



HYDROLOGY AND WATER QUALITY OF THE LEVITTOWN LAKE, TOA BAJA, PUERTO RICO April 2010 – June 2011

PRELIMINARY SUBJECT TO REVISION

US Geological Survey

In cooperation with the

Puerto Rico Department of Natural and Environmental Resources

**Sponsored by the Office of
Hon. Bernardo (Betito) Márquez**



Problem Description

Community contacted authorities to complain about foul odors and unsanitary conditions



Location of Levittown Lake in Northern Puerto Rico

ATLANTIC OCEAN

Levittown
Lake

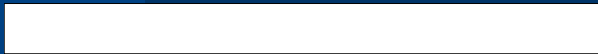
San Juan

PUERTO RICO

Mayagüez

Ponce

CARIBBEAN SEA



Location of USGS Office



Levittown Lake



Río Hondo and Río Bayamón



San Juan Bay

Río Hondo Plaza



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image U.S. Geological Survey
© 2010 Google



18°26'35.31" N 66°09'13.80" W elev 5 ft

Eye alt 26222 ft

**Man-made structure in the 1960s
for the construction of Levittown**



V-2-E-19

Study Components and Methodology

- Hydrology

rainfall tidal exchange

- Bathymetric Survey

bottom topography calculate volume

- Water Physical and Chemical Characteristics

pH dissolved oxygen DO saturation temperature
turbidity salinity specific conductance transparency
nutrients chlorophyll a

- Biological Characteristics

primary productivity – L/D bottles method diel study
fecal bacteria phytoplankton biomass

Levittown Lake Station Locations and USGS identification Numbers

- Field parameters – all stations
- Nutrients, productivity, biomass – 1 and 3
- Fecal bacteria – 2, 5, and 7
- Tidal station – 8

Monthly samplings

50046535

5

50046525

3

50046530

4

50046520

2

50046515

1

8

50046510

50046505

6

50046500

7

Continuously recording - real time satellite telemetry

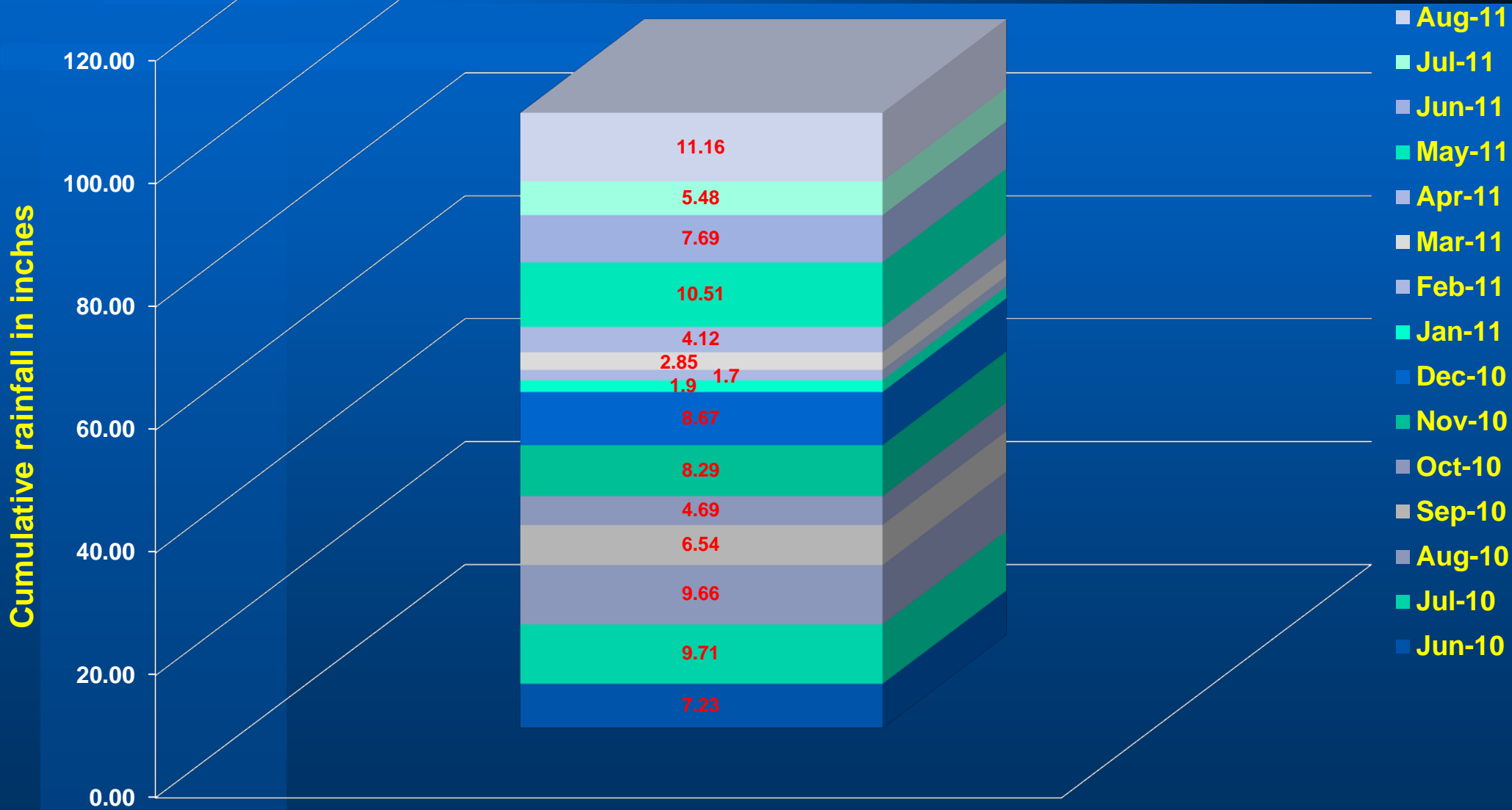
Water quality, rainfall,
and tidal station

Could be used as
an alert system for floods

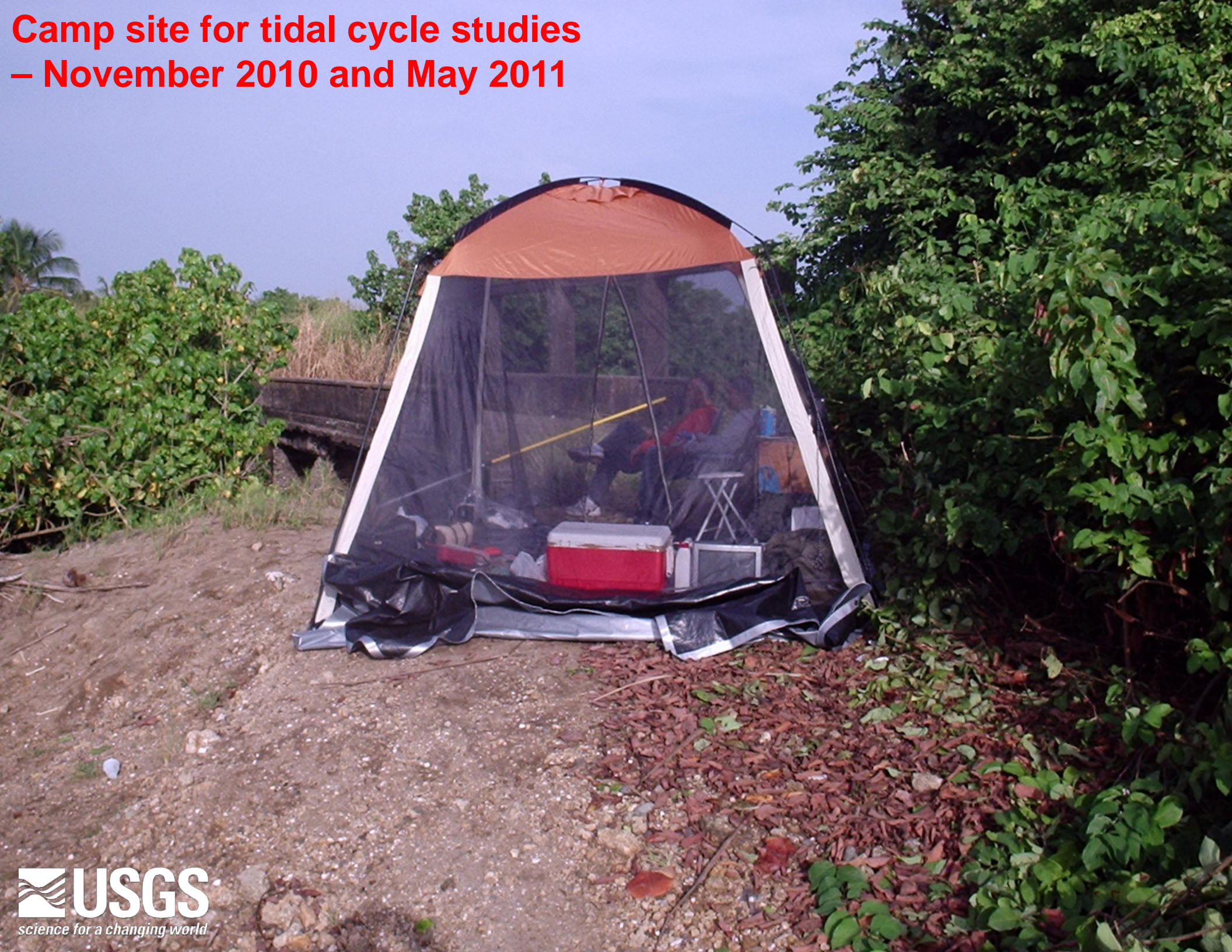
Rainfall – Continuously

TOTAL RAINFALL = 98.50 INCHES IN 15 MONTHS

RAINFALL AVERAGE FOR NORTH COAST = 70 INCHES/YEAR



Camp site for tidal cycle studies – November 2010 and May 2011



Acoustic Doppler Current Profiler – Twice Year



Tidal Cycle Hourly During 24 Hours – Low and High Tides



Bathymetric Survey System – Once During Study



GPS and fathometer integrated

Water Quality Multi-parameter Meter – Monthly

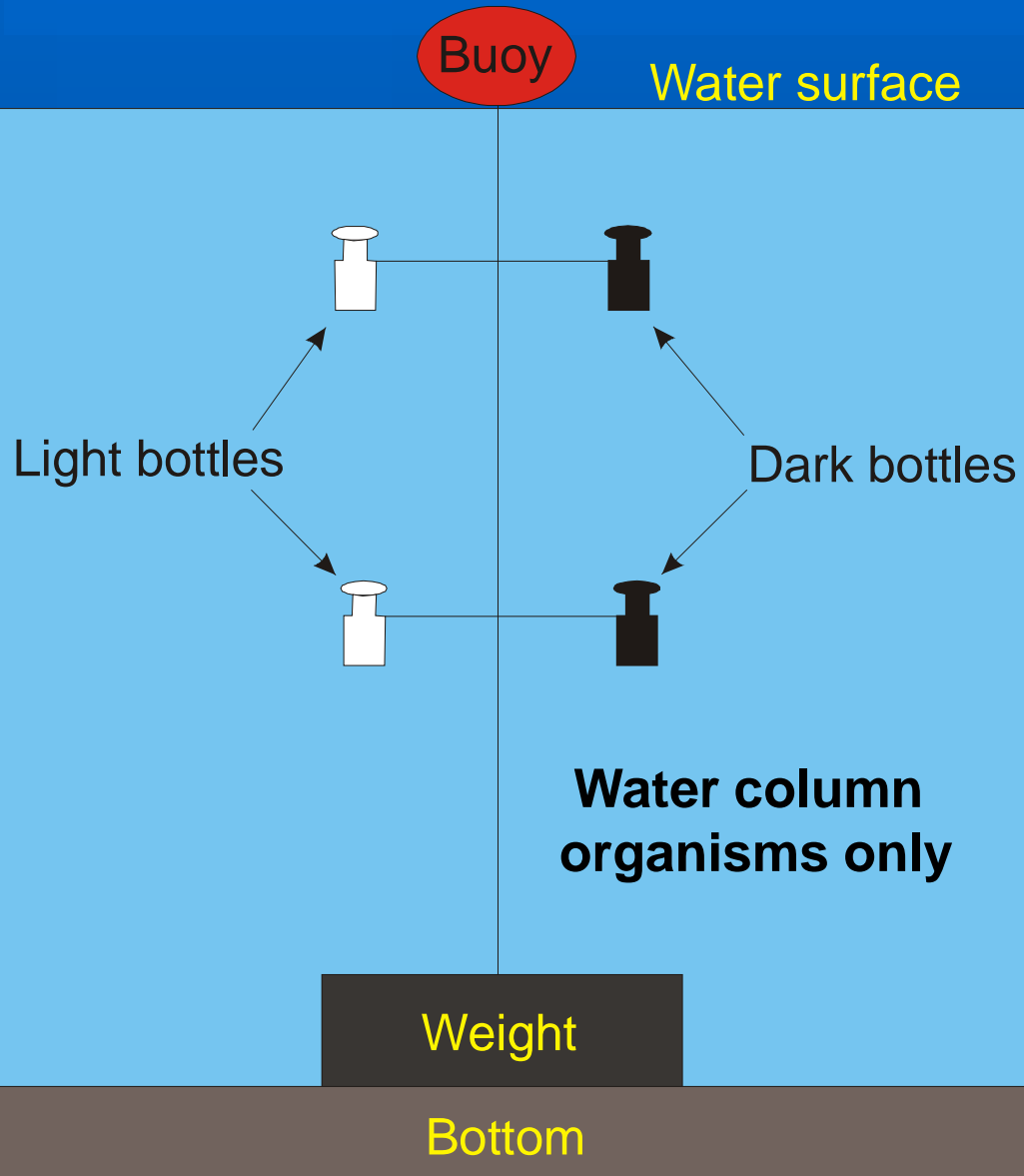


Primary Productivity

- Light/Dark bottles method – plankton productivity and respiration

Winkler titration

By measuring the production of O₂, we can calculate the amount of organic matter creation



Method Principles:

Light bottles – photosynthesis, respiration

Dark bottles – respiration

Gross productivity (Pg) = OL – OD

Net productivity (Pn) = OL – OI

Respiration (R) = OI – OD

BOD Bottles – Monthly

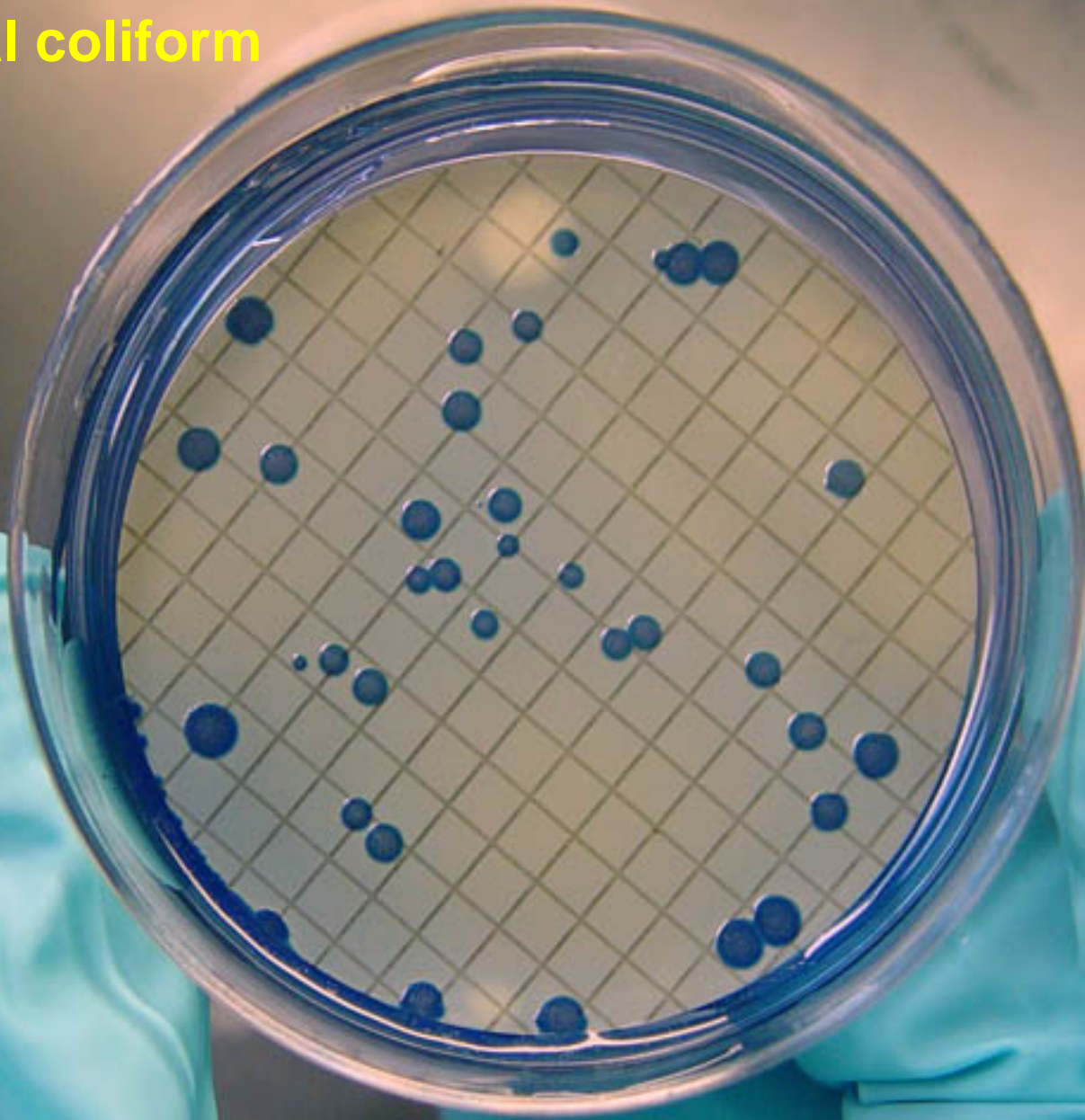
Light bottle
Respiration and photosynthesis

Dark bottle
Respiration only

Microfiltration System – Monthly



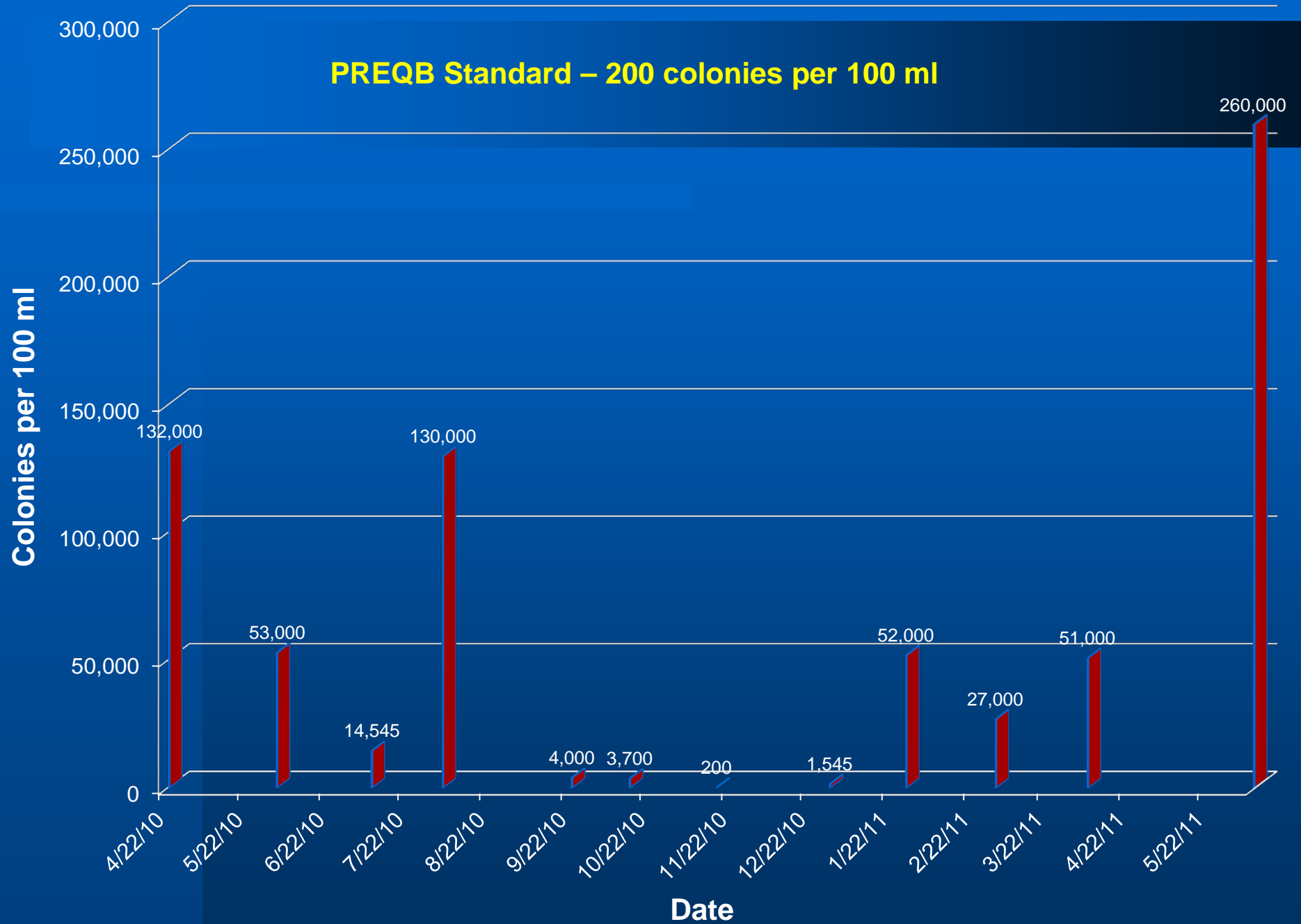
Typical fecal coliform colonies



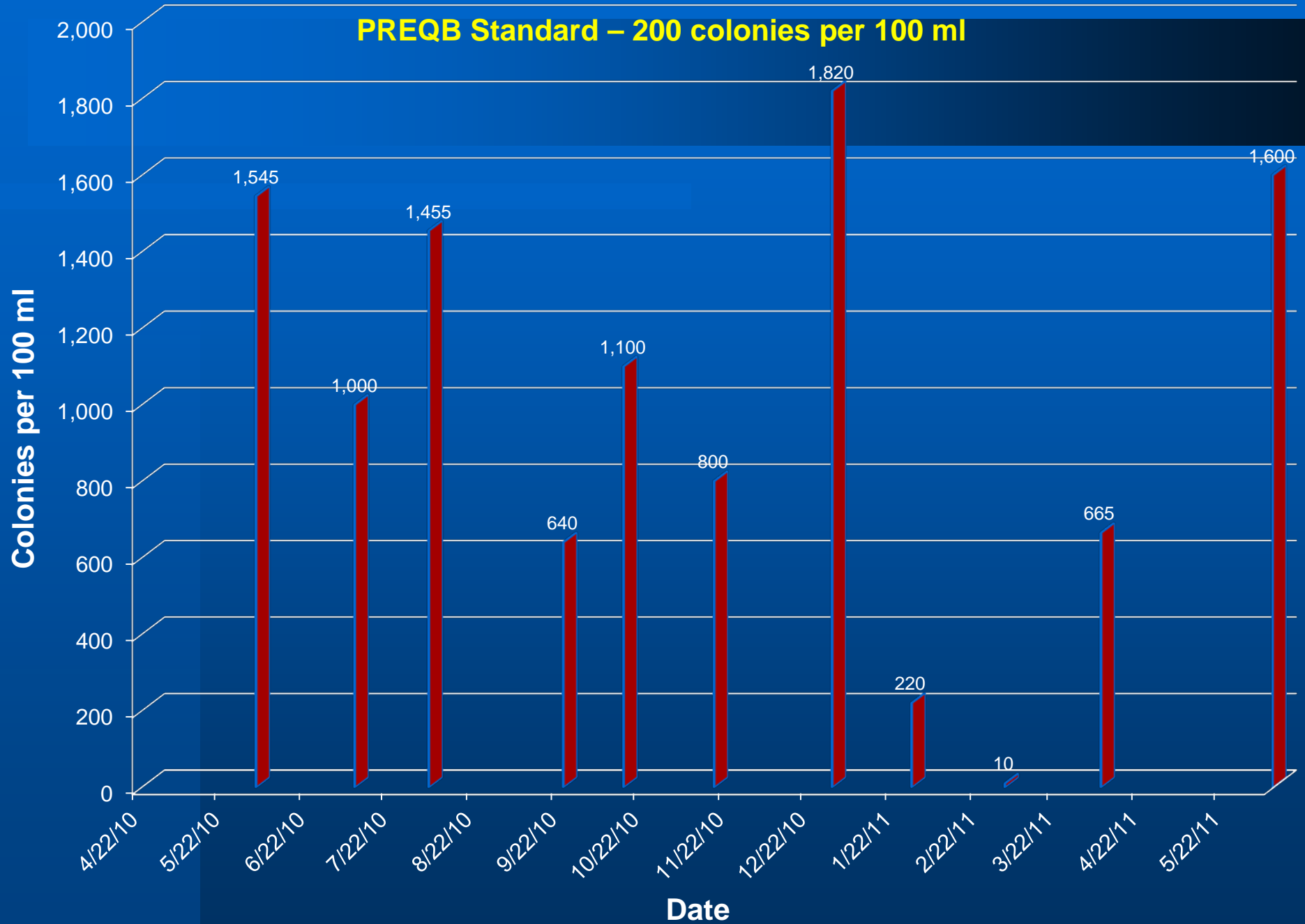
KEY FINDINGS

- VERY HIGH FECAL COLIFORM COUNTS
- VERY LOW DISSOLVED OXYGEN CONCENTRATION EPISODES
- LARGE VARIATIONS OF DISSOLVED OXYGEN DURING DIURNAL CYCLES
- HIGH NUTRIENTS CONCENTRATION
- SUDDEN SALINITY DROPS AFTER HEAVY RAINFALL
- MARKED WATER COLUMN STRATIFICATION
- POOR WATER MIXING
- TIDAL DATA INDICATE POOR CONNECTION WITH THE OCEAN
- LAGOON PRODUCES 370 TONNES OF ORGANIC MATTER PER YEAR (UPPER LAYER ONLY)

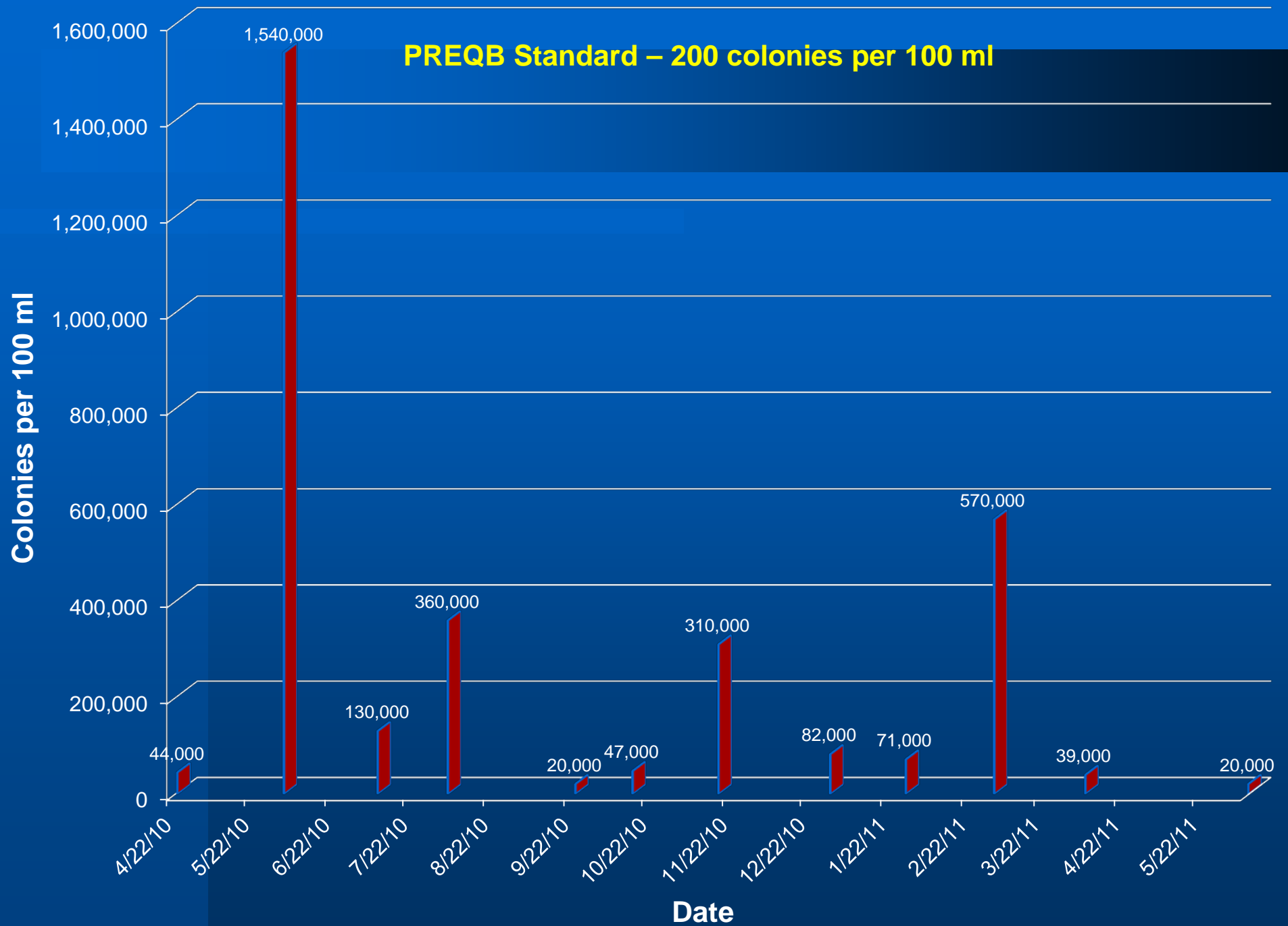
Fecal coliforms - Station 2



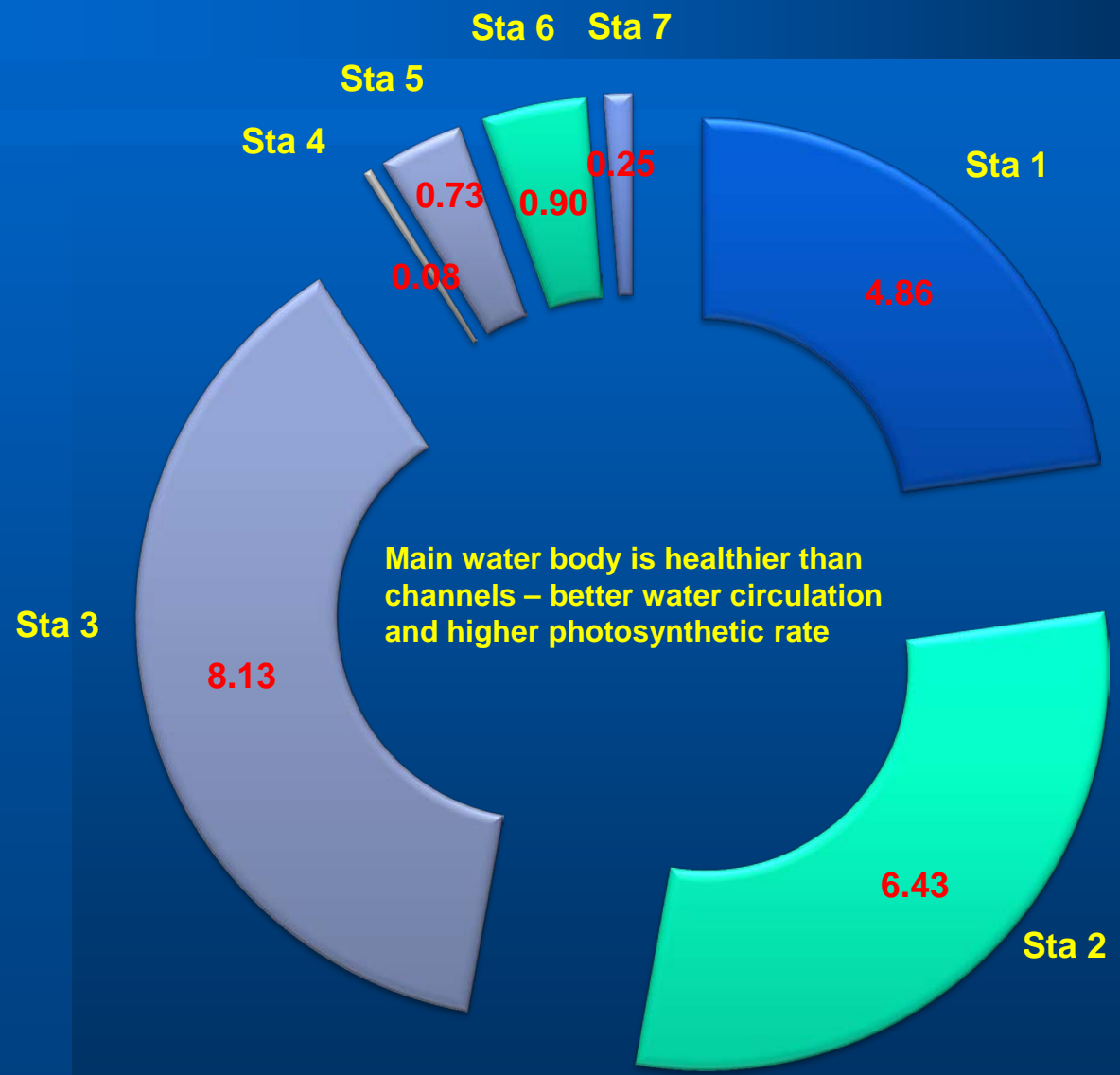
Fecal coliforms - Station 5



Fecal coliforms - Station 7

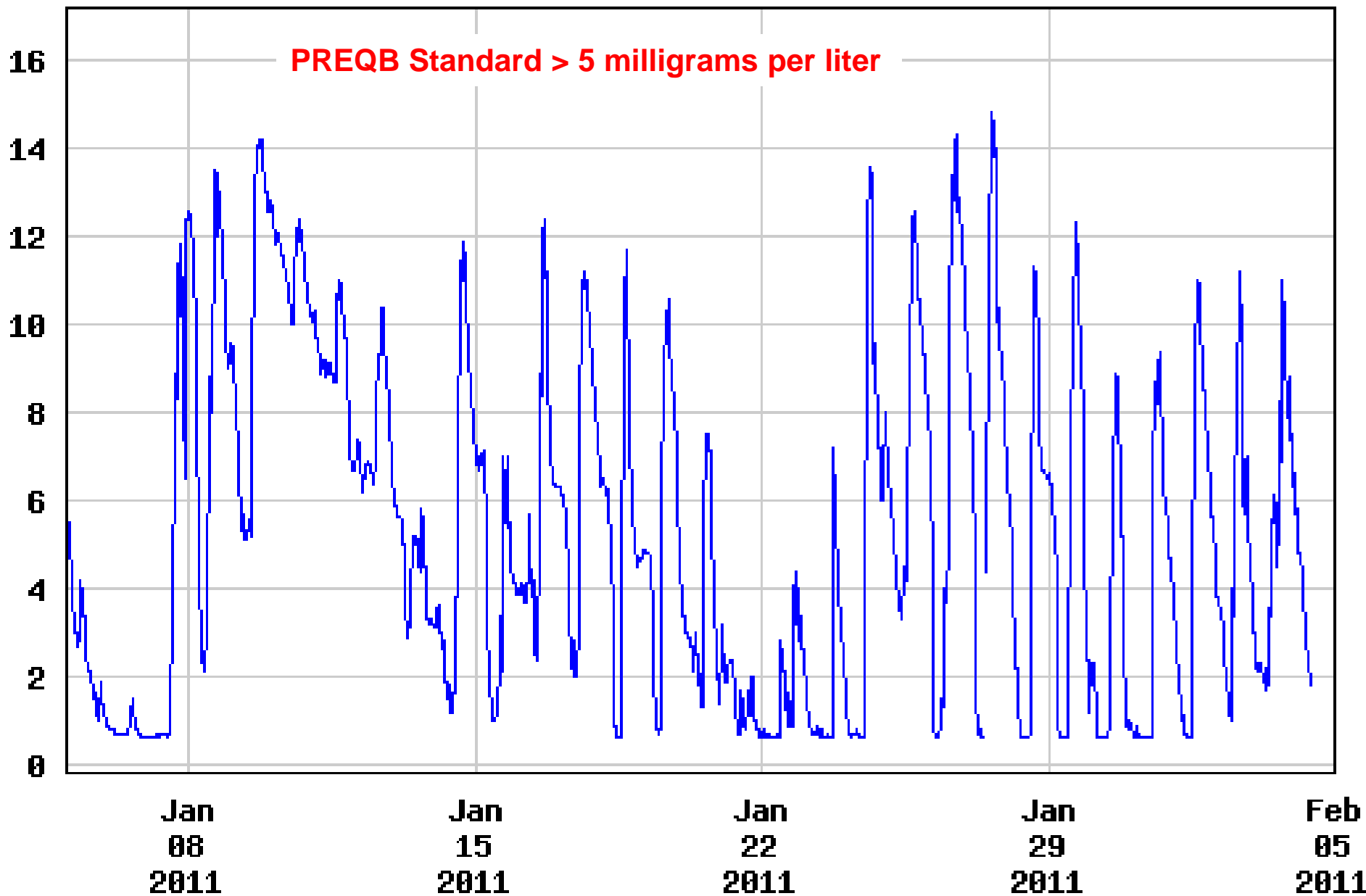


EXAMPLE – July 2010 top DO in milligrams per liter



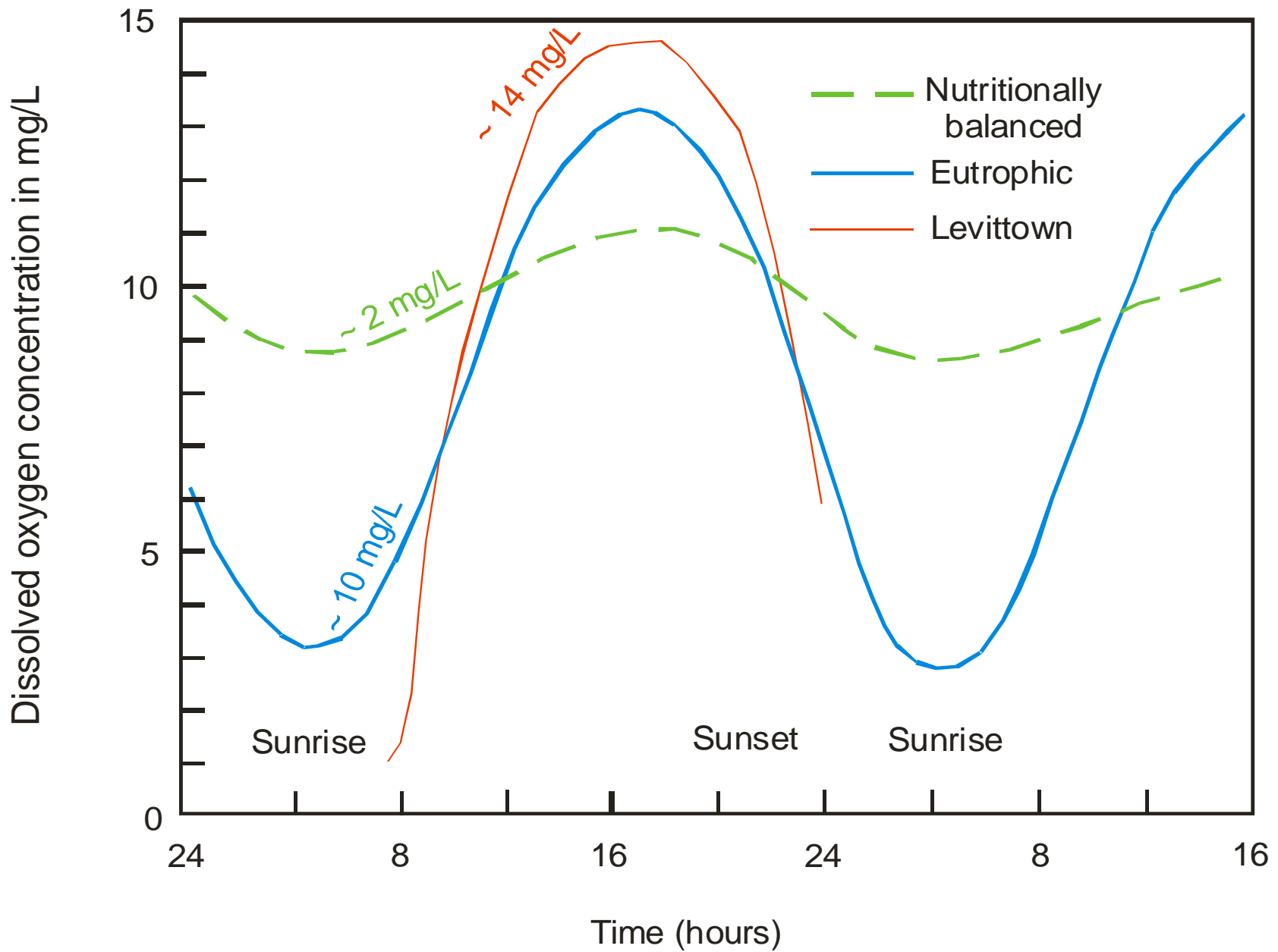
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Dissolved oxygen, water, unfiltered,
milligrams per liter

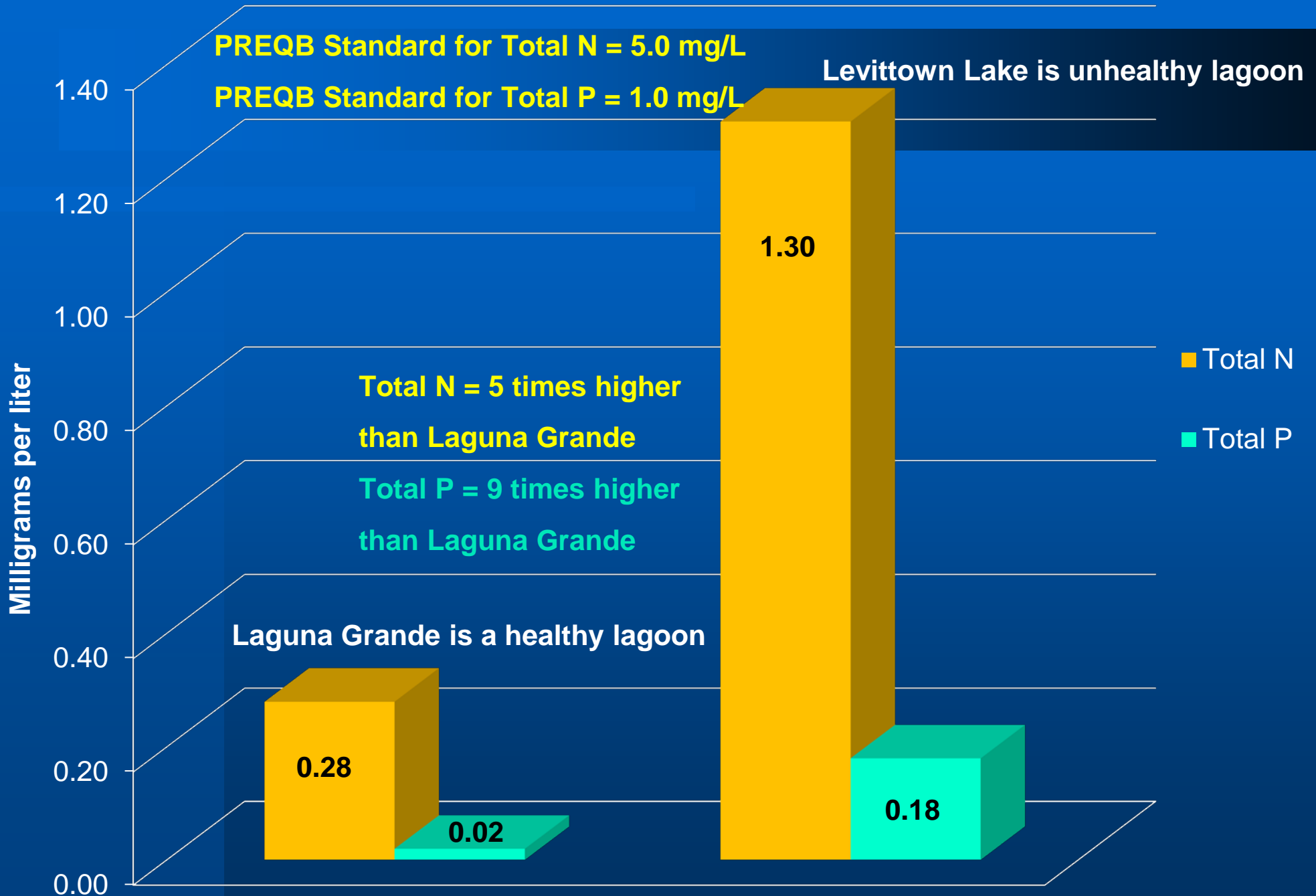


---- Provisional Data Subject to Revision ----

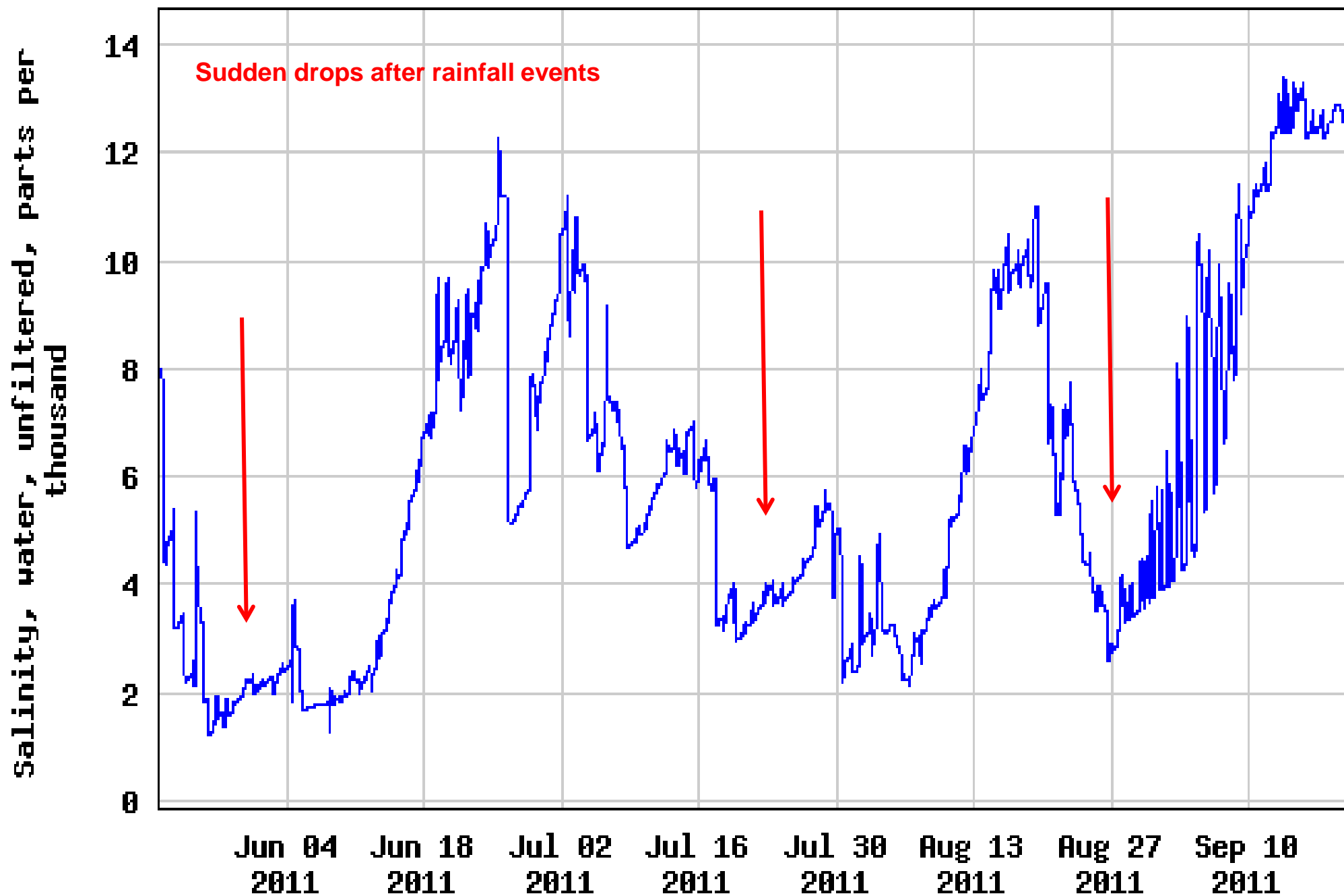
DO diurnal variation example conceived by Wetzel



Nutrients Concentrations



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---- Provisional Data Subject to Revision ----

Camino Delmar

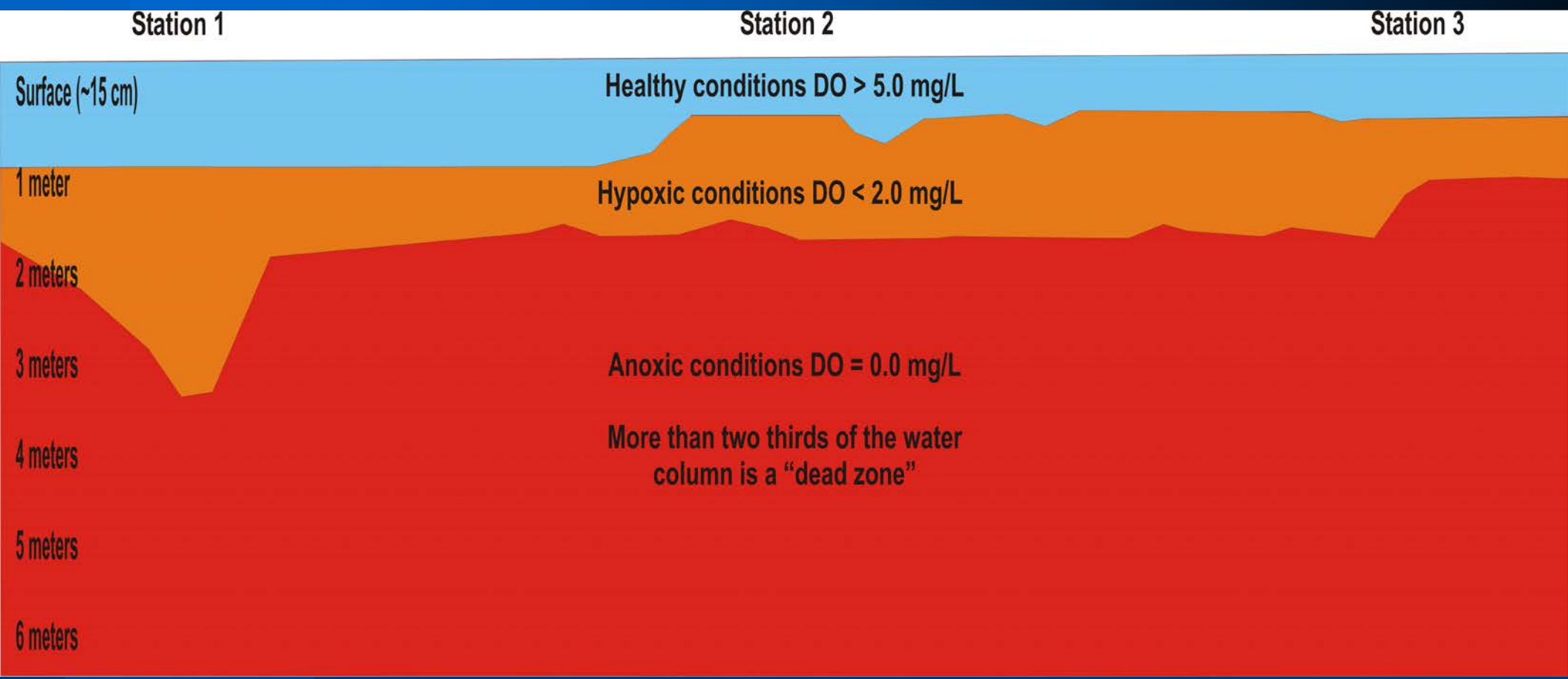
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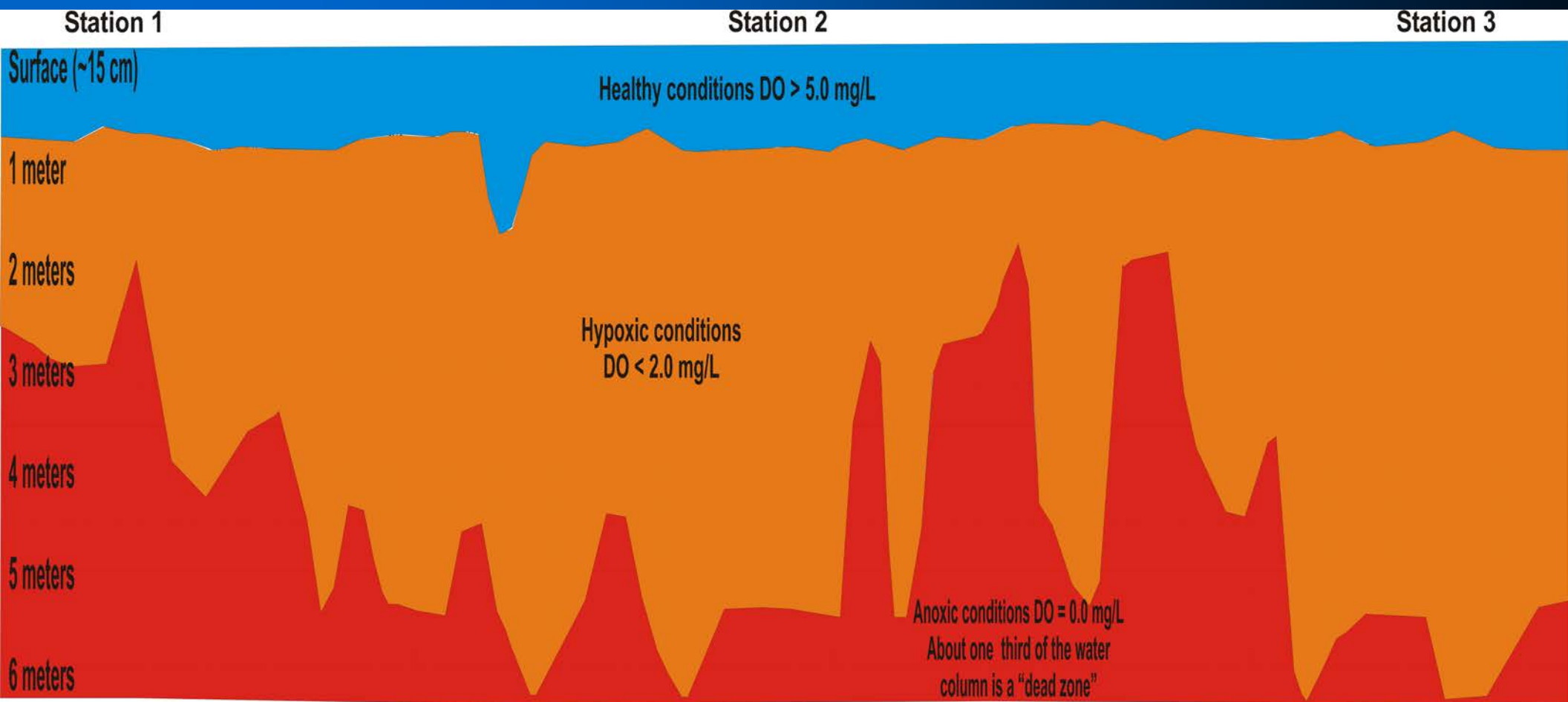
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Diurnal cycle stations
Twice year

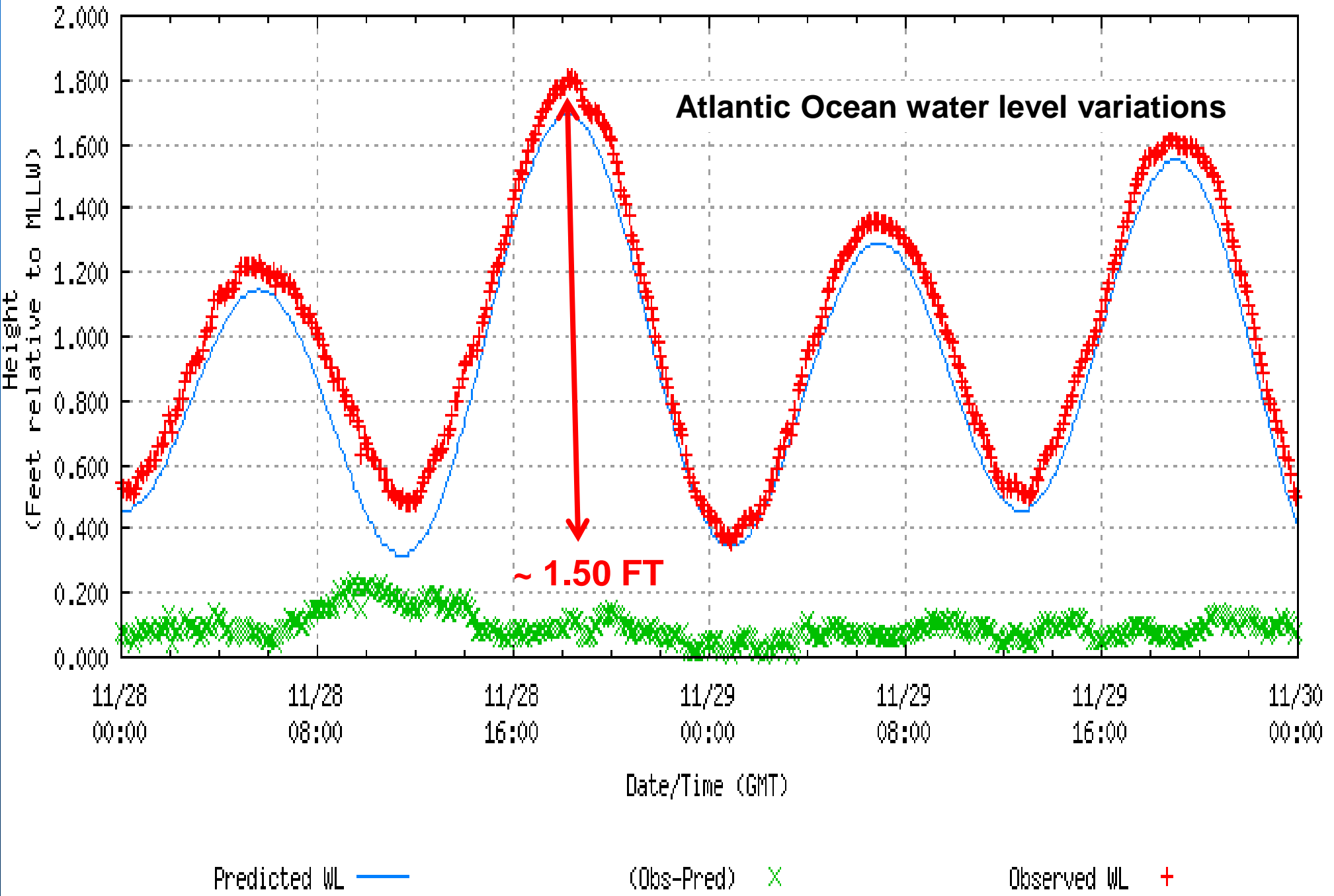
Levittown Lake Side View – November 2010



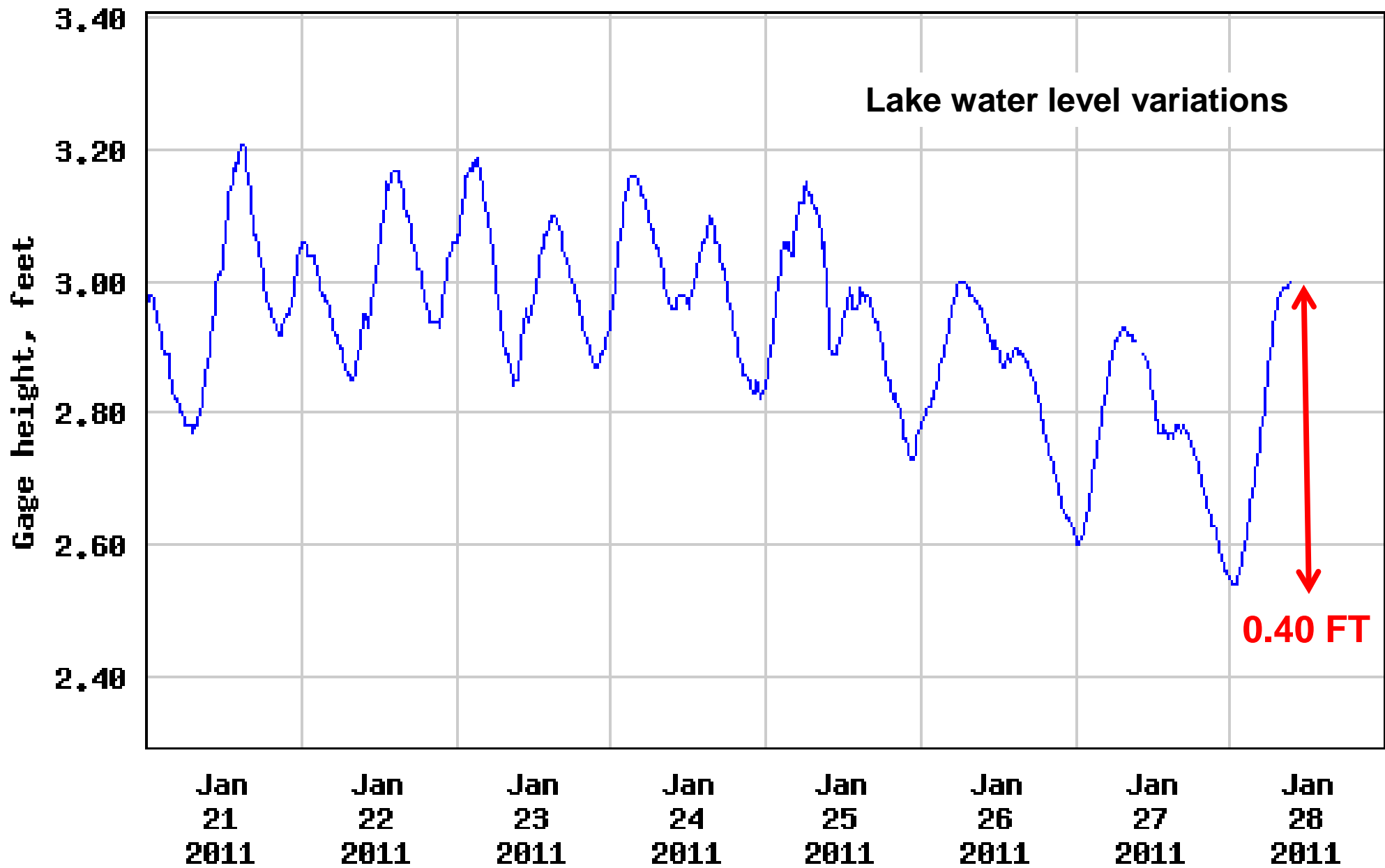
Levittown Lake Side View – May 2011



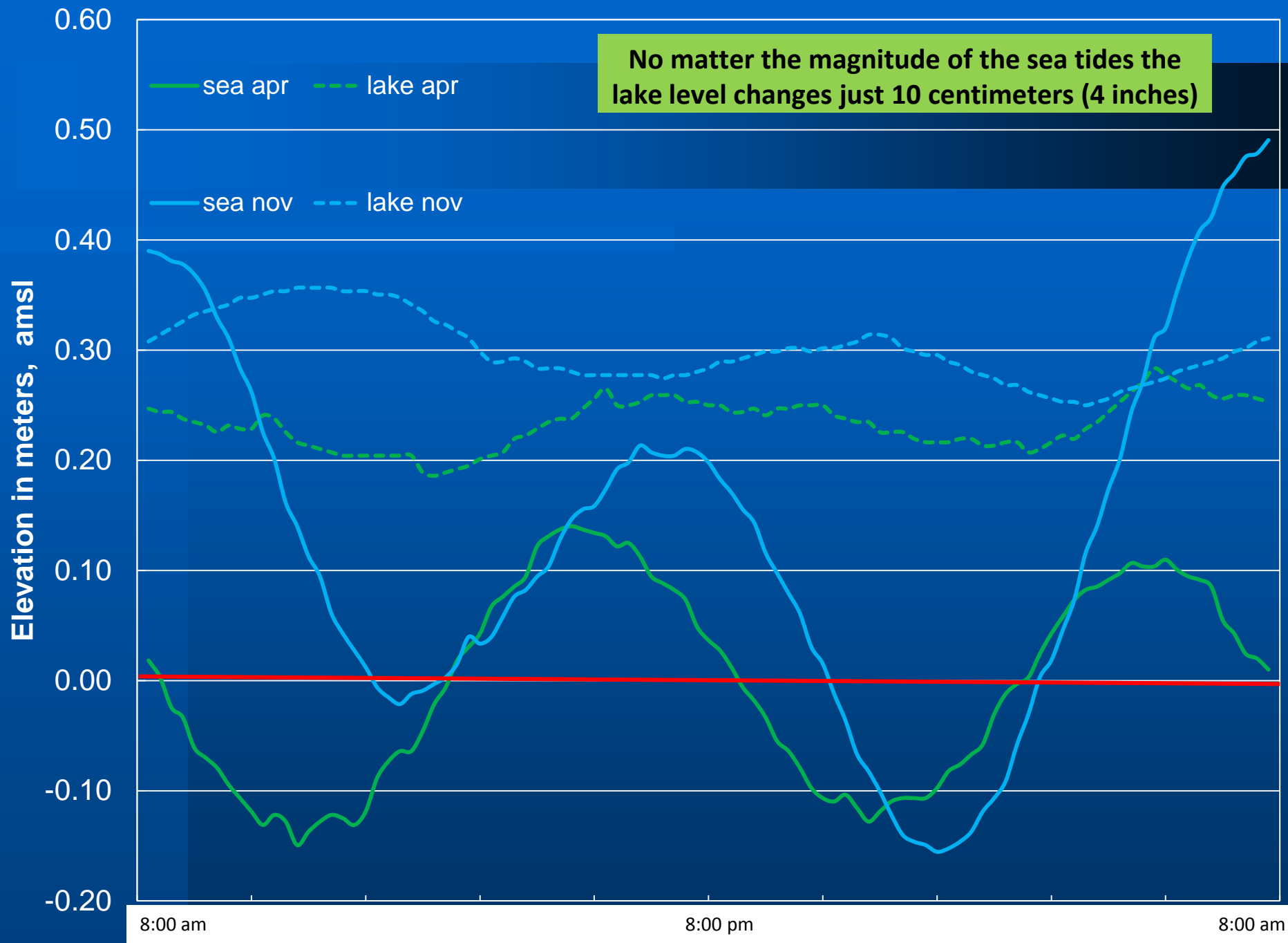
NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9755371 San Juan, PR
from 2010/11/28 - 2010/11/29



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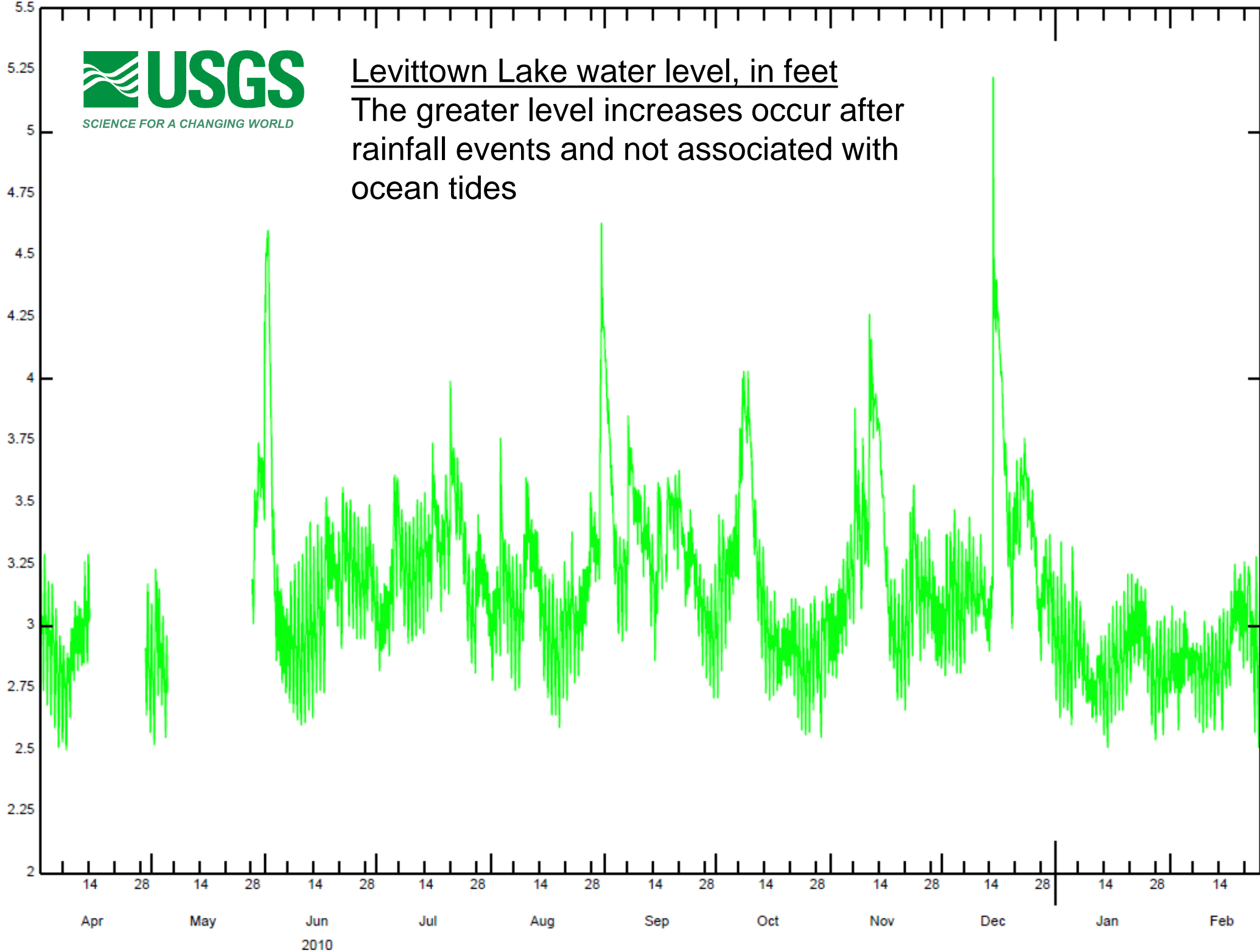
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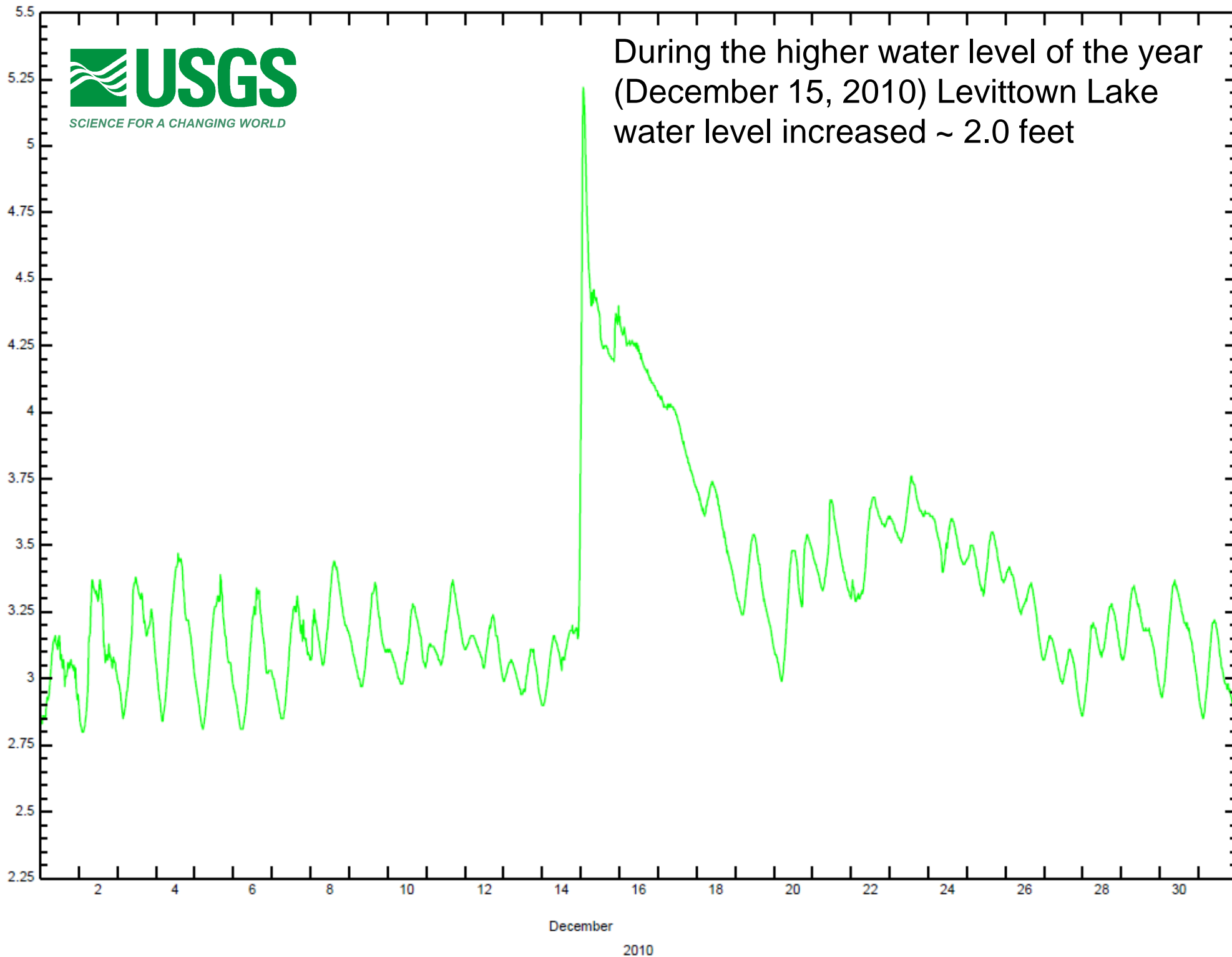
Levittown Lake water level, in feet

The greater level increases occur after rainfall events and not associated with ocean tides





During the higher water level of the year (December 15, 2010) Levittown Lake water level increased ~ 2.0 feet





The wider, deeper channel is mostly closed

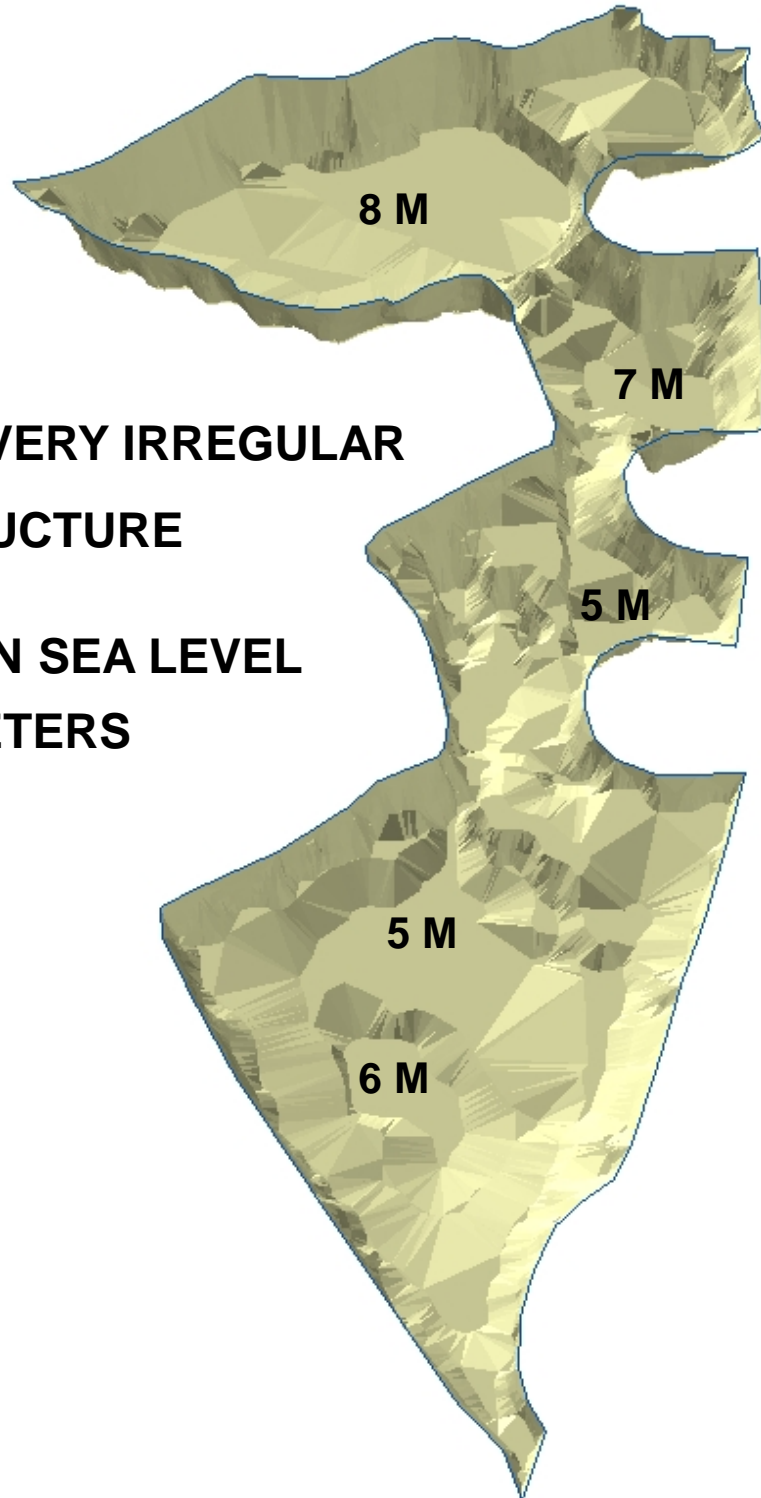


The real problem is the narrow shallow channel.
Only 29,000 m³ reach the lake daily



Navigation guides for bathymetry





**THE LAKE BOTTOM IS VERY IRREGULAR
FOR A MAN-MADE STRUCTURE**

**LAKE VOLUME AT MEAN SEA LEVEL
1.37 MILLION CUBIC METERS**



NET WATER BALANCE – HIGH AND LOW TIDES

- TYPICAL FLUSH IS 29,000 M³/DAY
- EVERY DAY FLUSHES 2% OF ENTIRE VOLUME
- FLUSHES ENTIRE VOLUME EVERY 48 DAYS
- FLUSHES ENTIRE VOLUME 8 TIMES PER YEAR
- FLUSHING RATE COULD BE INCREASED SUBSTANTIALLY BY WIDENING AND DEEPENING THE CHANNEL – POTENTIALLY FROM 2 TO 120 %

POOR HYDRAULIC CONNECTION WITH OCEAN



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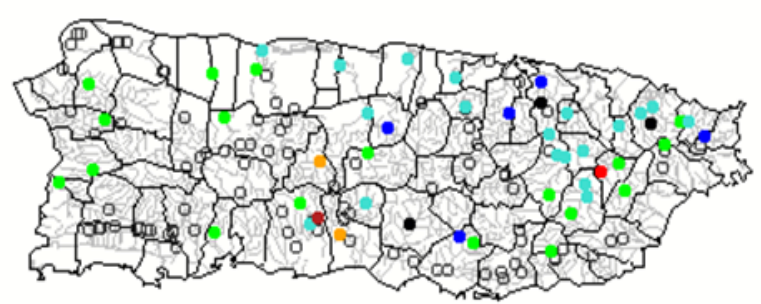
DATA CENTER

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Welcome to the USGS Caribbean Water Science Center. These pages are your source for water-resource information collected and interpreted by the U.S. Geological Survey in the Caribbean.

Mon., Sept. 19, 2011 11:30ET



- Caribbean Water Science Center activities include:
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 - ◆ Operation and oversight of an extensive network of water-resource monitoring sites.
 - ◆ Archive of water-resource information collected for more than 100 years.
 - ◆ Data collection and investigative studies related to issues of concern to water-management entities and citizens.
 - ◆ Publishing data and topical reports.

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Enter a USGS site number:

View site list: [SW](#) | [GW](#) | [WQ](#)

Quick Link to Water Data for Virgin Islands:
<http://waterdata.usgs.gov/vi/nwis>



Explanation - Percentile classes							
●	●	●	●	●	●	●	
Low	<10 Much below normal	10-24 Below normal	25-75 Normal	76-90 Above normal	>90 Much above normal	High	Not ranked

Caribbean Monitoring Networks

The USGS Caribbean Water Science Center continuously

Quick Access to Real-Time Monitoring Networks

VIRTUAL TOUR – WATER QUALITY AND TIDE STATION





VIRTUAL TOUR – 165 HIGHWAY VIEW FROM SEASHORE

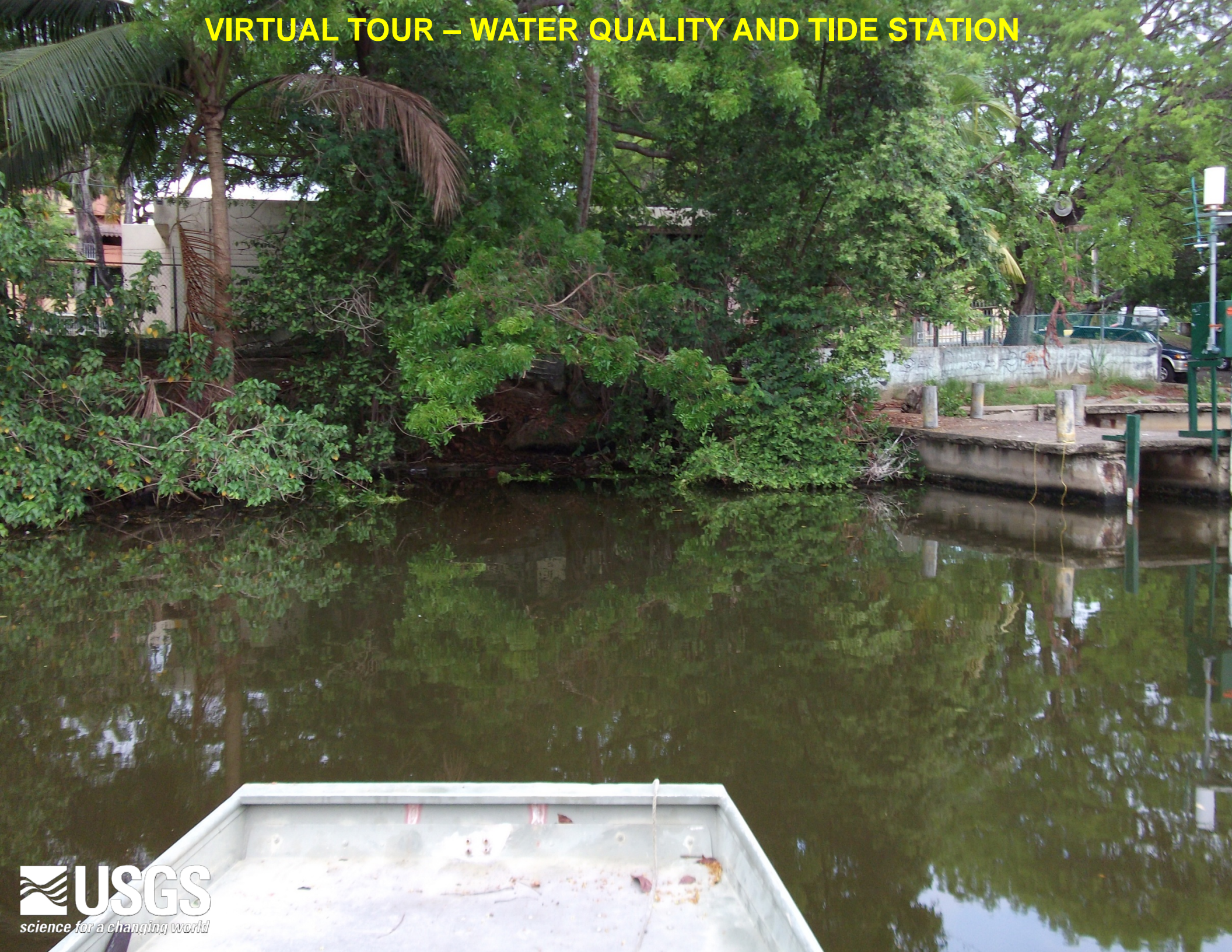






VIRTUAL TOUR – MANGROVE MORTALITY BLOCKS CHANNEL

VIRTUAL TOUR – WATER QUALITY AND TIDE STATION



VIRTUAL TOUR – FORMER LOCKS THAT CONTROLLED TIDES



VIRTUAL TOUR – PARTIALLY BLOCKED OCEAN CHANNEL





VIRTUAL TOUR – FULLY OPENED OCEAN CHANNEL

Camp site for tidal cycle studies – November 2010 and May 2011



Camp site for tidal cycle studies – November 2010 and May 2011



Camp site for tidal cycle studies – November 2010 and May 2011

