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AIRBORNE INFRARED SURVEY

INDIAN POINT AREA, HUDSON RIVER, NEW YORK

Encl #2

458

SCIENCE SERVICES DIVISION

TEXAS INSTRUMENTS
INCORPORATED
SCIENCE SERVICES DIVISION
13500 NORTH CENTRAL EXPRESSWAY
POST OFFICE BOX 5621 · DALLAS, TEXAS 75222

AIRBORNE INFRARED SURVEY

INDIAN POINT AREA,
HUDSON RIVER, NEW YORK

Prepared for

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

by

TEXAS INSTRUMENTS INCORPORATED
Dallas, Texas

December 1968

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TABLE

SECTION I

INTRODUCTION

Two airborne infrared data surveys of the Hudson River in the vicinity of the Indian Point power plant were performed for the Consolicated Edison Company of New York, Inc. The surveys were undertaken to collect data for compilation of isothermal maps of the river surface during four tidal conditions; i.e., low tide, high tide, ebb tide, and flood tide.

Data were first collected in October 1967 while the Indian Point power plant was shut down, and again in April 1968 while the plant was in operation. During one of these flights, aerial photographs were taken to provide a base map for the thermal data. The airborne data collection was coordinated with surface measurements observed by John S. Grim of Northeastern Biologists, Inc.

Survey results are presented as a set of eight isothermal maps. Sheets 1 through 4 were compiled from the October 1967 data while sheets 5 through 8 show the results of the flights in April 1968.

SECTION II
DATA COLLECTION

Infrared imagery, similar in appearance to strip photography, is produced by a series of scan lines perpendicular to the flight direction. Relative radiometric temperature differences are represented by different gray tones. Light tones on a positive print of infrared imagery represent relatively high radiometric temperatures. Dark tones are related to relatively low radiometric temperatures.

The Texas Instruments system produces imagery in the 8 to 14 micron wavelength band which is not rectified; i.e., the scale along the flight direction is relatively constant, but the scale perpendicular to the flight direction becomes smaller with increased distance away from the centerline.

Infrared mapping systems are designed so that electronic signal displacement between hot and cold objects is controlled within the dynamic range of the recording film. The system's thermal baseline continually adjusts itself to the average between hot and cold temperatures of the scanned area. This compensation occurs in the circuitry prior to the glow-modulator which exposes the recording film. Thus, the imagery contains the effects of thermal baseline adjustment.

The Texas Instruments system also monitors the video signal from the detector at the preamplification stage by a type-A oscilloscope. The oscilloscope presentation of individual sweeps (single scan lines) of the detector are recorded by a 35-mm camera. These A-Scope profile data, used to compile isothermal maps, are not affected by system compensation and can be considered quantitative.

Radiometric temperature references are provided by temperature-controlled blackbody baffles mounted within the scanning system's field of view. The temperature of each reference baffle is closely monitored during flight. The amplitude difference between the two reference baffles can be converted to a temperature scale from which temperature values can be assigned to individual points along the A-Scope trace. Correlation between A-Scope data and the scanner imagery is supplied by a fiducial system which also provides a means of tying airborne data to ground position.

Overflights were made between Croton Point and Bear Mountain Bridge at altitudes of 5000 and 10,000 ft above the river surface. Three straight segments were flown for each tidal coverage because of the meandering configuration of the river in the survey area. The first segment was flown northwestward from Croton Point to the vicinity of Tomkins Lake. Segment 2 covered the area from the town of Tomkins Cove to Annsville Creek. The third flightline extended from Peekskill Bay to Bear Mountain Bridge.

SECTION III

DATA COMPILATION

The infrared imagery was examined and compared with terrain features on the aerial photographs or on existing 7-1/2' quadrangle maps of the area. The following information was thus determined:

- True ground track of the aircraft
- Drift angle related to crosswinds
- Starting and ending A-Scope trace from each segment to be used in the map compilation
- Distance in feet between adjacent A-Scope traces along each flight segment

To facilitate data handling, the 35-mm film records of the A-Scope profiles were enlarged approximately 10 times. Each profile was carefully inspected, and a sufficient number of data points were selected to delineate surface temperature variations. The coordinates of these and other essential reference points were measured and keypunched onto data cards.

Because the raw profile data represent radiated power at the infrared detector relative to scan angle, a temperature and ground distance conversion is required. This is accomplished by a computer program which corrects the scale of the imagery and plots a temperature value for each preselected data point at its true ground position and at the desired map scale. These data are contoured manually in preliminary form, followed by final inked drafting.

Survey results (Table III-1) are presented as a set of eight isothermal maps at a scale of 1:18,000 (1 in. = 1500 ft). A contour interval of 1°F was used throughout most of the map compilation. However, intervals of 0.5°F or 5°F were used where required by either very low or extremely high temperature gradients.

Table III-1

DATA SUMMARY

Set	Sheet No.	Data Collection		Tide	Remarks
		Date	Time		
1	1	10/28/67	0848-0903	High	Indian Point plant shut down during Set 1 (sheets 1 through 4)
	2		1225-1235	Ebb	
	3		1506-1525	Low	
	4		1930-1947	Flood	
2	5	4/6/68	0834-0847	Ebb	Indian Point plant in operation during Set 2 (sheets 5 through 8)
	6		1205-1217	Low	
	7		1638-1650	Flood	
	8		1936-1949	High	

SECTION IV

DATA ANALYSIS

Sheets 1 through 4 were compiled from data collected in October 1967. The isothermal maps indicate that during this period the Hudson River was warm relative to the temperature of the small lakes, ponds, and tributary streams. This is particularly well illustrated on Sheet 2 taken during ebb tide. The discharge from Annsville Creek and Cedar Pond Brook is several degrees cooler than the main part of the Hudson River. The relatively cool surface runoff appears to keep the river surface cool along the shoreline, compared to the relatively warm midstream area.

The change in the surface thermal pattern during each tidal condition is indicated by the contours. The thermal discharge from the Lovett power plant on the west side of the river varies considerably in shape and direction from one map to the next. The highest temperature (about 8°F above river temperature) is indicated on Sheet 2. The mapped amplitude variations of this thermal discharge are related to the interval at which quantitative data were collected, approximately 1.5 sec or about 300 ft on the ground at normal flight speeds. This interval is suitable for mapping general surface thermal variations but is not adequate to observe on each overflight a small target such as a discharge channel. On Sheet 4, for example, the effluence from the Lovett power plant is not only restricted in area because of the current/tide situation but is mapped as only a 2°F thermal anomaly. During this overflight the discharge channel falls between two A-Scope profiles; thus, the true temperature of the thermal discharge was not measured.

Sheets 5 through 8 were compiled from data collected in April 1968. During this period the surface runoff from the tributary streams was warm relative to the Hudson River. All of the maps of the second set show that the central portion of the river is cool relative to the warm marginal zones.

The mapped thermal effluence from the Lovett power plant also varies in amplitude on the second set due to the data collection interval. However, a maximum temperature of 52°F was recorded on two of the maps, indicating that the water temperature at the discharge channel was about 9°F above the river temperature.

The Indian Point power plant thermal discharge varies in temperature, but the maximum value of 52°F on Sheets 6 and 7 agrees well with the observed surface data.

It is significant that the highest temperatures recorded in the second set of data are related to the discharge from Annsville Creek and from Dickey Brook, which enters the Hudson River at Lents Cove. Industrial or sewage disposal plants may contribute to the relatively high temperature of these creeks. However, the imagery and A-Scope data during some of the overflights indicate that the small lakes and ponds in the area have a high surface temperature, probably due to solar heating. Thus, the airborne data suggest that at certain parts of the year a considerable volume of warm water entering the Hudson River may be due to solar heating of shallow surface water.

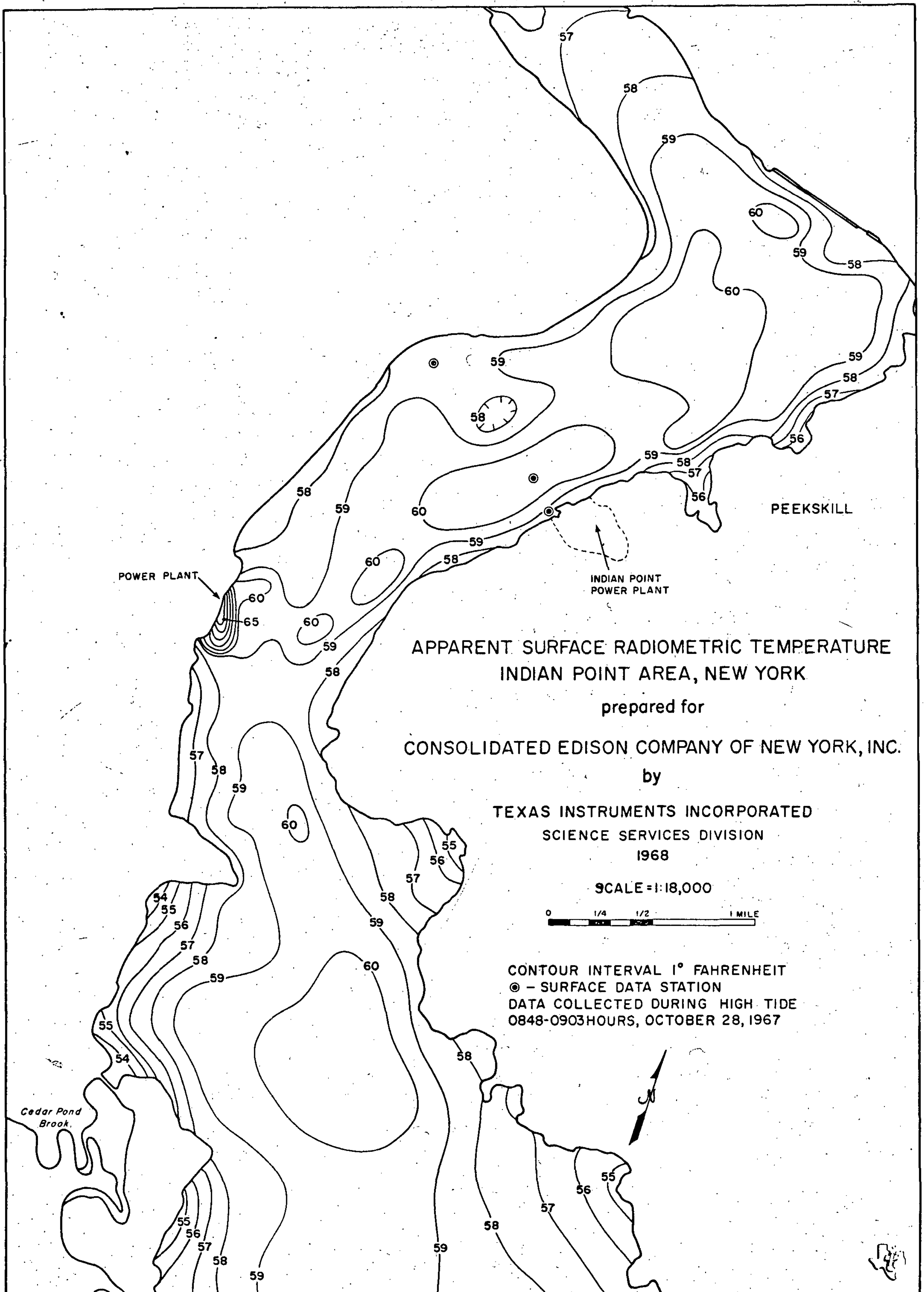
SECTION V

SUMMARY AND CONCLUSIONS

The results of the airborne infrared survey demonstrate the usefulness of remote sensing methods in mapping surface thermal patterns.

Each map sheet represents the thermal patterns at the river surface under almost static conditions because of the relatively short data collection time period. Mapping in such detail from the surface (such as in a boat) would be impossible because of the constantly changing river conditions.

Contour maps and infrared imagery indicate that the thermal patterns at the surface are extremely complex. Contributing factors are the interaction of river currents and tidal conditions, combined with natural and industrial discharges at various temperatures, and complicated by the river channel configuration and the shape of the bottom surface. The survey data should provide a useful basis for future studies in this area.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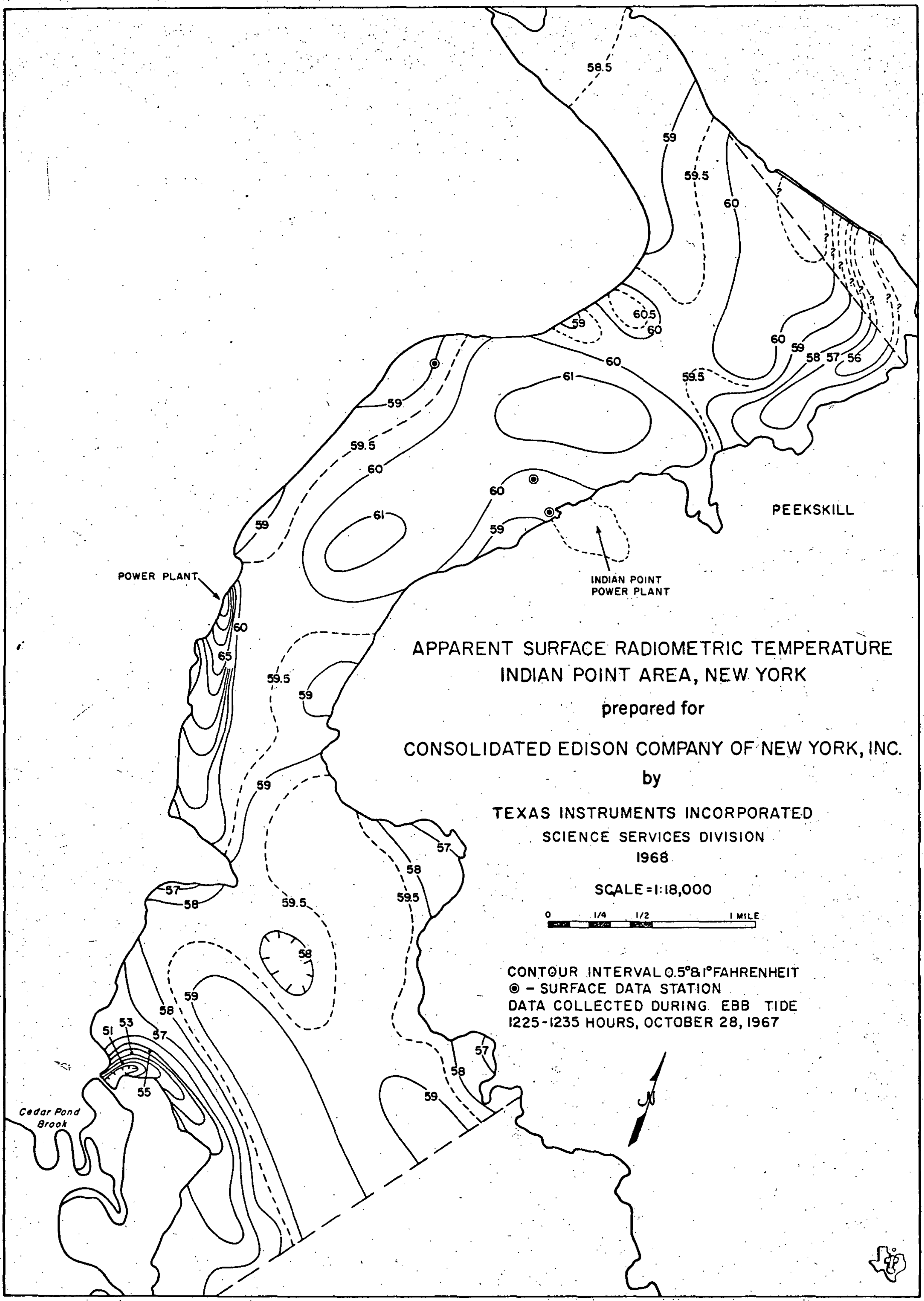
INDIAN POINT AREA, NEW YORK
prepared for
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
by
TEXAS INSTRUMENTS INCORPORATED
SCIENCE SERVICES DIVISION
1968
SCALE = 1:18,000
0
1/4
1/2
1 MILE
CONTOUR INTERVAL 1° FAHRENHEIT
◉ – SURFACE DATA STATION
DATA COLLECTED DURING HIGH TIDE
0848-0903 HOURS, OCTOBER 28, 1967
POWER PLANT
INDIAN POINT
POWER PLANT
PEEKSKILL
Cedar Pond
Brook.
N
54
55
56
57
58
59
60
65

SHEET I



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DATA COLLECTED DURING EBB TIDE
1225-1235 HOURS, OCTOBER 28, 1967
PEEKSKILL
INDIAN POINT
POWER PLANT
POWER PLANT
Cedar Pond
Brook
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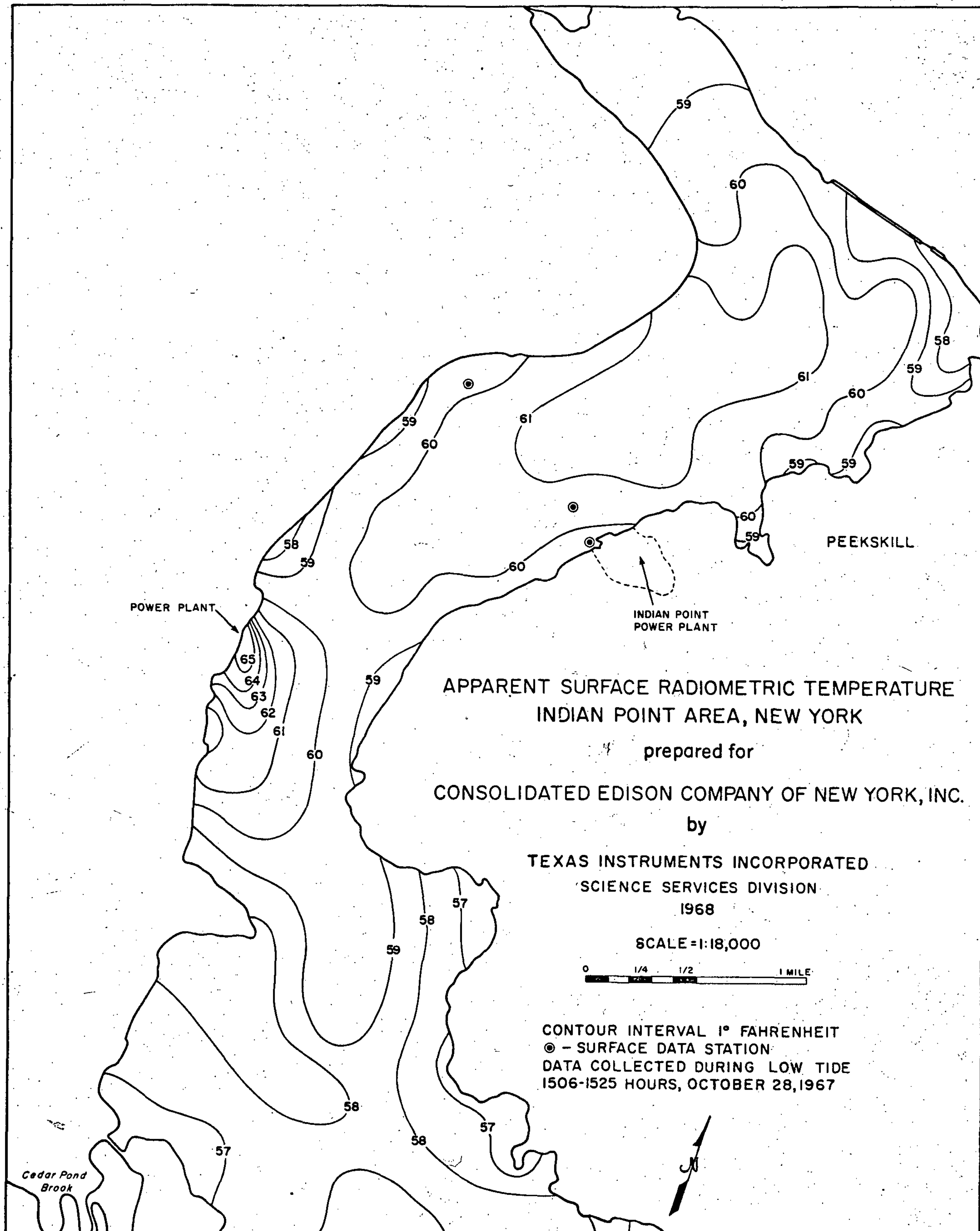

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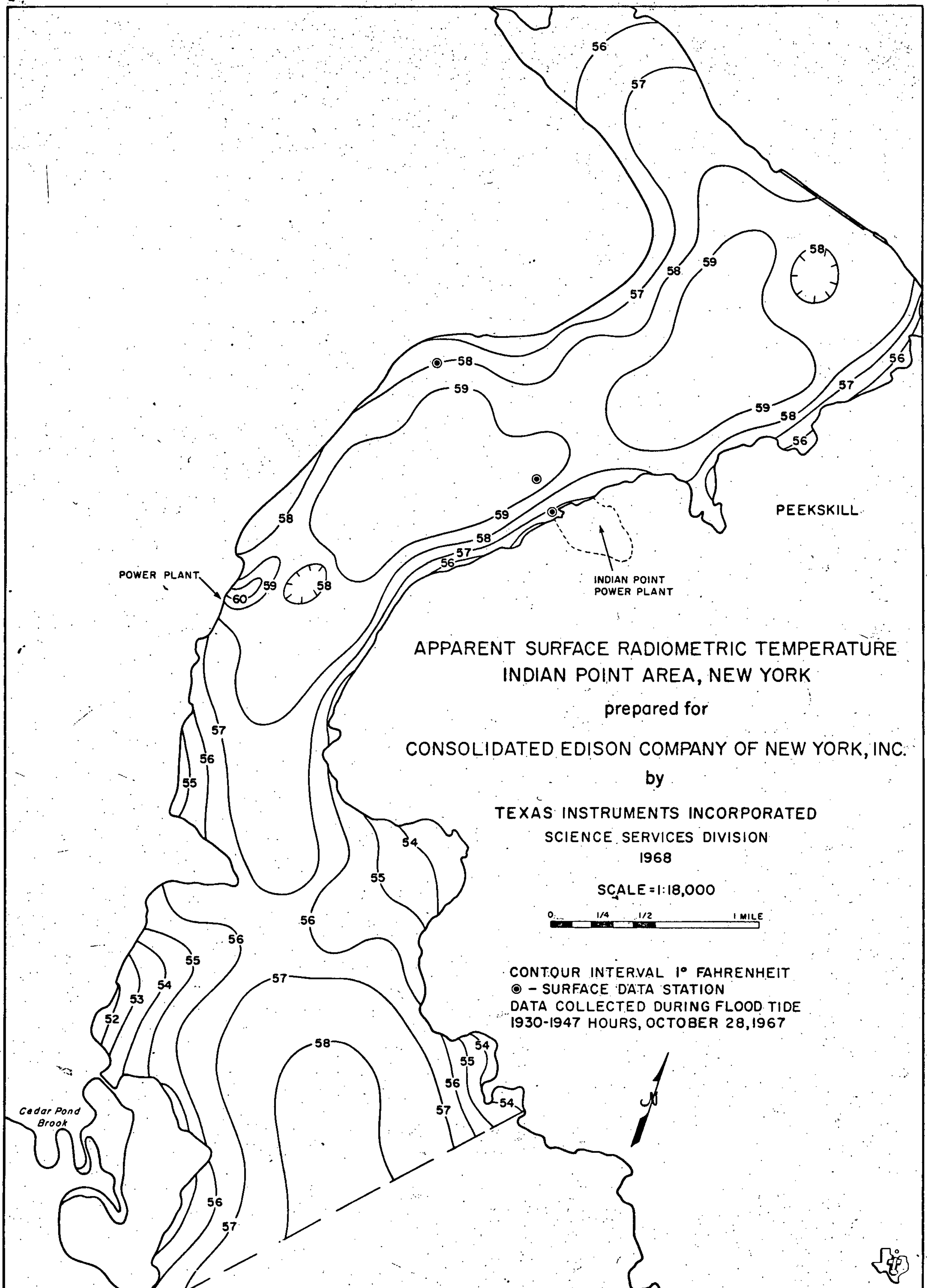
CONTOUR INTERVAL 1° FAHRENHEIT
◉ – SURFACE DATA STATION
DATA COLLECTED DURING LOW TIDE
1506-1525 HOURS, OCTOBER 28, 1967



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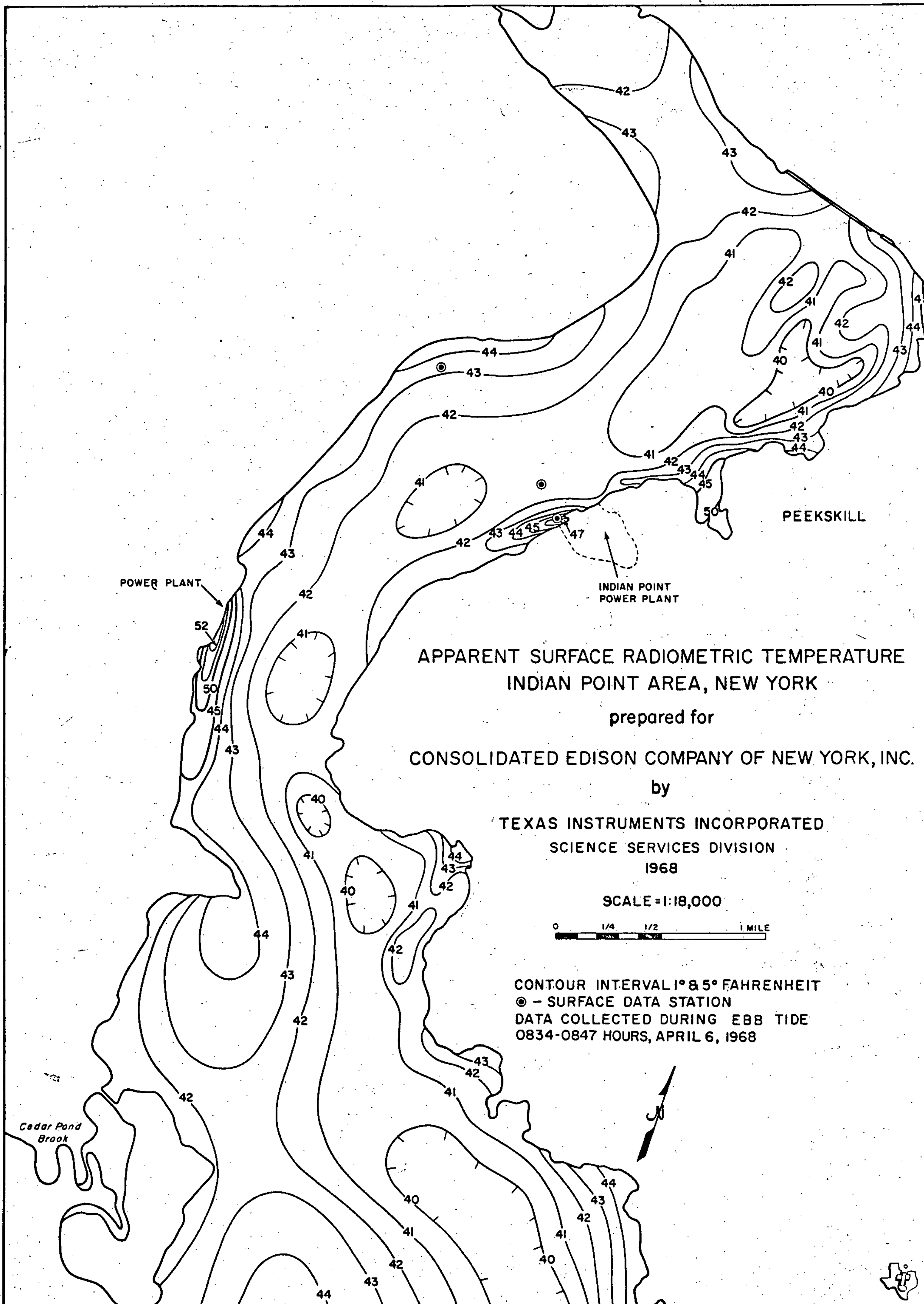
CONTOUR INTERVAL 1° FAHRENHEIT
◉ – SURFACE DATA STATION
DATA COLLECTED DURING FLOOD TIDE
1930-1947 HOURS, OCTOBER 28, 1967


PEEKSKILL
INDIAN POINT POWER PLANT
POWER PLANT
Cedar Pond Brook
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DATA COLLECTED DURING EBB TIDE
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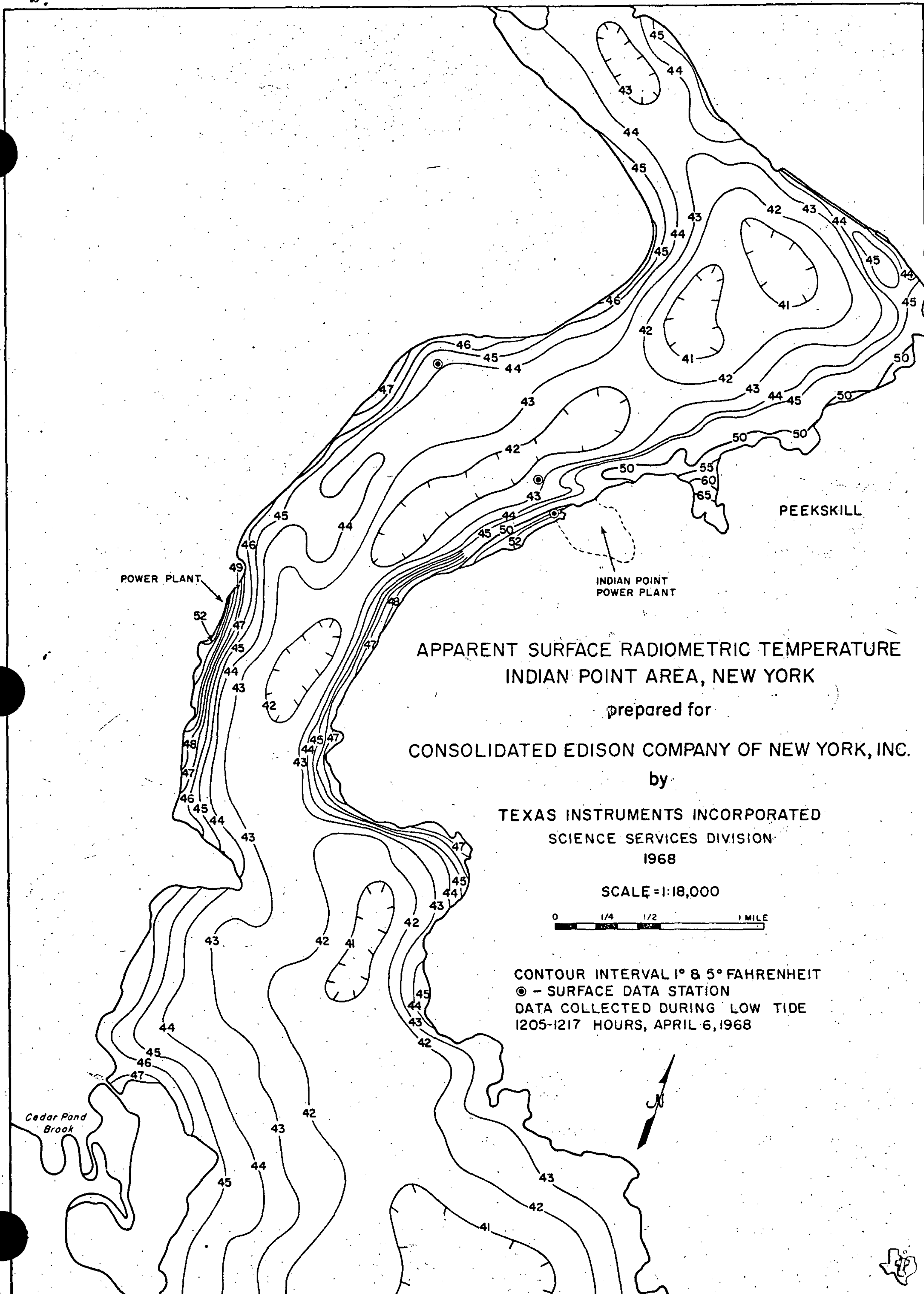

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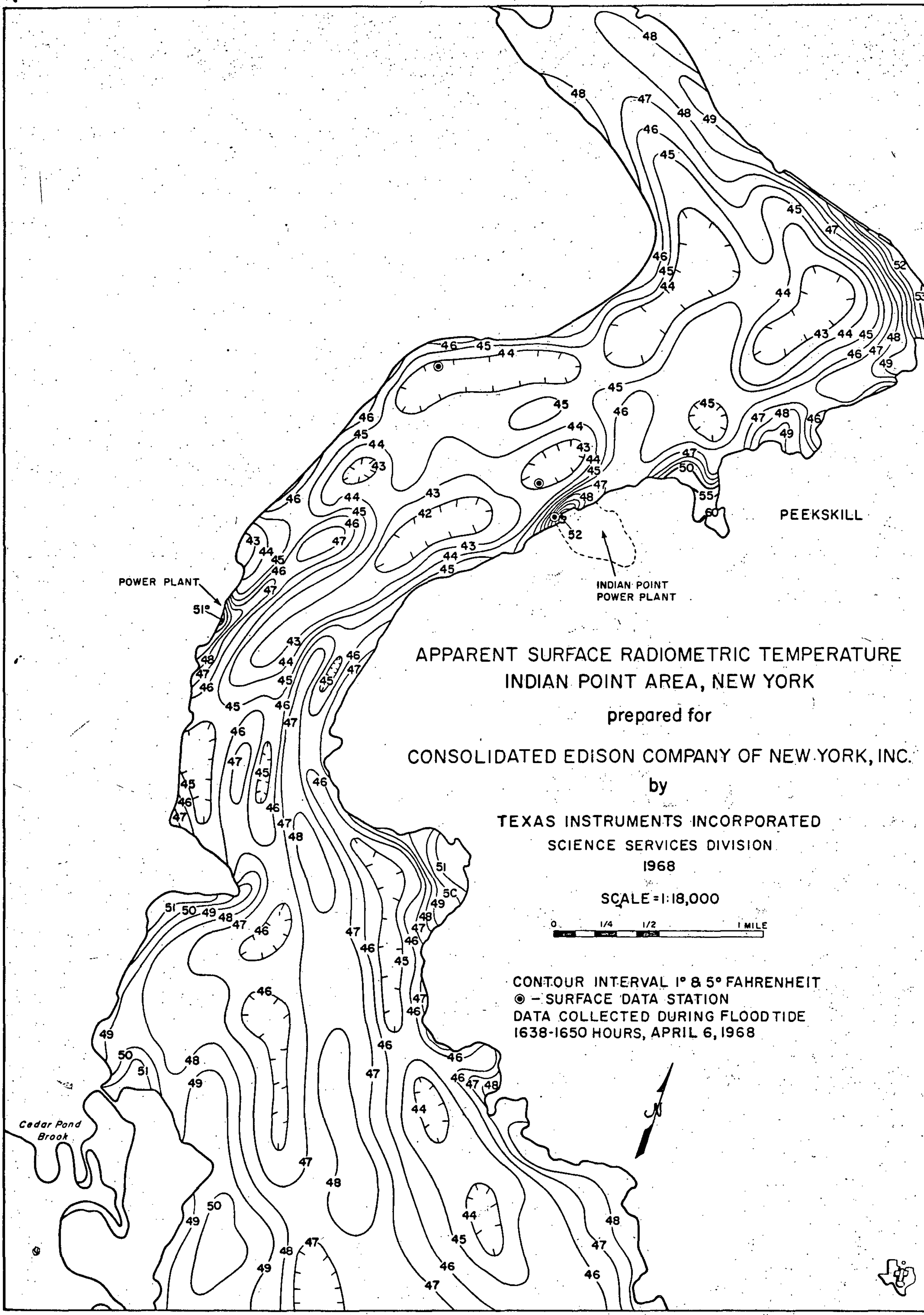
0 1/4 1/2 1 MILE

CONTOUR INTERVAL 1° & 5° FAHRENHEIT
◉ – SURFACE DATA STATION
DATA COLLECTED DURING LOW TIDE
1205-1217 HOURS, APRIL 6, 1968



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CONTOUR INTERVAL 1° & 5° FAHRENHEIT
◉ – SURFACE DATA STATION
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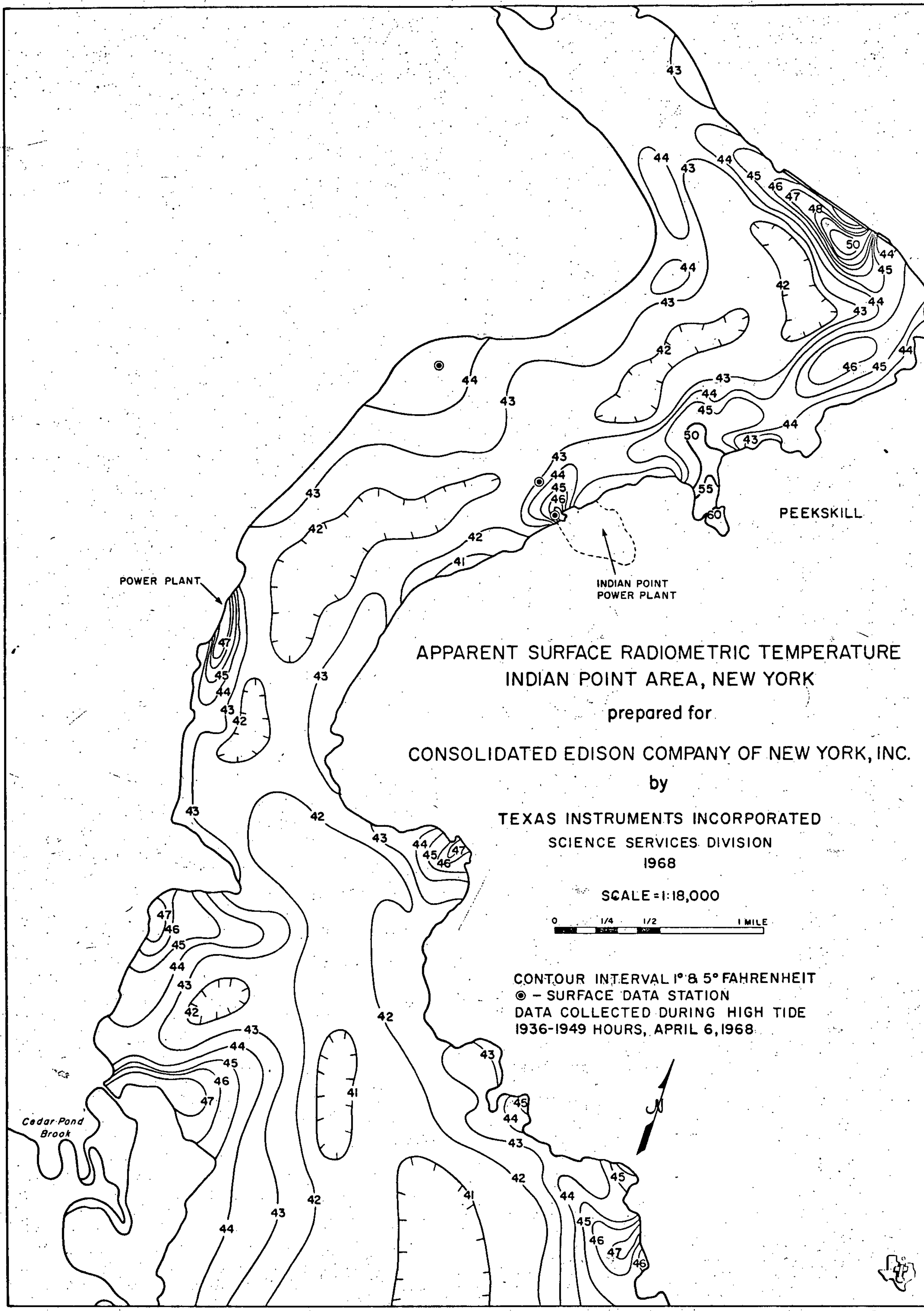
1638-1650 HOURS, APRIL 6, 1968



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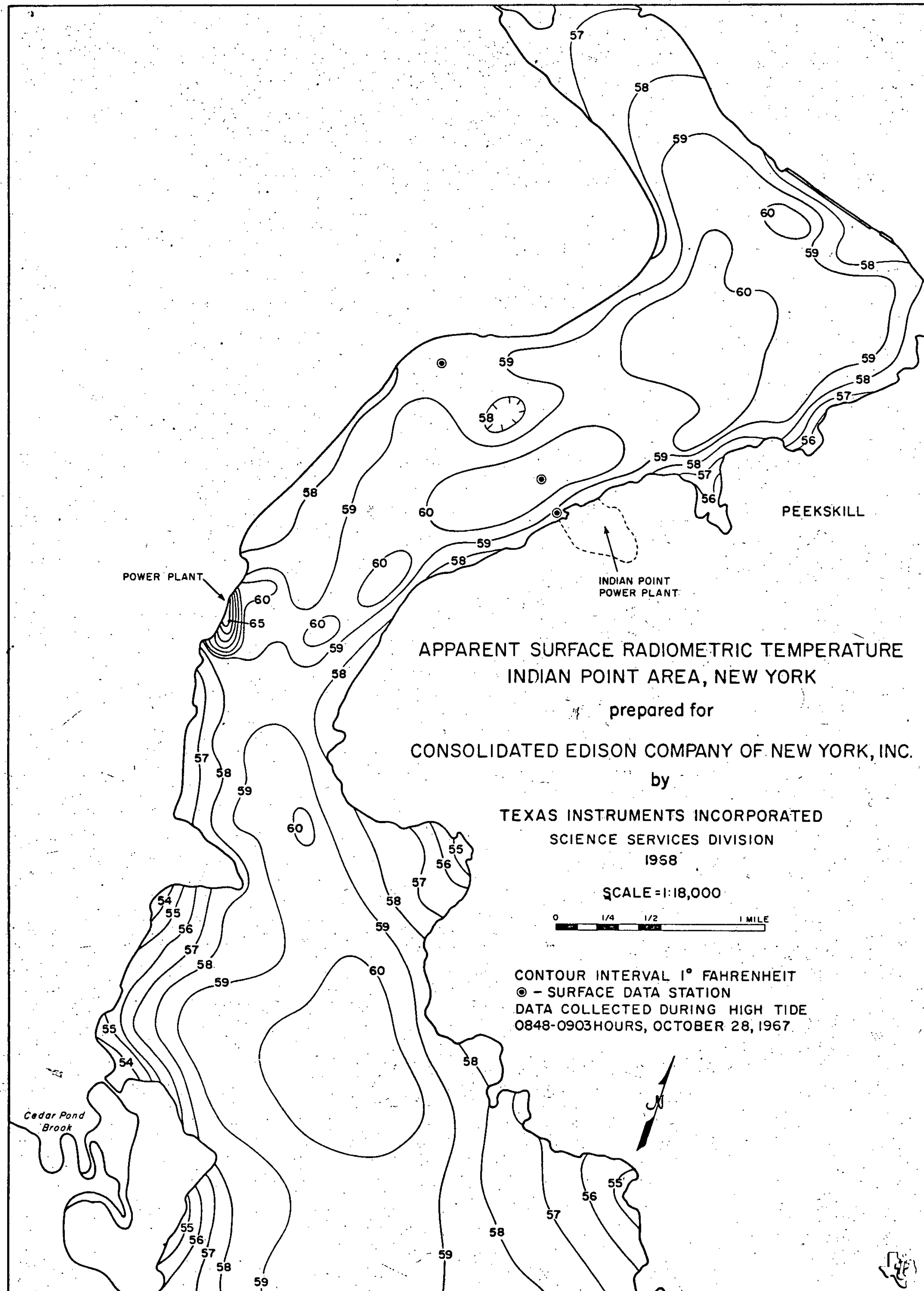
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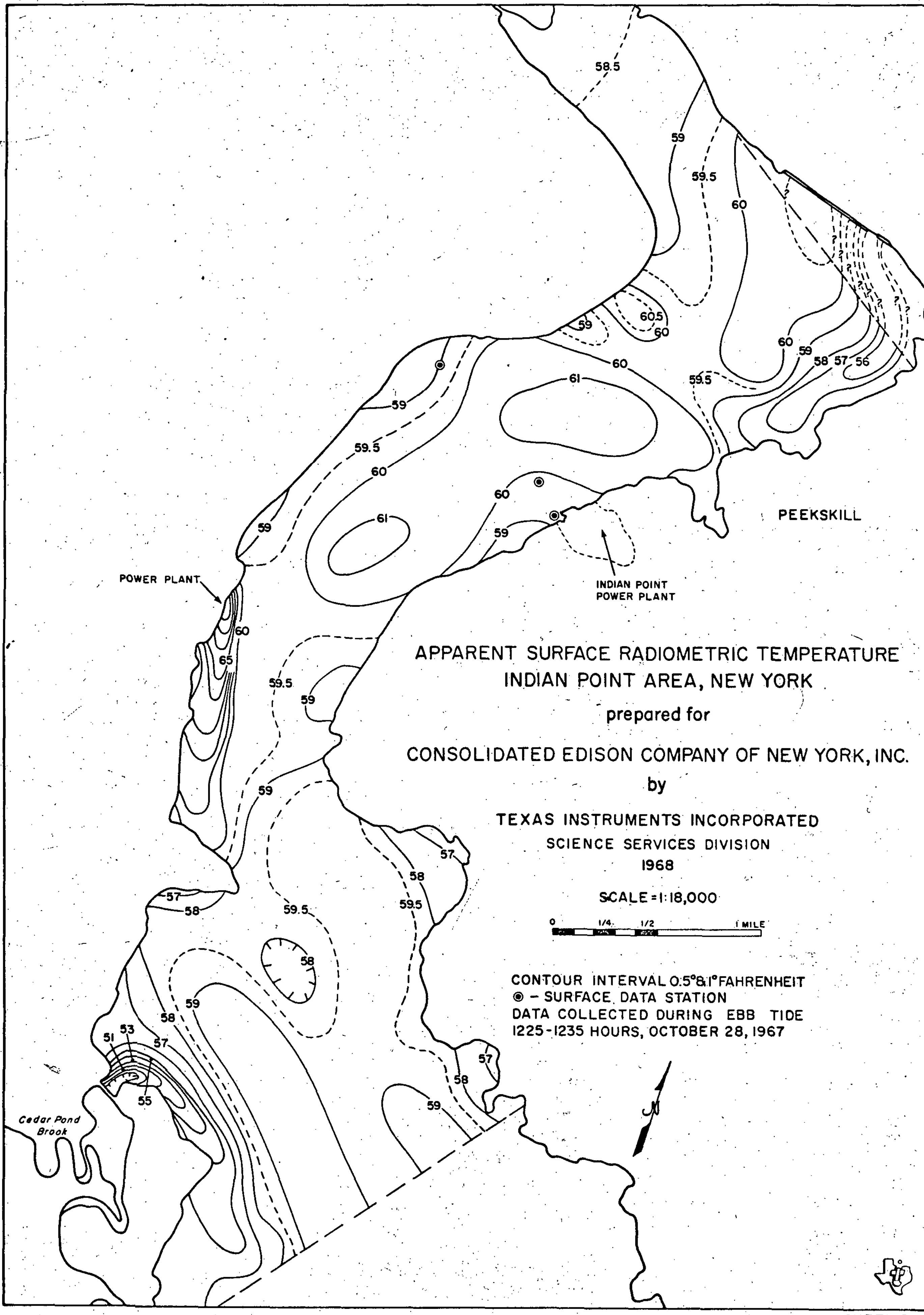
SHEET 1



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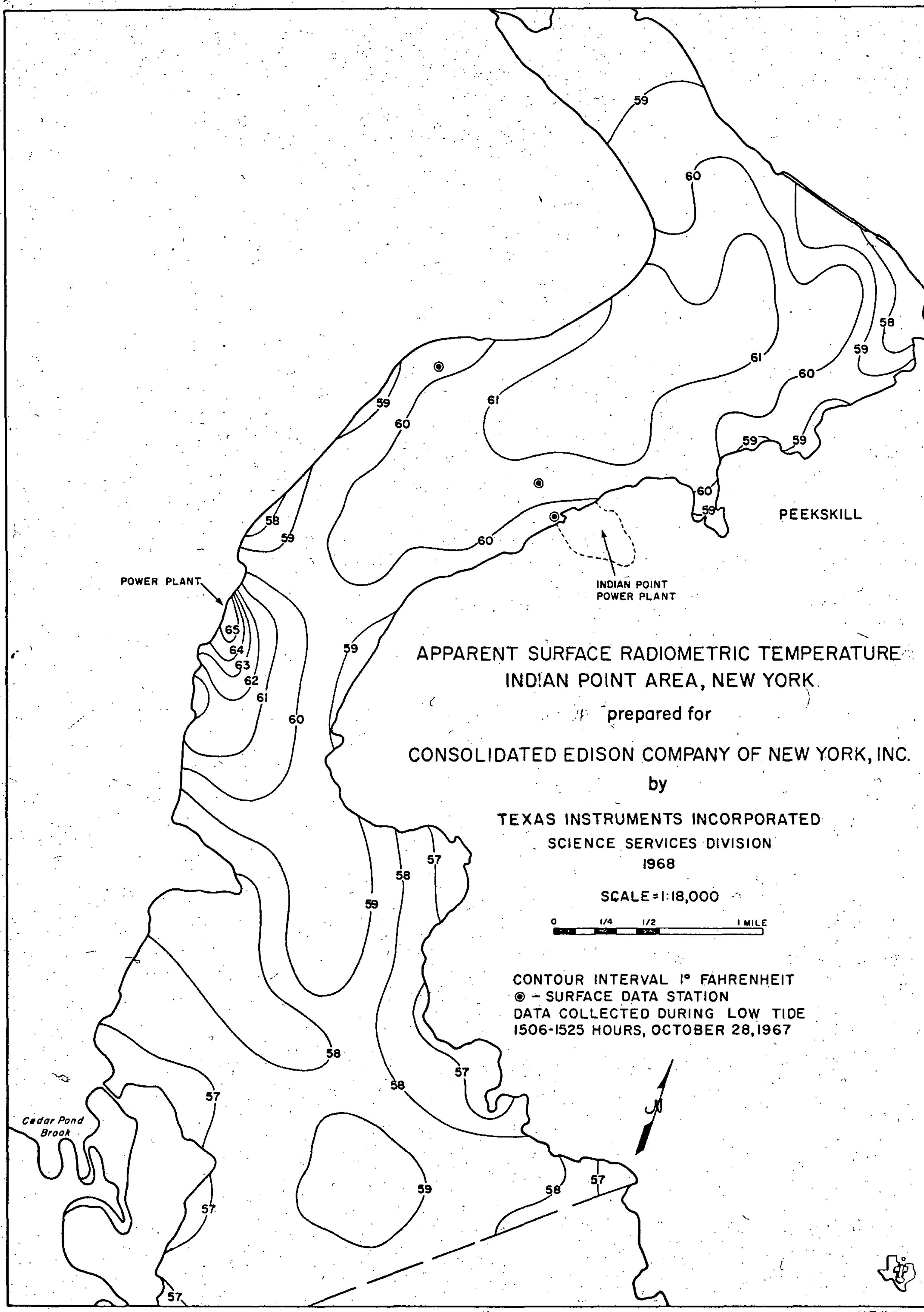
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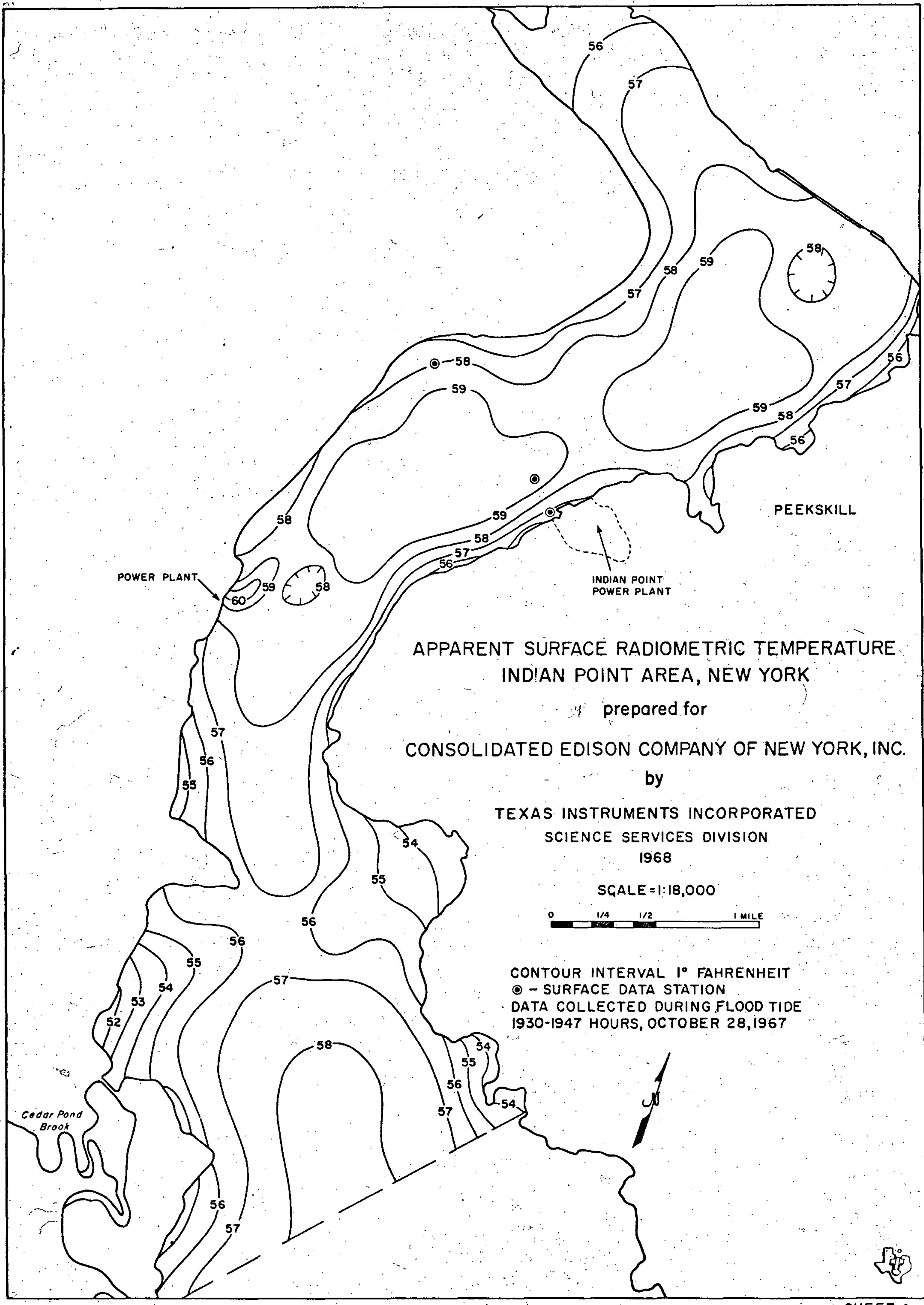
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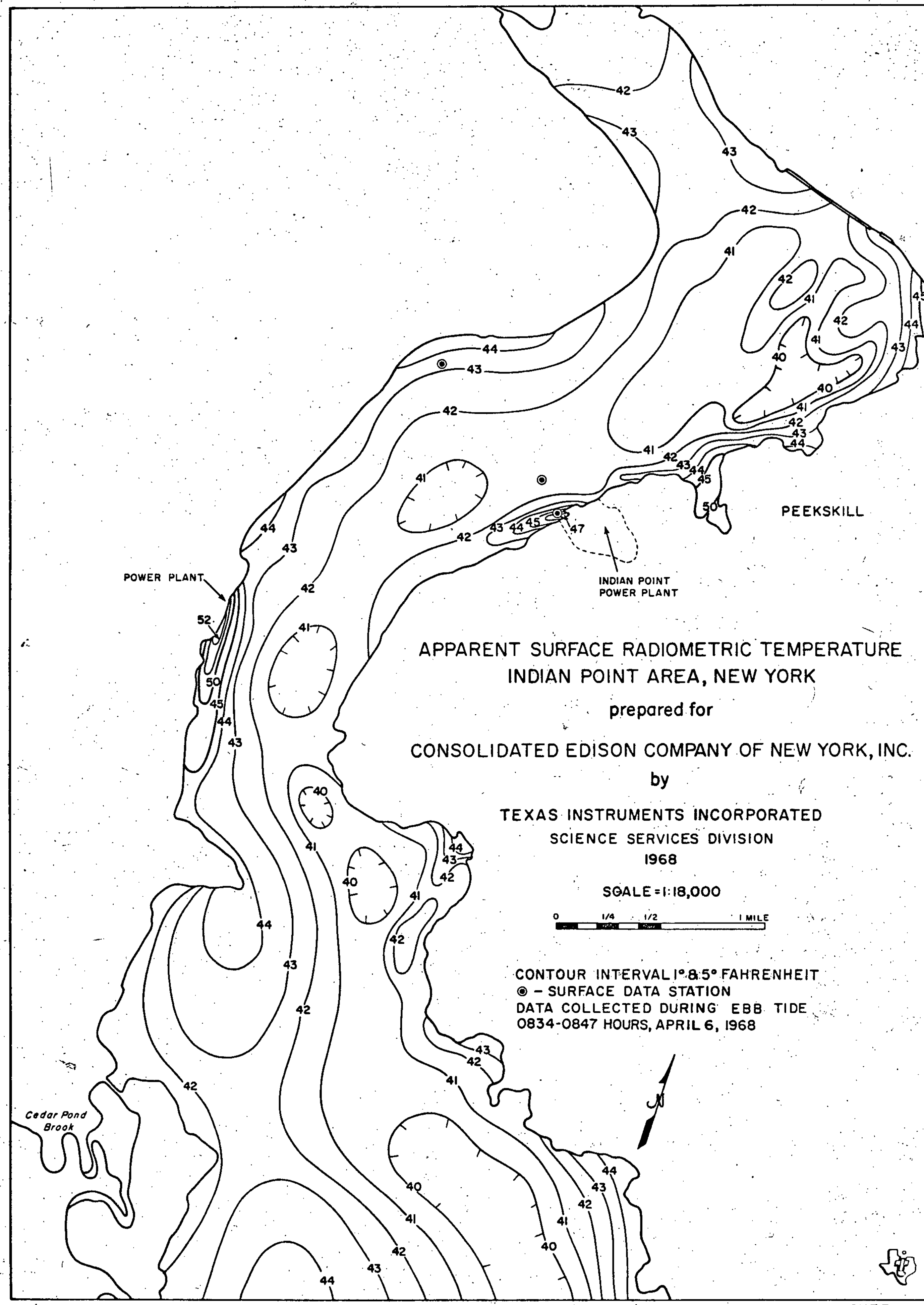
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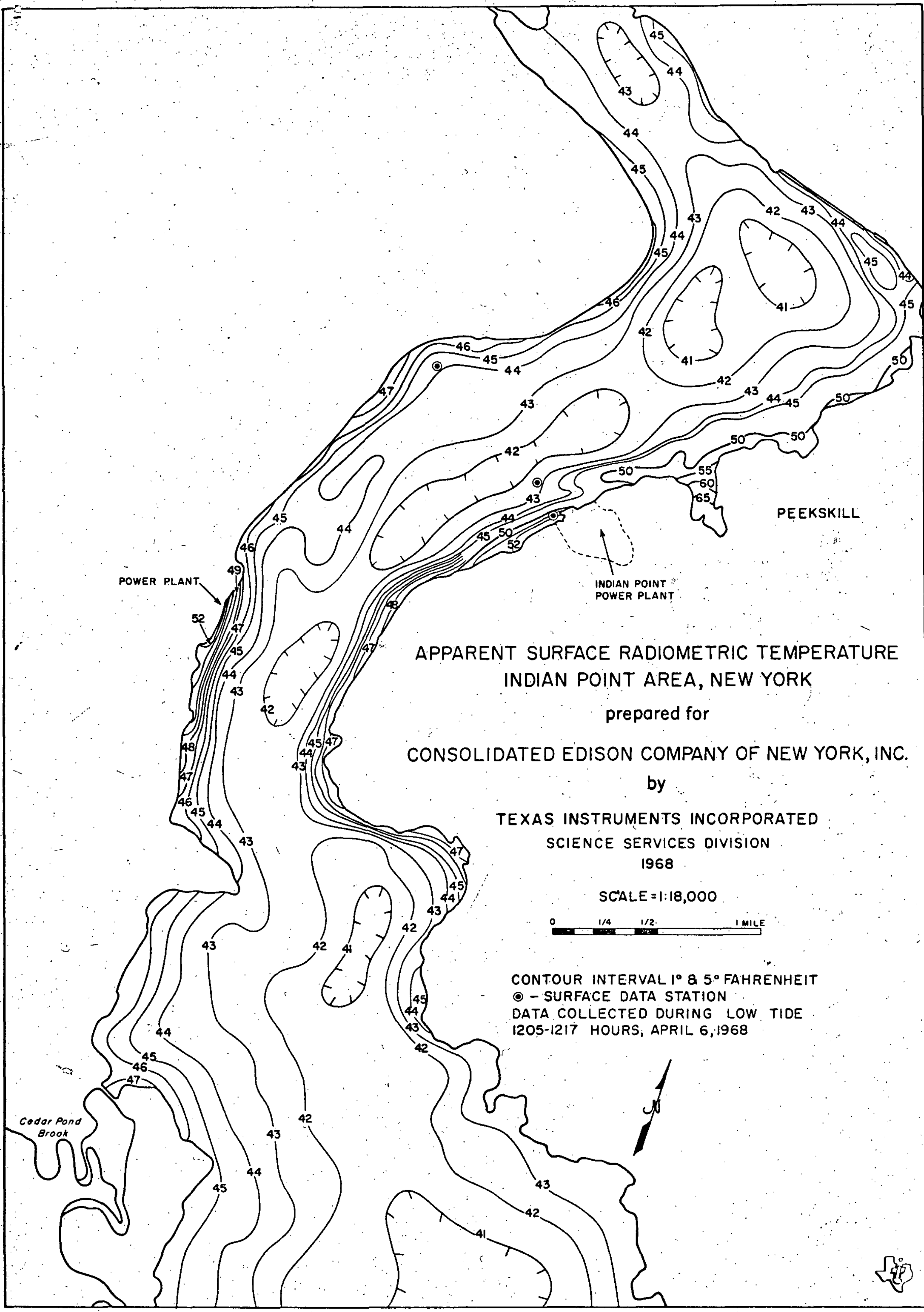
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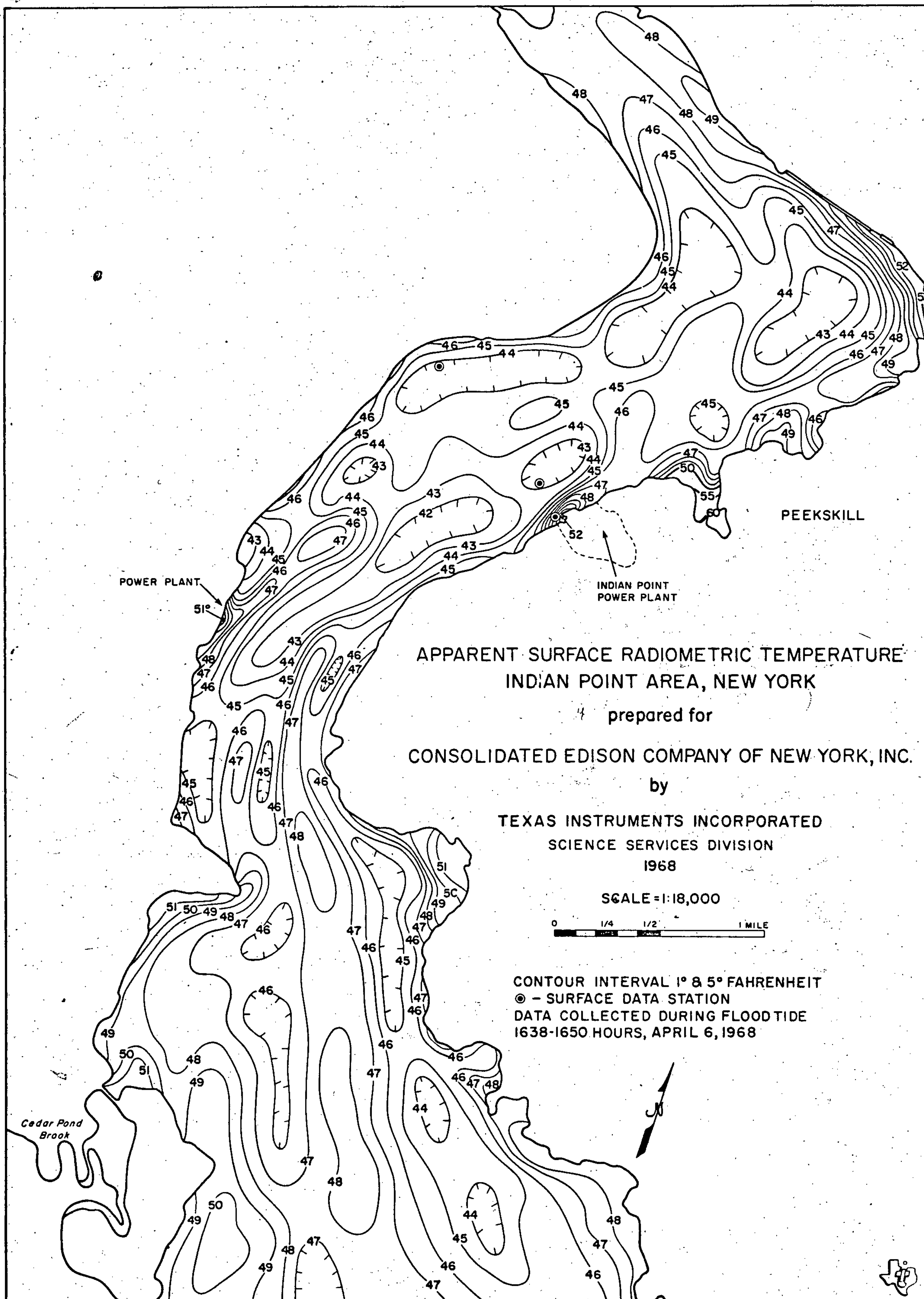
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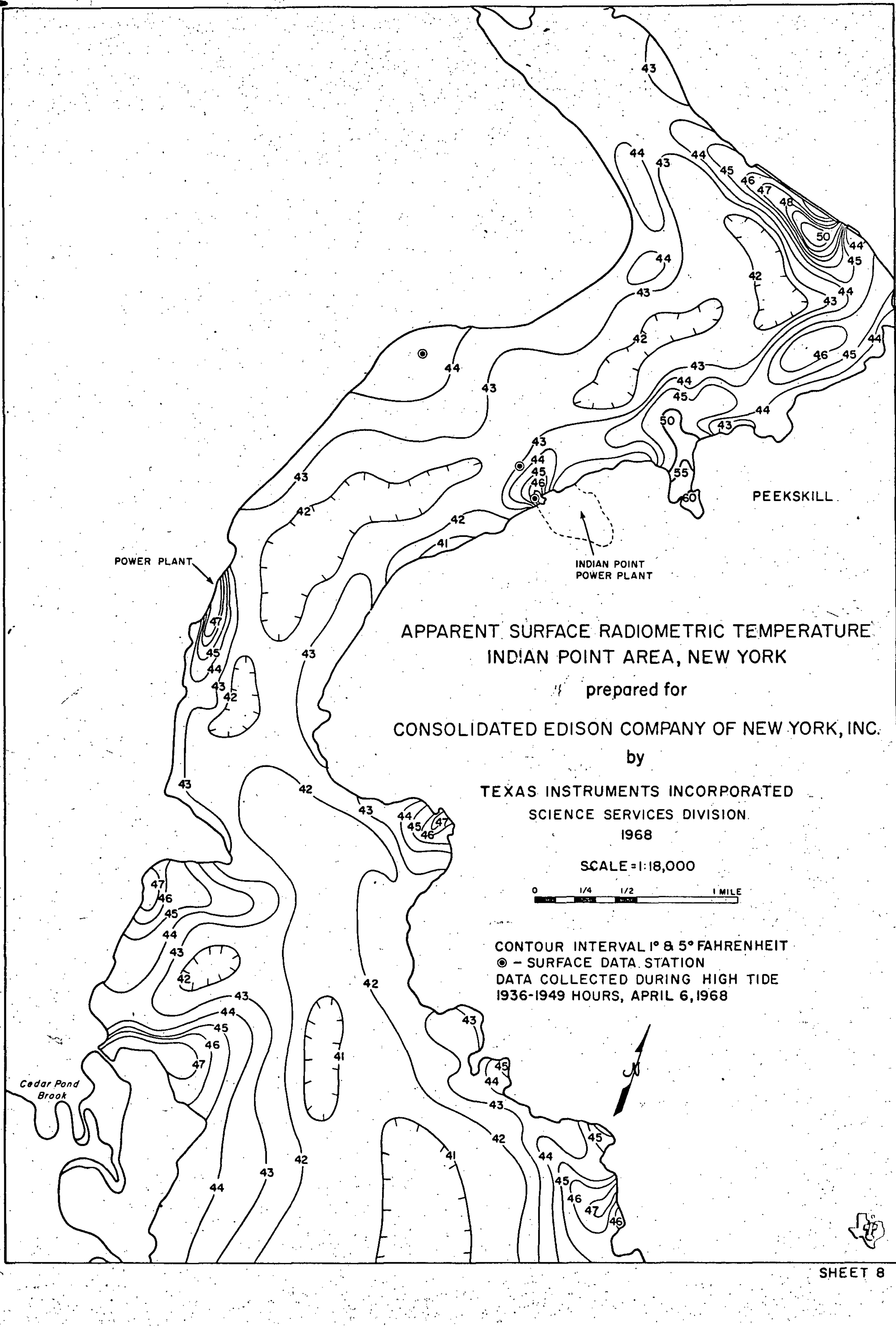
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INDIAN POINT
POWER PLANT
POWER PLANT
Cedar Pond
Brook
N