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RADIOLOGICAL EFFLUENT AND ONSITE AREA MONITORING REPORT FOR THE NEVADA TEST SITE (JANUARY 1986 THROUGH DECEMBER 1986)

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(JANUARY 1986 THROUGH DECEMBER 1986)

by

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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 1986 through December 1986. It presents results and evaluations of radioactivity measurements in air and water, and of direct gamma radiation exposure rates. Moreover, it establishes relevant correlations between the data recorded and DOE concentration guides (CG's).

This report was formerly titled Environmental Surveillance Report for the Nevada Test Site.

The monitoring results for CY-1986 reveal that external gamma exposure levels and radioactivity in air and water on the Nevada Test Site were low compared to DOE guidelines.

The highest average gross beta concentration in air was 0.005 percent of the DOE concentration guide (CG). This concentration is close to normal background for the Nevada Test Site. The highest average Pu-239 concentration was 7.7 percent of the standard. The highest average tritium concentration was 0.39 percent of the standard. Kr-85 concentrations increased slightly from CY-1985 to CY-1986. Xe-133 remained nondetectable with some exceptions.

The highest average gross beta concentration in potable water remained within the applicable standard for drinking water. These gross beta measurements demonstrated that no release or movement of radionuclides occurred in the NTS water system in CY-1986.

The highest average Pu-239 concentration from contaminated waters was 0.0005 percent of the concentration guide. The highest average tritium concentration in noncontaminated water was six percent of the level for drinking water required by the National Interim Primary Drinking Water Regulation. The amounts of tritium-bearing effluent released to contaminated waste ponds was calculated and reported to DOE Headquarters.

Gamma radiation measurements were roughly the same in CY-1986 relative to the previous year.

All surveillance results from the Radioactive Waste Management Site (RWMS) indicate that no detectable releases of radioactive materials occurred in that network in 1986.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

Credit must be given to D. Wilson for his excellent work in the program. I would also like to thank J. L. Morrison and the reviewers of this report for their cooperation and assistance.

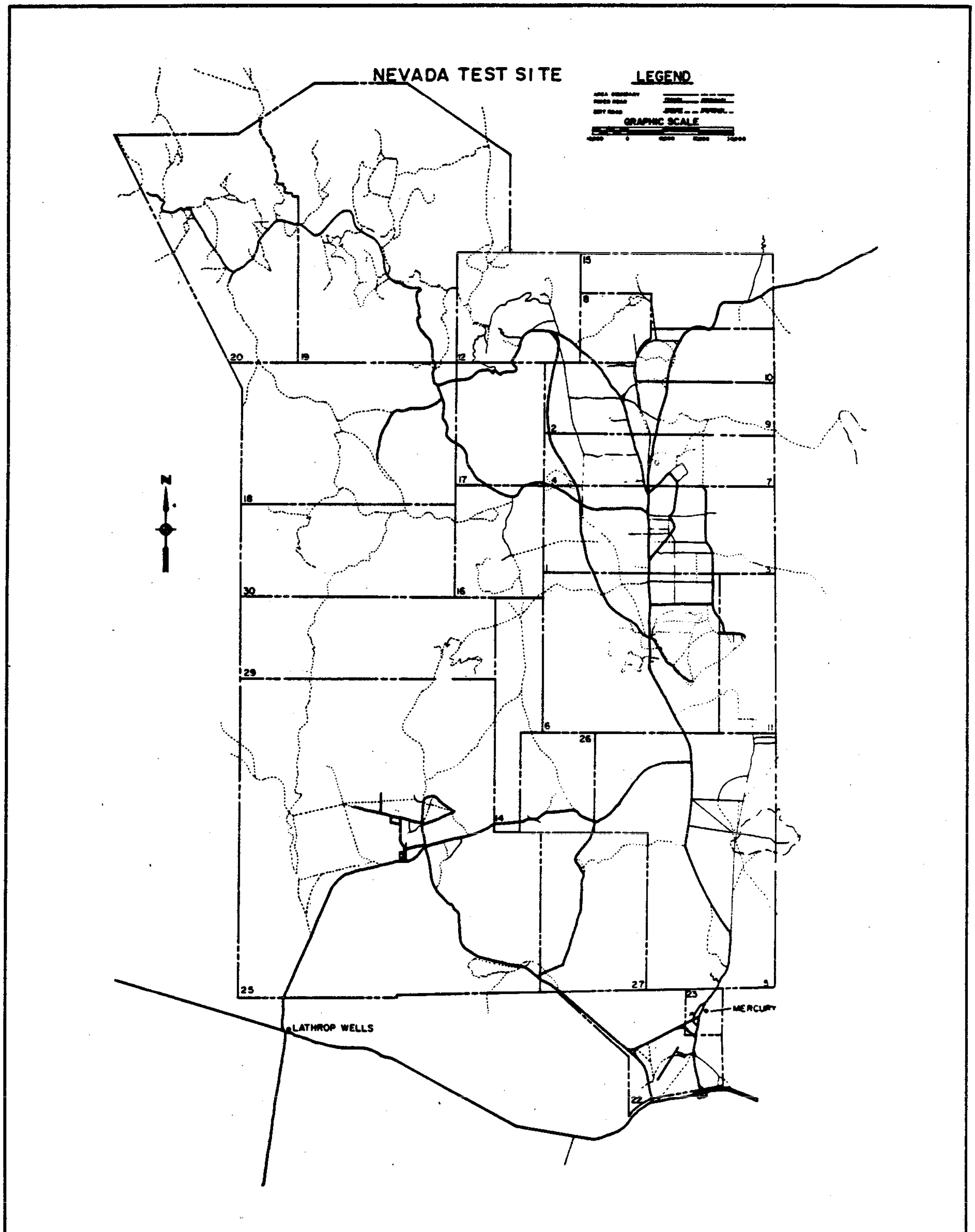
A. INTRODUCTION

This report documents the monitoring of radioactivity on the Nevada Test Site as performed by Reynolds Electrical and Engineering Co., Inc. (REECo) during the calendar year of 1986. As part of its contract, DE-AC08-84NV10327, REECo is responsible for providing radiological safety services within the confines of the test site. For a number of years, the Effluent and Onsite Area Monitoring 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, since 1951, has been the primary location for testing the nation's nuclear devices. 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 monitoring program examines the environment for radioactivity. This study supports documentation of the radiation exposure of NTS workers; that is, it backs up the personnel dosimetry system. The monitoring program provides data concerning onsite releases and acts as a monitoring locale for the detection of worldwide fallout in Nevada from foreign sources. The program follows the standards presented in "A Guide For Environmental Radiological Surveillance at U.S. Department of Energy Installations," DOE/EP-0023 (Reference 2). These standards dictate the following objectives for the protection of the public:

FIGURE 1


NEVADA TEST SITE
LEGEND
GRAPHIC SCALE
15
8
20
19
12
10
9
2
17
4
7
18
3
30
16
29
6
11
26
14
25
27
5
23
MERCURY
LATHROP WELLS
22

1. Evaluate the containment of radioactivity onsite.
2. Detect rapid changes in radioactivity and evaluate long-term trends.
3. Assess doses-to-man from radioactive releases as a result of DOE operations.
4. Discover unknown pathways of exposure by collecting data bearing on the movement of contaminants released to the environment.
5. Maintain a data base.
6. Detect and evaluate radioactivity from offsite sources.
7. Demonstrate compliance with applicable regulations and legal requirements concerning releases to the environment.

The Effluent and Onsite Area Monitoring Program achieves these objectives through a comprehensive program which samples radioactivity in air and water, in addition to measuring external gamma levels. 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 samples are taken at supply wells, open reservoirs, natural springs, contaminated ponds, and sewage ponds 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 determined by the potential for human exposure; for example, weekly water samples are taken at each cafeteria. Thermoluminescent dosimeters (TLD's) measure the ambient NTS external gamma levels and are collected quarterly. The "Summary of the Environmental Plan" is shown in Table 1.

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	47	Gamma spectroscopy, gross beta, plutonium (monthly composite)
	Low-volume sampling through silica gel	Biweekly	17	HTO (tritium)
	Continuous low volume sampling	Weekly	7	^{85}Kr and ^{133}Xe
Potable Water	1-liter grab sample	Weekly	8	Gamma spectroscopy, gross beta, tritium, plutonium (quarterly)
Supply Wells	1-liter grab sample	Monthly	15	Gamma spectroscopy, gross beta, tritium, plutonium (quarterly)
Open Reservoirs	1-liter grab sample	Monthly	17*	Gamma spectroscopy, gross beta, tritium, plutonium (quarterly)
Natural Springs	1-liter grab sample	Monthly	9*	Gamma spectroscopy, gross beta, tritium, plutonium (quarterly)
Contaminated Ponds	1-liter grab sample	Monthly	8*	Gamma spectroscopy, gross beta, tritium, plutonium (quarterly)
Effluent Ponds	3-liter grab sample	Quarterly	6	Gamma spectroscopy, gross beta, plutonium (quarterly)
External Gamma Radiation Levels	CaF_2:Dy Thermoluminescent Dosimeters	Quarterly	159	Total integrated exposure over field cycle

* All of these locations were not sampled due to inaccessibility or lack of water.

Except for removal of a station, inaccessibility of the location, loss of data, or absence of water, sampling was continuous during this reporting period. A review of all analytical results from this sampling program relative to the DOE applicable standards was performed daily to insure that potential problems were noted in a timely fashion. Table 2 lists the applicable standards for the NTS used in the evaluations of the results of this program (References 3, 22 and 29).

Laboratory operations employed several analysis procedures to evaluate samples. These procedures included gross beta analysis, gamma spectroscopy, noble gas sampling, plutonium analysis, tritium analysis and thermoluminescent dosimeter analysis. The gross beta analysis was the most informative of the test site samples. This analysis 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 demonstrated their worth in several instances. Gamma spectroscopy and noble gas sampling, for example, indicated whether radioactivity increases in air were caused by the Nevada Test Site or other offsite sources. Plutonium analysis measured small amounts of Pu-239 in the air near safety shot areas. Tritium analysis checked principally the water in the ponds below the Area 12 tunnels. TLD analysis of direct gamma radiation onsite showed: (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 were used over a three month period. All laboratory analyses procedures appropriate to the environmental surveillance program are shown in Table 3.

TABLE 2

APPLICABLE STANDARDS FOR THE NTS

Nuclide	DCG for Air* (μCi/ml)	CG for Major NTS Waters+ (μCi/ml) **	MCL for Drinking Water*** (μCi/ml)
^{3}H	1×10^{-7}	1×10^{-1}	2×10^{-5}
^{7}Be	4×10^{-8}	5×10^{-2}	6×10^{-6}
^{60}Co	8×10^{-11}	1×10^{-3}	1×10^{-7}
^{85}Kr	3×10^{-6}	--------	--------
^{89}Sr	2×10^{-9}	3×10^{-4}	8×10^{-8}
^{90}Sr	5×10^{-11}	1×10^{-5}	8×10^{-9}
^{95}Zr	6×10^{-10}	2×10^{-3}	2×10^{-7}
^{131}I	4×10^{-10}	3×10^{-5}	3×10^{-9}
^{132}Te	2×10^{-9}	9×10^{-4}	9×10^{-8}
^{133}Xe	5×10^{-7}	--------	--------
^{137}Cs	4×10^{-10}	4×10^{-4}	2×10^{-7}
^{140}Ba	3×10^{-9}	8×10^{-4}	9×10^{-8}
^{152}Eu	5×10^{-11}	2×10^{-3}	2×10^{-7}
^{238}Pu	3×10^{-14}	1×10^{-4}	5×10^{-6}
^{239}Pu	2×10^{-14}	1×10^{-4}	5×10^{-6}
gross β****	1×10^{-9}	1×10^{-5}	1.5×10^{-8}

*This column contains the derived concentration guides for the predominant nuclides detected at the NTS, as listed in DOE Order 5480.XX, Attachment 1. When more than one class level existed, the lowest value was used.

+These concentrations are applicable to the discharge of liquid effluents to sanitary sewage systems.

**This column contains the concentration guides for the predominant nuclides detected at the NTS, as listed in DOE Order 5480.1A, Chapter XI, Table 1.

***Drinking water concentration guides are as required by the National Interim Primary Drinking Water Regulations.

****Concentration guides for gross β are derived according to DOE ORDER 5480.1A, attachment XI-1.3, page 14.

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	Gas-flow Proportional Counter	20	Place filter on a 12.7 cm stainless steel planchet.	10^9 cc	2×10^{-16} µCi/cc
	Water	Gas-flow Proportional Counter	100	Evaporate, transfer residue to a 12.7 cm stainless steel planchet.	1000 ml	1×10^{-9} µCi/ml
Gamma Spectroscopy	Air (particulate)	Germanium Semiconductor	20	Same as for gross beta.	10^9 cc	5×10^{-15} µCi/cc
	Air (gaseous)	Germanium Semiconductor	20	Place charcoal cartridge in plastic bag.	10^9 cc	5×10^{-15} µCi/cc
	Water	Germanium Semiconductor	20	Aliquot sample into Nalgene bottle.	500 ml	1×10^{-8} µCi/ml
Krypton-85	Air	Liquid Scintillation Counter	200	Cryogenic-gas chromatographic techniques used to collect krypton into liquid scintillation solution.	3×10^5 cc	4×10^{-12} µCi/cc
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	1000	Pu is concentrated with $Fe(OH)_3$ and purified with anion resin column. Electrodeposited on a stainless steel disc.	1000 ml	4×10^{-11} 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	Distill 20 ml of sample and aliquot 4 ml into a scintillation solution.	4 ml	4×10^{-7} µCi/ml
Xenon-133	Air	Liquid Scintillation Counter	200	Cryogenic-gas chromatographic techniques used to collect xenon into liquid scintillation solution.	3×10^5 cc	10×10^{-12} µCi/cc
Direct Gamma Radiation	TLD	Harshaw 2000 TLD Reader		Post-anneal at 115°C for 15 minutes. Readout to 270° for 25 seconds.		10 mR/quarter

B. SUMMARY OF RESULTS

The results obtained from the Effluent and Onsite Area Monitoring Program for the reporting period of CY-1986 show that the radioactivity in air and water, and external gamma exposure levels in the NTS environments were low compared to DOE guidelines.

Radioactivity in Air

The highest CY-1986 average gross beta concentration in air was 5.4×10^{-14} µCi/cc at one of the forty-seven stations, excluding samples collected at Gate 200 and the Area 5 communications tower which were analyzed by a different procedure (see Section D). This average represents 0.005 percent of the applicable derived concentration guide of 1×10^{-9} µCi/cc as listed in Table 2. The site average for the forty-seven stations was 5.0×10^{-14} µCi/cc with one standard deviation being 20.1 percent. This gross beta concentration is considered to be normal background for the Nevada Test Site.

An inspection of the air sampling network results revealed an increase in the gross beta concentrations beginning late April and continuing through May. These elevated levels began decreasing in June and eventually reached typical NTS levels ($\cong 3 \times 10^{-14}$ µCi/cc) later in the year. There were two unrelated events which contributed to this increase: the Chernobyl reactor accident in the Soviet Union and the T Tunnel planned ventilation following the event MIGHTY OAK. Along with the elevated gross beta levels were the detection of various gamma emitting radionuclides at concentrations close to detection limits.

Pu-239 concentrations in air were primarily on the order of 10^{-17} μCi/cc as compared with the derived concentration guide of 2 X 10^{-14} μCi/ml [DOE Order 5480.xx, Chapter XI, Attachment 1, Table 1] (Reference 29). The highest average Pu-239 concentration occurred in Area 3 at U3ax/bl South. This Pu-239 concentration of <1.5 X 10^{-15} μCi/cc represents 7.7 percent of the derived concentration guide. The majority of NTS air sampling stations measured plutonium concentrations similar to those found in the base camp (Mercury), and all were negligible in terms of exposure to NTS personnel.

The highest average tritium concentration in air occurred at the Area 23 Building 650 roof. This concentration, <3.9 X 10^{-10} μCi/cc, represents 0.39 percent of the derived concentration guide.

The average concentration of Kr-85 for CY-1986 was 35 X 10^{-12} μCi/cc, which was slightly higher than the CY-1985 average of 33 X 10^{-12} μCi/cc. This increase in Kr-85 concentration in ambient air was expected since nuclear technologies, predominantly nuclear power generation, continue to generate and release small quantities of Kr-85 (Reference 25).

Xe-133 concentrations continued to be nondetectable except for instances related to specific events.

A survey of radon 222 and radon 222 daughter concentrations was conducted in the selected tunnels on Rainier Mesa at the Nevada Test Site during June 1984 (Reference 28). This study, conducted by D. N. Fauver, used the Rolle and Kusnetz methods as well as integrating monitoring instruments such as the "Passive Environmental Radon Monitor" or PERM. The purpose of the study was to quantitate radon daughter concentration levels inside the chosen tunnels. The radon daughter concentrations were reported in units of working levels (0.01 WL is equal to 3% of the EPA standard applicable to radiation workers).

The Fauver study took measurements in three tunnels, N, T, and G. Results of preliminary measurements indicated that N and T Tunnels had low radon daughter concentrations (RDC), that is, 0.01 WL with normal ventilation conditions. It was demonstrated, however, that RDCs can rise to relatively high levels, for example, 0.24 WL when ventilation rates are significantly lowered. The radon daughter concentrations measured in G Tunnel were an order of magnitude higher than those found in N and T Tunnels. The average RDC in the rock mechanics drift (the "worst-case" location in G Tunnel) was 0.13 WL with a range from 0.07 WL to 0.23 WL. Elevated RDCs found in the rock mechanics drift of G Tunnel seemed to be attributable to a lower ventilation rate in conjunction with the more highly fractured nature of the "welded tuff" rock formation in which the incline drift was mined. By increasing the ventilation rate, a 60% reduction in RDCs from an average of 0.13 WL to an average of 0.05 WL was achieved.

Radioactivity in Water

Measurements of radioactivity in the principal NTS water system showed that no release or movement of radionuclides occurred during the reporting period. One supply well sample was added in March 1986, at Well UE15D. The highest average gross beta concentration in potable waters and supply wells was 9.5×10^{-9} µCi/ml from the A-3 Cafeteria and 16.6×10^{-9} µCi/ml from Area 15 Well UE15D. Water from several of the open reservoirs 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 the applicable standards.

The highest average Pu-239 concentration from contaminated waters was <4.6 X 10^{-10} µCi/ml at T Tunnel Pond 1. This value represents 0.0005 percent of the concentration guide for Pu-239. For all other waters sampled, the highest average Pu-239 concentration was <1.4 X 10^{-9} µCi/ml at the Yucca Steam #2. This value represents 0.03 percent of the maximum contaminant level (MCL) for Pu-239. All of the positive plutonium results, however, have a high percentage error associated with them. This error factor could be due to statistical fluctuations of the counting system.

The highest average concentration of tritium in noncontaminated water occurred at Well J-12 Reservoir. This concentration of <1.2 X 10^{-6} µCi/ml represents 6 percent of the limit allowed by drinking water standards.

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 DOE Order 5484.1, Chapter IV.

TLD measurements of the NTS gamma radiation rates at the 159 locations showed some variation during CY-1986. A nine station control network displayed lower results than previous years. The remaining 150 stations recorded changes related to known effects. The maximum dose rate of 1610 mrem/y occurred at the Stake 2n-8 station but the majority of NTS locations measured in the range of approximately 100-160 mrem/y. Stake 2n-8 station was surrounded by four above-ground event sites. Similarly, a portion of the 159 TLD stations on NTS were at or near known Radiation Areas and Contamination Control Areas.

The maximum dose to an individual working at the NTS was calculated for CY-1986. A highly conservative approach was taken to determine these doses. The greatest average concentrations from the individual analyses were used to determine dose. This means that the highest concentration of Pu-239 in air at Area 3 U3ax/bl South and the highest tritium in air concentration at Area 23 building 650, along with the other analyses presented were used to determine dose to an individual working at the NTS.

In effect, this system assumes that an individual stands and breathes at various locations simultaneously during the entire work year.

The maximum calculated dose to the total body, bone, and lung was 1.0 mrem, 34 mrem, and 2.0 mrem respectively.

C. SAMPLING AND ANALYSIS

1. Air Monitoring

Air sampling units were located at 47 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 population density. 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 diameter Whatman GF/A filter for particulates, followed by a charcoal cartridge for radioiodines mounted on a plastic sample holder. A dry-gas meter was utilized to measure the volume of air displaced over the sampling period (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 naturally-occurring radon and its daughter products to decay. Gross beta counting was performed with a gas flow proportional counter for 20 minutes. The lower limit of detection for typical parameters involved was 2×10^{-16} μCi/cc. Gamma spectroscopy was accomplished using germanium detectors with an input to 2000 channels, calibrated at 1 kiloelectronvolt (keV) per channel from 0 to 2 megaelectronvolt (MeV).

The weekly air samples for a given sampling station were batched on a monthly basis and radiochemically analyzed for Pu-239. 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 Pu-236 tracer. Alpha spectroscopy was performed utilizing a solid state silicon surface barrier detector. The lower limit of detection for the parameters involved was 1 X 10^{-17} μCi/cc.

A separate sampler was designed for the collection of airborne tritiated water vapor (HTO) (Reference 4). The portable sampler was 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 Tritium (HTO) was removed from the air stream by two silica gel drying columns. Appropriate aliquots of condensed moisture were obtained by heating the silica gel. Liquid scintillation counting determined the HTO activity. A lower limit of detection for this analysis was 3 X 10^{-13} μCi/cc.

Noble gas sampling units are housed in a metal tool box. Three metal air bottles are attached to the sampling units with short hoses. A vacuum is maintained on the first bottle which causes a steady flow of air to be collected in the other two bottles. The flow rate is approximately 0.5 cubic centimeters per minute. The two collection bottles are exchanged weekly which yield a sample volume of about 3 X 10^5 cubic centimeters.

The noble gases are separated and collected from the atmospheric sample by a series of cryogenic-gas chromatographic techniques. Water and carbon dioxide are removed at room temperature and the krypton and xenon are collected on charcoal at liquid nitrogen temperatures. These gases are transferred to a molecular sieve where they are separated from any remaining gases and each other. The krypton and xenon are transferred to separate scintillation vials and counted on a liquid scintillation counter. The lower limits of detection for krypton and xenon are 4×10^{-12} and 10×10^{-12} 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. The frequency of collection was determined on the basis of a preliminary radiological pathways analysis. Potable water was collected weekly; supply wells, monthly. Samples were collected in 1-liter glass containers. All samples were analyzed for gross beta, tritium, and gamma emitting isotopes. Plutonium analyses were performed on a quarterly basis.

A 500-ml aliquot was taken from the water sample and counted in a Nalgene bottle for gamma activity with a germanium detector. A 5-ml aliquot was used for tritium analysis via liquid scintillation counting. 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 ("Air Monitoring") except that the water samples were counted for 100 minutes. Lower limits of detection were: (1) gamma spectroscopy, $\cong 1 \times 10^{-8}$ µCi/ml; (2) tritium, 9×10^{-7} µCi/ml; and (3) gross beta, 1×10^{-9} µCi/ml.

For the quarterly plutonium analysis, an additional one-liter sample was collected. The radiochemical procedure was similar to that described in section 1. As mentioned, alpha spectroscopy was used to measure any Pu-239. The lower limits of detection for this procedure was 4×10^{-11} µCi/ml.

3. Gamma Monitoring (TLD)

TLD's were located at 159 stations on the NTS to measure the external gamma radiation from the environment. These locations were chosen to: (1) provide a low-level control network; (2) measure the residual activity from the atmospheric testing program; and (3) document the radiological conditions at the Radioactive Waste Management Site (RWMS).

The dosimeters used were CaF_2:Dy (TLD-200 Calcium Fluoride doped with Dysprosion) 0.6 cm X 0.6 cm x 0.09 cm chips from Harshaw Chemical Company. Two badges consisting of two chips each, shielded by a 0.12 cm cadmium shield (1030 mg/cm^2) inside a 0.13 cm plastic (140 mg/cm^2) holder were placed about one meter above the ground at each location. The dosimeters detected gamma radiation above an energy cutoff of approximately 90 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 has indicated that only about 5-10% of the total exposure from natural background was from gamma emitters below 150 keV (cf. ref. 5).

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° C for 15 minutes to reduce the high-fade, low temperature traps.

4. Data Treatment

Each set of data obtained from this program underwent a thorough inspection for accuracy. Not only was the data analyzed automatically by computer, it was also verified by REECo Environmental Sciences Department (ESD) personnel prior to acceptance. If serious differences from the expected value were found, 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 whenever possible.

All data were inspected on a daily basis and listed in tabular form. This treatment facilitated the data review process and revealed trends or periodicity. 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 mean values, although severely affected by outliers (suspicious data), were compared to the concentration guides and listed in all tables.

D. RADIOACTIVITY IN AIR

Ambient air monitoring was performed at the 47 locations (Figures 2 and 3). Samples collected at Gate 200 and the Area 5 communications tower were counted for gross beta without allowing seven days for the decay of natural radioactivity, as were the other air samples. Although the results from these samples were higher and more variable due to the natural radioactivity, they served as rapid indicators of unusual events, such as fallout from foreign sources.

The computer plotted displays of the gross beta and Pu-239 activities for the entire air surveillance network are presented in Appendix A. In the first plot, weekly values were arithmetically averaged to show a smoothed presentation of the changes in airborne radioactivity over the surveillance period. The data ranges were included for each of these points. The remaining plots in Appendix A depict the actual measurements at each station.

Gross Beta

The network average for the whole year for gross beta activity, excluding Gate 200 and the Area 5 communications tower, was 4.8×10^{-14} or 0.005 percent of the derived concentration guide of 1×10^{-9} µCi/cc (DOE Order 5480.1B, Chapter XI). Figure 2 summarizes the 1986 gross beta averages by location. Table 4 lists these yearly averages along with half-year averages.

FIGURE 2

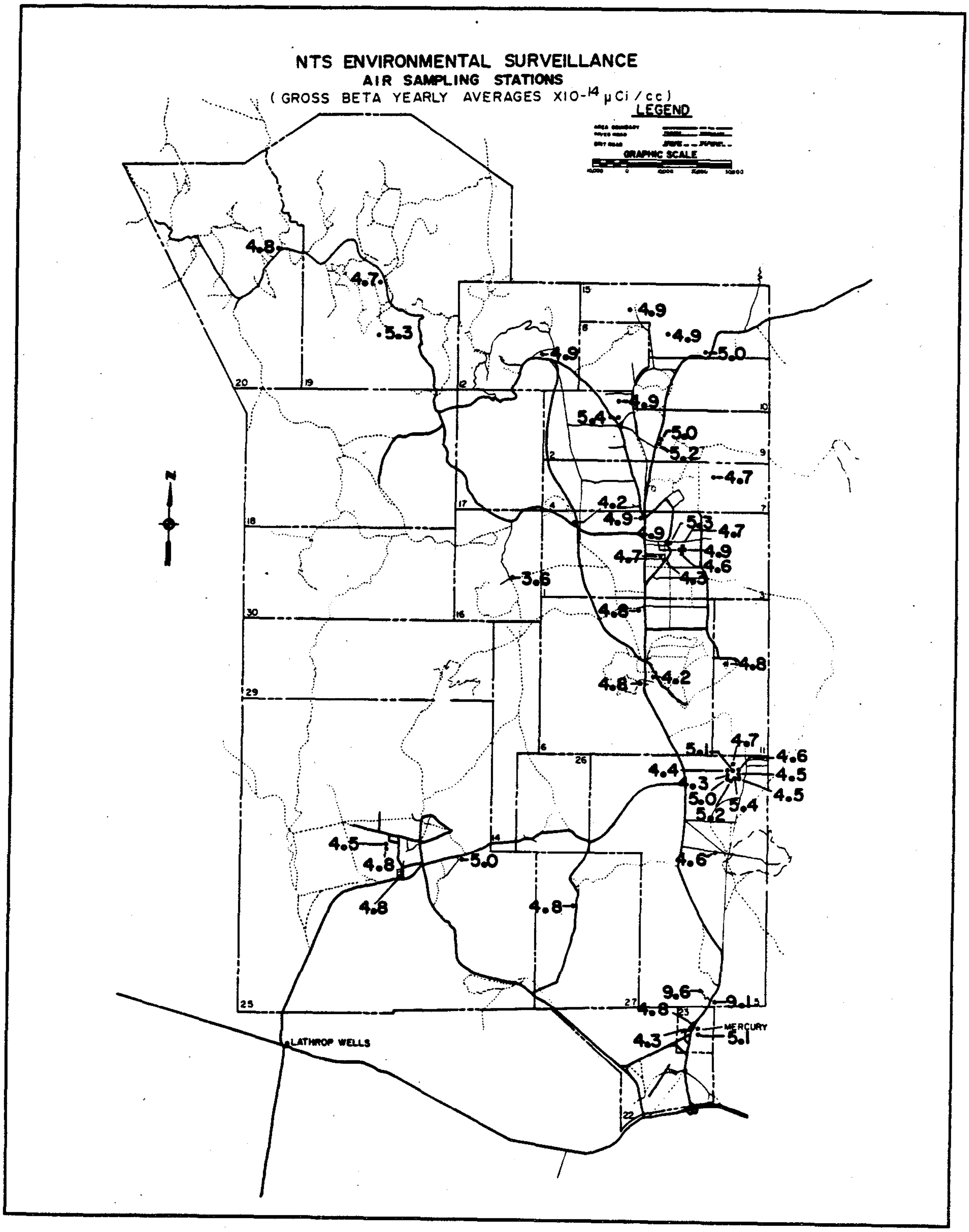

NTS ENVIRONMENTAL SURVEILLANCE
AIR SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X10-14 μCi / cc)
LEGEND
GRAPHIC SCALE
LATHROP WELLS
MERCURY

TABLE 4

AVERAGES OF AIR SURVEILLANCE DATA FOR GROSS BETA

(X 10^{-14} µCi/cc)

Station	01/01/86-06/30/86	07/01/86-12/31/86	01/01/86-12/31/86
Area 1 BJY	7.6	2.2	4.9
Area 1 Gravel Pit	7.0	1.5	4.2
Area 2 Hydraulic Lift Yard	7.7	1.9	4.9
Area 2 Compound	8.1	2.5	5.4
Area 3 Compound	7.3	1.8	4.7
Area 3 Complex No. 2	6.3	2.0	4.3
Area 3 3-300 Bunker	8.5	1.9	5.3
Area 3 U3ax South	7.2	1.7	4.6
Area 3 U3ax East	7.5	1.9	4.9
Area 3 U3ax North	7.7	1.7	4.7
Area 3 U3ax West	7.9	2.0	4.9
Area 5 DOD Yard	7.2	1.8	4.7
Area 5 Gate 200	14.1	3.6	9.1*
Area 5 RWMS No. 1	7.2	3.4	5.4
Area 5 RWMS No. 2	7.0	1.8	4.5
Area 5 RWMS No. 3	7.0	1.8	4.5
Area 5 RWMS No. 4	7.0	2.0	4.6
Area 5 RWMS No. 5	7.9	2.0	5.1
Area 5 RWMS No. 6	6.6	2.1	4.4
Area 5 RWMS No. 7	6.5	1.9	4.3
Area 5 RWMS No. 8	7.8	2.1	5.0
Area 5 RWMS No. 9	8.5	1.9	5.2
Area 5 Well 5B	7.2	1.8	4.6
Area 5 Communications Tower+	11.3	2.1	9.6*

*Samples collected at these locations are not held for decay of natural radon daughters, in order to obtain an immediate indicator.

+These stations were discontinued during CY-1986.

TABLE 4 (Continued)

(X 10^{-14} µCi/cc)

Station	01/01/86-06/30/86	07/01/86-12/31/86	01/01/86-12/31/86
Area 6 CP Complex	8.4	1.7	4.8
Area 6 Well 3 Complex	7.8	1.7	4.8
Area 6 Yucca Complex	6.5	1.8	4.2
Area 7 UE7ns	7.4	1.7	4.7
Area 9 9-300 Bunker	8.8	1.8	5.2
Area 9 9-300 Bunker No. 2+	7.7	1.7	5.0
Area 11 Gate 293	7.5	1.9	4.8
Area 12 Compound	7.4	2.1	4.9
Area 15 EPA Farm	7.9	1.7	4.9
Area 15 Gate 700 South	8.1	1.8	5.0
Area 15 Piledriver	7.9	1.8	4.9
Area 16 Substation	5.5	1.6	3.6
Area 19 Echo Peak	9.7	1.3	5.3
Area 19 Substation	7.7	1.5	4.7
Area 20 Dispensary	7.7	1.9	4.8
Area 23 Bldg. 790	6.6	1.9	4.3
Area 23 Bldg. 790 No. 2	7.6	1.7	4.8
Area 23 H and S Roof	8.0	1.9	5.1
Area 25 E-MAD South	7.9	1.5	4.8
Area 25 E-MAD North	7.4	1.6	4.5
Area 25 NRDS Warehouse	8.0	1.7	4.8
Area 25 Henre Site+	7.5	1.5	5.0
Area 27 Cafeteria	7.6	1.8	4.8

+These stations were discontinued during CY-1986.

Plutonium 239 (Pu-239)

All stations averaged below 10^{-14} μCi/cc of Pu-239 for CY-1986, with the majority being on the order of 10^{-17} μCi/cc. The maximum average concentration was found at U3ax/bl South. The average concentration at this location was <153 X 10^{-17} μCi/cc, or 7.7 percent of the derived concentration guides (DCG) for members of the public. Table 5 lists the Pu-239 concentrations for the year. Figure 3 shows the Pu-239 yearly results at their respective locations.

The presence of this radionuclide 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, increased plutonium concentrations in the air are still detected in Areas 1, 2, 3, 7, 8, 9, 10, and 15.

FIGURE 3

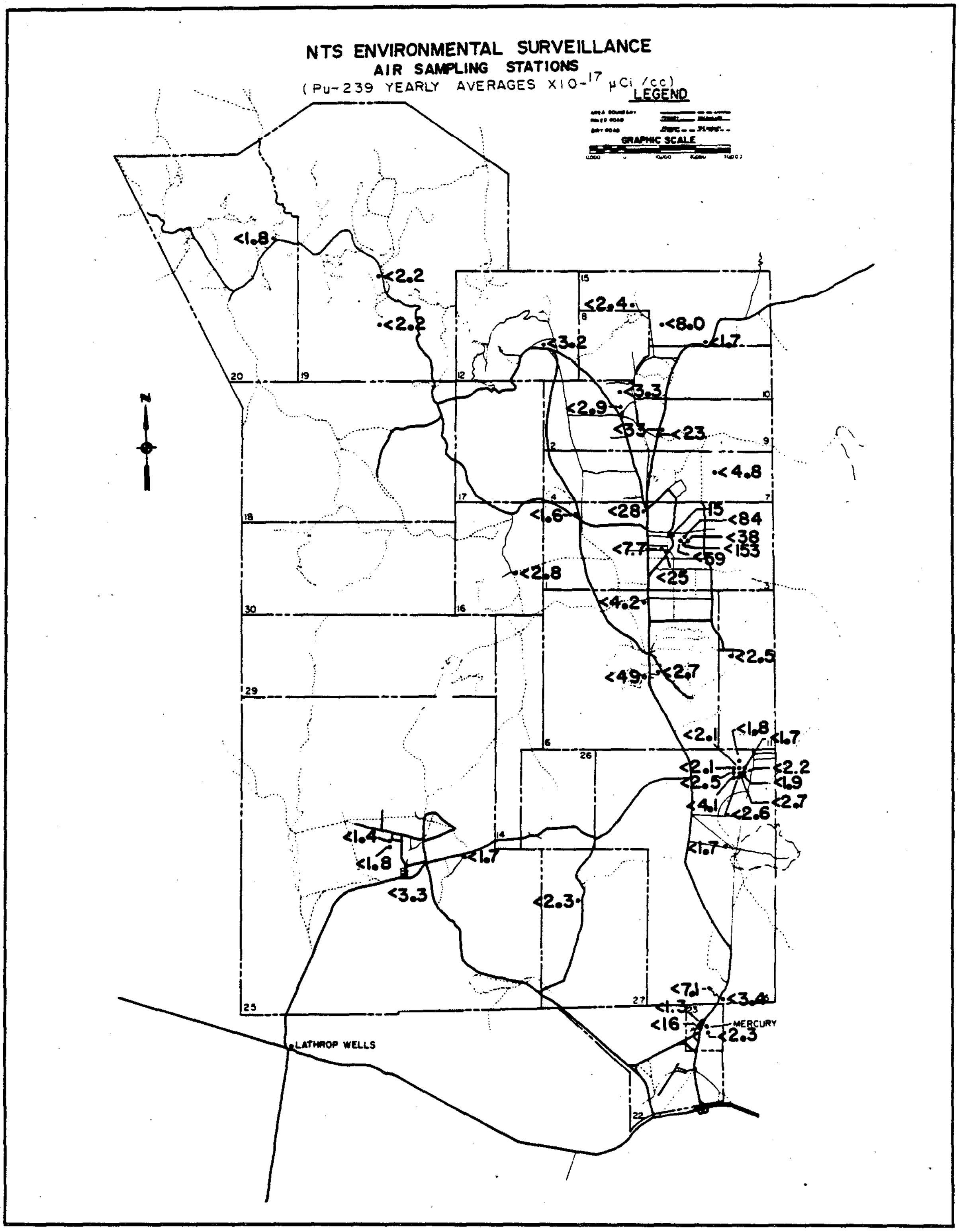

NTS ENVIRONMENTAL SURVEILLANCE
AIR SAMPLING STATIONS
(Pu-239 YEARLY AVERAGES X10^{-17} μCi/cc)
LEGEND
GRAPHIC SCALE
LATHROP WELLS
MERCURY

TABLE 5

AVERAGES OF AIR SURVEILLANCE DATA FOR PLUTONIUM

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

Station	01/01/86-06/30/86	07/01/86-12/31/86	01/01/86-12/31/86
Area 1 BJY	<50	<6.1	<28
Area 1 Gravel Pit	<1.3	<2.0	<1.6
Area 2 Hydraulic Lift Yard	<3.5	<2.4	<2.9
Area 2 Compound	<2.0	<4.7	<3.3
Area 3 Compound	<6.0	<9.7	<7.7
Area 3 Complex No. 2	<26	<24	<25
Area 3 U3ax South	<40	<267	<153
Area 3 U3ax East	<11	<65	<38
Area 3 U3ax North	<13	<154	<84
Area 3 U3ax West	<36	<81	<59
Area 3 3-300 Bunker	15	15	15
Area 5 DOD Yard	<1.7	<1.9	<1.8
Area 5 Gate 200	<5.1	<1.6	<3.4
Area 5 RWMS No. 1	<3.5	<2.0	<2.7
Area 5 RWMS No. 2	<2.4	<1.4	<1.9
Area 5 RWMS No. 3	<2.7	<1.7	<2.2
Area 5 RWMS No. 4	<1.8	<1.6	<1.7
Area 5 RWMS No. 5	<2.5	<1.7	<2.1
Area 5 RWMS No. 6	<2.4	<1.9	<2.1
Area 5 RWMS No. 7	<3.2	<1.9	<2.5
Area 5 RWMS No. 8	<5.2	<2.9	<4.1
Area 5 RWMS No. 9	<3.0	<2.3	<2.6
Area 5 Well 5B	<1.7	<1.7	<1.7
Area 5 Communications Tower+	<8.7	<2.2	<7.1
Area 6 CP Complex	<14	<83	<49

+These stations were discontinued during CY-1986.

TABLE 5 (Continued)

(X 10^{-17} µCi/cc)

Station	01/01/86-06/30/86	07/01/86-12/31/86	01/01/86-12/31/86
Area 6 Well 3 Complex	<3.8	<4.7	<4.2
Area 6 Yucca Complex	<2.1	<3.4	<2.7
Area 7 UE7ns	<2.4	<7.1	<4.8
Area 9 9-300 Bunker	31	<15	<23
Area 9 9-300 Bunker No. 2+	<28	<39	<33
Area 11 Gate 293	<3.3	<1.8	<2.5
Area 12 Compound	<4.7	<1.7	<3.2
Area 15 EPA Farm	<2.1	<1.4	<8.0
Area 15 Gate 700 South	<1.9	<1.5	<1.7
Area 15 Piledriver	<3.2	<1.5	<2.4
Area 16 Substation	<3.3	<2.3	<2.8
Area 19 Echo Peak	<2.3	<2.1	<2.2
Area 19 Substation	<1.7	<2.7	<2.2
Area 20 Dispensary	<2.0	<1.6	<1.8
Area 23 Bldg. 790	<1.3	<1.4	<1.3
Area 23 Bldg. 790 No. 2	<30	<2.8	<16
Area 23 H and S Roof	<2.7	<1.9	<2.3
Area 25 E-MAD South	<2.2	<1.4	<1.8
Area 25 E-MAD North	<1.6	<1.3	<1.4
Area 25 Henre Site+	<1.6	<1.8	<1.7
Area 25 NRDS Warehouse	<4.7	<2.0	<3.3
Area 27 Cafeteria	<1.4	<3.3	<2.3

+These stations were discontinued during CY-1986.

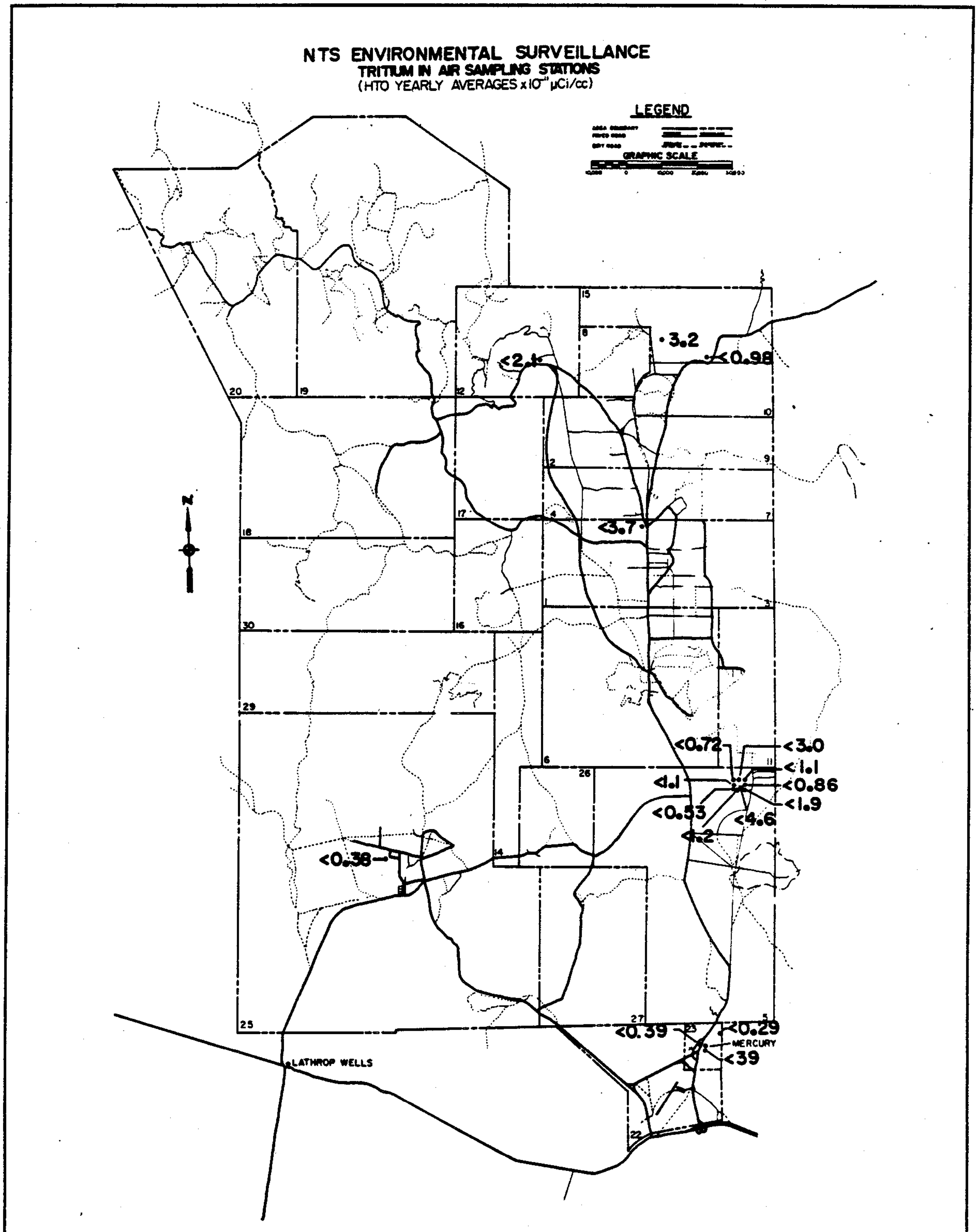
Tritium (HTO)

The highest average concentration of HTO was <3.9 x 10^{-10} µCi/cc at Building 650 representing 0.39 percent of the derived concentration guide. Both Buildings 650 and 790 released small amounts of tritium from processing samples. Due to the close proximity of the two tritium-in-air samplers, elevated concentrations of HTO were detected.

Table 6 lists the maximums, minimums, and averages for each sampling location. Appendix B plots actual measurements for each location.

The locations of all of the tritium samplers along with their yearly averages are shown in Figure 4. All of these stations were sampled for two week periods. Substantial fluctuations occurred throughout the year with most of the samplers. This may be due to the small volumes of air sampled or mechanical problems with the sampler.

FIGURE 4



NTS ENVIRONMENTAL SURVEILLANCE
TRITIUM IN AIR SAMPLING STATIONS
(HTO YEARLY AVERAGES x10⁻¹¹ μCi/cc)
LEGEND
GRAPHIC SCALE
•3.2
<0.98
<2.1
<3.7
<0.72
<3.0
<1.1
<0.86
<1.9
<1.1
<0.53
<4.6
<1.2
<0.38
<0.39
<0.29
MERCURY
<39
LATHROP WELLS

TABLE 6

TRITIUM IN AIR

Concentrations
(μCi/cc)

Stations	Maximum	Minimum	Average
Area 1 BJY	1.2×10^{-10}	9.9×10^{-13}	$<3.7 \times 10^{-11}$
Area 5 RWMS-1	1.5×10^{-10}	$<5.4 \times 10^{-12}$	$<4.6 \times 10^{-11}$
Area 5 RWMS-SE	5.6×10^{-11}	$<2.4 \times 10^{-12}$	$<1.9 \times 10^{-11}$
Area 5 RWMS-(SE-NE)	2.1×10^{-11}	$<2.3 \times 10^{-12}$	$<8.6 \times 10^{-12}$
Area 5 RWMS-NE	3.7×10^{-11}	$<2.7 \times 10^{-12}$	$<1.1 \times 10^{-11}$
Area 5 RWMS-(NE-NW)	1.4×10^{-10}	$<2.5 \times 10^{-12}$	$<3.0 \times 10^{-11}$
Area 5 RWMS-NW	2.1×10^{-11}	$<2.6 \times 10^{-12}$	$<7.2 \times 10^{-12}$
Area 5 RWMS-(NW-SW)	2.6×10^{-11}	$<2.5 \times 10^{-12}$	$<1.1 \times 10^{-11}$
Area 5 RWMS-SW	1.4×10^{-11}	$<1.7 \times 10^{-12}$	$<5.3 \times 10^{-12}$
Area 5 RWMS-(SW-SE)	2.3×10^{-11}	$<2.6 \times 10^{-12}$	$<1.2 \times 10^{-11}$
Area 12 Base Camp	6.6×10^{-11}	2.5×10^{-12}	$<2.1 \times 10^{-11}$
Area 15 EPA Farm	5.8×10^{-11}	1.2×10^{-11}	3.2×10^{-11}
Area 23 Bldg. 790	8.8×10^{-12}	$<6.7 \times 10^{-13}$	$<3.9 \times 10^{-12}$
Area 23 Bldg. 650	2.5×10^{-9}	$<2.6 \times 10^{-12}$	$<3.9 \times 10^{-10}$
Area 23 Site Boundary	4.7×10^{-12}	$<6.1 \times 10^{-13}$	$<2.9 \times 10^{-12}$
Area 25 EMAD	1.0×10^{-11}	$<8.6 \times 10^{-13}$	$<3.8 \times 10^{-12}$
Area 15 Gate 700 South	6.2×10^{-11}	$<1.7 \times 10^{-12}$	$<9.8 \times 10^{-12}$

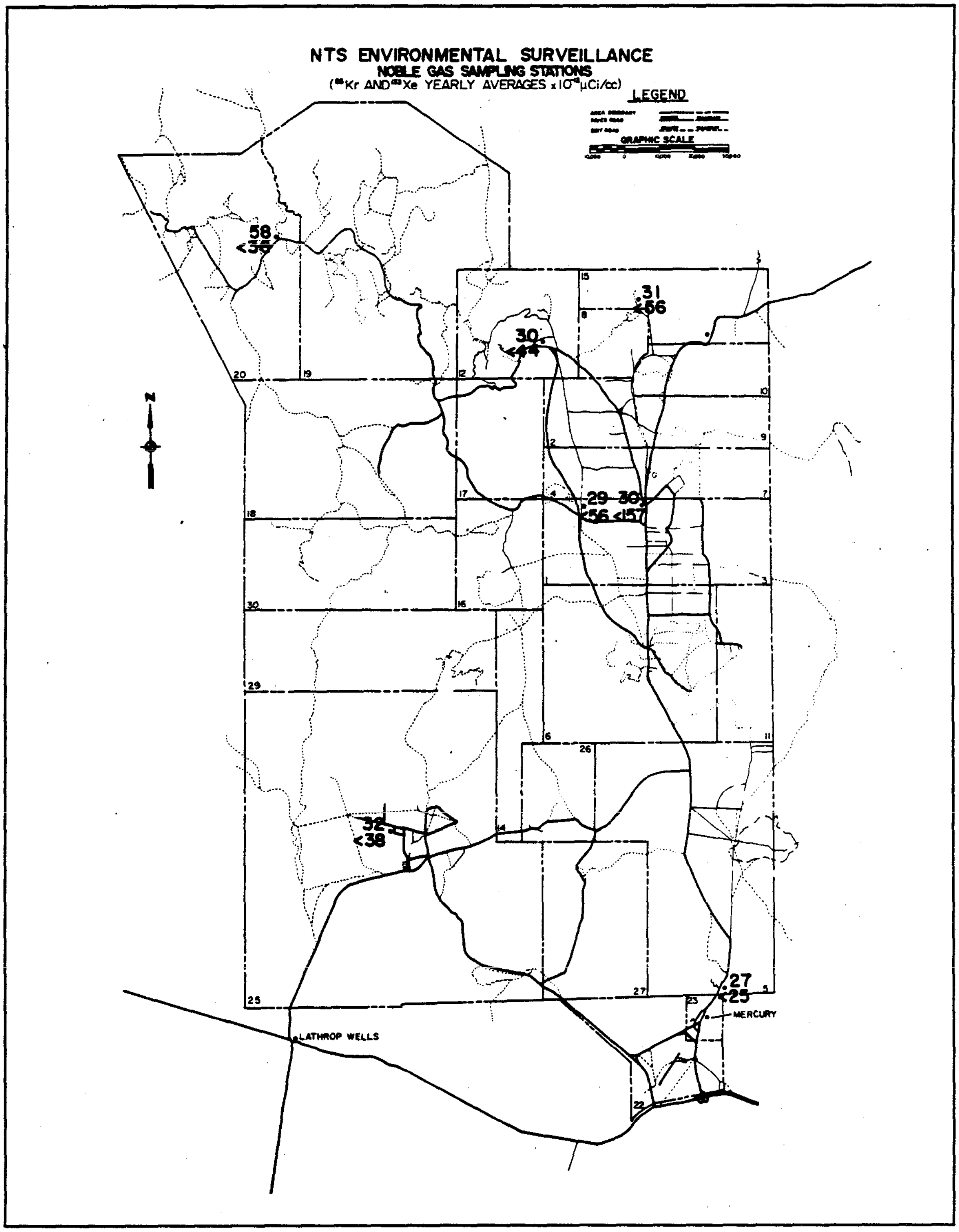
Krypton 85 (Kr-85)

The average concentration of Kr-85 for the entire network was slightly higher in CY-1986, rising from an average of 33 X 10^{-12} µCi/cc in CY-1985 to an average of 35 X 10^{-12} µCi/cc in CY-1986. This increase was expected since all sources worldwide (predominantly nuclear power generating facilities) continue to generate and release small quantities of Kr-85 (Reference 25). The network average of 35 X 10^{-12} µCi/cc includes elevated measurements taken at the Area 20 camp. These Kr-85 concentrations during CY-1986 ranged from 18 X 10^{-12} µCi/cc to 133 X 10^{-12} µCi/cc. The elevated concentrations at Area 20 Camp continued from 1985, and have been determined to be related to slight seepage from Pahute Mesa events. The location and yearly average for each noble gas sampling station is shown in Figure 5. Table 7 lists the average Kr-85 concentrations at each location along with the lowest and highest values detected.

Xenon 133 (Xe-133)

The maximum average Xe-133 concentration occurred at BJY. This concentration was 0.03 percent of the derived concentration guide. All positive Xe-133 results were directly related to slight seepage from Pahute Mesa and Rainier Mesa events. Table 7 lists the average Xe-133 concentrations at each location along with the lowest and highest values detected.

FIGURE 5



NTS ENVIRONMENTAL SURVEILLANCE
NOBLE GAS SAMPLING STATIONS
(Kr AND Xe YEARLY AVERAGES x10 μCi/cc)
LEGEND
GRAPHIC SCALE
N
58
<36
31
<56
30
<44
29
<56
30
<157
32
<38
27
<25
MERCURY
LATHROP WELLS

TABLE 7

NOBLE GASES IN AIR

Concentrations (X 10^{-12} µCi/cc)

Stations	^{85}Kr			^{133}Xe		
	Max	Min	Avg	Max	Min	Avg
Area 1 BJY	47	18	30	3513	<8	<157
Area 12 Base Camp	62	17	30	498	<11	<44
Area 15 EPA Farm	49	18	31	493	<11	<56
Area 5 Gate 200	51	18	27	<46	<11	<25
Area 25 EMAD	87	19	32	159	<10	<38
Area 20 Camp	133	23	58	335	<10	<36
Gravel Pit	73	18	29	1220	<11	<56

E. RADIOACTIVITY IN SURFACE AND GROUND WATER

The principal water distribution system on the NTS can be the critical pathway for the ingestion of waterborne radionuclides. Consequently, the system was sampled and evaluated on a frequent routine. The NTS water system consists of sixteen supply wells, eight potable water stations, and fifteen open reservoirs. One supply well was added to the sampling network in February 1986, at UE15D Well. The wells feed directly to many of the reservoirs, and the drinking water was pumped from the wells to the points of consumption. The supply wells and open reservoirs were sampled on a monthly basis. 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. The identification of any radionuclides above natural background in the supply well system initiated a closer review of the drinking water. The surface and ground/water monitoring network creates a large data base to evaluate long-term trends or intermittent changes in activity.

Natural springs, contaminated ponds, and effluent ponds were also monitored. The springs and contaminated ponds were collected monthly when water was available for sampling. The effluent ponds were sampled quarterly.

1. Supply Wells

Water from sixteen 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 secondary purpose was to document the radiological characteristics of NTS ground water and analyze the data for trends or changes.

Gross Beta

The highest average recorded of gross beta was 16.6×10^{-9} μCi/ml at UE15D Well. The lowest average gross beta activity for the onsite supply wells was $<2.0 \times 10^{-9}$ μCi/ml at Well U19c.

The yearly gross beta averages are shown at their respective locations in Figure 6. Appendix C 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 8 lists the 1986 averages for each location.

The activities of each well and the entire network average appeared consistent over this reporting period. In previous reports (References 8 and 23) it was shown that the majority of gross beta activity was attributable to naturally occurring potassium-40. 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 previous years was:

Year	Mean ($\times 10^{-9}$ μCi/ml)
CY-1986	8.1
CY-1985	5.8
CY-1984	6.4
CY-1983	6.6
CY-1982	7.0
CY-1981	8.3
CY-1980	8.8
CY-1979	9.4
CY-1978	9.1
July-December 1977	10.9

FIGURE 6

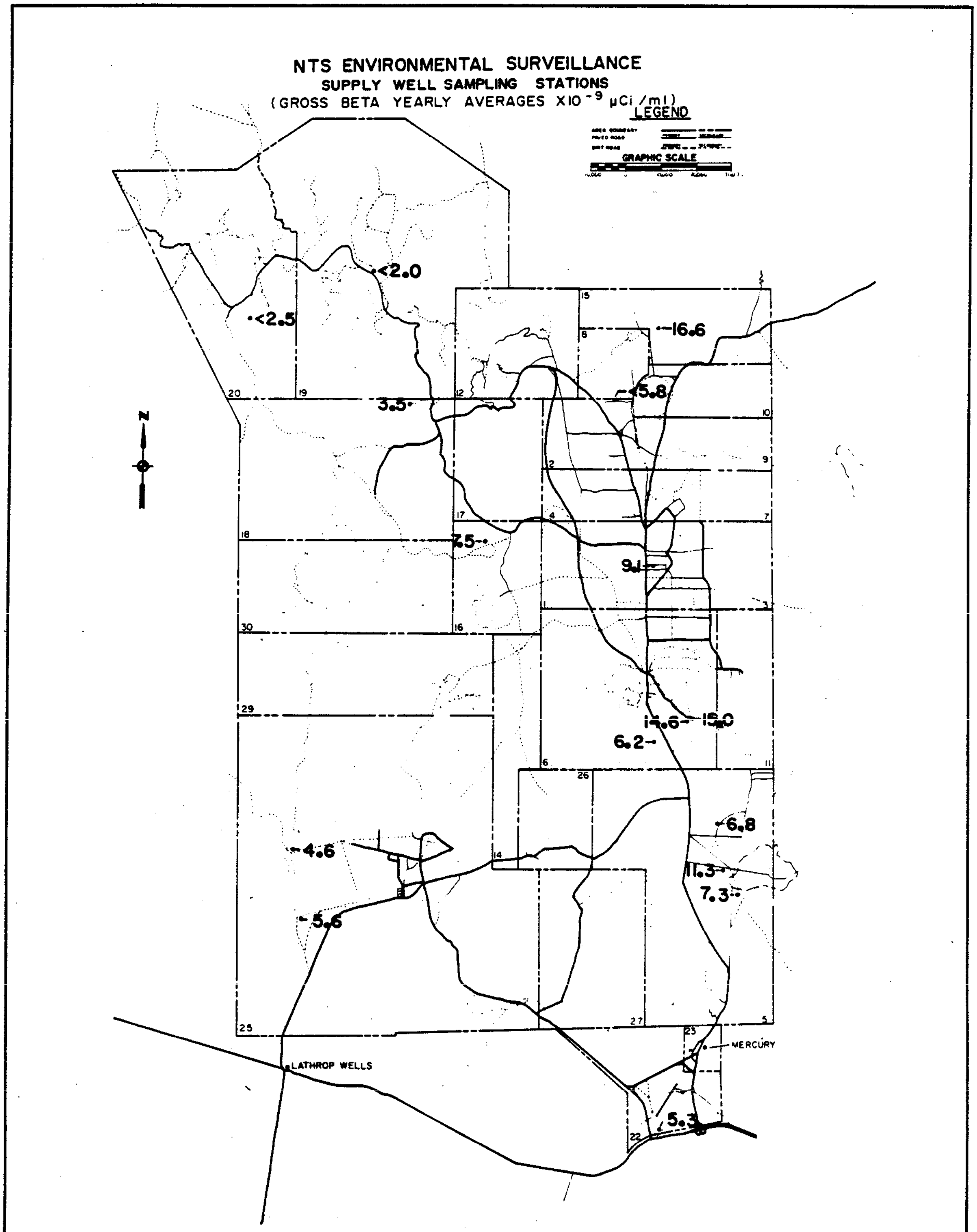

NTS ENVIRONMENTAL SURVEILLANCE
SUPPLY WELL SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X10^{-9} μCi/ml)
LEGEND
GRAPHIC SCALE
<2.0
<2.5
3.5
16.6
15.8
7.5
9.1
14.6
15.0
6.2
6.8
4.6
11.3
7.3
5.6
5.3
MERCURY
LATHROP WELLS

TABLE 8

AVERAGES OF SUPPLY WELL DATA FOR GROSS BETA

Station	Gross Beta Yearly Average (X 10^{-9} µCi/ml)
Area 2 Well 2	<5.8
Area 3 Well A	9.1
Area 5 Well 5B	11.3
Area 5 Well 5C	7.3
Area 5 Well Ue5c	6.8
Area 6 Well C	15.0
Area 6 Well C1	14.6
Area 6 Well 4	6.2
Area 15 Well UE15D	16.6
Area 16 Well 16D	7.5
Area 18 Well 8	3.5
Area 19 Well U19c	<2.0
Area 20 Area 20 Water Well	<2.5
Area 22 Army Well No. 1	5.3
Area 25 Well J12	5.6
Area 25 Well J13	4.6

Tritium and Plutonium

There was one positive tritium result for Supply Well 16D for CY-1986. This value of 3.6 X 10^{-6} μCi/ml represents 18 percent of the MCL. This positive result is considered an anomaly and is not indicative of the tritium concentrations in non-contaminated waters on the NTS. Further analysis at Well 16D showed no further positive results for the remainder of the 1986 and into the early quarters of 1987. The positive tritium results for all noncontaminated NTS waters are given in Table 9.

There was also one positive plutonium result for Supply Well 4 during CY-1986. This value of 2.9 X 10^{-10} μCi/ml represents 0.002 percent of the MCL. This positive plutonium value is also considered an anomaly and is not indicative of plutonium concentrations in non-contaminated waters on the NTS.

Appendix C includes plots of the network monthly averages for tritium and plutonium. Both of these positive results, however, are near the detection limits of the system and are believed to be caused by the statistical fluctuation inherent in counting.

TABLE 9

TRITIUM VALUES ABOVE DETECTION LIMITS
FROM NONCONTAMINATED WATERS

WATER TYPE	STATION	DATE	µCi/ml
Potable Water	Area 27 Cafeteria	06/02/86	$9.7 \times 10^{-6} \pm 8\%$
Potable Water	Area 25 Service Station	07/21/86	$1.0 \times 10^{-6} \pm 29\%$
Open Reservoir	Well U19c Reservoir	05/15/86	$7.3 \times 10^{-7} \pm 42\%$
Open Reservoir	Area 2 Mud Plant Reservoir	06/06/86	$8.5 \times 10^{-7} \pm 39\%$
Open Reservoir	Area 2 Mud Plant Reservoir	07/09/86	$1.6 \times 10^{-6} \pm 21\%$
Supply Well	Well 16D	03/01/86	$3.6 \times 10^{-6} \pm 9\%$

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.

Gross Beta

The highest average recorded was 9.5×10^{-9} µCi/ml at the Area 3 Cafeteria. This was 63.0 percent of the screening level for drinking water as required by the National Interim Primary Drinking Water Regulations. Appendix D contains the computer plots of the measured gross beta activity with the 2σ error bars included. An average plot is provided which shows the network mean trend throughout the reporting period along with the range at each point. Table 10 contains a list of the average gross beta activity measured at each sample location for CY-1986. The locations of all stations are shown in Figure 7 with their gross beta yearly averages.

The lowest average gross beta activity, excluding Cascade brand bottled water, was 3.8×10^{-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-1986.

The average of the entire network, as compared to averages reported in previous environmental reports, was:

Year	Mean (X 10^{-9} μCi/ml)
CY-1986	6.3
CY-1985	5.0
CY-1984	5.3
CY-1983	5.3
CY-1982	5.8
CY-1981	7.9
CY-1980	5.8
CY-1979	6.5
CY-1978	6.7
July-December 1977	7.8

All potable water, except Cascade bottled water, was obtained from the supply wells. A comparison of these waters and their suppliers appears in Table 11. In previous reports (References 8 and 23) it was shown that the majority of the radioactivity in supply well and potable water was from naturally occurring potassium-40.

FIGURE 7

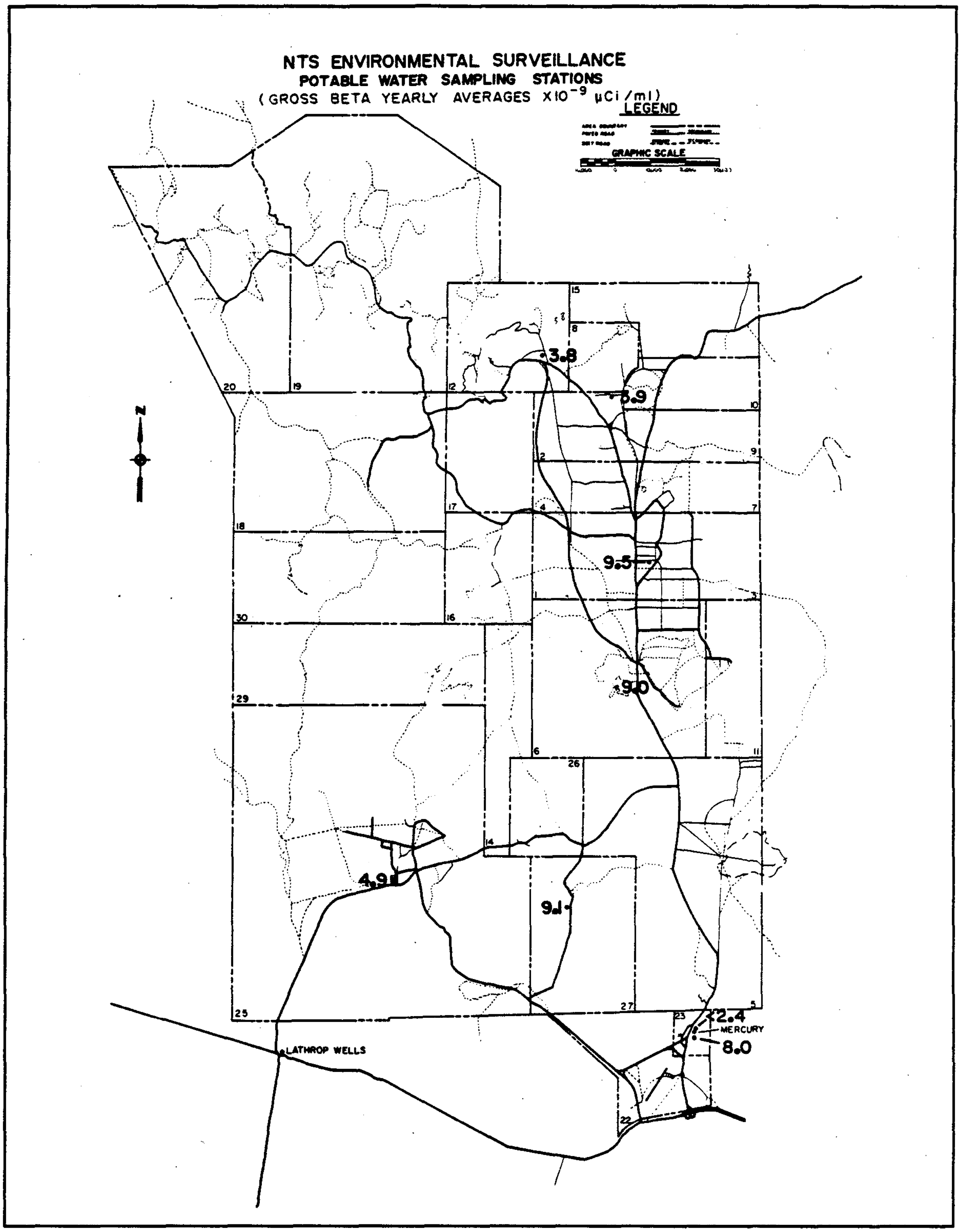

NTS ENVIRONMENTAL SURVEILLANCE
POTABLE WATER SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X10^{-9} μCi/ml)
LEGEND
GRAPHIC SCALE
3.8
9.5
9.0
4.9
9.1
2.4
MERCURY
8.0
LATHROP WELLS

TABLE 10

AVERAGES OF POTABLE WATER DATA FOR GROSS BETA

Station	Gross Beta Yearly Average (X 10^{-9} µCi/ml)
Area 2 Rest Room	3.9
Area 3 Cafeteria	9.5
Area 6 Cafeteria	9.0
Area 12 Cafeteria	3.8
Area 23 Cafeteria	8.0
Area 23 Cascade Water	<2.4
Area 25 Service Station	4.9
Area 27 Cafeteria	9.1

TABLE 11

COMPARISON OF END USE AND SUPPLY WATER

FOR GROSS BETA AVERAGES

(X 10^{-9} µCi/ml)

Station (end use/supply)	CY-1986
Area 2 Rest Room	3.9
Area 18 Well 8	3.5
Area 3 Cafeteria	9.5
Area 3 Well A	9.1
Area 6 Cafeteria	9.0
Area 6 Well C/C1	15.0/14.6
Area 12 Cafeteria	3.8
Area 18 Well 8	3.5
Area 23 Cafeteria	8.0
Area 5 Well 5B/5C	11.3/7.3
Area 22 Army Well No. 1	5.3
Area 23 Cascade Water (Demineralized Bottled Water)	<2.4
Area 27 Cafeteria	9.1
Area 5 Well 5B/5C	11.3/7.3
Area 22 Army Well No. 1	5.3

Tritium

The highest average of tritium was $<1.0 \times 10^{-6}$ μCi/ml at the Area 27 Cafeteria. This is 5.0 percent of the standard for tritium in drinking water. The majority of the seven positive measurements are near the detection limit of the system and are believed to be caused by the statistical fluctuation inherent in counting. The positive tritium results were given in Table 9.

Plutonium

There was one positive plutonium result for the Area 12 cafeteria. This value of 3.6×10^{-10} μCi/ml represents 0.007 percent of the standard for drinking water. Further sampling at Area 12 cafeteria showed no more positive plutonium results leading the author to conclude that the positive result was a false positive, possibly caused by statistical fluctuations inherent in counting. Appendix D includes the plots of the network averages for tritium and plutonium.

3. Safe Drinking Water Act Results

In accordance with the Safe Drinking Water Act of 1976, special water sampling was conducted during CY-1986 on all wells that supply potable water at the eight distribution points on the NTS.

The eight NTS potable water locations were sampled according to the stringent requirements for water systems near nuclear facilities. Potable water samples were collected and analyzed quarterly for tritium, gross alpha and gross beta. Strontium-90 analysis was performed on an annual basis. Iodine-131 was excluded from analyses because it was not considered a potential contaminant to the NTS water supply due to its short half-life and high chemical reactivity. These results are listed in Table 12. All concentrations were below the prescribed screening levels.

TABLE 12

NTS POTABLE WATERS

SAFE DRINKING WATER ACT RESULTS

Type of Analysis	Location: A-3 Cafe	A-2 Restroom	A-12 Cafe	Mercury Cafe	A-27 Cafe
Gross Alpha* ($\times 10^{-9}$ µCi/ml)					
Max	4.76	<3.2	<3.2	4.39	<7.8
Min	1.45	<.69	<.72	2.66	3.94
Avg	2.87	<1.34	<1.41	<3.45	<5.65
Gross Beta** ($\times 10^{-9}$ µCi/ml)					
Max	22	11	10	18	18
Min	5.9	2.1	1.8	2.1	6.2
Avg	9.5	3.9	3.8	8.0	9.1
^{3}H*** ($\times 10^{-7}$ µCi/ml)					
Max	<15	<15	<14	<15	97
Min	<6.3	<6.0	<6.0	<6.0	<6.0
Avg	<9.1	<9.5	<9.3	<9.3	<11
^{90}Sr*** ($\times 10^{-9}$ µCi/ml)					
Max****	<0.56	<0.41	<0.45	<0.56	<0.41

* Screening level for gross alpha activity is 5×10^{-9} µCi/ml.

** Screening level for gross beta activity near a nuclear facility is 1.5×10^{-8} µCi/ml.

*** Maximum contaminant levels for ^{3}H and ^{90}Sr are 2×10^{-5} µCi/ml and 8×10^{-9} µCi/ml, respectively.

**** Strontium-90 analysis is performed once a year.

Table 12 (Continued)

Type of Analysis	Location		
	Cascade Water	A-6 Cafe	A-25 Service Station
Gross Alpha* ($\times 10^{-9}$ µCi/ml)			
Max	<0.81	<16	<1.1
Min	<0.60	<2.3	<0.71
Avg	<0.69	<6.50	<0.94
Gross Beta** ($\times 10^{-9}$ µCi/ml)			
Max	13	19	13
Min	<1.6	4.6	3.1
Avg	<2.4	9.0	4.9
^{3}H*** ($\times 10^{-7}$ µCi/ml)			
Max	<15	<15	<14
Min	<6.0	<5.9	<5.9
Avg	<9.3	<9.3	<8.9
^{90}Sr*** ($\times 10^{-9}$ µCi/ml)			
Max****	<0.45	<0.37	--

* Screening level for gross alpha activity is 5×10^{-9} µCi/ml.

** Screening level for gross beta activity near a nuclear facility is 1.5×10^{-8} µCi/ml.

*** Maximum contaminant levels for ^{3}H and ^{90}Sr are 2×10^{-5} µCi/ml and 8×10^{-9} µCi/ml, respectively.

**** Strontium-90 analysis is performed once a year.

4. Open Reservoirs

Open reservoirs have been established at various locations on the NTS for industrial purposes. Fifteen locations were sampled during the report period. The locations are shown in Figure 8 along with their gross beta yearly averages. Open reservoirs are posted as non-swimming, non-drinking water. Therefore, comparisons were made to controlled area rather than drinking water standards.

Gross Beta

The highest average beta concentration was 13.6 X 10^{-9} μCi/ml at Well 3 Reservoir. The lowest gross beta average was <2.1 X 10^{-9} μCi/ml at Well U19c reservoir. Table 13 includes a list of the CY-1986 gross beta averages at each location.

The values for the reservoirs supplied by wells were in most cases slightly higher than other reservoirs. This is most likely caused by resuspended contaminated material settling into the open reservoirs and/or run-off into the reservoirs from contaminated areas. Table 14 shows the gross beta activities of the open reservoirs that were supplied by wells, along with the activities of the associated wells.

No 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 variable sampling procedures since some of the open reservoirs are difficult to sample. The average gross beta results for the entire network, as compared to previous years were:

Year	Mean (X 10^{-9} μCi/ml)
CY-1986	7.8
CY-1985	7.3
CY-1984	6.8
CY-1983	8.1
CY-1982	9.7
CY-1981	13.6
CY-1980	8.1
CY-1979	10.9
CY-1978	13.1
July-December 1977	19.4

Appendix E 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 entire network mean trend 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-1986.

FIGURE 8

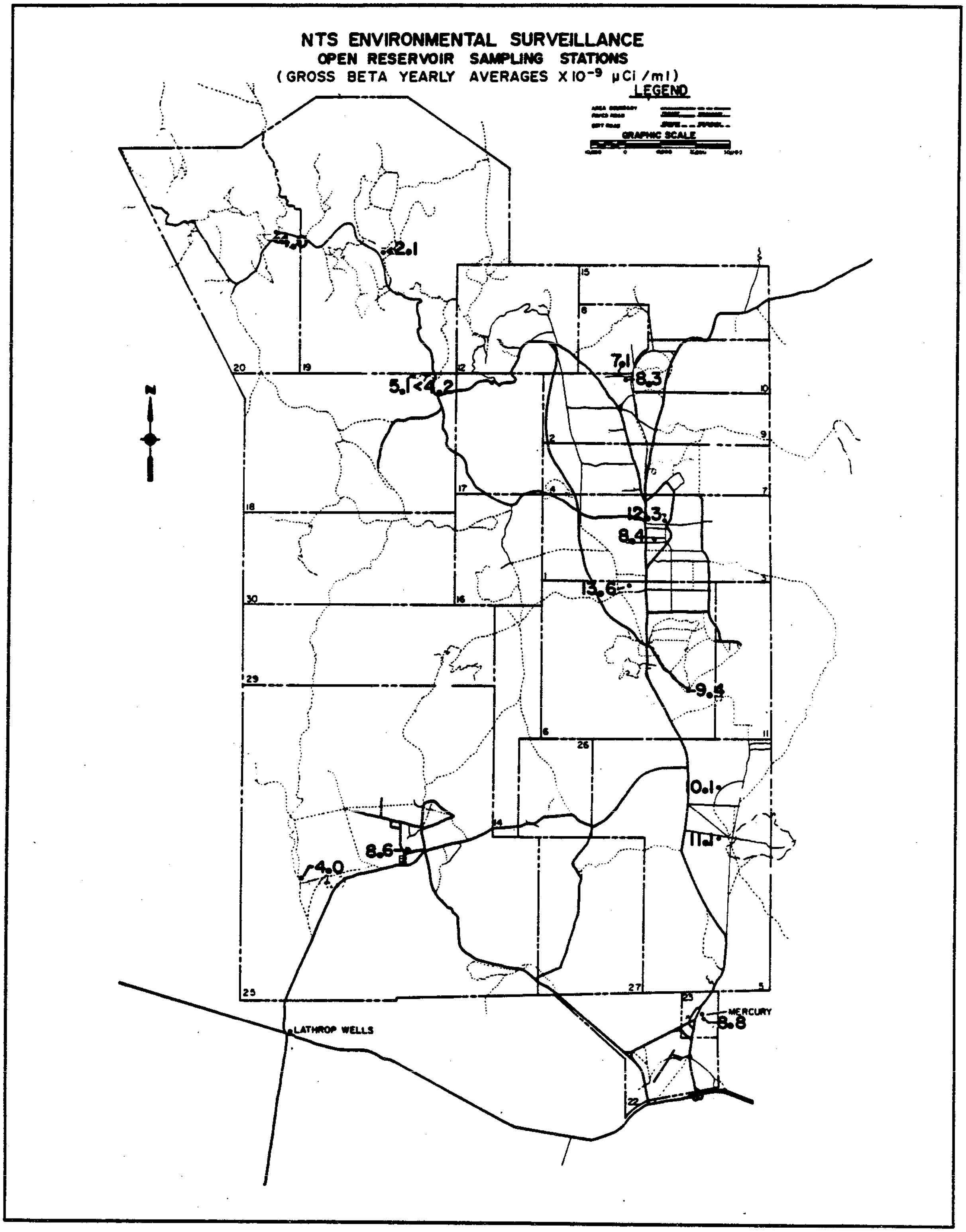

NTS ENVIRONMENTAL SURVEILLANCE
OPEN RESERVOIR SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X 10⁻⁹ μCi/ml)
LEGEND
GRAPHIC SCALE
24.0
2.1
7.1
8.3
5.1
<4.2
12.3
8.4
13.6
9.4
10.1
11.1
8.6
4.0
MERCURY
8.8
LATHROP WELLS

TABLE 13

AVERAGES OF OPEN RESERVOIR DATA FOR GROSS BETA

Station	Gross Beta Yearly Average ($X\ 10^{-9}\ \mu Ci/ml$)
Area 2 Well 2 Reservoir	7.1
Area 2 Mud Plant Reservoir	8.3
Area 3 Well A Reservoir	8.4
Area 3 Mud Plant Reservoir	12.3
Area 5 Well 5B Reservoir	11.1
Area 5 Well Ue5c Reservoir	10.1
Area 6 Well 3 Reservoir	13.6
Area 6 Well C1 Reservoir	9.4
Area 18 Camp 17 Reservoir	4.2
Area 18 Well 8 Reservoir	5.1
Area 19 Well 19c Reservoir	<2.1
Area 20 Well 20A Reservoir	<4.0
Area 23 Swimming Pool	8.8
Area 25 Well J-11 Reservoir	8.6
Area 25 Well J-12 Reservoir	4.0

TABLE 14

COMPARISON OF OPEN RESERVOIRS AND SUPPLY WATER FOR GROSS BETA AVERAGES

($\times 10^{-9}$ µCi/ml)

Station (Reservoir/Supply)	CY-1986
Area 2 Well 2 Reservoir	7.1
Area 2 Well 2	<5.8
Area 3 Well A Reservoir	8.4
Area 3 Well A	9.1
Area 5 Well 5B Reservoir	11.1
Area 5 Well 5B	11.3
Area 5 Well Ue5c Reservoir	10.1
Area 5 Well Ue5c	6.8
Area 6 Well C1 Reservoir	9.4
Area 6 Well C1	14.6
Area 19 Well U19c Reservoir	<2.1
Area 19 Well U19c	<2.0
Area 25 Well J-12 Reservoir	4.0
Area 25 Well J-12	5.6

Tritium and Plutonium

The highest positive tritium value for all reservoirs was 1.6 X 10^{-6} µCi/ml at the Area 2 Mud Plant Reservoir. This is 0.002 percent of the tritium concentration guide for controlled areas. There was one positive plutonium result at the Well A Reservoir with an activity level of 1.1 X 10^{-10}. This is 0.0001 percent of the concentration guide. The positive tritium and plutonium results can be seen in Tables 9 and 15. Appendix E also includes the plots of the network averages for tritium and plutonium.

TABLE 15

PLUTONIUM VALUES ABOVE DETECTION LIMITS
FROM NONCONTAMINATED WATERS

WATER TYPE	STATION	DATE	µCi/ml
Potable Water	Area 12 Cafeteria	06/02/86	3.6 X 10^{-10} ± 21%
Natural Spring	Capt. Jack Spring	12/26/86	9.3 X 10^{-11} ± 43%
Open Reservoir	Well A Reservoir	12/10/86	1.1 X 10^{-10} ± 42%
Supply Well	Well 4	03/01/86	2.9 X 10^{-10} ± 26%

5. Natural Springs

The term "natural springs" was a label given to the spring supplied pools located within the NTS. There is no known human consumption from these springs.

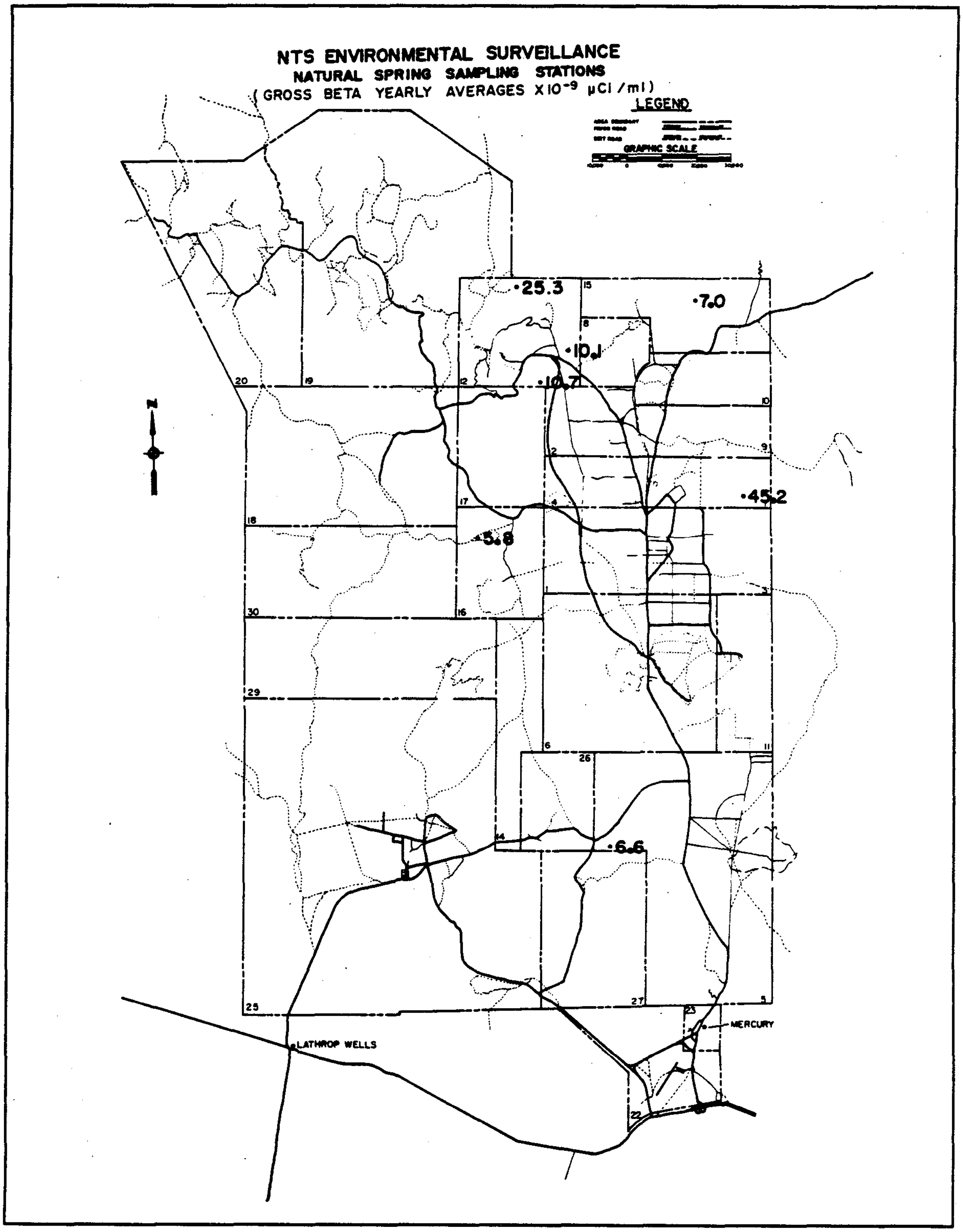
Gross Beta

The highest gross beta average recorded was 45.2 X 10^{-9} µCi/ml at Reitmann Seep. This was 0.45 percent of the CG. The network average, as compared to those presented in previous reports, was:

Year	Mean (X 10^{-9} µCi/ml)
CY-1986	14.9
CY-1985	9.8
CY-1984	10.3
CY-1983	7.6
CY-1982	9.0
CY-1981	10.5
CY-1980	16.7
CY-1979	22.1
CY-1978	23.7
July-December 1977	24.4

Appendix F contains the plots of all the natural spring sampling stations of the measured gross beta activity is presented with 2σ error bars. An averaging plot is included which shows the trend of the network mean throughout the reporting period as well as the range for each point. Table 16 presents a list of the gross beta averages at each location. Nine locations sampled on a monthly basis (when accessible) are shown in Figure 9 along with their gross beta yearly averages.

FIGURE 9



NTS ENVIRONMENTAL SURVEILLANCE
NATURAL SPRING SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X10^{-9} μCi/ml)
LEGEND
GRAPHIC SCALE
N
•25.3
•7.0
•10.1
•10.7
•45.2
•5.8
•6.6
MERCURY
LATHROP WELLS

TABLE 16

AVERAGES OF NATURAL SPRINGS DATA FOR GROSS BETA

Station	Gross Beta Yearly Average ($\times 10^{-9}$ µCi/ml)
Area 5 Cane Spring	6.6
Area 7 Reitmann Seep	45.2
Area 12 White Rock Spring	10.1
Area 12 Captain Jack Spring	10.7
Area 12 Gold Meadows Pond	25.3
Area 15 Tub Spring	7.0
Area 16 Tippipah Spring	5.8

Tritium and Plutonium

The only positive plutonium result was 9.3 X 10^{-11} μCi/ml at Capt. Jack Spring. This is 0.00009 percent of the concentration guide for plutonium. This value is extremely close to detection limits and, as such, may have been caused by statistical fluctuations inherent in radiation counting. The positive results for plutonium are listed in Tables 9 and 15. There were no positive tritium results for springs during CY-1986. Appendix F includes plots of the network averages for tritium and plutonium at the natural spring sampling stations.

6. Contaminated Ponds

Seven contaminated ponds were sampled on a special study basis. The gross beta concentration for each location is shown in Figure 10. These ponds were impound waters from tunnel test areas and a contaminated laundry release point. They are monitored in accordance with DOE Order 5484.1, Chapter IV, to provide a data base for calculations of any offsite releases. Tritium results from these sites are reported to DOE Headquarters on an annual basis.

Table 17 is a list of the gross beta, tritium, and Pu-239 averages at the seven active stations. The first two pages of Appendix G contain the contaminated pond network averages. The remaining plots show the gross beta, Pu-239, and tritium concentrations at each station. The differences between CY-1985 and CY-1986 can be attributed to the decrease or increase in use of the ponds.

7. Effluent Ponds

Samples from six effluent pond locations were collected during CY-1986. These ponds are closed systems which contain both sanitary and radioactive waste for evaporative treatment. Contact with the working population was minimal. The highest average gross beta value was 2.8×10^{-8} μCi/ml. Plutonium and tritium concentrations were less than detectable concentrations at all locations.

FIGURE 10

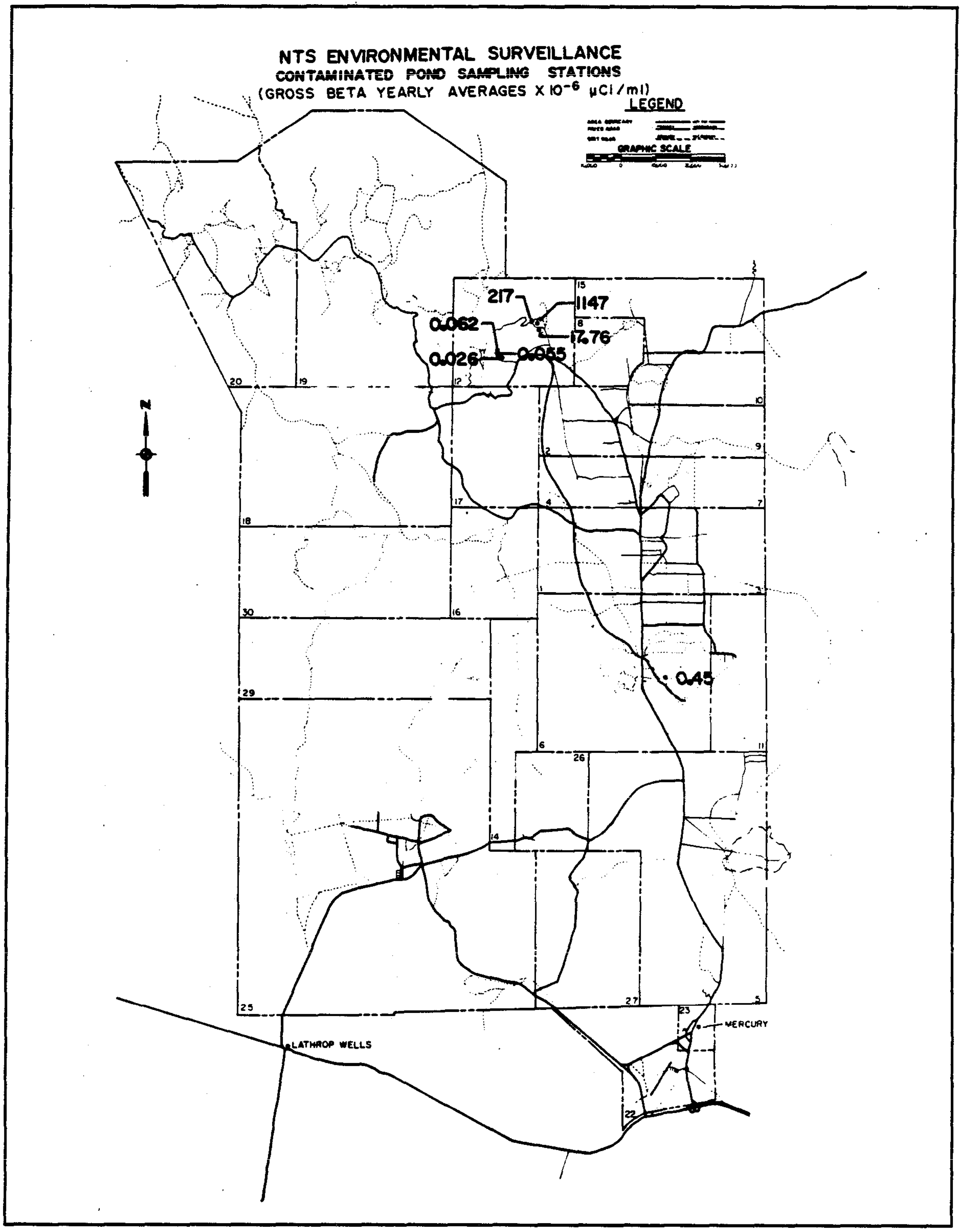

NTS ENVIRONMENTAL SURVEILLANCE
CONTAMINATED POND SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X 10^{-6} µCi/ml)
LEGEND
GRAPHIC SCALE
217
1147
0.062
17.76
0.026
0.055
0.45
20
19
15
8
12
10
9
2
17
4
7
18
16
30
3
29
6
11
26
14
25
27
5
23
MERCURY
LATHROP WELLS
22

TABLE 17

CONTAMINATED POND YEARLY CONCENTRATION AVERAGES

(μCi/cc)

Station	Tritium Yearly Average	Gross Beta Yearly Average	^{239}Pu Yearly Average
Area 6 Yucca Waste Pond	4.8×10^{-6}	4.5×10^{-7}	$<2.0 \times 10^{-10}$
Area 12 N Tunnel #1 Pond	8.1×10^{-4}	6.2×10^{-8}	$<6.0 \times 10^{-11}$
Area 12 N Tunnel #2 Pond	8.1×10^{-4}	5.5×10^{-8}	$<5.2 \times 10^{-11}$
Area 12 N Tunnel #3 Pond	7.5×10^{-4}	2.6×10^{-8}	$<4.4 \times 10^{-11}$
Area 12 T Tunnel #1 Pond	3.0×10^{-1}	1.1×10^{-3}	$<4.6 \times 10^{-10}$
Area 12 T Tunnel #2 Pond	3.3×10^{-1}	1.8×10^{-3}	$<1.7 \times 10^{-10}$
Area 12 T Tunnel effluent	2.8×10^{-1}	2.2×10^{-4}	$<2.9 \times 10^{-10}$

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, 139 stations in CY-1979, 152 stations in CY-1980, and 163 stations changing since CY-1981. Three stations were discontinued during the latter part of CY-1985. One station was discontinued in CY-1986, reducing the total to 159 stations. The TLD's are changed on a quarterly basis. Several TLD's were not collected for the fourth quarter in Areas 18, 19, and 20, due to impassable roads.

The overall network range of the control stations was 0.13 mrem/d to 0.31 mrem/d, with an average natural background on NTS of approximately 0.22 mrem/d (72 mrem/y). The control station values measured in CY-1984 correspond favorably with rates measured at surrounding offsite Nevada locations by the Environmental Protection Agency in CY-1983 (Reference 24). The remaining 151 stations of the network yielded dose rates which ranged from 0.13 mrem/d to 4.41 mrem/d.

Table 18 lists the maximum, minimum, and average dose rates, along with the adjusted annual dose for each monitoring station. Table 19 lists the results for the nine locations that comprised the original control network.

TABLE 18
GAMMA MONITORING RESULTS - SUMMARY OF 1986
REPORTING PERIOD: JANUARY 1986 TO JANUARY 1987

AREA	NAME	DOSE RATE mrem/d MIN.	MAX.	AVG.	1985 ADJ ANNUAL DOSE mrem/yr	1986 ADJ ANNUAL DOSE mrem/yr
1	BJY	0.17	0.28	0.24	105	89
1	SANDBAG HUT	0.26	0.27	0.26	97	96
1	STAKE TH-28	0.22	0.26	0.24	88	87
1	STAKE TH-38	0.24	0.30	0.27	103	99
2	STAKE M-140	0.18	0.33	0.27	116	99
2	STAKE M-150	0.19	0.33	0.28	120	102
2	STAKE 2N-8	4.18	4.72	4.41	1746	1610
2	STAKE 2L-6	0.51	0.65	0.60	248	217
2	STAKE TH-58	0.20	0.24	0.22	82	79
2	CABLE YARD	0.23	0.35	0.29	122	107
3	3-03 O.B. ROAD	0.21	0.22	0.22**	78	80
3	ANGLE ROAD	0.35	0.42	0.38	144	140
3	N844, 200 E704, 900	0.15	0.21	0.17	54	64
3	U3AX/BL, NE	0.61	0.77	0.70	259	254
3	U3AX/BL, NW	0.36	0.47	0.43	162	156
3	U3AX/BL, S	0.31	0.41	0.37	131	135
3	U3AX/BL, SE	0.38	0.45	0.42	157	152
3	U3BY, N	0.61	0.74	0.69	280	253
3	U3BY, S	0.34	0.40	0.38	146	139
3	U3BZ, N	0.44	0.53	0.50	185	181
3	U3BZ, S	0.31	0.36	0.34	124	123
3	U3CJ, N	0.29	0.35	0.32	120	117
3	U3CO, S	1.53	1.83	1.72	660	629
3	U3CO, N	2.70	3.14	2.75	1124	1003
3	U3EY, S	0.30	0.36	0.33	118	119
3	U3DU, N	0.33	0.41	0.38	147	138
3	U3DU, S	0.40	0.46	0.44	165	159
3	LANL TRAILERS	0.26	0.32	0.28	103	103
4	STAKE M-130	0.15	0.29	0.24	101	87
4	STAKE 4A-8	3.49	3.84	3.63	1817	1325
4	STAKE TH-48	0.29	0.33	0.26	117	96
5	N710,800 E720,000	0.14	0.22	0.17	47	62
5	RWMS CORNER, NW	0.19	0.32	0.26	109	95
5	RWMS, E, 500	0.17	0.33	0.25	102	92
5	RWMS, E, 1000	0.17	0.29	0.24	104	89
5	RWMS, E, 1500	0.17	0.20	0.24	100	88
5	RWMS, EAST GATE	0.15	0.30	0.23	107	85
5	RWMS, N, 500	0.20	0.33	0.27	108	98

* No sample collected in First Quarter
** No sample collected in Second Quarter
*** No sample collected in Third Quarter
**** No sample collected in Fourth Quarter

TABLE 18 (Continued)
GAMMA MONITORING RESULTS - SUMMARY OF 1986
REPORTING PERIOD: JANUARY 1986 TO JANUARY 1987

AREA	NAME	DOSE RATE mrem/d MIN.	MAX.	AVG.	1985 ADJ ANNUAL DOSE mrem/yr	1986 ADJ ANNUAL DOSE mrem/yr
5	RWMS, N, 1000	0.18	0.31	0.16	107	57
5	RWMS, N, 1500	0.17	0.30	0.25	103	91
5	RWMS, NORTHEAST CORNER	0.17	0.31	0.24	102	89
5	RWMS OFFICES	0.11	0.30	0.22	120	80
5	RWMS, S, 500	0.19	0.30	0.25	110	92
5	RWMS, SOUTH GATE	0.22	0.49	0.30	103	110
5	RWMS SW CORNER	0.16	0.28	0.24	102	88
5	RWMS W 500	0.18	0.31	0.25*	106	92
5	RWMS W 1000	0.20	0.32	0.27	112	98
5	RWMS W 1500	0.20	0.32	0.26	107	94
5	WELL 5B	0.15	0.26	0.22	93	79
6	6-09 O.B. ROAD	0.27	0.31	0.29	107	106
6	CP-6	0.05	0.18	0.13	60	49
6	CP-2 LOGISTICS DESK	0.05	0.22	0.16**	58	58
6	CP-50 CALIBRATION BENCH	0.16	0.31	0.23	100	82
6	CP-50 INSTRUMENT CALIBRATION DRAWER	0.24	0.41	0.33	146	122
6	DECONTAMINATION PAD BACK OFFICE	0.22	0.26	0.24***	88	87
6	DECONTAMINATION PAD FRONT OFFICE	0.14	0.15	0.14	89	52
6	STAKE TH-1	0.16	0.19	0.17	59	62
6	STAKE TH-9	0.23	0.26	0.25	90	89
6	STAKE TH-18	0.20	0.23	0.22	77	80
6	WELL 3	0.13	0.25	0.21	92	77
6	YUCCA OIL STORAGE	0.20	0.24	0.22	82	79
7	7-300 BUNKER	0.82	0.92	0.87	347	318
8	STAKE 8K-25	0.12	0.25	0.21	77	94
9	N874,600 E691,500	0.11	0.23	0.19	59	69
9	9-300 BUNKER	0.19	0.30	0.26	114	96
10	STAKE 10A-24	0.35	0.55	0.47	225	170
10	STAKE CA-14	0.19	0.32	0.27**	120	99
10	CIRCLE AND L ROAD	0.17	0.30	0.26	115	95
10	SEDAN CRATER VISITORS BOX	0.24	0.36	0.32	132	116
10	SEDAN CRATER ENTRY ROAD	1.30	1.40	1.36	563	496
11	SECURITY GATE 293	0.26	0.31	0.29	110	107

* No sample collected in First Quarter
** No sample collected in Second Quarter
*** No sample collected in Third Quarter
**** No sample collected in Fourth Quarter

TABLE 18 (Continued)
GAMMA MONITORING RESULTS - SUMMARY OF 1986
REPORTING PERIOD: JANUARY 1986 TO JANUARY 1987

AREA	NAME	DOSE RATE mrem/d MIN.	MAX.	AVG.	1985 ADJ ANNUAL DOSE mrem/yr	1986 ADJ ANNUAL DOSE mrem/yr
11	N788,800 E709,500	0.33	0.38	0.35	111	127
12	STAKE M-168	0.29	0.33	0.31	112	112
12	STAKE M-170	0.24	0.29	0.27	104	99
12	STAKE M-175	0.28	0.33	0.30	113	109
12	N903,800 E635,500	0.25	0.29	0.27	89	99
12	BUILDING 12-10	0.28	0.33	0.30	113	111
12	"T" TUNNEL #2 (LOWER MINT)	1.90	1.90	1.90* *** ****	381	694
12	STAKE TH-68.5	0.21	0.26	0.23	87	84
12	UPPER HAINES LAKE	0.29	0.32	0.30	109	108
12	UPPER "N" TUNNEL	0.29	0.33	0.31*** ****	117	112
15	EPA FARM	0.13	0.26	0.22	97	81
15	LAMP SHACK	0.18	0.29	0.26	106	94
15	LLNL TRAILER	0.17	0.32	0.27	118	99
15	N907,600 E686,200	0.36	2.99	1.03	128	376
15	U15E TRAILER #621	0.08	0.23	0.18	86	67
15	U15E STORAGE SHED	0.16	0.29	0.25	104	92
15	U15E SUBSTATION	0.10	0.22	0.18	88	67
17	STAKE M-185	0.30	0.34	0.32	115	116
18	N849,500 E545,000	0.31	0.39	0.36	121	131
18	STAKE 18P-35	0.32	0.37	0.34	127	124
18	STAKE 18P-39	0.32	0.35	0.34**	125	124
18	GATE 18-1C	0.31	0.35	0.34	111	122
18	STAKE A-100	0.35	0.37	0.35****	124	127
18	STAKE A-108	0.35	0.37	0.36****	128	131
18	STAKE A-90	0.33	0.37	0.35****	124	127
19	STAKE 19P-41	0.36	0.39	0.36	140	132
19	STAKE 19P-46	0.30	0.36	0.33	122	119
19	STAKE 19P-54	0.29	0.34	0.31	119	115
19	STAKE 19P-59	0.32	0.40	0.36	141	132
19	STAKE 19P-66	0.33	0.40	0.37	140	135
19	STAKE 19P-71	0.33	0.38	0.35	120	129
19	STAKE 19P-77	0.36	0.41	0.38	126	151
19	STAKE 19P-87	0.40	0.45	0.43	142	139
19	STAKE 19P-88	0.40	0.44	0.41	132	132
19	STAKE 19P-91	0.32	0.43	0.38	125	130

* No sample collected in First Quarter
** No sample collected in Second Quarter
*** No sample collected in Third Quarter
**** No sample collected in Fourth Quarter

TABLE 18 (Continued)
GAMMA MONITORING RESULTS - SUMMARY OF 1986
REPORTING PERIOD: JANUARY 1986 TO JANUARY 1987

AREA	NAME	DOSE RATE mrem/d MIN.	MAX.	AVG.	1985 ADJ ANNUAL DOSE mrem/yr	1986 ADJ ANNUAL DOSE mrem/yr
19	STAKE M-190	0.31	0.37	0.35	132	126
19	STAKE M-196	0.31	0.36	0.34	132	124
19	STAKE C-16	0.34	0.38	0.36	127	131
19	STAKE C-25	0.34	0.39	0.36	127	131
19	STAKE C-27	0.35	0.39	0.37	134	135
19	STAKE C-31	0.37	0.39	0.38*** ****	131	137
19	N935,500 E639,750	0.15	0.38	0.31	123	113
19	N955,500 E614,200	0.37	0.74	0.49***	126	180
19	STAKE R-20	0.36	0.37	0.36****	126	136
19	STAKE R-27	0.39	0.44	0.41****	127	139
19	STAKE R-3	0.40	0.45	0.42****	140	154
19	STAKE R-31	0.35	0.40	0.37****	127	158
19	STAKE R-9	0.40	0.46	0.36****	139	132
19	WELL U19C	0.36	0.37	0.36	129	132
20	20-GATE 4C	0.36	0.36	0.36*** ****	133	130
20	STAKE A-116	0.28	0.40	0.36	143	133
20	STAKE A-130	0.35	0.36	0.36*** ****	130	133
20	STAKE 20P-120.5	0.34	0.42	0.37****	115	147
20	STAKE 20P-116.5	0.35	0.41	0.37	114	140
20	AREA 20 CAMP	0.33	0.40	0.36	111	136
20	STAKE 20P-134	0.35	0.41	0.37	114	380
20	STAKE 20P-124	0.37	0.43	0.38	120	134
20	STAKE 20P-129	0.37	0.47	0.40	125	138
20	STAKE J-16	0.34	0.38	0.37	116	133
20	STAKE J-24	0.36	0.41	0.38****	118	134
20	STAKE J-31	0.97	1.19	1.04	374	142
20	STAKE J-6	0.38	0.39	0.39	138	142
20	N887,000 E558,000	0.38	0.46	0.42	147	155
20	N948,800 E527,800	0.35	0.41	0.38	129	139
20	N944,700 E563,300	0.20	0.27	0.23	76	84
22	DESERT ROCK CONTROL TOWER	0.13	0.17	0.15	58	55
22	N670,600 E667,300	0.12	0.18	0.15	47	53
22	BLDG. 190	0.16	0.27	0.20***	60	72
23	BLDG. 610 GATE	0.12	0.15	0.13	48	49

* No sample collected in First Quarter
** No sample collected in Second Quarter
*** No sample collected in Third Quarter
**** No sample collected in Fourth Quarter

TABLE 18 (Continued)
GAMMA MONITORING RESULTS - SUMMARY OF 1986
REPORTING PERIOD: JANUARY 1986 TO JANUARY 1987

AREA	NAME	DOSE RATE mrem/d MIN.	MAX.	AVG.	1985 ADJ ANNUAL DOSE mrem/yr	1986 ADJ ANNUAL DOSE mrem/yr
23	BLDG. 610 WORK AREA	0.77	2.42	1.47	547	536
23	BLDG. 650 DOSIMETRY ROOM	0.12	0.82	0.31	49	112
23	BLDG. 650 ROOF	0.11	0.15	0.13	45	47
23	BLDG. 650 SAMPLE STORAGE	0.15	0.44	0.29***	628	107
23	GATE 100	0.14	0.15	0.15	52	53
23	POST OFFICE	0.13	0.19	0.16*	47	57
23	BUILDING 180, SCALER	0.24	0.27	0.26****	94	93
25	25-GATE-4P	0.24	0.33	0.29	106	106
25	25-GATE-7P	0.25	0.33	0.27	100	99
25	E-MAD, E	0.25	0.30	0.27****	99	97
25	E-MAD, N	0.28	0.52	0.40	174	147
25	E-MAD, S	0.23	0.30	0.27	89	99
25	E-MAD, W	0.23	0.30	0.27	95	98
25	HENRE SITE	0.24	0.33	0.27	101	99
25	NRDS WAREHOUSE	0.26	0.32	0.28	101	100
27	A-27 CAFE	0.26	0.28	0.27****	106	89
25	N731,300 E638,700	0.22	0.28	0.24	78	98
25	N754,400 E557,800	0.29	0.37	0.32****	N/A	118
30	30-GATE-1C	0.37	0.37	0.37* *** ****	153	135

* No sample collected in First Quarter
** No sample collected in Second Quarter
*** No sample collected in Third Quarter
**** No sample collected in Fourth Quarter

TABLE 19

TLD CONTROL STATION COMPARISON

Station	Dose Rate (mrem/d) 1980	1981	1982	1983	1984	1985	1986
Bldg. 650 Dosimetry Room	0.18	0.21	0.19	0.21	0.15	0.13	0.31
Bldg. 650 Roof	0.16	0.18	0.18	0.18	0.14	0.12	0.13
Area 27 Cafeteria	0.37	0.41	0.37	0.39	0.32	0.29	0.27
CP-6	0.23	0.25	0.20	0.25	0.18	0.17	0.13
Henre Site	0.35	0.39	0.37	0.36	0.30	0.28	0.27
NRDS Warehouse	0.35	0.40	0.38	0.36	0.32	0.28	0.28
Post Office	0.16	0.20	0.18	0.18	0.14	0.13	0.16
Well 5B	0.34	0.38	0.33	0.33	0.27	0.26	0.22
Yucca Oil Storage	0.30	0.32	0.29	0.29	0.23	0.22	0.22
Network Average	0.27	0.30	0.28	0.28	0.23	0.21	0.22

G. RADIOACTIVE WASTE MANAGEMENT SITE (RWMS)

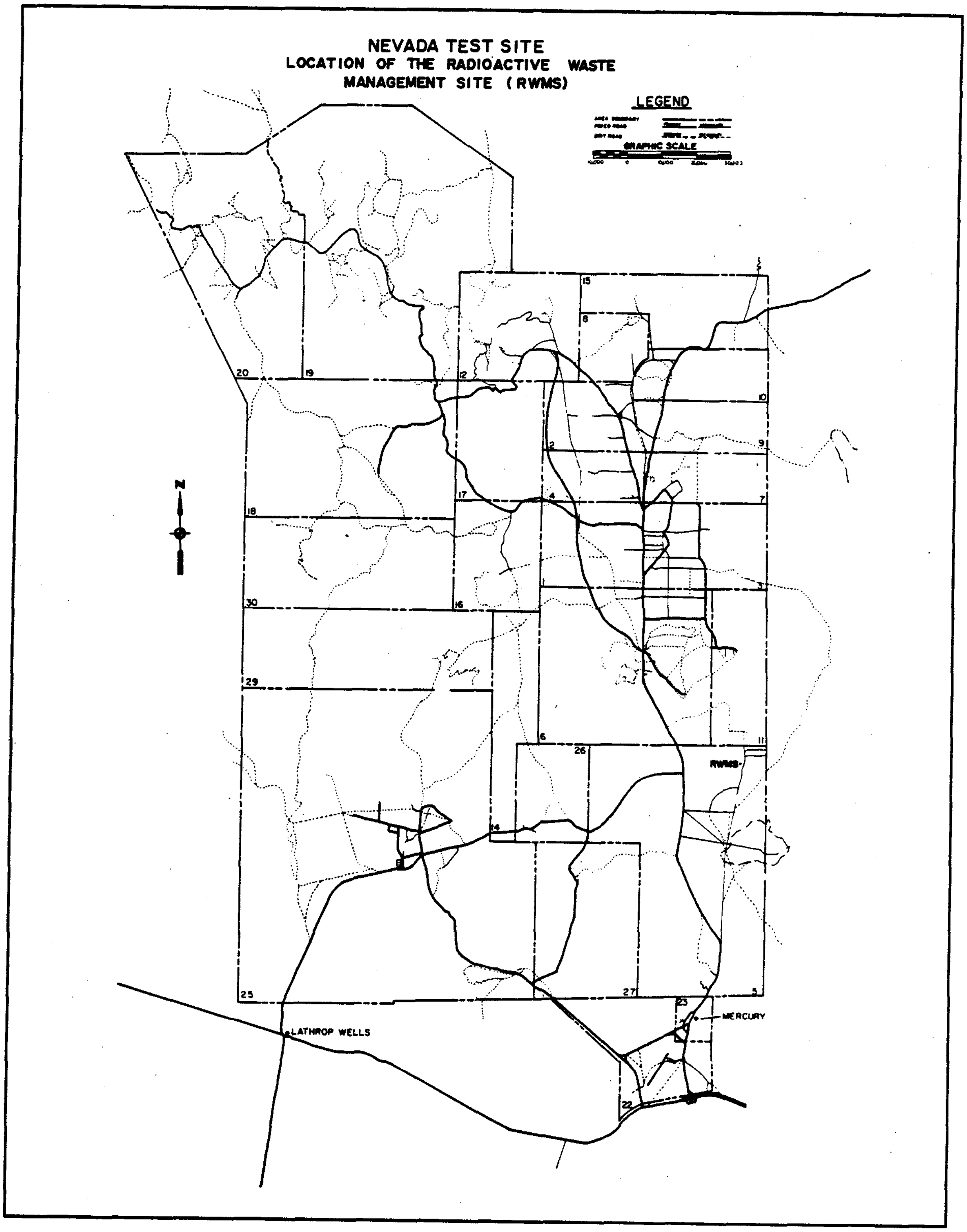
The Radioactive Waste Management Site is located in Area 5 of the Nevada Test Site (Figure 11). RWMS consists of approximately 37.2 hectares (92 acres) of land which is devoted to surface storage and disposal of defense low-level radioactive wastes. Waste facilities at the site include trenches, pits, and asphalt pads. The type of waste disposed of at RWMS includes tritium contaminated waste, low-level waste, and equipment that is activated or contaminated. The stored waste consists of transuranic (TRU) contaminated waste only. For a more detailed description of RWMS see "Meteorology and Atomic Energy," edited by D.H. Slade (reference 12).

Surveillance of the RWMS is accomplished by using eighteen air samplers, nine for tritium and nine for fission products and plutonium, and sixteen TLD's, for gamma monitoring, placed around the RWMS. Figures 12-14 show the locations of the stations and their yearly averages.

Tritium

The tritium-in-air samplers are placed around the perimeter of RWMS. The highest average for HTO was <4.6 x 10^{-11} µCi/cc at RWMS-1 Station, which is 0.05 percent of the derived concentration guide. Results for the RWMS surveillance are summarized in Table 6.

FIGURE 11


NEVADA TEST SITE
LOCATION OF THE RADIOACTIVE WASTE
MANAGEMENT SITE (RWMS)
LEGEND
GRAPHIC SCALE
15
8
10
9
7
3
11
20
19
12
2
17
4
18
16
30
29
6
26
RWMS
14
25
27
5
23
MERCURY
LATHROP WELLS
22

Gross Beta

The average gross beta in air concentration was 4.8×10^{-14} µCi/cc which was equal to the network average at the RWMS. These concentrations represent approximately 0.005 percent of the derived concentration guide. Results from the nine gross beta stations were grouped closely together and all were within two standard deviations from the average. Gross beta in air results for the site are summarized in Tables 4.

Plutonium

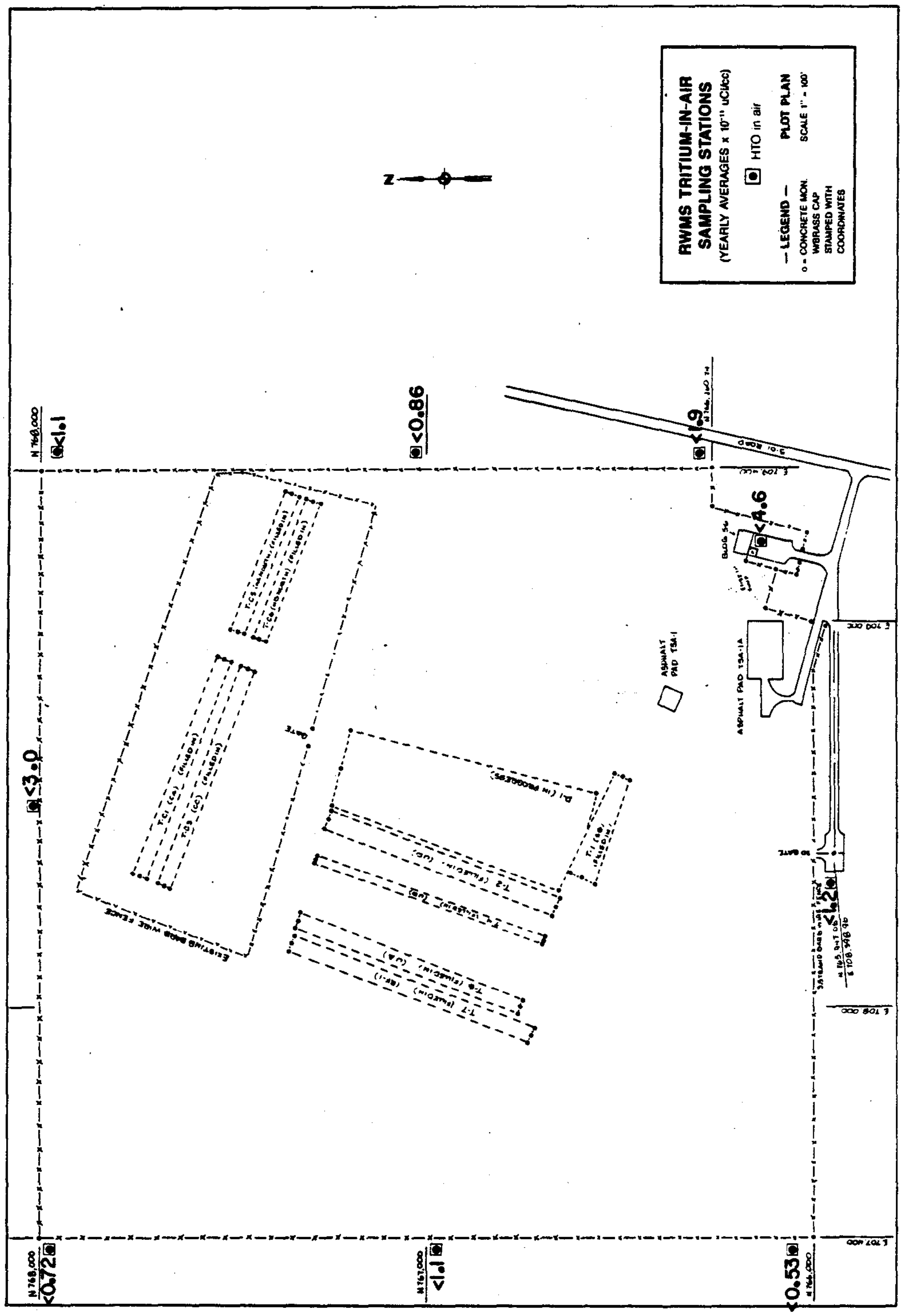
The average concentration of Pu-239 in air at RWMS was $<2.4 \times 10^{-17}$ µCi/cc. This is 0.12 percent of the derived concentration guide for Pu-239. Plutonium in air results for RWMS appear in Table 5.

Gamma Monitoring

The average annual dose for the control network was 81 mrem/y or 9 µrem/h. The natural background of Area 5 which averaged slightly higher at 92 mrem/y or 11 µrem/h compared favorably with the literature value of 11-20 µR/h (Reference 13). Another station, two miles south (Well 5B), had an annual dose rate of 79 mrem/y or 9 µrem/h. Table 18 gives a summary of the gamma monitoring results for 1986.

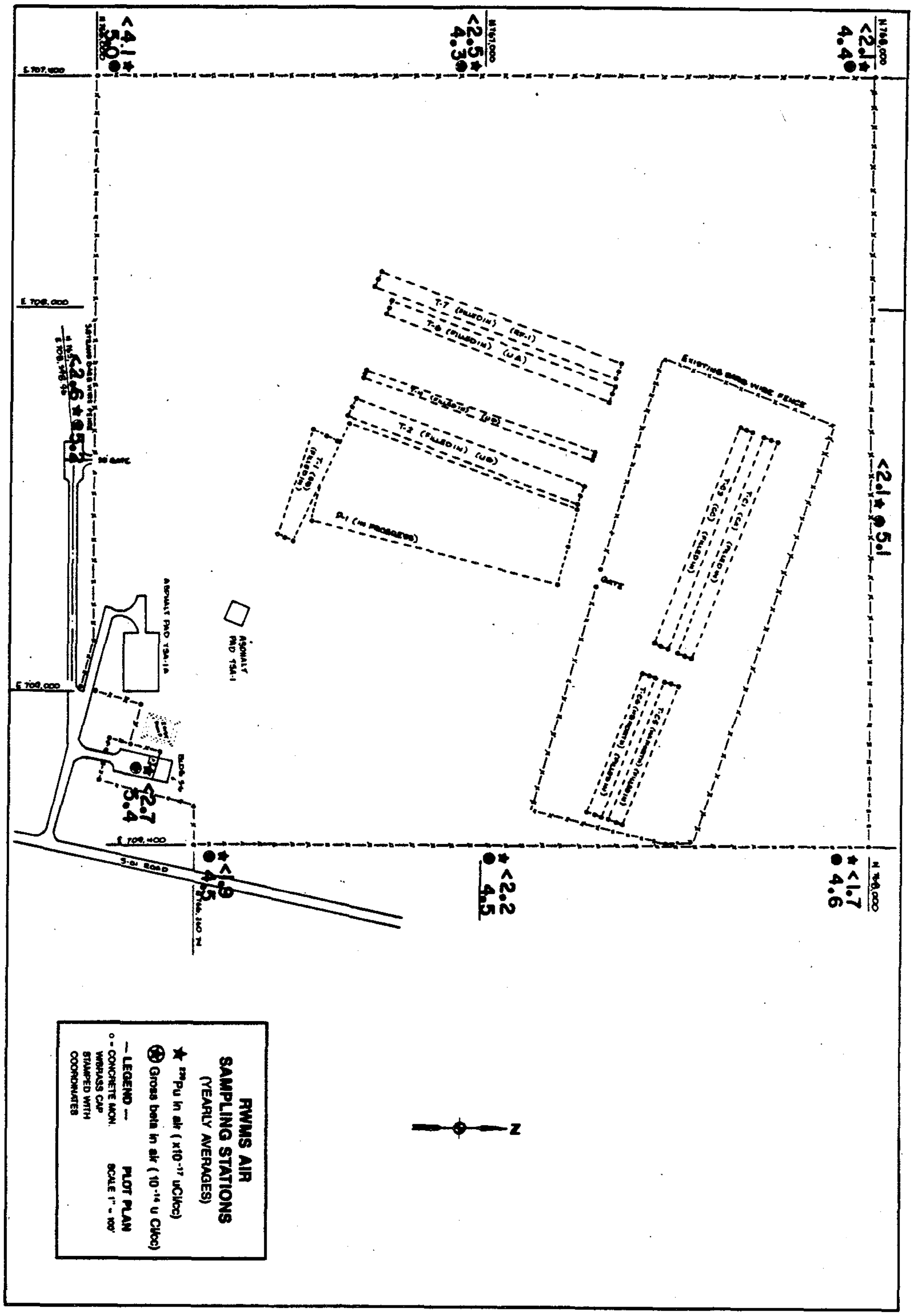
In conclusion, the results from the surveillance network around the RWMS indicate that there were no detectable releases of radioactive materials as a result of operations during 1986.

FIGURE 12



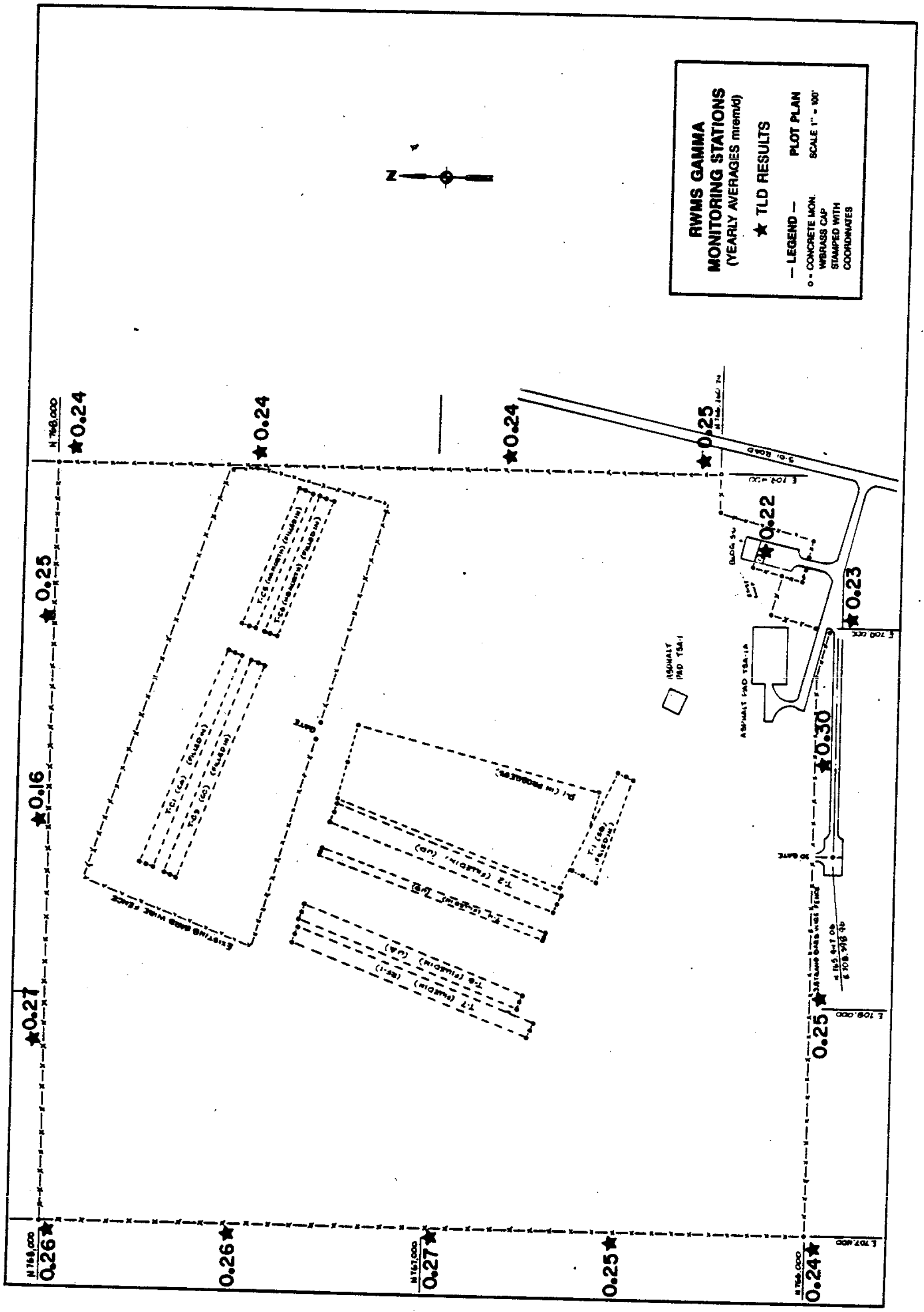
RWMS TRITIUM-IN-AIR
SAMPLING STATIONS
(YEARLY AVERAGES x 10⁻¹¹ uCi/cc)
— LEGEND —
HTO in air
o = CONCRETE MON. W/BRASS CAP STAMPED WITH COORDINATES
PLOT PLAN
SCALE 1" = 100'
N
<1.1
<0.86
<1.9
<3.0
<0.72
<1.1
<0.53
<1.2
ASPHALT PAD TSA-1
ASPHALT PAD TSA-1A
GATE

FIGURE 13



RWMS AIR
SAMPLING STATIONS
(YEARLY AVERAGES)
LEGEND
PLOT PLAN
N
<4.1 5.0
<2.5 4.3
<2.1 4.4
<2.6 5.4
<2.1 5.1
<2.7 5.4
<.9 4.5
<2.2 4.5
<1.7 4.6

FIGURE 14


RWMS GAMMA MONITORING STATIONS (YEARLY AVERAGES mrem/d)
★ TLD RESULTS
— LEGEND —
o - CONCRETE MON. W/BRASS CAP STAMPED WITH COORDINATES
PLOT PLAN
SCALE 1" = 100'
0.24
0.24
0.24
0.25
0.22
0.23
0.25
0.16
0.27
0.30
0.25
0.26
0.26
0.27
0.25
0.24

H. PERIMETER DOSE ASSESSMENT

The maximum postulated dose from the NTS operations was calculated for an individual at work within the test site during the entire CY-1986. This was done by calculating the fifty year cumulative dose for an individual receiving a one year occupational intake from measured radionuclide concentrations onsite. The dose from air immersion was calculated for a one year occupational exposure to a semi-infinite cloud. In the calculation the air immersion dose was treated like an external exposure and, therefore, once the radioactive source was considered removed, for the purposes of this calculation the end of CY-1986, there was no further exposure. As previously explained in the "Summary of Results" section, a highly conservative approach was taken to determine the doses received by an individual at the NTS. The dose conversion factors used for calculating the cumulative dose came from References 14 and 20, and are tabulated in Table 20. Basically, these reports used models and parameters equivalent to those used in ICRP Publication 2 (Reference 16). The radionuclides considered for the dose calculations were tritium, Kr-85, Xe-133, Pu-239, and Sr-90 (assuming the gross beta concentration in air consists entirely of Sr-90).

1. Dose From Ingestion of Radionuclides

The dose from the ingestion pathways was calculated for an individual at work within the NTS boundary during CY-1986. The only pathway considered was the ingestion of water. Ingestion of foodstuffs was not considered because of the lack of locally grown food adjacent to the site boundary. The water was assumed to be similar to the potable

TABLE 20

DOSE CONVERSION FACTORS*

	Inhalation (mrem/50 y per pCi inhaled)			Ingestion (mrem/50 y per pCi ingested)		Air Immersion (mrem/y per $\mu Ci/m^3$)	
Organ	^{3}H***	^{239}Pu****	^{90}Sr**	^{239}Pu****	^{3}H***	^{133}Xe	^{85}Kr
Total Body	$9.35X10^{-8}$	$1.55X10^{-1}$	$7.62X-10^{-4}$	$3.82X-10^{-5}$	$6.18X-10^{-8}$	$2.19X10^{2}$	$1.9X10^{1}$
Bone	0.0	$6.38X10^{0}$	$1.24X-10^{-2}$	$1.57X-10^{-3}$	0.0	$2.19X10^{2}$	$1.9X10^{1}$
Lung	$9.35X10^{-8}$	$3.44X10^{-1}$	$1.20X-10^{-3}$	0.0	$6.18X-10^{-8}$	$2.37X10^{2}$	$3.6X10^{1}$
Skin	-----	-----	-----	-----	-----	$6.04X10^{2}$	$1.4X10^{3}$

* Taken from References 14 and 20.

** Gross beta activity was assumed to be ^{90}Sr.

*** The dose conversion factor was divided by 1.7 to take into account the change in Quality Factor for weak beta emitters (DOE Order 5840.1, Chapter XI).

**** The dose conversion factor was multiplied by two to take into account the change in Quality Factor for alpha emitters (DOE Order 5840.1, Chapter XI).

water sampled onsite. The radionuclides considered for the calculation were Pu-239 and tritium. The gross beta concentration was not used in the calculation because it was shown earlier (reference 23) that the gross beta concentration was primarily due to the naturally occurring K-40 content. The Cascade bottled water brought onsite was assumed to have natural background levels of Pu-239 and tritium. These background concentrations were subtracted from the potable water stations having the maximum average Pu-239 and tritium concentrations to obtain the net concentrations used in the dose calculations. These values are listed in Table 21. The assumed fluid intake for the individual was 1.6 liters per day and was derived from ICRP Publications 23 (Reference 15). The resulting ingestion doses to the total body, lung, and bone for Pu-239 and tritium are given in Table 22.

2. Dose from Inhalation of Radionuclides

The doses from the inhalation of tritium, gross beta activity, and Pu-239 were calculated for the individual at work within the NTS boundary. The maximum average tritium in air and Pu-239 in air concentrations were used for the dose calculations after background concentrations were subtracted.

All of the gross beta activity was assumed to be Sr-90. The concentrations used for calculating the inhalation dose are listed in Table 21. The individual was assumed to breathe 1624 cubic meters of air in one year (Reference 15). The calculated fifty year cumulative doses to the whole body, lungs, and bone are given in Table 22.

TABLE 21

RADIONUCLIDE CONCENTRATIONS USED FOR DOSE ASSESSMENT

	Air (μCi/cc)					Potable Water (μCi/ml)	
	^{3}H	^{239}Pu	Gross Beta	^{133}Xe	^{85}Kr	^{239}Pu	^{3}H
Onsite Concentration	$<3.9 \times 10^{-10}$	1.5×10^{-15}	5.4×10^{-14}	$<1.6 \times 10^{-10}$	5.8×10^{-11}	$<1.3 \times 10^{-10}$	$<1.1 \times 10^{-6}$
Background Concentration	$<2.9 \times 10^{-12}$	$<1.3 \times 10^{-17}$	3.6×10^{-14}	0.0	2.7×10^{-11}	$<4.5 \times 10^{-11}$	$<8.9 \times 10^{-7}$
Net Concentration	$<3.9 \times 10^{-10}$	1.5×10^{-15}	1.8×10^{-14}	$<1.6 \times 10^{-10}$	3.1×10^{-11}	$<8.5 \times 10^{-11}$	$<2.1 \times 10^{-7}$

TABLE 22

50 YEAR CUMMULATIVE DOSES*

	Inhalation (mrem)			Ingestion (mrem)		Air Immersion (mrem)		
Organ	^{3}H	^{239}Pu	^{90}Sr**	^{239}Pu	^{3}H	^{133}Xe	^{85}Kr	Total (mrem)
Total Body	$<1.3X10^{-1}$	$8.2X10^{-1}$	$4.9X10^{-2}$	$<1.9X10^{-3}$	$<7.6X10^{-3}$	$<1.5X10^{-2}$	$2.5X10^{-4}$	$<1.0X10^{0}$
Bone	0.0	$3.4X10^{1}$	$7.9X10^{-1}$	$<7.8X10^{-2}$	0.0	$<1.5X10^{-2}$	$2.5X10^{-4}$	$<3.4X10^{1}$
Lung	$<1.3X10^{-1}$	$1.8X10^{0}$	$7.7X10^{-2}$	0.0	$<7.6X10^{-3}$	$<1.6X10^{-2}$	$4.7X10^{-4}$	$<2.0X10^{0}$
Skin	----	----	----	----	----	$<4.1X10^{-2}$	$1.8X10^{-2}$	$<5.9X10^{-2}$

* 50 year cummulative dose from inhalation and ingestion of radionuclides for one year. The air immersion dose rate was calculated for a one year exposure with no resulting exposure after CY-1985 ended.

** Assumed all of the gross beta activity was ^{90}Sr.

3. Dose from Air Immersion

The air immersion dose from Xe-133 was calculated for an individual working within the NTS boundary. The average Kr-85 concentration at the Area 20 dispensary was above the network average and was used in air immersion dose calculations, after subtraction of background. The highest average Xe-133 concentration was used to calculate the air immersion dose. These values are given in Table 22. The calculated doses to the whole body, lungs, bone, and skin are listed in Table 23.

TABLE 23

ESTIMATED NATURAL BACKGROUND DOSE AT THE NTS BOUNDARY*

Source	Total Body** (mrem/y)	Bone (mrem/y)	Lungs (mrem/y)
Cosmic Radiation***	36	36	36
Cosmic Radionuclides+	0.7	0.8	0.7
External Terrestrial++	56	56	56
Inhaled Radionuclides+++	---	---	100
Radionuclides in the Body+++	27	60	24
Total for One Year	120	153	217
U.S. Average Total	80	120	180

* These values were derived from References 13 and 20.

** The values for the total body are assumed to be the same as those for the gonads in Reference 18.

*** Assumed altitude of 1 km and a 10% reduction from structural shielding.

\+ Variation throughout U.S. very minimal, usually less than 1 mrem/y.

++ Value of 10 μrad/h assumed at the site boundary. Value reduced by 20% for shielding by housing and 20% for shielding by the body.

+++ Average values for the U.S.

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A P P E N D I X   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. 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.

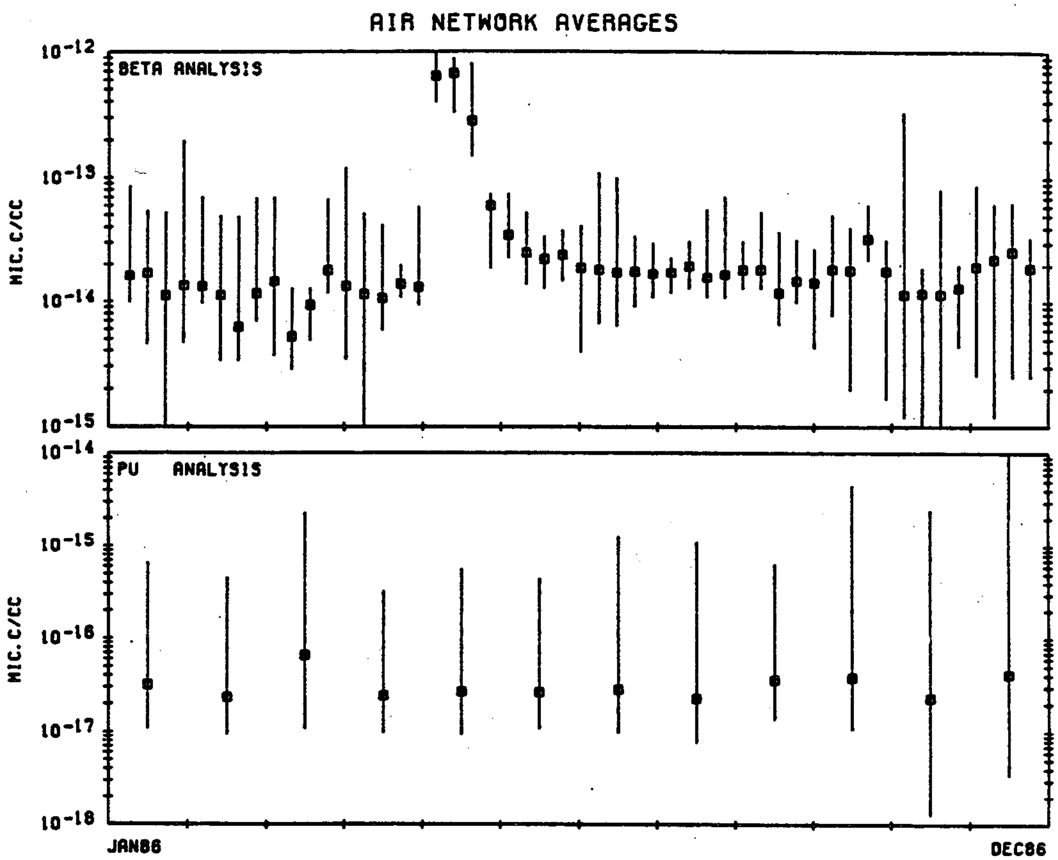
NTS ENVIRONMENTAL SURVEILLANCE
AIR SAMPLING LOCATIONS

Station Number	Location
1	Area 11 Gate 293
2	Area 6 Well 3 Complex
3	Area 3 Complex
4	Area 9 9-300 Bunker
5	Area 10 Gate 700
6	Area 2 Hydraulic Lift Yard
7	Area 2 Complex
8	Area 12 Complex
9	Area 19 Echo Peak
10	Area 19 Substation
11	Area 16 Substation
12	Area 9 9-300 Bunker No. 2
13	Area 23 H&S Roof
14	Area 23 Building 790
15	Area 23 Bldg. 790 No. 2
16	Area 27 Cafeteria
17	Area 25 NRDS Warehouse
18	Area 28 Henre Site
19	Area 5 Well 5B
20	Area 5 RWMS No. 1
21	Area 5 DOD Yard
22	Area 6 Yucca Complex
23	Area 6 CP Complex
25	Area 1 Gravel Pit
26	Area 3 BJY
27	Area 3 3-300 Bunker

NTS ENVIRONMENTAL SURVEILLANCE
AIR SAMPLING LOCATIONS

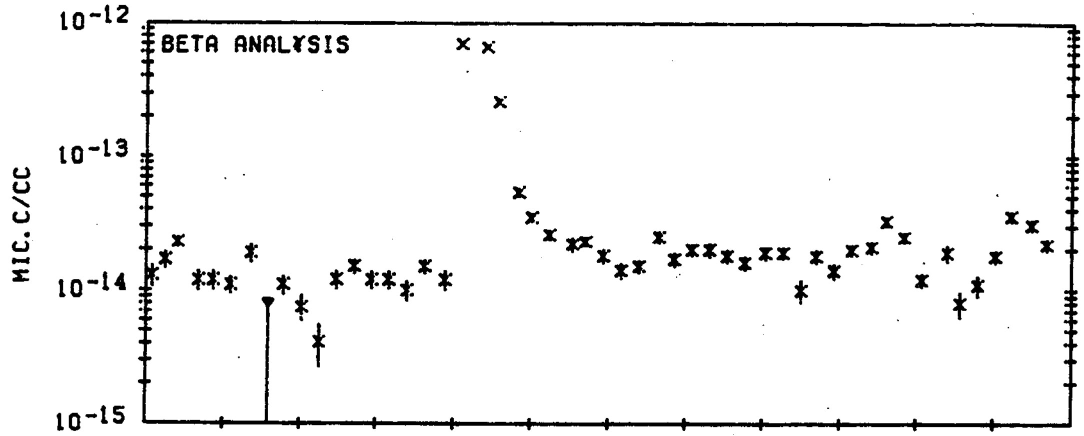
(Continued)

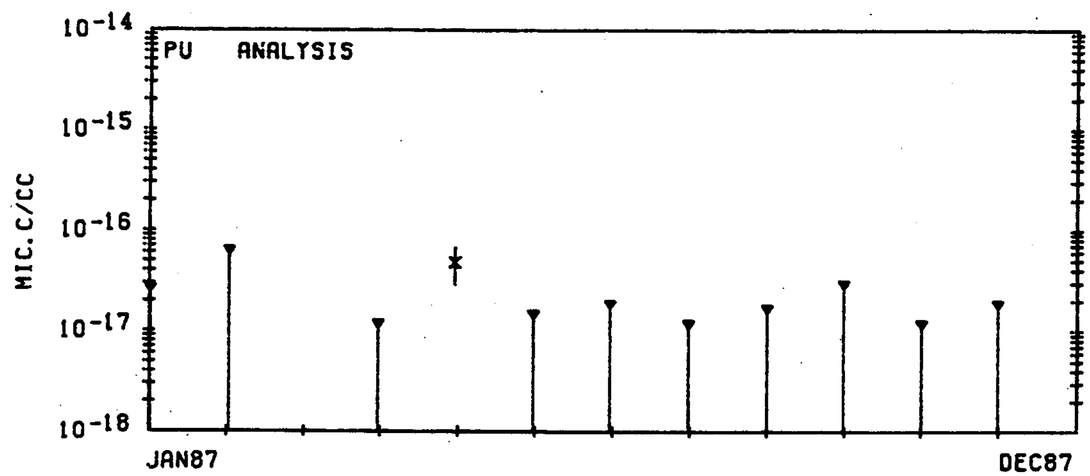
Station Number	Location
28	Area 5 RWMS No. 2
29	Area 5 RWMS No. 3
30	Area 25 E-MAD North
31	Area 25 E-MAD South
32	Area 5 RWMS No. 4
33	Area 3 U3ax South
34	Area 3 U3ax East
35	Area 3 U3ax North
36	Area 3 U3ax West
37	Area 7 UE7ns
38	Area 15 EPA Farm
39	Area 5 RWMS No. 5
40	Area 5 RWMS No. 6
41	Area 5 RWMS No. 7
42	Area 5 RWMS No. 8
43	Area 5 RWMS No. 9
44	Area 15 Pile Driver
46	Area 20 Dispensary
47	Area 3 Complex No. 2
48	Area 5 Gate 200
49	Area 5 Communications Tower



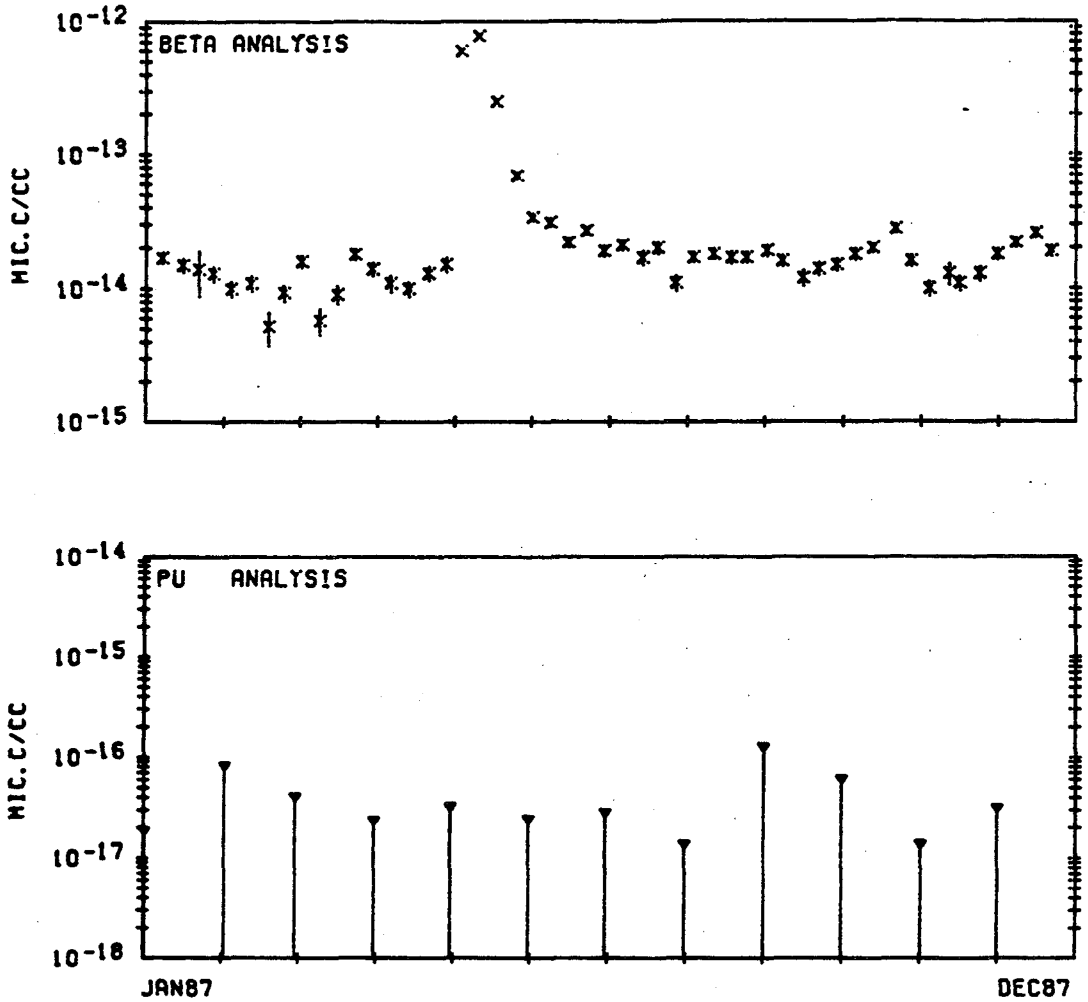
AIR NETWORK AVERAGES
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^-12
10^-13
10^-14
10^-15
10^-14
10^-15
10^-16
10^-17
10^-18
JAN86
DEC86

AIR SAMPLING STATION NUMBER 1

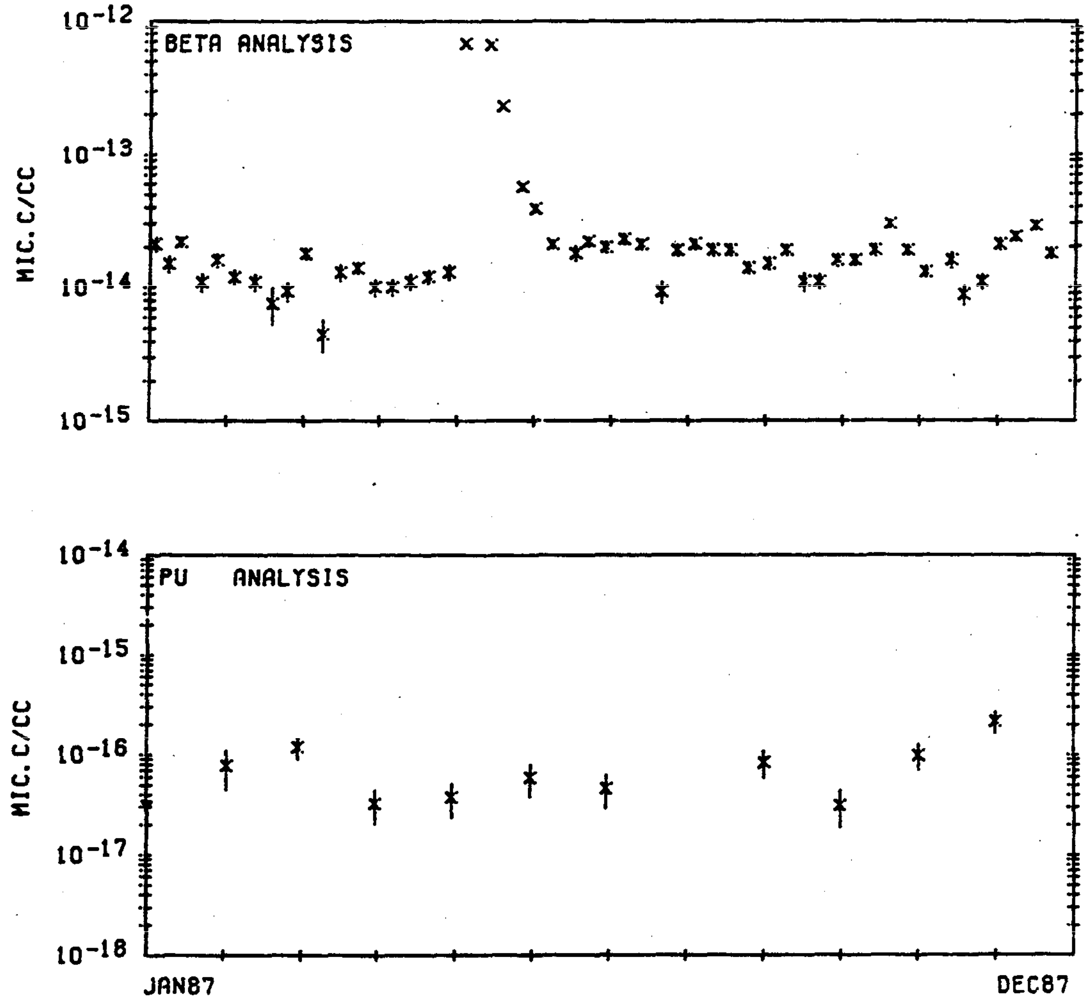




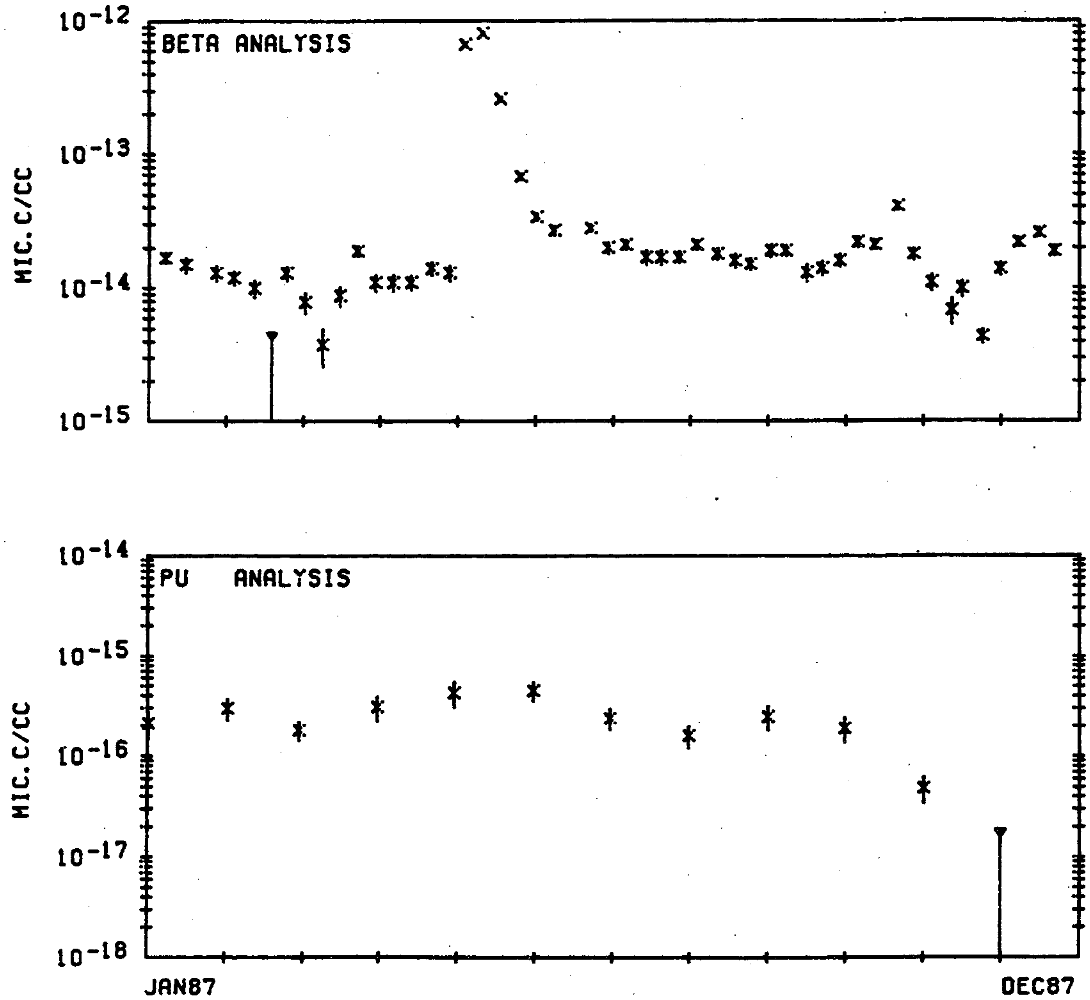
AIR SAMPLING STATION NUMBER 2



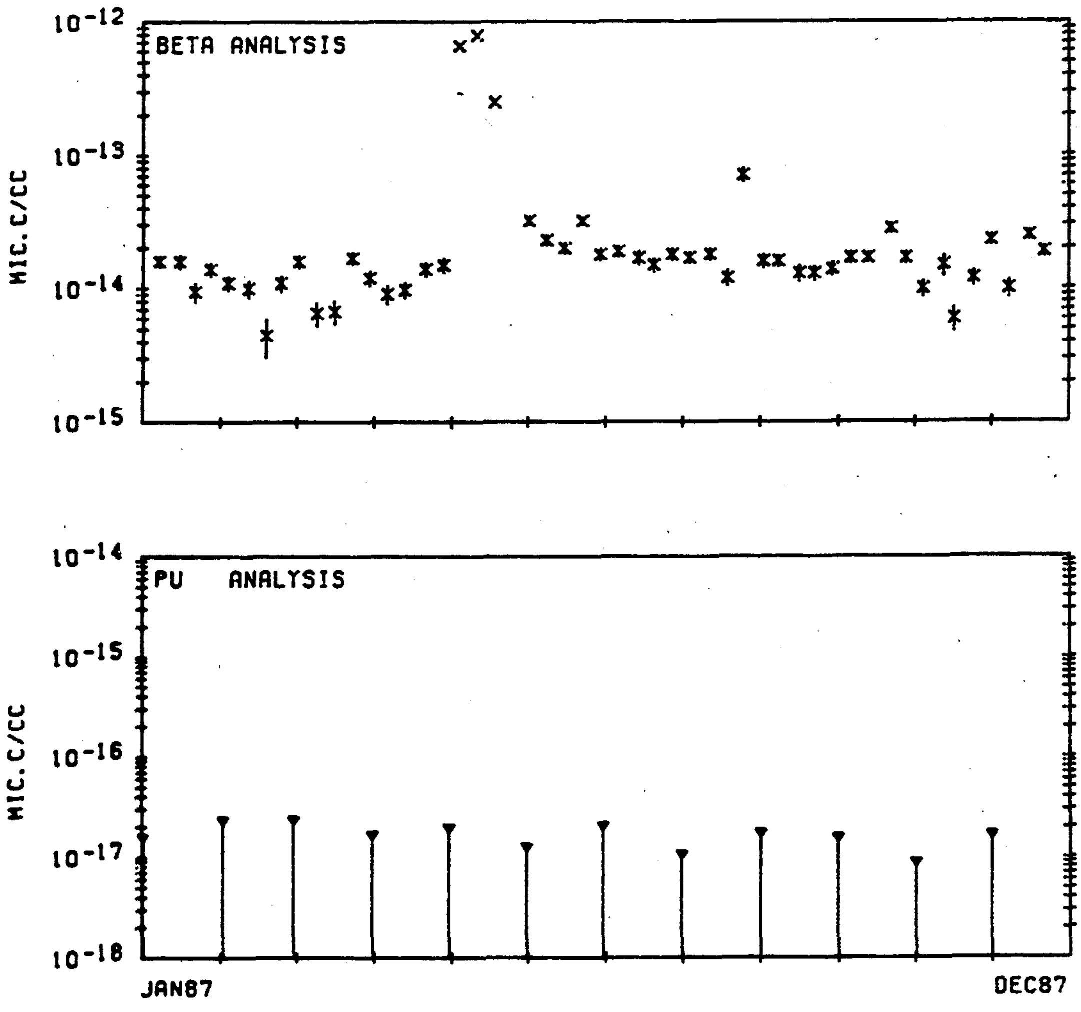
AIR SAMPLING STATION NUMBER 3



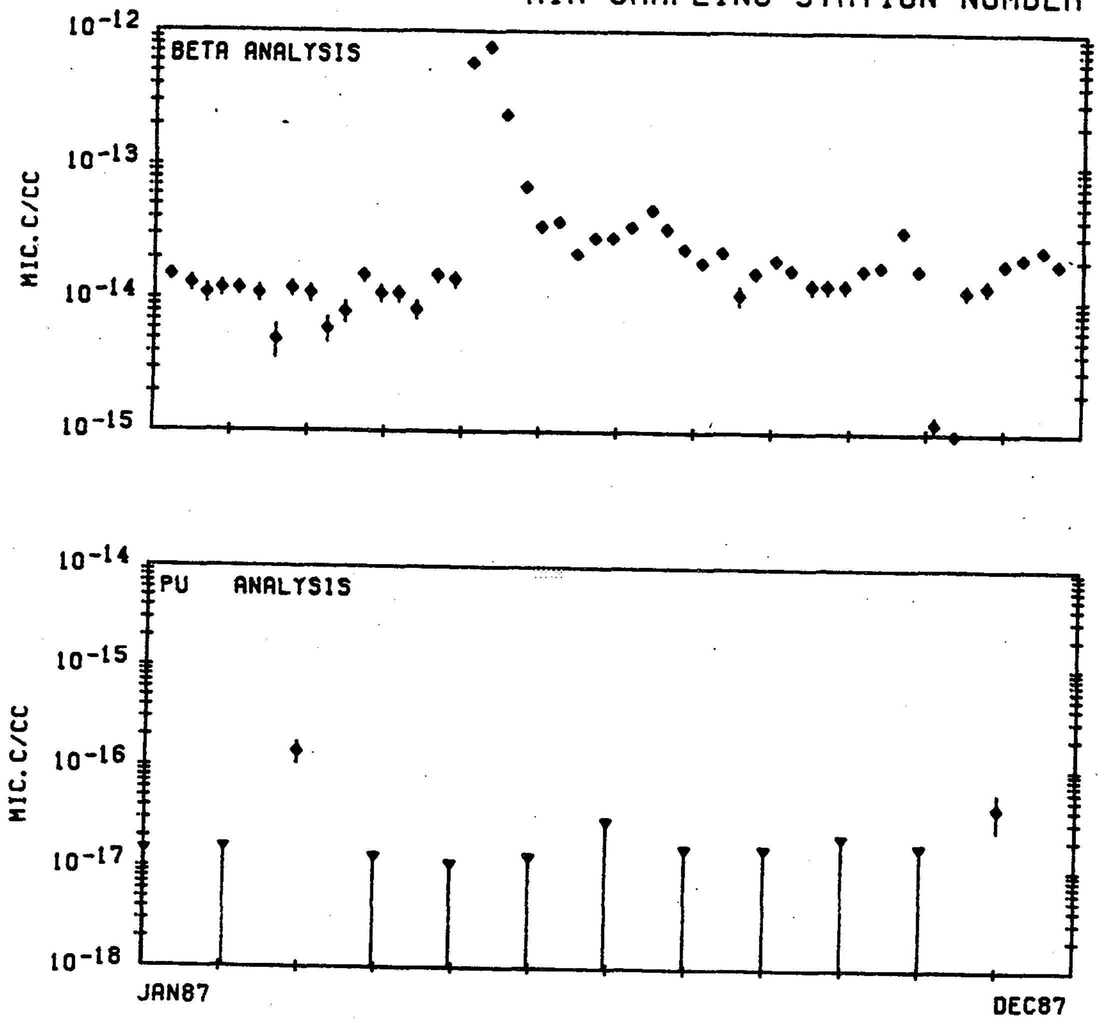
AIR SAMPLING STATION NUMBER 4



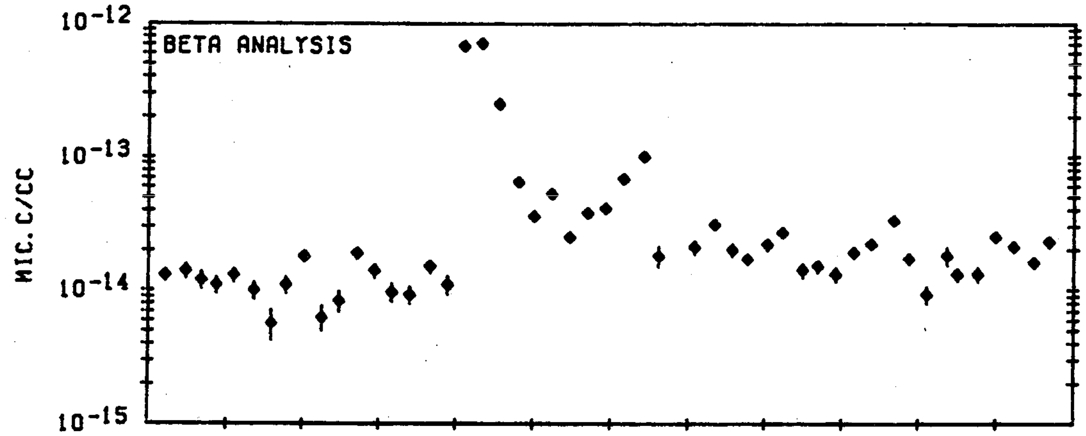
AIR SAMPLING STATION NUMBER 5

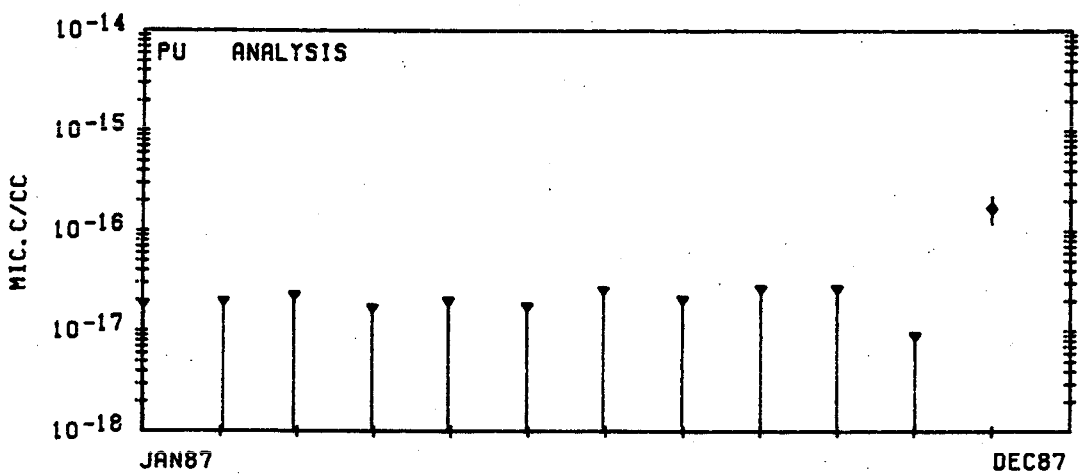


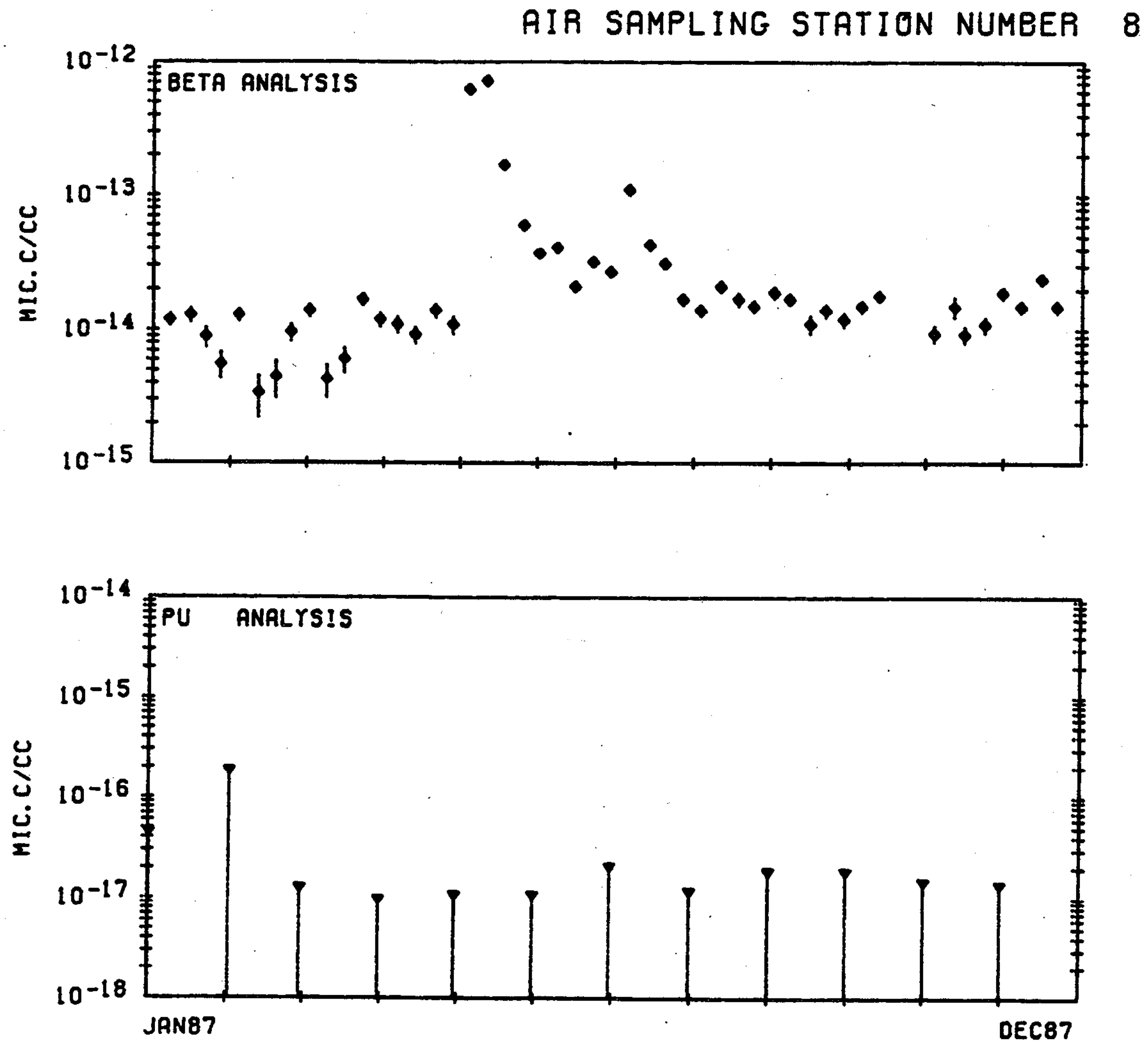
AIR SAMPLING STATION NUMBER 6

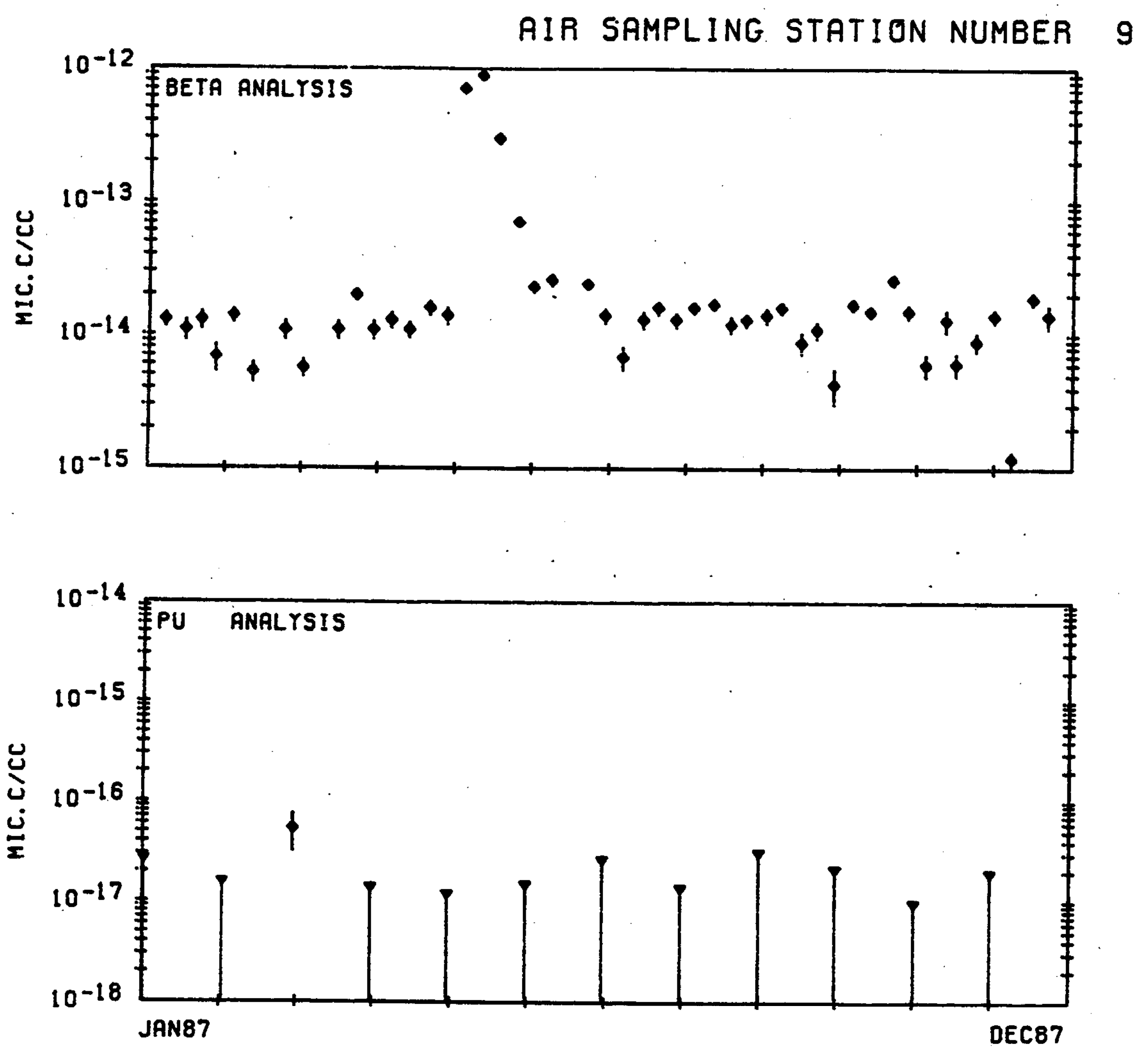


AIR SAMPLING STATION NUMBER 7

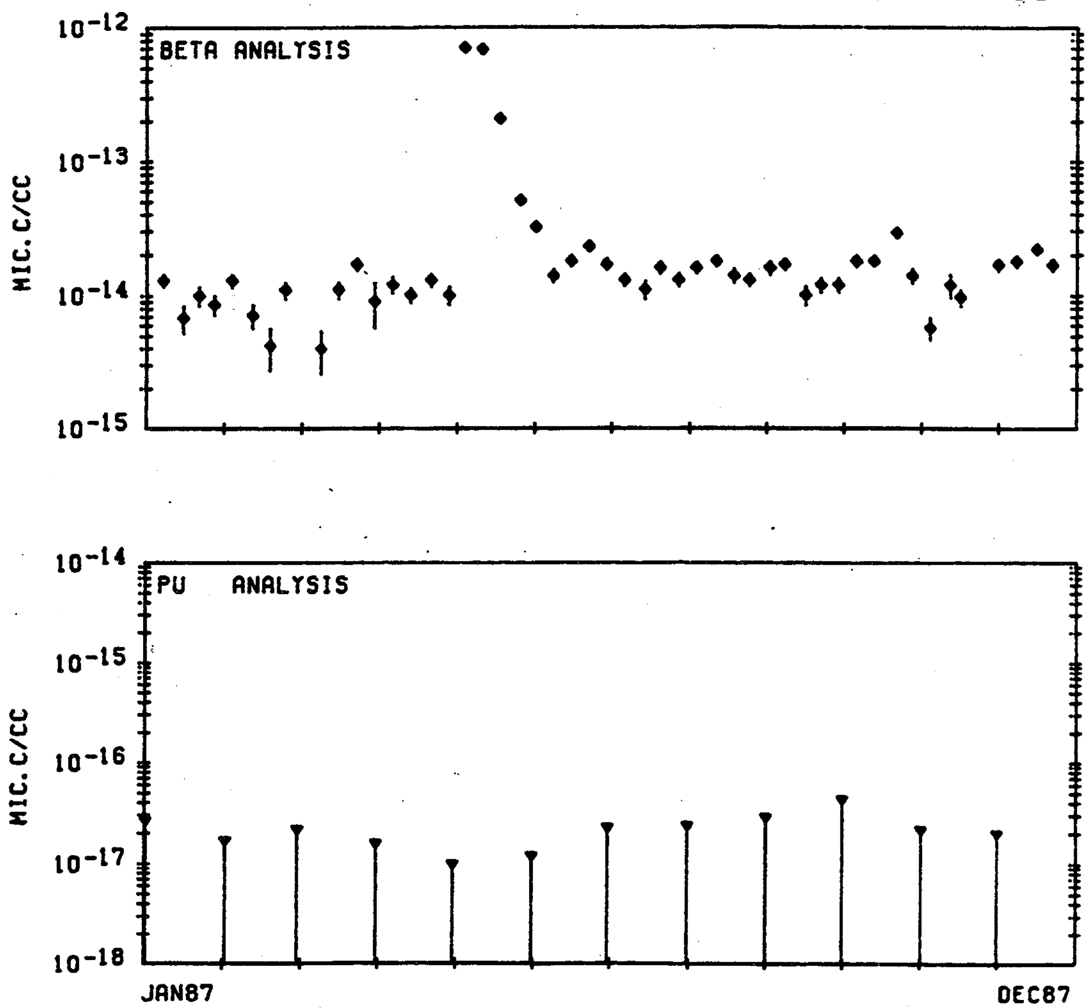




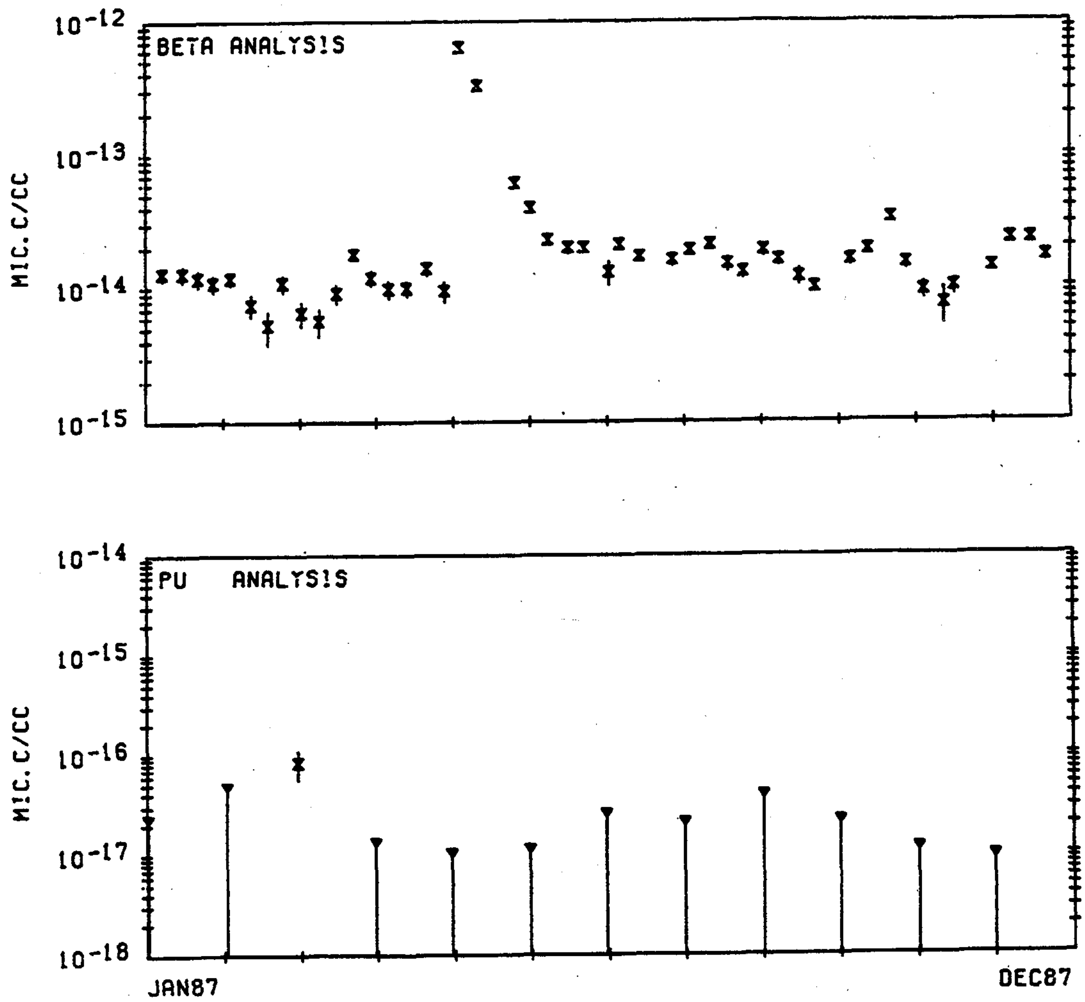

AIR SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
PU ANALYSIS
MIC.C/CC
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN87
DEC87


AIR SAMPLING STATION NUMBER 9
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}
JAN87
DEC87

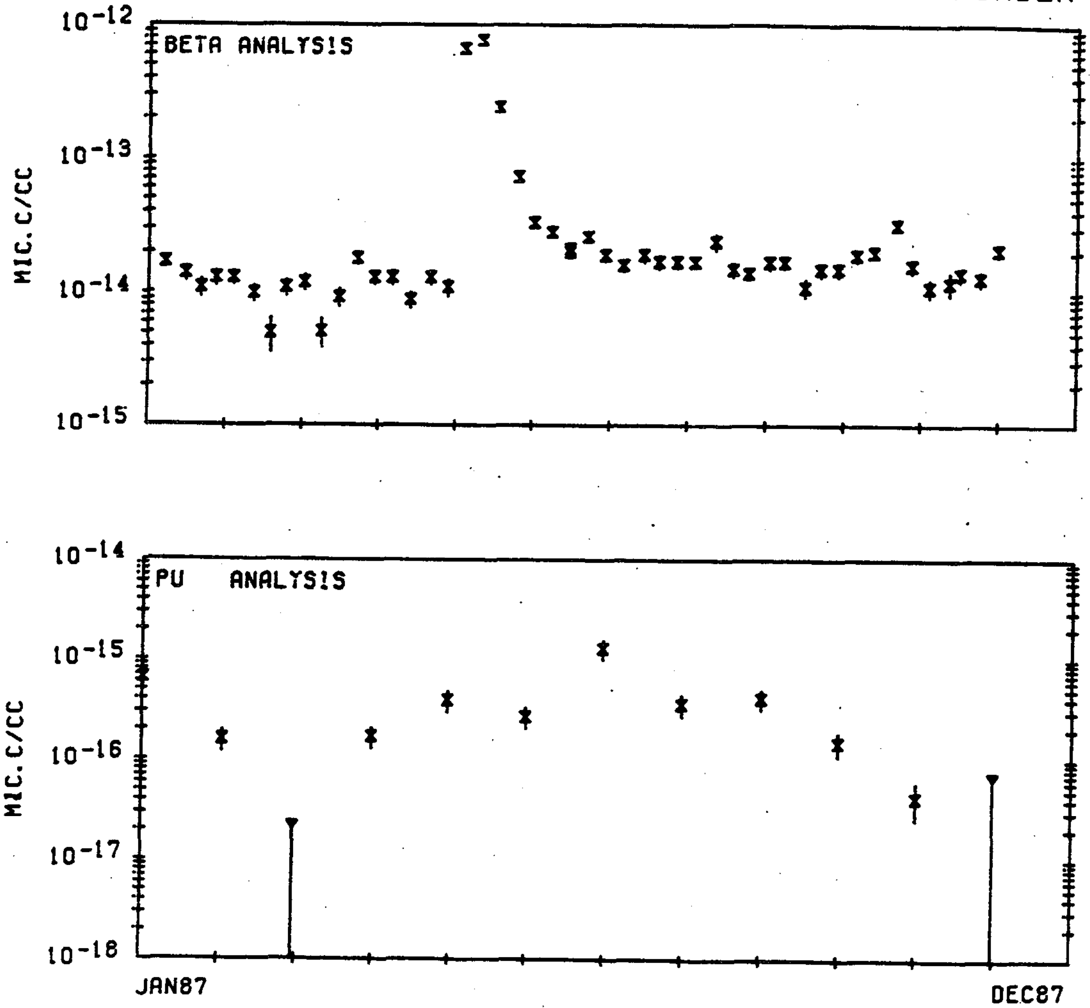
AIR SAMPLING STATION NUMBER 10



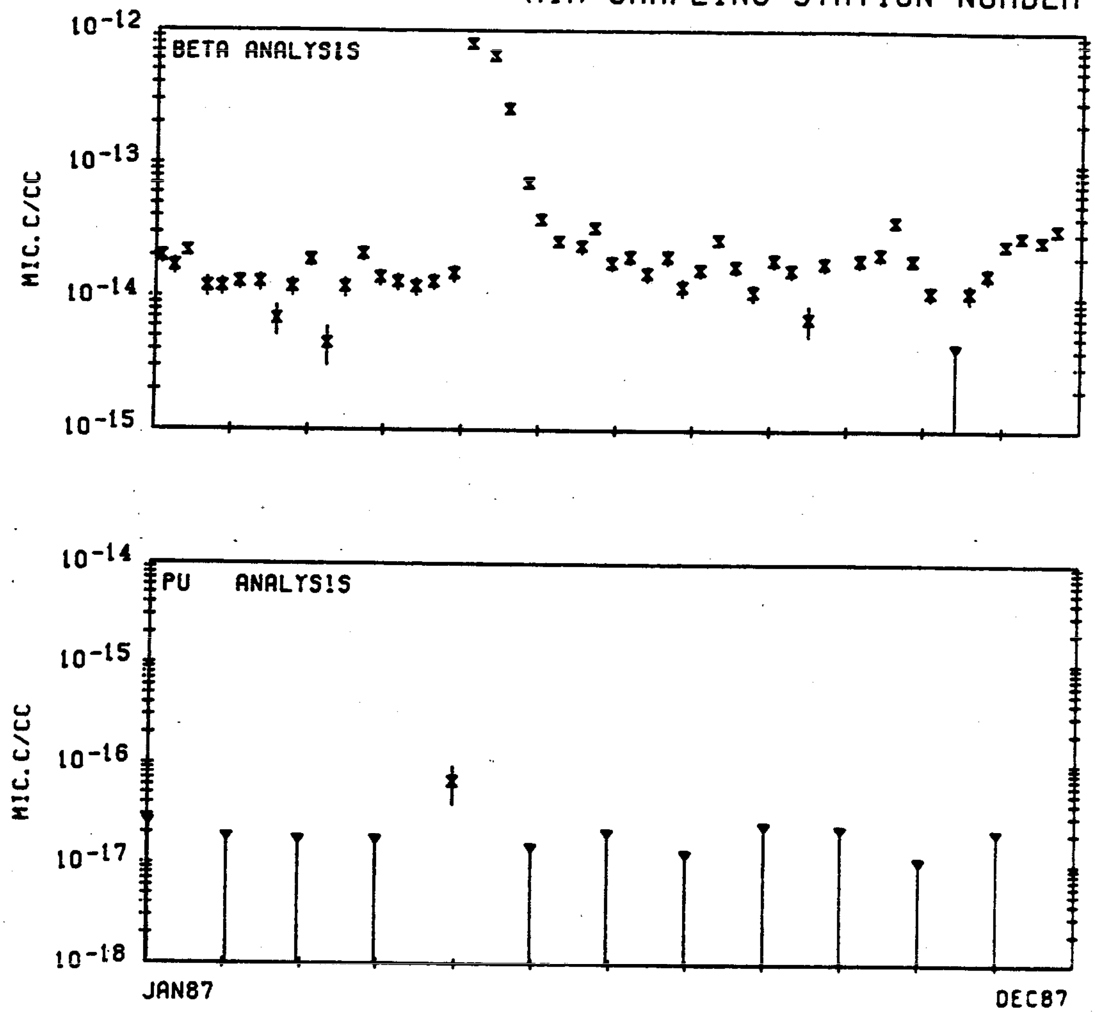
AIR SAMPLING STATION NUMBER 11



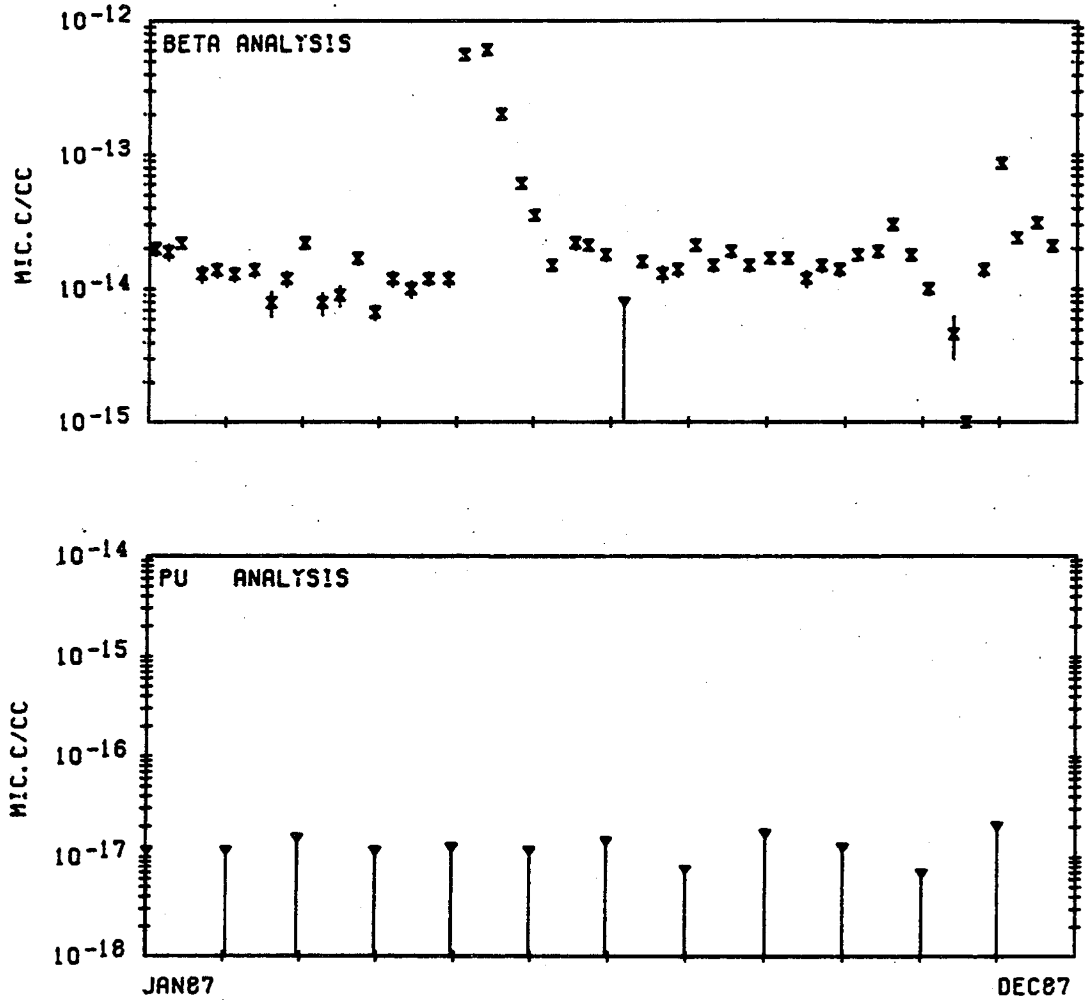
AIR SAMPLING STATION NUMBER 12



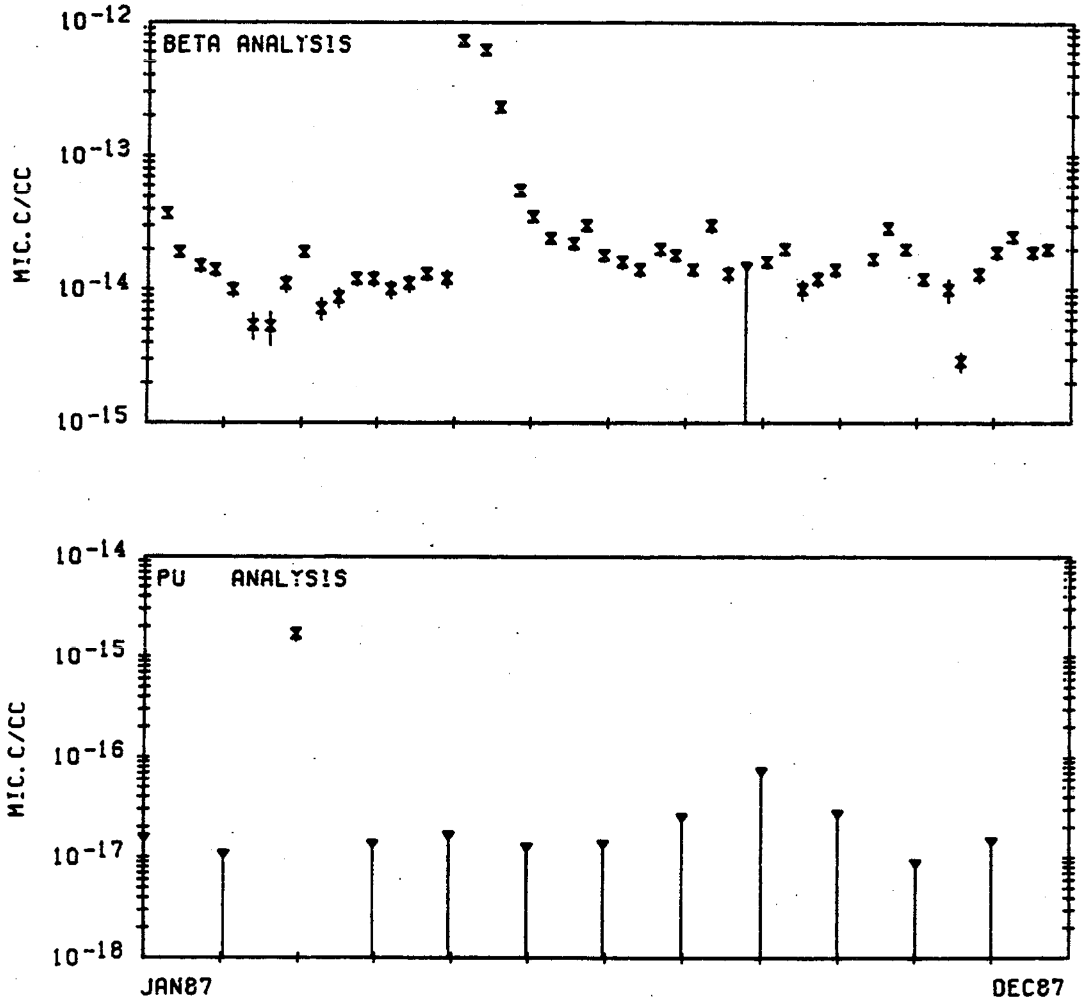
AIR SAMPLING STATION NUMBER 13



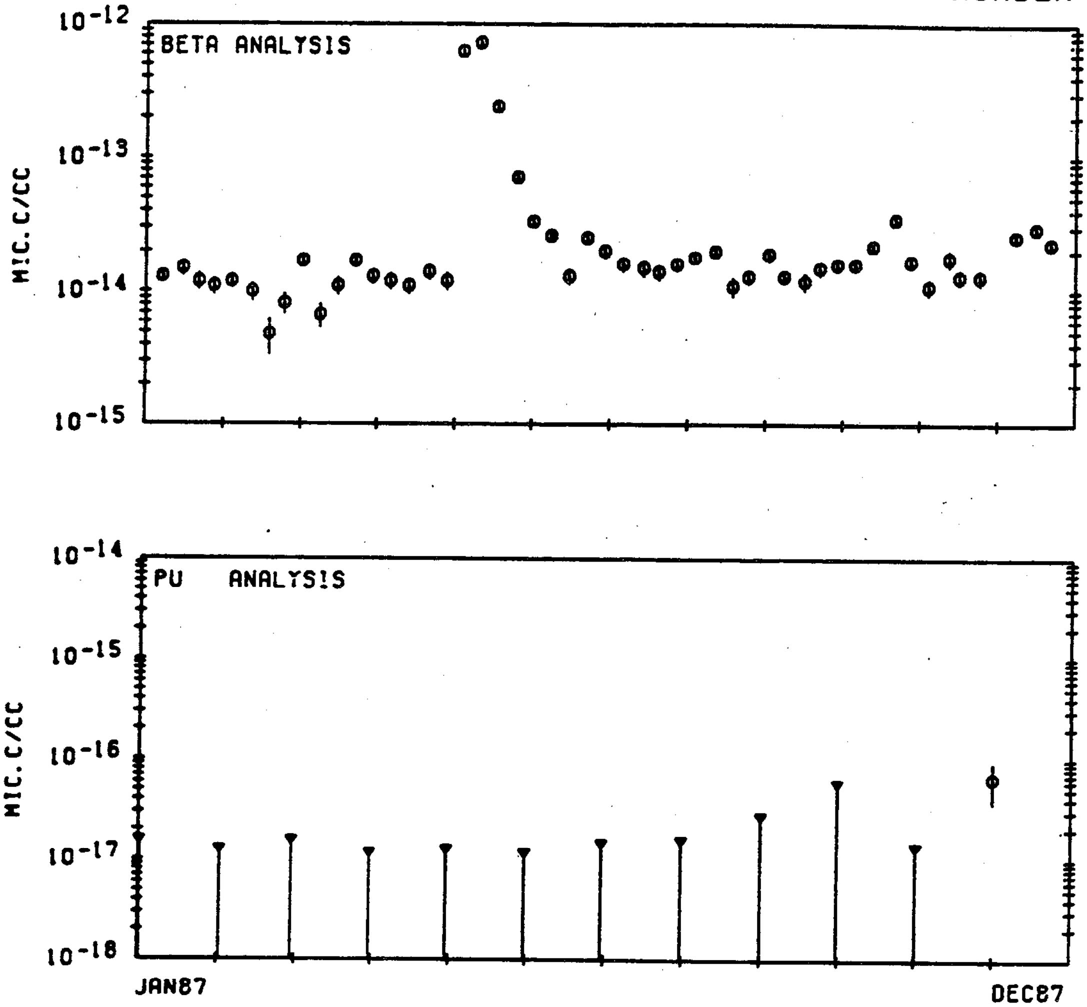
AIR SAMPLING STATION NUMBER 14



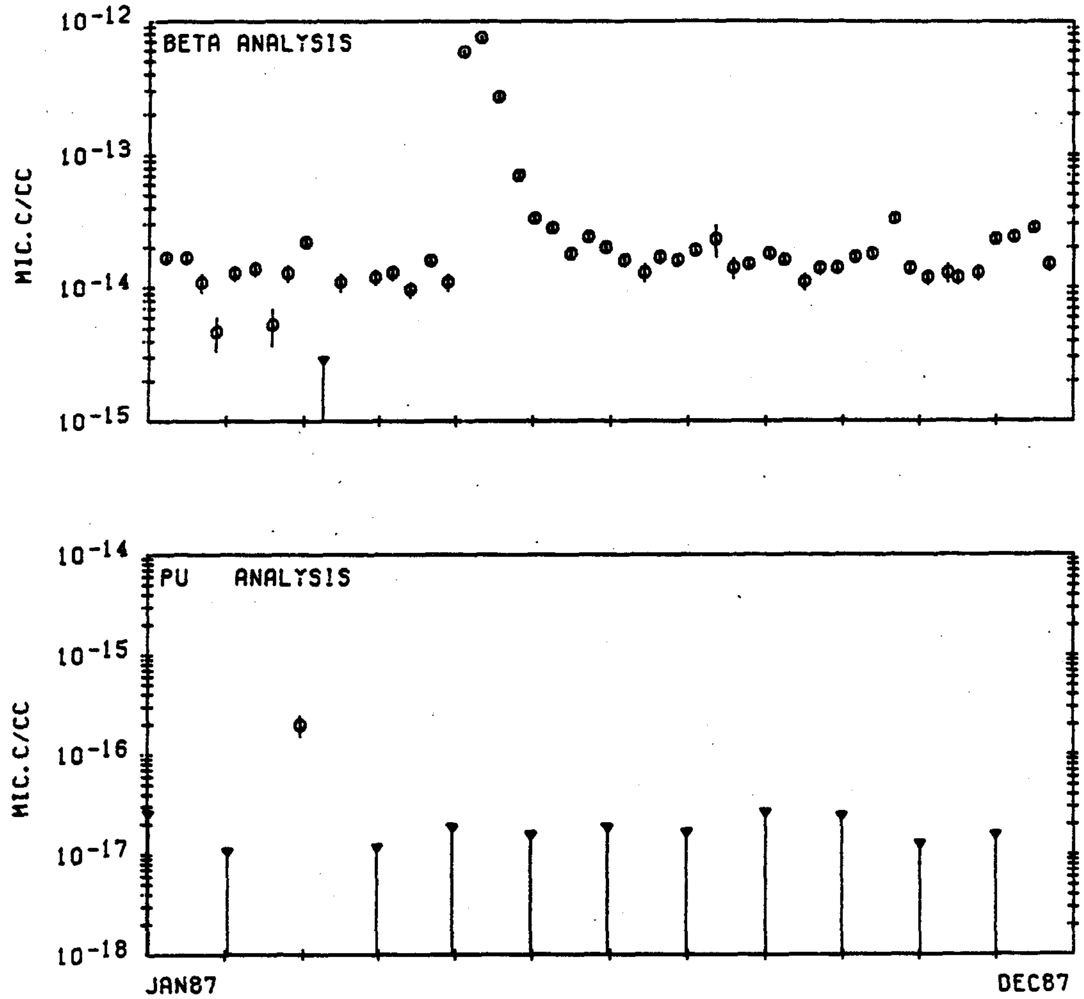
AIR SAMPLING STATION NUMBER 15



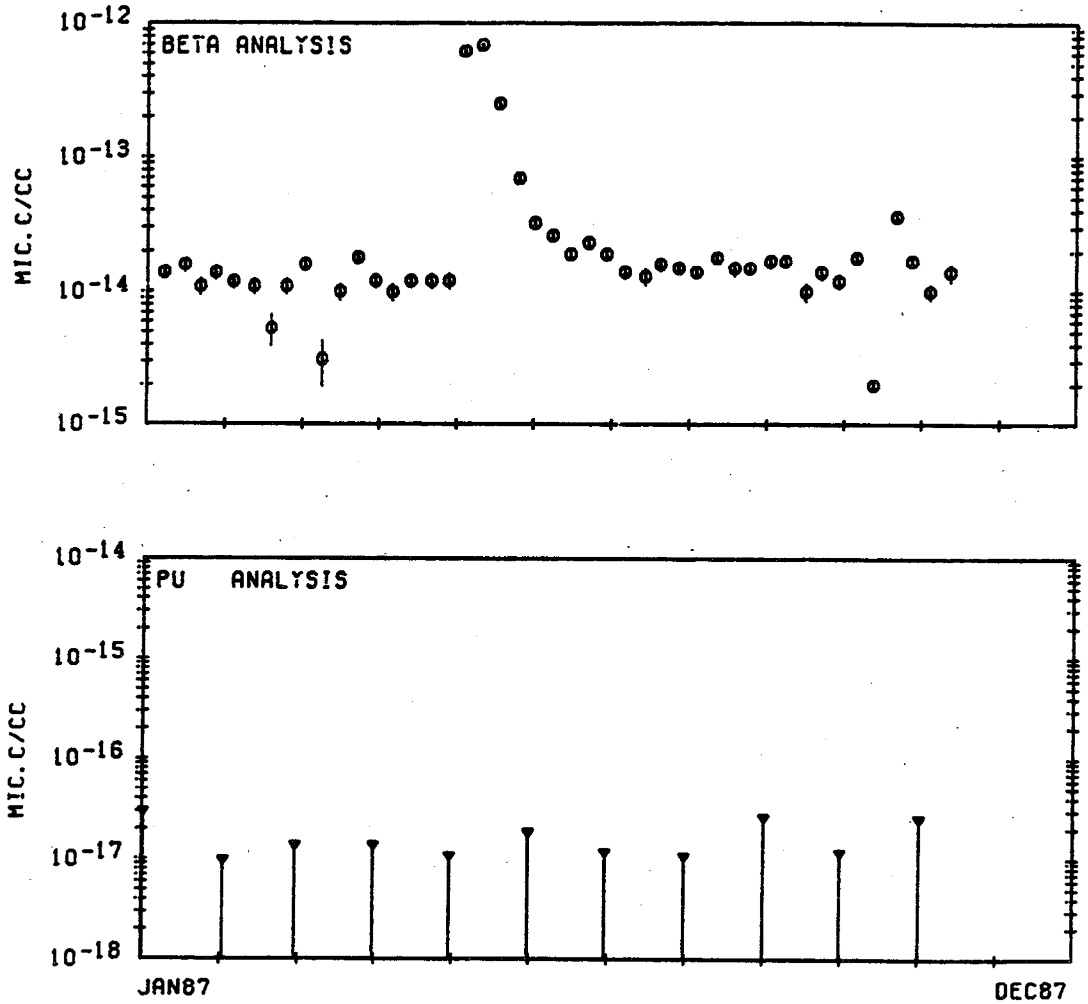
AIR SAMPLING STATION NUMBER 16



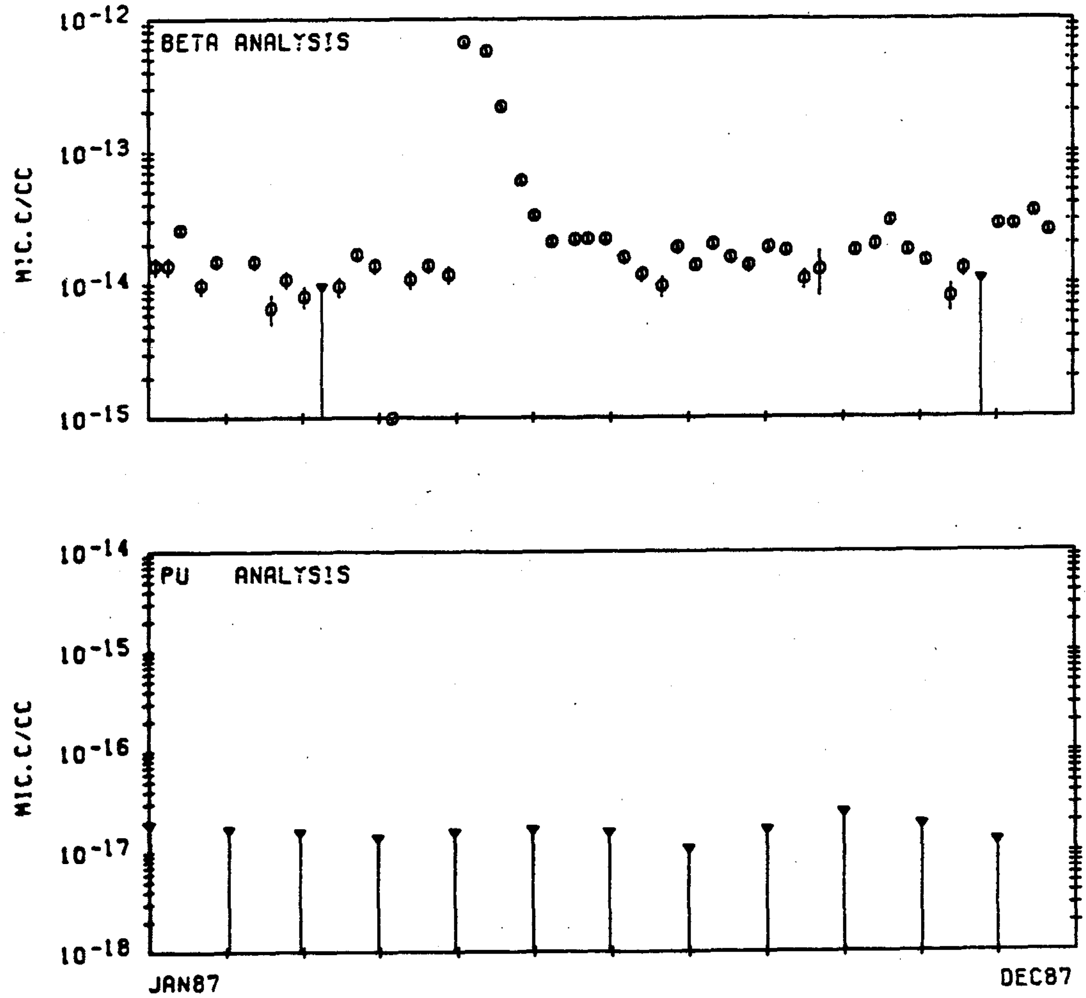
AIR SAMPLING STATION NUMBER 17



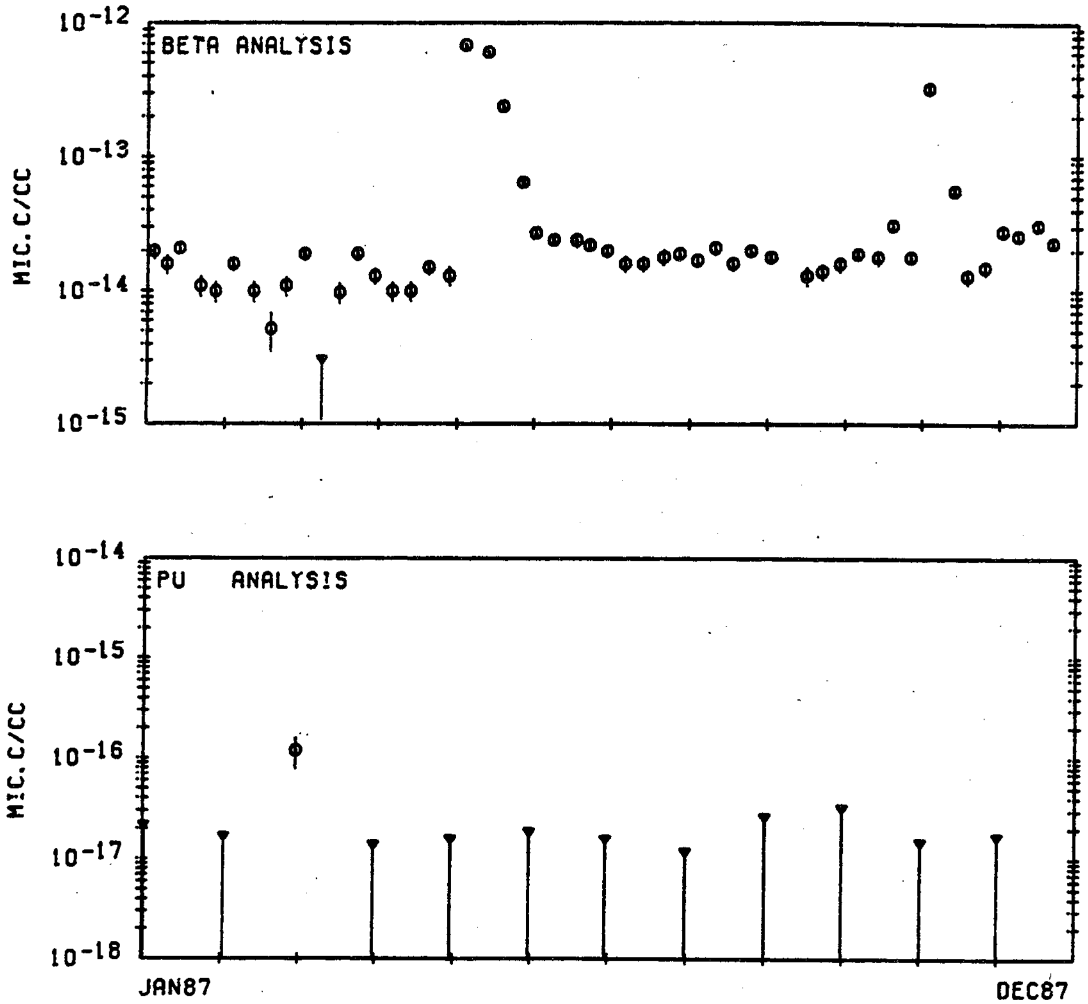
AIR SAMPLING STATION NUMBER 18



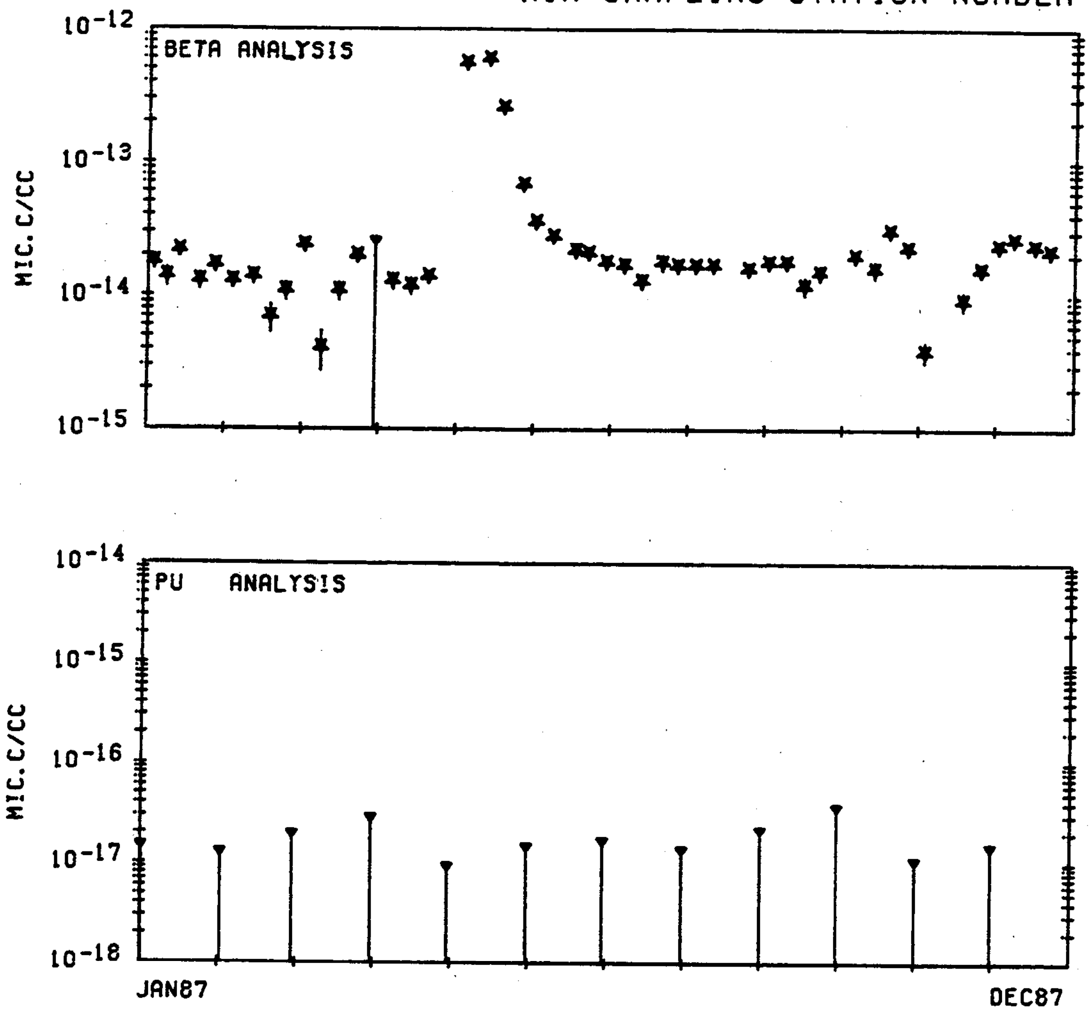
AIR SAMPLING STATION NUMBER 19



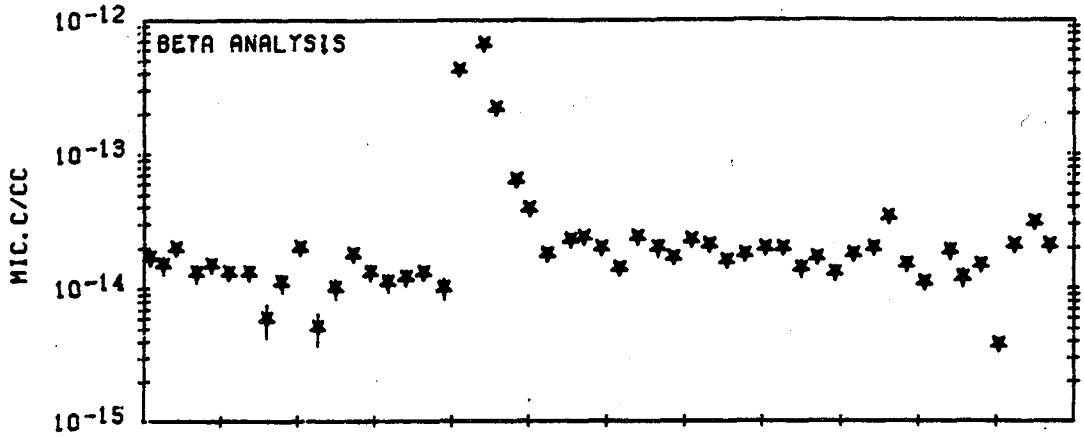
AIR SAMPLING STATION NUMBER 20

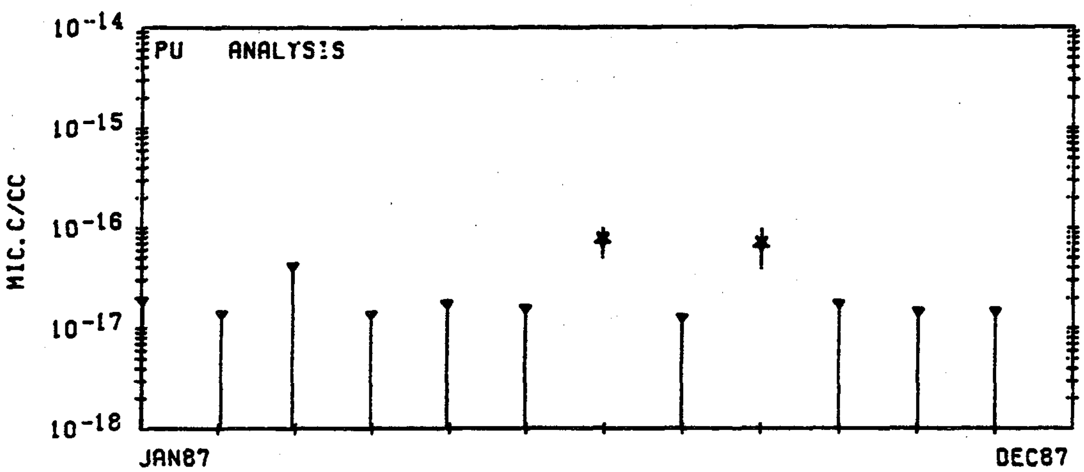


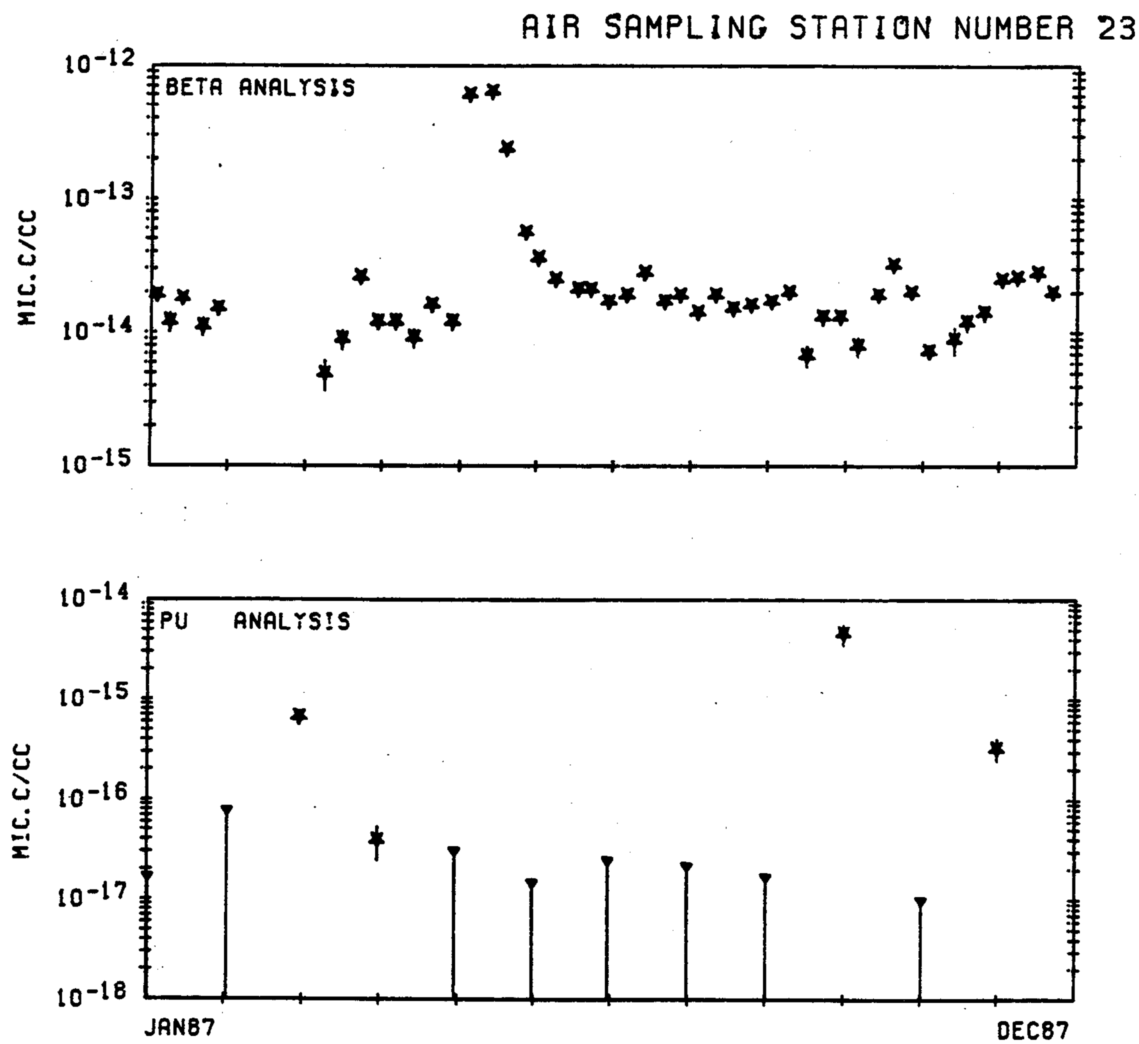
AIR SAMPLING STATION NUMBER 21



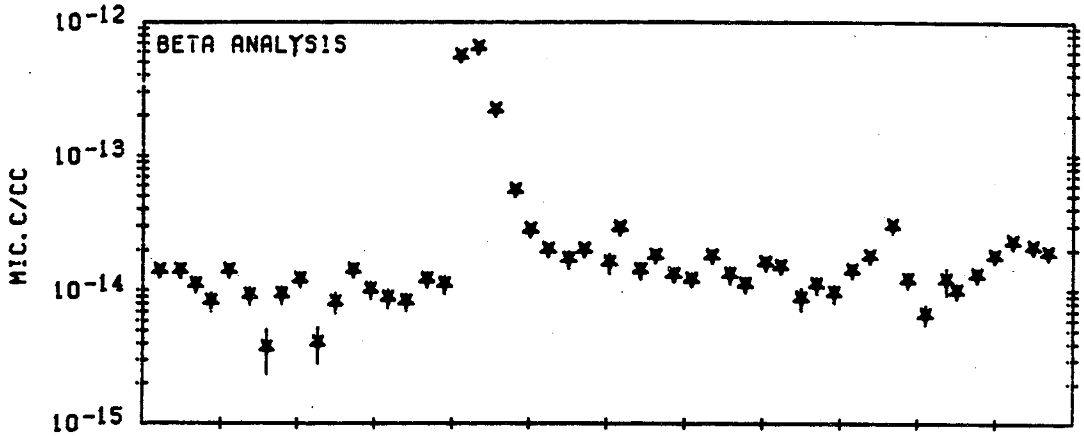
AIR SAMPLING STATION NUMBER 22

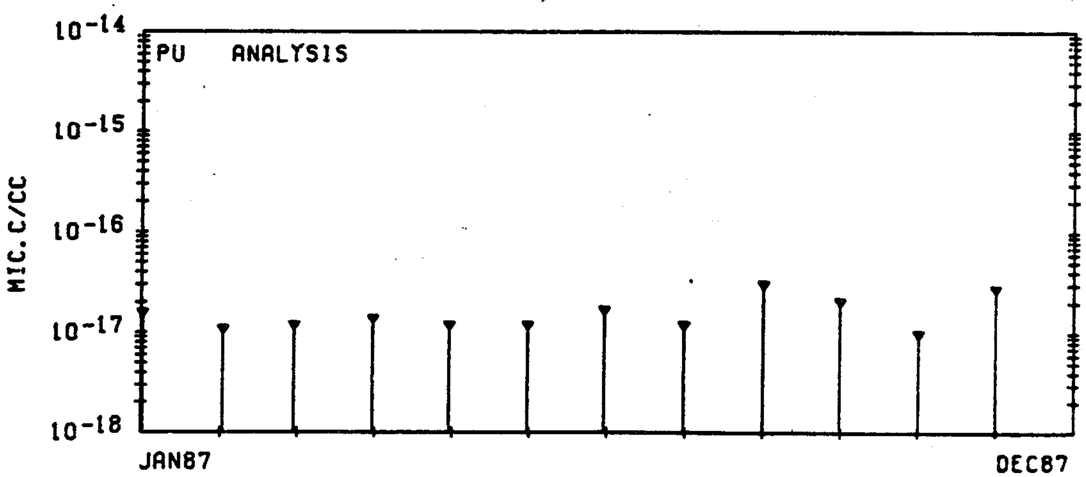


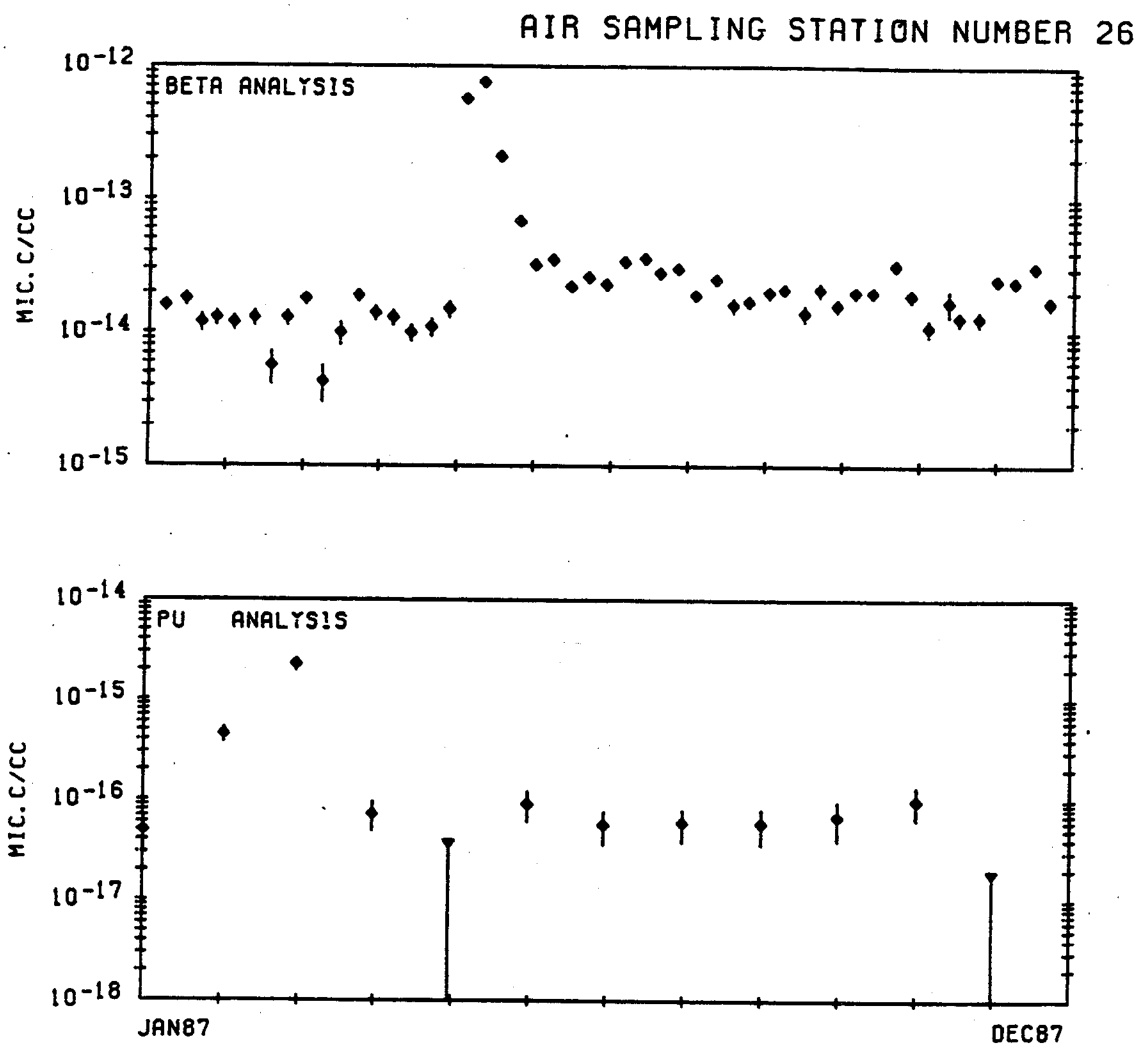



AIR SAMPLING STATION NUMBER 23
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
10-12
10-13
10-14
10-15
10-16
10-17
10-18
JAN87
DEC87

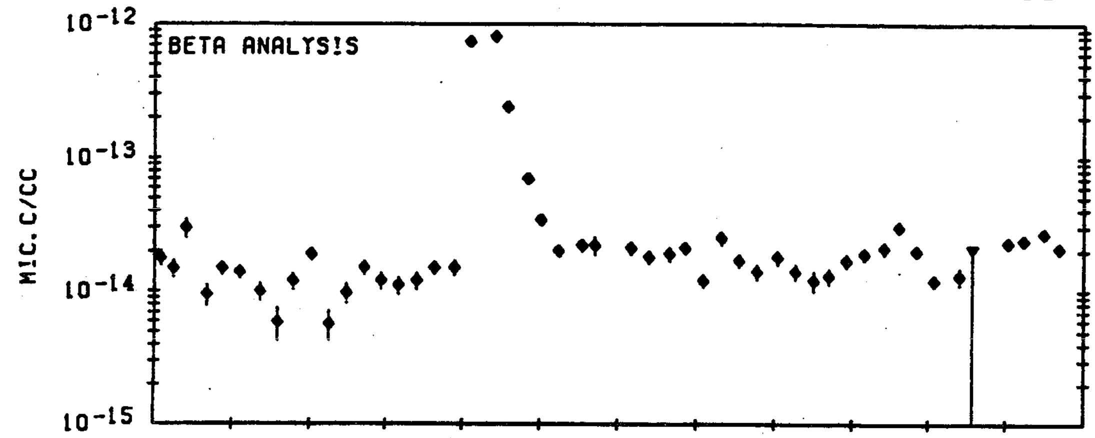
AIR SAMPLING STATION NUMBER 25

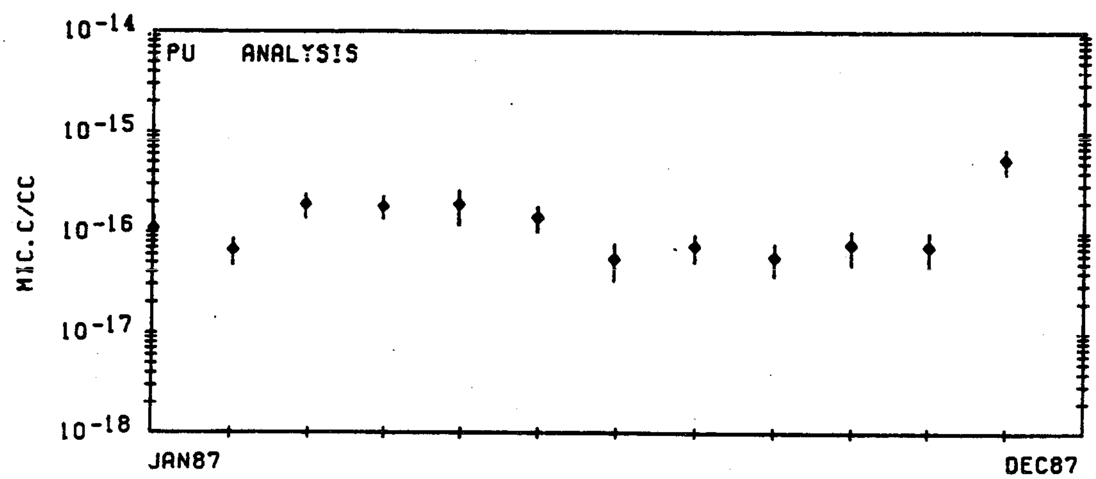




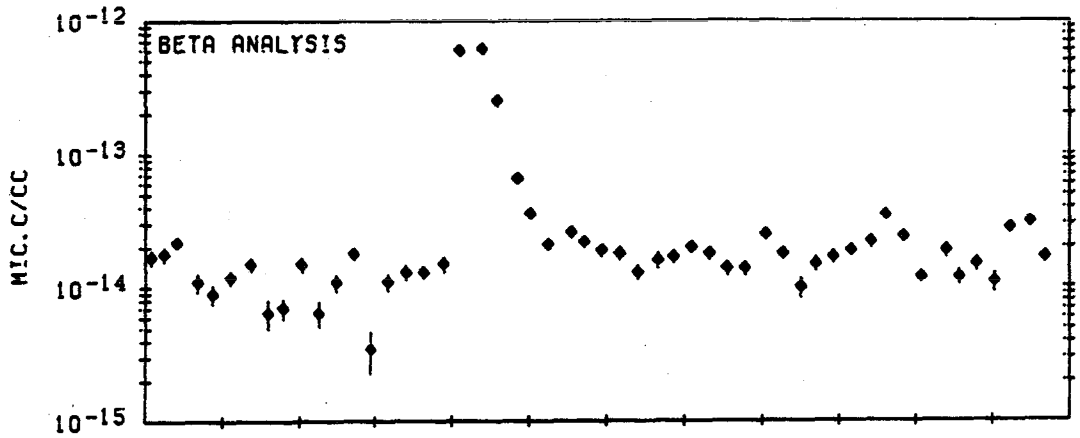

AIR SAMPLING STATION NUMBER 26
BETA ANALYSIS
MIC. C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
PU ANALYSIS
MIC. C/CC
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN87
DEC87

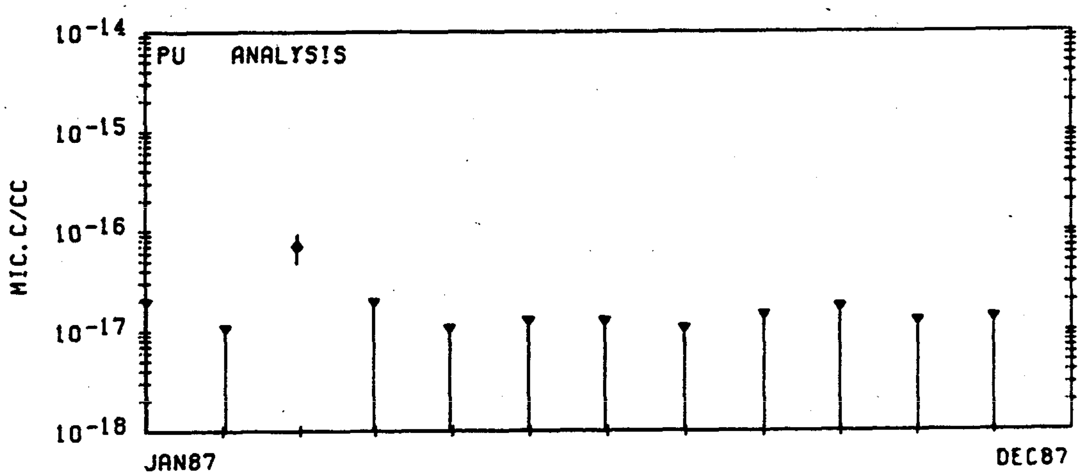
AIR SAMPLING STATION NUMBER 27

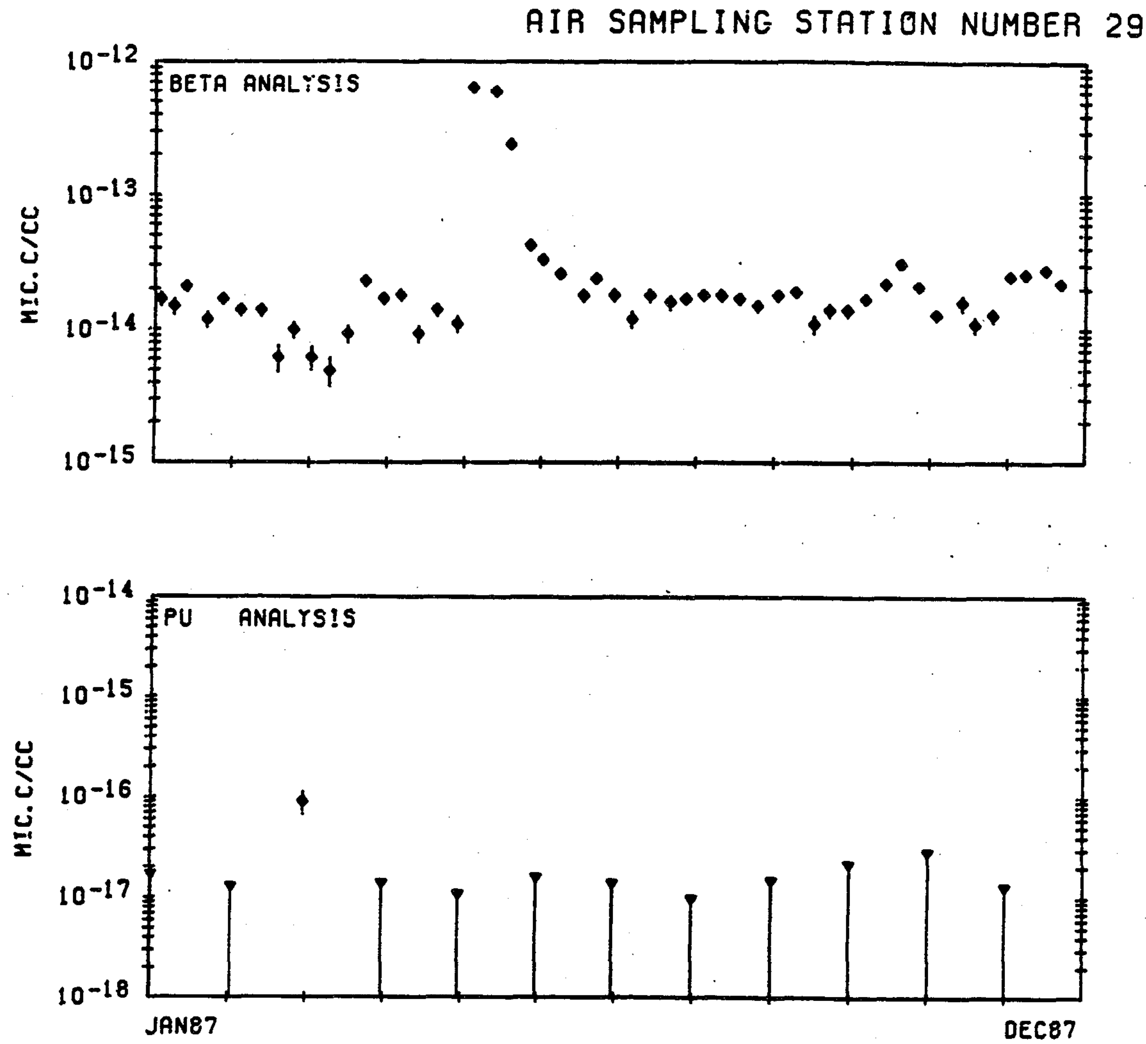




AIR SAMPLING STATION NUMBER 28

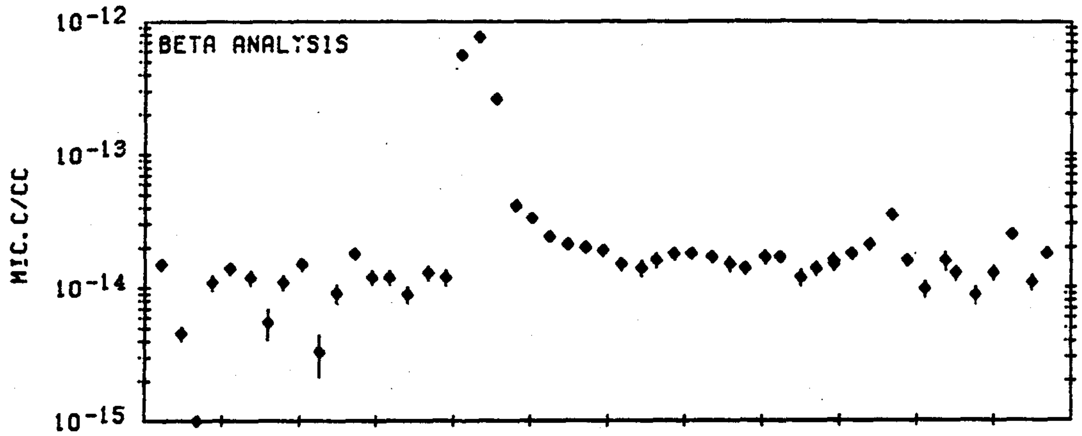


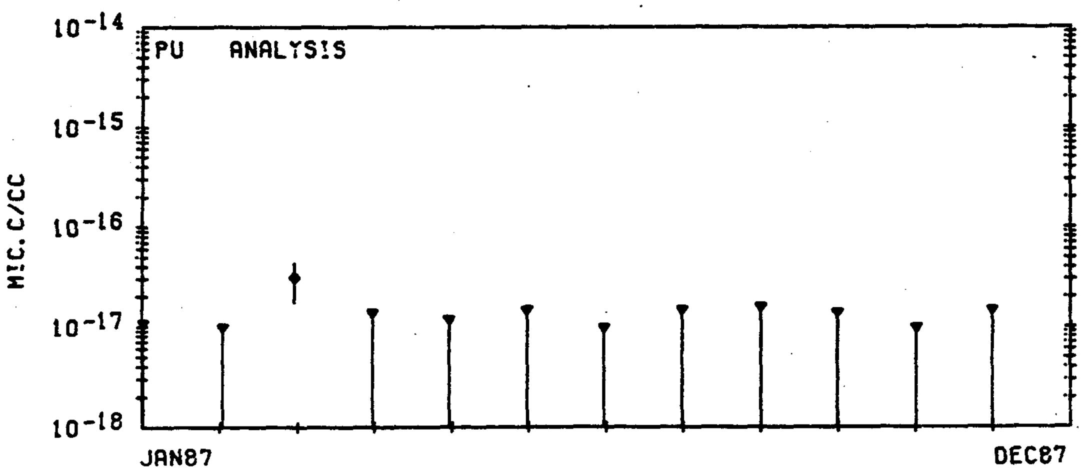




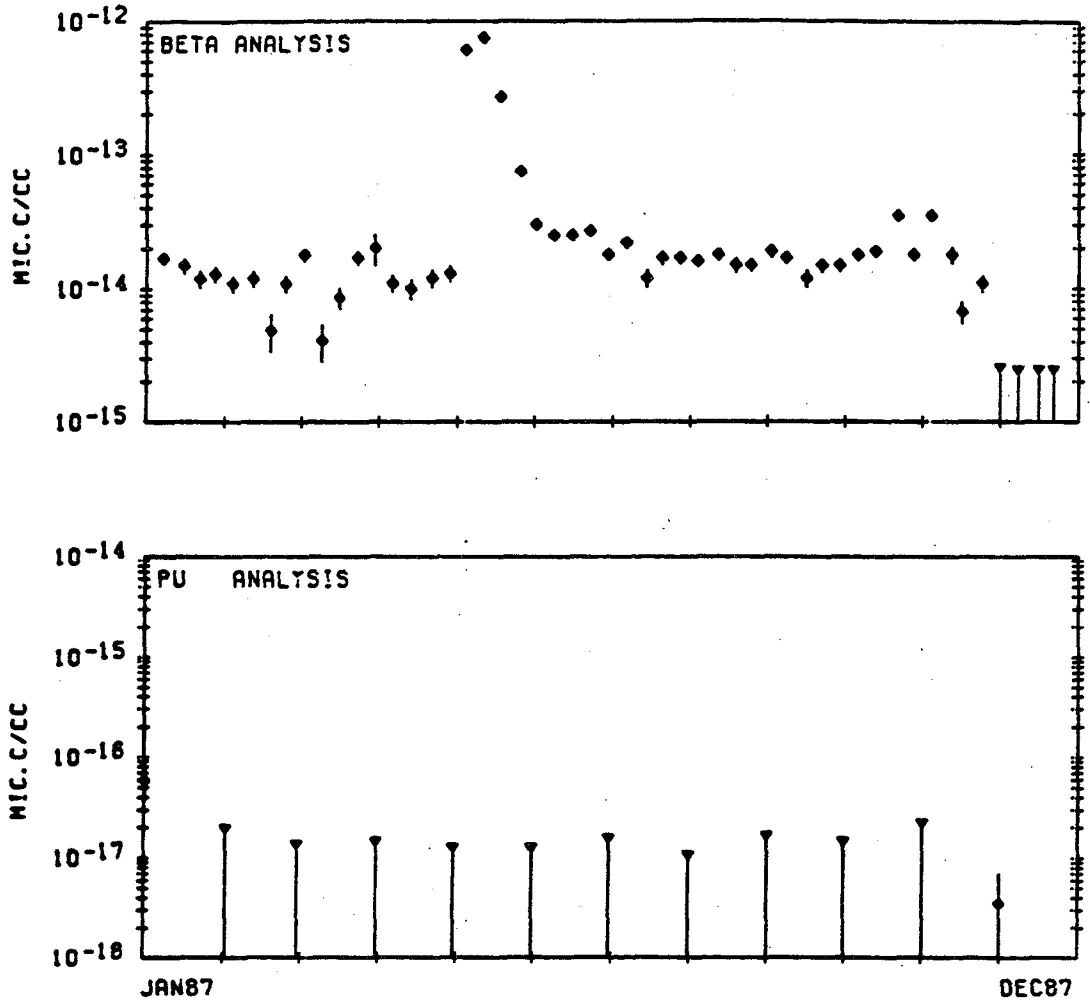
AIR SAMPLING STATION NUMBER 29
BETA ANALYSIS
MIC. C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
PU ANALYSIS
MIC. C/CC
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN87
DEC87

AIR SAMPLING STATION NUMBER 30

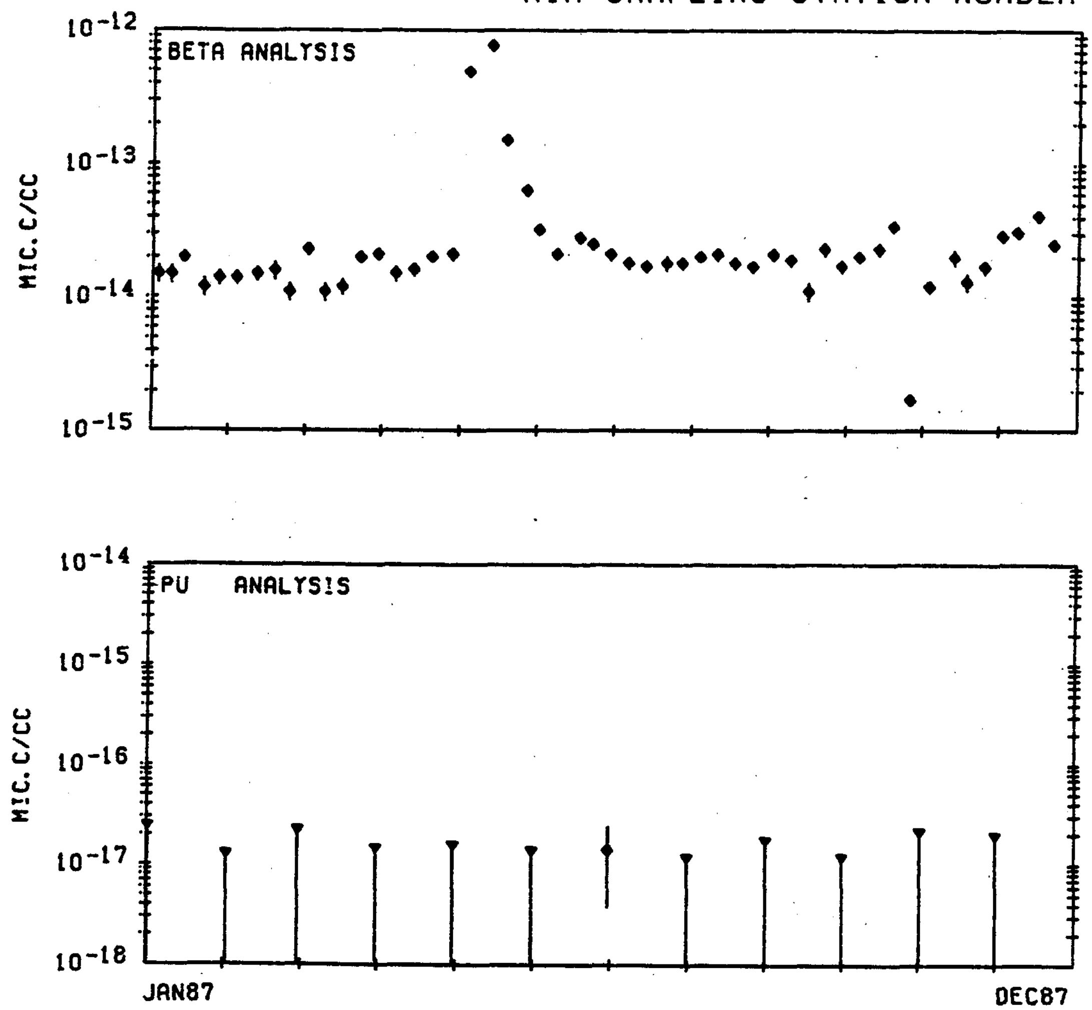


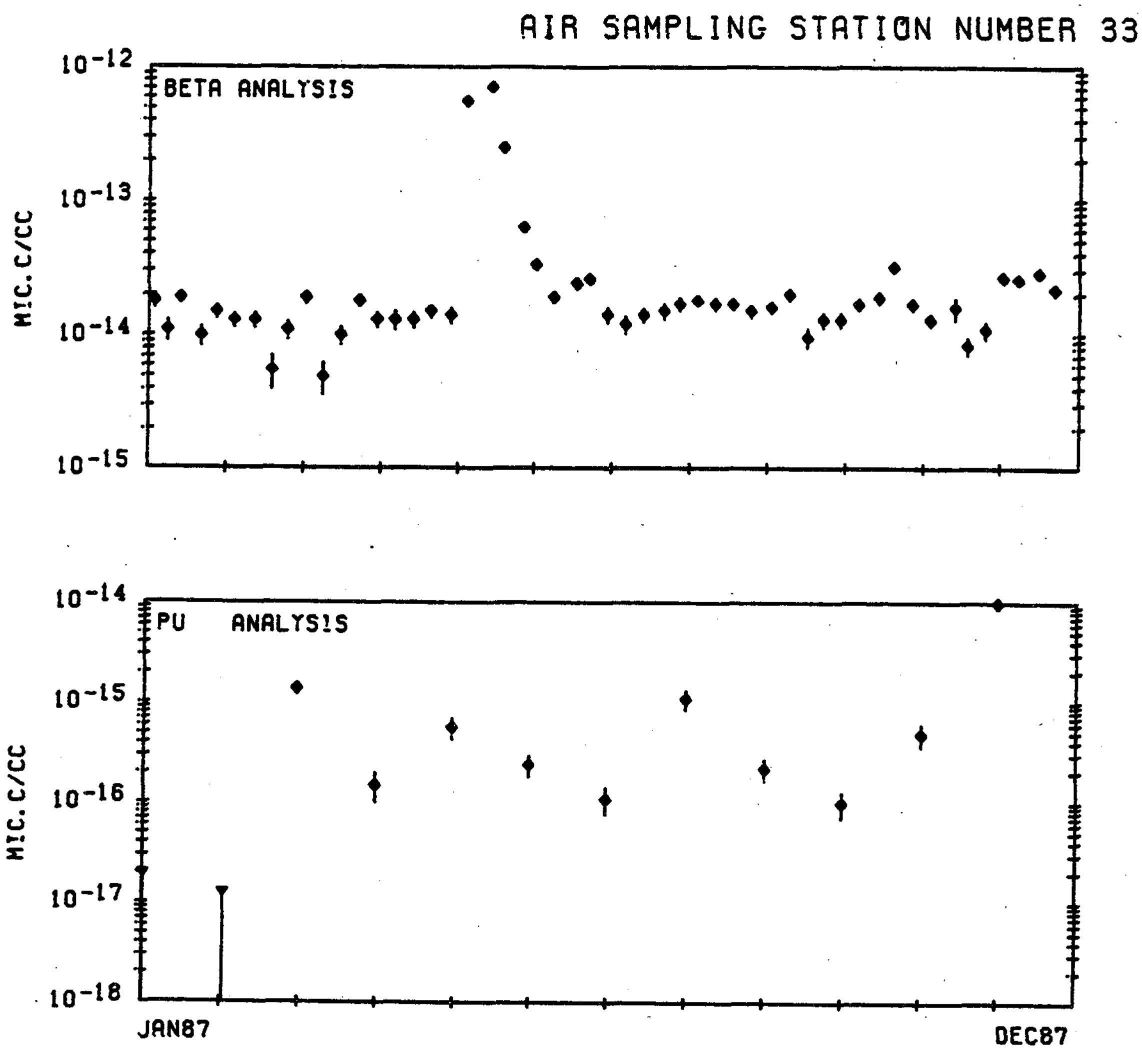


AIR SAMPLING STATION NUMBER 31

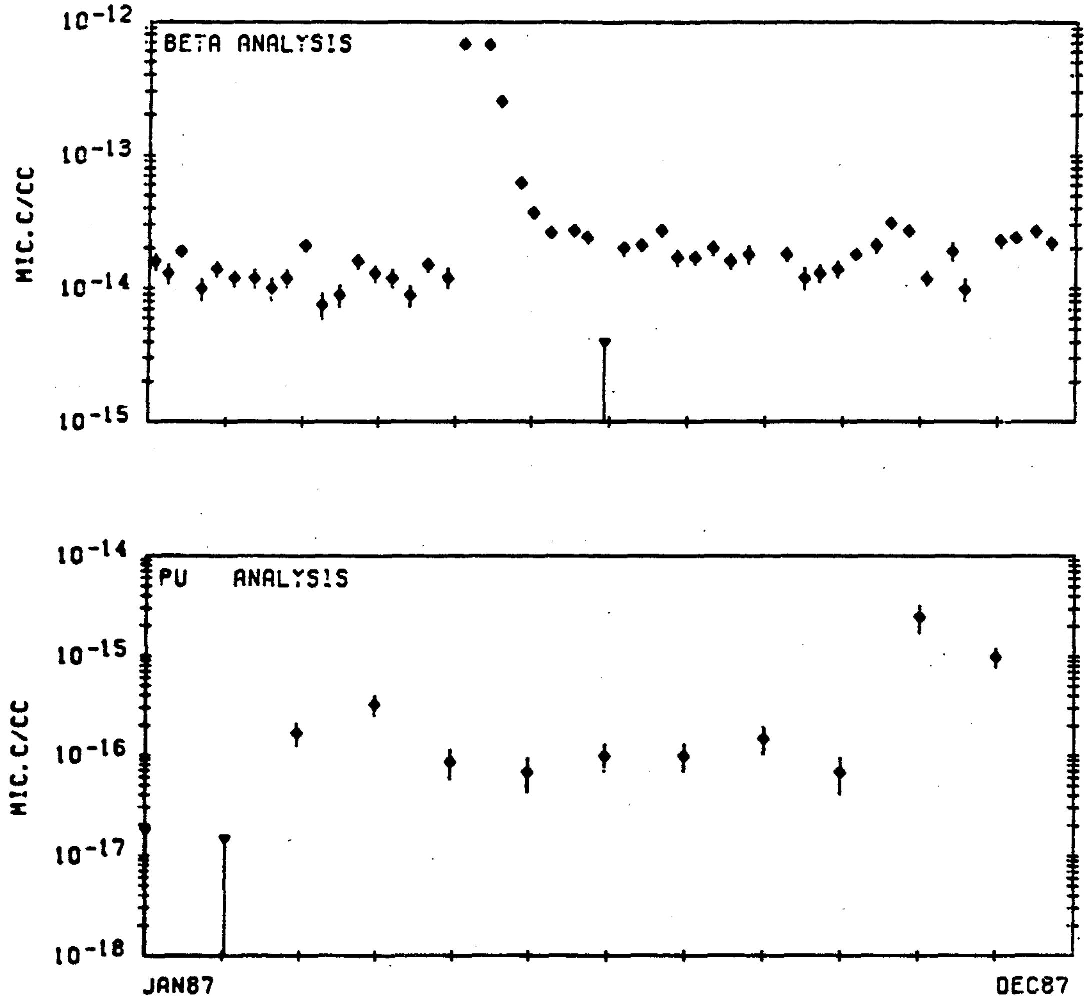


AIR SAMPLING STATION NUMBER 32

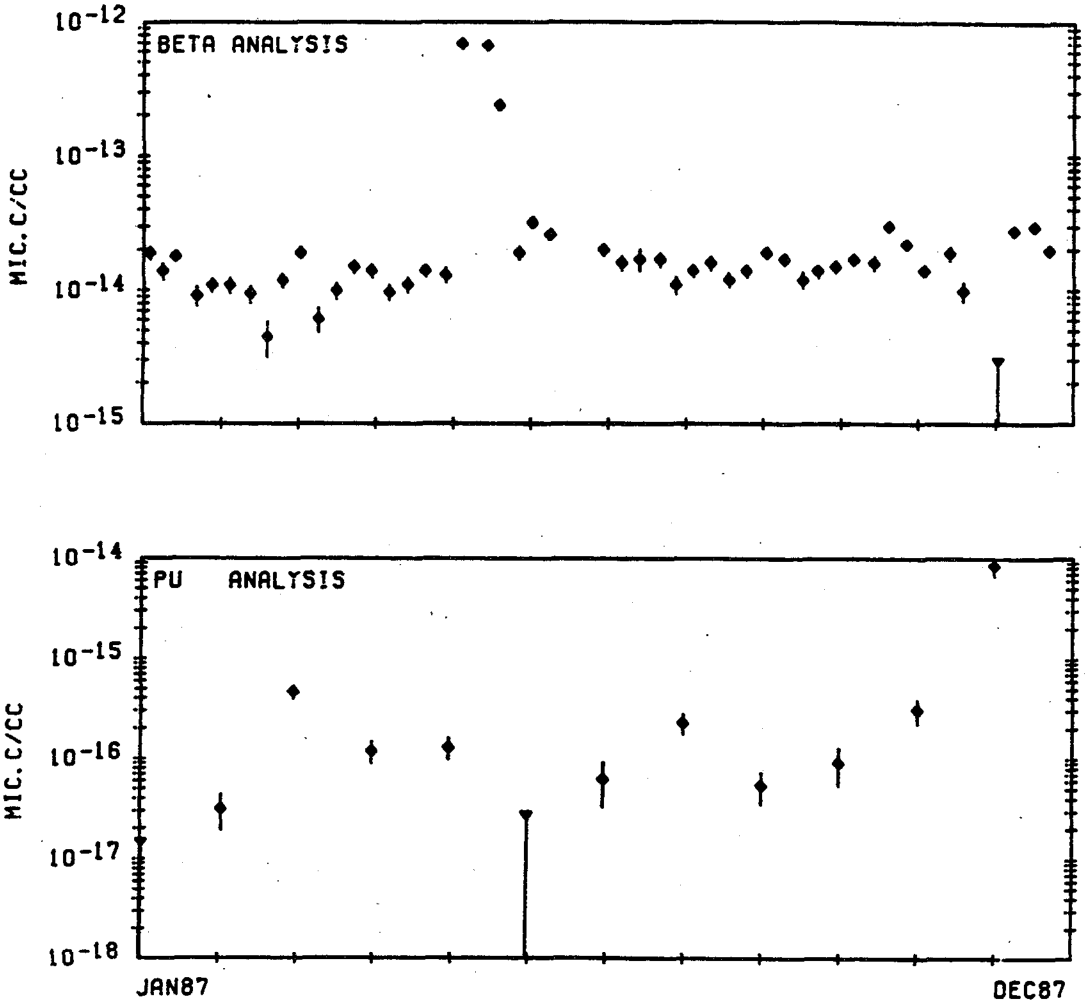



AIR SAMPLING STATION NUMBER 33
BETA ANALYSIS
MIC. C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
PU ANALYSIS
MIC. C/CC
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN87
DEC87

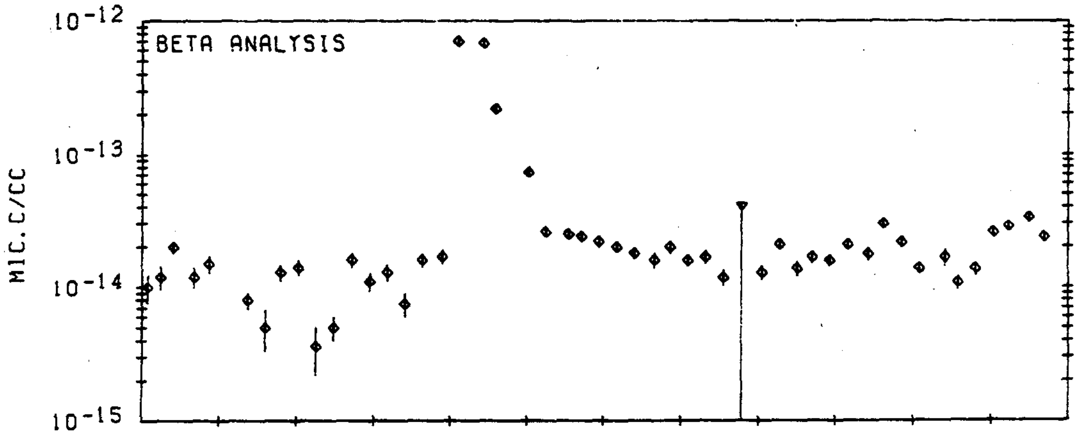
AIR SAMPLING STATION NUMBER 34

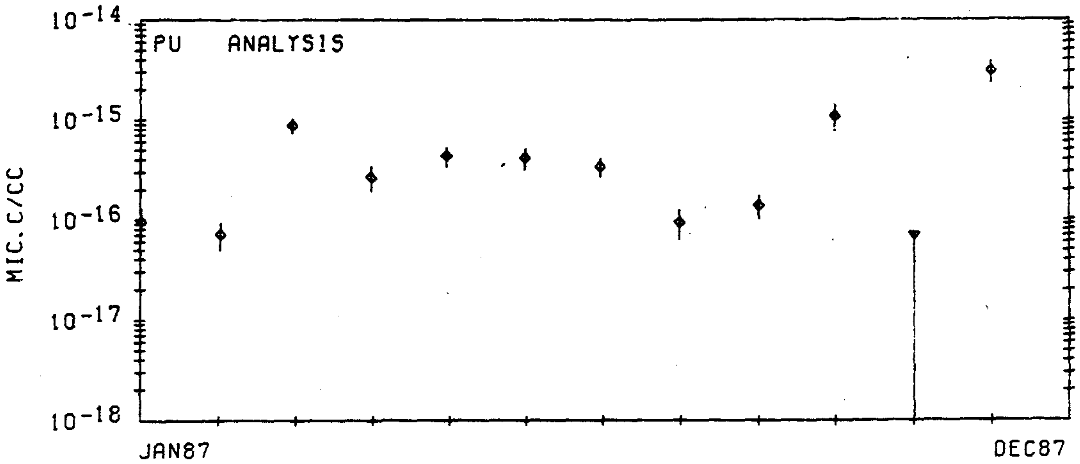


AIR SAMPLING STATION NUMBER 35

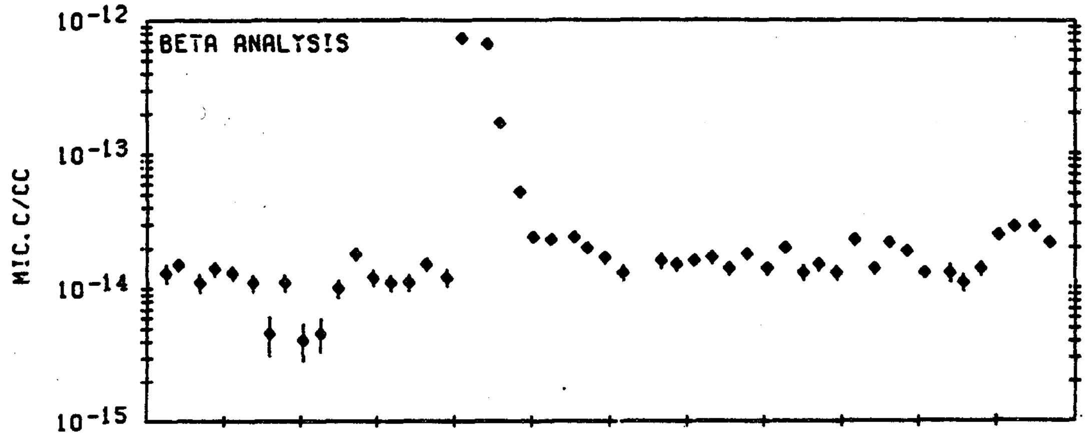


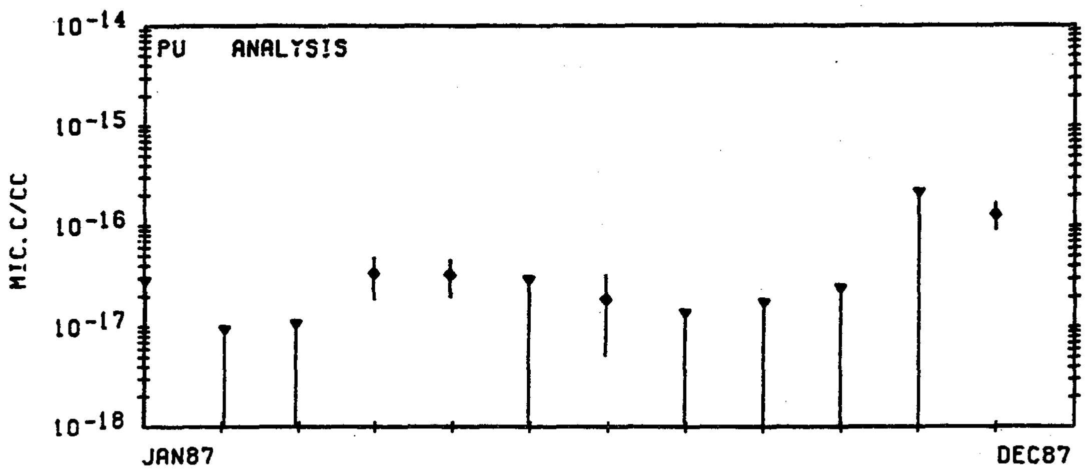
AIR SAMPLING STATION NUMBER 36



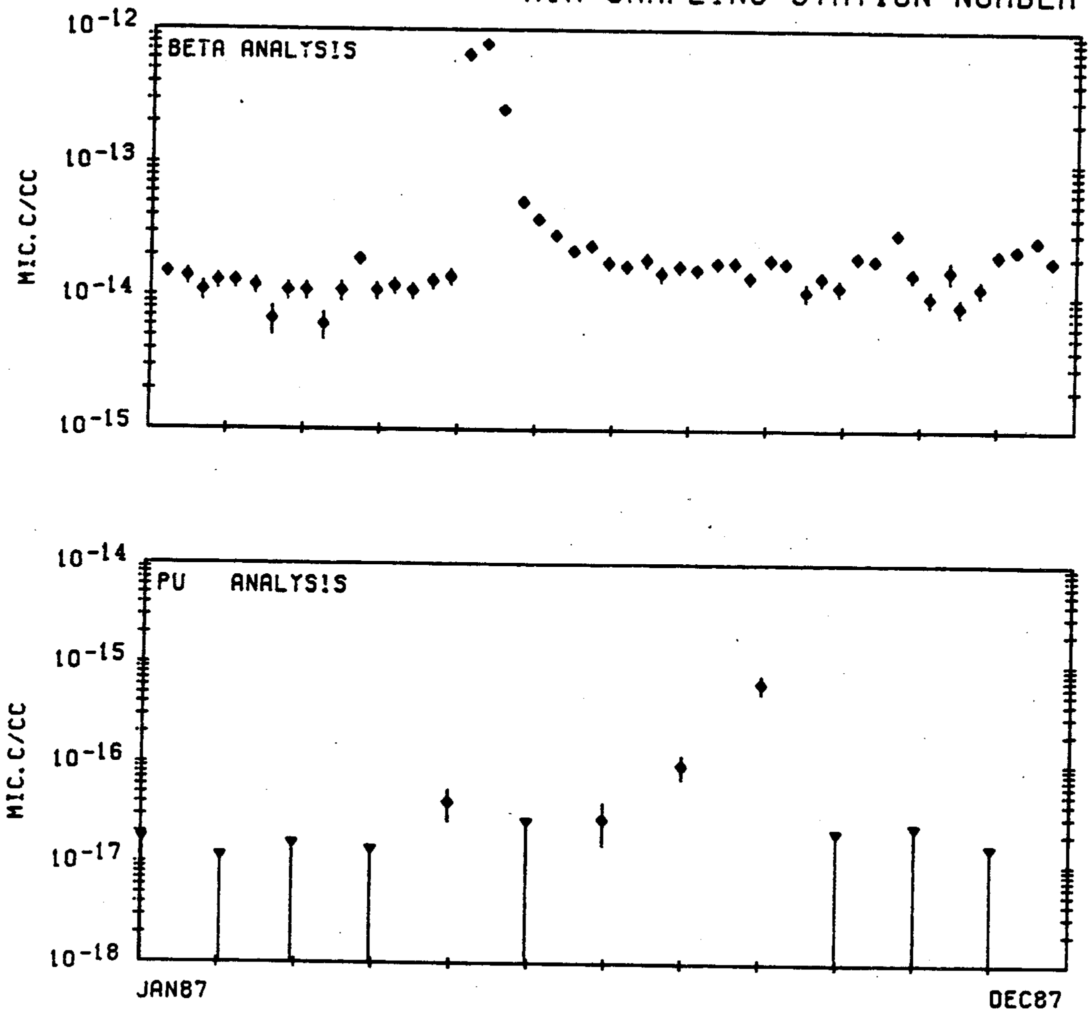


AIR SAMPLING STATION NUMBER 37

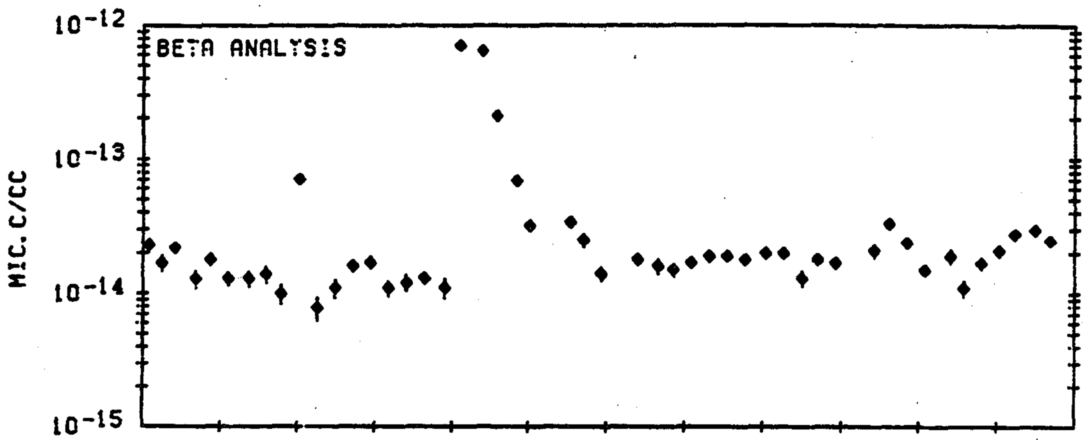


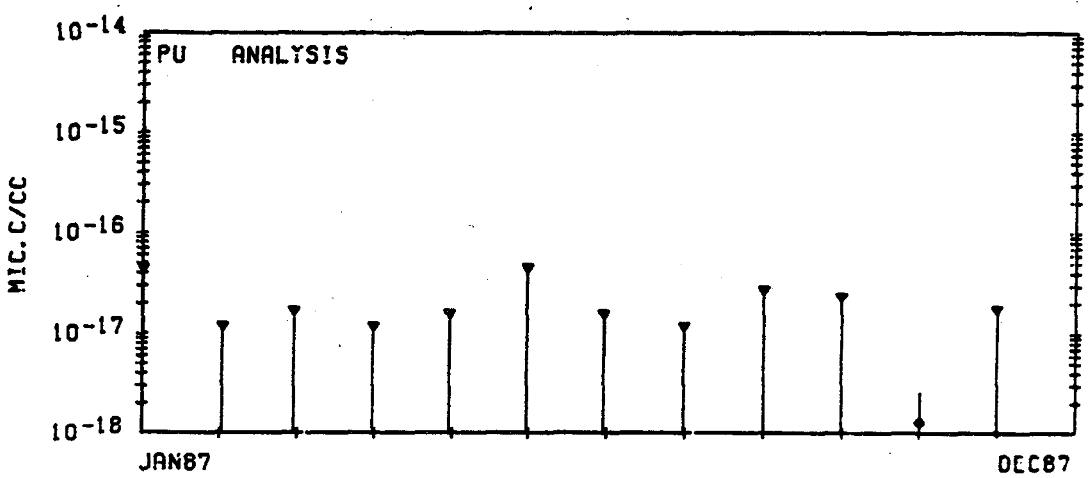


AIR SAMPLING STATION NUMBER 38

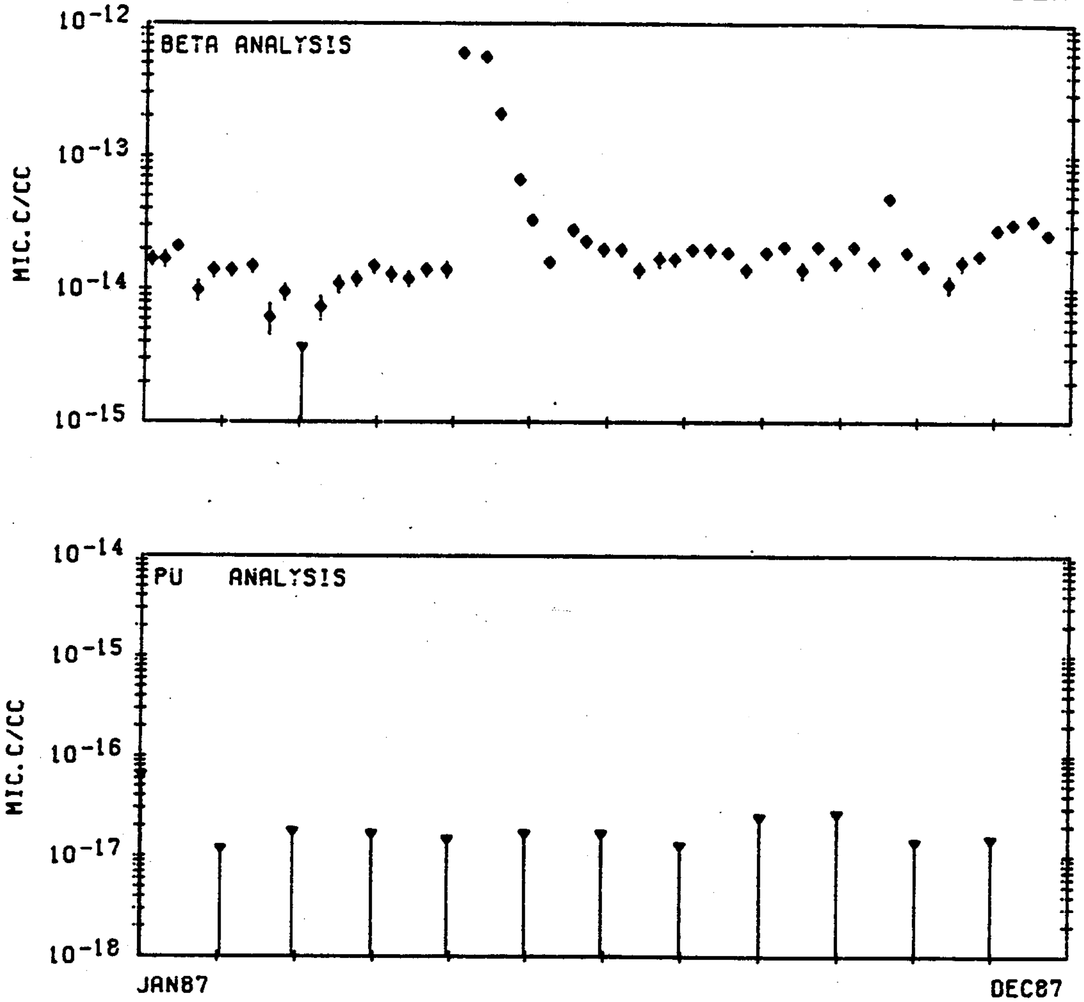


AIR SAMPLING STATION NUMBER 39

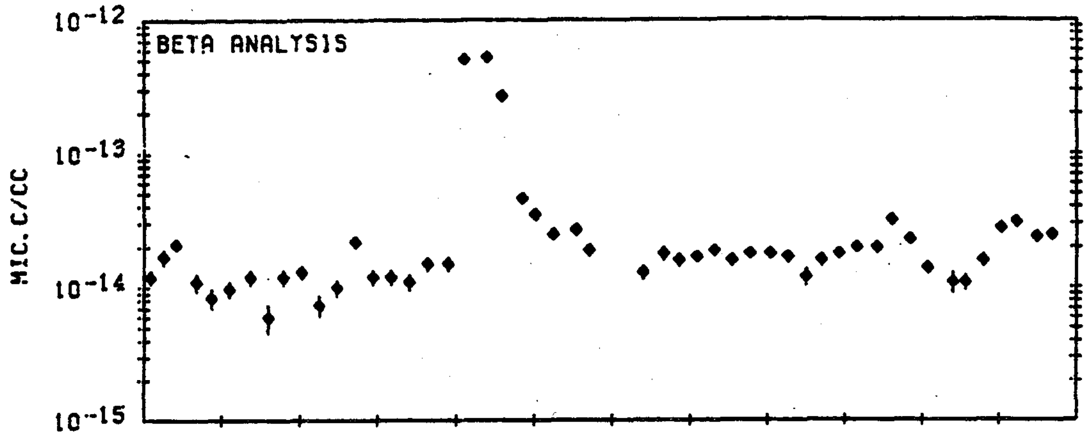


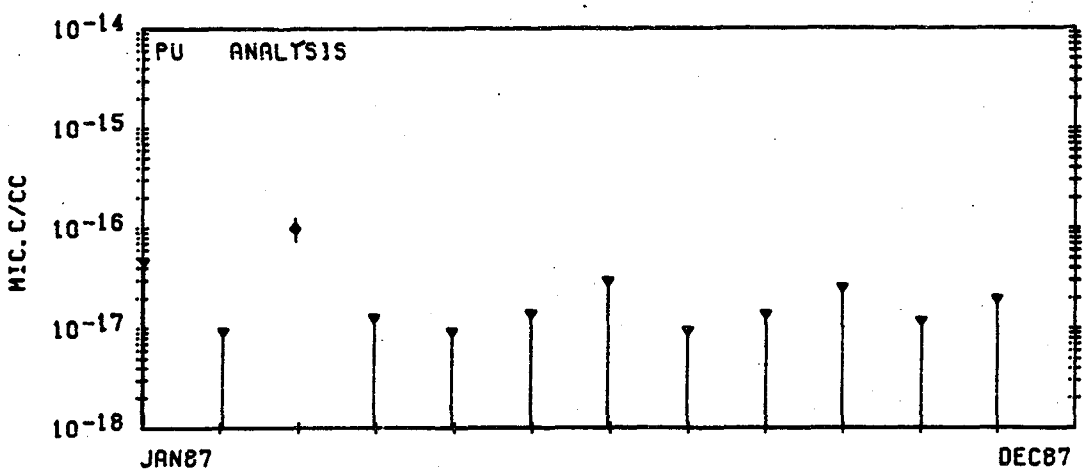


AIR SAMPLING STATION NUMBER 40

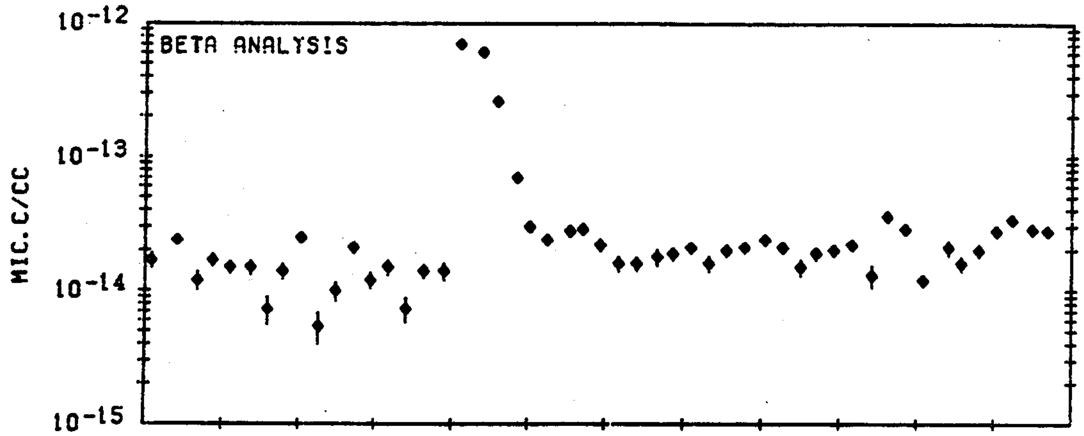


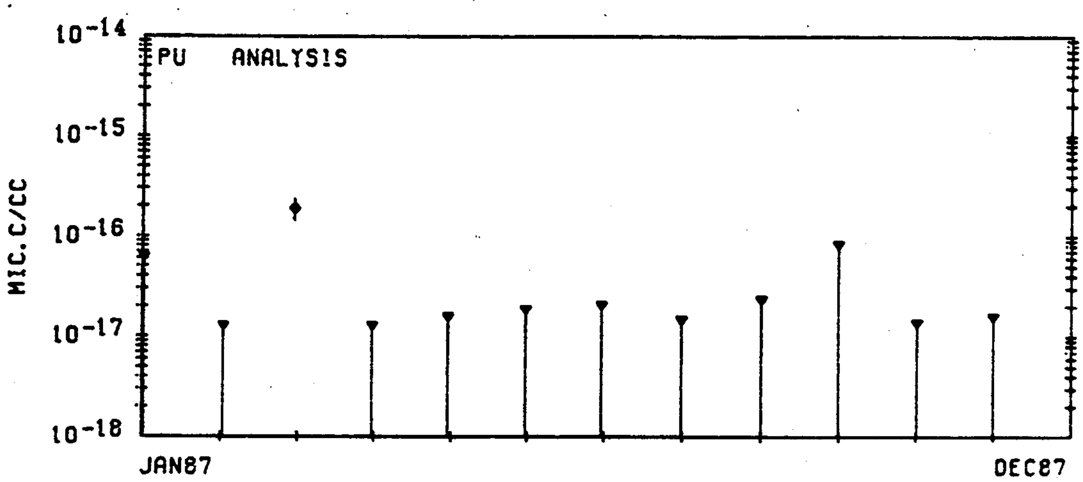
AIR SAMPLING STATION NUMBER 41



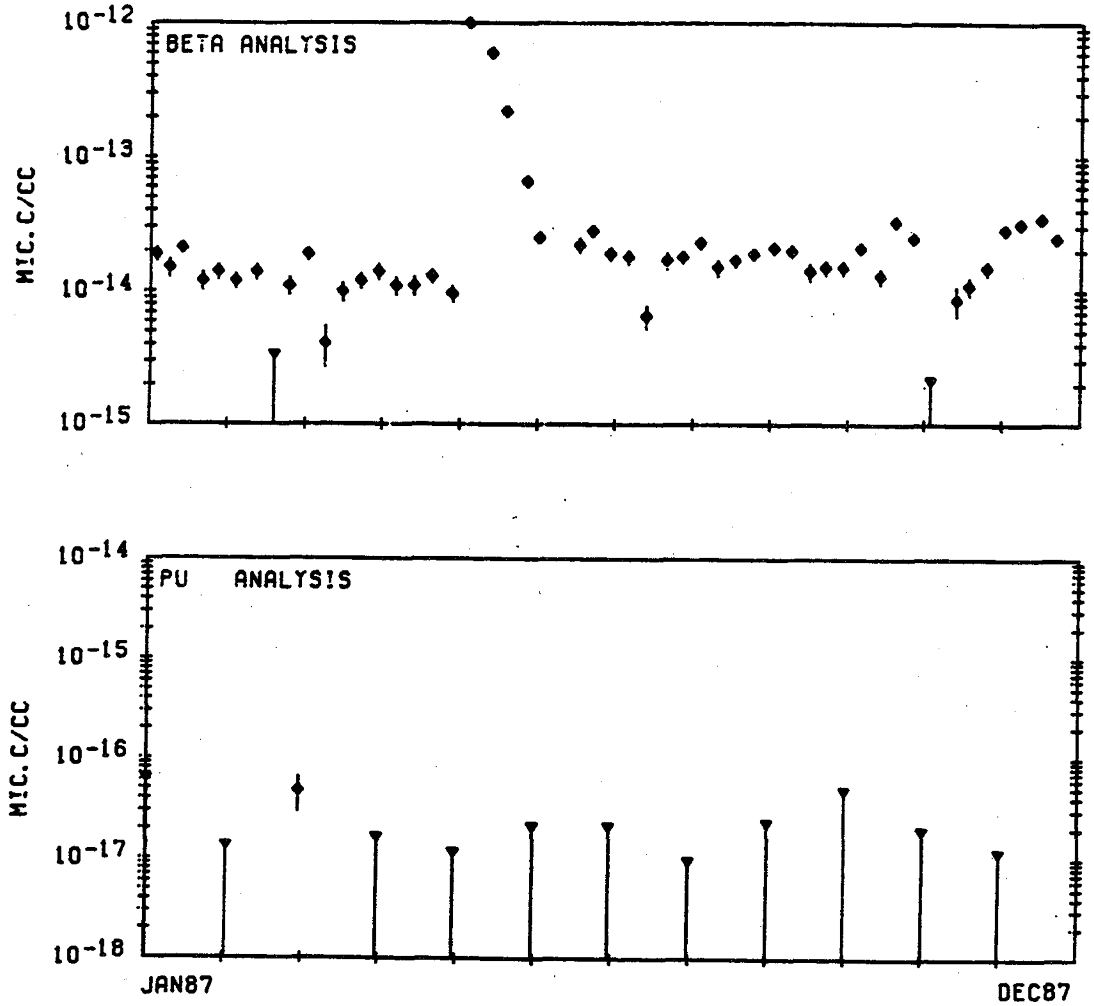


AIR SAMPLING STATION NUMBER 42

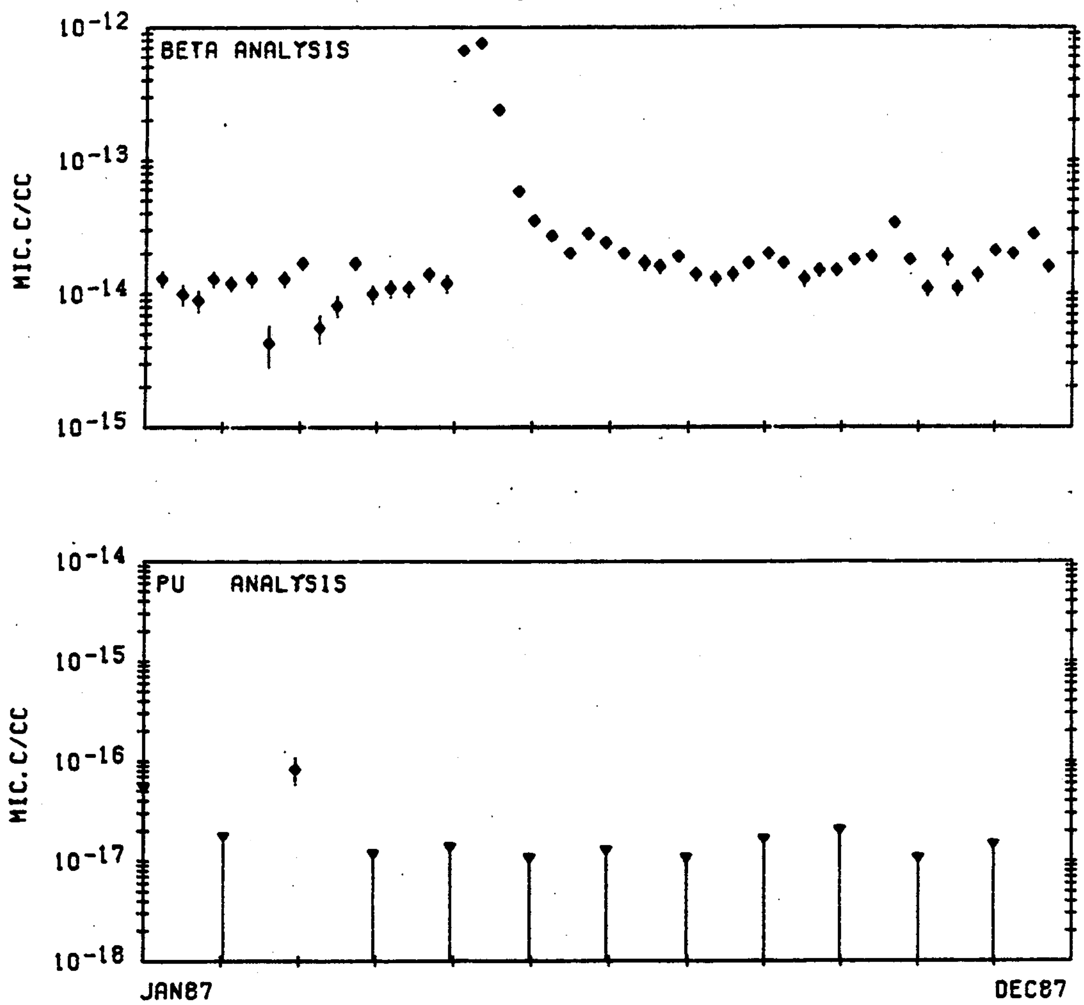




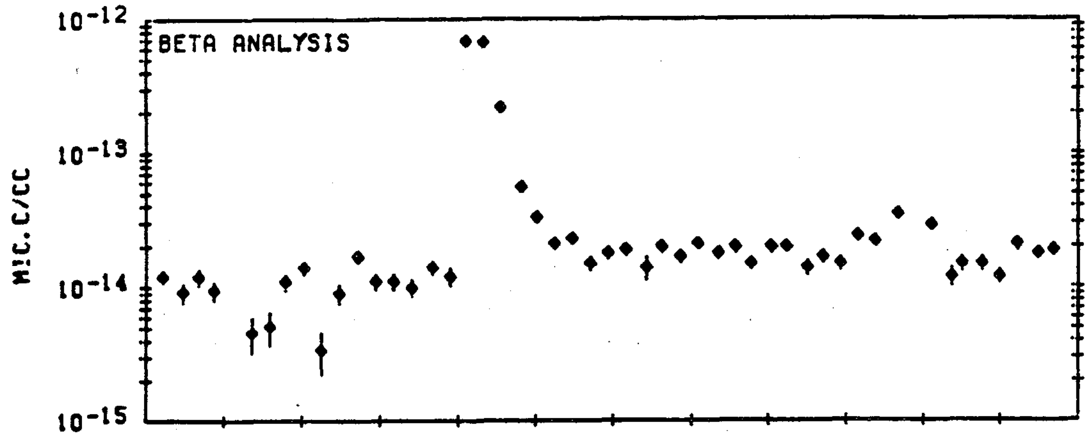
AIR SAMPLING STATION NUMBER 43

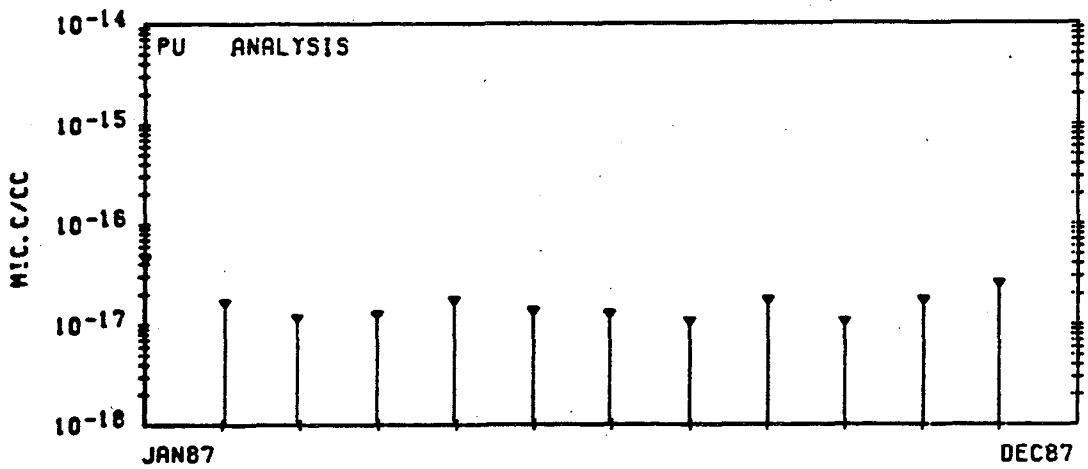


AIR SAMPLING STATION NUMBER 44

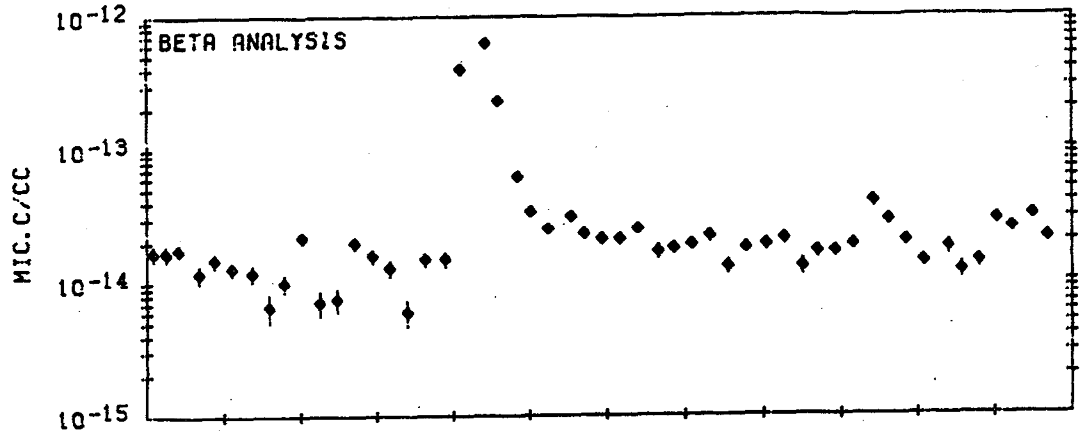


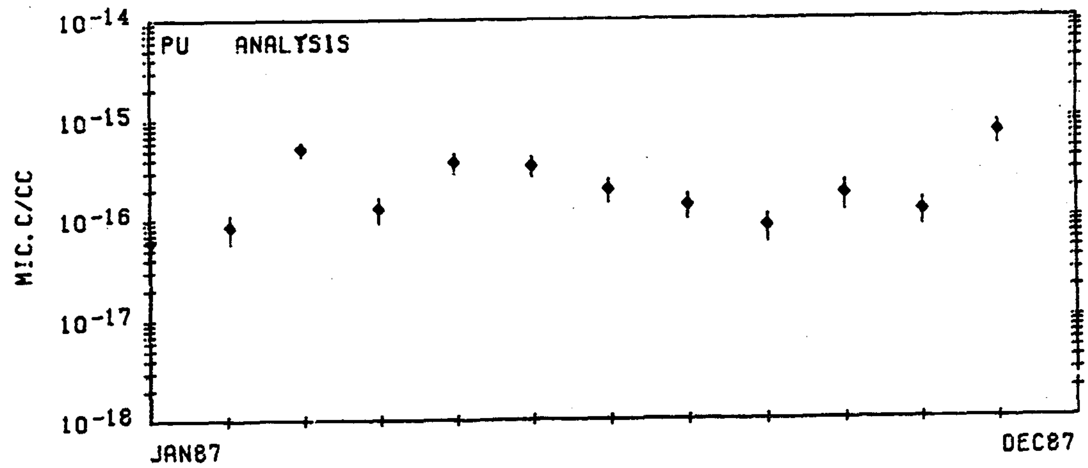
AIR SAMPLING STATION NUMBER 46



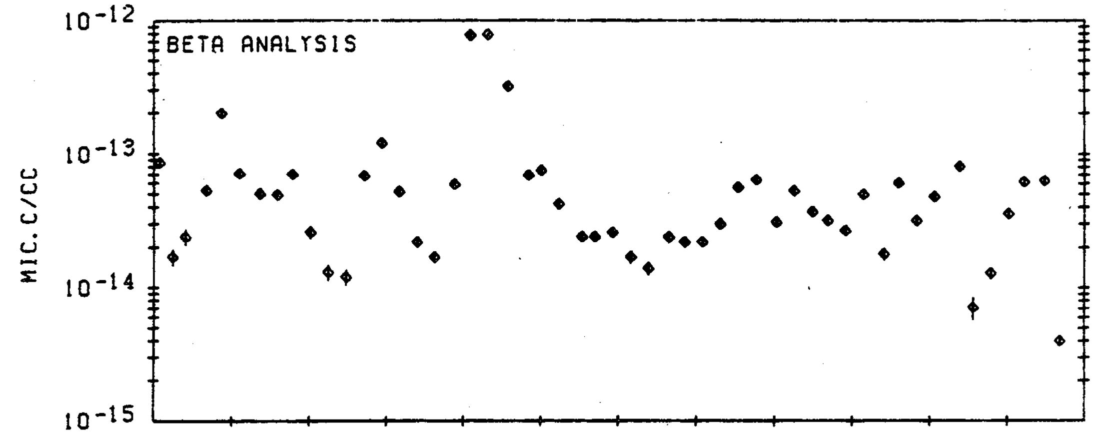


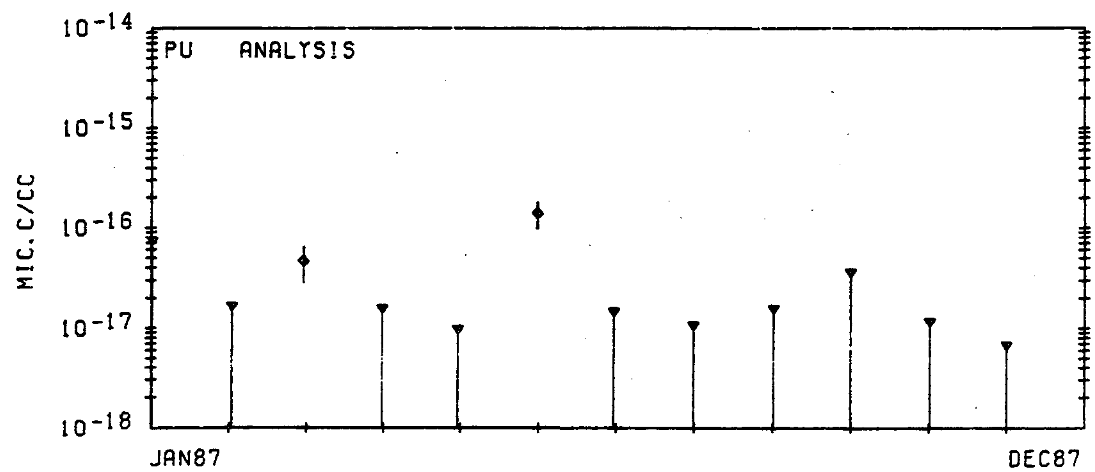
AIR SAMPLING STATION NUMBER 47



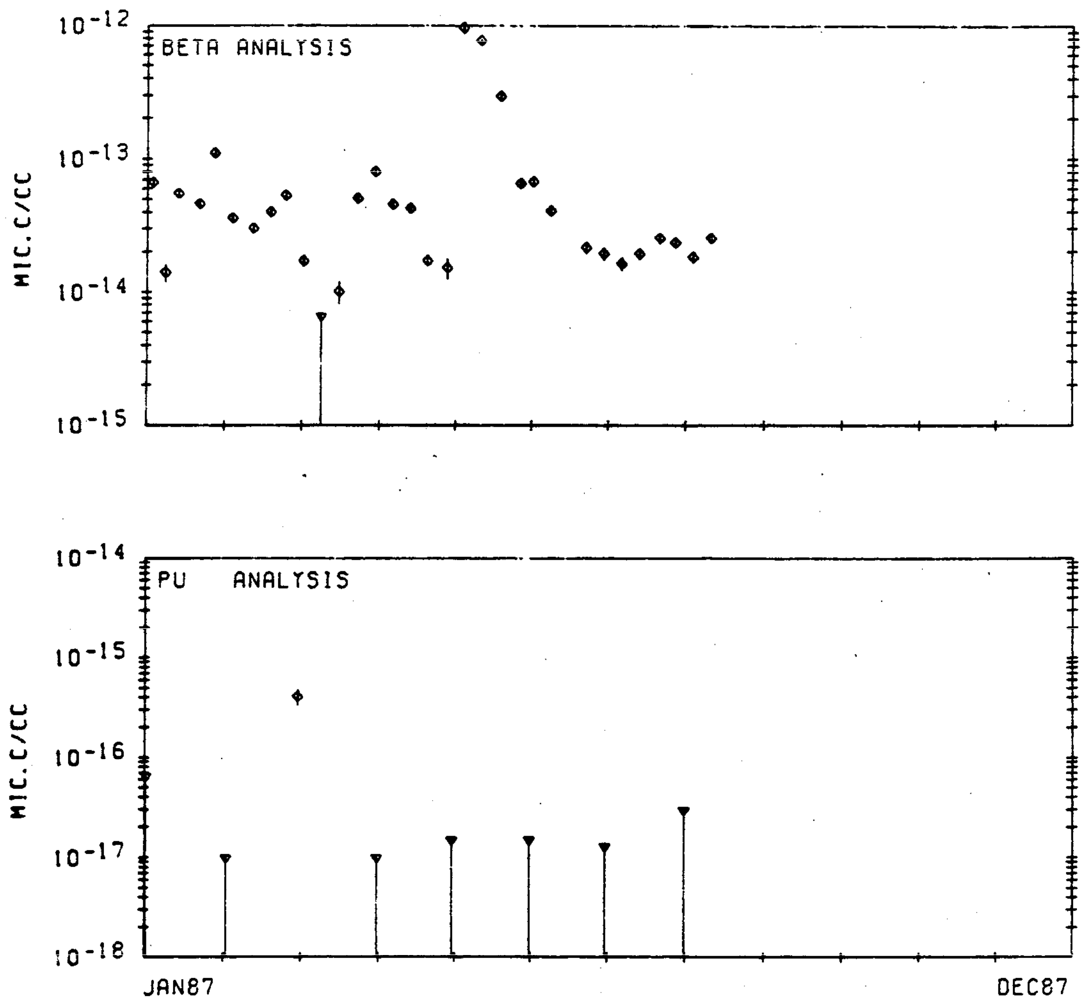


AIR SAMPLING STATION NUMBER 48





AIR SAMPLING STATION NUMBER 49



APPENDIX B

NTS Environmental Surveillance

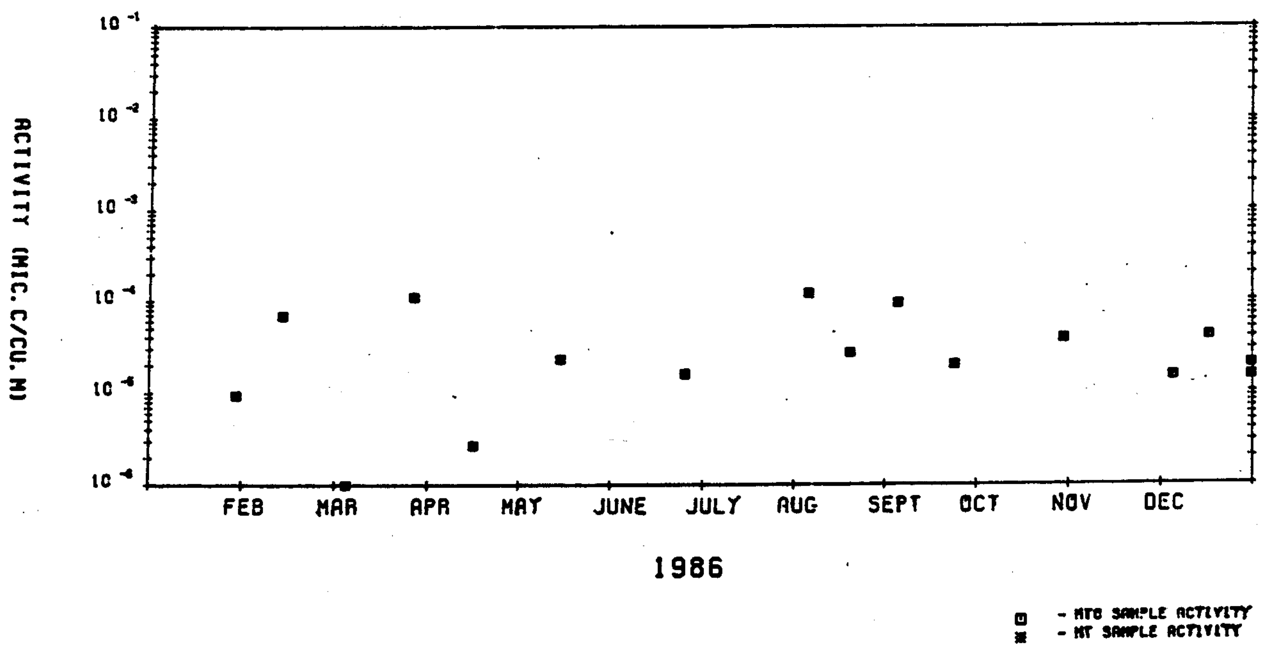
Tritium in Air Sampling Locations and Plots

The tritium in air data for each station is plotted in Appendix B for the entire year.

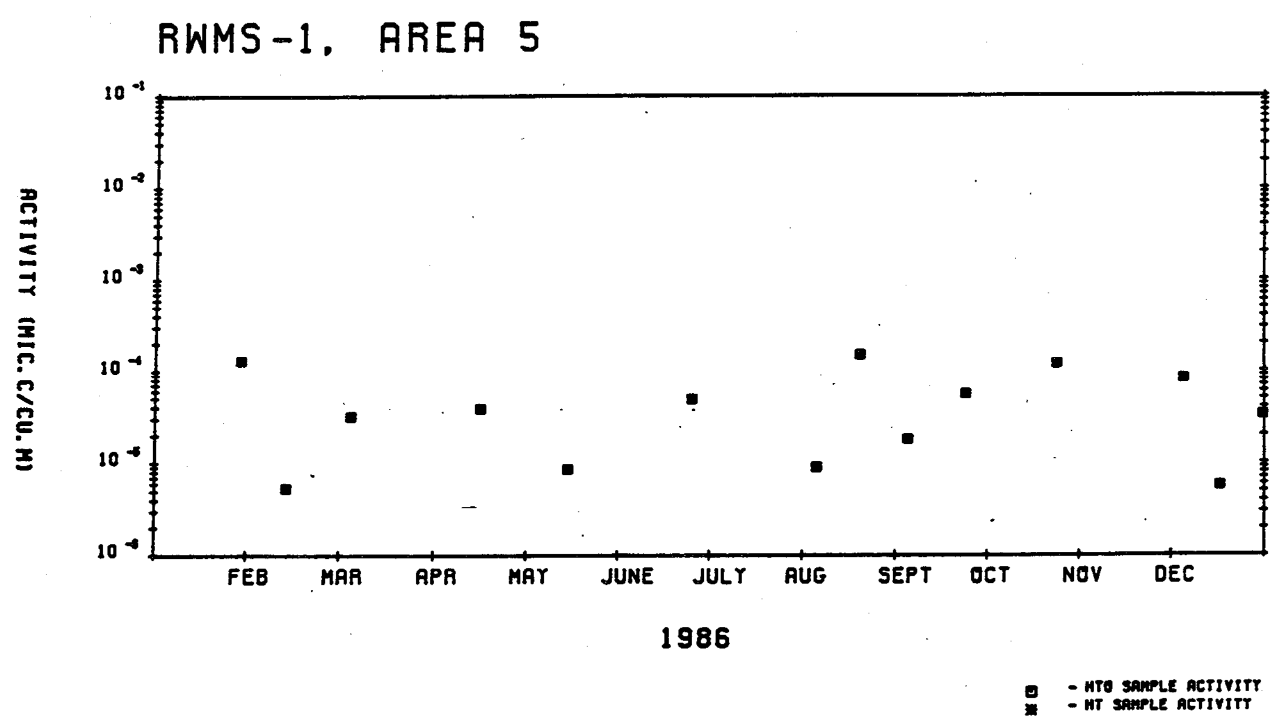
NTS ENVIRONMENTAL SURVEILLANCE
TRITIUM IN AIR SAMPLING LOCATIONS

Area	Location
1	BJY
5	RWMS - 1
5	RWMS - SE
5	RWMS - (SE-NE)
5	RWMS - NE
5	RWMS - (NE-NW)
5	RWMS - NW
5	RWMS - (NW-SW)
5	RWMS - SW
5	RWMS - (SW-SE)
12	Base Camp
15	EPA Farm
15	Gate 700
23	Bldg. 790
23	Bldg. 650
23	Site Boundary
25	EMAD

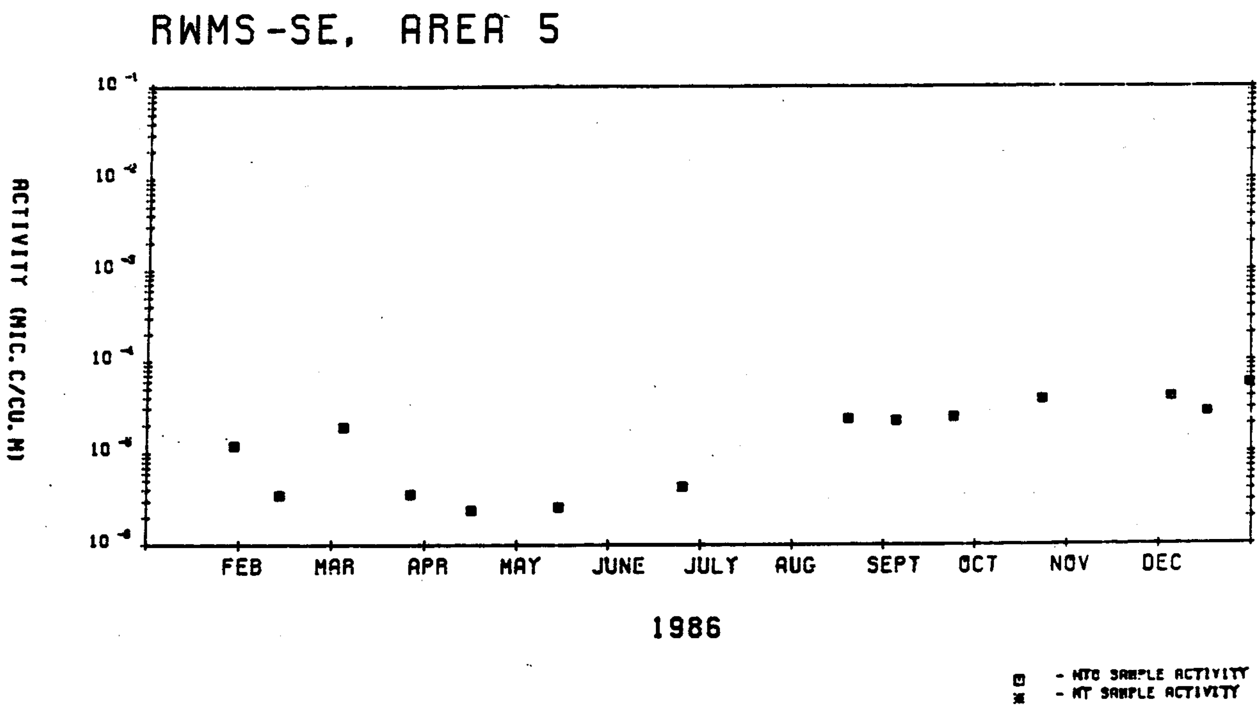
BJY, AREA 1



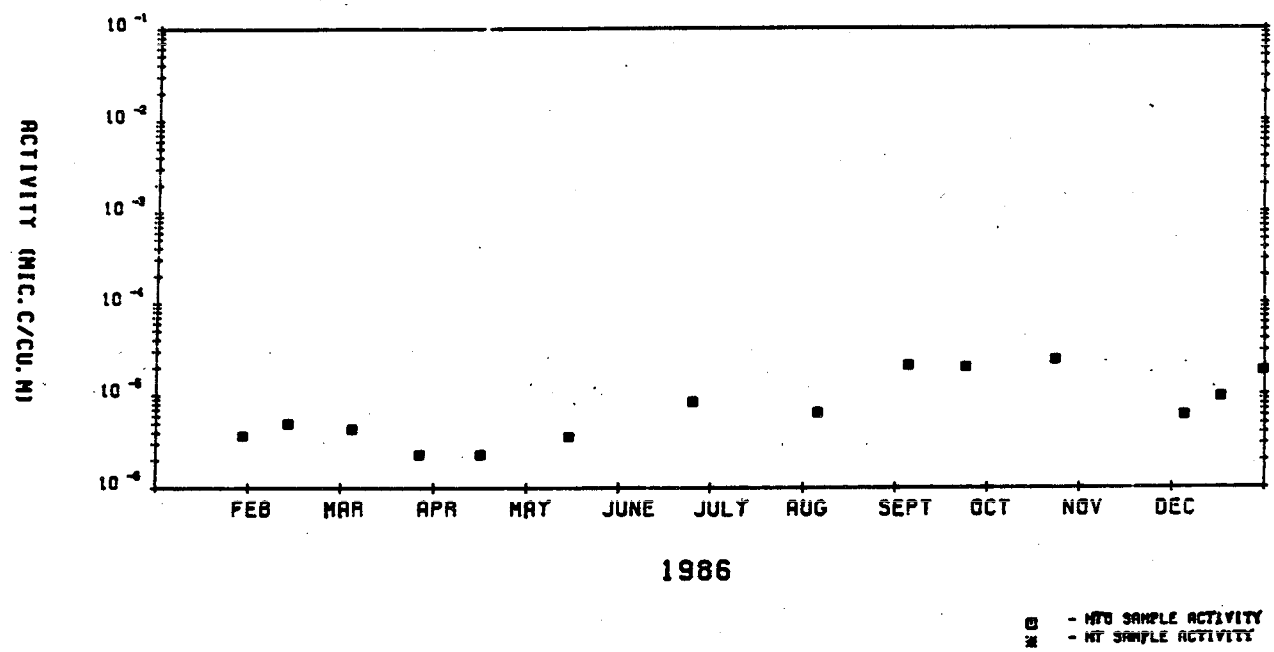
ACTIVITY (MIC.C/CU.M)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY



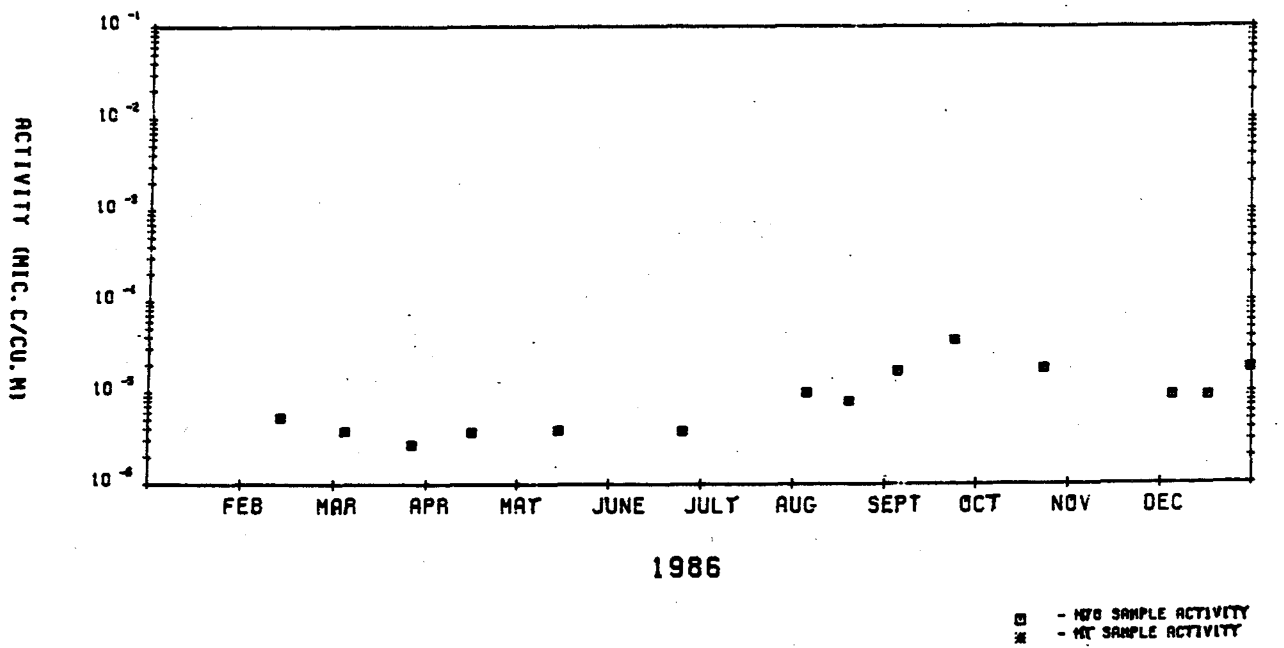
RWMS-1, AREA 5
ACTIVITY (MIC.C/CU.M)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY


RWMS-SE, AREA 5
ACTIVITY (MIC.C/CU.M)
10 -1
10 -2
10 -3
10 -4
10 -5
10 -6
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY

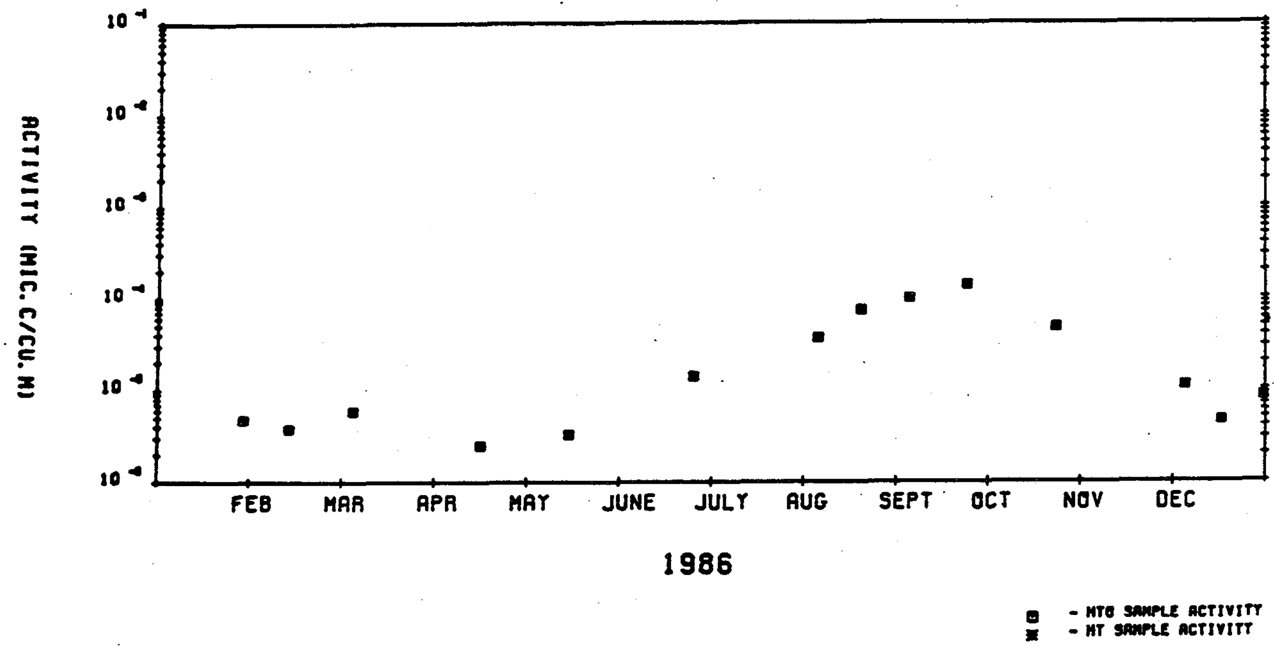
RWMS-(SE-NE), AREA 5



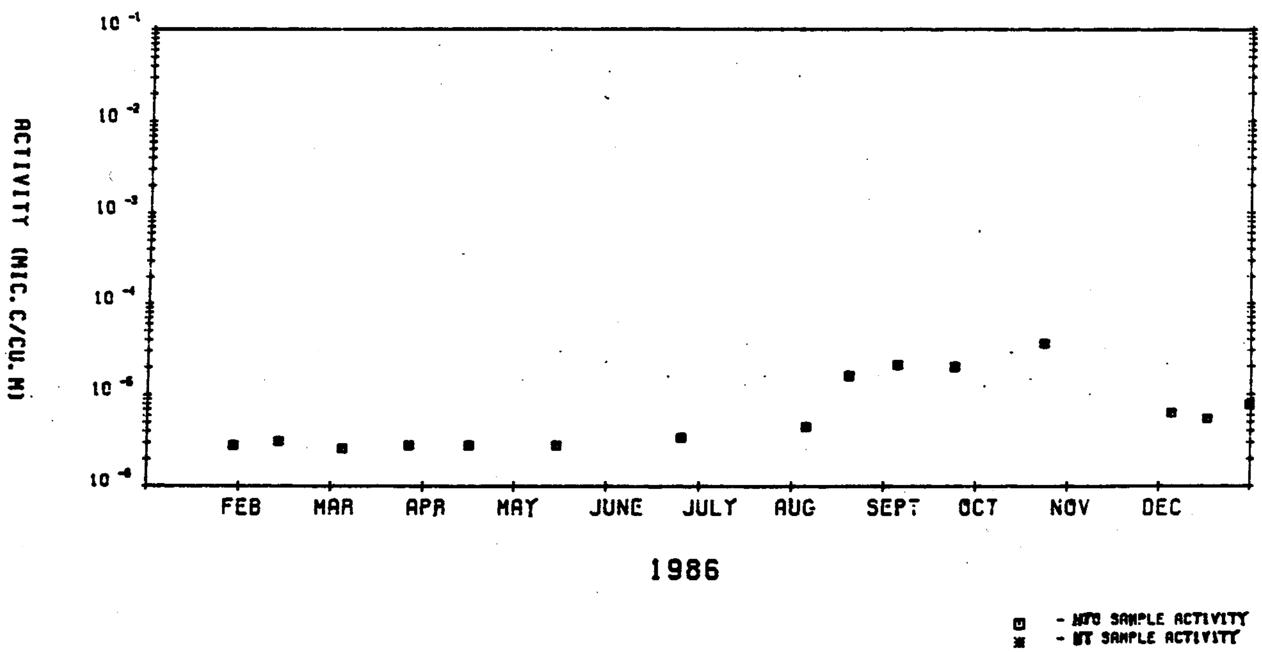
RWMS-NE, AREA 5



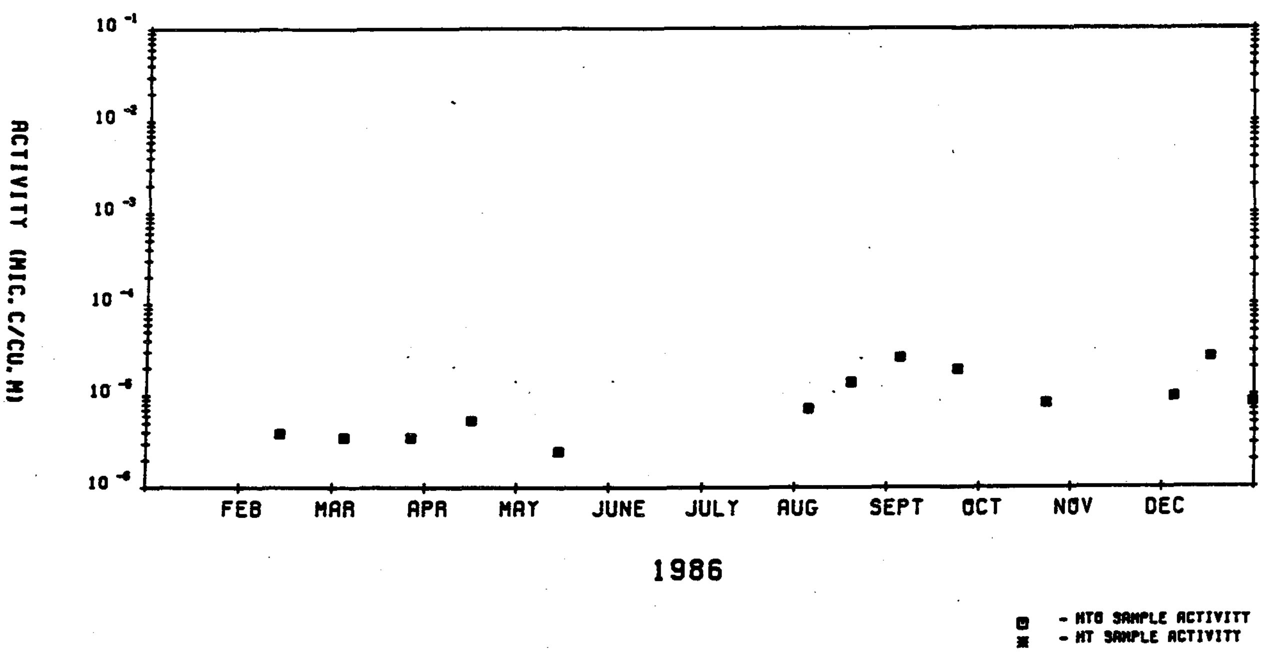
RWMS-(NE-NW), AREA 5

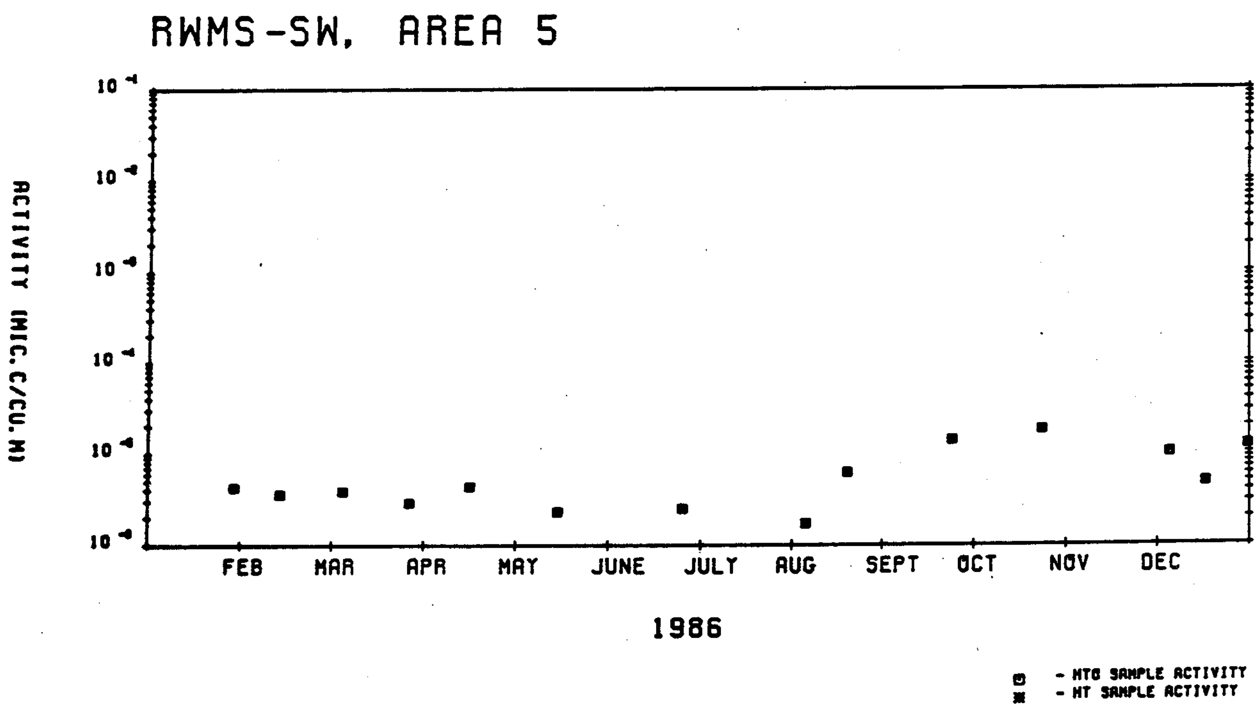


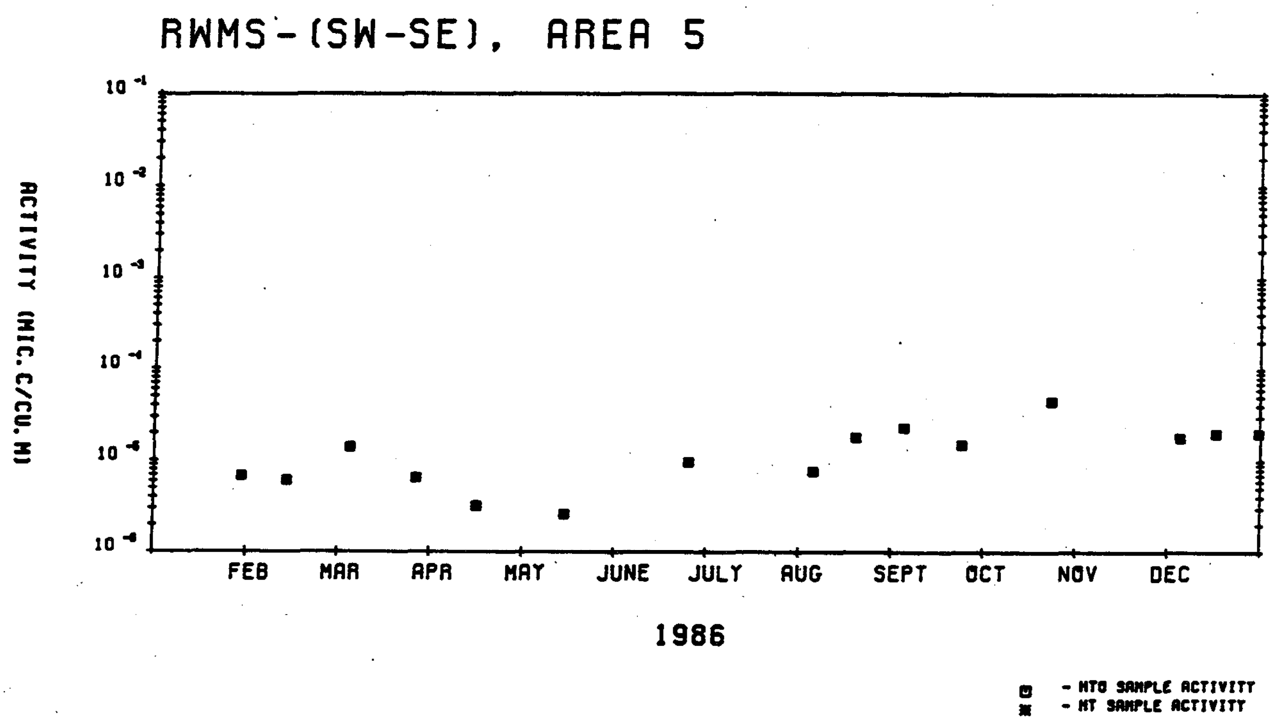
RWMS-NW, AREA 5



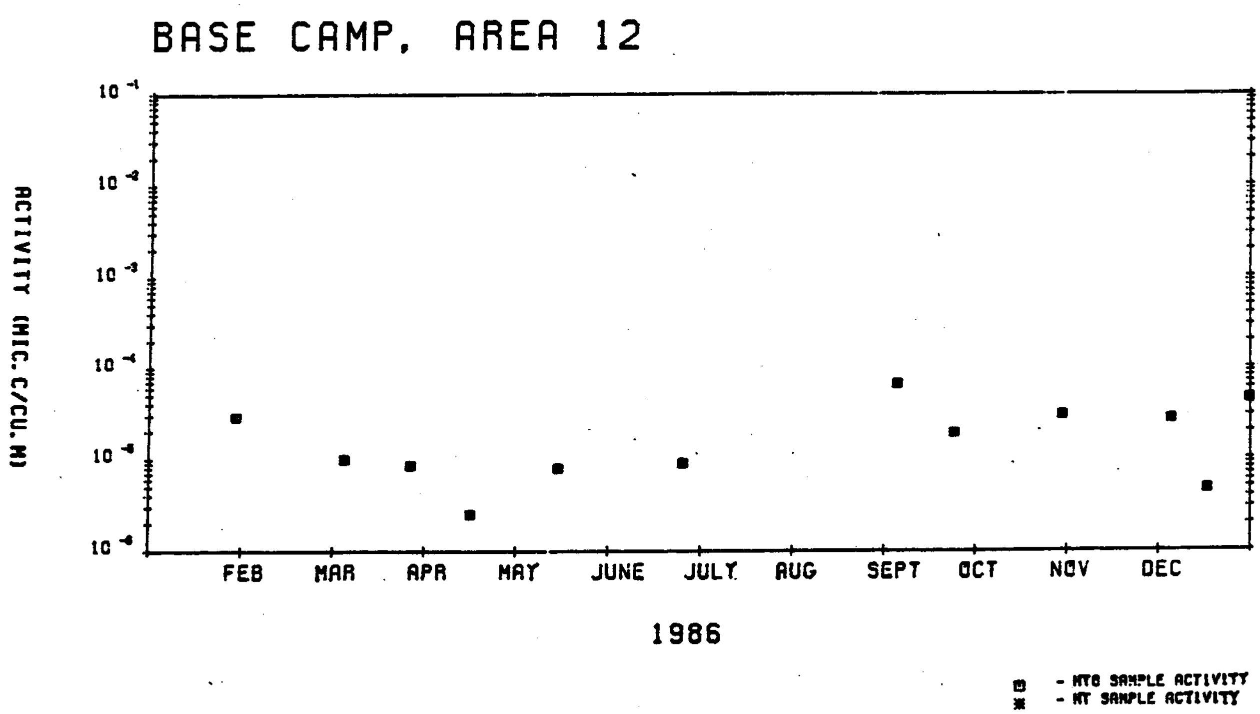
RWMS-(NW-SW), AREA 5



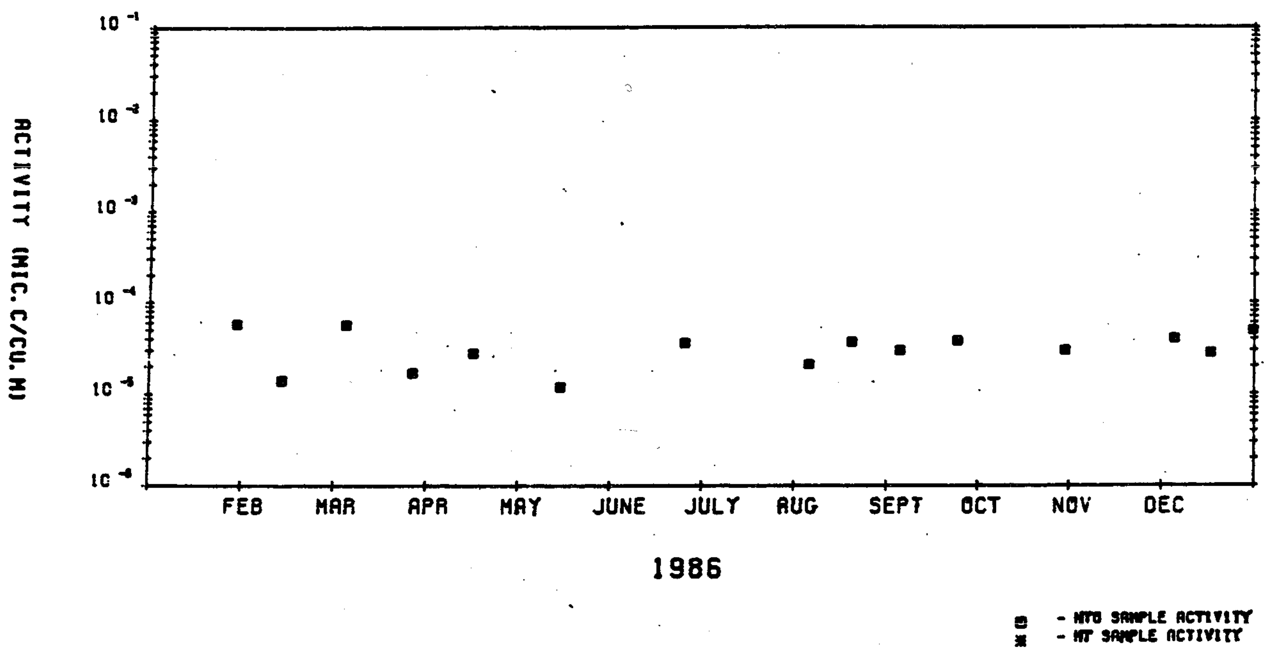

RWMS-SW, AREA 5
ACTIVITY (MIC.C/CU.M)
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY



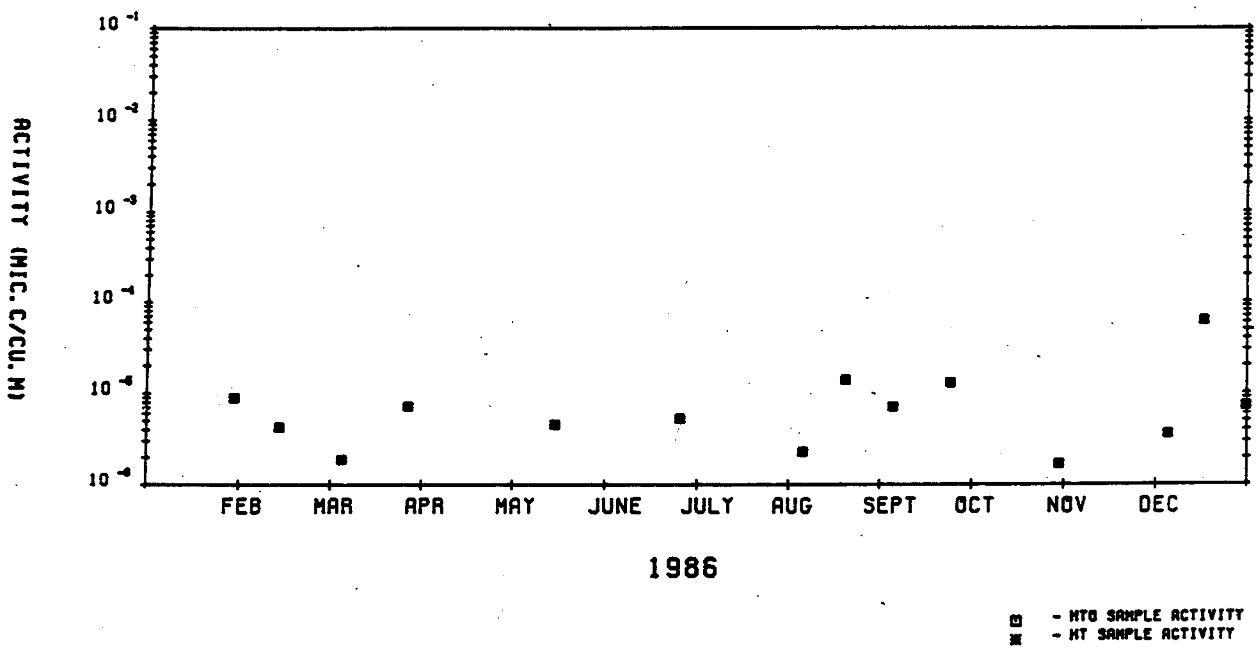
RWMS-(SW-SE), AREA 5
ACTIVITY (MIC.C/CU.M)
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY


BASE CAMP, AREA 12
10 ⁻¹
10 ⁻²
10 ⁻³
10 ⁻⁴
10 ⁻⁵
10 ⁻⁶
ACTIVITY (MIC.C/CU.M)
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY

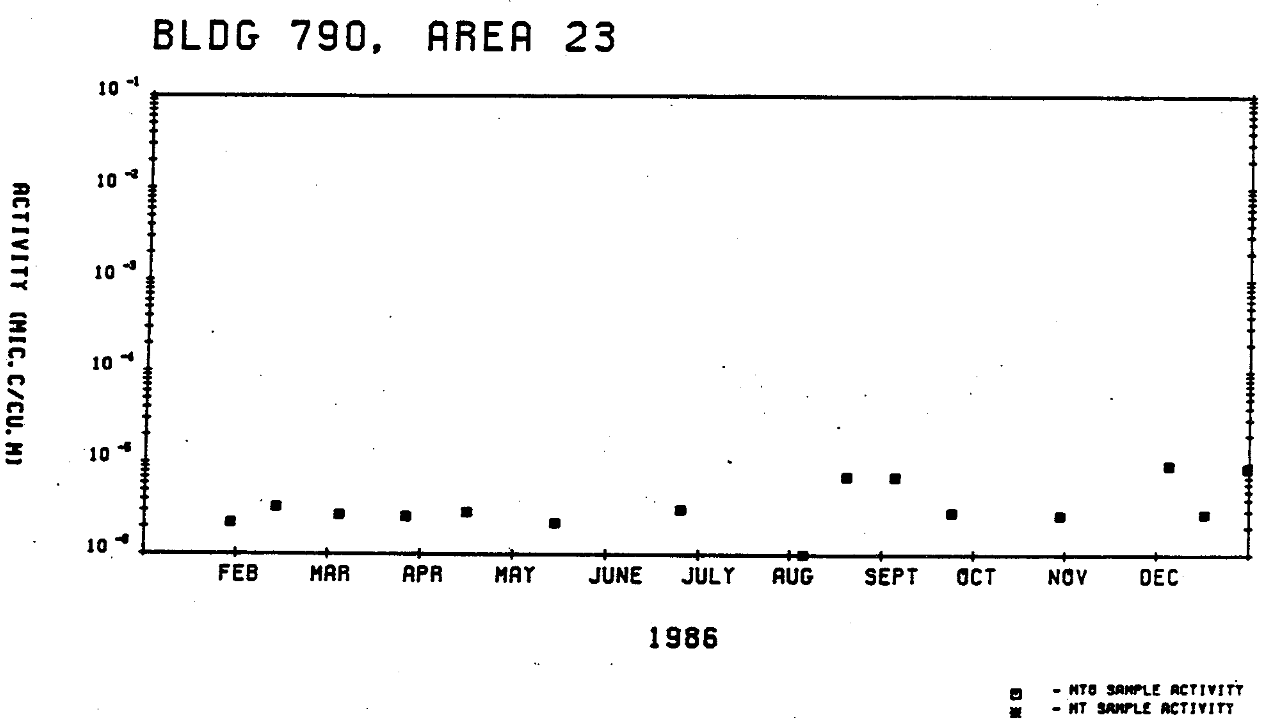
EPA FARM, AREA 15



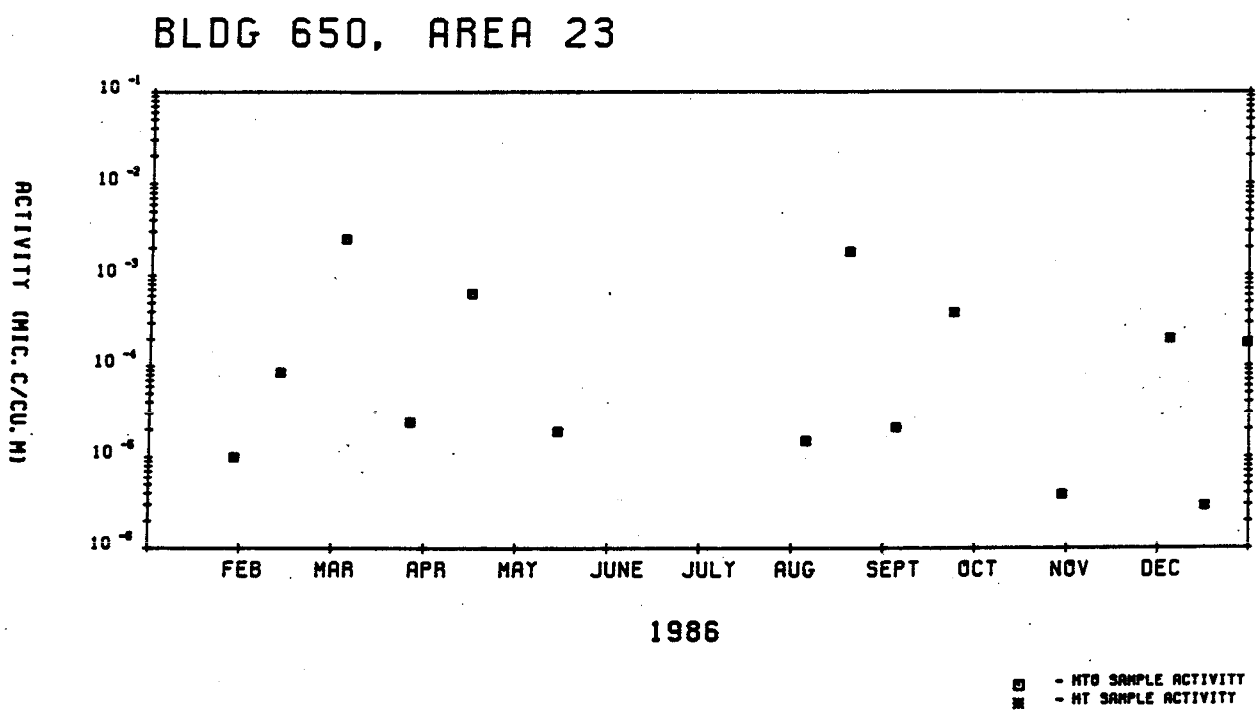
GATE 700

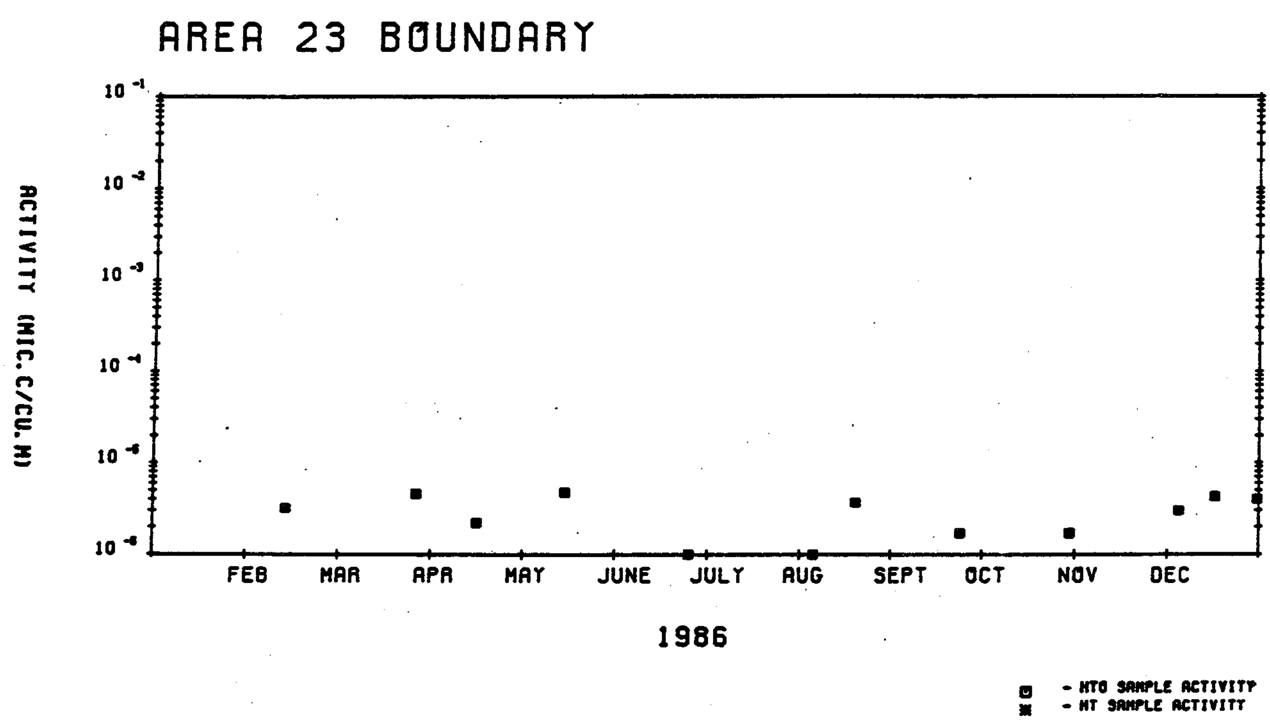


10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
ACTIVITY (MIC.C/CU.M)
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY

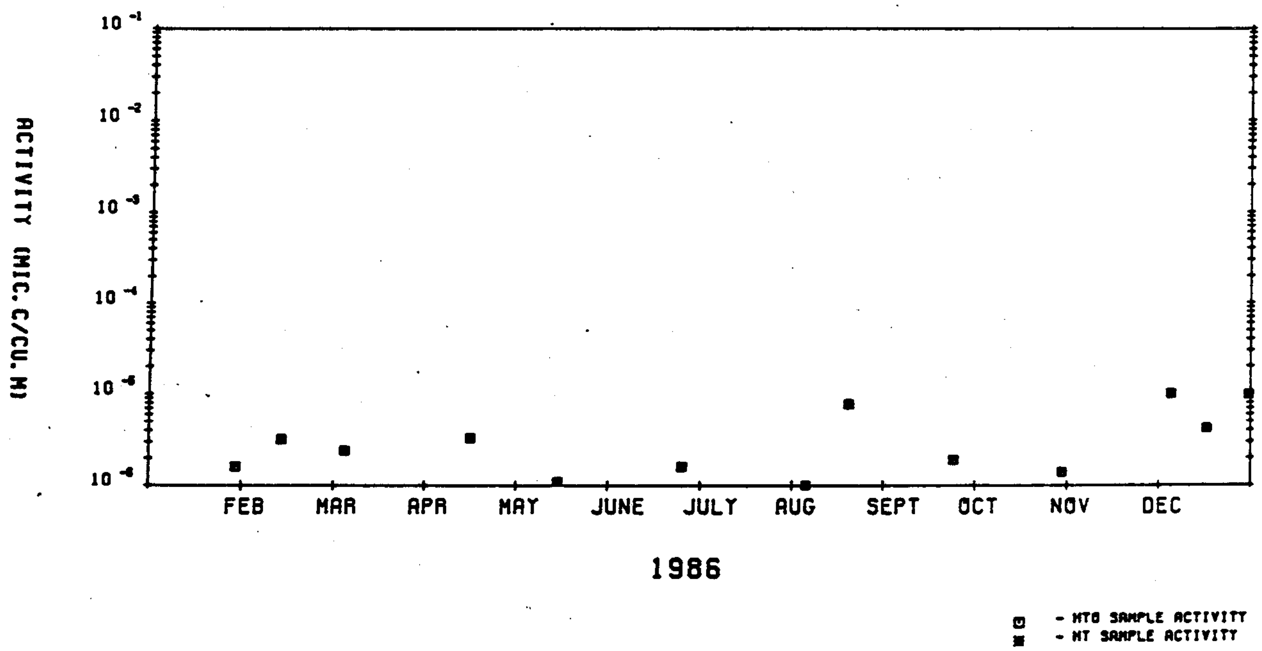


BLDG 790, AREA 23
ACTIVITY (MIC.C/CU.M)
10 -1
10 -2
10 -3
10 -4
10 -5
10 -6
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- MTG SAMPLE ACTIVITY
- MT SAMPLE ACTIVITY


BLDG 650, AREA 23
ACTIVITY (MIC.C/CU.M)
10 -1
10 -2
10 -3
10 -4
10 -5
10 -6
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY


AREA 23 BOUNDARY
ACTIVITY (MIC.C/CU.M)
10 -1
10 -2
10 -3
10 -4
10 -5
10 -6
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY

EMAD, AREA 25



10 -1
10 -2
10 -3
10 -4
10 -5
10 -6
ACTIVITY (MIC.C/CU.M)
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1986
- HTO SAMPLE ACTIVITY
- HT SAMPLE ACTIVITY

APPENDIX C

NTS Environmental Surveillance

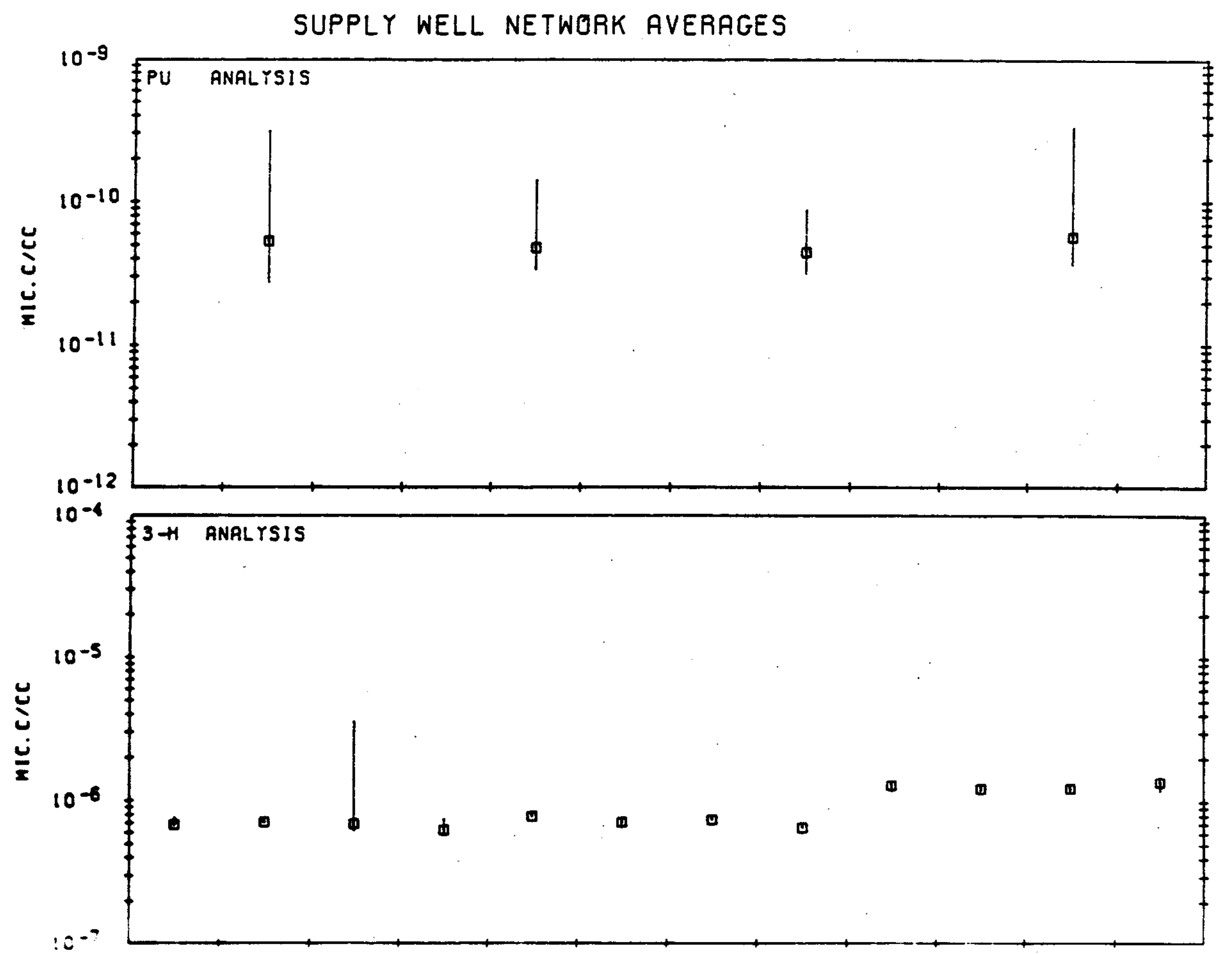
Supply Well Locations and Plots

Several symbols are used in Appendix C 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.

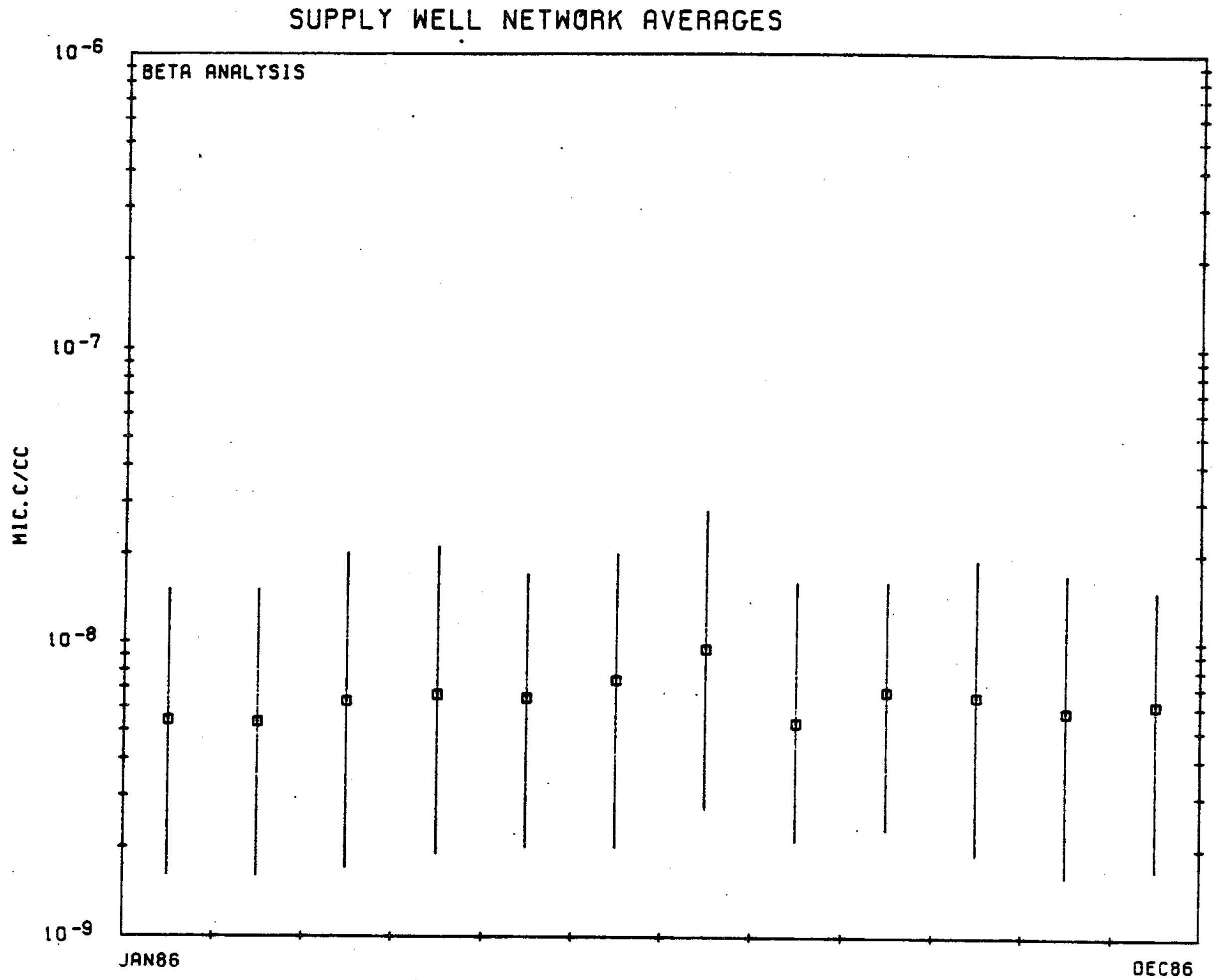
The remaining plots of Appendix B show the gross beta data of each station. A two-sigma error bar is also added to the data points, and, in all of the plots, a delta with the line to the bottom of the plot means below detection limit.

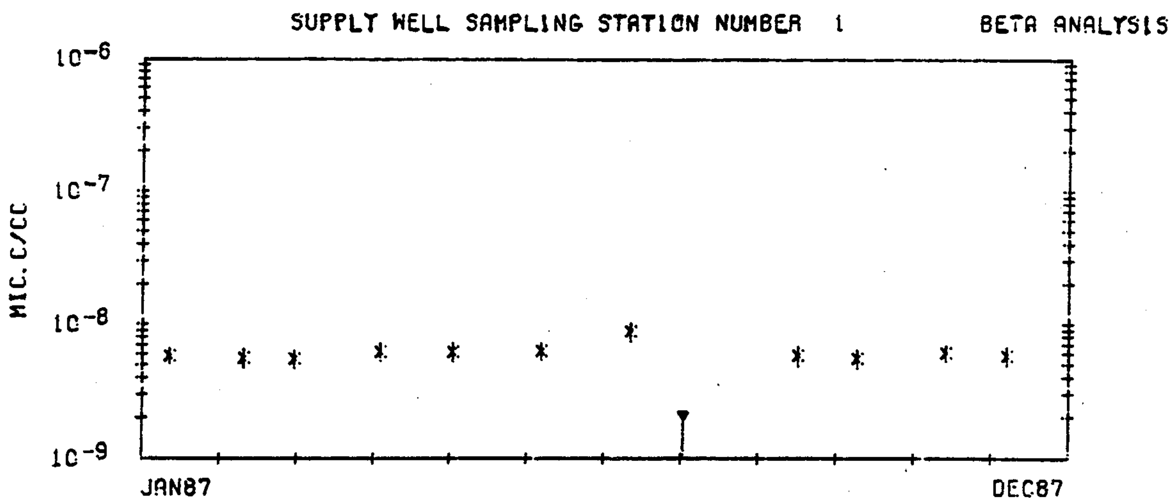
NTS ENVIRONMENTAL SURVEILLANCE
SUPPLY WELLS SAMPLING LOCATIONS

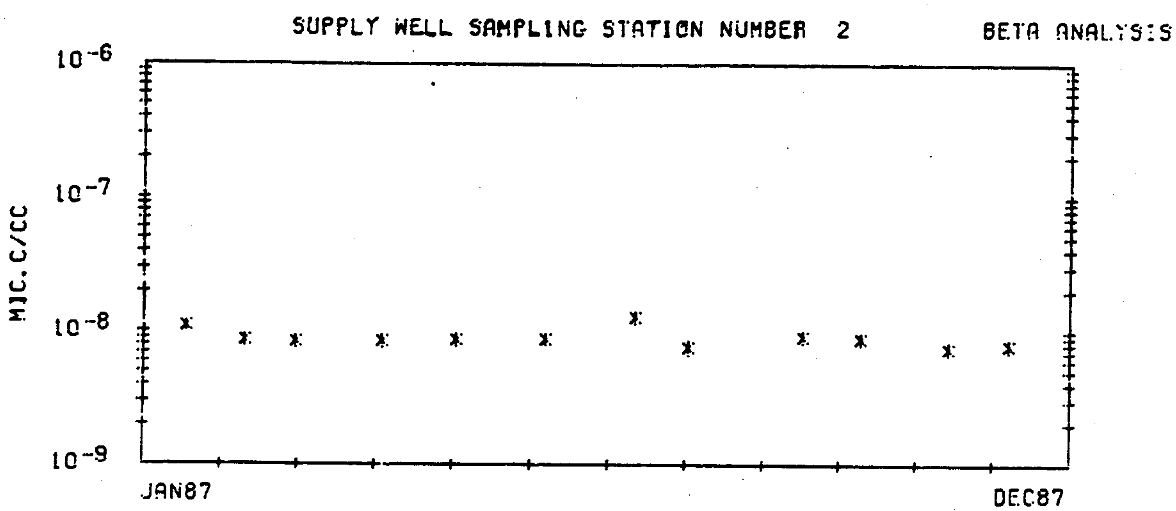
Station Number	Location
1	Area 2 Well 2
2	Area 3 Well A
3	Area 5 Well 5B
4	Area 5 Well 5C
5	Area 5 Well Ue5c
6	Area 6 Well C
7	Area 6 Well C1
8	Area 15 Well Ue15d
9	Area 18 Well 8
13	Area 22 Army Well No. 1
14	Area 25 Well J12
15	Area 25 Well J13
18	Area 19 Well U19c
19	Area 6 Well 4
20	Area 20 Water Well
21	Area 16 Well 16d

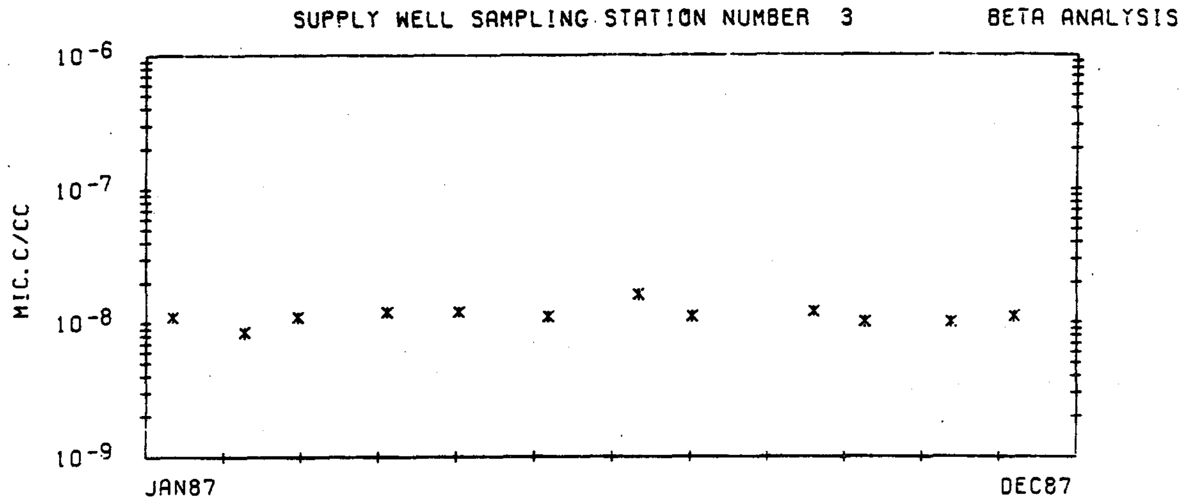


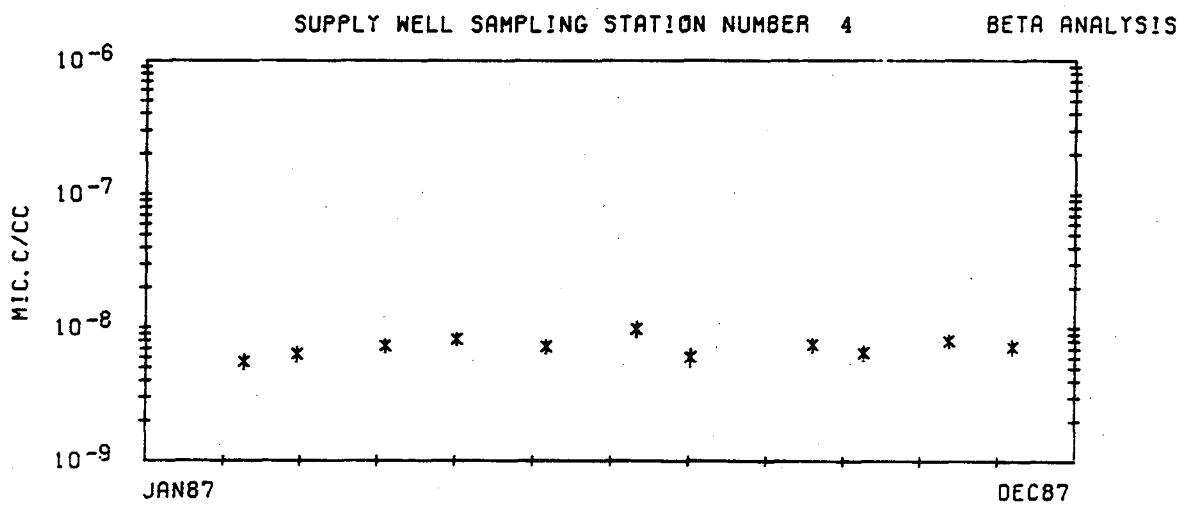
SUPPLY WELL NETWORK AVERAGES
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
MIC.C/CC
10^-9
10^-10
10^-11
10^-12
10^-4
10^-5
10^-6
10^-7

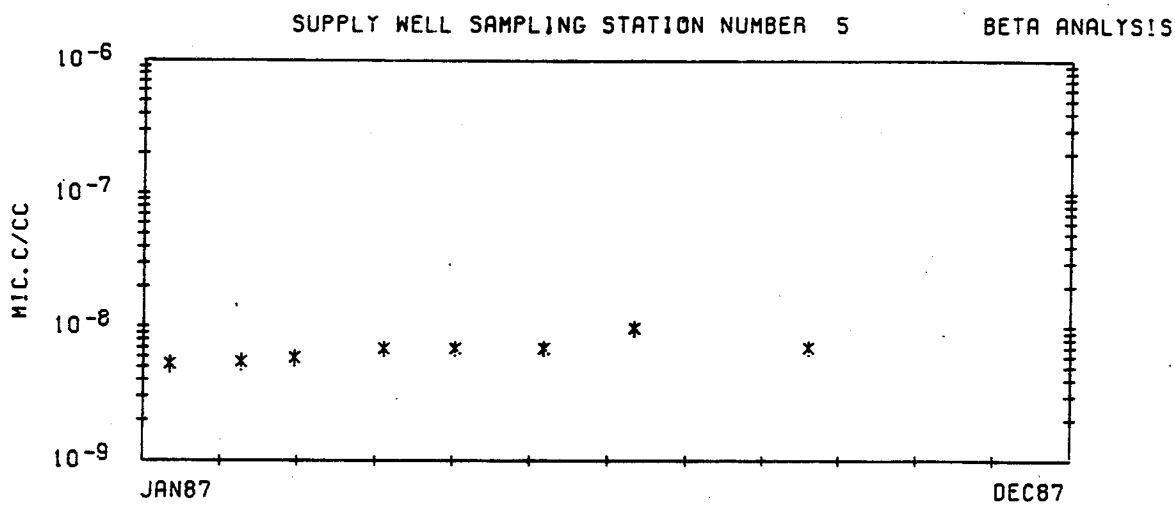

SUPPLY WELL NETWORK AVERAGES
BETA ANALYSIS
10^-6
10^-7
10^-8
10^-9
MIC.C/CC
JAN86
DEC86

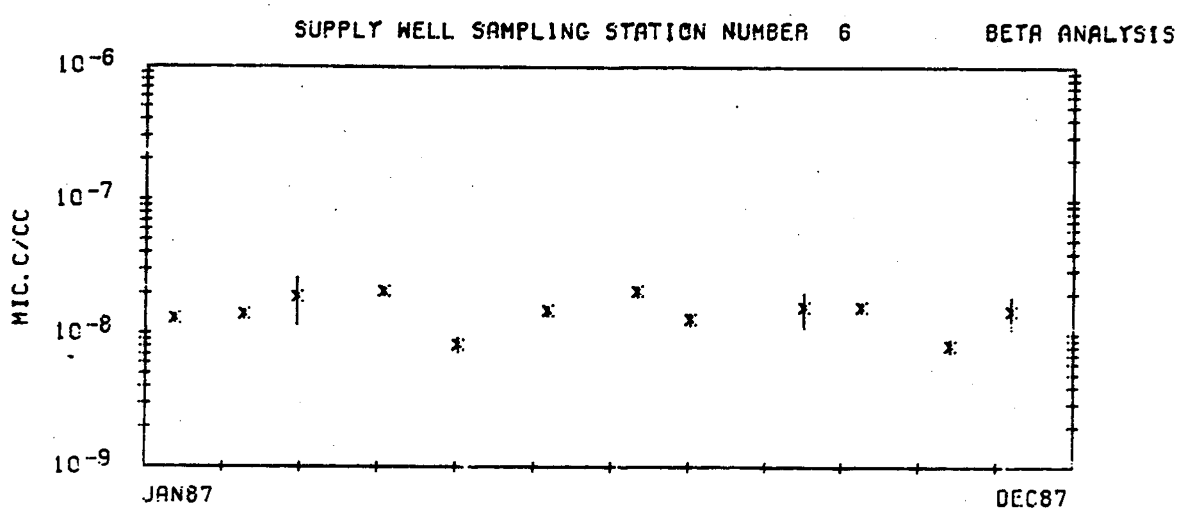

SUPPLY WELL SAMPLING STATION NUMBER 1
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN87
DEC87


SUPPLY WELL SAMPLING STATION NUMBER 2
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN87
DEC87

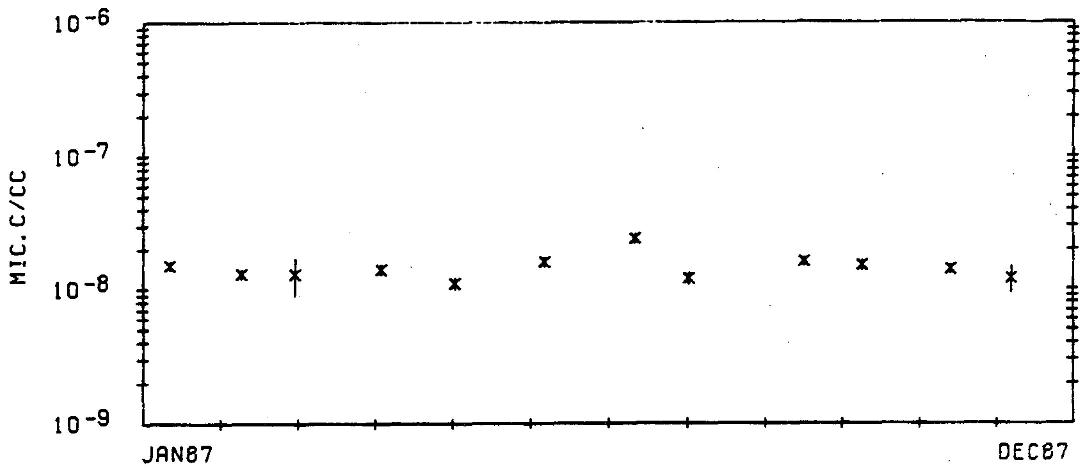

SUPPLY WELL SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87


SUPPLY WELL SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87

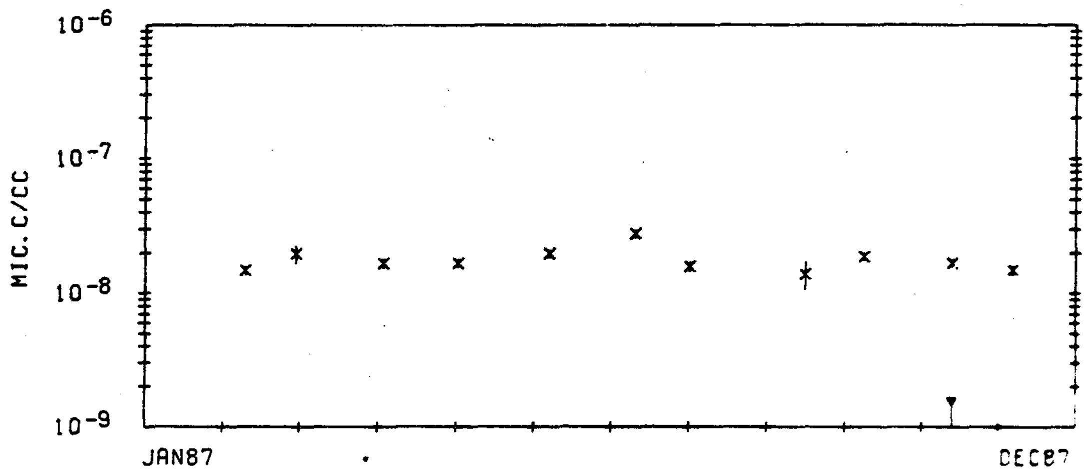

SUPPLY WELL SAMPLING STATION NUMBER 5
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87

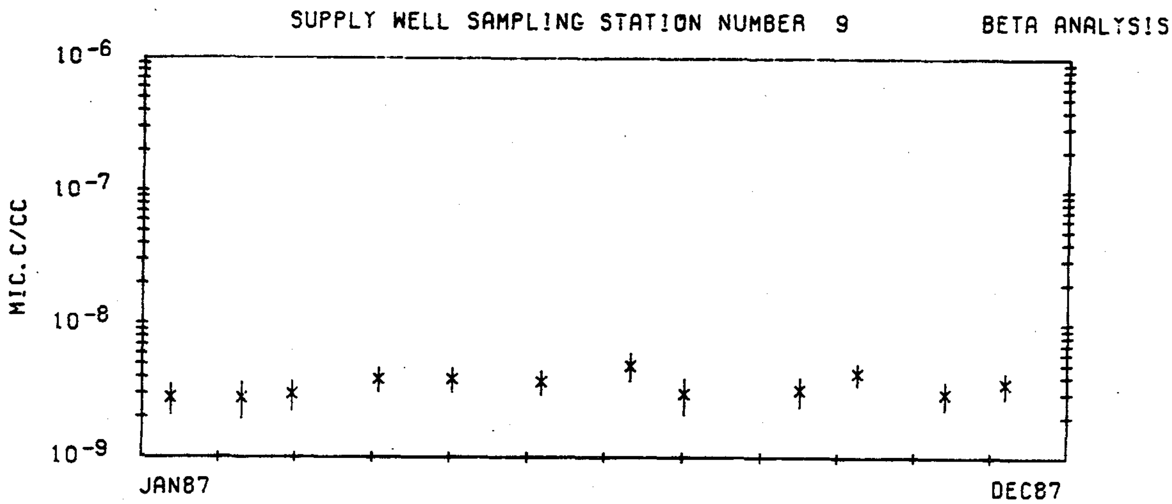

SUPPLY WELL SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87

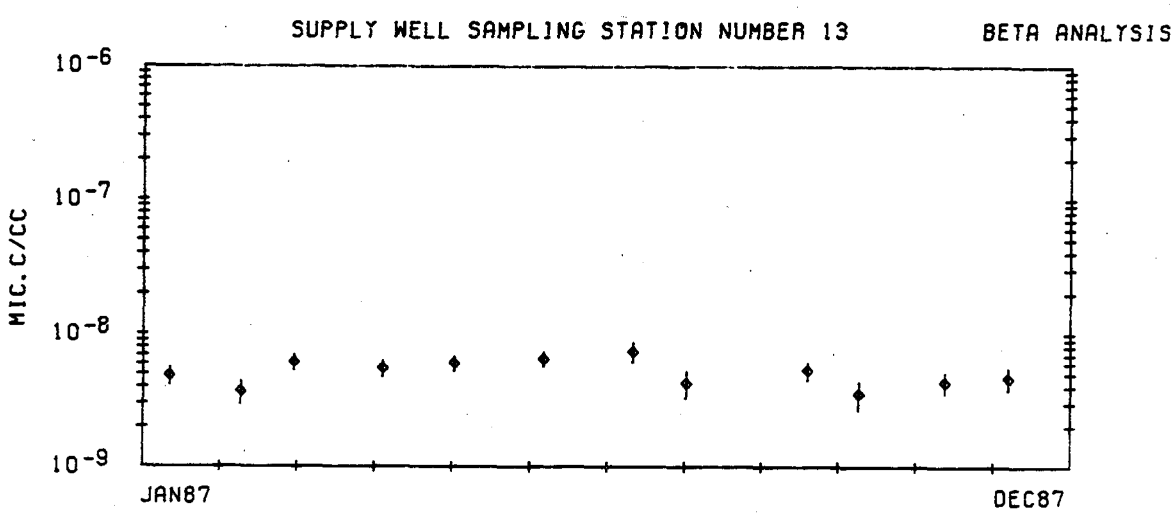
SUPPLY WELL SAMPLING STATION NUMBER 7 BETA ANALYSIS

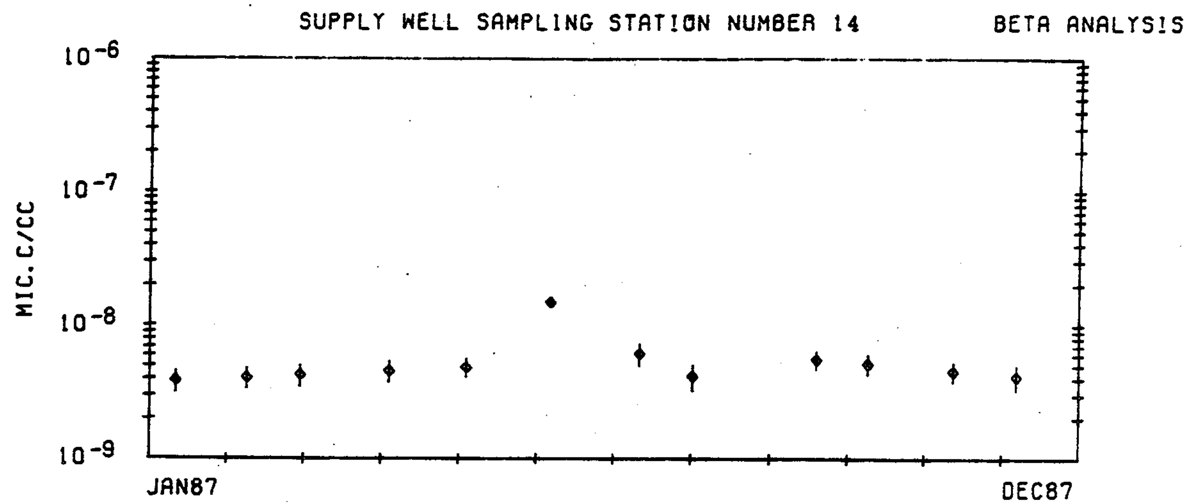


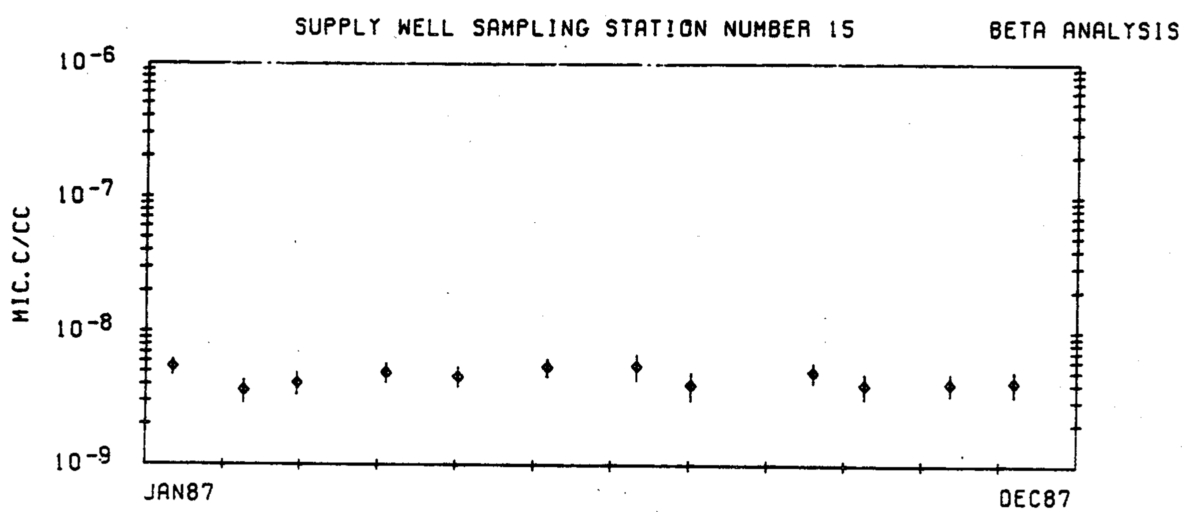
SUPPLY WELL SAMPLING STATION NUMBER 8 BETA ANALYSIS

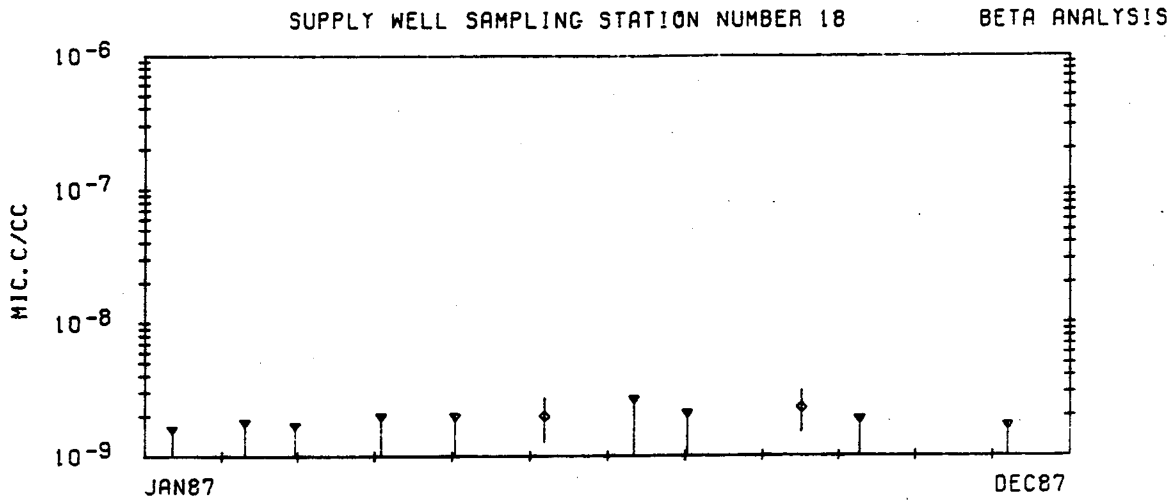


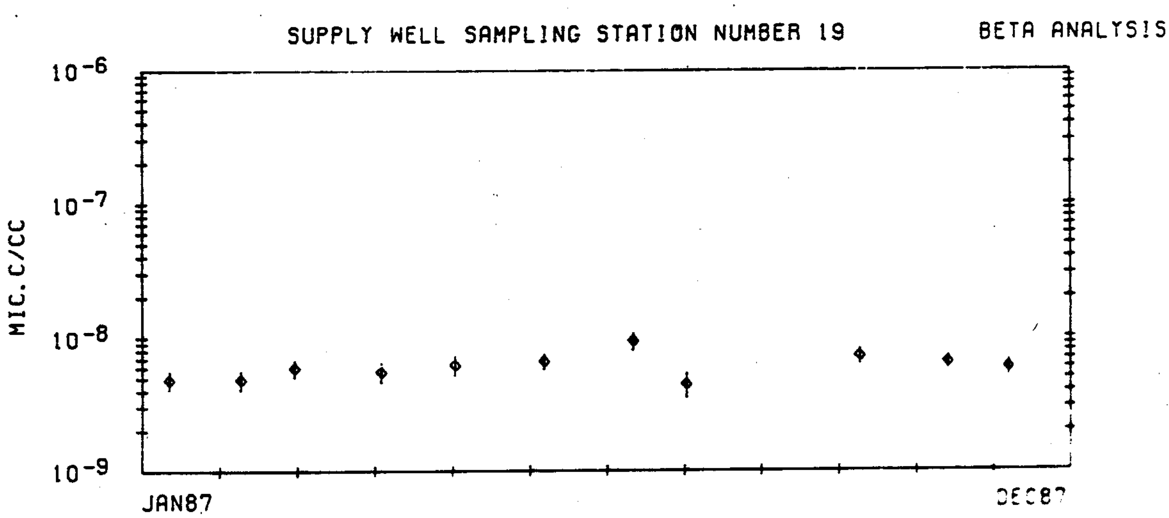

SUPPLY WELL SAMPLING STATION NUMBER 9
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87

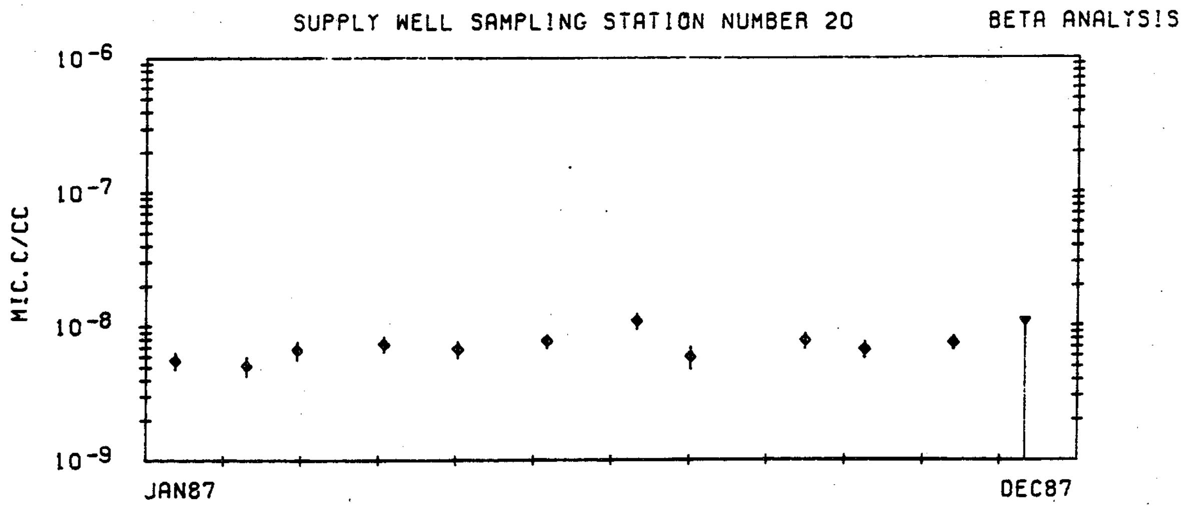

SUPPLY WELL SAMPLING STATION NUMBER 13
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87

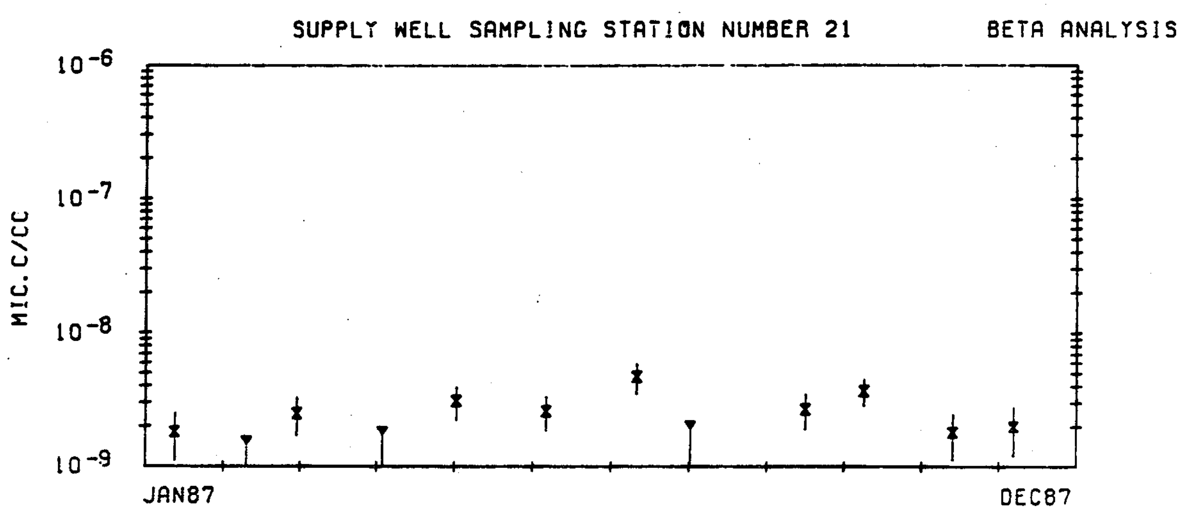

SUPPLY WELL SAMPLING STATION NUMBER 14
BETA ANALYSIS
MIC.C/CC
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
JAN87
DEC87


SUPPLY WELL SAMPLING STATION NUMBER 15
BETA ANALYSIS
MIC.C/CC
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
JAN87
DEC87


SUPPLY WELL SAMPLING STATION NUMBER 18
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN87
DEC87


SUPPLY WELL SAMPLING STATION NUMBER 19
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN87


SUPPLY WELL SAMPLING STATION NUMBER 20
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN87
DEC87


SUPPLY WELL SAMPLING STATION NUMBER 21
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN87
DEC87

APPENDIX D

NTS Environmental Surveillance

Potable Water Locations and Plots

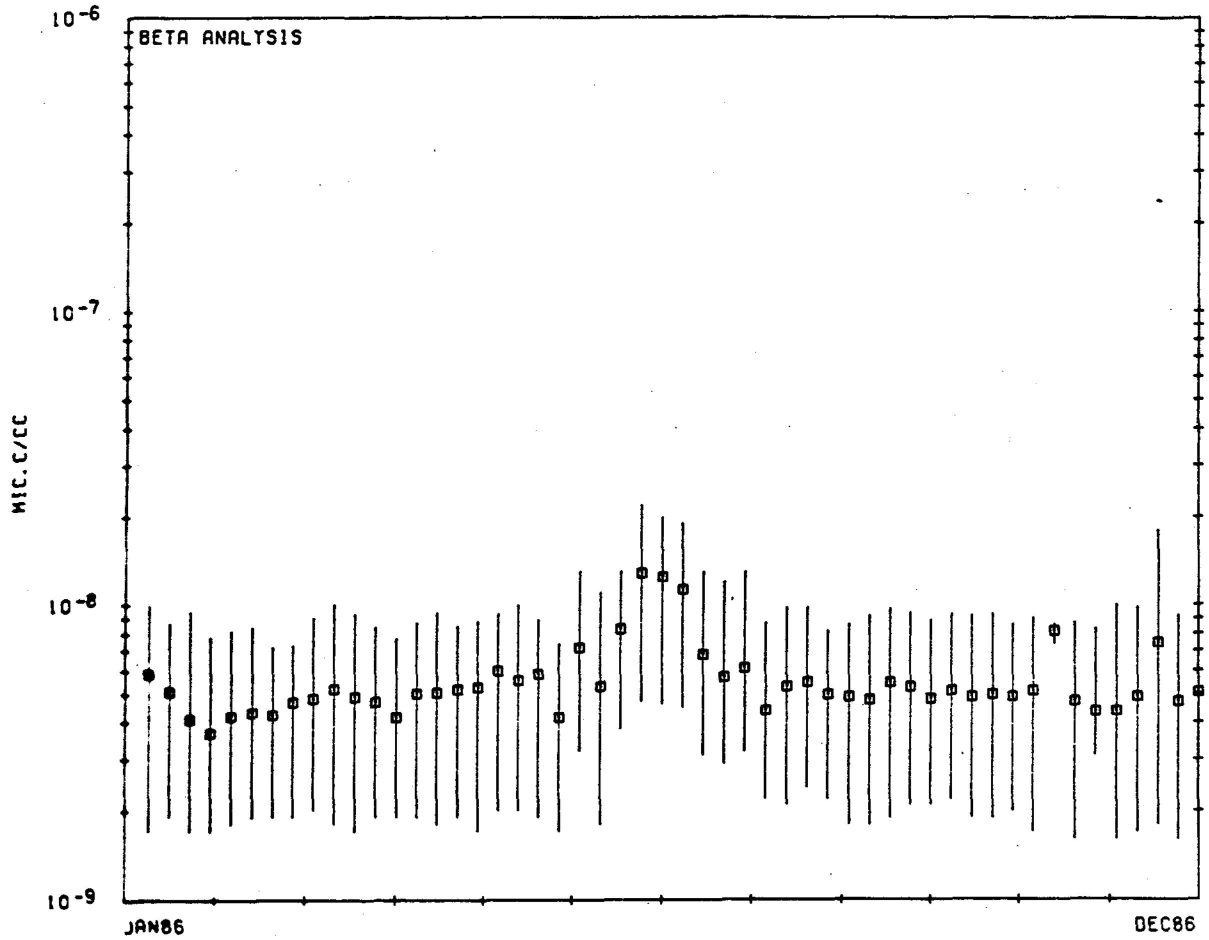
In the first two pages of plots in Appendix D, the potable water network averages, a square is used to represent the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

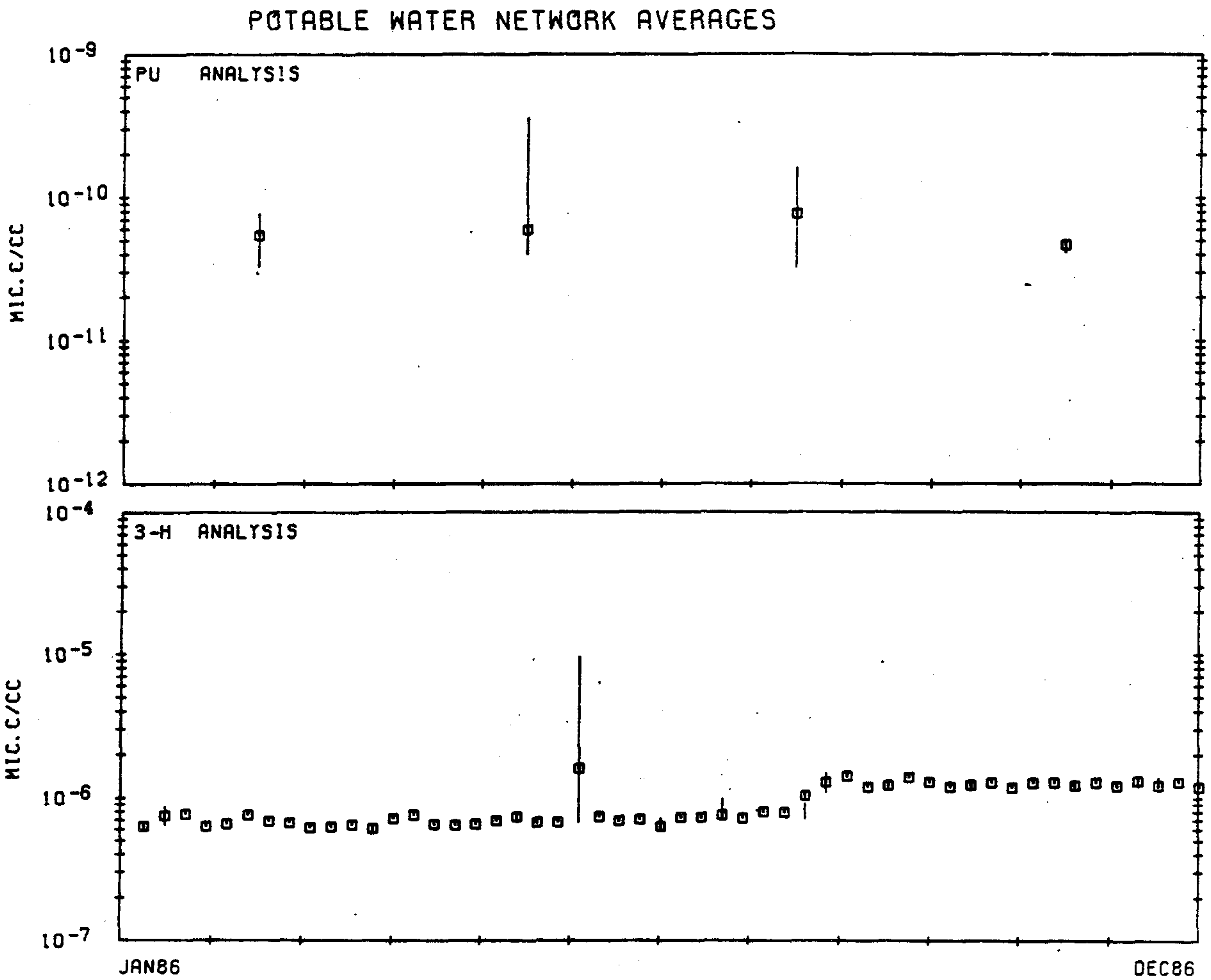
The remaining plots show the gross beta data of each station. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

NTS ENVIRONMENTAL SURVEILLANCE
POTABLE WATER SAMPLING LOCATIONS

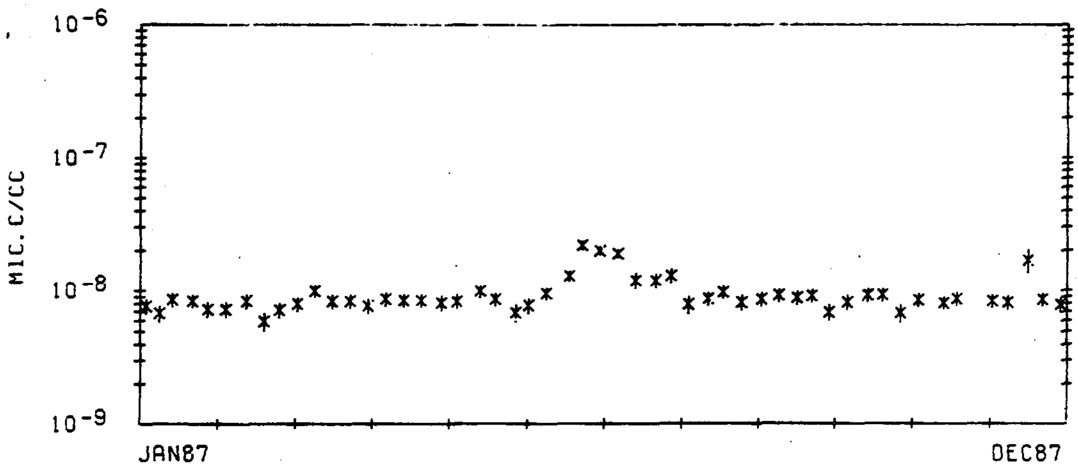
Station Number	Location
1	Area 3 Cafeteria
2	Area 2 Rest Room
3	Area 12 Cafeteria
4	Area 23 Cafeteria
5	Area 27 Cafeteria
6	Area 6 Cascade Water
7	Area 6 Cafeteria
10	Area 25 Service Station

POTABLE WATER NETWORK AVERAGES

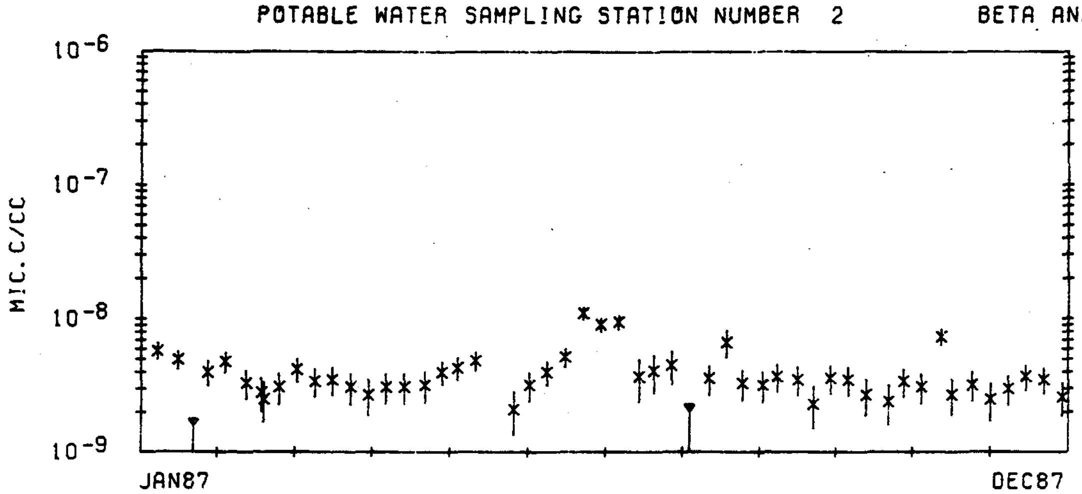


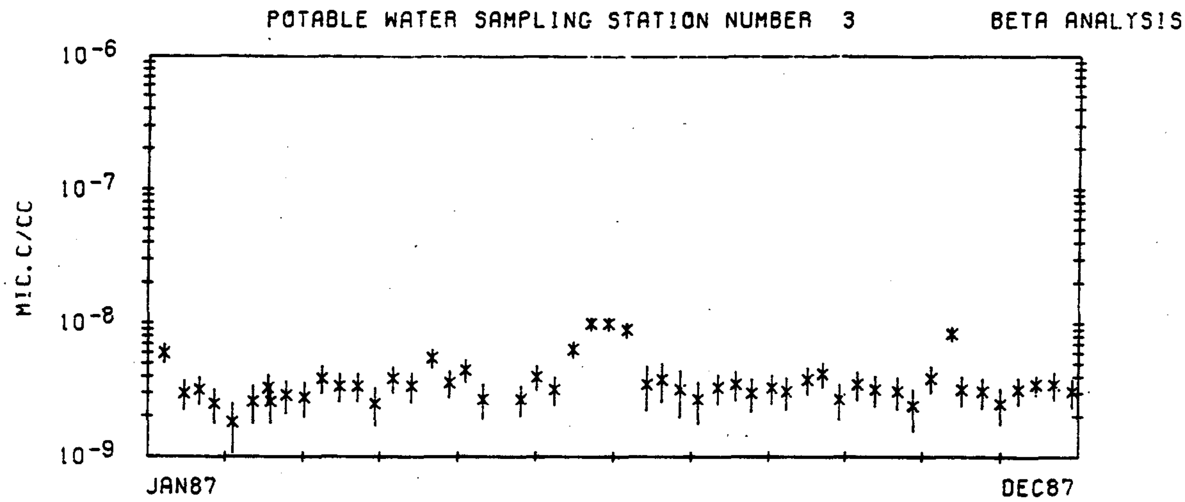

POTABLE WATER NETWORK AVERAGES
PU ANALYSIS
3-H ANALYSIS
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
MIC.C/CC
MIC.C/CC
JAN86
DEC86

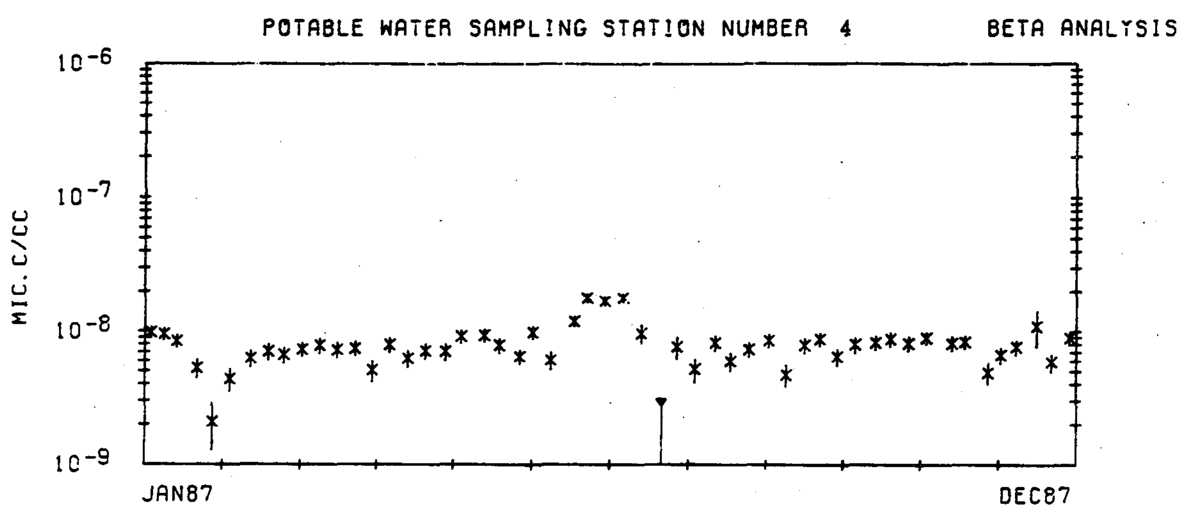
POTABLE WATER SAMPLING STATION NUMBER 1 BETA ANALYSIS

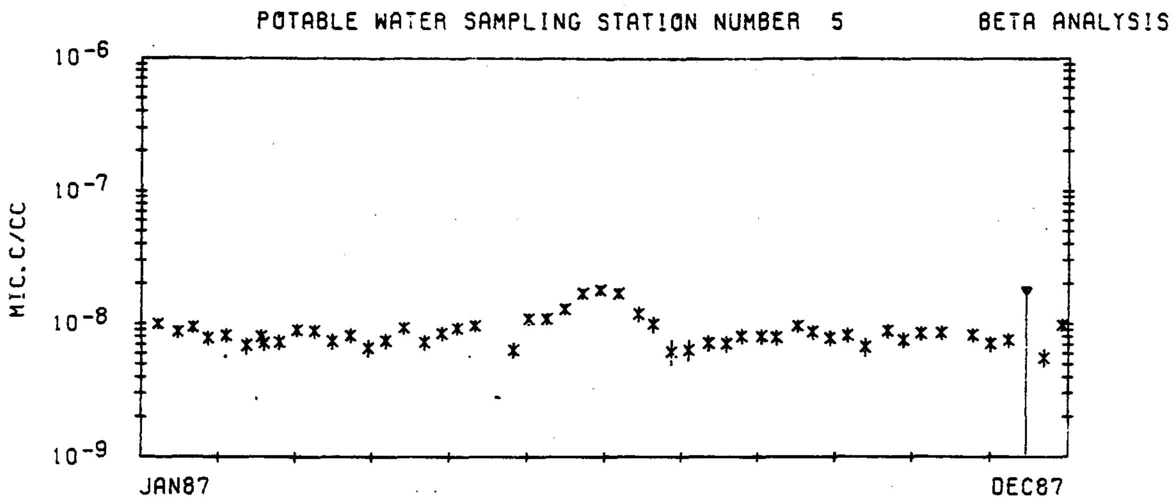


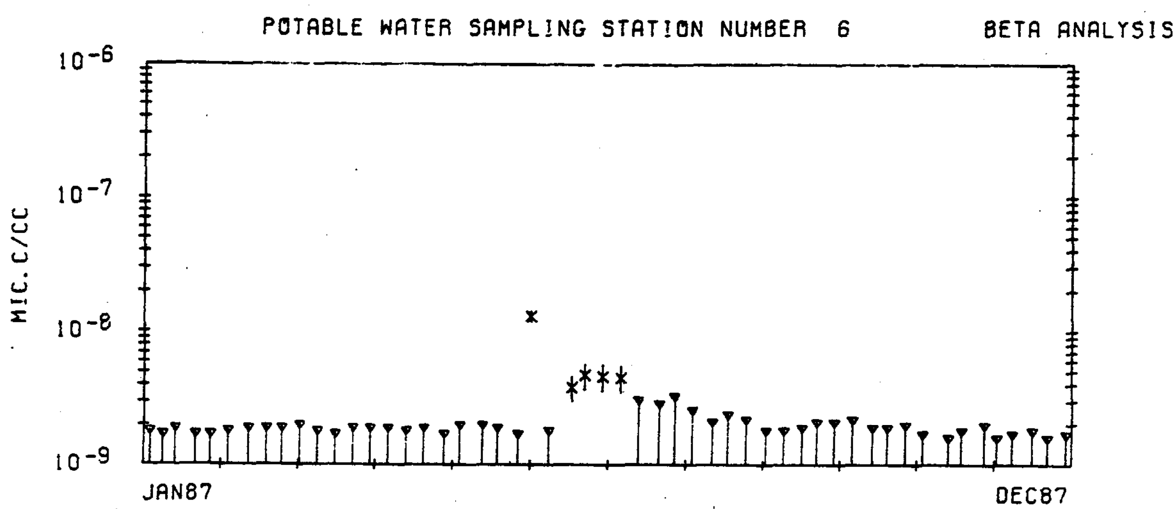
POTABLE WATER SAMPLING STATION NUMBER 2 BETA ANALYSIS

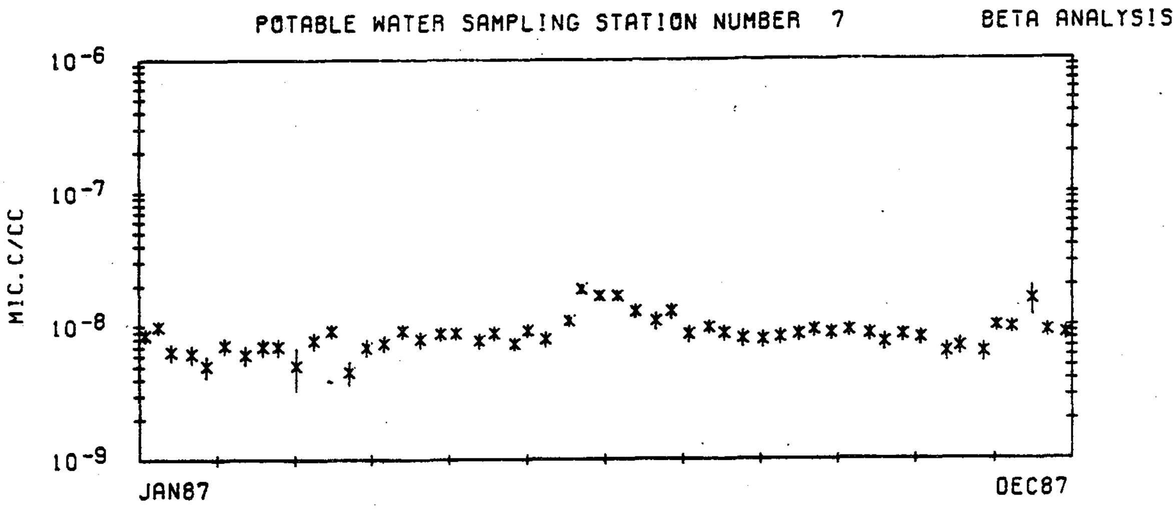


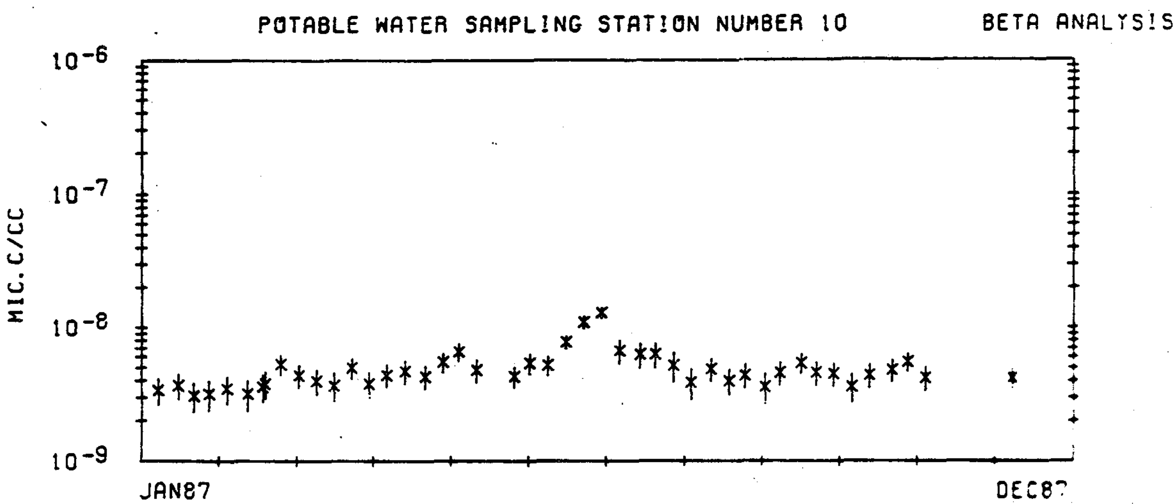

POTABLE WATER SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87


POTABLE WATER SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87


POTABLE WATER SAMPLING STATION NUMBER 5
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN87
DEC87


POTABLE WATER SAMPLING STATION NUMBER 6
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN87
DEC87


POTABLE WATER SAMPLING STATION NUMBER 7
BETA ANALYSIS
10^-6
10^-7
10^-8
10^-9
MIC.C/CC
JAN87
DEC87


POTABLE WATER SAMPLING STATION NUMBER 10
BETA ANALYSIS
10^-6
10^-7
10^-8
10^-9
MIC.C/CC
JAN87
DEC87

A P P E N D I X E

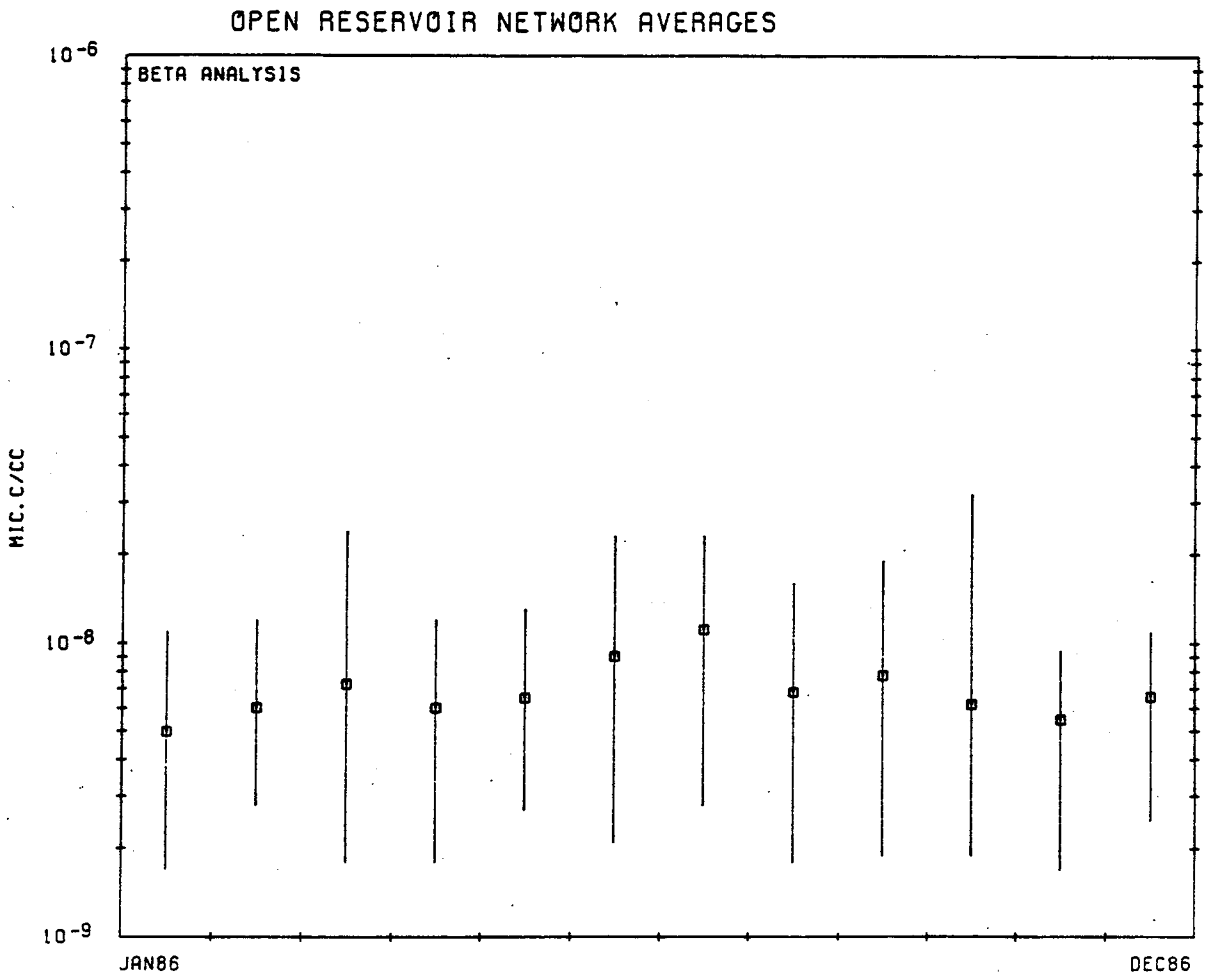
NTS Environmental Surveillance

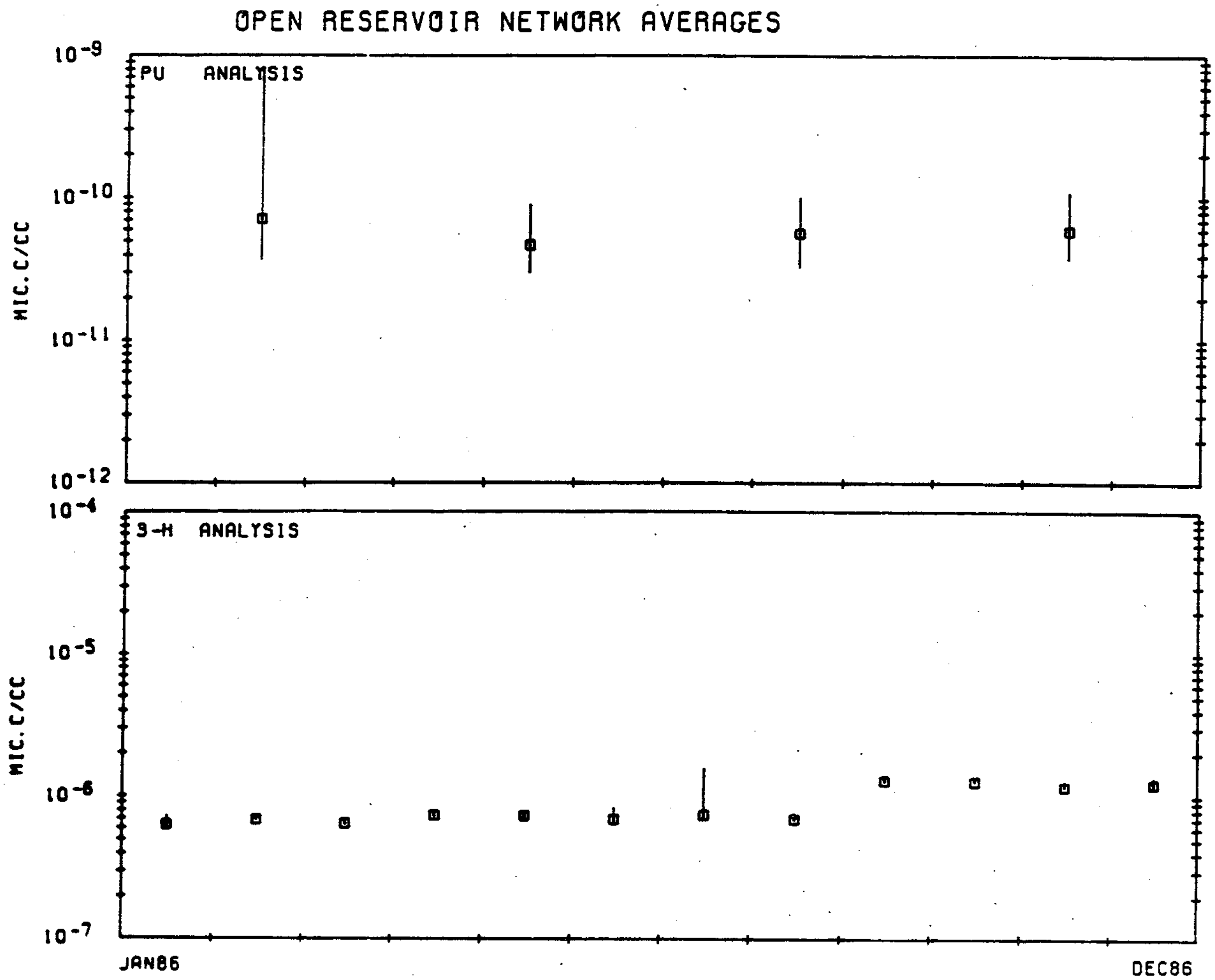
Open Reservoir Locations and Plots

Several symbols are used in Appendix E 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. 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.

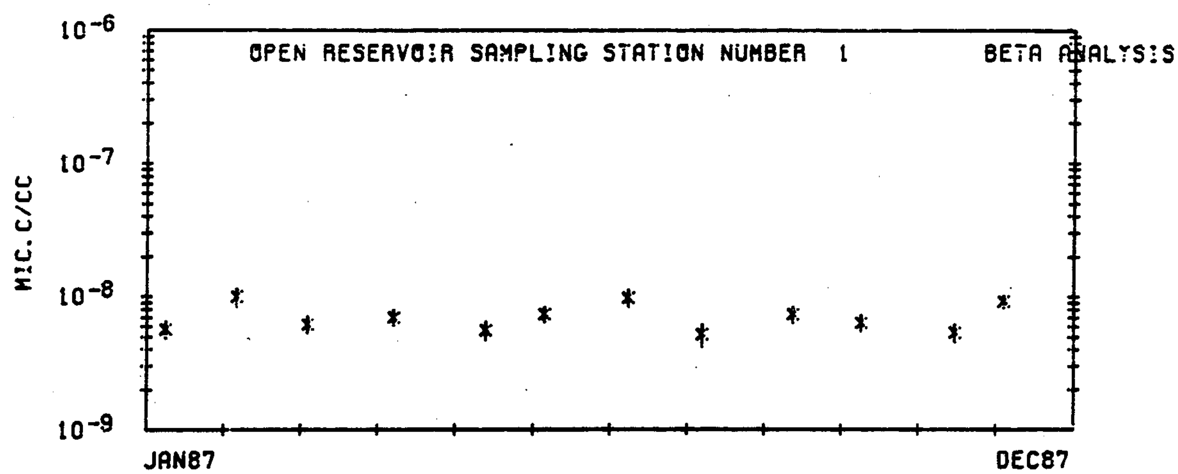
NTS ENVIRONMENTAL SURVEILLANCE
OPEN RESERVOIRS SAMPLING LOCATIONS

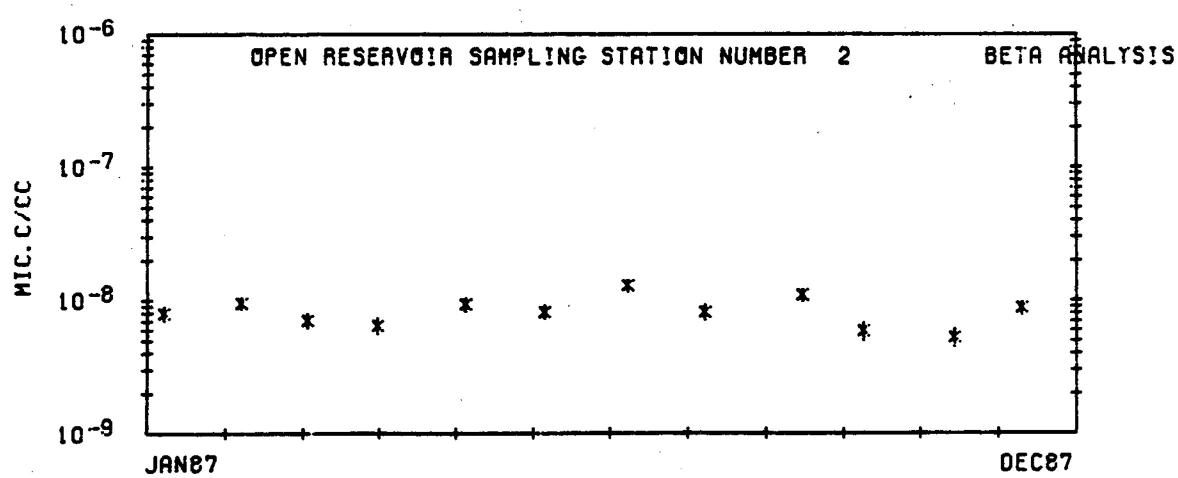
Station Number	Location
1	Area 2 Well 2 Reservoir
2	Area 3 Well A Reservoir
3	Area 5 Well 5B Reservoir
4	Area 5 Well Ue5c Reservoir
5	Area 6 Well 3 Reservoir
6	Area 6 Well C1 Reservoir
8	Area 18 Camp 17 Reservoir
11	Area 20 Well 20A Reservoir
12	Area 23 Swimming Pool
16	Area 19 Well U19c Reservoir
18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

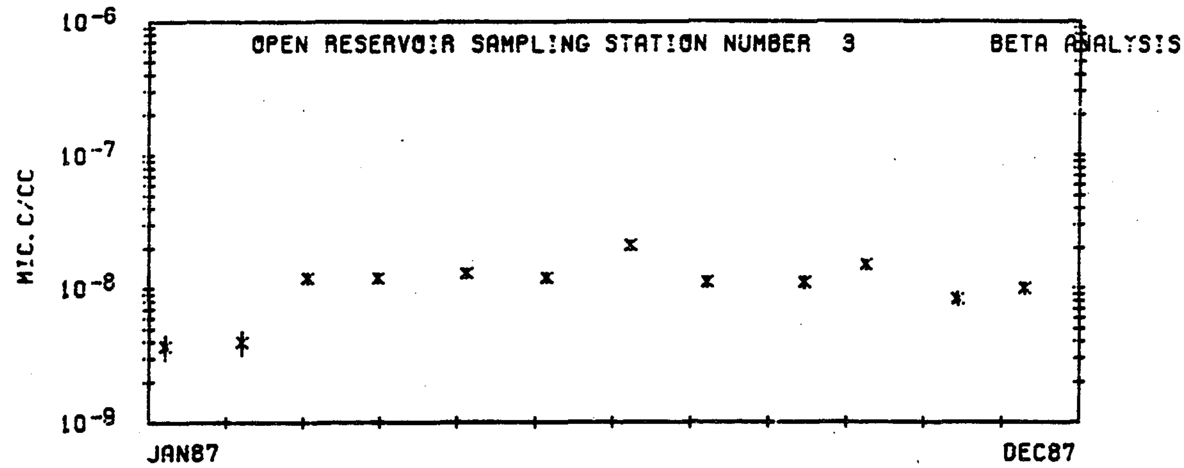

OPEN RESERVOIR NETWORK AVERAGES
BETA ANALYSIS
10 -6
10 -7
10 -8
10 -9
MIC.C/CC
JAN86
DEC86

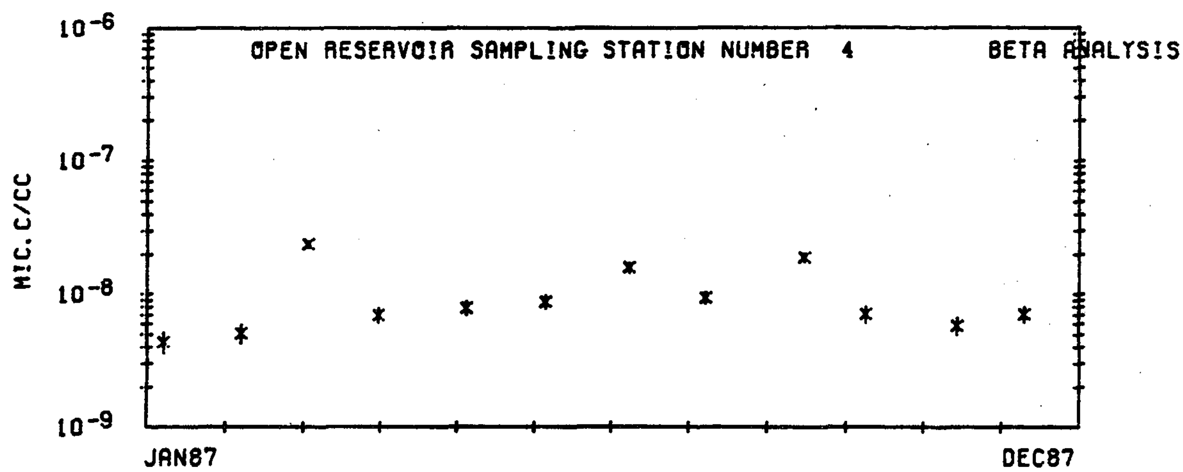


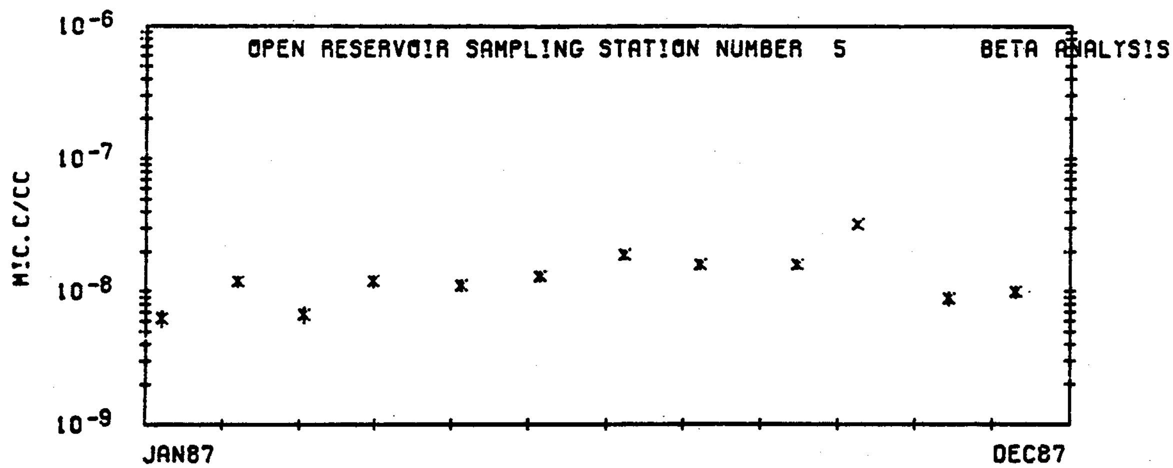
OPEN RESERVOIR NETWORK AVERAGES
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
JAN86
DEC86


OPEN RESERVOIR SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC. C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87

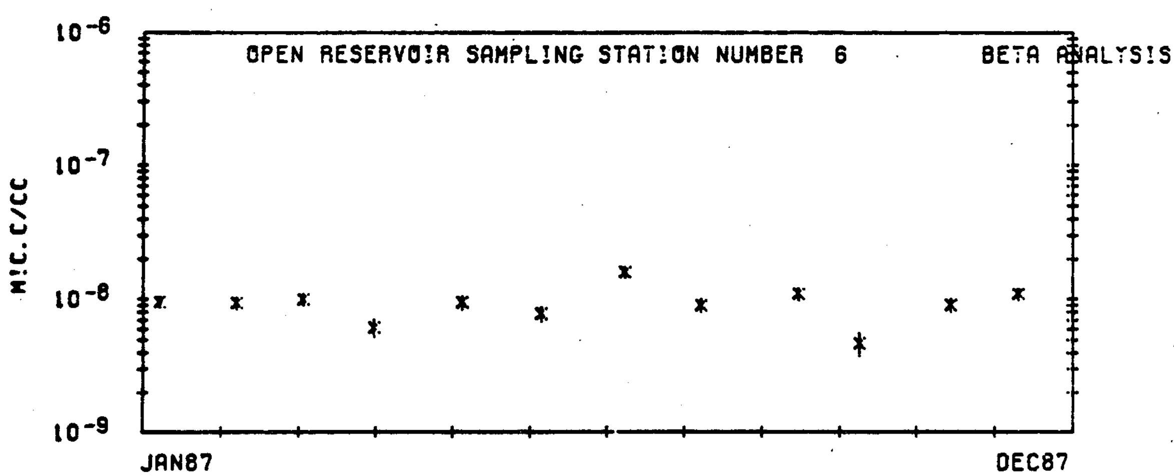

OPEN RESERVOIR SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC. C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87


OPEN RESERVOIR SAMPLING STATION NUMBER 3
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC. C/CC
JAN87
DEC87

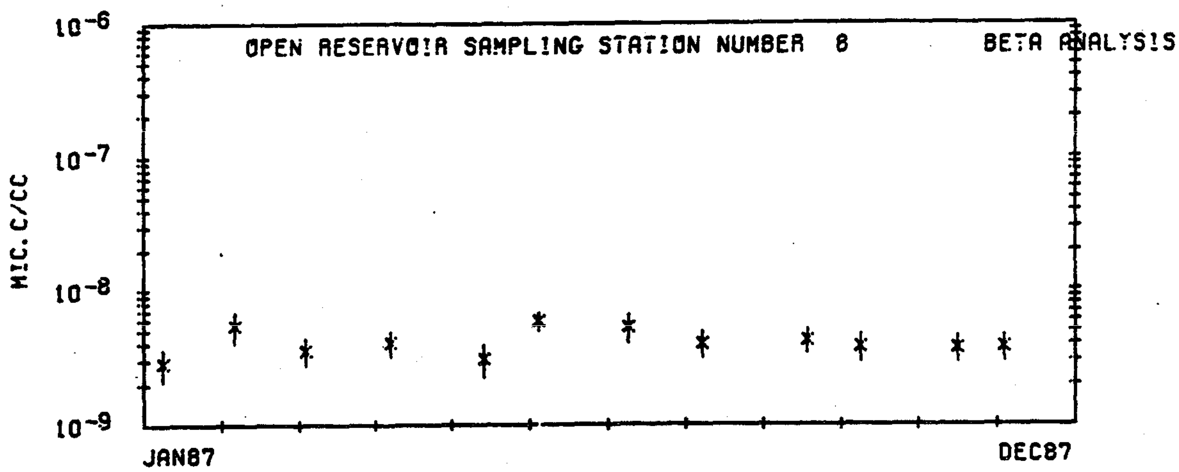

OPEN RESERVOIR SAMPLING STATION NUMBER 4
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC. C/CC
JAN87
DEC87



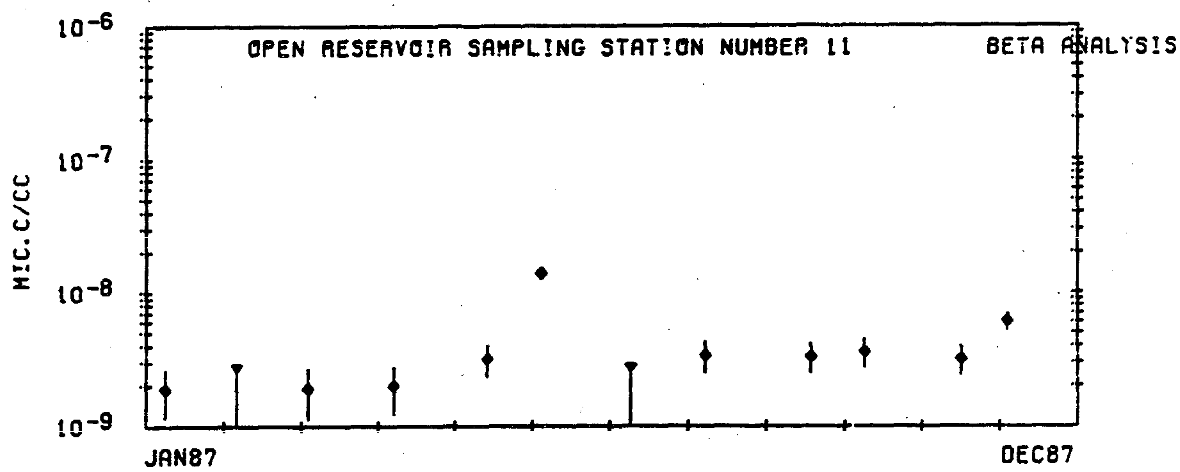
OPEN RESERVOIR SAMPLING STATION NUMBER 5
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87



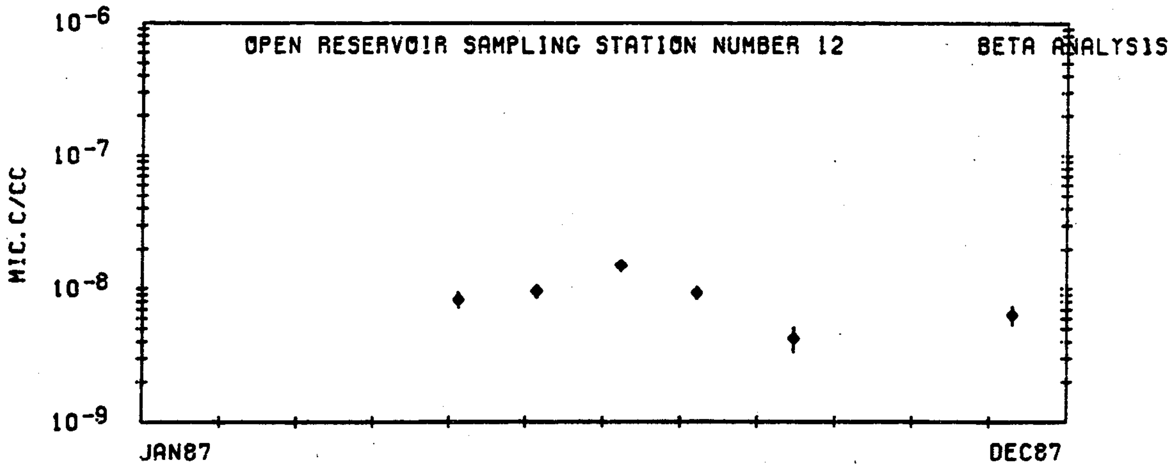
OPEN RESERVOIR SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87



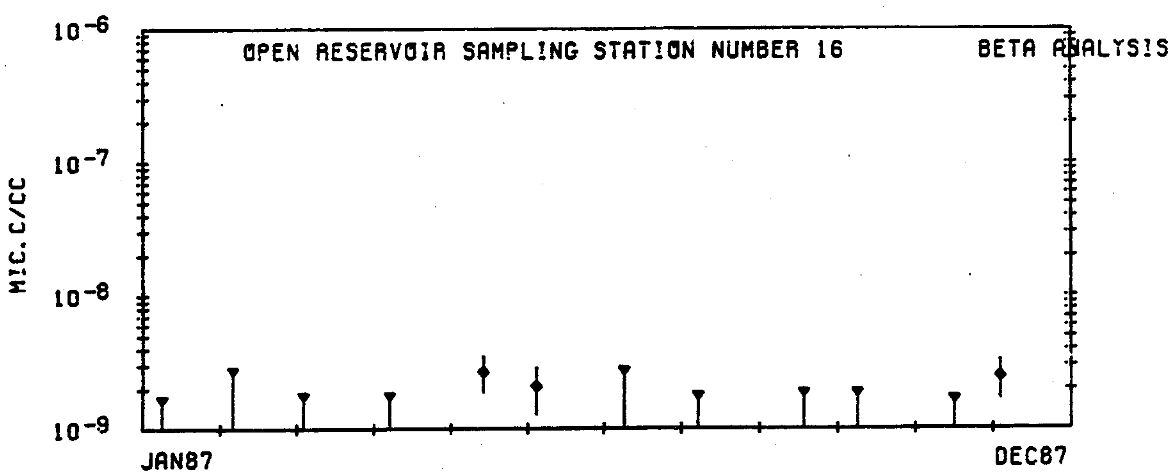
OPEN RESERVOIR SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87



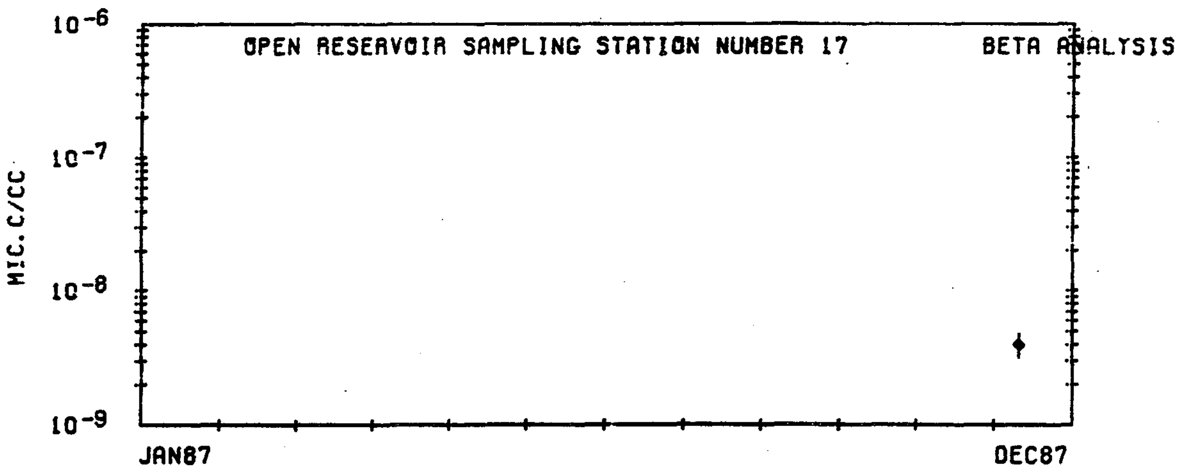
OPEN RESERVOIR SAMPLING STATION NUMBER 11
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87

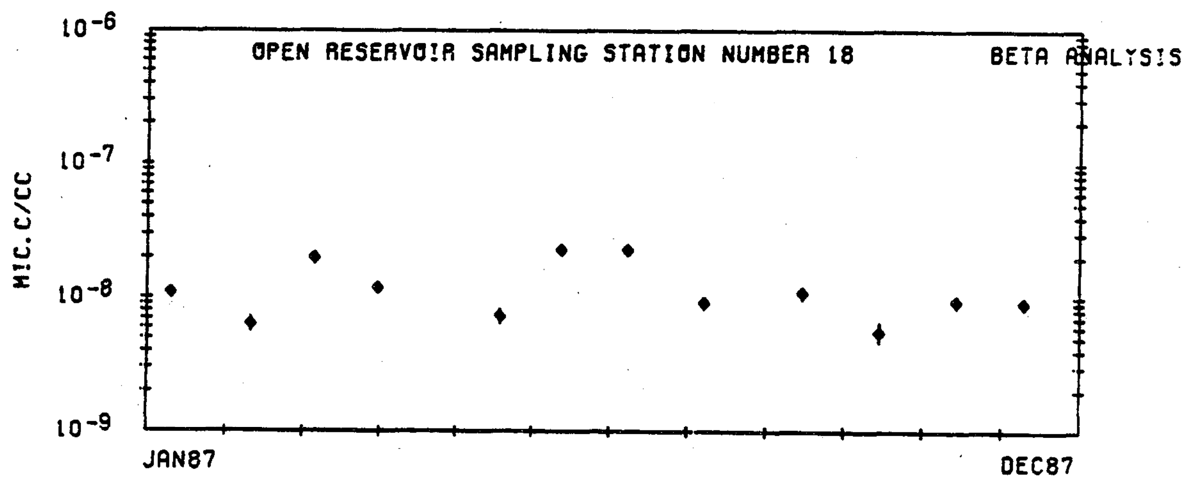


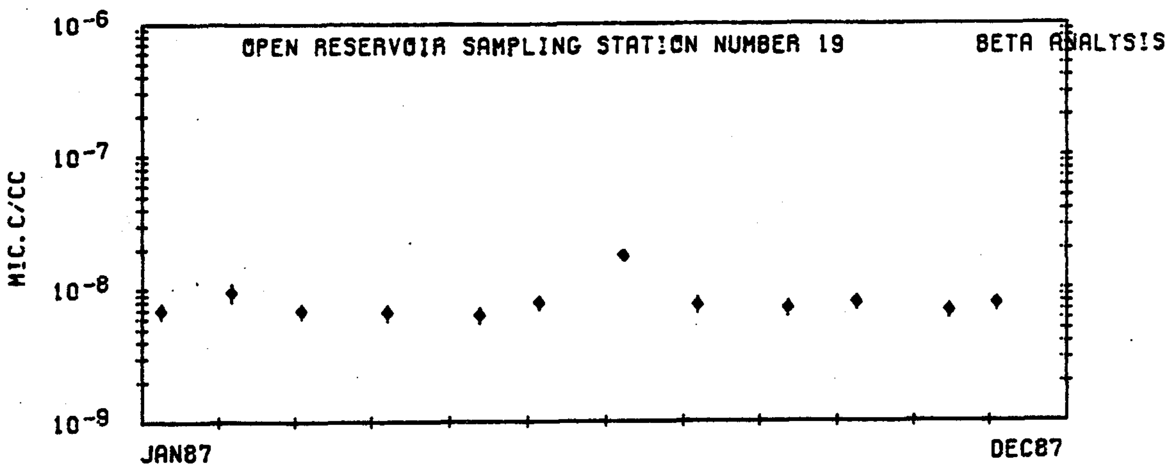
OPEN RESERVOIR SAMPLING STATION NUMBER 12
BETA ANALYSIS
MIC. C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87



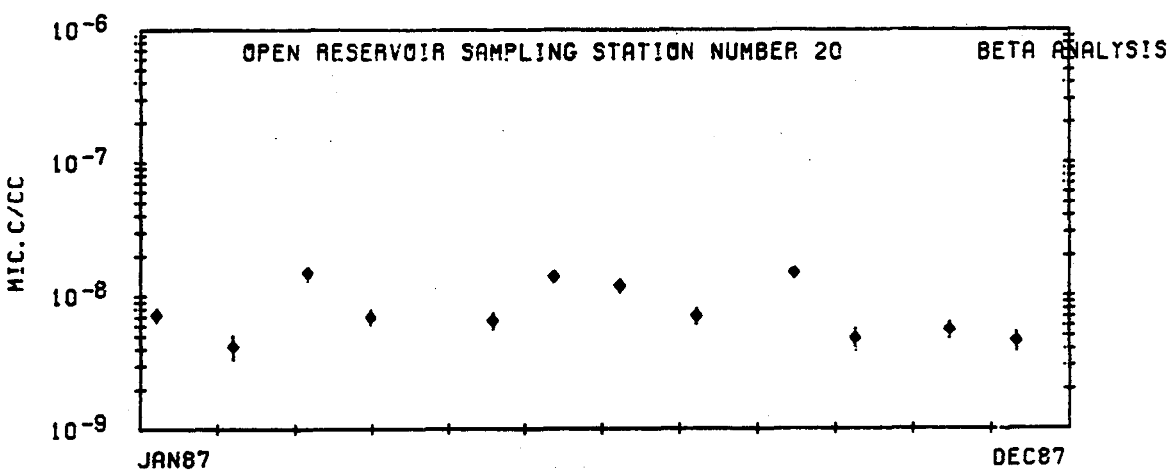
OPEN RESERVOIR SAMPLING STATION NUMBER 16
BETA ANALYSIS
MIC. C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87


OPEN RESERVOIR SAMPLING STATION NUMBER 17
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87

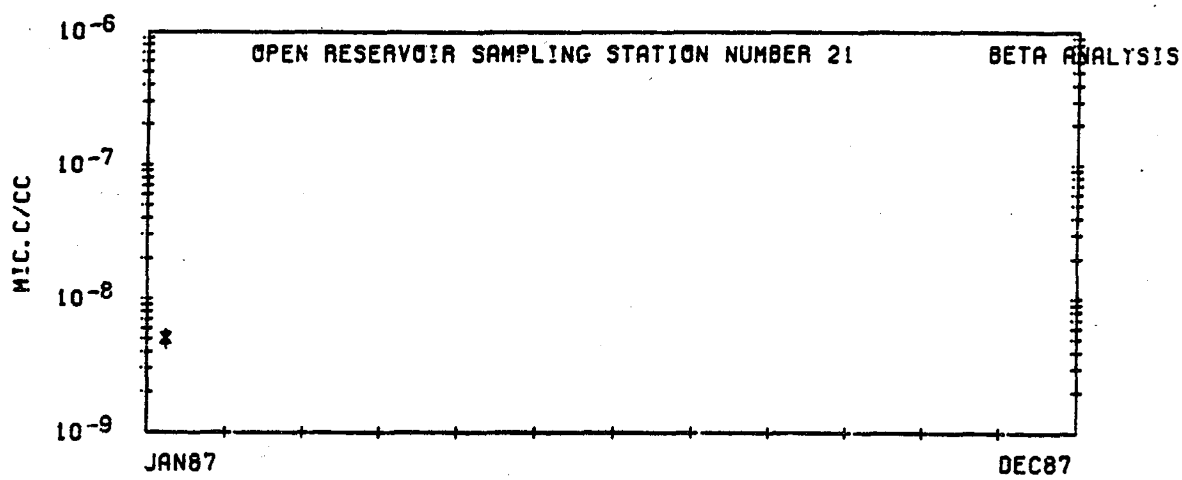

OPEN RESERVOIR SAMPLING STATION NUMBER 18
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87



OPEN RESERVOIR SAMPLING STATION NUMBER 19
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN87
DEC87



OPEN RESERVOIR SAMPLING STATION NUMBER 20
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN87
DEC87



OPEN RESERVOIR SAMPLING STATION NUMBER 21
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87

A P P E N D I X F

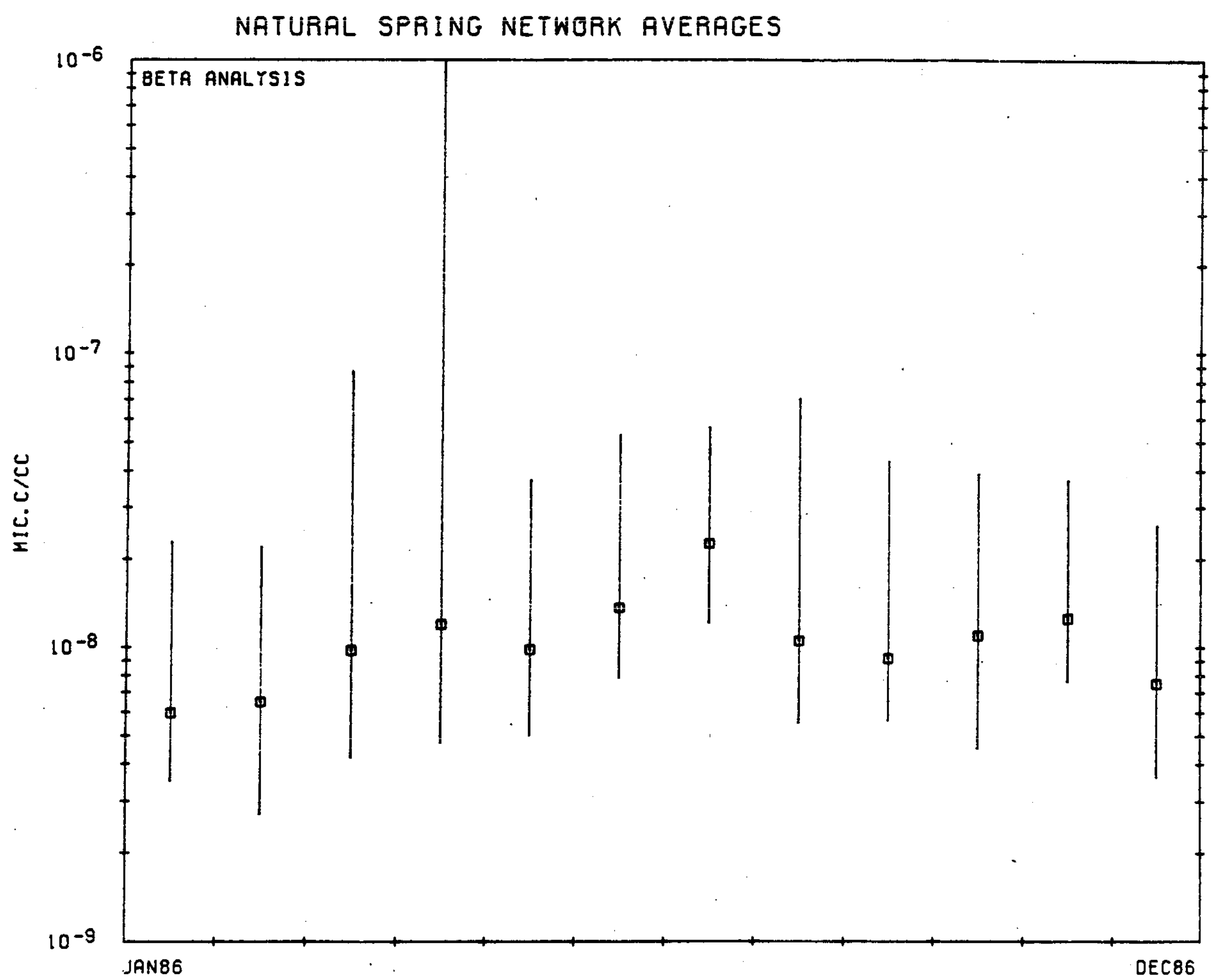
NTS Environmental Surveillance

Natural Spring Locations and Plots

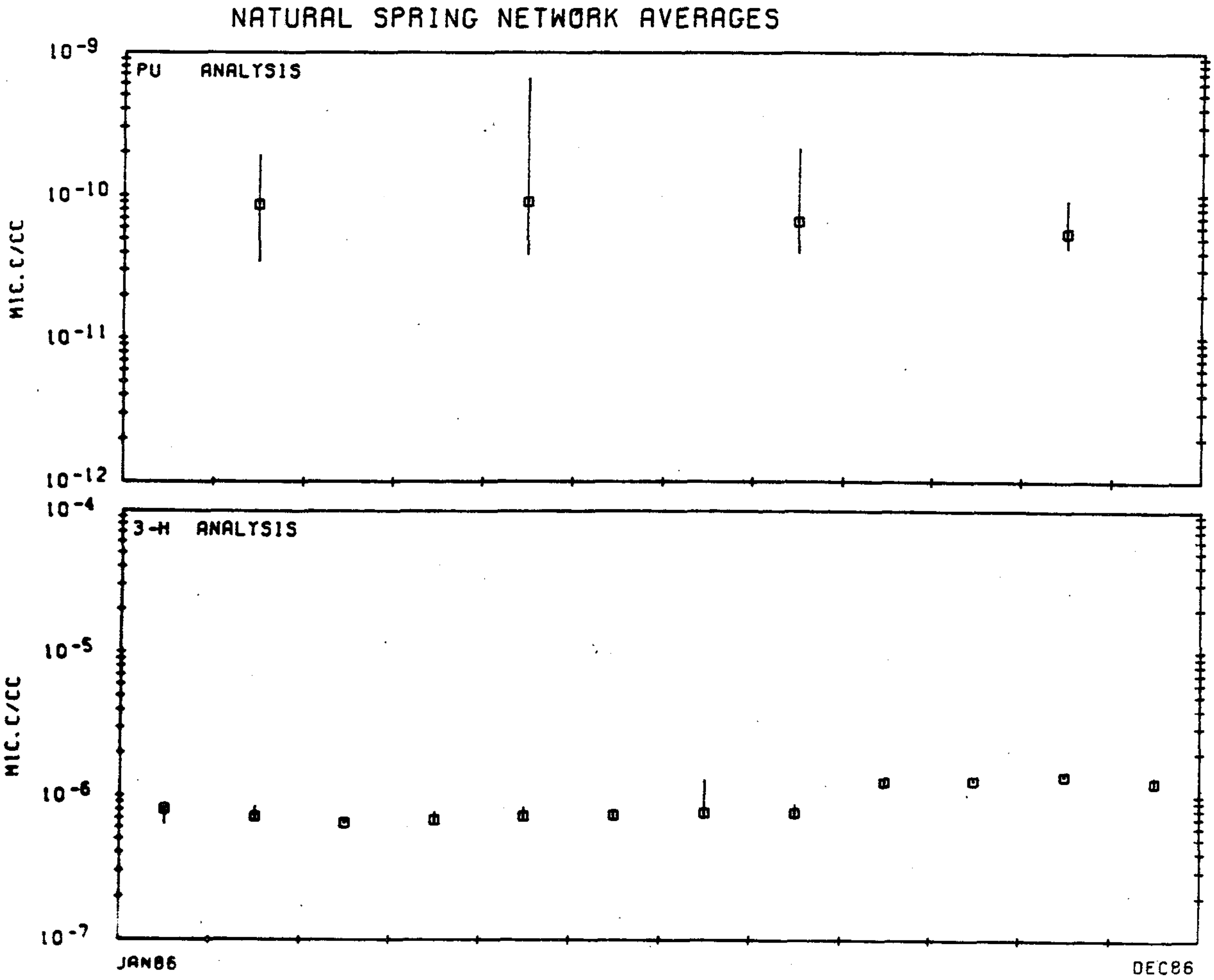
In the first two pages of plots in Appendix F, the natural springs network averages, a square is used to represent the arithmetic mean of all values at that point in time, and the vertical line is the range of the data. The remaining plots show the gross beta data of each station. A two-sigma error bar 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.

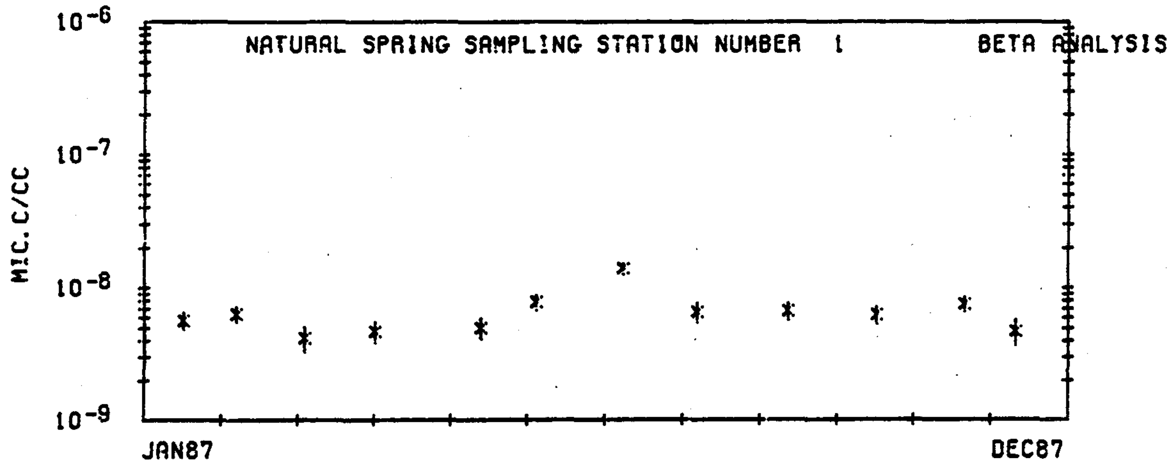
NTS ENVIRONMENTAL SURVEILLANCE
NATURAL SPRINGS SAMPLING LOCATIONS

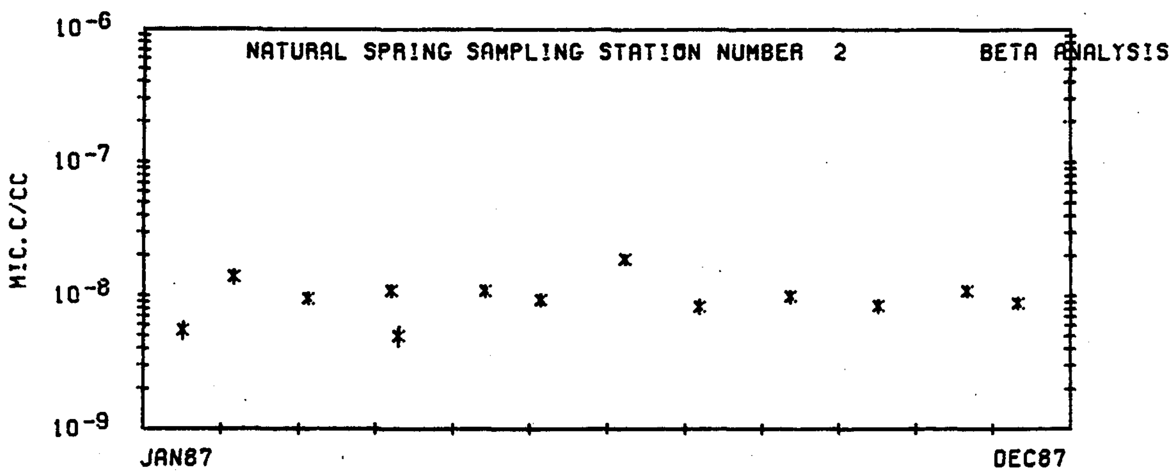
Station Number	Location
1	Area 5 Cane Springs
2	Area 12 White Rock Springs
3	Area 12 Captain Jack Spring
4	Area 12 Gold Meadows Pond
6	Area 15 Tub Spring
7	Area 29 Topopah Spring
8	Area 7 Reitmann Seep
9	Area 16 Tippipah Spring

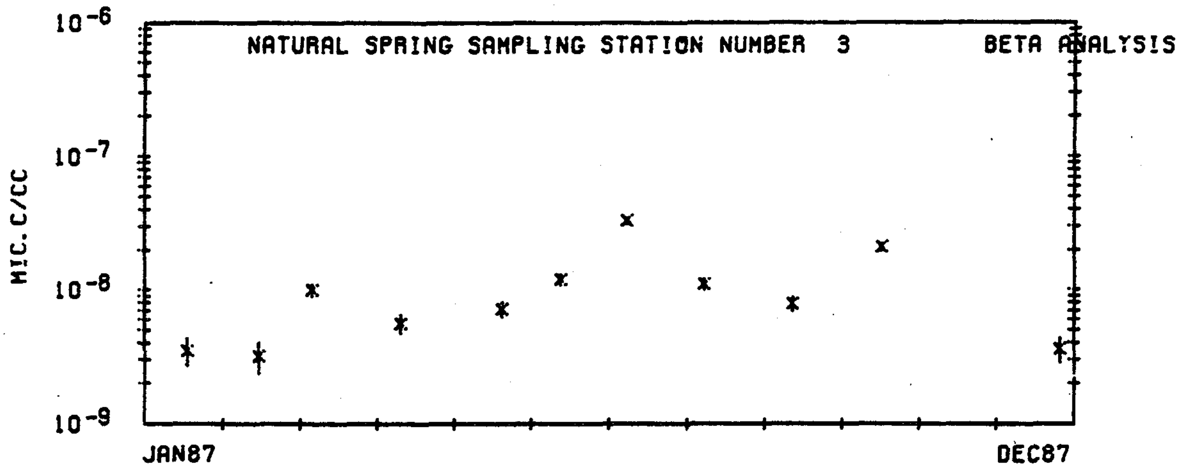


NATURAL SPRING NETWORK AVERAGES
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN86
DEC86

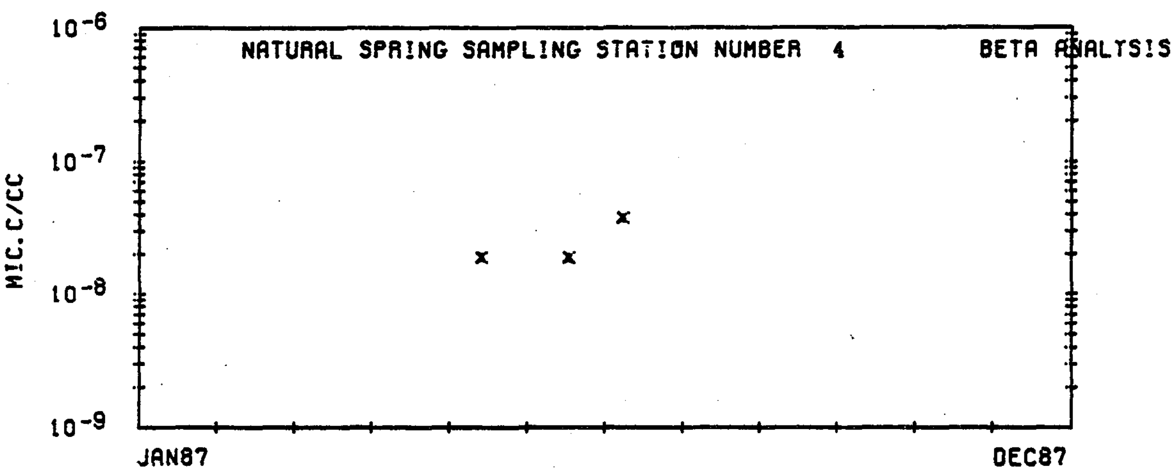

NATURAL SPRING NETWORK AVERAGES
PU ANALYSIS
MIC.C/CC
10^{-9}
10^{-10}
10^{-11}
10^{-12}
3-H ANALYSIS
MIC.C/CC
10^{-4}
10^{-5}
10^{-6}
10^{-7}
JAN86
DEC86


NATURAL SPRING SAMPLING STATION NUMBER 1
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN87
DEC87

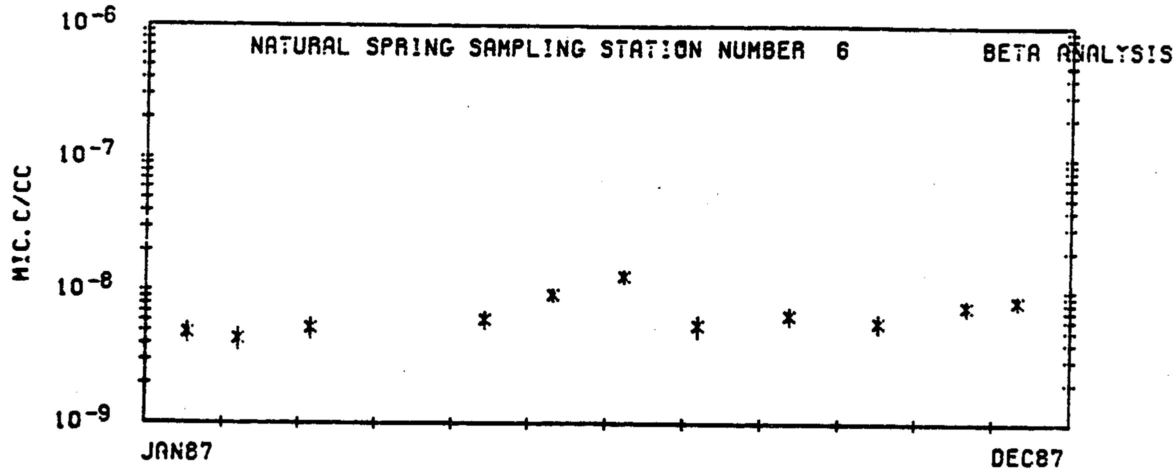

NATURAL SPRING SAMPLING STATION NUMBER 2
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN87
DEC87

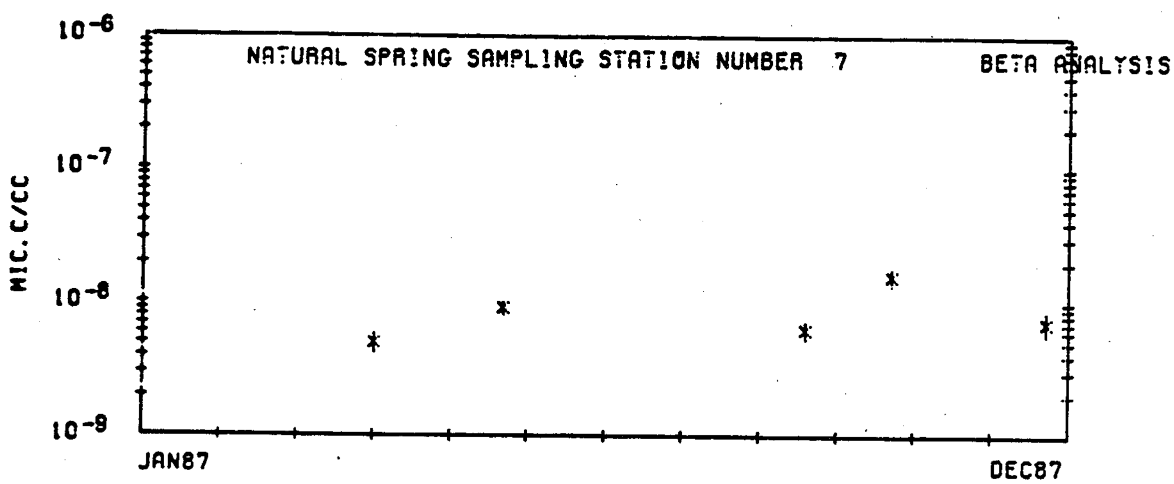


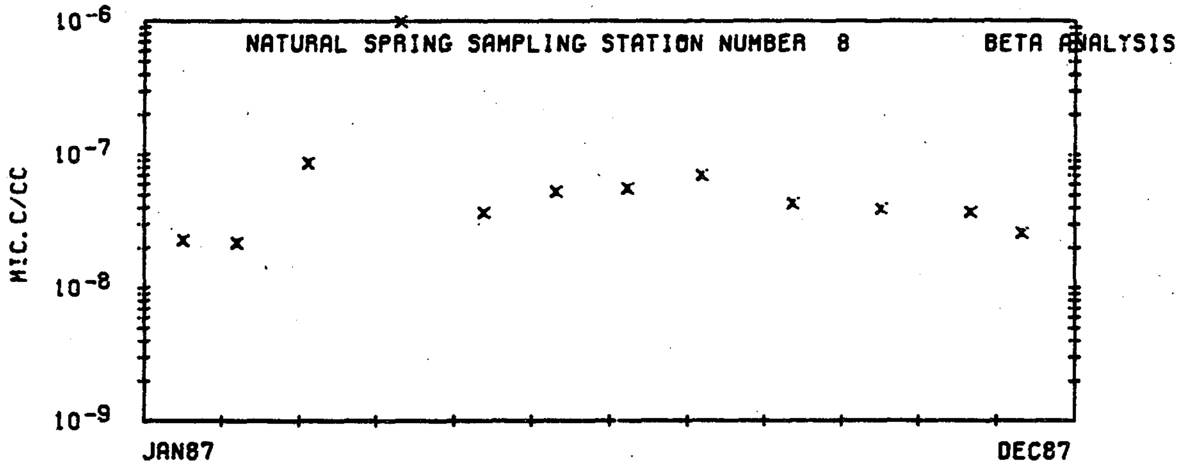
NATURAL SPRING SAMPLING STATION NUMBER 3
BETA ANALYSIS
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
MIC.C/CC
JAN87
DEC87

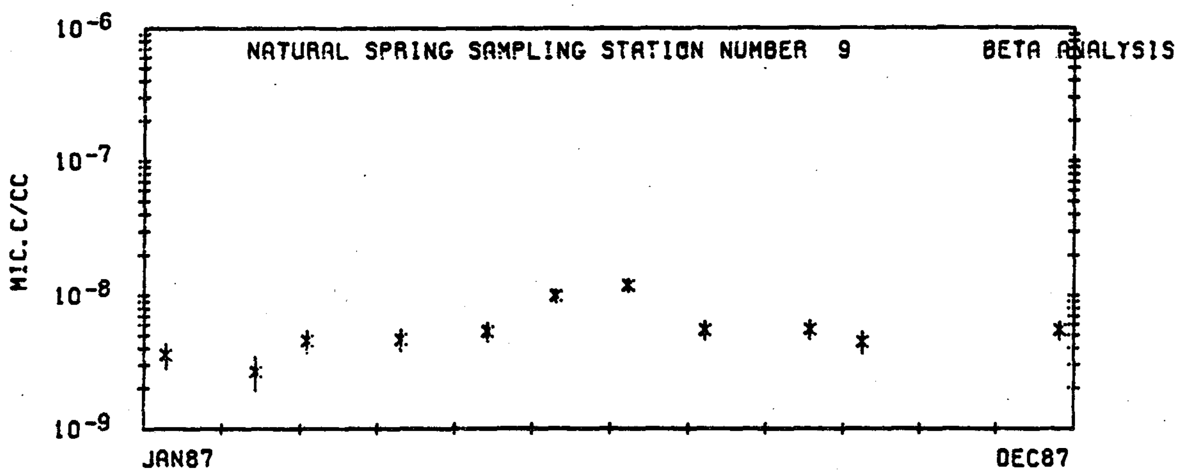


NATURAL SPRING SAMPLING STATION NUMBER 4
BETA ANALYSIS
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
MIC.C/CC
JAN87
DEC87


NATURAL SPRING SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87


NATURAL SPRING SAMPLING STATION NUMBER 7
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN87
DEC87


NATURAL SPRING SAMPLING STATION NUMBER 8
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN87
DEC87


NATURAL SPRING SAMPLING STATION NUMBER 9
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JAN87
DEC87

A P P E N D I X   G

NTS Environmental Surveillance
Contaminated Pond Locations and Plots

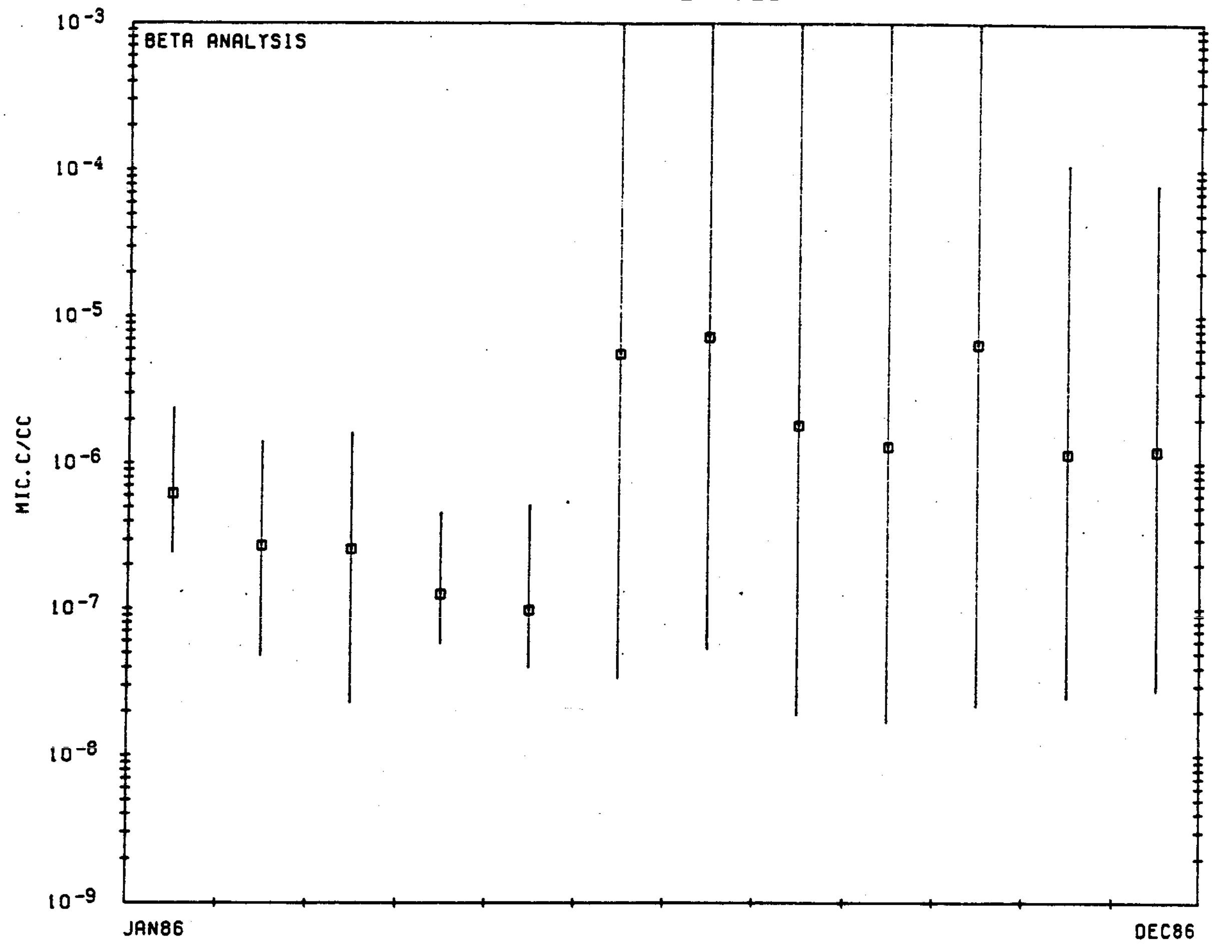
In the first two pages of plots in Appendix G, the contaminated pond network averages, a square is used to represent the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

The remaining plots show the gross beta of each station. 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.

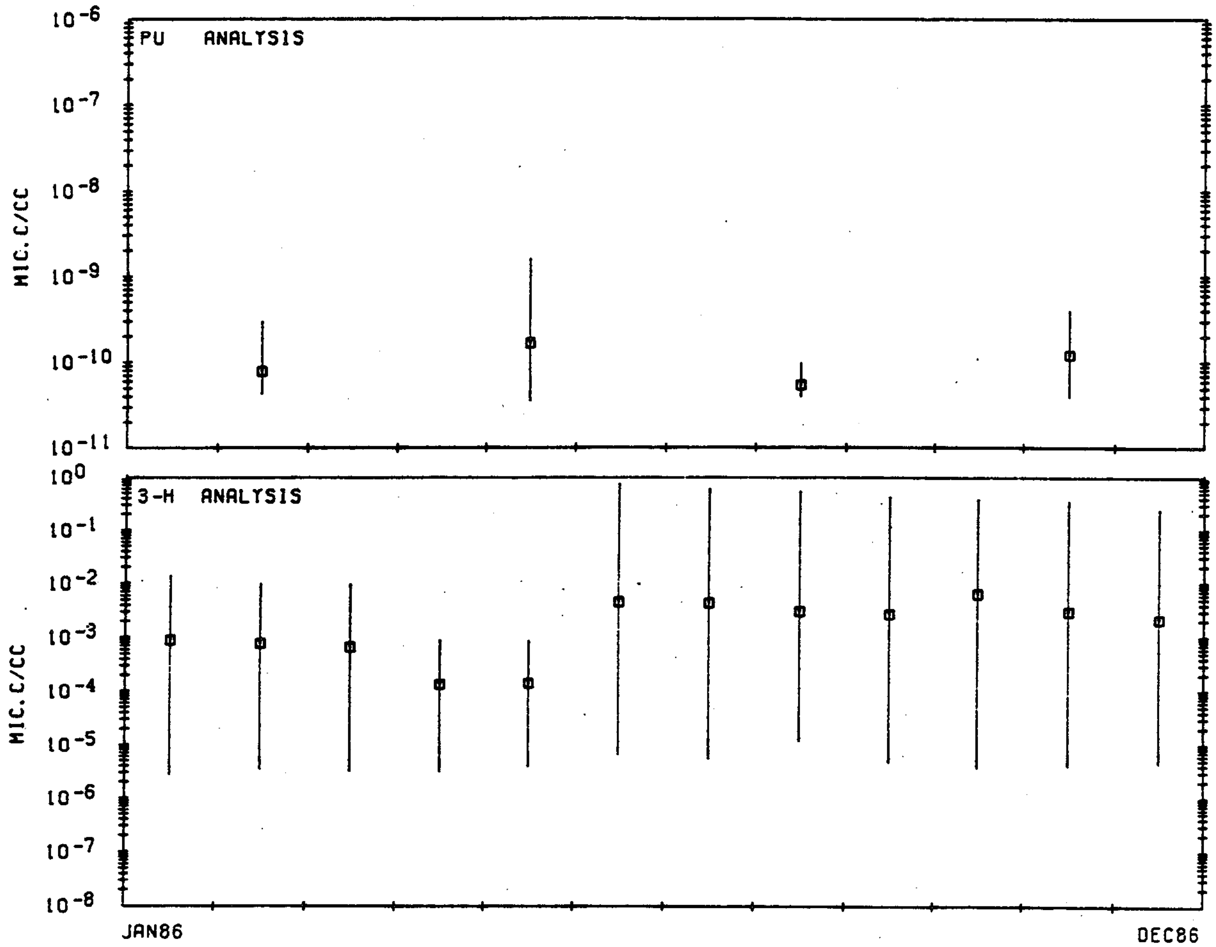
NTS ENVIRONMENTAL SURVEILLANCE
CONTAMINATED PONDS SAMPLING LOCATIONS

Station Number	Location
6	Area 12 T-Tunnel #1
7	Area 12 T-Tunnel #2
8	Area 12 N-Tunnel #3
9	Area 12 N-Tunnel #1
10	Area 12 N-Tunnel #2
12	Area 12 T-Tunnel Effluent
13	Area 6 Yucca Decontamination Pond

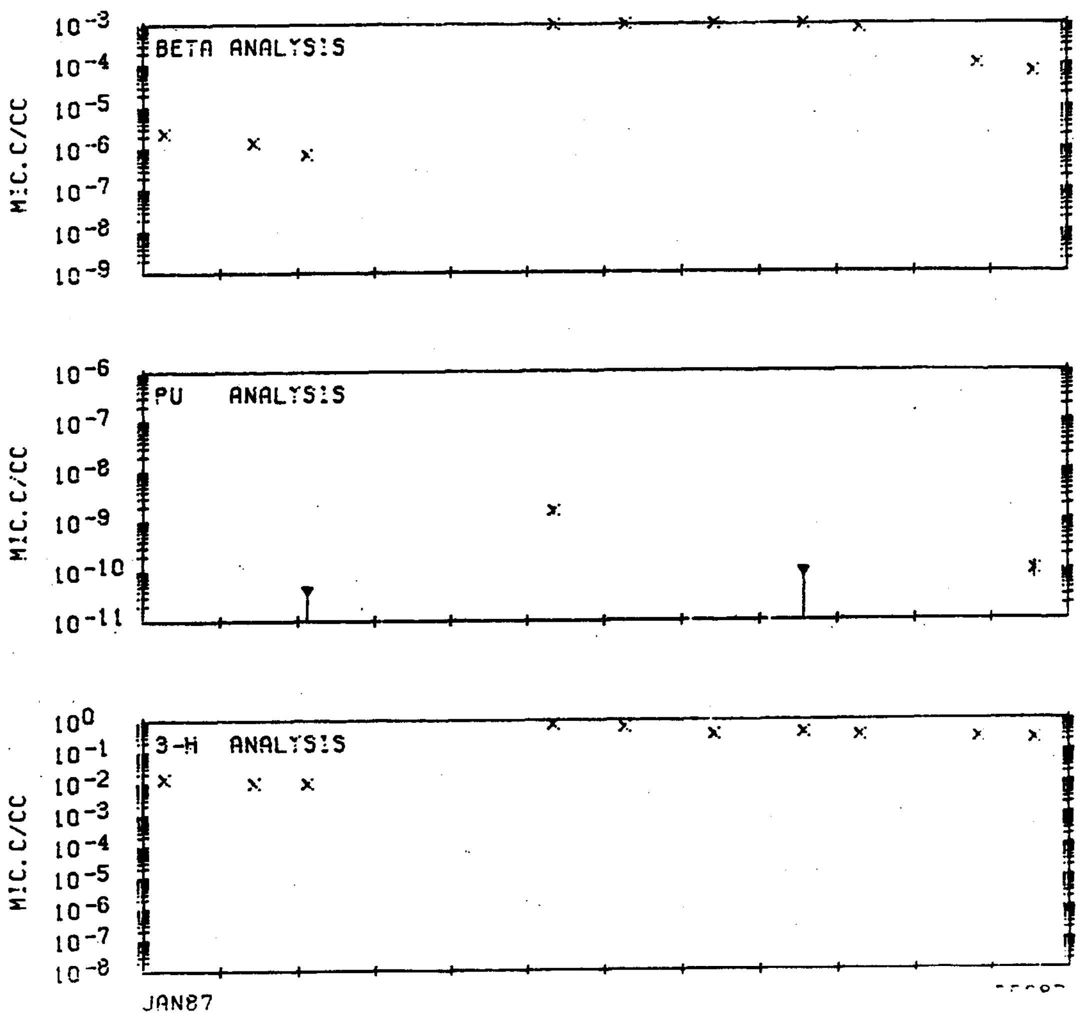
CONTAMINATED POND NETWORK AVERAGES



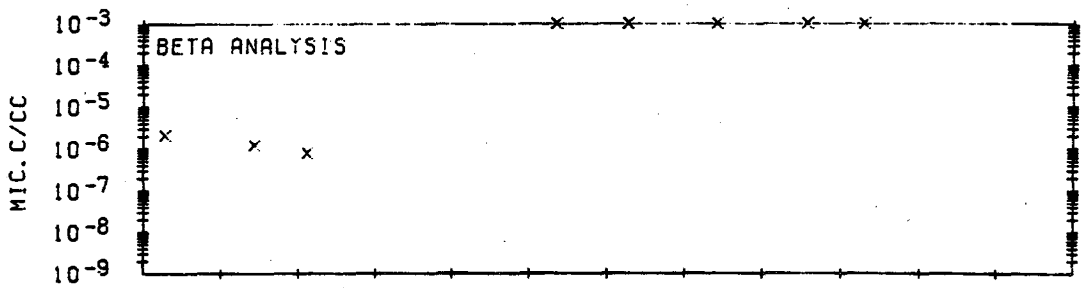
CONTAMINATED POND NETWORK AVERAGES

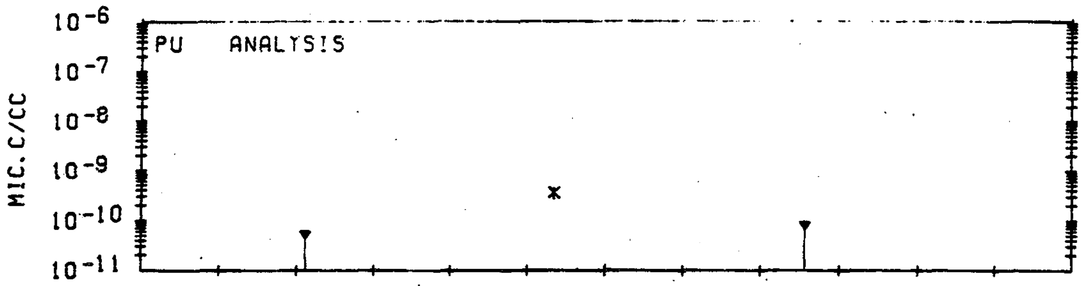


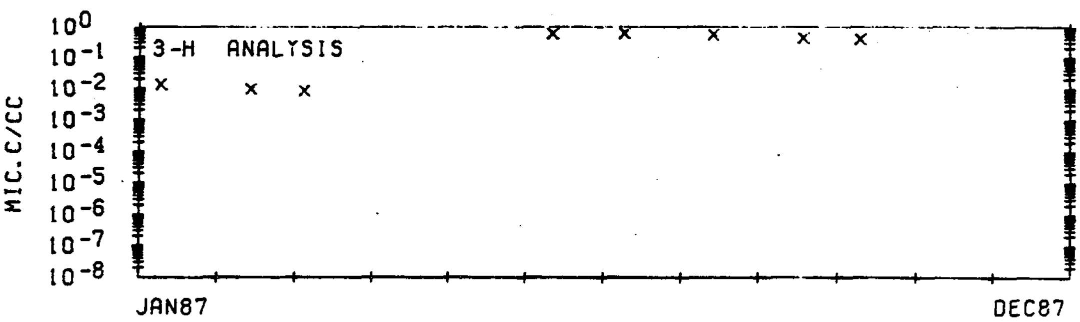
CONTAMINATED POND SAMPLING STATION NUMBER 6



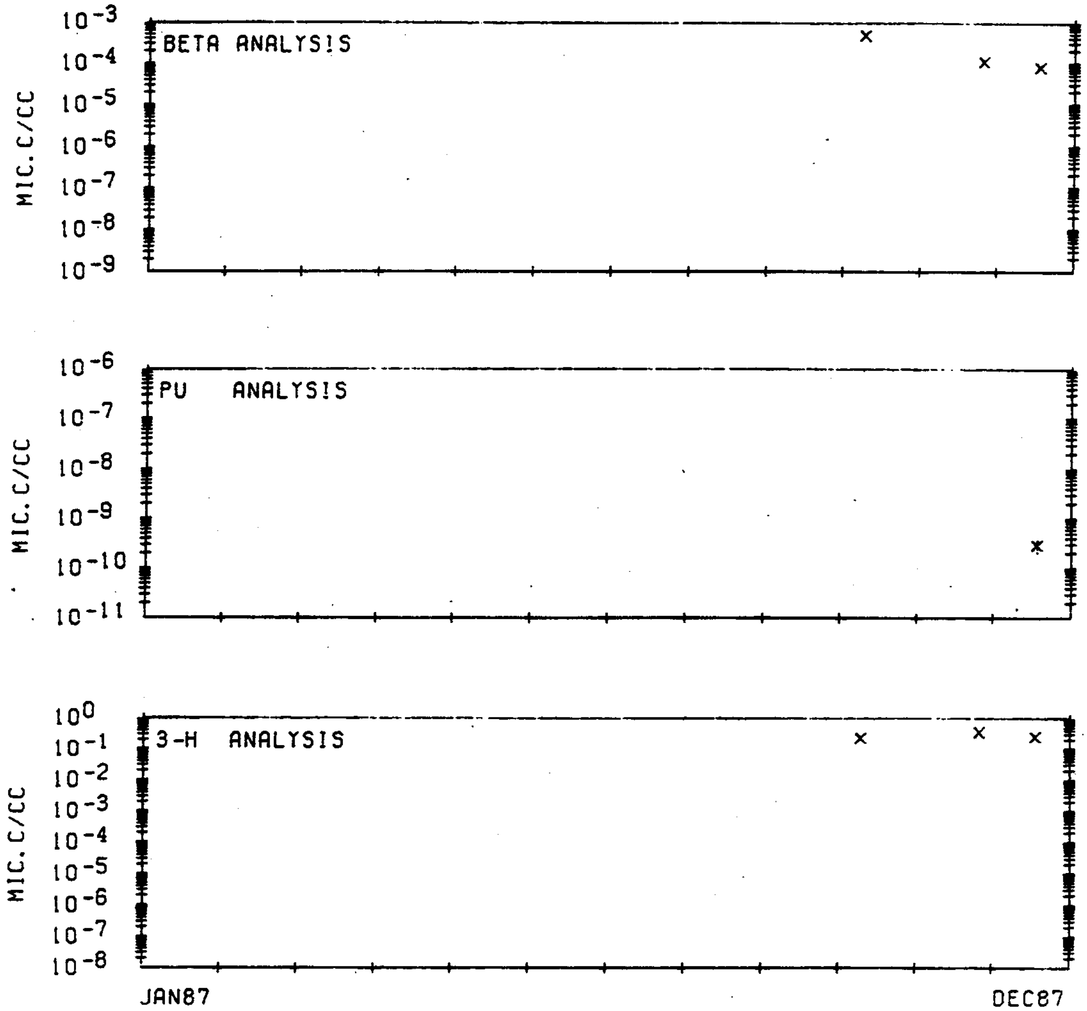
CONTAMINATED POND SAMPLING STATION NUMBER 7



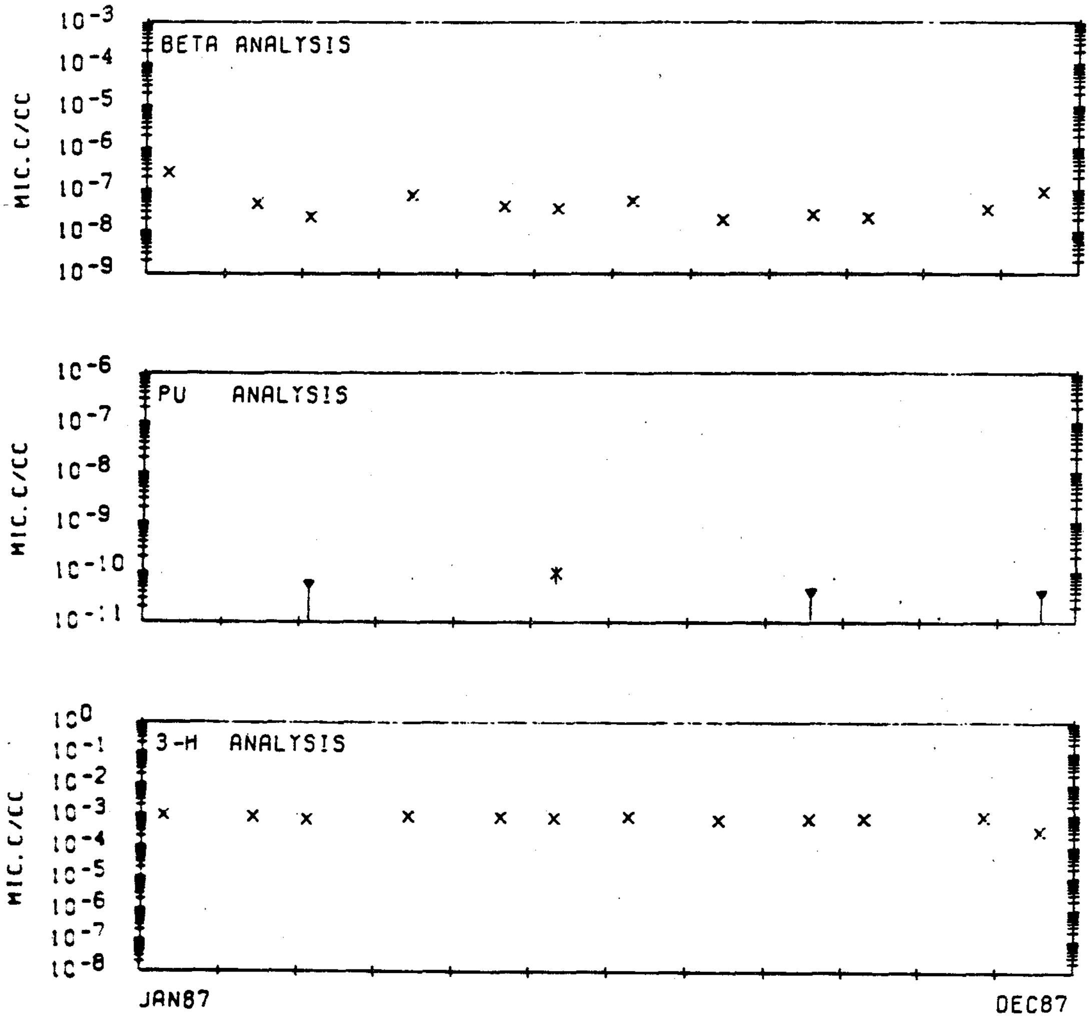


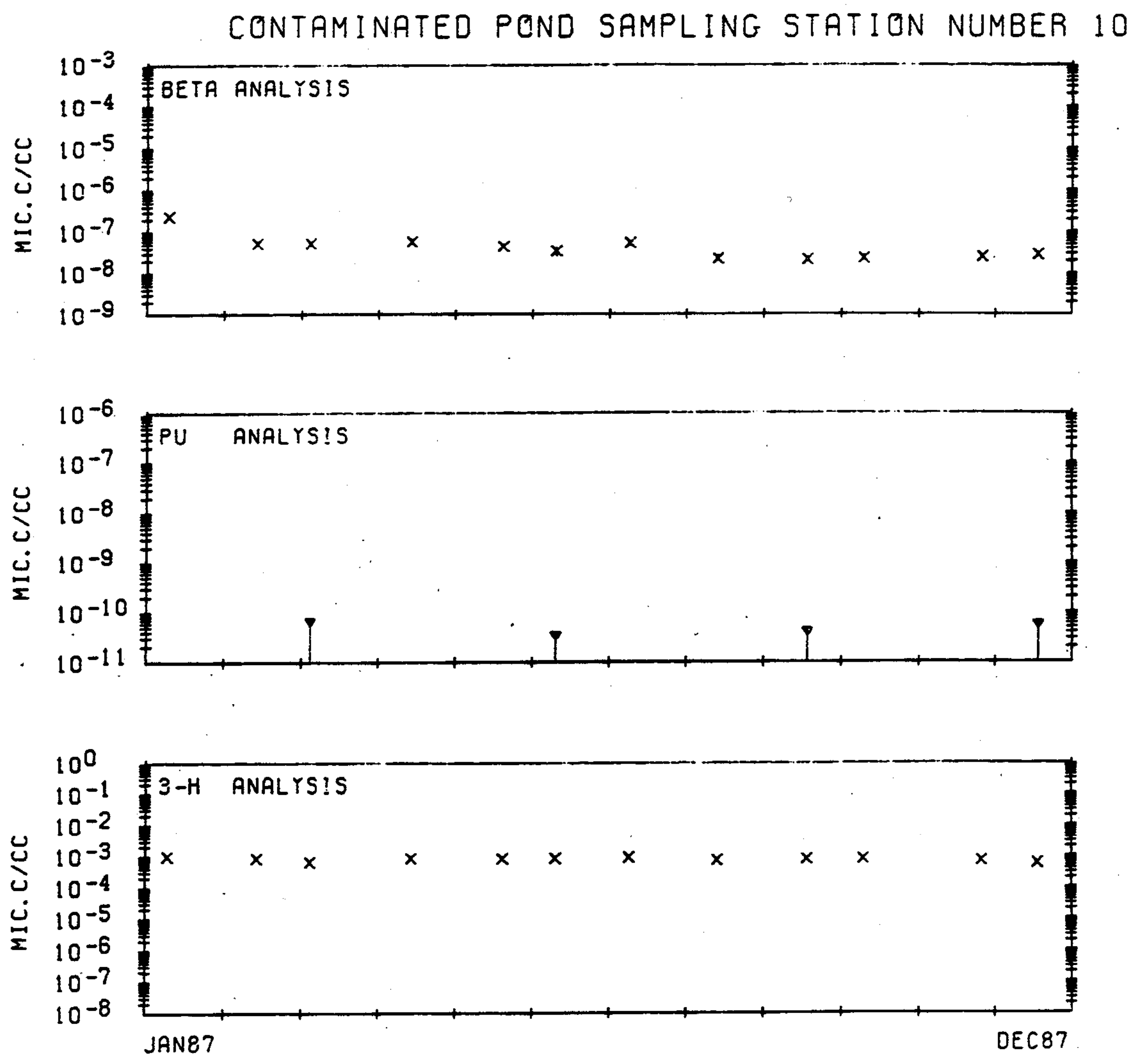


CONTAMINATED POND SAMPLING STATION NUMBER 8

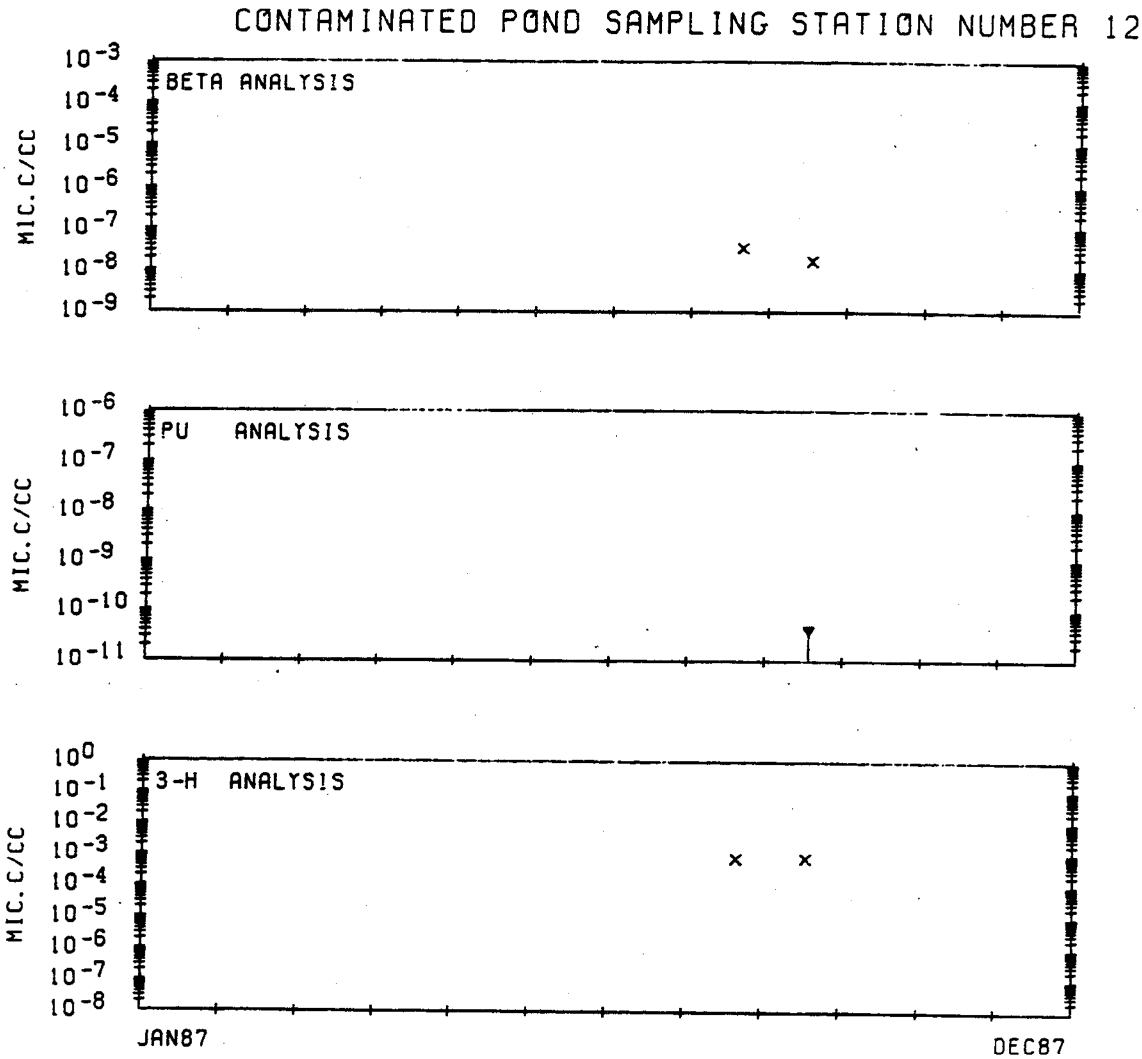


CONTAMINATED POND SAMPLING STATION NUMBER 9





CONTAMINATED POND SAMPLING STATION NUMBER 10
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{0}
10^{-1}
10^{-2}
JAN87
DEC87



CONTAMINATED POND SAMPLING STATION NUMBER 12
BETA ANALYSIS
MIC.C/CC
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
PU ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
3-H ANALYSIS
MIC.C/CC
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
JAN87
DEC87

CONTAMINATED POND SAMPLING STATION NUMBER 13