

M E M O R A N D U M

August 13, 1981

To: Jim Krull
From: John Bernhardt
Subject: Budd Inlet Fish Kill

As requested by your office the Water Quality Investigations Section performed a number of investigations to evaluate factors which may have caused or contributed to the June 2, 1981 kill of some 40,000 chinook salmon smolts in lower Budd Inlet. Our findings are as follows:

Waters depleted of oxygen sufficiently to kill fish existed as a narrow band along the east shore of West Bay during our late morning survey of June 2. It is reasonable to assume that similiar low D.O. conditions existed earlier in the day although the affected area would be shifted farther south due to tidal influx. Some 25 percent to 100 percent of the oxygen depletion in the affected area was attributed to Olympia STP effluent oxygen demand with the percent contribution increasing near the outfall. D.O.s increased somewhat right at the outfall apparently due to upwelling caused by the discharge.

Hydrogen sulfide concentrations reached critical levels near the Olympia STP outfall and in the vicinity of Fiddlehead Marina during extreme low tide conditions. The problem appeared to be transient lasting for about two hours. Hydrogen sulfide is typically generated during low tide when overlaying waters do not exert sufficient pressure to keep this gaseous constituent entrapped in the bottom sediments. H_2S is commonly associated with anaerobic decomposition of sewage sludge, sewage, algae and other deposited organic material.

Acute toxicity for the metals zinc, copper and silver were exceeded in the Olympia STP effluent but not sufficiently to cause fish mortalities if dilution in the receiving waters are considered. Other constituents including ethanol did not exceed the criteria. Total residual chlorine may have been a problem but analytical sensitivity was not sufficient to adequately address this constituent.

Specific investigations performed which resulted in the findings outlined above are summarized below:

1. Grid Sampling Data

A grid of 20 stations was sampled during July 2 and 3, 1981, to characterize water quality conditions following the fish kill (Figure 1). Parametric coverage included:

<u>Field</u>	<u>Laboratory</u>
Temperature (OC)	Dissolved Oxygen (mg/L)(Winkler)
Dissolved oxygen (mg/L)(probe)	pH (S.U.)
pH (S.U.) (probe)	Turbidity (NTU)
Secchi (M)	Total Suspended Solids (mg/L)
Total Residual Chlorine (mg/L)	Fecal Coliforms (Col./100 ml.)
	Nitrate-N (mg/L)
	Nitrite-N (mg/L)
	Ammonia-N (mg/L)
	Total phosphate-P (mg/L)
	Orthophosphate-P (mg/L)
	Salinity (ppt)
	Chlorophyll <u>a</u> (ug/L)
	Pheophytin <u>a</u> (ug/L)

For the field sampling, an Orion Research Ion Analyzer/Model 399 probe was used to measure pH. Dissolved oxygen and temperature were measured with an IBC probe. Total residual chlorine was determined by the DPD colorimetric method. Samples for laboratory analysis were packed in ice (if required) and transported to the WDOE Tumwater laboratory. All analyses were performed by Standard Methods for the Examination of Water and Wastewaters (APHA, AWWA and WPCF, 1976) or Methods for Chemical Analysis of Water and Wastes (EPA, 1979).

All parameters were not measured at every station during both surveys in an effort to keep within laboratory load limits. Depth profiles were obtained for the field parameters.

Sampling was conducted during the following periods:

<u>Date</u>	<u>Time</u>	<u>Tide Schedule</u>
June 2	1100-1450	1215 low tide at -2.8 feet
June 3	0855-1040	1300 low tide at -3.2 feet

The fish kill reportedly occurred at some time during the early morning hours of June 2.

For reference, the June 1981 tide schedule is shown in Figure 2.

The survey results are shown in Tables 1 and 2. Low dissolved oxygen was the principle water quality problem observed during the June 2 sampling. A narrow band of surface water containing extremely low levels of dissolved oxygen was evident along the east side of West Bay extending from the mouth of Percival Cove northward to the end of the peninsula which separates East and West Bay (Figure 3). D.O. levels were elevated somewhat in the vicinity of the Olympia STP outfall. Upwelling and turbulence associated with the STP discharge apparently were bringing the deeper well-oxygenated waters to the surface in this area. The elevated D.O. plume appeared to extend northward as would be expected during outgoing tide.

A detailed assessment of factors which may have contributed to the low D.O. condition cited above is given in a separate report by Yake (1981) (Appendix). Basically, this report shows that between 25 and 100 percent of the dissolved oxygen depletion along the east side of West Bay was attributable to Olympia STP effluent oxygen demand depending on location. The greatest STP impact was near the outfall as expected (excluding the localized effects of upwelling).

Chlorophyll a at less than 7 ug/L at all stations sampled indicated algal bloom conditions did not exist in lower Budd Inlet at the time of sampling. This is further supported by the generally low levels of pheophytin a observed.

A sample for total residual chlorine was collected near the Olympia STP outfall with none detected. The field DPD chlorine detection kit (amperometric) used for the survey is sensitive to 0.1 mg/L whereas the EPA criteria are considerably lower at .002 mg/L (EPA, 1976). It is unlikely that chlorine if present in toxic concentrations when discharged would remain as total residual chlorine for very long. It dissipates rapidly in saline waters and especially in waters containing substantial amounts of oxidizable compounds.

Water quality conditions were substantially better during the June 3 sampling. All of the dissolved oxygen readings although not at the desired levels were sufficiently high to protect fish life on the short-term basis. It should be noted that low D.O.'s were observed by WDF personnel during the early morning hours prior to the June 3 survey. As a result the Capitol Lake discharge gate was opened which quickly increased D.O.'s in the lower inlet. (The Capitol Lake discharge obviously has a substantial influence on dissolved oxygen levels in this area). Also, fecal coliform counts increased substantially from the previous day. This apparently occurred because Olympia STP reduced chlorination after being notified of the fish kill.

2. Hydrogen Sulfide

Two surveys were performed to measure sulfides generated during low tide in lower Budd Inlet. In both cases hydrogen sulfide exceeded levels considered safe for aquatic life in the nearshore areas during extreme low water. It is also important to note that H₂S toxicity is aggravated by low dissolved oxygen levels. The results of these two surveys are given in two reports (Joy, 1981; Johnson, 1981) which are included in the Appendix.

3. Toxic Substances

Three samples were collected and held on ice for approximately 24 hours then forwarded to the EPA Manchester laboratory for analyses of the 129 EPA priority pollutants and other selected constituents:

<u>Date</u>	<u>Time Collected</u>	<u>Location</u>
June 3, 1981	1500	Olympia STP Final Effluent
June 3, 1981	1500	Olympia STP Final Effluent
June 3, 1981	0900	Fiddlehead Marina Moorage Area

The analytical results for those toxic constituents detected in the samples and corresponding water quality criteria are shown in Table 3.

The EPA priority pollutants data report which lists all of the analyses performed is included in the Appendix.

Criteria for some parameters such as zinc, silver and copper were exceeded in the Olympia STP effluent but not to the degree which could be associated with the fish kill. Whether or not metals synergism was a factor is not known. None of the criteria were exceeded in the Fiddlehead Marina area.

4. Review of WDOE Ambient Monitoring Data

WDOE routinely monitors water quality at several locations in Budd Inlet as part of the marine ambient monitoring program. Samples are collected monthly generally during April through October by float plane. Conventional parameters such as temperature, pH, dissolved oxygen, specific conductivity, nutrients, etc., are sampled at the surface and 10 meters depth.

These data are an important consideration with respect to the Budd Inlet fish kill because Station BUD002 is located a short distance due west of the Olympia STP outfall. Water quality data for this station along with other data can be used to evaluate, to some extent, water quality conditions associated with Olympia STP wastewaters over time.

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An analysis of water quality sampling data collected during July 2 (Yake, Appendix) show that total phosphorous is the best constituent of the parameters measured for tracing the dispersion and dilution characteristics of Olympia STP wastewaters in lower Budd Inlet. Ambient monitoring data for this constituent at two Budd Inlet stations during 1976-1981 are shown in Figure 4.

As previously mentioned, the June 2 grid sampling data showed a poorly diluted block of Olympia STP wastewaters moving northward past the STP outfall during late morning. The Station 13 surface sample (Table 1) which approximately coincided with the location of BUD002 contained 0.52 mg/L total phosphorous. Similiar tidal, flushing and lake discharge conditions probably existed during the previous day at 0915 when the ambient sample contained 0.50 mg/L T-PO₄P. This corresponds to 6 percent effluent or about a 1:16 effluent-to-receiving water dilution ratio.

The sudden peak in the June 1 ambient data is probably due to timing with respect to movement of the poor dilution block rather than any unusual event associated with Olympia STP. The brewery wastes contained only trace amounts of phosphorous while the STP was discharging typical amounts of this constituent at the time of the fish kill.

JB:cl

Attachments

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2. June 1981 Seattle District tides (see correction table for Olympia times).
3. Map showing dissolved oxygen levels observed in West Bay of Budd Inlet during mid-day; June 2, 1981.
4. Summary of recent WDOE ambient monitoring data for total phosphorous collected in Budd Inlet.

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1. Results of water quality managements determined in the field and laboratory by WDOE personnel on June 2, 1981, in Budd Inlet.
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3. Summary of toxic substances detected by USEPA Manchester Laboratory in June 3, 1981 water quality samples collected in Lower Budd Inlet.
4. WDOE ambient water quality monitoring data for Budd Inlet near the south end of the port dock.

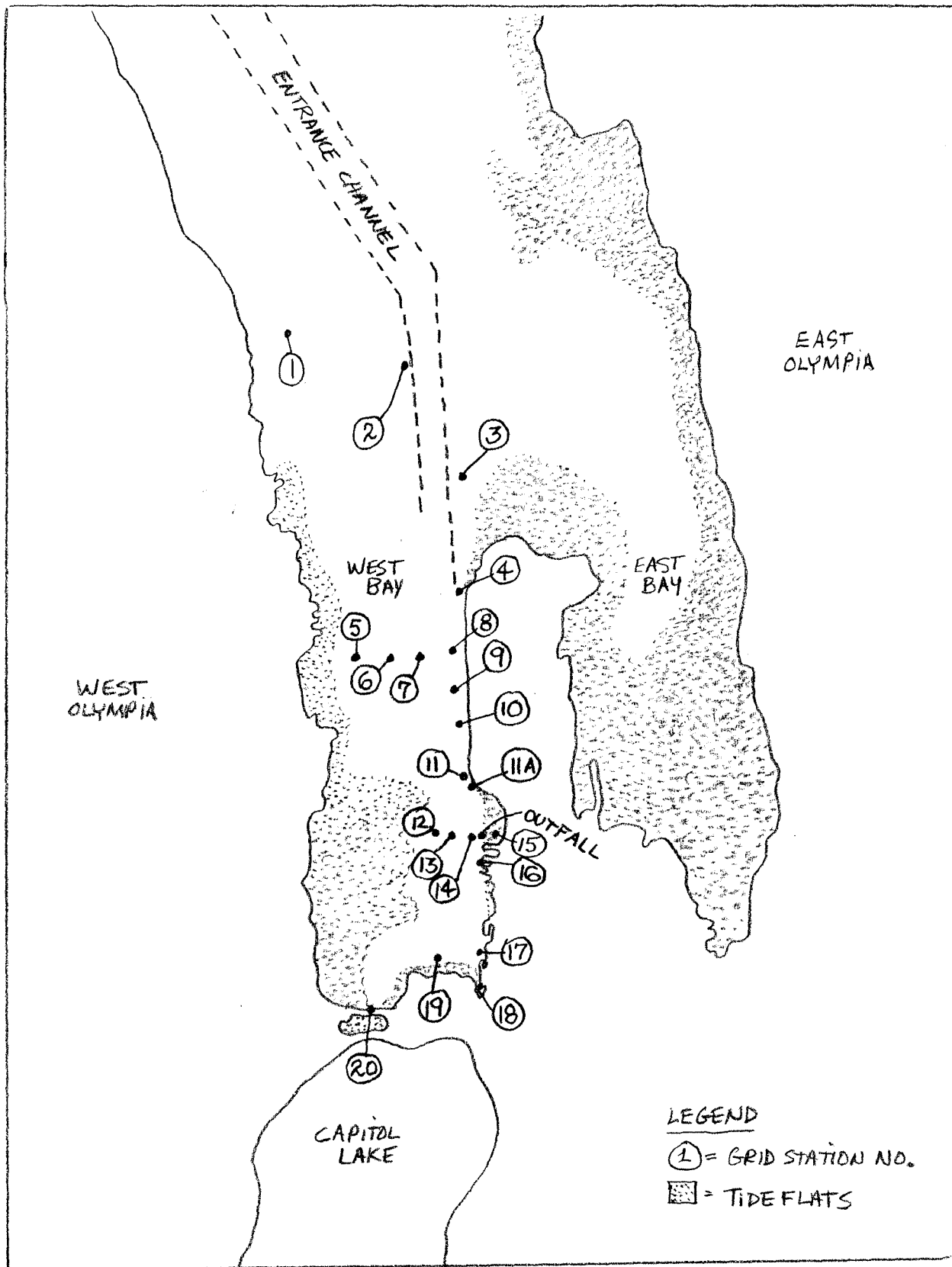


Figure 1. Map showing locations of grid stations sampled during DOE June 2-3, 1981, Budd Inlet Fish Kill Investigation

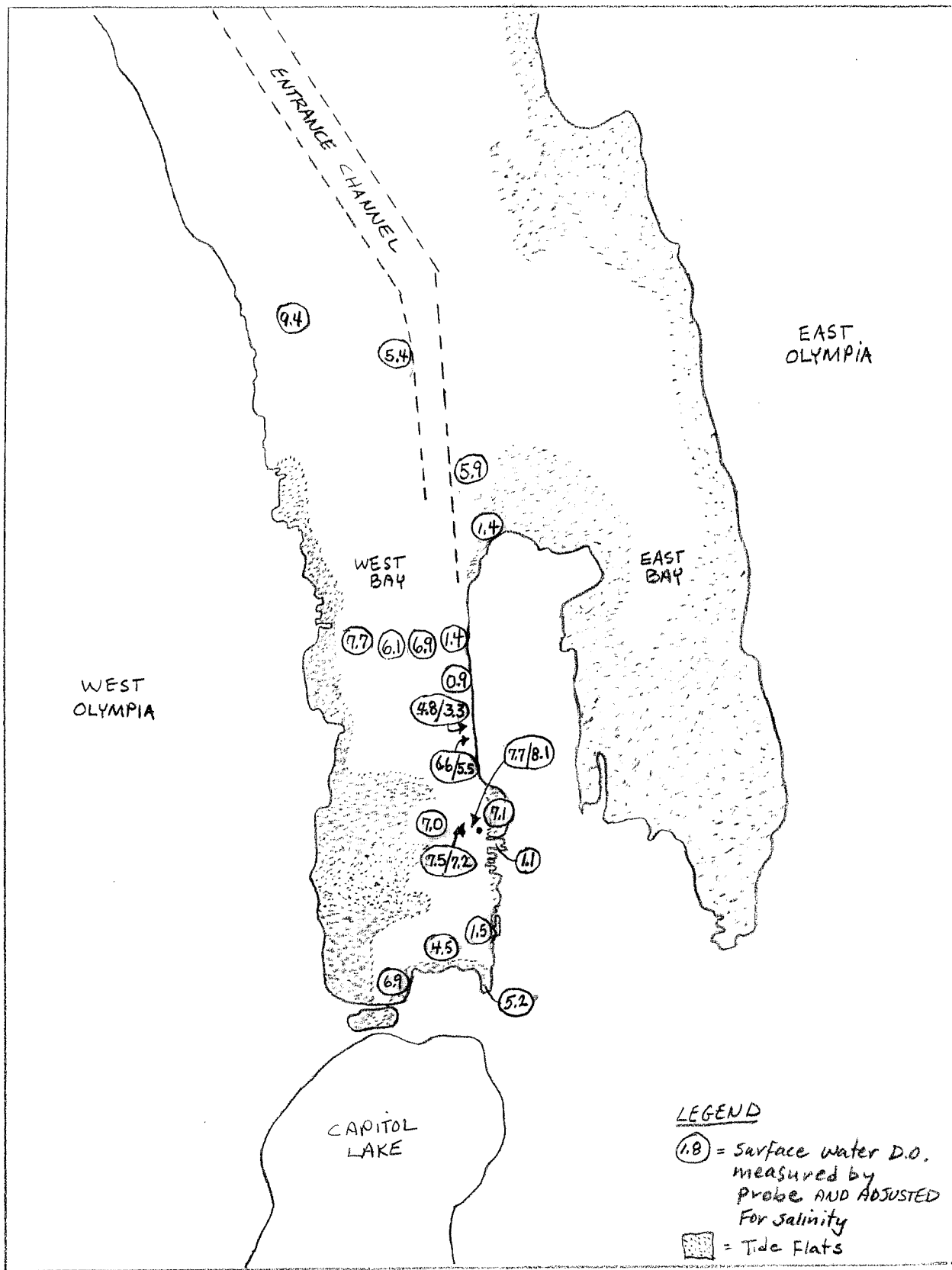


Figure 3. Map showing dissolved oxygen levels observed in West Bay of Budd Inlet during mid-day; June 2, 1981.

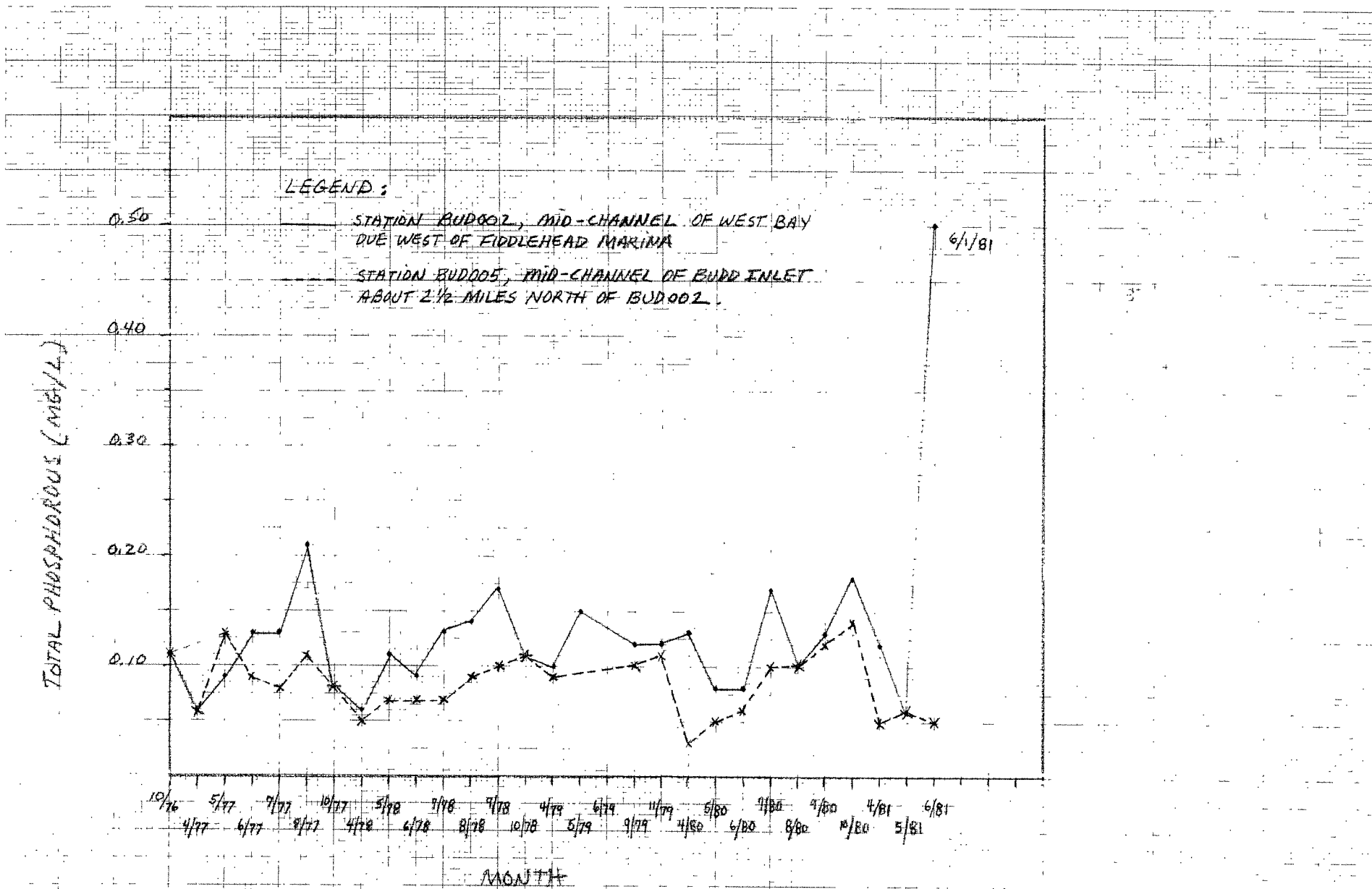
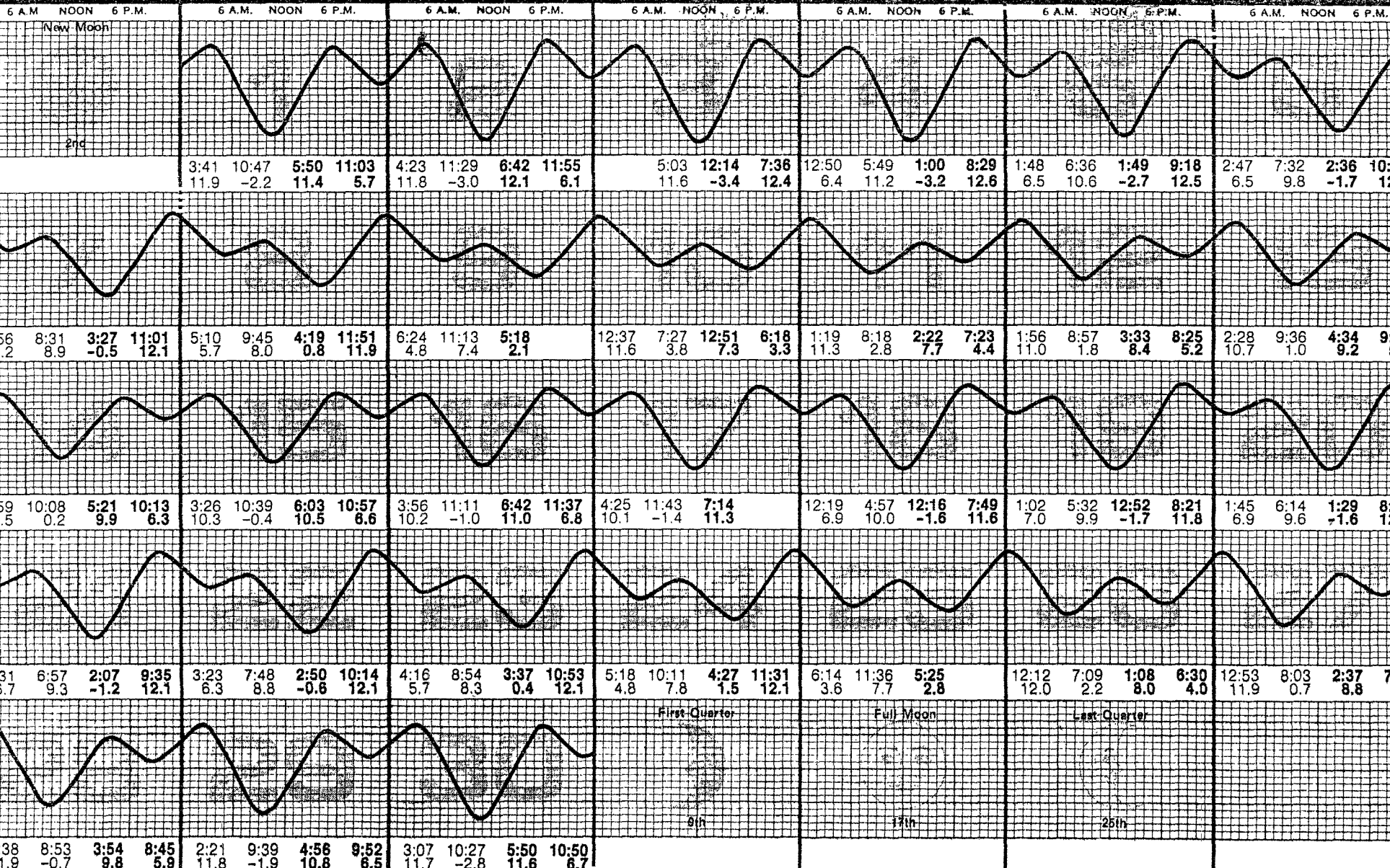


Figure 4: Summary of recent DOE Ambient Monitoring data for Total Phosphorous collected in Budd Inlet.

sunday monday tuesday wednesday thursday friday saturday



may							july						
S	M	T	W	T	F	S	S	M	T	W	T	F	S
					1	2				1	2	3	4
3	4	5	6	7	8	9	5	6	7	8	9	10	11
10	11	12	13	14	15	16	12	13	14	15	16	17	18
17	18	19	20	21	22	23	19	20	21	22	23	24	25
24/31	25	26	27	28	29	30	26	27	28	29	30	31	

PLACE	Time		Height	
	H.W.	L.W.	H.W.	L.W.
Tacoma	7 min. later	6 min. later	0.5 ft. higher	-0.0-
Olympia	31 min. later	46 min. later	3.1 ft. higher	0.2 ft. higher
Everett	9 min. earlier	11 min. earlier	0.2 ft. lower	-0.0-
Deception Pass	21 min. later	34 min. later	0.9 ft. lower	0.2 ft. lower
Port Ludlow	27 min. earlier	18 min. earlier	0.88 ratio	0.88 ratio
Seabeck	3 min. earlier	3 min. later	0.3 ft. higher	0.1 ft. higher
Union	4 min. earlier	10 min. later	0.4 ft. higher	0.1 ft. higher

Table 1. Results of Water Quality Measurements Determined in the Field and Laboratory by WDOE Personnel on June 2, 1981 in Budd Inlet

Field Measurements										Laboratory Measurements													
Stn. No.	Z	Time	Temp. (°C)	Specific Conduct. (µmhos/cm)	D.O. (Probe)			D.O. Winkler (mg/L)	pH (Units)	Secchi (m)	Turb. (NTU)	TSS (mg/L)	FC (per 100 ml)	NO ₃ -N (mg/L)	NO ₂ -N (mg/L)	NH ₃ -N (mg/L)	O-PO ₄ -P (mg/L)	T-PO ₄ -P (mg/L)	Sal (%)	pH (Units)	Chl-a (µg/L)	Pheo (µg/L)	Pigment Ratio
					2/ (mg/L)	3/ (mg/L)	(% Sat.)																
1	0 5 10	1450 ^{1/}	14.2 12.9 11.8	40,746	11.3 13.1 12.8	9.4	107.2	9.40	7.95	2.5	7	16	2 (est)	0.01	<0.01	0.08	0.08	0.11	27.3	7.9			
2	0 5 10	1222	14.2 13.2 12.8		6.3 10.5 12.5	5.4		5.10		2													
3	0	1230	14.2		6.8	5.9		4.34															
4	0 5	1215	14.5 12.8	37,015	1.6 9.0	1.4	15.8	0.98	6.75	>1.5	3	30	540	<0.01	<0.01	0.04	0.07	0.21	24.8	7.0			
5	0 5	1238	13.8 -		9.2 -	7.7				1.5													
6	0 5	1245	13.8 12.7		7.2 11.9	6.1				1.5													
7	0 5	1250	13.5 12.8		8.1 12.2	6.9				1.5													
8	0	1255	13.5		1.8	1.4																	
9	0 5 10 15	1200	13.0 12.5 11.5 7.7	39,403	1.1 6.1 7.6 11.5	0.9	10.0	0.11	6.8	1.3	5	20	1200	<0.01	<0.01	0.08	0.09	0.28	26.4	7.0	1.8	5.7	1.2
10	0 5 10 15	1125/1135	13.5/13.5 13.0/12.0 12.0/12.0 11.0/11.0	33,881	5.6/3.8 8.4/7.4 8.9/7.5 5.5/7.0	4.8/3.3	52.4/36.0	-/.44	-/6.72	1	5	32	3200	<0.01	<0.01	0.09	0.12	0.37	22.7	6.9	-	-	-

^{1/} Morning high tide - 4:54 a.m., 14.9 feet; following low tide - 12:15 a.m., 2.8 feet.

^{2/} Actual field probe readings, approximately 15% higher than actual values due to salinity interference.

^{3/} Field probe readings adjusted for salinity.

AV/W28(B2-7)

Table 1. Results of Water Quality Measurements Determined in the Field and Laboratory
by WDOE Personnel on June 2, 1981 in Budd Inlet
(Continued)

Stn. No.	Z	Time	Temp. (°C)	Field Measurements							Laboratory Measurements												
				Specific Conduct. (umhos/cm)	D.O. (Probe)			D.O. Winkler (mg/L)	pH (Units)	Secchi (m)	Turb. (NTU)	TSS (mg/L)	FC (per 100 ml)	NO ₃ -N (mg/L)	NO ₂ -N (mg/L)	NH ₃ -N (mg/L)	O-PO ₄ -P (mg/L)	T-PO ₄ -P (mg/L)	Sal (%)	pH (Units)	Chl-a (ug/L)	Pheo (ug/L)	Pigment Ratio
					2/ (mg/L)	3/ (mg/L)	(% Sat.)																
11	0 5 10 15	1130/1305	13/13.5 12.5/12.0 11.5/11.3 11.5/11.0	36,716	7.8/6.5 6.1/10.1 7.6/7.9 7.7/8.6	6.6/5.5	72.2/60.8	6.12/5.20	-7.24	-	19	27	120	<0.05	<0.05	1.6	0.50	0.84	24.6	6.8	0.0	6.4	1.0
11a	0	1300	14.0		5.9	5.0				-													
12	0 5	1120	13 13		8.2 9.5	7.0				-													
13	0 5	1115/1430	13/13.8 13/12.5	37,164	8.9/8.5 10.1/9.6	7.5/7.2	82.2/80.2	-7.89	-7.28	1.0	9	17	320	0.01	<0.01	0.5	0.22	0.52	24.9	6.8	-	-	-
14	0	1100/1400	14/15.5	32,537	8.9/9.3	7.7/8.1	84.4/91.5	-7.19	-7.6	0.4	26	52	220	<0.10	<0.10	4.0	0.8	1.8	21.8	7.0	6.7	9.2	1.3
15	0	1110	15		8.3	7.1																	
16	0 5	1415	15.5	37,015	1.3	1.1	12.7	0.17	7.20	-	5	26	210	0.01	<0.01	0.03	0.09	0.28	24.8	6.9	-	-	-
17	0 5 10	1320	14.0 12.8	37,463	1.8 8.9	1.5	16.8	1.09	7.32	0.8	4	22	190	0.01	<0.01	0.04	0.09	0.29	25.1	6.9	0.5	2.6	1.1
18	0 5	1345	13.5 12.5		6.1 6.7	5.2				1.0													
19	0 5	1355	13.8 13.5		5.3 9.9	4.5				2.0													
20	0 5	1420	15.2 13.0	29,104	7.8 7.9	6.9	76.4			2.0	2	15	10 (est)	0.04	<0.01	0.17	0.08	0.13	19.5	7.6	-	-	-

- 1/ Morning high tide - 4:54 a.m., 14.9 feet; following low tide - 12:15 a.m., 2.8 feet.
2/ Actual field probe readings, approximately 15% higher than actual values due to salinity interference.
3/ Field probe readings adjusted for salinity.

AV/W28(B8-13)

Table 2. Results of Water Quality Measurements Determined in the Field and Laboratory by WDOE Personnel on June 3, 1981 in Budd Inlet

Stn. No.	Z	Time	Temp. (°C)	Field Measurements					Laboratory Measurements											
				Specific Conduct. (umhos/cm)	D.O. (Probe)			D.O. Winkler (mg/L)	pH (Units)	Turb. (NTU)	TSS (mg/L)	FC (per 100 ml)	NO ₃ -N (mg/L)	NO ₂ -N (mg/L)	NH ₃ -N (mg/L)	O-P ₀₄ -P (mg/L)	Sal (%)	pH (Units)	Chl-a (ug/L)	Pheo (ug/L)
					2/ (mg/L)	3/ (mg/L)	(% Sat.)													
1	0 5 10	1040 ^{1/}	13.0 12.3 12.0	34,627	9.9 12.3 13.5	8.5	92.2	7.90		2	19		0.03	<0.01	0.07	0.06	23.2	7.8	4.8	1.7
6	0 5 10	0955	13.2 11.4 11.0	30,896	8.5 6.5 7.1	7.4	79.3	5.55		2	18	180 (est)	0.03	<0.01	0.09	0.07	20.7	7.5	4.6	1.6
7	0 5 10		13.0 11.8 11.4	28,507	8.7 8.6 8.2	7.7	81.3	5.65		2	33						19.1	7.6		
10	0 5 10 15	0930	13.2 11.7 11.2 11.2	28,955	8.6 6.4 10.7 9.7	7.6	80.8	6.65		3	25	6,200 (est)	0.03	<0.01	0.11	0.09	19.4	7.4	3.5	2.0
13	0 5 10	0915	13.2 12.0 11.5	29,403	8.7 9.6 10.3	7.7	82.0	7.15		3	20	4,800 (est)					19.7	7.4	4.0	1.0
14	0 5 10	0855	12.7 11.7 11.3	34,478	8.9 11.3 10.0	7.7	82.9	6.80		26	46	5,800	0.01	0.01	1.2	0.64	23.1	6.8	5.4	5.9
15	0		13.0	31,791	8.8	7.7	82.5	6.75		7	31	14,000 (est)	0.03	<0.01	0.11	0.05	21.3	7.2	6.0	1.6
16	0	0920	13.0	29,701	7.4	6.5	69.0	5.45		2	21	3,100	0.03	<0.01	0.39	0.23	19.9	7.4		
17	0 5 10	0945	13.0 11.8 11.2	31,194	7.5 6.7 7.7	6.6	70.5	4.40		4	21	21					20.9	7.4		
20	0 5	1020	12.2 11.7	37,015	9.5 8.7	8.1	87.3	6.85		3	21	1,300	0.04	<0.01	0.10	0.08	24.8	7.7	7.0	2.6

^{1/} Morning high tide - 5:34 a.m., 14.7 feet; following low tide - 1:00 p.m., 3.2 feet.

^{2/} Actual field probe readings, approximately 15% higher than actual due to salinity interference.

^{3/} Field probe readings adjusted for salinity.

AV/W28(B14-17)

Table 3. Summary of toxic substances detected by USEPA Manchester Laboratory in 3 June 1981 Water Quality Samples collected in Lower Budd Inlet.

Parameter	Sample Location		USEPA Water Quality Criteria (Acute toxicity)	
	Fiddlehead Marina (Sample No. 22030)	Olympia STP Effluent (Sample Nos. 22031 and 22032)	Freshwater	Saltwater
<u>Metals (ug/L)</u>				
Arsenic	4.2	4	440 ug/L	508 ug/L
Beryllium	0.6	.2	130	-
Cadmium	1.9	2.4	-	59
Chromium	23	31	21	1,260
Copper	20	55	-	23
Lead	7	80	-	668
Mercury	0.34	.08	.0017	3.7
Nickel	3	11	-	140
Silver	-	9	-	2.3
Zinc	90	240	-	170
<u>Miscellaneous (ug/L)</u>				
Cyanide	.005	.012	52	30
Phenolics	8	42	10,200	5,800
<u>Pesticides (ug/L)</u>				
None detected	-	-	-	-
<u>Base/Neutral Extractables</u>				
None detected	-	-	-	-
<u>Acid Extractables</u>				
None detected	-	-	-	-
<u>Volatile Organics (ug/L)</u>				
Benzene	-	1.1	5,300	5,100
1,1,1-trichloroethane	2.2	143	45,000	2,000
Chloroform	0.9	5.6	28,900	-
1,2-trans-dichloroethylene	1.2	7.1	11,600	224,000
Ethylbenzene	0.4	1.5	32,000	430
Tetrachloroethylene	20	180	5,280	10,200
Toluene	10	14	17,500	6,300
Trichloroethylene	1.4	9	45,000	2,000
Xylene	1.4	?	-	-
<u>VOA (ug/L)</u>				
Total xylene	1	4	-	-
Ethanol	2,600	255,000	>1,000,000*	>1,000,000*

*Reference NIOSH Criteria

RETRIEVAL -- 00 JULY 1991

OFFICE OF WATER PROGRAMS.
 WATER QUALITY MANAGEMENT DIVISION
 WATER & WASTEWATER MONITORING SECTION

BLISSON? BRIDG? INLET S END OLYMPIA PT DOCK

STORET MIND? BASIN: FLIGHT (SOUND) STORET SUB BASIN: DEBCHUTES

LATITUDE: 47 01 06.0 ELEVATION (FEET): 0 WATER CLASS: B
 LONGITUDE: 122 54 18.0 COUNTY: THURSTON SEGMENT: 06-13-03

AGENCY: 21540000 STATE: WASHINGTON STA TYPE: MF 4

TERMINAL 1ST LEV 2ND LEV 3RD LEV 4TH LEV 5TH LEV 6TH LEV
 STREAM MILES MILES MILES MILES MILES MILES

DATE FROM TO	TIME	DEPTH METERS	00010 WATER TEMP DEG C	00300 DISSOLVED OXYGEN mg/l	00701 DO PERCENT SATURATN	00400 pH STANDARD UNITS	00075 CONDUCTVY @ 25 C MICROMH-CM	31504 TOTAL COLIFORM /100ml MF	31616 FECAL COLIFORM /100ml MF	00070 TURBIDITY TURBIMETER NTU	00670 NITRATE T NOD-N mg/l	00615 NITRITE T NOD-N mg/l
76/10/25	07:00	0	17.5	5.1	7.5	7.5	42000		720	1.0	0.04	0.00
	07:05	10	17.7	5.7	7.7	7.7	46000		60	1.0	0.07	0.00
77/04/18	07:25	0	10.0	10.2	8.0	8.0	33000	84	2K	2.0	0.07	0.00
	07:30	10	9.0	9.6	8.0	8.0	47000			10.0	0.17	0.20
77/05/10	07:10	0	17.0	7.7	7.4	7.4	17000	620L	208	7.0	0.11	0.00
	07:15	10	10.5	8.5	7.6	7.6	44000			2.0	0.10	0.00
77/06/22	07:00	0	11.5	6.9	7.8	7.8	40000	100K	108	1.0	0.04	0.00
	07:05	10	10.8	8.1	7.8	7.8	44000			1.0K	0.05	0.00
77/07/18	07:45	0	14.7	6.0	8.0	8.0	40000	400	40	3.0	0.00	0.00
	07:50	10	12.7	4.8	7.8	7.8	45000			3.0	0.00	0.00
77/08/10	07:10	0	18.0	7.0	7.6	7.6	36000	1600L	160L	2.0	0.00	0.00
	07:15	10	15.0	1.7	7.4	7.4	35000			2.0	0.01	0.00
77/10/20	07:00	0	11.0	7.7	8.0	8.0	37500		92	1.0	0.20	0.00
	07:05	10	11.5	7.8	8.0	8.0	38200			1.0	0.20	0.00
78/04/25	07:35	0	10.0	9.5	7.8	7.8	25800		560	4.0	0.17	0.00
	07:40	10	8.8	8.8	7.9	7.9	36000			8.0	0.10	0.00
78/05/30	11:45	0	15.0	10.7	7.9	7.9	26300		7208	2.0	0.17	0.00
	11:50	10	17.5	6.9	7.7	7.7	37000			2.0	0.15	0.00
78/06/27	07:10	0	16.2	7.8	7.8	7.8	29000		1008	2.0	0.17	0.00
	07:15	10	14.0	6.2	7.7	7.7	38000			1.0	0.14	0.00
78/07/24	07:05	0	27.3	11.0	8.5	8.5	31000		84	2.0	0.00	0.00
	07:10	10	15.5	5.1	7.7	7.7	37500			1.0	0.00	0.00
78/08/20	10:05	0	17.5	6.5	7.7	7.7	19100		180	8.0	0.05	0.00
	10:10	10	15.1	4.0	7.8	7.8	38700			2.0	0.01	0.00
78/09/27	07:00	0	15.1	5.4	7.6	7.6	30500		450	4.0	0.10	0.00
	07:05	10	14.0	7.3	7.6	7.6	78700			2.0	0.07	0.20
78/10/23	07:55	0	12.9	6.4	7.7	7.7	39400		108	5.0	0.17	0.00
	07:00	10	12.0	6.5	7.8	7.8	41700			2.0	0.15	0.00
79/04/23	07:10	0	11.5		7.7	7.7	24300		700L	7.0	0.27	0.01K
	07:15	10	9.5		7.8	7.8	47500			4.0	0.15	0.01K
79/05/21	07:15	0	13.0	9.8	8.0	8.0	28200		108	3.0	0.01K	0.01K
	07:20	10	11.0	4.9	7.4	7.4	40000			4.0	0.01K	0.01K
79/06/26	07:20	0	16.5	9.1	7.9	7.9	30700		63	3.0	0.01K	0.01K

77/11/17	0975	0	10.0	6.7	57.7	7.5	34700		60	1.0	0.14	0.01K
	0940	10	10.5	6.7	72.1	7.6	70000			1.0	0.25	0.01K
80/04/23	0920	0	10.2	8.5	86.5	8.2	25700		3208	1.0	0.07	0.01K
	0920	10	10.8	7.4	77.4	7.6	27000			1.0	0.07	0.01K
80/05/27	1070	0	17.5	9.8	97.0	7.8	18000		40008	1.0	0.03	0.01K
	1040	10	11.0	7.9	85.1	7.8	42100			2.0	0.10	0.01K
80/05/24	0975	0	13.2	6.9	74.3	7.7	36300		408	2.0	0.10	0.01K
	0930	10	11.7	6.4	70.2	7.9	44700			2.0	0.13	0.01K
80/07/27	0975	0	18.0	7.3	87.8	7.8	32400		20	1.0	0.05	0.01K
	0940	10	14.5	5.0	57.7	7.7	47000			2.0	0.01K	0.01K
80/08/20	0910	0	15.7	7.2	80.7	7.7	30300		168	1.0	0.03	0.01K
	0915	10	14.8	5.9	68.7	7.8	47000			2.0	0.03	0.01K
80/07/30	1010	0	14.1	6.2	70.0	7.6	34200		55	2.0	0.14	0.01K
	1015	10	13.7	6.1	70.2	7.7	37000			1.0	0.14	0.01K
80/10/13	0970	0	12.5	5.0	54.7	7.5	33700		108	2.0	0.15	0.01K
	0975	10	12.8	6.2	61.8	7.7	40700			1.0	0.18	0.01K
81/04/05	0935	0	7.7	9.9	95.7	7.9	24300		2408	1.0	0.28	0.01K
	0940	10	8.7	9.5	97.7	7.9	37800			1.0	0.22	0.01K
81/05/06	0975	0	12.0	9.7	99.3	7.7	22700		648	1.0	0.17	0.01K
	0970	10	11.5	8.7	94.5	7.8	33600			1.0	0.12	0.01K
81/05/01	0915	0	15.7	8.1	80.7	7.0	20300		7008	1.0	0.02	0.01K
	0970	10	13.0	7.4	82.5	7.6	31600			2.0	0.01	0.01K

DATE FROM TO	TIME	DEPTH METERS	00010 AMMONIA T NITR N mg/l	00071 NIS ORTIN D PHSPTIRIS mg/l P	00065 TOTAL PHOSPH RUS mg/l P	00008 LAB LOG NUMBER	00760 DML PDI mg/l	32210 CHLOROPHL A TRICHRD ug/l	70305 SALINITY CONDUCTVY g/l	00078 TRANSPAR SECCHI METERS
76/10/25	0970	0	0.11	0.08	0.11		0		28.2	
	0975	10	0.09	0.07	0.11		0		29.4	
77/04/13	0975	0	0.21	0.05	0.06		0		20.6	
	0930	10	0.41	7.09	0.00M		5		28.9	
77/05/11	0910	0	0.07	0.05	0.07		5		10.3	
	0915	10	0.17	0.10	0.12		0		28.7	
77/05/22	0970	0	0.07	0.10	0.13		0		25.6	3.2
	0930	8	0.09	0.06	0.11		5		29.2	
77/07/18	0945	0	0.07	0.06	0.13		0		24.0	7.0
	0920	10	0.14	0.07	0.07		5		29.3	
77/08/15	1010	0	0.07	0.10	0.21				24.0	1.7
	1015	10	0.17	0.10	0.17				29.0	
77/10/21	0970	0	0.10	0.06	0.08				24.8	7.4
	0975	10	0.03	0.05	0.08				29.3	
78/04/25	0970	0	0.04	0.07	0.06				18.2	1.1
	0910	10	0.14	0.03	0.10				28.0	
78/05/30	1145	0	0.12	0.05	0.11				19.3	
	1120	10	0.14	0.08	0.12				28.4	
78/06/27	0910	0	0.06	0.03	0.09	2373			19.5	
	0915	10	0.18	0.08	0.11	2374			28.6	
78/07/24	0975	0	0.07	0.01	0.13	2315			22.6	
	0910	10	0.03	0.09	0.03	2316			28.9	
78/08/27	1005	0	0.16	0.11	0.14	3703			13.3	
	1010	10	0.17	0.03	0.17	3510			29.4	
78/09/27	0920	0	0.12	0.07	0.17	4018			22.2	
	0955	10	0.71	0.10	0.13	4019			29.3	
78/10/23	0955	0	0.07	0.06	0.11	4433			27.2	
	0900	10	0.07	0.07	0.10	4434			29.5	
79/04/23	0910	0	0.08	0.04	0.10	1371			14.4	1.0
	0915	10	0.07	0.06	0.12	1372			28.5	
79/05/21	0915	0	0.06	0.01	0.15	1755			18.5	1.2
	0920	10	0.12	0.11	0.21	1756			28.6	

	0940	10	0.07	0.08	0.11	4080			27.8	
80/04/27	0940	0	0.04	0.07	0.13	1431			20.7	0.5
	0945	10	0.10	0.04	0.06	1432			27.0	
80/05/27	1030	0	0.20	0.04	0.03	1782			11.1	1.2
	1040	10	0.15	0.02	0.04	1783			28.4	
80/06/24	0925	0	0.13	0.05	0.08	2209			21.4	2.5
	0930	10	0.16	0.07	0.07	2210			28.4	
80/07/22	0935	0	0.10	0.06	0.17	2796			24.0	1.6
	0940	10	0.12	0.07	0.13	2797			28.8	
80/08/26	0910	0	0.17	0.04	0.10	3562			19.0	2.0
	0915	10	0.27	0.06	0.11	3563			27.1	
80/09/30	1010	0	0.23	0.09	0.13	4406			26.0	5.0
	1015	10	0.14	0.08	0.12	4407			23.5	
80/10/13	0930	0	0.26	0.12	0.13	4644			26.8	4.0
	0935	10	0.10	0.10	0.11	4645			27.6	
81/04/06	0935	0	0.24	0.07	0.12	1423			18.3	1.6
	0940	10	0.07	0.05	0.10	1424			28.0	
81/05/06	0925	0	0.07	0.03	0.06	1856			17.4	
	0930	10	0.06	0.04	0.06	1857			23.1	
81/06/01	0915	0	0.11	0.07	0.09	2201			27.4	1.0
	0920	10	0.10	0.09	0.16	2202			28.4	

APPENDIX

1. Joy, Joe. June 10, 1981, memorandum to John Berhardt, "Sulfide concentrations in Vicinity of LOTT STP Bypass Outfall, Budd Inlet," State of Washington, Department of Ecology.
2. Johnson, Art and Shirley Prescott. July 7, 1981, memorandum to John Bernhardt, "Water Quality Measurements in Budd Inlet, July 2, 1981," State of Washington, Department of Ecology.
3. Yake, Bill. July 6, 1981, memorandum to John Bernhardt, "Interpretation of June 3, 1981, Budd Inlet Data with Particular Respect to Oxygen Depletion," State of Washington, Department of Ecology.
4. EPA Region 10 Laboratory, Priority Pollutants Data Report, Budd Inlet, June 3, 1981.