EXAMINATION OF NATURALLY OCCURRING RADIOACTIVITY IN THE SEDIMENTS NEAR THE DONALD C. COOK NUCLEAR POWER PLANT

Final Report Prepared by

Phillip Plato

Department of Environmental and Industrial Health
School of Public Health
The University of Michigan
Ann Arbor, Michigan

Submitted to:

The American Electric Power Service Corporation
New York City, New York

May 31, 1973

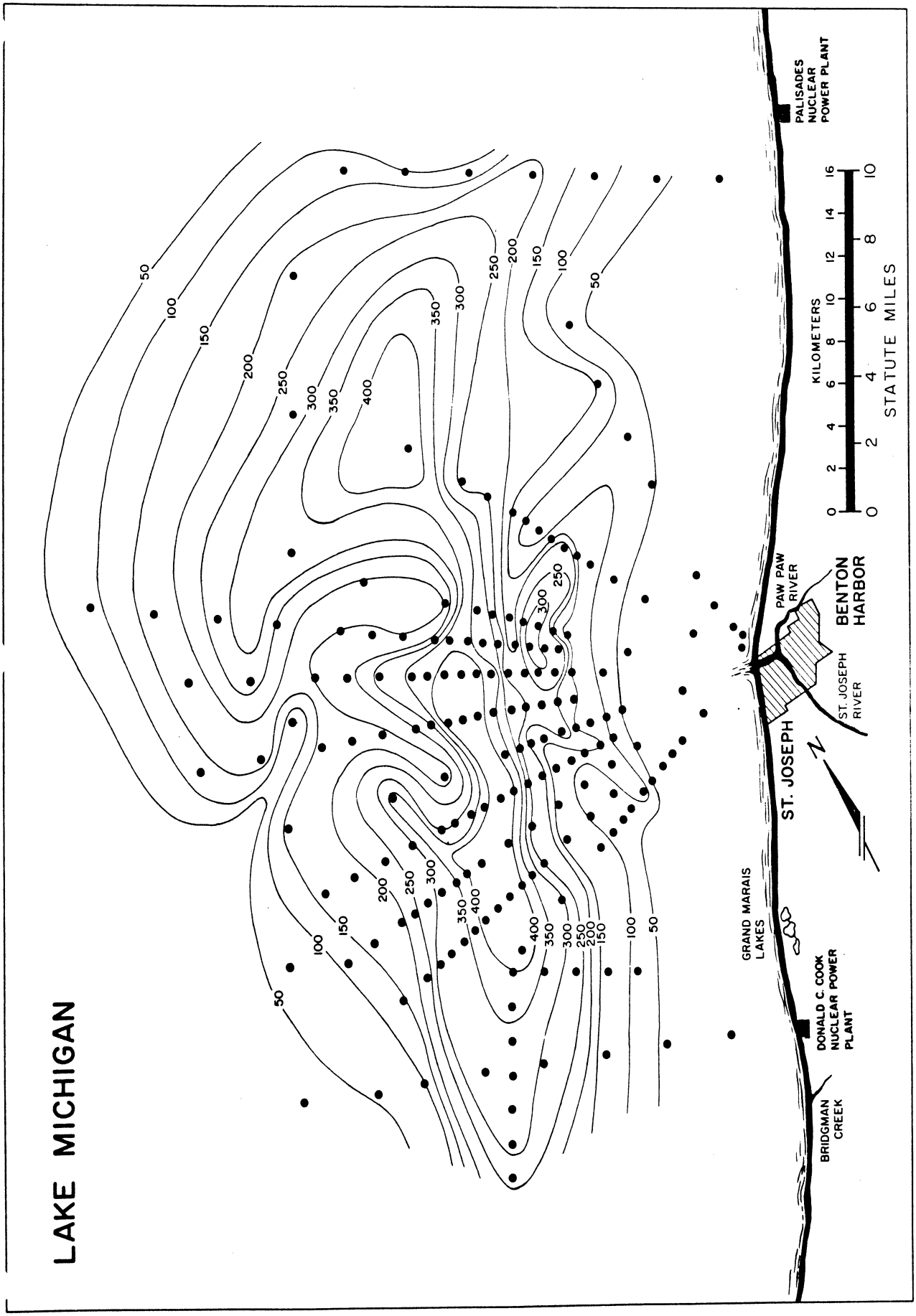

Figure 5. The deltaic facies produced by the St. Joseph River in Lake Michigan is shown. Each dot represents a sediment sampling station. The contour lines represent counts per minute of cesium-137 as measured in the field from the gamma ray spectra produced by the various sediment samples.

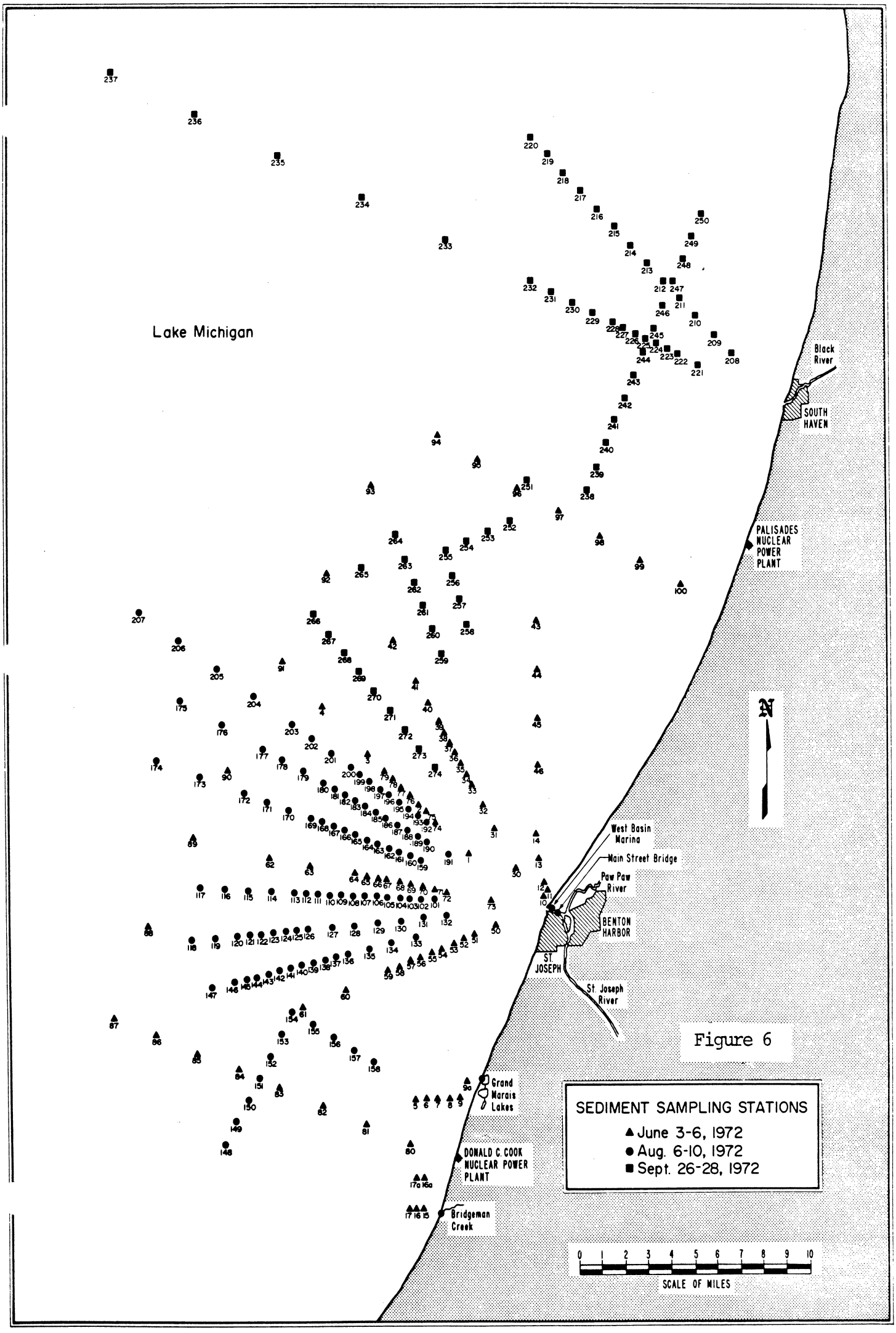
Lake Michigan
Black River
SOUTH HAVEN
PALISADES NUCLEAR POWER PLANT
West Basin Marina
Main Street Bridge
Paw Paw River
BENTON HARBOR
ST. JOSEPH
St. Joseph River
Grand Marais Lakes
DONALD C. COOK NUCLEAR POWER PLANT
Bridgeman Creek
N
SEDIMENT SAMPLING STATIONS
▲ June 3-6, 1972
● Aug. 6-10, 1972
■ Sept. 26-28, 1972
0 1 2 3 4 5 6 7 8 9 10
SCALE OF MILES

Figure 6

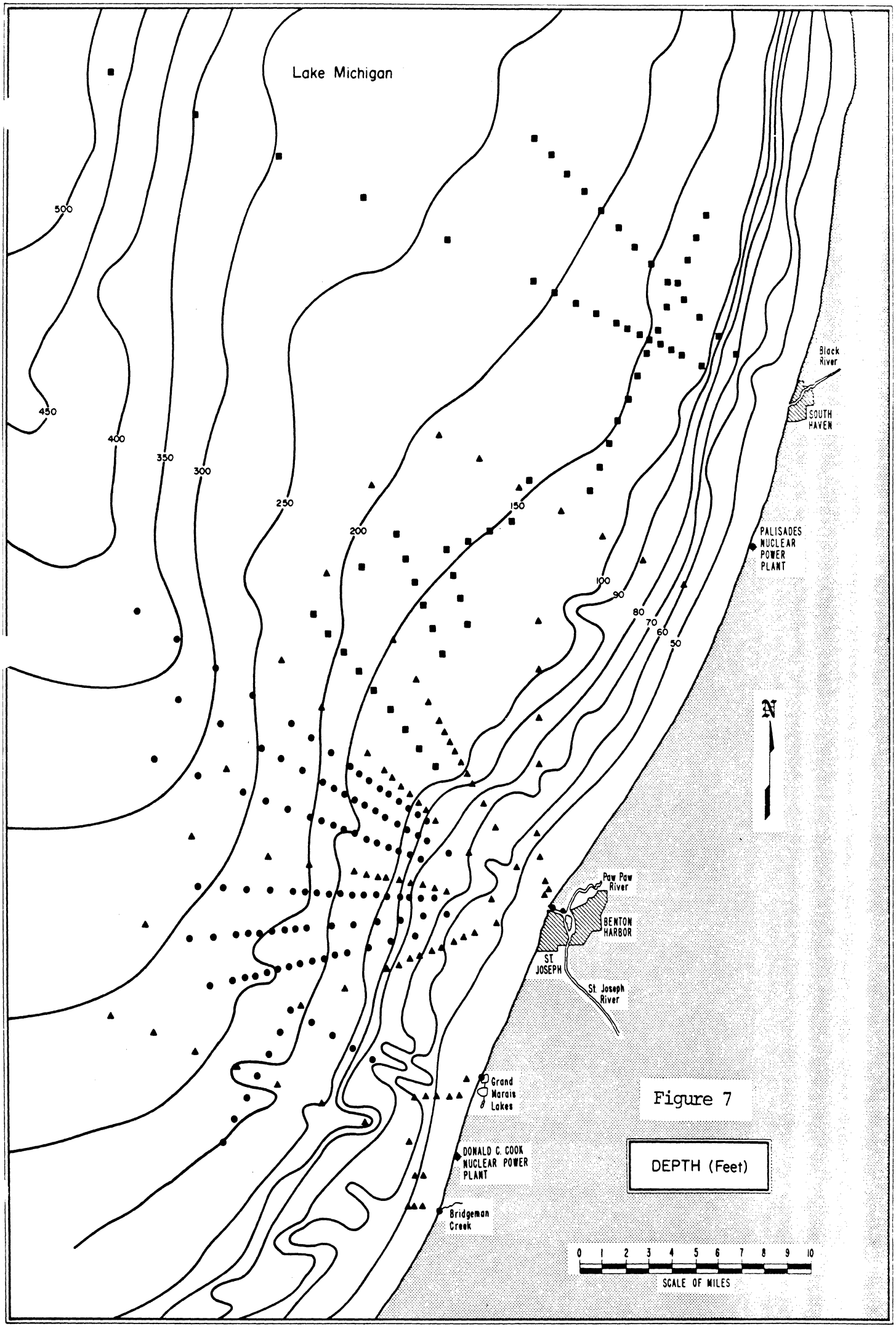
Lake Michigan
500
450
400
350
300
250
200
150
100
90
80
70
60
50
Black River
SOUTH HAVEN
PALISADES NUCLEAR POWER PLANT
N
Paw Paw River
BENTON HARBOR
ST JOSEPH
St Joseph River
Grand Marais Lakes
DONALD C. COOK NUCLEAR POWER PLANT
Bridgeman Creek
DEPTH (Feet)
0 1 2 3 4 5 6 7 8 9 10
SCALE OF MILES

Figure 7

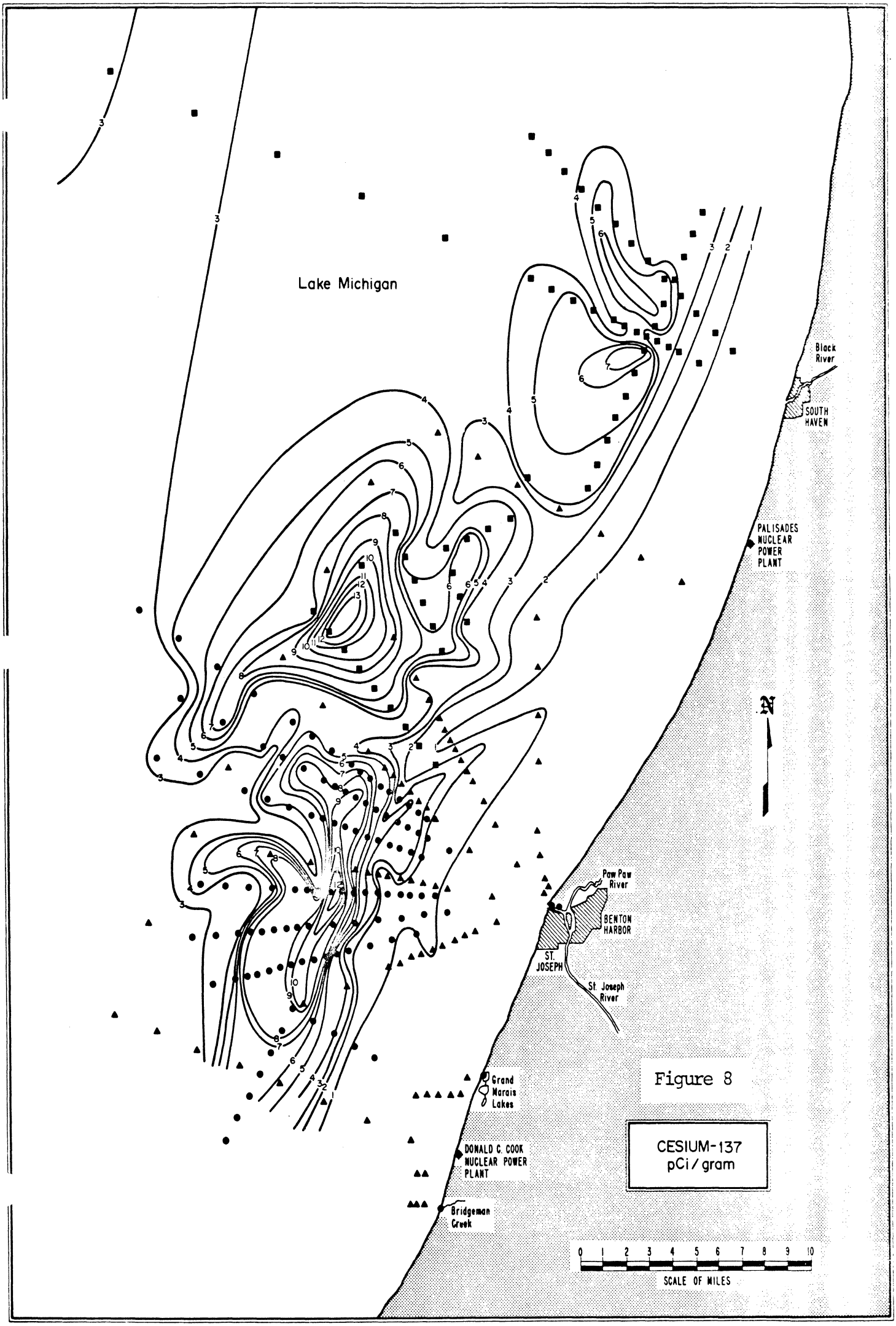
Lake Michigan
Black River
SOUTH HAVEN
PALISADES NUCLEAR POWER PLANT
N
Paw Paw River
BENTON HARBOR
ST. JOSEPH
St. Joseph River
Grand Marais Lakes
DONALD C. COOK NUCLEAR POWER PLANT
Bridgeman Creek
CESIUM-137
pCi/gram
0 1 2 3 4 5 6 7 8 9 10
SCALE OF MILES

Figure 8

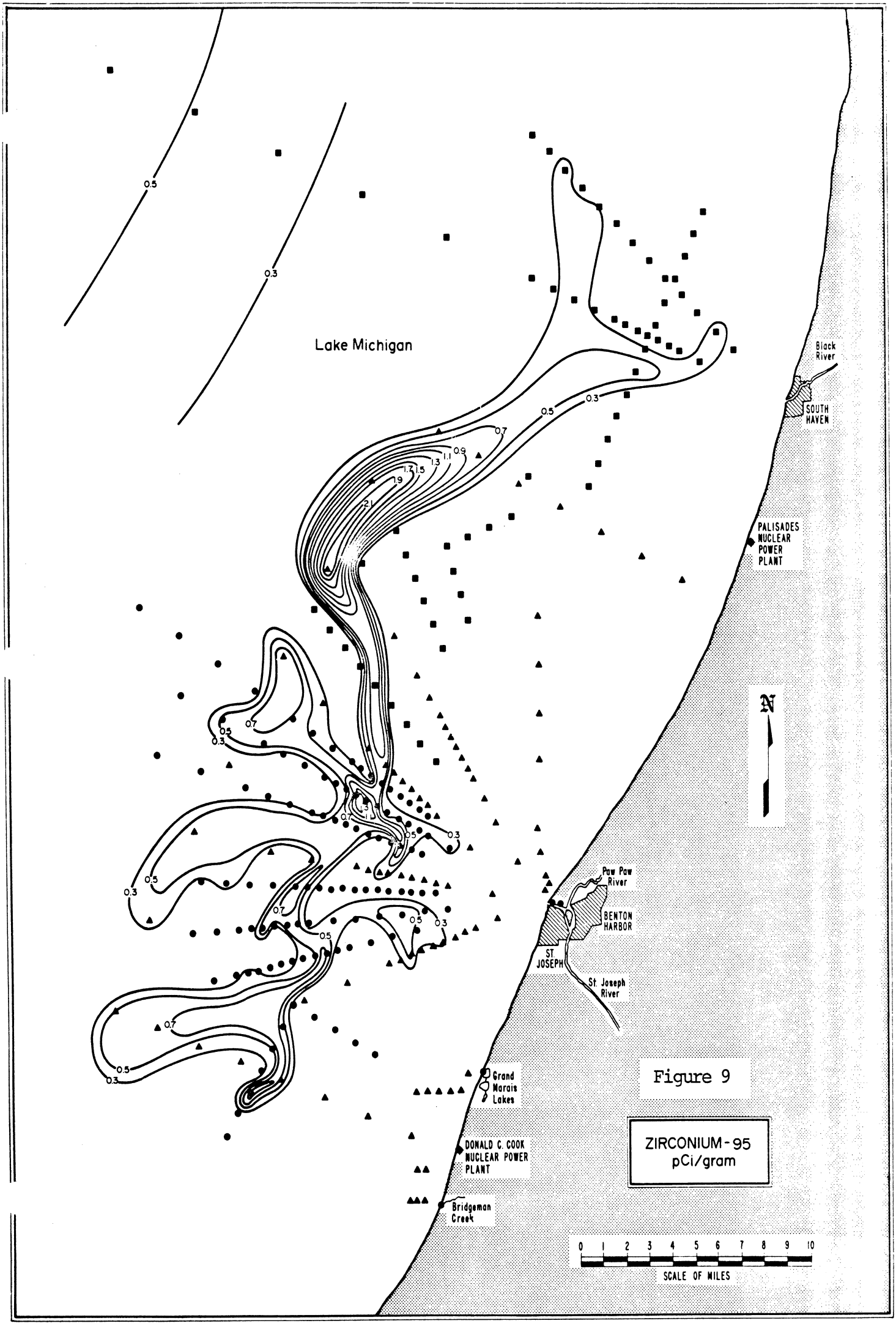
Lake Michigan
Black River
SOUTH HAVEN
PALISADES NUCLEAR POWER PLANT
Paw Paw River
BENTON HARBOR
ST JOSEPH
St. Joseph River
Grand Marais Lakes
DONALD C. COOK NUCLEAR POWER PLANT
Bridgeman Creek
N
0 1 2 3 4 5 6 7 8 9 10
SCALE OF MILES
ZIRCONIUM-95
pCi/gram

Figure 9

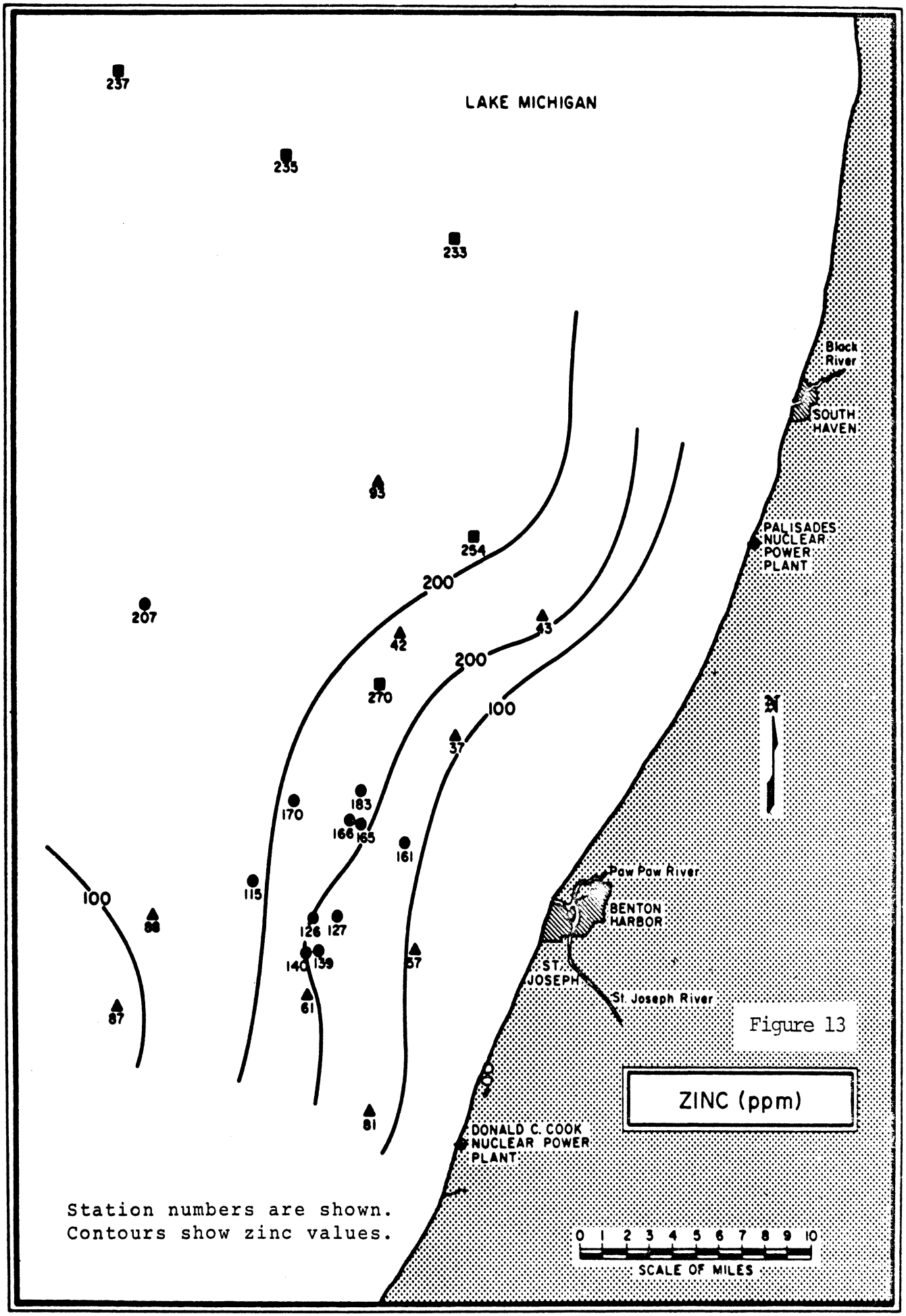
LAKE MICHIGAN
237
235
233
254
270
93
42
43
37
207
200
200
100
100
170
183
166
165
161
115
126
127
140
139
57
61
88
87
81
Black River
SOUTH HAVEN
PALISADES NUCLEAR POWER PLANT
Paw Paw River
BENTON HARBOR
ST. JOSEPH
St. Joseph River
DONALD C. COOK NUCLEAR POWER PLANT
ZINC (ppm)
Station numbers are shown.
Contours show zinc values.
0 1 2 3 4 5 6 7 8 9 10
SCALE OF MILES

Figure 13

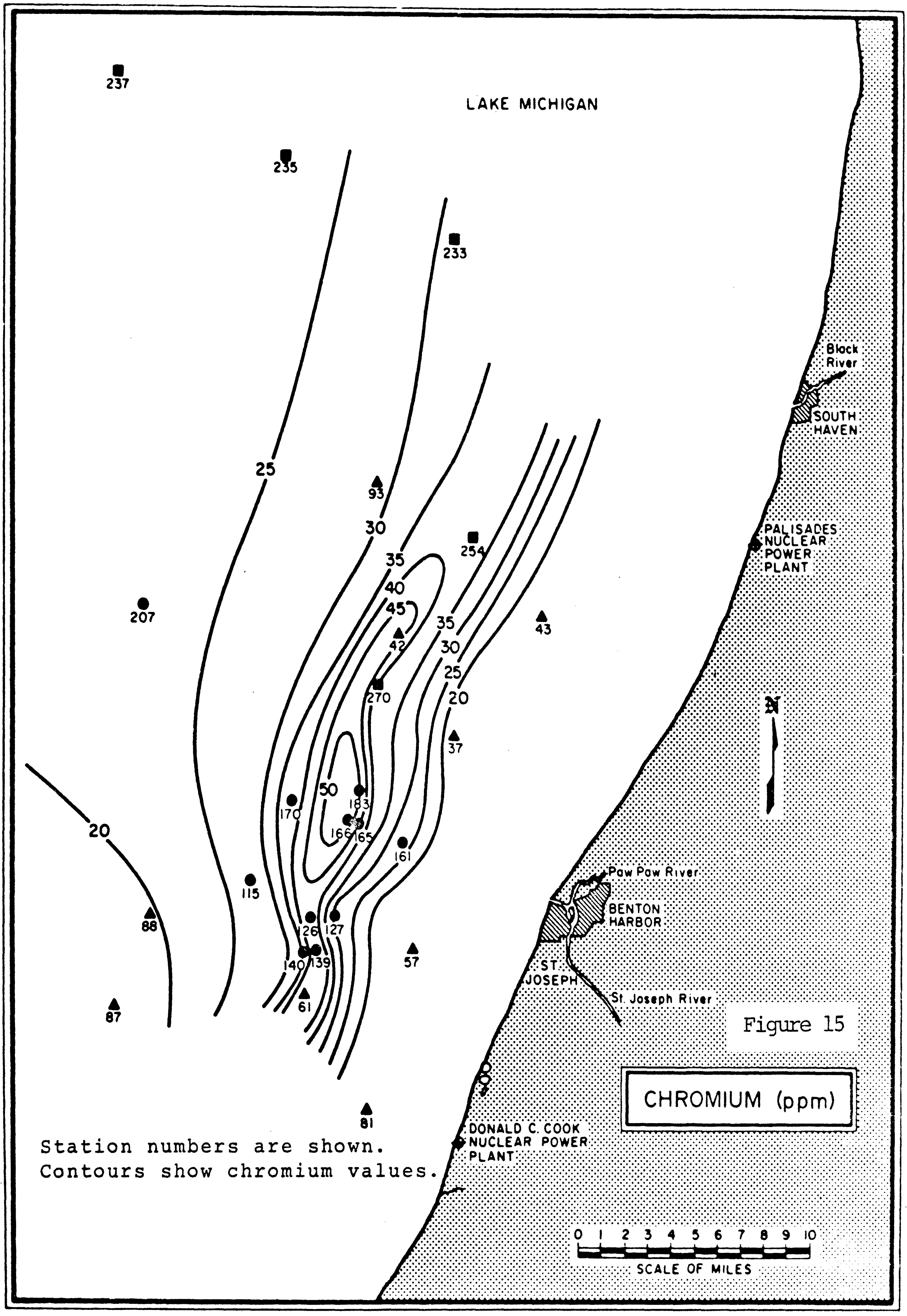

Figure 15

CHROMIUM (ppm)

Station numbers are shown.
Contours show chromium values.

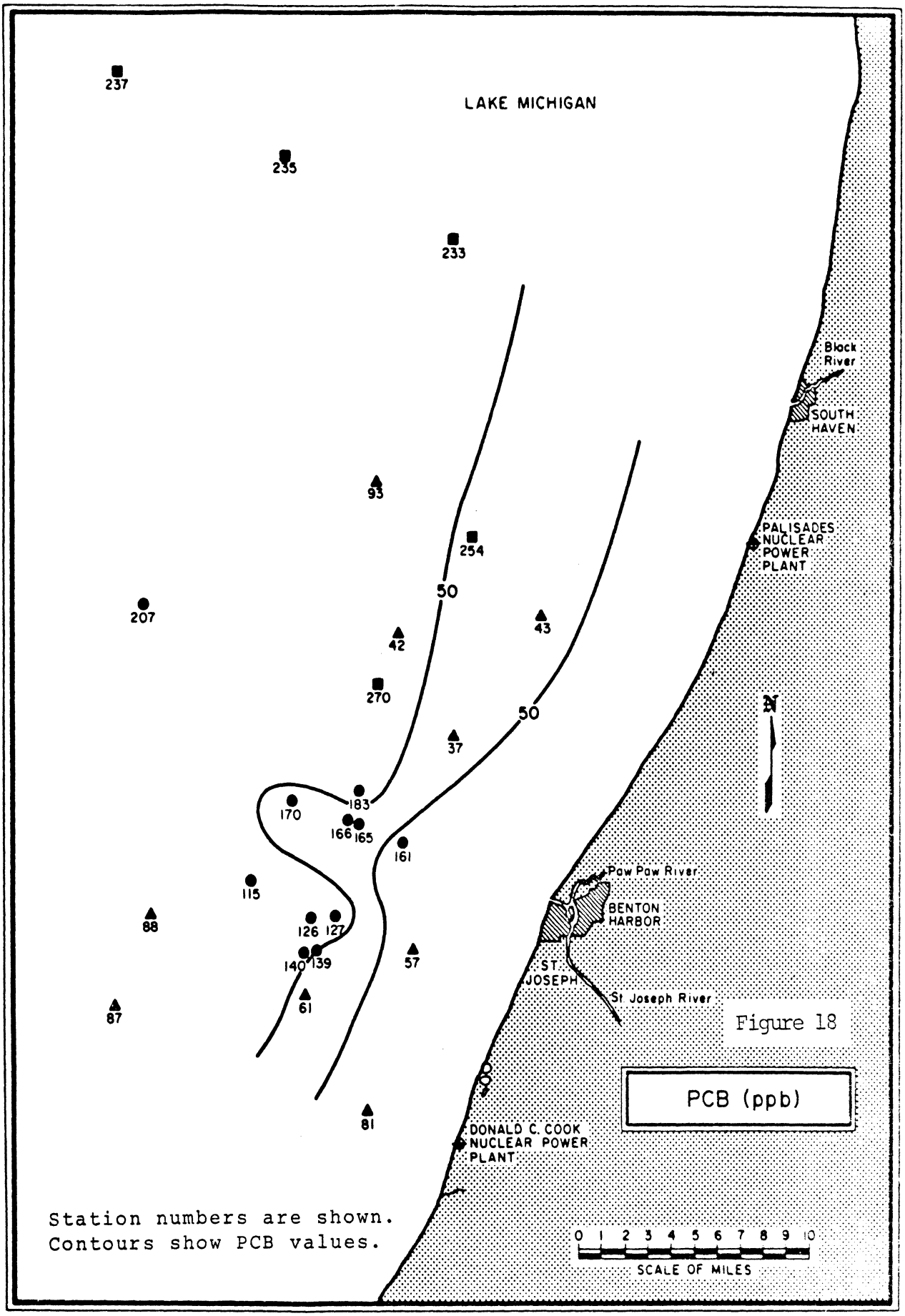
LAKE MICHIGAN
237
235
233
254
93
207
42
43
270
37
50
50
183
170
166
165
161
115
88
126
127
140
139
57
61
87
81
Block River
SOUTH HAVEN
PALISADES NUCLEAR POWER PLANT
Paw Paw River
BENTON HARBOR
ST. JOSEPH
St Joseph River
DONALD C. COOK NUCLEAR POWER PLANT
PCB (ppb)
Station numbers are shown.
Contours show PCB values.
0 1 2 3 4 5 6 7 8 9 10
SCALE OF MILES

Figure 18

Table 4. Correlation coefficients (r) for all 25 sediment samples of Group I and Group II from Appendix III. Only coefficients greater than .50 are shown.

	Cs (field)	Cs-137	Zn (Robbins)	Zn	Cu	Cd	Cr	Ni	Pb	Dieldrin	DDT	PCB	Zr-95	K-40	Ra-226	Th-232
Cs (field)	1.00															
Cs-137	.95	1.00														
Zn (Robbins)			1.00													
Zn			.94	1.00												
Cu					1.00											
Cd					.51	1.00										
Cr	.87	.88			.55		1.00									
Ni						.67		1.00								
Pb	.64	.70			.69		.90		1.00							
Dieldrin			.58	.60						1.00						
DDT										.71	1.00					
PCB										.72	.90	1.00				
Zr-95													1.00			
K-40					.62	.73		.64						1.00		
Ra-226								.54							1.00	
Th-232					.72	.75		.70						.96		1.00

r = .80 - 1.00 strong correlation
r = .50 - .79 moderate correlation
r < .50 (omitted) weak correlation

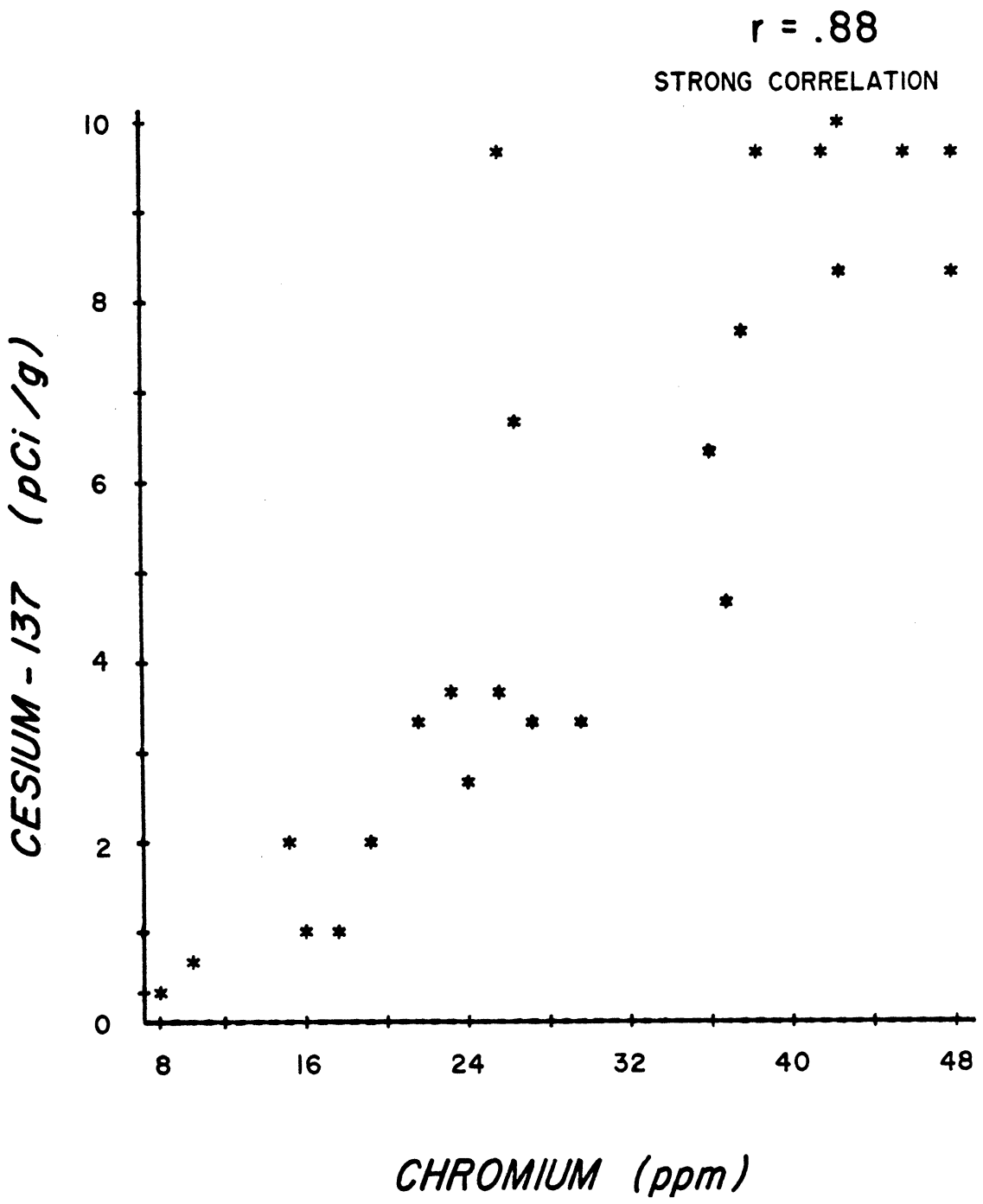

Figure 19. Scatter plot of cesium-137 versus chromium for the sediment samples from Appendix III. The plot shows a strong correlation (r = .88).

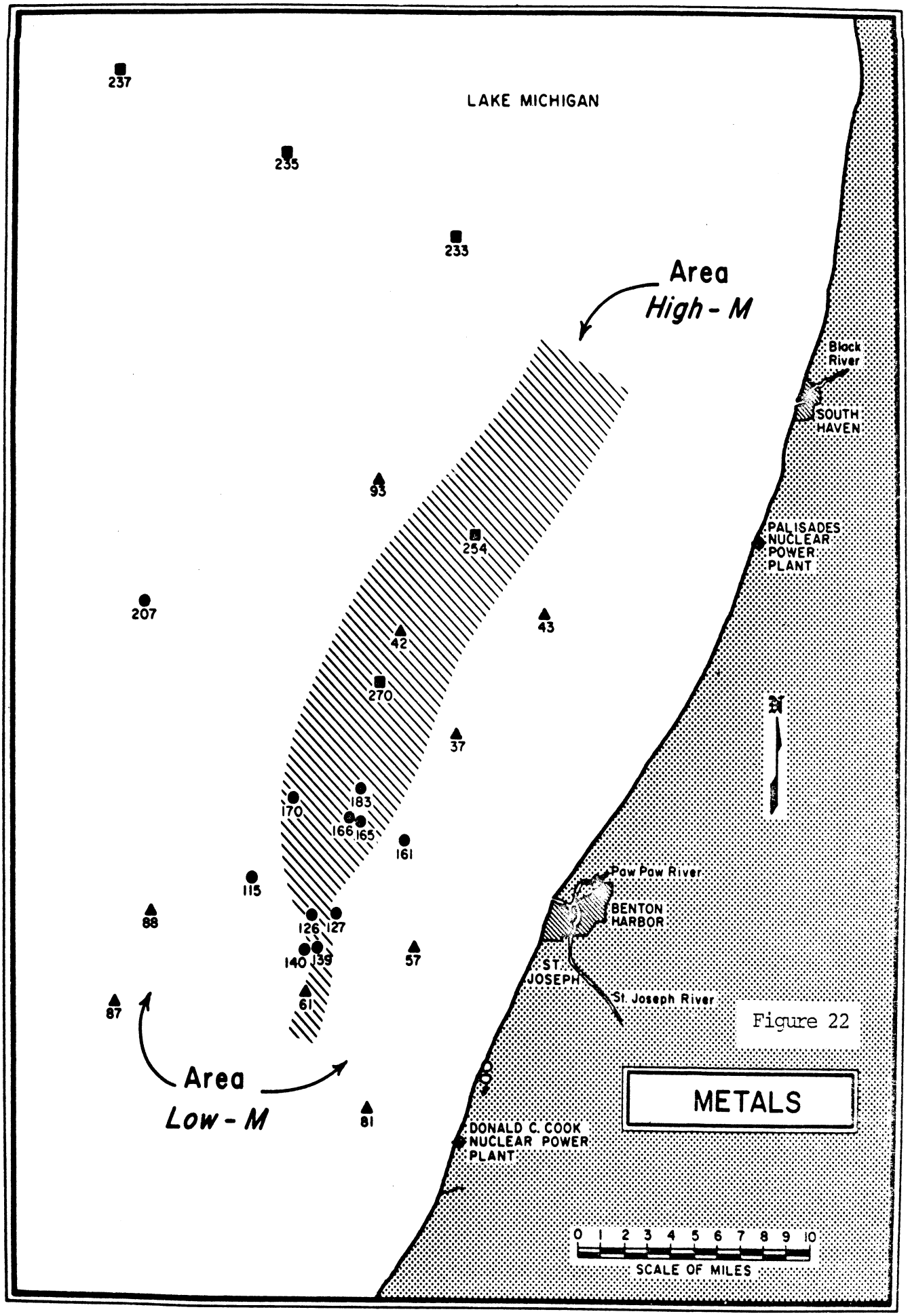
LAKE MICHIGAN
237
235
233
Area
High - M
Black
River
SOUTH
HAVEN
93
254
PALISADES
NUCLEAR
POWER
PLANT
207
42
43
270
37
170
183
166
165
161
115
Paw Paw River
BENTON
HARBOR
88
126
127
140
139
57
ST.
JOSEPH
St. Joseph River
87
61
Area
Low - M
81
DONALD C. COOK
NUCLEAR POWER
PLANT
METALS
0 1 2 3 4 5 6 7 8 9 10
SCALE OF MILES

Figure 22

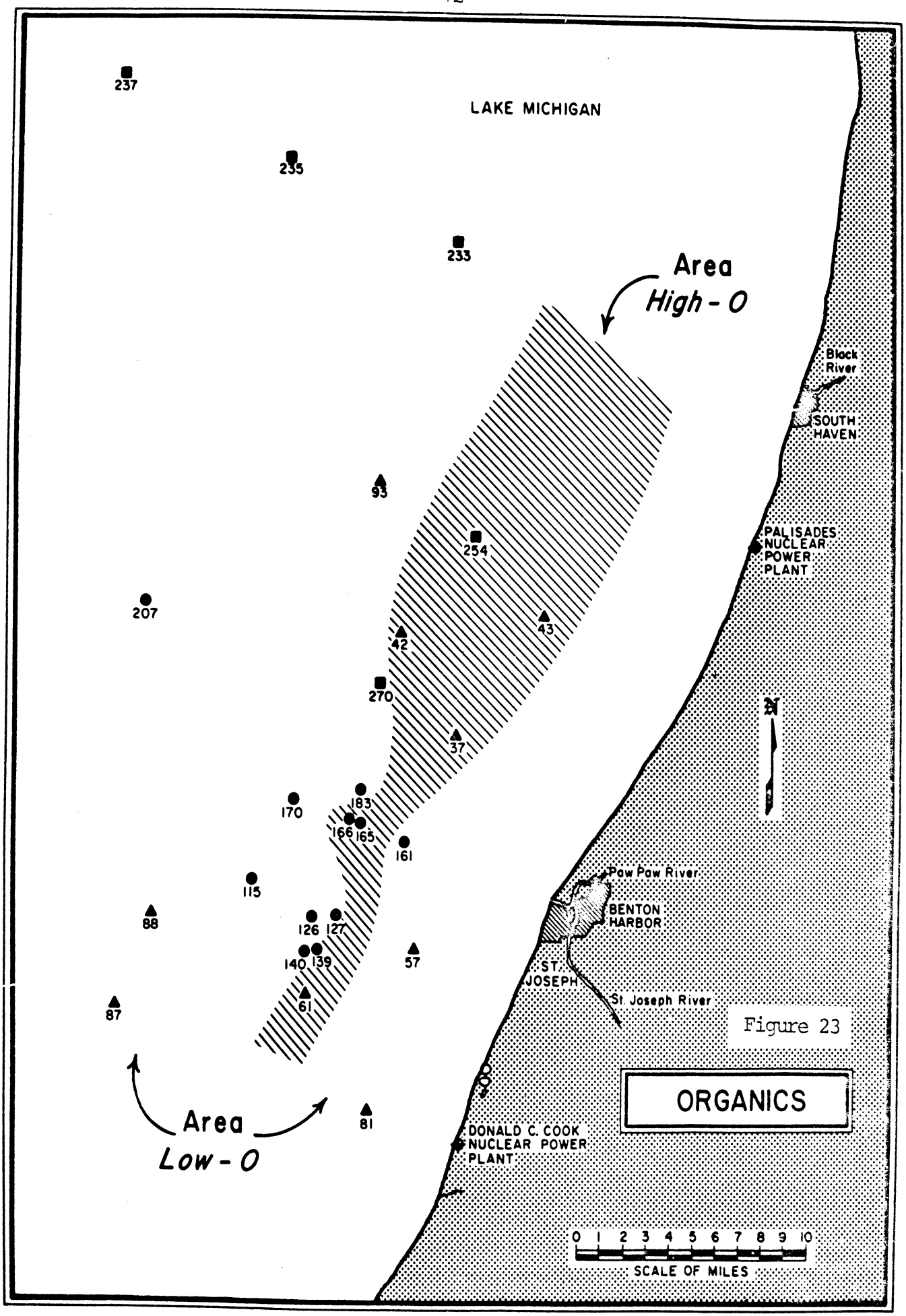

Figure 23

ORGANICS

TABLE 9. Summary of measurements made on the sediment samples from areas High-M and Low-M shown in Figure 22.

Variable	Average of 10 Samples Area High-M	Average of 15 Samples Area Low-M	Ratio High-M / Low-M	Is High-M >Low-M at Following Conf. Level? 90%	95%	99%
Cesium-137						
Field (cpm)	390 ± 29	142 ± 33	2.75 ± .67			x
Lab (pCi/g)	8.54± .55	3.19 ± .68	2.68 ± .60			x
Dr. John Robbins						
Zinc (ppm)	243 ± 36	173 ± 21	1.40 ± .27	x		
Michigan Water Resources Commission						
Zinc (ppm)	261 ± 54	149 ± 19	1.75 ± .43		x	
Copper (ppm)	32.7 ± 1.3	25.2 ± 3.1	1.30 ± .17	x		
Cadmium (ppm)	3.5 ± .3	4.0 ± .4	.88 ± .12			
Chromium (ppm)	43.2 ± 1.5	21.5 ± 1.8	2.01 ± .18			x
Nickel (ppm)	12.0 ± 1.3	15.3 ± 1.3	.78 ± .11			
Lead (ppm)	98.0 ± 2.0	64.3 ± 4.9	1.52 ± .12			x
Dieldrin (ppb)	.75± .08	.57 ± .05	1.32 ± .18		x	
DDT (ppb)	19.1 ± 4.5	9.8 ± 2.1	1.95 ± .62		x	
PCB (ppb)	48.5 ± 8.4	29.7 ± 3.3	1.63 ± .34		x	
Radionuclides						
Zironium-95 (pCi/g)	.436± .142	.457± .109	.95 ± .39			
Potassium-40 (pCi/g)	15.02 ± .49	18.50 ± 1.92	.81 ± .09			
Radium-226 (rel.)	3.86 ± 1.40	4.88 ± 1.01	.75 ± .33			
Thorium-232 (rel.)	3.27 ± .14	3.70 ± .45	.88 ± .11			