The City of New York
Department of Environmental Protection
Bureau of Wastewater Treatment

City-Wide Long Term CSO
Control Planning Project

Paerdegat Basin

Post-Construction Compliance Monitoring Analysis

February 2016

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LIST OF ACRONYMS

CSO	Combined Sewer Overflow
DEP	New York City Department of Environmental Protection
DO	Dissolved Oxygen
GM	Geometric Mean
IW	InfoWorks CS™
JEM	Jamaica Eutrophication Model
JEM-LT	Jamaica Eutrophication Model - Larval Transport
JFK	John F. Kennedy International Airport
LTCP	Long Term Control Plan
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
PCM	Post-Construction Compliance Monitoring
SPDES	State Pollution
STV	Standard Threshold Value
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

Located in southeastern Brooklyn, Paerdegat Basin extends from Flatlands Avenue at its head-end terminus to approximately the centerline of the Belt Parkway Bridge near its mouth, and includes all tidal wetlands, riparian areas, and associated uplands. The waterbody is classified by New York State (NYS) as Class I saline surface waters with best uses designated for primary contact recreation and fishing. The sewershed includes the entire combined sewer system serviced by the Coney Island Wastewater Treatment Plant (WWTP), and a small portion of the separately sewered area serviced by the Coney Island WWTP. In June 2011, the Paerdegat Basin Combined Sewer Overflow (CSO) Retention Facility (SPDES No. NY-0026182) began operation. The Paerdegat Basin CSO Retention Facility is designed to provide in-line storage of up to 20 MG of CSO, and off-line storage of an additional 30 MG of CSO. The Retention Facility provides for significant mitigation of the nuisance conditions (odors, exposed sediment mound, floatables) within the basin, which was its primary focus when originally planned. Dredging of the sediment mound near the head end of the basin was completed in August 2014.

An analysis of post-construction monitoring data and modeling results from the Jamaica Bay Eutrophication Model (JEM) was conducted to assess the water quality attainment of Paerdegat Basin since operation of the Paerdegat Basin CSO Retention Facility began. Both data and modeling results show that Paerdegat Basin generally attains current Class I water quality standards. Based on model results at the most critical cells in the model, attainment of recreational season fecal coliform criteria and annual DO criteria is very high, as shown in Table ES-1. Therefore, Paerdegat Basin should be considered in attainment with current standards.

Table ES-1. Summary Attainment

Indicator	Location	Attainment (%)
		Model
Fecal Coliform	PB2	95[1]
Time to Recover	PB3	26[2]
Enterococci	PB2	78[1]
DO	PB2	95[3]
Notes: (1) Recreation Season (2) Hours (3) Annual		

1.0 INTRODUCTION

Located in southeastern Brooklyn, Paerdegat Basin extends from Flatlands Avenue at its head-end terminus to approximately the centerline of the Belt Parkway Bridge near its mouth, and includes all tidal wetlands, riparian areas, and associated uplands. The waterbody is classified by NYS as Class I saline surface waters with best uses designated for primary contact recreation and fishing. The sewershed includes the entire combined sewer system serviced by the Coney Island WWTP, and a small portion of the separately sewered area serviced by the Coney Island WWTP. The sewershed includes 6,522 acres of combined sewer areas that led to five CSO outfalls that previously discharged directly to Paerdegat Basin. A CSO Long term Control Plan was developed to address the CSO discharges. This plan included the construction of a CSO retention facility. In June 2011, the Paerdegat Basin CSO Retention Facility (SPDES No. NY-0026182), located at 1887 Ralph Avenue in Brooklyn, began operation. The Paerdegat Basin CSO Retention Facility is designed to provide in-line storage of up to 20 MG of CSO, and off-line storage of an additional 30 MG of CSO. The facility was certified complete on May 31, 2011.

The Retention Facility provides for significant mitigation of the nuisance conditions (odors, exposed sediment mound, floatables) within the basin, which was its primary focus when originally planned. The Retention Facility was predicted to improve dissolved oxygen (DO) compliance to over 90 percent (DO standard of never less than 4 mg/L) in most areas, and total and fecal coliform was predicted to comply with the monthly geometric mean (GM) secondary contact standards on an annual basis for 2,000/100mL fecal coliform, allowing for the full attainment of the previously designated use of Paerdegat Basin for boating, canoeing and kayaking. In November 2015, New York State Department of Environmental Conservation (NYSDEC) issued new rulemaking that requires all waterbodies to meet primary contact standards for bacteria, which decreases the allowable fecal coliform concentrations to a monthly GM value of 200/100mL.

This document provides a detailed analysis of existing data that has been collected since the construction of the Retention Facility, as well as an analysis of modeling results to assess the attainment of the new Class I bacteria and dissolved oxygen water quality criteria in Paerdegat Basin.

2.0 DATA ANALYSIS

2.1   Waters Impacted by Paerdegat Basin CSO Retention Facility

2.1.1   Water Quality Monitoring Results—Paerdegat Basin/Jamaica Bay

Post-Construction Compliance Monitoring (PCM) for the Paerdegat Basin CSO Retention Facility consists of sample collection at two locations in Paerdegat Basin (Stations PB2 and PB3). In addition, New York City Department of Environmental Protection's (DEP) Harbor Survey program samples water quality at one nearby location in Jamaica Bay (Station J10). The applicable NYS water quality criteria are Class I at Stations PB2 and PB3 and Class SB at Station J10. Figure 2-1 presents a map of these station locations.

**Figure 2-1. Paerdegat Basin CSO Retention Facility
Location of Facility and Water Quality Monitoring Station**

Assessment of Monitoring Data

The following analysis assesses water quality data observed at Stations PB2, PB3, and JB10 following activation of the Paerdegat Basin CSO Retention Facility in June 2011 through early November 2015.

Figures 2-2 through 2-16 graphically summarize measured DO, fecal coliform bacteria, and enterococci bacteria at each station from the Harbor Survey Monitoring Program. The data are presented on an annual basis. Reference levels corresponding to NYS water quality standards for Paerdegat Basin (Class I) and Jamaica Bay (Class SB) are shown on the appropriate panels, as indicated by the plot legends. DO is measured with both a laboratory method (Winkler analysis) and with a YSI brand probe used in situ. The Winkler analysis is considered the more reliable of the two methods.

The data plots are ordered in groups of three pages—one page for each station—segregated by year. Thus, Figure 2-2 through Figure 2-4 present data for 2011; Figure 2-5 through Figure 2-7 present data for 2012; Figure 2-8 through Figure 2-10 present data for 2013; Figure 2-11 through Figure 2-13 present data for 2014; and Figure 2-14 through Figure 2-16 present data for 2015.

DO data for years 2011–2015 show a general rise in minimum DO concentrations at Stations PB2 and PB3, with years 2014 and 2015 being 100 percent compliant with Class I standards. This apparent trend might reflect a general decrease in sediment oxygen demand within Paerdegat Basin due to capture of CSO solids by the CSO Retention Facility in conjunction with recently completed dredging project. A similar increase in minimum DO concentrations is apparent at Station J10, but the increasing trend is smaller and has less impact on compliance with the Class SB standards but overall compliance with DO standards is very high at all locations. DO compliance statistics at Stations PB2, PB3, and J10 are summarized below in Table 2-1. Note that for Station JB10, the daily average is based on a single measurement.

Table 2-1. Annualized DO Compliance Statistics

PB2 (Class I)	DO ≥ 4.0 mg/L		PB3 (Class I)	DO ≥ 4.0 mg/L	
Year	Surface Data	Bottom Data	Year	Surface Data	Bottom Data
2011	75%	75%	2011	94%	n/a
2012	78%	82%	2012	89%	n/a
2013	88%	92%	2013	100%	n/a
2014	100%	100%	2014	100%	n/a
2015[1]	100%	100%	2015[1]	100%	n/a

J10 (Class SB)	DO ≥ 3.0 mg/L		Daily Average DO ≥ 4.8 mg/L	
Year	Surface Data	Bottom Data	Surface Data	Bottom Data
2011	100%	100%	95%	95%
2012	100%	100%	88%	92%
2013	100%	100%	100%	96%
2014	100%	100%	96%	96%
2015[1]	100%	100%	100%	100%
Notes: (1) 2015 is the first full year after dredging was completed. Note the high level of attainment.				

Recreational season (May 1st through October 31st) fecal coliform compliance (monthly GM ≤ 200 cfu/100mL for primary contact) shows considerable improvement in years 2013–2015 versus years 2011–2012. This improvement is more consistent at Stations PB3 and J10. Station PB2 is closer to the CSO outfall and, thus, shows more water quality variability when wet-weather events exceed capacity of the Paerdegat Basin CSO Retention Facility. It should be noted that, for most months, fewer than the minimum five samples per 30-day period to assess compliance are collected; therefore, percent compliance cannot be calculated. However, as illustrated on Figures 2-2 through 2-16, the overall water quality looks very good for both pathogens indicators and dissolved oxygen.

In general, water quality improves from the inner portion of Paerdegat Basin towards the mouth and into Jamaica Bay. In 2011, after the facility began operations, the recreational season geometric mean of fecal coliform was greater than 200 cfu/100mL at Stations PB2 and PB3. However, there has been a steady decline in the fecal coliform recreational season geometric mean, such that in 2015 the recreational season geometric mean was less than 65 cfu/100mL. Similarly, the recreational season rolling 30-day geometric mean, based on the available data, has been less than 35 cfu/100mL since 2012 at Stations PB2 and PB3. The dissolved oxygen data has been greater than or equal to 4.0 mg/L since 2014 at Stations PB2 and PB3.
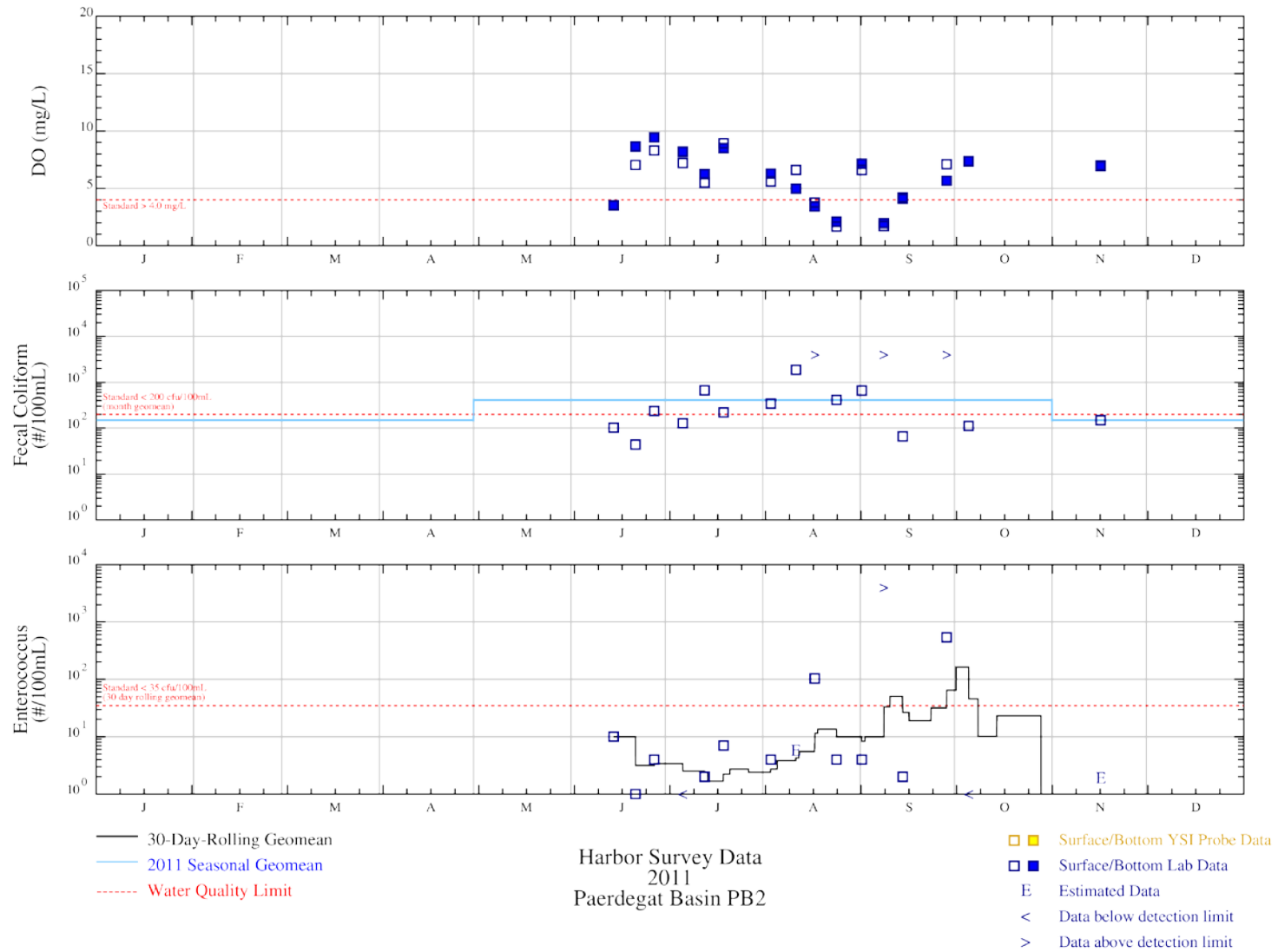
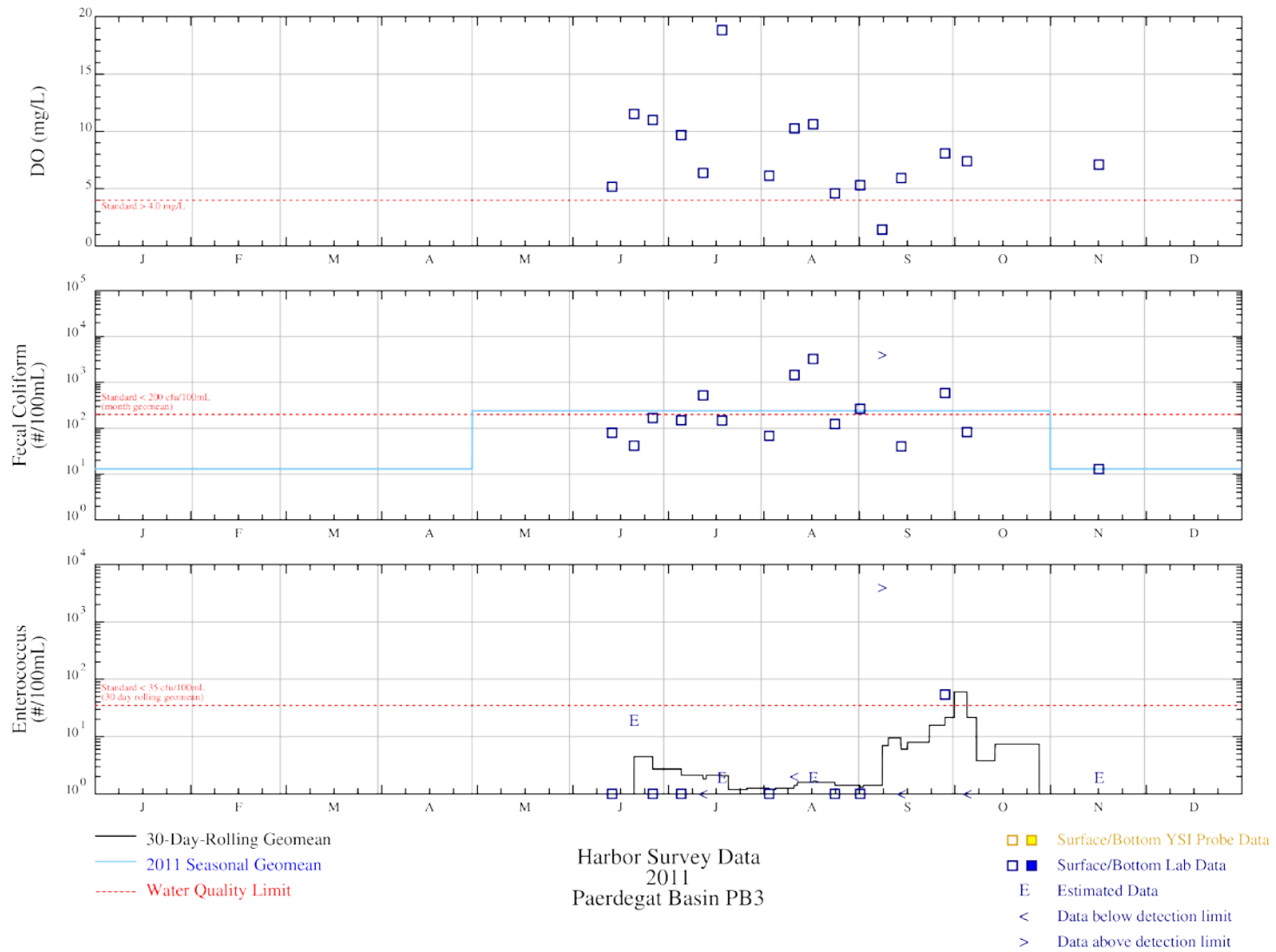**Figure 2-2. Data and Compliance Plot for Station PB2 (Class I) in Year 2011**

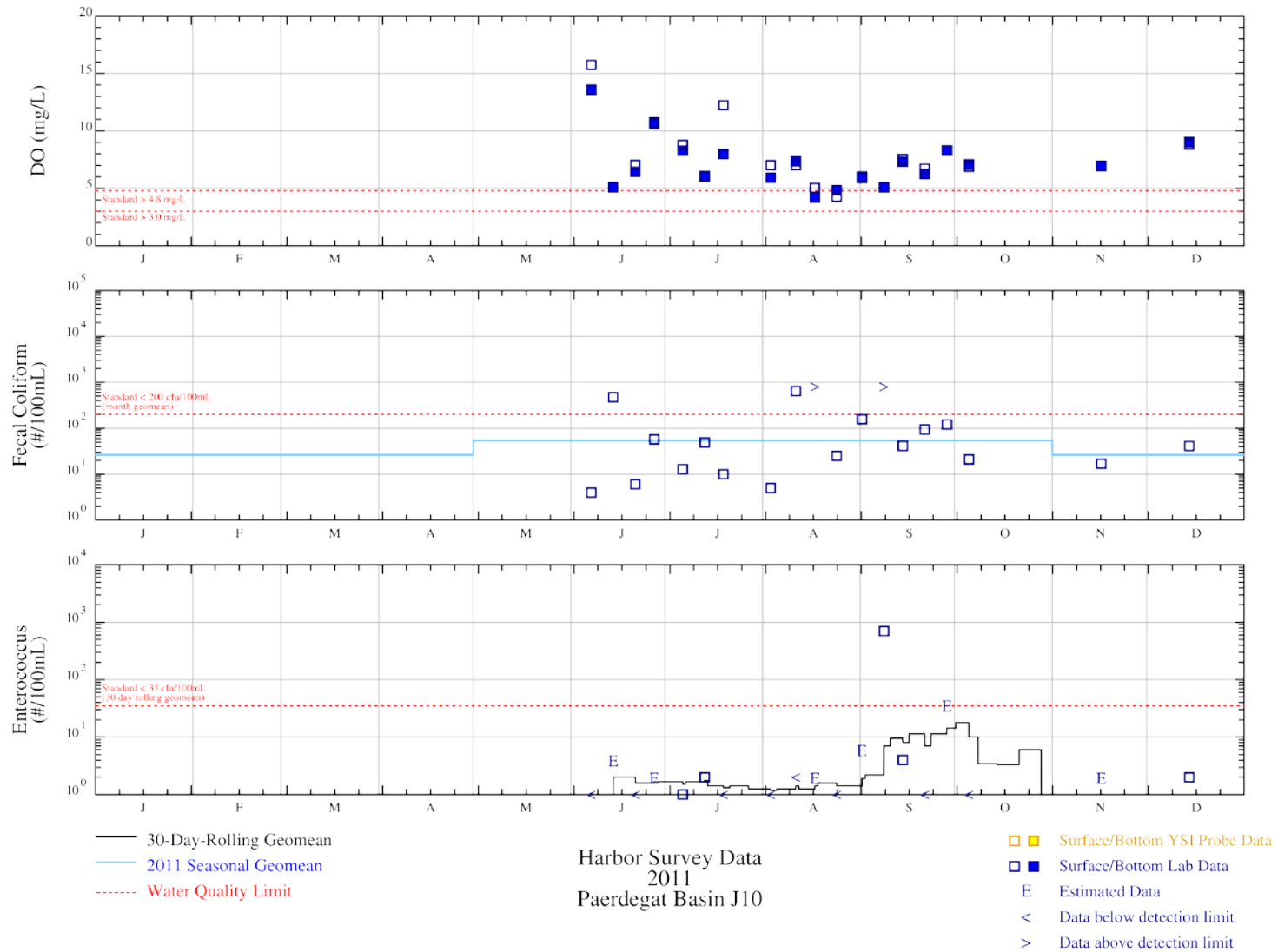**Figure 2-3. Data and Compliance Plot for Station PB3 (Class I) in Year 2011**

Figure 2-4. Data and Compliance Plot for Station J10 (Class SB) in Year 2011
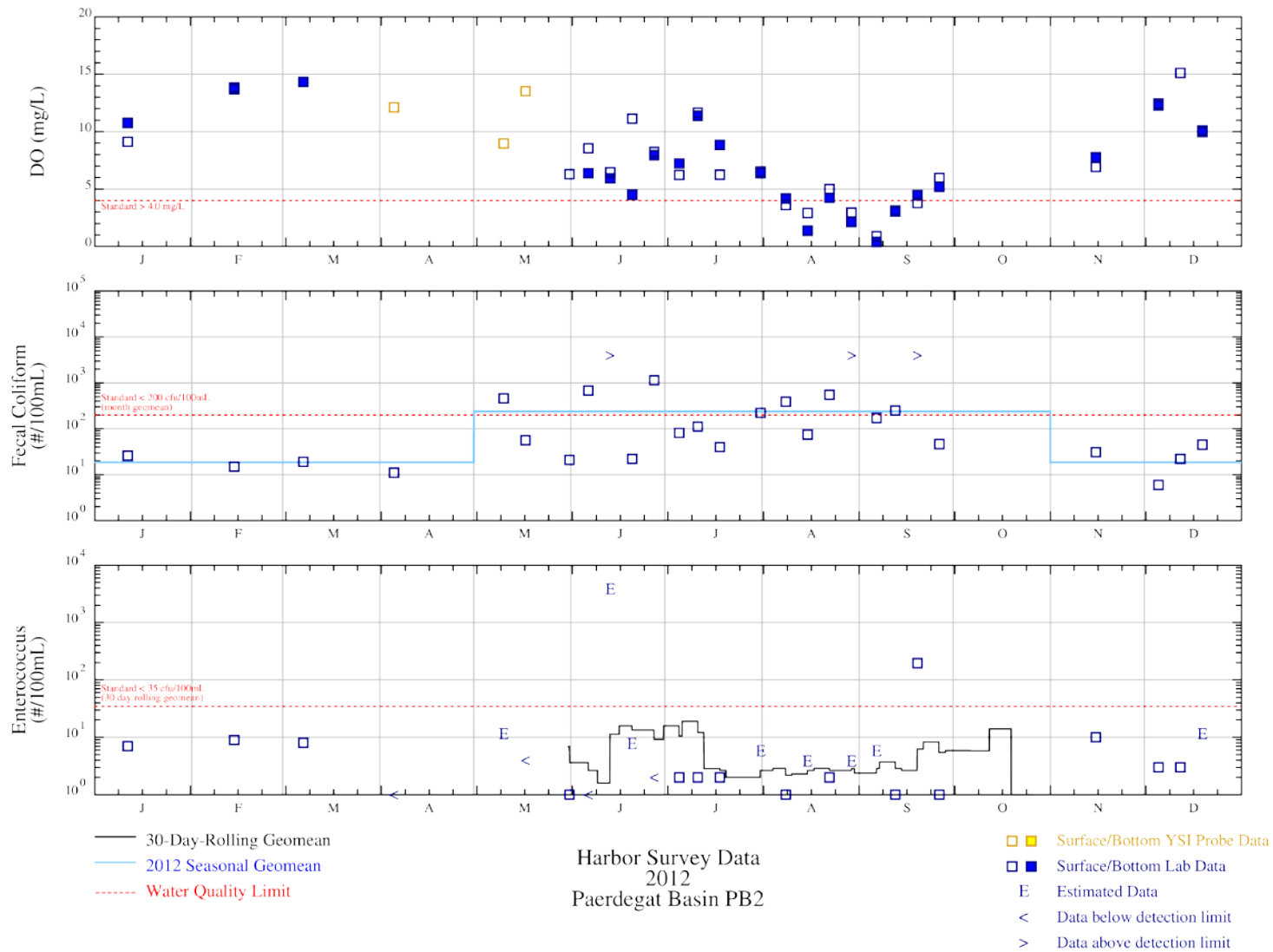
Figure 2-5. Data and Compliance Plot for Station PB2 (Class I) in Year 2012
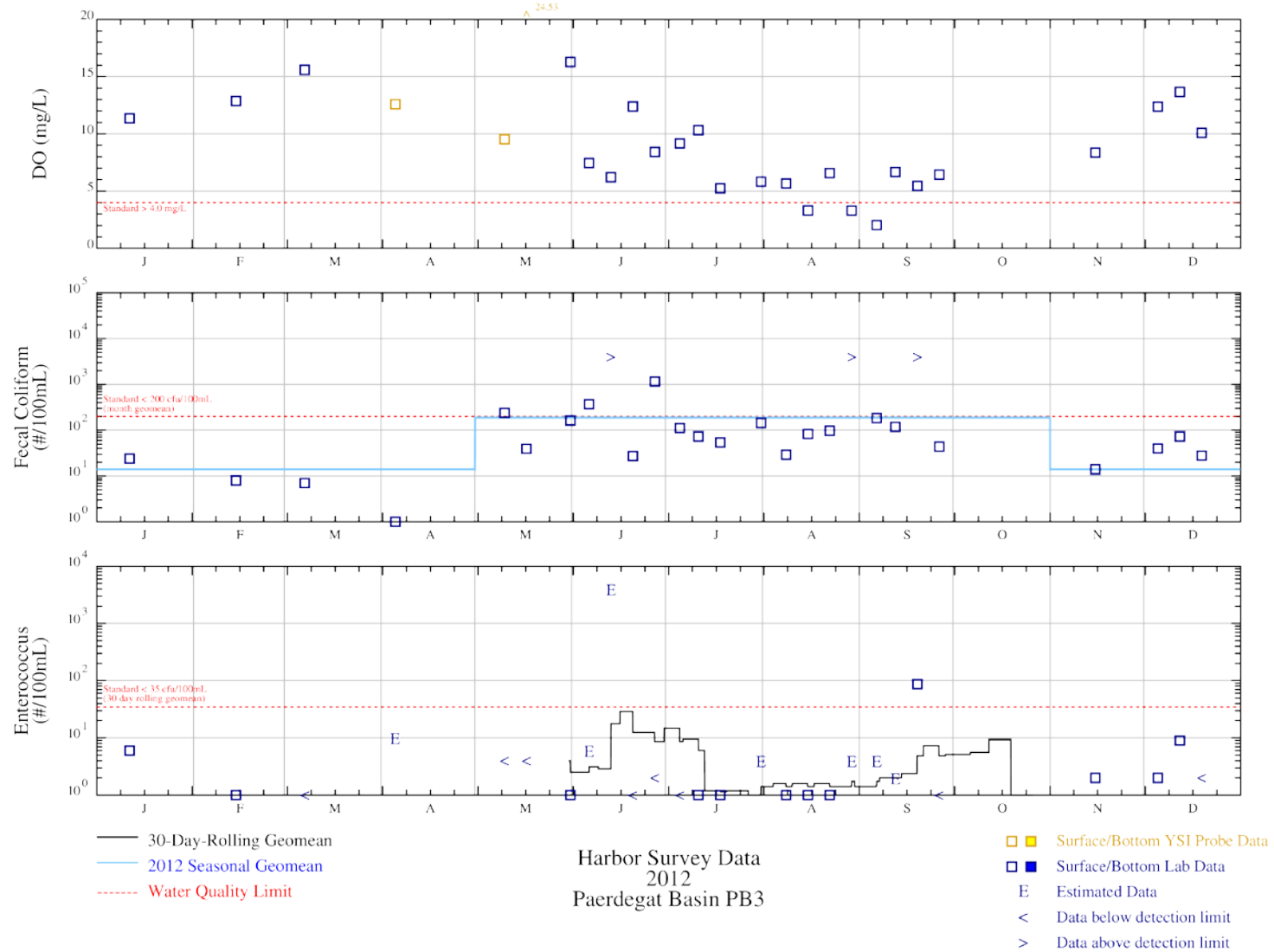
Figure 2-6. Data and Compliance Plot for Station PB3 (Class I) in Year 2012

Figure 2-7. Data and Compliance Plot for Station J10 (Class SB) in Year 2012

Figure 2-8. Data and Compliance Plot for Station PB2 (Class I) in Year 2013

Figure 2-9. Data and Compliance Plot for Station PB3 (Class I) in Year 2013
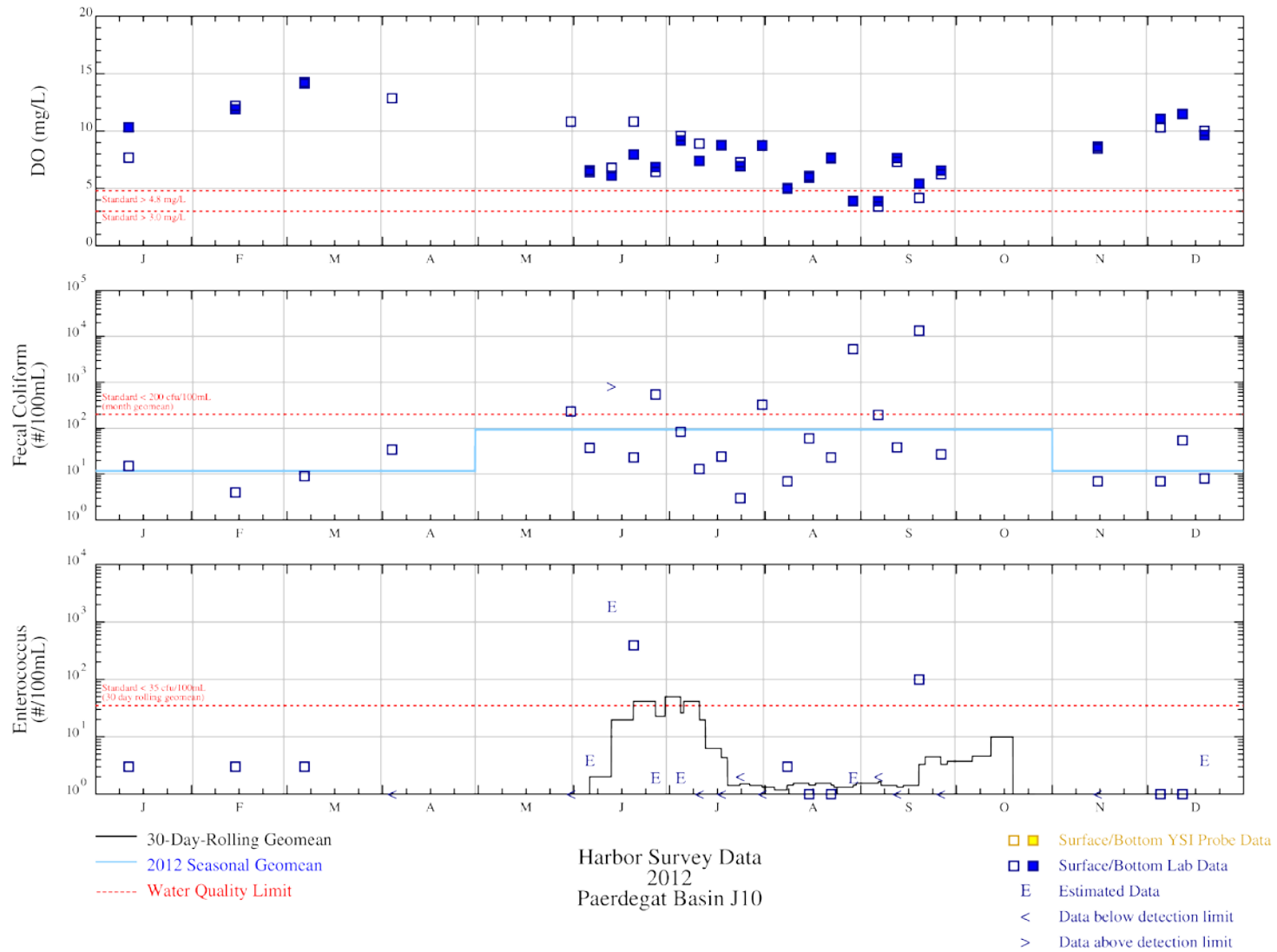
Figure 2-10. Data and Compliance Plot for Station J10 (Class SB) in Year 2013

Figure 2-11. Data and Compliance Plot for Station PB2 (Class I) in Year 2014

Figure 2-12. Data and Compliance Plot for Station PB3 (Class I) in Year 2014

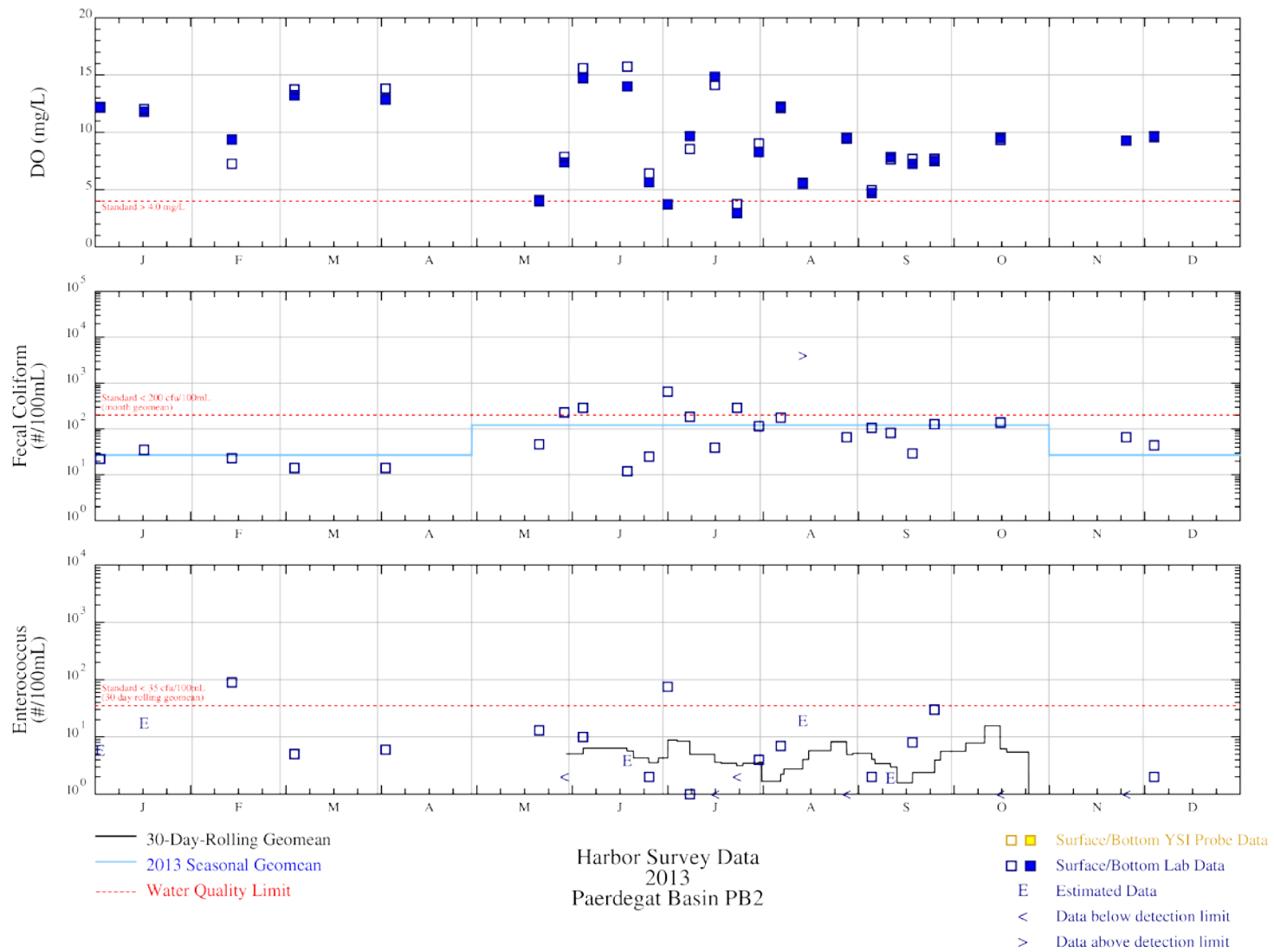**Figure 2-13. Data and Compliance Plot for Station J10 (Class SB) in Year 2014**

Figure 2-14. Data and Compliance Plot for Station PB2 (Class I) in Year 2015
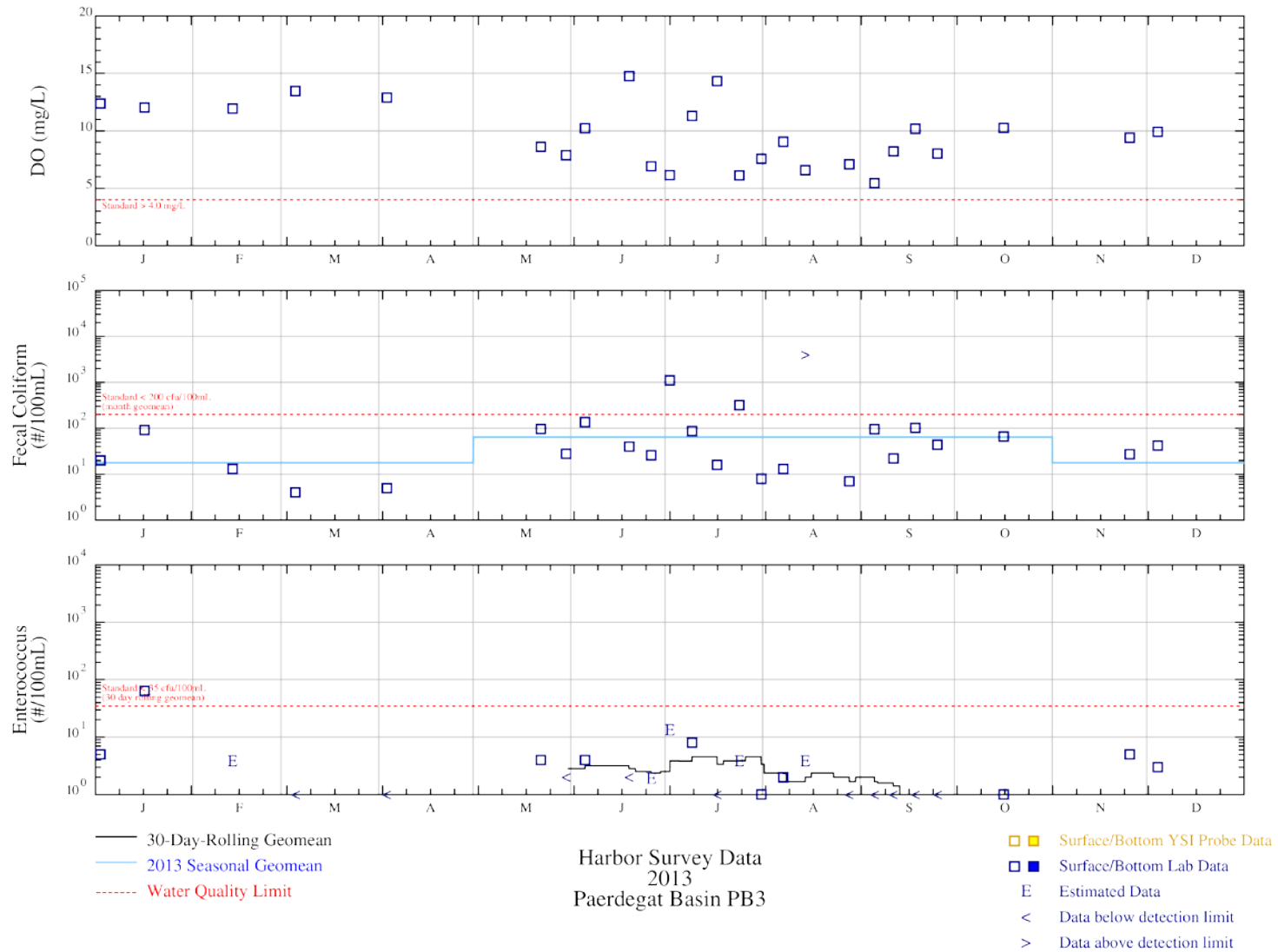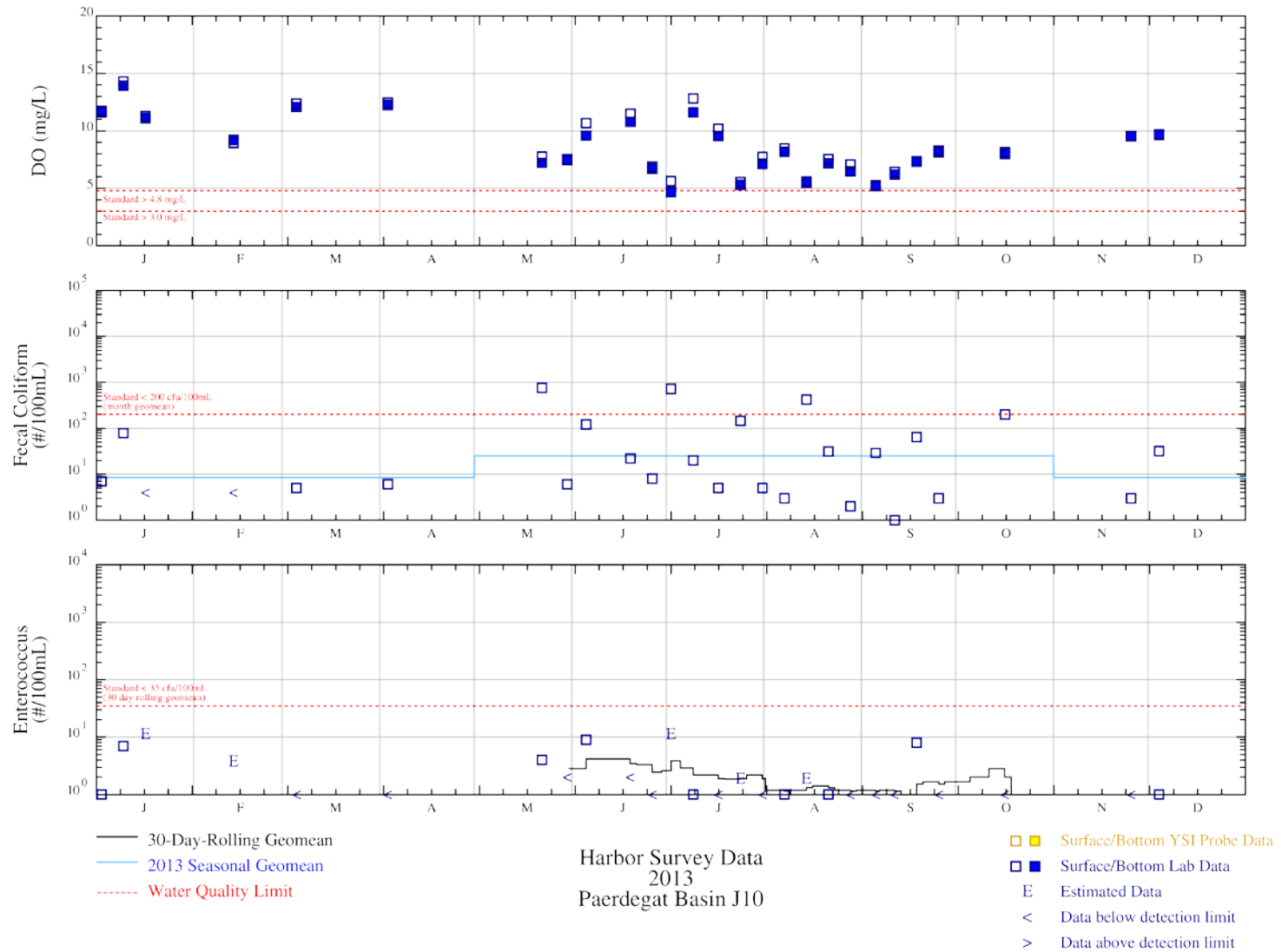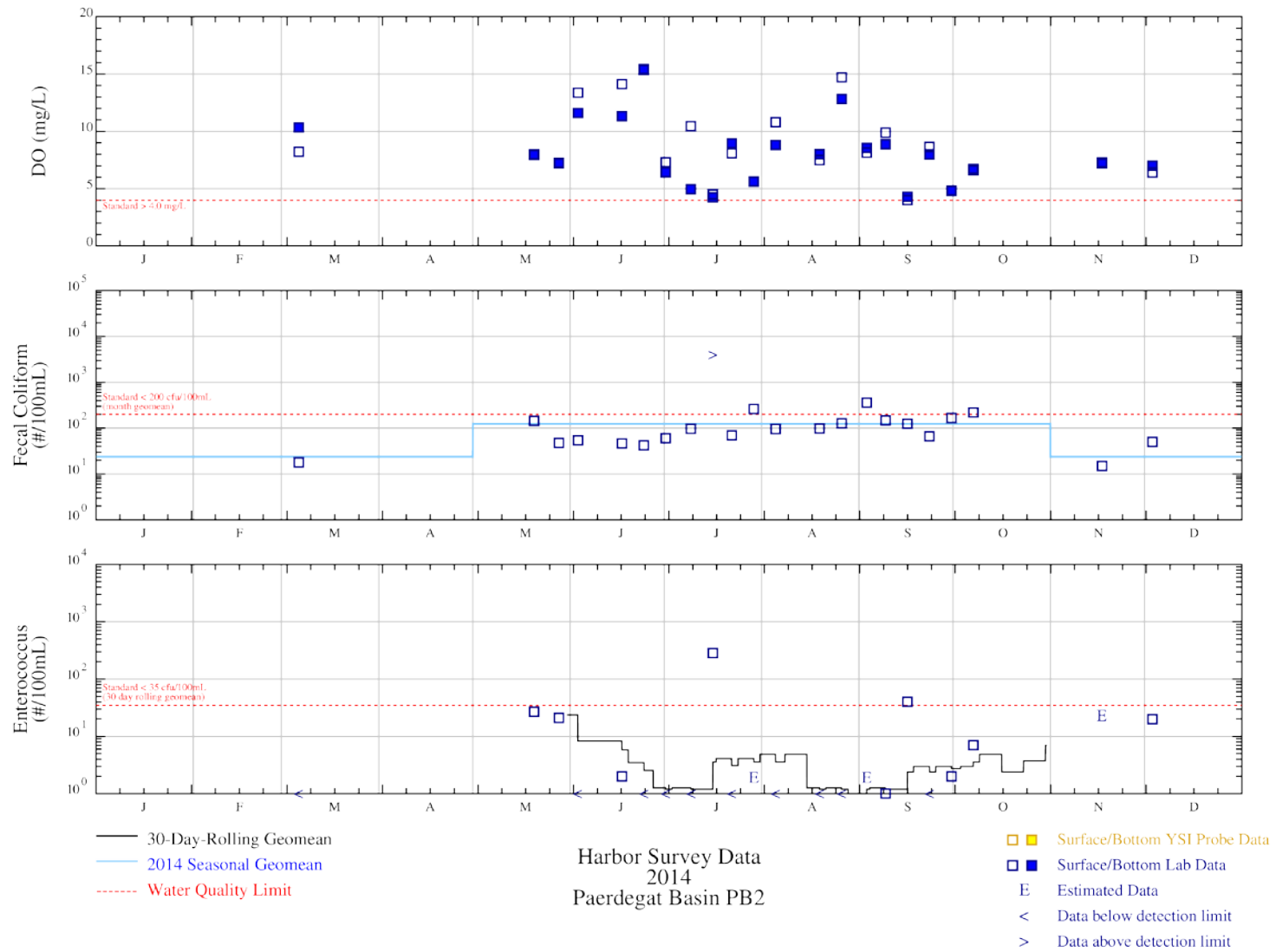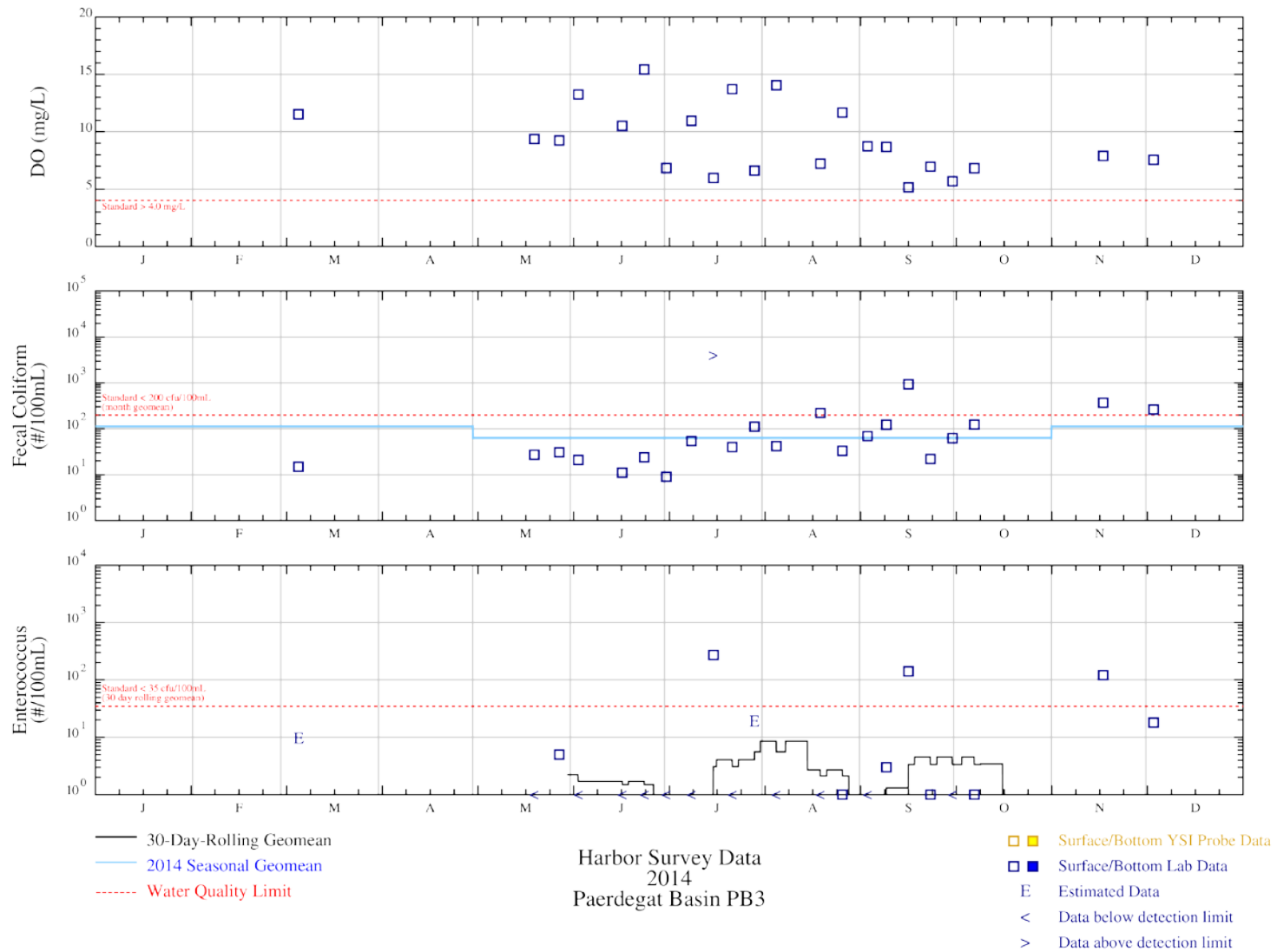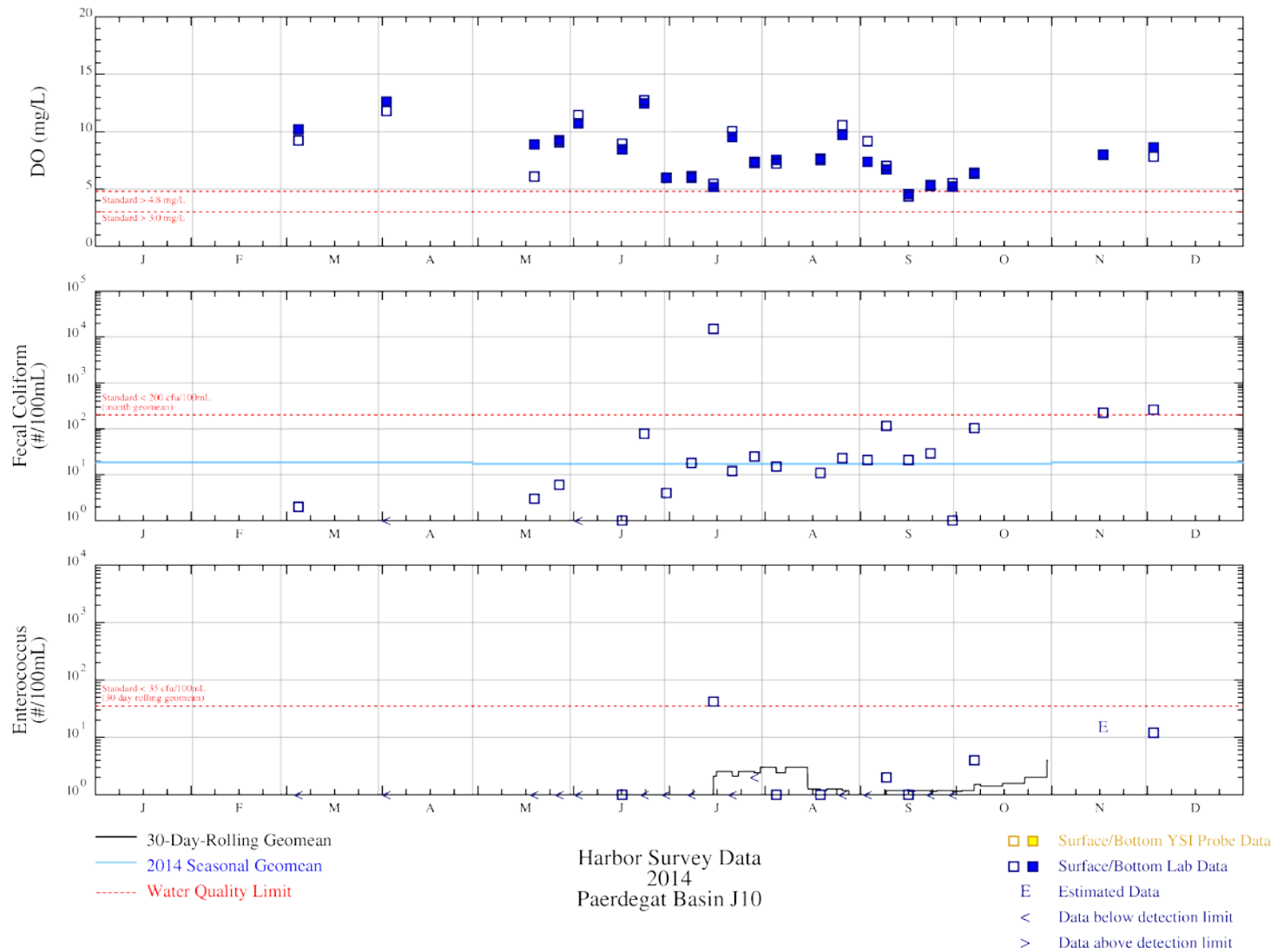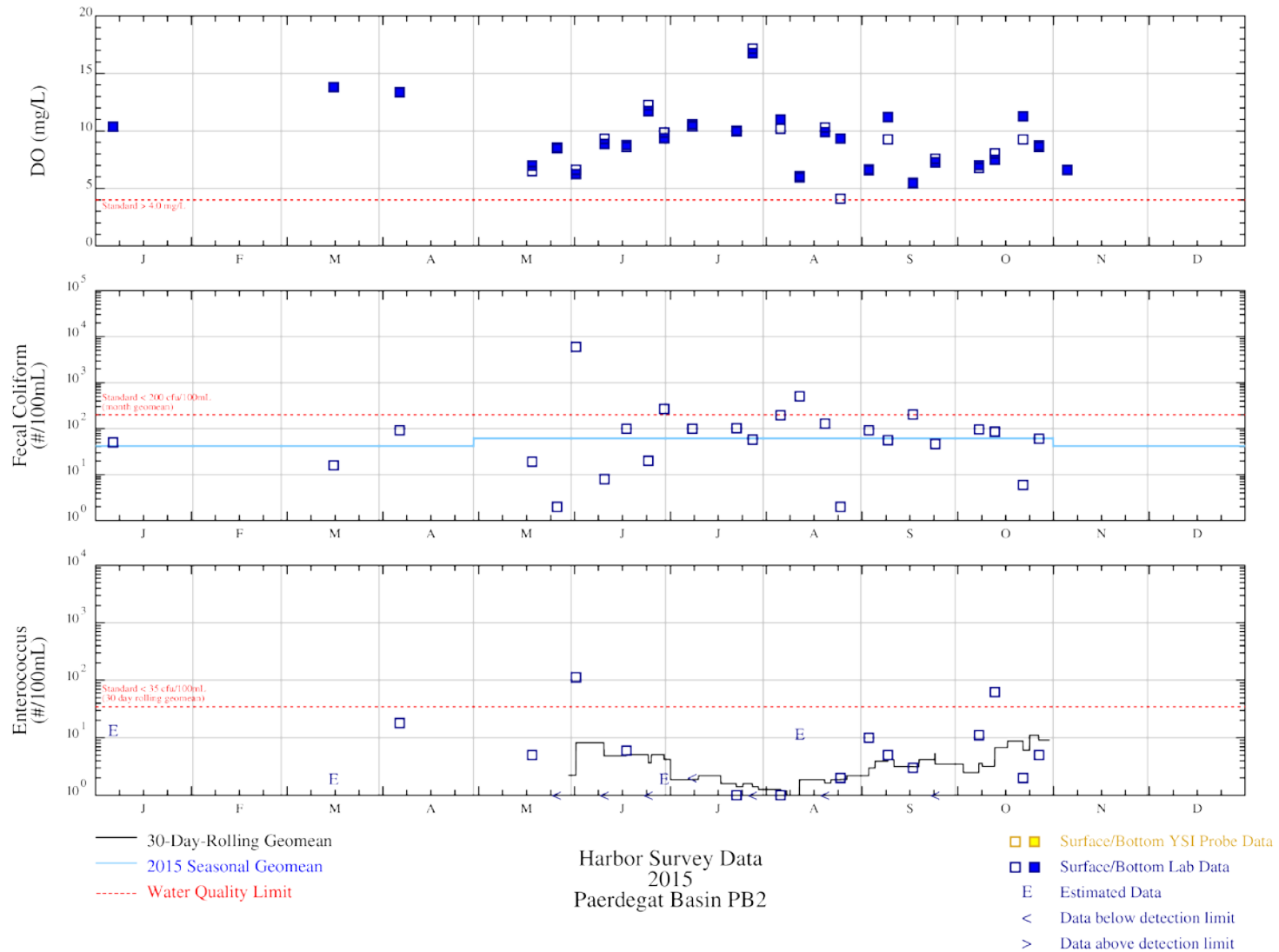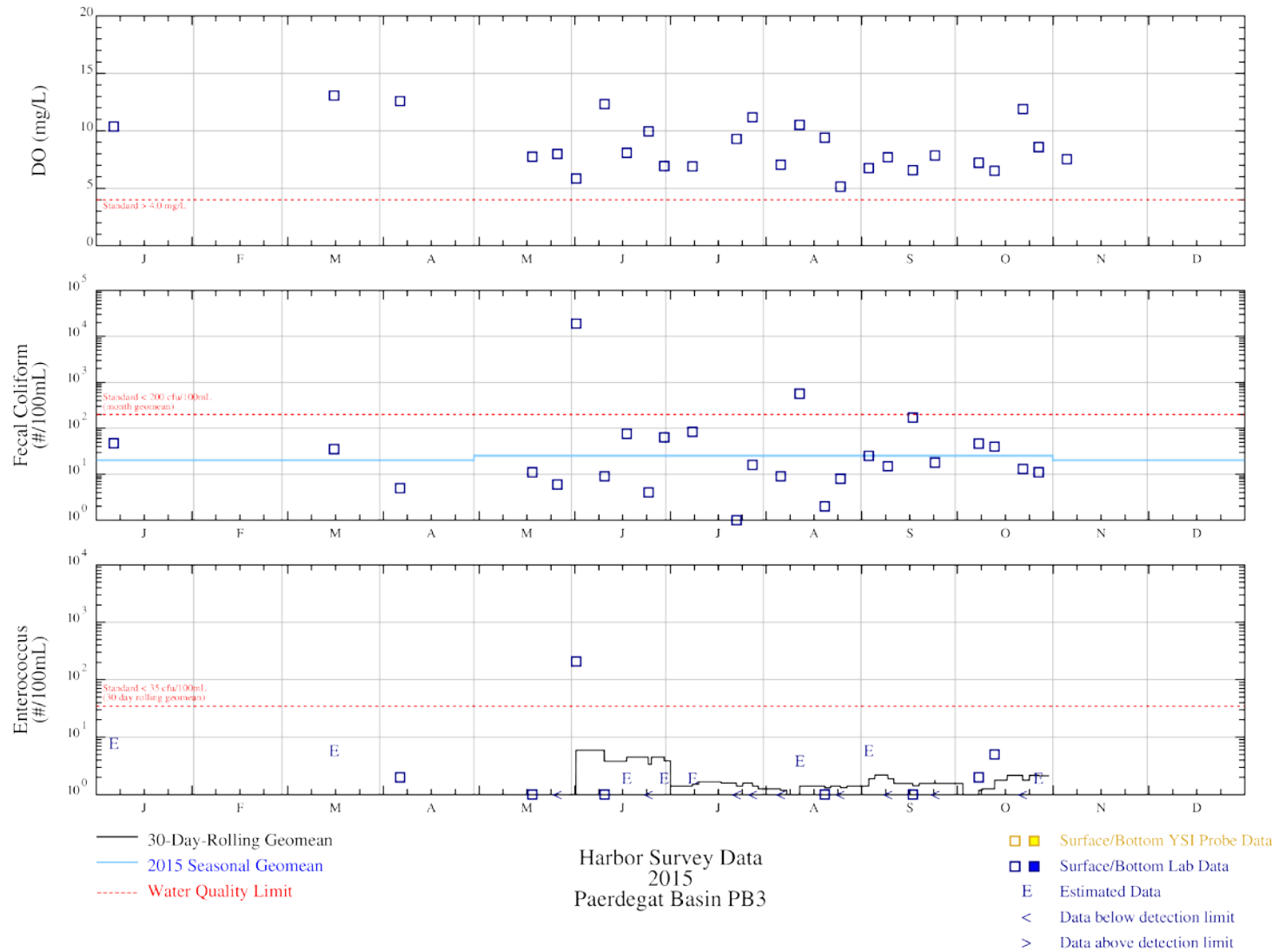
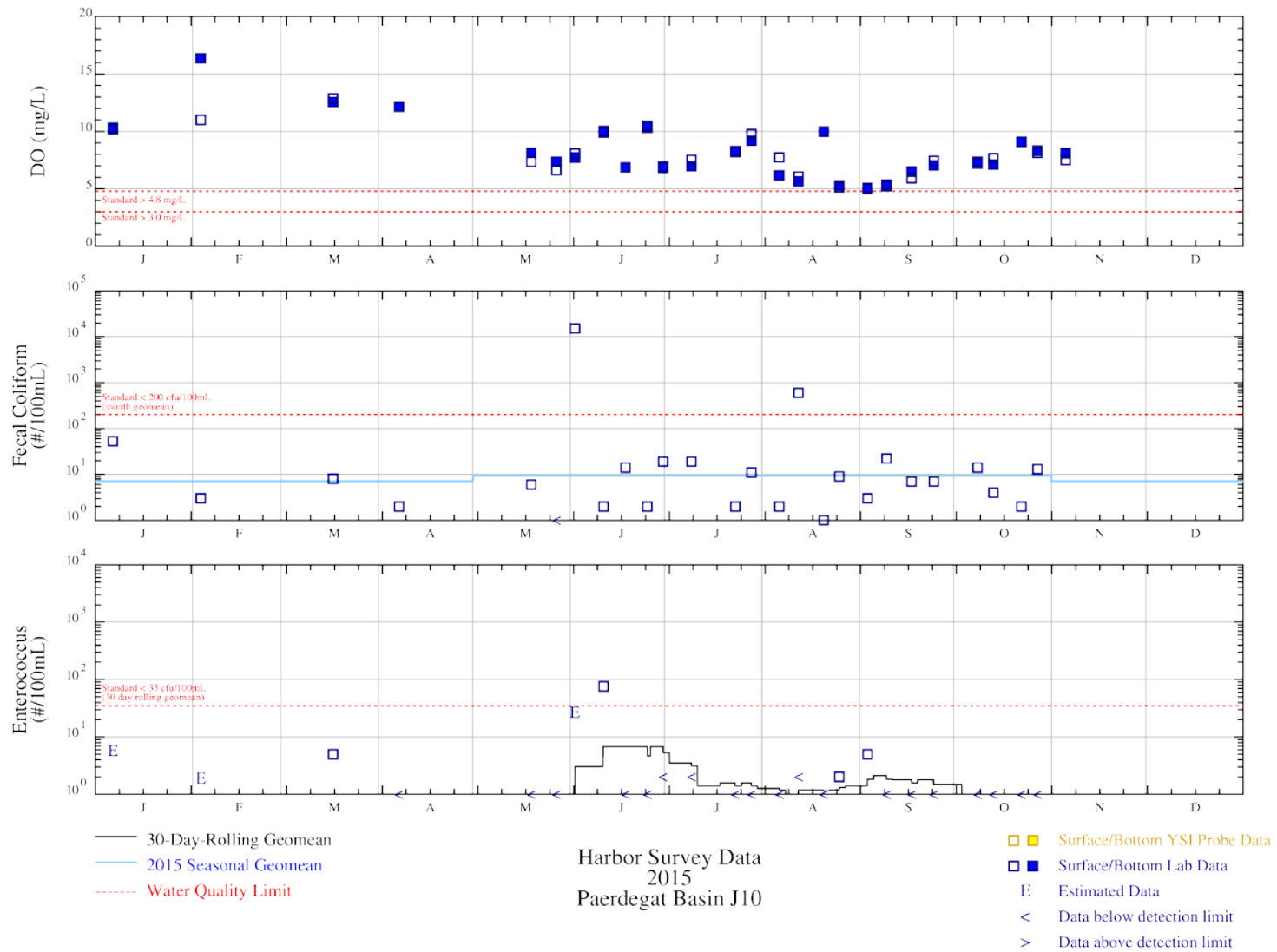**Figure 2-15. Data and Compliance Plot for Station PB3 (Class I) in Year 2015**

Figure 2-16. Data and Compliance Plot for Station J10 (Class SB) in Year 2015

3.0 MODELING ANALYSIS

3.1 Modeling Background

A modeling analysis was conducted as described herein to assess water quality conditions in Paerdegat Basin with the CSO Retention Facility operating. The approach taken for these analyses was to follow procedures that replicate the approach to similar analyses being performed for other waterbodies as part of the ongoing Long Term CSO Control Planning Study. The modeling analysis of Paerdegat Basin was performed using a combination of collection system, hydrodynamic, and water quality models. The InfoWorks CS™ (IW) collection-system models for the Owls Head and Coney Island WWTP service areas were applied to develop the quantities of discharged tank overflow, CSO, and stormwater to the receiving waters. Ten-year continuous IW model simulations were performed using 2002-2011 rainfall (JFK gage) and tidal conditions as input. Pollutant loads were determined through assignment of typical sanitary and stormwater concentrations to the volumetric sanitary and stormwater components of the discharges. Note that these loadings could change in the future based on data currently being collected to develop CSO LTCPs in Jamaica Bay.

The water quality model framework for the analysis was the Jamaica Eutrophication Model - Larval Transport (JEM-LT) that HDR|HydroQual developed in 2010 as a refinement to the JEM. The JEM-LT computational domain includes Paerdegat Basin, as well as all of Jamaica Bay, and provides a high level of spatial resolution for water quality simulations (Figure 3-1). The model is three-dimensional with ten vertical layers, and includes a hydrodynamic component (ECOM) to calculate tidal elevations and velocities. The information from the hydrodynamic model serves as input to the water quality model (RCA). RCA tracks the fate of pathogen concentrations using first-order decay kinetics, and computes DO concentrations based on complex eutrophication kinetics. For salinity and temperature, ECOM was verified using Harbor Survey data collected in 2012. 2012 Harbor Survey bacteria data in Paerdegat Basin was used to verify the model calibration. For DO, RCA was calibrated to data collected in 1995 and 1996 during DEP's Jamaica Bay Eutrophication Study and compared against data collected during 2012. The current analysis focuses on the Paerdegat Basin portion of the model domain. The model's comparison to data collected in Paerdegat Basin is presented in Appendix A.

JEM-LT bacteria results are based on conditions being used for the CSO LTCP project, the 10-year period of 2002 through 2011. This 10-year period was chosen to reflect the expected year-to-year variability in meteorological conditions that result in variable loading and ambient receiving-water conditions. DO model results are based on 2008 conditions, which is considered a typical year based on an analysis conducted for the CSO LTCP project. The model simulation conditions reflect future 2040 sanitary sewage flows at the Owls Head and Coney Island WWTPs and green infrastructure within the CSO areas. The modeling assumes no illicit dry-weather discharges are occurring.

Loads were based on previous work conducted for the Jamaica Bay and Tributaries Waterbody/Watershed work. Concentrations used for each source discharging into Paerdegat Basin are presented in Table 3-1. Sanitary concentrations are listed for the CSO source, but in reality these concentrations are mixed with the stormwater concentrations based on IW model output. Ongoing LTCP work suggests that the stormwater and direct drainage concentrations being used in this analysis are conservatively high.

Table 3-1. Concentrations Used for Source Loading

Source	Fecal Coliform (cfu/100mL)	Enterococci (cfu/100mL)	BOD (mg/L)
CSO (Sanitary)	4,000,000	1,000,000	120
Stormwater	120,000	50,000	15
Direct Drainage	120,000	50,000	15

Figure 3-1. Model Grid

3.2 Bacteria

Model results were extracted from five points within Paerdegat Basin, the three Harbor Survey station locations, plus a location at the head end of the basin and a location between Harbor Survey Stations PB2 and PB3 (labeled PB2-3). Model results were averaged over all ten layers. Table 3-2 presents the predicted annual and recreation season (May 1st through October 31st) attainment with the existing fecal coliform standard (30-day GM 200/100mL). NYSDEC has considered 95 percent attainment to be full compliance for the NYCDEP CSO LTCPs. Model results indicate that over the 10-year period that was analyzed, Paerdegat Basin achieves 95 percent or greater attainment of the fecal coliform criterion during the recreation season. The model also indicates that annual attainment of the former Class I 30-day GM fecal coliform criterion of 2,000 cfu/100mL is 100 percent.

**Table 3-2. Model Predicted Attainment of Fecal Coliform Criterion
(2002-2011 Conditions)**

Location	Seasonal Attainment (%)	Annual Attainment (%)
Head End	95	69
PB2	97	72
PB2-3	100	83
PB3	100	89
J10	100	98

NYSDEC has requested that a time to recover analysis be included in the development of CSO LTCPs. The time to recover is the period from the end of a precipitation event to when fecal coliform concentrations decrease to below 1,000 cfu/100mL. The time to recover analysis has been completed for Paerdegat Basin based on the design storm (August 15, 2008) being used for the NYCDEP CSO LTCPs. It is desirable to have time to recover times less than 24 hours. Table 3-3 presents the time to recover at four chosen locations in Paerdegat Basin. Paerdegat Basin is very close to the 24 hour target under the design storm conditions.

Table 3-3. Time to Recover

Location	Time to Recover (hours)
Head End	20
PB2	24
PB3	26
J10	19

NYSDEC has indicated that it plans to eventually promulgate enterococci water quality criteria based on U.S. Environmental Protection Agency's 2012 recommended water quality criteria. This would require attainment of either a recreational season 30-day rolling GM of 30 cfu/100mL with a standard threshold value (STV – 90th percentile) of 110 cfu/100mL, or a 30-day rolling GM of 35 cfu/100mL with an STV of 130 cfu/100mL. Table 3-4 presents the modeled recreation season attainment of the potential future enterococci criteria. The rolling 30-day GM criteria would not be met in Paerdegat Basin. The 90th percentile STV criteria attainment would be well below a goal of 95 percent.

**Table 3-4. Model Predicted Attainment of Potential Enterococci Criteria
(2002-2011 Recreation Season Conditions)**

Location	Recreation Season Percent Attainment			
	30-day GM 35 cfu/100mL	30-day GM 30 cfu/100mL	90th Percentile STV 130 cfu/100mL	90th Percentile STV 110 cfu/100mL
Head End	81	78	15	12
PB2	83	80	15	11
PB2-3	91	88	29	24
PB3	94	92	40	34
J10	99	98	71	66

3.3   Dissolved Oxygen

Paerdegat Basin has a DO water quality criterion of never less than 4.0 mg/L. Where Paerdegat Basin meets Jamaica Bay, the DO criteria change to never less than 3.0 mg/L and a daily average greater than or equal to 4.8 mg/L, with some allowances for occasional daily average excursions below 4.8 mg/L based on an exposure duration curve. Table 3-5 presents the attainment of the criteria for 2008 conditions. Attainment of the DO criteria in the bottom layer essentially meets the target of 95 percent. A water column average attainment would be even higher.

**Table 3-5. Model Predicted Attainment of
Dissolved Oxygen Criteria
(2008 Conditions)**

| Location	Bottom Layer Annual Attainment (%)
Head End	97.6
PB2	94.7
PB2-3	96.8
PB3	99.0
J10[1]	100
Notes: (1) J10 is Class SB	

4.0 CONCLUSIONS

Both the model and data indicate that the Paerdegat Basin CSO Retention Facility achieves the water quality attainment it was predicted to achieve. The former fecal coliform criterion of a monthly GM of less than 2,000 cfu/100mL and annual DO attainment of greater than 90 percent are currently being achieved. The data and model also indicate that Paerdegat Basin achieves or is close to achieving the primary contact recreation fecal coliform criterion and the time to recover target of 24 hours. If the enterococci criteria are promulgated, then additional CSO and/or stormwater controls might be necessary to reduce concentrations to levels that would achieve compliance based on model results. Existing data suggests that Paerdegat Basin may already be achieving the rolling 30-day GM targets for enterococci. Table 4-1 provides a summary of the model estimates of attainment in the areas with the lowest levels of attainment.

Table 4-1. Summary Attainment

Indicator	Location	Attainment (%)
		Model
Fecal Coliform	PB2	95[1]
Time to Recover	PB3	26[2]
Enterococci	PB2	78[1]
DO	PB2	95[3]

Notes:
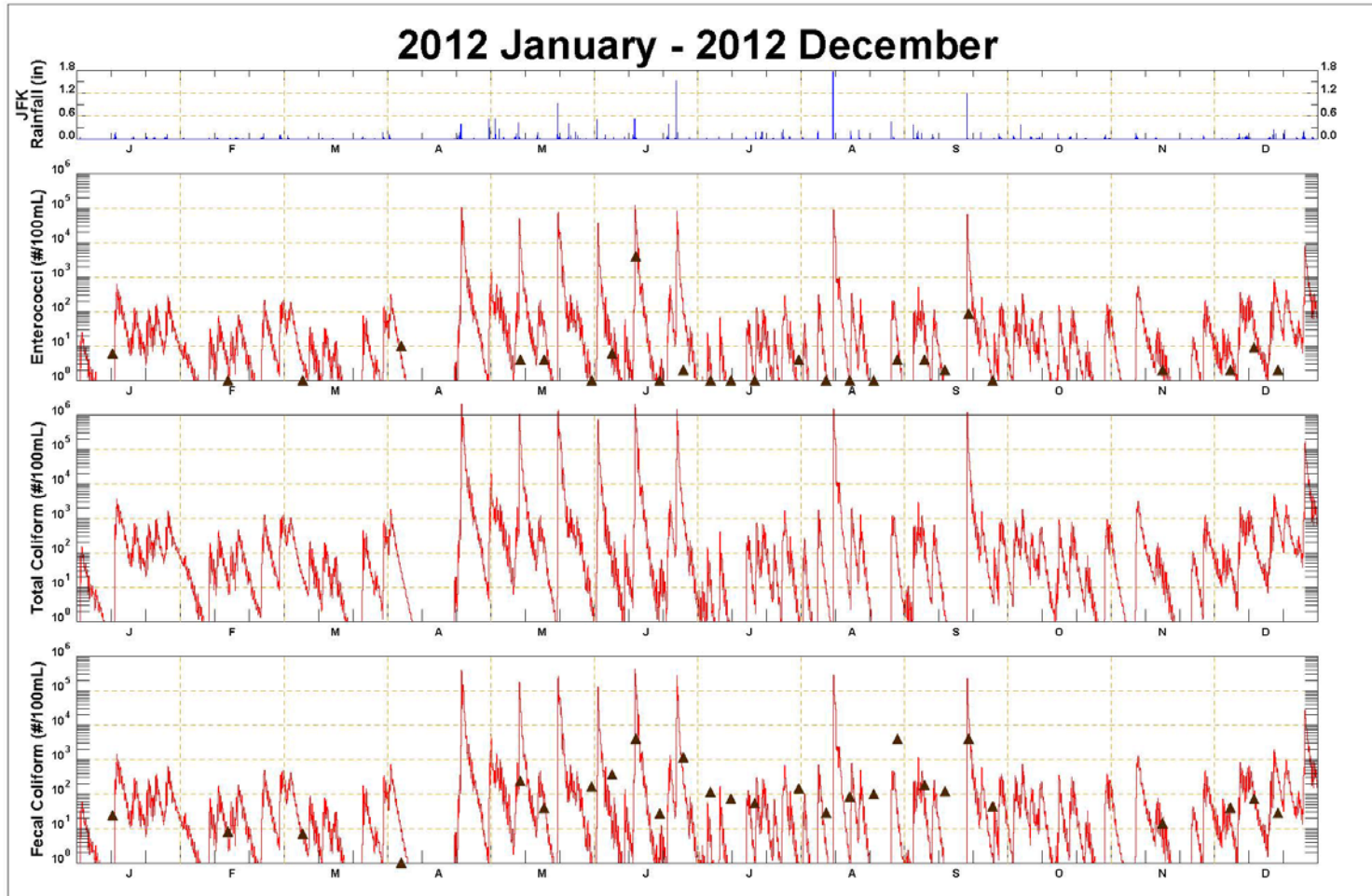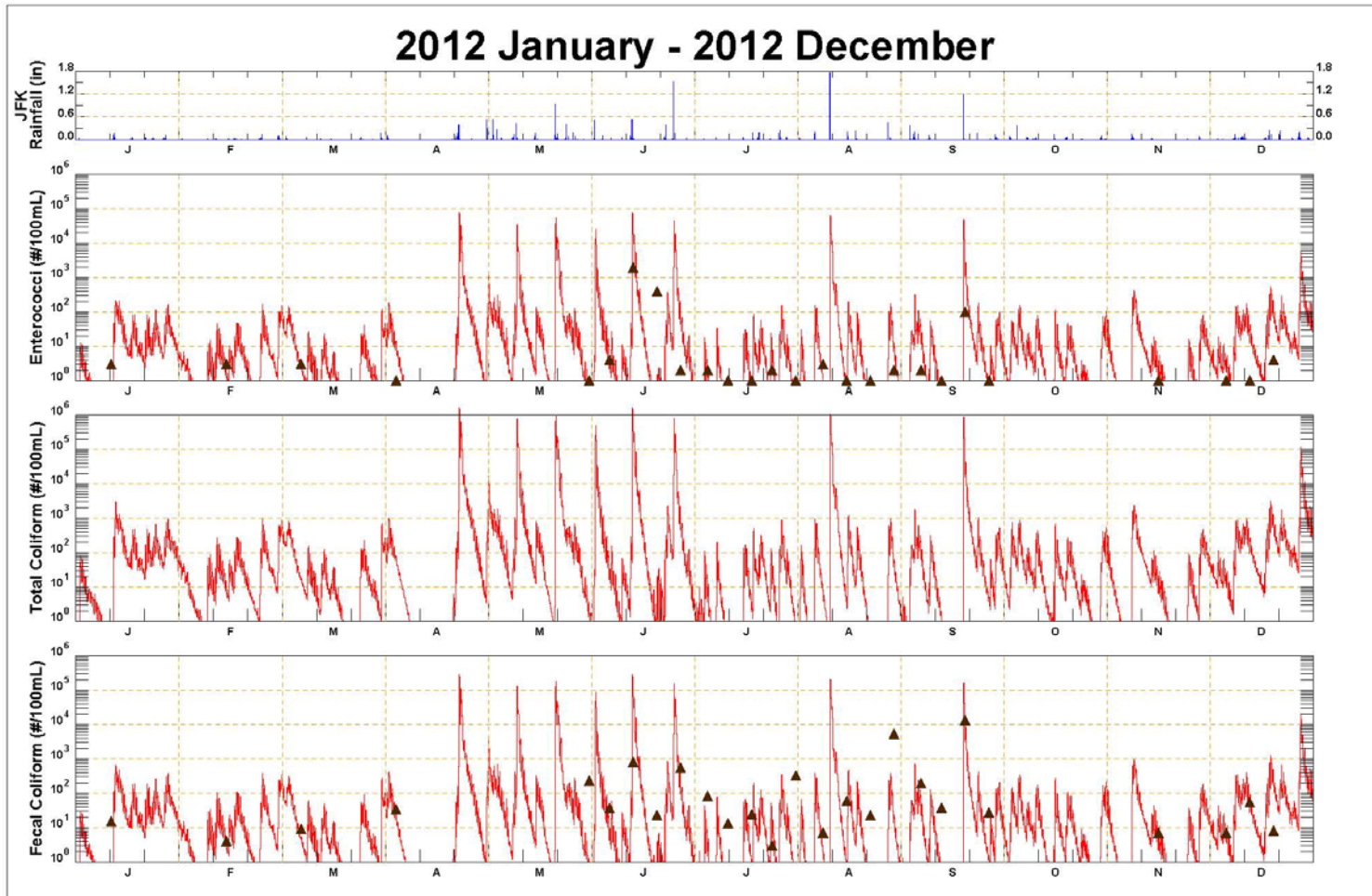   (1) Recreation Season
   (2) Hours
   (3) Annual

APPENDIX A

CALIBRATION FIGURES
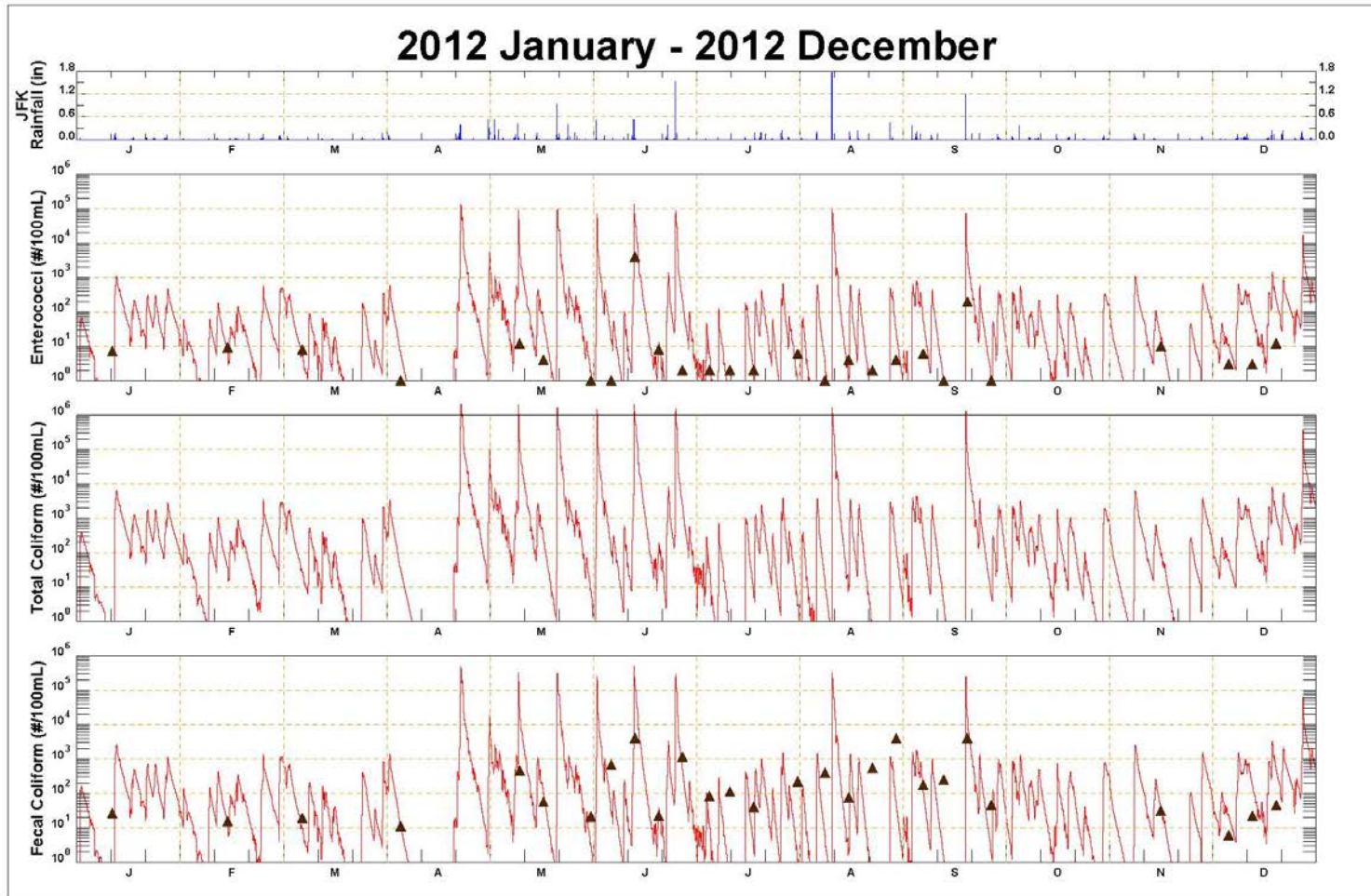
2012, Paerdegat Basin PB2, Cell (35,69)
(Paerdegat Basin with Tank)

▲ ▼ 2012 NYCDEP Harbor Survey Data
—— Surface Layer

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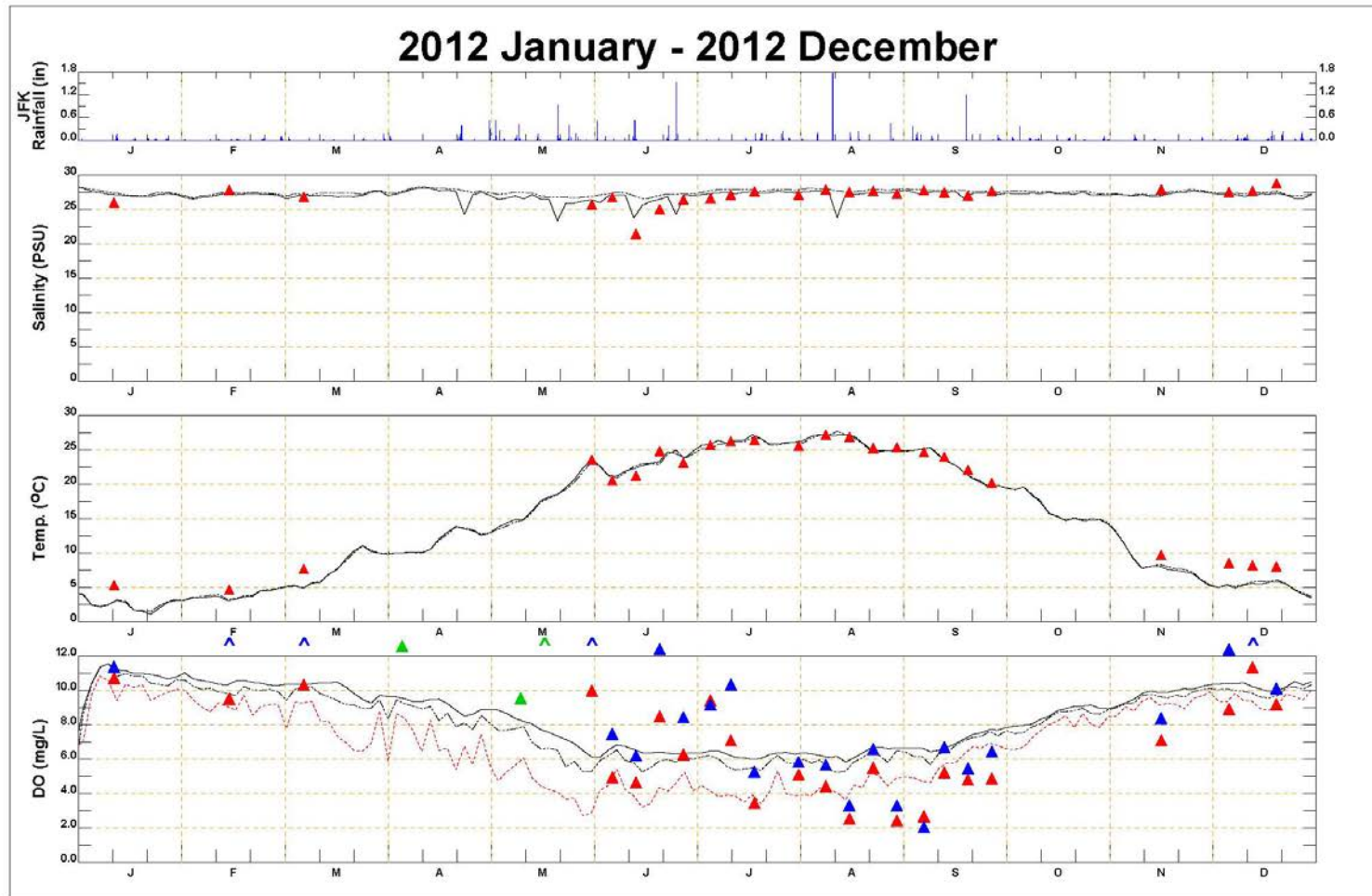
2012, Paerdegat Basin PB3, Cell (35,62)
(Paerdegat Basin with Tank)

▲ ▼ 2012 NYCDEP Harbor Survey Data
——— Surface Layer

DATE: 12/21/2015 TIME: 9:49:58

2012 January - 2012 December

2012, Jamaica Bay J10, Cell (35,58)
(Paerdegat Basin with Tank)

▲ ▼ 2012 NYCDEP Harbor Survey Data
──── Surface Layer
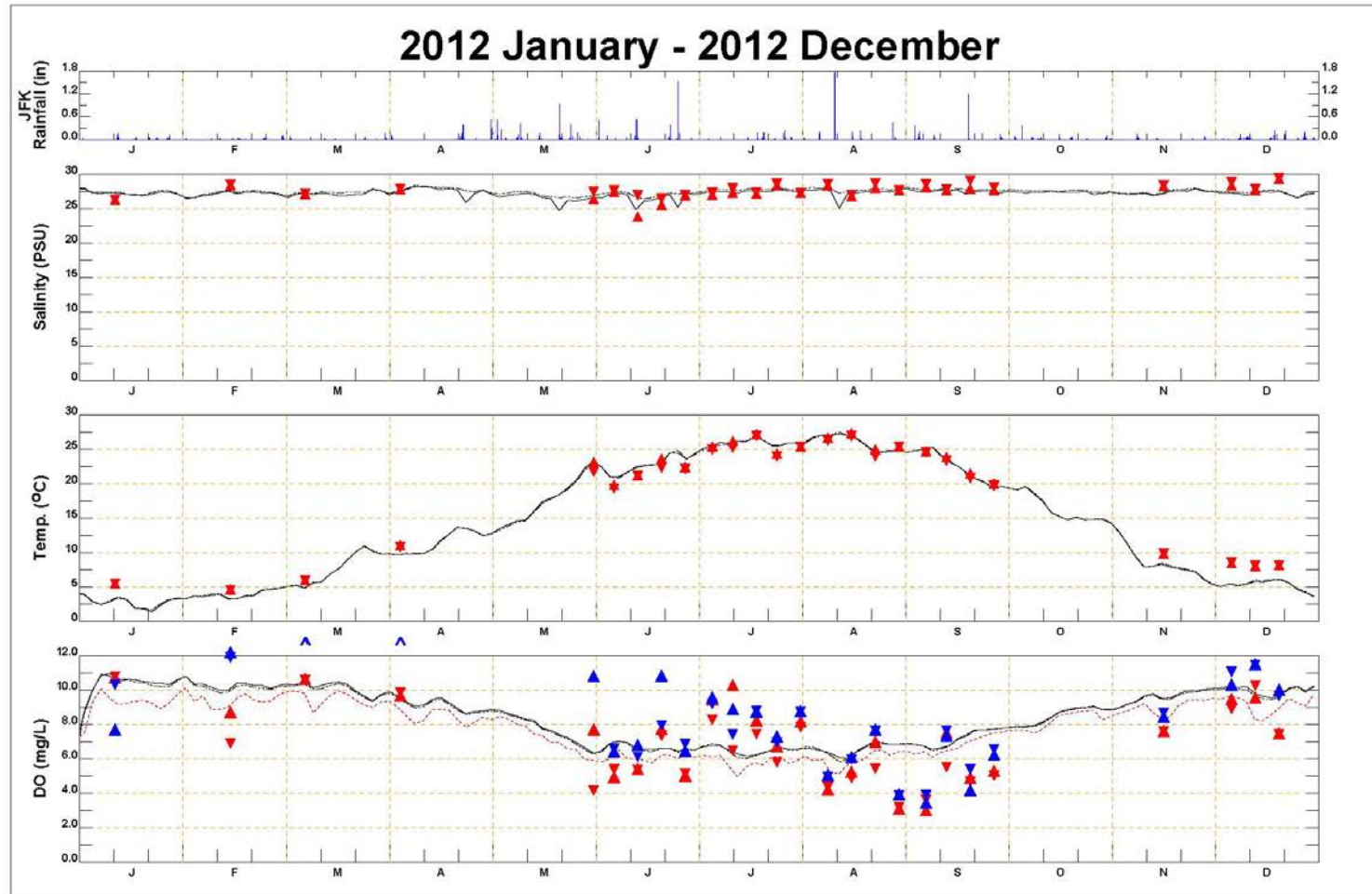
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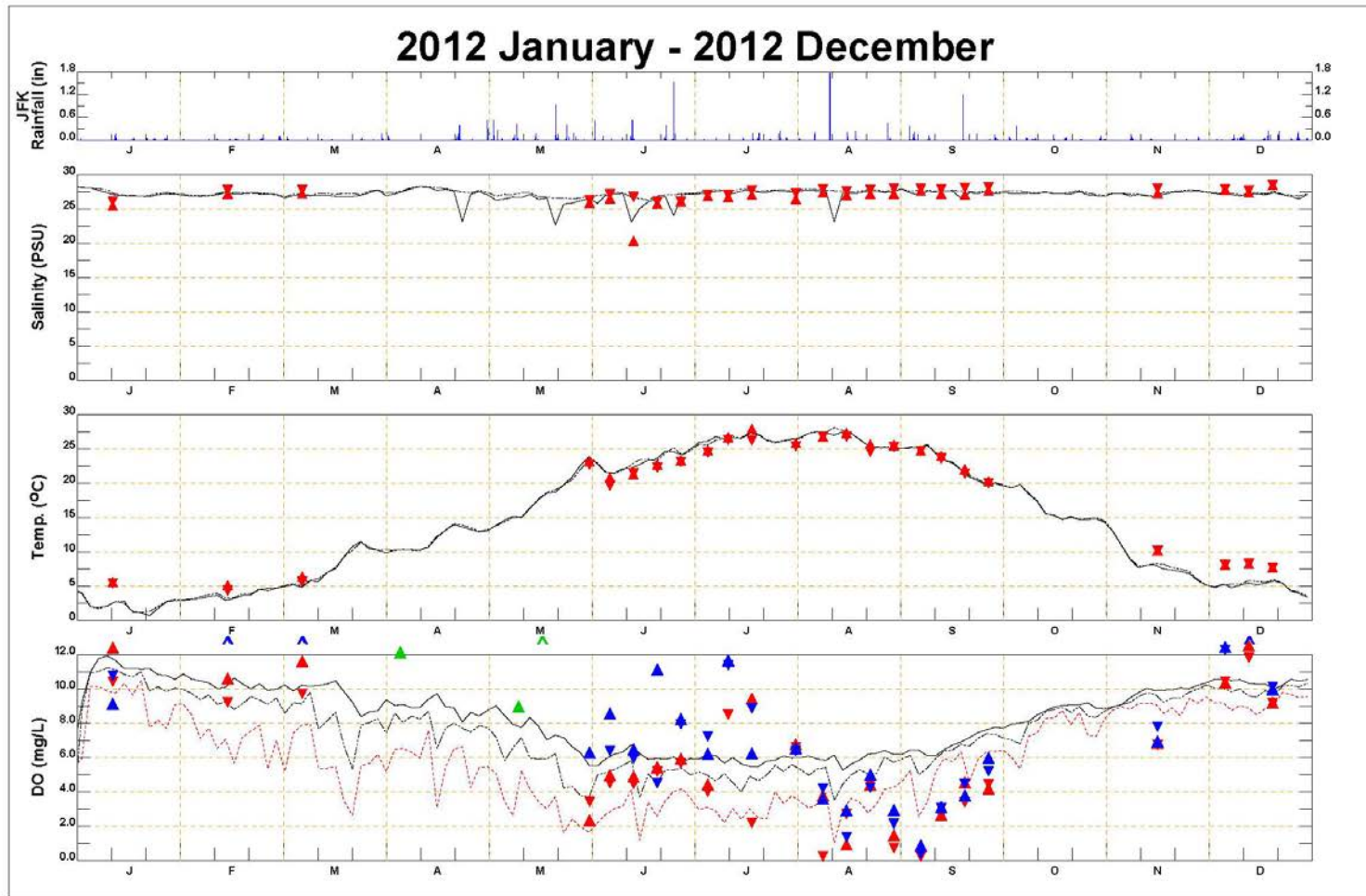
2012,Paerdegat Basin PB2, Cell (35,70)
(Paerdegat Basin with Tank)

▲ ▼ 2012 NYCDEP HS Winkler
▲ ▼ 2012 NYCDEP HS CTD Data
▲ ▼ 2012 NYCDEP HS YSI Field Data
Surface Average
Bottom Average
Bottom Minimum

YR1
PB with Tank

DATE: 12/21/2015 TIME: 10: 0:51

2012, Paerdegat Basin PB3, Cell (35,63)
(Paerdegat Basin with Tank)

2012 NYCDEP HS Winkler
2012 NYCDEP HS CTD Data
2012 NYCDEP HS YSI Field Data
Surface Average
Bottom Average
Bottom Minimum

YR1
PB with Tank

DATE: 12/21/2015 TIME: 10: 0:52

2012, Jamaica Bay J10, Cell (36,56)
(Paerdegat Basin with Tank)

YR1
PB with Tank

DATE: 12/21/2015 TIME: 10: 0:52