Publication No. 74-e20
WA-13-0030

Memo to: Ron Robinson, Mike Price, Gene Asselstine

Subject: Olympia STP, Budd Inlet Dye Survey and Aerial Photographs

From: Ronald C. Devitt DATE: FEB 1, 1974

I. OBJECTIVES:

1. To determine the efficiency of Olympia Sewage Treatment Plant.

2. To define the existing water quality of lower Budd Inlet with reference to Dissolved Oxygen and Total Coliform.

3. To depict the dispersion of sewage during the survey period.

II. SUMMARY:

A standard eight-hour in-plant efficiency survey was conducted at Olympia STP. Rhodamine dye was added to the effluent. Receiving water samples were taken through a tidal change from high to low. Dye travel was documented by aerial photography.

IIA. CONCLUSION:

Although the degree of treatment is within the anticipated range for a primary system, The effluent from Olympia sewage treatment plant was characterized as having an extremely high BOD_5 (410 ppm), and total suspended solids (498 ppm). The pH varied significantly (6.0-9.0).

The water quality of lower Budd Inlet is substandard; and violations of "Class B" criteria were recorded.

The effluent was dispersed due to tidal and river currents, but on the incoming tide some of the sewage returned to the point of discharge and even traveled "upstream" in the river.

III. PROCEDURES:

A. Sewage Treatment Plant

The influent was sampled in the west channel of the splitter box at the headworks; the effluent was sampled at the outlet from the west cell of the rectangular clarifiers.

Eight-hour composite samples were obtained by portioning the sample to flow every half hour. Laboratory analyses included BOD_5, COD, solids, pH, conductivity, and turbidity.

Grab samples were also taken for temperature, pH, and conductivity determination. Settleable solids were run every hour. The total flow for the eight-hour period was recorded.

B. Receiving Water and Dye Survey

Stations were located which coincided with preexisting stations established by DOE water surveillance monitoring and Department of Health. Additional samples were taken above the sewage outfall and in the dye area. Dye was added three times during the outgoing tide.

The sampling locations are shown by the map and are described below:

STATION	LOCATION
#1	(southernmost) Midchannel at Olympia Yacht Basin, center of most seaward pier.
#2	Midchannel between southern end of Olympia Port Dock and bouy # 10.
#3	Adjacent to bouy #10, channel side.
#4	Adjacent to light bouy #6, channel side.
#5	(northernmost) Southern side of Olympia Shoals adjacent to red light and horn.
#6	Ellis Cove- South of Priest Point Park.
#7	Eastern Fork of Budd Inlet.
A	At sewage treatment plant outfall.
R	Adjacent to Int. equal interval green 6 second bouy-40 ft.
T	50 yards from Bouy 8 at 205°
Z	300 yards from Flashing Green light 4 sec.-21 ft. at 120°
W	Center of outer channel between equal interval light 6 sec.-23 ft. and quick flashing light -14 ft.
X	400 yards from flashing dolphin-4 sec. at 90°
B	50 yards south of outfall.
C	50 yards west of red nun 14

Temperature, conductivity, pH, dissolved oxygen and salinity were determined at the surface and at the recorded depth. Grab samples were taken for fluorescence and coliform at the surface.

C. Aerial Survey

Black and white, color, and infared photographs were taken from a Cessna 182 between 0850 and 1235 hours. Air speed was approximately 80 mile per hour during photgraphy. The course of the dye was apparent. In addition, quite by coincidence, Bill Kimbel of Bill Kimbel Photography, Steilacoom was in the area after the tide had turned. He obtained a professional print showing the southerly passage of dye toward the port dock.

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The plant was experiencing difficulties with one of their digestors and efforts were being made to restart it using seed sludge.

The temperature did not vary significantly. On the influent, the pH ranged from 10.4 to 6.2. The greatest change occurring within 30 minutes was 7.1 to 10.0. Other drastic pH changes were noted. (See table 1) The effluent was tested to have a pH of 9.0 at 1230 hours.

The efficiency of the plant was 48 percent BOD_5 reduction and 36 percent total suspended solids reduction. However, the effluent BOD was very high (410 ppm). Based on flow rates and effluent characteristics on the day of the survey, ~~over two million pounds~~ ~40,000 lbs* of BOD loading and 14 thousand pounds of settleable solids enter Budd Inlet from the treatment plant daily.

The effluent was very turbid; and especially at low tide, the course of the effluent was apparent without the use of dye.

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Rhodamine dye was added to the effluent from the clarifier at 0820, 1110, and 1335 hours. Quantities of dye added were 5600 ml, 4680 ml, and 4800 ml, respectively.

There is no chlorine contact chamber per se; the minimum contact time was determined by the rate of travel through the outfall pipe. Flow rate and tide heights affect the exposure. At 0820 the dye showed at the surface at Station A after 45 minutes; at 1110 hours-28 minutes and at 1325-27 minutes.

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Aerial photography showed the general dispersion of the sewage. From 0820 to 0850, the sewage flowed in a general northerly (outward) direction in a fan shaped flume. The infared photo at 0851 shows some of the sewage proceeding westerly.

The dye was observed at station A at 0905 hours and the sewage travel was defined more clearly. Pictures taken at 0925 show the continued outward passage of the dye; in addition a splitting was observed. A portion traveled westerly toward red nun "8", and a portion easterly in front of the Jacarunda Restaurant. At 0940 dye (added until 0846) quit showing at Station A, establishing that the maximum chlorine detention time through the outfall line was fifty four minutes under these specific tide and flow conditions.

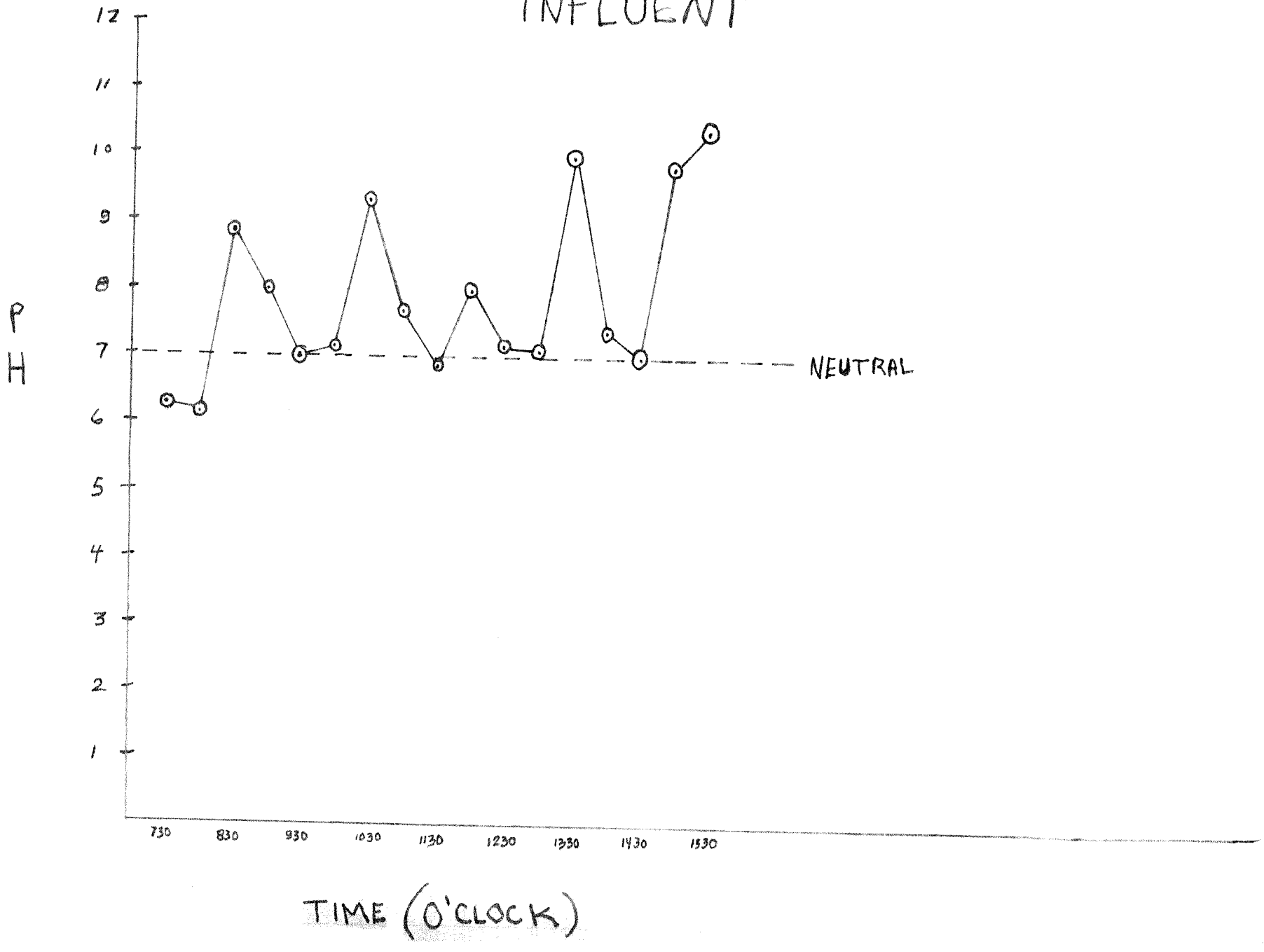
By 1110 hours, the first dye had separated into three clumps; one cloud was near shore by KGY Radio Station, another cloud had traveled north and was near the beginning of the entrance channel. The third was near the log booms to the west of the entrance channel.

*PML 2-75

#5
Z
X
#6
W
4
T
R
3
A
B 1430
C 1435
1545
1300
1000
#7
#1

TABLE I

OLYMPIA STP
INFLUENT

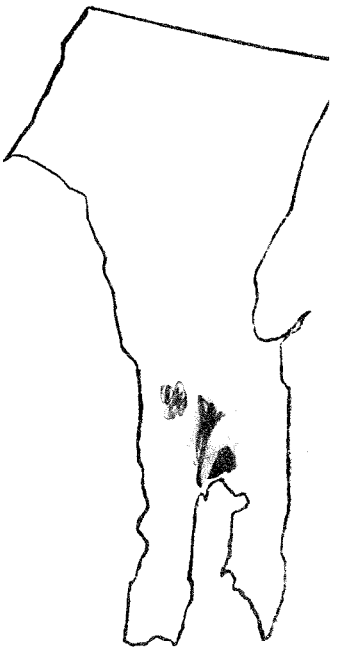


DYE TRAVEL

0925
from color (C)
BW
/R

0940
B&W
&
C

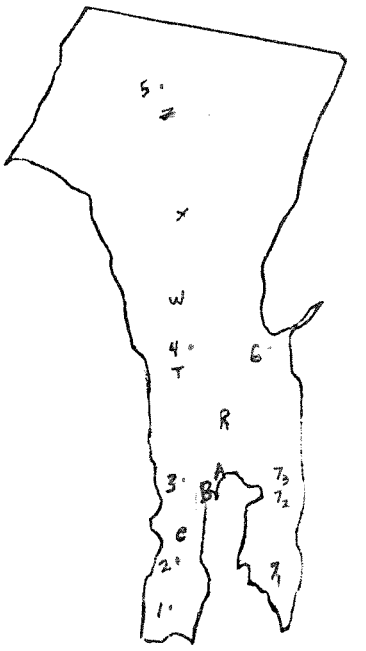
0954



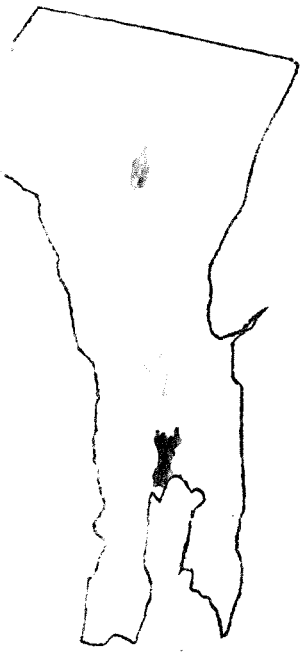
1110

1127

1140



1150



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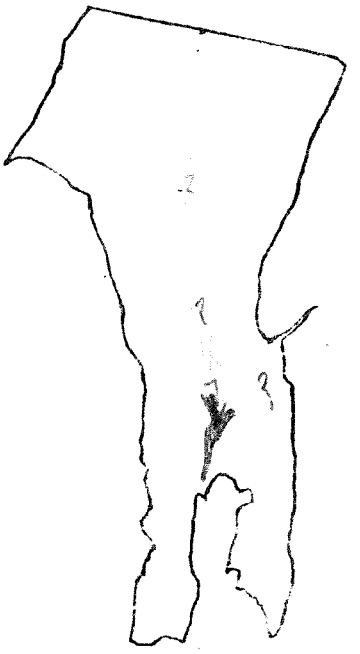
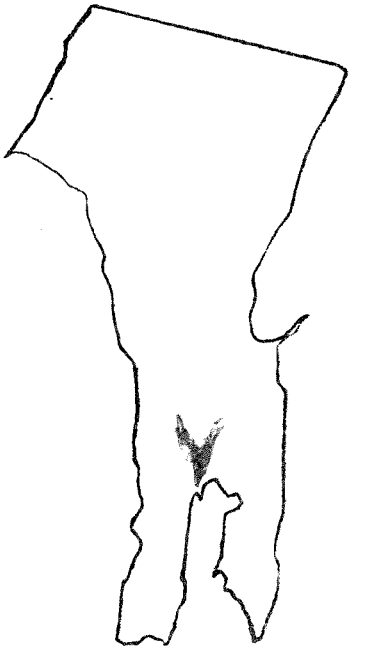


1220

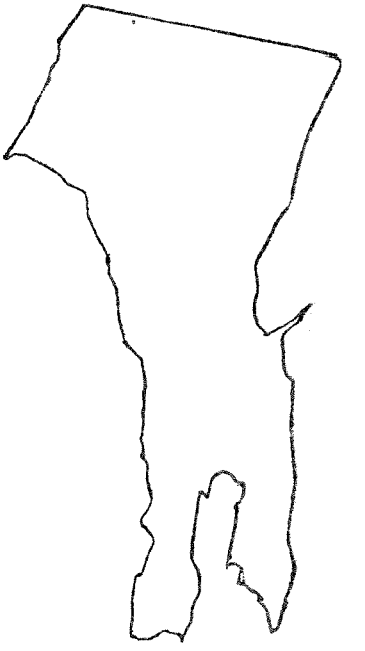
1235



?

1402

?



At 1127, the dye near the log booms was no longer distinguishable. The main dye cloud at the outer channel traveled northerly. The patch near shore proceeded easterly.

Another quantity of dye had been added and was visible at the surface. The tide was going out at a faster rate, and consequently dye movement was more rapid. By 1235 the first patch of dye had become unnoticeable except for a band south of Olympia Shoals. The second cloud had proceeded primarily north with a finger branching off toward Priest Point Park. Maximum chlorine contact time was 57 minutes.

The tide changed at 1340 hours. The third dye addition arrived at the water surface at 1402 hours. The color picture taken by Bill Kimbel Photography showed the third dye plume traveling west and south diagonally to the opposite shore in the vicinity of red nun "14". More dye was dissipated in the general vicinity of Red Nun "10". It is thought that this is the second dye cloud. A portion of the dye was also trapped in the Marina.

In summary, on the day of the survey the dye split into three clouds on the early outgoing tide. One proceeded outward toward Olympia Shoals, one went westerly from the entrance channel and one went easterly and lingered near shore. Droages released at 0834 and 0940 beached in front of KGY radio station within two hours. On the fast outgoing tide, dye went primarily northward; one branch traveled toward Priest Point Park. On the early incoming tide, dye passed west and south from the point of discharge to the opposite shore. It seems plausible that during the latter stages of the incoming tide, the dye would have proceeded nearly to the dam at Capitol Lake. It also appears that part of the dye released on the fast outgoing tide returned to the vicinity from which it was released.

V. WATER QUALITY STANDARDS-INTERSTATE

Lower Budd Inlet which includes Stations 1,2,3,4,6,7,A,B,C,R,T,W, (South of Priest Point Park) is "Class B" water as defined by the Department of Ecology "Implementation and Enforcement Plan for Water Quality Regulations," (I & E Plan). The water quality criteria for Class B waters are:

1. Total Coliform - median value of 1,000 colonies/100 ml with less than 20 percent exceeding 2,400 when associated with a fecal source.

2. Dissolved Oxygen - exceeding 5.0 mg/l or 70 percent saturation whichever is greater.

3. Temperature - less than 70° F....

4. pH - 7.8 to 8.5 with an induced variation of less than .5 units.

5. Turbidity - less than 10 JTU over natural conditions.

6. Toxic - Radioactive or deleterious material...

7. Aesthetic values shall not be reduced by dissolved, suspended, floating, or submerged matter not attributable to natural causes so as to affect water usage or taint the flesh of edible species.

The I & E Plan states that Lower Budd Inlet is unsatisfactory (violates water quality criteria) for total coliform, dissolved oxygen and aesthetics. This statement is based on historical data gathered by Department of Ecology's Water Monitoring section. The data was collected over the years under different seasonal and tidal conditions.

The data collected on July 2, 1973 indicate that pH, dissolved oxygen and coliform violations exist; but that the tide plays an important role in determining the severity. Seasonal conditions obviously are also significant in determining water quality. On the day of the survey the majority of coliform violations occurred at high tide.

The water north of Priest Point (Station # 5) is "Class A" water, the criteria being more stringent than "Class B". Total coliform shall not exceed median values of 70 with less than 10 percent exceeding 230. Dissolved oxygen shall exceed 6.0 mg/1. Temperature shall exceed 61° F... No violations of water quality criteria were recorded at Station #5.

Run # 1

STATION	TIME	DEPTH	COND	SALINITY	T	RECORDED DO	ACTUAL DO	ACTUAL % SAT	pH	TOTAL COLIFORM	FLUORESCENCE
1	0835	S	-	-	-	-	-	-	-	4,500	1
2	0900	S	-	-	-	-	-	-	-	5,000	1
3	0916	S	33.7	26.9	15.0	8.0	6.8	79	8.2	3.500	1
	0917	40'	35.7	29.0	13.1	7.9	6.6	72	8.5	-	-
4	0925	S	34.3	26.8	15.3	9.0	7.6	89	8.3	3,500	1
	0930	40	40.0	32.5	13.0	8.3	6.7	87	8.5	-	-
5	0935	S	36.7	28.7	15.2	9.8	8.2	96	8.5	<40	1
	0940	50'	39.0	33.5	12.5	8.3	6.6	75	8.5		
6	0950	S	33.4	26.0	14.8	8.3	7.1	82	8.6	4,000	1
	0955	10'	36.8	29.0	14.8	9.4	7.8	92	8.6	-	-
7	1000	S	30.3	23.6	15.6	7.0	6.1	69	8.2	60,000	1
	1005	14'	36.4	29.1	14.0	8.8	7.3	84	8.2	-	-
A	0805	S	-	-	-	-	-	-	-	> 80,000	1
	0805	18	-	-	-	-	-	-	-	5,000	1

Depth= feet
Conductivity = X 1000 ~~µ~~mhoσ/cm @ 25° C
Salinity = ~~ppm~~ PARTS/THOUSAND
DO = mg/l
Coliform = colonies/100 ml
Barometric P = 30.2 inches @ 0900 hrs.
DO% = Reported DO/100% DO
Data for Stations A, 1 & 2 lost.

Selected data indicating violation
of Water Quality Criteria

	Run #1	% Sat.		Run #2	% Sat.		Run #3	% Sat.	
	Coliform	DO	pH	Coliform	DO	pH	Coliform	DO	pH
Station 1	4,500	0	0	0	0	0	2,500	66	
2	5,000	0	0	0	67	0	0	69	0
3	3,500	0	0	0	0	0	1,200	0	0
4	3,500	0	0	0	0	0	0	68	0
5	0	0	0	0	0	0	0	0	0
6	4,000	0	8.6	0	0	0	0	0	0
7	60,000	69	0	0	0	0	0	0	0
A	>80,000	0	0	120,000	0	0	?	-	-
B	-	-	-	-	-	-	?	-	-
C	-	-	-	-	-	-	?	-	-
Z	-	-	-	-	-	-	-	-	-
X	-	-	-	2,500	0	0	-	-	-
W	-	-	-	4,500	0	0	-	-	-
T	-	-	-	3,500	0	0		-	-
R	-	-		-	-	-	?	0	0

? = Questionable
0 = Acceptable
- = Not Sampled

Run #2

Sta.	Time	D	Cond.	Sal.	T.	Rec. DO	Act. DO	% DO	pH	Total Colif.	Fluorescence
A	1133	S	31.3	24.1	16.3	-	7.0	81	8.3	120,000	3300
		5'	36.3	28.5	14.8	-	7.6	89	8.4	3,000	75
1	1145	S	29.1	22.4	16.3	8.6	7.5	86	8.4	300	1
		15'	35.9	29.1	13.6	8.7	7.3	85	8.2	-	1
2	1155	S	30.1	23.3	16.1	8.2	7.1	82	8.3	150	-
		35'	35.9	28.9	13.4	7.5	6.3	67	8.3		1
3	1200	S	30.6	24.1	15.5	8.7	7.5	86	8.3	125	1
		35'	35.8	29.0	13.3	8.0	6.7	76	8.3		1
4	1205	S	34.3	26.9	15.2	8.0	6.7	76	8.0	150	1
		35	35.8	28.9	13.4	7.9	6.6	75	7.9		
5	1216	S	36.7	29.2	14.2	10.6	8.8	101	8.5	30	1
		40'	35.7	29.2	12.9	9.8	8.2	93	8.5		
6	1252	S	34.0	25.4	17.7	8.1	6.9	83	8.2	360	1
		4'	34.0	25.4	17.7	8.1	6.9	83	8.2		
7	1300	S	36.2	27.7	16.7	8.0	6.7	80	8.4	200	1
Z	1225									20	1
X	1230									2,500	4
W	1240									4,500	12
T	1245	S	33.0	25.7	15.5	8.4	7.2	84	8.3	3,500	129
		7'	38.0	30.0	15.5	8.0	6.6	78	8.2	-	2

Run #3

Station	Time	D	Cond.	Sal.	T.	Rec. DO	Act. DO	% DO	pH	Total Colif.	Fluorscence
A	1423	S	34.1	25.5	16.9	-	6.5*	77		<10,000	33
		10'	35.9	27.3	15.9						
B	1430	S								<10,000	1680
		22								-	3
C	1435	S								<10,000	810
		33								-	2
C	1525	S	31.5	23.0	18.8	7.8	6.8	82	8.2	< 2,000	-
1	1410	S	26.5	19.6	18.5	8.7	7.7	90	8.3	2,500	2
		14'	36.5	28.3	15.4	6.7	5.6	66	8.2		
2	1420	S	31.1	22.9	18.2	7.5	6.5	77	8.2	< 100	1
		30	35.9	28.9	13.8	7.3	6.1	69	8.2	-	1
2	1530	S								< 20	1
3	1437	S	35.2	26.4	17.1	8.0	6.8	82	8.3	1,200	16
		30	35.8	28.7	13.7	7.5	6.3	72	8.3	-	13
4	1444	S	35.6	26.3	18.4	7.7	6.6	80	8.1	150	28
		32'	35.8	28.9	13.4	7.2	6.0	68	8.3	-	1
5	1454	S	35.7	28.9	15.0	9.0	7.5	88	8.4	25	1
		45'	36.9	29.0	13.2	8.6	7.2	81	8.4	-	1
6	1515	S								-	38
7	1515	S	35.5	26.1	18.8	8.4	7.2	90	8.2	300	10
R	1510									< 2,000	23

* Run by azide modification of the Winkler Method.

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JUN 9 983
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SOUTHWEST REGIONAL

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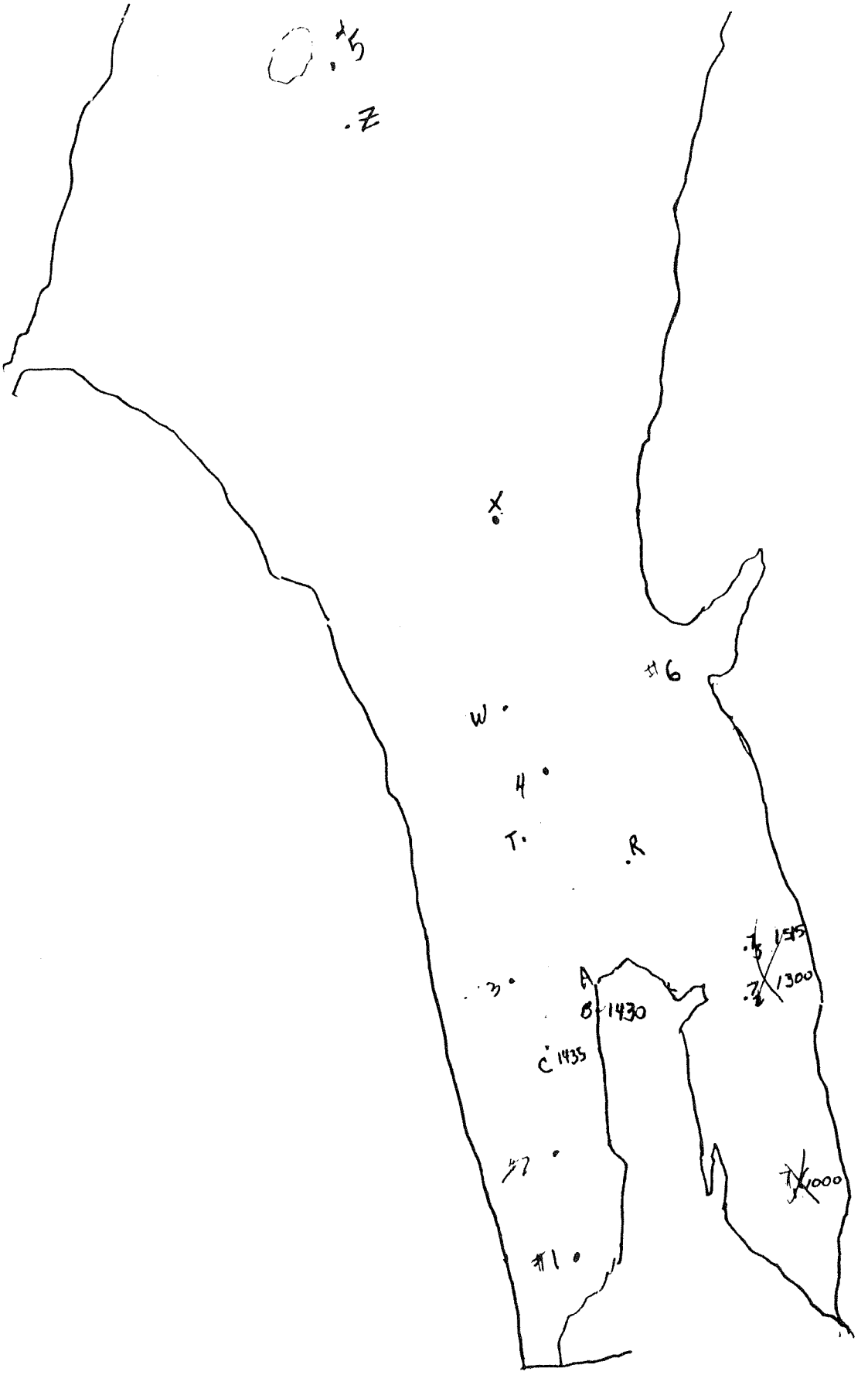
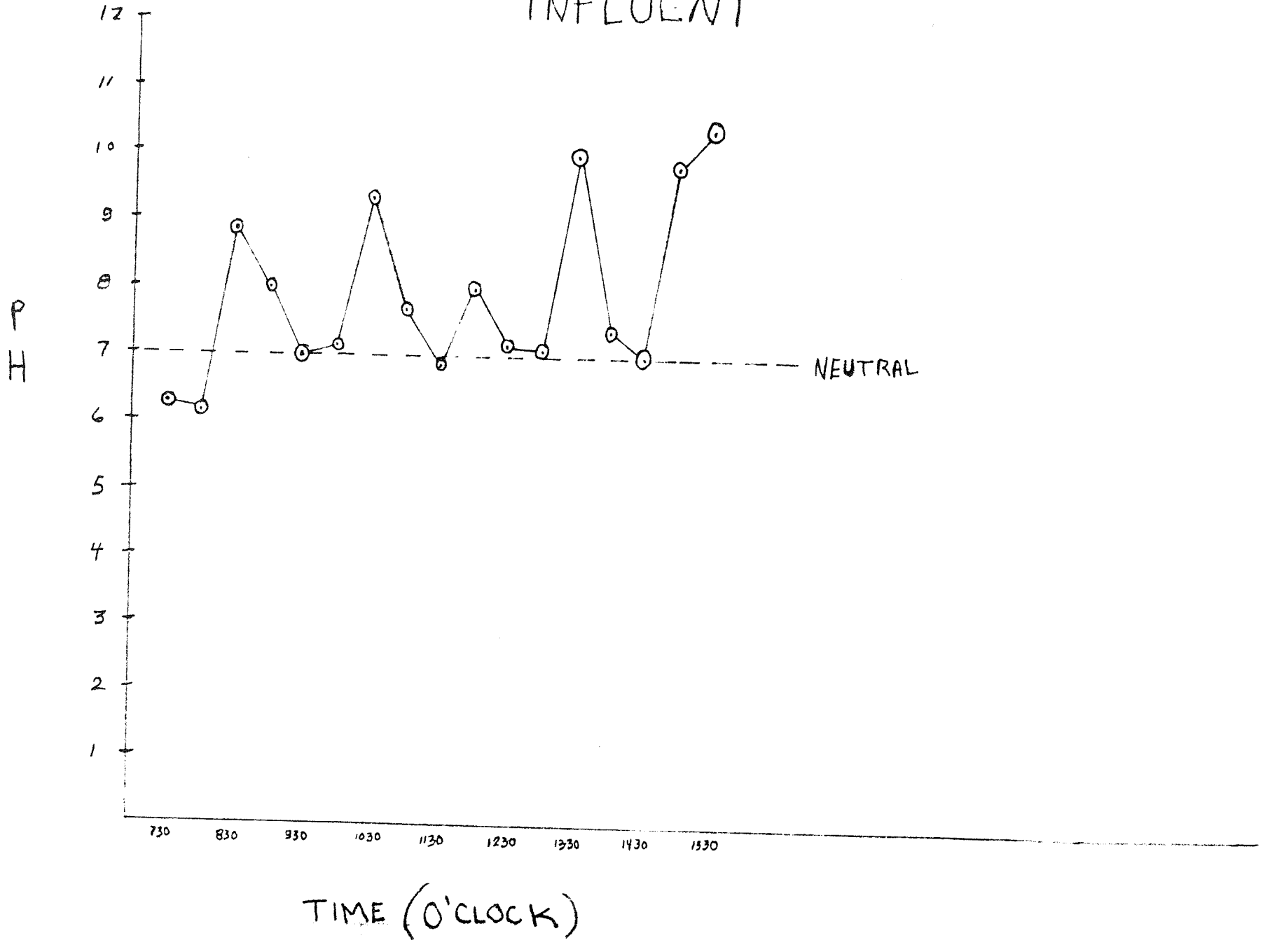
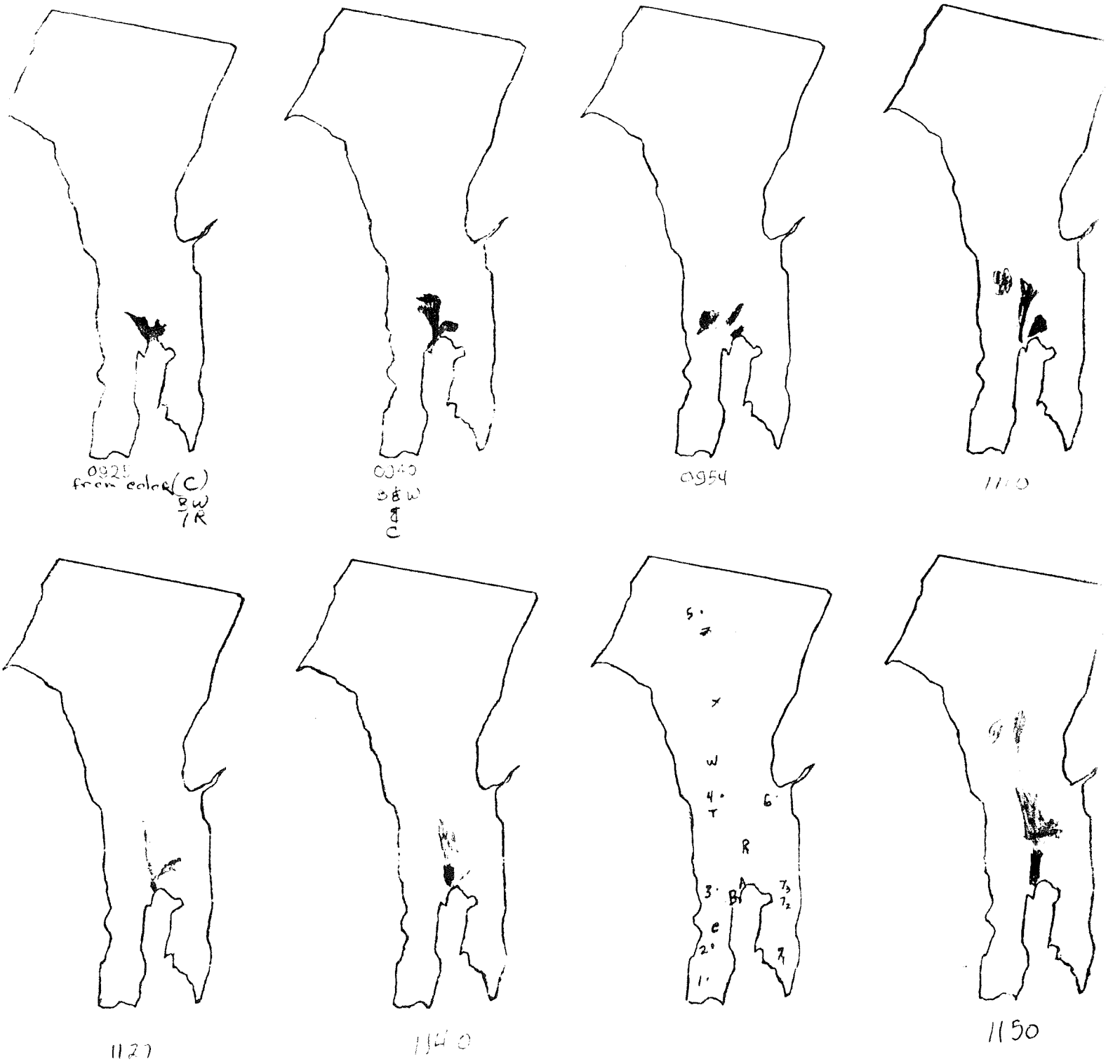

#5
Z
X
#6
W
4
T
R
1545
1300
3
A
B 1430
C 1435
#7
1000
#1

TABLE I

OLYMPIA STP
INFLUENT



DYE TRAVEL


0921
from color (C)
BW
/R
0940
B&W
&
C
0954
1110
1127
1140
S.
W
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6.
R
3.
B
A
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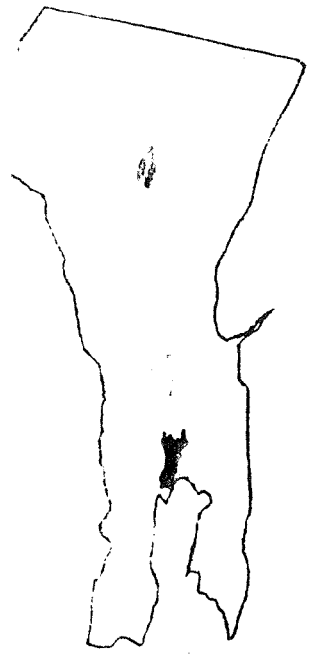
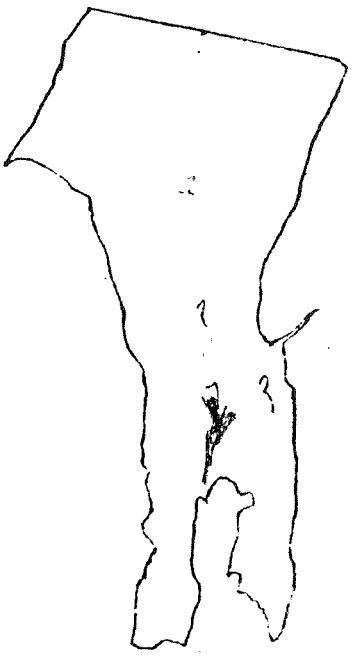
7₂
C
2.
7₁
1.
1150

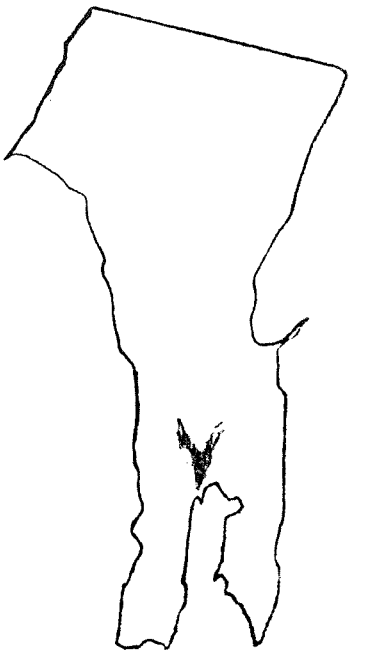


1200

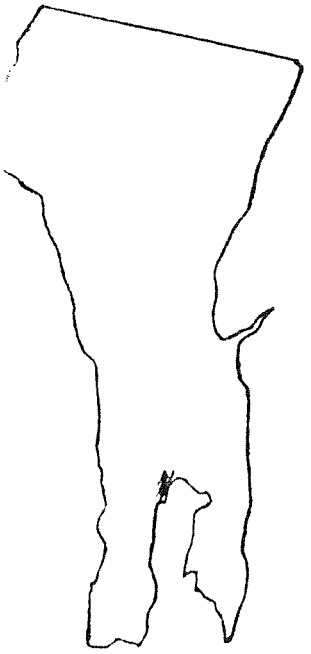


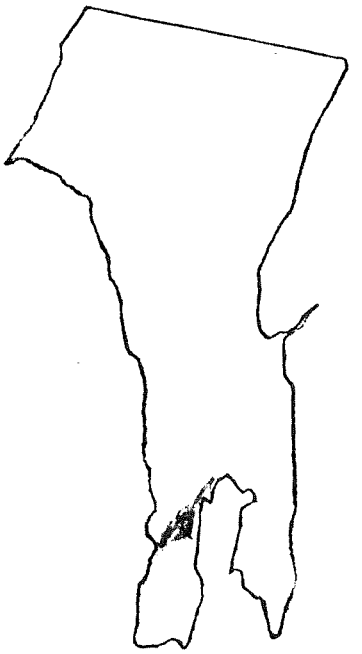
1220

1235



?





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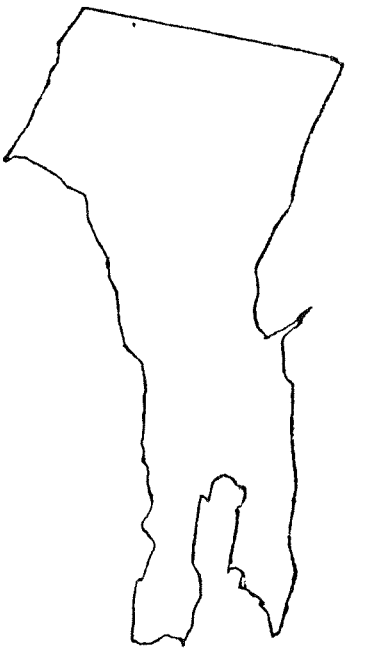

At 1127, the dye near the log booms was no longer distinguishable. The main dye cloud at the outer channel traveled northerly. The patch near shore proceeded easterly.

Another quantity of dye had been added and was visible at the surface. The tide was going out at a faster rate, and consequently dye movement was more rapid. By 1235 the first patch of dye had become unnoticeable except for a band south of Olympia Shoals. The second cloud had proceeded primarily north with a finger branching off toward Priest Point Park. Maximum chlorine contact time was 57 minutes.

The tide changed at 1340 hours. The third dye addition arrived at the water surface at 1402 hours. The color picture taken by Bill Kimbel Photography showed the third dye plume traveling west and south diagonally to the opposite shore in the vicinity of red nun "14". More dye was dissipated in the general vicinity of Red Nun "10". It is thought that this is the second dye cloud. A portion of the dye was also trapped in the Marina.

In summary, on the day of the survey the dye split into three clouds on the early outgoing tide. One proceeded outward toward Olympia Shoals, one went westerly from the entrance channel and one went easterly and lingered near shore. Droages released at 0834 and 0940 beached in front of KGY radio station within two hours. On the fast outgoing tide, dye went primarily northward; one branch traveled toward Priest Point Park. On the early incoming tide, dye passed west and south from the point of discharge to the opposite shore. It seems plausible that during the latter stages of the incoming tide, the dye would have proceeded nearly to the dam at Capitol Lake. It also appears that part of the dye released on the fast outgoing tide returned to the vicinity from which it was released.

V. WATER QUALITY STANDARDS-INTERSTATE

Lower Budd Inlet which includes Stations 1,2,3,4,6,7,A,B,C,R,T,W, (South of Priest Point Park) is "Class B" water as defined by the Department of Ecology "Implementation and Enforcement Plan for Water Quality Regulations," (I & E Plan). The water quality criteria for Class B waters are:

1. Total Coliform - median value of 1,000 colonies/100 ml with less than 20 percent exceeding 2,400 when associated with a fecal source.

2. Dissolved Oxygen - exceeding 5.0 mg/l or 70 percent saturation whichever is greater.

3. Temperature - less than 70° F....

4. pH - 7.8 to 8.5 with an induced variation of less than .5 units.

5. Turbidity - less than 10 JTU over natural conditions.

6. Toxic - Radioactive or deleterious material...

7. Aesthetic values shall not be reduced by dissolved, suspended, floating, or submerged matter not attributable to natural causes so as to affect water usage or taint the flesh of edible species.

The I & E Plan states that Lower Budd Inlet is unsatisfactory (violates water quality criteria) for total coliform, dissolved oxygen and aesthetics. This statement is based on historical data gathered by Department of Ecology's Water Monitoring section. The data was collected over the years under different seasonal and tidal conditions.

The data collected on July 2, 1973 indicate that pH, dissolved oxygen and coliform violations exist; but that the tide plays an important role in determining the severity. Seasonal conditions obviously are also significant in determining water quality. On the day of the survey the majority of coliform violations occurred at high tide.

The water north of Priest Point (Station # 5) is "Class A" water, the criteria being more stringent than "Class B". Total coliform shall not exceed median values of 70 with less than 10 percent exceeding 230. Dissolved oxygen shall exceed 6.0 mg/1. Temperature shall exceed 61° F... No violations of water quality criteria were recorded at Station #5.

Selected data indicating violation
of Water Quality Criteria

	Run #1	% Sat.		Run #2	% Sat.		Run #3	% Sat.	
	Coliform	DO	pH	Coliform	DO	pH	Coliform	DO	pH
Station 1	4,500	0	0	0	0	0	2,500	66	
2	5,000	0	0	0	67	0	0	69	0
3	3,500	0	0	0	0	0	1,200	0	0
4	3,500	0	0	0	0	0	0	68	0
5	0	0	0	0	0	0	0	0	0
6	4,000	0	8.6	0	0	0	0	0	0
7	60,000	69	0	0	0	0	0	0	0
A	>80,000	0	0	120,000	0	0	?	-	-
B	-	-	-	-	-	-	?	-	-
C	-	-	-	-	-	-	?	-	-
Z	-	-	-	-	-	-	-	-	-
X	-	-	-	2,500	0	0	-	-	-
W	-	-	-	4,500	0	0	-	-	-
T	-	-	-	3,500	0	0		-	-
R	-	-		-	-	-	?	0	0

? = Questionable
0 = Acceptable
- = Not Sampled

Run # 1

STATION	TIME	DEPTH	COND	SALINITY	T	RECORDED DO	ACTUAL DO	ACTUAL % SAT	pH	TOTAL COLIFORM	FLUORESCENCE
1	0835	S	-	-	-	-	-	-	-	4,500	1
2	0900	S	-	-	-	-	-	-	-	5,000	1
3	0916	S	33.7	26.9	15.0	8.0	6.8	79	8.2	3.500	1
	0917	40'	35.7	29.0	13.1	7.9	6.6	72	8.5	-	-
4	0925	S	34.3	26.8	15.3	9.0	7.6	89	8.3	3,500	1
	0930	40	40.0	32.5	13.0	8.3	6.7	87	8.5	-	-
5	0935	S	36.7	28.7	15.2	9.8	8.2	96	8.5	<40	1
	0940	50'	39.0	33.5	12.5	8.3	6.6	75	8.5		
6	0950	S	33.4	26.0	14.8	8.3	7.1	82	8.6	4,000	1
	0955	10'	36.8	29.0	14.8	9.4	7.8	92	8.6	-	-
7	1000	S	30.3	23.6	15.6	7.0	6.1	69	8.2	60,000	1
	1005	14'	36.4	29.1	14.0	8.8	7.3	84	8.2	-	-
A	0805	S	-	-	-	-	-	-	-	> 80,000	1
	0805	18	-	-	-	-	-	-	-	5,000	1

Depth= feet
Conductivity = X 1000 ~~µ~~mhoσ/cm @ 25° C
Salinity = ~~ppm~~ PARTS/THOUSAND
DO = mg/l
Coliform = colonies/100 ml
Barometric P = 30.2 inches @ 0900 hrs.
DO% = Reported DO/100% DO
Data for Stations A, 1 & 2 lost.

Run #2

Sta.	Time	D	Cond.	Sal.	T.	Rec. DO	Act. DO	% DO	pH	Total Colif.	Fluorescence
A	1133	S	31.3	24.1	16.3	-	7.0	81	8.3	120,000	3300
		5'	36.3	28.5	14.8	-	7.6	89	8.4	3,000	75
1	1145	S	29.1	22.4	16.3	8.6	7.5	86	8.4	300	1
		15'	35.9	29.1	13.6	8.7	7.3	85	8.2	-	1
2	1155	S	30.1	23.3	16.1	8.2	7.1	82	8.3	150	-
		35'	35.9	28.9	13.4	7.5	6.3	67	8.3		1
3	1200	S	30.6	24.1	15.5	8.7	7.5	86	8.3	125	1
		35'	35.8	29.0	13.3	8.0	6.7	76	8.3		1
4	1205	S	34.3	26.9	15.2	8.0	6.7	76	8.0	150	1
		35	35.8	28.9	13.4	7.9	6.6	75	7.9		
5	1216	S	36.7	29.2	14.2	10.6	8.8	101	8.5	30	1
		40'	35.7	29.2	12.9	9.8	8.2	93	8.5		
6	1252	S	34.0	25.4	17.7	8.1	6.9	83	8.2	360	1
		4'	34.0	25.4	17.7	8.1	6.9	83	8.2		
7	1300	S	36.2	27.7	16.7	8.0	6.7	80	8.4	200	1
Z	1225									20	1
X	1230									2,500	4
W	1240									4,500	12
T	1245	S	33.0	25.7	15.5	8.4	7.2	84	8.3	3,500	129
		7'	38.0	30.0	15.5	8.0	6.6	78	8.2	-	2

Run #3

Station	Time	D	Cond.	Sal.	T.	Rec. DO	Act. DO	% DO	pH	Total Colif.	Fluorscence
A	1423	S	34.1	25.5	16.9	-	6.5*	77		<10,000	33
		10'	35.9	27.3	15.9						
B	1430	S								<10,000	1680
		22								-	3
C	1435	S								<10,000	810
		33								-	2
C	1525	S	31.5	23.0	18.8	7.8	6.8	82	8.2	< 2,000	-
1	1410	S	26.5	19.6	18.5	8.7	7.7	90	8.3	2,500	2
		14'	36.5	28.3	15.4	6.7	5.6	66	8.2		
2	1420	S	31.1	22.9	18.2	7.5	6.5	77	8.2	< 100	1
		30	35.9	28.9	13.8	7.3	6.1	69	8.2	-	1
2	1530	S								< 20	1
3	1437	S	35.2	26.4	17.1	8.0	6.8	82	8.3	1,200	16
		30	35.8	28.7	13.7	7.5	6.3	72	8.3	-	13
4	1444	S	35.6	26.3	18.4	7.7	6.6	80	8.1	150	28
		32'	35.8	28.9	13.4	7.2	6.0	68	8.3	-	1
5	1454	S	35.7	28.9	15.0	9.0	7.5	88	8.4	25	1
		45'	36.9	29.0	13.2	8.6	7.2	81	8.4	-	1
6	1515	S								-	38
7	1515	S	35.5	26.1	18.8	8.4	7.2	90	8.2	300	10
R	1510									< 2,000	23

* Run by azide modification of the Winkler Method.