



**Consumers
Power
Company**

ENV-85

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April 15, 1986

James G Keppler, Administrator
Region III
US Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT -
1985 RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT

Attached is the 1985 Radiological Environmental Monitoring Report for the Palisades Plant. This covers the period January 1 through December 31, 1985 and is submitted in accordance with Technical Specification 6.9.3.1.b.

Brian D Johnson (Signed)

Brian D Johnson
Staff Licensing Engineer

CC Director, Office of Nuclear Reactor Regulation
Director, Office of Inspection & Enforcement
NRC Resident Inspector - Palisades

Attachment

OC0386-0054-NL04

ATTACHMENT

Consumers Power Company
Palisades Plant
Docket 50-255

PALISADES NUCLEAR PLANT
ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT
JANUARY THROUGH DECEMBER, 1985

April 15, 1986

52 Pages

A. INTRODUCTION

The results of all environmental samples taken during 1985 were statistically analyzed at the 95% confidence level by the method described in Palisades Procedure HP 10.4. The data was evaluated against two criteria. The first is the statistical level which indicates that sample results taken from near sites are greater than those taken from control locations, but the difference is not significant. The second is the reporting level (two times the statistical level) which is the minimum detectable difference that exceeds zero at a 95% confidence level. Doses to the public are evaluated if the reporting level is exceeded. Palisades was on-line for most of 1985, only coming down November 30th for a refueling outage. All 1985 laboratory analyses were completed for inclusion into this report.

Table 10.4-1 addresses the 1985 Sampling Analysis Summary for Palisades; Table 10.4-2 provides a Sample Data Summary of collected sample results and Table 10.4-3 lists the High, Low and Average Reporting Results for the highest average sampling locations. In addition to the annual Radiological Environmental Operating Report statistical analysis, there are several supplemental attachments provided to further define the Palisades Radiological Environmental Monitoring Program.

B. DISCUSSION AND INTERPRETATION OF RESULTS

1. Air Samples

Comparison of the airborne particulate sample data between near-site and control locations did not exceed the statistical level. In many instances, control site sample values were greater.

No I-131 activity was reported above minimum detectable levels.

A total of 624 samples were collected and analyzed; however 20 sample results were deleted from statistical evaluation due to insufficient sample volume flows.

The missing sample results do not indicate any significant reduction in the overall sample program. Technical Specification sensitivities were met.

The results are consistent with actual effluent releases and site-specific meteorology.

2. Lake Water

Comparison between the plant lake water intake and the South Haven treated drinking water samples showed that statistical levels for gross beta and tritium were not exceeded. The plant lake water outlet samples contained tritium above the statistical limit; however, this is consistent with monthly reported tritium effluent releases. There were no gross beta releases above the administrative notification limit of 10 pCi/l from lake-out discharge. Technical Specification sampling and sensitivity requirements were met.

3. Drinking Water

See lake water and well water discussion.

4. Well Water

Comparative data analysis between the site and two off-site well locations showed that the statistical level was not exceeded. The State Park control location has historically had greater gross beta concentrations than either the township park or on-site well locations. A K-40 and Ra 226/228 isotopic study between the Palisades site and State Park wells was initiated in June 1984 to determine cause of the higher gross beta concentrations at the State Park. Results of the study were inconclusive; however sufficient evidence indicates that effluents from Palisades are not a contributing factor to the elevated gross beta concentrations.

The isotopic study was terminated October 1985 after consultation with the NRC. All Technical Specification sampling and sensitivity requirements were met.

5. Milk

No problems were encountered in obtaining milk samples for 1985. With the exception of one elevated I-131 result at control station SD, all I-131, Sr-89 and Cs-137 levels were less than detectable. The one elevated LLD was the result of a laboratory delay in sample counting time. Data comparison of the near site and control locations indicated that Sr-90 levels exceeded the statistical but not the reporting level. Effective September 4, 1985, Constantine Dairy replaced Sherman Dairy as the control location. All Technical Specification sampling and sensitivity requirements were met except as noted.

6. Sediment

A comparative analysis of sediment data was accomplished by using control samples from the Ludington Pump Storage Facility (located approximately 200 miles North of South Haven) and site samples. Gross beta results did not exceed the statistical level. In some cases, the control sample gross beta values were greater than the site values. Sr-89 results were at minimum detectable levels with Sr-90 concentrations only slightly above LLD. Data results of on-site Sr-90 concentrations are approximately 1.5 times less than comparative 1984 values. Trace amounts of Cs-137 were detected in the on-site samples. Technical Specification sampling and analysis requirements were met.

7. Aquatics - Fish

Concentrations of Cs-137, Sr-89 and I-131 were below minimum detectable levels. Gross beta results of on-site fish samples were only slightly above LLD requirements. The Sr-90 levels for both the Ludington control and on-site locations were approximately 2.8 and 2.0 times (respectively) greater than for comparative 1984 values. The 1985 control location Sr-90 data was 1.5 times greater than the on-site data. Reportable limits for Sr-90 were not exceeded. Technical Specification sampling and analysis requirements were met.

8. Crops

Concentrations of Cs-137, Sr-89, and I-131 were below minimum detectable levels. Gross beta results were minimal; being slightly below those of 1984, however Sr-90 levels were elevated approximately 2.0 times from 1984. Reportable limits for Sr-90 were not exceeded. All Technical Specification sampling and analysis requirements were met.

9. Gamma Dose - TLD's

There were 14 reported stolen TLD's during 1985 with an additional TLD reader card being damaged at the laboratory (April monthly - Station 2). Total loss of TLD datum is 15: 8 monthly, 4 quarterly and 3 annual. Evaluation of TLD data was done by comparing all indicator locations to control locations. No monthly, quarterly or annual results exceeded the statistical level. The Palisades gamma dose program consists of 23 locations: 10 directly on-site, 10 off-site (1-6 miles) and 3 control locations (30-55 miles). The on-site locations had an average of 4.8 mR/month; the control locations had an average of 5.3 mR/month; and the near-site (middle perimeter) had an average of 5.4 mR/month. This is consistent with expected results based on effluent releases. Technical Specification sensitivities were met.

C. SUMMARY

1. No required Technical Specification analyses were missed in 1985. Twenty of the 624 weekly air samples collected in 1985 were deleted from statistical evaluation because of insufficient sample volume flows.
2. A total loss of 15 TLD's is reported for 1985: 14 were stolen from various field locations and 1 TLD reader card damaged at the contractor's laboratory prior to being evaluated. Because of the excessive loss of TLD's during 1985, a security type (tamperproof) of TLD holder will be installed at the theft-prone TLD locations during 1986.

3. The K-40 and Ra 226/228 isotopic study between the Palisades on-site and State Park wells was terminated October 1985 after consultation with the NRC. A cause for the higher gross beta concentrations in the State Park well remains unclear; however sufficient evidence indicates that effluents from Palisades are not a contributing factor.
 4. Constantine Dairy replaced Sherman Dairy as the control milk sample location effective September 4, 1985. Reasons for the change of location were: 1) Sherman Dairy was in the process of switching to a new milk supplier from the Benton Harbor area, and 2) Sherman Dairy was only providing cream samples for analysis. Milk is preferable for a control sample as it has a higher calcium content than cream. Cream's low calcium content results in a much lower Sr-90 yield than is present in milk.
 5. The required collection and analyses of principle area crops (blueberries and apples) were performed as per Technical Specification Table 4.11-1.
 6. The missing and/or deleted air sample and TLD results did not constitute a significant reduction in the overall program and no special reports per Technical Specification 5.9.3.2 were submitted on 1985 requirements.
- D. The 1985 radiological environmental samples were analyzed by Teledyne Isotopes Midwest Laboratory, Northbrook, Illinois.
- E. ATTACHMENTS
1. Radiological Environmental Trending Graphs for 1985.
 2. Radiological Environmental Sampling Methods and Collection Schedule.
 3. Radiological Environmental Monitoring Program Sample Locations and Map.
 4. 1985 Palisades Land Use Census.
 5. Results of Interlaboratory Comparison Program.

Table HP 10.4-1
Sampling Analysis Summary
Palisades Nuclear Plant Annual Radiological
Environmental Operating Report
January 1, 1985 to December 31, 1985

<u>Medium</u>	<u>Description</u>	<u>Location</u>	<u>Number of Samples Collected</u>	<u>Type of Analysis</u>	<u>Frequency of Analysis</u>
Air	Continuous at Approx 1 CFM	All	624	Gross Beta, I-131	Weekly
Lake Water	1 Gallon Composite	Intake, Discharge	24	Gross Beta, Gross Alpha, Tritium	Monthly
Drinking Water	1 Gallon Composite	South Haven	24	Gross Beta, Tritium	Monthly
Well Water	1 Gallon Grab	Site, TP, SP	36	Gross Beta, Tritium	Monthly
Milk	1 Gallon Grab	CD, GM, GH, KK	48	I-131, Sr-89 and Sr-90, Cs-137, other gamma	Monthly
TLD	Continuous	All	269 88 20	Gamma	Monthly Quarterly Annual
Crops	Grab	JS, PR, RB	19	Gross Beta, Sr-89 and Sr-90, Cs-137, other gamma	In Season
Sediment	Grab	Discharge, N & S Site Boundary, South Haven Beach	10	Gross Beta, Sr-89 and Sr-90, Cs-137, other gamma	Semi-Annual
Aquatic	Grab	Intake, Discharge	14	Gross Beta, Sr-89, Sr-90, other gamma	Semi-Annual

Table HP 10.4-2

SAMPLE DATA SUMMARY
PALISADES NUCLEAR PLANT ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

January 1, 1985 to December 31, 1985

Medium or Pathway Sampled Unit of Measurement	Total Number of Analyses Performed		Lower Limit of Detection(a) LLD	All Indicator Locations Mean(b) Range(b)	Location with Highest Annual Mean		All Control Locations Mean(b) Range(b)	Nonroutine Reported (c) Measurements
					Name Distance & Direction	Mean(b) Range(b)		
Air (pCi/m ³)	Gross Beta	624	0.01	(454/468) 0.02(.004-.055)	H. Solderberg (5 mi S)	.025 (.010-.055)	(150/156) 0.02(.005-.053)	None
	I-131	624	0.02	(0/468) LLD	All LLD		(0/156) LLD	None
Lake Water (pCi/l)	Gross Alpha	24	1.0	(0/12) <1 (<1)	Discharge	<1 (<1)	(0/12) <1	None
	Gross Beta	24	1.0	(12/12) 2.9(1.6-7.4)	Discharge	2.9(1.6-7.4)	(12/12) 2.6(1.6-6.2)	None
	Tritium	24	100.0	(12/12) 3577(320-10875)	Discharge	3577 (320-10875)	(12/12) 195(100-420)	None
Drinking Water (pCi/l)	Gross Beta	12	1.0	Control, lake and well water samples are drinking water supplies.				
	Tritium	12	100.0					
Well Water (pCi/l)	Gross Beta	36	1.0	(12/12) 1.6(1-3.7)	State Park (1 mi N)	2.7 (1.4-4.1)	(24/24) 2.1(1-4.1)	None
	Tritium	36	100.0	(12/12) 261.7(100-450)	Site	261.7 (100-450)	(24/24) 175.8(100-360)	None

Table HP 10.4-2

SAMPLE DATA SUMMARY

PALISADES NUCLEAR PLANT ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

January 1, 1985 to December 31, 1985

Medium or Pathway Sampled Unit of Measurement	Total Number of Analyses Performed		Lower Limit of Detection(a) LLD	All Indicator Locations Mean(b) Range(b)	Location with Highest Annual Mean		All Control Locations Mean(b) Range(b)	Nonroutine Reported (c) Measurements
					Name Distance & Direction	Mean(b) Range(b)		
Milk (pCi/l)	*I-131	48	.5	(0/36) LLD	All LLD	N/A	0/12 LLD	None
	Sr-89	48	5.0	(0/36)	All LLD	N/A	0/12 LLD	None
	Sr-90	48	1.0	(35/36) 3.3(<1.0-7.7)	GH (6 mi E)	3.6 (<1.0-5.0)	(11/12) 2.4(<1.0-5.0)	None
	Cs-137	48	5.0	(0/36) LLD	All LLD	N/A	0/12 LLD	None
	Other Gamma		5.0	(0/36) LLD	All LLD	N/A	0/12 LLD	None
Gamma Exposure (mR/month) (mR/quarter)	TLD (monthly)	268	1.0	(233/233) 5.2(3.2-8.0)	ST-06(4.25 mi NE)	6.4 (5.0-7.8)	(35/35) 5.3(3.5-7.8)	None
	TLD (quarterly)	88		(77/77) 15.4(11.2-20.5)	ST-06(4.25 mi NE)	19.4 (16.5-23.6)	(11/11) 16.4(11.5-20.5)	None
	TLD (annually)	20		(17/17) 69.9(58.7-85.6)	ST-06(4.25 mi NE)	85.6	(3/3) 66.5(48.2-79.1)	None
Crops (pCi/g wet)	Gross Beta	19	1.0	(12/19) 1.9(<1.0-4.8)	JS (3.5 mi SE) Rape (herb)	4.8	None	None

Note: *One I-131 result at control location (Sherman Dairy) was elevated to 0.7 due to delay in sample counting time.

Table HP 10.4-2

SAMPLE DATA SUMMARY

PALISADES NUCLEAR PLANT ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

January 1, 1985 to December 31, 1985

Medium or Pathway Sampled Unit of Measurement	Total Number of Analyses Performed		Lower Limit of Detection(a) LLD	All Indicator Locations Mean(b) Range(b)	Location with Highest Annual Mean		All Control Locations Mean(b) Range(b)	Nonroutine Reported (c) Measurements
					Name Distance & Direction	Mean(b) Range(b)		
Crops (pCi/g wet)	Sr-89	19	0.025	(0/19) LLD	All LLD		None	None
	Sr-90	19	0.005	(9/19) 0.028(<0.005-.12)	JS (3.5 mi SE) Rape (herb)	0.12	None	None
	Cs-137	19	0.08	(0/19) LLD	All LLD		None	None
	I-131	19	0.05	(0/19) LLD	All LLD		None	None
	Other Gamma	19	0.1	(0/19) LLD	All LLD		None	None
Sediment (pCi/g dry)	Gross Beta	10	1.0	(7/7) 9.0(3.4-12.6)	Site - ½ mi North	12.0 N/A	(3/3) 5.3(3.2-7.3)	None
	Sr-89	10	0.025	(0/7) LLD	All LLD	N/A	(0/3) LLD	None
	Sr-90	10	0.005	(4/7) 0.013(<.005-.026)	South Haven Beach	0.016 (<.005-.026)	(1/3) 0.005(<.005-.006)	None
	Cs-137	10	0.08	(3/7) 0.19(.08-.75)	Discharge	0.41 (.08-.75)	(1/3) 0.005(<.005-.006)	None
	Other Gamma (Zr-Nb)	10	0.1	(1/7) 0.12(<.1-.21)	Site - ½ mi South	.16 (<.1-.21)	(0/3) LLD	None

Table HP 10.4-2

SAMPLE DATA SUMMARY

PALISADES NUCLEAR PLANT ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

January 1, 1985 to December 31, 1985

Medium or Pathway Sampled Unit of Measurement	Total Number of Analyses Performed		Lower Limit of Detection(a) LLD	All Indicator Locations Mean(b) Range(b)	Location with Highest Annual Mean		All Control Locations Mean(b) Range(b)	Nonroutine Reported (c) Measurements
					Name Distance & Direction	Mean(b) Range(b)		
Sediment (pCi/g dry)	I-131	10	0.05	(0/7) LLD	All LLD	N/A	(0/3) LLD	None
Aquatic (pCi/g wet)	Gross Beta	14	1.0	(10/10) 2.4(1.6-4.6)	Site - ½ mi South	2.9 (2.1-4.6)	(4/4) 2.4(1.4-3.2)	None
	Sr-89	14	0.025	(0/10) LLD	All LLD	N/A	(0/4) LLD	None
	Sr-90	14	0.005	(4/10) 0.013(<.005-.027)	Discharge	0.018 (<.005-.027)	(1/4) 0.02(<.005-.020)	None
	Gamma	14	0.1	(0/10) LLD	All LLD		(0/4) LLD	None
	Cs-137	14	0.08	(0/10) LLD	All LLD		(0/4) LLD	None
	I-131	14	0.05	(0/10) LLD	All LLD		(0/4) LLD	None

a. Nominal Lower Limit of Detection (LLD) as defined in HASL-300 (rev 8/73), paged D-08-01, 02, and 03.

b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses.

c. Nonroutine reported measurements are defined in the Palisades Technical Specifications, Section 6.9.3.2.

Table HP 10.4-3

HIGH, LOW AND AVERAGE REPORTING RESULTS FOR HIGHEST AVERAGE SAMPLING LOCATION
PALISADES NUCLEAR PLANT ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

January 1, 1985 to December 31, 1985

<u>Medium</u>	<u>Type of Analysis</u> ⁽¹⁾	<u>Location</u>	<u>High</u>	<u>Low</u>	<u>Average</u> ⁽⁵⁾
Air	Gross Beta	H. Solderberg (5 mi. S)	0.055 pCi/m ³	0.010 pCi/m ³	0.025 pCi/m ³
	I-131	All LLD	--	--	<.02 pCi/m ³
Lake Water	Gross Beta	Discharge	7.4 pCi/l	1.6 pCi/l	2.9 pCi/l
	Gross Alpha	Discharge	<1 pCi/l	<1 pCi/l	<1 pCi/l
	Tritium	Discharge	10875 pCi/l	320 pCi/l	3577 pCi/l
Drinking Water	Gross Beta	See Table HP 10.4-2			
	Tritium ⁽⁴⁾	See Table HP 10.4-2			
Well Water	Gross Beta	State Park (1 mi N)	4.1 pCi/l	1.4 pCi/l	2.7 pCi/l
	Tritium	Site Well	450 pCi/l	100 pCi/l	261.7 pCi/l

(1) Minimum detectable level (MDL) = air, gross beta 0.01 pCi/m³, I-131 0.02 pCi/m³; water, gross beta 1.0 pCi/l, gross alpha 1.0 pCi/l, H-3 100 pCi/l; milk, I-131 0.5 pCi/l, Sr-89 5.0 pCi/l, gamma isotopic 5.0 pCi/l; crops and sediment, gross beta 1.0 pCi/g, Sr-89 0.025 pCi/g, Sr-90 0.005 pCi/g, gamma isotopic 0.05 pCi/g; some samples may have higher MDLs due to sample size, shipping delays or statistical phenomenon.

(2) Samples collected monthly in season.

(3) Two samples per location.

(4) Tritium analysis performed on South Haven treated only.

(5) Only samples greater than LLD included in average.

(6) Transit dose of approximately 3.4 mR/round trip has been subtracted from TLD results.

Table HP 10.4-3

HIGH, LOW AND AVERAGE REPORTING RESULTS FOR HIGHEST AVERAGE SAMPLING LOCATION
PALISADES NUCLEAR PLANT ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

January 1, 1985 to December 31, 1985

<u>Medium</u>	<u>Type of Analysis</u> ⁽¹⁾	<u>Location</u>	<u>High</u>	<u>Low</u>	<u>Average</u> ⁽⁵⁾
Milk	*I-131	SD (6 mi. NNE)	0.7 pCi/l	<0.5 pCi/l	0.52 pCi/l
	Sr-89	All LLD	--	--	--
	Sr-90	GH (6 mi. E)	5.0 pCi/l	<1.0 pCi/l	3.6 pCi/l
	Cs-137	All LLD	--	--	--
	Other Gamma	All LLD	--	--	--
Gamma Dose ⁽⁶⁾	TLD (Monthly)	ST-06 (4.25 mi. NE)	7.8 mR	5.0 mR	6.4 mR
	TLD (Quarterly)	ST-06 (4.25 mi. NE)	23.6 mR	16.5 mR	19.4 mR
	TLD (Annual)	ST-06 (4.25 Mi. NE)	--	--	85.6 mR
Crops ⁽²⁾	Gross Beta	JS (3.5 mi. SE)	4.8 pCi/g	<1.0 pCi/g	2.0 pCi/g
	Sr-89	All LLD	--	--	--
	Sr-90	JS (3.5 mi. SE)	0.12 pCi/g	<0.005 pCi/g	0.031 pCi/g
	Cs-137	All LLD	--	--	--
	Other Gamma	All LLD	--	--	--
	I-131	All LLD	--	--	--

*I-131 result at control location (Sherman Dairy) was elevated due to delay in sample counting time.

Table HP 10.4-3

HIGH, LOW AND AVERAGE REPORTING RESULTS FOR HIGHEST AVERAGE SAMPLING LOCATION
PALISADES NUCLEAR PLANT ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

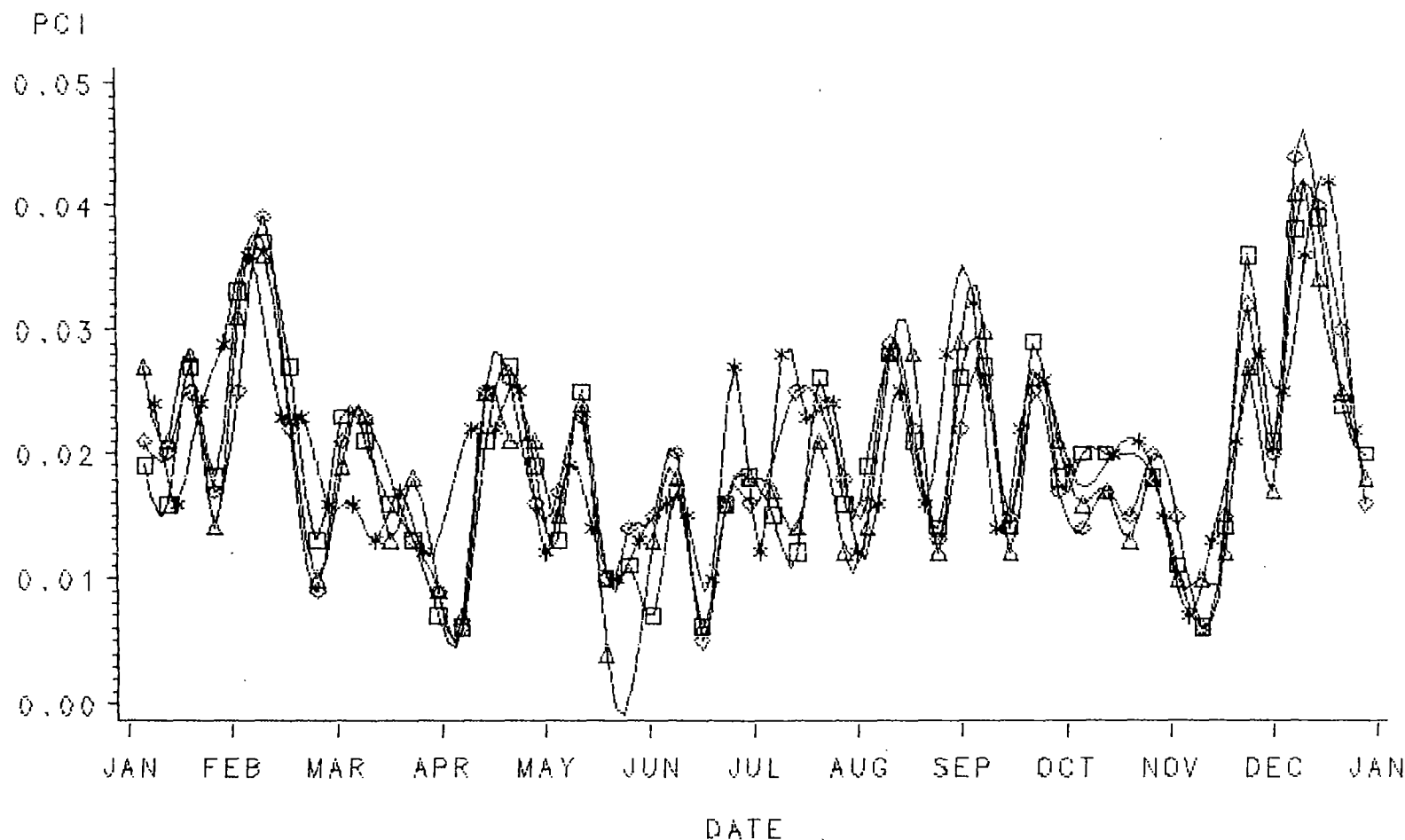
January 1, 1985 to December 31, 1985

<u>Medium</u>	<u>Type of Analysis</u> ⁽¹⁾	<u>Location</u>	<u>High</u>	<u>Low</u>	<u>Average</u> ⁽⁵⁾
Sediment ⁽³⁾	Gross Beta	Site - 1/2 mi. North	--	--	12.0 pCi/g
	Sr-89	All LLD	--	--	--
	Sr-90	South Haven Beach	0.026 pCi/g	<0.005 pCi/g	0.016 pCi/g
	Cs-137	Discharge	0.75 pCi/g	0.08 pCi/g	0.41 pCi/g
	Other Gamma (Zr-Nb)	Site - 1/2 mi. South	0.21 pCi/g	<0.1 pCi/g	0.16 pCi/g
	I-131	All LLD	--	--	--
Aquatic	Gross Beta	Site - 1/2 mi. South	4.6 pCi/g	2.1 pCi/g	2.9 pCi/g
	Sr-89	All LLD	--	--	--
	Sr-90	Discharge	0.027 pCi/g	<0.005 pCi/g	0.018 pCi/g
	Other Gamma	All LLD	--	--	--
	Cs-137	All LLD	--	--	--
	I-131	All LLD	--	--	--

1985 PALISADES AIR PARTICULATE

03/24/86

DOWAGIAC-CONTROL VS SHERMAN DAIRY, R.BUS, P.RUDE
DAILY GROSS BETA PCI/CUBIC METER



LOCATION

--* DOWAG-C 39 SSE

□-□-□ R.BUS 4.75 NF

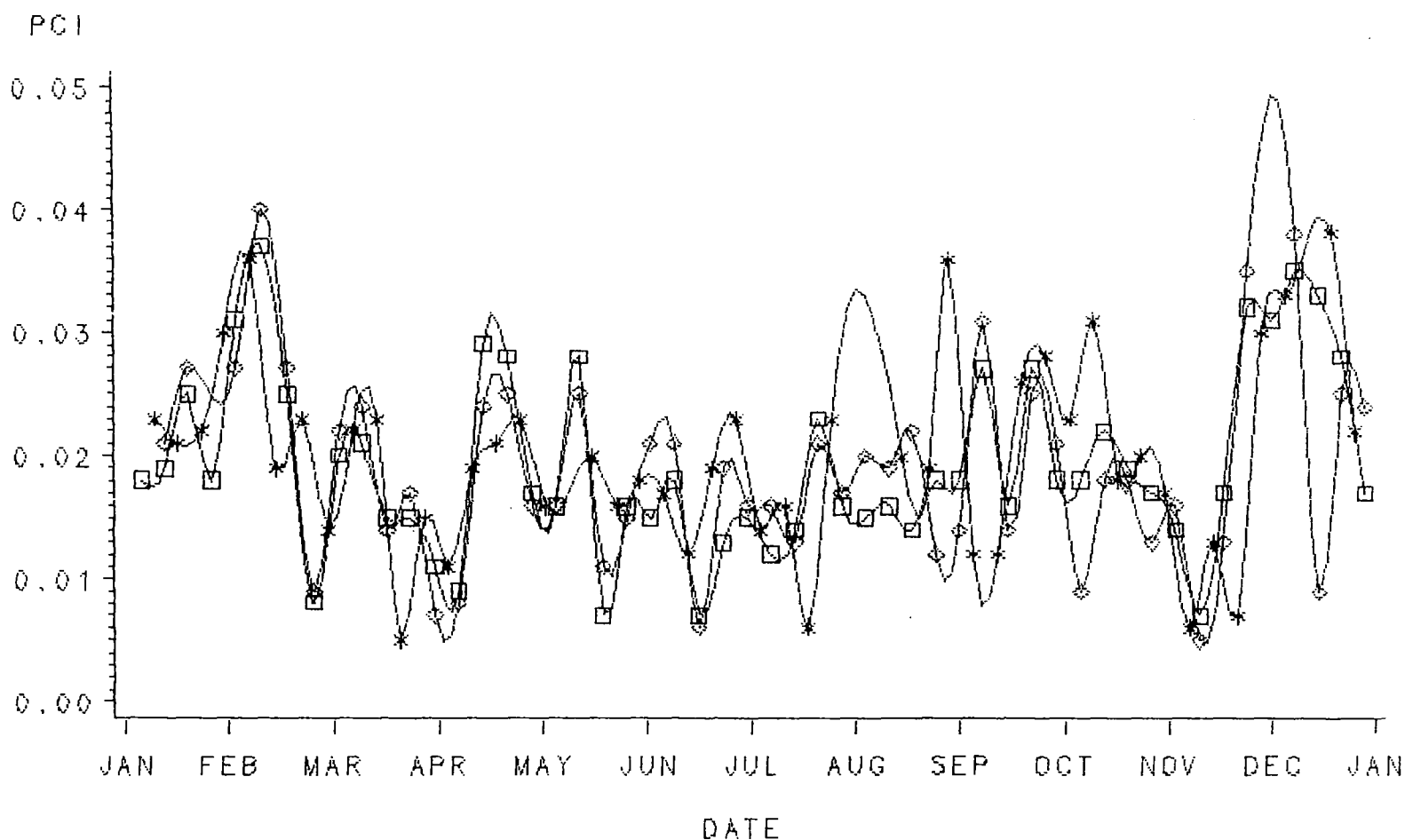
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△-△-△ S DAIRY 7.5 NNE

1985 PALISADES AIR PARTICULATE

03/24/86

KALAMAZOO-CONTROL VS TOWNSHIP PARK, STATE PARK
DAILY GROSS BETA PCI/CUBIC METER



LOCATION

- KAZOO-C 35 E

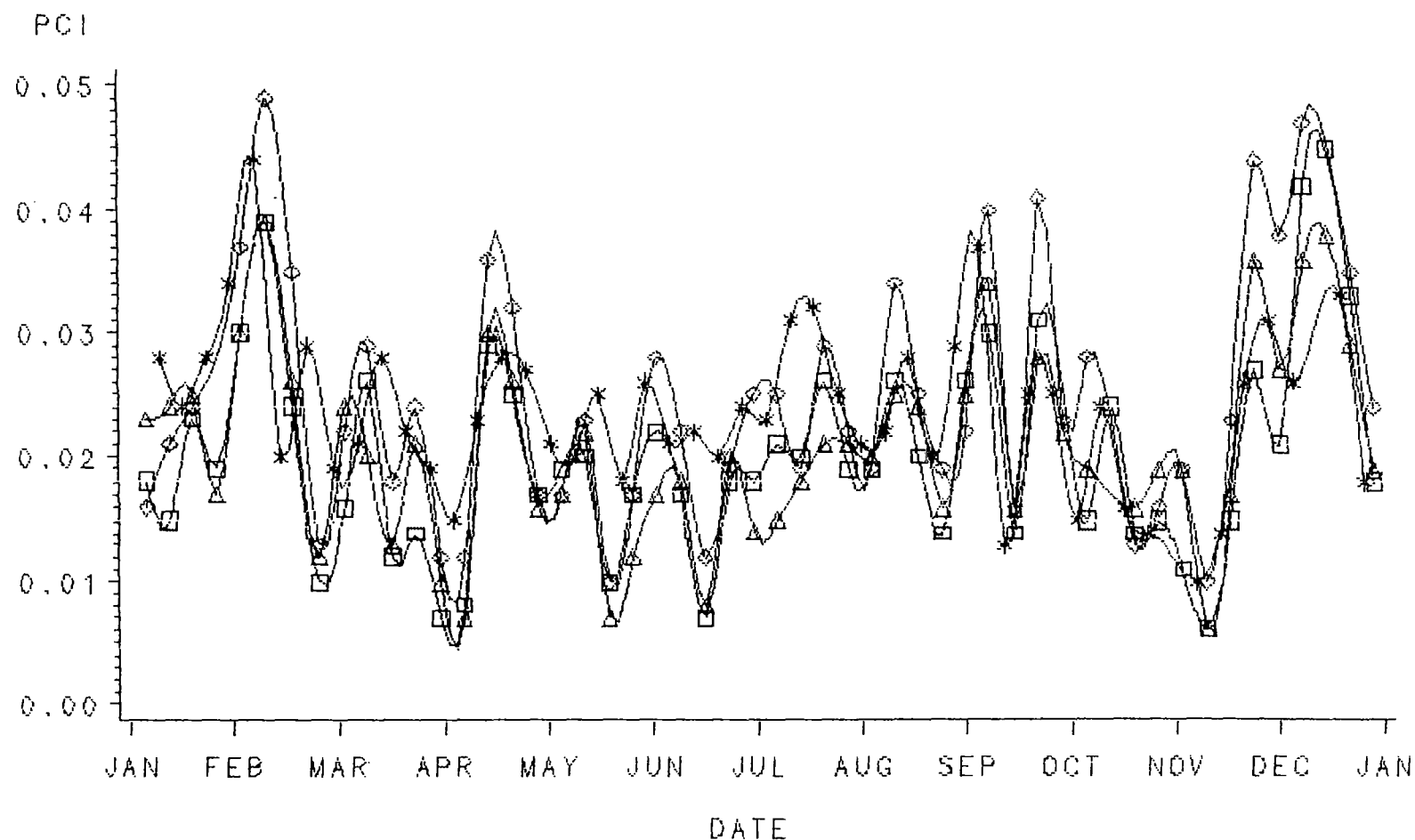
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◇-◇ ST PARK 1 N

1985 PALISADES AIR PARTICULATE

03/24/86

GRAND RAPIDS-CONTROL VS TOWER HILL, H. SEDERBERG, J. SARNO
DAILY GROSS BETA PCI/CUBIC METER



LOCATION

--* G.R.-C 55 NNE
□-□-□ J. SARNO 3.5 E

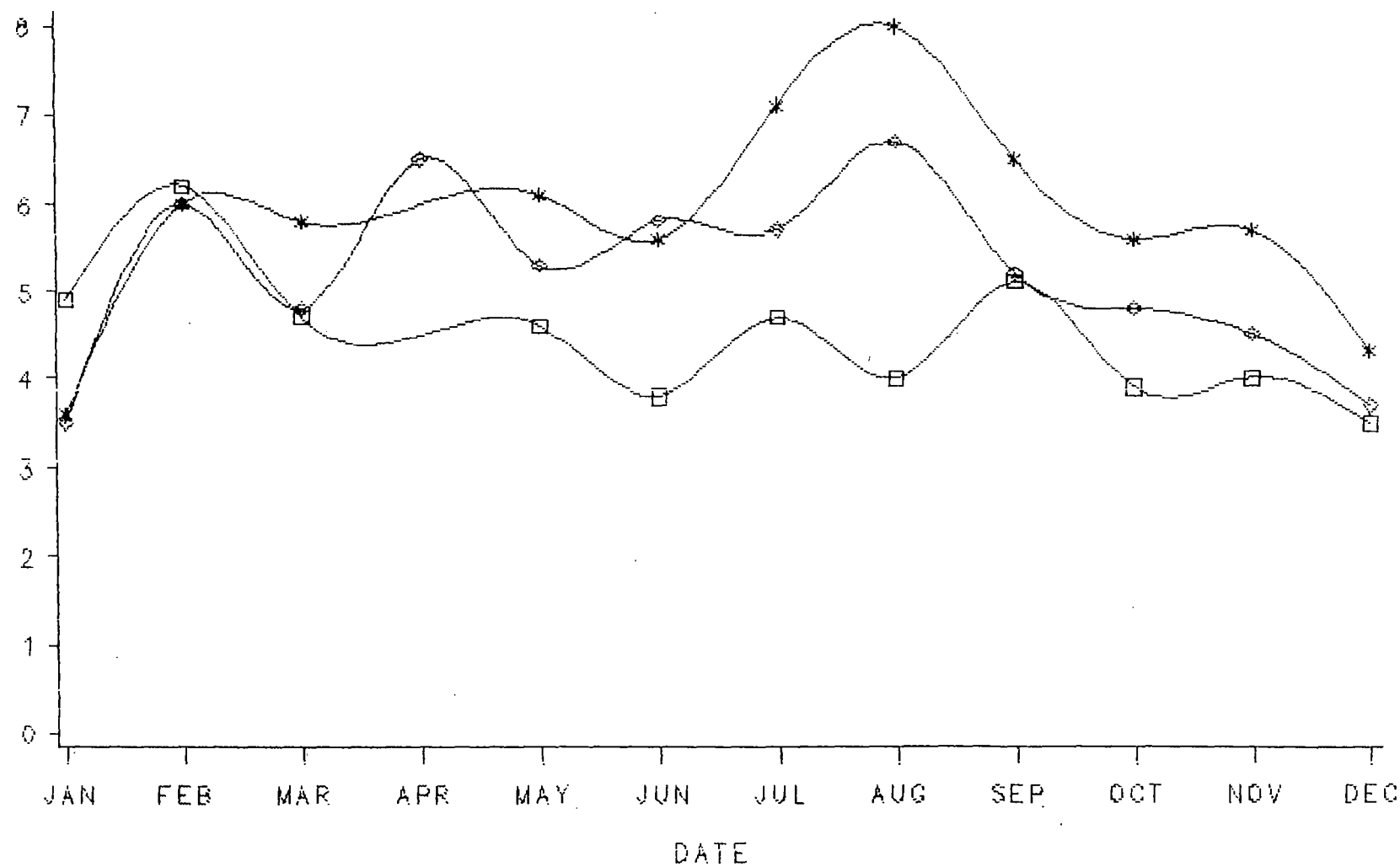
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△-△-△ TOWER HILL 5 SSE

1985 PALISADES TLD

03/24/86

P10 CONTROL VS P02 P03
MILLIREM

MR



LOCATION

--* P02 5 SSE

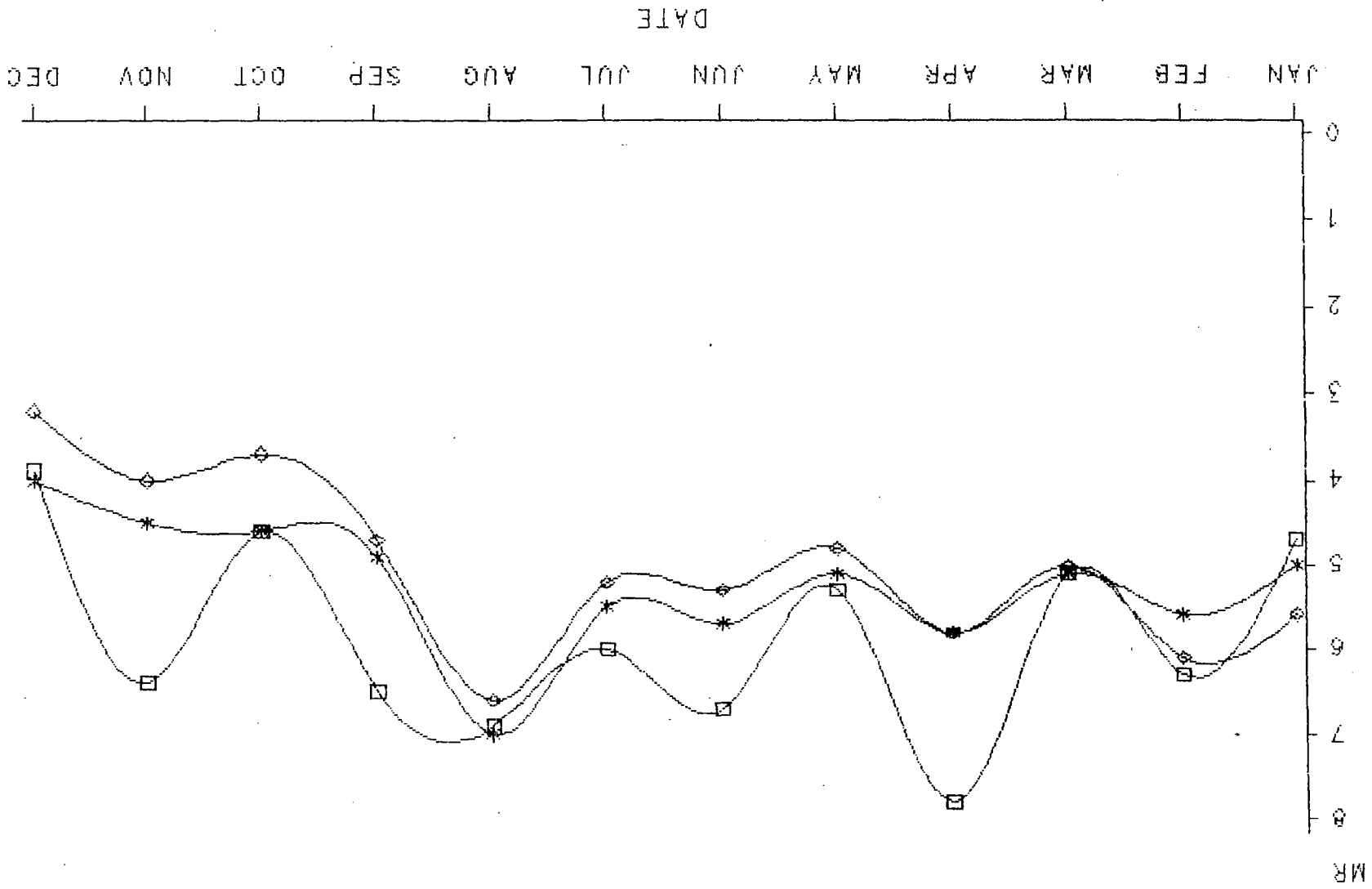
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□□□ P10C 55 MNE

1985 PALISADES TLD

P11 CONTROL VS P08 P09
MILLIREM

03/24/86

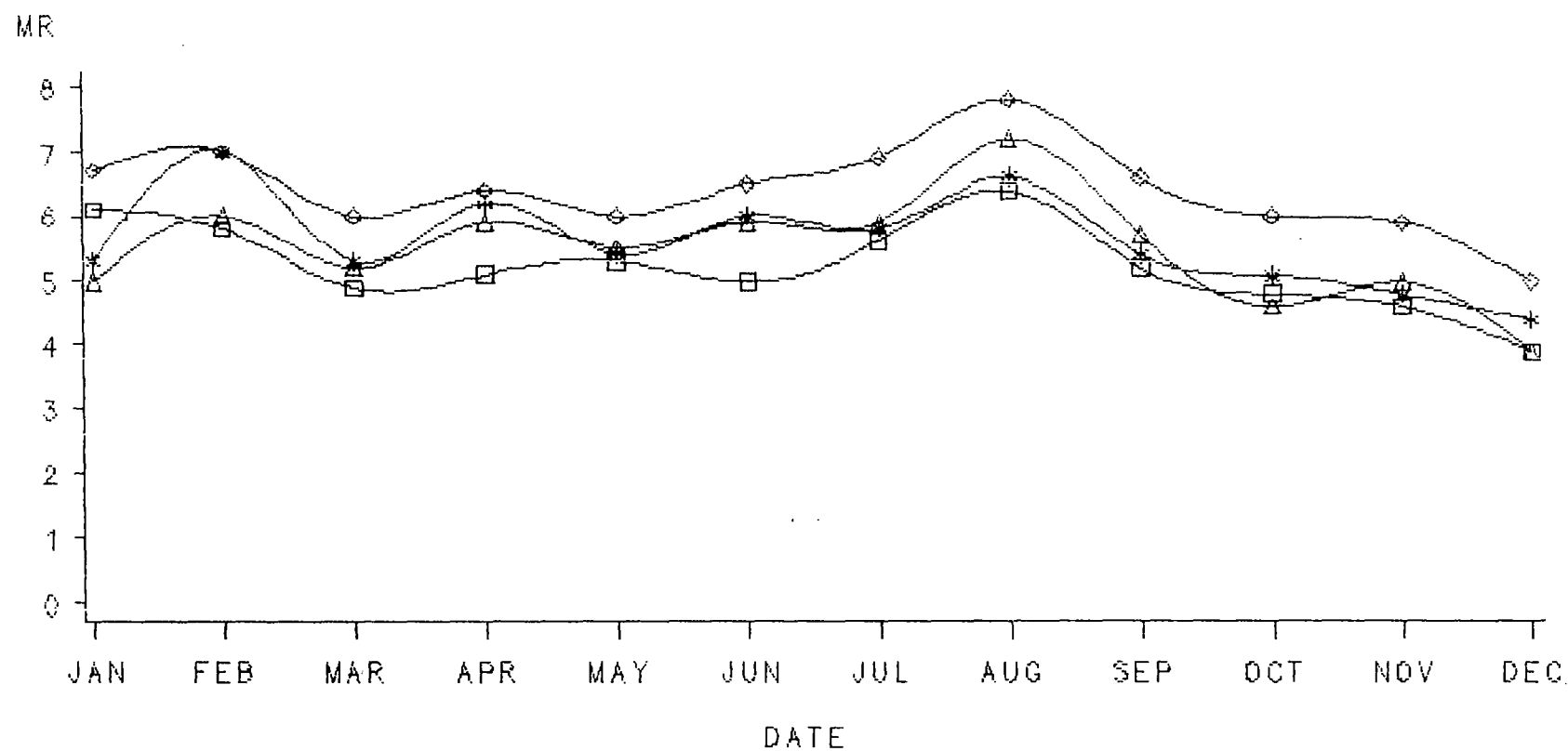


LOCATION * * * P08 1 N * * * P09 1.5 S * * * P110 35 E * * * P110 35 W

1985 PALISADES TLD

03/24/86

P12 CONTROL VS P05 P06 P07A
MILLIREM



LOCATION

--* P05 3 E

□-□-□ P07A 4.75 NNE

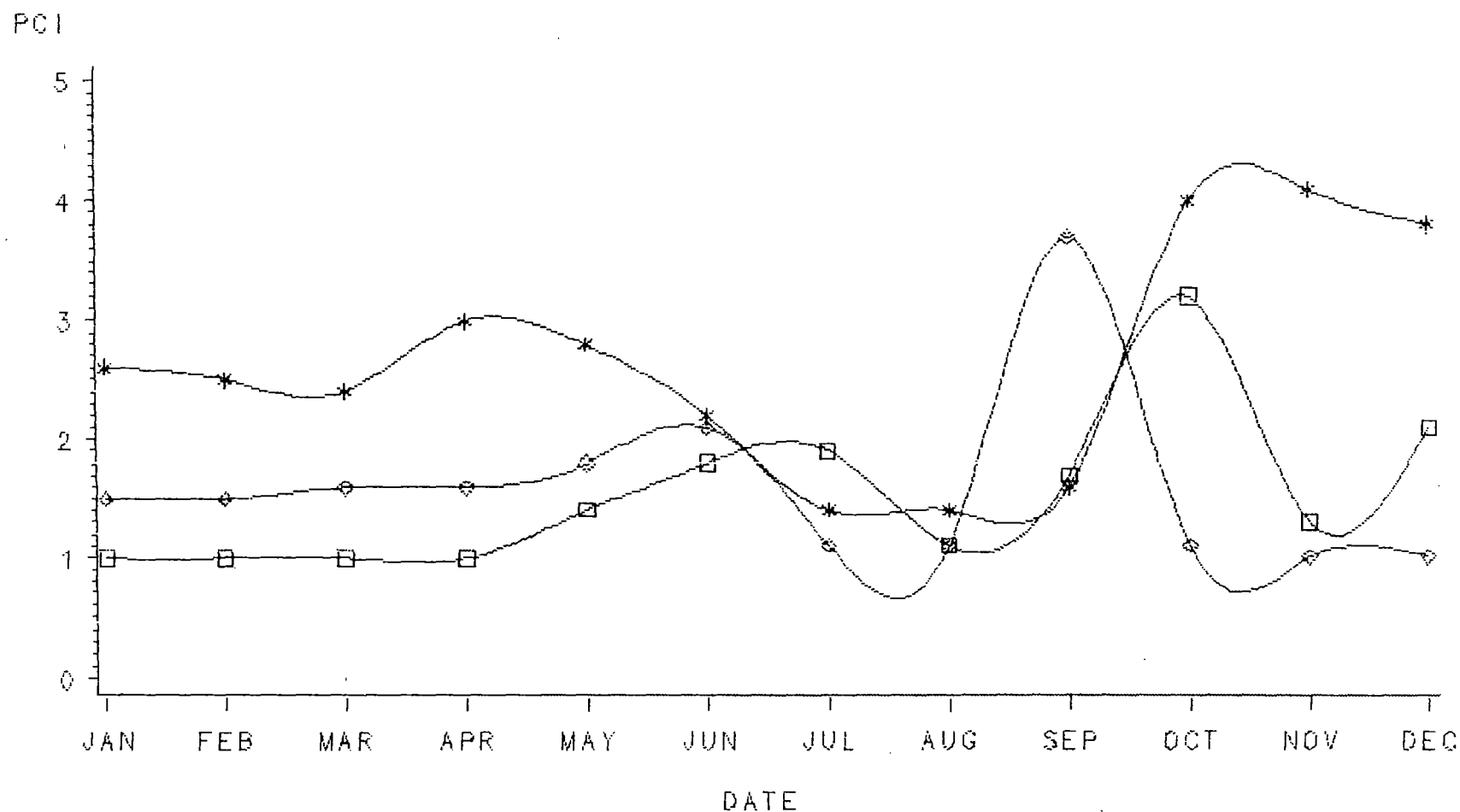
○-○-○ P06 4.75 NE

△-△-△ P12C 30 SSE

1985 PALISADES WELL WATER SAMPLES

03/24/86

TOWNSHIP PARK & STATE PARK-CONTROL VS SITE
GROSS BETA PCI/L



LOCATION

◆◆◆ PAL SITE

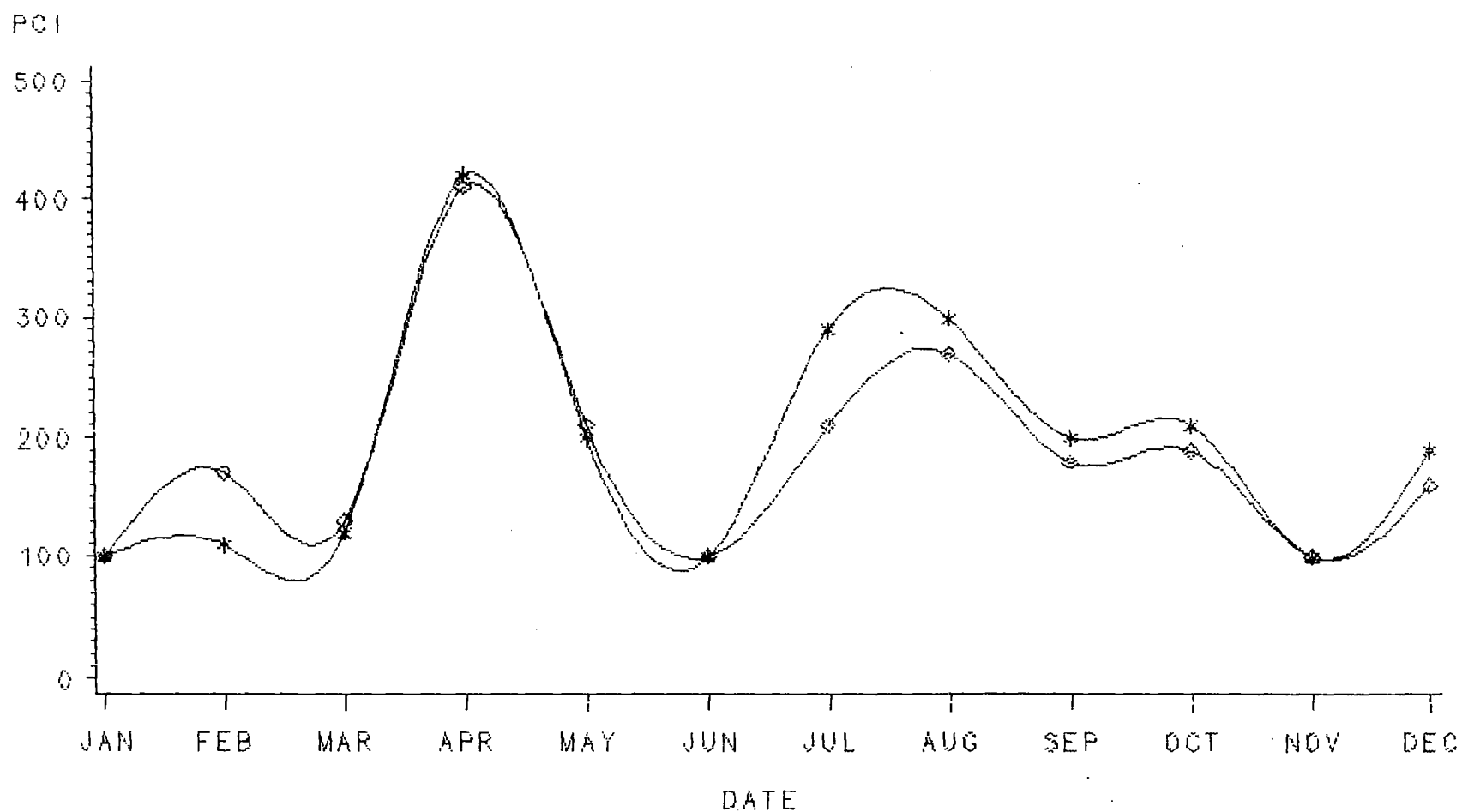
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--* ST PARK-CONT

1985 PALISADES LAKE WATER SAMPLES

03/24/86

SOUTH HAVEN TREATED-CONTROL VS INTAKE
TRITIUM PCI/L



LOCATION

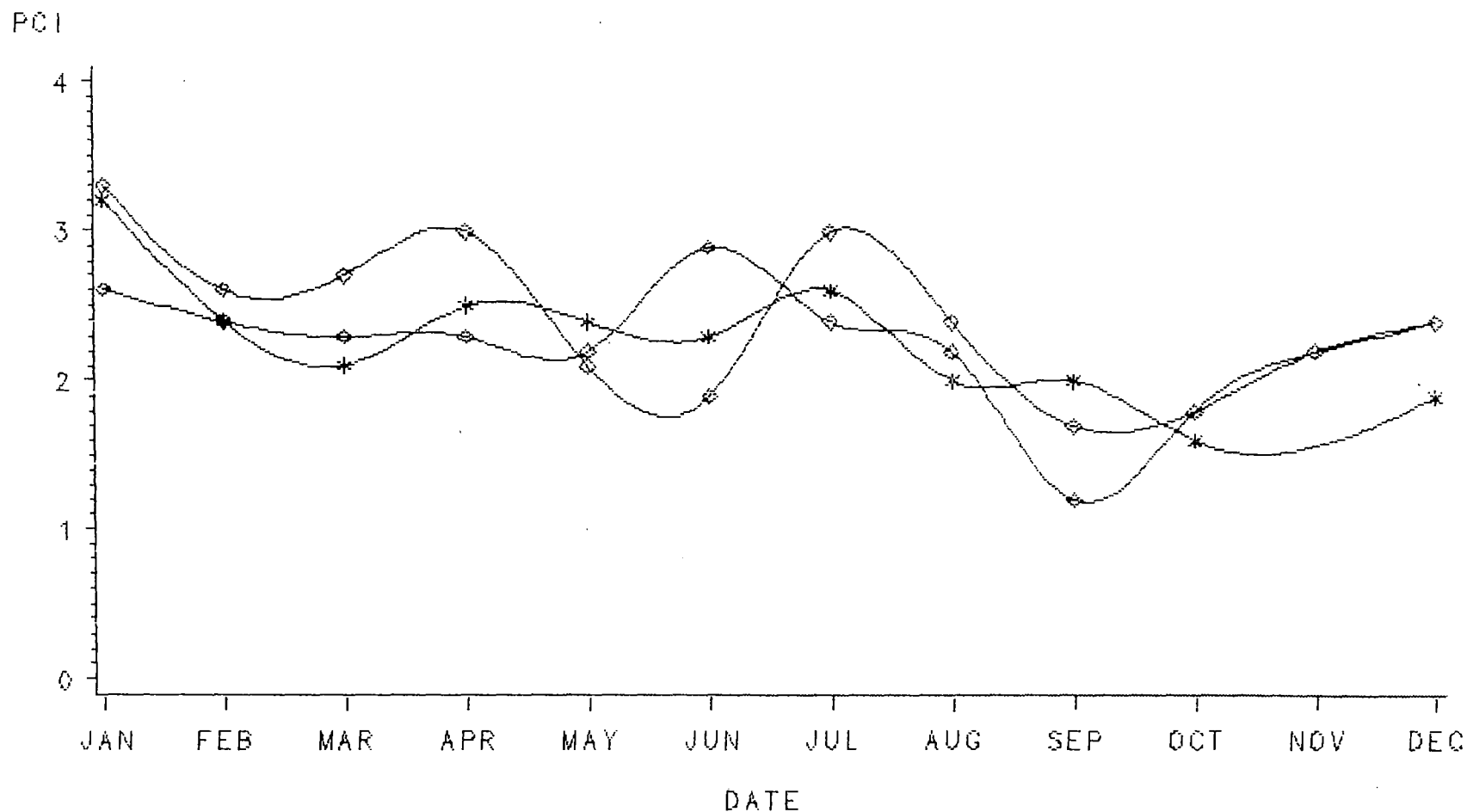
* * * INTAKE

◇ ◇ ◇ S.H.TREATED C

1985 PALISADES LAKE WATER SAMPLES

03/24/86

SOUTH HAVEN TREATED & RAW-CONTROL VS INTAKE
BETA PCI/L



LOCATION

--* INTAKE

◇-◇-◇ S.H. TREATED C

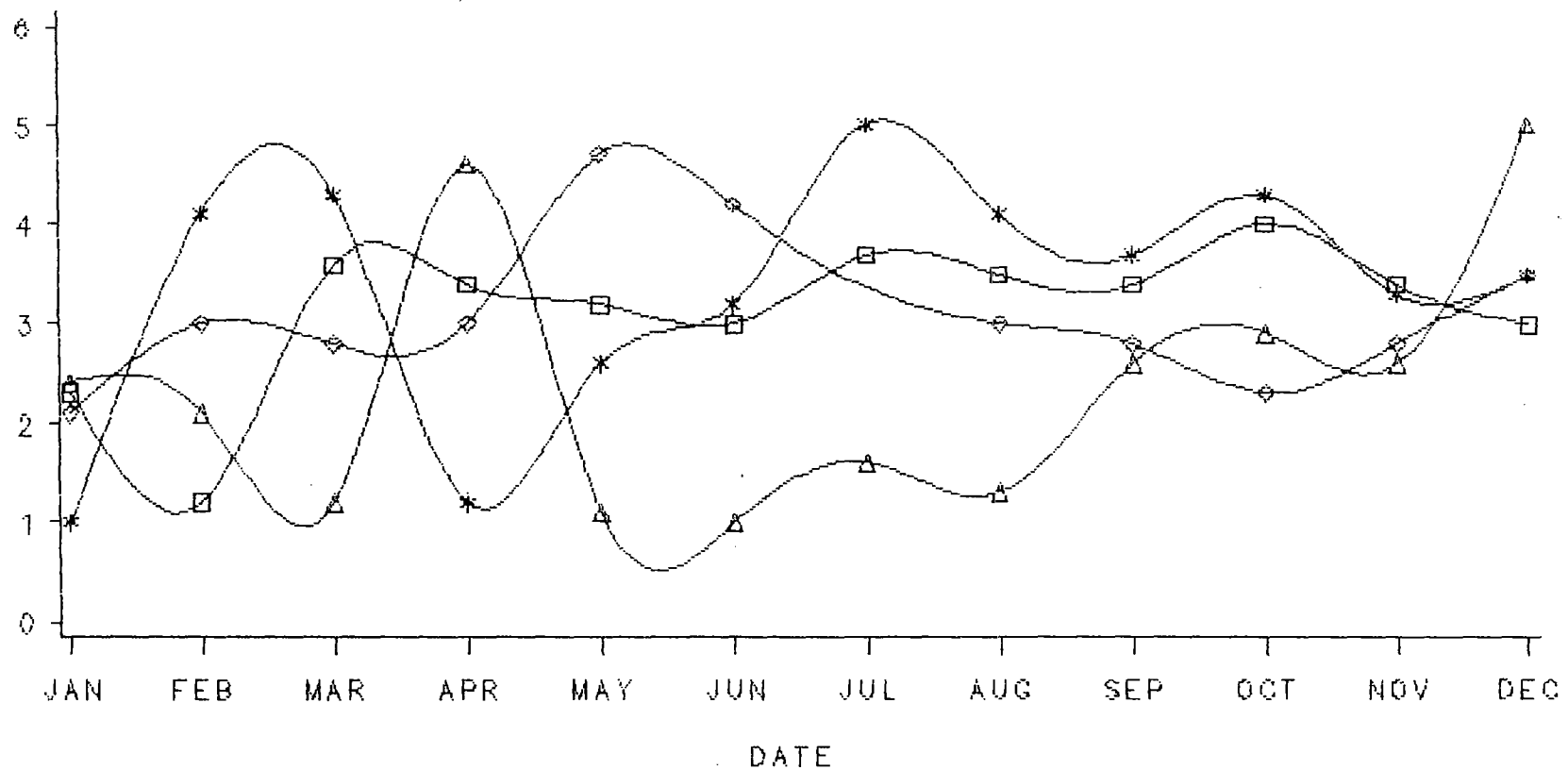
◇-◇-◇ S.H. RAW C

1985 PALISADES MILK SAMPLES

03/24/86

SHERMAN-CONTROL VS HESSEY MILLER KEMP
SR-90 PCI/L

PCI



LOCATION

--* HESSEY
□-□-□ MILLER

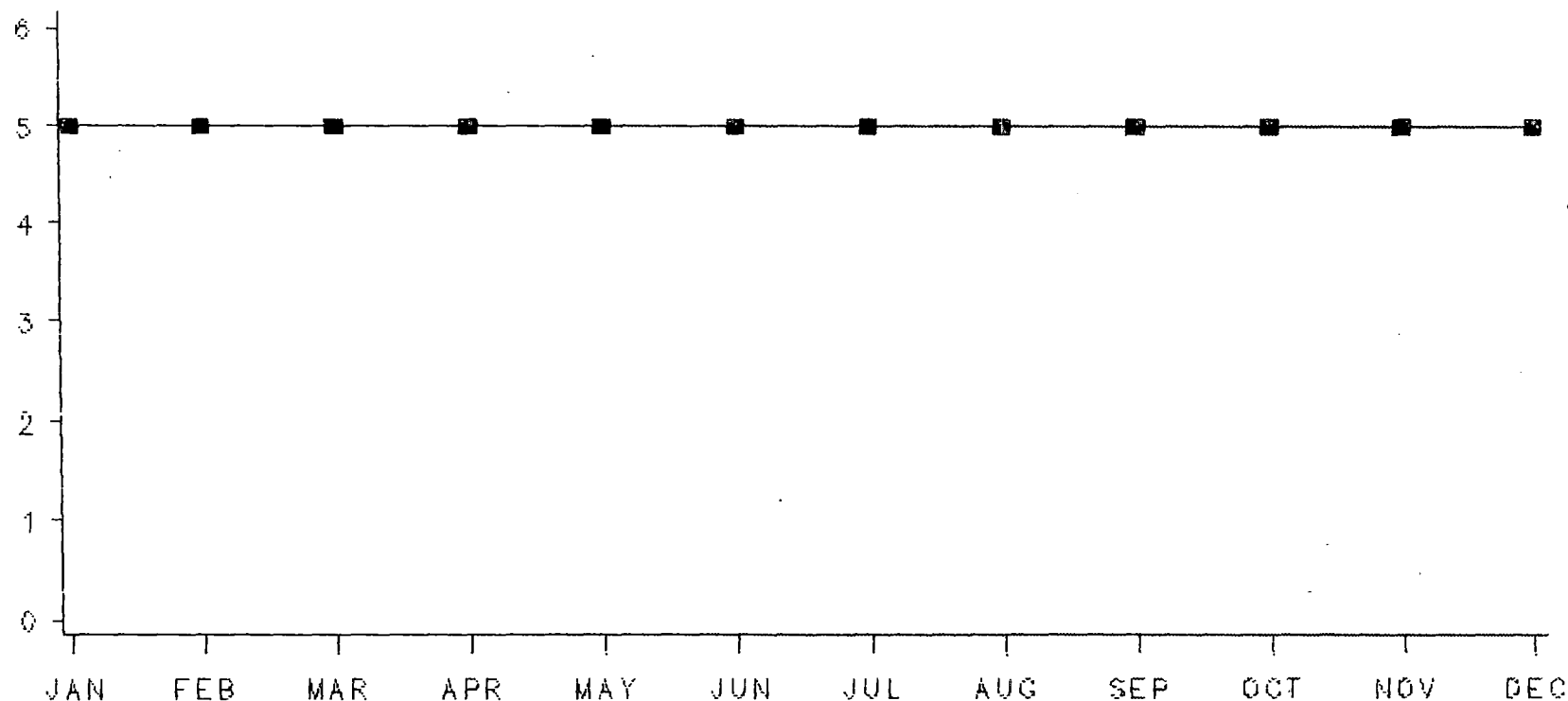
◆-◆-◆ KEMP
△-△-△ SHERMAN-CONTROL

1985 PALISADES MILK SAMPLES

03/24/88

SHERMAN-CONTROL VS HESSEY MILLER KEMP
CS-137 PCI/L

PCI



LOCATION

--* HESSEY
□-□-□ MILLER

◇-◇-◇ KEMP
△-△-△ SHERMAN-CONTROL

ENVIRONMENTAL SAMPLE COLLECTION SCHEDULE
Palisades Nuclear Plant

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations*</u>	<u>Sample Type</u>	<u>Collection Frequency</u>
Airborne:			
Particulates	1 - Onsite 8 - Within a 10 km Radius 3 - 25 to 89 km Distant	Continuous at approximately 1 cfm (may be less due to dust loading)	Weekly
Iodines	Same as Particulates	Same as particulates	Weekly
Waterborne:			
Lake Water	1 - Intake 1 - Discharge	Daily composite to obtain a two- gallon sample	Monthly
Drinking Water	1 - S Haven Municipal System - Raw 1 - S Haven Municipal System - Treated		
Well Water	1 - Site 1 - State Park 1 - Township Park	Two-gallon grab sample	Monthly
Sediment	1 - Within 152.4 m of discharge (500 ft) 1 - Between North boundary and State Park beach 1 - 0.8 km South of discharge 1 - 8.9 km North 1 - Ludington control (2 recommended)	One-liter grab sample	Semiannually

*If samples are unavailable at the specified location, an attempt should be made to sample at an alternate location (refer to 4.5).

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations*</u>	<u>Sample Type</u>	<u>Collection Frequency</u>
Ingestion:			
Milk	3 - From 5 to 13 km 1 - Control from 15 to 30 km	Two-gallon grab sample	Monthly
Food Products	1 - Each of two principal fruit crops (blueberries and apples).	Two-pound grab sample	At time of harvest
Fish and Invertebrates	2 - Species in vicin- ity of plant dis- charge 1 - Ludington control	One-liter fish flesh	In season or semiannually
Direct:			
TLD	1 - On site 10 - Site boundary 9 - Within 12 km radius 3 - Control stations	Continuous	Monthly, Quarterly and Annually

*If samples are unavailable at the specified location, an attempt should be made to sample at an alternate location (refer to 4.5).

SAMPLING LOCATIONS
Palisades Nuclear Plant

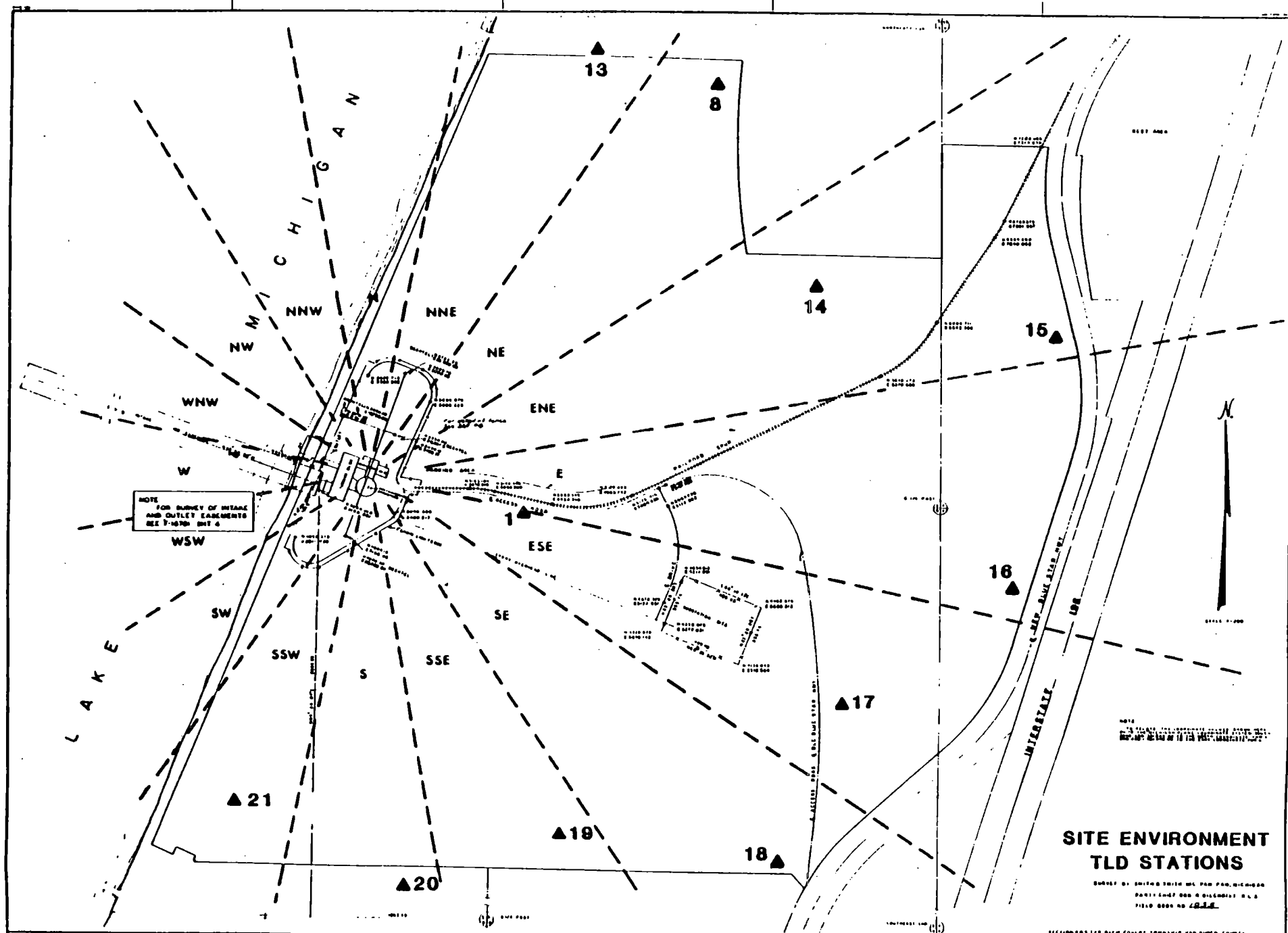
Station	Code	Location	Sample								
			Air Par- ticulates	Air Iodine	Lake Water	Well Water	Milk	Crops	Sediment	TLD	Fish
1	ST	Palisades Nuclear Plant	X	X	X	X			X	X	X
2	TH	Tower Hill Farms RR3, Coloma, Michigan 5 Miles (8.1 km) S	X	X				X		X	
3	HS	Herbert Soderberg RR1, Covert, Michigan 5 Miles (8.1 km) S	X	X						X	
*4	JS	Jerry Sarno RR1, Covert, Michigan 3-1/2 Miles (5.6 km) SE	X	X				X		X	
5	PR	Paul Rude RR1, Covert, Michigan 3-1/2 Miles (5.6 km) ESE	X	X				X		X	
6	RB	Richard Bus RR3, South Haven, MI 4-1/4 Miles (7.3 km) NE	X	X				X		X	
7	SD	Sherman Dairy South Haven, Michigan 6 Miles (9.7 km) NNE	X	X							
7a	SN35	Emergency Siren 35 4-3/4 Miles (7.7 km) NNE								X	
8	SP	State Park 1 mile (1.6 km) N	X	X		X				X	

*TLD P-22 is a control in lead cave at Station 4.

hpl285-0112c-91-154

			Sample								
Station	Code	Location	Air Par- ticulates	Air Iodine	Lake Water	Well Water	Milk	Crops	Sediment	TLD	Fish
9	TP	Covert Township Park 1-1/2 Miles (2.4 km) SSW	X	X		X				X	
10	GR	Grand Rapids, Michigan 55 Miles (88.7 km) NNE	X	X						X	
11	KZ	Kalamazoo, Michigan 35 Miles (56.4 km) SSE	X	X						X	
12	DG	Dowagiac, Michigan 30 Miles (48.4 km) SSE	X	X						X	
13-21	ST	Perimeter of Palisades								X	
23	SN25	Emergency Siren 25 3 Miles (4.8 km) ENE								X	
24	SN22	Emergency Siren 22 4 Miles (6.4 km) E								X	
25	SH	South Haven, Michigan 5-1/2 Miles (8.9 km) NNE			X				X		
26	GM	Glenn Miller Rt 1, Box 20 Covert, MI 4.3 Miles (6.9 km) SE					X				
27	KK	Kenneth Kemp Rt 4, Box 32 South Haven, MI 8 Miles (12.9 km) NE					X				

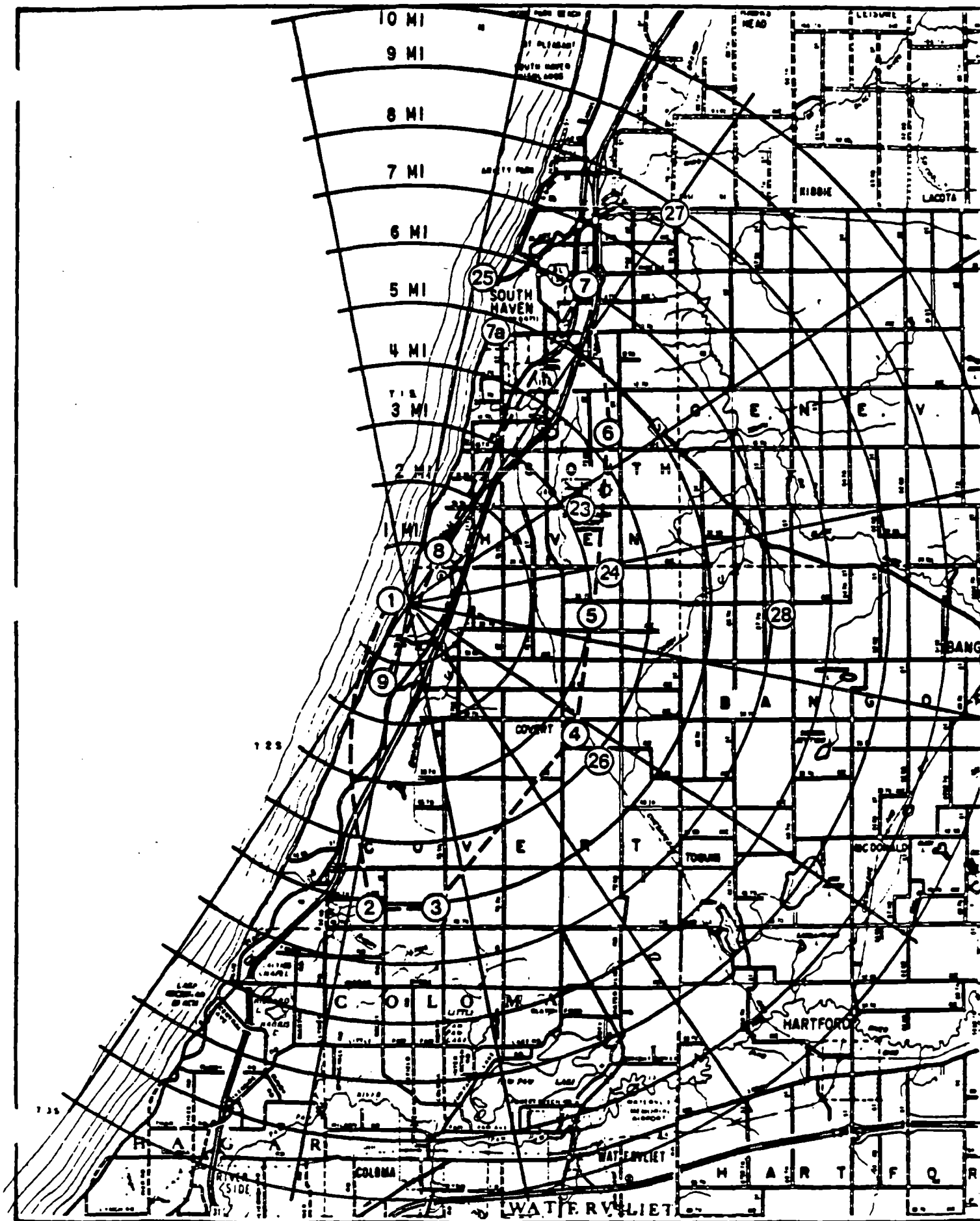
			Sample								
Station	Code	Location	Air Par- ticulates	Air Iodine	Lake Water	Well Water	Milk	Crops	Sediment	TLD	Fish
28	GH	Glen Hessey Rt 2, Box 94 Bangor, MI 6 Miles (9.7 km) E					X				
29	CD	Constantine Dairy Constantine, MI 48 Miles (77 km) SE					X				
30	STN	1/2 Mile N of Discharge (0.8 km)							X		
31	STS	1/2 Mile S of Discharge (0.8 km)							X		
	LP	Ludington Pumped Storage							X		X



SITE ENVIRONMENT TLD STATIONS

SURVEY BY: SHIRLEY THOMAS, JR. FOR P.M. CHICAGO
PARTIAL SURVEY OF 10 TO 100 MILES
FIELD BOOK NO. 100

SHEET 1: SURVEY SURVEY		CONSUMERS POWER CO.		PALISADES PLANT SITE DEVELOPMENT	
DATE: 10/10/61		DATE: 10/10/61		DATE: 10/10/61	
BY: [Signature]		BY: [Signature]		BY: [Signature]	
CHECKED BY: [Signature]		CHECKED BY: [Signature]		CHECKED BY: [Signature]	
APPROVED BY: [Signature]		APPROVED BY: [Signature]		APPROVED BY: [Signature]	



PALISADES NUCLEAR PLANT

1985 LAND USE CENSUS

The attached tables and maps are the result of the Palisades Land Use Survey conducted on July 22, 1985. Table 1 references the distance from Palisades to the nearest residence, garden, dairy cow, beef cattle and goat per meteorological sector. Table 2 identifies the location of the nearest residence and garden per sector; and all dairy cows, beef cattle and goats within a five-mile radius. The map illustrates the proximity of each item to Palisades.

Both the Van Buren County Agricultural Extension Office and the CPCo Southwestern Region Manager's Office were contacted (July 17, 1985) prior to starting the Land Use Survey. The most noticeable change between the 1984 and 1985 Land Use Surveys is the decrease in numbers of dairy cows and beef cattle found within a five-mile radius of Palisades.

PALISADES

Table 1

Distance to the nearest residence, garden, beef cattle, dairy cow and goat in each sector.

<u>SECTOR</u>	<u>RESIDENCE</u>	<u>GARDEN</u>	<u>BEEF CATTLE</u>	<u>DAIRY COW</u>	<u>GOAT</u>
N	>5 mi	>5 mi	>5 mi	>5 mi	>5 mi
NNE	1.6 mi	1.5 mi	>5 mi	>5 mi	>5 mi
NE	1.8 mi	1.8 mi	>5 mi	2.8 mi	>5 mi
ENE	1.3 mi	1.6 mi	4.0 mi	4.0 mi	>5 mi
E	1.0 mi	1.5 mi	>5 mi	>5 mi	>5 mi
ESE	1.0 mi	2.1 mi	2.2 mi	>5 mi	3.1 mi
SE	.9 mi	1.0 mi	3.8 mi	4.3 mi	>5 mi
SSE	.75 mi	1.5 mi	>5 mi	>5 mi	>5 mi
S	.5 mi	1.5 mi	>5 mi	>5 mi	>5 mi
SSW	.75 mi	1.5 mi	>5 mi	>5 mi	>5 mi

PALISADES

Table II

Verification of Nearest Items

<u>Sector and Road</u>	<u>Location/Description</u>	<u>Item</u>	<u>Number</u>
NNE Ruggles Road	L. Kern-State Park Manager	Residence	1
NNE Fire Lane 0	Gardens-South of 20th Avenue	Gardens	3
NE Blue Star Hwy	L. Swetay, Route 3, Box 133, South Haven-(East side of Hwy)	Residence Garden	1 1
NE M-140 Hwy	1/4 mile North of M-140 and 20th Avenue (CR 380) intersection (West side of M-140)	Cattle	3-Dairy Cows
ENE 24th Avenue, dead end	Trailer - West 24th Avenue, dead end at sand dune	Residence	1
ENE 76th Street	Mr. Oliver - 23846 76th Street 1/4 mile North of 76th Street and 24th Avenue intersection (West side of 76th Street)	Garden	1
ENE 72nd Street	Cecil Hodge, 16971 72nd Street 3/8 mile South of 16th Avenue and 72nd Street intersection (West side of 72nd Street)	Cattle	1-Dairy Cow 7-Beef
E 77th Street, dead end	77th Street - 1 mile North of 77th Street and 28th Avenue intersection	Residence	1
E 76th Street	Mr. Reed - 25434 76th Street, 1-1/2 miles South of 76th Street and 24th Avenue intersection (West side of 76th Street)	Garden	1
ESE 7750 Street	O. Ashely - Northwest corner of 7750th Street and 28th Avenue intersection	Residence	1

PALISADES

Table II (cont'd)

Verification of Nearest Items

<u>Sector and Road</u>	<u>Location/Description</u>	<u>Item</u>	<u>Number</u>
ESE 28th Avenue	L.A. Lewis, Northeast corner of 28th Avenue and 75th Street intersection	Garden	1
ESE 28th Avenue	John Williams, 74927 28th Avenue Southeast corner of 28th Avenue and 75th Street intersection	Cattle	2-Beef
ESE 30th Avenue	Mr. Newell-1/2 mile East of M-140 and 30th Avenue intersection	Cattle Goats	1-Beef 6
SE 7750 Street	Mr. Lloyd, 28160 7750th Street - 1/4 mile South of 7750 Street and 28th Avenue intersection (West side of 7750th Street)	Residence Garden	1 1
SE 7750 Street	Carl Dunson, 30602 7750th Street 1/2 mile South of 7750th Street and 28th Avenue intersection (West side of 7750th Street)	Garden	1
SE 34th Avenue	L. Burrows - 1/2 mile East of 34th Avenue and M-140 inter- section (South side of 34th Avenue)	Cattle	15-Beef
SE 36th Avenue	G. Miller, Route 1, Box 20, Covert - 1/2 mile West of 36th Avenue and 72nd Street intersection (South side of 36th Street)	Cattle	1-Dairy Cow 4-Beef
SSE 29th Avenue	L. Burrows - Route 1, Box 167, Covert - Southwest corner of 29th Avenue and Blue Star Hwy intersection.	Residence	1
SSE 7750 Street	1/4 mile North of 7750 Street and 32nd Avenue intersection (West side of 7750 Street)	Garden	1
SSE CR 376	Mr. Marshall - Southwest corner of CR 376 and M-40	Cattle Goats	8-Beef 2-Dairy Cows 2-Goats

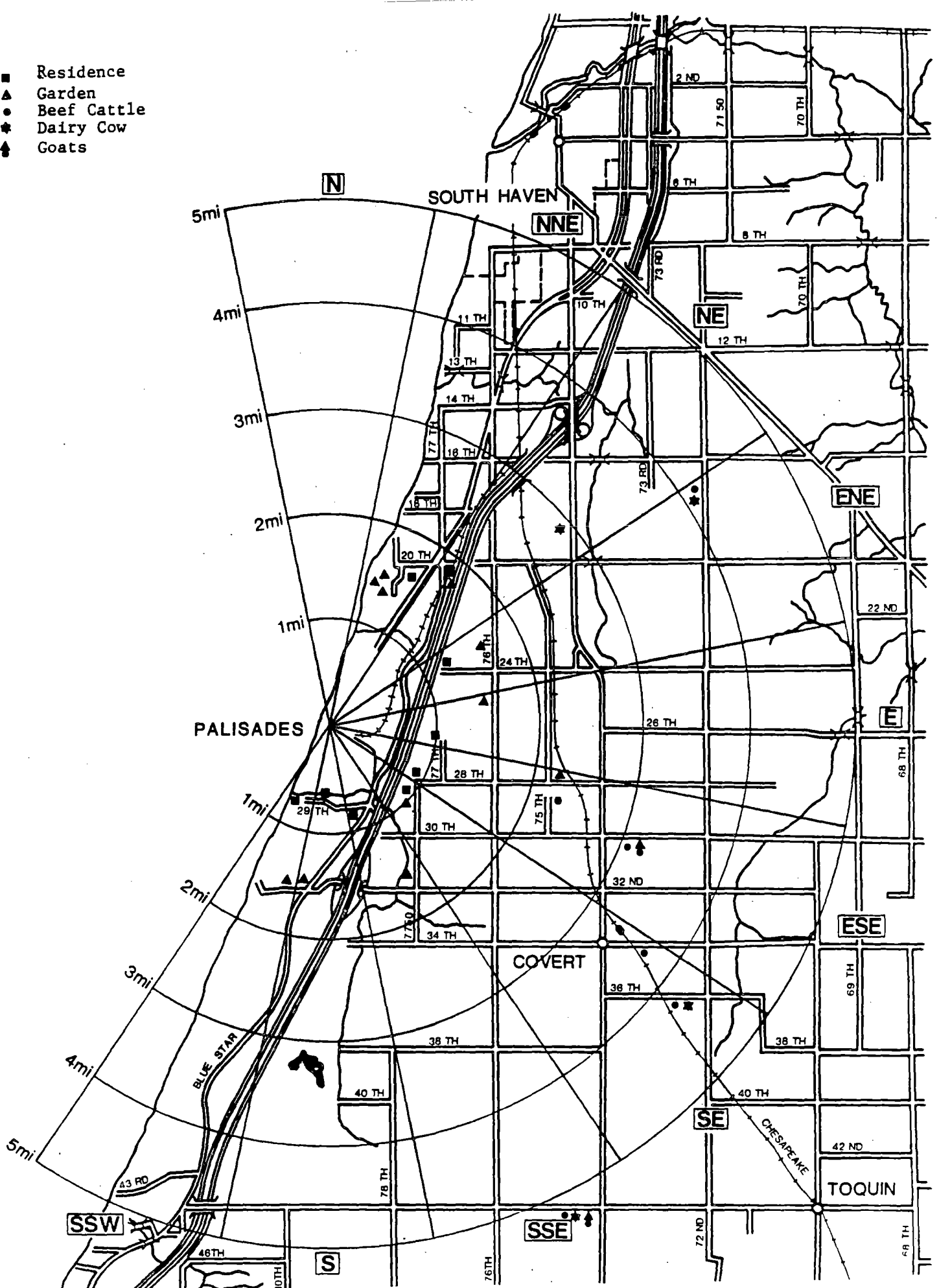
PALISADES

Table II (cont'd)

Verification of Nearest Items

<u>Sector and Road</u>	<u>Location/Description</u>	<u>Item</u>	<u>Number</u>
S 29th Avenue	Residence - Palisades Park; 3/4 mile West of 29th Avenue and Blue Star Hwy intersection (North side of 29th Avenue)	Residence	1
S 32nd Avenue	Northwest corner of 32nd Avenue and Blue Star Hwy	Garden	1
SSW 29th Avenue dead end	R. James - 29th Avenue, dead end, Palisades Park	Residence	1
SSW 32nd Avenue	Dead end of dirt road, 1/2 mile West from 32nd Avenue and Blue Star Hwy intersection	Garden	1

- Residence
- ▲ Garden
- Beef Cattle
- ★ Dairy Cow
- ⬆ Goats



Appendix A

Interlaboratory Comparison Program Results

Teledyne Isotopes Midwest Laboratory (formerly Hazleton Environmental Sciences) has participated in interlaboratory comparison (crosscheck) programs since the formulation of its quality control program in December 1971. These programs are operated by agencies which supply environmental-type samples (e.g., milk or water) containing concentrations of radionuclides known to the issuing agency but not to participant laboratories. The purpose of such a program is to provide an independent check on the laboratory's analytical procedures and to alert it to any possible problems.

Participant laboratories measure the concentrations of specified radionuclides and report them to the issuing agency. Several months later, the agency reports the known values to the participant laboratories and specifies control limits. Results consistently higher or lower than the known values or outside the control limits indicate a need to check the instruments or procedures used.

The results in Table A-1 were obtained through participation in the environmental sample crosscheck program for milk, water, air filters, and food samples during the period 1980 through June 1985. This program has been conducted by the U. S. Environmental Protection Agency Intercomparison and Calibration Section, Quality Assurance Branch, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada.

The results in Table A-2 were obtained for thermoluminescent dosimeters (TLD's) during the period 1976, 1977, 1979, 1980, and 1981 through participation in the Second, Third, Fourth, and Fifth International Intercomparison of Environmental Dosimeters under the sponsorships listed in Table A-2.

Table A-1. U.S. Environmental Protection Agency's crosscheck program, comparison of EPA and Teledyne Isotopes Midwest Laboratory results for milk, water, air filters, and food samples, 1980 through 1984.^a

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/lb	
				TIML Result $\pm 2\sigma^c$	EPA Result $\pm 3\sigma, n=1^d$
STW-206	Water	Jan. 1980	Gross Alpha Gross Beta	19.0 \pm 2.0 48.0 \pm 2.0	30.0 \pm 8.0 45.0 \pm 5.0
STW-208	Water	Jan. 1980	Sr-89 Sr-90	6.1 \pm 1.2 23.9 \pm 1.1	10.0 \pm 0.5 25.5 \pm 1.5
STW-209	Water	Feb. 1980	Cr-51 Co-60 Zn-65 Ru-106 Cs-134 Cs-137	112 \pm 14 12.7 \pm 2.3 29.7 \pm 2.3 71.7 \pm 1.5 12.0 \pm 2.0 30.0 \pm 2.7	101 \pm 5.0 11 \pm 5.0 25 \pm 5.0 51 \pm 5 10 \pm 5.0 30 \pm 5.0
STW-210	Water	Feb. 1980	H-3	1800 \pm 120	1750 \pm 340
STW-211	Water	March 1980	Ra-226 Ra-228	15.7 \pm 0.2 3.5 \pm 0.3	16.0 \pm 2.4 2.6 \pm 0.4
STM-217	Milk	May 1980	Sr-89 Sr-90	4.4 \pm 2.69 10.0 \pm 1.0	5 \pm 5 12 \pm 1.5
STW-221	Water	June 1980	Ra-226 Ra-228	2.0 \pm 0.0 1.6 \pm 0.1	1.7 \pm 0.8 1.7 \pm 0.8
STW-223	Water	July 1980	Gross Alpha Gross Beta	31 \pm 3.0 44 \pm 4	38 \pm 5.0 35 \pm 5.0
STW-224	Water	July 1980	Cs-137 Ba-140 K-40 I-131	33.9 \pm 0.4 <12 1350 \pm 60 <5.0	35 \pm 5.0 0 1550 \pm 78 0
STW-225	Water	Aug. 1980	H-3	1280 \pm 50	1210 \pm 329
STW-226	Water	Sept. 1980	Sr-89 Sr-90	22 \pm 1.2 12 \pm 0.6	24 \pm 8.6 15 \pm 2.6
STW-228	Water	Sept. 1980	Gross Alpha Gross Beta	NA ^e 22.5 \pm 0.0	32.0 \pm 8.0 21.0 \pm 5.0
STW-235	Water	Dec. 1980	H-3	2420 \pm 30	2240 \pm 604

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l ^b	
				TIML Result $\pm 2\sigma^c$	EPA Result $\pm 3\sigma$, n=1 ^d
STW-237	Water	Jan. 1981	Sr-89	13.0 \pm 1.0	16 \pm 8.7
			Sr-90	24.0 \pm 0.6	34 \pm 2.9
STM-239	Milk	Jan. 1981	Sr-89	<2.0	0
			Sr-90	15.7 \pm 2.6	20 \pm 3.0
			I-131	30.9 \pm 4.8	26 \pm 10.0
			Cs-137	46.9 \pm 2.9	43 \pm 9.0
			Ba-140	<21	0
			K-40	1330 \pm 53	1550 \pm 134
STW-240	Water	Jan. 1981	Gross alpha	7.3 \pm 2.0	9 \pm 5.0
			Gross beta	41.0 \pm 3.1	44 \pm 5.0
STW-243	Water	Mar. 1981	Ra-226	3.5 \pm 0.06	3.4 \pm 0.5
			Ra-228	6.5 \pm 2.3	7.3 \pm 1.1
STW-245	Water	Apr. 1981	H-3	3210 \pm 115	2710 \pm 355
STW-249	Water	May 1981	Sr-89	51 \pm 3.6	36 \pm 8.7
			Sr-90	22.7 \pm 0.6	22 \pm 2.6
STW-251	Water	May 1981	Gross alpha	24.0 \pm 5.3	21 \pm 5.2
			Gross beta	16.1 \pm 1.9	14 \pm 5.0
STW-252	Water	Jun. 1981	H-3	2140 \pm 95	1950 \pm 596
STW-255	Water	Jul. 1981	Gross alpha	20 \pm 1.5	22 \pm 9.5
			Gross beta	13.0 \pm 2.0	15 \pm 8.7
STW-259	Water	Sep. 1981	Sr-89	16.1 \pm 1.0	23 \pm 5
			Sr-90	10.3 \pm 0.9	11 \pm 1.5
STW-265	Water	Oct. 1981	Gross alpha	71.2 \pm 19.1	80 \pm 20
			Gross beta	123.3 \pm 16.6	111 \pm 5.6
			Sr-89	14.9 \pm 2.0	21 \pm 5
			Sr-90	13.1 \pm 1.7	14.4 \pm 1.5
			Ra-226	13.0 \pm 2.0	12.7 \pm 1.9
STW-269	Water	Dec. 1981	H-3	2516 \pm 181	2700 \pm 355

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l ^b	
				TIML Result $\pm 2\sigma^c$	EPA Result $\pm 3\sigma, n=1^d$
STW-270	Water	Jan. 1982	Sr-89	24.3 \pm 2.0	21.0 \pm 5.0
			Sr-90	9.4 \pm 0.5	12.0 \pm 1.5
STW-273	Water	Jan. 1982	I-131	8.6 \pm 0.6	8.4 \pm 1.5
STW-275	Water	Feb. 1982	H-3	1580 \pm 147	1820 \pm 342
STW-276	Water	Feb. 1982	Cr-51	<61	0
			Co-60	26.0 \pm 3.7	20 \pm 5
			Zn-65	<13	15 \pm 5
			Ru-106	<46	20 \pm 5
			Cs-134	26.8 \pm 0.7	22 \pm 5
			Cs-137	29.7 \pm 1.4	23 \pm 5
STW-277	Water	Mar. 1982	Ra-226	11.9 \pm 1.9	11.6 \pm 1.7
STW-278	Water	Mar. 1982	Gross alpha	15.6 \pm 1.9	19 \pm 5
			Gross beta	19.2 \pm 0.4	19 \pm 5
STW-280	Water	Apr. 1982	H-3	2690 \pm 80	2860 \pm 360
STW-281	Water	Apr. 1982	Gross alpha	75 \pm 7.9	85 \pm 21
			Gross beta	114.1 \pm 5.9	106 \pm 5.3
			Sr-89	17.4 \pm 1.8	24 \pm 5
			Sr-90	10.5 \pm 0.6	12 \pm 1.5
			Ra-226	11.4 \pm 2.0	10.9 \pm 1.5
			Co-60	<4.6	0
STW-284	Water	May 1982	Gross alpha	31.5 \pm 6.5	27.5 \pm 7
			Gross beta	25.9 \pm 3.4	29 \pm 5
STW-285	Water	June 1982	H-3	1970 \pm 1408	1830 \pm 340
STW-286	Water	June 1982	Ra-226	12.6 \pm 1.5	13.4 \pm 3.5
			Ra-228	11.1 \pm 2.5	8.7 \pm 2.3
STW-287	Water	June 1982	I-131	6.5 \pm 0.3	4.4 \pm 0.7
STW-290	Water	Aug. 1982	H-3	3210 \pm 140	2890 \pm 619
STW-291	Water	Aug. 1982	I-131	94.6 \pm 2.5	87 \pm 15

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l ^b	
				TIML Result ±2σ ^c	EPA Result ±3σ, n=1 ^d
STW-292	Water	Sept 1982	Sr-89	22.7±3.8	24.5±8.7
			Sr-90	10.9±0.3	14.5±2.6
STW-296	Water	Oct. 1982	Co-60	20.0±1.0	20±8.7
			Zn-65	32.3±5.1	24±8.7
			Cs-134	15.3±1.5	19.0±8.7
			Cs-137	21.0±1.7	20.0±8.7
STW-297	Water	Oct. 1982	H-3	2470±20	2560±612
STW-298	Water	Oct. 1982	Gross alpha	32±30	55±24
			Gross beta	81.7±6.1	81±8.7
			Sr-89	<2	0
			Sr-90	14.1±0.9	17.2±2.6
			Cs-134	<2	1.8±8.7
			Cs-137	22.7±0.6	20±8.7
			Ra-226	13.6±0.3	12.5±3.2
			Ra-228	3.9±1.0	3.6±0.9
STW-301	Water	Nov. 1982	Gross alpha	12.0±1.0	19.0±8.7
			Gross beta	34.0±2.7	24.0±8.7
STW-302	Water	Dec. 1982	I-131	40.0±0.0	37.0±10
STW-303	Water	Dec. 1982	H-3	1940±20	1990±345
STW-304	Water	Dec. 1982	Ra-226	11.7±0.6	11.0±1.7
			Ra-228	<3	0
STW-306	Water	Jan. 1983	Sr-89	20.0±8.7	29.2±5
			Sr-90	21.7±8.4	17.2±1.5
STW-307	Water	Jan. 1983	Gross alpha	29.0±4.0 ^g	29.0±13
			Gross beta	29.3±0.6	31.0±8.7
STM-309	Milk	Feb. 1983	Sr-89	35±2.0	37±8.7
			Sr-90	13.7±0.6	18±2.6
			I-131	55.7±3.2	55±10.4
			Cs-137	29±1.0	26±8.7
			Ba-140	<27	0
			K-40	1637±5.8	1512±131

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/lb	
				TIML Result $\pm 2\sigma^c$	EPA Result $\pm 3\sigma, n=1^d$
STW-310	Water	Feb. 1983	H-3	2470 \pm 80	2560 \pm 612
STW-311	Water	March 1983	Ra-226 Ra-228	11.9 \pm 1.3 <2.7	12.7 \pm 3.3 0
STW-312	Water	March 1983	Gross alpha Gross beta	31.6 \pm 4.59 27.0 \pm 2.0	31 \pm 13.4 28 \pm 8.7
STW-313	Water	April 1983	H-3	3240 \pm 80	3330 \pm 627
STW-316	Water	May 1983	Gross alpha Gross beta Sr-89 Sr-90 Ra-226 Co-60 Cs-134 Cs-137	94 \pm 7 133 \pm 5 19 \pm 1 12 \pm 1 7.9 \pm 0.4 30 \pm 2 27 \pm 2 29 \pm 1	64 \pm 19.9 149 \pm 12.4 24 \pm 8.7 13 \pm 2.6 8.5 \pm 2.25 30 \pm 8.7 33 \pm 8.7 27 \pm 8.7
STW-317	Water	May 1983	Sr-89 Sr-90	59.7 \pm 2.1 33.7 \pm 1.5	57 \pm 8.7 38 \pm 3.3
STW-318 ^f	Water	May 1983	Gross alpha Gross beta	12.8 \pm 1.5 49.4 \pm 3.9	11 \pm 8.7 57 \pm 8.7
STM-320	Milk	June 1983	Sr-89 Sr-90 I-131 Cs-137 K-40	20 \pm 0 10 \pm 1 30 \pm 1 52 \pm 2 1553 \pm 57	25 \pm 8.7 16 \pm 2.6 30 \pm 10.4 47 \pm 8.7 1486 \pm 129
STW-321	Water	June 1983	H-3	1470 \pm 89	1529 \pm 583
STW-322	Water	June 1983	Ra-226 Ra-228	4.3 \pm 0.2 <2.5	4.8 \pm 1.24 0
STW-323	Water	July 1983	Gross alpha Gross beta	3 \pm 1 21 \pm 0	7 \pm 8.7 22 \pm 8.7
STW-324	Water	August 1983	I-131	13.3 \pm 0.6	14 \pm 10.4

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l ^b	
				TIML Result $\pm 2\sigma^c$	EPA Result $\pm 3\sigma$, n=1 ^d
STAF-326	Air Filter	August 1983	Gross beta Sr-90 Cs-137	42 \pm 2 14 \pm 2 19 \pm 1	36 \pm 8.7 10 \pm 2.6 15 \pm 8.7
STW-328	Water	Sept. 1983	Gross alpha Gross beta	2.3 \pm 0.6 10.7 \pm 1.2	5 \pm 8.7 9 \pm 8.7
STW-329	Water	Sept. 1983	Ra-226 Ra-228	3.0 \pm 0.2 3.2 \pm 0.7	3.1 \pm 0.81 2.0 \pm 0.52
STW-331	Water	Oct. 1983	H-3	1300 \pm 30	1210 \pm 570
STW-335	Water	Dec. 1983	I-131	19.6 \pm 1.9	20 \pm 10.4
STW-336	Water	Dec. 1983	H-3	2870 \pm 100	2389 \pm 608
STAF-337	Air Filter	Nov. 1983	Gross alpha Gross beta Sr-90 Cs-137	18.0 \pm 0.2 58.6 \pm 1.2 10.9 \pm 0.1 30.1 \pm 2.5	19 \pm 8.7 50 \pm 8.7 15 \pm 2.6 20 \pm 8.7
STW-339	Water	Jan. 1984	Sr-89 Sr-90	47.2 \pm 1.9 22.5 \pm 4.0	36 \pm 8.7 24 \pm 2.6
STW-343	Water	Feb. 1984	H-3	2487 \pm 76	2383 \pm 607
STM-347	Milk	March 1984	I-131	5.3 \pm 1.1	6 \pm 1.6
STW-349	Water	March 1984	Ra-226 Ra-228	4.0 \pm 0.2 3.6 \pm 0.3	4.1 \pm 1.06 2.0 \pm 0.52
STW-350	Water	March 1984	Gross alpha Gross beta	3.8 \pm 1.1 24.2 \pm 2.0	5 \pm 8.7 20 \pm 8.7
STW-354	Water	April 1984	H-3	3560 \pm 50	3508 \pm 630
STW-355	Water	April 1984	Gross alpha Gross beta Sr-89 Sr-90 Ra-226 Co-60 Cs-134 Cs-137	21.0 \pm 4.1 127.8 \pm 4.1 29.3 \pm 2.0 16.6 \pm 0.7 4.0 \pm 1.0 32.3 \pm 1.4 33.6 \pm 3.1 33.3 \pm 2.2	35 \pm 15.2 147 \pm 12.7 23 \pm 8.7 26 \pm 2.6 4.0 \pm 1.04 30 \pm 8.7 30 \pm 8.7 26 \pm 8.7

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/lb	
				TIML Result $\pm 2\sigma^c$	EPA Result $\pm 3\sigma$, $n=1^d$
STW-358	Water	May 1984	Gross alpha Gross beta	3.0 \pm 0.6 6.7 \pm 1.2	3 \pm 8.7 6 \pm 8.7
STM-366	Milk	June 1984	Sr-89 Sr-90 I-131 Cs-137 K-40	21 \pm 3.1 13 \pm 2.0 46 \pm 5.3 38 \pm 4.0 1577 \pm 172	25 \pm 8.7 17 \pm 2.6 43 \pm 10.4 35 \pm 8.7 1496 \pm 130
STW-368	Water	July 1984	Gross alpha Gross beta	5.1 \pm 1.1 11.9 \pm 2.4	6 \pm 8.7 13 \pm 8.7
STW-369	Water	August 1984	I-131	34.3 \pm 5.0	34.0 \pm 10.4
STW-370	Water	August 1984	H-3	3003 \pm 253	2817 \pm 617
STF-371	Food	July 1984	Sr-89 Sr-90 I-131 Cs-137 K-40	22.0 \pm 5.3 14.7 \pm 3.1 <172 24.0 \pm 5.3 2503 \pm 132	25.0 \pm 8.7 20.0 \pm 2.6 39.0 \pm 10.4 25.0 \pm 8.7 2605 \pm 226.0
STAF-372	Air Filter	August 1984	Gross alpha Gross beta Sr-90 Cs-137	15.3 \pm 1.2 56.0 \pm 0.0 14.3 \pm 1.2 21.0 \pm 2.0	17 \pm 8.7 51 \pm 8.7 18 \pm 2.4 15 \pm 8.7
STW-375	Water	Sept. 1984	Ra-226 Ra-228	5.1 \pm 0.4 2.2 \pm 0.1	4.9 \pm 1.27 2.3 \pm 0.60
STW-377	Water	Sept. 1984	Gross alpha Gross beta	3.3 \pm 1.2 12.7 \pm 2.3	5.0 \pm 8.7 16.0 \pm 8.7
STW-379	Water	Oct. 1984	H-3	2860 \pm 312	2810 \pm 356
STW-380	Water	Oct. 1984	Cr-51 Co-60 Zn-65 Ru-106 Cs-134 Cs-137	<36 20.3 \pm 1.2 150 \pm 8.1 <30 31.3 \pm 7.0 26.7 \pm 1.2	40 \pm 8.7 20 \pm 8.7 147 \pm 8.7 47 \pm 8.7 31 \pm 8.7 24 \pm 8.7

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/lb	
				TIML Result $\pm 2\sigma^c$	EPA Result $\pm 3\sigma, n=1^d$
STM-382	Milk	Oct. 1984	Sr-89	15.7 \pm 4.2	22 \pm 8.7
			Sr-90	12.7 \pm 1.2	16 \pm 2.6
			I-131	41.7 \pm 3.1	42 \pm 10.4
			Cs-137	31.3 \pm 6.1	32 \pm 8.7
			K-40	1447 \pm 66	1517 \pm 131
STW-384	Water (Blind)	Oct. 1984 Sample A	Gross alpha	9.7 \pm 1.2	14 \pm 8.7
			Ra-226	3.3 \pm 0.2	3.0 \pm 0.8
			Ra-228	3.4 \pm 1.6	2.1 \pm 0.5
			Uranium	NA ^e	5 \pm 10.4
		Sample B	Gross beta	48.3 \pm 5.0	64 \pm 8.7
			Sr-89	10.7 \pm 4.6	11 \pm 8.7
			Sr-90	7.3 \pm 1.2	12 \pm 2.6
			Co-60	16.3 \pm 1.2	14 \pm 8.7
			Cs-134	<2	2 \pm 8.7
			Cs-137	16.7 \pm 1.2	14 \pm 8.7
STAF-387	Air Filter	Nov. 1984	Gross alpha	18.7 \pm 1.2	15 \pm 8.7
			Gross beta	59.0 \pm 5.3	52 \pm 8.7
			Sr-89	18.3 \pm 1.2	21 \pm 2.6
			Cs-137	10.3 \pm 1.2	10 \pm 8.7
STW-388	Water	Dec. 1984	I-131	28.0 \pm 2.0	36 \pm 10.4
STW-389	Water	Dec. 1984	H-3	3583 \pm 110	3182 \pm 624
STW-391	Water	Dec. 1984	Ra-226	8.4 \pm 1.7	8.6 \pm 2.2
			Ra-228	3.1 \pm 0.2	4.1 \pm 1.1
STW-392	Water	Jan. 1985	Sr-89	<3.0	3.0 \pm 8.7
			Sr-90	27.3 \pm 5.2	30.0 \pm 2.6
STW-393	Water	Jan. 1985	Gross alpha	3.3 \pm 1.2	5 \pm 8.7
			Gross beta	17.3 \pm 3.0	15 \pm 8.7
STS-395	Food	Jan. 1985	Sr-89	25.3 \pm 6.4	34.0 \pm 5.0
			Sr-90	27.0 \pm 8.8	26.0 \pm 1.5
			I-131	38.0 \pm 2.0	35.0 \pm 6.0
			Cs-137	32.7 \pm 2.4	29.0 \pm 5.0
			K-40	1410 \pm 212	1382 \pm 120

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l ^b	
				TIML Result ±2 ^c	EPA Result ±3, n=1 ^d
STW-397	Water	Feb. 1985	Cr-51	<29	48±8.7
			Co-60	21.3±3.0	20±8.7
			Zn-65	53.7±5.0	55±8.7
			Ru-106	<23	25±8.7
			Cs-134	32.3±1.2	35±8.7
			Cs-137	25.3±3.0	25±8.7
STW-398	Water	Feb. 1985	H-3	3869±319	3796±634
STW-400	Milk	March 1985	I-131	7.3±2.4	9.0±0.9
STW-402	Water	March 1985	Ra-226	4.6±0.6	5.0±1.3
			Ra-228	<0.8	9.0±2.3
			Reanalysis Ra-228	9.0±0.4	
STW-404	Water	March 1985	Gross alpha	4.7±2.3	6±8.7
			Gross beta	11.3±1.2	15±8.7
STW-405	Air Filter	March 1985	Gross alpha	9.3±1.0	10.0±8.7
			Gross beta	42.0±1.1	36.0±8.7
			Sr-90	13.3±1.0	15.0±2.6
			Cs-137	6.3±1.0	6.0±8.7
STW-407	Water	April 1985	I-131	8.0±0.0	7.5±1.3
STW-408	Water	April 1985	H-3	3399±150	3559±630
STW-409	Water	April 1985			
			(Blind)		
			Sample A		
			Gross alpha	29.7±1.8	32.0±5.0
			Ra-226	4.4±0.2	4.1±0.6
			Ra-228	NA ^e	6.2±0.9
			Uranium	NA ^e	7.0±6.0
			Sample B		
			Gross beta	74.3±11.8	72.0±5.0
			Sr-89	12.3±7.6	10.0±5.0
			Sr-90	14.7±2.4	15.0±1.5
			Co-60	14.7±2.4	15.0±5.0
			Cs-134	12.0±2.0	15.0±5.0
Cs-137	14.0±2.0	12.0±5.0			

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l ^b	
				TIML Result $\pm 2\sigma^c$	EPA Result $\pm 3\sigma$, $n=1^d$
STW-413	Water	May 1985	Sr-89	36.0 \pm 12.4	39.0 \pm 5.0
			Sr-90	14.3 \pm 4.2	15.0 \pm 1.5
STW-414	Water	May 1985	Gross alpha	8.3 \pm 4.1	12.0 \pm 5.0
			Gross beta	8.7 \pm 1.2	11.0 \pm 5.0
STW-416	Water	June 1985	Cr-51	44.7 \pm 6.0	44.0 \pm 5.0
			Co-60	14.3 \pm 1.2	14.0 \pm 5.0
			Zn-65	50.3 \pm 7.0	47.0 \pm 5.0
			Ru-106	55.3 \pm 5.8	62.0 \pm 5.0
			Cs-134	32.7 \pm 1.2	35.0 \pm 5.0
			Cs-137	22.7 \pm 2.4	20.0 \pm 5.0
STW-418	Water	June 1985	H-3	2446 \pm 132	2416 \pm 351

^a Results obtained by Teledyne Isotopes Midwest Laboratory as a participant in the environmental sample crosscheck program operated by the Intercomparison and Calibration Section, Quality Assurance Branch, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, (EPA), Las Vegas, Nevada.

^b All results are in pCi/l, except for elemental potassium (K) data, which are in mg/l; air filter samples, which are in pCi/filter; and food, which is in pCi/kg.

^c Unless otherwise indicated, the TIML results are given as the mean ± 2 standard deviations for three determinations.

^d USEPA results are presented as the known values \pm control limits of 3σ for $n=1$.

^e NA = Not analyzed.

^f Analyzed but not reported to the EPA.

^g Results after calculations corrected (error in calculations when reported to EPA).

Table A-2. Crosscheck program results, thermoluminescent dosimeters (TLDs).

Lab Code	TLD Type	Measurement	mR		Average $\pm 2\sigma$ ^d (all participants)
			Teledyne Result $\pm 2\sigma^a$	Known Value	
<u>2nd International Intercomparison^b</u>					
115-2 ^b	CaF ₂ :Mn Bulb	Gamma-Field	17.0 \pm 1.9	17.1 ^c	16.4 \pm 7.7
		Gamma-Lab	20.8 \pm 4.1	21.3 ^c	18.8 \pm 7.6
<u>3rd International Intercomparison^e</u>					
115-3 ^e	CaF ₂ :Mn Bulb	Gamma-Field	30.7 \pm 3.2	34.9 \pm 4.8 ^f	31.5 \pm 3.0
		Gamma-Lab	89.6 \pm 6.4	91.7 \pm 14.6 ^f	86.2 \pm 24.0
<u>4th International Intercomparison^g</u>					
115-49	CaF ₂ :Mn Bulb	Gamma-Field	14.1 \pm 1.1	14.1 \pm 1.4 ^f	16.0 \pm 9.0
		Gamma-Lab (Low)	9.3 \pm 1.3	12.2 \pm 2.4 ^f	12.0 \pm 7.6
		Gamma-Lab (High)	40.4 \pm 1.4	45.8 \pm 9.2 ^f	43.9 \pm 13.2
<u>5th International Intercomparison^h</u>					
115-5A ^h	CaF ₂ :Mn Bulb	Gamma-Field	31.4 \pm 1.8	30.0 \pm 6.0 ⁱ	30.2 \pm 14.6
		Gamma-Lab at beginning	77.4 \pm 5.8	75.2 \pm 7.6 ⁱ	75.8 \pm 40.4
		Gamma-Lab at the end	96.6 \pm 5.8	88.4 \pm 8.8 ⁱ	90.7 \pm 31.2

Table A-2. (Continued)

Lab Code	TLD Type	Measurement	mR		
			Teledyne Result $\pm 2\sigma^a$	Known Value	Average $\pm 2\sigma^d$ (all participants)
115-5B ^h	LiF-100 Chips	Gamma-Field	30.3 \pm 4.8	30.0 \pm 6 ⁱ	30.2 \pm 14.6
		Gamma-Lab at beginning	81.1 \pm 7.4	75.2 \pm 7.6 ⁱ	75.8 \pm 40.4
		Gamma-Lab at the end	85.4 \pm 11.7	88.4 \pm 8.8 ⁱ	90.7 \pm 31.2

^a Lab result given is the mean ± 2 standard deviations of three determinations.

^b Second International Intercomparison of Environmental Dosimeters conducted in April of 1976 by the Health and Safety Laboratory (GASL), New York, New York, and the School of Public Health of the University of Texas, Houston, Texas.

^c Value determined by sponsor of the intercomparison using continuously operated pressurized ion chamber.

^d Mean ± 2 standard deviations of results obtained by all laboratories participating in the program.

^e Third International Intercomparison of Environmental Dosimeters conducted in summer of 1977 by Oak Ridge National Laboratory and the School of Public Health of the University of Texas, Houston, Texas.

^f Value ± 2 standard deviations as determined by sponsor of the intercomparison using continuously operated pressurized ion chamber.

^g Fourth International Intercomparison of Environmental Dosimeters conducted in summer of 1979 by the School of Public Health of the University of Texas, Houston, Texas.

^h Fifth International Intercomparison of Environmental Dosimeter conducted in fall of 1980 at Idaho Falls, Idaho and sponsored by the School of Public Health of the University of Texas, Houston, Texas and Environmental Measurements Laboratory, New York, New York, U.S. Department of Energy.

ⁱ Value determined by sponsor of the intercomparison using continuously operated pressurized ion chamber.

Appendix B
Data Reporting Conventions

Data Reporting Conventions

1.0. All activities are decay corrected to collection time.

2.0. Single Measurements

Each single measurement is reported as follows:

$$x \pm s$$

where x = value of the measurement;

$s = 2\sigma$ counting uncertainty (corresponding to the 95% confidence level).

In cases where the activity is found to be below the lower limit of detection L it is reported as

$$<L$$

where L = is the lower limit of detection based on 4.66 uncertainty for a background sample.

3.0. Duplicate Analyses

3.1. Individual results: $x_1 \pm s_1$
 $x_2 \pm s_2$

Reported result: $x \pm s$

where $x = (1/2) (x_1 + x_2)$

$$s = (1/2) \sqrt{s_1^2 + s_2^2}$$

3.2. Individual results: $<L_1$
 $<L_2$

Reported result: $<L$

where L = lower of L_1 and L_2

3.3. Individual results: $x \pm s$
 $<L$

Reported result: $x \pm s$ if $x \geq L$;

$<L$ otherwise

4.0. Computation of Averages and Standard Deviations

- 4.1 Averages and standard deviations listed in the tables are computed from all of the individual measurements over the period averaged; for example, an annual standard deviation would not be the average of quarterly standard deviations. The average \bar{x} and standard deviations of a set of n numbers x_1, x_2, \dots, x_n are defined as follows:

$$\bar{x} = \frac{1}{n} \sum x$$

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

- 4.2 Values below the highest lower limit of detection are not included in the average.
- 4.3 If all of the values in the averaging group are less than the highest LLD, the highest LLD is reported.
- 4.4 If all but one of the values are less than the highest LLD, the single value x and associated two sigma error is reported.
- 4.5. In rounding off, the following rules are followed:
- 4.5.1. If the figure following those to be retained is less than 5, the figure is dropped, and the retained figures are kept unchanged. As an example, 11.443 is rounded off to 11.44.
- 4.5.2 If the figure following those to be retained is greater than 5, the figure is dropped, and the last retained figure is raised by 1. As an example, 11.446 is rounded off to 11.45.
- 4.5.3. If the figure following those to be retained is 5, and if there are no figures other than zeros beyond the five, the figure 5 is dropped, and the last-place figure retained is increased by one if it is an odd number or it is kept unchanged if an even number. As an example, 11.435 is rounded off to 11.44, while 11.425 is rounded off to 11.42.