STRESS AND RECOVERY OF BENTHIC INFAUNA FROM OCEAN DISCHARGE OFF ORANGE COUNTY, CALIFORNIA

SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT

November 1974

Effects of Diversion to Deepwater off Orange County, California

On 31 March 1971, a discharge of 133 MGD of primary treated wastewater was diverted from a one-mile outfall to a five-mile long outfall off the Orange County Coast by the County Sanitation Districts of Orange County. Biological data taken by Marine Biological Consultants and by Gary Smith (S.I.O.) and sediment metals data taken by D. Young and J. Galloway suggested that after 17 years of continuous discharge (from 27 to 133 MGD) the inshore benthic environment at the nearshore outfall recovered within a year. In addition, offshore data suggested that no major effects in the benthic environment were found during the first year of discharge out the long outfall.

We propose to re-examine these data, complete analyses of remaining un-analyzed samples (especially from Smith) and initiate sampling at sites not now being surveyed. Such a program should provide urgently needed data on both the reversibility of effects from nearshore discharge of a large volume of primary effluent and provide insight into the kinds of environmental responses (or lack of them) engendered by a modern, well-designed sub-thermocline diffuser system.

I. Work Plan

A. Previous data (cited above) will be collated and reviewed for its adequacy to describe the significance of environmental changes which may have occurred at the old outfall site as a result of effluent diversion. This will include pre- and post-

discharge switch quantitative information on fish abundance, diversity and disease incidences, benthic infaunal species abundances and diversities and on sediment metals (copper and lead) and chlorinated hydrocarbons.

B. Completion of Benthic Infaunal Samples

Between July 1970 and September 1972, Dr. Gary Smith, Scripps Institution of Oceanography, collected a total of 342 benthic samples at six stations near the outfalls and at two control stations. The outfall stations involved one transect at each outfall with stations at 0.25, 0.5 and 1.0 mile downcoast of the outfalls. Sampling was approximately bimonthly with six samplings before and six after the discharge switch. Two replicates from each station were analyzed for total sulphides ($mgS^{=}/g$ sediment dry weight) in the upper 1 cm layer and for total organic carbon (% organic carbon, dry weight basis). However, only the 0.25 mile stations were completely analyzed for benthic infaunal species. The remaining samples (288), now at the Allan Hancock Foundation, are available for further analysis to confirm or supplement Dr. Smith's conclusions. We propose to initially analyze two samples from each of the 0.5 and 1.0 mile stations (4 stations) for six of the 12 sampling periods. This amounts to 48 samples at an approximate cost of $60/sample (total $3,000) by a qualified outside laboratory (U.S.C. or M.B.C.).

These data will be examined for changes in diversity and abundance and their relation to the available physical data

and to the already analyzed 0.25 mile infaunal data.

C. New SCCWRP and ORCOSAN Sampling and Analysis

Until September 1974, the County Sanitation Districts had no benthic sampling program other than special sampling for metals and pesticides. Thus, a nearly two-year gap exists in our knowledge between Smith's last sampling and the new program instituted at the new outfall site by ORCOSAN.

ORCOSAN sampling will continue quarterly as of September 1974 and will provide information on benthic infaunal and chemistry changes from that time on at the new outfall site. However, the sampling will not provide additional data on recovery at the one-mile outfall nor an assessment of the benthic fauna and chemistry over a larger region surrounding both outfalls.

Such information will be necessary to adequately assess past and future effects. Therefore, we propose to conduct one major, but complementary, benthic sampling program at sites about ORCOSAN's present grid of stations and to include three of Dr. Smith's previous sites at the one-mile outfall. This program is described below.

In addition, we will continue to participate in the continuing quarterly otter trawl program (established in 1969).

STATIONS

Sampling will initially be conducted at 24 stations offshore of Huntington Beach, Newport Beach and Corona del Mar. The stations selected surround the ORCOSAN stations and extend their benthic sampling pattern inshore to 10 fm (including Gary

Smith's three inshore stations labeled A, B, and C), upcoast to a distance of 5 miles from the outfalls, offshore to depths of 100 fm and downcoast to Corona del Mar. These stations are labeled in the accompanying tables and figures as S-1 through S-21 (SCCWRP stations) and B-1 through B-17 including Smith's offshore stations labeled D, E, and F (Orange Co. San Stations).

SAMPLING

Benthic sampling will be done using the Orange Co. San. Petersen grab aboard Mr. Munson's vessel or one with similar capabilities and navigational equipment (fathometer accurate to a depth of 100 fm, Loran, and radar).

Three replicate samples will be taken at each station. Each sample will be examined for sediment color and consistency, then placed in a bucket to measure wet volume. Each sample will then be washed separately through 0.5 mm mesh screen. Retained organisms will be preserved in buffered formalin and later transferred to isopropyl alcohol for sorting, identification, weighing and counting.

One or two additional grab samples will be taken at each station to obtain sediment samples for:

a. particle size distribution - 100 gm
b. total carbon determination - 100 gm
c. C.O.D. determination - 100 gm
d. metals determination - 100 gm (chromium, copper, zinc, selenium and antimony)
e. CHC determination - 100 gm (DDT, DDE, Dieldrin and PCBs)

At each station, the sequence of taking biological and physical samples will be randomized; i.e., the physical samples will be taken first at some stations, second at others, third at others, etc. This should reduce bias introduced by ship drift in the comparison between biological and physical data.

ANALYSIS OF SAMPLES

Biological Samples. The biological samples from the initial survey will be analyzed by a qualified laboratory under SCCWRP direction, and a reference collection of specimens will be maintained for future reference. A duplicate collection will be given to the Orange County Sanitation District.

Species abundance lists from each replicate and station will be coded, keypunched and stored for calculation of diversity indices (Gleason, Simpson, Shannon-Weaver, Brillouin, standard deviation and scaled versions of these indices) and similarity indices (Bray-Curtis). The latter will be used to conduct a site-group analysis which will also include data taken by ORCOSAN.

These procedures will (a) produce a series of charts showing site-groupings and their distribution and geographical diversity gradients and (b) data for regression against physical-chemical parameters (below).

Sediment Particle Size Analysis will be done from one sample at each station by the Geology Dept. laboratory at USC (Dr. D. Gorsline). Data on median and mean distributions (mm), sorting coefficients and percent gravel, sand, silt and clay will be obtained.

Total Carbon will be done from one sample from each station by the Geology Department laboratory at USC or a similar suitable laboratory.

To obtain compatible information at existing Orange County stations, we will request samples from ORCOSAN and submit them with those from our survey.

C.O.D. will be measured by submitting samples to the ORCOSAN laboratory so results will be comparable.

Metals (chromium, copper, zinc, selenium and antimony) will be analyzed by absorption spectroscopy at SCCWRP.

Chlorinated Hydrocarbons will be analyzed by gas liquid chromatography at SCCWRP.

These physical and chemical data (including sediment color and consistency) will be used to prepare geographical charts showing gradients in these parameters. These data will then be examined for possible gradients associated with the discharge sites and with other important factors such as depth. Analyses will then be conducted to determine if correlations exist between these physical parameters and the biological data such as diversity, species richness, site-groupings, abundance and dominant species.

Following this initial survey, we will examine the data to determine sites and sampling frequencies for future surveys which will adequately assess chronic effects of the discharges and separate such effects from seasonal fluctuation in species and physical parameters.

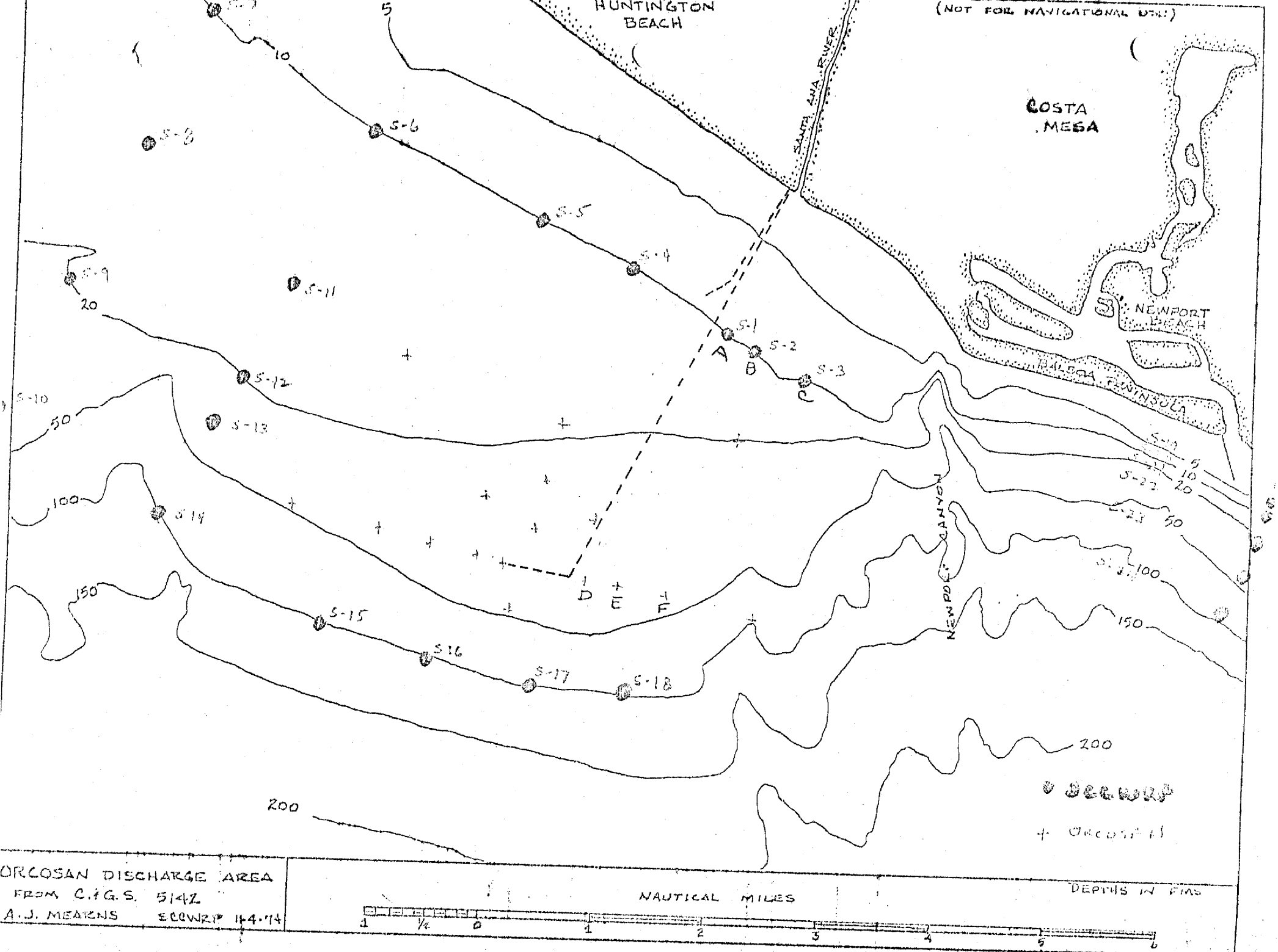
SCCWRP PROPOSED STATIONS

San Pedro Grid

Station	Depth (fm)	Location (approximate only)
S-1	10	1/4 mi SE of 1-mi outfall
S-2	10	1/2 mi SE " " "
S-3	10	1.0 mi SE " " "
S-4	10	0.85 mi NW " " "
S-5	10	1.75 mi NW " " "
S-6	10	3.2 mi NW " " "
S-7	10	5.1 mi NW " " "
S-8	15	4.9 mi NW " 5-mi diffuser end
S-9	20	4.7 mi WNW " " " "
S-10	31	4.9 mi W " " " "
S-11	15	3.1 mi NW " " " "
S-12	20	3.0 mi WNW " " " "
S-13	31	3.0 mi WNW " " " "
S-14	100	3.2 mi W " " " "
S-15	100	1.8 mi WSW " " " "
S-16	100	1.2 mi SSW " " " "
S-17	100	1.0 mi S " " " "
S-18	100	1.5 mi SSE " " " "

Corona del Mar Control Transect

S-19	8	0.4 mi SE of Newport Jetty
S-20	15	0.5 mi SSE " " "
S-21	20	0.6 mi SSE " " "
S-22	31	0.8 mi S " " "
S-23	50	1.1 mi S " " "
S-24	100	1.4 mi S " " "


(NOT FOR NAVIGATIONAL USE)
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
S-1
S-2
S-3
S-4
S-5
S-6
S-7
S-8
S-9
S-10
S-11
S-12
S-13
S-14
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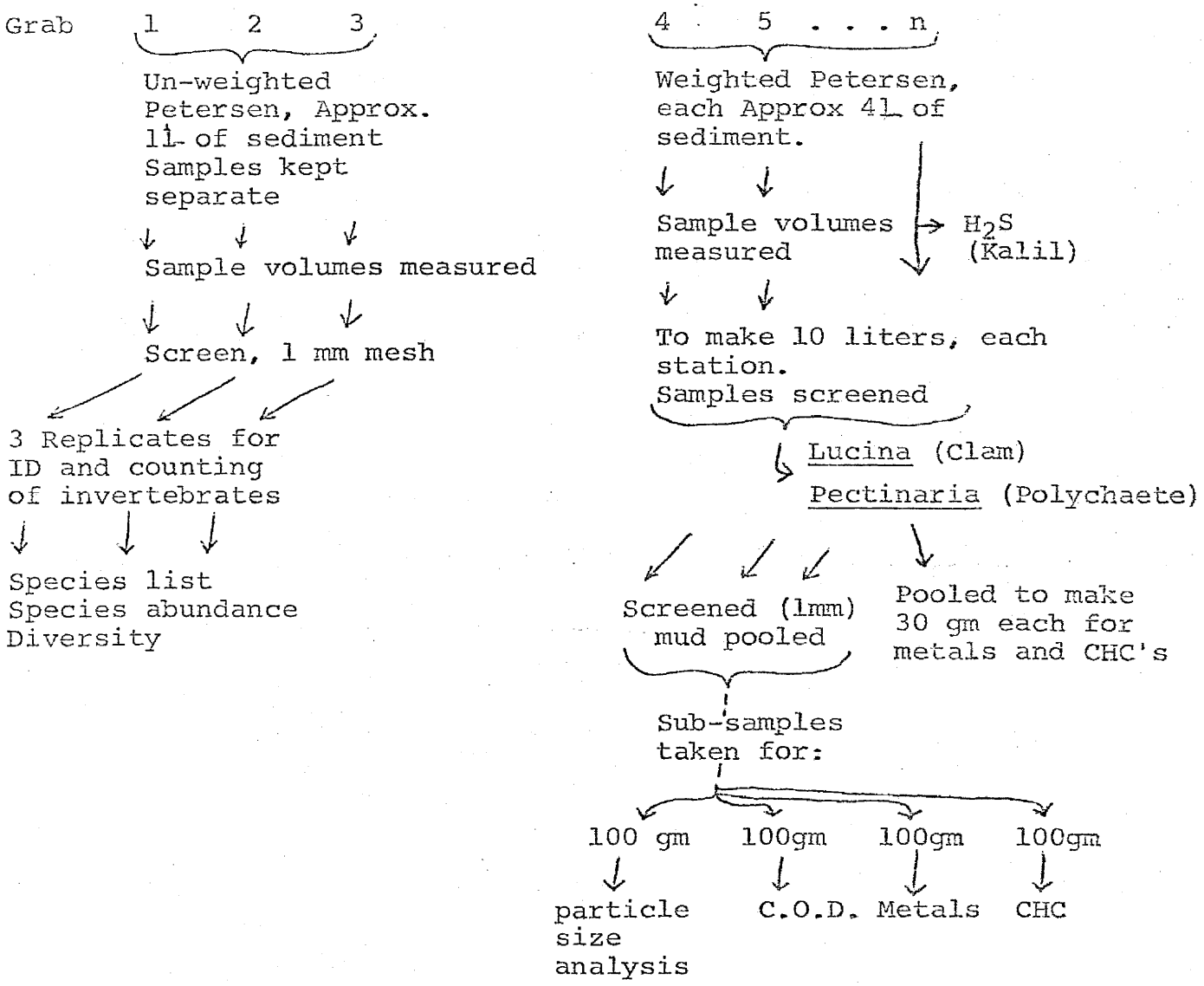
S-17
S-18
S-19
S-20
S-21
S-22
S-23
A
B
C
D
E
F
5
10
20
50
100
150
200
DISCHARGE
ORIGIN
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
1 1/2 0 1 2 3 4 5 6
DEPTHS IN FMS

APPENDIX II

INFORMATION ON PRESENT BENTHIC MONITORING PROGRAMS IN THE ORANGE COUNTY OUTFALL AREA

FLOW DIAGRAM FOR BOTTOM SAMPLING
AT ORANGE COUNTY SANITATION
SHIPBOARD FATE OF SAMPLE

Five or More Samples are Taken at Each Station



MEMORANDUM

October 30, 1974

To: Willard Bascom, Charles Greene, Jack Word, Dave Young

From: Alan Mearns

Re: Present Sampling Program (Benthic) at Orange County

The County Sanitation Districts of Orange County initiated their new quarterly and weekly ocean sampling programs in September and October 1974, as specified by the Santa Ana Regional Water Quality Control Board (Order No. 74-11, pp.22-33).

I talked with the laboratory staff at Orance County Sanitation to obtain specific information on progress and procedures used in their sediment sampling program.

Seventeen bottom stations are taken each quarter of the year (August complete; November and January planned) using a Petersen grab sampler with 0.1m^2 maximum area. Approximately 4 stations are completed in one ship day requiring four or more ship days to complete a survey. These are done on Tuesdays and Thursdays, in the morning hours to avoid effects of afternoon wind and chop on vessel and gear performance.

The vessel used is Fred Munson's out of Newport.

At each station, at least five grab samples are taken as described below and as shown in the accompanying flow diagram:

1. Three separate replicate samples are taken using the Petersen without addition of lead weights (obtain small samples). Each sample volume is measured in a calibrated bucket, then the sample is washed thru 1 mm screen. Retained organisms are preserved in labeled jars for sorting, identification and counting.

2. Two or more samples are taken using the Petersen fitted with lead weights (to obtain large sediment volumes). Each sample volume is measured and sampling is continued until 10 liters of sediment are obtained. Hydrogen sulfide is measured by Kalil. After each volume measurement, the samples are washed thru 1 mm screen and both the sediment and screened fractions are retained. The screened fractions are sorted to obtain 30 gm of the clam Lucina and 30 gm of the polychaete Pectinaria for analysis of metals and chlorinated hydrocarbons.

Memorandum
October 30, 1974
To: WB, CG, JW, DY
From: AM
Re: Present Sampling Program at OC

The sediments from the washings are subsampled as follows:

100 gm	for particle size analysis.
100 gm	for C.O.D. (which replaces total carbon as specified by SARWQCB).
100 gm	for metals.
100 gm	for chlorinated hydrocarbons.

This completes the work at one station.

All analyses are performed at Orange County Sanitation. The physical/chemical determinations are made using methods cited in the following publications:

Particle Size Analysis -
Water Quality Control Plan, Ocean Waters of California SWRCB 1972 and Methods for Chemical Analysis of Waters and Wastes, EPA 1971

Metals -
Great Lakes Region: Chemical Laboratory Manual for Bottom Sediments. Compiled by the Great Lakes Regional Committee on Analytical Methods. EPA. December 1969. (Including H_2O_2, Nitric acid, HCl and Aqua Regia methods).

Pesticides -
Analysis of Pesticide Residues in Human and Environmental Samples. EPA. Revised November 1972.

C.O.D. (Chemical Oxygen Denad) -
Standard Methods for Wastewater Analysis.

Benthic Infauna -
References and methods recommended by SCCWRP (J. Word) Biologists training for ID work include:

Ida Duesberg
Ann Martin
Fred O'Brien
Mike Hines

BOTTOM SAMPLING STATIONS

ORANGE COUNTY SANITATION DISTRICTS

ADOPTED JUNE 7, 1974

Station Sediments	Depth fm	Approximate Distance and Bearing from Diffuser end
B-0	32	End point of Diffuser
B-1	30	0.31 mi @ 265°
B-2	28	0.31 mi @ 015°
B-3	45	0.31 mi @ 195°
B-4	31	0.62 mi @ 105°
B-5	31	0.93 mi @ 265°
B-6	25	0.93 mi @ 310°
B-7	23	0.93 mi @ 015°
B-8	28	0.93 mi @ 060°
B-9	31	0.93 mi @ 105°
B-10	30	1.55 mi @ 265°
B-11	18	1.55 mi @ 015°
B-12	32	1.55 mi @ 105°
B-13	45	2.48 mi @ 265°
B-14	15	2.48 mi @ 310°
B-15	20	2.48 mi @ 060°
B-16	80	2.48 mi @ 105°

Bottom Sampling Stations (cont'd)

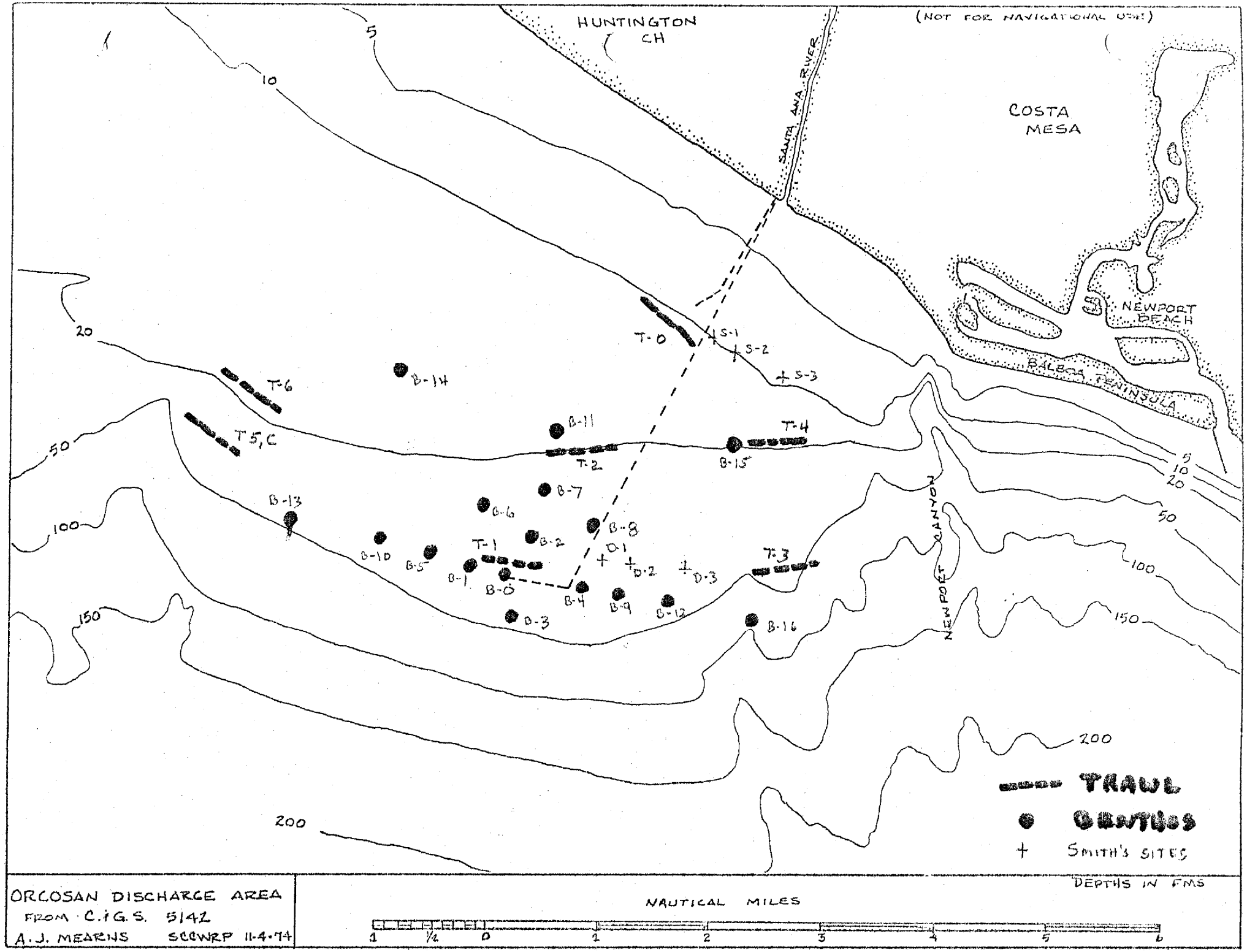
Station Trawls	Depth fm	Approximate Distance and Bearing from Diffuser end
T-0	10	3.1 mi @ 035° (old Diffuser end)
T-1	31	New Diffuser end (0.12 mi @ 020°)
T-2	20	1.48 mi @ 030°
T-3	35	2.79 mi @ 090°
T-4	20	3.1 mi @ 060°
T-5	23	3.41 mi @ 295°
T-6	20	3.41 mi @ 305°

BENTHIC STATIONS SAMPLED

BY GARY SMITH (S.I.O.)

SEPTEMBER 1970 to SEPTEMBER 1972

Smith's Stations	Depth fm	Approximate Location
A	10	1/4 mi from outfall
B	10	1/2 mi from outfall
C	10	1 mi from outfall
D	31	1/4 mi from outfall
E	31	1/2 mi from outfall
F	31	1 mi from outfall


HUNTINGTON CH
(NOT FOR NAVIGATIONAL USE)
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
5
10
20
50
100
150
200
T-0
T-1
T-2
T-3
T-4
T-5,C
T-6
S-1
S-2
S-3
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
B-10
B-11
B-12
B-13
B-14
B-15
B-16
D-1
D-2
D-3
TRAWL
GRABS
SMITH'S SITES
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
1 1/2 0 1 2 3 4 5 6
DEPTHS IN FMS

SCCWRP
CHLORINATED HYDROCARBON ANALYSIS

SAMPLE AND LOCATION Orange Co. Sediments

DESCRIPTION

DATE 11/6/75 UNITS REPORTED ppb dry weight

SAMPLE NUMBER	SE30 (24)	NC30 (20)	NJ30 (18)	SC30 (23)	SB30 (22)
SAMPLE DESCRIPTION / CONSTITUENT					
op'-DDE					
pp'-DDE	10.2	16.7	18.9	8.0	24.9
op'-DDD					1.7
pp'-DDD	1.5	2.7			8.5
op'-DDT			0.3		
pp'-DDT	0.6		1.5		
Heptachlor Epoxide					
Aldrin					
Dieldrin					
TOTAL DDT					
TOTAL PESTICIDE (total DDT)	12.3	19.4	20.7	8.6	35.1
Arochlor 1242 ★	100.8	52.6	166.8	68.6	121.4
Arochlor 1254 ★	27.2	26.2	68.5	22.8	61.9
Arochlor 1260					
TOTAL PCB	128.0	78.8	235.3	91.4	183.3
TOTAL CHLORINATED HYDROCARBONS	140.3	98.2	256.0	99.4	218.4

SCCWRP 4-2

★ PCB's based on "saponified" Sample

UNIVERSITY OF SOUTHERN CALIFORNIA
UNIVERSITY PARK
LOS ANGELES, CALIFORNIA 90007

DEPARTMENT OF GEOLOGICAL SCIENCES
TELEPHONE: (213) 746-2717

December 18, 1975

BRIEF ANALYSIS
SCCWRP SAMPLE SET

Samples are all silty sands with major modes in fine sand and coarse silt. Clay fractions are negligible in all samples and in all instances less than 5% of total sediment weight. Since the amount of clay was very small (clay in the particle size sense) the samples were analysed in terms of regular Wentworth size grades down to the 4 micron diameter (boundary between silt and clay) and then the clay-sized particles were lumped. This will influence the tail of the size distribution as plotted on log probability paper and give the appearance of a third component distribution below the silt range. In actual fact the silt and clay is all one normal distribution and is a matrix for a single or double mode sand size distribution. Most samples show a poorly sorted, normal medium sand with fine sand-silt matrix. A few samples, as for example in SB 30, a coarse mode also appears. This is probably either an artifact of compositing several discrete sedimentation units in a grab sample or may represent shell or gravel clasts in a sand mass.

Soluble organic fraction is everywhere less than 6% and has a mode at about 1.5% by weight. This is probably also a separate addition to the basic sediment. All samples were treated with a 50:50 acetone/distilled water washing solution and decanted and washed with distilled water. Dry residue are after acetone leaching therefore.

General size parameters show the influence of the dominant fine sand-silt component and all have mean diameters in the range from 30-100 microns with changes due to the amount of the coarse mode contributed. Only one sample (7C) falls below the range considering normal error of analysis. In this sample the median is in the fine sand and silt range and the weighted mean is thus perhaps not really that far off the group.

Mean diameter, standard deviation and skewness are relatively insensitive to the small tail contribution and thus lumping the clay grade has little or no effect on those for comparison purposes. Kurtosis is markedly changed by the degree of subdivision in the sizing process and should be used with caution in inter-group comparisons.

NHO 10460/2

SCCWRP Sediment samples: Moment measures. (Mean diameter ϕ, mean diameter mm, sorting coefficient, skewness, kurtosis)

NC-50 NB-50 SC-50 SE50

MEASURE	NJ50	~~NB50~~	~~SB50~~	NE 30	SB 30	SC 30	SC 8	~~SE50~~	~~SE50~~
M.D. ϕ	4.32	3.95	3.93	3.89	3.43	3.28	2.72	3.44	2.96
M.D. mm	0.0499	0.0644	0.0652	0.0671	0.0922	0.1024	0.1508	0.0917	0.1283
So.	1.32	1.10	1.20	1.11	1.26	1.75	0.77	1.09	1.21
Sk.	2.55	3.51	3.22	3.49	2.08	1.14	2.45	2.88	1.37
K.	6.93	13.39	11.24	13.74	8.14	2.23	15.68	13.03	3.69
									~~SB-50~~
	NC 25	SF 30	NC 30	NB 20	NN 25	NE 20	NJ 25	SB 25	~~SC50~~
M.D. ϕ	4.22	3.17	3.84	4.92	3.85	4.08	3.99	4.34	3.83
M.D. mm	0.0534	0.1107	0.0694	0.0328	0.0690	0.0587	0.0627	0.0492	0.0700
So.	1.29	1.48	0.95	1.77	0.88	1.31	1.27	1.40	1.32
Sk.	2.43	2.01	3.22	1.38	2.22	2.41	2.72	2.37	2.43
K.	7.31	6.79	11.79	1.28	5.04	7.28	8.76	5.51	7.36
								NE 50	
	SE 30	NJ 30	NB 25	NE 8	SC 20	SE 25	SC 25	~~NE50~~	SE 8
M.D. ϕ	3.57	4.03	4.04	3.84	3.84	4.34	4.51	3.98	2.84
M.D. mm	0.0841	0.0610	0.0606	0.0695	0.0697	0.0491	0.0436	0.0632	0.1390
So.	1.30	1.16	1.26	0.91	1.24	1.40	1.55	1.18	0.71
Sk.	2.34	3.18	2.61	2.69	3.26	2.33	1.79	3.41	3.95
K.	8.16	11.28	8.39	15.19	10.82	5.45	3.61	12.26	28.45
						100			
	NB 30	SC 100 #1	NB 100	NN 30	NB 8	NF ~~80~~	SB 8	NE 25	1255
M.D. ϕ	3.86	4.75	4.70	4.00	2.50	4.56	3.75	4.02	1.57
M.D. mm	0.0684	0.0370	0.0384	0.0623	0.1762	0.0423	0.0738	0.0613	0.3360
So.	1.15	1.53	1.57	1.10	0.50	1.59	1.06	1.32	0.80
Sk.	3.34	1.90	1.89	3.13	-0.69	1.62	1.51	2.47	2.74
K	12.45	3.20	3.15	10.80	3.66	3.18	6.32	8.20	20.58
	10 C	7 C	4D	5D	5C				
M.D. ϕ	3.88	5.69	4.35	1.95	5.25				
M.D. mm	0.0678	0.0193	0.0489	0.2582	0.0261				
So.	1.44	1.89	1.75	1.75	2.24				
Sk.	2.27	0.94	1.52	2.05	0.22				
K.	7.04	-0.32	2.77	4.75	0.04				

NHO 10460/2 SCCWRP Sediment samples: Weight % by size grade. (P. 1)

Size Grade ϕ	NJ 50	~~NC 50 DB 50~~	~~NB 50 SB 50~~	NE 30	SB 30	SC 30	SC 8	~~SC 50 SE 50~~	~~SE 50 SEE 50~~
-1 - 0	0	0	0	0	0.23	0.57	0	0	0
0 - 1	0	0	0	0	0.58	5.22	0	0.24	2.94
1 - 2	0	0	0	0.13	4.67	13.64	9.59	0.95	10.28
2 - 3	0.74	0	3.28	2.28	26.02	29.03	63.73	28.12	47.03
3 - 4	49.60	74.94	73.08	74.73	53.08	28.74	23.50	57.90	27.92
4 - 5	37.86	17.80	15.54	16.45	9.27	6.83	2.02	8.36	6.89
5 - 6	3.57	2.07	2.42	1.42	1.86	9.94	0.49	1.22	1.28
6 - 7	2.77	1.76	1.66	1.70	1.55	2.23	0.25	1.11	1.30
7 - 8	1.53	1.17	1.20	0.96	1.13	1.42	0.21	0.69	2.31
8 - 10	3.93	2.26	2.83	2.33	1.61	2.30	0.20	1.41	0
									SB 50
	NC 25	SF 30	NC 30	NB 20	NN 25	NE 20	NE 25	SB 25	~~SC 50~~
-1 - 0	0	0.44	0	0	0	0	0	0	0
0 - 1	0.24	1.03	0	0	0	0	0.19	0	0
1 - 2	0.36	13.24	0	0.80	0	1.60	0.77	0	0.26
2 - 3	1.78	35.31	1.81	1.60	3.24	2.80	2.51	0	17.85
3 - 4	51.50	33.84	78.02	29.67	73.58	59.10	69.84	55.61	54.96
4 - 5	35.57	10.32	13.46	40.23	14.93	26.13	15.94	29.38	17.59
- 6	3.07	1.84	1.63	7.20	2.05	3.03	4.51	4.95	2.97
6 - 7	2.66	1.10	1.73	7.42	4.94	2.84	1.93	3.78	2.37
7 - 8	1.49	0.29	2.71	4.69	1.26	1.39	1.31	2.04	1.31
8 - 10	3.34	2.60	0.64	8.38	0	3.11	2.99	4.25	2.69
								NE 50	
	SE 30	NJ 30	NB 25	NE 8	SC 20	SE 25	SC 25	~~NE 50~~	SE 8
-1 - 0	0	0	0	0	0	0	0.15	0	0
0 - 1	0.48	0	0.23	0.22	0	0	0.23	0	0
1 - 2	1.91	0	0.91	1.12	0.48	0	0.38	0	1.12
2 - 3	27.07	1.28	1.70	3.13	2.39	0.83	1.55	0.39	69.40
3 - 4	50.40	66.65	65.21	65.33	86.86	53.32	41.99	74.83	26.30
4 - 5	13.23	24.27	22.27	25.29	0	30.84	37.40	18.06	1.91
5 - 6	2.05	2.38	2.90	2.85	3.26	5.07	5.53	2.32	0.66
6 - 7	1.68	1.54	2.40	0.73	2.77	3.74	4.81	1.48	0.12
7 - 8	1.00	1.17	1.52	0.28	1.50	1.94	2.56	0.93	0.13
8 - 10	2.18	2.71	2.87	1.06	2.78	4.26	5.40	2.96	0.36

NHO 10460/2 SCCWRP Sediment samples: Weight % by size grade. (P. 2)

Size Grade ϕ	NB 30	SC 100 #1	NB 100	NN 30	NB 8	NF ~~150~~ 100	SB 8	NE 25	1255
-1 - 0	0	0	0	0	0	0.21	0	0.07	1.11
0 - 1	0	0	0	0	1.55	0.21	0	0.59	12.73
1 - 2	0	0	0	0	8.06	0.83	0.87	0.66	70.30
2 - 3	4.67	0	0.79	0.13	78.76	2.48	22.15	3.28	12.18
3 - 4	74.79	32.35	35.61	71.20	11.63	37.75	38.42	62.69	2.44
4 - 5	13.37	45.49	42.05	20.44	0	37.85	32.51	23.82	0.73
5 - 6	1.80	8.22	8.24	2.35	0	7.92	3.85	2.40	0.12
6 - 7	1.77	4.59	3.87	1.75	0	4.47	0.90	1.99	0.15
7 - 8	1.15	3.18	2.95	2.40	0	2.57	0.46	1.17	0.10
8 - 10	2.45	6.18	6.49	1.73	0	5.72	0.85	3.34	0.15
	10 C	7C	4D	5D	5C				
-1 - 0	0.44	0	0.77	0.21	0				
0 - 1	0.44	0	0.31	28.13	4.66				
1 - 2	1.75	0	0.77	45.14	4.35				
2 - 3	6.57	0	4.13	8.19	0.62				
3 - 4	69.20	12.73	53.75	5.46	9.33				
- 5	12.29	39.97	21.43	6.34	38.00				
5 - 6	1.87	14.05	5.09	2.34	13.31				
6 - 7	1.89	10.67	4.27	1.63	9.41				
7 - 8	1.86	8.24	3.23	1.08	7.76				
8 - 10	3.69	14.34	6.27	1.47	12.55				

NHO 10460/2

SCCWRP Sediment Samples: Sample weights before treatment and weight % soluble organics.

SAMPLE #	DRY WT. UNTREAT.		% SOL. ORG.						
NJ 50	21.0954		1.40						
NCAB 50	18.7836		1.57						
NBSB 50	31.1816		1.21						
NE 30	25.7923		1.34						
SB 30	21.4620		1.42						
SC 30	35.8990		1.24						
SC 8	21.7449		0.70						
SCSC 50	21.4989		1.20						
SESE 50	33.3549		0.89						
NC 25	20.7838		1.67						
SF 30	34.2971		1.06						
NC 30	25.8372		1.20						
NB 20	18.2012		2.14						
NN 25	26.5510		1.05						
NE 20	25.5939		1.40						
NE 25	34.8760		1.34						
SB25	24.3737		1.37						
SBSC 50	24.2930		1.24						
[illegible] 30	28.7722		1.06						
NJ 30	30.9657		1.17						
NB 25	24.2817		1.63						
NE 8	30.0621		3.40						
SC 20	24.8766		1.13						
SE 25	29.0587		1.56						
SC 25	33.5974		1.12						
NENC 50	26.8258		1.12						
SE 8	25.4179		1.47						
NB 30	30.1006		1.29						
SC 100 #1	30.1297		1.31						
NB 100	32.4943		1.27						
NN 30	33.6843		1.13						
NB 8	28.9600		1.17						
NF 100	24.9864		1.35						
SB 8	30.5285		0.97						
NE 25	36.8965		1.33						
1255	38.6288		0.75						
10 C	24.1707		1.54						
7C	7.3530		6.33	T.H.					
4 D	24.7120		1.40						
5 D	41.0553		1.01						
5 C	7.8038		4.77						

CNIDARIA
HYDROZOA
Hydroida, unid. 91101
Monobrachium parasitum Mereschkovsky 91113

ANTHOZOA
Anthozoa, unid. 91100
Ceriantharia, unid. 92030
Edwardsiella californica McMurrich 92075
Filigella mitsukurii Kinoshita 91875
?Renilla kollikeri Pfeffer 91950
Pennatulacea, unid. 92017
Virgulariidae, unid. 91986

PLATYHELMINTHES
Platyhelminthes, unid. 92500

NEMERTEA
Nemertea, unid. 93000

NEMATODA
Nematoda, unid. 94500

ENTOPROCTA
Barentsia sp. 93985

ANNELIDA
POLYCHAETA
ERRANTIA
Anaitides sp. 21210
Chloeia pinnata Moore 21012
Diopatra ornata Moore 23011
Drilonereis falcata Moore 23331
D. mexicana Fauchald 23335
Drilonereis sp. 23330
Eteone californica Hartman 21243
E. dilatae Hartman 21244
Eulalia quadrioculata Moore 21254
Eulalia sp. 21250
Eunice americana Hartman 23111
Eusigalion spinosum Hartman [illegible]
Exogone gemmifera Pagenstecher 22181
E. lourei Berkeley & Berkeley 22182
E. uniformis Hartman 22183
Glycera americana Leidy 22811
G. branchiopoda Moore 22812
G. capitata Oersted 22813
G. convoluta Keferstein 22814
G. oxycephala Ehlers 22817
G. robusta Ehlers 22818
Glycera sp. 22810
Glyceridae, unid. 22800
Glycinde polygnatha Hartman 22912
Glycinde sp. 22910

Goniada brunnea Treadwell 22923
G. littorea Hartman 22924
Goniada sp. 22920
Goniadidae, unid. 22900
Gyptis brevipalpa Hartman-Schroeder 21923
Hyalinoecia juvenalis Moore 23021
Langerhansia heterochaeta (Moore) 22221
Lumbrineris californiensis Hartman 23215
L. cruzensis Hartman 23216
L. lagunae Fauchald 23214
L. latreilli Audouin & Milne Edwards 23222
L. tetraura (Schmarda) 23229
Lumbrineris sp. 23210
Marphysa belli oculata Treadwell 23131
Nephtys caecoides Hartman 22623
N. californiensis Hartman 22624
N. cornuta franciscana Clark & Jones 22625
N. ferruginea Hartman 22626
Nephtys sp. 22620
Nereidae, unid. 22400
Nereis sp. 22470
Ninoe gemmea Moore 23242
Nothria iridescens (Johnson) 23035
Nothria sp. 23030
Onuphidae, unid. 23000
Onuphis eremita Audouin & Milne Edwards 23051
O. nebulosa Moore 23054
Onuphis sp. 23050
Ophiodromus pugettensis (Johnson) 21941

Paleanotus bellis (Johnson) 20921
Paranaitis polynoides (Moore) 21321
Peisidice (era Johnson 20521
Pholoe glabra Hartman 20621
Phyllodocidae, unid. 21300
Platynereis bicanaliculata (Baird) 22521
Polyodontes panamensis (Chamberlin) 20531
Protodorvillea gracilis (Hartman) 23531
scaleworm, unid. 20200
Sigambra tentaculata (Treadwell) 22042
Sphaerodoridium biserialis (Berkeley & Berkeley) 22711
Sphaerodoridium sp. 22710
Steggoa californiensis Hartman 21351
Sthenelais tertiaglabra Moore 20642
Sthenelais verruculosa Johnson 20643
Sthenelanella uniformis Moore 20651
Streptosyllis sp. 22310
Syllidae, unid. 22200
Typosyllis sp. 22280

EDENTARIA
Aedicira pacifica (Hartman) 25212
A. ramosa (Annenkova) 25213
Amage anops (Johnson) 28011
Ammotrypane aulogaster Rathke 27011
Ampharete arctica Malmgren 28032
A. labrops Hartman 28034
Ampharete sp. 28030
Ampharetidae, unid 28000
Amphicteis scaphobranchiata Moore 28043
Amphisamytha bioculata (Moore) 28051
Apoprionospio pygmaeus (Hartman) 25615
Aricidea neosuecica Hartman 25223
A. suecica Eliason 25224
A. wassi Pettibone 25225
Aricidea sp. 25220
Armandia bioculata Hartman 27021
Axiothella rubrocincta (Johnson) 27522
Boccardia basilaria Hartman 25511
Capitella capitata (Fabricius) 27231
Capitellidae, unid. 27200
Chaetozone corona Berkeley & Berkeley 26332
C. setosa Malmgren 26335
Chaetozone sp. 26330
Chone ecaudata (Moore) 28621
C. veleronis Banse 28626
Chone sp. 28620
Cirriformia sp. 26350
Clymenura gracilis Hartman 27551
Cossura candida Hartman 26511
Decamastus gracilis Hartman 27261
Euchone incolor Hartman 28652
Flabelligeridae, unid. 26700
Haploscoloplos elongatus (Johnson) 25121
Harmothoe crassicirrata Johnson 20271
H. lunulata (delle Chiaje) 20276
H. priops Hartman 20277
Harmothoe sp. 20270
Hesionidae, unid. 21900
Hesperonoe complanata (Johnson) 20292
Heteroclymene glabra Moore 27571
Laonice cirrata (Sars) 25541
Loimia medusa (Savigny) 28291
Magelona pitelkai Hartman 25813
M. sacculata Hartman 25814
Magelona sp. 25810
Maldane cristata Treadwell 27611
M. sarsi Malmgren 27613
Maldanidae, unid. 27600
Megalomma splendida (Moore) 28724
Melinna heterodonta Moore 28111
M. oculata Hartman 28112
Myriochele gracilis Hartman 27711
Nerinides acuta (Treadwell) 25571
N. maculata Hartman 25572
N. pigmentata (Reish) 25573
Notomastus sp. 27330
Paraonidae, unid. 25200
Paraonis gracilis oculata Hartman 25251
Paraprionospio pinnata (Ehlers) 25614
Pectinaria californiensis Hartman 27921
Pherusa sp. 26760
Pista disjuncta Moore 28344
P. fasciata (Grube) 28346
P. moorei Berkeley & Berkeley 28348
Pista sp. 28340
Poecilochaetus johnsoni Hartman 26011
Polycirrus perplexus Moore 28362

SEDENTERIA (Cont)

Polydora citrona Hartman 25583
Polydora sp. 25580
Potamilla neglecta (Sars) 28761
Praxillella affinis pacifica Berkeley 27661
P. gracilis (Sars) 27662
Prionospio cirrifera Wiren 25611
P. malmgreni Claparede 25613
Sabellaria cementarium Moore 27832
Sabellidae, unid. 27800
Scalibregma inflatum Rathke 26931
Scoloplos armiger (Mueller) 25163
Spio sp. 25650
Spiochaetopterus costarum (Claparede) 26741
Spionidae, unid. 25600
Spiophanes bombyx (Claparede) 25662
S. cirrata Berkeley & Berkeley 25666
S. missionensis Hartman 25664
Spiophanes sp. 25660
Sternaspis fossor Stimpson 27111
Streblosoma crassibranchia Treadwell 28421
Terebellidae, unid. 28200
Terebellides stroemi Sars 28512
Tharyx sp. 26380
Travisia brevis Moore 27061
T. foetida Hartman 27062

SIPUNCULOIDEA

Sipunculoidea, unid. 94300

ECHIUROIDEA

Listriolobus pelodes Fisher 94411

ARTHROPODA

CRUSTACEA

OSTRACODA

Cylindroberididae, unid. 52043
Cyprinidae, unid. 52250
Cythereidae, unid. 52324
Euphilomedes carcharodonta (Smith) 52029
E. longiseta Juday 52031
E. oblonga Juday 52033
E. producta Poulsen 52032
Euphilomedes sp. 52028
Myodocopidae, unid. 52001
Rutiderma lomae (Juday) 52086
Rutiderma rostrata Juday 52088
Rutiderma sp. 52083
Scleroconcha sp. 52037

CIRRIPEDIA

Scalpellum californicum Pilsbry 54311
Scalpellum sp. 54310

MALACOSTRACA

NEBALIACEA

Nebaliacea, unid. 55000

MYSIDACEA

Mysidacea, unid. 58000
Acanthomysis macropsis Tattersall 58733
Acanthomysis sp. 58730
Archaeomysis grebnitzkii Czerniavsky 58512
Archaeomysis sp. 58510

MYSIDACEA (Cont)

Neomysis kadiakensis Ortmann 58723
Neomysis sp. 58720

CUMACEA
Anchicolurus occidentalis Calman 59111
Campyla[illegible]is canaliculata Zimmer 59148
C. hartae Lie 59149
C. rubromaculata Lie 59157
Campylaspis sp. C 59143
Cumella sp. A 59131
Cumella sp. B 59132
Cumella sp. C 59133
Cyclaspis sp. A 59162
Cyclaspis sp. B 59163
Cyclaspis sp. 59160
Diastylidae, unid. 59169
Diastylis californica Zimmer 59171
Diastylis sp. A 59172
Diastylis sp. 59170
Diastylopsis tenuis Zimmer 59271
Eudorella pacifica Hart 59191
Hemilamprops californica Zimmer 59211
Lampropidae, unid. 59219
Lamprops carinata Hart 59221
L. quadriplicata Smith 59222
Lamprops sp. 59220
Leptostylis sp. A 59361
Leucon subnasica Given 59241
Leucon sp. 59240
Mesolamprops bispinosa Given 59321
Oxyurostylis pacifica Zimmer 59251

TANAIDACEA
Leptochelia sp. 60410
Leptognathia sp. 60420

ISOPODA
VALVIFERA 61100
Edotea sublittoralis Menzies & Barnard 61381
Neastacilla californica (Boone) 61221
Synidotea magnifica Menzies & Barnard 61343

ANTHURIDEA 61600
Hallophasma geminata Menzies & Barnard 61751

GNATHIIDEA 63400
Gnathia crenulatifrons Monod 63514
Gnathia sp. 63540

ASELLOTA 60100 63700
Austrosignum tillerae Menzies & Barnard 64631
Munna sp. 64640
Pleurogonium sp. 64620

AMPHIPODA
GAMMARIDEA 70000
Gammaridea, unid. 70000
Ampelisca brevisimulata Barnard 70211
A. compressa Holmes 70215 = A. agassizi Judd
A. cristata Holmes 70212
A. cucullata Barnard 70229
A. hancocki Barnard 70219
A. indentata Barnard 70234
A. macrocephala Liljeborg 70222
A. milleri Barnard 70226
Ampelisca pacifica Holmes 70214
A. pugetica Stimpson 70216
A. cf. shoemakeri Barnard 70239
Ampelisca sp. 70210
Amphideutopus oculatus Barnard 70671
Aoridae, unid. 70600
Byblis veleronis Barnard 70251
Byblis sp. 70250
Eohaustorius washingtonianus (Thorsteinson) 72421
Gammaropsis sp. 72890
Gitana calitemplado Barnard 70331
Heterophoxus oculatus (Holmes) 74671
Isaeidae, unid. 72800
Isaeidae sp. A 72801
Lembos audbettius Barnard 70621
Listriella diffusa Barnard 73515
L. goleta Barnard 73511
L. melanica Barnard 73513
Listriella sp. 73510
Lysianassidae, unid. 73600
Mandibulophoxus uncirostratus (Giles) 74661
Megaluropus longimerus Schellenberg 72231
?Melphisana bola Barnard 74012
Metaphoxus frequens Barnard 74641
Metopa cf. dawsoni Barnard 75325
Microjassa litotes Barnard 72931
Monoculodes sp. 74130
Oedicerotidae, unid. 74100

GAMMARIDEA (Cont)
Paraphoxus bicuspidatus Barnard 74611
P. heterodactylus Barnard 74623
P. obtusidens (Alderman) 74615
Paraphoxus sp. 74610
Parapleustes sp. 74810
Photis bifurcata Barnard 72811
P. brevipes Shoemaker 72812
P. californica Stout 72813
P. macrotica Barnard 72817
Photis sp. 72810
Pleustidae, unid. 74800
Rudilemboides stenopropodus Barnard 70651
Stenothoidae, unid. 75300
Synchelidium sp. 74110
Tiron biocellata Barnard 75521
Westwoodilla caecula (Bate) 74121

CAPRELLIDEA 79000
Caprella californica Stimpson 79012
C. equilibra Say 79011
C. mendax Mayer 79022
Caprella sp. 79010
Mayerella banksia Laubitz 79071
Tritella pilimana Mayer 79052
Tritella sp. 79050

EUPHAUSIACEA
Euphausiacea, unid. 66000

DECAPODA
Decapoda, unid. 89900

CARIDEA
Crangon communis Rathbun 82928

ANOMURA
Anomura, unid. 86000
Callianassa sp. 86210
Callianassidae, unid. 86200
Lepidopa myops, zoea Stimpson 86922
Porcellanidae, unid. 87200

BRACHYURA
Brachyura, unid. 88000
Cancer sp. 88910
?Parapinnixa sp. 89430
Pinnixa franciscana Rathbun 89447
P. occidentalis Rathbun 89446
Pinnixa sp. 89440
Pinnotheridae, unid. 89400
Randallia ornata (Randall) 88411

INSECTA
Insecta, unid.

MOLLUSCA
GASTROPODA 30000
MESOGASTROPODA
Balcis micans (Carpenter) 31722
B. oldroydi (Bartsch) 31725
B. rutila (Carpenter) 31723
Bittium quadrifilatum Carpenter 33327
Caecum crebricinctum Carpenter 33141
Epitonium cf. acrostephanus (Dall) 31935
Eulima californica (Bartsch) 31741
Fartulum occidentale Bartsch 33131
Neverita recluziana (Deshayes) 34261

NEOGASTROPODA
Amphissa sp. 35920
Kurtzia arteaga (Dall & Bartsch) 37131
Kurtziella beta (Dall) 37122
K. plumbea (Hinds) 37124
Mitrella sp. 35930
Nassarius fossatus (Gould) 36022
Olivella baetica Carpenter 36512

OPISTHOBRANCHIA
Acteocina intermedia Willet 38271
Acteocina sp. 38270
Aglaja ocelligera (Bergh) 38245
Aglaja sp. 38240
Cephalaspidea sp. A 38101
Cylichna diegensis (Dall) 38282
Gastropteron pacificum Bergh 38261
Odostomia sp. C 38020
Rictaxis punctocaelatus (Carpenter) 38131

Turbonilla sp. D 38044
Turbonil[illegible] sp. E 38045
Turbonilla sp. G 38046
Turbonilla sp. J 38047
Volvulella californica Dall 38193
V. cylindrica (Carpenter) 38191
V. panamica Dall 38192
Volvulella sp. 38190

PELECYPODA 40006
Pelecypoda, unid. 40000

NUCULOIDA
Acila castrensis (Hinds) 40211
Nucula sp. 40220
Nuculana sp. 40320
Yoldia scissurata (Dall) 40343

MYTILOIDA
Amygdalum pallidulum (Dall) 41121
Crenella decussata (Montagu) 41131
C. divaricata (Orbigny) 41132
Crenella sp. 41130
Megacrenella columbiana (Dall) 41231
Modiolus neglectus Soot-Ryen 41182
Mytilidae, unid. 41100

VENEROIDA
Adontorhina cyclica Berry 43211
Axinopsida serricata (Carpenter) 43221
Compsomyax subdiaphana (Carpenter) 43581
Cooperella subdiaphana (Carpenter) 43911
Cyclocardia ventricosa (Gould) 42212
Cyclocardia sp. 42210
Gari californica (Conrad) 44411
~~Lepton mercoeum Carpenter~~ OROBITELLA CHACEI 42931
Lucina nuttallii (Conrad) 43151
Lucinoma annulata (Reeve) 43142
Macoma acolasta Dall 44226
M. carlottensis Whiteaves 44224

VENEROIDA (Cont)
Macoma sp. 44220
Mactra californica Conrad 44012
Mysella pedroana (Dall) 42923
Mysella sp. C 42927
Mysella sp. 42920
Nemocardium centifilosum (Carpenter) 43461
Parvilucina sp. 43180
Siliqua lucida (Conrad) 44731
Solen sp. 44710
Tellina bodegensis (Hinds) 44211
T. modesta Carpenter 44216
Tellina sp. 44210
Thyasira flexuosa (Montagu) 43233

MYOIDA
Corbula luteola Carpenter 44911
Corbula sp. 44910
Panopea generosa (Gould) 45041

PHOLADOMYOIDA
Cardiomya californica (Dall 46012
C. cf. pseustes Dall 46016
Cuspidaria parapodema Barnard 46022
Lyonsia californica Conrad 45621
Periploma discus Stearns 45711
Thracia curta Conrad 45831
T. diegensis Dall 45833

SCAPHOPODA
Scaphopoda, unid. 48600
Cadulus fusiformis Pilsbry & Sharp 48761
Dentalium rectius Carpenter 48692

APLACOPHORA
Chaetoderma cf. nitidulum (Loven) 48127
Chaetoderma sp. 48110

PHORONIDA 94050
Phoronida, unid. 94050
Phoronis sp. 94060

ECTOPROCTA 73300
GYMNOLAEMASTA 93301
CTENOSTOMATA 93866
Alcyonidium mammillatum Alder 93872

BRACHIOPODA 94001
Glottidia albida (Hinds) 94005

ECHINODERMATA
ASTEROIDEA 96200
Asteroidea, unid. 96200
Astropecten verrilli De Loriol 96222

OPHIUROIDEA 97000
Ophiuroidea, unid. 97000

ECHINOIDEA 96600
Echinoidea, unid. 96600
Dendraster excentricus (Eschscholtz) 96641

HOLOTHUROIDEA 97600
Holothuroidea, unid. 97600
Caudina sp. 97690
Leptosynapta sp. B 97673

HEMICHORDATA 98000
Enteropneusta, unid. 98000

CHORDATA
ASCIDIACEA 98100
Ascidiacea, unid. 98100

CEPHALOCORDATA 98600
Branchiostoma californiense Andrews 98611

VERTEBRATA
PISCES
Pisces, unid.
Icelinus quadriseriatus (Lockington) 16407
Symphurus atricauda (Jordan & Gilbert) 139000

Amphiodia sp. 97140
Amphiodia occidentalus 97161
Amphiodia (Amphispina) 97170
A. (A) urtica 97171
A. (A). digitata 97172
Amphiuridae 97120
Amphichondrius granulosus 97131
Amphipholis squamata 97191
Amphiura sp. 97200
A. arcystata 97233
Ophiura luetkeni 97352
Astropectinidae 96220
Astropecten sp. 96220
A. verrilli 96222
Brissopsis sp. 96680

MEMORANDUM

To: Alan Mearns

From: Charles Greene

Re: Benthic Grab Survey of Orange County Outfalls (29-31 July 1975)

Date: July 16, 1975

In compliance with the revised EPA Research Plan (Biology), a detailed sampling program for the Orange County outfall area has been designed. This survey will provide follow-up data on Gary Smith's study and a broad detailed data base for comparison with future studies. The plan is based on a review of the results obtained from the preliminary survey of this area conducted by SCCWRP in February and March, 1975.

The survey is tentatively scheduled for 29-31 July 1975, with the Marine Surveyor.

It is recommended that the 52 stations shown on Figure 1 be occupied and samples taken with the weighted (G. Smith's) Van Veen Grab (0.1 m^2) according to the following schedule:

A. Biological Samples (C. Greene)
   1. Three replicate samples will be taken at 26 stations and a single sample at each of the remaining 26 stations (Figure 1 and Table 1).
   2. Sample volume, color, texture, and odor, if any, should be recorded along with station number and depth for each sample.
   3. Samples collected at the 6 Smith stations (Figure 1 and Table 1) are to be washed over 1.0 and 0.5 mm screens. All remaining samples are to be washed over a 1.0 mm screen.
   4. Screened samples shall be preserved in 10% buffered formalin and submitted to an outside agency for sorting.

B. Physical/Chemical Samples (B. Mitchell & D. Young)
   1. These samples will be sub-samples from the biological samples and consist of the following:
      a. One 2½" diameter core/sample (98 cores) - to be capped and frozen up-right.
      b. One 1" x 2" core/station at the 23 station indicated on Table 1 to be preserved for acid volatile sulfide analysis.
      c. One 50-100 gms of sediment (4-5 cm deep) from each station for grain-size analysis.
      d. One scoop (1-2 cm from surface) in small glass jar and frozen for DDT, PCB, and ACB's.
   2. Physical/chemical samples will be returned to SCCWRP at the end of each day for storage (freezing) or immediate analysis (BOD). The sub-sample for BOD analysis is to be taken from the sediment grain-size samples.

A detailed schedule of times, places, and personnel will be circulated next week.

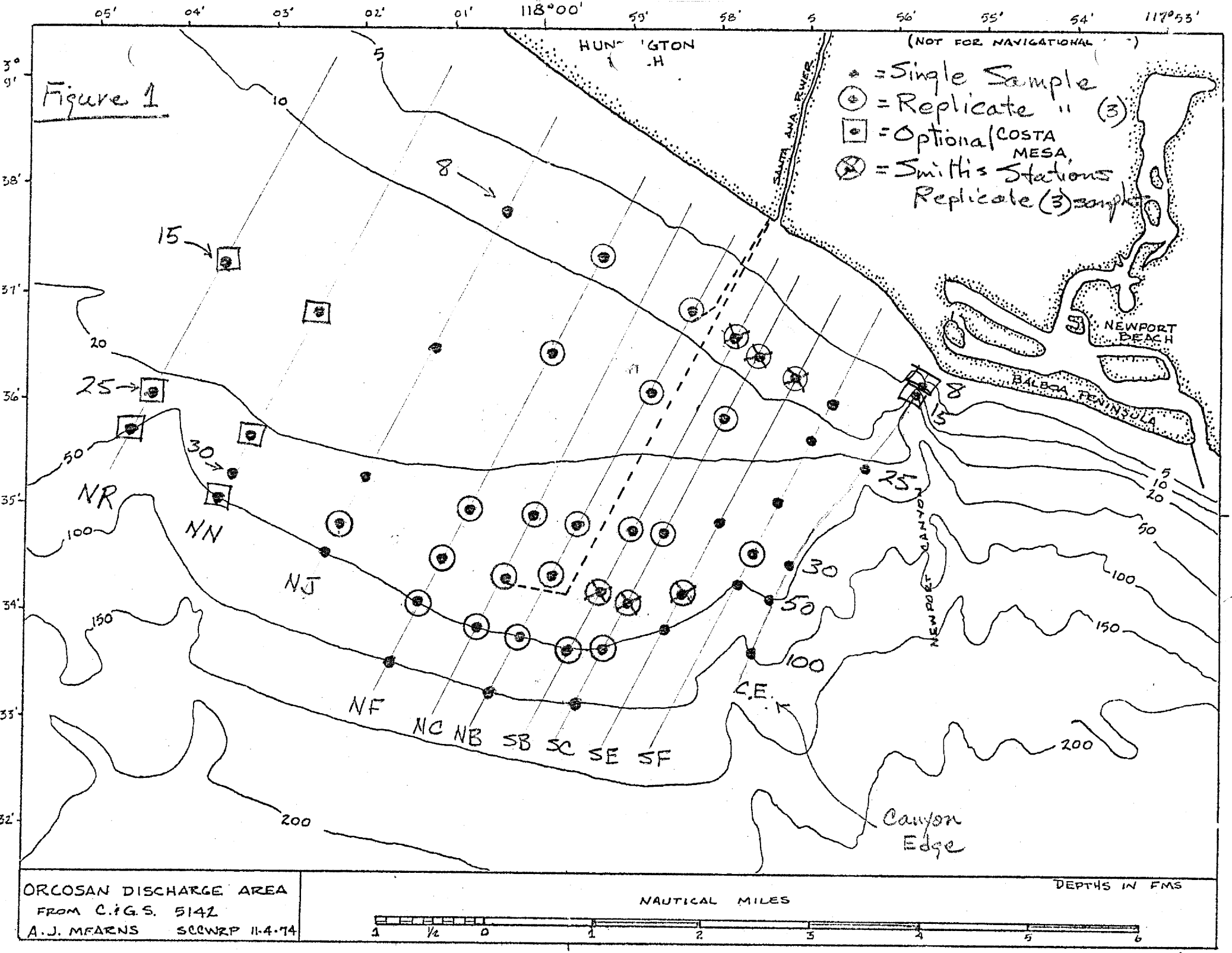


Figure 1
(NOT FOR NAVIGATIONAL USE)
= Single Sample
= Replicate " (3)
= Optional/COSTA MESA
= Smith's Stations
Replicate (3) samples
HUNTINGTON HARBOR
SANTA ANA RIVER
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
C.E.
Canyon Edge
NR
NN
NJ
NF
NC NB SB SC SE SF
5
10
15
20
25
30
50
100
150
200
118°00'
117°53'
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
DEPTHS IN FMS

Table 1. Summary of grab samples and physical/chemical sub-samples to be collected off Orange Co. — 29-31 July 1975.

TRANSECT	DEPTH 8 (FM)	15 (FM)	25 (FM)	30 (FM)	50 FM	100 (FM)
CE	1 Grab	1 Grab	1 Grab	1 Grab	1 Grab	1 Grab
SF	1 Grab	1 Grab	1 Grab	3 Grab	1 Grab	
SE	3 Grabs *		1 Grab	3 Grabs *	1 Grab	
SC	3 Grabs *	3 Grabs *	3 Grabs *	3 Grabs *	3 Grabs *	1 Grab
SB	3 Grab *		3 Grabs *	3 Grabs *	3 Grabs *	
NB	3 Grabs	3 Grabs	3 Grabs *	3 Grabs *	3 Grabs *	1 Grab
NC			3 Grabs *	3 Grabs *	3 Grabs *	
NF	3 Grabs	3 Grabs	3 Grabs *	3 Grabs *	3 Grabs *	1 Grab
NJ	1 Grab *	1 Grab	1 Grab	3 Grabs *	1 Grab	
NN		1 Grab Opt.	1 Grab Opt.	1 Grab *	1 Grab Opt.	
NR		1 Grab Opt.	1 Grab Opt.		1 Grab Opt.	

1) 2½" Core to depth of sample — 1/sample = 104 cores
2) 1-2 cm deep scoop of surface for DDT — 1/station = 52
3) 50-100 gm surface sediment (4-5 cm) — 1/station = 52
4) * 1"x2" core placed in preservative — see above

MEMORANDUM

To: Willard Bascom

From: Mike Moore

Re: Orange County Benthic Grab Survey

February 18, 1975

Of the 47 stations to be sampled on the 15th of February, only 15 were completed due to high seas and high winds. We found it impossible to stay on station and to get Dr. Gary Smiths modified van veen grab to penetrate and obtain a sample.

The stations that were completed are now being analyzed for biological community structure and for volatile solids as stated in the project outline.

A brief outline of area sampled: (see chart) Depths: 8, 15, 25, 30, 50, 100 fathoms. Bottom type: Varied from solid sand in the shallow stations to a silty-clay in deeper stations. Shell fragments were found in large quantities in the 8-50 fathom stations. Field Biology Observation: In the canyon stations we found what appeared to be a polycheate community (Terebelids, maldonids) where as in the flatland stations we found what appeared to be a brittle star, sea urchin community (Ophiofragmus, Lytichinus). This was only from a quick inspection of the screened sediments and is not intended to be an accurate statement of the community structure of the area.

Orange County - Two surveys in 1975

Purpose

1. To provide background data for a detailed comparison of areas surrounding the sewage diffuser pipe in Huntington Beach. The detailed comparison would be to determine effects (if any) of a modern sewage diffuser on the benthic marine environment.

2. To compare stress and recovery at both the one mile and the five mile outfall.

Surveys

I. A rough descriptive analysis of an area approximately four miles by five miles surrounding both discharge sites consisting of forty stations. One bottom grab sample for each

station will be taken and analyzed for:

1. Dominant species
2. Volitile solids

One day in the field will be needed to provide these data to justify the limiting of the size of the sample area for the detailed comparison survey and to provide the background data needed for that survey.

II. A detailed chemical and biological analysis of the area of expected effect. One field day will be needed to obtain samples.

A. Parameters

1. Water column

a. temperature
b. D.O. — on boat
c. Salinity — C. Smith
d. pH

2. Bottom types

a. sand-silt — Observation on boat (Word and Moore)
b. silt-clay
c. sediment grain size analysis (Greene, Gorsline)

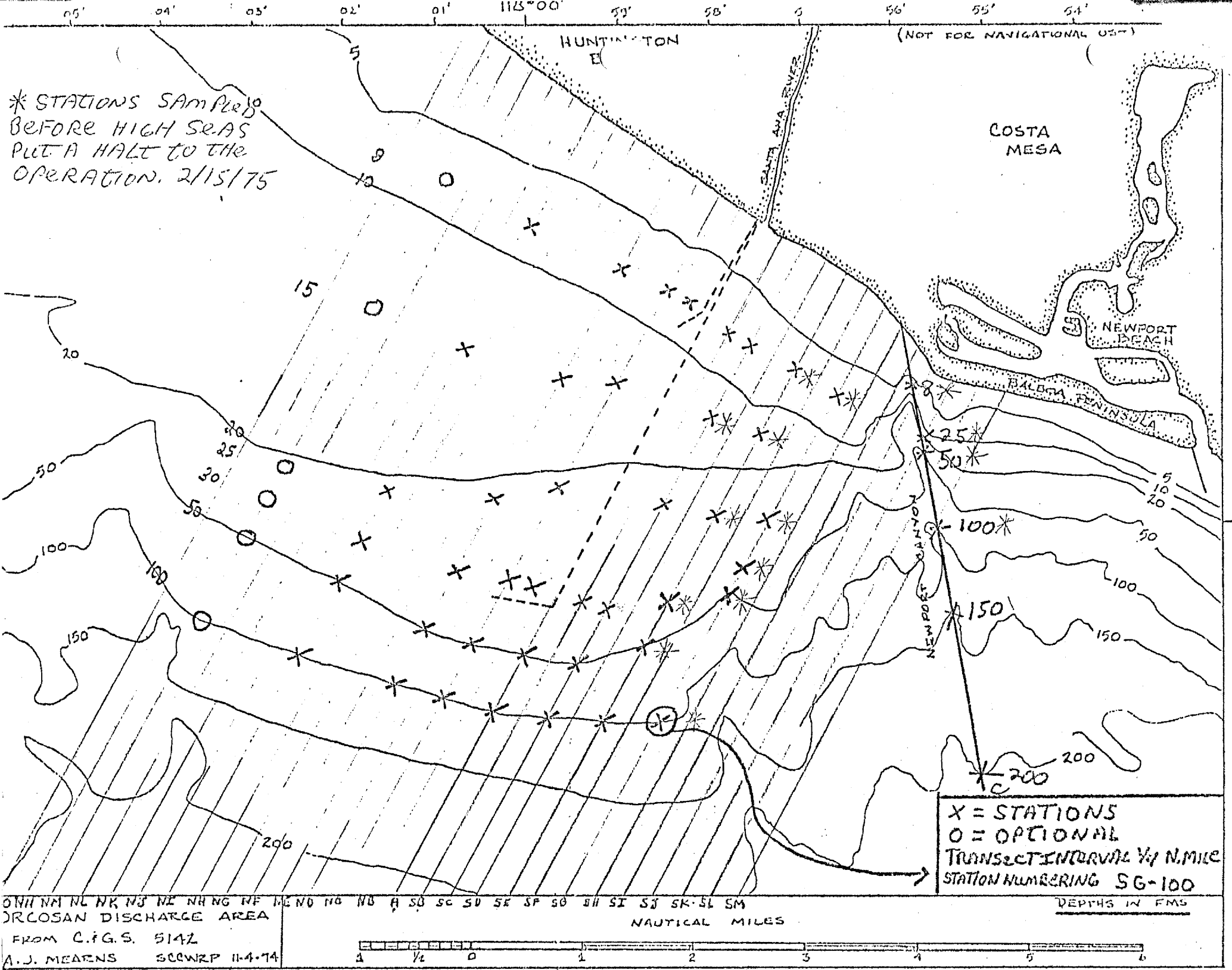
3. Outfall effects physical measurements

a. COD
b. BOD — Most samples
   1. BOD/COD
c. Volatile solids (all samples)
d. organic carbon (2 or 3 for each range of COD levels) and organic nitrogen (M.B.C.)
e. metals
   1. Cr (total), Cu, Cd, -(Ni,Zn), Se, At
f. chlorinated hydrocarbons (DDT, DDE, ACBs)
g. Hexane extractibles (oil and greese)

4. Biological Analysis

a. Two grabs will be screened and preserved on board boat to be later analyzed by outside laboratory under supervision of SCCWRP
   M.B.C. $60/sample.

A total of three benthic grabs per station will be used for the biological analysis. One sub core from each of these grabs will be used for the physical parameters.



ONH NM NL NK NJ NI NH NG NF NE ND NC NB A SO SC SD SE SF SG SH SI SJ SK SL SM

ORCOSAN DISCHARGE AREA

FROM C.&G.S. 5142

A.J. MEARNS SCCWRP 11-4-74

MEMORANDUM

To: Jack Word April 17, 1975

From: Brad Myers

Re: Orange County Sanitation District Outfall: Preliminary Study

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I completed the initial investigation of benthic organisms from ORCOSAN with an average effort of about 3 hours per sample. Several species that I feel occur uncommonly were observed, as well as a depth extension for Cephalaspidean sp A.

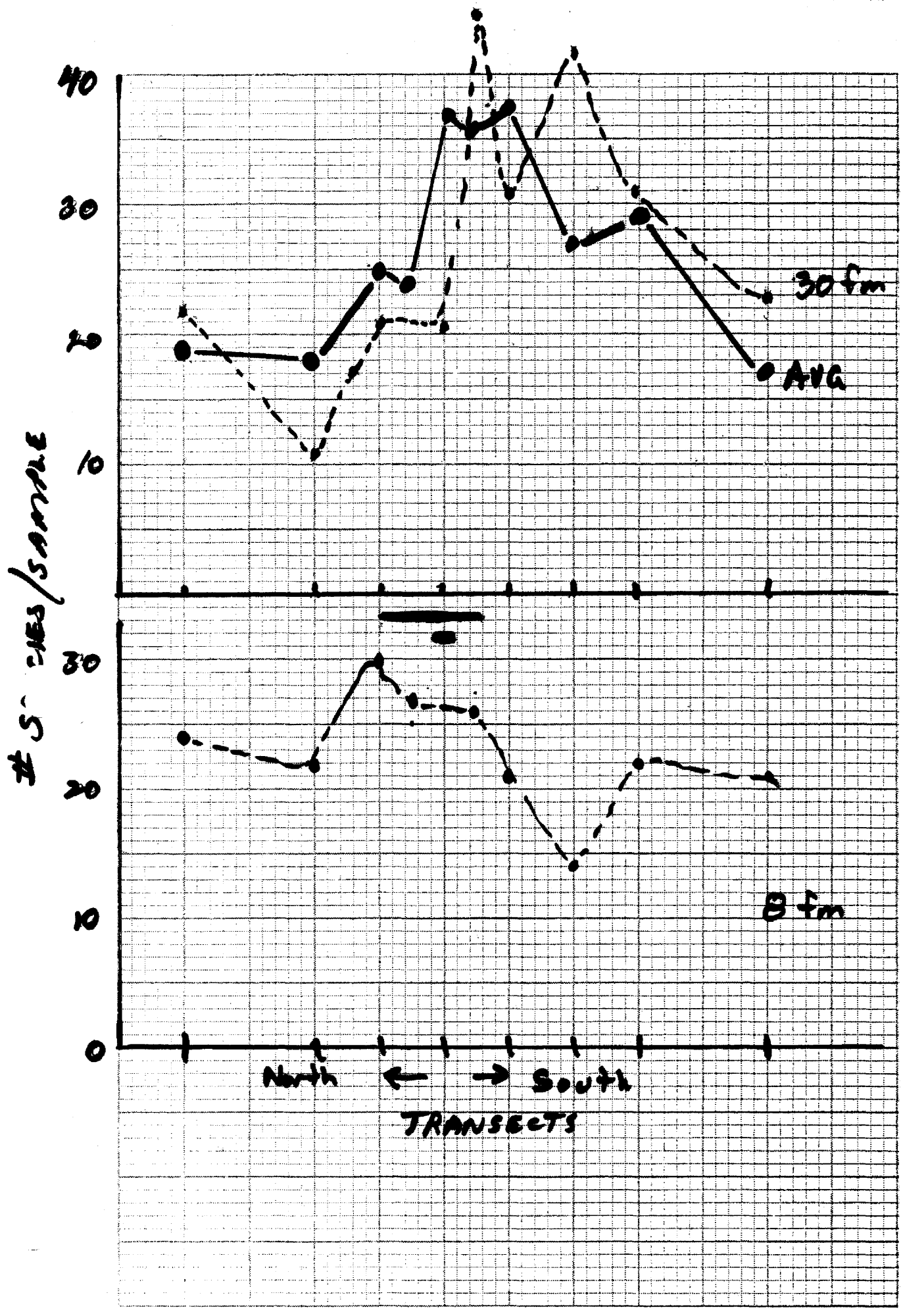
I attempted to observe any trends of populations in the area of the outfall by plotting occurrence and relative abundance for 10 species (or assemblages) on station charts. The observed trends were most evident in Euphilomedes carcharodonta and E. producta both detritus feeders, whose highest abundances occurred within the area of the sludge field (see overlay for sludge field). Prionospio occurred in high abundance near the outfall at 3 of the 4 stations where it was abundant. All stations where Lucinidae (Lucinoma, parvilucina, etc.) occurred in high abundance corresponded with the sludge field around the outfall. None of the other species plotted showed any trends relating to the sludge field.

I also applied an overaly of grainsize data to the plotted species, however no correlation could be made from the information. An interesting point however was that Pectenaria did not occur in abundant numbers in any sandy areas, nor was it collected at any stations less than 25 fm (See plotted chart).

Numbers of species observed were also plotted by stations, as well as mean numbers of species by transect and strata, this showed a general increase in number of species near the outfall, as well as a generally higher number of species south of the pipe (between the pipe and the canyon). The canyon transect showed very low species diversity and numbers of animals, generally decreasing with depth.

Please look at information and see if you have any other observations you can add.

Brad


40
30
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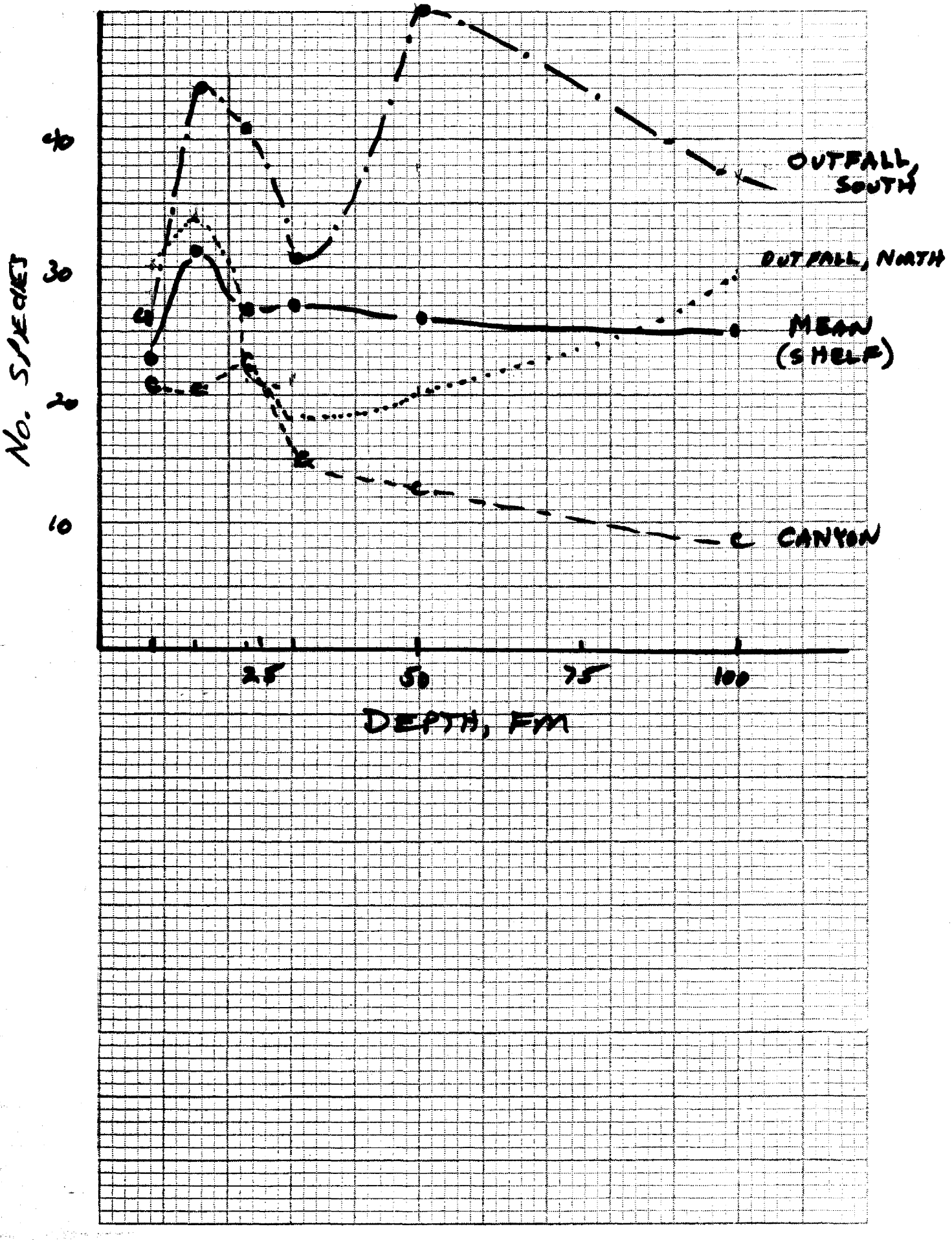
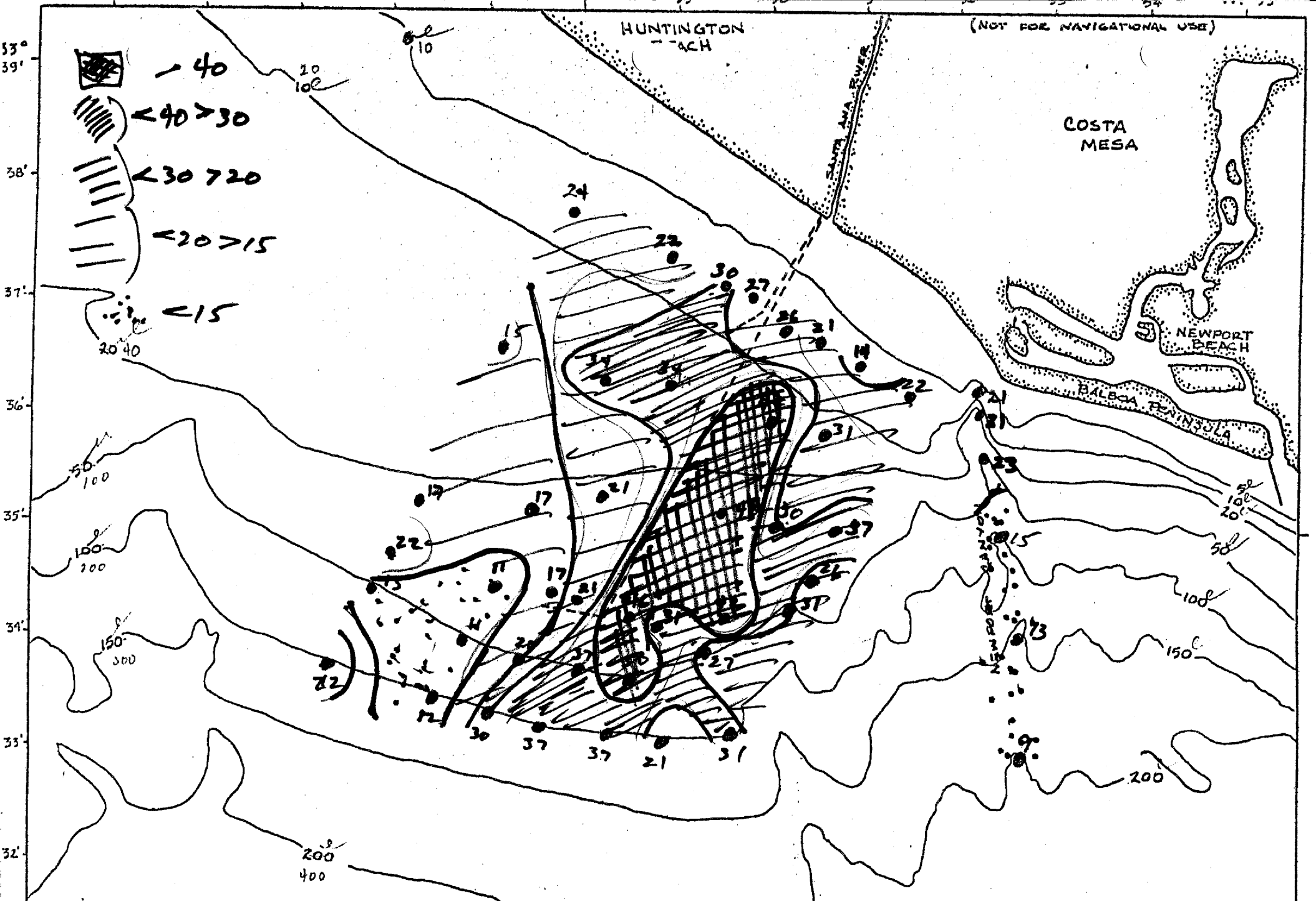
10
#S. ites/sample
30 fm
AVG
30
20
10
0
8 fm
North
South
TRANSECTS

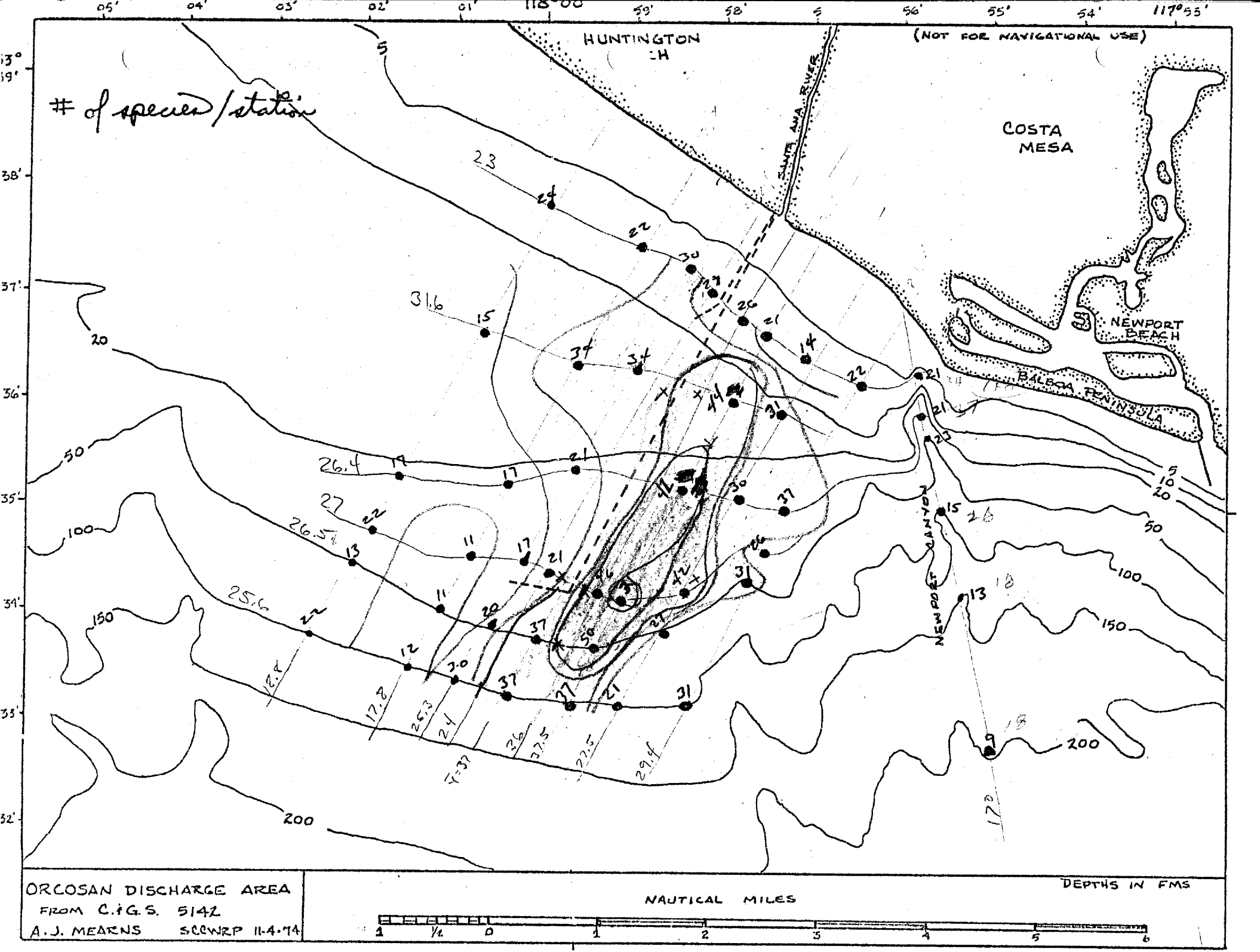

No. SPECIES
40
30
20
10
OUTFALL, SOUTH
OUTFALL, NORTH
MEAN (SHELF)
CANYON
25
50
75
100
DEPTH, FM

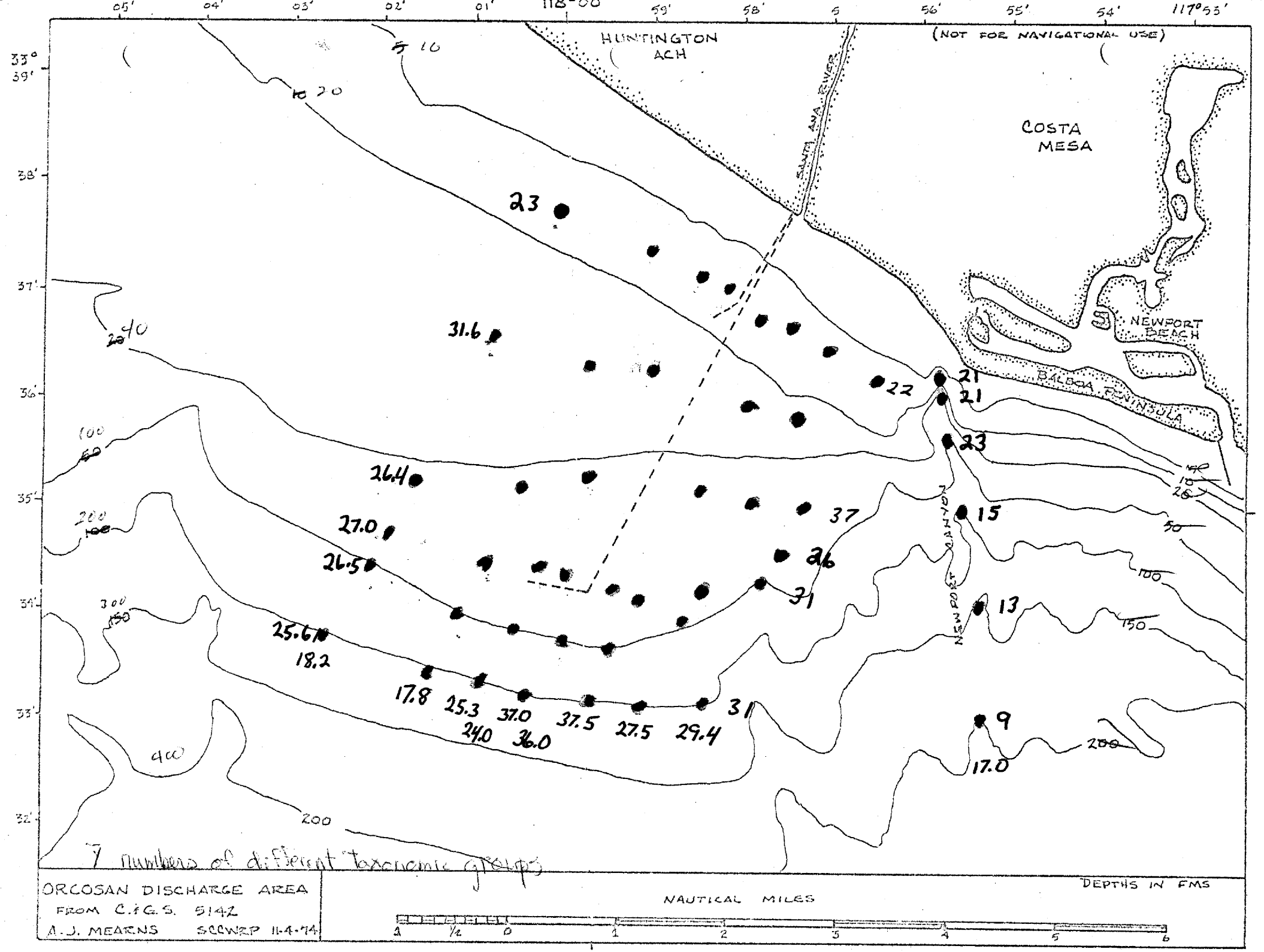


ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74

Fig 1 D

SPECIES RICHNESS (# TAXA)


# of species/station
HUNTINGTON
CH
(NOT FOR NAVIGATIONAL USE)
SANTA ANA RIVER
COSTA
MESA
NEWPORT
BEACH
BALBOA PENINSULA
NEWPORT CANYON
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
DEPTHS IN FMS


(NOT FOR NAVIGATIONAL USE)
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
118°00'
05'
04'
03'
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59'
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56'
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54'
117°53'
33° 39'
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37
27.0
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13
25.6
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17.8
25.3
37.0
37.5
27.5
29.4
24.0
36.0
31
9
17.0
50
100
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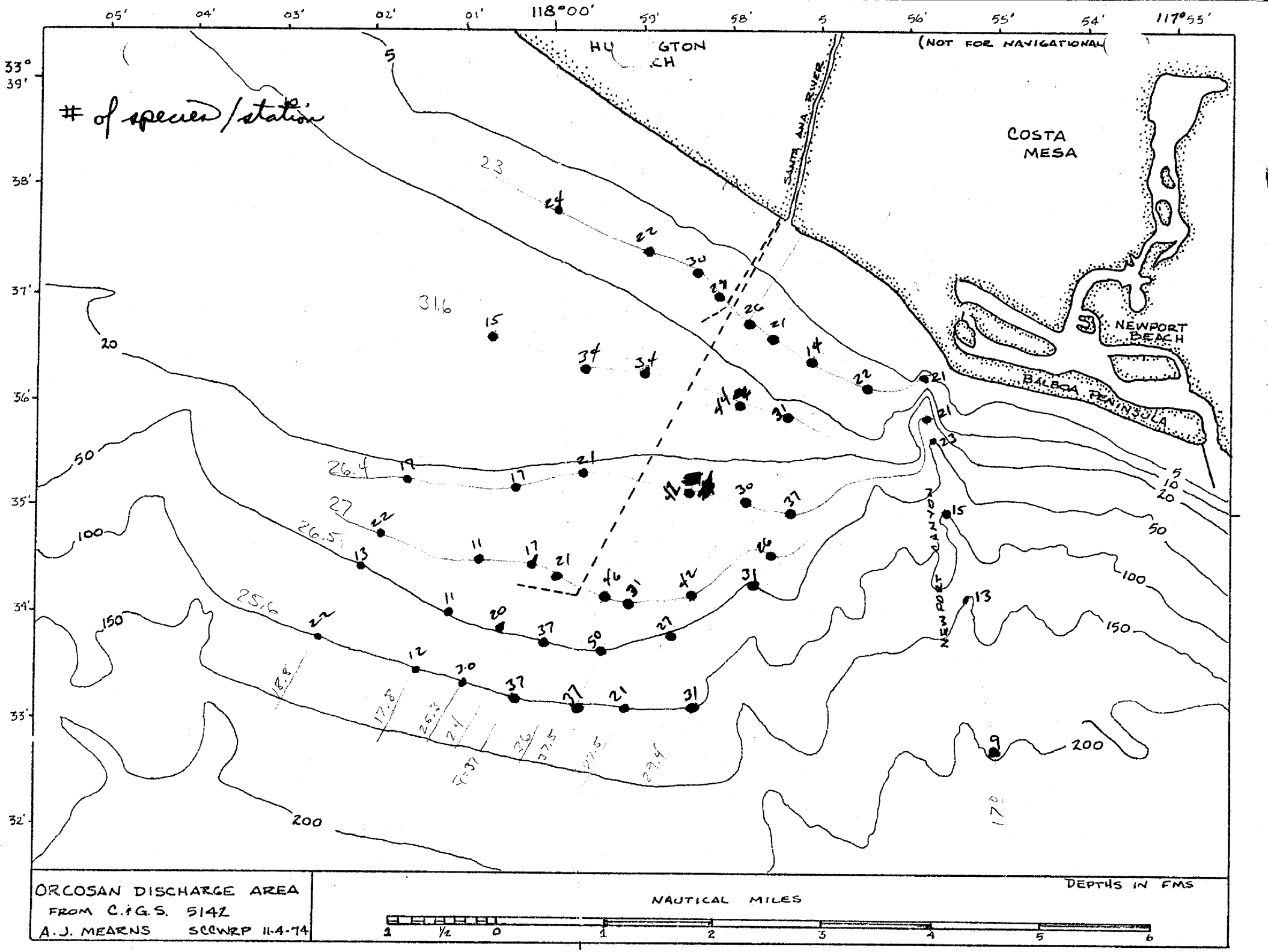
200
7 numbers of different taxonomic groups
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
DEPTHS IN FMS


# of species/station
(NOT FOR NAVIGATIONAL
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COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
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ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
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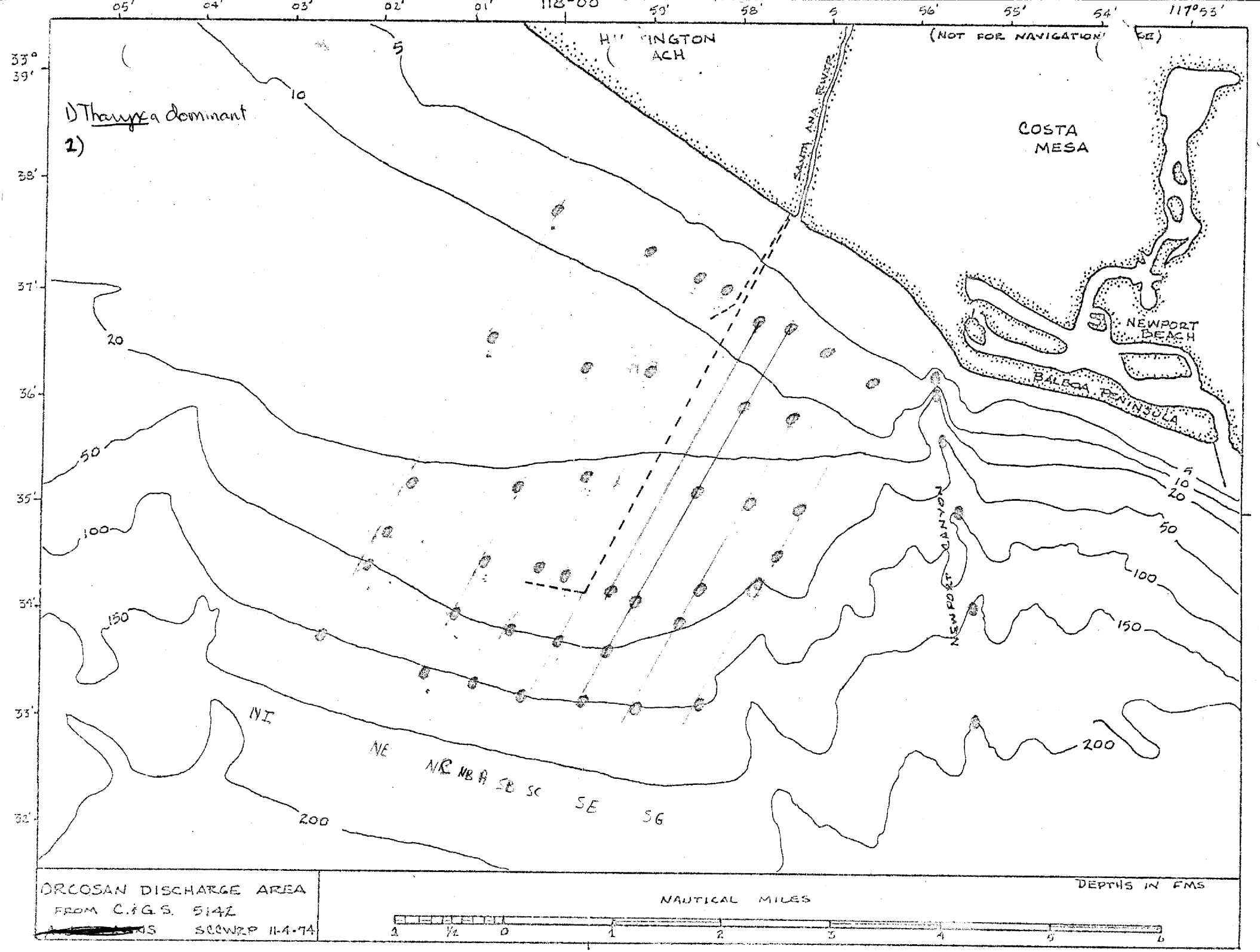
DEPTHS IN FMS


1) Thayer a dominant
2)
(NOT FOR NAVIGATION)
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
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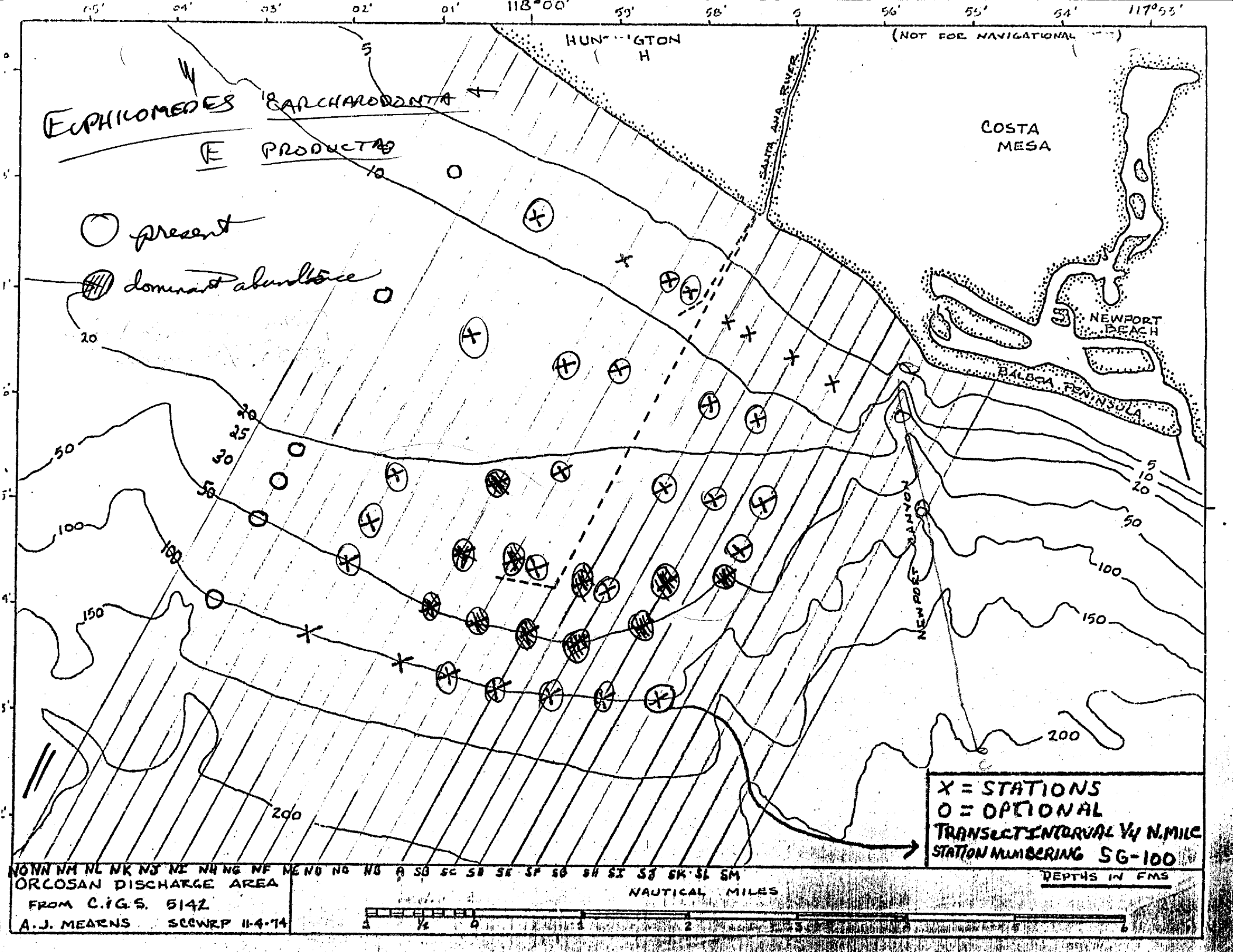
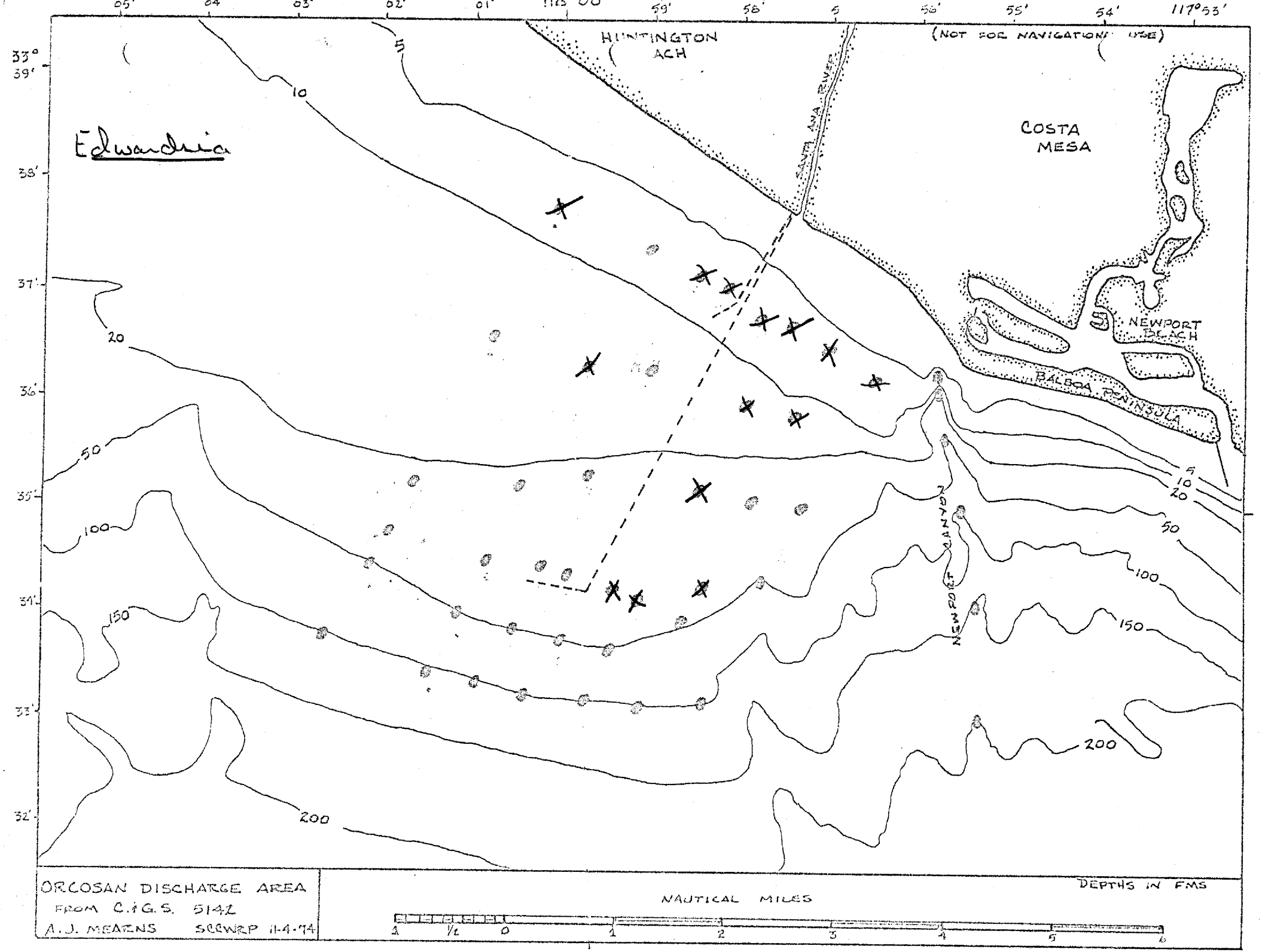
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
SCCWRP 11-4-74
NAUTICAL MILES
DEPTHS IN FMS


EPHILOMEDES CARCHARODONTA
E PRODUCTA
present
dominant abundance
HUNTINGTON H
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
X = STATIONS
O = OPTIONAL
TRANSECT INTERVAL ¼ N.MILE
STATION NUMBERING SG-100
NONN NM NL NK NJ NI NH NG NF ME ND NC NB A SB SC SD SE SF SG SH SI SJ SK SL SM
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
DEPTHS IN FMS


(NOT FOR NAVIGATION USE)
HUNTINGTON BEACH
SANTA ANA RIVER
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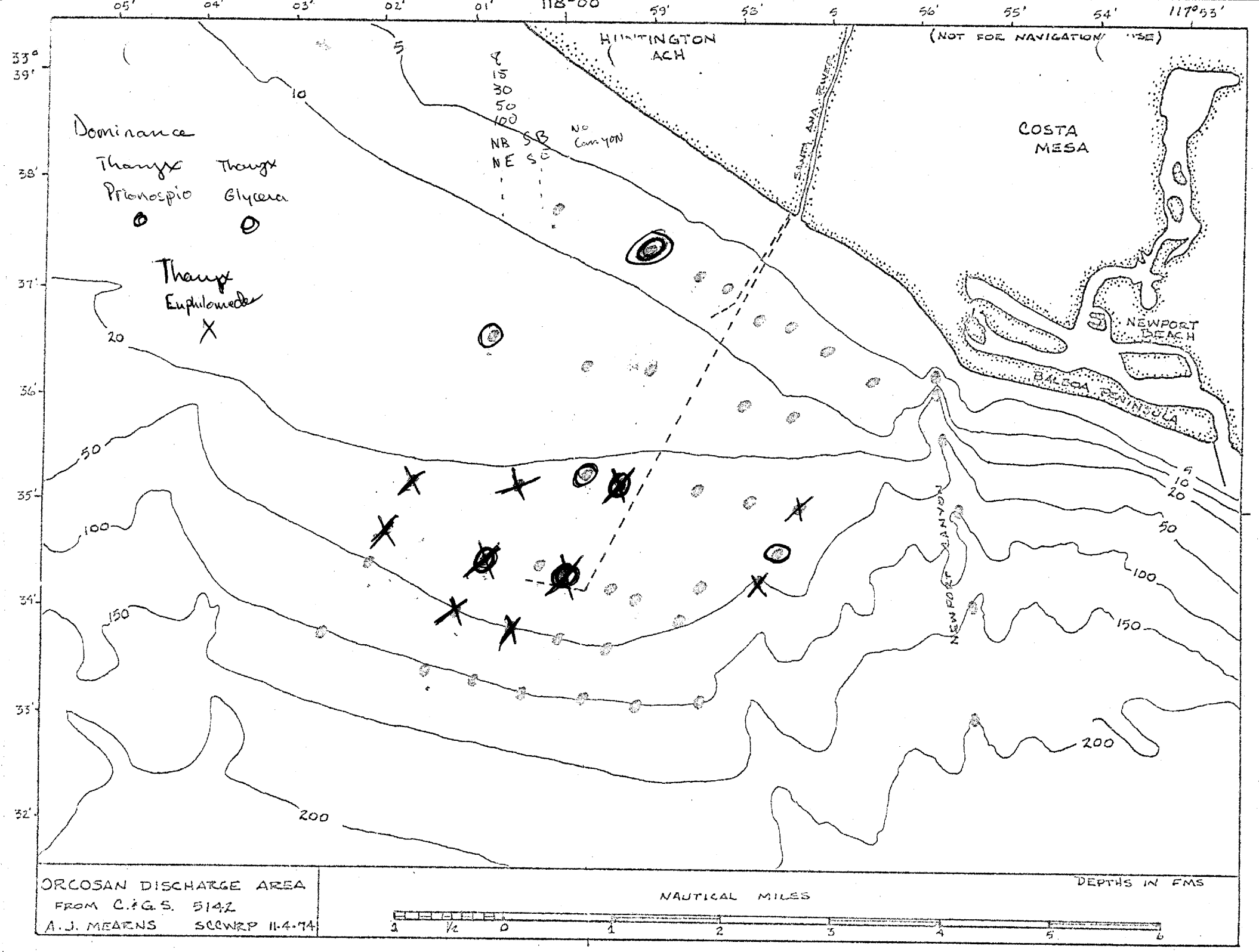
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
1 1/2 0 1 2 3 4 5 6
DEPTHS IN FMS


(NOT FOR NAVIGATION USE)
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
No Canyon
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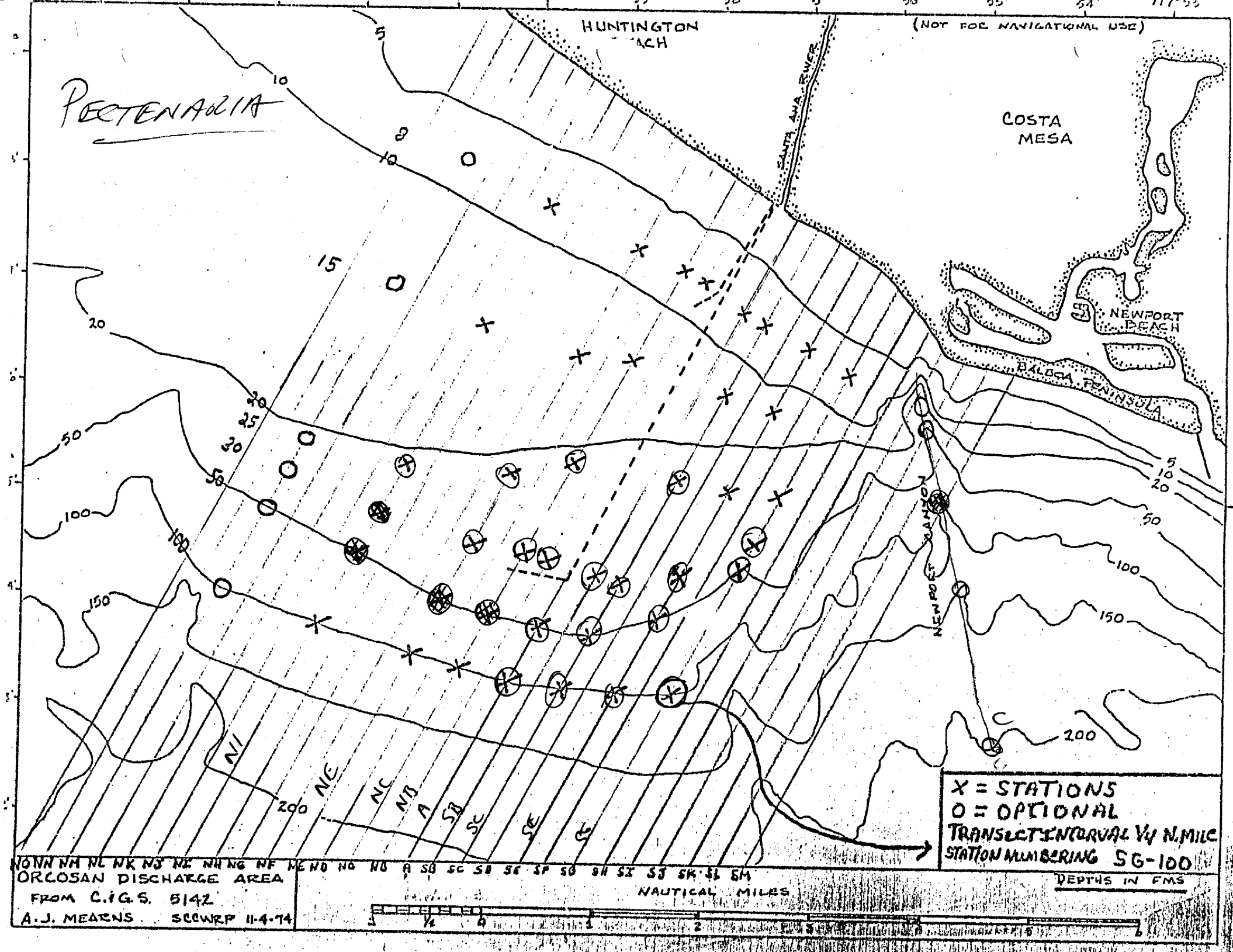
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
DEPTHS IN FMS


(NOT FOR NAVIGATIONAL USE)
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
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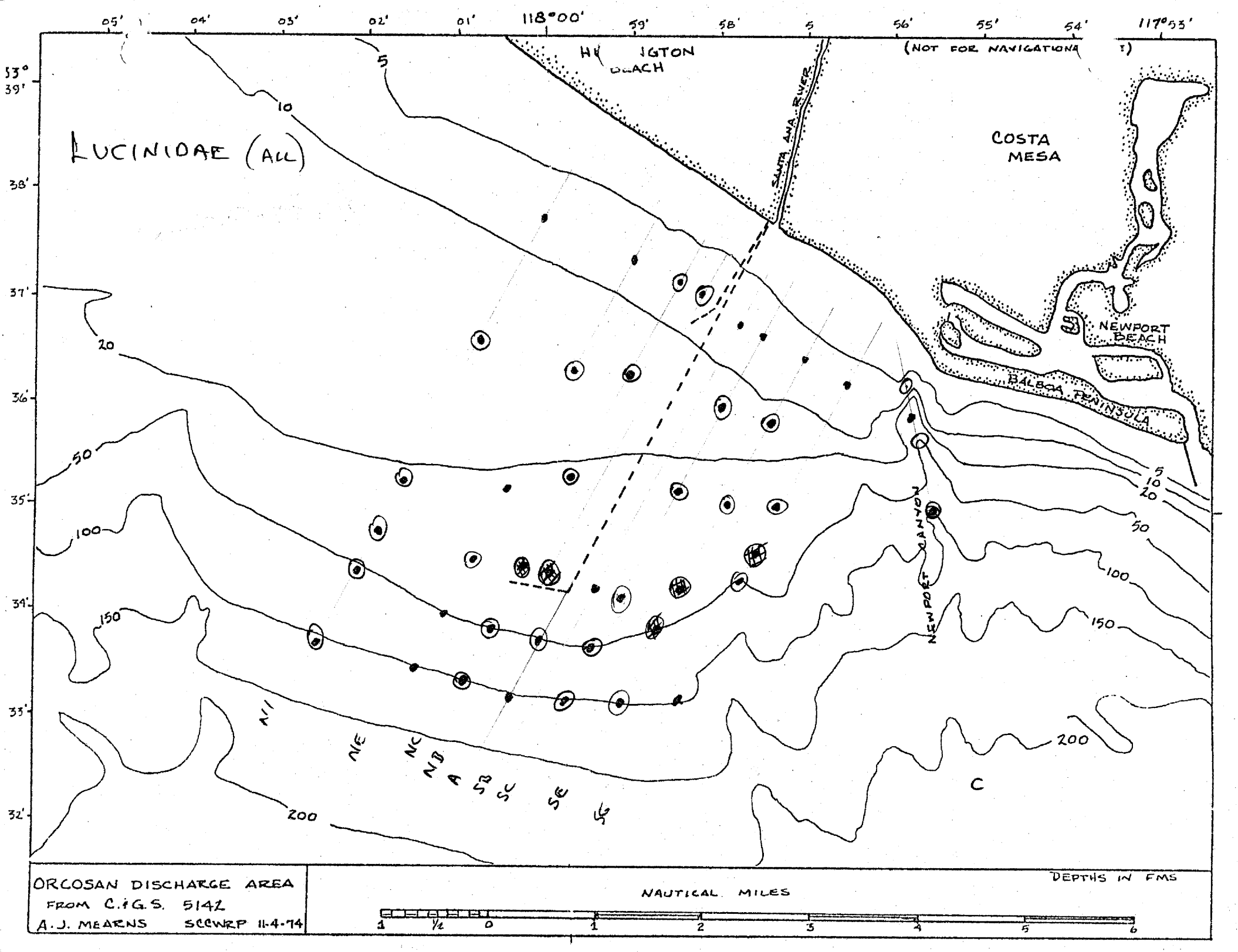
X = STATIONS
O = OPTIONAL
TRANSECT INTERVAL ¼ N. MILE
STATION NUMBERING SG-100
NO NN NM NL NK NJ NI NH NG NF ME ND NC NB A SB SC SD SE SF SG SH SI SJ SK SL SM
NAUTICAL MILES
DEPTHS IN FMS
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74


LUCINIDAE (ALL)
(NOT FOR NAVIGATIONAL USE)
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
118°00'
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ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
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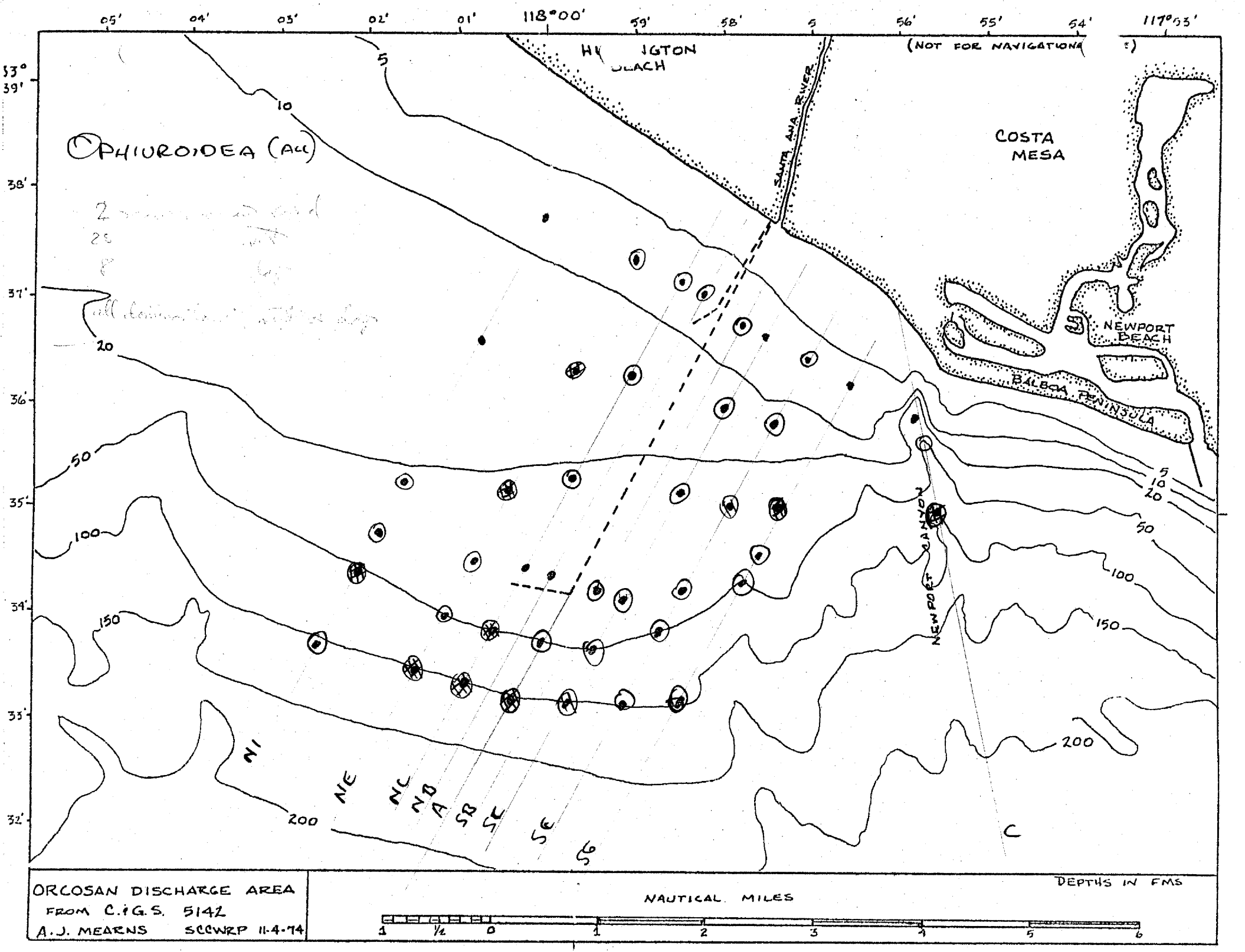
DEPTHS IN FMS


05' 04' 03' 02' 01' 118°00' 59' 58' 5 56' 55' 54' 117°53'
(NOT FOR NAVIGATIONAL USE)
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
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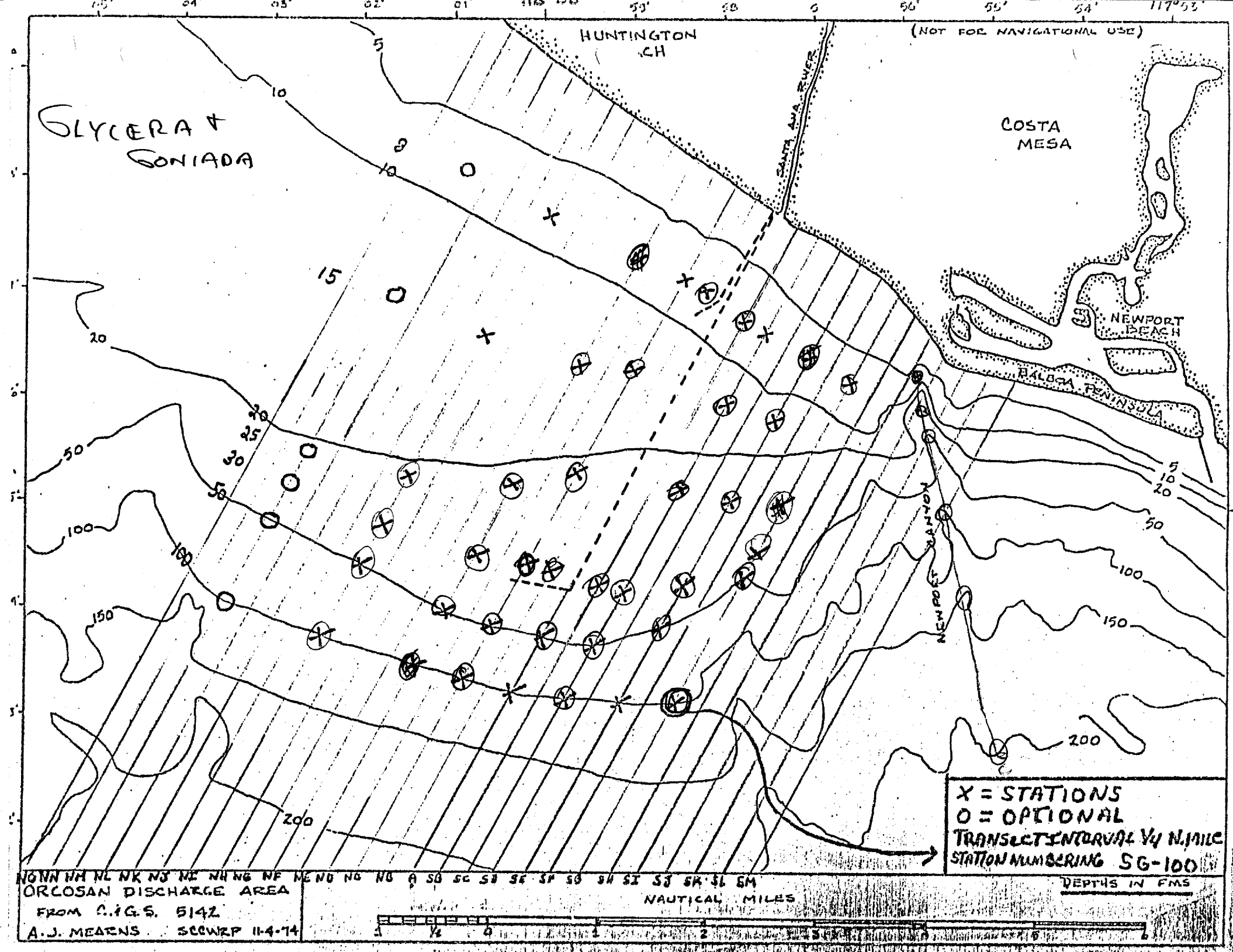
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
1 ½ 0 1 2 3 4 5 6
DEPTHS IN FMS


(NOT FOR NAVIGATIONAL USE)
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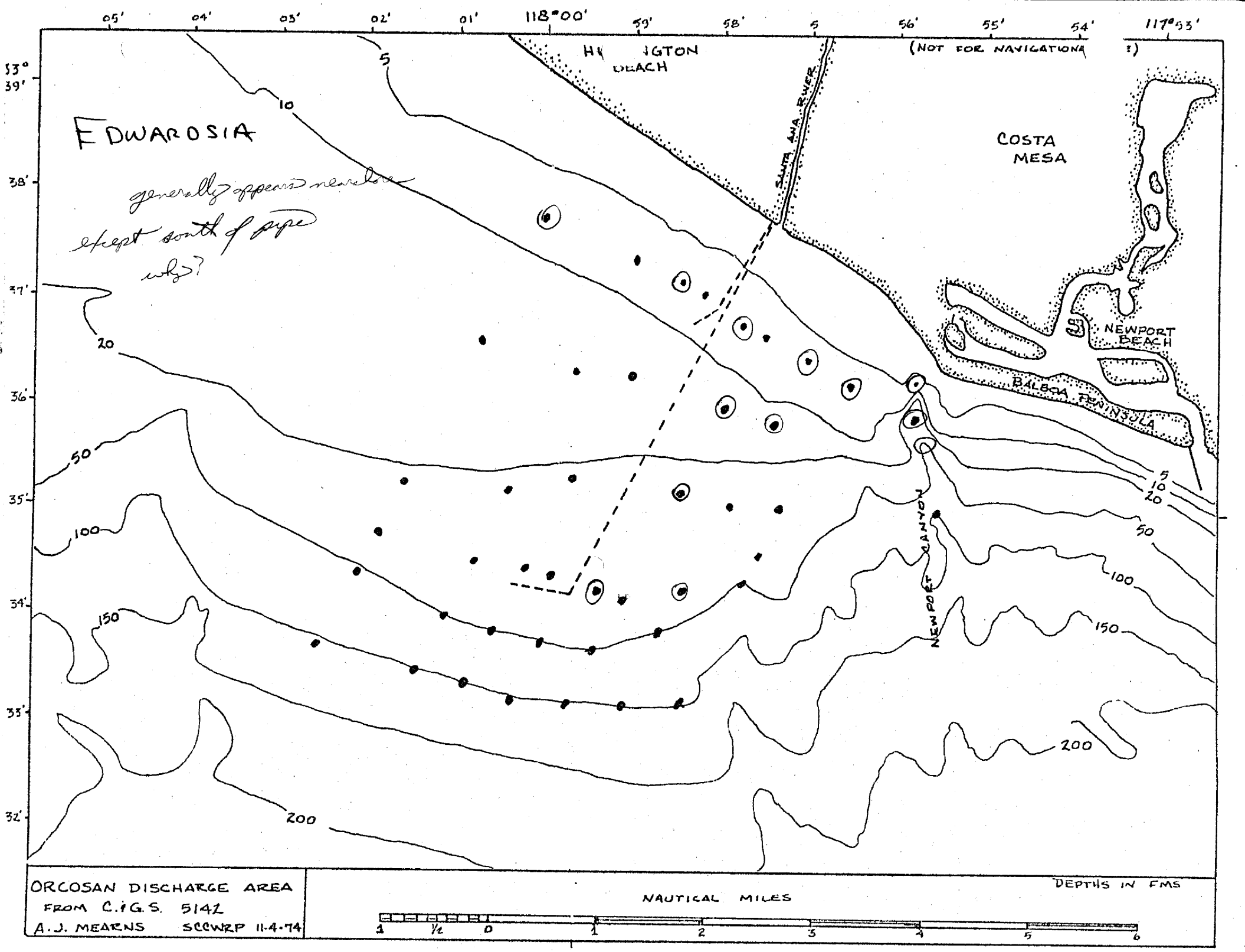
X = STATIONS
O = OPTIONAL
TRANSECT INTERVAL ½ N. MILE
STATION NUMBERING SG-100
NO NN NH NL NK NJ NI NH NG NF NE ND NC NB A SB SC SD SE SF SG SH SI SJ SK SL SM
NAUTICAL MILES
DEPTHS IN FMS
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74


05' 04' 03' 02' 01' 118°00' 59' 58' 5 56' 55' 54' 117°53'
(NOT FOR NAVIGATIONAL USE)
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
EDWARDSIA
generally appears near bottom
except south of pipe
why?
5
10
20
50
100
150
200
53°
39'
38'
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36'
35'
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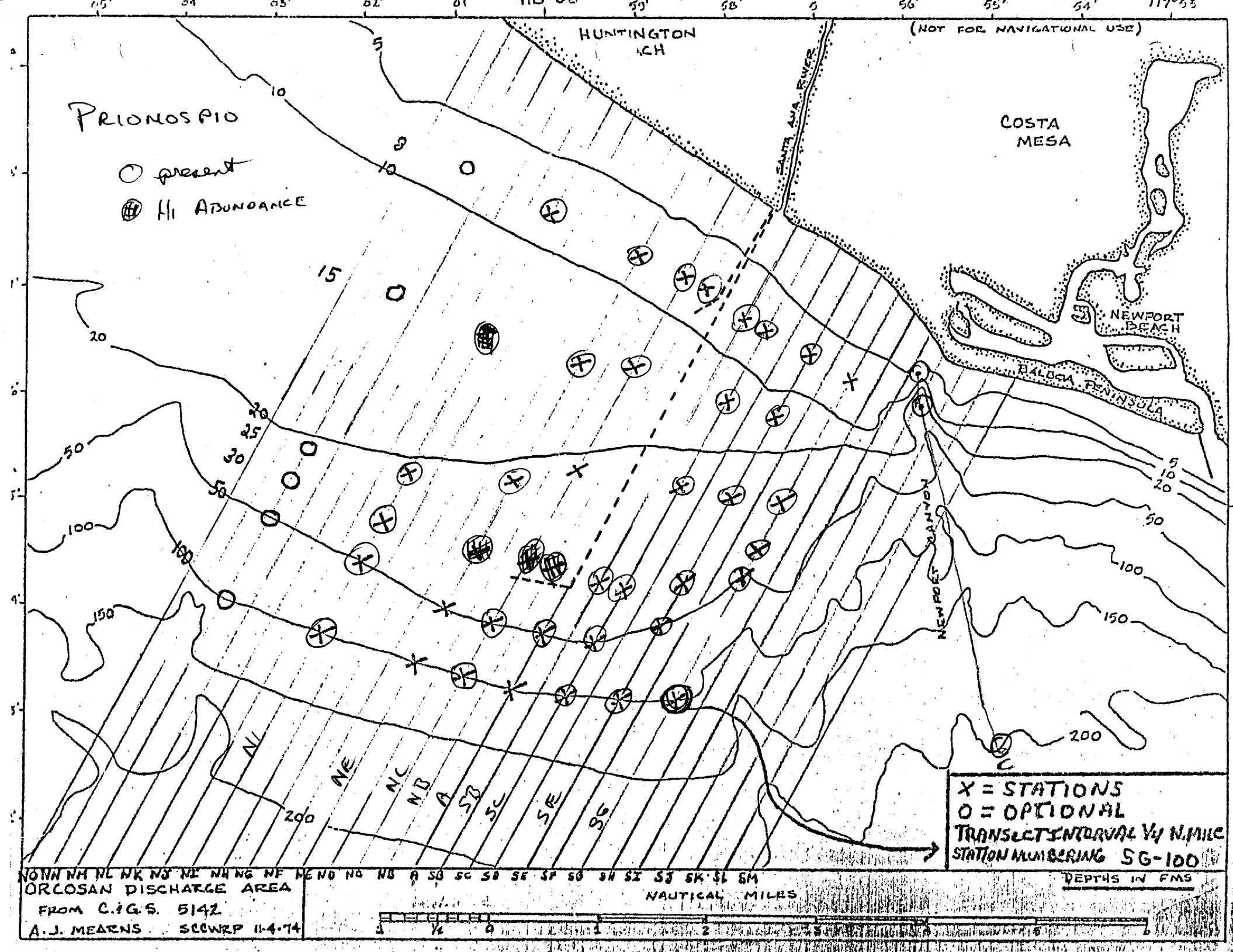
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
1 ½ 0 1 2 3 4 5 6
DEPTHS IN FMS


PRIONOSPIO
○ present
⊕ HI ABUNDANCE
HUNTINGTON BEACH
(NOT FOR NAVIGATIONAL USE)
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
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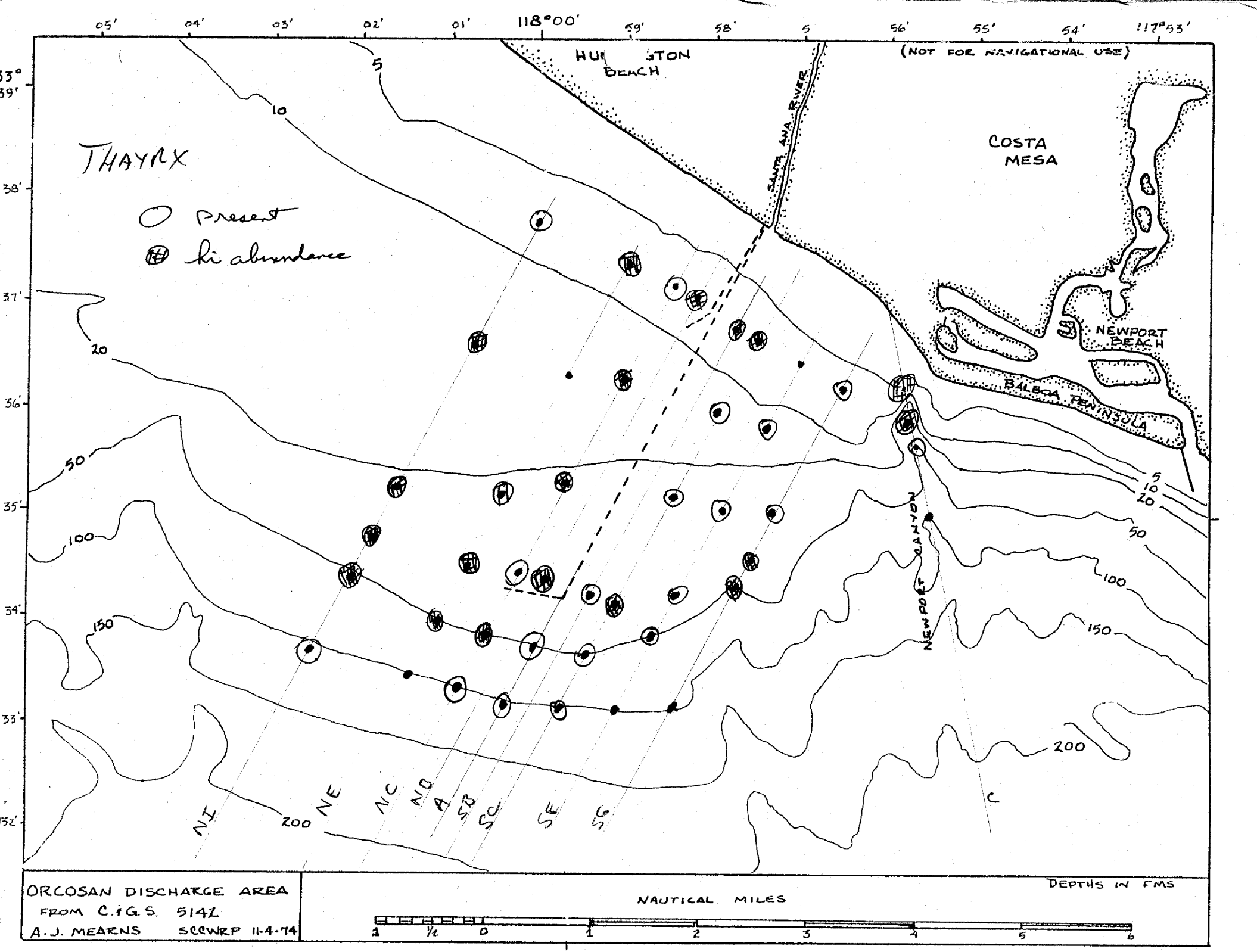
X = STATIONS
O = OPTIONAL
TRANSECT INTERVAL ½ N.MILE
STATION NUMBERING SG-100
NO NN NH NL NK NJ NE NH NG NF ME NO NG NB A SB SC SD SE SF SG SH SI SJ SK SL SM
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
DEPTHS IN FMS


05' 04' 03' 02' 01' 118°00' 59' 58' 5 56' 55' 54' 117°53'
(NOT FOR NAVIGATIONAL USE)
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
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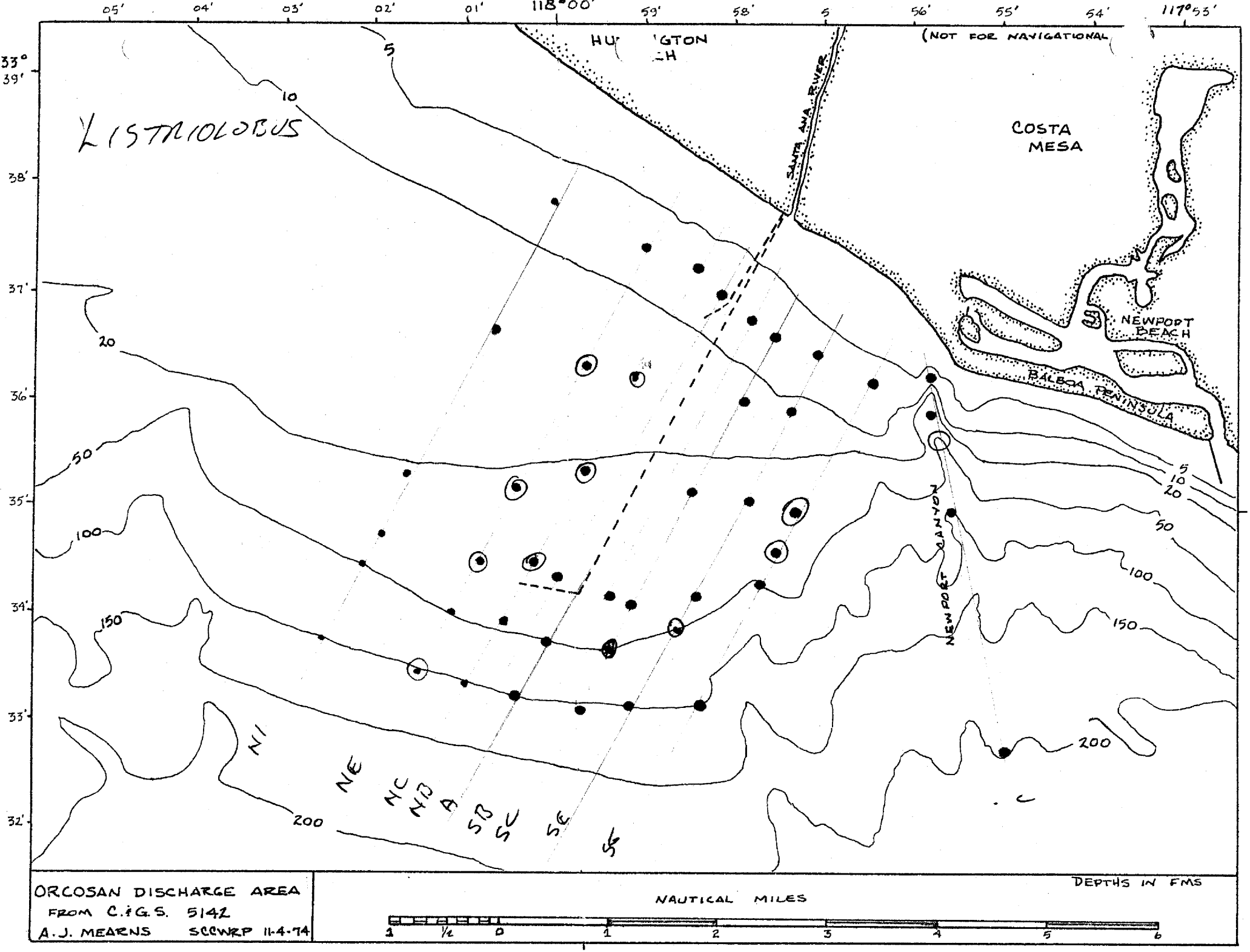
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
DEPTHS IN FMS


LISTRIOLOBUS
(NOT FOR NAVIGATIONAL
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
118°00'
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38'
37'
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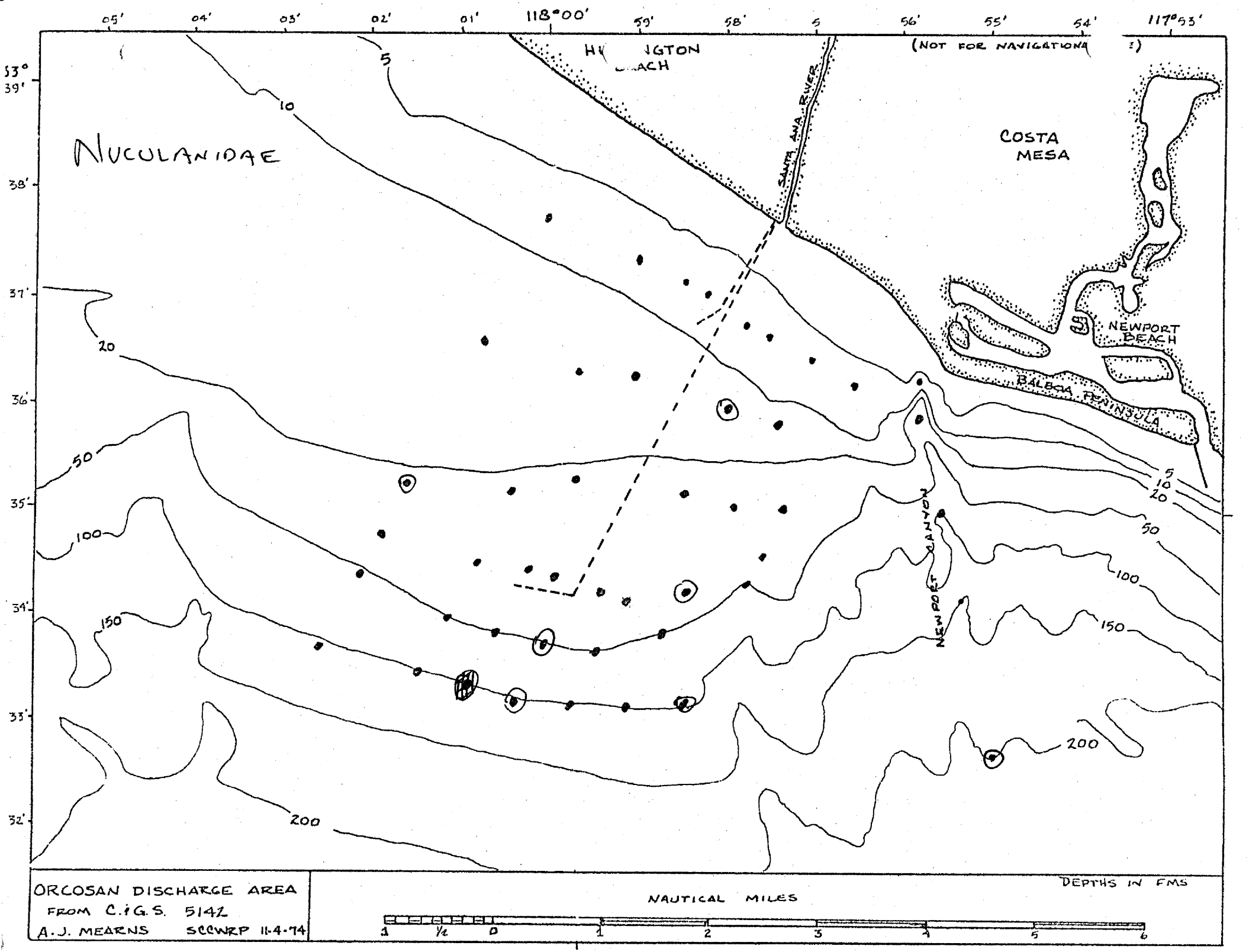
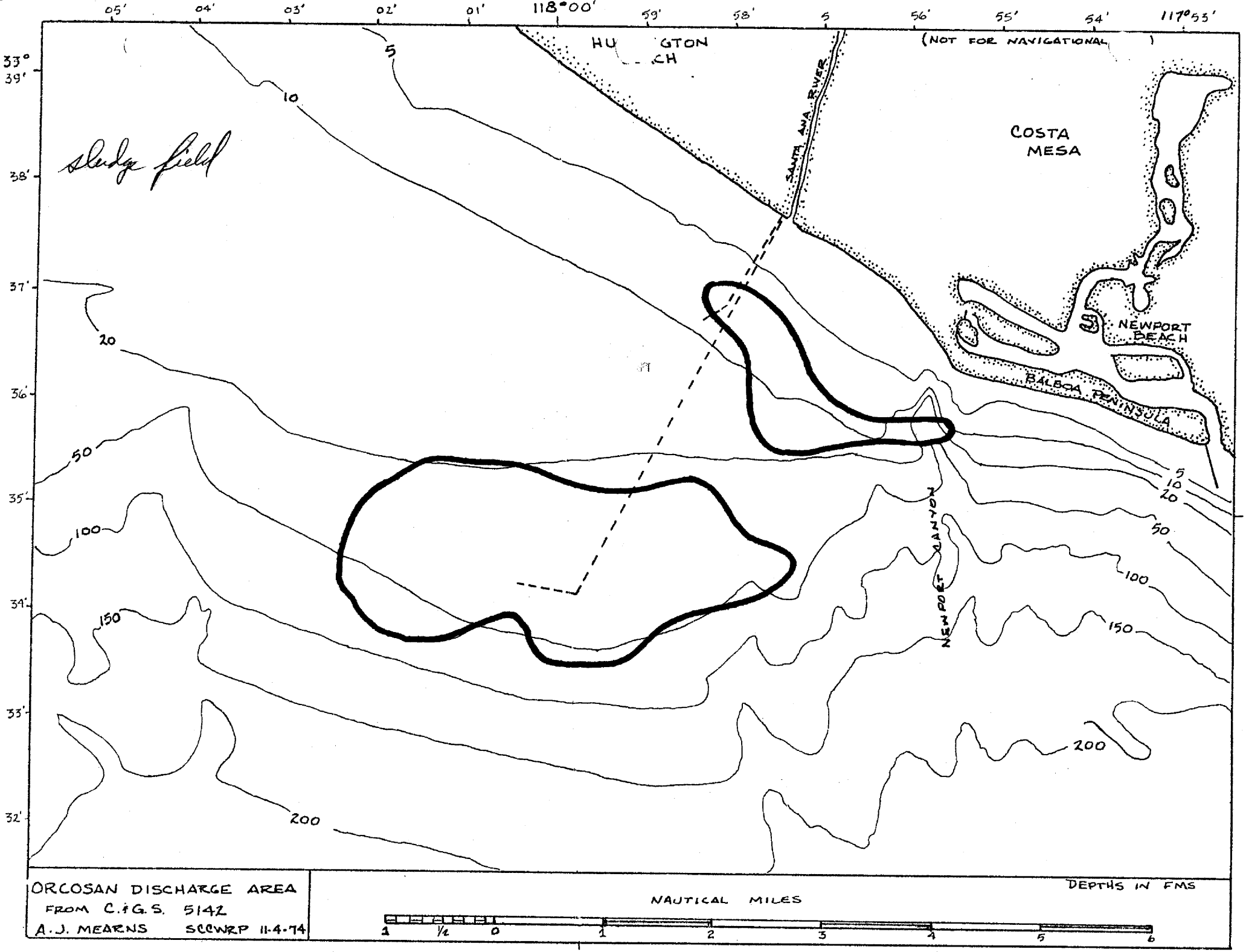
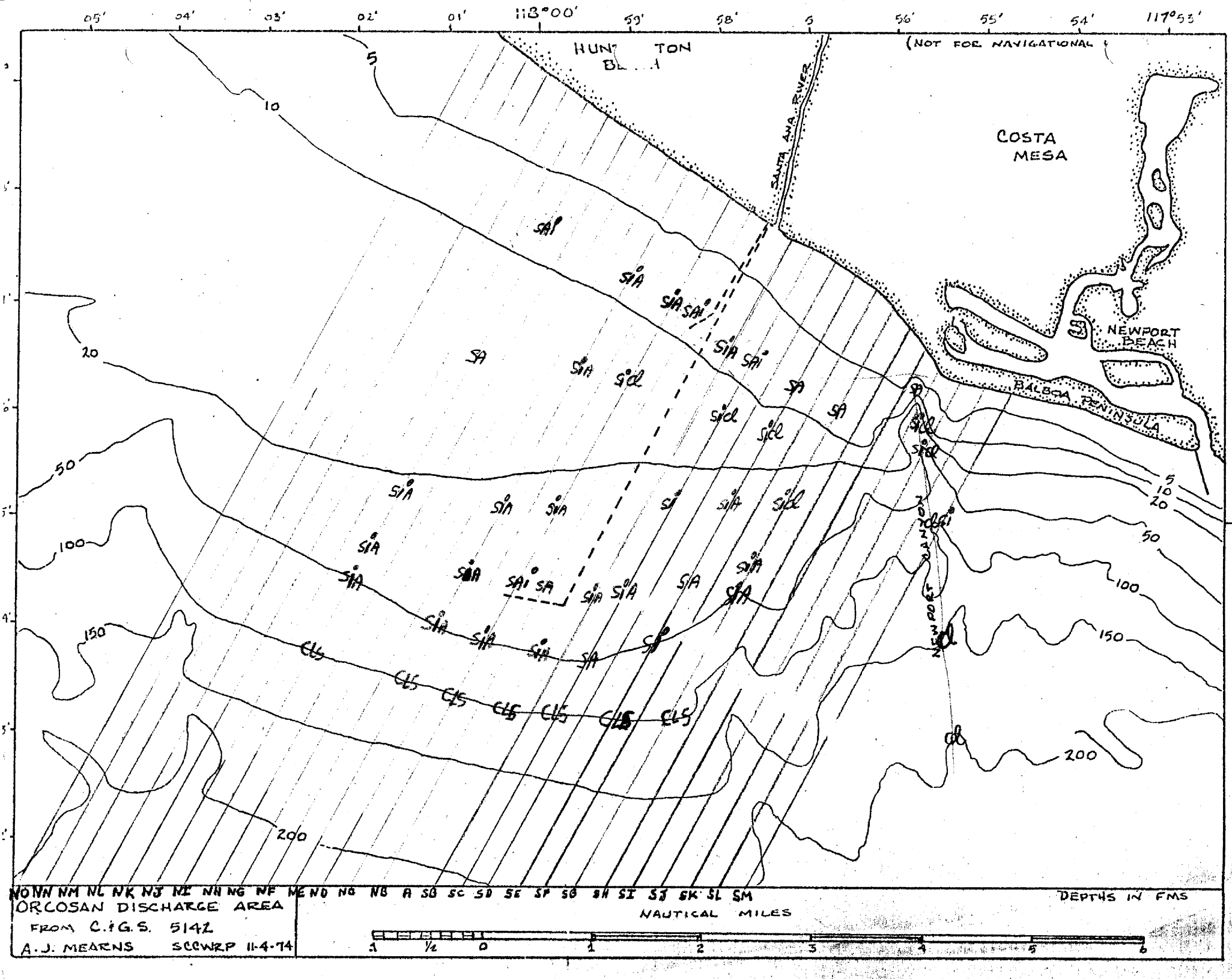
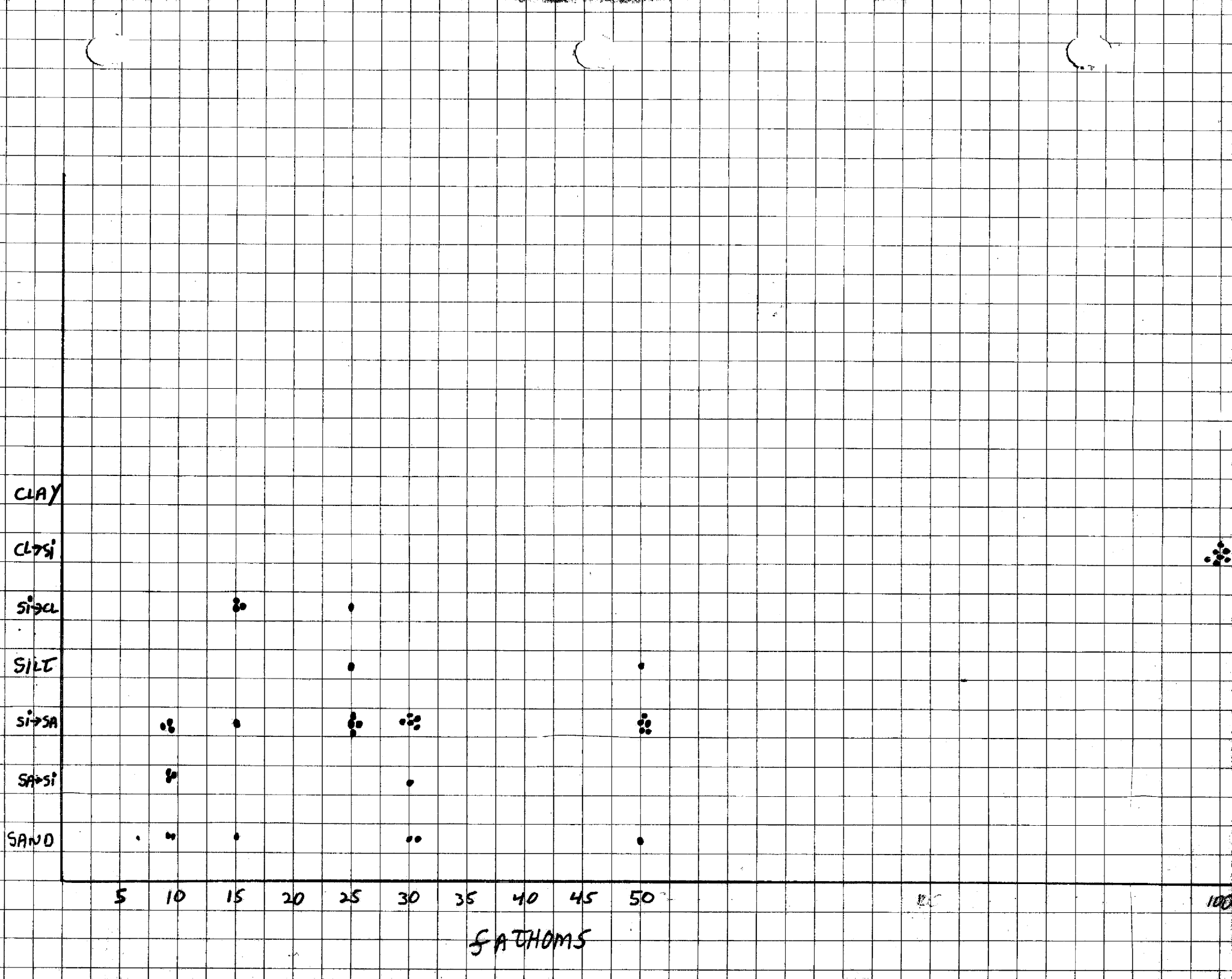
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
1 ½ 0 1 2 3 4 5 6
DEPTHS IN FMS


05'
04'
03'
02'
01'
118°00'
59'
58'
5
56'
55'
54'
117°53'
(NOT FOR NAVIGATIONAL USE)
33°
39'
38'
37'
36'
35'
34'
33'
32'
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
NUCULANIDAE
5
10
20
50
100
150
200
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
1
½
0
1
2
3
4
5
6
DEPTHS IN FMS


05' 04' 03' 02' 01' 118°00' 59' 58' 5 56' 55' 54' 117°53'
33° 39' 38' 37' 36' 35' 34' 33' 32'
(NOT FOR NAVIGATIONAL
HU GTON
CH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
Sludge field
5
10
20
50
100
150
200
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
NAUTICAL MILES
1 1/2 0 1 2 3 4 5 6
DEPTHS IN FMS

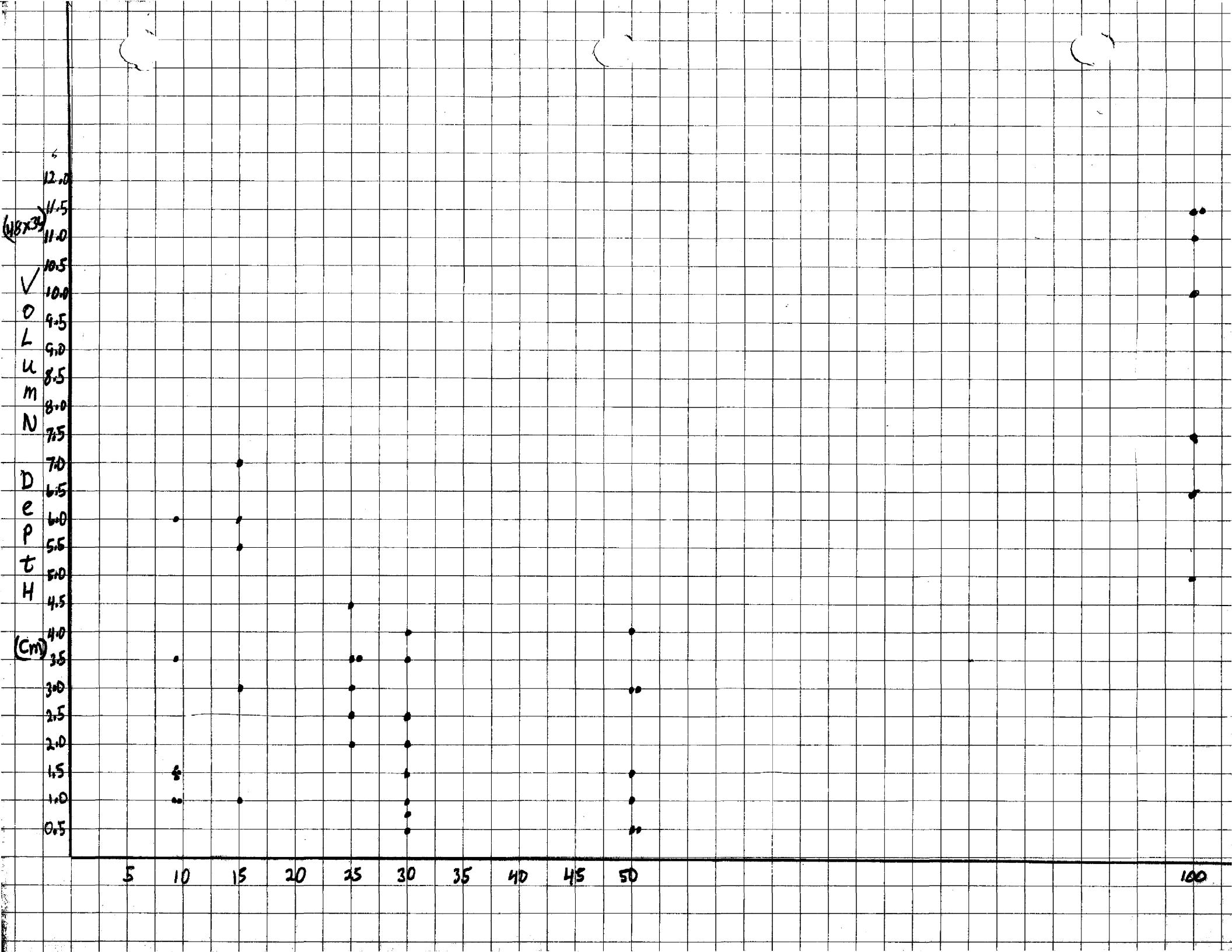

05' 04' 03' 02' 01' 118°00' 59' 58' 5 56' 55' 54' 117°53'
(NOT FOR NAVIGATIONAL
HUNTINGTON BEACH
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
5
10
20
50
100
150
200
SA
SIA
SIL
CLS
NO NN NM NL NK NJ NI NH NG NF ME ND NC NB A SB SC SD SE SF SG SH SI SJ SK SL SM
ORCOSAN DISCHARGE AREA
FROM C.&G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
DEPTHS IN FMS
NAUTICAL MILES
1 ½ 0 1 2 3 4 5 6

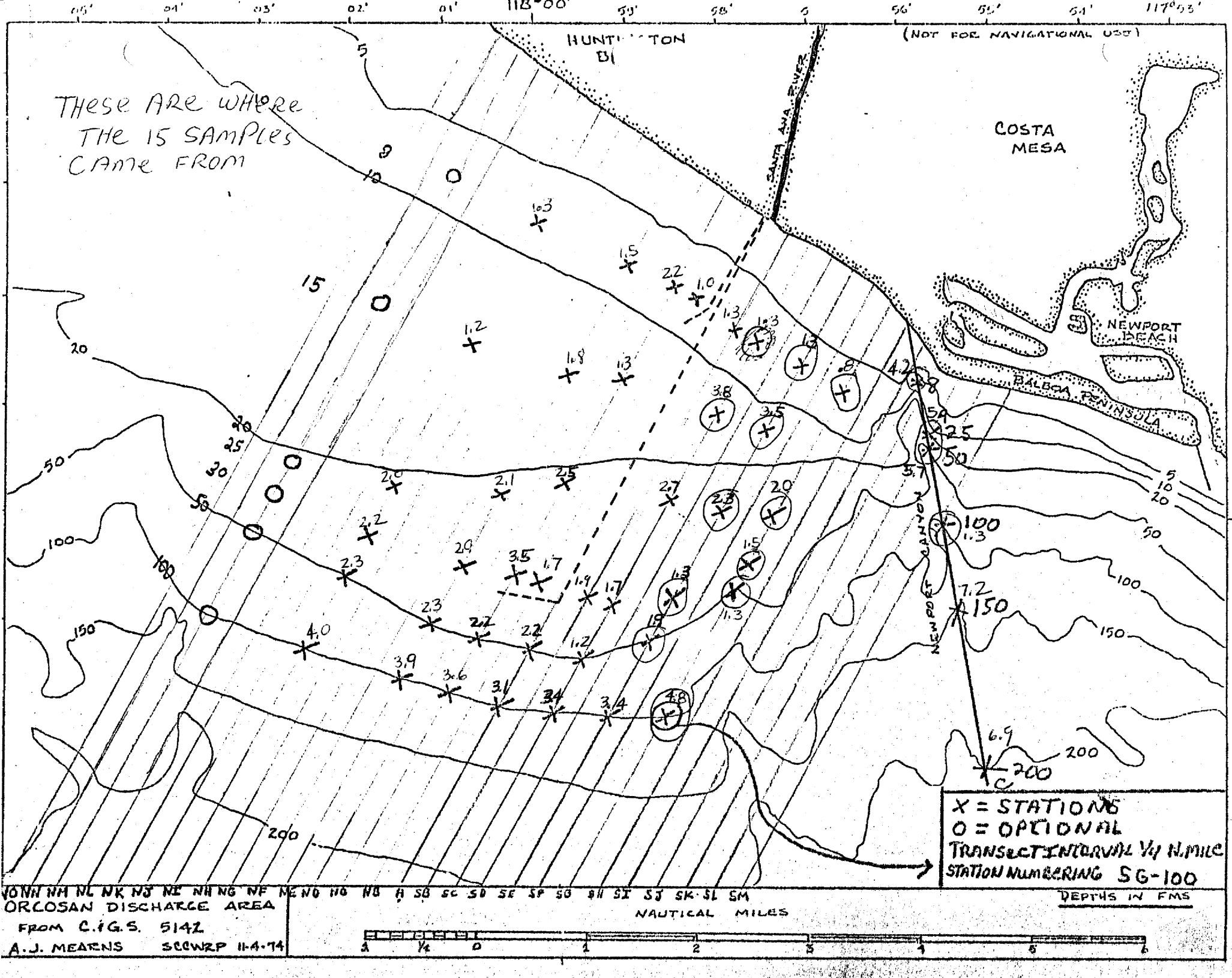

CLAY
CL→Si
Si→CL
SILT
Si→SA
SA→Si
SAND
5
10
15
20
25
30
35
40
45
50
100
FATHOMS

STATION	8 Fm	15 Fm	25 Fm	30 Fm	50 Fm	100 Fm	150 Fm	200 Fm	STATION
SG-8	SA (1.5cm)								SG-8
SG-25			Si→CL (3.5cm)						SG-25
SG-30				Si→SA (½ cm)					SG-30
SG-50					Si→SA (½cm)				SG-50
SG-100						CL→Si (10cm)			SG-100
SE-8	SA (1cm)								SE-8
SE-15		Si→CL (2cm)							SE-15
SE-25			Si→SA (4.5cm)						SE-25
SE-30				SA (0.75)					SE-30
SE-50					Si (0.5)				SE-50
SE-100						CL→Si (7.5)			SE-100
SC-8	SA→Si (1.5)								SC-8
SC-15		Si→CL (6)							SC-15
SC-25			Si (2.0)						SC-25
SC-30				Si→SA (2.5)					SC-30
SC-50					SA (1.5)				SC-50
SC-100						CL→Si (6.5)			SC-100
SB-8	Si→SA 6								SB-8
SB-30				Si→SA (1.5)					SB-30
A-50					Si→SA (1)				A-50
A-100						CL→Si (5)			A-100
NB-8	SA→SL (1cm)								NB-8
NB-30				SA (1)					NB-30
NC-8	Si→SA (3.5)								NC-8
NC-15		Si→CL (5.5)							NC-15
NC-25			Si→SA (3)						NC-25
NC-30				SA→SL ? (2)					NC-30
NC-50					Si→SA (4cm)				NC-50
NC-100						CL→Si (11.5)			NC-100
NE-8	Si→SA (1.5)								NE-8
NE-15		Si→SA (3)							NE-15
NE-25			Si→SA (3.5)						NE-25
NE-30				Si→SA (4)					NE-30
NE-50					Si→SA (3)				NE-50
NE-100						CL→Si (11)			NE-100
NI-8	SA→Si (1.5)								NI-8
NI-15		SA (1cm)							NI-15
NI-25			Si→SA (2.5)						NI-25
NI-30				Si→SA (3.5)					NI-30
NI-50					Si→SA (3)				NI-50
NI-100						CL→Si (11.5)			NI-100

(Xcm) = VOLUMN 48.5X36X(Xcm)

CL = CLAY
Si = SILT
SA = SAND


(48x36)
VOLUMN DEPTH (Cm)
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
5
10
15
20
25
30
35
40
45
50
100


(NOT FOR NAVIGATIONAL USE)
HUNTINGTON BI
SANTA ANA RIVER
COSTA MESA
NEWPORT BEACH
BALBOA PENINSULA
NEWPORT CANYON
These are where the 15 samples came from
X = STATIONS
O = OPTIONAL
TRANSECT INTERVAL 1/4 N.MILE
STATION NUMBERING SG-100
VONH NH NL NK NJ NI NH NG NF ME NO NG NB A SB SC SD SE SF SG SH SI SJ SK SL SM
ORCOSAN DISCHARGE AREA
FROM C.I.G.S. 5142
A.J. MEARNS SCCWRP 11-4-74
DEPTHS IN FMS
NAUTICAL MILES