

Flood Adaptation through Urban Green Stormwater Infrastructure: The City of Cape Canaveral's "Smart Rain Garden Project"



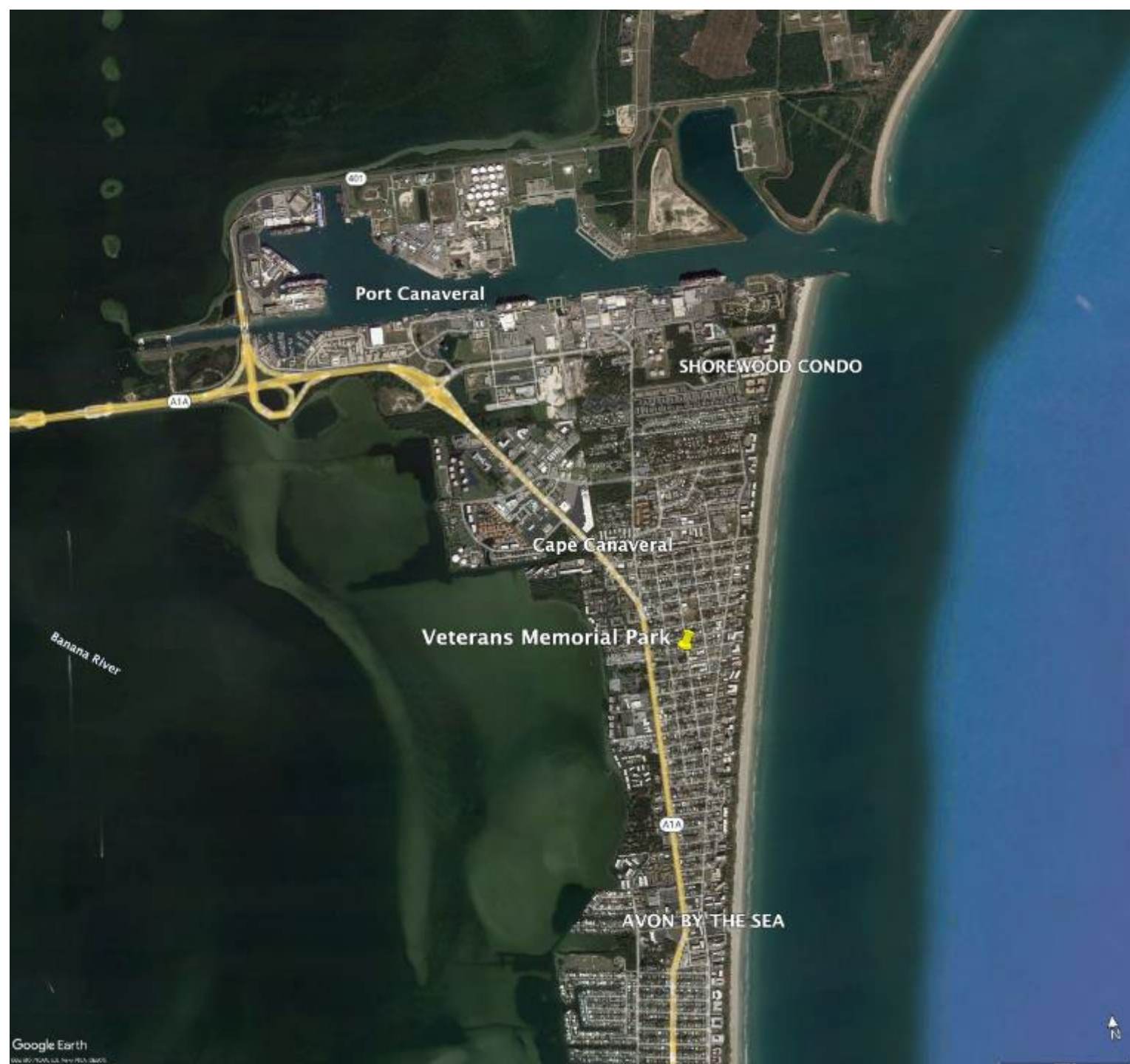
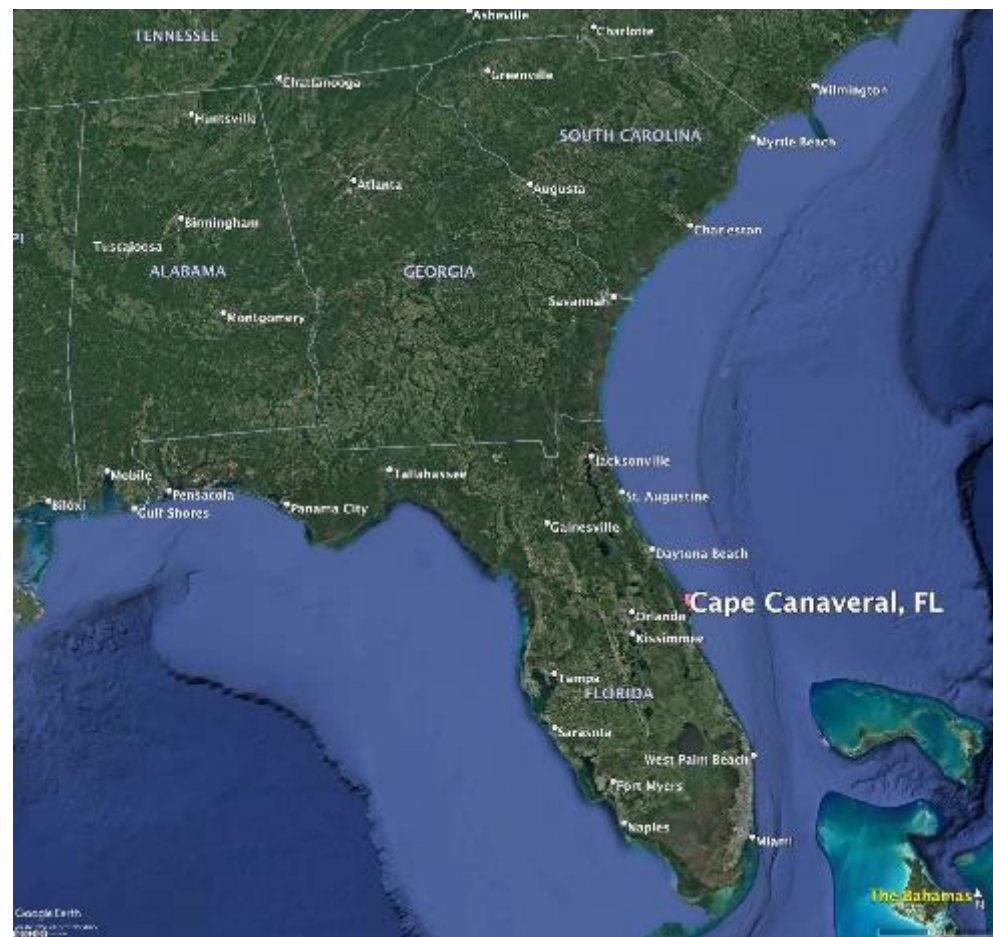
Dr. Jason M. Evans, Stetson University
Alexis Miller, ASHA Planning Consultancy, Inc.
Brenda Defoe-Surprenant, East Central Florida Regional Planning Council

October 30, 2024

Symposium on Flooding Adaptation

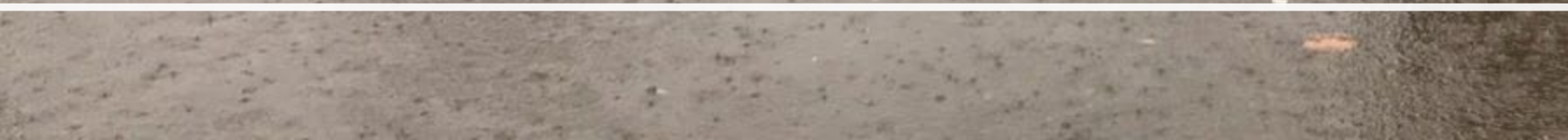
Kissimmee, FL







City of Cape Canaveral, Center St. drainage
June 13, 2021



Councilman Wes Morrison shared a post.

June 14 · 🌐

[SHARE] FLOODING PHOTOS/VIDEOS NEEDED in Cape Canaveral

Hey Neighbors!

Would you please send me any photos or videos of street flooding so I can share them before tomorrow night's City Council Meeting to address the stormwater drainage/flooding issues we experienced over the last couple of days and several month's back after heavy rainfall.

If you do not have any photos during the storm, any information is appreciated by commenting below. Also, any photos showing home flooding or the waterline after the storms is helpful too.

You can post them in the comments below.

Or you can text message them to:

321-593-2335

Or email them to:

W.Morrison@CityofCapeCanaveral.org

I know this is very stressful for members of our community who have experienced property damage and our City Staff is working hard to identify and solve the problems.

I appreciate the quick response from our City Manager when I spoke with him yesterday along with the Infrastructure Maintenance, BCSO/CCVFD and other Staff Members who have helped with the areas experiencing flooding.

A big thanks to all of the residents who have already reached out and any others who are able to help remove/prevent debris from flowing into our stormwater drains.

If you can make the meeting, please consider attending to share your experience and ideas so that we can make the improvements we need.



~2.53 inches in ~1 hour on June 13, 2021
(About a 5-year storm across 60-minutes)

Date & Time ↑ Hide Units	City of Cape Canaveral									Public Works	
	WLL Inside Temp/Hum					WLL Barometer				1 Vantage Vue, Wireless	
	Inside Hum %	High Inside Hum %	Low Inside Hum %	Inside Dew Point °F	Inside Heat Index °F	Barometer in Hg	High Bar in Hg	Low Bar in Hg	Absolute Pressure in Hg	Rain in	High Rain Rate in/h
06/13/2021 - 2:15 PM	43	45	43	49	71	29.92	29.92	29.88	29.91	0.68	9.14
06/13/2021 - 2:30 PM	44	45	43	50	71	29.88	29.92	29.86	29.88	0.66	12.80
06/13/2021 - 2:45 PM	43	44	43	49	71	29.89	29.89	29.86	29.89	0.04	0.32
06/13/2021 - 3:00 PM	43	45	43	49	71	29.97	29.98	29.89	29.97	0.79	9.44
06/13/2021 - 3:15 PM	44	44	43	50	72	29.92	29.97	29.92	29.92	0.36	5.38

~2.9 inches in 1 hour on July 8, 2021
(About a 10-year storm
over the most intense 30 minutes)

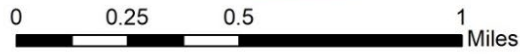
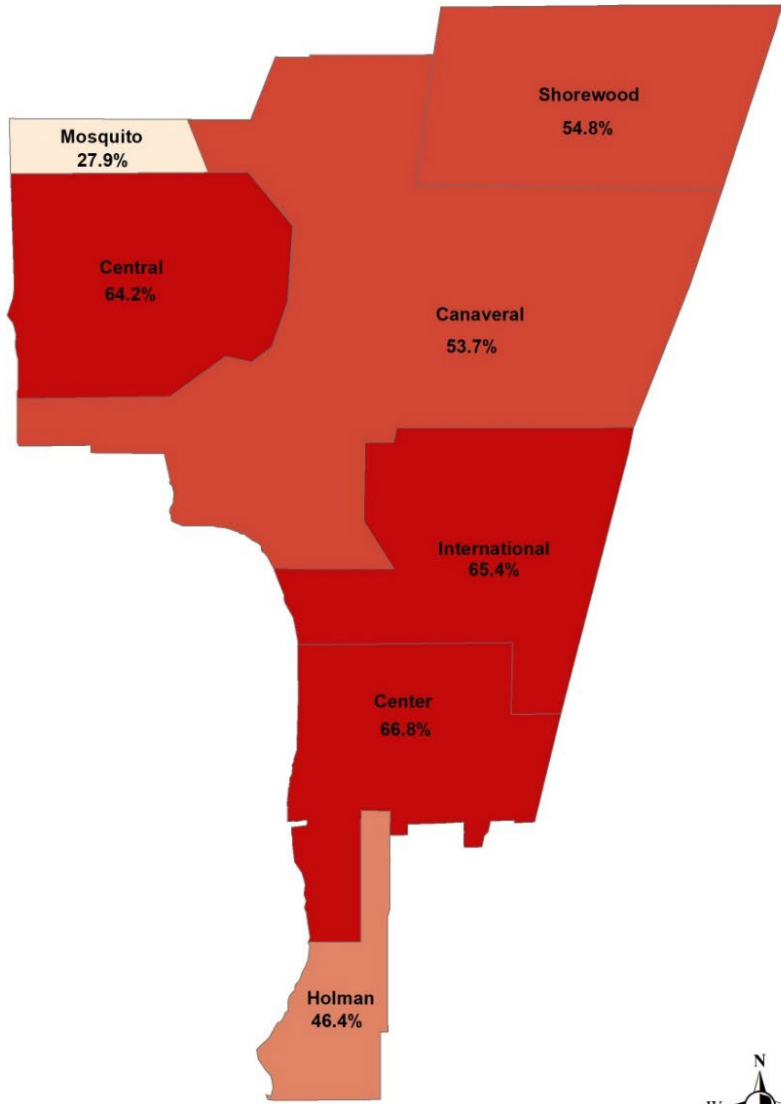
Start: 07/08/21 | Span: 1 day | City of Cape Canaveral

Date & Time ↑ Hide Units	City of Cape Canaveral									Public Works	
	WLL Inside Temp/Hum					WLL Barometer				1 Vantage Vue, Wireless	
	Inside Hum %	High Inside Hum %	Low Inside Hum %	Inside Dew Point °F	Inside Heat Index °F	Barometer in Hg	High Bar in Hg	Low Bar in Hg	Absolute Pressure in Hg	Rain in	High Rain Rate in/h
07/08/2021 - 2:45 PM	44	45	44	53	76	30.14	30.14	30.10	30.13	0.15	19.20
07/08/2021 - 3:00 PM	45	46	44	54	76	30.14	30.15	30.13	30.13	1.24	7.78
07/08/2021 - 3:15 PM	45	45	44	53	76	30.16	30.17	30.14	30.16	1.05	6.70
07/08/2021 - 3:30 PM	43	45	43	52	76	30.14	30.16	30.14	30.14	0.46	4.76

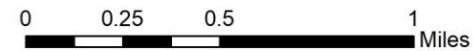
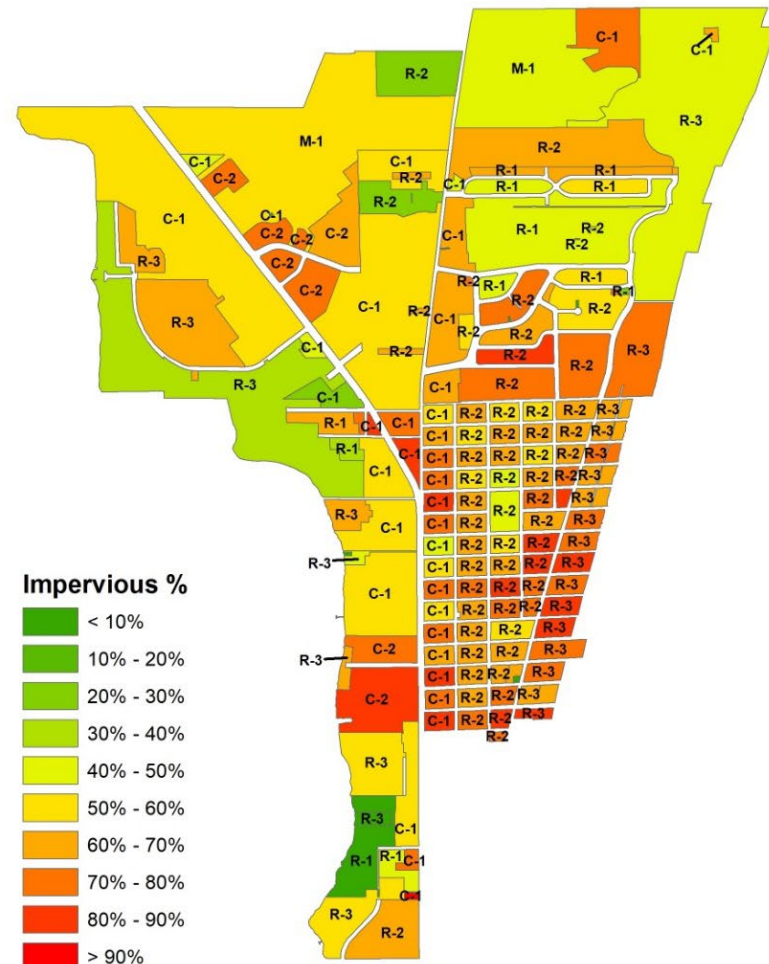
~3.93 inches in 75 minutes on 9/14/22
(Close to a 50-year event over the most
intense 60 minutes)

Cape Canaveral City Hall										
1 Vantage Vue, Wireless										
Date & Time ↑	Low Wet Bulb °F	Avg Wind Speed mph	Prevailing Wind Direction	High Wind Speed mph	High Wind Direction	Wind Chill °F	Low Wind Chill °F	Wind Run mi	Rain in	High Rain Rate in/h
09/14/2022 - 6:45 PM										
09/14/2022 - 7:00 PM	-32	6	SSE	14	ESE	75	75	1.5	0.13	1.82
09/14/2022 - 7:15 PM	-31	3	SW	8	SW	73	73	0.9	1.34	7.89
09/14/2022 - 7:30 PM	-31	3	SW	7	WSW	73	73	0.6	1.17	6.55
09/14/2022 - 7:45 PM	-31	6	SW	11	SW	73	72	1.5	0.85	5.19
09/14/2022 - 8:00 PM	-31	5	SW	12	SW	72	72	1.2	0.44	3.35

Impervious Cover by Storm Basin



Impervious Cover by Zoning Class





City of Cape
Canaveral

Center St. outfall

Cape Canaveral, Center St. Drainage





Cape Canaveral, Center St. Outfall (September 2021)

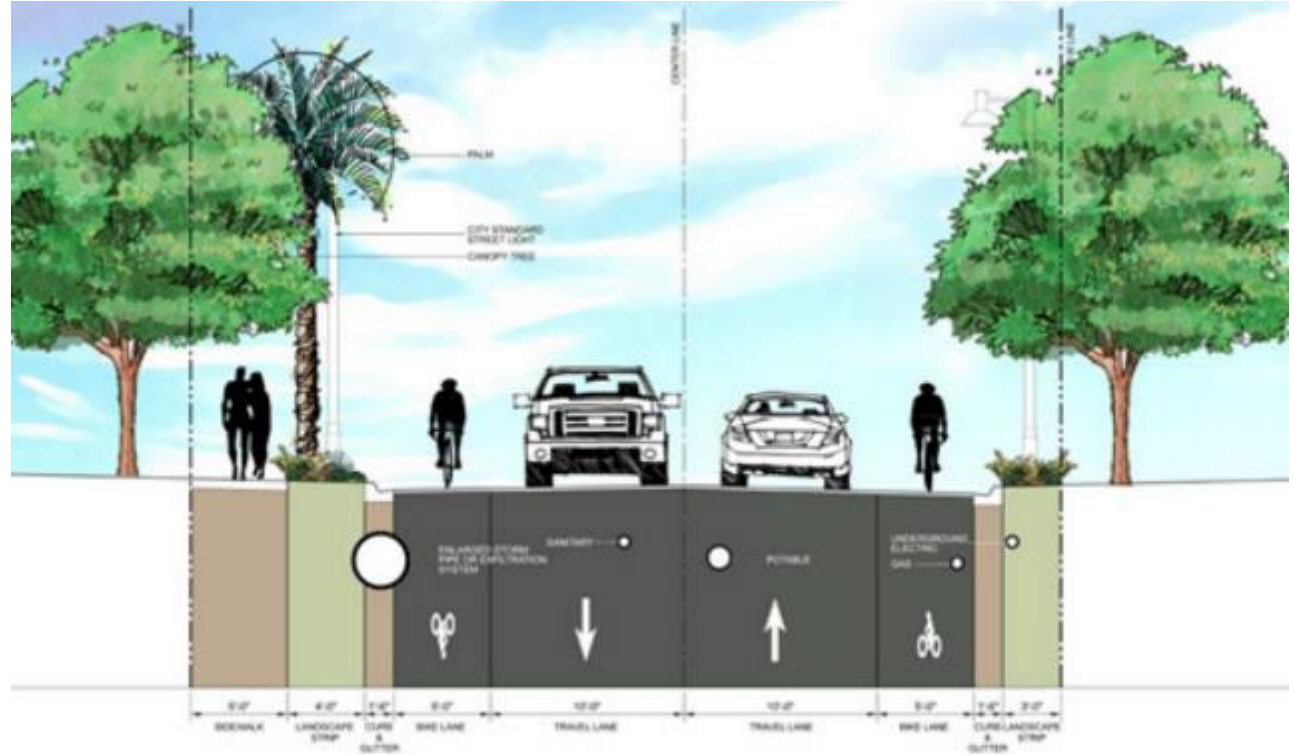


City of Cape Canaveral



Presidential Streets Master Plan

DRAFT
September 2022



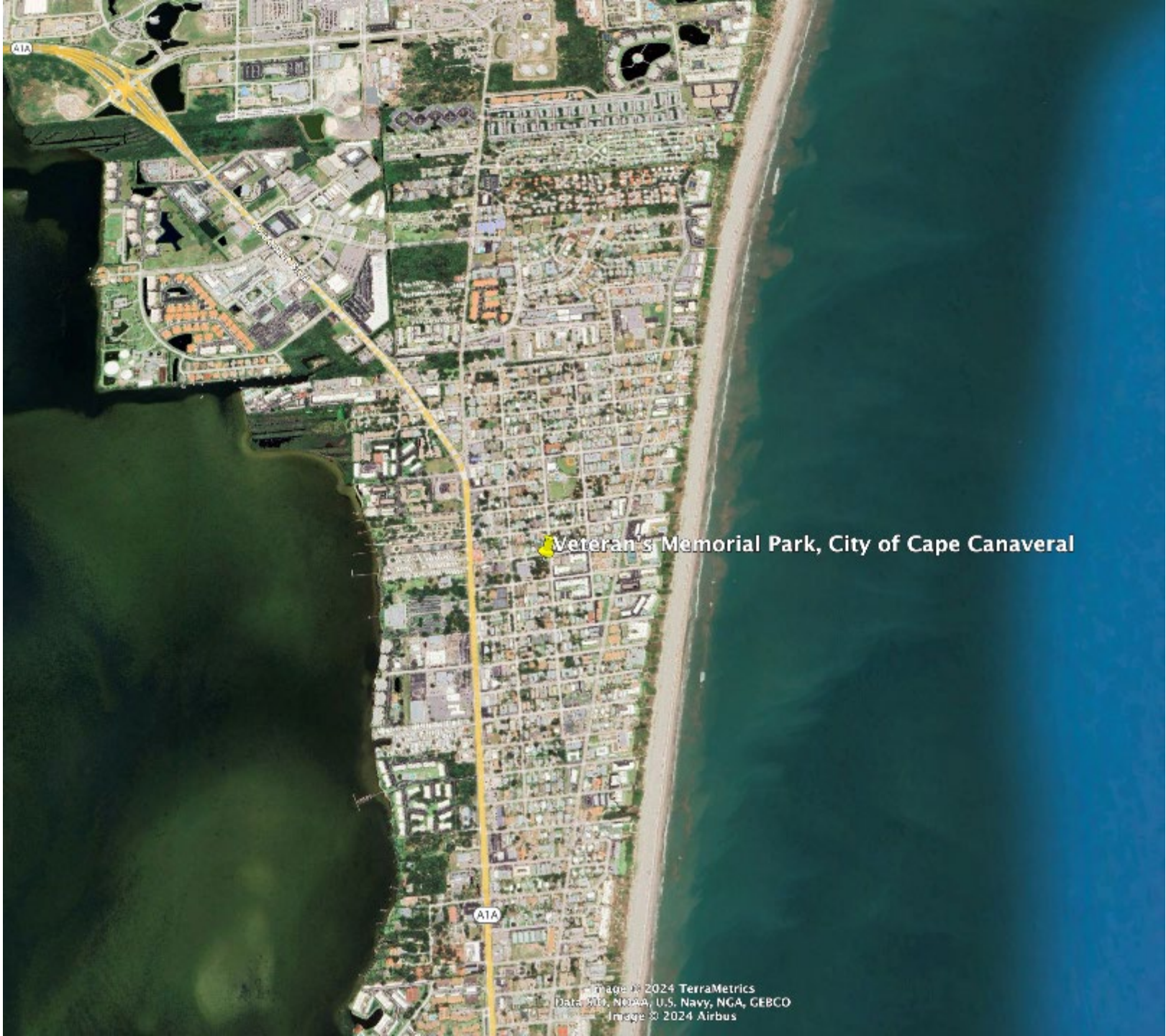


CIVIC
INNOVATION
CHALLENGE



Community
Workshop in
Cape Canaveral,
November 2022





Veteran's Memorial Park, City of Cape Canaveral







VETERAN'S PARK RAIN GARDEN - AERIAL VIEW

NSF Awards \$1M To Stetson's Water Institute To Reduce Flooding

September 22, 2023



Stetson University's **Institute for Water and Environmental Resilience** (IWER) has received a \$1 million **Stage 2 Civic Innovation Challenge (CIVIC) award** from the National Science Foundation to begin a research-based pilot project to reduce flooding and improve water quality in the City of Cape Canaveral.

Applied Research Goals

- Construct a “smart rain garden” outfitted with hydrologic sensors to measure volumetric capture and infiltration
- Utilize high-resolution imagery and LIDAR from drones to develop site-level hydrologic models calibrated with field data
- Monitor nutrient dynamics and other contaminants within the rain garden over time
- Monitor pollinator and other wildlife utilization of the new urban habitat











Well Installations (5/29/24)

- 3 monitoring wells



Figure 1: Well locations



Figure 2: Well 1 installation

Well Number Location

1	NW
2	SW
3	SE

Depth to bottom of pipe
("refusal") from top (cm)

210
203
181

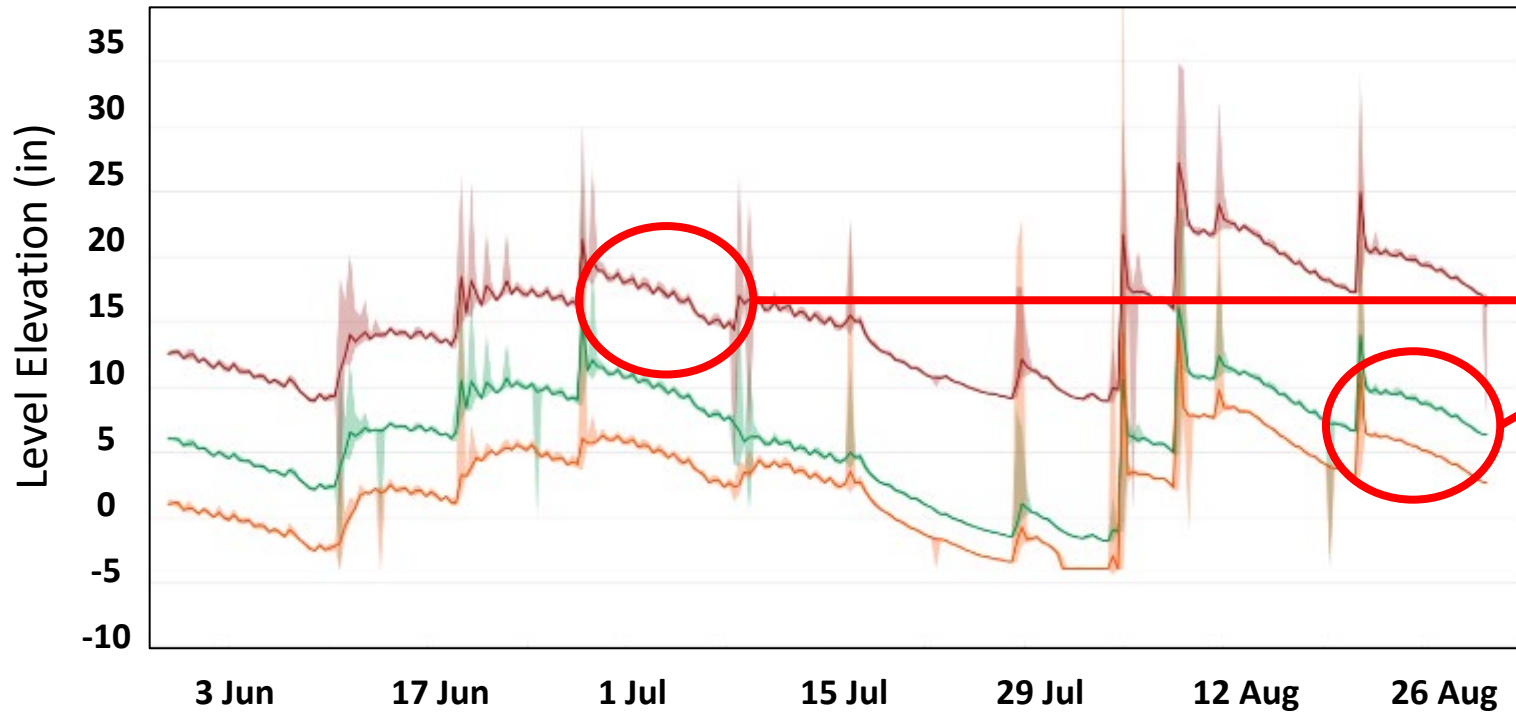
Distance to water table from
ground on 5/29/24 (cm)

72
76
61

Water Level Gauges

- Aqua TROLL 200 Data Logger
- Water level, pressure, conductivity, temperature
- *15-minute* intervals
- Manual uploads

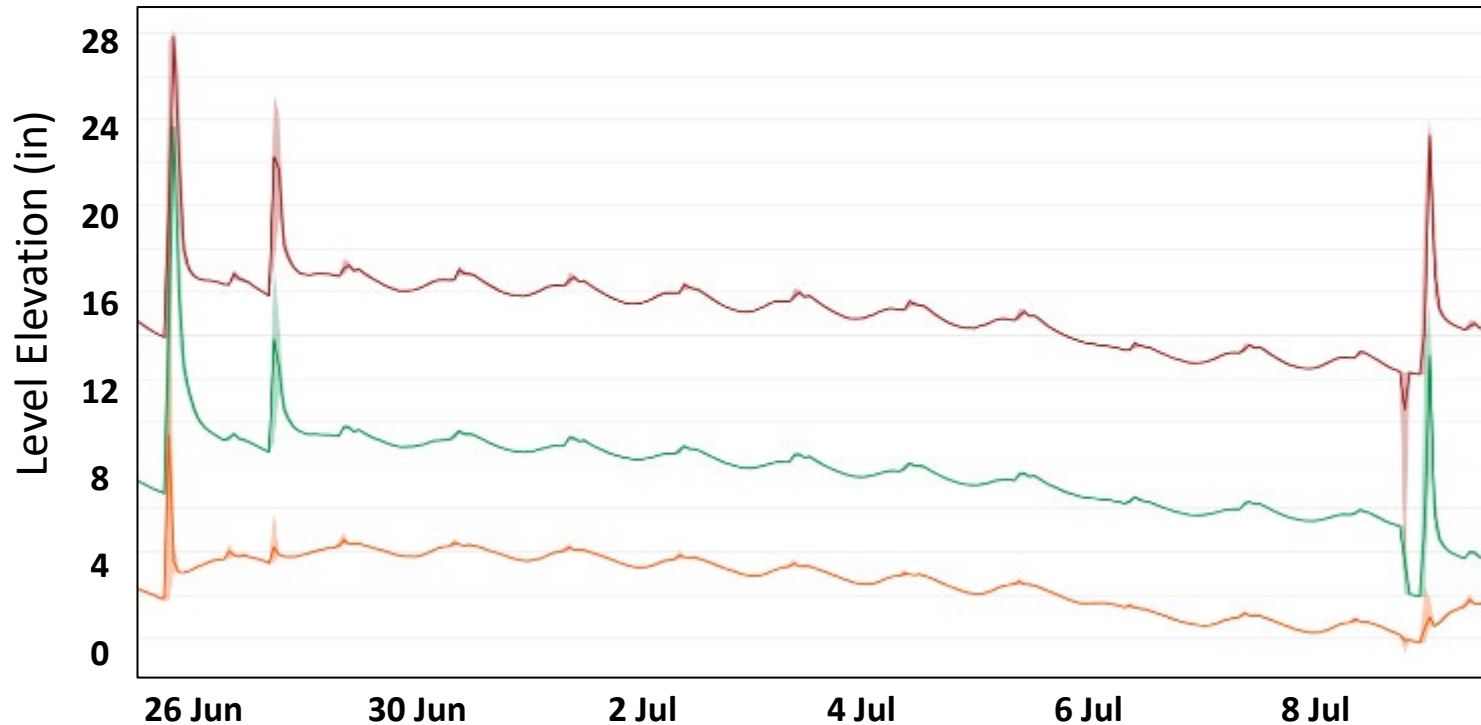
Location	Level Elevation (in)		Net Change
	29-May	30-Aug	
Well 1	12.531	16.253	+3.722
Well 2	6.031	6.348	+0.317
Well 3	1.015	2.63	+1.615



???

Water Level Gauges

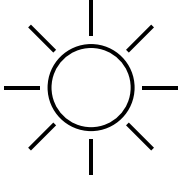
- Aqua TROLL 200 Data Logger
- Water level, pressure, conductivity, temperature
- *15-minute* intervals
- Manual uploads



Transpiration of oak trees

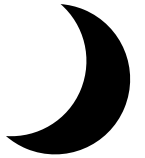
Daytime

- Photosynthesizing
- Water table uptake
- Transpiration



Nighttime

- No transpiration
- Water table recovery



Legend

---- Well 1

---- Well 2

---- Well 3

Soil Moisture Sensor Installations (6/13/24)

- 6 sensors per well
- 18 total

Features

- Solar powered
- *5-minute intervals*
- Remote uploads

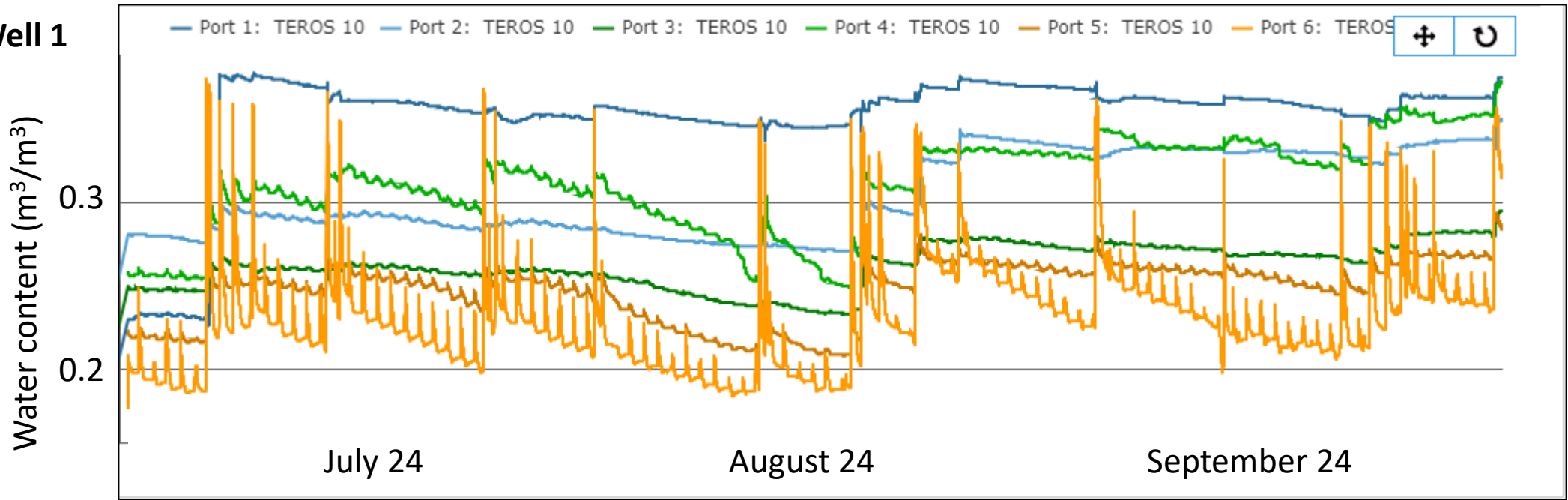


Figure 1: Soil sensor installs at Well 1



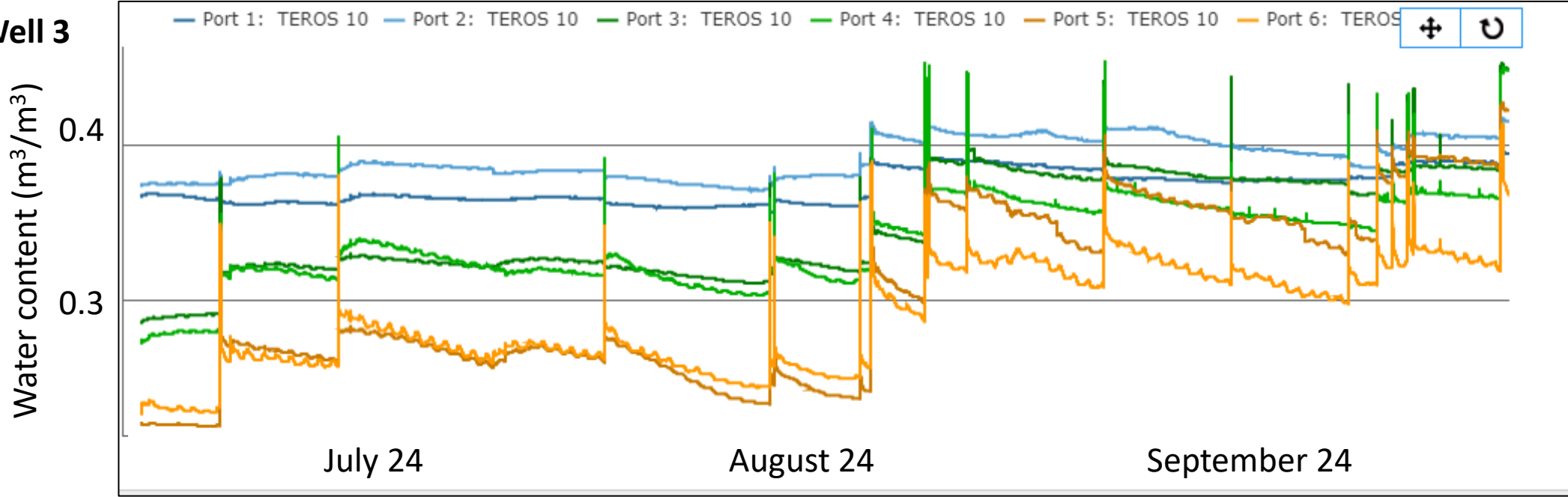
Location	Well 1	Well 2	Well 3
Port #	Depth (cm)	Depth (cm)	Depth (cm)
1	-50.0	-60.0	-40.5
2	-41.0	-49.0	-33.5
3	-32.0	-38.0	-26.5
4	-23.0	-27.0	-19.5
5	-14.0	-16.0	-12.5
6	-5.0	-5.0	-5.5

Well 1



- Record of storm events
- Spatial variability
- Irrigation impact

Well 3



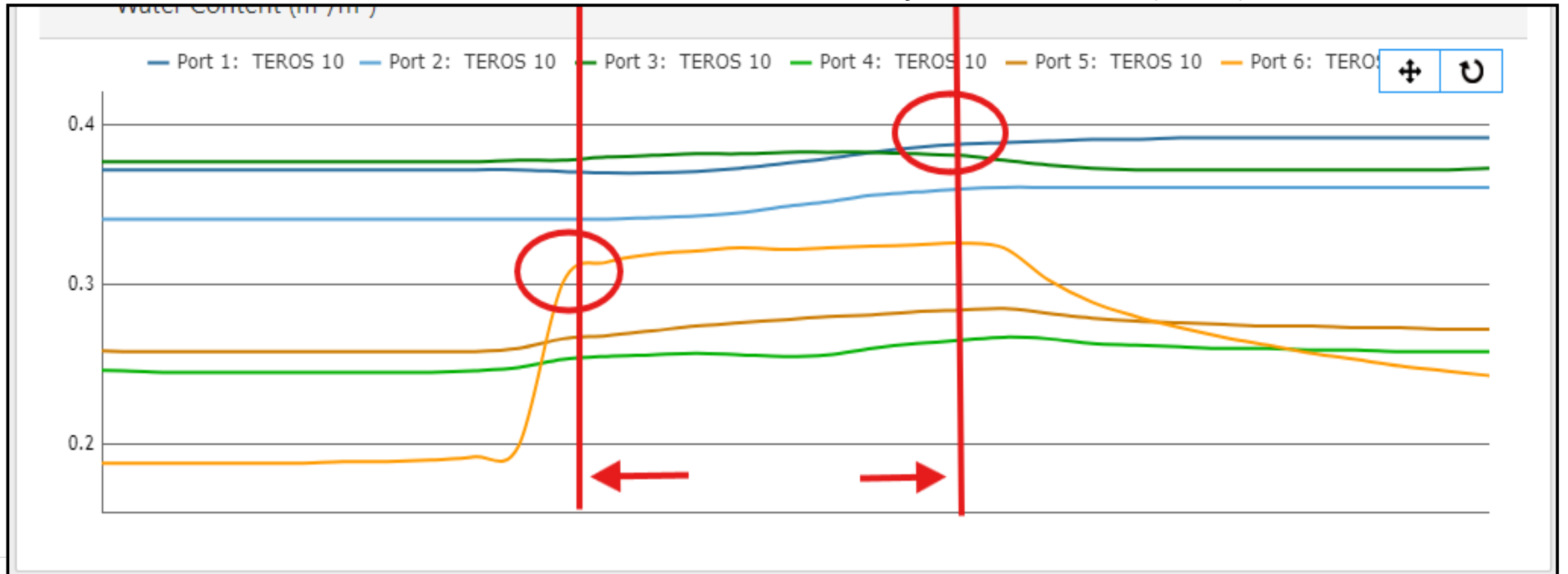
Infiltration rates

- ❑ Ecohydrological function of lower coastal plain bioretention cells in South Carolina
- ❑ *Palazzo 2013*

Calculations

$$f = \frac{d_2 - d_1}{t_2 - t_1}$$

f = infiltration rate (cm/hr),



Well 1

<i>Precipitation Event</i>	<i>Start</i>	<i>Peak</i>	<i>Infiltration Rate (cm/hr)</i>
1	06/19/2024 02:05:00 AM	06/19/2024 03:05:00 AM	36.00
2	06/20/2024 12:50:00 AM	06/20/2024 01:55:00 AM	33.23
3	06/21/2024 12:55:00 AM	06/21/2024 02:05:00 AM	30.86
...
19	08/11/2024 05:25:00 PM	08/11/2024 06:20:00 PM	39.27
20	08/21/2024 12:40:00 PM	08/21/2024 02:15:00 PM	22.74
21	08/30/2024 03:15:00 PM	08/30/2024 04:10:00 PM	39.27

Data analysis (*in progress...*)

- At each well
- Cumulative / composite mean?

Hurricane Milton



Hurricane Milton



Take Home Messages

- 1) The rain garden has performed very well during major rain events – including Hurricane Milton – since construction was completed in April 2024
 - Plant survival is at or near 100% currently
- 1) We are looking for additional partners to freely utilize the site, sensors, and other data for hydrologic monitoring research
- 2) Long-term maintenance costs and efficacy over time is one of the big questions – i.e., what happens when the “newness” wears off?

Thank you!

*Funding support for this project provided by **Florida Sea Grant** through the **Karl Havens Memorial South Atlantic Regional Research on Coastal Community Resilience** and the **National Science Foundation CIVIC Innovation Challenge***

