Executive Summary

In response to the anthropause (i.e. lack of human activity) caused by the COVID-19 pandemic in the Key West Harbor and Ship Channel, The College of the Florida Keys (CFK) has been awarded three federal grants from the U.S. Environmental Protection Agency (EPA) to monitor water quality around the islands of Key West. The Key West Water Quality (KWWQ) monitoring program has burgeoned over the last four years and evolved into a partnership with the City of Key West, as well as other agencies, organizations, and companies, and promises to endure beyond the duration of the EPA grants. The KWWQ will create a long-term water quality monitoring program that will help to inform local, regional, and national marine resource management decisions as they relate to the marine environment around Key West. The objectives for each EPA grant are outlined and figures illustrating some of the key accomplishments are provided as follows:

EPA Grant 1. Key West Water Quality (KWWQ) – Mini-grant for Planning and Support to Continue Key West Harbor and Ship Channel

Status: Completed

Objectives:

1. Maintain water quality monitoring equipment that are collecting and archiving continuous water quality measurements (i.e. turbidity, salinity, temperature, and depth), (2) collect bi-weekly water samples and measurements along the Key West Ship Channel for: (*i*) dissolved oxygen, (*ii*) pH, (*iii*) ammonia nitrogen (NH_3/NH_4^+), and (*iv*) H_2S from the water column and near the water/sediment interface.
2. Collect water samples and water quality measurements every 2-3 weeks at locations along the Key West Harbor and Ship Channel
3. Incorporate KWWQ into marine science courses at CFK.

EPA Grant 2. KWWQ – Monitoring WQ in Key West Harbor and Ship Channel

Status: Ongoing but ending December 31, 2024

Objectives:

1. Deploy additional equipment to form a broad array of continuous water quality monitoring equipment to determine connectivity between Key West Harbor and the Key West ship channel to surrounding areas of critical concern, especially Eastern Dry Rocks - Sanctuary Preservation Area (EDR-SPA) (Figure 1 and 2).
2. For one year, perform bi-weekly field measurements and monthly collection of water samples (for lab analysis at Florida International University; FIU) from the waters of the Key West Harbor and along the Key West ship channel at ten predetermined sites.
3. For one year, perform bi-weekly field measurements and monthly collection of water samples (for lab analysis at FIU) from the waters at EDR and WDR for field and lab analysis to compare to Key West Harbor and Key West ship channel water samples (Figures 1 and 2).
4. For a period of one year, periodically (i.e. weekly if ships arrive) measure water quality immediately before and after large industrial ships enter and exit Key West Harbor (Figures 3-6).

EPA Grant 3. KWWQ – Monitoring other Contaminants of Emerging Concern (CEC) in other Areas of Concern (AOC) (*In partnership with the City of Key West)

Status: Ongoing but expected to be extended until December 31, 2025

Objectives:

1. Continue water quality monitoring in the Key West harbor and ship channel using existing technology and infrastructure.
2. Expand water quality monitoring to seven AOC around the islands of Key West using an Autonomous Underwater Vehicle equipped with sensors for dissolved oxygen, temperature, salinity, turbidity, and total algae (Figure 7).

3. Expand water quality monitoring to beach AOC around the southern section of Key West for oxybenzone in the marine food chain (Figures 8-1, 8-2, and 8-3 and Figure 9).
4. Expand water quality monitoring to seven AOC around the islands of Key West for sewage discharge indicators (i.e. ammonia and sucralose) (Figure 8).
5. Expand water quality monitoring to the marine environment near Stock Island Landfill for toxic pollutants (i.e. hydrogen sulfide) (Figure 8-5 and Figure 10-11).
6. Provide data and input for the City of Key West's Water Quality Improvement Plan (Figure 12).

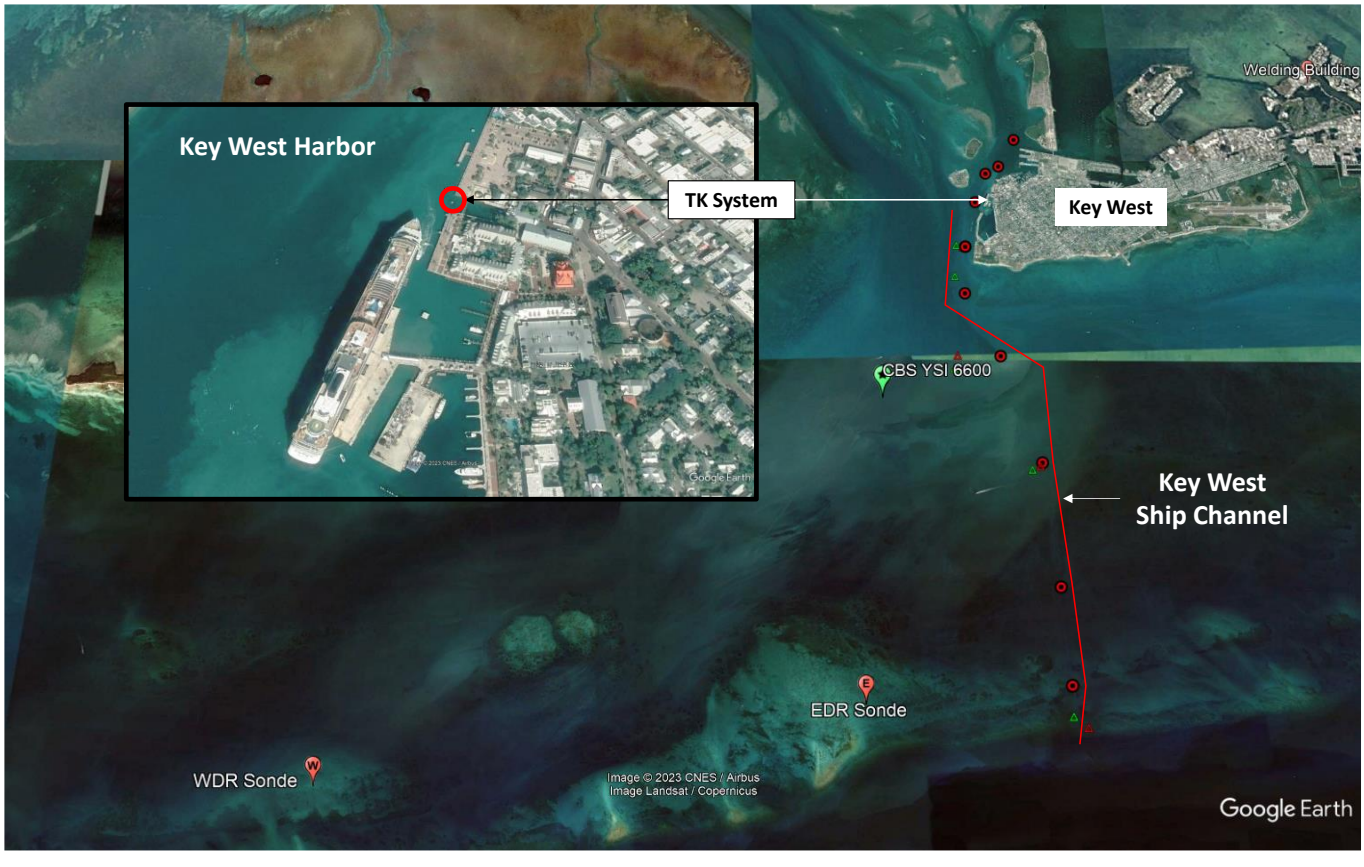

Figure 1. Aerial view of the Key West Harbor and Ship Channel and nearby areas of concern (AOC) showing water quality monitoring locations: (1) along the ship channel (red targets), (2) at Mallory square (i.e. TK System), and (3) near Eastern Dry Rocks (EDR Sonde) and Western Dry Rocks (WDR Sonde).

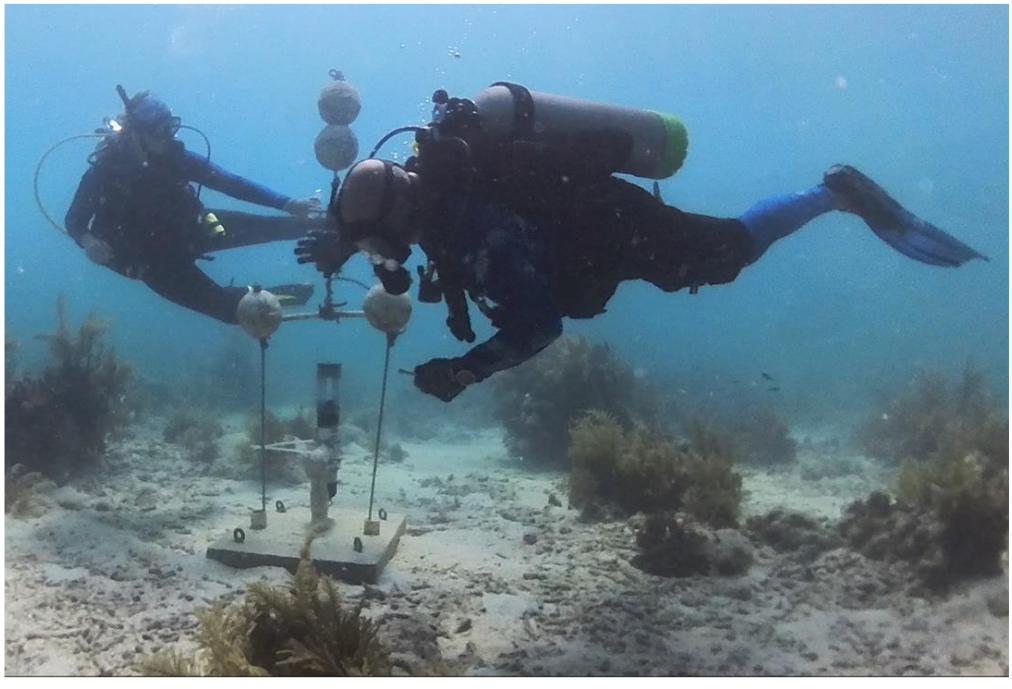

Figure 2. Deploying water quality monitoring equipment near Eastern Dry Rock (EDR).

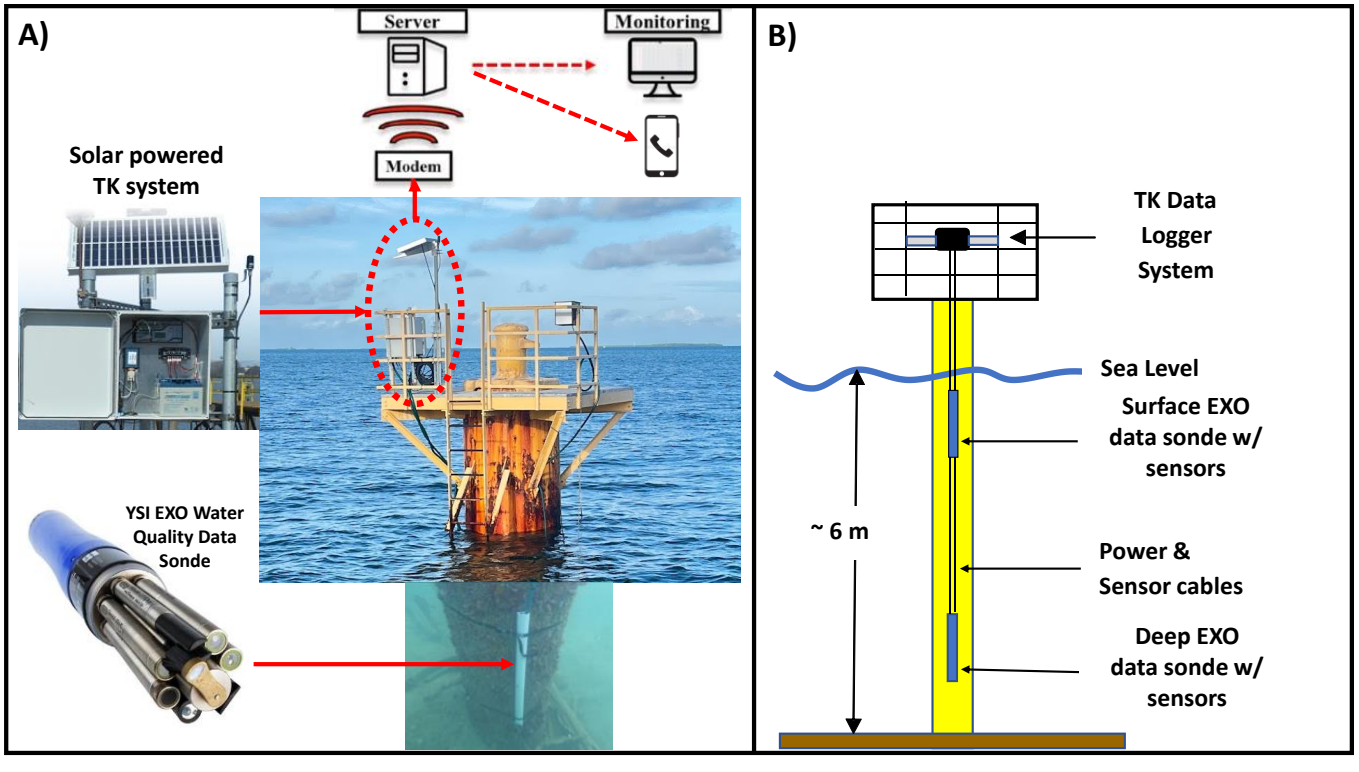

Figure 3. (A) The Turn-Key (TK) System deployed on the "Yellow Man" mooring station (red dash oval) showing: (*i*) the YSI water quality monitoring equipment and submerged placement near the sea bottom, (*ii*) an illustration of how the equipment transmits the data via cellular modem to a server that allows authorized users to monitor the information immediately. (B) a schematic showing the placement of the water quality monitoring equipment on the "Yellow Man" mooring station.

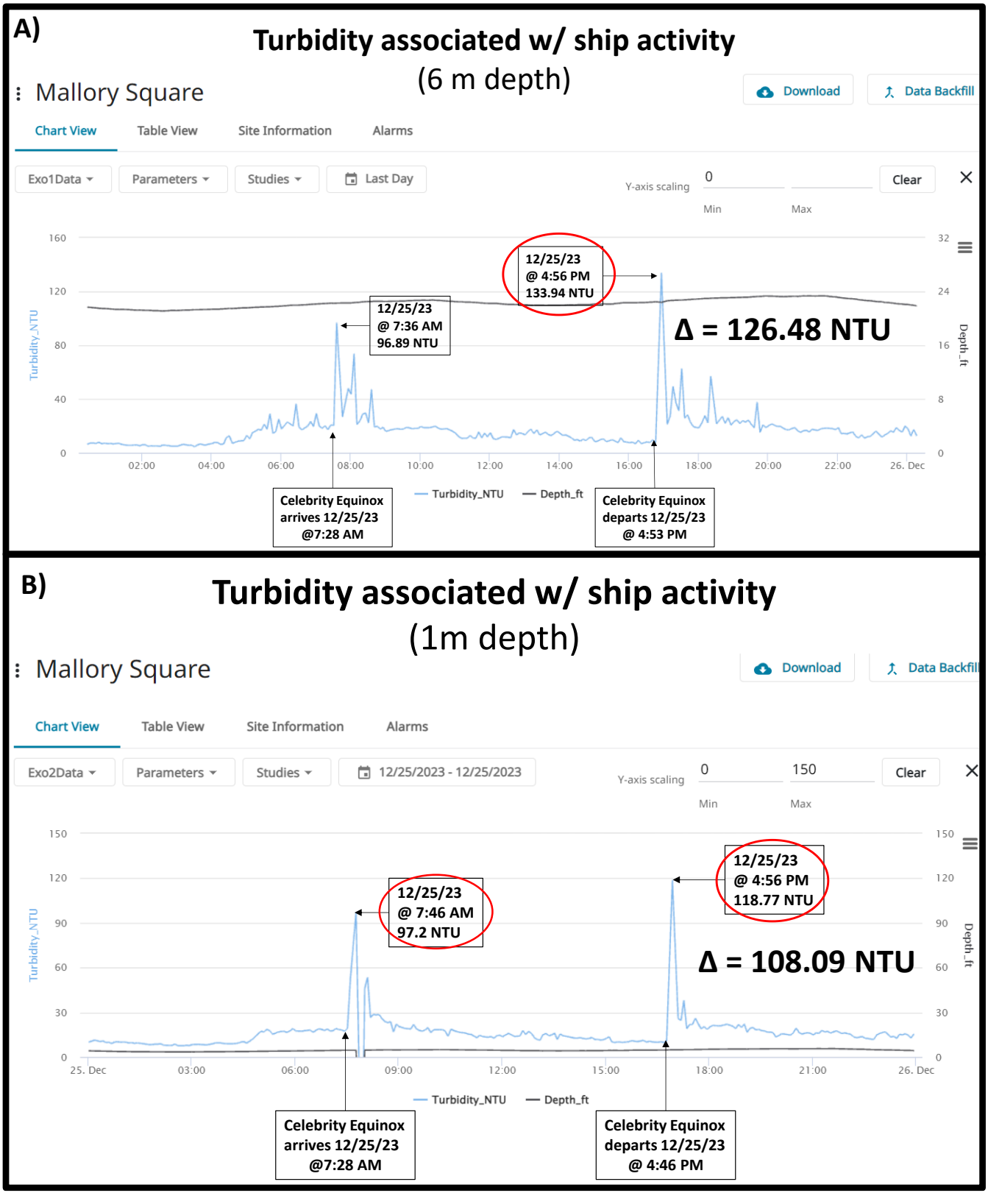

Figure 4. An example of a turbidity event associated with the arrival and departure of the cruise ship Celebrity Equinox on 12/25/2023: (A) turbidity measured by the deep (6 m) turbidity sensor, and (B) turbidity measured by the shallow (1 m) turbidity sensor. Note – the red circles indicate turbidity measurements that exceed the Environmental Protection Agency (EPA) water quality standard [EPA Chapter 62.302.530(70)] not to exceed ≤ 29 NTU above natural background conditions.

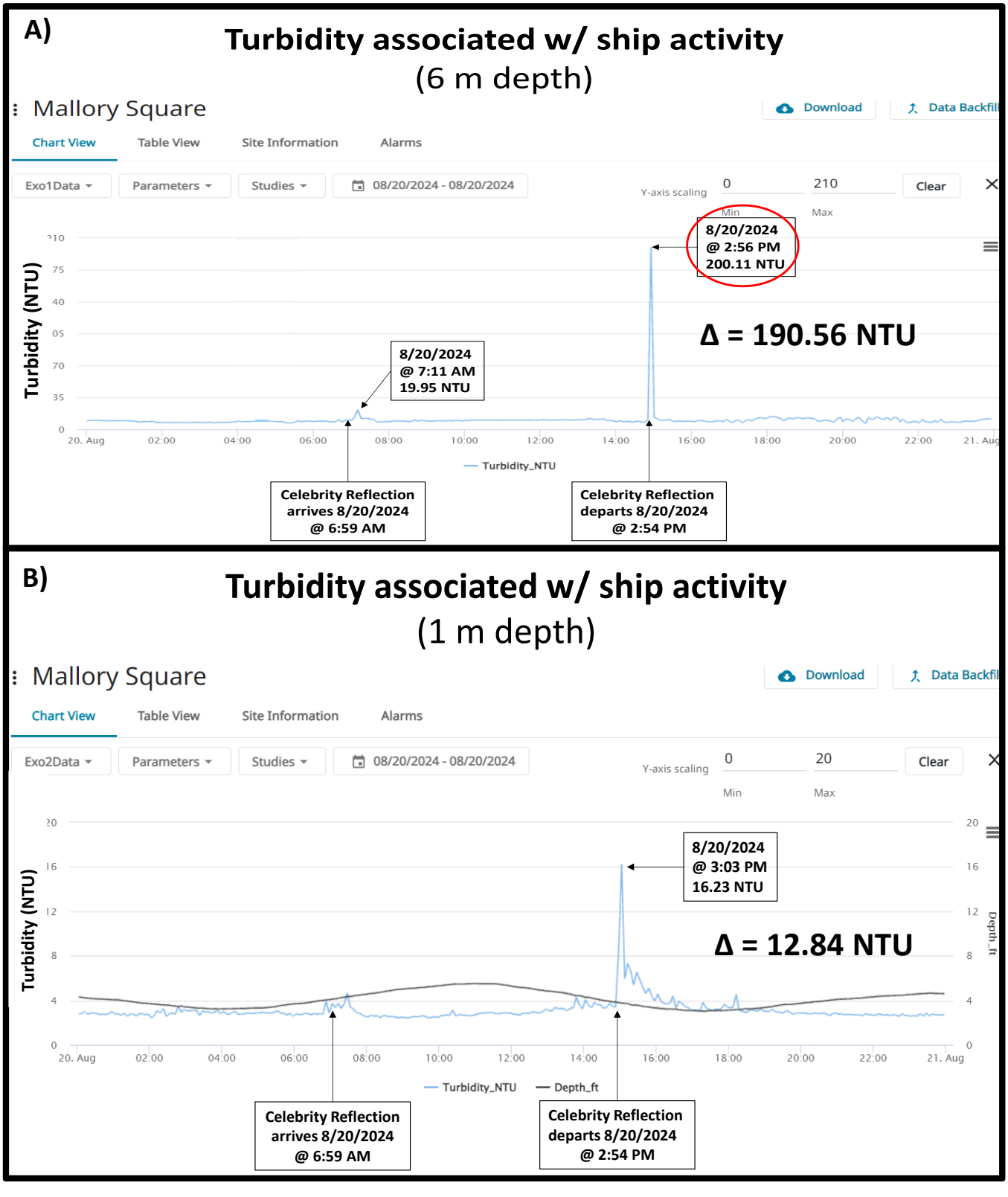

Figure 5. An example of a turbidity event associated with the arrival and departure of the cruise ship Celebrity Reflection on 8/20/2024: (A) turbidity measured by the deep (6 m) turbidity sensor, and (B) turbidity measured by the shallow (1 m) turbidity sensor. Note – the red circles indicate turbidity measurements that exceed the Environmental Protection Agency (EPA) water quality standard [EPA Chapter 62.302.530(70)] not to exceed ≤ 29 NTU above natural background conditions.

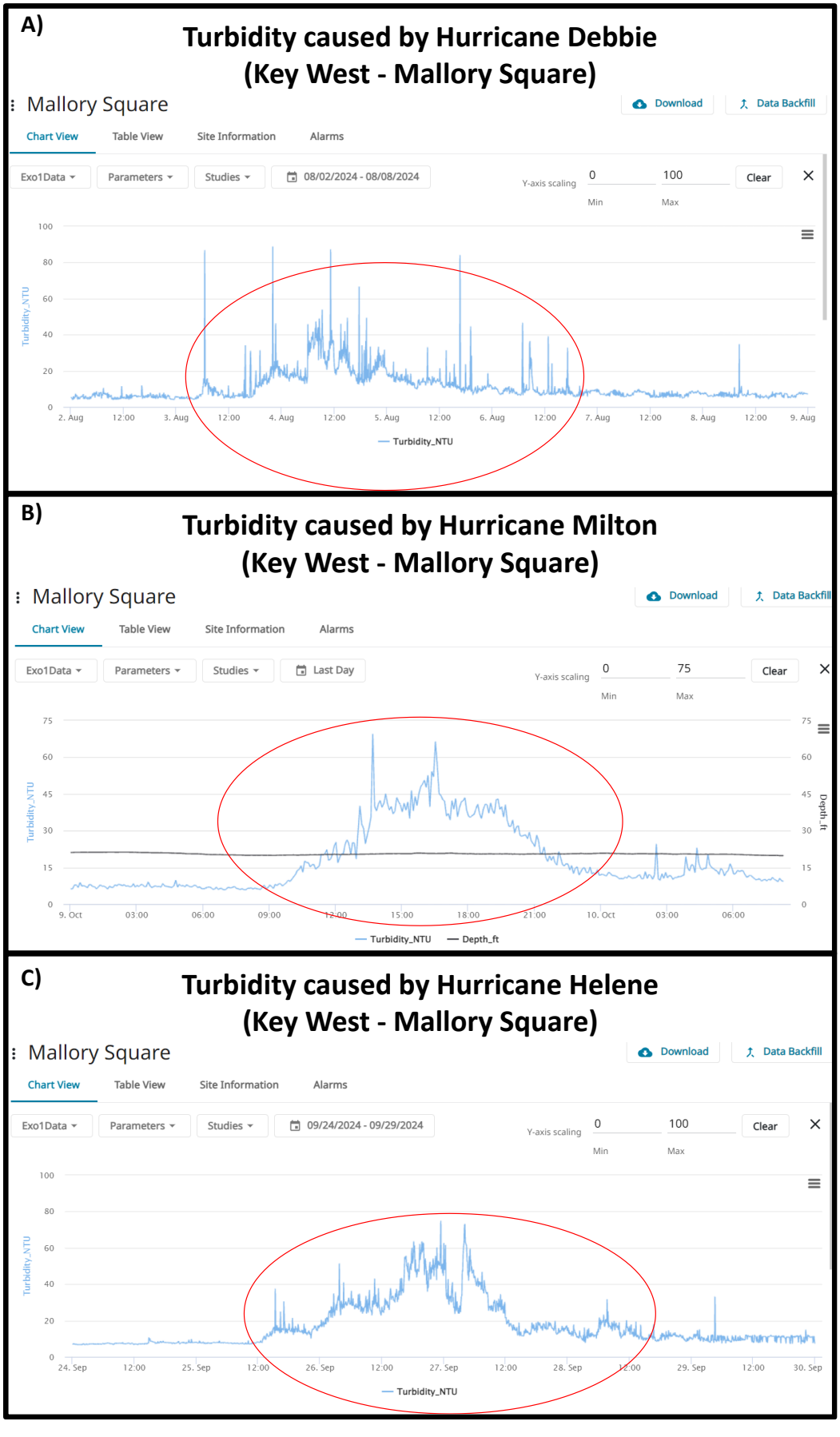

Figure 6. An example of turbidity events associated with three hurricanes during 2024: (A) Hurricane Debbie, (B) Hurricane Helene, and (C) Hurricane Milton. Note – red circles indicate the approximate time and duration of the storm and impacts on water turbidity.

YSI i3XO EcoMapper Autonomous Underwater Vehicle (AUV)

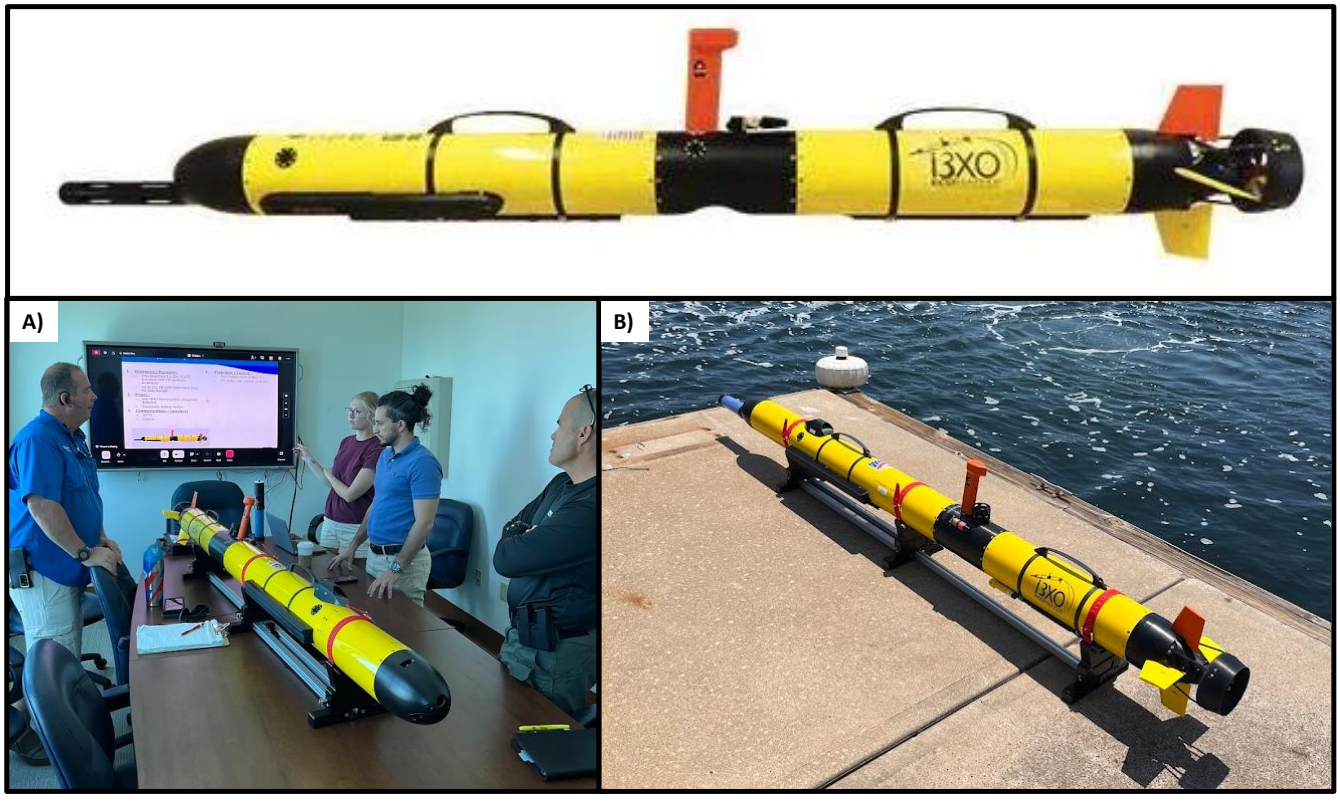

Figure 7. The recently acquired College of the Florida Keys (CFK) YSI i3XO EcoMapper Autonomous Underwater Vehicle (AUV): (A) YSI staff training college staff, and Monroe County Sherriffs Office (MCSO) staff (April 2024), and (B) the AUV prior to being deployed for a training demonstration in the CFK lagoon.

Figure 8. Aerial map of Key West showing the Areas of Concern (AOC) for study during the KWWQ Project.

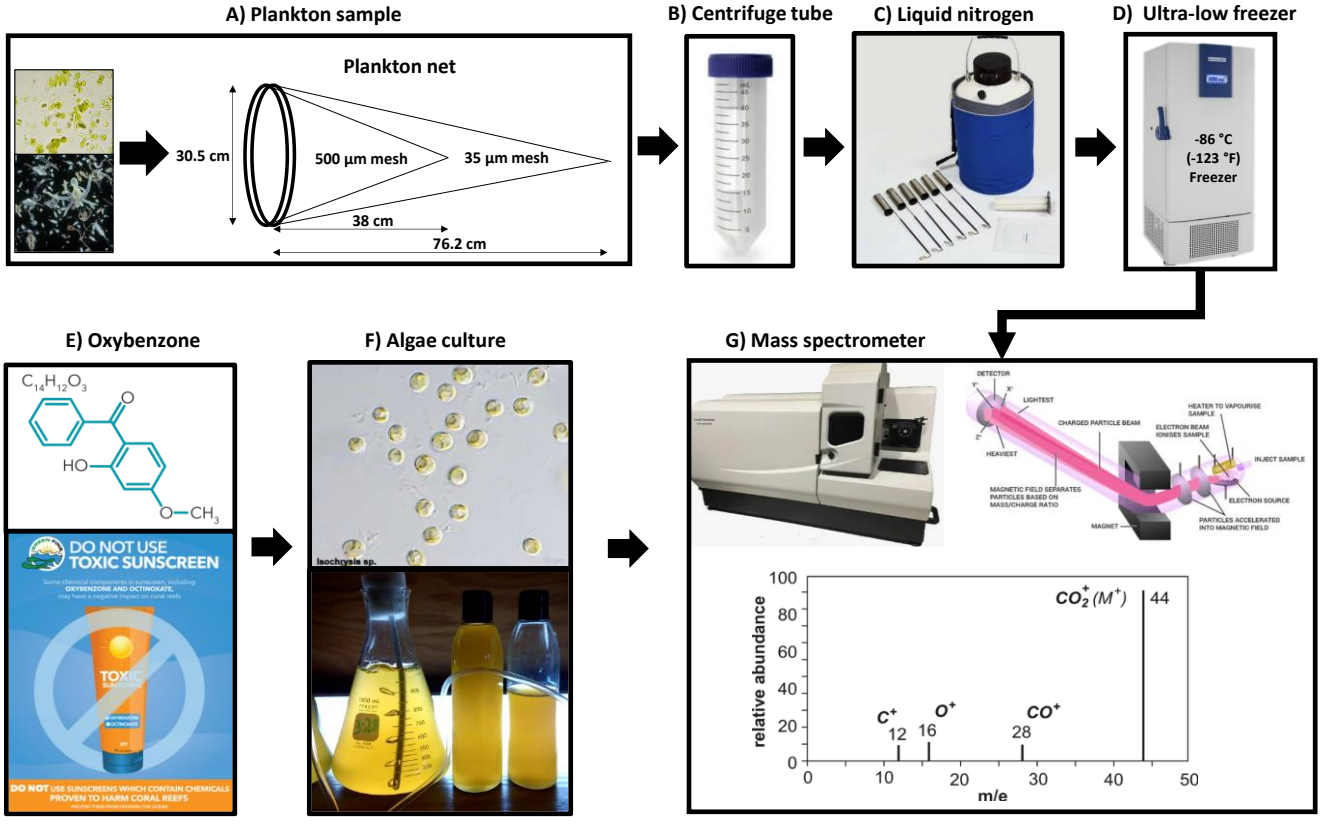

Figure 9. An image illustrating the process for determining the presence of oxybenzone in a plankton sample. (A) field collection of a plankton sample using a plankton net, (B) plankton samples are placed into a 50 ml centrifuge tube, and (C) flash frozen in liquid nitrogen in the field, then (D) stored in a -86ºC freezer for long-term storage. Meanwhile, a standard is being developed whereby: (E) sunscreen with oxybenzone will be inoculated into (F) a sample of phytoplankton cultured at the CFK Southernmost Marine Aquaculture Research & Training (SMART) Center. The sample will be analyzed in a (G) mass spectrometer to develop a standard. Field samples from the ultra-low freezer will be thawed and similarly analyzed in the mass spectrometer and compared to the know sample standard.

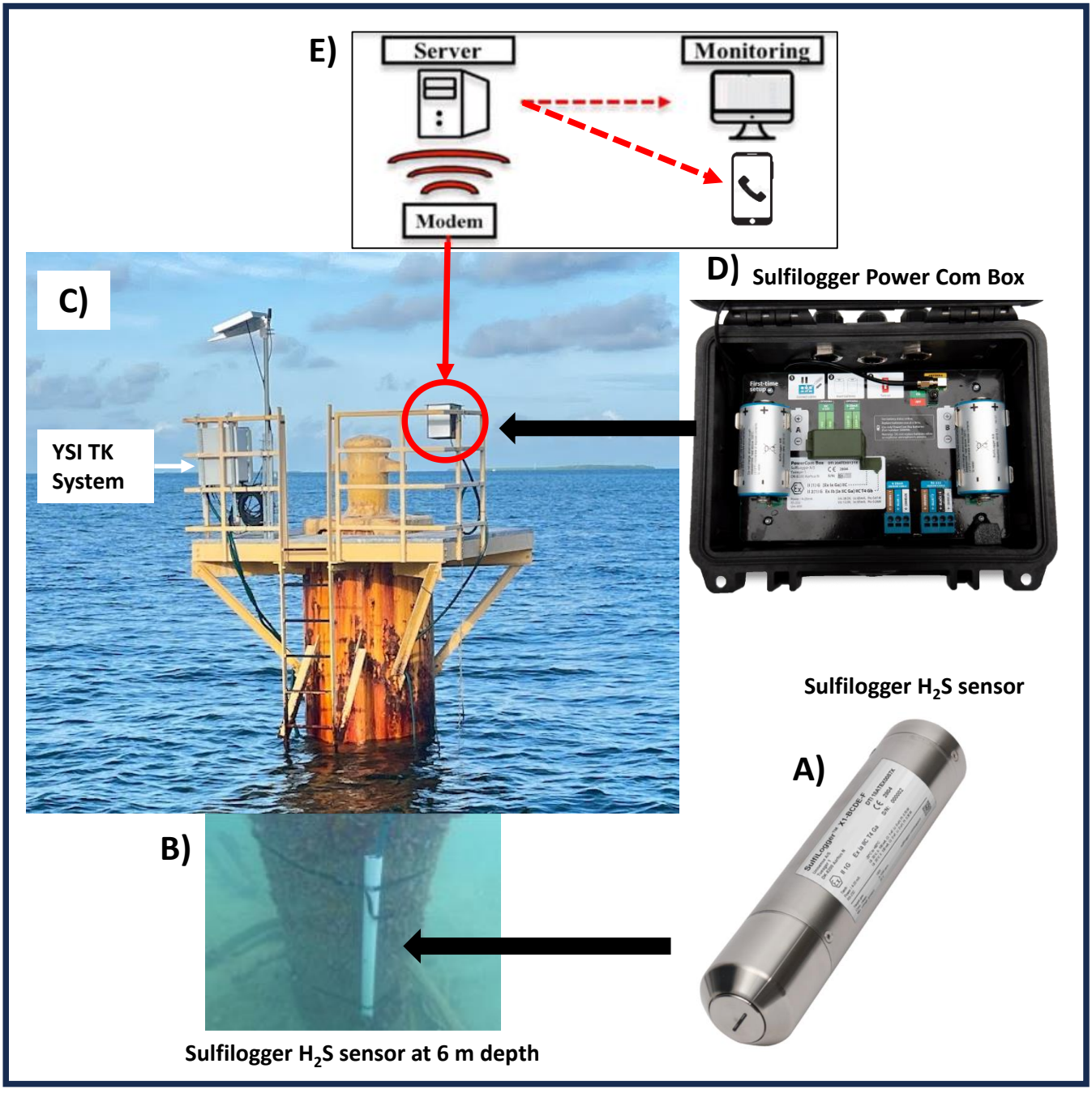

Figure 10. An illustration of the Sulfilogger™ hydrogen sulfide (H_2S) monitoring system installed on the "Yellow-Man" mooring station at Mallory Square: (A) the H_2S sensor installed at (B) 6 m depth on the base of the (C) "Yellow-man mooring station and connected to (D) the Sulfilogger™ Power Com Box which sends data via (E) a wireless modem to a web-based server that allows real-time monitoring of H_2S. The system was recently removed and placed in the CFK lagoon to monitor H_2S concentrations.

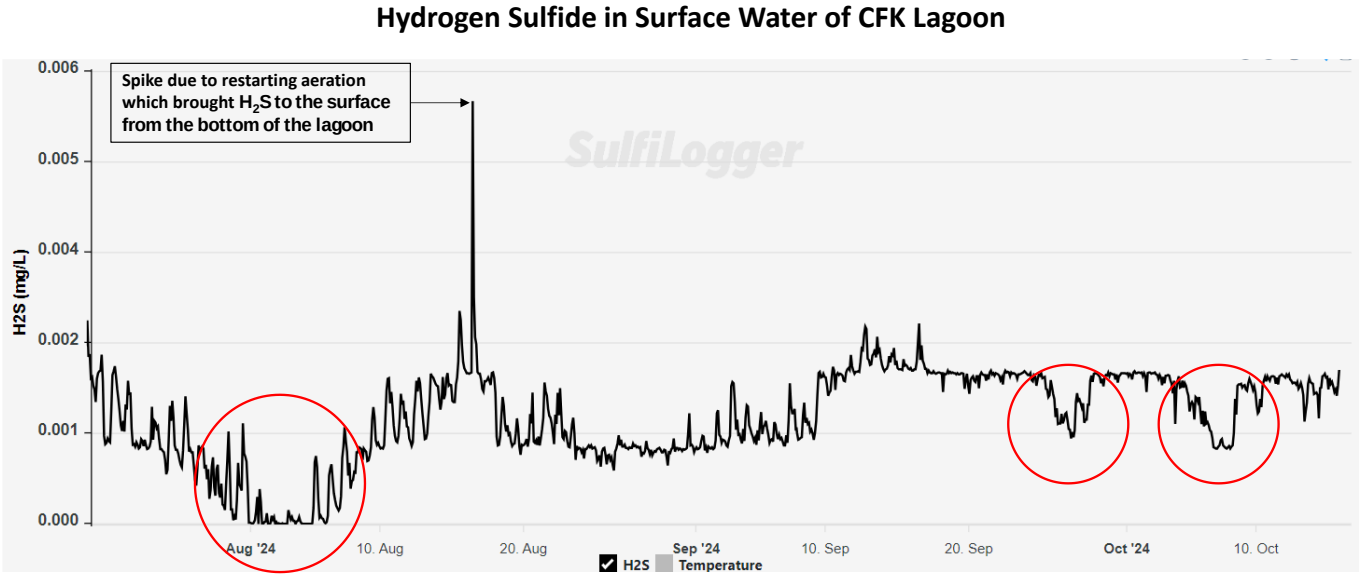

Figure 11. Graph of hydrogen sulfide (H_2S) concentration in the surface waters of The College of the Florida Keys (CFK) lagoon. Note – red circles indicate freshwater at the surface from: (A) Hurricane Debbie, (B) Hurricane Helene, and (C) Hurricane Milton. Special note – the spike in H_2S on 8/16/2024 is most likely associated with the restart of a submerged aeration system along the bottom of the lagoon that brought deep water with concentrated H_2S to the surface.

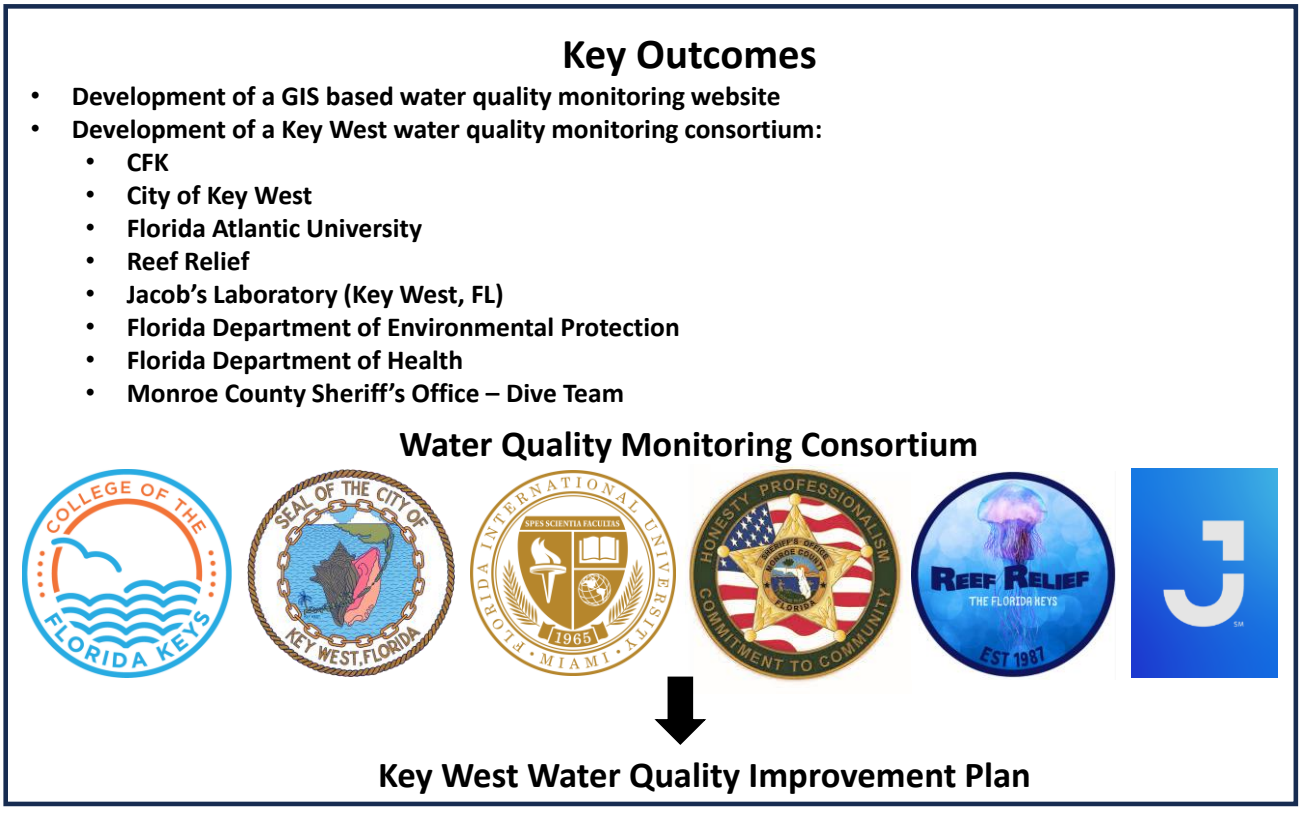

Figure 11. Key Outcomes and partners associated with the development of the Key West Water Quality Monitoring Consortium.