

Water Quality Modeling Update

Model Evaluation Group – Session 3

Rich Isleib, HDR

September 15, 2017



GREELEY AND HANSEN

CDM
Smith

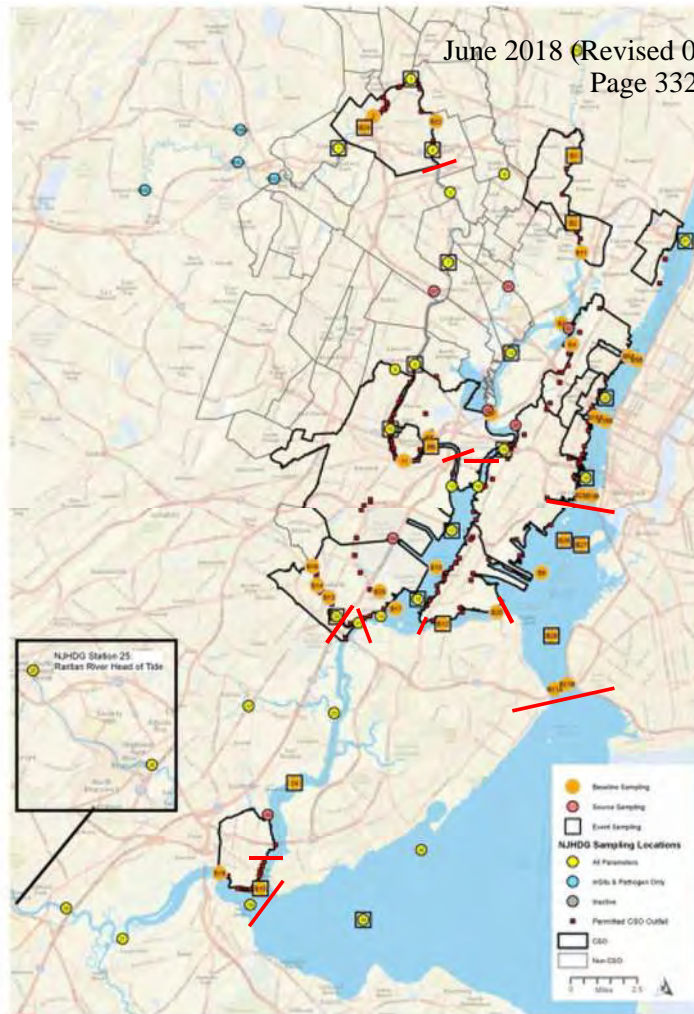
HDR

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Agenda

- Receiving Water Data Summary
- Source Loading Approach
 - Stormwater
 - CSO
 - Rivers
- Model Calibration
- Next Steps

Receiving Water Sampling Locations



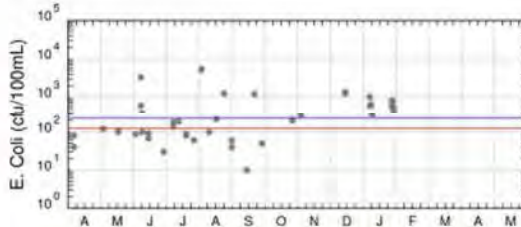
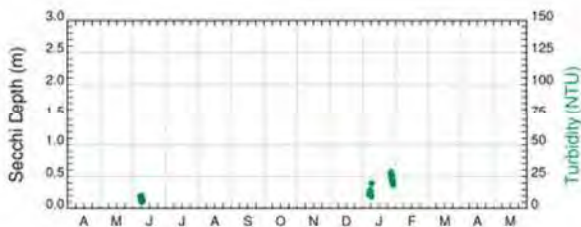
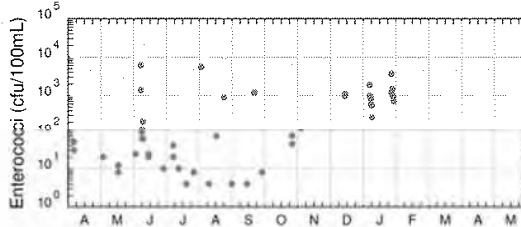
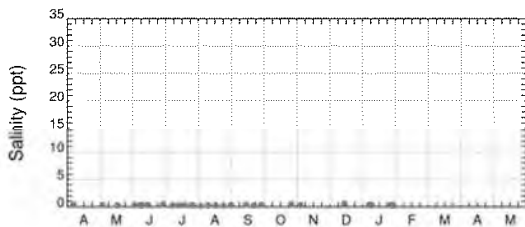
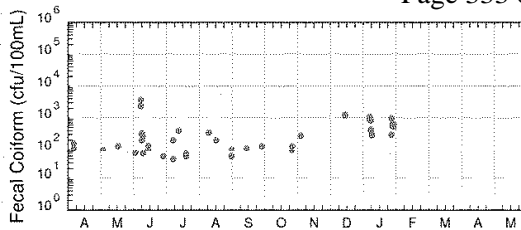
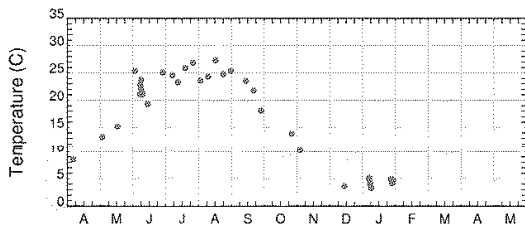
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NJ Pathogen Criteria

- Primary Contact Recreation:
 - Enterococci levels shall not exceed a geometric mean of **35/100 ml**, or a single sample maximum of **104/100 ml**. (SE1 and SC)
 - Hackensack R. (upper), Hudson R. (north of Harlem R.), Raritan R., Raritan Bay
 - E. coli levels shall not exceed a geometric mean of **126/100 ml** or a single sample maximum of **235/100 ml**. (All FW2)
 - Elizabeth R., Passaic R., Raritan R.
- Secondary Contact Recreation:
 - Fecal coliform levels shall not exceed a geometric mean of **770/100 ml**. (SE2)
 - Arthur Kill (lower), Hackensack R. (mid), Hudson R., Passaic R. (mid), Rahway R.
 - Fecal coliform levels shall not exceed a geometric mean of **1500/100ml**. (SE3)
 - Arthur Kill (upper), Elizabeth R., Hackensack R. (lower), Kill Van Kull, Newark Bay, Passaic R. (lower)



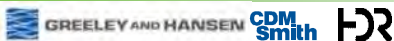


Time (Month)
2016 / 2017

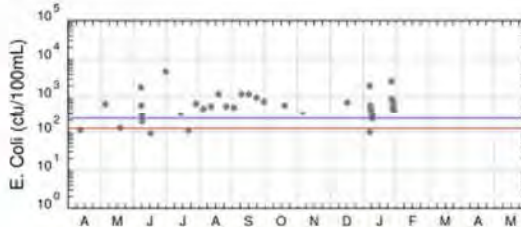
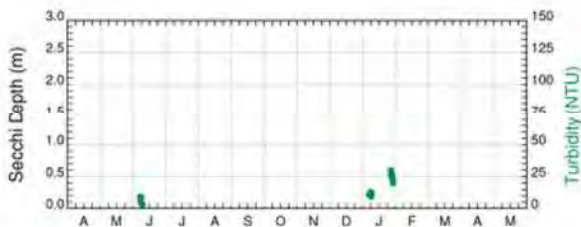
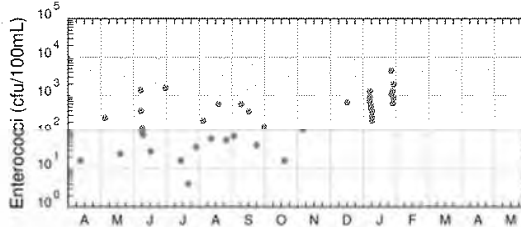
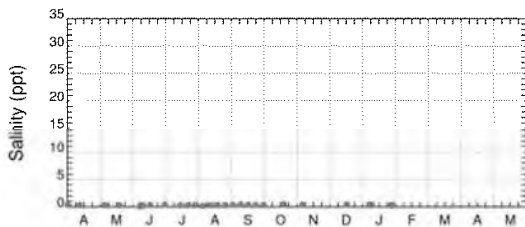
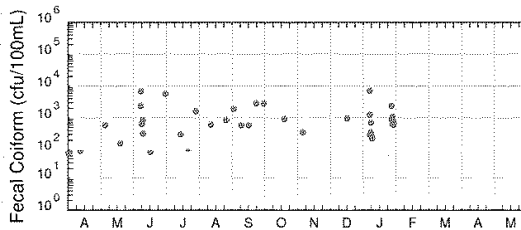
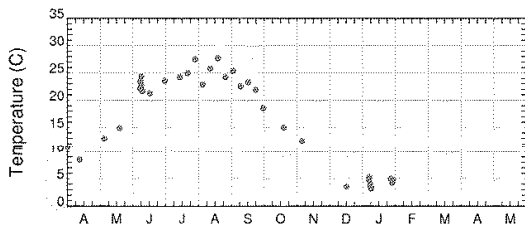
Time (Month)
2016 / 2017

○ Surface
 ● Mid-Depth
 ● Bottom
 — GM
 — SSM

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Passaic River & Tributaries, Passaic River, 3, (FW2)

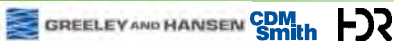


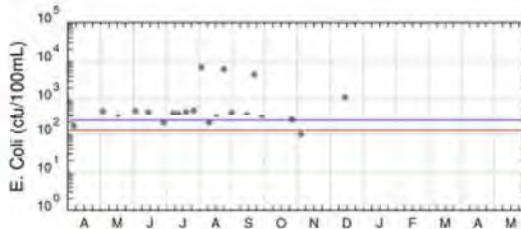
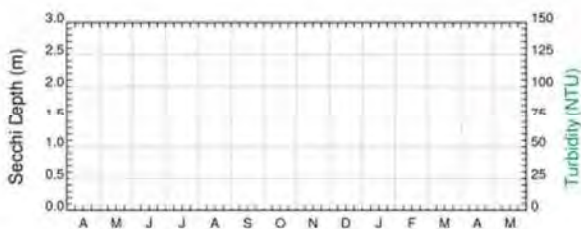
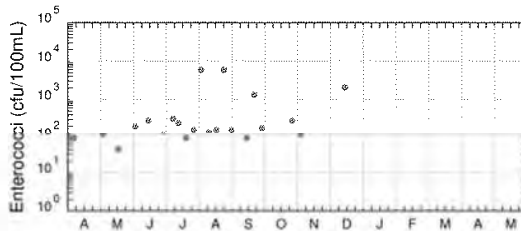
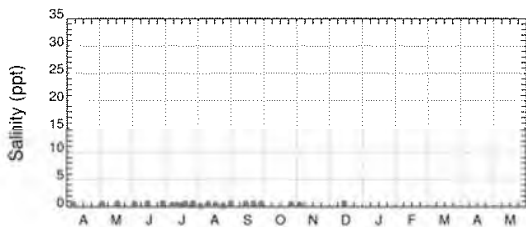
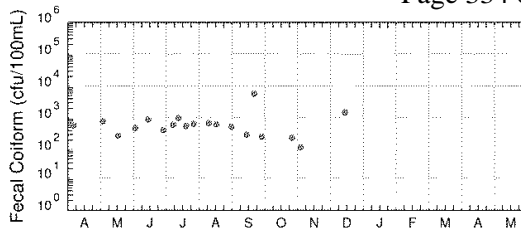
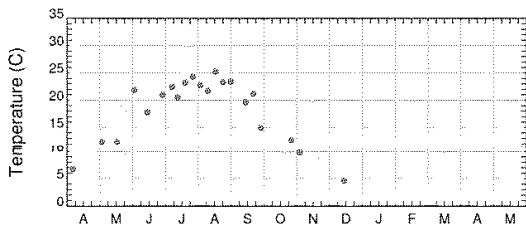
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2016 / 2017

Time (Month)
2016 / 2017

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Time (Month)
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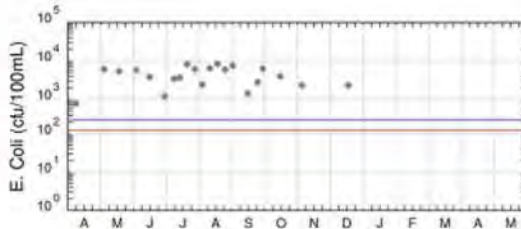
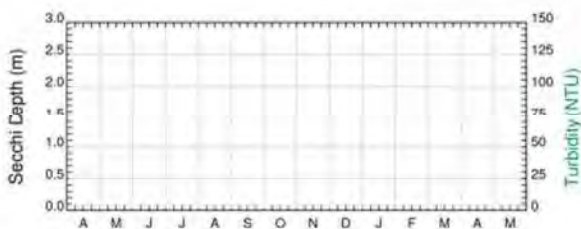
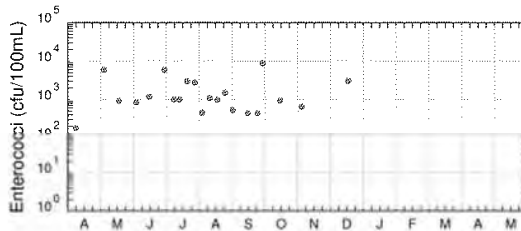
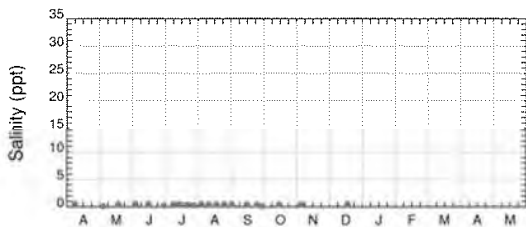
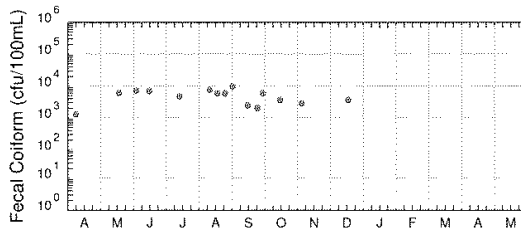
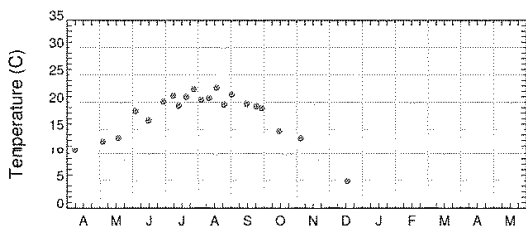
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— SSM

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Passaic River & Tributaries, Second River, 9, (FW2)



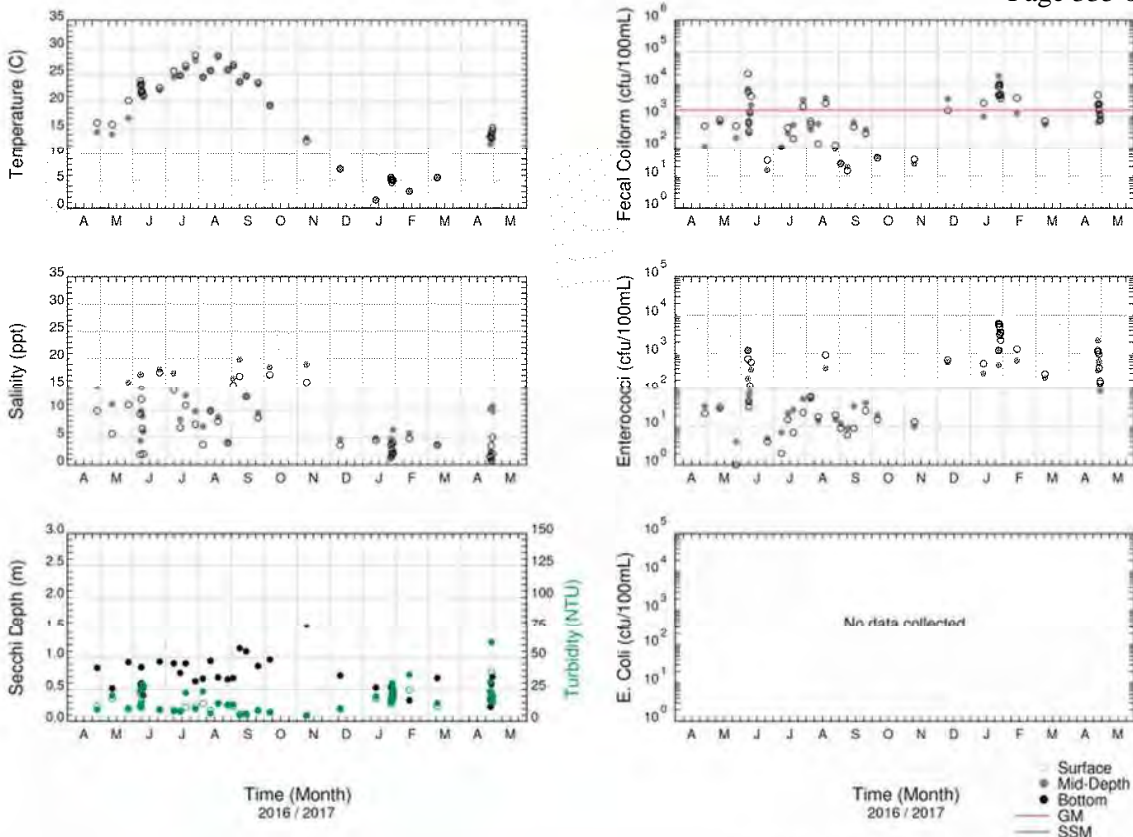
Time (Month)
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Time (Month)
2016 / 2017

● Surface
● Mid-Depth
● Bottom
— GM
— SSM

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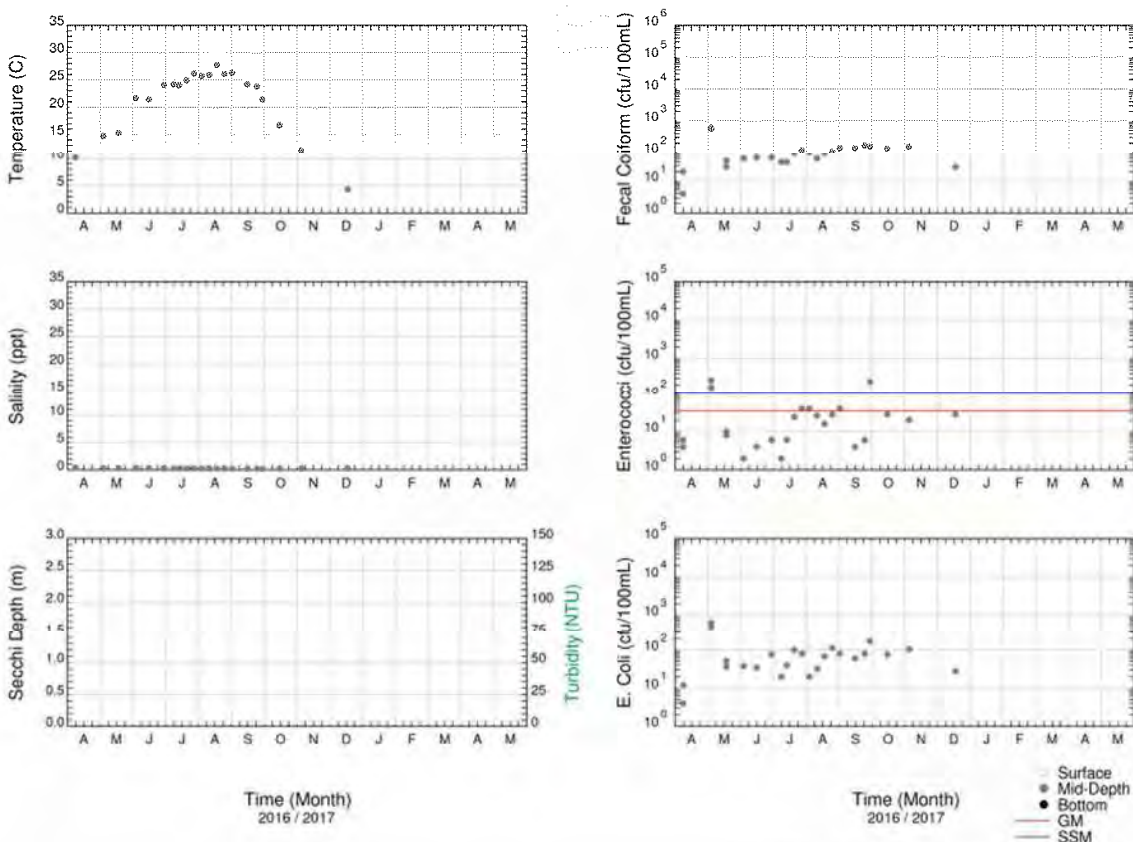




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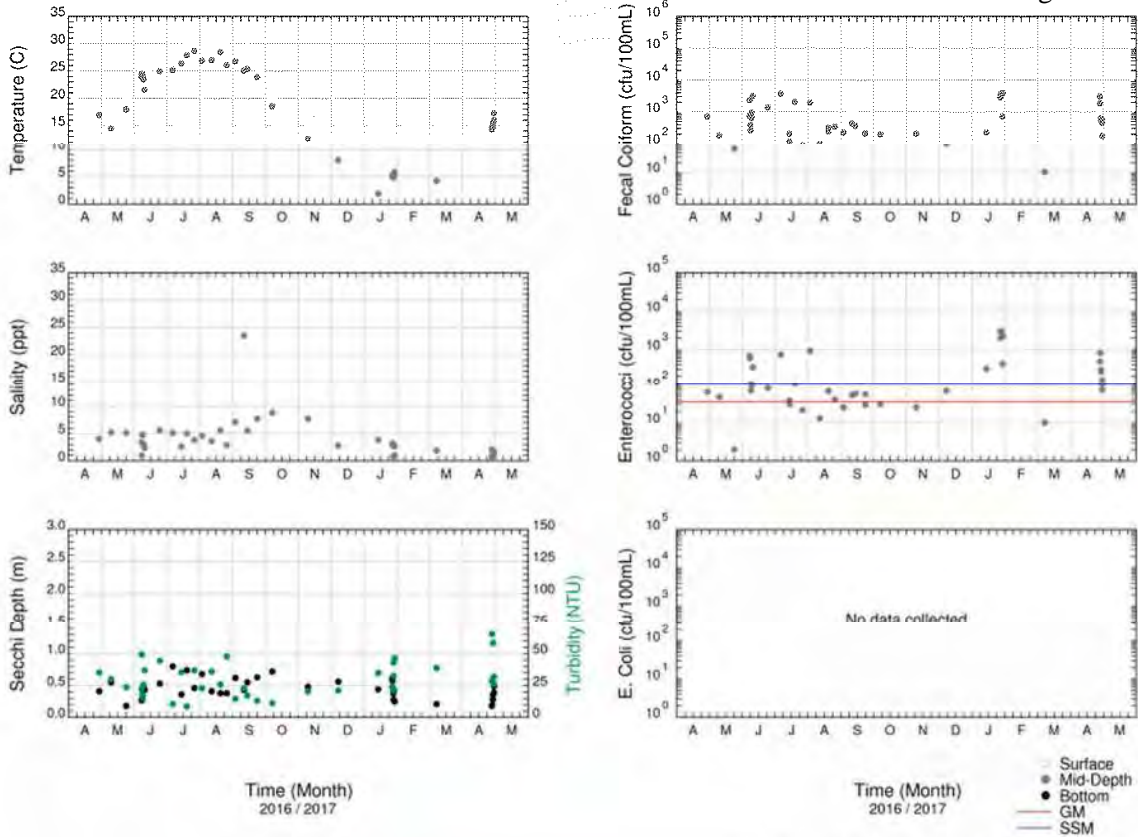


Hackensack River & Tributaries, Hackensack River, 13, (SE1)



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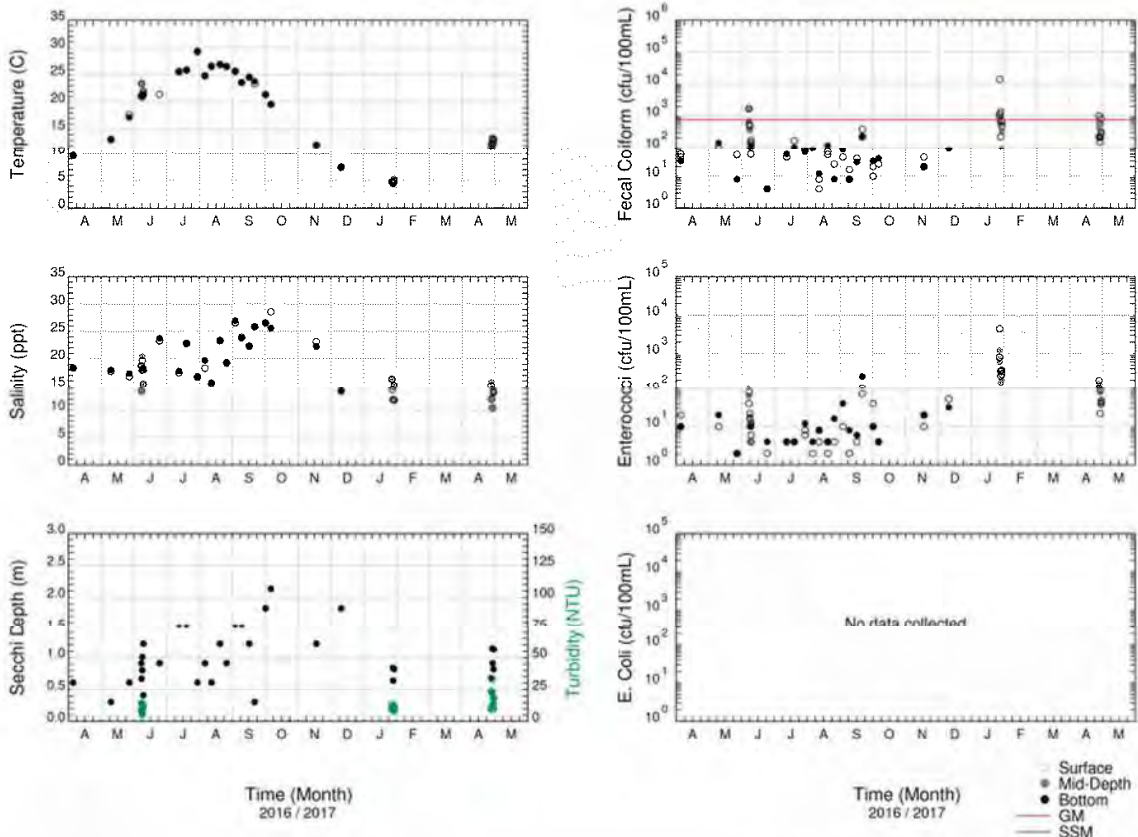




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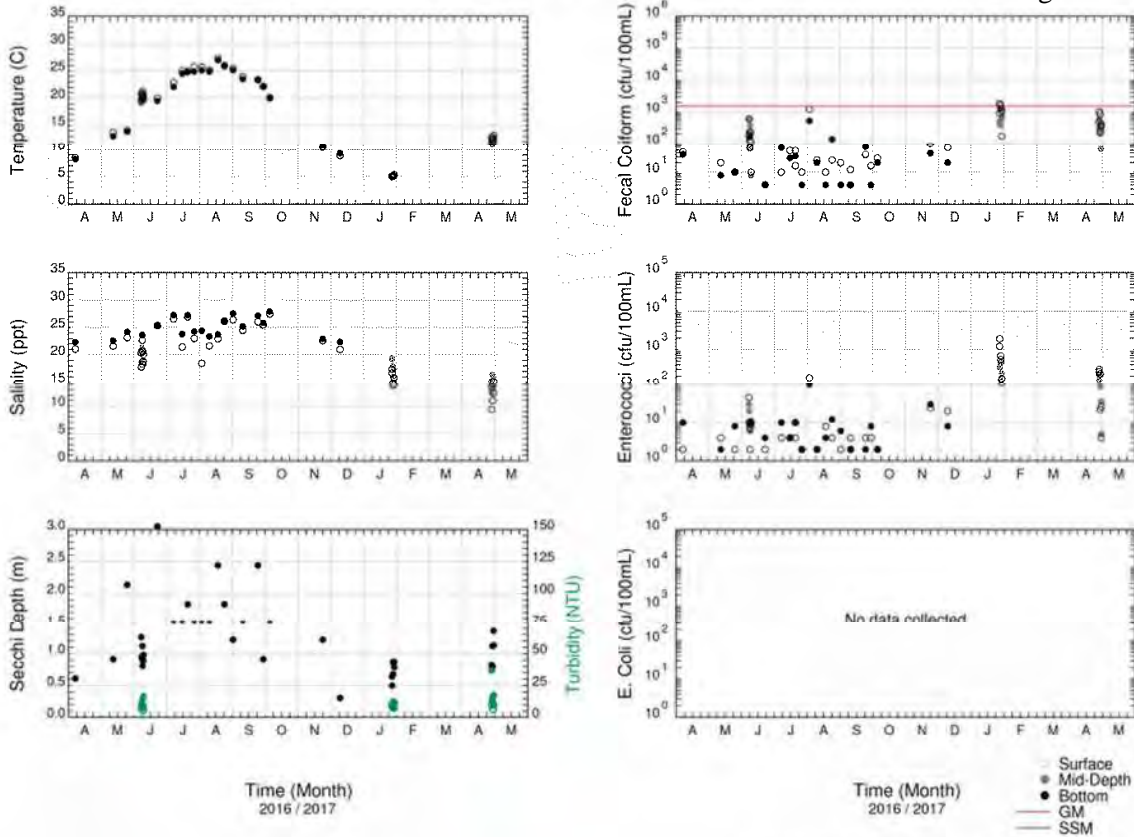


Hackensack River & Tributaries, Hackensack River, 15, (SE2)



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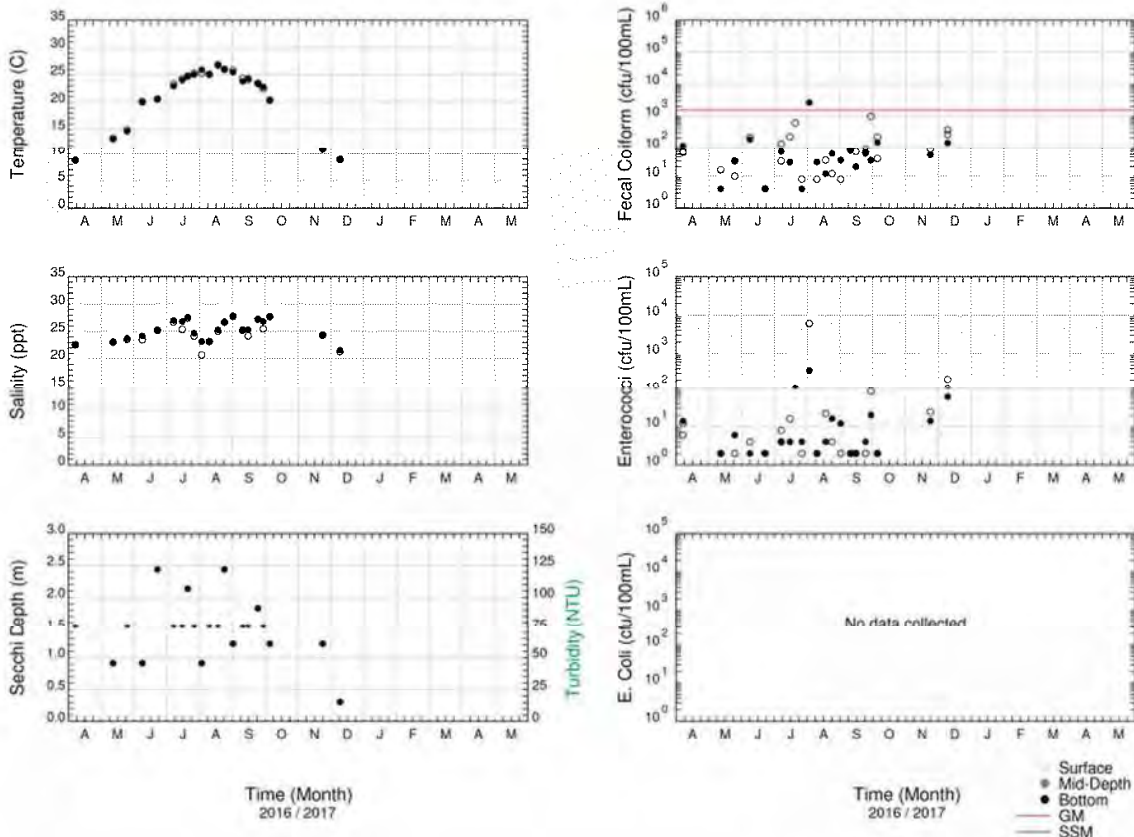




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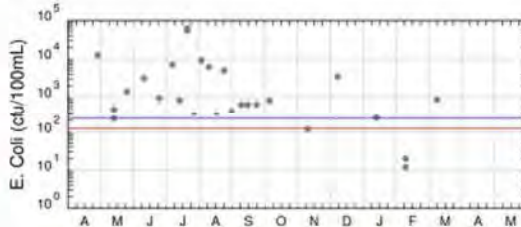
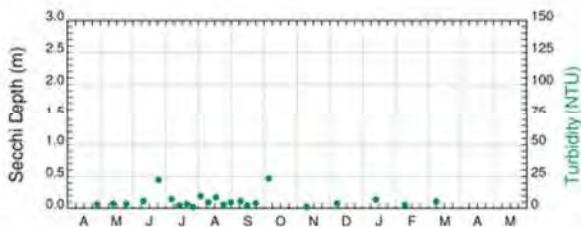
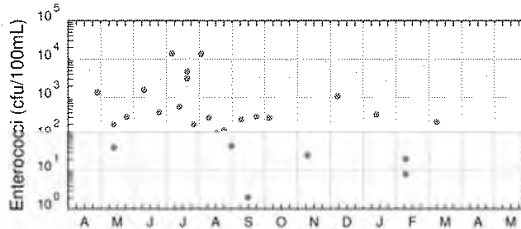
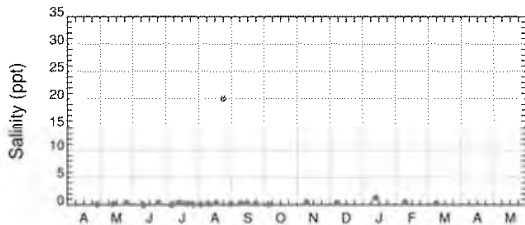
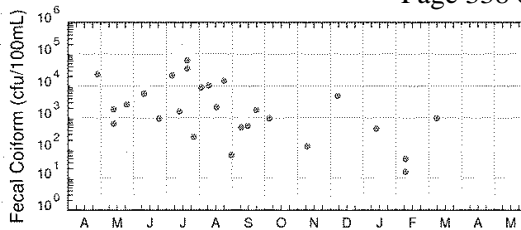
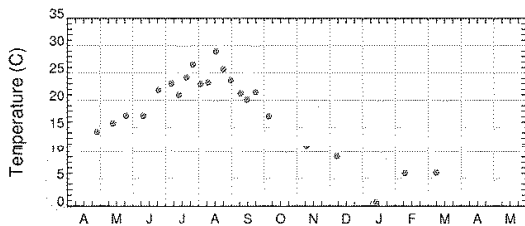


Newark Bay & Tributaries, Arthur Kill, 21, (SE3)



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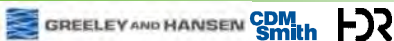


Time (Month)
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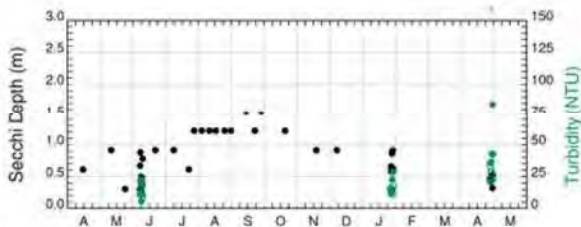
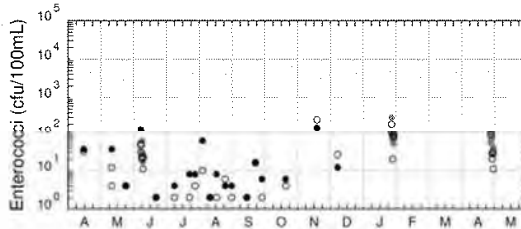
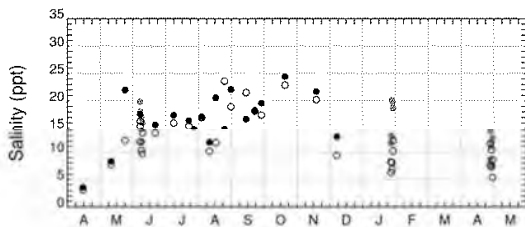
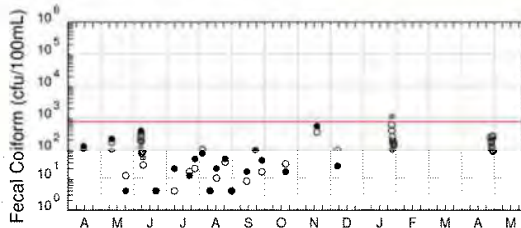
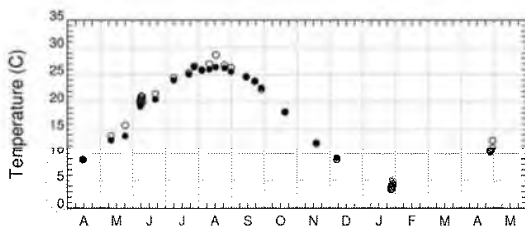
Time (Month)
2016 / 2017

○ Surface
 ● Mid-Depth
 ● Bottom
 — GM
 — SSM

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Hudson River, Upper Bay, Hudson River, 31, (SE2)

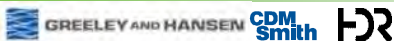


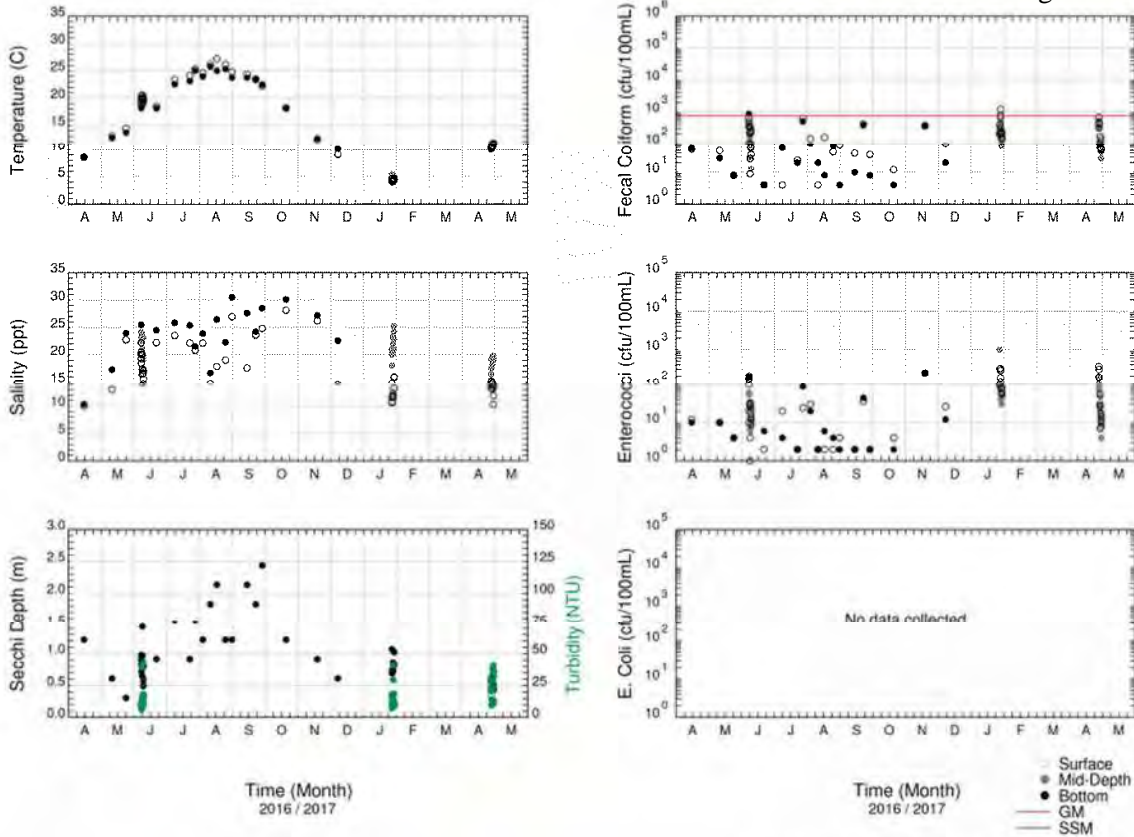
Time (Month)
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2016 / 2017

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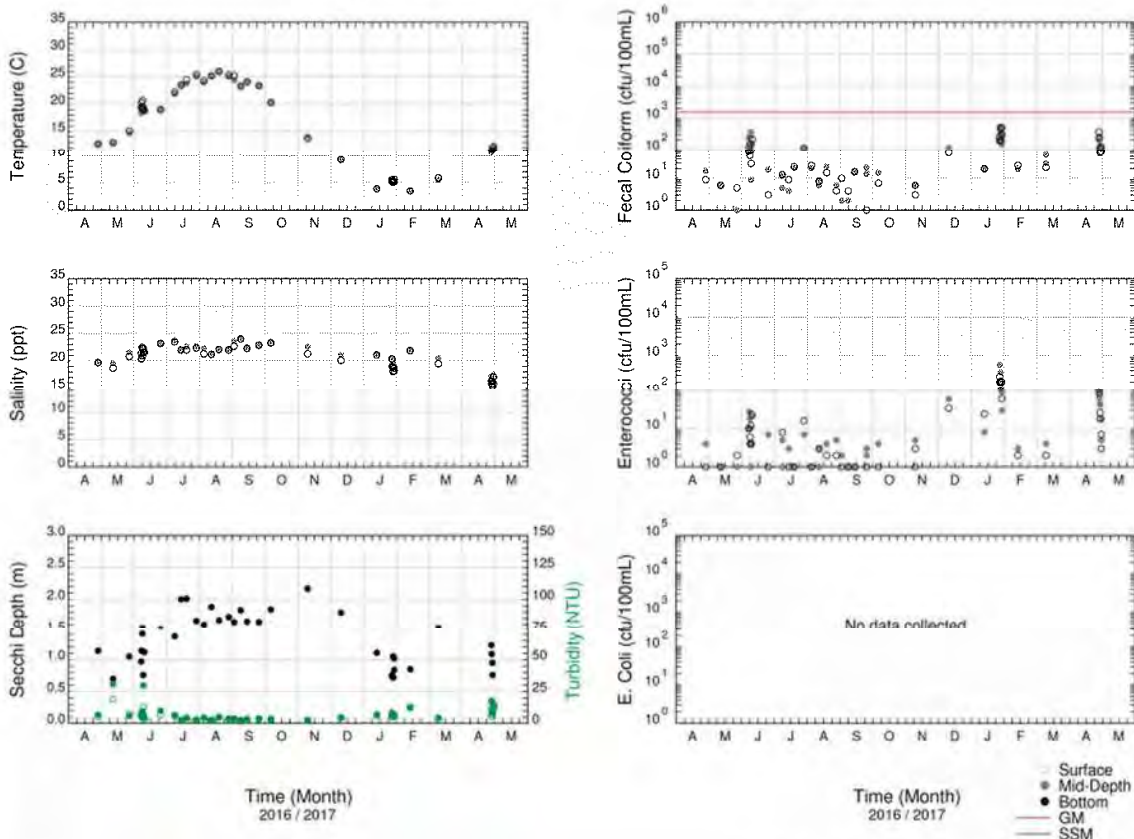




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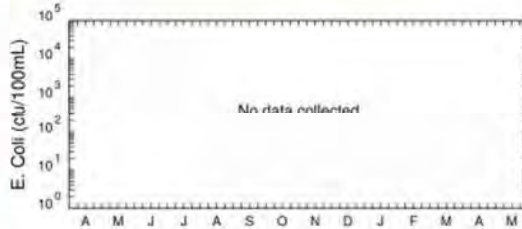
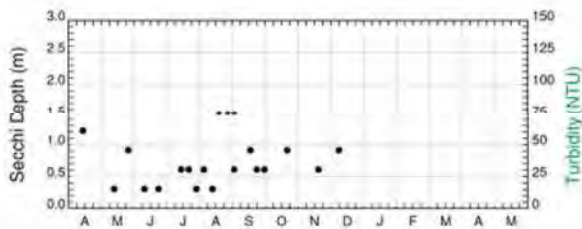
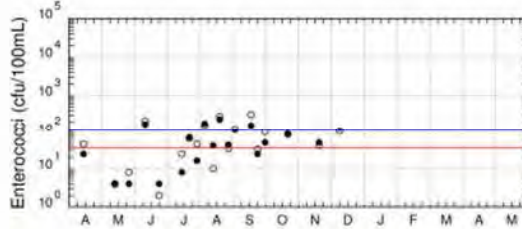
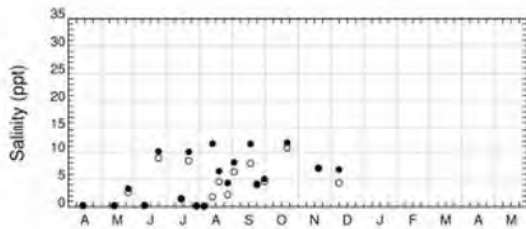
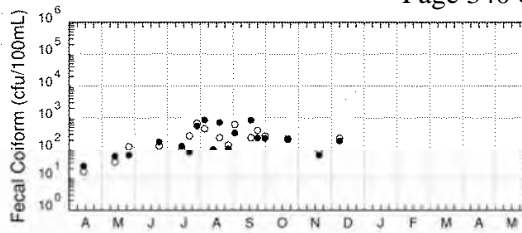
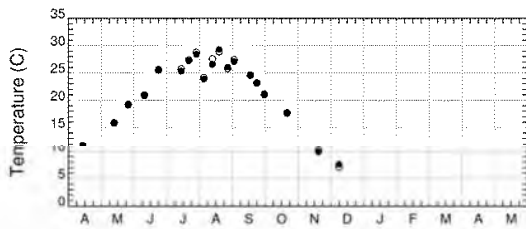


Hudson River, Upper Bay, Kill Van Kull, B12, (SE3)



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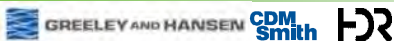


Time (Month)
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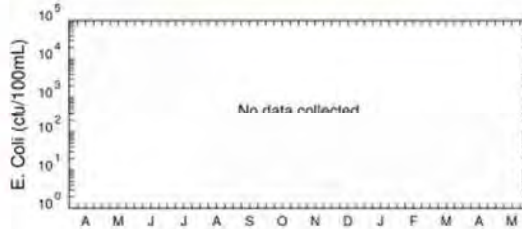
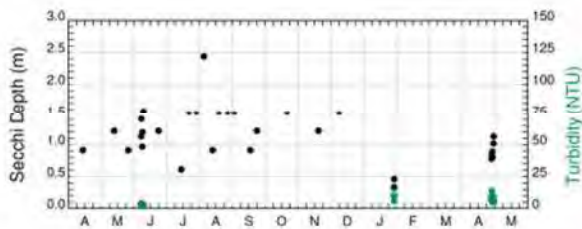
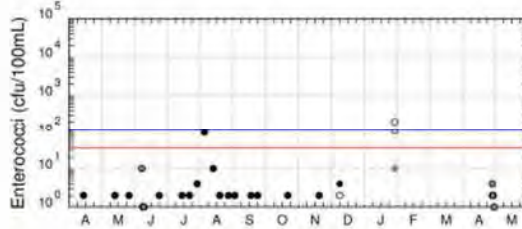
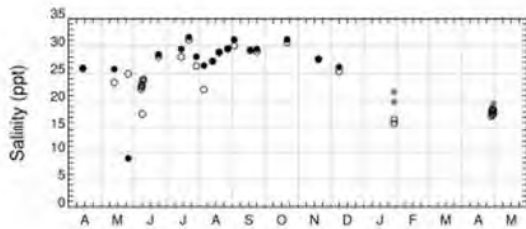
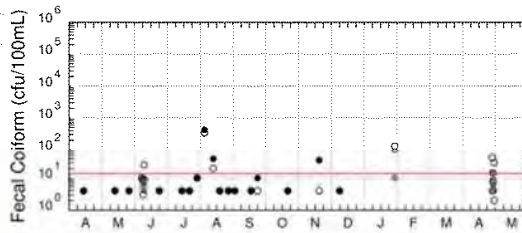
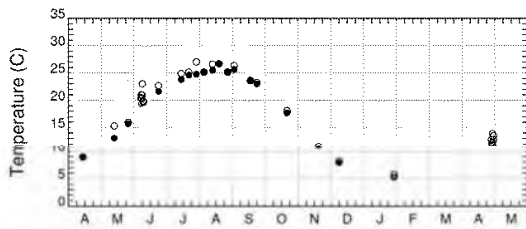
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Arthur Kill, Raritan River/Bay & Tributaries, Raritan Bay, 29, (Shellfish)

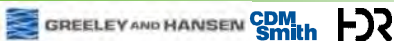


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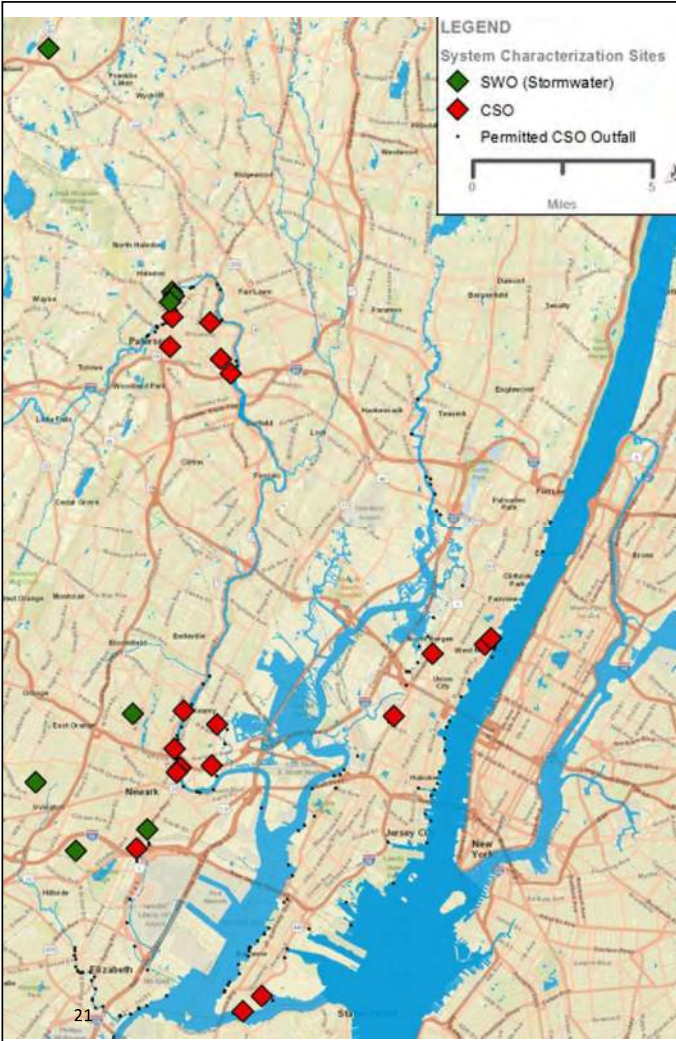
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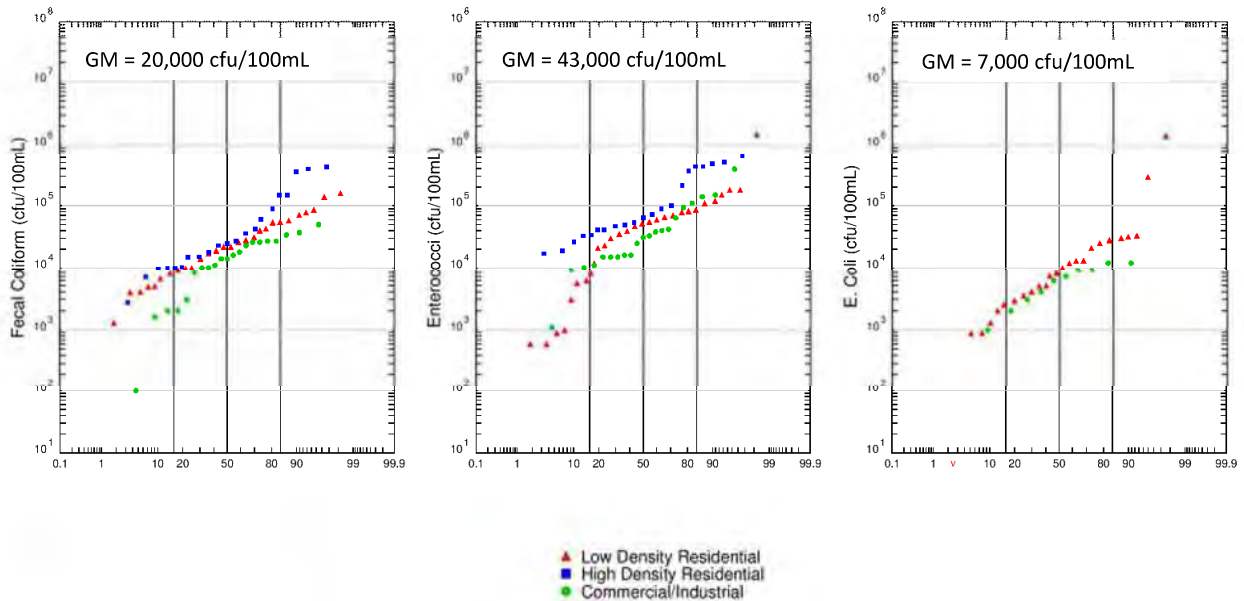
Landside Pathogen Concentration Stations



- Stormwater – 8 locations
 - Low Density Residential (4)
 - High Density Residential (2)
 - Commercial / Industrial (2)
- CSO – 18 Locations
 - Paterson (5)
 - Newark (4)
 - North Bergen (3)
 - Harrison (2)
 - Bayonne (2)
 - Guttenberg (1)
 - Kearny (1)

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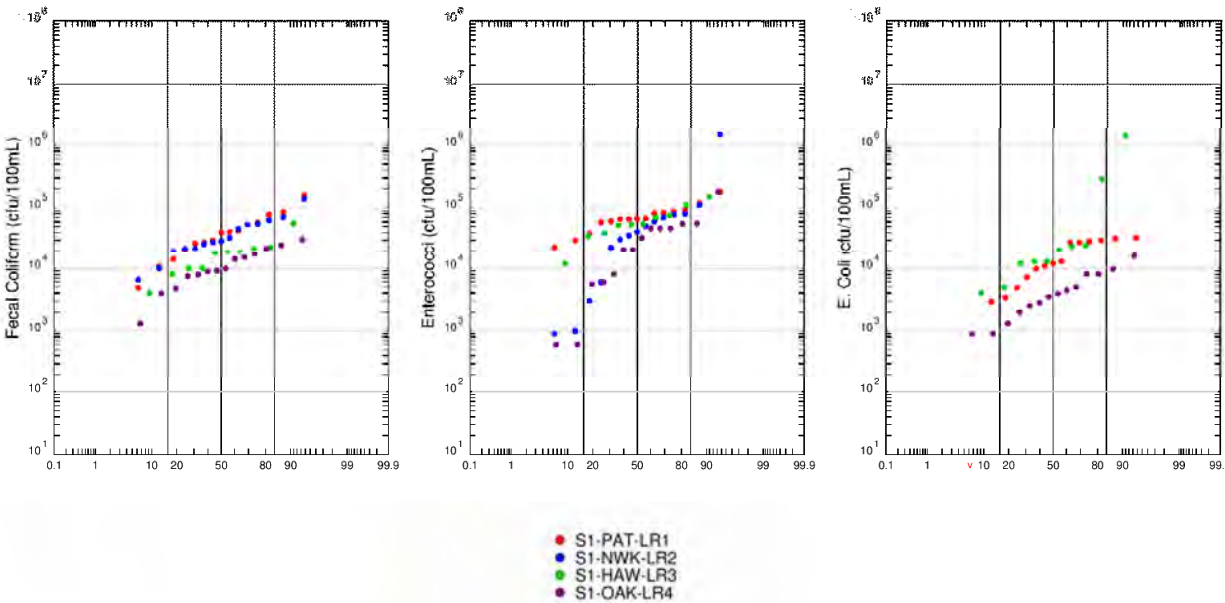
Probability Plot of Stormwater Pathogen Data
 By Land Use
 2016-2017



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Probability Plot of Stormwater Pathogen Data
By Individual Location
2016-2017

Low Density Residential

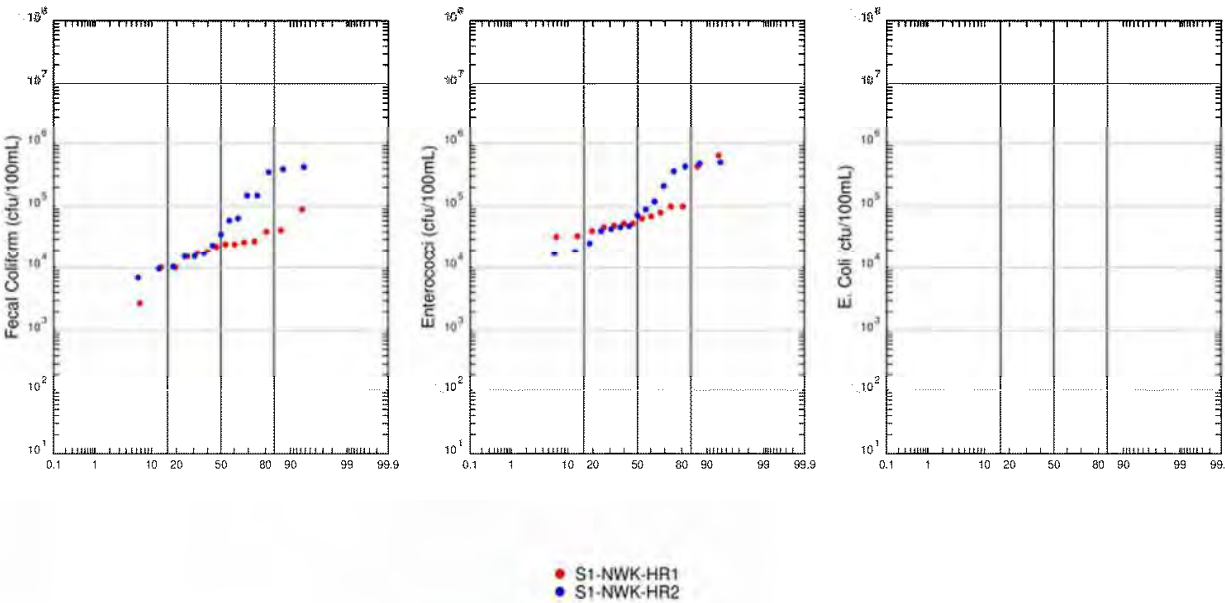


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Probability Plot of Stormwater Pathogen Data
By Individual Location
2016-2017

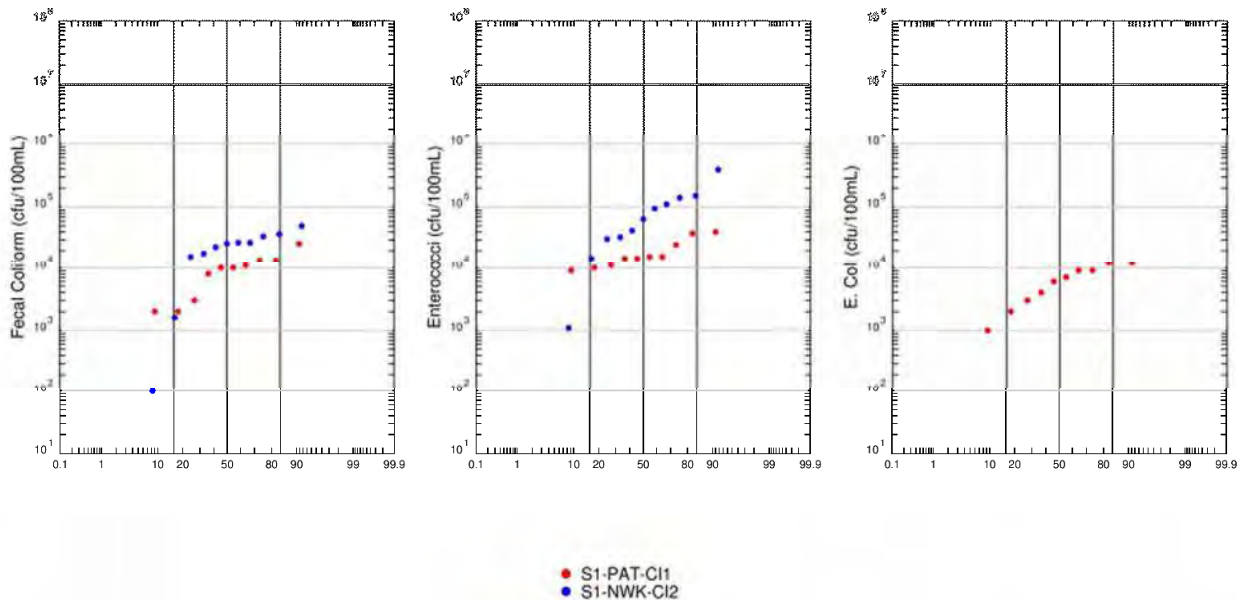
High Density Residential



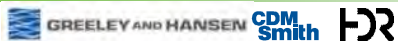
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Commercial/Industrial



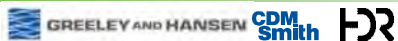
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Stormwater Flows



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CSO Loading Calculations

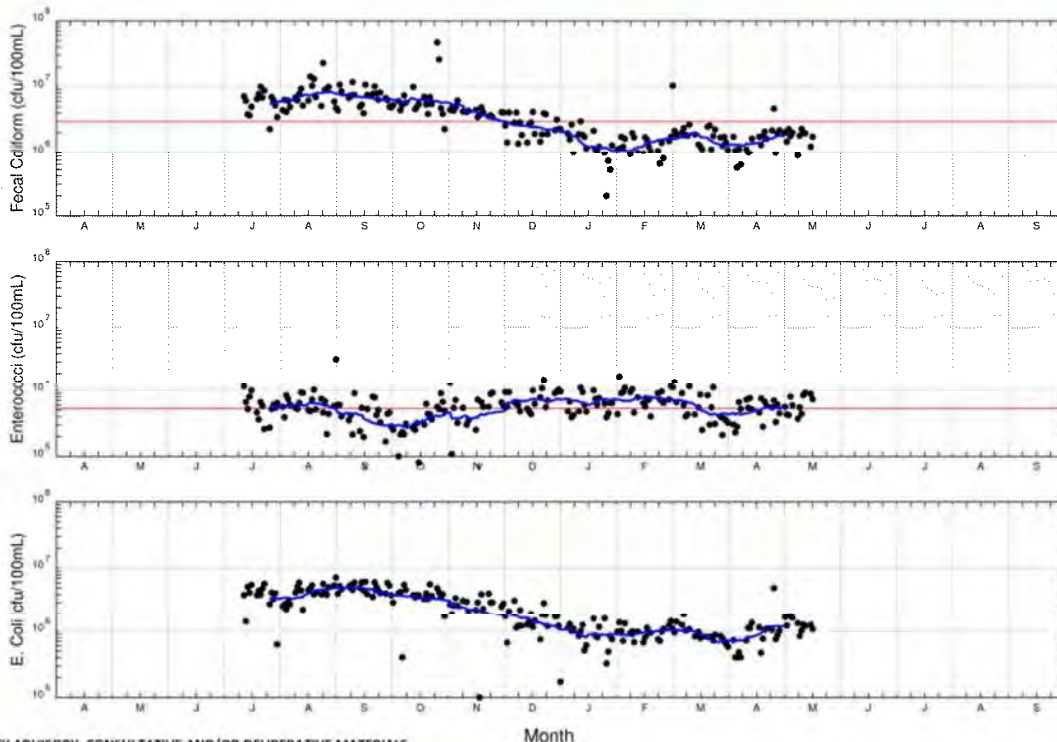
- The Mass Balance approach will be used to assign loading to the CSOs
- The hydraulic models will provide flow and the sanitary/stormwater flow fractions.
 - The hydraulic models are still undergoing calibration
- CSO concentrations will be calculated using sanitary and stormwater concentrations.
- Estimated CSO concentrations will be compared to CSO concentration data.
 - Sampling program is behind schedule due to lower than normal precipitation.
- In some cases, the approach to calculating the CSO loads will need to be modified if the Mass Balance approach does not compare well to the data.

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PVSC WWTP Pathogen Influent Concentrations

July 2016-May 2017

PVSC WWTP Influent



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2016 / 2017

— 30-Day Moving Geometric Mean
— Geometric Mean for All Available Data

Measured CSO Concentrations

- 10 Locations have been sampled
- 17 events have been sampled

	CSO Bacteria Concentrations (cfu/100mL)	
	Fecal Coliform	Enterococci
Geometric Mean ¹	305,300	110,400
Average ²	469,300	186,200
Range ³	53,200 – 1,414,000	21,800-782,200
WWTP Sanitary	~3,000,000	~500,000
Event Sanitary	2,100,000	690,000

1 - GM of event GMs
 2 - Average of event GMs
 3 -Range of event GMs

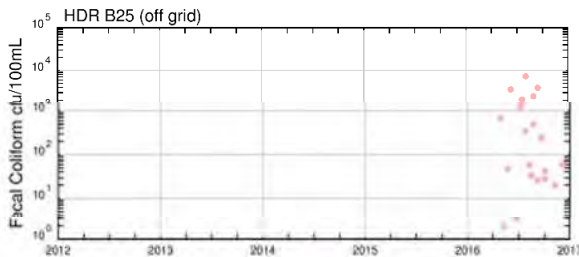
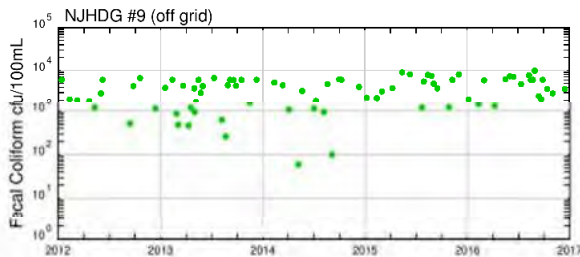
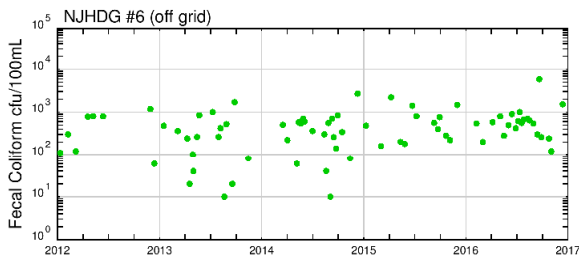
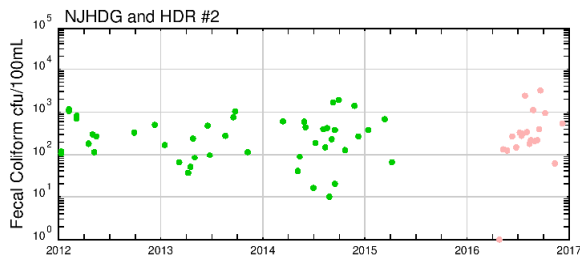
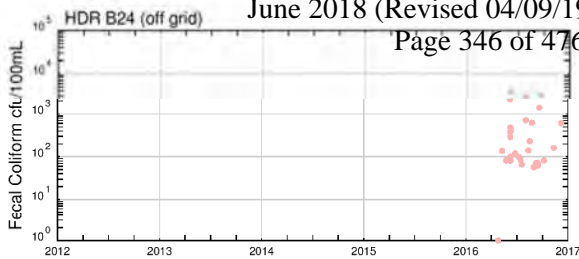
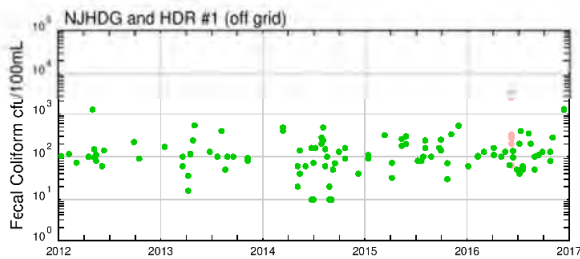
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River Loads

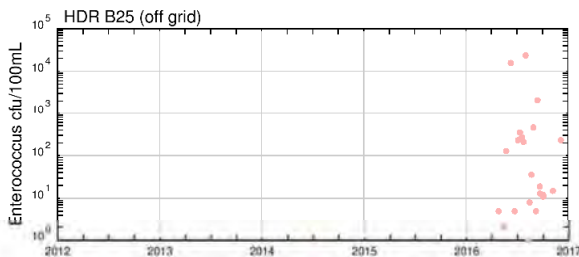
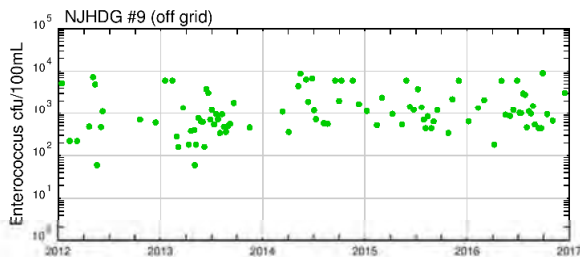
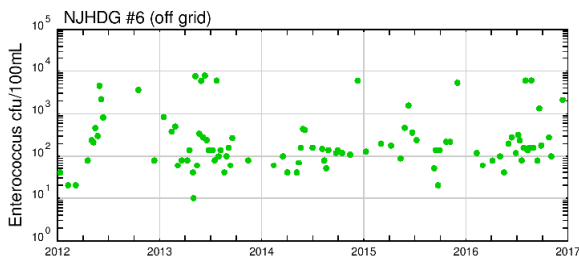
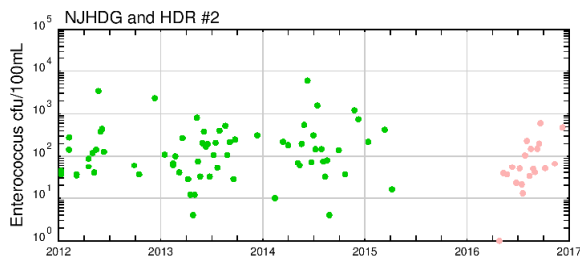
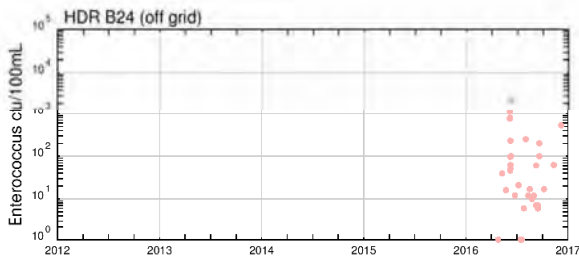
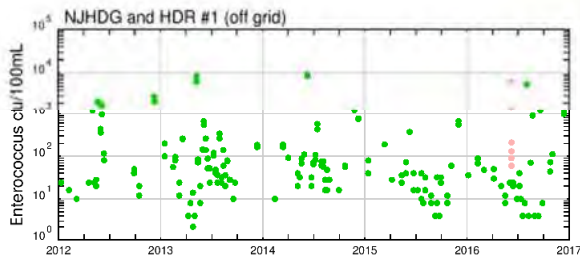
- Dry-weather
 - “Monte Carlo”
- Wet-weather
 - Concentration vs. 24-hr rainfall

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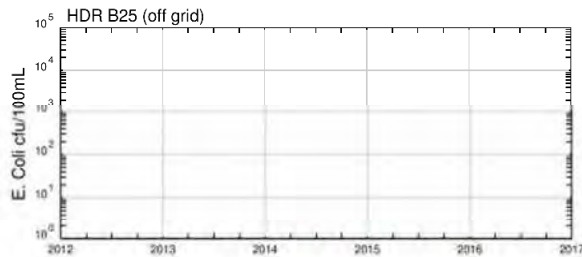
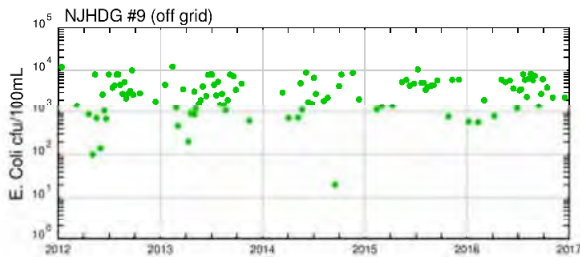
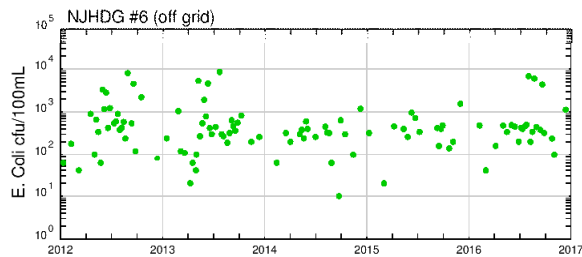
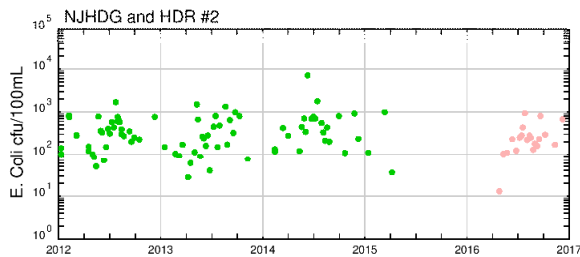
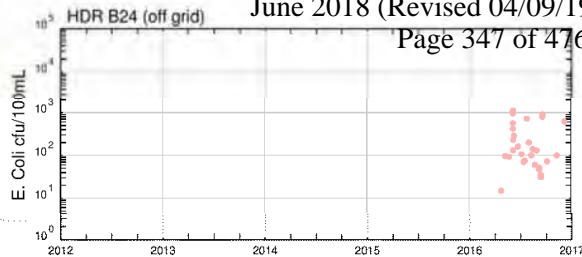
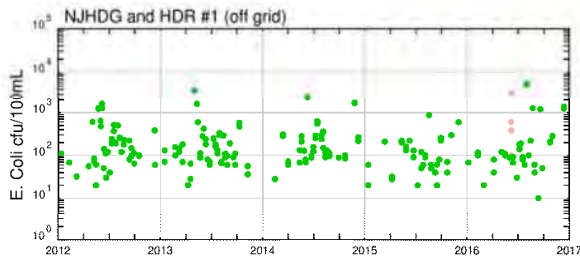
● HDR at Surface ● NJHDG at Surface
● HDR at Mid-Depth ● NJHDG at Mid-Depth
● NJHDG at Bottom

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● HDR at Surface ● NJHDG at Surface
● HDR at Mid-Depth ● NJHDG at Mid-Depth
● NJHDG at Bottom

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● HDR at Surface
○ HDR at Mid-Depth
● NJHDG at Surface
○ NJHDG at Mid-Depth
● NJHDG at Bottom

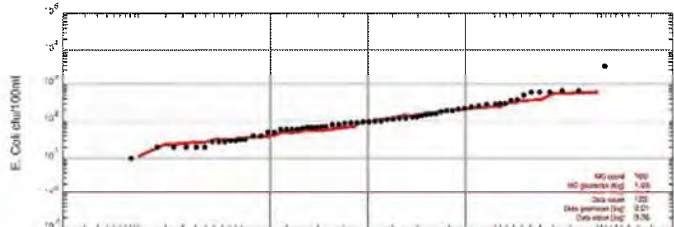
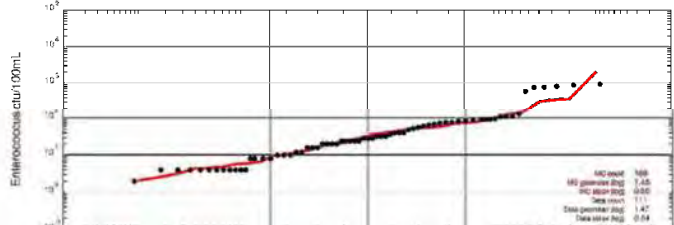
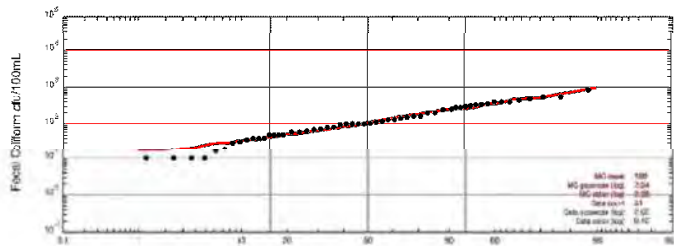
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Dry-weather concentrations

PASSAIC RIVER

HDR and NJHDG #1

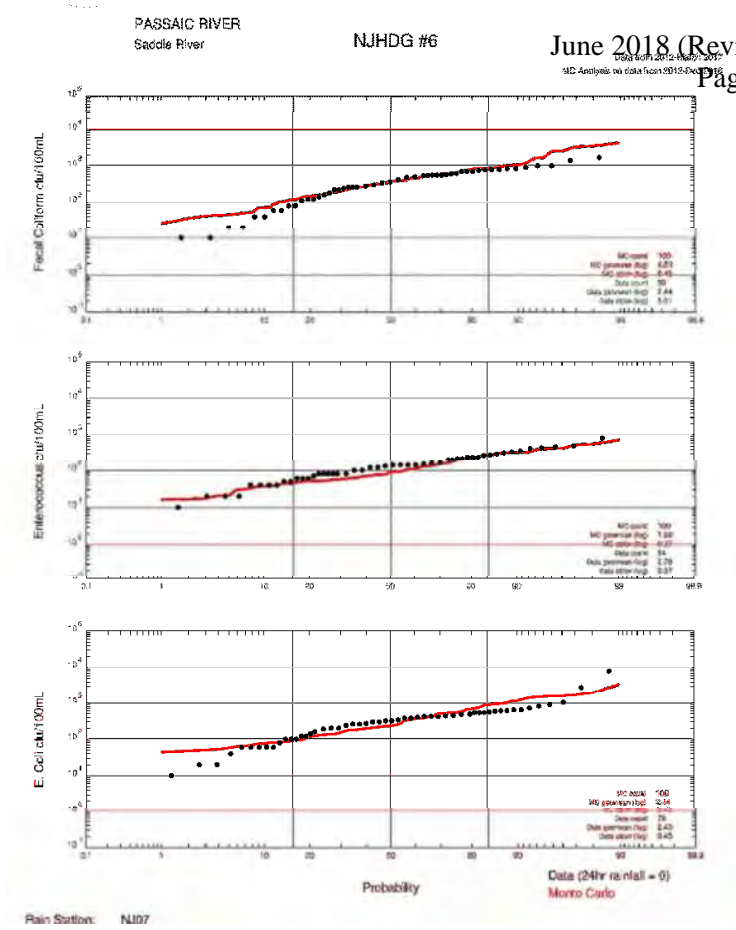
Data from 2012-4/2017
MC Analysis on data from 2012-DEC 2016



Rain Station: NJ07

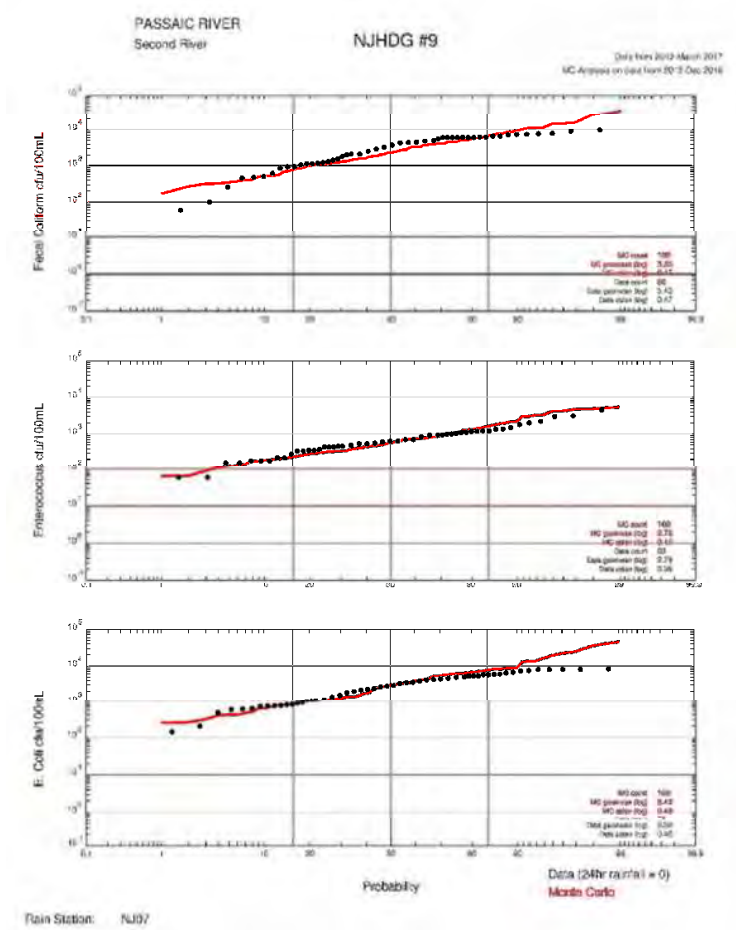
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Dry-weather concentrations



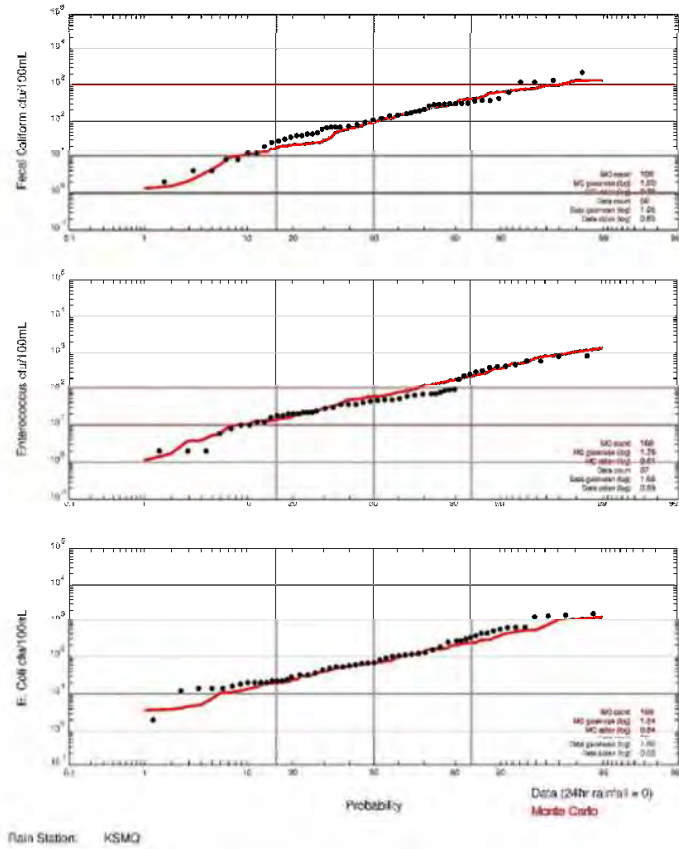
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Dry-weather concentrations



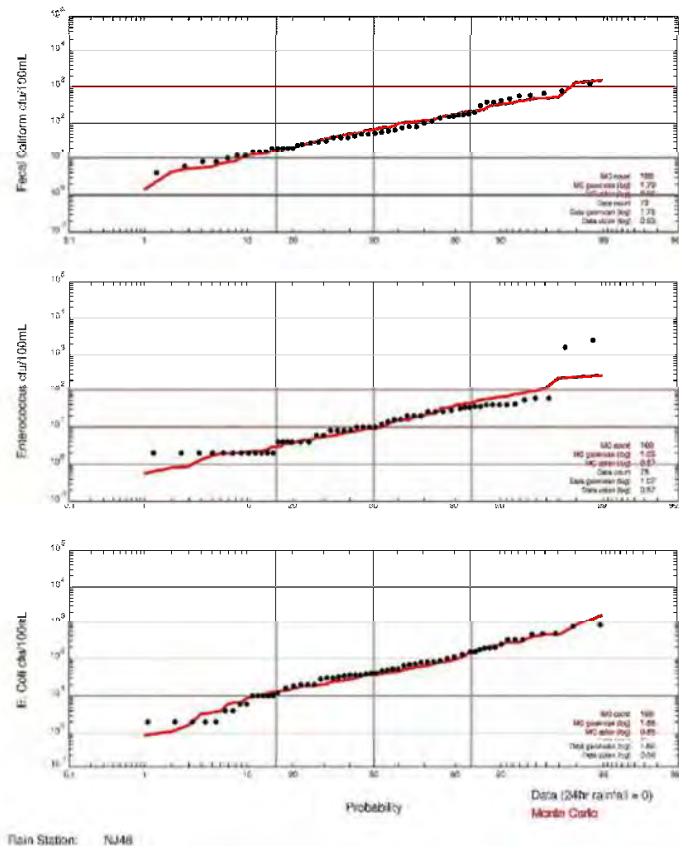
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Dry-weather concentrations



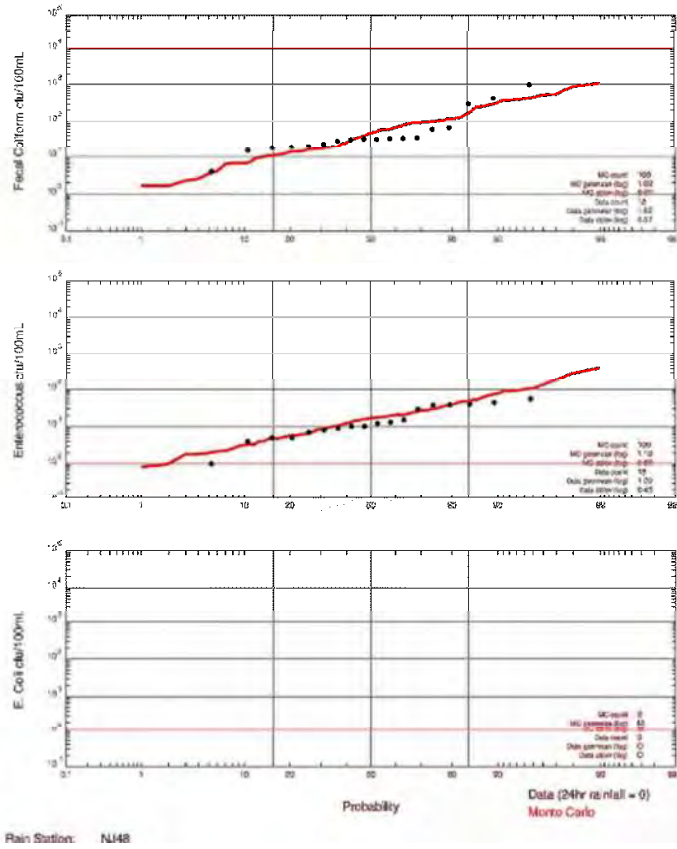
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Dry-weather concentrations



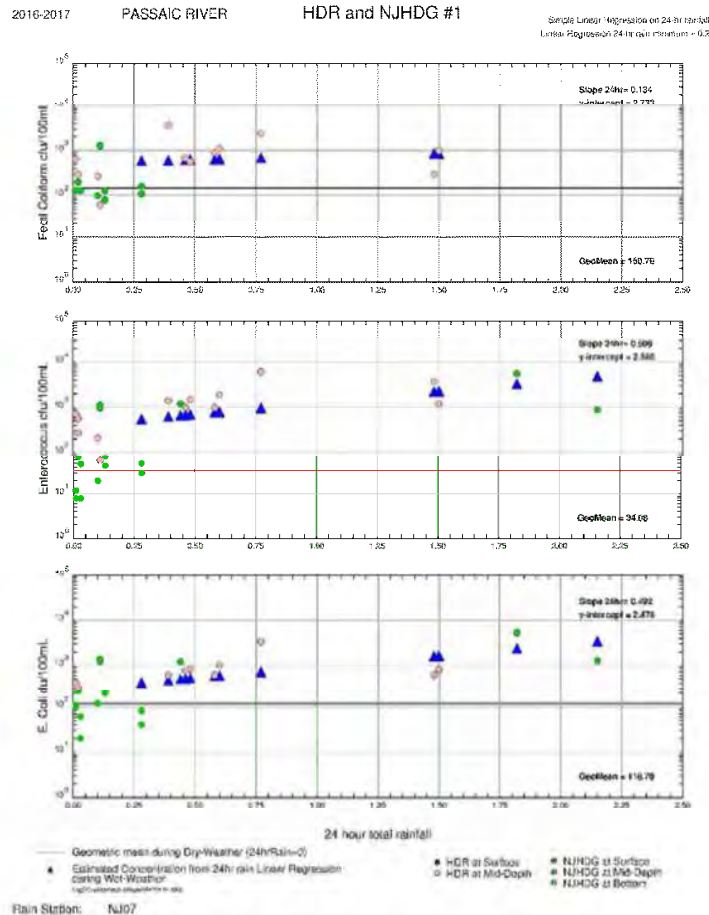
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Dry-weather concentrations



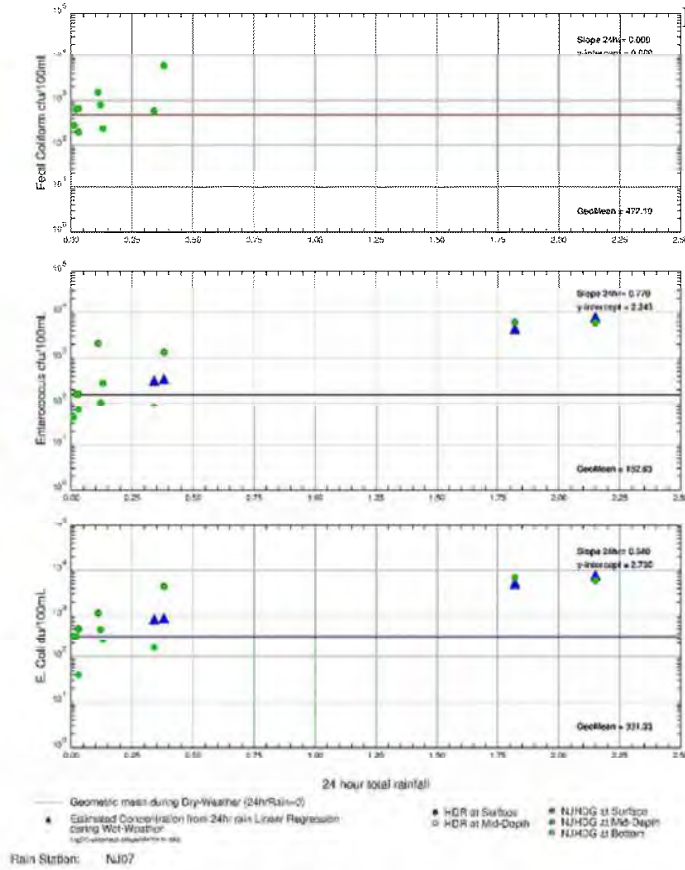
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Wet-weather concentrations



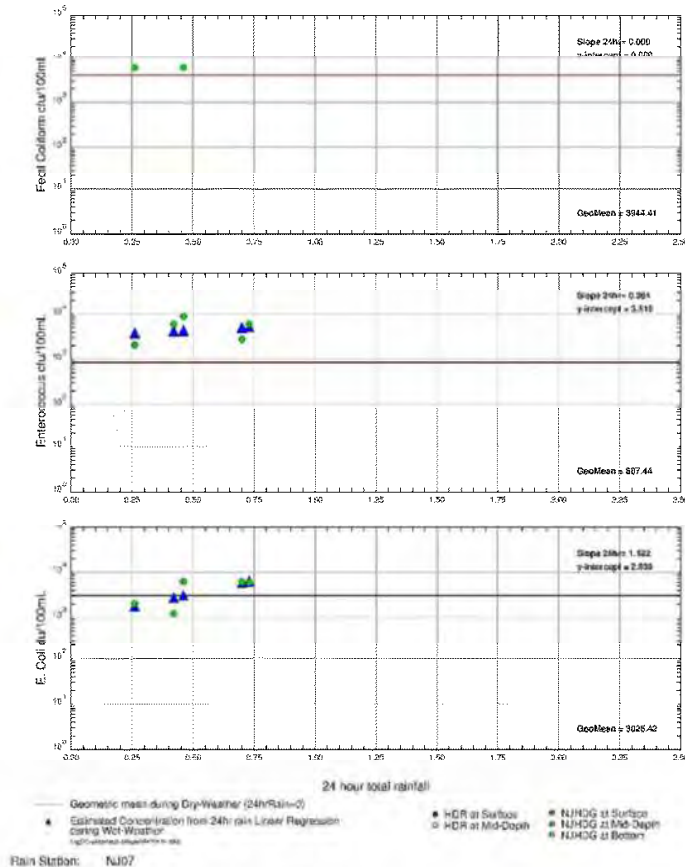
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Wet-weather concentrations



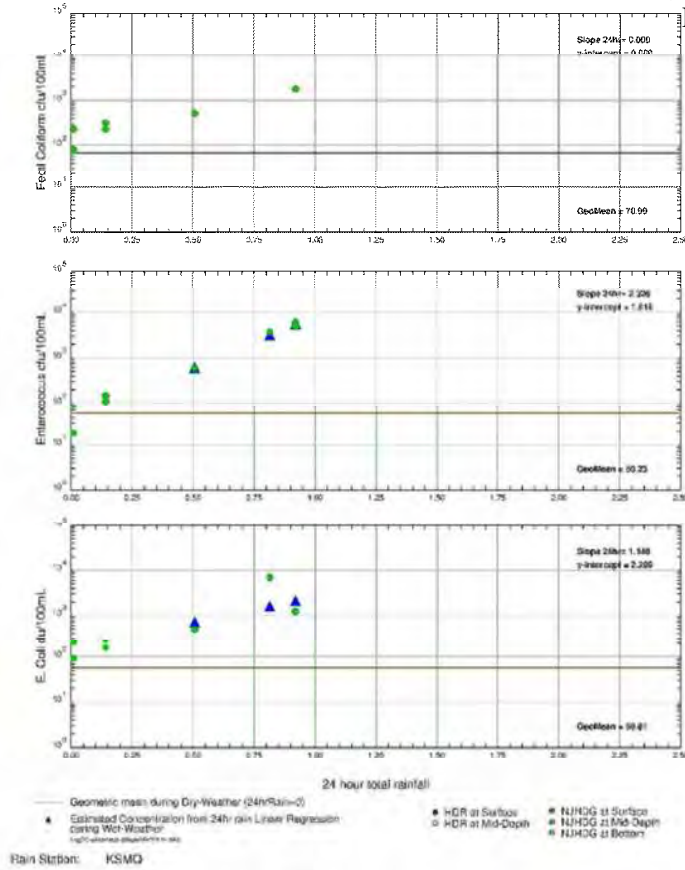
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Wet-weather concentrations



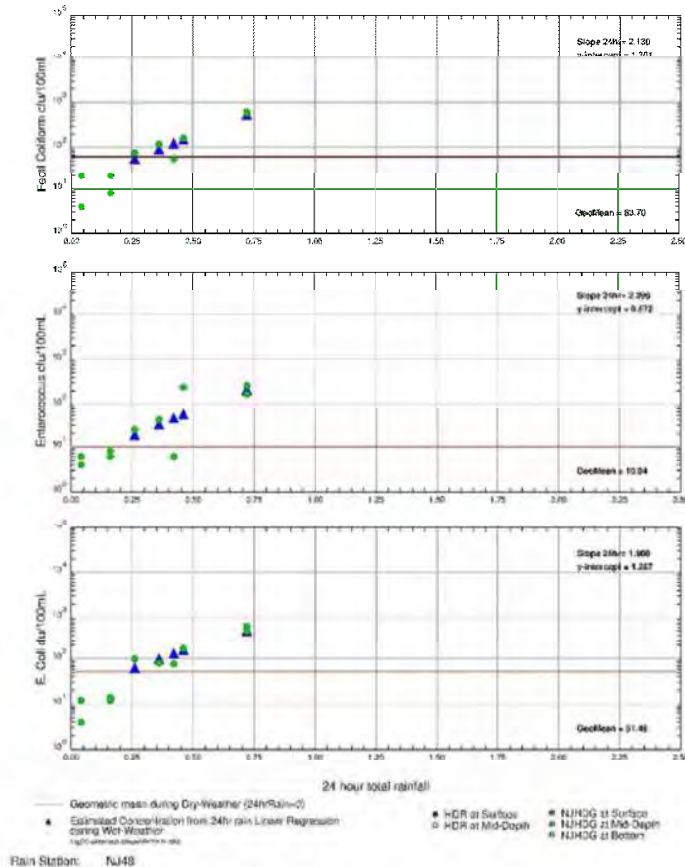
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Wet-weather concentrations



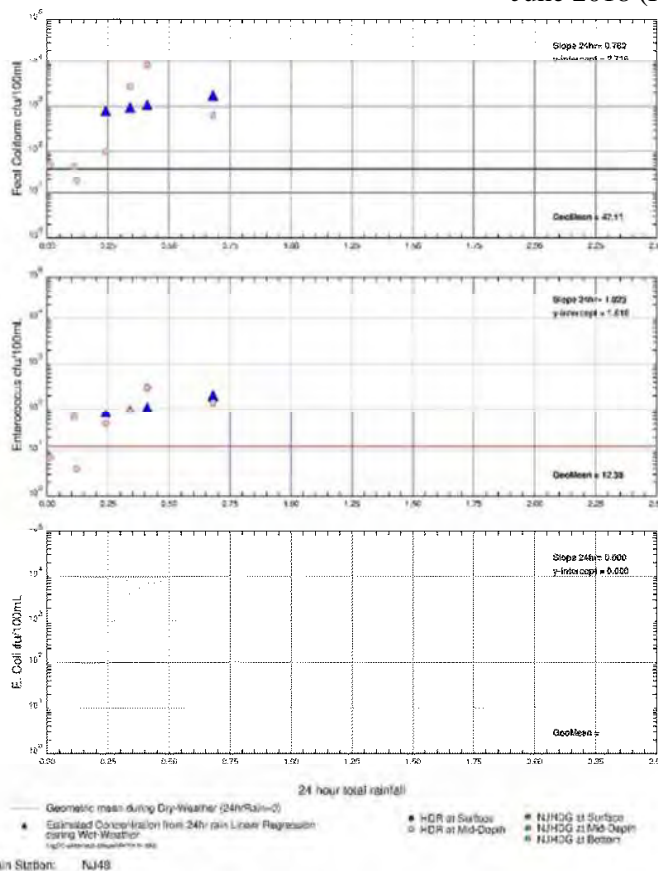
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Wet-weather concentrations

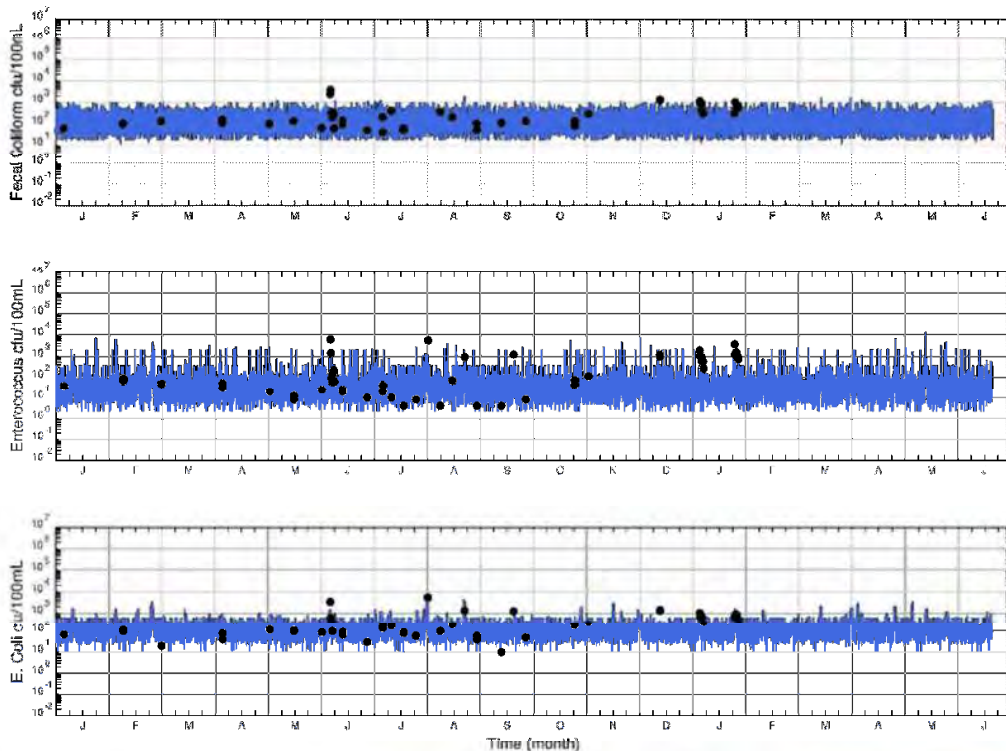


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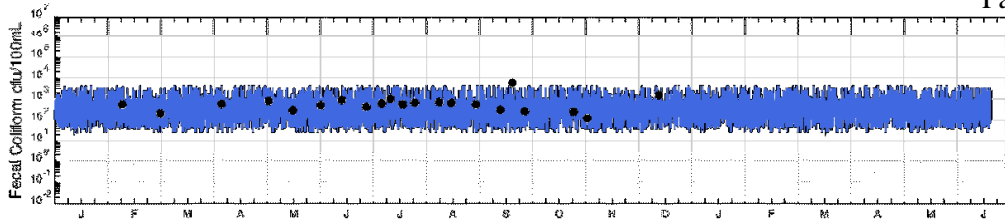
Wet-weather concentrations



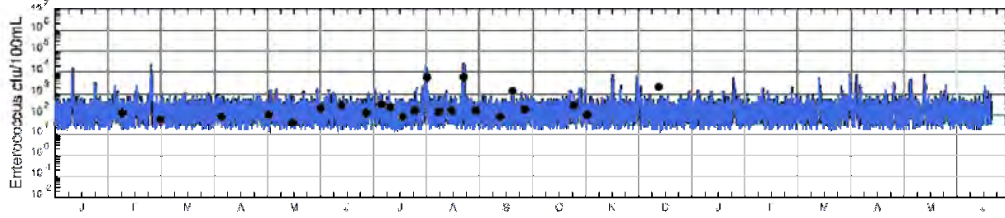
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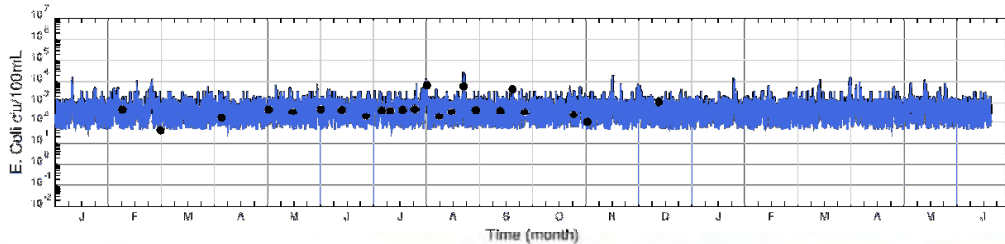
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Slope 24hr= 0.000
y-intercept = 0.000



Slope 24hr= 0.770
y-intercept = 2.243



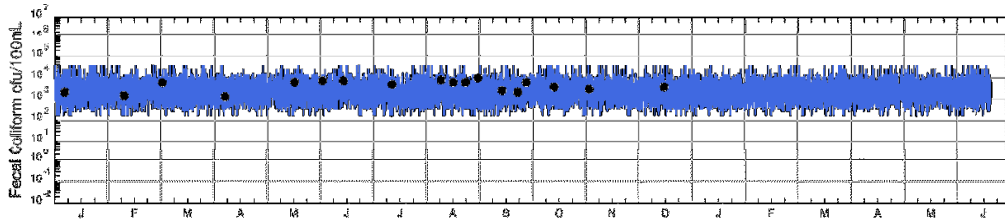
Slope 24hr= 0.540
y-intercept = 2.730

Log(Estimated)-MonteCarloConcentration (slope@24hr rain)

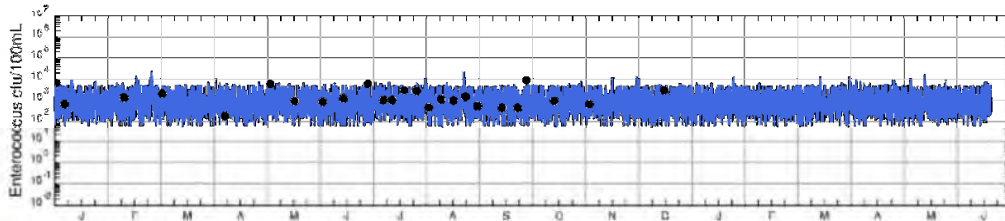
Estimated by Linear Regression and Monte Carlo Analysis
Data

Rain Station: NJ07

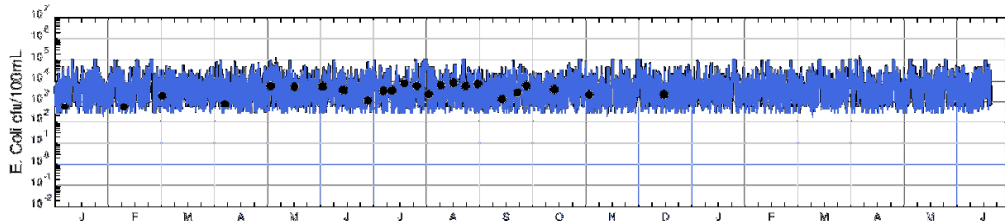
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Slope 24hr= 0.000
y-intercept = 0.000



Slope 24hr= 0.284
y-intercept = 3.510



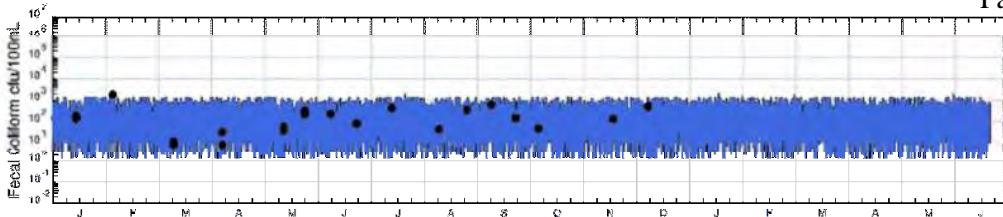
Slope 24hr= 1.182
y-intercept = 2.930

Log(Estimated)-MonteCarloConcentration (slope@24hr rain)

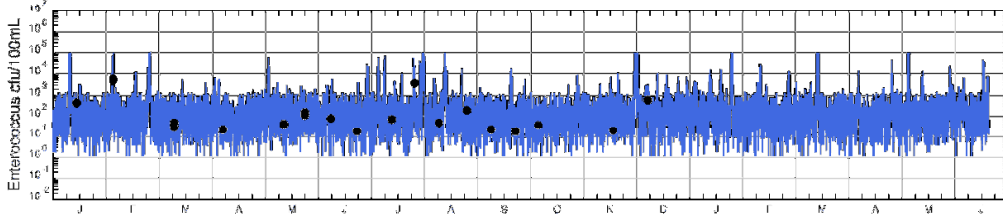
Estimated by Linear Regression and Monte Carlo Analysis
Data

Rain Station: NJ07

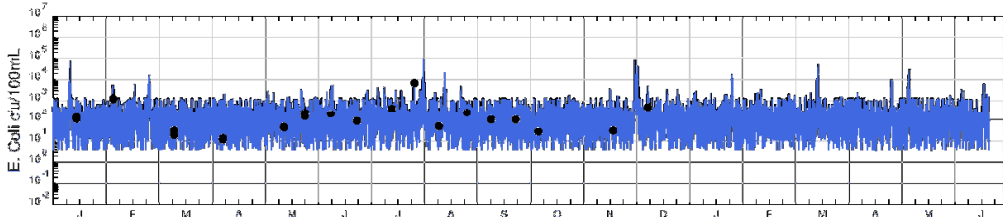
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Slope 24hr = 0.000
y-intercept = 0.000



Slope 24hr = 2.326
y-intercept = 1.616



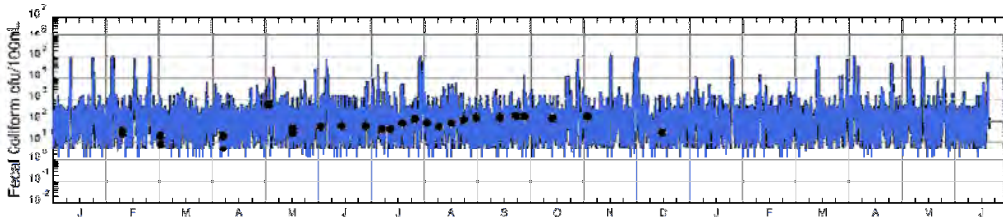
Slope 24hr = 1.148
y-intercept = 2.269

Log(Estimated)-MonteCarloConcentration (slope24hr rain)

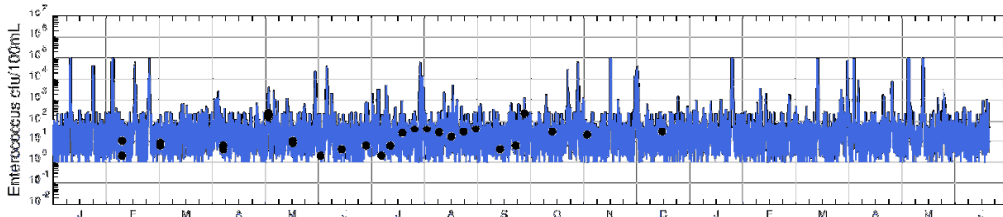
Estimated by Linear Regression and Monte Carlo Analysis
Data

Rain Station: KSMQ

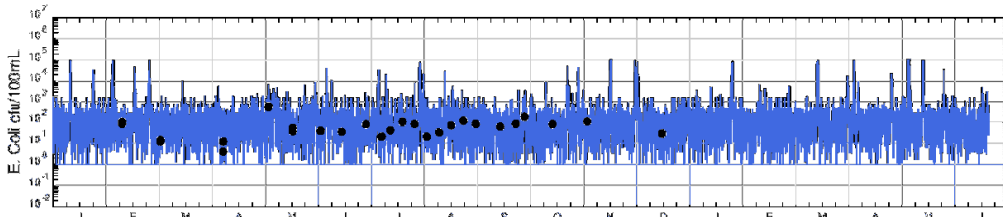
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Slope 24hr = 2.150
y-intercept = 1.591



Slope 24hr = 2.298
y-intercept = 0.672



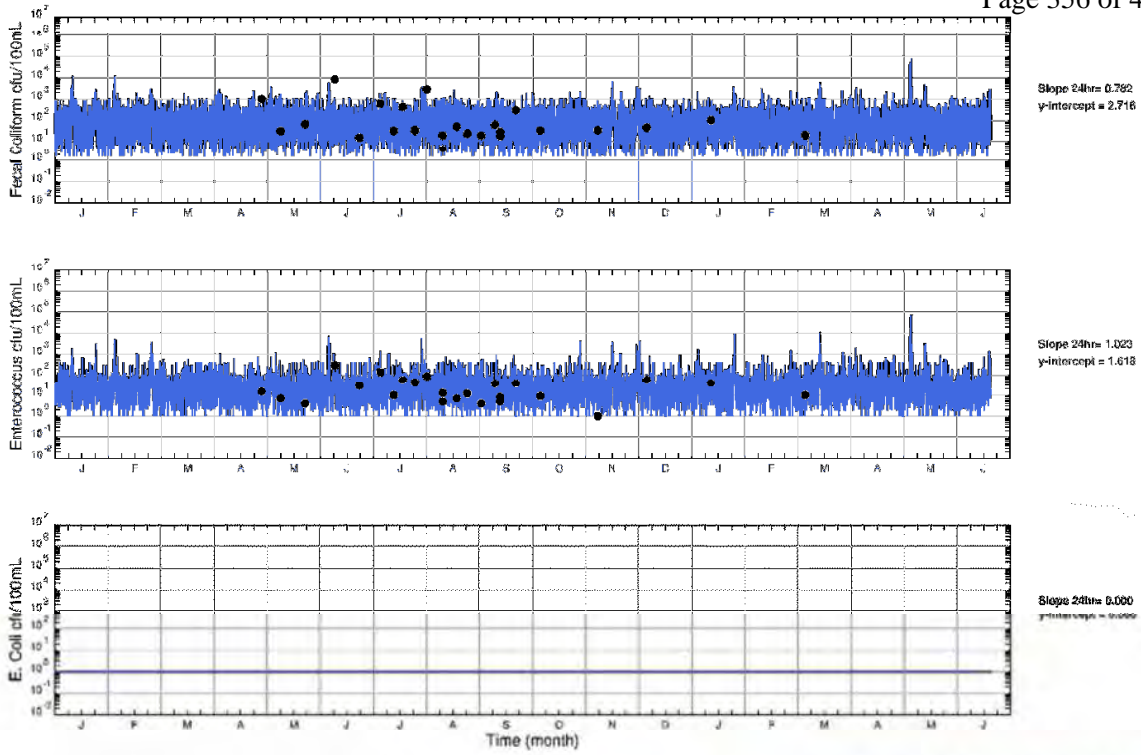
Slope 24hr = 1.966
y-intercept = 1.297

Log(Estimated)-MonteCarloConcentration (slope24hr rain)

Estimated by Linear Regression and Monte Carlo Analysis
Data

Rain Station: NJ48

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Log(Estimate)-MonteCarloConcentration (slope24hr24 hr rain)

Estimated by Linear Regression and Monte Carlo Analysis Data

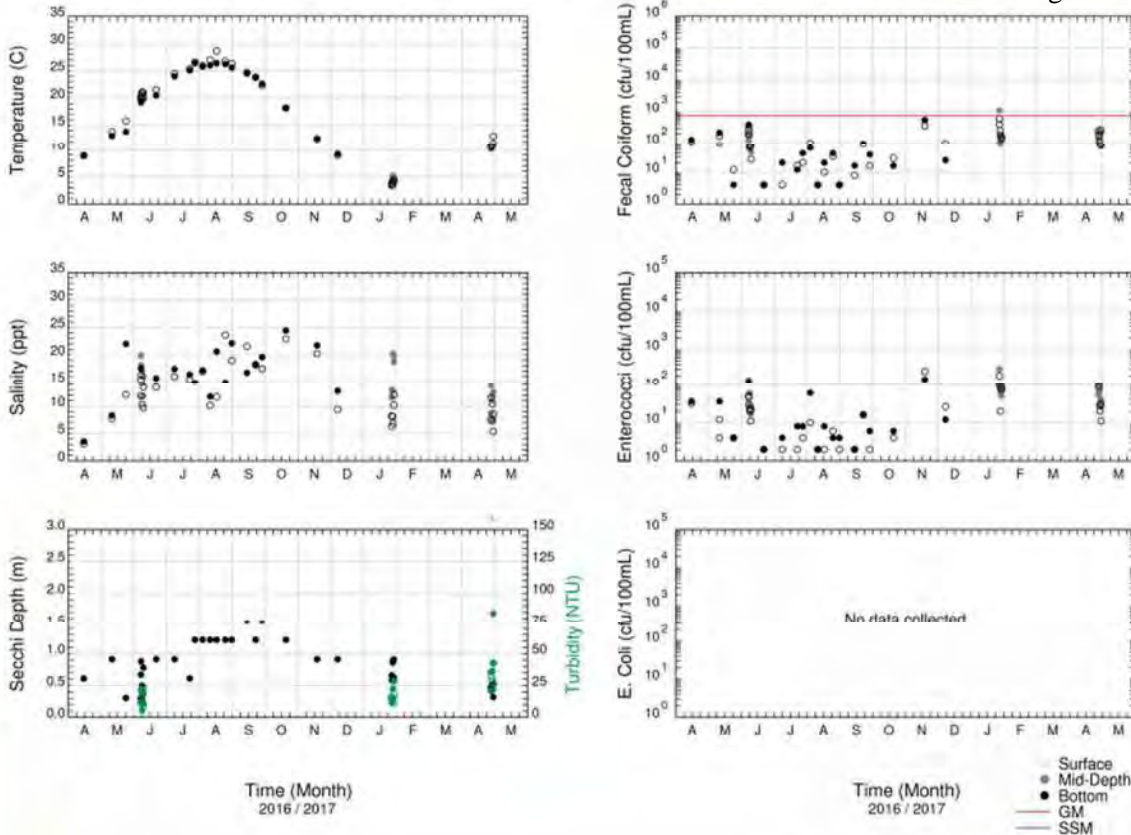
Rain Station: NJ48

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Other Loads

- Dry-weather sources
 - May be need for calibration during dry-weather
 - Projection conditions?
- Hudson River

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Pathogen Model Kinetics

$$N = N_0 \exp(-KBt)$$

$$K_B = [0.8 + 0.006(\%seawater)]1.07^{(T-20)}$$

$$+ \alpha I_0(t)/K_e H [1 - \exp(-K_e H)]$$

$$+ V_s/H \quad (\text{Mancini, 1978})$$

N = Bacteria concentration

K_B = Bacteria loss rate

T = Temperature (°C)

α = proportionality constant

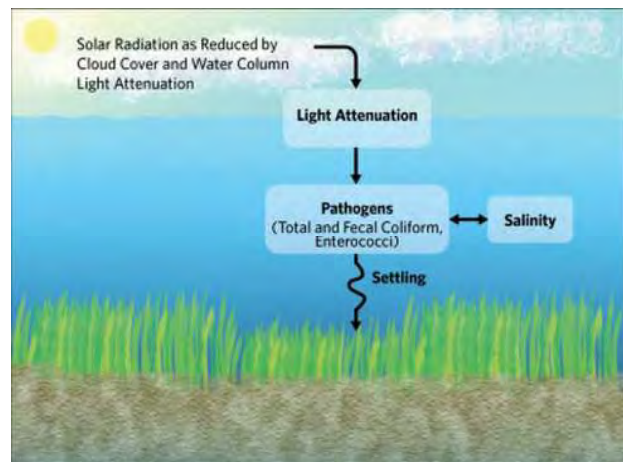
I_0 = Surface solar radiation

t = time

K_e = Extinction coefficient (/m)

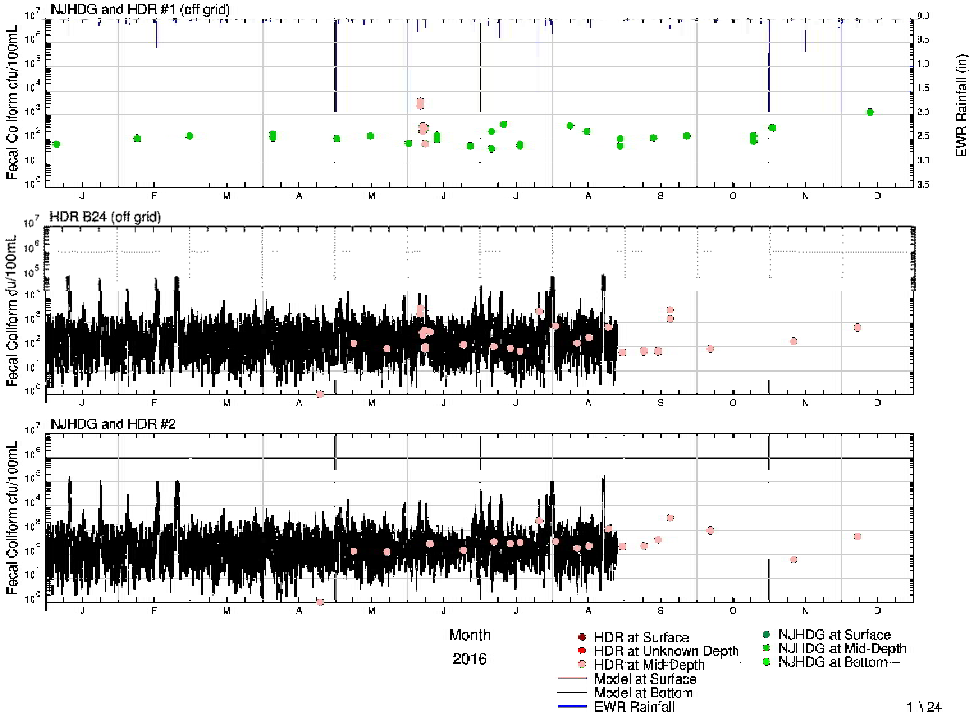
H = Depth (m)

V_s = Net settling rate (m/d)



Model Calibration

PASSAIC RIVER

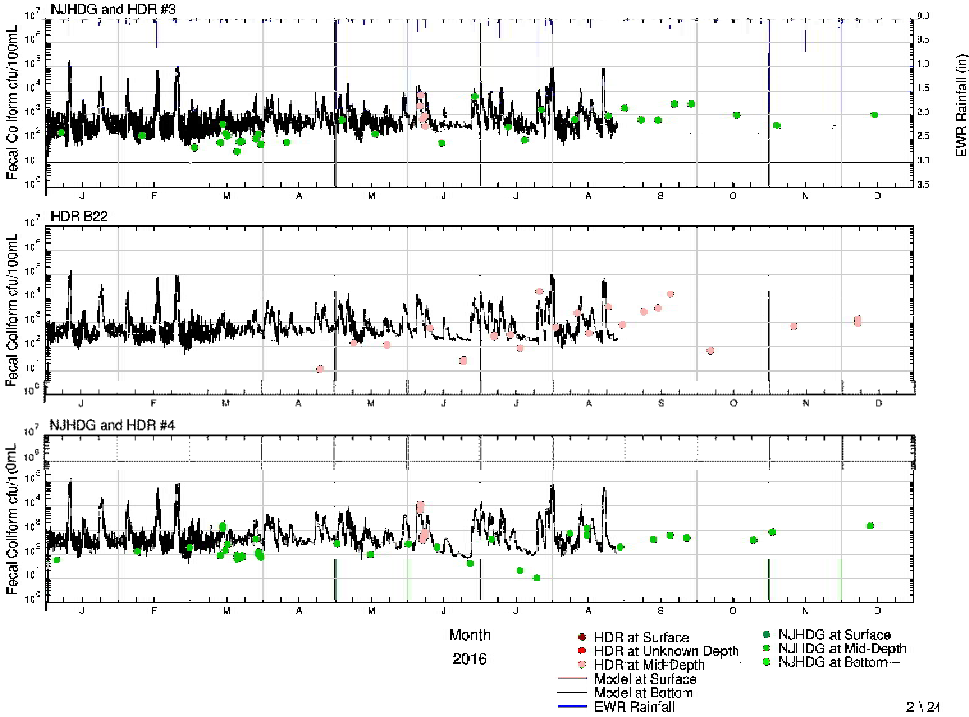


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Model Calibration

PASSAIC RIVER

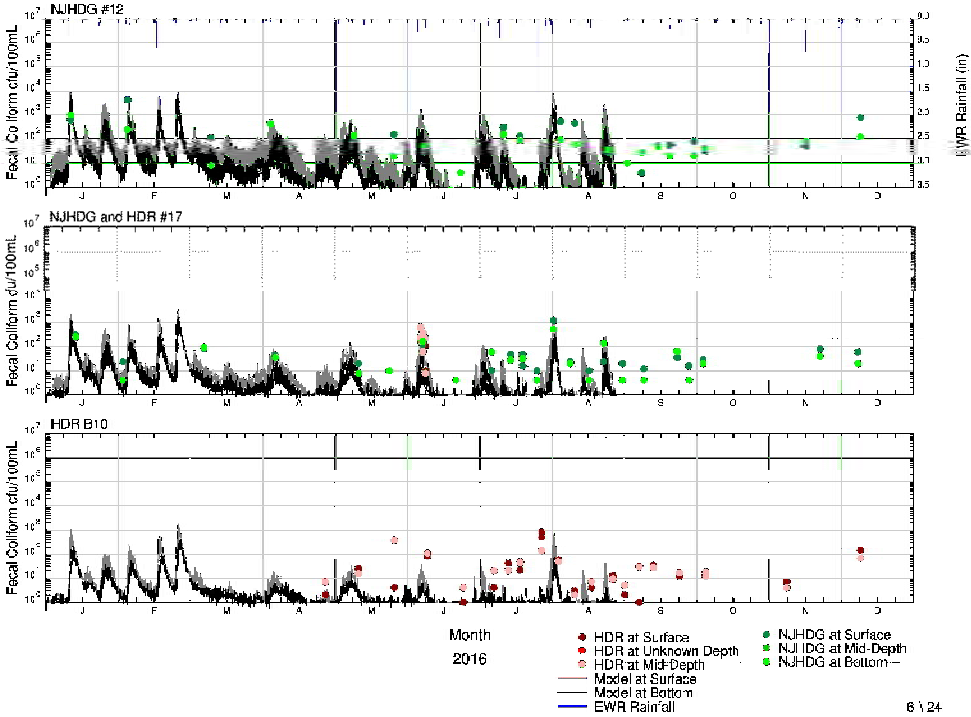


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Model Calibration

PASSAIC RIVER

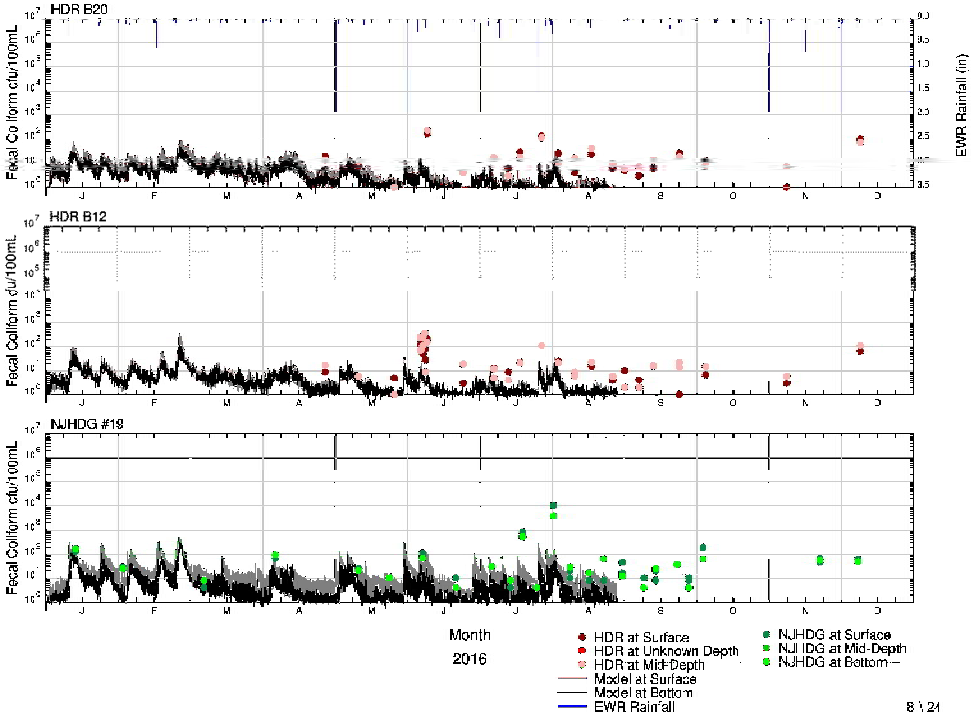


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Model Calibration

KILL VAN KULL

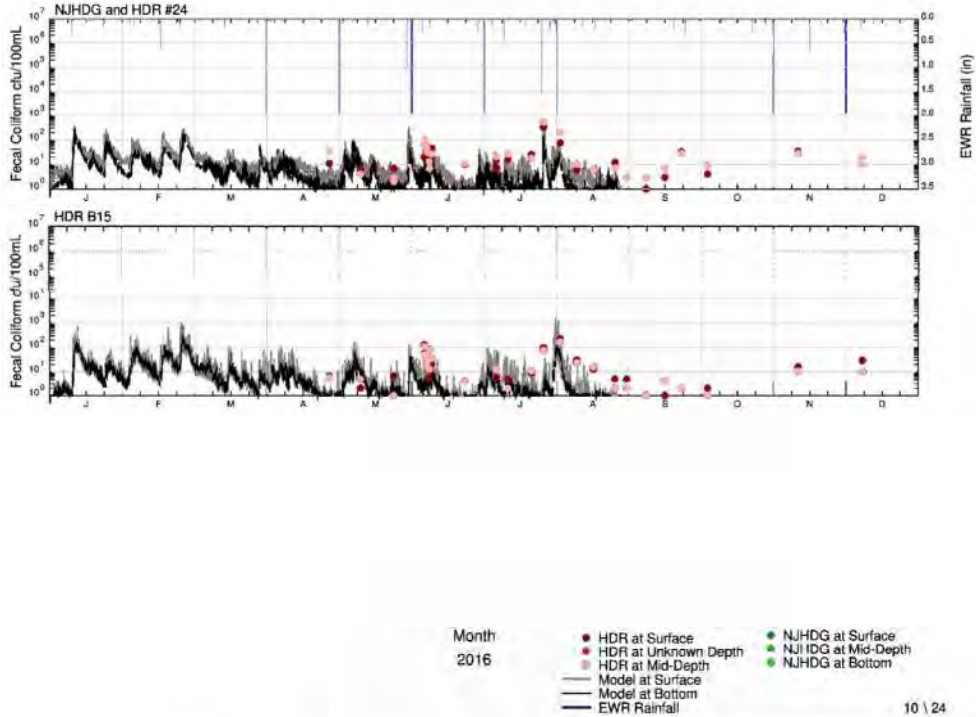


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Model Calibration

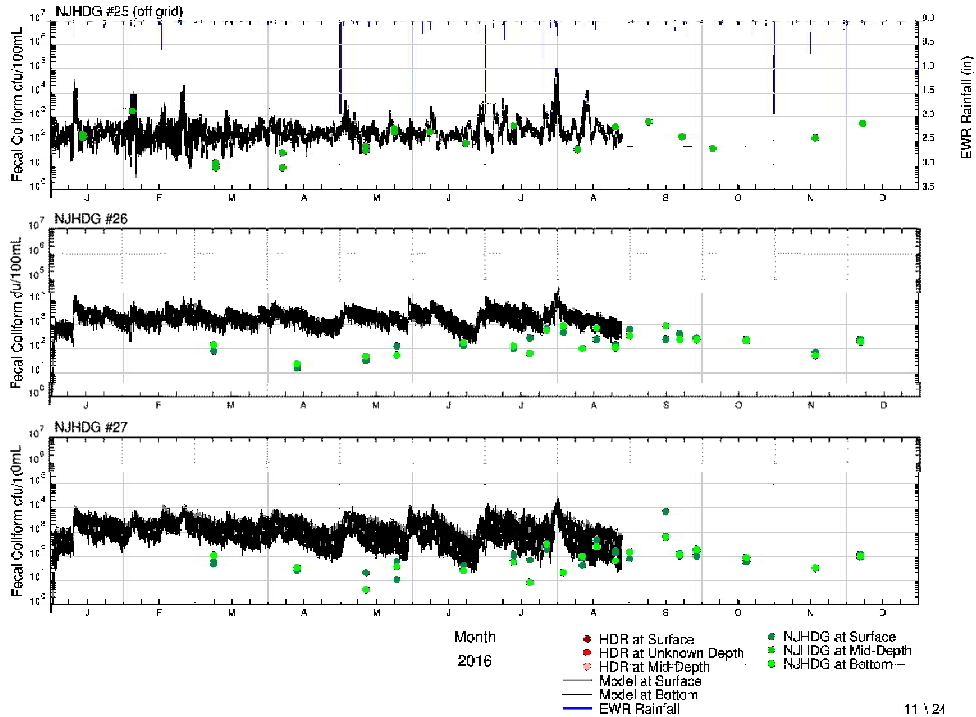
KILL VAN KULL



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Model Calibration

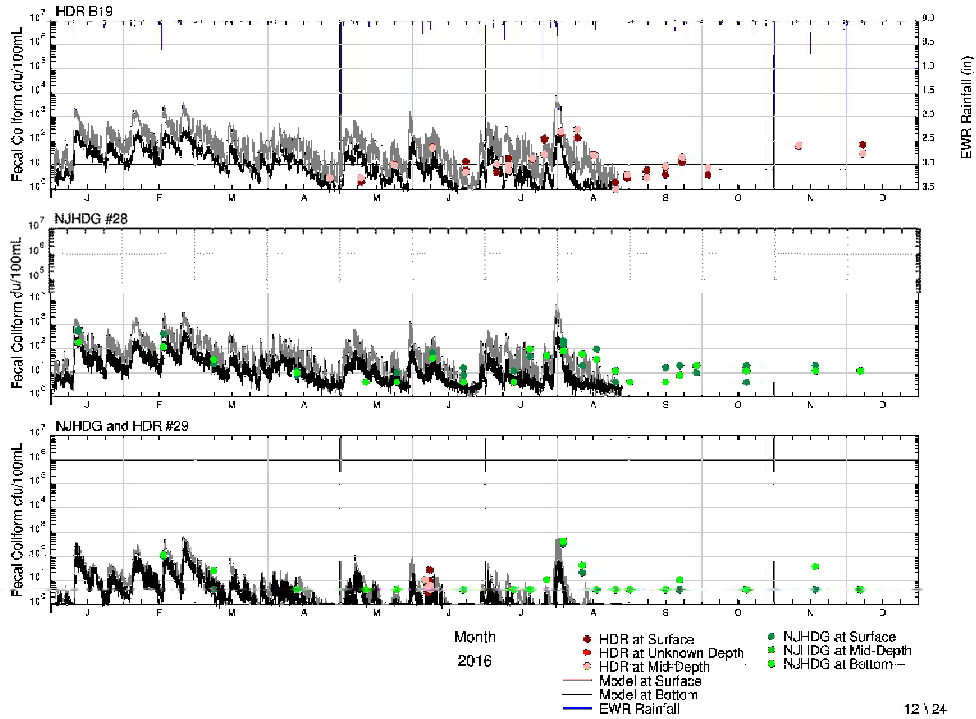
RARITAN RIVER/BAY



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Model Calibration

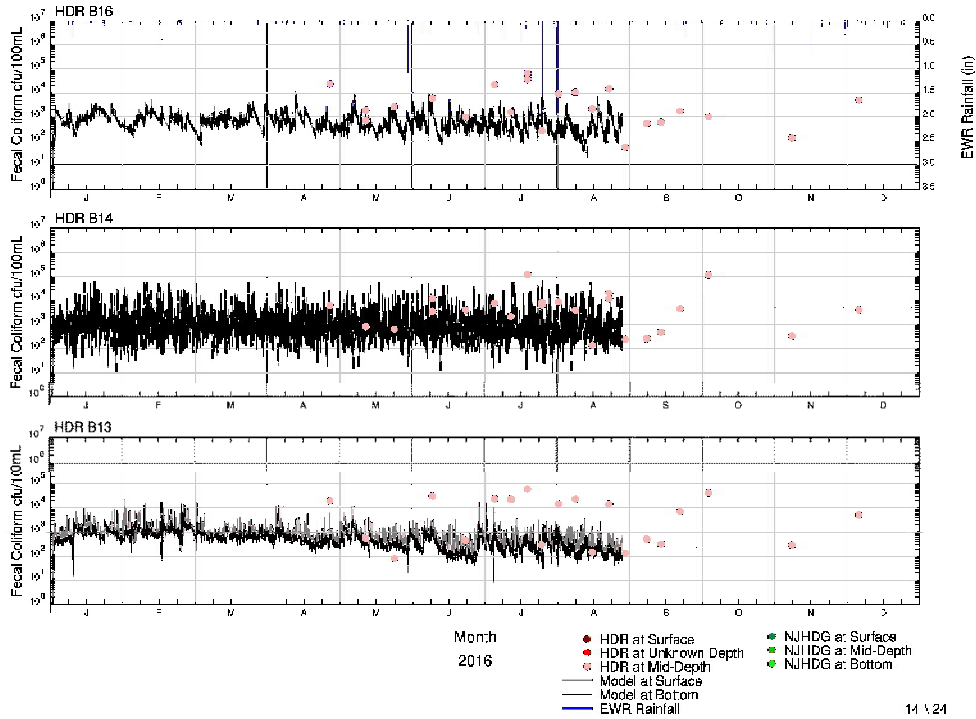
RARITAN RIVER/BAY



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Model Calibration

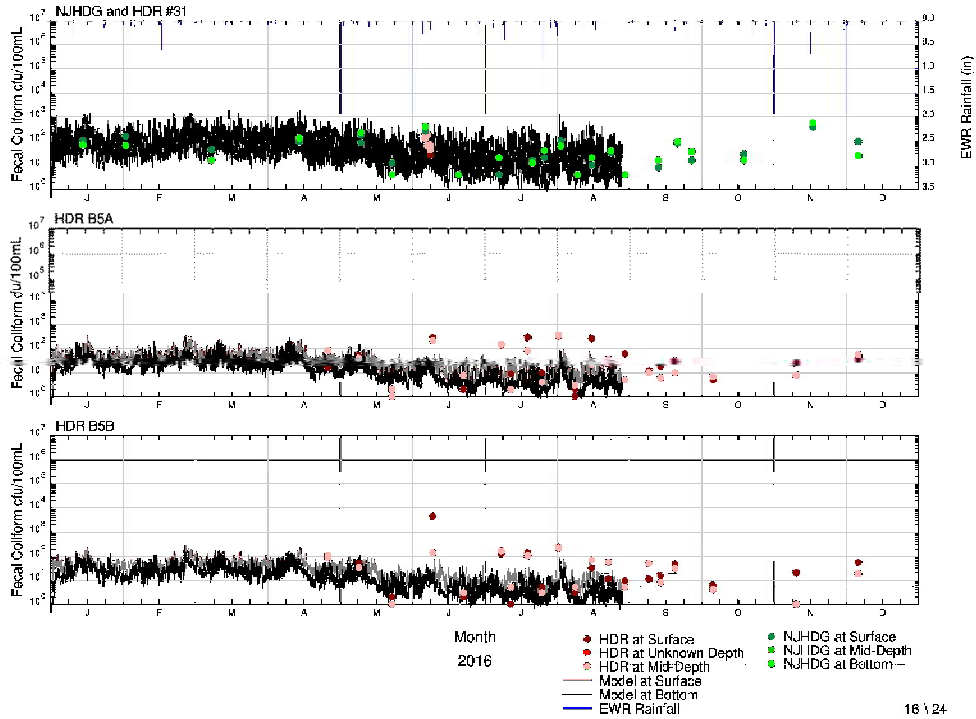
ELIZABETH RIVER



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Model Calibration

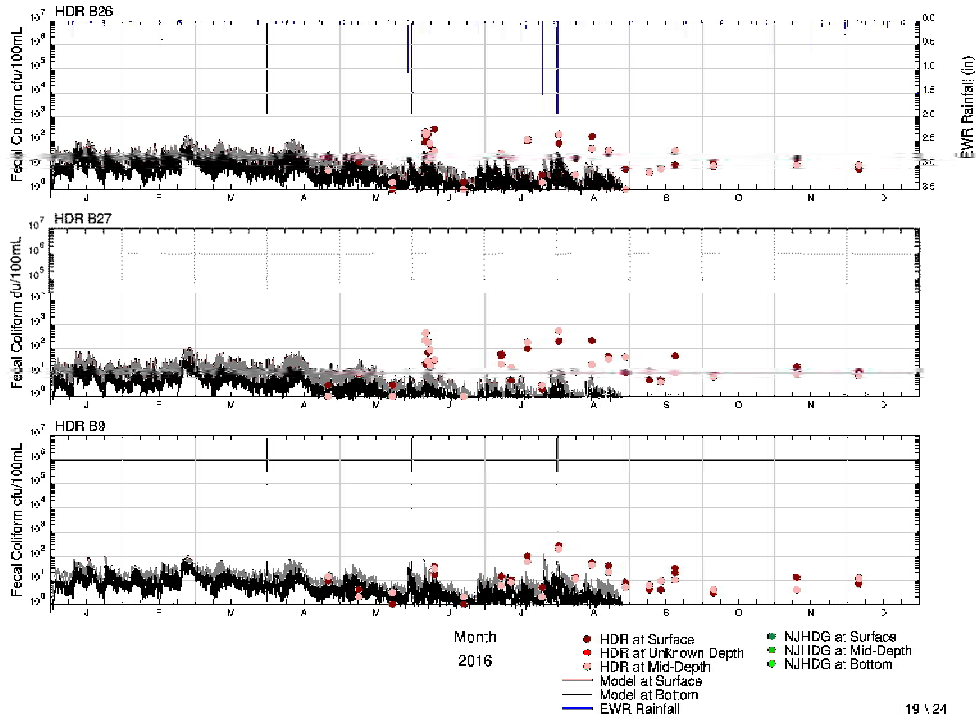
HUDSON RIVER



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Model Calibration

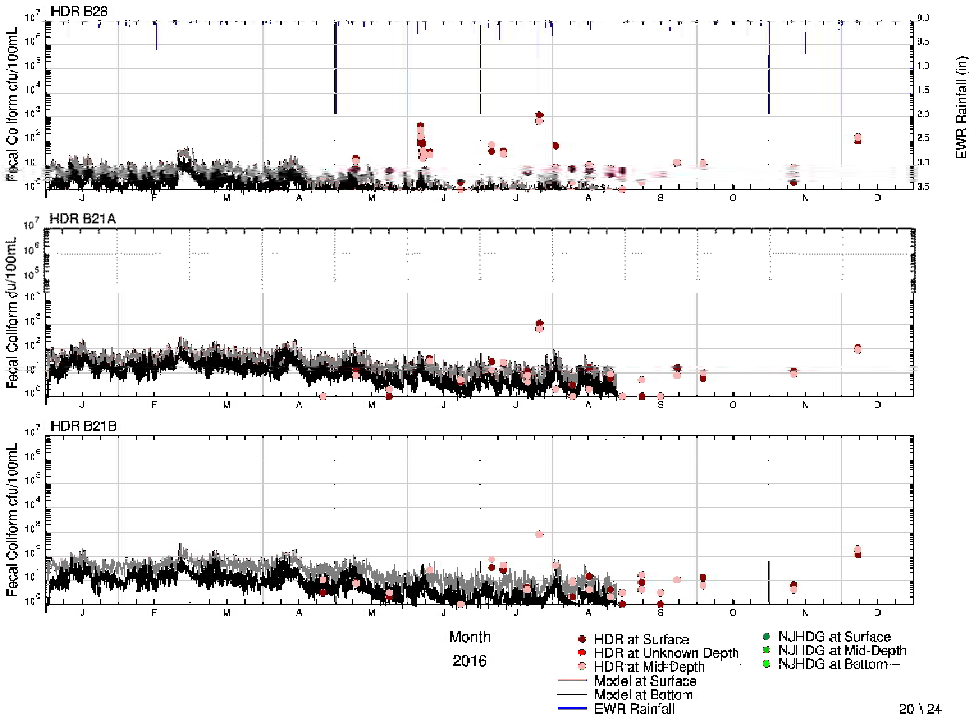
HUDSON RIVER



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Model Calibration

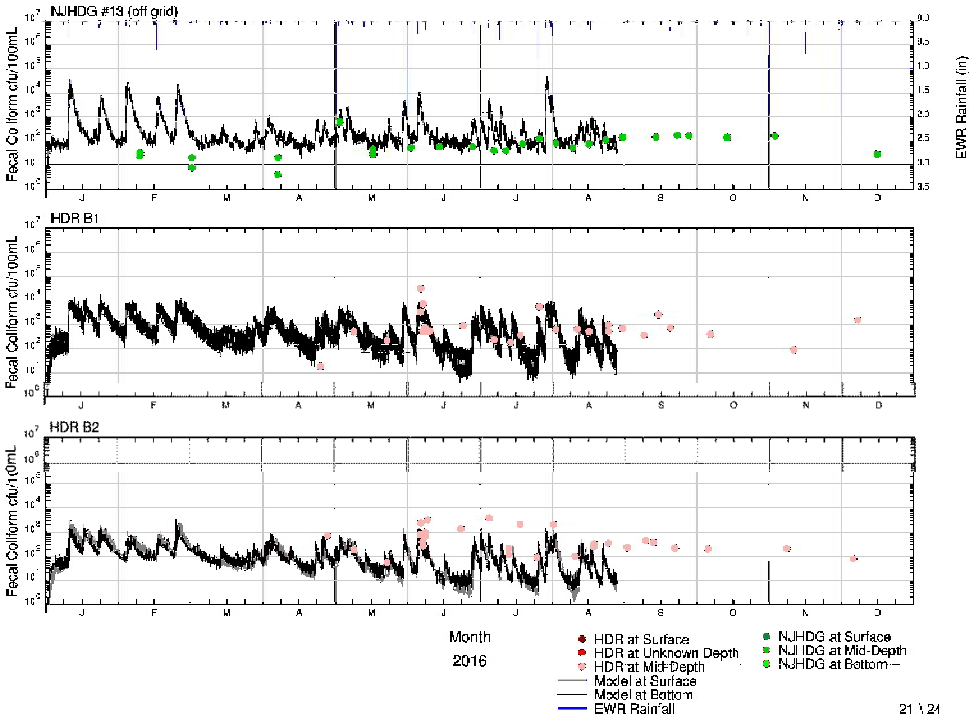
HUDSON RIVER



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Model Calibration

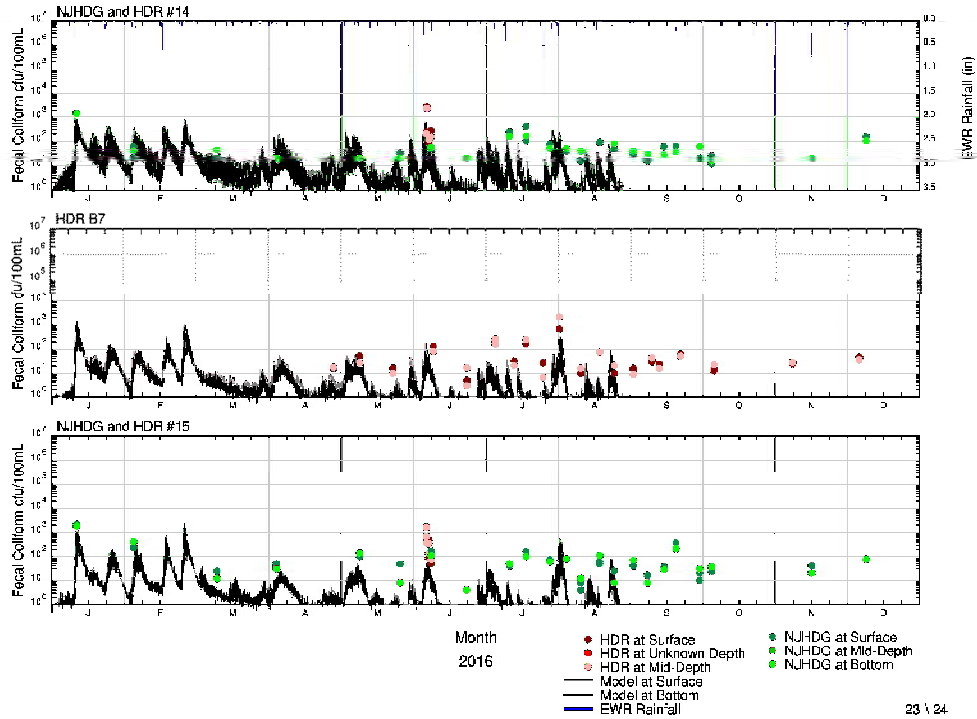
HACKENSACK RIVER



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Model Calibration

HACKENSACK RIVER



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Next Steps

- CSO data
- Obtain CSO flow and load files from consultant teams
- Continue model calibration

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