DOE/NV/00410-60

DOE/NV/00410-60
Costa

#40

68107

ENVIRONMENTAL SURVEILLANCE REPORT FOR THE NEVADA TEST SITE

(JANUARY 1979 THROUGH DECEMBER 1979)

JUNE 1980

WORK PERFORMED UNDER CONTRACT NO. DE-AC08-76NV00410

REYNOLDS ELECTRICAL & ENGINEERING CO., INC.
POST OFFICE BOX 14400
LAS VEGAS, NV 89114

DOE/NV/00410-60

ENVIRONMENTAL SURVEILLANCE REPORT
FOR THE
NEVADA TEST SITE
(JANUARY 1979 THROUGH DECEMBER 1979)

MICHAEL W. LANTZ

REYNOLDS ELECTRICAL & ENGINEERING CO., INC.
POST OFFICE BOX 14400
LAS VEGAS, NV 89114

PREPARED FOR THE

U.S. DEPARTMENT OF ENERGY
DIVISION OF ENVIRONMENTAL CONTROL TECHNOLOGY
NEVADA OPERATIONS OFFICE UNDER CONTRACT
DE-AC08-76NV00410

ABSTRACT

This report documents the environmental surveillance program at the Nevada Test Site as conducted by the Department of Energy (DOE) onsite radiological safety contractor from January 1979 through December 1979. The results and evaluations of measurements of radioactivity in air and water, and of direct gamma radiation exposure rates are presented. Relevancy to DOE concentration guides (CG'S) is established.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

The author would like to acknowledge the valuable assistance received from the REECo Printing Plant, REECo Engineering Group and Pan-Am Photography Group during preparation and review of this report. Credit must also be given to J. Morrison, B. A. Poole, D. J. Douglass, D. Wilson and W. Doppe for their fine work on the project. The author would also like to thank all of those who reviewed this report.

A. INTRODUCTION

This report documents the program conducted at the Nevada Test Site (NTS) for monitoring of radioactivity in the general onsite environment as performed by Reynolds Electrical & Engineering Co., Inc. (REECo) during the calendar year of 1979. As part of its contract, DE-AC08-76NV00410, REECo is responsible for providing radiological safety services within the confines of the test site. For a number of years, the environmental surveillance program has been part of a Department of Energy (DOE) program designed to control, minimize, and document exposures to the NTS working population.

The NTS covers an area of 3,711 square kilometers, with terrain and climate conditions typical of the high southwest desert region and mountainous areas (Figure 1). Temperatures vary from -20°C to 50°C. The area is subject to high winds, dust-laden atmosphere, and low humidity. Elevations range from dry lake beds to rugged mountains as high as 2,300 meters. The NTS, since 1951, has been the primary location for testing the nation's nuclear devices. For a detailed description of the location, background, and existing environment of the Nevada Test Site, see Reference 1.

The monitoring program originally was designed to examine the environment for levels of radioactivity that are of interest in documenting the radiation exposure to NTS workers; i.e., a backup for the onsite personnel dosimetry system. This program also could provide data concerning onsite releases or be a monitoring locale for the detection of worldwide fallout from foreign

NTS ENVIRONMENTAL SURVEILLANCE

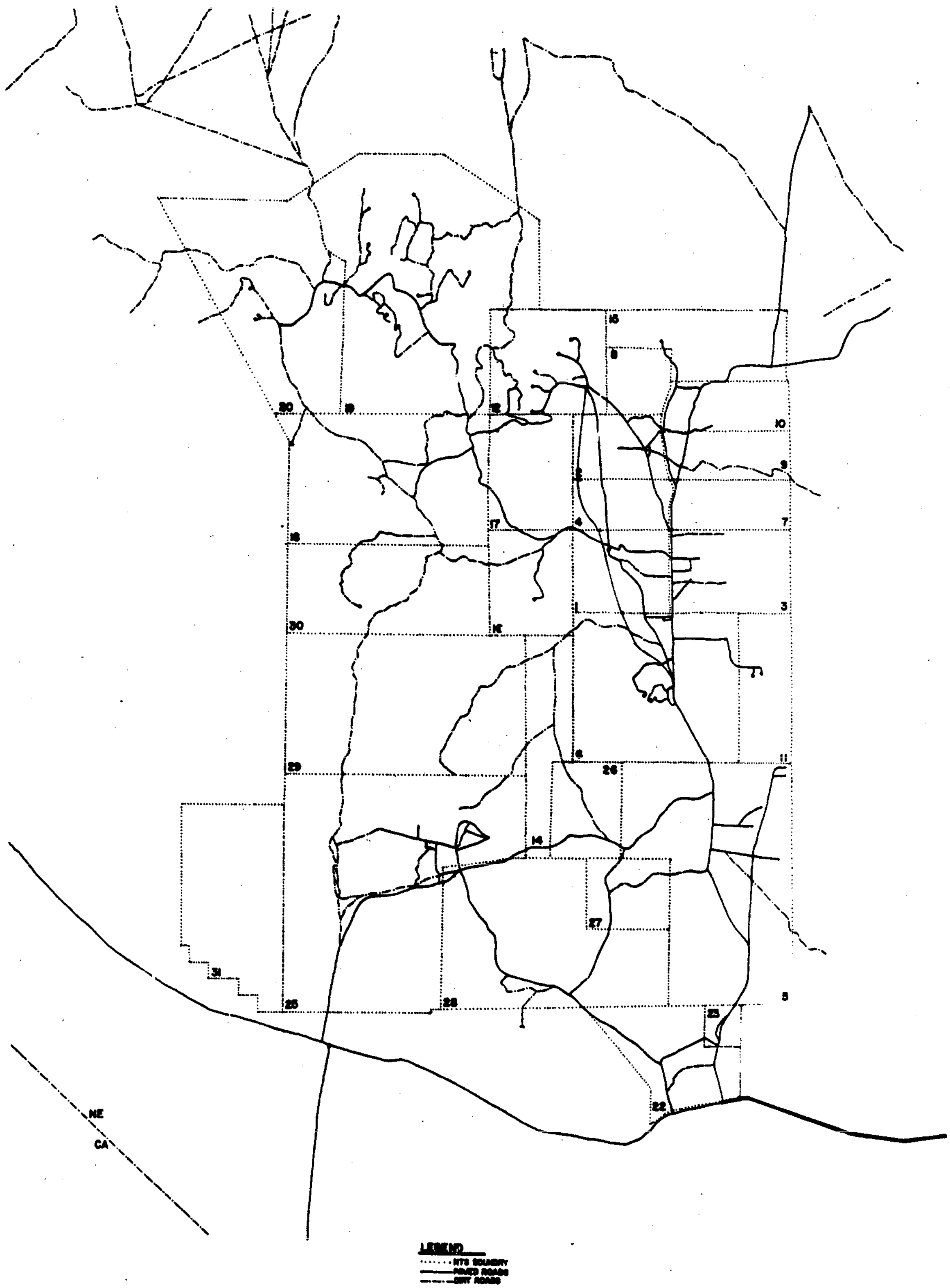


Figure 1

sources in Nevada. The program follows the standards presented in "A Guide for Environmental Radiological Surveillance at ERDA Installations," ERDA 77-24 (Reference 2). The standards dictate the following objectives for the protection of the public:

(1) Evaluation of containment of radioactivity onsite.

(2) Detection of rapid changes and evaluation of long-term trends.

(3) Assessment of doses-to-man from radioactive releases as a result of DOE operations.

(4) Collection of data bearing on the movement of contaminants released to the environment, with the intent of discovering unknown pathways of exposure.

(5) Maintenance of a data base.

(6) Detection and evaluation of radioactivity from offsite sources.

(7) Demonstration of compliance with applicable regulations and legal requirements concerning releases to the environment.

These objectives are met through the operation of the environmental surveillance program. A summary of the environmental plan is shown in Table 1. Air and potable water samples are collected at specific areas where personnel spend significant amounts of time. Additional air sampling stations are located at sites throughout the NTS in support of the testing program and the radiological waste management program. Water sampling of supply wells, open reservoirs, natural springs, contaminated ponds, and sewage ponds is also done to evaluate the possibility of any movement of radioactive contaminants into the NTS water system. The rate of sampling for each of these surveillance networks is related to potential personnel exposure; i.e., weekly water

TABLE 1

SUMMARY OF ENVIRONMENTAL PROGRAM

Sample Type	Description	Collection Frequency	Number of Samples	Analysis
Air	Continuous sampling through Whatman GF/A glass filter and a charcoal cartridge.	Weekly	34	Gamma spectroscopy, gross beta, plutonium (monthly composite)
	Low-volume sampling through a desiccant.	Weekly	8	HT-HTO
Drinking Water	1-liter grab sample.	Weekly	8	Gross gamma, gross beta, plutonium (quarterly)
Well Water Surface Water	1-liter grab sample.	Monthly	43	Gross gamma, gamma spectroscopy*, gross beta, plutonium (quarterly)
Effluent Ponds	1-liter grab sample.	Quarterly	7	Gross gamma, gamma spectroscopy*, gross beta, plutonium (quarterly)
External Gamma Radiation Levels	CaF_2:Dy and LiF Thermoluminescent Dosimeters	Quarterly	139	Total integrated exposure over field cycle.

*If the gross gamma measurement can be determined with a two sigma error of less than ten percent.

TABLE 2

DOE CONCENTRATION GUIDES (CGs) FOR CONTROLLED AREAS(a)

Nuclide	CG for Air (μCi/cc)	CG for Major NTS Waters (μCi/ml)	CG for Drinking Water (μCi/ml)
^{3}H	5×10^{-6}	1×10^{-1}	3×10^{-3}
^{7}Be	6×10^{-6}	5×10^{-2}	2×10^{-3}
^{89}Sr	3×10^{-8}	3×10^{-4}	3×10^{-6}
^{90}Sr	1×10^{-9}	1×10^{-5}	3×10^{-7}
^{95}Zr	1×10^{-7}	2×10^{-3}	6×10^{-5}
^{131}I	9×10^{-9}	6×10^{-5}	3×10^{-7}
^{132}Te	2×10^{-7}	9×10^{-4}	3×10^{-5}
^{137}Cs	6×10^{-8}	4×10^{-4}	2×10^{-5}
^{140}Ba	1×10^{-7}	8×10^{-4}	3×10^{-5}
^{238}Pu	2×10^{-12}	1×10^{-4}	5×10^{-6}
^{239}Pu	2×10^{-12}	1×10^{-4}	5×10^{-6}

(a) This table contains the CGs for the nuclides of major interest at the NTS (Manual Chapter 0524, Annex A).

samples at each cafeteria. Thermoluminescent dosimeters (TLD's) are used to survey the ambient NTS external gamma levels and are collected on a three month cycle. Except for removal of a station, inaccessibility of the location, or loss of data, sampling was continuous during this reporting period. A review of all analyses from this sampling program relative to the DOE concentration guides were performed daily to insure that potential problems were noted in a timely fashion. Table 2 lists the CG's used in the evaluations of this program (Reference 3).

All laboratory analyses appropriate to the environmental surveillance program are shown in Table 3. The analysis that provided the most information on the majority of test site samples has been the gross beta analysis. It allowed for rapid determinations of trends in gross radioactivity, and, because of counting system characteristics, had a low detection limit. This meant that positive measurements were obtained down to the lowest limits of ambient radioactivity. The remaining analyses show their worth to the program in more specific instances. Gamma spectroscopy has proved its importance by indicating the arrival of fresh fission products in the air after foreign nuclear testing. The analysis of the timing of these fission products dismisses the Nevada Test Site as the source. TLD analysis of direct gamma radiation onsite has shown: (1) elevated exposure rates at the coordinates of the NTS atmospheric tests; and (2) consistent exposure rates at all radiation levels when the TLD's are integrated over a three month period; and (3) an excellent correlation between an aerial survey and the ground survey. Plutonium analysis was primarily an indicator of the small amounts of plutonium-239 in the air near areas with histories of safety shots. Tritium analysis was used principally as a check of the water in the ponds below the

TABLE 3

LABORATORY ANALYTICAL PROCEDURES

Type of Analysis	Type of Sample	Analytical Equipment	Counting Period (Min.)	Analytical Procedures	Sample Size	Detection Limit
Gross Beta	Air	Wide Beta II	20	Place filter on a 5-inch stainless steel planchet	10^9 cc	1×10^{-16} µCi/cc
	Water	Wide Beta II	100	Evaporate, transfer residue to a 5-inch stainless steel planchet	1000 ml	5×10^{-10} µCi/ml
Gross Gamma	Water	9" X 9" NaI Well crystal	20	Aliquot sample into Nalgene bottle	500 ml	6×10^{-8} µCi/ml
Gamma Spectroscopy	Air (particulate)	Ge(Li)	20	Same as beta	10^9 cc	5×10^{-15} µCi/cc
	Air (gaseous)	Ge(Li)	20	Place charcoal cartridge in plastic bag	10^9 cc	5×10^{-15} µCi/cc
	Water	Ge(Li)	20	Count the planchet after beta analysis	500 ml	1×10^{-8} µCi/ml
Tritium	Air	Liquid Scintillation Counter	100	Distill the H_2O and aliquot 5 ml into a scintillation solution	6×10^6 cc	3×10^{-13} µCi/cc
	Water	Liquid Scintillation Counter	100	Aliquot 5 ml into a scintillation solution	5 ml	1×10^{-7} µCi/ml
Plutonium-239	Air	Silicon Semiconductor	333	Filter is ashed and put in solution. Pu is purified by anion exchange resin column, then electrodeposited on a stainless steel disc	4×10^9 cc	1×10^{-17} µCi/cc
	Water	Silicon Semiconductor	333	Pu is concentrated with $Fe(OH)_3$ and purified with anion resin column. Electrodeposited on a stainless steel disc	1000 ml	1×10^{-11} µCi/ml
Direct Gamma Radiation	TLD	Harshaw 2000		Post-anneal at 115°C for 15 minutes. Readout to 270° for 25 seconds		5 mR/quarter

Area 12 tunnels. Gross gamma analysis was used as a screening tool for elevated gamma activity in NTS water samples. It was found to be of minimal use to this program.

B. SUMMARY OF RESULTS

The results obtained from the environmental surveillance program for the reporting period of CY-1979 show that the radioactivity in air and water in the NTS environments was low compared to DOE guidelines. However, elevated plutonium-239 concentrations in air were detected and external gamma radiation at certain NTS sites approached the annual dose commitment for an individual in a controlled area (5 rem/yr).

The maximum CY-1979 average gross beta concentration in air was 3.7×10^{-14} μCi/cc at the Gravel Pit. This average represents 0.004 percent of the applicable Concentration Guide of 1×10^{-9} μCi/cc as listed in Manual Chapter 0524, Annex A (assuming Sr-90 to be the beta emitter present). The stations that were sampled over the entire report period demonstrated similar average results. The site average of these twenty-seven stations was 3.4×10^{-14} μCi/cc with one standard deviation being only four percent. The remaining seven stations averaged 3.0×10^{-14} μCi/cc with one standard deviation being nine percent. The small standard deviations were evidence that a radioactive release, originating on the test site, did not occur during CY-1979; i.e., no stations detected any radiation in excess of worldwide background. Airborne radioactivity from foreign atmospheric testing during CY-1978 affected the results of this report period slightly. Gross beta results during the first six months of the year were approximately 40 percent higher than the last six months of the year. Measurements at the end of CY-1979 were at the baseline level of previous years.

Plutonium-239 concentrations in air were primarily on the order of 10^{-16} $\mu Ci/cc$ or below, as compared with a CG of 2×10^{-12} $\mu Ci/cc$ (Manual Chapter 0524, Annex A). The three highest plutonium-239 concentrations were recorded in the northeast region of the test site; Areas 2, 9, and 15. These locations were:

Area 2	Cable Yard	8.9×10^{-16} $\mu Ci/cc$
Area 9	9-300 Bunker	5.2×10^{-16} $\mu Ci/cc$
Area 15	Gate 700	4.6×10^{-16} $\mu Ci/cc$

The majority of NTS air sampling stations measured plutonium concentrations above those found in the basecamp (Mercury), although all were negligible in terms of dose to NTS personnel.

Measurements of radioactivity in the principal NTS water system showed that no release or movement of radionuclides occurred during the reporting period. It was shown that the radioactivity in the closed water system (supply wells and potable waters) was determined by the specific activity of the associated potassium concentration (naturally-occurring ^{40}K). The highest average gross beta in the potable waters was 1.24×10^{-8} $\mu Ci/ml$ at the Area 6 Cafeteria. It also had the highest potassium concentration of the drinking waters, 9.9 mg/liter. Gross beta analysis of the open reservoirs indicated slight excesses above their respective ^{40}K activities, thus showing the probability of increased dissolved solids and worldwide fallout. Water from three natural springs (White Rock, Captain Jack Springs, and the Reitmann Seep) showed gross beta activities believed to be associated with the occasional influx of radionuclides from surface contamination in the surrounding areas. There was no human consumption of this water, and the activity was still within any applicable concentration guides.

No measurements of ^{239}Pu were above the detection limit of the counting system, 1×10^{-11} µCi/ml, except in the contaminated ponds of Area 12.

Eleven tritium results were above the detection limit of 1×10^{-7} µCi/ml. Seven of these measurements were not related to any NTS activities and were believed to be statistical fluctuations of the counting system. Four of these were from bottled water stored near a facility with concentrations of tritium in air. It is possible that these are true positive results. The highest tritium measurement was 1.96×10^{-6} µCi/ml, as compared to the CG's of 1.0×10^{-1} µCi/ml for well water and 3×10^{-3} µCi/ml for drinking water.

Measurable amounts of tritium were present in the contaminated waste ponds. The amounts of effluent released to the environment for the year were calculated and reported to DOE Headquarters in accordance with Manual Chapter 0513.

TLD measurements of the NTS gamma radiation rates at the 139 locations showed minimal changes throughout CY-1979. A nine station control network displayed no changes, while the remaining 130 stations recorded only a few small changes related to known effects. Correlation to a 1970-1972 EG&G aerial survey showed minimal differences between the rates recorded by each monitoring system. Rates were recorded up to 3600 mrem/yr, but the majority of NTS locations measured in the range of approximately 100-160 mrem/yr.

C. SAMPLING AND ANALYSIS

1. Air Monitoring

Air sampling units were located at 34 stations on the NTS to measure the radionuclides in the form of particulates and halogens. All placements were chosen primarily to provide monitoring of radioactivity at sites with high occupational factors. Geographical coverage, access, and availability of commercial power were also considered.

The sampling units consist of a positive displacement pump drawing air at approximately 100 liters per minute through a 9-centimeter Whatman GF/A filter for particulates, followed by a charcoal cartridge for radio-iodines, and mounted on a plastic sample holder. A dry-gas meter was utilized to measure the volume of air displaced over the sampling period which was typically seven days. The total volume sampled was approximately 1000 cubic meters.

The samples were held for about seven days prior to analysis to allow the naturally-occurring radioactive noble gas products to decay to insignificant levels. Gross beta counting was performed with a gas flow proportional counter (Beckman WIDE BETA II) for 20 minutes. A nominal minimum detection limit (MDL), defined as that value for which the relative two-sigma counting error was 100 percent, for the typical parameters involved was 1×10^{-16} μCi/cc. Gamma spectroscopy was accomplished using a lithium-drifted germanium detector with an input to 2000 channels which were calibrated at 1 keV per channel from 0 to 2 MeV.

The weekly air samples for a given sampling station were batched on a monthly basis and radiochemically analyzed for ^{239}Pu. The procedure incorporated an acid dissolution and an ion exchange recovery on a resin bed. Plutonium was deposited by plating on a stainless steel disc. The chemical yield of the plutonium was determined with an internal ^{236}Pu tracer. Alpha spectroscopy was performed utilizing a solid state silicon surface barrier detector. A nominal minimuum detection limit (MDL) for this analysis was 1 X 10^{-17} μCi/cc for the parameters involved.

A separate sampler was designed for the collection of airborne tritium (HT) and tritiated water vapor (HTO) (Reference 4). It was portable and capable of unattended operation for up to two weeks in desert areas. A small electronic pump drew air into the apparatus at approximately 0.5 liters per minute, and the HTO was removed from the air stream by a silica gel drying column. The dry air then passed through a catalytic converter containing platinum to generate HTO from HT according to the reaction $2H_2 + O_2 \xrightarrow{Pt} 2H_2O$. The generated vapor was collected on another drying column to which a small volume of distilled water served as a trap for HTO and made a supplemental supply of hydrogen unnecessary. Appropriate aliquots of condensed moisture were obtained by heating the silica gel. Counting via liquid scintillation techniques allowed for the determination of the HT and HTO activities. A nominal MDL for this analysis was 3 X 10^{-13} μCi/cc.

2. Water Monitoring

Water samples were collected at various frequencies from selected potable water consumption points, supply wells, natural springs, open reservoirs, final effluent ponds and contaminated ponds. Frequency was determined on the basis of a preliminary radiological pathways analysis; i.e., potable water weekly, supply wells monthly, etc. Samples were collected in 1-liter glass containers. All samples were analyzed for gross beta and tritium concentrations, and were screened for gross gamma. Plutonium analyses were performed on a quarterly basis.

A 500-ml aliquot was taken from the original sample and counted in a Nalgene bottle for gross gamma activity in a NaI well crystal. A 5-ml sample was aliquoted and subjected to tritium analysis via liquid scintillation. The remainder of the original sample was evaporated to 15 ml, transferred to a stainless steel counting planchet, and evaporated to dryness after the addition of a wetting agent. Beta counting was accomplished as described in Section 1 except that the water samples were counted for 100 minutes. Nominal MDL's were: (1) gross gamma, 6×10^{-8} μCi/ml; (2) tritium, 1×10^{-7} μCi/ml; and (3) gross beta, 5×10^{-10} μCi/ml.

For the quarterly plutonium analysis, an additional 1-liter sample was collected. The radiochemical procedure was similar to that described in Section 1. As mentioned, alpha spectroscopy was used to measure any ^{239}Pu. The typical MDL for this procedure was 1×10^{-11} μCi/ml.

3. Gamma Monitoring (TLD)

TLD's were located at 139 stations on the NTS to measure the external gamma radiation from the environment. These locations were chosen to: (1) provide a low level control type network; (2) provide an arc coverage for the nuclear testing program; (3) measure the residual activity from the atmospheric testing program; and (4) document the radiological conditions at the radioactive waste management sites (RWMS).

The dosimeters used were CaF_2:Dy (TLD-200) 1/4" X 1/4" X 0.035" chips from Harshaw Chemical Company. A badge consisting of at least two chips shielded by 0.047" cadmium (1030 mg/cm^2) inside a 0.050" black plastic (140 mg/cm^2) holder was placed about one meter above the ground at each location. The dosimeters detected gamma radiation above an energy cutoff of approximately 70 keV. The known systematic errors of the dosimeter in this application were the minimized detection of lower energy photons and fade of the phosphor's stored energy with time. Previous research indicated that only about 5-10% of the total exposure from natural background was from gamma emitters below 150 keV (Reference 5). For this system, a five percent increase in the measured value has been appropriate in field determinations. In locations where the spectrum differed appreciably in the lower energy range, LiF TLD's were used in conjunction with the CaF_2:Dy TLD's. These dosimeters, although not preferable for environmental applications because of their low sensitivity, provided a secondary system that detected the lower energy photons (the energy response curve was flat to about 10 keV).

Fade in TLD-200 can be high when used in elevated temperatures such as those encountered at certain NTS locations. This loss of the phosphor's stored energy was minimized both physically and analytically by the REECo dosimetry group. Before readout, the chips were annealed at 115^{o}C for 15 minutes to reduce the high-fade, low temperature traps. Calibration TLD's were stored in a lead pig to empirically determine the value of this minimized fade (usually less than 10 percent).

Random errors included dosimeter variance, source calibration, and transit exposure. One method of error analysis was contained in a paper by Burke and Gesell, "Error Analysis of Environmental Radiation Measurements Made with Integrating Detectors," NBS Special Publication 456, pp. 187-198, (1976), (Reference 6). For our purposes, a less rigid statistical evaluation was sufficient. All analyses are being evaluated as to their compliance with ANSI N545-1975, "American National Standard Performance, Testing, and Procedural Specification for Thermoluminscent Dosimetry (Environmental Applications)" (Reference 7).

The evaluations of the Fourth International Intercomparison of Environmental Dosimeters were completed in CY-1979. Three types of exposures were done for the dosimeters and the REECo results were quite accurate.

	Reference Dose	REECo (CaF_2:Dy + LIF Average)	Error
Field	14.1	14.25	+1%
Laboratory Low	12.2	12.55	+3%
Laboratory High	45.8	43.55	-5%

4. Data Treatment

Each set of data obtained from this program underwent a thorough inspection as to its accuracy. Not only is the data analyzed automatically by computer, it is also verified by the REECo Environmental Sciences Department (ESD) personnel on a separate calculator before completion. If serious differences were found from the expected value, a review of the field handling, sample preparation, and processing was done. On the occasions when the problem could not be resolved by an environmental analyst a recount or second sample was secured.

All data were plotted on a daily basis or listed in tabular form. This treatment facilitated the data review process and revealed trends or periodicity in the radioactivity. Each station's data were plotted against a logarithmic axis because of the possible magnitudes of variation in environmental data. The averaging plots in each section show arithmetic means and the range of data at each point. Arithmetic means, although severely affected by outliers (suspicious data), were those values compared to the CG's and listed in all tables. The plots provided reassurance to the means by graphically demonstrating the data file.

In this program, the value used to check for inaccuracies, trends, or periodicity was the central tendency of the plots. This statistic showed the center of the data file with a strong resistance to outliers and allowed the judgement of the analyst to be imposed upon the system. Any suspected radiation excesses were checked against the station's central tendency and prior measures of dispersion.

Dispersion of the laboratory results was evaluated continuously. Samples were recounted and the percent differences between the original and the second count described the variance of the counting system. When these checks indicated a problem, the systems were reviewed. The Median Absolute Deviation (MAD) was the statistic used to evaluate new data relative to prior measurements. The MAD was highly resistant to the outliers of environmental data, and was valuable in the measurement of station-to-station variations and laboratory quality.

D. RADIOACTIVITY IN AIR

Ambient air monitoring was performed at the 34 locations shown in Figures 2 and 3. Of these 34 locations, twenty-seven stations (numbered 1 through 28, 30, 31, and 45) were sampled continuously over the entire report period. The remaining locations were installed in May and November, and were sampled until the end of the year. These new stations were:

Area 3 U3ax South
Area 3 U3ax East
Area 3 U3ax North
Area 3 U3ax West
Area 7 UE7ns
Area 15 EPA Farm
Area 23 Bldg. 790 #2

The computer plotted displays of the gross beta and plutonium activities for the entire air surveillance network are presented in Appendix A. In the first plot, the thirty-four weekly values were arithmetically averaged to show a smoothed presentation of the changes in airborne radioactivity over the surveillance period. The data ranges are included for each of these points. The remaining plots in Appendix A depict the actual measurements at each station.

Figures 2 and 3 summarize the CY-1979 gross beta and plutonium-239 yearly locational averages. Tables 4 and 5 list those yearly averages along with the half-year averages. In previous years, the gross beta measurements have been the more important environmental indicators. Since no reported or detected nuclear atmospheric testing occurred in CY-1979, this system demonstrated only the minimal effects of the CY-1978 foreign tests. Table 4 shows that all of the stations measured slightly higher gross beta activity during the first six

NTS ENVIRONMENTAL SURVEILLANCE

AIR SAMPLING STATIONS

(GROSS BETA YEARLY AVERAGES x 10^{-14} μ Ci/cc)

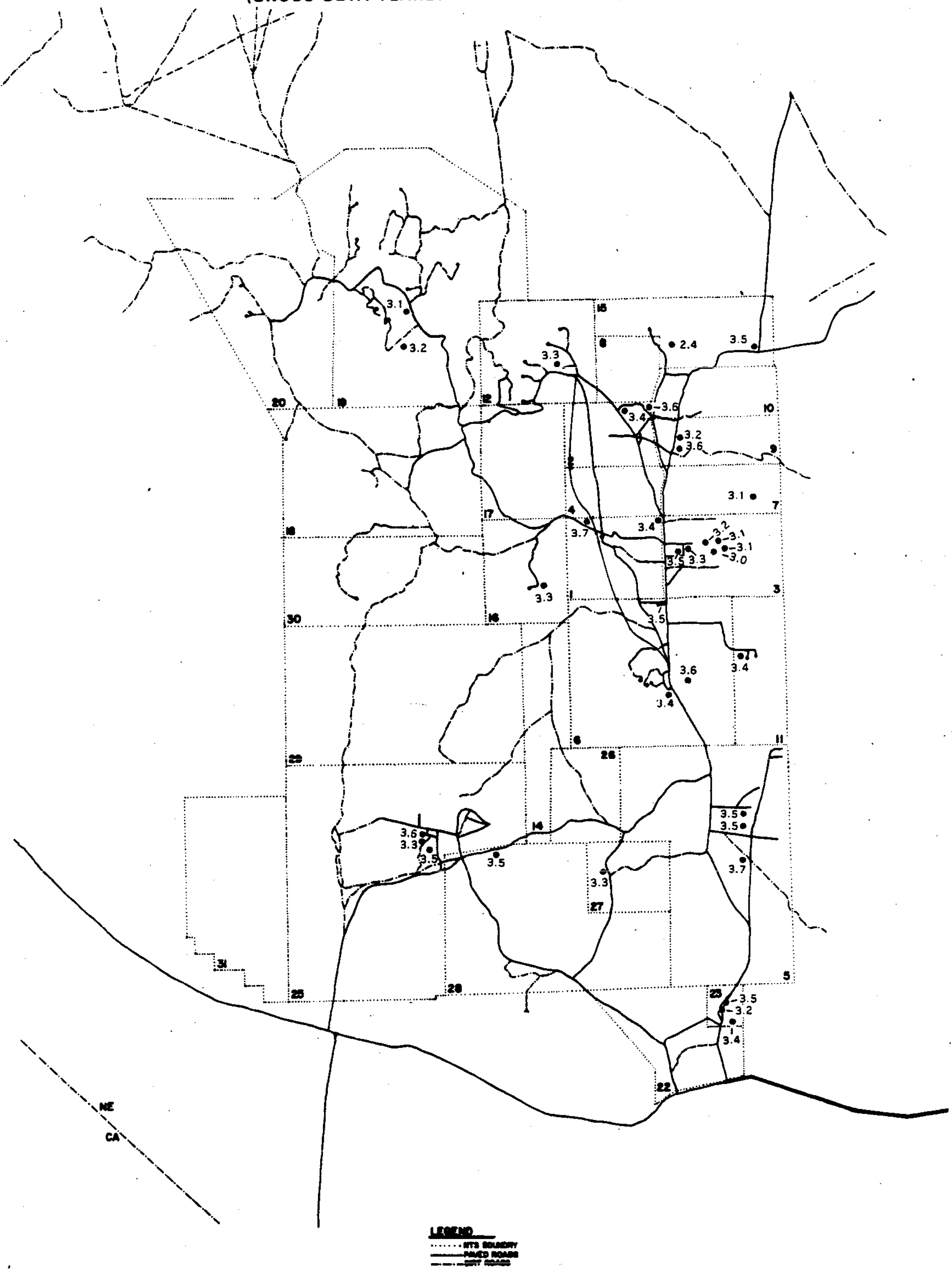


Figure 2

NTS ENVIRONMENTAL SURVEILLANCE

AIR SAMPLING STATIONS

(Pu-239 YEARLY AVERAGES x 10^{-17} μ Ci/cc)

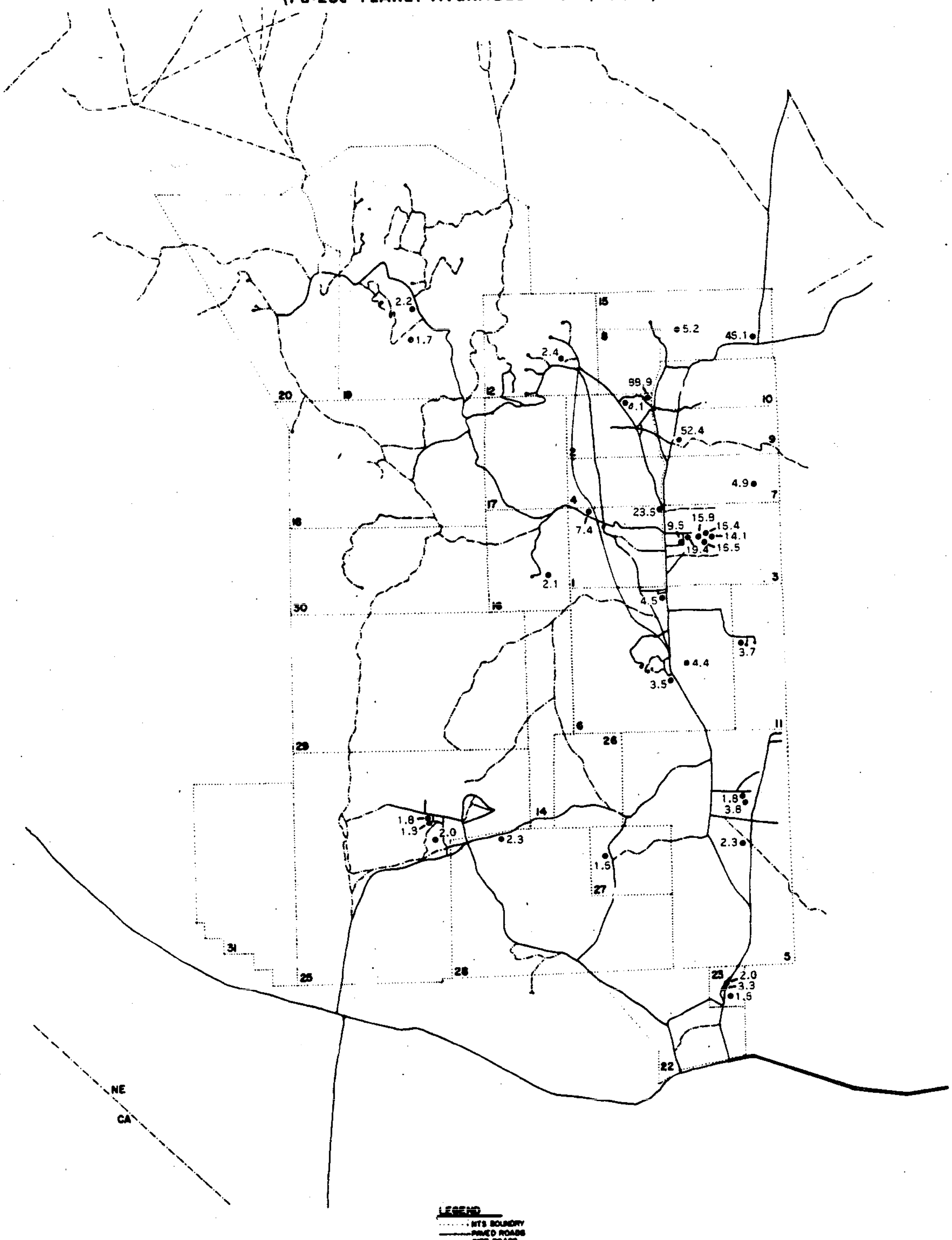


Figure 3

TABLE 4

AVERAGES OF AIR SURVEILLANCE DATA FOR GROSS BETA

($\times 10^{-14}$ μCi/cc)

Station	1/1/79-6/30/79	7/1/79-12/31/79	1/1/79-12/31/79
Area 1 Gravel Pit	4.5	2.9	3.7
Area 2 Compound	3.8	2.9	3.4
Area 3 Cafeteria	3.9	3.1	3.5
Area 5 DOD Yard	3.9	3.2	3.5
Area 5 Well 5B	3.9	3.4	3.6
Area 6 Yucca Complex	4.1	3.1	3.6
Area 6 CP Complex	3.9	3.0	3.4
Area 6 Well 3 Complex	3.9	3.1	3.5
Area 9 9-300 Bunker	4.1	3.0	3.6
Area 15 Gate 700	4.3	2.9	3.5
Area 11 Gate 293	3.8	3.0	3.4
Area 12 Changehouse	3.8	2.7	3.3
Area 16 Substation	3.9	2.7	3.3
Area 19 Echo Peak	3.5	2.9	3.2
Area 19 Substation	3.6	2.6	3.1
Area 23 Bldg. 790	4.0	3.0	3.5
Area 23 H&S Roof	4.1	2.8	3.4
Area 25 NRDS Warehouse	4.0	2.9	3.5
Area 27 Cafeteria	3.8	2.8	3.3
Area 28 Henre Site	4.1	2.9	3.5
Area 2 Cable Yard	4.2	3.1	3.6
Area 3 BJY	3.8	3.0	3.4
Area 3 3-300 Bunker	3.8	3.0	3.3
Area 5 RWMS	4.1	3.0	3.5
Area 23 Bldg. 790 #2	3.8	3.0	3.2
Area 25 E-MAD South	3.8	2.9	3.3
Area 25 E-MAD North	4.2	2.9	3.6
Area 3 U3ax South	4.3	2.9	3.0
Area 3 U3ax East	4.4	2.9	3.1
Area 3 U3ax North	4.2	2.8	3.1
Area 3 U3ax West	4.0	3.1	3.2
Area 7 UE7ns	4.5	2.8	3.1
Area 15 EPA Farm	--	2.4	2.4
Area 9 9-300 Bunker #2	3.8	2.7	3.2

TABLE 5

AVERAGES OF AIR SURVEILLANCE DATA FOR PLUTONIUM

($\times 10^{-17}$ $\mu Ci/cc$)

Station			1/1/79-6/30/79	7/1/79-12/31/79	1/1/79-12/31/79
Area	1	Gravel Pit	5.0	10.6	7.4
Area	2	Compound	4.5	3.5	4.1
Area	3	Cafeteria	10.5	8.3	9.6
Area	5	DOD Yard	1.7	2.0	1.8
Area	5	Well 5B	2.6	2.0	2.3
Area	6	Yucca Complex	4.2	4.7	4.4
Area	6	CP Complex	3.1	4.3	3.5
Area	6	Well 3 Complex	5.9	2.6	4.5
Area	9	9-300 Bunker	58.0	44.7	52.4
Area	15	Gate 700	38.9	57.0	46.1
Area	11	Gate 293	4.8	2.4	3.7
Area	12	Changehouse	2.3	2.5	2.4
Area	16	Substation	2.6	1.3	2.1
Area	19	Echo Peak	2.1	1.2	1.7
Area	19	Substation	2.4	2.0	2.2
Area	23	Bldg. 790	2.1	1.8	2.0
Area	23	H&S Roof	1.9	1.2	1.6
Area	25	NRDS Warehouse	2.6	1.2	2.0
Area	27	Cafeteria	2.0	1.1	1.6
Area	28	Henre Site	3.2	1.0	2.3
Area	2	Cable Yard	72.3	112.0	88.9
Area	3	BJY	19.5	29.4	23.6
Area	3	3-300 Bunker	16.2	23.8	19.4
Area	5	RWMS	4.9	2.2	3.8
Area	23	Bldg. 790 #2	2.5	3.9	3.3
Area	25	E-MAD South	2.2	1.1	1.8
Area	25	E-MAD North	2.1	1.4	1.8
Area	3	U3ax South	22.6	12.8	16.5
Area	3	U3ax East	18.3	11.6	14.1
Area	3	U3ax North	25.4	11.9	16.4
Area	3	U3ax West	25.0	12.2	15.8
Area	7	UE7ns	8.5	3.5	4.9
Area	15	EPA Farm	--	5.2	5.2

months of CY-1979. For the stations that ran during the entire year, the average gross beta concentration for the first six months of CY-1979 was 4.0 X 10^{-14} μCi/cc. This was 0.004 percent of the concentration guide for controlled areas as listed in Manual Chapter 0524, Annex A (assuming ^{90}Sr to be the most radiotoxic beta emitter present). During the second six months of CY-1979, the network average dropped to a 2.9 X 10^{-14} μCi/cc, very nearly the baseline level detected in years of non-testing. No fission products were detected at any time by the gamma spectroscopy system. All stations detected equivalent concentrations of gross beta activity, indicating that there were no measurable NTS related releases of beta radiation during CY-1979.

Table 5 lists the plutonium-239 concentrations for the year. All stations averaged below 10^{-15} μCi/cc for CY-1979, with the majority being on the order of 10^{-17} μCi/cc. The highest activity was found at the Area 2 Cable Yard; the average activity at this location was 8.9 X 10^{-16} μCi/cc, or 0.04 percent of the controlled area CG of 2 X 10^{-12} μCi/cc. Figure 3 shows the ^{239}Pu yearly results at their respective locations. This map highlights the areas of plutonium contamination. The radioactivity is primarily due to tests conducted before 1960 in which nuclear devices were detonated with high explosives (safety shots). These tests spread low-fired plutonium throughout the eastern and northeastern areas of the NTS. Two decades later, the effects of these tests were demonstrated in increased plutonium concentrations in air in Areas 1, 2, 3, 7, 8, 9, 10, and 15.

The Area 3 cafeteria and the Area 2 compound demonstrated lower plutonium concentrations than expected. It was believed that the placement of these samplers (near buildings) had much to do with the decreased detection of resuspended plutonium. The four stations at U3ax in Area 3 verified the precision of the plutonium detection system. The yearly averages of each station are equivalent and the data, as plotted in Appendix A, are very consistent.

The overall network average plutonium concentration in air was shown to increase during the mid-year months of CY-1979 (see Appendix A, plot of the network averages). Since this effect was also seen in CY-1978, and these two years were the most accurate data available, an investigation was performed. Ten stations which displayed elevated plutonium concentrations also correlated well with regions of high plutonium levels in soil. The peaking in the mid-year months was accentuated in these stations. The June to January ratio of these ten stations was ~70 to 1. It is believed that the resuspension of the plutonium in the soil of these areas would be directly related to the dryness of the soil and the average wind speed. This would correlate to the description of the mid-year months of the year at the NTS; i.e., dry and windy. Past data from the Plutonium Ad Hoc Committee of the Nevada Applied Ecology Group has been investigated, and this effect was indicated in the earlier reports.

Using the pathways analysis developed in Reference 8, the total lung dose to personnel living at the Area 2 Cable Yard from the plutonium-239 concentrations would be approximately 3.5 mrem/yr.

Although tritium in air data were collected, it was currently being re-evaluated at the time of publication. It will be reported together with next year's report.

E. RADIOACTIVITY IN SURFACE AND GROUND WATER

The principal water distribution system on the NTS consists of thirteen supply wells, eight potable water stations, and fifteen open reservoirs. The wells feed directly to many of the reservoirs and the drinking water was pumped from the wells to the points of consumption. While the air surveillance network consisted of thirty-four stations measuring one general atmospheric radioactivity, results from the water stations would only correspond where there was direct "communication" of fluid. This was the critical pathway for the ingestion of waterborne radionuclides, so the system was sampled and evaluated as a special monitoring program. All drinking water was collected weekly to provide a constant check of the end use activity and to allow frequent comparisons to the radioactivity of the water in the wells. This also created a large data base to evaluate long-term trends or intermittent changes in activity. The supply wells and open reservoirs were collected on a monthly schedule. The identification of any radionuclides above natural background in this system initiated a closer review of the drinking water.

The other water systems monitored onsite were the natural springs, contaminated ponds, and effluent ponds. The springs were collected monthly. The contaminated and effluent ponds were collected on non-routine schedules because of limitations in the amount of water at each location.

NTS ENVIRONMENTAL SURVEILLANCE

SUPPLY WELL SAMPLING STATIONS

(GROSS BETA YEARLY AVERAGES x 10^{-9} μCi/ml)

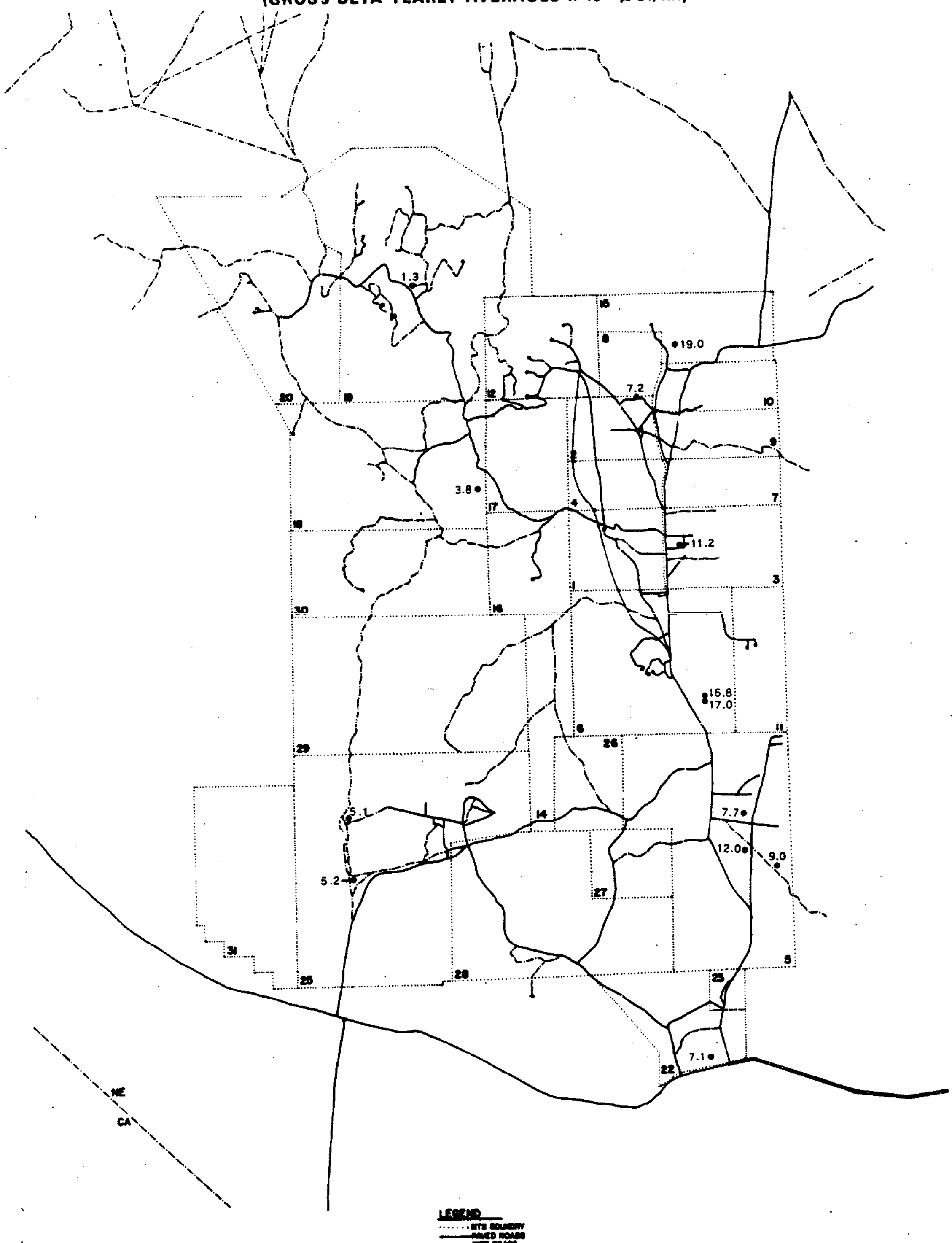


Figure 4

1. <u>Supply Wells</u>

Water from thirteen supply wells was used for a variety of sanitary and industrial purposes. The criteria for collection was primarily based on potential for human consumption. The yearly gross beta averages are shown at their respective locations in Figure 4. Appendix B consists of the plots of each station for measured gross beta activity with 2σ error bars. An averaging plot is included which shows the trend of the mean of the network throughout the reporting period. The range at each point is also given. Table 6 lists the 1979 averages for each location. The highest average recorded was 1.90×10^{-8} μCi/ml at Well Ue15d. This was a 0.2 percent of the CG assuming ^{90}Sr to be the most radiotoxic beta emitter present. The lowest average gross beta activity for the onsite supply wells was 1.3×10^{-9} μCi/ml at Well U19c.

The activities of each well and the entire network average appeared consistent over this report period. No trends in the plots were discernible, verifying that no movement of radionuclides occurred in this NTS water system. The average of the entire network, as compared to averages from a previous report (Reference 9), was:

Year	Mean ($\times 10^{-9}$ μCi/ml)
CY-1979	9.4
CY-1978	9.1
July-December 1977	10.9
FY-1977	10.4
FY-1976	9.1

TABLE 6

AVERAGES OF SUPPLY WELL DATA FOR GROSS BETA

Station	Gross Beta Yearly Average ($\times 10^{-9}$ μCi/ml)
Area 2 Well 2	7.2
Area 3 Well A	11.2
Area 5 Well 5B	12.0
Area 5 Well 5C	9.0
Area 5 Well Ue5c	7.7
Area 6 Well C	16.8
Area 6 Well C1	17.0
Area 15 Well Ue15d	19.0
Area 18 Well 8	3.8
Area 22 Army Well #1	7.1
Area 25 Well J12	5.2
Area 25 Well J13	5.1
Area 19 Well U19c	1.3

The most significant study accomplished with this network's data file, was an investigation of the correlation of gross beta results to a laboratory chemical analysis for cations. The naturally-occurring beta emitter, potassium, was found to be the cation of interest in this water system. The beta emitting isotope of potassium, ^{40}K, which occurs 0.012 percent of the time in nature, was shown to be the primary source of radioactivity in the NTS supply wells. Figure 5 graphically displays the relationship for the primary waters onsite. A linear regression from the supply well data obtained the following equation: Gross Beta=[0.79 + 1.27 (potassium in mg/liter)] X 10^{-9} µCi/ml. The correlation coefficient was 0.952. Therefore, the variation of gross beta results in NTS water was principally dependent upon potassium, or more specifically, the beta emitter ^{40}K.

Calculations of the specific activity associated with the amount of ^{40}K in this water was determined using Reference 10. The results of these calculations were the basis for the solid line shown in Figure 5.

$$N\lambda = A$$

where: N = Number of radioactive atoms per unit mass (1mg)
λ = Decay constant
A = Activity

$$N = \frac{(0.001\ g)(N_0)(a)}{(\text{Atomic Mass})}$$

where: N_0 = Avogadro's number
a = ^{40}K abundance

$$\lambda = \frac{\text{Ln } 2}{(1.26 \times 10^9)(365.25)(1440)}$$

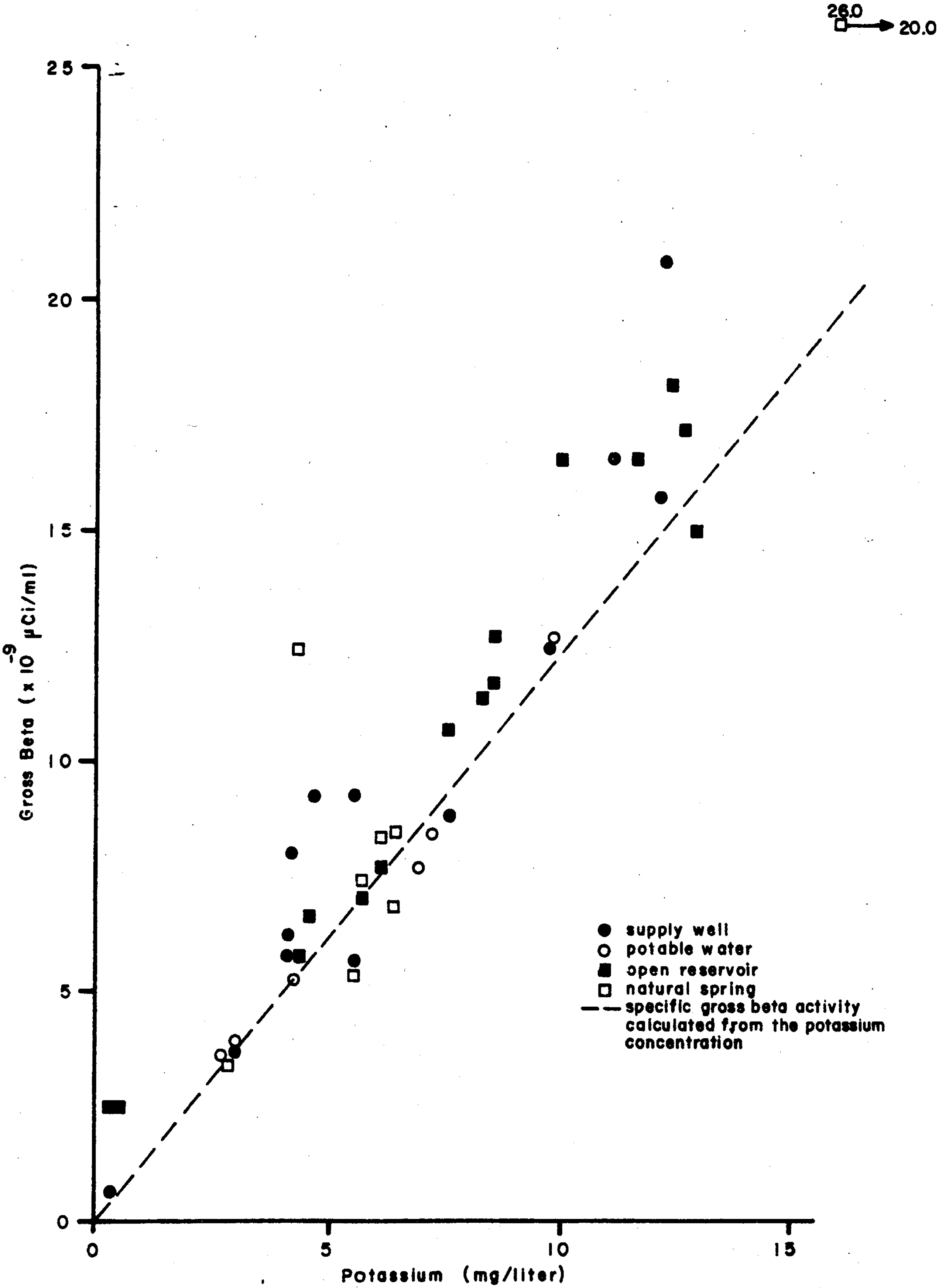


FIGURE 5 WATER RADIOACTIVITY vs. POTASSIUM CONCENTRATION

$$\text{Thus, } A(\text{dpm}) = \frac{(0.001)(N_0)(a)(\text{Ln } 2)}{(1.26 \times 10^9)(365.25)(1440)(\text{Atomic Mass})}$$

$$A(\mu\text{Ci}) = \frac{(0.001)(6.0225 \times 10^{23})(1.18 \times 10^{-4})(0.69315)}{(1.26 \times 10^9)(365.25)(1440)(39.1)(2.22 \times 10^6)}$$

$$A = 1.23 \times 10^{-6} \ \mu\text{Ci/mg(potassium)}$$

$$A = 1.23 \times 10^{-9} \ \mu\text{Ci/ml per mg/liter}$$

The calculated activity of 1.23×10^{-9} µCi/ml per mg/liter correlated well with 1.27×10^{-9} µCi/ml per mg/liter from the linear regression analysis of the supply well data. This demonstrated conclusively that naturally-occurring potassium was the determining factor of the radioactivity in the NTS water. No other radionuclides could give rise to more than ten percent of the measured gross beta activity.

Appendix B includes plots of the network monthly averages for tritium and plutonium. They are presentations of the detection limits of each system because there were no plutonium positives and only two tritium positive during the report period. The highest tritium value was 1.96×10^{-6} µCi/ml at Well J-13 and the subsequent measurements dropped to below the detection limit immediately. Each positive was assumed to be a fluctuation of the counter.

2. Potable Water

As a check of any effect the water distribution system might have on end use activity, eight consumption points were sampled during the reporting period. The locations of all station are shown in Figure 6 with their gross beta yearly averages.

Appendix C contains the computer plots of the measured gross beta activity with the 2σ error bars included. An average plot is provided which shows the trend of the mean of the network throughout the reporting period along with the range at each point. Table 7 contains a list of the average gross beta measured at each sample location for the calendar year 1979. The highest average recorded was 1.24×10^{-8} μCi/ml at the Area 6 Cafeteria. This was 4.1 percent of the CG for drinking water assuming ^{90}Sr to be the most radiotoxic beta emitter present. The lowest gross beta activity, excluding Cascade bottled water, was 3.72×10^{-9} μCi/ml at the Area 12 Cafeteria. The Cascade water was demineralized water brought in from offsite and was used as a check of the laboratory system. It was included in the results listing because the bottles were stored onsite and the water was consumed by NTS personnel.

Gross beta measurements at these potable water stations demonstrated that no release or movement of radionuclides occurred in the NTS water system throughout CY-1979. No discernible trends were seen on the plotted data. The average of the entire network, as compared to averages reported in a previous environmental report, was:

NTS ENVIRONMENTAL SURVEILLANCE

POTABLE WATER SAMPLING STATIONS

(GROSS BETA YEARLY AVERAGES x 10^{-9} μCi/ml)

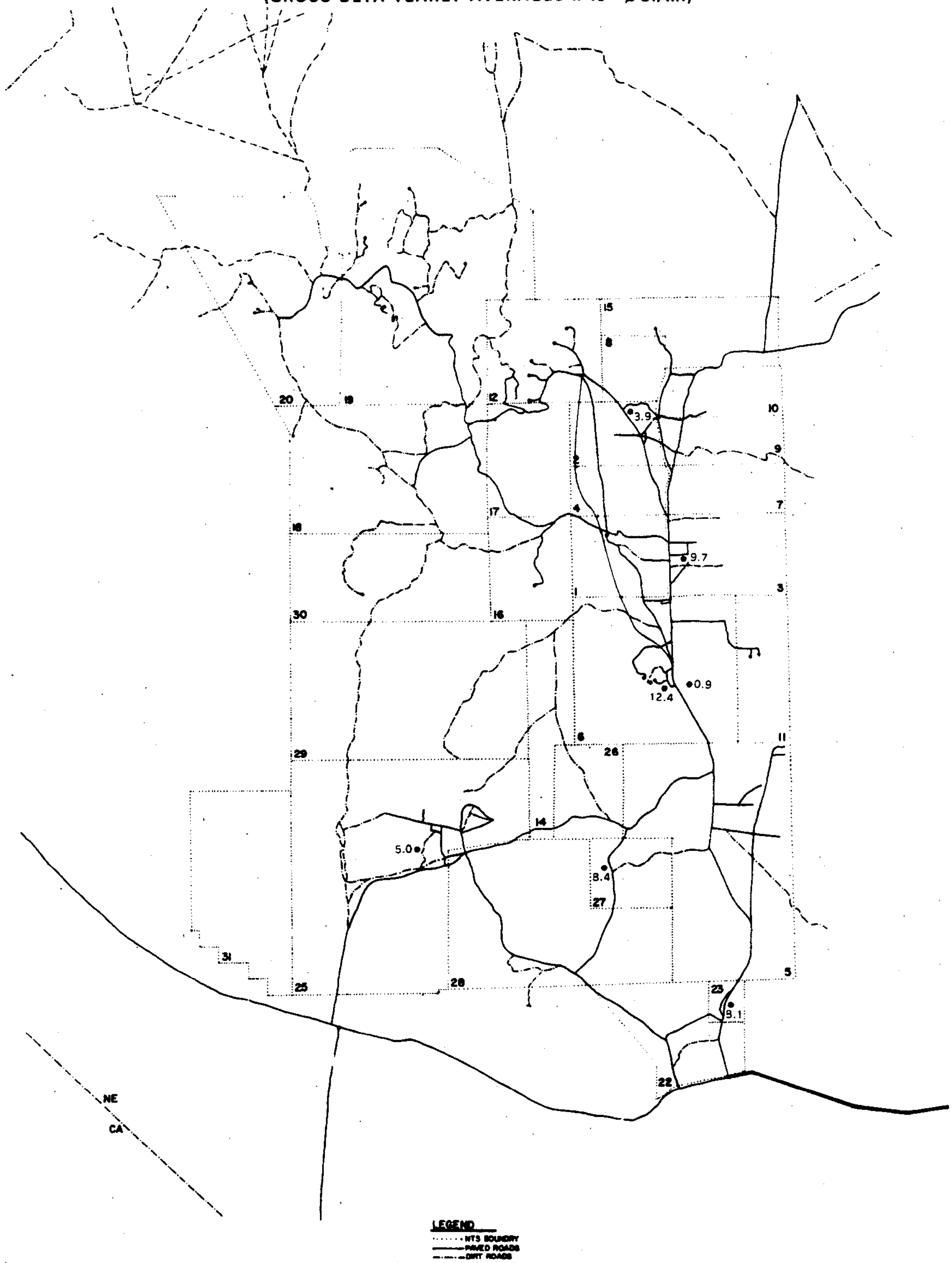


Figure 6

TABLE 7

AVERAGES OF POTABLE WATER DATA FOR GROSS BETA

Station	Gross Beta Yearly Average ($\times 10^{-9}$ $\mu Ci/ml$)
Area 2 Restroom	3.9
Area 3 Cafeteria	9.7
Area 6 Cascade Water	0.9
Area 6 Cafeteria	12.4
Area 12 Cafeteria	3.7
Area 23 Cafeteria	8.1
Area 27 Cafeteria	8.4
Area 25 Service Station	5.0

Year	Mean ($\times 10^{-9}$ μCi/ml)
CY-1979	6.5
CY-1978	6.7
July-December 1977	7.8
FY-1977	7.3
FY-1976	7.4

All potable water except Cascade bottled water was obtained from the supply wells. A comparison of these waters and their suppliers is shown in Table 8. As shown in the previous section, the majority of radioactivity in supply well water and, therefore, in potable water was from the naturally-occurring potassium. Figure 5 showed this graphically. The potable water results lie very close to the line calculated from the specific activity of the associated potassium results. The linear regression of the potable water data was: Gross Beta=[-0.05 + 1.27 (potassium in mg/liter)] X 10^{-9} μCi/ml. The correlation coefficient was 0.998.

Appendix C also includes the plots of the network averages for tritium and plutonium. As in the case of the supply well data, these plots are primarily presentations of the detection limits of the analysis system because there were no positive plutonium results and only five positive tritium values during the report period. All of the tritium values were less than 9 X 10^{-7} μCi/ml and four were from the Cascade water samples

TABLE 8

COMPARISON OF END USE AND SUPPLY WATER

FOR GROSS BETA AVERAGES

($\times 10^{-9}$ μCi/ml)

Station (end use/supply)	CY-1979
Area 2 Restroom	4.28
Area 18 Well 8	3.88
Area 3 Cafeteria	9.27
Area 3 Well A	9.58
Area 6 Cascade Water	0.97
(Demineralized Bottled Water)	--
Area 6 Cafeteria	11.50
Area 6 Well C/C1	14.80/16.20
Area 12 Cafeteria	4.13
Area 18 Well 8	3.88
Area 23 Cafeteria	8.19
Area 5 Well 5B/5C	12.80/7.58
Area 22 Army Well #1	6.98
Area 27 Cafeteria	8.24
Area 5 Well 5B/5C	12.80/7.58
Area 22 Army Well #1	6.98

after the detection limit of the counting system was improved to approximately 1×10^{-7} μCi/ml. Further investigation of these values has concluded that they were truly above the detection limit; i.e., positive tritium concentrations. It was believed to be due to tritium in the air in the Cascade water storage area.

3. Open Reservoirs

Open reservoirs have been established at various locations on the NTS for industrial purposes. Fifteen of these impoundments were sampled during the report period. The locations are shown in Figure 7 along with their gross beta yearly averages.

Appendix D consists of the plots of each station of the measured gross beta activity with 2σ error bars. An averaging plot is included which shows the trend of the mean of the entire network throughout the reporting period. The range at each point is also given. These plots demonstrate consistent concentrations of gross beta activity at all locations throughout CY-1979.

Flat trends were seen for the network, although the data were more variable than the supply well data. The large variation could have been caused by real activity fluctuations or, simply, more variable sampling procedures.

NTS ENVIRONMENTAL SURVEILLANCE

OPEN RESERVOIR SAMPLING STATIONS

(GROSS BETA YEARLY AVERAGES x 10^{-9} μ Ci/ml)

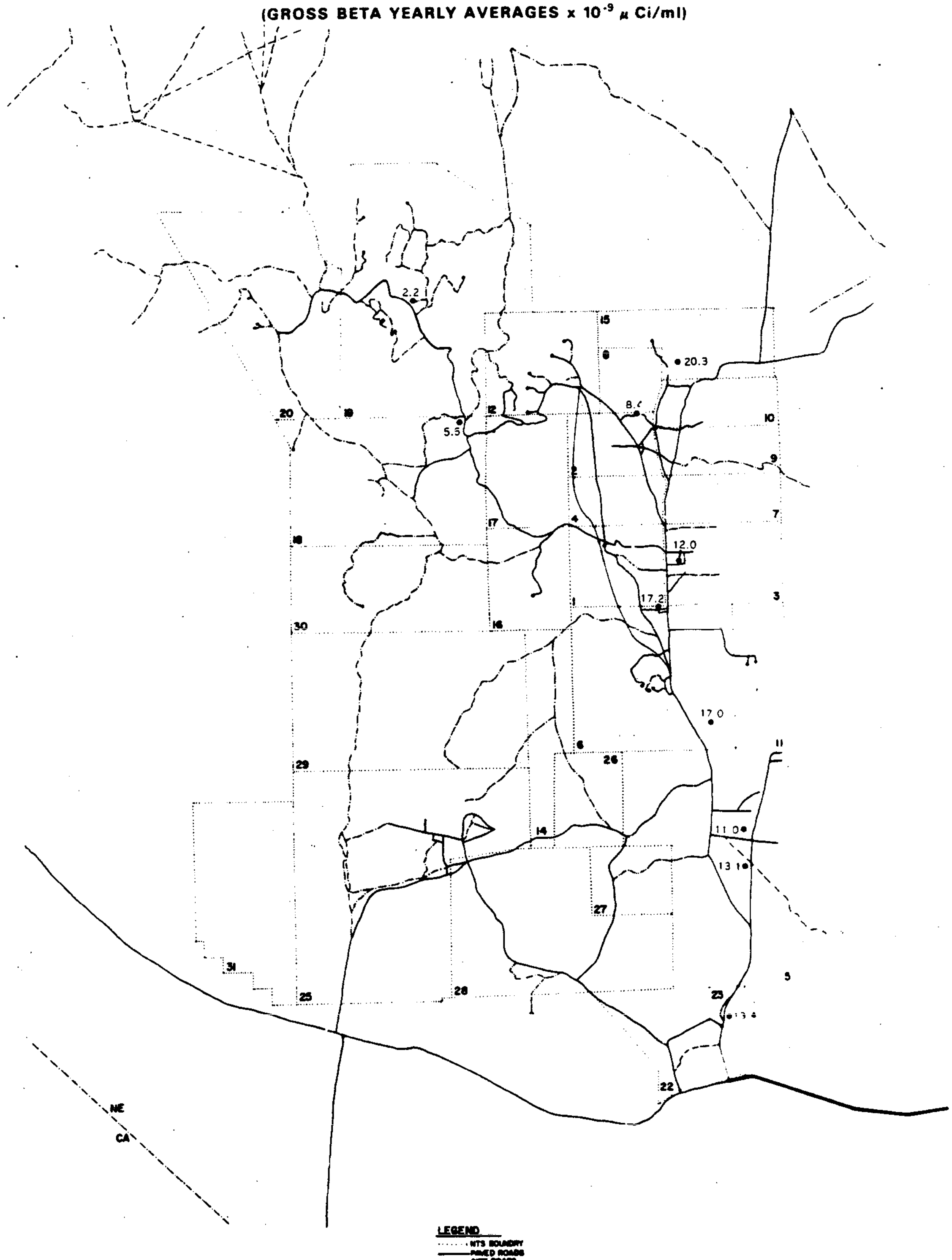


Figure 7

Table 9 includes a list of the CY-1979 gross beta averages at each location. The highest beta content was 2.03 X 10^{-8} μCi/ml at Well Ue15d Reservoir. This result was 0.2 percent of the conservative concentration guide proposed in Section E.1. The lowest gross beta average was 2.2 X 10^{-9} μCi/ml at Well U19c Reservoir.

Table 10 shows the gross beta activities of the open reservoirs that were supplied by wells, along with the activities of the associated wells. The values for the reservoirs were similar to the suppliers, although consistently higher than the wells. The explanation for this was that these surface waters were open to worldwide fallout and were also more likely to increase in total dissolved solids through evaporation. The average of the entire open reservoir network, as compared to averages from a previous report, was:

Year	Mean (X 10^{-9} μCi/ml)
CY-1979	10.9
CY-1978	13.1
July-December 1977	19.4
FY-1977	19.6
FY-1976	22.0

The decrease in the mean was primarily due to the addition of five stations of lower gross beta content. As shown in the supply well section, the majority of the radioactivity in the water of the supply wells and, therefore, in the open reservoirs was from the naturally-occurring potassium. The results from the reservoirs do lie above the calculated potassium line, as shown in Figure 5, in most instances. These

TABLE 9

AVERAGES OF OPEN RESERVOIR DATA FOR GROSS BETA

Station	Gross Beta Yearly Average (X 10^{-9} μCi/ml)
Area 2 Well 2 Reservoir	8.4
Area 3 Well A Reservoir	12.0
Area 5 Well 5B Reservoir	13.1
Area 5 Well Ue5c Reservoir	11.0
Area 6 Well 3 Reservoir	17.2
Area 6 Well C1 Reservoir	17.0
Area 15 Well Ue15d Reservoir	20.3
Area 18 Camp 17 Reservoir	5.6
Area 20 Well 20A Reservoir	2.4
Area 23 Swimming Pool	13.4
Area 19 Well U19c Reservoir	2.2
Area 3 Mud Plant Reservoir	12.8
Area 2 Mud Plant Reservoir	5.9
Area 25 Well J-11 Reservoir	5.9
Area 18 Well 8 Reservoir	16.4

Table 10

COMPARISON OF OPEN RESERVOIRS AND SUPPLY WATER FOR GROSS BETA AVERAGES

($X\ 10^{-9}\ \mu Ci/ml$)

Station (Reservoir/Supply)	CY-1979
Area 2 Well 2 Reservoir	8.4
Area 2 Well 2	7.2
Area 3 Well A Reservoir	12.0
Area 3 Well A	11.2
Area 5 Well 5B Reservoir	13.1
Area 5 Well 5B	12.0
Area 5 Well Ue5c Reservoir	11.0
Area 5 Well Ue5c	7.7
Area 6 Well C1 Reservoir	17.0
Area 6 Well C1	17.0
Area 15 Well Ue15d Reservoir	20.3
Area 15 Well Ue15d	19.0
Area 19 Well U19c Reservoir	2.2
Area 19 Well U19c	1.3

cases seem to be evidence for the theory of increased dissolved solids and worldwide fallout for open bodies of water.

Appendix D also includes the plots of the network averages for tritium and plutonium. As in the case of the supply well data, these plots are presentations of the detection limits of the analysis system because there were no positive plutonium results and only two tritium positives during the report period. The highest positive tritium value, 7.41×10^{-7} μCi/ml at Well Ue15d Reservoir, dropped to below detection limit immediately as did the other value, and they were assumed to be a statistical variations of the counting system.

4. Natural Springs

The term "natural springs" was a label given to the spring-supplied pools located within the NTS. Human consumption was insignificant. Nine such locations were sampled on a monthly basis or when accessible, and are shown in Figure 8 along with their gross beta yearly averages. A new station, Tippipah Spring, was added this year.

Appendix E consists of the plots of all stations of the measured gross beta activity with 2σ error bars. An averaging plot is included which shows the trend of the network mean throughout the reporting period. The range at each point is also given. Table 11 includes a list of the averages at each location. The highest average recorded was 8.93×10^{-8} μCi/ml at White Rock Spring. This was 0.6 percent of the CG assuming ^{90}Sr to be the most radiotoxic beta emitter present. The lowest beta activity was 3.8×10^{-9} μCi/ml at Tippipah Spring.

NTS ENVIRONMENTAL SURVEILLANCE

NATURAL SPRING SAMPLING STATIONS

(GROSS BETA YEARLY AVERAGES x 10^{-9} μCi/ml)

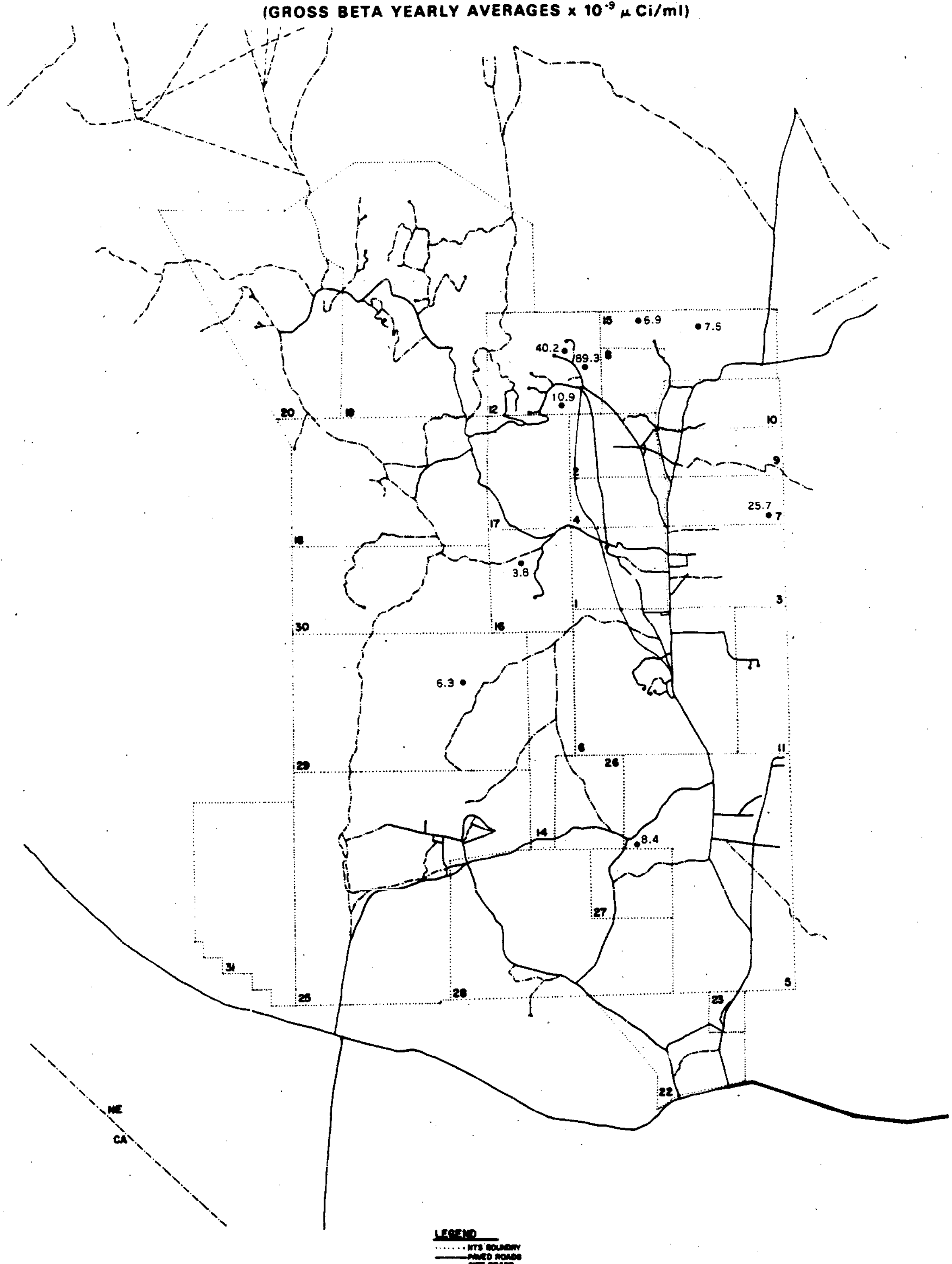


Figure 8

TABLE 11

AVERAGES OF NATURAL SPRINGS DATA FOR GROSS BETA

Station	Gross Beta Yearly Average ($\times 10^{-9}$ $\mu Ci/ml$)
Area 5 Cane Spring	8.4
Area 12 White Rock Spring	89.3
Area 12 Captain Jack Spring	10.9
Area 12 Gold Meadows Pond	40.2
Area 15 Oak Butte Spring	6.9
Area 15 Tub Spring	7.6
Area 29 Topopah Spring	6.3
Area 7 Reitmann Seep	25.7
Area 16 Tippipah Spring	3.8

The most significant gross beta results were found at the White Rock Spring. Highly variable, it has been demonstrated for several years that the substantial increases were due to surface runoff of contaminated soils after rains. This was shown by the cyclic nature of activity that was related to the rainy seasons. The region, Area 12, was exposed to fallout from atmospheric tests and the Baneberry release in 1970. The other locations showed no significant trends in their plots. White Rock Spring, Captain Jack Spring, and Reitmann Seep were all above the gross beta results calculated from their potassium concentrations as shown in Figure 5. This indicated that there were excess radionuclides in these waters. The Gold Meadows Spring, although quite high in gross beta content, fit the curve well; i.e., 40 mg/l (potassium) and 46 X 10^{-9} μCi/cc (gross beta). Urine from the wildlife utilizing this pond seemed to be the cause of this high potassium content.

The network average, as compared to those presented in a previous report, was:

Year	Mean (X 10^{-9} μCi/ml)
CY-1979	22.1
CY-1978	23.7
July-December 1977	24.4
FY-1977	15.2
FY-1976	14.6

NTS ENVIRONMENTAL SURVEILLANCE

CONTAMINATED POND SAMPLING STATIONS

(GROSS BETA YEARLY AVERAGES x 10^{-9} μ Ci/ml)

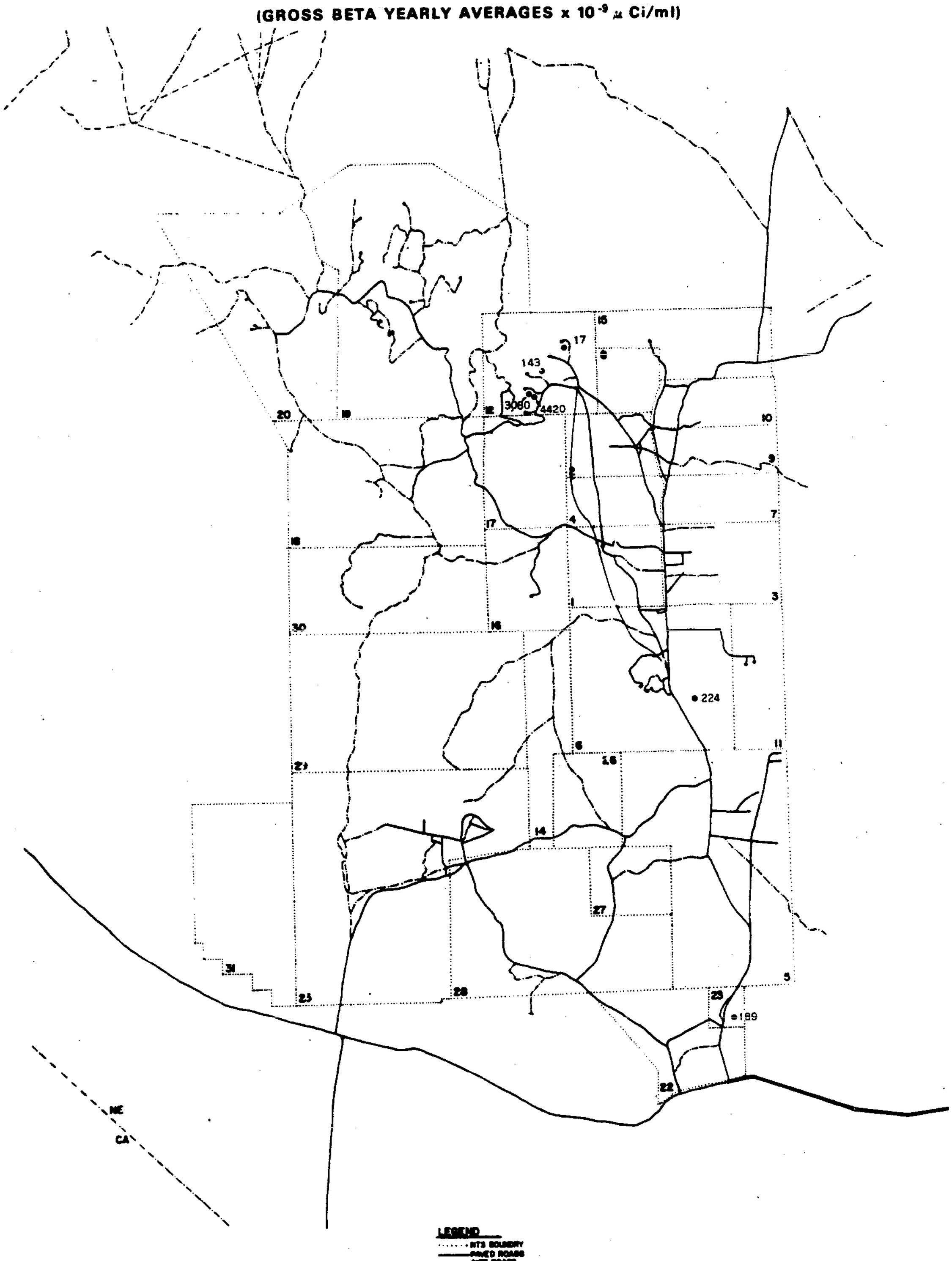


Figure 9

Appendix E includes plots of the network averages for tritium and plutonium. These plots are representations of the detection limits through time because no positive plutonium values and only two positive tritium were found. The highest tritium value was 9.48 X 10^{-7} μCi/ml at the Captain Jack Spring.

5. Contaminated Ponds

Six contaminated ponds were sampled on a special study basis. The locations are shown in Figure 9. These ponds were impound waters from tunnel test areas, a laboratory waste sump, and a contaminated laundry release point. They are monitored in accordance with Manual Chapter 0513 to provide a data base for calculations of any offsite releases. These calculations for tritium are reported to DOE Headquarters on an annual basis.

Table 12 is a list of the gross beta averages at the six active stations. The averages of the Haines Ponds decreased by a factor of about 20 during CY-1979 because of seepage into the ground. The N Upper Pond gross beta results also decreased by a factor of eight due to seepage into the sediment of the pond. The principal isotopes detected were ^{3}H, ^{137}Cs, and ^{239}Pu. The Mint Ponds and the H&S Sump averaged similar values to the 1978 results and the Yucca Decontamination Pond doubled the previous year's averages. The data was not plotted because of the irregularity of sampling.

6. Effluent Ponds

Samples from seven effluent pond locations were collected during CY-1979. These ponds are closed systems which contain both sanitary and radioactive waste for evaporative treatment. Contact with the working population was minimal. All tritium and plutonium analyses were negative and all gross beta measurements were within the applicable concentration guides.

TABLE 12

AVERAGES OF CONTAMINATED PONDS FOR GROSS BETA

Station	Gross Beta Yearly Average ($\times 10^{-9}$ μCi/ml)
Area 12 Haines #3	3080
Area 12 Haines Lower	4420
Area 12 Mint Upper	17
Area 12 N Upper	143
Area 23 H&S Sump	189
Area 6 Yucca Decontamination Pond	224

F. AMBIENT GAMMA MONITORING

A program to measure the ambient gamma exposure rates on the NTS was established in 1977 with 21 stations. In CY-1978, the program was expanded to 86 locations and, then in CY-1979, it was further expanded to a total of 139 stations. Table 13 lists the maximum, minimum, and average dose rates, and the adjusted annual dose for each monitoring station. The expansion was carried out for four aspects of the NTS environment: (1) additional measurement of dose rates in areas of elevated gamma activity; (2) coverage of the nuclear testing areas; (3) coverage of the RWMS locations; and (4) coverage of the mountainous borders of the NTS. Nine control-type stations from the 1977 network were retained for comparison to all new stations and for detection of any small variations in the general NTS background.

The nine locations that comprised the original control network demonstrated consistent data throughout the year and compared well to the 1977 and 1978 data. Table 14 summarizes these stations' average dose rates for the three years. The largest variance was only 0.02 mrem/d. The overall network range of these stations was 0.15 mrem/d to 0.35 mrem/d, with an average NTS background of approximately 0.26 mrem/d (95 mrem/yr). This corresponds favorably with rates measured at offsite Nevada locations by the Environmental Protection Agency (Reference 11).

TABLE 13
GAMMA MONITORING RESULTS - SUMMARY OF 1979

STATION (AREA)	MEASUREMENT PERIOD	DOSE RATE (mrem/d) MAX.	MIN.	AVG.	ADJUSTED ANNUAL DOSE (mrem/yr)
Angle Road (3)	01/12/79 - 1/11/80	2.07	1.91	2.01	730
Bldg. 190 (23)	07/17/79 - 1/11/80	0.16	0.14	0.15	55
Bldg. 610 Fence (23)	01/12/79 - 1/11/80	0.17	0.15	0.16	58
Bldg. 610 X-Ray Area (23)	07/17/79 - 1/11/80	11.30	4.10	7.70	2800
Bldg. 650 Dosimetry Room (23)	01/12/79 - 1/11/80	0.18	0.16	0.17	62
Bldg. 650 Roof (23)	01/12/79 - 1/11/80	0.16	0.14	0.15	55
Bldg. 650 Sample Storage (23)	01/12/79 - 1/11/80	1.51	0.80	1.20	440
B.J.Y. (3)	01/12/79 - 1/11/80	0.38	0.32	0.35	130
Cable Yard (2)	01/12/79 - 1/11/80	0.45	0.40	0.43	155
Cafeteria (3)	01/12/79 - 1/11/80	0.39	0.34	0.36	130
Cafeteria (27)	01/12/79 - 1/11/80	0.37	0.34	0.35	130
Circle & L Road (10)	04/04/79 - 1/11/80	0.46	0.40	0.43	155
Complex (12)	01/12/79 - 1/11/80	0.43	0.35	0.40	145
CP Complex (6)	01/12/79 - 1/11/80	0.62*	0.21*	0.21*	77
CP-50 Calibration Bench (6)	07/17/79 - 1/11/80	0.54	0.27	0.40	145
CP-50 Instrument Calib. Door (6)	07/17/79 - 1/11/80	0.96	0.50	0.73	265
CA-14 (10)	07/17/79 - 1/11/80	0.59	0.49	0.53	195
Decon Pad Front Office (6)	07/17/79 - 1/11/80	0.33	0.22	0.28	100
Decon Pad Back Office (6)	07/17/79 - 1/11/80	0.75	0.26	0.51	185
Desert Rock Weather Stn. (22)	01/12/79 - 1/11/80	0.19	0.16	0.17	60
E-MAD East (25)	01/12/79 - 1/11/80	0.33	0.30	0.31	115
E-MAD North (25)	01/12/79 - 1/11/80	0.79	0.62	0.71	260
E-MAD Tile Bed (25)	01/12/79 - 1/11/80	0.36	0.32	0.33	120
E-MAD West (25)	01/12/79 - 1/11/80	0.35	0.32	0.33	120
EPA Farm (15)	01/12/79 - 1/11/80	0.34	0.27	0.31	115
Gate 100 (23)	07/17/79 - 1/11/80	0.17	0.17	0.17	60
Gate 700 (15)	01/12/79 - 1/11/80	0.31	0.25	0.28	100
Gravel Pit (1)	01/12/79 - 1/11/80	0.34	0.29	0.32	115

*Maximum value was due to source nearby.
Normal background equals 0.21 mrem/d.

Table 13 (Continued)

STATION (AREA)	MEASUREMENT PERIOD	DOSE RATE (mrem/d) MAX.	MIN.	AVG.	ADJUSTED ANNUAL DOSE (mrem/yr)
Groom Pass L43.5 (15)	01/12/79 - 1/11/80	0.38	0.32	0.35	130
Henre Site (28)	01/12/79 - 1/11/80	0.34	0.31	0.33	120
Lamp Shack (15)	04/04/79 - 1/11/80	0.36	0.34	0.35	130
LLL Trailer (15)	04/04/79 - 1/11/80	0.44	0.40	0.42	155
Logistics Desk (6)	07/17/80 - 1/11/80	0.20	0.18	0.19	70
Lower Mint Lake (12)	01/12/79 - 1/11/80	1.49**	0.76**	1.49**	540
L-40 (15)	04/04/79 - 1/11/80	0.48	0.47	0.48	175
L-49 (15)	04/04/79 - 1/11/80	0.32	0.26	0.30	110
NRDS Warehouse (25)	01/12/79 - 1/11/80	0.35	0.32	0.33	120
Office (15)	04/04/79 - 1/11/80	0.28	0.27	0.27	100
Post Office (23)	01/12/79 - 1/11/80	0.16	0.15	0.15	55
Rainier Mesa Road-M150 (2)	01/12/79 - 1/11/80	0.42	0.34	0.38	140
Ramatrol (23)	07/17/79 - 1/11/80	0.32	0.28	0.30	110
RWMS East (5)	01/12/79 - 1/11/80	0.40	0.33	0.36	130
RWMS Gate (5)	01/12/79 - 1/11/80	0.52	0.41	0.46	170
RWMS North (5)	01/12/79 - 1/11/80	0.36	0.29	0.33	120
RWMS Southwest (5)	01/12/79 - 1/11/80	0.42	0.31	0.36	130
RWMS West (5)	01/12/79 - 1/11/80	0.38	0.35	0.35	130
Security Gate 293 (11)	01/12/79 - 1/11/80	0.48	0.37	0.43	155
Sedan Crater Visitor's Box (10)	01/12/79 - 1/11/80	0.76	0.63	0.69	250
Sedan Crater West Area (10)	01/12/79 - 1/11/80	4.18	3.43	3.80	1390
Storage Shed (15)	04/04/79 - 1/11/80	0.36	0.32	0.34	125
Substation Bus (15)	04/04/79 - 1/11/80	0.35	0.31	0.33	120
TH-1 (6)	04/04/79 - 1/11/80	0.22	0.21	0.21	75
TH-9 (6)	04/04/79 - 1/11/80	0.33	0.30	0.31	115
TH-18 (1)	04/04/79 - 1/11/80	0.28	0.25	0.26	95
TH-27 (1)	04/04/79 - 1/11/80	0.32	0.28	0.30	110
TH-37 (1)	04/04/79 - 1/11/80	0.37	0.34	0.35	130
TH-47 (4)	04/04/79 - 1/11/80	0.46	0.41	0.43	155
TH-57 (2)	04/04/79 - 1/11/80	0.29	0.28	0.29	105
TH-67.5 (12)	04/04/79 - 1/11/80	0.31	0.30	0.31	115
Upper Haines Lake No. 1 (12)	01/12/79 - 1/11/80	0.43	0.38	0.41	150
Upper N Tunnel Pond (12)	01/12/79 - 1/11/80	0.47	0.38	0.42	155
U3ax Northeast (3)	01/12/79 - 1/11/80	1.53	1.48	1.51	550

**Dosimeter location was moved on 7/17/79.
Background at the new location equals 1.49 mrem/d.

Table 13 (Continued)

STATION (AREA)	MEASUREMENT PERIOD	DOSE RATE (mrem/d) MAX.	MIN.	AVG.	ADJUSTED ANNUAL DOSE (mrem/yr)
U3ax Northwest (3)	01/12/79 - 1/11/80	0.85	0.68	0.79	290
U3ax South (3)	01/12/79 - 1/11/80	0.64	0.45	0.55	200
U3ax Southeast (3)	01/12/79 - 1/11/80	0.70	0.59	0.66	240
U3by North (3)	01/12/79 - 1/11/80	1.27	1.11	1.18	430
U3by South (3)	01/12/79 - 1/11/80	0.55	0.52	0.53	195
U3bz North (3)	01/12/79 - 1/11/80	0.78	0.74	0.76	280
U3bz South (3)	01/12/79 - 1/11/80	0.42	0.36	0.40	145
U3co North (3)	01/12/79 - 1/11/80	5.25	5.15	5.21	1900
U3co South (3)	01/12/79 - 1/11/80	3.05	2.97	3.03	1110
RADEX North *** (3)	01/12/79 - 1/11/80	0.51	0.45	0.48	175
RADEX South *** (3)	01/12/79 - 1/11/80	0.42	0.37	0.40	145
U3du North (3)	01/12/79 - 1/11/80	0.57	0.52	0.55	200
U3du South (3)	01/12/79 - 1/11/80	0.70	0.65	0.68	250
Well 3 (6)	01/12/79 - 1/11/80	0.32	0.28	0.31	115
Well 5B (5)	01/12/79 - 1/11/80	0.32	0.29	0.31	115
Yucca Complex (6)	01/12/79 - 1/11/80	0.31	0.28	0.30	110
2-04 Road (2)	01/12/79 - 1/11/80	9.75	6.93	8.07	2950
2-07 Road (2)	01/12/79 - 1/11/80	1.14	0.99	1.05	385
3-03, O.B. Roads (3)	01/12/79 - 1/11/80	0.24	0.22	0.24	88
4-04 Road (4)	01/12/79 - 1/11/80	10.30	8.95	9.81	3580
6-09, O.B. Roads (6)	01/12/79 - 1/11/80	0.39	0.33	0.35	130
7R 6 (7)	01/12/79 - 1/11/80	0.37	0.32	0.34	125
7-300 Bunker (7)	01/12/79 - 1/11/80	1.36	1.13	1.25	460
8K 25 (8)	01/12/79 - 1/11/80	0.36	0.28	0.31	115
9-300 Bunker (9)	01/12/79 - 1/11/80	0.44	0.34	0.39	140
10 A-24 (10)	04/04/79 - 1/11/80	1.23	1.10	1.16	420
18-1C Gate (18)	04/04/79 - 1/11/80	0.42	0.39	0.41	150
18P 35 (18)	01/12/79 - 1/11/80	0.44	0.36	0.40	145
18P 37 (18)	01/12/79 - 1/11/80	0.46	0.33	0.40	145
18P 39 (18)	01/12/79 - 1/11/80	0.44	0.33	0.38	140
19P 41 (19)	01/12/79 - 1/11/80	0.48	0.38	0.44	160
19P 44 (19)	01/12/79 - 1/11/80	0.43	0.35	0.40	145
19P 46 (19)	01/12/79 - 1/11/80	0.44	0.34	0.38	140
19P 49 (19)	01/12/79 - 1/11/80	0.44	0.32	0.38	140
19P 52 (19)	01/12/79 - 1/11/80	0.44	0.36	0.40	145

***Radiation exclusion area.

Table 13 (Continued)

STATION (AREA)	MEASUREMENT PERIOD	DOSE RATE (mrem/d) MAX.	MIN.	AVG.	ADJUSTED ANNUAL DOSE (mrem/yr)
19P 54 (19)	01/12/79 - 1/11/80	0.41	0.31	0.37	135
19P 56 (19)	01/12/79 - 1/11/80	0.46	0.32	0.41	150
19P 59 (19)	01/12/79 - 1/11/80	0.49	0.32	0.42	155
19P 61 (19)	01/12/79 - 1/11/80	0.48	0.36	0.44	160
19P 66 (19)	01/12/79 - 1/11/80	0.50	0.40	0.46	170
19P 69 (19)	01/12/79 - 1/11/80	0.45	0.29	0.39	140
19P 71 (19)	01/12/79 - 1/11/80	0.50	0.31	0.43	155
19P 75 (19)	01/12/79 - 1/11/80	0.52	0.34	0.44	160
19P 77 (19)	01/12/79 - 1/11/80	0.51	0.32	0.44	160
19P 80 (19)	01/12/79 - 1/11/80	0.50	0.38	0.43	155
19P 85 (19)	01/12/79 - 1/11/80	0.46	0.39	0.43	155
19P 87 (19)	01/12/79 - 1/11/80	0.54	0.51	0.52	190
19P 88 (19)	01/12/79 - 1/11/80	0.59	0.46	0.49	180
19P 90 (19)	01/12/79 - 1/11/80	0.52	0.38	0.44	160
19P 91 (19)	01/12/79 - 1/11/80	0.49	0.40	0.43	155
20-4C Gate (20)	04/04/79 - 1/11/80	0.46	0.42	0.44	160
25-4P Gate (25)	04/04/79 - 1/11/80	0.33	0.33	0.33	120
25-7P Gate (25)	04/04/79 - 1/11/80	0.49	0.33	0.44	160
30-1C Gate (30)	04/04/79 - 1/11/80	0.55	0.35	0.46	170
130 M (4)	04/04/79 - 1/11/80	0.35	0.33	0.34	125
140 M (2)	04/04/79 - 1/11/80	0.40	0.36	0.39	140
168 M (12)	04/04/79 - 1/11/80	0.40	0.40	0.40	145
170 M (12)	04/04/79 - 1/11/80	0.34	0.32	0.33	120
175 M (12)	04/04/79 - 1/11/80	0.43	0.39	0.42	155
185 Holmes Road (17)	04/04/79 - 1/11/80	0.43	0.39	0.41	150
190 M (19)	01/12/79 - 1/11/80	0.46	0.35	0.42	155
196 M (19)	01/12/79 - 1/11/80	0.45	0.36	0.41	150

Table 13 (Continued)

STATION (AREA)	MEASUREMENT PERIOD	ELEVATION (FT)	DOSE (mrem)	DOSE RATE (mrem/d)	ADJUSTED ANNUAL DOSE (mrem/yr)
N670,600 E667,300 (22)	11/16/79 - 1/8/80	4000	8.5	0.17	60
N731,300 E638,700 (28)	11/16/79 - 1/8/80	5750	11.5	0.24	90
N754,000 E557,800 (31)	11/16/79 - 1/8/80	4800	19.4	0.37	135
N849,500 E545,000 (30)	11/16/79 - 1/21/80	7100	25.0	0.38	140
N887,000 E558,000 (20)	11/16/79 - 1/8/80	6100	26.6	0.50	185
N948,800 E527,800 (20)	11/16/79 - 1/21/80	5650	29.7	0.45	165
N944,700 E563,300 (19)	11/16/79 - 1/8/80	6300	13.1	0.25	90
N955,500 E614,200 (19)	11/16/79 - 1/8/80	7200	22.3	0.42	155
N935,500 E639,750 (19)	11/16/79 - 1/8/80	6550	21.8	0.41	150
N903,800 E635,500 (12)	11/16/79 - 1/8/80	6900	15.8	0.30	110
N907,600 E686,200 (8)	11/16/79 - 1/8/80	5826	22.8	0.43	155

Table 13 (Continued)

STATION (AREA)	MEASUREMENT PERIOD	ELEVATION (FT)	DOSE (mrem)	DOSE RATE (mrem/d)	ADJUSTED ANNUAL DOSE (mrem/yr)
N874,600 E691,500 (10)	11/16/79 - 1/8/80	5000	10.4	0.20	75
N844,200 E704,900 (3)	11/16/79 - 1/8/80	5100	10.6	0.20	75
N788,800 E709,500 (11)	11/16/79 - 1/8/80	5200	20.4	0.39	140
N710,800 E720,000 (11)	11/16/79 - 1/8/80	4280	7.8	0.16	58

TABLE 14

TLD Control Station Comparison

Station	Dose Rate (mrem/d) 1977	1978	1979
Bldg. 650 Dosimetry Room	0.15	0.16	0.17
Bldg. 650 Roof	0.15	0.15	0.15
Area 27 Cafeteria	0.37	0.37	0.35
CP Complex	0.21	0.22	0.21
Henre Site	0.34	0.34	0.33
NRDS Warehouse	0.35	0.35	0.33
Post Office	0.15	0.15	0.15
Well 5B	0.32	0.32	0.31
Yucca Complex	0.29	0.31	0.30
Network Average	0.26	0.26	0.26

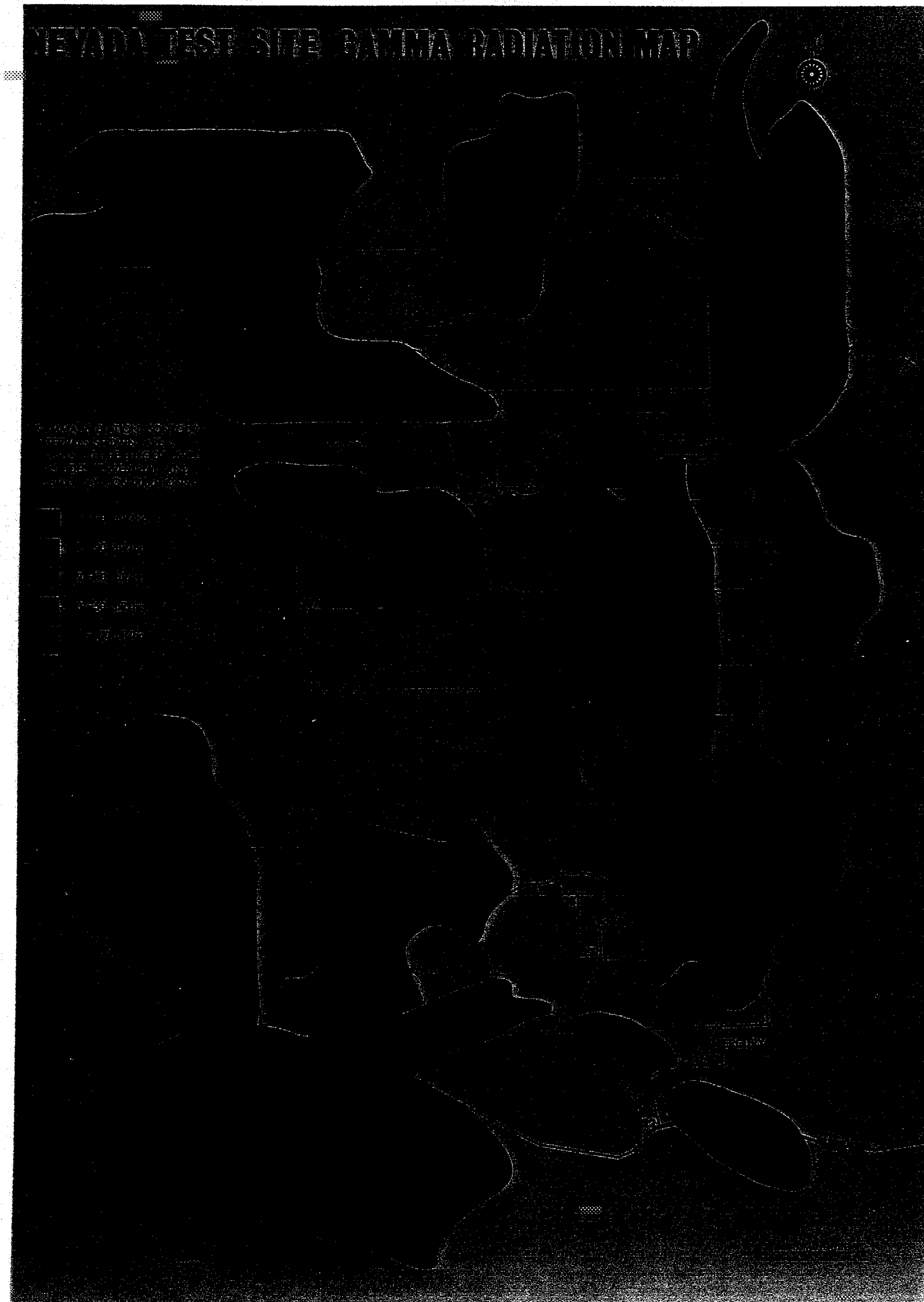
The remaining 130 stations of the network yielded dose rates which ranged from 0.14 mrem/d to 10.3 mrem/d, a factor of 80 variation. The majority of individual location measurements were consistent within a range of ± 10 percent between field cycles. This suggested that the elevated gamma dose rates were caused by the presence of long-lived radionuclides, a theory borne out by the fact that most of the soil-deposited NTS fission products were well over a decade old. Few stations displayed substantial variations, and fluctuations were related to known radioactive source movement or moderation. The following six stations showed decreases at the end of CY-1979 because of fewer radioactive sources being used in their vicinity:

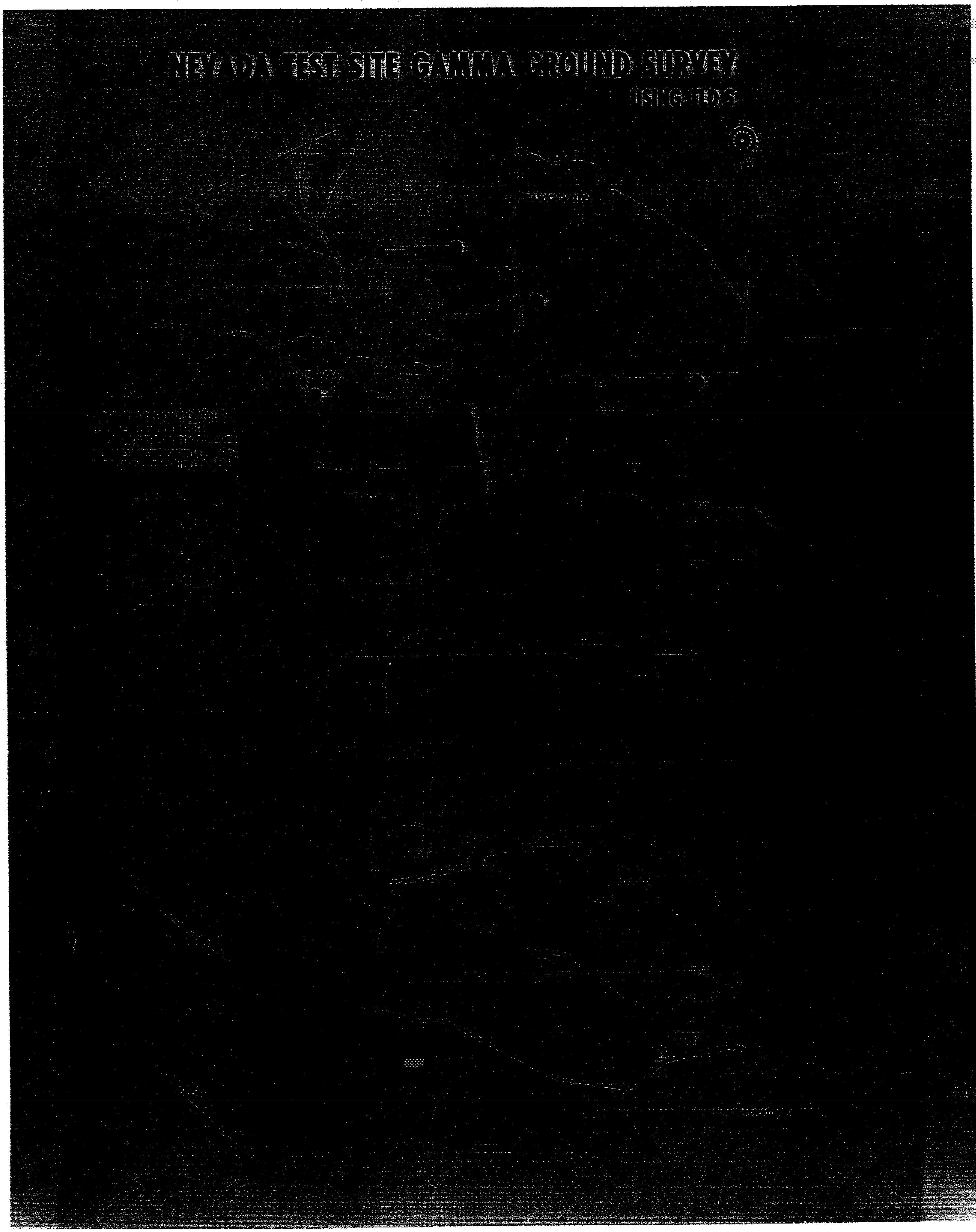
Bldg. 600, X-Ray Area
Bldg. 650, Sample Storage
CP-50, Calibration Bench
CP-50, Instrument Calibration Door
Decon Pad, Front Office
Decon Pad, Back Office

The CP complex showed a 33 mrem excess during the first quarter of the year. This resulted from a well-documented incident involving a 946 Ci ^{60}Co source located approximately 50 meters from the TLD (Reference 12). The Lower Mint Lake station's dose rate changed because it was moved 20 meters during the third quarter of the year. The 2-04 and 4-04 road stations displayed large variations due to the movement of windborne radionuclides in the soil surrounding the TLD's.

The analysis of the TLD's from the first quarter of CY-1979 demonstrated an interesting meterological effect on the network measurements. Dose rate decreases of from 10 to 30 percent occurred at the stations on the Pahute Mesa Road during that field cycle. The sides of the road where the TLD's were situated were covered with several feet of snow which attenuated the terrestrial gamma radiation. The TLD which decreased by 30 percent was located at a point where snowplows from two directions piled snow higher than normal. The rates at these stations returned to normal during the remaining quarters of CY-1979.

In 1970-1972, EG&G Inc. conducted an aerial survey of the NTS. It was stated in the conclusion of the EG&G report, "Radiological Survey of the Nevada Test Site" (Reference 13), that "intercomparisons with ground surveys could provide a comprehensive, point-by-point detailed picture of the 3 foot radiation levels for planning and study purposes". Figures 10 and 11 show the color representations of the NTS gamma radiation rates as determined by the EG&G aerial survey and the 1979 REECo TLD ground survey, respectively. The aerial survey was described fully in the above report. The EG&G survey results were generated by computer conversion of NaI data obtained on a helicopter fly-by at 300 feet to the gamma radiation rates at 3 feet. Using the EG&G exposure rate color code, the TLD locations have been represented by dots in Figure 11. Where portable instruments and site histories made it clear that the TLD measurement represented a large area, a large dot was used. Small dots depict locations where the ambient gamma levels varied and represent a small area. One other variation in the TLD map was a breakdown of the 11-20 μR/h category into 11-15 μR/h (light green) and 16-20 μR/h subdivisions (dark green). This was done because: (1) the TLD's could differentiate to this precision; (2) the majority of stations fell into this rate grouping; and (3) a significant amount of information would be lost without such a distinction.


NEVADA TEST SITE GAMMA RADIATION MAP


NEVADA TEST SITE GAMMA GROUND SURVEY
USING TDS

Aerial and TLD ground survey correlation was excellent. The radiation rates measured nine years ago by EG&G have not changed, as shown by an overlay of the maps (viewgraphs are in the back of this report). All but three TLD's measured the same radiation rate as the aerial survey where the surveys were in the same general vicinity. These three locations were in the north and northeast sections of the NTS where, in late 1970, the Baneberry Test released fresh fission products throughout. Those short-lived radionuclides raised the dose rates for several years but have since decayed out. Therefore, the 1979 measurements were slightly lower.

Since the aerial survey was limited to non-mountainous terrain, the TLD ground survey provided much additional information about the radiological environment of the NTS. The most significant addition was shown by the Area 19 monitors. Immediately south of the final Area 19 aerial survey, the radiation rates dropped from the 21-30 μR/h division to the 16-20 μR/h division. The TLD ground survey showed that most of the remainder of the test site is in this 16-20 μR/h rate group or in the 4-10 μR/h group.

G. REFERENCES

(1) ERDA. "Final Environmental Impact Statement, Nye County Nevada." ERDA-1551. Nevada Operations Office, U.S. Energy Research and Development Administration, Las Vegas, Nevada. Available from U.S. Dept. of Commerce, NTIS, Springfield, VA, 22161. September 1977.

(2) ERDA 77-24, "A Guide for Environmental Radiological Surveillance at ERDA Installations," Battelle Pacific Northwest Laboratories, Richland, Washington, 1977.

(3) ERDA Manual Chapter 0524, "Standards for Radiation Protection." U.S. Energy Research and Development Administration, Washington, D.C., March 20, 1978.

(4) Straight, R. J., "HT-HTO Sampling at the Nevada Test Site," IAEA/NEA International Symposium on the Behavior of Tritium in the Environment, San Francisco, 1978.

(5) Beck, Harold L., "Environmental Radiation Fields", Health and Safety Laboratory, U.S. Atomic Energy Commission, New York, New York, 1972.

(6) Burke, Gail De Planque, Thomas F. Gesell. "Error Analysis of Environmental Radiation Measurements Made With Integrating Detector," NBS Special Publication 456, pp. 187-198, 1976.

(7) ANSI N545-1975, "American National Standard; Performance Testing And Procedural Specifications For Thermoluminescent Dosimetry (Environmental Applications)," American National Standards Institute, Inc., New York, New York, 1975.

(8) ERDA 77-24, "A Guide for Environmental Radiological Surveillance at ERDA Installations," Battelle Pacific Northwest Laboratories, Richland, Washington, 1977.

(9) Lantz, Michael W., NVO/0410-52, "Environmental Surveillance Report for the Nevada Test Site January 1978 through December 1978, Reynolds Electrical and Engineering Co., Inc., Las Vegas, Nevada, 1979.

(10) Bureau of Radiological Health, "Radiological Health Handbook," U.S. Department of Health, Education, and Welfare, Rockville, Maryland, 1970.

(11) EMSL-LV-0539-18, "Off-site Environmental Monitoring Report for the Nevada Test Site and Other Test Areas Used for Underground Detonations," January through December 1977, Environmental Protection Agency, Las Vegas, Nevada, 1978.

(12) Z. G. Burson, "Dose Assessment of Radiation Incident Involving Calibration Source Removal," EG&G, March 20, 1979.

(13) J. F. Doyle, "Radiological Survey of the Nevada Test Site 1970 - 1979," EG&G, August 1, 1972.

APPENDIX A

NTS Environmental Surveillance

Air Sampling Locations and Plots

Several symbols are used in Appendix A to denote the data points. In the first plot, the air network weekly averages, a square represents the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

The remaining plots of Appendix A show the gross beta and plutonium data of each station. The data symbols for the plots are as follows:

Plot #	Symbol
1-5	×
7-10	◊
11-14	⧗
16-20	○
21-25	*
26-45	◇

A two-sigma error bar is also added to the data points, and, in all of the plots, a delta with the line to the bottom of the plot means below detection limit.

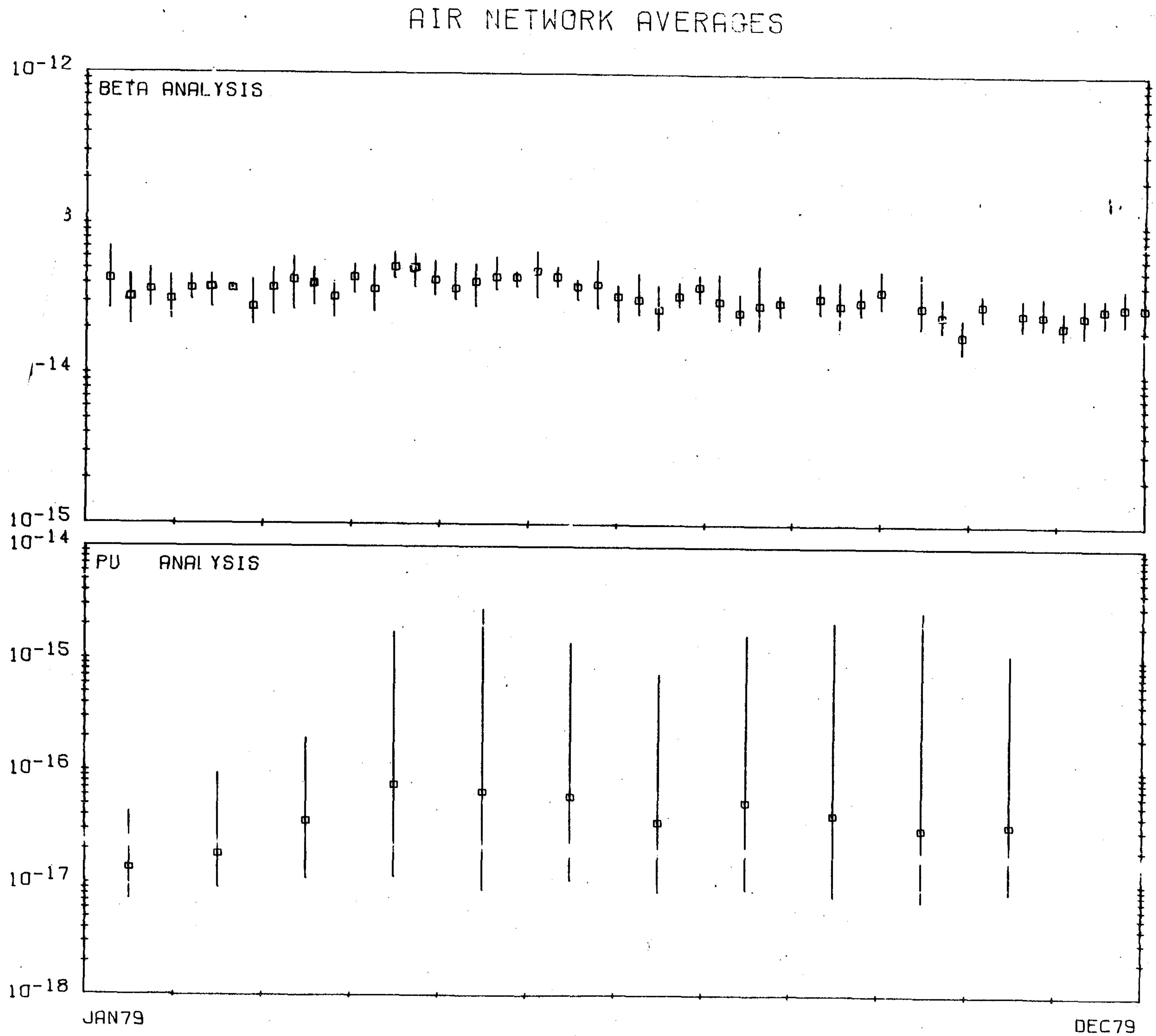
NTS ENVIRONMENTAL SURVEILLANCE
AIR SAMPLING LOCATIONS

Station Number	Location
1	Area 1 Gravel Pit
2	Area 2 Compound
3	Area 3 Cafeteria
4	Area 5 Maintenance Complex
5	Area 5 Well 5B
7	Area 6 Yucca Complex
8	Area 6 CP Complex
9	Area 6 Well 3 Complex
10	Area 9 9-300 Bunker
11	Area 10 Gate 700
12	Area 11 Gate 293
13	Area 12 Changehouse
14	Area 16 Substation
16	Area 19 Echo Peak
17	Area 19 Substation
19	Area 23 Building 790
20	Area 23 H&S Roof
21	Area 25 NRDS Warehouse
22	Area 27 Cafeteria
23	Area 28 Henre Site
25	Area 2 Cable Yard
26	Area 3 BJY
27	Area 3 3-300 Bunker
28	Area 5 RWMS
29	Area 23 Bldg. 790 #2
30	Area 25 E-MAD South
31	Area 25 E-MAD North
33	Area 3 U3ax South
34	Area 3 U3ax East
35	Area 3 U3ax North
36	Area 3 U3ax West

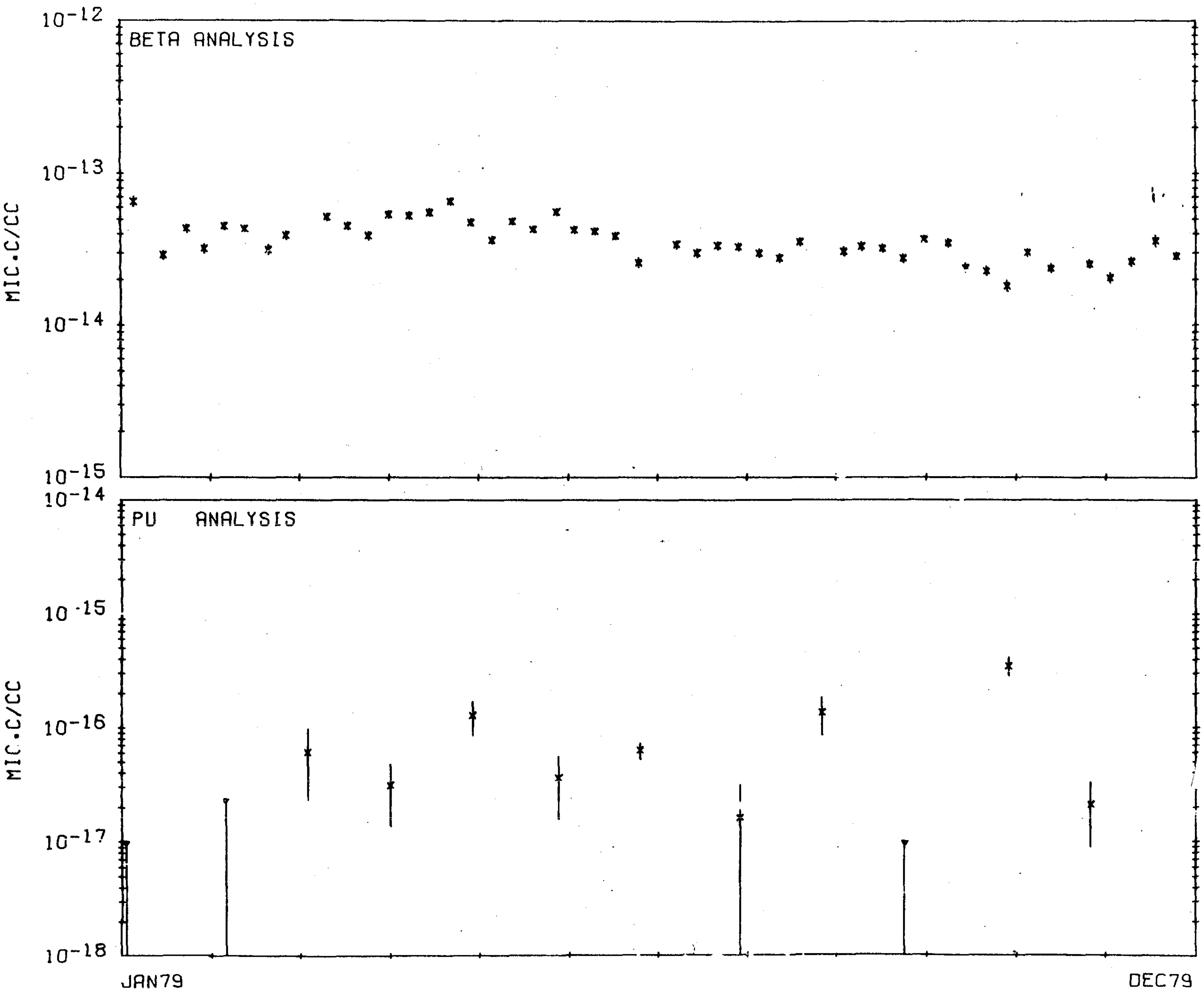
NTS ENVIRONMENTAL SURVEILLANCE AIR SAMPLING LOCATIONS

(Continued)

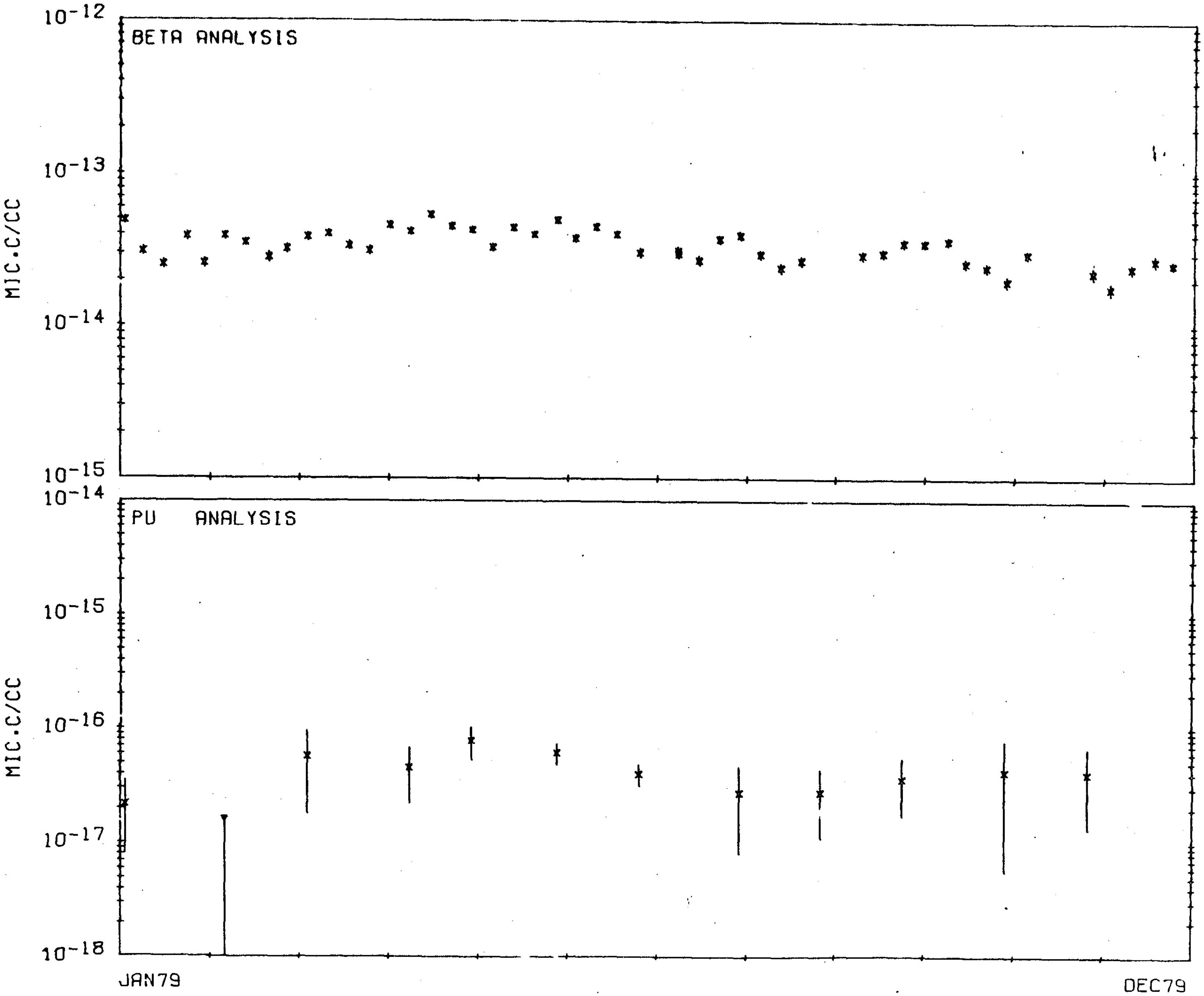
Station Number	Location
37	Area 7 UE7ns
38	Area 15 EPA Farm
45	Area 9 9-300 Bunker #2


AIR NETWORK AVERAGES
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
10-12
10-15
10-14
10-15
10-16
10-17
10-18
JAN79
DEC79

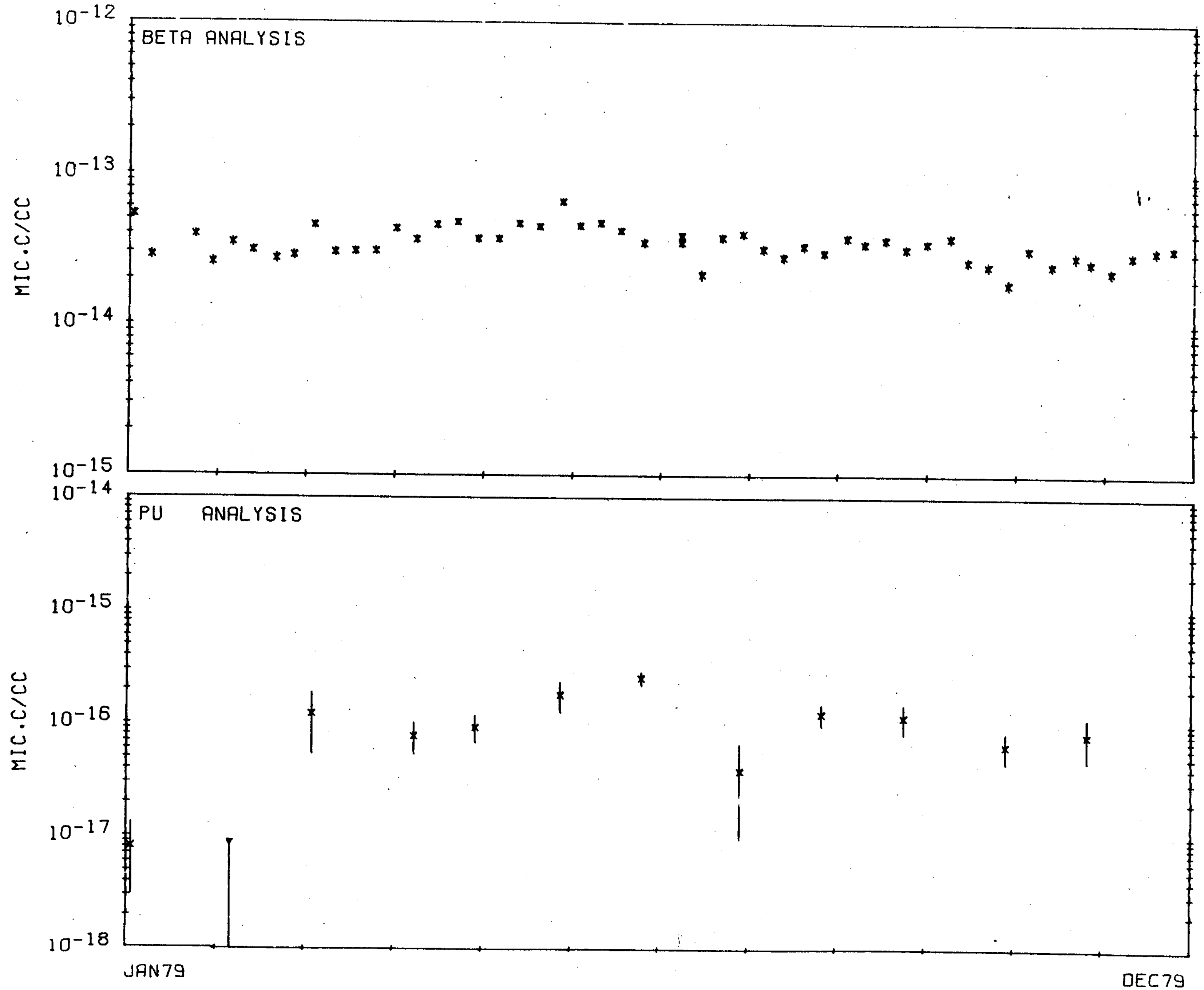
AIR SAMPLING STATION NUMBER 1

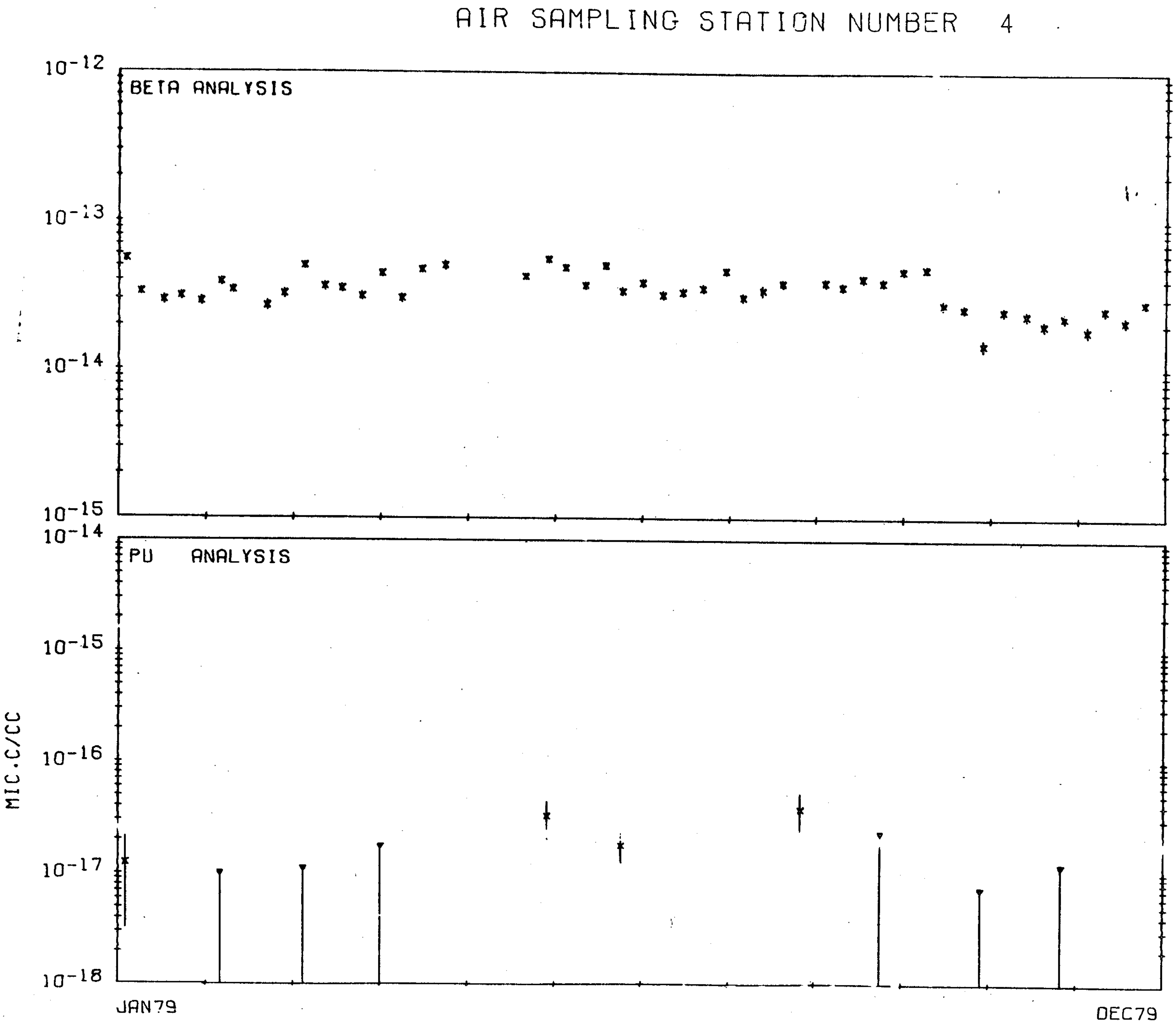


AIR SAMPLING STATION NUMBER 2

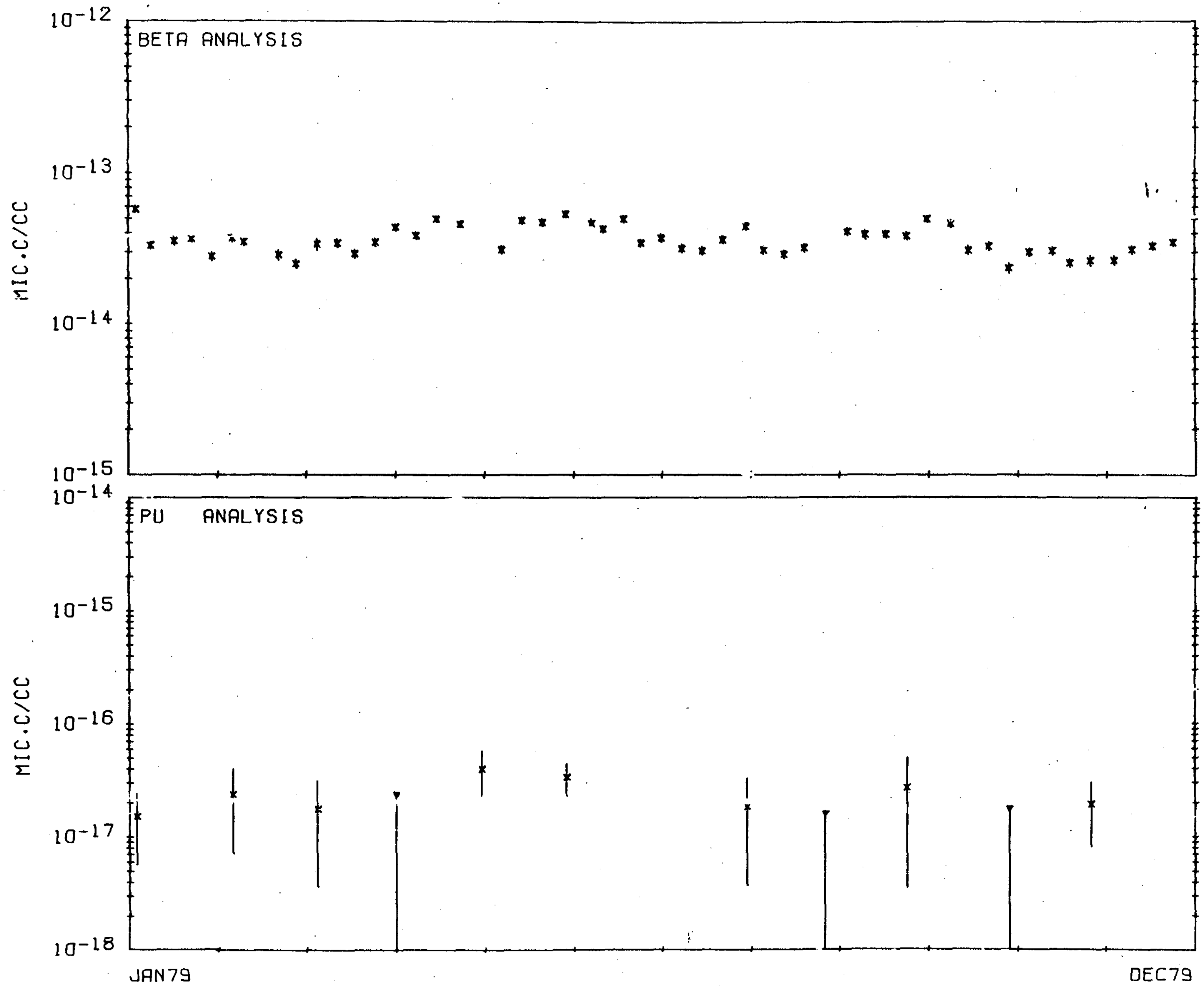


AIR SAMPLING STATION NUMBER 3

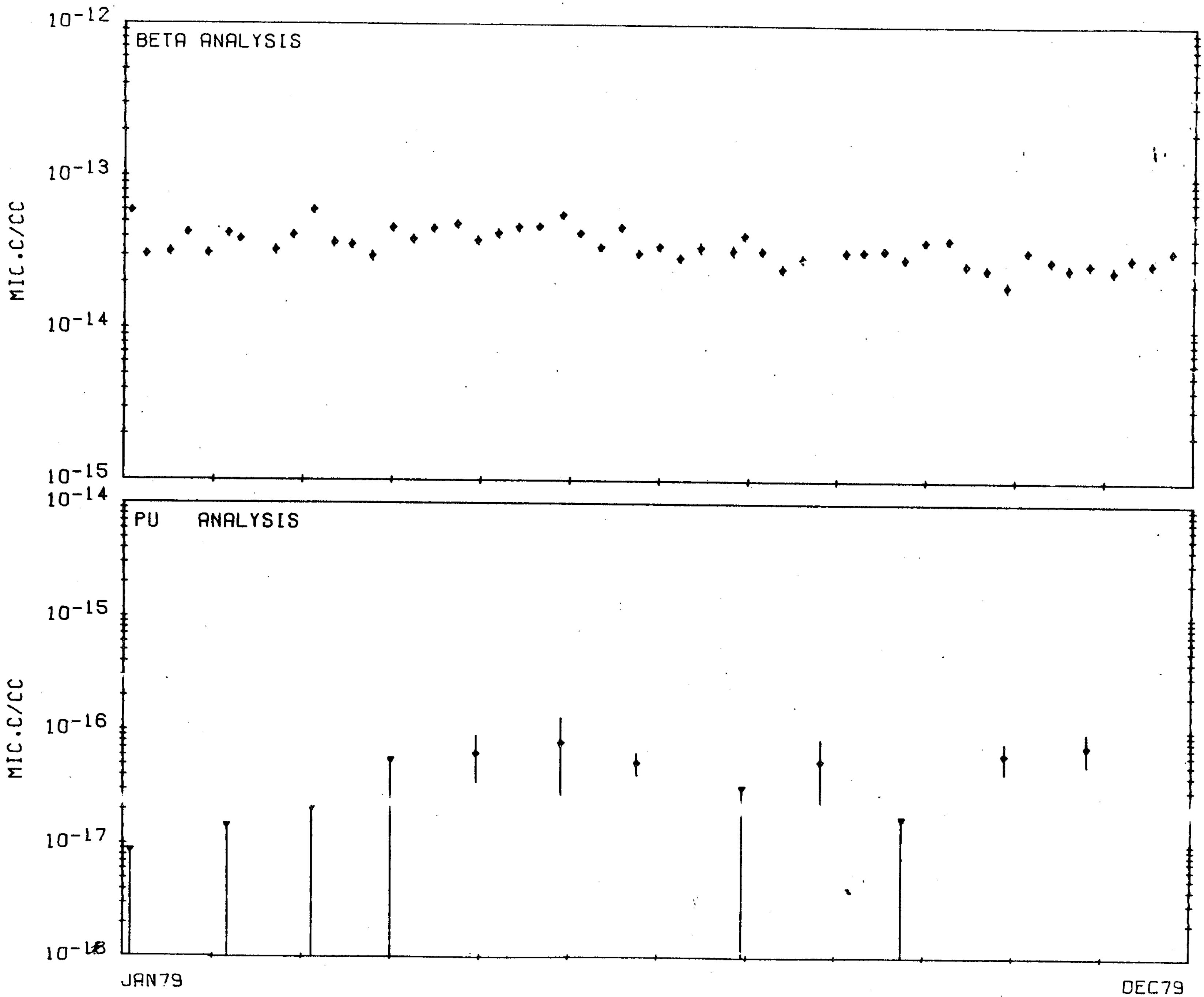



AIR SAMPLING STATION NUMBER 4
BETA ANALYSIS
PU ANALYSIS
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
MIC.C/CC
JAN79
DEC79

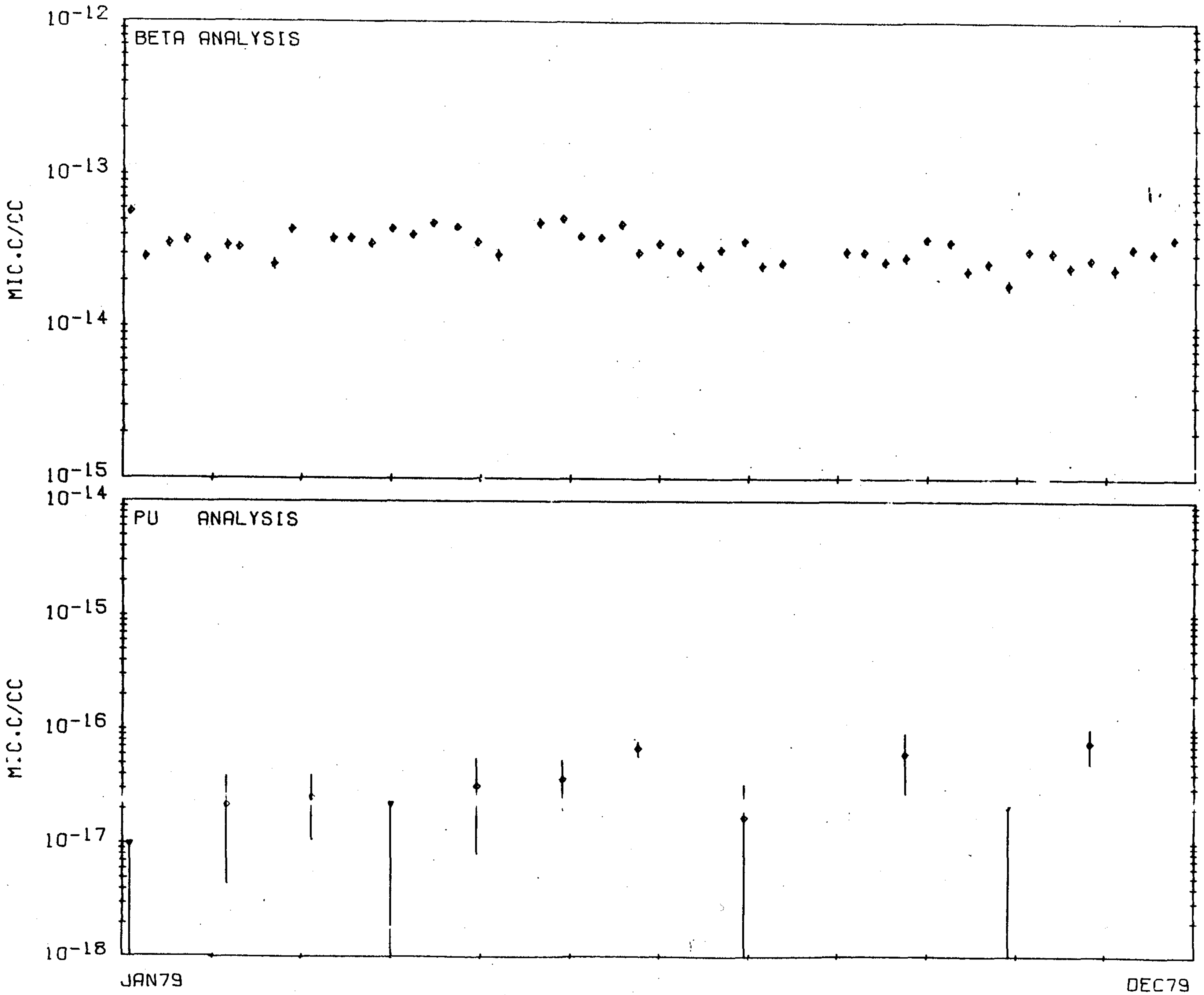
AIR SAMPLING STATION NUMBER 5



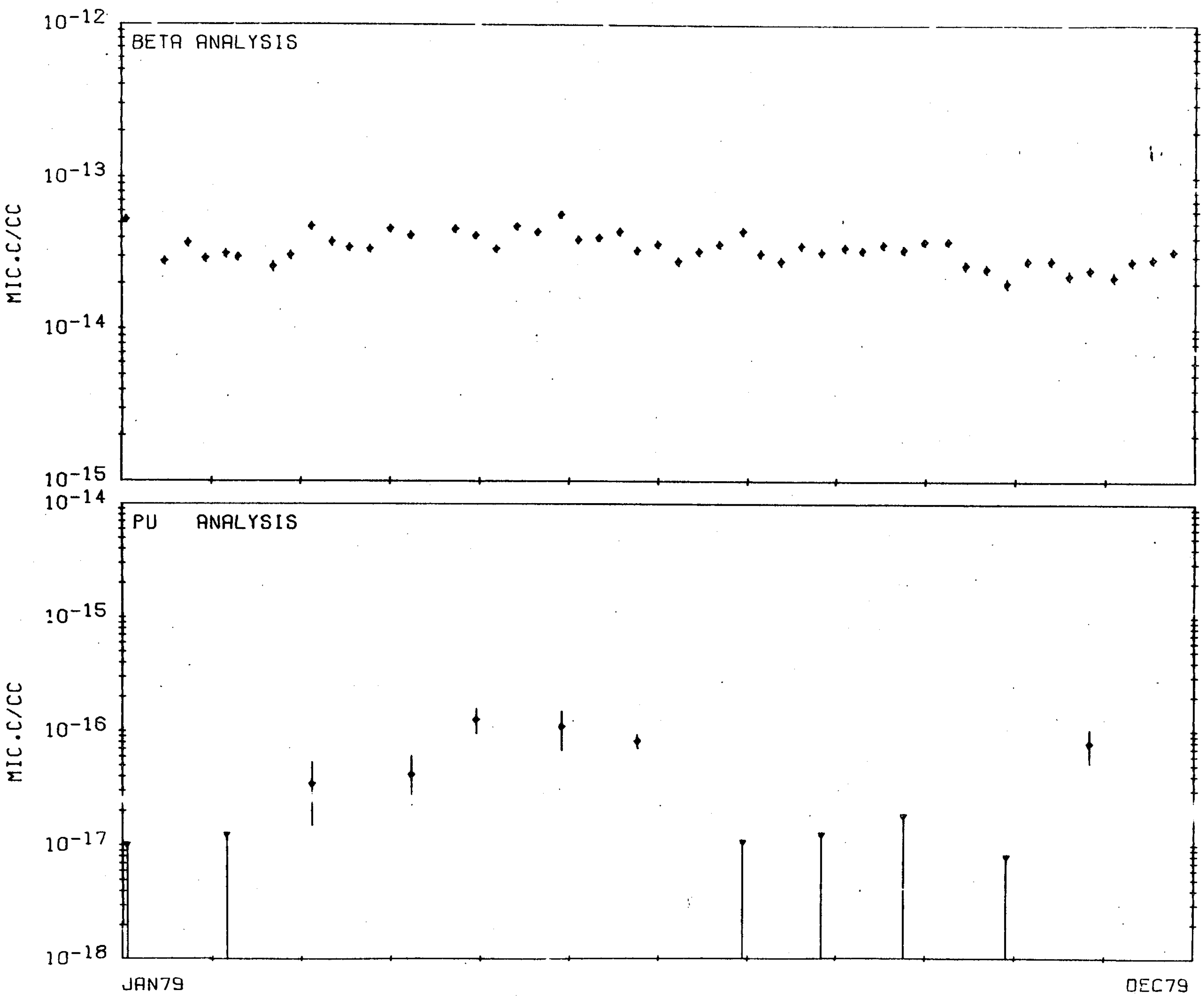
AIR SAMPLING STATION NUMBER 7



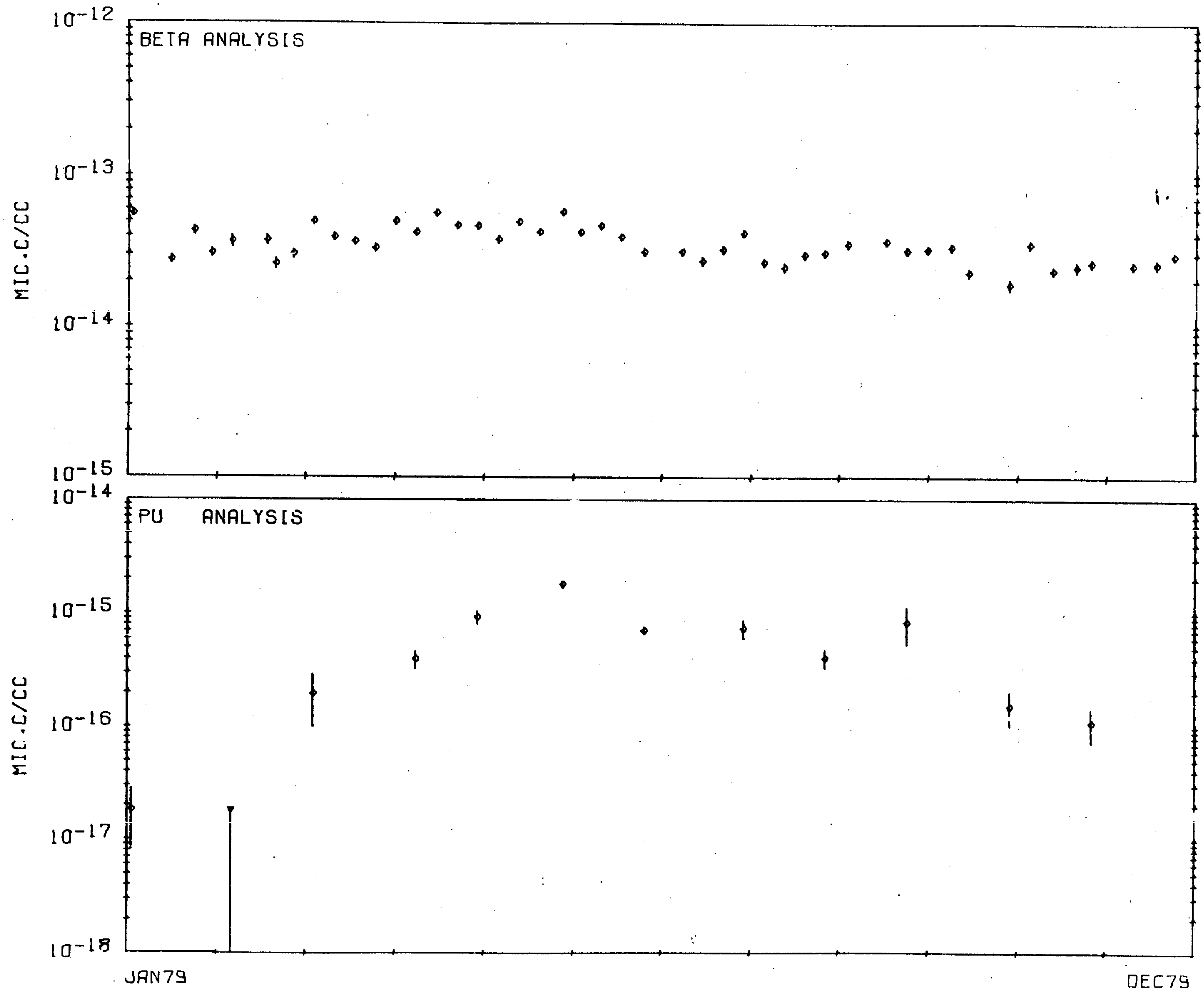
AIR SAMPLING STATION NUMBER 8



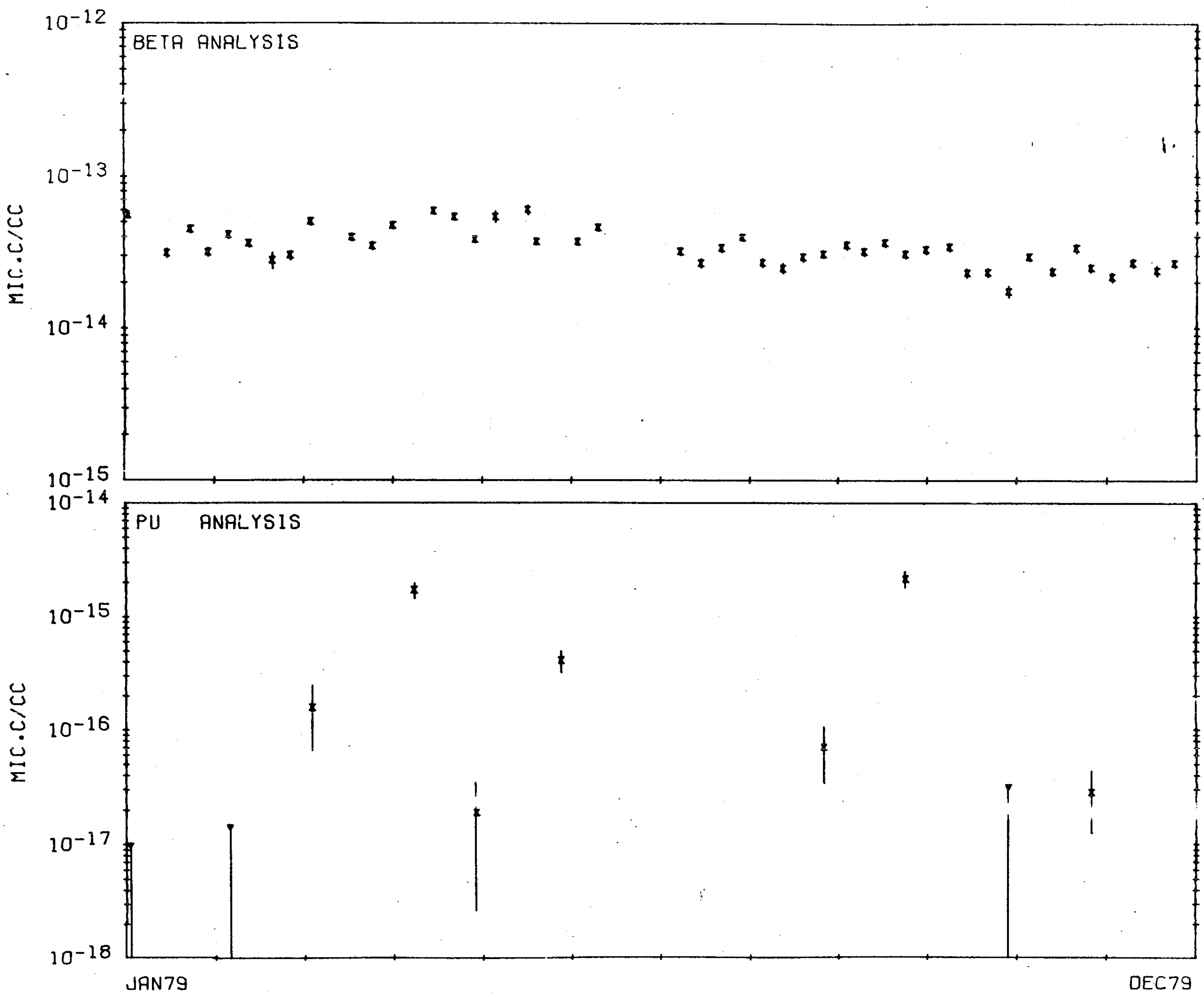
AIR SAMPLING STATION NUMBER 9

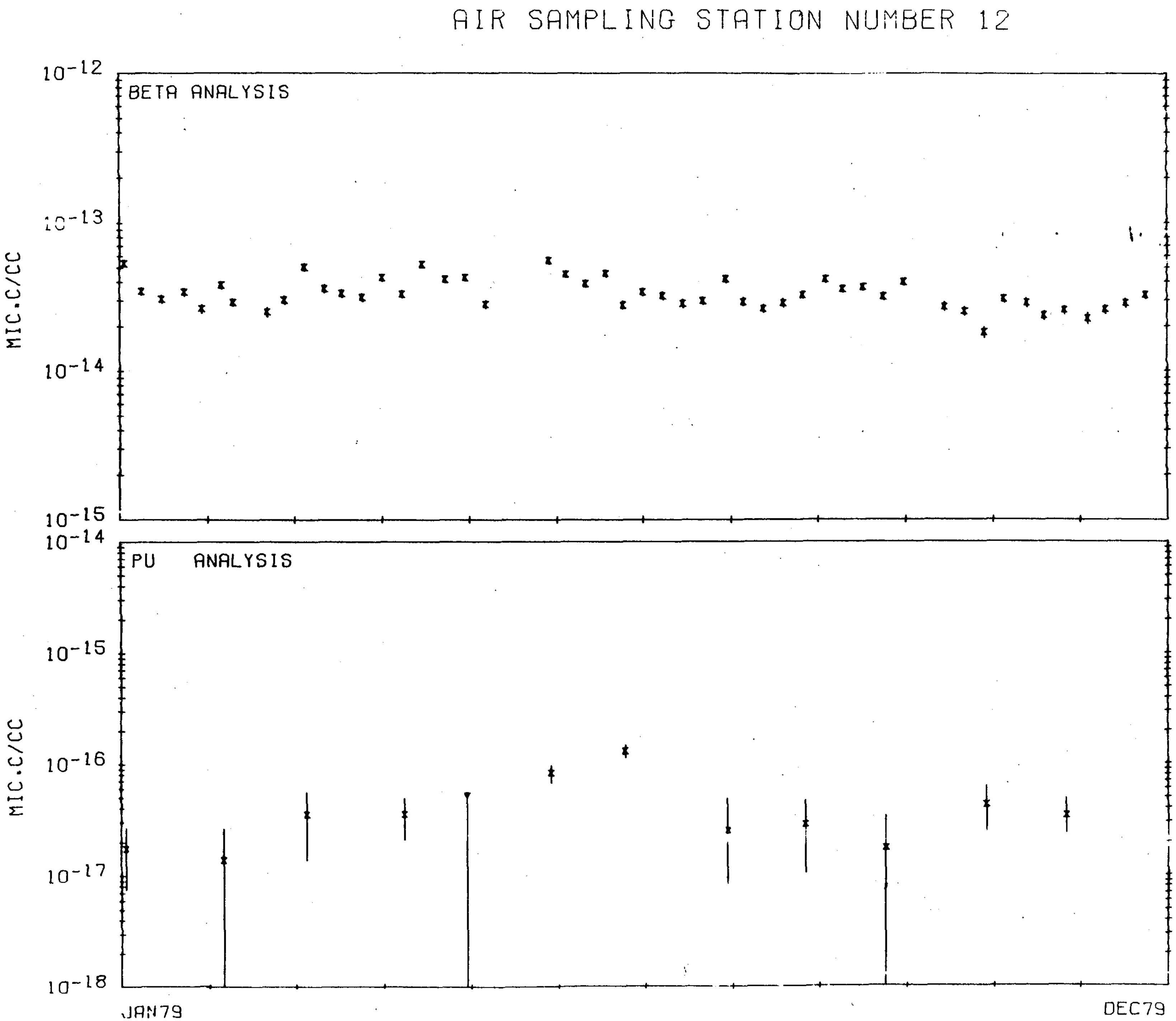


AIR SAMPLING STATION NUMBER 10



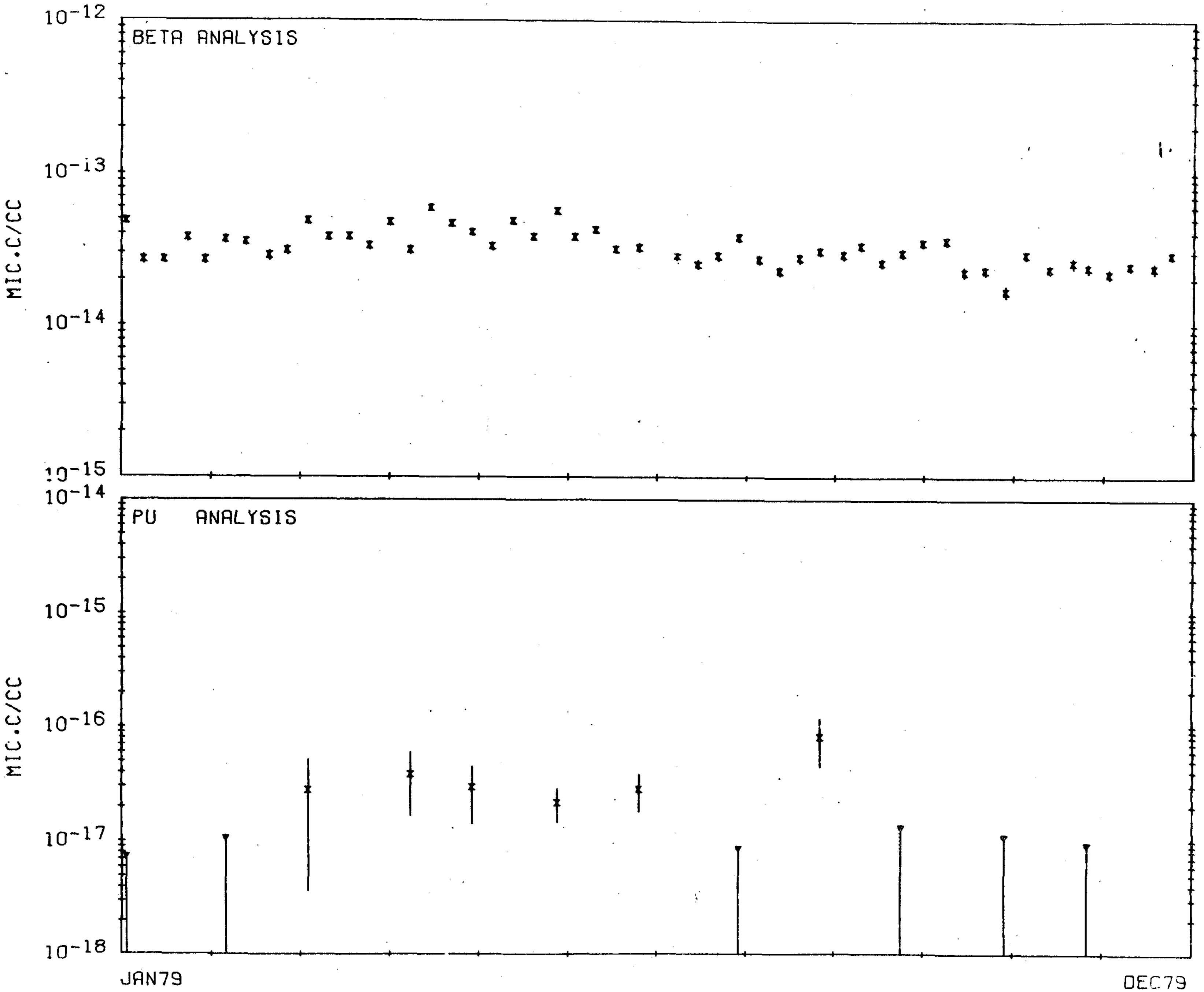
AIR SAMPLING STATION NUMBER 11



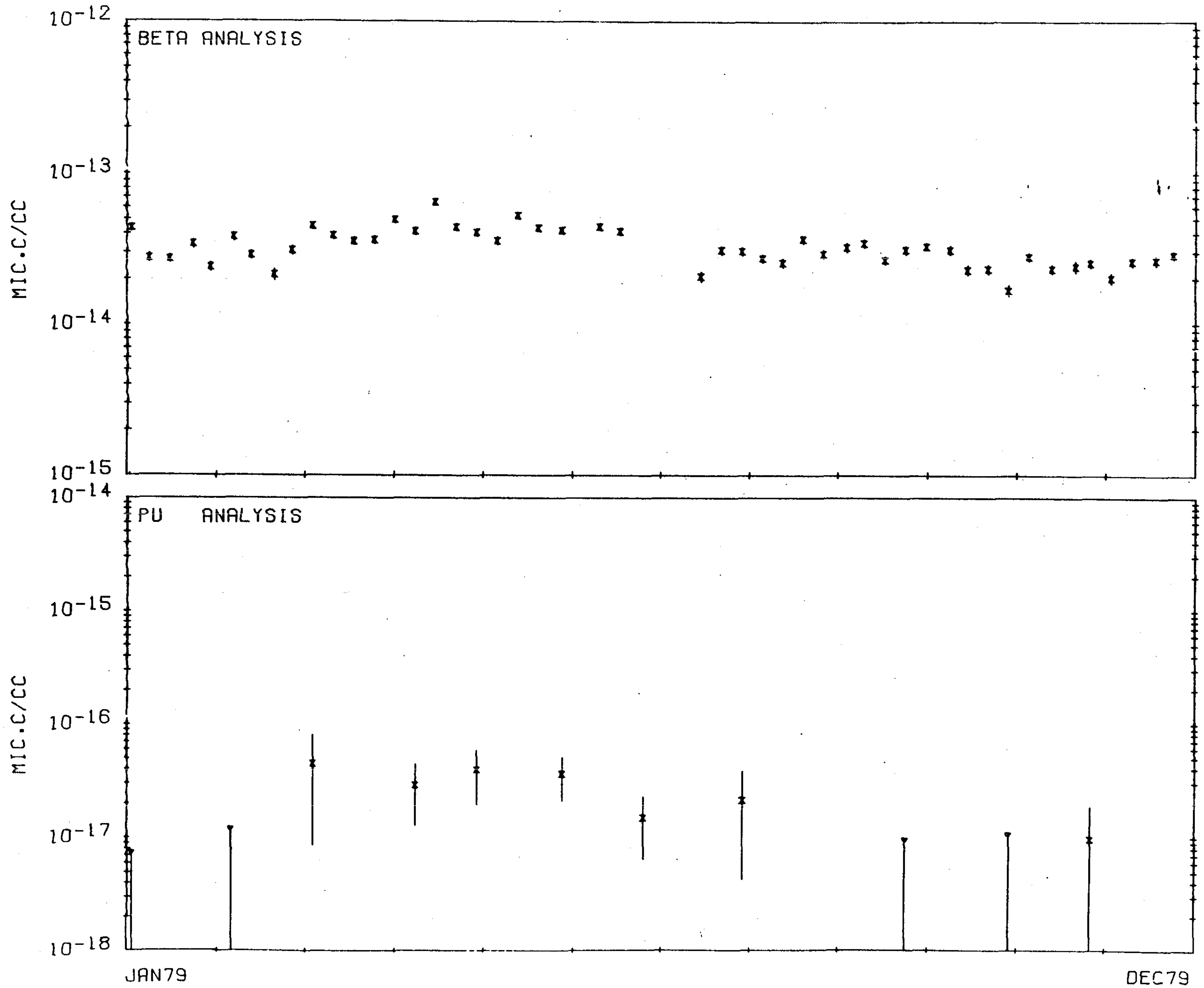


AIR SAMPLING STATION NUMBER 12
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10-12
10-13
10-14
10-15
10-14
10-15
10-16
10-17
10-18
JAN79
DEC79

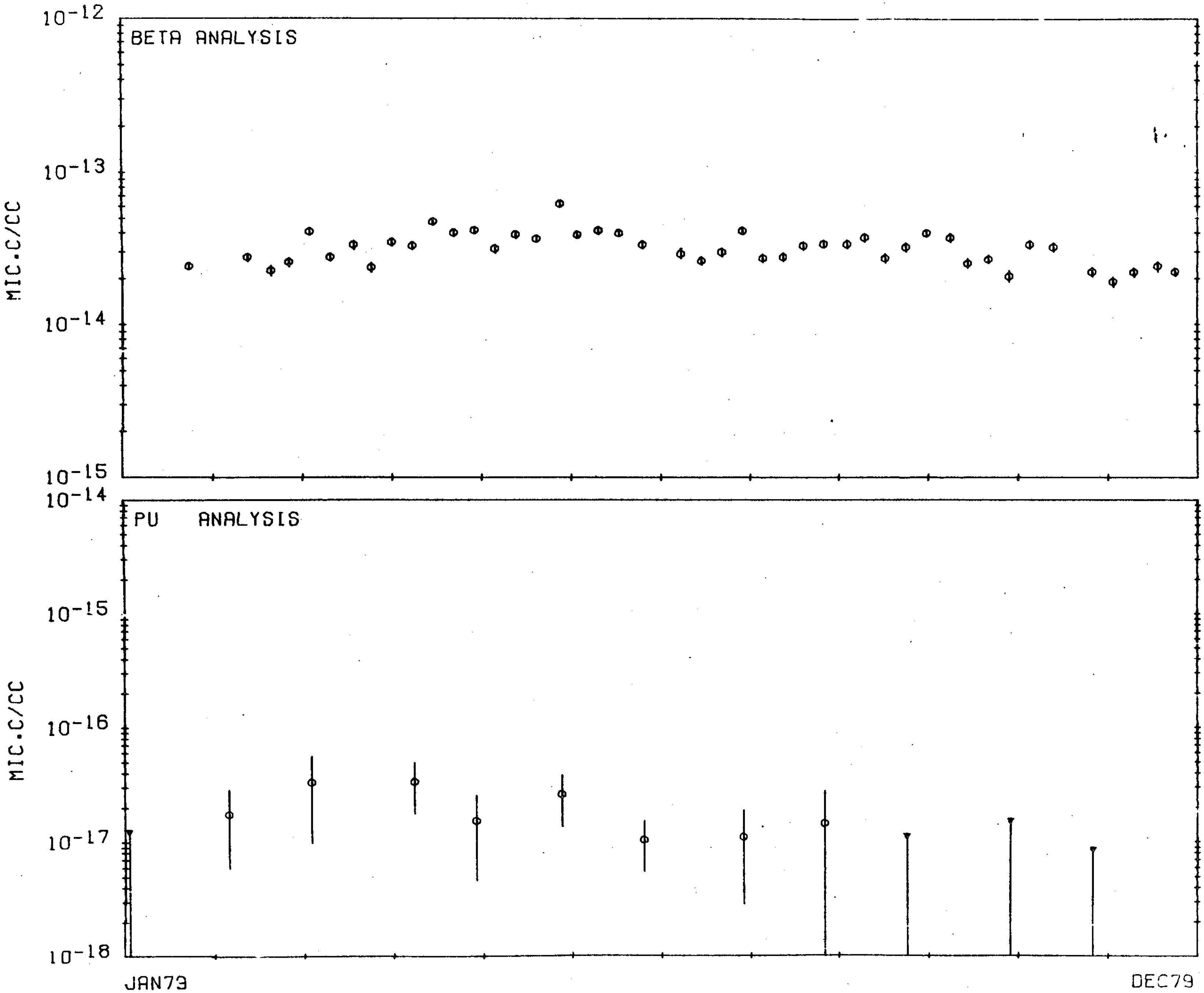
AIR SAMPLING STATION NUMBER 13



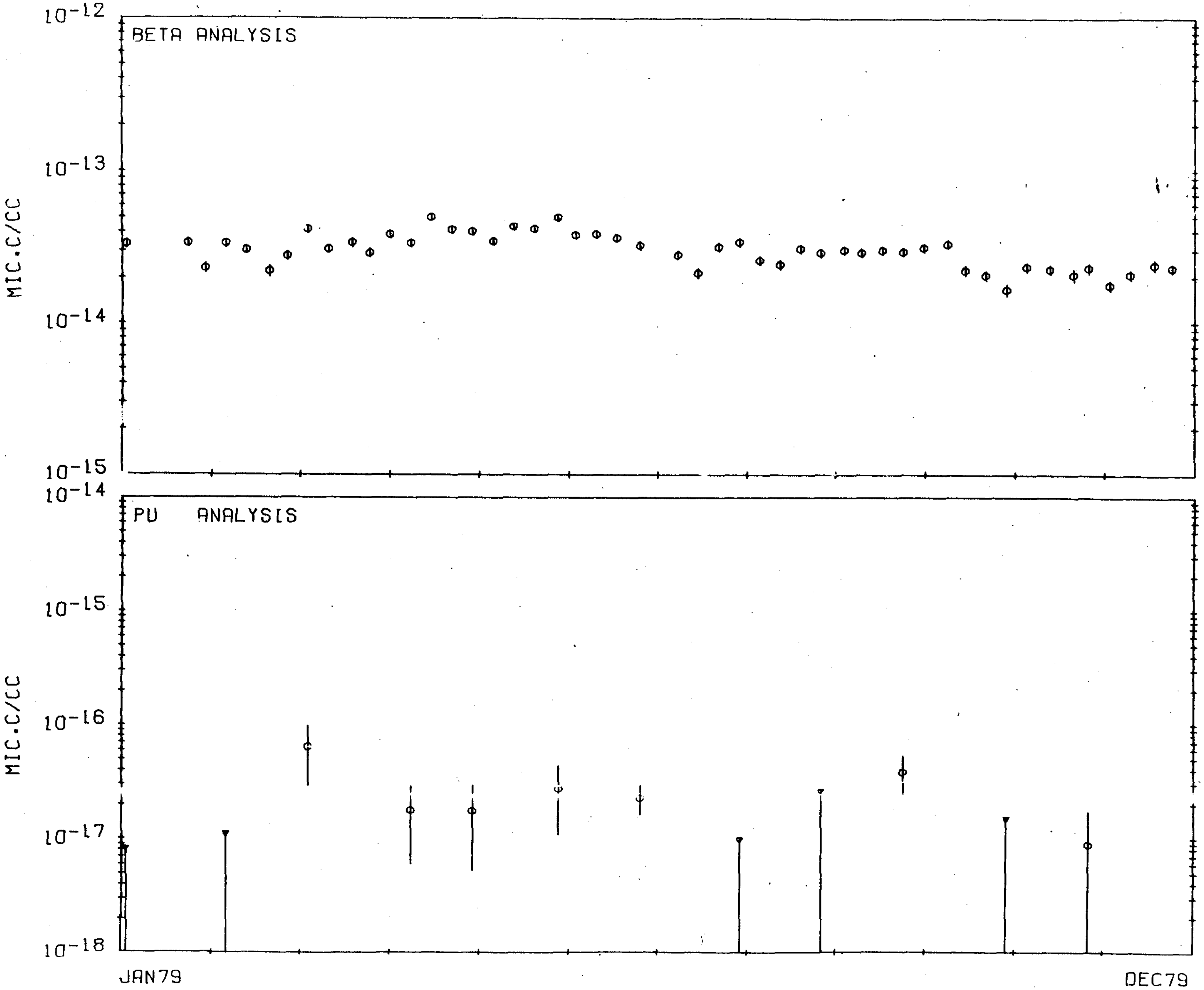
AIR SAMPLING STATION NUMBER 14

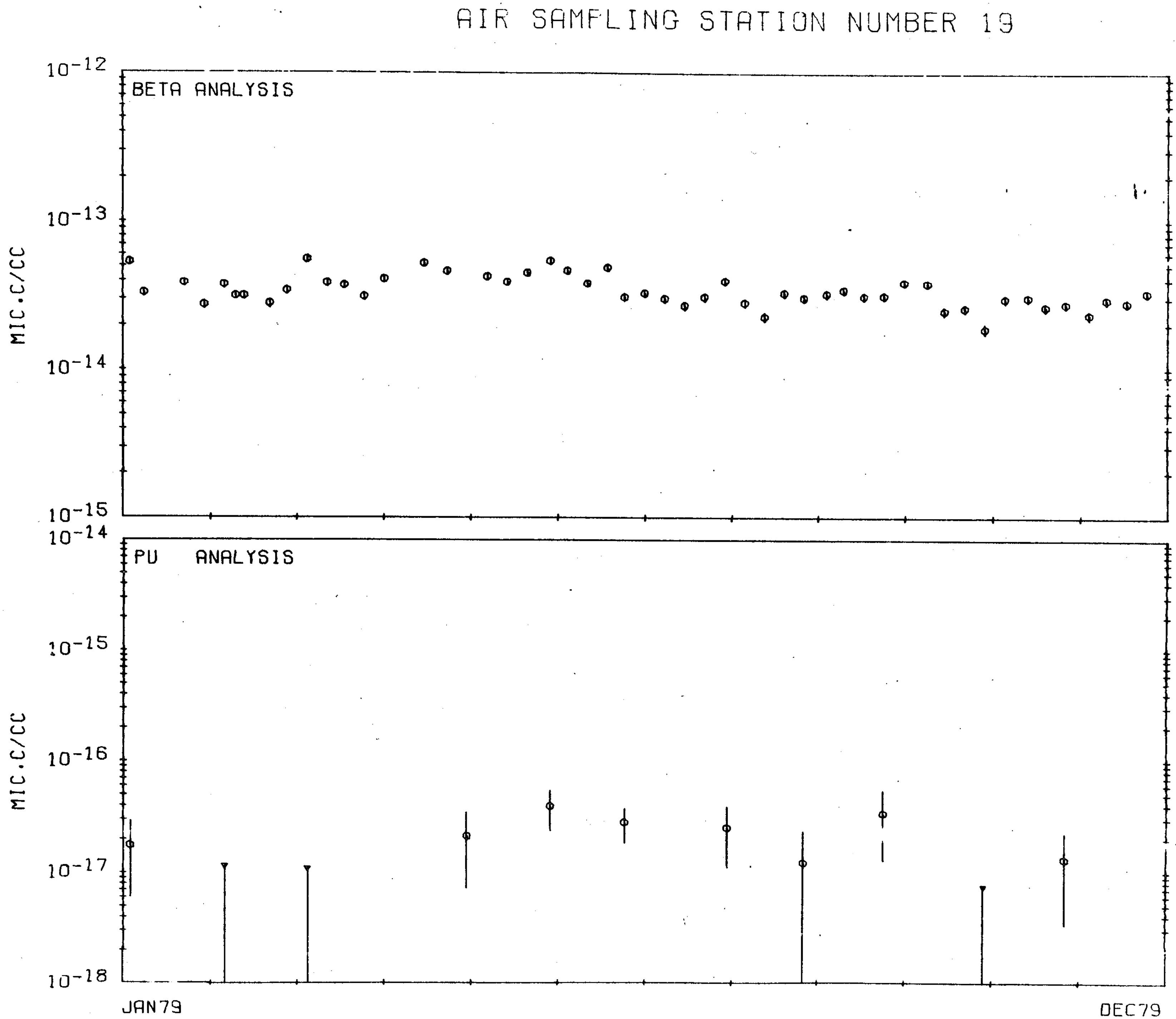


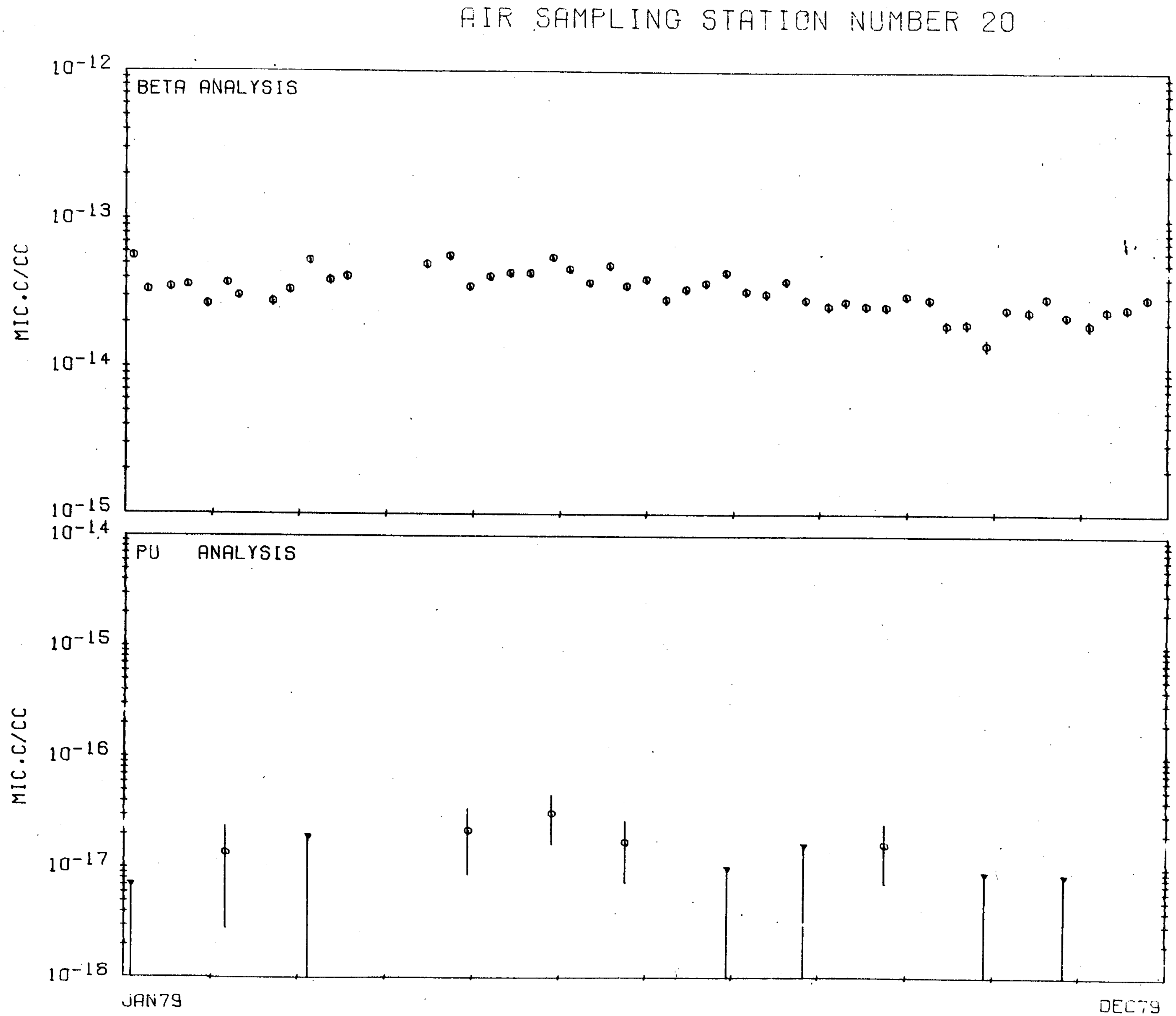
AIR SAMPLING STATION NUMBER 16



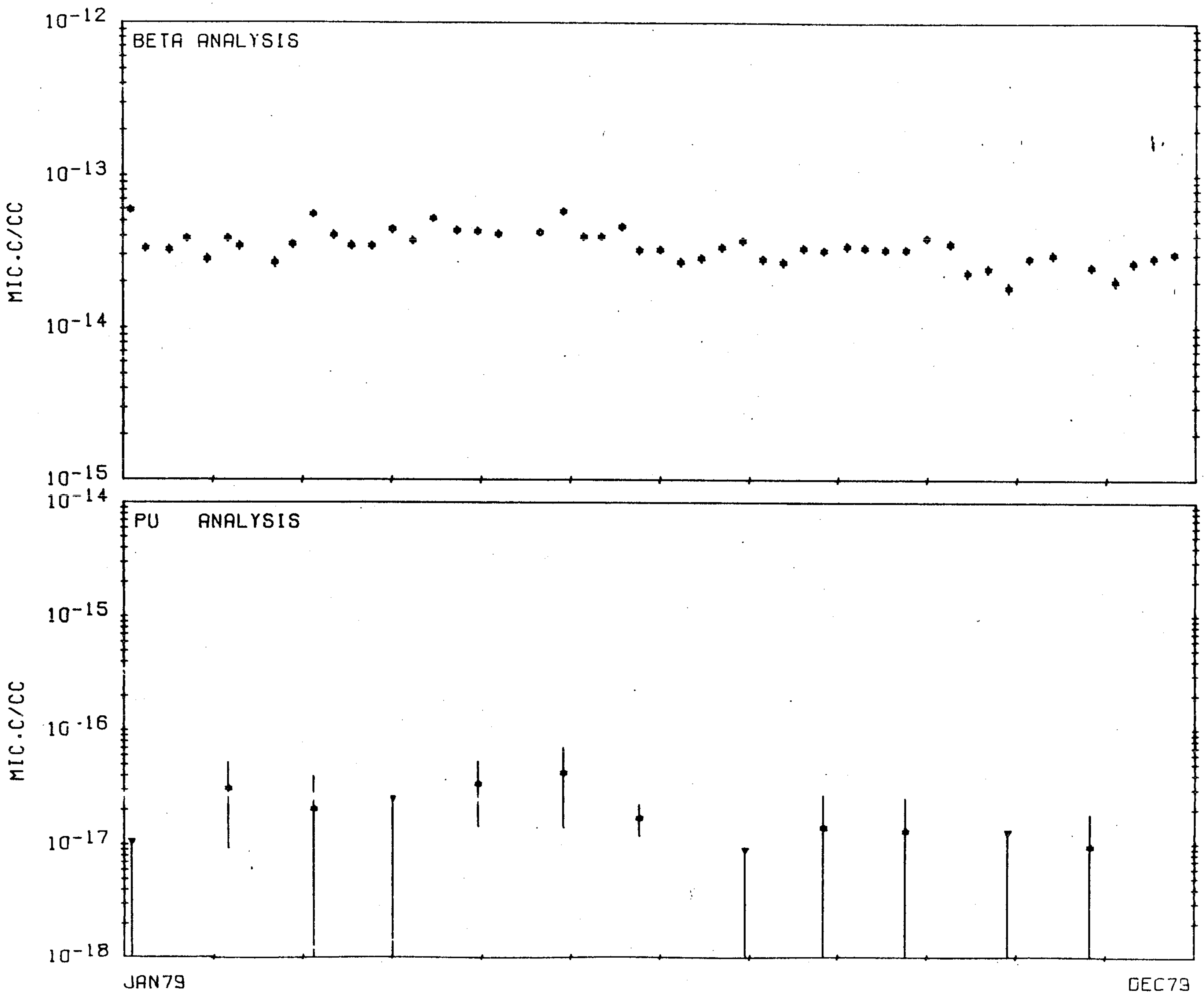
AIR SAMPLING STATION NUMBER 17



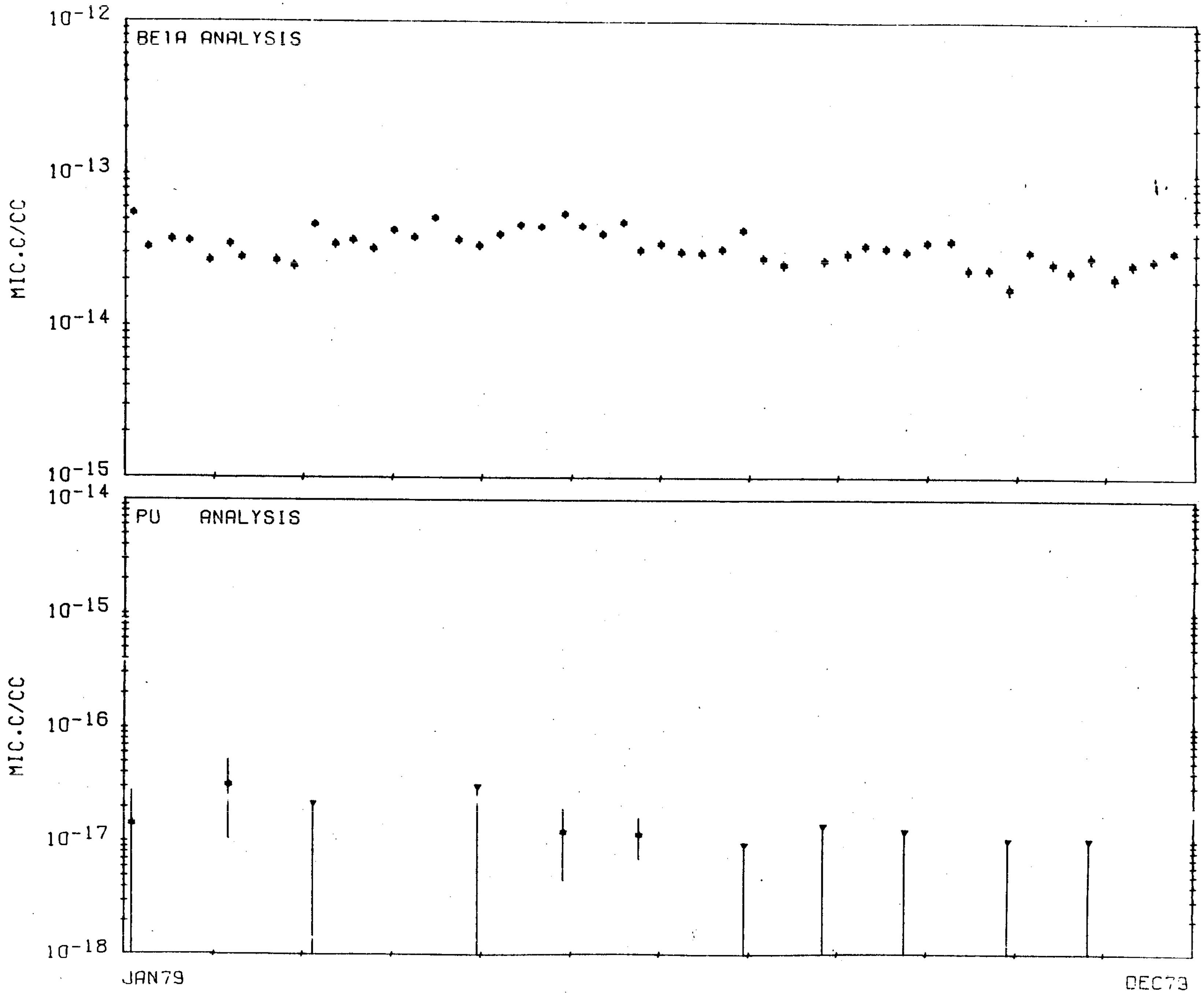

AIR SAMPLING STATION NUMBER 19
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN79
DEC79


AIR SAMPLING STATION NUMBER 20
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN79
DEC79

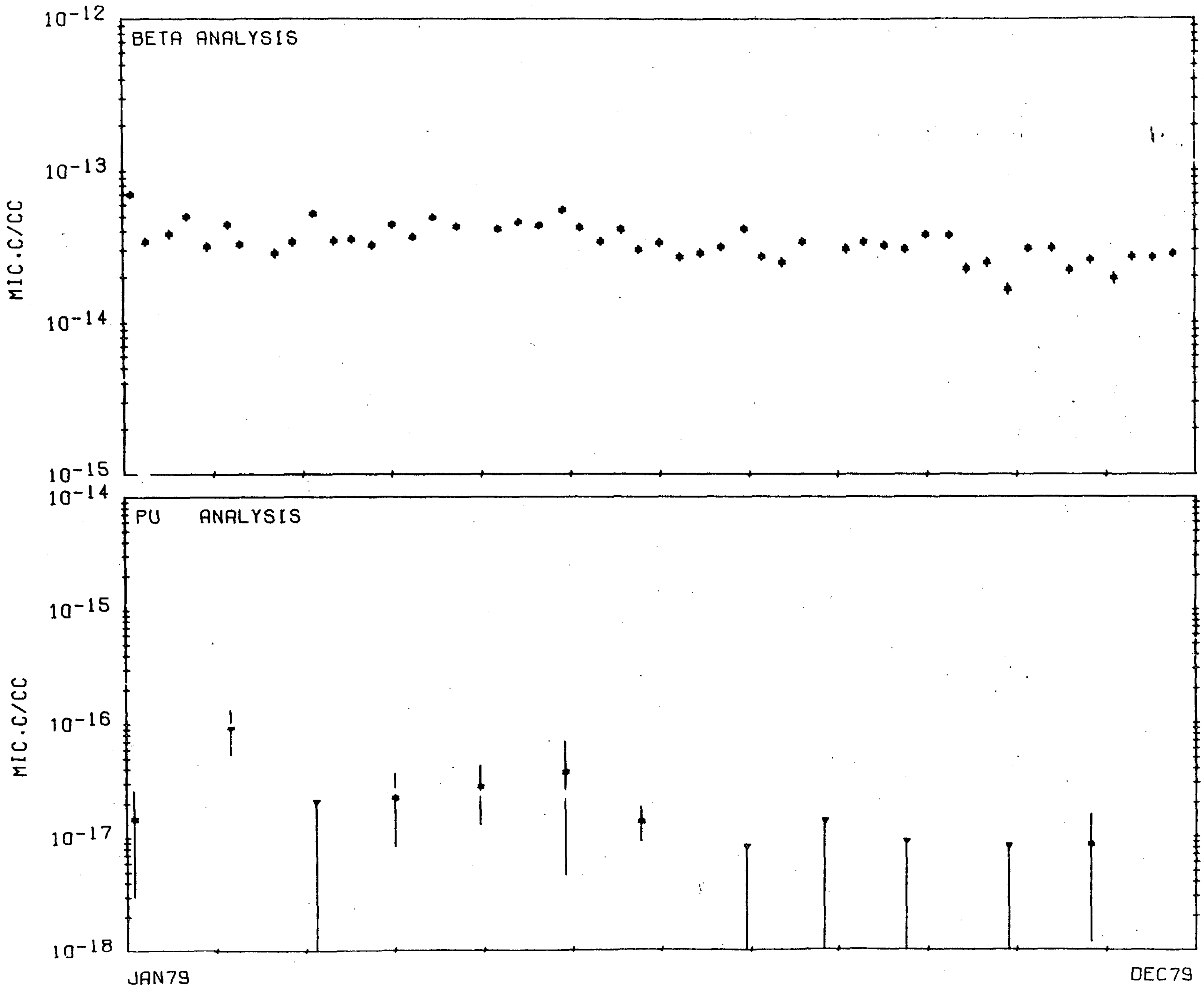
AIR SAMPLING STATION NUMBER 21



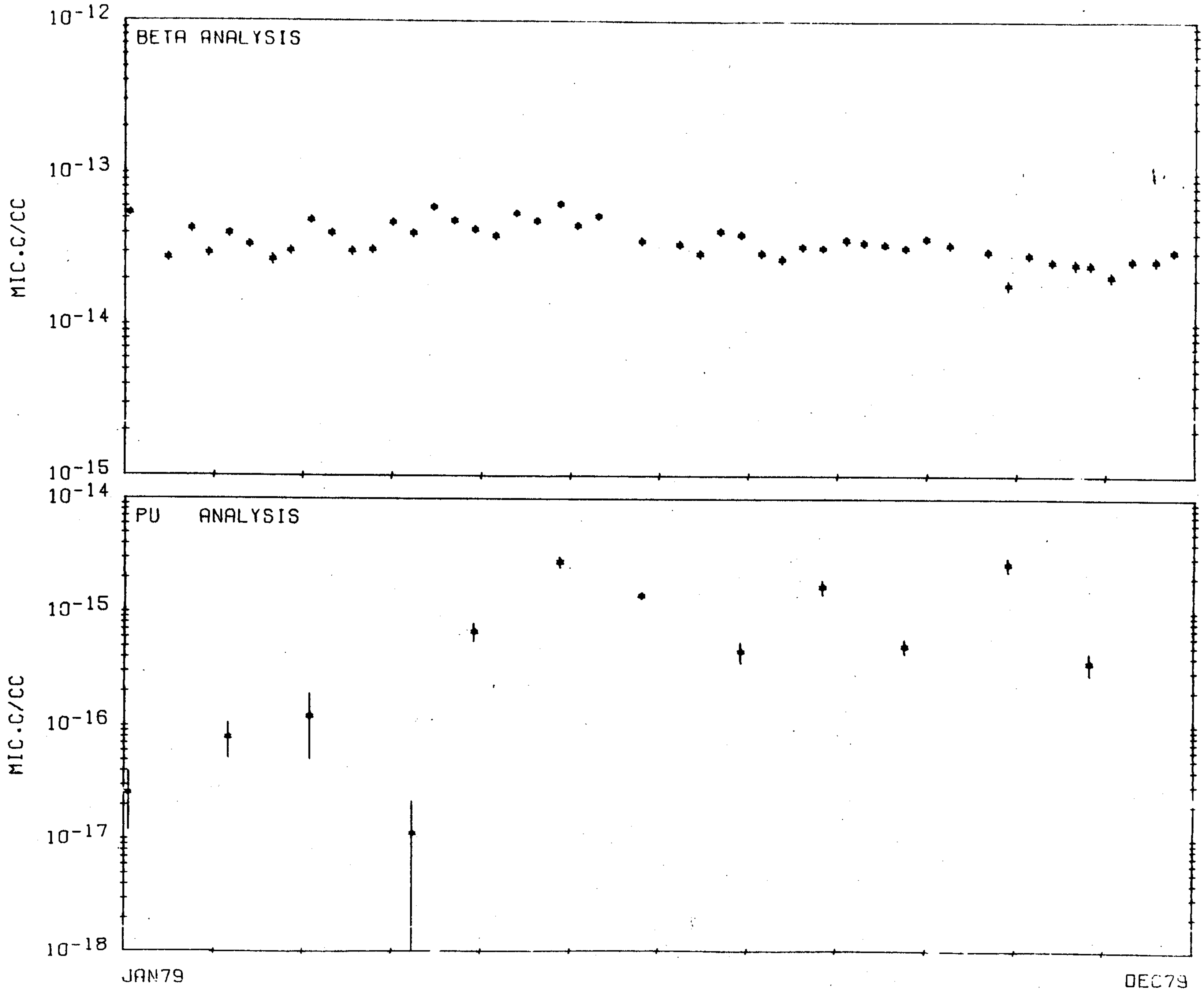
AIR SAMPLING STATION NUMBER 22



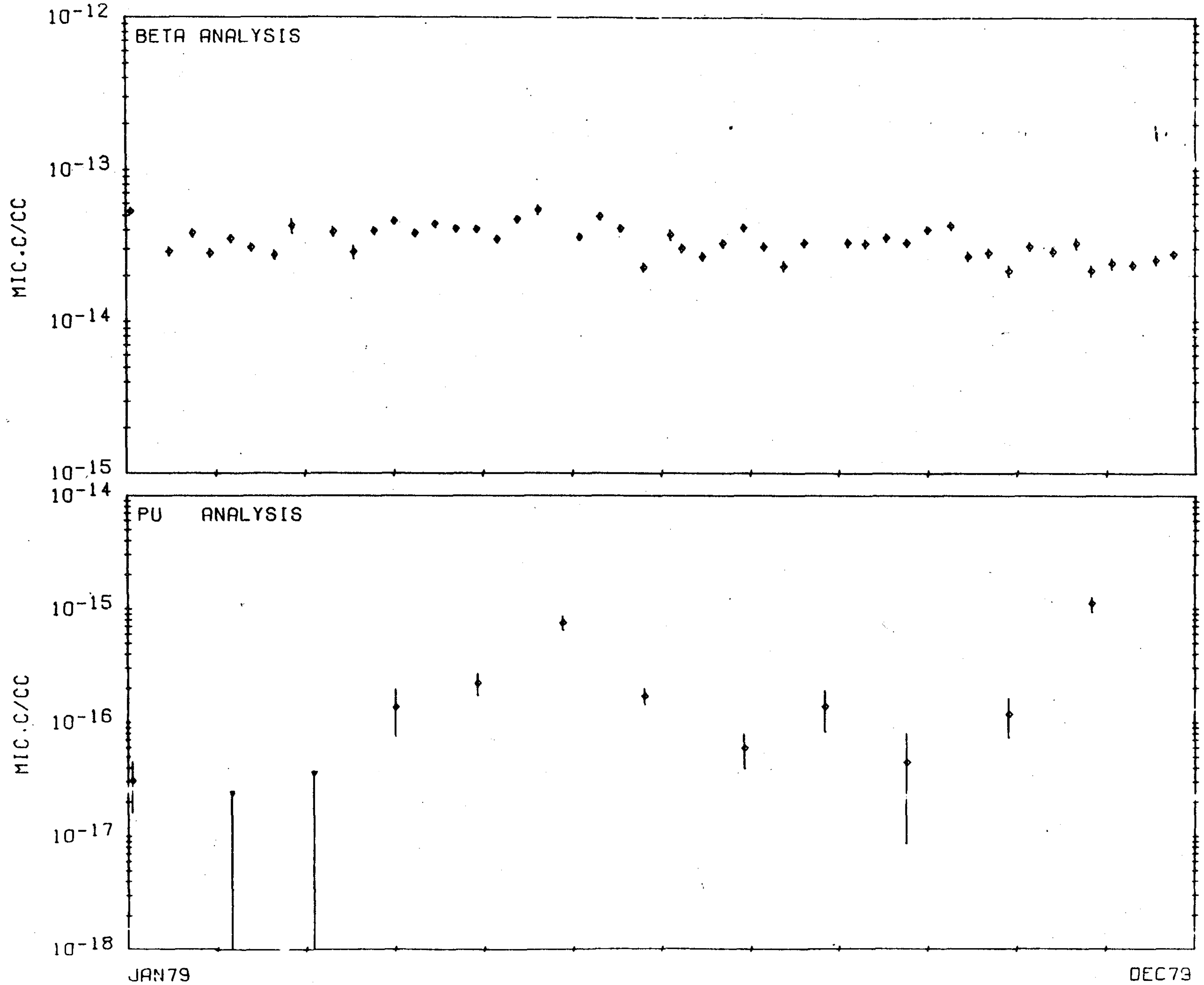
AIR SAMPLING STATION NUMBER 23



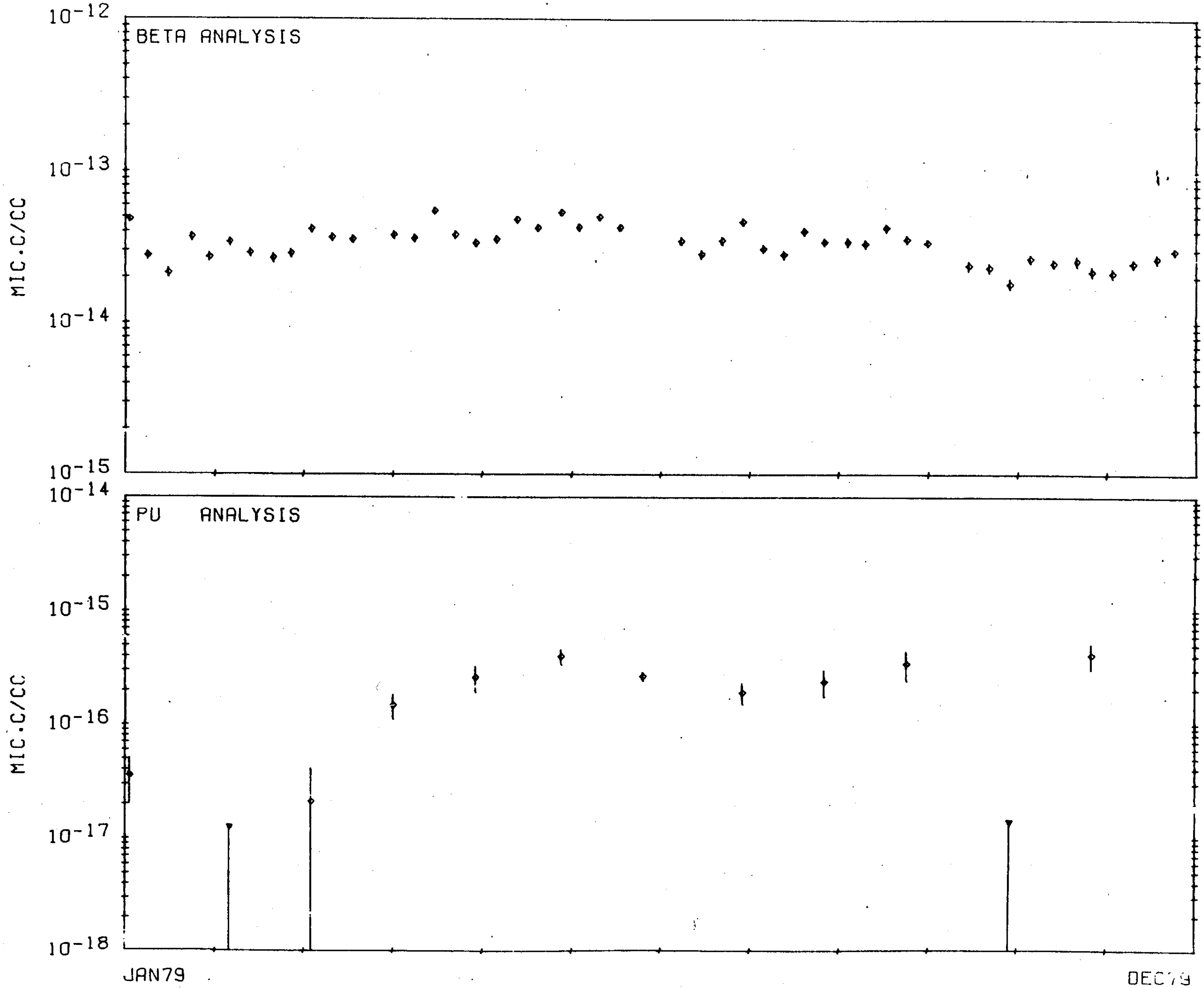
AIR SAMPLING STATION NUMBER 25

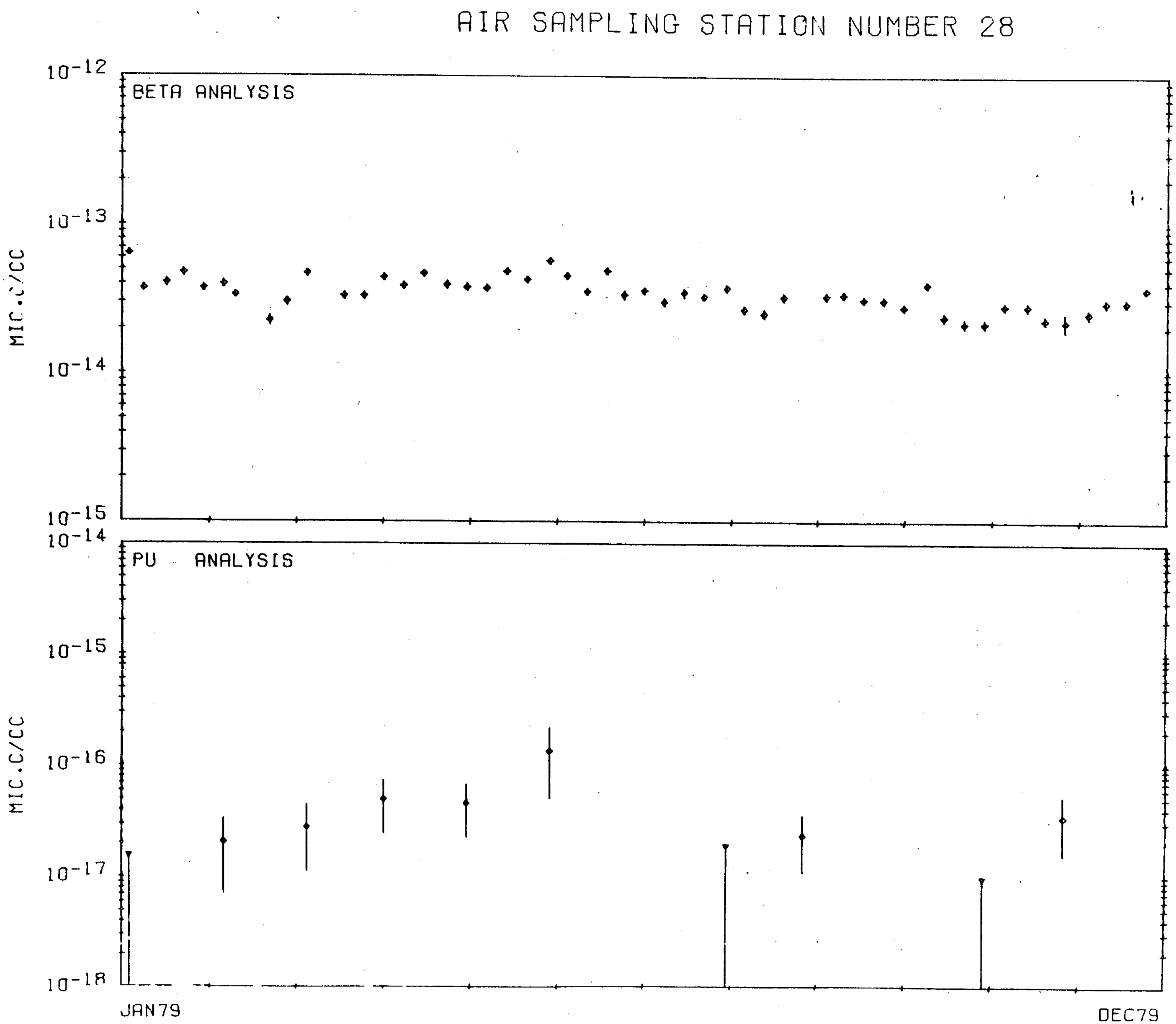


AIR SAMPLING STATION NUMBER 26

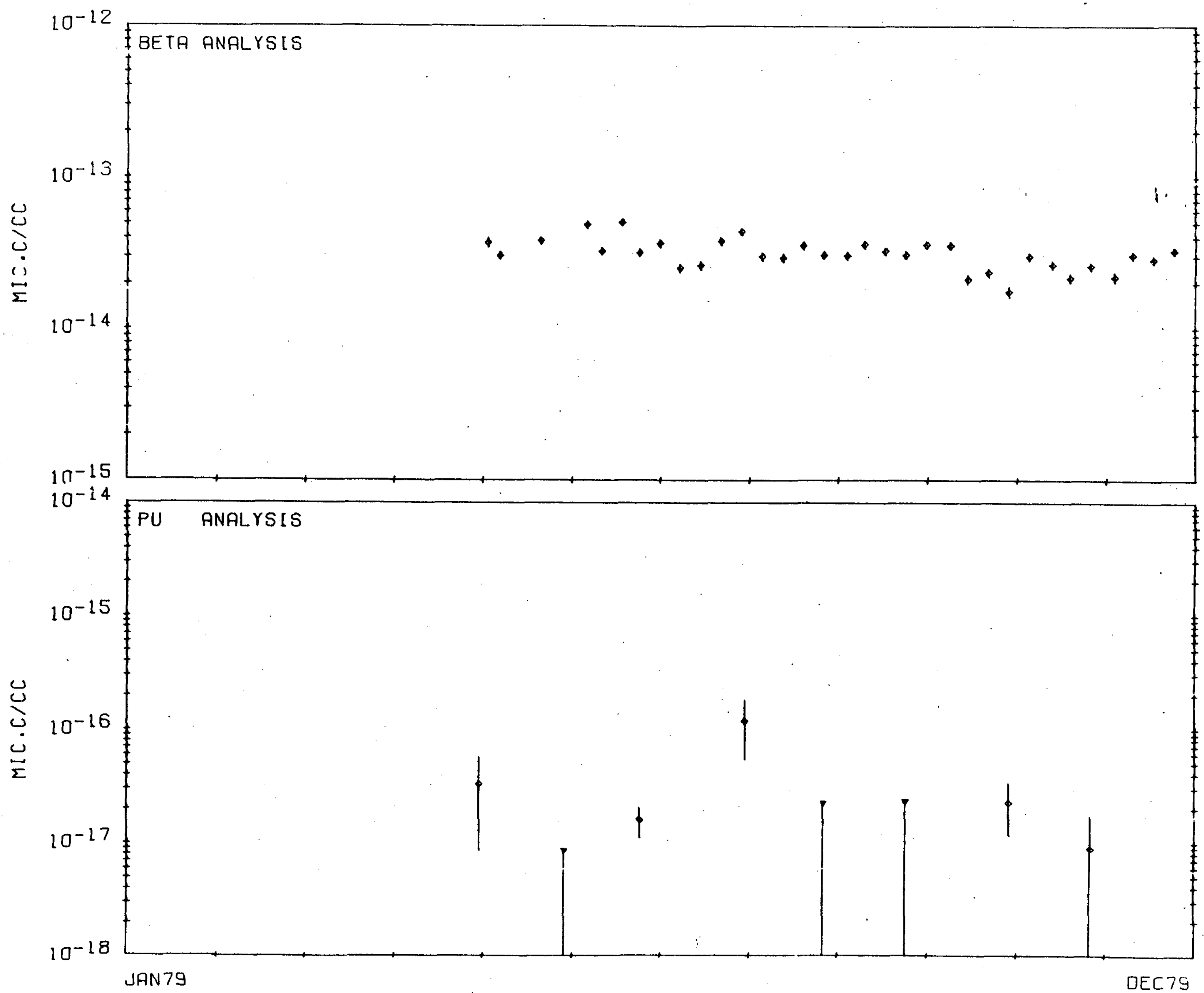


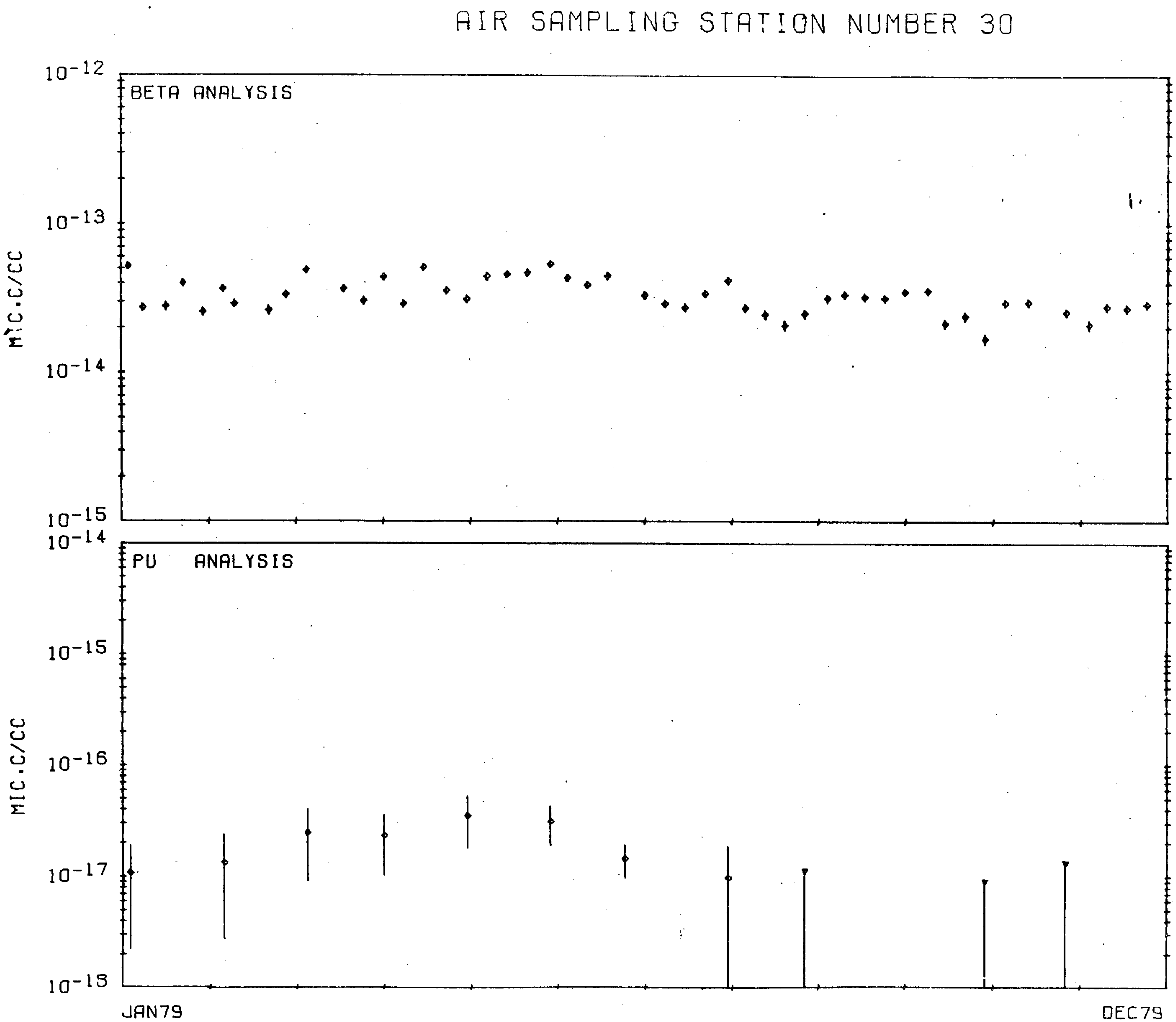
AIR SAMPLING STATION NUMBER 27



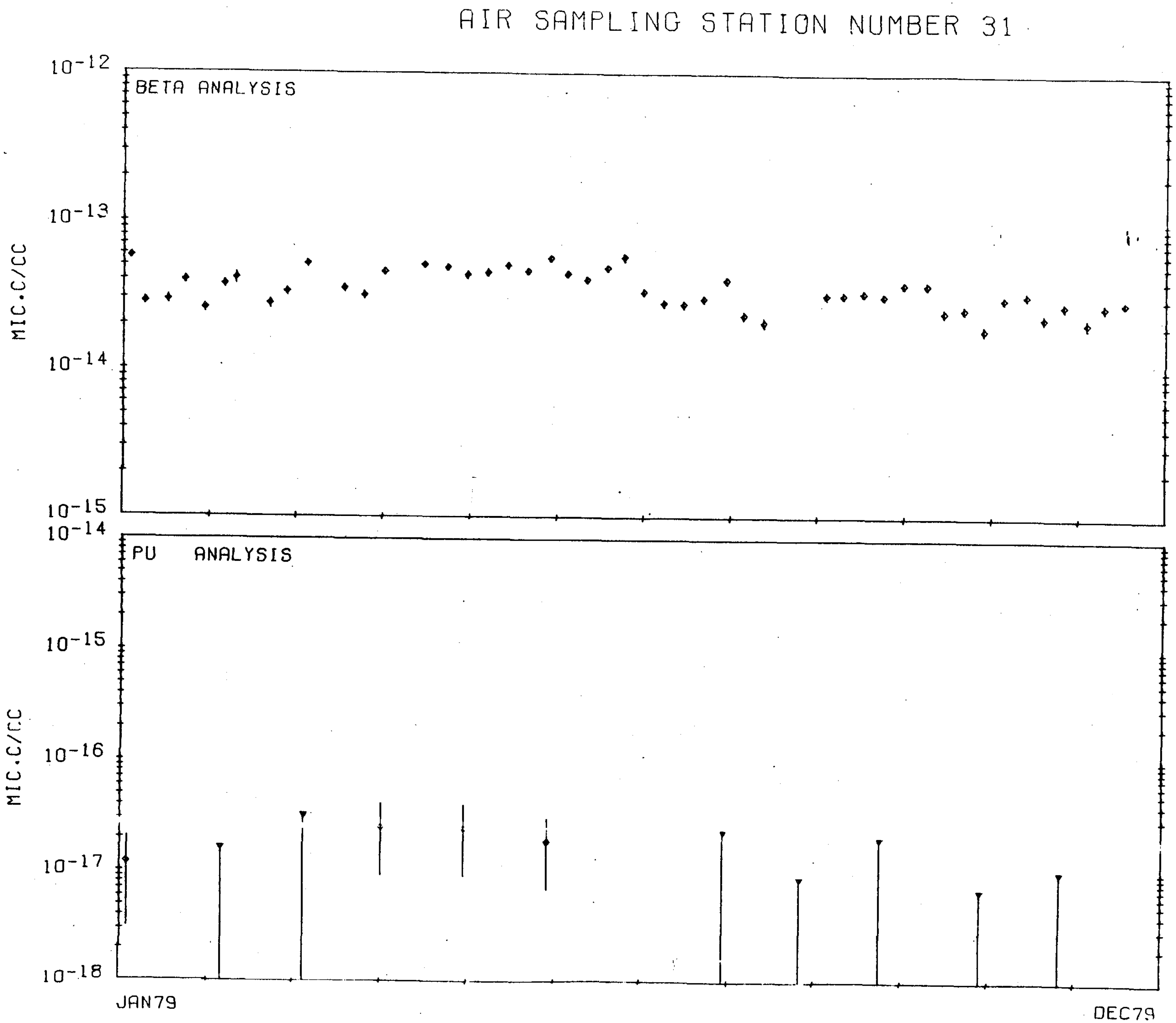

AIR SAMPLING STATION NUMBER 28
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN79
DEC79

AIR SAMPLING STATION NUMBER 29

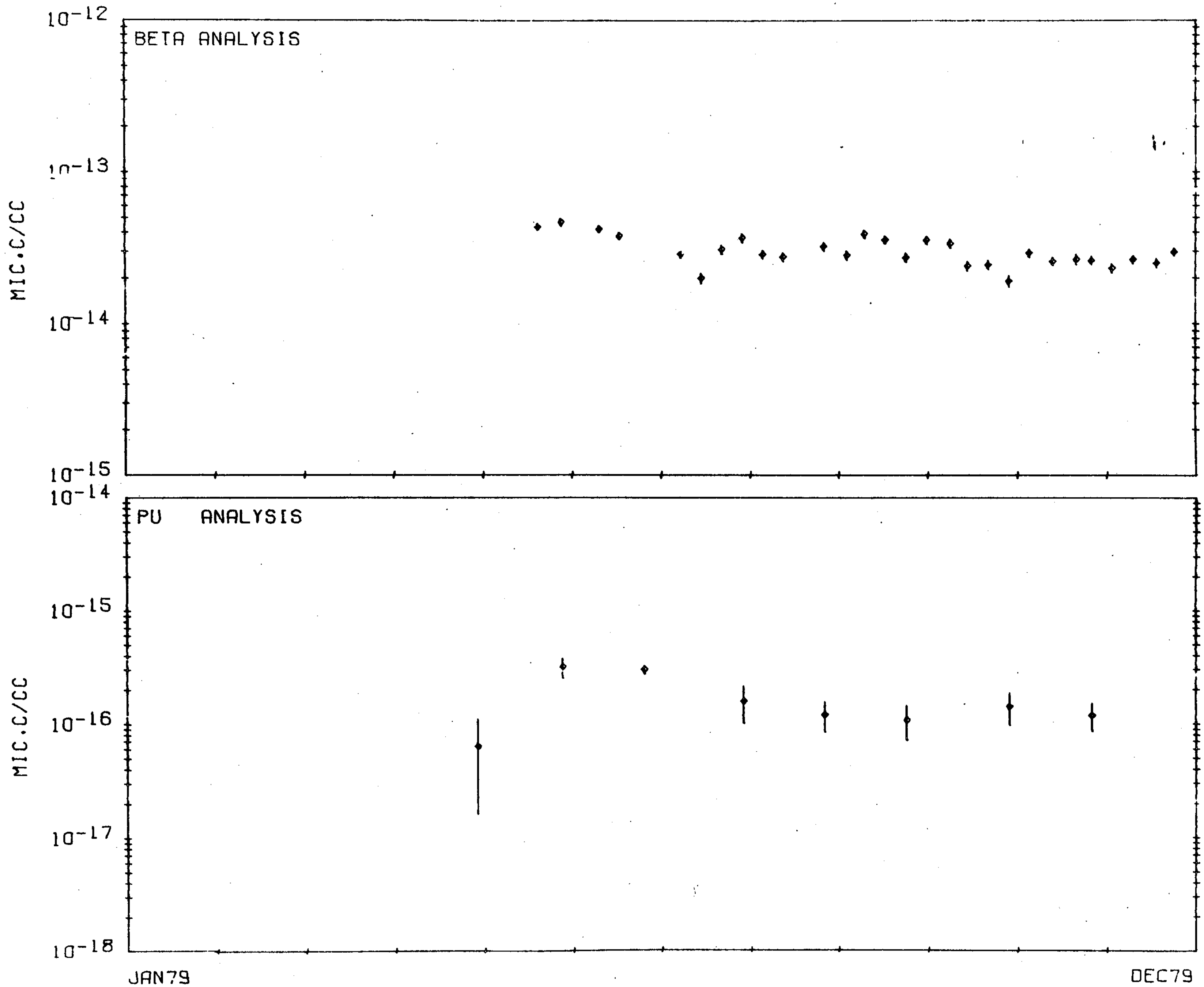


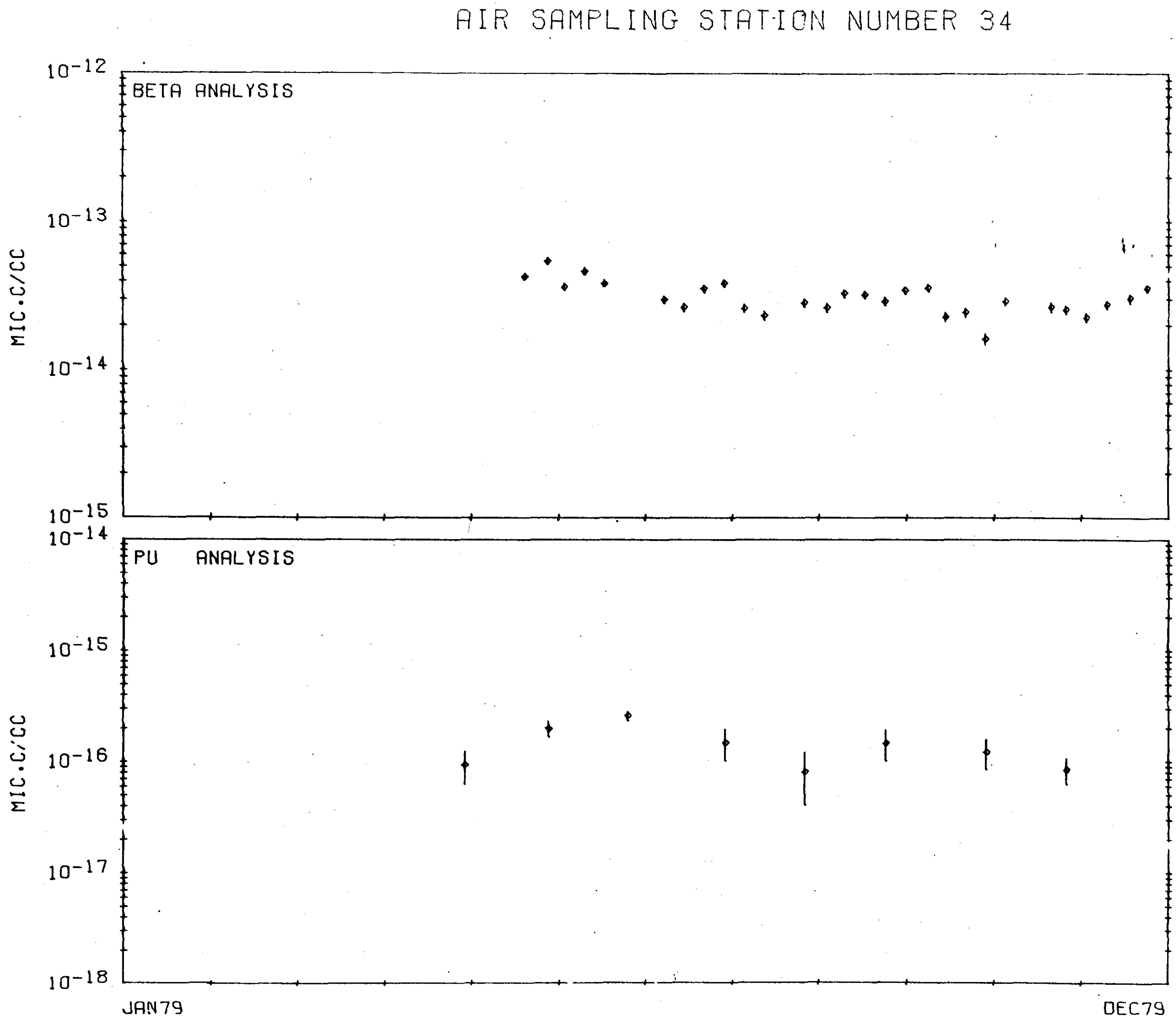

AIR SAMPLING STATION NUMBER 30
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN79
DEC79

-96-


AIR SAMPLING STATION NUMBER 31
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN79
DEC79

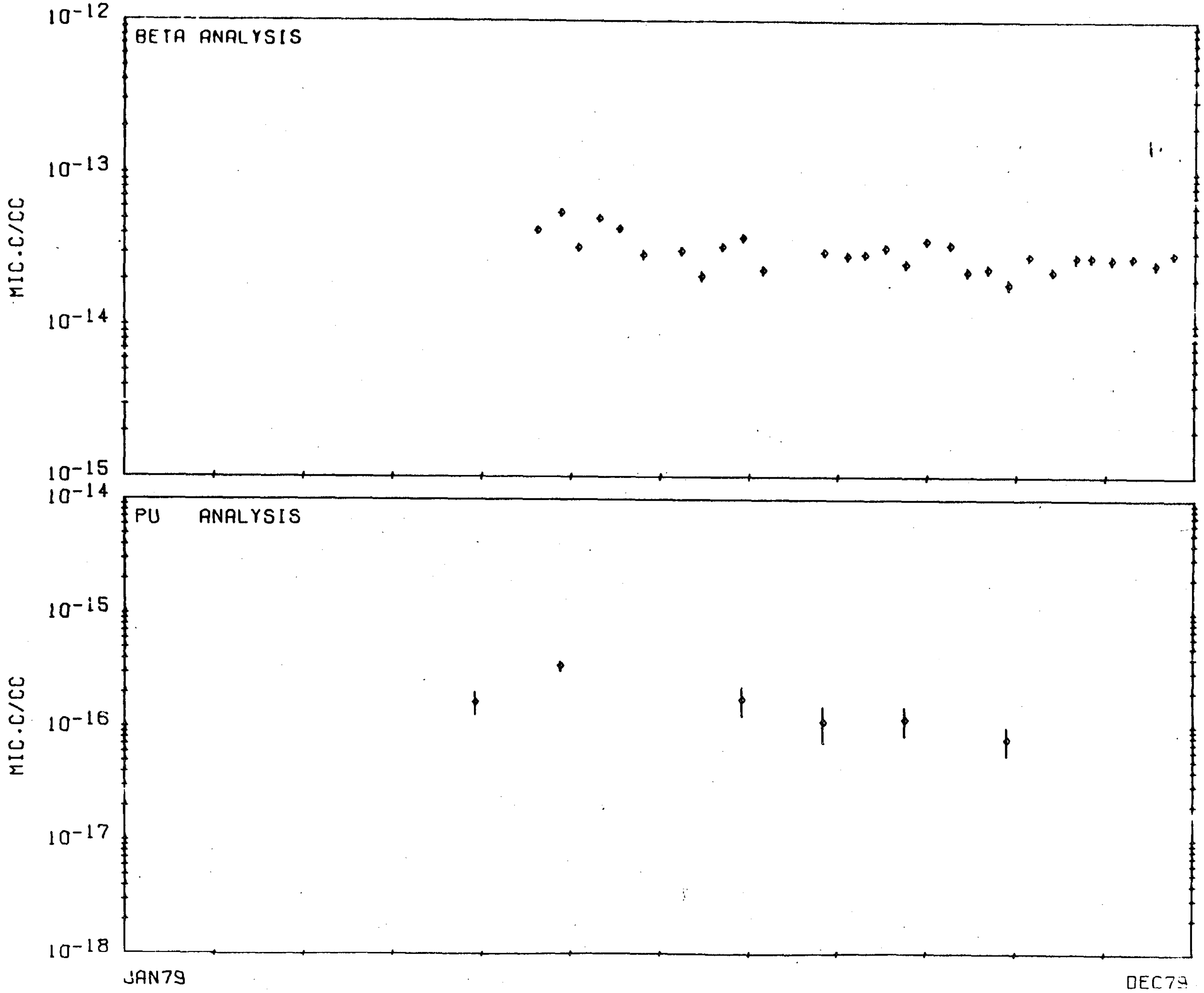
AIR SAMPLING STATION NUMBER 33



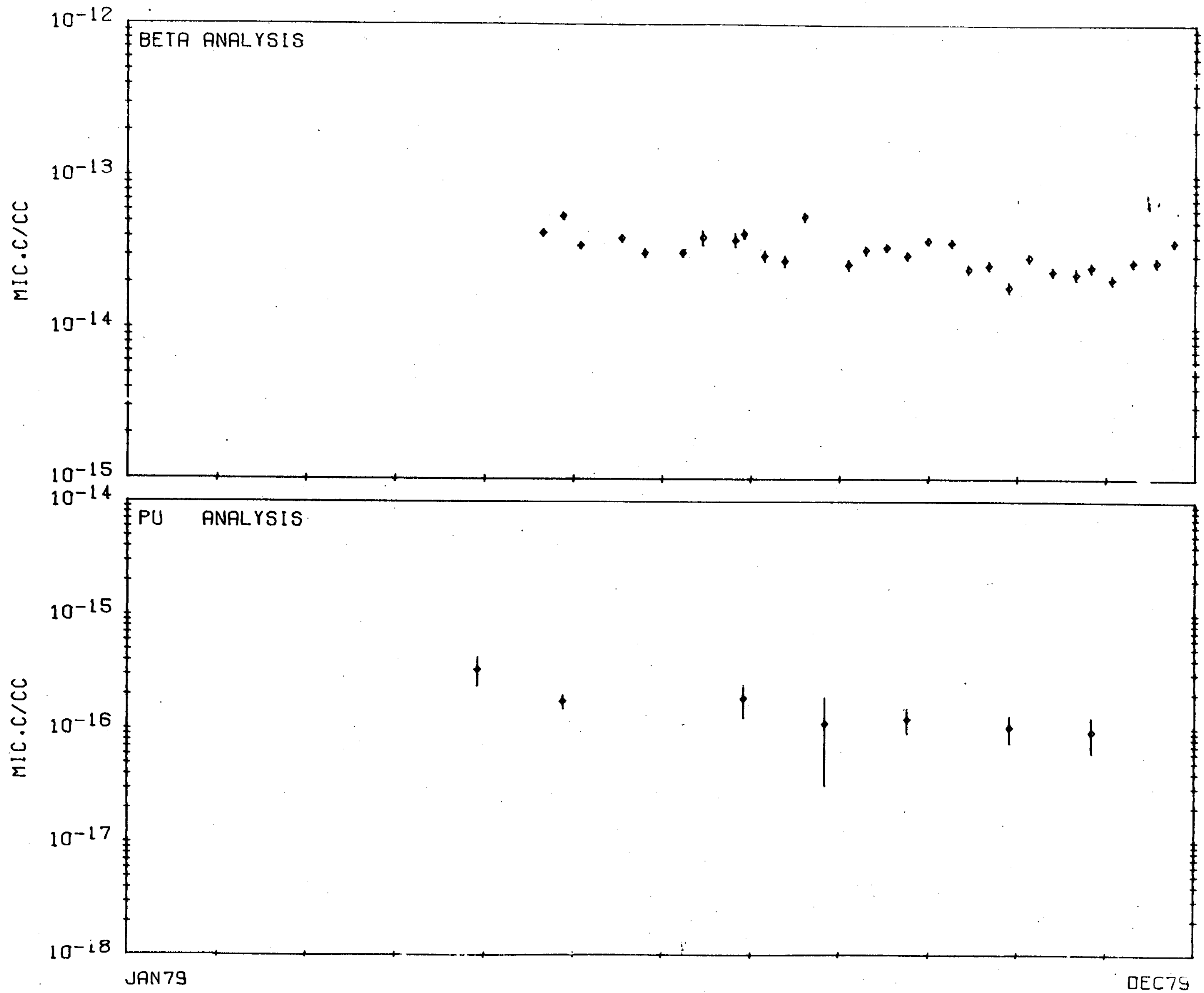


AIR SAMPLING STATION NUMBER 34
BETA ANALYSIS
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
PU ANALYSIS
MIC.C/CC
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN79
DEC79

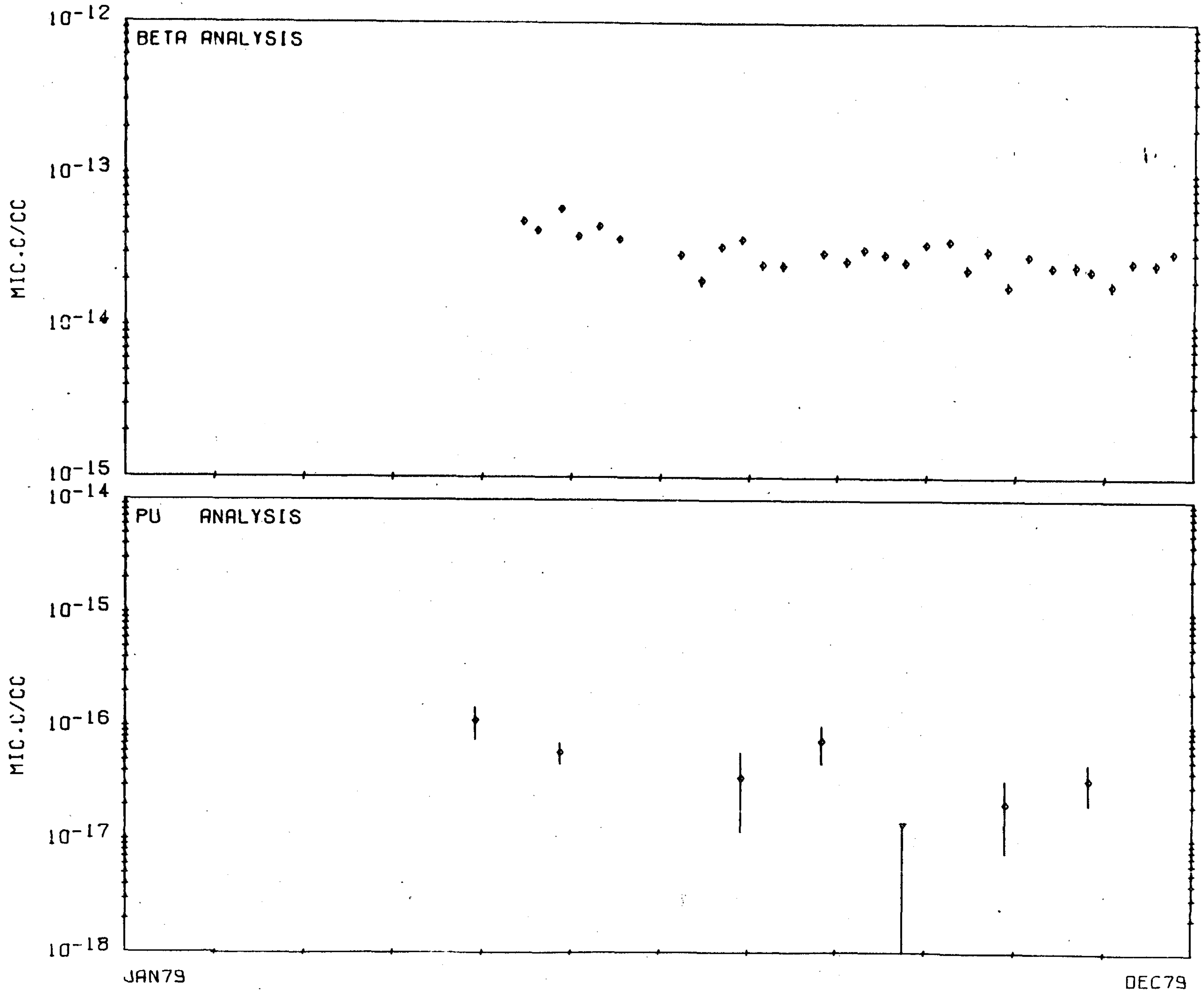
AIR SAMPLING STATION NUMBER 35



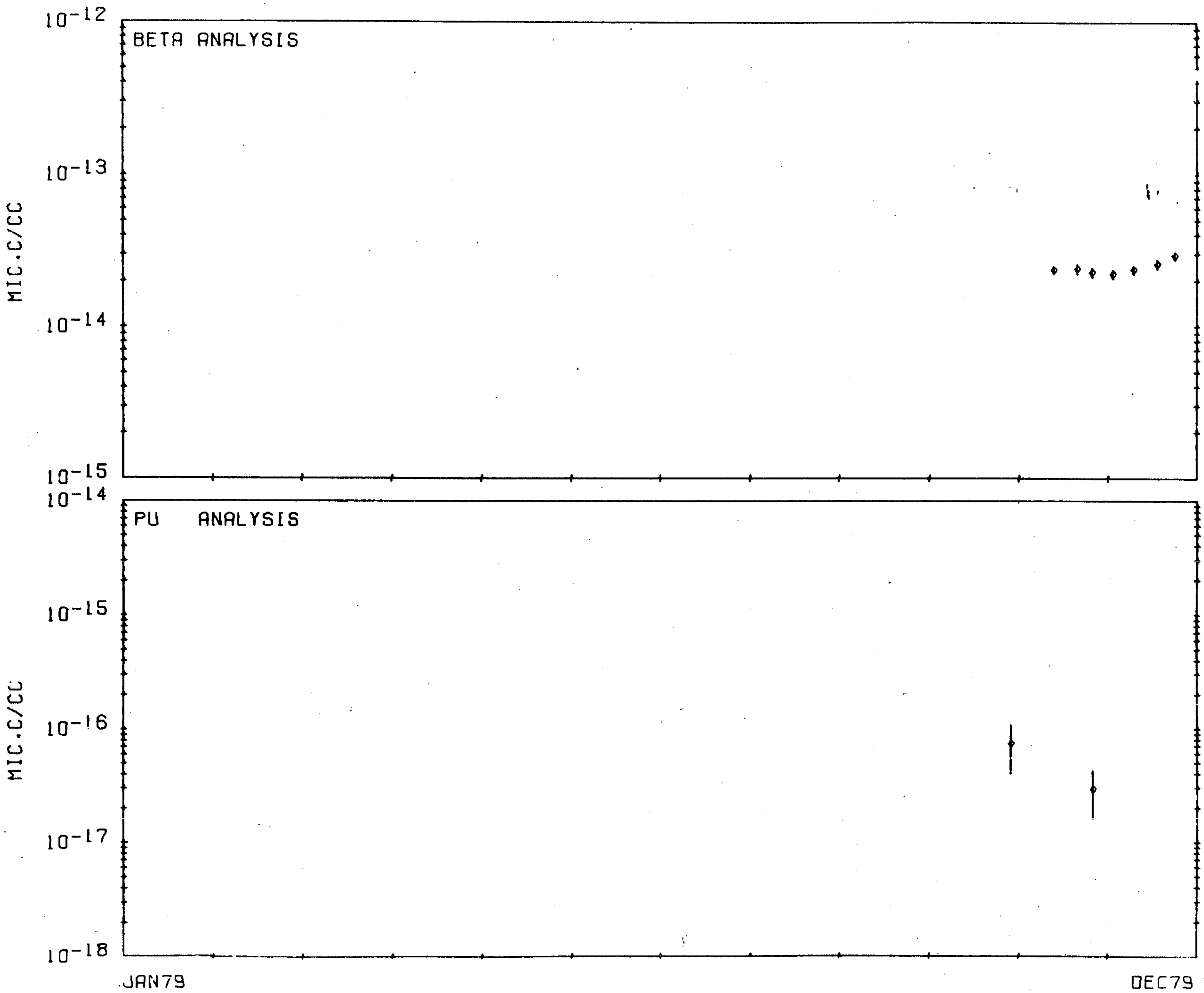
AIR SAMPLING STATION NUMBER 36

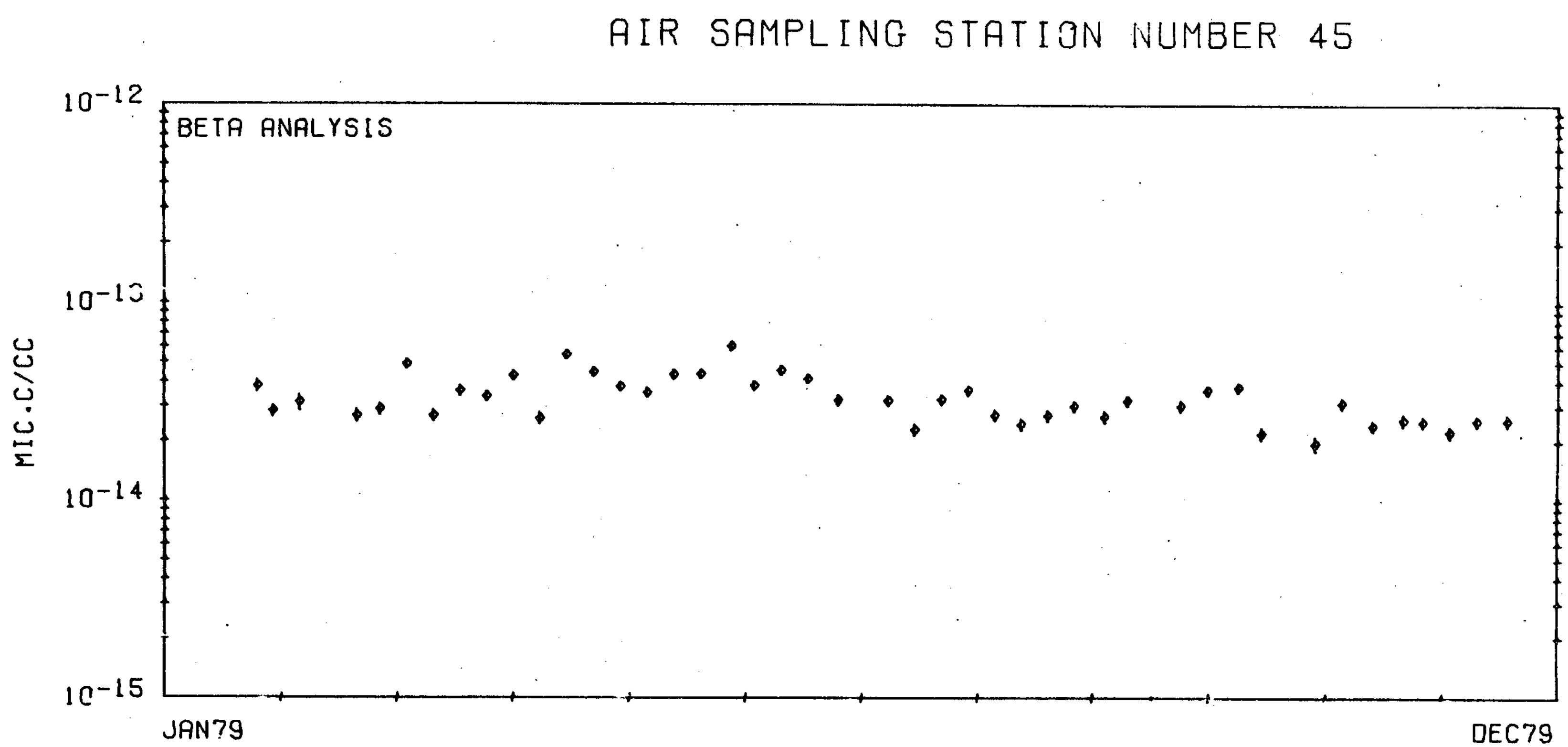


AIR SAMPLING STATION NUMBER 37



AIR SAMPLING STATION NUMBER 38





AIR SAMPLING STATION NUMBER 45
BETA ANALYSIS
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
JAN79
DEC79

-103-

A P P E N D I X B

NTS Environmental Surveillance

Supply Wells Locations and Plots

Several symbols are used in Appendix B to denote the data points. In the first two pages of plots, the supply well network averages, a square represents the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

The remaining plots of Appendix B show the gross beta data of each station. The data symbols for the plots are as follows:

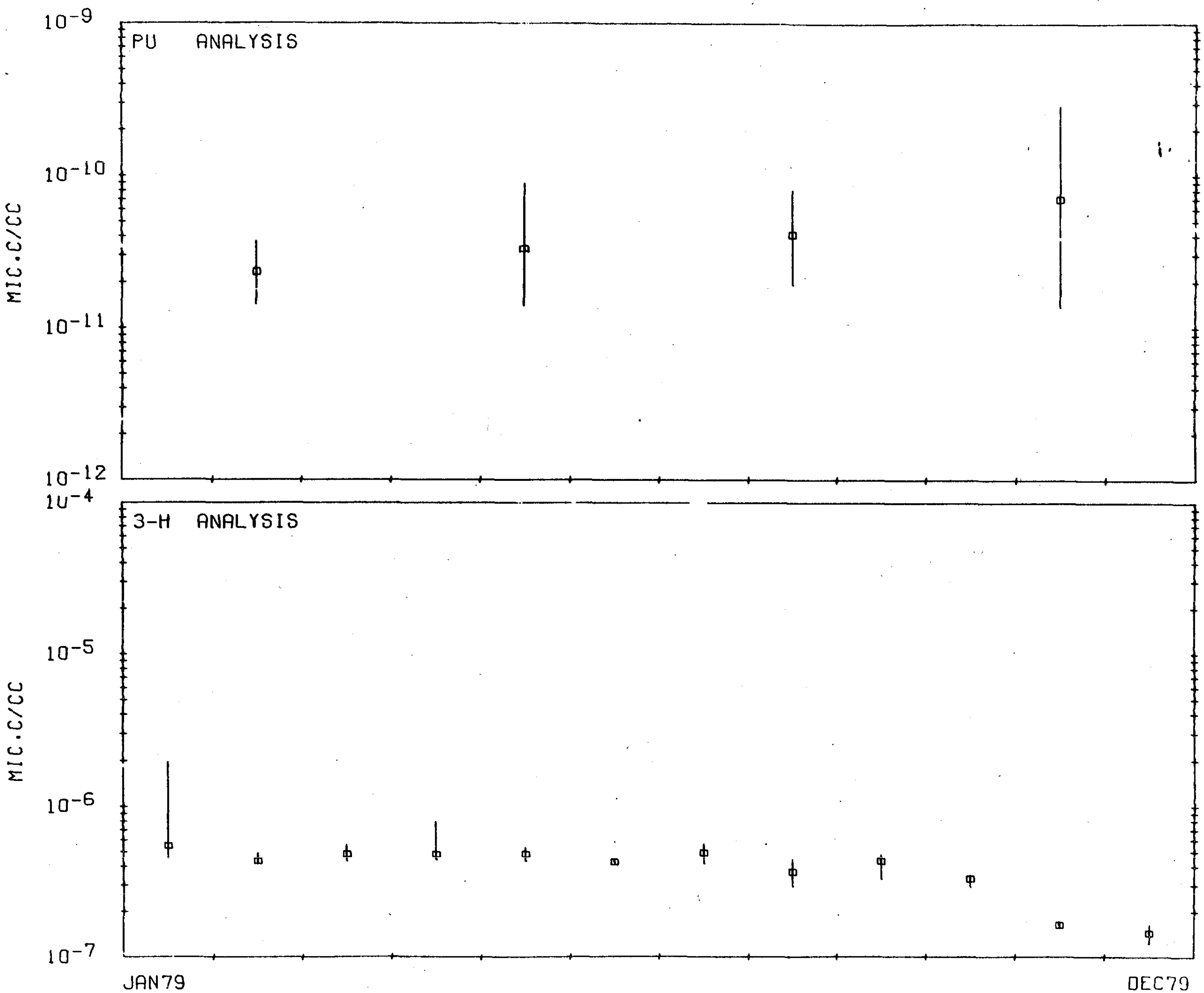
Plot #	Symbol
1-9	X
13-18	◊

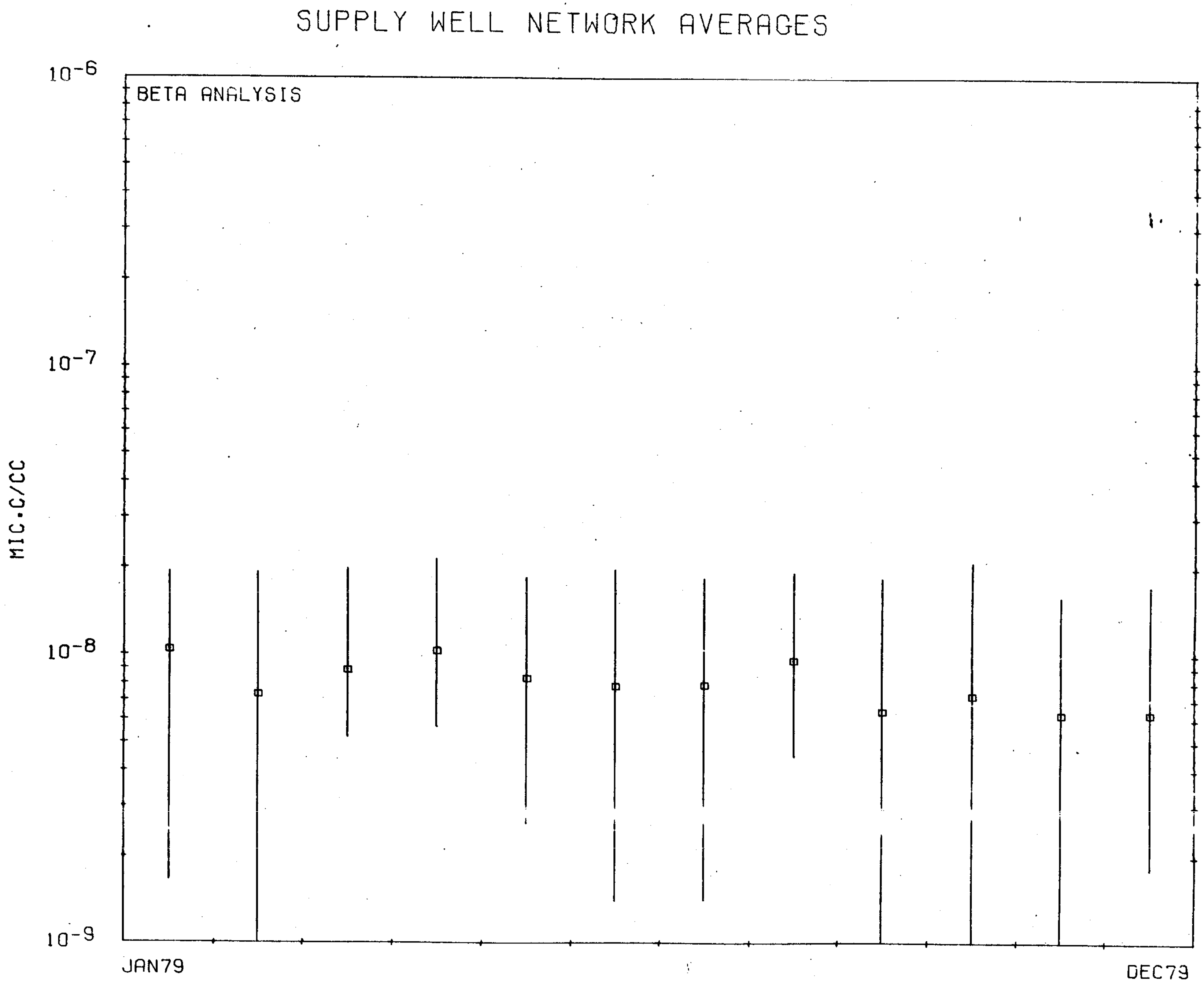
A two-sigma error bar is also added to the data points, and, in all of the plots, a delta with the line to the bottom of the plot means below detection limit.

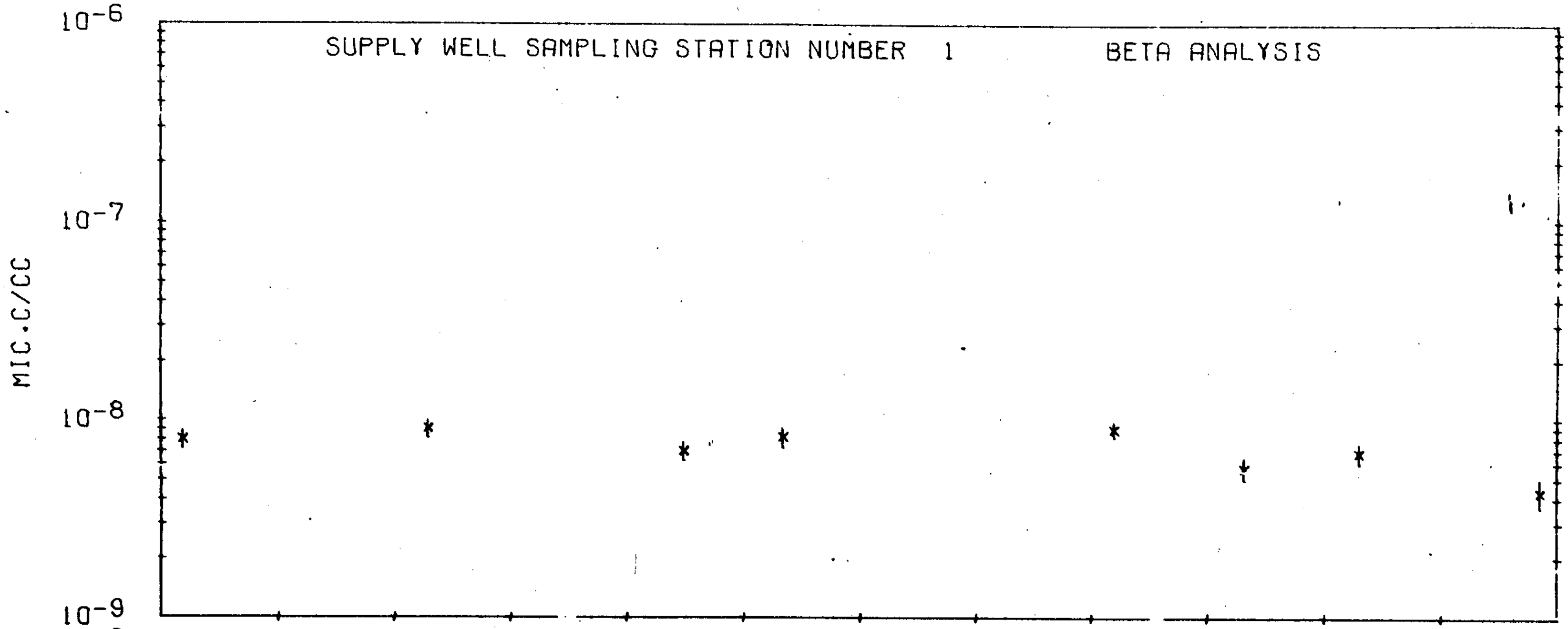
NTS ENVIRONMENTAL SURVEILLANCE
SUPPLY WELLS SAMPLING LOCATIONS

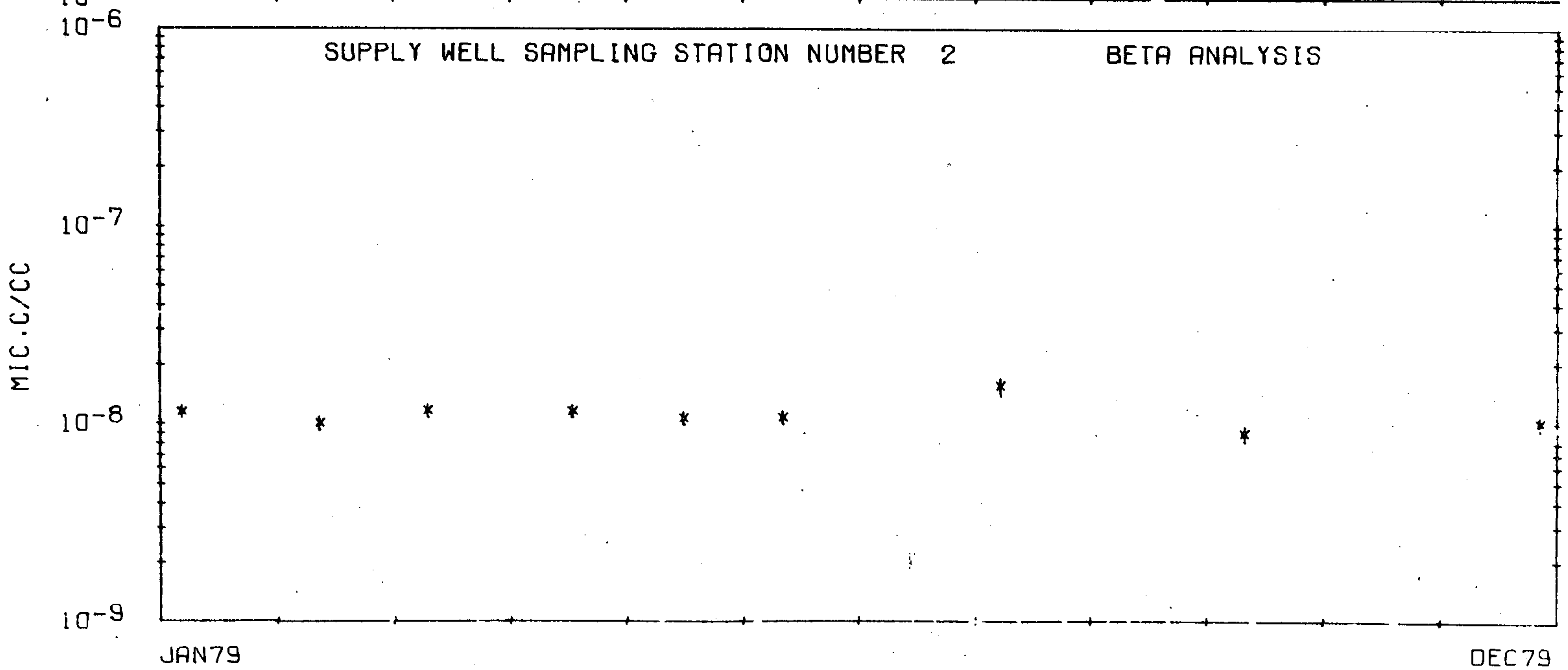
Station Number	Location
1	Area 2 Well 2
2	Area 3 Well A
3	Area 5 Well 5B
4	Area 5 Well 5C
5	Area 5 Well Ue5c
6	Area 6 Well C
7	Area 6 Well C1
8	Area 15 Well Ue15d
9	Area 18 Well 8
13	Area 22 Army Well #1
14	Area 25 Well J12
15	Area 25 Well J13
18	Area 19 Well U19c

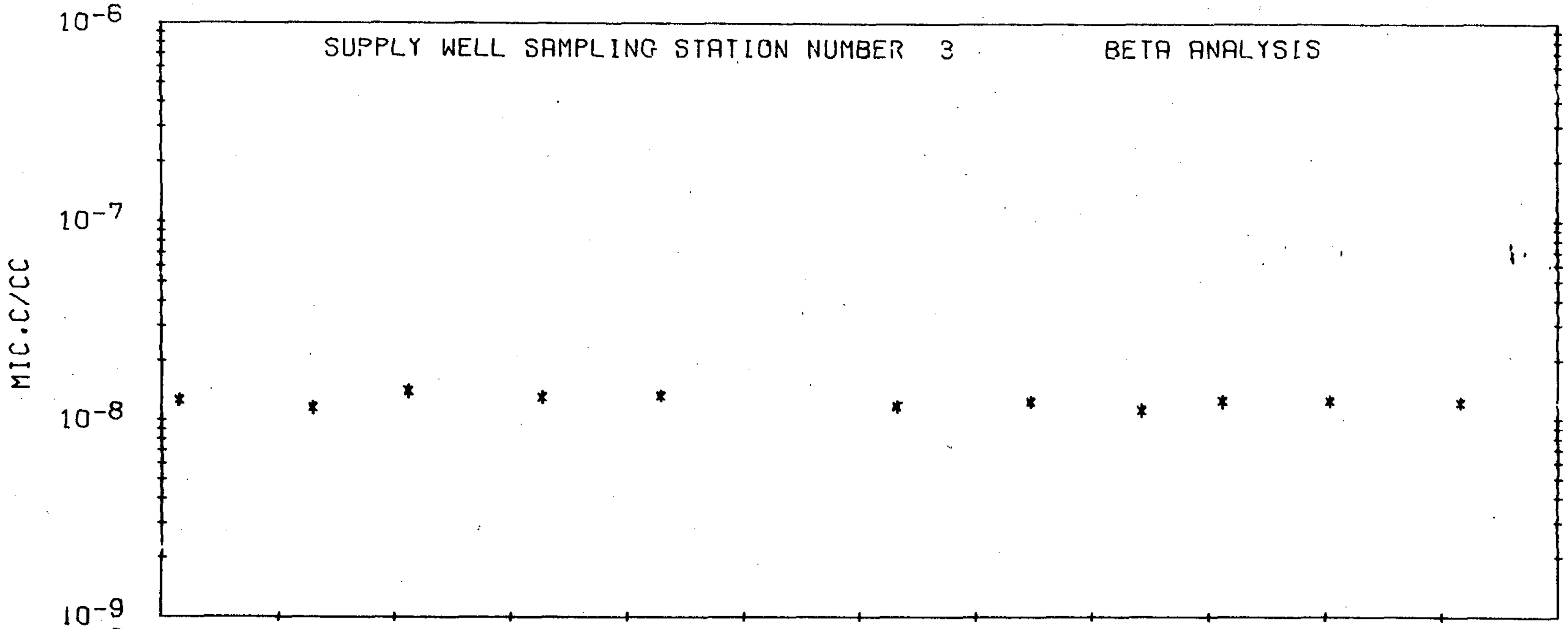
SUPPLY WELL NETWORK AVERAGES

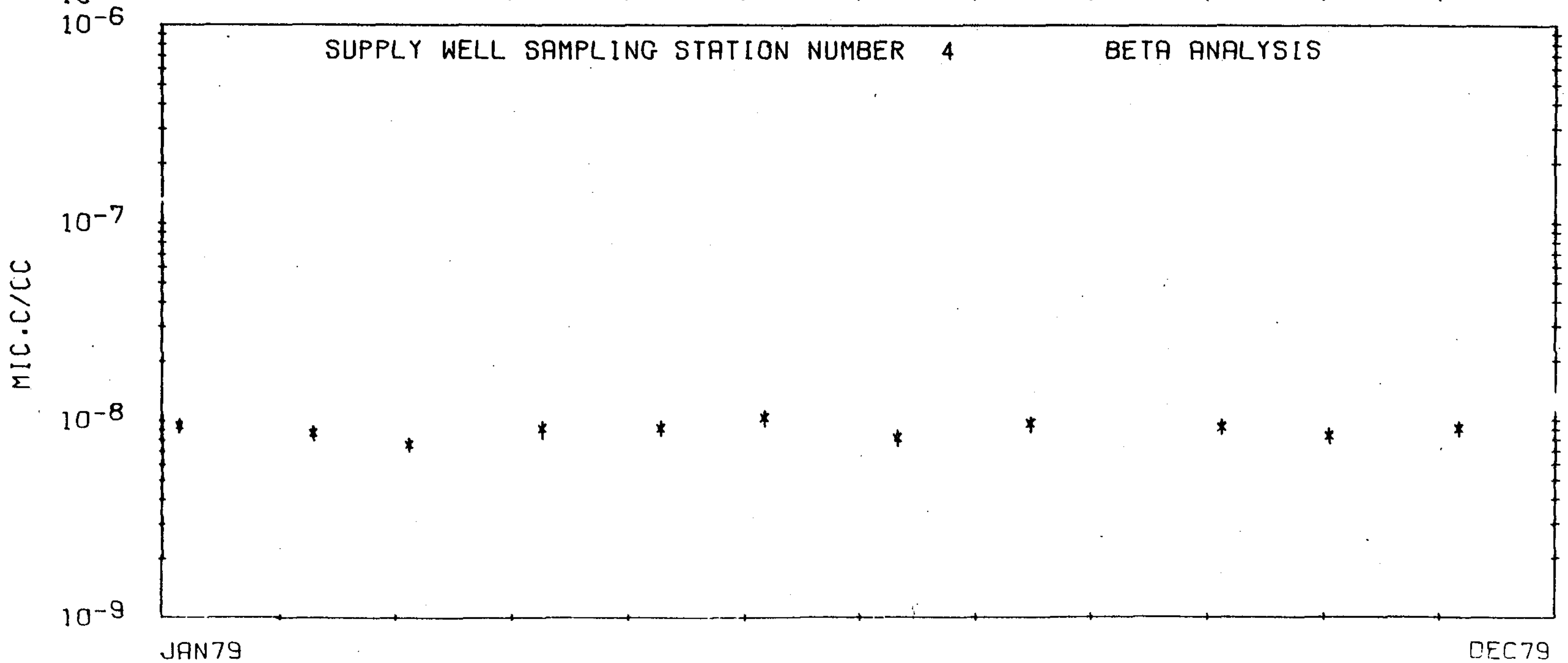


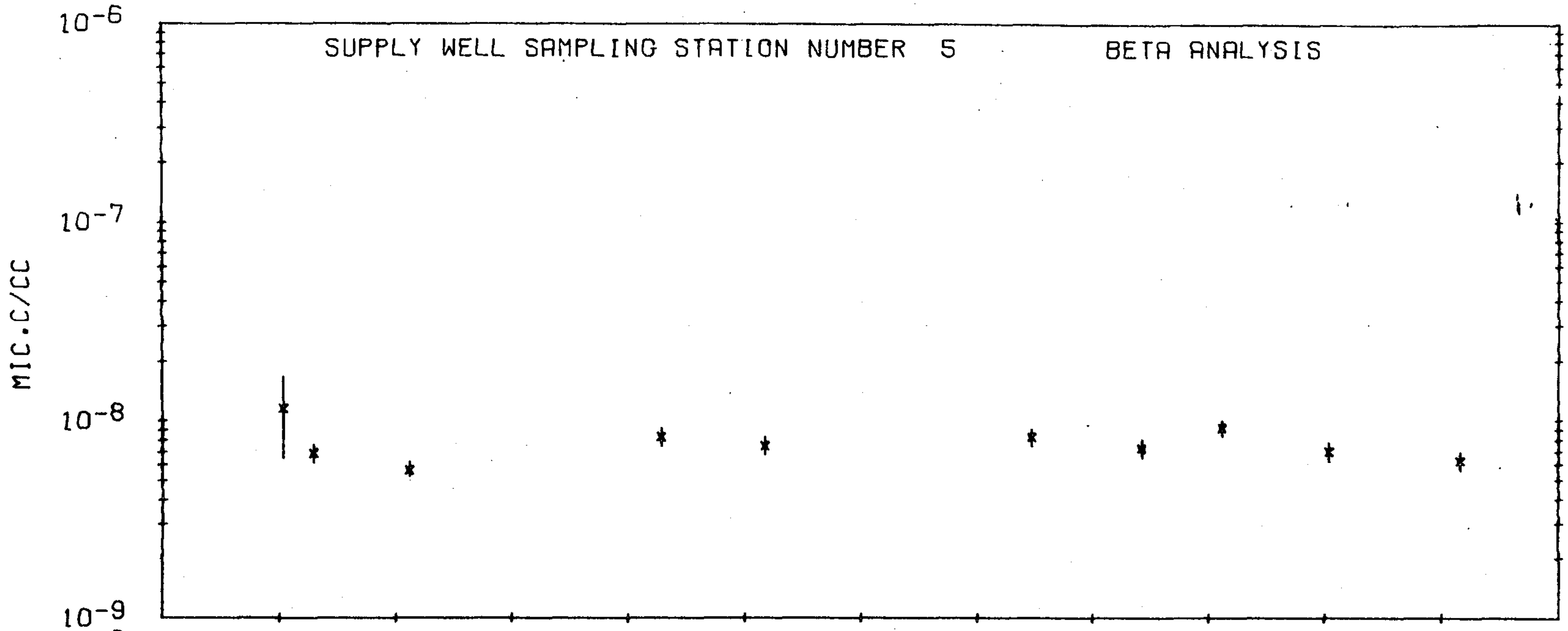

SUPPLY WELL NETWORK AVERAGES
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN79
DEC79

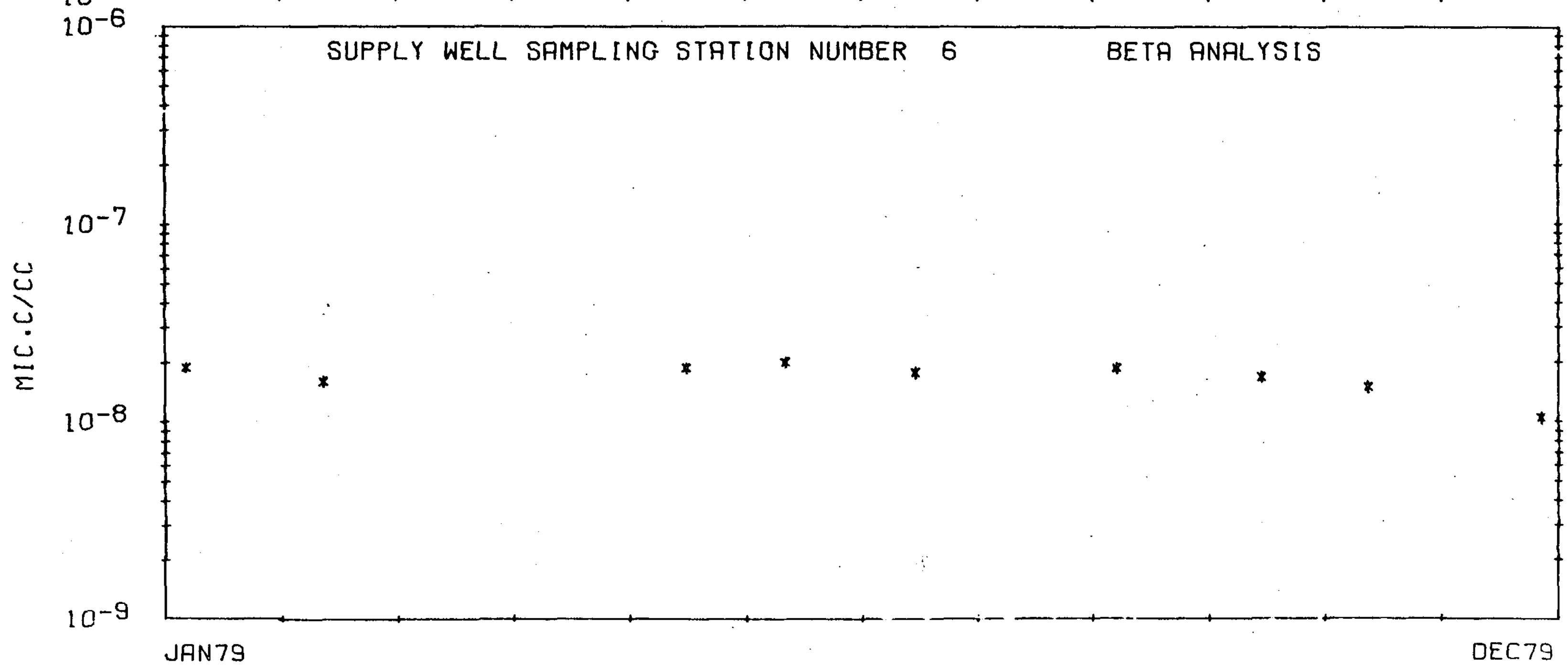

SUPPLY WELL SAMPLING STATION NUMBER 1 BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

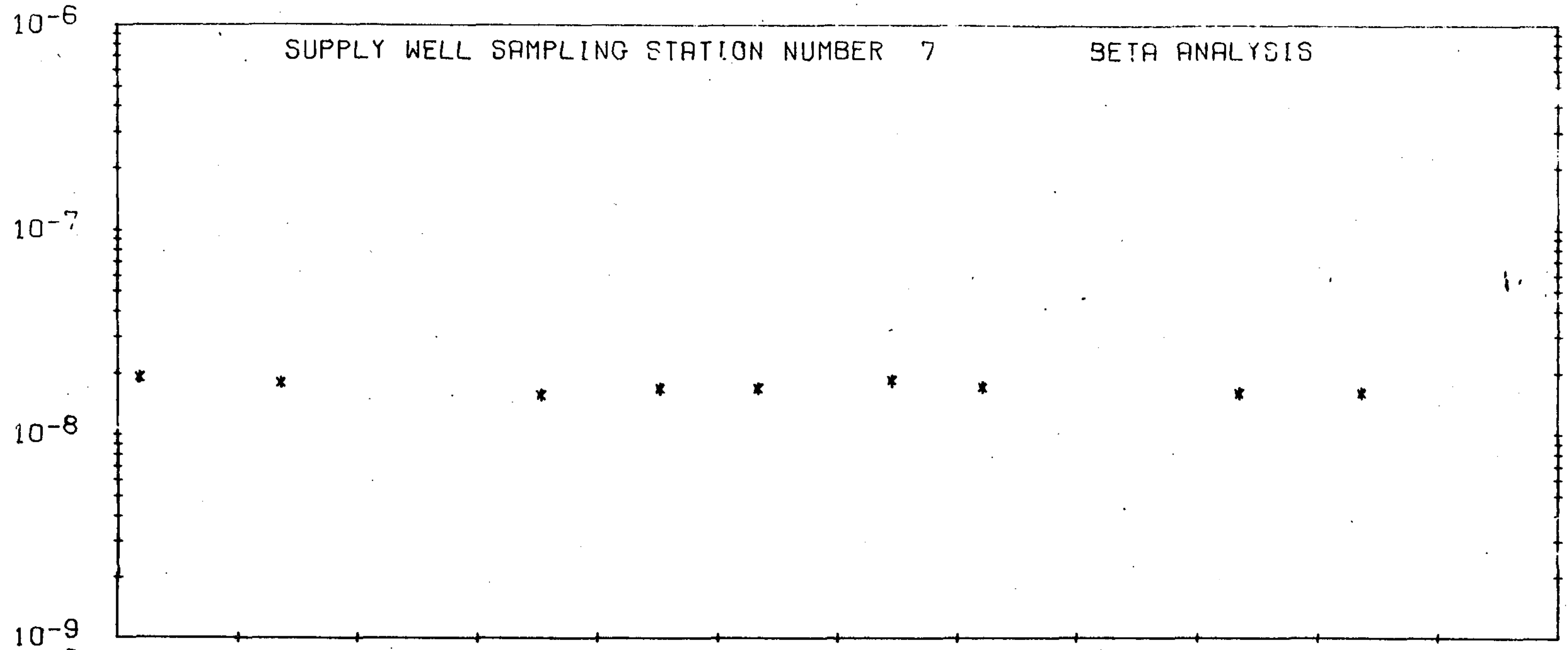

SUPPLY WELL SAMPLING STATION NUMBER 2 BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

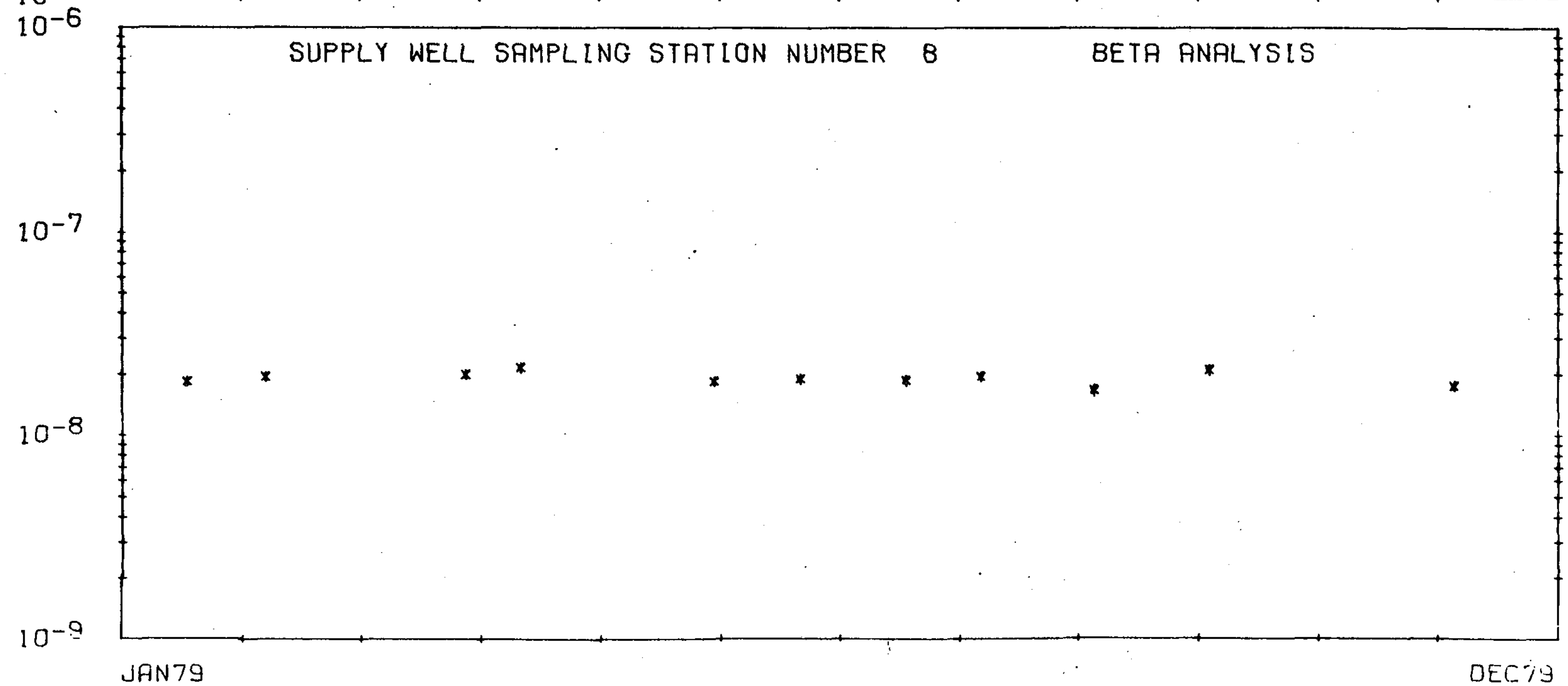

SUPPLY WELL SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

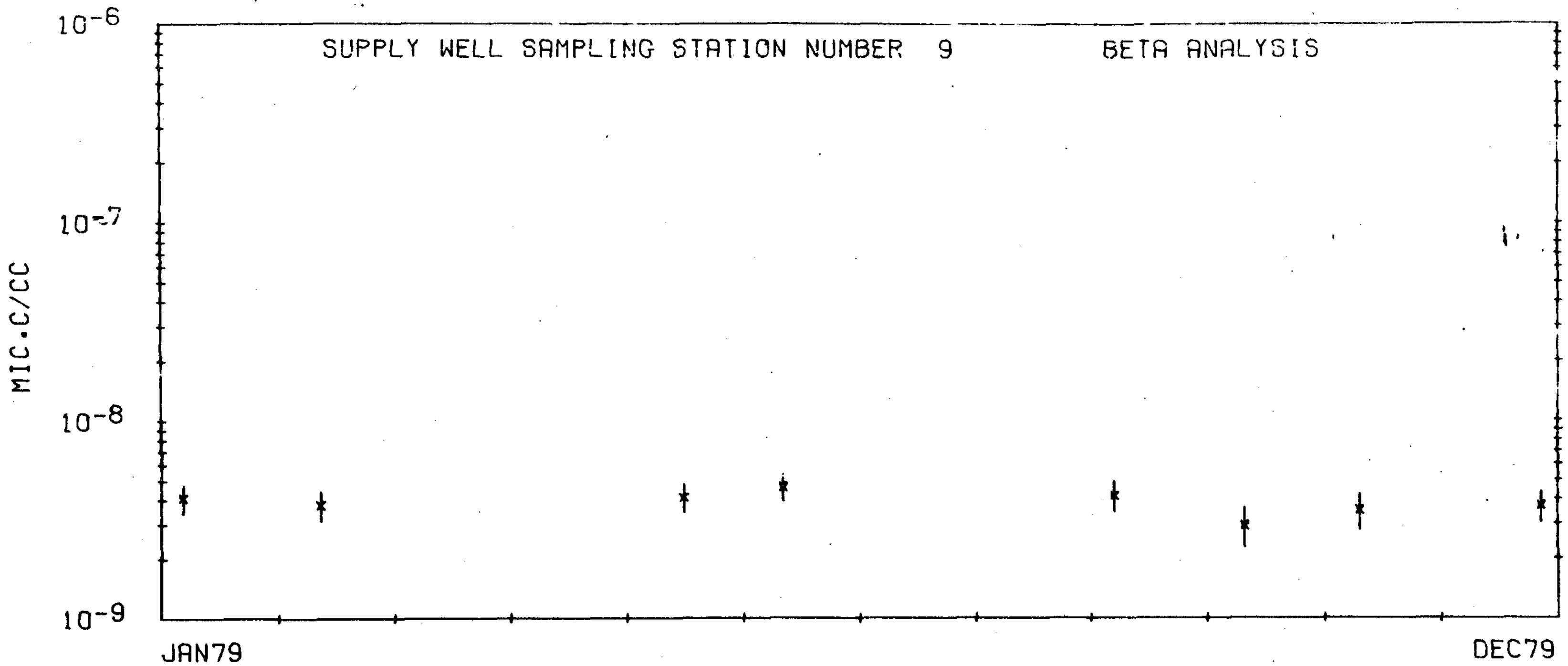

SUPPLY WELL SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

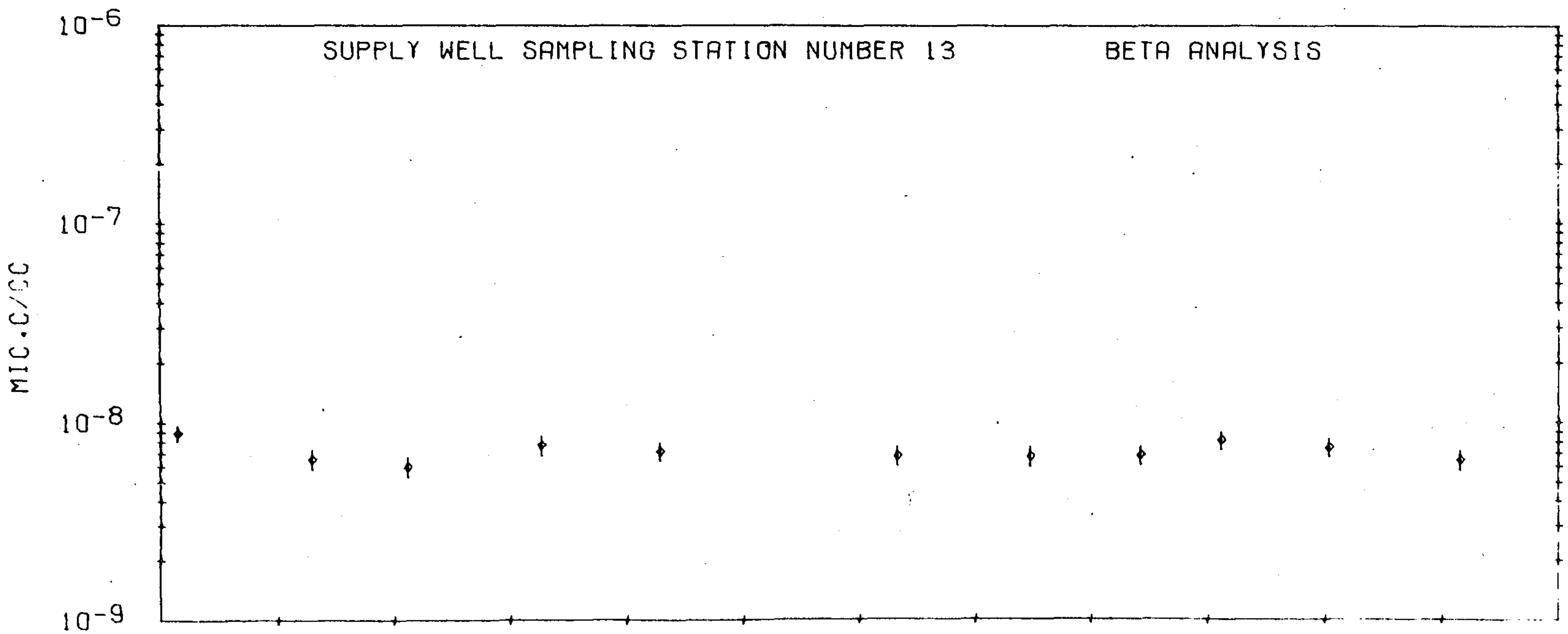

SUPPLY WELL SAMPLING STATION NUMBER 5
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

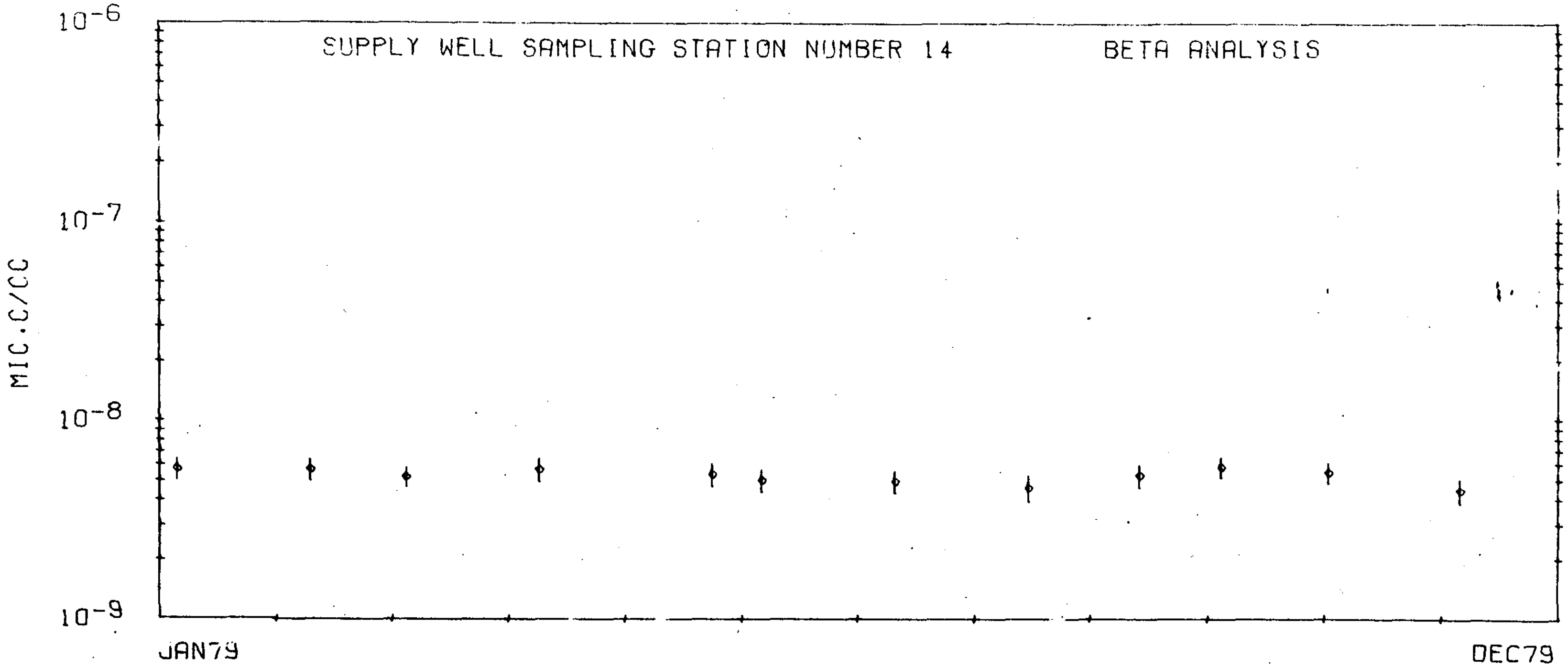

SUPPLY WELL SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

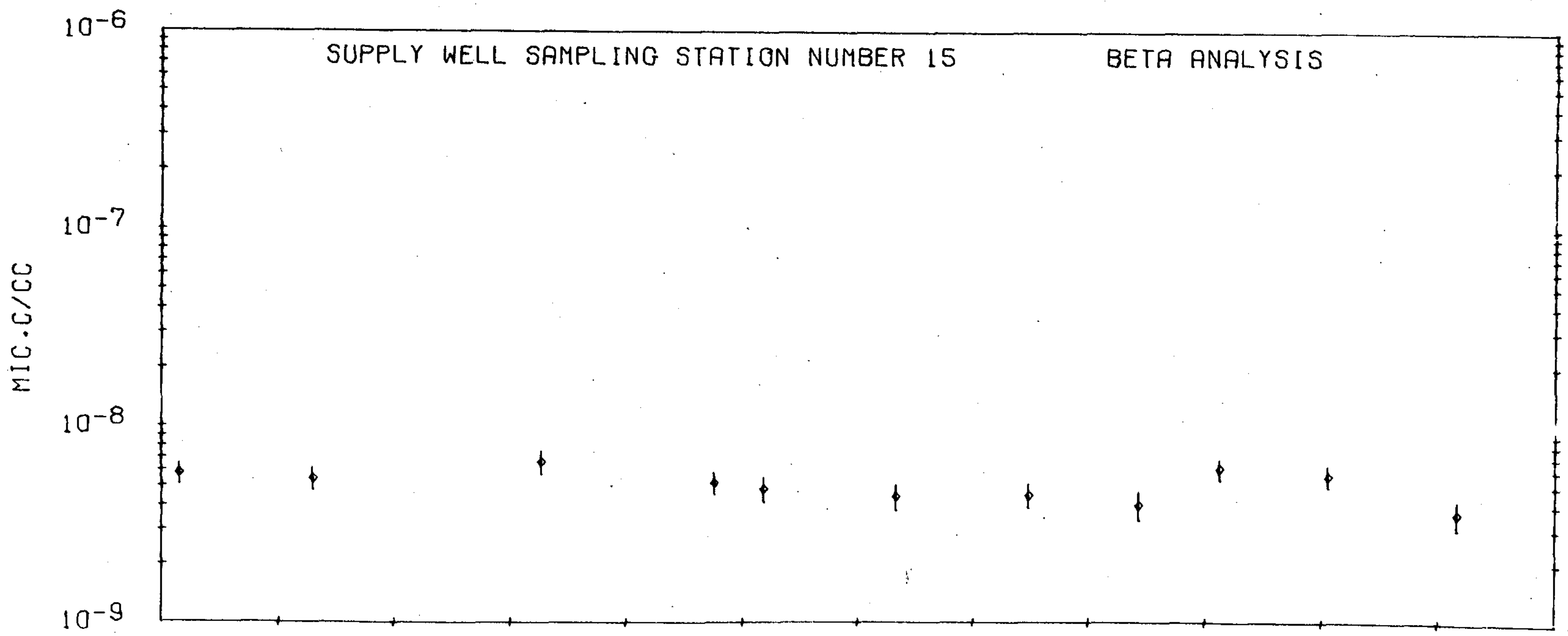

SUPPLY WELL SAMPLING STATION NUMBER 7
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

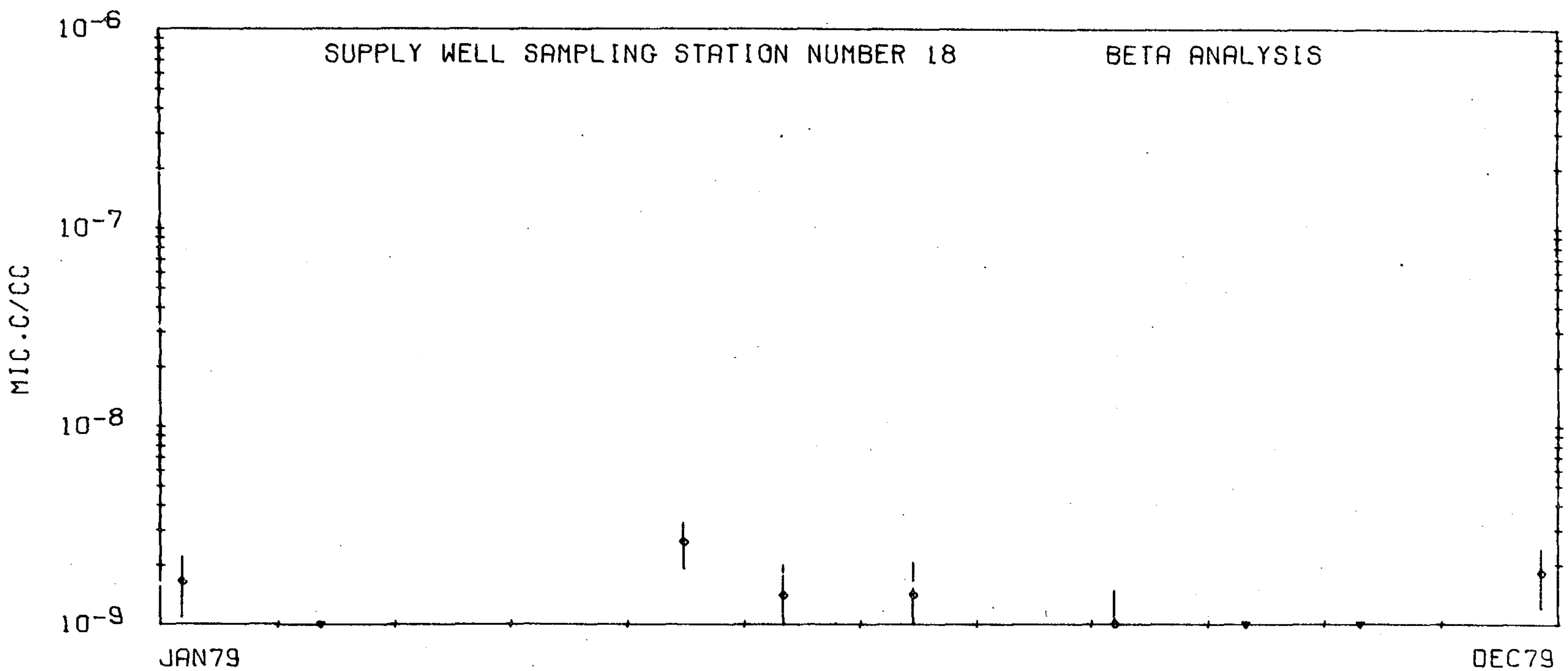

SUPPLY WELL SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79


SUPPLY WELL SAMPLING STATION NUMBER 9
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN79
DEC79


SUPPLY WELL SAMPLING STATION NUMBER 13
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9


SUPPLY WELL SAMPLING STATION NUMBER 14
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN79
DEC79


SUPPLY WELL SAMPLING STATION NUMBER 15
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9


SUPPLY WELL SAMPLING STATION NUMBER 18
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN79
DEC79

APPENDIX C

NTS Environmental Surveillance

Potable Water Locations and Plots

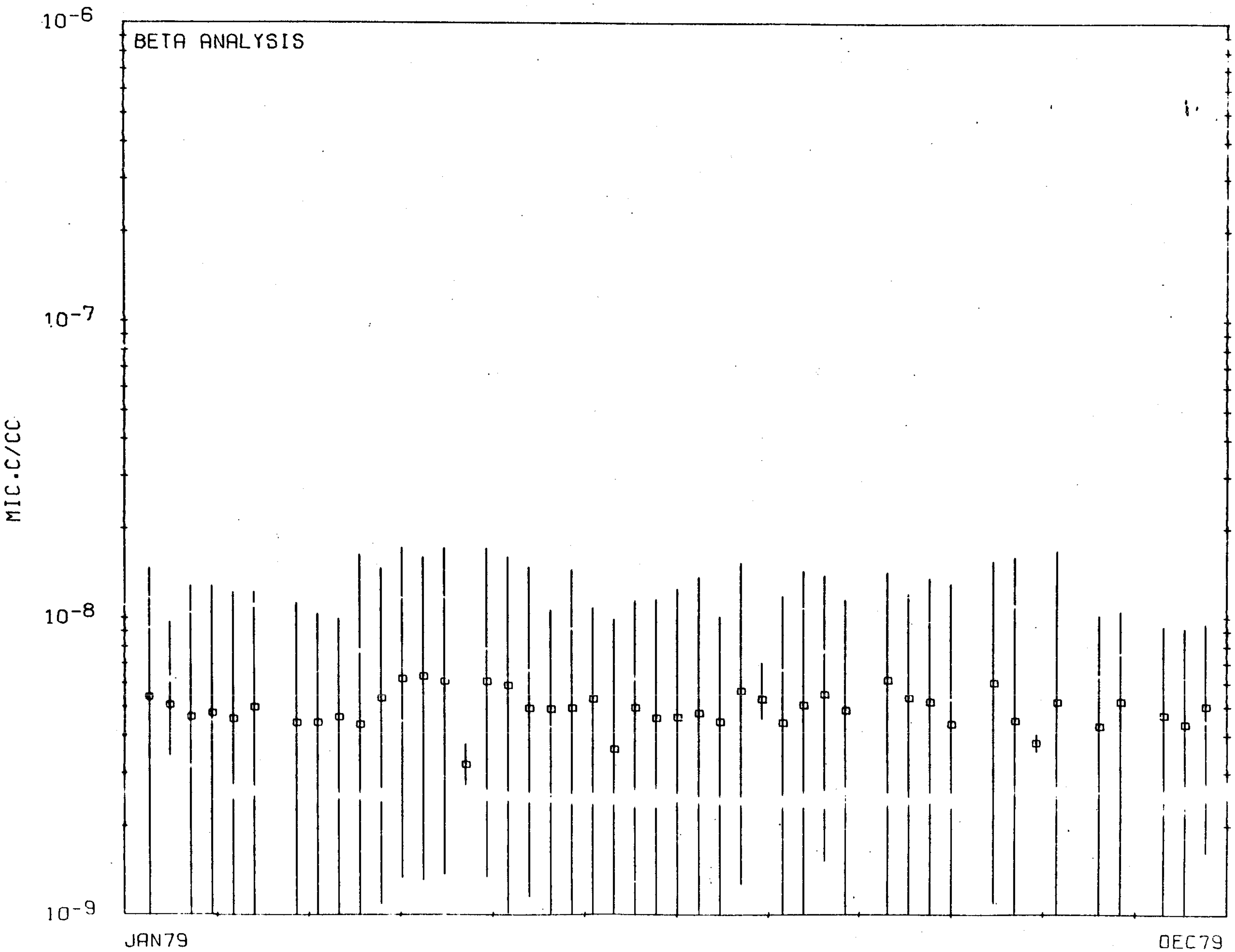
In the first two pages of plots in Appendix C, the potable water network averages, a square is used to represent the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

The remaining plots show the gross beta data of each station utilizing the symbol, X, as the data point. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

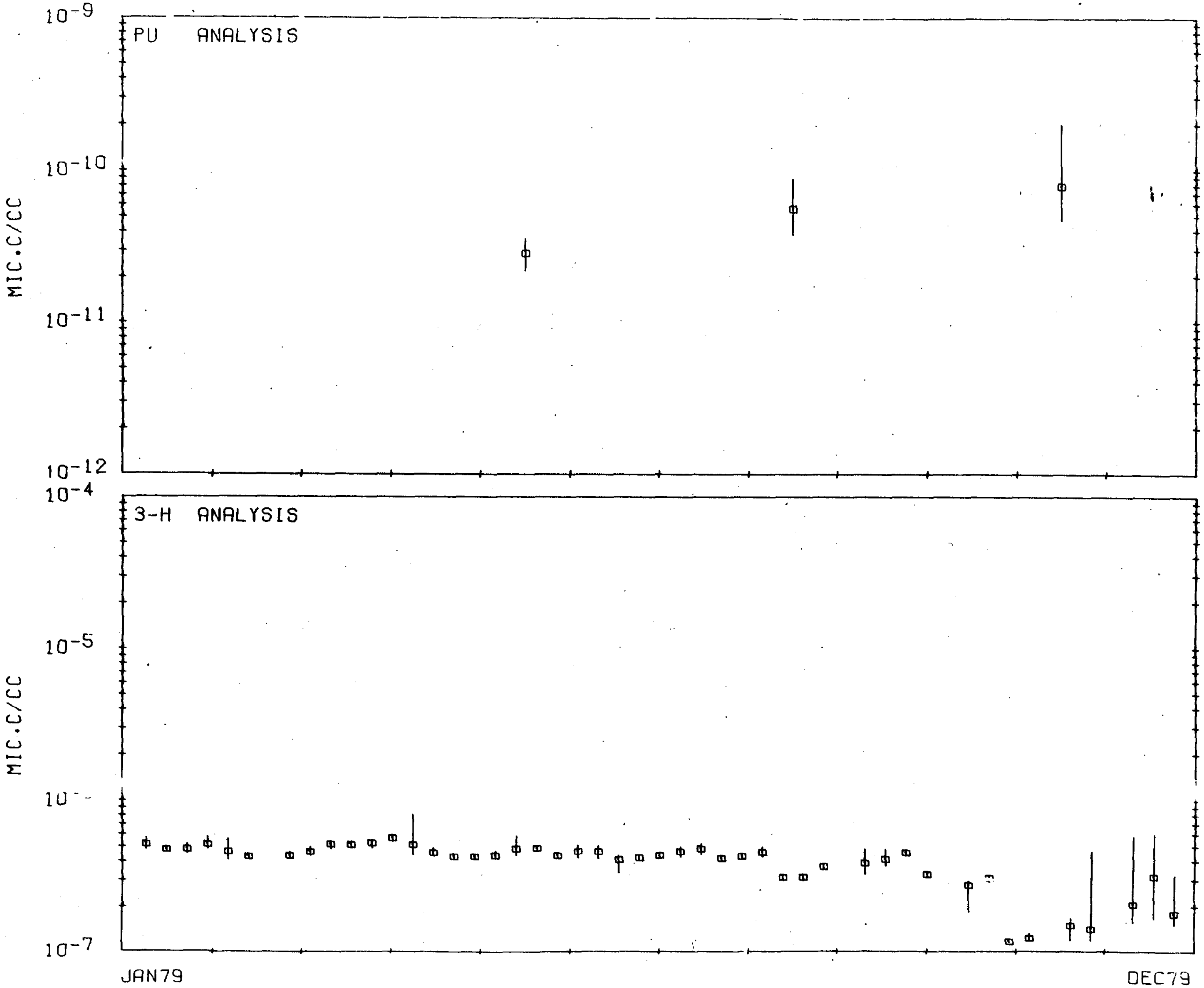
NTS ENVIRONMENTAL SURVEILLANCE
POTABLE WATER SAMPLING LOCATIONS

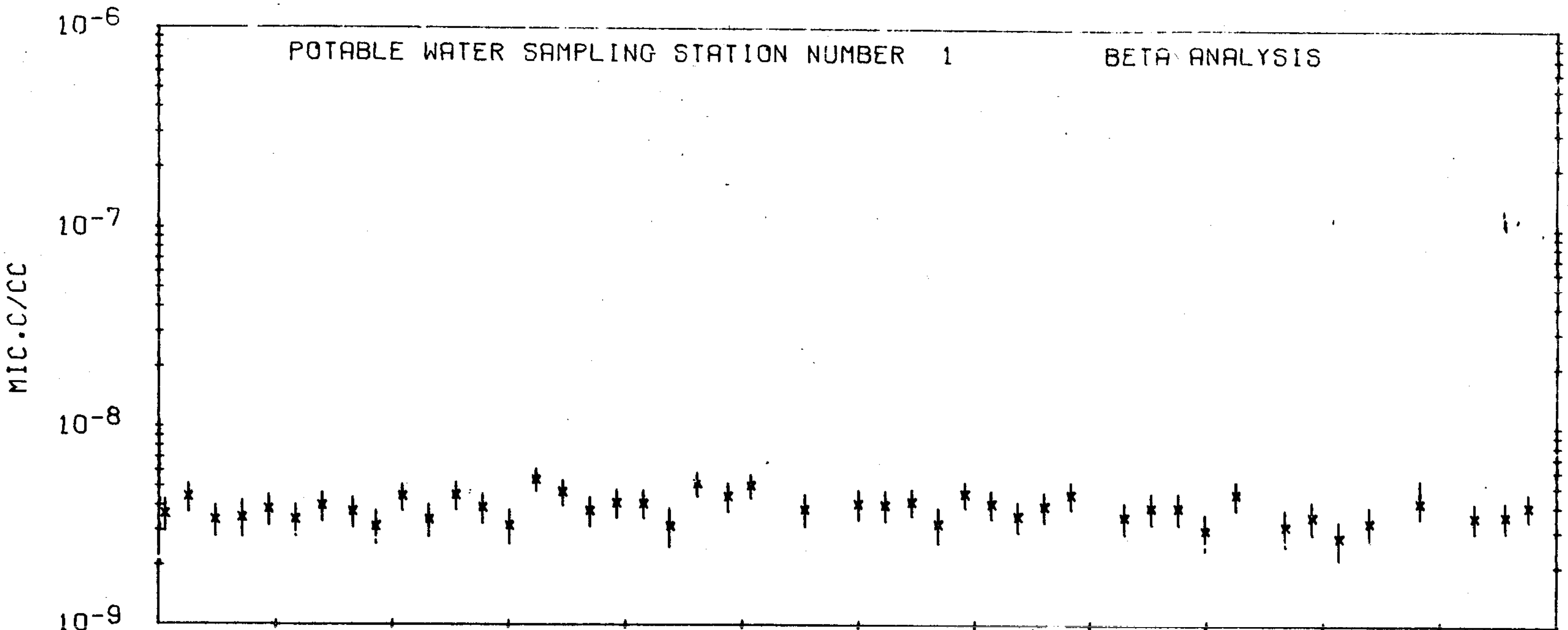
Station Number	Location
1	Area 2 Rest Room
2	Area 3 Cafeteria
3	Area 6 Cascade Water
4	Area 6 Cafeteria
5	Area 12 Cafeteria
7	Area 23 Cafeteria
8	Area 27 Cafeteria
10	Area 25 Service Station

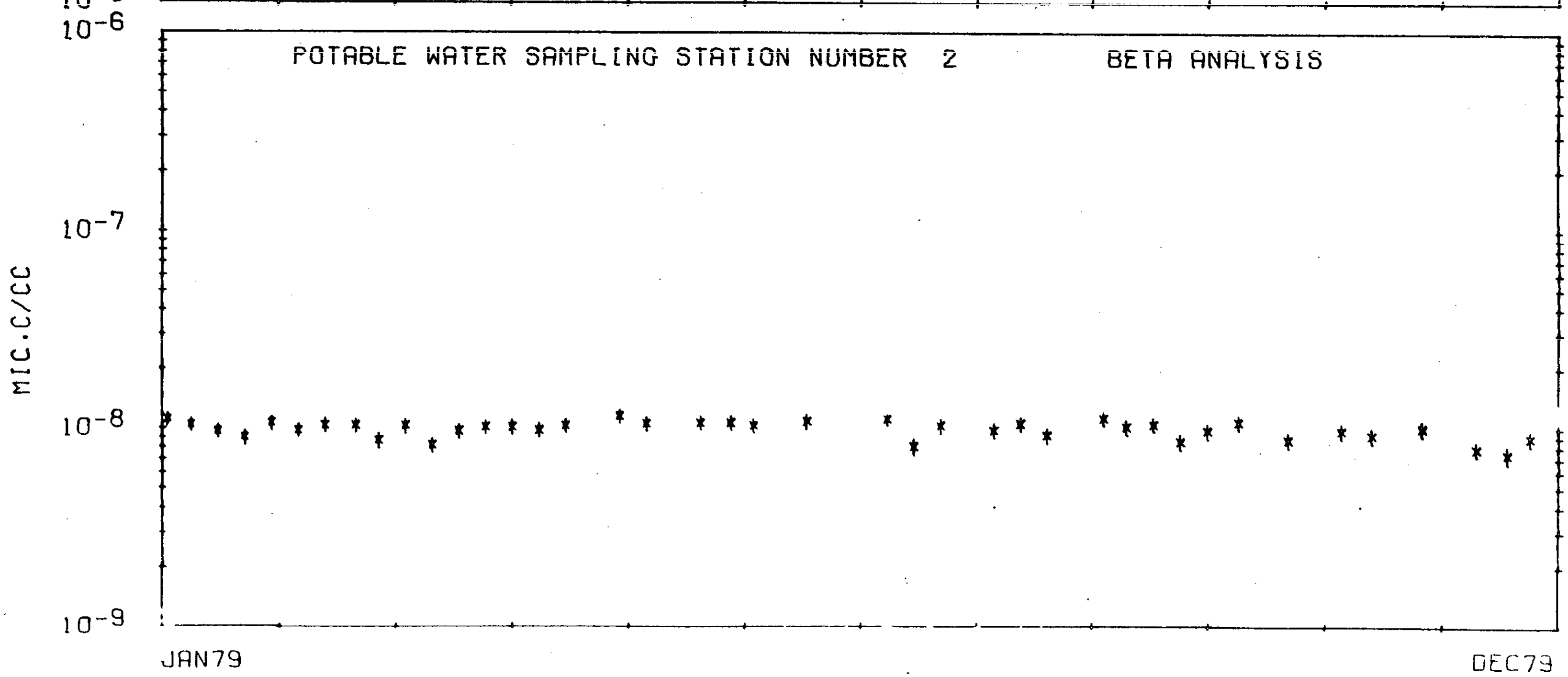
POTABLE WATER NETWORK AVERAGES

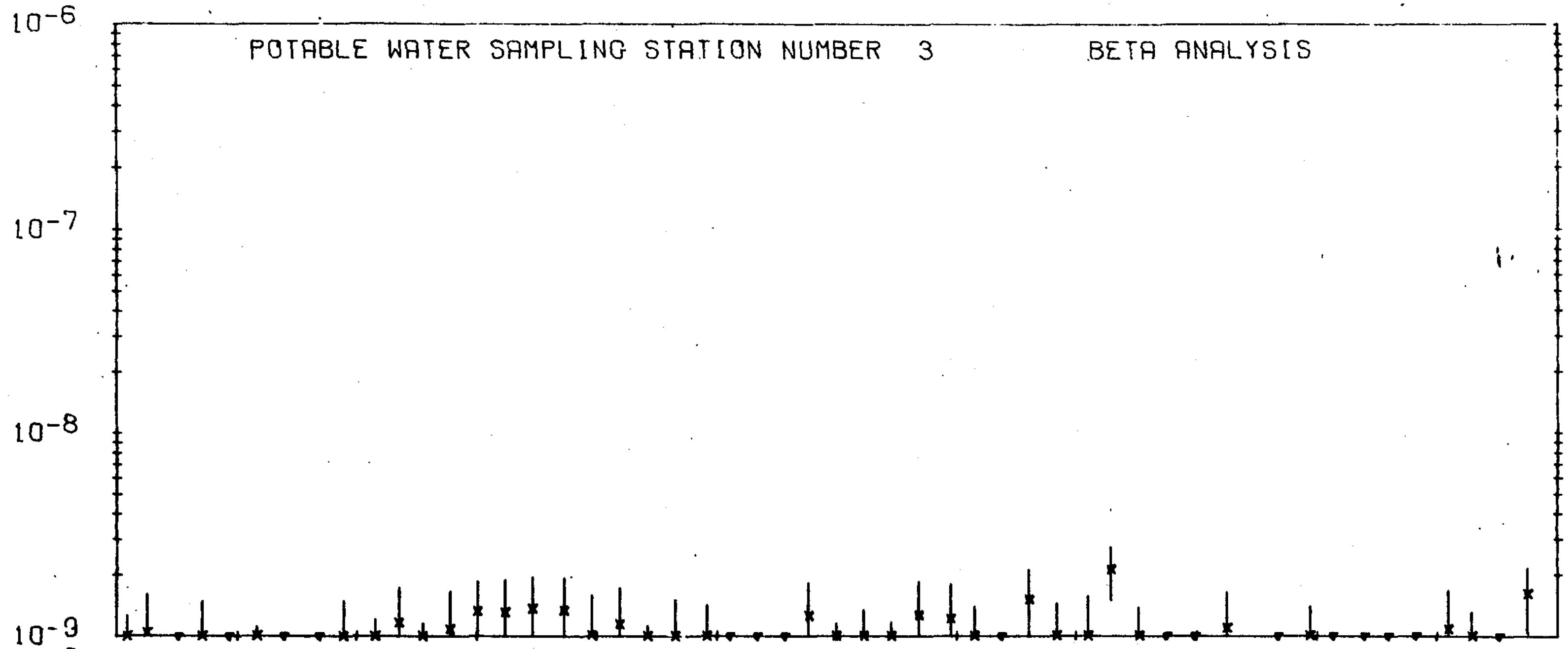


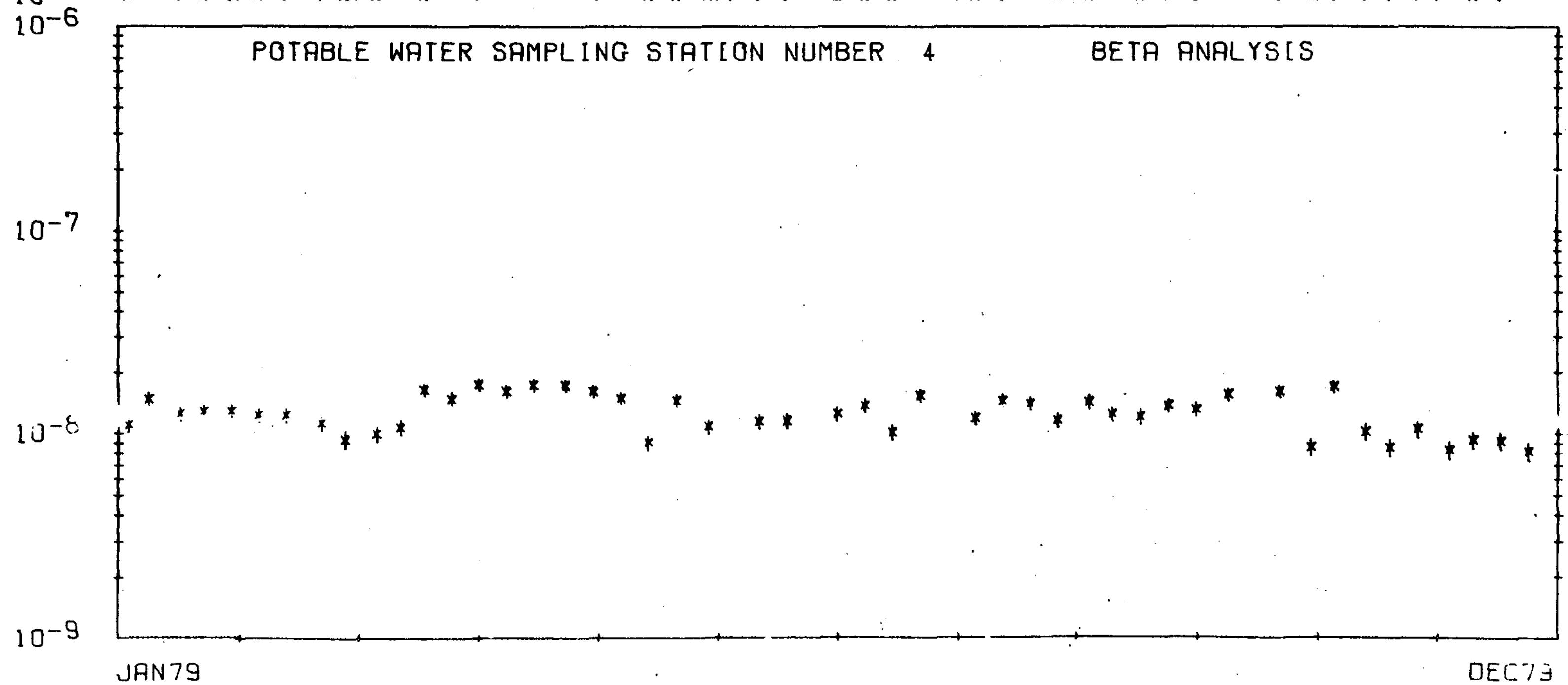
POTABLE WATER NETWORK AVERAGES

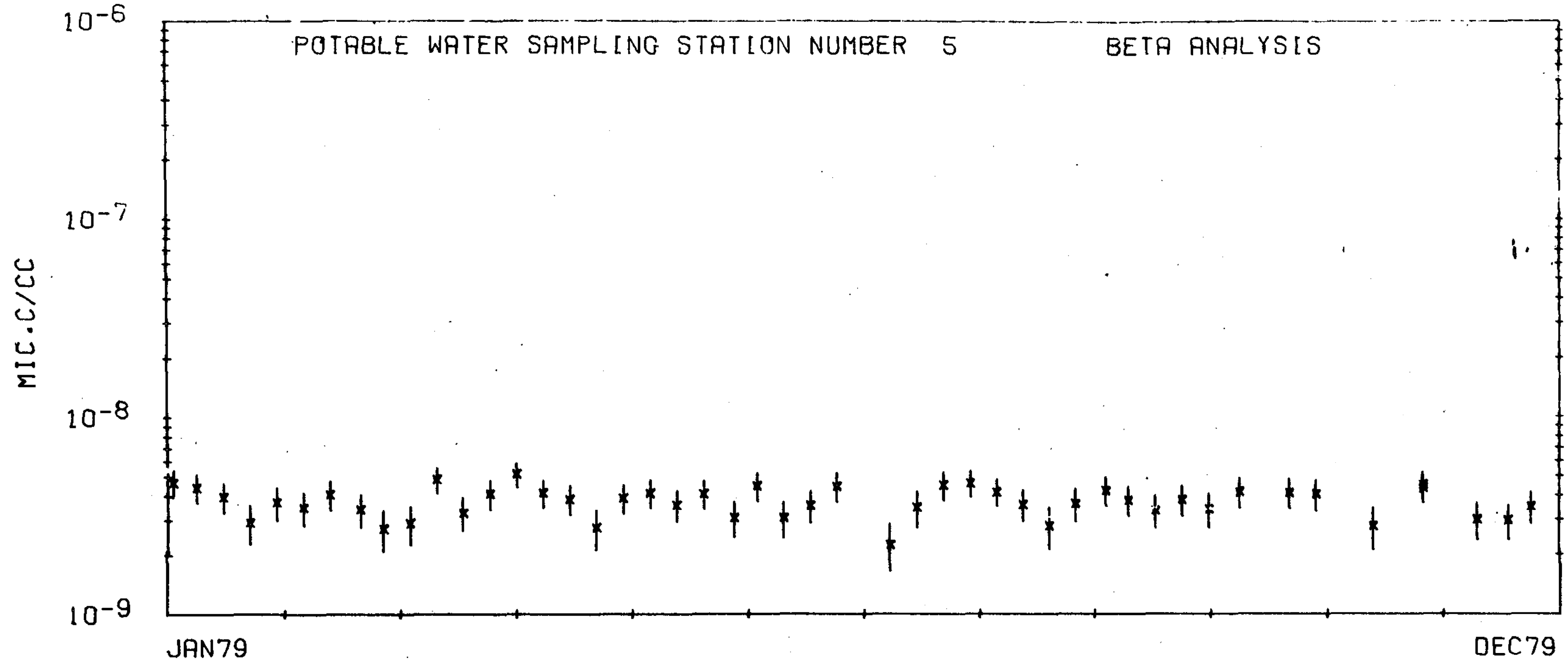


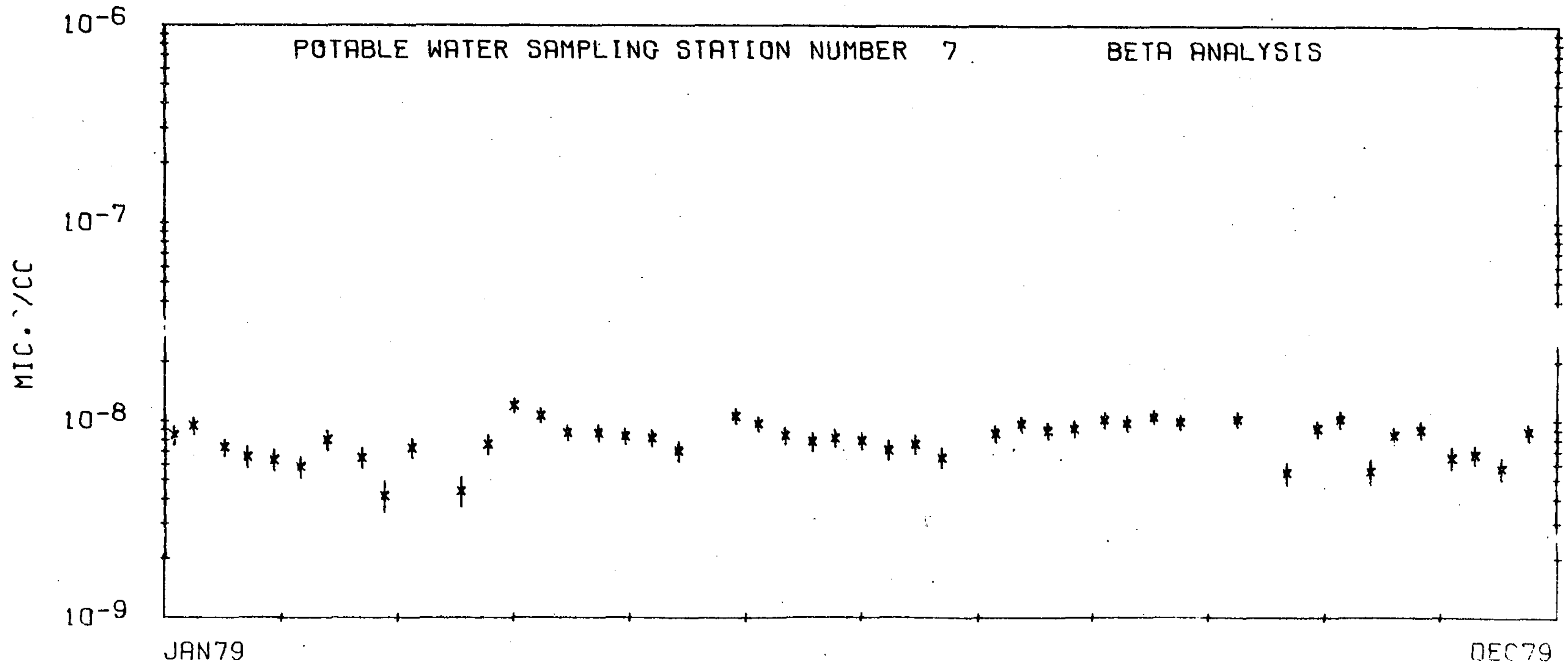

POTABLE WATER SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

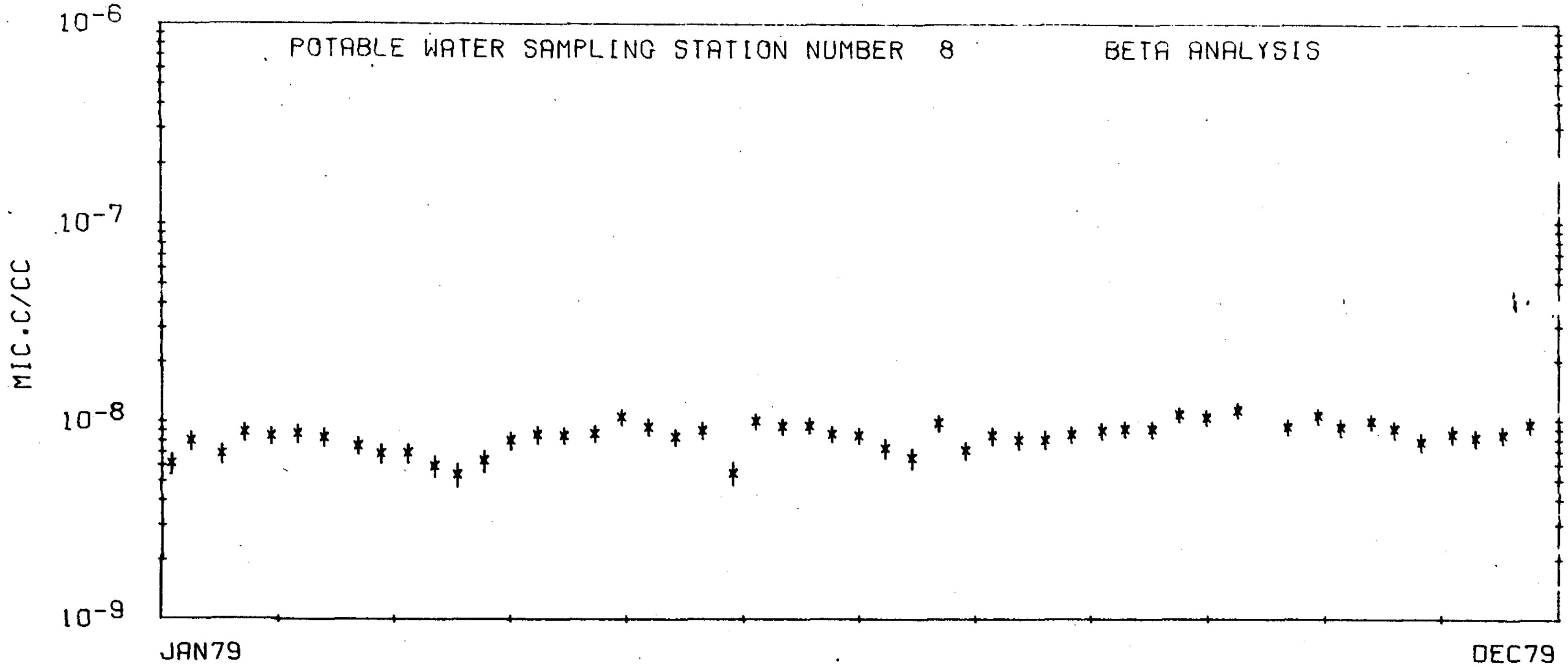

POTABLE WATER SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

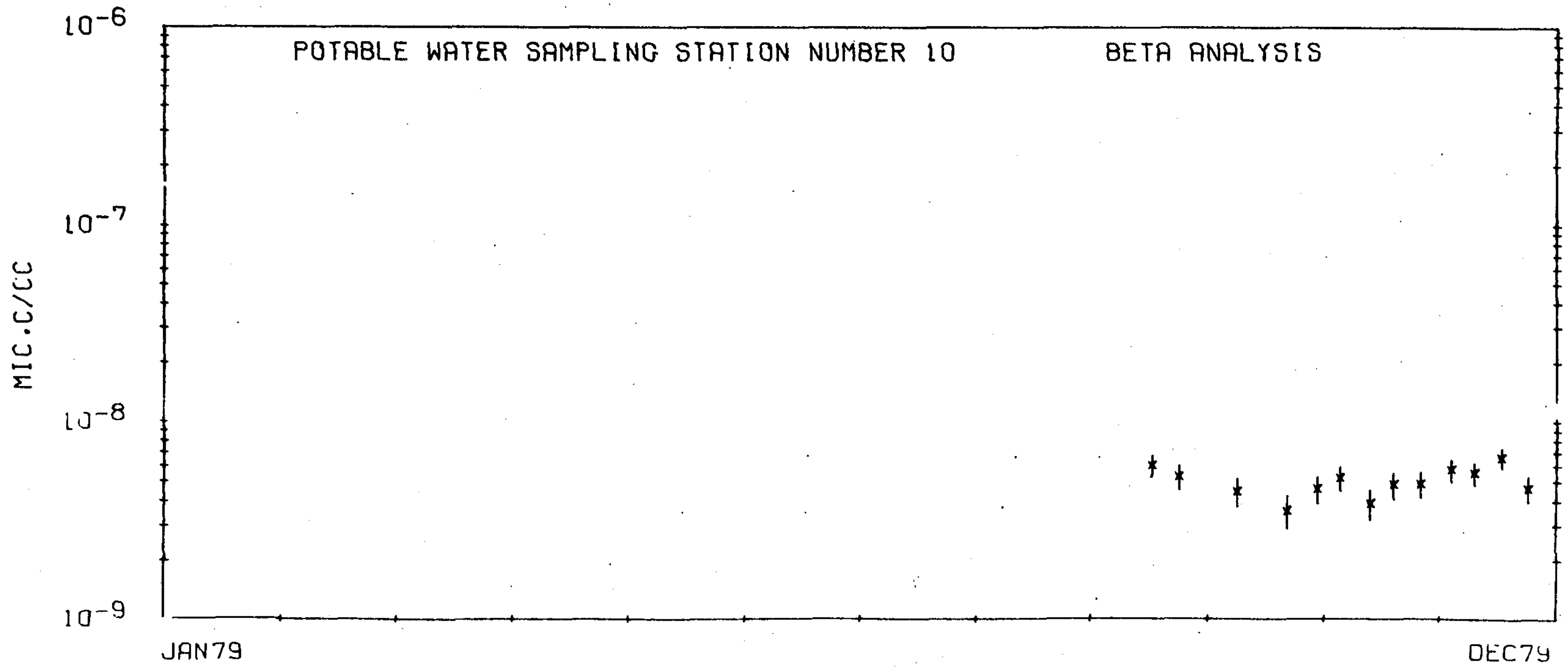

POTABLE WATER SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


POTABLE WATER SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79


POTABLE WATER SAMPLING STATION NUMBER 5
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN79
DEC79


POTABLE WATER SAMPLING STATION NUMBER 7
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79


POTABLE WATER SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79


POTABLE WATER SAMPLING STATION NUMBER 10
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

Several symbols are used in Appendix D to denote the data points. In the first two pages of plots, the open reservoir network averages, a square represents the arithmetic mean of all values at that point in time, and the vertical line is the range of the data. The remaining plots of Appendix E show the gross beta data of each station. The data symbols for the plots are as follows:

Plot #	Symbol
1-8	×
11-20	◇
21	⧗

A two-sigma error is also added to the data points, and, in all plots, a delta with the line to the bottom of the plot means below detection limit.

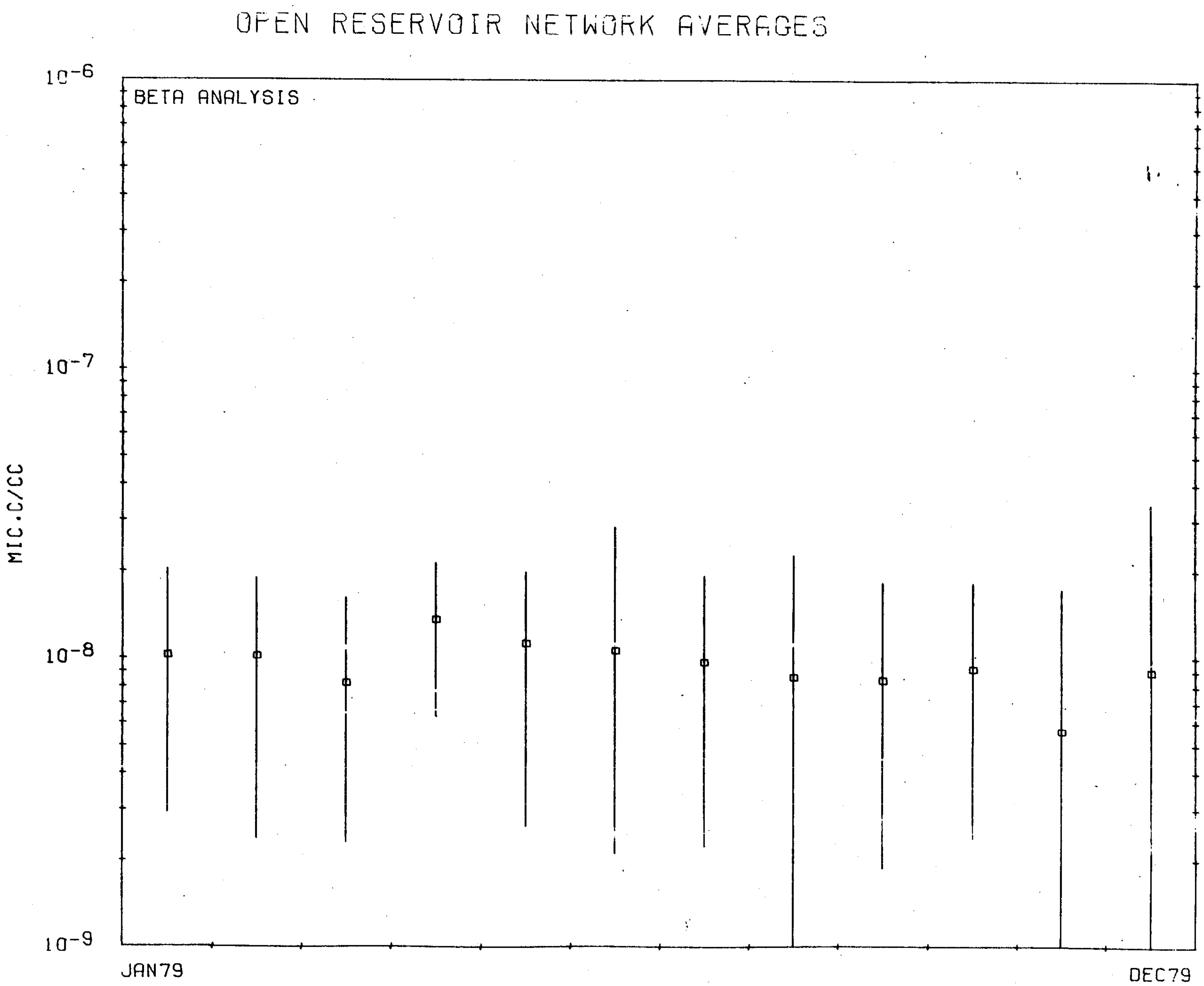
NTS ENVIRONMENTAL SURVEILLANCE
OPEN RESERVOIRS SAMPLING LOCATIONS

Station Number	Location
1	Area 2 Well 2 Reservoir
2	Area 3 Well A Reservoir
3	Area 5 Well 5B Reservoir
4	Area 5 Well Ue5c Reservoir
5	Area 6 Well 3 Reservoir
6	Area 6 Well C1 Reservoir
7	Area 15 Well Ue15d Reservoir
8	Area 18 Camp 17 Reservoir
11	Area 20 Well 20A Reservoir
12	Area 23 Swimming Pool
16	Area 19 Well U19c Reservoir
17	Area 25 Well J-12 Reservoir
18	Area 3 Mud Plant Reservoir
19	Area 2 Mud Plant Reservoir
20	Area 25 Well J-11 Reservoir
21	Area 18 Well 8 Reservoir

A P P E N D I X E

NTS Environmental Surveillance

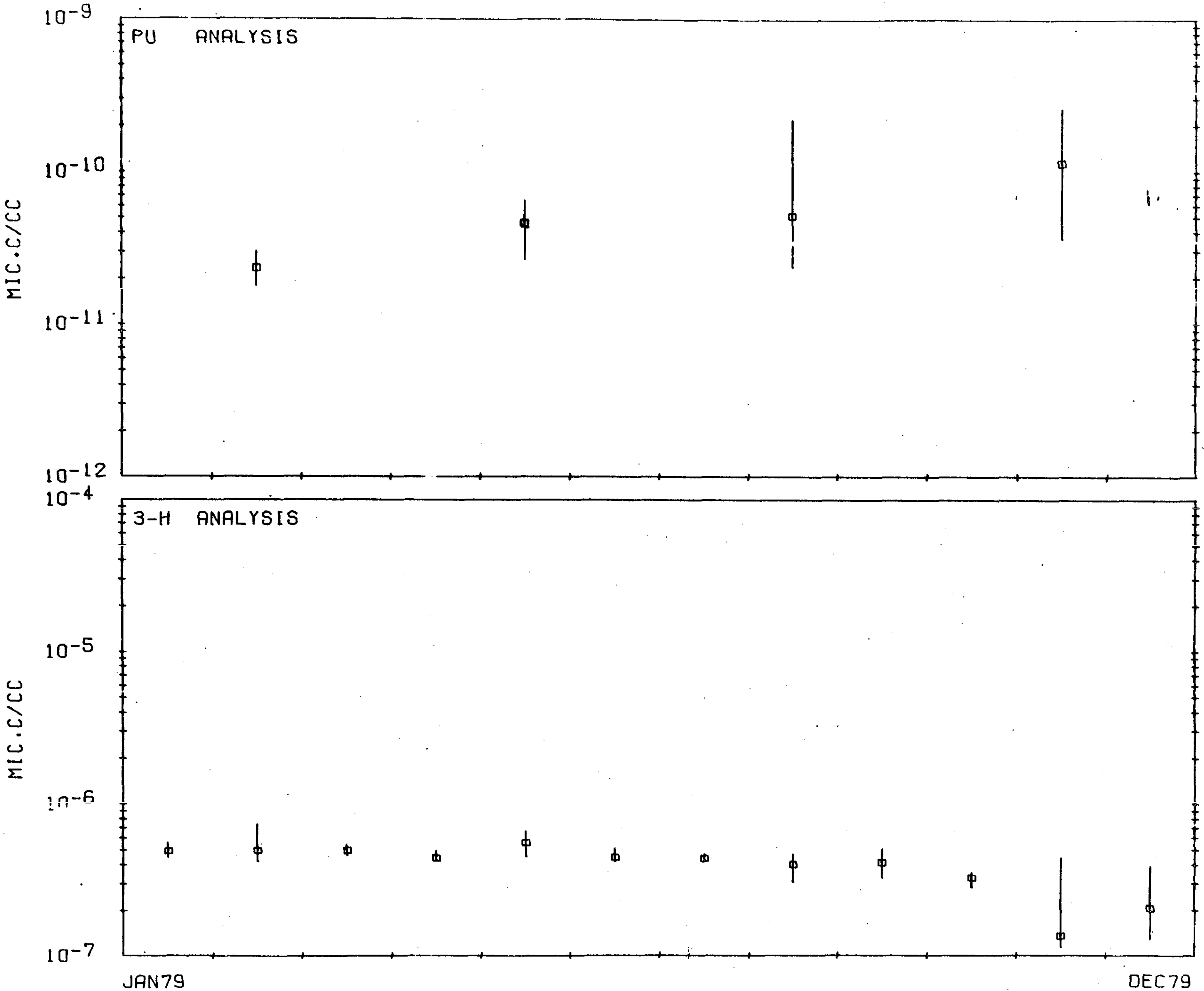
Natural Springs Locations and Plots

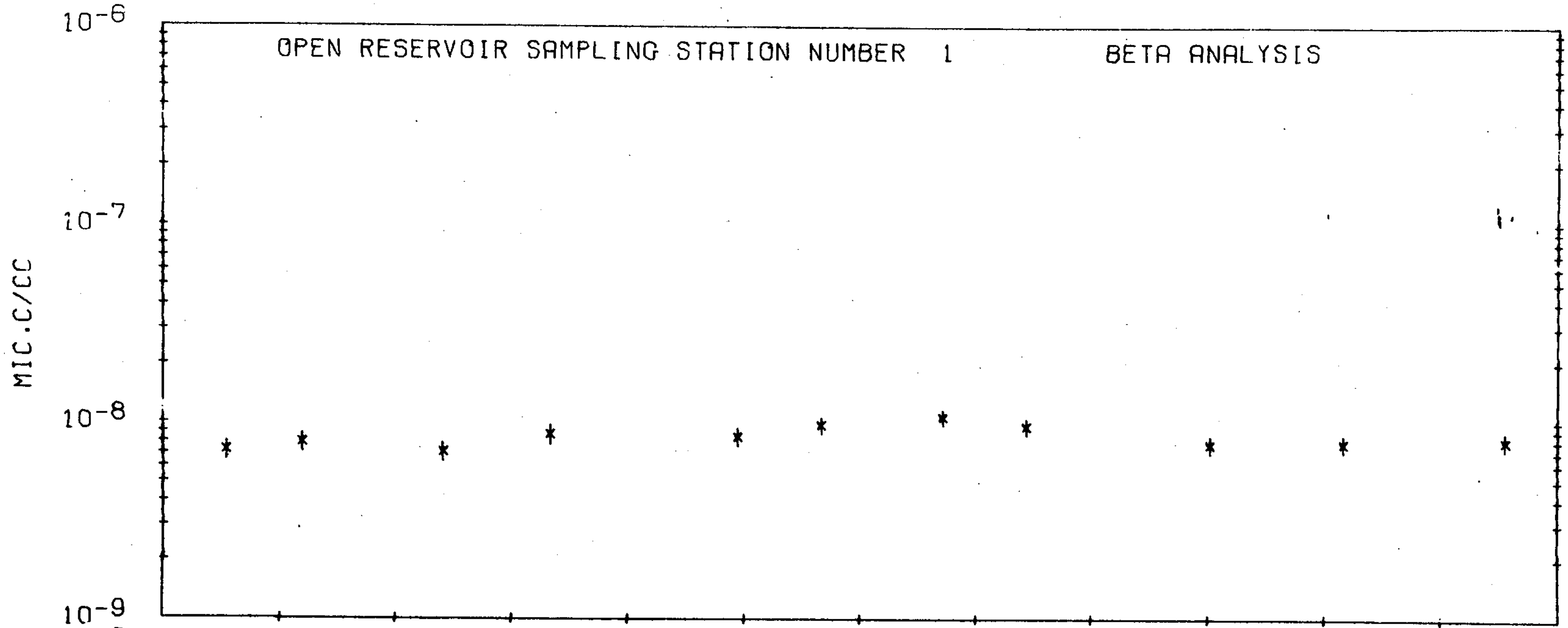


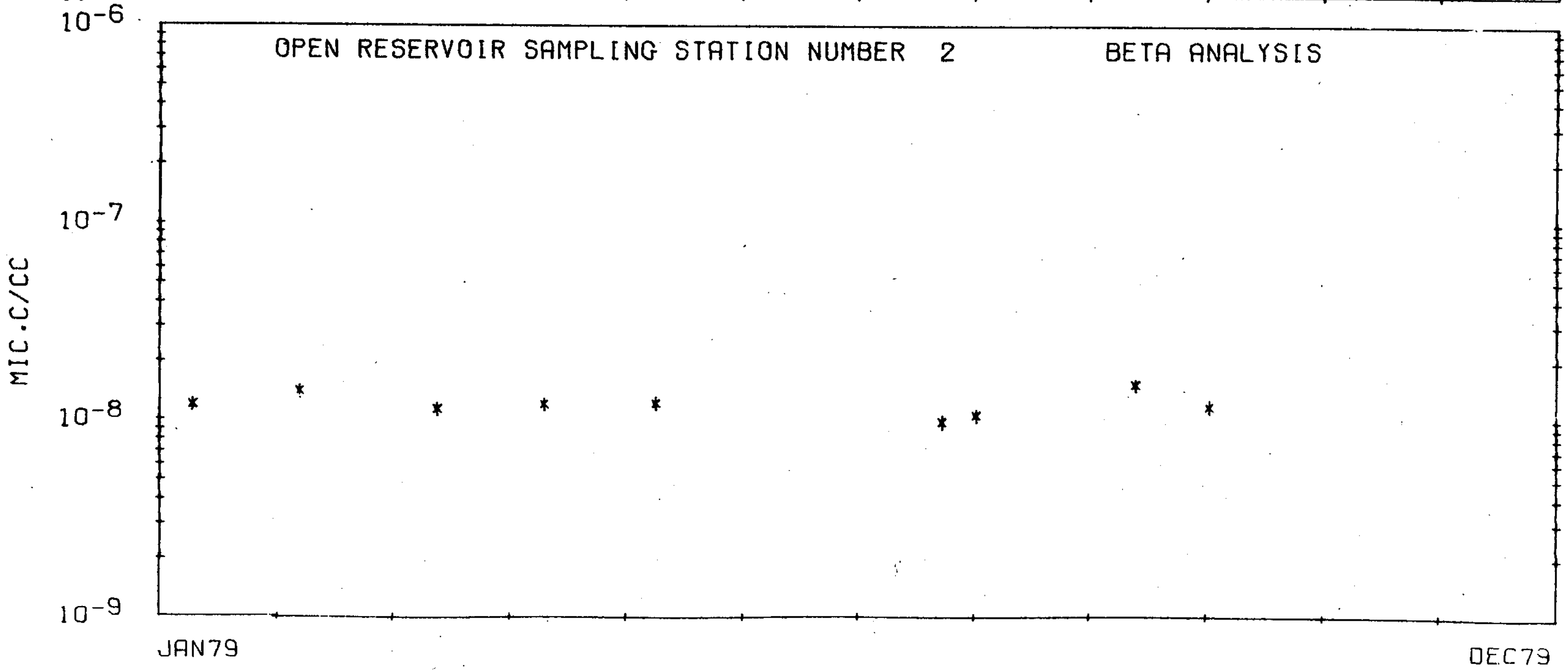
OPEN RESERVOIR NETWORK AVERAGES
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN79
DEC79

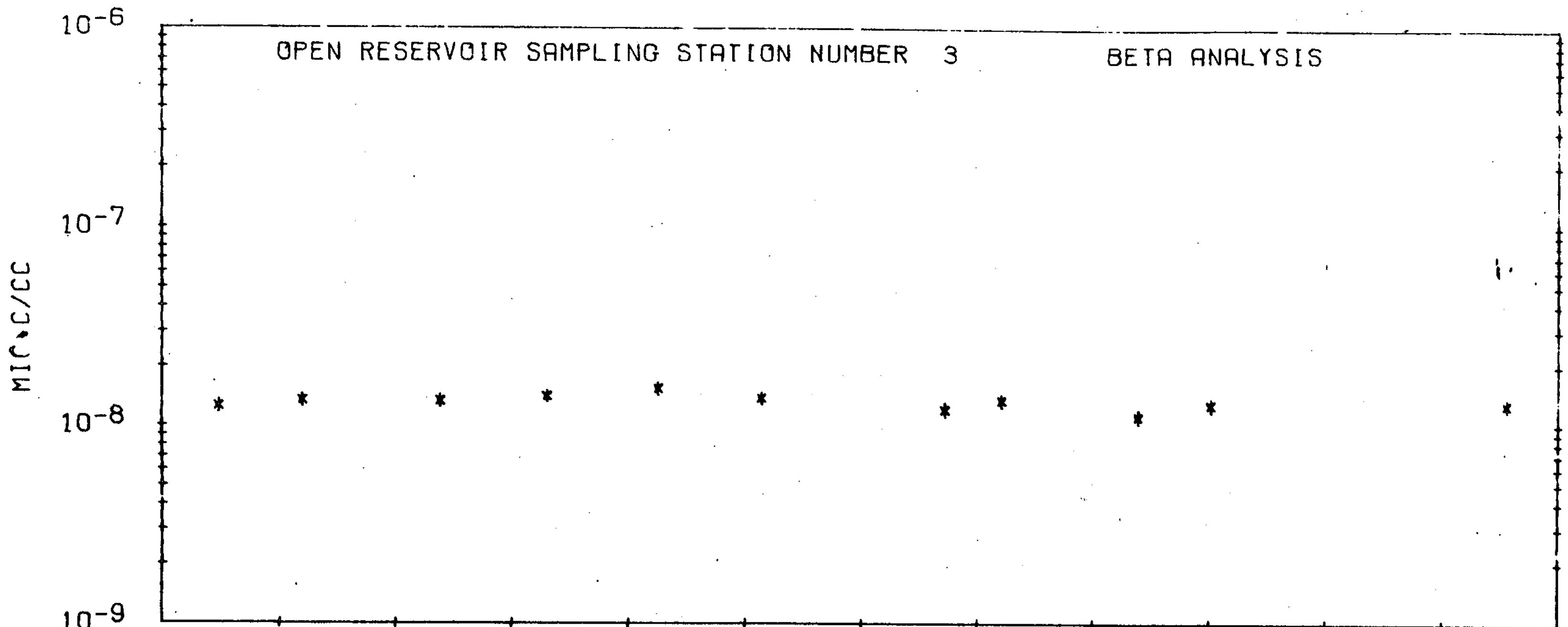
-127-

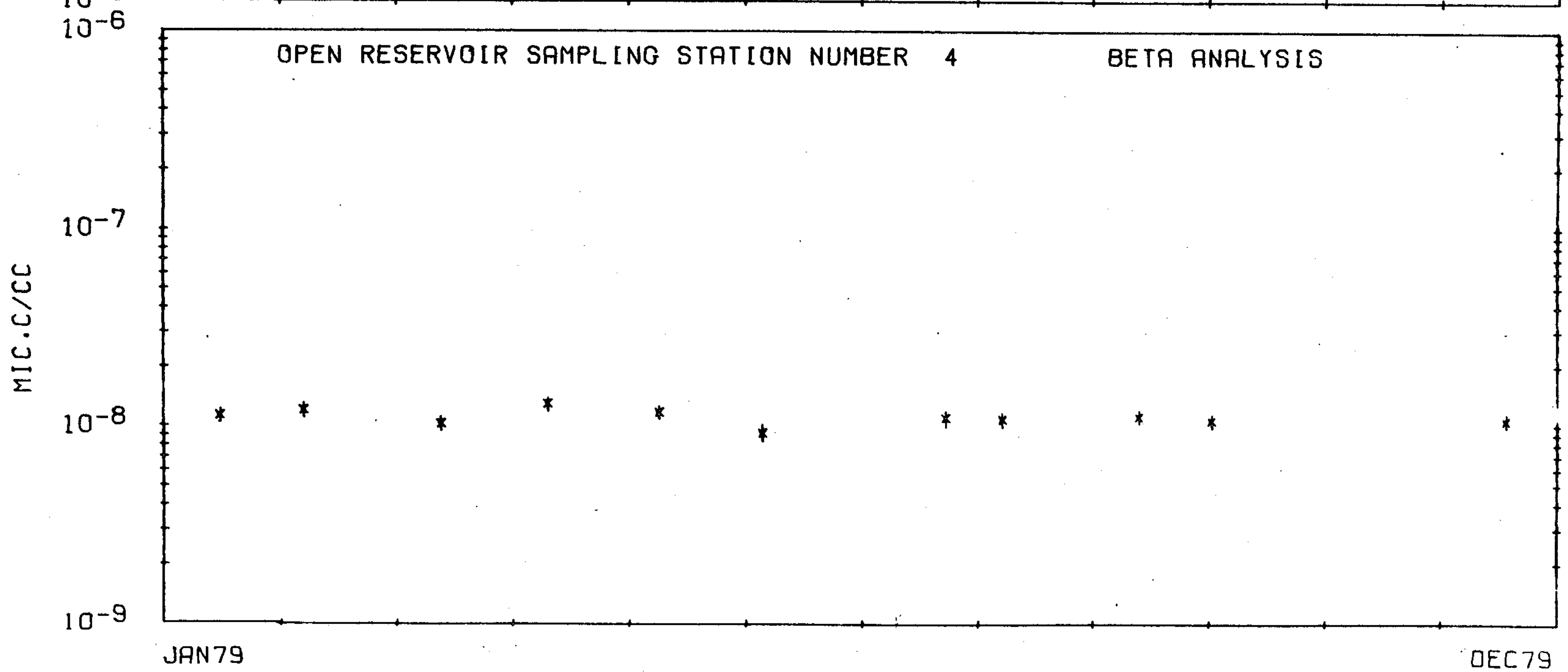
OPEN RESERVOIR NETWORK AVERAGES

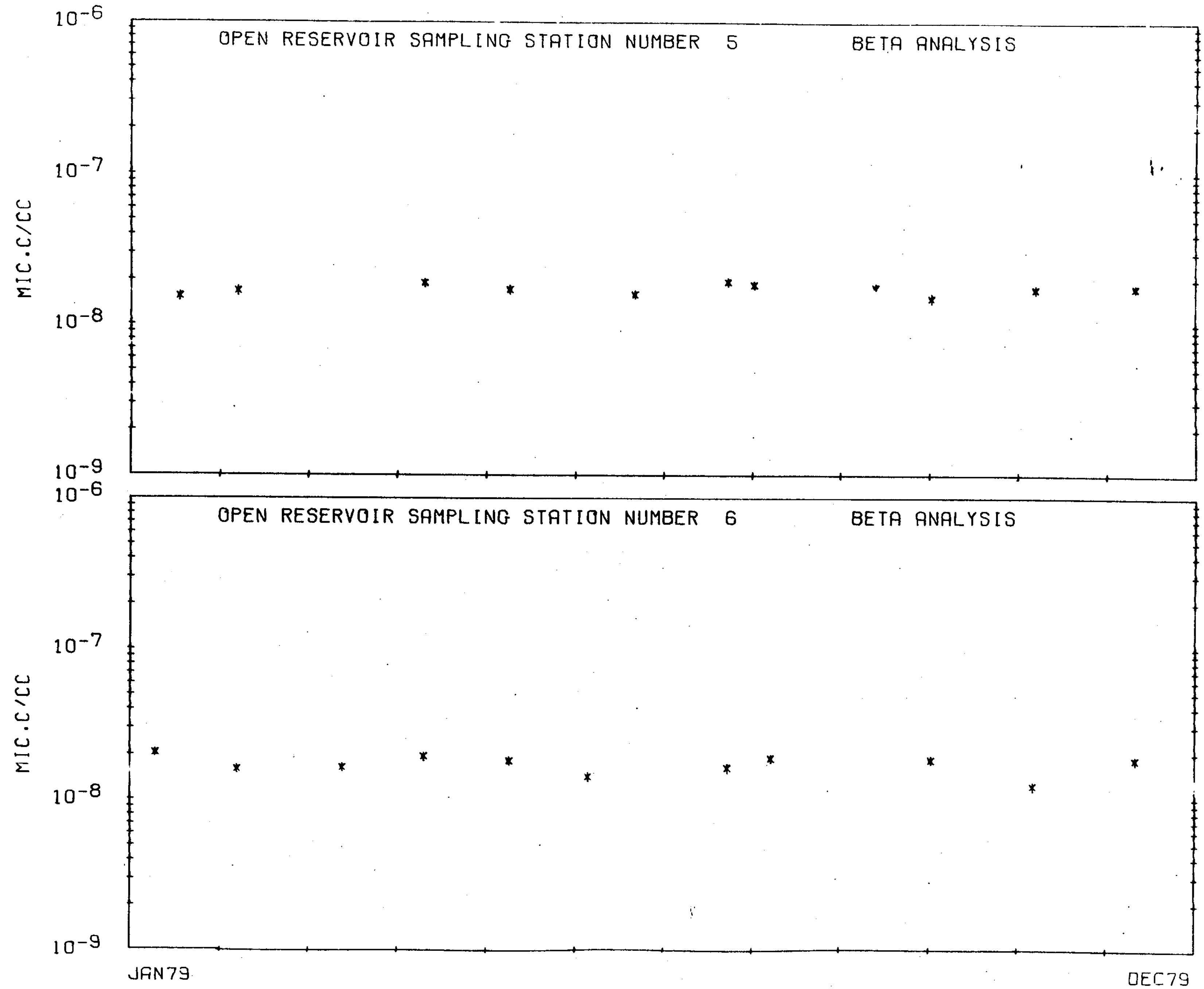


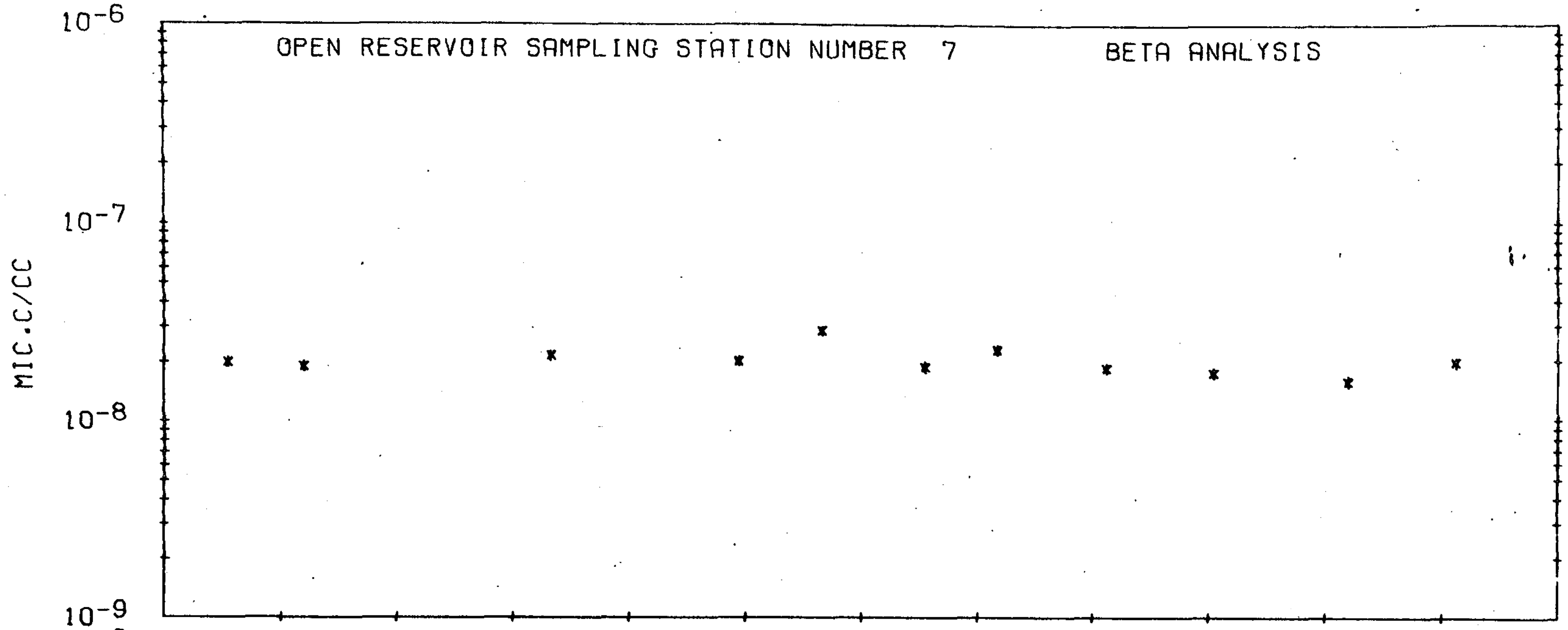

OPEN RESERVOIR SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

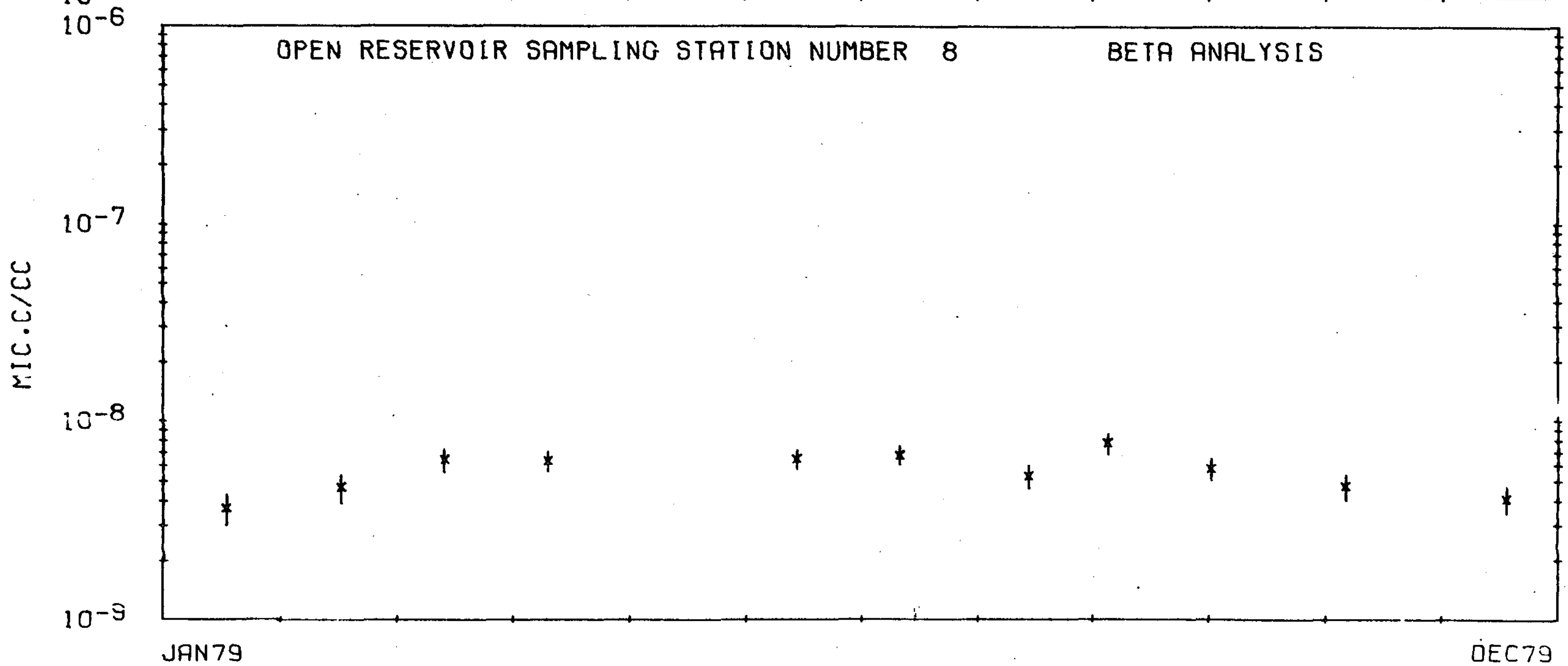

OPEN RESERVOIR SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

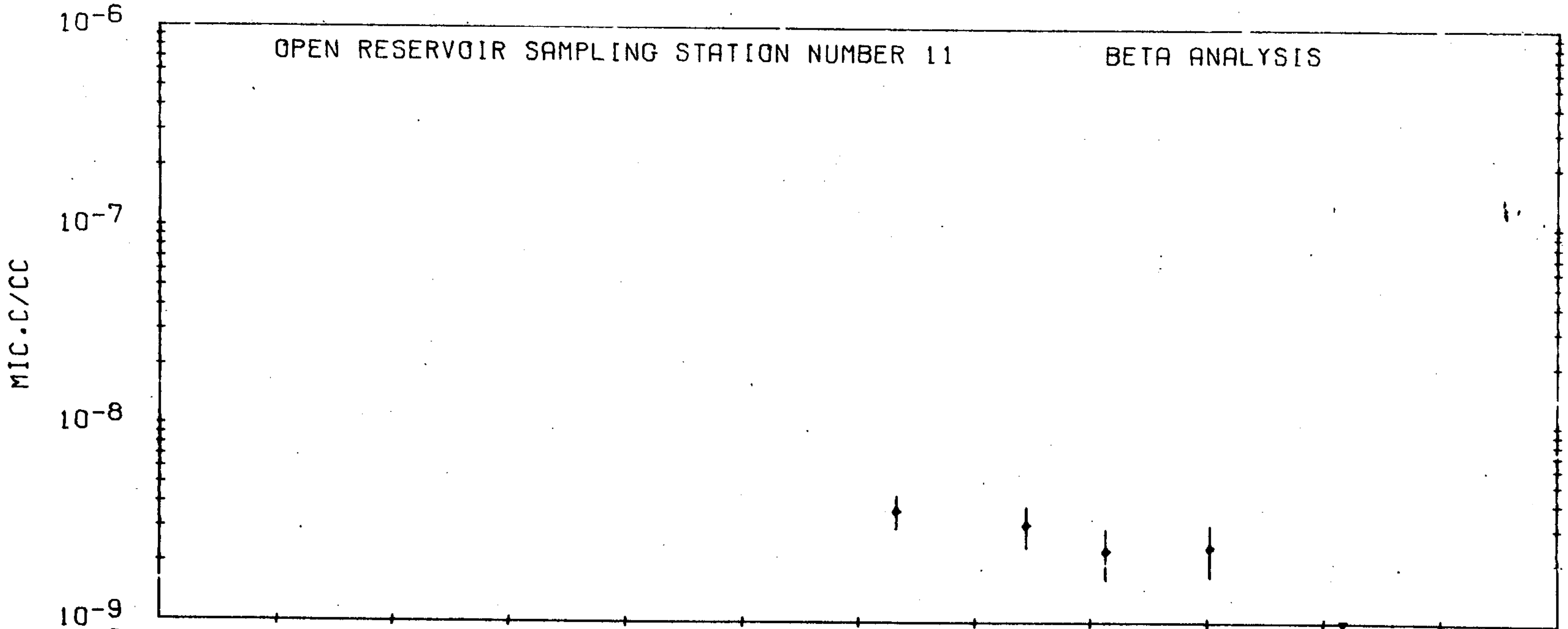

OPEN RESERVOIR SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

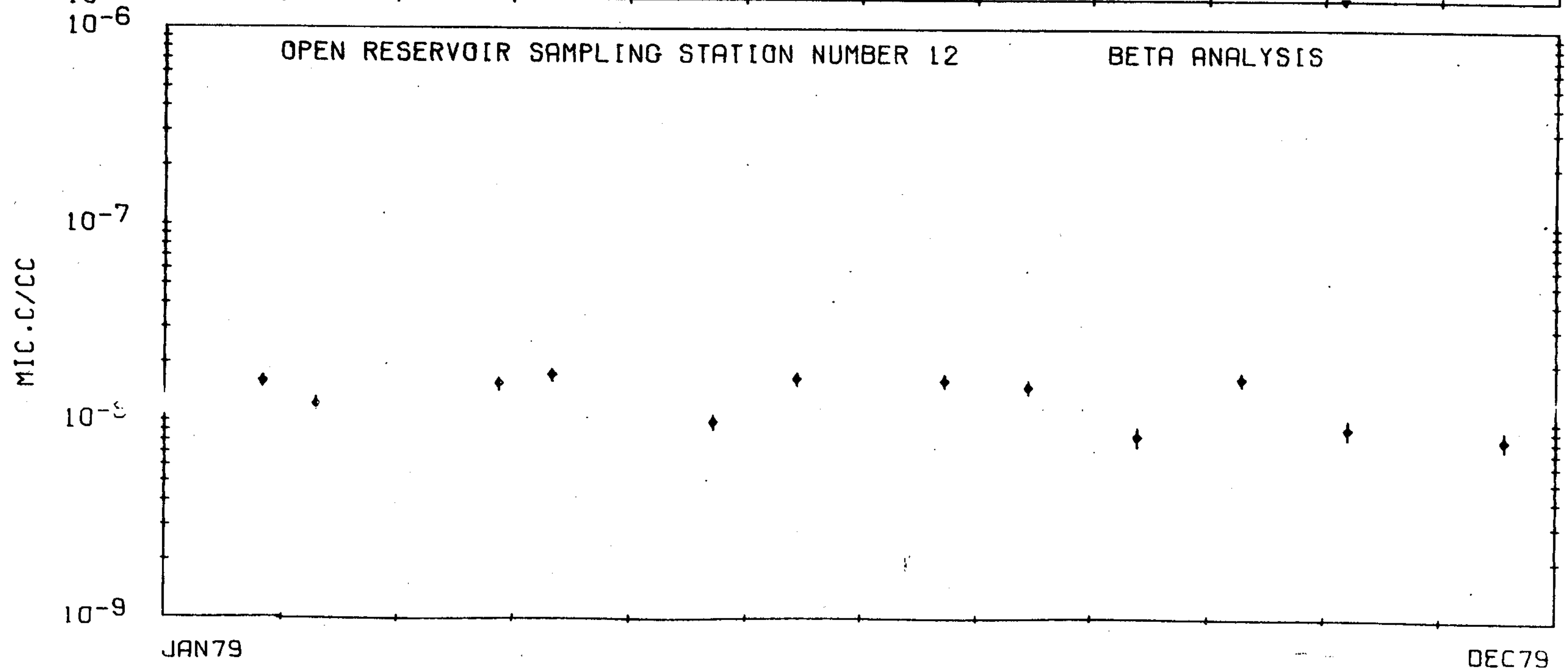

OPEN RESERVOIR SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

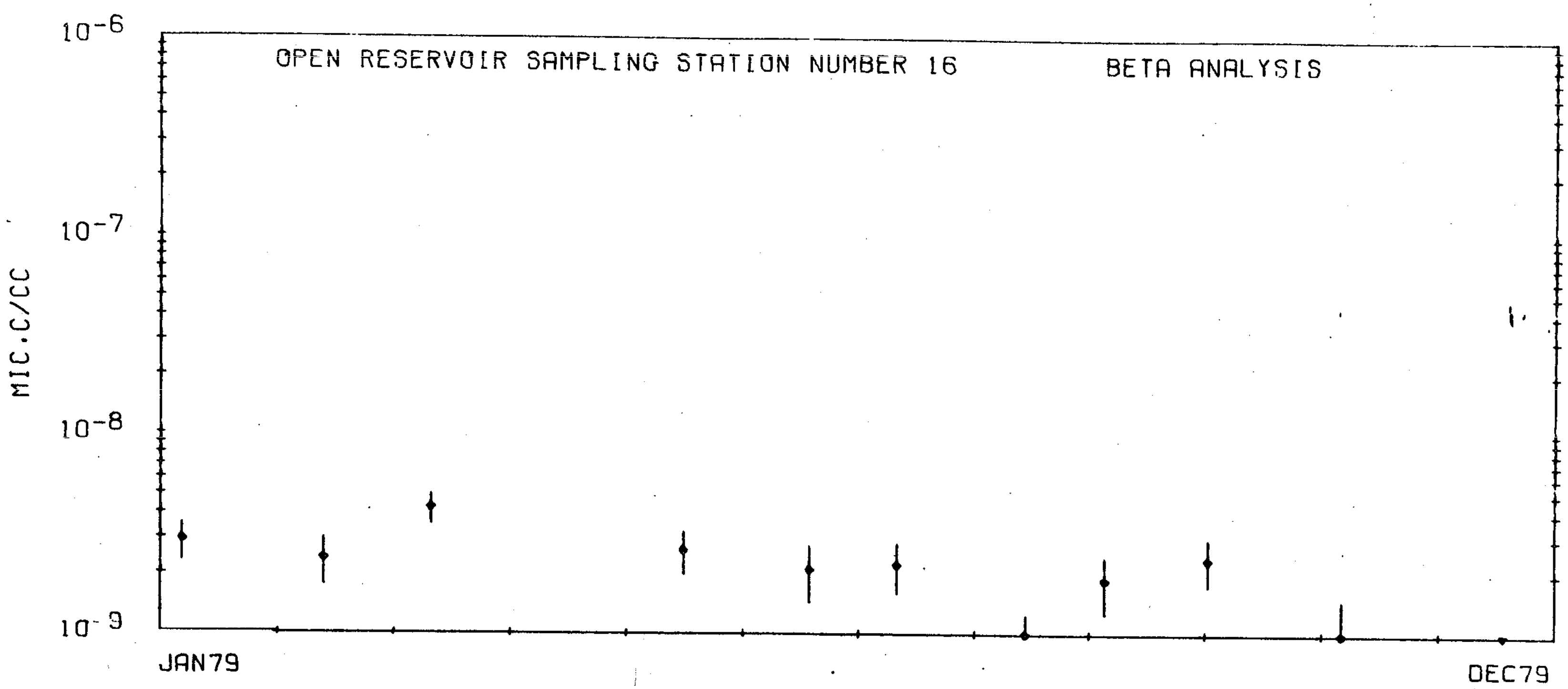

OPEN RESERVOIR SAMPLING STATION NUMBER 5
BETA ANALYSIS
OPEN RESERVOIR SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

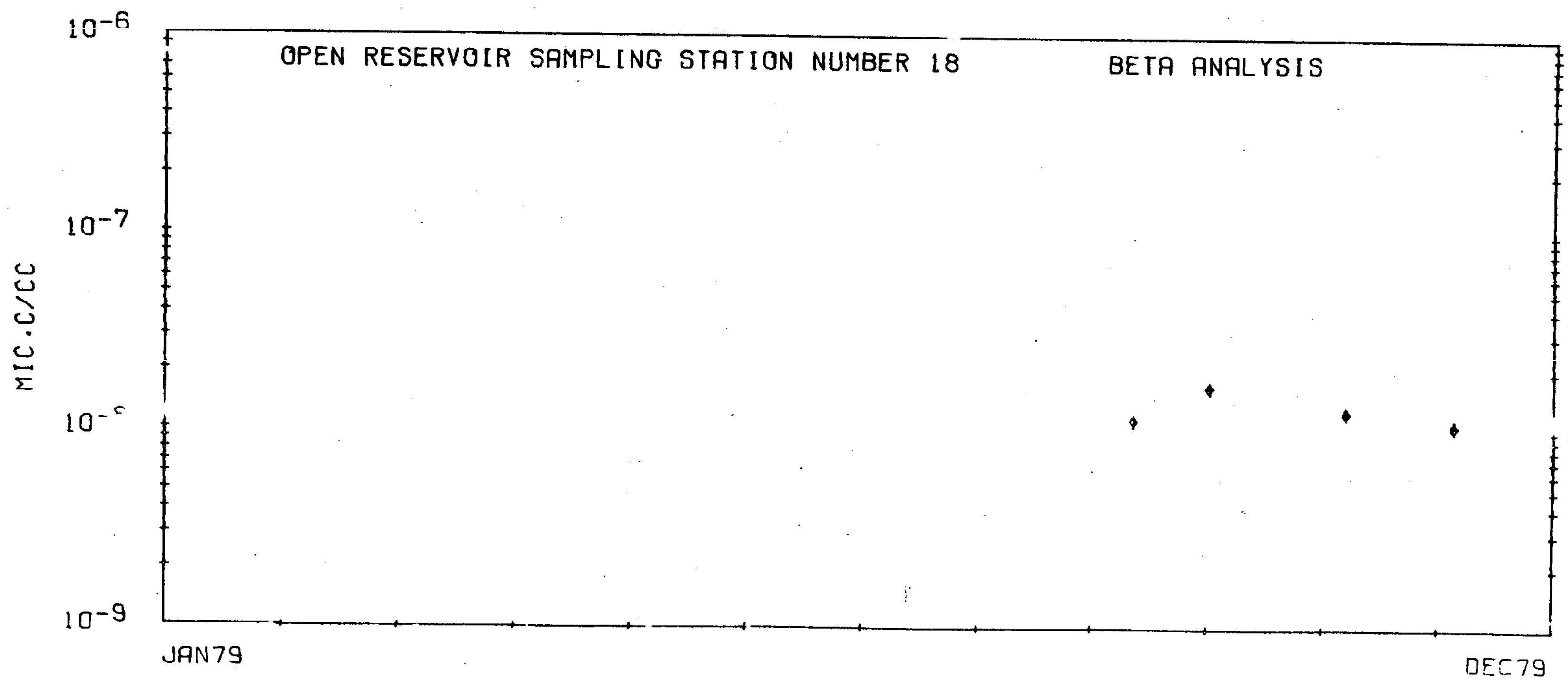

OPEN RESERVOIR SAMPLING STATION NUMBER 7
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

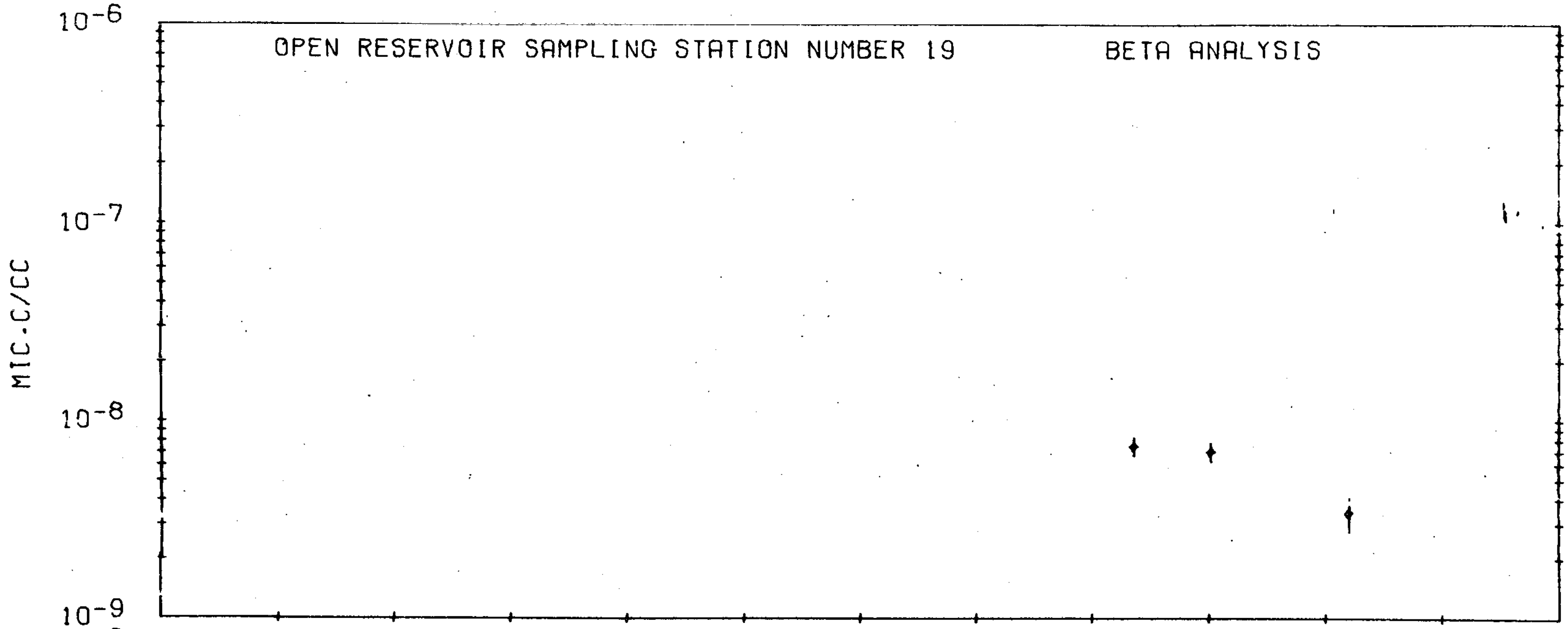

OPEN RESERVOIR SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

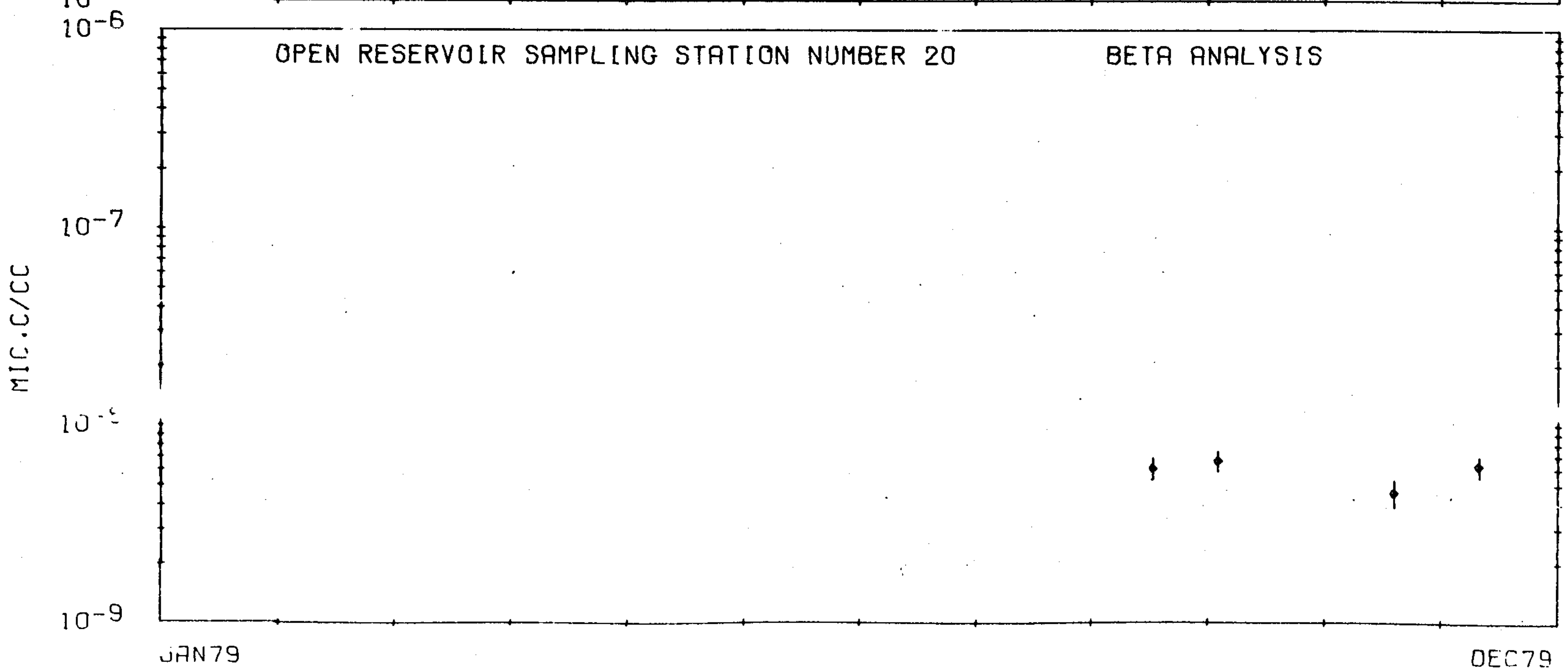

OPEN RESERVOIR SAMPLING STATION NUMBER 11
BETA ANALYSIS
MIC.C/CC
10−6
10−7
10−8
10−9

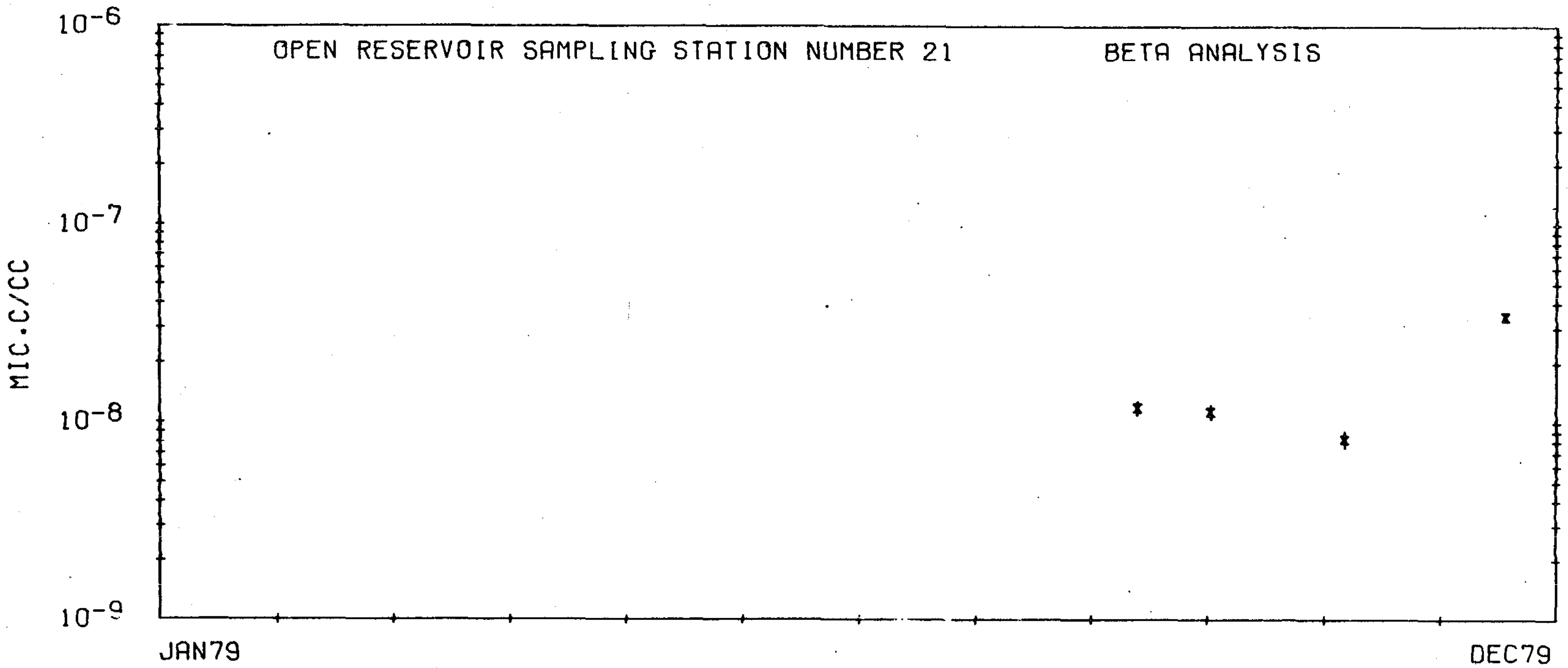

OPEN RESERVOIR SAMPLING STATION NUMBER 12
BETA ANALYSIS
MIC.C/CC
10−6
10−7
10−9
JAN79
DEC79


OPEN RESERVOIR SAMPLING STATION NUMBER 16
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79


OPEN RESERVOIR SAMPLING STATION NUMBER 18
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-9}
JAN79
DEC79


OPEN RESERVOIR SAMPLING STATION NUMBER 19
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


OPEN RESERVOIR SAMPLING STATION NUMBER 20
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-9}
JAN79
DEC79



OPEN RESERVOIR SAMPLING STATION NUMBER 21
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN79
DEC79

In the first two pages of plots in Appendix E, the natural springs network averages, a square is used to represent the arithmetic mean of all values at that point in time, and the vertical line is the range of the data. The remaining plots show the gross beta data of each station utilizing the symbol, X, as the data point. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

NTS ENVIRONMENTAL SURVEILLANCE
NATURAL SPRINGS SAMPLING LOCATIONS

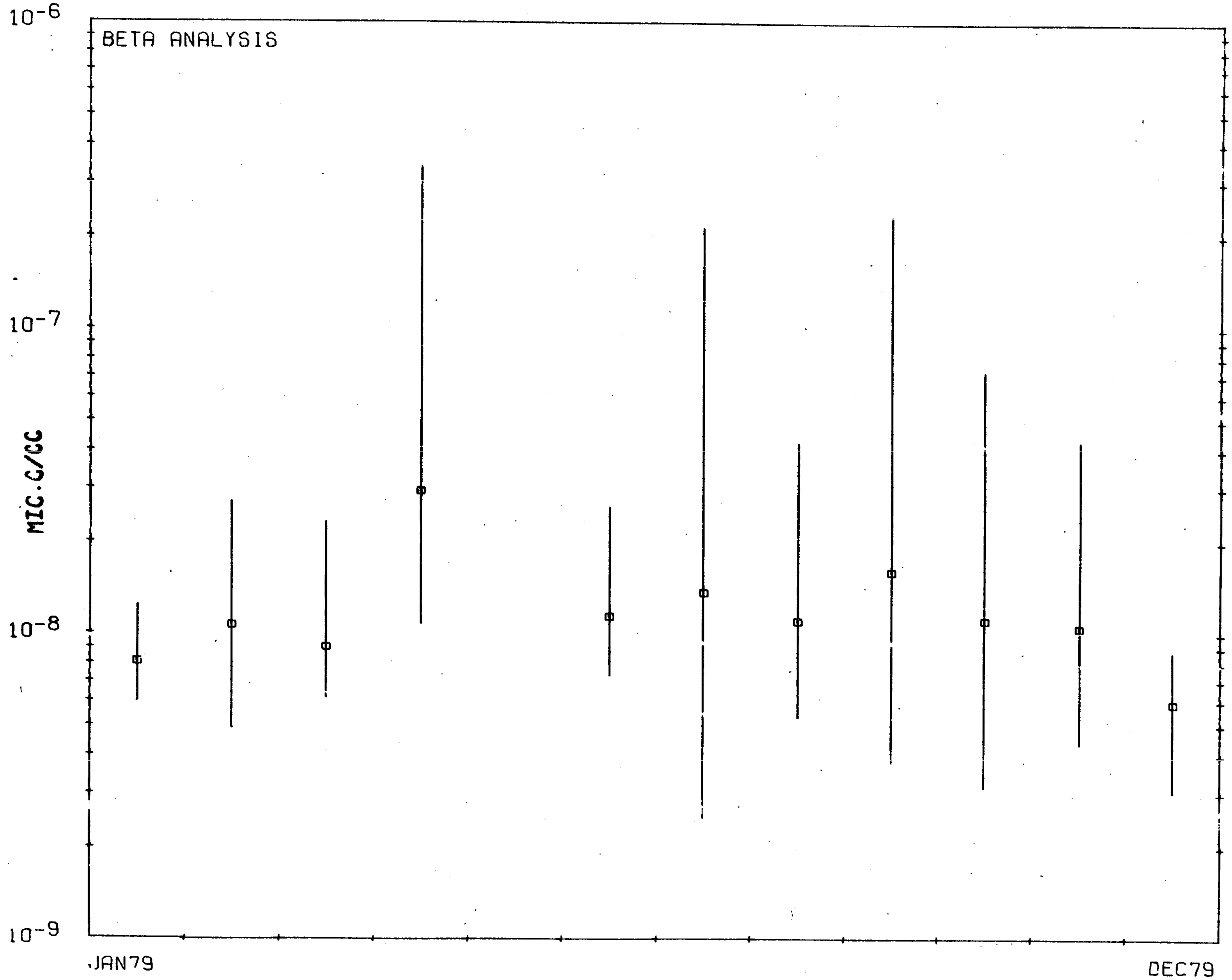
Station Number	Location
1	Area 5 Cane Springs
2	Area 12 White Rock Springs
3	Area 12 Captain Jack Spring
4	Area 12 Gold Meadows Pond
5	Area 15 Oak Butte Spring
6	Area 15 Tub Spring
7	Area 29 Topopah Spring
8	Area 7 Reitmann Seep
9	Area 16 Tippipah Spring

APPENDIX F

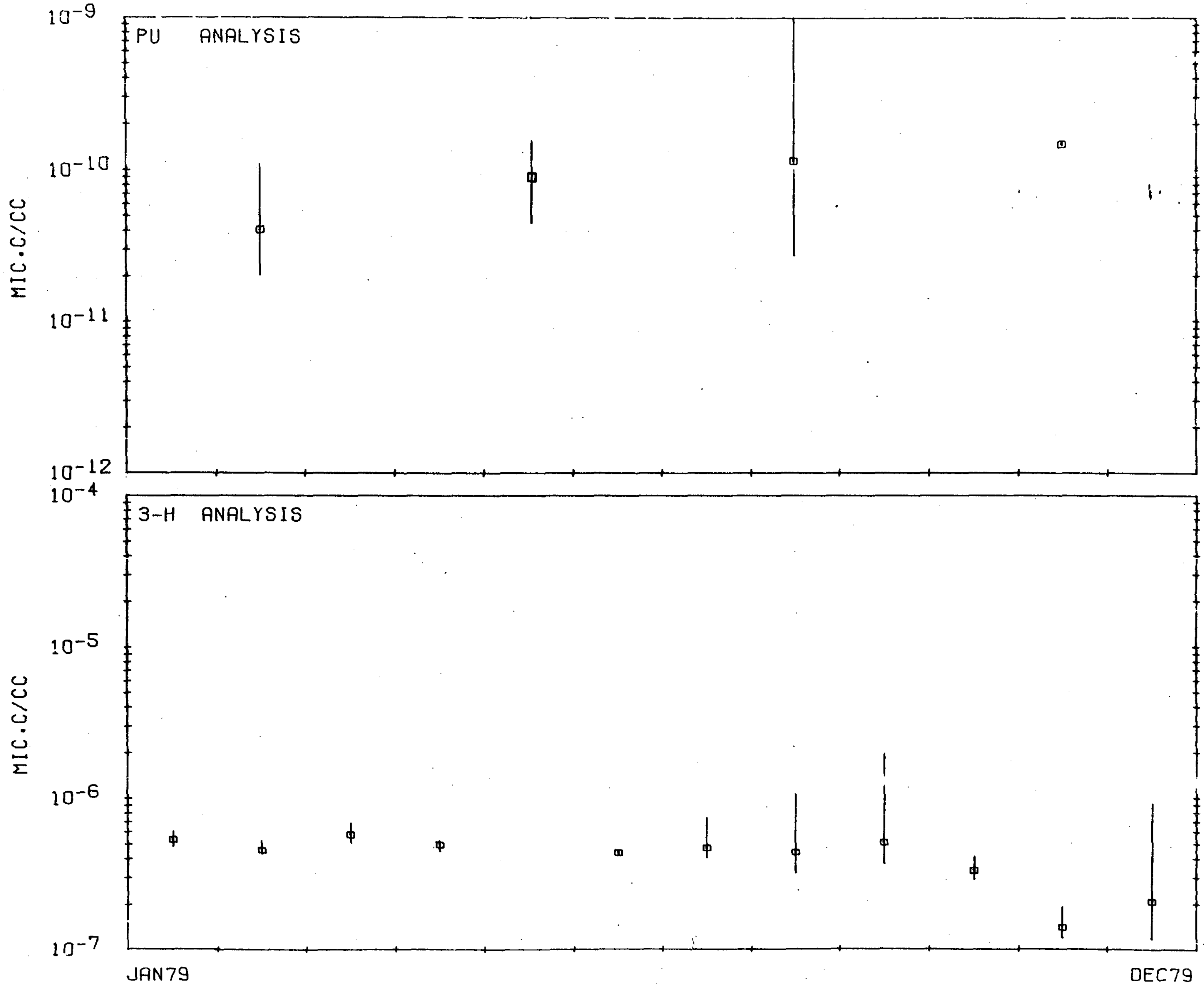
NTS Environmental Surveillance

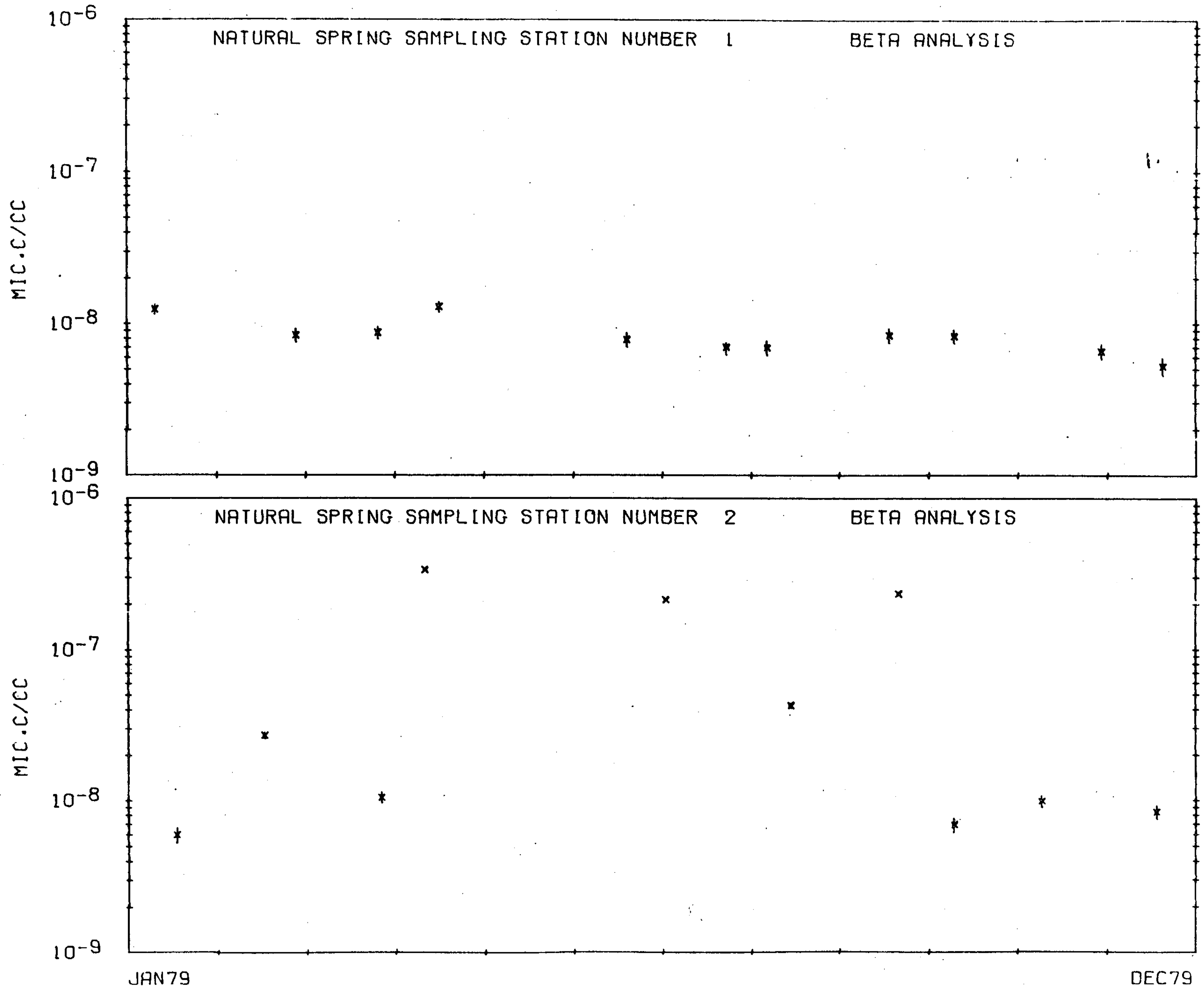
Contaminated Ponds Locations and Plots

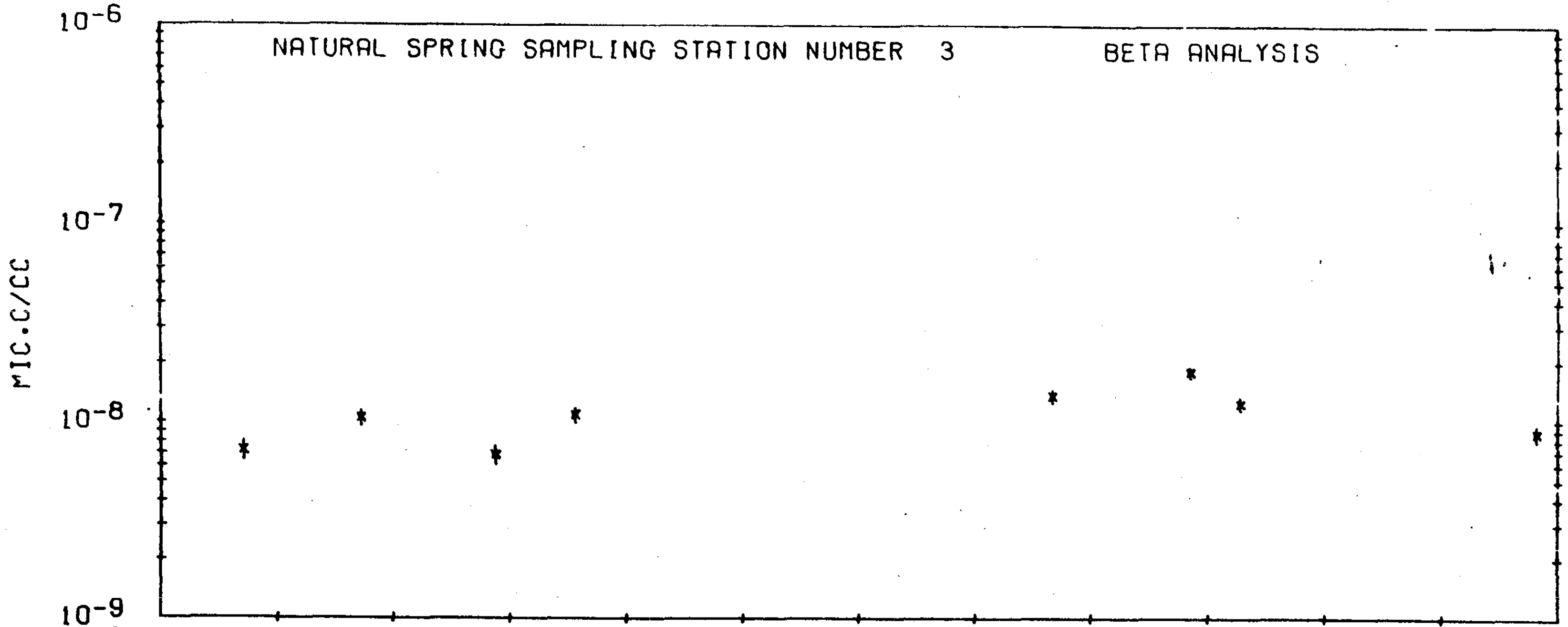
NATURAL SPRING NETWORK AVERAGES

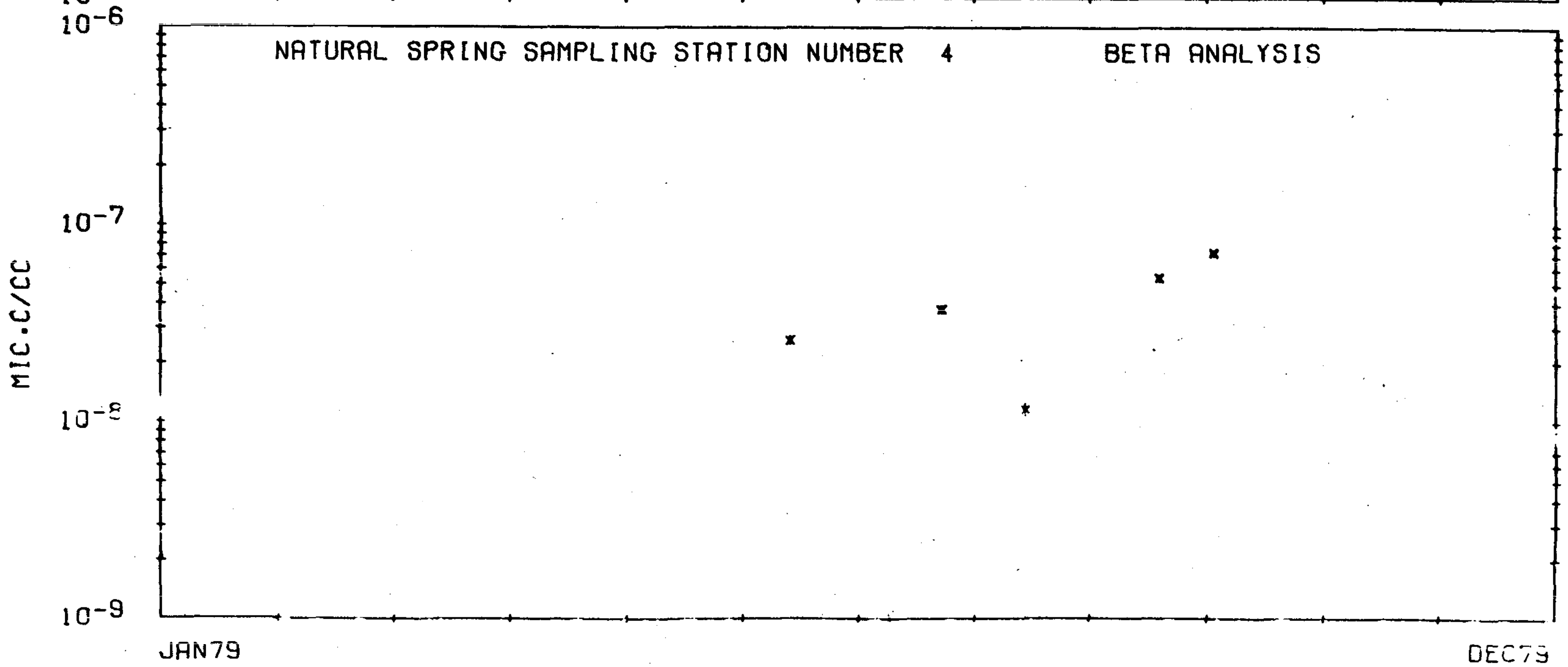


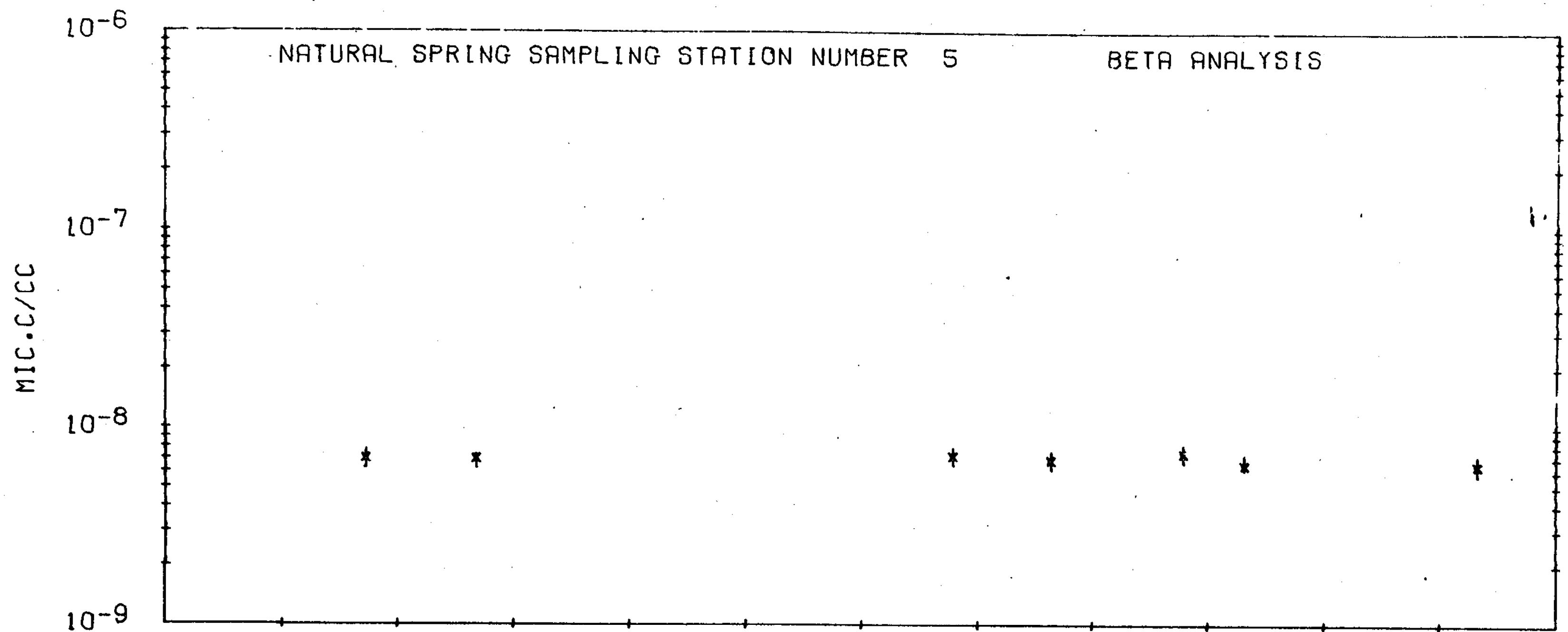
NATURAL SPRING NETWORK AVERAGES



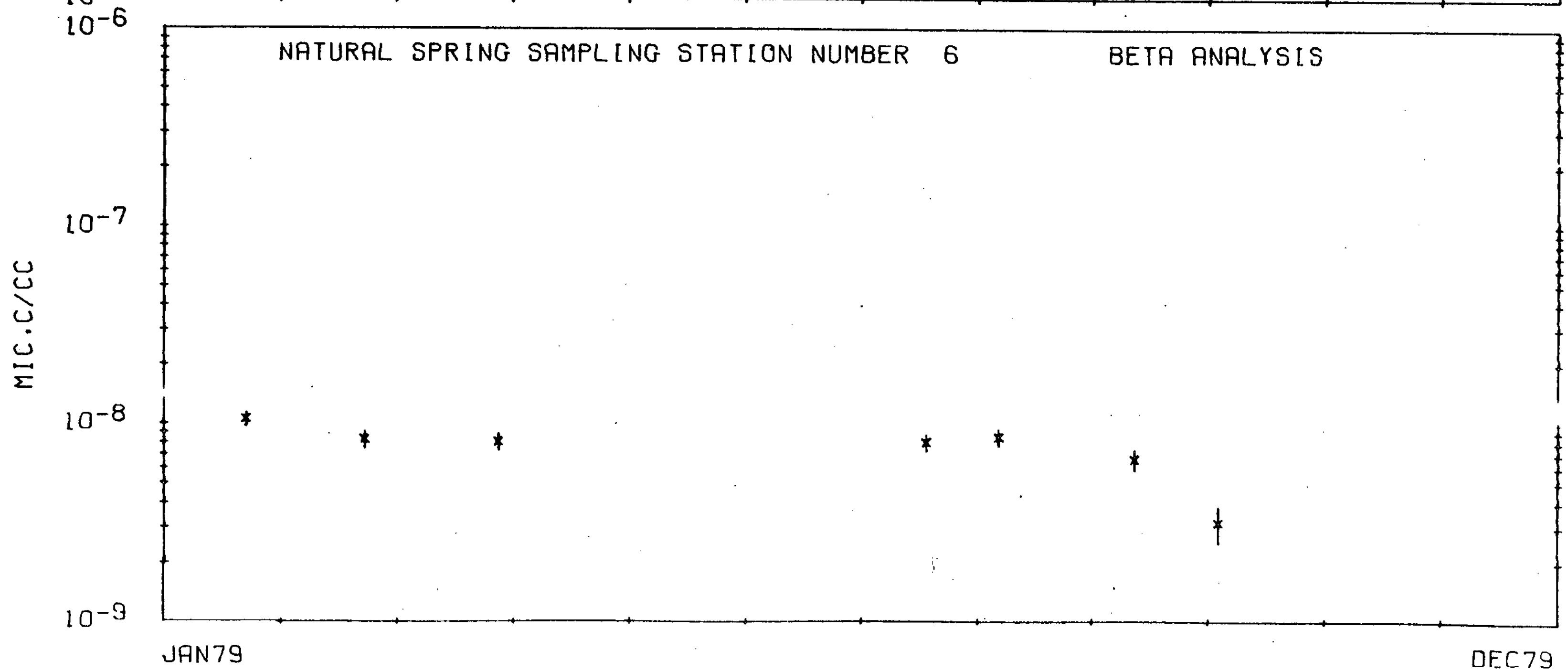

NATURAL SPRING SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
NATURAL SPRING SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79


NATURAL SPRING SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

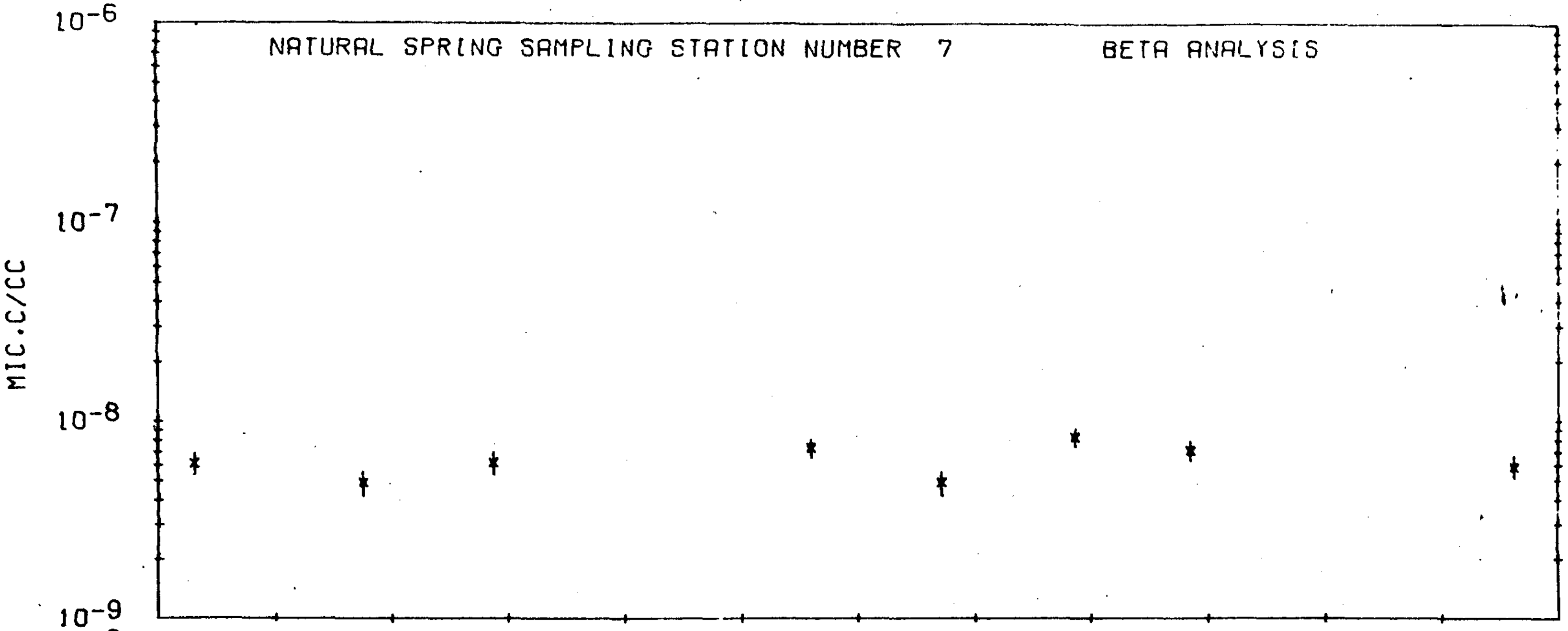

NATURAL SPRING SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79

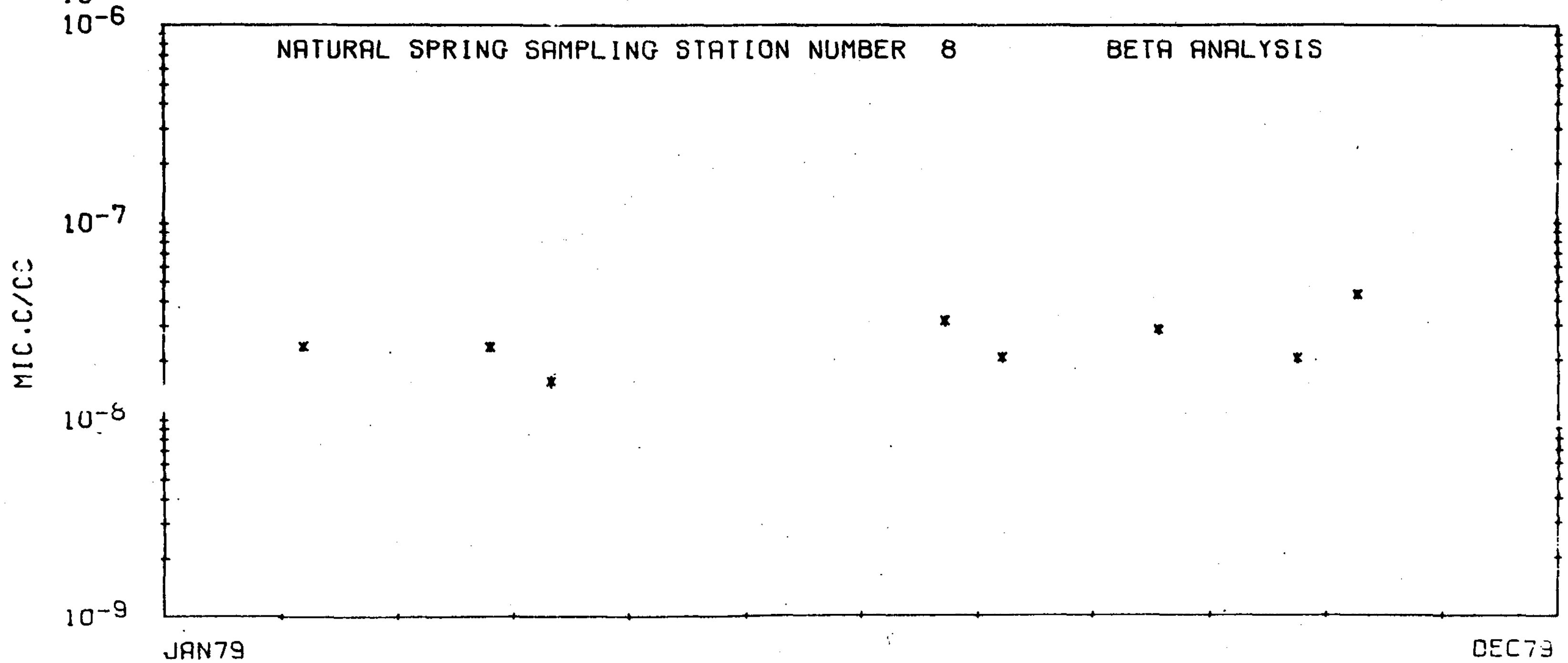


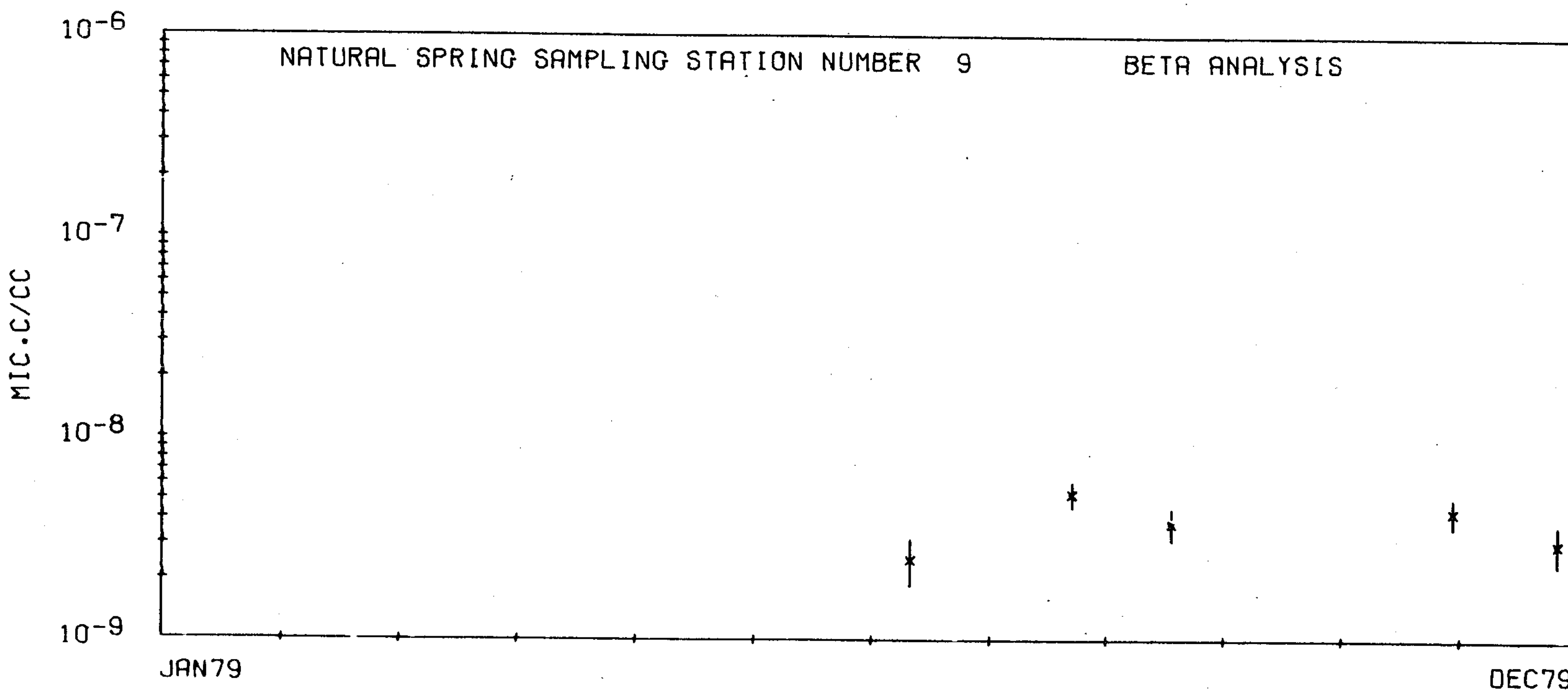
NATURAL SPRING SAMPLING STATION NUMBER 5
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}



NATURAL SPRING SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79


NATURAL SPRING SAMPLING STATION NUMBER 7
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


NATURAL SPRING SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN79
DEC79


NATURAL SPRING SAMPLING STATION NUMBER 9
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9
JAN79
DEC79

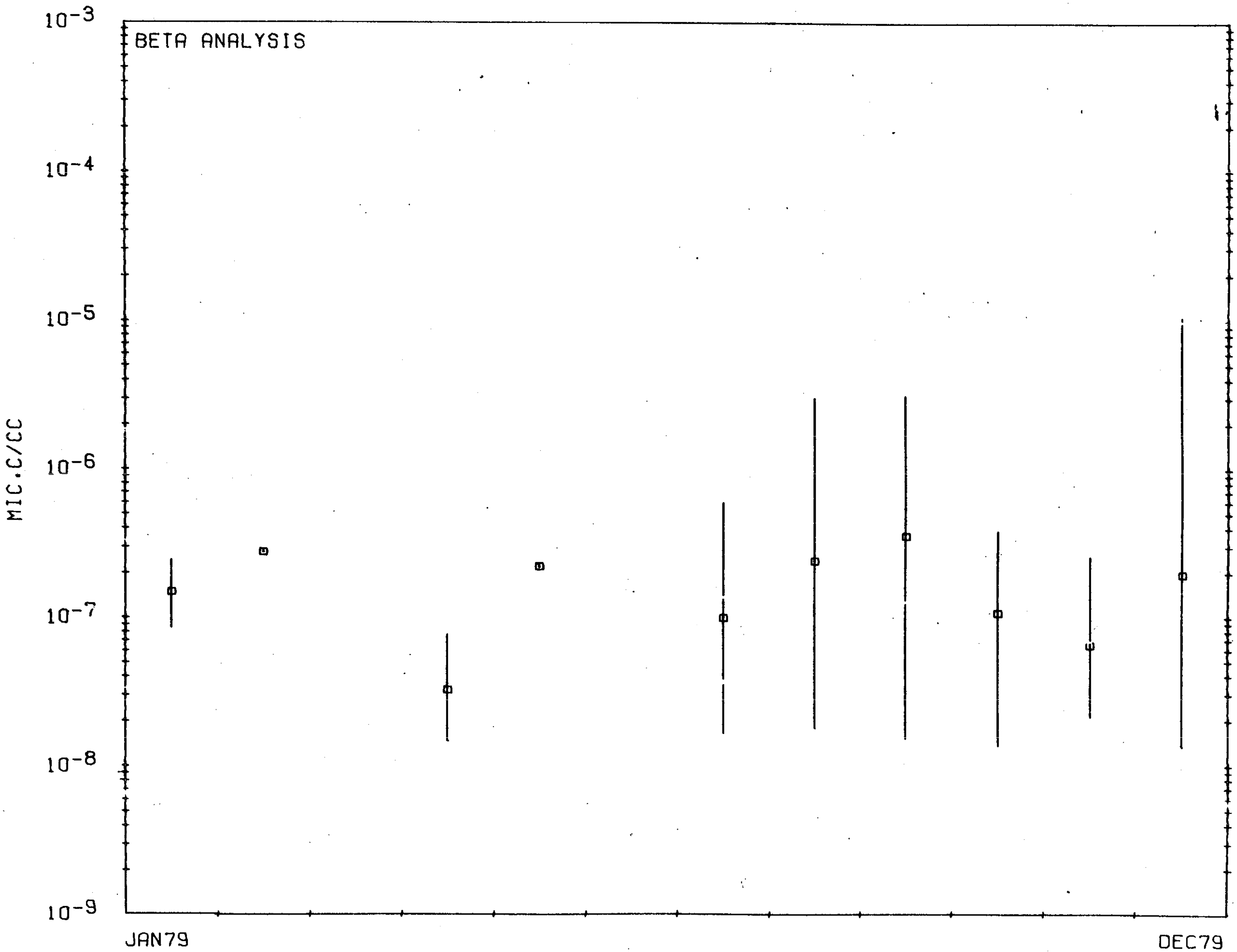
In the first two pages of plots in Appendix F, the contaminated pond network averages, a square is used to represent the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

The remaining plots show the gross beta of each station utilizing the symbol, X, as the data point. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

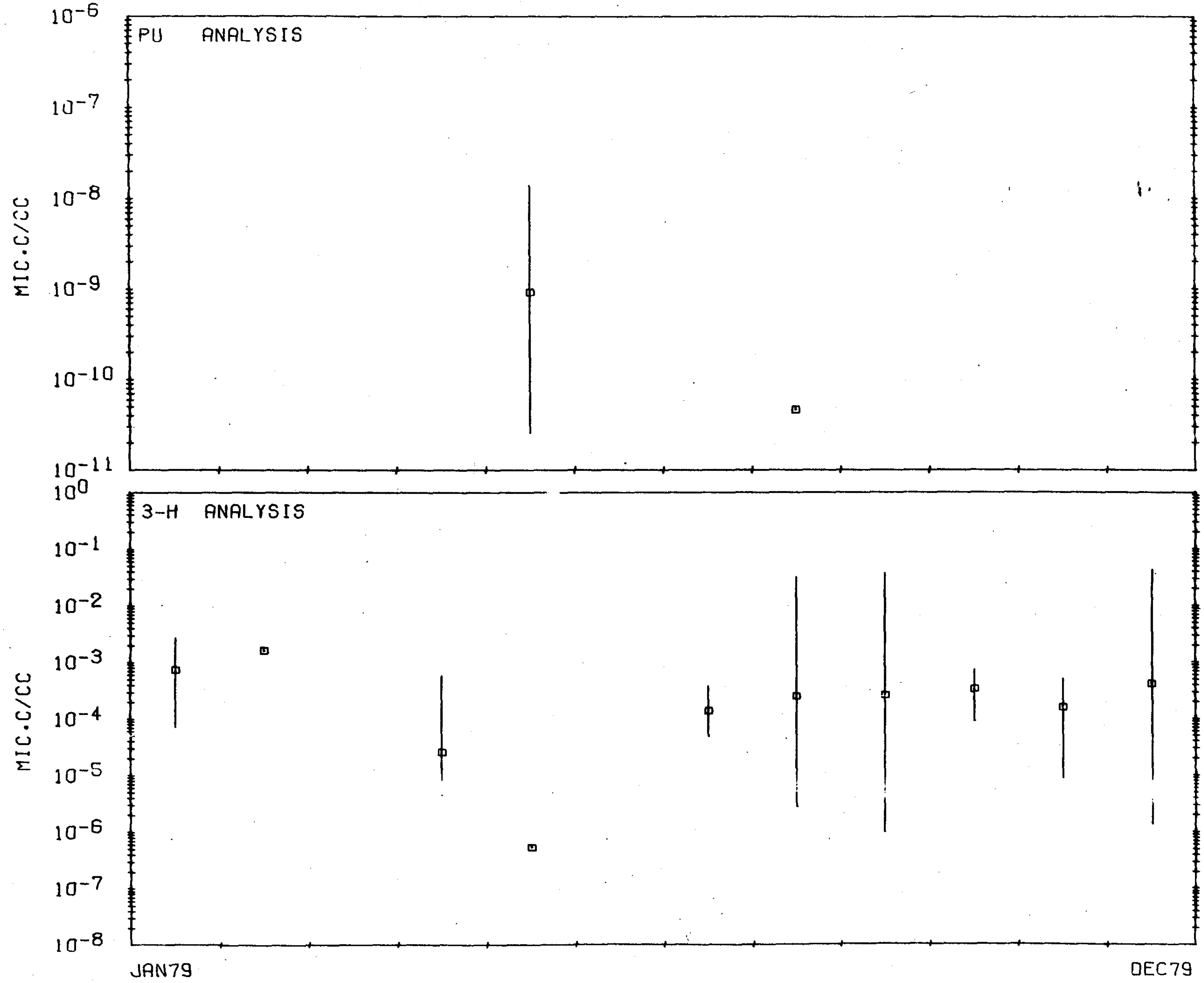
NTS ENVIRONMENTAL SURVEILLANCE
CONTAMINATED PONDS SAMPLING LOCATIONS

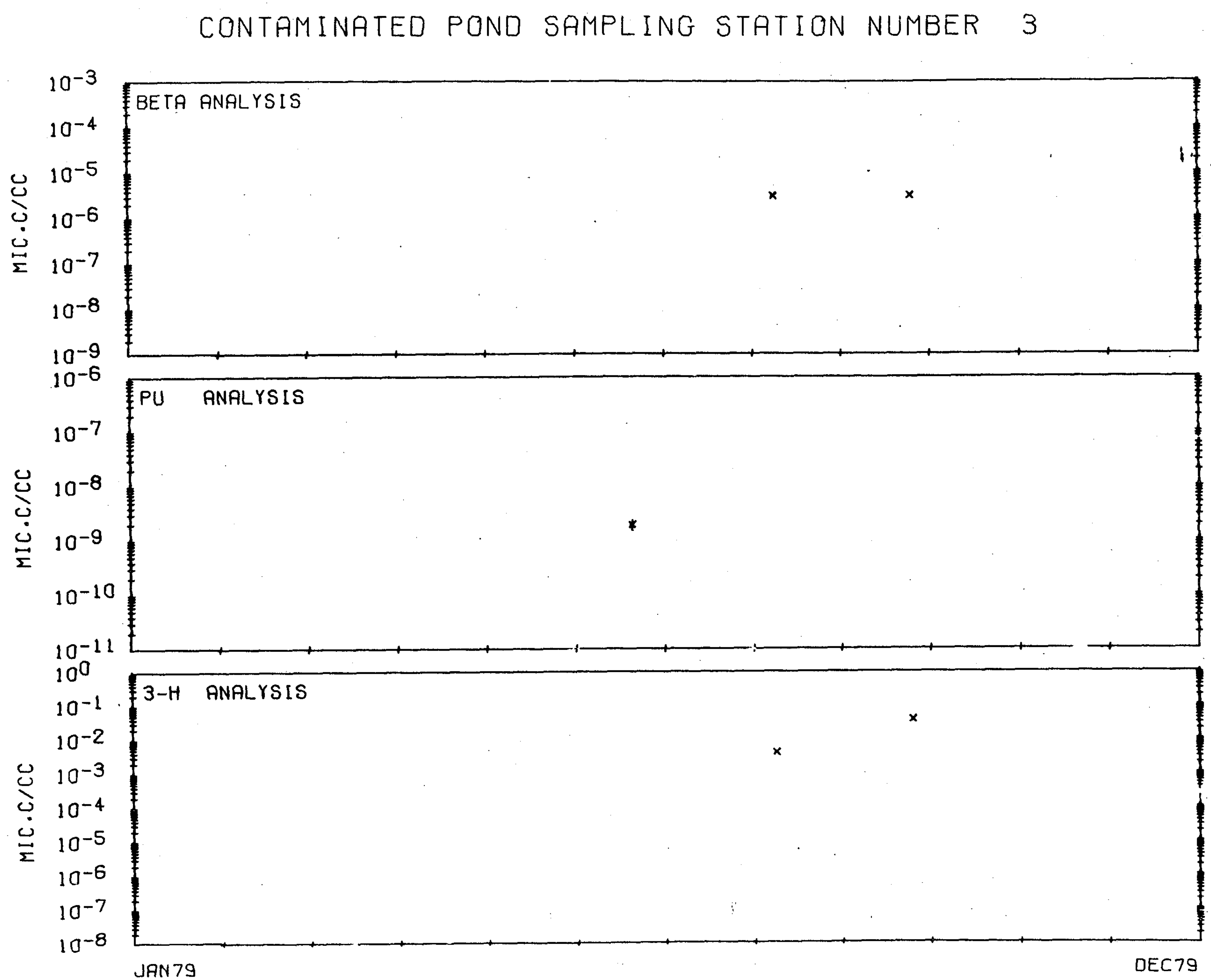
Station Number	Location
1	Area 12 Haines Upper
2	Area 12 Haines #2
3	Area 12 Haines #3
4	Area 12 Haines Lower
5	Area 12 Mint Upper
6	Area 12 Mint Mid
7	Area 12 Mint Lower
8	Area 12 N Upper
9	Area 12 N Mid
10	Area 12 N Lower
11	Area 12 G Tunnel
12	Area 12 H&S Sump
13	Area 6 Yucca Decontamination Pond

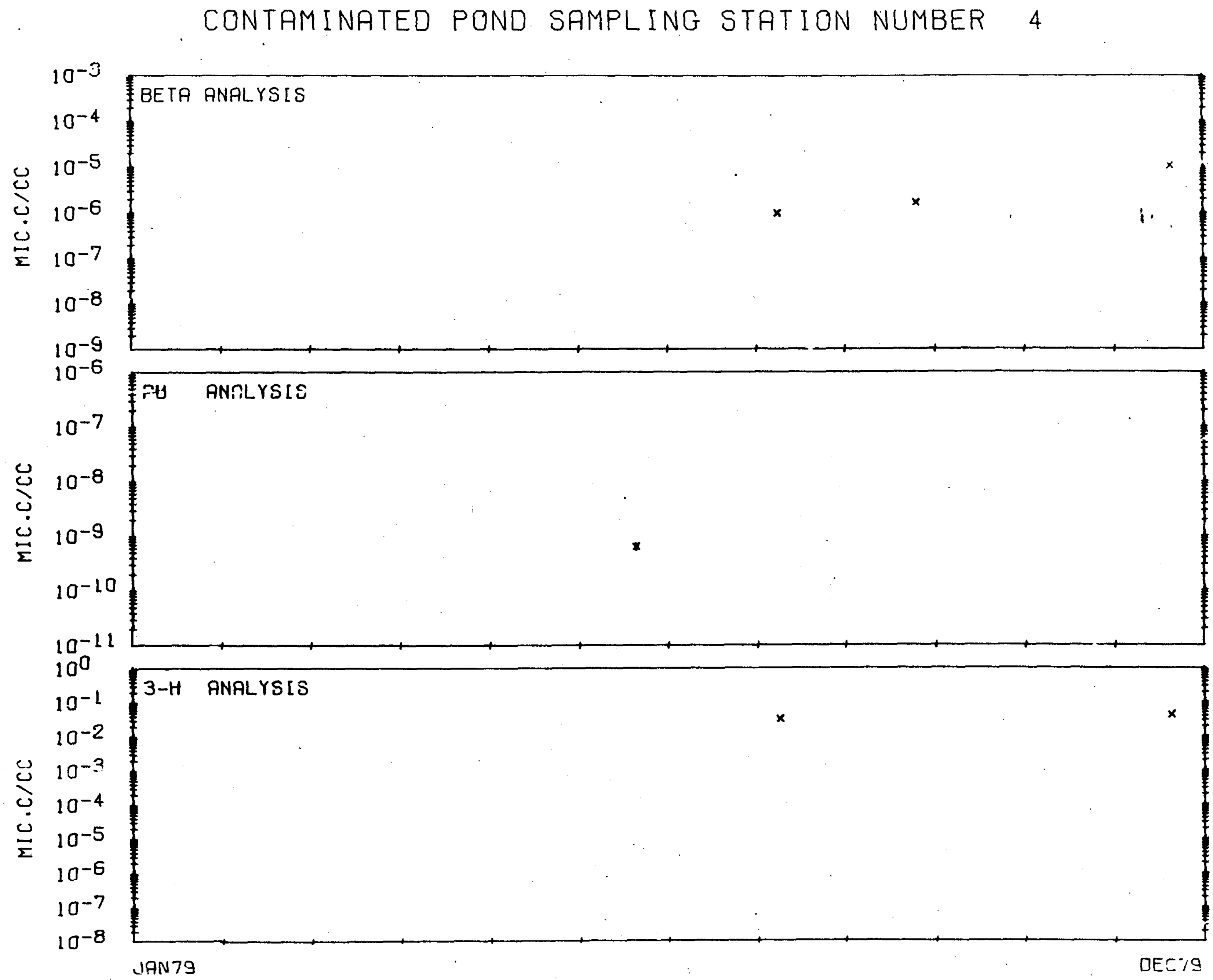
CONTAMINATED POND NETWORK AVERAGES

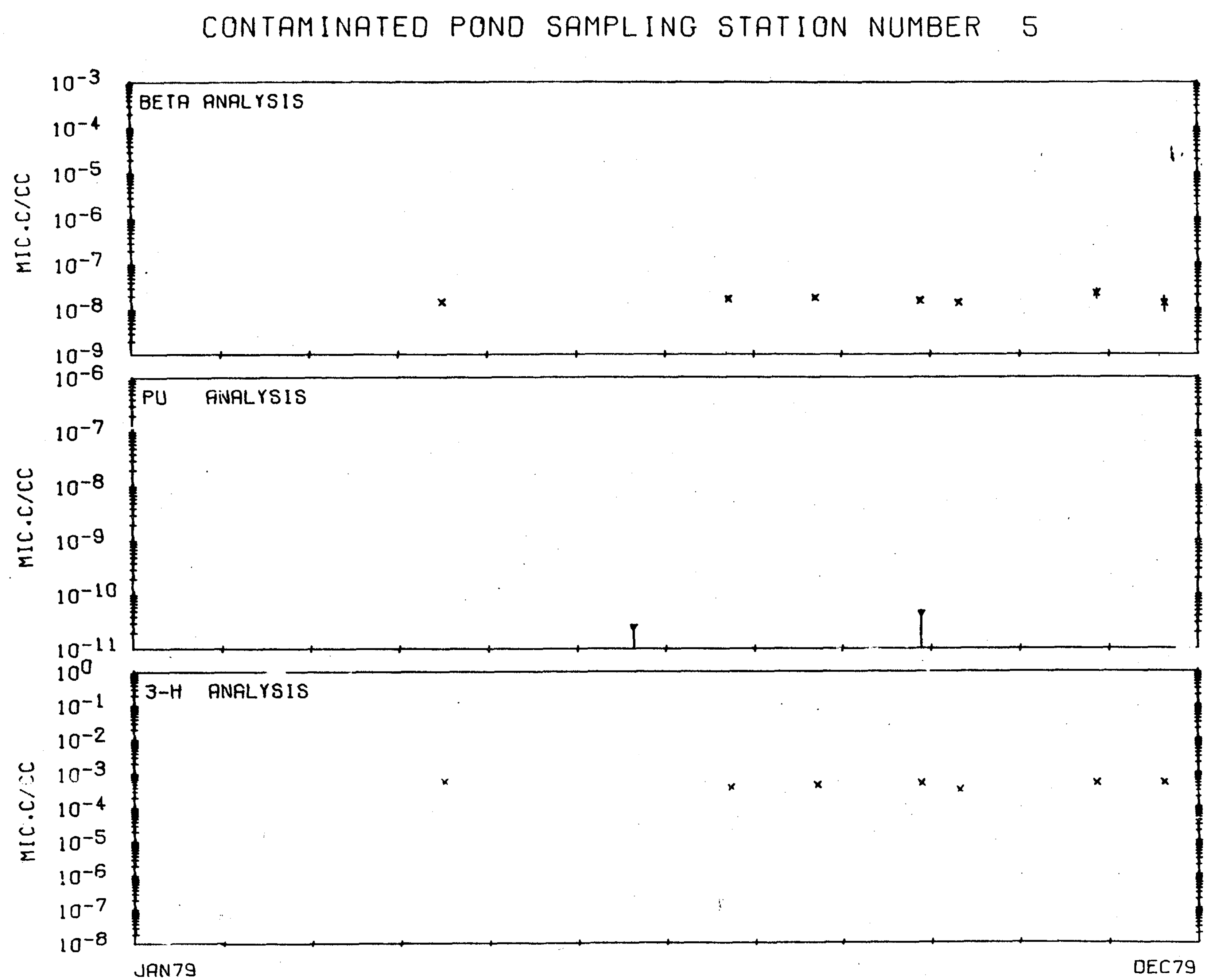


CONTAMINATED POND NETWORK AVERAGES

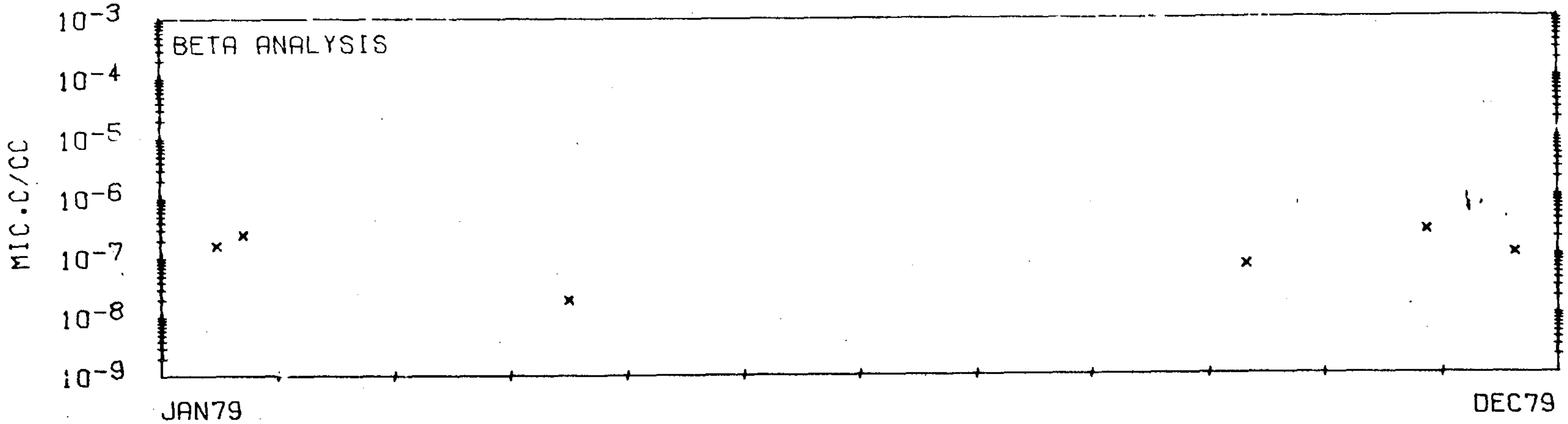



CONTAMINATED POND SAMPLING STATION NUMBER 3
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
MIC.C/CC
MIC.C/CC
JAN79
DEC79

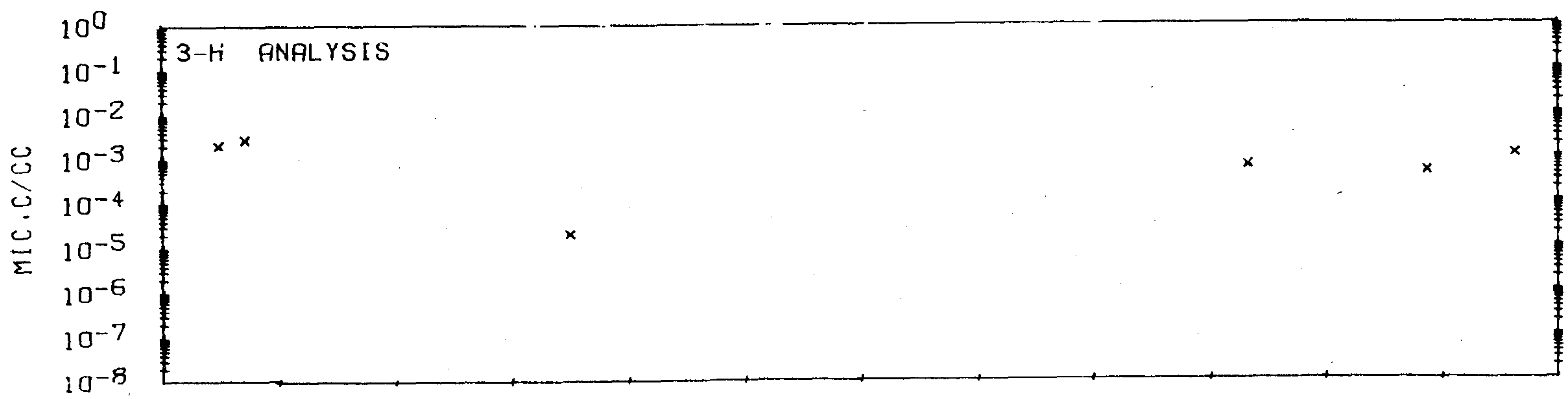

CONTAMINATED POND SAMPLING STATION NUMBER 4
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
MIC.C/CC
MIC.C/CC
JAN79
DEC79


CONTAMINATED POND SAMPLING STATION NUMBER 5
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
JAN79
DEC79

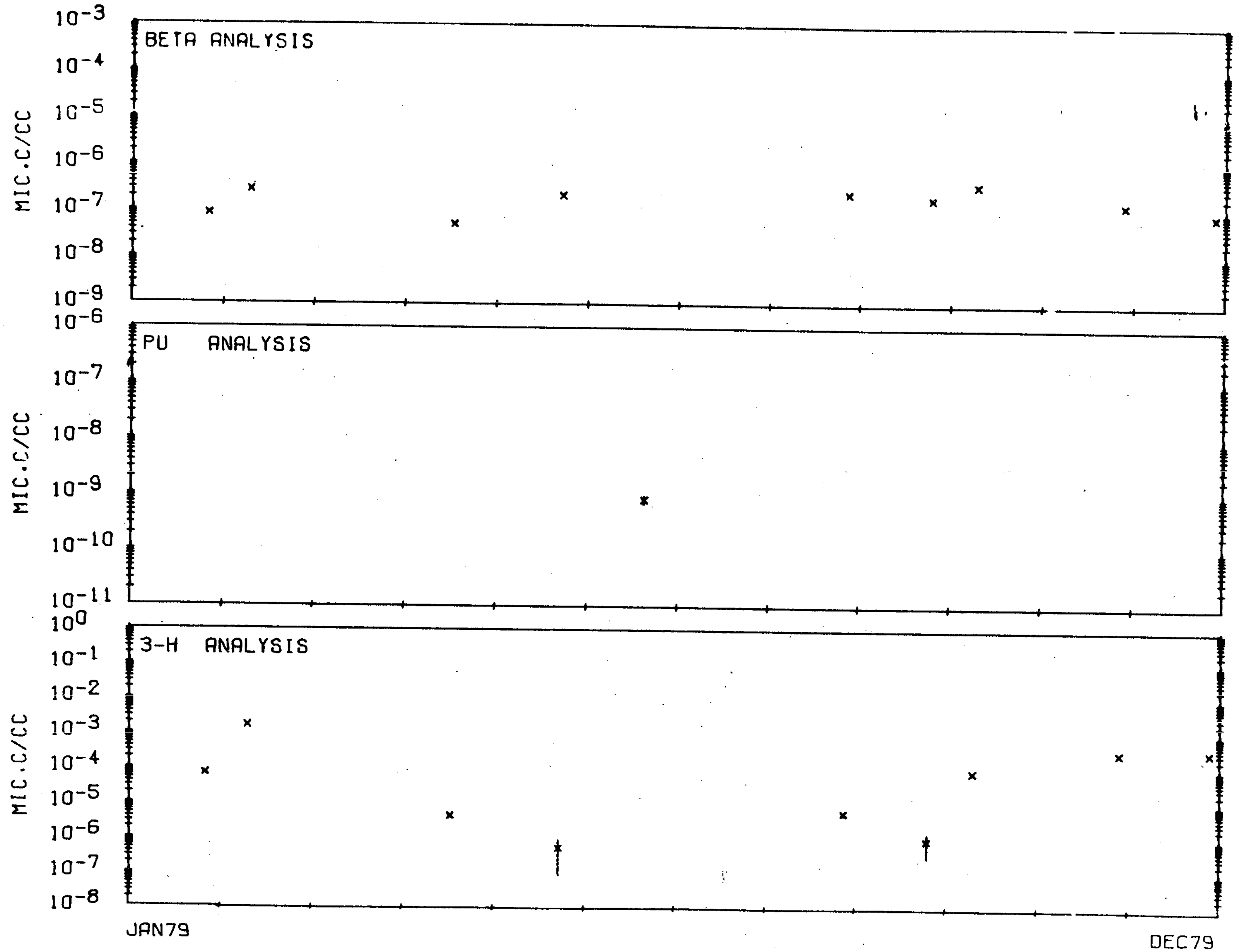
CONTAMINATED POND SAMPLING STATION NUMBER 8



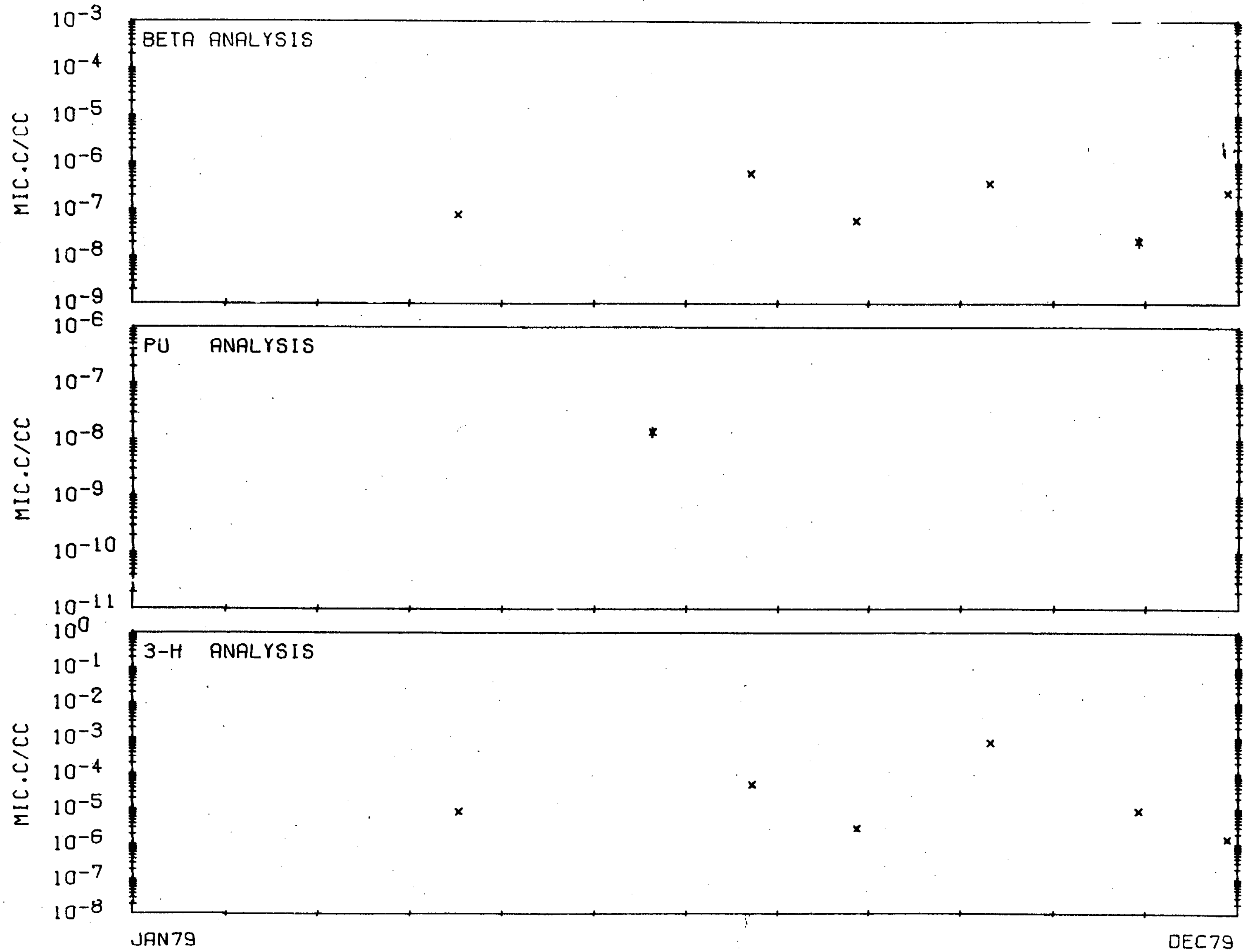
CONTAMINATED POND SAMPLING STATION NUMBER 8



CONTAMINATED POND SAMPLING STATION NUMBER 12



CONTAMINATED POND SAMPLING STATION NUMBER 13



DISTRIBUTION

T. H. Blankenship, DOE/NV
J. R. Boland, DOE/NV
C. D. Broyles, SL, Albuquerque, NM
E. D. Campbell, DOE/NV
B. W. Church, DOE/NV (2)
R. C. Clusen, AS/EV, DOE/HQ
C. F. Costa, EPA/EMSL, Las Vegas, NV
G. P. Dix, DOES, DOE/HQ (2)
E. M. Douthett, DOE/NV
J. F. Doyle, EG&G, Las Vegas, NV
J. E. Dummer, LASL, Los Alamcs, NV
P. B. Dunaway, DOE/NV
P. K. Fitzsimmons, DOE/NV
M. E. Gates, Manager, DOE/NV
R. F. Grossman, EPA/EMSL, Las Vegas, NV
Major General George Hoover, MA, DOE/HQ (2)
J. C. Hopkins, LASL, Los Alamos, NM
D. G. Jackson, DOE/NV
J. S. Kahn, LLL, Livermore, CA
Librarian, EG&G, Las Vegas, NV
R. R. Loux, DOE/NV (2)
M. A. Marelli, DOE/NV
P. J. Mudra, DOE/NV
H. F. Mueller, WSNSO/NOAA, Las Vegas, NV
P. C. Murphy, EG&G, Las Vegas, NV
R. W. Newman, AMD DOE/NV
L. J. O'Neill, DOE/NV
G. Oertel, Office of Nuclear Waste Management, DOE/HQ (3)
K. M. Oswald, LLL, Mercury, NV
E. Rippeon, Library, DOE/HQ (2)
G. E. Schweitzer, EPA/EMSL, Las Vegas, NV
T. P. Stuart, EG&G, Las Vegas, NV
Technical Information, REECo, Las Vegas, NV
Technical Library, DOE/NV (3)
Technical Library, REECo, Mercury, NV
J. Toman, LLL, Livermore, CA
G. E. Tucker, SL, Albuquerque, NM
USDOE TIC, Oak Ridge, TN (27)
T. E. Wade, Deputy Manager, DOE/NV