

Pend Oreille River Preliminary Nutrient Load Analysis

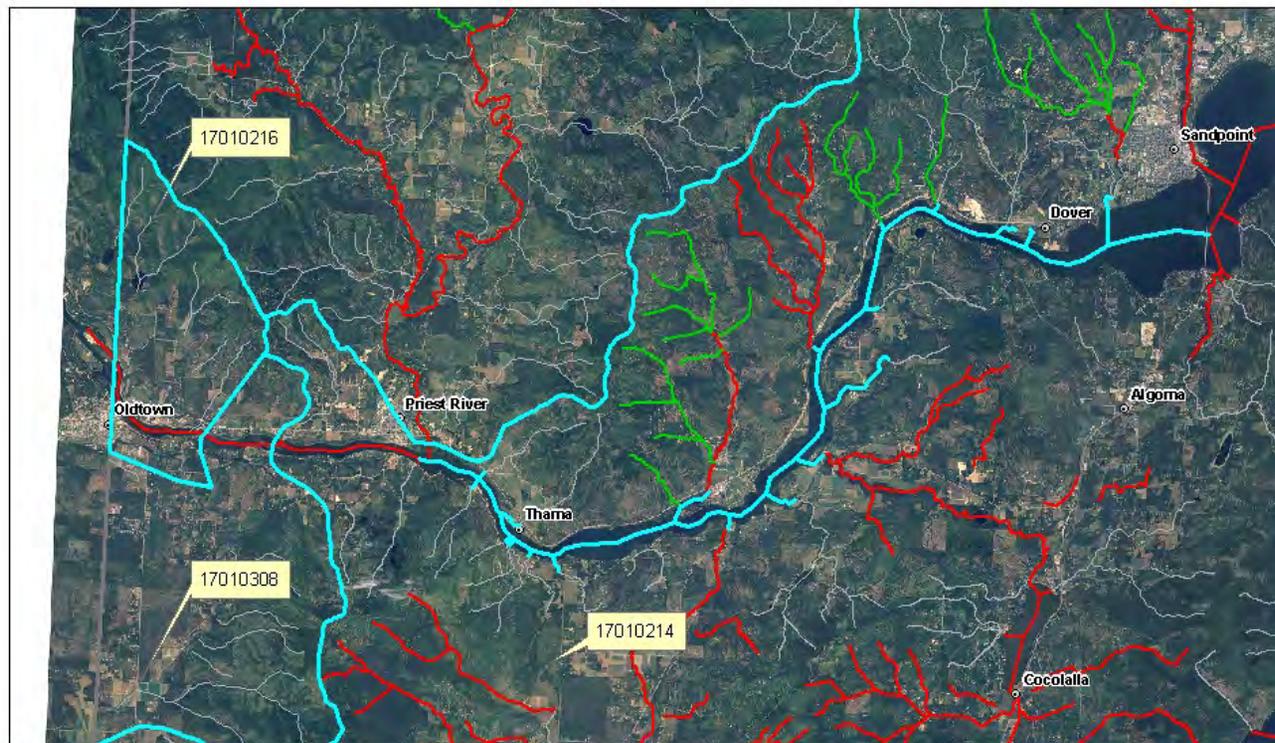


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Pend Oreille River Assessed Reach

Assessment Unit = "Pend Oreille River near Murphy Bay,
ID17010214PN002_08"

Pend Oreille River
Listing Status 2008 Integrated Report
Sandpoint to Washington Border



Legend

- Idaho Cities/Towns
- Not Supporting
- Not Assessed
- Fully Supporting
- Wilderness
- 4th Field HUICS (Idaho)

0 2.5 5 10 Miles



Pend Oreille River Sampled Extent

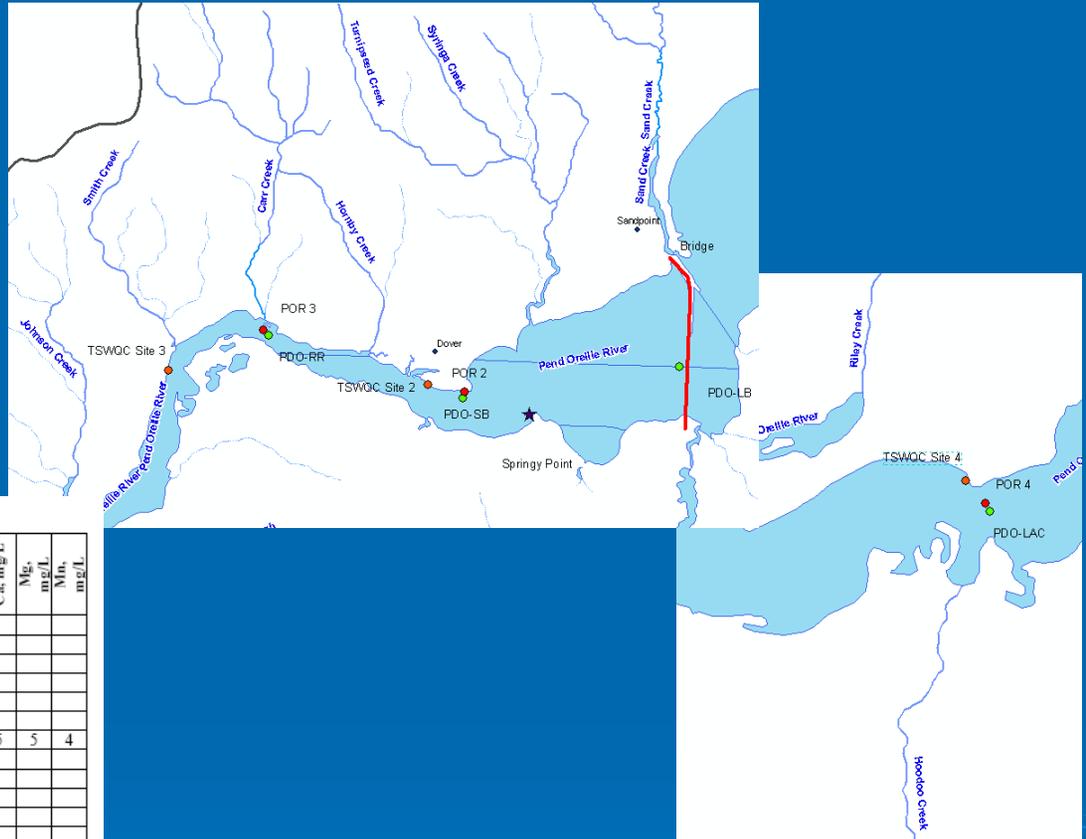
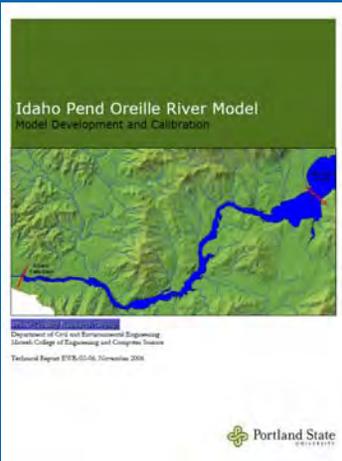
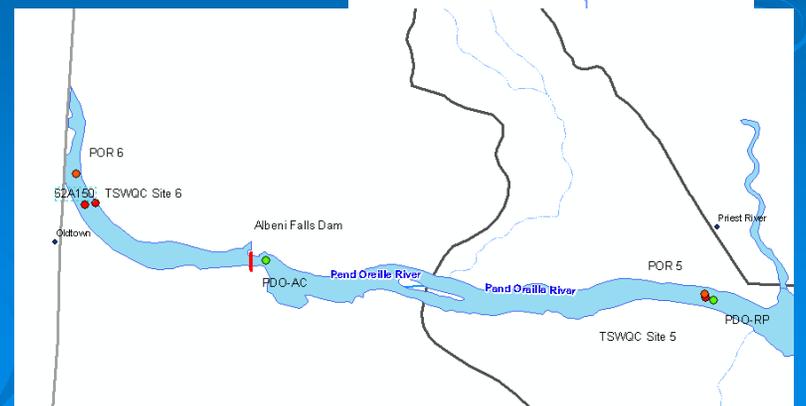


Table 26: Extent of grab sample water quality data, part 1 (counts of measurements)

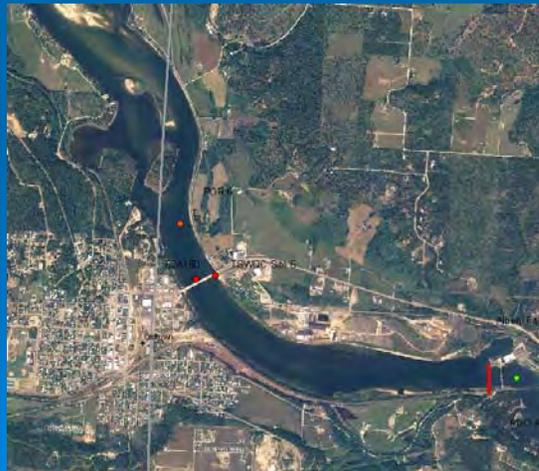
Site ID	Min Date	Max Date	Temp, C	pH	BOD, mg/L	chl a, ug/L	TPN, mg/L	NHx, mg/L	NO2+NO3, mg/L	SRP, mg/L	TP, mg/L	Turb, NTU	Ca, mg/L	Mg, mg/L	Min, mg/L
PDO-AC	08/11/2004	09/09/2004		3	3	6	6	6	6	3	6				
PDO-LAC	08/11/2004	09/09/2004		5	5	10	10	10	10	5	10				
PDO-LB	08/11/2004	09/09/2004		2	2	4	4	4	4	2	4				
PDO-RP	08/11/2004	09/09/2004		3	3	6	6	6	6	3	6				
PDO-RR	08/11/2004	09/09/2004		7	7	11	11	11	11	7	11				
PDO-SB	08/11/2004	09/09/2004		3	3	6	6	6	6	3	6				
SandPt	03/30/2004	12/14/2004	5	5								5	5	5	4
POR2	06/01/2004	09/10/2004		4		4	4				4				
POR3	06/01/2004	09/10/2004		4		4	4				4				
POR4	06/01/2004	09/10/2004		4		4	4				4				
POR5	06/02/2004	09/10/2004		4		4	4				4				
POR6	06/02/2004	09/10/2004		4		4	4				4				
62A150	01/12/2004	07/12/2005	19	19			19	19	19	19	18	19			
ALFFB	02/23/2005	11/22/2005				10	10	8	10	10	10		4	4	
ALFLPD	02/23/2005	11/22/2005				9	18	15	18	18	18		7	7	
ALFLPS	02/23/2005	11/22/2005				10	15	13	15	15	15		6	6	

● TSWQC Sites



Washington DOE Water Quality Monitoring Station 62A150 Pend Oreille River at Newport, WA

- Streamflow and dissolved oxygen since 7/29/1959
- Streamflow, dissolved oxygen, and total phosphorus since 10/7/1975
- Out of 451 dissolved oxygen samples, only five violate Washington's water quality standard of 8.0 mg/L (Idaho's standard is 6.0 mg/L)



date	time	FLOW (CFS)	OXYGEN (mg/L)	TP_P (mg/L)	TP_P_ICP (mg/L)
12/16/1965	0:00		7.6		
8/4/1981	8:00	15400	7.9	0.01	
10/7/1987	8:35	24600	6.8	0.01	
8/4/1998	6:05	26100	7.9	0.01 U	
8/7/2007	7:45	8170	7.93		0.0033

Washington DOE Water Quality Monitoring Station 62A150 Pend Oreille River at Newport, WA

- WA DOE's Water Quality Index scores for total phosphorus at this site



Water Quality Index Score	
Total Phosphorus	
1992	96
1993	100
1994	93
1995	93
1996	100
1997	51
1998	50
1999	84
2000	98
2001	96
2002	95
2003	91
2004	100
2005	100
2006	100
2007	100

Scores of less than 40 = poor
40 through 79 = moderate
80 through 100 = good

Water Quality Index methodology based on WAC 173-201A for numeric criteria and relative to expected conditions in a given ecoregion for narrative standards

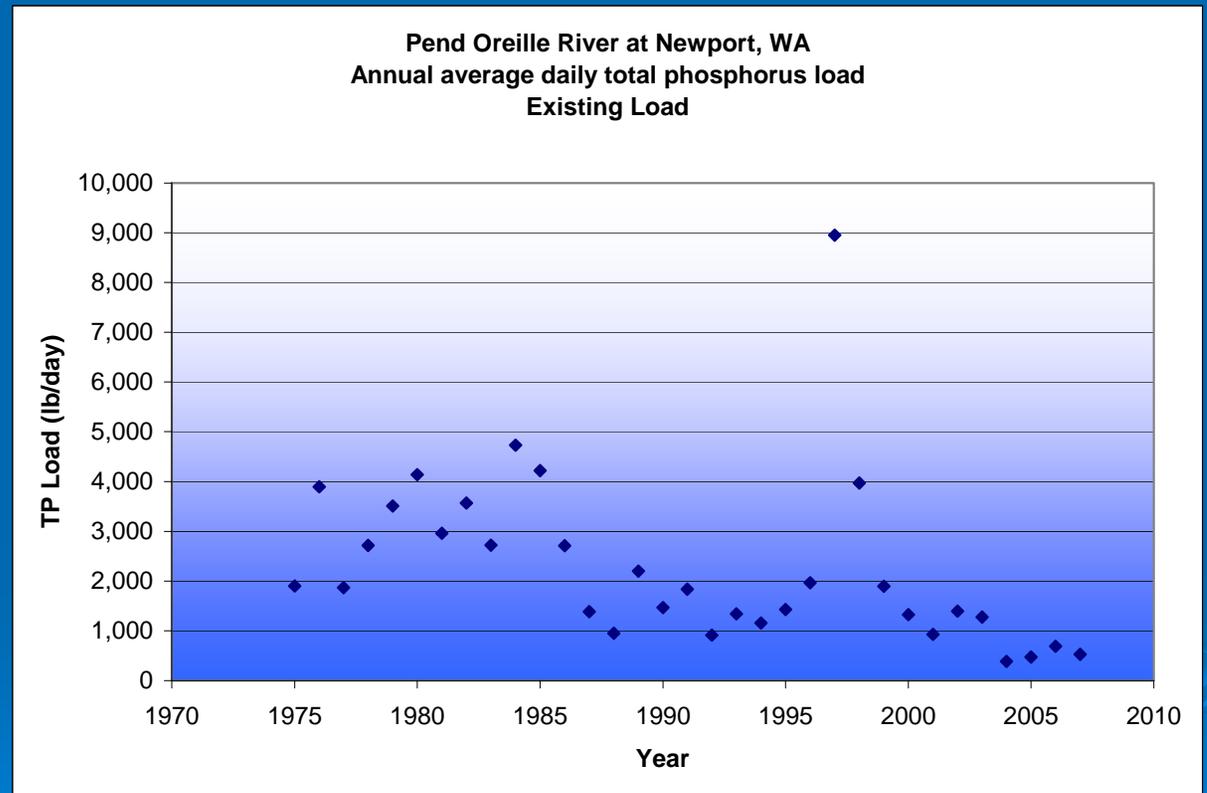
Pend Oreille River Preliminary Nutrient Load Analysis from WA DOE Data at 62A150

Conversion from concentration to load

$$\frac{x \text{ milligram}}{\text{liters}} \cdot \frac{y \text{ cubic feet}}{\text{second}} \cdot (60 \cdot 60 \cdot 24) \frac{\text{seconds}}{\text{day}} \cdot 28.317 \frac{\text{liters}}{1 \text{ cubic foot}} \cdot 2.205 \times 10^{-6} \frac{\text{pounds}}{1 \text{ milligram}}$$

Pend Oreille River Preliminary Nutrient Load Analysis from WA DOE Data at 62A150

Year	Average TP load (lb/day)	WA DOE WQI Score for total phosphorus
1975	1,900	
1976	3,896	
1977	1,867	
1978	2,716	
1979	3,508	
1980	4,139	
1981	2,963	
1982	3,569	
1983	2,722	
1984	4,730	
1985	4,221	
1986	2,710	
1987	1,384	
1988	953	
1989	2,201	
1990	1,469	
1991	1,836	
1992	913	96
1993	1,342	100
1994	1,157	93
1995	1,429	93
1996	1,966	100
1997	8,953	51
1998	3,970	50
1999	1,897	84
2000	1,328	98
2001	931	96
2002	1,395	95
2003	1,279	91
2004	383	100
2005	472	100
2006	692	100
2007	528	100



Pend Oreille River Preliminary Nutrient Load Analysis Target Evaluation

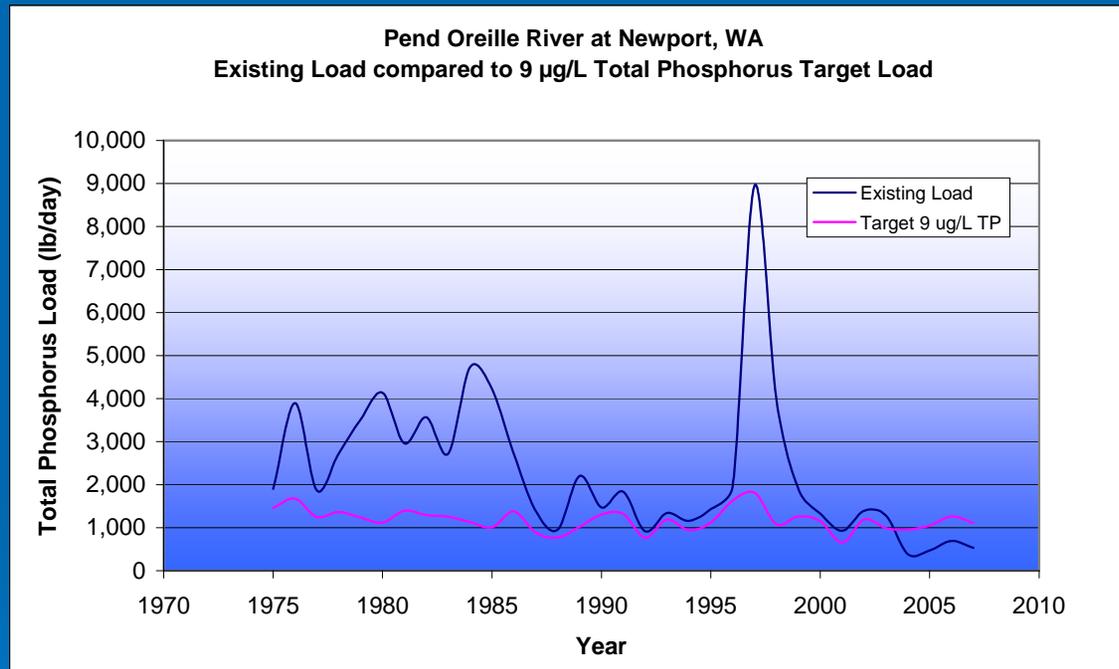
- Pend Oreille Lake nearshore nutrient TMDL target = 9 $\mu\text{g/L}$ average and 12 $\mu\text{g/L}$ instantaneous
- Applicable to:
 - Water level 52 feet or less
 - Nonpoint sources

Pend Oreille River

Preliminary Nutrient Load Analysis

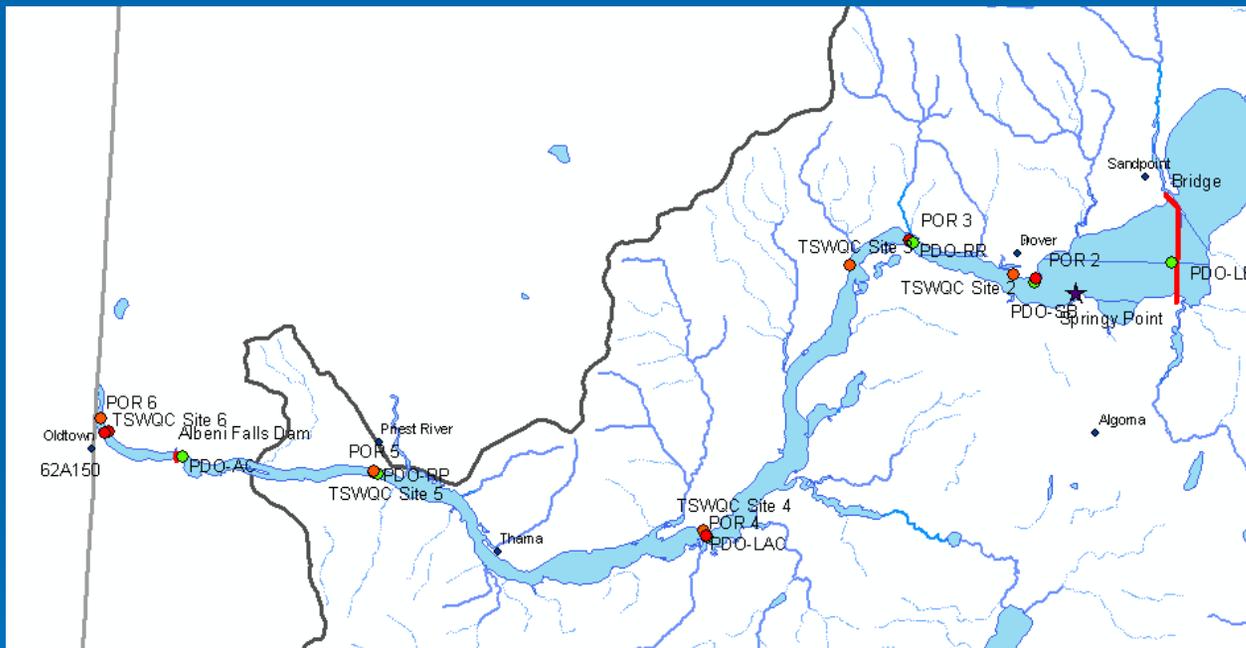
from WA DOE Data at 62A150

Average TP load (lb/day)		
	Existing Load	Target
1975	1,900	1,459
1976	3,896	1,674
1977	1,867	1,248
1978	2,716	1,369
1979	3,508	1,238
1980	4,139	1,115
1981	2,963	1,394
1982	3,569	1,297
1983	2,722	1,252
1984	4,730	1,130
1985	4,221	1,009
1986	2,710	1,377
1987	1,384	885
1988	953	771
1989	2,201	1,020
1990	1,469	1,307
1991	1,836	1,320
1992	913	762
1993	1,342	1,190
1994	1,157	944
1995	1,429	1,119
1996	1,966	1,630
1997	8,953	1,808
1998	3,970	1,077
1999	1,897	1,260
2000	1,328	1,150
2001	931	657
2002	1,395	1,188
2003	1,279	984
2004	383	952
2005	472	1,044
2006	692	1,263
2007	528	1,112



1975-1998	TP_P Average	0.02021
1999-2003	TP_P Inline Average	0.01163
2003-2007	TP_P ICP Average	0.00405

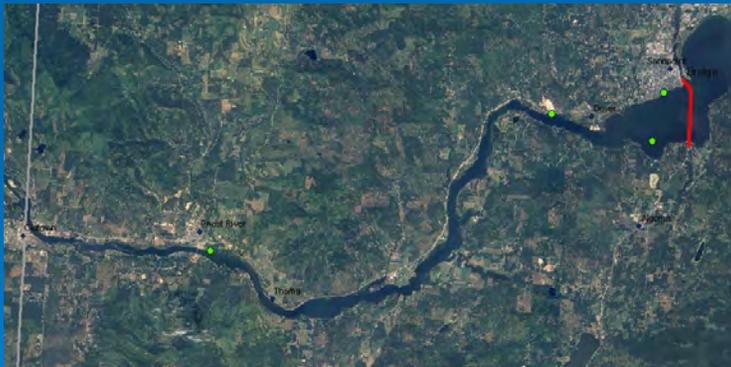
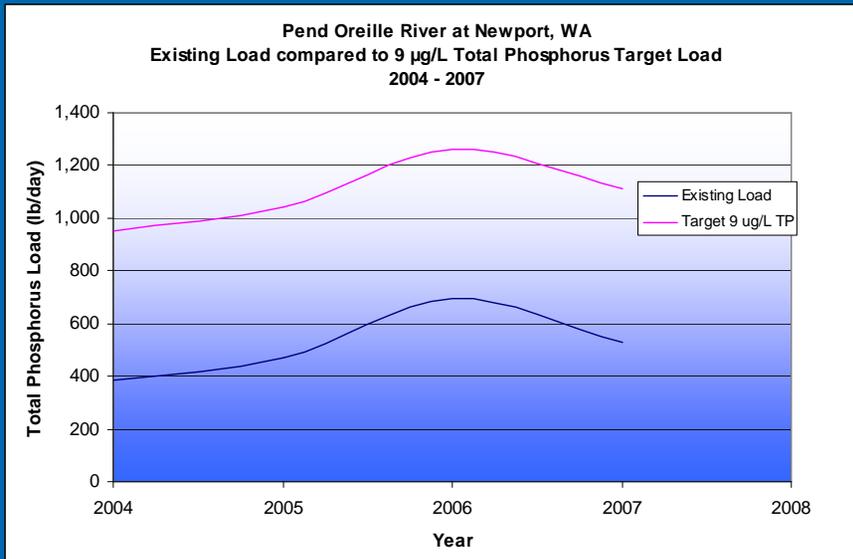
Pend Oreille River Preliminary Nutrient Load Analysis from WA DOE Data at 62A150 Sources of Uncertainty



Watershed
11,217 km²
Average Target
Load = 1,182 lb/day

Watershed
7,870 km², 70% of the size of
the larger watershed, average
target load = 827 lb/day

Pend Oreille River Preliminary Nutrient Load Analysis



Sandpoint WWTP			
	TP mg/L	Flow mgd	Load lb/day
1/2/2007	2.22	4.3	80
2/6/2007	3.54	2.3	68
3/6/2007	1.59	5	66
4/3/2007	1.55	3.2	41
5/1/2007	3.84	1.9	61
6/5/2007	3.72	1.9	59
7/3/2007	4.26	1.8	64
8/8/2007	1.93	2.5	40
9/4/2007	1.87	2.7	42
10/2/2007	2.81	2.1	49
11/27/2007	4.22	1.6	56
12/4/2007	1.89	6	95
Average			60
1/8/2008	2.82	3.2	75
2/5/2008	3.01	2.2	55
4/8/2008	0.96	6.5	52
5/6/2008	1.72	2.0	29
6/3/2008	3.4	3.3	94
7/1/2008	3.93	2.1	69
9/2/2008	3.65	2.0	61
10/14/2008	4.52	2.1	79
Average			62

Priest River WWTP			
TP mg/L	Flow gpd	Load lb/day	
4.5	240000		9

Dover WWTP			
TP mg/L	Flow gpd	Load lb/day	
3.5	45000		1

Proposed Southside WWTP			
TP mg/L	Flow gpd	Load lb/day	
4.5	30000		1

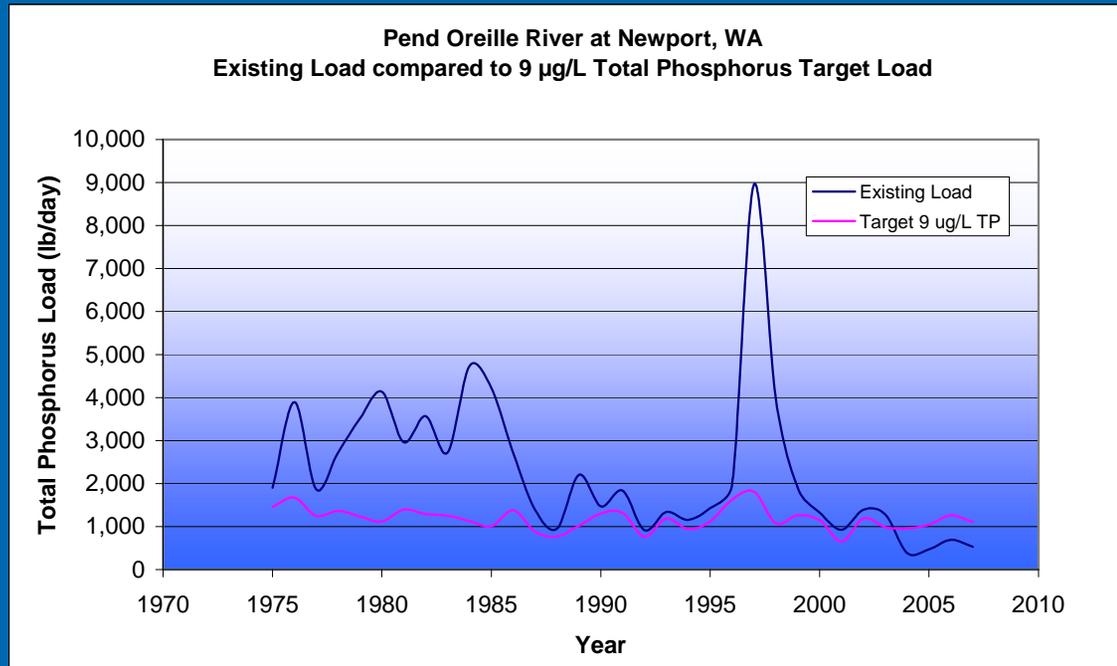
Albeni Falls Dam			
TP mg/L	Flow gpd	Load lb/day	
4.5	270	0.01	

mg/L = milligrams per liter
mgd = million gallons per day
gpd = gallons per day
lb/day = pounds per day

Average streamflow
USGS gaging station =
25,600 cfs
Average load 2004-2007
= 519 lbs/day.

Average streamflow
WWTPs = 4.6 cfs
Average load 72
pounds per day.

Pend Oreille River Preliminary Nutrient Load Analysis



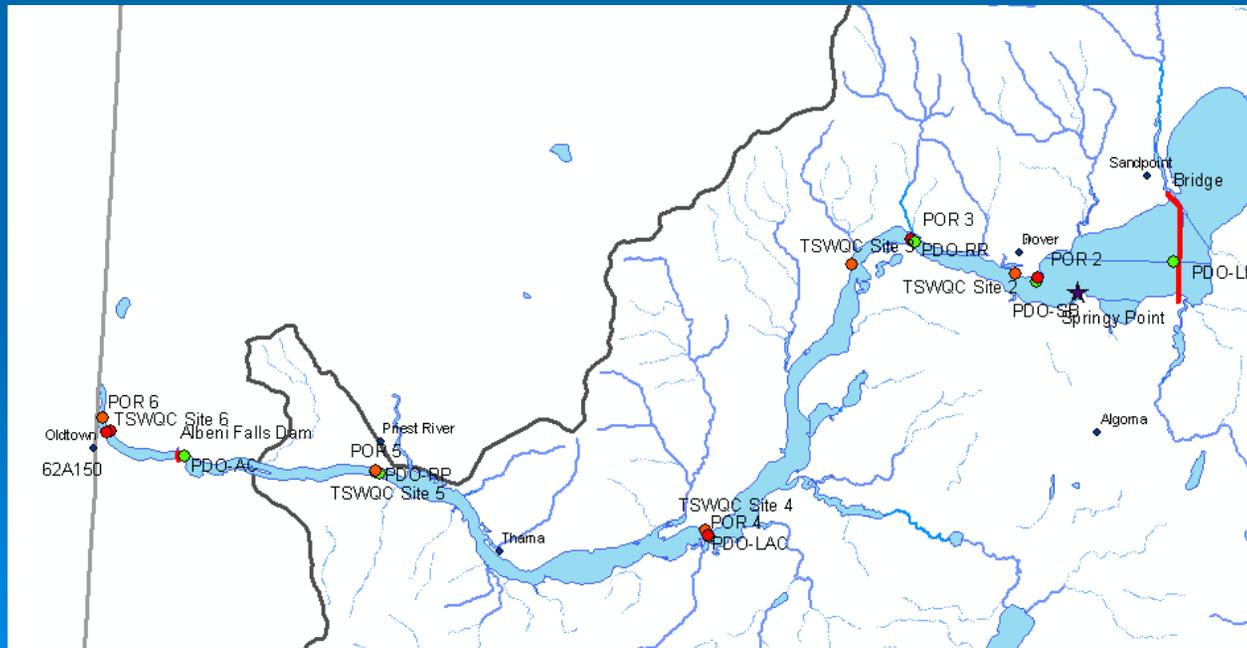
However:

- Dissolved oxygen does not violate water quality standards
- Chlorophyll-a data in the assessment unit range from 1-2.6 µg/L
 - less than 10 µg/L supports primary contact recreational uses (Raschke 1993).
 - Chlorophyll-a data range shows oligotrophic state

Raschke 1993. Guidelines for assessing and predicting eutrophication status of small southeastern Piedmont impoundments. US EPA, Athens, GA.

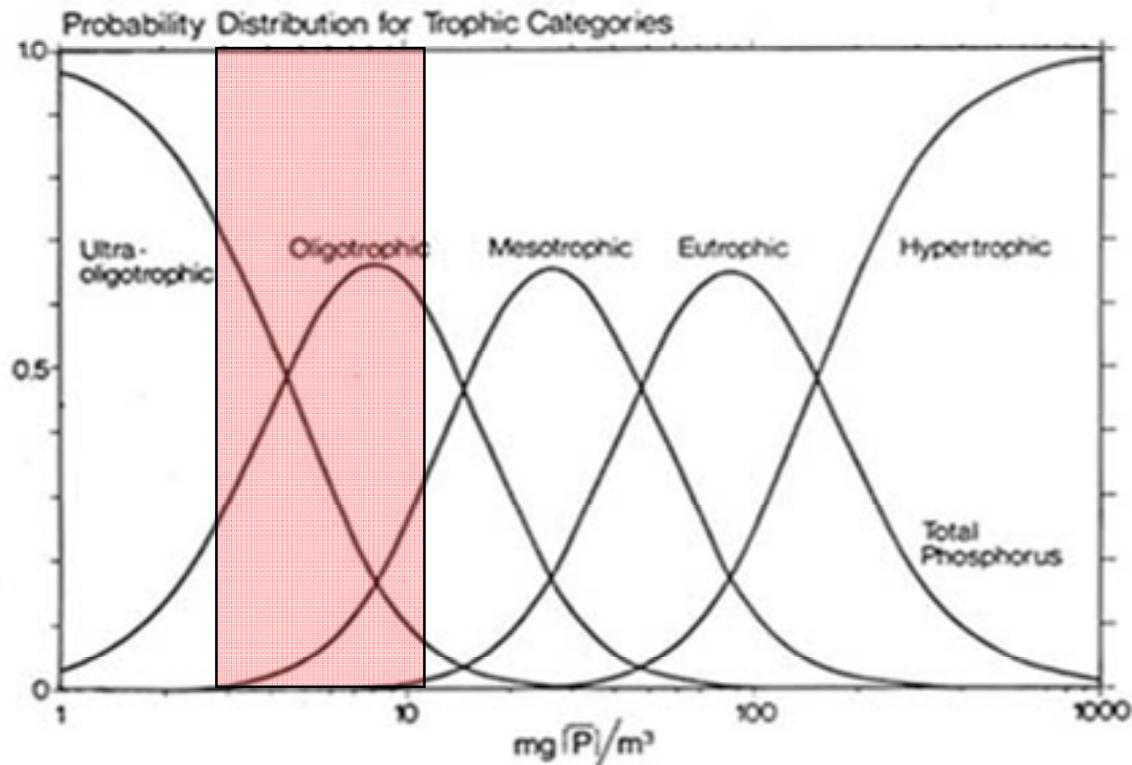
Pend Oreille River Water Quality Data

- Most of the other water quality data was collected in 2004
- POR by Tetra-Tech
- PDO by Idaho DEQ
- Sites 2 through 6 by TSWQC



Pend Oreille River Trophic Category Analysis

Probability distribution curve for average phosphorus



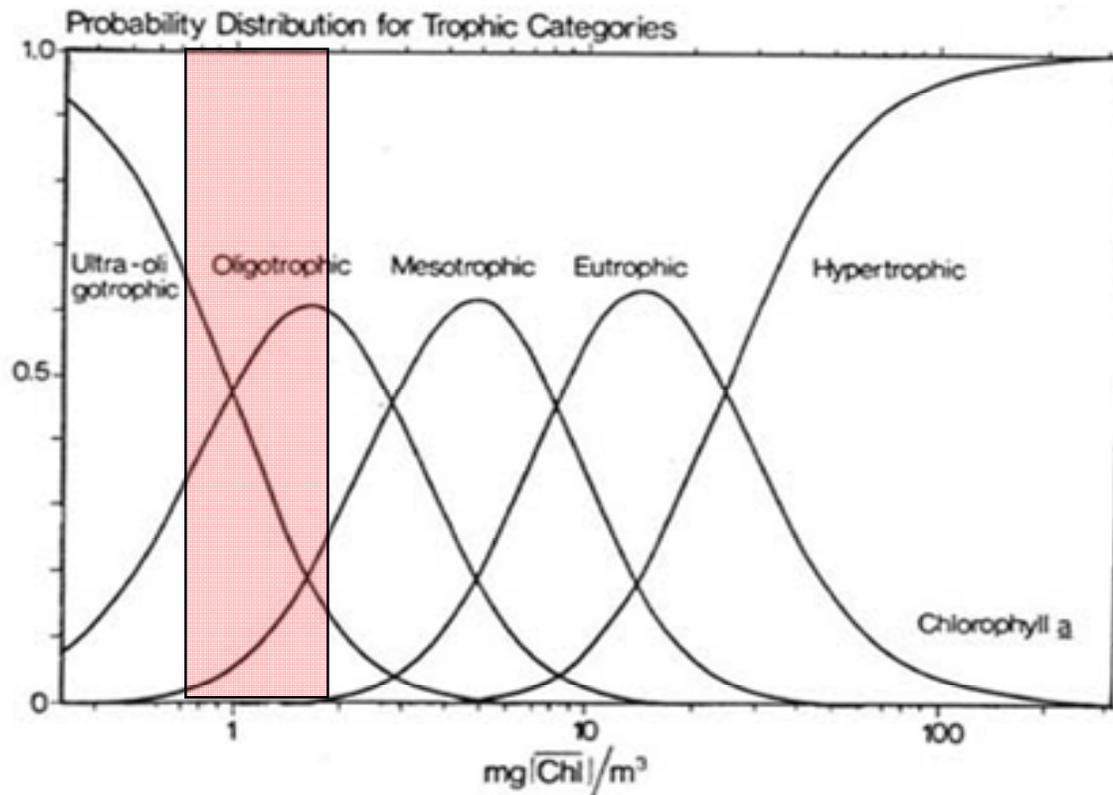
Data ranges:

2.3 to 20 mg/m³ with 62A150

5 to 20 mg/m³ without 62A150

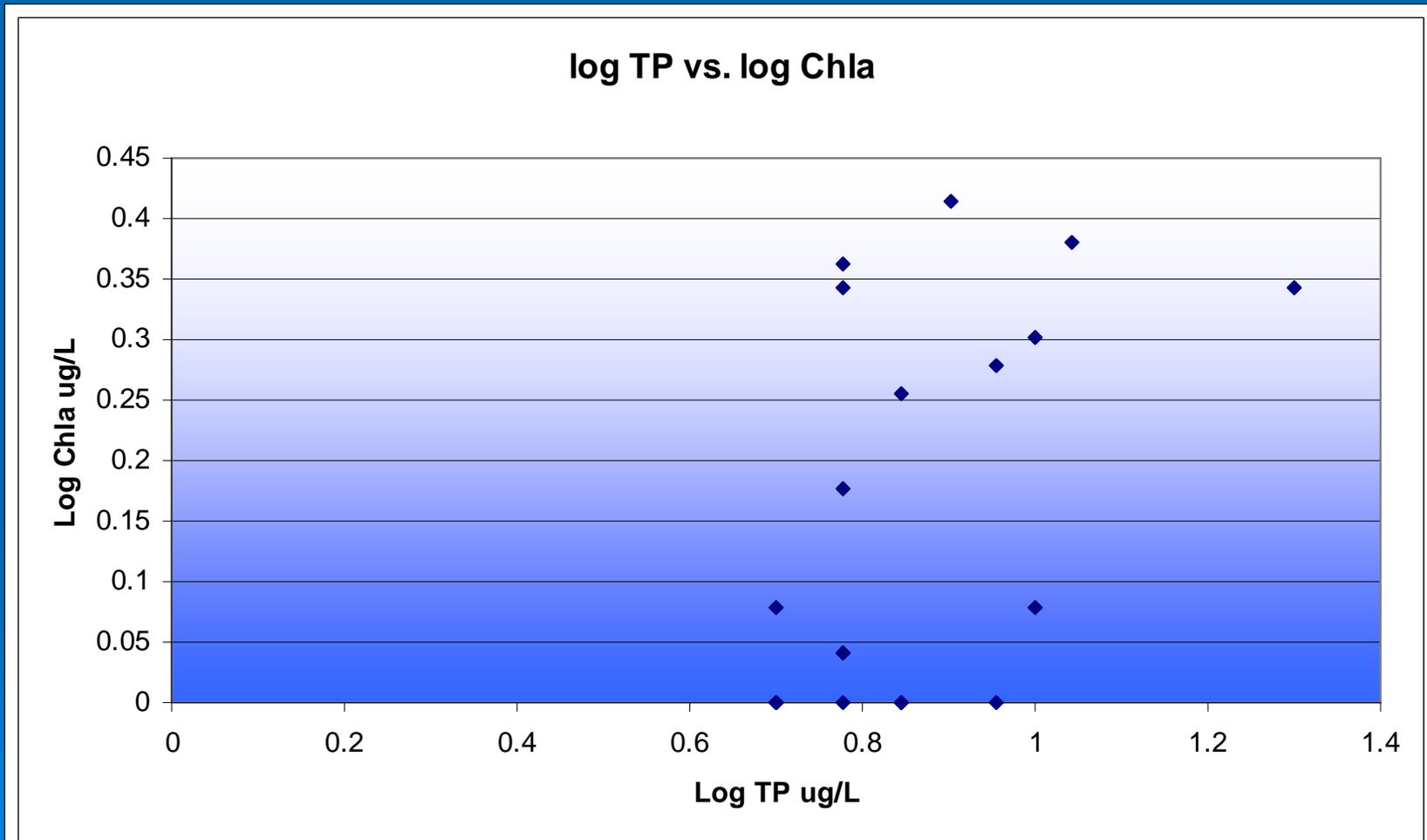
Pend Oreille River Trophic Category Analysis

Probability distribution curve for the average chlorophyll *a* :



Data Range
1 to 2.6 mg/m^3

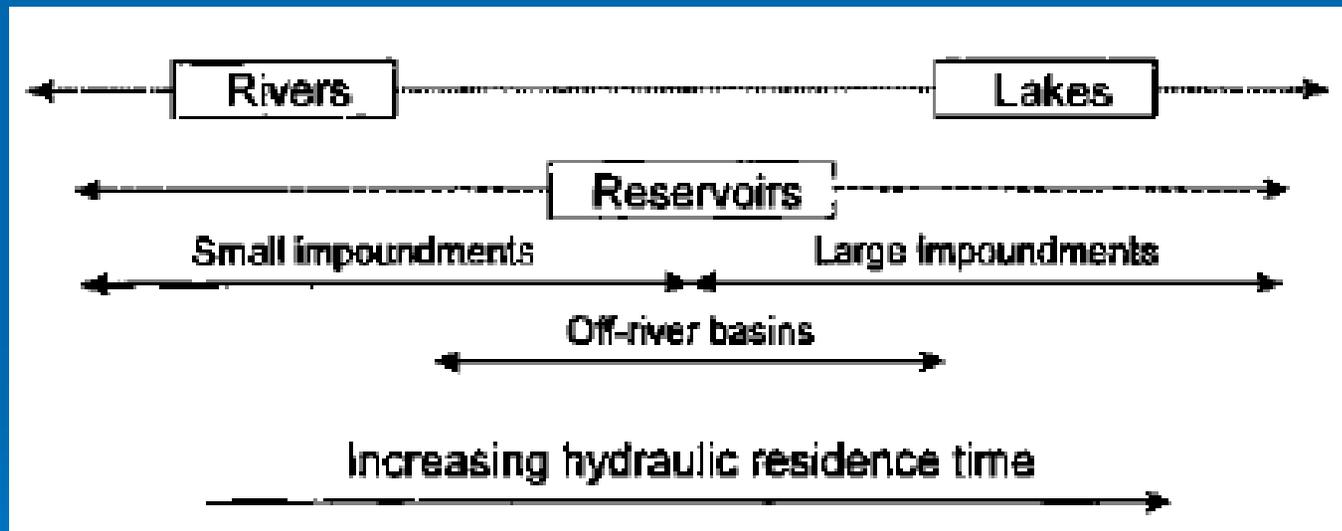
Pend Oreille River Trophic Category Analysis



Vollenweider, R.A. 1976. Advances in defining critical loading levels of phosphorus in lake eutrophication. Mem. 1st Ital. Idrobiol. 33:53-83. in: Correl, D.L. 1998. The role of phosphorus in the eutrophication of receiving waters: a review. J. Environ. Qual. 27:261-266.

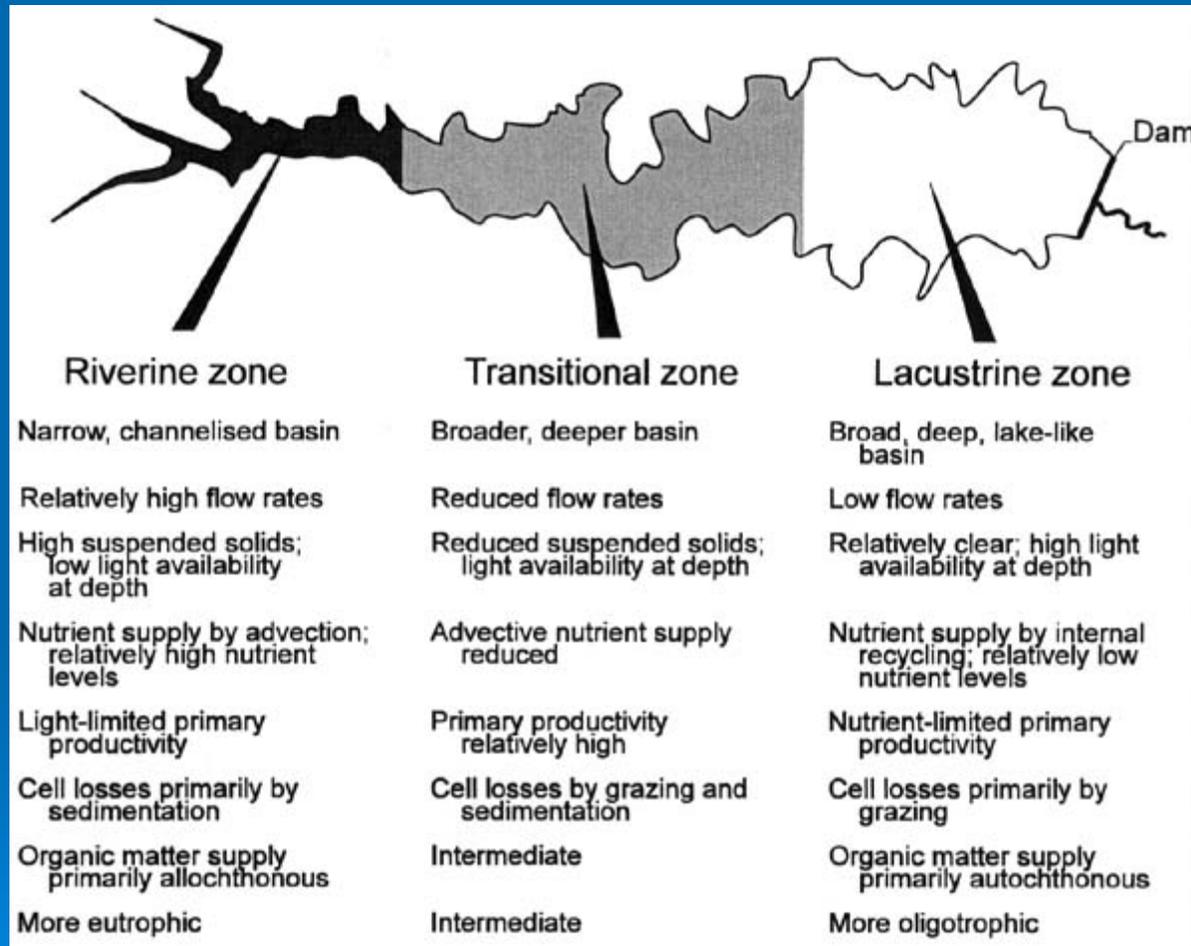
Pend Oreille River Reservoir evaluation

- Phosphorus and chlorophyll a ratios not lake-like
- Water residence time at Albeni Falls dam is 2 – 12 days



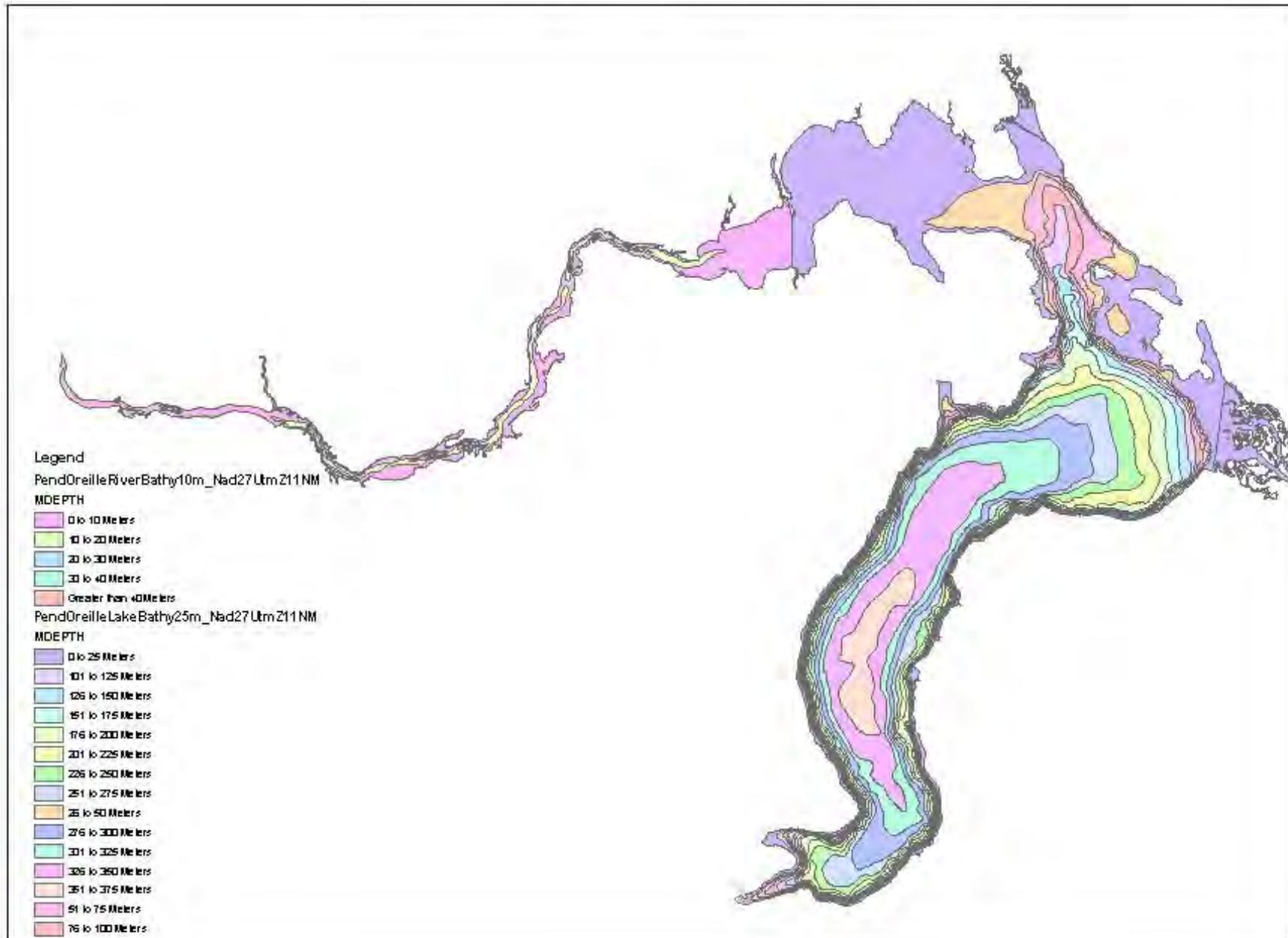
Modified from Kimmel and Groeger, Lake and Reservoir Management, EPA 440/5-84-001 (1984)

Pend Oreille River Reservoir evaluation



Modified from Kimmel and Groeger, Lake and Reservoir Management, EPA 440/5-84-001 (1984)

Pend Oreille Lake and River Bathymetry



Pend Oreille River Target Analysis

- What is an appropriate target for an oligotrophic, riverine reservoir?
 - Reference reaches
 - Modeling
 - Ecoregion
 - Guidance

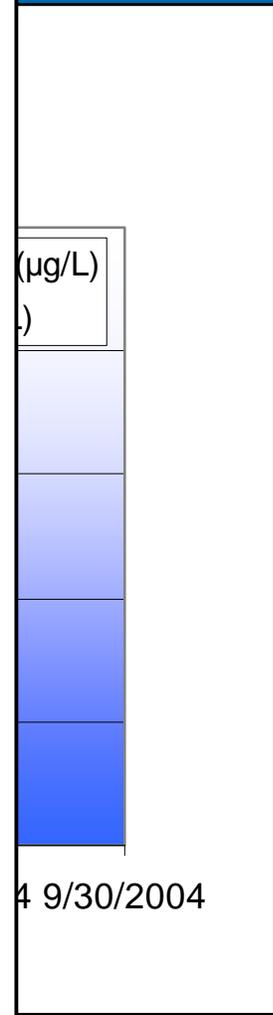
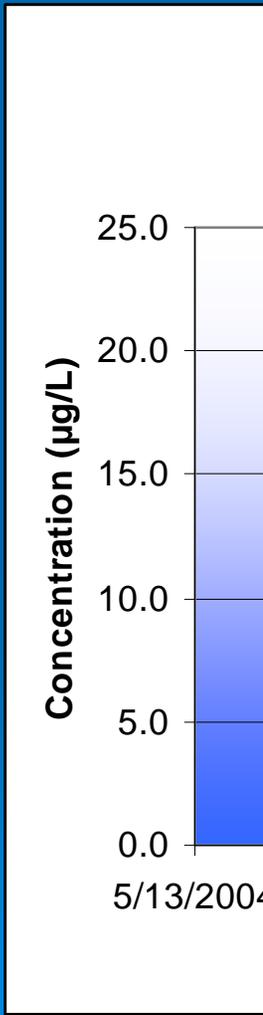
Table 1. General guidelines for in-pool water quality sampling.

Boundary Conditions		
Minimum parameters	Additional parameters	Frequency
inflow/outflow temperature	conductivity dissolved oxygen pH total dissolved solids ¹	daily or continuous
total organic carbon	dissolved and/or particulate organic carbon BOD ²	weekly w/ storm sampling
soluble reactive phosphorous total phosphorous	total dissolved phosphorus total inorganic phosphorus dissolved inorganic phosphorus	weekly w/ storm sampling

nitrate+nitrite nitrogen ammonium nitrogen	total Kjeldahl nitrogen filtered total Kjeldahl nitrogen	weekly w/ storm sampling
	total suspended solids ³ inorganic and/or volatile suspended solids	weekly w/ storm sampling
	chlorophyll a dissolved silica ⁴ alkalinity	weekly w/ storm sampling

In-Pool		
Minimum parameters	Additional parameters	Frequency
Temperature ⁵ Dissolved oxygen ⁵ pH ⁵ Conductivity ⁵	total dissolved solids ¹	monthly ⁶
Chlorophyll a ⁷	phytoplankton biomass and type	monthly
Total organic carbon ⁷	dissolved and/or particulate organic carbon BOD ²	monthly
Soluble reactive phosphorus Total phosphorus ⁷	total dissolved phosphorus total inorganic phosphorus dissolved inorganic phosphorus	monthly
nitrate + nitrite nitrogen ammonium nitrogen ⁷	total Kjeldahl nitrogen filtered total Kjeldahl nitrogen	monthly
	secchi depth/light transmission	monthly
	total inorganic carbon alkalinity	monthly
	total suspended solids ³ inorganic and/or volatile suspended solids	monthly
	dissolved/total iron ⁸ dissolved/total manganese ⁸ dissolved/total silica ⁸ total dissolved sulfide ⁸ sulfate ⁸ iron sulfide ⁸	monthly

- ¹ enough samples to correlate to conductivity - important for density effects
² used to characterize decay rates of organic matter
³ suspended solids affect phosphorus partitioning, light penetration, and density
⁴ can be limiting for diatom growth
⁵ preferably bi-weekly - samples should be taken at 1m intervals
⁶ 1m intervals
⁷ minimum number of samples includes one each in epilimnion, metalimnion, and hypolimnion - preferred number of samples (depending on depth) would be at 3m intervals with more frequent metalimnetic sampling
⁸ when concerned about sediment release during anoxic periods



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Pend Oreille River Target Analysis

➤ What is an appropriate target for an oligotrophic, riverine reservoir?

- Reference reaches
 - Modeling
 - Ecoregion

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 7 BASIN: MIDDLE ARKANSAS RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS						TEMPORARY MODIFICATIONS AND QUALIFIERS
			PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			
1. Pueblo Reservoir.		Aq Life Cold 1 Recreation E Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=126/100ml	NH ₃ (ac/ch)=TVS CL ₂ (ac)=0.018 CL ₂ (ch)=0.011 CN=0.005 S=0.002	B=0.75 NO ₂ =0.05 NO ₃ =10 Cl=250 SO ₄ =WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis)	Hg(ch)=0.01(tot) Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	

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