THE FEDERAL REPUBLIC OF NIGERIA

REPORT ON THE NEW OCEAN TERMINAL PROJECT LAGOS

PHASE II

(AERIAL SURVEY AND OCEANOGRAPHIC SURVEY)

FEBRUARY 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

I. Survey Team:

1. Member of the Survey team and working period,

Project leader : Mr. Takeshi YAMAMOTO,
(KOKUSAI AERIAL SURVEYS CO. LTD)
from November 7, 1978 to January 19, 1979.

Liaison officer: Mr. Tatsuya YAMAUCHI,
(KOKUSAI AERIAL SURVEYS CO. LTD)
from October 15, 1978 to January 19, 1979.

Surveyor : Mr. Toshiharu NOZAKI
(KOKUSAI AERIAL SURVEYS CO. LTD)
from November 14, 1978 to January 19, 1979.

Mr. Tadahiro TAGUCHI
Same period as above.

Mr. Seiji SASAKI
Same period as above.

Mr. Satoru SUZUKI
Same period as above.

2. Purpose / Content of the Work:

The works are, for the areas selected by the previous survey "Phase I", to make Topographical Maps, Sounding Charts, and Geological Survey of sea-bed which would be necessary for more detailed Master Plan of the areas. Within the working areas, there exist no Nigerian official control points needed first to start working, the survey team had to start working for Traverse Surveying and Levelling Surveying, using the control

points in Ikoyi Island. Then went on to Grand Control Surveying traverse survey and levelling survey in the working areas.

And the works of Aerial Photography, Sounding Surveying, Sonic Prospecting; and of Topographic Mapping at a scale of 1/10,000, and Sounding Charts compiling, both based on those surveys previously done, were carried out.

II. Field Operation

1. Outline of the Work

1-1. Surveying Operations for Topographic Mapping at a scale of 1/10,000, and Sounding charts at a scale of 1/10,000, are as follows:

(1) Aerial photographs

(2) Grand control Survey

(3) Sounding and sonic prospecting

(4) Pole sounding

(5) Aerial triangulation

(6) Topographical mapping

(7) Sounding charts compilation

1-2. Topography of the Area

It is in Lagos State, about 50 km easter, of its Capital, Lagos, the land area of 30 km x 7.5 km, 10 km along the seacoast, and 3 km off the coast.

The seacoast area is dotted with numbers of fishing villages at intervals of about 4 km, in the land area some small villages scattered.

There are two big roads, one running along the seacoast and the other running through inland, 5 km on shore. These two big roads are crossed by many other narrow ones, all of which are very rough and in poor shape, mostly sandy faced. Therefore, during the rainy season, instant bridge of logs must be used to walk on those puddly roads puddles during the rainy season. Vehicles are the worst effected, and transportation so limited that four-wheeled vehicles (Jeep) become the only practical means to go by.

For the roads within 1 km on shore the puddles are often large enough to require the use of canues to cross over. As for the vegetation in the area, palm trees are growing around the villages along the seacoast, and other areas are covered with thick forests. In the areas in between a number of fields which were made arable by the slash-and-burn method lay scattered, for "CASAVA" plantation.

1-3. Volume of the Work

(1) Aerial photographs
1: 25,000 : 2 lines, 20 photos

(2) Control points survey
a. Traverse : 150 Km
b. Levelling : 150 Km

(3) Sounding : 10 Km x 3 Km
(21 lines + 2 lines)

(4) Sonic prospecting : Identical with the above figures

(5) Pole sounding : 41 lines

(6) Topographical mapping
1: 10,000 : 150 Km^2

(7) Sounding charts
1: 10,000 : 80 Km

(8) Track chart
1: 10,000 : 80 Km

2. Field Operation

2-1. Work Preparation

The Japanese Survey Team, after the entry into the Federal Republic of Nigeria, was first to meet with the people from Japanese Embassy there, the Japan International Cooperation Agency, LAGOS office, and the Nigerian Port Authority (N.P.A.) which acted as a counter part of the Project.

Next was to apply to the Federal Survey Department for the permission to carry out various surveys and also to obtain usefull records of surveys executed before.

Then, the officer from N.P.A. explained about the Project itself and its survey team from Japan to each chief of the Villages in the area, whose helps were expected for the team to do the surveys in their villages.

In order to make sure the State control points, which would be needed for Traverse and Levelling Surveys, the sketch map with the control points obtained from the Federal Survey Department was examined, then as a result

two of the second class traverse points were found and confirmed in Ikoyi Island.

2-2. The Aerial Photography

The aeroplane was made available for the operation by KOKUSAI AERIAL SURVEYS CO. LTD, which had brought it in to Nigeria from Japan since 1976.

Its crew are ;

Mitsuoki HARADA, Captain
Yuji YAJIMA, Navigator
Kenji NAGASHIMA, Mechanic

2-2-1. Equipment used for the Aerial Photography

Air craft : AERO COMMANDER 680-E JA 5065

Camera : RMK 15/23 equipped with a wide-angle lens "PLEOGON" 152,95mm

Film : Fuji Aerographic Film "SS"

2-2-2. Climate

Nigeria, situated in the westernpart of Africa has the rainy and dry seasons.

As a vast country there is a big difference in the climate between the southern and northern parts of Nigeria.

The places like LAGOS, etc. which face the Atlantic Ocean are covered with tropical forests.

In these areas the sky is clouded in the morning even during the dry season, and the clouds disappeare after 3 o'clock in the afternoon almost every day.

Considering such an operation as an aerial photography,

there can be only few days left suitable for the operation. During the dry season, there occures the "HARMATTAN" phenomenon when the northerly wind blew and carry the sand from SAHARA desert, which make the visibility very poor in the area. These phenomenon normally last about a week, while no photographic operation is possible at all. So the climate in this part of Africa makes the aerial photographic operations extremely difficult.

2-2-3. Processing Work

In Nigeria, the photo-laboratory of KOKUSAI AERIAL SURVEYS CO. LTD, in Enugu City, was available for the processing works of film development and printing for contact-prints.

The equipment used for above operations are of all "Carl Zeiss made", in West Germany ; the Film developer, the Film Dryer and the Contact Printer.

2-2-4. Results

The aerial photography was carried out for the period of December 2 and December 13, then on December 6 and December 7, 1978. Those films were developed and contact prints made. After the check, two lots of photographs taken during those periods were considered sound enough for further operations, though some harmless amount of clouds can be seen on them, and the rates of overlapping for them were a little too less, i.e. the rate in December 6 was 53% for the smallest.

2-3. Traverse and Levelling

2-3-1. Outline

The traverse surveys had to be started on 2 existing L.S.C., 1862 S and 1864 S in Ikoyi Island. These two points, certified as Nigerian Colony (Traverse - Mercator) system, use 'feet' for the measurement. (See Appendix I & II)

The Co-ordinates of those control points had to be converted first into the geographical coordinates using the Nigerian Formulae, and then into U.T.M coordinates using the international formulae.

As for the levelling surveys, they also had to be worked from those two points, 1862 S and 1864 S, same as the traverse surveys.

As the figures were given in 'feet', the coefficient of metric measurement (1m = 3.28086933 f) was needed to convert them into metric ones.

The heights of the L S C beacons are on Lagos Datum which is normally used for all governmental mapping.

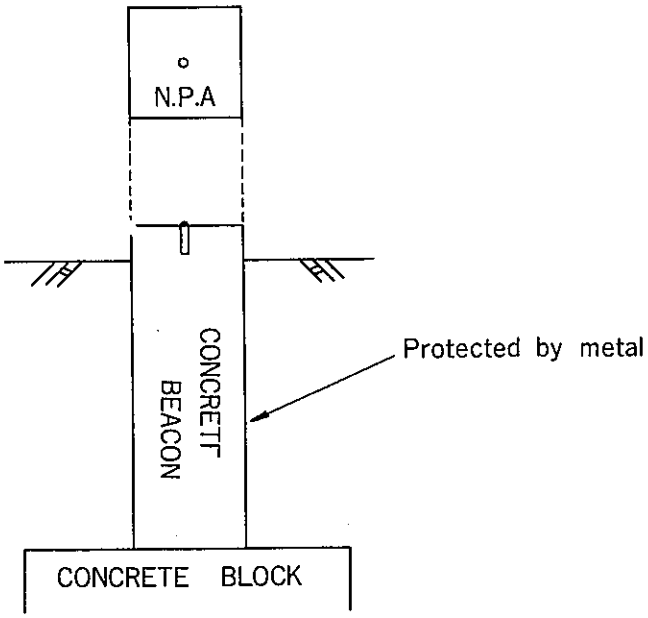
The Japanese survey team decided the heights of all control points to be measured on the direct level.

Also, in the areas to be surveyed, they placed extra three control points for any subsequent survey operations. (Attached plan - Fig 23a shows the shape of those newly set points.)

Fig－23a

MONUMENT

SCALE 1/20



2-3-2. Equipment

For traverse :

1) Geodimeter 6BL No. 63059
2) WILD T2 No. 131206

For levelling :

1) Automatic Levels (Nippon Kogaku K.K., Japan)
No. 33038
No. 29934

2-3-3. Results

Attached plan ' Fig. 23b ' shows the network for traverse and levelling. In traverse surveying, 0° and 90° were chosen as an included angle and supplementary angle for the measuring angles, and to be observed in the reciprocal observation method. Maximum difference of 5 seconds was observed by subtracting the added total of these included and supplementary angles from 360°. Average difference turned to be 3 seconds, staying well in its range limits safely.

The area for the traverse survey is inside the forest zone, so its intervisibility was poor. Therefore, the minimum distance of station became less than 50m, while numbers of the station counted so many as 150, which altogether deteriorated the accuracy rather. However, this could be regarded sufficient for the ground control point for the topographic mapping at a scale of 1/10,000.

The levelling was practiced at fore and back sight, but the closure errors could not be checked properly, except checking them in each section as the work proceeding.

Final result tables are :

Table 23a . . . . . Ground Control Point

Table 23b . . . . . Monumented Point

TABLE-23a List of Co-ordinates (ground control point)

Name of point	B N	L E	Height
T 1	6 25 59.304 711 082.07	3 45 25.766 583 729.57	3.57
T 2	6 26 24.438 711 860.27	3 47 43.244 587 951.66	3.89
T 3	6 26 18.984 711 702.56	3 51 0.793 594 020.57	3.99
T 4	6 26 14.335 711 568.64	3 53 48.973 599 187.31	4.33
T 5	6 26 13.619 711 554.34	3 56 8.477 603 473.00	4.04
T 6	6 28 7.724 715 061.68	3 57 8.652 605 315.06	2.20
T 7	6 29 18.247 717 215.15	3 53 30.974 598 624.47	3.97
T 8	6 29 6.471 716 849.37	3 52 12.752 596 222.35	4.30
T 9	6 28 29.671 715 715.29	3 50 54.587 593 823.22	3.74
T 10	6 28 22.963 715 501.65	3 48 21.988 589 136.08	5.36

TABLE-23b List of Co-ordinates (monumented point)

Name of point	B N	L E	Height	Location
NPA 1	6 26 18.781 711 686.61	3 47 44.575 587 992.82	3.81	LAGOS STA. OKUNSOLO
NPA 2	6 26 22.342 711 802.28	3 49 53.407 591 950.31	4.09	" DEBOJO
NPA 3	6 26 15.508 711 604.67	3 53 49.373 599 199.53	3.75	" MOSAYO

* height is based on Lagos Datum

Fig—23a

Appendix I

ORIGINAL/DUPLICATE
1862 S

°~~BENCH MARK~~/TRAVERSE STATION DESCRIPTION

°Line/Traverse 103 from KINGSWAY to ANGLOMO RD

No. 1862 S Type

Coordinates 890 057.33 N Origin COLONY

369 224.50 E North — °True/Colony

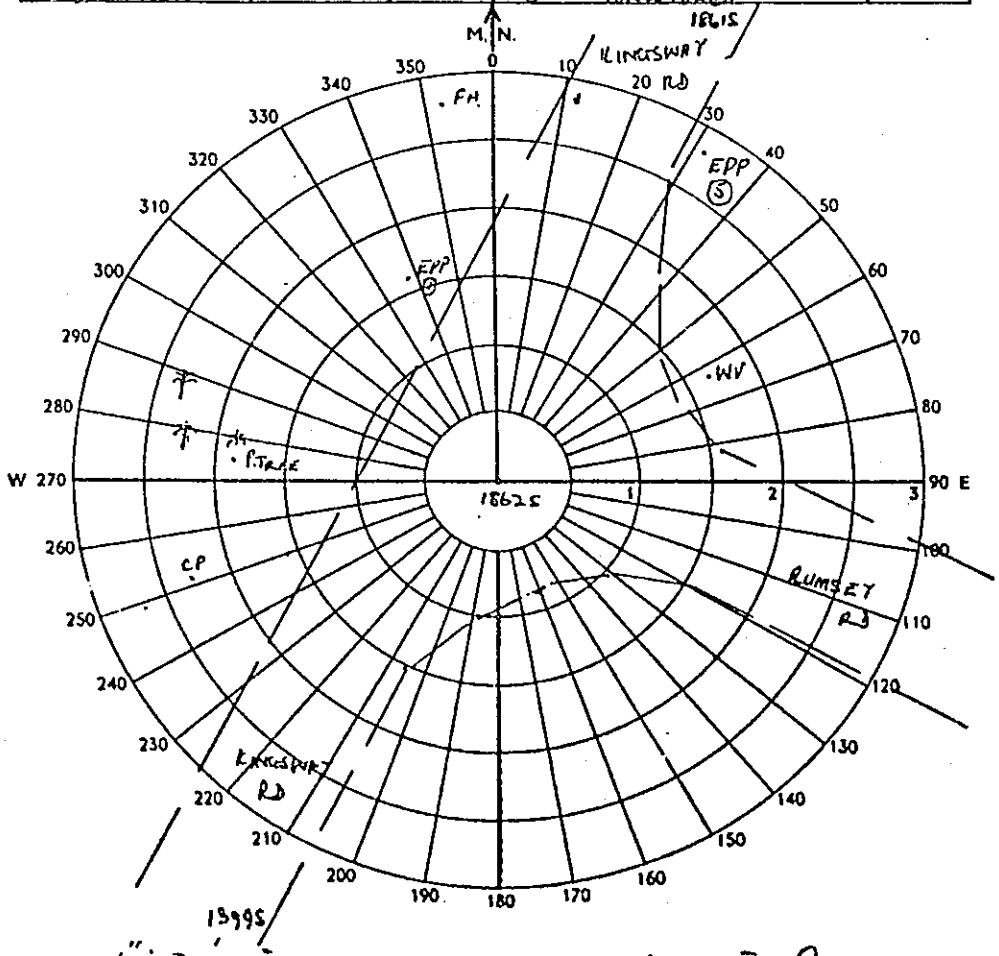
Height 11.78 Datum LAGOS SURVEY DATUM

Access: °Road/Railway from to

between/near milepost and

Description of Surface mark 4" x 4" brass plug in concrete protected by metal cover

Reference Point	Bearing	Distance	Reference Point	Bearing	Distance
Electric Power Pole (S)	31	56.5	Nearest Palm Tree	275	37
Water Valve	63	33.3	Fire Hydrant	353	56.9
Cable Pillar	251	45.8	Electric Power Pole (T)	338	32.1



Scale 1" : 20'

Signature K. C. E. OMESUH

°DELETE ONE.

Date 14 - 2 - 61

Fig – 23a

Appendix II

ORIGINAL/DUPLICATE
1864S

°~~BENCH MARK~~/TRAVERSE STATION DESCRIPTION

°Line/Traverse 103 from KINGSWAY to AWOLOWO RD

No. 1864S Type

Coordinates 888 208·21 N Origin COLONY

368 548·64 E North — °~~True~~/Colony

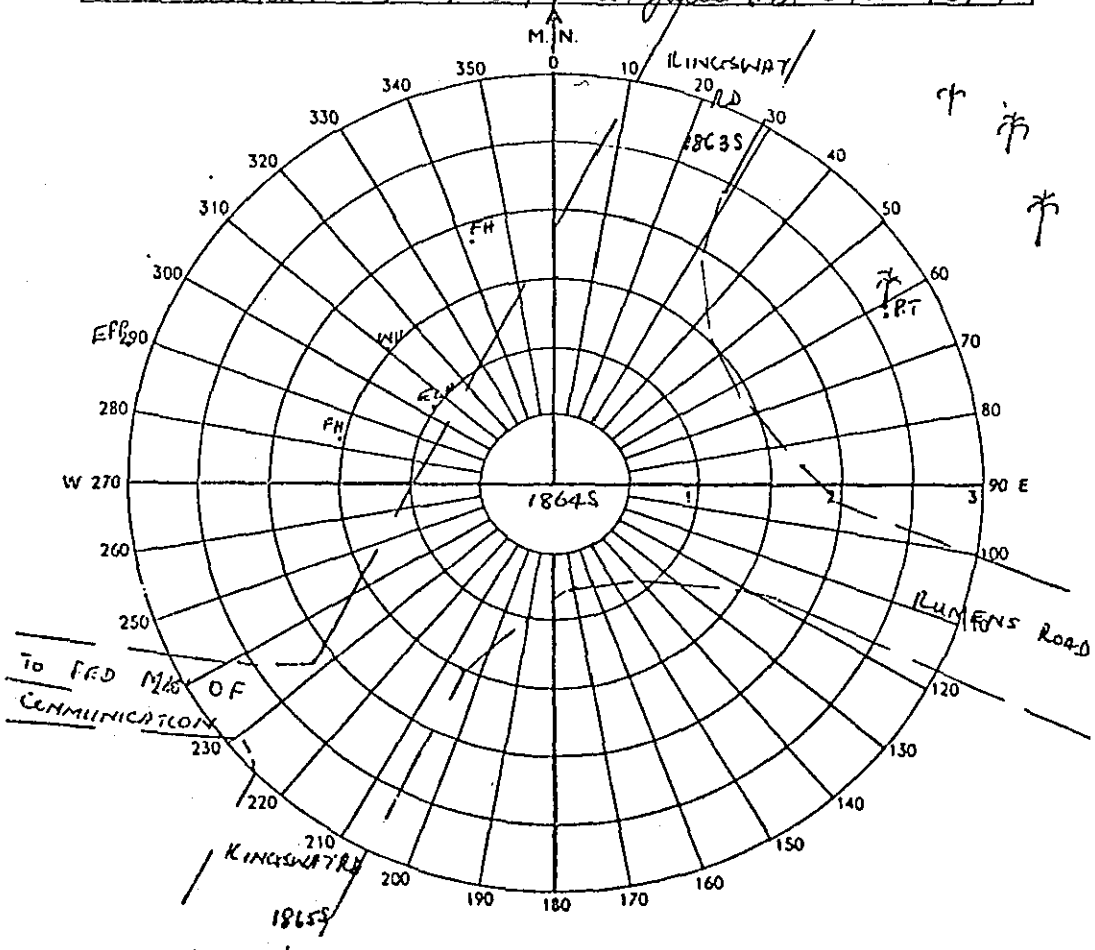
Height 6·88 Datum LAGOS SURVEY DATUM

Access: °Road/Railway from to

between/near milepost and

Description of Surface mark M is brass plug in Concrete protected by metal cover

Reference Point	Bearing	Distance	Reference Point	Bearing	Distance
Nearest Palm Tree	61	53·2	Electric Light Pole	304	20·2
Fire Hydrant (FP)	283	308	Water Valve	310	30·8
Electric Power Pole	289	63·7	Fire Hydrant (FP)	342	37·7



Scale 1" : 20'

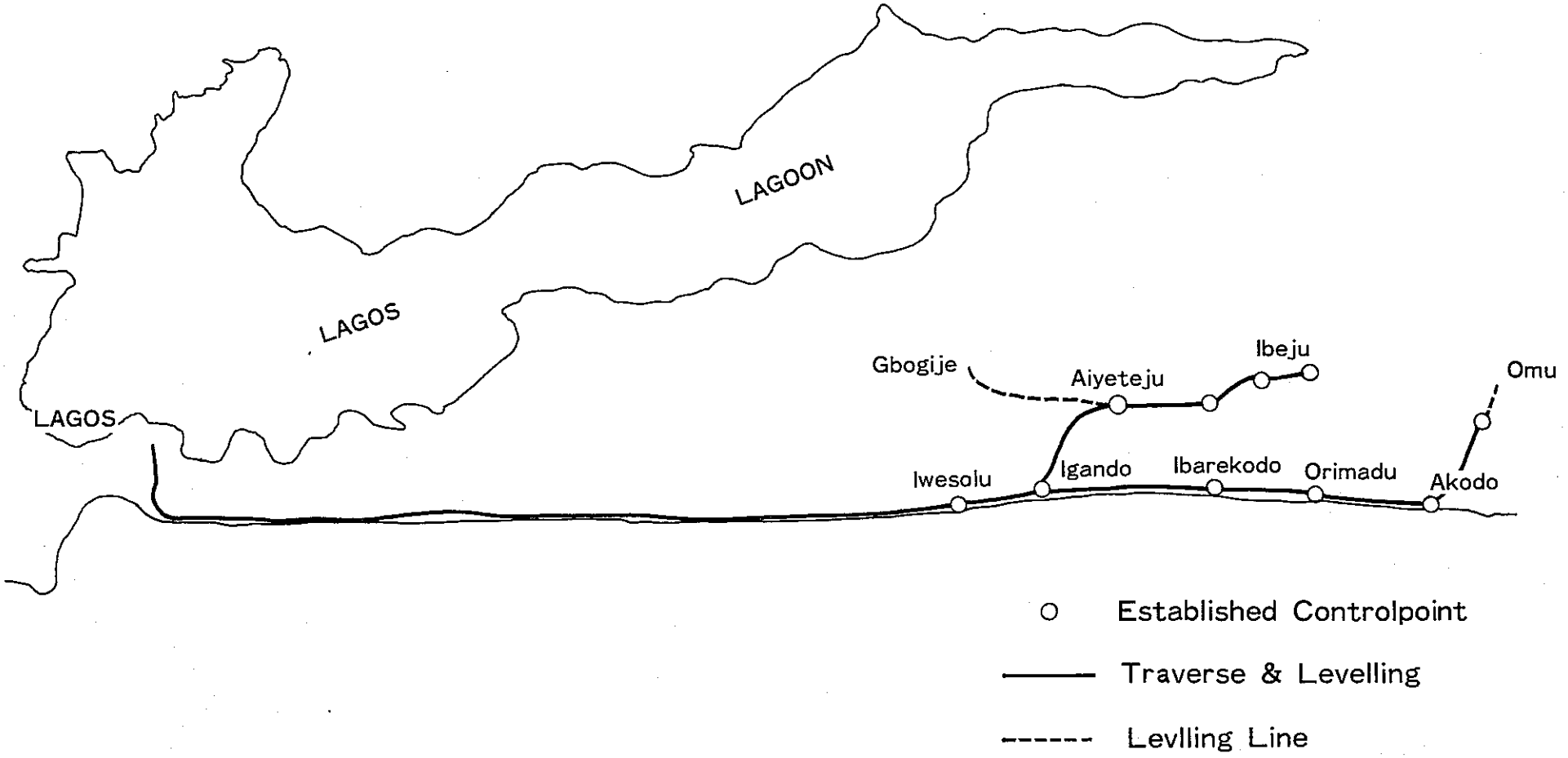
Signature B. C. E. OMESUH

*DELETE ONE.

Date 14 – 2 – 61

Fig.–23b

Network of Traverse & Levelling



2-4. Sounding and Sonic Prospecting

2-4-1. Outline

The vessel used by the survey team belonged to a fishing company stationed in LAGOS Port. It was a fishing boat, 20 deadweight tons and 2m draft. As the boat was unable to anchor off shore to stay on althrough the whole operation, the survey team had to sail to the spots and return to LAGOS Port daily.

The position for the survey boat was set by using the two methods ;

' One Angle Measurement ' a pre-arranged strait-line and three-point sextant method.

The surveys were conducted with the vessel moving at a speed of 3 to 4 knots.

Fig. 24a shows the topographic features at the sea bottom surrounding the sea areas.

Operations for sonic prospecting and sounding were taken place at the same time. The team settled the maximum erergy of electric discharge at 200 joules, using the underwater electric discharge electrode of multi-tandem type.

Attached plan ' Fig 24b ' shows the survey operations.

2-4-2. Equipment

For sounding :

1) Precision echo sounder RS-61

2) Transit 10" No.107632

3) Sextant

For Sonic prospecting

Electric discharge type "SPARKER" NE-19C

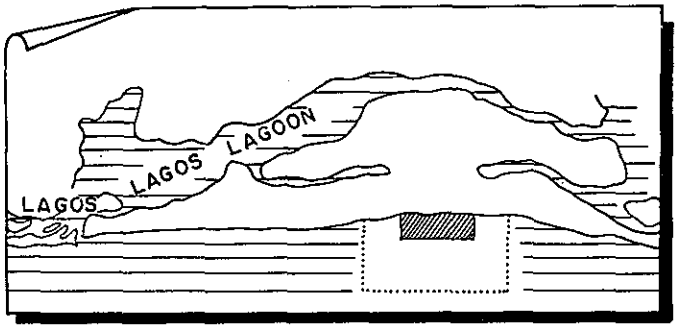
2-4-3. Results

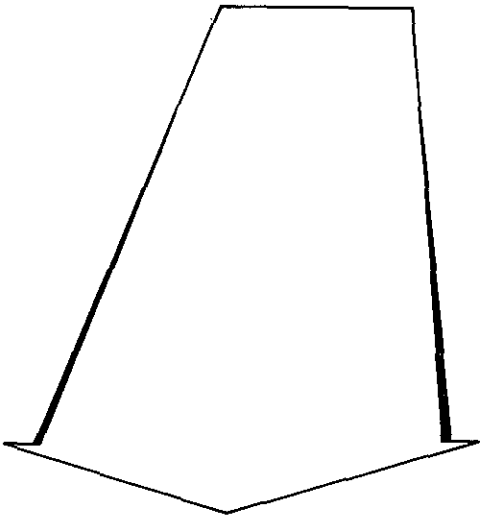
The results of both sounding and sonic prospecting were recorded on the chart paper by automatic recording machine, and were as good as expected. The total length of surveying amounted to 100 Km. The survey covered the areas 3.7 Km off the shore on the average, and reached the maximum of 5 Km area off shore.

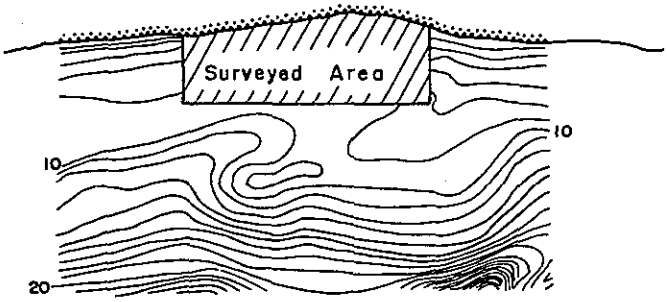
The number of surveying lines amounted to 21 with intervals of 500m each in the perpendicular direction to the coastline, and one line each at the position of 1 Km and 3 Km in parallel the coastline, which totaled 23 lines.

Attached table ' Fig 24c ' shows the recorded data of the echo sounder, and ' Fig 24d ' the Sparker.

Fig—24a SOUNDING LOCATION MAP





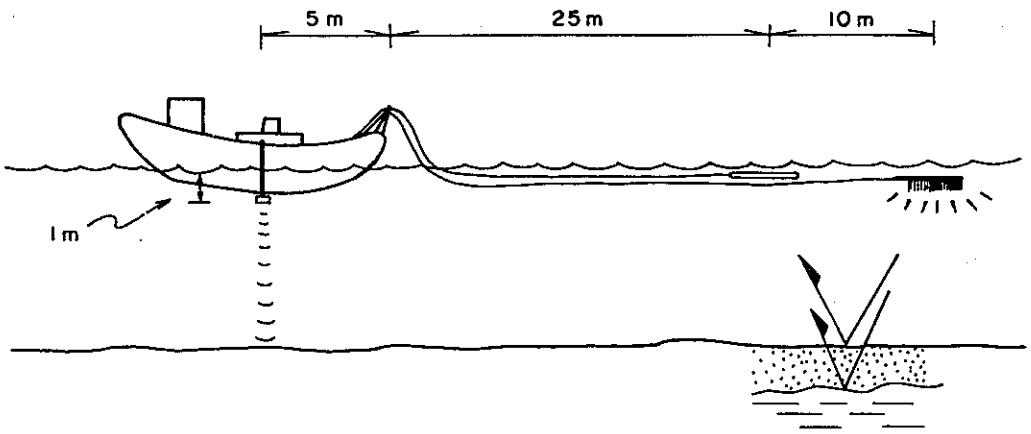


Surrounding Topography.
of Surveyed Area.

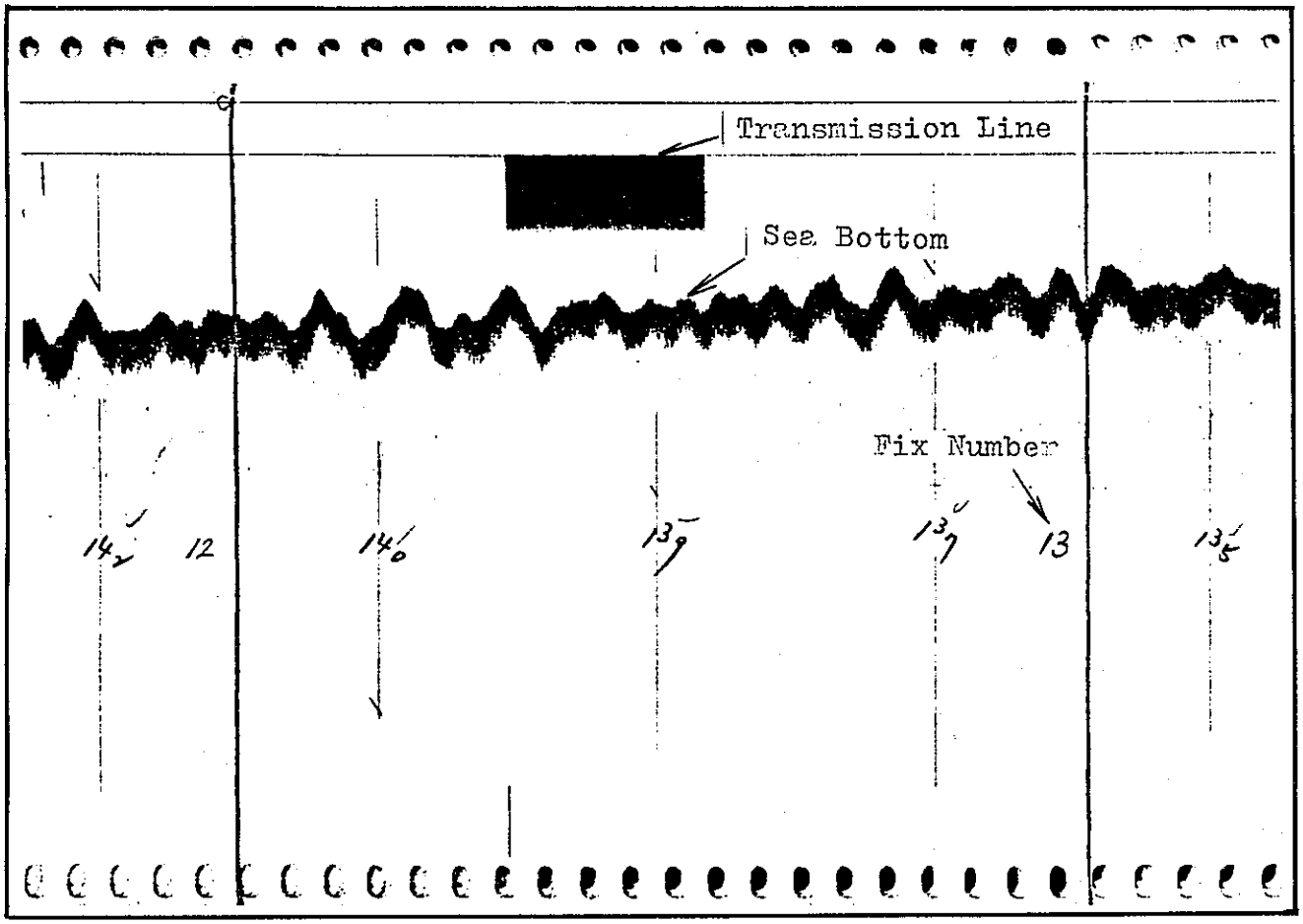
Note : Depth Contours In Fathoms.

Compiled from the American Chart.

Fig—24b

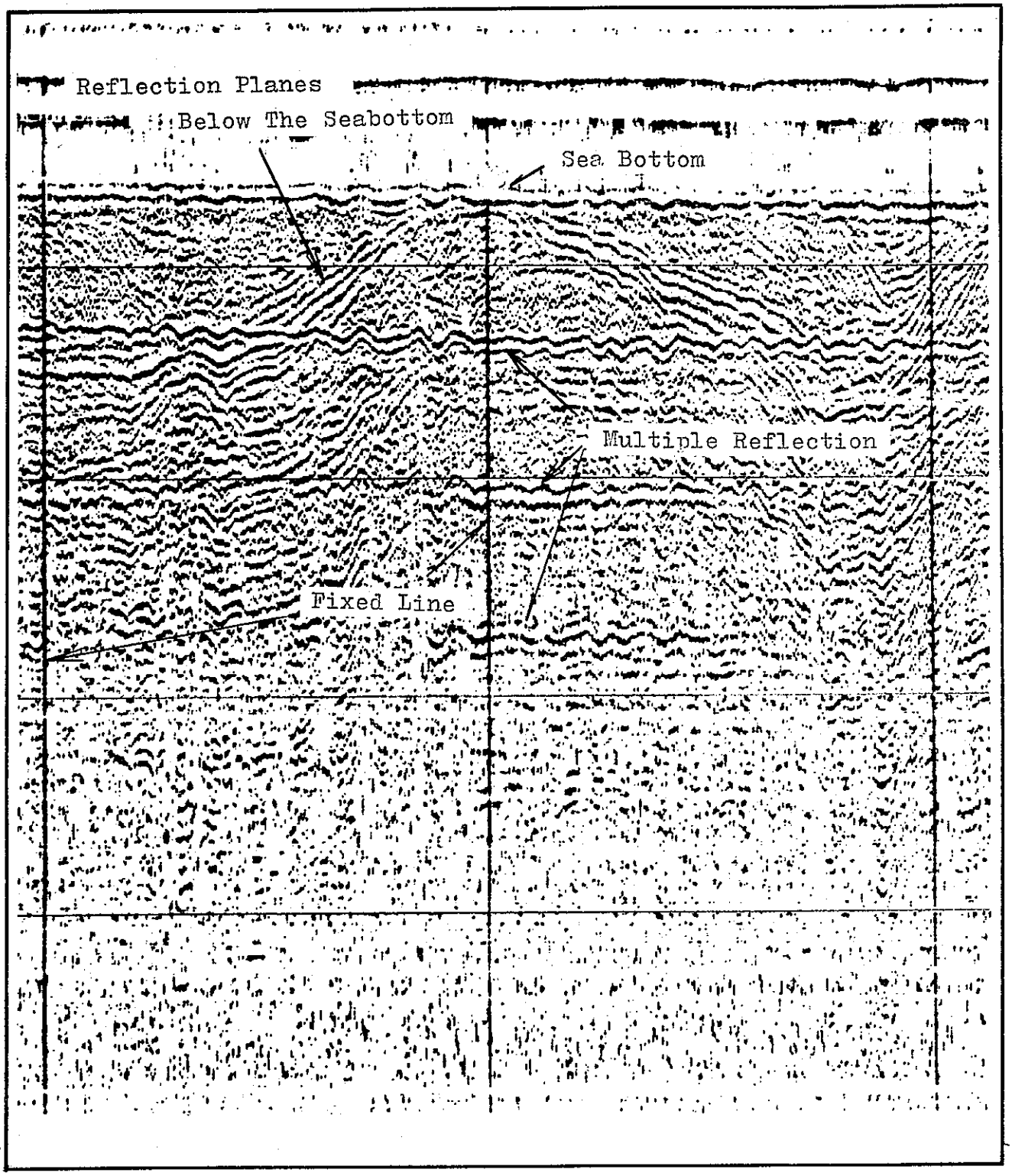


Fig—24c



Profiling Record of Echo Sounder

Fig—24d



Profiling Record of SPARKER

2-5. Pole Sounding

This survey was to grasp the topographic features of the beachline in the area. The direct levelling met the purpose by setting up the survey lines, on the extended lines of sounding, also some in every 250m in the middle.

The base height for this levelling was adopted from that of the navigation point, which had been fixed in setting the ground control points.

3. Works done in Japan

All of the field operation data were brought back to Japan by the survey from Nigeria.

At the Hino Technological Center of KOKUSAI AERIAL SURVEYS CO. LTD, during the period of January and February in 1979, the team worked on the data, sorting them out and producing the final results - Topographical Map and Sounding Charts.

3-1. Topographical Mapping

3-1-1. Aerial Triangulation

In order to produce a topographical map, it is necessary that each model has a few points whose locations and heights were already known. Obtaining these points through field operations is too coastly as well as time-consuming. The aerial triangulation is the developed method to solve both of these problems.

1) Coordinate Measuring

Selection of the pass point and tie point by using contact prints.

These selected points can be marked onto the right positions on the positive films with the help of the point transfer device (P.U.G II).

The diameter of these marks was about 0.06mm.

Then those marked points on the positive films were measured in 0.001mm unit.

By using the machine, Stereo-Comparator ("Stecometer Zeiss Jena").

All the data were recorded on paper tapes to be stored.

2) Adjustment

The Computer ("FACOM" 230-45 S, 256 ^{KB}) was used to figure out on the basis of both coordinates, measured by Stereo-Comparator, and geodetic coordinate of the control points, measured by field operation.

As for the compulation system, first, coordinates figured by Stereo-Comparator were to be converted into the photo-coordinates on the basis of the photo indexes. Secondly, the stereomodel was to be produced out of the two adjoining photos. After the stereo-coordinates on each points being calculated, the unknowns -the rotation, parallel shift and scale of each stereomodels- were to be figured out, keeping the squared sum of the differences of coordinates at ground control points, and of tie points in its minimum.

The results of the above adjustment show the residuals against the figures of the ground control points.

Planimetry - maximum, 2.85^{m}
average, 1.35^{m}

Height - maximum, 2.89^{m}
average, 1.38^{m}

3-1-2. Plotting

On the basis of the coordinates figured through aerial triangulation, manuscript maps for the topographical maps were produced at a scale of 1/10,000, using the precesion stereo-plotter (WILD A8). Those manuscript maps were furnished further with the data from field operations to be reformed duely, Tracing works were executed on those maps before turning them into their final shape as topographical maps.

The legends adopted was the one used for Nigerian Government issued maps of scale 1/50,000.

For the hight information, the intermediate contour interval was 5^{m}, and assisting spot-heights were measured at intervals of 10cm on maps.

3-2. Sounding Charts Compilation

Actual water depth was decided, after correcting the water depth recorded by the echo sounder machine, by examining their sound velocities, equipment deviations, tidal levels, and draft amounts.

Barcheck method was used for checking both sound velocities and equipment deviations. As for tidal levels, the revised figures could be found out of the Tidal Records of LAGOS EAST MOLE.

The under-water depth set for the transmitter and receiver during sounding was fixed for 1.0^{m}.

CHART DATUM was adopted as the basis of water depth.

On the basis of those final figures of water depth, depth contours with 1^{m} intervals each were drawn before producing the completed sounding charts at a scale of 1/10,000.

Also the conbined brack chart was produced at a scale of 1/10,000, tracing each sea positions of the survey boat, measured in the one-angle measurement method and three-point sextand method.

The sea bottom in the surveying area could be divided into two parts, the eastern and western.

The depth contours in the west were running almost in parallel with the coastline, sloping between 1/500 and 1/600, while those in the east were rolling considerably towards the axis for NE - SW, and were shallow compared with the west, including some area of 3^{km} off shore with its depth of only 14^{m}.

3-3. Production of Topographic cross-section of the Beach

The cross-section on the scale of 1:500 were produced on the basis of the values obtained from the surveying of beachlines.

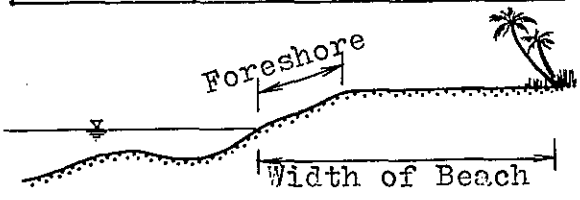
Table 33a shows a summary of both the width of seacoast of each line and the gradient of the fore shore.

The average width amounted to 60^{m} and the gradient was 1:6. Fig 33a and Table 33a show the average cross-section at the beach.

TABLE—33a

Present Situation of Beach

Line NO	Width of Beach	Slope of Foreshore
C-(-1)	53	1 : 4.8
+250	59	1 : 6.0
C-0	49	1 : 4.2
+250	73	1 : 6.6
C-1	66	1 : 7.6
+250	46	1 : 5.2
C-2	44	1 : 6.7
+250	49	1 : 6.8
C-3	52	1 : 5.5
+250	53	1 : 5.9
C-4	52	1 : 4.4
+250	51	1 : 6.2
C-5	54	1 : 5.0
+250	47	1 : 6.7
C-6	52	1 : 6.0
+250	54	1 : 6.0
C-7	58	1 : 4.7
+250	63	1 : 5.5
C-8	57	1 : 6.0
+250	65	1 : 5.3
C-9	66	1 : 6.2
+250	60	1 : 5.9
C-10	63	1 : 7.8
+250	64	1 : 4.5
C-11	67	1 : 5.9
+250	64	1 : 4.1
C-12	67	1 : 7.1
+250	58	1 : 6.6
C-13	57	1 : 7.2
+250	56	1 : 5.0
C-14	55	1 : 6.2
+250	62	1 : 5.0
C-15	62	1 : 6.2
+250	64	1 : 6.2
C-16	61	1 : 6.8
+250	70	1 : 6.9
C-17	69	1 : 7.1
+250	62	1 : 5.6
C-18	64	1 : 7.5
+250	68	1 : 6.7
C-19	57	1 : 6.8
Mean	58.85	1 : 6.0



Surveyed on 18th~21st DEC.78

Fig—33a