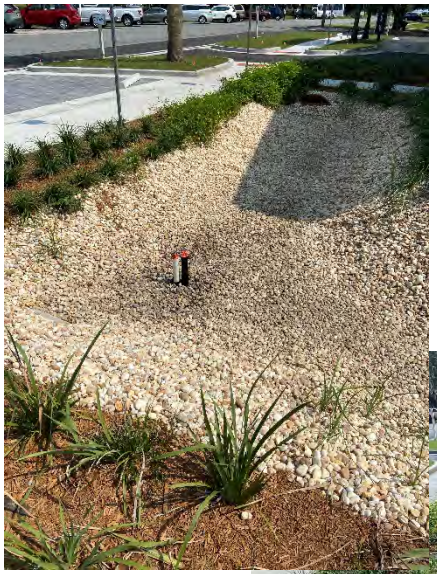
- 11 Months – 39.19 inches
  - –Avg is upper 40s to low 50s
- Oct. – June (9 months)
  - –22.90 inches (58%)
    - ~9” below normal
- July – August (2 months)
  - –16.29 inches (42%)
    - ~3” above normal



# DEPLOYED AT CITY HALL (PHASE 2)

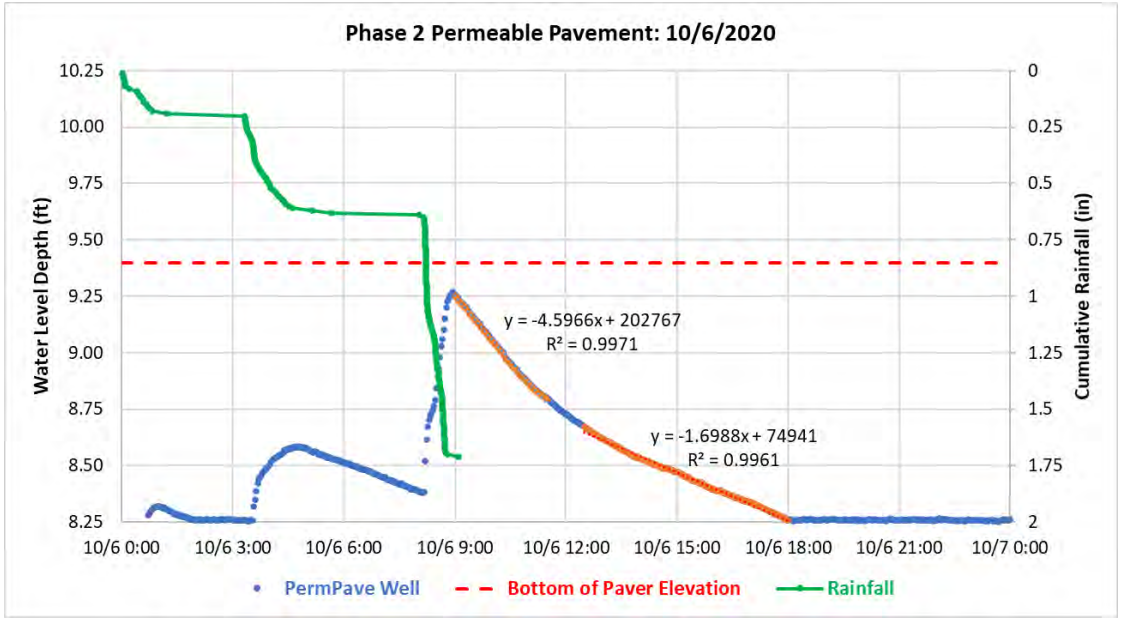
- Permeable Pavement
  - –Exfiltration Rate
- Bioretention
  - –Infiltration & Exfiltration Rate



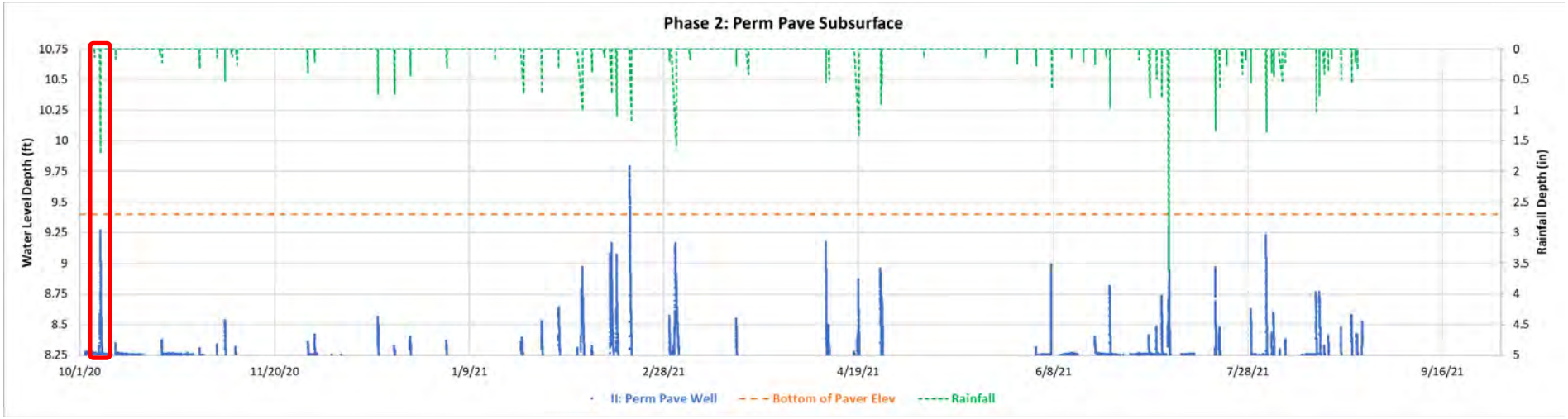


# PERMEABLE PAVEMENT: EXAMPLE EVENT – 10/6/2020; 1.71” RAINFALL

- No Underdrain
  - –Fully infiltrates runoff
- Exfiltration Rate
  - –Water level drawdown x 35% porosity
  - –Upper: 0.8 in/hr
  - –Lower: 0.3 in/hr
- Bottom of Pavers is 9.4 ft
- Water depth 1.0 ft; near capacity
  - –Recovered completely in 9 hrs



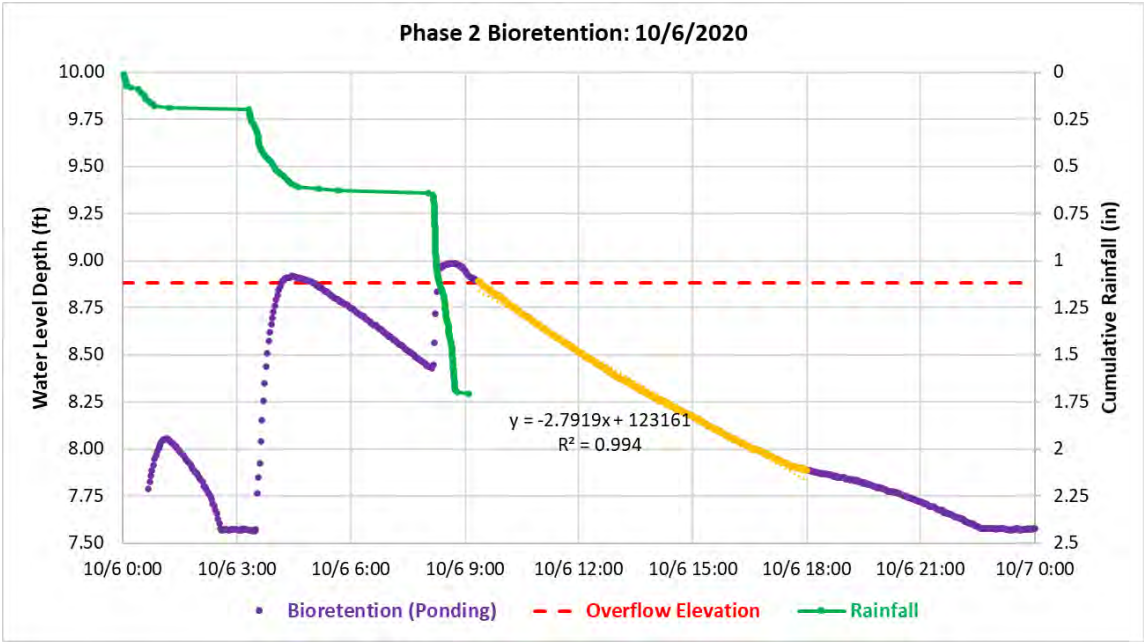
# LONG-TERM MONITORING: PERMEABLE PAVEMENT PHASE 2



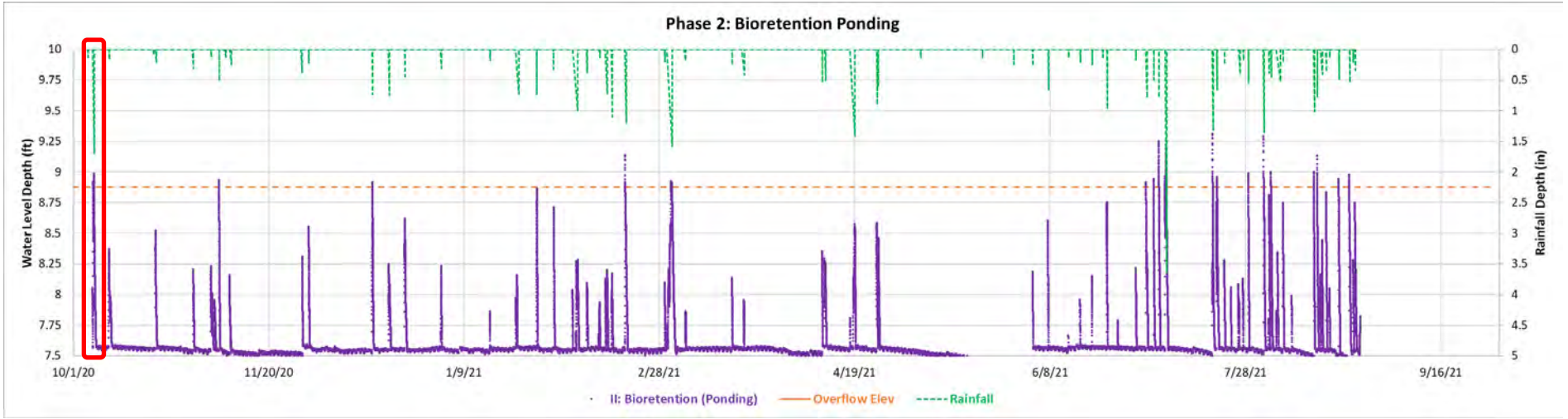

- 71 Events
  - 1 event completely filled gravel storage layer
- Surface Condition
  - Similar trends of water infiltrating through 1st year

# BIORETENTION:
# EXAMPLE EVENT – 10/6/2020; 1.71” RAINFALL

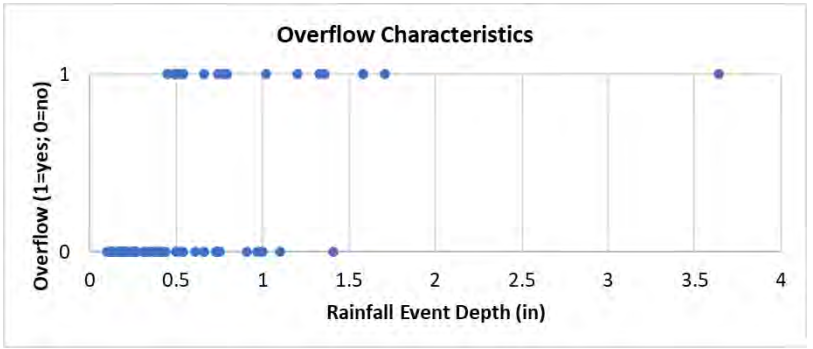
- No Underdrain
  - –Fully infiltrates runoff
- Infiltration Rate
  - –1.4 in/hr
- Overflow Grate: 8.9 ft
- Max ponding depth is ~1.3 ft
  - –Recovered completely in 14 hrs



# LONG-TERM MONITORING: BIORETENTION PHASE 2

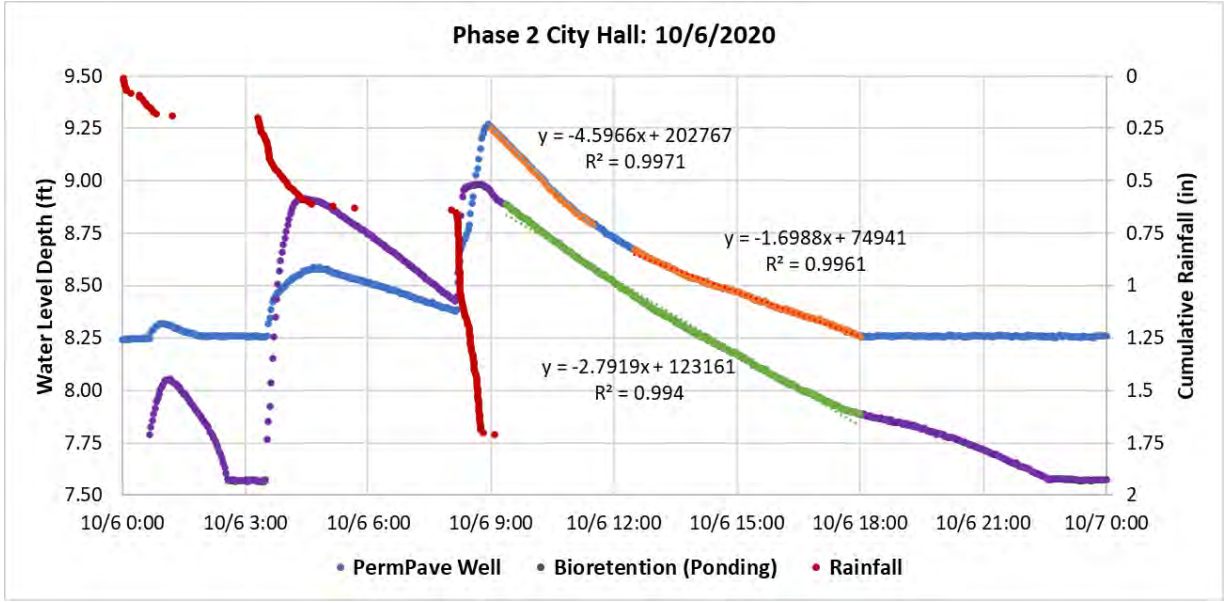



- 71 Events
  - –18 with Overflow (25%)
    - Smallest 0.45” & Largest without 1.41”
- Infiltration Rate Range:
  - –1.0 to 3.3 in/hr
    - Lower during extreme wet weather and when cooler



# EXAMPLE EVENT – 10/6/2020; 1.71” RAINFALL

- Intra-event infiltration is substantial
- 3 segments over 8 hours
  - –0.19”→2 hrs→0.44”→3 hrs→1.08”




*Capacity Elevations*

Bottom of Pavers: 9.4’ (blue)

Overflow Grate: 8.9’ (purple)

# PHASE 1 – TIDAL INFLUENCE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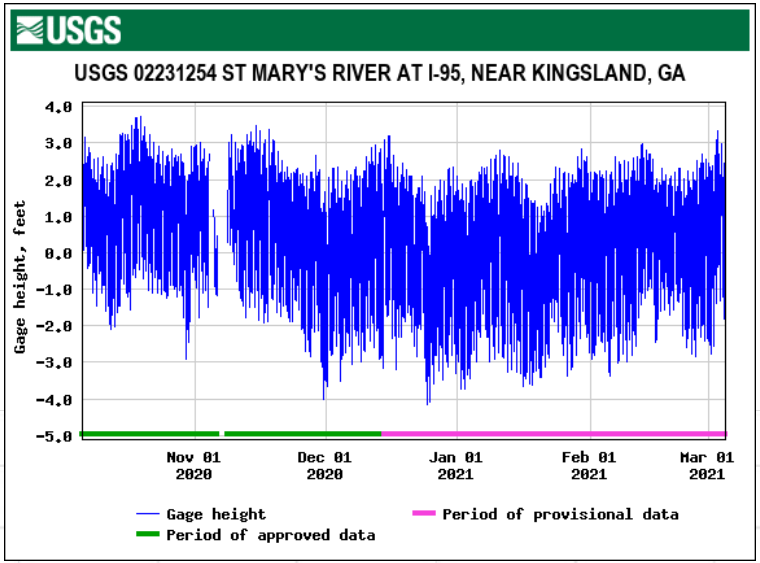
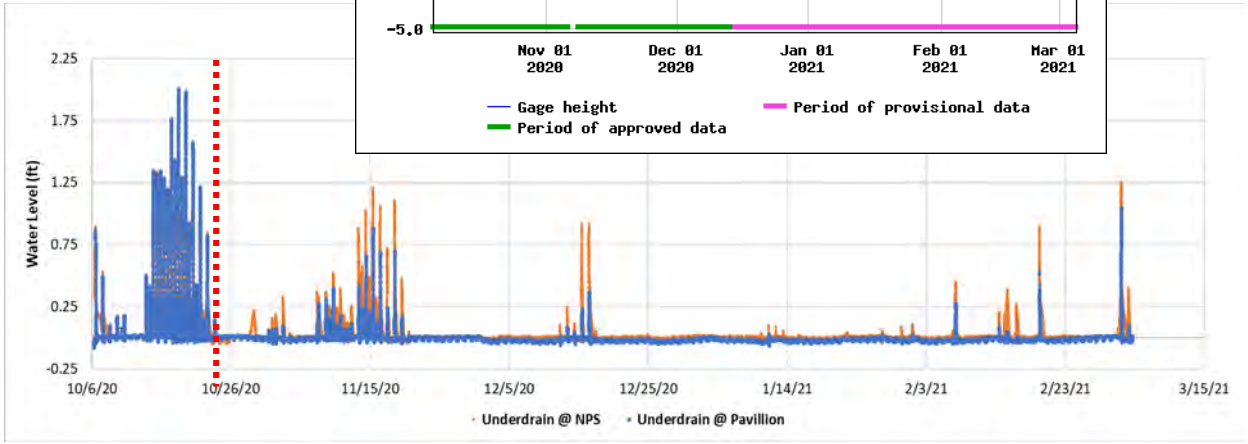
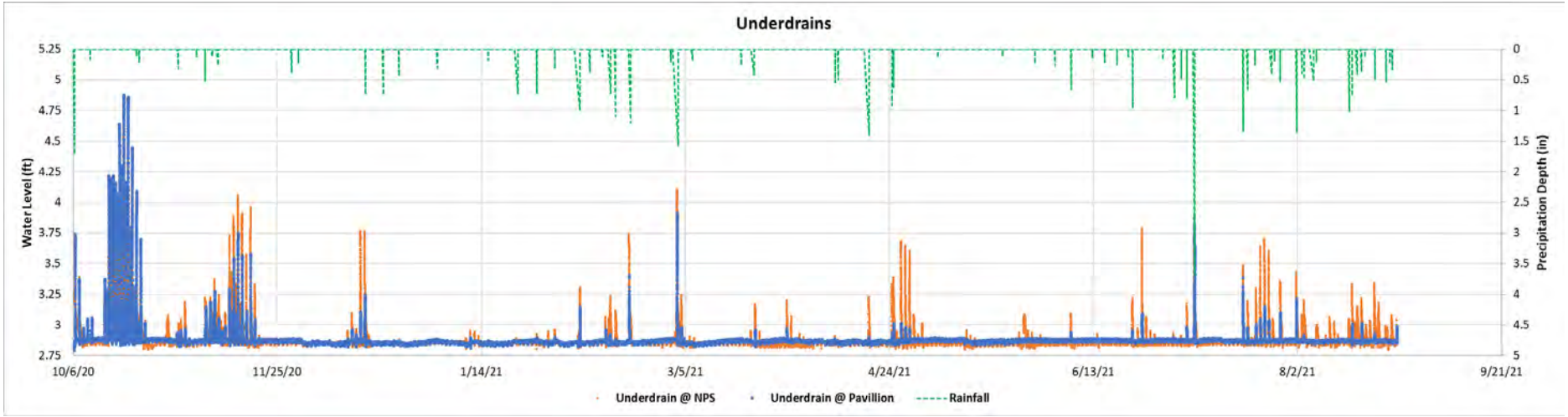
- In-line tide flaps for underdrain installed Oct. 23, 2020

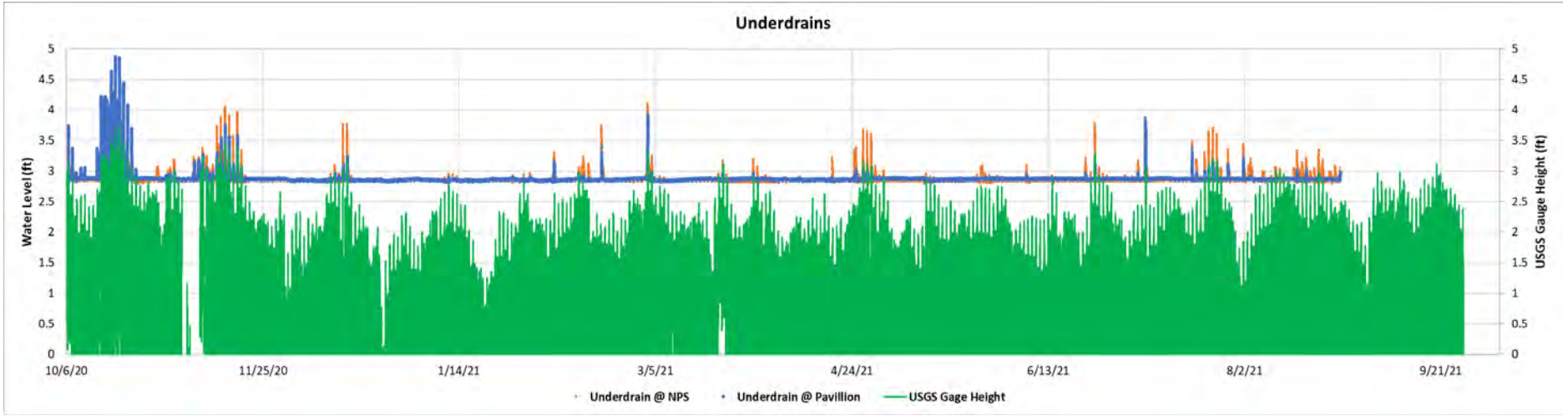


# PHASE 1 – TIDAL INFLUENCE – 11 MONTHS

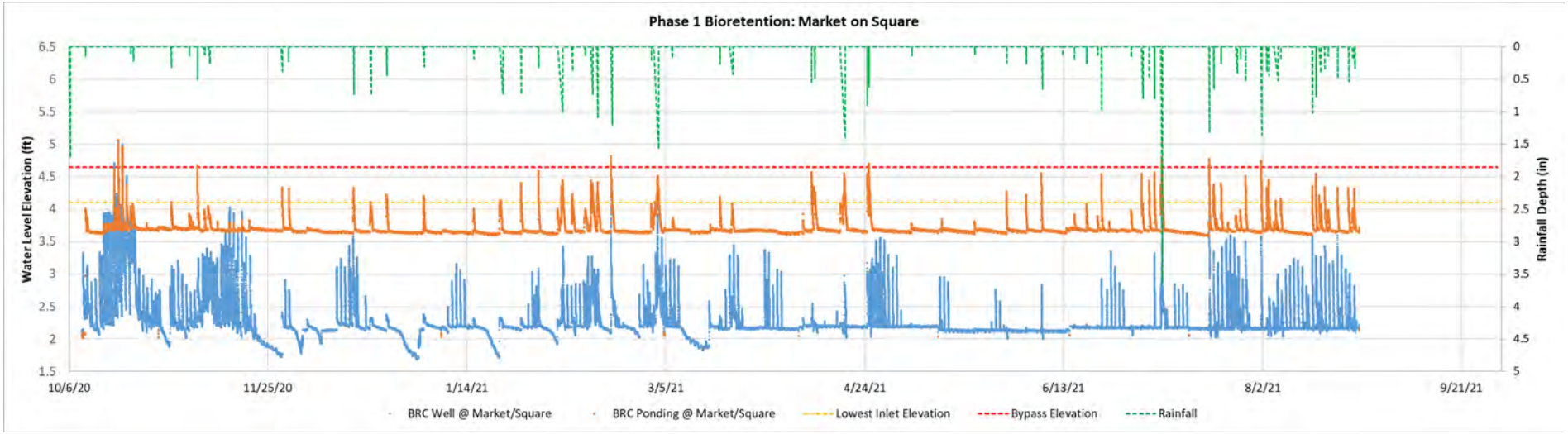


# PHASE 1 – TIDAL INFLUENCE – OVERLAY USGS GAUGE DATA



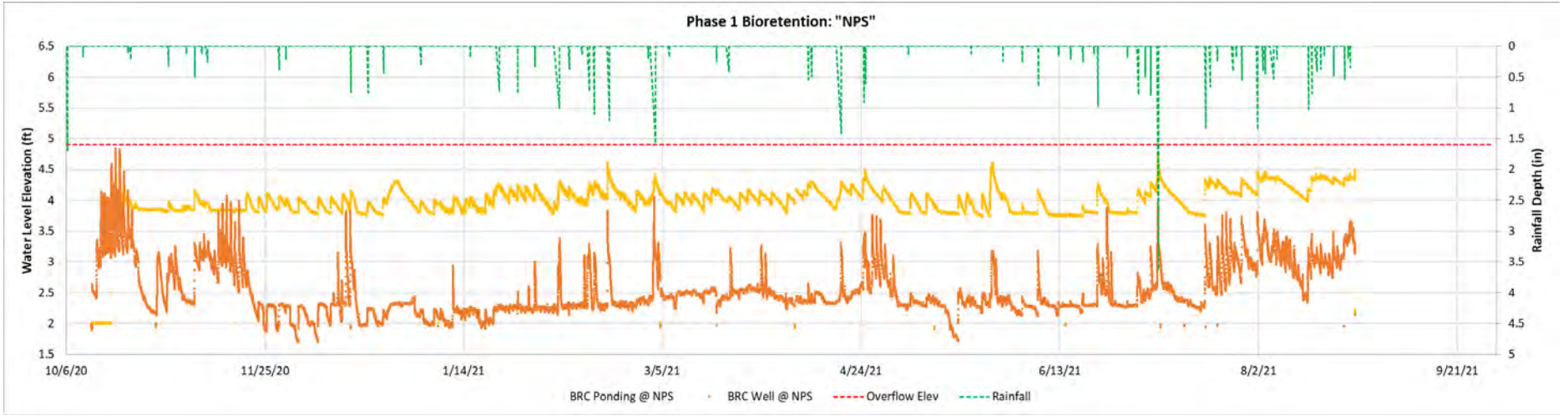
# PHASE 1 MONITORING WELLS: SURFACE & SUBSURFACE

- Bypass Elevation Exceeded 9 times
  - –3 were due to tidal event only
- Ponding zone drains in ~8-18 hours



# PHASE 1 MONITORING WELLS: SURFACE & SUBSURFACE

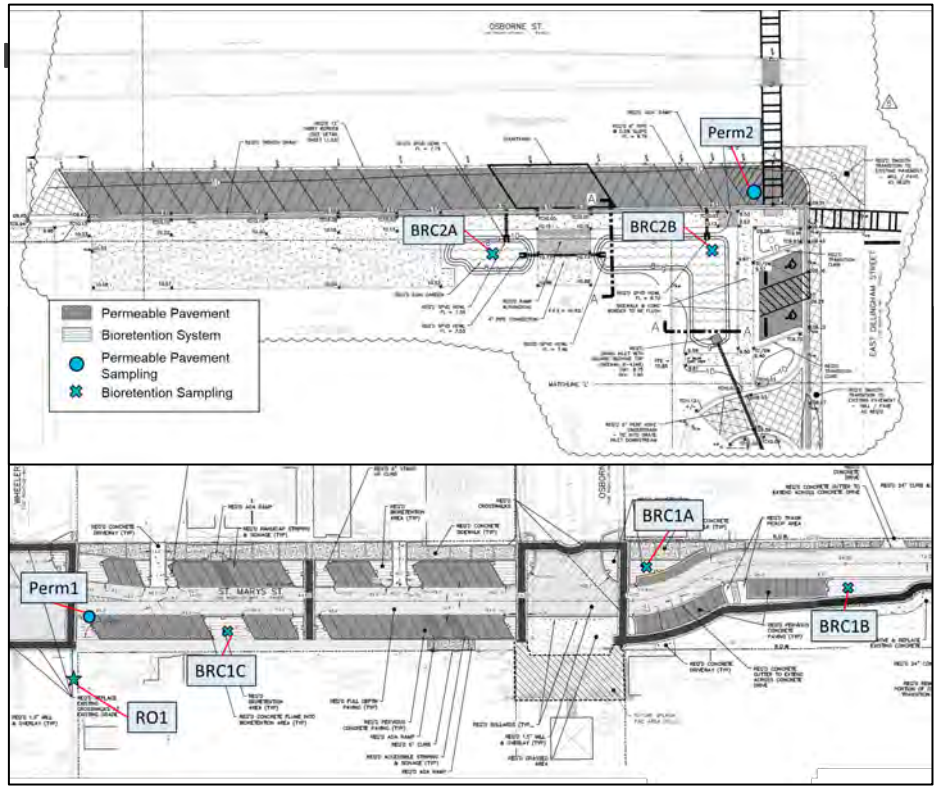
- Overflow Elevation has not been reached
- Ponding zone drains in ~2-5+ days
- Subsurface water stays present longer during wetter (and king tide) periods



# Research Program & Monitoring Results: Water Quality

# WATER QUALITY MONITORING

- Dissolved Oxygen at USGS Site on St. Mar River (~12 miles upstream)
  - –12 months, continuous (15-mins)
- Dissolved Oxygen at City Dock
  - –Monthly
- Storm Samples
  - –Representative Runoff
  - –Phase 1
    - Underdrain from Permeable Pavement & Bioretention
    - Bioretention Well
  - –Phase 2
    - Wells from Permeable Pavement & Bioretention



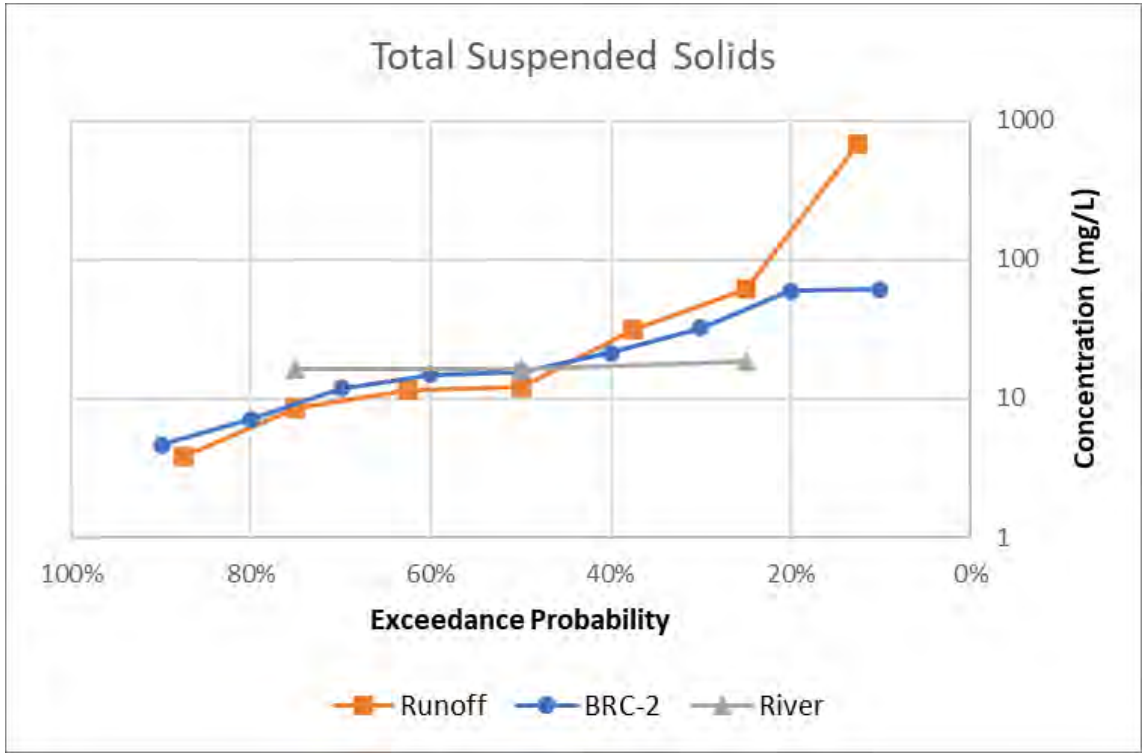
# WATER QUALITY:
# DISSOLVED OXYGEN IN ST. MARYS RIVER (mg/L)

| Month | 2015-2017 (Pre-BMPs) | 2020-2021 (Post-BMPs) | Difference |
|---|---|---|---|
| January | 7.80 | 8.82 | 1.01 |
| February | 8.16 | 7.85 | –0.31 |
| March | 6.92 | 6.78 | –0.13 |
| April | 5.87 | 6.51 | 0.64 |
| May | 5.37 | 5.72 | 0.35 |
| June | 4.64 | 5.07 | 0.43 |
| July | 4.32 | 3.39 | –0.93 |
| August | 4.16 | 3.46 | –0.70 |
| September | 3.91 | 3.63 | –0.28 |
| October | 4.88 | 4.79 | –0.09 |
| November | 6.16 | 6.35 | 0.19 |
| December | 7.07 | 8.08 | 1.00 |

Monthly Average DO (mg/L) at: USGS 02231254 *St. Marys River at I-95, near Kingsland, GA*

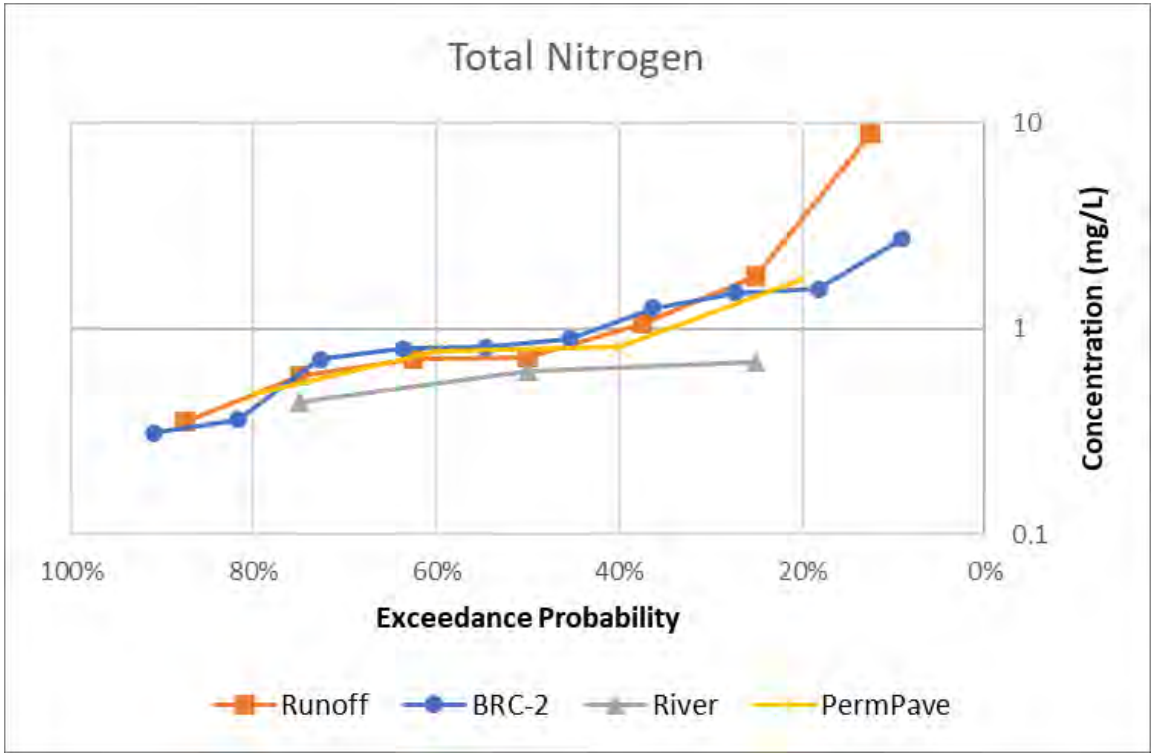
# WATER QUALITY – STORMWATER - TSS

- Grab Samples
  - –Runoff Avg: 114.2 mg/L
  - –Bioretention Avg: 25.2
  - –Phase 1 Underdrain: 9.0
    - N=1
  - –River Avg: 16.9
- At Median:
  - –River > Bioretention > Runoff > PermPave
- Several storm events were sampled toward end of event (first flush)



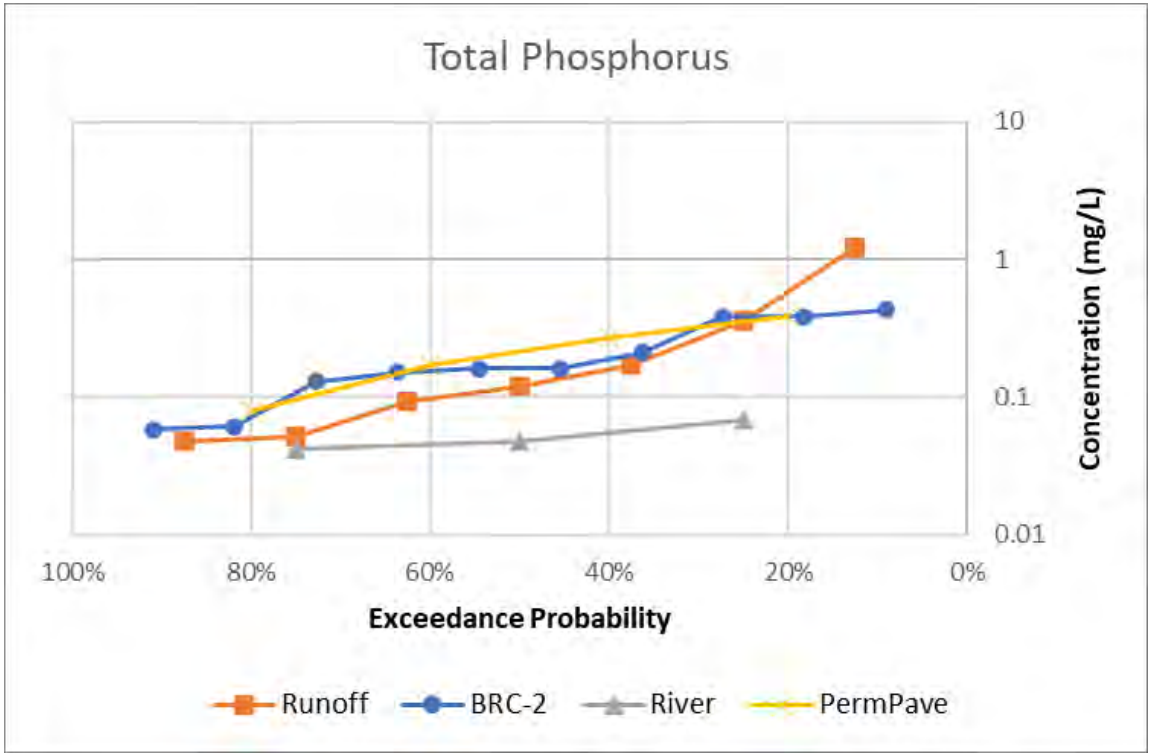
# WATER QUALITY – STORMWATER - NITROGEN

- Grab Samples
  - –Runoff Avg: 1.99 mg/L
  - –Bioretention Avg: 1.09
  - –Perm Pave Avg: 0.95
  - –River Avg: 0.59
- At Median:
  - –Bioretention > PermPave > Runoff > River
- Reduces Ammonia & Organic-N
- Increases NOx



# WATER QUALITY – STORMWATER - PHOSPHORUS

- Grab Samples
  - –Runoff Avg: 0.29 mg/L
  - –Bioretention Avg: 0.21
  - –Perm Pave Avg: 0.22
  - –River Avg: 0.05
- At Median:
  - –PermPave > Bioretention > Runoff > River
- Slight reduction to no net change in orthophosphate
- Reduced particulate phosphorus



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# Next Steps & Conclusions

# NEXT STEPS FOR FINAL REPORTING

- Calibrate hydrologic model with infiltration/exfiltration rates to predict expected capture volumes
  - –Compare with literature for piedmont/coastal sites
  - –Assess if capture decreases over time due to surface clogging

- Review timing of rainfall/runoff events to see frequency compared with tidal cycle

Future Work:

- When tide control is put on outfalls to the river (and not just underdrain), pursue funding to resume monitoring

# CONCLUSIONS & TAKE-HOME POINTS

- Coastal environments with sandy soils and deeper water tables are ideal for infiltration.
  - –No underdrain & spec-ed a shallower profile (media depth: 12 to 18 inches)
  - –Permeable pavement easier to construct with a low profile
- Be cautious with higher-water tables & tidally-influenced systems
  - –Reduced functionality – tide-control is preferred
- Water Quality results were too limited to draw major conclusions:
  - –Grab samples only (flow-weighted composite are preferred but more $$$)
  - –Dry monitoring period (few samples & few with flow from underdrain)
    - Infiltration was too fast for some sites
    - Tropical Storm Elsa 3.64” infiltrated mostly within 12 hours
  - –Many runoff samples were relatively clean (low TSS/TN/TP concentrations)

*"The preparation of this report, map, document, project, etc., was financed in part through a grant from the U.S. Environmental Protection Agency under the Provisions of Section 319(h) of the Federal Water Pollution Control Act, as amended."*

GMC | Q&A

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