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Baltimore Harbor and channels : surface sediments in Virginia channels

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CONTRACT REPORT

BALTIMORE HARBOR AND CHANNELS:
SURFACE SEDIMENTS IN VIRGINIA CHANNELS

by

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FINAL REPORT

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Summary

Bottom surface sediment samples in the Virginia Channels portion of the Baltimore Harbor and Channels Project and the four specified disposal sites were obtained and chemically analysed in accordance with DAC W31-78-C-0038. In addition, chemical analyses were performed on 15 sediment samples delivered to us from Maryland.

In total, 90 stations were occupied in Virginia Channels and the four proposed disposal sites for bottom surface sediments for bulk chemical analyses. Samples from the Maryland Channels were supplied by the Maryland Geological Survey.

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SEDIMENT AND WATER SAMPLING PROCEDURE

Sampling Procedure

Sample Collection

In the Cape Henry, York Spit, and Rappahannock Channels, samples were recovered at 1 km intervals. In each of the four disposal areas, ten samples were recovered in a suitably spaced grid pattern so that the entire area of the site is represented. In the case of Site No. 3, Wolf Trap, sampling was concentrated in the eastern extension.

After the sampling was conducted in each of the channels and disposal sites, a field determination of sediment type (i.e. clay, silty clay, silty sand, sand) for each station was determined.

Station position was determined by calibrated Loran C navigation system. The station locations and field sediment type determinations will be transmitted to the Corps as a listing of coordinates (Table 1) and a visual display on appropriate National Ocean Survey charts (Figures 1, 2 and 3).

Sampling Technique

Previous experience in sediment collections in the Chesapeake Bay indicates that sample recovery will be insufficient if a coring device is used. Therefore, the Smith-MacIntyre grab which has shown positive results even in medium to fine sands was used. After recovery of the sampler to the surface of the sampling vessel, sufficient sediment was extracted from the horizon between 5 and 15 cm of the surface and sealed in containers without air entrapment and appropriately marked with station identification. Along with the primary sample, a short core was extracted so that in addition to bulk chemical characteristics a cut of each sample is being sent to the Baltimore District for reference and/or granulometric analysis. After retrieval to the deck, samples were refrigerated and transported to the laboratory and stored at $4^{o}C$.

Elutriate Test

Sediment samples from the channel sites were secured by the Smith-MacIntyre grab sampler. About 1 gallon of sediment was collected for each elutriate test and stored in airtight containers so that no air bubbles were contained. The samples were refrigerated aboard the ship and maintained under refrigeration (not frozen) at the laboratory until the tests were run.

Water samples were collected in non-contaminating containers and were refrigerated aboard the ship and at the laboratory at 2 to $4^{o}C$.

Table 1

SAMPLING STATION COORDINATES

	Sample Number	Latitude (N)	Longitude (W)	Field Description*
Disposal Area No. 1	1	36°46.9'	75°54.2'	SM
	2	36°46.9'	75°53.7'	SM
	3	36°47.6'	75°54.2'	SM
	4	36°47.6'	75°53.7'	SM
	5	36°48.3'	75°54.2'	SM
	6	36°48.3'	75°53.7'	MS
	7	36°49.0'	75°54.2'	S
	8	36°49.0'	75°53.7'	SM
	9	36°49.7'	75°54.2'	S (sh)
	10	36°49.7'	75°53.7'	S (sh)
Disposal Area No. 2	11	37°16.2'	76°05.4'	M
	12	37°15.9'	76°05.2'	M (or)
	13	37°15.7'	76°05.0'	M
	14	37°15.4'	76°04.8'	M
	15	37°15.2'	76°04.7'	M
	16	37°15.0'	76°04.5'	M (sh)
	17	37°14.7'	76°04.3'	M (sh)
	18	37°14.5'	76°04.2'	M (sh)
	19	37°14.2'	76°04.0'	M
	20	37°14.0'	76°03.8'	M (sh)
Disposal Area No. 3	21	37°20.4'	76°07.2'	M
	22	37°20.3'	76°06.7'	M
	23	37°20.8'	76°06.6'	M
	24	37°20.9'	76°07.0'	M
	25	37°21.5'	76°06.9'	M
	26	37°21.4'	76°06.5'	M (sh)
	27	37°22.0'	76°06.8'	M
	28	37°21.9'	76°06.4'	M
	29	37°22.6'	76°06.7'	M
	30	37°22.5'	76°06.3'	M

*Field Description

SG = sandy-gravel
S = sand
MS = muddy-sand
SM = sandy-mud
M = mud
(sh) = shells
(or) = organic material

SAMPLING STATION COORDINATES

	Sample Number	Latitude (N)	Longitude (W)	Field Description*
	31	37°42.3'	76°10.7'	MS
	32	37°42.3'	76°11.2'	M
	33	37°42.7'	76°11.3'	MS (or)
Disposal	34	37°42.7'	76°10.8'	MS
Site	35	37°43.2'	76°11.3'	M
No. 4	36	37°43.2'	76°10.8'	SM
	37	37°43.7'	76°11.4'	M
	38	37°43.7'	76°10.9'	SM
	39	37°44.1'	76°11.4'	M
	40	37°44.1'	76°10.9'	M
	41	36°58.3'	75°59.9'	MS
Cape	42	36°58.9'	76°00.2'	SM
Henry	43	36°59.3'	76°00.5'	SM
Channel	44	36°59.8'	76°01.2'	SM
	45	37°02.8'	76°04.4'	SM
	46	37°03.2'	76°04.8'	S (sh)
	47	37°03.8'	76°05.3'	MS (sh)
	48	37°04.2'	76°05.6'	SG
	49	37°04.8'	76°06.0'	SM
	50	37°05.2'	76°06.4'	MS
	51	37°05.6'	76°06.6'	MS
York	52	37°05.9'	76°07.0'	SM
Spit	53	37°06.4'	76°07.4'	MS (sh)
Channel	54	37°06.9'	76°07.7'	MS
	55	37°07.3'	76°08.0'	MS (sh)
	56	37°07.8'	76°08.3'	MS
	57	37°08.3'	76°08.7'	MS
	58	37°08.7'	76°09.0'	MS
	59	37°09.2'	76°09.0'	SM
	60	37°09.7'	76°09.1'	SM

*Field Description

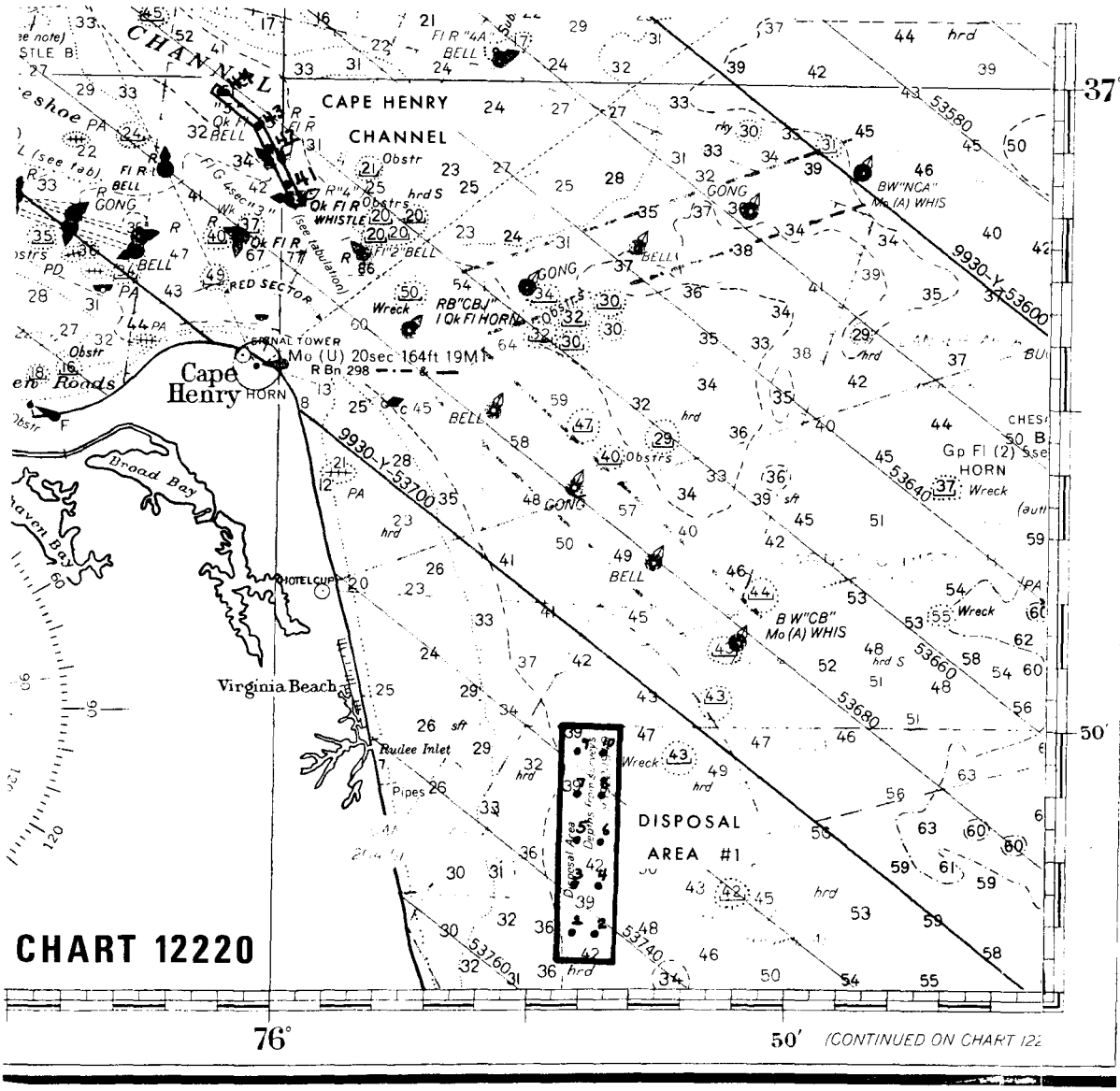
SG = sandy-gravel
S = sand
MS = muddy-sand
SM = sandy-mud
M = mud
(sh) = shells
(or) = organic material

SAMPLING STATION COORDINATES

	Sample Number	Latitude (N)	Longitude (W)	Field Description*
York Spit Channel (cont'd.)	61	37°10.3'	76°09.2'	M
	62	37°10.8'	76°09.3'	M
	63	37°11.4'	76°09.2'	S
	64	37°11.8'	76°09.0'	SM
	65	37°12.4'	76°08.8'	SM (sh)
	66	37°12.8'	76°08.6'	M
	67	37°13.2'	76°08.5'	SM
	68	37°13.8'	76°08.3'	SM
	69	37°14.4'	76°08.0'	SM
	70	37°14.9'	76°07.9'	SM
	71	37°15.3'	76°07.8'	M
	72	37°15.9'	76°07.5'	M
	73	37°16.3'	76°07.3'	M
	74	37°16.8'	76°07.2'	M
Rappahannock Shoal Channel	75	37°33.9'	76°02.6'	M
	76	37°34.5'	76°03.2'	M (sh)
	77	37°34.8'	76°03.5'	M
	78	37°35.3'	76°03.9'	M
	79	37°35.6'	76°04.3'	M
	80	37°36.0'	76°04.7'	M
	81	37°36.5'	76°05.2'	M
	82	37°37.3'	76°06.1'	M
	83	37°37.6'	76°06.4'	M
	84	37°36.8'	76°05.6'	M
	85	37°38.2'	76°07.0'	M
	86	37°38.5'	76°07.4'	MS
	87	37°39.0'	76°07.9'	MS
	88	37°39.3'	76°08.3'	MS (sh)
	89	37°39.7'	76°08.7'	M
	90	37°40.3'	76°09.2'	M

*Field Description

SG = sandy-gravel
S = sand
MS = muddy-sand
SM = sandy-mud
M = mud
(sh) = shells
(or) = organic material


CHANNEL
CAPE HENRY
CHANNEL
Cape Henry HORN
SIGNAL TOWER
Mo (U) 20sec 164ft 19M
R Bn 298
RED SECTOR
RB"CBJ"
1 Ok Fl HORN
Wreck
Broad Bay
Virginia Beach
HOTELCUP
Rudee Inlet
Pipes
DISPOSAL
AREA #1
Disposal Area
Debris from Sewage Sludge
BW"NCA"
Mo (A) WHIS
B W"CB"
Mo (A) WHIS
Gp Fl (2)
HORN
9930-Y-53600
9930-Y-53700
53580
53640
53660
53680
53740
53760
CHART 12220
76°
50'
(CONTINUED ON CHART 122

FIGURE

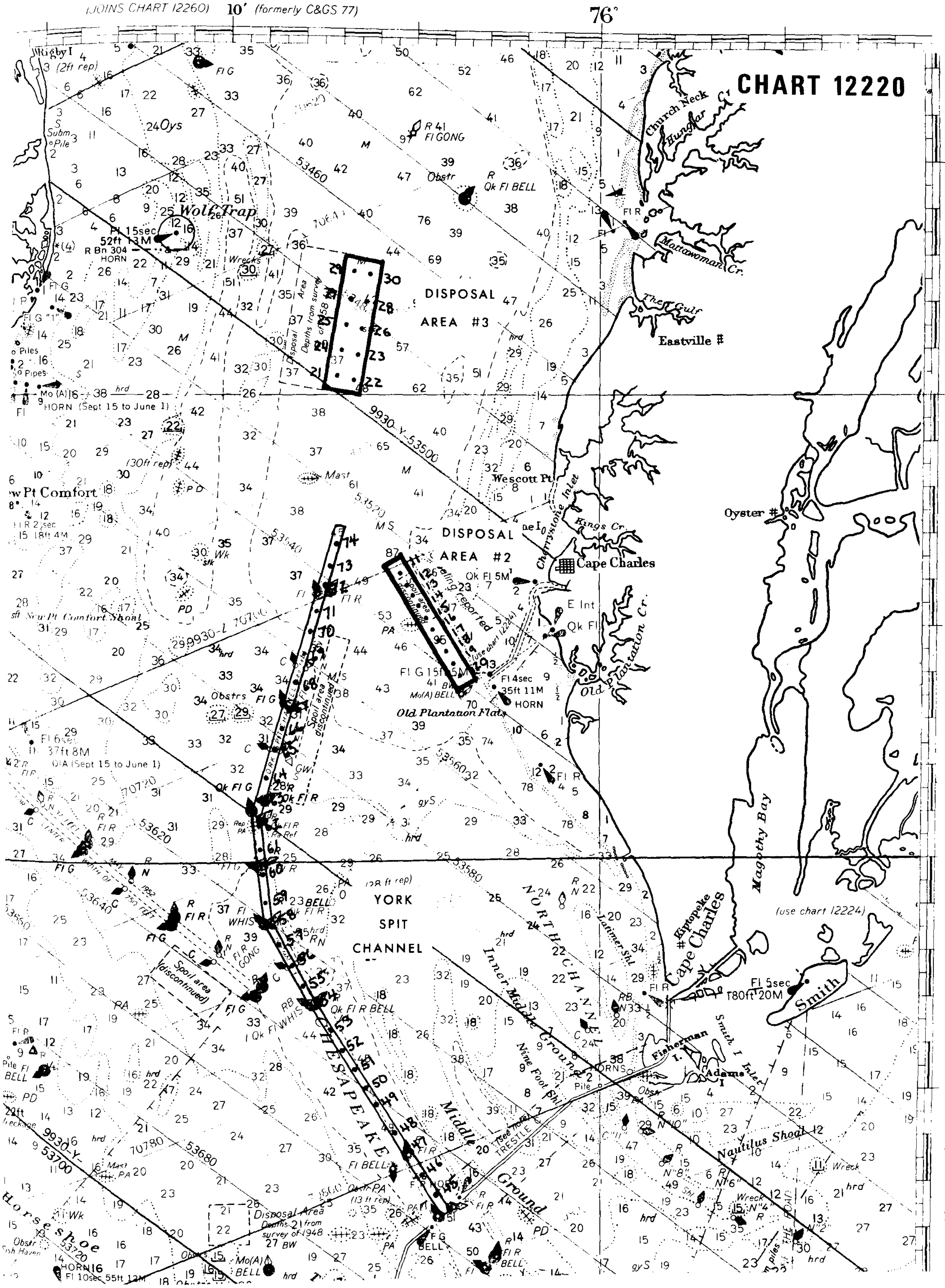

(JOINS CHART 12260) 10' (formerly C&GS 77)
76°
CHART 12220
Wolf Trap
DISPOSAL AREA #3
DISPOSAL AREA #2
YORK SPIT CHANNEL
CHESAPEAKE
NORTH CHANNEL
Inner Middle Ground
Middle Ground
Old Plantation Flats
Cape Charles
Wescott Pt
Cherrystone Inlet
Kings Cr.
Old Plantation Cr.
Church Neck
Hungar Cr.
Mattawoman Cr.
The Gulf
Eastville
Oyster
Magothy Bay
Kiptopeke
Fisherman I.
Smith
Smith I Inlet
Nautilus Shoal
Horseshoe
Latimer Shl
Nine Foot Shl
Spoil area (discontinued)
Disposal Area Depths 21 from survey of 1948
(use chart 12224)
37° 20'
(CONTINUED ON CHART 12221)

FIGURE 2

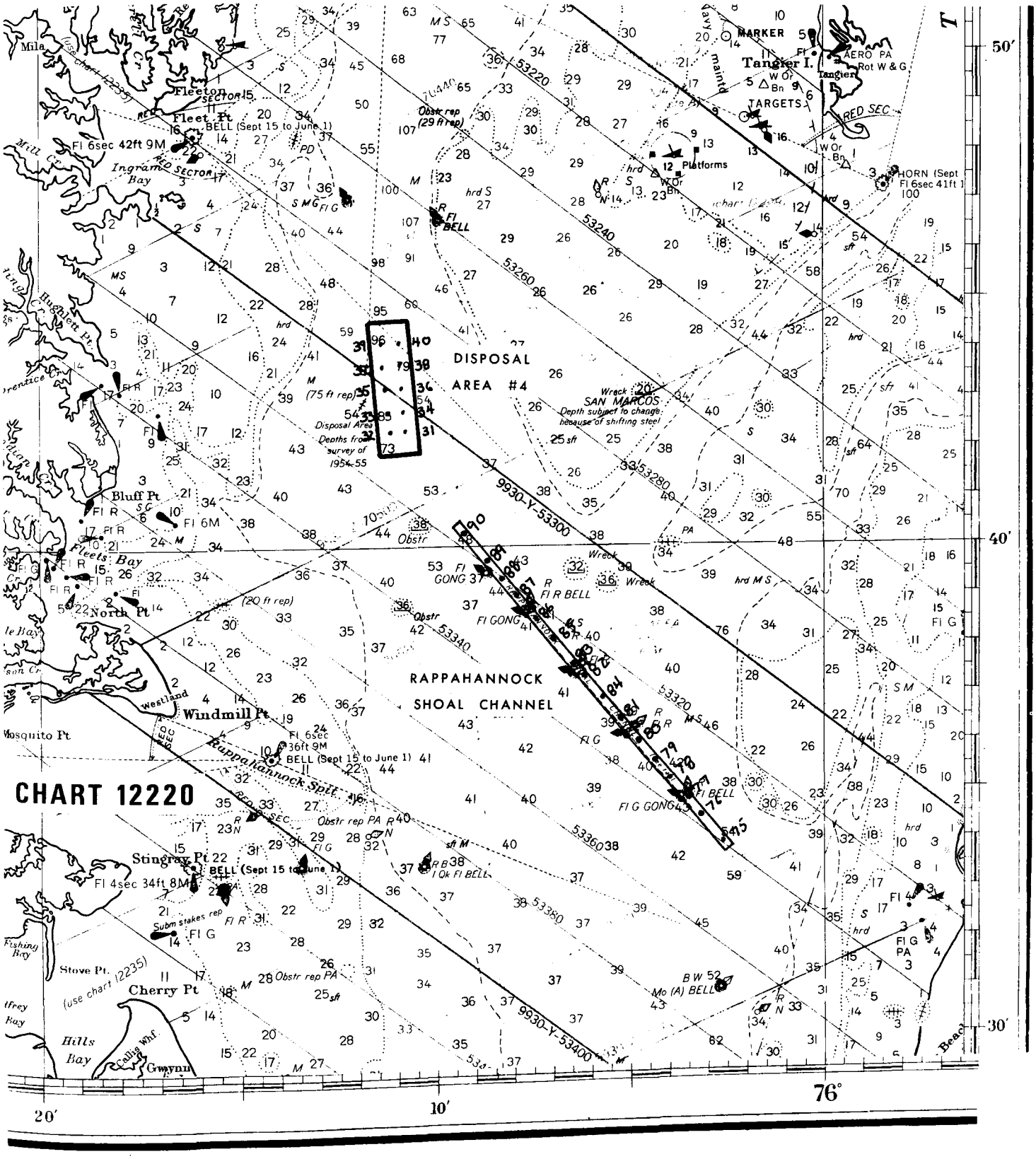


CHART 12220
DISPOSAL AREA #4
RAPPAHANNOCK SHOAL CHANNEL
Fleeton SECTOR
Fleet Pt
BELL (Sept 15 to June 1)
Fl 6sec 42ft 9M
Ingram Bay
Bluff Pt
Fl 6M
Fleets Bay
North Pt
Windmill Pt
Fl 6sec 36ft 9M
BELL (Sept 15 to June 1)
Mosquito Pt
Rappahannock Spit
Stingray Pt
Fl 4sec 34ft 8M
BELL (Sept 15 to June 1)
Stove Pt.
Cherry Pt
Hills Bay
Gwynn
Tangier I.
Tangier
MARKER
TARGETS
RED SEC
HORN (Sept
Fl 6sec 41ft
12 Platforms
Wreck
SAN MARCOS
Depth subject to change because of shifting steel
Disposal Area
Depths from survey of 1954-55
Obstr rep (29 ft rep)
Obstr rep (20 ft rep)
Obstr rep (75 ft rep)
Obstr rep PA
9930-Y-53300
9930-Y-53400
53220
53240
53260
53280
53320
53340
53360
53380
76°
20′
10′
50′
40′
30′

FIGURE 3

CHEMICAL ANALYSIS

SEDIMENT (Suite A)

Total Kjeldahl Nitrogen (TKN)

The samples were digested with a solution containing sulfuric acid, potassium sulfate, and mercuric sulfate converting organic nitrogen to ammonium sulfate. The digested samples were steam-distilled into a saturated boric acid solution and titrated with standard hydrochloric acid.

Total Phosphorus (TP)

The samples were digested in concentrated HNO_3 and evaporated to dryness; concentrated H_2SO_4 was added and heated until the solution cleared. Water was then added and the samples were filtered through a glass filter. The filtrates were analyzed for total phosphorus by the single solution method, using ascorbic acid as the reducing agent. The developed samples were read on a Klett-Summerson Photoelectric colorimeter, model 900-3.

Metals (Cd, Zn, Pb, Cr, Cu)

One gram of sample was heated to fuming with five milliliters of concentrated HNO_3 acid. After cooling, five additional milliliters of acid were added, heated and cooled. The samples were then centrifuged and the supernatants measured for volume and analyzed on a Varian Atomic Absorption Spectrophotometer, model AA-5

Mercury (Hg)

The samples were digested with concentrated H_2SO_4 overnight. The digested samples were oxidized with 5% $KMNO_4$ and transferred to

Mercury (cont'd.)

300 ml BOD bottles. After the addition of reductant* solution the BOD bottles were immediately attached to the aeration apparatus of a Coleman Mercury Analyzer MAS-50. Mercury concentrations were then determined from standard curves.

* Composition of reductant solution:

H_2O	600 ml
H_2SO_4	100 ml
NaCl	5 grams
$(NH_2OH)_2SO_4$	20 grams

q.s. to 1 liter

Hexane Extractables

The sediment samples were dried with magnesium sulfate monohydrate, then soxhlet-extracted with hexane (Standard Methods for the Examinations of Water and Wastewater, 12th Ed., APHA, Inc., N.Y., 1965; 531-532). The hexane was then evaporated to dryness. The weight of solid residue from the solvent evaporation yielded oil and grease.

Volatile Solids

The sediment samples were dried in an oven at 103°C to constant weight. The dried samples were placed in a muffle furnace for one hour at 550-600°C. The decrease in weight after ashing is reported as volatile solids.

Chemical Oxygen Demand (COD)

The parameter was determined by the dichromate reflux method. The oxidizable substances were oxidized by a standard solution

Chemical Oxygen Demand (cont'd.)

of potassium dichromate in sulfuric acid. The excess dichromate was then titrated with standard ferrous ammonium sulfate. Silver sulfate was used as a catalyst, and mercuric sulfate used to eliminate the interference of chloride ions.

Total Organic Carbon (TOC)

TOC values were calculated from the COD values (wet basis) using the following equation:

$$\% \text{ Organic C (dry weight)} = (\text{mg O/kg wet sediment}/\%TS) \times (0.288)/(100)$$

The 0.288 factor used in the above equation is the so-called "Redfield Ratio" of oxygen to carbon by weight. (The Influence of Organisms on the Composition of Seawater, p. 26-77. In M. N. Hill (Ed.) The Sea, Vol. 2. Interscience, New York).

ELUTRIATE PREPARATION (Suite A)

A 500 gram portion of the homogenized sediment was mixed with 2 liters of "site" water in a one-gallon wide-mouth jar and agitated on a Burrell shaker for 30 minutes. The agitated mix was allowed to settle for 1-1/2 hours then centrifuged for ten minutes at 10 x 10^3 rpm (9800 x gravity) and/or filtered through 0.45 millipore filters.

Metals (Cd, Pb, Zn, Cr, Cu)

Lead, Cadmium, Zinc, Chromium, Copper were determined by the solvent extractions technique on a Varian Aerograph AA-5 Atomic Absorption Spectrophotometer. Ammonium Pyrolodine Dithiocarbamate

Metals (cont'd.)

(APDC) was used as a chelating agent and the metals were extracted with Methyl Isobutyl Ketone (MIBK), (Methods for Chemical Analysis of Water and Wastes, Environmental Protection Agency, 1971).

Other components (COD, TKN, TP, Hexane Extractables) were determined on the elutriate water by the methods previously described for "Sediments".

SEDIMENT (Suite B)

Kepone

Each sample (20 gm) was dessicated on a ratio of three parts dessicant (consisting of Na_2SO_4-"Quso," 9:1) to one part sediment. The dessicated samples were Soxhlet extracted (16 hrs) with petroleum ether, ethyl ether (1:1) and the resulting extract volume reduced by rotary evaporation to approximately fifteen (15) ml. Two (2) ml of the concentrate were placed on florisil clean-up column (Moseman, et. al., 1977) and the final extract analyzed by ECGC (Tracor 222) under the following parameters:

^{63}Ni detectors at 350°C

columns: 4mm ID x 6 ft x 1/4 in O.D.

3% OV-1 on 80/100 supelcoport

4% SE-30/6% OV-210 on 80/100 Gas-Chrom Q at 210°C

injection port at 230°C

5% Methane in Argon flow at 80ml/min

Polychlorinated Biphenyls and Heptachlor

The sediment samples were dried to constant weight at 45°C, and Soxhlet-extracted for 16 hours using hexane.

The concentrated extract was placed on successive clean-up columns of florisil and activated silica gel, and eluted with 1:1 pentane-hexane. The final extract was analyzed by electron capture gas chromatography. The resultant chromatograms were compared to standards of arochlor 1242, 1254, and 1260 and heptachlor.

Table 2

SEDIMENT (DRY BASIS)

Sample #	TVS %	COD %	TOC %	TKN ppm	Hexane Ext. mg/kg	TP ppm	Hg ppm	Cd ppm	Cu ppm	Zn ppm	Cr ppm	Pb ppm	Kepone	PCB	Heptachlor
1													N.D.**	N.D.	N.D.
2	1.44	0.42	0.12	199	97.5	307	<0.01	0.18	1.82	16.0	3.4	2.7			
3	1.29	0.35	0.10	146	106	266	<0.01	0.11	1.50	16.4	2.7	3.6			
4	1.46	0.29	0.08	134	58.2	232	0.047	0.17	1.48	14.4	2.3	3.1			
5	0.91	0.24	0.07	158	98.1	284	<0.01	0.10	1.35	13.8	2.7	3.0			
6	0.82	0.25	0.07	111	108	268	<0.01	0.08	1.00	12.6	2.3	3.1			
7	0.31	0.02	0.01	45.8	70.9	111	<0.01	0.08	0.34	3.62	0.49	2.5			
8	1.09	0.64	0.19	242	104	247	<0.01	0.05	2.02	17.7	3.5	5.6			
9	0.94	<0.40*	<0.2*	26.5	89.1	57.7	<0.01	0.04	0.38	2.52	0.49	1.9			
10													N.D.	N.D.	N.D.
11													N.D.	N.D.	N.D.
12	2.75	1.77	0.51	1040	796	222	<0.01	0.32	5.56	31.5	9.4	9.6			
13	2.33	3.69	1.06	1120	573	197	0.425	0.35	7.67	39.8	13.9	13.0			
14	3.38	3.28	0.94	972	766	368	<0.01	0.39	8.15	41.6	13.5	13.0			
15	3.88	1.64	0.47	1460	667	284	0.014	0.38	7.49	38.7	13.1	12.0			
16	3.21	3.39	0.98	1160	382	268	0.038	0.75	51.2	24.8	7.8	18.0			
17	1.65	1.29	0.37	594	450	174	<0.01	0.65	2.59	15.3	3.6	8.4			
18	2.21	2.98	0.86	772	1000	217	0.01	0.62	5.27	26.5	6.5	11.0			
19	2.89	2.77	2.75	918	669	222	<0.01	0.48	5.38	28.9	5.8	11.0			
20													N.D.	N.D.	N.D.

*ppm

**N.D. $\leq$ 0.01 ppm

Sediment (Dry Basis)

Sample #	TVS %	COD %	TOC %	TKN %	Hexane Ext. Mg/Kg	TP ppm	Hg ppm	Cd ppm	Cu ppm	Zn ppm	Cr ppm	Pb ppm	Kepone	PCB	Heptachlor
21	2.38	2.45	0.71	710	339	297	0.49	0.30	5.92	35.2	9.4	8.0			
22													N.D.*	N.D.	N.D.
23	2.75	2.56	0.74	756	309	262	<0.01	0.30	6.36	36.1	9.6	8.7			
24	2.61	2.70	0.78	598	271	255	0.07	0.24	5.24	34.1	9.2	7.3			
25	2.84	2.37	0.68	847	547	235	<0.01	0.24	5.69	35.6	9.4	8.9			
26	2.50	2.39	0.69	697	431	281	0.03	0.25	5.78	34.6	9.5	8.2			
27	2.72	2.72	0.78	797	326	319	0.26	0.23	6.32	37.6	10.3	9.7			
28	2.56	2.70	0.78	734	294	295	<0.01	0.22	5.95	34.6	9.3	7.9			
29	2.71	2.82	0.81	617	320	261	0.18	0.24	5.83	35.6	9.2	8.1			
30													N.D.	N.D.	N.D.
31													N.D.	N.D.	N.D.
32	3.94	3.93	1.13	1310	750	254	<0.01	0.16	8.23	57.6	14.6	15.0			
33	3.40	4.14	1.19	872	733	182	0.048	0.43	8.06	51.9	14.4	14.0			
34	1.66	1.44	0.41	482	182	159	<0.01	0.34	5.56	33.3	7.6	7.2			
35	6.79	8.33	2.40	2680	2390	610	<0.01	0.71	14.7	75.6	22.0	23.0			
36	2.19	3.56	1.02	591	196	217	0.01	0.35	4.41	29.9	9.9	6.9			
37	6.48	6.80	1.96	2560	2530	366	<0.01	0.95	14.5	73.6	22.3	23.0			
38	2.28	1.24	0.36	424	178	283	0.033	0.38	2.94	30.2	7.0	13.0			

*N.D. $\leq$ 0.01 ppm

SEDIMENT

Sample #	TVS %	COD %	TOC %	TKN %	Hexane Ext. mg/kg	TP ppm	Hg ppm	Cd ppm	Cu ppm	Zn ppm	Cr ppm	Pb ppm	Kepone	PCB	Heptachlor
39	7.19	8.34	2.40	2810	2840	214	0.07	1.07	14.7	76.1	22.0	24.0			
40													N.D.*	N.D.	N.D.
41	2.08	0.74	0.21	285	117	261	<0.01	<0.01	2.59	18.4	4.4	6.0			
42	2.78	2.07	0.60	975	244	357	<0.01	<0.01	2.55	16.4	5.7	3.5			
43													N.D.	N.D.	N.D.
44	1.40	1.14	0.33	228	149	86.4	<0.01	<0.01	1.80	21.4	5.6	2.6			
45	5.45	0.46	0.13	386	61.5	158	<0.01	<0.01	2.84	18.2	4.8	5.5			
46	1.89	0.08	0.02	23.8	37.2	46.8	<0.01	<0.01	0.17	4.8	0.73	1.5			
47	0.69	0.32	0.01	89.3	56.9	122	<0.01	<0.01	0.35	12.9	2.0	3.0			
48	0.45	0.20	0.06	67.9	33.1	75.3	<0.01	<0.01	0.47	13.9	2.1	2.9			
49													N.D.	N.D.	N.D.
50	0.80	0.38	0.11	177	125	163	0.29	<0.01	1.03	11.5	2.2	1.9			
51	0.65	0.32	0.09	113	91.8	104	<0.01	0.10	0.84	14.2	2.4	2.0			
52	0.73	0.68	0.20	136	112	56.2	<0.01	0.06	0.96	17.3	3.8	3.0			
53	1.37	0.24	0.07	152	126	251	0.053	0.01	1.93	18.9	3.8	2.1			
54													N.D.	N.D.	N.D.
55	1.17	0.70	0.20	288	124	134	<0.01	0.17	1.87	15.4	4.8	3.4			
56	0.61	<0.40*	<0.2*	93.6	105	49.6	<0.01	0.15	1.31	9.2	2.9	2.7			

*ppm

*N.D. $\leq$ 0.01 ppm

SEDIMENT

Sample #	TVS %	COD %	TOC %	TKN ppm	Hexane Ext. mg/kg	TP ppm	Hg ppm	Cd ppm	Cu ppm	Zn ppm	Cr ppm	Pb ppm	Kepone	PCB	Heptachlor
57	0.52	0.006	0.003	74.9	50.9	115	<0.01	0.04	0.59	11.1	3.1	2.8			
58	1.56	0.65	0.02	249	90.2	138	<0.01	0.18	2.40	18.1	8.1	4.5			
59													N.D.*	N.D.	N.D.
60	1.10	0.36	0.10	145	119	202	<0.01	0.11	1.13	14.7	4.3	2.6			
61	1.52	0.93	0.27	386	255	195	<0.01	<0.01	3.80	24.1	7.7	5.6			
62	1.14	0.91	0.26	271	118	148	<0.01	<0.01	2.33	19.6	5.4	4.1			
63	0.68	0.17	0.05	119	85.3	127	<0.01	<0.01	1.09	12.4	3.2	2.2			
64													N.D.	N.D.	N.D.
65	1.26	0.86	0.25	279	89.8	277	<0.01	<0.01	2.51	36.9	6.4	5.1			
66	1.52	0.71	0.002	374	97.1	192	0.021	<0.01	2.47	20.4	5.6	4.2			
67	0.90	0.29	0.08	156	71.5	53.1	<0.01	<0.01	1.59	18.2	4.5	2.8			
68													N.D.	N.D.	N.D.
69	1.29	0.48	0.14	191	134	301	<0.01	<0.01	2.09	18.8	5.1	2.4			
70	1.84	1.36	0.39	494	182	185	<0.01	<0.01	4.25	29.5	7.9	6.8			
71	2.94	2.32	0.67	824	366	307	0.01	0.30	5.52	32.8	11.0	9.6			
72	2.29	0.20	0.06	556	135	188	0.028	0.30	4.47	24.5	8.1	5.9			

*N.D. $\leq$ 0.01 ppm

SEDIMENT

Sample #	TVS %	COD %	TOC %	TKN %	Hexane Ext. mg/kg	TP ppm	Hg ppm	Cd ppm	Cu ppm	Zn ppm	Cr ppm	Pb ppm	Kepone	PCB	Heptachlor
73													0.06	N.D.*	N.D.
74	3.57	3.14	0.09	955	316	223	0.026	0.28	7.58	37.4	13.0	9.8			
75	4.66	3.47	1.00	1010	232	176	0.401	0.55	6.40	33.6	16.5	8.1			
76	4.66	3.86	1.11	1030	191	244	0.198	0.38	6.75	37.4	18.1	9.9			
77	3.22	2.86	0.82	673	134	215	<0.01	<0.01	5.58	33.6	14.1	7.0			
78	3.09	4.22	1.21	1070	141	362	<0.01	0.07	7.17	44.3	24.2	6.4			
79	3.23	3.18	0.92	779	152	252	<0.01	<0.01	6.11	7.05	15.7	9.4			
80													0.04	N.D.	N.D.
81	3.83	3.39	0.98	914	187	200	0.148	0.19	6.32	36.4	14.9	11.0			
82	4.57	4.48	1.29	1660	784	226	0.066	0.12	9.55	50.4	16.9	17.0			
83	3.93	4.02	1.16	1230	574	187	0.021	0.05	8.37	45.2	14.2	14.0			
84	3.48	3.24	0.93	859	180	209	0.034	<0.01	6.72	35.8	15.1	11.0			
85													0.02	N.D.	N.D.
86	0.53	0.17	0.05	25.0	130	67.2	<0.01	<0.01	1.37	7.2	1.9	1.1			
87	0.51	0.52	0.15	74.6	95.2	41.0	<0.01	<0.01	0.57	9.5	2.0	2.5			
88	2.64	0.90	0.26	561	100	173	0.045	0.27	4.06	26.6	11.0	6.8			
89	4.71	3.47	1.00	1060	115	402	<0.01	0.36	6.07	37.5	18.2	10.0			
90													0.05	N.D.	N.D.

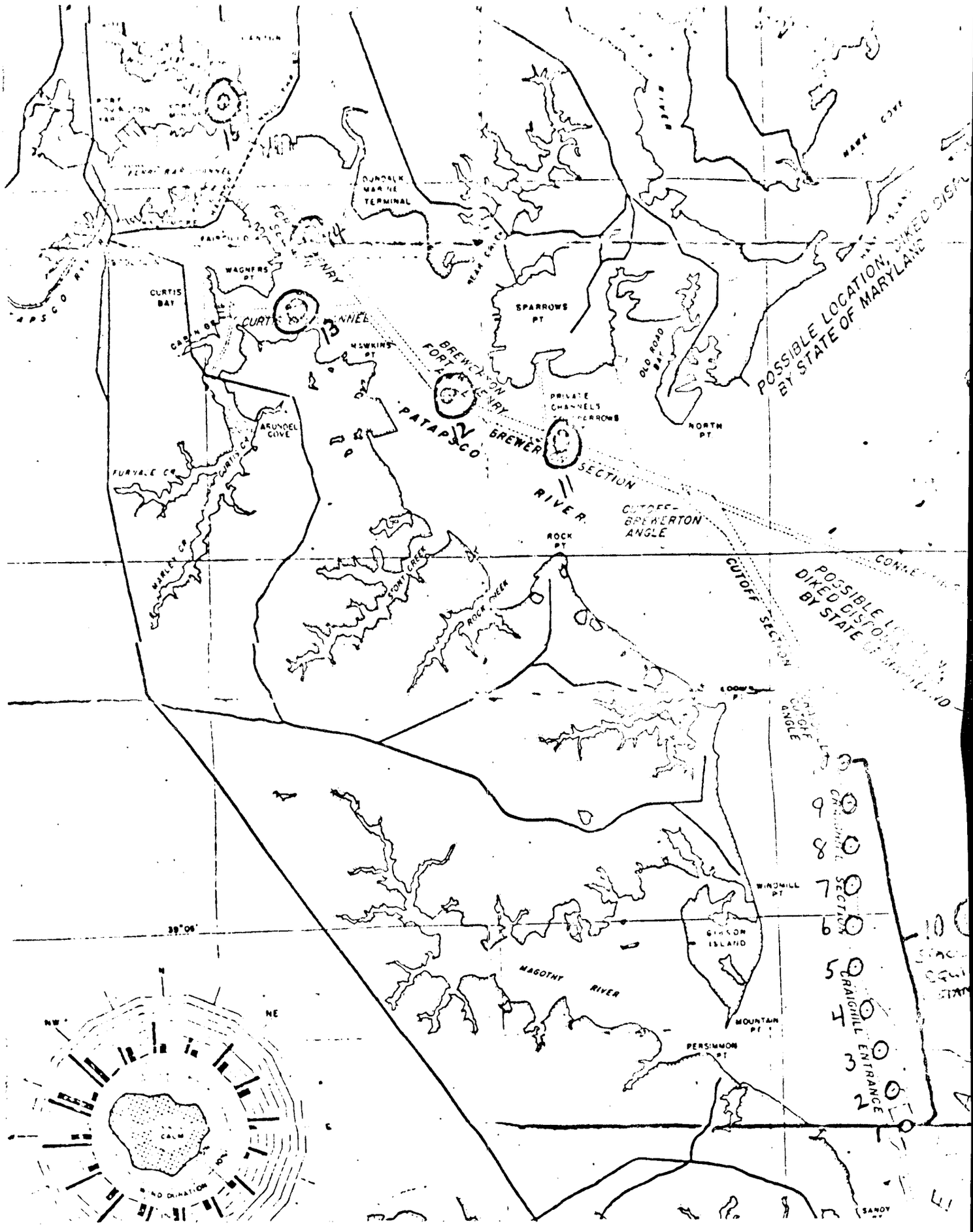
*N.D. $\leq$ 0.01 ppm

DRY BASIS RESULTS

Sample #	TVS	COD	TOC	TKN	Hexane Ext.	TP	Hg	Cd	Cu	Zn	Cr	Pb	Kepone	PCB	Heptachlor
	%	%	%	ppm	mg/kg	ppm	ppm	ppm	ppm	ppm	ppm	ppm			
MC1	8.38	11.2	3.23	3430	5340	549	0.34	1.34	44.8	302	37.7	61	0.03	N.D.	N.D.
MC2	8.81	8.62	2.48	3360	2820	447	0.32	1.48	43.8	270	35.2	66	N.D.*	N.D.	N.D.
MC3	3.87	5.53	1.59	1270	298	278	0.28	0.62	47.3	152	16.0	18	0.03	0.14	N.D.
MC4	4.39	4.37	1.26	1330	374	318	0.05	0.64	12.7	71.9	16.8	17	0.02	N.D.	N.D.
MC5	4.65	5.74	1.65	1740	278	270	0.14	0.62	13.0	70.8	16.1	17	N.D.	N.D.	N.D.
MC6	7.86	9.31	2.68	3460	1850	630	0.47	1.30	41.8	267	33.7	60	0.03	N.D.	N.D.
MC7	7.41	7.38	2.13	3280	1930	632	0.34	1.04	40.8	245	31.2	55	N.D.	N.D.	N.D.
MC8	7.81	14.7	4.24	2500	4110	634	0.35	1.10	57.1	301	27.5	68	N.D.	N.D.	N.D.
MC9	6.49	8.32	2.39	2060	1390	388	0.34	1.01	34.6	218	25.4	46	N.D.	N.D.	N.D.
MC10	3.67	5.65	1.63	1790	239	298	0.02	0.58	17.6	88.7	20.9	20	N.D.	N.D.	N.D.
MC11	5.22	10.1	2.92	2740	2170	654	0.21	1.21	41.0	256	63.4	59	N.D.	N.D.	N.D.
MC12	8.71	13.4	3.85	3640	6690	705	0.55	2.76	128	704	251	160	N.D.	N.D.	N.D.
MC13	8.21	12.5	3.59	3400	4320	483	0.40	1.74	119	323	133	115	N.D.	0.03	N.D.
MC14	9.26	11.9	3.42	3520	5740	805	0.66	3.08	236	607	286	165	N.D.	0.05	N.D.
MC15	8.44	11.7	3.37	3140	944	455	0.46	0.84	44.4	75.0	38.2	27	N.D.	0.03	N.D.

MC = Maryland Channel

*N.D. $\leq$ 0.01 ppm



Maryland Channel

FIGURE 4

Table 3

ELUTRIATES AND WATER (SEDIMENTS ON DRY BASIS)

Parameter / Sample #	Total Solids %	COD ppm	TOC %	TKN ppm	Hexane Ext. ppm	TP ppm	Hg ppm	Cd ppb	Cu ppb	Sample Site
Sediment #42	67.48	2.06%	0.60%	975	244	356	<0.01 ppm	≤0.01 ppm	2.6 ppm	Cape Henry Chan. Sed. #42
Water #42		83		0.39	0.6	0.03	≤0.01	≤0.5	3.9	Cape Henry Chan. H_2O #42
Elut. #42-42		79		0.98	0.8	0.05	≤0.01	≤0.5	3.0	Cape Henry Chan. Sed. & H_2O #42
Water 1(5)		58		0.50	0.8	0.03	≤0.01	≤0.5	4.1	Disposal Area 1 Station 5
Elut. #42-1(5)		81		0.68	0.5	0.04	≤0.01	≤0.5	1.2	Sed. #42 & H_2O Site 1 - Sta. 5
Sediment #44	80.60	1.14%	0.33%	228	149	86.5	<0.01 ppm	≤0.01 ppm	1.8 ppm	Cape Henry Chan. Sed. #44
Water #44		41		0.51	<0.5	0.04	≤0.01	≤0.5	3.6	Cape Henry Chan. H_2O #44
Elut. #44-44		75		0.45	0.6	0.05	0.03	≤0.5	1.4	Cape Henry Chan. Sed. & H_2O #44
Elut. #44-1(5)		75		0.46	0.6	0.07	≤0.01	≤0.5	0.8	Sed. #44 & H_2O Site 1 - Sta. 5
Sediment #53	79.30	0.59%	0.07%	152	126	251	0.05 ppm	≤0.01 ppm	1.9 ppm	York Spit Chan. Sed. #53
Water #53		66		0.28	<0.5	0.03	≤0.01	≤0.5	2.0	York Spit Chan. H_2O #53
Elut. #53-53		61		0.49	<0.5	0.04	≤0.01	0.7	1.1	York Spit Chan. Sed. & H_2O #53
Elut. #53-1(5)		76		0.50	0.6	0.04	≤0.01	0.6	1.0	Sed. #53 & H_2O Site 1 - Sta. 5
Water 2(15)		61		0.50	<0.5	0.03	≤0.01	0.7	2.0	Disposal Area 2 Station 15
Elut. 53-2(15)		48		0.41	<0.5	0.05	≤0.01	0.7	0.70	Sed. #53 & H_2O Site 2 - Sta. 15
Water 3(25)		14		0.36	0.5	0.03	≤0.01	≤0.5	3.3	Disposal Area 3 Station 25
Elut. #53-3(25)		18		0.40	0.6	0.06	≤0.01	0.6	0.90	Sed. #53 & H_2O Site 3 - Sta. 25
Sediment #69	74.59	0.48%	0.14%	191	134	301	<0.01 ppm	≤0.01 ppm	2.1 ppm	York Spit Chan. Sed. #69
Water #69		17		0.41	0.5	0.02	≤0.01	≤0.5	2.0	York Spit Chan. H_2O #69

ELUTRIATES AND WATER (SEDIMENTS ON DRY BASIS)

Parameter / Sample #	Total Solids %	COD ppm	TOC %	TKN ppm	Hexane Ext. ppm	TP ppm	Hg ppm	Cd ppb	Cu ppb	Sample Site
Elut. #69-69		50		0.43	0.8	0.06	≤0.01	≤0.5	1.0	York Spit Chan. Sed. & H_2O #69
Elut. 69-1(5)		49		0.49	0.7	0.05	≤0.01	0.7	1.2	Sed. #69 & H_2O Site 1 - Sta. 5
Elut. 69-2(15)		43		0.42	0.7	0.06	≤0.01	0.7	1.1	Sed. #69 & H_2O Site 2 - Sta. 15
Elut. 69-3(25)		26		0.48	1.2	0.06	0.02	≤0.5	1.0	Sed. #69 & H_2O Site 3 - Sta. 25
Sediment #78	60.14	4.22%	1.21%	1070	141	362	<0.01 ppm	0.07 ppm	7.2 ppm	Rappahannock Shoals Sed. #78
Water #78		6.1		0.22	0.5	0.02	≤0.01	≤0.5	2.3	Rappahannock Shoals H_2O #78
Elut. #78-78		37		0.81	1.3	0.06	≤0.01	≤0.5	1.1	Rappahannock Shoals Sed. & H_2O #78
Water 4(36)		21		0.68	0.5	0.02	≤0.01	≤0.5	4.5	Disposal Area 4 - Station 36
Elut. 78-4(36)		27		0.90	0.9	0.08	≤0.01	≤0.5	1.0	Sed. #78 & H_2O Site 4 - Sta. 36
Sediment #86	76.81	0.17%	0.05%	25.0	130	269	<0.01 ppm	≤0.01 ppm	1.4 ppm	Rappahannock Shoals Sed. #86
Water #86		20		0.45	<0.5	0.02	≤0.01	≤0.5	3.0	Rappahannock Shoals H_2O #86
Elut. #86-86		0		0.32	0.8	0.06	≤0.01	≤0.5	1.6	Rappahannock Shoals Sed. & H_2O #86
Elut. 86-4(36)		18		0.25	0.5	0.03	≤0.01	0.7	2.3	Sed. #86 & H_2O Site 4 - Sta. 36
		Chemical Oxygen Demand	Total Organic Carbon	Total Kjeldahl Nitrogen		Total Phos-phorus	Mercury	Cadmium	Copper	

ELUTRIATES AND WATER (SEDIMENTS ON DRY BASIS)

Parameter Sample #	Zn ppb	Cr ppb	Pb ppm	TVS %	Sample Site
Sediment #42	16.4 ppm	5.75 ppm	3.54	2.78	Cape Henry Chan. Sed. #42
Water #42	7.4	$\leq$2.5	<0.05		Cape Henry Chan. H_2O #42
Elut. #42-42	4.2	$\leq$2.5	<0.05		Cape Henry Chan. Sed. & H_2O #42
Water 1(5)	5.3	$\leq$2.5	<0.05		Disposal Area 1 Station 5
Elut. #42-1(5)	0.32	$\leq$2.5	<0.05		Sed. #42 & H_2O Site 1 - Sta. 5
Sediment #44	21.5 ppm	5.63 ppm	2.64	1.40	Cape Henry Chan. Sed. #44
Water #44	6.4	$\leq$2.5	<0.05		Cape Henry Chan. H_2O #44
Elut. #44-44	0.88	$\leq$2.5	<0.05		Cape Henry Chan. Sed. & H_2O #44
Elut. #44-1(5)	1.4	$\leq$2.5	<0.05		Sed. #44 & H_2O Site 1 - Sta. 5
Sediment #53	19.0 ppm	3.87 ppm	2.08	1.37	York Spit Chan. Sed. #53
Water #53	5.9	$\leq$2.5	<0.05		York Spit Chan. H_2O #53
Elut. #53-53	2.0	$\leq$2.5	<0.05		York Spit Chan. Sed. & H_2O #53
Elut. #53-1(5)	2.6	$\leq$2.5	<0.05		Sed. #53 & H_2O Site 1 - Sta. 5
Water 2(15)	6.0	$\leq$2.5	<0.05		Disposal Area 2 Station 15
Elut. 53-2(15)	0.80	$\leq$2.5	<0.05		Sed. #53 & H_2O Site 2 - Sta. 15
Water 3(25)	7.2	$\leq$2.5	<0.05		Disposal Area 3 Station 25
Elut. #53-3(25)	0.48	$\leq$2.5	<0.05		Sed. #53 & H_2O Site 3 - Station 25

ELUTRIATES AND WATER (SEDIMENTS ON DRY BASIS)

Parameter	Zn	Cr	Pb	TVS	Sample Site
Sample #	ppb	ppb	ppm	%	
Sediment #69	18.9 ppm	5.20 ppm	2.36	1.29	York Spit Chan. Sed. #69
Water #69	5.5	$\leq$2.5	<0.05		York Spit Chan. H_2O #69
Elut. #69-69	0.57	$\leq$2.5	<0.05		York Spit Chan. Sed. & H_2O #69
Elut. 69-1(5)	1.2	$\leq$2.5	<0.05		Sed. #69 & H_2O Site 1 - Sta. 5
Elut. 69-2(15)	1.2	$\leq$2.5	<0.05		Sed. #69 & H_2O Site 2 - Sta. 15
Elut. 69-3(25)	0.66	$\leq$2.5	<0.05		Sed. #69 & H_2O Site 3 - Sta. 25
Sediment #78	44.2 ppm	24.1 ppm	6.34	3.09	Rappahannock Shoals Sed. #78
Water #78	6.5	$\leq$2.5	<0.05		Rappahannock Shoals H_2O #78
Elut. #78-78	0.72	$\leq$2.5	<0.05		Rappahannock Shoals Sed. & H_2O #78
Water 4(36)	32.2	$\leq$2.5	<0.05		Disposal Area 4 Station 36
Elut. 78-4(36)	0.24	$\leq$2.5	<0.05		Sed. #78 & H_2O Site 4 - Sta. 36
Sediment #86	7.21 ppm	1.99 ppm	1.07	0.53	Rappahannock Shoals Sed. #86
Water #86	5.4	$\leq$2.5	<0.05		Rappahannock Shoals H_2O #86
Elut. #86-86	2.8	$\leq$2.5	<0.05		Rappahannock Shoals Sed. & H_2O #86
Elut. 86-4(36)	1.1	$\leq$2.5	<0.05		Sed. #86 & H_2O Site 4 - Sta. 36
	Zinc	Chromium	Lead	Total Volatile Solids	