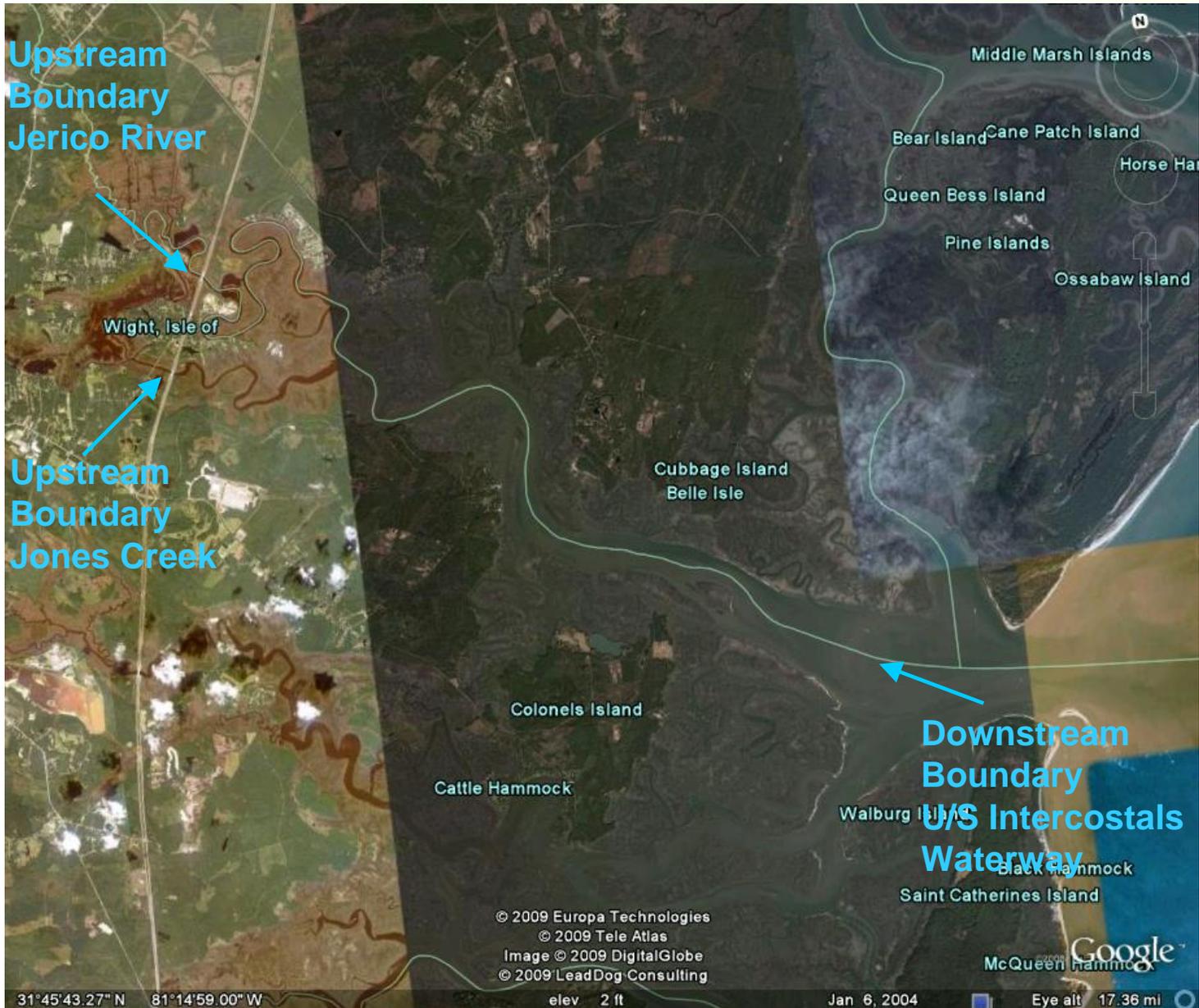
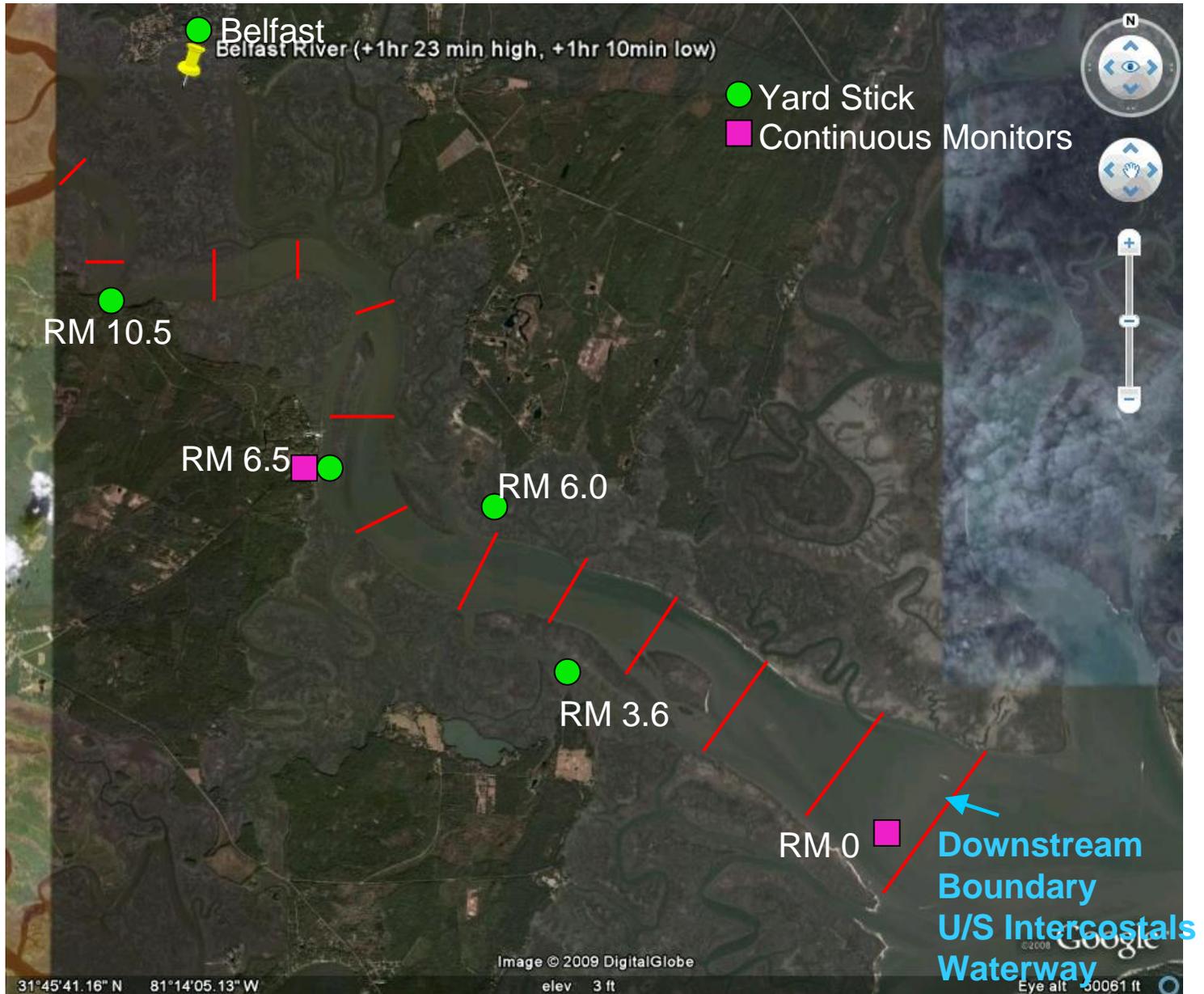


# *Laurel View River Study Plan*

Jeremy Smith  
Intensity Survey Unit Coordinator  
Watershed Protection Branch  
GA EPD

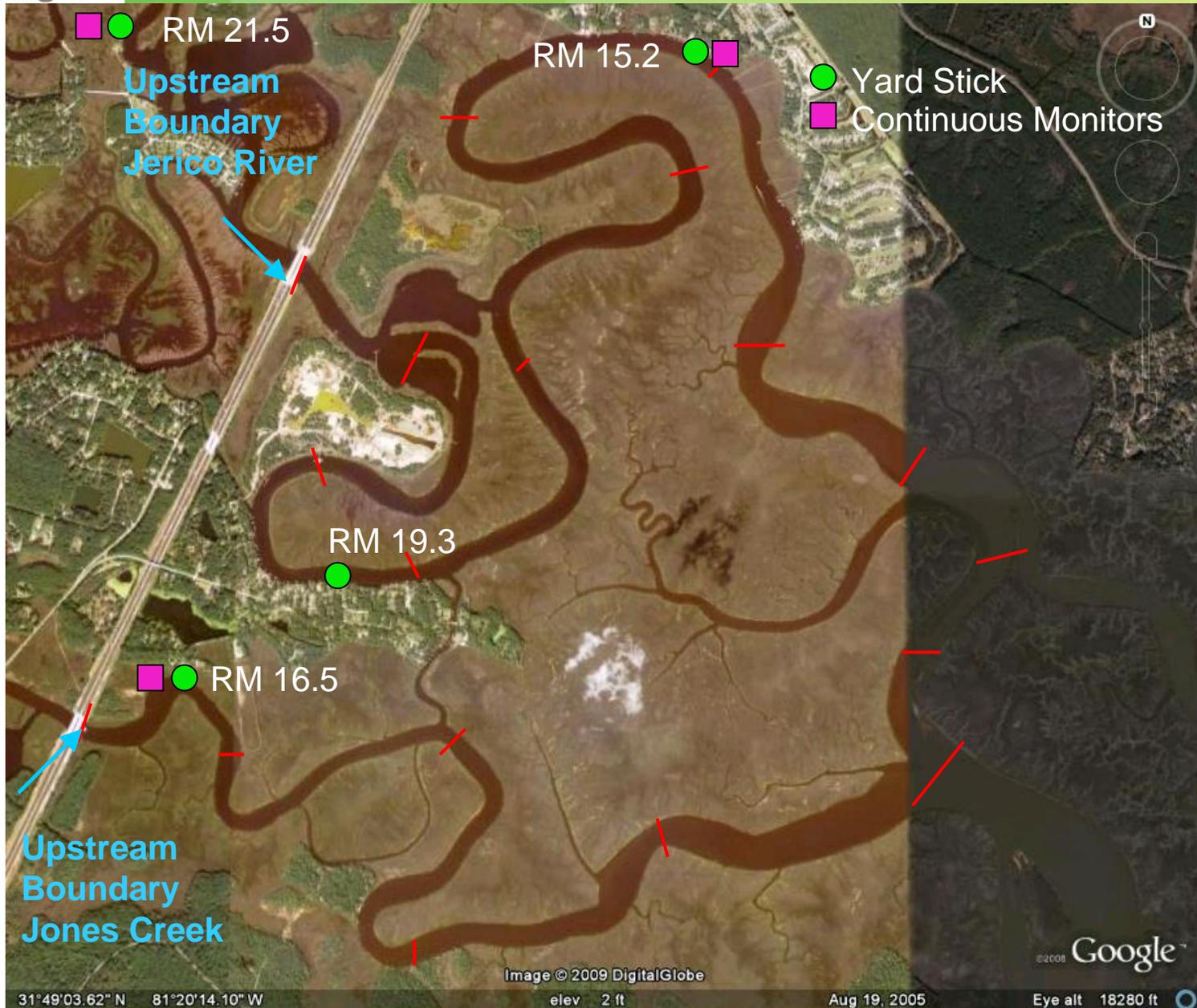


# Model Segments in Medway and Laurel View Rivers





# Model Segments in Jones Creek and Jerico Rivers





- Yard Stick Survey
- Bathymetry Measurements
- Depth Profiles
- Slack Tide Centerline Run
- Long Term BODs
- Continuous Dye Release
- Drogue Study



# *Field Study – September 2009*

- Install Continuous Monitors
- Slack Tide Centerline Runs
- Water Sampling for Chemistry
- Drogue Study

- Attach yard sticks on nine docks

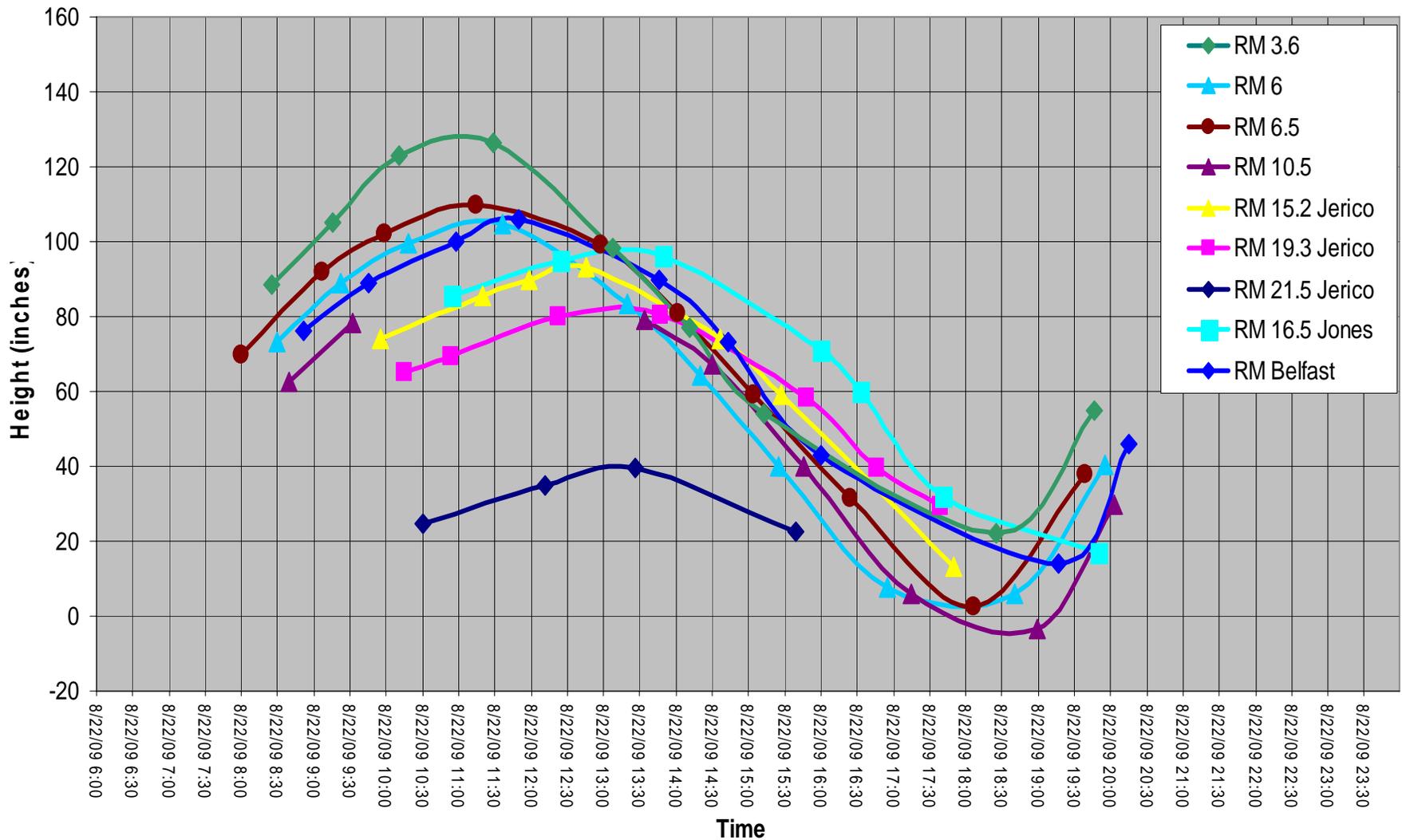
- RM 3.6 Medway
- RM 6.0 Medway
- RM 6.5 Medway
- RM 10.5 Laurel View
- RM 15.2 Jerico
- RM 19.3 Jerico
- RM 21.5 Jerico
- RM 16.5 Jones
- Belfast



- Record water level at various times throughout the tidal cycle



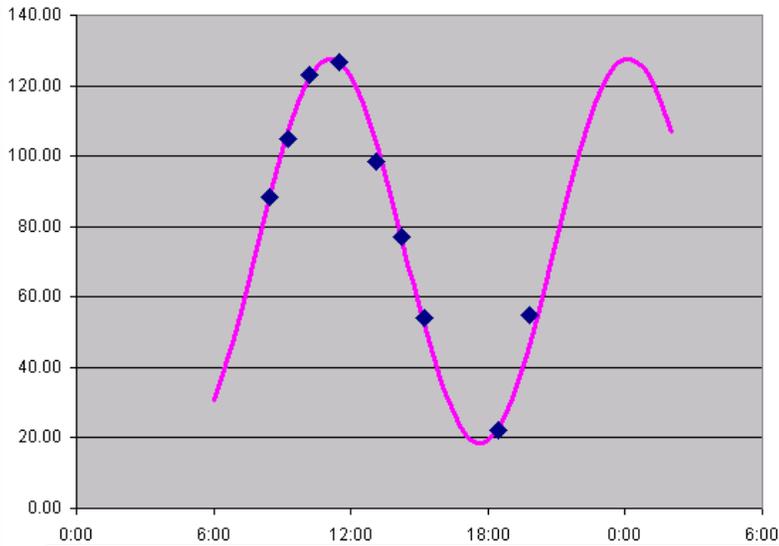
# Yard Stick Survey



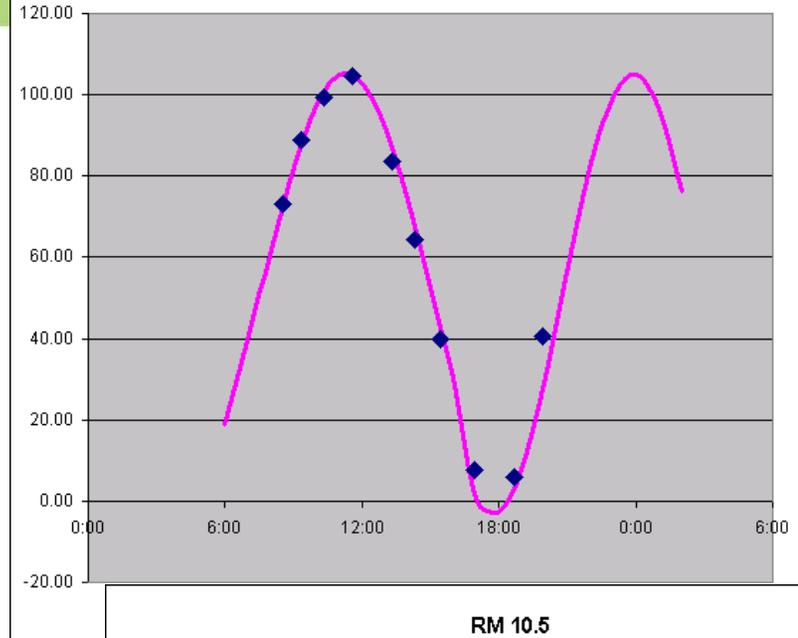


# Yard Stick Survey

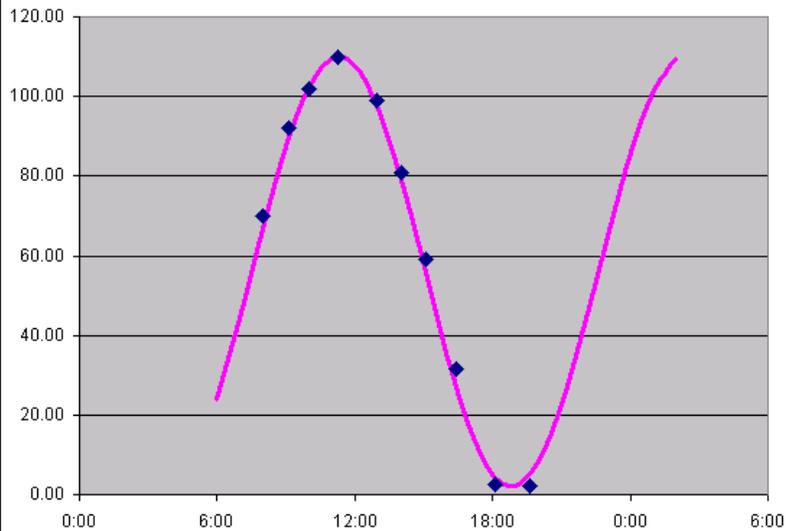
RM 3.5



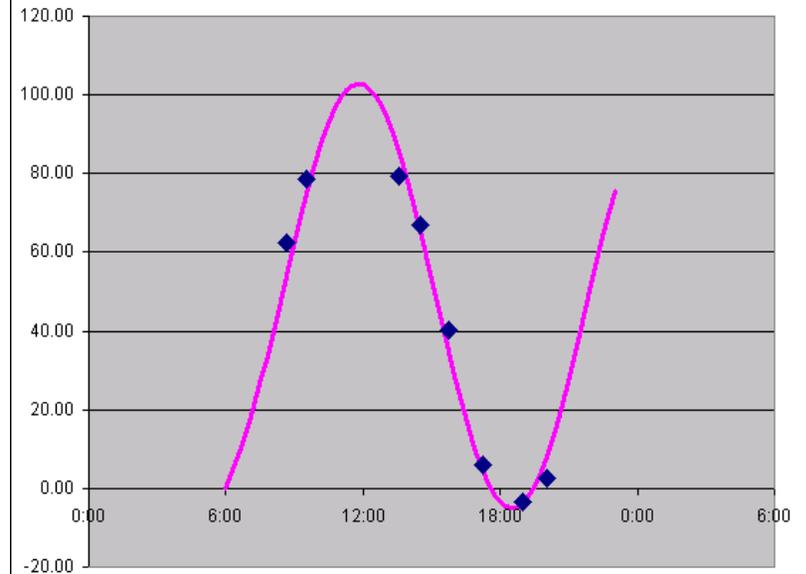
RM 6.0



RM 6.5



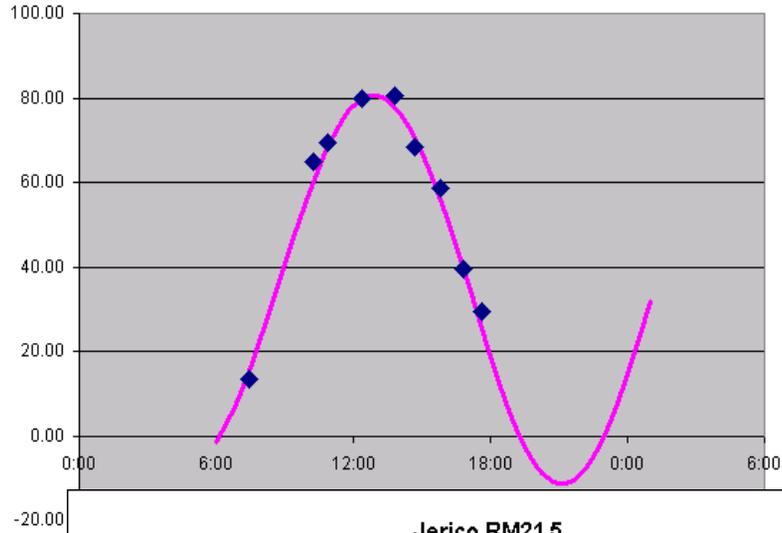
RM 10.5



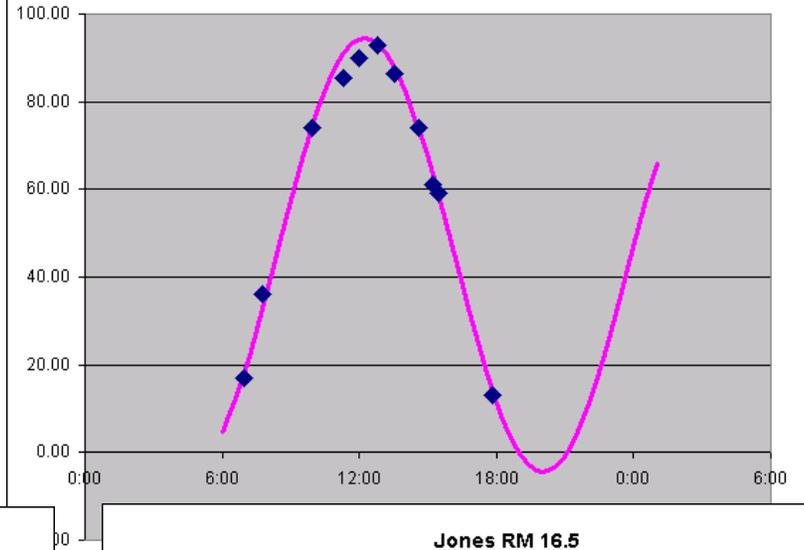


# Yard Stick Survey

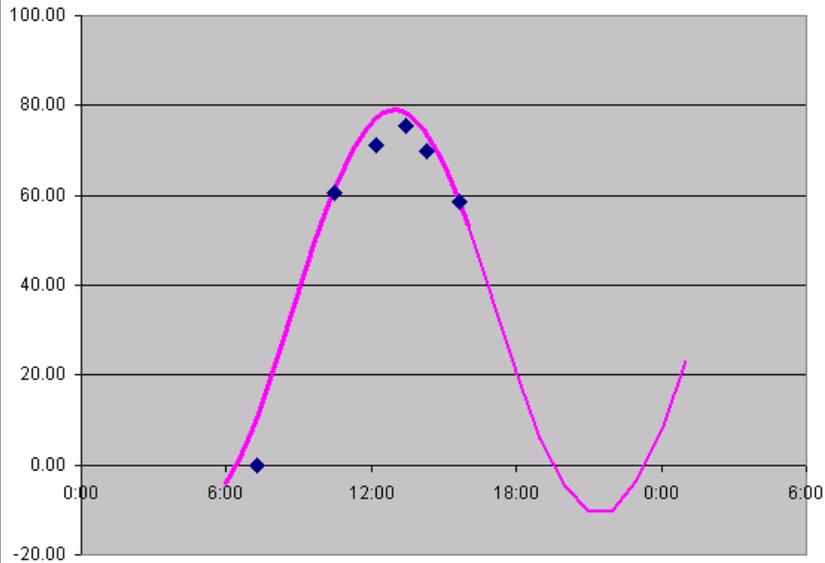
**Jerico RM19.3**



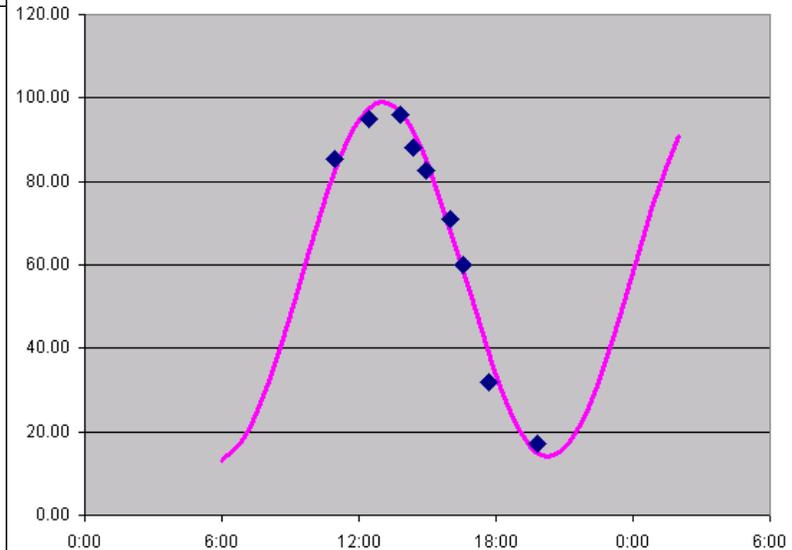
**Jerico RM 15.2**



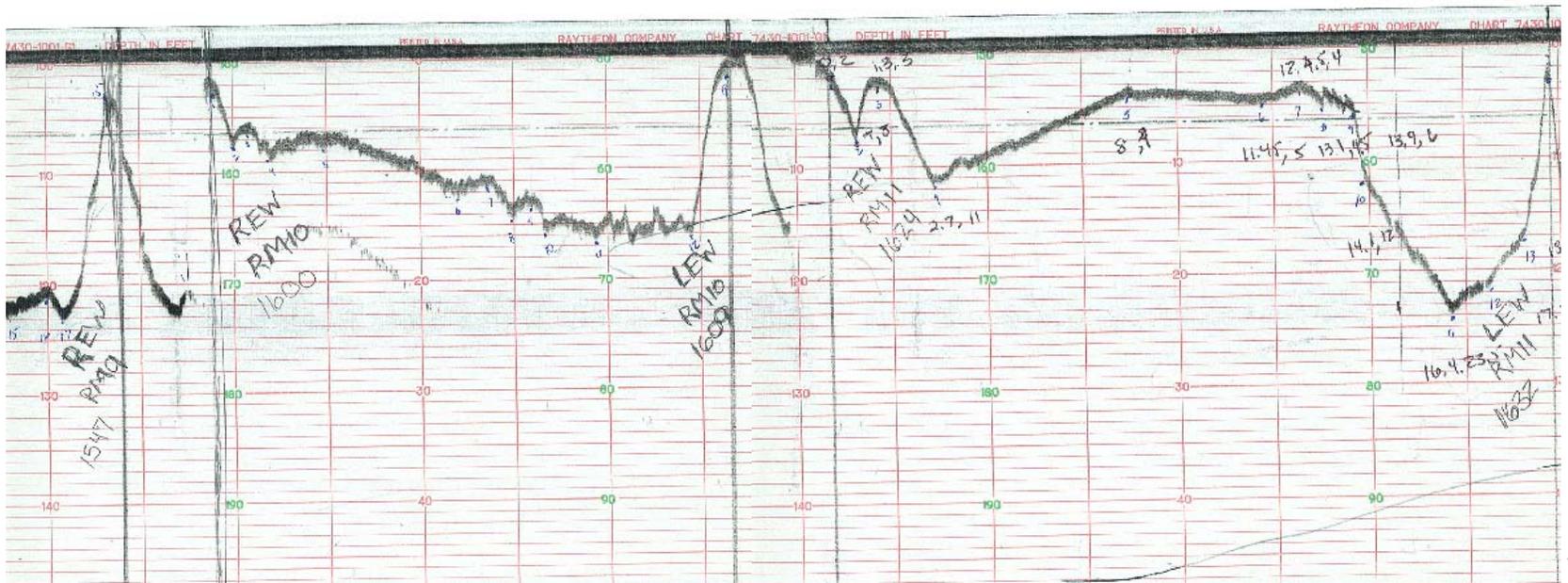
**Jerico RM21.5**



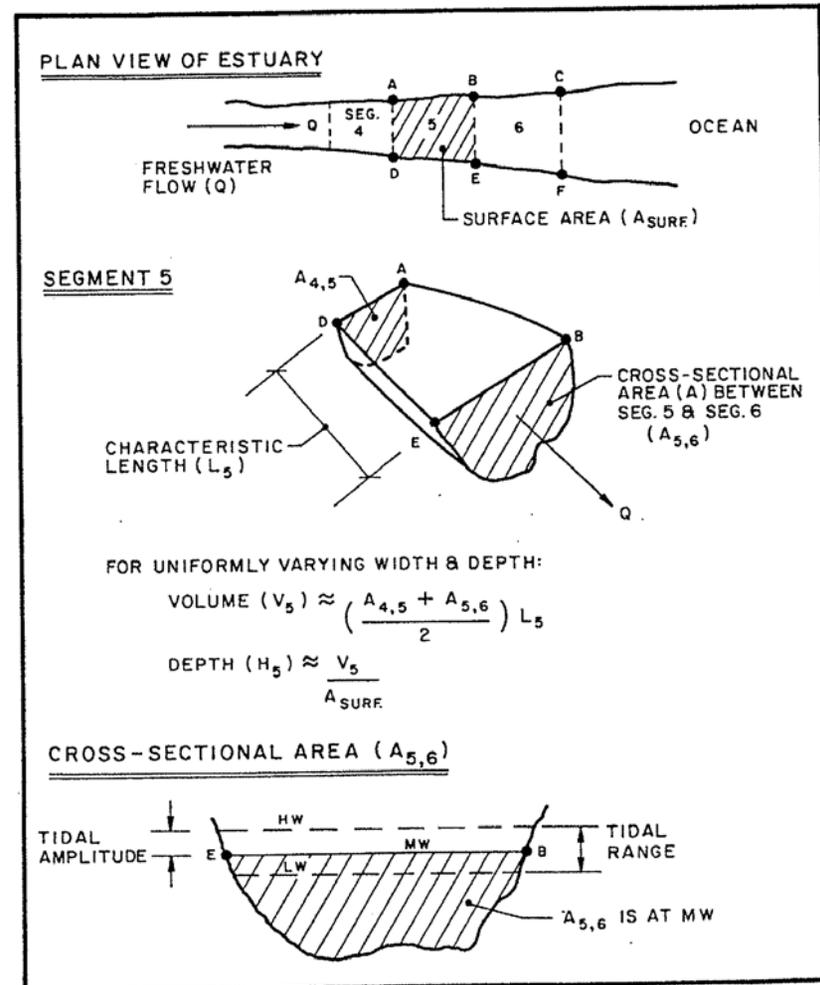
**Jones RM 16.5**



- Measure Channel Bottom Using a Fathometer
- Motor Across Channel at a Constant Speed
- Record Time
  - Adjust to Mid-Tide using yard stick data



- Use Data for
  - Segment Volume
  - Depth
  - Cross-Sectional Area





# Bathymetry Measurements

From yard stick study

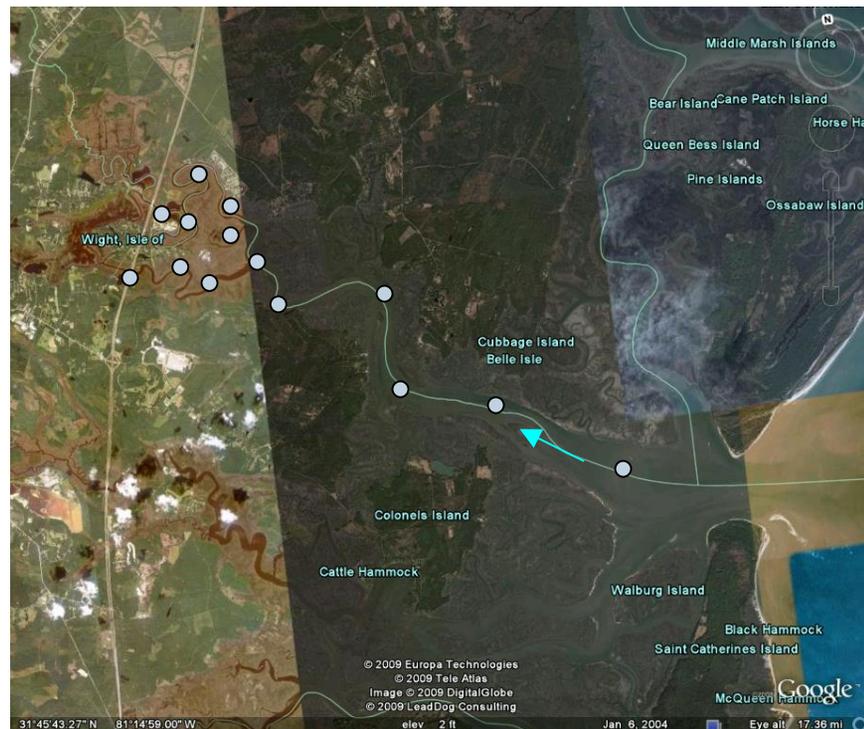
Cross Section	Depth to add or subtract (ft)	Cross Sectional Area (ft <sup>2</sup> )	Avg Cross Sectional Area (ft <sup>2</sup> )	Section Area (1000 ft <sup>2</sup> )	Length (ft)	Volume (MG)	Average Width (ft)	Surface Area (ft <sup>2</sup> )	Average Depth (ft)
21.56 Jerico	-3.74	4,268.43	7,648.93	7.65	2,808.96	160.73	715.65	2,010,232.22	10.69
21 Jerico	-3.73	11,029.43	7,359.62	7.36	5,258.88	289.54	685.45	3,604,699.30	10.74
20 Jerico	-3.54	3,689.81	3,693.41	3.69	5,596.80	154.64	321.85	1,801,330.08	11.48
19 Jerico	-3.33	3,697.01	3,745.37	3.75	5,385.60	150.90	339.35	1,827,603.36	11.04
18 Jerico	-3.13	3,793.73	4,383.91	4.38	5,755.20	188.75	372.45	2,143,524.24	11.77
17 Jerico	-3.00	4,974.09	5,086.91	5.09	4,788.96	182.24	359.05	1,719,476.09	14.17
16 Jerico	-2.75	5,199.73	4,942.21	4.94	5,755.20	212.79	333.40	1,918,783.68	14.82
15 Jerico	-3.08	4,684.69	5,841.73	5.84	5,702.40	249.21	416.15	2,373,053.76	14.04
14 Jerico	-3.75	6,998.77	10,679.41	10.68	4,873.44	389.35	962.35	4,689,954.98	11.10
13 Jerico	-4.00	14,360.06	16,495.66	16.50	5,385.60	664.60	1,149.47	6,190,585.63	14.35
RM 12	2.70	18,631.26	21,116.28	21.12	5,649.60	892.47	1,454.52	8,217,456.19	14.52
RM 11	2.53	23,601.29	21,986.57	21.99	6,230.40	1,024.79	1,740.50	10,844,011.20	12.63
RM 10	2.08	20,371.84	23,661.19	23.66	5,126.88	907.51	1,644.00	8,428,590.72	14.39
RM 9	1.08	26,950.53	30,938.78	30.94	5,544.00	1,283.18	1,883.00	10,439,352.00	16.43
RM 8	0.17	34,927.04	33,603.08	33.60	4,208.16	1,057.87	1,893.50	7,968,150.96	17.75
RM 7	-0.42	32,279.13	42,731.38	42.73	5,031.84	1,608.55	2,685.50	13,513,006.32	15.91
RM 6	-1.20	53,183.64	53,241.04	53.24	5,913.60	2,355.36	3,395.00	20,076,672.00	15.68
RM 5	-1.00	53,298.44	55,917.03	55.92	6,811.20	2,849.23	3,496.00	23,811,955.20	15.99
RM 4	-2.33	58,535.62	53,255.87	53.26	3,241.92	1,291.60	3,142.50	10,187,733.60	16.95
RM 3	-3.08	47,976.12	61,176.03	61.18	5,808.00	2,658.08	3,973.80	23,079,830.40	15.39
RM 2	-3.50	74,375.95	83,532.49	83.53	4,720.32	2,949.76	6,019.20	28,412,550.14	13.88
RM 1	-4.42	92,689.03	95,323.87	95.32	4,044.48	2,884.19	7,444.80	30,110,344.70	12.80
16.71 Jones	1.25	5,144.22	4,597.57	4.60	3,764.64	129.48	412.50	1,552,914.00	11.15
16 Jones	1.92	4,050.93	4,492.00	4.49	5,544.00	186.30	405.50	2,248,092.00	11.08
15 Jones	2.96	4,933.07	9,191.92	9.19	4,831.20	332.22	720.00	3,478,464.00	12.77
14 Jones	3.54	13,450.78	8,173.91	8.17	6,705.60	410.04	653.00	4,378,756.80	12.52
13 Jones	4.00	2,897.04	10,764.15	10.76	3,764.64	303.15	716.22	2,696,310.46	15.03
Bel 3	1.66	5,515.70	5,596.76	5.60	3,981.12	166.69	485.15	1,931,440.37	11.54
Bel 2	1.35	5,677.82	5,020.41	5.02	3,817.44	143.37	435.55	1,662,685.99	11.53
Bel 1	0.64	4,363.00	5,771.51	5.77	7,339.20	316.88	324.80	2,383,772.16	17.77
Bel 4	3.68	7,840.97	6,678.34	6.68	5,913.60	295.45	619.80	3,665,249.28	10.77
Bel 5	3.94	2,083.97	4,962.47	4.96	6,494.40	241.10	465.85	3,025,416.24	10.65
Bel 6	4.00	9240	5,661.98	5.66	2,956.80	125.24	400.45	1,184,050.56	14.14

- Measurements taken throughout the system
- Taken at quarter-points or centerline
- Used to determine that system is vertically mixed
- Record time each depth profile is made
- Measure
  - DO
  - pH
  - Temperature
  - Conductivity



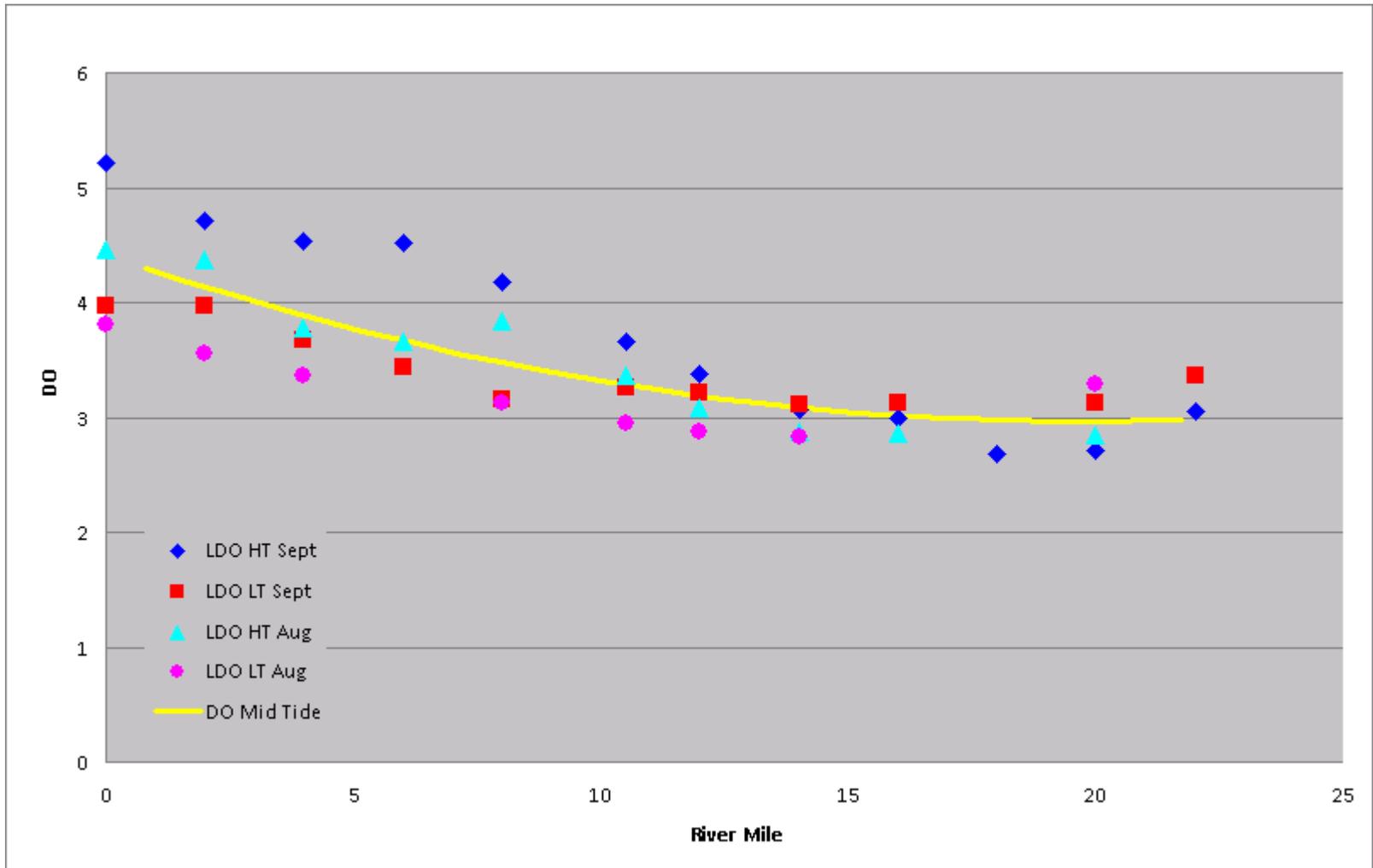


- Centerline run is from downstream to upstream
- Use yard stick survey to determine sampling times and sampling period
- At high and low slack tide measure
  - DO
  - pH
  - Temperature
  - Conductivity

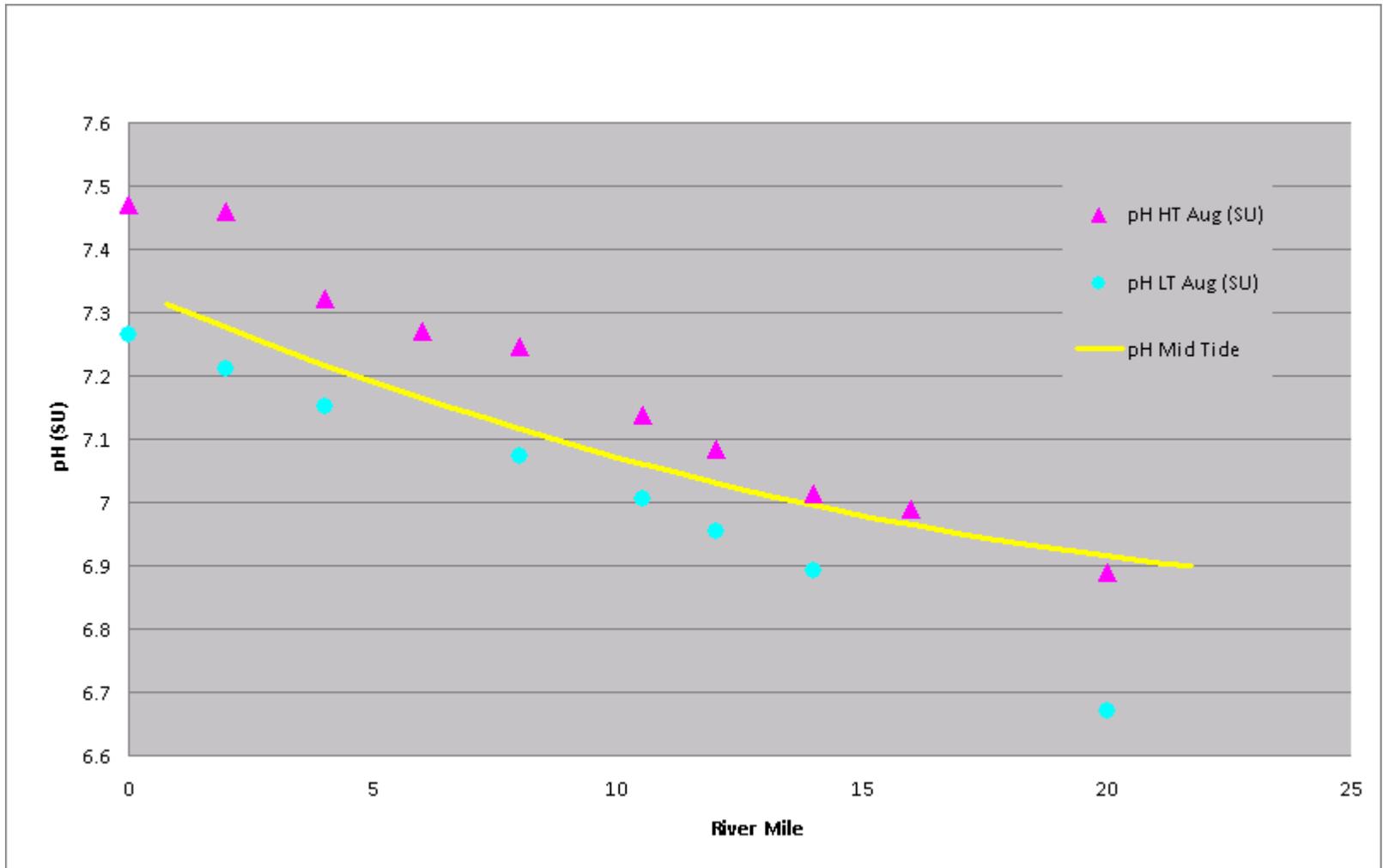




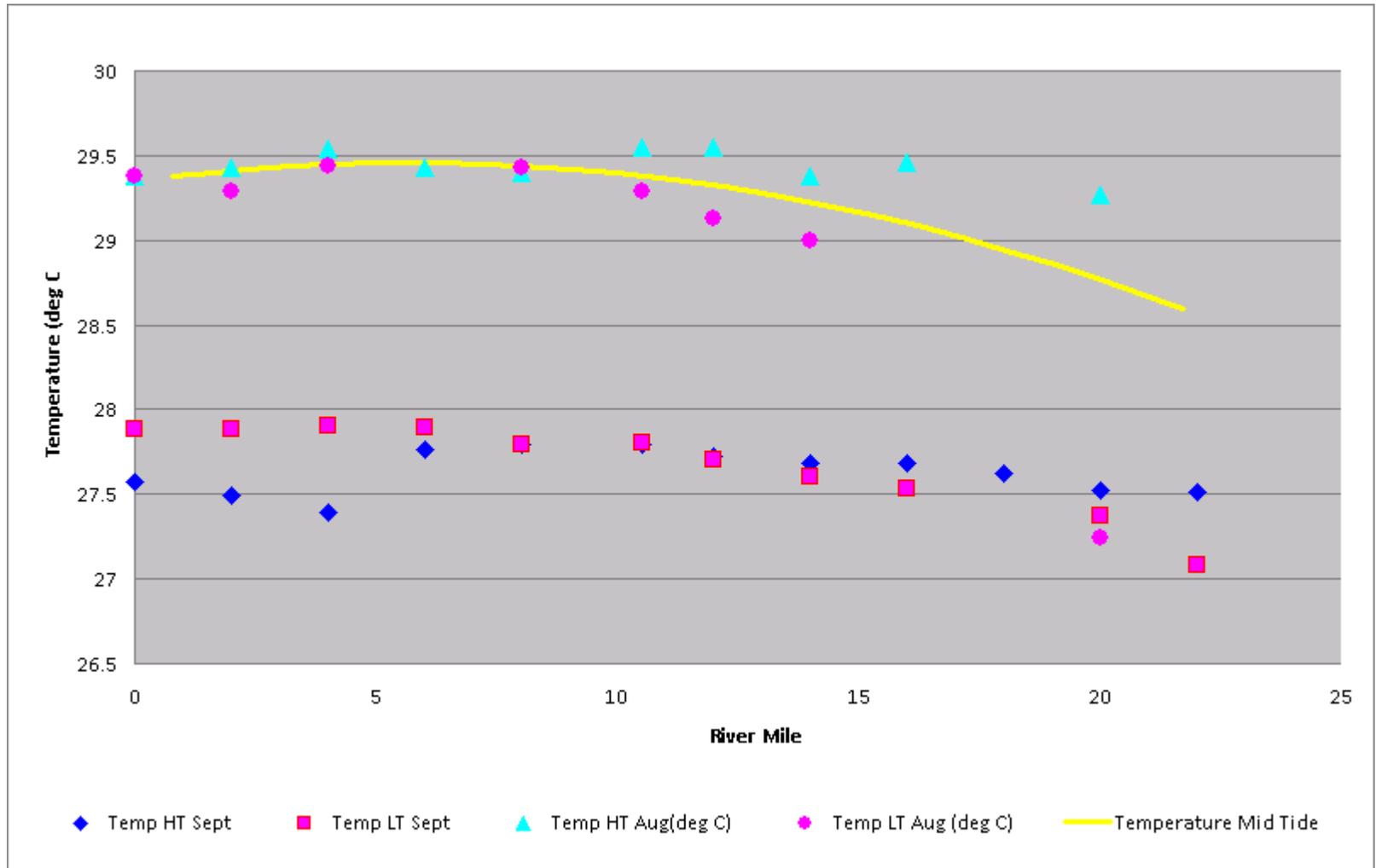
# Slack Tide Centerline Run



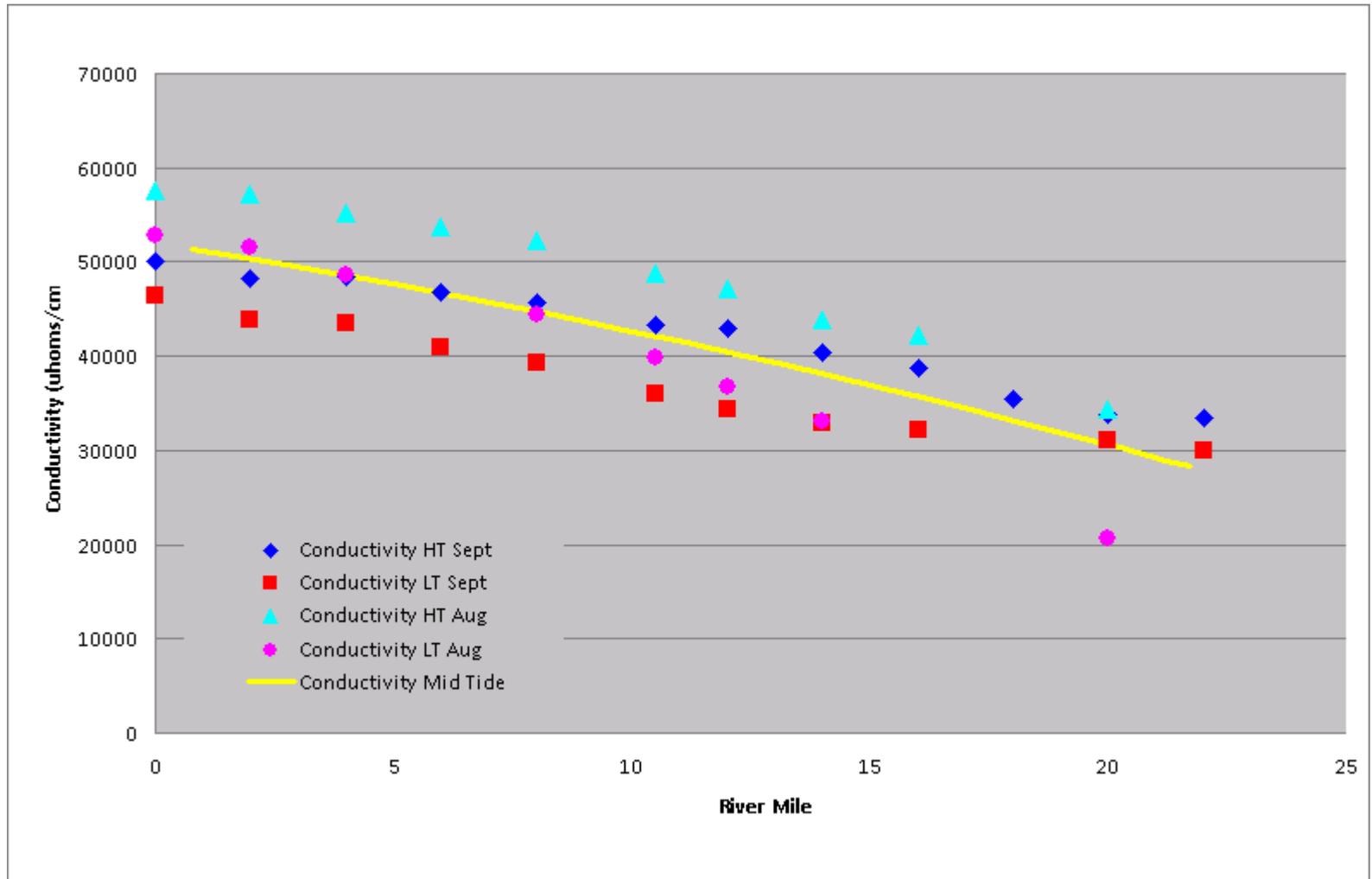
# Slack Tide Centerline Run



# Slack Tide Centerline Run

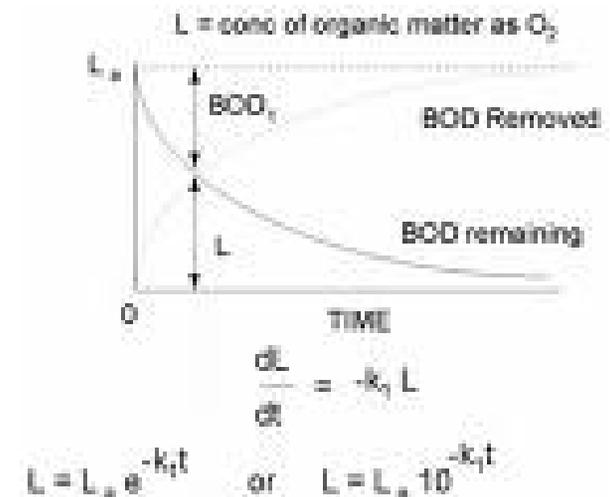


# Slack Tide Centerline Run



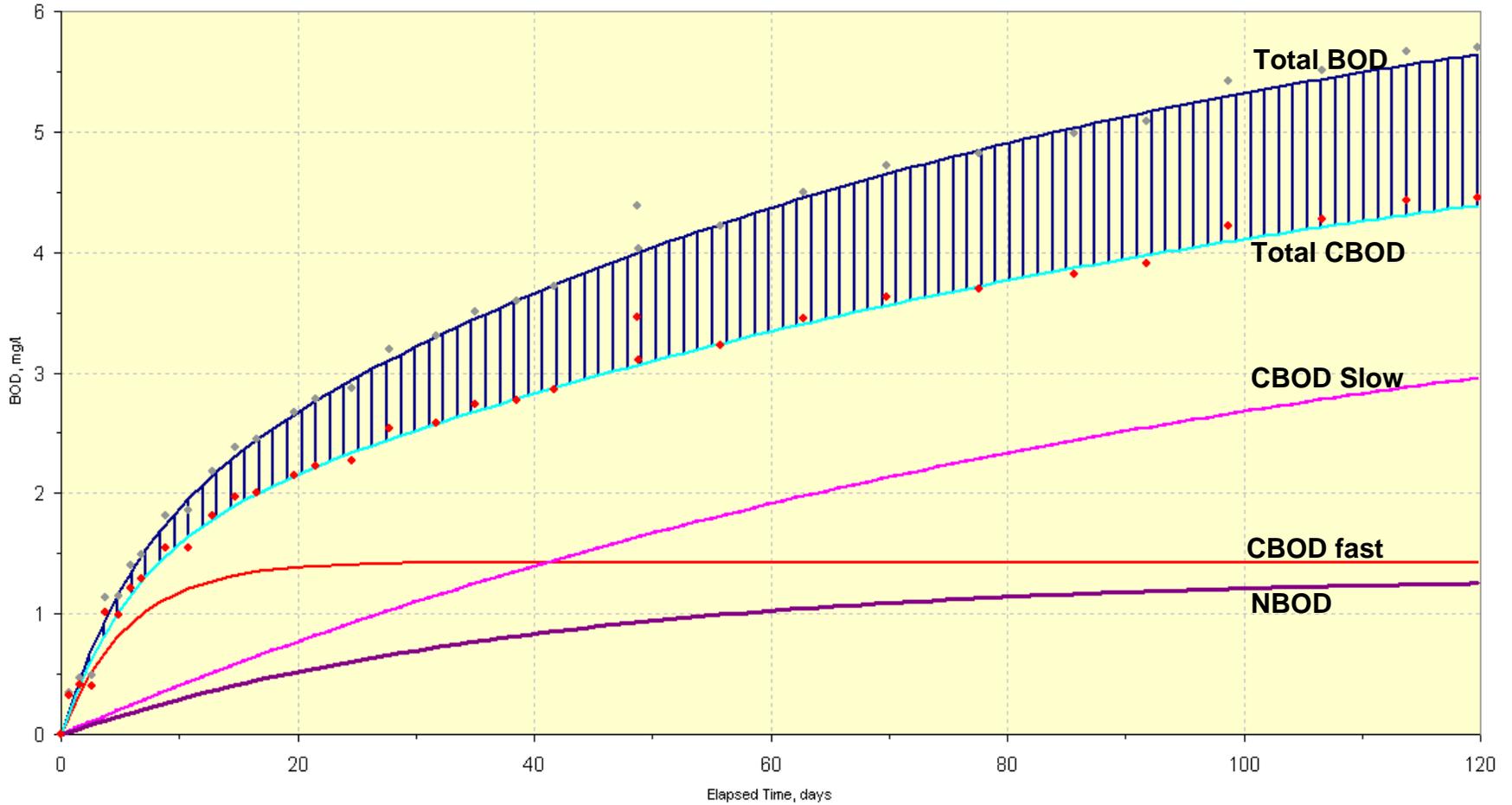
- Collect water from
  - Boundary conditions
  - Middle of model
    - Collect water sample during one of the stack tide runs
    - Locations need to coincide with the mid-tide locations

- Data will be used to determine
  - CBOD  $k$  rate
  - NBOD  $k$  rate
  - $f$  ratio ( $BOD_u/BOD_5$ )



# Long-Term BODs

Laurel View River - Mile 0, Aug 2009

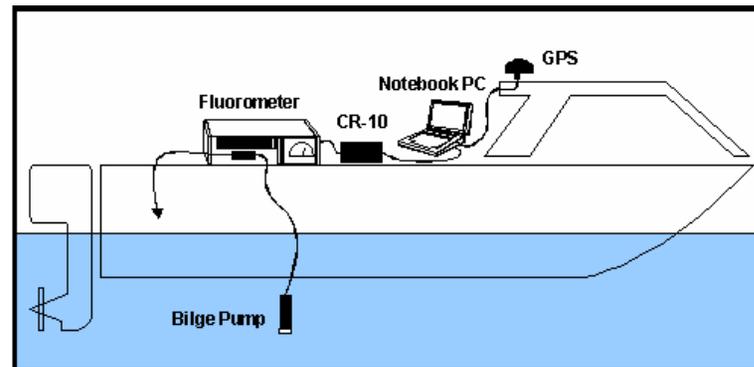




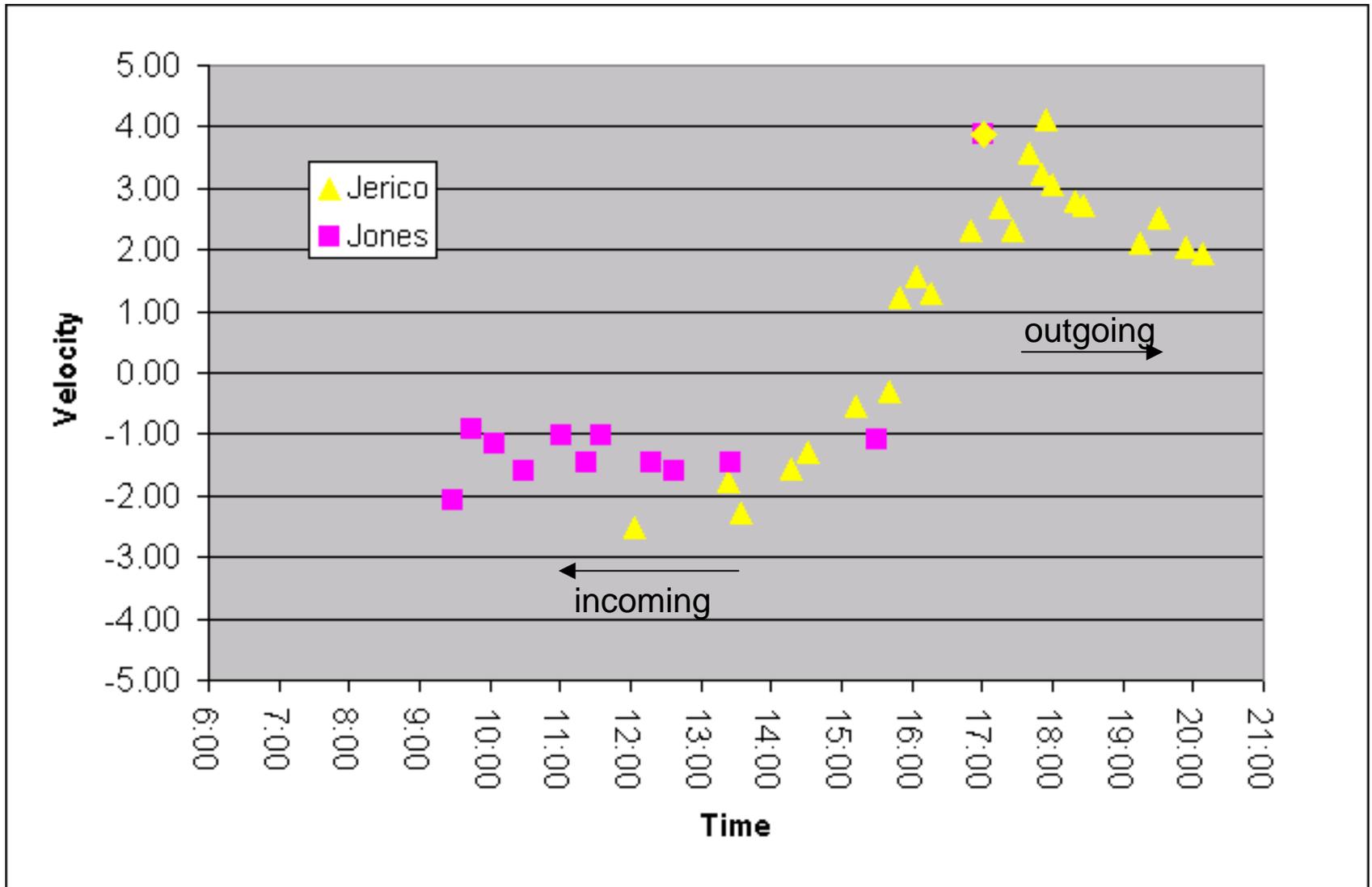
# Long-Term BODs

RM	NBOD			CBOD fast			CBOD slow		
	NBOD Ult.	NBOD KRate	NBOD f-Ratio	CBODf Ult.	CBODf KRate	CBODf f-Ratio	CBODs Ult.	CBODs KRate	CBODs f-Ratio
RM 0 Medway	1.32	0.025	8.51	1.43	0.174	1.72	4.24	0.010	20.50
RM 6 Medway	1.40	0.025	8.51	1.78	0.150	1.90	8.32	0.006	33.84
RM 10.5 Laurel View	0.97	0.025	8.51	1.76	0.122	2.19	9.15	0.003	67.17
RM 16 Jerico	0.86	0.029	7.41	1.24	0.113	2.32	7.77	0.004	50.50
RM 22.5 Jerico	0.91	0.034	6.40	1.09	0.131	2.08	7.95	0.005	40.50
RM 14 Jones	0.88	0.030	7.18	1.55	0.113	2.32	18.28	0.001	200.50
RM 16.5 Jones	1.00	0.033	6.57	1.68	0.125	2.15	33.45	0.001	200.50
<b>Medway/Laurel View</b>	1.23	<b>0.025</b>	8.51	1.66	<b>0.160-0.120</b>	1.94	7.24	<b>0.005</b>	40.50
<b>Jerico</b>	0.89	<b>0.030-0.033</b>	6.91	1.17	<b>0.120</b>	2.20	7.86	<b>0.005</b>	45.50
<b>Jones</b>	0.94	<b>0.030</b>	6.88	1.62	<b>0.120</b>	2.24	25.87	<b>0.001</b>	200.50

- Continuous Dye Release
- Fluorometer will be used to measure dye
- Used to determine velocity









# Raingage Installation

- Collect daily rainfall data for at least 30 days
- Used to determine local surface drainage based on rational formula

$$Q = CIA$$

Where Q = flow, cfs

C = runoff coefficient

I = rainfall intensity, in/hr

A = drainage area, acres

- Drainage areas for the open water, marshes, and upland are measured from USGS quad sheets
- Runoff coefficients are literature values



# Rainfall Data

Georgia Automated Environmental Monitoring Network [www.GeorgiaWeather.net](http://www.GeorgiaWeather.net)

Ossabaw Island

Ossabaw Island, Chatham County, Georgia

Day of the Month	July		Aug		Sept		July	Aug	Sept
	Max. Temp. (°F)	Min. Temp. (°F)	Max. Temp. (°F)	Min. Temp. (°F)	Max. Temp. (°F)	Min. Temp. (°F)	Rain (in)	Rain (in)	Rain (in)
1	95.2	73.6	91	73.6	84	70.9	0	0.15	0
2	95.5	74.1	90	72.7	79.2	71.1	0	0.76	0
3	94.3	71.6	88.9	73.4	86	68	0	0.17	0
4	88.9	74.3	88.9	74.7	84.7	70.2	0	0.09	0
5	94.6	75.4	90	71.8	85.8	69.4	0	0	0
6	90.9	72.9	89.8	70.7	87.4	70.9	0.11	0.32	0
7	87.1	70.9	87.8	71.6	86.2	68.9	1.28	0.01	0
8	85.6	71.2	89.4	73.2	88.5	69.1	2.9	0	0
9	82.2	69.4	89.6	73.8	85.5	71.1	0.89	0	0
10	81.3	68	91.9	72.5	85.1	71.1	3.5	0	0
11	84	70	95.7	75	83.5	71.2	0	0	0
12	85.8	70	94.8	72.3	86	71.1	0	1.69	0
13	89.4	73.4	88.2	71.6	86.9	73	0.24	0.48	0
14	86.9	74.1	85.3	72.3	85.3	71.2	0	0.66	0
15	87.6	75.2	88	74.3	85.6	70.5	0	0.1	0
16	92.3	74.1	88.5	77	85.3	71.1	0	0	0
17	93.4	73.9	89.6	76.5	84.4	73.2	0	0	0.29
18	87.4	71.4	88.7	75.7	83.7	75.6	0.04	0	0
19	89.4	70.2	89.2	76.6	87.1	74.3	0	0	0
20	84	69.3	88.7	76.1	88.9	75	0.03	0	0
21	85.3	71.2	90.1	74.3	87.3	75.9	0	0	0
22	86.4	71.8	87.8	71.2	89.6	71.1	0	2.12	0
23	91.4	72.5	88.2	69.4	84.7	75.6	0	0.01	0.15
24	88.3	74.5	87.4	68.4	88	74.5	0	0	0
25	90.7	73.2	89.4	71.6	86.5	73.4	0	0	0
26	88.3	73.8	88.5	73	84.9	73.4	0	0	0.32
27	88.7	72	81.5	71.6	84.4	68.2	0	1.65	0
28	89.2	73.4	82.2	73	89.1	64.2	0	0.41	0
29	90.5	73	87.3	70.3	79.2	60.6	1.31	0	0
30	91.8	73.2	88.9	73.2	78.1	55.6	0	0	0
31	91	73	86.9	69.8			0.35	4.44	

Sept Field Study



# Ungaged Freshwater Flow

Location	RM	Depth	Volume MG	Volume f3	SI Salinity	Fraction of Freshwater $f1=(So-S1)/So$	$f1*V1$
RM 22 Jerico	21.52	10.69	160.73	21485096	18517	0.42	9,052,610.74
RM 21 Jerico	20.99	10.74	289.54	38703382	18894	0.41	15,851,453.85
RM 20 Jerico	20	11.48	154.64	20671033	19406	0.39	8,135,343.54
RM 19 Jerico	18.94	11.04	150.9	20171100	19927	0.38	7,610,177.87
RM 18 Jerico	17.92	11.77	188.75	25230584	20458	0.36	9,100,356.32
RM17 Jerico	16.83	14.17	182.24	24360380	20965	0.34	8,400,524.66
RM 16 Jerico	15.92	14.82	212.79	28444058	21474	0.33	9,356,317.42
RM 15 Jerico	14.83	14.04	249.21	33312391	22029	0.31	10,379,932.96
RM 14 Jerico	13.75	11.1	389.35	52045181	22544	0.30	15,379,351.02
RM 13 Jerico	12.83	14.35	664.6	88838391	23046	0.28	24,858,092.17
RM12 Laurel View River	11.81	14.52	892.47	1.19E+08	23590	0.26	31,353,064.01
RM11 Laurel View River	10.74	12.63	1024.79	1.37E+08	24182	0.24	33,467,318.12
RM10 Laurel View River	9.55	14.39	907.51	1.21E+08	24752	0.23	27,476,408.90
RM9 Laurel View River	8.58	16.43	1283.18	1.72E+08	25289	0.21	35,972,049.94
RM 8 Medway	7.53	17.75	1057.87	1.41E+08	25784	0.19	27,468,419.66
RM 7 Medway	6.74	15.91	1608.55	2.15E+08	26253	0.18	38,615,897.15
RM 6 Medway	5.78	15.68	2355.36	3.15E+08	26817	0.16	50,995,149.71
RM 5 Medway	4.66	15.99	2849.23	3.81E+08	27476	0.14	53,844,391.29
RM 4 Medway	3.37	16.95	1291.6	1.73E+08	28000	0.13	21,581,339.39
RM 3 Medway	2.76	15.39	2658.08	3.55E+08	28475	0.11	39,139,703.92
RM 2 Medway	1.66	13.88	2949.76	3.94E+08	27709	0.13	52,873,196.10
RM 1 Medway	0.77	12.8	2884.19	3.86E+08	29500	0.08	30,119,949.71
Ocean So	0				32000		
RM 16.6 Jones	15.93	11.15	129.48	17307847	21372	0.33	5,748,368.53
RM 16 Jones	15.22	11.08	186.3	24903088	21821	0.32	7,921,516.59
RM 15 Jones	14.17	12.77	332.22	44408502	22327	0.30	13,423,857.36
RM 14 Jones	13.25	12.52	410.04	54810854	22893	0.28	15,598,826.53
RM 13 Jones	11.98	15.03	303.15	40522657	23000	0.28	11,396,997.39
RM 3 Belfast	15.18	11.54	166.69	22281781	21765	0.32	7,126,688.24
RM 2 Belfast	14.43	11.53	143.37	19164550	22142	0.31	5,903,879.24
RM 3 Befast	13.71	17.77	316.88	42357974	22686	0.29	12,328,817.67
RM 4 Belfast	10.97	10.77	295.45	39493383	24043	0.25	9,820,276.58
RM 5 Belfast	9.85	10.65	241.1	32228312	24662	0.23	7,390,354.73
RM 6 Belfast	8.62	14.14	125.24	16741077	25138	0.21	3,589,914.78
<b>Avg</b>		<b>13.50</b>				<b>F=Sum (f1*V1)</b>	<b>661,280,546.09</b>

Total Duration of the Averaging Period					Days	17	26	22	21
					I	0.26	0.33	0.30	0.31
					in/day				
C	1	1	0.10	0.6					
Area (sq miles)	% Open	% Marsh	% Undevelop	% Developed	Q cfs	Q cfs	Q cfs	Q cfs	Q cfs
0.242	29.8	52.3	17.9	0.00	1.4	1.8	1.6	1.7	
0.346	37.3	28.7	34.0	0.00	1.7	2.1	1.9	2.0	
0.352	18.4	24.0	57.6	0.00	1.2	1.5	1.3	1.4	
0.651	10.1	84.3	5.6	0.00	4.3	5.5	4.9	5.1	
0.486	15.8	62.1	22.1	0.00	2.7	3.5	3.1	3.2	
0.396	15.6	80.4	4.0	0.00	2.7	3.4	3.0	3.2	
2.450	2.8	9.5	87.7	0.00	3.6	4.6	4.1	4.3	
1.154	7.4	21.2	71.4	0.00	2.9	3.7	3.3	3.4	
2.771	6.1	45.5	48.4	0.00	11.0	14.0	12.4	13.0	
0.358	62.0	38.0	0.0	0.00	2.5	3.2	2.8	3.0	
0.628	38.2	61.8	0.0	0.00	4.4	5.6	5.0	5.2	
2.551	12.9	1.2	85.9	0.00	4.1	5.2	4.6	4.8	
1.097	27.6	72.4	0.0	0.00	7.7	9.8	8.7	9.1	
1.590	23.5	32.9	43.6	0.00	6.8	8.6	7.7	8.0	
2.409	11.9	49.6	38.5	0.00	11.1	14.1	12.5	13.1	
4.188	11.6	37.9	50.5	0.00	16.0	20.4	18.2	19.0	
6.643	10.8	40.8	48.4	0.00	26.3	33.5	29.8	31.2	
6.486	13.2	44.0	42.8	0.00	28.0	35.6	31.7	33.2	
3.456	10.6	46.0	43.4	0.00	14.8	18.8	16.7	17.5	
4.164	19.9	71.1	9.0	0.00	26.9	34.2	30.4	31.9	
3.611	28.2	71.8	0.0	0.00	25.4	32.2	28.7	30.1	
5.103	21.2	78.8	0.0	0.00	35.8	45.5	40.5	42.5	
2.422	9.1	40.6	50.3	0.00	9.3	11.8	10.5	11.0	
0.670	3.3	20.9	75.8	0.00	1.5	1.9	1.7	1.8	
2.968	18.6	28.6	52.8	0.00	10.9	13.9	12.4	13.0	
0.955	5.3	15.7	79.0	0.00	1.9	2.5	2.2	2.3	
2.424	10.1	71.4	18.5	0.00	14.2	18.0	16.1	16.8	
0.278	3.5	6.8	89.7	0.00	0.4	0.5	0.4	0.4	
0.763	21.5	78.5	0.0	0.00	5.4	6.8	6.1	6.3	
2.424	9.1	90.9	0.0	0.00	17.0	21.6	19.3	20.2	
1.279	10.3	24.0	65.7	0.00	3.7	4.7	4.2	4.4	
0.624	17.4	82.6	0.0	0.00	4.4	5.6	5.0	5.2	
9.972	0.4	25.4	74.2	0.00	23.3	29.6	26.3	27.6	
75.91				Sum Q	333.548	423.9	377.3	395.3	
				Retention Time (F/Q)	22.9464	18.056	20.28	19.36	
						cfs/sq mile		0.56	

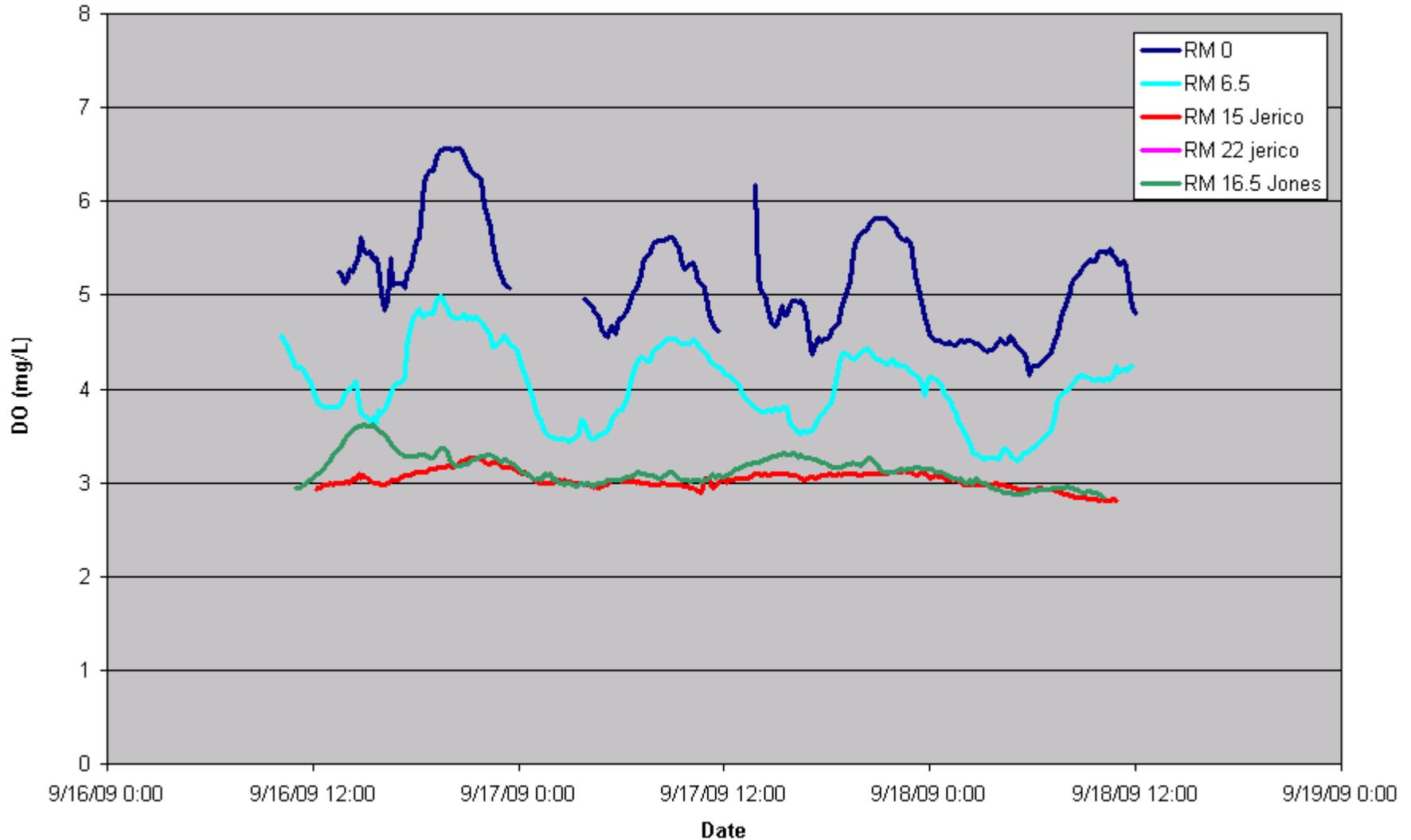
- Install continuous monitors at the boundaries
  - Downstream boundary RM 0
  - Sunbury dock RM 6.5
  - Jerico River RM 15.2
  - Upstream boundary Jerico RM 21.5
  - Upstream boundary Jones RM 16.5
- Monitors will collect data every 10 minutes for at least 2 days
  - DO
  - pH
  - Temperature
  - Conductivity
- Information will be used to determine boundary conditions in the model and will provide mid-tide information





# Continuous Monitors

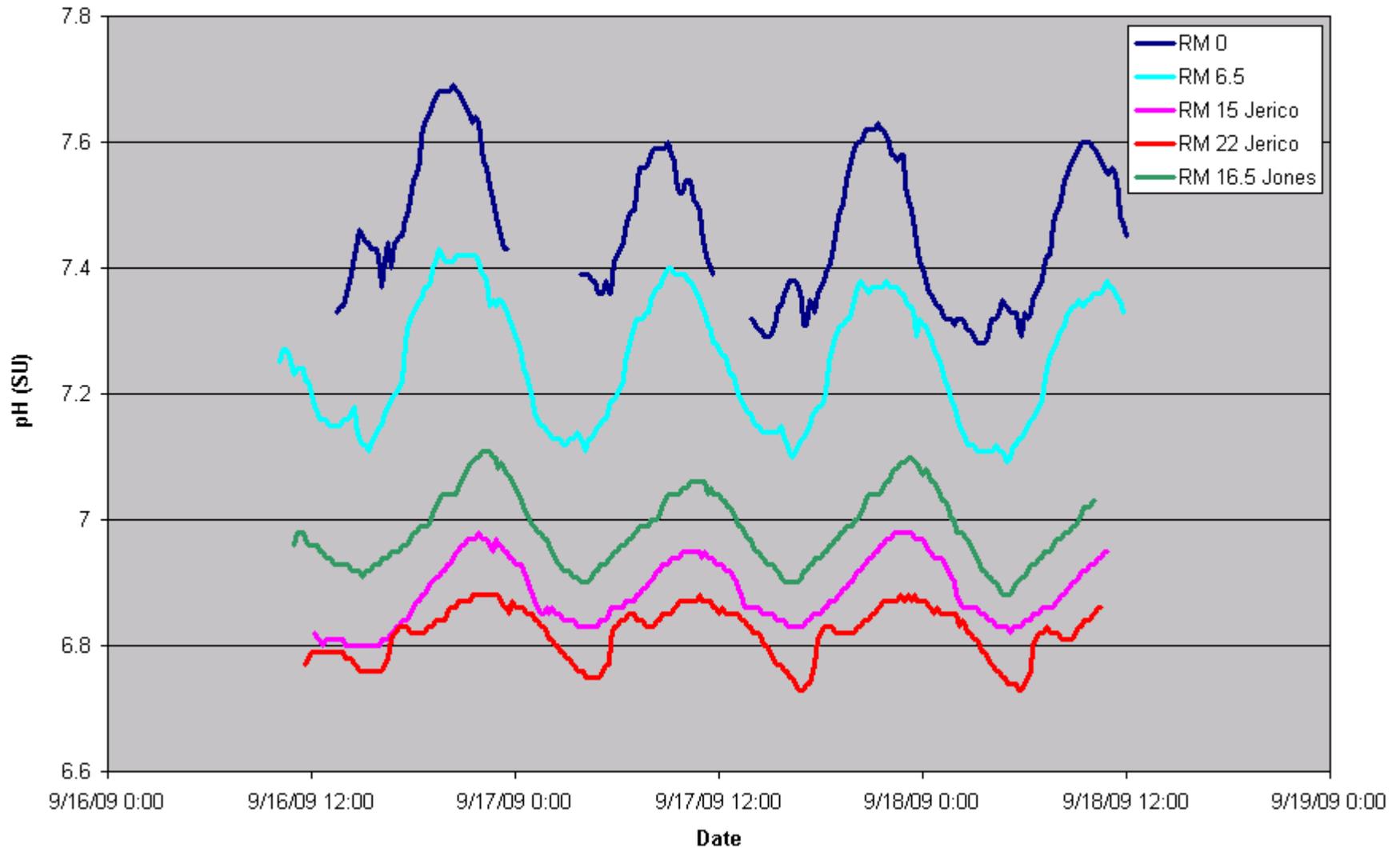
Continuous Monitoring Data- DO





# Continuous Monitors

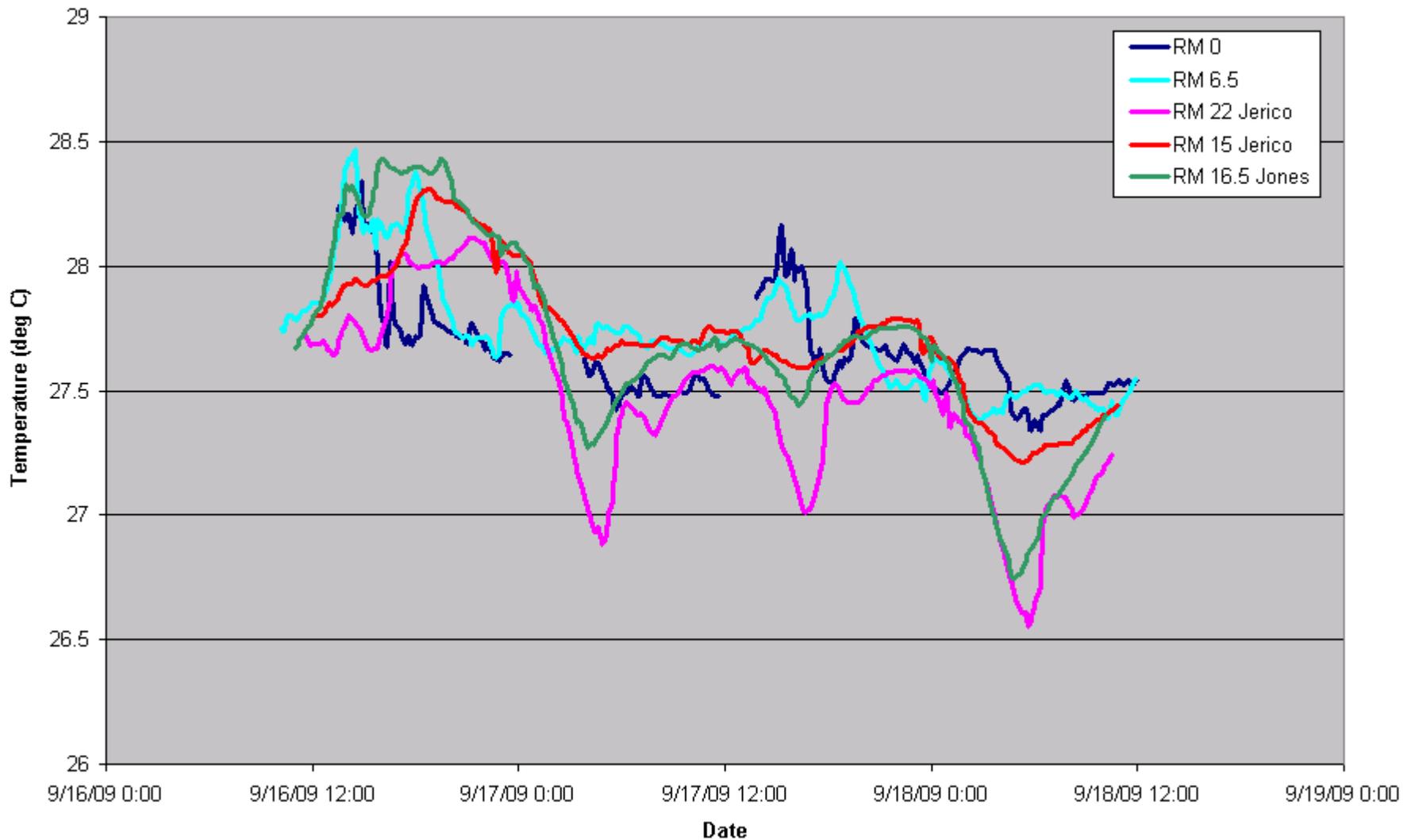
Continuous Monitoring Data- pH





# Continuous Monitors

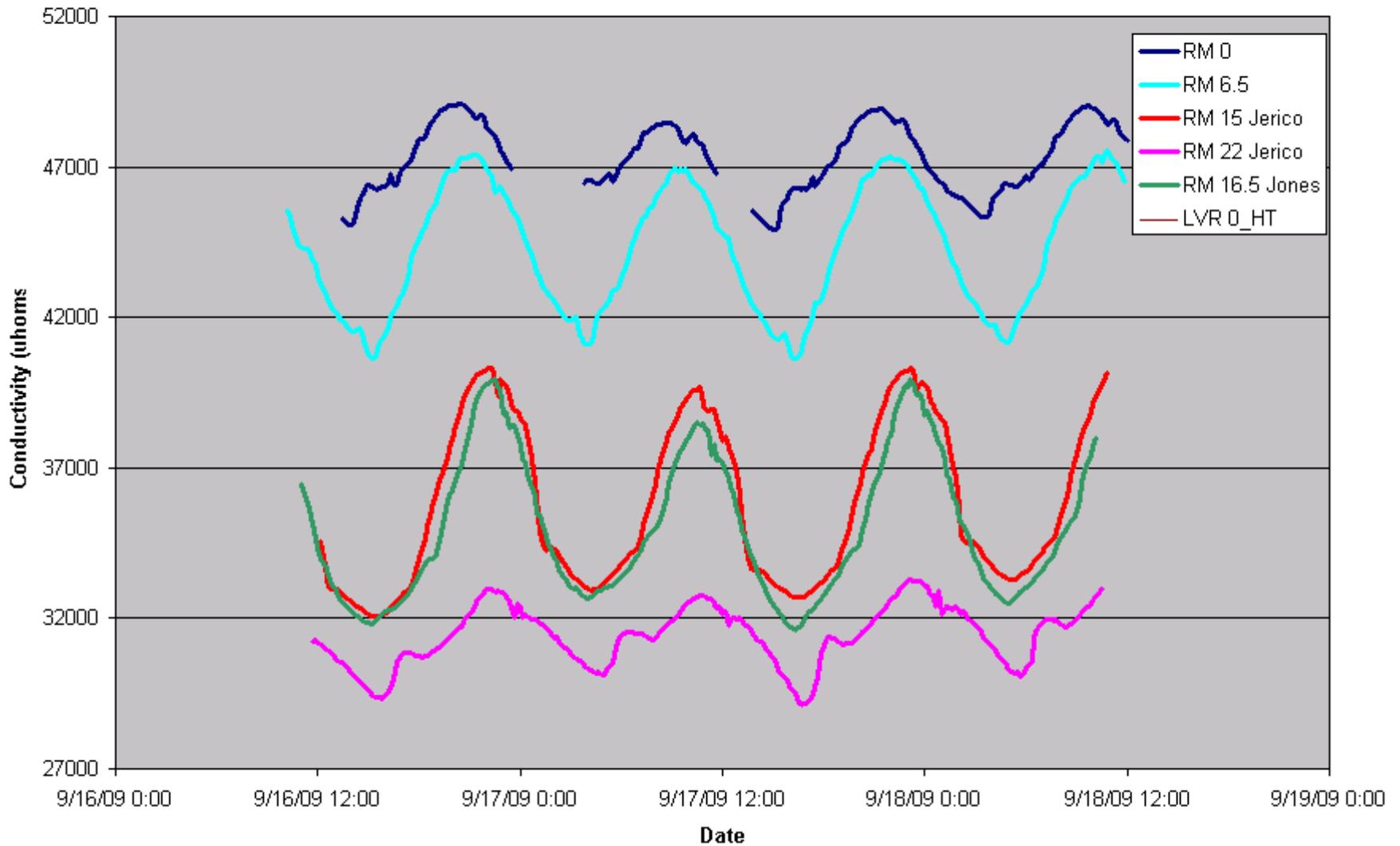
Continuous Monitoring Data- Temperature





# Continuous Monitors

Continuous Monitoring Data- Specific Conductance



- During the stack tide centerline runs water samples will be collected (mid-depth grab or depth composite) for chemical analysis

- Parameters to be analyzed

- BOD<sub>5</sub>
- TKN
- NH<sub>3</sub>
- NO<sub>2</sub>/NO<sub>3</sub>
- Total P
- Ortho P



- Data will be used to provide mid-tide information

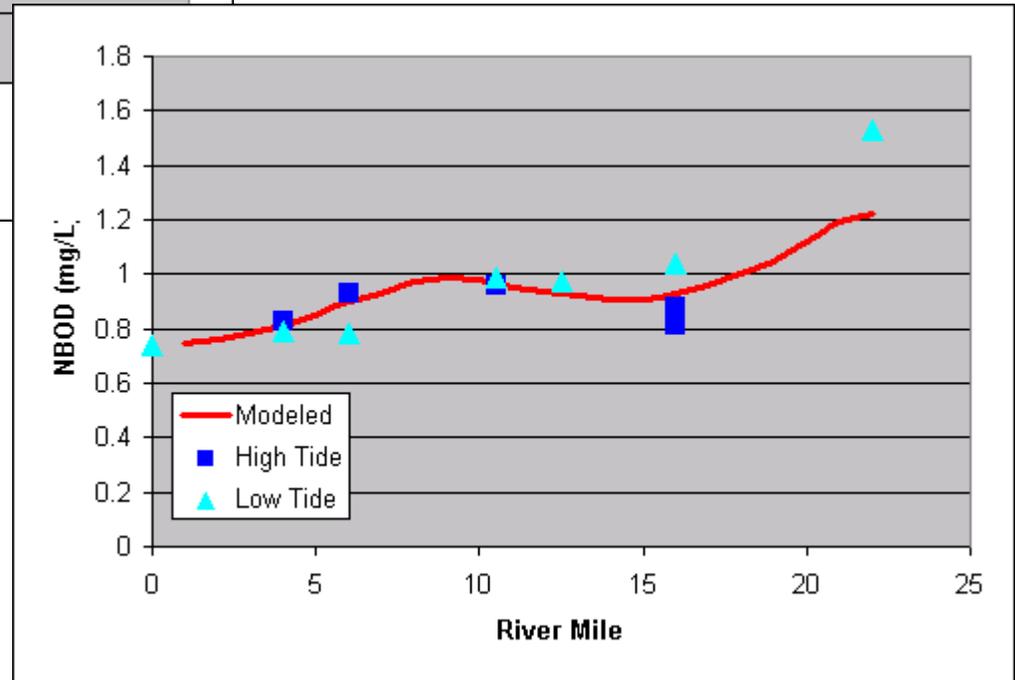
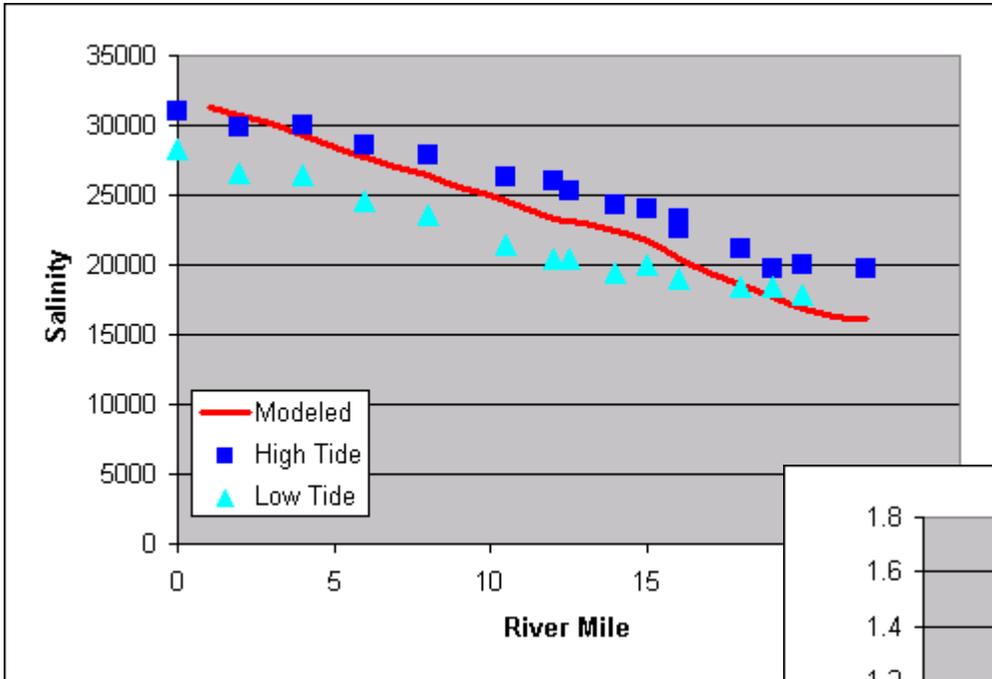


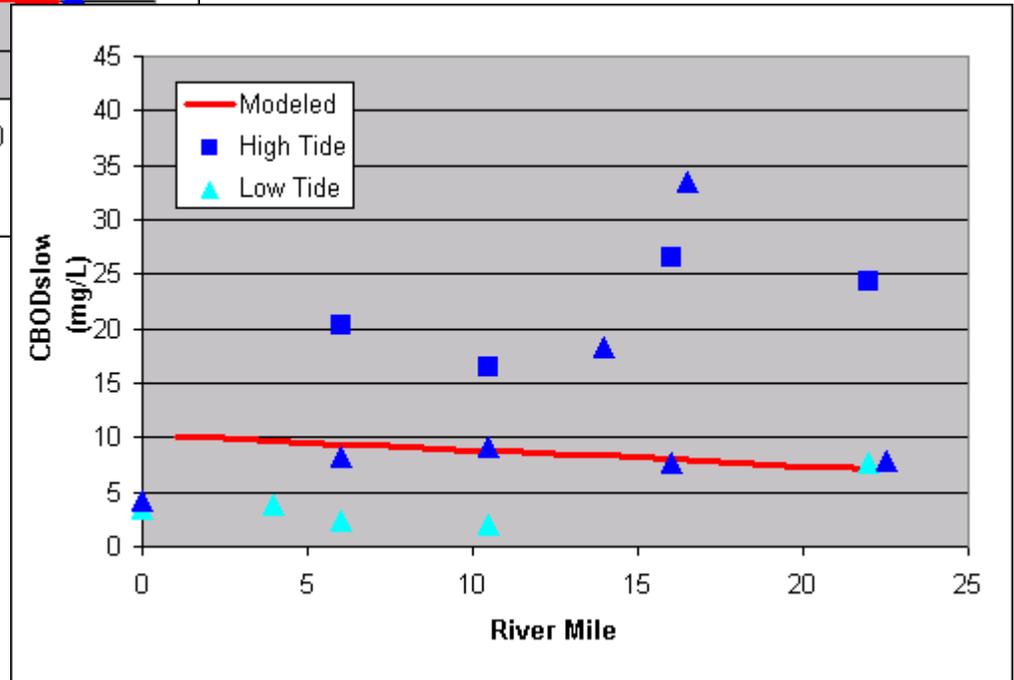
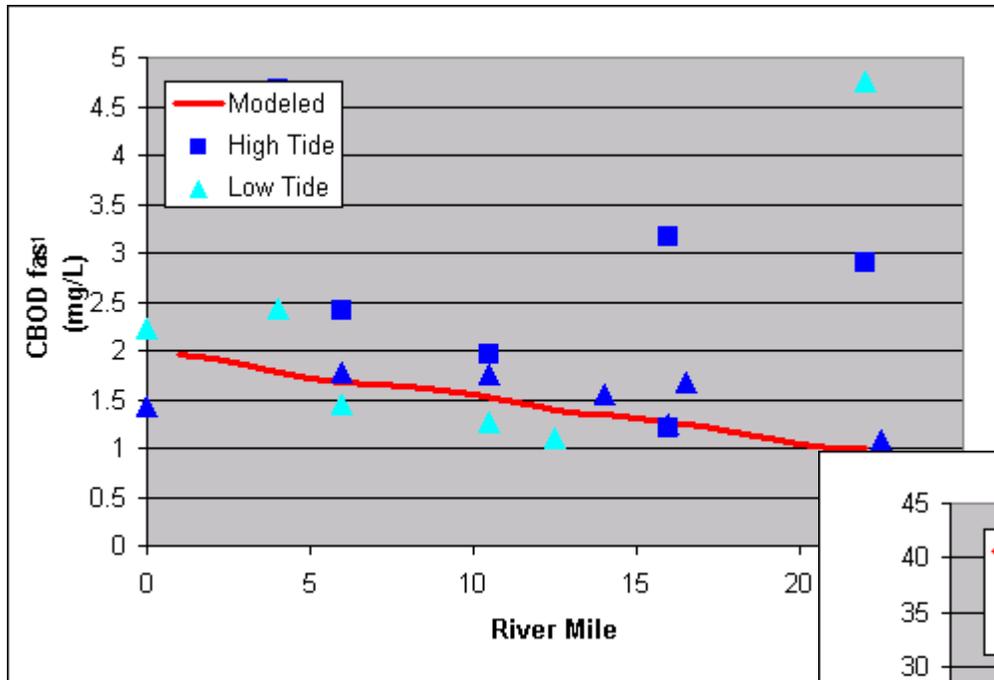
# Water Chemistry Data

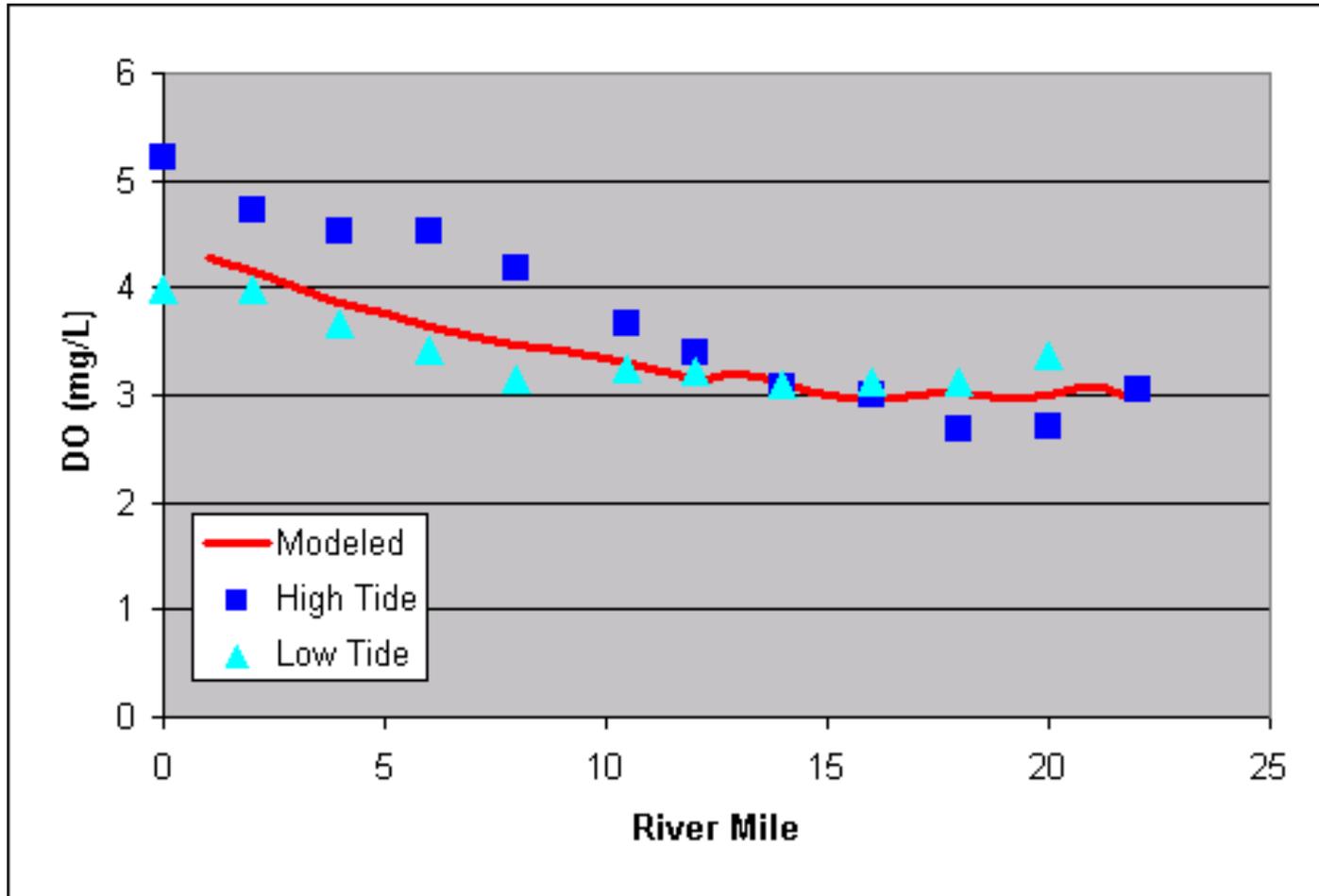
Date-Time Collected	Station Number	Ammonia-N (mg/L)	NO3+NO2 (mg/L)	TKN (mg/L)	Total N (mg/L)	Total P (mg/L)	BOD (mg/L)	Comment
9/17/09 14:39	RM 0	0.09	<0.05	0.74	0.83	0.16	2.38	low tide
9/17/09 14:57	RM 4	0.12	<0.05	0.79	0.91	0.11	2.6	low tide
9/17/09 15:20	RM 6	0.12	<0.05	0.78	0.9	0.14	1.63	low tide
9/17/09 15:55	RM 10.5	0.12	<0.05	0.99	1.11	0.19	1.48	low tide
9/17/09 16:15	RM 12.5 Jo	0.17	<0.05	0.97	1.14	0.2	1.31	low tide
9/17/09 16:37	RM 16 Jeric	0.1	<0.05	1.04	1.14	0.23		low tide
9/17/09 16:50	RM 22 Jeric	0.13	<0.05	1.53	1.66	0.34	5.09	low tide

Date-Time Collected	Station Number	Ammonia-N (mg/L)	NO3+NO2 (mg/L)	TKN (mg/L)	Total N (mg/L)	Total P (mg/L)	BOD (mg/L)	Comment
9/17/09 8:07	RM 4	0.08	<0.05	0.83	0.91	0.18	3.1	high tide
9/17/09 8:15	RM 6	0.08	<0.05	0.93	1.01	0.17	1.71	high tide
9/17/09 9:00	RM 10.5	0.12	<0.05	0.96	1.08	0.23	1.44	high tide
9/17/09 10:44	RM 16.5 Jo	0.13	<0.05	0.88	1.01	0.13	0.95	high tide
9/17/09 10:30	RM 16 Jeric	0.13	<0.05	0.81	0.94	0.15	2.15	high tide
9/17/09 11:24	RM 22 Jeric	0.12	<0.05				2	high tide

Dispersion – 4 sq mile/day



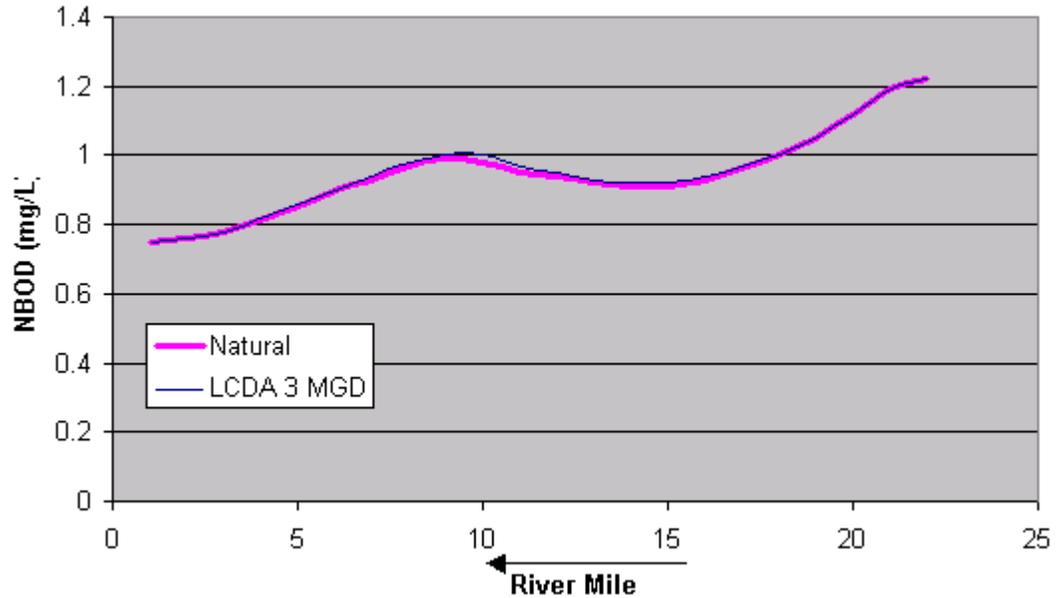
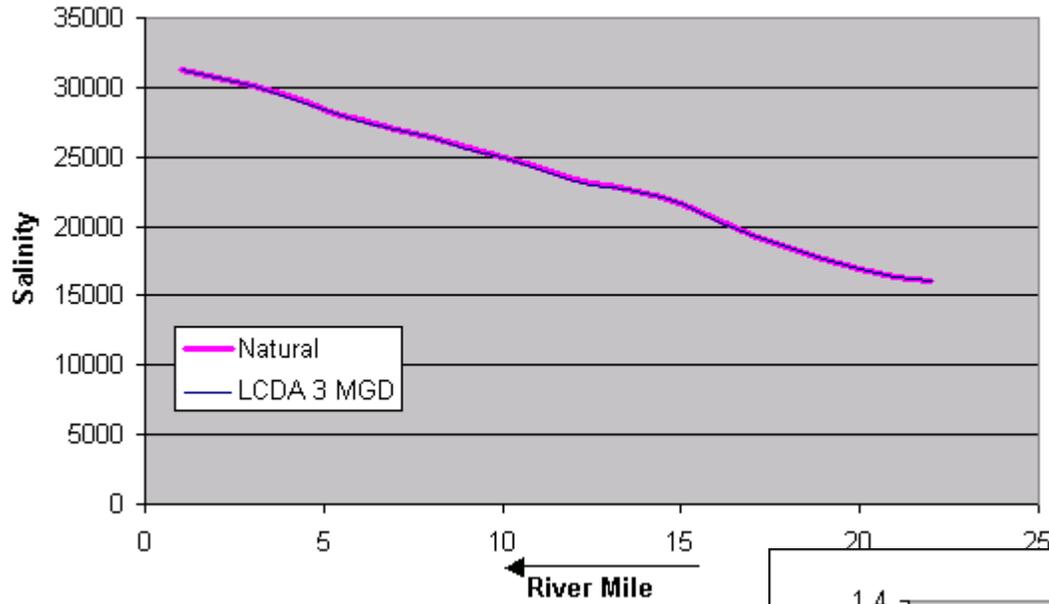




Reaeration - 1 1/day  
 SOD - 1 gm/cm/day

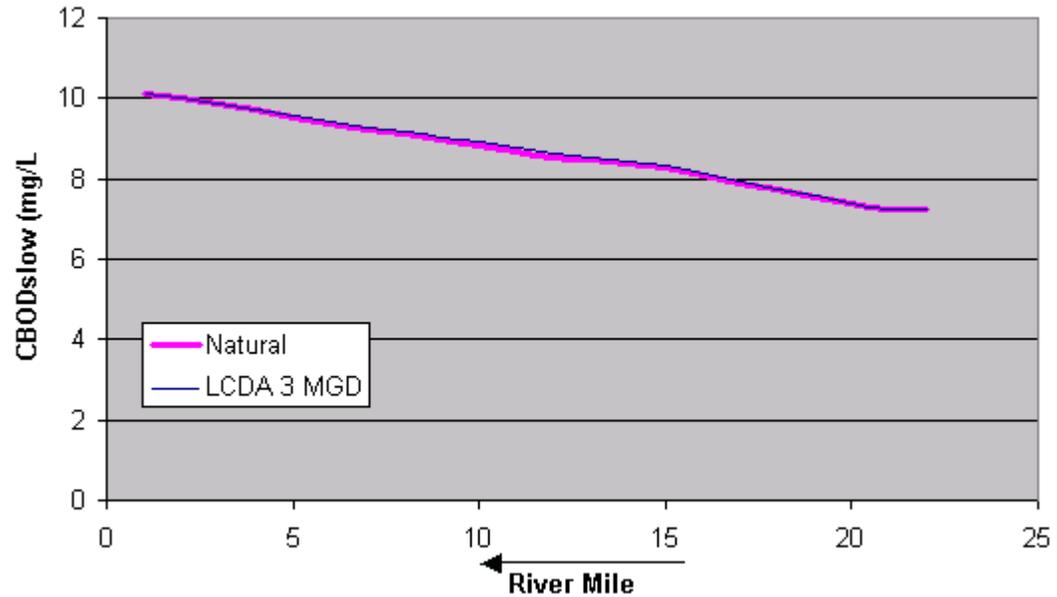
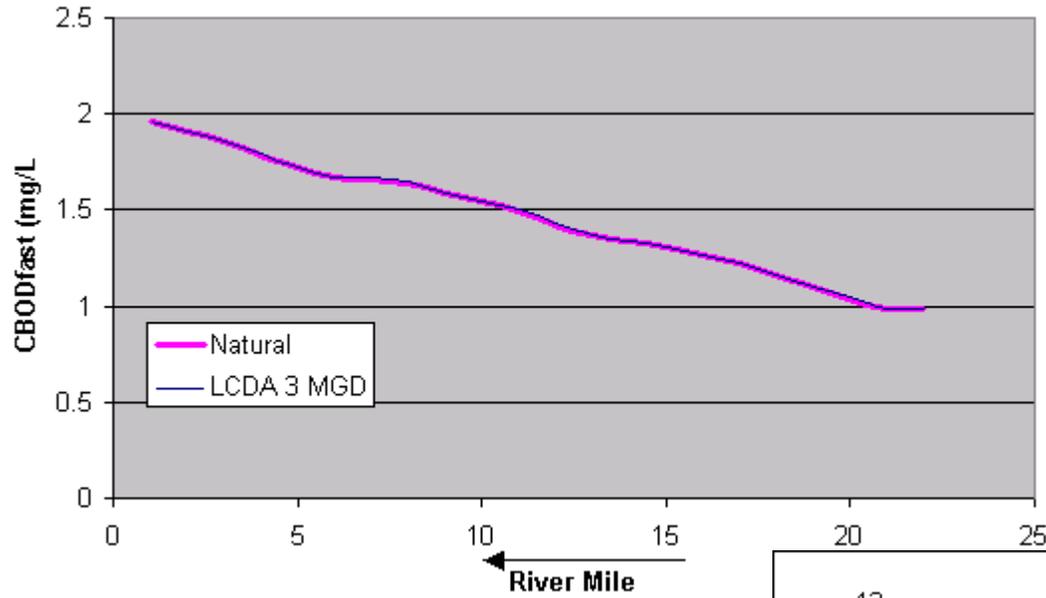


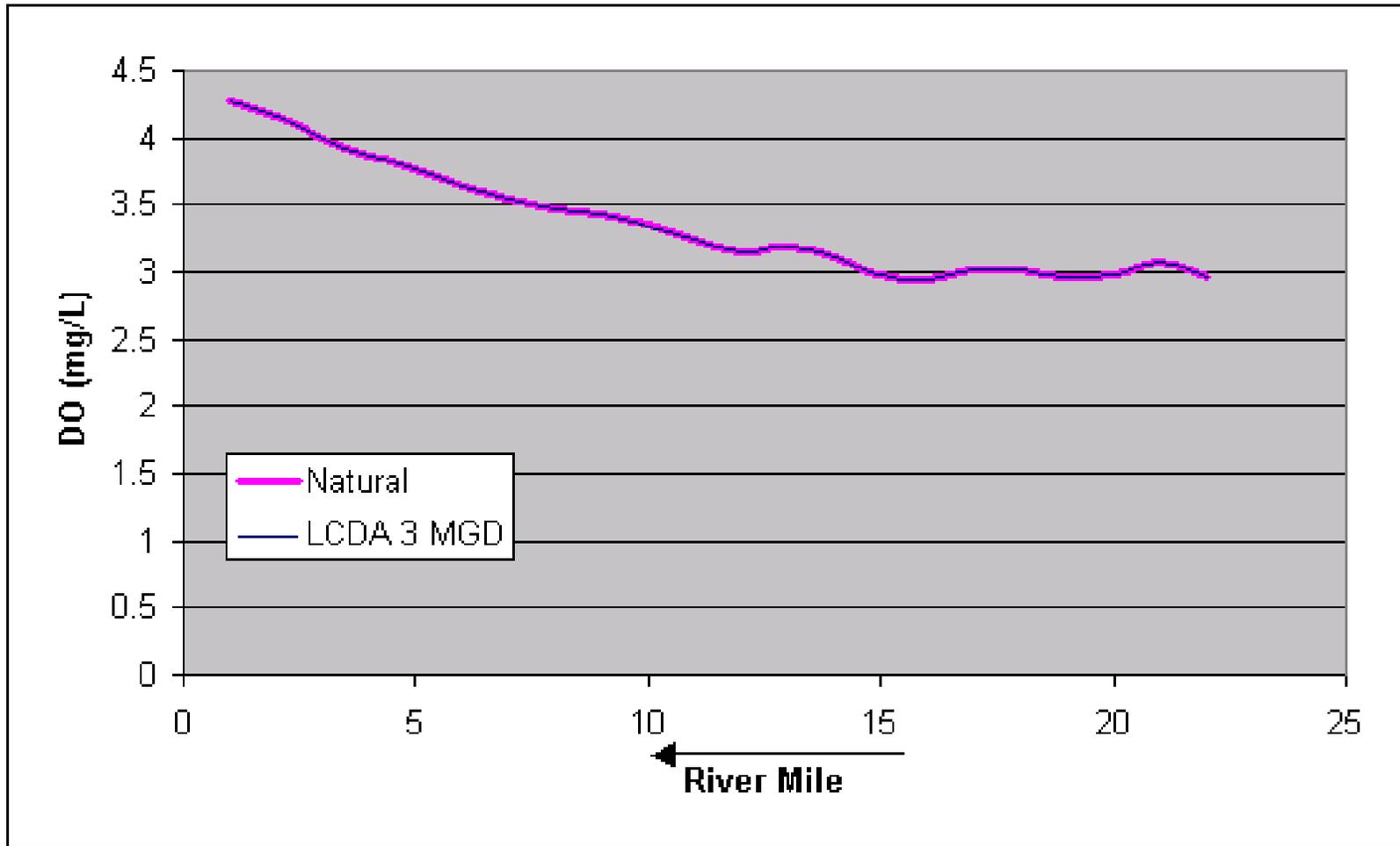
# Model LCDA 3 MGD Discharge





# Model LCDA 3 MGD Discharge







- Retention Time of the system is approximately 21 days
- Freshwater flow in the system is approximately 400 cfs
- 3 MGD Discharge of Reuse Water is de minimis
  - 5 mg/L BOD5
  - 2 mg/L NH3
  - 5 mg/L DO