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MEMORANDUM

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION

TO : Mr. David Alton, Regional Shellfish Specialist DATE: July 18, 1979
Region IX

FROM : Staff Engineers - NTSU

SUBJECT: Hydrographic Studies - Arcata Bay, California - April 21-28.

The purpose of this memorandum is to present the results of the hydrographic work performed during the above time period. The effluent times of travel and dilutions were studied for three waste treatment facilities, (1) Murray Street STP in Eureka (2) Hill Street STP in Eureka and (3) Arcata STP in Arcata. From the dilutions, coliform level predictions were made in the Bay. The coliform levels would result when operational malfunctions occur.

Each STP effluent was studied individually. Results and discussions for each STP consider that the other two STP's are operating adequately and not adding coliforms to the estuary. No cumulative circumstances were considered.

All studies were performed with Rhodamine WT dye (20%, specific gravity 1.2) mixed in equal volumes with methanol. The mixture was continuously pumped into each STP effluent. Three boat crews with fluorometers performed the tracing. A total of 10 people were involved in the data collection.

MURRAY STREET STP

The study was conducted on April 26, 1979. A predicted low tide of -0.7 ft was at 0554; a predicted high tide of 5.6 ft was at 1213. Predicted slack low tide was at 0611. Light rain occurred throughout the study. Wind was usually calm, but an intermittent breeze occurred to about 5 MPH.

Dye was released into a manhole at DelNorte Street from 0715 to 1043. (See Figure 1). The STP flow during this period varied from 2.5 to 4.2 MGD. The high flow was at about 0900 representing a morning flow increase. It took about 14 minutes for the dye to reach the effluent boil in Eureka Channel. As shown in Figure 1 the dye traveled on both sides of Indian Island and on both sides of Woodley Island.

The dye stayed to the eastern half of Arcata Channel. There was good lateral spread in Indian and Daby Street Channels. Vertical mixing was very rapid. Dye extended to depths greater than 10 feet about 1,500 feet from the outfall.

Maximum dye concentration contours found are shown in Figure 2. An effluent dilution factor of 19 to 25 was found in the boil and was determined by dividing dye concentrations added in the effluent by the concentrations found in the boil (Fig. 2).

Figures 3 and 4 show maximum dye concentrations vs. distance from the outfall for Indian and Arcata Channels. In both figures the slope of the line changes when splitting around Indian Channel. The effects of increasing the dye feed rate in the STP effluent are reflected in the 0.2 and 0.3 ppb contours. All other contours reflect the 3,000 ppb concentration in the effluent.

HILL STREET STP

The Hill Street STP Study was performed on April 24, 1979. Dye was added in the elevated manhole (about 6 feet off ground) on the STP premises. The release period was 1120 to 1640. The STP flow was 1.1 MGD. The average dye concentration in the effluent was 2,750 ppb.

Tidal predictions by NOAA were as follows: high tide 1026, low tide 1625, slack low tide 1653.

Dye concentrations and times of travel are shown for the ebb tide portion of the study in Figure 5. Boil grab samples indicated only about at 1:2 initial dilution occurred in Eureka Slough. Figure 6 is a plot of maximum concentrations vs. distance from the outfall. Dye was greater than 10 ft deep when it reached the west end of Woodley Island.

The travel time of 2 hours in Figure 5 was used as a starting time for effluent flowing up Indian Channel on flood tide. Two hours were added to the flood tide travel times from that point to arrive at the travel times in Figure 7 which represents travel times from the Hill Street STP.

Maximum dye concentrations found on the flood tide study are shown in Figure 8. Figure 9 is a plot of maximum concentrations in Indian Channel plotted against distance of travel on flood tide. The slope of the curve is very similar to that in Figure 3 for the Murray Street study. That indicates, as expected, the effluents from both the Murray Street and Hill Street plants are diluted similarly as they are carried up Indian Channel on flood tide.

ARCATA STP

The study was performed on April 25, 1979. Dye was released from 1255 to 1630 following the dechlorination chamber which was very near the outfall. Average flow was 2.0 MGD during the dye addition. Predicted high tide was 1127, predicted low was 1707, predicted slack low was at 1736.

A westerly wind kept the dye toward the eastern side of the bay as shown in Figure 10. Because of this the effluent did not reach a boat for first detection until about an hour and 50 minutes after dye addition started. By that time the dye was confined to channels. The times of travels to the leading edges are shown in Figure 10.

The maximum dye concentrations detected are shown in Figure 11. There was no initial dilution at the outfall because it was so shallow (exposed during much of the tide). The maximum concentrations along the Ruins Channel are plotted against distance from the outfall in Figure 12. The plot shows that a dye concentration of 0.1 ppb could occur about 15,500 feet from the outfall which is about 1,000 feet downstream of where last detected in Figure 11. The time for the dye to travel 1,000 feet based upon average velocities is only about 20 minutes. Therefore Figure 12 indicates that with no wind or an easterly wind the dye concentration at the limit of detection we observed with a westerly wind (Travel Distance - Figure 11) could have been as high as 0.2 ppb. Easterly winds as well as tidal ebbs larger than occurred during our study could result in dye concentrations of 0.1 ppb 1,000 feet further down the bay.

SUMMARY

The results of all dye studies are summarized in the following Table. The Table enables one to refer to the Figure indicated, pick off a concentration from a dye contour and from the Table read time of travel of the effluent to that point, dilution factor at that location and predicted coliform concentration.

The dye studies showed that the whole Bay (except the northwesterly corner) can be influenced by STP effluent.

The Murray Street STP has primary treatment. During a chlorination breakdown, the effluent could contain 10^7 coliforms/100 ml. According to the Table the lowest coliform count would be 290 MPN/100 ml at the 0.2 ppb contour shown in Figure 2.

The Hill Street STP had poor operation during the study. The primary settling tank and the trickling filter were not operating. During a chlorination failure 10^7 coliforms could be expected in the effluent. The Table indicates a 730 coliform MPN/100 ml expected value at the 0.2 ppb contour shown in Figure 8.

The Arcata STP has a substantial flow time through the pond system resulting in some coliform reduction. The Table indicates 10^6 coliforms/100 ml would result in 110 MPN at the travel distance shown in Figure 11. An effluent quality of 10^5 coliforms/100 ml would result in only 11 MPN at that location. The effectiveness of the treatment system prior to disinfection at destroying coliforms will influence greatly the classification of the portion of the Bay influenced by the Arcata STP.

The travel times of the effluents are all short (4.5 hours or less) necessitating short warning and notification times.

Page 4 - Mr. David Alton

If there are comments or if we can be of assistance, please call. Four extra copies of the memorandum are enclosed for your distribution.

Virgil E. Carr

Virgil E. Carr

John F. Musselman

John F. Musselman
Staff Engineers
NE Technical Services Unit

Attachments

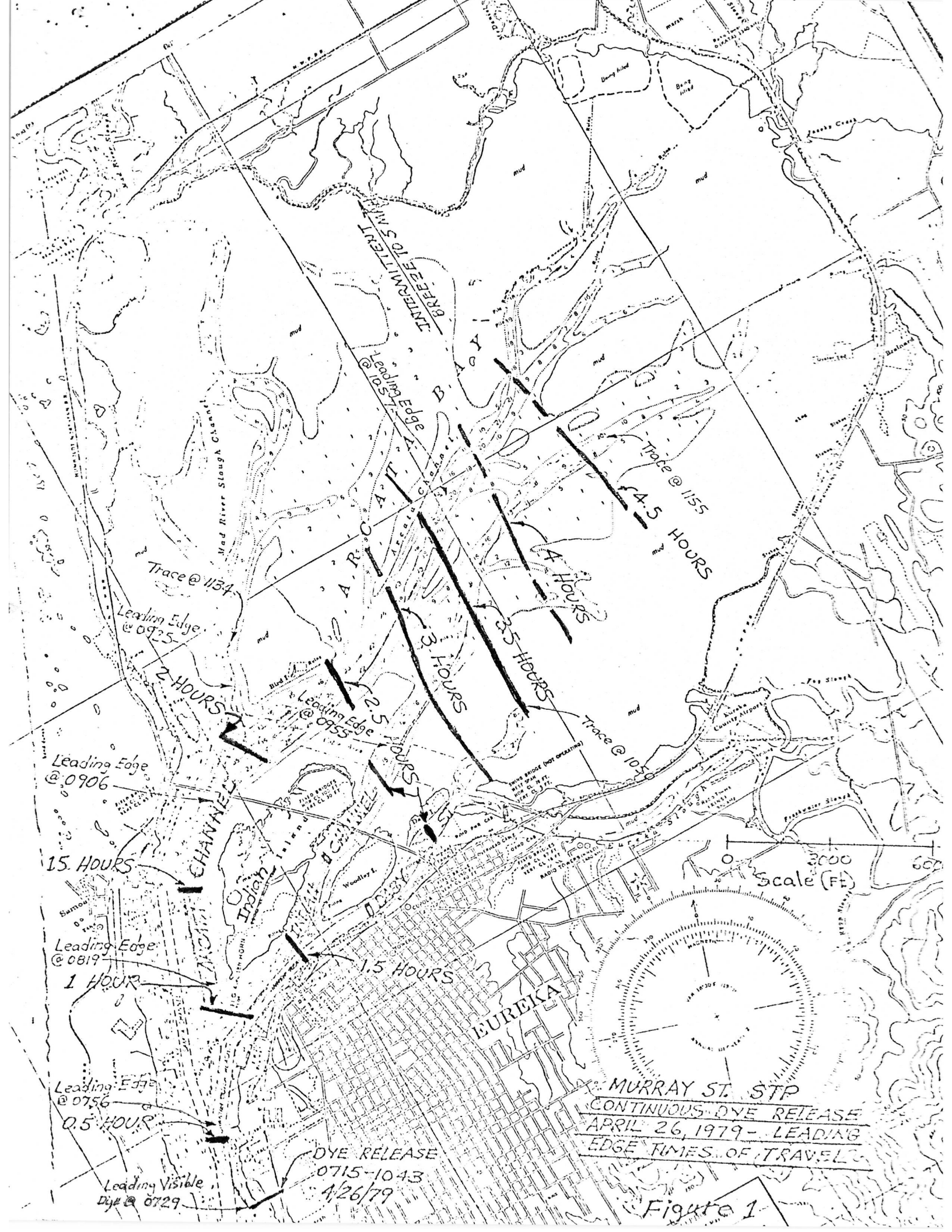
cc: Mr. George Morrison HFF-417
Mr. Santo Furfari HFH-410

ARCATA BAY, CALIFORNIA

RESULTS OF HYDROGRAPHIC STUDIES - APRIL, 1979

STP STUDY	REFER TO FIGURE NO.	DYE CONC. (ppb)	TIME OF TRAVEL (HRS)	DILUTION FACTOR	PREDICTED COLIFORMS AT DYE CONC. POORLY TREATED SEWAGE MPN/100ml		
					10 ⁷	10 ⁶	10 ⁵
MURRAY ST.	2	*3,000	-	-	-	-	-
4/26/79							
ARCATA CHANNEL		0.4	1.7	7,500	1,300	130	13
CHANNEL		0.3	2.3	23,000**	430	43	4.3
CHANNEL		0.2	3.0	34,000**	290	29	2.9
CHANNEL		0.1	3.6	30,000	330	33	3.3
INDIAN CHANNEL		0.4	1.8	7,500	1,300	130	13
CHANNEL		0.3	3.1	23,000**	430	43	4.3
CHANNEL		0.2	3.8	34,000**	290	29	2.9
CHANNEL		0.1	4.0	30,000	330	33	3.3
HILL ST.	8	*2,750	-	-	-	-	-
4/24/79							
INDIAN CHANNEL		0.5	2.7	5,500	1,800	180	18
CHANNEL		0.4	3.2	6,900	1,400	140	14
CHANNEL		0.3	3.6	9,200	1,100	110	11
CHANNEL		0.2	3.9	13,700	730	73	7.3
ARCATA	11	*1,800	-	-	-	-	-
4/25/79							
RUINS CHANNEL		10	2.8	180	56,000	5,600	560
CHANNEL		3	3.6	600	17,000	1,700	170
CHANNEL		1	4.1	1,800	5,600	560	56
CHANNEL		TRAVEL DIST.	4.5	9,000***	1,100	110	11

* Average concentration of dye added to effluent.
 ** Calculated from increased 6,857 ppb dye feed.
 *** Based upon Figure 12. (0.2 ppb)



MURRAY ST. STP
 CONTINUOUS DYE RELEASE
 APRIL 26, 1979 - LEADING
 EDGE TIMES OF TRAVEL

Figure 1

DYE RELEASE
 0715-1043
 4/26/79

Scale (FT)
 0 3000 6000



EUREKA

INDIAN CHANNEL

INTERMITTENT
 BREEZE TO SW

Trace @ 1134

Trace @ 1155
 4.5 HOURS

Leading Edge @ 0925

Leading Edge @ 0955

Leading Edge @ 0906

15 HOURS

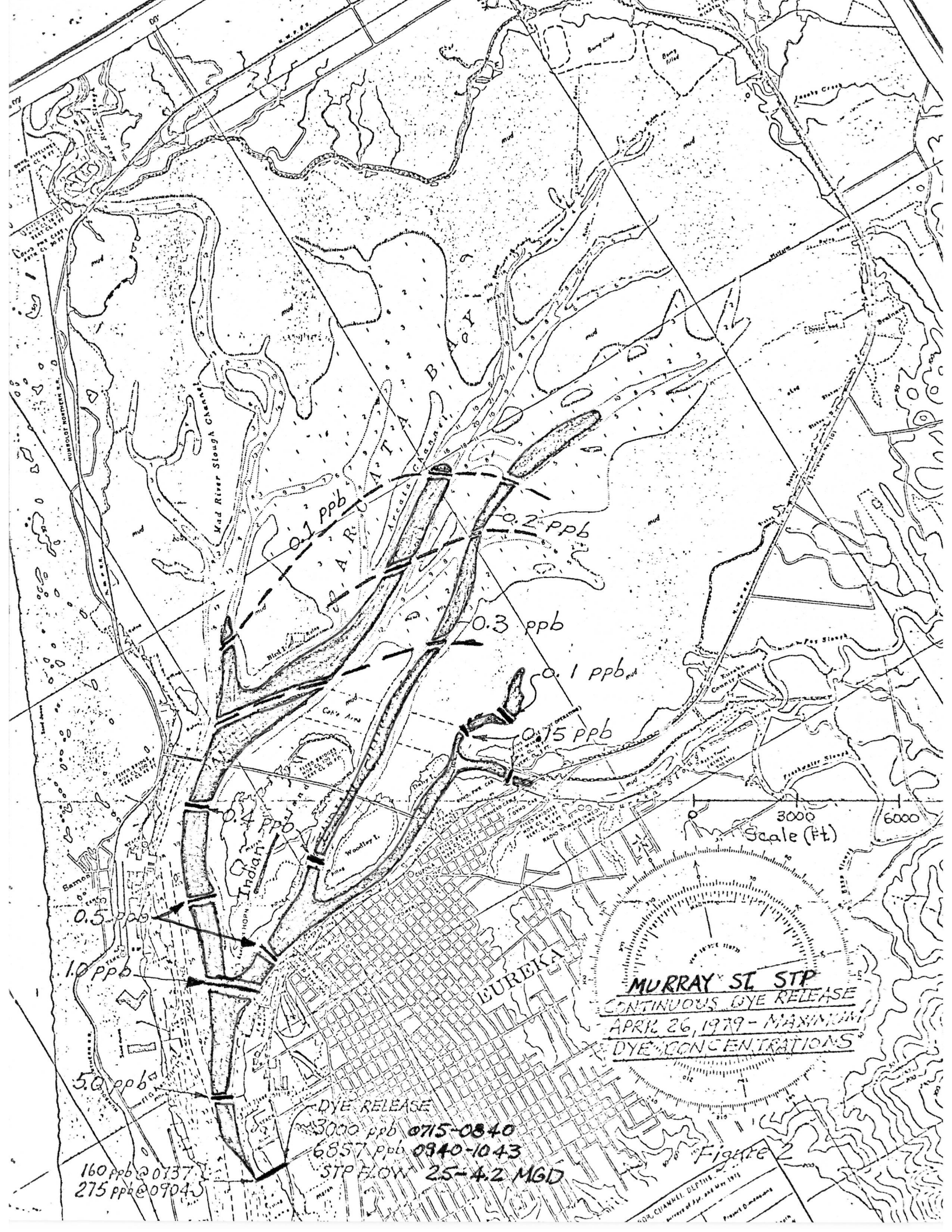
Leading Edge @ 0819

1 HOUR

Leading Edge @ 0756

0.5 HOUR

Leading Visible
 Dye @ 0729



160 ppb @ 0137
 275 ppb @ 0904

DYE RELEASE
 3000 ppb 0715-0840
 6857 ppb 0940-1043
 STP FLOW 25-42 MGD

MURRAY ST STP
 CONTINUOUS DYE RELEASE
 APRIL 26, 1979 - MAXIMUM
 DYE CONCENTRATIONS

Figure 2

U.S. NAVY CHART NO. 1811
 Edition of 1964 and May 1978
 Project Department

MURRAY ST STP 4/26/79

CONTINUOUS DYE RELEASE

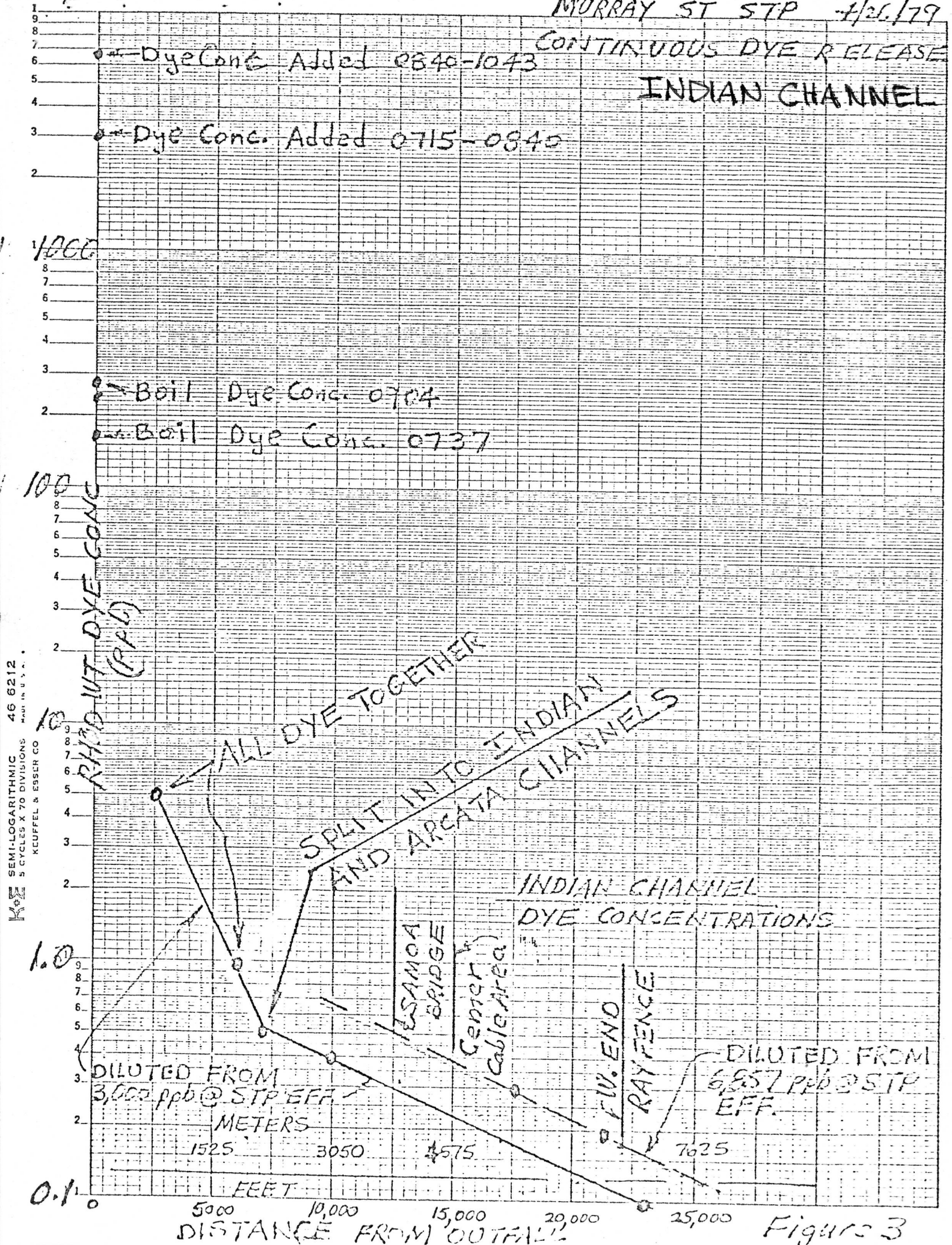
INDIAN CHANNEL

Dye Conc Added 0840-1043

Dye Conc. Added 0715-0840

Boil Dye Conc. 0704

Boil Dye Conc. 0737



SEMI-LOGARITHMIC 46 6212 5 CYCLES X 70 DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A.

Figures 3

MURRAY ST. STP 4/26/79

CONTINUOUS DYE RELEASE

Dye Conc. Added 0840-1043

ARCATA CHANNEL

Dye Conc. Added 0715-0840

Boil Dye Conc. @ 0904

Boil Dye Conc. 0757

K&Z 5 CYCLES X 70 DIVISION KEUFFEL & ESSER CO

RHO. WT DYE CONC. (PPB)

ALL DYE TOGETHER

SPLIT INTO INDIAN AND ARCATA CHANNELS

ARCATA CHANNEL DYE CONCENTRATIONS

DILUTED FROM 3000 PPB @ STP EFF.

DILUTED FROM 6857 PPB IN STP EFF

METERS

FEET

1525

3050

3575

6100

15000

29000

25,000

Figure 4



Wind 5 knots
@ 1108

3000
Scale (Ft)

DYE RELEASE 11/20-1640
AVG. CONC. 2750 ppb
Range 2000-3500 ppb

HILL ST. STP
CONTINUOUS DYE
RELEASE - APRIL 24 1979
MAXIMUM DYE CONCENTRATION
AVG. LEADING EDGE TIME
OF TRAVEL (ebb tide)

Figure 5

HUMBOLDT BAY AND HARBOR CHANNEL, EUREKA, CALIF.

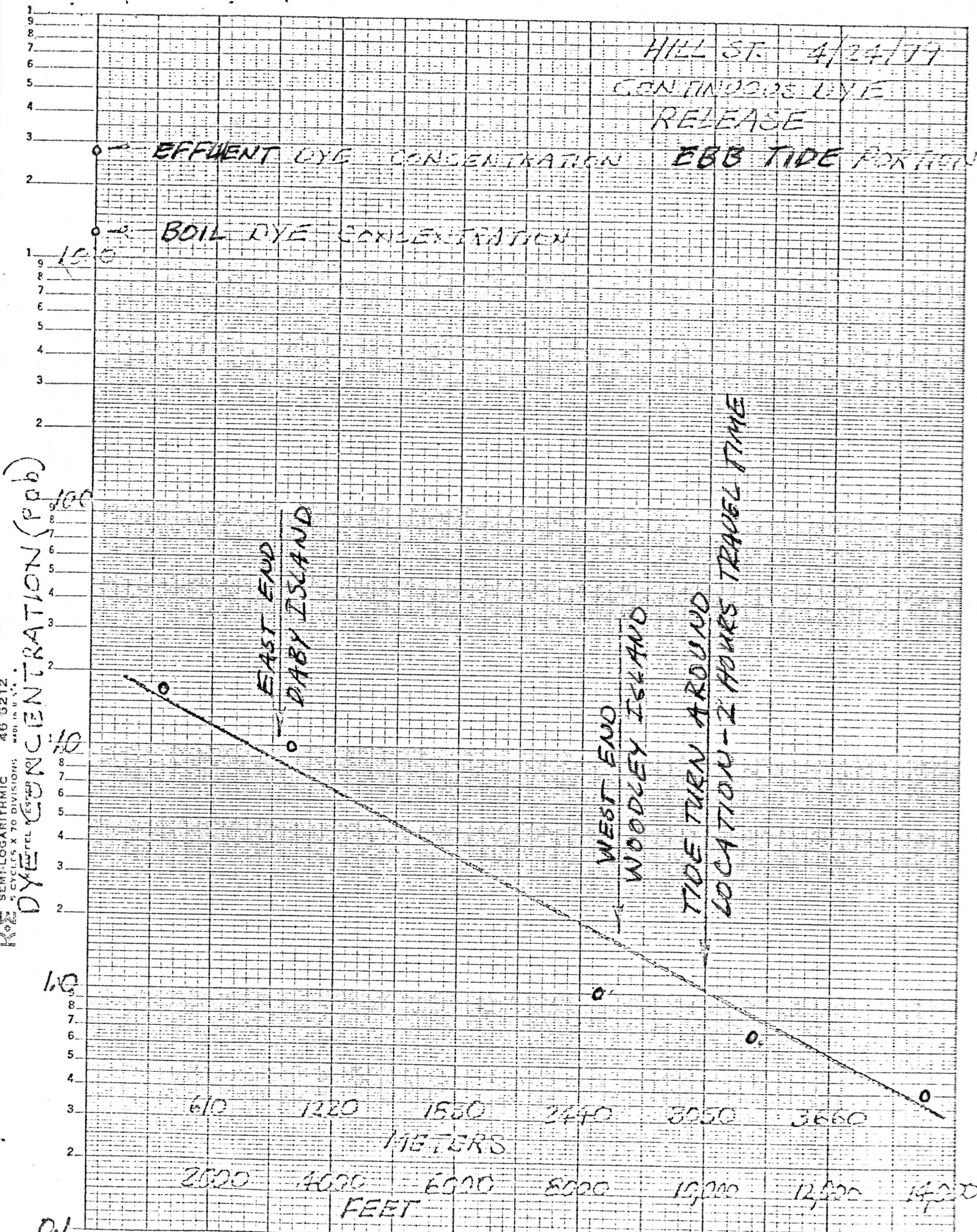
Continuing depths in channels starting from
reference in text at Mean Lower Low Water

Chart	Left	Right	Right	Date	Project	Depth	Depth
	with	inside	inside	of		1000	1000
	depth	depth	depth	Survey		to	to
						depth	depth
11	178	162	150	4/1/71	1	100	100
11	178	162	150	4/1/71	2	100	100
11	178	162	150	4/1/71	3	100	100
11	178	162	150	4/1/71	4	100	100
11	178	162	150	4/1/71	5	100	100
11	178	162	150	4/1/71	6	100	100
11	178	162	150	4/1/71	7	100	100
11	178	162	150	4/1/71	8	100	100
11	178	162	150	4/1/71	9	100	100
11	178	162	150	4/1/71	10	100	100

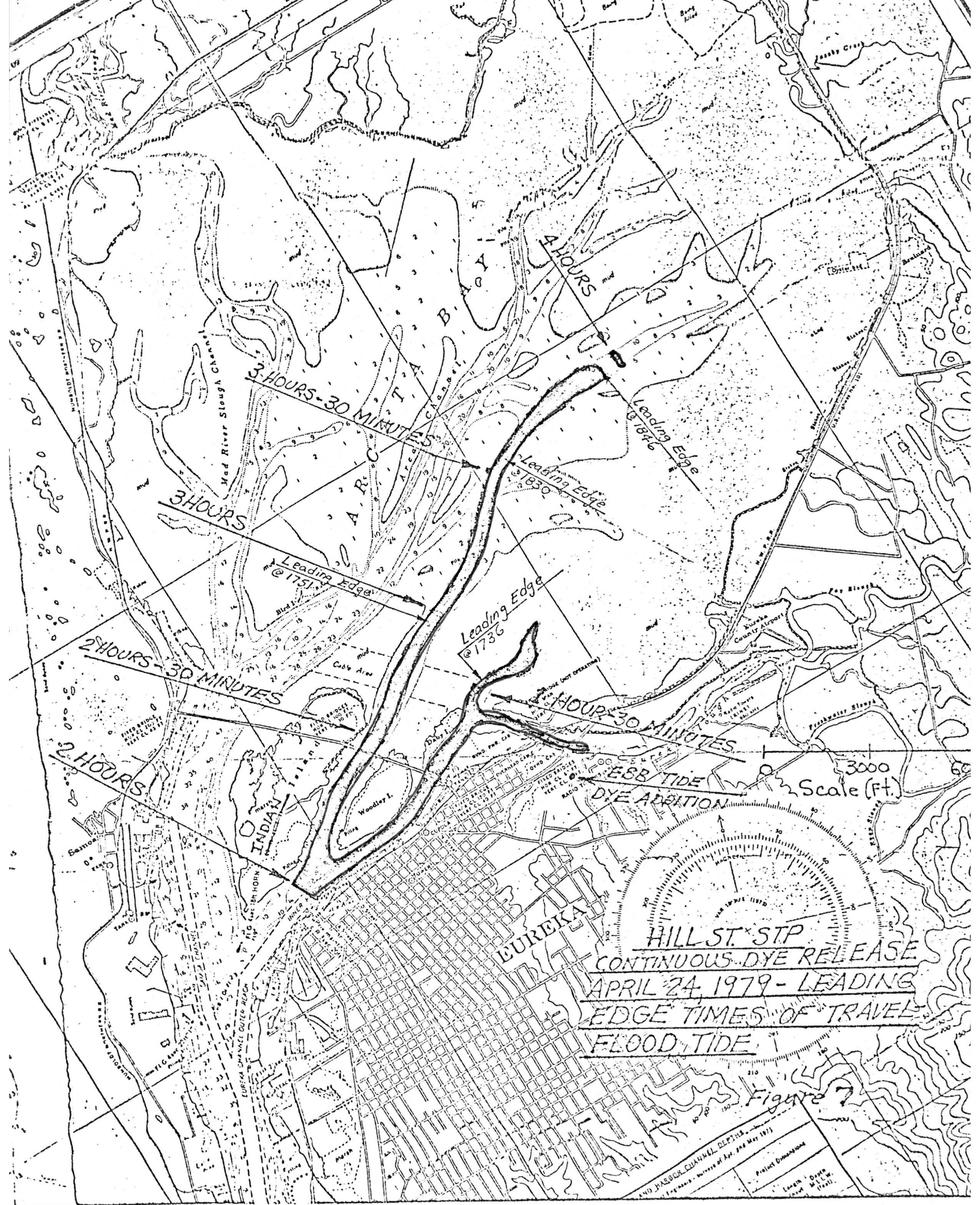
HILL ST. 4/24/79
 CONTINUOUS DYE
 RELEASE

EFFLUENT DYE CONCENTRATION EBB TIDE PORTION
 BOIL DYE CONCENTRATION

SEMI-LOGARITHMIC
 5 CYCLES X 70 DIVISIONS
 MADE IN U.S.A.
 DYE CONCENTRATION (ppb)



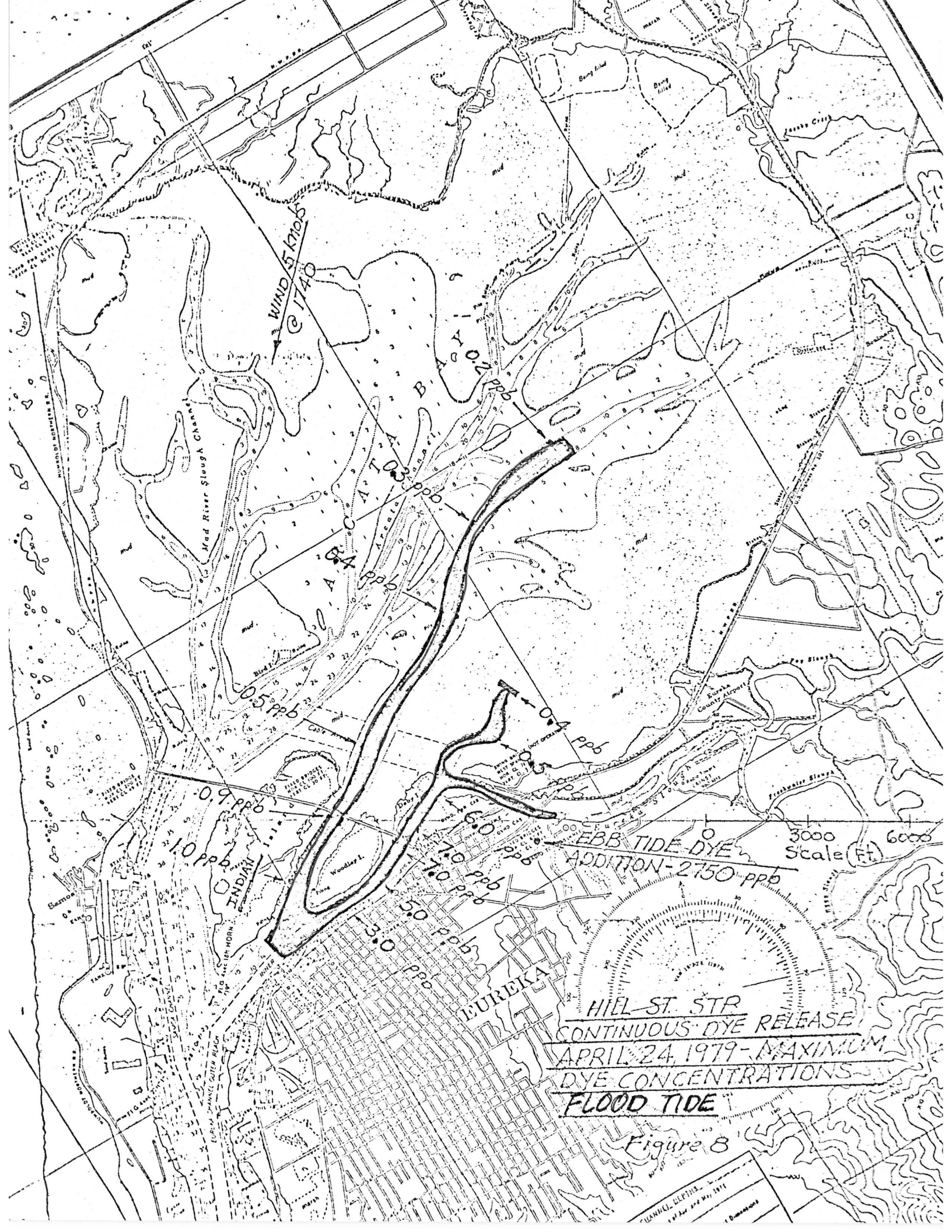
DISTANCE FROM OUTFALL Figure 6



HILL ST. STP
 CONTINUOUS DYE RELEASE
 APRIL 24, 1979 - LEADING
 EDGE TIMES OF TRAVEL
 FLOOD TIDE

Figure 7

AND JAMES R. CLARK, JR., DEPT. OF THE
 PROJECT DRAINAGE
 LENGTH - DYE
 (1979)



WIND 5 KNOTS @ 1740

EBB TIDE DYE ADDITION - 2750 ppb
 3000 Scale (Ft.) 6000

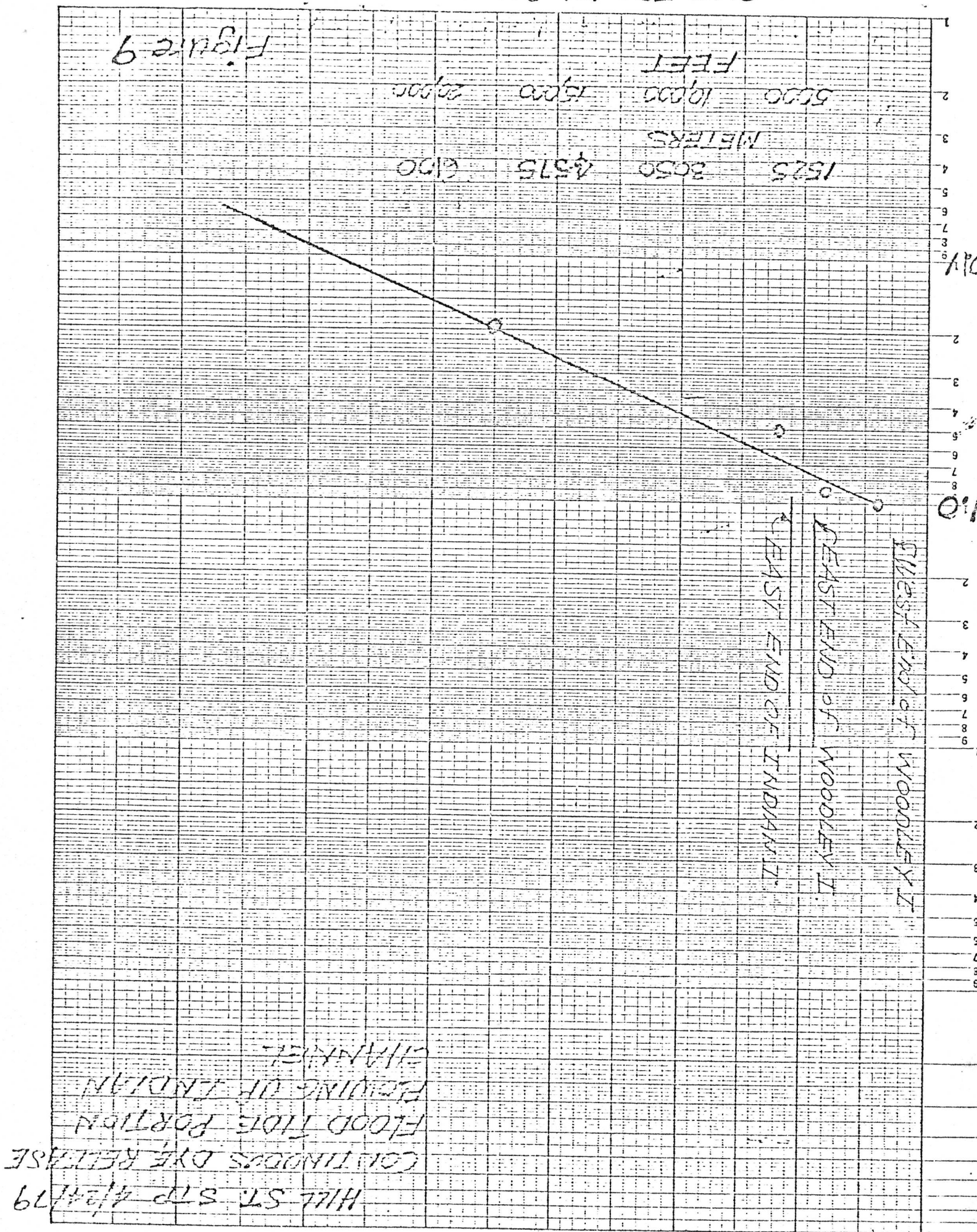
HILL ST. STR
 CONTINUOUS DYE RELEASE
 APRIL 24, 1979 - MAXIMUM
 DYE CONCENTRATIONS
 FLOOD TIDE

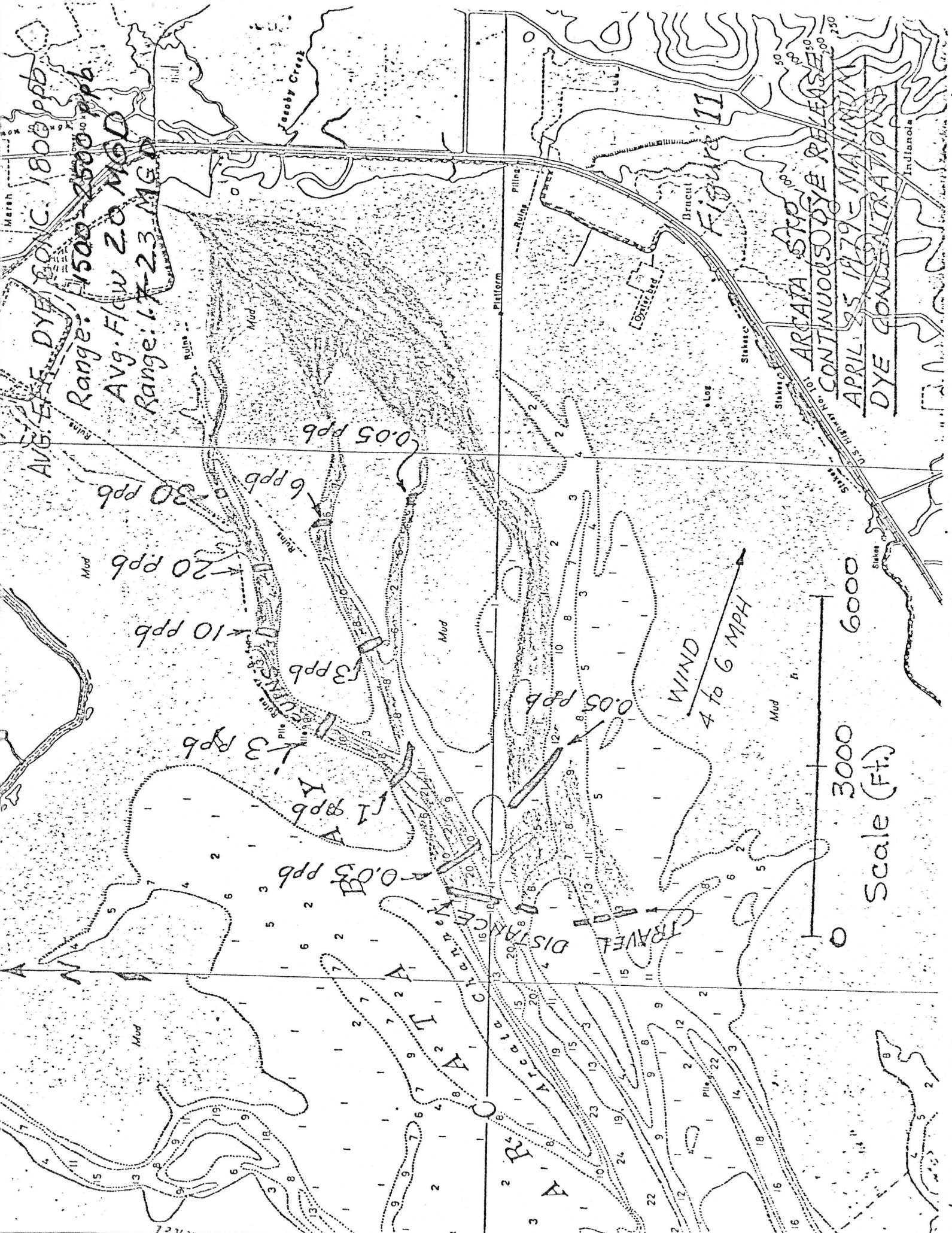
Figure 8

CLARK, CLETTIE
 1 of Apr. and May 1979
 1 Dimension

DYE TRAVEL DISTANCE ON FLOOD TIDE

Figure 9



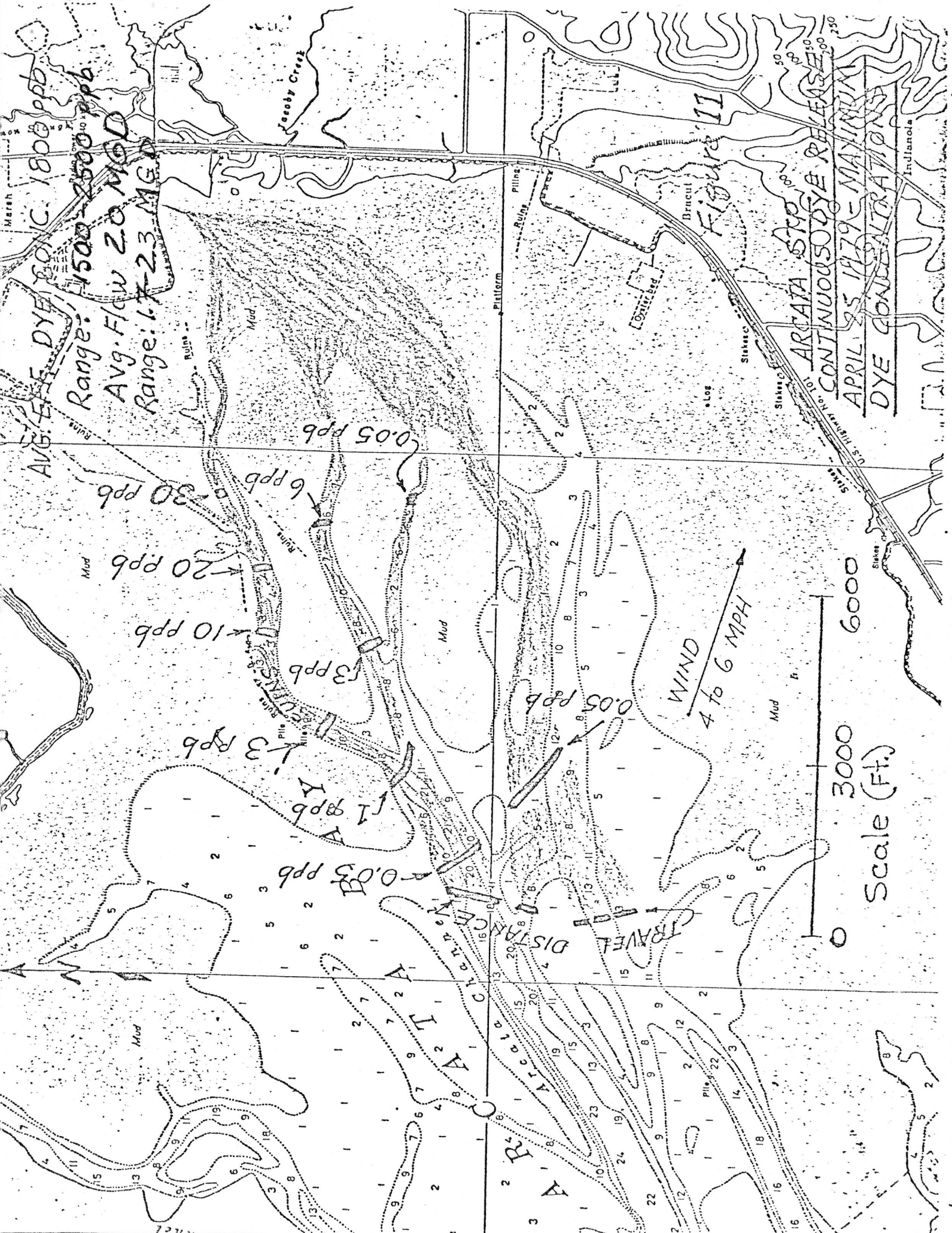
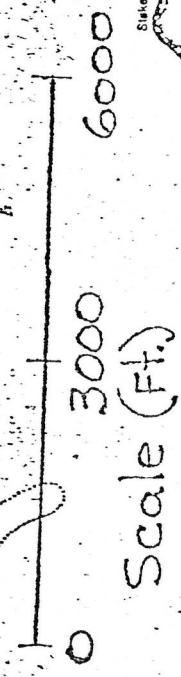


Avg. Eff. Dye Conc. 1800 ppb
 Range: 1500 - 2500 ppb
 Avg. Flow 2.0 MGD
 Range: 1.7 - 2.3 MGD

0.05 ppb
 6 ppb
 20 ppb
 10 ppb
 3 ppb
 13 ppb
 1 ppb
 0.05 ppb
 0.05 ppb
 WIND 4 to 6 MPH

Figure 11

ARCATA STOP CONTINUOUS DYE RELEASE
 APRIL 25 1979 - MAXIMUM DYE CONCENTRATIONS

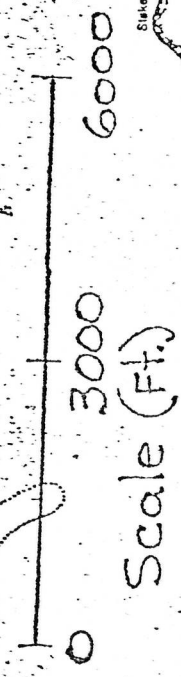


Avg. Eff. Dye Conc. 1800 ppb
 Range: 1500 - 2500 ppb
 Avg. Flow 2.0 MGD
 Range: 1.7 - 2.3 MGD

0.05 ppb
 6 ppb
 20 ppb
 10 ppb
 3 ppb
 13 ppb
 1 ppb
 0.05 ppb
 0.05 ppb
 WIND 4 to 6 MPH

Figure 11

ARCATA STOP CONTINUOUS DYE RELEASE
 APRIL 25 1979 - MAXIMUM DYE CONCENTRATIONS



CONTINUOUS DYE RELEASE
RUINS CHANNEL

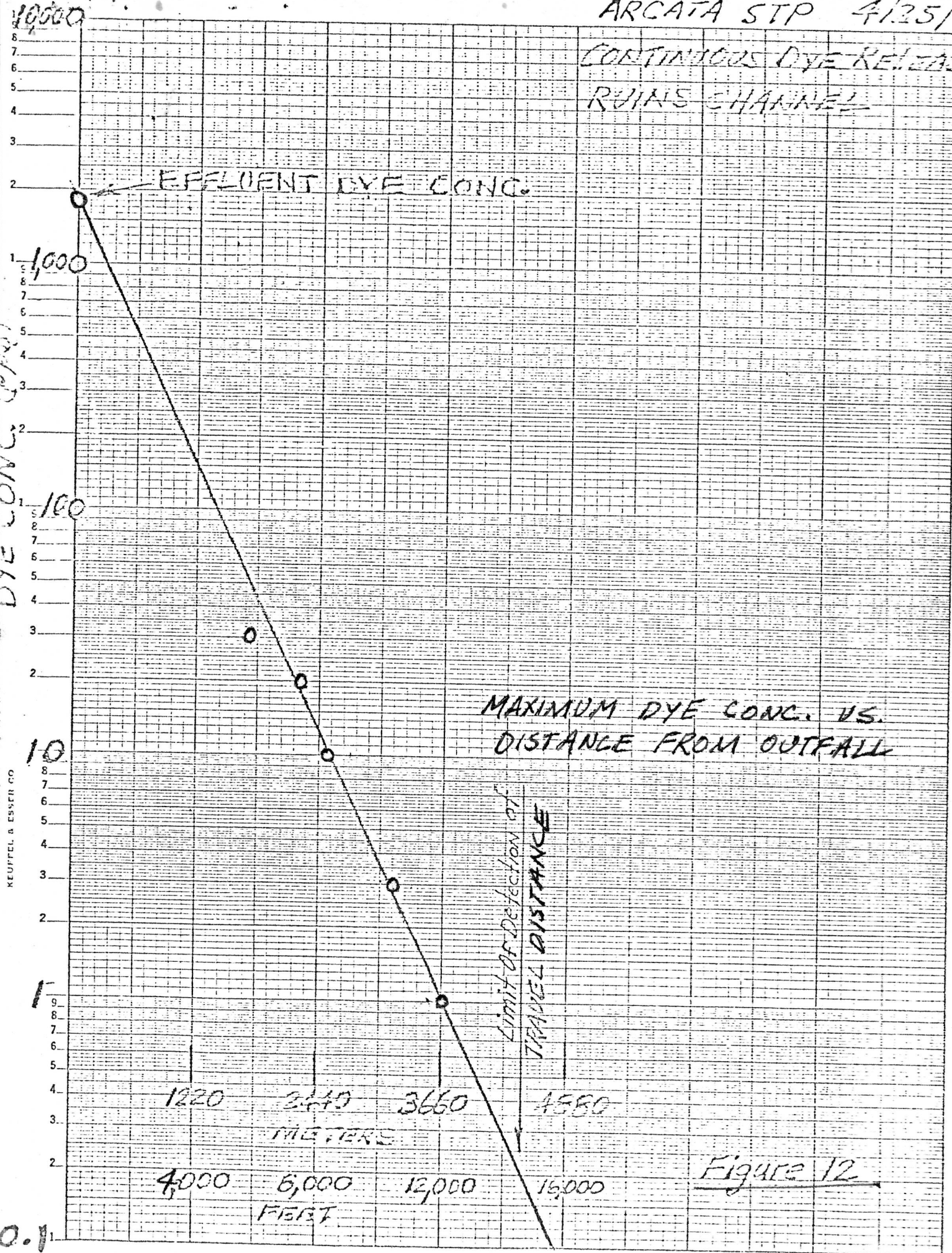


Figure 12

KEUFFEL & ESSER CO