AIRBORNE THERMAL INFRARED SURVEY
WINTER 1977
ST. LUCIE PLANT
QUARTER IV FLIGHT
November 8, 1977

Prepared for

FLORIDA POWER & LIGHT COMPANY
P.O. Box 013100
Miami, FL 33101

Revised

15 March 1978

Prepared by

TEXAS INSTRUMENTS INCORPORATED
ECOLOGICAL SERVICES
P.O. Box 5621
Dallas, Texas 75222

TABLE OF CONTENTS

APPENDIXES

ILLUSTRATIONS

TABLE

PLATES

SECTION I

REGULATORY PURPOSE

The thermal infrared surveys performed by Texas Instruments for Florida Power & Light Company (FPL) are designed to demonstrate compliance with the requirements of the facility NPDES Permit and the facility Environmental Technical Specifications. The specific regulatory requirements are as follows:

- NPDES Permit FL0002208 Special Conditions B., b., sentence 1 and 2.

  The discharge into the Atlantic Ocean shall not cause a temperature rise in excess of 0.8°C (1.5°F) above ambient surface temperature outside a 162 hectacres (400 acre) zone of mixing during the months of June through September, nor 2.2°C (4°F) rise during the remaining months. In addition, the surface temperature conditions within the zone of mixing will not exceed a rise of 3.1°C (5.5°F) over ambient temperature nor a maximum temperature of 33.9°C (93°F) as an instantaneous maximum at any point.

- St. Lucie Unit No. 1 Technical Specifications, Appendix B, Limiting Conditions, 2.1.1, Specification, paragraph 1.

  The thermal discharge of St. Lucie Unit No. 1 into the Atlantic Ocean shall be limited to a maximum release temperature of 111°F and shall not cause a temperature rise in excess of 1.5°F above ambient surface temperature outside a 400 acre zone of mixing during the months of June through September, nor a 4°F rise during the remaining months. In addition, the surface temperature conditions within the zone of mixing shall not exceed a rise of 5.5°F over ambient temperature nor a maximum temperature of 93°F as an instantaneous maximum at any point.

In accordance with the last sentence of the St. Lucie plant NPDES Permit, Special Conditions B., b., FPL submitted to the EPA Regional Administrator on November 21, 1974, a proposed thermal monitoring program to satisfy the NPDES Permit and Environmental Technical Specifications monitoring requirements, which included the surface area temperature limitation. The thermal infrared survey performed for FPL and reported in this document complies with all the regulatory and monitoring program criteria relating to

the thermal infrared imagery requirements. In addition, the four required flight patterns were to be performed approximately on a quarterly basis in order to obtain a representation of seasonal effects due to wind, temperature and currents on the St. Lucie plant plume. The four flights are to be represented in separate reports as Quarter I through Quarter IV Flights.*

*Environmental Technical Specifications, St. Lucie Plant Unit No. 1 Technical Specifications, Appendix B,3.1.A.6.

SECTION II

FACILITY DESCRIPTION

A. PLANT LOCATION

The plant is located on Hutchinson Island in St. Lucie County, about halfway between the cities of Fort Pierce and Stuart on the east coast of Florida (see Figure II-1). The site is approximately 120 highway miles north of Miami, 225 miles south of Jacksonville and 150 miles east of Tampa. Lake Okeechobee is approximately 35 miles to the southwest.

Hutchinson Island is approximately 22 miles long by 1 mile wide at its maximum width. The Atlantic Ocean lies to the east, and the Indian River separates the island from the mainland to the west. Indian River is not a river in the usual sense. It is a long, thin, tidal lagoon stretching down the southeastern coast of Florida between the mainland and a series of offshore islands. The river is approximately 7200 feet wide at the plant site.

Hutchinson Island is generally flat. Much of it consists of swamp covered with dense vegetation characteristic of Florida coastal mangrove swamps. From the ocean shore the land rises slightly in a dune or ridge to approximately 15 feet above mean low water.

The plant is located on 1132 acres near the midpoint of the island. The plant occupies approximately 300 acres adjacent to Big Mud Creek, an inlet off the Indian River, and across State Road A-1-A from the ocean shore.

B. GENERATING UNIT DESCRIPTION

St. Lucie Unit No. 1 is a nuclear unit of pressurized water design. The reactor heat from the reactor's primary system coolant loops is transferred to a secondary coolant system in two steam generators.

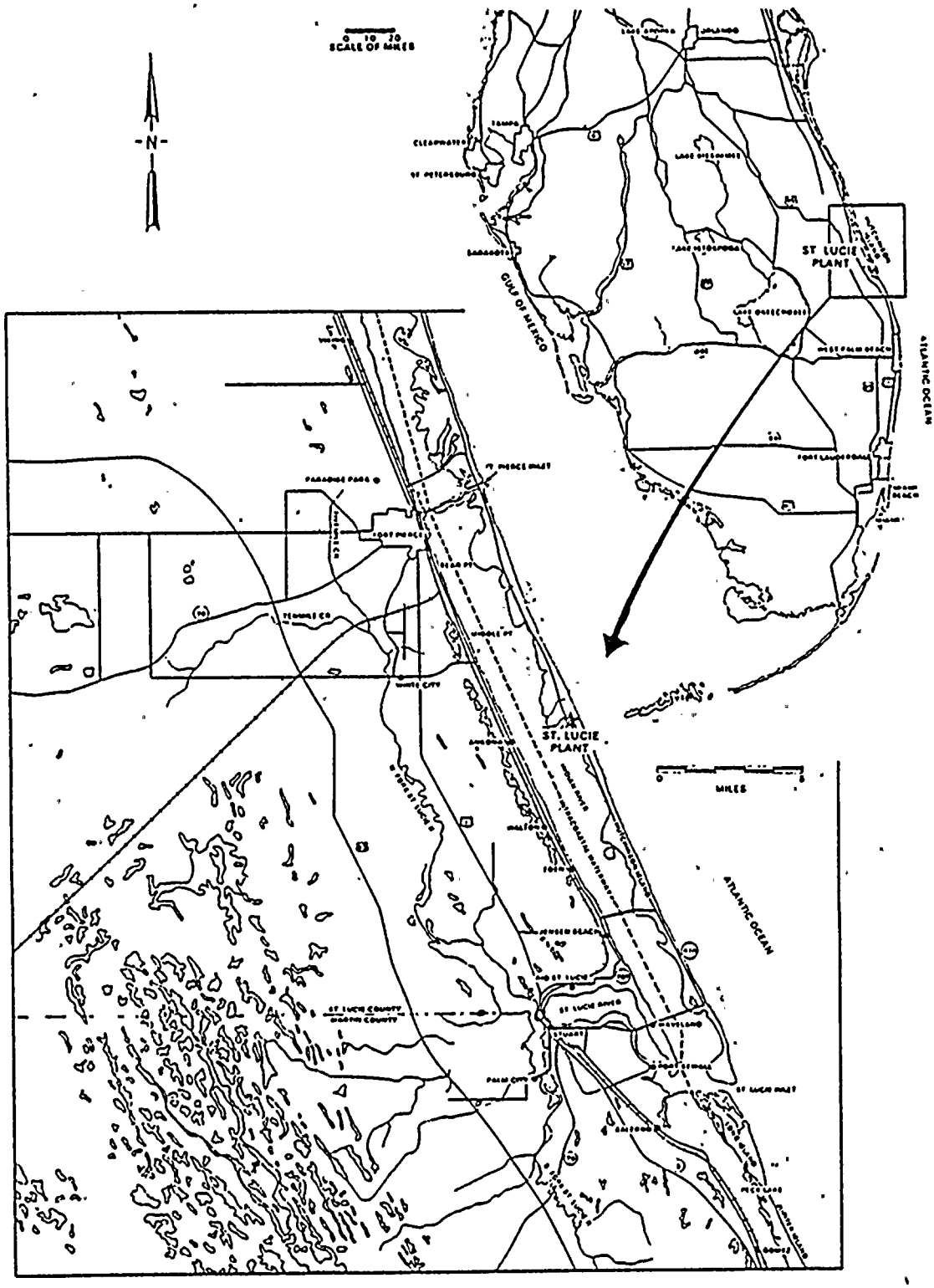


Figure II-1. Site Location Map

The water in the secondary system is converted to steam to drive the turbine-generator and the secondary coolant steam is condensed in a condenser cooled by water from the Atlantic Ocean.

C. COOLING WATER SYSTEM CHARACTERISTICS - ST. LUCIE UNIT NO. 1

The condenser cooling water system is a once-through system with intake and discharge in the Atlantic Ocean. Design flow is 530,000 gpm (1180 cfs) with a normal temperature rise across the condenser of 24°F. The major components of the system includes (1) two intake lines, (2) one discharge line*, (3) an intake canal, and (4) a discharge canal. Figure II-2 presents a general plan view of the system.

The intake is located 1200 feet offshore and about 2400 feet south of the discharge structure. As shown in Figure II-2, the top of the intake is situated approximately 8 feet below the water surface at mean low water (MLW). Horizontal intake velocities approach 1 fps.

From the ocean intake point, water is drawn through two buried pipelines (ID 10.5 feet) at 6 fps to the intake canal. This 300-foot wide canal begins 450 feet west of the shoreline and carries the cooling water some 5000 feet to the plant intake structure at approximately 0.3 to 0.5 fps.

The plant intake structure consists of four bays, each containing one coarse screen, traveling screen and one circulating water pump. Approach velocities to each bay is less than 1 fps. From this structure, the water flows through a buried pipeline to the condenser at about 7 fps.

The heated water leaving the condenser flows through a buried pipeline for 500 feet to the discharge canal. This open canal is 200 feet wide and extends approximately 1735 feet to a point 400 feet west of the

*A separate discharge line will be installed to accommodate 2 unit operation

shoreline. There, the discharged water is carried in a 12-foot diameter concrete pipe buried under the beach and ocean floor out to the ocean discharge structure, located 1200 feet out from the shoreline.

The ocean discharge structure, shown in Figure II-2, consists of a short transition section and a Y-type, high-velocity jet discharge; each port is 7.5-feet in diameter. Ocean depth at the discharge point is -18 feet (MLW). The centerline of the discharge ports is 30 feet below the water surface. Exit velocity of the discharge water from each port is 13 fps. The design is a high-momentum type, which produces a relatively high degree of entrainment of ambient water, thus enhancing the diluting characteristics of the outfall.

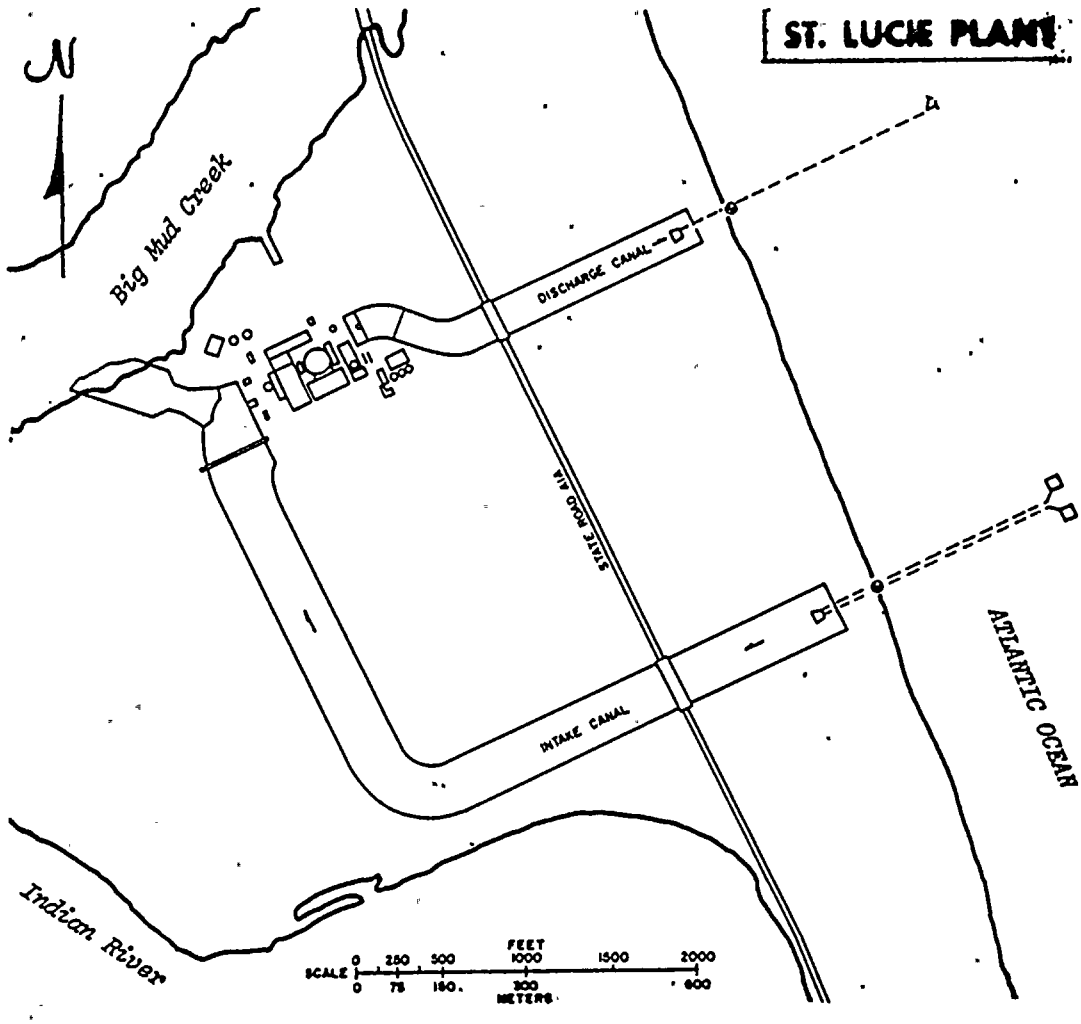


Figure II-2. Plant Intake and Discharge Systems

SECTION III

GENERAL INTRODUCTION TO THERMAL INFRARED IMAGERY TECHNIQUES

A. INTRODUCTION

Thermal infrared imagery in the 8- to 14-micrometer portion of the electromagnetic spectrum is collected in the Atlantic Ocean area of the St. Lucie Plant intake and discharge. The survey provides surface thermal data compiled from more than 1,000,000 points per square mile.

All plume data are taken within 1 minute, allowing illustration of the thermal mixing pattern and other areas of warm water in a near-synoptic manner. Ambient surface temperatures are observed by ground personnel during the period of airborne data collection and used for the purpose of calibrating the computer-printed temperature maps.

Surface thermal data are developed into a series of computer printed maps; each computer map of the discharge area is then optically changed to a scale of 1 inch = 500 feet. Also, an overlay map of the discharge area is presented at a scale of either 1 inch = 1000 feet or 1 inch = 1250 feet. Additionally, computer printouts of enlarged areas, included in Appendix B, are used for calibration purposes.

B. DATA COLLECTION

Infrared imagery is produced by a series of scan lines perpendicular to the flight direction and is similar in appearance to strip photography. Relative radiometric temperature differences are represented by the imaged grey tones as illustrated in Plates IV-1 through IV-6. Light tones, as they appear on the positive print of infrared imagery, represent higher radiometric temperatures. Dark image tones correspond to lower radiometric temperatures.

A Texas Instruments RS-310D airborne infrared scanning system is used to collect the thermal infrared data over the St. Lucie plant. This

system records data in the 8- to 14-micrometer portion of the electromagnetic spectrum, and temperature reference sources are located within the field-of-view of the scanner system to allow temperature calibration of the image tones for map compilation.

At the start of each scan, the detector is focused first on a hot calibrated radiation source and then on a cold calibrated source. These two sources thus provide verification of calibration of temperature and system gain on each scan line. To aid in analyzing data, the two radiation sources usually are set near the highest and lowest radiation expected from the water to be measured.

As a further aid to produce clear, usable data from these scans, the detector voltage is digitized each 1/2000 radian of scan angle (0.0286). The resulting computer tape has one scan line per record on the tape with 1890 points digitized on that tape for each record (scan line). The digitized information, which includes the calibration sources, is recorded on a standard computer tape (9 track 1600 BPI).

A map is formed by printing a series of scan lines (computer records) along a computer page. Each digitized point is a measure of the radiation from the surface as modified by the atmosphere between the surface and the scanner. Since infrared radiation will not pass through water, the radiation power is a function of the surface only; no radiation can come from below the surface.

Other involved factors are:

1) Radiation efficiency of water

2) Angle of water surface to the scanner

3) Difference between temperature of surface molecules and temperature of water 1 to 6 inches below the surface, where it can be measured by a thermometer

4) Atmospheric loss or absorption

5) Difference in atmospheric path length

Factor 1) is small, about 0.98 percent, and is calibrated out through the use of ground measurements. Factor 2) is also small and is averaged out in the computer; it is seen as $\pm 0.3^{\circ}F$ when looking at waves. Factor 3) is small but is also calibrated out through use of ground temperature measurements.

Factor 4) is variable, depending on water vapor, water droplets in the air, and temperature of the droplets; most could be calibrated through the use of ground measurements. Factor 5) is a function of scan angle and is small for the 30° off-axis scan angles used in the calibrated scanner, therefore no correction is made for this factor.

C. CALIBRATION

It is possible to have sufficiently calibrated information by using only the calibrated sources and flying one extremely low pass with the normal higher pass. However, when possible, final calibration of the data is done by using water bodies in the areas of measurement as hot and cold calibration sources. At the St. Lucie plant site, the intake and discharge canals provide two sources for this calibration.

For final calibration, two areas are used: the intake canal and the discharge canal. A computer printout is made of each area and 400 digitized elements are averaged to obtain the average value of the radiation number received in the area. Using average radiation numbers derived for the intake canal and the discharge canal, the computer reads from the computer tape and prints out a map of the surface water temperature over the entire area covered by the tape. Using the mathematics of the scanner, aircraft height, and aircraft speed, the map is scaled to fit existing maps.

D. PROCESSING TECHNIQUES AND DATA PRESENTATION FORMAT

The recorded airborne thermal infrared data is prepared in two formats: qualitative image presentations and quantitative isothermal maps.

The qualitative data included in this report illustrates the qualitative, near-synoptic view of surface-temperature variations of the survey area depicted as image tones. These grey-tone maps have some panoramic distortion on the sides, making a scale change-out on the sides of the "heat picture".

The plane's altitude is used to determine the computer's printout for the temperature point areas from a linear relationship with the mapping scales. To make a computer printout of temperature, flight data is sampled along the x direction (across flight path) and along the y direction (along flight path) in a ratio of samples to produce the same map scale in both x and y directions. At the same time, the panoramic distortion is removed in the x direction. Therefore, the resulting map is reasonably distortion-free, and the map can either be enlarged or compressed optically to any desired scale. Isotherm lines are drawn directly on the printed temperature map and an isotherm line map traces off of these lines.

The digital number of radiation for each point is multiplied by a scale factor that produces a scale of numbers in degrees Fahrenheit or Centigrade as desired. An offset number is then applied to make one of the areas printout as the zero reference. It is easier to visualize a plume if it is referenced against a zero background rather than printing the actual temperature as read from a thermometer. The scaling factor used to produce Fahrenheight degrees and the offset factor to produce a zero reference area in the printout are derived from a calibration printout of enlarged areas which show the intake canal, discharge canal, and a reference ocean area. This calibration printout is adjusted to follow closely the delta temperatures as measured in the canals from the ground.

SECTION IV

RESULTS

FLIGHT PASS, 11/8/77, TIME 1106

This flight pass consists of a coverage perpendicular to the coast in an east-west direction. The Eastern limit is the Atlantic Ocean, center portion is Fort Pierce Inlet and the western boundary is the town of Fort Pierce. Plate IV-1 is the gray toned image of the flight pass.

The following parameters were measured during the over flight:

Wind - 6.5 mph at 30°

Ambient air temperature over land - 74.5°F

Tide @ 1106 low tide

Discharge canal elevation 9.20 feet above MLW

Plant delta T (combined condenser) - 24.0°F

Discharge flow - 479,500

Reactor power 99.55 percent

Gross power generated - 822 megawatts

Intake surface canal temperature (taken at east end of canal) - 78.1°F

Discharge surface temperature - 101.9°F

Temperature difference between canals - 23.8°F

Calibration: The flight pass data of 1130 was used to calibrate the 1106 calibration printout. The ground truth measurements showed a temperature differential of 23.8°F between canals. The calibration printout which is included as Attachment D shows a temperature differential between the canals of 23.83°F.

SUMMARY OF FINDINGS

Temperature distributions measured offshore from the Fort Pierce Inlet (~ 7 1/2 miles north of the St. Lucie plant) are presented as Attachment A. The computer printout shows excess temperatures to be in °F. Ambient temperature was referenced from the intake canal. North-west of the

Fort Pierce Inlet, the Indian River was -3.0°F in excess temperature in the middle of the river and increasing to a -2.0°F excess temperature toward each shore. The excess temperature from inside the Fort Pierce Inlet area was a -3.0°F below reference ambient. The Fort Pierce Inlet itself had the cooler water toward the center while warmer water was staying close to both sides of the inlet. However, at the Fort Pierce Inlet going east toward the Atlantic Ocean, the excess temperatures in open water was a -3.0°F extending easterly to the end of the flight pass coverage about 3 miles long.

FLIGHT PASS 11/8/77, TIME 1118

The flight pass consists of a coverage along the coast in a north-south direction. The northern limit of the printout is the Fort Pierce Inlet and the southern boundary is the St. Lucie Inlet. Plate IV-2 is the gray-toned image of the flight pass.

The following parameters were measured during the over flight:

Wind 6.5 mph @ 30°

Ambient air temperature over land - 74.5°F

Tide @ 1106 low tide

Discharge canal elevation - 9.20 feet above MLW

Plant delta T (combined condenser) - 24.0°F

Discharge flow - 479,500

Reactor power - 99.55 percent

Gross power generated - 822 megawatts

Intake surface canal temperature (taken at east end of canal) - 78.1°F

Discharge surface temperature - 101.9°F

Temperature difference between intake and discharge canal - 23.8°F

Calibration: The flight pass of 1130 was used to calibrate the 1118 calibration printout. The ground measurements showed a temperature differential of 23.8°F between canals. The calibration printout, which is included as Attachment D, shows a temperature differential between the canals of 23.83°F.

SUMMARY OF FINDINGS

Fort Pierce, shown at the top left of the computer printout, is north of the St. Lucie plant. The water from this inlet, which flows into the Atlantic Ocean, is 3.0°F below the reference ambient temperature. The reference ambient temperature is the water temperature at the St. Lucie plant intake canal. A warmer (2.0°F below ambient) water mass, approximately 0.5 mile in width, can be seen transversing the computer printout at a 45° angle. South of this about 4.75 miles north of the thermal plume, the temperature of the water increased to 1.0°F below ambient and remained constant within 0.2 mile above the thermal plume. The plume is described in flight pass 1130. South of the plume, the ocean temperature remained 1.0°F below reference ambient temperature for about 1.75 miles. Beyond this the water temperature fluctuated below ambient and 1.0°F below ambient for about 5.25 miles. The water temperature returned to and remained at 1.0°F below ambient for 6 miles. At the St. Lucie Inlet which is 12 miles south of the St. Lucie Plant, a small narrow mass of cooler (2.0°F below ambient) water can be seen flowing into the Atlantic Ocean.

FLIGHT PASS 11/8/77, TIME 1130

This flight pass shows both the plant area and the Atlantic Ocean in front of the plant. This pass covers the essential portion of the plume. Both the intake and the discharge canals are used in calibration. Plate IV-3 is a gray-toned image of the mid-morning flight pass.

The following parameters were measured during the over flight:

Wind - 6.5 mph @ 30°
Ambient air temperature over land - 74.5°F
Tide @ 1106 low tide
Discharge canal elevations - 9.20 feet above MLW

Plant delta T (combined condenser) - 24.0°F

Discharge flow - 479,500

Reactor power - 99.55 percent

Gross power generated - 822 megawatts

Intake surface canal temperatures (taken at east end of canal) - 78.1°F

Discharge surface temperature - 101.9°F

Temperature difference between intake and discharge canals - 23.8°F

Calibration: The ground measurements showed a temperature differential of 23.8°F between canals. The calibration printout, which showed a differential of 23.83°F between the canals, is included as Attachment D.

SUMMARY OF FINDINGS

Temperature distributions measured offshore at the St. Lucie plant are presented as Plate IV-3 and Attachment C.

The maximum surface temperature within the plume is 81.1°F (3.0°F above ambient reference), covering an area of 1.34 acres. The 1.5°F isotherm is shown to cover an area of 120 acres. The plume appeared to be fanning in a north-east direction. Each temperature point on the printout (Attachment C) is approximately 0.191 acre.

Temperature isotherms and their respective areas for various temperatures above ambient (ΔT) are listed as follows:

ΔT Isotherms (°F)	Area (Acres)
3.0	1.3
2.0	51.7
1.5	120.2

No temperature isotherms for 4°F and above were discernible from the data.

FLIGHT PASS 11/8/77, TIME 1642

This flight pass consists of a coverage perpendicular to the coast line in an west-east direction. The eastern limit is the Atlantic Ocean, the center portion is the Fort Pierce Inlet and the western boundary is the edge of the town of Fort Pierce. Plate IV-5 is a gray-toned image of the flight pass.

The following parameters were measured during the over flight:

Wind 6 mph @ 45°

Ambient air temperature over land - 75.2°F

Tide @ 1711 high tide

Discharge canal elevation - 10.80 feet above MLW

Plant delta T (combined condenser) - 24.1°F

Discharge flow - 479,500

Reactor power - 100.0 percent

Gross power generated - 824 megawatts

Intake surface canal temperature (taken at east end of canal) - 79.0°F

Discharge surface canal temperature - 102.1

Temperature difference between intake and discharge canals - 23.1°F

Calibration: The 1713 flight pass data was used to calibrate the 1642 calibration printout. The ground measurements showed a temperature differential of 23.1°F. The calibration printout, which is included as Attachment H, shows a temperature differential of 23.06°F between the canals.

SUMMARY OF FINDINGS

Temperature distribution measurements at the Fort Pierce Inlet area (~7.5 miles north of the St. Lucie plant) are presented as Attachment E. The temperature distributions from the 1642 flight pass coverage, west of the St. Lucie Inlet, in the Indian River varied from reference ambient temperature (reference ambient temperature taken to be at the St. Lucie plant intake canal) to 2.0°F below reference ambient temperature. The

warmer water appeared to be due to shallow water as is shown in the areas of Tucker Cove and Cook Point.

The Indian River water, which is 2.0°F below reference ambient temperature, flows through the Fort Pierce Inlet into the colder (3.0°F below reference ambient) Atlantic Ocean and appears to be floating and not mixing with the ocean water (from flight pass coverage only). The probable reason that these waters are not mixing is due to density differences. The density of water decreases with increasing temperature and decreasing salinity.

FLIGHT PASS 11/8/77, TIME 1702

This flight pass of the St. Lucie Inlet goes offshore in a southeast direction. The St. Lucie River and the Indian River merge just before going out to sea through the St. Lucie Inlets. Plate IV-6 is a gray-toned image of this late afternoon flight.

The following parameters were used during the over flight:

Wind 6 mph @ 45°
Ambient air temperature over land - 75.2°F
Tide @ 1711 high tide
Discharge canal elevation - 10.80 feet above MLW
Plant delta T (combined condenser) - 24.0°F
Discharge flow - 479,500
Reactor power - 100.1 percent
Gross power generated - 824 megawatts
Intake surface canal temperature (taken at east end of canal) - 79.0°F
Discharge surface canal temperature - 102.1°F
Temperature differences between canals - 23.1°F

Calibration: The 1713 flight pass data was used to calibrate the 1702 flight pass. The ground measurements showed a temperature differential of 23.1°F between canals. The calibration printout, which is included as

Attachment H, shows a temperature differential between the canals of 23.06°F.

SUMMARY OF FINDINGS

Temperature distributions measured at the St. Lucie Inlet area are presented as Attachment F. St. Lucie Inlet area, approximately 11 1/3 miles south of the St. Lucie plant, showed both the Indian River and the St. Lucie River to be the same reference ambient temperature (reference ambient taken from the intake canal) flowing (east) into the Atlantic Ocean. A rise of 1.0°F above reference ambient was observed on the north side of the St. Lucie Inlet keeping near the shore following the coast line north on the Atlantic side of the ocean.

FLIGHT PASS 11/8/77, TIME 1713

This flight pass shows the Atlantic Ocean area and the shore line in front of the plant at late afternoon. The north-south pass covers the essential portions of the plume and the intake and discharge canals. Plate IV-7 is a gray-toned image of the mid-day flight pass.

The following parameters were measured during the over flight:

Wind 6 mph @ 45°

Ambient air temperature over land - 75.2°F

Tide @ 1711 high tide

Discharge canal elevations - 10.80 feet above MLW

Plant delta T (combined condenser) - 24.1°F

Discharge flow - 479,500

Reactor power - 100.1 percent

Gross power generated - 824 megawatts

Intake surface canal temperature (taken at east end of the canal) - 79.0°F

Discharge surface canal temperature - 102.1°F

Temperature difference between canals - 23.1°F

Calibration: The ground measurements showed a temperature difference between canals of 23.1°F. The calibration printout showed a differential of 23.06°F between canals which is included as Attachment H.

SUMMARY OF FINDINGS

Temperature distributions measured offshore at the St. Lucie plant discharge are presented as Plate IV-7 and Attachment G.

The maximum surface temperature within the plume was 85.0°F (6.0° above ambient) covering an area of 0.19 acre. The 1.5°F isotherm was shown to cover an area of 636 estimated acres. Due to the flight pass not covering the entire thermal plume, an estimated 20 acres were added to the 2.0°F isotherm, and 30 acres were added to the 1.5°F isotherm, which was not shown on the computer printout. Each temperature point on the printout (Attachment G) was approximately 0.191 acre.

Temperature isotherms and their respective areas for various temperatures above ambient (ΔT) are as follows:

ΔT Isotherm (°F)	Area (acres)
6.0	0.19
5.0	2.10
4.0	22.19
3.0	157.46
2.0	529 est.
1.5	636 est.

The 4°F isotherm was well below the 400 acre mixing zone limit provided for by regulatory limitations.

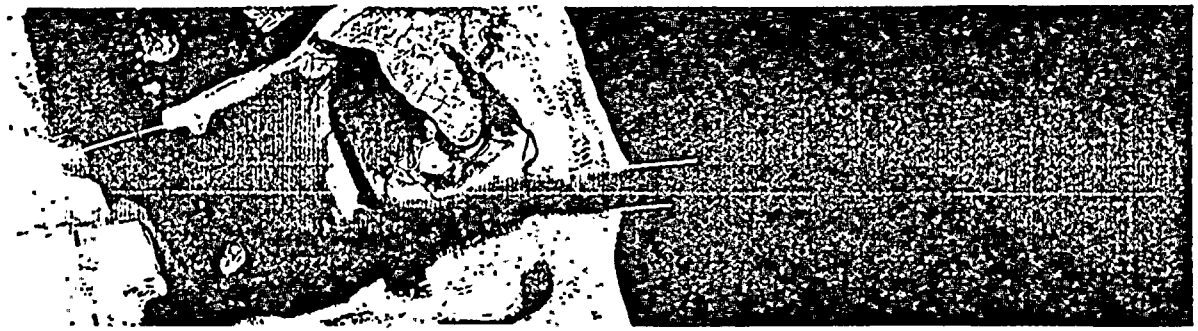


Plate IV-1. Flight Pass, 11/8/77, Time 1106

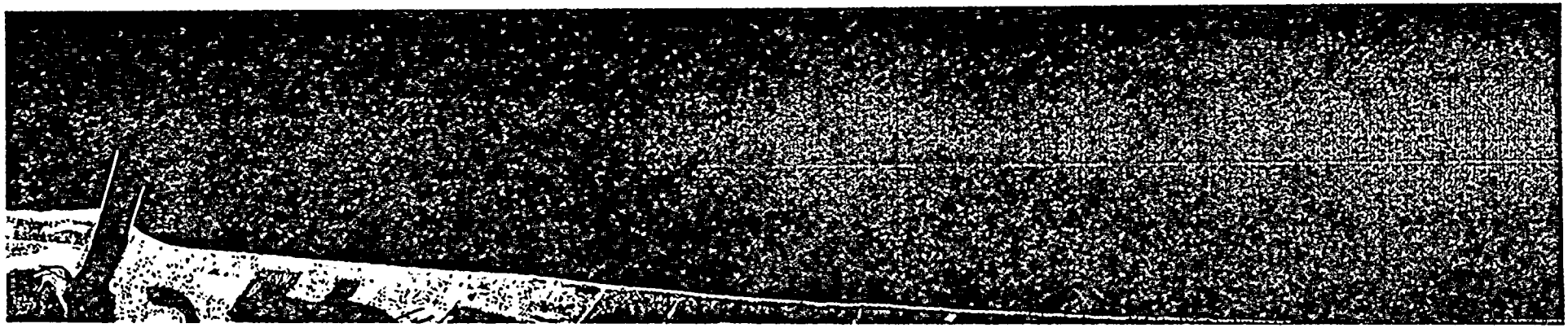


Plate IV-2. Flight Pass, 11/8/77, Time 1118

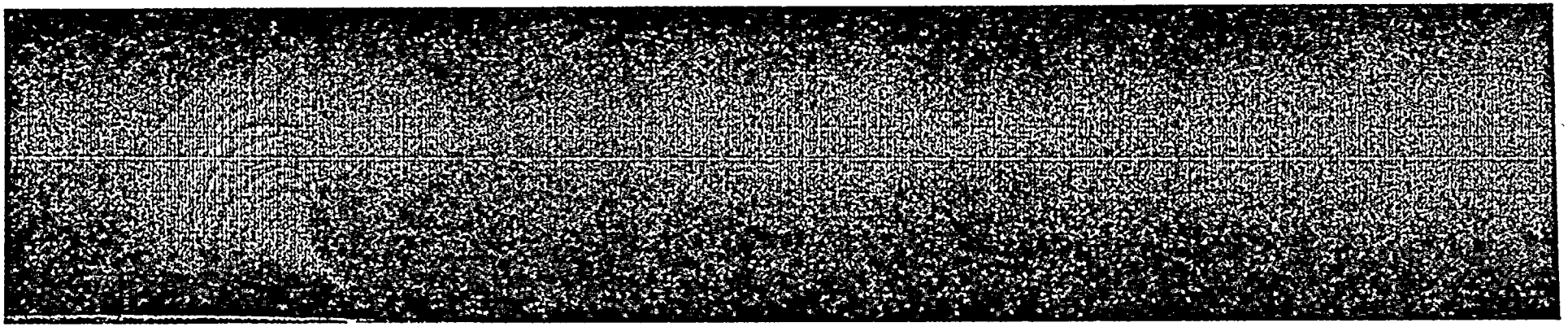


Plate IV-2. Continued

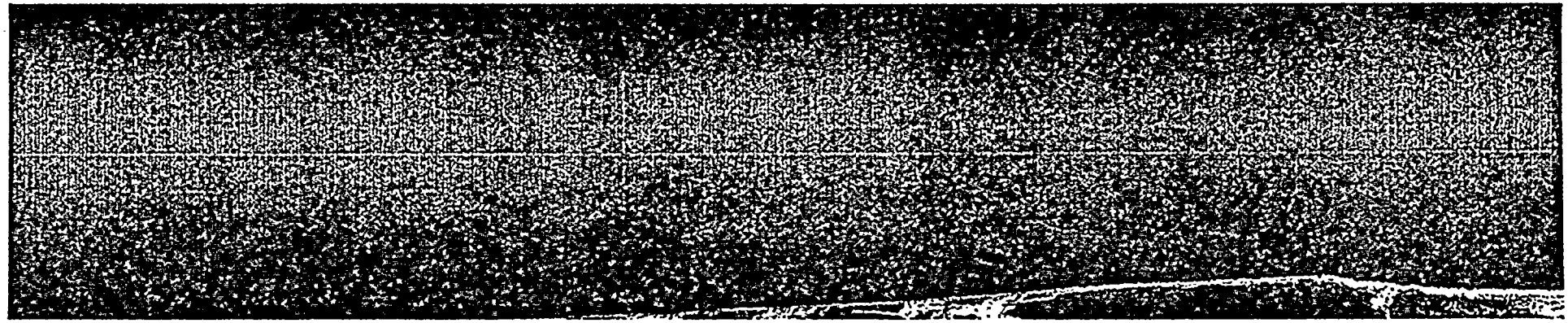


Plate IV-2. Continued

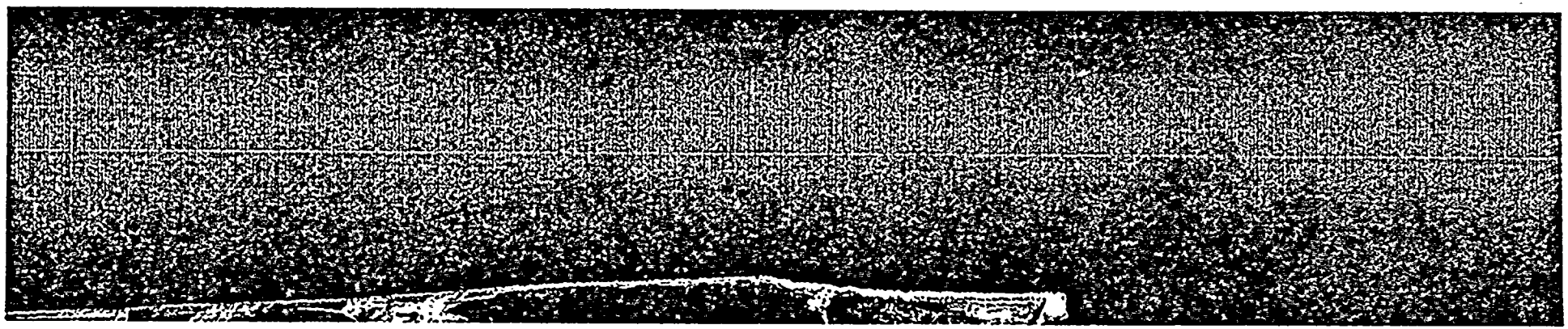


Plate IV-2. Continued

Plate IV-3. Flight Pass, 11/8/77, Time 1130

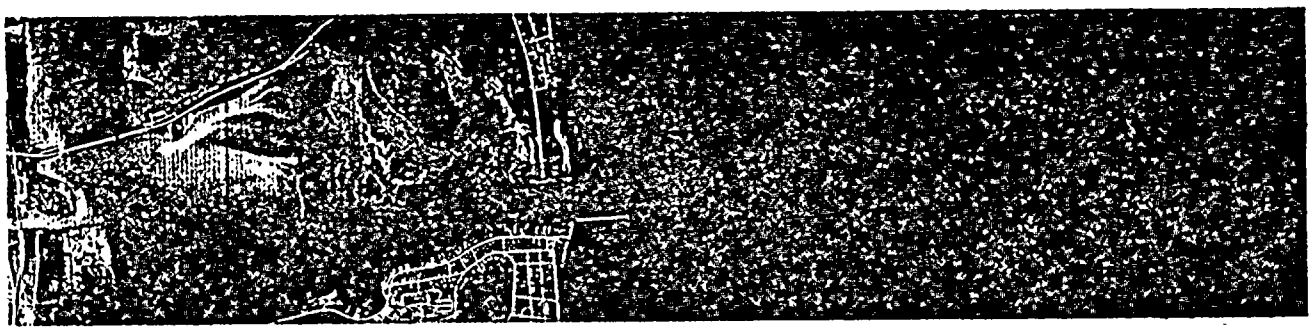


Plate IV-4. Flight Pass, 11/8/77, Time 1642

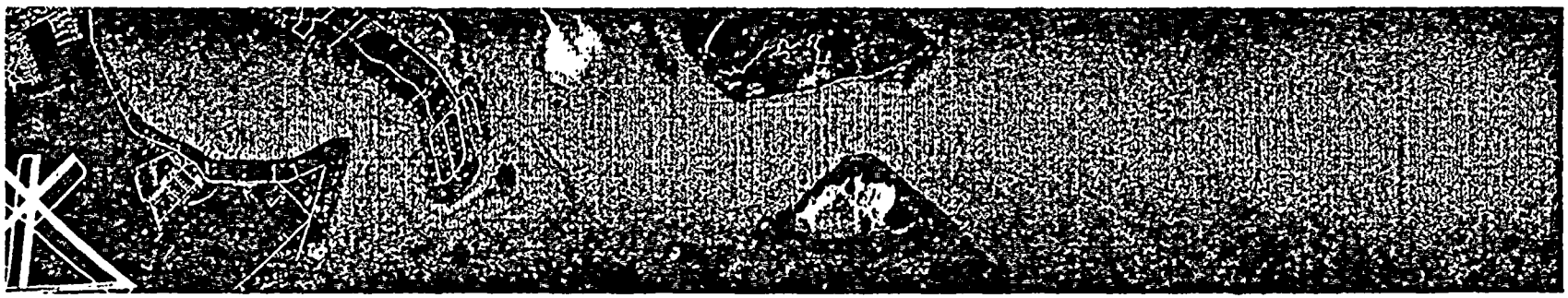


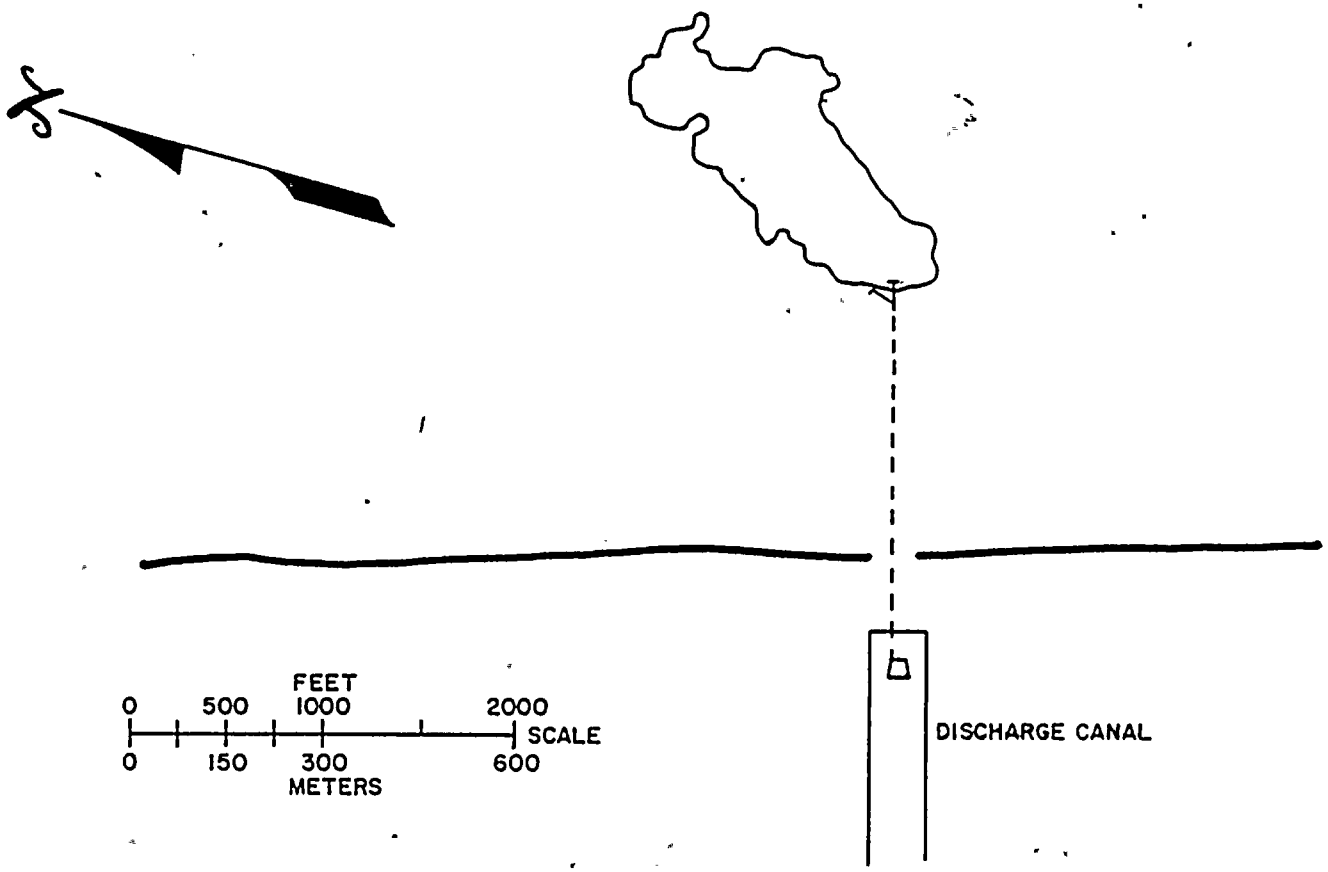
Plate IV-5. Flight Pass, 11/8/77, Time 1702

Plate IV-6. Flight Pass, 11/8/77, Time 1713

ST. LUCIE PLANT ISOTHERMS PLATE IV-7 A
FLIGHT PASS 11/8/77, TIME 1713

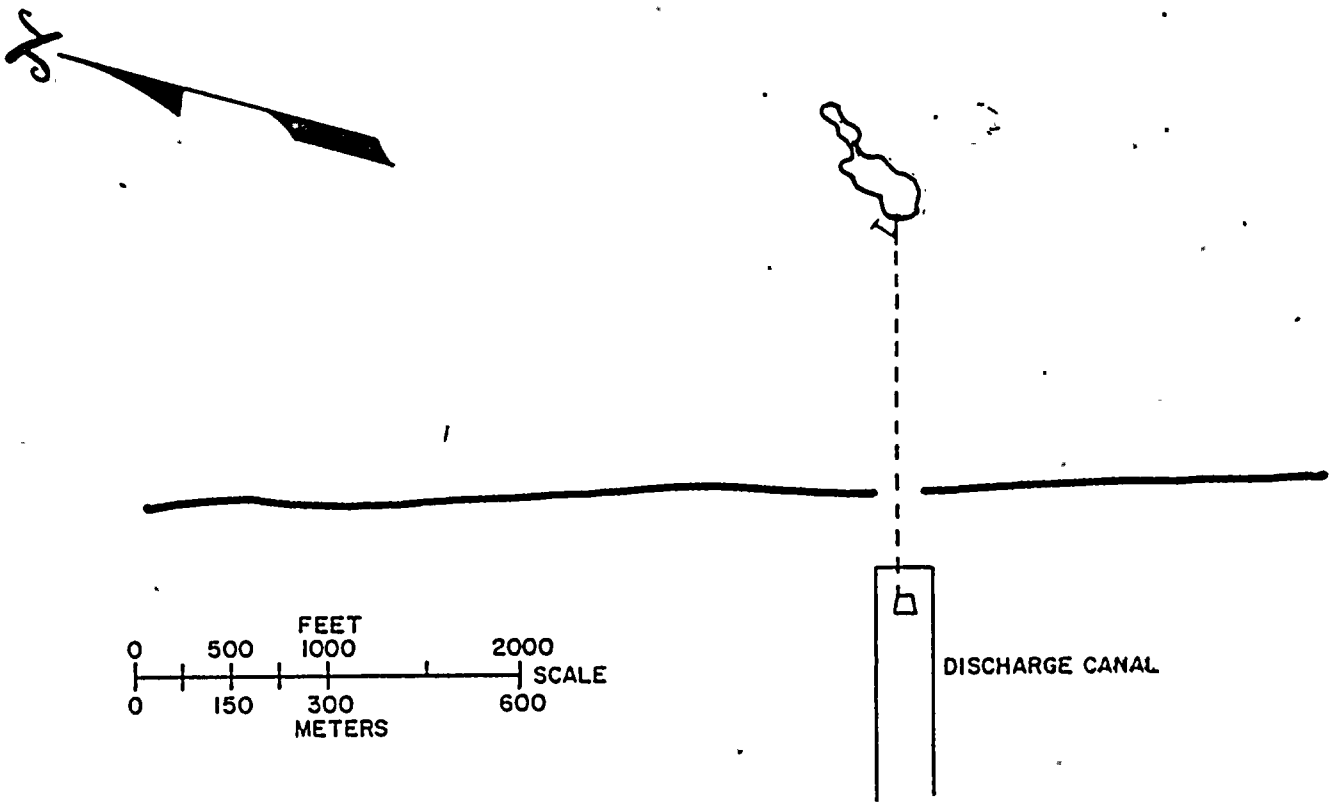
REACTOR POWER 100.1%
DISCHARGE FLOW 479,500
WIND 45° 6MPH
AMBIENT TEMP. INTAKE CANAL 79.0°F
DISCHARGE CANAL 102.1°F
HIGH TIDE
MAX. PLUME 6°F
ACRES 22.2

4.0°F



ST. LUCIE PLANT ISOTHERMS PLATE IV-7 B
FLIGHT PASS 11/8/77, TIME 1713

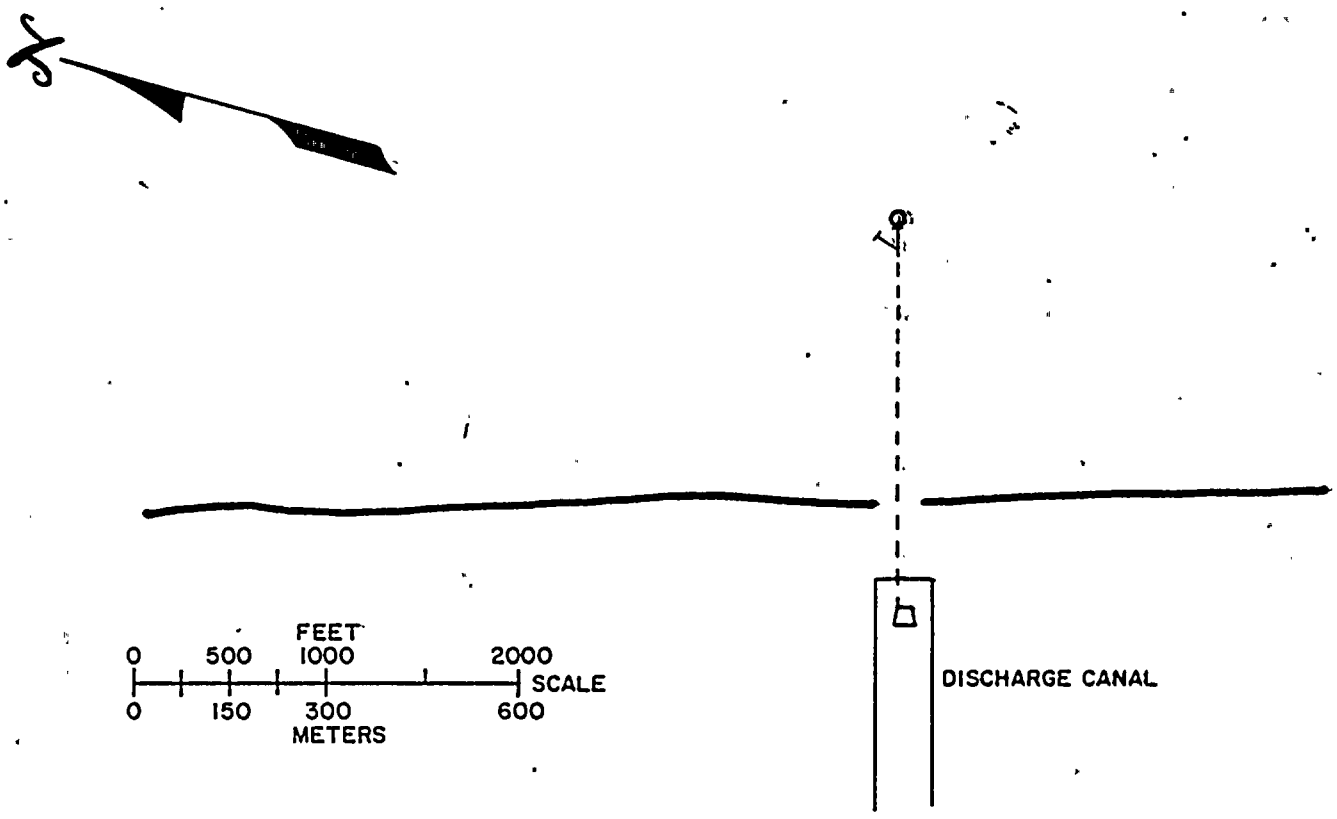
REACTOR POWER 100.1%
DISCHARGE FLOW 479,500 5.0°F
WIND 45° 6MPH
AMBIENT TEMP. INTAKE CANAL 79.0°F
DISCHARGE CANAL 102.1°F
HIGH TIDE
MAX. PLUME 6°F
ACRES 2.1



ST. LUCIE PLANT ISOTHERMS PLATE IV-7 C
FLIGHT PASS 11/8/77, TIME 1713

REACTOR POWER 100.1%
DISCHARGE FLOW 479,500
WIND 45° 6MPH
AMBIENT TEMP. INTAKE CANAL 79.0°F
DISCHARGE CANAL 102.1°F
HIGH TIDE
MAX. PLUME 6°F
ACRE 0.2

6.0°F



SECTION V

DISCUSSION

The imagery taken during the 1713 flight pass on 8 November, 1977 showed the plume to have been possibly affected by wind and current conditions. The plume spread in a northerly direction. The calculated length of the plume (south to north direction) showed to be approximately 1.5 miles long and the maximum width was calculated to be an estimated 0.9 mile wide.

The imagery of the 1130 flight pass showed to be small in area ΔT temperature distributions (see Table V-1). The morning plume was moving out with very little spreading in a northerly direction, thus appearing to be affected mainly by wind conditions. The length of the plume was calculated to be approximately 0.66 mile long and approximatley 0.33 mile wide at the maximum width.

Table V-1

Excess Temperature ΔT Isotherm

FLIGHT PASS 11/8/77 1130 REACTOR POWER 99.55% LOW TIDE @ 1106 Reference Ambient		FLIGHT PASS 11/8/77 1713 REACTOR POWER 100.1% HIGH TIDE @ 1711 Reference Ambient	
ΔT Isotherms (^{o}F)	Area (acres)	ΔT Isotherms (^{o}F)	Area (acres)
6.0	-	6.0	0.19
5.0	-	5.0	2.10
4.0	-	4.0	22.2
3.0	1.34	3.0	157
2.0	51.7	2.0	529 est.
1.5	120	1.5	636 est.

Table V-1 is the comparisons of ΔT excess temperatures above reference ambient and the areas of each ΔT isotherms. The maximum ΔT isotherm for low tide conditions on flight pass 1130 showed that the excess maximum temperature did not exceed $3.0^{\circ}F$ above reference ambient. The maximum ΔT excess temperature for high tide conditions for flight pass 1713 was $6.0^{\circ}F$ above reference ambient temperature.

However, flight pass 1130 and 1713 at the $4.0^{\circ}F$ ΔT isotherm had calculated areas well below the mixing zone limit of 400 acres.

APPENDIX A

FLIGHT LOGS

During the flights on 8 November 1977, there was an offset temperature measured by the scanner. This is a normal occurrence caused by the cool moist air between the scanner and the ground. This offset is calibrated through the use of ground temperature measurements.

Since the scanner looks through a longer path at side angles than at center angles, the offset factor is greater at side angles than at center. This difference between side and center is normally .1° to .2°F and is considered negligible. However, on the 8 November 1977 flights, the difference between center 0° angle and side 33° angle was 1°F in the morning flights and .9°F in the afternoon flights.

Therefore, a correction factor was applied by adding a factor of cosecant -1 to the computed values for each angle. The exact factor of 1°F and .9°F was determined by using data from flight passes at 90° angles. One pass shows that radiation power is constant along a flight path. The crossing pass shows the variation of radiation power with scan angle.

FLIGHT LOG FP&L St. Lucie Plant

DATE 11/8/77

ENGINE START TIME

TAKE OFF TIME 1623

TAKE OFF WIND N @ 9 kt

TAKE OFF PLACE Stewart

CLOUD

CAL SOURCES

RUN #	TIME		TAPE		FILM		HEAD	ALT	V	COMMENTS
	ON	OFF	ON	OFF	ON	OFF				
1		1642	50	696			27°	6000	150	Ft Pierce
2		1656	690	3966			150°			Ft Pierce/St Lucie
3		1702	3960	4779			27°			St Lucie
4		1708	4779	5270			70°			Plant
5		1713	5270	5761			150°			Plant
6		1719	5761	6377			50°			Plant

TI-24266

FLIGHT LOG FP&L St. Lucie Plant

DATE 11/8/77

ENGINE START TIME

TAKE OFF TIME 1029

TAKE OFF WIND N @ 5 kt

TAKE OFF PLACE Stewart

CLOUD

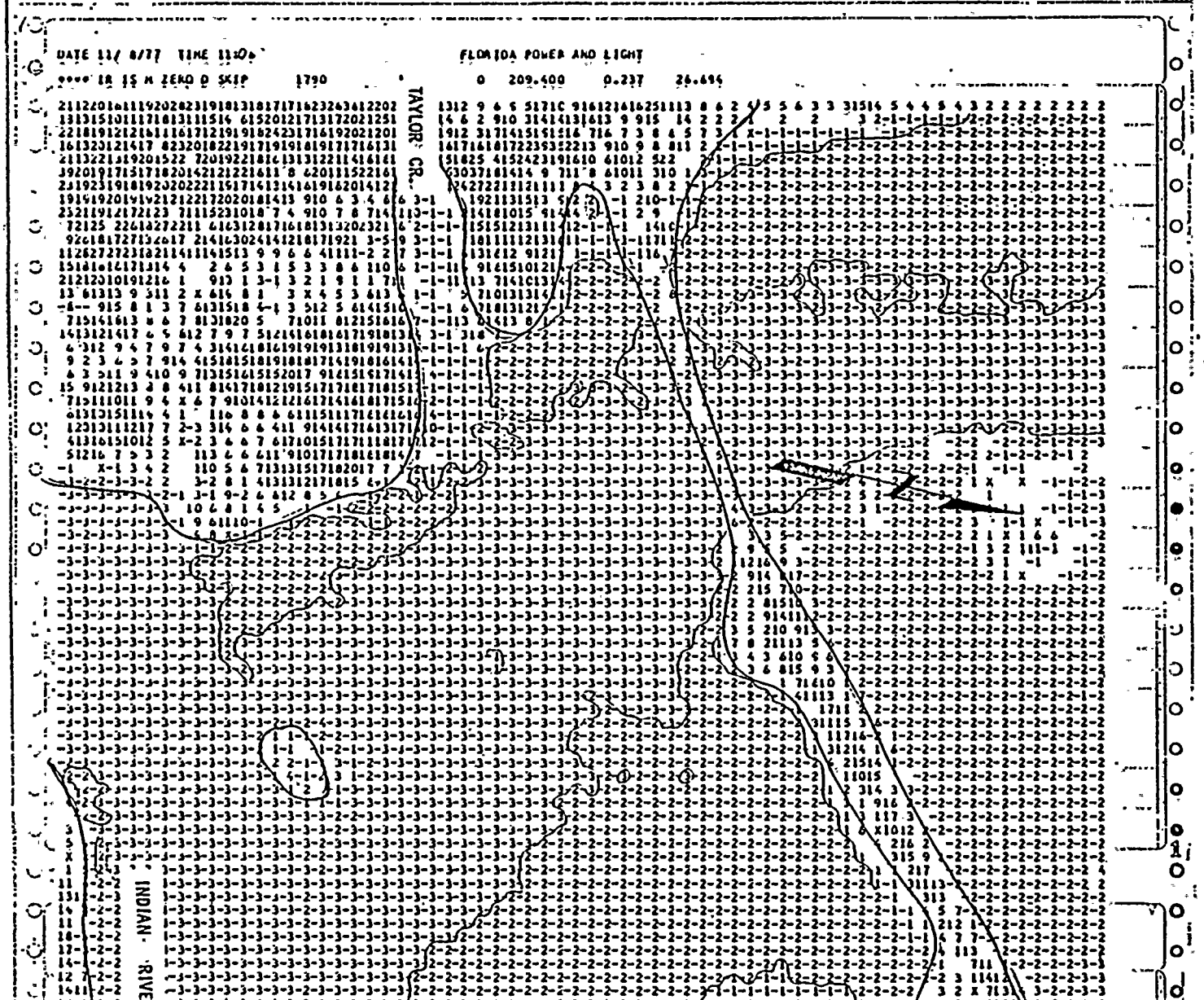
CAL SOURCES

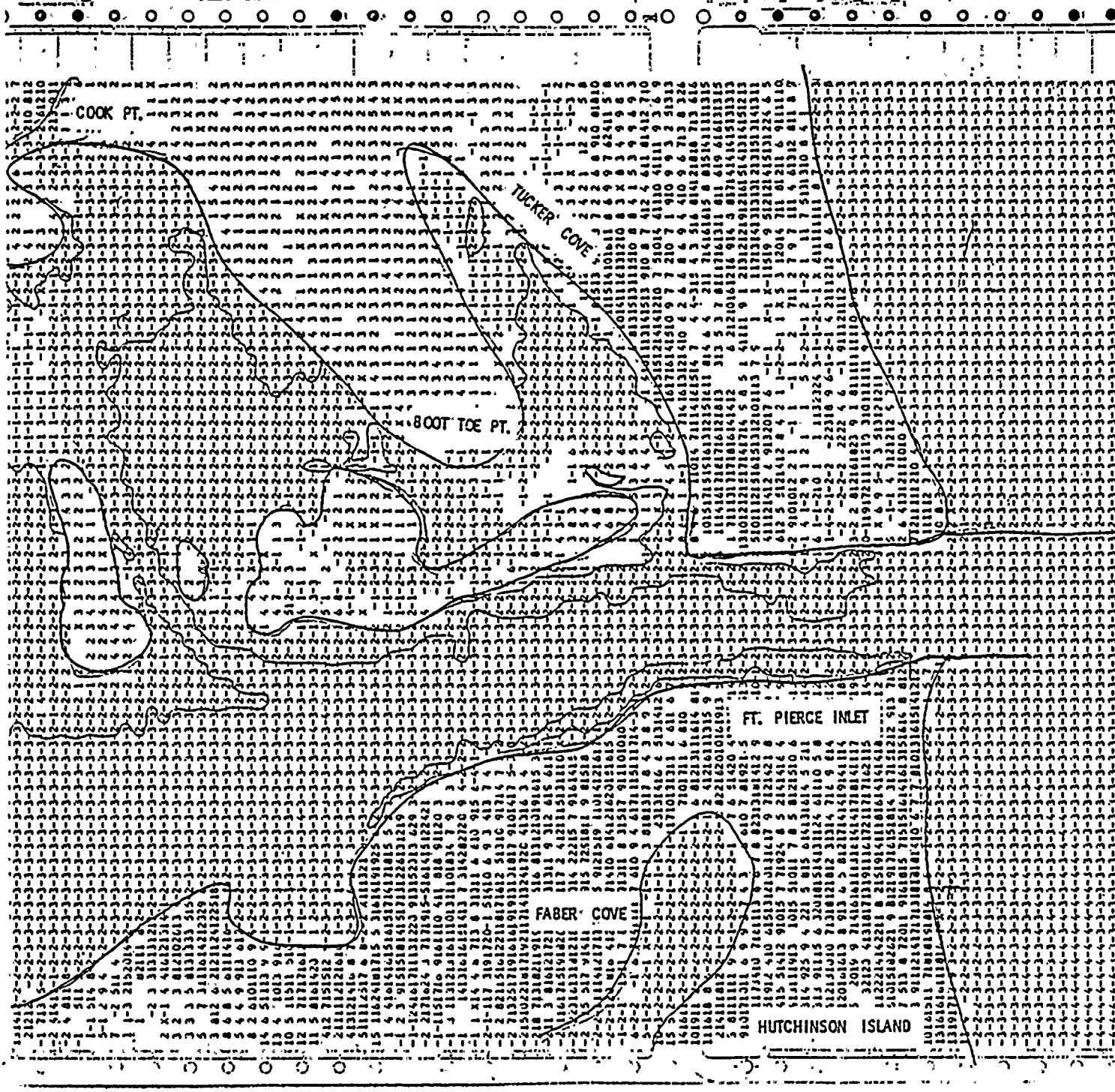
RUN #	TIME		TAPE		FILM		HEAD	ALT	V	COMMENTS
	ON	OFF	ON	OFF	ON	OFF			kt	
		1054	0	516			W	6000	150	Ft Pierce/bad tape
		1058	516	941			E			Ft Pierce/bad tape
		1103	941	1517			W			Ft Pierce/bad tape
		1106	1517	2085			E			Ft Pierce/good tape
		1118	2085	4895			155°			Ft Pierce/St Lucie
		1124	4895	5542			285°			St Lucie Inlet
		1130	5542	6056			60°			Plant
		1134	6056	6501			160°			Plant
		1140	6501	6901			165°			Plant

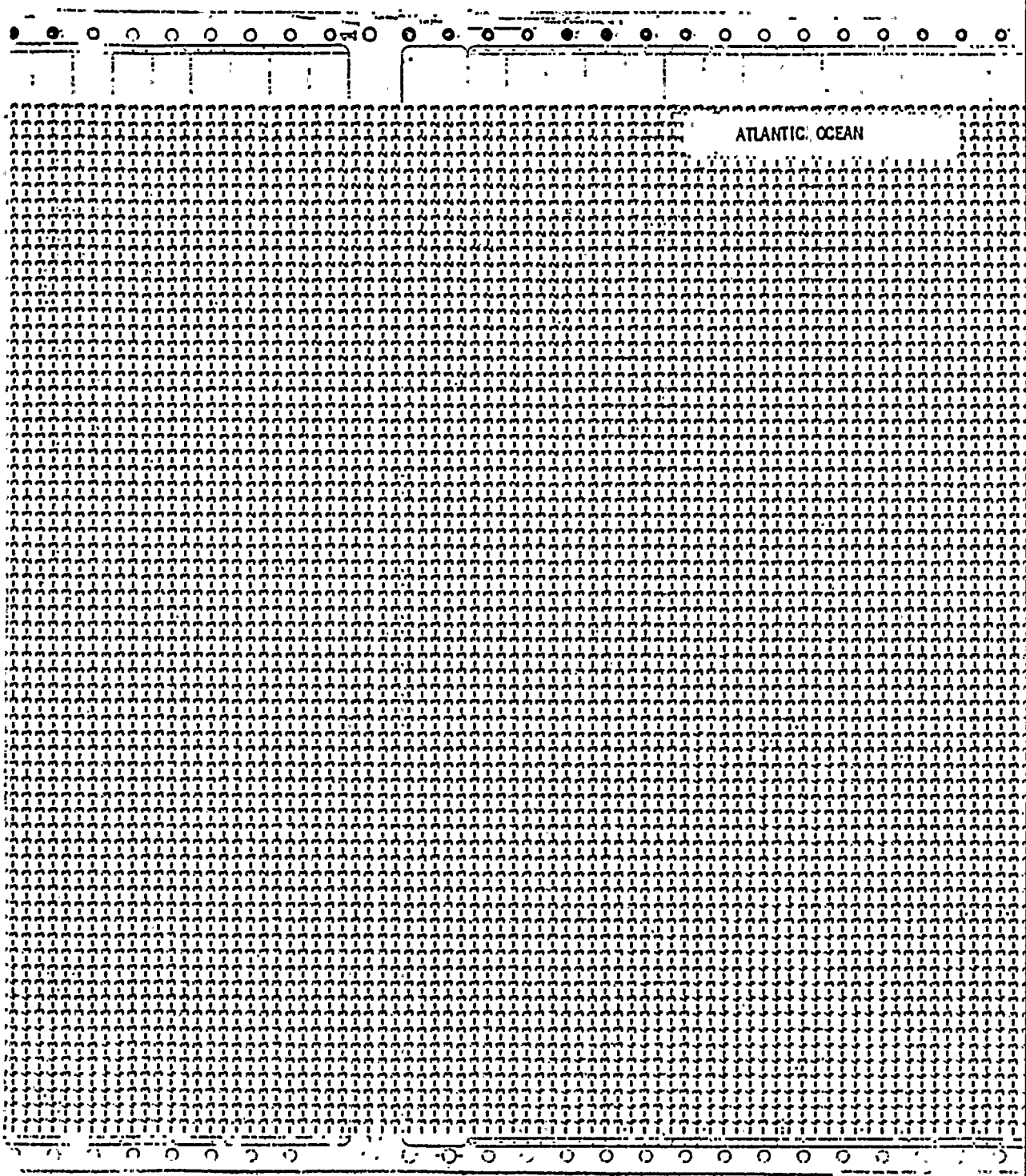
TI-24266

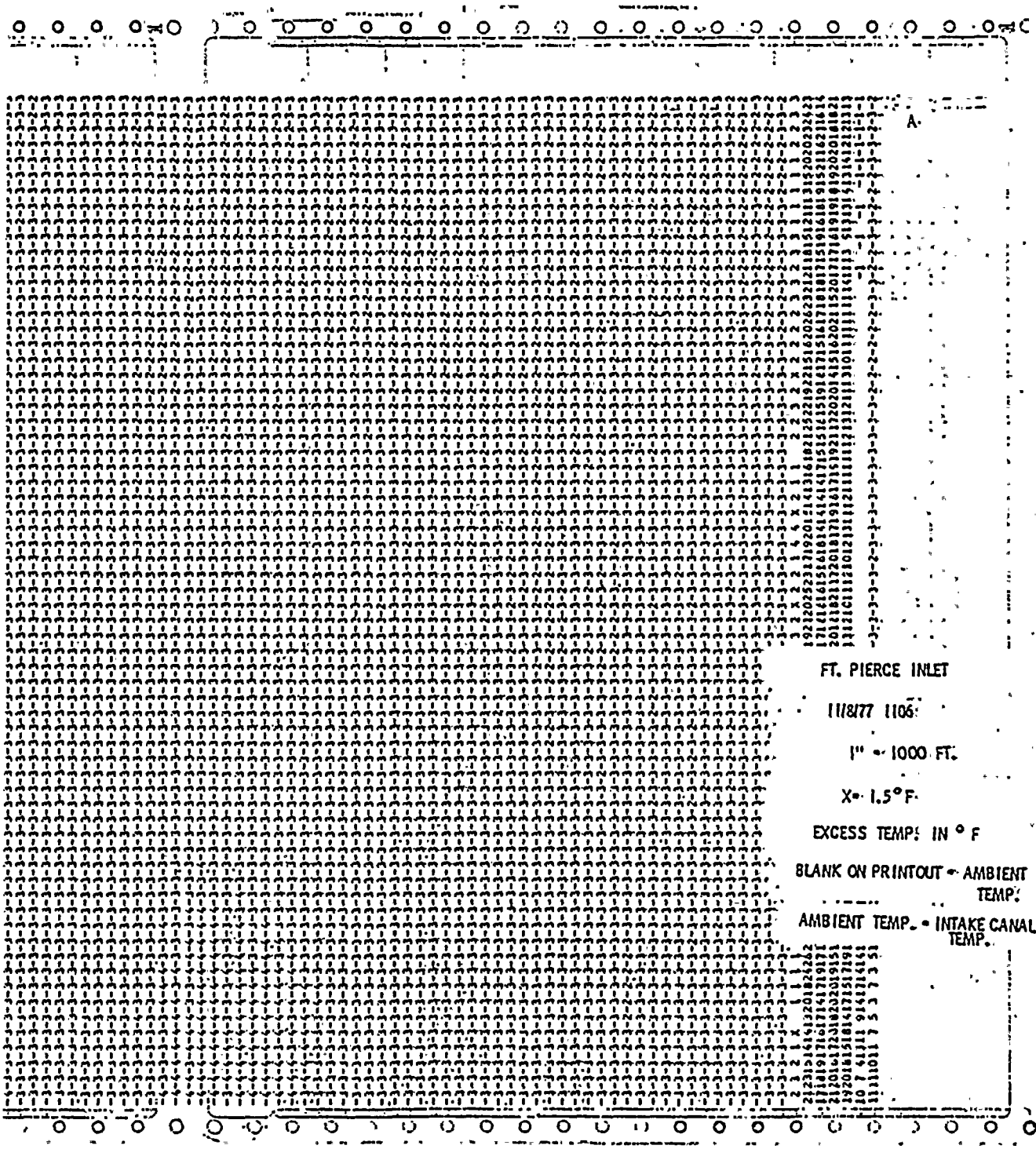
APPENDIX B

DATA PRINTOUTS
ATTACHMENTS
A-G

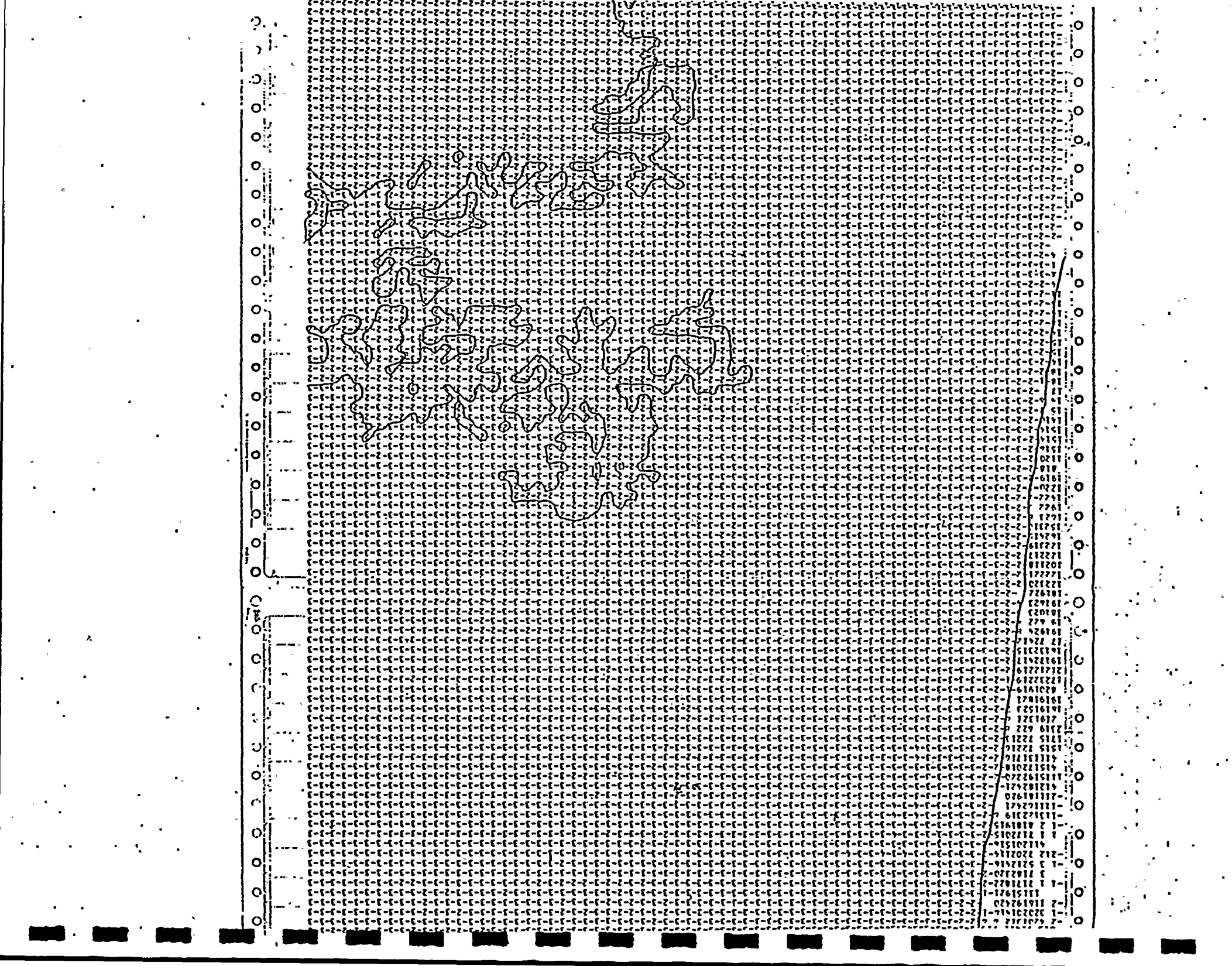

DATE 11/ 8/77 TIME 11:04
FLORIDA POWER AND LIGHT
TAYLOR CR.
INDIAN RIVE

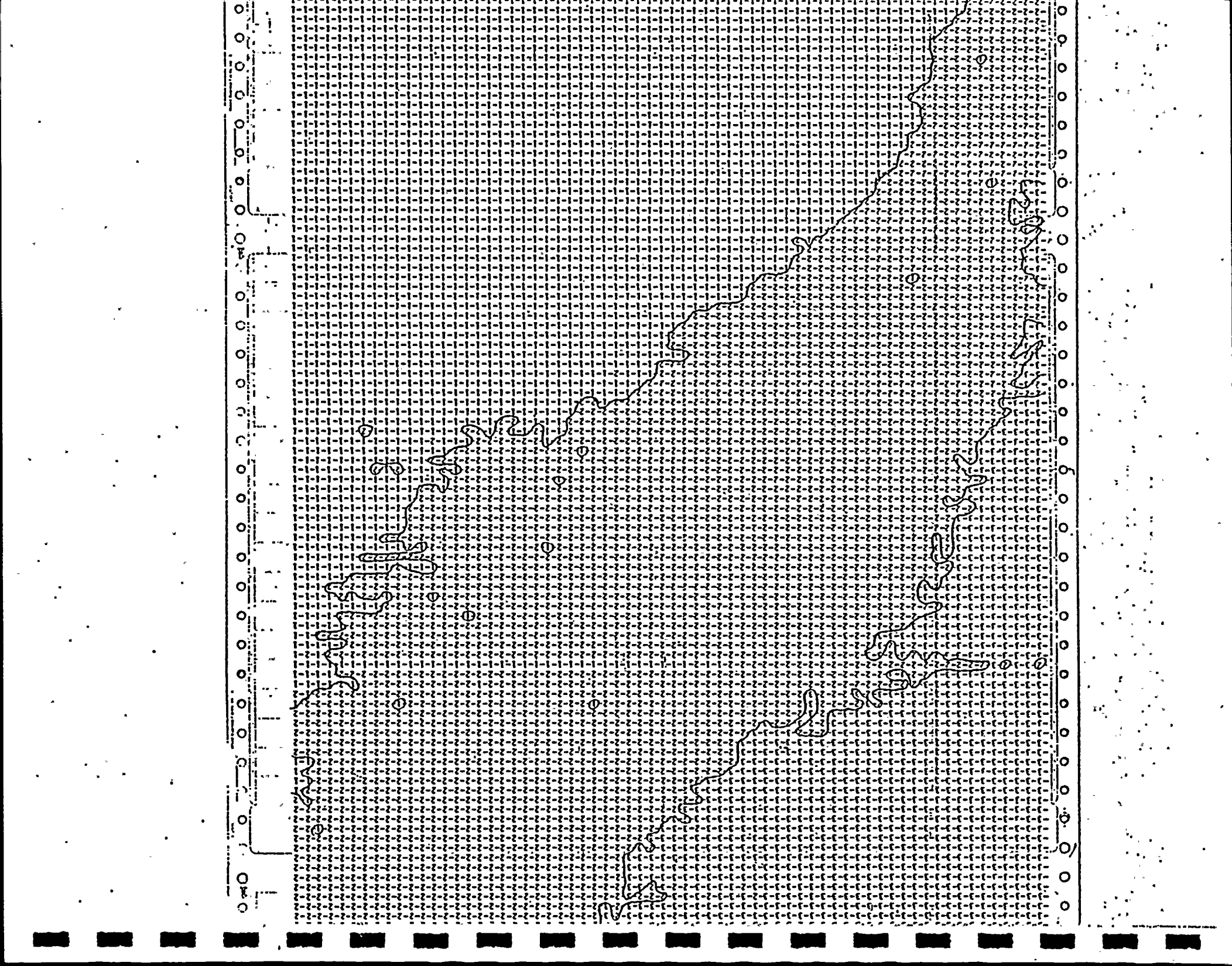

COOK PT.
TUCKER COVE
BOOT TOE PT.
FT. PIERCE INLET
FABER COVE
HUTCHINSON ISLAND

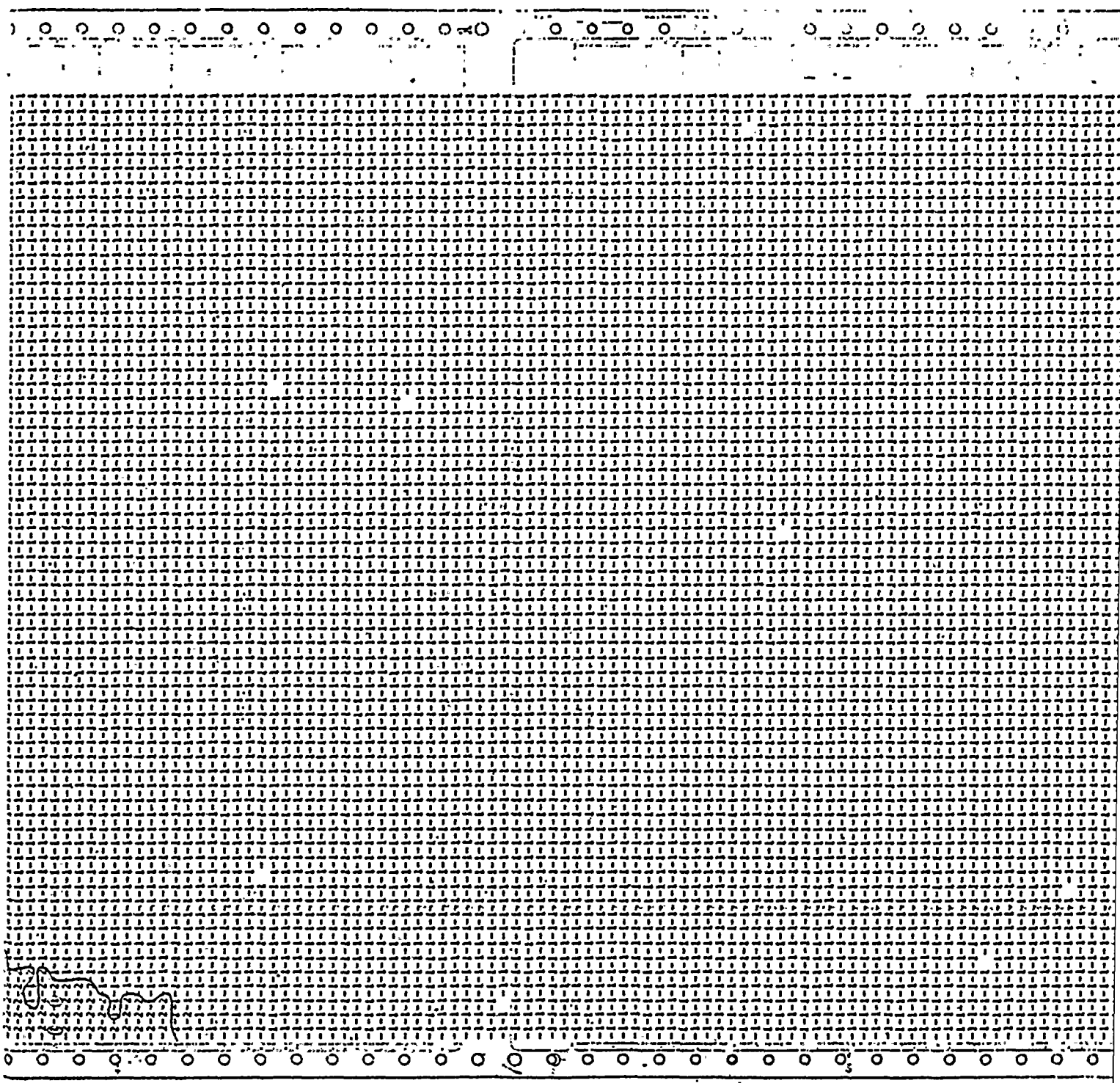

ATLANTIC OCEAN

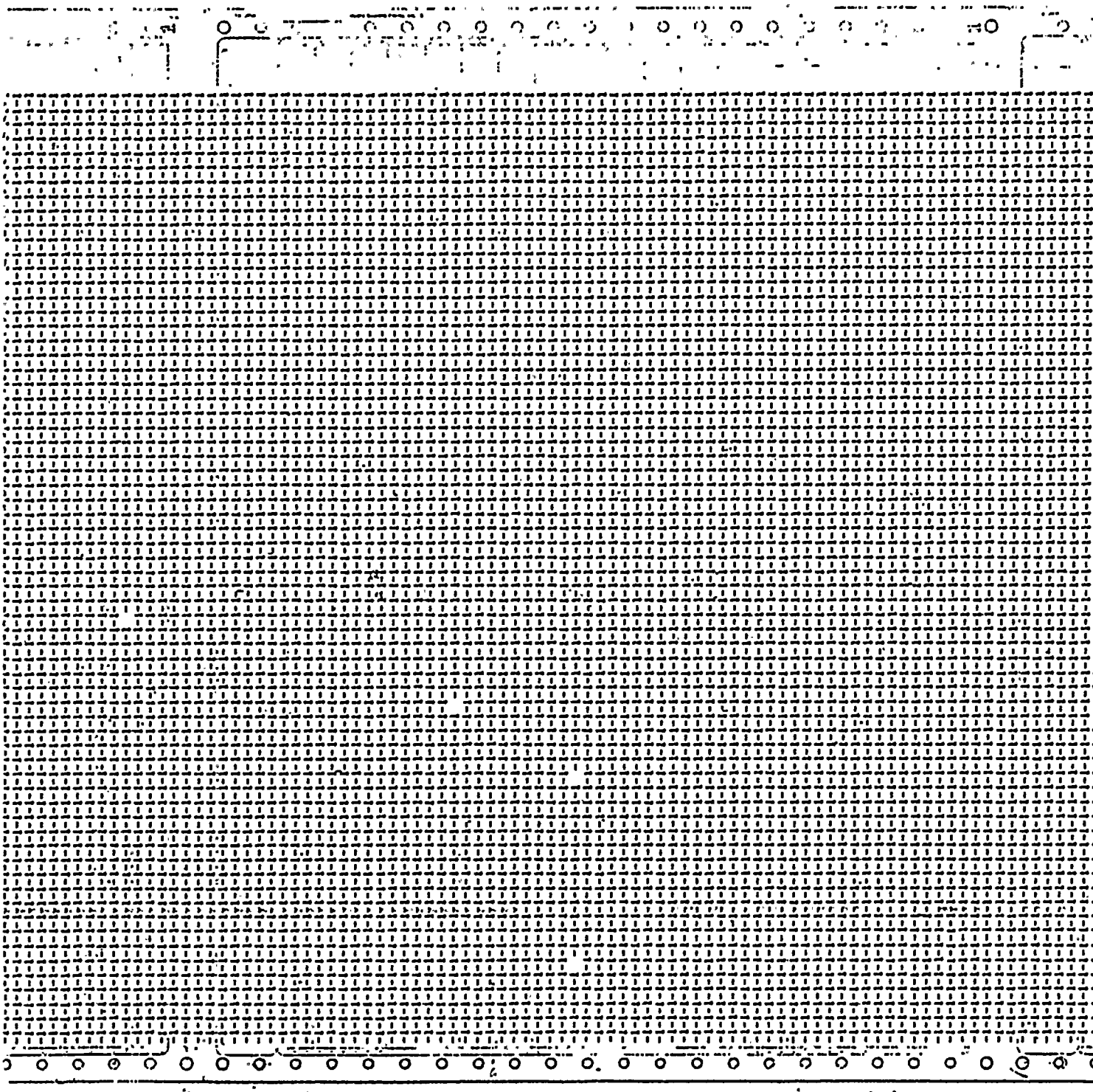

A
FT. PIERCE INLET
1118/77 1106
1" = 1000 FT.
X= 1.5°F
EXCESS TEMPS IN °F
BLANK ON PRINTOUT = AMBIENT TEMPS
AMBIENT TEMP. = INTAKE CANAL TEMP.

ATLANTIC OCEAN
FT. PIERCE INLET

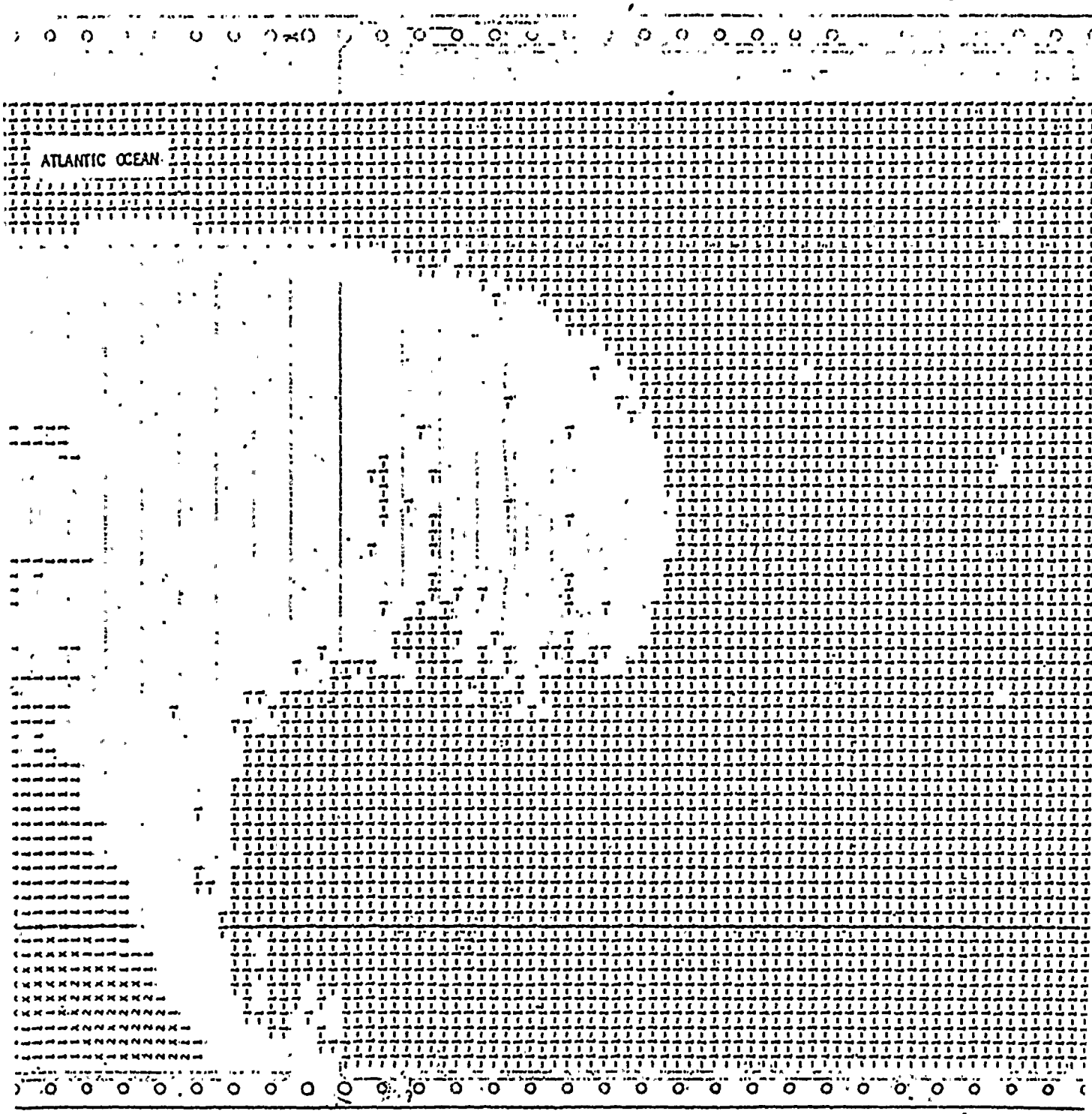


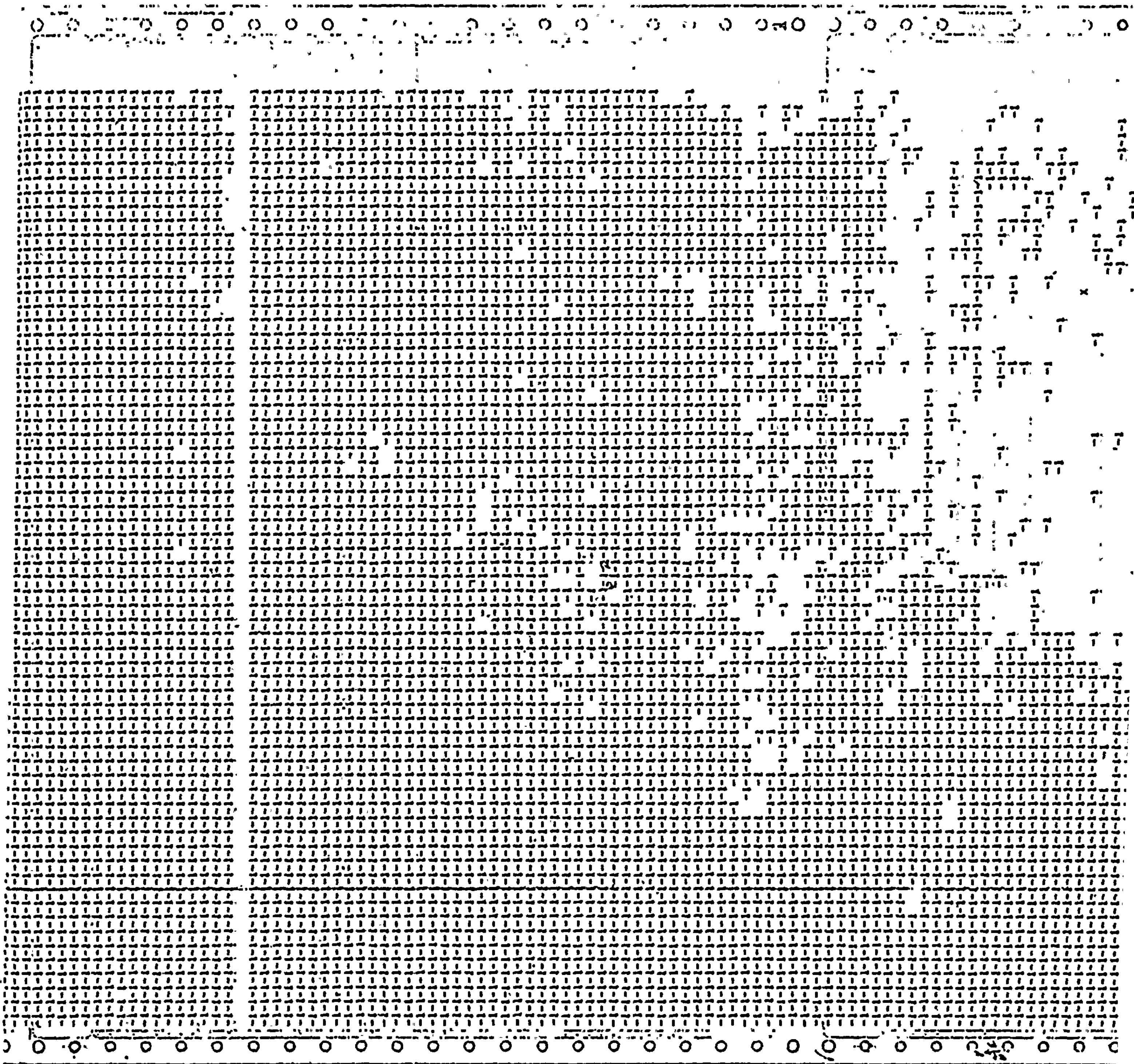


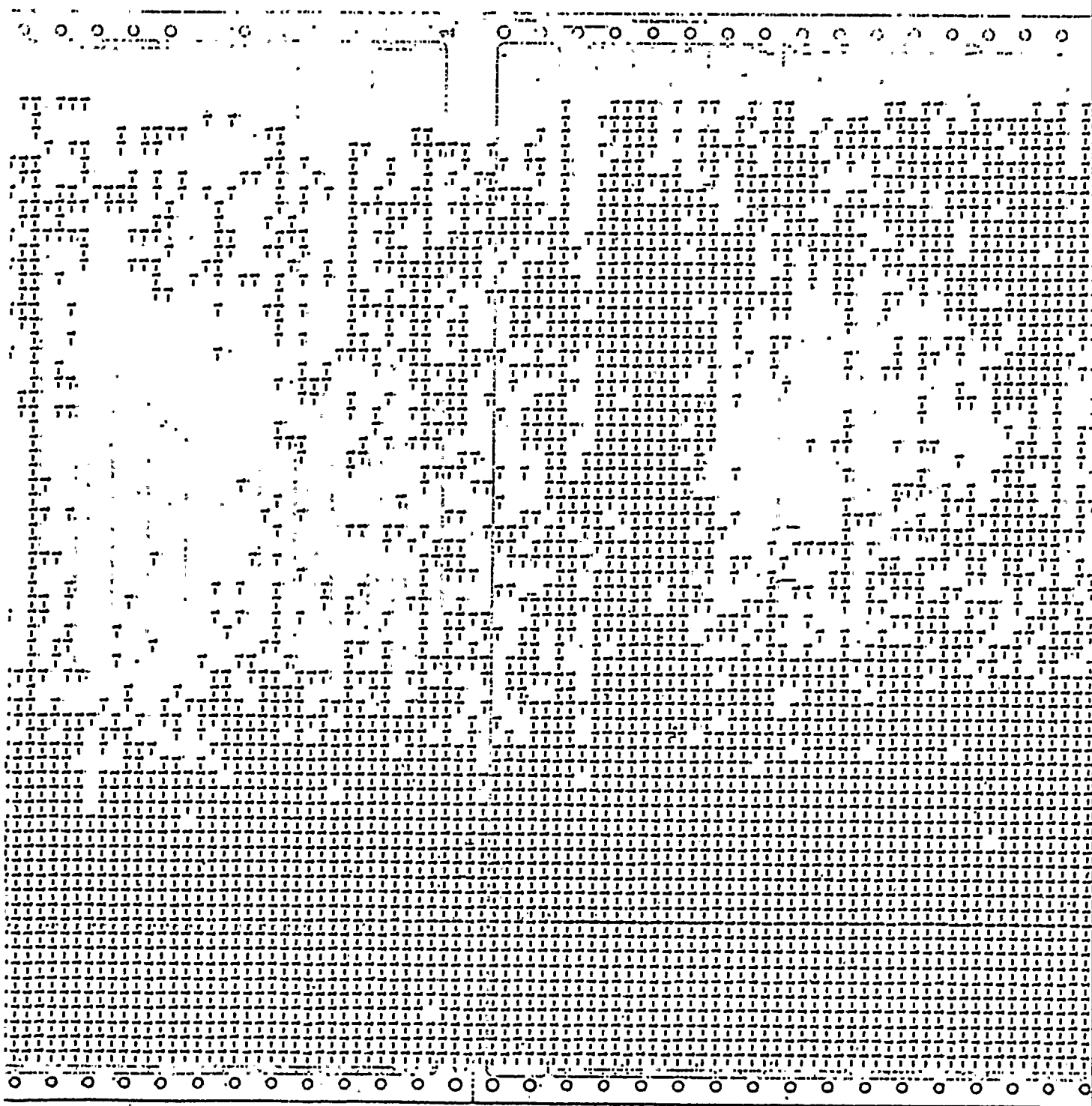


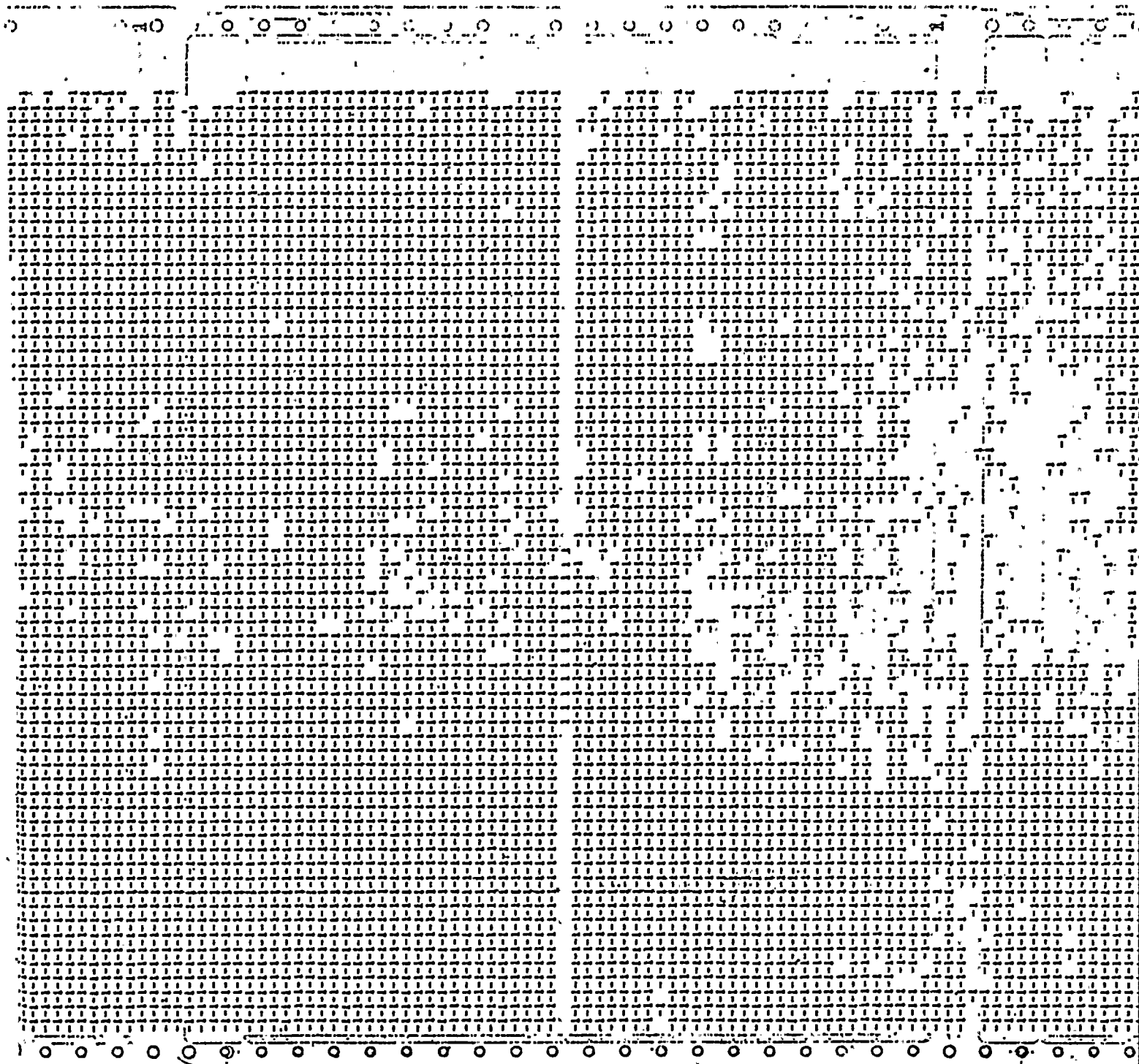


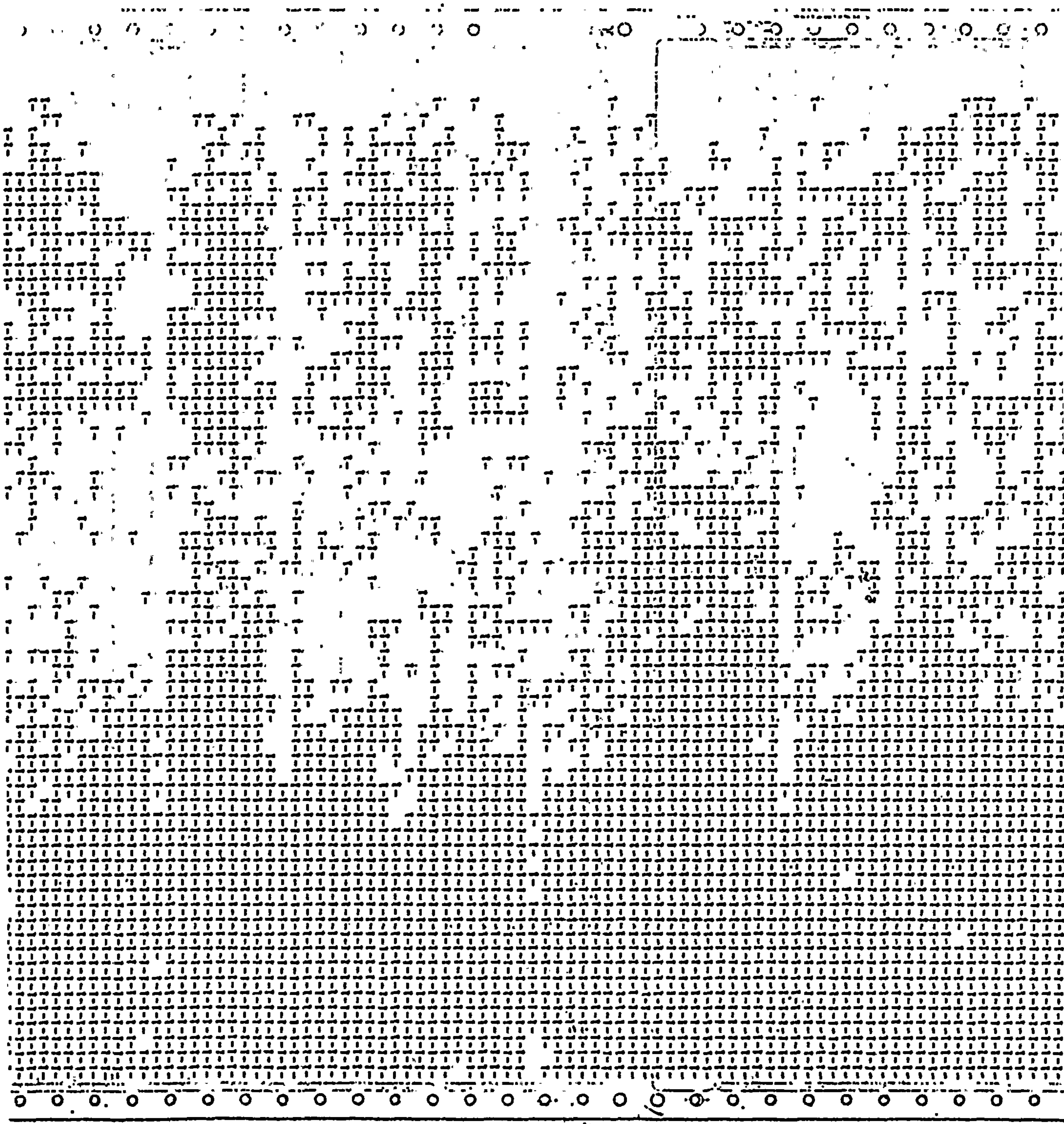

ST. LUCIE PLANT

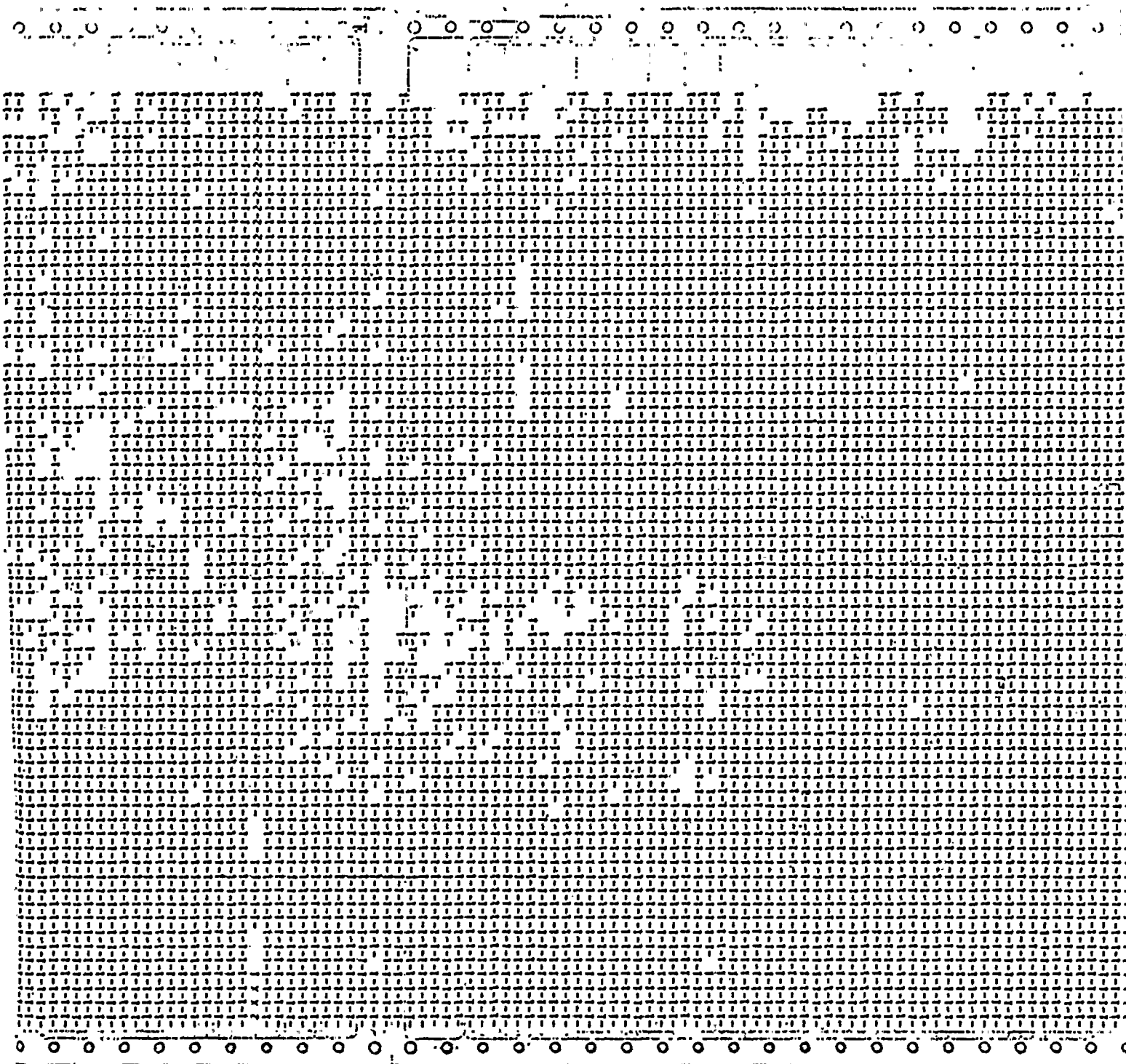

ATLANTIC OCEAN

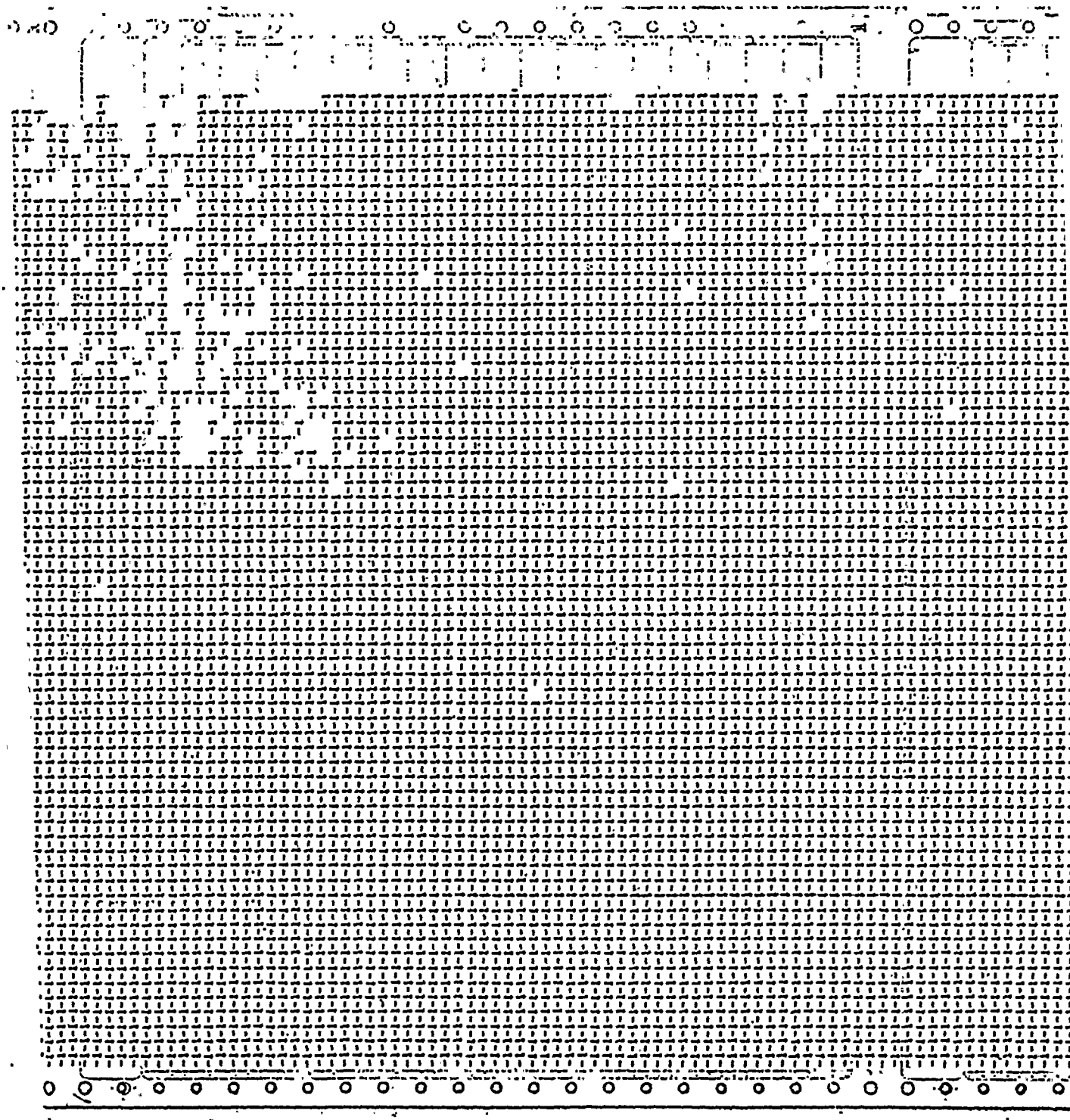


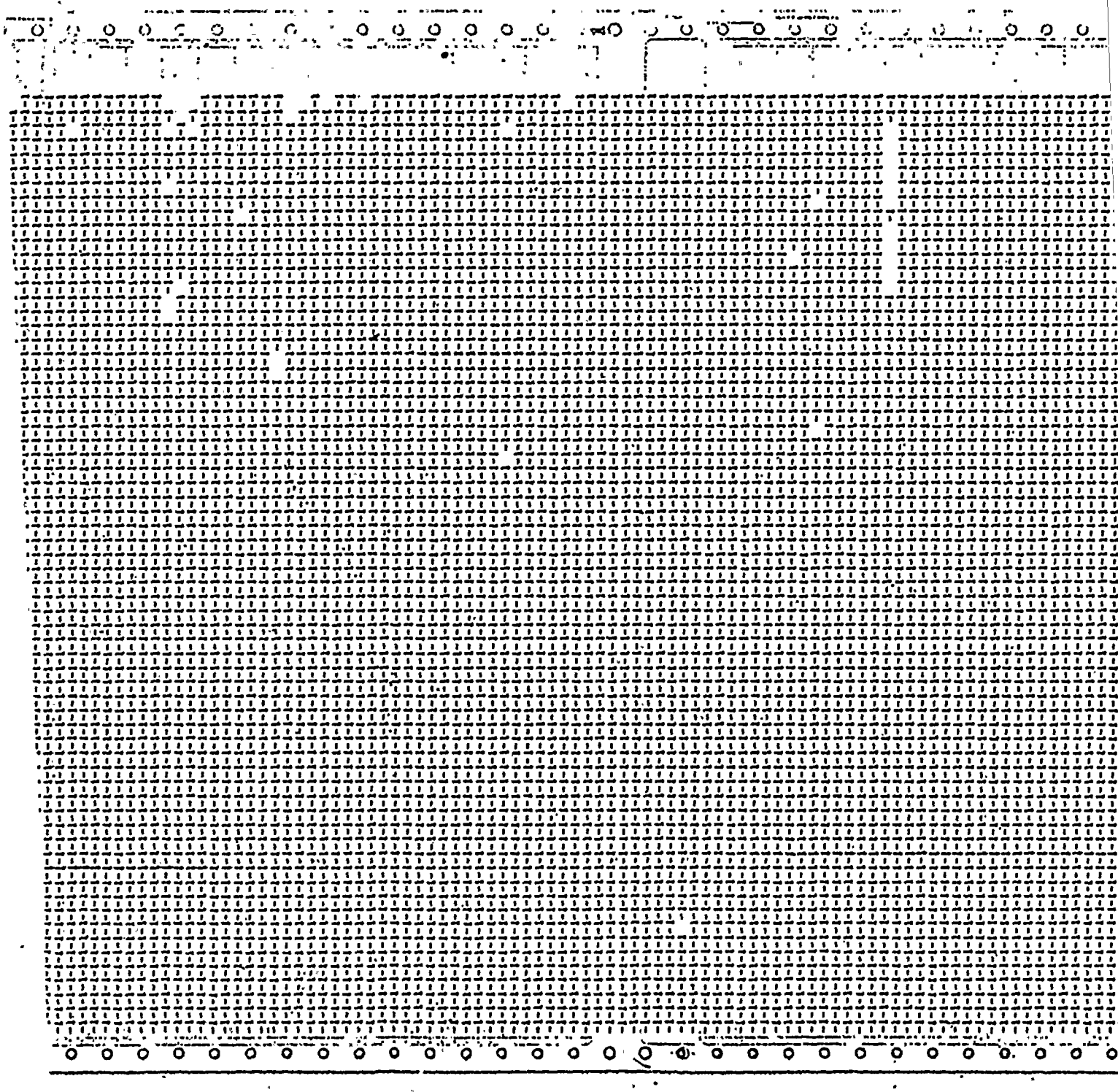


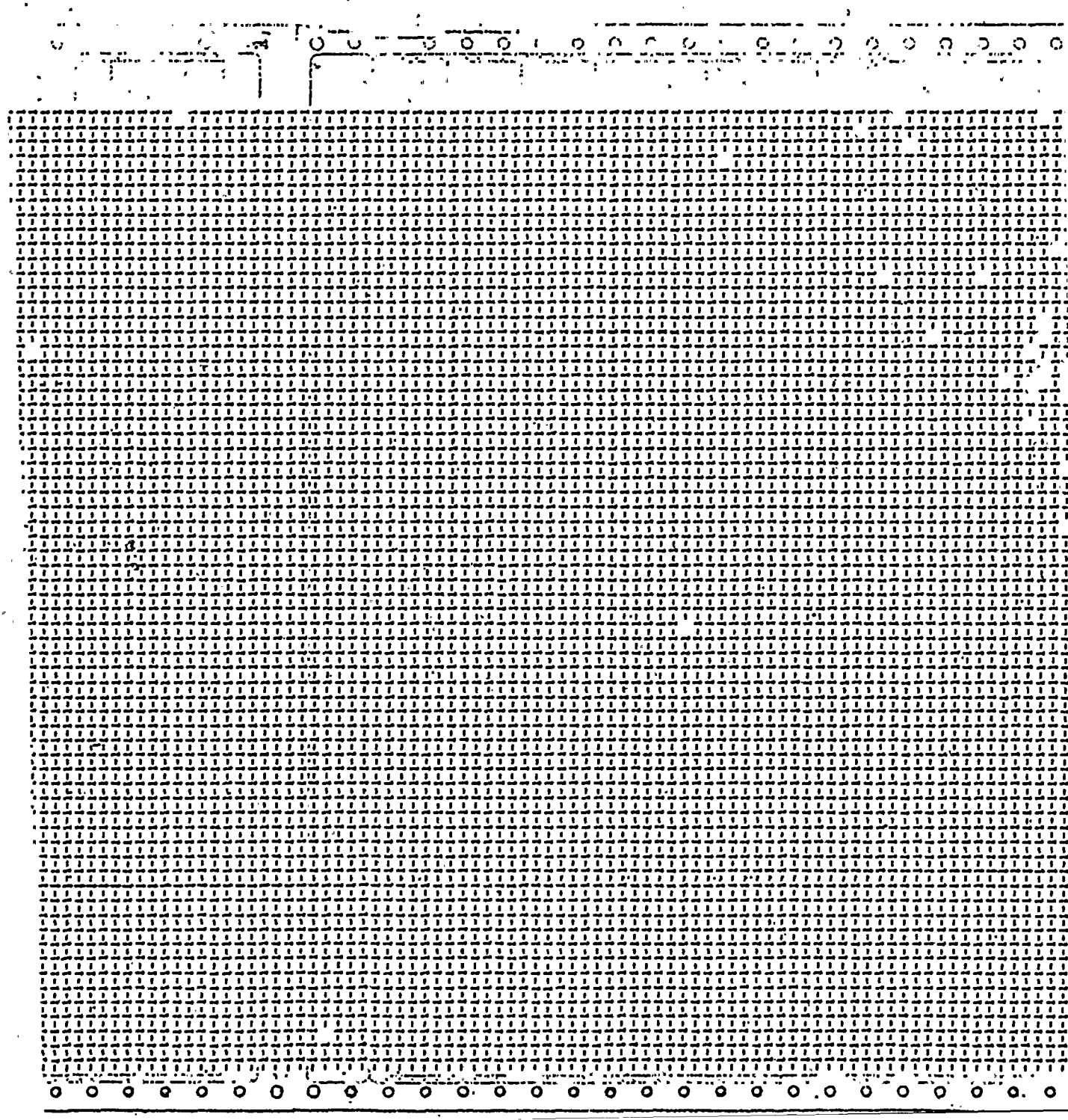


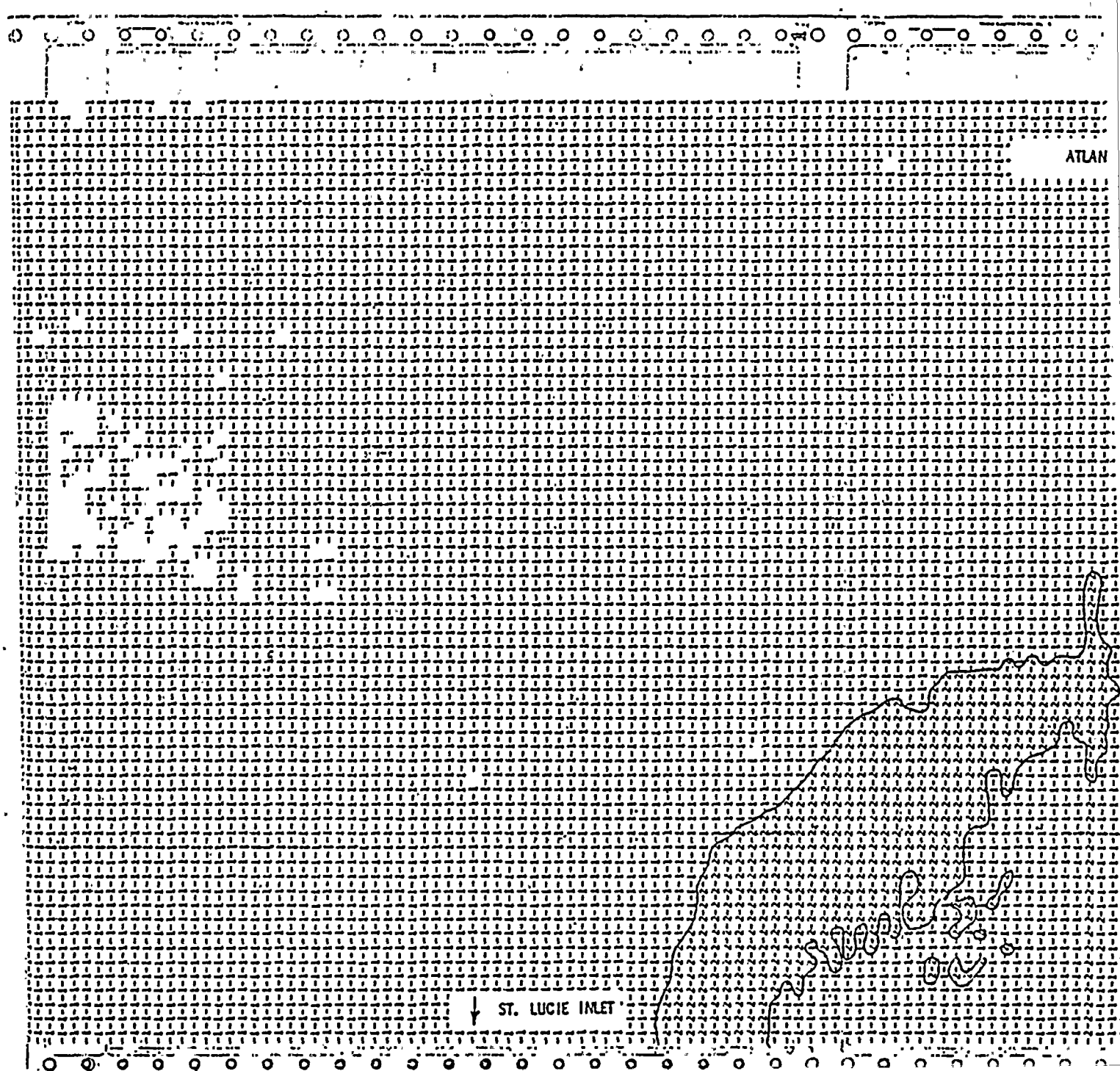


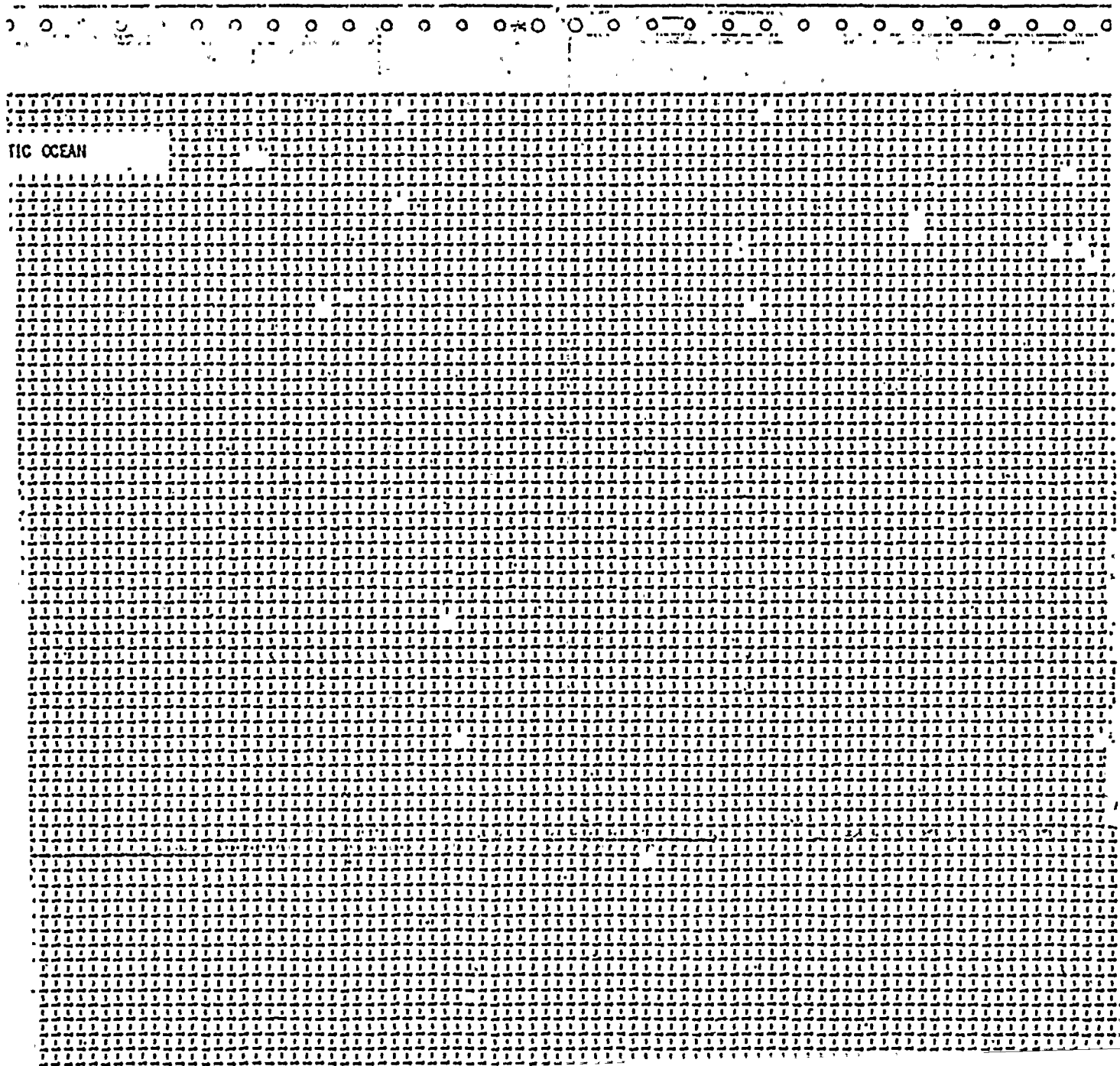


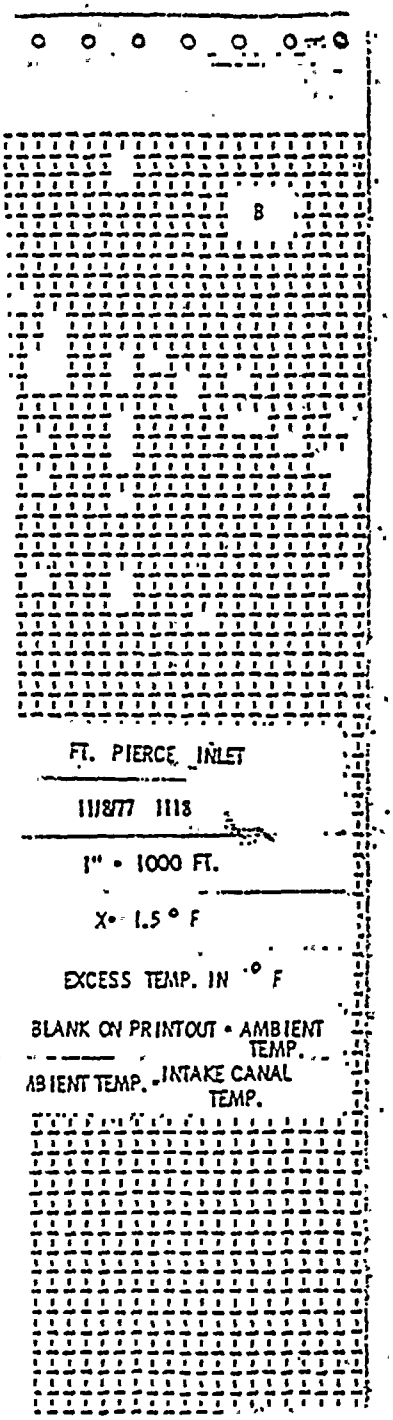


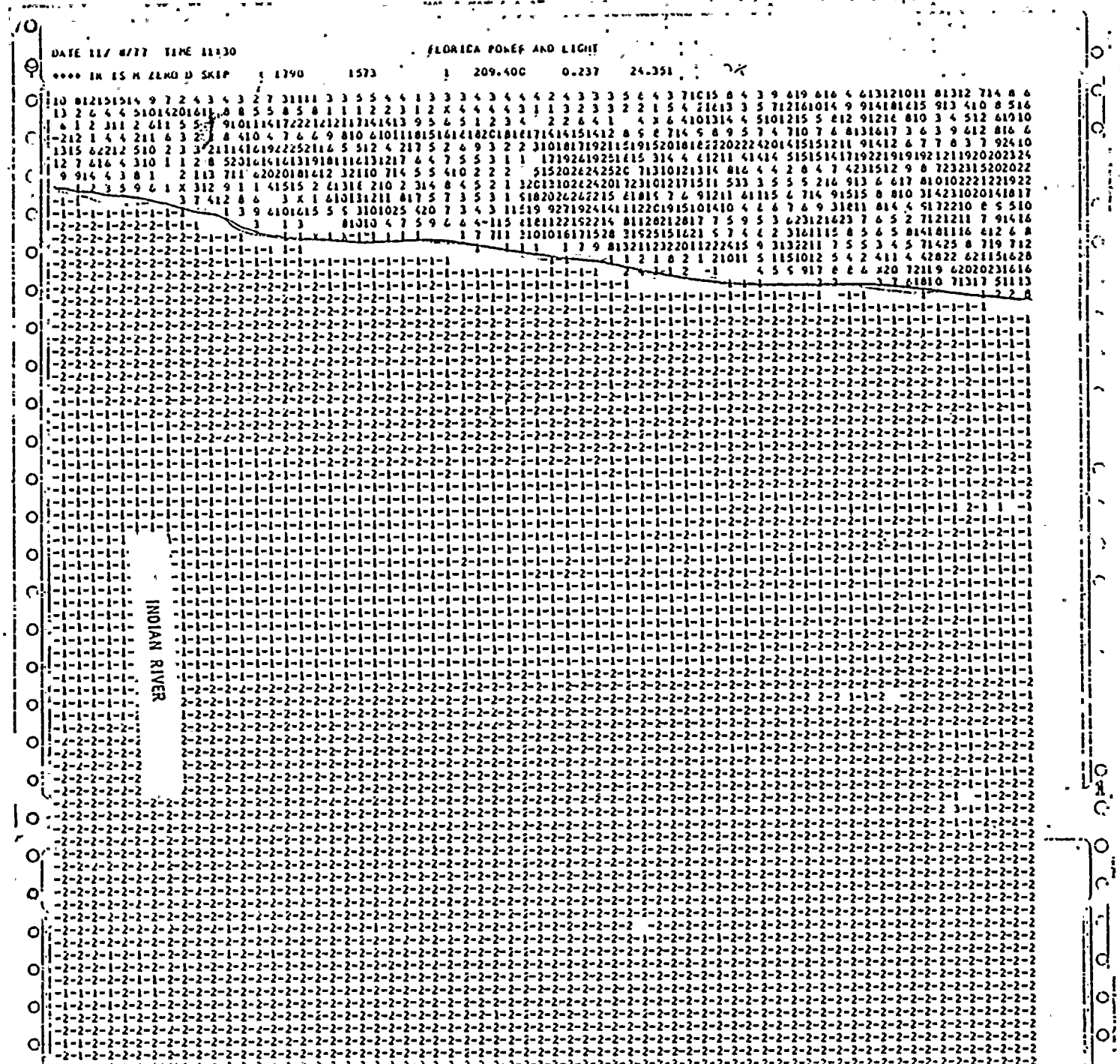


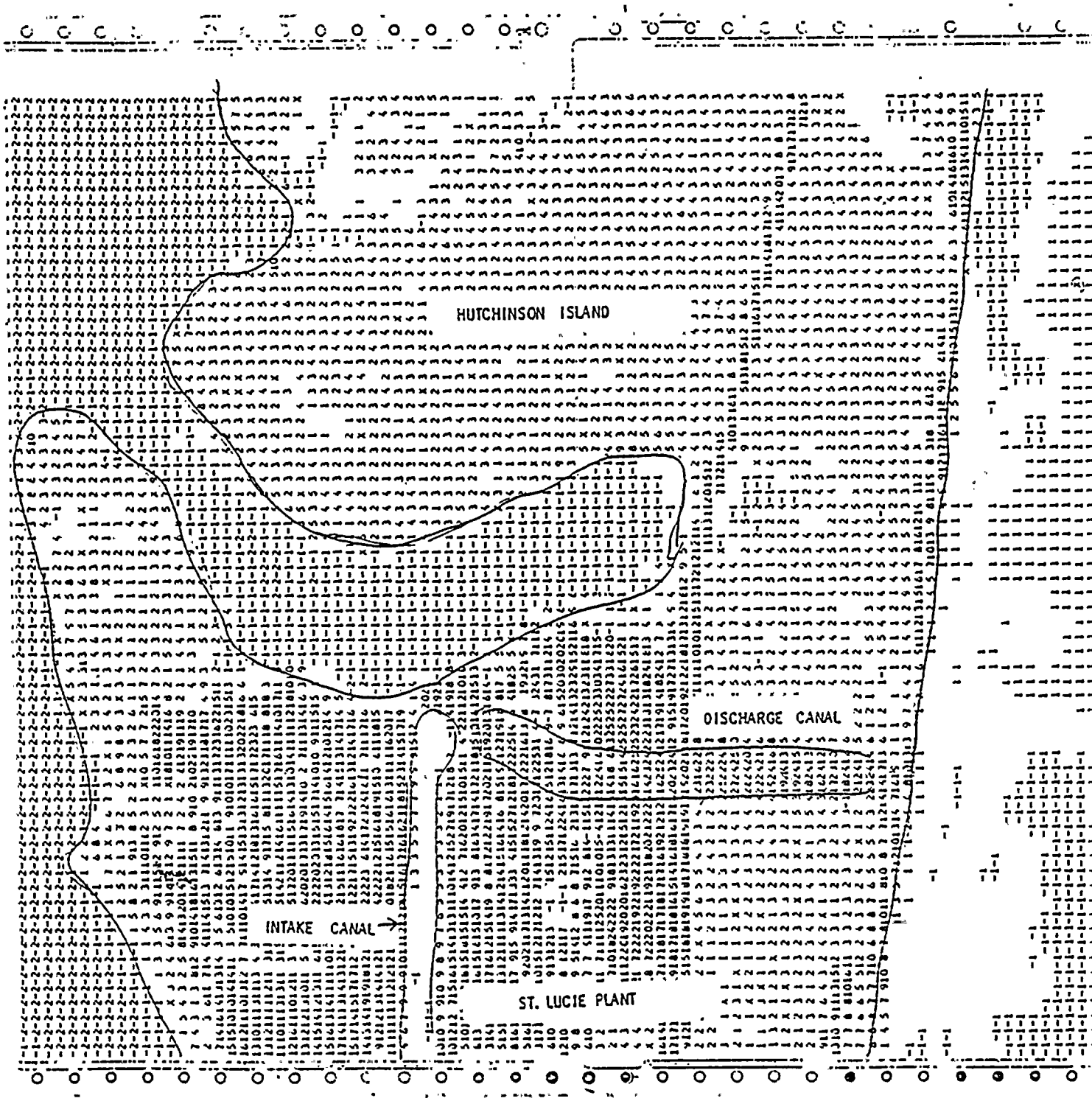


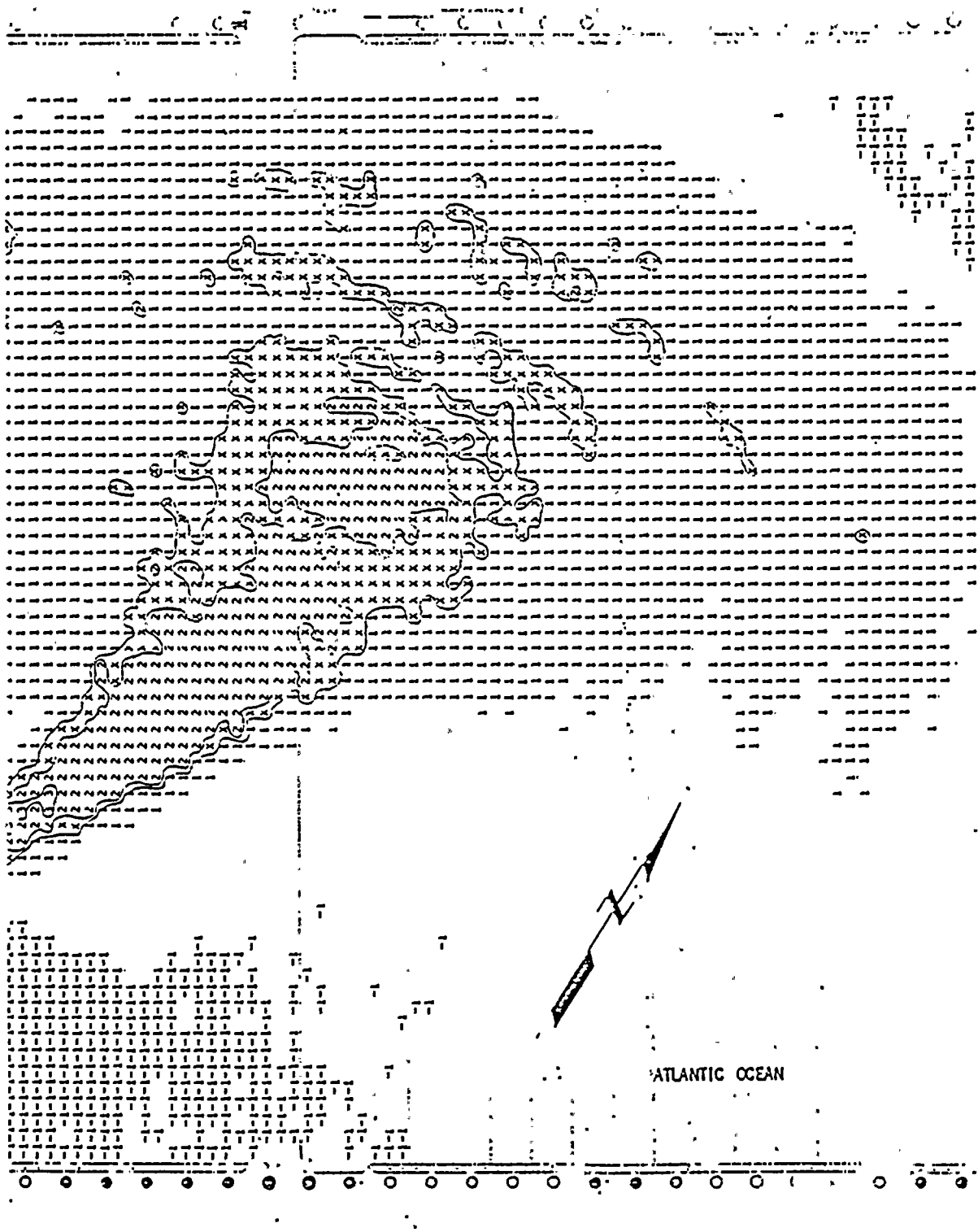

ATLAN
ST. LUCIE INLET

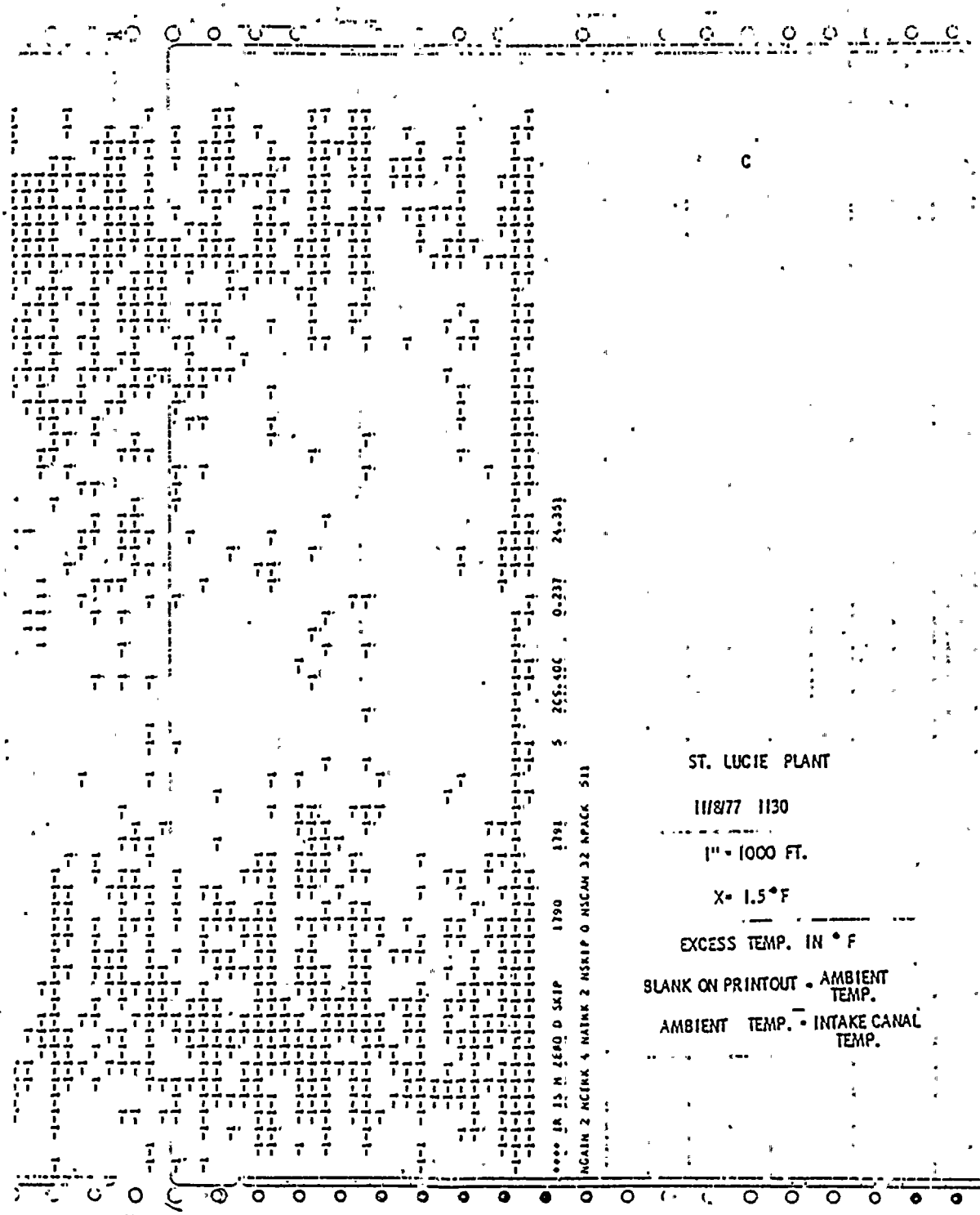

TIC OCEAN

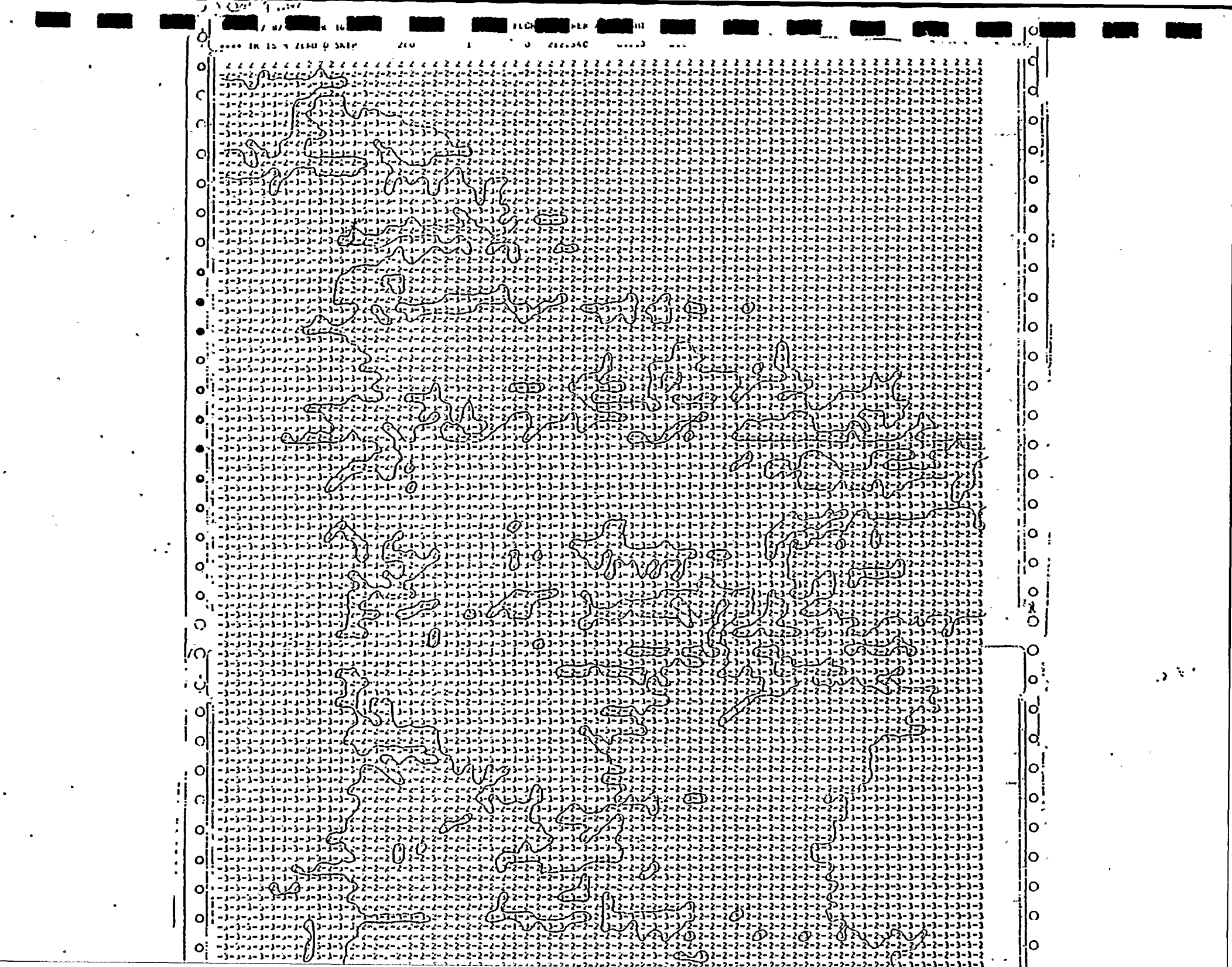

B
FT. PIERCE INLET
111877 1118
1" • 1000 FT.
X• 1.5 ° F
EXCESS TEMP. IN ° F
BLANK ON PRINTOUT • AMBIENT TEMP.
AMBIENT TEMP. • INTAKE CANAL TEMP.

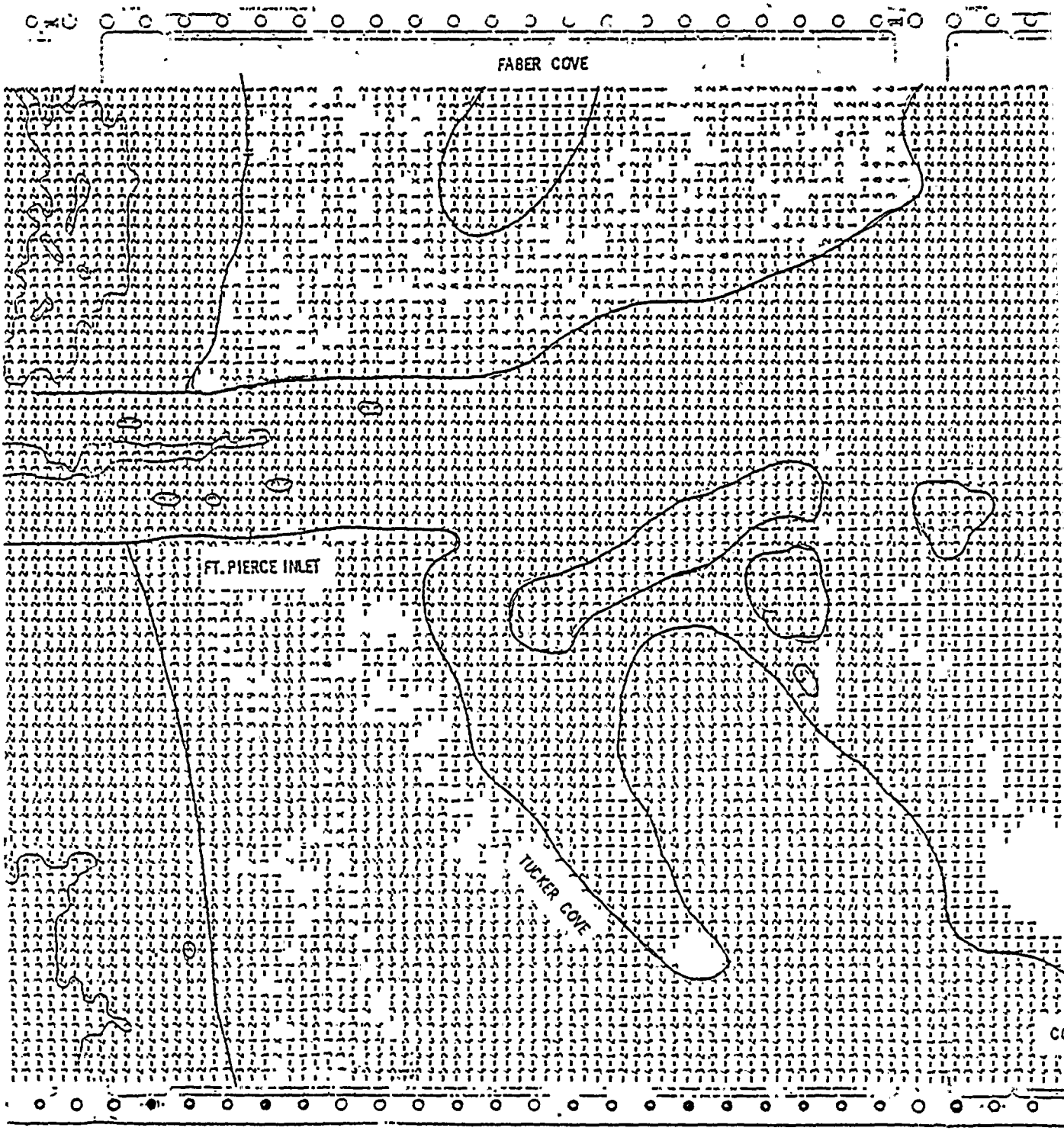

DATE 11/ 8/77 TIME 11:30
FLORIDA POWER AND LIGHT
INDIAN RIVER

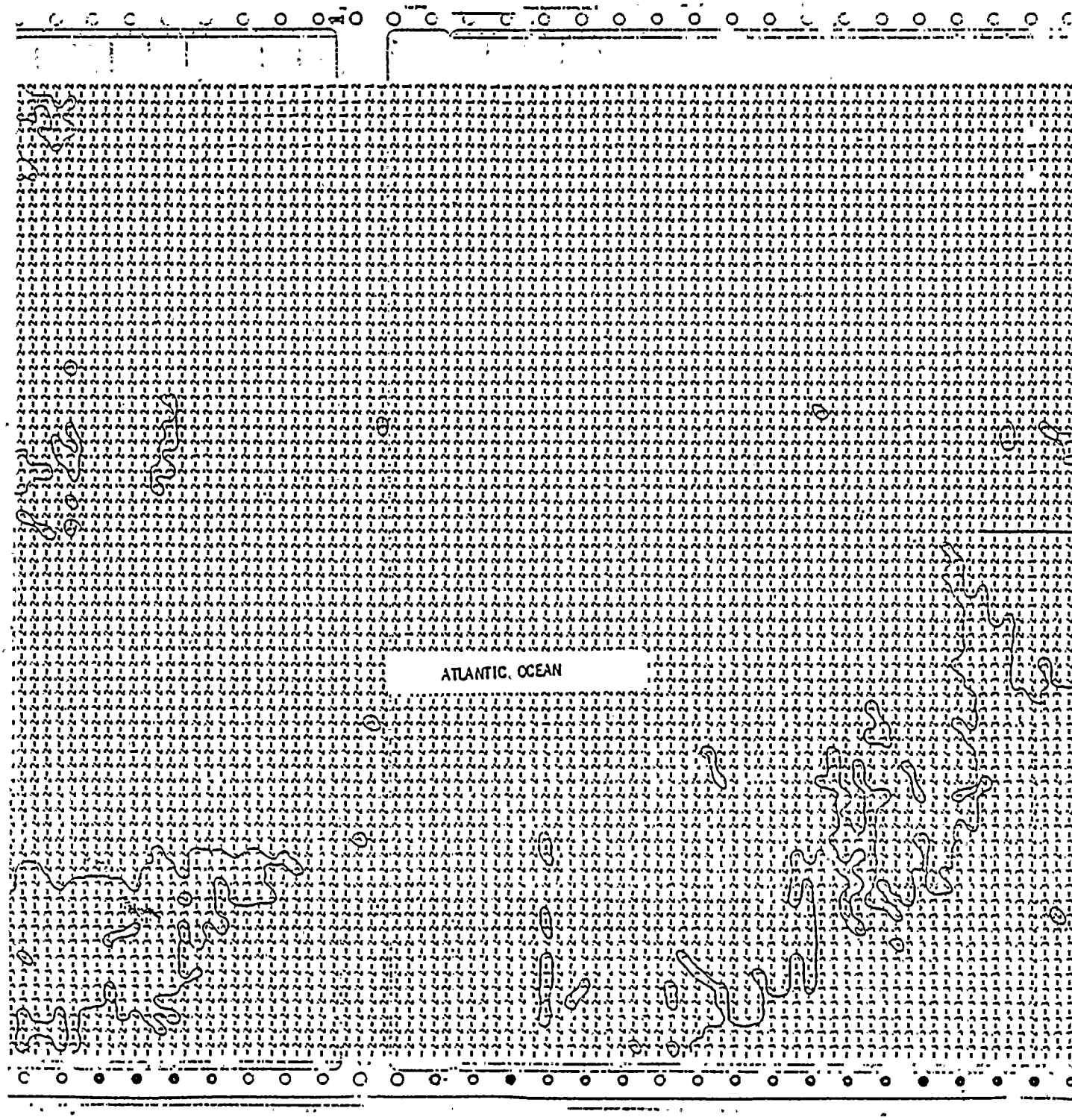

HUTCHINSON ISLAND
DISCHARGE CANAL
INTAKE CANAL
ST. LUCIE PLANT

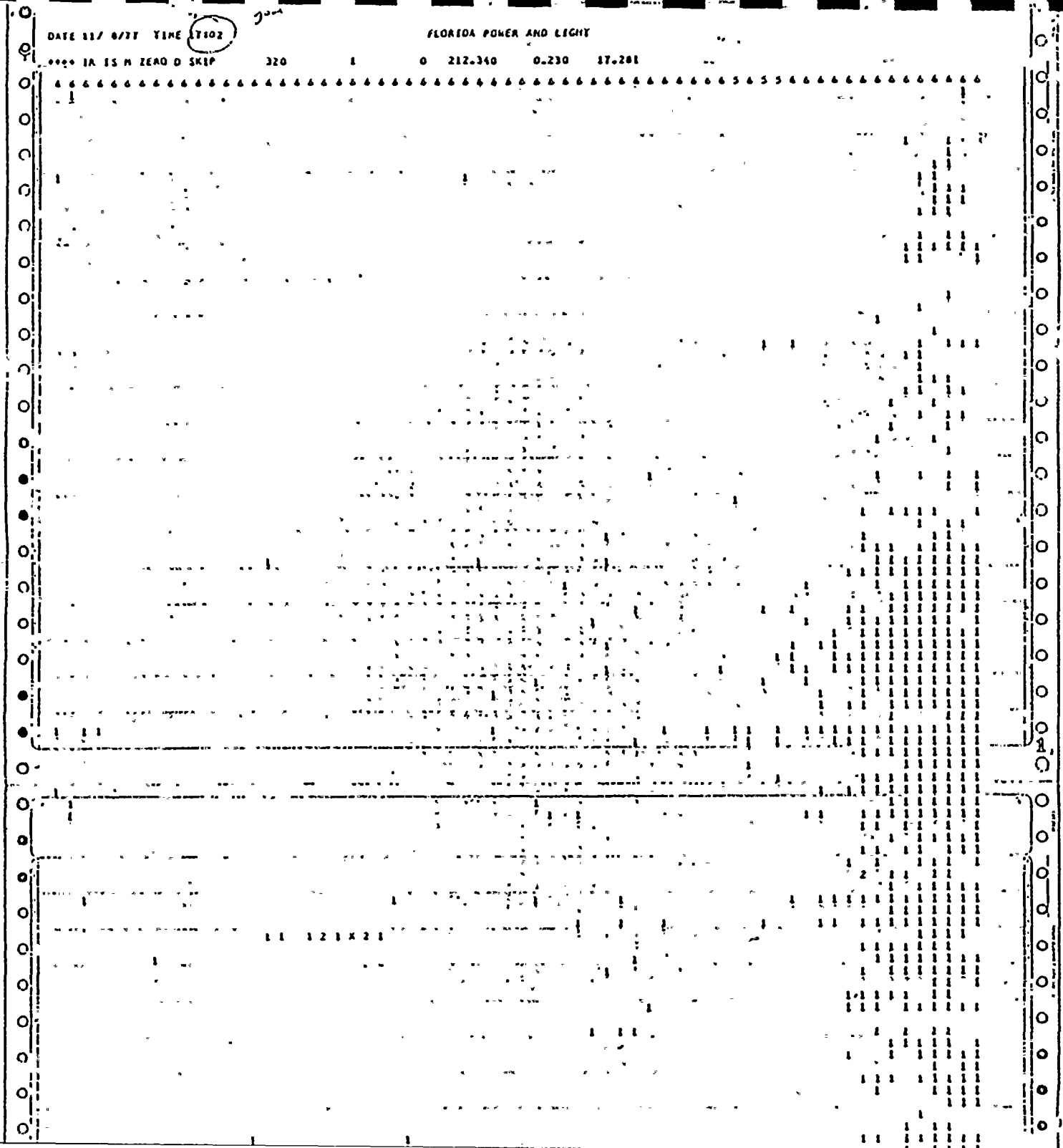

ATLANTIC OCEAN

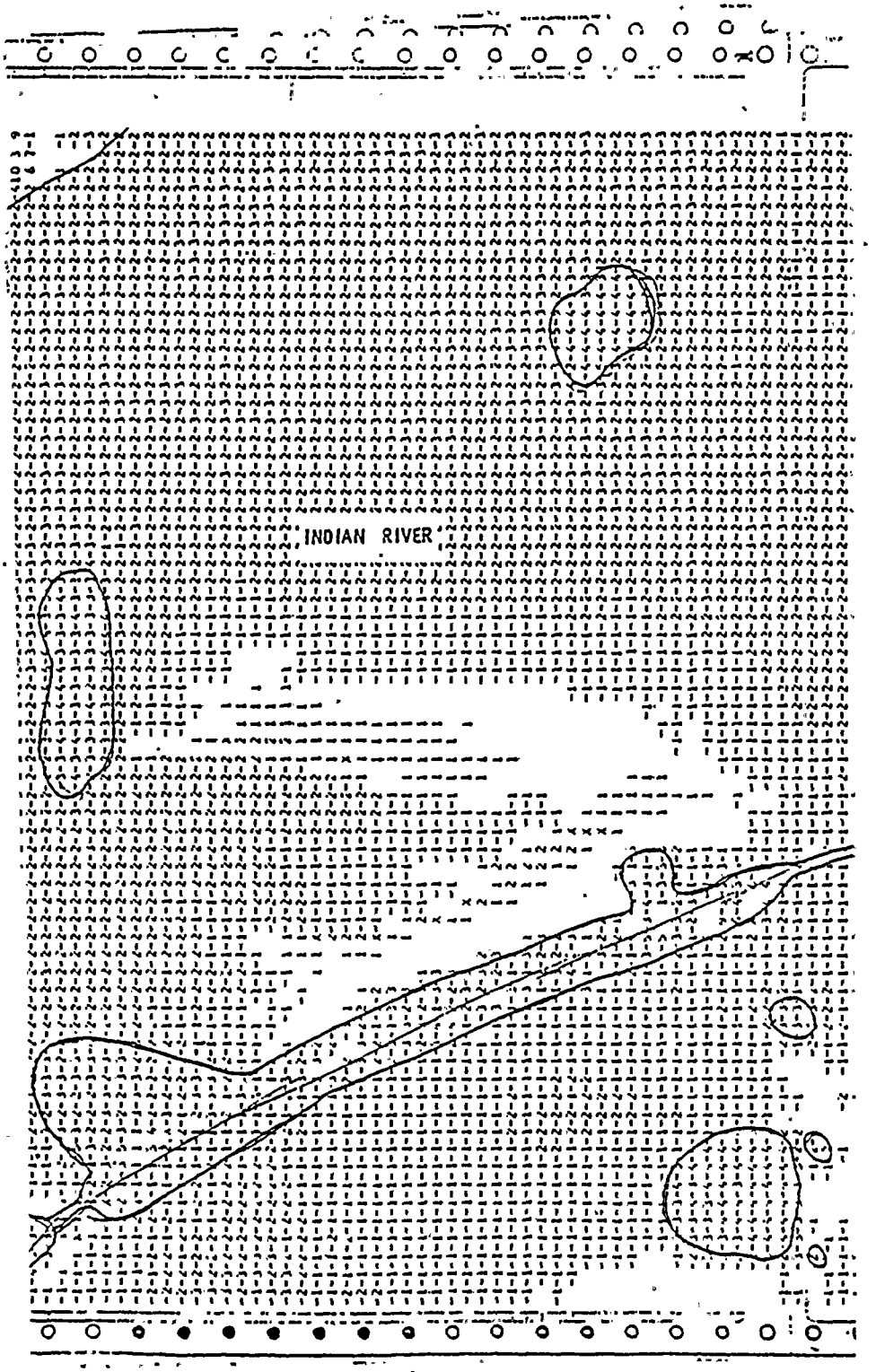

C
ST. LUCIE PLANT
11/8/77 1130
1" = 1000 FT.
X= 1.5°F
EXCESS TEMP. IN °F
BLANK ON PRINTOUT = AMBIENT TEMP.
AMBIENT TEMP. = INTAKE CANAL TEMP.

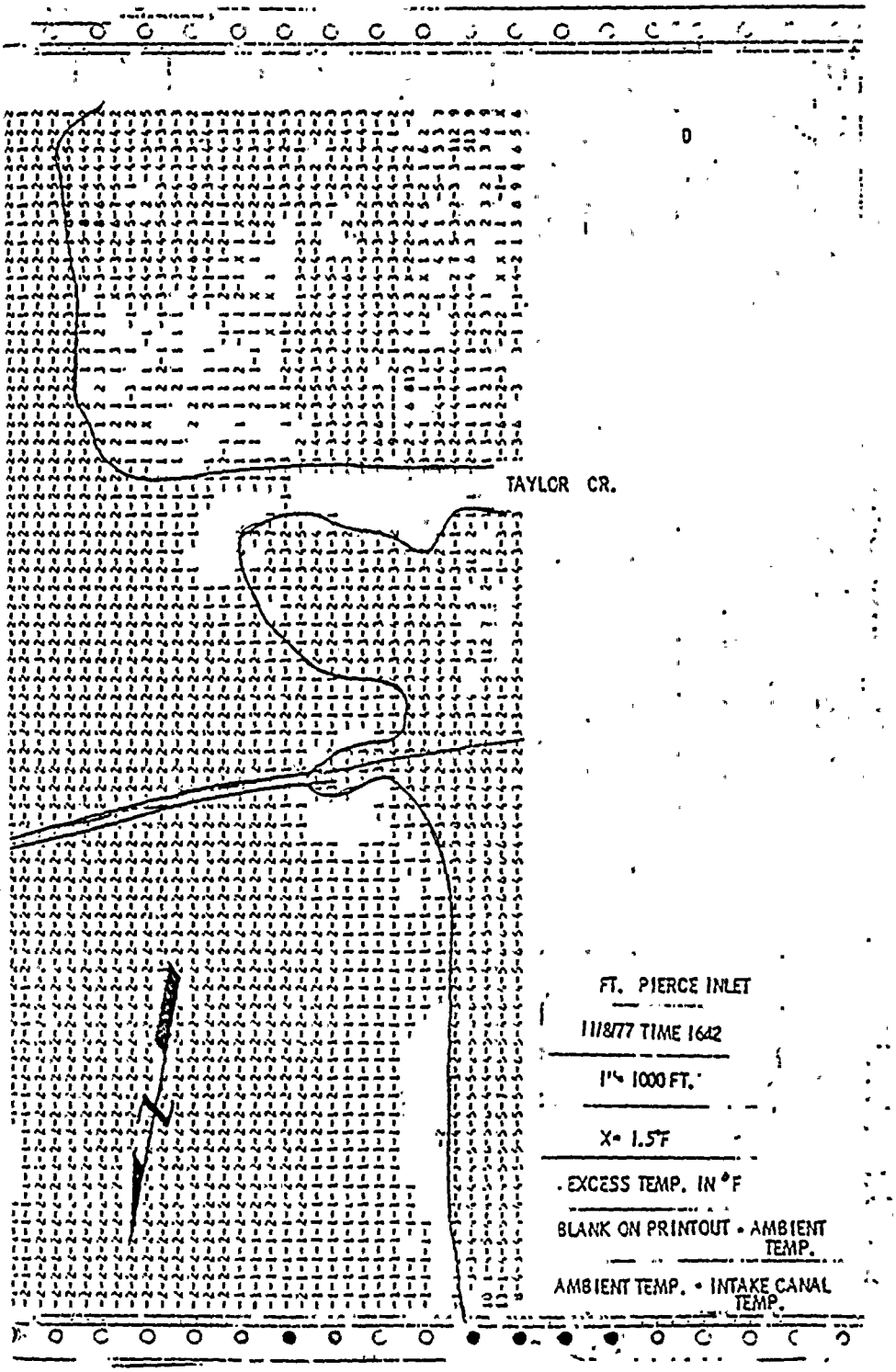


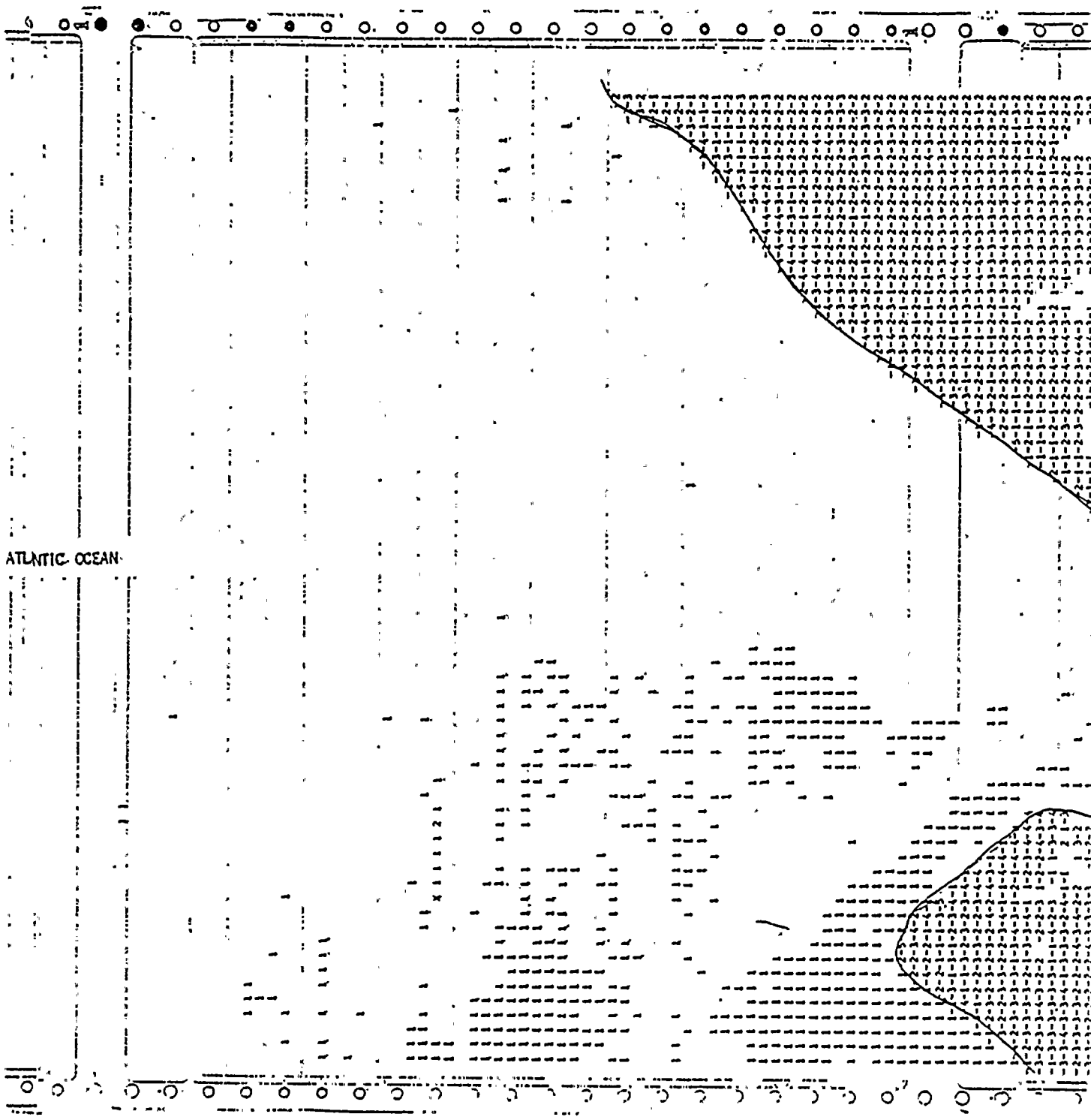

FABER COVE
FT. PIERCE INLET
TUCKER COVE

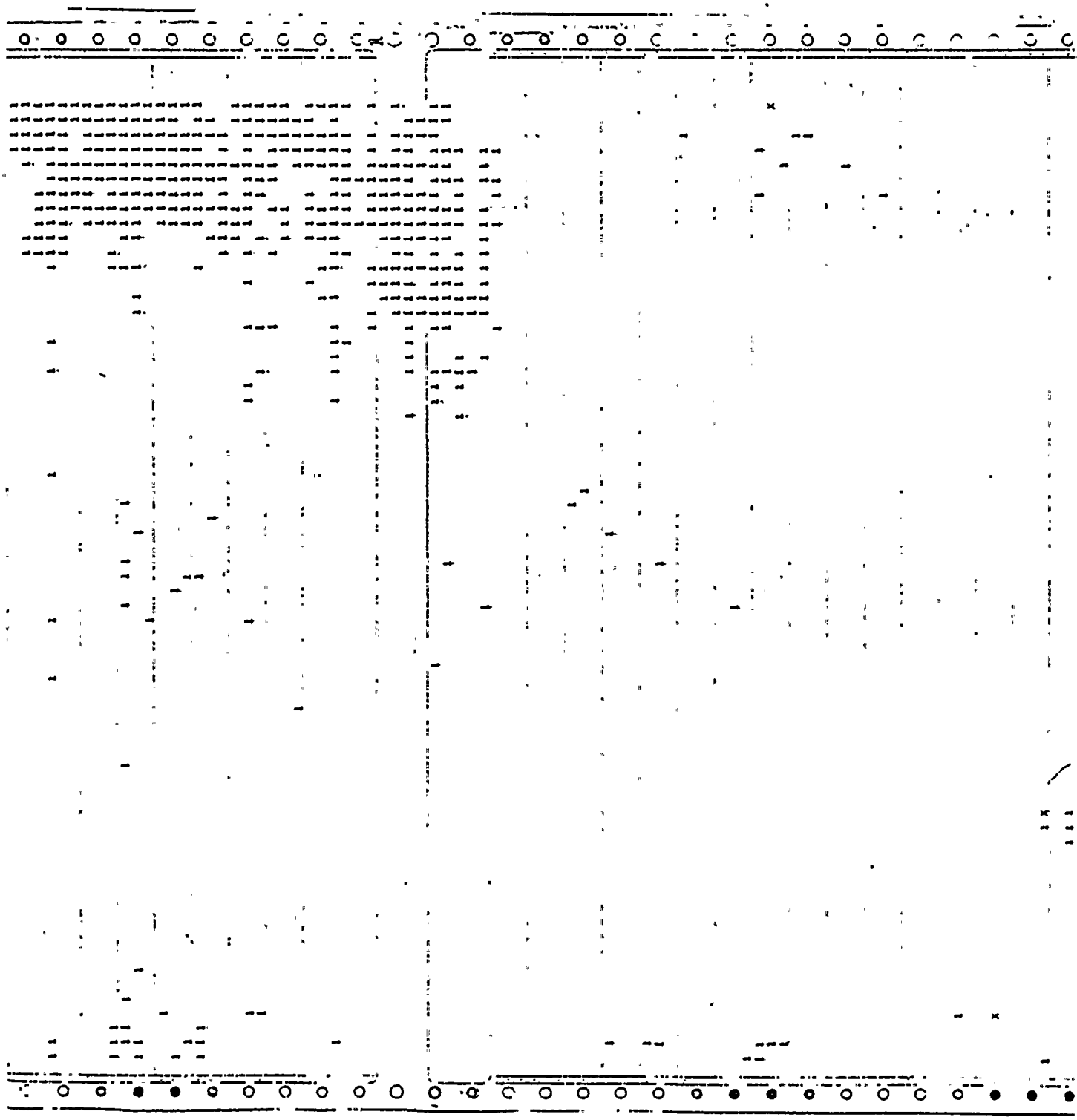

ATLANTIC. OCEAN

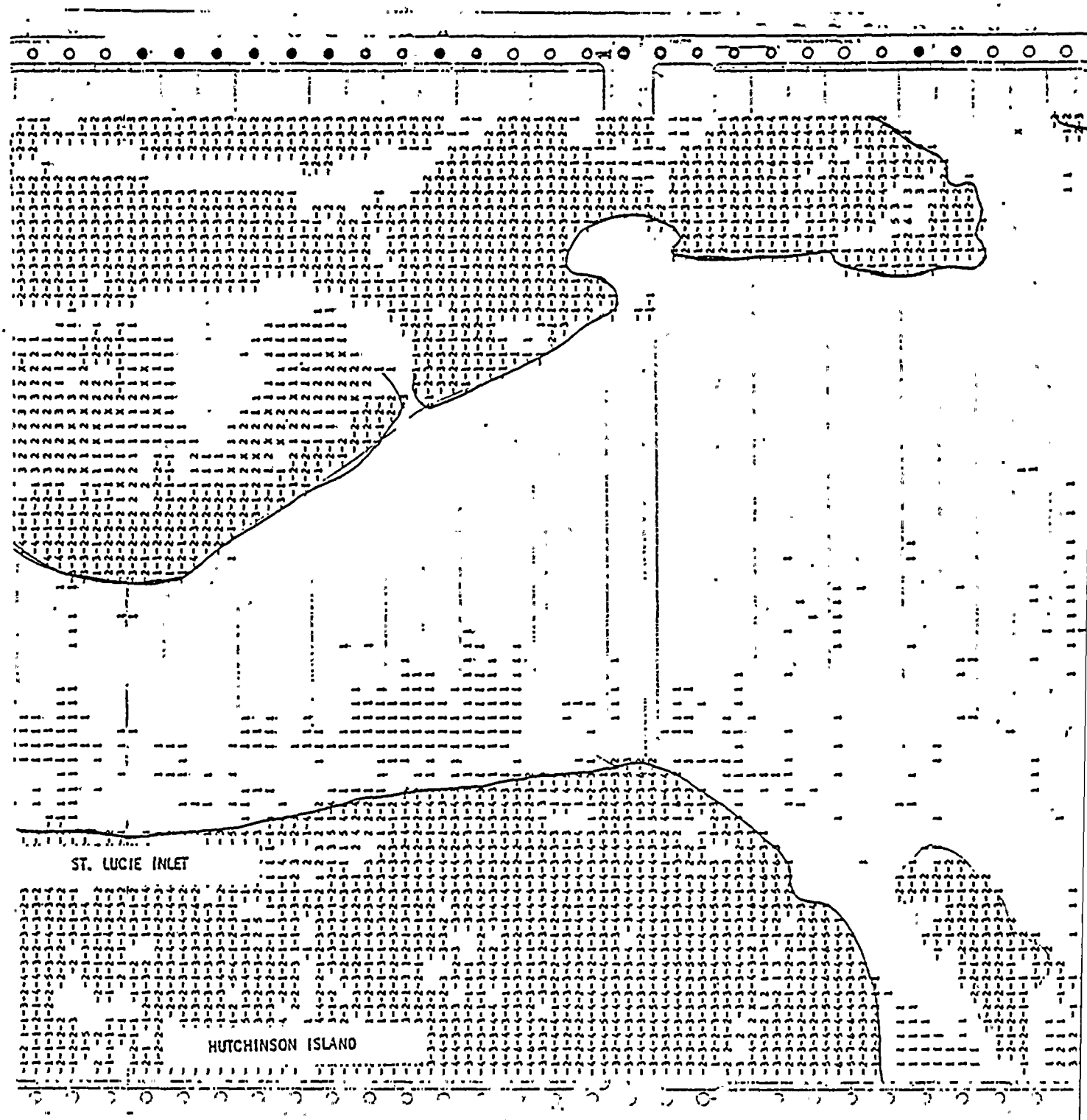

DATE 11/ 8/77 TIME 1102
FLORIDA POWER AND LIGHT
**** IA IS N ZERO D SKIP 320 1 0 212.340 0.230 17.281

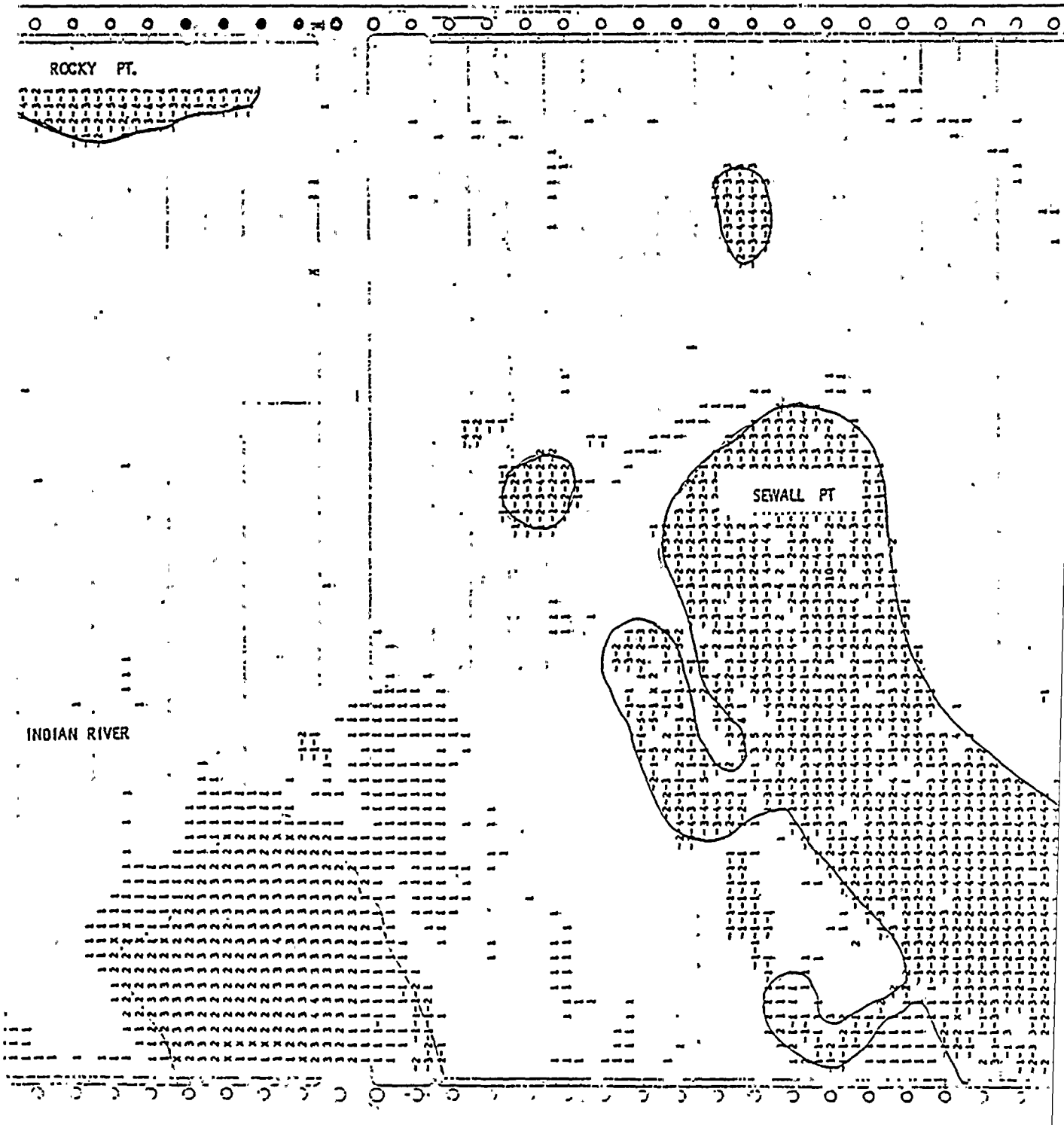

INDIAN RIVER

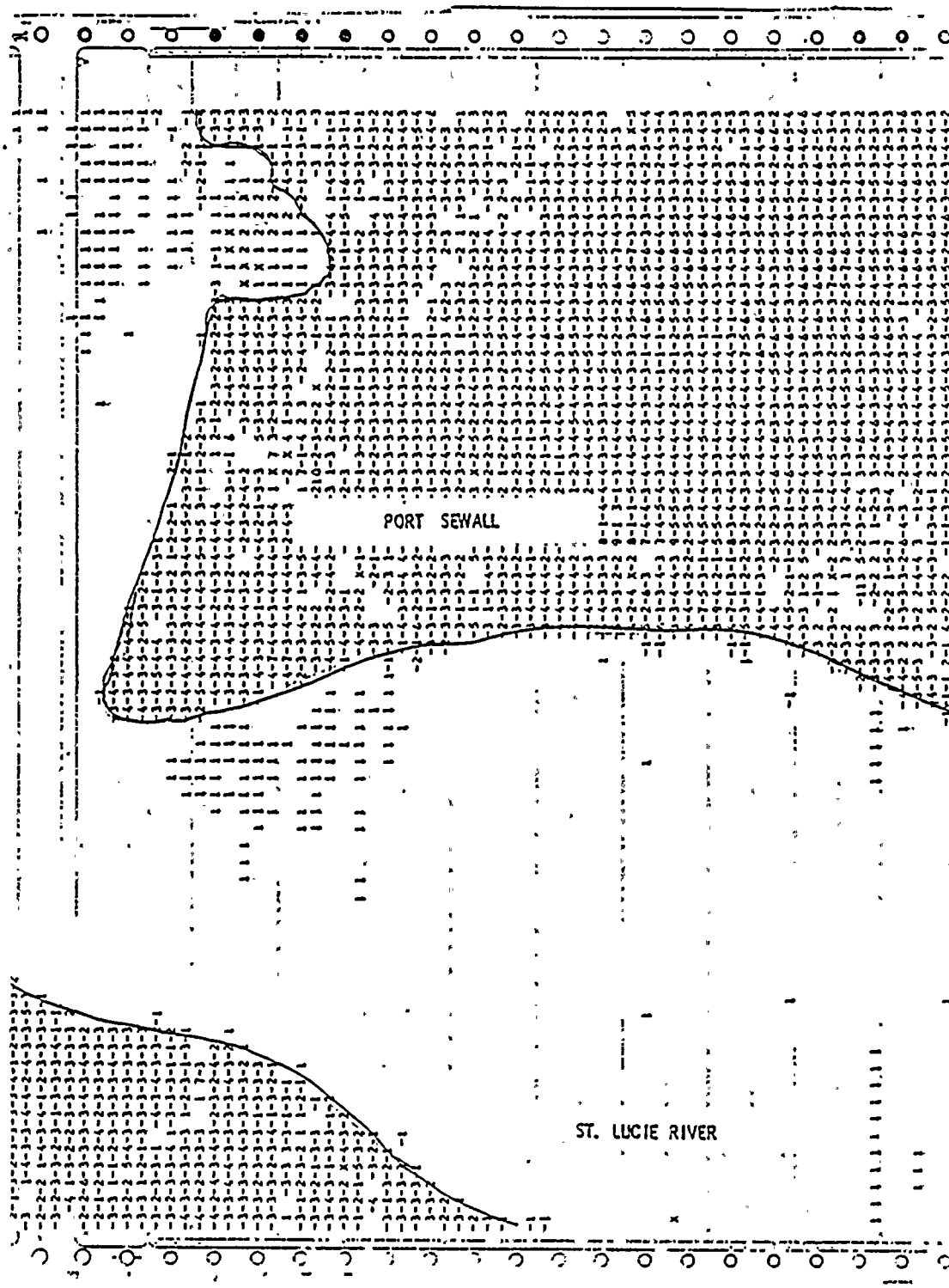

TAYLOR CR.
FT. PIERCE INLET
11/8/77 TIME 1642
1" = 1000 FT.
X= 1.5°F
EXCESS TEMP. IN °F
BLANK ON PRINTOUT = AMBIENT TEMP.
AMBIENT TEMP. = INTAKE CANAL TEMP.

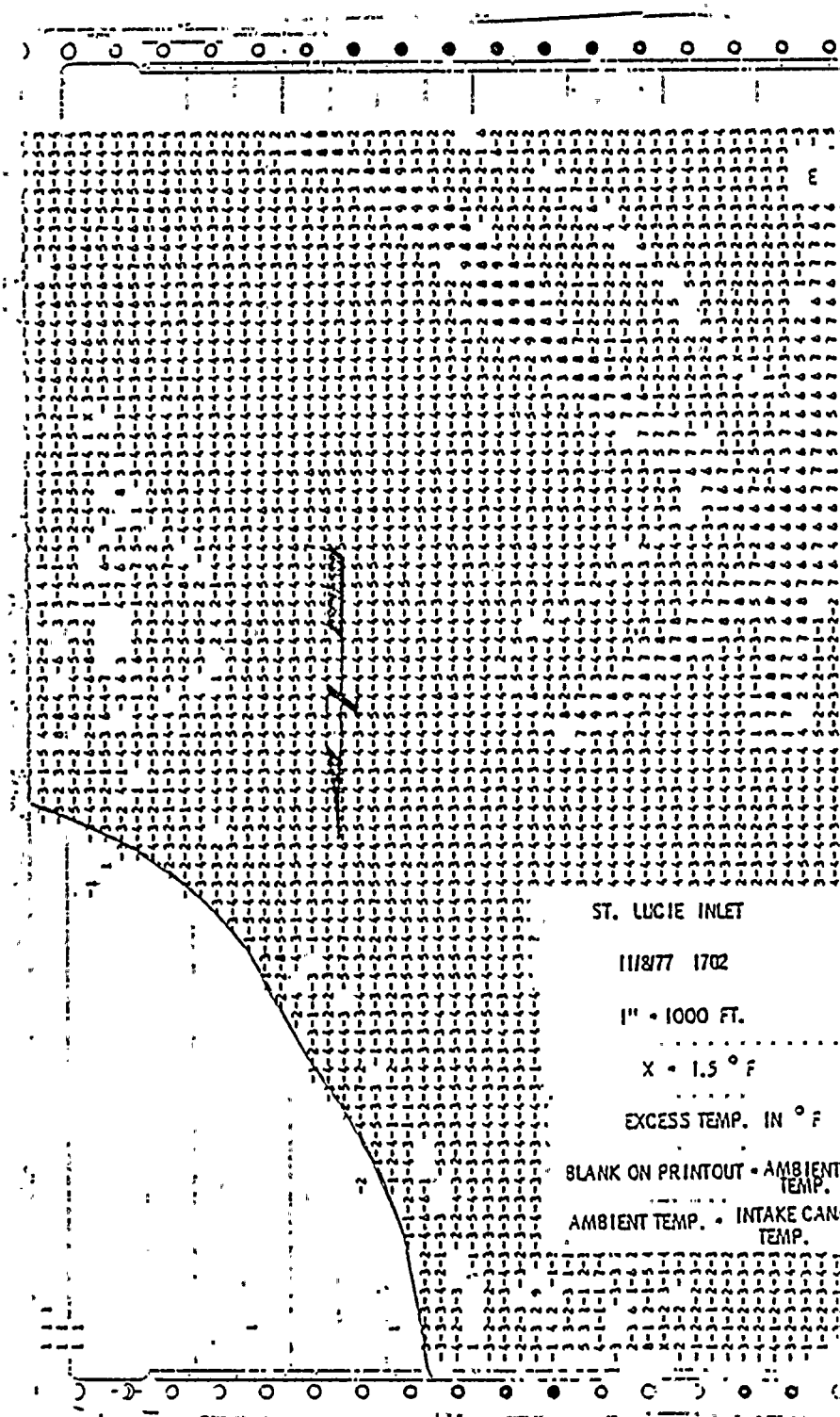

ATLANTIC OCEAN

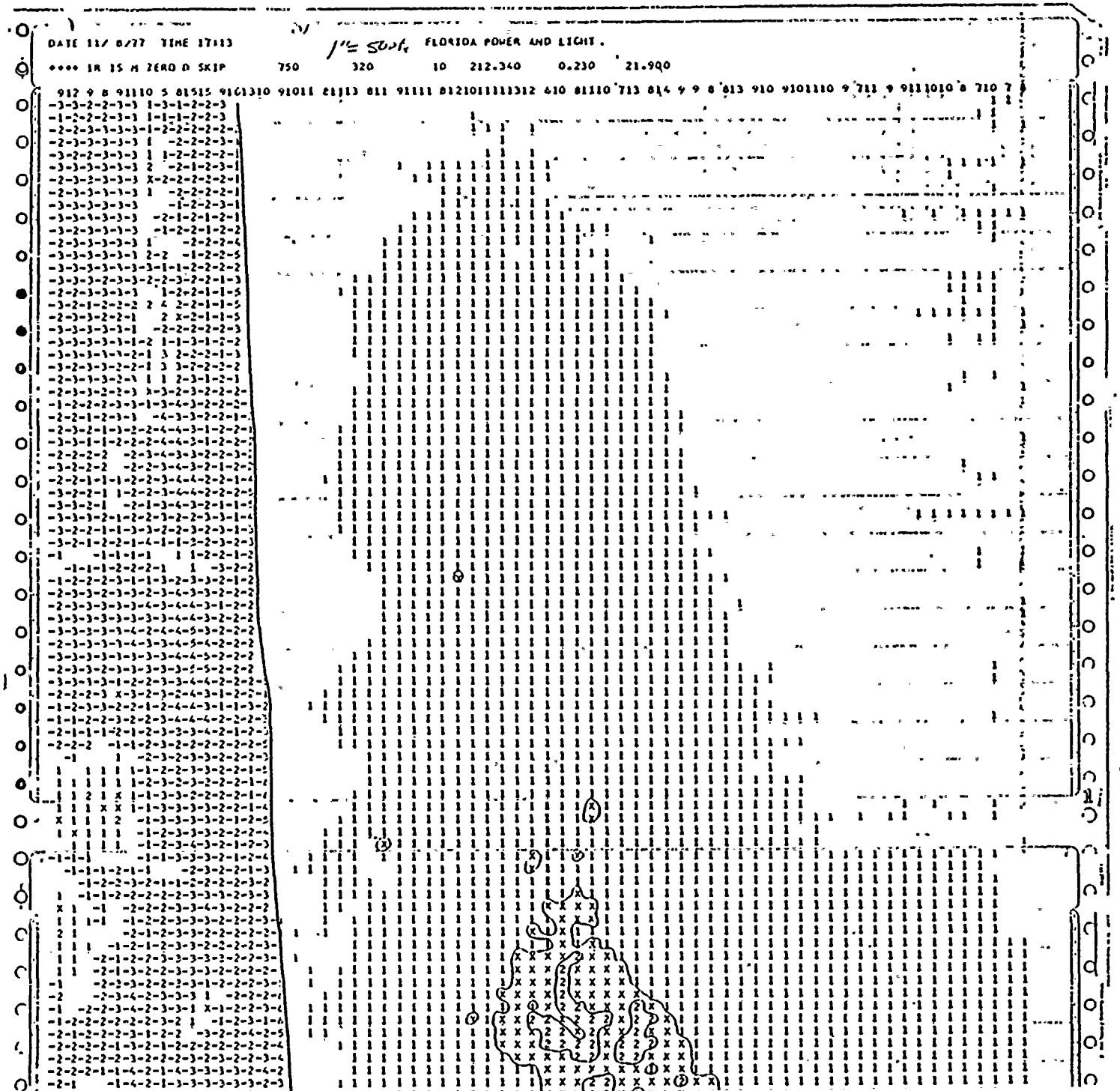


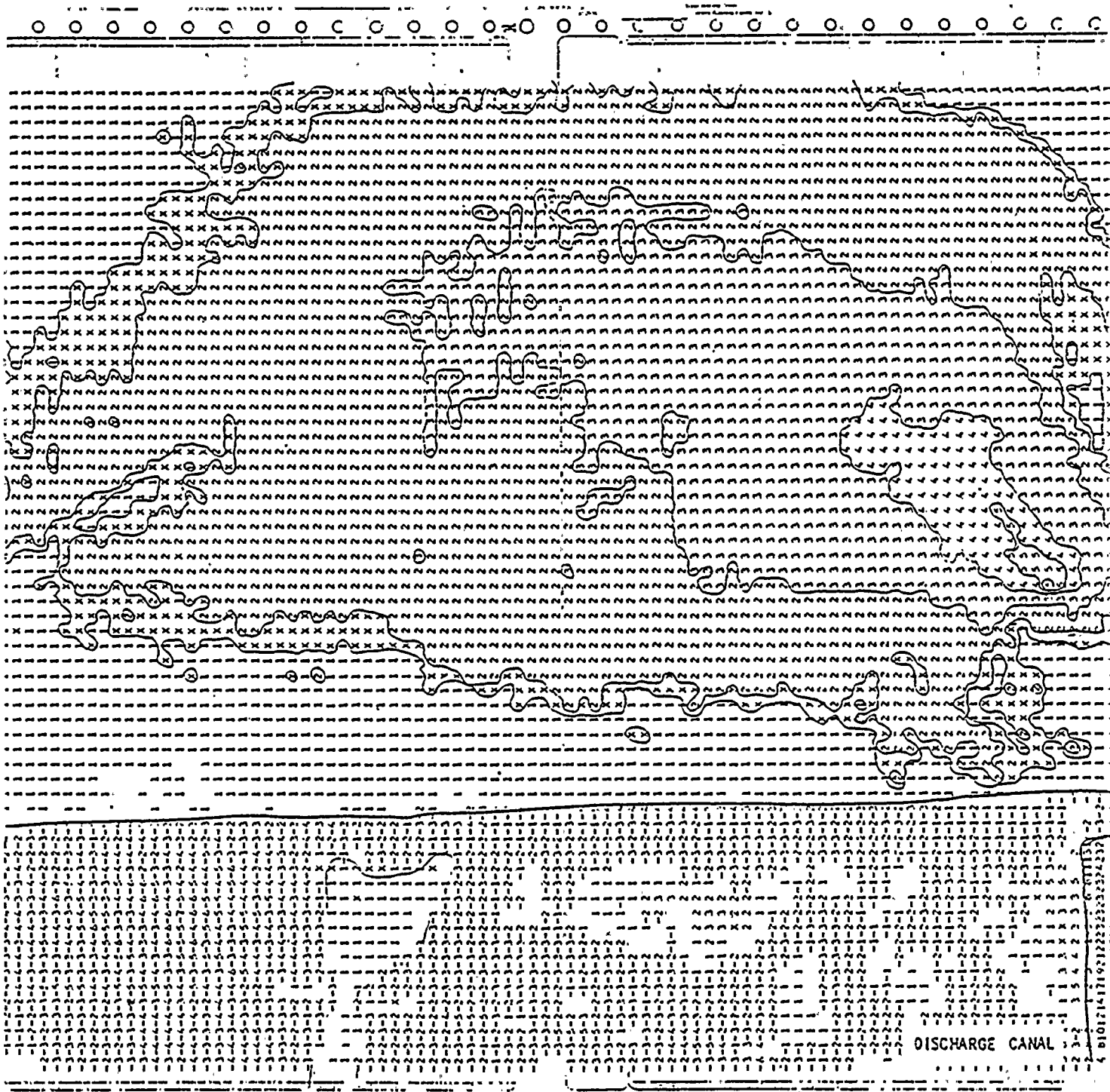

ST. LUCIE INLET
HUTCHINSON ISLAND

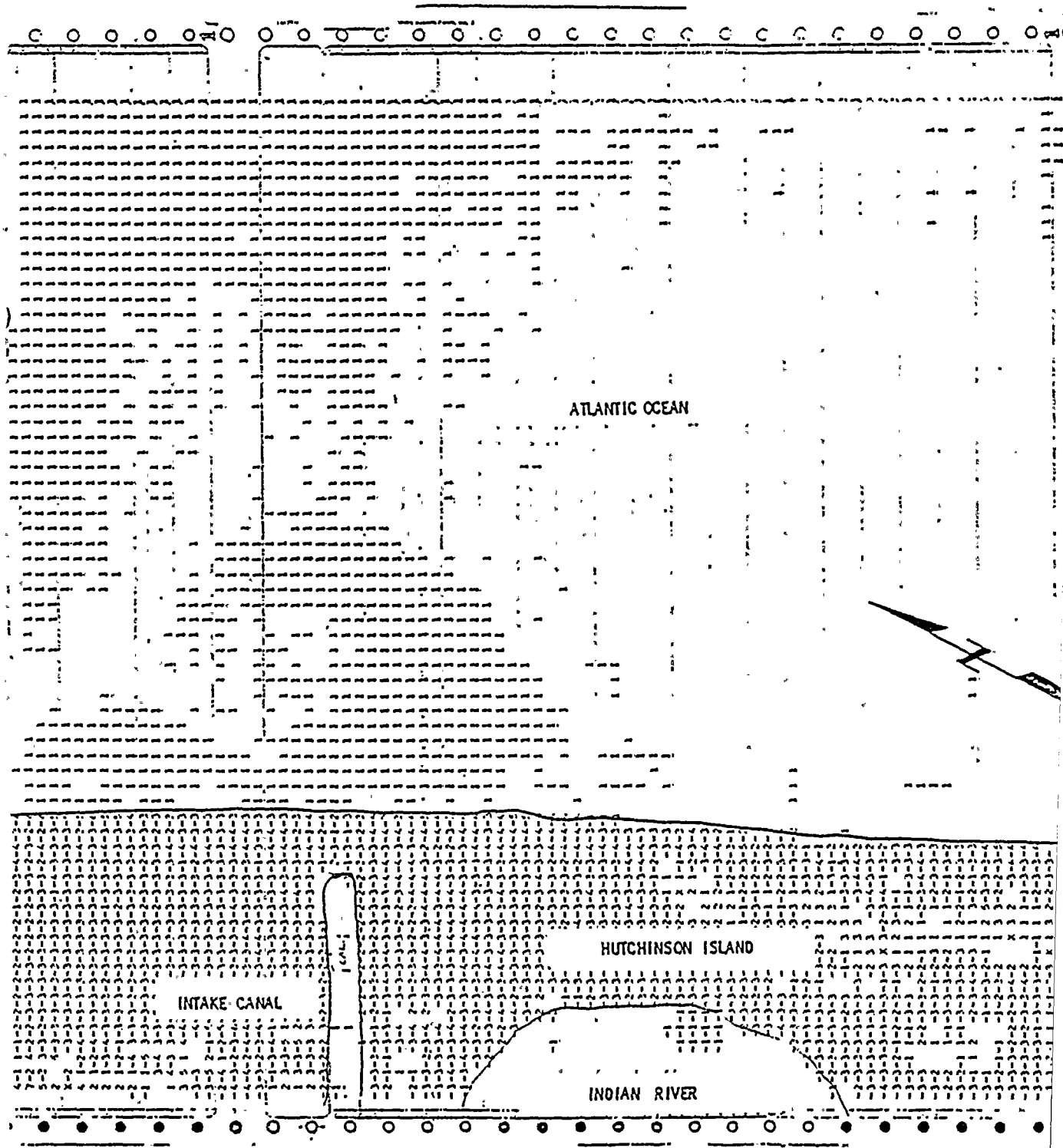

ROCKY PT.
SEWALL PT
INDIAN RIVER

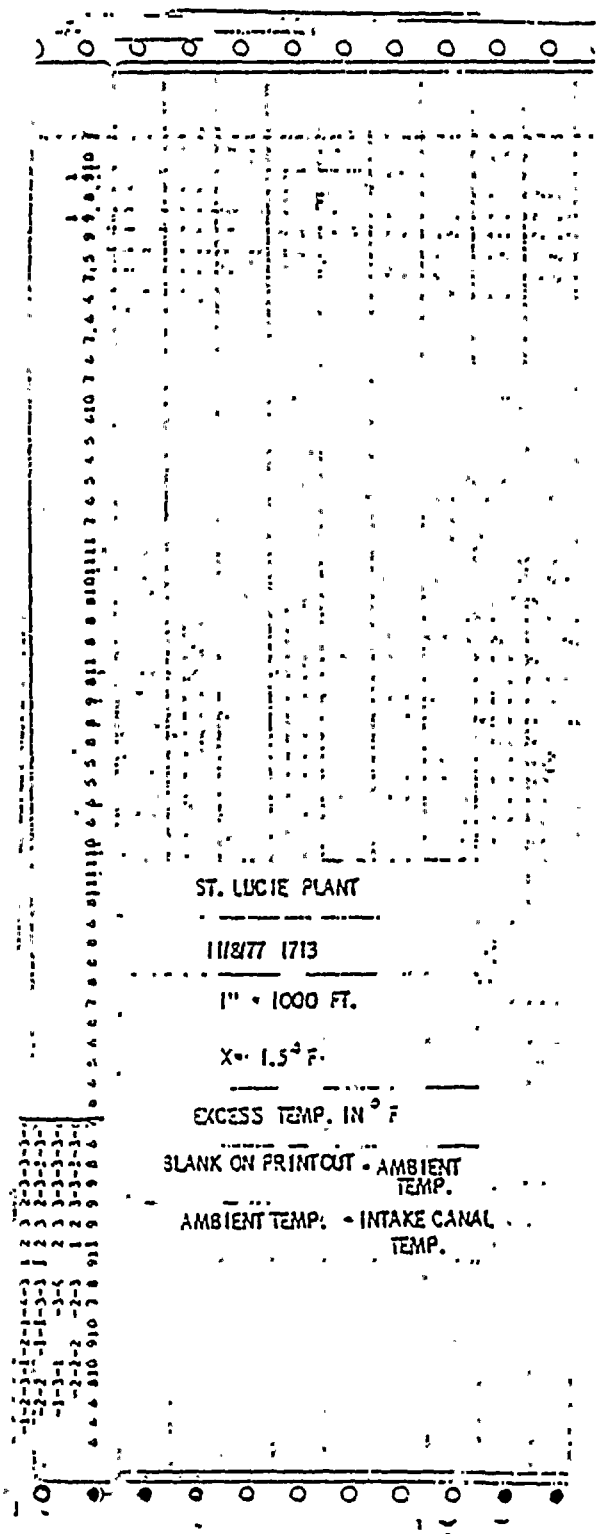

PORT SEWALL
ST. LUCIE RIVER

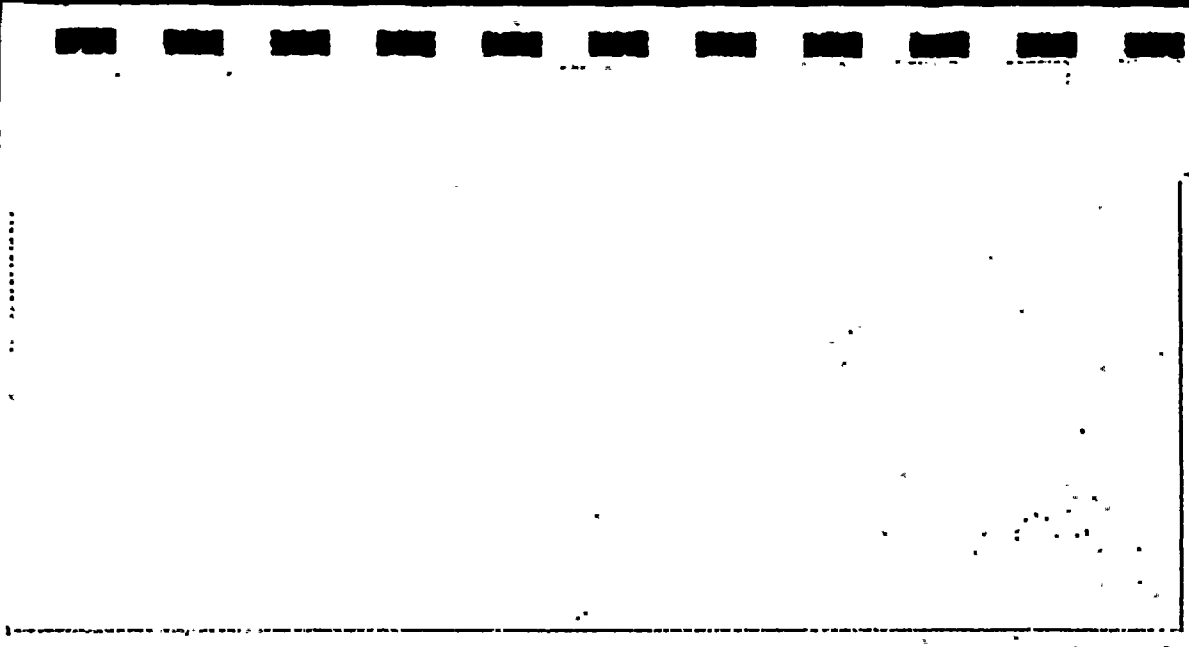

E
ST. LUCIE INLET
11/8/77 1702
1" = 1000 FT.
X = 1.5 °F
EXCESS TEMP. IN °F
BLANK ON PRINTOUT = AMBIENT TEMP.
AMBIENT TEMP. = INTAKE CAN TEMP.

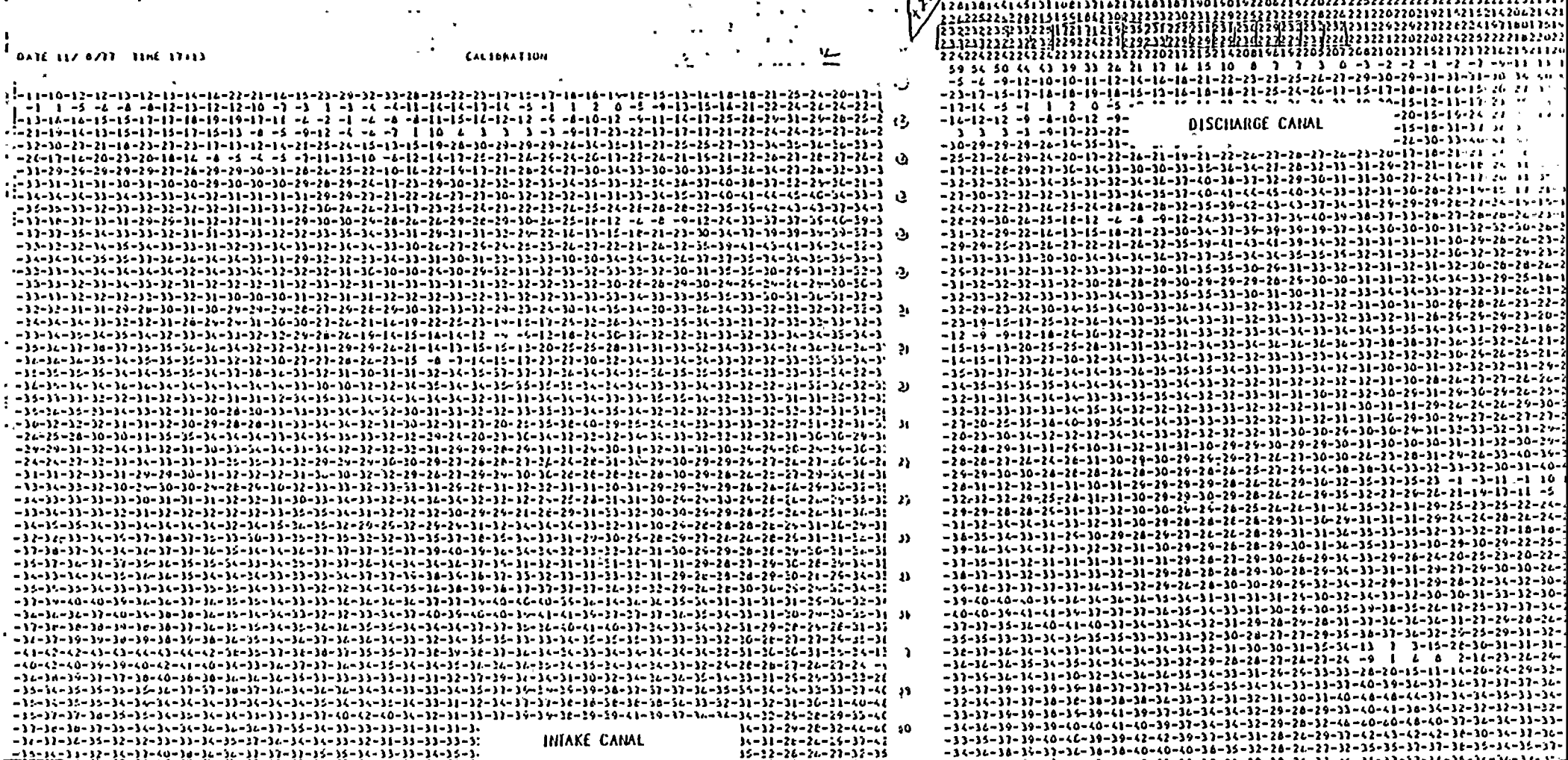

DATE 11/ 8/77 TIME 17:13
1" = 500'
FLORIDA POWER AND LIGHT.
**** IR IS H ZERO D SKIP 750 320 10 212.340 0.230 21.900

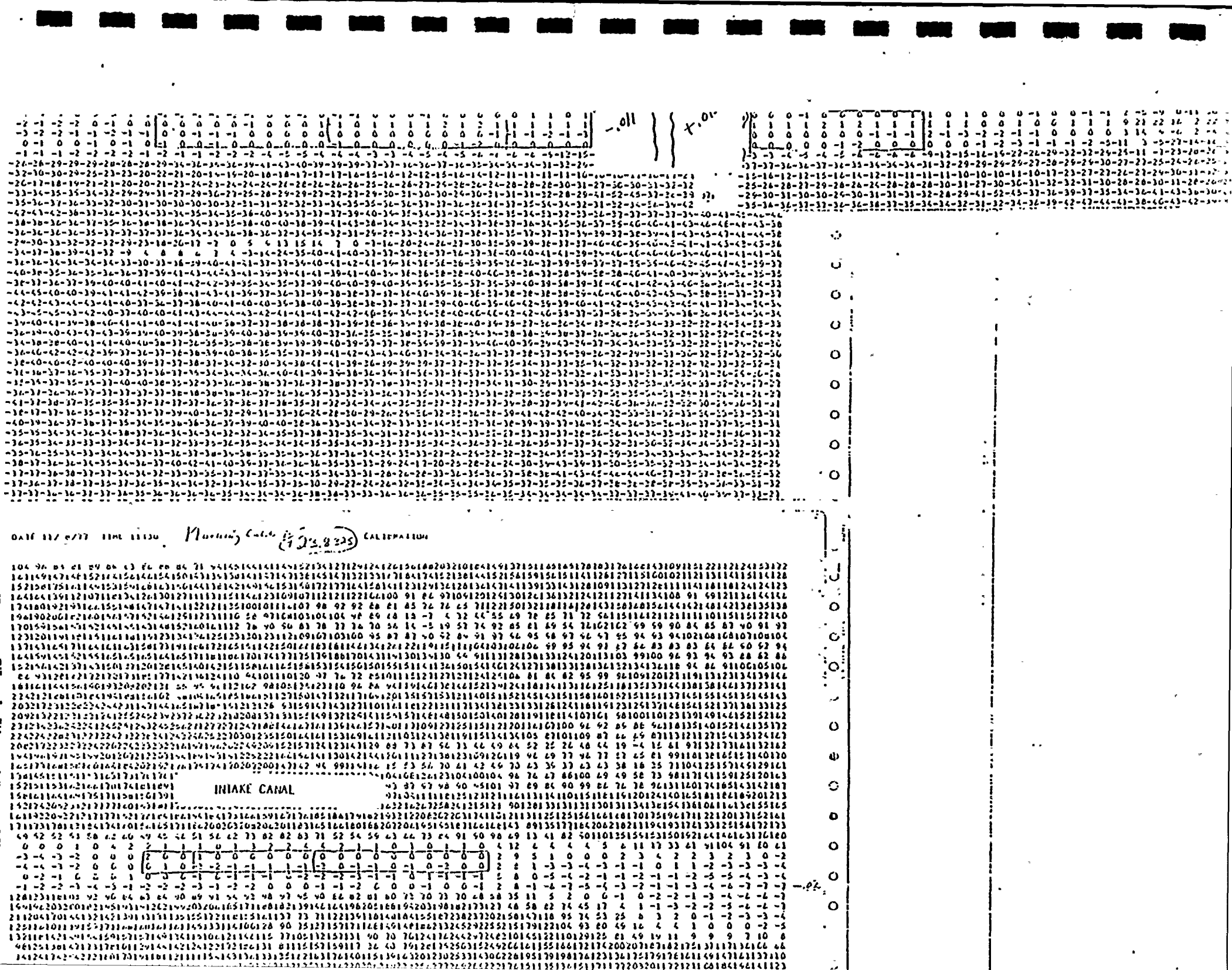

DISCHARGE CANAL

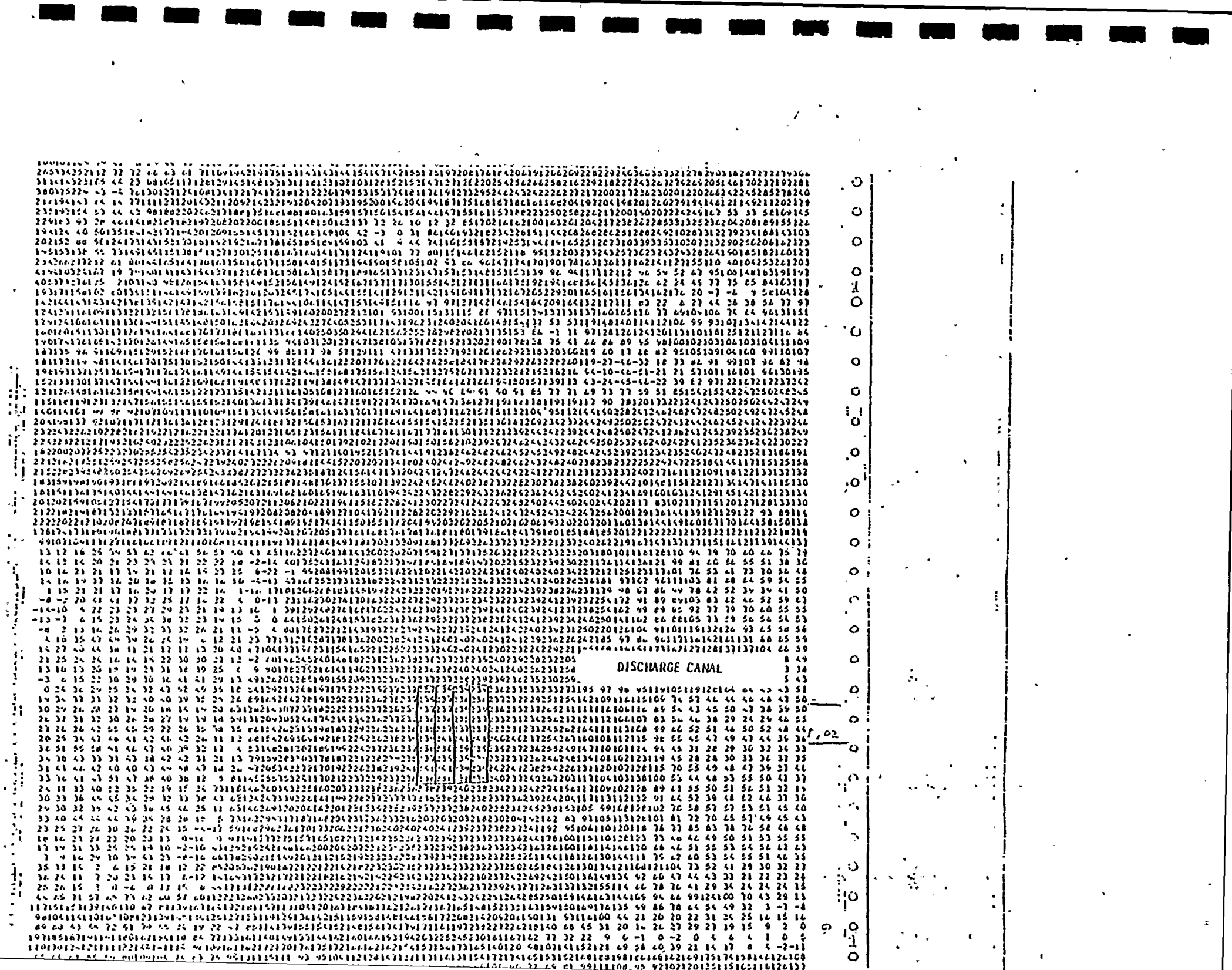

ATLANTIC OCEAN
HUTCHINSON ISLAND
INTAKE CANAL
INDIAN RIVER


ST. LUCIE PLANT
11/8/77 1713
1" = 1000 FT.
X= 1.5° F.
EXCESS TEMP. IN ° F
BLANK ON PRINTOUT = AMBIENT TEMP.
AMBIENT TEMP. = INTAKE CANAL TEMP.




DATE 11/ 8/77 TIME 17:13
CALIBRATION
INTAKE CANAL
DISCHARGE CANAL


INTAKE CANAL


DISCHARGE CANAL