Overview for 2009

Annual Loading = 244.6 vs. 175 lbs limit (JN/Sigma)

3 Month Loading Violations: 61.3 (Mar), 60.8 (Apr), 68.5 (Sep), 110.1 (Oct), 110.7 (Nov), 88.2 (Dec)

Hatchery Flow = 7.57 vs. 20 mgd limit

14,781 passed vs. 20,000 Adult Coho limit

138 passed vs. 1,000 Adult Chinook limit

Lake TP Concentration: 8.34 mg/m^3 volume - weighted

58% vs. 95% compliance with 8 mg/m^3 goal

Treatment elements added to Hatchery to improve phosphorus removal:
(1) Reduce filter mesh size to 20 microns, (2) add Ferric chloride precipitation,
(3) recycle sludge tank overflow back to clarifier, and (4) dredge pond.

Hatchery Bio-Energetic, Process & Feeding Model – development & calibration continues.

Watershed P and Flow Mass Balance have been refined & completed.

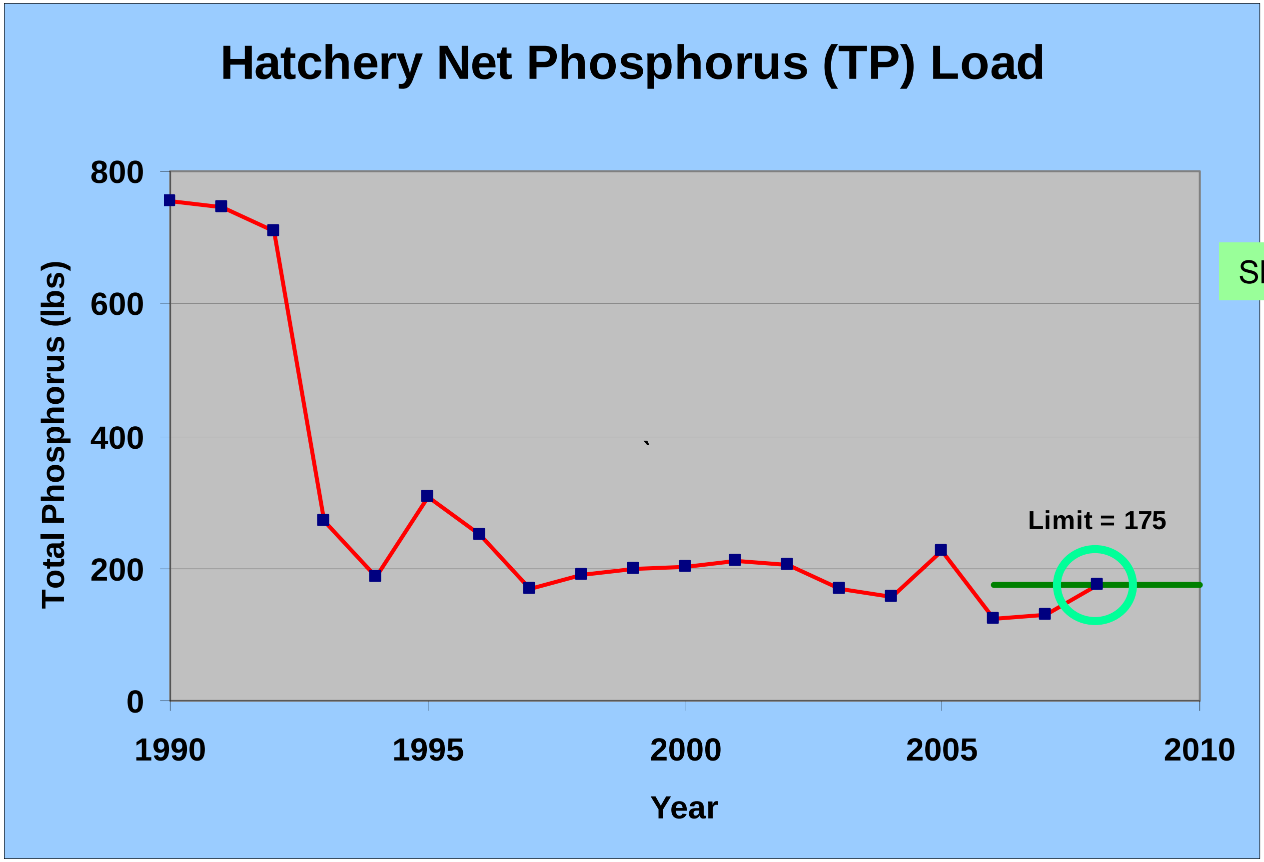
Long-term model for phosphorus in water and sediments completed for Lake.

Peer reviewed watershed management paper to be published by ASCE in September

Special Studies: Bio-availability study report completed.

CMU billing and NPDES reporting connected to database.

Figure 1. Overview for Annual Report.



Slide from last year

Why worry as long as the load is below 175 Lbs/Yr?

What factors cause load to go up like 2005 & 2008?
Why 3 Month violations for the past 3 years?
Suppose you want to increase production in the future, what is the non-compliance risk?
Suppose you want to control loading from another MDNR Hatchery facility?

We need to quantitatively understand the link between
Net Load and Fish Production Activities and Plant Operations

Figure 2. Hatchery phosphorus loading changes over time.

Slide from last year

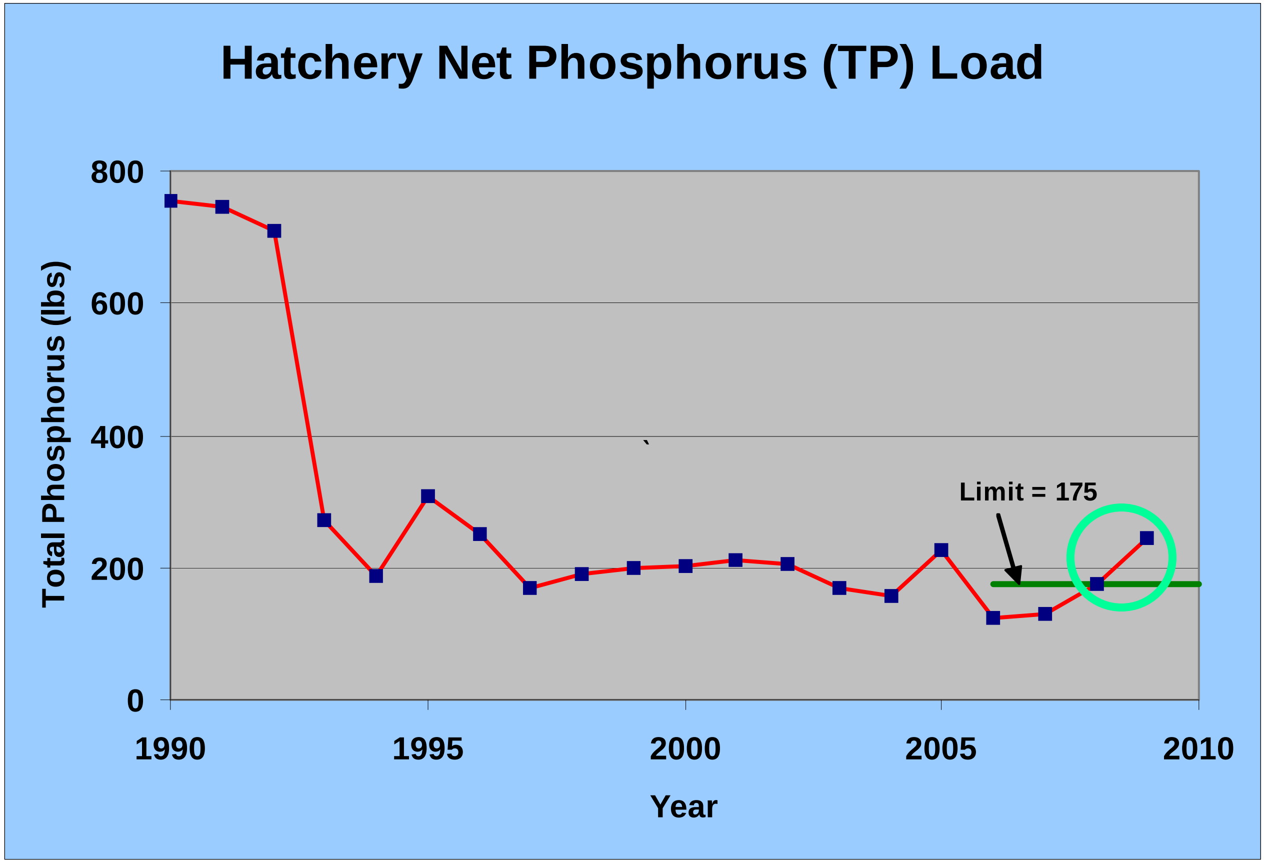
The goal is to quantify mechanisms, anticipate difficulties, and plan responses rather than observe problems and then react.

What factors cause the loads to go up like 2005 & 2008?
What factors cause the loads to go down like 2006 & 2007?
Why 3 Month violations for the past 3 years?

Suppose you want to increase production in the future, what is the non-compliance risk?

Suppose you decide to decrease production, how much will the loading actually be reduced?

We need to quantitatively understand the link between
Net Load and Fish Production Activities and Plant Operations

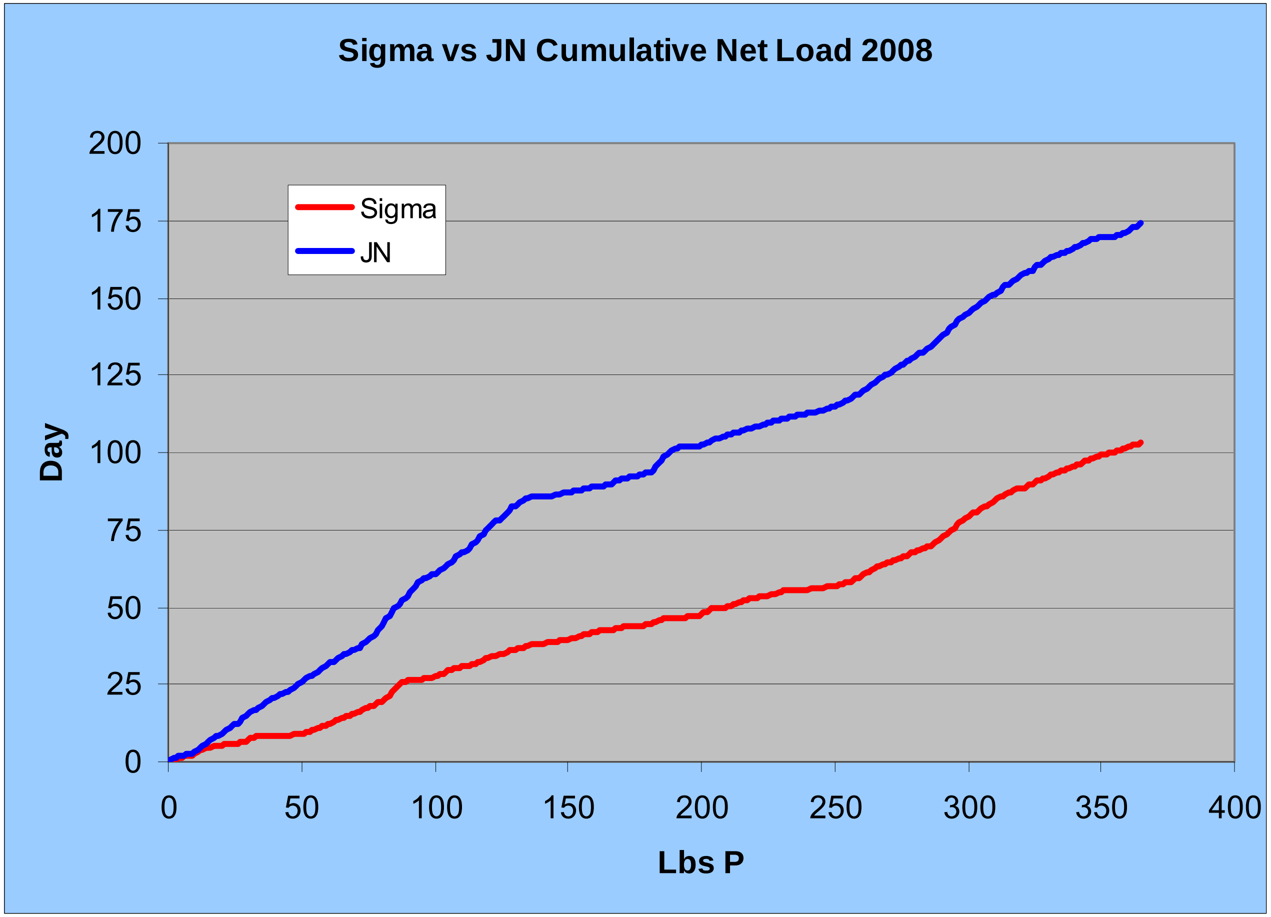


Why worry as long as the load is below 175 Lbs/Yr?

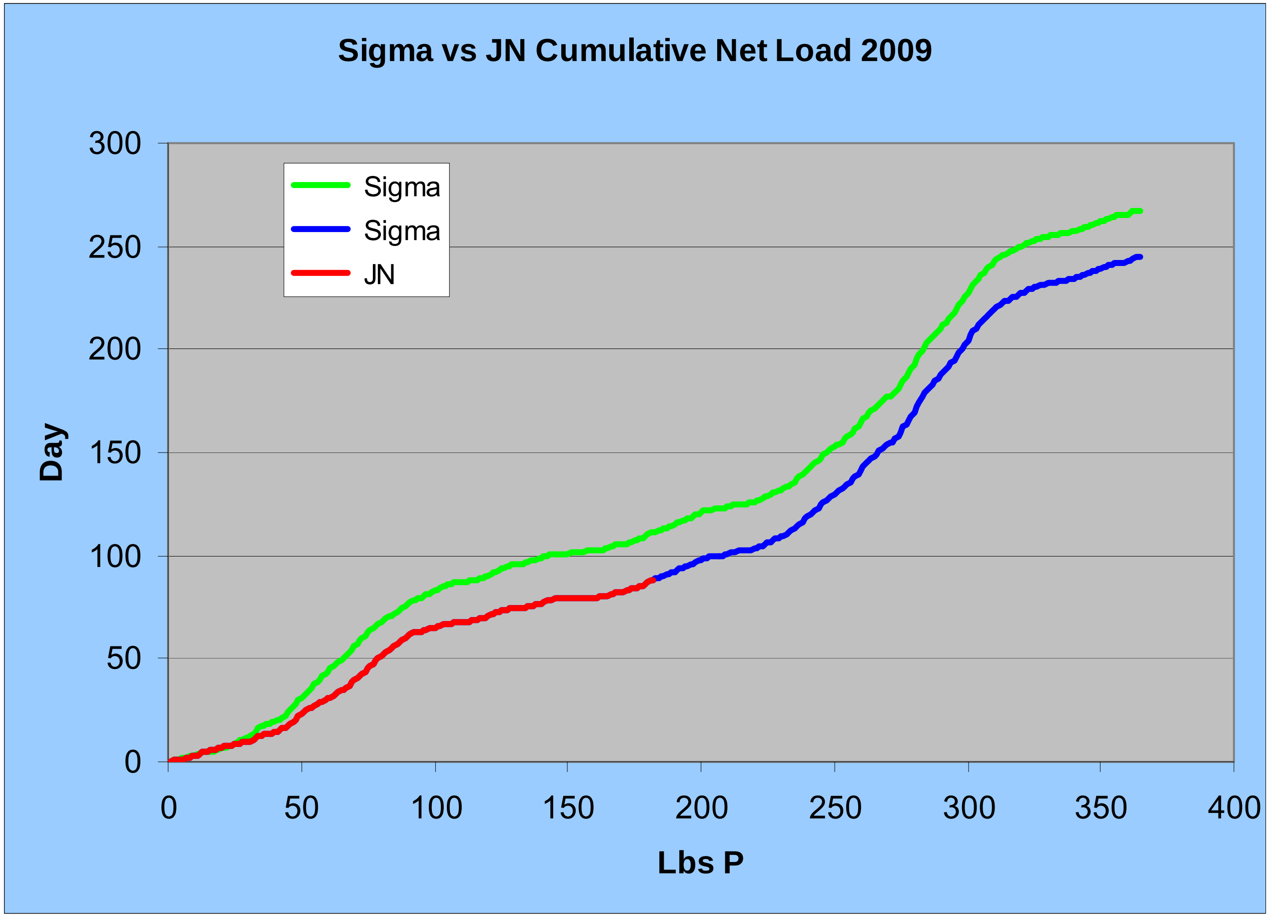
What factors cause load to go up like 2005, 2008, and 2009?
Why 3 Month violations for the past 4 years?
Suppose you want to increase production in the future, what is the non-compliance risk?
Suppose you want to control loading from another MDNR Hatchery facility?

We need to quantitatively understand the link between
Net Load and Fish Production Activities and Plant Operations

Figure 2. Hatchery phosphorus loading changes over time.



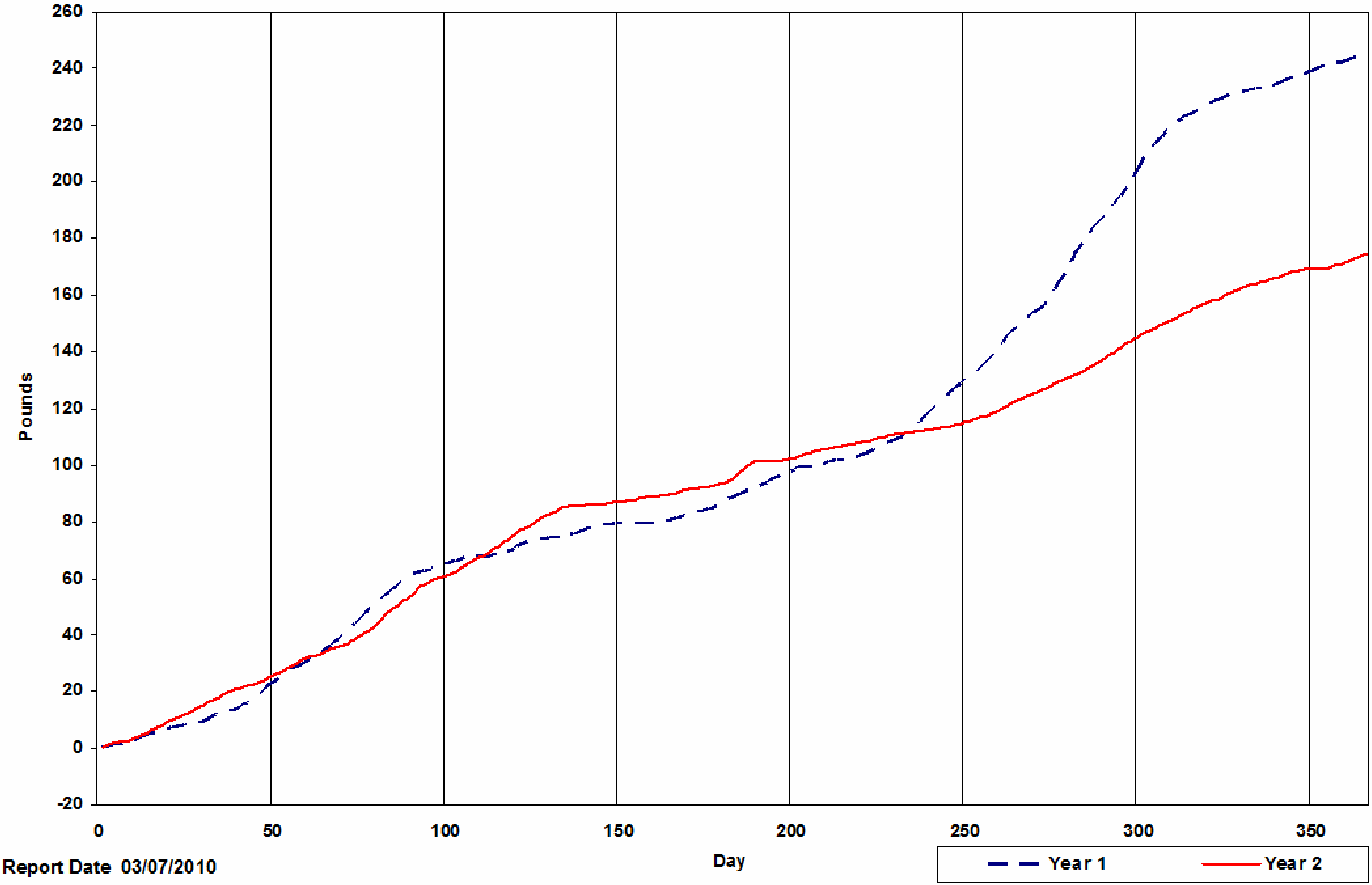
Sigma vs JN Cumulative Net Load 2008
Sigma
JN
Day
Lbs P
0
25
50
75
100
125
150
175
200
0
50
100
150
200
250
300
350
400



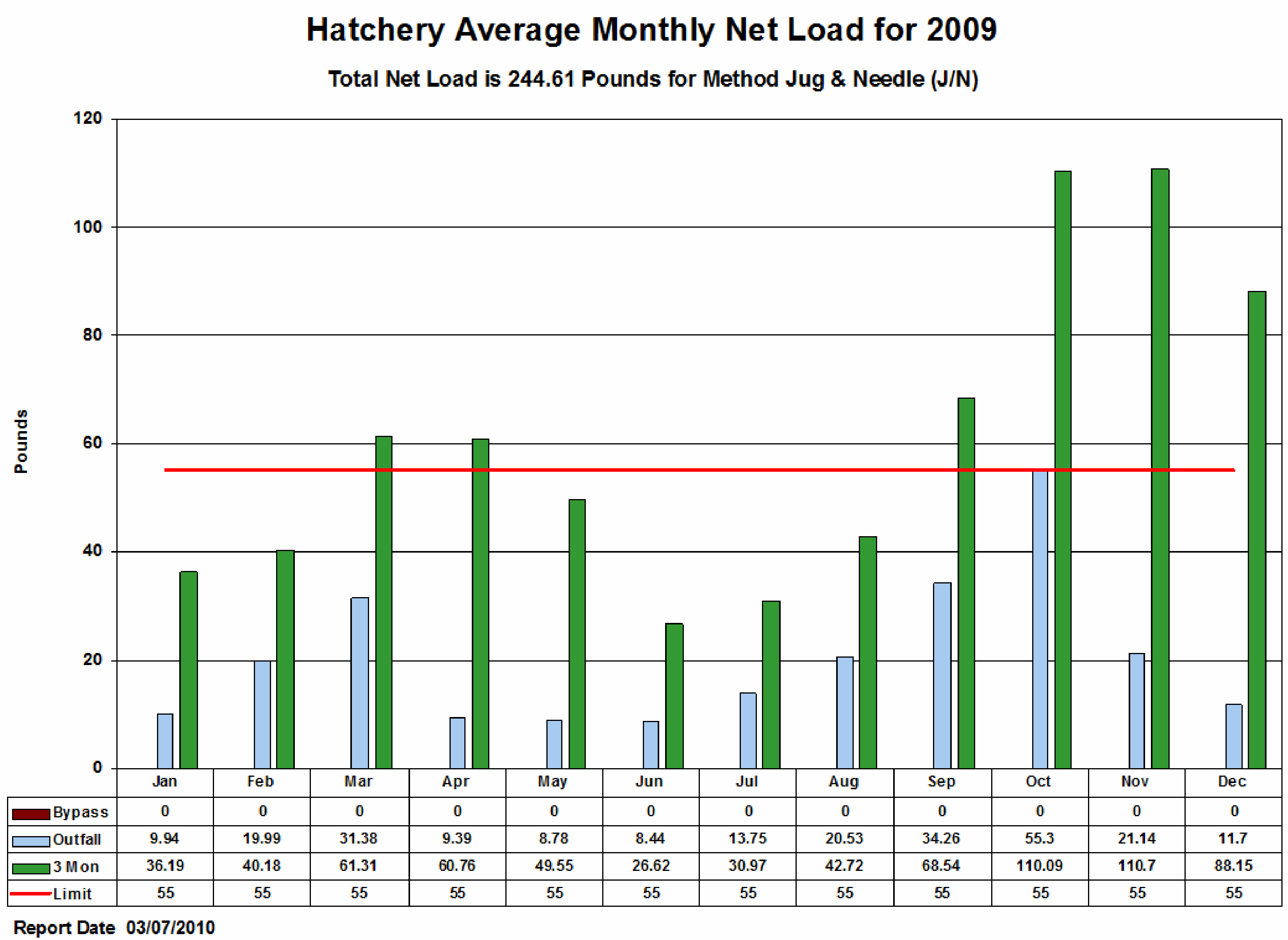
Sigma vs JN Cumulative Net Load 2009
Sigma
Sigma
JN
Day
Lbs P
300
250
200
150
100
50
0
0
50
100
150
200
250
300
350
400

Cumulative Net Hatchery Phosphorus Loading for Years 2009 and 2008

Method: J/N, Total Phos Load for Year 1 (2009): 244.59, Total Phos Load for Year 2 (2008): 174.70



Report Date 03/07/2010

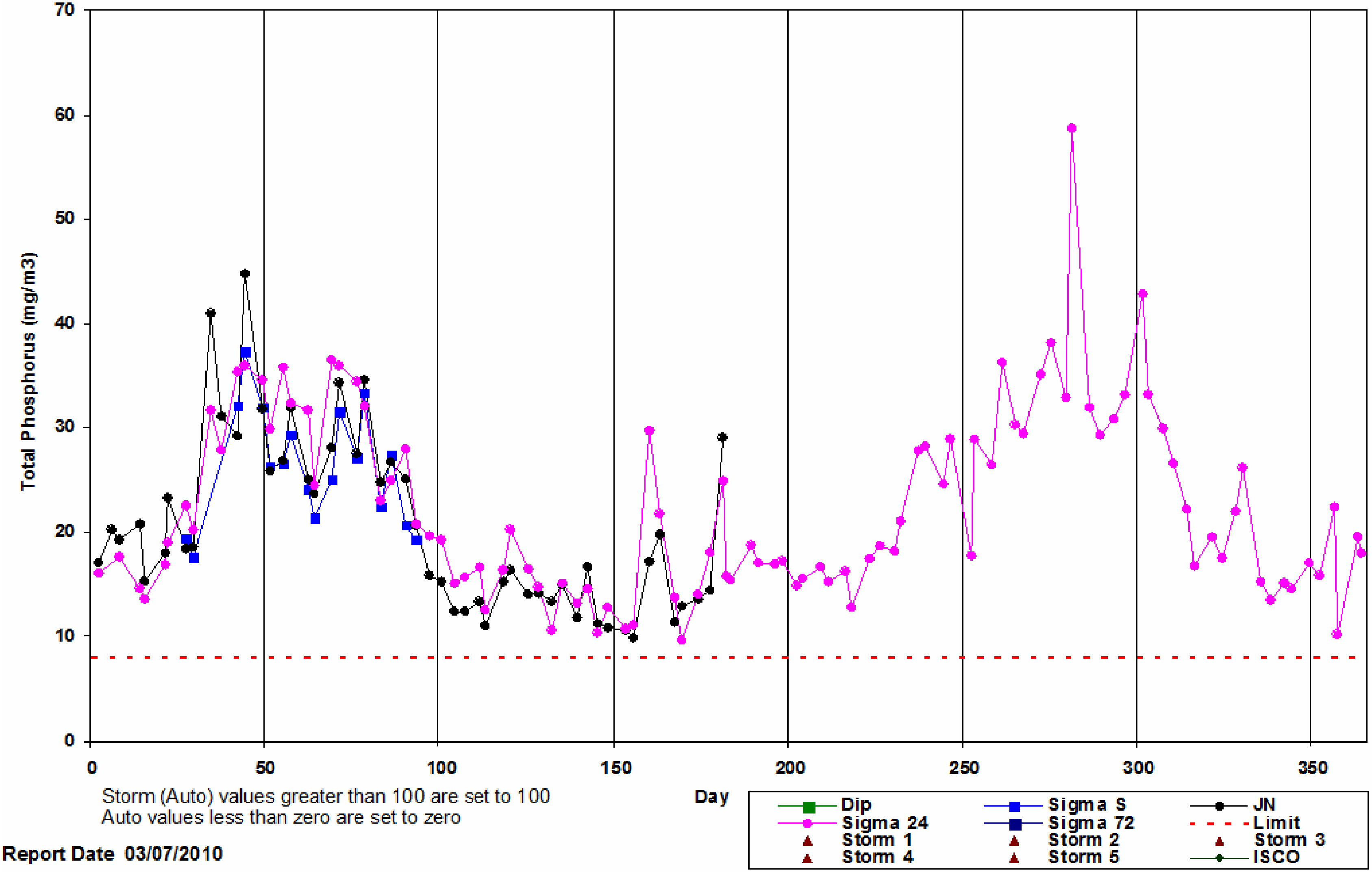


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bypass	0	0	0	0	0	0	0	0	0	0	0	0
Outfall	9.94	19.99	31.38	9.39	8.78	8.44	13.75	20.53	34.26	55.3	21.14	11.7
3 Mon	36.19	40.18	61.31	60.76	49.55	26.62	30.97	42.72	68.54	110.09	110.7	88.15
Limit	55	55	55	55	55	55	55	55	55	55	55	55

Figure 3. Hatchery monthly phosphorus loads.

Upper Discharge - Outfall 0002 - Phosphorus for Year 2009

Average Sigma S: 26.29, Average J/N: 20.44, Average Sigma 24: 22.39

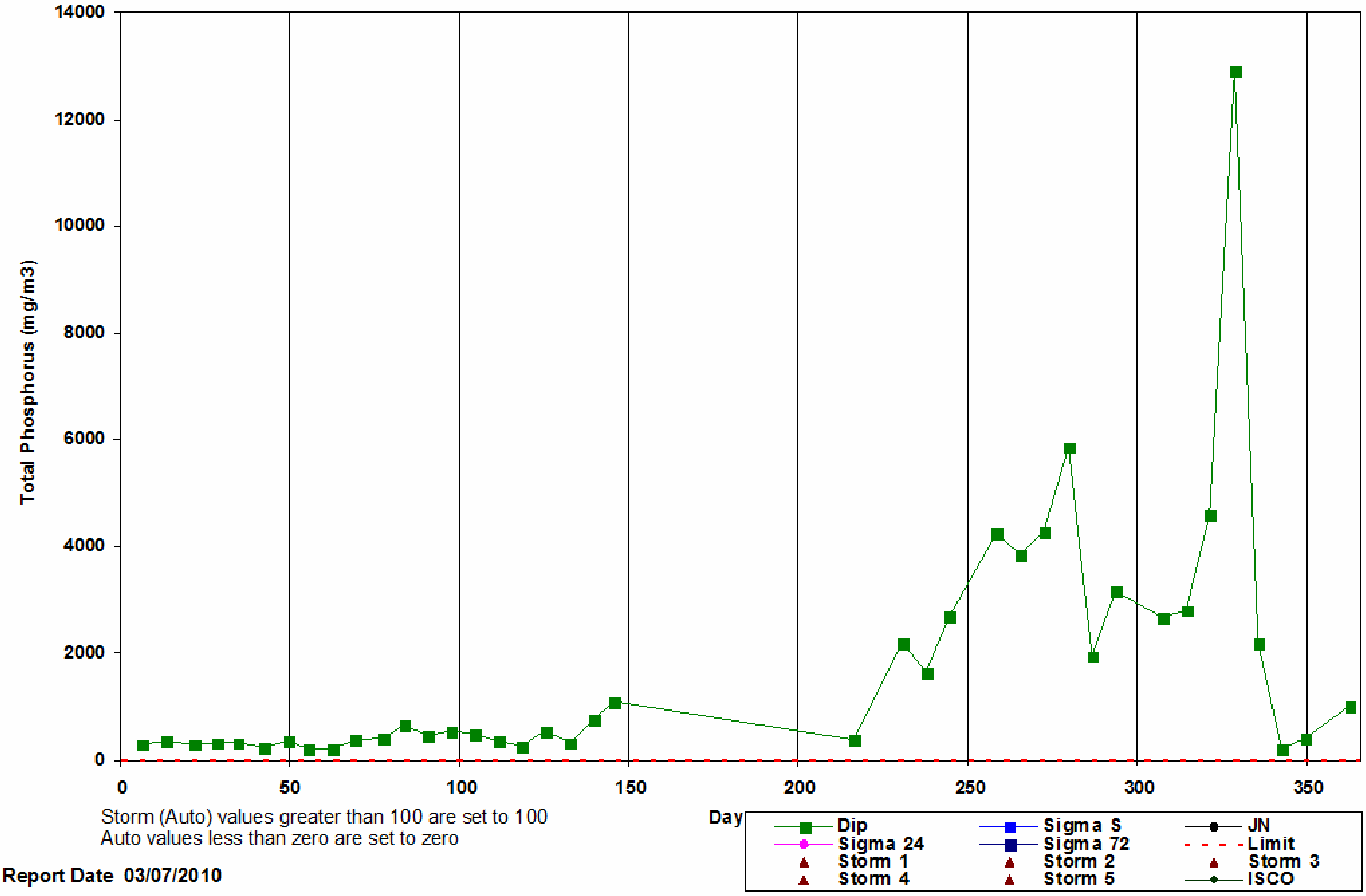


Storm (Auto) values greater than 100 are set to 100
Auto values less than zero are set to zero

Report Date 03/07/2010

Sludge Tank Overflow - Phosphorus for Year 2009

Average Dip: 1699.13

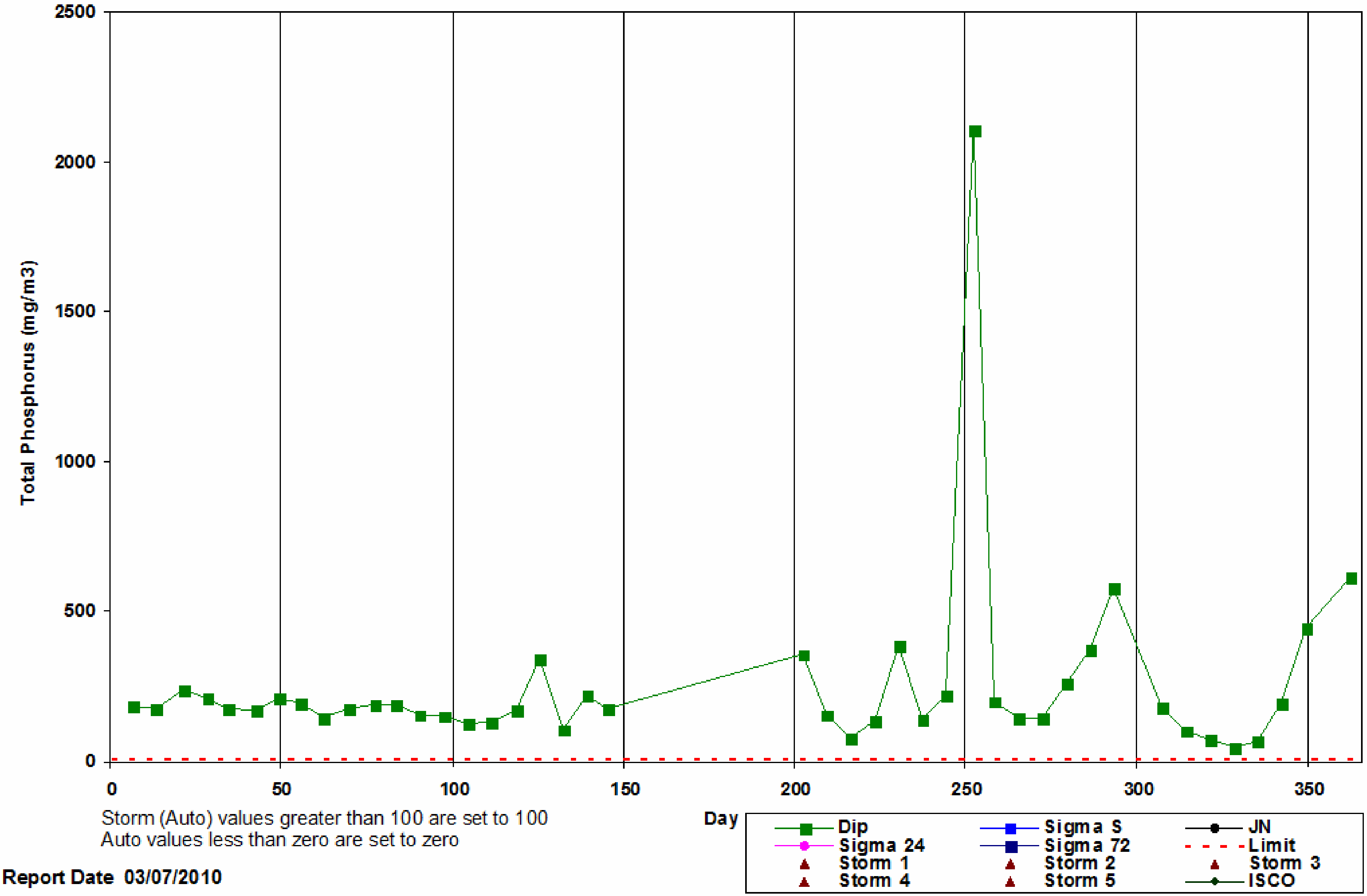


Storm (Auto) values greater than 100 are set to 100
Auto values less than zero are set to zero

Report Date 03/07/2010

Clarifier Overflow - Phosphorus for Year 2009

Average Dip: 253.62

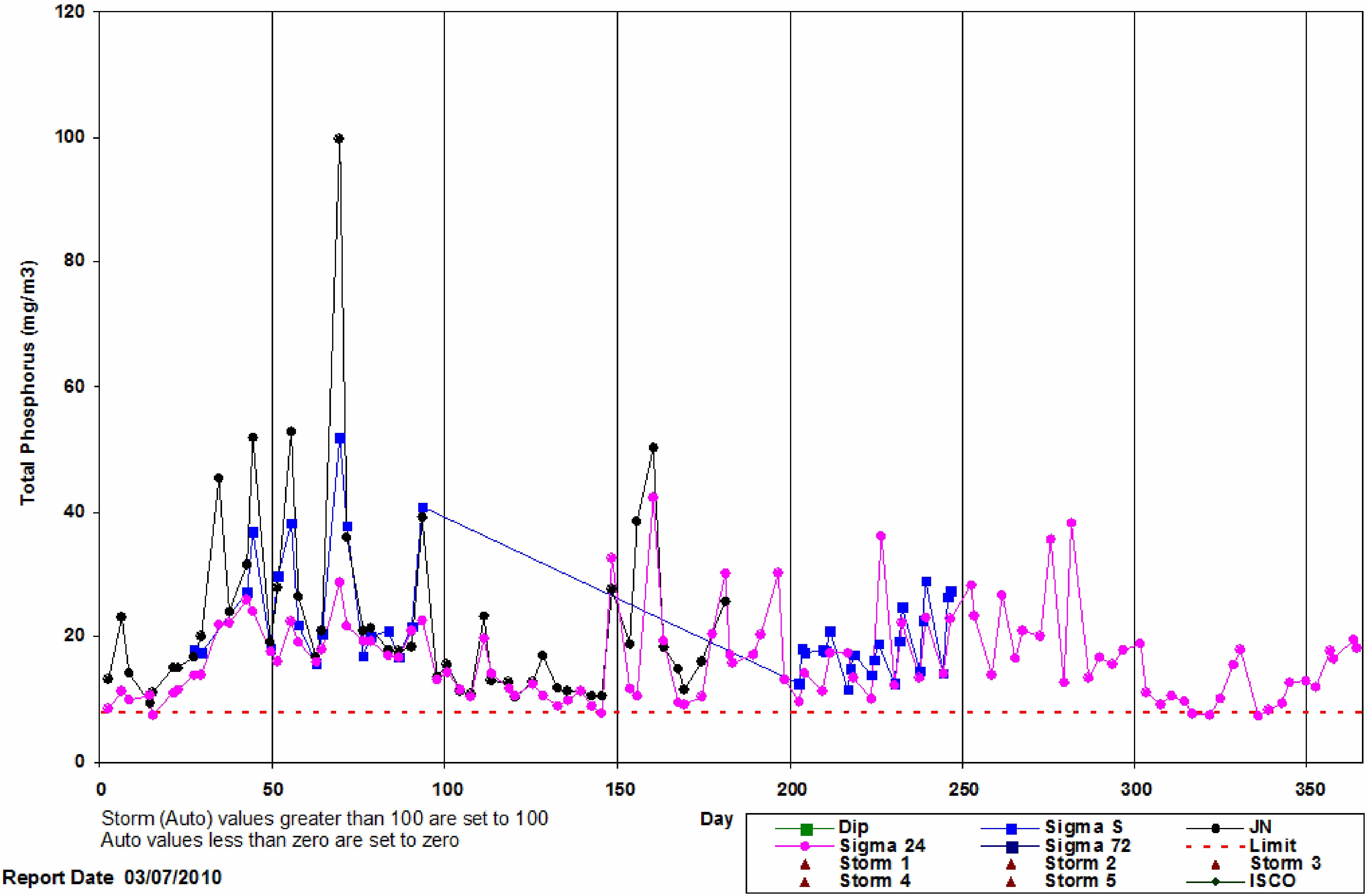


Storm (Auto) values greater than 100 are set to 100
Auto values less than zero are set to zero

Report Date 03/07/2010

Screens to Treatment Pond - Phosphorus for Year 2009

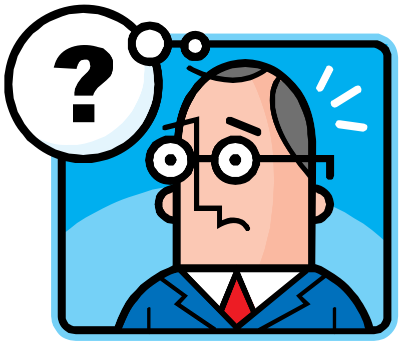
Average Sigma S: 22.05, Average J/N: 22.43, Average Sigma 24: 16.47



Storm (Auto) values greater than 100 are set to 100
Auto values less than zero are set to zero

Report Date 03/07/2010

Why?



More Food/Production ??

Failure of Screens

Failure of Clarifier/Sludge Tank

Failure of Pond

Comparison of Production and Feeding Activities for 2008 vs 2009

		Jun-Dec 2008	Jun-Dec 2009
Start Number		669,614	1,671,545
End Number		636,595	1,605,795
Start #/kg		115	269
End #/kg		27	40
Total Production (kg)		17,770	38,166
Food Fed (kg)		19,451	38,623
Food % P		0.88	0.92
Conversion Rate	(Δfood/Δfish)	1.09	1.01
Average T (^{o}C)		8.5	8.7

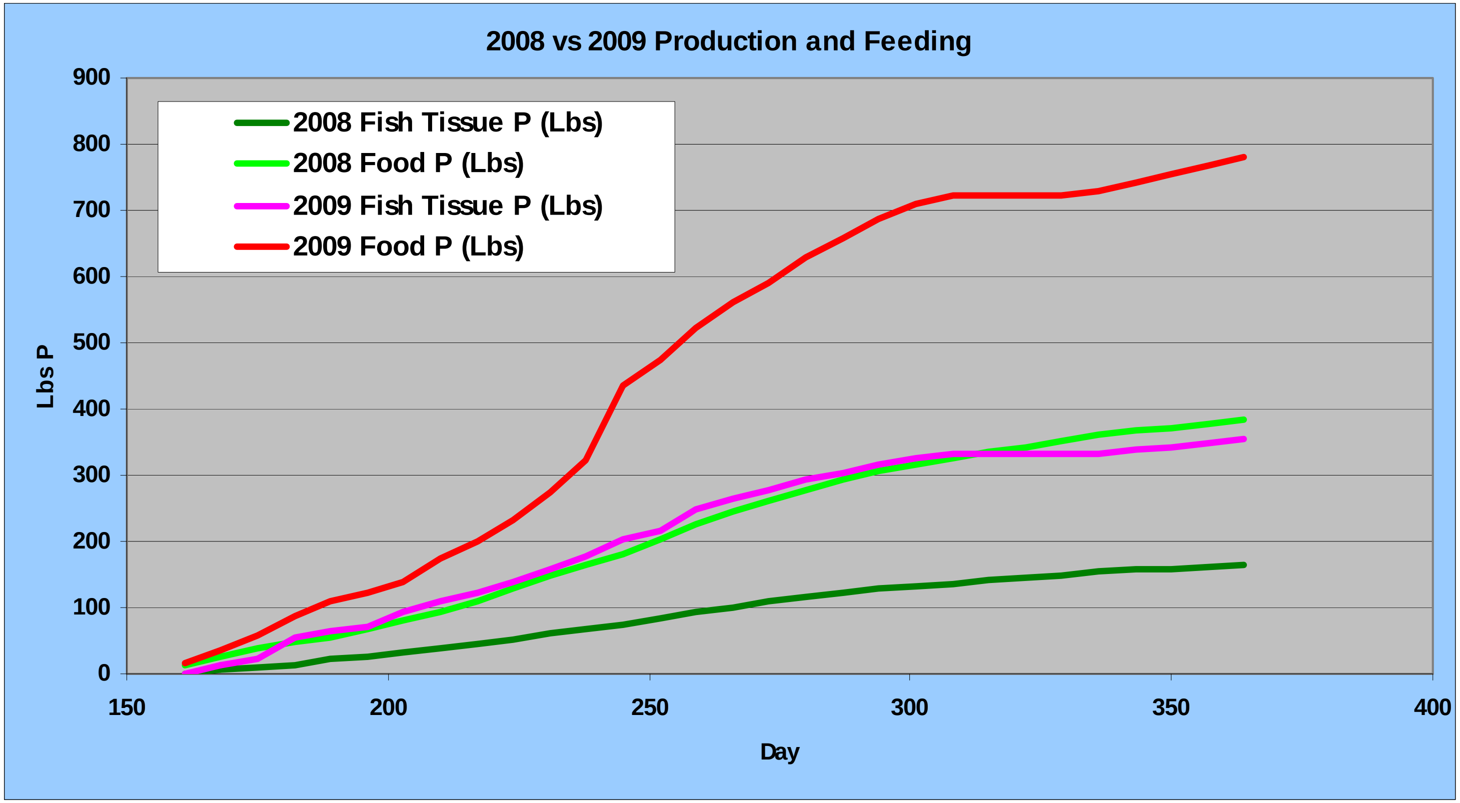
CR value does not tell whole story.

	Jun-Dec 2008	Jun-Dec 2009
P Supplied in Food (Lbs P)	383	781
P in New Fish Tissue (Lbs P)	165	353
Limit (Lbs P)	175	175
Load to Date (Lbs P)	88	80
Removal Required to Meet Limit (Lbs P)	132	333

Assumes % P = 0.42

Day	Start Date	End Date	Inventory #	Biomass	#/kg	Indiv. Wt (g)	Indiv. Length (cm)	Feed fed	Feed Type	Mort #	Mort Wt	Feed Conversion	Temp (^oc)	Waste Destination	Notes
144	05/24/2009	05/30/2009	1661809	4483	371	2.7	5.92	346.2	BDR/SVC	1142	2.73	#REF!	8	CF/HP	complete inventory ?
151	05/31/2009	06/06/2009	1672064	5320	314	3.2	6.26	760.1	BDR/SVC	745	2.12	0.91	8	CF/HP	
158	06/07/2009	06/13/2009	1671545	6218	269	3.7	6.59	854.8	BDR/SVC	519	1.77	0.95	11.5	CF/HP	
165	06/14/2009	06/20/2009	1671074	7452	224	4.5	7.00	1174.3	BDR/SVC	471	1.93	0.95	11.5	CF/HP	
172	06/21/2009	06/27/2009	1670667	8723	192	5.2	7.38	1184.4	BDR/SVC	407	1.89	0.93	11	CF/HP	
179	06/28/2009	07/04/2009	1670379	12009	139	7.2	8.21	1621.5	BDR/SVC	288	1.77	0.49	10	CF/HP	Sampling adjustment
186	07/05/2009	07/11/2009	1670142	13178	127	7.9	8.47	1111.8	BDR/SVC	231	1.87	0.95	11	CF/HP	
193	07/12/2009	07/18/2009	1865225	13768	135	7.4	8.28	732.1	BDR/SVC	520	3.74	1.23	10	CF/HP	Moving fish outdoors
200	07/19/2009	07/25/2009	1842448	16250	113	8.8	8.79	831.56	BDR/SVC	482	4.14	0.33	11	Sys	Moving fish outdoors
207	07/26/2009	08/01/2009	1841611	18034	102	9.8	9.10	1788.8	BDR/SVC	843	7.8	1.00	10	Sys	
214	08/02/2009	08/08/2009	1839936	19347	95	10.5	9.32	1262.8	BDR/SVC	1676	16.77	0.95	10	Sys	
221	08/09/2009	08/15/2009	1838972	20999	88	11.4	9.58	1579.7	BDR/SVC	964	10.5	0.95	12	Sys	
228	08/16/2009	08/22/2009	1838746	23127	80	12.6	9.89	2023.8	BDR/SVC	227	2.87	0.95	11	Sys	
235	08/23/2009	08/29/2009	1838465	25435	72	13.8	10.21	2201.8	BDR/SVC	272	3.79	0.95	10	Sys	
242	08/30/2009	09/05/2009	1838197	28213	65	15.3	10.57	5369.4	BDR/SVC	620	8.56	1.93	9	Sys	
249	09/06/2009	09/12/2009	1795972	29624	61	16.5	10.83	1919.1	BDR/SVC	124	1.89	1.36	11	Sys	Began stocking ff
256	09/13/2009	09/19/2009	1611986	28496	57	17.7	11.08	2239	BDR/SVC	157	4324.7	0.70	10	Sys	Finished stocking ff
263	09/20/2009	09/26/2009	1611828	30339	53	18.8	11.31	1957.4	BDR/SVC	158	2.91	1.06	10	Sys	
270	09/27/2009	10/03/2009	1611703	31652	51	19.6	11.47	1369.9	BDR/SVC	125	2.32	1.04	8	Sys	
277	10/04/2009	10/10/2009	1611605	33391	48	20.7	11.68	1898.6	BDR/SVC	98	2	1.09	8.5	Sys	
284	10/11/2009	10/17/2009	1611501	34681	46	21.5	11.83	1422	BDR/SVC	104	2.19	1.10	7	Sys	
291	10/18/2009	10/24/2009	1611388	36003	45	22.3	11.98	1486.3	BDR/SVC	113	2.49	1.12	8	Sys	
298	10/25/2009	10/31/2009	1611283	36891	44	22.9	12.08	979.6	BDR/SVC	105	2.4	1.10	9	Sys	
305	11/01/2009	11/07/2009	1611196	37527	43	23.3	12.15	702.1	BDR/SVC	87	2.07	1.10	8	Sys	
312	11/08/2009	11/14/2009	1611075	37538	43	23.3	12.15	15.6	BDR/SVC	121	2.88	1.10	8	Sys	
319	11/15/2009	11/21/2009	1610899	37534	43	23.3	12.15	0	BDR/SVC	176	4.37	0.00	8	Sys	
326	11/22/2009	11/28/2009	1610714	37529	43	23.3	12.15	0	BDR/SVC	185	4.28	0.00	6.5	Sys	
333	11/29/2009	12/05/2009	1610459	37820	43	23.5	12.18	330.5	BDR/SVC	257	6.04	1.11	5	Sys	
340	12/06/2009	12/12/2009	1610345	38420	42	23.9	12.24	663	BDR/SVC	109	2.52	1.10	3	Sys	
347	12/13/2009	12/19/2009	1606038	38774	41	24.1	12.29	612.2	BDR/SVC	236	5.31	1.70	4.5	Sys	Complete inv. On A-08
354	12/20/2009	12/26/2009	1605907	39338	41	24.5	12.35	622.9	BDR/SVC	131	3.18	1.10	5	Sys	
361	12/27/2009	01/02/2010	1605795	39942	40	24.9	12.41	667.6	BDR/SVC	112	2.69	1.10	3	Sys	

2009							
DOY	**Inven #**	**Biomass kg**	**#/kg**	**Food kg**	**Feed Type**	**TP**	**Notes**
161	1,671,545	6,218	268.8	855	BDR/SVC	0.822	
168	1,671,074	7,452	224.2	1174	BDR/SVC	0.822	
175	1,670,667	8,723	191.5	1184	BDR/SVC	0.822	
182	1,670,379	12,009	139.1	1622	BDR/SVC	0.822	
189	1,670,142	13,178	126.7	1112	BDR/SVC	0.882	
196	1,865,225	13,768	135.5	732	BDR/SVC	0.882	Moving fish outdoors
203	1,842,448	16,250	113.4	832	BDR/SVC	0.882	Moving fish outdoors
210	1,841,611	18,034	102.1	1789	BDR/SVC	0.882	
217	1,839,936	19,347	95.1	1263	BDR/SVC	0.942	
224	1,838,972	20,999	87.6	1580	BDR/SVC	0.942	
231	1,838,746	23,127	79.5	2024	BDR/SVC	0.942	
238	1,838,465	25,435	72.3	2202	BDR/SVC	0.942	
245	1,838,197	28,213	65.2	5369	BDR/SVC	0.953	
252	1,795,972	29,624	60.6	1919	BDR/SVC	0.953	Began stocking
259	1,611,986	28,496	56.6	2239	BDR/SVC	0.953	Finished stocking
266	1,611,828	30,339	53.1	1957	BDR/SVC	0.953	
273	1,611,703	31,652	50.9	1370	BDR/SVC	0.927	
280	1,611,605	33,391	48.3	1899	BDR/SVC	0.927	
287	1,611,501	34,681	46.5	1422	BDR/SVC	0.927	
294	1,611,388	36,003	44.8	1486	BDR/SVC	0.927	
301	1,611,283	36,891	43.7	980	BDR/SVC	0.932	
308	1,611,196	37,527	42.9	702	BDR/SVC	0.932	
315	1,611,075	37,538	42.9	16	BDR/SVC	0.932	
322	1,610,899	37,534	42.9	0	BDR/SVC	0.932	
329	1,610,714	37,529	42.9	0	BDR/SVC	0.932	
336	1,610,459	37,820	42.6	331	BDR/SVC	0.908	
343	1,610,345	38,420	41.9	663	BDR/SVC	0.908	
350	1,606,038	38,774	41.4	612	BDR/SVC	0.908	
357	1,605,907	39,338	40.8	623	BDR/SVC	0.908	
364	1,605,795	39,942	40.2	668	BDR/SVC	0.908	

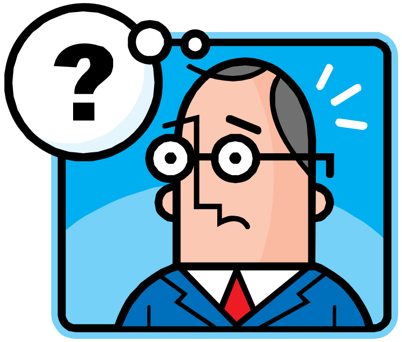


June to December 2008 Lbs P

Current	+ Food	– Production	– Limit	= Need to Remove
88	383	165	175 =	132

June to December 2009 Lbs P

Current	+ Food	– Production	– Limit	= Need to Remove
80	781	353	175 =	333

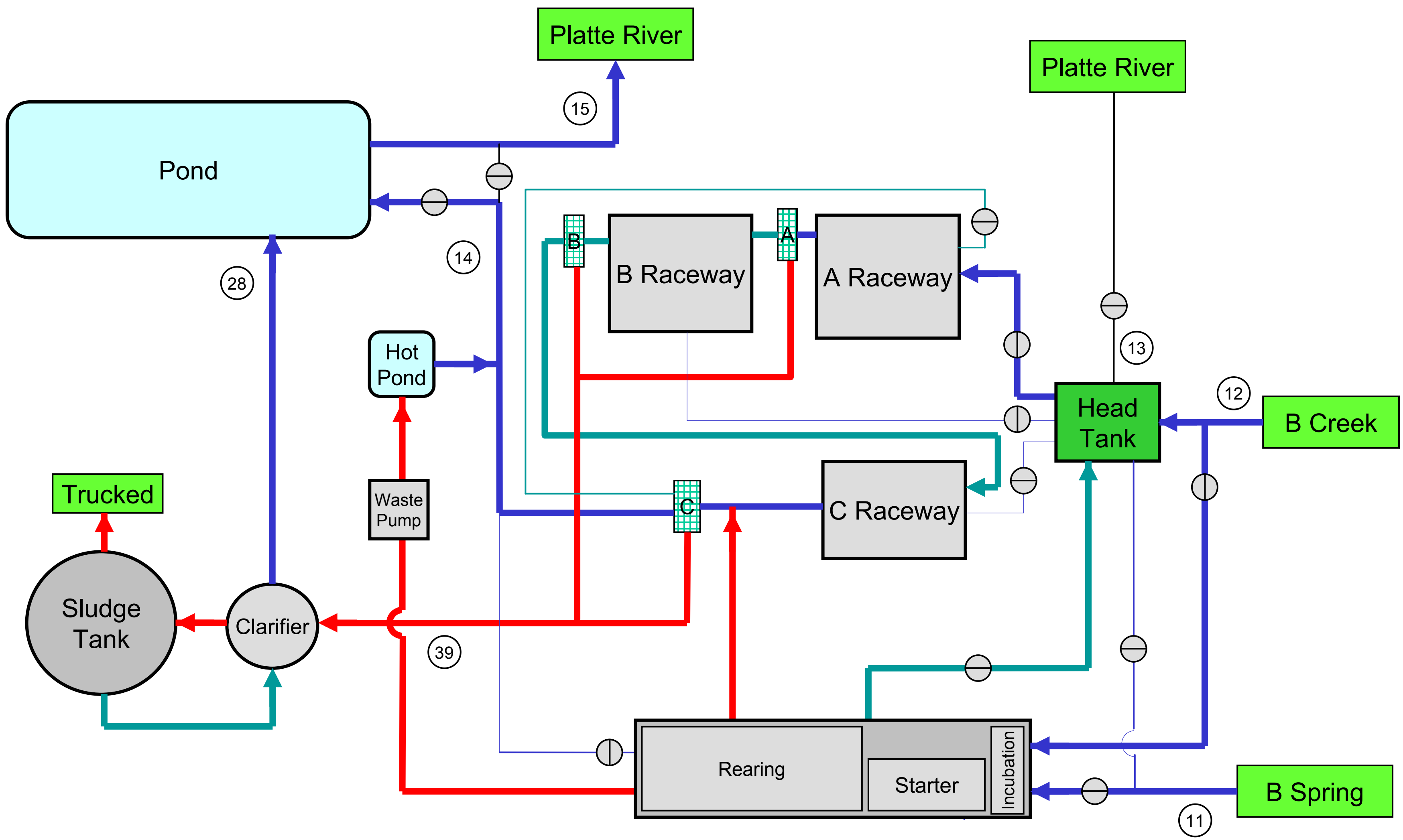


Why?

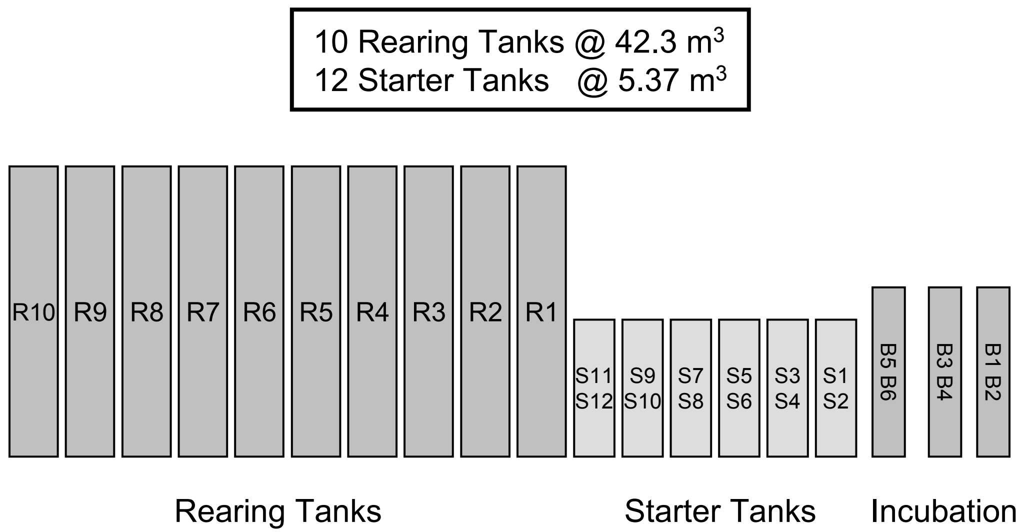
More Food/Production

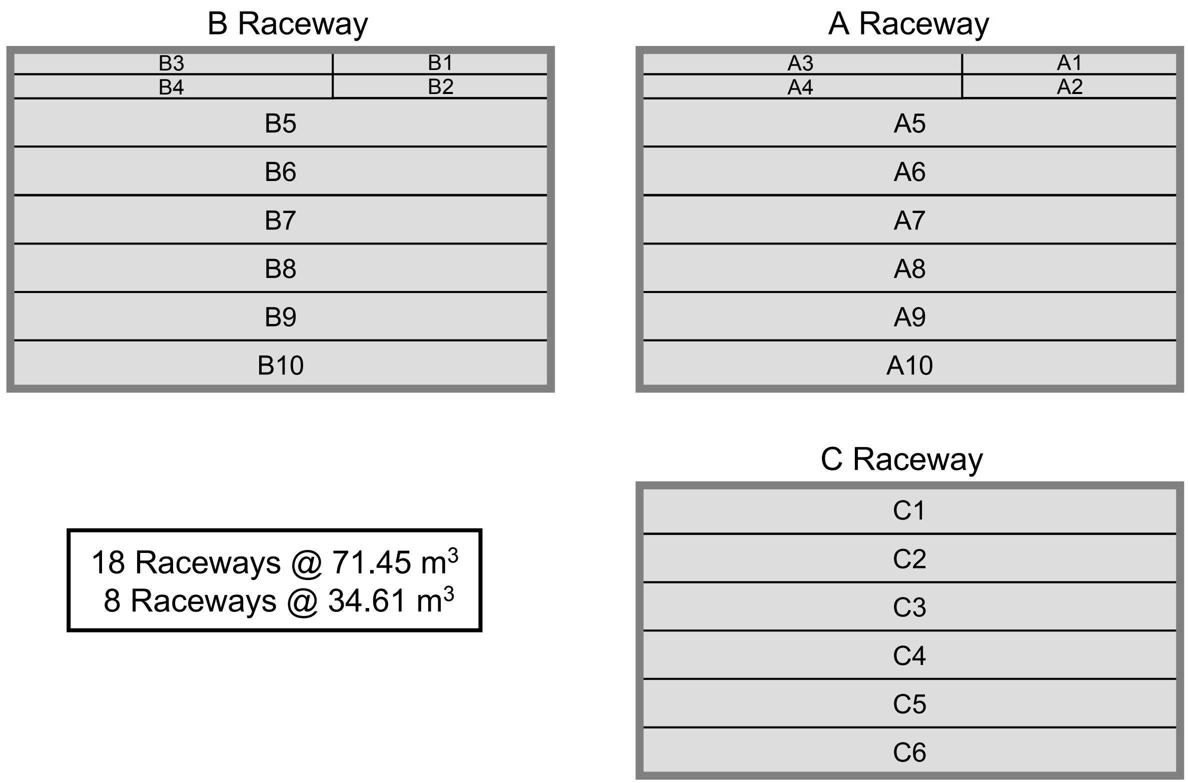
- Failure of Screens ??
- Failure of Clarifier/Sludge Tank ??
- Failure of Pond ??

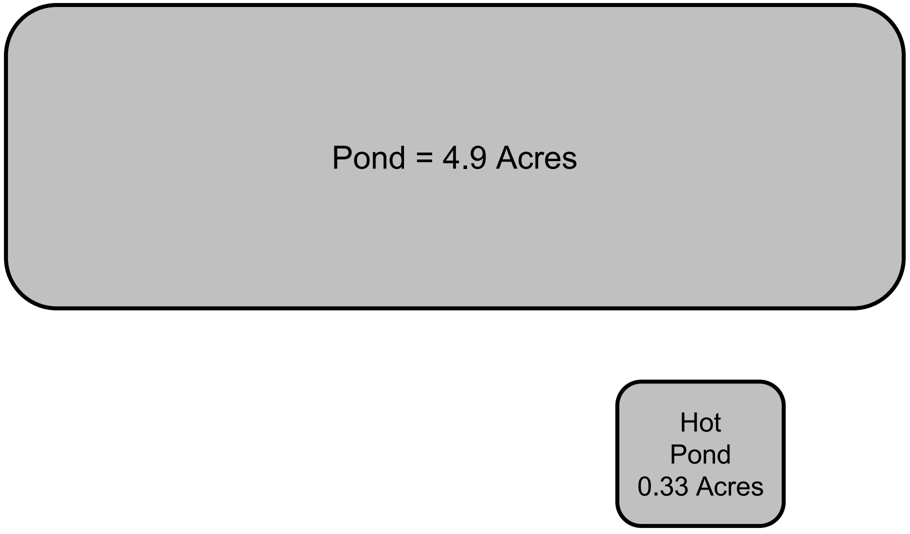
Full operation – Fish in both Hatchery Building and Raceways (Jan - May)



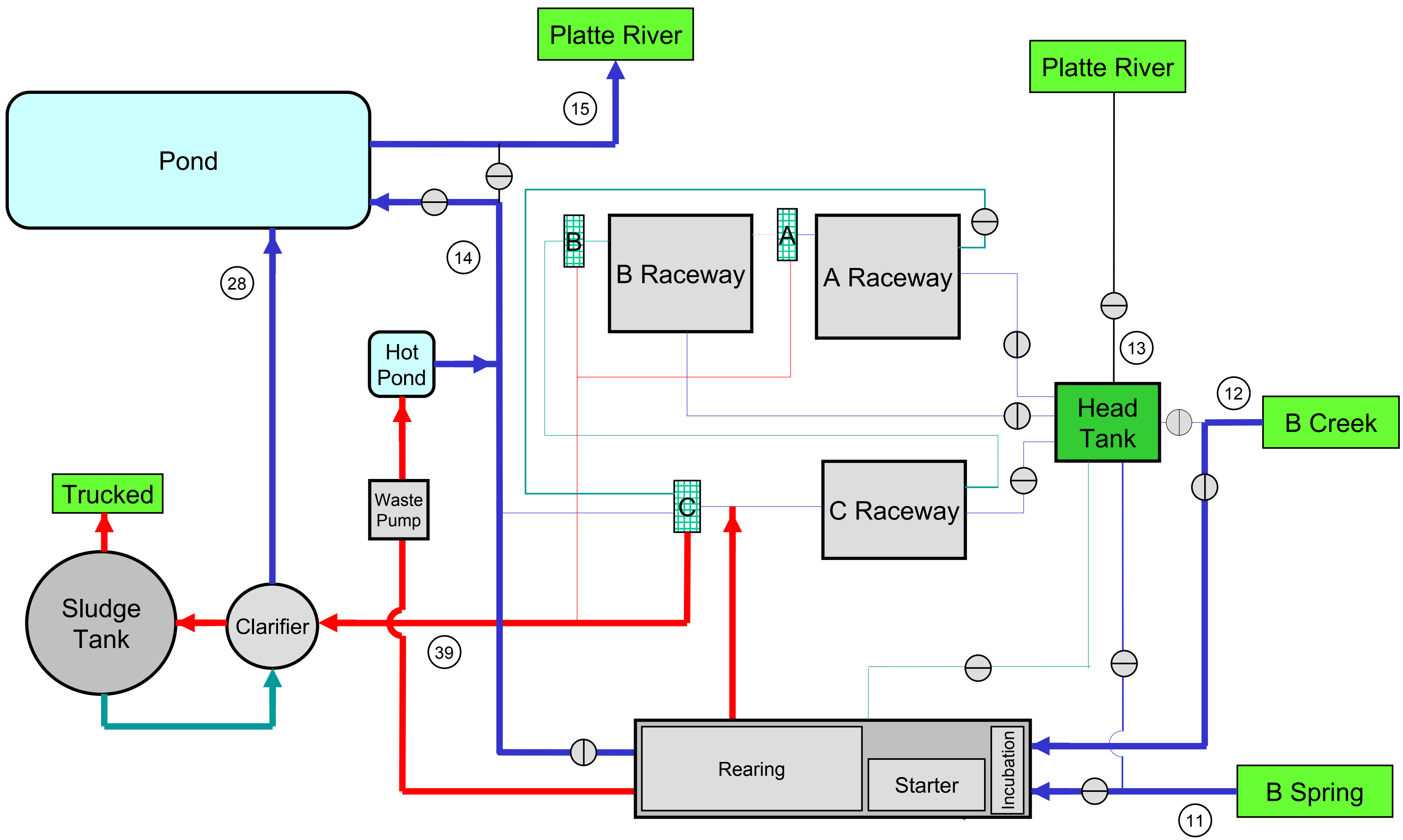
Notes:
Red Lines = Concentrated Underflows and Waste Flows
Blue Lines = In, Out, and Overflows
Dark Green Line = Re-Use or Recycle Flow
Thick Lines = Primary Active Flows during Period
Thin Lines = Secondary Inactive Flows during Period


10 Rearing Tanks @ 42.3 m3
12 Starter Tanks @ 5.37 m3
R10
R9
R8
R7
R6
R5
R4
R3
R2
R1
S11 S12
S9 S10
S7 S8
S5 S6
S3 S4
S1 S2
B5 B6
B3 B4
B1 B2
Rearing Tanks
Starter Tanks
Incubation


B Raceway
B3
B1
B4
B2
B5
B6
B7
B8
B9
B10
A Raceway
A3
A1
A4
A2
A5
A6
A7
A8
A9
A10
C Raceway
C1
C2
C3
C4
C5
C6
18 Raceways @ 71.45 m3
8 Raceways @ 34.61 m3

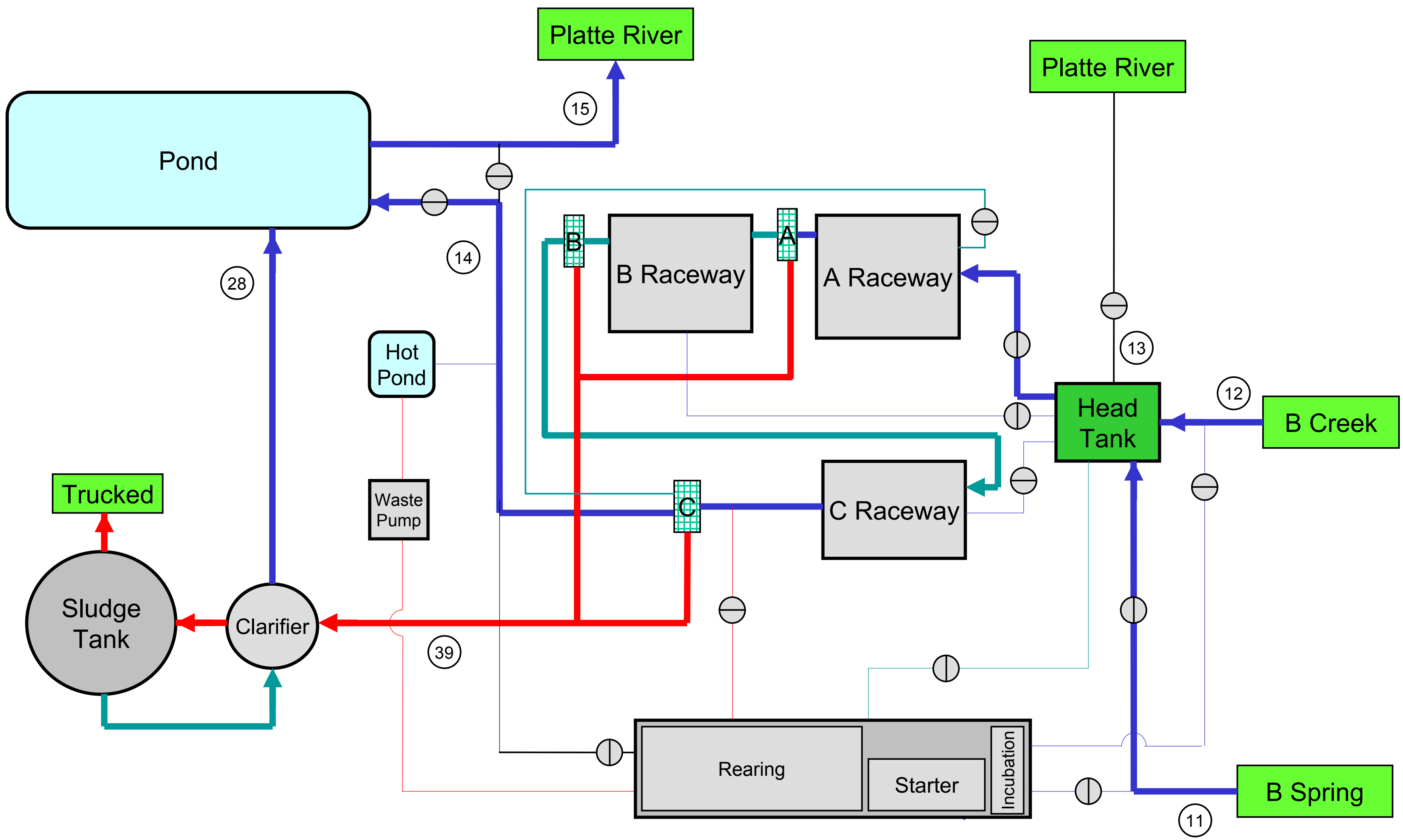

Pond = 4.9 Acres
Hot
Pond
0.33 Acres

Full operation – Fish in both Hatchery Building and Raceways (June - July)



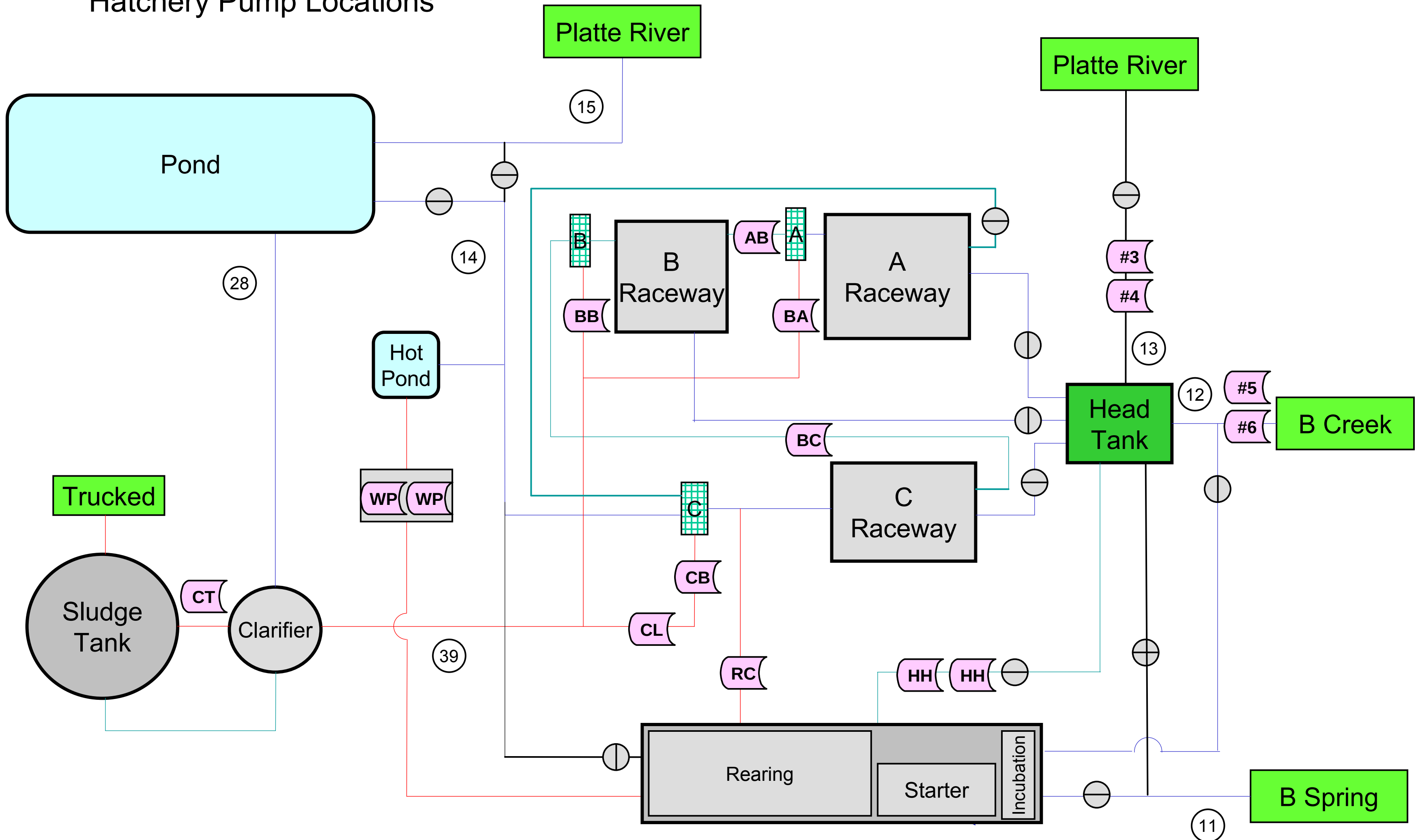
Notes:
Red Lines = Concentrated Underflows and Waste Flows
Blue Lines = In, Out, and Overflows
Dark Green Line = Re-Use or Recycle Flow
Thick Lines = Primary Active Flows during Period
Thin Lines = Secondary Inactive Flows during Period

Full operation – Fish in both Hatchery Building and Raceways (Aug - Dec)



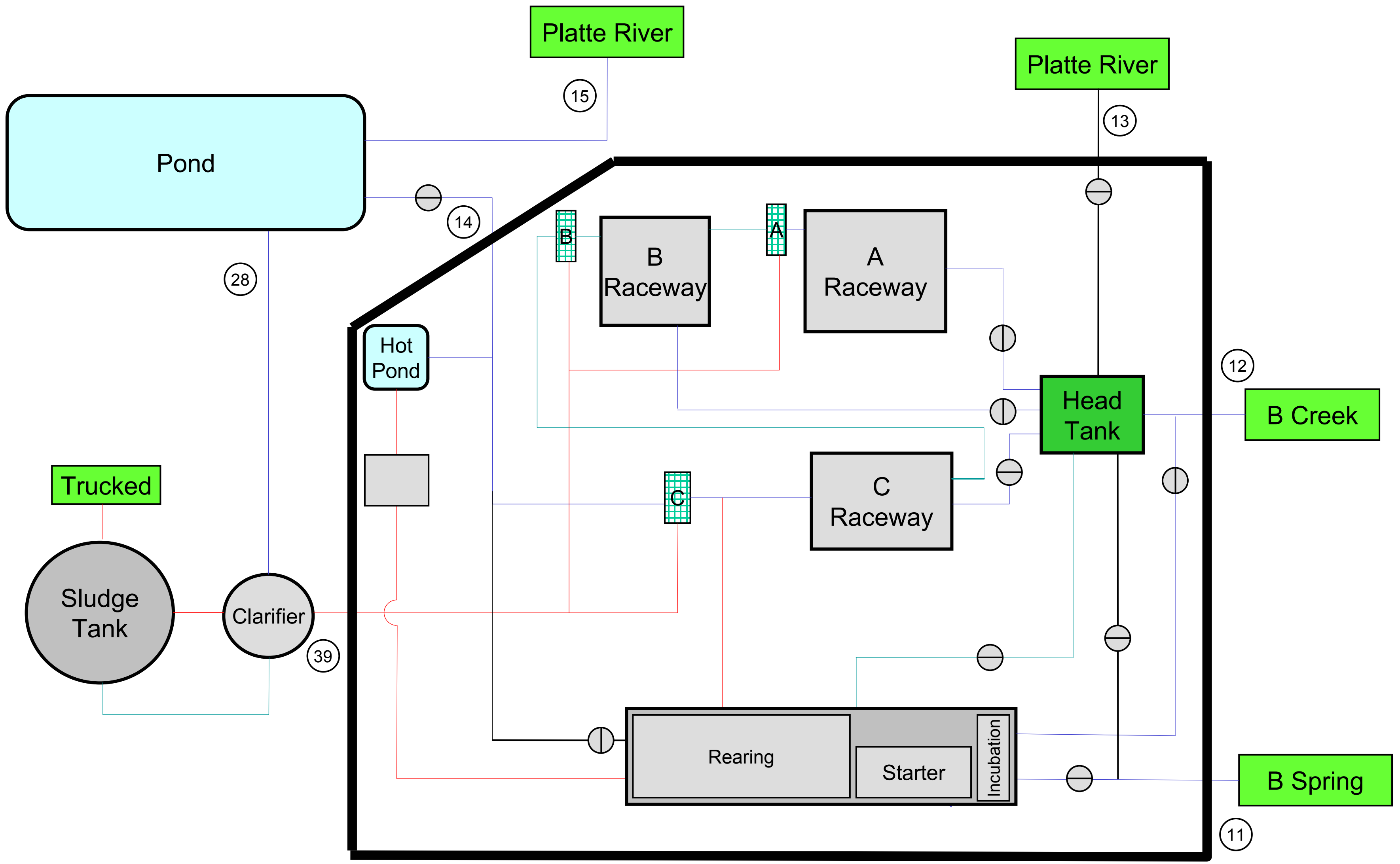
Notes:
Red Lines = Concentrated Underflows and Waste Flows
Blue Lines = In, Out, and Overflows
Dark Green Line = Re-Use or Recycle Flow
Thick Lines = Primary Active Flows during Period
Thin Lines = Secondary Inactive Flows during Period

Hatchery Pump Locations

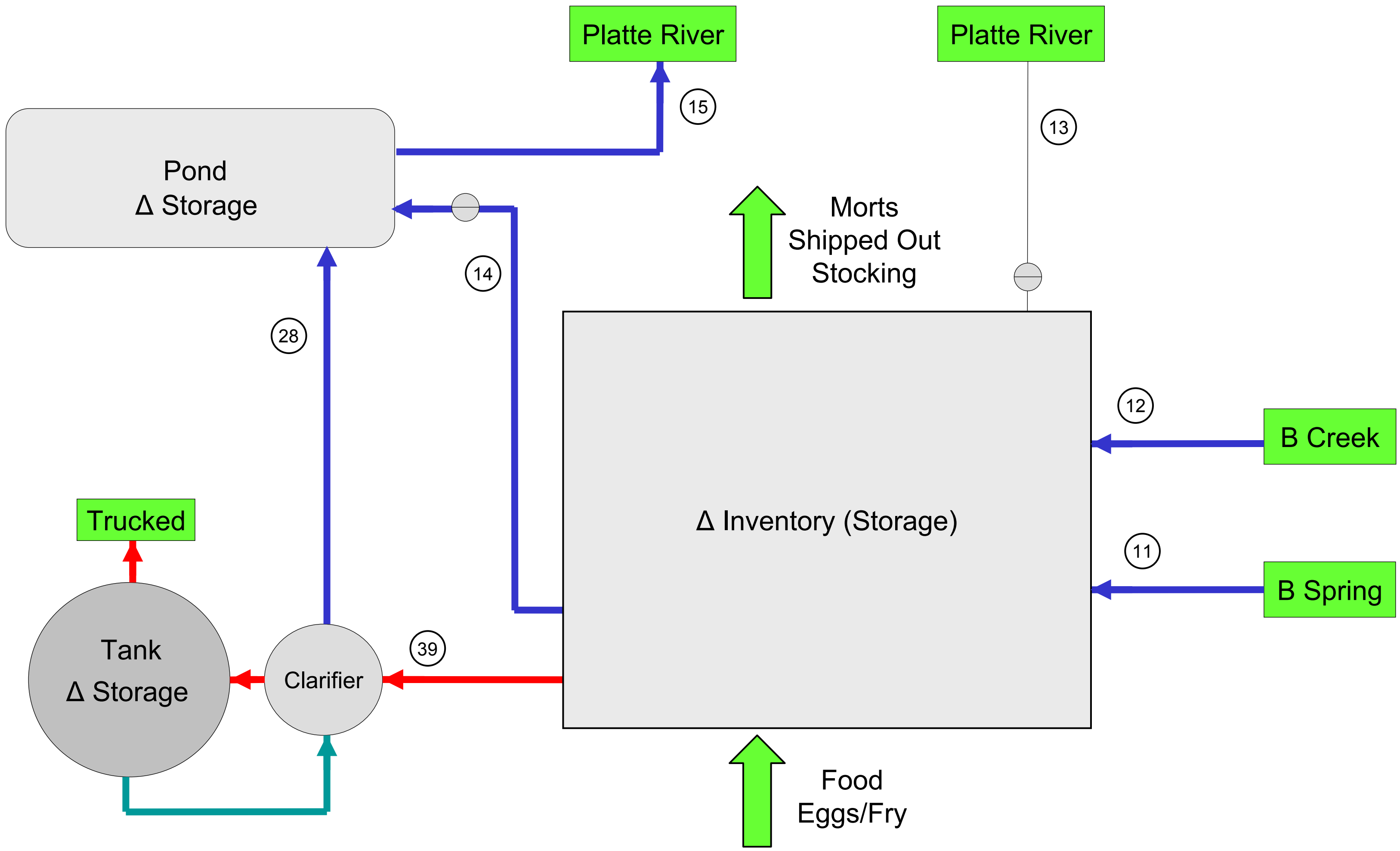


Notes:

#3 = Platte River Intake	BA = A Filter Backwash Pump
#4 = Platte River Intake	BB = B Filter Backwash Pump
#5 = Brundage Creek Intake	CB = C Filter Backwash Pump
#6 = Brundage Creek Intake	CL = C Backwash Flow Lift Pump
AB = A to B Serial Re-Use	WP = Hatchery Bldg to Waste Pump Bldg
BC = B to C Serial Re-Use	CT = Clarifier to Sludge Tank
HH = Hatchery to Head Tank	RC = Rearing Tank Waste Pump


Platte River
Platte River
15
13
Pond
14
28
B
A
B Raceway
A Raceway
Hot Pond
12
Head Tank
B Creek
C
C Raceway
Trucked
Sludge Tank
Clarifier
39
Rearing
Starter
Incubation
B Spring
11

Consolidated Representation of Hatchery Phosphorus Pathways



General Case: **Storage = Inputs - Outputs**

All in units of Lbs P

Storage	Inputs	Outputs
Δ Fish	Source Water	Discharge
Δ Tank	Food	Stocked Fish
Δ Pond	Fry	Shipped Fish
		Mort Fish
		Trucked Sludge

Definitions & Assumptions

Net Load = Discharge – Source Water

Harvest = Σ [Stocked + Shipped + Mort]   [Harvest = Fish that leave the Hatchery]

Fish Increase = Fish End – Fish Start (Inventory)

Production = Fish Increase + Harvest – Fry In   [Production = Actual Net Growth of new Fish Biomass]

Tank Removal = Trucked + Tank End – Tank Start

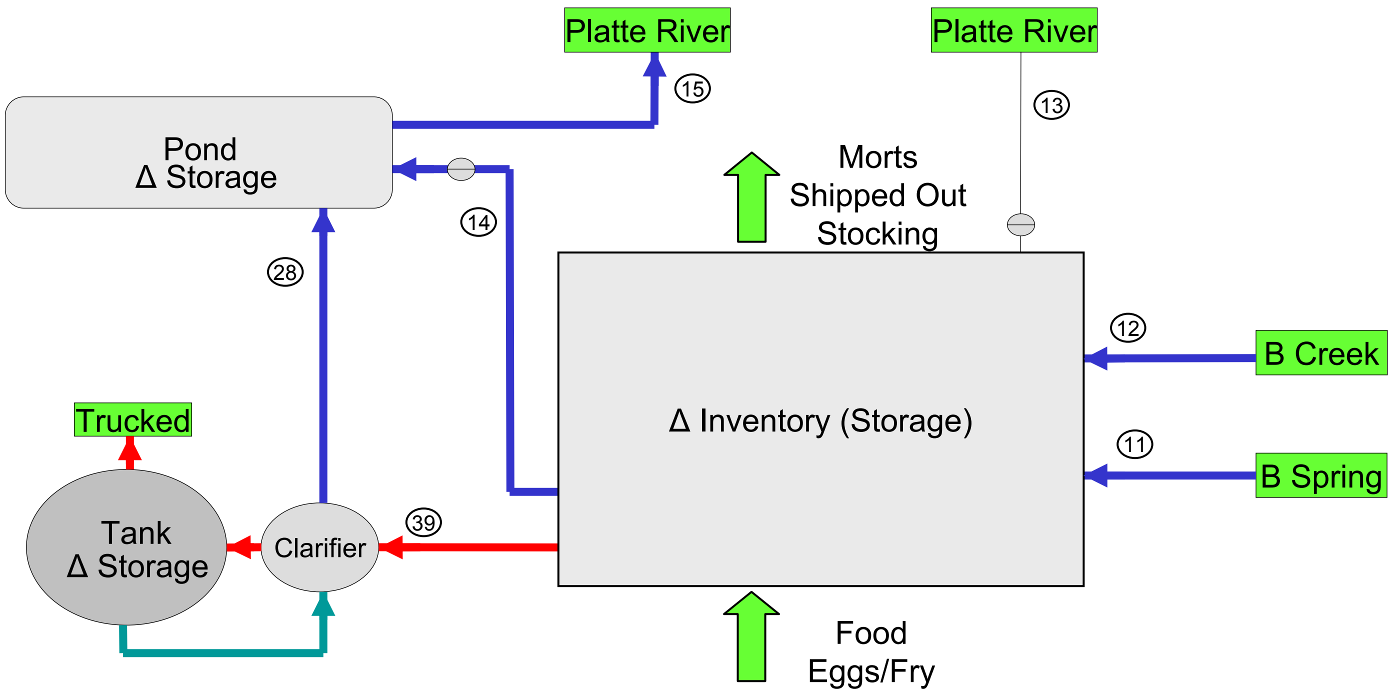
Pond Storage = Screen + Clarifier + Tank - Discharge

Discharge – Source = Food – [Harvest + Fish End – Fish Start – Fry] - Trucked – ΔPond + [Tank Start – Tank End]

Net Load = Food – Production – Tank Removal – Pond Storage

Figure 8. Definition of terms in Mass Balance Equation.

Consolidated Representation of Hatchery Phosphorus Pathways Mass Balance Application



Food P = Food x %P

Production P = [Mort + Shipped + Stocked + Δ Inventory] x %P

Pond Storage = (28) + (14) - (15)

Measured as Trucked +ΔTank

Calculated Net Load

Measured Net Load

Net Load = Food – Production – Tank Removal – Pond Storage

Net Load = (15) - (11) - (12) - (13)

			% Tissue P 0.42					
						Mass Bal		
			Fish	Tank	Pond	Expected	Meas	
Method	Year	Food	Production	Retention	Loss	Net Load	Net Load	Error
JN	2001	1272	647	0	37	588	210	379
JN	2002	1019	591	0	25	403	206	197
JN	2003	704	376	24	84	220	171	49
Sigma	2003	704	376	24	115	189	174	15
JN	2004	1071	656	214	98	103	161	-58
Sigma	2004	1071	656	214	46	155	134	21
JN	2005	993	567	255	-1	172	231	-59
Sigma	2005	993	567	255	-55	226	203	23
JN	2006	963	551	149	53	209	127	82
Sigma	2006	963	551	149	14	248	100	148
JN	2007	1016	580	63	103	270	131	139
Sigma	2007	1016	580	63	280	93	105	-12
JN	2008	787	391	80	5	311	175	136
Sigma	2008	787	391	80	51	265	103	162
JN	2009	1062	547	70	38	407	245	162
Sigma	2009	1062	547	70	-42	487	267	220

June 6, 2009 to December 31, 2009

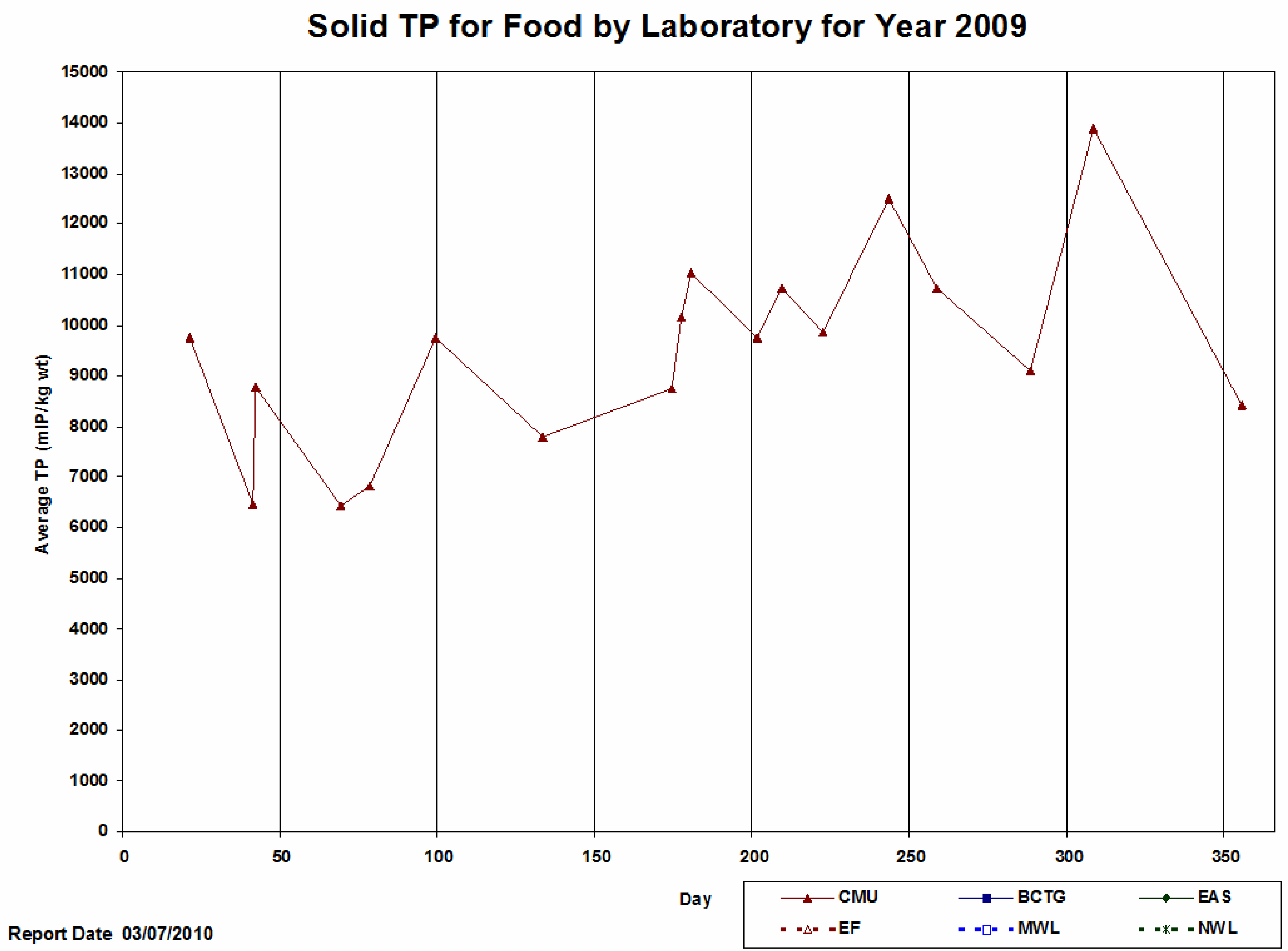
	Weight kg	% P	Load Lbs P
Food	38,623	0.92	779
Inventory Increase	33,724	0.42	312
Morts + Stocking	4,442	0.42	41

	Flow mgd	TP mg/m3	Load Lbs P
Spring	2.75	9.5	45
Creek	4.9	11.2	94
Screened	7.65	17.0	223
Clarifier Overflow	0.047	280	23
Tank Overflow	0.012	2800	57
Discharge	7.71	22.5	297
Pond Loss			5

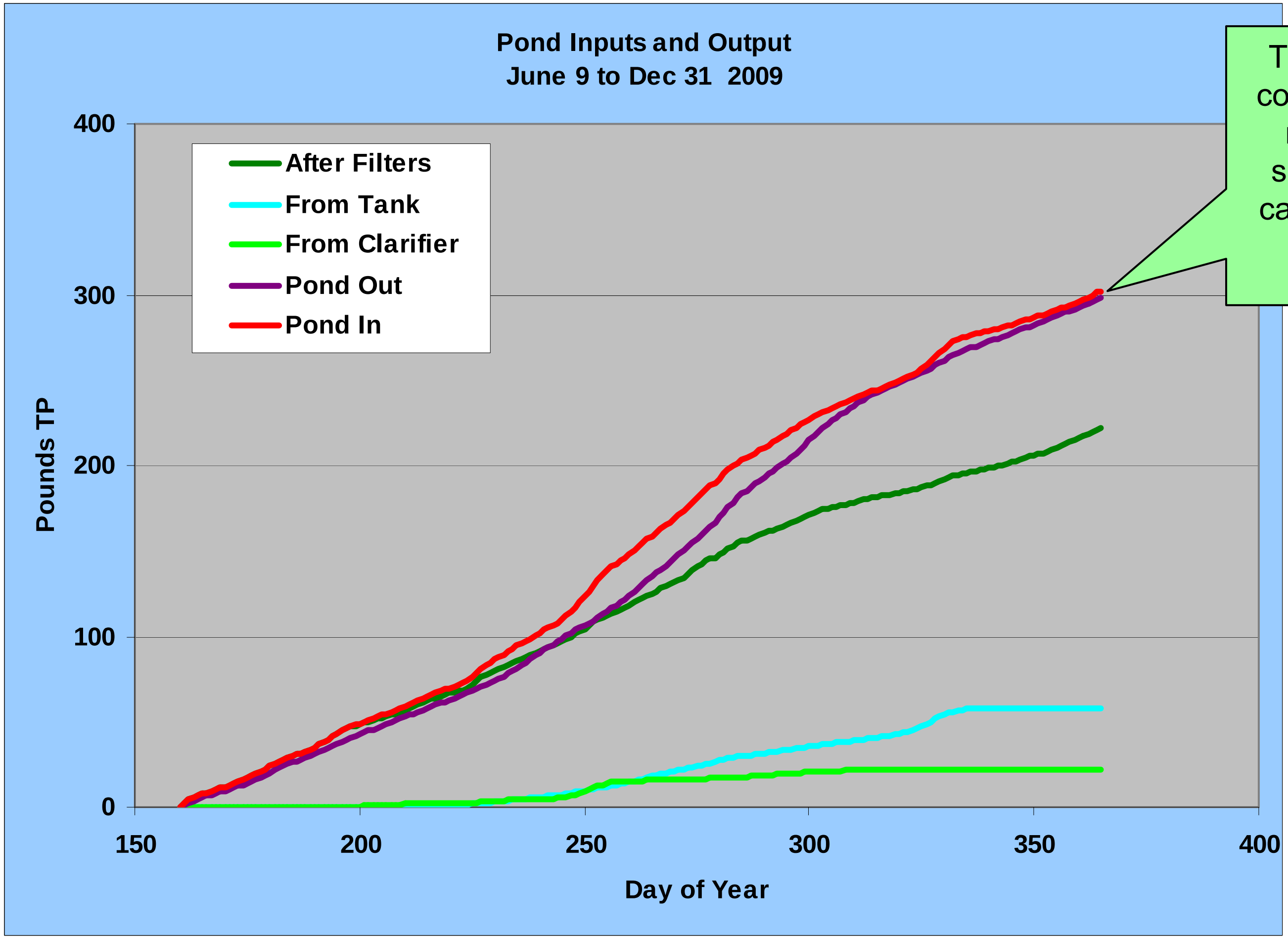
	Volume million gal	TP mg/m3	Load Lbs P
Trucked	0.152	22,000	28

Inputs	918
Losses	684
Unaccounted	234

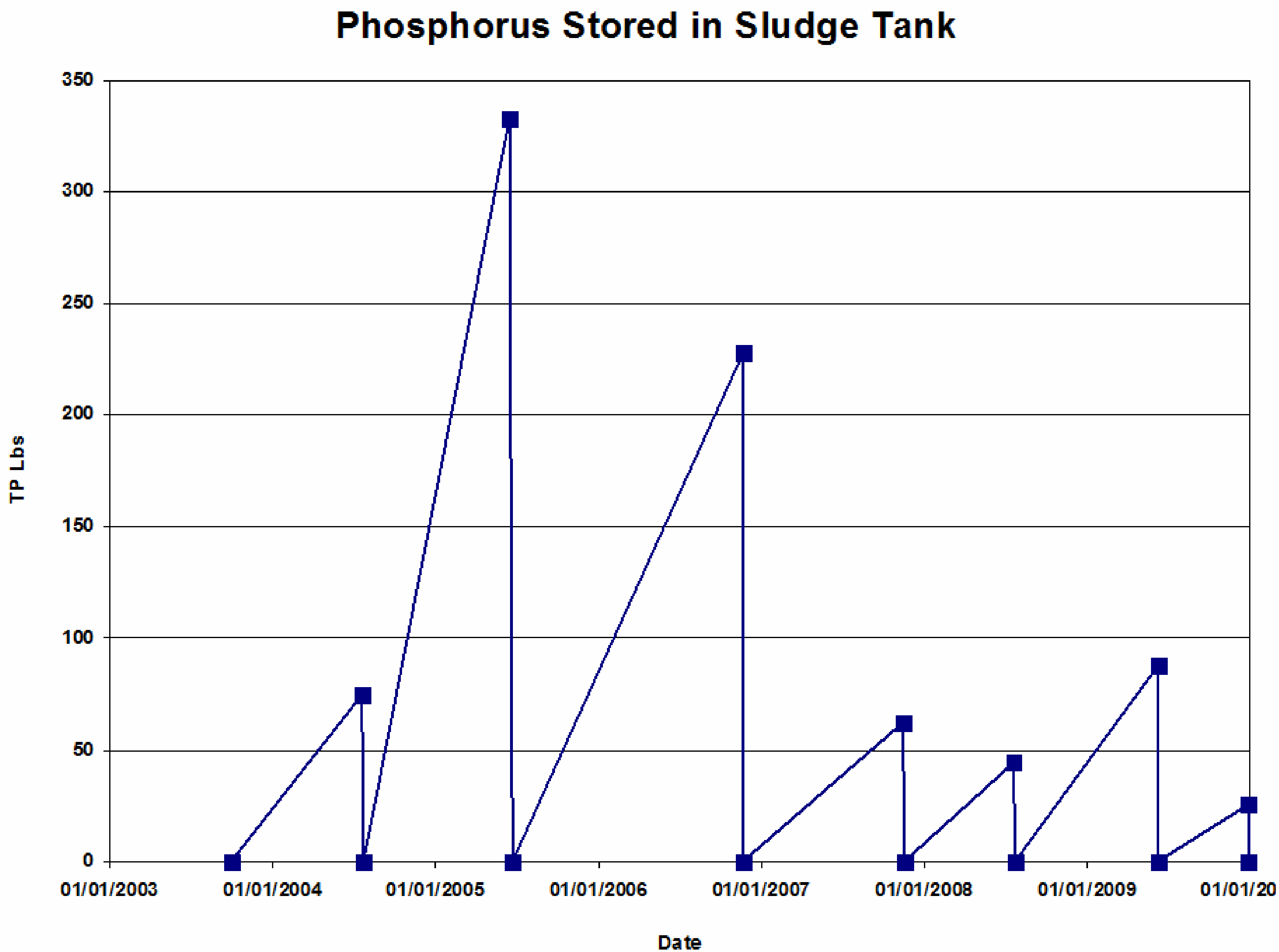
Day	Start Date	End Date	Inventory #	Biomass	#/kg	Indiv. Wt (g)	Indiv. Length (cm)	Feed fed	Feed Type	Mort #	Mort Wt	Feed Conversion	Temp (^{o}c)	Waste Destination	Notes
144	05/24/2009	05/30/2009	1661809	4483	371	2.7	5.92	346.2	BDR/SVC	1142	2.73	#REF!	8	CF/HP	complete inventory ?
151	05/31/2009	06/06/2009	1672064	5320	314	3.2	6.26	760.1	BDR/SVC	745	2.12	0.91	8	CF/HP	
158	06/07/2009	06/13/2009	1671545	6218	269	3.7	6.59	854.8	BDR/SVC	519	1.77	0.95	11.5	CF/HP	
165	06/14/2009	06/20/2009	1671074	7452	224	4.5	7.00	1174.3	BDR/SVC	471	1.93	0.95	11.5	CF/HP	
172	06/21/2009	06/27/2009	1670667	8723	192	5.2	7.38	1184.4	BDR/SVC	407	1.89	0.93	11	CF/HP	
179	06/28/2009	07/04/2009	1670379	12009	139	7.2	8.21	1621.5	BDR/SVC	288	1.77	0.49	10	CF/HP	Sampling adjustment
186	07/05/2009	07/11/2009	1670142	13178	127	7.9	8.47	1111.8	BDR/SVC	231	1.87	0.95	11	CF/HP	
193	07/12/2009	07/18/2009	1865225	13768	135	7.4	8.28	732.1	BDR/SVC	520	3.74	1.23	10	CF/HP	Moving fish outdoors
200	07/19/2009	07/25/2009	1842448	16250	113	8.8	8.79	831.56	BDR/SVC	482	4.14	0.33	11	Sys	Moving fish outdoors
207	07/26/2009	08/01/2009	1841611	18034	102	9.8	9.10	1788.8	BDR/SVC	843	7.8	1.00	10	Sys	
214	08/02/2009	08/08/2009	1839936	19347	95	10.5	9.32	1262.8	BDR/SVC	1676	16.77	0.95	10	Sys	
221	08/09/2009	08/15/2009	1838972	20999	88	11.4	9.58	1579.7	BDR/SVC	964	10.5	0.95	12	Sys	
228	08/16/2009	08/22/2009	1838746	23127	80	12.6	9.89	2023.8	BDR/SVC	227	2.87	0.95	11	Sys	
235	08/23/2009	08/29/2009	1838465	25435	72	13.8	10.21	2201.8	BDR/SVC	272	3.79	0.95	10	Sys	
242	08/30/2009	09/05/2009	1838197	28213	65	15.3	10.57	5369.4	BDR/SVC	620	8.56	1.93	9	Sys	
249	09/06/2009	09/12/2009	1795972	29624	61	16.5	10.83	1919.1	BDR/SVC	124	1.89	1.36	11	Sys	Began stocking ff
256	09/13/2009	09/19/2009	1611986	28496	57	17.7	11.08	2239	BDR/SVC	157	4324.7	0.70	10	Sys	Finished stocking ff
263	09/20/2009	09/26/2009	1611828	30339	53	18.8	11.31	1957.4	BDR/SVC	158	2.91	1.06	10	Sys	
270	09/27/2009	10/03/2009	1611703	31652	51	19.6	11.47	1369.9	BDR/SVC	125	2.32	1.04	8	Sys	
277	10/04/2009	10/10/2009	1611605	33391	48	20.7	11.68	1898.6	BDR/SVC	98	2	1.09	8.5	Sys	
284	10/11/2009	10/17/2009	1611501	34681	46	21.5	11.83	1422	BDR/SVC	104	2.19	1.10	7	Sys	
291	10/18/2009	10/24/2009	1611388	36003	45	22.3	11.98	1486.3	BDR/SVC	113	2.49	1.12	8	Sys	
298	10/25/2009	10/31/2009	1611283	36891	44	22.9	12.08	979.6	BDR/SVC	105	2.4	1.10	9	Sys	
305	11/01/2009	11/07/2009	1611196	37527	43	23.3	12.15	702.1	BDR/SVC	87	2.07	1.10	8	Sys	
312	11/08/2009	11/14/2009	1611075	37538	43	23.3	12.15	15.6	BDR/SVC	121	2.88	1.10	8	Sys	
319	11/15/2009	11/21/2009	1610899	37534	43	23.3	12.15	0	BDR/SVC	176	4.37	0.00	8	Sys	
326	11/22/2009	11/28/2009	1610714	37529	43	23.3	12.15	0	BDR/SVC	185	4.28	0.00	6.5	Sys	
333	11/29/2009	12/05/2009	1610459	37820	43	23.5	12.18	330.5	BDR/SVC	257	6.04	1.11	5	Sys	
340	12/06/2009	12/12/2009	1610345	38420	42	23.9	12.24	663	BDR/SVC	109	2.52	1.10	3	Sys	
347	12/13/2009	12/19/2009	1606038	38774	41	24.1	12.29	612.2	BDR/SVC	236	5.31	1.70	4.5	Sys	Complete inv. On A-08
354	12/20/2009	12/26/2009	1605907	39338	41	24.5	12.35	622.9	BDR/SVC	131	3.18	1.10	5	Sys	
361	12/27/2009	01/02/2010	1605795	39942	40	24.9	12.41	667.6	BDR/SVC	112	2.69	1.10	3	Sys	



Report Date 03/07/2010

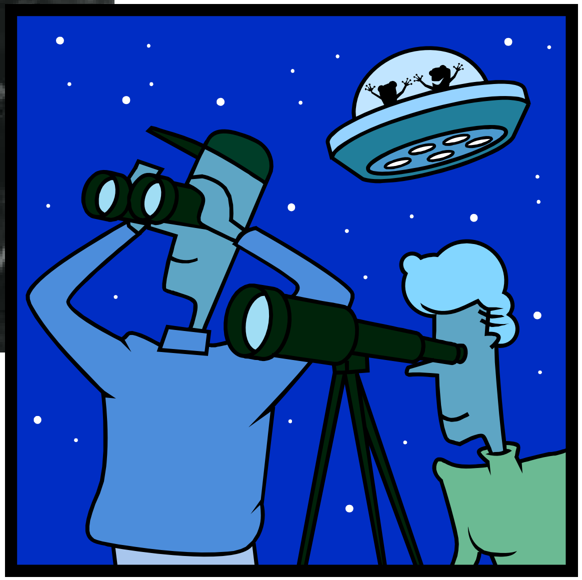


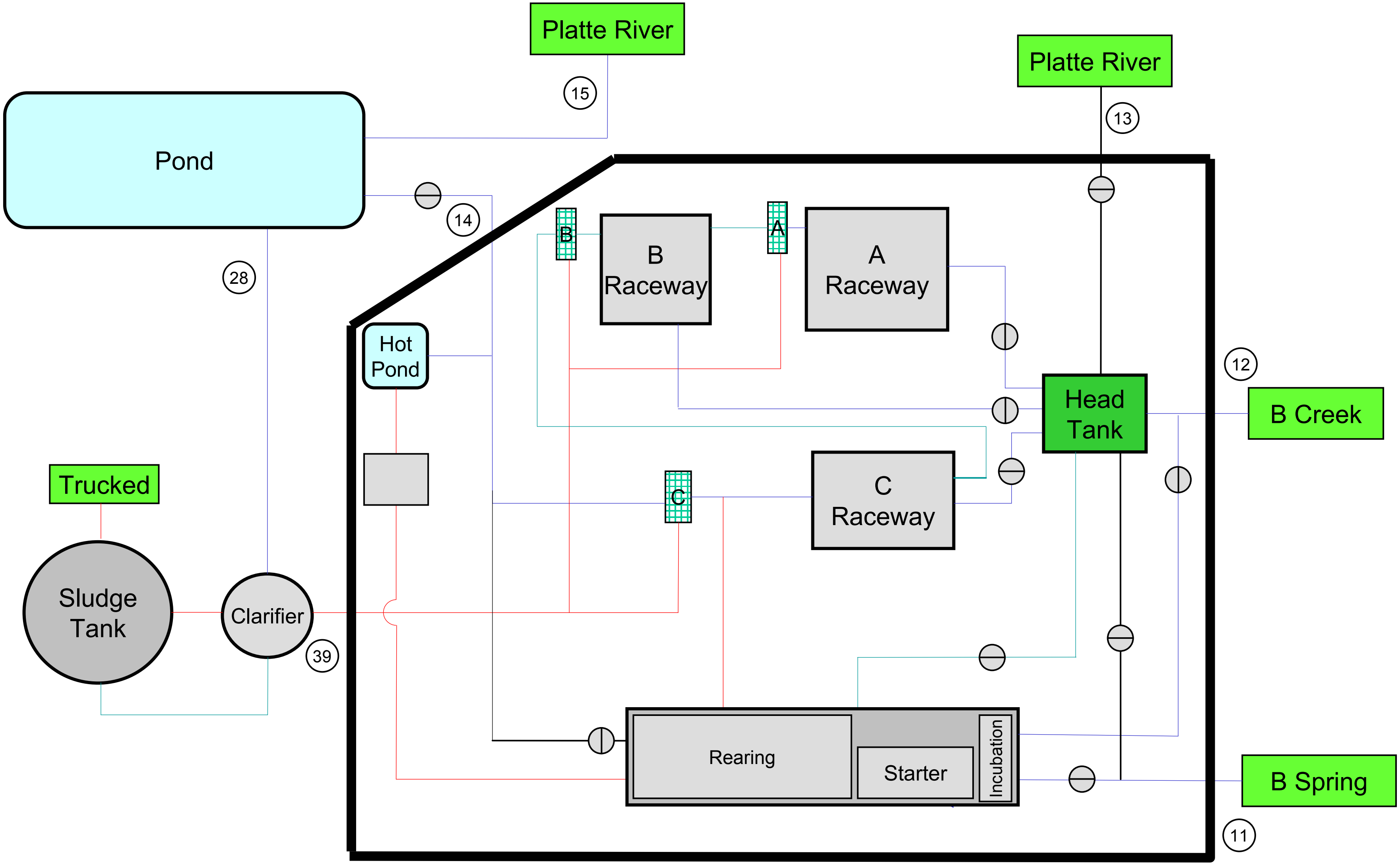
This does not support the contention that phosphorus releases from the pond sediments were the main cause of the 2009 violation

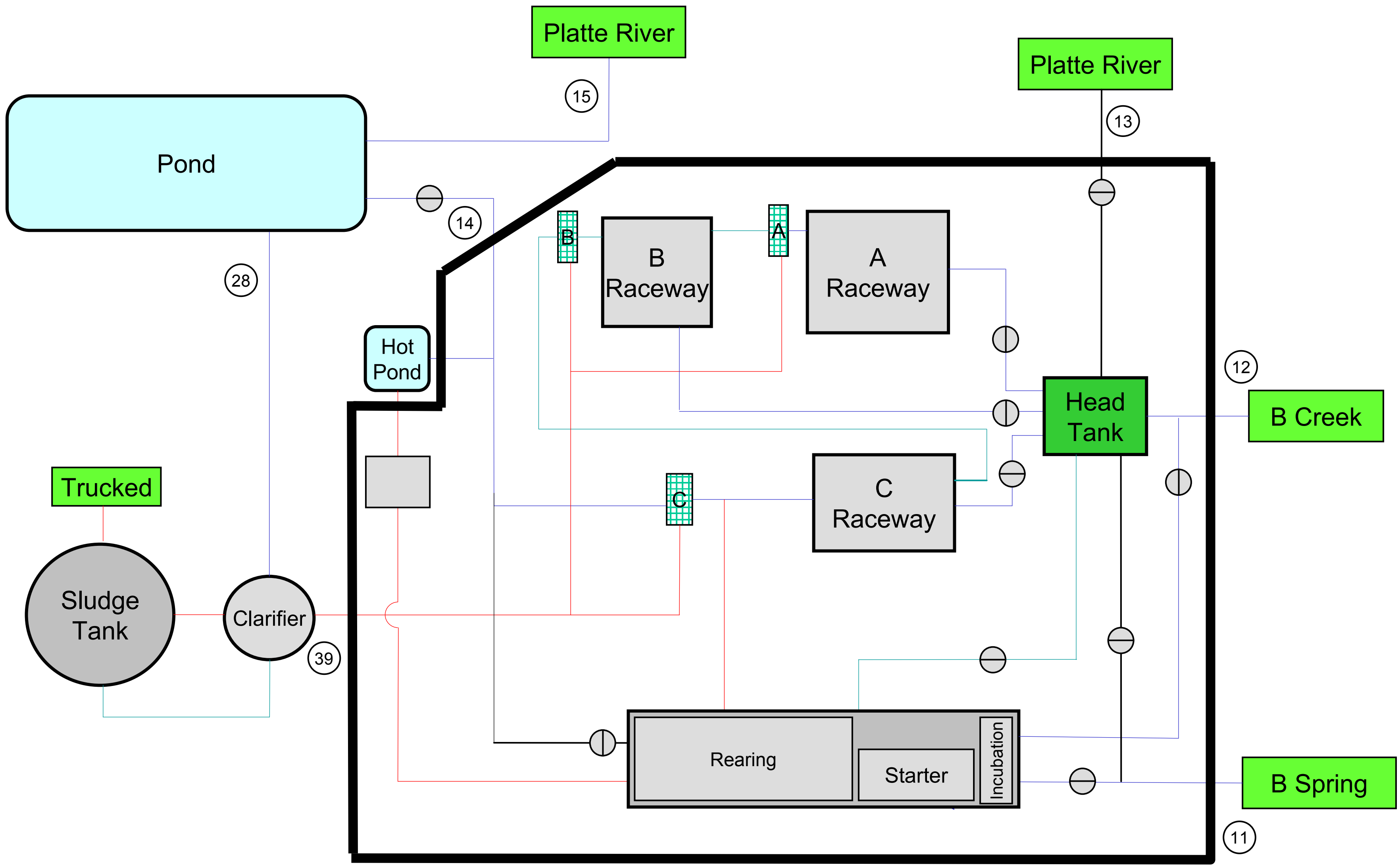


Report Date 03/07/2010

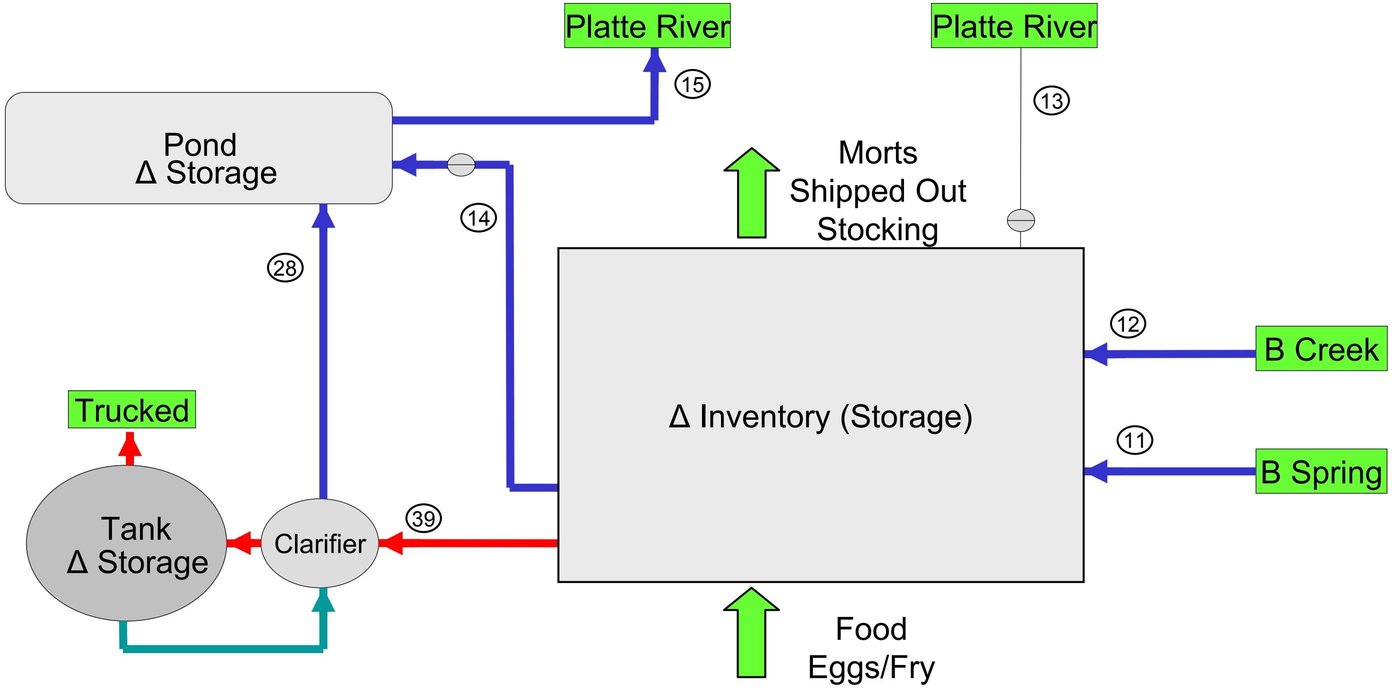
Go to spreadsheet demo on mass balance




Platte River
Platte River
15
13
Pond
14
28
B
A
B Raceway
A Raceway
Hot Pond
12
Head Tank
B Creek
C
C Raceway
Trucked
Sludge Tank
Clarifier
39
Rearing
Starter
Incubation
B Spring
11


Platte River
Platte River
15
13
Pond
14
28
B
A
B Raceway
A Raceway
Hot Pond
12
Head Tank
B Creek
C
C Raceway
Trucked
Sludge Tank
Clarifier
39
Rearing
Starter
Incubation
B Spring
11

Real-Time Assessment and Management Application



Food P = Food x %P
Production P = [Mort + Shipped + Stocked + Δ Inventory] x %P
Excess P = Food P – Production P

Filter + Tank (Ferric Chloride) Removal = [TP(39) - TP(28)] * Flow(39) * ΔTime

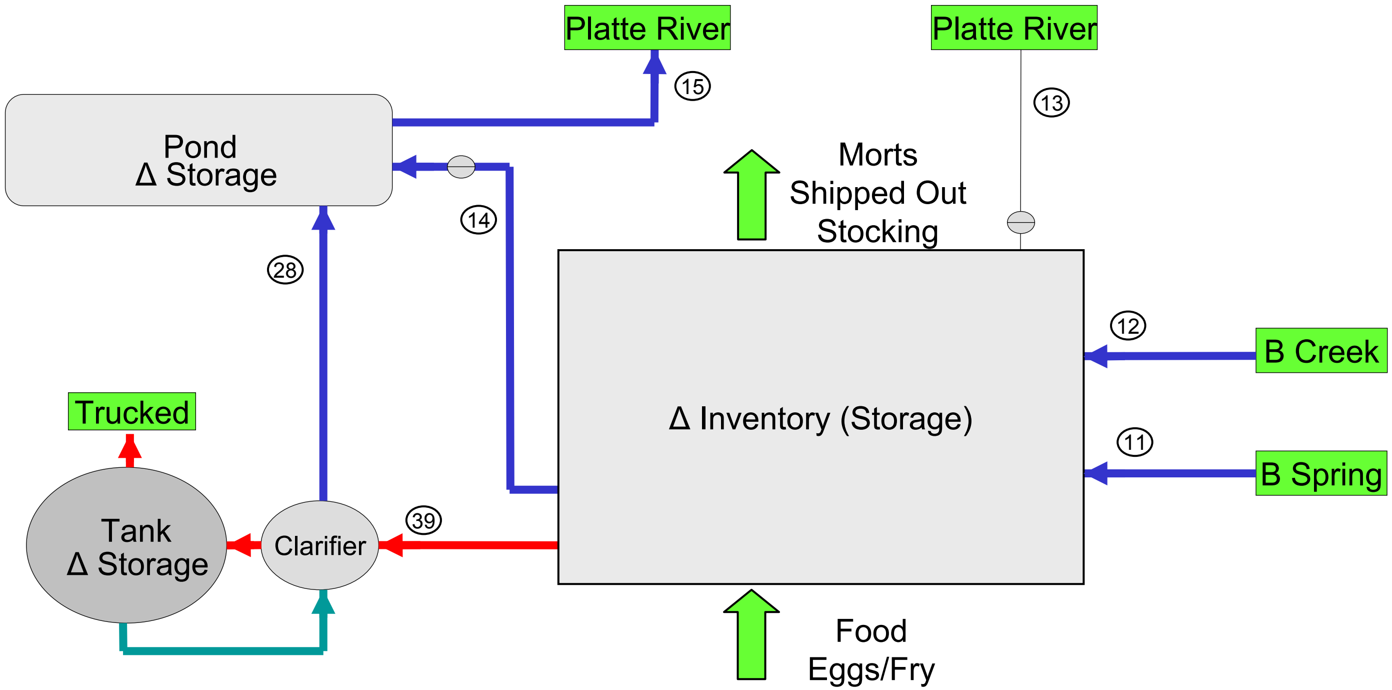
Pond Storage = [TP(28)*Flow(28) + TP(14)*Flow(14) - TP(15)*Flow (15)] * ΔTime

Could be < 0

Net Load = Food – Production – Tank Removal – Pond Storage

Go to management model spreadsheet

Real-Time Assessment and Management Application



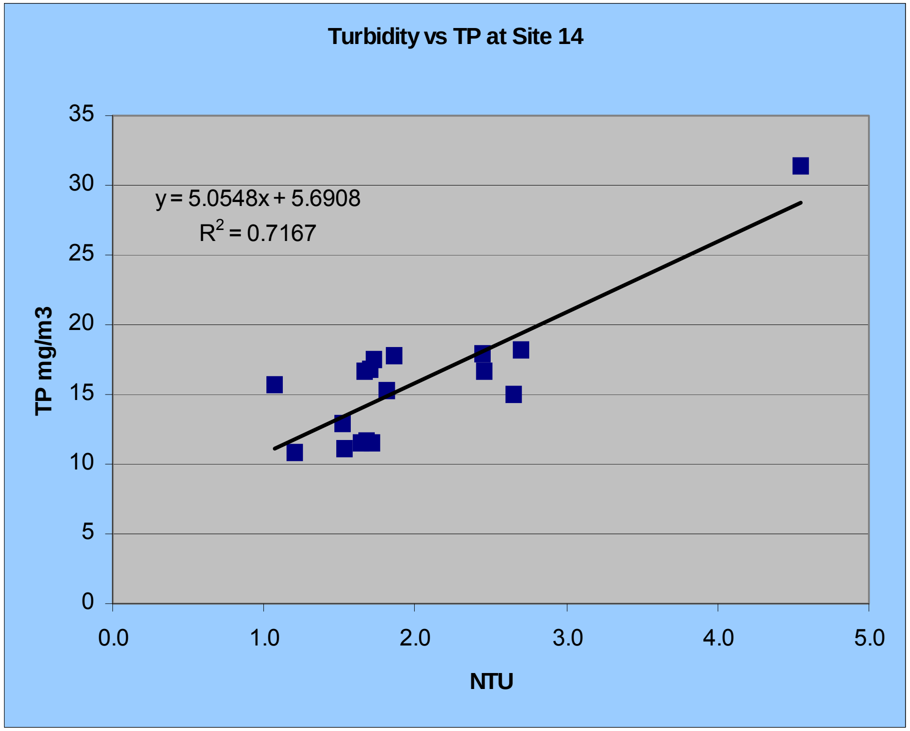
Food P = Food x %P
Production P = [Mort + Shipped + Stocked + Δ Inventory] x %P
Excess P = Food P – Production P

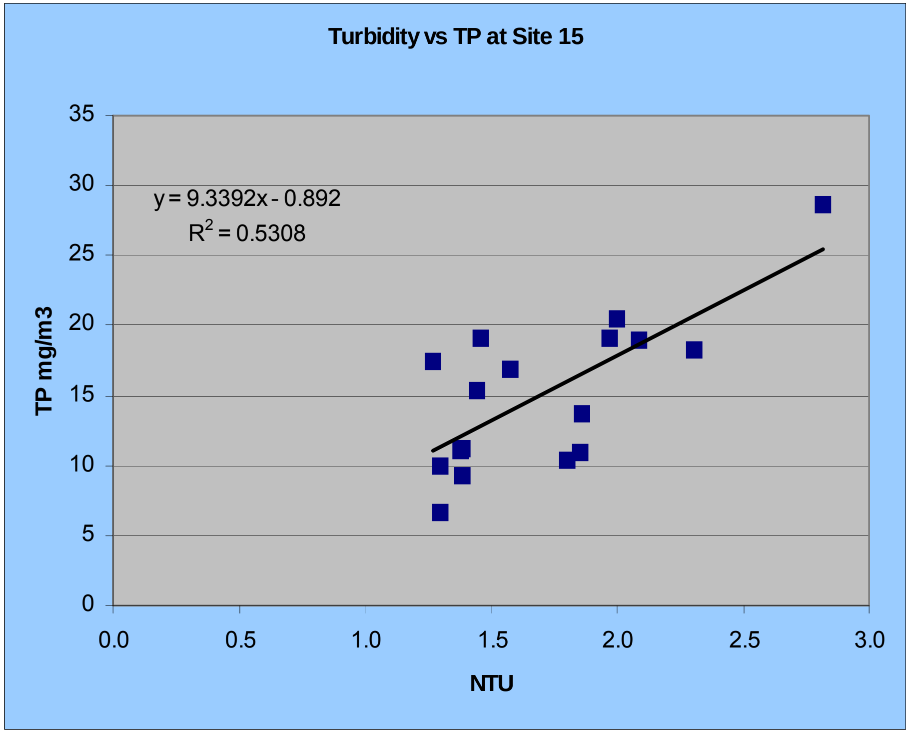
Filter + Tank (Ferric Chloride) Removal = [TP(39) - TP(28)] * Flow(39) * ΔTime

Pond Storage = [TP(28)*Flow(28) + TP(14)*Flow(14) - TP(15)*Flow (15)] * ΔTime

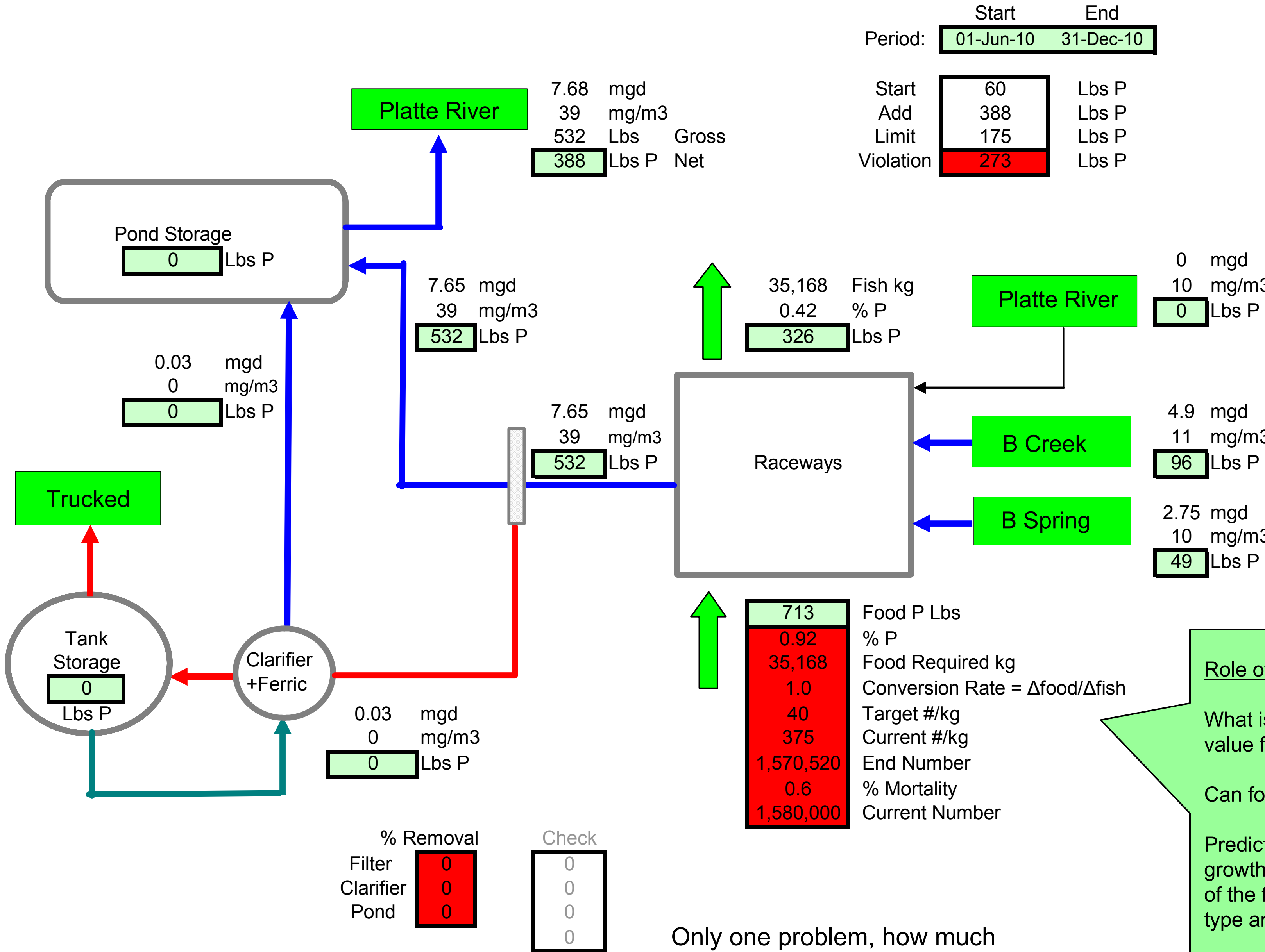
Use Turbidity Correlation to estimate TP 14 & 15

Net Load = Food – Production – Tank Removal – Pond Storage





Sigma 72 data only



Only one problem, how much
Food do you feed to achieve CR = 1.0 ??
You feed, measure growth then find CR.
So CR is after the fact

<u>Role of Bioenergetics</u>

What is the optimum value for CR?

Can food %P be lowered?

Predict decrease in growth rate as Function of the food amount And type and temperature

What is maximum growth Rate as function of temperature for unlimited food?

2010 Real-Time Monitoring Program Recommendations

Measure Big Coho Production every 2 weeks
Where: Production = Fish Increase + Harvest – Fry In
Measure Amount and TP content of food fed to Big Coho every 2 weeks (PRSFH)
Measure TP Content and Composition of Big Coho every 2 weeks (PRSFH)

Measure Small Coho Production every 2 weeks
Where: Production = Fish Increase + Harvest – Fry In
Measure Amount and TP content of food fed to Small Coho every 2 weeks (PRSFH)
Measure TP Content and Composition of Small Coho every 2 weeks (PRSFH)

Measure Chinook Production every 2 weeks
Where: Production = Fish Increase + Harvest – Fry In
Measure Amount and TP content of food fed to Chinook every 2 weeks (PRSFH)
Measure TP Content and Composition of Chinook every 2 weeks (PRSFH)

Measure TP of 72 hour composite samples from Sites # 28 and #39 ((PRSFH)
And use Flow(39) to determine performance of filters and clarifier

Calibrate 3 backwash pumps Flow(39) = ∑ Backwash flow from A, B, C

Measure turbidity measurements from Sites 14 & 15, use correlation to estimate TP,
Combine with flow measurements to estimate pond storage

Verify CMU measurements of Trucked P with PRSFH measurements of TP

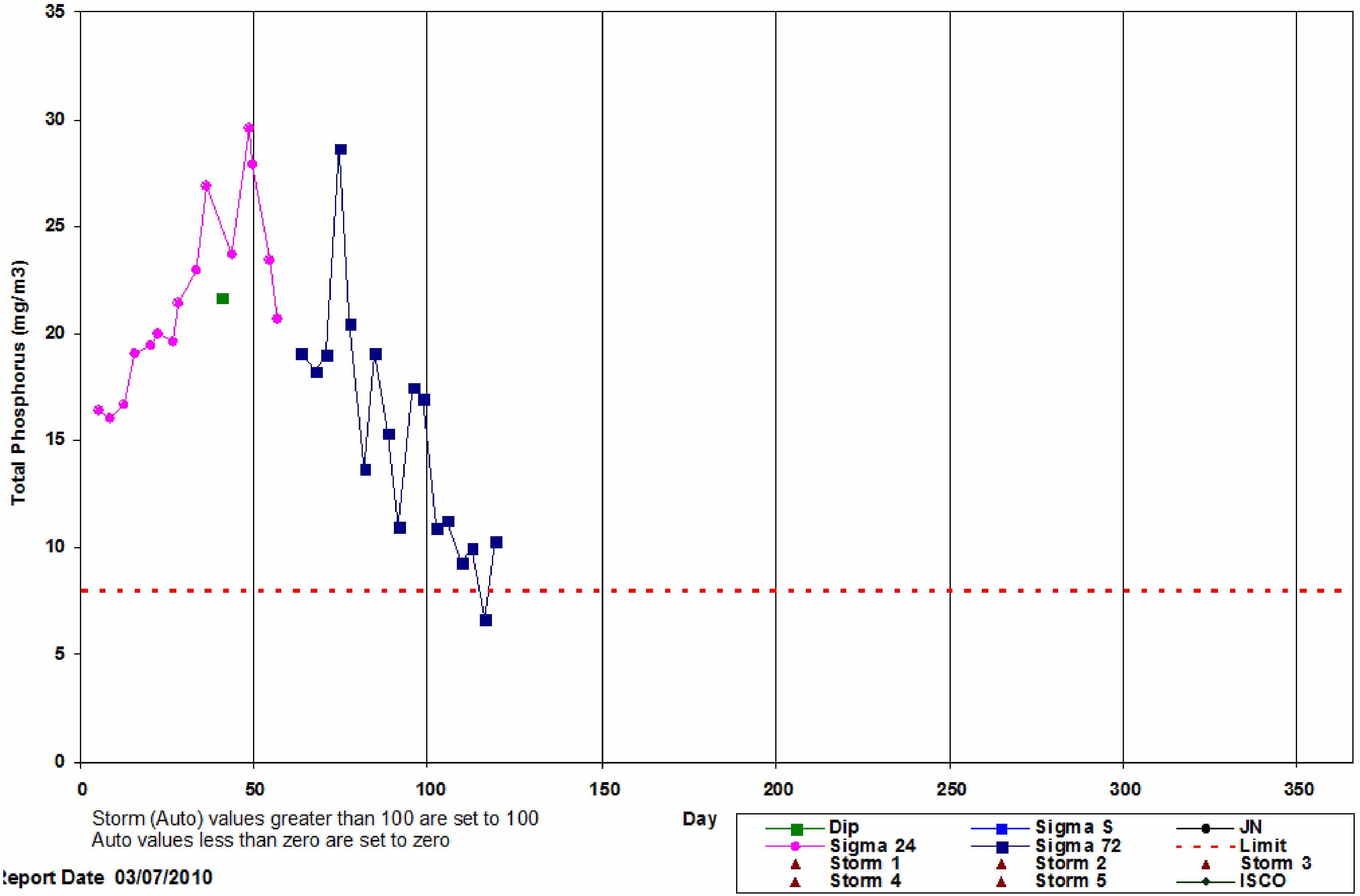
Measure flow to Hot Pond and sediment phosphorus accumulation

Measure TP of surface of tank and compare with Site 28 (PRSFH)

Measure Before, After, and Backwash TP of C Series Filter as needed to evaluate
alternative mesh size, washing cycle, etc.

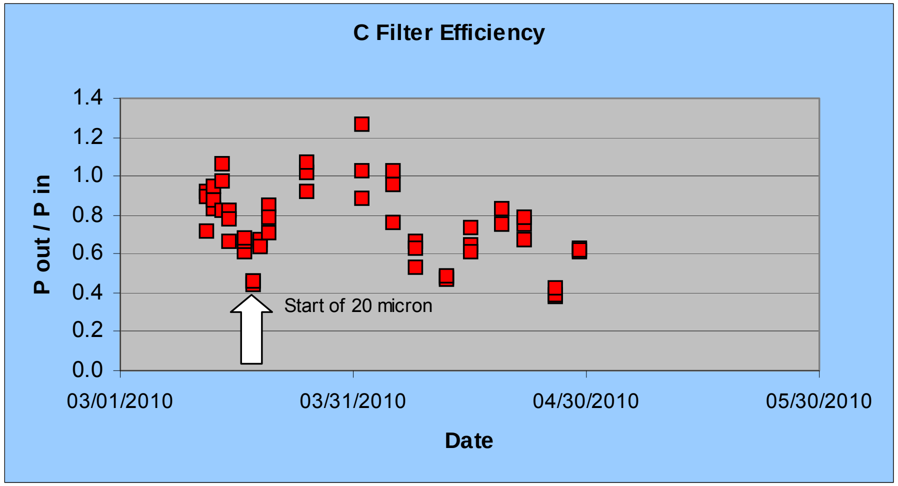
Upper Discharge - Outfall 0002 - Phosphorus for Year 2010

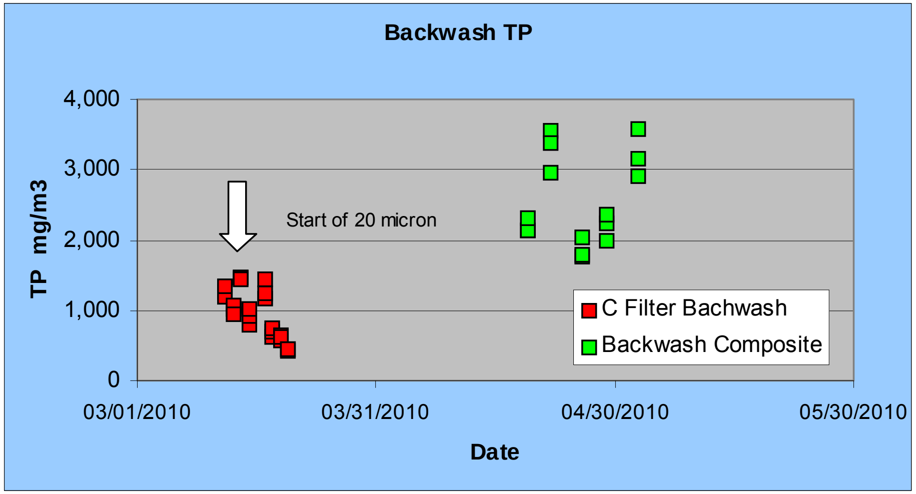
Average Dip: 21.71, Average Sigma 72: 15.15, Average Sigma 24: 21.58

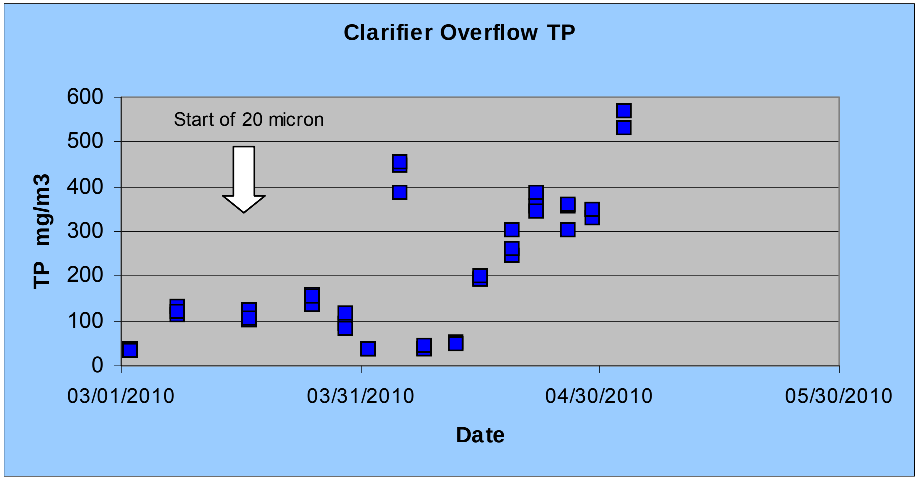


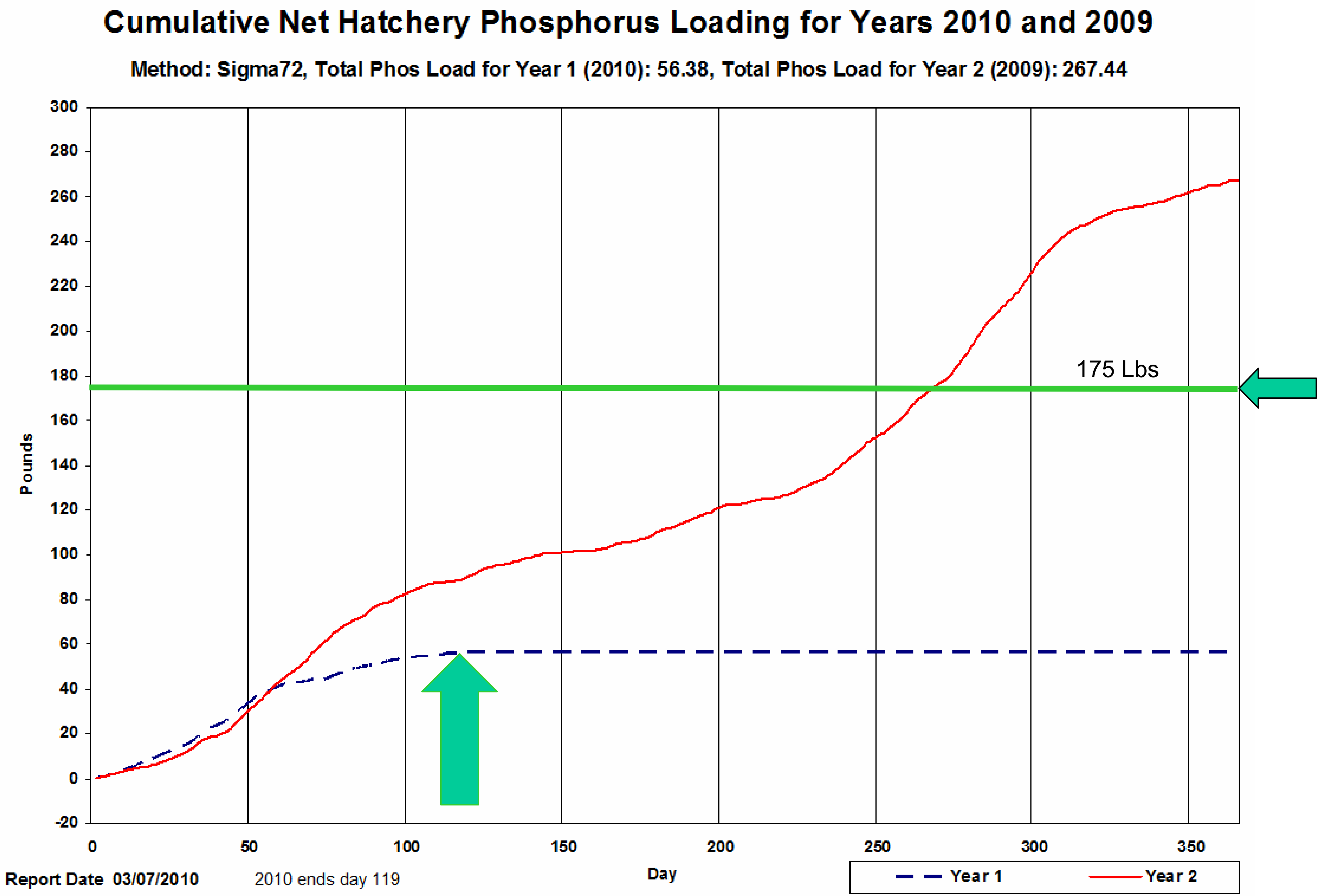
Storm (Auto) values greater than 100 are set to 100
Auto values less than zero are set to zero

Report Date 03/07/2010


C Filter Efficiency
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
P out / P in
Start of 20 micron
03/01/2010
03/31/2010
04/30/2010
05/30/2010
Date


Backwash TP
4,000
3,000
2,000
1,000
0
TP mg/m3
Start of 20 micron
C Filter Bachwash
Backwash Composite
03/01/2010
03/31/2010
04/30/2010
05/30/2010
Date


Clarifier Overflow TP
600
500
400
300
200
100
0
TP mg/m3
Start of 20 micron
03/01/2010
03/31/2010
04/30/2010
05/30/2010
Date



Cumulative Net Hatchery Phosphorus Loading for Years 2010 and 2009
Method: Sigma72, Total Phos Load for Year 1 (2010): 56.38, Total Phos Load for Year 2 (2009): 267.44
Pounds
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
0
50
100
150
200
250
300
350
Day
175 Lbs
Report Date 03/07/2010
2010 ends day 119
Year 1
Year 2

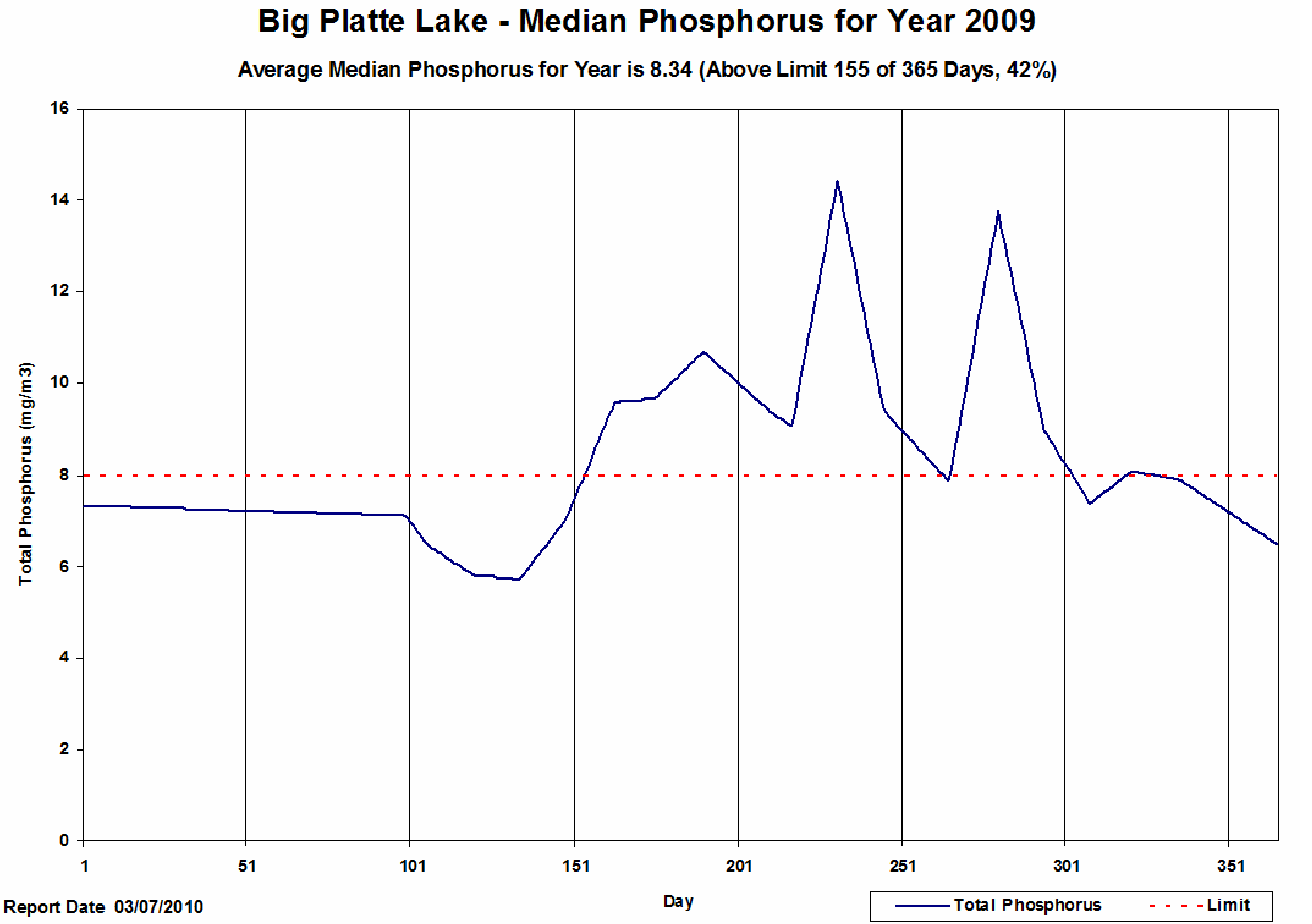
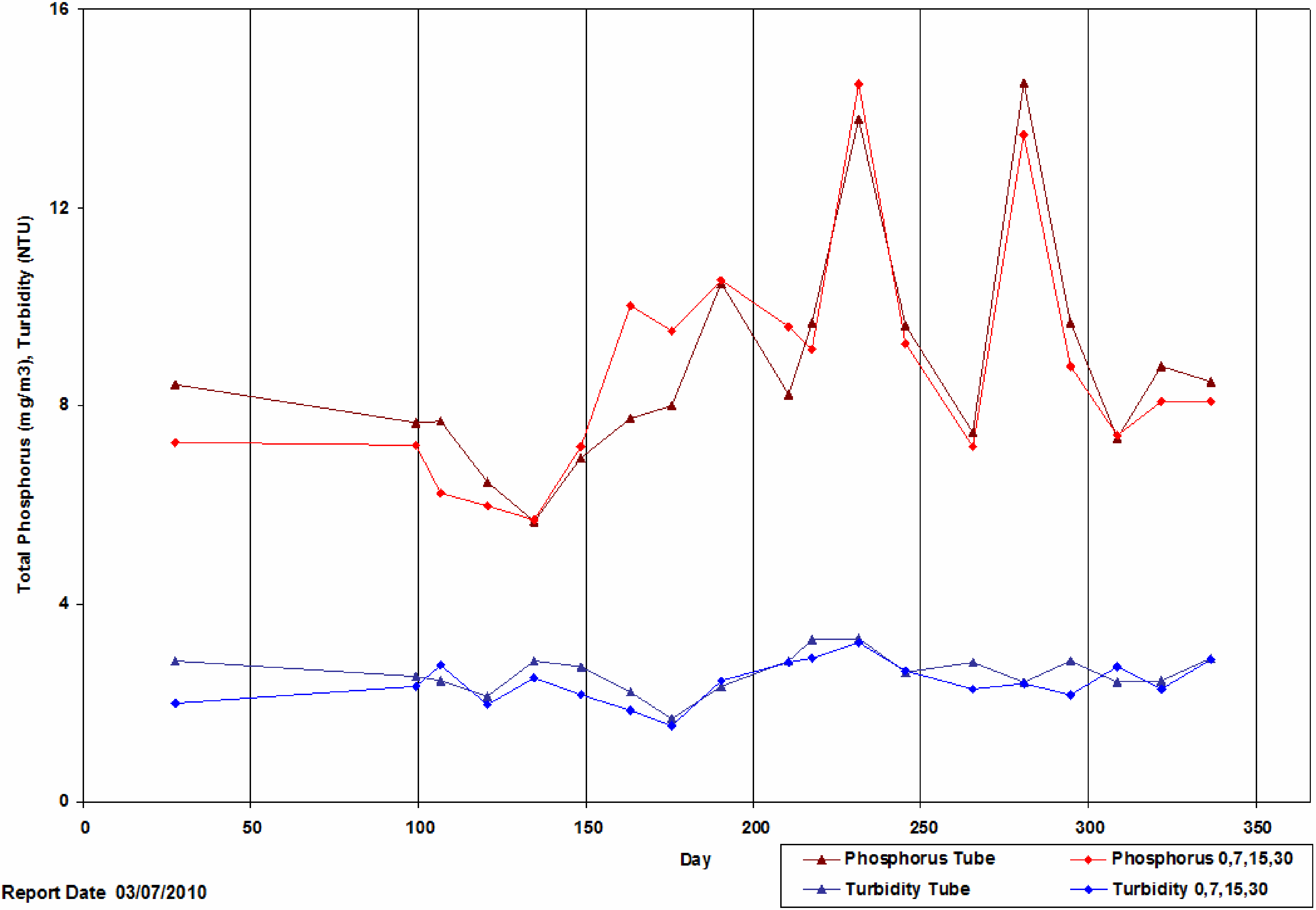


Figure 20. Volume-weighted total phosphorus concentration of Big Platte Lake.

Big Platte Lake - Phosphorus And Turbidity (0/30 vs Tube) for Year 2009



Report Date 03/07/2010

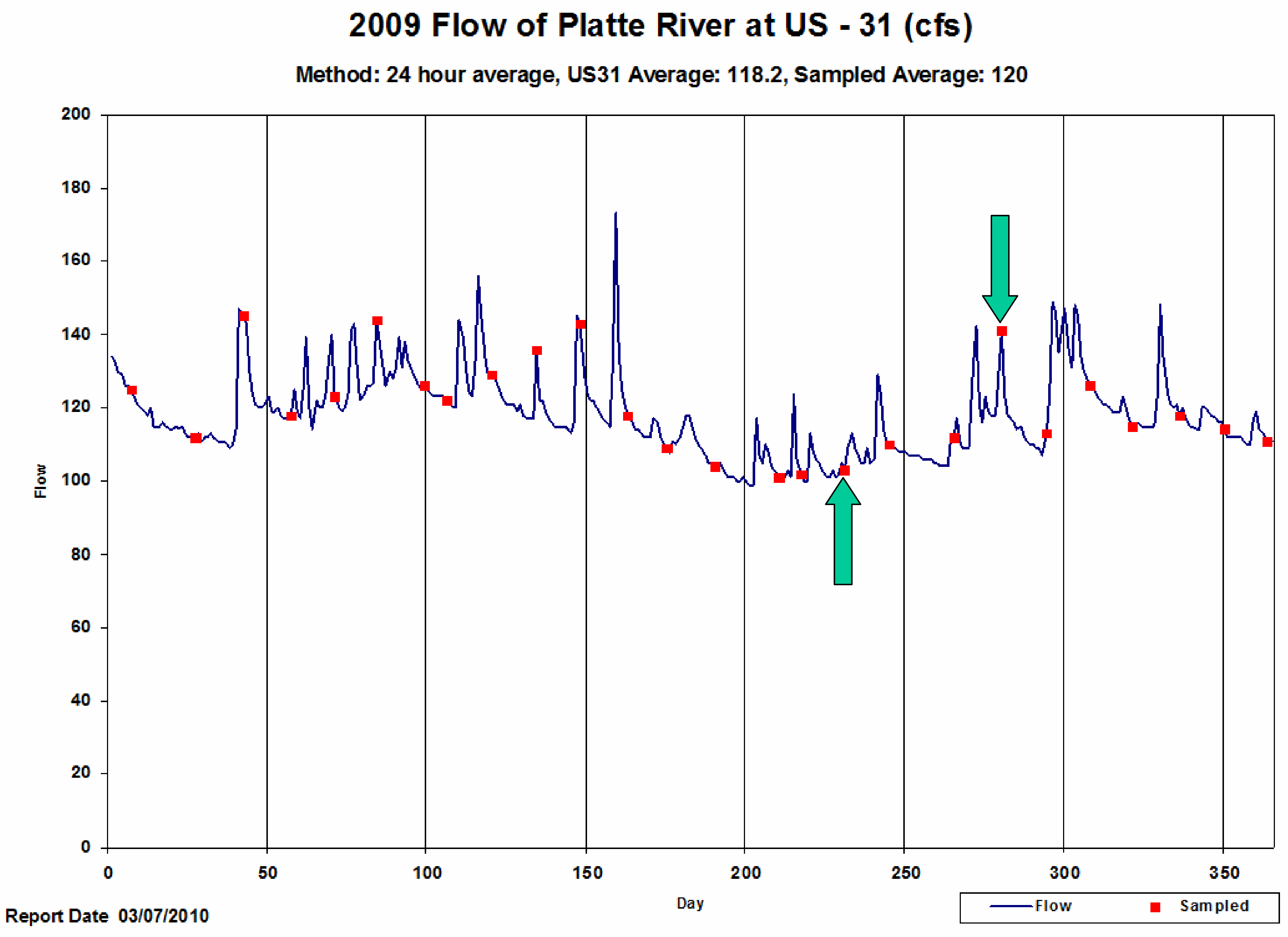
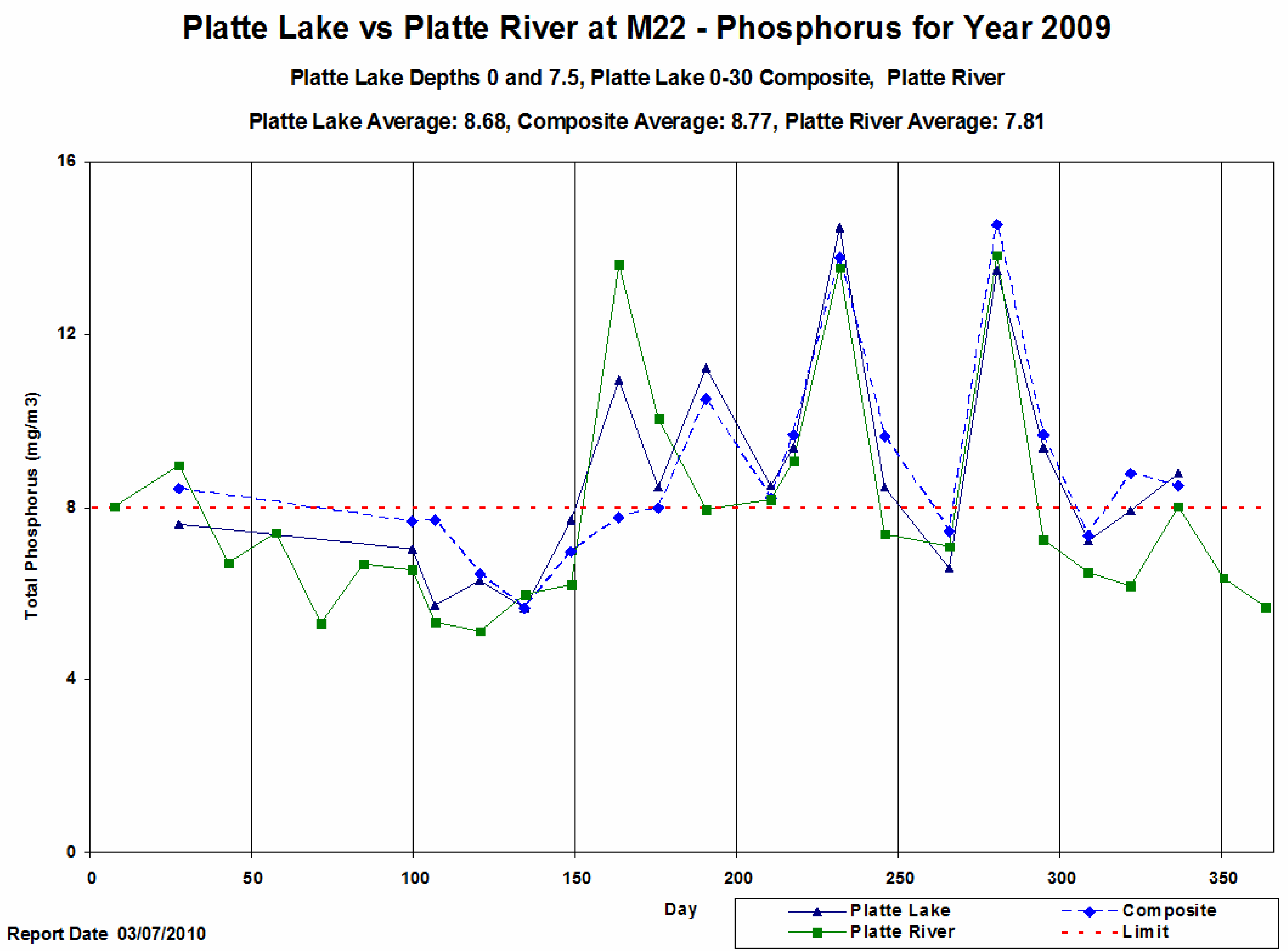
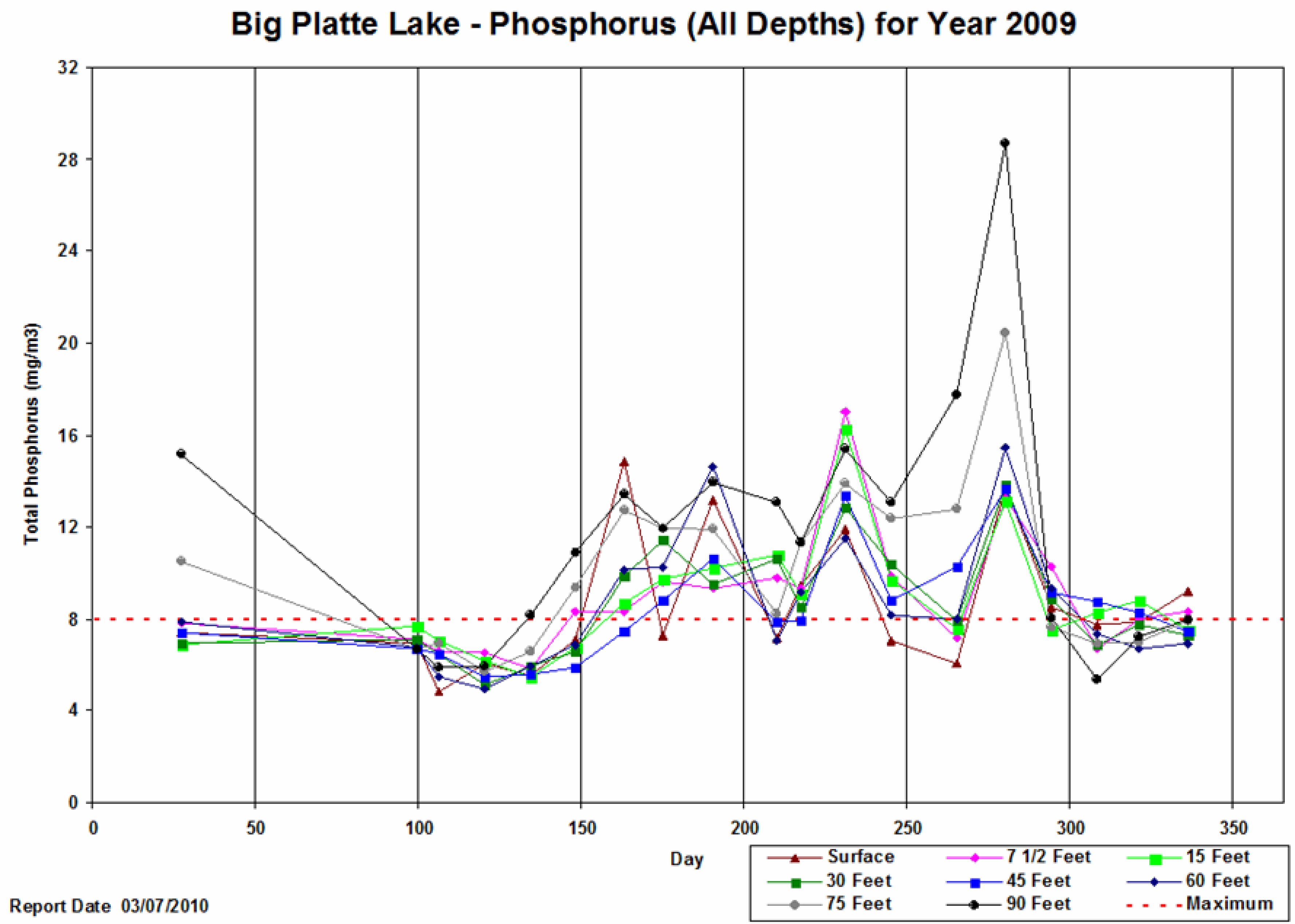
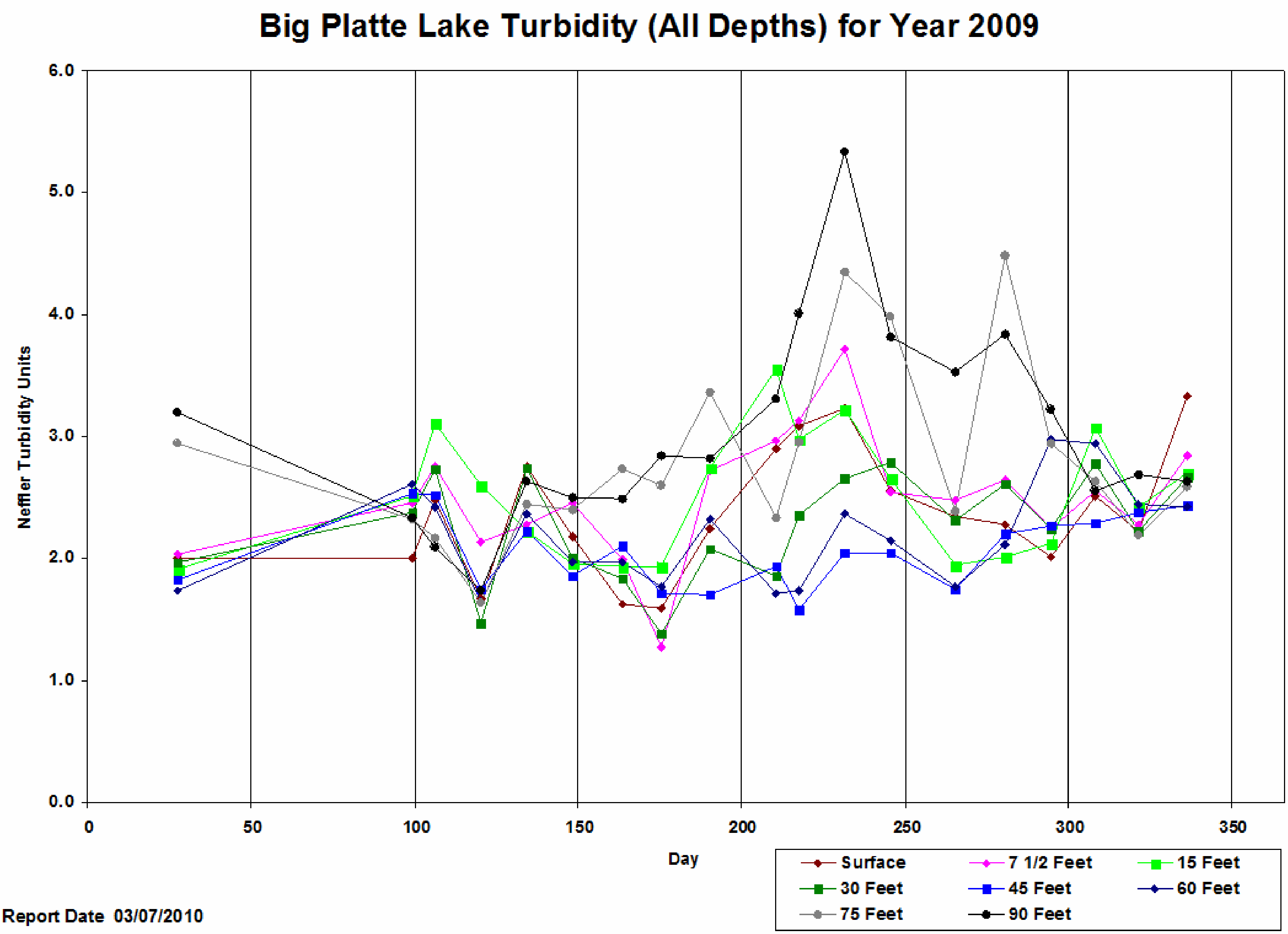


Figure 29. Daily average flows of Platte River at USGS and sampling days.



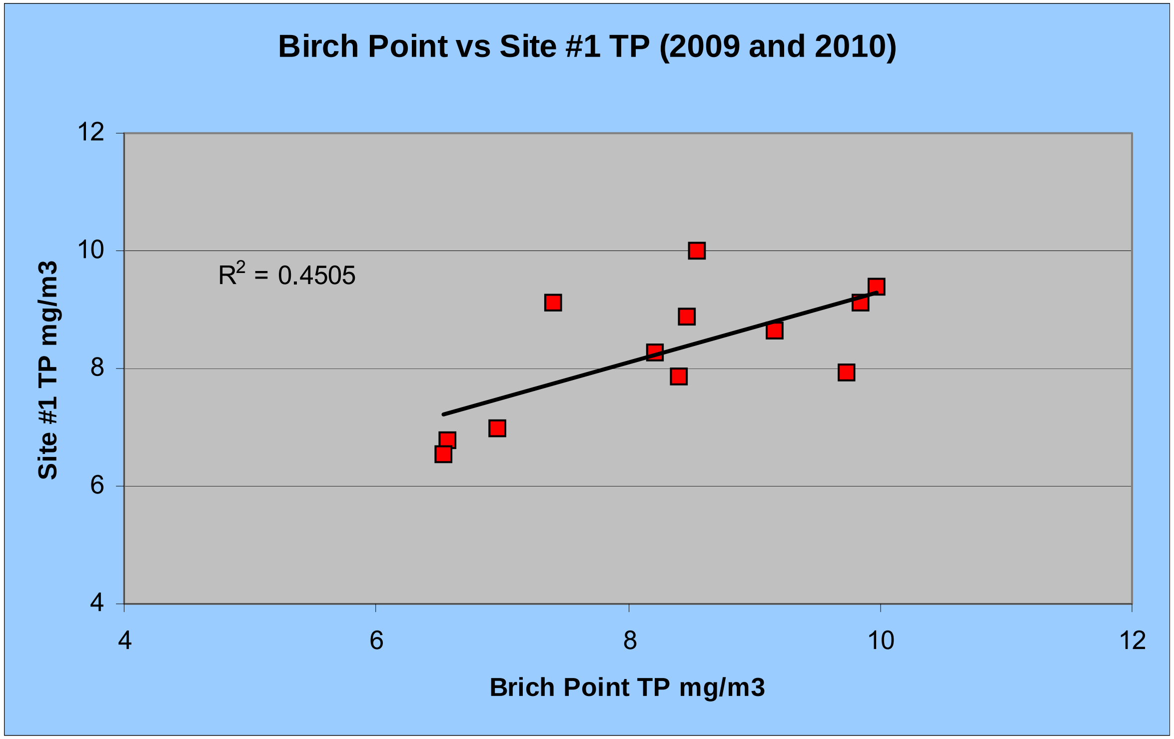
Platte Lake vs Platte River at M22 - Phosphorus for Year 2009
Platte Lake Depths 0 and 7.5, Platte Lake 0-30 Composite, Platte River
Platte Lake Average: 8.68, Composite Average: 8.77, Platte River Average: 7.81
Total Phosphorus (mg/m3)
16
12
8
4
0
0
50
100
150
200
250
300
350
Day
Platte Lake
Composite
Platte River
Limit
Report Date 03/07/2010


Big Platte Lake - Phosphorus (All Depths) for Year 2009
Total Phosphorus (mg/m3)
0
4
8
12
16
20
24
28
32
0
50
100
150
200
250
300
350
Day
Surface
7 1/2 Feet
15 Feet
30 Feet
45 Feet
60 Feet
75 Feet
90 Feet
Maximum
Report Date 03/07/2010



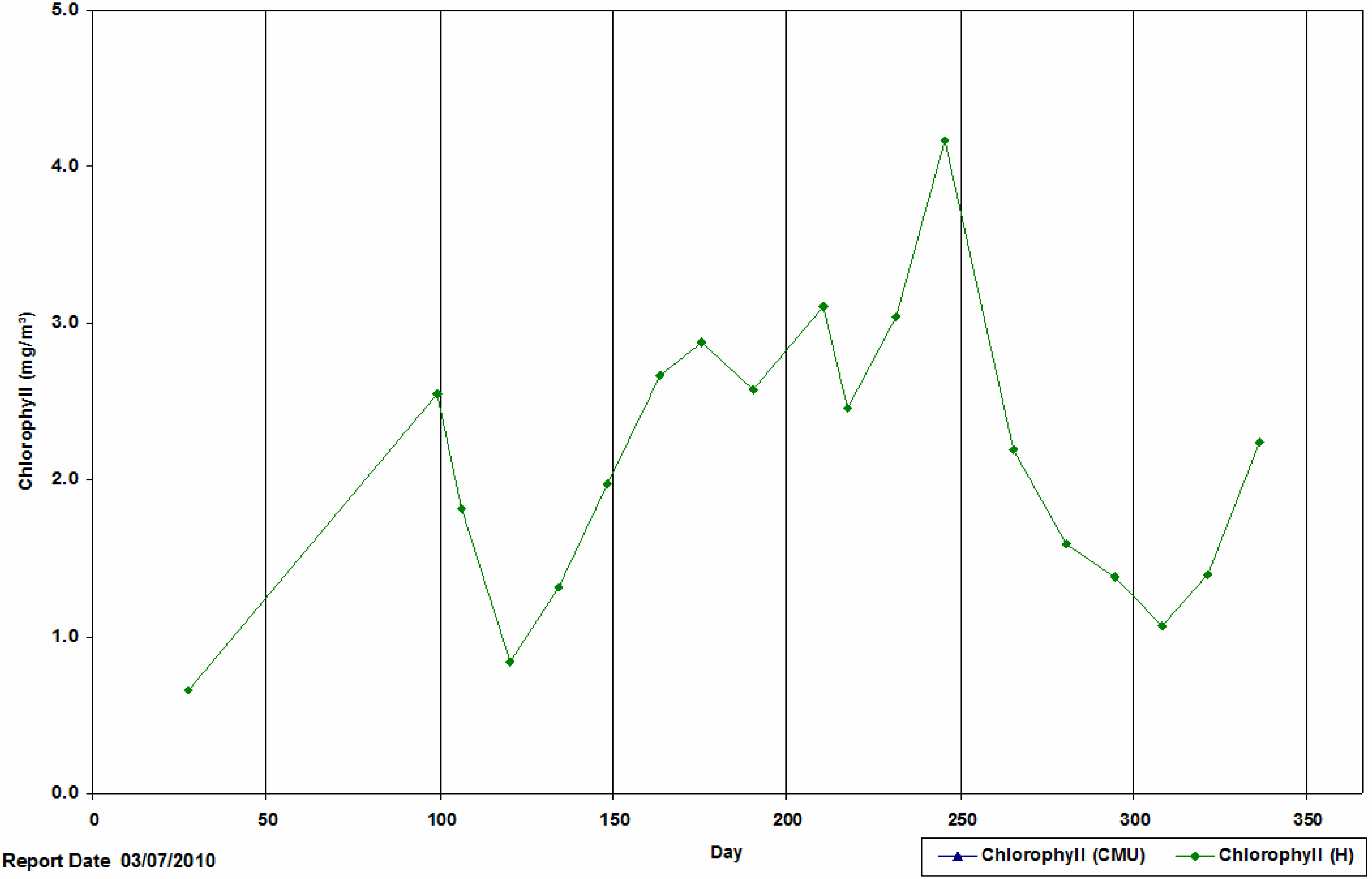
Report Date 03/07/2010

Birch Point TP mg/m3	Site #1 TP mg/m3
8.4	7.88
9.98	9.38
9.85	9.11
9.17	8.64
8.47	8.89
9.73	7.92
8.22	8.27
7.4	9.13
8.55	10.01
6.56	6.78
6.97	6.98
6.53	6.54
Average 8.32	8.29

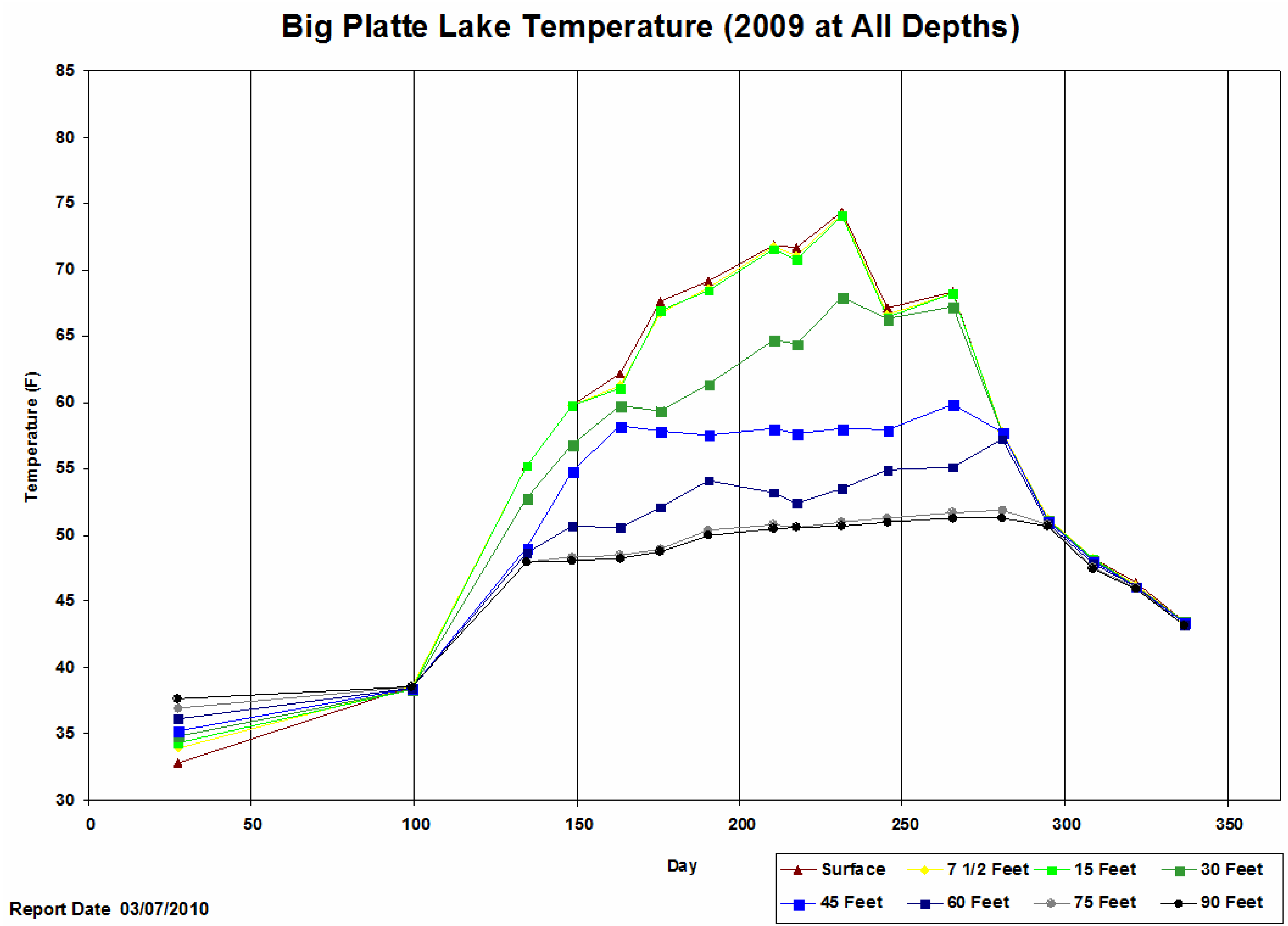


Big Platte Lake - Chlorophyll(a) (0-30) for Year 2009

CMU (Avg: 0.000) and Hatchery (Avg: 2.102)



Report Date 03/07/2010



Big Platte Lake Temperature (2009 at All Depths)
Temperature (F)
85
80
75
70
65
60
55
50
45
40
35
30
0
50
100
150
200
250
300
350
Day
Surface
7 1/2 Feet
15 Feet
30 Feet
45 Feet
60 Feet
75 Feet
90 Feet
Report Date 03/07/2010

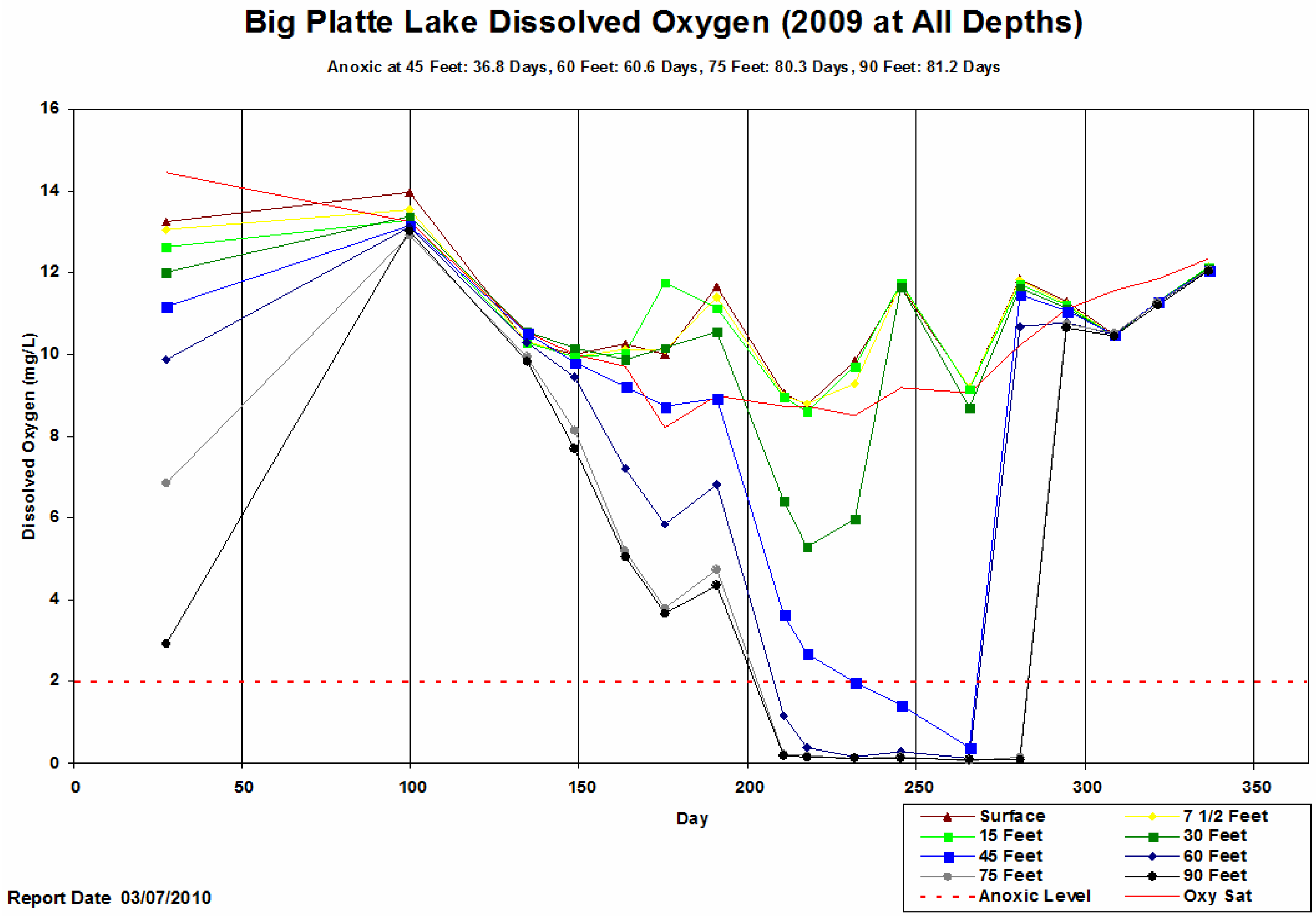


Figure 21. Dissolved oxygen as a function of depth.

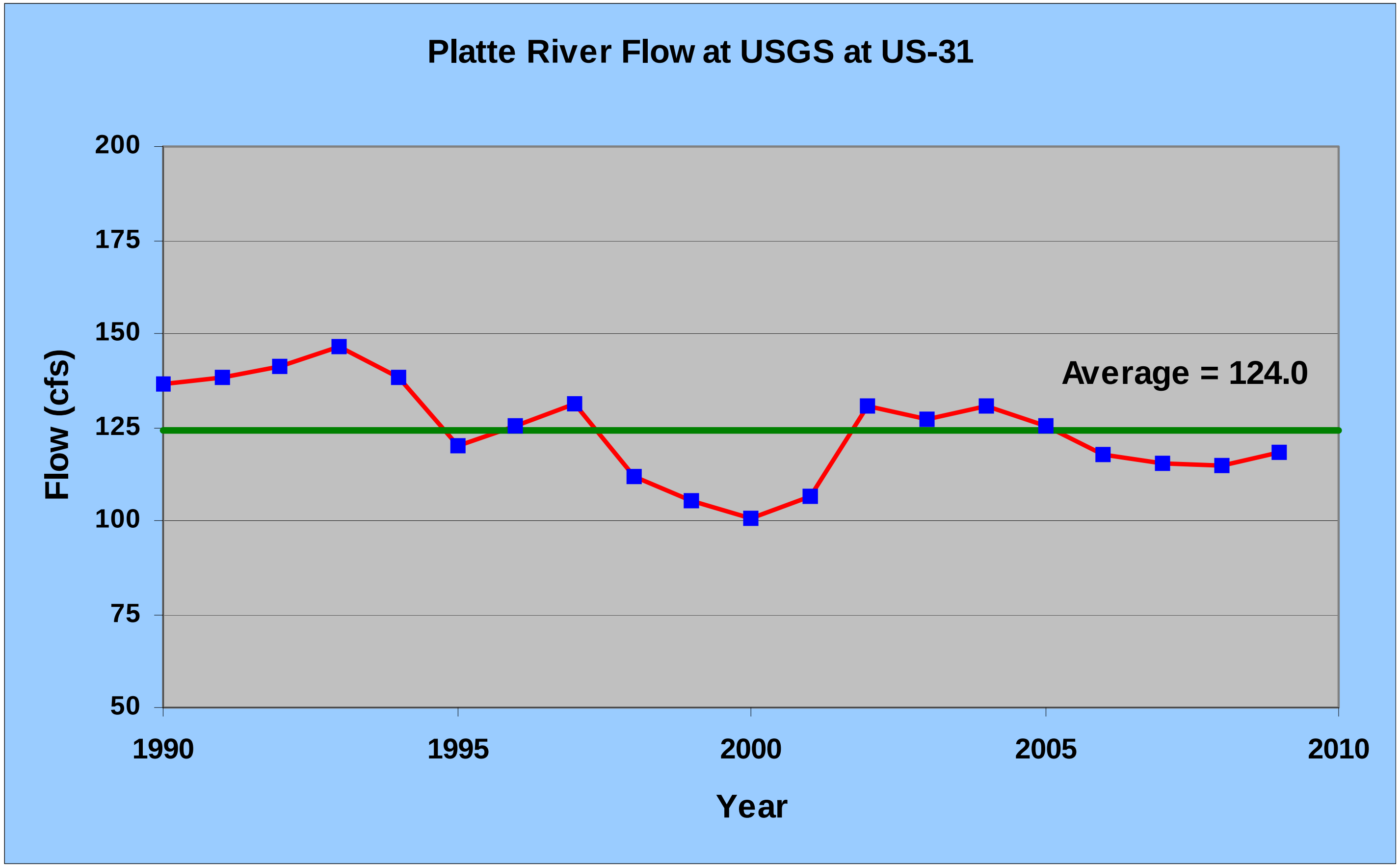
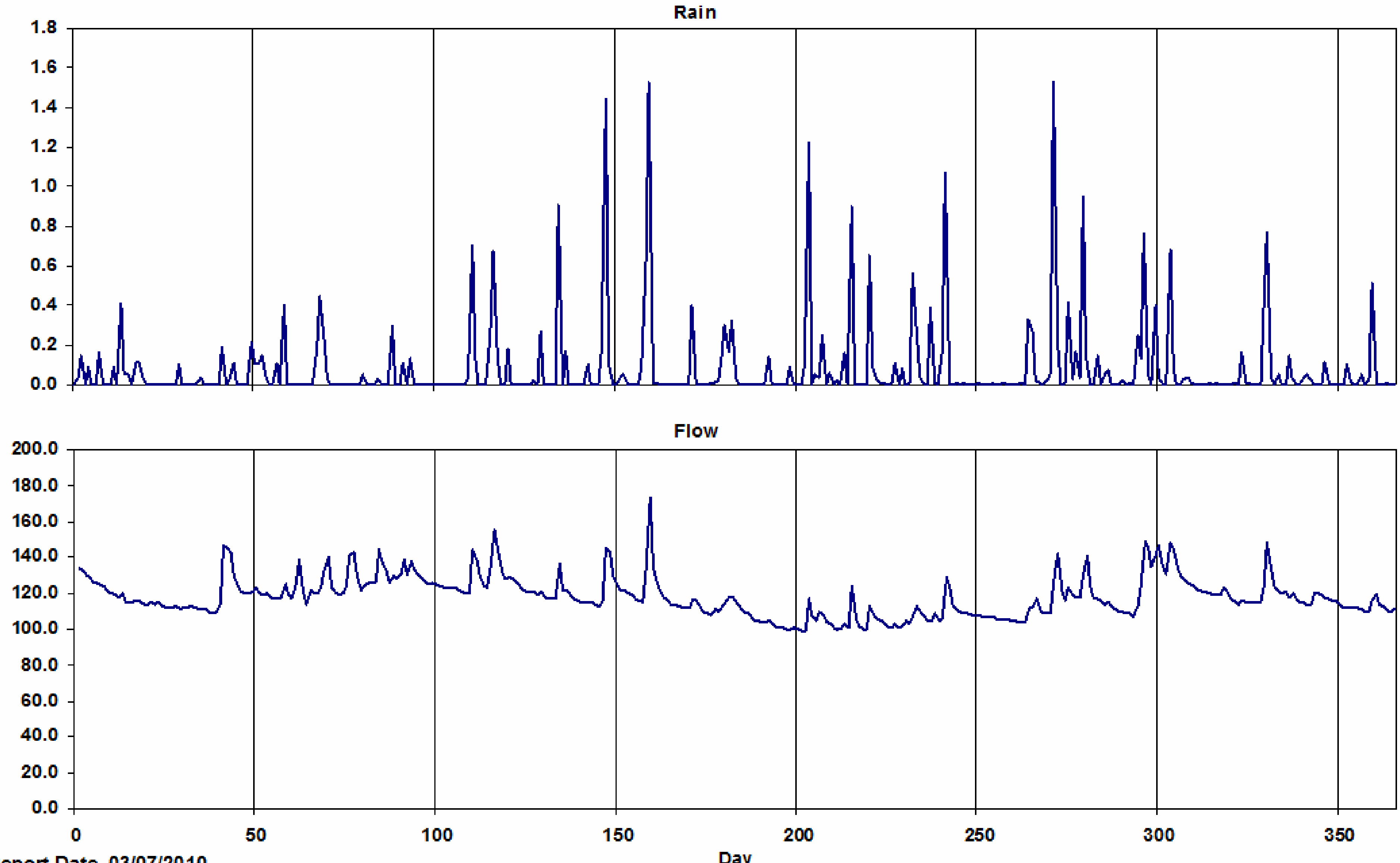


Figure 27. Historical record of annual average flows of Platte River.

Platte Lake Watershed RAIN for Year 2009

Total Rainfall: 29.520 inches, Average Flow: 118.181

Rain from Site 91, Hatchery Weather Station, Flow from Site 43, Platte River at US 31 - USGS



Report Date 03/07/2010

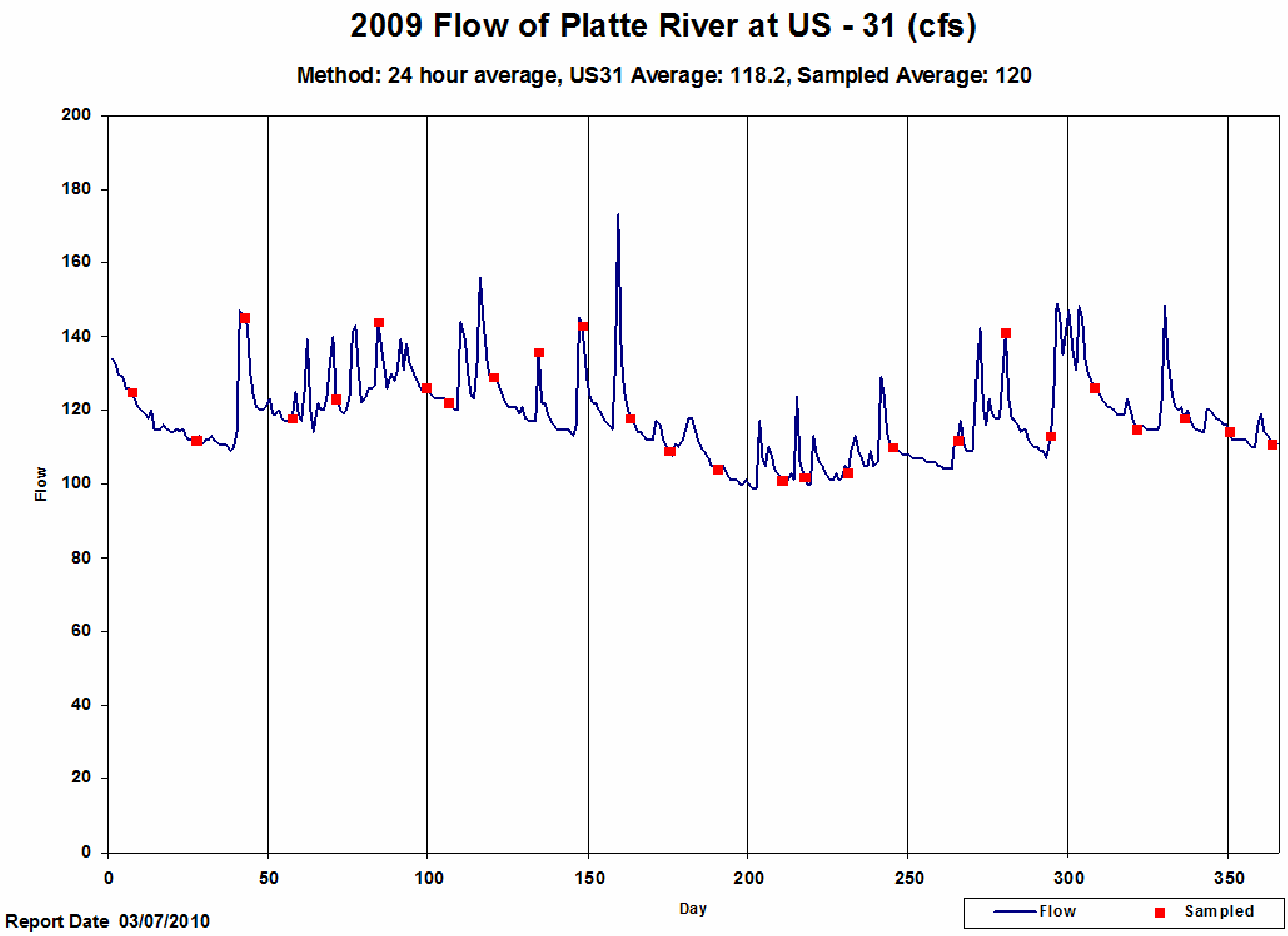


Figure 29. Daily average flows of Platte River at USGS and sampling days.

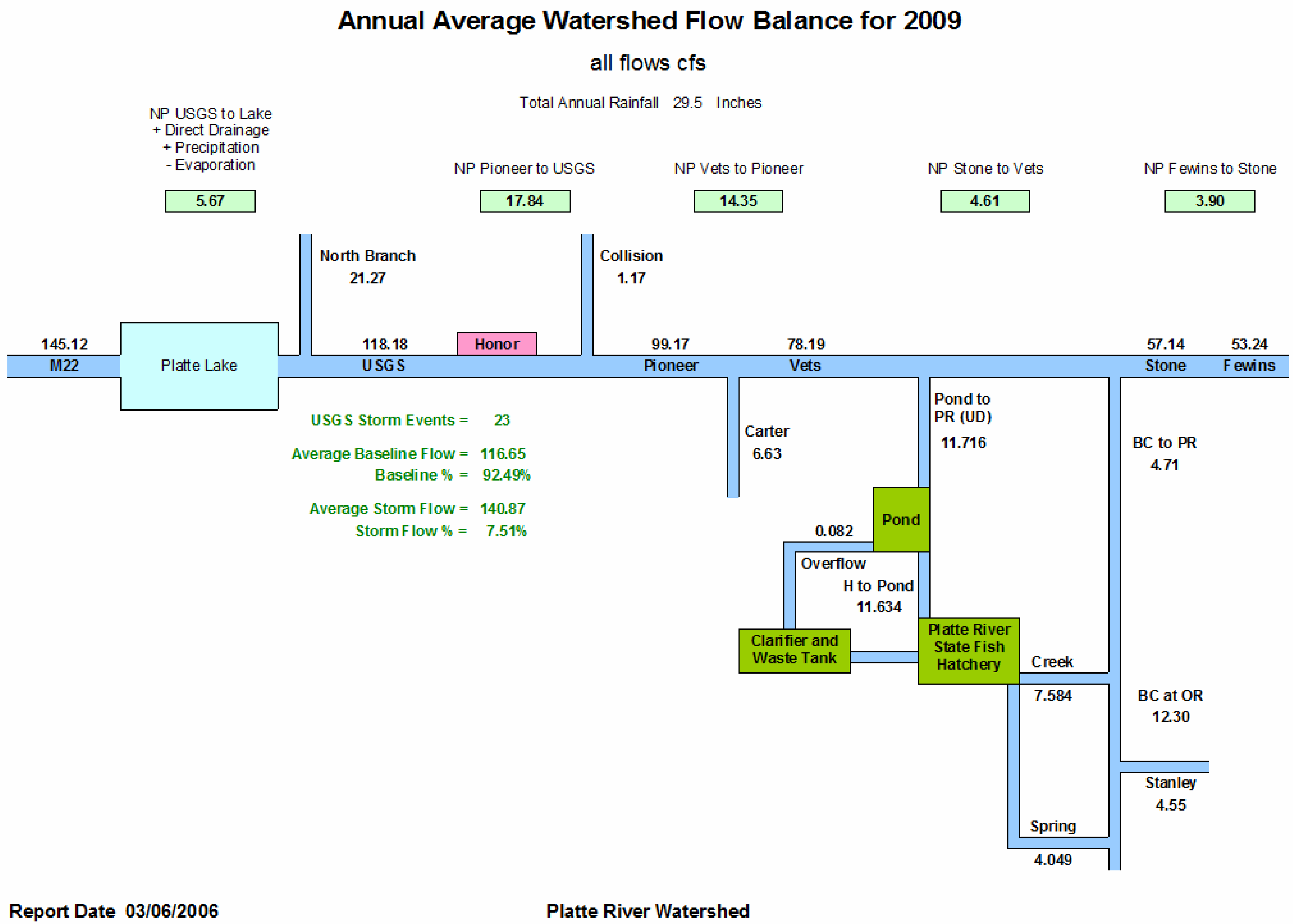
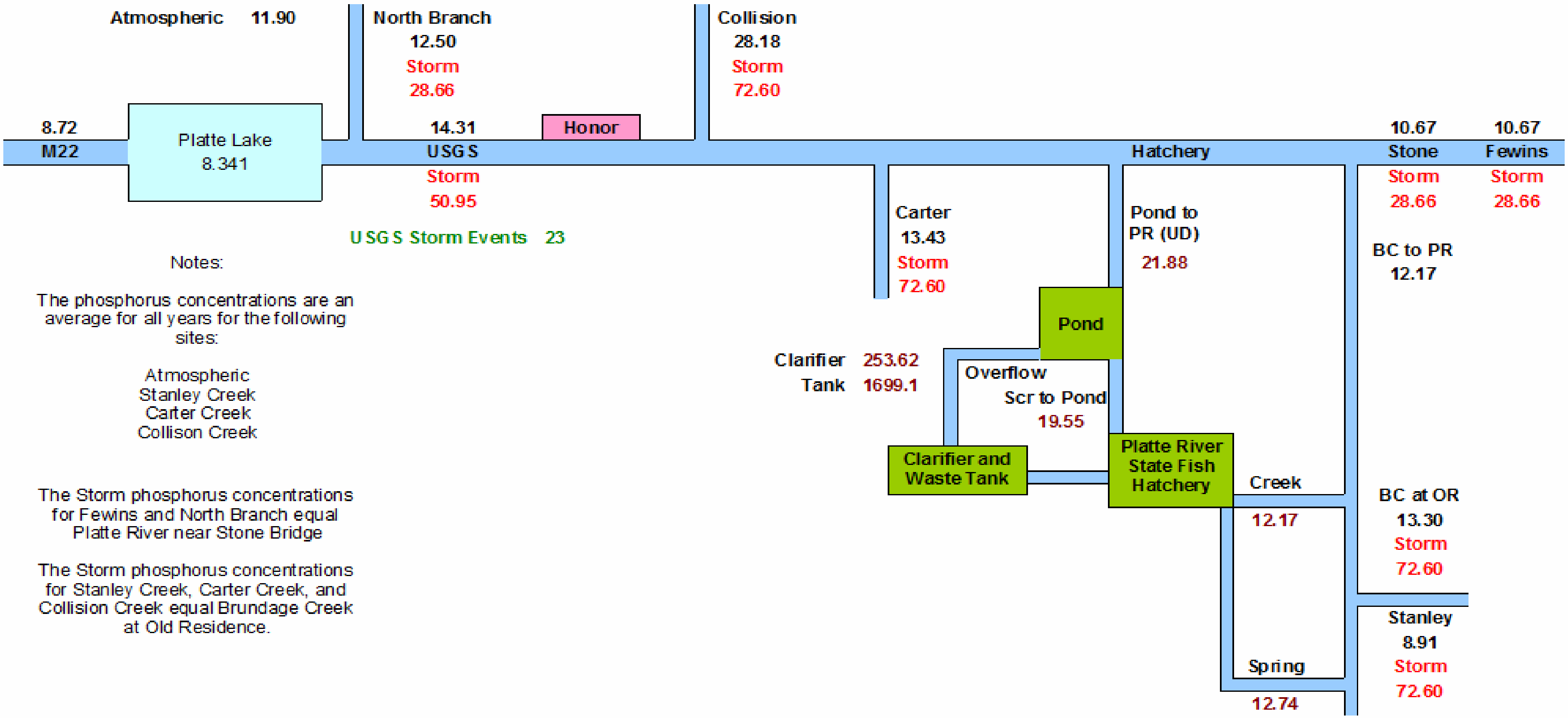


Figure 28. Watershed flow balance.

Annual Average Watershed TP Concentrations for 2009



Notes:

The phosphorus concentrations are an average for all years for the following sites:

Atmospheric
Stanley Creek
Carter Creek
Collison Creek

The Storm phosphorus concentrations for Fewins and North Branch equal Platte River near Stone Bridge

The Storm phosphorus concentrations for Stanley Creek, Carter Creek, and Collision Creek equal Brundage Creek at Old Residence.

Report Date 03/06/2006 **Platte River Watershed**

Annual Average Watershed Load Balance for 2009

all loads annual pounds

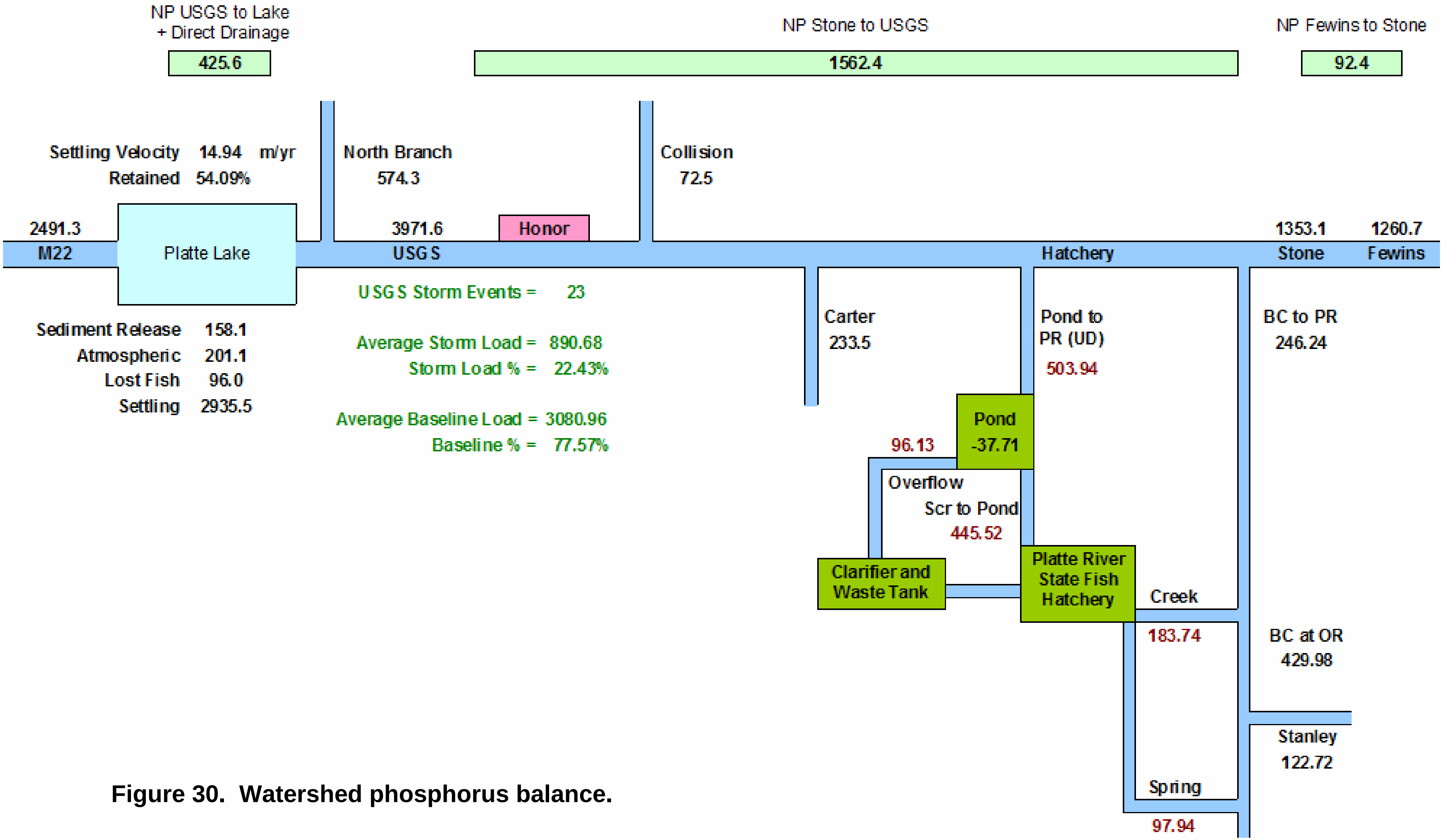


Figure 30. Watershed phosphorus balance.

	PLIA Flow cfs	PLIA TP mg/m3	DEQ TP mg/m3	Average TP Load Lbs/yr
Tamarack West (Landfill)	1.73	11.6	12.5	41.1
Tamarack East (barnyard	1.61	26.0	26.1	82.6
Platte Road (Downstream Mixture)	0.85	21.9	19.5	34.7
Bixler/Baker Creek (Control)	0.5	21.9	19.8	20.5

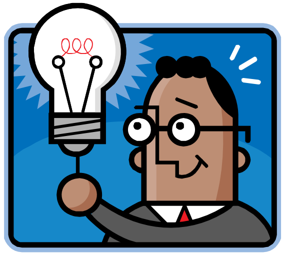
	PLIA Turbidity NTU	DEQ COD mg/L	DEQ BOD5 mg/L	DEQ NO2+NO3 mg/L	DEQ Iron mg/L
Tamarack West (Landfill)	16.76	23.33	19.17	0.29	5.5
Tamarack East (barnyard	5.78	6.20	-	0.82	
Platte Road (Downstream Mixture)	2.06	11.62	-	0.08	
Bixler/Baker Creek (Control)	4.02	11.64	-	0.87	

Thiobacillus

Reduction of Total Phosphorus Loads to Big Platte Lake, MI through Point Source Reduction and Watershed Management.

By
Dr. Raymond P. Canale, Emeritus Professor, The University of Michigan.
Ron Harrison, Benzie County Conservation District.
Penelope Moskus, Limno-Tech Inc, Ann Arbor, Michigan
Troy Naperala, Limno-Tech Inc, Ann Arbor, Michigan
Wilfred Swiecki, Platte Lake Improvement Association.
Gary Whelan, Michigan Department of Natural Resources-Fisheries Division.

We need a rational, scientifically valid way to determine how much the non-point phosphorus loads must be reduced to meet water quality standards for Big Platte Lake



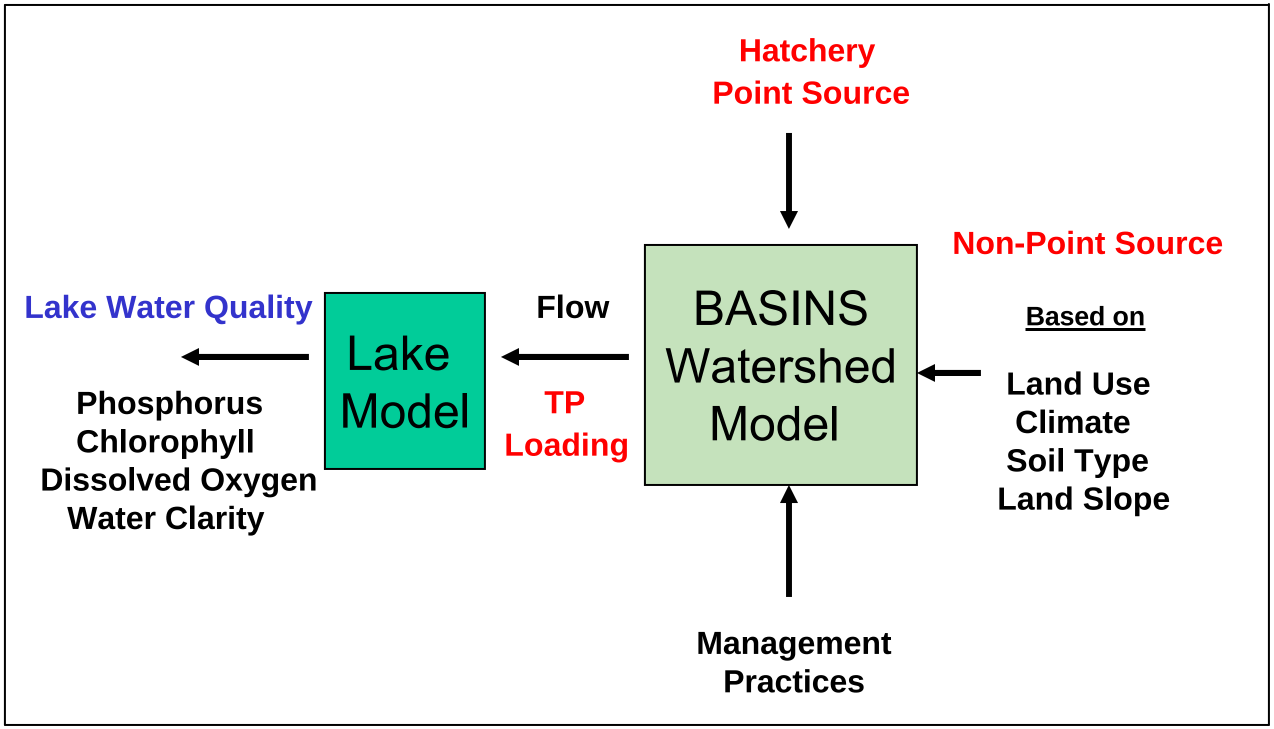


Figure 31. Components of watershed management program.

Phosphorus Action Plan for Big Platte Lake, MI.
by
Dr. Raymond P. Canale, Emeritus Professor, The University of Michigan.
Todd Redder, LimnoTech, Ann Arbor, Michigan
Wilfred Swiecki, Platte Lake Improvement Association
Gary Whelan, Michigan Department of Natural Resources-Fisheries Division

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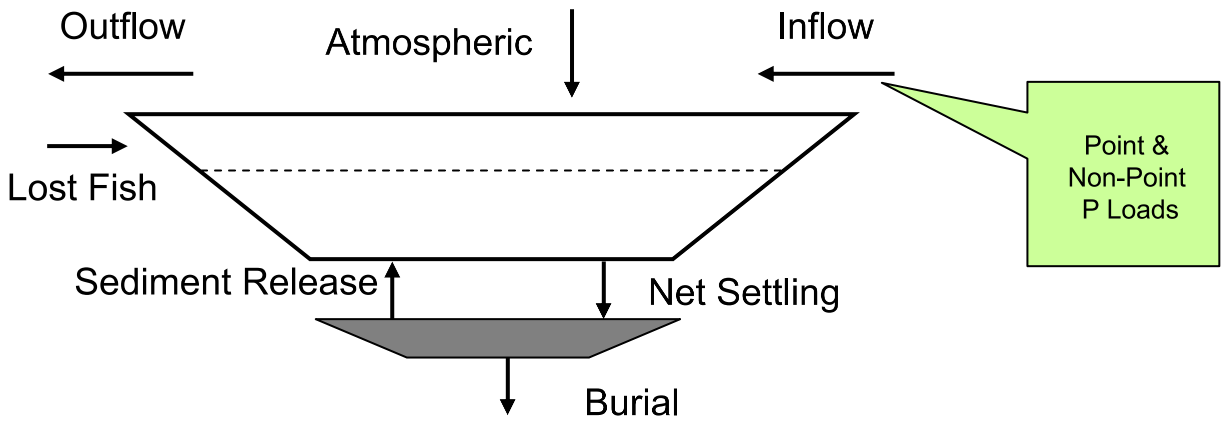
Journal of Water Resources Planning and Management
American Society of Civil Engineers



$$V_w \frac{dP_w}{dt} = W - QP_w - v_s A_s P_w + v_r A_r P_s$$

$$V_s \frac{dP_s}{dt} = v_s A_s P_w - v_r A_r P_s - v_b A_r P_s$$

$$V_h \frac{dDO_h}{dt} = v_e A_r (DO_e - DO_h) - A_r (HOD)$$

Figure 32. Water and sediment model for Big Platte Lake.

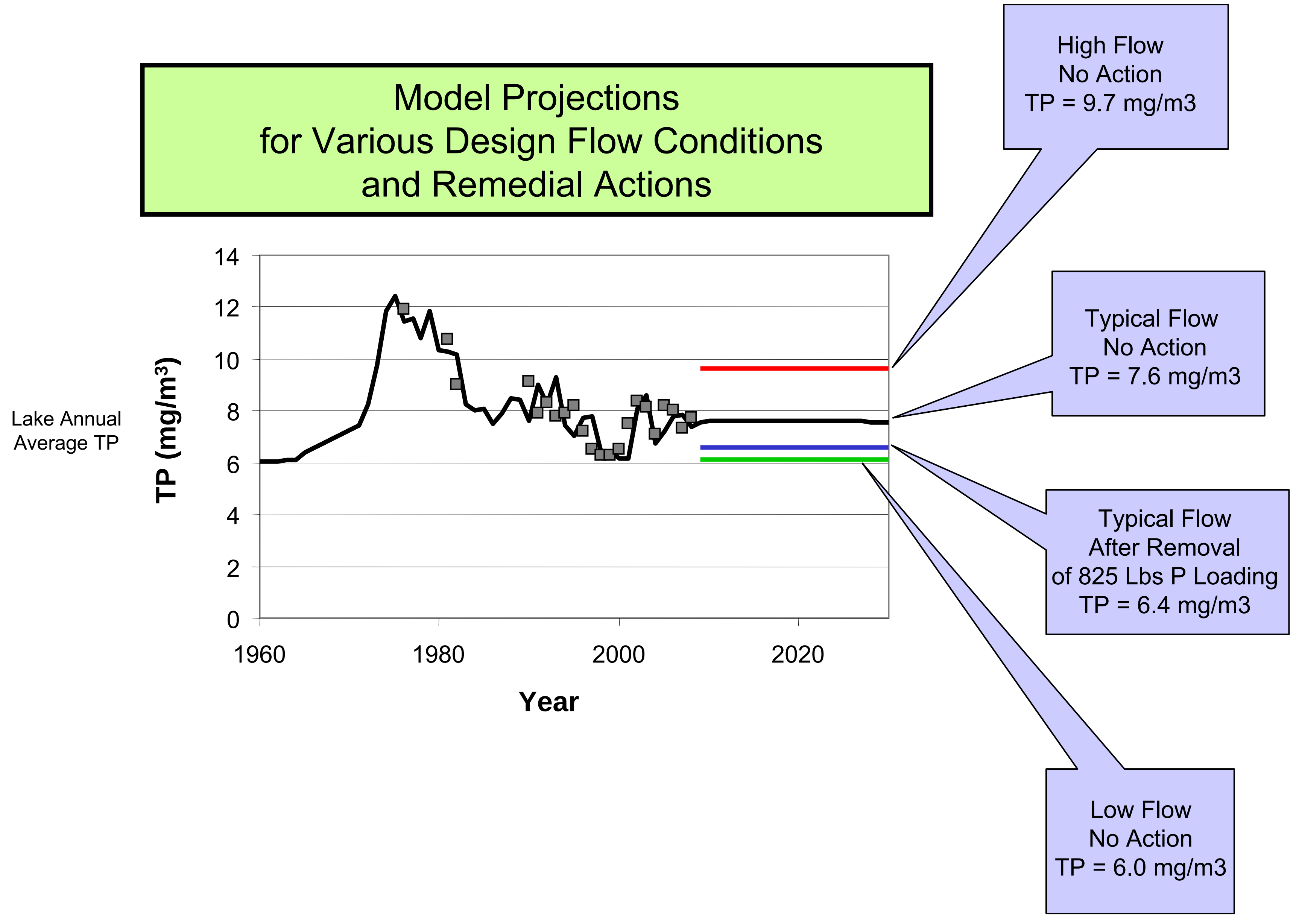
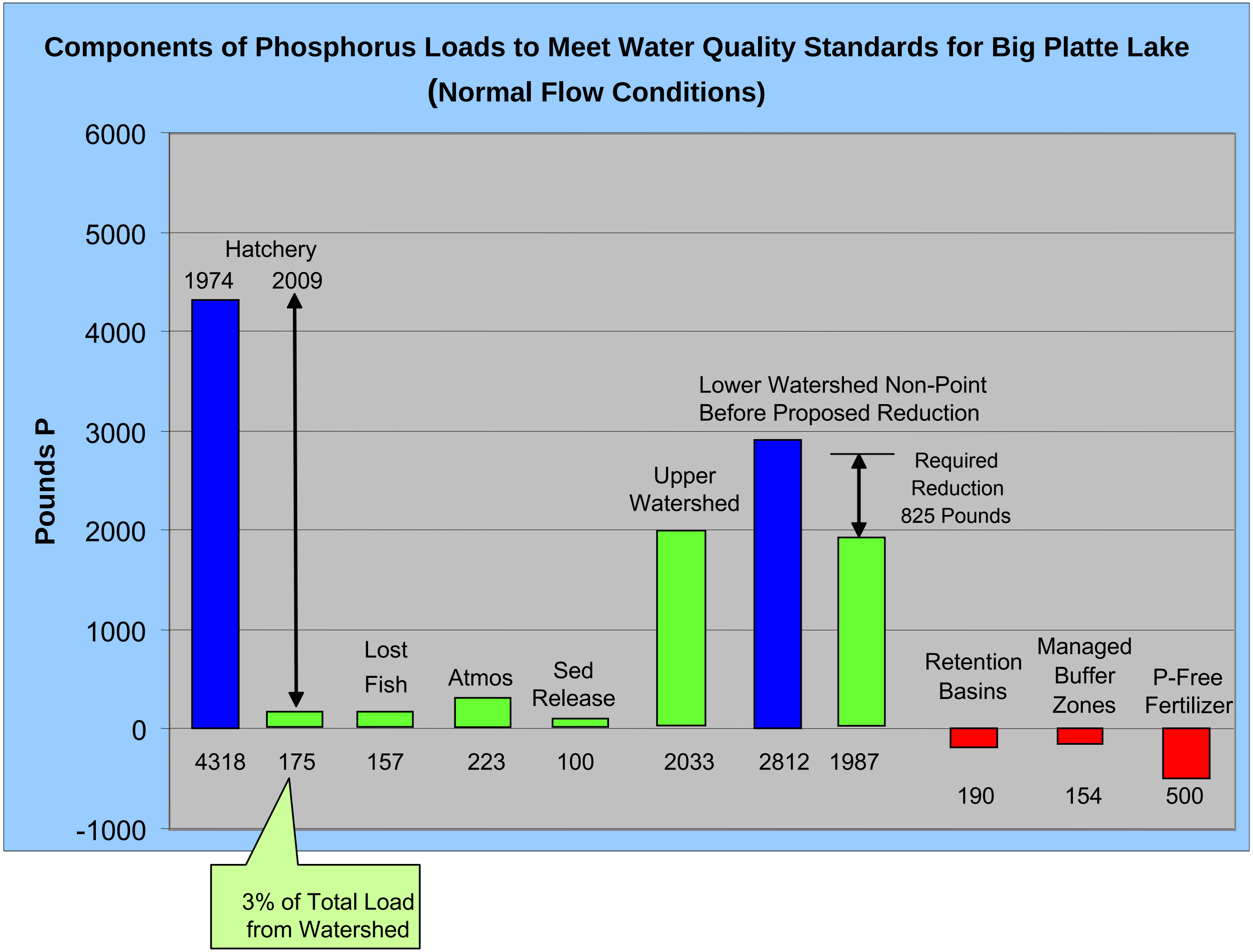
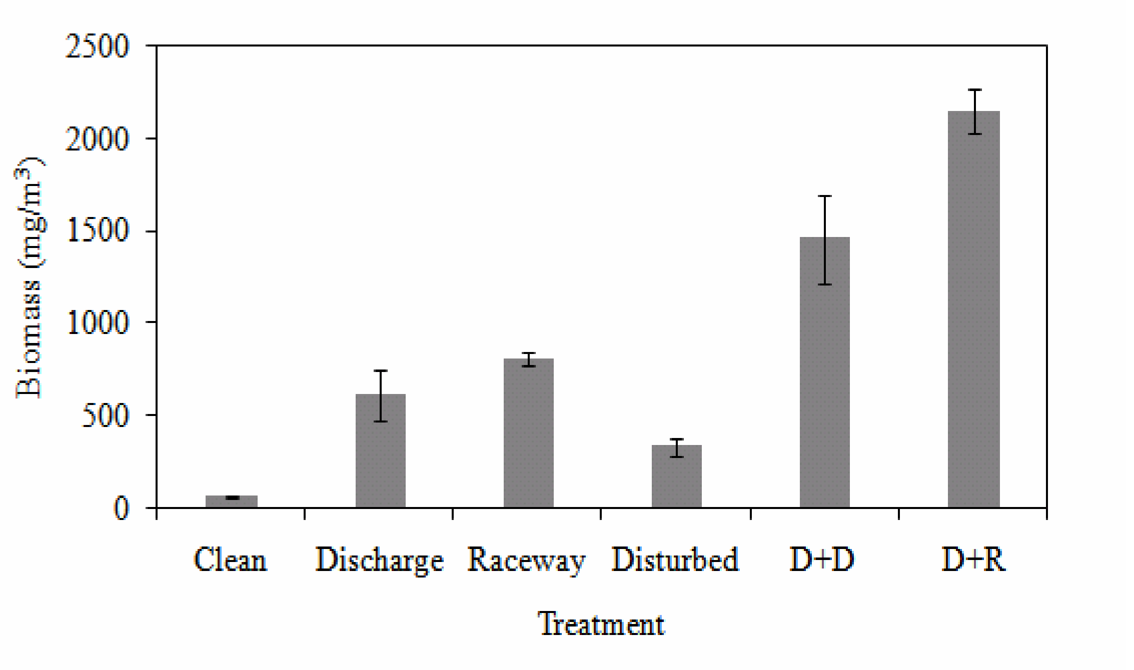


Figure 33. Model validation and projections for total phosphorus in Big Platte Lake.


Components of Phosphorus Loads to Meet Water Quality Standards for Big Platte Lake
(Normal Flow Conditions)
Pounds P
6000
5000
4000
3000
2000
1000
0
-1000
Hatchery
1974
2009
Lower Watershed Non-Point
Before Proposed Reduction
Upper
Watershed
Required
Reduction
825 Pounds
Lost
Fish
Atmos
Sed
Release
Retention
Basins
Managed
Buffer
Zones
P-Free
Fertilizer
4318
175
157
223
100
2033
2812
1987
190
154
500
3% of Total Load
from Watershed

Site	TP (µg/L)	SRP (µg/L)
Clean	8.03	1.95
Discharge	16.61	6.17
Raceway	22.60	7.85
Disturbed	38.00	6.35
Discharge + Disturbed	40.96	7.79
Raceway + Disturbed	43.62	7.46



	Big Platte Dates	Big Platte Depths	Big Platte Reps	Little Platte Dates	Little Platte Depths	Little Platte Reps	Trib Dates	Trib Sites	Trib Reps	Total Count	Unit Cost	Sub Total
Alkalinity	20	1	1	0	1	0				20	$ 5.90	$ 118
Calcium	20	1	1	0	1	0				20	$ 9.44	$ 189
TDS	20	1	1	0	1	0				20	$ 5.90	$ 118
TP	20	10	3	0	1	0	20	4	3	840	$ 7.67	$ 6,443
TDP	20	2	0	0	1	0	20	0	0	0	$ 7.67	$ -
NO2 + NO2	20	2	0	0	1	0	20	0	0	0	$ 12.39	$ -
TN	20	2	0	0	1	0	20	0	0	0	$ 32.50	$ -
TDN	20	2	0	0	1	0	20	0	0	0	$ 32.50	$ -
Chlorophyll	20	2	3	0	1	0				120	$ 14.75	$ 1,770
Phytoplankton	3	1	4	0	1	0				12	$ 76.70	$ 920
Zooplankton	3	1	3							9	$ 76.70	$ 690
												$ 10,248

	Hatchery Dates	Hatchery Sites	Hatchery Reps	Tank Dates	Tank Sites	Tank Reps	Special Dates	Special Sites	Special Reps	Total Count	Unit Cost	Sub Total
TP	100	6	3	2	30	3	50	3	3	2430	$ 7.67	$ 18,638
Hach TP	100	3	3	2	30	1				960	$ 1.25	$ 1,200
mg P/mg DW	24	2	3							144	$ 17.50	$ 2,520
% water	24	2	3							144	$ 11.80	$ 1,699
P/L/C	12	2	1							24	$ 100.00	**$ 2,400**
												$ 26,457

Figure 35. Proposed sampling program and costs for 2010.