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: 7.87 mg/m^3 volume - weighted

59% 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 published by ASCE in September

Special Studies: Bio-availability study report completed.

CMU billing and NPDES reporting connected to database.

Figure 1. Overview for 2009 Annual Report.

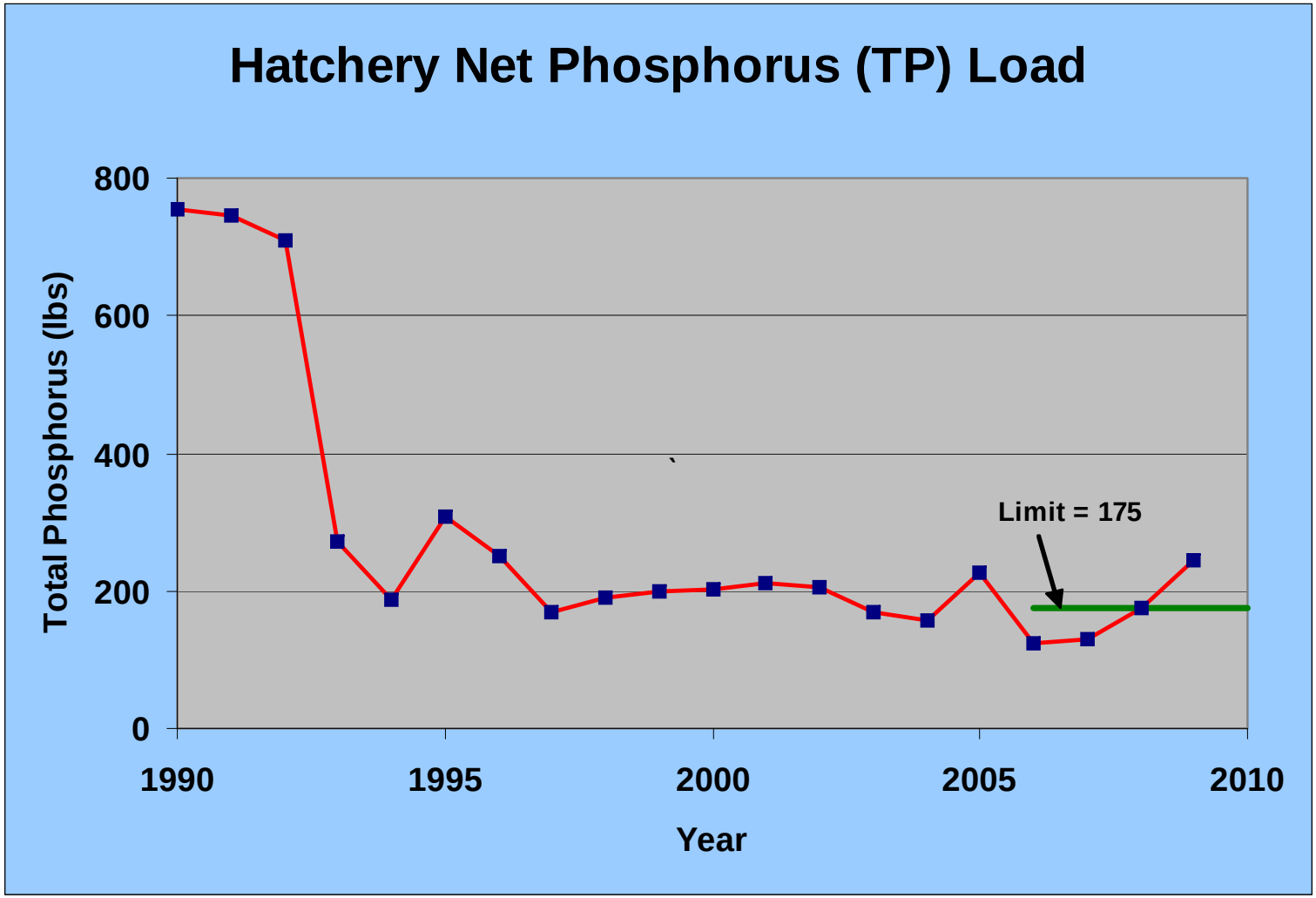


Figure 2. Hatchery phosphorus loading changes over time.

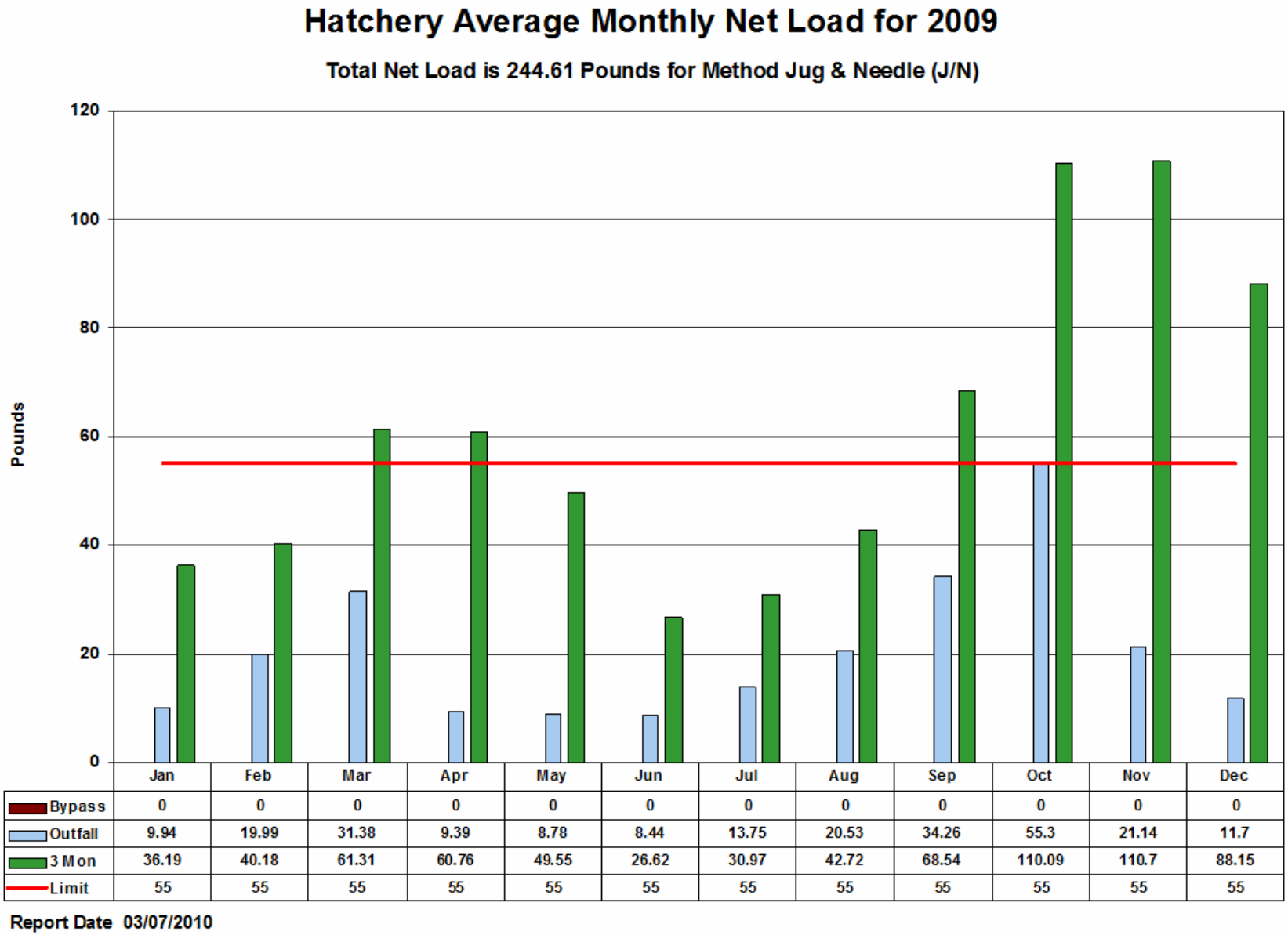


Figure 3. Hatchery monthly phosphorus loads.

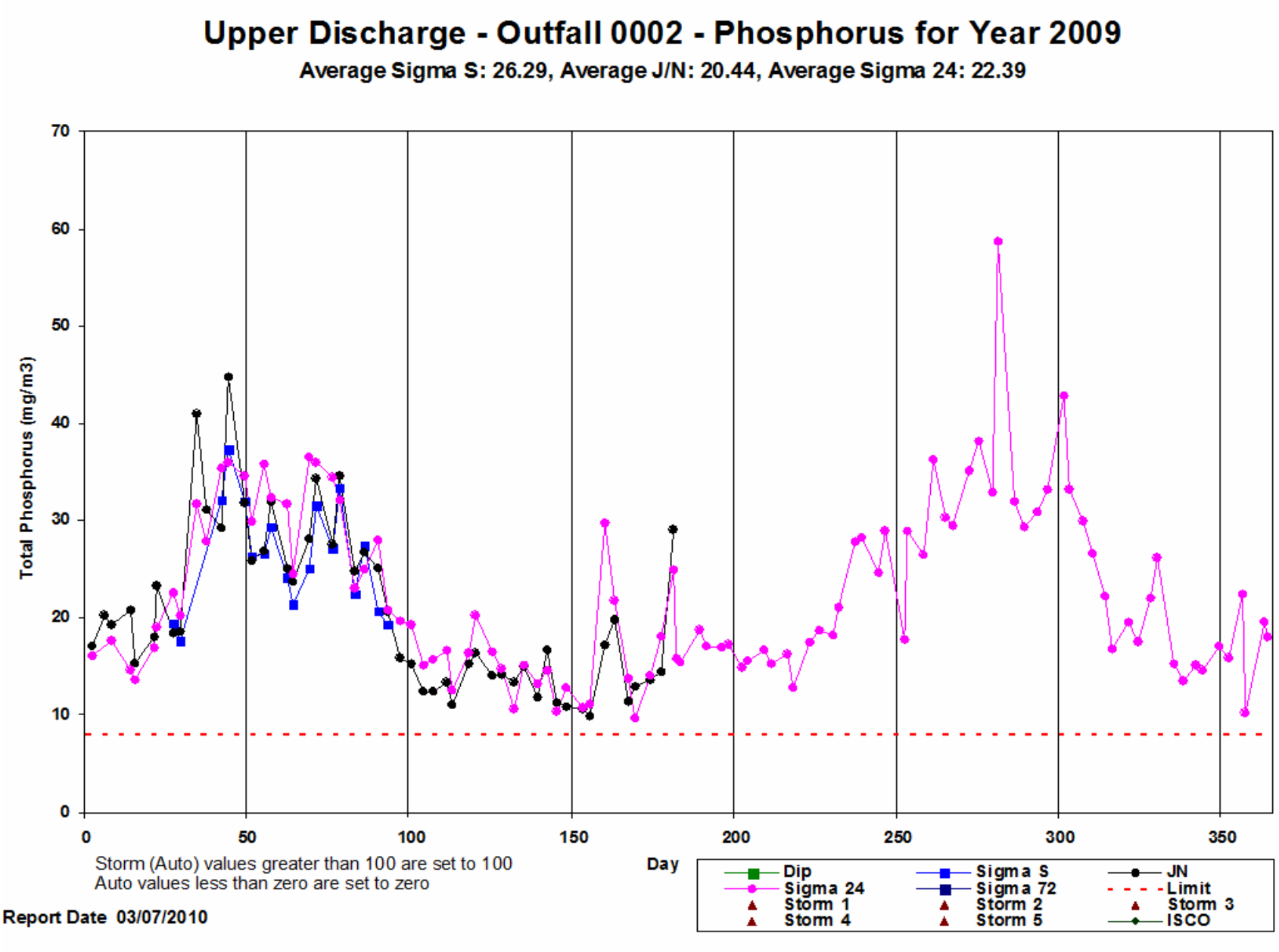


Figure 4. Upper Discharge TP concentration during 2009.

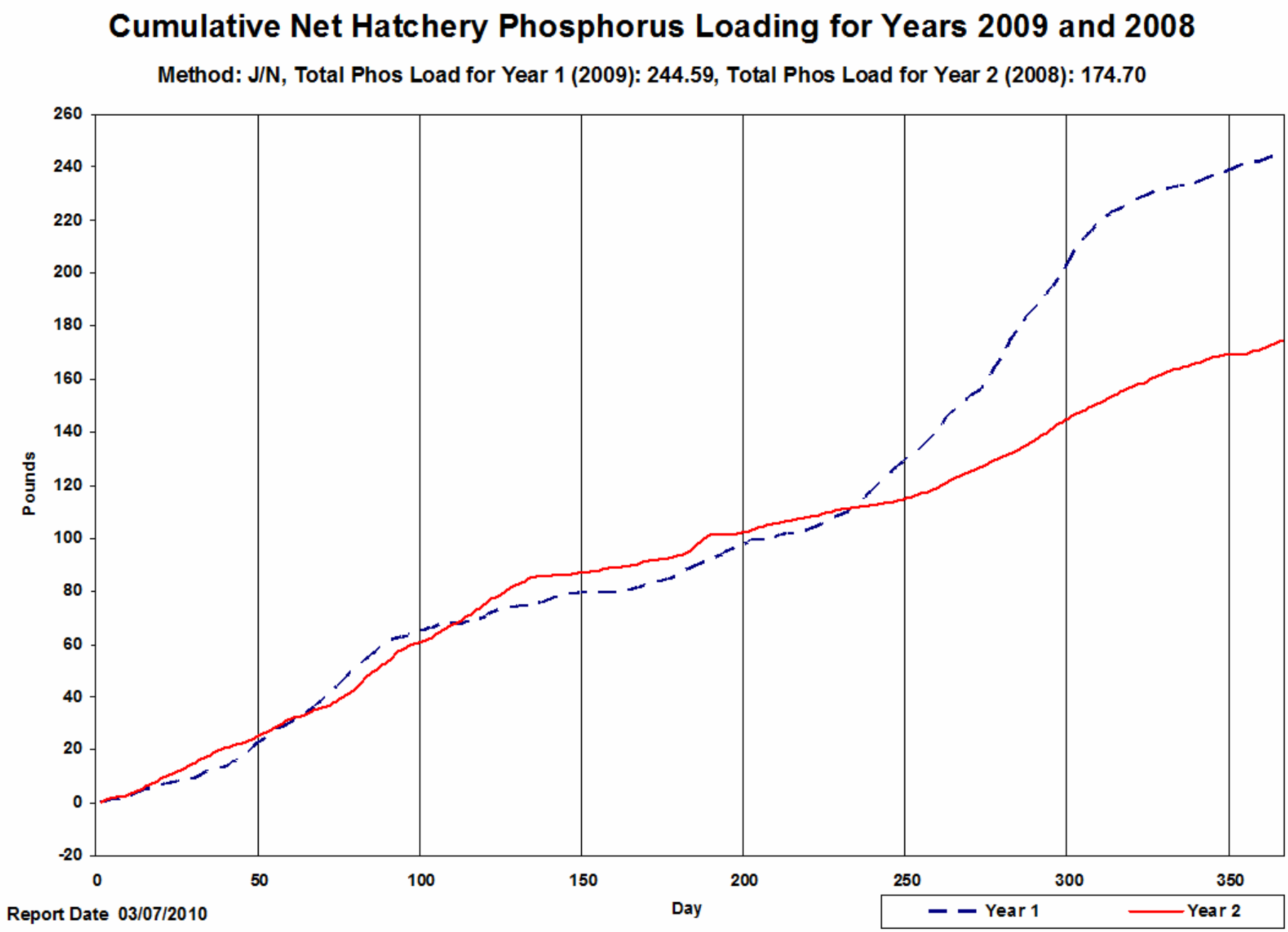


Figure 5. Comparison between cumulative load for 2008 and 2009.

Fish Production for year 2008

Month	Fish Weight (kg)			Food			Morts	Shipped	Planted	Harvest	Fry Wt In (kg)		Net Growth		Conversion
	Start	End	Avg	Wt (kg)	% Phos	kg Phos	Wt (kg)	Wt (kg)	Wt (kg)	Wt (kg)	Coho	Chinook	(kg)	%	
Jan	43,648	46,674	45,161	2961.1	0.870	25.8	192.7	0.0	0.0	192.7	264.94	129	2824.8	6.25	1.05
Feb	46,674	50,103	48,389	2800.2	1.058	29.6	124.8	0.0	0.0	124.8	0	0	3553.8	7.34	0.79
Mar	50,103	53,226	51,665	6944.8	0.882	61.3	146.0	3928.6	0.0	4074.6	17.3	183.8	6996.5	13.54	0.99
Apr	53,226	12,962	33,094	4291.7	0.912	39.1	51.6	12852.6	36138.0	49042.2	0	0	8778.2	26.53	0.49
May	12,962	3,208	8,085	2404.0	0.932	22.4	7.6	9551.0	0.0	9558.6	0	0	-195.4	-2.42	-12.30
Jun	3,208	7,070	5,139	2460.0	1.013	24.9	7.8	0.0	0.0	7.8	0	0	3869.8	75.30	0.64
Jul	7,070	9,758	8,414	2520.0	0.898	22.6	21.5	0.0	0.0	21.5	0	0	2709.5	32.20	0.93
Aug	9,758	13,018	11,388	3760.0	0.903	34.0	23.8	0.0	0.0	23.8	0	0	3283.8	28.84	1.15
Sep	13,018	16,987	15,003	4280.0	0.915	39.2	32.7	0.0	0.0	32.7	0	0	4001.7	26.67	1.07
Oct	16,987	20,008	18,498	3360.0	0.876	29.4	20.9	0.0	0.0	20.9	0	0	3041.9	16.44	1.10
Nov	20,008	21,750	20,879	1920.0	0.821	15.8	21.6	0.0	0.0	21.6	0	0	1763.6	8.45	1.09
Dec	21,750	23,288	22,519	1600.0	0.800	12.8	37.9	0.0	0.0	37.9	0	0	1575.9	7.00	1.02
Totals				**39301.8**	**0.91**	**356.8**	**688.8**	**26332.2**	**36138.0**	**63158.9**	**282.2**	**312.8**	**42203.9**	**20.51**	

Annual Check	**42203.88**	**0.93**

Annual Sum	Fish Start	Fish End	Fish Avg		Food	Morts	Shipped	Planted	Harvest		Fry In	Net Prod		Excess Food
Lbs P	423.47	225.94	233.04		786.85	6.68	255.47	350.61	612.77		5.77	409.47		377.4

Figure 6. Summary of Production and Feeding Activities for 2008.

Fish Production for year 2009

Month	Fish Weight (kg)			Food			Morts	Shipped	Planted	Harvest	Fry Wt In (kg)		Net Growth		Conversion
	Start	End	Avg	Wt (kg)	% Phos	kg Phos	Wt (kg)	Wt (kg)	Wt (kg)	Wt (kg)	Coho	Chinook	(kg)	%	
Jan	23,288	26,102	24,695	1633.0	0.887	14.5	207.6	0.0	0.0	207.6	575.55	847.91	1598.1	6.47	1.02
Feb	26,102	28,664	27,383	2263.0	1.110	25.1	80.4	0.0	0.0	80.4	0	0	2642.4	9.65	0.86
Mar	28,664	34,089	31,377	4759.0	0.944	44.9	90.8	0.0	0.0	90.8	0	0	5515.8	17.58	0.86
Apr	34,089	10,041	22,065	3282.4	0.784	25.7	40.6	0.0	28463.0	28503.6	0	0	4455.6	20.19	0.74
May	10,041	5,103	7,572	3625.6	0.813	29.5	22.7	10327.0	0.0	10349.7	0	0	5411.7	71.47	0.67
Jun	5,103	12,339	8,721	5241.0	0.822	43.1	9.0	0.0	0.0	9.0	0	0	7245.0	83.08	0.72
Jul	12,339	19,411	15,875	5669.7	0.882	50.0	16.2	0.0	0.0	16.2	0	0	7088.2	44.65	0.80
Aug	19,411	25,999	22,705	7615.4	0.942	71.7	36.9	0.0	0.0	36.9	0	0	6624.9	29.18	1.15
Sep	25,999	31,193	28,596	9115.0	0.953	86.9	11.6	4322.9	0.0	4334.4	0	0	9528.4	33.32	0.96
Oct	31,193	37,085	34,139	6120.4	0.927	56.7	10.4	0.0	0.0	10.4	0	0	5902.4	17.29	1.04
Nov	37,085	37,814	37,450	729.4	0.932	6.8	14.3	0.0	0.0	14.3	194.7	0	548.6	1.46	1.33
Dec	37,814	40,253	39,034	2924.1	0.908	26.6	18.7	0.0	0.0	18.7	0	0	2457.7	6.30	1.19
Totals				**52978.0**	**0.91**	**481.5**	**559.2**	**14649.9**	**28463.0**	**43672.1**	**770.3**	**847.9**	**59018.9**	**28.39**	

Annual Check	59018.9	0.90

Annual Sum	Fish Start	Fish End	Fish Avg		Food	Morts	Shipped	Planted	Harvest		Fry In	Net Prod	Excess Food
Lbs P	225.94	390.53	242.24		1061.74	5.43	142.13	276.15	423.71		15.70	572.60	489.1

Figure 7. Summary of Production and Feeding Activities for 2009.

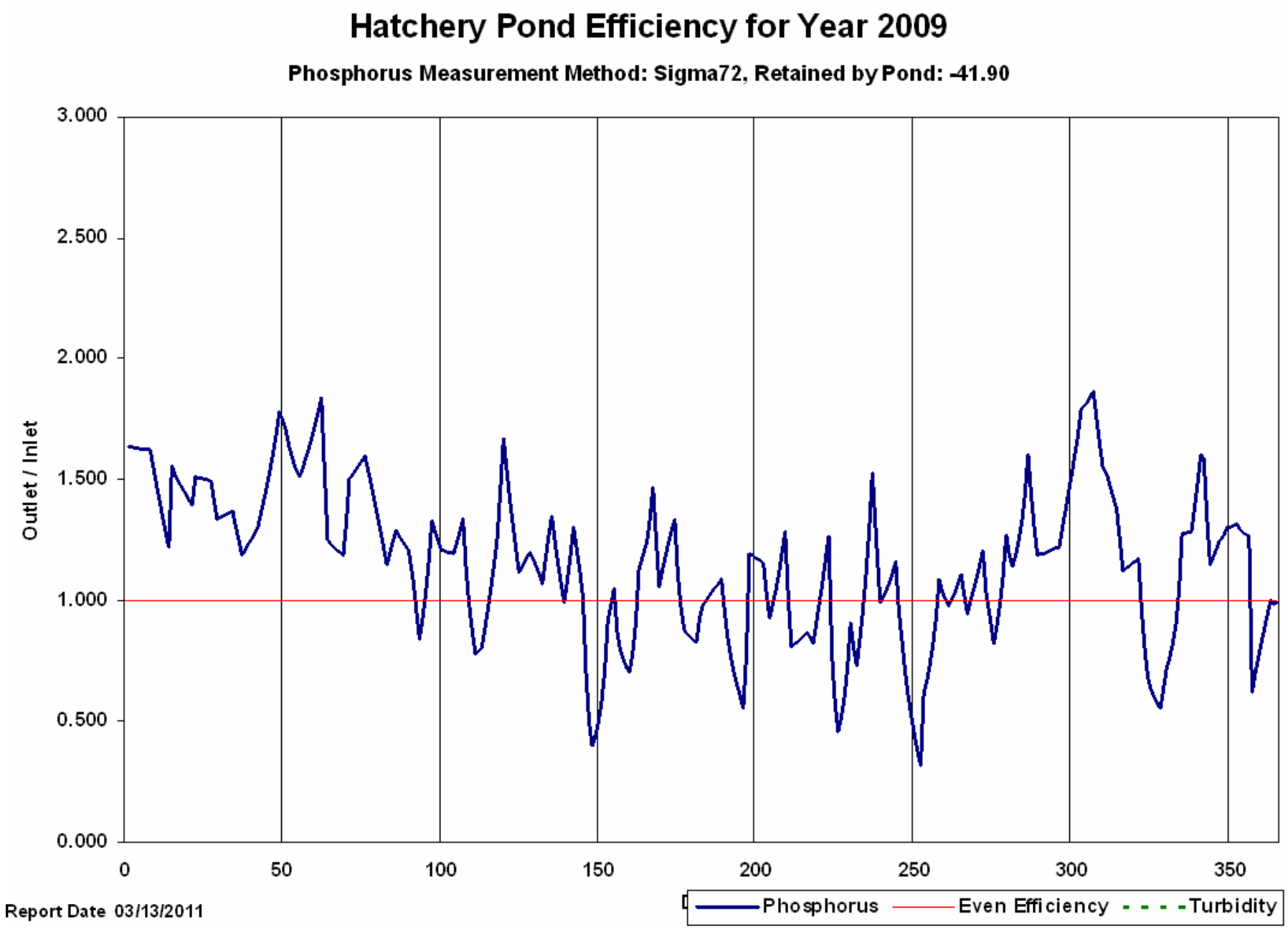


Figure 8. Pond Efficiency for 2009.

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]

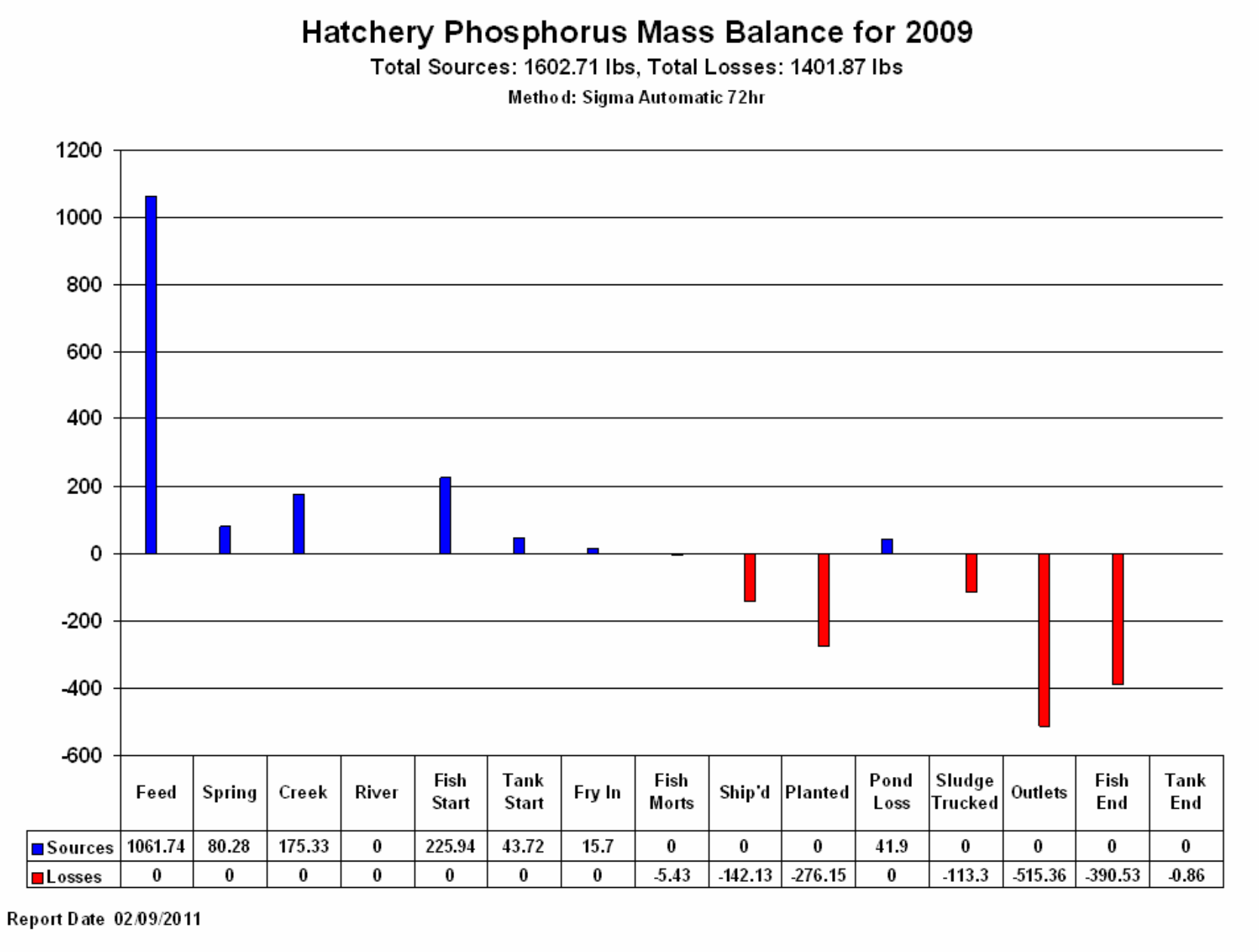
Tank Removal = Trucked + Tank End – Tank Start

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 9. Definition of terms in Mass Balance Equation.



	Feed	Spring	Creek	River	Fish Start	Tank Start	Fry In	Fish Morts	Ship'd	Planted	Pond Loss	Sludge Trucked	Outlets	Fish End	Tank End
Sources	1061.74	80.28	175.33	0	225.94	43.72	15.7	0	0	0	41.9	0	0	0	0
Losses	0	0	0	0	0	0	0	-5.43	-142.13	-276.15	0	-113.3	-515.36	-390.53	-0.86

Figure 10. Hatchery Phosphorus Mass Balance for 2009.

Method	Year	Food	% Tissue P 0.42 Fish Production	Tank Retention	Pond Loss	Mass Bal Expected Net Load	Meas 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

Figure 11. Hatchery Mass balance vs. Measured for various years.

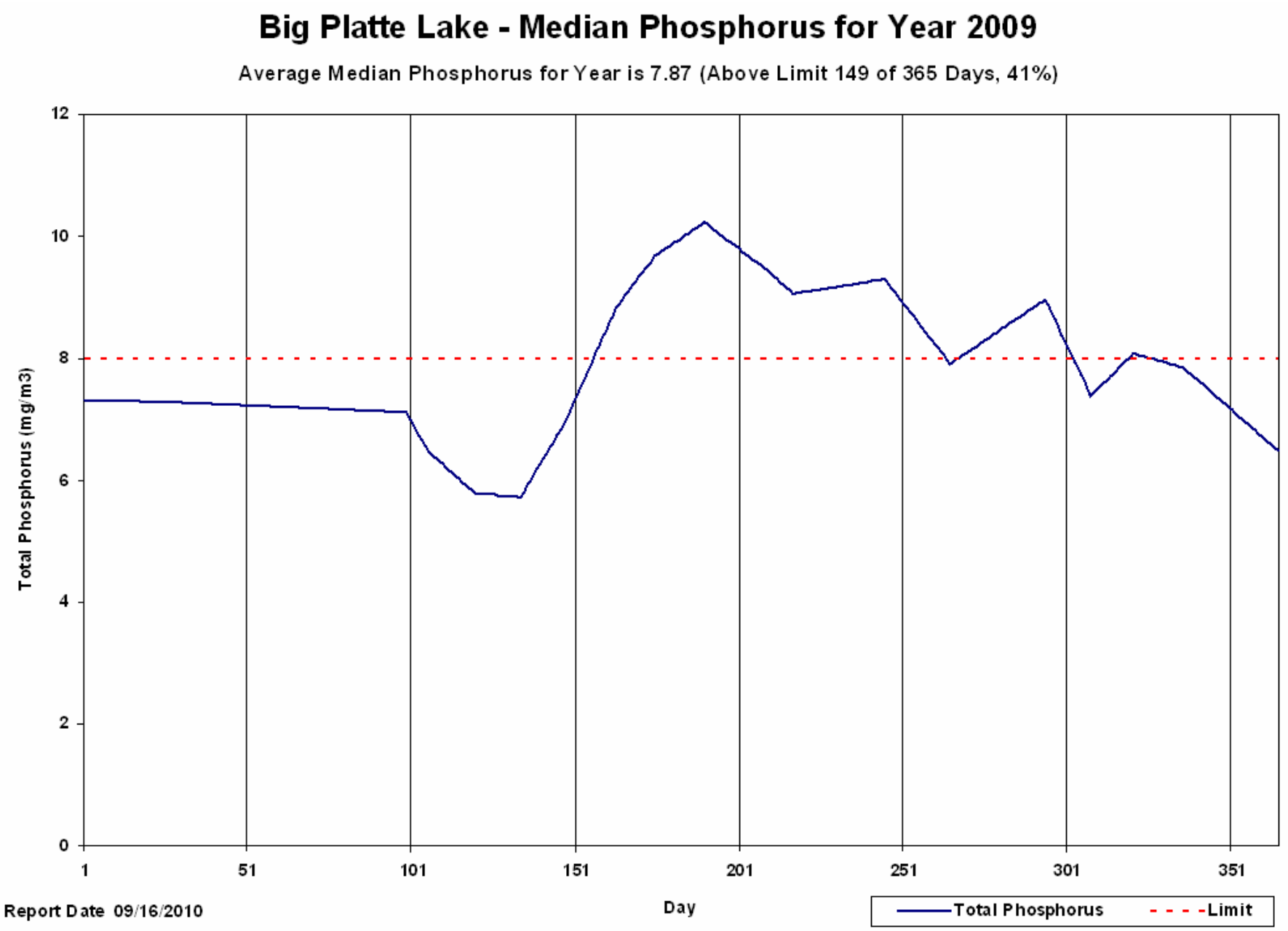


Figure 12. Volume-weighted total phosphorus concentration of Big Platte Lake.

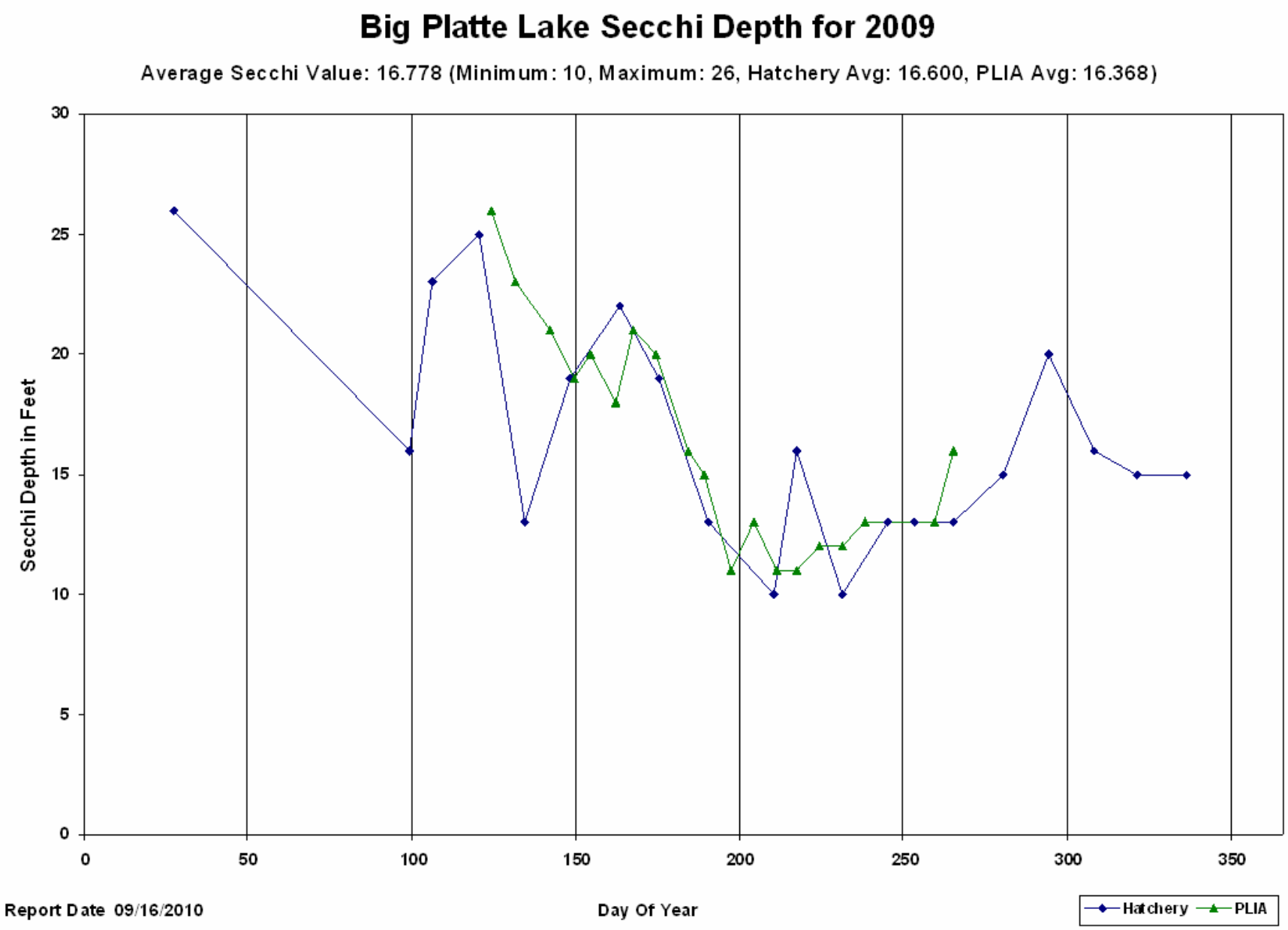


Figure 13. Variation of Secchi Depth during 2009.

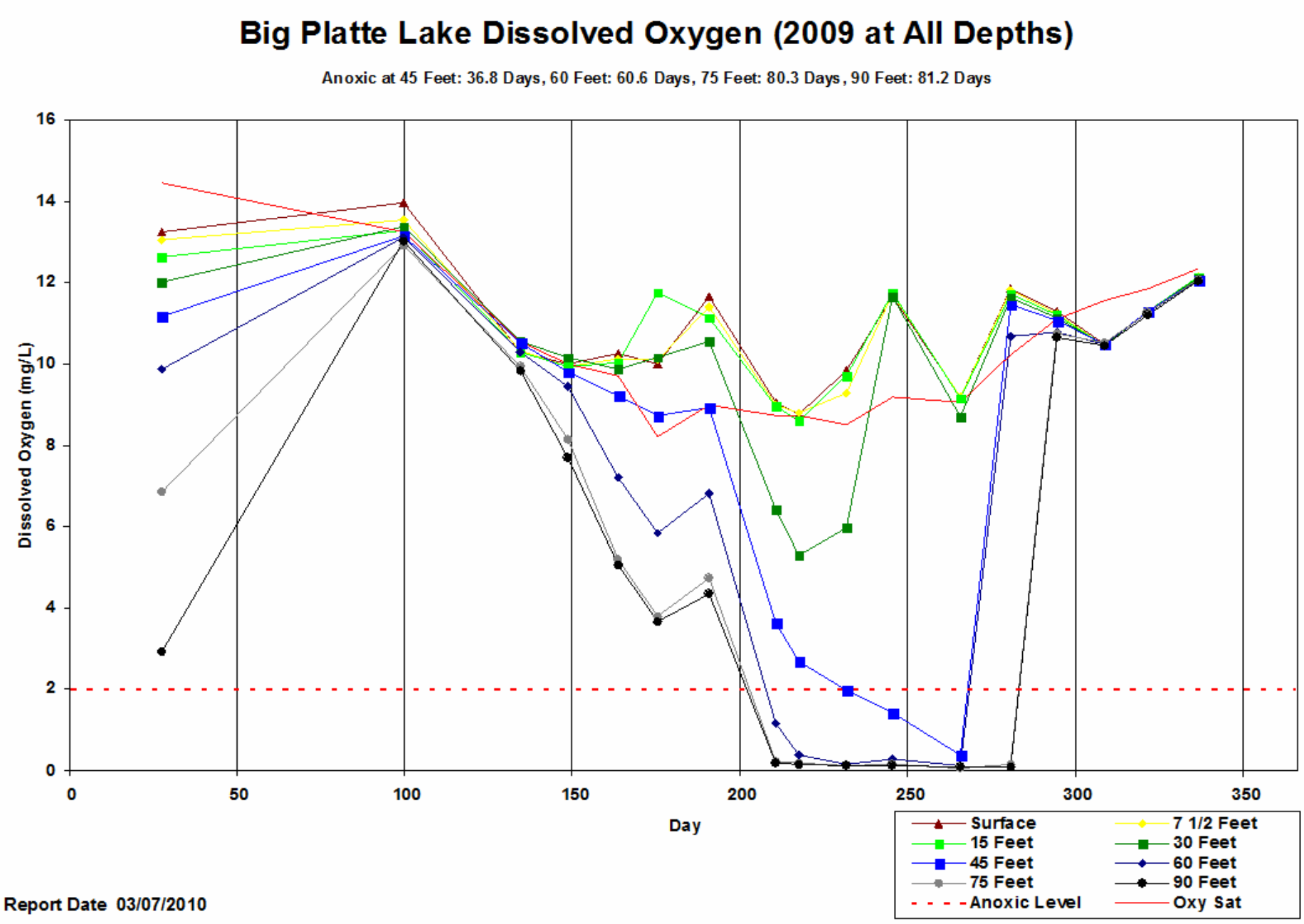


Figure 14. Dissolved oxygen as a function of depth.

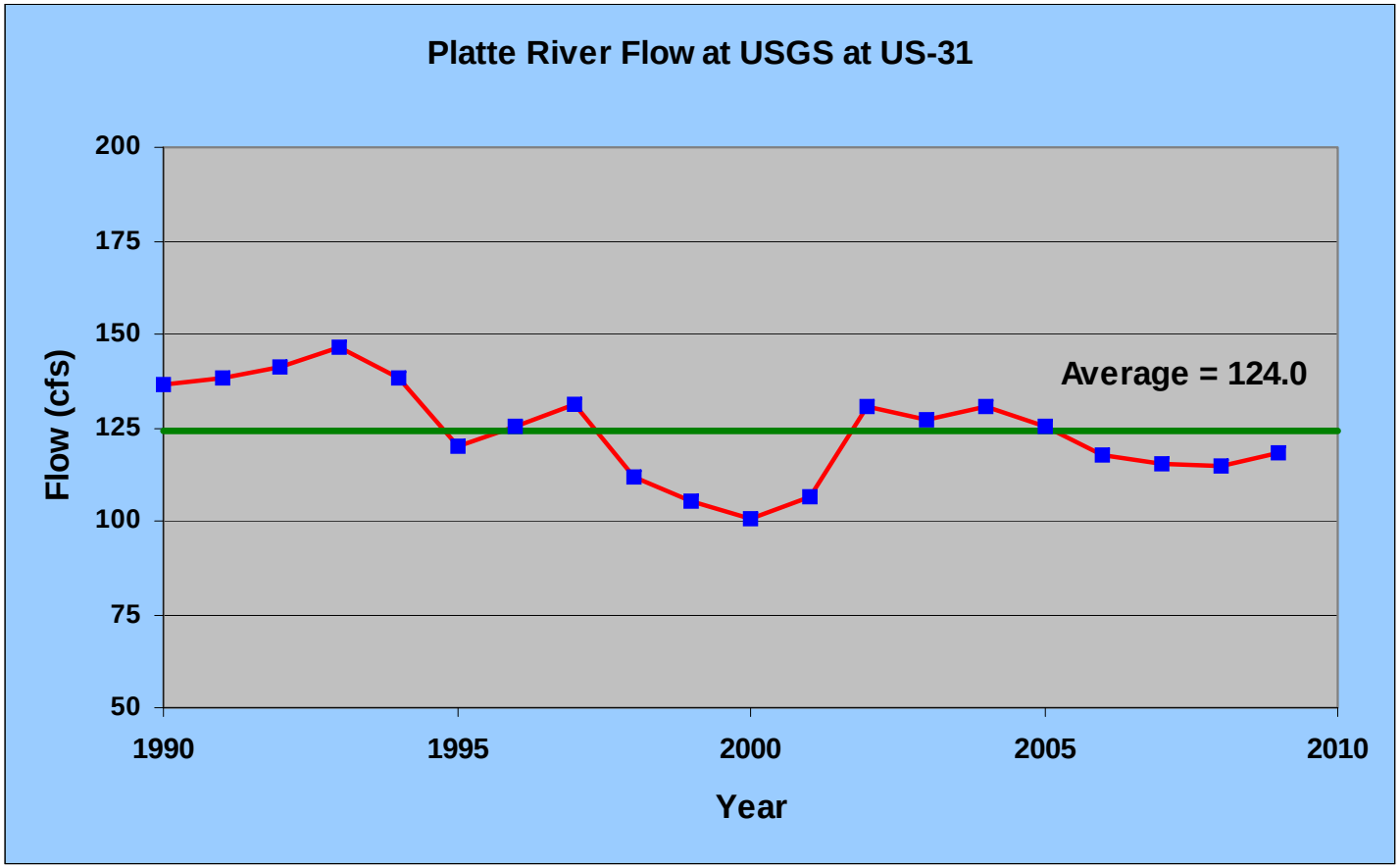


Figure 15. Historical record of annual average flows of Platte River.

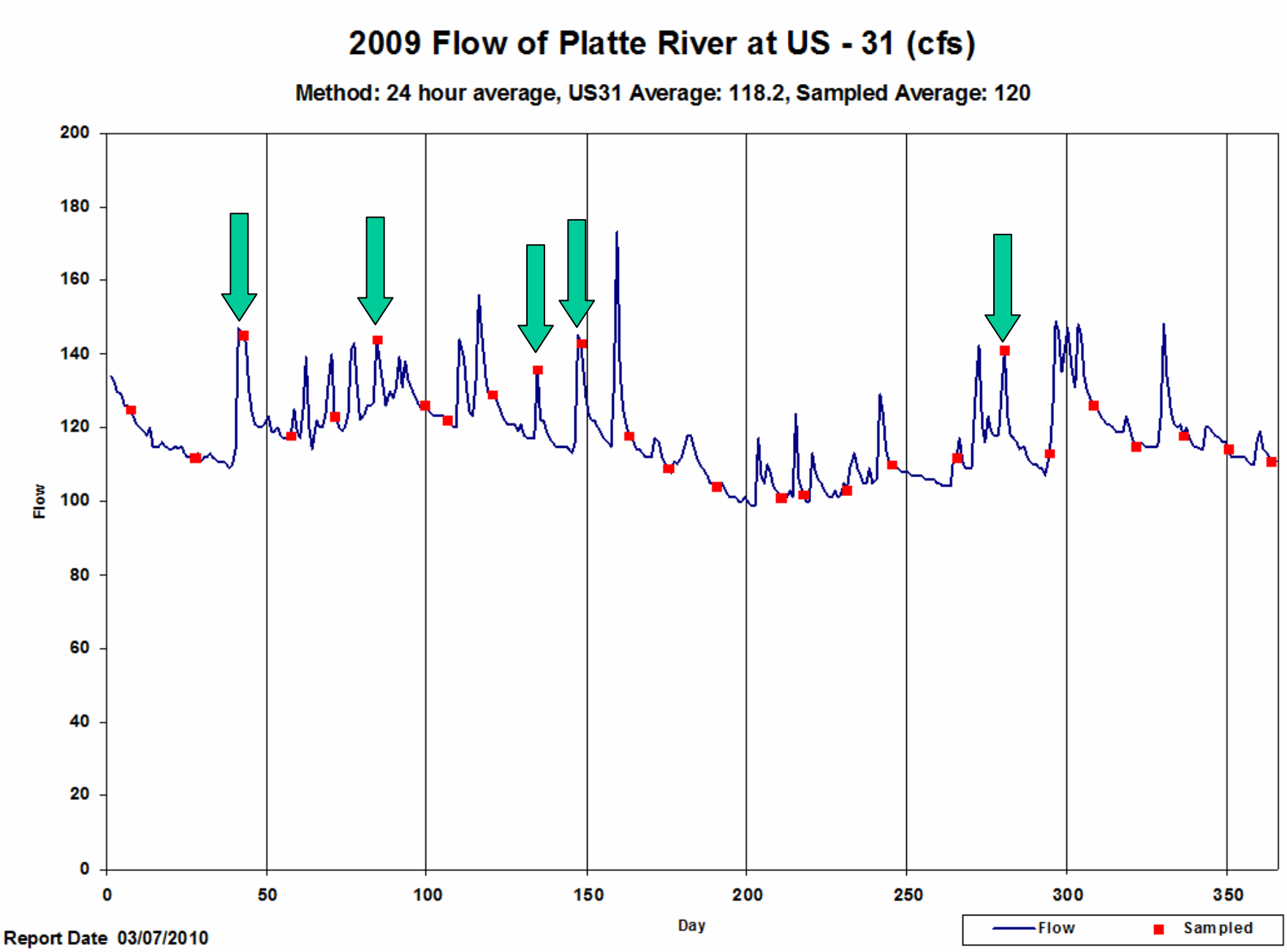


Figure 16. Daily average flows of Platte River at USGS and sampling days.

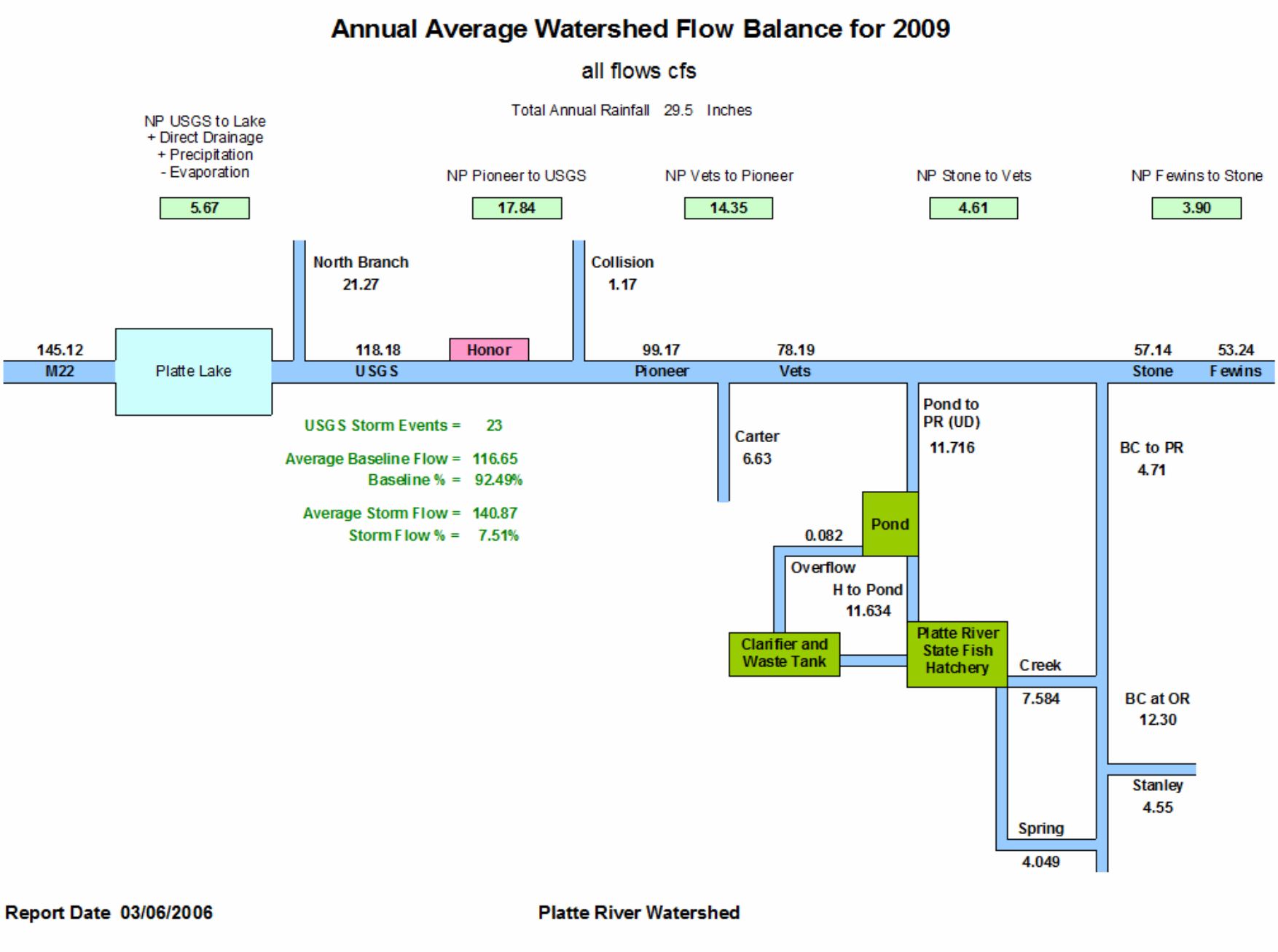


Figure 17. Watershed flow balance.

Annual Average Watershed TP Concentrations for 2009

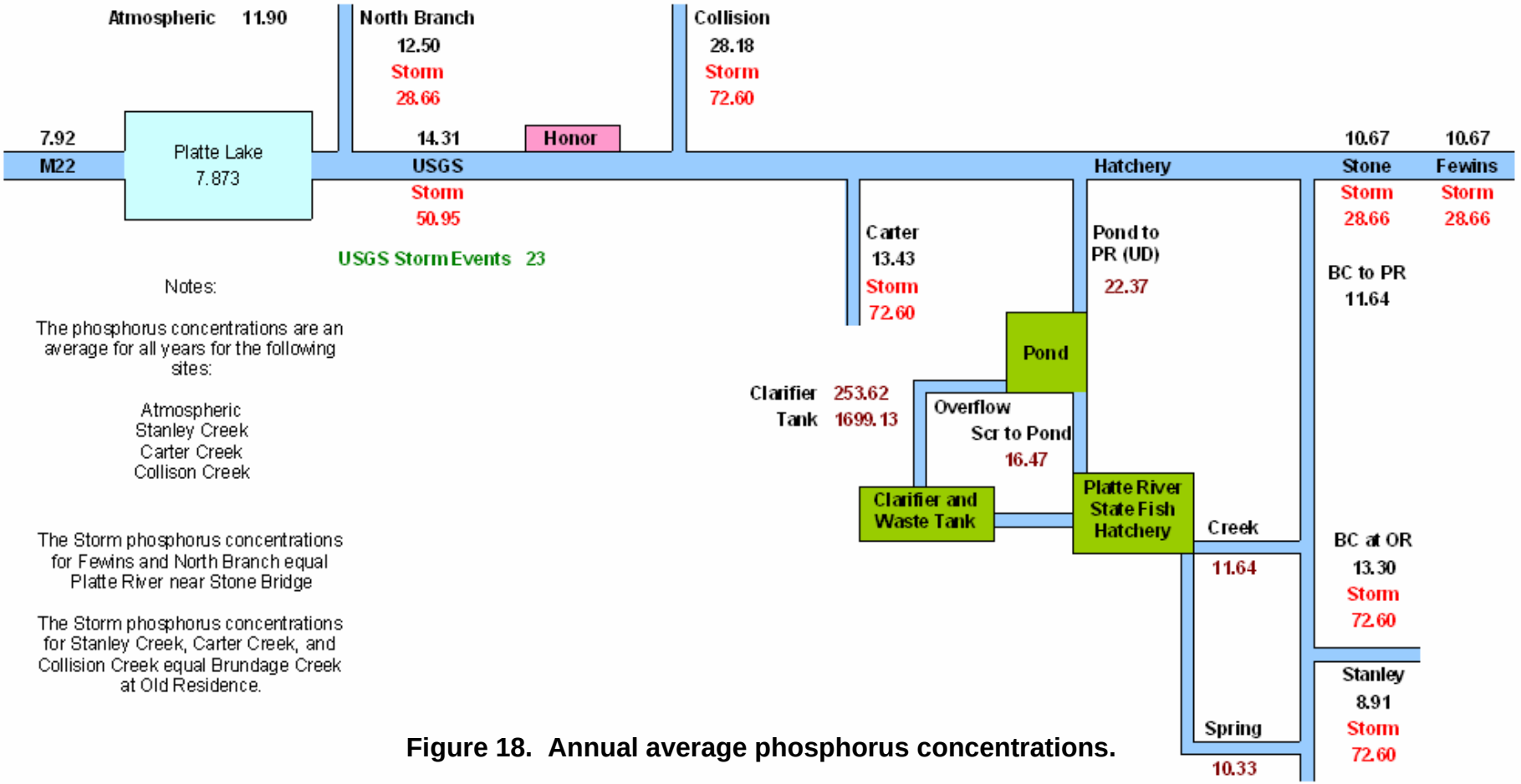


Figure 18. Annual average phosphorus concentrations.

Annual Average Watershed Load Balance for 2009

all loads annual pounds

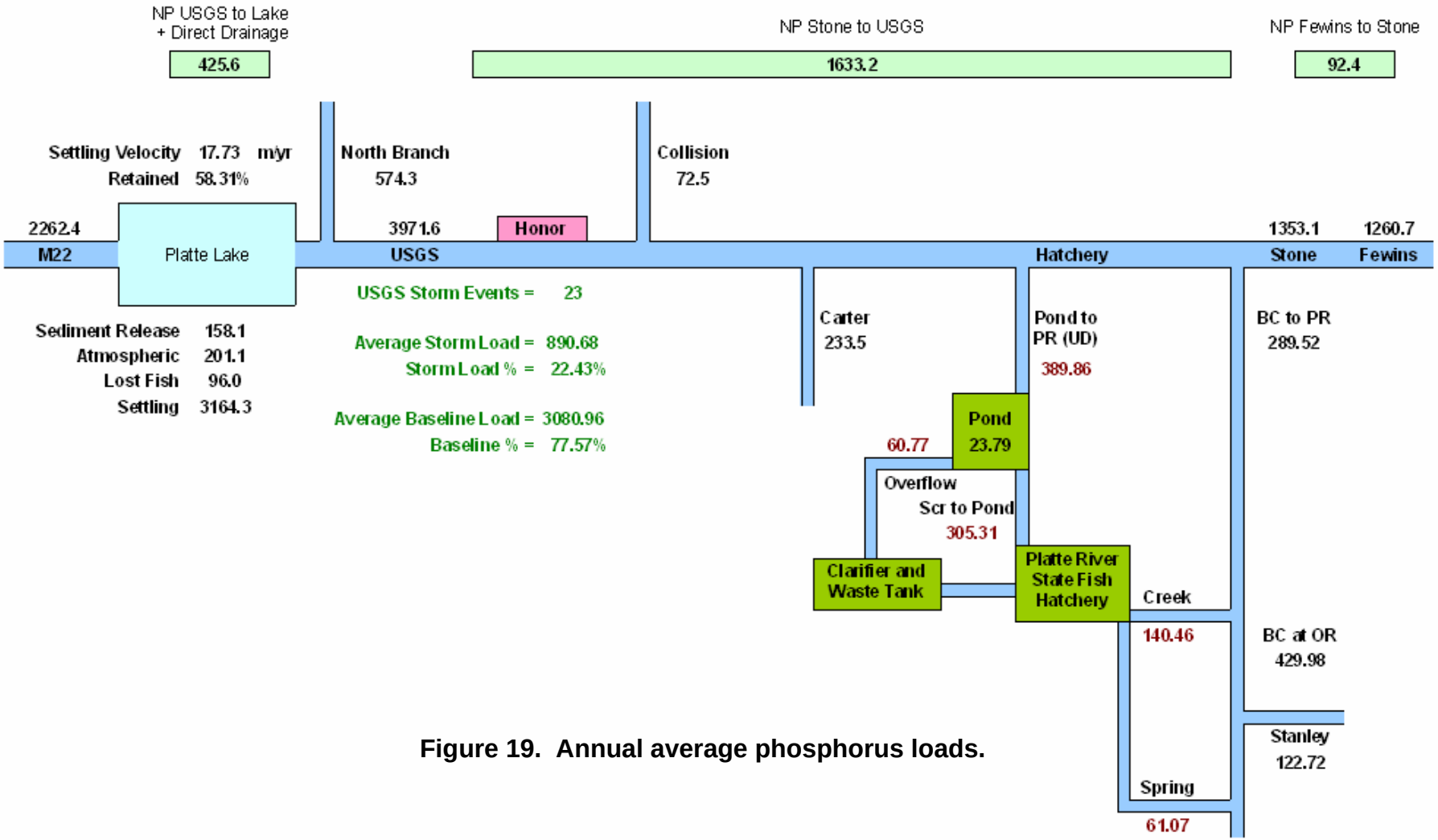


Figure 19. Annual average phosphorus loads.

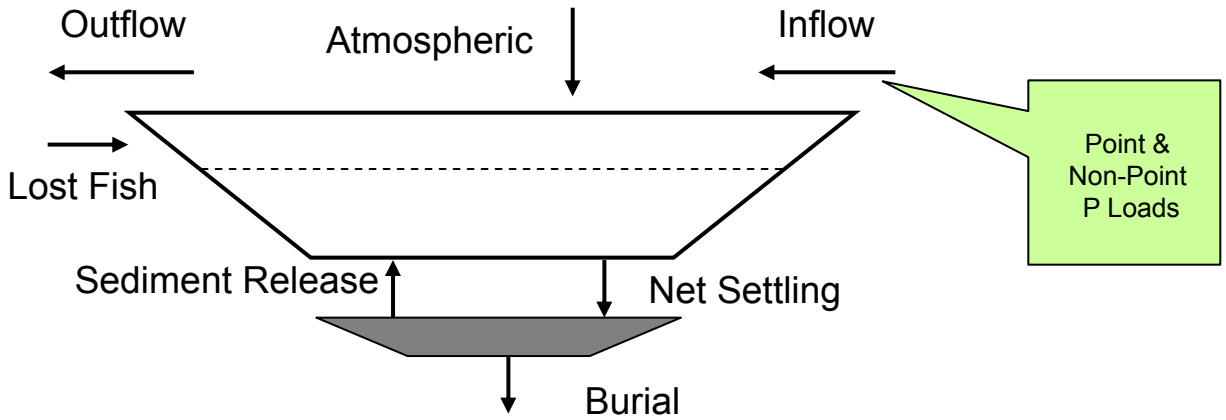
	Landfill Site Tamarack West	Barnyard Site Tamarack East	Mixture Platte Road	Control Bixler Cr
Flow (cfs)	1.73	1.61	3.34	0.5
TP mg/m3)	12.1	26	20.7	20.8
TP Load (Lbs/yr)	41.2	82.5	136.4	20.5
Turbidity (NTU)	16.8	5.8	2.1	4.0
COD (mg/L)	23.3	6.2	11.6	11.6
BOD5 (mg/L)	19.2			
NO2+NO3 (mg/m3)	290	822	75	868
Iron (mg/L)	0.55			

Figure 20. Average MDNRE and PLIA measurement for Tamarack Creek.

Figure 21. Comparison between East (left) and West (right) branches of Tamarack Creek.

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

Manuscript Submitted To
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 22. Water and sediment model for Big Platte Lake.

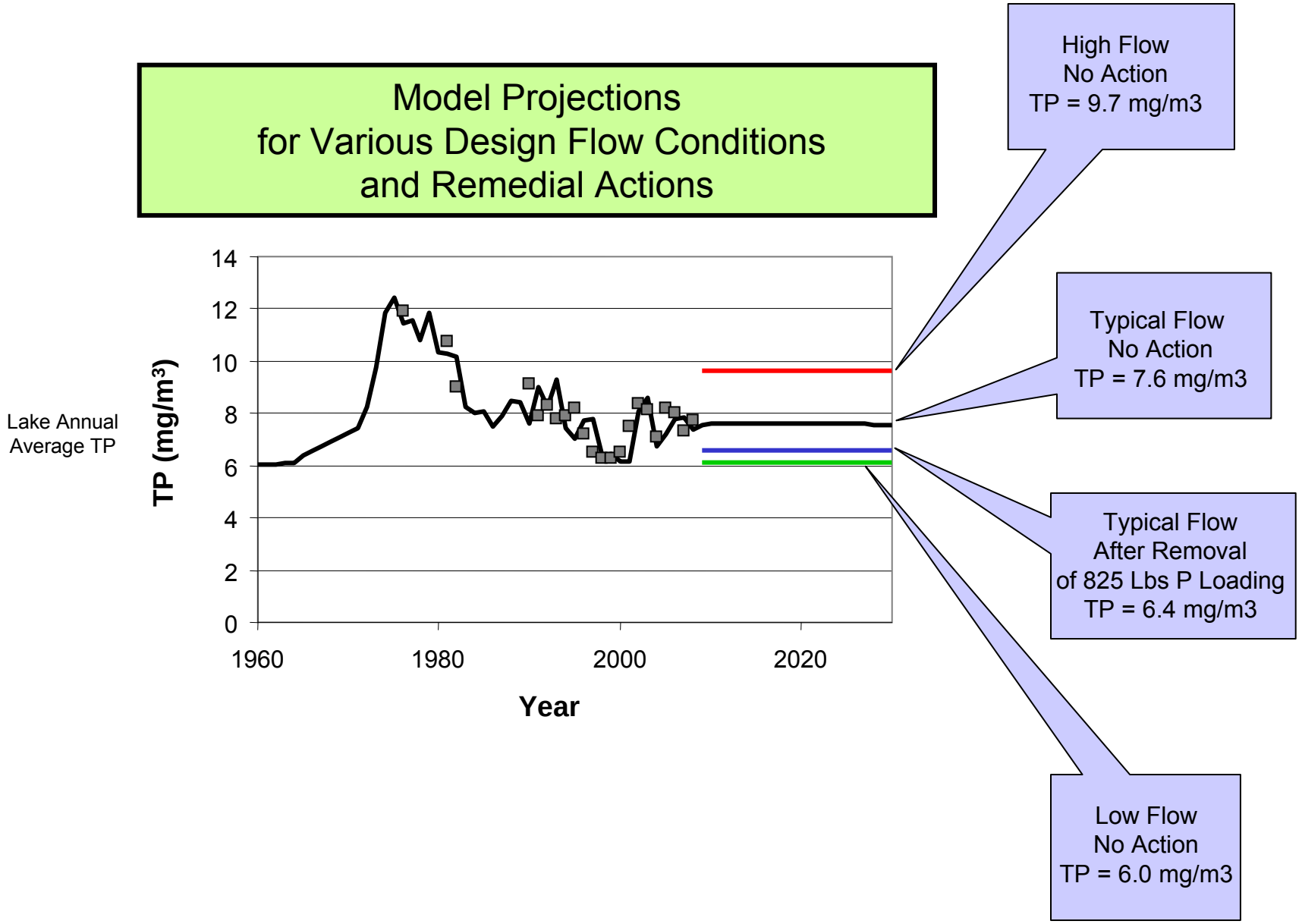


Figure 23. Model validation and projections for total phosphorus in Big Platte Lake.

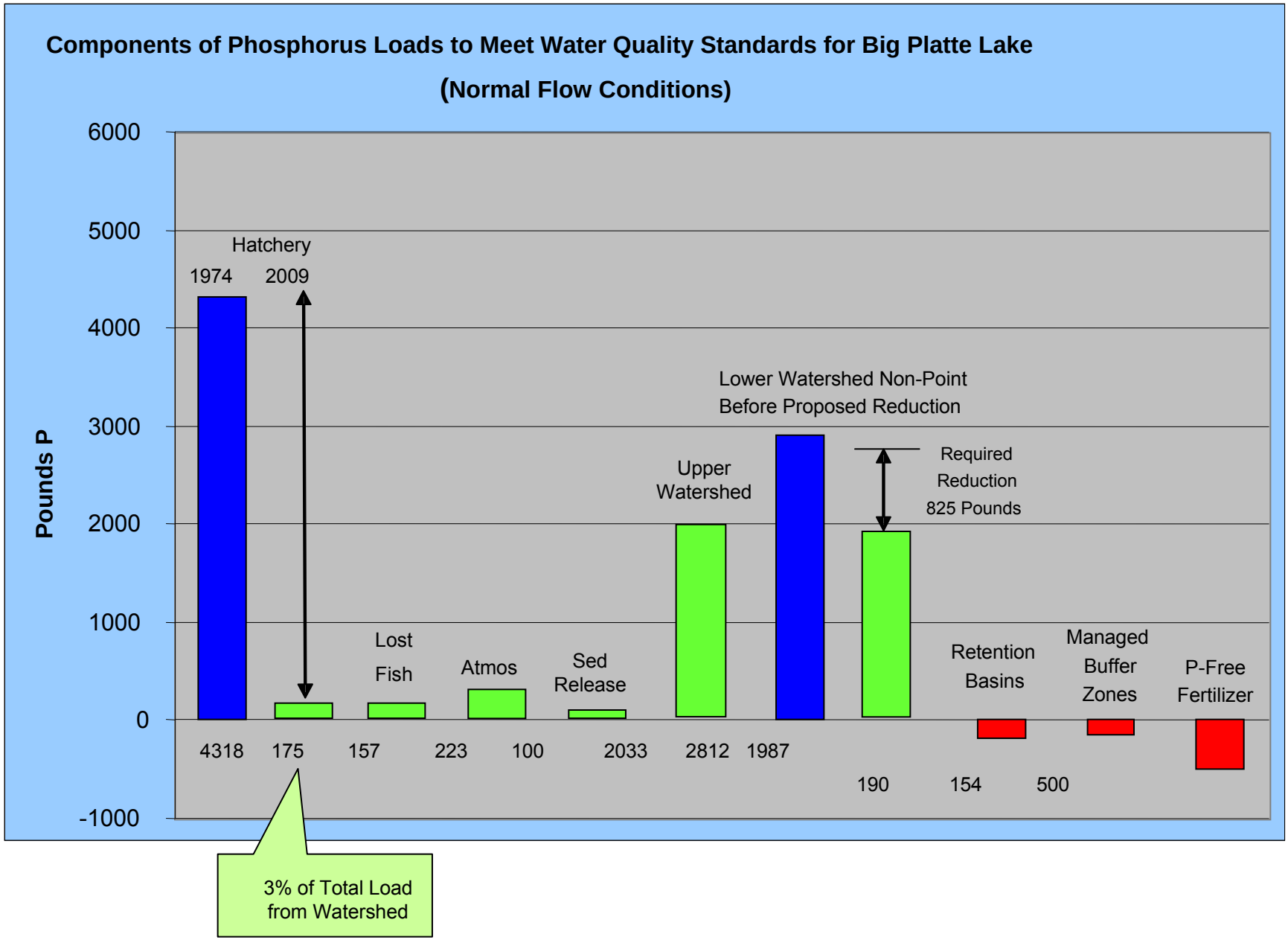


Figure 24. Phosphorus Loading Components.

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

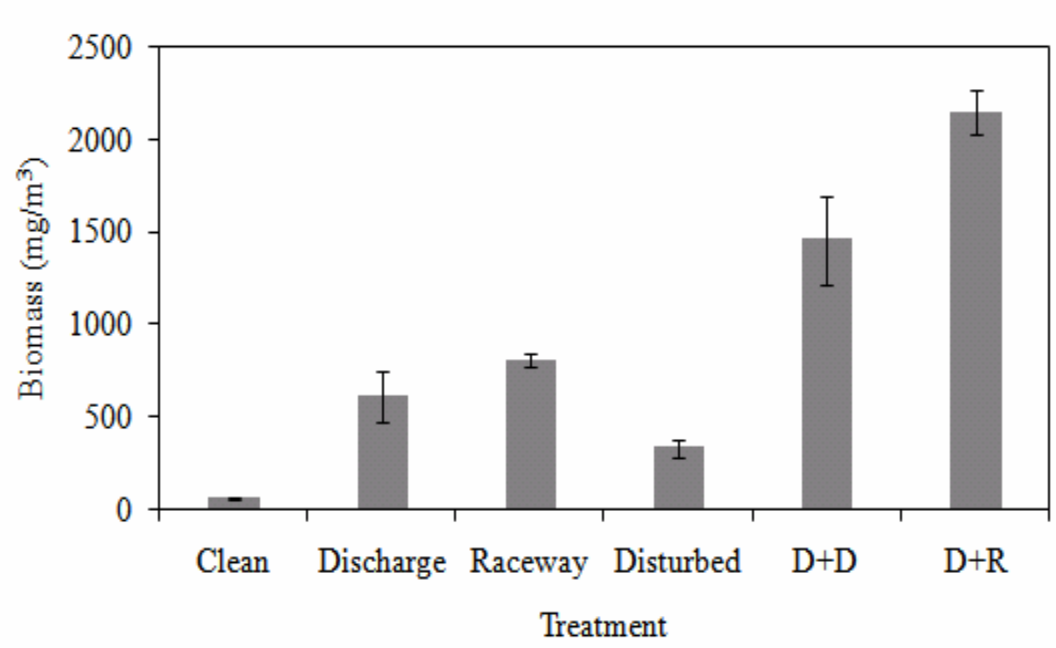


Figure 25. Algal growth in various point and non-point source waters (from Qian, 2009)

	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 26. Proposed sampling program and costs for 2010.