Analysis of Data Related to Surface Water Quality in Columbia Slough and its North Slough Arm within the Smith & Bybee Lakes Natural Area

(October 1997 - December 1998)

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Regulatory Standards:

The Oregon Administrative Rules require:

- the instantaneous *dissolved oxygen* is not less than 4 mg/l, the 7-day average of the daily minimum D.O. is not less than 5 mg/l, and the 30-day average of the daily mean D.O. is not less than 6.5 mg/l;
- the 7-day average of the daily maximum *water temperature* over a 7-day period is not to exceed 68°F; and
- *pH* is not to be less than 6.5 or greater than 8.5.

There are no regulatory standards for *specific conductivity*.

Background:

Water quality data from Columbia Slough and its North Slough arm have been collected by Metro as part of its surface water quality monitoring plan for the Smith and Bybee Lakes Natural Area, including St. Johns Landfill. The data have been collected since October 1997, using in-stream Hydrolab monitoring sensors. The plan has the following objectives:

- measure water quality parameters in correspondence with hydrologic cycles;
- evaluate the influence of the Willamette River and Columbia Slough waters on the Smith/Bybee Lakes Management area;
- provide monitoring associated with environmental enhancement projects; and
- provide short-term investigative monitoring, as needed.

The data are available to be used in the future to look for correlations, to verify, compare or test hypotheses and models, and to generally contribute to the study of the Columbia Slough within the Smith and Bybee Management area.

Metro Data Analysis:

Figures 2a, 2b, and 2c are plots of the data at each of the three stations (North Portland St. Bridge, east end of the North Slough, and the Lombard St. Bridge) shown in Figure 1. In the next step, known bad data (due to instrument error such as the probes being in the mud or a bad sensor) were eliminated. This was done with the use of field notes, and was often corroborated by noting when a significant change only occurred at one location. Tables 1 and 2 and Figures 3 and 4 show: (1) violations at each of the three monitoring locations, and (2) average water quality parameters at each station. The data are presented by season (which were selected based on the amount of rainfall during the month):

- Dry season (July 1 to September 30)
- Wet season (October 1 to June 30)

Data at Lombard Street Bridge was further broken out by tide. This was determined by finding the average daily water level. Any data taken at a time when the water level was above this average were assumed to be high tide. If below the average, it was assumed to be data collected at low tide. This approach seemed to provide a reasonable estimate.

- High tide - all data taken when the water level was above the daily average
- Low tide - all data taken when the water level was below the daily average

Since Table 1 (Number of Occurrences of Violations) and Table 2 (Seasonal Average Values of Water Quality Data) seemed inconclusive as to the effect of high vs. low tide, additional plots of average monthly water quality parameters were created (Figures 5a and 5b). Monthly averages of high tide and low tide for Lombard Street Bridge (LB) were compared to monthly averages at the North Portland Street Bridge (NPB) in the Columbia Slough, and it was found that the NPB data correlated well with the LB low tide data (see Figure 5a). The same LB water quality data was also plotted with data collected at the east end of the North Slough (ENS), and showed no significant correlations (see Figure 5b).

Conclusions:

The following conclusions were reached:

(1) High pH correlates to high D.O. (see Figures 2a, 2b, and 2c). Both conditions are probably caused by algae.

(2) Most D.O. violations occurred during the wet season (see Table 1 and Figure 3).

(3) Of the three monitoring sites, ENS had the most D.O. violations (see Table 1 and Figure 3). However, seasonally the monthly averages of D.O. at ENS were only lower than the other two sites from March-September (see Figure 5b).

(4) The majority of temperature violations occurred during the dry season, as much as 100% of occurrences (see Table 1).

(5) Average specific conductance (i.e., electricity conducting salts) was higher during the dry season at all stations (see Table 2 and Figure 4).

(6) Average specific conductance (i.e., electricity conducting salts) is greater at NPB than the other stations (see Table 2 and Figure 4).

(7) LB low tide water appears to emanate from east of the NPB (see Figure 5a comparing monthly average water quality parameters at LB and NPB, and note tracking of NPB with low tide).

(8) There appears to have been significant discharge of a dissolved oxygen depleting substance into Columbia Slough on or near October 25, 1997. It may also be noted that there is a similar D.O. drop to less than 3 mg/l at LB a few days later (10/28/97), such that it appears the oxygen depletion has reached the mouth of the lower slough. However, on 10/29/97 (during routine data collection and equipment maintenance/calibration) field staff reported finding the D.O. probe at LB had a torn membrane. It is not known what affect this had on the data. (See Figures 2a and 2c.)

Table 1. Number of Occurrences of Violations

	North Portland Bridge (NPB) 10/15/97 - 9/30/98		East end of North Sl. (ENS) 10/30/97 - 9/10/98		Lombard Bridge (LB) 10/16/97 - 9/16/98	
	#Violations	Total #Meas.*	#Violations	Total #Meas.*	#Violations	Total #Meas.*
Instantaneous D.O.<4.0 mg/l	Dry: 0 (0.0%) Wet: 38 (0.4%) 38 (0.3%)	1537 (d) 10300 (e) 11837	Dry: 6 (0.2%) Wet: 187 (2.2%) 193 (1.6%)	3208 (i) 8530 (j) 11738	Dry: Low: 0 (0.0%) High: 0 (0.0%) Wet: Low: 4 (0.2%) High: 5 (0.2%) 9 (0.2%)	728 (m) 625 (m) 2362 (n) 2264 (n) 5979
7-day avg. of daily min. D.O.<5 mg/l	Dry: 0 (0.0%) Wet: 6 (2.6%) 6 (2.3%)	32 (d) 235 (e) 267	Dry: 2 (3.1%) Wet: 9 (5.1%) 11 (4.6%)	64 (i) 176 (j) 240	Dry: 1 (1.7%) Wet: 5 (2.2%) 6 (2.1%)	58 (m) 223 (n) 281
30-day avg. of daily mean D.O.<6.5 mg/l	Dry: 0 (0.0%) Wet: 0 (0.0%) 0 (0.0%)	32 (d) 224 (e) 256	Dry: 0 (0.0%) Wet: 1 (0.6%) 1 (0.4%)	64 (i) 165 (j) 229	Dry: 0 (0.0%) Wet: 0 (0.0%) 0 (0.0%)	66 (m) 212 (n) 278
7-day avg. of daily max. water temp.>68°F	Dry: 77 (97%) Wet: 13 (6%) 90 (29%)	79 (f) 235 (e) 314	Dry: 64 (100%) Wet: 26 (15%) 90 (38%)	64 (i) 176 (j) 240	Dry: 66 (100%) Wet: 24 (11%) 90 (31%)	66 (o) 223 (n) 289
pH<6.5	Dry: 30 (1.2%) Wet: 0 (0%) 30 (0.2%)	2572 (g) 10282 (e) 12854	Dry: 0 (0%) Wet: 0 (0%) 0 (0%)	3208 (i) 8531 (j) 11739	Dry: 0 (0%) Wet: 0 (0%) 0 (0%)	3497 (o) 10167 (n) 13664
ph>8.5	Dry: 121 (4.7%) Wet: 357 (3.5%) 478 (3.7%)	2572 (g) 10282 (e) 12854	Dry: 586 (18%) Wet: 0 (0%) 586 (5%)	3208 (i) 8531 (j) 11739	Dry: 6 (0.2%) Wet: 240 (2.4%) 246 (1.8%)	3497 (o) 10167 (n) 13664

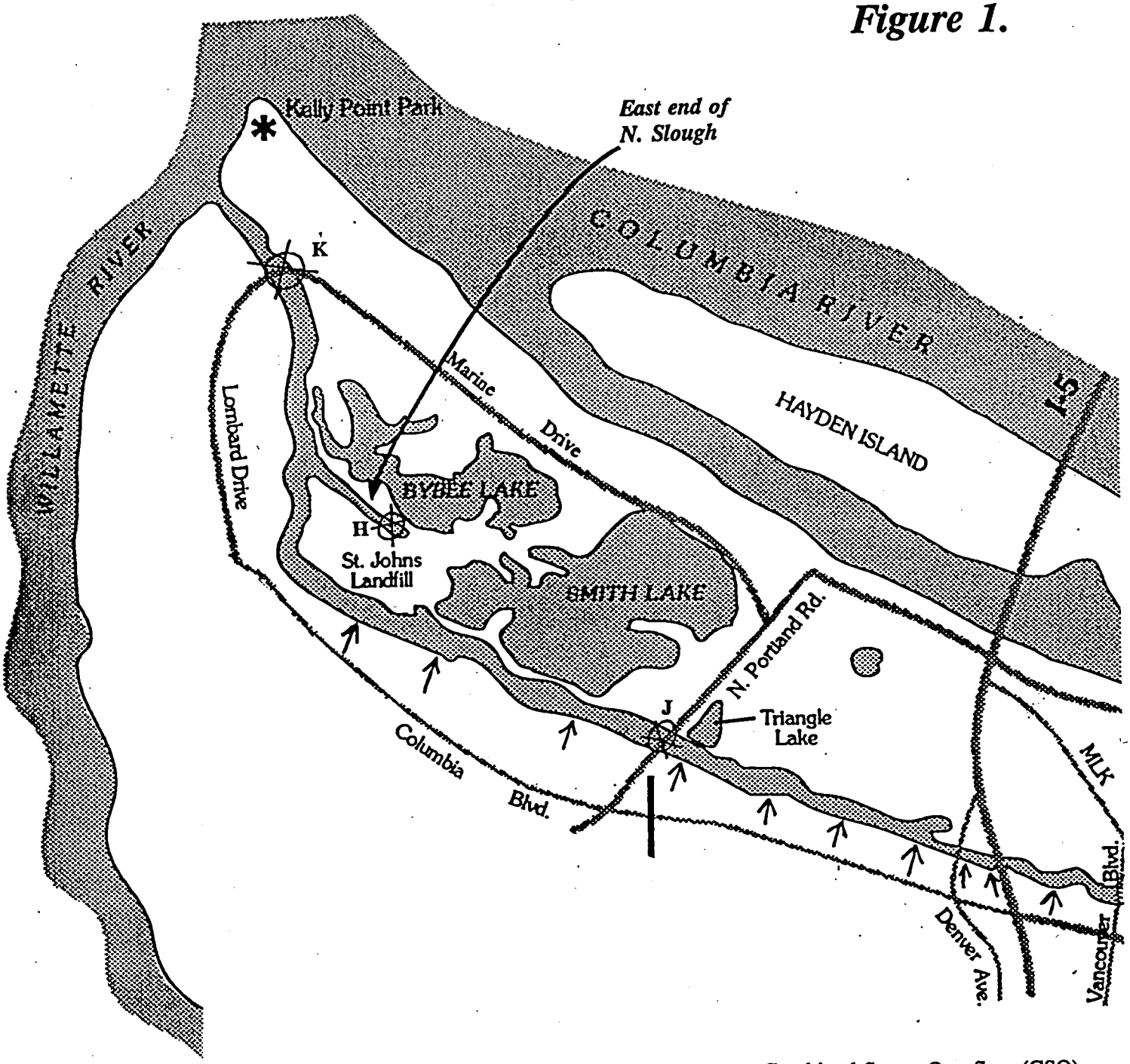
Table 2. Seasonal Average Values of Water Quality Data

	Dry	Wet	Total	Dry	Wet	Total	Dry	Wet	Total
DO (mg/l)	14.7 (d)	11.2 (e)	11.7 (a)	7.5 (i)	9.1 (j)	8.7 (h)	L: 10.7 (m) H: 9.2 (m)	10.5 (n) 10.6 (n)	10.4 (k)
Specific Conductance (μS/cm)	249 (f)	176 (e)	197 (c)	161 (i)	81 (j)	103 (h)	L: 197 (o) H: 139 (o)	142 (n) 103 (n)	136 (l)
Temp (°F)	71.1 (f)	52.8 (e)	57.9 (c)	75.7 (i)	52.1 (j)	58.6 (h)	L: 72.2 (o) H: 70.9 (o)	51.8 (n) 51.3 (n)	57.2 (l)
pH	7.6 (g)	7.2 (e)	7.3 (b)	7.9 (i)	7.3 (j)	7.5 (h)	L: 7.7 (o) H: 7.8 (o)	7.3 (n) 7.2 (n)	7.4 (l)

*Data logged every 30 min.

(a) 10/15/97-8/4/98
(b) 10/15/98-8/28/98
(c) 10/15/97-9/30/98
(d) 7/1/98-8/4/98
(e) 10/15/97-6/30/98
(f) 7/1/98-9/30/98
(g) 7/1/98-8/28/98
(h) 10/30/97-9/10/98
(i) 7/1/98-9/10/98
(j) 10/30/98-6/30/98
(k) 10/15/98-9/1/98
(l) 10/15/97-9/16/98
(m) 7/1/98-9/1/98
(n) 10/15/97-6/30/98
(o) 7/1/98-9/16/98

Figure 1.

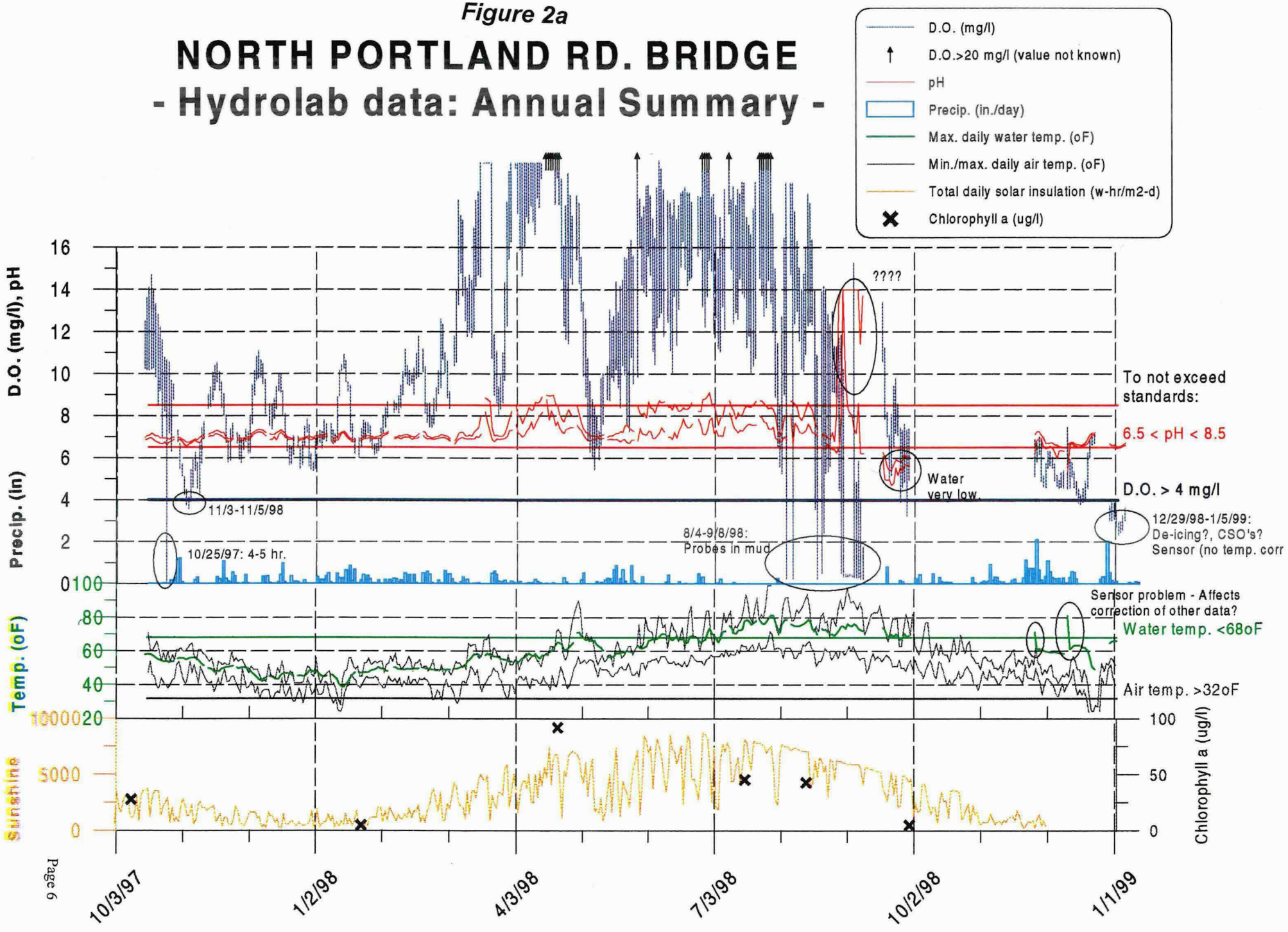


↘ Combined Sewer Overflow (CSO)

⊗ Monitoring Locations

Figure 2a

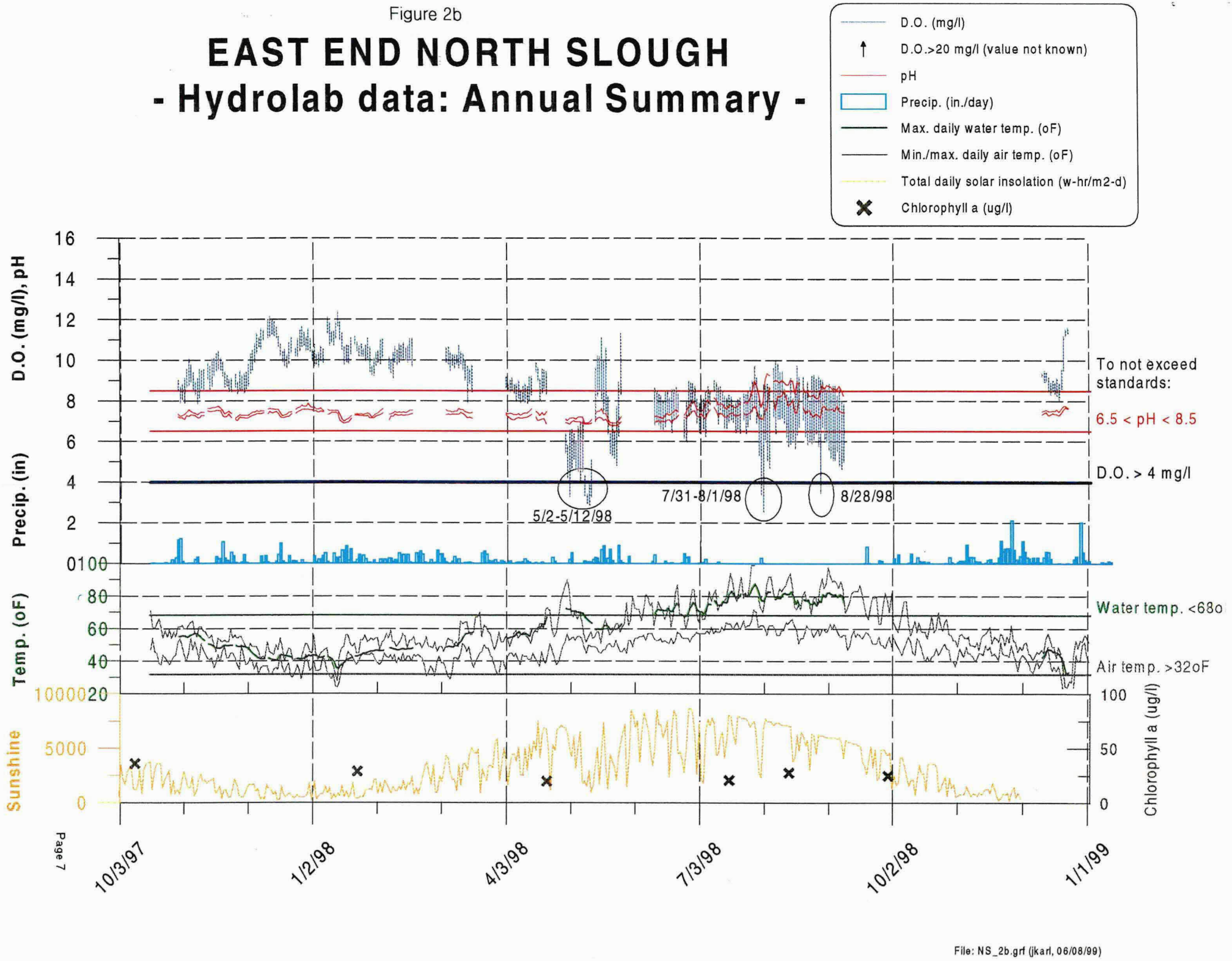
NORTH PORTLAND RD. BRIDGE
- Hydrolab data: Annual Summary -



File: NB_2a.grf (jkarl, 05/19/99)

Figure 2b

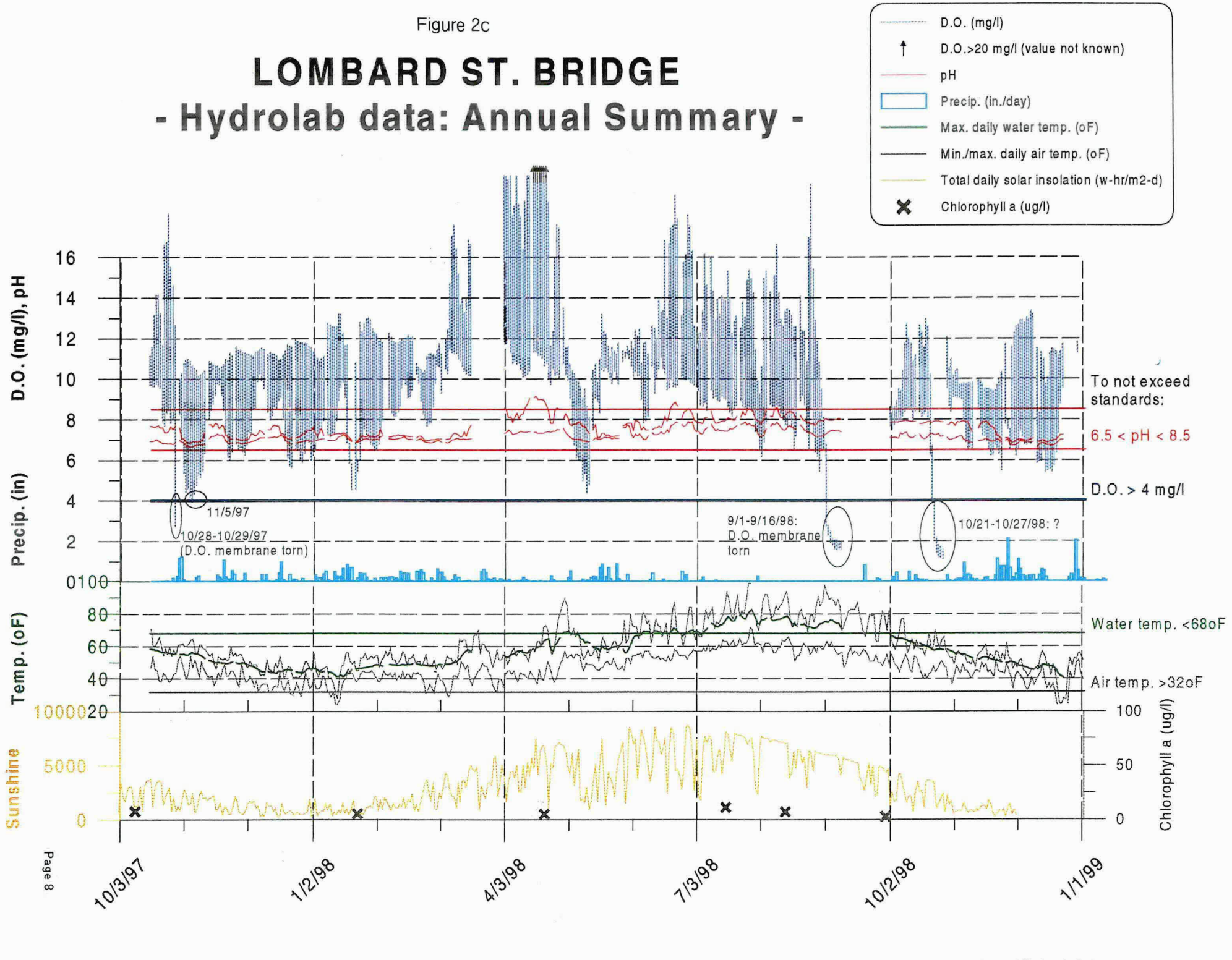
EAST END NORTH SLOUGH
- Hydrolab data: Annual Summary -



File: NS_2b.grf (jkarl, 06/08/99)

Figure 2c

LOMBARD ST. BRIDGE
- Hydrolab data: Annual Summary -



File: LB_2c.grf (jkarl, 06/08/99)

Figure 3. Number of Occurrences of Violations (10/97-10/98)

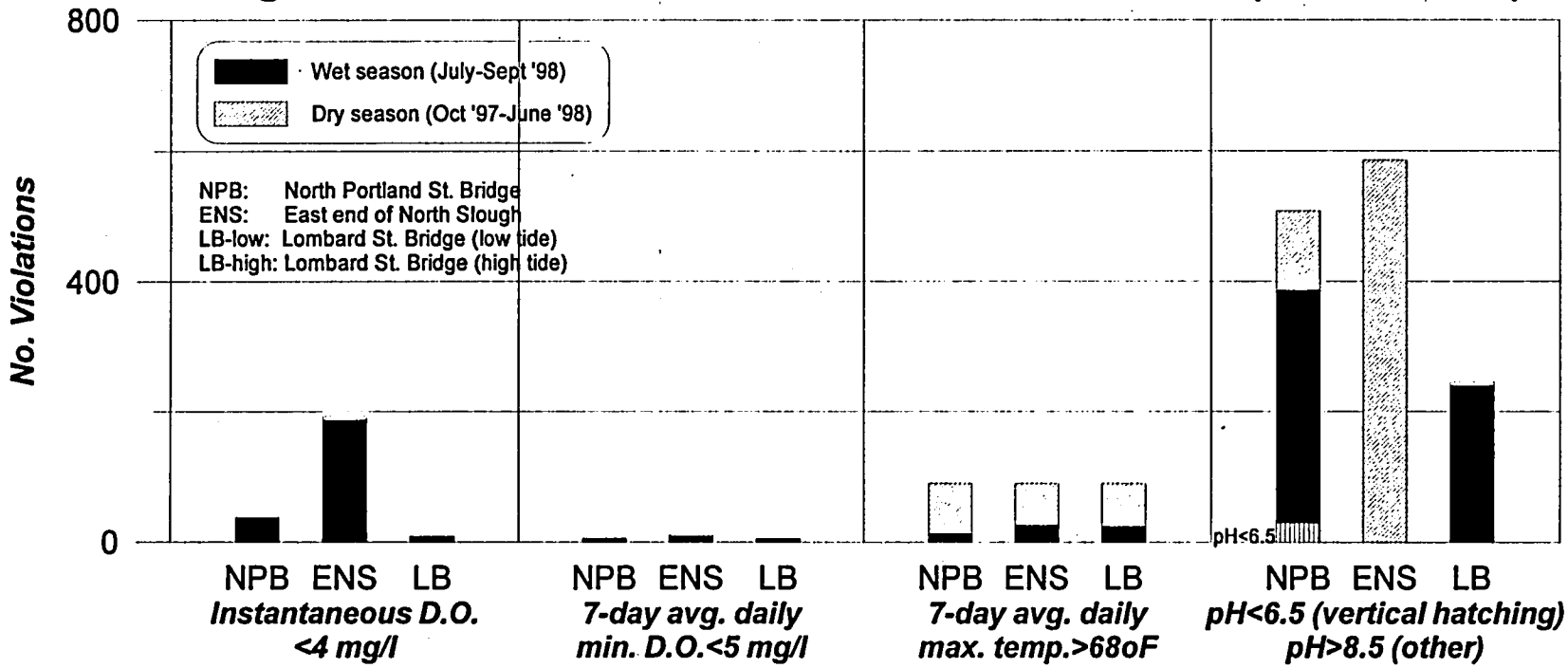


Figure 4. Annual Average Values (10/97-9/98)

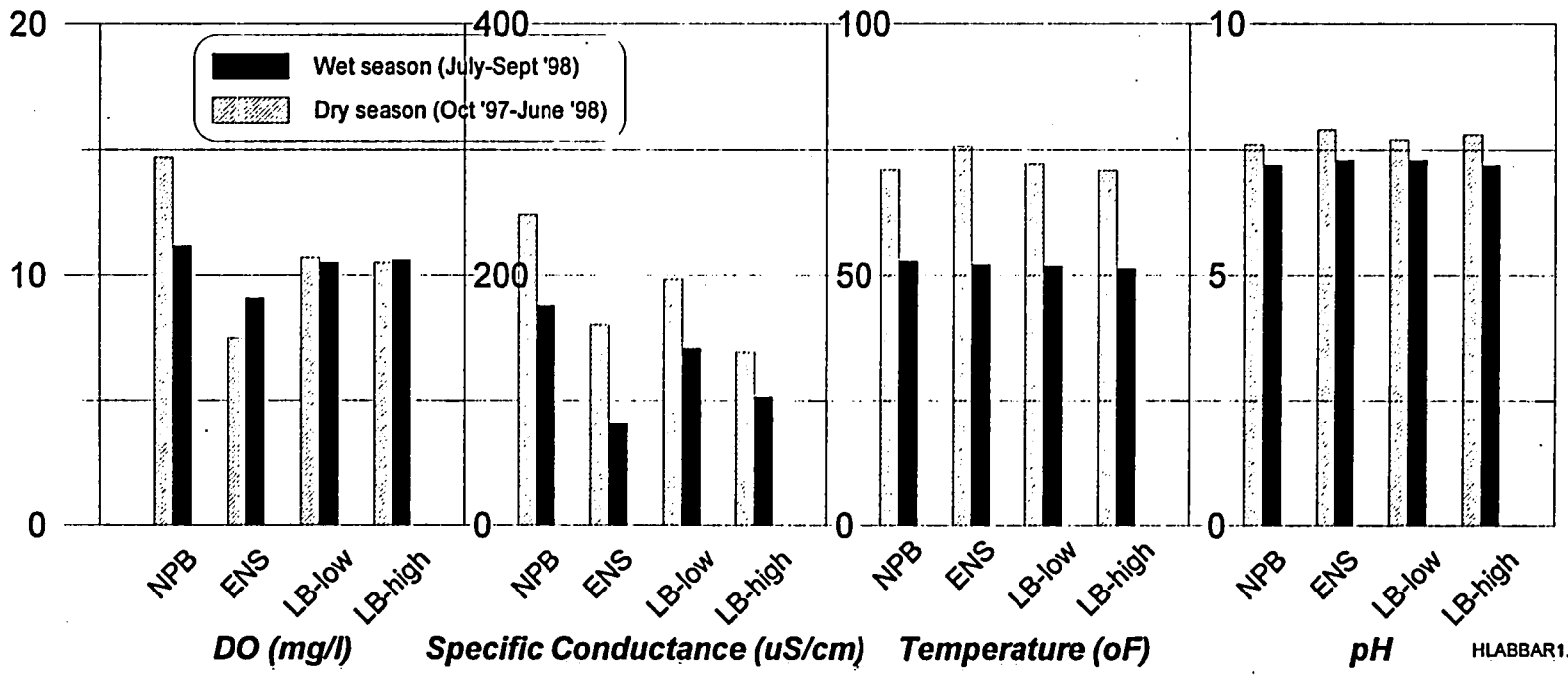


Figure 5a. LOMBARD ST. BRIDGE vs. NORTH PORTLAND ST. BRIDGE
Monthly Avg. Data

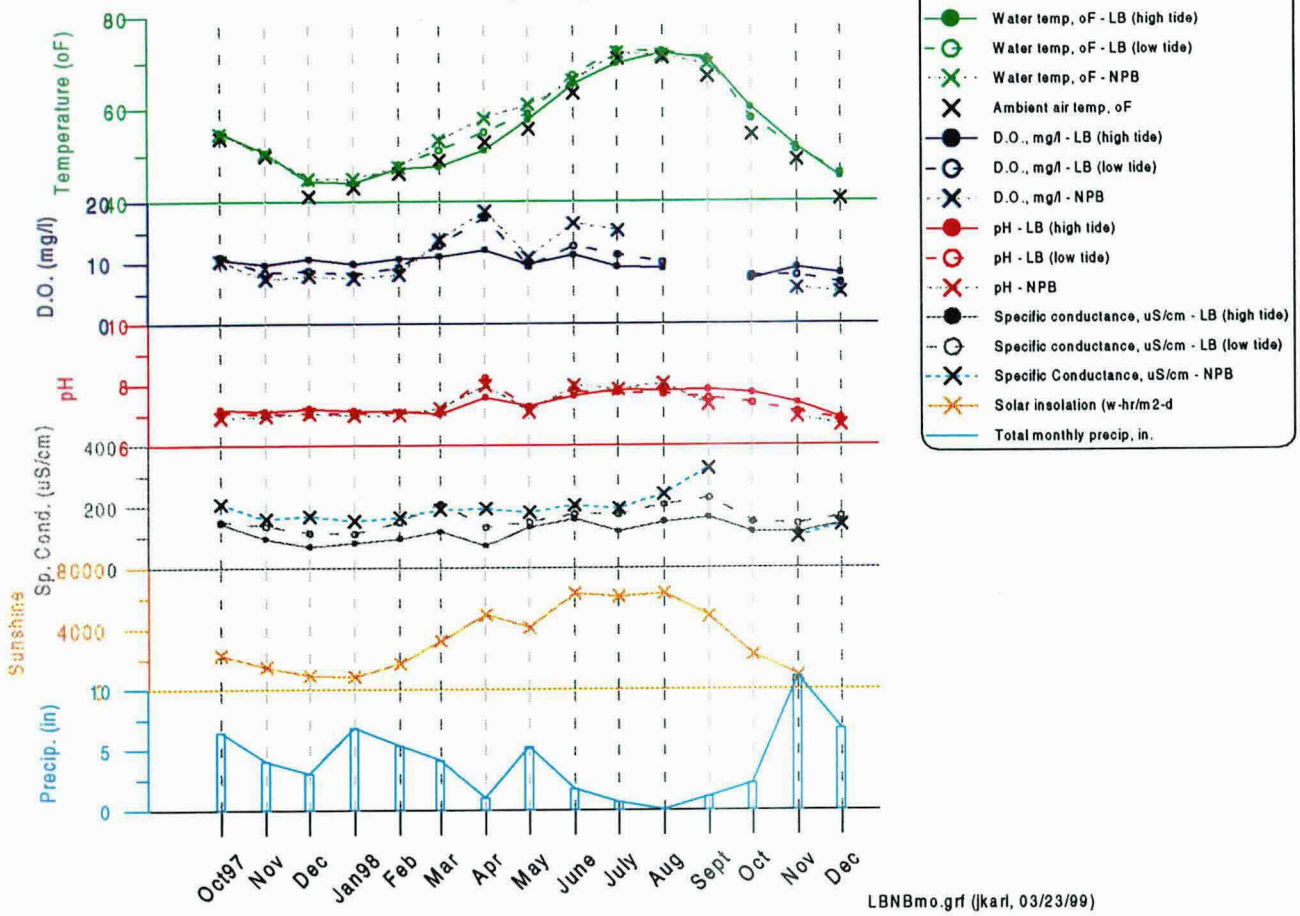
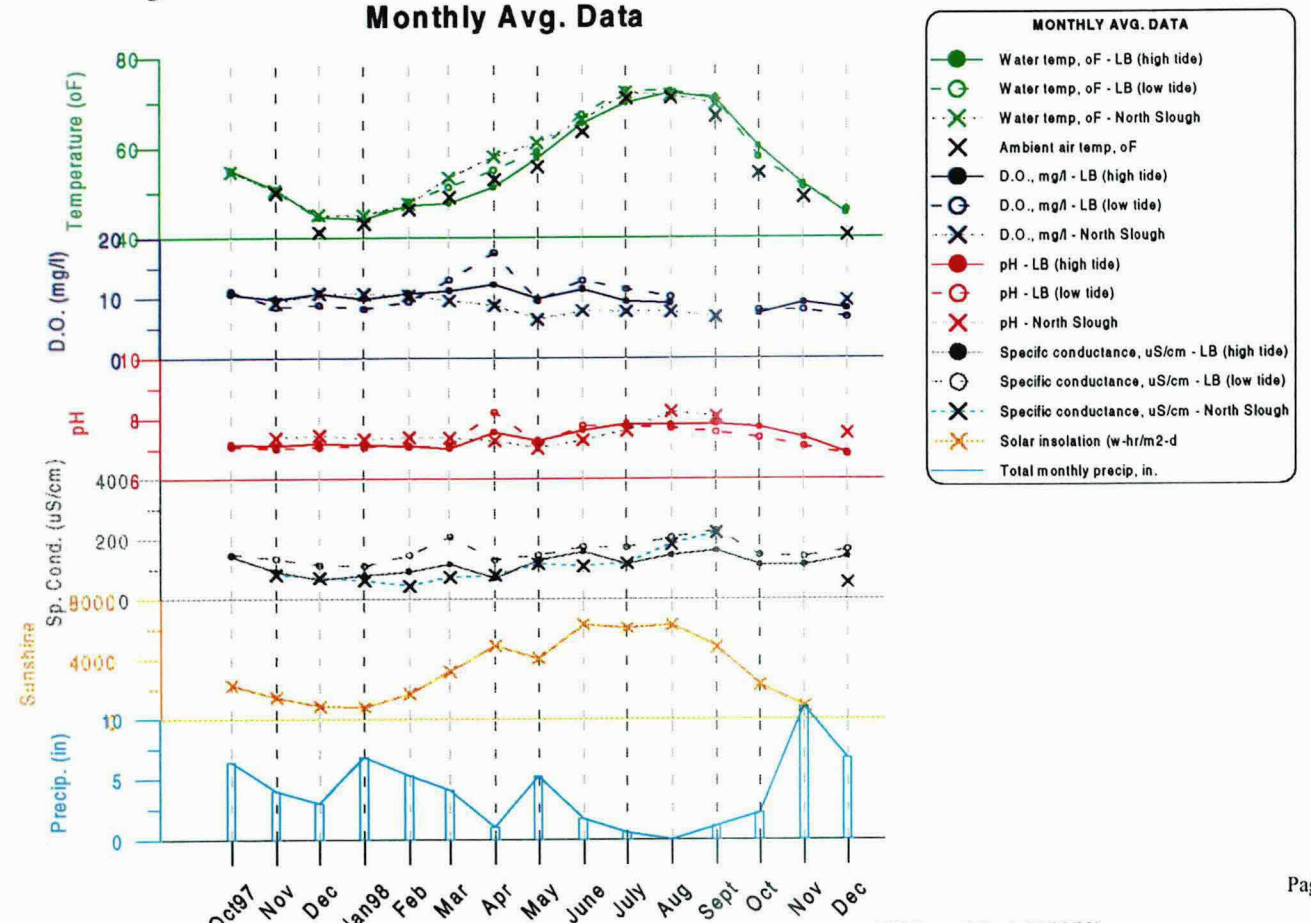


Figure 5b. LOMBARD ST. BRIDGE vs. NORTH SLOUGH
Monthly Avg. Data



LBNPNSmo.grf (jkarl, 05/11/99)