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MEMORANDUM

October 1, 2015

TO: Elizabeth Van Rabenswaay

FROM: Lirio Márquez D'Acunti
Project Manager

SUBJECT: Report: Visual Inspection of how the erosion and sedimentation control remedy implemented under Assistance Agreement X797210301 managed rain and runoff during tropical storm Erika

Dear Mrs. Van Rabenswaay: This document is the report that was produced by the Technical Project Manager for the erosion and sedimentation control project on the road to Puerto Mosquito Bioluminescent Bay that was financed through EPA Assistance Agreement X797210301 after tropical storm Erika.

Sincerely,

Lirio Márquez, D'Acunti
Project Manager, VCHT Executive Director

Site Visit report: Visual Inspection of Tropical Storm Erika effects on implemented remedy Puerto Mosquito Erosion and Sedimentation Control Project developed under Assistance Agreement X797210301

I. Introduction

A 2008 study commissioned by the Puerto Rico Department of Natural Resources from Carlos Ramos Scharron, PhD¹ indicated that the dirt road from SunBay to Puerto Mosquito Bioluminescent Bay (South Bahía Mosquito top and bottom, and Playa Panteón) deliver sediment directly into Bahía Mosquito with an estimated efficiency of 100%. Thus, that road, according to Dr. Ramos Scharron was expected to deliver 6 Mg or about 4.6 m³ of sediment every year into Mosquito Bay. This amount of sediments is detrimental to the stability of this highly complex ecosystem. The effect of sediment in the waters, especially on high precipitation events in combination with the vehicular traffic and tourism activities, presented an impact to the natural water quality of the system. It has been established that some water quality parameters such as salinity, temperature and turbidity appear to have a correlation with the abundance of bioluminescent dinoflagellates that are in the system. In his report Dr. Ramos Scharron recommended the implementation “of an erosion control plan to mitigate the adverse effects that this increased rate of sedimentation might be having on the quality of the marine habitat in Mosquito Bay”².

In 2014, funded by DNER, erosion and sedimentation control measures were implemented on the three segments of this road (South Bahía Mosquito top and bottom, and Playa Panteón) through the use of green infrastructure. These measures included closing and reforesting the steepest segment of the road and moving the road to terrain that was better suited for the implementation of erosion control measures, checkdams and sediment traps, rain gardens and the use of permeable pavement. These measures have greatly reduced the sediment and runoff coming into the Bay from this road. It has also greatly improved the organization and vehicular traffic of tourism operators, DNER Rangers and managers, and other users. The project also has been recognized as a successful green infrastructure design to be used as a model for similarly complex and delicate systems.

II. Purpose

This report focuses on the visual inspections and available data for the precipitation events of Tropical Storm Erika which passed approximately 0809898 miles from Vieques on August 27, 2015.

The purpose of the visual assessment was to establish the functionality of the installed measures and to document any damages caused by the storm. The supporting data is provided

1 Land Erosion and Sedimentation of Mosquito Bay, Vieques-Puerto Rico, Carlos E. Ramos-Scharrón, Ph.D., July 1, 2008

2 Idem.

by the USGS' real-time monitoring station located near the center of Puerto Mosquito Bioluminescent Bay. The station's data is publicly available at http://waterdata.usgs.gov/pr/nwis/uv?site_no=50231500

III. Place and Date

Puerto Mosquito bioluminescent Bay
Vieques Puerto Rico
Access Road-DNER Nature Reserve
August 28, 2015 11:30am

IV. Attendees

Mark Martin Bras
Assistant Project Manager, Technical Project Manager VCHT

V. General Description

A. General description of the area on the day of the visual inspection

The area of the road leading to the reserve showed signs of heavy rains and some vegetative debris. The coastline in the area of Esperanza and SunBay beach which are within the nature reserve had waves between 2 to 5 feet in height. The access road to the Bay and the implemented remedy site was relatively clear of vegetative debris except for two fallen trees approximately between 8 to 10 feet in height. One of them, in the beginning of the access road to the Bay. This area of the road before the green infrastructure installations, had significant water accumulation in at least 5 sites and signs of runoff in multiple part of the road. At the place where the implanted green infrastructure remedy begins the amount of water was minimal. No standing water anywhere in the green infrastructure was evident. There was minimal to zero damage caused by the storm in terms of structure, sediment accumulation or debris within the green infrastructure-remedied part of the access road to the Bioluminescent Bay, the new parking area, or the project staging areas. The shoreline appeared minimally affected with small amounts of sand and algae.

Water clarity was excellent and photographically documented. An inspection around the shoreline of the Bay revealed no sediment or other abnormal accumulation. There was a total of 13 red mangrove propagules found directly on the shoreline and several small (3 to 5 inches diameter) rocks from the remedied shoreline in the water. The wildlife observed in the area consisted of several shorebirds, fiddler crabs, blue crabs and several species of small fish. The USGS station and the water level mark appeared and were later verified as structurally solid. The station lost its buoy marker light during the storm.

A visit to the remedied Panteón road which connects to the main access road and which was identified as the main source of sediments and heavy runoff flow before the erosion control remedy was put in place, showed no signs of damage and inspections of the check

dams, rain gardens and French drains showed no signs of damage and very little sediment accumulation. The green infrastructure remedy-system appears to have worked efficiently in managing the sediments and handling the water pressure.

B. Photographic evidence

The visit was documented with a series of photographs of the area and several videos that we plan to use in public awareness campaigns regarding the use of green infrastructure solutions in unpaved roads to manage erosion and sedimentation, and the need for clean water in delicate ecosystems. The photographs are included with explanatory captions. Videos will be featured on our website www.vcht.org.



Photo 1. This is the beginning portion of the road. This area was not part of the erosion control project. Notice the water-created depressions.

Photo 2. Fallen tree on road next to water puddles at beginning of the access road. Also not part of the project.





Photo 3. Puddles and deposited sediment on the road.

Photo 4. Larger water and sediment deposits on the access road area just before the start of the remedied section of the road.





Photo 5. Beginning of access road green infrastructure sediment and erosion control.

Photo 6. Vegetated sediment trap on connecting road to Panteón beach; it was free of sediment which demonstrates it is working properly.





Photo 6. Check dam on connecting road to Panteón beach. This is the steepest road and of highest elevation. It was identified as the main producer of sediments and runoff speed during substantial precipitation events.

Photo 7. Remedied road to the Bay with permeable pavement and rain gardens to the sides and center. The area was dry and showed no signs of damage.





Photo 8. Turnaround area with rain gardens. With the exception of some small plants the vegetation appeared to receive little to no damage.



Photo 9. Shoreline of Puerto Mosquito. This is a heavy traffic area, as it is a kayak and boat drop-off area as well as the embarking and disembarking point for the nighttime tours to the Bay. A large amount of sediments used to accumulate in area before the remedy was implemented.



Photo 10. Water on shoreline was very clear.



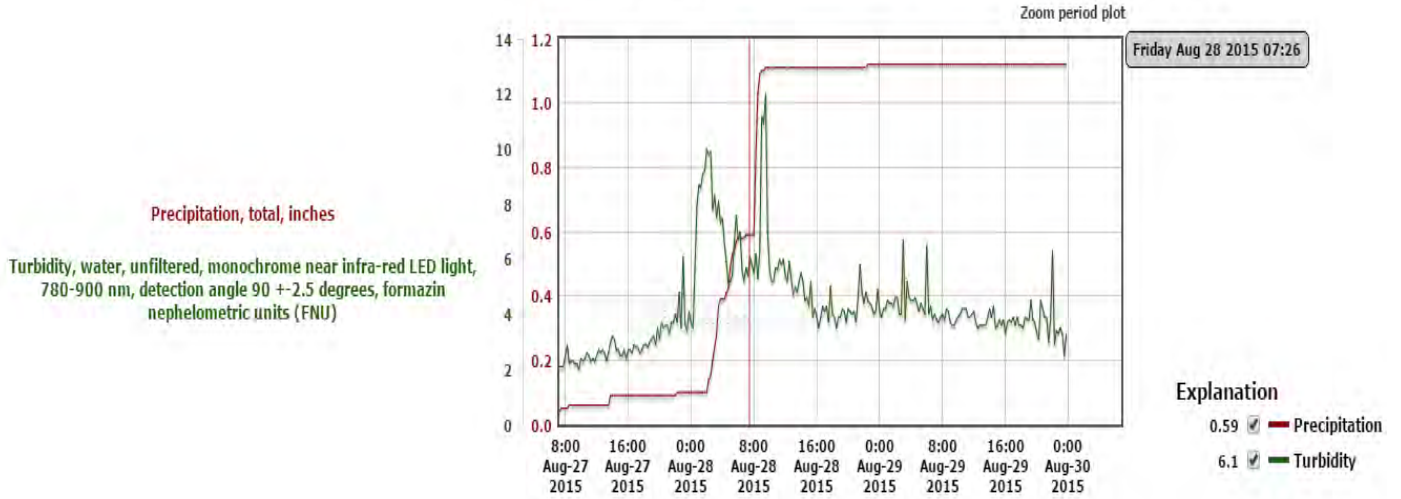
Photo 11. Water on the shoreline appears to have very little signs of sediments; it is very clear in comparison to past observations during storm events. The absence of the white rocks used to remedy the shoreline embarking and disembarking area suggests a controlled flow of water and sediment.



C. Water Quality Data USGS Real Time Station.
The water quality data is available at the USGS station Bahia Mosquito.

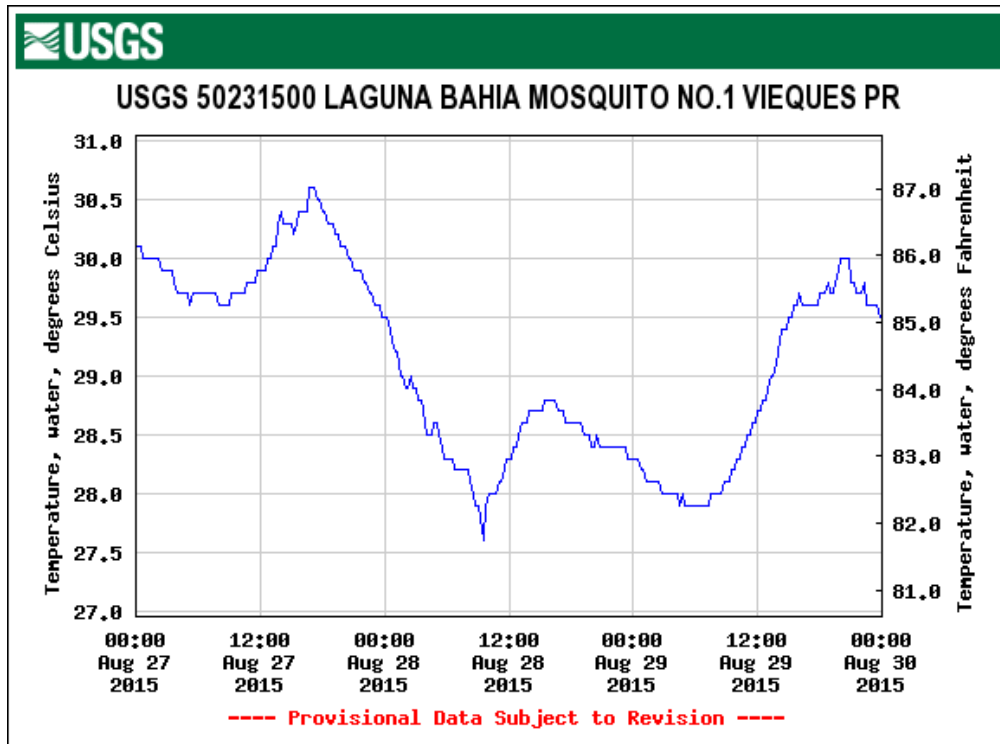
Graph #1 Turbidity/Precipitation

USGS 50231500 LAGUNA BAHIA MOSQUITO NO.1 VIEQUES PR



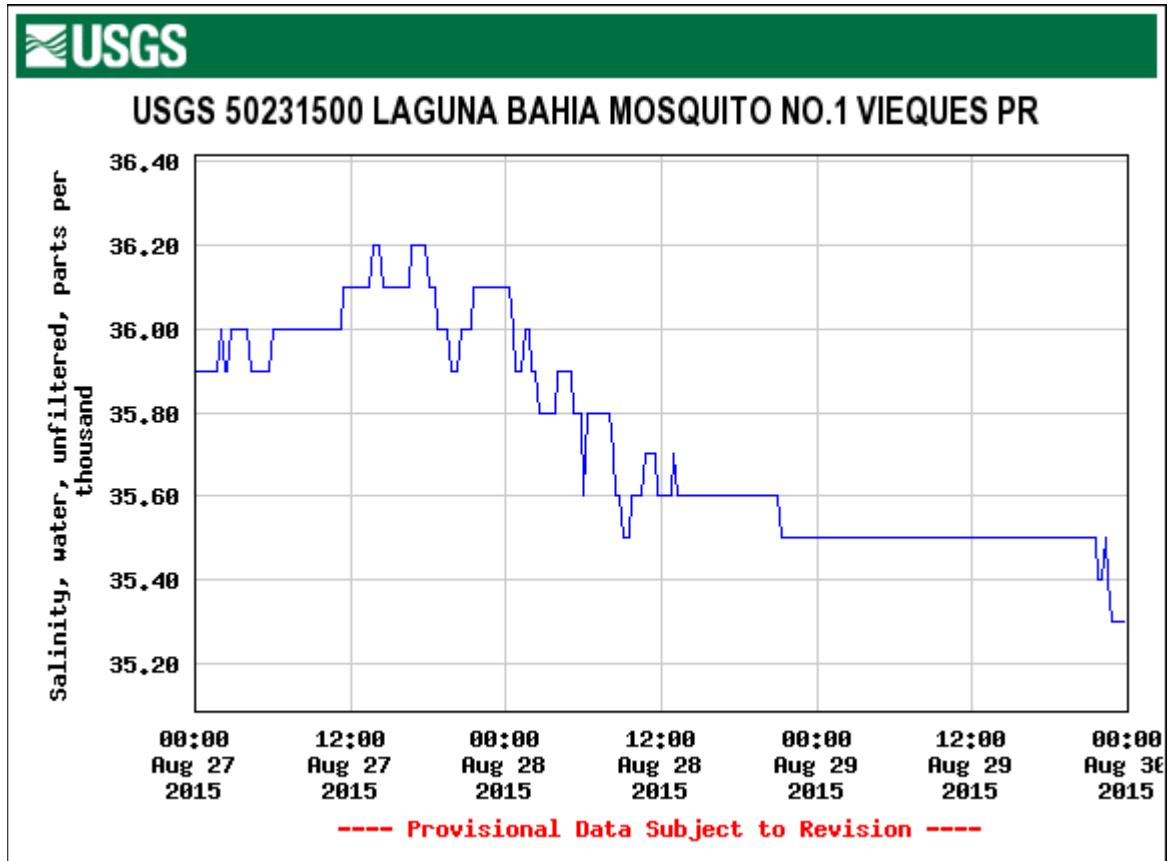
We can observe that the turbidity spike correlates to the precipitation event. Notice a relatively fast recovery from the spike.

Graph #2. Temperature. The temperature dropped 3 degrees Celsius.

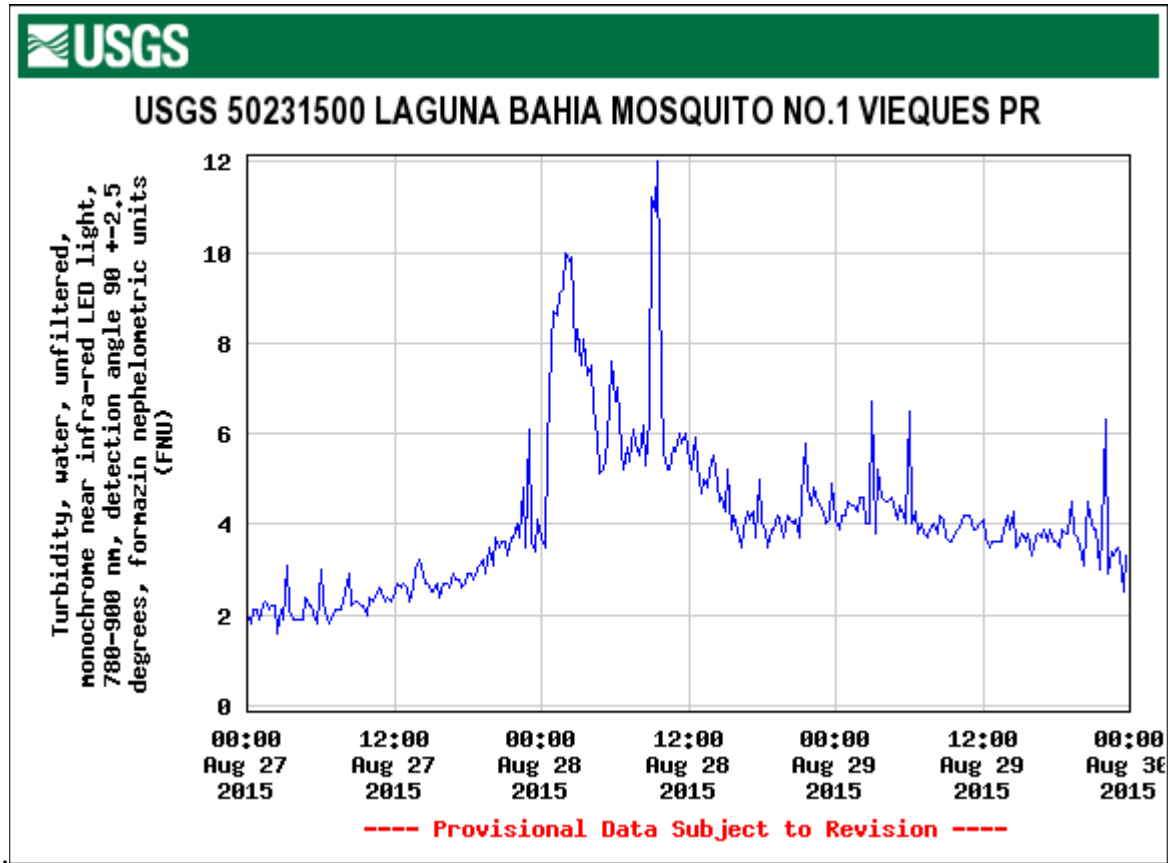


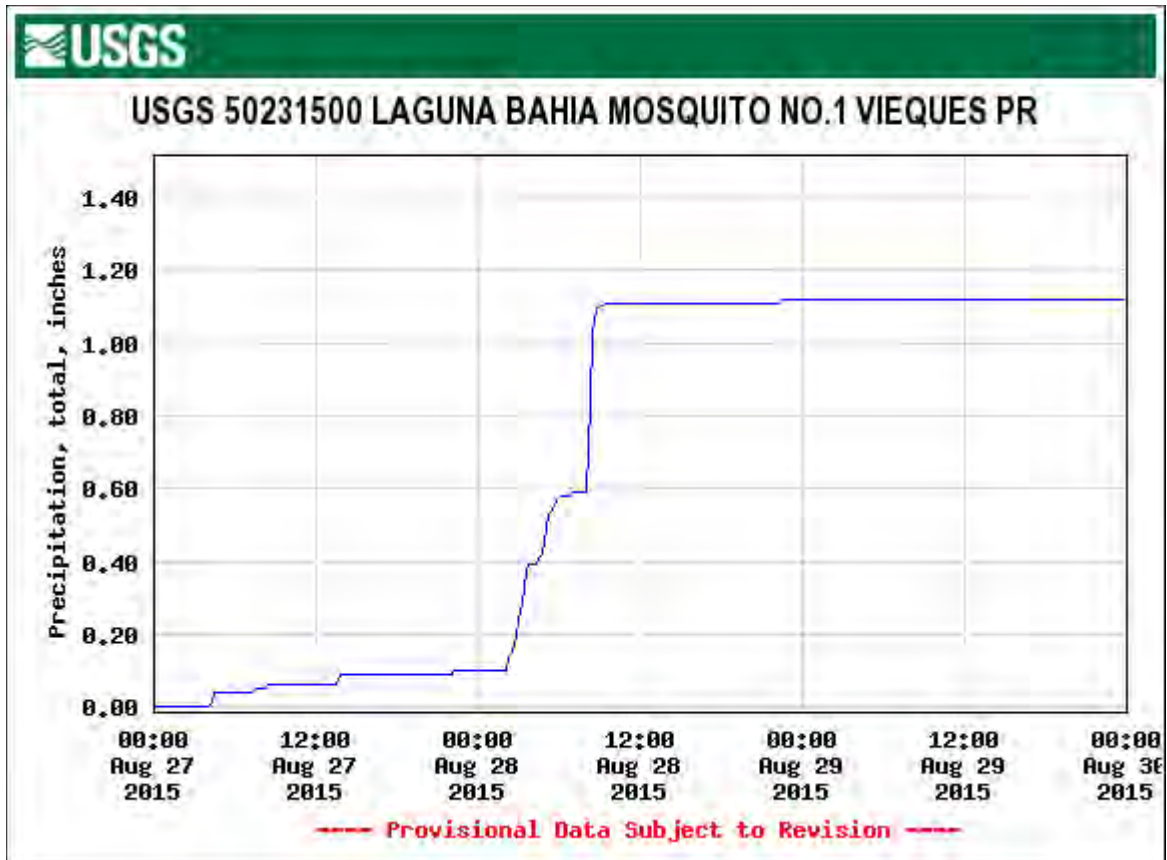
Graph #3. Salinity. The salinity drop relates to freshwater entering the Bay by way of rain and access points and hydrological strain

s.

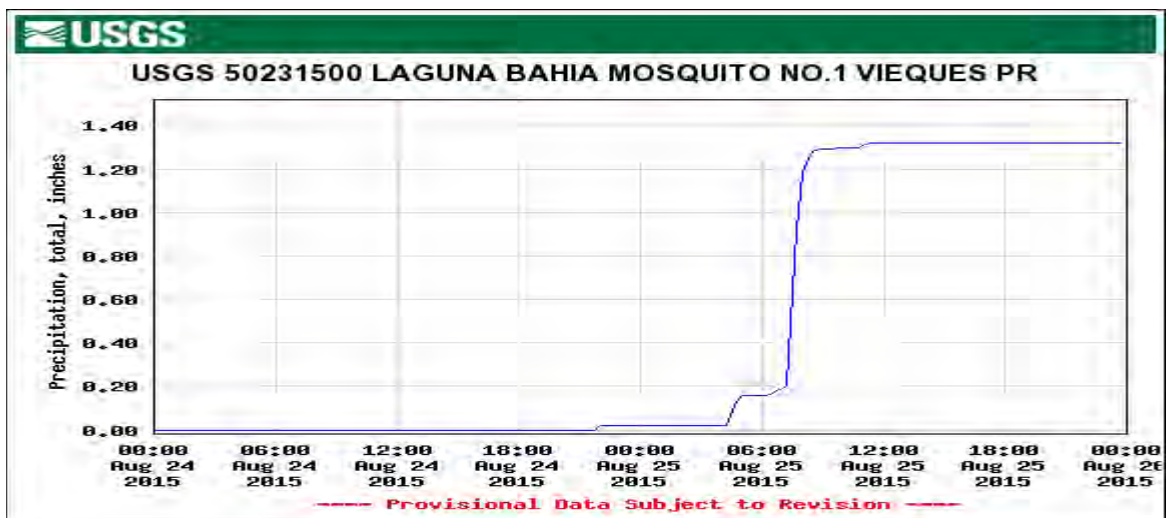


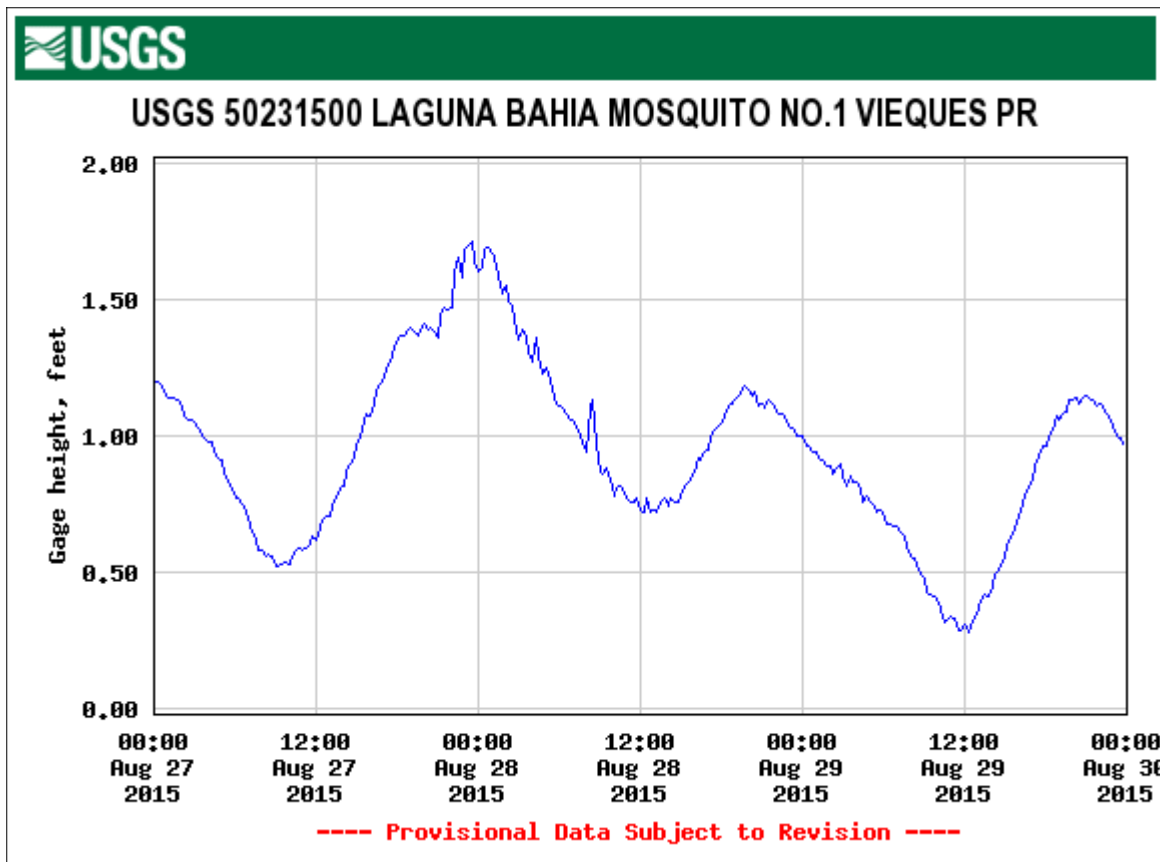
Graph #4. Turbidity. 5.0 is considered to be an indicator for higher turbidity than normally found





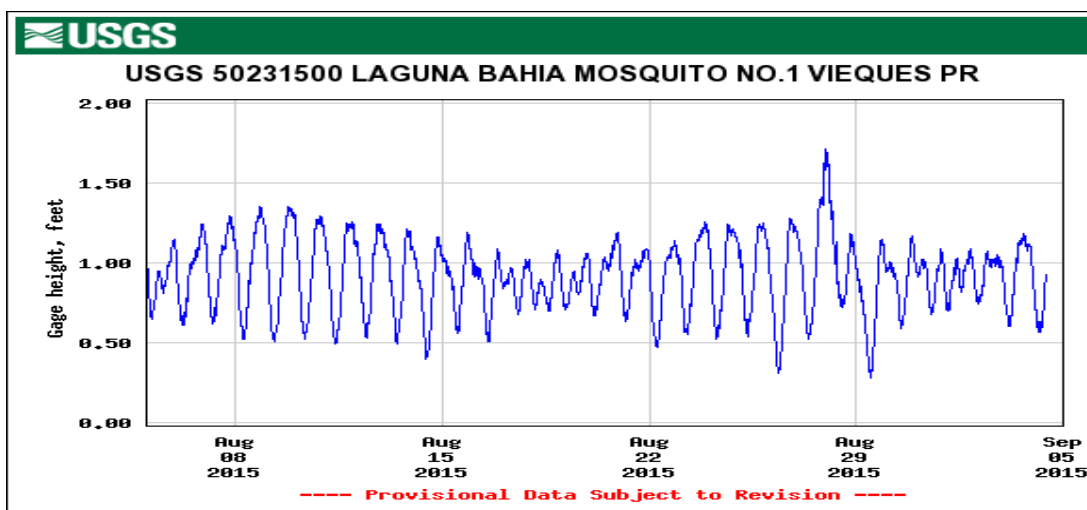
Graphs #5a and 5b. Reference for rain event. Not including rain event at the beginning of the same week. Below the rain event of 8/25/15.





Graphs 6a and 6b. Gage height

The gage height is included to reference water exchange by tidal exchange and water coming onto the Bay from precipitation. The fluctuation is presented in 72 hour period (above) and 30 days (below) period.



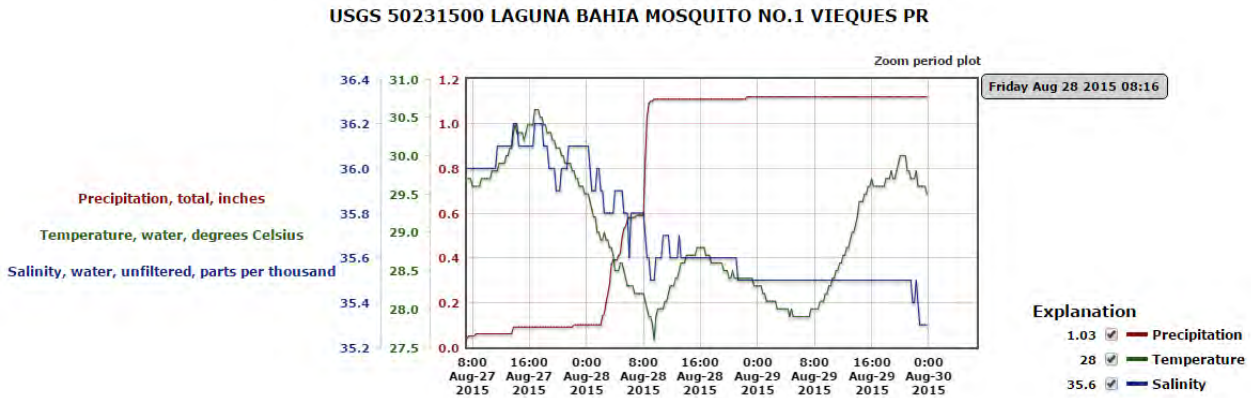
Comparison Graphs.

These graphs are provided for further analysis of correlations between water quality parameters. The USGS Bahia Mosquito Station is accessible on the USGS website and provides graphing options to choose different dates and parameters. It also allows for the data to be retrieved in different formats.

Gage height/Precipitation/Turbidity

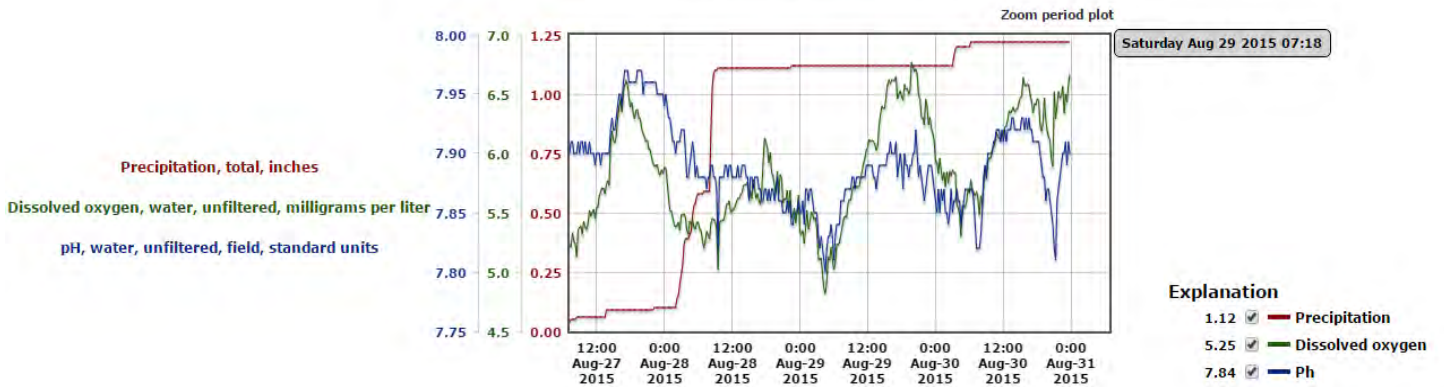


Precipitation/Temperature/Salinity



Precipitation/DO in Mg/l/pH

USGS 50231500 LAGUNA BAHIA MOSQUITO NO.1 VIEQUES PR



Conclusions

It appears the erosion and sedimentation green infrastructure remedy was able to manage significant precipitation from two separate rain events in a week, (2.45 inches) with minimal negative impact. It was evident that the structural integrity of the installations was not compromised. The turbidity rose as expected during the rain event but settled in a short amount of time after the event. There is a correlation between precipitation, temperature, turbidity and the salinity of the Bay. The recent drought recorded in the area was considered in determining if it would affect the normal runoff that would reach the Bay. This was considered not to be a factor due to the precipitation event that occurred before Tropical Storm Erika associated to Tropical storm Danny which became a lesser storm but still recorded 1.32 inches in precipitation. The wind was recorded at 35 knots in the NOAA Esperanza Tide station.

Phytoplankton analysis is not available at the time of this report but the ongoing sampling will provide important information regarding the abundance and species variety in relation to the water quality changes during this events.

The users of the Bay such as the tour operators, researchers and the Reserve Manager, biologist Edgardo Belardo, have expressed that in their opinion the remedied segment of the road to the Bay managed the runoff well during the tropical storm.

The amount of visible sedimentation, vegetative debris, rocks and upland soils that have traditionally been reported in the area during storms was not present.

We will continue to provide information and further analysis as the data is processed.

We welcome additional analysis and comments. Please let us know of any additional information or data.

Sincerely

A handwritten signature in black ink, appearing to read 'Mark Martin Bras', with a stylized flourish at the end.

Mark Martin Bras
Assistant Project Manager, Technical Project Manager