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Kewaunee Nuclear Power Plant
Operated by Nuclear Management Company, LLC

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ANNUAL ENVIRONMENTAL MONITORING REPORT JANUARY-DECEMBER 2003

Enclosed is the 2003 Annual Environmental Monitoring Report for the Kewaunee Nuclear Power Plant (KNPP). This report was prepared by Environmental Inc. and satisfies the requirements of KNPP Technical Specification 6.9.b.1.

The results of the 2003 Land Use Census, submitted in accordance with KNPP's Offsite Dose Calculation Manual, Section 3/4.7.1, are also included in this report.

Thomas Coutu

Thomas Coutu
Site Vice-President, Kewaunee Nuclear Power Plant
Nuclear Management Company, LLC

cc: US NRC, Region III
US NRC Senior Resident Inspector

Enclosure

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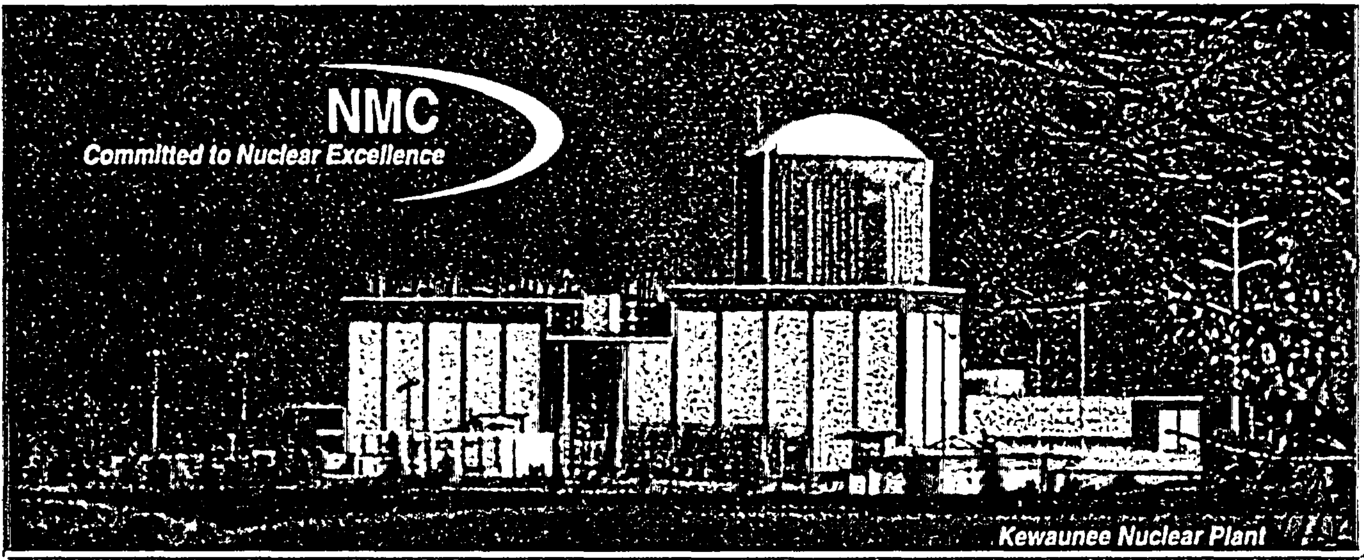
KEWAUNEE NUCLEAR POWER PLANT

ANNUAL ENVIRONMENTAL MONITORING REPORT

January/December 2003



Kewaunee Nuclear Plant

NUCLEAR MANAGEMENT COMPANY, LLC

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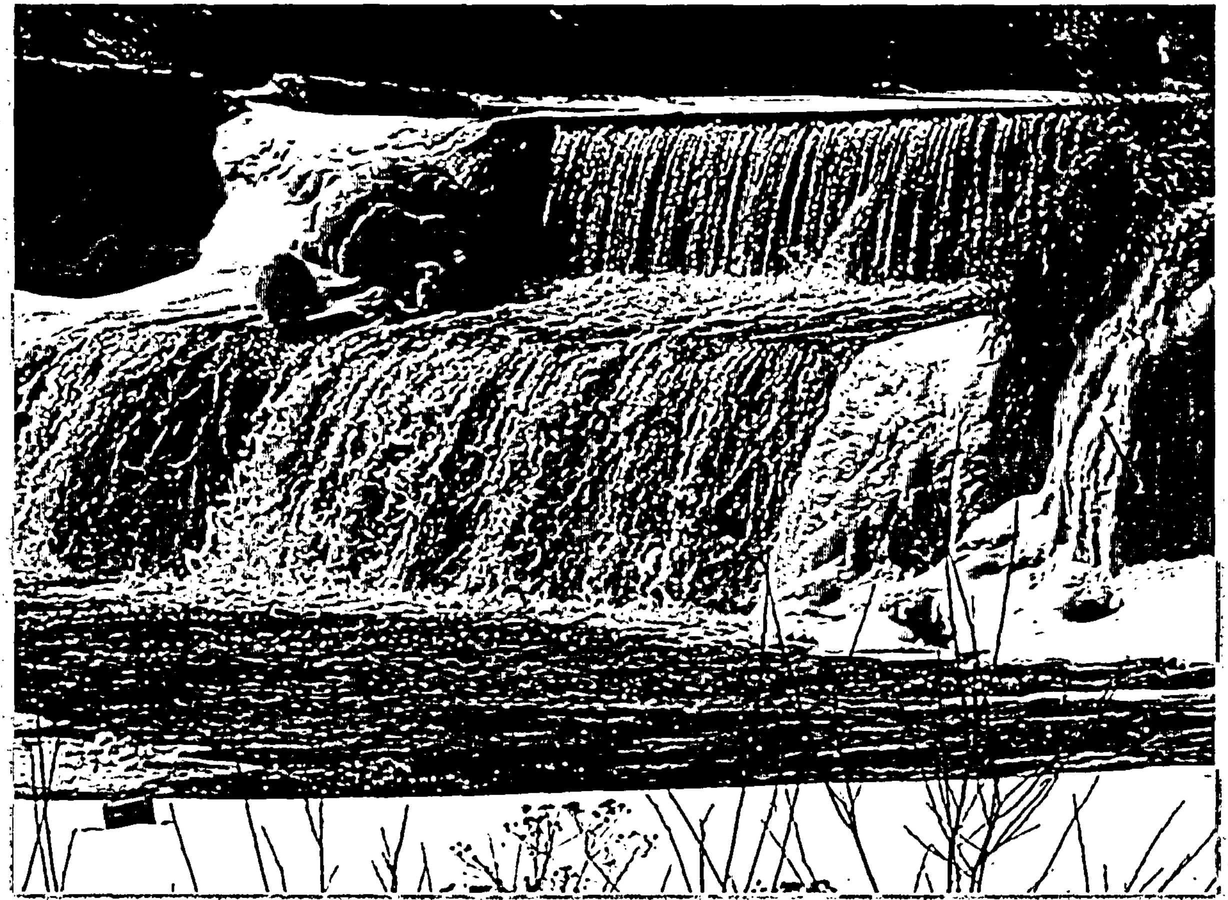
KEWAUNEE NUCLEAR POWER PLANT

ANNUAL REPORT PART I

PROGRAMMATIC REVIEW OF SAMPLING RESULTS



Shoto Dam in Winter

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REPORT TO

NUCLEAR MANAGEMENT CO, LLC

RADIOLOGICAL MONITORING PROGRAM FOR THE KEWAUNEE NUCLEAR POWER PLANT KEWAUNEE, WISCONSIN

ANNUAL REPORT - PART I
SUMMARY AND INTERPRETATION

January 1 to December 31, 2003

Prepared and submitted by:

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PREFACE

The staff of Environmental, Inc., Midwest Laboratory were responsible for the acquisition of data presented in this report. Assistance in sample collection was provided by Kewaunee Nuclear Power Plant personnel. The report was prepared by staff members of Environmental, Inc., Midwest Laboratory.

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1.0 INTRODUCTION

The Kewaunee Nuclear Power Plant is a 598 megawatt pressurized water reactor located on the Wisconsin shore of Lake Michigan in Kewaunee County. The Plant became critical on March 7, 1974. Initial power generation was achieved on April 8, 1974, and the Plant was declared commercial on June 16, 1974. This report summarizes the environmental operation data collected during the period January - December 2003.

Nuclear Management Company, LLC, an operating company for the Kewaunee Nuclear Power Plant, assumes the responsibility for the environmental program at the Plant and any questions relating to this subject should be directed to Mr. Stanley F. Baker, Radiation Protection Manager, at (920) 388-8103.

2.0 SUMMARY

Results of sample analyses during the period January - December 2003 are summarized in Table 4.5. Radionuclide concentrations measured at indicator locations are compared with levels measured at control locations and in preoperational studies. The comparisons indicate background-level radioactivities in all samples collected.

3.0 RADIOLOGICAL SURVEILLANCE PROGRAM

Following is a description of the Radiological Surveillance Program and its execution.

3.1 Methodology

The sampling locations are shown in Figure 4-1. Table 4.1 describes the locations, lists for each direction and distance from the reactor, and indicates which are indicators and which are control locations.

The sampling program monitors the air, terrestrial, and aquatic environments. The types of samples collected at each location and the frequency of collections are presented in Table 4.2, using sample codes defined in Table 4.3. The collections and analyses that comprise the program are described below. Finally, the execution of the program in the current reporting year is discussed.

3.1.1 The Air Program

Airborne Particulates

The airborne particulate samples are collected on 47 mm diameter glass fiber filters at a volumetric rate of approximately one cubic foot per minute. The filters are collected weekly from six locations (K-1f, K-2, K-7, K-8, K-16 and K-31), and dispatched by mail to Environmental, Inc. for radiometric analysis. The material on the filter is counted for gross beta activity approximately 72 hours or later after collection to allow for decay of naturally-occurring short-lived radionuclides.

Quarterly composites from each sampling location are analyzed for gamma-emitting isotopes on a high-purity germanium (HPGe) detector.

Airborne Iodine

Charcoal filters are located at locations K-1f, K-2, K-7, K-8, K-16 and K-31. The filters are changed bi-weekly and analyzed for iodine-131 immediately after arrival at the laboratory.

Ambient Gamma Radiation - TLDs

The integrated gamma-ray background is measured at the six air sampling locations (K-1f, K-2, K-7, K-8, K-16 and K-31), at four milk sampling locations (K-3, K-5, K-25 and K-39), and four additional sites (K-15, located 9.25 miles northwest of the plant; K-17, located 4.25 miles west of the plant; K-27, located 1.5 miles northwest of the plant and K-30, located 1.0 miles north of the plant) by thermoluminescent dosimetry (TLDs). Two TLD cards, each having four main readout areas containing $CaSO_4$:Dy phosphor, are placed at each location (eight TLDs at each location). One card is exchanged quarterly, the other card is exchanged annually and read only on an emergency basis.

Precipitation

Monthly composites of precipitation samples collected at K-11 are analyzed for tritium activity and counted using a liquid scintillation method.

3.1.2 The Terrestrial Program

Milk

Milk is collected semimonthly from May through October, and monthly during the rest of the year from five herds that graze within four miles of the reactor site (K-5, K-25, K-34, K-38 and K-39), from one herd grazing between four and ten miles from the reactor site (K-3), and from a dairy in Green Bay (K-28). The samples are analyzed for iodine-131, strontium-89 and -90, cesium-137, barium-lanthanum-140, potassium-40, calcium and stable potassium.

Well Water

One gallon of water is collected quarterly from four off-site wells located at K-10, K-11, K-13 and K-25 and from two on-site wells located at K-1g and K-1h.

Gamma spectroscopic analyses and gross beta on the total residue are performed for each water sample. The concentration of potassium-40 is calculated from total potassium, determined by atomic absorption, on all samples.

Additionally, samples of water from two on-site wells (K-1g and K-1h) are analyzed for gross alpha. Water from the on-site well (K-1g) is also analyzed for tritium, strontium-89 and strontium-90.

Domestic Meat

Domestic meat samples are obtained annually (in the third quarter) at locations K-24, K-29, K-32 and K-34 (if available). The flesh is separated from the bones and analyzed for gross alpha, gross beta and gamma emitting isotopes.

Eggs

Eggs are collected quarterly from locations K-24, K-27 (if available) and K-32. Samples are analyzed for gross beta, strontium-89, strontium-90 and gamma-emitting isotopes.

Vegetables

Vegetable samples (6 varieties) are collected at locations K-17 and K-26, and two varieties of grain, if available, at location K-23. The samples are analyzed for gross beta, strontium-89 and -90, and gamma emitting isotopes.

Grass and Cattle Feed

Grass is collected during the second, third and fourth quarters from two on-site locations (K-1b and K-1f) and from the dairy farm locations. Cattle feed is collected during the first quarter from the same farms. The samples are analyzed for gross beta, strontium-89 and -90, and gamma emitting isotopes.

Soil

Soil samples are collected twice a year on-site at K-1f and from the dairy farm locations (K-3, K-5, K-25, K-34, K-37 and K-38). The samples are analyzed for gross alpha, gross beta, strontium-89, strontium-90 and gamma emitting isotopes.

3.1.3 The Aquatic Program

Surface Water

One-gallon water samples are taken monthly from three locations on Lake Michigan: 1) at the point where the condenser water is discharged into Lake Michigan (K-1d); 2) Two Creeks Park (K-14) located 2.5 miles south of the reactor site; and 3) at the main pumping station located approximately equidistant from Kewaunee and Green Bay, which pumps water from the Rostok water intake (K-9) located 11.5 miles north of the reactor site. Both raw and tap water are collected at K-9. One-gallon water samples are taken monthly from three creeks that pass through the site (K-1a, K-1b, and K-1e). Samples from North and Middle Creeks (K-1a, K-1b) are collected near the mouth of each creek. Samples from the South Creek (K-1e) are collected about ten feet downstream from the point where the outflow from the two drain pipes meet. Additionally, the drainage pond (K-1k), located approximately 0.6 miles southwest of the plant, is included in the sampling program. Water samples at K-14 are collected and analyzed in duplicate.

The water is analyzed for gamma emitting isotopes, gross beta activity in total residue, dissolved solids and suspended solids, and potassium-40. The concentration of potassium-40 is calculated from total potassium, which is determined by flame photometry. In addition, quarterly composites of the monthly grab samples are analyzed for tritium, strontium-89 and strontium-90.

Fish

Fish samples are collected during the second, third and fourth quarters at location K-1d. The flesh is separated from the bones, gamma scanned and analyzed for gross beta activity. Ashed bone samples are analyzed for gross beta, strontium-89 and strontium-90 activities.

Slime

Slime samples are collected during the second and third quarters from three Lake Michigan locations (K-1d, K-9 and K-14), from three creek locations (K-1a, K-1b and K-1e) and from the drainage pond (K-1k), if available. The samples are analyzed for gross beta activity. If the quantity is sufficient, they are also gamma scanned and analyzed for strontium-89 and strontium-90 activities.

Bottom Sediment

Bottom sediments are collected in May and November from five locations (K-1c, K-1d, K-1j, K-9 and K-14). The samples are analyzed for gross beta, strontium-89, strontium-90 and gamma emitting isotopes. It is known that the measured radioactivity per unit mass of sediment increases with decreasing particle size, and the sampling procedure is designed to assure collection of very fine particles.

3.1.4 Program Execution

Program execution is summarized in Table 4.4. The program was executed for the year 2003 as described in the preceding sections, with the following exceptions:

Vegetables were not available at location K-17, Jansky's Farm. The garden was discontinued. One sample of pumpkin was collected at K-29, Kunesh Farm.

Surface water was not available for the months of January, February and March, 2003 at location K-1k. The pond was frozen.

3.1.5 Program Modifications

A new indicator location, the Wojta Farm (K-39, 3.0 miles N) was added to the sampling program in July, 2003.

The two TLD cards located at K-37 (Hardtke) were moved to location K-39 (Wojta farm) starting in the second quarter of 2003.

3.2 Results and Discussion

The results for the reporting period January to December 2003 are presented in summary form in Table 4.5. For each type of analysis, of each sampled medium, this table shows the annual mean and range for all indicator and control locations. The location with the highest annual mean and the results for this location are also given.

The discussion of the results has been divided into three broad categories: the air, terrestrial, and aquatic environments. Within each category, samples will be discussed in the order listed in Table 4.4. Any discussion of previous environmental data for the Kewaunee Nuclear Power Plant refers to data collected by Environmental Inc., Midwest Laboratory.

The tabulated results of all measurements made in 2003 are not included in this section, although references to these results will be made in the discussion. A complete tabulation of results is contained in Part II of the 2003 annual report on the Radiological Monitoring Program for the Kewaunee Nuclear Power Plant.

3.2.1 Atmospheric Nuclear Detonations and Nuclear Accidents

There were no atmospheric nuclear tests or accidents reported in 2003. The last reported test was conducted by the People's Republic of China on October 16, 1980.

3.2.2 The Air Environment

Airborne Particulates

The annual gross beta concentration in air particulates measured 0.022 pCi/m^3 at both indicator control locations. The averages were almost identical to the means observed from 1992 (and prior to) through 2002. Results are tabulated below.

Year	Average of Indicators	Average of Controls
	Concentration (pCi/m^3)	
1992	0.018	0.019
1993	0.020	0.020
1994	0.016	0.018
1995	0.019	0.018
1996	0.020	0.019
1997	0.019	0.019
1998	0.019	0.019
1999	0.022	0.023
2000	0.022	0.021
2001	0.024	0.023
2002	0.023	0.023
2003	0.022	0.022

Average annual gross beta concentrations in airborne particulates.

Airborne Particulates (continued)

Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded similar results for indicator and control locations. Beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation (Arnold and Al-Salih, 1955), was detected in all samples. All other gamma-emitting isotopes were below their respective LLD limits.

Airborne Iodine

Bi-monthly levels of airborne iodine-131 were below the lower limit of detection (LLD) of 0.030 pCi/m^3 at all locations. There is no indication of an effect of the plant operation on the local air environment.

Ambient Gamma Radiation - TLDs

Ambient gamma radiation was monitored by TLDs at fourteen locations: seven indicator and seven control.

Quarterly TLDs at indicator locations measured a mean dose equivalent of (14.1 mR/91 days), in agreement with the mean at the control locations of (13.7 mR/91 days), and were similar to the means obtained from 1992 (and prior to) through 2002. The results are tabulated below. No plant effect on ambient gamma radiation was indicated These values are slightly lower than the United States average value of 19.5 mR/91 days due to natural background radiation (National Council on Radiation Protection and Measurements, 1975). The highest annual mean was 17.0 mR/91 days, measured at the indicator location K-7.

Year	Average (Indicators)	Average (Controls)
	Dose rate (mR/91 days)	
1992	15.0	13.8
1993	15.0	13.8
1994	14.8	13.8
1995	16.7	15.6
1996	15.9	14.9
1997	16.0	15.1
1998	16.1	15.5
1999	17.4	16.9
2000	18.7	18.2
2001	18.6	18.3
2002	16.1	15.1
2003	14.1	13.7

Ambient gamma radiation as measured by thermoluminescent dosimetry.
Average quarterly dose rates.

Precipitation

Precipitation was monitored at one indicator location, K-11. The tritium concentration was below the LLD level of 330 pCi/L in all samples.

3.2.3 The Terrestrial Environment

Milk

Of the 118 analyses for iodine-131 in milk, all were below the LLD level of 0.5 pCi/L.

Strontium-89 concentrations measured below an LLD level of 1.3 pCi/L in all samples. Low levels of strontium-90 were found in seventy-four of the seventy-eight samples tested. Mean values were identical for indicator and control locations (1.3 pCi/L) and are similar to or less than averages seen from 1989 through 2002.

Barium-lanthanum-140 concentrations were below the LLD of 15 pCi/L and Cesium-137 concentrations were below the LLD of 10 pCi/L in all samples. Potassium-40 results are similar at both the indicator and control locations (1351and 1398 pCi/L, respectively), and are essentially identical to the levels observed from 1989 through 2002. There was no indication of any effect due to the operation of the KNPP.

Due to the chemical similarities between strontium and calcium, and cesium and potassium, organisms tend to deposit cesium-137 in the soft tissue and muscle and strontium-89 and strontium-90 in the bone. Consequently, ratios of strontium-90 activity to the weight of calcium in milk and cesium-137 activity to the weight of potassium in milk were monitored in order to detect potential environmental accumulation of these radionuclides. The measured concentrations of stable potassium and calcium are in agreement with previously determined values of 1.50 ± 0.21 g/L and 1.16 ± 0.08 g/L, respectively (National Center for Radiological Health, 1968).

Well Water

Gross alpha and gross beta concentrations, measured at the two on-site wells (K-1g and K-1h), averaged 2.8 pCi/L and 4.2 pCi/L respectively. A beta activity of 3.8 pCi/L was measured in one of four samples from location K-10, above the LLD value of 2.1 pCi/L. All other measurements for gross beta concentration, both indicators and control, were below the LLD, similar to values observed from 1989 through 2002.

Levels of tritium and strontium-89, strontium-90 were measured for the on-site well (K-1g). Tritium measured below the LLD of 330 pCi/L in all samples. Strontium-89 and strontium-90 concentrations measured below the LLD value of 1.1 and 0.6 pCi/L, respectively.

All gamma-emitting isotopes measured below their respective LLDs in all samples.

Potassium-40 averages are generally in proportion to gross beta measurements and were in agreement with previously measured values. No plant effect was indicated.

Domestic Meat

In domestic meat samples, gross alpha concentration measured below the lower limit of detection for both indicator and control locations. Gross beta concentration averaged 3.14 pCi/g wet for indicator locations and 5.04 pCi/g wet for the control location. The differences are not significant. Gamma-spectroscopic analyses showed that almost all of the beta activity was due to naturally occurring potassium-40. All other gamma-emitting isotopes were below their respective LLD limits.

Eggs

In egg samples, gross beta concentrations averaged 1.22 pCi/g wet for the indicator location and 1.35 pCi/g wet for the control, almost identical to concentrations of naturally-occurring potassium-40 observed in the samples (1.26 and 1.33 pCi/g wet respectively). Other gamma-emitting isotopes were below their respective LLDs. Levels of strontium-89 measured below the LLD of 0.015 pCi/g wet in all samples, strontium-90 measured below the LLD level of 0.007 pCi/g wet.

Vegetables and Grain

In vegetables, gross beta concentrations measured 2.04 pCi/g wet at the control location K-26, due primarily to potassium-40 activity. All other gamma emitting isotopes measured below respective LLDs. Strontium-89 measured below the LLD level of 0.009 pCi/g wet. Strontium-89 measured below the LLD level of 0.002 pCi/g wet.

In two grain samples (clover and oats) from location K-23, gross beta concentrations averaged 4.49 pCi/g wet, due primarily to potassium-40 and beryllium-7 activity (4.41 and 1.27 pCi/g wet, respectively). Strontium-89 measured below the LLD levels of 0.027 pCi/g wet, strontium-90 measured 0.008 pCi/g wet in one of the two samples tested.

Grass and Cattle Feed

In grass, mean gross beta concentrations measured 6.76 and 9.30 pCi/g wet at indicator and control locations, respectively, and in all cases was predominantly due to naturally occurring potassium-40 and beryllium-7. All other gamma-emitting isotopes were below their respective LLDs. Strontium-89 measured below the LLD levels of 0.029 pCi/g wet for all samples tested, strontium-90 averaged 0.022 pCi/g wet in six of twenty samples tested from indicator locations and 0.084 pCi/g wet from the control location, K-3.

In cattlefeed, the mean gross beta concentration was lower at the control locations (6.86 pCi/g wet) than at indicator locations (13.52 pCi/g wet). The highest average gross beta levels were in samples from the indicator location K-38 (17.89 pCi/g wet), and reflected the high combined beryllium-7 and potassium-40 levels observed in the samples. This pattern is similar to that observed since 1978. Strontium-89 levels were below the LLD level of 0.055 pCi/g wet in all samples. Low levels of strontium-90 activity were detected in three of ten samples and averaged 0.025 pCi/g wet, similar or lower than levels observed in 1995 through 2002. The presence of radiostrontium in the environment can still be attributed to fallout from the nuclear testing in previous decades.

With the exceptions of naturally-occurring beryllium and potassium, gamma-emitting isotopes were below their respective LLD levels.

Soil

Gross alpha concentrations in soil samples measured 11.18 pCi/g dry at the indicator locations averaged and 7.90 pCi/g dry at the control locations. Mean gross beta levels measured at the indicator and control locations averaged 32.06 and 27.65 pCi/g dry, respectively, primarily due to the potassium-40 activity. Strontium-89 was below the LLD level of 0.11 pCi/g dry in all samples. Low levels of strontium-90 activity were detected in three of the thirteen samples tested and averaged 0.067 pCi/g dry.

Low levels of Cesium-137 were detected in ten of thirteen soil samples, identical at the indicator and control locations (0.13 pCi/g dry). Potassium-40 was detected in all samples and averaged 19.68 and 18.61 pCi/g dry at indicator and control locations, respectively. All other gamma-emitting isotopes were below their respective LLD's. These levels of detected activities are similar to those observed from 1989 through 2002.

3.2.4 The Aquatic Environment

Surface Water

In all surface water tested, gross beta activity in suspended solids measured below the LLD level of 1.8 pCi/L. Mean gross beta concentration in dissolved solids was higher at the indicator locations (7.3 pCi/L) as compared to the control locations (2.4 pCi/L). The pattern is similar to activity distribution observed from 1978 through 2002.

Year	Average (Indicators)	Average (Controls)
	Dose rate (mR/91 days)	
1992	4.5	2.2
1993	5.0	2.3
1994	5.0	2.3
1995	4.3	2.2
1996	4.3	2.2
1997	6.3	2.4
1998	5.9	2.1
1999	5.6	2.2
2000	7.0	2.4
2001	5.9	2.2
2002	5.7	2.2
2003	7.3	2.4

Average annual gross beta concentrations in surface water (DS).

The difference in levels are due in part to the indicator location (K-1k), a pond formed by drainage of surrounding fields to the southwest. The control sample is Lake Michigan water, which varies very little in gross beta concentration during the year, while indicator samples include two creek locations (K-1a and K-1e) which are much higher in gross beta concentration and exhibit large month-to-month variations. The K-1a creek draws its water from the surrounding fields which are heavily fertilized; and the K-1e creek draws its water mainly from the Sewage Treatment Plant. In general, gross beta concentrations were high when potassium-40 levels were high and low when potassium-40 levels were low, indicating that the fluctuations in beta concentration were due to variations in potassium-40 concentrations and not to plant operations. The fact that similar fluctuations at these locations were observed in the pre-operational studies conducted prior to 1974 supports this assessment.

No tritium was detected above an LLD of 330 pCi/L in any sample.

Strontium-89 concentrations were below the LLD of 1.9 pCi/L. Strontium-90 measured 1.0 pCi/L in three of twenty-six indicator samples and 1.3 pCi/L in one of four control samples. All other samples measured below an LLD value of 0.9 pCi/L.

Gamma-emitting isotopes were below their respective LLDs in all samples.

Fish

In fish, gross beta concentrations averaged 2.50 pCi/g wet in muscles and 1.99 pCi/g wet in bone fractions. In muscle, the gross beta concentration was primarily due to potassium-40 activity.

Cesium-137 concentration in muscle was detected in two of seven samples tested at a level of 0.048 pCi/g wet, lower than levels observed between 1979 and 1991 (average of 0.12 pCi/g wet), and similar to levels seen in 1992 (0.066 pCi/g wet), in 1993 (0.068 pCi/g wet), in 1994 (0.067 pCi/g wet), in 1995 (0.056 pCi/g wet), in 1996 (0.055 pCi/g wet), in 1997 (0.053 pCi/g wet), 1998 (0.075 pCi/g wet), in 1999 (0.062 pCi/g wet), in 2000 (0.063 pCi/g wet) and 0.040 pCi/g wet in 2001 and 2002.

The strontium-89 concentration was below the LLD of 0.28 pCi/g wet in all samples. Strontium-90 was detected above the LLD value of 0.05 pCi/g wet and averaged 0.12 pCi/g wet.

Periphyton (Slime) or Aquatic Vegetation

In periphyton (slime) and aquatic vegetation samples, mean gross beta concentrations were slightly higher at the control location than at the indicators (6.83 and 4.09 pCi/g wet, respectively).

The strontium-89 concentration was below the LLD of 0.33 pCi/g wet in all samples. Strontium-90 was detected above the LLD value of 0.095 pCi/g wet in one of the twelve indicator samples, measuring 0.10 pCi/g wet.

Traces of Co-58 and Co-60 were detected in one of two periphyton samples collected from location K-14 at concentrations of 0.063 and 0.035 pCi/g wet, respectively.

Cs-137 activity was also detected, above the LLD value of 0.032 pCi/g wet, in one of the fourteen indicator and control samples collected, averaging 0.035 pCi/g wet, similar or lower than measurements taken from 1989 through 2002. Other gamma-emitting isotopes, with the exception of naturally-occurring beryllium-7 and potassium-40, were below their respective LLDs.

Bottom Sediments

In bottom sediment samples, the mean gross beta concentrations measured 9.21 pCi/g dry at the indicator locations and 27.36 pCi/g dry at the control, attributable primarily to levels of potassium-40.

Cs-134 was below the LLD level of 0.038 pCi/g dry in all samples. Low levels of cesium-137 were detected in one of eight samples from indicator locations and one of two controls, with concentrations of 0.046 and 0.092 pCi/g dry, respectively. On average, cesium-137 measurements are lower than or similar to levels observed from 1979 through 2002.

Levels of strontium-89 measured below the detection limit of 0.074 pCi/g dry in all samples. Strontium-90 could not be detected above the LLD level of 0.017 pCi/g dry.

3.3 Land Use Census

The Land Use Census satisfies the requirements of the KNPP Radiological Environmental Monitoring Manual. Section 2.2.2 states:

> "A land use census shall be conducted and shall identify within a distance of 8 km (5 mi.) the location, in each of the 10 meteorological sectors, of the nearest milk animal, the nearest residence and the nearest garden of greater than 50m^2 (500 ft^2) producing broad leaf vegetation."

The 2002 Land Use Census was an annual census conducted in the years between the complete five year census. This census is used to verify that no changes have occurred with the locations of the nearest residence, milk animal or garden. "Drive-bys" were conducted to verify that no changes have occurred over the previous census.

The Land Use Census was completed on September 2, 2003. This census is conducted annually during the growing season per Health Physics Procedure HP 1.14.

Table 4.6.1 lists the results of the 2003 census. There were no significant changes identified from the 2002 census.

Table 4.6.2 describes the changes from 2002 to 2003.

4.0 FIGURES AND TABLES

Table 4.1. Sampling locations, Kewaunee Nuclear Power Plant.

Code	Type[a]	Distance (miles)[b] and Sector	Location
K-1			Onsite
K-1a	I	0.62 N	North Creek
K-1b	I	0.12 N	Middle Creek
K-1c	I	0.10 N	500' north of condenser discharge
K-1d	I	0.10 E	Condenser discharge
K-1e	I	0.12 S	South Creek
K-1f	I	0.12 S	Meteorological Tower
K-1g	I	0.06 W	South Well
K-1h	I	0.12 NW	North Well
K-1j	I	0.10 S	500' south of condenser discharge
K-1k	I	0.60 SW	Drainage Pond, south of plant
K-2	C	9.5 NNE	WPS Operations Building in Kewaunee
K-3	C	6.0 N	Lyle and John Siegmund Farm, N2815 Hy 12, Kewaunee
K-5	I	3.5 NNW	Ed Paplham Farm, E4160 Old Settlers Rd, Kewaunee
K-7	I	2.75 SSW	Ron Zimmerman Farm, 17620 Nero Road, Two Rivers
K-8	C	5.0 WSW	Saint Mary's Church, Tisch Mills
K-9	C	11.5 NNE	Rostok Water Intake for Green Bay, Wisconsin, two miles north of Kewaunee
K-10	I	1.5 NNE	Turner Farm, Kewaunee site
K-11	I	1.0 NW	Harlan Ihlenfeld Farm, N879 Hy 42, Kewaunee
K-13	C	3.0 SSW	Rand's General Store
K-14	I	2.5 S	Two Creeks Park, 2.5 miles south of site
K-15	C	9.25 NW	Gas Substation, 1.5 miles north of Stangelville
K-16	C	26 NW	WPS Division Office Building, Green Bay, Wisconsin
K-17	I	4.25 W	Jansky's Farm, N885 Tk B, Kewaunee
K-20	I	2.5 N	Carl Struck Farm, Lakeshore Dr, Kewaunee
K-23	I	0.5 W	0.5 miles west of plant, Kewaunee site
K-24	I	5.45 N	Fectum Farm, N2653 Hy 42, Kewaunee
K-25	I	2.0 WSW	Wotachek Farm, 4819 E. Cty Tk BB, Denmark
K-26	C	10.7 SSW	Bertler's Fruit Stand (8.0 miles south of "BB")
K-27	I	1.5 NW	Schlies Farm, E4298 Sandy Bay Rd, Kewaunee
K-28	C	26 NW	Hansen Dairy, Green Bay, Wisconsin
K-29	I	5.75 W	Kunesh Farm, Route 1, Kewaunee
K-30	I	1.00N	End of site boundary
K-31	C	6.25NNW	E. Krok Substation
K-32	C	11.50 N	Piggly Wiggly, 931 Marquette Dr., Kewaunee
K-34	I	2.5 N	Leon and Vicki Struck, N1549 Lakeshore Dr., Kewaunee
K-36	I	8.5 mi. NNE	Fiala's Fish Market, Kewaunee
K-37	I	4.0 mi. N	Gary and Ann Hardtke, E4282 Old Settlers Road, Kewaunee
K-38	I	3.8 mi. WNW	Dave Sinkula Farm, N890 Town Hall Road, Kewaunee
K-39[c]	I	3.0 mi. N	Francis and Sue Wojta, N1859 Lakeshore Dr., Kewaunee

[a] I = indicator; C = control.

[b] Distances are measured from reactor stack.

[c] Location added to program in July, 2003.

KEWAUNEE

Table 4.2. Type and frequency of collection.

Location	Weekly	Biweekly	Monthly	Quarterly	Semiannually	Annually
K-1a			SW		SL	
K-1b			SW	GR[a]	SL	
K-1c					BS[b]	
K-1d			SW	FI	BS[b], SL	
K-1e			SW		SL	
K-1f	AP	AI		GR[a], TLD	SO	
K-1g				WW		
K-1h				WW		
K-1j					BS[b]	
K-1k			SW		SL	
K-2	AP	AI		TLD		
K-3			MI[c]	GR[a], TLD, CF[d]	SO	
K-5			MI[c]	GR[a], TLD, CF[d]	SO	
K-7	AP	AI		TLD		
K-8	AP	AI		TLD		
K-9			SW		BS[b], SL	
K-10				WW		
K-11			PR	WW		
K-13				WW		
K-14			SW		BS[b], SL	
K-15				TLD		
K-16	AP	AI		TLD		
K-17				TLD		VE
K-20						
K-23						GRN
K-24				EG		DM
K-25			MI[c]	GR[a], TLD, CF[d], WW	SO	
K-26						VE
K-27				TLD, EG		
K-28			MI[c]			
K-29						DM, VE
K-30				TLD		
K-31	AP	AI		TLD		
K-32				EG		DM
K-34			MI[c]	GR[a], CF[d]	SO	DM
K-36				FI		
K-37			MI[c]	GR[a], TLD, CF[d]	SO	
K-38			MI[c]	GR[a], CF[d]	SO	
K-39			MI[c]	GR[a], CF[d]	SO	

[a] Three times a year, second, third and fourth quarters.

[b] To be collected in May and November.

[c] Monthly from November through April; semimonthly May through October.

[d] First quarter (January, February, March) only.

Table 4.3. Sample Codes:

AP	Airborne particulates	MI	Milk
AI	Airborne Iodine	PR	Precipitation
BS	Bottom (river) sediments	SL	Slime
CF	Cattlefeed	SO	Soil
DM	Domestic Meat	SW	Surface water
EG	Eggs	TLD	Thermoluminescent Dosimeter
FI	Fish	VE	Vegetables
GRN	Grain	WW	Well water
GR	Grass		

Table 4.4. Sampling Summary, January - December 2003.

Sample Type	Collection Type and Frequency[a]	Number of Locations	Number of Samples Collected	Number of Samples Missed
Air Environment				
Airborne particulates	C/W	6	312	0
Airborne Iodine	C/BW	6	156	0
TLD's	C/Q	14	55	1
Precipitation	C/M	1	12	0
Terrestrial Environment				
Milk (May-Oct)	G/SM	7	80	0
(Nov-Apr)	G/M	7	38	0
Well water	G/Q	6	24	0
Domestic meat	G/A	3	3	0
Eggs	G/Q	2	8	0
Vegetables - 5 varieties	G/A	2	8	0
Grain - wheat	G/A	1	1	0
- clover	G/A	1	1	0
Grass	G/TA	8	23	0
Cattle feed	G/A	5	10	0
Soil	G/SA	7	13	0
Aquatic Environment				
Surface water	G/M	7	105	3
Fish	G/TA	1	3	0
Slime	G/SA	7	14	0
Bottom sediments	G/SA	5	10	0

[a] Type of collection is coded as follows: C = continuous; G = grab.
Frequency is coded as follows: W = weekly; BW = bi-weekly; SM = semimonthly; M = monthly; Q = quarterly; SA = semiannually; TA = three times per year; A = annually.

Table 4.5 Environmental Radiation Monitoring Program Summary.

Name of Facility Kewaunee Nuclear Power Plant
Location of Facility Kewaunee County, Wisconsin
(County, State)
Docket No. 50-305
Reporting Period January-December, 2003

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean		Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
				Location[d]	Mean (F)[c] Range[c]		
TLDs (Quarterly) (mR/91days)	Gamma 55	3.0	14.1 (31/31) (10.3-17.8)	K-7, Zimmerman Farm [f] 2.75 mi. SSW	17.0 (4/4) (16.1-17.8)	13.7 (24/24) (10.8-24.4)	0
Airborne Particulates (pCi/m³)	GB 312	0.002	0.022 (104/104) (0.011-0.041)	K-8, St. Mary's Church 5.0 mi. WSW	0.023 (52/52) (0.011-0.043)	0.022 (208/208) (0.010-0.047)	0
	GS 24						
	Be-7	0.020	0.060 (8/8) (0.039-0.071)	K-31, E. Krok Sub-station, 6.25 mi. NNW	0.063 (4/4) (0.040-0.080)	0.061 (16/16) (0.040-0.080)	0
	Nb-95	0.0014	< LLD	-	-	< LLD	0
	Zr-Nb-95	0.0019	< LLD	-	-	< LLD	0
	Ru-103	0.0010	< LLD	-	-	< LLD	0
	Ru-106	0.0076	< LLD	-	-	< LLD	0
	Cs-134	0.0007	< LLD	-	-	< LLD	0
	Cs-137	0.0009	< LLD	-	-	< LLD	0
	Ce-141	0.0020	< LLD	-	-	< LLD	0
	Ce-144	0.0054	< LLD	-	-	< LLD	0
Airborne Iodine (pCi/m³)	I-131 156	0.03	< LLD	-	-	< LLD	0
Precipitation (pCi/L)	H-3 12	330	< LLD	-	-	None	0
Milk (pCi/L)	I-131 118	0.5	< LLD	-	-	< LLD	0
	Sr-89 78	1.3	< LLD	-	-	< LLD	0
	Sr-90 78	0.7	1.3 (50/54) (0.7-3.1)	K-5 K-5, Paplham Farm	1.5 (11/12) (0.8-3.1)	1.3 (24/24) (0.7-2.4)	0
	GS 118						
	K-40	50	1351 (82/82) (1020-1544)	K-34, Struck Farm 2.5 mi. N	1418 (18/18) (1020-1544)	1398 (36/36) (1170-1560)	0
	Cs-134	10	< LLD	-	-	< LLD	0
	Cs-137	10	< LLD	-	-	< LLD	0
	Ba-La-140	15	< LLD	-	-	< LLD	0
(g/L)	K-stable 78	1.0	1.60 (54/54) (1.33-1.78)	K-34, Struck Farm 2.5 mi. N	1.65 (12/12) (1.45-1.78)	1.60 (24/24) (1.41-1.80)	0
(g/L)	Ca 78	0.4	0.86 (54/54) (0.73-1.11)	K-25, Wotachek Farm 2.0 mi. WSW	0.90 (12/12) (0.79-1.11)	0.88 (24/24) (0.78-1.10)	0

Table 4.5 Environmental Radiation Monitoring Program Summary.

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Location of Facility	Kewaunee County, Wisconsin (County, State)	Reporting Period	January-December, 2003

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean		Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
				Location[d]	Mean (F)[c] Range[c]		
Well Water (pCi/L)	GA 8	1.9	2.8 (4/8) (2.4-3.8)	K-1g, South Well 0.06 mi. W	3.1 (2/4) (2.4-3.8)	None	0
	GB 24	2.1	4.1 (7/20) (3.6-4.6)	K-1h, North Well 0.12 mi. NW	4.5 (3/4) (4.3-4.6)	< LLD	0
	H-3 4	330	< LLD	-	-	None	0
	K-40 24	0.87	1.80 (15/20) (0.87-3.20)	K-1g, South Well 0.06 mi. W	2.53 (4/4) (2.08-3.20)	0.97 (4/4) (0.87-1.04)	0
	Sr-89 4	1.1	< LLD	-	-	None	0
	Sr-90 4	0.6	< LLD	-	-	< LLD	0
	GS 24						
	Mn-54	15	< LLD	-	-	< LLD	0
	Fe-59	30	< LLD	-	-	< LLD	0
	Co-58	15	< LLD	-	-	< LLD	0
	Co-60	15	< LLD	-	-	< LLD	0
	Zn-65	30	< LLD	-	-	< LLD	0
	Zr-Nb-95	15	< LLD	-	-	< LLD	0
	Cs-134	15	< LLD	-	-	< LLD	0
	Cs-137	18	< LLD	-	-	< LLD	0
	Ba-La-140	15	< LLD	-	-	< LLD	0
Domestic Meat (pCi/gwet)	GA 3	0.14	< LLD	-	-	< LLD	0
	GB 3	0.030	3.14 (2/2) (2.90-3.38)	K-32, Grocery 11.5 mi. N	5.04 (1/1) -	5.04 (1/1) -	0
	GS 3						
	Be-7	0.24	< LLD	-	-	< LLD	0
	K-40	0.50	2.77 (2/2) (2.46-3.08)	K-29, Kunesh Farm 5.75 mi. W	3.08 (1/1)	2.57 (1/1) -	0
	Nb-95	0.030	< LLD	-	-	< LLD	0
	Zr-95	0.05	< LLD	-	-	< LLD	0
	Ru-103	0.026	< LLD	-	-	< LLD	0
	Ru-106	0.13	< LLD	-	-	< LLD	0
	Cs-134	0.012	< LLD	-	-	< LLD	0
	Cs-137	0.018	< LLD	-	-	< LLD	0
	Ce-141	0.055	< LLD	-	-	< LLD	0
	Ce-144	0.11	< LLD	-	-	< LLD	0
Eggs (pCi/gwet)	GB 8	0.010	1.22 (4/4) (0.69-1.48)	K-32, Grocery 11.5 mi. N	1.35 (4/4) (1.31-1.45)	1.35 (4/4) (1.31-1.45)	0
	Sr-89 8	0.015	< LLD	-	-	< LLD	0
	Sr-90 8	0.007	0.010 (1/4)	K-24, Fectum Farm 5.45 mi. N	0.010 (1/4)	0.008 (1/4)	0
	GS 8						
	Be-7	0.11	< LLD	-	-	< LLD	0
	K-40	0.50	1.26 (4/4) (1.15-1.41)	K-32, Grocery 11.5 mi. N	1.33 (4/4) (1.08-1.58)	1.33 (4/4) (1.08-1.58)	0
	Nb-95	0.013	< LLD	-	-	< LLD	0
	Zr-95	0.017	< LLD	-	-	< LLD	0
	Ru-103	0.012	< LLD	-	-	< LLD	0
	Ru-106	0.12	< LLD	-	-	< LLD	0
	Cs-134	0.011	< LLD	-	-	< LLD	0
	Cs-137	0.010	< LLD	-	-	< LLD	0
	Ce-141	0.023	< LLD	-	-	< LLD	0
	Ce-144	0.058	< LLD	-	-	< LLD	0

Table 4.5 Environmental Radiation Monitoring Program Summary.

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Docket No. 50-305
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Sample Type (Units)	Type and Number of Analyses[a]		LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean		Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
					Location[d]	Mean (F)[c] Range[c]		
Vegetables (pCi/gwet)	GB	8	0.010	2.50 (1/1)	K-29, Kunesh Farm 5.75 mi. W	2.50 (1/1)	2.04 (7/7) (1.04-2.82)	0
	Sr-89	8	0.009	< LLD	-	-	< LLD	0
	Sr-90	8	0.002	< LLD	-	-	< LLD	0
					-			0
	GS	8						
	Be-7		0.12	< LLD	-	-	< LLD	0
					-			
	K-40		0.50	2.34 (1/1)	K-29, Kunesh Farm 5.75 mi. W	2.34 (1/1)	1.82 (7/7) (0.72-2.43)	0
	Nb-95		0.011	< LLD	-	-	< LLD	0
	Zr-95		0.025	< LLD	-	-	< LLD	0
	Ru-103		0.015	< LLD	-	-	< LLD	0
	Ru-106		0.11	< LLD	-	-	< LLD	0
	Cs-134		0.012	< LLD	-	-	< LLD	0
	Cs-137		0.015	< LLD	-	-	< LLD	0
	Ce-141		0.024	< LLD	-	-	< LLD	0
	Ce-144		0.084	< LLD	-	-	< LLD	0
Grain - Oats & Clover (pCi/gwet)	GB	2	0.010	4.49 (2/2) (4.19-4.78)	K-23, Kewaunee Site, 0.5 mi. W	4.49 (2/2) (4.19-4.78)	None	0
	Sr-89	2	0.027	< LLD	-	-	None	0
	Sr-90	2	0.008	0.008 (1/2)	K-23, Kewaunee Site, 0.5 mi. W	0.008 (1/2)	None	0
	GS	2						
	Be-7		0.50	1.27 (2/2) (0.80-1.74)	K-23, Kewaunee Site, 0.5 mi. W	1.27 (2/2) (0.80-1.74)	None	0
	K-40		0.50	4.41 (2/2) (4.31-4.50)	K-23, Kewaunee Site, 0.5 mi. W	4.41 (2/2) (4.31-4.50)	None	0
	Nb-95		0.038	< LLD	-	-	None	0
	Zr-95		0.080	< LLD	-	-	None	0
	Ru-103		0.027	< LLD	-	-	None	0
	Ru-106		0.18	< LLD	-	-	None	0
	Cs-134		0.023	< LLD	-	-	None	0
	Cs-137		0.022	< LLD	-	-	None	0
	Ce-141		0.053	< LLD	-	-	None	0
	Ce-144		0.13	< LLD	-	-	None	0
Cattlefeed (pCi/gwet)	GB	10	0.10	13.52 (8/8) (2.78-26.38)	K-38, Sinkula Farm 3.8 mi. WNW	17.89 (2/2) (9.40-26.38)	6.86 (2/2) (3.27-10.44)	0
	Sr-89	10	0.055	< LLD	-	-	< LLD	0
	Sr-90	10	0.024	0.025 (3/8) (0.024-0.026)	K-25, Wotachek Farm 2.0 mi. WSW	0.026 (1/2)	<LLD -	0
	GS	10						
	Be-7		0.48	1.17 (2/8) (0.75-1.59)	K-34, Struck Farm 2.5 mi. N	1.59 (1/2)	< LLD	0
	K-40		0.10	13.12 (8/8) (2.47-27.47)	K-38, Sinkula Farm 3.8 mi. WNW	18.99 (2/2) (10.51-27.47)	6.81 (2/2) (2.94-10.68)	0

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				Location[d]	Mean (F)[c] Range[c]		
Cattlefeed (continued)	Nb-95	0.060	< LLD	-	-	< LLD	0
	Zr-95	0.094	< LLD	-	-	< LLD	0
	Ru-103	0.046	< LLD	-	-	< LLD	0
	Ru-106	0.37	< LLD	-	-	< LLD	0
	Cs-134	0.049	< LLD	-	-	< LLD	0
	Cs-137	0.044	< LLD	-	-	< LLD	0
	Ce-141	0.090	< LLD	-	-	< LLD	0
	Ce-144	0.29	< LLD	-	-	< LLD	0
Grass (pCi/gwet)	GB 23	0.10	6.76 (20/20) (4.28-9.34)	K-3, Siegmund Farm 6.0 mi. N	9.30 (3/3) (7.64-11.23)	9.30 (3/3) (7.64-11.23)	0
	Sr-89 23	0.029	< LLD	-	-	< LLD	0
	Sr-90 23	0.010	0.022 (6/20) (0.011-0.030)	K-3, Siegmund Farm 6.0 mi. N	0.084 (1/3)	0.084 (1/3)	0
	GS 23						
	Be-7	0.30	2.36 (17/20) (0.45-4.10)	K-38, Sinkula Farm 3.8 mi. WNW	3.67 (2/3) (3.23-4.10)	1.31 (3/3) (0.94-1.88)	0
	K-40	0.50	6.42 (20/20) (4.37-8.52)	K-3, Siegmund Farm 6.0 mi. N	9.32 (3/3) (6.28-12.46)	9.32 (3/3) (6.28-12.46)	0
	Nb-95	0.050	< LLD	-	-	< LLD	0
	Zr-95	0.083	< LLD	-	-	< LLD	0
	Ru-103	0.044	< LLD		-	< LLD	0
	Ru-106	0.46	< LLD	-	-	< LLD	0
	Cs-134	0.040	< LLD	-	-	< LLD	0
	Cs-137	0.038	< LLD	-	-	< LLD	0
	Ce-141	0.11	< LLD	-	-	< LLD	0
	Ce-144	0.31	< LLD	-	-	< LLD	0
Soil (pCi/gdry)	GA 13	1.0	11.18 (11/11) (6.40-15.77)	K-5, Paplham Farm 3.5 mi. NNW	14.09 (2/2) (12.40-15.77)	7.90 (2/2) (7.05-8.75)	0
	GB 13	2.0	32.06 (11/11) (26.21-37.62)	K-34, Struck Farm 2.5 mi. N	35.32 (2/2) (33.01-37.62)	27.65 (2/2) (26.62-28.68)	0
	Sr-89 13	0.11	< LLD	-	-	< LLD	0
	Sr-90 13	0.042	0.067 (3/11) (0.048-0.079)	K-25, Wotachek Farm 2.0 mi. WSW	0.079 (1/2)	< LLD	0
	GS 13						
	Be-7	0.64	< LLD	-	-	< LLD	0
	K-40	1.4	19.68 (11/11) (16.57-23.25)	K-38, Sinkula Farm 3.8 mi. WNW	21.99 (2/2) (20.73-23.25)	18.61 (2/2) (17.80-19.41)	0
	Nb-95	0.12	< LLD	-	-	< LLD	0
	Zr-95	0.12	< LLD	-	-	< LLD	0
	Ru-103	0.074	< LLD		-	< LLD	0
	Ru-106	0.30	< LLD	-	-	< LLD	0
	Cs-134	0.049	< LLD	-	-	< LLD	0
	Cs-137	0.036	0.13 (8/11) (0.089-0.16)	K-34, Struck Farm 2.5 mi. N	0.16 (2/2) (0.16-0.16)	0.13 (2/2) (0.12-0.13)	0
	Ce-141	0.15	< LLD	-	-	< LLD	0
	Ce-144	0.21	< LLD	-	-	< LLD	0

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				Location[d]	Mean (F)[c] Range[c]		
Surface Water	GB (SS) 105	1.8	< LLD	- -	- -	< LLD	0
(pCi/L)	GB (DS) 105	1.2	7.3 (81/81) (1.7-34.2)	K-1k, Drainage Pond 0.60 mi. SW	16.6 (9/9) (5.9-27.3)	2.4 (24/24) (1.6-6.0)	0
	GB (TR) 105	1.2	7.3 (81/81) (1.7-34.2)	K-1k, Drainage Pond 0.60 mi. SW	16.6 (9/9) (5.9-27.3)	2.4 (24/24) (1.6-6.0)	0
	GS 105						
	Mn-54	15	< LLD	-	-	< LLD	0
	Fe-59	30	< LLD	-	-	< LLD	0
	Co-58	15	< LLD	-	-	< LLD	0
	Co-60	15	< LLD	-	-	< LLD	0
	Zn-65	30	< LLD	-	-	< LLD	0
	Zr-Nb-95	15	< LLD	-	-	< LLD	0
	Cs-134	10	< LLD	-	-	< LLD	0
	Cs-137	10	< LLD	-	-	< LLD	0
	Ba-La-140	15	< LLD	-	-	< LLD	0
	H-3 31	330	< LLD	-	-	< LLD	0
	Sr-89 31	1.9	< LLD	-	-	< LLD	0
	Sr-90 31	0.9	1.0 (3/27) (1.0-1.0)	K-9, Rostok Intake 11.5 mi. NNE	1.3 (1/4)	1.3 (1/4)	0
	K-40 105	0.87	5.1 (81/81) (1.0-37.2)	K-1a, North Creek 0.62 mi. N	11.8 (12/12) (4.5-37.2)	1.2 (24/24) (1.0-1.4)	0
Fish (Muscle) (pCi/gwet)	GB 3	0.5	2.50 (3/3) (1.85-3.17)	K-1d, Cond. Discharge 0.10 mi. E	2.50 (3/3) (1.85-3.17)	None	0
	GS 3						
	K-40	0.5	2.37 (3/3) (1.71-3.10)	K-1d, Cond. Discharge 0.10 mi. E	2.37 (3/3) (1.71-3.10)	None	0
	Mn-54	0.033	< LLD	-	-	None	0
	Fe-59	0.082	< LLD	-	-	None	0
	Co-58	0.067	< LLD	-	-	None	0
	Co-60	0.013	< LLD	-	-	None	0
	Cs-134	0.024	< LLD	-	-	None	0
	Cs-137	0.047	0.048 (1/3)	K-1d, Cond. Discharge 0.10 mi. E	0.048 (1/3)	None	0
Fish (Bones) (pCi/gwet)	GB 3	1.99	1.61 (3/3) (1.49-1.82)	K-1d, Cond. Discharge 0.10 mi. E	1.61 (3/3) (1.49-1.82)	None	0
	Sr-89 3	0.28	< LLD	-	-	None	0
	Sr-90 3	0.05	0.12 (3/3) (0.098-0.14)	K-1d, Cond. Discharge 0.10 mi. E	0.12 (3/3) (0.098-0.14)	None	0 0

Environmental Radiation Monitoring Program Summary.

Name of Facility Kewaunee Nuclear Power Plant Docket No. 50-305
Location of Facility Kewaunee County, Wisconsin Reporting Period January-December, 2003
(County, State)

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean		Control Locations Mean (F)[c] Range[c]	Number Non-Routine Results[e]
				Location[d]	Mean (F)[c] Range[c]		
Periphyton (Slime) (pCi/gwet)	GB 14	0.1	4.09 (12/12) (2.08-6.90)	K-9, Rostok Intake 11.5 mi. NNE	6.83 (2/2) (6.31-7.35)	6.83 (2/2) (6.31-7.35)	0
	Sr-89 14	0.33	< LLD	-	-	< LLD	0
	Sr-90 14	0.095	0.10 (1/12)	K-1d, Discharge 0.10 mi. E	0.10 (1/2)	< LLD	0
	GS 14						
	Be-7	0.51	1.55 (9/12) (0.63-4.53)	K-1k, Drainage Pond 0.60 mi. SW	2.58 (2/2) (0.63-4.53)	< LLD	0
	K-40	0.50	3.50 (11/12) (1.23-6.17)	K-9, Rostok Intake 11.5 mi. NNE	4.86 (2/2) (3.70-6.01)	4.86 (2/2) (3.70-6.01)	0
	Mn-54	0.045	< LLD	-	-	< LLD	0
	Co-58	0.049	0.063 (1/12)	K-14, Two Creeks Park	0.063 (1/2)	< LLD	0
	Co-60	0.034	0.035 (1/12)	K-14, Two Creeks Park 2.5 mi. S	0.035 (1/2)	< LLD	0
	Nb-95	0.083	< LLD	-	-	< LLD	0
	Zr-95	0.082	< LLD	-	-	< LLD	0
	Ru-103	0.071	< LLD	-	-	< LLD	0
	Ru-106	0.34	< LLD	-	-	< LLD	0
	Cs-134	0.050	< LLD	-	-	< LLD	0
	Cs-137	0.032	0.034 (1/12)	K-14, Two Creeks Park 2.5 mi. S	0.034 (1/2)	< LLD	0
	Ce-141	0.12	< LLD	-	-	< LLD	0
	Ce-144	0.24	< LLD	-	-	< LLD	0
Bottom Sediments (pCi/gdry)	GB 10	1.0	9.21 (8/8) (7.61-11.47)	K-9, Rostok Intake 11.5 mi. NNE	27.36 (2/2) (27.01-27.70)	27.36 (2/2) (27.01-27.70)	0
	Sr-89 10	0.074	< LLD	-	-	< LLD	0
	Sr-90 10	0.017	< LLD	-	-	< LLD	0
	GS 10						
	K-40	0.5	7.71 (8/8) (6.61-9.56)	K-9, Rostok Intake 11.5 mi. NNE	9.54 (2/2) (8.82-10.25)	9.54 (2/2) (8.82-10.25)	0
	Co-58	0.040	< LLD	-	-	< LLD	0
	Co-60	0.022	< LLD	-	-	< LLD	0
	Cs-134	0.038	< LLD	-	-	< LLD	0
	Cs-137	0.038	0.046 (1/8)	K-9, Rostok Intake 11.5 mi. NNE	0.092 (1/2)	0.092 (1/2)	0

[a] GA = gross alpha, GB = gross beta, GS = gamma spectroscopy, SS = suspended solids, DS = dissolved solids, TR = total residue.

[b] LLD = nominal lower limit of detection based on a 4.66 sigma counting error for background sample.

[c] Mean and range are based on detectable measurements only (i.e., >LLD) Fraction of detectable measurements at specified locations is indicated in parentheses (F).

[d] Locations are specified by station code (Table 4.1) and distance (miles) and direction relative to reactor site.

[e] Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten times the preoperational value for the location.

[f] One reading was suspect (25.2 ± 1.4 mR/hr, K-30, 1.0 mi. N) and not included in the calculation for mean ± standard deviation. The TLD was found removed from its plastic holder, may have been collected and then replaced by outside personnel.

Table 4.6.1 Land Use Census

The following table lists an inventory of residence, gardens ≥500 ft^2 and milk animals found nearest to the plant in each of the 10 meteorological sectors within a five mile radius of the Kewaunee Nuclear Power Plant.

Sector	Township No.	Residence	Garden	Milk Animals	Distance From Plant (miles)	Location ID
A	12			X	3.50	
A	13		X		3.05	
A	24	X			1.81	
B	18			X	2.69	K-34
B	24	X			1.26	
B	24		X		1.47	K-19
R	23			X	2.21	
R	26	X	X		1.05	K-11
Q	23	X			1.37	
Q	23		X	X	1.47	K-27
P	20			X	4.20	
P	26	X			1.42	
P	26		X		1.52	
N	26		X		1.16	
N	34			X	2.53	
N	35	X			1.05	
M	34		X		1.58	
M	34			X	1.98	K-25
M	35	X			1.42	
L	35	X			1.05	
L	35		X	X	1.30	
K	10			X	3.24	
K	35	X	X		0.96	
J	11	X	X	(Note 1)	2.68	

Note 1. There were no milk animals located in Sector J within five miles of the Kewaunee Nuclear Power Plant.

Table 4.6.2 Land Use Census

The following is a sector by sector listing of those changes between the 2002 and 2003 census.

Sector A	The nearest milk animal location was changed. Milk animals were not observed at the T. Stangel farm.
Sector B	No changes
Sector R	Milk animals are no longer present at the G. Hardtke farm.
Sector Q	No changes
Sector P	No changes
Sector N	No changes
Sector M	No changes

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APPENDIX A

INTERLABORATORY COMPARISON PROGRAM RESULTS

NOTE: Environmental Inc., Midwest Laboratory participates in intercomparison studies administered by Environmental Resources Associates, and serves as a replacement for studies conducted previously by the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. Results are reported in Appendix A. TLD Intercomparison results, in-house spikes, blanks, duplicates and mixed analyte performance evaluation program results are also reported. Appendix A is updated four times a year; the complete Appendix is included in March, June, September and December monthly progress reports only.

January, 2003 through December, 2003.

Appendix A

Interlaboratory Comparison Program Results

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

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

Results in Table A-1 were obtained through participation in the environmental sample crosscheck program administered by Environmental Resources Associates, serving as a replacement for studies conducted previously by the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

The results in Table A-2 were obtained for Thermoluminescent Dosimeters (TLDs), via International Intercomparison of Environmental Dosimeters under the sponsorships listed in Table A-2. Results of internal laboratory testing is also listed.

Table A-3 lists results of the analyses on in-house "spiked" samples for the past twelve months. All samples are prepared using NIST traceable sources. Data for previous years available upon request.

Table A-4 lists results of the analyses on in-house "blank" samples for the past twelve months. Data for previous years available upon request. request.

Table A-5 list results of the in-house "duplicate" program for the past twelve months. Acceptance is based on the difference of the results being less than the sum of the errors. Data for previous years available upon request.

The results in Table A-6 were obtained through participation in the Mixed Analyte Performance Evaluation Program.

The results in Table A-7 were obtained through participation in the Environmental Measurement Laboratory Quality Assessment Program.

Attachment A lists acceptance criteria for "spiked" samples.

Out-of-limit results are explained directly below the result.

Attachment A

ACCEPTANCE CRITERIA FOR "SPIKED" SAMPLES

LABORATORY PRECISION: ONE STANDARD DEVIATION VALUES FOR VARIOUS ANALYSES[a]

Analysis	Level	One standard deviation for single determination
Gamma Emitters	5 to 100 pCi/liter or kg > 100 pCi/liter or kg	5.0 pCi/liter 5% of known value
Strontium-89[b]	5 to 50 pCi/liter or kg > 50 pCi/liter or kg	5.0 pCi/liter 10% of known value
Strontium-90[b]	2 to 30 pCi/liter or kg > 30 pCi/liter or kg	5.0 pCi/liter 10% of known value
Potassium-40	> 0.1 g/liter or kg	5% of known value
Gross alpha	20 pCi/liter > 20 pCi/liter	5.0 pCi/liter 25% of known value
Gross beta	100 pCi/liter > 100 pCi/liter	5.0 pCi/liter 5% of known value
Tritium	4,000 pCi/liter	$1s = (pCi/liter) = 169.85 \times (known)^{0.0933}$
	> 4,000 pCi/liter	10% of known value
Radium-226,-228	0.1 pCi/liter	15% of known value
Plutonium	0.1 pCi/liter, gram, or sample	10% of known value
Iodine-131, Iodine-129[b]	55 pCi/liter > 55 pCi/liter	6.0 pCi/liter 10% of known value
Uranium-238, Nickel-63[b] Technetium-99[b]	35 pCi/liter > 35 pCi/liter	6.0 pCi/liter 15% of known value
Iron-55[b]	50 to 100 pCi/liter > 100 pCi/liter	10 pCi/liter 10% of known value
Others[b]	—	20% of known value

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[a] From EPA publication, "Environmental Radioactivity Laboratory Intercomparison Studies Program, Fiscal Year, 1981-1982, EPA-600/4-81-004.

[b] Laboratory limit.

TABLE A-1. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA)[a].

		Concentration (pCi/L)			
Lab Code	Date	Analysis	Laboratory Result[b]	ERA Result[c]	Control Limits
STW-973	02/17/03	Sr-89	17.0 ± 0.5	15.9 ± 5.0	7.2 - 24.6
STW-973	02/17/03	Sr-90	8.9 ± 0.3	9.0 ± 5.0	0.4 - 17.7
STW-974	02/17/03	Ba-133	14.5 ± 0.9	19.5 ± 5.0	10.8 - 28.2
STW-974	02/17/03	Co-60	37.5 ± 0.9	37.4 ± 5.0	28.7 - 46.1
STW-974	02/17/03	Cs-134	18.2 ± 0.6	17.8 ± 5.0	9.1 - 26.5
STW-974	02/17/03	Cs-137	42.7 ± 1.0	44.2 ± 5.0	35.5 - 52.9
STW-974	02/17/03	Zn-65	56.8 ± 2.2	60.3 ± 6.0	49.9 - 70.7
STW-975[d]	02/17/03	Gr. Alpha	18.4 ± 0.3	37.6 ± 9.4	21.3 - 53.9
STW-975	02/17/03	Gr. Beta	11.7 ± 0.5	8.6 ± 5.0	0.0 - 17.2
STW-976	02/17/03	Ra-226	4.1 ± 0.1	4.7 ± 0.7	3.5 - 6.0
STW-976	02/17/03	Ra-228	7.6 ± 0.5	6.5 ± 1.6	3.7 - 9.3
STW-976	02/17/03	Uranium	52.9 ± 1.9	53.7 ± 5.4	44.4 - 63.0
STW-983	05/19/03	H-3	1290.0 ± 25.0	1250.0 ± 331.0	678.0 - 1820.0
STW-984	05/19/03	I-131	19.7 ± 1.3	20.8 ± 3.0	15.6 - 26.0
STW-985	05/19/03	Gr. Alpha	54.4 ± 3.0	70.3 ± 17.6	39.9 - 101.0
STW-985	05/19/03	Ra-226	14.9 ± 0.2	16.5 ± 2.5	12.2 - 20.8
STW-985	05/19/03	Ra-228	13.1 ± 0.6	10.3 ± 2.6	5.8 - 14.8
STW-985	05/19/03	Uranium	14.5 ± 0.4	15.1 ± 3.0	9.9 - 20.3
STW-986	05/19/03	Co-60	56.9 ± 8.6	63.8 ± 5.0	55.1 - 72.5
STW-986[e]	05/19/03	Cs-134	61.6 ± 6.6	75.7 ± 5.0	67.0 - 84.4
STW-986	05/19/03	Cs-137	143.0 ± 1.2	150.0 ± 7.5	137.0 - 163.0
STW-986	05/19/03	Gr. Beta	309.0 ± 2.7	363.0 ± 54.5	269.0 - 457.0
STW-986	05/19/03	Sr-89	33.1 ± 0.2	31.3 ± 5.0	22.6 - 40.0
STW-986	05/19/03	Sr-90	28.8 ± 1.3	27.4 ± 5.0	18.7 - 36.1
STW-988	08/18/03	Ra-226	13.3 ± 1.1	13.4 ± 2.0	9.9 - 16.9
STW-988	08/18/03	Ra-228	11.5 ± 1.0	12.5 ± 3.1	7.1 - 17.9
STW-988	08/18/03	Uranium	12.3 ± 0.4	11.4 ± 3.0	6.2 - 16.6
STW-989	08/18/03	Ba-133	18.1 ± 1.9	20.7 ± 5.0	12.0 - 29.4
STW-989	08/18/03	Co-60	35.9 ± 1.3	37.4 ± 5.0	28.7 - 46.1
STW-989	08/18/03	Cs-134	32.6 ± 1.8	32.6 ± 5.0	23.9 - 41.3
STW-989	08/18/03	Cs-137	48.3 ± 0.6	44.3 ± 5.0	35.6 - 53.0
STW-989	08/18/03	Zn-65	58.9 ± 2.1	60.2 ± 6.0	49.8 - 70.6
STW-990	08/18/03	Gr. Alpha	41.8 ± 3.4	56.2 ± 16.3	36.9 - 93.3
STW-990[f]	08/18/03	Gr. Beta	51.3 ± 3.0	31.6 ± 5.0	22.9 - 40.3
STW-991	08/18/03	Sr-89	57.2 ± 4.3	58.8 ± 5.0	50.1 - 67.5
STW-991	08/18/03	Sr-90	21.2 ± 0.9	20.6 ± 5.0	11.9 - 29.3

TABLE A-1. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA)[a].

			Concentration (pCi/L)		
Lab Code	Date	Analysis	Laboratory Result[b]	ERA Result[c]	Control Limits
STW-997	11/18/03	Gr. Alpha	37.0 ± 2.0	29.5 ± 7.4	16.7 - 42.3
STW-997	11/18/03	Gr. Beta	26.5 ± 0.8	26.3 ± 5.0	17.6 - 35.0
STW-998	11/18/03	I-131	14.8 ± 0.3	16.5 ± 3.0	11.3 - 21.7
STW-999	11/18/03	Ra-226	17.2 ± 1.1	17.8 ± 2.7	13.2 - 22.4
STW-999	11/18/03	Ra-228	6.6 ± 0.3	6.8 ± 1.7	3.8 - 9.7
STW-999	11/18/03	Uranium	11.7 ± 0.3	11.7 ± 3.0	6.5 - 16.9
STW-1000	11/18/03	H-3	15900.0 ± 174.0	14300.0 ± 1430.0	11800.0 - 16800.0
STW-1001	11/18/03	Gr. Alpha	32.9 ± 0.3	54.2 ± 3.0	30.7 - 77.7
STW-1001	11/18/03	Ra-226	16.5 ± 0.9	16.1 ± 2.4	11.9 - 20.3
STW-1001	11/18/03	Ra-228	6.2 ± 0.5	5.5 ± 1.4	3.1 - 7.9
STW-1001	11/18/03	Uranium	9.7 ± 1.5	9.3 ± 13.6	4.1 - 14.5
STW-1002	11/18/03	Co-60	27.7 ± 1.9	27.7 ± 5.0	19.0 - 36.4
STW-1002	11/18/03	Cs-134	21.5 ± 1.1	23.4 ± 5.0	17.6 - 29.2
STW-1002	11/18/03	Cs-137	66.3 ± 2.8	64.2 ± 5.0	55.5 - 72.9
STW-1002	11/18/03	Gr. Beta	159.0 ± 2.5	168.0 ± 5.0	124.0 - 212.0
STW-1002	11/18/03	Sr-89	48.5 ± 0.4	50.4 ± 5.0	41.7 - 59.1
STW-1002	11/18/03	Sr-90	10.1 ± 3.0	10.2 ± 25.2	1.5 - 18.9

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[a] Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the environmental samples crosscheck program operated by Environmental Resources Associates (ERA).

[b] Unless otherwise indicated, the laboratory result is given as the mean ± standard deviation for three determinations.

[c] Results are presented as the known values, expected laboratory precision (1 sigma, 1 determination) and control limits as provided by ERA.

[d] Recount of the original sample still low. The ERA blank was spiked in the lab; known value of 20.1 pCi/L, measured 21.5 ± 1.1 pCi/L. No explanation for ERA test failure.

[e] Lower bias observed for gamma spectroscopic analysis. The undiluted sample was reanalyzed; Results of reanalysis, Co-60: 62.3 pCi/L., Cs-134: 69.2 pCi/L., Cs-137: 152.3 pCi/L.

[f] Reason for deviation unknown. A recount of the original planchets averaged 43.4 pCi/L. Cs-137activity by gamma spectroscopy; 28.3 pCi/L. Result of reanalysis; 29.3 pCi/L.

TABLE A-2. Crosscheck program results; Thermoluminescent Dosimetry, (TLDs).

Lab Code	TLD Type	Date			mR	
			Description	Known Value	Lab Result ± 2 sigma	Control Limits
Environmental, Inc.						
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 120	4.69	4.74 ± 0.54	3.28 - 6.10
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 150	3.00	3.02 ± 0.20	2.10 - 3.90
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 180	2.08	1.89 ± 0.45	1.46 - 2.70
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 180	2.08	2.11 ± 0.22	1.46 - 2.70
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 30	75.00	84.40 ± 4.87	52.50 - 97.50
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 60	18.75	19.11 ± 1.86	13.13 - 24.38
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 60	18.75	22.82 ± 5.41	13.13 - 24.38
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 90	8.33	9.05 ± 1.17	5.83 - 10.83
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 90	8.33	7.60 ± 1.08	5.83 - 10.83
Environmental, Inc.						
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 30	61.96	73.50 ± 2.58	43.37 - 80.55
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 60	15.49	19.70 ± 0.51	10.84 - 20.14
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 60	15.49	16.93 ± 1.37	10.84 - 20.14
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 90	6.88	8.06 ± 0.60	4.82 - 8.94
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 90	6.88	6.64 ± 0.58	4.82 - 8.94
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 120	3.87	4.39 ± 0.17	2.71 - 5.03
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 150	2.48	2.34 ± 0.18	1.74 - 3.22
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 150	2.48	2.51 ± 0.16	1.74 - 3.22
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 180	1.72	2.01 ± 0.13	1.20 - 2.24

TABLE A-3. In-House "Spike" Samples

Lab Code	Sample Type	Date	Concentration (pCi/L)[a]			
			Analysis	Laboratory results 2s, n=1[b]	Known Activity	Control Limits[c]
SPW-356	water	1/2/2003	Sr-90	34.04 ± 1.57	30.93	24.74 - 37.12
W-10303	water	1/3/2003	Gr. Beta	63.24 ± 1.20	63.90	53.90 - 73.90
W-11303	water	1/13/2003	Gr. Beta	59.75 ± 1.10	63.90	53.90 - 73.90
W-12103	water	1/21/2003	Gr. Beta	61.56 ± 1.59	63.99	53.99 - 73.99
SPAP-446	Air Filter	1/31/2003	Gr. Beta	1.49 ± 0.02	1.52	-8.48 - 11.52
SPW-468	water	1/31/2003	H-3	95982.00 ± 865.00	89607.00	71685.60 - 107528.40
W-20703	water	2/7/2003	Fe-55	9095.00 ± 114.00	10587.00	8469.60 - 12704.40
SPU-1347	Urine	3/1/2003	H-3	1724.00 ± 412.00	1784.33	1101.27 - 2467.39
DW-30303	water	3/3/2003	Gr. Beta	65.44 ± 0.59	63.90	53.90 - 73.90
SPCH-964	Charcoal	3/8/2003	I-131(G)	73.37 ± 0.28	69.45	59.45 - 79.45
SPMI-1086	Milk	3/13/2003	Cs-137	57.18 ± 8.03	49.50	39.50 - 59.50
SPMI-1086	Milk	3/13/2003	I-131	75.13 ± 12.01	67.60	54.08 - 81.12
SPMI-1086	Milk	3/13/2003	I-131(G)	65.81 ± 1.06	67.56	57.56 - 77.56
SPW-1088	water	3/13/2003	Co-60	27.16 ± 4.79	28.20	18.20 - 38.20
SPW-1088	water	3/13/2003	Cs-137	51.74 ± 9.15	49.50	39.50 - 59.50
SPW-1088	water	3/13/2003	I-131(G)	68.14 ± 12.92	67.60	57.60 - 77.60
SPW-1088	water	3/13/2003	I-131	76.94 ± 1.13	67.56	54.05 - 81.07
SPVE-1110	Vegetation	3/14/2003	I-131(G)	122.80 ± 16.80	124.00	111.60 - 136.40
SPW-1194	water	3/21/2003	Co-60	31.09 ± 6.28	28.15	18.15 - 38.15
SPW-1194	water	3/21/2003	Cs-137	55.11 ± 0.13	49.50	39.50 - 59.50
SPW-1194	water	3/21/2003	I-131(G)	66.17 ± 9.15	67.60	57.60 - 77.60
W-32103	water	3/21/2003	C-14	5201.00 ± 16.60	4966.00	2979.60 - 6952.40
SPCH-1429	Charcoal	4/1/2003	I-131(G)	8.83 ± 0.11	9.18	-0.82 - 19.18
W-40103	water	4/1/2003	Gr. Beta	67.74 ± 0.52	63.39	53.39 - 73.39
SPF-1407	Fish	4/2/2003	Cs-134	0.58 ± 0.03	0.59	0.35 - 0.83
SPF-1407	Fish	4/2/2003	Cs-137	1.29 ± 0.06	1.32	0.79 - 1.85
SPAP-1409	Air Filter	4/2/2003	Gr. Beta	1.44 ± 0.02	1.51	-8.49 - 11.51
SPU-41203	Urine	4/12/2003	H-3	1798.50 ± 409.30	1784.33	1101.27 - 2467.39
SPU-41703	Urine	4/17/2003	H-3	1625.10 ± 401.30	1784.33	1101.27 - 2467.39
SPW-2022	water	4/25/2003	H-3	89007.00 ± 798.00	88463.00	70770.40 - 106155.60
SPW-2053	water	4/28/2003	Cs-137	45.70 ± 9.44	49.35	39.35 - 59.35
SPW-2053	water	4/28/2003	Sr-90	47.51 ± 1.87	44.47	35.58 - 53.36
SPMI-2055	Milk	4/28/2003	Cs-137	61.65 ± 7.17	65.80	55.80 - 75.80
SPMI-2055	Milk	4/28/2003	Sr-90	38.45 ± 1.59	44.74	35.79 - 53.69
W-50603	water	5/6/2003	Gr. Beta	70.95 ± 0.53	63.39	53.39 - 73.39
W-60303	water	6/3/2003	Gr. Beta	63.00 ± 0.51	65.73	55.73 - 75.73
SPW-3960	water	7/15/2003	H-3	88700.00 ± 822.00	87369.00	69895.20 - 104842.80
SPMI-4019	Milk	7/18/2003	Cs-137	47.17 ± 7.22	49.11	39.11 - 59.11
SPMI-4019	Milk	7/18/2003	Sr-89	40.95 ± 4.88	49.49	39.49 - 59.49
SPMI-4019	Milk	7/18/2003	Sr-90	45.30 ± 1.73	44.24	35.39 - 53.09
SPW-4023	water	7/18/2003	Cs-137	51.92 ± 6.24	49.11	39.11 - 59.11
SPW-4023	water	7/18/2003	Sr-89	42.49 ± 10.23	49.49	39.49 - 59.49
SPW-4023	water	7/18/2003	Sr-90	49.69 ± 3.04	44.24	35.39 - 53.09
SPW-4518	water	8/8/2003	Fe-55	8176.00 ± 107.00	9330.00	7464.00 - 11196.00

TABLE A-3. In-House "Spike" Samples

Lab Code	Sample Type	Date	Concentration (pCi/L) Analysis	Laboratory results 2s, n=1[b]	Known Activity	Control Limits[c]
SPW-6197	water	10/16/2003	Tc-99	540.14 ± 54.00	539.73	377.81 - 701.65
SPAP-3958	Air Filter	10/28/2003	Gr. Beta	1.45 ± 0.02	1.50	-8.50 - 11.50
SPW-6401	water	10/28/2003	H-3	84867.00 ± 826.00	85984.00	68787.20 - 103180.80
SPAP-6403	Air Filter	10/28/2003	Gr. Beta	1.71 ± 0.02	1.49	-8.51 - 11.49
SPF-6418	Fish	10/28/2003	Cs-134	0.50 ± 0.02	0.49	0.29 - 0.69
SPF-6418	Fish	10/28/2003	Cs-137	1.37 ± 0.05	1.30	0.78 - 1.82
SPW-6421	water	10/28/2003	Fe-55	104.18 ± 1.26	88.18	68.18 - 108.18
SPMI-7459	Milk	12/12/2003	Cs-134	41.06 ± 2.45	41.88	31.88 - 51.88
SPMI-7459	Milk	12/12/2003	Cs-137	48.48 ± 4.99	48.64	38.64 - 58.64
SPMI-7459	Milk	12/12/2003	Sr-89	55.94 ± 4.12	65.80	52.64 - 78.96
SPMI-7459	Milk	12/12/2003	Sr-90	41.86 ± 1.57	43.80	35.04 - 52.56
SPW-7461	water	12/12/2003	Cs-134	44.07 ± 1.49	41.88	31.88 - 51.88
SPW-7461	water	12/12/2003	Cs-137	50.26 ± 2.67	48.64	38.64 - 58.64
SPW-7461	water	12/12/2003	Sr-89	56.41 ± 4.87	65.80	52.64 - 78.96
SPW-7461	water	12/12/2003	Sr-90	48.44 ± 1.84	43.80	35.04 - 52.56

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[c] Control limits are based on Attachment A, Page A2 of this report.

NOTE: For fish, Jello is used for the Spike matrix. For Vegetation, cabbage is used for the Spike matrix.

TABLE A-4. In-House "Blank" Samples

Lab Code	Sample Type	Date	Analysis	Concentration (pCi/L)[a]		
				Laboratory results (4.66σ)		Acceptance Criteria (4.66 σ)
				LLD	Activity[b]	
SPW-357	water	1/2/2003	Sr-90	0.50	0.12 ± 0.25	1
W-10303	water	1/3/2003	Gr. Beta	0.12	0.022 ± 0.10	3.2
W-11303	water	1/13/2003	Gr. Beta	0.14	0.035 ± 0.10	3.2
W-12103	water	1/21/2003	Gr. Beta	0.12	0.029 ± 0.09	3.2
SPAP-447	Air Filter	1/31/2003	Gr. Beta	0.00	-0.0034 ± 0.00	3.2
SPW-469	water	1/31/2003	H-3	160.20	19.3 ± 80.30	200
W-20103	water	2/1/2003	Gr. Beta	0.17	0.0 ± 0.12	3.2
W-20703	water	2/7/2003	Fe-55	802.00	149 ± 498.00	1000
DW-30303		3/3/2003	Gr. Beta	0.15	0.007 ± 0.11	3.2
SPCH-965	Charcoal Cani	3/8/2003	I-131(G)	0.01		9.6
SPMI-1087	Milk	3/13/2003	Cs-134	7.49		10
SPMI-1087	Milk	3/13/2003	Cs-137	7.90		10
SPMI-1087	Milk	3/13/2003	I-131	0.33	-0.013 ± 0.18	0.5
SPMI-1087	Milk	3/13/2003	I-131(G)	7.76		20
SPW-1089	water	3/13/2003	Co-60	4.48		10
SPW-1089	water	3/13/2003	Cs-134	5.60		10
SPW-1089	water	3/13/2003	Cs-137	4.32		10
SPW-1089	water	3/13/2003	I-131	0.29	-0.050 ± 0.16	0.5
SPVE-1111	Vegetation	3/14/2003	I-131(G)	7.53		20
W-32103	water	3/21/2003	C-14	17.50	-0.4 ± 9.200	200
SPCH-1430	Charcoal Cani	4/1/2003	I-131(G)	0.01		9.6
W-40103	water	4/1/2003	Gr. Beta	0.14	-0.11 ± 0.100	3.2
SPF-1408	Fish	4/2/2003	Cs-134	0.01		100
SPF-1408	Fish	4/2/2003	Cs-137	0.01		100
SPAP-1410	Air Filter	4/2/2003	Gr. Beta	0.00	-0.0029 ± 0.002	3.2
SPU-41203	Urine	4/12/2003	H-3	653.99	542.28 ± 364.780	200
SPU-41703	Urine	4/17/2003	H-3	648.35	100.1 ± 344.800	200
SPW-2054	water	4/28/2003	Cs-137	3.16		10
SPW-2054	water	4/28/2003	Sr-89	0.55	0.45 ± 0.50	5
SPW-2054	water	4/28/2003	Sr-90	0.55	0.072 ± 0.260	1
SPMI-2056 [c]	Milk	4/28/2003	Sr-90	0.77	0.66 ± 0.430	1
SPMI-2056	Milk	4/28/2003	Cs-137	2.74		10
SPMI-2056	Milk	4/28/2003	I-131(G)	3.54		20
W-50603	water	5/6/2003	Gr. Beta	0.12	0 ± 0.090	3.2
W-60303	water	6/3/2003	Gr. Beta	0.14	-0.035 ± 0.095	3.2
SPW-3960	water	7/15/2003	H-3	156.60	53.4 ± 80.200	200
SPMI-4018	Milk	7/18/2003	Cs-137	4.10		10
SPMI-4018	Milk	7/18/2003	Sr-89	0.73	0.39 ± 0.880	5
SPMI-4018 [c]	Milk	7/18/2003	Sr-90	0.51	0.93 ± 0.340	1
SPW-4024	water	7/18/2003	Sr-89	0.83	0.21 ± 0.730	5
SPW-4024	water	7/18/2003	Sr-90	0.62	0.09 ± 0.300	1
SPW-4519	water	8/8/2003	Fe-55	527.00	87 ± 369.000	1000
SPW-6401	water	10/28/2003	H-3	163.80	-23.8 ± 85.000	200

TABLE A-4. In-House "Blank" Samples

Lab Code	Sample Type	Date	Analysis	Concentration (pCi/L)[a]		
				Laboratory results (4.66σ)		Acceptance Criteria (4.66 σ)
				LLD	Activity[b]	
SPAP-6404	Air Filter	10/28/2003	Gr. Beta	0.87	-0.99 ± 0.440	3.2
SPF-6419	Fish	10/28/2003	Cs-134	0.01		100
SPF-6419	Fish	10/28/2003	Cs-137	0.01		100
SPMI-7460	Milk	12/12/2003	Cs-134	4.52		10
SPMI-7460	Milk	12/12/2003	Cs-137	5.77		10
SPMI-7460[c]	Milk	12/12/2003	Sr-90	0.50	1.26 ± 0.370	1

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[a] Liquid sample results are reported in pCi/Liter, air filters(pCi/filter), charcoal (pCi/charcoal canister), and solid samples (pCi/kg).

[b] The activity reported is the net activity result.

[c] Low levels of Sr-90 are still detected in the environment. A concentration of (1-5 pCi/L) in milk is not unusual.

TABLE A-5. In-House "Duplicate" Samples

			Concentration (pCi/L)^a		
Lab Code	Date	Analysis	First Result	Second Result	Averaged Result
MI-24, 25	1/2/2003	K-40	1362.00 ± 117.00	1377.00 ± 188.00	1369.50 ± 110.72
MI-24, 25	1/2/2003	Sr-90	1.45 ± 0.40	2.21 ± 0.50	1.83 ± 0.32
CF-47, 48	1/2/2003	Gr. Beta	2.72 ± 0.10	2.84 ± 0.10	2.78 ± 0.07
CF-47, 48	1/2/2003	K-40	2.61 ± 0.31	2.32 ± 0.12	2.47 ± 0.17
AP-8827, 8828	1/2/2003	Be-7	0.06 ± 0.01	0.05 ± 0.02	0.05 ± 0.01
AP-8869, 8870	1/2/2003	Be-7	0.04 ± 0.02	0.05 ± 0.02	0.05 ± 0.01
MI-119, 120	1/8/2003	K-40	1351.90 ± 116.10	1234.70 ± 108.70	1293.30 ± 79.52
MI-119, 120	1/8/2003	Sr-90	2.22 ± 0.43	1.88 ± 0.40	2.05 ± 0.30
MI-213, 214	1/14/2003	K-40	1372.30 ± 104.80	1303.80 ± 109.10	1338.05 ± 75.64
MI-213, 214	1/14/2003	Sr-90	1.81 ± 0.41	2.29 ± 0.45	2.05 ± 0.31
MI-262, 263	1/15/2003	K-40	1399.20 ± 200.70	1347.70 ± 126.40	1373.45 ± 118.59
S-696, 697	1/29/2003	Gr. Alpha	24.70 ± 4.89	23.23 ± 4.64	23.97 ± 3.37
S-696, 697	1/29/2003	Gr. Beta	22.89 ± 2.67	22.71 ± 2.73	22.80 ± 1.91
MI-448, 449	2/3/2003	K-40	1159.70 ± 157.90	1396.40 ± 106.20	1278.05 ± 95.15
SW-470, 471	2/3/2003	Gr. Beta	13.62 ± 1.23	15.21 ± 1.21	14.42 ± 0.86
SW-470, 471	2/3/2003	K-40 (ICP)	5.10 ± 0.51	5.20 ± 0.52	5.15 ± 0.36
SW-470, 471	2/3/2003	K-40	5.80 ± 0.51	5.90 ± 0.52	5.85 ± 0.36
MI-517, 518	2/4/2003	K-40	1437.70 ± 125.50	1357.70 ± 188.00	1397.70 ± 113.02
MI-541, 542	2/5/2003	K-40	1443.00 ± 194.80	1385.20 ± 190.10	1414.10 ± 136.09
MI-620, 621	2/11/2003	K-40	1294.70 ± 115.10	1234.10 ± 165.10	1264.40 ± 100.63
DW-922, 923	3/4/2003	I-131	0.67 ± 0.16	0.79 ± 0.16	0.73 ± 0.11
CF-1048, 1049 b	3/10/2003	K-40	3.09 ± 0.12	2.67 ± 0.07	2.88 ± 0.07
LW-1152, 1153	3/13/2003	H-3	1147.26 ± 122.56	1094.42 ± 120.92	1120.84 ± 86.09
F-1120, 1121	3/14/2003	Cs-137	0.04 ± 0.02	0.05 ± 0.01	0.05 ± 0.01
F-1120, 1121	3/14/2003	Gr. Beta	2.04 ± 0.06	2.11 ± 0.06	2.08 ± 0.04
F-1120, 1121	3/14/2003	K-40	1.93 ± 0.38	1.89 ± 0.25	1.91 ± 0.23
DW-1278, 1279	3/25/2003	I-131	0.37 ± 0.22	0.34 ± 0.29	0.36 ± 0.18
SO-1380, 1381	3/25/2003	Gr. Beta	18.60 ± 2.68	20.53 ± 2.83	19.57 ± 1.95
LW-1299, 1300	3/27/2003	Gr. Beta	2.35 ± 0.55	2.48 ± 0.56	2.42 ± 0.39
LW-1320, 1321	3/27/2003	H-3	487.12 ± 104.43	422.00 ± 102.00	454.56 ± 72.99
W-1403, 1404	3/31/2003	Sr-90	0.96 ± 0.32	1.10 ± 0.42	1.03 ± 0.26
AP-2019, 2020	3/31/2003	Be-7	0.07 ± 0.01	0.08 ± 0.01	0.07 ± 0.01
MI-1422, 1423	4/1/2003	K-40	1410.00 ± 176.00	1340.00 ± 114.00	1375.00 ± 104.85
MI-2170, 2171	4/1/2003	K-40	1452.30 ± 129.10	1472.50 ± 191.00	1462.40 ± 115.27
MI-1422, 1423	4/2/2003	Sr-90	1.84 ± 0.42	1.15 ± 0.39	1.50 ± 0.29
AP-1633, 1634	4/2/2003	Be-7	0.05 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
AP-1871, 1872	4/2/2003	Be-7	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01
AP-1974, 1975	4/2/2003	Be-7	0.08 ± 0.02	0.07 ± 0.02	0.08 ± 0.01
LW-1828, 1829	4/11/2003	Gr. Beta	2.49 ± 0.58	3.42 ± 0.63	2.96 ± 0.43
S-1544, 1545	4/15/2003	K-40	15.84 ± 2.36	15.41 ± 2.02	15.63 ± 1.55
DW-1913, 1914	4/15/2003	I-131	0.29 ± 0.21	0.42 ± 0.19	0.36 ± 0.14
MI-1996, 1997	4/21/2003	Sr-90	2.05 ± 0.74	3.25 ± 0.91	2.65 ± 0.58
MI-1996, 1997	4/22/2003	K-40	1580.20 ± 118.90	1602.10 ± 120.40	1591.15 ± 84.61

TABLE A-5. In-House "Duplicate" Samples

			Concentration (pCi/L)^a		
Lab Code	Date	Analysis	First Result	Second Result	Averaged Result
LW-2063, 2064	4/28/2003	Gr. Beta	2.33 ± 0.66	2.68 ± 0.60	2.51 ± 0.45
SWU-2275, 2276	4/28/2003	Gr. Beta	3.62 ± 0.67	4.60 ± 0.71	4.11 ± 0.49
G-2149, 2150	4/30/2003	Be-7	0.71 ± 0.19	0.69 ± 0.20	0.70 ± 0.14
TD-2339, 2340	5/1/2003	H-3	221.00 ± 91.00	161.00 ± 88.00	191.00 ± 63.29
SO-2381, 2382	5/1/2003	Cs-137	0.11 ± 0.03	0.10 ± 0.02	0.10 ± 0.02
SO-2381, 2382	5/1/2003	Gr. Alpha	11.14 ± 5.15	10.39 ± 5.60	10.77 ± 3.80
SO-2381, 2382	5/1/2003	Gr. Beta	35.18 ± 4.69	39.66 ± 5.24	37.42 ± 3.52
SO-2381, 2382	5/1/2003	K-40	18.29 ± 0.84	17.83 ± 0.84	18.06 ± 0.59
SO-2381, 2382	5/1/2003	Sr-90	0.06 ± 0.02	0.10 ± 0.02	0.08 ± 0.01
DW-2317, 2318	5/6/2003	I-131	1.77 ± 0.27	1.47 ± 0.26	1.62 ± 0.19
BS-2595, 2596	5/6/2003	Cs-137	0.06 ± 0.02	0.06 ± 0.02	0.06 ± 0.02
BS-2595, 2596	5/6/2003	K-40	13.74 ± 0.62	14.10 ± 0.73	13.92 ± 0.48
U-2484, 2485	5/9/2003	H-3	512.00 ± 100.00	370.00 ± 95.00	441.00 ± 68.97
SO-2645, 2646	5/14/2003	Be-7	1.18 ± 0.42	1.21 ± 0.35	1.19 ± 0.27
SO-2645, 2646	5/14/2003	Cs-137	0.11 ± 0.04	0.09 ± 0.05	0.10 ± 0.03
SO-2645, 2646	5/14/2003	K-40	16.50 ± 1.13	15.33 ± 1.09	15.91 ± 0.79
MI-2696, 2697	5/19/2003	K-40	1320.40 ± 124.50	1394.10 ± 113.00	1357.25 ± 84.07
MI-2696, 2697	5/19/2003	Sr-90	1.49 ± 0.47	2.01 ± 0.45	1.75 ± 0.32
SO-2787, 2788	5/28/2003	Cs-137	0.27 ± 0.04	0.23 ± 0.04	0.25 ± 0.03
SO-2787, 2788	5/28/2003	Gr. Beta	19.62 ± 1.73	20.81 ± 1.72	20.21 ± 1.22
SO-2787, 2788	5/28/2003	K-40	14.77 ± 1.02	14.41 ± 1.00	14.59 ± 0.71
MI-2840, 2841	5/28/2003	K-40	1179.50 ± 167.80	1401.70 ± 120.20	1290.60 ± 103.20
SWU-2864, 2865	5/28/2003	Gr. Beta	3.39 ± 0.59	3.41 ± 0.64	3.40 ± 0.43
BS-2888, 2889	5/29/2003	Cs-137	0.05 ± 0.02	0.07 ± 0.04	0.06 ± 0.02
BS-2888, 2889	5/29/2003	K-40	9.70 ± 0.83	10.17 ± 0.87	9.93 ± 0.60
W-3230, 3231	5/30/2003	Gr. Beta	4.33 ± 1.00	3.28 ± 1.22	3.81 ± 0.79
TD-3036, 3037	6/2/2003	H-3	529.50 ± 100.00	585.50 ± 102.00	557.50 ± 71.42
SL-2909, 2910 b	6/3/2003	Gr. Beta	7.10 ± 0.15	7.60 ± 0.16	7.35 ± 0.11
SL-2909, 2910	6/3/2003	K-40	3.90 ± 0.67	3.49 ± 0.52	3.70 ± 0.42
SW-3080, 3081	6/10/2003	Gr. Alpha	4.63 ± 1.90	4.47 ± 1.71	4.55 ± 1.28
SW-3080, 3081	6/10/2003	Gr. Beta	9.07 ± 1.29	8.98 ± 1.28	9.02 ± 0.91
VE-3172, 3173	6/11/2003	K-40	2.62 ± 0.35	3.17 ± 0.58	2.90 ± 0.34
F-3742, 3743	6/11/2003	Gr. Beta	3.47 ± 0.13	3.71 ± 0.14	3.59 ± 0.10
F-3742, 3743	6/11/2003	K-40	2.94 ± 0.39	2.70 ± 0.40	2.82 ± 0.28
SO-3325, 3326	6/13/2003	Gr. Beta	20.95 ± 1.88	19.97 ± 2.01	20.46 ± 1.38
MI-3253, 3254	6/17/2003	K-40	1329.40 ± 121.80	1417.60 ± 130.90	1373.50 ± 89.40
MI-3297, 3298	6/17/2003	Sr-90	2.14 ± 0.57	2.27 ± 0.50	2.21 ± 0.38
WW-3380, 3381	6/23/2003	Gr. Beta	5.58 ± 0.69	5.03 ± 0.69	5.31 ± 0.49
SWT-3403, 3404	6/24/2003	Gr. Beta	2.80 ± 0.56	2.63 ± 0.55	2.72 ± 0.39
MI-3424, 3425	6/24/2003	K-40	1422.80 ± 185.40	1216.20 ± 170.10	1319.50 ± 125.80
SW-3862, 3863	6/24/2003	Gr. Beta	3.66 ± 1.18	3.70 ± 1.22	3.68 ± 0.85
G-3479, 3480	6/25/2003	Be-7	1.52 ± 0.25	1.43 ± 0.28	1.47 ± 0.19
G-3479, 3480	6/25/2003	K-40	5.02 ± 0.45	5.10 ± 0.48	5.06 ± 0.33
LW-3809, 3810	6/30/2003	Gr. Beta	2.12 ± 0.76	2.39 ± 0.72	2.25 ± 0.52

TABLE A-5. In-House "Duplicate" Samples

			Concentration (pCi/L)[a]		
Lab Code	Date	Analysis	First Result	Second Result	Averaged Result
LW-3809, 3810	6/30/2003	H-3	2814.09 ± 167.99	2812.17 ± 167.94	2813.13 ± 118.77
AP-4105, 4106	6/30/2003	Be-7	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01
G-3572, 3573	7/1/2003	Be-7	0.91 ± 0.24	0.81 ± 0.28	0.86 ± 0.18
G-3572, 3573	7/1/2003	Gr. Beta	6.35 ± 0.15	6.35 ± 0.15	6.35 ± 0.11
G-3572, 3573	7/1/2003	K-40	5.44 ± 0.55	5.68 ± 0.28	5.56 ± 0.31
G-3572, 3573	7/1/2003	Sr-90	0.01 ± 0.00	0.02 ± 0.00	0.01 ± 0.00
MI-3601, 3602	7/1/2003	K-40	1318.60 ± 117.40	1435.10 ± 117.80	1376.85 ± 83.16
MI-3601, 3602	7/1/2003	Sr-90	0.86 ± 0.51	1.74 ± 0.60	1.30 ± 0.39
AP-3933, 3934	7/1/2003	Be-7	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01
AP-4061, 4062	7/2/2003	Be-7	0.07 ± 0.01	0.08 ± 0.01	0.08 ± 0.01
AP-4147, 4148	7/2/2003	Be-7	0.08 ± 0.01	0.07 ± 0.01	0.07 ± 0.01
AP-4084, 4085	7/3/2003	Be-7	0.09 ± 0.02	0.08 ± 0.02	0.08 ± 0.01
LW-3786, 3787	7/9/2003	Gr. Beta	2.13 ± 0.56	2.93 ± 0.62	2.53 ± 0.42
WW-4168, 4169	7/11/2003	Gr. Beta	3.79 ± 1.87	4.48 ± 1.98	4.14 ± 1.36
CF-3975, 3976	7/14/2003	Be-7	1.64 ± 0.81	1.66 ± 0.57	1.65 ± 0.50
CF-3975, 3976	7/14/2003	K-40	6.54 ± 0.75	6.19 ± 0.50	6.36 ± 0.45
MI-4020, 4021	7/16/2003	K-40	1350.90 ± 174.90	1199.80 ± 153.20	1275.35 ± 116.25
DW-4272, 4273	7/29/2003	Gr. Beta	2.35 ± 0.92	2.29 ± 0.89	2.32 ± 0.64
SWU-4461, 4462	7/30/2003	Gr. Beta	2.28 ± 0.44	1.93 ± 0.43	2.10 ± 0.31
SL-4398, 4399	8/4/2003	Be-7	4.55 ± 1.05	4.50 ± 1.10	4.53 ± 0.76
SL-4398, 4399 [b]	8/4/2003	Gr. Beta	3.41 ± 0.12	3.12 ± 0.11	3.27 ± 0.08
SL-4398, 4399	8/4/2003	K-40	2.47 ± 0.67	2.44 ± 0.87	2.46 ± 0.55
G-4419, 4420	8/4/2003	Be-7	3.98 ± 0.63	3.93 ± 0.57	3.96 ± 0.42
G-4419, 4420	8/4/2003	Gr. Beta	5.38 ± 0.14	5.35 ± 0.16	5.37 ± 0.11
G-4419, 4420	8/4/2003	K-40	4.42 ± 0.66	4.32 ± 0.74	4.37 ± 0.50
TD-4550, 4551	8/4/2003	H-3	327.30 ± 95.10	390.20 ± 92.10	358.75 ± 66.19
MI-4482, 4483	8/6/2003	K-40	1301.40 ± 115.20	1370.30 ± 116.80	1335.85 ± 82.03
MI-4482, 4483	8/6/2003	Sr-90	0.81 ± 0.30	0.85 ± 0.31	0.83 ± 0.21
G-4526, 4527	8/6/2003	Be-7	1.47 ± 0.29	1.42 ± 0.28	1.45 ± 0.20
G-4526, 4527	8/6/2003	K-40	5.42 ± 0.56	5.21 ± 0.63	5.31 ± 0.42
SWU-4609, 4610	8/6/2003	Gr. Beta	3.22 ± 0.63	2.67 ± 0.64	2.95 ± 0.45
CW-4694, 4695	8/6/2003	Gr. Beta	1.48 ± 0.34	1.09 ± 0.34	1.29 ± 0.24
CW-4694, 4695	8/6/2003	H-3	22776.41 ± 428.73	21831.75 ± 420.10	22304.08 ± 300.12
LW-4673, 4674	8/13/2003	Gr. Beta	2.86 ± 0.65	3.75 ± 0.71	3.30 ± 0.48
MI-4735, 4736	8/19/2003	K-40	1396.30 ± 127.90	1410.10 ± 120.20	1403.20 ± 87.76
MI-4756, 4757	8/19/2003	Sr-90	1.66 ± 0.47	1.53 ± 0.44	1.60 ± 0.32
VE-4832, 4833	8/20/2003	K-40	1.96 ± 0.50	1.43 ± 0.47	1.70 ± 0.34
MI-4860, 4861	8/26/2003	K-40	1312.10 ± 191.80	1307.80 ± 109.30	1309.95 ± 110.38
SO-5082, 5083	8/28/2003	Cs-137	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00
SO-5082, 5083	8/28/2003	Gr. Beta	20.02 ± 1.84	20.92 ± 2.03	20.47 ± 1.37
CW-5349, 5350	8/31/2003	Gr. Beta	1.45 ± 0.39	1.55 ± 0.45	1.50 ± 0.30
CW-5349, 5350	8/31/2003	H-3	24429.50 ± 444.42	24744.25 ± 447.18	24586.88 ± 315.23
ME-4968, 4969	9/2/2003	Gr. Beta	4.90 ± 0.23	5.18 ± 0.24	5.04 ± 0.17
ME-4968, 4969	9/2/2003	K-40	2.46 ± 0.41	2.68 ± 0.37	2.57 ± 0.28

TABLE A-5. In-House "Duplicate" Samples

			Concentration (pCi/L)[a]		
Lab Code	Date	Analysis	First Result	Second Result	Averaged Result
DW-4989, 4990	9/2/2003	Gr. Beta	2.20 ± 1.04	3.19 ± 1.14	2.70 ± 0.77
MI-5154, 5155	9/8/2003	K-40	1365.50 ± 116.70	1456.70 ± 119.10	1411.10 ± 83.37
MI-5154, 5155	9/8/2003	Sr-90	1.19 ± 0.39	1.39 ± 0.39	1.29 ± 0.28
AP-6177, 6178	9/29/2003	Be-7	0.07 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
SWU-5773, 5774	9/30/2003	Gr. Beta	2.55 ± 0.63	2.83 ± 0.60	2.69 ± 0.44
AP-6102, 6103	9/30/2003	Be-7	0.07 ± 0.01	0.05 ± 0.01	0.06 ± 0.01
G-5631, 5632	10/1/2003	Be-7	1.88 ± 0.48	2.21 ± 0.40	2.05 ± 0.31
G-5631, 5632	10/1/2003	Gr. Beta	5.87 ± 0.09	5.85 ± 0.08	5.86 ± 0.06
G-5631, 5632	10/1/2003	K-40	5.24 ± 0.77	5.26 ± 0.58	5.25 ± 0.48
SO-5660, 5661	10/1/2003	Cs-137	0.15 ± 0.04	0.16 ± 0.05	0.16 ± 0.03
SO-5660, 5661	10/1/2003	Gr. Alpha	12.72 ± 3.72	14.86 ± 3.88	13.79 ± 2.69
SO-5660, 5661	10/1/2003	Gr. Beta	32.42 ± 3.09	33.60 ± 3.04	33.01 ± 2.17
SO-5660, 5661	10/1/2003	K-40	18.93 ± 0.87	18.25 ± 1.19	18.59 ± 0.74
SO-5660, 5661	10/1/2003	Sr-90	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01
AP-6334, 6335	10/1/2003	Be-7	0.06 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
AP-6363, 6364	10/2/2003	Be-7	0.07 ± 0.02	0.07 ± 0.02	0.07 ± 0.01
MI-5794, 5795	10/6/2003	Sr-90	1.37 ± 0.37	1.02 ± 0.37	1.19 ± 0.26
MI-5838, 5839	10/8/2003	K-40	1364.30 ± 124.10	1414.40 ± 110.40	1389.35 ± 83.05
MI-5838, 5839	10/8/2003	Sr-90	0.76 ± 0.30	1.00 ± 0.34	0.88 ± 0.23
BS-5938, 5939	10/8/2003	Cs-137	0.18 ± 0.03	0.20 ± 0.05	0.19 ± 0.03
BS-5938, 5939	10/8/2003	K-40	15.59 ± 0.70	16.69 ± 0.80	16.14 ± 0.53
SS-5959, 5960	10/13/2003	K-40	7.49 ± 0.42	7.29 ± 0.63	7.39 ± 0.38
MI-6011, 6012	10/13/2003	K-40	1165.20 ± 118.70	1191.20 ± 99.50	1178.20 ± 77.44
MI-6034, 6035	10/14/2003	Sr-90	0.86 ± 0.33	0.90 ± 0.34	0.88 ± 0.24
VE-6055, 6056	10/15/2003	Gr. Beta	5.18 ± 0.18	5.33 ± 0.18	5.25 ± 0.13
VE-6055, 6056	10/15/2003	K-40	5.31 ± 0.57	4.52 ± 0.51	4.92 ± 0.38
MI-6291, 6292	10/21/2003	K-40	1935.60 ± 147.70	1936.10 ± 116.50	1935.85 ± 94.06
MI-6291, 6292	10/21/2003	Sr-90	1.22 ± 0.39	1.41 ± 0.37	1.31 ± 0.27
SS-6435, 6436	10/21/2003	Cs-137	0.05 ± 0.02	0.05 ± 0.03	0.05 ± 0.02
SS-6435, 6436	10/21/2003	K-40	14.08 ± 0.54	14.28 ± 0.80	14.18 ± 0.48
CF-6313, 6314	10/22/2003	K-40	14.56 ± 0.45	14.70 ± 0.95	14.63 ± 0.53
SO-6528, 6529	10/22/2003	Cs-137	0.15 ± 0.03	0.16 ± 0.05	0.16 ± 0.03
SO-6528, 6529	10/22/2003	K-40	17.46 ± 0.69	17.90 ± 1.05	17.68 ± 0.63
SO-6393, 6394	10/25/2003	Cs-137	0.09 ± 0.03	0.10 ± 0.04	0.10 ± 0.03
SO-6393, 6394	10/25/2003	Gr. Beta	23.21 ± 1.98	21.76 ± 1.91	22.48 ± 1.38
SO-6393, 6394	10/25/2003	K-40	13.98 ± 0.80	14.57 ± 0.86	14.27 ± 0.59
SWT-6507, 6508	10/28/2003	Gr. Beta	2.64 ± 0.52	2.63 ± 0.53	2.63 ± 0.37
DW-6647, 6648	10/31/2003	I-131	0.46 ± 0.27	0.61 ± 0.31	0.53 ± 0.21
BS-6603, 6604	11/3/2003	Cs-137	9.03 ± 0.82	8.60 ± 1.13	8.82 ± 0.70
BS-6603, 6604	11/3/2003	Gr. Beta	26.83 ± 1.94	27.18 ± 1.95	27.01 ± 1.38
SO-6670, 6671	11/5/2003	Cs-137	0.15 ± 0.04	0.13 ± 0.04	0.14 ± 0.03
SO-6670, 6671	11/5/2003	K-40	12.96 ± 0.66	12.95 ± 0.72	12.96 ± 0.49
S-7067, 7068	11/10/2003	Cs-137	0.21 ± 0.05	0.19 ± 0.08	0.20 ± 0.05
MI-6818, 6819	11/11/2003	K-40	1695.50 ± 129.80	1709.40 ± 143.00	1702.45 ± 96.56

TABLE A-5. In-House "Duplicate" Samples

			Concentration (pCi/L)[a]		
Lab Code	Date	Analysis	First Result	Second Result	Averaged Result
MI-6818, 6819	11/11/2003	Sr-90	2.01 ± 0.41	1.59 ± 0.39	1.80 ± 0.28
WL-6987, 6988	11/17/2003	Fe-55	603.49 ± 53.32	619.65 ± 53.97	611.57 ± 37.93
SO-7156, 7157	11/21/2003	Cs-137	0.74 ± 0.08	0.77 ± 0.07	0.76 ± 0.06
SO-7156, 7157	11/21/2003	Gr. Alpha	14.90 ± 4.24	19.25 ± 4.45	17.07 ± 3.07
SO-7156, 7157	11/21/2003	Gr. Beta	22.97 ± 3.12	25.51 ± 2.98	24.24 ± 2.16
SO-7156, 7157	11/21/2003	K-40	12.51 ± 1.06	12.94 ± 1.07	12.73 ± 0.75
S-7281, 7282	11/24/2003	Cs-137	0.82 ± 0.15	1.16 ± 0.20	0.99 ± 0.12
SWU-7198, 7199	11/25/2003	Gr. Beta	2.60 ± 0.53	2.54 ± 0.55	2.57 ± 0.38
DW-7221, 7222	11/25/2003	Gr. Beta	12.32 ± 1.40	12.38 ± 1.43	12.35 ± 1.00
SW-7133, 7134	12/1/2003	Gr. Beta	2.10 ± 0.23	2.46 ± 0.23	2.28 ± 0.16
SW-7133, 7134	12/1/2003	K-40	1.50 ± 0.15	1.40 ± 0.14	1.45 ± 0.10
W-7519, 7520	12/1/2003	Fe-55	3.03 ± 0.65	3.12 ± 0.64	3.08 ± 0.46
SW-7805, 7806	12/1/2003	Sr-90	0.59 ± 0.32	0.56 ± 0.33	0.58 ± 0.23
VE-7399, 7400	12/9/2003	Gr. Beta	4.99 ± 0.15	5.24 ± 0.15	5.11 ± 0.11
VE-7399, 7400	12/9/2003	K-40	5.04 ± 0.46	5.34 ± 0.74	5.19 ± 0.43
SW-7540, 7541	12/9/2003	Gr. Alpha	2.64 ± 1.36	2.10 ± 1.19	2.37 ± 0.91
SW-7540, 7541	12/9/2003	Gr. Beta	6.62 ± 1.22	5.89 ± 1.35	6.25 ± 0.91
LW-7736, 7737	12/26/2003	Gr. Beta	2.62 ± 0.54	2.83 ± 0.56	2.73 ± 0.39
AP-7868, 7869	12/30/2003	Be-7	0.05 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
AP-7952, 7953	12/30/2003	Be-7	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
AP-7994, 7995	12/31/2003	Be-7	0.05 ± 0.02	0.05 ± 0.01	0.05 ± 0.01

Note: Duplicate analyses are performed on every twentieth sample received in-house. Results are not listed for those analyses with activities that measure below the LLD.

[a] Results are reported in units of pCi/L, except for air filters (pCi/Filter), food products, vegetation, soil, sediment (pCi/g).

[b] 200 minute count time or longer, resulting in lower error.

TABLE A-6. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP)[a].

			Concentration[b]			
Lab Code	Type	Date	Analysis	Laboratory result	Known Activity	Control Limits[c]
STW-972	water	12/01/02	Am-241	0.56 ± 0.06	0.58 ± 0.09	0.40 - 0.75
STW-972	water	12/01/02	Co-57	57.10 ± 1.90	57.00 ± 5.70	39.90 - 74.10
STW-972	water	12/01/02	Co-60	38.30 ± 0.60	38.20 ± 3.82	26.74 - 49.66
STW-972	water	12/01/02	Cs-134	395.30 ± 10.10	421.00 ± 42.10	294.70 - 547.30
STW-972	water	12/01/02	Cs-137	316.40 ± 5.30	329.00 ± 32.90	230.30 - 427.70
STW-972	water	12/01/02	Fe-55	94.90 ± 24.50	96.00 ± 9.60	67.20 - 124.80
STW-972	water	12/01/02	Mn-54	33.40 ± 0.10	32.90 ± 3.29	23.03 - 42.77
STW-972	water	12/01/02	Ni-63	123.80 ± 5.50	136.50 ± 13.70	95.55 - 177.45
STW-972	water	12/01/02	Pu-238	0.66 ± 0.06	0.83 ± 0.08	0.58 - 1.08
STW-972	water	12/01/02	Pu-239/40	0.001 ± 0.001	0.000 ± 0.000	0.000 - 0.005
STW-972	water	12/01/02	Sr-90	13.80 ± 1.00	12.31 ± 1.23	8.62 - 16.00
STW-972	water	12/01/02	Tc-99	128.10 ± 3.80	132.00 ± 13.20	92.40 - 171.60
STW-972	water	12/01/02	U-233/4	1.60 ± 0.09	1.54 ± 0.15	1.08 - 2.00
STW-972	water	12/01/02	U-238	1.64 ± 0.09	1.60 ± 0.16	1.12 - 2.08
STW-972	water	12/01/02	Zn-65	540.40 ± 9.90	516.00 ± 51.60	361.20 - 670.80
STSO-987	soil	01/01/03	Co-57	534.36 ± 2.61	530.00 ± 53.00	371.00 - 689.00
STSO-987	soil	01/01/03	Co-60	442.16 ± 2.31	420.00 ± 42.00	294.00 - 546.00
STSO-987	soil	01/01/03	Cs-134	211.00 ± 2.30	238.00 ± 23.80	166.60 - 309.40
STSO-987	soil	01/01/03	Cs-137	849.50 ± 3.30	832.00 ± 83.20	582.40 - 1081.60
STSO-987	soil	01/01/03	K-40	716.50 ± 12.80	652.00 ± 65.20	456.40 - 847.60
STSO-987	soil	01/01/03	Mn-54	148.76 ± 2.84	137.00 ± 13.70	95.90 - 178.10
STSO-987	soil	01/01/03	Ni-63	597.10 ± 23.50	770.00 ± 77.00	539.00 - 1001.00
STSO-987	soil	01/01/03	Pu-238	67.05 ± 3.10	66.90 ± 6.70	46.83 - 86.97
STSO-987	soil	01/01/03	Pu-239/40	52.80 ± 3.60	52.70 ± 5.30	36.90 - 68.50
STSO-987	soil	01/01/03	Sr-90	609.50 ± 9.80	714.00 ± 71.40	499.80 - 928.20
STSO-987	soil	01/01/03	U-233/4	99.50 ± 7.60	89.00 ± 8.90	62.30 - 115.70
STSO-987	soil	01/01/03	U-238	508.60 ± 42.20	421.00 ± 42.10	294.70 - 547.30
STSO-987	soil	01/01/03	Zn-65	492.70 ± 28.10	490.00 ± 49.00	343.00 - 637.00

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[a] Results obtained by Environmental, Inc. ,Midwest Laboratory as a participant in the Department of Energy's Mixed Analyte Performance Evaluation Program, Idaho Operations office, Idaho Falls, Idaho

[b] All results are in Bq/kg or Bq/L as requested by the Department of Energy.

[c] MAPEP results are presented as the known values and expected laboratory precision (1 sigma, 1 determination) and control limits as defined by the MAPEP.

TABLE A-7. Environmental Measurements Laboratory Quality Assessment Program (EML)

			Concentration[a]			
Lab Code	Type	Date	Analysis	Laboratory results	EML Result[b]	Control Limits[c]
STW-977	water	03/01/03	Gr. Alpha	304.30 ± 53.10	377.50	0.58 - 1.29
STW-977	water	03/01/03	Gr. Beta	615.80 ± 14.70	627.50	0.61 - 1.43
STW-978	water	03/01/03	Am-241	2.00 ± 0.10	2.13	0.79 - 1.41
STW-978	water	03/01/03	Co-60	221.30 ± 1.20	234.00	0.80 - 1.20
STW-978 [d]	water	03/01/03	Cs-134	23.30 ± 1.10	30.50	0.80 - 1.30
STW-978	water	03/01/03	Cs-137	61.40 ± 0.60	63.80	0.80 - 1.22
STW-978 [e]	water	03/01/03	H-3	341.90 ± 22.70	390.00	0.78 - 2.45
STW-978	water	03/01/03	Pu-238	3.70 ± 0.20	3.33	0.74 - 1.20
STW-978	water	03/01/03	Pu-239/40	4.40 ± 0.10	3.92	0.79 - 1.20
STW-978	water	03/01/03	Sr-90	4.60 ± 0.30	4.34	0.69 - 1.34
STW-978	water	03/01/03	Uranium	5.10 ± 0.60	4.29	0.75 - 1.33
STSO-979	soil	03/01/03	Ac-228	55.60 ± 2.50	57.60	0.80 - 1.38
STSO-979	soil	03/01/03	Am-241	12.42 ± 0.90	15.60	0.65 - 2.28
STSO-979	soil	03/01/03	Bi-212	57.70 ± 3.20	60.60	0.50 - 1.34
STSO-979	soil	03/01/03	Bi-214	60.40 ± 3.20	67.00	0.78 - 1.42
STSO-979	soil	03/01/03	Cs-137	1416.80 ± 70.00	1450.00	0.80 - 1.25
STSO-979	soil	03/01/03	K-40	653.80 ± 11.90	636.00	0.80 - 1.32
STSO-979	soil	03/01/03	Pb-212	51.10 ± 5.20	57.90	0.78 - 1.32
STSO-979	soil	03/01/03	Pb-214	64.70 ± 5.10	71.10	0.76 - 1.46
STSO-979	soil	03/01/03	Pu-239/40	24.40 ± 0.30	23.40	0.71 - 1.30
STSO-979	soil	03/01/03	Sr-90	54.50 ± 2.60	64.40	0.67 - 2.90
STSO-979	soil	03/01/03	Uranium	245.00 ± 1.50	249.00	0.71 - 1.32
STVE-980	Vegetation	03/01/03	Am-241	3.10 ± 0.20	3.51	0.73 - 2.02
STVE-980	Vegetation	03/01/03	Cm-244	1.40 ± 0.50	2.01	0.61 - 1.59
STVE-980	Vegetation	03/01/03	Co-60	12.60 ± 0.40	12.10	0.80 - 1.44
STVE-980	Vegetation	03/01/03	Cs-137	449.70 ± 6.20	444.00	0.80 - 1.31
STVE-980	Vegetation	03/01/03	K-40	1159.00 ± 38.60	1120.00	0.79 - 1.39
STVE-980	Vegetation	03/01/03	Pu-239/40	4.80 ± 0.40	5.17	0.69 - 1.31
STVE-980	Vegetation	03/01/03	Sr-90	659.70 ± 50.40	650.00	0.55 - 1.21
STAP-981	Air Filter	03/01/03	Am-241	0.27 ± 0.10	0.34	0.70 - 2.34
STAP-981	Air Filter	03/01/03	Co-60	30.20 ± 0.30	33.50	0.80 - 1.26
STAP-981	Air Filter	03/01/03	Cs-137	90.30 ± 1.30	99.70	0.80 - 1.32
STAP-981	Air Filter	03/01/03	Mn-54	41.80 ± 0.60	43.80	0.80 - 1.35
STAP-981	Air Filter	03/01/03	Pu-238	0.52 ± 0.10	0.52	0.67 - 1.33
STAP-981	Air Filter	03/01/03	Pu-239/40	0.35 ± 0.10	0.33	0.73 - 1.26
STAP-981	Air Filter	03/01/03	Sr-90	2.50 ± 0.10	2.80	0.53 - 1.84
STAP-981	Air Filter	03/01/03	Uranium	0.51 ± 0.10	0.50	0.79 - 2.10
STAP-982	Air Filter	03/01/03	Gr. Alpha	0.90 ± 0.10	1.17	0.73 - 1.43
STAP-982	Air Filter	03/01/03	Gr. Beta	1.50 ± 0.10	1.50	0.76 - 1.36

TABLE A-7. Environmental Measurements Laboratory Quality Assessment Program (EML)

			Concentration[a]			
Lab Code	Type	Date	Analysis	Laboratory results	EML Result[b]	Control Limits[c]
STW-992	water	09/02/03	Am-241	9.78 ± 0.32	8.76	0.79 - 1.41
The September, 2003 results are preliminary. Control limits used were taken from the March, 2003 data. Control limits may vary slightly when the final study is published.						
STW-992	water	09/02/03	Co-60	468.30 ± 4.10	513.00	0.80 - 1.20
STW-992	water	09/02/03	Cs-134	53.90 ± 0.80	63.00	0.80 - 1.30
STW-992	water	09/02/03	Cs-137	76.10 ± 1.40	80.30	0.80 - 1.22
STW-992	water	09/02/03	H-3	355.20 ± 12.80	446.30	0.78 - 2.45
STW-992	water	09/02/03	Pu-238	1.71 ± 0.07	2.07	0.74 - 1.20
STW-992	water	09/02/03	Pu-239/40	4.24 ± 0.01	4.99	0.79 - 1.20
STW-992	water	09/02/03	Sr-90	6.70 ± 0.50	7.04	0.69 - 1.34
STW-992	water	09/02/03	Uranium	6.03 ± 0.14	5.69	0.75 - 1.33
STW-993	water	09/02/03	Gr. Alpha	688.00 ± 7.60	622.00	0.58 - 1.29
STW-993	water	09/02/03	Gr. Beta	1985.00 ± 111.00	1948.00	0.61 - 1.43
STSO-994	soil	09/02/03	Am-241	19.70 ± 1.50	18.40	0.65 - 2.28
STSO-994	soil	09/02/03	Cs-137	1928.00 ± 19.00	1973.00	0.80 - 1.25
STSO-994	soil	09/02/03	K-40	533.00 ± 79.00	488.00	0.80 - 1.32
STSO-994	soil	09/02/03	Pu-238	15.30 ± 0.80	14.60	0.59 - 2.88
STSO-994	soil	09/02/03	Pu-239/40	32.50 ± 2.30	30.40	0.71 - 1.30
STSO-994	soil	09/02/03	Sr-90	69.80 ± 2.30	80.30	0.67 - 2.90
STSO-994	soil	09/02/03	Uranium	228.30 ± 17.10	259.30	0.71 - 1.32
STAP-995	Air Filter	09/02/03	Am-241	0.64 ± 0.05	0.44	0.70 - 2.34
STAP-995	Air Filter	09/02/03	Co-60	48.50 ± 0.40	55.10	0.80 - 1.26
STAP-995	Air Filter	09/02/03	Cs-137	51.20 ± 1.10	54.80	0.80 - 1.32
STAP-995	Air Filter	09/02/03	Mn-54	53.70 ± 1.10	58.00	0.80 - 1.35
STAP-995	Air Filter	09/02/03	Pu-238	0.24 ± 0.05	0.23	0.67 - 1.33
STAP-995	Air Filter	09/02/03	Pu-239/40	0.41 ± 0.10	0.40	0.73 - 1.26
STAP-995	Air Filter	09/02/03	Sr-90	1.90 ± 0.10	2.06	0.53 - 1.84
STAP-995	Air Filter	09/02/03	Uranium	0.80 ± 0.06	0.82	0.79 - 2.10
STAP-996	Air Filter	09/02/03	Gr. Alpha	3.23 ± 0.07	3.11	0.73 - 1.43
STAP-996	Air Filter	09/02/03	Gr. Beta	4.18 ± 0.03	3.89	0.76 - 1.36

---

[a] Results are reported in Bq/L with the following exceptions: Air Filters (Bq/Filter), Soil and Vegetation (Bq/kg).

[b] The EML result listed is the mean of replicate determinations for each nuclide ± the standard error of the mean.

[c] Control limits are reported by EML as the ratio of Reported Value / EML value.

[d] A low bias for Cs-134 activity has been observed in the past. No errors have been found in the library or efficiency. Additional spike analyses will be performed and a correction factored into the calculation.

[e] Reporting error.

APPENDIX B

DATA REPORTING CONVENTIONS

Data Reporting Conventions

1.0. All activities, except gross alpha and gross beta, are decay corrected to collection time or the end of the collection period.

2.0. Single Measurements

Each single measurement is reported as follows: $x \pm s$

where: x = value of the measurement;

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

In cases where the activity is less than the lower limit of detection L, it is reported as: <L,

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

3.0. Duplicate analyses

3.1 Individual results: For two analysis results; $x_1 \pm s_1$ and $x_2 \pm s_2$

Reported result: $x \pm s$; where $x = (1/2)(x_1 + x_2)$ and $s = (1/2)\sqrt{s_1^2 + s_2^2}$

3.2. Individual results: $<L_1$, $<L_2$ Reported result: <L, where L = lower of L_1 and L_2

3.3. Individual results: $x \pm s$, <L Reported result: $x \pm s$ if $x \geq L$; <L otherwise.

4.0. Computation of Averages and Standard Deviations

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

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

4.2 Values below the highest lower limit of detection are not included in the average.

4.3 If all values in the averaging group are less than the highest LLD, the highest LLD is reported.

4.4 If all but one of the values are less than the highest LLD, the single value x and associated two sigma error is reported.

4.5 *In rounding off, the following rules are followed:*

4.5.1. If the number following those to be retained is less than 5, the number is dropped, and the retained number s are kept unchanged. As an example, 11.443 is rounded off to 11.44.

4.5.2. If the number following those to be retained is equal to or greater than 5, the number is dropped and the last retained number is raised by 1. As an example, 11.445 is rounded off to 11.45.

APPENDIX C

Maximum Permissible Concentrations
of Radioactivity in Air and Water
Above Background in Unrestricted Areas

Table C-1. Maximum permissible concentrations of radioactivity in air and water above natural background in unrestricted areas[a].

	Air (pCi/m^3)	Water (pCi/L)	
Gross alpha	1×10^{-3}	Strontium-89	8,000
Gross beta	1	Strontium-90	500
Iodine-131[b]	2.8×10^{-1}	Cesium-137	1,000
		Barium-140	8,000
		Iodine-131	1,000
		Potassium-40[c]	4,000
		Gross alpha	2
		Gross beta	10
		Tritium	1×10^6

[a] Taken from Table 2 of Appendix B to Code of Federal Regulations Title 10, Part 20, and appropriate footnotes. Concentrations may be averaged over a period not greater than one year.

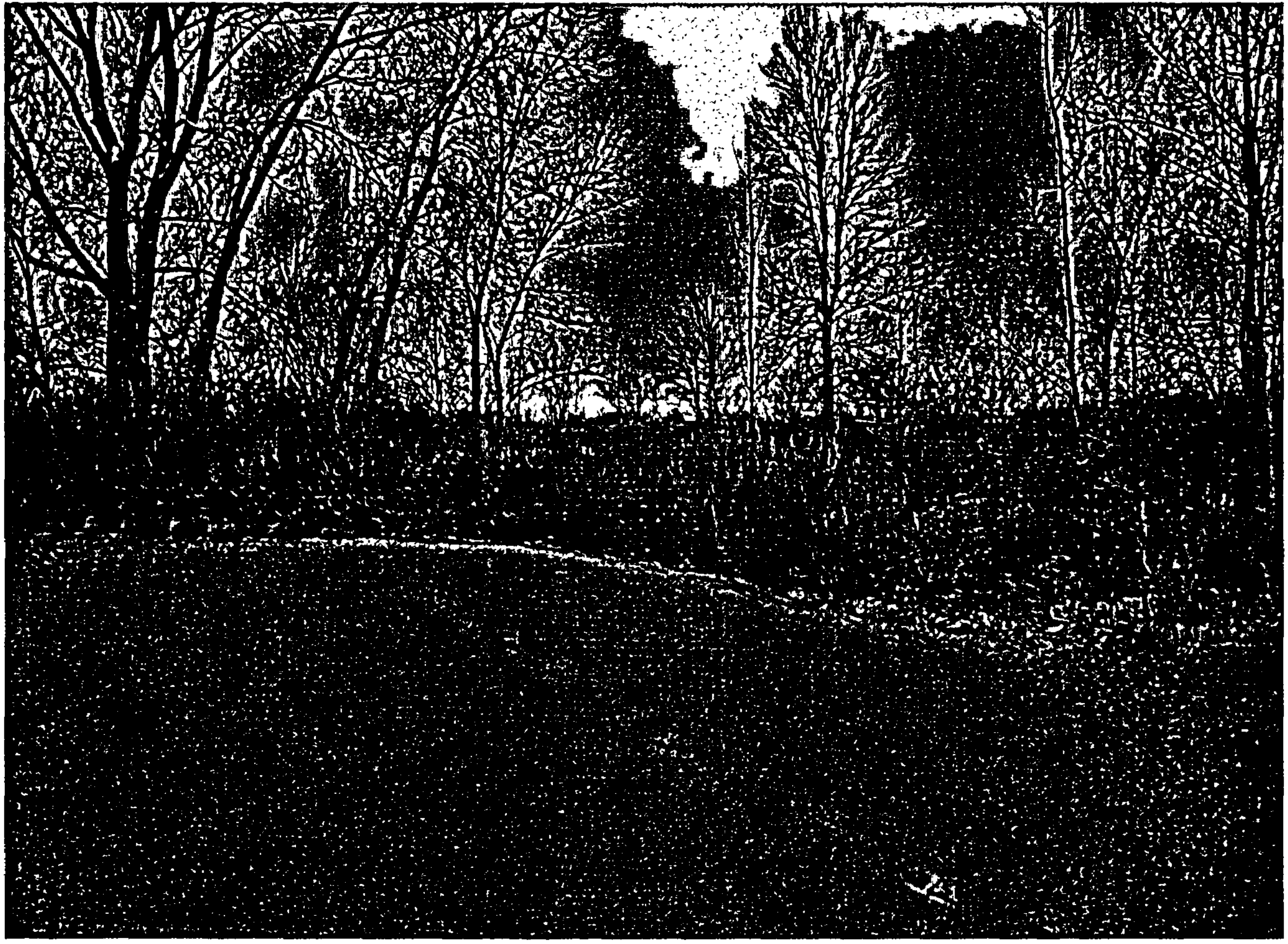
[b] Value adjusted by a factor of 700 to reduce the dose resulting from the air-grass-cow-milk-child pathway.

[c] A natural radionuclide.

KEWAUNEE NUCLEAR POWER PLANT

ANNUAL REPORT PART II

DATA TABULATIONS
GRAPHS AND ANALYSES



Environmental, Inc.
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REPORT TO

NUCLEAR MANAGEMENT CO, LLC

RADIOLOGICAL MONITORING PROGRAM FOR THE KEWAUNEE NUCLEAR POWER PLANT KEWAUNEE, WISCONSIN

ANNUAL REPORT - PART II
DATA TABULATIONS AND ANALYSES

January 1 to December 31, 2003

Prepared and submitted by

ENVIRONMENTAL, Inc.
Midwest Laboratory
Project No. 8002

Approved :

Bronia Grob
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Paula Adams for
Stanley F. Baker
Radiation Protection Mgr., KNPP

PREFACE

The staff members of Environmental, Inc., Midwest Laboratory were responsible for the acquisition of data presented in this report. Samples were collected by the personnel of Environmental, Inc., Midwest Laboratory and the Kewaunee Nuclear Power Plant.

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1.0 INTRODUCTION

The following constitutes Part II of the final report for the 2003 Radiological Monitoring Program conducted at the Kewaunee Nuclear Power Plant (KNPP), Kewaunee, Wisconsin.

Included are tabulations of data for all samples collected in 2003, graphs of data trends and descriptions of radiochemical procedures. A summary and interpretation of the data presented here are published in Part I of the 2003 Annual Report on the Radiological Monitoring Program for the Kewaunee Nuclear Power Plant.

NOTE: Page 2 is intentionally left out.

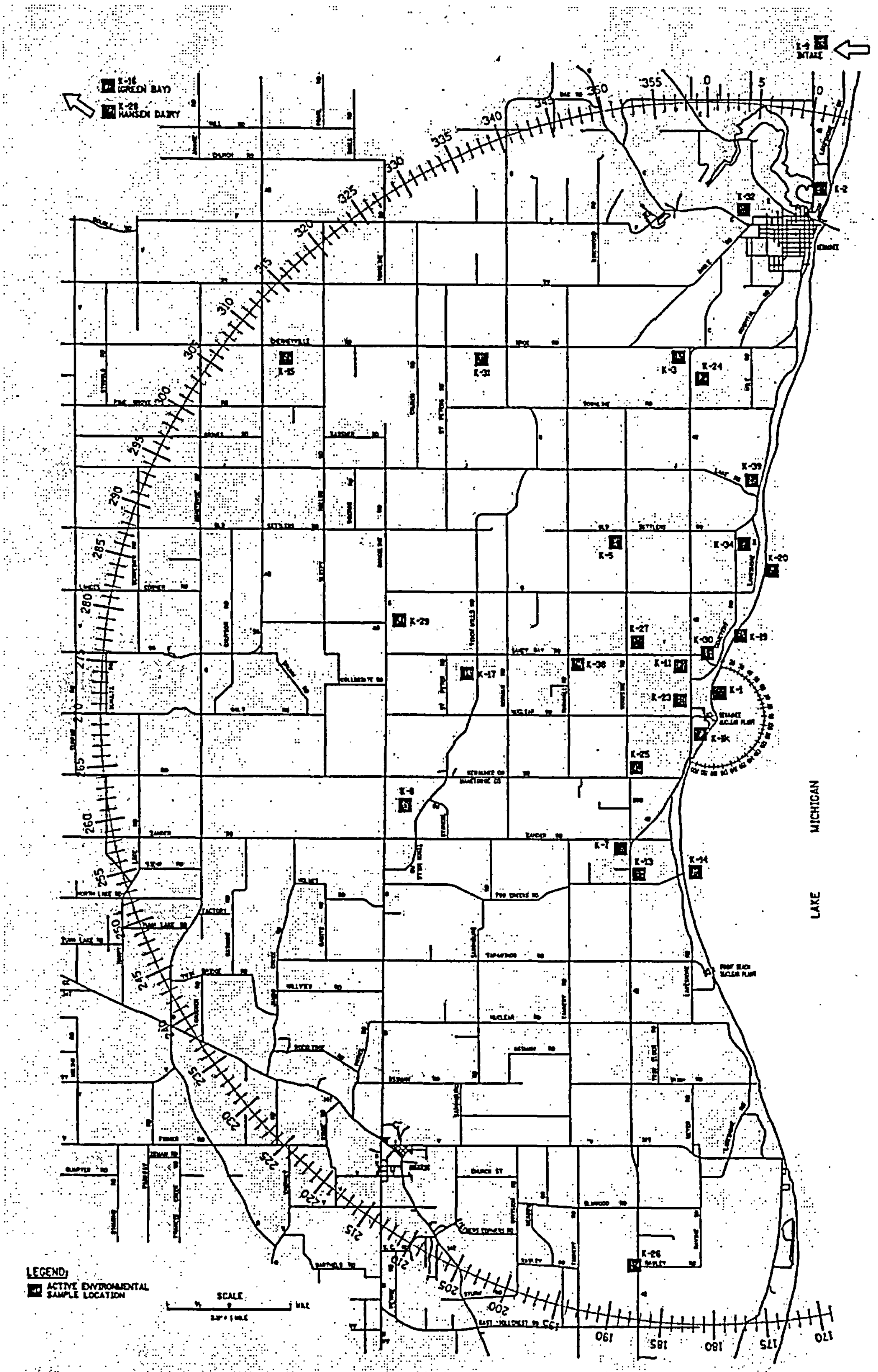

Figure 1. Sampling locations, Kewaunee Nuclear Power Plant

Table 1. Sampling locations, Kewaunee Nuclear Power Plant.

Code	Type[a]	Distance (miles)[b] and Sector	Location
K-1			Onsite
K-1a	I	0.62 N	North Creek
K-1b	I	0.12 N	Middle Creek
K-1c	I	0.10 N	500' north of condenser discharge
K-1d	I	0.10 E	Condenser discharge
K-1e	I	0.12 S	South Creek
K-1f	I	0.12 S	Meteorological Tower
K-1g	I	0.06 W	South Well
K-1h	I	0.12 NW	North Well
K-1j	I	0.10 S	500' south of condenser discharge
K-1k	I	0.60 SW	Drainage Pond, south of plant
K-2	C	9.5 NNE	WPS Operations Building in Kewaunee
K-3	C	6.0 N	Lyle and John Siegmund Farm, N2815 Hy 12, Kewaunee
K-5	I	3.5 NNW	Ed Paplham Farm, E4160 Old Settlers Rd, Kewaunee
K-7	I	2.75 SSW	Ron Zimmerman Farm, 17620 Nero Road, Two Rivers
K-8	C	5.0 WSW	Saint Mary's Church, Tisch Mills
K-9	C	11.5 NNE	Rostok Water Intake for Green Bay, Wisconsin, two miles north of Kewaunee
K-10	I	1.5 NNE	Turner Farm, Kewaunee site
K-11	I	1.0 NW	Harlan Ihlenfeld Farm, N879 Hy 42, Kewaunee
K-13	C	3.0 SSW	Rand's General Store
K-14	I	2.5 S	Two Creeks Park, 2.5 miles south of site
K-15	C	9.25 NW	Gas Substation, 1.5 miles north of Stangelville
K-16	C	26 NW	WPS Division Office Building, Green Bay, Wisconsin
K-17	I	4.25 W	Jansky's Farm, N885 Tk B, Kewaunee
K-20	I	2.5 N	Carl Struck Farm, Lakeshore Dr, Kewaunee
K-23	I	0.5 W	0.5 miles west of plant, Kewaunee site
K-24	I	5.45 N	Fectum Farm, N2653 Hy 42, Kewaunee
K-25	I	2.0 WSW	Wotachek Farm, 4819 E. Cty Tk BB, Denmark
K-26	C	10.7 SSW	Bertler's Fruit Stand (8.0 miles south of "BB")
K-27	I	1.5 NW	Schlies Farm, E4298 Sandy Bay Rd, Kewaunee
K-28	C	26 NW	Hansen Dairy, Green Bay, Wisconsin
K-29	I	5.75 W	Kunesh Farm, Route 1, Kewaunee
K-30	I	1.00N	End of site boundary
K-31	C	6.25NNW	E. Krok Substation
K-32	C	11.50 N	Piggly Wiggly, 931 Marquette Dr., Kewaunee
K-34	I	2.5 N	Leon and Vicki Struck, N1549 Lakeshore Dr., Kewaunee
K-36	I	8.5 mi. NNE	Fiala's Fish Market, Kewaunee
K-37	I	4.0 mi. N	Gary and Ann Hardtke, E4282 Old Settlers Road, Kewaunee
K-38	I	3.8 mi. WNW	Dave Sinkula Farm, N890 Town Hall Road, Kewaunee
K-39[c]	I	3.0 mi. N	Francis and Sue Wojta, N1859 Lakeshore Dr., Kewaunee

[a] I = indicator; C = control.

[b] Distances are measured from reactor stack.

[c] Location added to program in July, 2003.

KEWAUNEE

Table 2. Type and frequency of collection.

Location	Weekly	Biweekly	Monthly	Quarterly	Semiannually	Annually
K-1a			SW		SL	
K-1b			SW	GR[a]	SL	
K-1c					BS[b]	
K-1d			SW	FI	BS[b], SL	
K-1e			SW		SL	
K-1f	AP	AI		GR[a], TLD	SO	
K-1g				WW		
K-1h				WW		
K-1j					BS[b]	
K-1k			SW		SL	
K-2	AP	AI		TLD		
K-3			MI[c]	GR[a], TLD, CF[d]	SO	
K-5			MI[c]	GR[a], TLD, CF[d]	SO	
K-7	AP	AI		TLD		
K-8	AP	AI		TLD		
K-9			SW		BS[b], SL	
K-10				WW		
K-11			PR	WW		
K-13				WW		
K-14			SW		BS[b], SL	
K-15				TLD		
K-16	AP	AI		TLD		
K-17				TLD		VE
K-20						
K-23						GRN
K-24				EG		DM
K-25			MI[c]	GR[a], TLD, CF[d], WW	SO	
K-26						VE
K-27				TLD, EG		
K-28			MI[c]			
K-29						DM, VE
K-30				TLD		
K-31	AP	AI		TLD		
K-32				EG		DM
K-34			MI[c]	GR[a], CF[d]	SO	DM
K-36				FI		
K-37			MI[c]	GR[a], TLD, CF[d]	SO	
K-38			MI[c]	GR[a], CF[d]	SO	
K-39			MI[c]	GR[a], CF[d]	SO	

[a] Three times a year, second, third and fourth quarters.

[b] To be collected in May and November.

[c] Monthly from November through April; semimonthly May through October.

[d] First quarter (January, February, March) only.

Table 3. Sample Codes:

AP	Airborne particulates	MI	Milk
AI	Airborne Iodine	PR	Precipitation
BS	Bottom (river) sediments	SL	Slime
CF	Cattlefeed	SO	Soil
DM	Domestic Meat	SW	Surface water
EG	Eggs	TLD	Thermoluminescent Dosimeter
FI	Fish	VE	Vegetables
GRN	Grain	WW	Well water
GR	Grass		

Note: Page 6 is intentionally left out.

GRAPHS OF DATA TRENDS

Note: Conventions used in trending data.

The following conventions should be used in the interpretation of the graphs of data trends:

1. Both solid and open data points may be used in the graphs. A solid point indicates an activity, an open point, a lower limit of detection (LLD) value.
2. Data points are connected by a solid line. A break in the plot indicates missing data.

Kewaunee

Air Particulates - Gross Beta

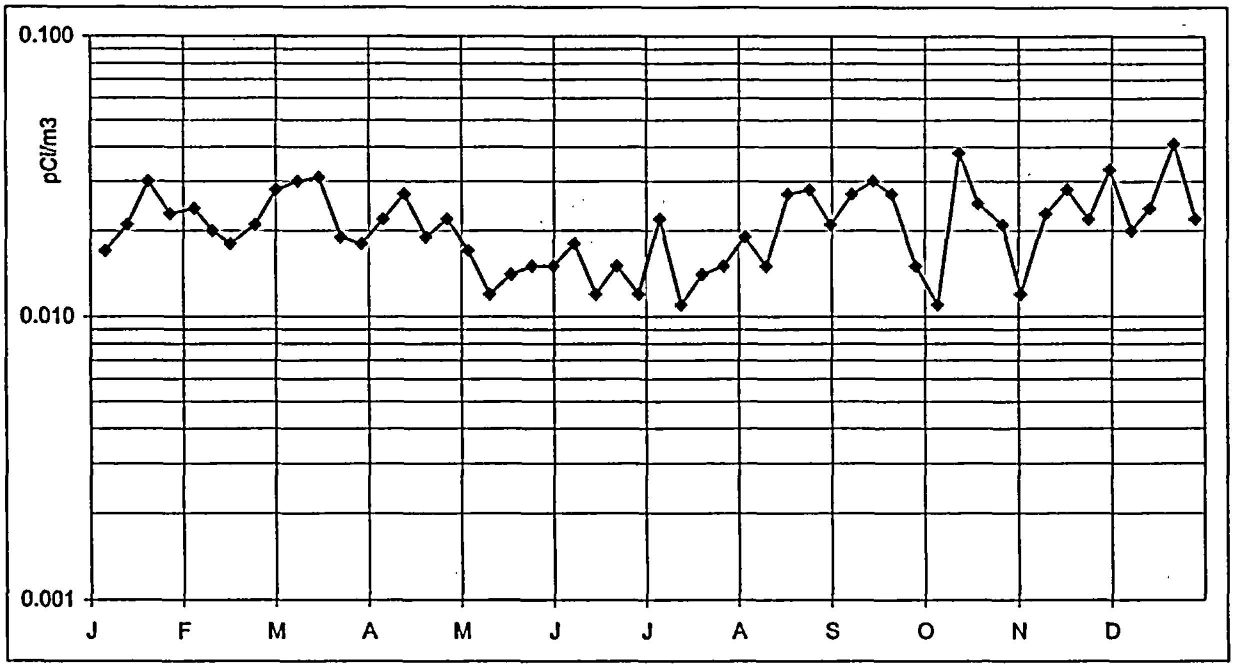

Figure 2. Location K-1f (weekly samples, 2003).

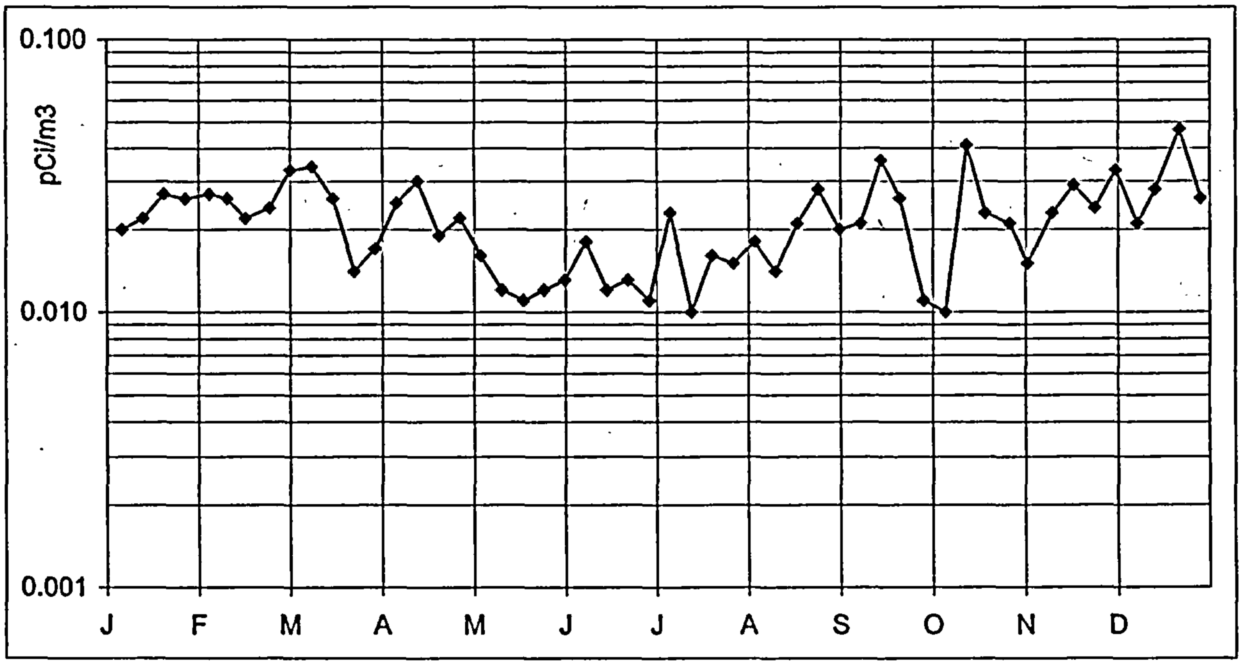

Figure 3. Location K-2 (weekly samples, 2003).

Kewaunee

Air Particulates - Gross Beta

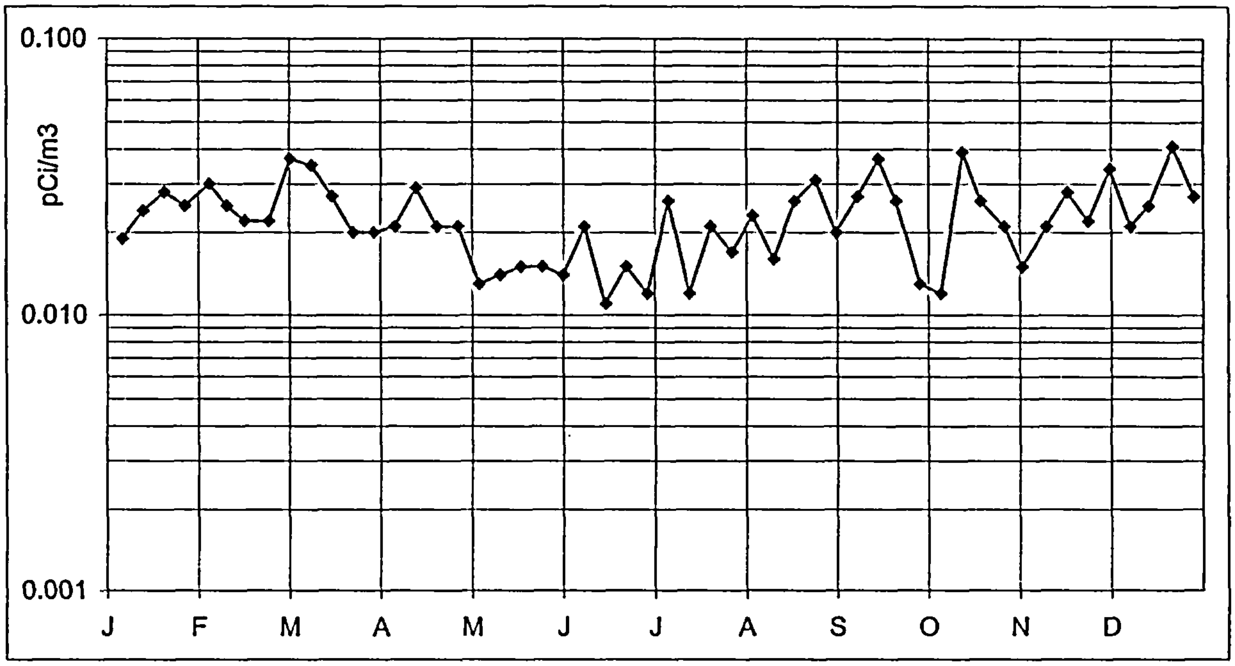

Figure 4. Location K-7 (weekly samples, 2003).

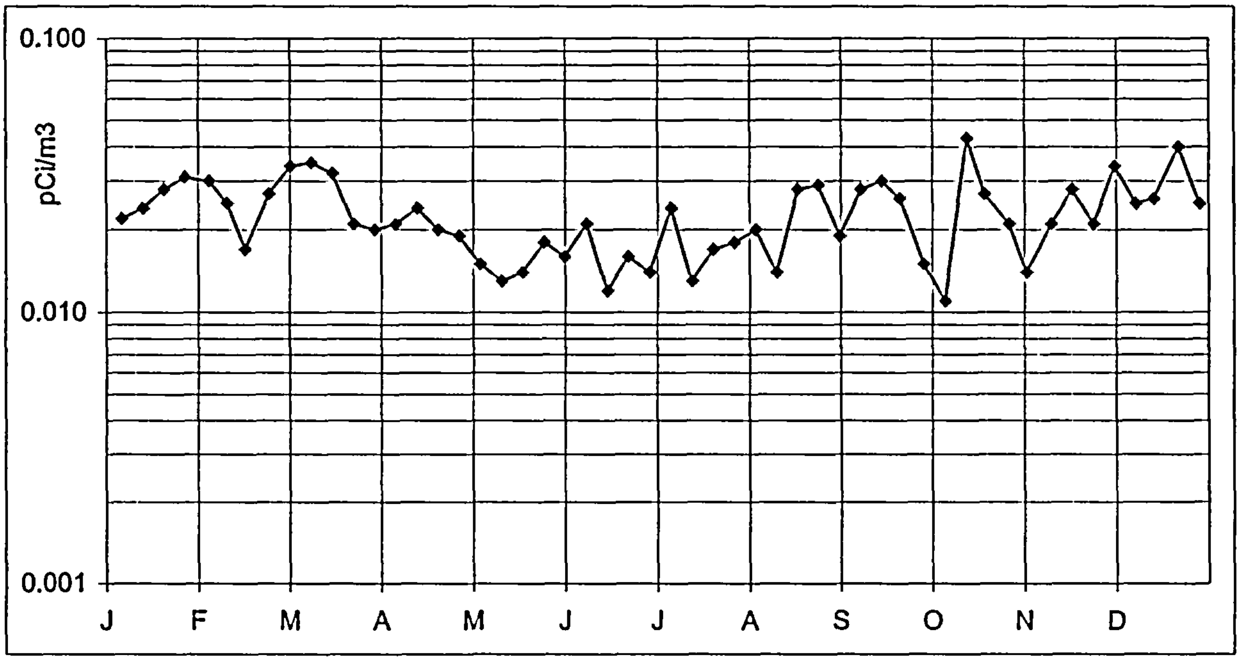

Figure 5. Location K-8 (weekly samples, 2003).

Kewaunee

Air Particulates - Gross Beta

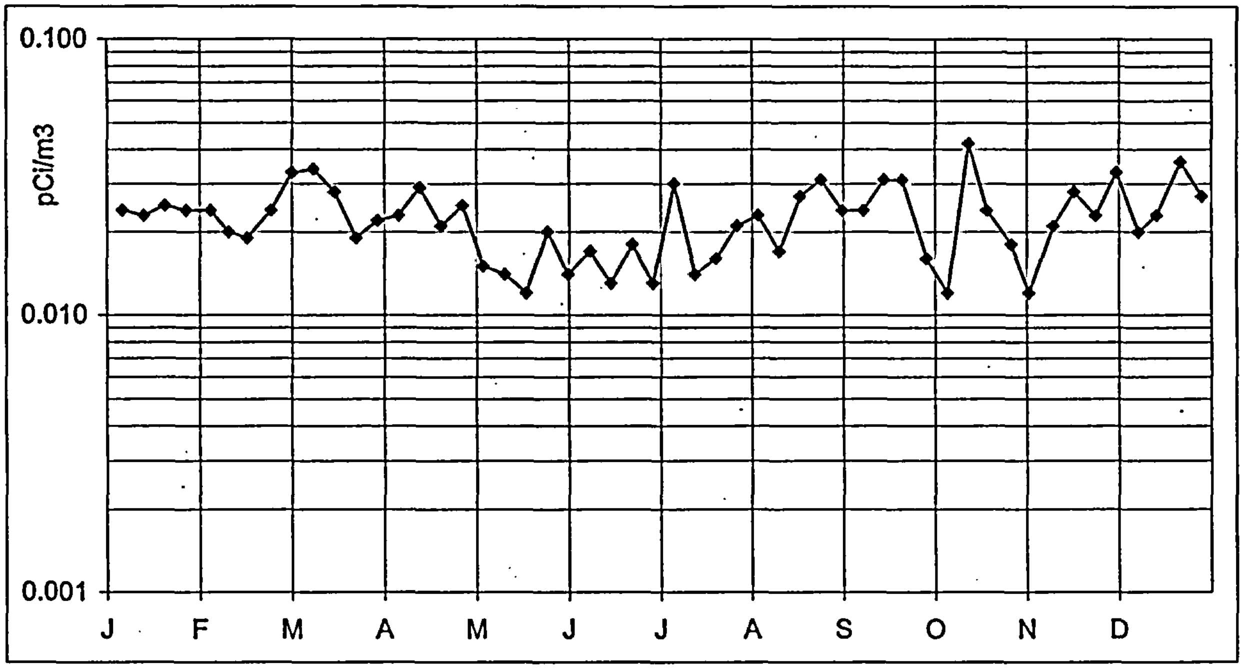

Figure 6. Location K-31 (weekly samples, 2003).

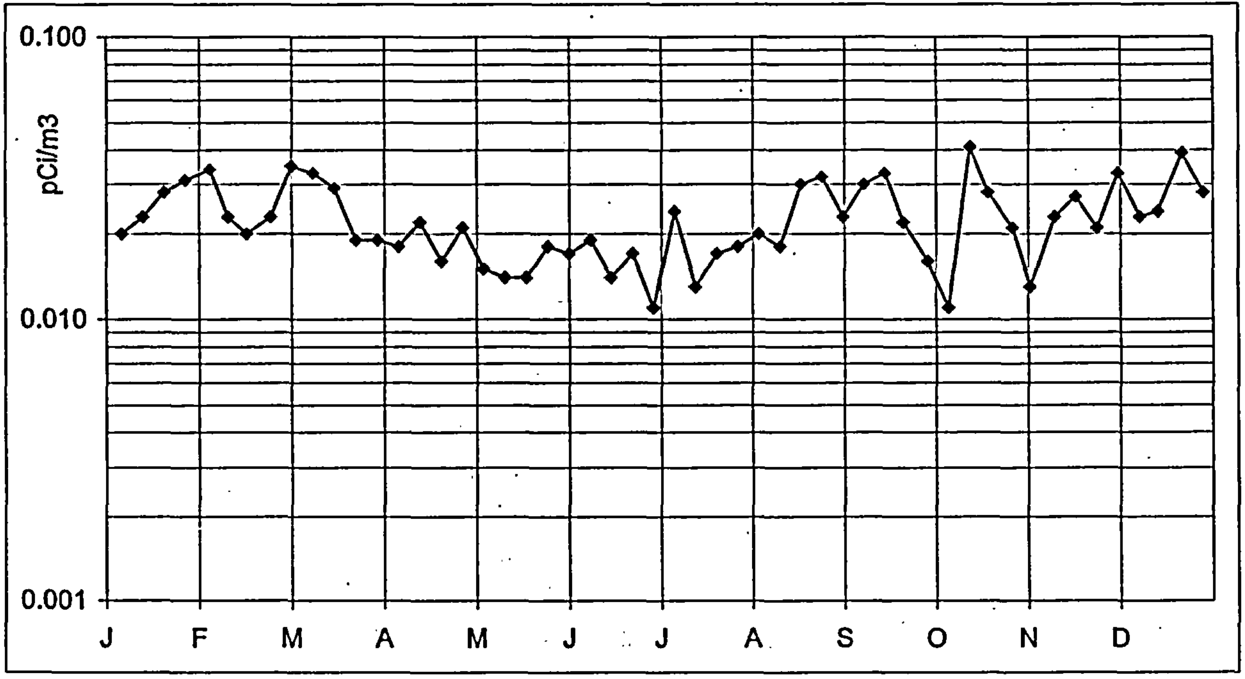

Figure 7. Location K-16 (weekly samples, 2003).

Kewaunee

Air Particulates - Gross Beta

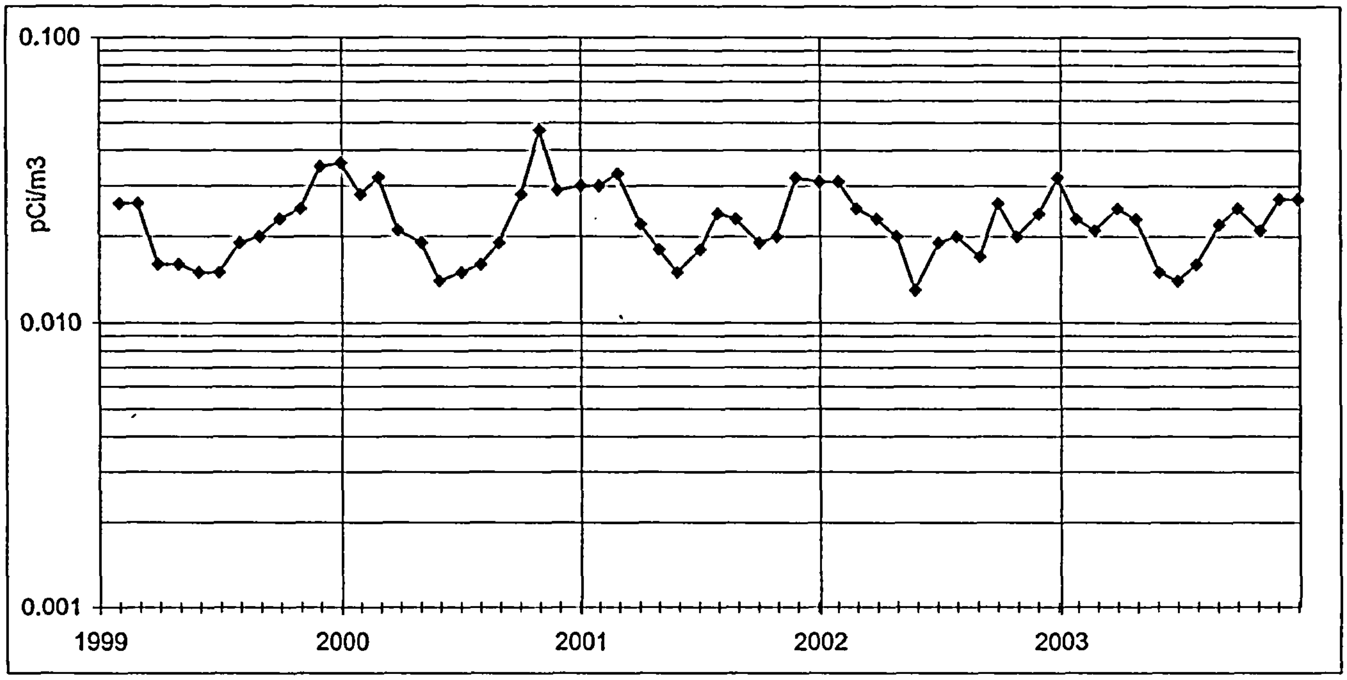

Figure 8. Location K-1f (monthly averages, 1999-2003).

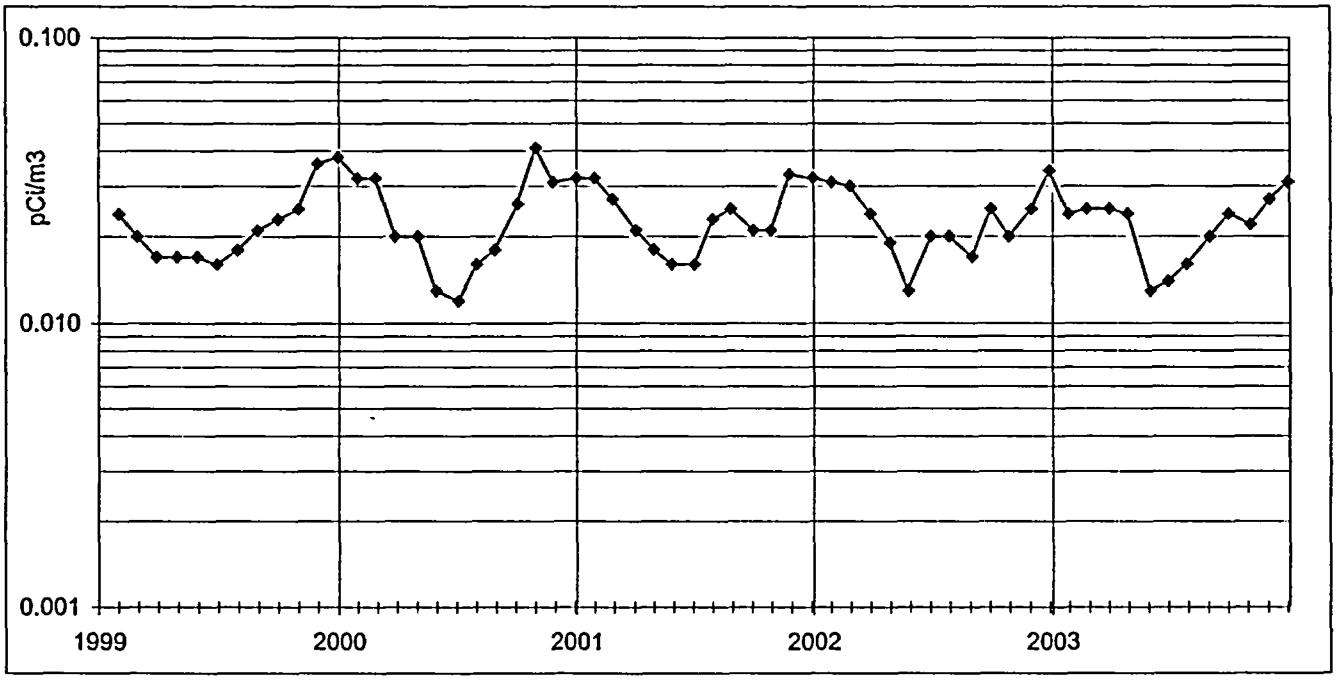

Figure 9. Location K-2 (monthly averages, 1999-2003).

Kewaunee

Air Particulates - Gross Beta

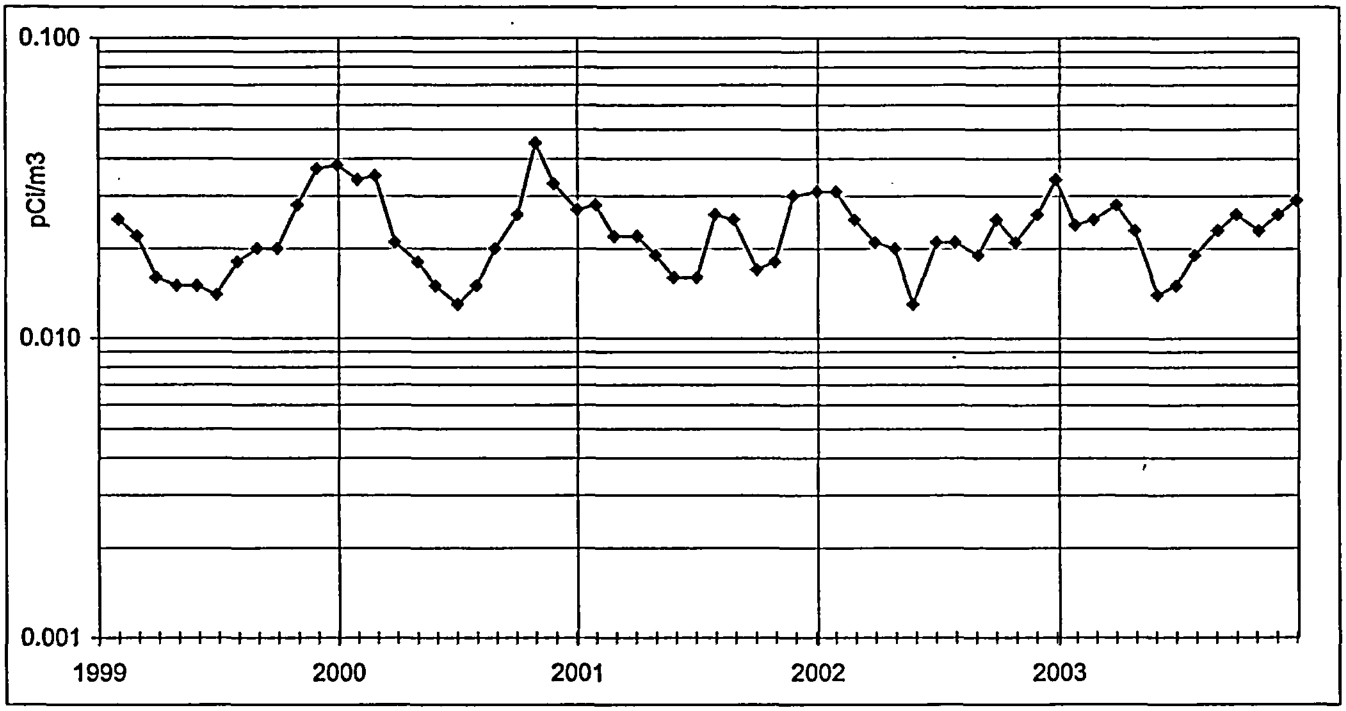

Figure 10. Location K-7 (monthly averages, 1999-2003).

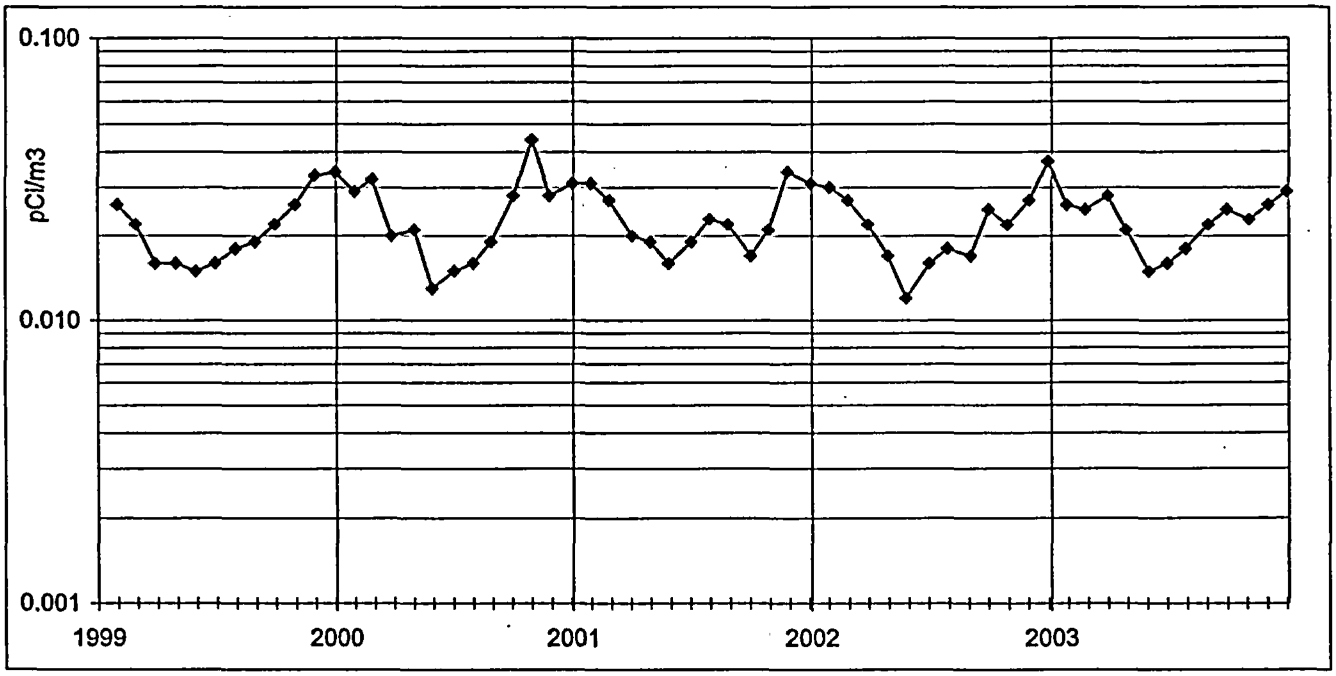

Figure 11. Location K-8 (monthly averages, 1999-2003).

Kewaunee

Air Particulates - Gross Beta

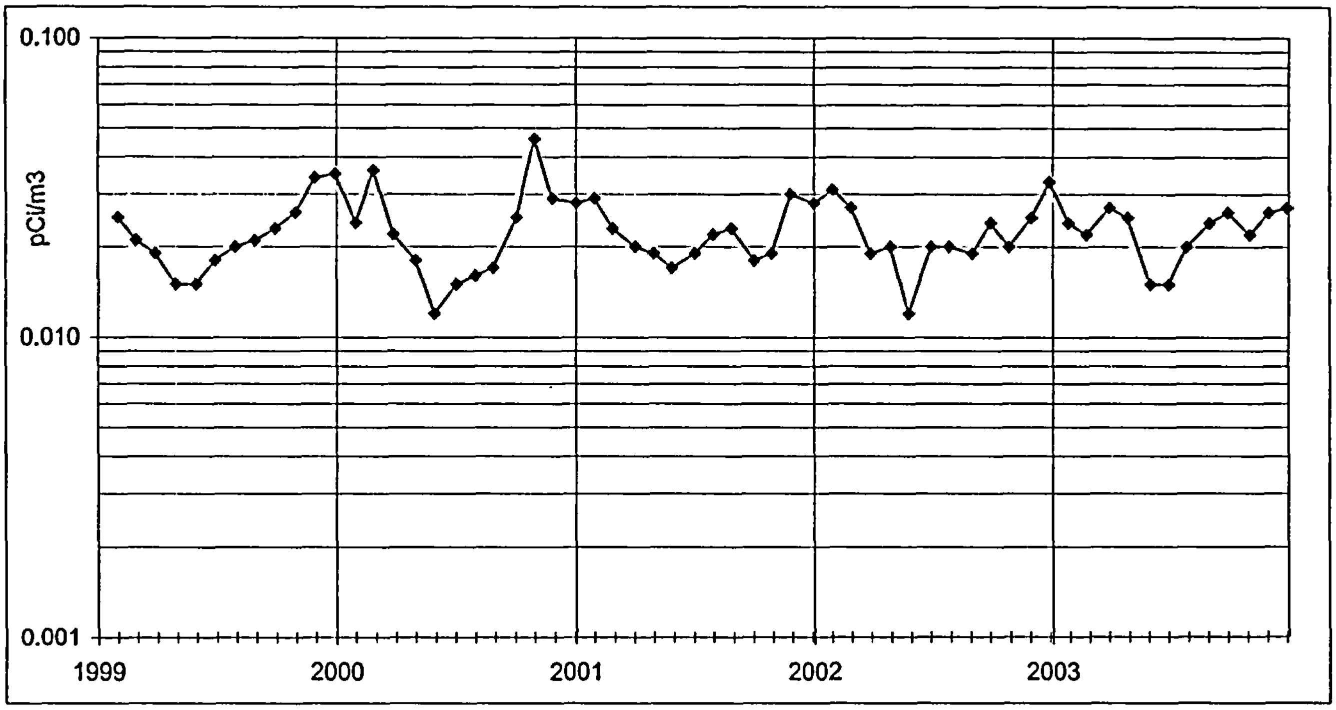

Figure 12. Location K-31 (monthly averages, 1999-2003).

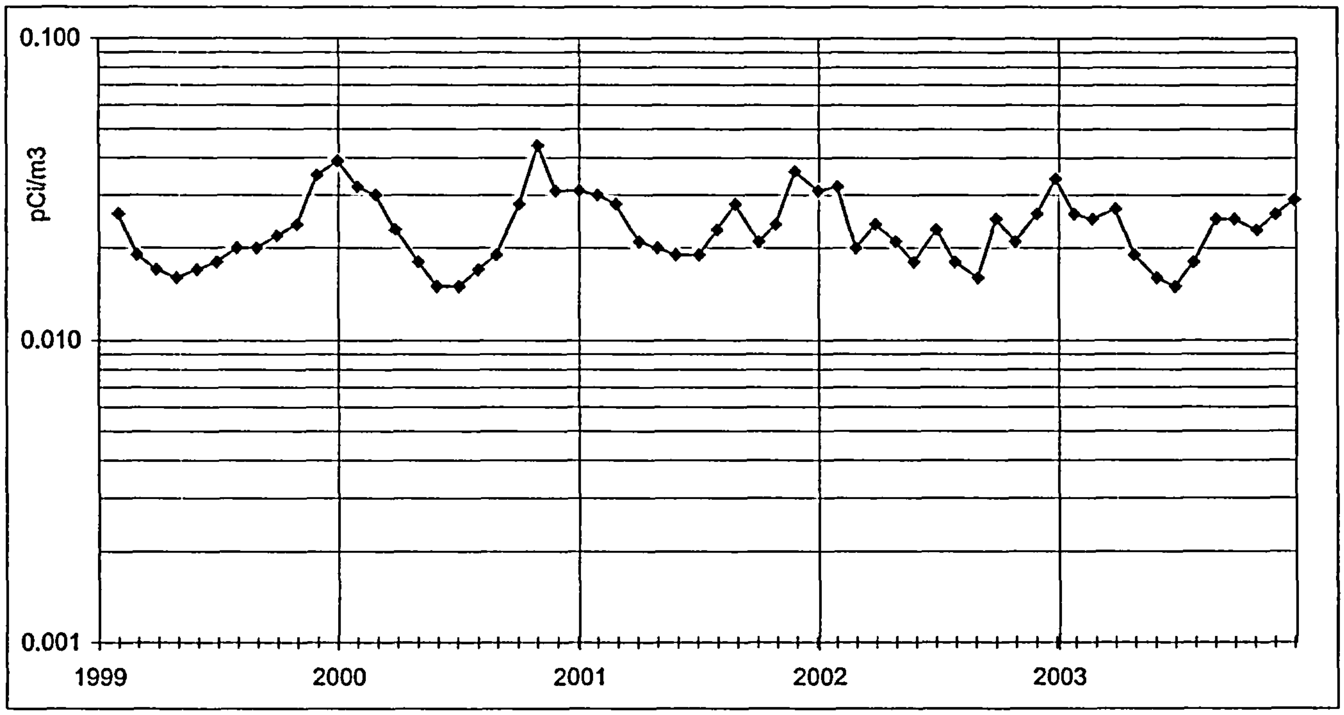

Figure 13. Location K-16 (monthly averages, 1999-2003).

Kewaunee

WELL WATER-GROSS ALPHA

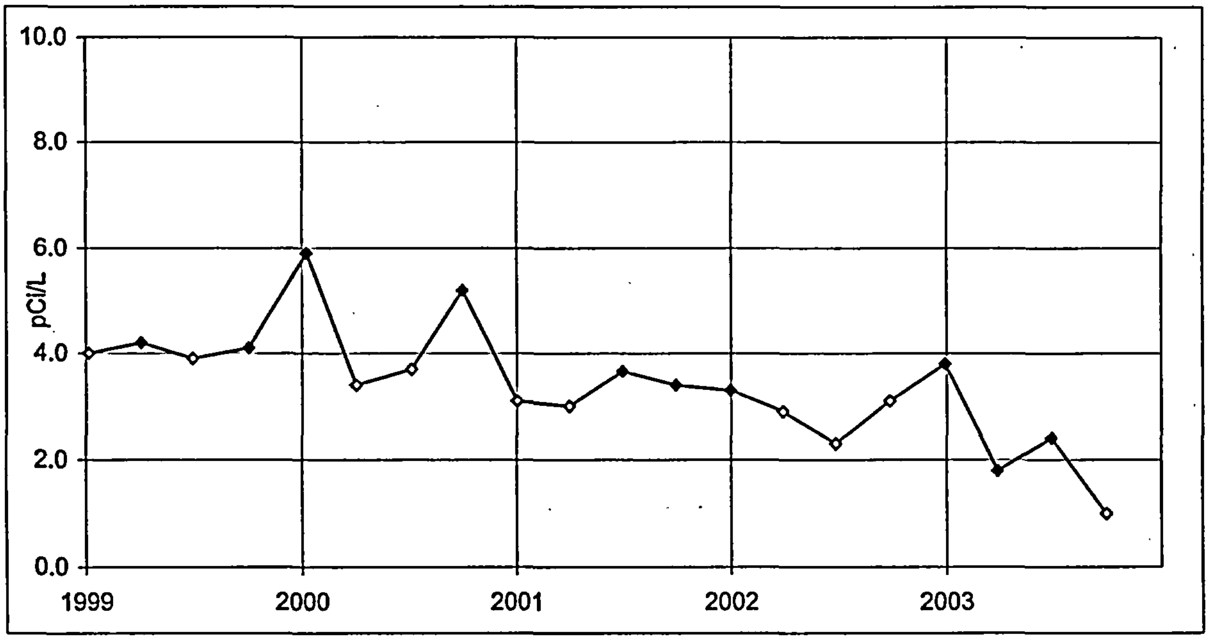

Figure 14. Location K-1g. Total Residue. Quarterly collection.

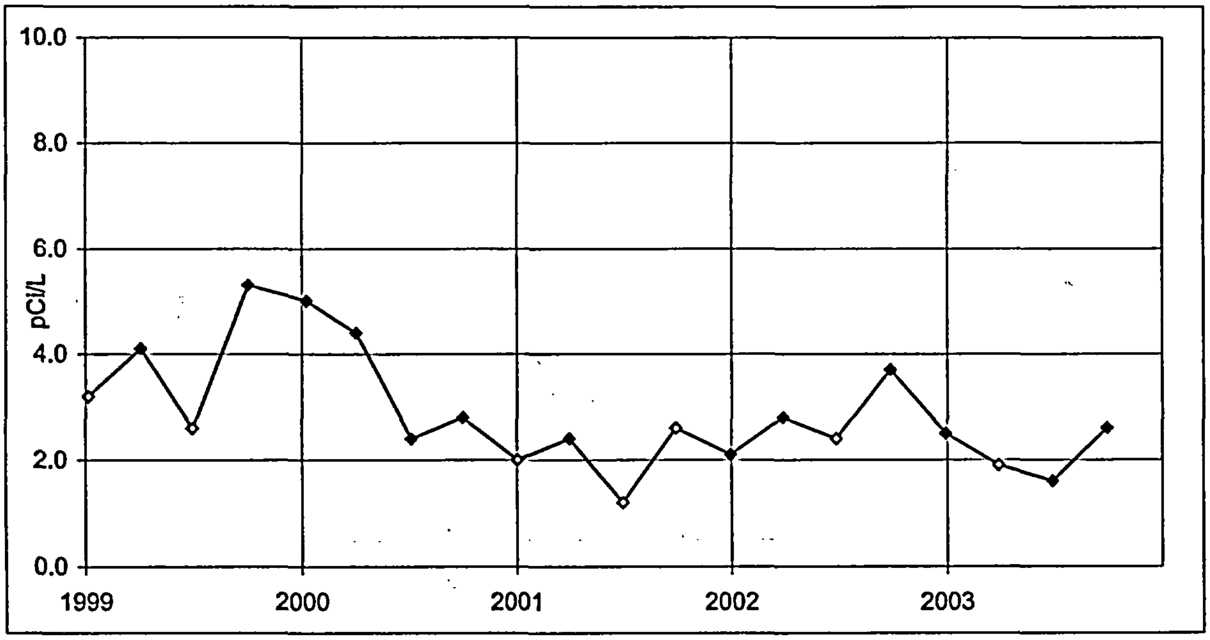

Figure 15. Location K-1h. Total Residue. Quarterly collection.

Note: An open data point indicates activity less than the lower limit of detection (LLD).

Kewaunee

WELL WATER-GROSS BETA

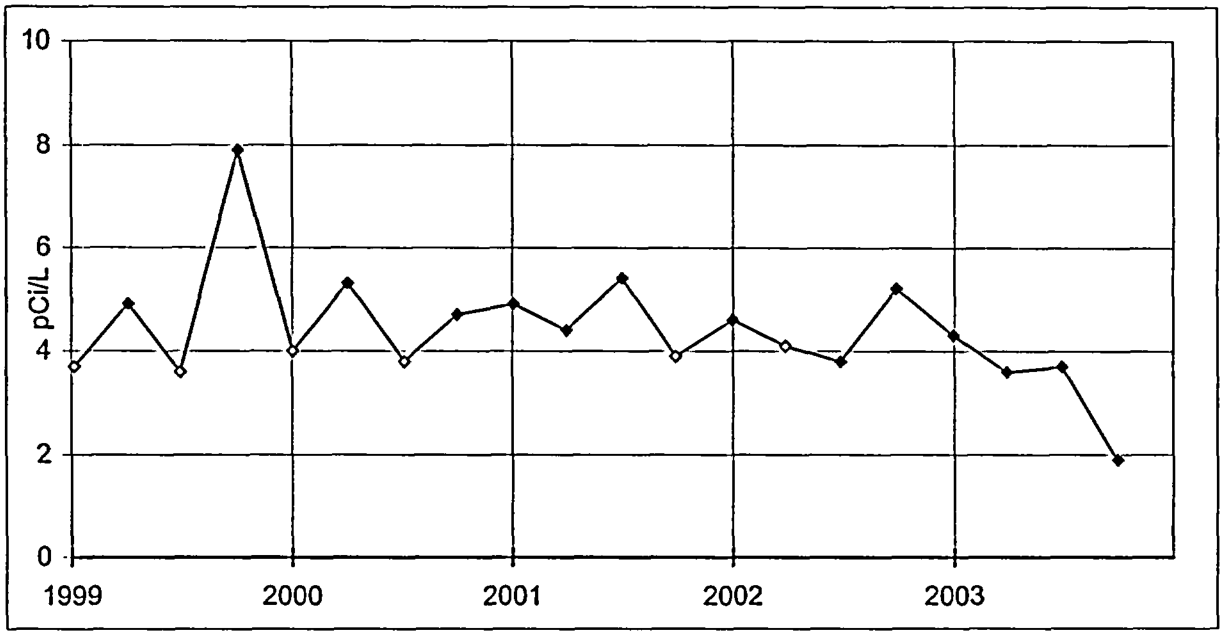

Figure 16. Location K-1g. Total Residue. Quarterly collection.

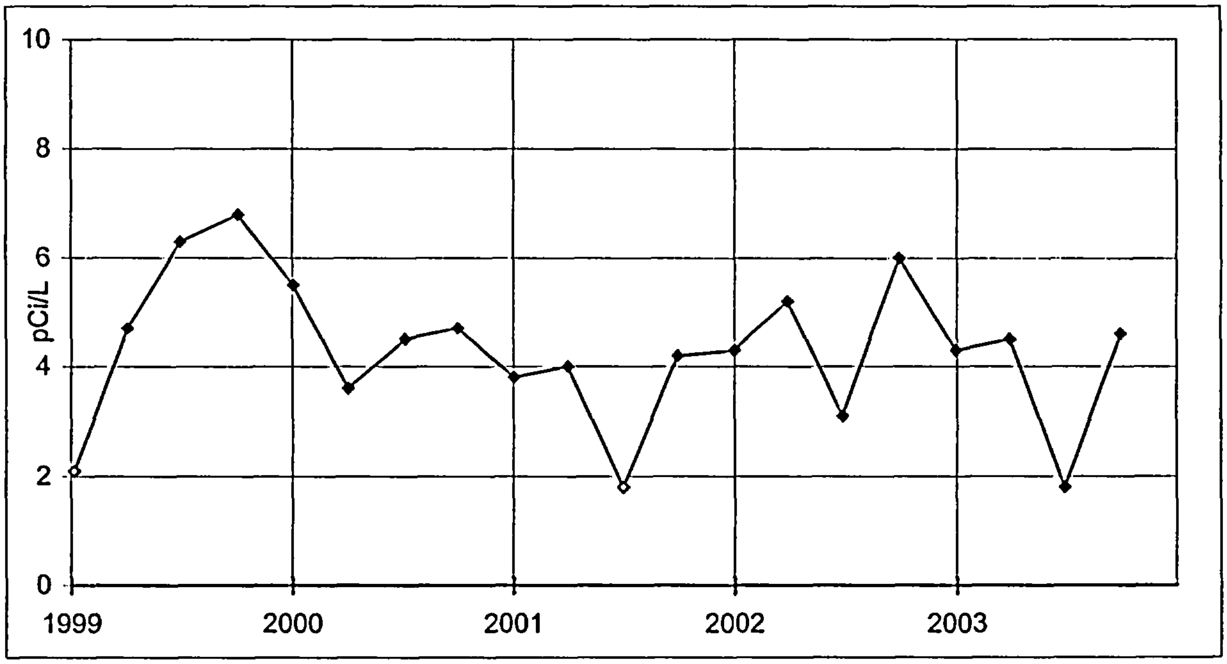

Figure 17. Location K-1h. Total Residue. Quarterly collection.

Note: An open data point indicates activity less than the lower limit of detection (LLD).

Kewaunee

WELL WATER-GROSS BETA

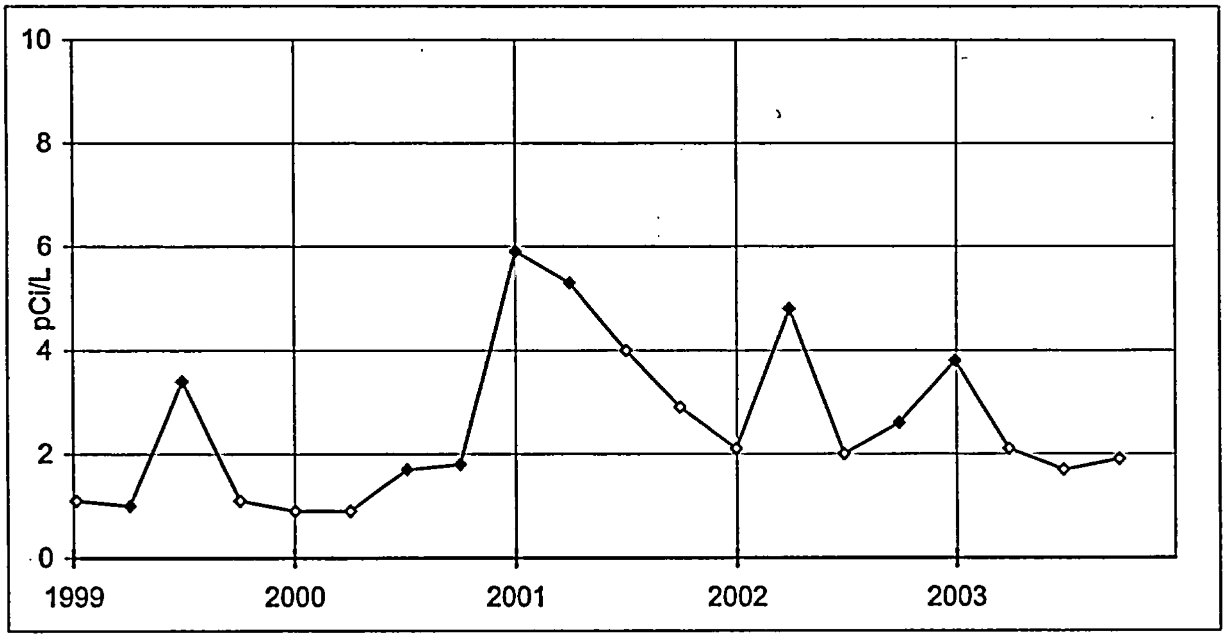

Figure 18. Location K-10. Total Residue. Quarterly collection.

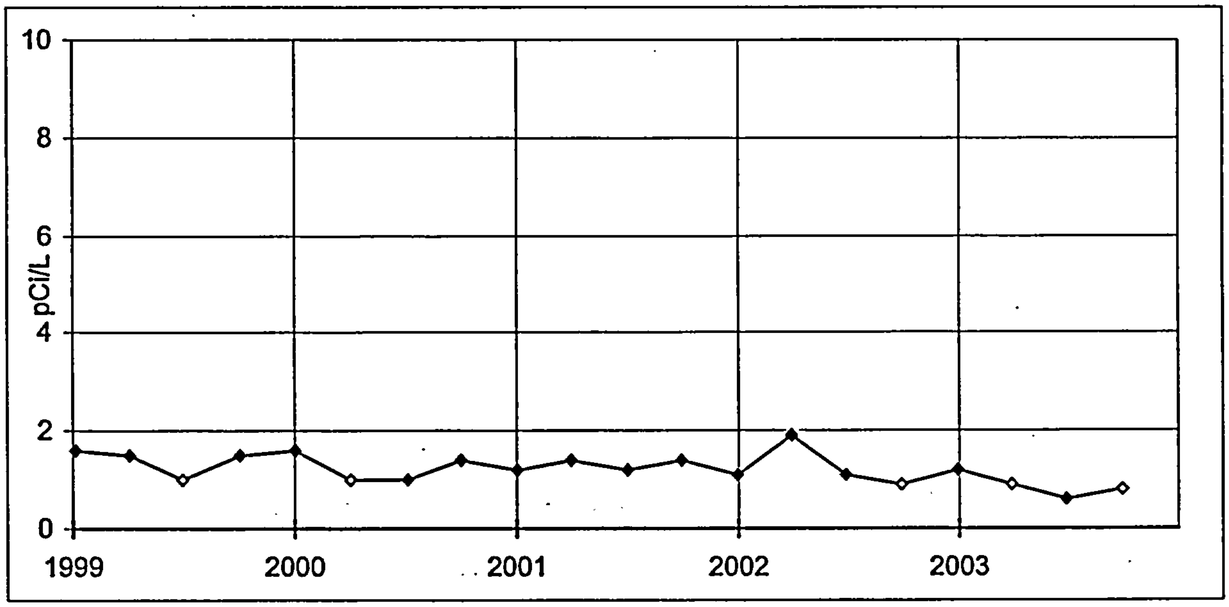

Figure 19. Location K-11. Total Residue. Quarterly collection.

Note: An open data point indicates activity less than the lower limit of detection (LLD).

Kewaunee

WELL WATER-GROSS BETA

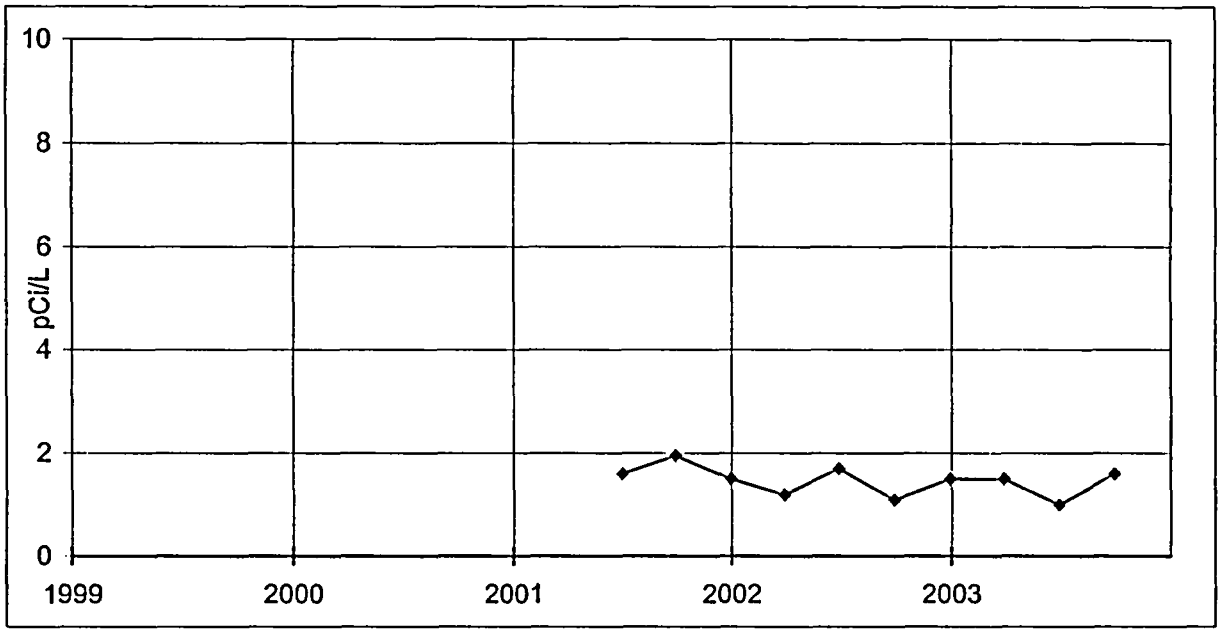

Figure 20. Location K-25. Total Residue. Quarterly collection.

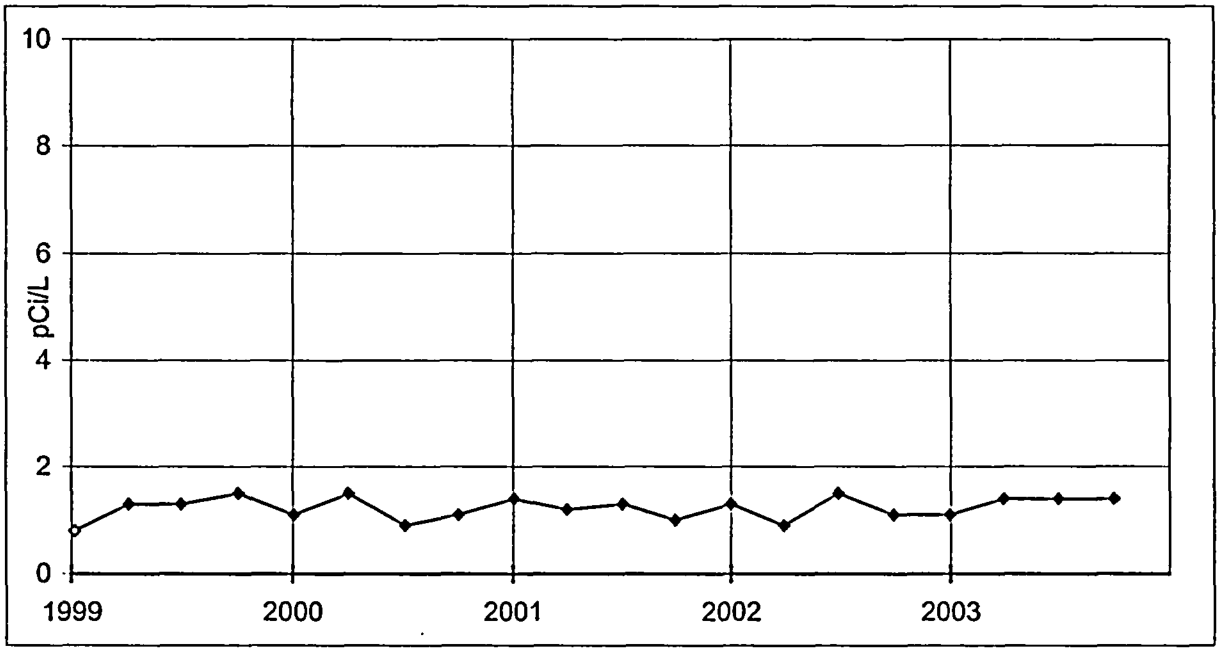

Figure 21. Location K-13. Total Residue. Quarterly collection.

Note: An open data point indicates activity less than the lower limit of detection (LLD).

Kewaunee
Milk - Strontium-90

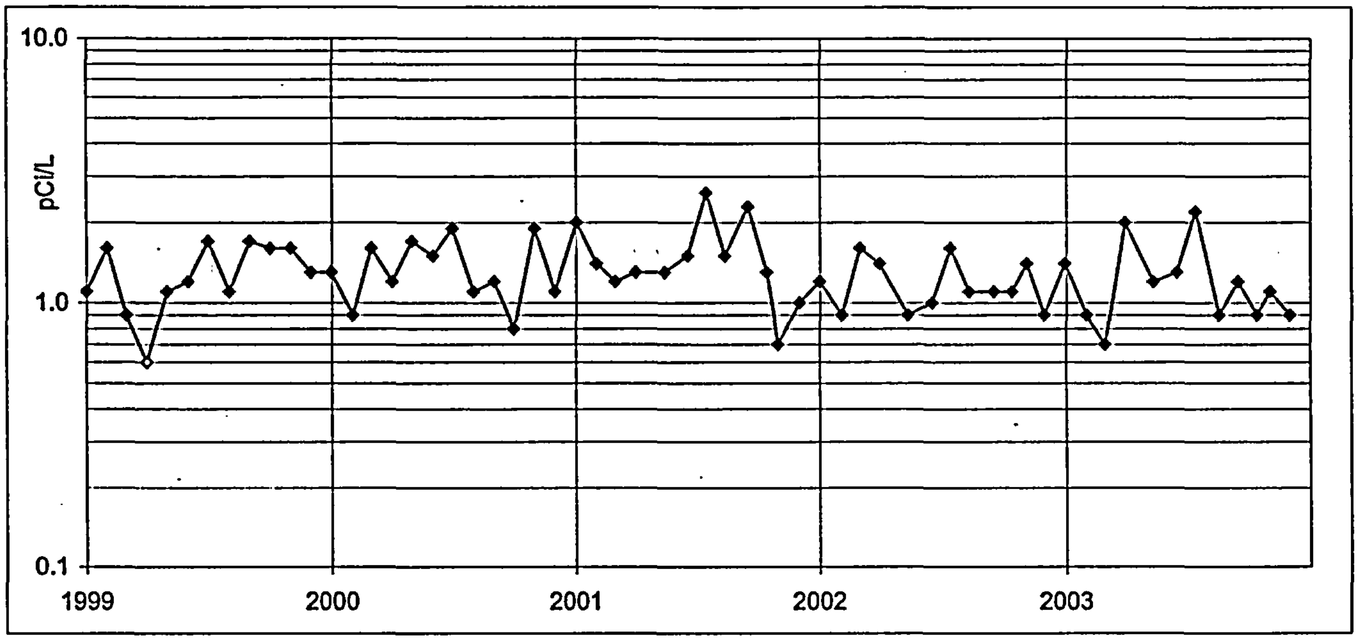

Figure 22. Milk samples. Location K-3.

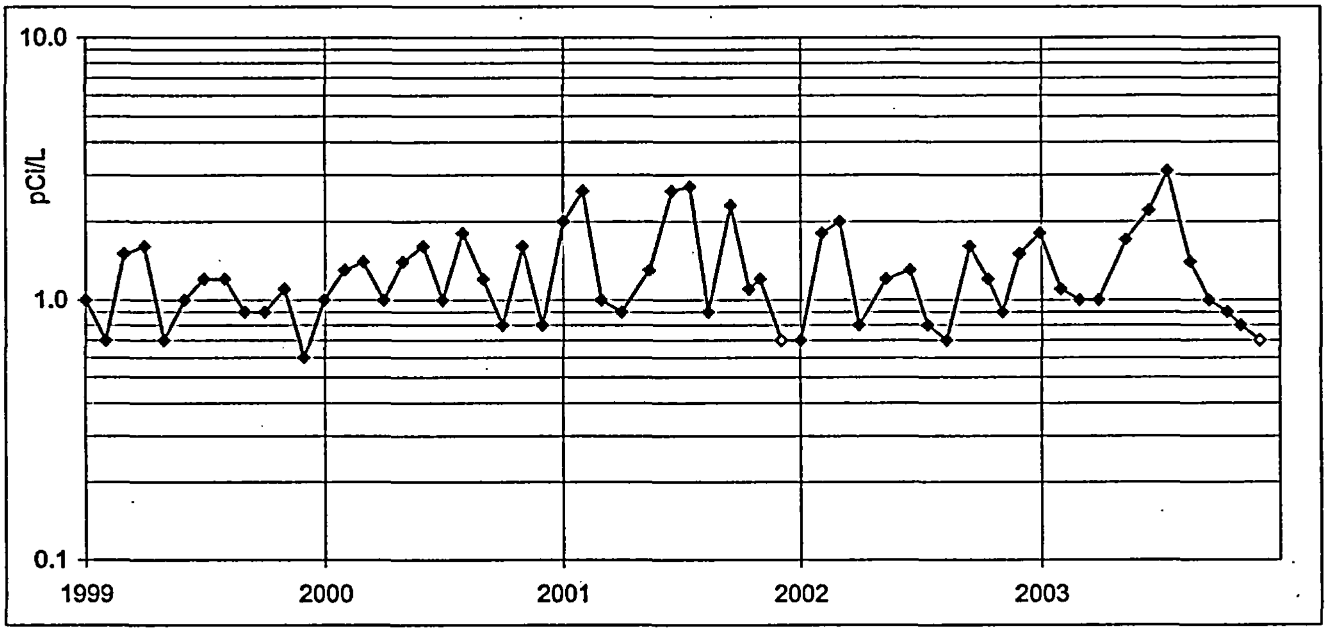

Figure 23. Milk samples. Location K-5.

Note: An open data point indicates activity less than the lower limit of detection (LLD).

Kewaunee
Milk - Strontium-90

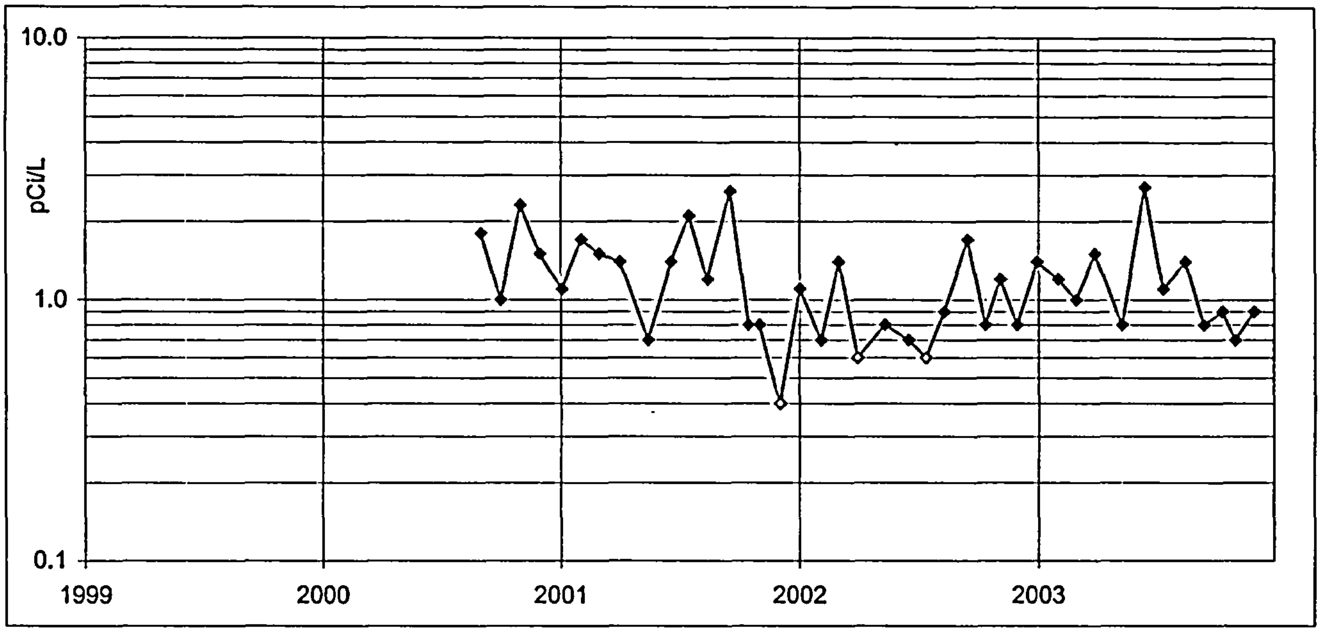

Figure 24. Milk samples. Location K-25.

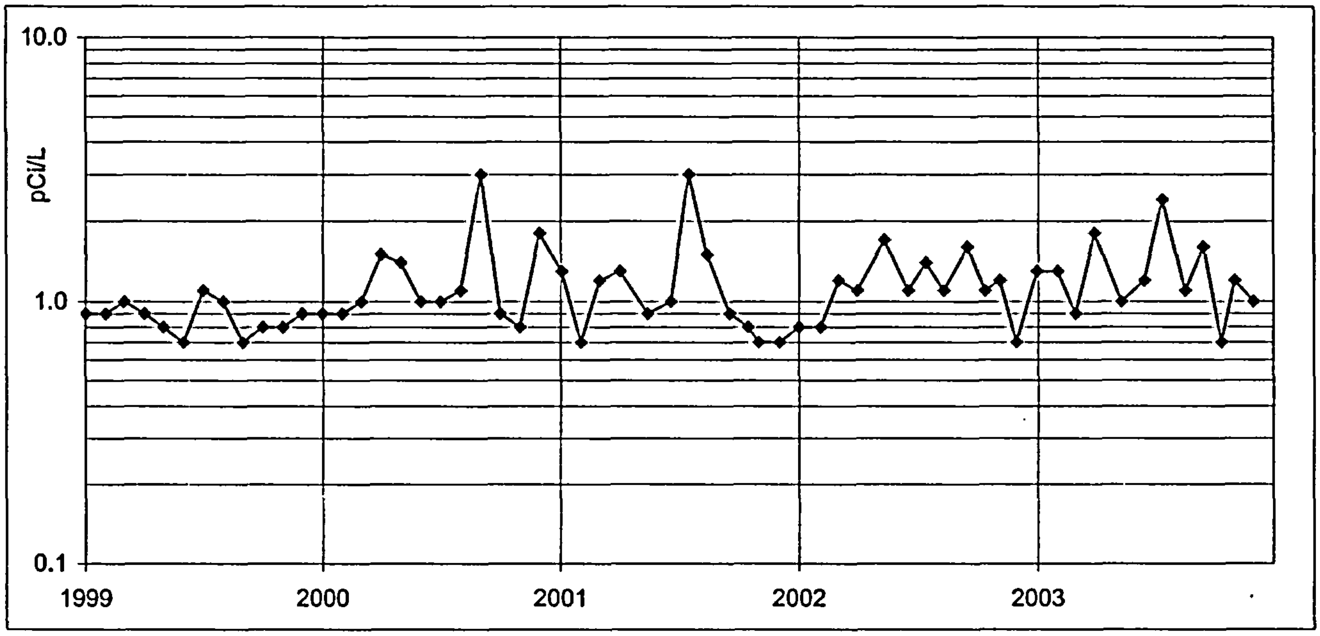

Figure 25. Milk samples. Location K-28.

Kewaunee
Milk - Strontium-90

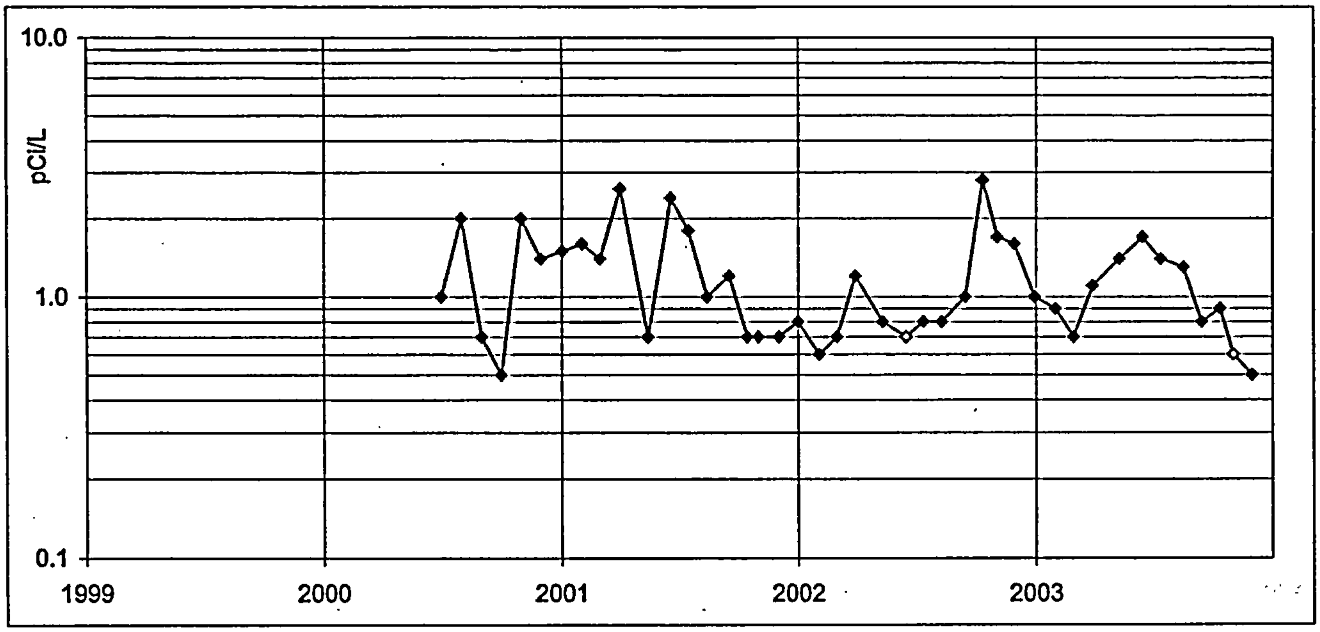

Figure 26. Milk samples. Location K-34.

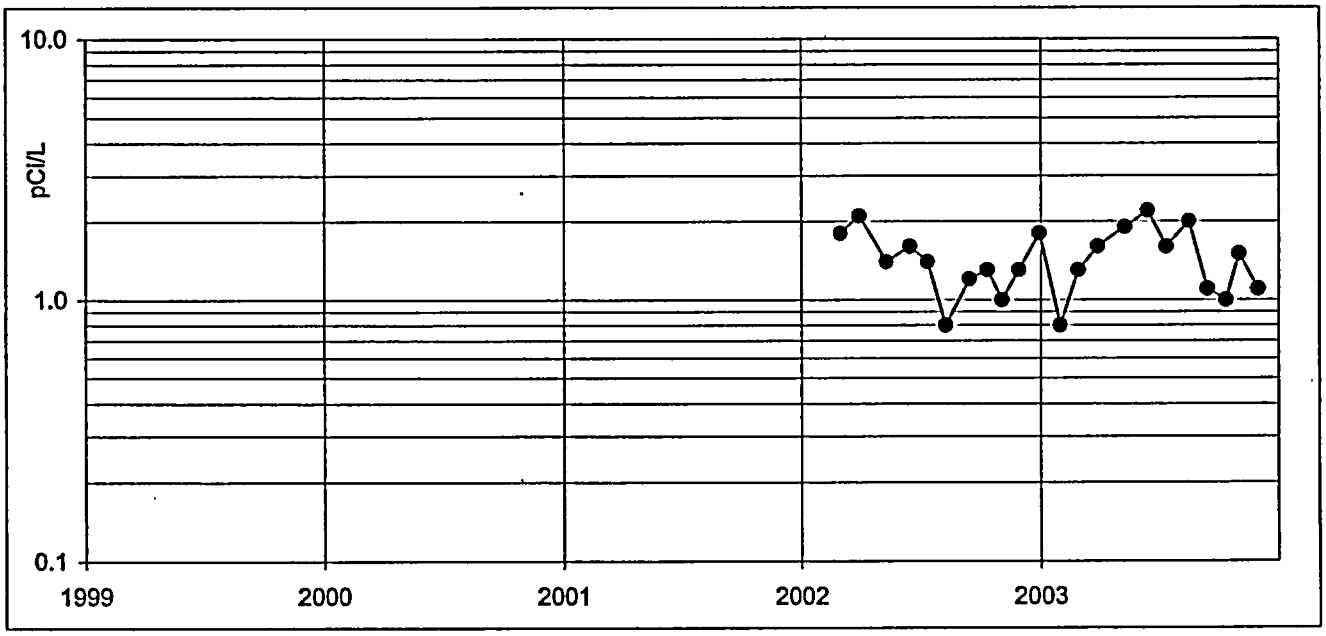

Figure 28. Milk samples. Location K-38.
New location; first collection, March, 2002

Kewaunee
Milk - Strontium-90

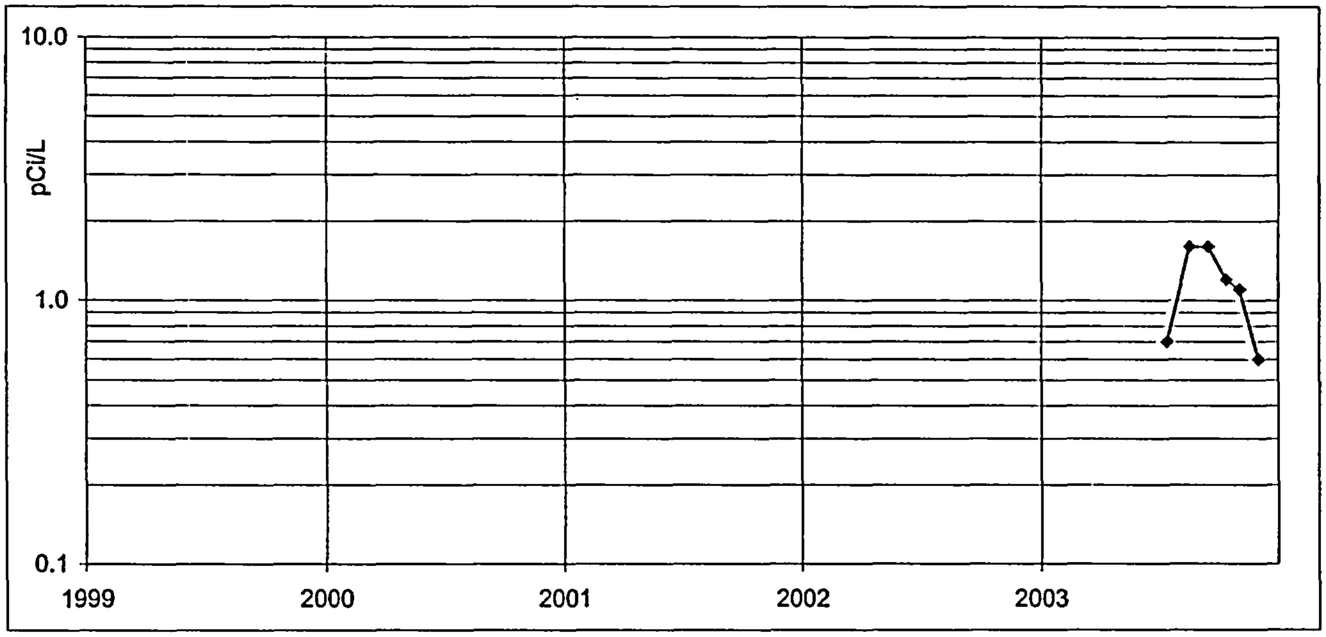

Figure 29. Milk samples. Location K-39.
New location; first collection, July, 2003

Kewaunee

Surface Water - Gross Beta

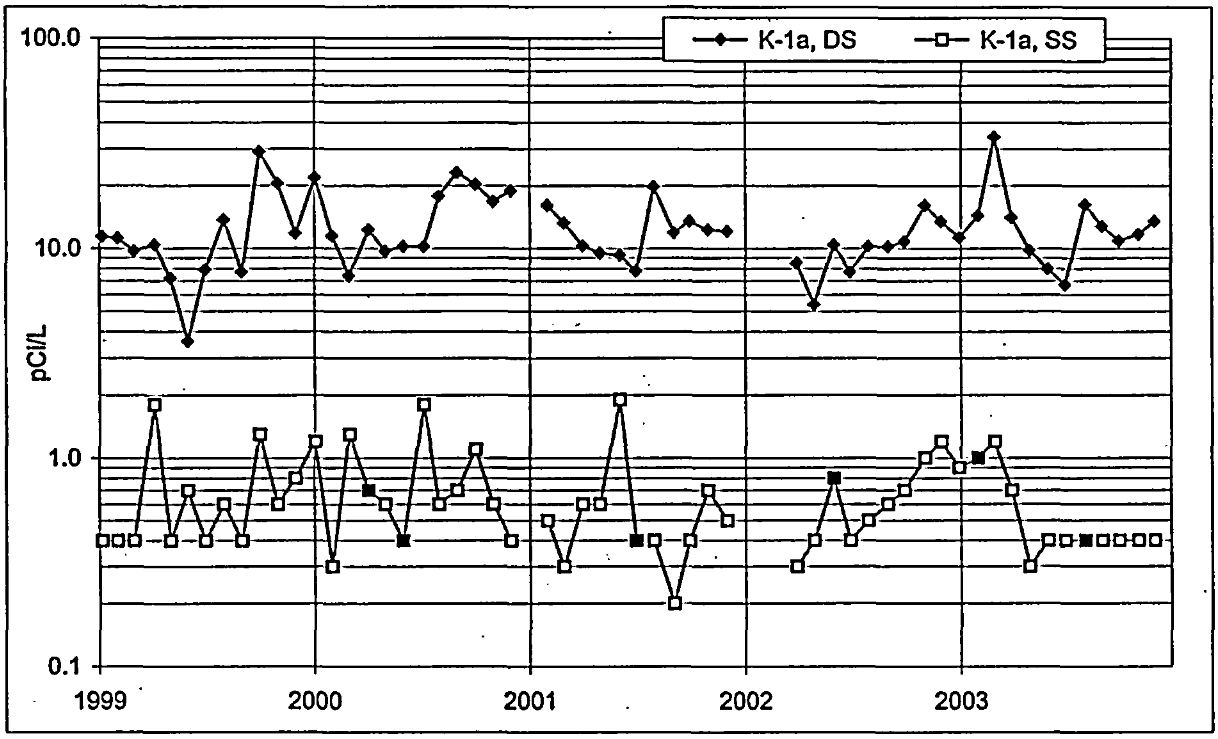

Figure 29. Surface water . North Creek, Onsite (K-1a).

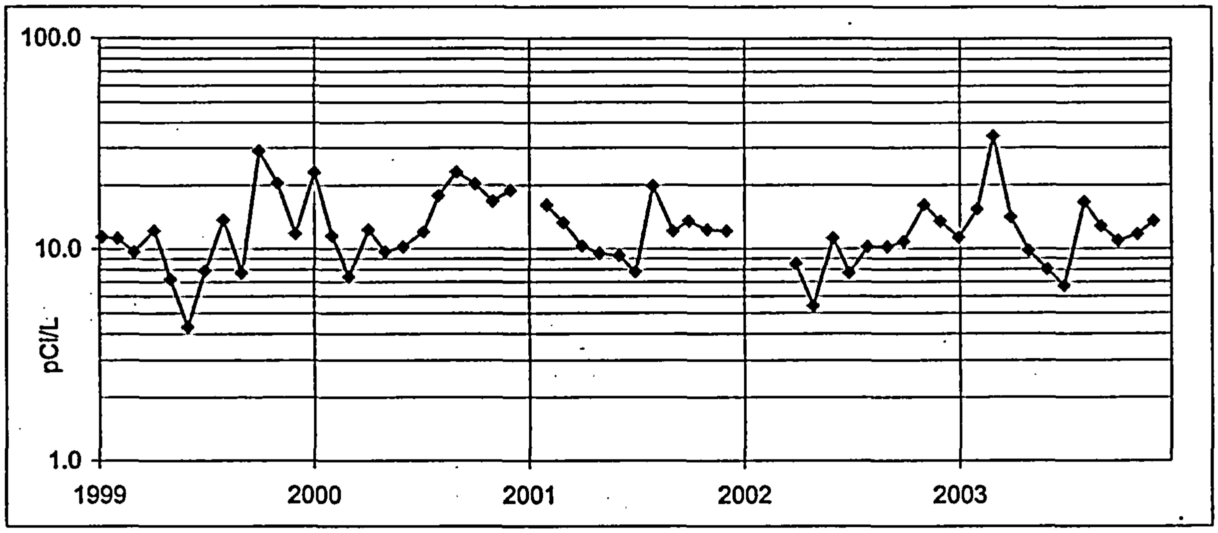

Figure 30. Surface water . North Creek, Onsite (K-1a).
Total Residue

Kewaunee

Surface Water - Gross Beta

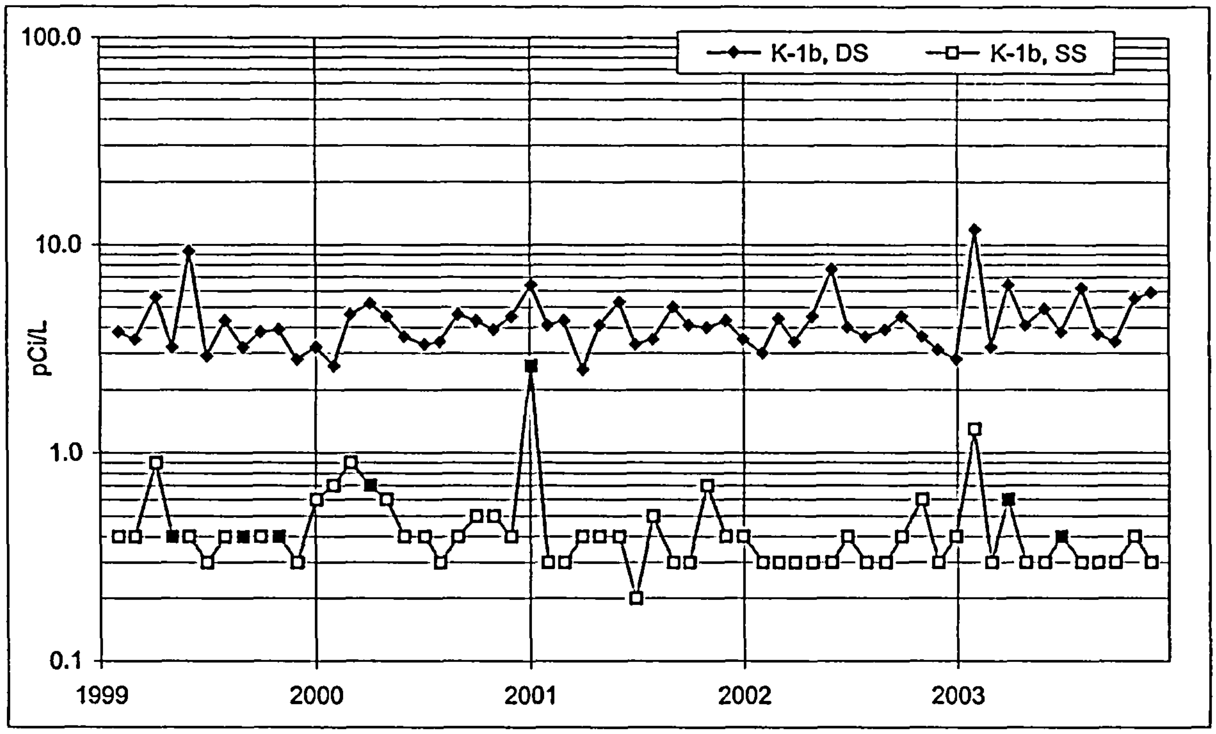

Figure 31. Surface water . Middle Creek, Onsite (K-1b).

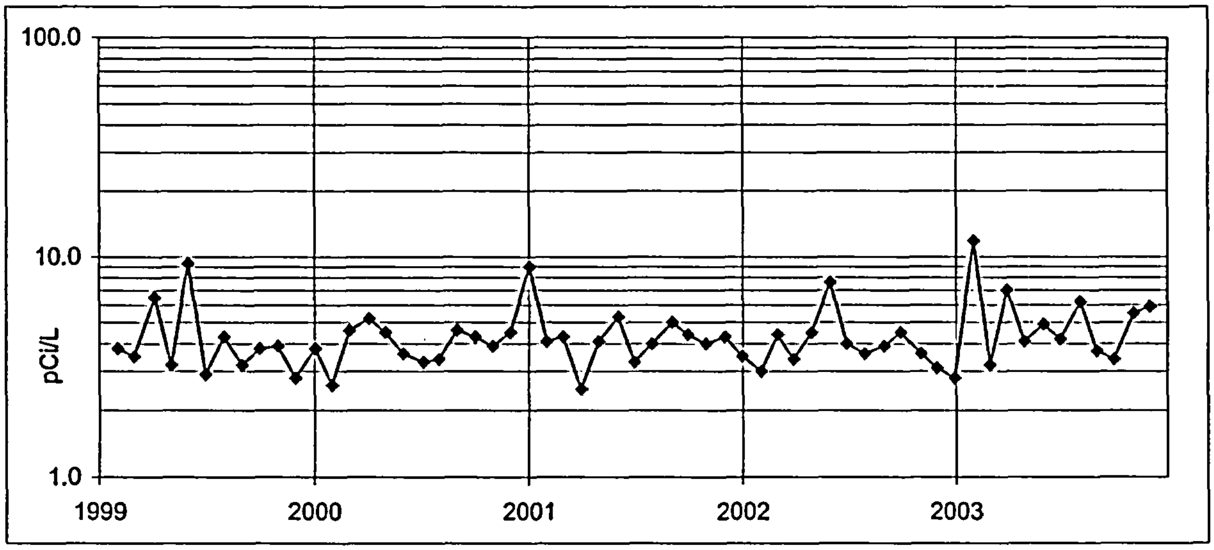

Figure 32. Surface water . Middle Creek, Onsite (K-1b).
Total Residue

Kewaunee

Surface Water - Gross Beta

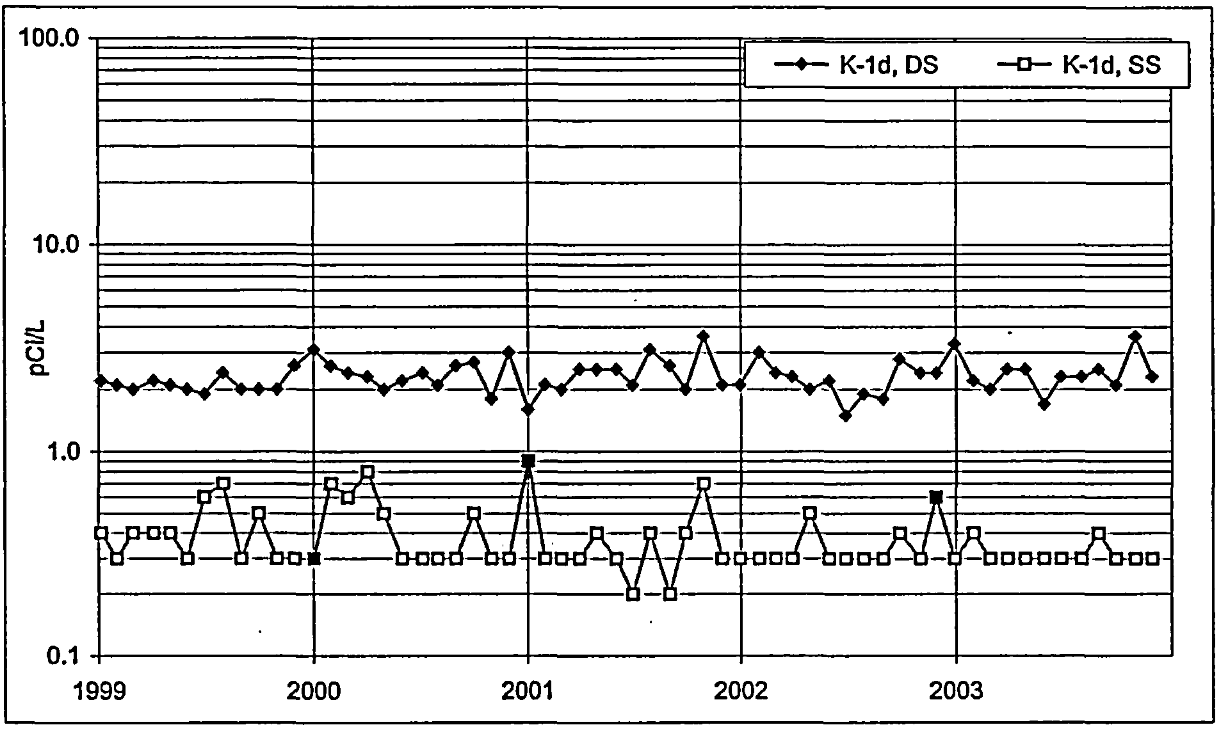

Figure 33. Surface water. Lake Michigan, condenser discharge, Onsite (K-1d).

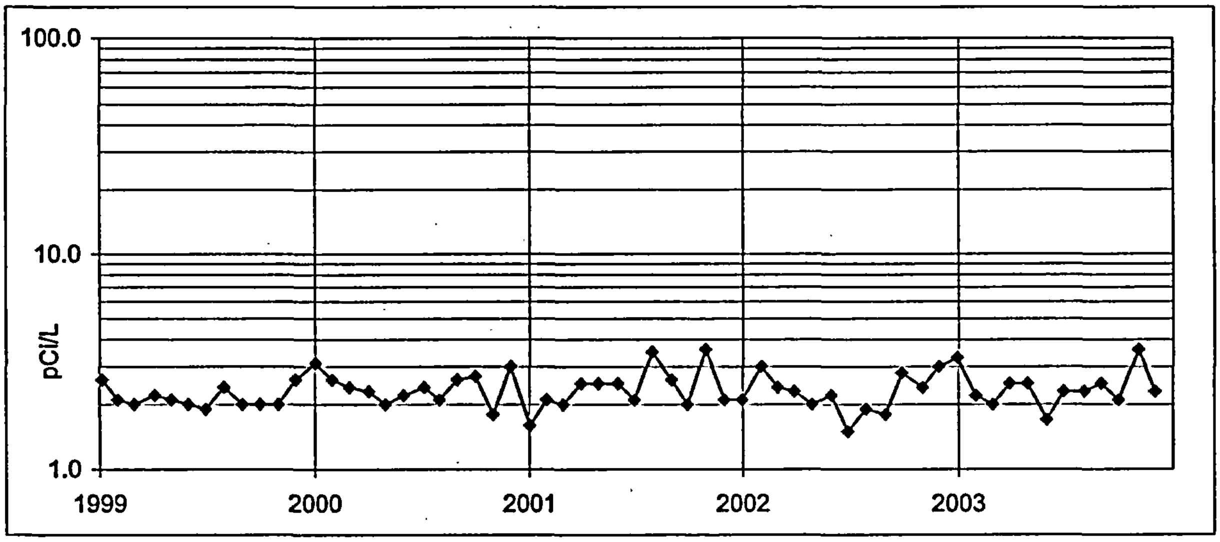

Figure 34. Surface water. Lake Michigan, condenser discharge, Onsite (K-1d).
Total Residue

Kewaunee

Surface Water - Gross Beta

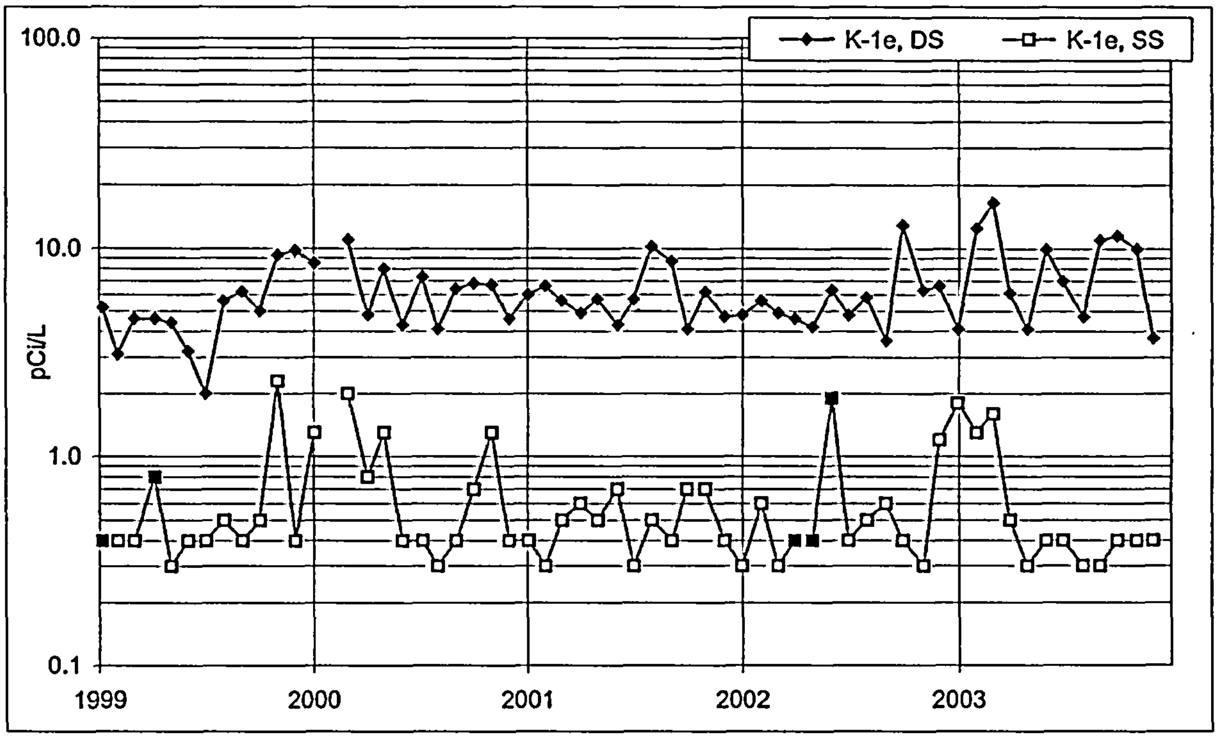

Figure 35. Surface water. South Creek, Onsite (K-1e).

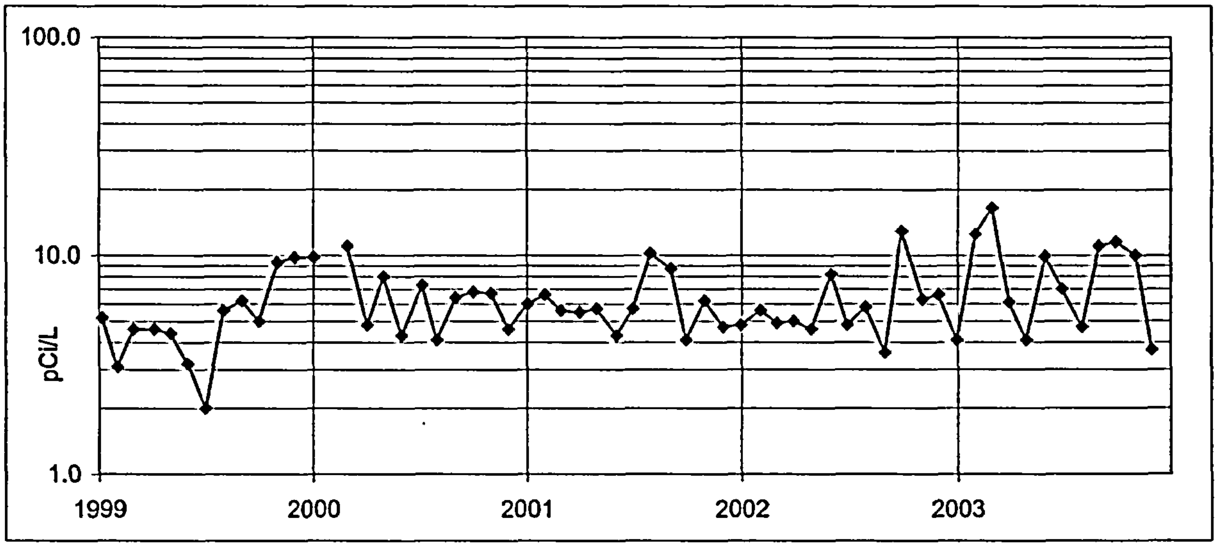

Figure 36. Surface water. South Creek, Onsite (K-1e).
Total Residue

Kewaunee

Surface Water - Gross Beta

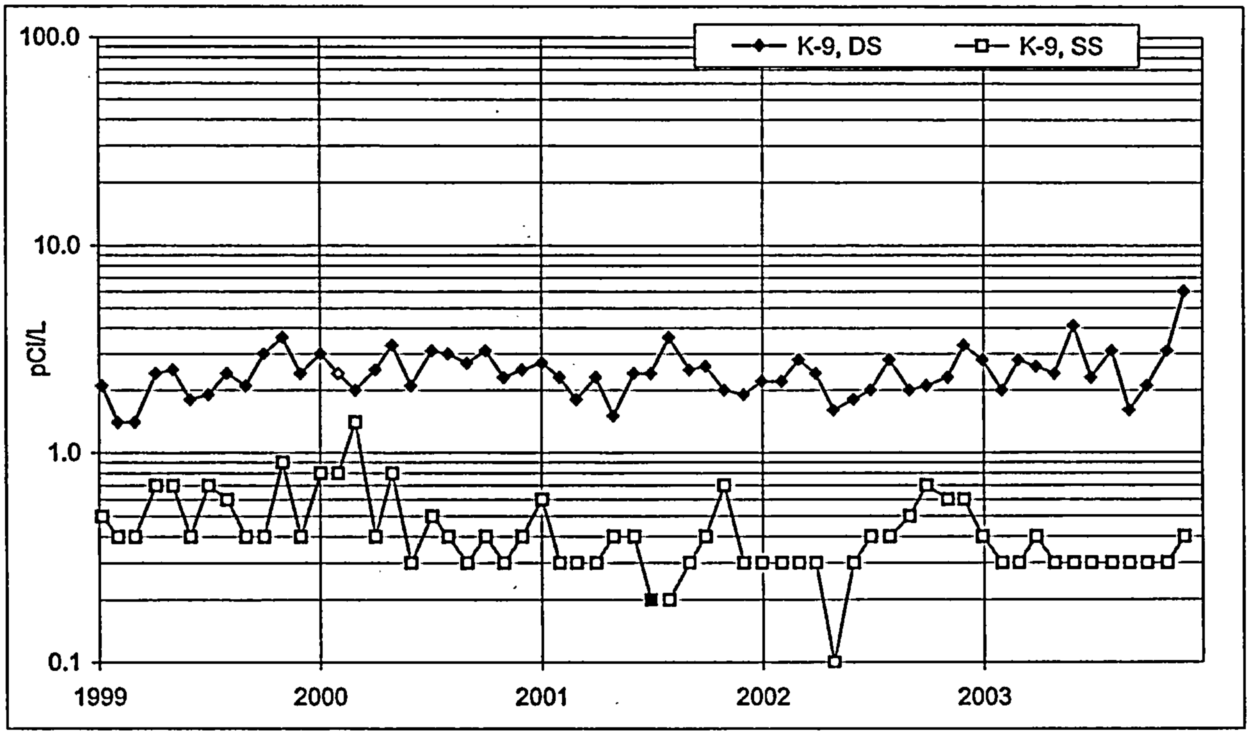

Figure 37. Surface water (raw). Lake Michigan, Rostok Intake (K-9)

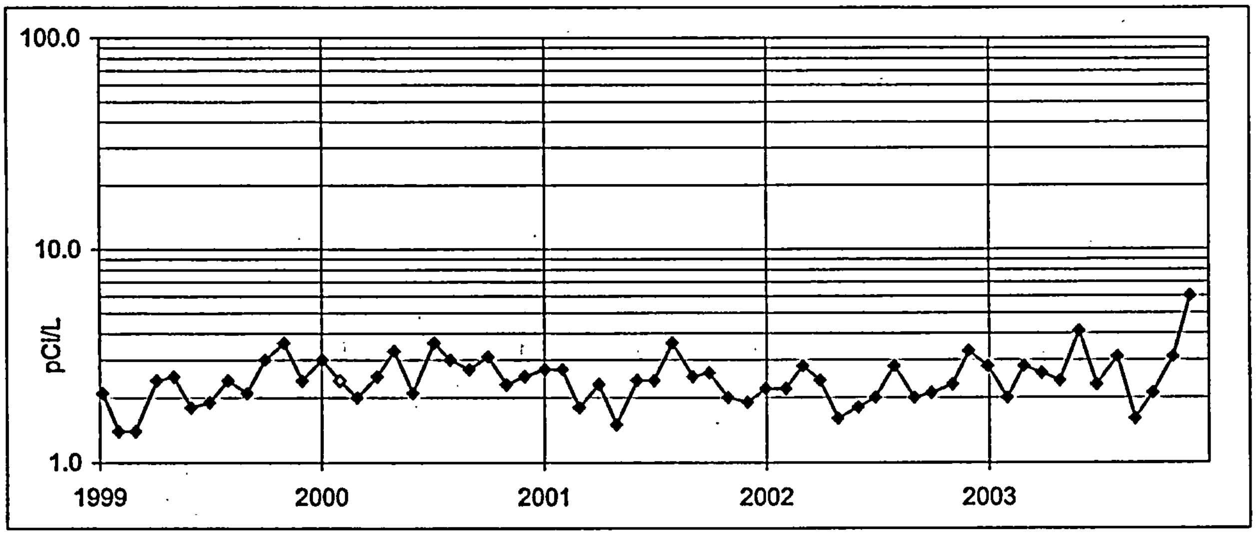

Figure 38. Surface water (raw). Lake Michigan, Rostok Intake (K-9)
Total Residue

Kewaunee

Surface Water - Gross Beta

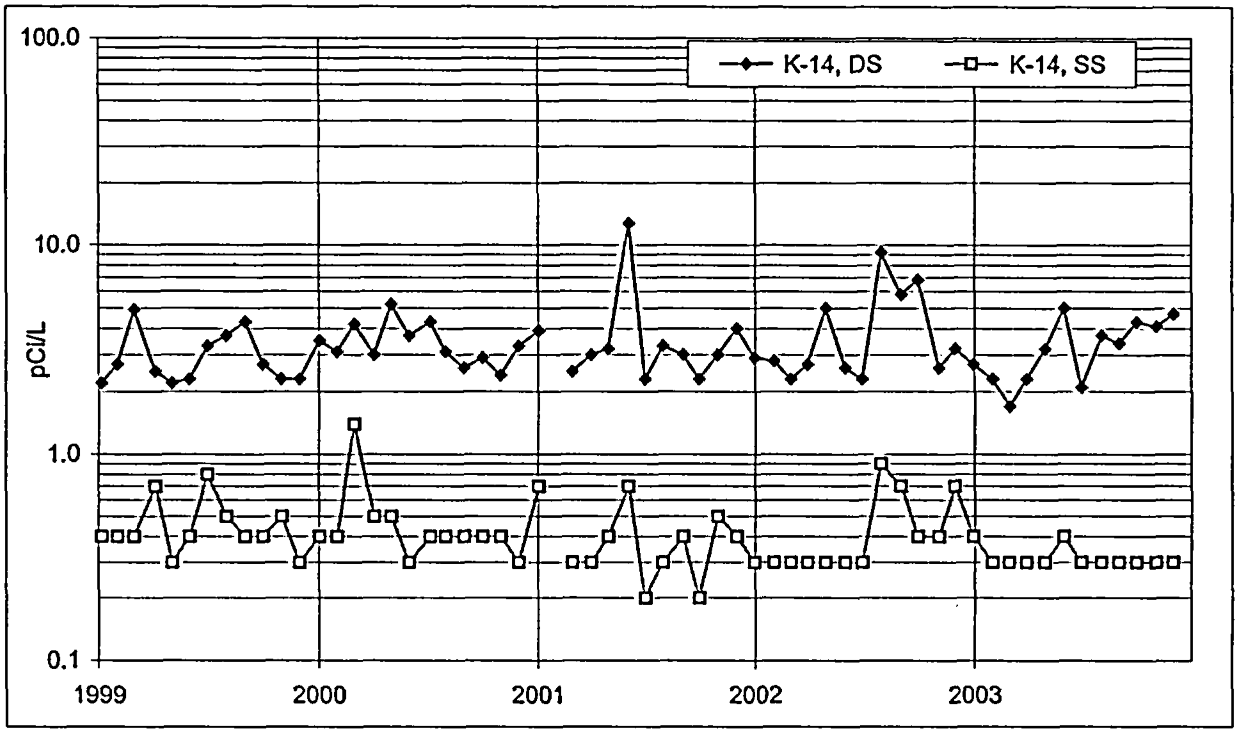

Figure 39. Surface water . Lake Michigan, Two Creeks Park (K-14a).

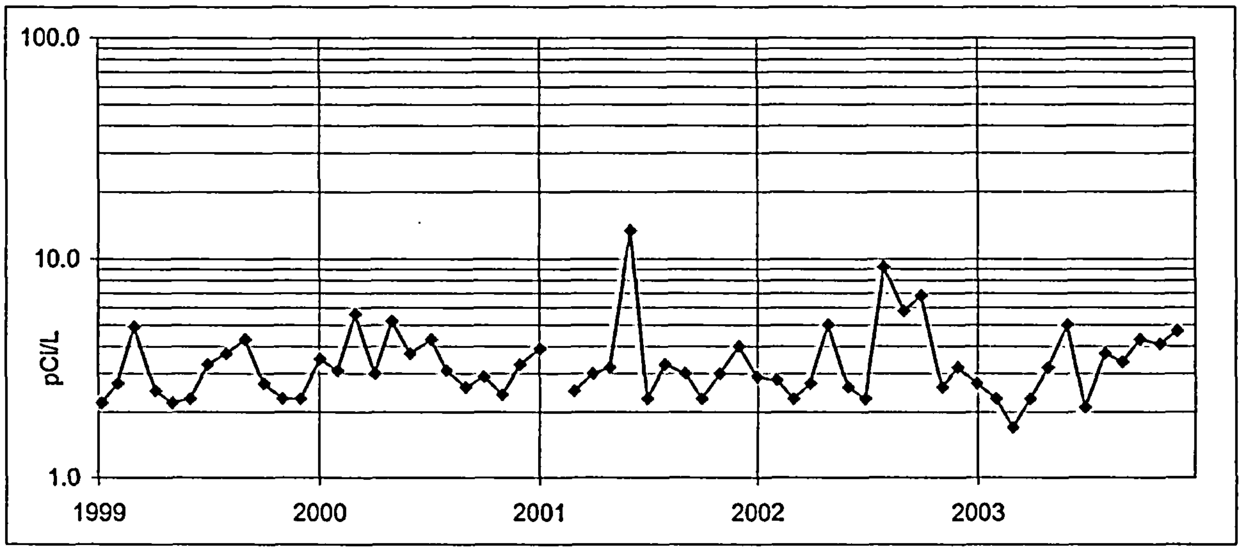

Figure 40. Surface water . Lake Michigan, Two Creeks Park (K-14a).
Total Residue

Kewaunee

Surface Water - Gross Beta

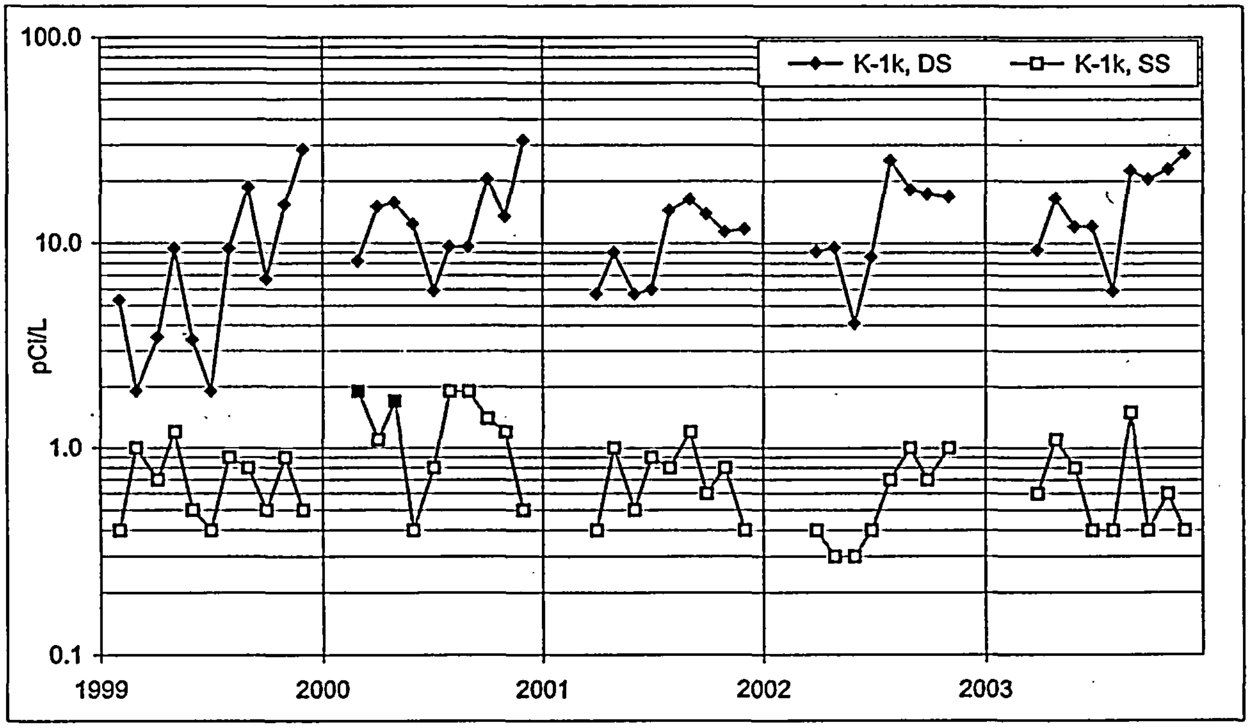

Figure 41. Surface water . School Forest Pond (K-1k).

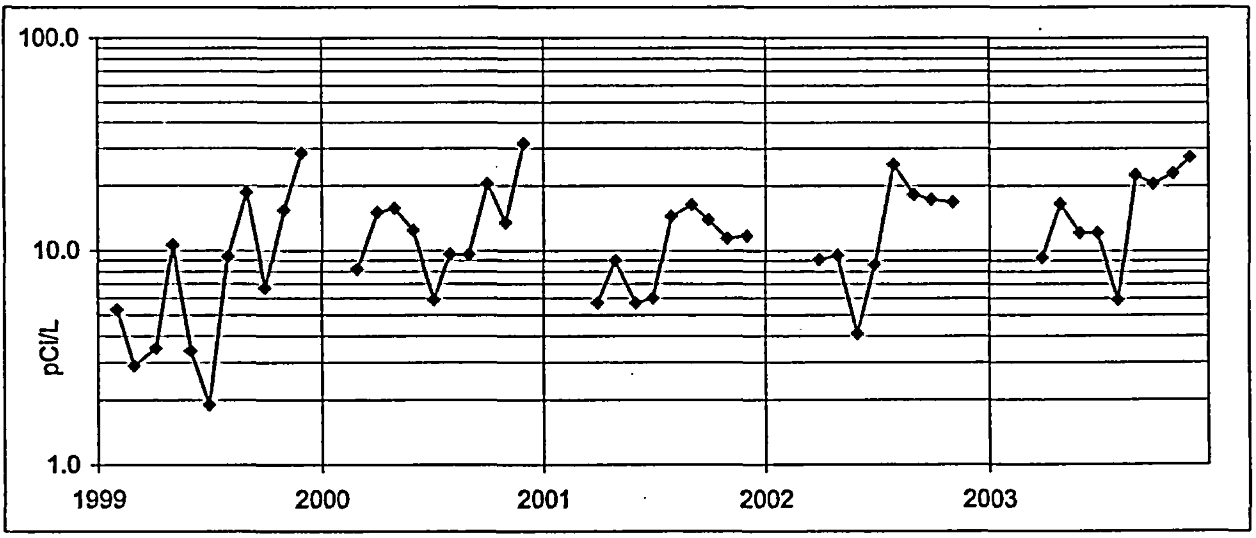

Figure 42. Surface water . School Forest Pond (K-1k).
Total Residue

Kewaunee

Surface Water - Tritium

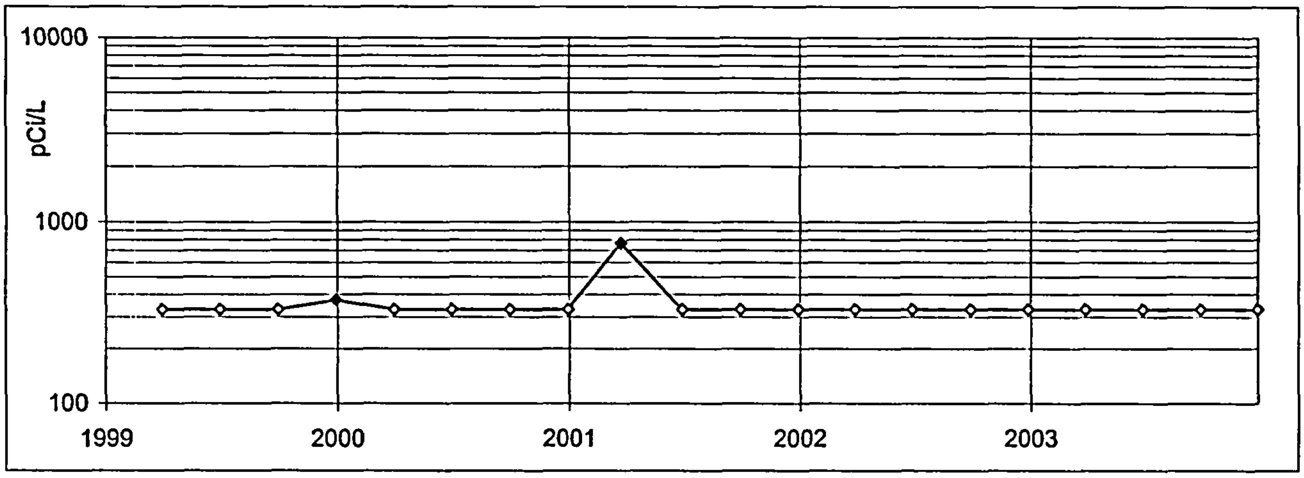

Figure 43. Surface water. Lake Michigan, condenser discharge, K-1d. Quarterly collection.

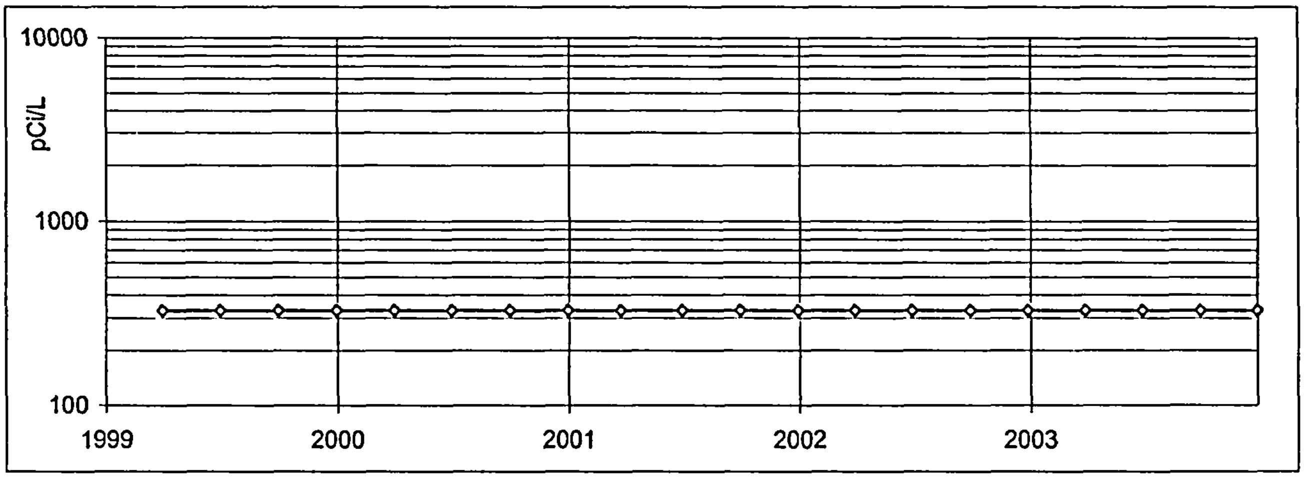

Figure 44. Surface water. Lake Michigan, Two Creeks Park, K-14a. Quarterly collection.

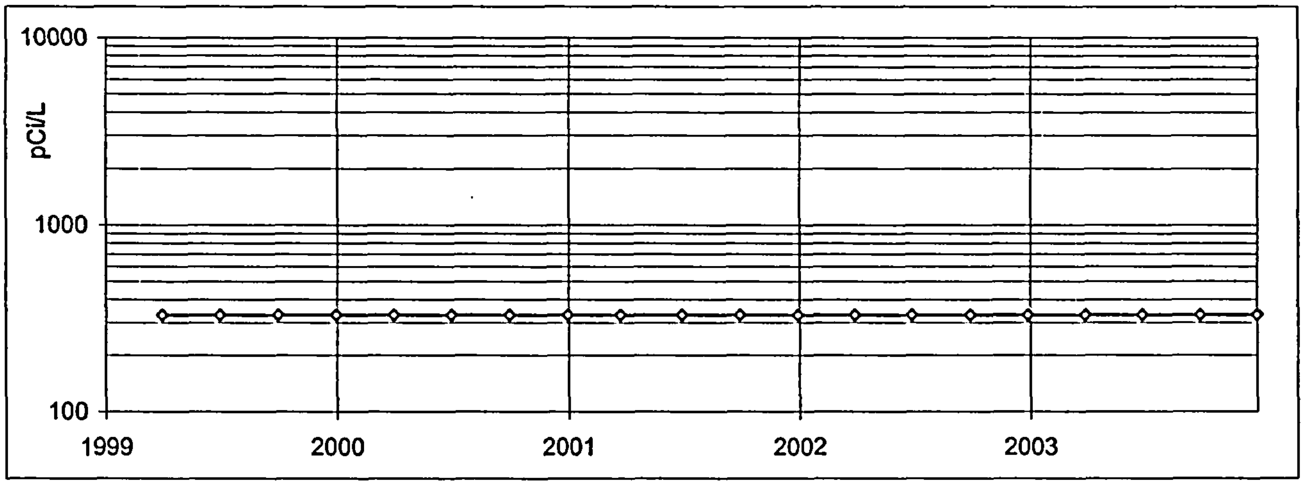

Figure 45. Surface water. Lake Michigan, Rostok Intake, K-9. Quarterly collection.

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6.0 DATA TABULATIONS

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Table 4. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].
Location: K-1f
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-07-03	350	0.017 ± 0.003	07-08-03	307	0.022 ± 0.003
01-14-03	302	0.021 ± 0.003	07-15-03	298	0.011 ± 0.003
01-21-03	305	0.030 ± 0.004	07-22-03	307	0.014 ± 0.003
01-28-03	303	0.023 ± 0.003	07-29-03	303	0.015 ± 0.003
02-05-03	376	0.024 ± 0.003	08-05-03	303	0.019 ± 0.003
02-11-03	261	0.020 ± 0.004	08-12-03	306	0.015 ± 0.003
02-17-03	262	0.018 ± 0.003	08-19-03	307	0.027 ± 0.004
02-25-03	352	0.021 ± 0.003	08-26-03	305	0.028 ± 0.003
			09-02-03	303	0.021 ± 0.003
03-04-03	299	0.028 ± 0.004			
03-11-03	303	0.030 ± 0.004	09-09-03	309	0.027 ± 0.003
03-18-03	303	0.031 ± 0.004	09-16-03	303	0.030 ± 0.004
03-25-03	305	0.019 ± 0.003	09-22-03	258	0.027 ± 0.004
04-01-03	305	0.018 ± 0.003	09-30-03	351	0.015 ± 0.003
1st Quarter Mean ± s.d.		0.023 ± 0.005	3rd Quarter Mean ± s.d.		0.021 ± 0.006
04-08-03	301	0.022 ± 0.003	10-07-03	305	0.011 ± 0.002
04-15-03	303	0.027 ± 0.003	10-14-03	297	0.038 ± 0.004
04-22-03	306	0.019 ± 0.003	10-20-03	261	0.025 ± 0.004
04-29-03	307	0.022 ± 0.003	10-28-03	351	0.021 ± 0.003
			11-03-03	261	0.012 ± 0.003
05-06-03	300	0.017 ± 0.003			
05-13-03	308	0.012 ± 0.002	11-11-03	346	0.023 ± 0.003
05-20-03	300	0.014 ± 0.003	11-18-03	310	0.028 ± 0.004
05-27-03	304	0.015 ± 0.003	11-25-03	297	0.022 ± 0.003
06-03-03	303	0.015 ± 0.003	12-02-03	303	0.033 ± 0.003
06-10-03	304	0.018 ± 0.003	12-09-03	303	0.020 ± 0.003
06-17-03	310	0.012 ± 0.003	12-15-03	261	0.024 ± 0.004
06-24-03	298	0.015 ± 0.003	12-23-03	347	0.041 ± 0.004
07-01-03	305	0.012 ± 0.003	12-30-03	305	0.022 ± 0.003
2nd Quarter Mean ± s.d.		0.017 ± 0.005	4th Quarter Mean ± s.d.		0.025 ± 0.009
			Cumulative Average		0.021
			Previous Annual Average		0.022

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[a] Iodine-131 is sampled biweekly. Concentrations are < 0.03 pCi/m^3 unless otherwise noted.

Table 5. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].
Location: K-2
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-07-03	349	0.020 ± 0.003	07-08-03	298	0.023 ± 0.003
01-14-03	302	0.022 ± 0.003	07-15-03	303	0.010 ± 0.003
01-21-03	304	0.027 ± 0.004	07-22-03	306	0.016 ± 0.003
01-28-03	303	0.026 ± 0.003	07-29-03	304	0.015 ± 0.003
02-05-03	347	0.027 ± 0.004	08-05-03	305	0.018 ± 0.003
02-11-03	261	0.026 ± 0.004	08-12-03	304	0.014 ± 0.003
02-17-03	263	0.022 ± 0.004	08-19-03	302	0.021 ± 0.003
02-25-03	346	0.024 ± 0.004	08-26-03	306	0.028 ± 0.003
			09-02-03	303	0.020 ± 0.003
03-04-03	295	0.033 ± 0.004			
03-11-03	292	0.034 ± 0.004	09-09-03	354	0.021 ± 0.003
03-18-03	334	0.026 ± 0.004	09-16-03	358	0.036 ± 0.004
03-25-03	349	0.014 ± 0.002	09-22-03	307	0.026 ± 0.004
04-01-03	321	0.017 ± 0.003	09-30-03	403	0.011 ± 0.002
1st Quarter Mean ± s.d.		0.024 ± 0.006	3rd Quarter Mean ± s.d.		0.020 ± 0.007
04-08-03	275	0.025 ± 0.004	10-07-03	361	0.010 ± 0.002
04-15-03	282	0.030 ± 0.004	10-14-03	347	0.041 ± 0.004
04-22-03	296	0.019 ± 0.003	10-20-03	305	0.023 ± 0.004
04-29-03	303	0.022 ± 0.003	10-28-03	409	0.021 ± 0.003
			11-03-03	286	0.015 ± 0.003
05-06-03	294	0.016 ± 0.003			
05-13-03	291	0.012 ± 0.003	11-11-03	405	0.023 ± 0.003
05-20-03	307	0.011 ± 0.003	11-18-03	361	0.029 ± 0.003
05-27-03	304	0.012 ± 0.003	11-25-03	347	0.024 ± 0.003
06-03-03	303	0.013 ± 0.003	12-02-03	358	0.033 ± 0.003
06-10-03	303	0.018 ± 0.003	12-09-03	353	0.021 ± 0.003
06-17-03	309	0.012 ± 0.003	12-15-03	305	0.028 ± 0.003
06-24-03	300	0.013 ± 0.003	12-23-03	382	0.047 ± 0.004
07-01-03	308	0.011 ± 0.003	12-30-03	356	0.026 ± 0.003
2nd Quarter Mean ± s.d.		0.016 ± 0.006	4th Quarter Mean ± s.d.		0.026 ± 0.010
			Cumulative Average		0.022
			Previous Annual Average		0.023

---

[a] Iodine-131 is sampled biweekly. Concentrations are < 0.03 pCi/m^3 unless otherwise noted.

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Table 6. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].
Location: K-7
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-07-03	408	0.019 ± 0.003	07-08-03	303	0.026 ± 0.003
01-14-03	354	0.024 ± 0.003	07-15-03	303	0.012 ± 0.003
01-21-03	356	0.028 ± 0.003	07-22-03	306	0.021 ± 0.003
01-28-03	359	0.025 ± 0.003	07-29-03	306	0.017 ± 0.003
02-05-03	405	0.030 ± 0.003	08-05-03	300	0.023 ± 0.004
02-11-03	307	0.025 ± 0.004	08-12-03	307	0.016 ± 0.003
02-17-03	263	0.022 ± 0.004	08-19-03	305	0.026 ± 0.004
02-25-03	405	0.022 ± 0.003	08-26-03	303	0.031 ± 0.003
			09-02-03	301	0.020 ± 0.003
03-04-03	355	0.037 ± 0.004			
03-11-03	353	0.035 ± 0.004	09-09-03	309	0.027 ± 0.003
03-18-03	328	0.027 ± 0.004	09-16-03	297	0.037 ± 0.004
03-25-03	310	0.020 ± 0.003	09-22-03	265	0.026 ± 0.004
04-01-03	300	0.020 ± 0.003	09-30-03	344	0.013 ± 0.003
1st Quarter Mean ± s.d.		0.026 ± 0.006	3rd Quarter Mean ± s.d.		0.023 ± 0.007
04-08-03	270	0.021 ± 0.003	10-07-03	311	0.012 ± 0.003
04-15-03	307	0.029 ± 0.003	10-14-03	347	0.039 ± 0.004
04-22-03	306	0.021 ± 0.003	10-20-03	261	0.026 ± 0.004
04-29-03	302	0.021 ± 0.003	10-28-03	352	0.021 ± 0.003
			11-03-03	261	0.015 ± 0.003
05-06-03	301	0.013 ± 0.003			
05-13-03	302	0.014 ± 0.003	11-11-03	356	0.021 ± 0.003
05-20-03	311	0.015 ± 0.003	11-18-03	325	0.028 ± 0.004
05-27-03	304	0.015 ± 0.003	11-25-03	298	0.022 ± 0.003
06-03-03	299	0.014 ± 0.003	12-02-03	326	0.034 ± 0.003
06-10-03	305	0.021 ± 0.003	12-09-03	314	0.021 ± 0.003
06-17-03	302	0.011 ± 0.003	12-15-03	265	0.025 ± 0.004
06-24-03	307	0.015 ± 0.003	12-23-03	342	0.041 ± 0.004
07-01-03	304	0.012 ± 0.003	12-30-03	307	0.027 ± 0.004
2nd Quarter Mean ± s.d.		0.017 ± 0.005	4th Quarter Mean ± s.d.		0.026 ± 0.009
			Cumulative Average		0.023
			Previous Annual Average		0.023

[a] Iodine-131 is sampled biweekly. Concentrations are < 0.03 pCi/m^3 unless otherwise noted.

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Table 7. Airborne particulates and charcoal canisters, analyses for gross beta and Iodine-131[a].
Location: K-8
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-07-03	354	0.022 ± 0.003	07-08-03	303	0.024 ± 0.003
01-14-03	299	0.024 ± 0.003	07-15-03	302	0.013 ± 0.003
01-21-03	304	0.028 ± 0.004	07-22-03	306	0.017 ± 0.003
01-28-03	303	0.031 ± 0.003	07-29-03	320	0.018 ± 0.003
02-05-03	347	0.030 ± 0.004	08-05-03	317	0.020 ± 0.003
02-11-03	276	0.025 ± 0.004	08-12-03	306	0.014 ± 0.003
02-17-03	272	0.017 ± 0.003	08-19-03	320	0.028 ± 0.004
02-25-03	346	0.027 ± 0.004	08-26-03	333	0.029 ± 0.003
			09-02-03	318	0.019 ± 0.003
03-04-03	305	0.034 ± 0.004			
03-11-03	302	0.035 ± 0.004	09-09-03	308	0.028 ± 0.003
03-18-03	303	0.032 ± 0.004	09-16-03	297	0.030 ± 0.004
03-25-03	309	0.021 ± 0.003	09-22-03	266	0.026 ± 0.004
04-01-03	296	0.020 ± 0.003	09-30-03	343	0.015 ± 0.003
1st Quarter Mean ± s.d.		0.027 ± 0.006	3rd Quarter Mean ± s.d.		0.022 ± 0.006
04-08-03	273	0.021 ± 0.003	10-07-03	312	0.011 ± 0.002
04-15-03	317	0.024 ± 0.003	10-14-03	296	0.043 ± 0.004
04-22-03	317	0.020 ± 0.003	10-20-03	261	0.027 ± 0.004
04-29-03	302	0.019 ± 0.003	10-28-03	352	0.021 ± 0.003
			11-03-03	260	0.014 ± 0.003
05-06-03	301	0.015 ± 0.003			
05-13-03	302	0.013 ± 0.003	11-11-03	345	0.021 ± 0.003
05-20-03	311	0.014 ± 0.003	11-18-03	311	0.028 ± 0.004
05-27-03	303	0.018 ± 0.003	11-25-03	297	0.021 ± 0.003
06-03-03	300	0.016 ± 0.003	12-02-03	325	0.034 ± 0.003
06-10-03	305	0.021 ± 0.003	12-09-03	315	0.025 ± 0.003
06-17-03	303	0.012 ± 0.003	12-15-03	286	0.026 ± 0.004
06-24-03	306	0.016 ± 0.003	12-23-03	400	0.040 ± 0.004
07-01-03	303	0.014 ± 0.003	12-30-03	348	0.025 ± 0.003
2nd Quarter Mean ± s.d.		0.017 ± 0.004	4th Quarter Mean ± s.d.		0.026 ± 0.009
			Cumulative Average		0.023
			Previous Annual Average		0.022

[a] Iodine-131 is sampled biweekly. Concentrations are < 0.03 pCi/m^3 unless otherwise noted.

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Table 8. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].

Location: K-31

Units: pCi/m^3

Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-07-03	349	0.024 ± 0.003	07-08-03	298	0.030 ± 0.003
01-14-03	302	0.023 ± 0.003	07-15-03	303	0.014 ± 0.003
01-21-03	331	0.025 ± 0.003	07-22-03	306	0.016 ± 0.003
01-28-03	354	0.024 ± 0.003	07-29-03	303	0.021 ± 0.003
02-05-03	404	0.024 ± 0.003	08-05-03	306	0.023 ± 0.003
02-11-03	304	0.020 ± 0.003	08-12-03	303	0.017 ± 0.003
02-17-03	307	0.019 ± 0.002	08-19-03	301	0.027 ± 0.004
02-25-03	404	0.024 ± 0.003	08-26-03	307	0.031 ± 0.003
			09-02-03	304	0.024 ± 0.003
03-04-03	341	0.033 ± 0.004			
03-11-03	312	0.034 ± 0.004	09-09-03	313	0.024 ± 0.003
03-18-03	304	0.028 ± 0.004	09-16-03	293	0.031 ± 0.004
03-25-03	304	0.019 ± 0.003	09-22-03	263	0.031 ± 0.004
04-01-03	307	0.022 ± 0.003	09-30-03	345	0.016 ± 0.003
1st Quarter Mean ± s.d.		0.025 ± 0.005	3rd Quarter Mean ± s.d.		0.023 ± 0.006
04-08-03	300	0.023 ± 0.003	10-07-03	311	0.012 ± 0.003
04-15-03	303	0.029 ± 0.003	10-14-03	296	0.042 ± 0.004
04-22-03	306	0.021 ± 0.003	10-20-03	261	0.024 ± 0.004
04-29-03	305	0.025 ± 0.004	10-28-03	350	0.018 ± 0.003
			11-03-03	261	0.012 ± 0.003
05-06-03	303	0.015 ± 0.003			
05-13-03	302	0.014 ± 0.003	11-11-03	346	0.021 ± 0.003
05-20-03	306	0.012 ± 0.003	11-18-03	310	0.028 ± 0.004
05-27-03	303	0.020 ± 0.003	11-25-03	297	0.023 ± 0.003
06-03-03	304	0.014 ± 0.003	12-02-03	322	0.033 ± 0.003
06-10-03	303	0.017 ± 0.003	12-09-03	319	0.020 ± 0.003
06-17-03	308	0.013 ± 0.003	12-15-03	261	0.023 ± 0.004
06-24-03	300	0.018 ± 0.003	12-23-03	347	0.036 ± 0.004
07-01-03	309	0.013 ± 0.003	12-30-03	305	0.027 ± 0.004
2nd Quarter Mean ± s.d.		0.018 ± 0.005	4th Quarter Mean ± s.d.		0.025 ± 0.009
			Cumulative Average		0.023
			Previous Annual Average		0.022

[a] Iodine-131 is sampled biweekly. Concentrations are < 0.03 pCi/m^3 unless otherwise noted.

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Table 9. Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131[a].
Location: K-16
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Volume (m^3)	Gross Beta	Date Collected	Volume (m^3)	Gross Beta
Required LLD		0.010	Required LLD		0.010
01-07-03	350	0.020 ± 0.003	07-08-03	303	0.024 ± 0.003
01-14-03	302	0.023 ± 0.003	07-15-03	303	0.013 ± 0.003
01-21-03	305	0.028 ± 0.004	07-22-03	306	0.017 ± 0.003
01-28-03	305	0.031 ± 0.003	07-29-03	329	0.018 ± 0.003
02-05-03	345	0.034 ± 0.004	08-05-03	346	0.020 ± 0.003
02-11-03	273	0.023 ± 0.004	08-12-03	322	0.018 ± 0.003
02-17-03	289	0.020 ± 0.003	08-19-03	324	0.030 ± 0.004
02-25-03	381	0.023 ± 0.003	08-26-03	358	0.032 ± 0.003
			09-02-03	327	0.023 ± 0.003
03-04-03	321	0.035 ± 0.004			
03-11-03	302	0.033 ± 0.004	09-09-03	371	0.030 ± 0.003
03-18-03	308	0.029 ± 0.004	09-16-03	472	0.033 ± 0.003
03-25-03	305	0.019 ± 0.003	09-22-03	439	0.022 ± 0.003
04-01-03	307	0.019 ± 0.003	09-30-03	474	0.016 ± 0.002
1st Quarter Mean ± s.d.		0.026 ± 0.006	3rd Quarter Mean ± s.d.		0.023 ± 0.007
04-08-03	324	0.018 ± 0.003	10-07-03	300	0.011 ± 0.003
04-15-03	343	0.022 ± 0.003	10-14-03	297	0.041 ± 0.004
04-22-03	347	0.016 ± 0.003	10-20-03	261	0.028 ± 0.004
04-29-03	326	0.021 ± 0.003	10-28-03	351	0.021 ± 0.003
			11-03-03	260	0.013 ± 0.003
05-06-03	308	0.015 ± 0.003			
05-13-03	301	0.014 ± 0.003	11-11-03	345	0.023 ± 0.003
05-20-03	306	0.014 ± 0.003	11-18-03	309	0.027 ± 0.004
05-27-03	303	0.018 ± 0.003	11-25-03	298	0.021 ± 0.003
06-03-03	304	0.017 ± 0.003	12-02-03	307	0.033 ± 0.003
06-10-03	303	0.019 ± 0.003	12-09-03	303	0.023 ± 0.003
06-17-03	304	0.014 ± 0.003	12-15-03	261	0.024 ± 0.004
06-24-03	305	0.017 ± 0.003	12-23-03	347	0.039 ± 0.004
07-01-03	304	0.011 ± 0.003	12-30-03	306	0.028 ± 0.004
2nd Quarter Mean ± s.d.		0.017 ± 0.003	4th Quarter Mean ± s.d.		0.026 ± 0.009
			Cumulative Average		0.023
			Previous Annual Average		0.023

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[a] Iodine-131 is sampled biweekly. Concentrations are < 0.03 pCi/m^3 unless otherwise noted.

Table 7. Airborne particulate data, gross beta analyses, monthly averages, minima and maxima.

January

Location	Average	Minima	Maxima
Indicators	0.023	0.017	0.030
K-1f	0.023	0.017	0.030
K-7	0.024	0.019	0.028
Controls	0.025	0.020	0.031
K-2	0.024	0.020	0.027
K-8	0.026	0.022	0.031
K-31	0.024	0.023	0.025
K-16	0.026	0.020	0.031

April

Location	Average	Minima	Maxima
Indicators	0.023	0.019	0.029
K-1f	0.023	0.019	0.027
K-7	0.023	0.021	0.029
Controls	0.022	0.016	0.030
K-2	0.024	0.019	0.030
K-8	0.021	0.019	0.024
K-31	0.025	0.021	0.029
K-16	0.019	0.016	0.022

February

Location	Average	Minima	Maxima
Indicators	0.023	0.018	0.030
K-1f	0.021	0.018	0.024
K-7	0.025	0.022	0.030
Controls	0.024	0.017	0.034
K-2	0.025	0.022	0.027
K-8	0.025	0.017	0.030
K-31	0.022	0.019	0.024
K-16	0.025	0.020	0.034

May

Location	Average	Minima	Maxima
Indicators	0.014	0.012	0.017
K-1f	0.015	0.012	0.017
K-7	0.014	0.013	0.015
Controls	0.015	0.011	0.020
K-2	0.013	0.011	0.016
K-8	0.015	0.013	0.018
K-31	0.015	0.012	0.020
K-16	0.016	0.014	0.018

March

Location	Average	Minima	Maxima
Indicators	0.027	0.018	0.037
K-1f	0.025	0.018	0.031
K-7	0.028	0.020	0.037
Controls	0.027	0.014	0.035
K-2	0.025	0.014	0.034
K-8	0.028	0.020	0.035
K-31	0.027	0.019	0.034
K-16	0.027	0.019	0.035

June

Location	Average	Minima	Maxima
Indicators			
K-1f	0.014	0.012	0.018
K-7	0.015	0.011	0.021
Controls	0.015	0.011	0.021
K-2	0.014	0.011	0.018
K-8	0.016	0.012	0.021
K-31	0.015	0.013	0.018
K-16	0.015	0.011	0.019

Note: unless otherwise specified, samples collected on the first, second or third day of the month are grouped with data of the previous month.

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Table 7. Airborne particulate data,gross beta analyses, monthly averages, minima and maxima.

July

Location	Average	Minima	Maxima
Indicators	0.017	0.011	0.026
K-1f	0.016	0.011	0.022
K-7	0.019	0.012	0.026
Controls	0.018	0.010	0.030
K-2	0.016	0.010	0.023
K-8	0.018	0.013	0.024
K-31	0.020	0.014	0.030
K-16	0.018	0.013	0.024

October

Location	Average	Minima	Maxima
Indicators	0.022	0.011	0.039
K-1f	0.021	0.011	0.038
K-7	0.023	0.012	0.039
Controls	0.022	0.010	0.043
K-2	0.022	0.010	0.041
K-8	0.023	0.011	0.043
K-31	0.022	0.012	0.042
K-16	0.023	0.011	0.041

August

Location	Average	Minima	Maxima
Indicators	0.023	0.015	0.031
K-1f	0.022	0.015	0.028
K-7	0.023	0.016	0.031
Controls	0.023	0.014	0.032
K-2	0.020	0.014	0.028
K-8	0.022	0.014	0.029
K-31	0.024	0.017	0.031
K-16	0.025	0.018	0.032

November

Location	Average	Minima	Maxima
Indicators	0.026	0.021	0.034
K-1f	0.027	0.022	0.033
K-7	0.026	0.021	0.034
Controls	0.026	0.021	0.034
K-2	0.027	0.023	0.033
K-8	0.026	0.021	0.034
K-31	0.026	0.021	0.033
K-16	0.026	0.021	0.033

September

Location	Average	Minima	Maxima
Indicators	0.025	0.013	0.037
K-1f	0.025	0.015	0.030
K-7	0.026	0.013	0.037
Controls	0.025	0.011	0.036
K-2	0.024	0.011	0.036
K-8	0.025	0.015	0.030
K-31	0.026	0.016	0.031
K-16	0.025	0.016	0.033

December

Location	Average	Minima	Maxima
Indicators	0.028	0.020	0.041
K-1f	0.027	0.020	0.041
K-7	0.029	0.021	0.041
Controls	0.029	0.020	0.047
K-2	0.031	0.021	0.047
K-8	0.029	0.025	0.040
K-31	0.027	0.020	0.036
K-16	0.029	0.023	0.039

Note: unless otherwise specified, samples collected on the first, second or third day of the month are grouped with data of the previous month.

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Table 11. Airborne particulate samples, quarterly composites of weekly samples, analysis for gamma-emitting isotopes.

	Sample Description and Concentration (pCi/m^3)			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Indicator				
K-1f				
Lab Code	KAP-1669	KAP-4070	KAP-6101	KAP-7864
Volume (m^3)	4026	3949	3960	3947
Be-7	0.069 ± 0.015	0.065 ± 0.015	0.059 ± 0.014	0.039 ± 0.011
Nb-95	< 0.0006	< 0.0010	< 0.0010	< 0.0003
Zr-95	< 0.0009	< 0.0013	< 0.0007	< 0.0013
Ru-103	< 0.0004	< 0.0007	< 0.0010	< 0.0005
Ru-106	< 0.0051	< 0.0064	< 0.0031	< 0.0037
Cs-134	< 0.0007	< 0.0006	< 0.0007	< 0.0007
Cs-137	< 0.0005	< 0.0008	< 0.0004	< 0.0004
Ce-141	< 0.0013	< 0.0009	< 0.0015	< 0.0011
Ce-144	< 0.0030	< 0.0028	< 0.0044	< 0.0040
K-7				
Lab Code	KAP-1671	KAP-4072	KAP-6104	KAP-7866
Volume (m^3)	4503	3920	3949	4065
Be-7	0.059 ± 0.012	0.071 ± 0.014	0.062 ± 0.014	0.052 ± 0.012
Nb-95	< 0.0004	< 0.0014	< 0.0009	< 0.0005
Zr-95	< 0.0016	< 0.0019	< 0.0008	< 0.0012
Ru-103	< 0.0003	< 0.0003	< 0.0006	< 0.0006
Ru-106	< 0.0048	< 0.0058	< 0.0057	< 0.0037
Cs-134	< 0.0007	< 0.0004	< 0.0005	< 0.0008
Cs-137	< 0.0006	< 0.0004	< 0.0007	< 0.0008
Ce-141	< 0.0012	< 0.0016	< 0.0015	< 0.0011
Ce-144	< 0.0028	< 0.0041	< 0.0054	< 0.0025

Table 11. Airborne particulate samples, quarterly composites of weekly samples, analysis for gamma-emitting isotopes, (continued).

	Sample Description and Concentration (pCi/m^3)			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Control				
K-2				
Lab Code	KAP-1670	KAP-4071	KAP-6102, 3	KAP-7865
Volume (m^3)	4066	3875	4153	4575
Be-7	0.053 ± 0.014	0.060 ± 0.014	0.059 ± 0.010	0.042 ± 0.010
Nb-95	< 0.0005	< 0.0012	< 0.0009	< 0.0003
Zr-95	< 0.0009	< 0.0013	< 0.0007	< 0.0012
Ru-103	< 0.0005	< 0.0008	< 0.0008	< 0.0006
Ru-106	< 0.0037	< 0.0067	< 0.0051	< 0.0029
Cs-134	< 0.0006	< 0.0005	< 0.0006	< 0.0008
Cs-137	< 0.0008	< 0.0005	< 0.0006	< 0.0008
Ce-141	< 0.0013	< 0.0012	< 0.0016	< 0.0015
Ce-144	< 0.0044	< 0.0041	< 0.0044	< 0.0044
K-8				
Lab Code	KAP-1672	KAP-4073	KAP-6105	KAP-7867
Volume (m^3)	4016	3943	4039	4108
Be-7	0.068 ± 0.012	0.071 ± 0.017	0.064 ± 0.015	0.043 ± 0.009
Nb-95	< 0.0005	< 0.0010	< 0.0008	< 0.0006
Zr-95	< 0.0012	< 0.0015	< 0.0015	< 0.0013
Ru-103	< 0.0004	< 0.0005	< 0.0006	< 0.0008
Ru-106	< 0.0062	< 0.0070	< 0.0041	< 0.0064
Cs-134	< 0.0005	< 0.0007	< 0.0004	< 0.0007
Cs-137	< 0.0005	< 0.0003	< 0.0004	< 0.0007
Ce-141	< 0.0012	< 0.0019	< 0.0008	< 0.0009
Ce-144	< 0.0044	< 0.0028	< 0.0038	< 0.0037

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Table 11. Airborne particulate samples, quarterly composites of weekly samples, analysis for gamma-emitting isotopes, (continued).

	Sample Description and Concentration (pCi/m^3)			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Control				
K-31				
Lab Code	KAP-1674	KAP-4075	KAP-6107	KAP-7870
Volume (m^3)	4323	3952	3945	3986
Be-7	0.080 ± 0.015	0.073 ± 0.014	0.060 ± 0.014	0.040 ± 0.011
Nb-95	< 0.0006	< 0.0012	< 0.0010	< 0.0005
Zr-95	< 0.0007	< 0.0014	< 0.0013	< 0.0012
Ru-103	< 0.0007	< 0.0005	< 0.0006	< 0.0005
Ru-106	< 0.0037	< 0.0075	< 0.0076	< 0.0068
Cs-134	< 0.0006	< 0.0005	< 0.0005	< 0.0008
Cs-137	< 0.0007	< 0.0008	< 0.0006	< 0.0005
Ce-141	< 0.0011	< 0.0020	< 0.0017	< 0.0010
Ce-144	< 0.0036	< 0.0034	< 0.0032	< 0.0028
K-16				
Lab Code	KAP-1673	KAP-4074	KAP-6106	KAP-7868, 9
Volume (m^3)	4093	4078	4674	3945
Be-7	0.067 ± 0.012	0.070 ± 0.012	0.069 ± 0.014	0.044 ± 0.007
Nb-95	< 0.0005	< 0.0011	< 0.0010	< 0.0003
Zr-95	< 0.0010	< 0.0015	< 0.0008	< 0.0007
Ru-103	< 0.0008	< 0.0006	< 0.0008	< 0.0004
Ru-106	< 0.0066	< 0.0073	< 0.0036	< 0.0068
Cs-134	< 0.0005	< 0.0005	< 0.0007	< 0.0008
Cs-137	< 0.0007	< 0.0009	< 0.0007	< 0.0004
Ce-141	< 0.0013	< 0.0009	< 0.0013	< 0.0008
Ce-144	< 0.0031	< 0.0048	< 0.0040	< 0.0038

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Table 12. Ambient gamma radiation (TLD), quarterly exposure.

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	
Date Placed	01-02-03	04-01-03	07-01-03	10-01-03	
Date Removed	04-01-03	07-01-03	10-01-03	01-05-04	
	mR/91 days[a]				
Indicator					Mean±s.d.
K-1f	12.5 ± 0.6	10.3 ± 0.5	11.3 ± 0.4	11.4 ± 0.7	11.4 ± 0.9
K-5	14.3 ± 0.6	13.0 ± 0.5	16.6 ± 0.6	17.2 ± 0.7	15.3 ± 2.0
K-7	17.0 ± 0.3	16.1 ± 0.6	17.0 ± 0.9	17.8 ± 0.7	17.0 ± 0.7
K-17	16.6 ± 0.4	13.8 ± 0.5	16.9 ± 0.5	15.0 ± 0.5	15.6 ± 1.4
K-25	14.4 ± 0.2	13.8 ± 0.6	14.2 ± 0.7	14.7 ± 0.6	14.3 ± 0.4
K-27	12.7 ± 0.3	10.6 ± 0.6	11.7 ± 0.4	11.5 ± 0.6	11.6 ± 0.9
K-30	13.8 ± 0.5	ND[c]	14.1 ± 0.6	25.2 ± 1.4[d]	14.0 ± 0.2
K-37[b]	13.2 ± 0.7	12.7 ± 1.0	-	-	13.0 ± 0.4
K-39[b]	-	-	14.5 ± 0.8	15.4 ± 0.4	
Mean ± s.d.	14.3 ± 1.7	12.9 ± 2.0	14.5 ± 2.2	14.7 ± 4.4	14.1 ± 0.8
Control					
K-2	12.4 ± 0.4	10.8 ± 0.4	11.8 ± 0.5	12.1 ± 0.5	11.8 ± 0.7
K-3	16.3 ± 0.7	14.1 ± 0.7	16.2 ± 0.7	16.0 ± 0.8	15.7 ± 1.0
K-8	14.5 ± 0.6	13.1 ± 0.2	14.2 ± 0.4	14.0 ± 0.6	14.0 ± 0.6
K-15	13.6 ± 0.4	12.1 ± 0.3	13.4 ± 0.3	13.4 ± 0.3	13.1 ± 0.7
K-16	14.0 ± 0.6	16.8 ± 0.5	24.4 ± 0.8	11.1 ± 0.4	16.6 ± 5.7
K-31	11.8 ± 0.5	10.8 ± 0.5	11.3 ± 0.5	11.7 ± 0.7	11.4 ± 0.5
Mean ± s.d.	13.8 ± 1.6	13.0 ± 2.3	15.2 ± 4.8	13.1 ± 1.8	13.7 ± 1.0

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[a] The uncertainty for each location corresponds to the two-standard deviation error of the average dose of eight dosimeters placed at this location.

[b] Location dropped from program; replaced by K-39 in the third quarter, 2003.

[c] TLDs lost in the field.

[d] Reading suspect, The TLD was found without a plastic holder bag, possibly removed mistakenly by outside personnel and then replaced again. Could also account for missing 2nd Qtr. TLD. This reading is not included in the calculation of mean and standard deviation.

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Table 13. Precipitation samples collected at Location K-11; analysis for tritium.

Date Collected	Lab Code	H-3 pCi/L	H-3 T.U. (100 T.U. = 320 pCi/L)
01/07/03	KP -176	< 330	< 103
02/05/03	-556	< 330	< 103
03/04/03	-975	< 330	< 103
04/01/03	-1524	< 330	< 103
05/06/03	-2416	< 330	< 103
06/05/03	-3026	< 330	< 103
07/01/03	-3680	< 330	< 103
08/05/03	-4538	< 330	< 103
09/02/03	-5010, 11	< 330	< 103
10/07/03	-5845	< 330	< 103
11/03/03	-6644	< 330	< 103
12/02/04	-7240	< 330	< 103

Table 14. Milk, analyses for iodine-131 and gamma-emitting isotopes.
Collection: Semimonthly during grazing season, monthly at other times.

Collection	Lab	Concentration (pCi/L)				
Date	Code	I-131	Cs-134	Cs-137	Ba-La-140	K-40
Indicators						
K-5						
01-02-03	KMI - 20	< 0.5	< 10	< 10	< 15	1308 ± 116
02-03-03	- 460	< 0.5	< 10	< 10	< 15	1429 ± 183
03-03-03	- 886	< 0.5	< 10	< 10	< 15	1481 ± 182
04-01-03	- 1421	< 0.5	< 10	< 10	< 15	1152 ± 166
05-01-03	- 2167	< 0.5	< 10	< 10	< 15	1336 ± 190
05-13-03	- 2569	< 0.5	< 10	< 10	< 15	1242 ± 112
06-02-03	- 2893	< 0.5	< 10	< 10	< 15	1254 ± 175
06-17-03	- 3287	< 0.5	< 10	< 10	< 15	1376 ± 170
07-01-03	- 3578	< 0.5	< 10	< 10	< 15	1295 ± 157
07-15-03	- 3985	< 0.5	< 10	< 10	< 15	1177 ± 168
08-04-03	- 4391	< 0.5	< 10	< 10	< 15	1195 ± 159
08-19-03	- 4737	< 0.5	< 10	< 10	< 15	1293 ± 118
09-02-03	- 4981	< 0.5	< 10	< 10	< 15	1305 ± 176
09-16-03	- 5282	< 0.5	< 10	< 10	< 15	1350 ± 121
10-01-03	- 5614	< 0.5	< 10	< 10	< 15	1307 ± 181
10-14-03	- 6028	< 0.5	< 10	< 10	< 15	1190 ± 160
11-03-03	- 6607	< 0.5	< 10	< 10	< 15	1275 ± 112
12-01-03	- 7142	< 0.5	< 10	< 10	< 15	1277 ± 171
K-25						
01-03-03	KMI - 21	< 0.5	< 10	< 10	< 15	1331 ± 130
02-04-03	- 461	< 0.5	< 10	< 10	< 15	1527 ± 126
03-04-03	- 887	< 0.5	< 10	< 10	< 15	1239 ± 161
04-01-03	- 1422, 3	< 0.5	< 10	< 10	< 15	1375 ± 105
05-01-03	- 2168	< 0.5	< 10	< 10	< 15	1146 ± 157
05-13-03	- 2570	< 0.5	< 10	< 10	< 15	1198 ± 169
06-02-03	- 2894	< 0.5	< 10	< 10	< 15	1346 ± 115
06-17-03	- 3288	< 0.5	< 10	< 10	< 15	1205 ± 166
07-01-03	- 3579	< 0.5	< 10	< 10	< 15	1400 ± 176
07-15-03	- 3986	< 0.5	< 10	< 10	< 15	1378 ± 123
08-04-03	- 4392	< 0.5	< 10	< 10	< 15	1427 ± 186
08-19-03	- 4738	< 0.5	< 10	< 10	< 15	1356 ± 122
09-02-03	- 4982	< 0.5	< 10	< 10	< 15	1436 ± 205
09-16-03	- 5283	< 0.5	< 10	< 10	< 15	1254 ± 113
10-01-03	- 5615	< 0.5	< 10	< 10	< 15	1347 ± 191
10-14-03	- 6029	< 0.5	< 10	< 10	< 15	1352 ± 114
11-04-03	- 6608	< 0.5	< 10	< 10	< 15	1544 ± 134
12-01-03	- 7143	< 0.5	< 10	< 10	< 15	1419 ± 170

Table 14. Milk, analyses for iodine-131 and gamma-emitting isotopes (continued).

Collection Date	Lab Code	Concentration (pCi/L)				
		I-131	Cs-134	Cs-137	Ba-La-140	K-40
Indicators						
K-34						
01-02-03	KMI - 23	< 0.5	< 10	< 10	< 15	1544 ± 181
02-03-03	- 463	< 0.5	< 10	< 10	< 15	1509 ± 134
03-03-03	- 889	< 0.5	< 10	< 10	< 15	1515 ± 127
04-01-03	- 1425	< 0.5	< 10	< 10	< 15	1387 ± 194
05-01-03	- 2170, 1	< 0.5	< 10	< 10	< 15	1462 ± 115
05-13-03	- 2572	< 0.5	< 10	< 10	< 15	1448 ± 186
06-02-03	- 2896	< 0.5	< 10	< 10	< 15	1400 ± 175
06-17-03	- 3290	< 0.5	< 10	< 10	< 15	1508 ± 188
07-02-03	- 3581	< 0.5	< 10	< 10	< 15	1373 ± 167
07-15-03	- 3988	< 0.5	< 10	< 10	< 15	1491 ± 189
08-05-03	- 4394	< 0.5	< 10	< 10	< 15	1469 ± 198
08-19-03	- 4740	< 0.5	< 10	< 10	< 15	1459 ± 187
09-02-03	- 4984	< 0.5	< 10	< 10	< 15	1357 ± 179
09-16-03	- 5285	< 0.5	< 10	< 10	< 15	1388 ± 171
10-02-03	- 5617	< 0.5	< 10	< 10	< 15	1020 ± 175
10-14-03	- 6031	< 0.5	< 10	< 10	< 15	1484 ± 125
11-03-03	- 6610	< 0.5	< 10	< 10	< 15	1278 ± 180
12-01-03	- 7145	< 0.5	< 10	< 10	< 15	1440 ± 174

Table 14. Milk, analyses for iodine-131 and gamma-emitting isotopes (continued).

Collection Date	Lab Code	Concentration (pCi/L)				
		I-131	Cs-134	Cs-137	Ba-La-140	K-40
Indicators						
K-38						
01-02-03	KMI -24, 5	< 0.5	< 10	< 10	< 15	1370 ± 111
02-03-03	- 464	< 0.5	< 10	< 10	< 15	1340 ± 119
03-03-03	- 890	< 0.5	< 10	< 10	< 15	1362 ± 161
04-02-03	- 1426	< 0.5	< 10	< 10	< 15	1313 ± 91
05-02-03	- 2172	< 0.5	< 10	< 10	< 15	1418 ± 119
05-13-03	- 2573	< 0.5	< 10	< 10	< 15	1287 ± 123
06-03-03	- 2897	< 0.5	< 10	< 10	< 15	1399 ± 200
06-17-03	- 3291	< 0.5	< 10	< 10	< 15	1434 ± 173
07-01-03	- 3582	< 0.5	< 10	< 10	< 15	1364 ± 114
07-15-03	- 3989	< 0.5	< 10	< 10	< 15	1381 ± 126
08-07-03	- 4531	< 0.5	< 10	< 10	< 15	1366 ± 168
08-19-03	- 4741	< 0.5	< 10	< 10	< 15	1438 ± 186
09-03-03	- 4985	< 0.5	< 10	< 10	< 15	1404 ± 119
09-16-03	- 5286	< 0.5	< 10	< 10	< 15	1110 ± 165
10-01-03	- 5618	< 0.5	< 10	< 10	< 15	1186 ± 161
10-14-03	- 6032	< 0.5	< 10	< 10	< 15	1200 ± 103
11-04-03	- 6611	< 0.5	< 10	< 10	< 15	1304 ± 131
12-02-03	- 7146	< 0.5	< 10	< 10	< 15	1326 ± 175
K-39 [a]						
01-03-03						
02-04-03						
03-04-03						
04-01-03						
05-01-03						
05-13-03						
06-02-03						
06-17-03						
07-01-03	KMI - 3583	< 0.5	< 10	< 10	< 15	1400 ± 176
07-15-03	- 3990	< 0.5	< 10	< 10	< 15	1245 ± 177
08-04-03	- 4395	< 0.5	< 10	< 10	< 15	1313 ± 183
08-19-03	- 4742	< 0.5	< 10	< 10	< 15	1364 ± 133
09-03-03	- 4986	< 0.5	< 10	< 10	< 15	1491 ± 127
09-16-03	- 5287	< 0.5	< 10	< 10	< 15	1392 ± 123
10-01-03	- 5619	< 0.5	< 10	< 10	< 15	1201 ± 165
10-14-03	- 6033	< 0.5	< 10	< 10	< 15	1458 ± 125
11-04-03	- 6612	< 0.5	< 10	< 10	< 15	1418 ± 120
12-02-03	- 7147	< 0.5	< 10	< 10	< 15	1351 ± 127

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[a] K-39, Wojta Farm, added to program July 1, 2003.

Table 14. Milk, analyses for iodine-131 and gamma-emitting isotopes (continued).

Collection Date	Lab Code	Concentration (pCi/L)				
		I-131	Cs-134	Cs-137	Ba-La-140	K-40
Control						
K-3						
01-03-03	KMI - 19	< 0.5	< 10	< 10	< 15	1362 ± 182
02-04-03	- 459	< 0.5	< 10	< 10	< 15	1560 ± 130
03-04-03	- 885	< 0.5	< 10	< 10	< 15	1536 ± 212
04-02-03	- 1420	< 0.5	< 10	< 10	< 15	1394 ± 114
05-02-03	- 2166	< 0.5	< 10	< 10	< 15	1496 ± 128
05-13-03	- 2568	< 0.5	< 10	< 10	< 15	1411 ± 112
06-03-03	- 2892	< 0.5	< 10	< 10	< 15	1170 ± 173
06-17-03	- 3286	< 0.5	< 10	< 10	< 15	1391 ± 173
07-02-03	- 3577	< 0.5	< 10	< 10	< 15	1514 ± 195
07-15-03	- 3984	< 0.5	< 10	< 10	< 15	1386 ± 120
08-05-03	- 4390	< 0.5	< 10	< 10	< 15	1380 ± 112
08-19-03	- 4735, 6	< 0.5	< 10	< 10	< 15	1403 ± 88
09-03-03	- 4980	< 0.5	< 10	< 10	< 15	1457 ± 174
09-16-03	- 5281	< 0.5	< 10	< 10	< 15	1404 ± 206
10-02-03	- 5613	< 0.5	< 10	< 10	< 15	1399 ± 157
10-14-03	- 6027	< 0.5	< 10	< 10	< 15	1483 ± 182
11-04-03	- 6606	< 0.5	< 10	< 10	< 15	1299 ± 109
12-02-03	- 7141	< 0.5	< 10	< 10	< 15	1367 ± 162
K-28						
01-03-03	KMI - 22	< 0.5	< 10	< 10	< 15	1482 ± 120
02-04-03	- 462	< 0.5	< 10	< 10	< 15	1453 ± 113
03-04-03	- 888	< 0.5	< 10	< 10	< 15	1420 ± 204
04-02-03	- 1424	< 0.5	< 10	< 10	< 15	1466 ± 170
05-01-03	- 2169	< 0.5	< 10	< 10	< 15	1376 ± 119
05-13-03	- 2571	< 0.5	< 10	< 10	< 15	1415 ± 175
06-02-03	- 2895	< 0.5	< 10	< 10	< 15	1332 ± 123
06-17-03	- 3289	< 0.5	< 10	< 10	< 15	1398 ± 190
07-02-03	- 3580	< 0.5	< 10	< 10	< 15	1482 ± 185
07-15-03	- 3987	< 0.5	< 10	< 10	< 15	1465 ± 186
08-04-03	- 4393	< 0.5	< 10	< 10	< 15	1291 ± 128
08-19-03	- 4739	< 0.5	< 10	< 10	< 15	1298 ± 125
09-03-03	- 4983	< 0.5	< 10	< 10	< 15	1310 ± 177
09-16-03	- 5284	< 0.5	< 10	< 10	< 15	1381 ± 187
10-02-03	- 5616	< 0.5	< 10	< 10	< 15	1401 ± 204
10-14-03	- 6030	< 0.5	< 10	< 10	< 15	1325 ± 167
11-04-03	- 6609	< 0.5	< 10	< 10	< 15	1220 ± 164
12-02-03	- 7144	< 0.5	< 10	< 10	< 15	1398 ± 179

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Table 15. Milk, analyses for strontium-89, strontium-90, stable potassium, stable calcium, and ratios of strontium-90 per gram of calcium and cesium-137 per gram of potassium. Collection: Monthly composites.

		Concentration				Ratios	
Collection Period	Lab Code	Sr-89 (pCi/L)	Sr-90 (pCi/L)	K (g/L)	Ca (g/L)	Sr-90 per gram Ca	Cs-137 per gram K
Indicators							
			K-5				
January	KMI - 20	< 1.2	1.8 ± 0.5	1.51 ± 0.13	0.84	2.10	< 6.61
February	- 460	< 1.0	1.1 ± 0.4	1.65 ± 0.21	0.89	1.24	< 6.05
March	- 886	< 0.8	1.0 ± 0.4	1.71 ± 0.21	1.10	0.91	< 5.84
April	- 1421	< 1.1	1.0 ± 0.4	1.33 ± 0.19	0.75	1.33	< 7.51
May	- 2577	< 0.9	1.7 ± 0.4	1.49 ± 0.17	0.76	2.24	< 6.71
June	- 3293	< 1.2	2.2 ± 0.6	1.52 ± 0.20	0.85	2.59	< 6.58
July	- 4129	< 0.9	3.1 ± 0.6	1.43 ± 0.19	0.93	3.33	< 7.00
August	- 4751	< 0.9	1.4 ± 0.4	1.44 ± 0.16	1.03	1.36	< 6.95
September	- 5313	< 1.1	1.0 ± 0.4	1.53 ± 0.17	0.76	1.32	< 6.52
October	- 6036	< 0.9	0.9 ± 0.4	1.44 ± 0.20	0.78	1.15	< 6.93
November	- 6607	< 0.9	0.8 ± 0.4	1.47 ± 0.13	0.84	0.95	< 6.78
December	- 7142	< 1.0	< 0.7	1.48 ± 0.20	0.78	< 0.90	< 6.77
			K-25				
January	KMI - 21	< 0.9	1.4 ± 0.4	1.54 ± 0.15	0.86	1.64	< 6.50
February	- 461	< 0.7	1.2 ± 0.4	1.77 ± 0.15	0.98	1.22	< 5.66
March	- 887	< 0.6	1.0 ± 0.4	1.43 ± 0.19	0.93	1.08	< 6.98
April	- 1422, 3	< 0.7	1.5 ± 0.3	1.59 ± 0.12	0.89	1.69	< 6.29
May	- 2578	< 0.7	0.8 ± 0.4	1.35 ± 0.19	0.79	1.01	< 7.38
June	- 3294	< 1.1	2.7 ± 0.6	1.47 ± 0.16	0.81	3.33	< 6.78
July	- 4130	< 1.0	1.1 ± 0.5	1.61 ± 0.17	0.95	1.16	< 6.23
August	- 4752	< 0.7	1.4 ± 0.4	1.61 ± 0.18	0.98	1.43	< 6.22
September	- 5314	< 0.9	0.8 ± 0.3	1.55 ± 0.18	0.84	0.95	< 6.43
October	- 6037	< 1.1	0.9 ± 0.4	1.56 ± 0.18	1.11	0.81	< 6.41
November	- 6608	< 0.7	0.7 ± 0.3	1.78 ± 0.15	0.81	0.86	< 5.60
December	- 7143	< 0.8	0.9 ± 0.4	1.64 ± 0.20	0.86	1.05	< 6.10

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Table 15. Milk, analyses for strontium-89, strontium-90, stable potassium, stable calcium, and ratios of strontium-90 per gram of calcium and cesium-137 per gram of potassium (continued).

						Ratios	
		Concentration					
Collection Period	Lab Code	Sr-89 (pCi/L)	Sr-90 (pCi/L)	K (g/L)	Ca (g/L)	Sr-90 per gram Ca	Cs-137 per gram K
Indicators							
K-34							
January	KMI - 23	< 0.8	1.0 ± 0.4	1.78 ± 0.21	0.78	1.28	< 5.60
February	- 463	< 0.9	0.9 ± 0.4	1.74 ± 0.15	0.84	1.07	< 5.73
March	- 889	< 0.6	0.7 ± 0.3	1.75 ± 0.15	0.89	0.79	< 5.71
April	- 1425	< 0.9	1.1 ± 0.4	1.60 ± 0.22	0.79	1.41	< 6.24
May	- 2580	< 0.8	1.4 ± 0.4	1.68 ± 0.17	0.74	1.89	< 5.95
June	- 3296	< 0.8	1.7 ± 0.4	1.68 ± 0.21	0.85	2.00	< 5.95
July	- 4132	< 0.7	1.4 ± 0.4	1.66 ± 0.21	0.90	1.56	< 6.04
August	- 4754	< 0.8	1.3 ± 0.5	1.69 ± 0.22	0.73	1.78	< 5.91
September	- 5316	< 1.1	0.8 ± 0.3	1.59 ± 0.20	0.75	1.07	< 6.30
October	- 6039	< 0.7	0.9 ± 0.3	1.45 ± 0.17	0.92	0.98	< 6.91
November	- 6610	< 0.7	< 0.6	1.48 ± 0.21	0.85	< 0.71	< 6.77
December	- 7145	< 0.7	< 0.6	1.66 ± 0.20	0.76		< 6.01

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Table 15. Milk, analyses for strontium-89, strontium-90, stable potassium, stable calcium, and ratios of strontium-90 per gram of calcium and cesium-137 per gram of potassium (continued).

						Ratios	
		Concentration				Sr-90 per gram Ca	Cs-137 per gram K
Collection Period	Lab Code	Sr-89 (pCi/L)	Sr-90 (pCi/L)	K (g/L)	Ca (g/L)		
Indicators							
			K-38				
January	KMI - 24, 5	< 1.1	1.8 ± 0.3	1.58 ± 0.13	0.82	2.20	< 6.31
February	- 464	< 0.8	0.8 ± 0.4	1.55 ± 0.14	0.86	0.93	< 6.46
March	- 890	< 0.7	1.3 ± 0.5	1.57 ± 0.19	0.90	1.44	< 6.35
April	- 1426	< 0.9	1.6 ± 0.4	1.52 ± 0.11	0.83	1.98	< 6.59
May	- 2581	< 0.8	1.9 ± 0.5	1.56 ± 0.14	0.79	2.41	< 6.40
June	- 3297, 8	< 0.9	2.2 ± 0.4	1.64 ± 0.22	0.81	2.72	< 6.11
July	- 4133	< 0.7	1.6 ± 0.4	1.59 ± 0.14	1.02	1.57	< 6.30
August	- 4755	< 0.8	2.0 ± 0.5	1.62 ± 0.20	0.78	2.56	< 6.17
September	- 5317	< 1.0	1.1 ± 0.4	1.45 ± 0.16	0.76	1.45	< 6.88
October	- 6040	< 0.7	1.0 ± 0.4	1.38 ± 0.15	0.84	1.19	< 7.25
November	- 6611	< 0.9	1.5 ± 0.4	1.51 ± 0.15	0.77	1.95	< 6.63
December	- 7146	< 0.7	1.1 ± 0.3	1.53 ± 0.20	0.86	1.28	< 6.52
			K-39				
January							
February							
March							
April							
May							
June							
July	KMI - 4134	< 0.8	0.7 ± 0.4	1.53 ± 0.20	1.01	0.69	< 6.54
August	- 4756, 7	< 0.7	1.6 ± 0.3	1.55 ± 0.18	0.89	1.80	< 6.46
September	- 5318	< 1.3	1.6 ± 0.5	1.67 ± 0.14	0.78	2.05	< 6.00
October	- 6041	< 0.7	1.2 ± 0.3	1.54 ± 0.17	0.97	1.24	< 6.51
November	- 6612	< 0.9	1.1 ± 0.4	1.64 ± 0.14	0.78	1.41	< 6.10
December	- 7147	< 0.8	< 0.6	1.56 ± 0.15	0.77		< 6.40

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Table 15. Milk, analyses for strontium-89, strontium-90, stable potassium, stable calcium, and ratios of strontium-90 per gram of calcium and cesium-137 per gram of potassium (continued).

						Ratios	
		Concentration				Sr-90 per gram Ca	Cs-137 per gram K
Collection Period	Lab Code	Sr-89 (pCi/L)	Sr-90 (pCi/L)	K (g/L)	Ca (g/L)		
Control							
			K-3				
January	KMI - 19	< 1.0	1.4 ± 0.4	1.57 ± 0.21	0.78	1.85	< 6.35
February	- 459	< 0.8	0.9 ± 0.4	1.80 ± 0.15	0.94	0.96	< 5.54
March	- 885	< 0.6	0.7 ± 0.4	1.78 ± 0.25	0.94	0.74	< 5.63
April	- 1420	< 0.8	2.0 ± 0.4	1.61 ± 0.13	0.90	2.26	< 6.21
May	- 2576	< 0.8	1.2 ± 0.4	1.68 ± 0.14	0.85	1.41	< 5.95
June	- 3292	< 0.8	1.3 ± 0.3[a]	1.48 ± 0.20	1.02	1.27	< 6.76
July	- 4128	< 0.8	2.2 ± 0.5	1.68 ± 0.18	0.86	2.56	< 5.97
August	- 4750	< 0.8	0.9 ± 0.4	1.61 ± 0.12	0.81	1.11	< 6.22
September	- 5312	< 1.0	1.2 ± 0.4	1.65 ± 0.22	0.83	1.45	< 6.05
October	- 6034, 5	< 0.7	0.9 ± 0.2	1.67 ± 0.20	0.93	0.97	< 6.00
November	- 6606	< 0.8	1.1 ± 0.4	1.50 ± 0.13	1.10	1.00	< 6.66
December	- 7141	< 0.8	0.9 ± 0.4	1.58 ± 0.19	0.81	1.11	< 6.33
			K-28				
January	KMI - 22	< 0.8	1.3 ± 0.4	1.71 ± 0.14	0.87	1.48	< 5.84
February	- 462	< 0.8	1.3 ± 0.4	1.68 ± 0.13	0.82	1.59	< 5.95
March	- 888	< 0.6	0.9 ± 0.4	1.64 ± 0.24	0.90	1.00	< 6.09
April	- 1424	< 0.7	1.8 ± 0.4	1.69 ± 0.20	0.83	2.19	< 5.90
May	- 2579	< 0.7	1.0 ± 0.4	1.61 ± 0.17	0.85	1.18	< 6.20
June	- 3295	< 0.8	1.2 ± 0.4	1.58 ± 0.18	0.93	1.29	< 6.34
July	- 4131	< 0.7	2.4 ± 0.5	1.70 ± 0.21	0.89	2.70	< 5.87
August	- 4753	< 0.7	1.1 ± 0.4	1.50 ± 0.15	0.82	1.34	< 6.68
September	- 5315	< 0.9	1.6 ± 0.4	1.56 ± 0.21	0.80	2.00	< 6.43
October	- 6038	< 0.8	0.7 ± 0.3	1.58 ± 0.21	0.87	0.80	< 6.35
November	- 6609	< 0.6	1.2 ± 0.4	1.41 ± 0.19	0.87	1.38	< 7.09
December	- 7144	< 0.7	1.0 ± 0.4	1.62 ± 0.21	0.84	1.19	< 6.19

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[a] Result of reanalysis.

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Table 16. Well water, analyses for gross alpha[a], gross beta, potassium-40, and gamma-emitting isotopes.
Collection: Quarterly.

Sample Description and Concentration (pCi/L)

Indicator

K-1g

Date Collected	01-02-03	04-01-03	07-01-03	10-01-03
Lab Code	KWW-13	KWW-1431	KWW-3584	KWW-5690
Gross alpha	3.8 ± 2.2	1.8 ± 1.2	2.4 ± 1.4	< 1.0
Gross beta	4.3 ± 2.8	3.6 ± 1.3	3.7 ± 1.2	1.9 ± 1.3
K-40 (ICP)	2.08	2.60	3.20	2.25
Mn-54	< 15	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30	< 30
Co-58	< 15	< 15	< 15	< 15
Co-60	< 15	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15

K-1h

Date Collected	01-02-03	04-01-03	07-01-03	10-01-03
Lab Code	KWW-14	KWW-1432	KWW-3585	KWW-5691
Gross alpha	2.5 ± 1.3	< 1.9	1.6 ± 0.9	2.6 ± 1.6
Gross beta	4.3 ± 1.4	4.5 ± 1.3	1.8 ± 1.1	4.6 ± 1.4
K-40 (ICP)	2.34	2.68	2.68	2.34
Mn-54	< 15	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30	< 30
Co-58	< 15	< 15	< 15	< 15
Co-60	< 15	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15

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[a] Gross Alpha analyses required on samples from K-1g and K-1h only.

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Table 16. Well water, analyses for gross alpha, gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)				
Indicator				
K-10				
Date Collected	01-02-03	04-01-03	07-01-03	10-01-03
Lab Code	KWW-15	KWW-1433	KWW-3586	KWW-5692
Gross beta	3.8 ± 2.2	< 2.1	< 1.7	< 1.9
K-40 (ICP)	1.04	0.87	< 0.87	< 0.87
Mn-54	< 15	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30	< 30
Co-58	< 15	< 15	< 15	< 15
Co-60	< 15	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15
K-11				
Date Collected	01-02-03	04-01-03	07-01-03	10-01-03
Lab Code	KWW-16	KWW-1434	KWW-3587	KWW-5693
Gross beta	1.2 ± 0.6	< 0.9	0.6 ± 0.3	< 0.8
K-40 (ICP)	< 0.87	0.95	< 0.87	< 0.87
Mn-54	< 15	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30	< 30
Co-58	< 15	< 15	< 15	< 15
Co-60	< 15	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15

Table 16. Well water, analyses for gross alpha, gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)				
Indicator				
K-25				
Date Collected	01-02-03	04-01-03	07-01-03	10-01-03
Lab Code	KWW-18	KWW-1436	KWW-3589	KWW-5695
Gross beta	1.5 ± 0.5	1.5 ± 0.5	1.0 ± 0.2	1.6 ± 0.5
K-40 (ICP)	0.95	1.12	0.87	1.04
Mn-54	< 15	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30	< 30
Co-58	< 15	< 15	< 15	< 15
Co-60	< 15	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15
Control				
K-13				
Date Collected	01-02-03	04-01-03	07-01-03	10-01-03
Lab Code	KWW-17	KWW-1435	KWW-3588	KWW-5694
Gross beta	1.1 ± 0.5	1.4 ± 0.5	1.4 ± 0.2	1.4 ± 0.5
K-40 (ICP)	0.95	1.04	1.04	0.87
Mn-54	< 15	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30	< 30
Co-58	< 15	< 15	< 15	< 15
Co-60	< 15	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15	< 15

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Table 17. Well waters from K-1g , analyses for tritium, strontium-89, and strontium-90.
Collection: Quarterly.

Date Collected	Lab Code	Concentration (pCi/L)		
		H-3	Sr-89	Sr-90
01-02-03	KWW - 13	< 131	< 1.1	< 0.6
04-01-03	- 1431	< 157	< 0.5	< 0.5
07-01-03	- 3584	< 158	< 0.5	< 0.5
10-01-03	- 5690	< 166	< 0,8	< 0.5

Table 18. Domestic meat samples (chickens), analyses of flesh for gross alpha, gross beta, and gamma-emitting isotopes. Annual collection.

Sample Description and Concentration (pCi/g wet)

	Indicator			Control
Location	K-24	K-29	K-34	K-32
Date Collected	09-02-03	09-02-03		09-02-03
Lab Code	KME-4966	KME-4967		KME-4968, 9
Gross Alpha	< 0.10	< 0.10		< 0.14
Gross Beta	2.90 ± 0.17	3.38 ± 0.18		5.04 ± 0.17
Be-7	< 0.14	< 0.24		< 0.15
K-40	2.46 ± 0.44	3.08 ± 0.45		2.57 ± 0.28
Nb-95	< 0.028	< 0.030		< 0.013
Zr-95	< 0.052	< 0.041		< 0.031
Ru-103	< 0.026	< 0.019		< 0.019
Ru-106	< 0.12	< 0.093		< 0.13
Cs-134	< 0.012	< 0.011		< 0.011
Cs-137	< 0.018	< 0.009		< 0.013
Ce-141	< 0.041	< 0.055		< 0.032
Ce-144	< 0.11	< 0.10		< 0.069

Table 19. Eggs, analyses for gross beta, strontium-89, strontium-90 and gamma emitting isotopes.
Collection: Quarterly

Sample Description and Concentration (pCi/g wet)

Location	K-24			
Date Collected	01-02-03	04-01-03	07-01-03	10-01-03
Lab Code	KE-26	KE-1427	KE-3575	KE-5620
Gross beta	1.36 ± 0.09	1.48 ± 0.12	0.69 ± 0.04	1.36 ± 0.04
Sr-89	< 0.008	< 0.014	< 0.005	< 0.007
Sr-90	0.003 ± 0.002	0.010 ± 0.004	< 0.003	< 0.002
Be-7	< 0.080	< 0.055	< 0.061	< 0.057
K-40	1.15 ± 0.20	1.41 ± 0.21	1.24 ± 0.22	1.24 ± 0.18
Nb-95	< 0.010	< 0.008	< 0.004	< 0.013
Zr-95	< 0.012	< 0.015	< 0.010	< 0.017
Ru-103	< 0.006	< 0.005	< 0.005	< 0.012
Ru-106	< 0.055	< 0.073	< 0.053	< 0.057
Cs-134	< 0.009	< 0.009	< 0.007	< 0.005
Cs-137	< 0.004	< 0.008	< 0.005	< 0.007
Ce-141	< 0.014	< 0.012	< 0.014	< 0.013
Ce-144	< 0.030	< 0.054	< 0.046	< 0.029

Location	K-32			
Date Collected	01-02-03	04-01-03	07-01-03	10-01-03
Lab Code	KE-27	KE-1428	KE-3576	KE-5621
Gross beta	1.34 ± 0.08	1.31 ± 0.10	1.45 ± 0.06	1.31 ± 0.04
Sr-89	< 0.014	< 0.015	< 0.009	< 0.010
Sr-90	< 0.005	0.008 ± 0.004	< 0.007	< 0.003
Be-7	< 0.11	< 0.027	< 0.074	< 0.055
K-40	1.58 ± 0.29	1.19 ± 0.16	1.08 ± 0.24	1.45 ± 0.16
Nb-95	< 0.013	< 0.003	< 0.006	< 0.007
Zr-95	< 0.012	< 0.009	< 0.014	< 0.012
Ru-103	< 0.009	< 0.004	< 0.010	< 0.008
Ru-106	< 0.12	< 0.038	< 0.10	< 0.046
Cs-134	< 0.011	< 0.004	< 0.007	< 0.007
Cs-137	< 0.004	< 0.005	< 0.010	< 0.005
Ce-141	< 0.017	< 0.008	< 0.008	< 0.023
Ce-144	< 0.058	< 0.036	< 0.043	< 0.041

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Table 20. Vegetable and grain samples, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes. Annual collection.

Sample Description and Concentration (pCi/g wet)

	Indicator		
Location	K-17	K-23	K-29
Date Collected			09-03-03
Lab Code		Make separate PAGE FOR CALCULATION	KVE-5005
Type			Pumpkin
Gross beta			2.50 ± 0.05
Sr-89			< 0.009
Sr-90			< 0.002
Be-7			< 0.11
K-40			2.34 ± 0.29
Nb-95			< 0.011
Zr-95			< 0.016
Ru-103			< 0.011
Ru-106			< 0.075
Cs-134			< 0.009
Cs-137			< 0.008
Ce-141			< 0.024
Ce-144			< 0.058

Location	K-26 (control)			
Date Collected	09-03-03	09-03-03	09-03-03	09-03-03
Lab Code	KVE-4999	KVE-5000	KVE-5001	KVE-5002
Type	Corn	Cucumber	Cabbage	Cauliflower
Gross beta	2.69 ± 0.05	1.08 ± 0.02	1.71 ± 0.04	2.62 ± 0.05
Sr-89	< 0.004	< 0.002	< 0.003	< 0.007
Sr-90	< 0.002	< 0.001	0.001 ± 0.001	< 0.002
Be-7	< 0.12	< 0.046	< 0.040	< 0.075
K-40	2.43 ± 0.43	0.72 ± 0.14	1.45 ± 0.18	2.37 ± 0.27
Nb-95	< 0.009	< 0.002	< 0.008	< 0.008
Zr-95	< 0.018	< 0.005	< 0.008	< 0.021
Ru-103	< 0.012	< 0.005	< 0.007	< 0.011
Ru-106	< 0.079	< 0.037	< 0.045	< 0.077
Cs-134	< 0.012	< 0.005	< 0.006	< 0.011
Cs-137	< 0.012	< 0.007	< 0.006	< 0.006
Ce-141	< 0.023	< 0.007	< 0.009	< 0.021
Ce-144	< 0.058	< 0.039	< 0.063	< 0.081

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Table 20. Vegetable and grain samples, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/g wet)			
Location	K-26 (control)		
Date Collected	09-03-03	09-03-03	10-02-03
Lab Code	KVE-5003	KVE-5004	KVE-5643
Type	Red Cabbage	Tomato	Pumpkin
Gross beta	2.82 ± 0.05	2.33 ± 0.05	1.04 ± 0.02
Sr-89	< 0.003	< 0.004	< 0.003
Sr-90	< 0.001	< 0.002	< 0.001
Be-7	< 0.060	< 0.058	< 0.12
K-40	2.15 ± 0.32	2.24 ± 0.32	1.37 ± 0.26
Nb-95	< 0.008	< 0.004	< 0.011
Zr-95	< 0.018	< 0.021	< 0.025
Ru-103	< 0.010	< 0.008	< 0.015
Ru-106	< 0.093	< 0.11	< 0.056
Cs-134	< 0.011	< 0.007	< 0.008
Cs-137	< 0.015	< 0.011	< 0.007
Ce-141	< 0.023	< 0.012	< 0.024
Ce-144	< 0.079	< 0.041	< 0.084

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Table 20. Vegetable and grain samples, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes. Annual collection.

Sample Description and Concentration (pCi/g wet)

	Indicator		
Location	K-17	K-23	K-29
Date Collected		08-04-03	08-04-03
Lab Code		KVE-4416	KVE-4417
Type		Clover	Wheat
Gross beta		4.78 ± 0.11	4.19 ± 0.11
Sr-89		< 0.023	< 0.027
Sr-90		0.008 ± 0.004	< 0.008
Be-7		1.74 ± 0.41	0.80 ± 0.28
K-40		4.50 ± 0.63	4.31 ± 0.47
Nb-95		< 0.037	< 0.038
Zr-95		< 0.080	< 0.052
Ru-103		< 0.025	< 0.027
Ru-106		< 0.18	< 0.12
Cs-134		< 0.023	< 0.020
Cs-137		< 0.022	< 0.021
Ce-141		< 0.039	< 0.053
Ce-144		< 0.12	< 0.13

Location	K-26 (control)
Date Collected	
Lab Code	
Type	
Gross beta	
Sr-89	
Sr-90	
Be-7	
K-40	
Nb-95	
Zr-95	
Ru-103	
Ru-106	
Cs-134	
Cs-137	
Ce-141	
Ce-144	

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Table 20. Vegetable and grain samples, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/g wet)	
Location	K-26 (control)
Date Collected	
Lab Code	
Type	
Gross beta	
Sr-89	
Sr-90	
Be-7	
K-40	
Nb-95	
Zr-95	
Ru-103	
Ru-106	
Cs-134	
Cs-137	
Ce-141	
Ce-144	

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Table 21. Cattlefeed, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes.
Collection: First Quarter.

Sample Description and Concentration (pCi/g wet)	Control	
Location	K-3	K-3
Date Collected	01-02-03	01-02-03
Lab Code	KCF-40	KCF-45
Type	Hay	Silage
Gross beta	10.44 ± 0.33	3.27 ± 0.11
Sr-89	< 0.033	< 0.004
Sr-90	< 0.018	0.004 ± 0.001
Be-7	< 0.20	< 0.16
K-40	10.68 ± 0.79	2.94 ± 0.38
Nb-95	< 0.013	< 0.019
Zr-95	< 0.028	< 0.018
Ru-103	< 0.020	< 0.018
Ru-106	< 0.16	< 0.062
Cs-134	< 0.030	< 0.013
Cs-137	< 0.014	< 0.016
Ce-141	< 0.044	< 0.027
Ce-144	< 0.13	< 0.11

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Table 21. Cattlefeed, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes (continued).

	Sample Description and Concentration (pCi/g wet)			
	Indicator			
Location	K-5	K-5	K-25	K-25
Date Collected	01-02-03	01-02-03	01-02-03	01-02-03
Lab Code	KCF-41	KCF-46	KCF-42	KCF-47, 8
Type	Hay	Silage	Hay	Silage
Gross beta	18.71 ± 0.55	15.02 ± 0.46	15.85 ± 0.55	2.78 ± 0.07
Sr-89	< 0.055	< 0.031	< 0.029	< 0.013
Sr-90	< 0.024	0.024 ± 0.011	0.026 ± 0.009	< 0.006
Be-7	< 0.41	< 0.19	0.75 ± 0.43	< 0.20
K-40	17.86 ± 1.36	12.67 ± 0.65	16.70 ± 1.16	2.47 ± 0.17
Nb-95	< 0.043	< 0.019	< 0.049	< 0.008
Zr-95	< 0.058	< 0.022	< 0.094	< 0.020
Ru-103	< 0.026	< 0.011	< 0.046	< 0.009
Ru-106	< 0.37	< 0.090	< 0.23	< 0.062
Cs-134	< 0.045	< 0.010	< 0.042	< 0.008
Cs-137	< 0.038	< 0.015	< 0.039	< 0.010
Ce-141	< 0.090	< 0.025	< 0.073	< 0.012
Ce-144	< 0.29	< 0.11	< 0.23	< 0.040
Location	K-34	K-34	K-38	K-38
Date Collected	01-02-03	01-02-03	01-02-03	01-02-03
Lab Code	KCF-43	KCF-49	KCF-44	KCF-50
Type	Hay	Silage	Hay	Silage
Gross beta	13.02 ± 0.49	6.96 ± 0.22	26.38 ± 0.80	9.40 ± 0.31
Sr-89	< 0.033	< 0.017	< 0.024	< 0.013
Sr-90	< 0.017	0.013 ± 0.006	0.026 ± 0.009	0.013 ± 0.005
Be-7	1.59 ± 0.41	< 0.16	< 0.48	< 0.20
K-40	10.88 ± 1.11	6.40 ± 0.53	27.47 ± 1.65	10.51 ± 0.66
Nb-95	< 0.044	< 0.014	< 0.060	< 0.022
Zr-95	< 0.088	< 0.022	< 0.075	< 0.034
Ru-103	< 0.028	< 0.014	< 0.029	< 0.017
Ru-106	< 0.19	< 0.090	< 0.36	< 0.12
Cs-134	< 0.044	< 0.018	< 0.049	< 0.013
Cs-137	< 0.038	< 0.012	< 0.044	< 0.023
Ce-141	< 0.078	< 0.014	< 0.088	< 0.035
Ce-144	< 0.21	< 0.064	< 0.29	< 0.11

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Table 22. Grass, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes.
Collection: Quarterly, April through December
Units: pCi/g wet

Sample Description and Concentration

	Indicator			
Location	K-1b	K-1f	K-5	K-25
Date Collected	06-02-03	06-02-03	05-01-03	05-01-03
Lab Code	KG-2902	KG-2903	KG-2174	KG-2175
Gross beta	6.57 ± 0.13	5.51 ± 0.11	8.37 ± 0.22	6.95 ± 0.18
Sr-89	< 0.007	< 0.008	< 0.005	< 0.005
Sr-90	0.005 ± 0.003	< 0.005	0.007 ± 0.002	< 0.002
Be-7	0.45 ± 0.22	2.67 ± 0.48	1.18 ± 0.39	0.28 ± 0.15
K-40	8.07 ± 0.77	6.22 ± 0.90	8.52 ± 0.86	5.55 ± 0.51
Mn-54	< 0.022	< 0.024	< 0.036	< 0.015
Co-58	< 0.021	< 0.014	< 0.019	< 0.011
Co-60	< 0.024	< 0.017	< 0.024	< 0.012
Nb-95	< 0.026	< 0.019	< 0.014	< 0.015
Zr-95	< 0.038	< 0.057	< 0.045	< 0.022
Ru-103	< 0.029	< 0.027	< 0.036	< 0.011
Ru-106	< 0.12	< 0.23	< 0.28	< 0.13
Cs-134	< 0.026	< 0.021	< 0.029	< 0.014
Cs-137	< 0.021	< 0.028	< 0.021	< 0.010
Ce-141	< 0.040	< 0.044	< 0.072	< 0.017
Ce-144	< 0.17	< 0.13	< 0.27	< 0.075

	Indicator		Control
Location	K-34	K-38	K-3
Date Collected	06-02-03	06-02-03	05-01-03
Lab Code	KG-2904	KG-2905	KG-2173
Gross beta	6.02 ± 0.11	5.95 ± 0.11	7.64 ± 0.21
Sr-89	< 0.005	< 0.005	< 0.006
Sr-90	0.004 ± 0.002	0.007 ± 0.002	< 0.004
Be-7	< 0.30	< 0.29	0.94 ± 0.28
K-40	6.48 ± 0.79	5.79 ± 0.74	6.28 ± 0.74
Mn-54	< 0.024	< 0.026	< 0.015
Co-58	< 0.016	< 0.021	< 0.011
Co-60	< 0.030	< 0.022	< 0.021
Nb-95	< 0.026	< 0.021	< 0.032
Zr-95	< 0.034	< 0.063	< 0.034
Ru-103	< 0.014	< 0.027	< 0.019
Ru-106	< 0.27	< 0.17	< 0.14
Cs-134	< 0.032	< 0.036	< 0.020
Cs-137	< 0.027	< 0.018	< 0.028
Ce-141	< 0.033	< 0.042	< 0.032
Ce-144	< 0.15	< 0.14	< 0.11

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Table 22. Grass samples, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes (continued).

Sample Description and Concentration

	Indicator			
Location	K-1b	K-1f	K-5	K-25
Date Collected	08-04-03	09-02-03	07-01-03	07-01-03
Lab Code	KG-4414	KG-5006	KG-3571	KG-3572, 3
Gross beta	4.28 ± 0.11	8.73 ± 0.22	7.49 ± 0.16	6.35 ± 0.11
Sr-89	< 0.020	< 0.028	< 0.007	< 0.005
Sr-90	< 0.004	0.007 ± 0.004	0.025 ± 0.004	0.015 ± 0.003
Be-7	1.60 ± 0.46	2.24 ± 0.43	0.56 ± 0.24	0.86 ± 0.18
K-40	5.09 ± 0.76	7.93 ± 0.88	6.86 ± 0.57	5.56 ± 0.31
Mn-54	< 0.019	< 0.035	< 0.020	< 0.012
Co-58	< 0.033	< 0.020	< 0.015	< 0.015
Co-60	< 0.021	< 0.023	< 0.013	< 0.015
Nb-95	< 0.042	< 0.035	< 0.022	< 0.008
Zr-95	< 0.074	< 0.053	< 0.019	< 0.045
Ru-103	< 0.044	< 0.023	< 0.029	< 0.018
Ru-106	< 0.21	< 0.32	< 0.16	< 0.16
Cs-134	< 0.033	< 0.028	< 0.028	< 0.018
Cs-137	< 0.017	< 0.026	< 0.018	< 0.018
Ce-141	< 0.11	< 0.044	< 0.049	< 0.036
Ce-144	< 0.19	< 0.19	< 0.18	< 0.095

	Indicator			Control
Location	K-34	K-38	K-39	K-3
Date Collected	08-04-03	09-15-03	07-01-03	07-01-03
Lab Code	KG-4419, 20	KG-5280	KG-3574	KG-3570
Gross beta	5.37 ± 0.11	5.82 ± 0.16	8.66 ± 0.19	11.23 ± 0.22
Sr-89	< 0.015	< 0.014	< 0.017	< 0.023
Sr-90	< 0.008	< 0.006	0.030 ± 0.012	0.084 ± 0.015
Be-7	3.96 ± 0.42	4.10 ± 0.33	0.63 ± 0.33	1.10 ± 0.50
K-40	4.37 ± 0.50	4.48 ± 0.45	7.29 ± 0.81	12.46 ± 1.57
Mn-54	< 0.022	< 0.014	< 0.019	< 0.037
Co-58	< 0.022	< 0.020	< 0.038	< 0.035
Co-60	< 0.017	< 0.006	< 0.026	< 0.044
Nb-95	< 0.039	< 0.016	< 0.021	< 0.026
Zr-95	< 0.046	< 0.030	< 0.061	< 0.083
Ru-103	< 0.033	< 0.018	< 0.033	< 0.034
Ru-106	< 0.24	< 0.10	< 0.32	< 0.46
Cs-134	< 0.028	< 0.017	< 0.025	< 0.040
Cs-137	< 0.026	< 0.011	< 0.023	< 0.035
Ce-141	< 0.085	< 0.023	< 0.064	< 0.078
Ce-144	< 0.16	< 0.11	< 0.24	< 0.31

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Table 22. Grass samples, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/g wet)

	Indicator			
Location	K-1b	K-1f	K-5	K-25
Date Collected	10-01-03	10-01-03	10-01-03	10-01-03
Lab Code	KG-5631, 2	KG-5633	KG-5635	KG-5636
Gross beta	5.86 ± 0.06	6.45 ± 0.09	8.80 ± 0.11	7.83 ± 0.09
Sr-89	< 0.017	< 0.014	< 0.011	< 0.017
Sr-90	< 0.008	< 0.010	0.007 ± 0.003	0.013 ± 0.005
Be-7	2.05 ± 0.31	2.89 ± 0.43	3.44 ± 0.56	2.39 ± 0.23
K-40	5.25 ± 0.48	5.26 ± 0.60	7.25 ± 0.98	5.54 ± 0.36
Mn-54	< 0.013	< 0.020	< 0.035	< 0.013
Co-58	< 0.023	< 0.023	< 0.029	< 0.013
Co-60	< 0.009	< 0.022	< 0.021	< 0.014
Nb-95	< 0.026	< 0.026	< 0.027	< 0.011
Zr-95	< 0.022	< 0.063	< 0.079	< 0.032
Ru-103	< 0.022	< 0.024	< 0.036	< 0.011
Ru-106	< 0.14	< 0.14	< 0.20	< 0.11
Cs-134	< 0.023	< 0.015	< 0.032	< 0.012
Cs-137	< 0.022	< 0.020	< 0.032	< 0.013
Ce-141	< 0.050	< 0.050	< 0.061	< 0.025
Ce-144	< 0.14	< 0.13	< 0.17	< 0.061

	Indicator			Control
Location	K-34	K-38	K-39	K-3
Date Collected	10-01-03	10-01-03	10-01-03	10-01-03
Lab Code	KG-5637	KG-5638	KG-5639	KG-5634
Gross beta	9.34 ± 0.14	6.83 ± 0.24	8.10 ± 0.29	9.04 ± 0.10
Sr-89	< 0.029	< 0.009	< 0.017	< 0.011
Sr-90	0.019 ± 0.009	0.009 ± 0.003	0.011 ± 0.005	< 0.006
Be-7	2.34 ± 0.57	3.23 ± 0.39	3.36 ± 0.51	1.88 ± 0.34
K-40	8.36 ± 0.95	6.44 ± 0.62	7.74 ± 0.88	9.21 ± 0.67
Mn-54	< 0.024	< 0.024	< 0.031	< 0.014
Co-58	< 0.024	< 0.015	< 0.027	< 0.022
Co-60	< 0.029	< 0.030	< 0.034	< 0.025
Nb-95	< 0.033	< 0.022	< 0.050	< 0.028
Zr-95	< 0.047	< 0.055	< 0.053	< 0.061
Ru-103	< 0.037	< 0.034	< 0.041	< 0.028
Ru-106	< 0.19	< 0.21	< 0.27	< 0.21
Cs-134	< 0.016	< 0.024	< 0.026	< 0.026
Cs-137	< 0.038	< 0.023	< 0.037	< 0.023
Ce-141	< 0.050	< 0.038	< 0.045	< 0.070
Ce-144	< 0.18	< 0.10	< 0.24	< 0.14

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Table 23. Soil samples, analyses for gross alpha, gross beta, strontium-89, strontium-90, and gamma-emitting isotopes.

Collection: Semiannually

Sample Description and Concentration (pCi/g dry)

	Indicator		
Location	K-1f	K-5	K-25
Date Collected	05-01-03	05-01-03	05-01-03
Lab Code	KSO-2379	KSO-2383	KSO-2381, 2
Gross alpha	6.40 ± 4.35	12.40 ± 5.66	10.77 ± 3.80
Gross beta	28.73 ± 4.64	30.88 ± 4.91	37.42 ± 3.52
Sr-89	< 0.11	< 0.098	< 0.049
Sr-90	< 0.042	0.035 ± 0.015	0.079 ± 0.014
Be-7	< 0.17	< 0.17	< 0.18
K-40	17.66 ± 0.81	19.52 ± 0.77	18.06 ± 0.59
Nb-95	< 0.015	< 0.014	< 0.014
Zr-95	< 0.035	< 0.033	< 0.030
Ru-103	< 0.020	< 0.013	< 0.023
Ru-106	< 0.15	< 0.14	< 0.15
Cs-134	< 0.021	< 0.021	< 0.013
Cs-137	< 0.009	< 0.036	0.10 ± 0.019
Ce-141	< 0.040	< 0.032	< 0.034
Ce-144	< 0.096	< 0.13	< 0.079

Location	K-1f	K-5	K-25
Date Collected	10-01-03	10-01-03	10-01-03
Lab Code	KSO-5656	KSO-5658	KSO-5659
Gross alpha	8.03 ± 3.18	15.77 ± 4.16	6.40 ± 4.35
Gross beta	26.21 ± 3.10	37.44 ± 3.38	28.73 ± 4.64
Sr-89	< 0.043	< 0.042	< 0.062
Sr-90	< 0.014	0.025 ± 0.009	0.032 ± 0.012
Be-7	< 0.53	< 0.52	< 0.31
K-40	16.57 ± 1.04	20.49 ± 1.25	19.44 ± 0.83
Nb-95	< 0.065	< 0.12	< 0.058
Zr-95	< 0.12	< 0.093	< 0.058
Ru-103	< 0.041	< 0.074	< 0.029
Ru-106	< 0.25	< 0.30	< 0.11
Cs-134	< 0.044	< 0.049	< 0.039
Cs-137	< 0.033	0.096 ± 0.033	0.13 ± 0.025
Ce-141	< 0.10	< 0.15	< 0.14
Ce-144	< 0.18	< 0.21	< 0.16

Table 23. Soil samples, analyses for gross alpha, gross beta, strontium-89, strontium-90, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/g dry)

	Indicator		
Location	K-34	K-38	
Date Collected	05-01-03	05-01-03	
Lab Code	KSO-2385	KSO-2384	
Gross alpha	14.04 ± 6.31	11.38 ± 5.57	
Gross beta	37.62 ± 5.20	34.27 ± 4.70	
Sr-89	< 0.049	< 0.079	
Sr-90	0.075 ± 0.017	0.048 ± 0.023	
Be-7	0.29 ± 0.13	< 0.20	
K-40	20.51 ± 0.85	23.25 ± 0.94	
Nb-95	< 0.020	< 0.021	
Zr-95	< 0.018	< 0.031	
Ru-103	< 0.019	< 0.009	
Ru-106	< 0.17	< 0.11	
Cs-134	< 0.013	< 0.031	
Cs-137	0.16 ± 0.028	0.15 ± 0.030	
Ce-141	< 0.040	< 0.048	
Ce-144	< 0.12	< 0.15	

Location	K-34	K-38	K-39[a]
Date Collected	10-01-03	10-01-03	10-01-03
Lab Code	KSO-5660, 1	KSO-5662	KSO-5663
Gross alpha	13.79 ± 2.69	12.24 ± 3.69	11.74 ± 3.75
Gross beta	33.01 ± 2.17	30.49 ± 2.92	27.81 ± 3.20
Sr-89	< 0.037	< 0.049	< 0.058
Sr-90	0.033 ± 0.007	0.036 ± 0.011	0.032 ± 0.012
Be-7	< 0.32	< 0.64	< 0.30
K-40	18.59 ± 0.74	20.73 ± 1.21	17.61 ± 1.06
Nb-95	< 0.069	< 0.062	< 0.082
Zr-95	< 0.079	< 0.071	< 0.093
Ru-103	< 0.064	< 0.056	< 0.052
Ru-106	< 0.17	< 0.28	< 0.20
Cs-134	< 0.030	< 0.048	< 0.041
Cs-137	0.16 ± 0.031	0.15 ± 0.036	0.089 ± 0.028
Ce-141	< 0.13	< 0.14	< 0.12
Ce-144	< 0.16	< 0.16	< 0.15

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[a] K-39, Wojta Farm, added to program July 1, 2003.

Table 23. Soil samples, analyses for gross alpha, gross beta, strontium-89, strontium-90, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/g dry)

	Control	
Location	K-3	K-3
Date Collected	05-01-03	10-01-03
Lab Code	KSO-2380	KSO-5657
Gross alpha	8.75 ± 4.64	7.05 ± 2.88
Gross beta	26.62 ± 4.20	28.68 ± 3.05
Sr-89	< 0.045	< 0.042
Sr-90	0.038 ± 0.012	0.035 ± 0.011
Be-7	< 0.16	< 0.41
K-40	19.41 ± 0.77	17.80 ± 0.88
Nb-95	< 0.015	< 0.068
Zr-95	< 0.023	< 0.038
Ru-103	< 0.019	< 0.034
Ru-106	< 0.15	< 0.11
Cs-134	< 0.015	< 0.028
Cs-137	0.13 ± 0.026	0.12 ± 0.035
Ce-141	< 0.040	< 0.13
Ce-144	< 0.10	< 0.12

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Table 24. Surface water samples, analyses for gross beta, potassium-40 and gamma-emitting isotopes.
Collection: Monthly

	Sample Description and Concentration (pCi/L)		
Indicator			
K-1a			
Date Collected	01-02-03	02-03-03	03-03-03
Lab Code	KSW-5	KSW-470, 1	KSW-891
Gross beta			
Suspended Solids	< 0.9	1.0 ± 0.2	< 1.2
Dissolved Solids	11.3 ± 1.1	14.4 ± 0.9	34.2 ± 2.6
Total Residue	11.3 ± 1.1	15.4 ± 0.9	34.2 ± 2.6
K-40 (ICP)	10.29	4.45	37.20
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-1b			
Date Collected	01-02-03	02-03-03	03-03-03
Lab Code	KSW-6	KSW-472	KSW-892
Gross beta			
Suspended Solids	< 0.4	< 1.3	< 0.3
Dissolved Solids	2.8 ± 0.6	11.8 ± 1.1	3.2 ± 0.6
Total Residue	2.8 ± 0.6	11.8 ± 1.1	3.2 ± 0.6
K-40 (ICP)	1.64	9.17	1.21
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

[a] Sample counted longer to lower MDA.

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Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

	Sample Description and Concentration (pCi/L)		
Indicator			
K-1a			
Date Collected	04-01-03	05-01-03	06-02-03
Lab Code	KSW-1411	KSW-2236	KSW-2879
Gross beta			
Suspended Solids	< 0.7	< 0.3	< 0.4
Dissolved Solids	14.1 ± 1.2	9.8 ± 1.2	8.0 ± 1.1
Total Residue	14.1 ± 1.2	9.8 ± 1.2	8.0 ± 1.1
K-40 (ICP)	12.11	8.13	6.92
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-1b			
Date Collected	04-01-03	05-01-03	06-02-03
Lab Code	KSW-1412	KSW-2237	KSW-2880
Gross beta			
Suspended Solids	0.6 ± 0.3	< 0.3	< 0.3
Dissolved Solids	6.4 ± 0.7	4.1 ± 0.7	4.9 ± 0.8
Total Residue	7.0 ± 0.8	4.1 ± 0.7	4.9 ± 0.8
K-40 (ICP)	4.93	2.60	2.25
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)			
Indicator			
K-1a			
Date Collected	07-01-03	08-04-03	09-02-03
Lab Code	KSW-3561	KSW-4405	KSW-4971
Gross beta			
Suspended Solids	< 0.4	0.4 ± 0.2	< 0.4
Dissolved Solids	6.7 ± 0.8	16.2 ± 1.2	12.8 ± 1.1
Total Residue	6.7 ± 0.8	16.6 ± 1.2	12.8 ± 1.1
K-40 (ICP)	6.23	14.01	11.85
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-1b			
Date Collected	07-01-03	08-04-03	09-02-03
Lab Code	KSW-3562	KSW-4406	KSW-4972
Gross beta			
Suspended Solids	0.4 ± 0.2	< 0.3	< 0.3
Dissolved Solids	3.8 ± 0.6	6.2 ± 0.7	3.7 ± 0.6
Total Residue	4.2 ± 0.7	6.2 ± 0.7	3.7 ± 0.6
K-40 (ICP)	2.08	4.67	2.34
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

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Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)

Indicator

K-1a

Date Collected	10-01-03	11-03-03	12-01-03
Lab Code	KSW-5601	KSW-6590	KSW-7131
Gross beta			
Suspended Solids	< 0.4	< 0.4	< 0.4
Dissolved Solids	10.9 ± 1.2	11.7 ± 1.3	13.5 ± 1.2
Total Residue	10.9 ± 1.2	11.7 ± 1.3	13.5 ± 1.2
K-40 (ICP)	9.08	9.52	11.25
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

K-1b

Date Collected	10-01-03	11-03-03	12-01-03
Lab Code	KSW-5602	KSW-6591	KSW-7132
Gross beta			
Suspended Solids	< 0.3	< 0.4	< 0.3
Dissolved Solids	3.4 ± 0.7	5.5 ± 0.8	5.9 ± 0.7
Total Residue	3.4 ± 0.7	5.5 ± 0.8	5.9 ± 0.7
K-40 (ICP)	1.99	3.55	3.46
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 24. Surface water samples, analyses for gross beta, potassium-40 and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)			
Indicator			
K-1d			
Date Collected	01-02-03	02-03-03	03-03-03
Lab Code	KSW-7	KSW-473	KSW-893
Gross beta			
Suspended Solids	< 0.3	< 0.4	< 0.3
Dissolved Solids	3.3 ± 0.5	2.2 ± 0.5	2.0 ± 0.4
Total Residue	3.3 ± 0.5	2.2 ± 0.5	2.0 ± 0.4
K-40 (ICP)	1.38	1.12	1.12
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-1e			
Date Collected	01-02-03	02-03-03	03-03-03
Lab Code	KSW-8	KSW-474	KSW-894
Gross beta			
Suspended Solids	< 1.8	< 1.3	< 1.6
Dissolved Solids	4.1 ± 1.1	12.5 ± 3.9	16.5 ± 2.5
Total Residue	4.1 ± 1.1	12.5 ± 3.9	16.5 ± 2.5
K-40 (ICP)	5.71	13.84	17.30
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

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Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)

Indicator

K-1d

Date Collected	04-01-03	05-01-03	06-02-03
Lab Code	KSW-1413	KSW-2238	KSW-2881
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.3
Dissolved Solids	2.5 ± 0.4	2.5 ± 0.4	1.7 ± 0.4
Total Residue	2.5 ± 0.4	2.5 ± 0.4	1.7 ± 0.4
K-40 (ICP)	1.38	1.47	1.38
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

K-1e

Date Collected	04-01-03	05-01-03	06-02-03
Lab Code	KSW-1414	KSW-2239	KSW-2882
Gross beta			
Suspended Solids	< 0.5	< 0.3	< 0.4
Dissolved Solids	6.1 ± 1.1	4.1 ± 0.7	9.9 ± 1.6
Total Residue	6.1 ± 1.1	4.1 ± 0.7	9.9 ± 1.6
K-40 (ICP)	5.10	3.46	4.58
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

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Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)

Indicator

K-1d

Date Collected	07-01-03	08-04-03	09-02-03
Lab Code	KSW-3563	KSW-4407	KSW-4973
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.4
Dissolved Solids	2.3 ± 0.4	2.3 ± 0.4	2.5 ± 0.4
Total Residue	2.3 ± 0.4	2.3 ± 0.4	2.5 ± 0.4
K-40 (ICP)	1.21	1.38	1.47
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

K-1e

Date Collected	07-01-03	08-04-03	09-02-03
Lab Code	KSW-3564	KSW-4408	KSW-4974
Gross beta			
Suspended Solids	< 0.4	< 0.3	< 0.3
Dissolved Solids	7.0 ± 1.3	4.7 ± 1.2	11.0 ± 1.5
Total Residue	7.0 ± 1.3	4.7 ± 1.2	11.0 ± 1.5
K-40 (ICP)	7.35	2.34	10.47
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)

Indicator

K-1d

Date Collected	10-01-03	11-03-03	12-01-03
Lab Code	KSW-5603	KSW-6592	KSW-7133, 4
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.3
Dissolved Solids	2.1 ± 0.4	3.6 ± 0.5	2.3 ± 0.2
Total Residue	2.1 ± 0.4	3.6 ± 0.5	2.3 ± 0.2
K-40 (ICP)	1.12	1.21	1.25
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

K-1e

Date Collected	10-01-03	11-03-03	12-01-03
Lab Code	KSW-5604	KSW-6593	KSW-7135
Gross beta			
Suspended Solids	< 0.4	< 0.4	< 0.4
Dissolved Solids	11.5 ± 1.7	10.0 ± 1.6	3.7 ± 0.6
Total Residue	11.5 ± 1.7	10.0 ± 1.6	3.7 ± 0.6
K-40 (ICP)	11.33	6.57	2.77
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

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Table 24. Surface water samples, analyses for gross beta, potassium-40 and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)			
Indicator			
K-1k			
Date Collected	01-02-03	02-03-03	03-03-03
Lab Code	NS[a]	NS[a]	NS[a]
Gross beta			
Suspended Solids	-	-	-
Dissolved Solids	-	-	-
Total Residue	-	-	-
K-40 (ICP)			
Mn-54	-	-	-
Fe-59	-	-	-
Co-58	-	-	-
Co-60	-	-	-
Zn-65	-	-	-
Zr-Nb-95	-	-	-
Cs-134	-	-	-
Cs-137	-	-	-
Ba-La-140	-	-	-
Date Collected	04-01-03	05-01-03	06-02-03
Lab Code	KSW-1415	KSW-2240	KSW-2883
Gross beta			
Suspended Solids	< 0.6	< 1.1	< 0.8
Dissolved Solids	9.3 ± 1.3	16.5 ± 1.8	12.1 ± 1.6
Total Residue	9.3 ± 1.3	16.5 ± 1.8	12.1 ± 1.6
K-40 (ICP)	8.56	13.84	10.38
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

[a] NS= No sample; water frozen.

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Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)

Indicator

K-1k

Date Collected	07-01-03	08-04-03	09-02-03
Lab Code	KSW-3565	KSW-4409	KSW-4975
Gross beta			
Suspended Solids	< 0.4	< 0.4	< 1.5
Dissolved Solids	12.1 ± 2.2	5.9 ± 1.1	22.5 ± 1.9
Total Residue	12.1 ± 2.2	5.9 ± 1.1	22.5 ± 1.9
K-40 (f.p.)	5.88	4.58	13.15
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Date Collected	10-01-03	11-03-03	12-01-03
Lab Code	KSW-5605	KSW-6594	KSW-7136
Gross beta			
Suspended Solids	< 0.4	< 0.6	< 0.4
Dissolved Solids	20.5 ± 2.0	22.9 ± 2.1	27.3 ± 0.9
Total Residue	20.5 ± 2.0	22.9 ± 2.1	27.3 ± 0.9
K-40 (f.p.)	11.33	9.17	12.11
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

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[a] NS= No sample; water frozen.

Table 24. Surface water samples, analyses for gross beta, potassium-40 and gamma-emitting isotopes.
Collection: Monthly

Sample Description and Concentration (pCi/L)			
Indicator			
K-9 (Raw)			
Date Collected	01-02-03	02-03-03	03-03-03
Lab Code	KSW-9	KSW-475	KSW-895
Gross beta			
Suspended Solids	< 0.4	< 0.3	< 0.3
Dissolved Solids	2.8 ± 0.7	2.0 ± 0.8	2.8 ± 0.7
Total Residue	2.8 ± 0.7	2.0 ± 0.8	2.8 ± 0.7
K-40 (ICP)	1.04	1.04	1.12
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-9 (Tap)			
Date Collected	01-02-03	02-03-03	03-03-03
Lab Code	KSW-10	KSW-476	KSW-896
Gross beta			
Suspended Solids	< 0.4	< 0.3	< 0.3
Dissolved Solids	2.5 ± 0.4	1.8 ± 0.4	2.0 ± 0.4
Total Residue	2.5 ± 0.4	1.8 ± 0.4	2.0 ± 0.4
K-40 (ICP)	1.12	1.04	1.21
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)			
Indicator			
K-9 (Raw)			
Date Collected	04-01-03	05-01-03	06-02-03
Lab Code	KSW-1416	KSW-2241	KSW-2884
Gross beta			
Suspended Solids	< 0.4	< 0.3	< 0.3
Dissolved Solids	2.6 ± 0.7	2.4 ± 0.8	4.1 ± 0.9
Total Residue	2.6 ± 0.7	2.4 ± 0.8	4.1 ± 0.9
K-40 (ICP)	1.30	1.30	1.30
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-9 (Tap)			
Date Collected	04-01-03	05-01-03	06-02-03
Lab Code	KSW-1417	KSW-2242	KSW-2885
Gross beta			
Suspended Solids	< 0.4	< 0.3	< 0.4
Dissolved Solids	1.8 ± 0.4	2.0 ± 0.4	1.9 ± 0.5
Total Residue	1.8 ± 0.4	2.0 ± 0.4	1.9 ± 0.5
K-40 (ICP)	1.30	1.21	1.30
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)			
Indicator			
K-9 (Raw)			
Date Collected	07-01-03	08-04-03	09-02-03
Lab Code	KSW-3566	KSW-4410	KSW-4976
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.3
Dissolved Solids	2.3 ± 1.0	3.1 ± 0.7	1.6 ± 0.6
Total Residue	2.3 ± 1.0	3.1 ± 0.7	1.6 ± 0.6
K-40 (ICP)	1.21	1.12	1.38
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-9 (Tap)			
Date Collected	07-01-03	08-04-03	09-02-03
Lab Code	KSW-3567	KSW-4411	KSW-4977
Gross beta			
Suspended Solids	< 0.4	< 0.3	< 0.3
Dissolved Solids	1.7 ± 0.6	2.0 ± 0.4	2.3 ± 0.5
Total Residue	1.7 ± 0.6	2.0 ± 0.4	2.3 ± 0.5
K-40 (ICP)	1.21	1.12	1.38
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

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Table 24. Surface water samples, analyses for gross beta, potassium-40, and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)			
Indicator			
K-9 (Raw)			
Date Collected	10-01-03	11-03-03	12-01-03
Lab Code	KSW-5606	KSW-6595	KSW-7137
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.4
Dissolved Solids	2.1 ± 0.7	3.1 ± 0.8	6.0 ± 0.5
Total Residue	2.1 ± 0.7	3.1 ± 0.8	6.0 ± 0.5
K-40 (ICP)	1.12	1.12	1.12
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-9 (Tap)			
Date Collected	10-01-03	11-03-03	12-01-03
Lab Code	KSW-5607	KSW-6596	KSW-7138
Gross beta			
Suspended Solids	< 0.4	< 0.4	< 0.3
Dissolved Solids	1.7 ± 0.5	1.9 ± 0.5	2.1 ± 0.2
Total Residue	1.7 ± 0.5	1.9 ± 0.5	2.1 ± 0.2
K-40 (ICP)	1.21	1.21	1.12
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 24. Surface water, analyses for gross beta, potassium-40 and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)			
Indicator			
K-14a			
Date Collected	01-02-03	02-03-03	03-03-03
Lab Code	KSW-11	KSW-477	KSW-897
Gross beta			
Suspended Solids	< 0.4	< 0.3	< 0.3
Dissolved Solids	2.7 ± 0.6	2.3 ± 0.6	1.7 ± 0.6
Total Residue	2.7 ± 0.6	2.3 ± 0.6	1.7 ± 0.6
K-40 (ICP)	1.21	1.04	1.30
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-14b			
Date Collected	01-02-03	02-03-03	03-03-03
Lab Code	KSW-12	KSW-478	KSW-898
Gross beta			
Suspended Solids	< 0.4	< 0.3	< 0.3
Dissolved Solids	3.2 ± 0.6	2.2 ± 0.5	2.5 ± 0.6
Total Residue	3.2 ± 0.6	2.2 ± 0.5	2.5 ± 0.6
K-40 (ICP)	1.21	1.12	1.30
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 24. Surface water, analyses for gross beta, potassium-40 and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)			
Indicator			
K-14a			
Date Collected	04-01-03	05-01-03	06-02-03
Lab Code	KSW-1418	KSW-2243	KSW-2886
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.4
Dissolved Solids	2.3 ± 0.5	3.2 ± 0.7	5.0 ± 0.6
Total Residue	2.3 ± 0.5	3.2 ± 0.7	5.0 ± 0.6
K-40 (ICP)	1.56	1.90	1.30
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-14b			
Date Collected	04-01-03	05-01-03	06-02-03
Lab Code	KSW-1419	KSW-2244	KSW-2887
Gross beta			
Suspended Solids	< 0.4	< 0.3	< 0.3
Dissolved Solids	2.5 ± 0.5	2.8 ± 0.6	6.7 ± 0.6
Total Residue	2.5 ± 0.5	2.8 ± 0.6	6.7 ± 0.6
K-40 (ICP)	1.64	1.82	1.38
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 24. Surface water, analyses for gross beta, potassium-40 and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)			
Indicator			
K-14a			
Date Collected	07-01-03	08-04-03	09-02-03
Lab Code	KSW-3568	KSW-4412	KSW-4978
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.3
Dissolved Solids	2.1 ± 0.8	3.7 ± 0.6	3.4 ± 0.6
Total Residue	2.1 ± 0.8	3.7 ± 0.6	3.4 ± 0.6
K-40 (ICP)	1.38	1.82	1.47
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15
K-14b			
Date Collected	07-01-03	08-04-03	09-02-03
Lab Code	KSW-3569	KSW-4413	KSW-4979
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.3
Dissolved Solids	2.1 ± 0.8	6.0 ± 0.7	4.1 ± 0.7
Total Residue	2.1 ± 0.8	6.0 ± 0.7	4.1 ± 0.7
K-40 (ICP)	1.38	2.25	1.47
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 24. Surface water, analyses for gross beta, potassium-40 and gamma-emitting isotopes (continued).

Sample Description and Concentration (pCi/L)

Indicator

K-14a

Date Collected	10-01-03	11-03-03	12-01-03
Lab Code	KSW-5608	KSW-6597	KSW-7139
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.3
Dissolved Solids	4.3 ± 0.6	4.1 ± 0.7	4.7 ± 0.4
Total Residue	4.3 ± 0.6	4.1 ± 0.7	4.7 ± 0.4
K-40 (ICP)	1.21	1.21	2.51
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

K-14b

Date Collected	10-01-03	11-03-03	12-01-03
Lab Code	KSW-5609	KSW-6598	KSW-7140
Gross beta			
Suspended Solids	< 0.3	< 0.3	< 0.3
Dissolved Solids	3.3 ± 0.6	3.6 ± 0.6	4.4 ± 0.4
Total Residue	3.3 ± 0.6	3.6 ± 0.6	4.4 ± 0.4
K-40 (ICP)	2.25	1.30	2.51
Mn-54	< 15	< 15	< 15
Fe-59	< 30	< 30	< 30
Co-58	< 15	< 15	< 15
Co-60	< 15	< 15	< 15
Zn-65	< 30	< 30	< 30
Zr-Nb-95	< 15	< 15	< 15
Cs-134	< 10	< 10	< 10
Cs-137	< 10	< 10	< 10
Ba-La-140	< 15	< 15	< 15

Table 25. Surface water, analyses for tritium, strontium-89 and strontium-90.
Collection: Quarterly composites of monthly samples.

Location and		Concentration pCi/L		
Collection Period	Lab Code	H-3	Sr-89	Sr-90
Indicator				
K-1a				
1st Quarter	KSW -996	< 330	< 0.6	< 0.6
2nd Quarter	-3631	< 330	< 1.0	< 0.6
3rd Quarter	-5680	< 330	< 0.9	< 0.6
4th Quarter	-7798	< 330	< 1.4	< 0.7
K-1b				
1st Quarter	KSW -997	< 330	< 0.7	< 0.6
2nd Quarter	-3632	< 330	< 1.9	< 0.9
3rd Quarter	-5681	< 330	< 1.0	< 0.8
4th Quarter	-7799	< 330	< 0.9	< 0.6
K-1d				
1st Quarter	KSW -998	< 330	< 0.6	1.0 ± 0.3
2nd Quarter	-3633	< 330	< 1.5	< 0.7
3rd Quarter	-5682	< 330	< 0.9	< 0.5
4th Quarter	-7800	< 330	< 0.9	< 0.5
K-1e				
1st Quarter	KSW -999	< 330	< 0.7	< 0.4
2nd Quarter	-3634	< 330	< 1.2	1.0 ± 0.5
3rd Quarter	-5683	< 330	< 0.7	< 0.5
4th Quarter	-7801	< 330	< 0.8	< 0.5

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Table 25. Surface water, analyses for tritium, strontium-89 and strontium-90 (continued).

Location and Collection Period		Concentration pCi/L H-3	Sr-89	Sr-90
Indicator				
K-14a				
1st Quarter	KSW -1002	< 330	< 0.7	< 0.6
2nd Quarter	-3638	< 330	< 1.3	< 0.5
3rd Quarter	-5687, 8	< 330	< 0.8	< 0.6
4th Quarter	-7805, 6	< 330	< 0.7	< 0.6
K-14b				
1st Quarter	KSW -1003	< 330	< 0.6	< 0.6
2nd Quarter	-3639	< 330	< 0.8	< 0.7
3rd Quarter	-5689	< 330	< 1.0	< 0.8
4th Quarter	-7807	< 330	< 0.8	< 0.5
K-1k				
1st Quarter	ND[a]	-	-	-
2nd Quarter	KSW -3635	< 330	< 1.3	< 0.7
3rd Quarter	-5684	< 330	< 0.8	1.0 ± 0.4
4th Quarter	-7802	< 330	< 1.4	< 0.6
Control				
K-9				
1st Quarter	KSW -1000 (Raw)	< 330	< 0.6	1.3 ± 0.4
	-1001 (Tap)	< 330	< 0.6	< 0.6
2nd Quarter	KSW -3636 (Raw)	< 330	< 1.0	< 0.7
	-3637 (Tap)	< 330	< 1.0	< 0.7
3rd Quarter	KSW -5685 (Raw)	< 330	< 1.0	< 0.7
	-5686 (Tap)	< 330	< 1.1	< 0.7
4th Quarter	KSW -7803 (Raw)	< 330	< 1.3	< 0.6
	-7804 (Tap)	< 330	< 0.8	< 0.6

[a] No data; water frozen.

Table 26. Fish, collected at K-1d, analyses for gross beta, strontium-89, strontium-90, strontium-90, and gamma-emitting isotopes.
Collection: Three times a year

Sample Description and Concentration (pCi/g wet)

Collected	04-04-03		07-18-03	
Lab Code	KF-2165		KF-4389	
Type	White Catfish		White Sucker	
Portion	Flesh	Bones	Flesh	Bones
Gross beta	2.47 ± 0.09	1.52 ± 0.61	1.85 ± 0.06	1.49 ± 0.43
Sr-89	NA[a]	< 0.28	NA[a]	< 0.10
Sr-90	NA	0.098 ± 0.040	NA	0.12 ± 0.035
K-40	2.31 ± 0.37	NA[a]	1.71 ± 0.71	NA[a]
Mn-54	< 0.016	NA	< 0.033	NA
Fe-59	< 0.070	NA	< 0.082	NA
Co-58	< 0.026	NA	< 0.067	NA
Co-60	< 0.005	NA	< 0.013	NA
Cs-134	< 0.010	NA	< 0.024	NA
Cs-137	0.048 ± 0.022	NA	< 0.047	NA

Collected	10-03-03	
Lab Code	KF-6599	
Type	White Sucker	
Portion	Flesh	Bones
Gross beta	3.17 ± 0.06	1.82 ± 0.35
Sr-89	NA[a]	< 0.15
Sr-90	NA	0.14 ± 0.038
K-40	3.10 ± 0.40	NA[a]
Mn-54	< 0.012	NA
Fe-59	< 0.059	NA
Co-58	< 0.015	NA
Co-60	< 0.012	NA
Cs-134	< 0.015	NA
Cs-137	< 0.015	NA

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[a] NA = Not analyzed; analyses not required.

Note: Page 89 is intentionally left out.

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Table 27. Slime or aquatic vegetation, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes.
Collection: Semiannually

Sample Description and Concentration				
	Indicators			Control
Location	K-1a	K-1b	K-1d	K-9
Date Collected	06-03-03	06-03-03	05-01-03	06-03-03
Lab Code	KSL-2906	KSL-2907	KSL-2389	KSL-2909, 10
Gross beta	4.01 ± 0.07	5.85 ± 0.16	4.44 ± 0.70	7.35 ± 0.11
Sr-89	< 0.020	< 0.030 [a]	< 0.12	< 0.007
Sr-90	< 0.012	0.025 ± 0.008 [a]	0.10 ± 0.031	< 0.004
Be-7	< 0.23	< 0.33	0.66 ± 0.20	< 0.18
K-40	5.53 ± 0.69	6.17 ± 0.90	1.90 ± 0.42	3.70 ± 0.42
Mn-54	< 0.026	< 0.029	< 0.019	< 0.013
Co-58	< 0.020	< 0.030	0.027 ± 0.015	< 0.009
Co-60	< 0.021	< 0.017	< 0.017	< 0.011
Nb-95	< 0.025	< 0.020	< 0.019	< 0.015
Zr-95	< 0.049	< 0.053	< 0.036	< 0.029
Ru-103	< 0.023	< 0.026	< 0.013	< 0.017
Ru-106	< 0.18	< 0.27	< 0.19	< 0.11
Cs-134	< 0.025	< 0.034	< 0.012	< 0.019
Cs-137	< 0.020	< 0.022	< 0.018	< 0.013
Ce-141	< 0.044	< 0.041	< 0.026	< 0.028
Ce-144	< 0.19	< 0.15	< 0.082	< 0.071

Location	K-1e	K-1k	K-14
Date Collected	05-01-03	06-03-03	05-01-03
Lab Code	KSL-2390	KSL-2908	KSL-2391
Gross beta	2.65 ± 0.36	5.27 ± 0.11	3.90 ± 0.45
Sr-89	< 0.049	< 0.011	< 0.037
Sr-90	0.025 ± 0.012	< 0.006	0.032 ± 0.016
Be-7	1.16 ± 0.22	0.63 ± 0.25	1.30 ± 0.22
K-40	< 0.58	5.19 ± 0.76	1.34 ± 0.25
Mn-54	< 0.013	< 0.021	< 0.014
Co-58	< 0.024	< 0.018	0.063 ± 0.015
Co-60	< 0.016	< 0.018	0.035 ± 0.010
Nb-95	< 0.011	< 0.026	< 0.015
Zr-95	< 0.042	< 0.031	< 0.022
Ru-103	< 0.018	< 0.024	< 0.013
Ru-106	< 0.12	< 0.19	< 0.097
Cs-134	< 0.020	< 0.024	< 0.012
Cs-137	< 0.023	< 0.032	0.034 ± 0.012
Ce-141	< 0.029	< 0.044	< 0.018
Ce-144	< 0.094	< 0.13	< 0.046

---

[a] Result of reanalysis

Table 27. Slime or aquatic vegetation, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes.
Collection: Semiannually

Sample Description and Concentration

	Indicators			Control
Location	K-1a	K-1b	K-1d	K-9
Date Collected	08-04-03	08-04-03	07-01-03	08-04-03
Lab Code	KSL-4396	KSL-4397	KSL-3558	KSL-4415
Gross beta	6.90 ± 0.53	2.08 ± 0.06	5.35 ± 0.31	6.31 ± 0.13
Sr-89	< 0.33	< 0.026 [a]	< 0.059	< 0.010
Sr-90	< 0.095	0.009 ± 0.004 [a]	0.048 ± 0.022	0.009 ± 0.003
Be-7	1.43 ± 0.60	< 0.19	2.23 ± 0.29	< 0.51
K-40	3.11 ± 0.66	1.23 ± 0.24	3.13 ± 0.54	6.01 ± 0.83
Mn-54	< 0.045	< 0.013	< 0.019	< 0.029
Co-58	< 0.049	< 0.005	< 0.021	< 0.037
Co-60	< 0.031	< 0.010	< 0.016	< 0.022
Nb-95	< 0.068	< 0.016	< 0.022	< 0.041
Zr-95	< 0.064	< 0.018	< 0.042	< 0.061
Ru-103	< 0.071	< 0.012	< 0.016	< 0.049
Ru-106	< 0.22	< 0.084	< 0.17	< 0.28
Cs-134	< 0.050	< 0.016	< 0.017	< 0.032
Cs-137	< 0.022	< 0.009	< 0.019	< 0.026
Ce-141	< 0.12	< 0.024	< 0.021	< 0.10
Ce-144	< 0.15	< 0.063	< 0.070	< 0.24

Location	K-1e	K-1k	K-14
Date Collected	07-01-03	08-04-03	07-01-03
Lab Code	KSL-3559	KSL-4398, 9	KSL-3560
Gross beta	4.05 ± 0.23	3.27 ± 0.08	4.06 ± 0.22
Sr-89	< 0.040	< 0.023	< 0.037
Sr-90	0.023 ± 0.012	0.017 ± 0.008	< 0.018
Be-7	1.12 ± 0.25	4.53 ± 1.10	0.85 ± 0.29
K-40	2.43 ± 0.46	2.46 ± 0.55	3.31 ± 0.56
Mn-54	< 0.014	< 0.036	< 0.019
Co-58	< 0.019	< 0.020	< 0.016
Co-60	< 0.010	< 0.034	< 0.025
Nb-95	< 0.025	< 0.083	< 0.028
Zr-95	< 0.046	< 0.082	< 0.049
Ru-103	< 0.019	< 0.056	< 0.020
Ru-106	< 0.15	< 0.34	< 0.16
Cs-134	< 0.027	< 0.045	< 0.016
Cs-137	< 0.028	< 0.029	< 0.020
Ce-141	< 0.027	< 0.083	< 0.021
Ce-144	< 0.097	< 0.24	< 0.071

---

[a] Result of reanalysis

Table 28. Bottom sediment samples, analyses for gross beta, strontium-89, strontium-90, and gamma-emitting isotopes.
Collection: May and November

Sample Description and Concentration (pCi/g dry)

	Indicator				Control
Location	K-1c	K-1d	K-1j	K-14	K-9
Collection Date	05-01-03	05-01-03	05-01-03	05-01-03	05-01-03
Lab Code	KBS-2374	KBS-2375	KBS-2376	KBS-2378	KBS-2377
Gross beta	8.76 ± 1.82	8.74 ± 1.77	9.02 ± 1.86	8.87 ± 1.99	27.70 ± 3.16
Sr-89	< 0.039	< 0.040	< 0.067	< 0.043	< 0.044
Sr-90	< 0.014	< 0.013	0.035 ± 0.014	< 0.017	0.042 ± 0.012
K-40	6.72 ± 0.41	6.87 ± 0.40	6.68 ± 0.41	8.87 ± 0.46	10.25 ± 0.71
Co-58	< 0.012	< 0.010	< 0.010	< 0.012	< 0.025
Co-60	< 0.011	< 0.010	< 0.011	< 0.010	< 0.020
Cs-134	< 0.012	< 0.009	< 0.015	< 0.012	< 0.022
Cs-137	0.025 ± 0.013	0.032 ± 0.018	0.023 ± 0.010	< 0.012	0.092 ± 0.035
Collection Date	11-03-03	11-03-03	11-03-03	11-03-03	11-03-03
Lab Code	KBS-6600	KBS-6601	KBS-6602	KBS-6605	KBS-6603, 4
Gross beta	8.42 ± 1.27	7.61 ± 1.25	11.47 ± 1.40	10.79 ± 1.39	27.01 ± 1.38
Sr-89	< 0.041	< 0.040	< 0.043	< 0.037	< 0.074
Sr-90	< 0.017	< 0.017	< 0.017	< 0.015	0.048 ± 0.016
K-40	6.61 ± 0.65	7.46 ± 0.59	8.87 ± 0.38	9.56 ± 0.68	8.82 ± 0.70
Co-58	< 0.017	< 0.024	< 0.009	< 0.021	< 0.040
Co-60	< 0.017	< 0.014	< 0.007	< 0.015	< 0.022
Cs-134	< 0.021	< 0.027	< 0.010	< 0.020	< 0.038
Cs-137	0.046 ± 0.024	0.037 ± 0.014	0.021 ± 0.012	< 0.019	< 0.038

APPENDIX A

RADIOCHEMICAL ANALYTICAL PROCEDURES

Environmental, Inc.
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an Allegheny Technologies Co.

ANALYTICAL PROCEDURES MANUAL

ENVIRONMENTAL, Inc.
MIDWEST LABORATORY

prepared for

NUCLEAR MANAGEMENT Co, LLC

KEWAUNEE NUCLEAR POWER PLANT

Revised 02-03-04

KNPP

List of Procedures

Procedure Number		Revision Number	Revision Date
SP-01	Sample Preparation	6	01-26-04
TLD-01	Preparation and Readout of Teledyne Isotopes TLD Cards	7	06-07-01
AP-02	Determination of Gross Alpha and/or Gross Beta in Air Particulate Filters	1	07-15-91
AP-03	Procedure for Compositing Air Particulate Filters for Gamma Spectroscopic Analysis	2	07-21-98
W(DS)-01	Determination of Gross Alpha and/or Gross Beta in Water (Dissolved Solids or Total Residue)	4	07-21-98
W(SS)-02	Determination of Gross Alpha and/or Gross Beta in Water (Suspended Solids)	2	07-21-98
AB-01	Determination of Gross Alpha and/or Gross Beta in Solid Samples	2	06-11-01
GS-01	Determination of Gamma Emitters by Gamma Spectroscopy	3	02-03-04
T-02	Determination of Tritium in Water	5	01-29-02
I-131-01	Determination of I-131 in Milk by Anion Exchange (Batch Method)	5	09-24-92
I-131-02	Determination of I-131 in Charcoal Cartridges by Gamma Spectroscopy	1	08-01-92
SR-02	Determination of Sr-89 and Sr-90 in Water (Clear or Drinking Water	0	03-21-86
SR-05	Determination of Sr-89 and Sr-90 in Ashed Samples	0	07-23-86
SR-06	Determination of Sr-89 and Sr-90 in Soil and Bottom Sediments	0	07-23-86
SR-07	Determination of Sr-89 and Sr-90 in Milk (Ion Exchange Batch Method)	4	08-18-94
COMP-01	Procedure for Compositing Water and Milk Samples	0	11-07-88
CA-01	Determination of Stable Calcium in Milk	0	07-08-88

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SAMPLE PREPARATION

EIML-SP-01

Prepared by

Environmental, Inc.
Midwest Laboratory

Copy No. ______________

Revision #	Date	Pages	Prepared by	Approved by
5	05-07-02	14	S. A. Coorlim	B. Grob
6	01-26-04	9	S. A. Coorlim	

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SAMPLE PREPARATION

Principle of Method

Different classes of samples require different preparations. In general, food products are prepared as for home use, while others are dried and ashed as received.

Reagents

Formaldehyde

Apparatus

Balance
Ceramic Dishes
Counting Containers
Cutting Board
Drying Oven
Drying Pans
Grinder
High Temperature Marking Pen
Knives
Labels
Muffle Furnace
Plastic Bags
Pulverizer
Scissors
Spatulas

PROCEDURE FOR PACKING STANDARD CALIBRATED COUNTING CONTAINERS

A. 1.0, 2.0, 3.5 L: Pour 1.0, 2.0, or 3.5 liters of water into corresponding container. Mark the level and empty the container. Fill with the sample to the mark, except for grass. Pack as much as will fit into the container.

B. 250 mL, and 500 mL: Fill to the rim on the inside wall, which is 1/4" from the top.

C. 4 oz: Fill to the 100 mL mark.

Notes to Procedures:

1. Pack sample containers tightly. For soil, sediments or other dried samples, make sure samples are leveled.
2. A few mL. of formaldehyde may be added to wet samples to prevent spoilage.
3. For tritium analysis, transfer approximately 100 g of wet sample to a 4 oz. container. Label with the sample number and seal.
4. If a gamma scan is the only required analysis, the drying and ashing steps are skipped. Transfer the samples to a plastic bag, seal, label, and store in a cooler or freezer until disposal.
5. If there is sufficient quantity, use surplus sample for drying and ashing instead of waiting for gamma scanning to be completed.
6. US Ecology Inc. samples: record total weight received.
7. US Ecology Inc. and Maxey Flats samples are DRIED before gamma spectroscopic analysis.
8. If I-131 analysis is required, the sample must be prepared and submitted to the counting room immediately. Mark "I-131" on the tape.

A. Vegetables, Fruits, Grass, Green Leafy Vegetation and Cattle Feed

Note: Do not wash the samples.

1. Cut vegetables and hard fruits into small pieces (about 1/4" cubes). Mash soft fruits. Cut grass and green leafy vegetation into approximately 1-2" long stems. Pack cattle feed and silage as is. Use larger containers if sufficient amount of sample is available.
2. Transfer sample to a standard calibrated container. Use the largest size possible for the amount of sample available. Pack tightly but DO NOT FILL ABOVE THE MARK. Record the wet weight.
3. Seal with cover. Attach label to the cover recording the sample number, weight, and collection date.
4. Submit to the counting room for gamma spectroscopic analysis without delay or store in a cooler, (for short period), until counting.
5. Proceed to Drying and Ashing, Vegetation Samples

B. Slime and Aquatic Vegetation

1. Remove any foreign material. Place the sample in a sieve pan and wash until all sand and dirt is removed (turn the sample over several times). Squeeze out the water by hand.
2. Place the sample in a standard calibrated container. Use the largest size possible for the amount of sample available. Weigh and record wet weight. DO NOT FILL ABOVE THE RIM.

6. Seal with cover. Attach label to the cover recording the sample number, weight, and collection date.

4. Submit to the counting room without delay. Slime decomposes quickly, even with formaldehyde. If gamma scanning must be delayed, freeze.
5. Proceed to Drying and Ashing, Vegetation Samples

C. Drying and Ashing, Vegetation Samples

1. After gamma scan is complete, transfer the sample to a drying pan and dry at 110°C.
2. Cool, weigh, and record dry weight.
3. Transfer to a tared ceramic dish, and record dry weight for ashing. Ash in a muffle furnace by gradually increasing the temperature to 600°C.

NOTE: If ashing is incomplete (black carbon remains), cool the dish, crush the ash with spatula, and continue ashing overnight at 600°C. It is not necessary to increase the temperature gradually.

4. Cool and weigh the ashed sample and record ash weight. Grind and sieve through a 30 mesh screen. Transfer to a 4 oz. container, seal, and label with sample number, weight, analyses required, and date of collection. The sample is now ready for analysis.

D. Fish

1. Wash the fish.
2. Fillet and pack the fish immediately (to prevent moisture loss) in a 250 mL, 500 mL, or 4 oz. standard calibrated container. Use 500 mL size if enough sample is available. **DO NOT FILL ABOVE THE RIM.** Record the wet weight.
3. Proceed to Step 2, Waterfowl, Meat and Wildlife Samples below.

E. Waterfowl, Meat, and Wildlife

1. Skin and clean the animal. Remove a sufficient amount of flesh to fill an appropriate standard calibrated container (500 mL, 250 mL, or 4 oz). Weigh without delay (to prevent moisture loss). **DO NOT FILL ABOVE THE RIM.** Record the wet weight.
2. If bones are to be analyzed, boil remaining flesh and bones in water for about 1 hour. Clean the bones. Air dry, weigh, and record as wet weight. Dry at 110°C. Record dry weight. Ash at 800°C, cool, weigh, and record the ash weight. Grind to a homogeneous sample. The sample is ready for analysis.
3. Seal with cover. Attach label to the cover recording the sample number, weight, and collection date.
4. Submit to the counting room for gamma spectroscopic analysis without delay or store in a refrigerator, (for short period), until counting.
5. Proceed to Drying and Ashing, Fish and Game Samples

F. Drying and Ashing, Fish and Meat Samples

1. After gamma scan is complete, transfer the sample to a drying pan and dry at 110°C.
2. Cool, weigh, and record dry weight.
3. Transfer to a tared ceramic dish. Record dry weight for ashing.
4. Ash in a muffle furnace by gradually increasing the temperature to 450°C. If considerable amount of carbon remains after overnight ashing, the ash should be crushed with a spatula and placed back in the muffle furnace until ashing is completed.
5. Cool and weigh the ashed sample and record the ash weight. Grind and sieve through a 30 mesh screen. Transfer to a 4 oz. container, seal, and record sample number, weight, analyses required, and date of collection. The sample is now ready for analysis.

G. Eggs

1. Remove the egg shells and mix the eggs with a spatula.
2. Transfer the mixed eggs to a standard calibrated 500 mL container. Record the wet weight. DO NOT FILL ABOVE THE RIM.
3. Seal with cover. Attach label to the cover recording the sample number, weight, and collection date.
4. Submit to the counting room for gamma spectroscopic analysis without delay or store in a refrigerator, (for short period), until counting.
5. After the gamma scan is complete, transfer the sample to a drying pan and dry at 110°C.
6. Cool, weigh, and record dry weight.
7. Transfer to tared ceramic dish. Record dry weight for ashing.
8. Cool and weigh the ashed sample and record the weight. Grind and sieve through a 30 mesh screen. Transfer to a 4 oz. container, seal, and record sample number, weight, analyses required, and date of collection. The sample is now ready for analysis.
9. Store the remaining dry sample in a plastic bag.

H. Bottom Sediments and Soil

1. Remove rocks, roots, and any other foreign materials.
2. Place approximately 1 kg of sample on the drying pan and dry at 110°C.
3. Seal, label, and save remaining sample.
4. Grind or pulverize the dried sample and sieve through a No. 20 mesh screen.
5. For gamma spectroscopic analysis, transfer sieved sample to a standard calibrated 500 mL, 250 mL, or 4 oz. container. DO NOT FILL ABOVE THE RIM. Record dry weight.
6. Seal with cover. Attach label to the top of the cover and record the sample number, weight, and date of collection..
7. Submit to the counting room for gamma spectroscopic analysis without delay.
8. For gross alpha and beta analysis transfer 1-2 g of sample to a 4 oz. container, seal and label with the sample number. For other analysis (i.e., radiostrontium, transuranics etc.,) transfer to a ceramic dish and ash in a muffler furnance at 600°C. Cool and transfer to a 4 oz. container, seal and label with the sample number.
9. Store the remaining sieved sample in a plastic bag.
10. After the gamma scan is complete, transfer the sample to a plastic bag, seal, label, and store until disposal.

I. Milk

1. Transfer 25 mL of milk for gross alpha and beta analysis or 100-1000 mL for other analysis into a glass beaker.
2. Dry at 110°C.
3. Ash in the muffler furnance by gradually increasing the temperature to 600°C. If a considerable amount of carbon remains (black), cool the beaker, crush the ash with a spatula and continue ashing until completed (white or light gray in color).
4. Cool and weigh the ashed sample and record the ash weight. Grind and transfer to a 4oz. container, seal and record the sample number. The sample is now ready for analysis.

J. Dry Foods (Powdered Milk, Infant Formula, Animal Feed)

For gamma isotopic analysis of powdered samples, no preparation is necessary. The samples are transferred to a Marinelli beaker as received.

1. Tare a 250 or 500 ml. Marinelli beaker (with lid), depending on sample size available. Record the tare weight.
2. Transfer sample to the beaker. (Refer to pg. 4, "PROCEDURE FOR PACKING STANDARD CALIBRATED COUNTING CONTAINERS")
3. Attach a label to the top of the cover and record the sample number, weight and collection date.
4. Submit to the counting room without delay.
5. Submit to the counting room for gamma spectroscopic analysis without delay.
6. For gross alpha and beta analysis transfer 1-2 g of sample to a 4 oz. container, seal and label with the sample number. For other analysis (i.e., radiostrontium, transuranics etc.) transfer to a ceramic dish and ash in a muffle furnance at 600°C. Cool and transfer to a 4 oz. container, seal and label with the sample number.

K. Feces

NOTE: Perform Transfer operation in the hood. Wear new plastic gloves and face mask.

1. Take a 600 mL beaker, clean acid etched area and write sample # using HI-Temp marker.
2. Cover the beaker with parafilm and weigh. Record the weight.
3. Transfer the whole sample to the beaker using a new plastic spoon.
4. Cover the beaker with the same parafilm and weigh. Record total weight.
5. Transfer the beaker to the drying oven, remove parafilm and dry the sample overnight at 110°C.
6. In the morning, turn oven off. Let the exhaust fan run until sample cools to room temperature.
7. Transfer beaker to the muffle furnace. Set temperature to 175°C. Gradually increase the temperature to 450°C and ash the sample overnight.

NOTE: In the morning, carefully open the door and visually inspect the sample. Do not touch or remove the beaker from the furnace. If ashing is incomplete, (black carbon remains), continue ashing for another 24 hours or until the ash is grey-white.

8. Once ashing is complete, turn the temperature off. Let the exhaust fan run until beaker is cool.
9. Remove the beaker from the furnace and cover with parafilm. The sample is ready for analysis.

NOTE: Digest the whole ash sample in the same beaker before taking aliquot for analysis. Do not weigh the beaker.

L. Bottom Sediments and Soil, Analysis for Ra-226 by Gamma Spectroscopy

1. Remove rocks, roots and any other foreign materials.
2. Place approximately 1 kg of sample in a drying pan and dry at 110°C. Save any remaining sample.
3. Grind or pulverize the dried sample and sieve through a No. 20 mesh screen.
4. Transfer sieved sample to a standard calibrated 500 mL or 250 mL container.
   DO NOT FILL ABOVE THE RIM. Record dry weight.
5. Seal with cover and electrical tape. Attach label to the top of the cover and record the sample number, weight, and date of collection and date and time the container was sealed.
6. Deliver to counting room for gamma spectroscopic analysis. (The sample is stored for a minimum of 20 days to allow Pb-214 to come to equilibrium with Ra-226. The Pb-214 peak is then used to calculate the Ra-226 concentration.)
7. Store the remaining sieved sample in a plastic bag for possible future reanalysis.
8. After the gamma scan is completed, transfer sample to a plastic bag, label and store until disposal.

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MEASUREMENT of AMBIENT GAMMA RADIATION by THERMOLUMINESCENT DOSIMETRY ($CaSO_4$:Dy)

PROCEDURE NO. EIML-TLD-01

Prepared by

Environmental, Inc.
Midwest Laboratory

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Revision #	Date	Pages	Prepared by	Approved by
5	01-08-90	6	B Grob	LG Huebner
6	04-24-95	6	B Grob	LG Huebner
7,Reissue	06-07-01	3	SA Coorlim	B Grob

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MEASUREMENT of AMBIENT GAMMA RADIATION by THERMOLUMINESCENT DOSIMETRY (CaSO$_4$:Dy)

Principle of Method

The cards are spread out in a single layer on a perforated metal tray and annealed for two hours at 250-260 °C. After annealing, the cards are packaged and sent to the field.

Once the cards are returned from the field they are read as soon as possible. After reading, several cards are chosen, annealed and irradiated with a known dose using a Ra-226 source encapsulated in an iridium needle to calculate efficiency. The net exposure is calculated after in-transit exposure is subtracted.

I. Equipment & Materials:

TLD Reader: (Teledyne Isotopes Model 8300)
TLD Cards (CaSO$_4$:Dy phosphor)
TLD Card Holder with copper shielding
Transparent plastic bags (6oz and 8oz puncture proof Whirl-Pak)
Heat sealer
Labels
Ra-226 Needle: ("American Radium" No. 37852)

Annealing oven
Forceps
Black Plastic bags (pouches)

Scotch tape
Recording sheet
Turntable

II. Preparation

1. Enter location I.D, dosimeter (card) number, and date annealed on the readout recording sheet. As per project requirements, include cards for in-transits and spares.
2. Spread the cards in a single layer on the perforated tray.
3. Preheat the annealing oven to 250-260 °C
4. Set the alarm and anneal for two hours. Remove tray from the oven and let cool.
5. Place each card in a black plastic bag (pouch), seal the flap with scotch tape, and place in the card holder.
6 Attach a label identifying the station, location, and exposure period, on each holder. Place the holders into a transparent plastic bag and heat seal.
7. Ship without delay. Place a "Do Not X-Ray" sticker on the mailing container.

III. Reader Calibration

1. Adjust the nitrogen flow control to 6 SCF per hour.
2. Open the card drawer.
3. Turn "FUNCTION" switch to "CALIBRATE". The "WAIT" sign will be illuminated and the reading will change every three seconds. The reading should be 1000 ±10. If not, adjust using the "CALIBRATE" dial.

III. Reader Calibration (continued)

4. Turn "FUNCTION" switch to "OPERATE". Press "START". When the "READ" signal appears, the reading should be as posted. If not, adjust with "Sensitivity" dial. (Turn clockwise if reading is low, counterclockwise if reading is high).
5. Wait for "START" button to light before continuing. Press "START". Continue adjusting "SENSITIVITY" until the reading is as posted. Make and record 5 readings.
6. When the "START" button lights, push in the card drawer to position No. 3. Press "START". Wait for the "READ" signal and record the reading. (dark current / background)
7. Repeat this step four more times (total of five readings) and record the results.

NOTE: The reading should be as posted on the reader. If not, notify the Lab supervisor.

IV. Readout of TLD Cards

1. After the "START" button lights, pull out card drawer. Take the card out of the holder and insert in the drawer with printed card number facing down and to the back (away from you).
2. Push drawer into position No. 1. Push "START" button.
3. When "READ" sign appears, record the reading.
4. When "START" button lights up, push the drawer to position No. 2. Push "START" button. Repeat steps 2.3 and 2.4 until all positions are read out.
5. Read out and record the reading for the rest of the cards in the same manner.

V. Efficiency Determination

NOTE: Perform an efficiency calibration after each field cycle. (i.e. random TLDs from each project are calibrated after every readout of that project.).

1. After readout of a project is completed, select two to three cards at random.
2. Anneal and package as described in Part II, Steps 2 thru 8.
3. Clip the holders (with the freshly annealed cards) on the irradiation turntable. Start rotation.
4. Attach the Ra-226 needle to center of the turntable. Record the time. Irradiate overnight.
5. Remove the needle, record the time, and read out the cards as in Part III.
6. Average all the readings, and subtract average dark current reading (Part III, Step 6-7).
7. Calculate efficiency (light response) as follows:

$$\text{Efficiency} = \frac{\text{Net Average Reading (from step 6.)}}{\text{Hours of exposure x 2.097}}$$

8. Submit the field data and efficiency data sheets to data clerk for calculations.

NOTE:
The calculation program will automatically subtract the in-transit exposure and prorate exposure to a selected number of days (usually 30 or 91). Occasionally, some TLDs are placed and/or removed at different times resulting in a different number of exposure days in the field. Exposure will be prorated for the selected number of days.

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DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN AIR PARTICULATE FILTERS

PROCEDURE NO. TIML-AP-02

Prepared by
Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revised Pages	Revision No.	Date	Pages	Prepared by	Approved by
	0	07-11-86	3	B. Grob	L. G. Huebner
2	1	07-15-91	3	B. Grob	L. G. Huebner

DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN AIR PARTICULATE FILTERS

Principle of Method

Air particulate filters are stored for at least 72 hours to allow for the decay of short-lived radon and thoron daughters and then counted in the proportional counter. | 1

Apparatus

Forceps
Loading Sheet
Proportional Counter
Stainless Steel Planchets (standard 2" x 1/8")

Procedure

1. Store the filters for at least 72 hours from the day of collection. | 1

2. Place filters on a stainless steel planchet.

3. Fill out a sample loading sheet. Fill in the date, counter number, counting time, sample identification number, sample collection date, and initials.

   NOTES: When loading samples in the holder, load blanks (unexposed filter paper) in positions 1, 12, 23, 34, 45, etc.

   If filters from more than one project are loaded, make sure that the appropriate blanks are loaded with each batch. Load the counter blank planchet as a last sample.

4. Count in a proporational counter long enough to obtain the required LLDs.

5. After counting is completed, return the filters to the original envelopes.

6. Submit the counter printout, field collection sheet, and the loading sheet to the data clerk for calculations.

Calculations

Gross alpha (beta) concentration:

$$(\text{pCi/liter}) = \frac{A}{B \times C \times 2.22} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{B \times C \times 2.22}$$

Where:

A = Net alpha (beta) count (cpm)

B = Efficiency for counting alpha (beta) activity (cpm/dpm)

C = Volume of sample

E_{sb} = Counting error of sample plus background

E_b = Counting error of background

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PROCEDURE for COMPOSITING AIR PARTICULATE FILTERS for GAMMA SPECTROSCOPIC ANALYSIS

PROCEDURE NO. AP-03

Prepared by

Environmental Inc.
Midwest Laboratory

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Revised Pages	Revision #	Date	Pages	Prepared by	Approved by
	0	12-15-89	3	B. Grob	L.G. Huebner
	1	03-21-95	3	B. Grob	L.G. Huebner
	2	07-21-98	3	A. Fayman	B. Grob

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PROCEDURE FOR COMPOSITING AIR PARTICULATE FILTERS FOR GAMMA SPECTROSCOPIC ANALYSIS

Principle of Method

AP filters are placed in a Petri dish in chronological order, labeled and submitted to the counting room for analysis.

Materials

Tweezers (long)
Blank filter paper
Small Petri Dish (50 x 9 mm)
Scotch Tape

Procedure

1. In the Recording Book enter:
   - Sample ID (project)
   - Sample No.
   - Location
   - Collection Period
   - Date Composited

2. Obtain sample numbers from Receiving Clerk.

3. Stack the envelopes with APs from each location in chronological order, starting with the earliest date on the bottom. After you are done, flip the stack over.

4. Place blank filter paper, "fluffy" side down, in deep half of Petri dish.

5. Beginning from the top of the stack, remove each AP from its envelope and place in the Petri Dish with the deposit facing down.

6. Continue transferring AP's from envelopes into the Petri Dish. 2

7. Place blank filter, "fluffy" side down, on top of APs.

8. Cap the Petri Dish using the shallow half (you may use Scotch tape to hold cap in place, (if needed). Turn the Petri dish over.

9. On the Petri dish and each stack of glassine envelopes (each location kept together by either paperclips or rubber bands) using a black marker write:
   - Sample ID
   - Sample No.
   - Last date of collection
   - Collection Period

10. Submit the samples to the counting room.

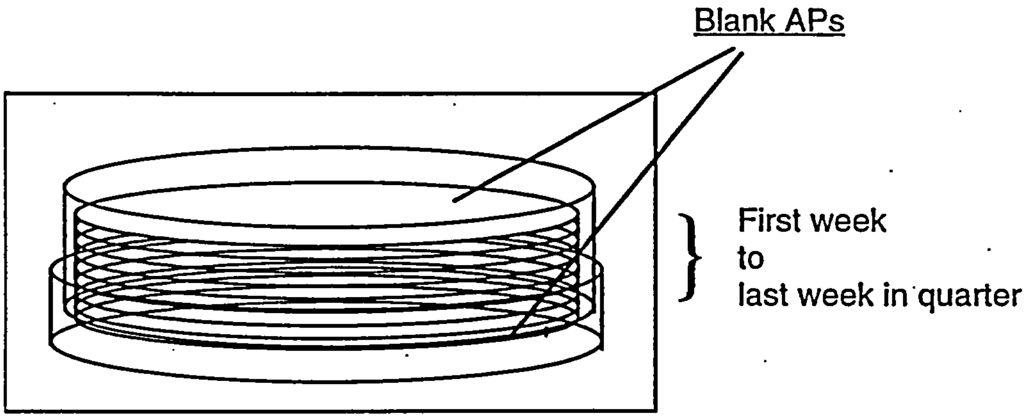
11. After counting, samples are stored in the warehouse, according to client's requirements.

PROCEDURE for COMPOSITING AIR PARTICULATE FILTERS FOR GAMMA SPECTROSCOPIC ANALYSIS

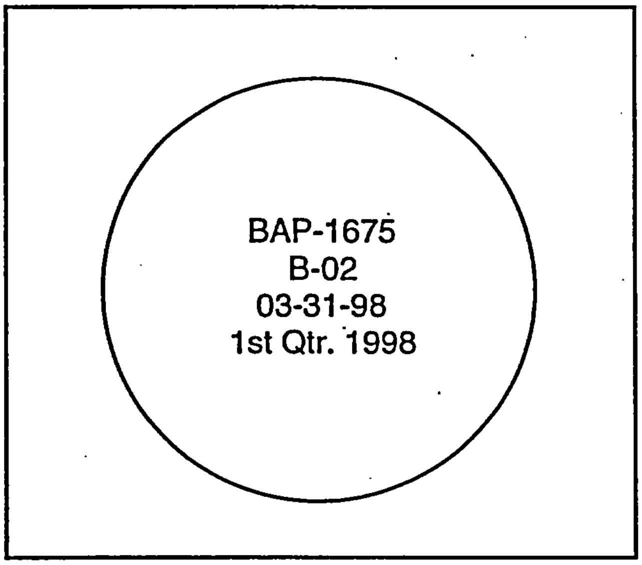
Example

• Sample ID (project)	BAP
• Sample No.	2
• Location	1675
• Last Collection Date	03-31-98
• Collection Period	1st Qtr. 1998

2



Side View



2

Top View

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MIDWEST LABORATORY

DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN WATER

(DISSOLVED SOLIDS OR TOTAL RESIDUE)

PROCEDURE NO. TIML-W(DS)-01

Prepared by

Teledyne Brown Engineering Environmental Services
Midwest Laboratory

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Revision #	Date	Pages	Prepared by	Approved by
0	11-25-85	4	B. Grob	L.G. Huebner
1	02-28-91	4	B. Grob	L.G. Huebner
2	05-03-91	4	B. Grob	L.G. Huebner
3	08-14-92	4	B. Grob	L.G. Huebner
4	07-21-98	4	D. Rieter	

DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN WATER

(Dissolved Solids or Total Residue)[a]

Principle of Method

Water samples containing suspended matter are filtered through a membrane filter and the filtrate is analyzed. The filtered water sample is evaporated and the residue is transferred to a tared planchet for counting gross alpha and gross beta activity.

Reagents

All chemicals should be of "reagent-grade" or equivalent whenever they are commercially available.

Lucite: 0.5 mg/ml in acetone
Nitric acid, HNO_3: 16 N (concentrated), 1 N (62 ml of N HNO_3 diluted to 1 liter)

Apparatus

Filter, membrane Type AA, 0.08
Filtration equipment
Planchets (Standard 2"x1/8" stainless steel, ringed planchet)
Electric hotplate
Heat lamp
Drying oven
Muffle furnace
Analytical Balance
Dessicator
Proportional counter

Procedure

1. Filter a volume of sample containing not more than 100 mg of dissolved solids for alpha assay, or not more than 200 mg of dissolved solids for beta assay.[a]

   NOTE: For gross alpha and gross beta assay in the same sample, limit the amount of solids to 100 mg.

2. Filter sample through a membrane filter. Wash the sides of the funnel with deionized (D. I.) water. Discard the filter, unless determining suspended solids also. See procedure TIML-W(SS-)02.

3. Evaporate the filtrate to NEAR dryness on a hot plate.

4. Add 20 ml of concentrated HNO_3 and evaporate to NEAR dryness again.

   NOTE: If water samples are known or suspected to contain chloride salts, these chloride salts should be converted to nitrate salts before the sample residue is transferred to a stainless steel planchet. (Chlorides will attack stainless steel and increase the sample solids. No correction can be made for these added solids.) Chloride salts can be converted to nitrate salts by adding concentrated HNO^3 and evaporating to near dryness.

5. Transfer quantitatively the residue to a TARED PLANCHET, using an unused plastic disposable pipette for each sample, (not more than 1 or 2 ml at a time) evaporating each portion to dryness under the lamp. Spread residue uniformly on the planchet.

   NOTE: Non-uniformity of the sample residue in the counting planchet interferes with the accuracy and precision of the method.

6. Wash the beaker with DI water several times and combine the washings and the residue in the planchet, using the rubber policeman to wash the walls. Evaporate to dryness.

   NOTE: Rinse the rubber policeman with DI water between samples.

7. Bake in muffle furnace at 400 ° C for 45 minutes, cool and weigh.

   NOTE: If the sample is very powdery, add a few drops (6-7) of the Lucite solution and dry under the infrared lamp for 10-20 minutes.

8. Store the sample in a dessicator until ready to count since vapors from the moist residue can damage the detector and the window and can cause erratic measurements.

9. Count the gross alpha and/or the gross beta activity in a low background proportional counter.

   NOTE: If the gas-flow internal proportional counter does not discriminate for the higher energy alpha pulses at the beta plateau, the activity must be subtracted from the beta plus alpha activity. This is particularly important for samples with high alpha activity.

   Samples may be counted for beta activity immediately after baking; alpha counting should be delayed at least 72 hours (until equilibrium has occurred).

[a] For analysis of total residue (for clear water), proceed as described above but do not filter the water. Measure out the appropriate amount and proceed to Step 3.

Calculations

Gross alpha (beta) activity:

$$\text{pCi/L} = \frac{A}{B \times C \times D \times 2.22} \pm \frac{2\sqrt{E^2_{sb}+E^2_{b}}}{B \times C \times D \times 2.22}$$

Where:

A = Net alpha (beta) count (cpm)

B = Efficiency for counting alpha (beta) activity (cpm/dpm)

C =Volume of sample (liters)

D = Correction factor for self-absorption (See Proc. TIML-AB-02)

E_{sb} =Counting error of sample plus background

E_b = Counting error of background

References: Radio assay Procedures for Environmental Samples, US. Department of Health, Education and Welfare. Environmental Health Series, Jan. 1967.

EPA Prescribed Procedures for Measurement of Radioactivity in Drinking Water. August 1980

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DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN WATER

(SUSPENDED SOLIDS)

PROCEDURE NO. TIML-W(SS)-02

Prepared by

Teledyne Brown Engineering Environmental Services
Midwest Laboratory

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Revision #	Date	Pages	Prepared by	Approved by
0	10-21-86	4	L.G. Huebner	L.G. Huebner
1	08-14-92	4	B. Grob	L.G. Huebner
2	07-21-98	3		BGrob

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DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN WATER

(SUSPENDED SOLIDS)

Principle of Method

The sample is filtered through a tared membrane filter. The filter containing the solids is placed on a ringless, stainless steel planchet and air dried, then placed in a dessicator until ready for weighing. The gross alpha and gross beta activities are measured in a low background internal proportional counter.

Reagent

Acetone

Apparatus

Filter, membrane Type AA 0.08
Filtration equipment
Planchets (Standard 2"x1/8" stainless steel, ringless planchet)
Heat lamp
Analytical Balance
Dessicator
Proportional counter

Procedure

1. Filter one liter of sample through a TARED membrane filter. Wash the sides of the funnel with deionized water.

   NOTE: If the sample contains sand, place it in the separatory funnel, allow the sand to settle for 30 minutes, then drain off the sand at the bottom. Shake the funnel and repeat as above two (2) more times.

2. Place the filter on a ringless planchet and air dry for 24 hours.

3. Dry under the infrared lamp for 20-30 minutes. Desiccate to constant weight and weigh.

4. Count for gross alpha and gross beta activity using a proportional counter.

5. Calculate the activity in pCi/L, using the computer program designed for this analysis.

Calculations

Gross alpha (beta) activity:

$$\text{pCi/L} = \frac{A}{B \times C \times D \times 2.22} \pm \frac{2\sqrt{E^2{}_{sb} + E^2{}_b}}{B \times C \times D \times 2.22}$$

Where:

A = Net alpha (beta) count (cpm)

B = Efficiency for counting alpha (beta) activity (cpm/dpm)

C =Volume of sample (liters)

D = Correction factor for self-absorption (See Proc. TIML-AB-02)

E_{sb} =Counting error of sample plus background

E_b = Counting error of background

References: Radio assay Procedures for Environmental Samples, U.S. Department of Health, Education and Welfare. Environmental Health Series, January 1967.

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DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN SOLID SAMPLES

PROCEDURE NO. EIML-AB-01

Prepared by

Environmental, Inc.
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Revision #	Date	Pages	Prepared by	Approved by
0	08-04-86	4	B Grob	LG Huebner
1	08-14-92	5	B Grob	LG Huebner
2	06-11-01	3	SA Coorlim	

DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN SOLID SAMPLES

Principle of Method

100 mg to 200 mg of sample is distributed evenly on a 2" ringed planchet, counted in a proportional counter, and concentrations of gross alpha and /or gross beta are calculated.

A. Vegetation, Meat, Fish, and Wildlife

Procedure

1. Weigh out accurately in a planchet no more than 100 mg of ashed or dried and ground sample for gross alpha assay and no more than 200 mg for gross beta assay.

   NOTE: If both gross alpha and gross beta analyses are required, do not use more than 100mg.

2. Add a few drops of water and spread uniformly over area of the planchet. Dry under a heat lamp.

NOTE: If necessary, a few drops (6-7) of a lucite solution (0.5 mg/ml in acetone) may be added to keep residue in place. Dry under an infrared lamp for 10-20 minutes. 2

4. Store the planchets in a dessicator until counting.

5. Count the gross alpha and gross beta activity in a low background proportional counter.

Calculations

Gross alpha / gross beta activity:

$$(\text{pCi/g wet}) = \frac{A}{B \times C \times D \times F \times 2.22} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{B \times C \times D \times F \times 2.22}$$

Where:

A = Net alpha / beta counts (cpm)
B = Efficiency for counting alpha / beta activity (cpm/dpm)
C = Weight of sample (grams), ash or dry
D = Correction factor for self absorption (See Proc. TIML-AB-02)
E_{sb} = Counting error of sample plus background
E_b = Counting error of background
F = Ratio of wet weight to ashed or dry weight

REFERENCES: Radioassay Procedures for Environmental Samples, U.S. Department of Health, Education and Welfare. Environmental Health Series, January 1967.

B. Gross Alpha and/or Gross beta in Soil and Bottom Sediments

Procedure

1. Weigh out accurately in a planchet no more than 100 mg of a pulverized sample for a gross alpha assay and no more than 200 mg for a gross beta assay.

   NOTE: If both gross alpha and gross beta analyses are required, do not use more than 100mg.

2. Add a few drops of water and spread uniformly over area of the planchet. Dry under a heat lamp.

NOTE: If necessary, a few drops (6-7) of a lucite solution (0.5 mg/ml in acetone) may be added to keep residue in place. Dry under an infrared lamp for 10-20 minutes. 2

3. Store the planchets in a dessicator until counting.
4. Count the gross alpha and gross beta activity in a low background proportional counter.

Calculations

Gross alpha / gross beta activity:

$$(\text{pCi/g dry}) = \frac{A}{B \times C \times D \times F \times 2.22} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{B \times C \times D \times F \times 2.22}$$

Where:

A = Net alpha / beta counts (cpm)
B = Efficiency for counting alpha / beta activity (cpm/dpm)
C = Weight of sample (grams)
D = Correction factor for self absorption (See Proc. EIML-AB-02)
E_{sb} = Counting error of sample plus background
E_b = Counting error of background
F = Ratio of wet weight to ashed or dry weight

REFERENCES: Radioassay Procedures for Environmental Samples, U.S. Department of Health, Education and Welfare. Environmental Health Series, January 1967,

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DETERMINATION OF GAMMA EMITTERS BY GAMMA SPECTROSCOPY

(GERMANIUM DETECTORS)

GS-01

Prepared by

Environmental Inc.
Midwest Laboratory

Copy No. ______________

Revised Pages	Revision #	Date	Pages	Prepared by	Approved by
Reprint	2	07-01-98	3	F. G. Shaw	S. A. Coorlim
	3	02-03-04	4	S. A. Coorlim	

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DETERMINATION OF GAMMA EMITTERS BY GAMMA SPECTROSCOPY

(GERMANIUM DETECTORS)

Principle of Method

Samples are weighed or measured into calibrated containers and set directly on an HPGe (high-purity germanium) detector. The sample is counted for a sufficient length of time necessary to reach the required MDA (Minimum Detectable Activity). Results are decay corrected to the date of collection, where appropriate, using a dedicated computer and software.

Apparatus

Counting Containers
Counting Equipment
Cylinders
Marking Pens
Recording Books

A. Milk, Water, and other Liquid Samples

1. Measure with a graduated cylinder, 500 mL, 1.0 L, 2.0 L or 3.5 L of sample into a calibrated sample container (Marinelli beaker). Use the largest volume possible, based on available sample quantity.
2. Affix a label to the container cover with the sample number, volume, date and time of collection. Mark "I-131" if analysis for I-131 by gamma spectroscopy is required.
3. Count for estimated time required to meet the client's specifications. Record file number, sample identification number, date and time counting started, detector number, geometry, sample size, and date and time of collection.
4. Stop the counting; transfer the spectrum to the disk, and print out the results.
5. Check the results for required MDAs. If the client's specifications are not met, continue the counting.
6. Once the required MDAs have been met, record the counting time.
7. Return the sample to the original container and mark with a red marker.

NOTE: Refer to procedure OP-10, Operating Procedure for the EG&G ORTEC OMNIGAM Gamma Spectroscopy System.

B. Airborne Particulates

1. Place the air filters in a small Petrie dish following Procedure AP-03.
2. Place Petrie dish (with marked side up) on the detector and count long enough to meet the client specifications. Record the file number, sample identification number, date and time counting started, detector number, geometry, sample size, and date and time collected.

NOTE: When counting individual filters, place in a labeled Petrie dish with active (deposit) side up.

3. Stop counting and transfer spectrum to the disk. Print out and check the results before removing the sample. If client specifications are not met, continue counting.
4. When the required MDAs have been met, record the counting time.
5. Replace air filters in the original envelopes for storage or further analyses.

NOTE: Refer to procedure OP-10, Operating Procedure for the EG&G ORTEC OMNIGAM Gamma Spectroscopy System.

C. Other Samples

NOTE: Samples, e.g. soil, vegetation, fish, powdered samples, etc., are prepared in the prep lab and delivered to the counting room

1. Place the sample on the detector and count long enough to meet client's technical requirements. Record the file number, sample identification number, date and time counting started, detector number, geometry, sample size, and date (and time, if applicable) of collection.
2. Stop the counting and transfer the spectrum to the disk. Print out and check the results before removing the sample. If client specifications are not met, continue counting.
3. When the required MDAs have been met, record the counting time. Mark the container with red marker and return to the prep lab for transfer to storage or further analyses.

NOTE: Refer to procedure OP-10, Operating Procedure for the EG&G ORTEC OMNIGAM Gamma Spectroscopy System.

D. Charcoal Cartridges

For counting charcoal cartridges, follow Procedure I-131-02, I-131-04 or I-131-05.

CALCULATIONS:

Activity (pCi/L) ± the two sigma error for a select gamma peak, region of interest (ROI) =

$$\frac{A}{2.22 \times C \times D \times G \times Y} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{2.22 \times C \times D \times G \times Y}$$

where:

A = Net cpm, (ROI)

C = Volume of sample (liter)

G = Efficiency (cpm/dpm)

Y = Abundance (% of gamma disintegrations)

E_{sb} = Counting error of sample plus background

E_b = Counting error for background.

D = Correction for decay to the time of collection $= e^{-\lambda t}$ or $e^{\frac{-0.693 \times t}{t\frac{1}{2}}}$

where:

t = elapsed time from the time of collection to the counting time (in days)

$t\frac{1}{2}$ = half-life

MDA (Minimum Detectable Activity) is calculated using the RISO method.

$$\text{MDA} = 4.65 \times \frac{\sqrt{B}/LT}{2.22 \times C \times D \times G \times Y}$$

where:

B = Background (cpm)

LT = Live time (min)

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DETERMINATION OF TRITIUM IN WATER
(DIRECT METHOD)

PROCEDURE NO. EIML-T-02

Prepared by

Environmental Inc., Midwest Laboratory

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Revision #	Date	Pages	Prepared by	Approved by
0	11-22-85	5	B Grob	L. G. Huebner
1	09-27-91	4	B Grob	L. G. Huebner
2	04-24-95	4	B Grob	L. G. Huebner
3	07-07-98	4	D. Rieter	B Grob
4	06-06-00	4	R. Amrofdin	B Grob
5	01-29-02	4		

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DETERMINATION OF TRITIUM IN WATER (DIRECT METHOD)

Principle of Method

The water sample is purified by distillation, a portion of the distillate is transferred to a counting vial and the scintillation fluid added. The contents of the vial are thoroughly mixed and counted in aliquot scintillation counter.

Reagents

Scintillation medium, Ultima-Gold LLT, Packard Instruments Co.
Tritium standard solution
Dead water
Ethyl alcohol
Sodium Hydroxide (pellets)
Potassium permanganate (crystals)

Apparatus

Condenser
Distillation flask, 250-mL capacity
Liquid scintillation counter
Pipette and disposable tips (0.1ml., 5-10 ml.)
Kimwipes

Procedure

NOTE: All glassware must be dry. Set drying oven for 100-125°C.

1. Place 60-70 mL of the sample in a 250-mL distillation flask. Add a boiling chip to the flask. Add one NaOH pellet and about 0.02g KMnO4. Connect a side arm adapter and a condenser to the outlet of the flask. Place a receptacle at the outlet of the condenser. Set variac at 70 mark. Heat to boiling to distill. Discard the first 5-10mL of distillate. Collect next 20-25mL of distillate for analysis. Do not distill to dryness.

2. Mark the vial caps with the sample number and date.

   NOTE: Use the same type of vial for the whole batch (samples, background and standard.)

3. Mark three vial caps "BKG-1", " BKG-2", " BKG-3", and date.

4. Mark three vial caps "ST-1", " ST-2", " ST-3"; standard number, and date.

5. Dispense 13 mL of sample into marked vials and "dead" water into vials marked BKG-1, BKG-2, BKG-3.

NOTE 1: The Pipette is set (and calibrated) to deliver 6.5 mL, so pipette twice into each vial. Use new tip for each sample and new tip (one) for three background samples.

NOTE 2: Make sure the pipette has not been reset. If it has been reset, or if you are not sure, do not use it; check with your supervisor.

NOTE 3: Make sure the plastic tip is pushed all the way on the pipette and is tight. If it is not, the air will be draw in and the volume withdrawn will not be correct (it will be smaller).

6. Dispense 13 mL (see Notes 1, 2, and 3, above) of "dead" water into each vial marked "ST-1", "ST-2" and "ST-3."

7. Using a 0.1 mL pipette, withdraw water from each of the three standard vials. Discard this 0.1 mL of water.

8. Take a new 0.1 mL tip. Dispense 0.1 mL of standard into each of the three vials marked "ST-1," "ST-2," and "ST-3."

9. Take all vials containing samples, background, and standard to the counting room.

   NOTE: To avoid spurious counts, scintillation fluid should not be added under fluorescent light.

10. Dispense 10 mL of scintillation fluid into each vial (one at a time), cap tightly, and shake VIGOROUSLY for at least 30 seconds. Recheck the cap for tightness.

11. Wet a Kimwipe with alcohol and wipe off each vial in the following order:
    Background
    Samples
    Standard

12. Load the vials in the following order:
    BKG-1
    ST-1
    Samples
    BKG -2*
    ST -2*
    Samples
    BKG-3
    ST -3

    *BKG-2 and ST-2 should be approximately in the middle of the batch

13. Let the vials dark- and temperature-adapt for about one hour.

NOTE 1: To check if vials have reached counter temperature, inspect one vial (Bkg). The liquid should be transparent. If the temperature is too high (or too low), the liquid will be white and very viscous.

NOTE 2: The temperature inside the counter should be between 10° and 14°C (check thermometer). In this temperature range, the liquid is transparent.

14. Set the counter for 100-minute counting time and infinite cycles. (Follow manufacturer's procedure for setting the counter.)

15. Fill out the loading sheet, being sure to indicate the date and time counting started, and your initials.

NOTE 1: Do not count prepared background and standard sets with another batch of samples if plastic vials are used. Prepare new backgrounds and standards for each batch.

NOTE 2: If glass vials are used, the prepared background and standard sets can be counted with other batches up to one month after preparation, provided they are not taken out of the counter (not warmed up) and the same vial type from the same manufacturing batch (the same carton) is used. After one month prepare new sets of backgrounds and standards.

Calculations

$$\mathrm{pCi/L} = \frac{\dfrac{A}{t_1} - \dfrac{B}{t_2}}{2.22EVe^{-\lambda t_3}} + \frac{2\sqrt{\dfrac{A}{t_1^2} + \dfrac{B}{t_2^2}}}{2.22EVe^{\lambda t_3}}$$

Where:

A = Total counts, sample
B = Total counts, background
E = Efficiency, (cpm/dpm)
V = Volume (liter)
e = Base of the natural logarithm = 2.71828
λ = $\dfrac{0.693}{12.26} = 0.5652$
t_1 = Counting time, sample
t_2 = Counting time, background
t_3 = Elapsed time from the time of collection to the time of counting (in years)

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DETERMINATION OF I-131 IN MILK BY ANION EXCHANGE (BATCH METHOD)

PROCEDURE NO. I-131-01

Prepared by

Environmental Inc., Midwest Laboratory

Copy No. ____________

Revised Pages	Revision #	Date	Pages	Prepared by	Approved by
Reprint	5	09-24-92	5	B. Grob	L. G. Huebner

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Determination of I-131 in milk by Ion Exchange

(Batch Method)

Principle of Method

Iodine, as the iodide, is concentrated by adsorption on an anion resin. Following a NaCl wash, the iodine is eluted with sodium hypochlorite. Iodine in the iodate form is reduced to I_2 and the elemental iodine extracted into $CHCl_3$, back-extracted into water, then finally precipitated as palladium iodide.

Chemical recovery of the added carrier is determined gravimetrically from the PdI_2 precipitate. I-131 is determined by beta counting the PdI_2.

Reagents

Anion Exchange Resin, Dowex 1-X8 (20-50 mesh) chloride form
Chloroform, $CHCl_3$ - reagent grade
Hydrochloric Acid, HCl, 1N
Hydrochloric Acid, HCl, 3N
Wash Solution: H_2O - HNO_3 - NH_2OH HCL, 50 mL H_2O; 10 mL 1M - NH_2OH-HCl;
10 mL conc. HNO_3
Hydroxylamine Hydrochloride, NH_2OH HCl - 1 M
Nitric Acid, HNO_3 - concentrated
Palladium Chloride, $PdCl_2$, 7.2 mg Pd^{++}/mL (1.2 g $PdCl_2$/100 mL of 6N HCl)
Sodium Bisulfite, $NaHSO_3$ - 1 M
Sodium Chloride, NaCl – 2 M
Sodium Hypochlorite, NaOCl - 5% (Clorox)
Potassium Iodide, KI, ca 29 mg KI/mL (See Proc. CAR-01 for preparation)

Special Apparatus

Chromatographic Column, 20 mm x 150 mm (Reliance Glass Cat. #R2725T)
Vacuum Filter Holder, 2.5 cm^2 filter area
Filter Paper, Whatman #42, 21 mm
Mylar
Polyester Gummed Tape, 1 1/2", Scotch #853
Heat Lamp

Determination of I-131 in milk by Ion Exchange

(Batch Method)

Part A

Ion Exchange Procedure

1. Transfer 2 liters (if available) of sample to the beaker. Add 1.00 mL of standardized iodide carrier to each sample.

2. Add a clean magnetic stirring bar to each sample beaker. Stir each sample for 5 minutes or longer on a magnetic stirrer. Allow sample to equilibrate at least 1/2 hour. If a milk sample is curdled or lumpy, vacuum filter the sample through a Buchner funnel using a cheesecloth filter. Wash the curd thoroughly with deionized water, collecting the washings with the filtrate. Pour the filtrate back into the original washed and labeled 4 liter beaker and discard the curd.

3. Add approximately 45 grams of Dowex 1X8 (20-50 mesh) anion resin to each sample beaker and stir on a magnetic stirrer for at least 1 hour. Turn off the stirrer and allow the resin to settle for 10 minutes.

4. Gently decant and discard the milk or water sample taking care to retain as much resin as possible in the beaker. Add approximately 1 liter of deionized water to rinse the resin, allow to settle 2 minutes, and pour off the rinse. Repeat rinsing in the case of milk samples until all traces of milk are removed from the resin.

5. Using a deionized water wash bottle, transfer the resin to the column marked with the sample number. Allow resin to settle 2 minutes and drain the standing water. Wash the resin with 100 mL of 2 M NaCl.

6. Measure 50 mL 5% sodium hypochlorite in a graduated cylinder. Add sodium hypochlorite to column in 10-20 mL increments, stirring resin as needed.to eliminate gas bubbles and maintain a flow rate of 2 mL/min. Collect eluate in 250 mL beaker and discard the resin.

Part B

Iodine Extraction Procedure

CAUTION: Perform the following steps in the fume hood.

1. Acidify the eluate from Step 6 by adding ca. 15 mL of concentrated HNO_3 to make the sample 2-3 N in HNO_3 and transfer to a 250 mL separatory funnel. (Add the acid slowly with stirring until the vigorous reaction subsides).

2. Add 50 mL of $CHCl_3$ and 10 mL of 1 M hydroxylamine hydrochloride (freshly prepared). Extract iodine into organic phase (about 2 minutes equilibration). Draw off the organic phase (lower phase) into another separatory funnel.

3. Add 25 mL of $CHCl_3$ and 5 mL of 1 M hydroxylamine hydrochloride to the first separatory funnel and again equilibrate for 2 minutes. Combine the organic phases. Discard the aqueous phase (upper phase).

4. Add 20 mL H_2O-HNO_3-NH_2OH HCl wash solution to the separatory funnel containing the $CHCl_3$. Equilibrate 2 minutes. Allow phases to separate and transfer $CHCl_3$ (lower phase) to clean separatory funnel. Discard the wash solution.

5. Add 25 mL H_2O and 10 drops of 1 M sodium bisulfite (freshly prepared) to the separatory funnel containing the $CHCl_3$. Equilibrate for 2 minutes. Discard the organic phase (lower phase). Drain aqueous phase (upper phase) into a 100 mL beaker. Proceed to the Precipitation of PdI_2.

Determination of I-131 in milk by Ion Exchange

(Batch Method)

Part C

Precipitation of Palladium Iodide

CAUTION: AMMONIUM HYDROXIDE INTERFERES WITH THIS PROCEDURE

1. Add 10 mL of 3 N HCl to the aqueous phase from the iodine extraction procedure in Step 5.
2. Place the beaker on a stirrer-hot plate. Using the magnetic stirrer, boil and stir the sample until it evaporates to 30 mL or begins to turn yellow.
3. Turn the heat off. Remove the magnetic stirrer, rinse with deionized water.
4. Add, dropwise, to the solution, 2.0 mL of palladium chloride.
5. Cool the sample to room temperature. Place the beaker with sample on the stainless steel tray and put in the refrigerator overnight.
6. Weigh a clean 21 mm Whatman #42 filter which has been dried under a heat lamp.
7. Place the weighed filter in the filter holder. Filter the sample and wash the residue with water and then with absolute alcohol.
8. Remove filter from filter holder and place it in the labeled petri dish.
9. Dry under the lamp for 5-10 minutes.
10. Weigh the filter with the precipitate and calculate the carrier recovery.
11. Cut a 1-1/2" strip of polyester tape and lay it on a clean surface, gummed side up. Place the filter, precipitate side up, in the center of the tape.
12. Cut a 1-1/2" wide piece of mylar. Using a spatula to press it in place, put it directly over the precipitate and seal the edges to the polyester tape. Trim to about 5 mm from the edge of the filter with scissors.
13. Mount the sample on a plastic disc and write the sample number on the back side of the disc.
14. Count the sample on a proportional beta counter.

Determination of I-131 in milk by Ion Exchange

(Batch Method)

Calculations

Calculate the sample activity using computer program I131.

I-131 concentration:

$$(\text{pCi/L}) = \frac{A}{2.2 \times B \times C \times D \times R} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{2.22 \times B \times C \times D \times R}$$

where:

A = Net cpm, sample

B = Efficiency for counting beta I-131 (cpm/dpm)

C = Volume of sample (liters)

D = Correction for decay to the time of collection = $e^{-\lambda t}$ =

$$Exp\left(-\frac{0.693 \times t}{8.04}\right) = e^{-0.0862t}$$

where t = elapsed time from the time of collection to the counting time (in days)

E_{sb} = Counting error of sample plus background

E_b = Counting error of background

R = Carrier recovery

2.22 = dpm/pCi

Reference: "Determination of I-131 by Beta-Gamma coincidence Counting of PdI_2". Radiological Science Laboratory. Division of Laboratories and Research, New York State Department of Health, March 1975, Revised February 1977.

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DETERMINATION OF AIRBORNE I-131 IN CHARCOAL CARTRIDGES BY GAMMA SPECTROSCOPY (BATCH METHOD)

PROCEDURE NO. TIML-I-131-02

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revised Pages	Revision #	Date	Pages	Prepared by	Approved by
	0	07-04-86	3	B. Grob	LG Huebner
1,2,3,4	1	08-01-92	4	B. Grob	LG Huebner

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DETERMINATION OF AIRBORNE I-131 IN CHARCOAL CARTRIDGES BY GAMMA SPECTROSCOPY (BATCH METHOD)

Principle of Method

Five or six cartridges are mounted in a specially designed holder and counted. A peak of 0.36 MeV is used to calculate the concentration at counting time. The concentration at the end of collection is then calculated.

NOTE: This procedure is used for screening only. If I-131 is detected, each cartridge from the batch is analyzed individually.

Materials

Charcoal Cartridges

Apparatus

Counting Container
Germanium Detector
Rubber Band

Procedure

NOTE: Because of the short half-life of I-131, count the samples as soon as possible after receipt, but no later than 8 days after collection.

1. Load the charcoal cartridges in a specially designed holder with the rim facing the detector and the arrow (if there is one - not all cartridges have arrows) pointing away from the detector (see Figure 1). Use rubber band to hold side mounted cartridges in place.
2. Place the holder on the detector and count for a period of time that will meet the required Lower Limit of Detection (LLD).
3. Calculate concentration of I-131 at counting time by inputting sample ID, volume (use $1m^3$) and date and time (midpoint) of counting. Submit printout to data clerk for final calculations without delay.

NOTE: If I-131 is detected, (positive result) count each cartridge from the batch individually in accordance with Procedure TIML-I-131-04 and notify supervisor immediately.

Calculations:

A_1 = I-131 concentration (pCi/sample) = $\frac{A}{2.22 \times B}$ (at counting time)

Where:

A = Net count rate of I-131 in the 0.36 MeV peak (cpm)

B = Efficiency for the I-131 in 0.36 MeV peak (cpm/dpm)

2.22 = dpm/pCi

I-131 concentration at the time of collection:

$$(\text{pCi/m}^3) = \frac{A_1}{C \times D} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{C \times D}$$

where:

C = Volume of sample (m^3)
D = Correction for decay to the time of collection = $e^{-\lambda t}$ =

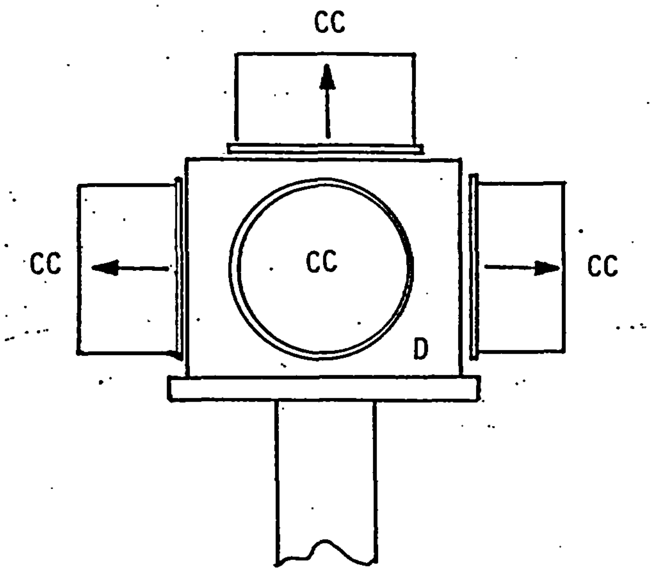
$$\text{Exp}\left(-\frac{0.693 \times t}{8.04}\right) = e^{-0.0862t}$$

where t = elapsed time from the time of collection to the counting time (in days)

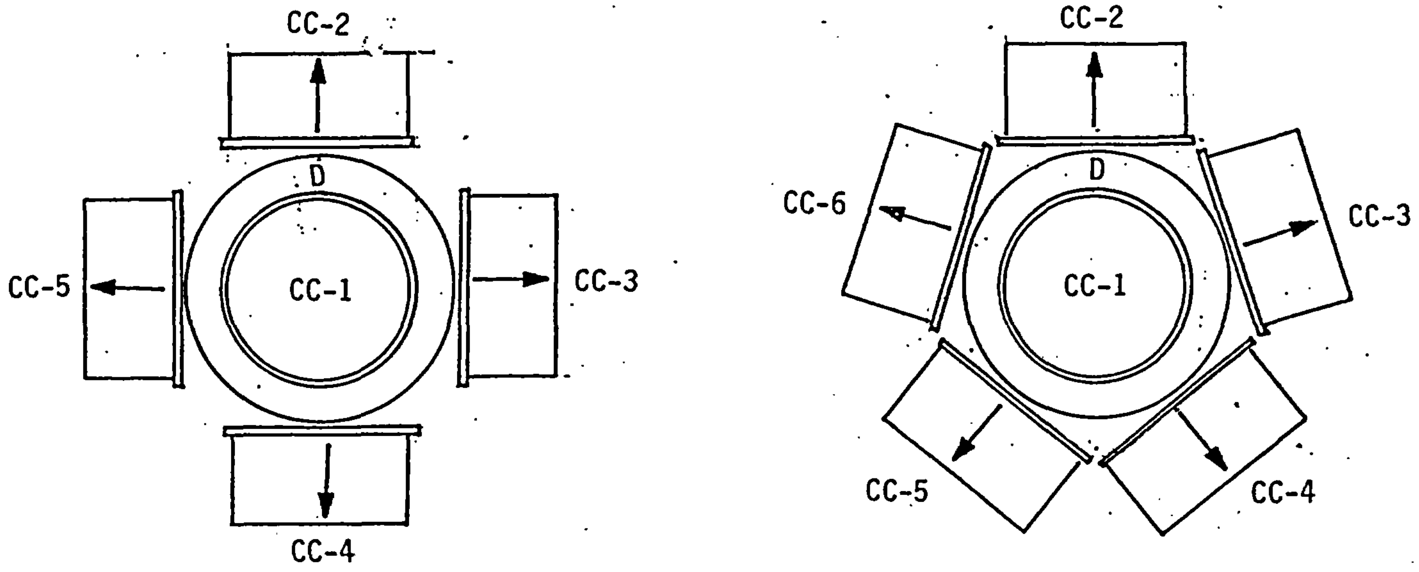
E_{sb} = Counting error of sample plus background

E_b = Counting error of background

Figure 1.



Side View (5 CC's)



5 CC's

6 CC's

Top View

Charcoal Cartridge: CC
Germanium Detector: D

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DETERMINATION OF SR-89 AND SR-90 IN WATER
(CLEAR OR DRINKING WATER)

PROCEDURE NO. TIML-SR-02

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revision No.	Date	Pages	Prepared by	Approved by
0	03-21-86	7	J. Kattner	

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Determination of Sr-89 and Sr-90 in Water

Principle of Method

The acidified sample of clear water with stable strontium, barium, and calcium carriers is treated with oxalic acid at a pH of 3.0 to precipitate insoluble oxalates. The oxalates are dissolved in nitric acid, and strontium nitrate is separated from calcium as a precipitate in 70% nitric acid. The residue is purified by adding iron and rare earth carriers and precipitating them as hydroxides. After a second strontium nitrate precipitation from 70% nitric acid, the nitrates are dissolved in acid with added yttrium carrier and are stored for ingrowth of yttrium-90. The ittrium is again precipitated as hydroxide and separated from strontium with the strontium being in the supernate. Each fraction is precipitated separately as an oxalate (yttrium) and carbonate (strontium) and collected on No. 42 (2.4 cm) Whatman filter for counting.

Reagents

Ammonium acetate buffer: pH 5.0
Ammonium hydroxide, NH_4OH: concentrated (15N), 6 N
Ammonium oxalate, $(NH_4)_2C_2O_4.H_2O$: 0.5% w/v
Carrier solutions:
    Ba^{+2} as barium nitrate, $Ba(NO_3)2$: 20 mgBa^{+2} per ml
    Ca^{+2} as calcium nitrate, $Ca(NO_3)_24H_2O$: 40 mg Ca^{+2} per ml
    Sr^{+2} as strontium nitrate, $Sr(NO_3)_2$: 20 mg Sr^{+2} per ml
    Y^{+3} as yttrium nitrate, $Y(NO_3)$: 10 mg $^{+3}$ per ml
Hydrochloric acid, HCl: concentrated (3 N)
Nitric acid, HNO_3: Fuming (90%), concentrated (16 N), 6 N
Oxalic acid, $H_2C_2O_2$. $2H_2O$: Saturated at room temperature
Scavenger solutions: 20 mg Fe^{+3} per ml, 10 mg each Ce^{+3} and Zr^{+4} per ml
    Fe^{+} as ferric chloride, $FeCl_3.hH_2O$
    Ce^{+3} as cerous nitrate, $Ce(NO_3)_3.6H_2O$
    Zr^{4} as zirconyl chloride, $ZrOCl_2.8H_2O$
Sodium carbonate, Na_2CO_3:3N, 0.1N
Sodium chromate, Na_2CrO_4:3N

Apparatus

Analytical balance
Low background beta counter
pH meter

Procedure

1. Measure 1 liter of acidified water into a 2 liter beaker.

   NOTE: If the sample contains foreign mater, such as sand, dirt, etc., filter through a 47 mm glass fiber filter using suction flask.

2. To acidified clear water in a 2 liter beaker, add 1 ml of strontium carrier solution, 1 ml barium carrier solution, and if necessary, 1 ml of calcium carrier solution. (Improved precipitation may be obtained by additng calcium to soft waters.) Stir thoroughly, and while stirring add 125 ml of saturated oxalic acid solution.

3. Using a pH meter, adjust the pH to 3.0 with 15N NH_4OH and allow the precipitate to settle for 5 - 6 hours or overnight.

4. Decant to waste most of the supernate (liquid) and transfer the precipitate to a 250 ml centrifuge bottle using D.I. water. Discard the supernate to waste.

5. Dissolve the precipitate with 10 ml of 6N HNO^3 and transfer to a 250 ml beaker. Then use 20 ml of 16N HNO^3 to rinse the centrifuge tube and combine it to the solution in the 250 ml beaker.

6. Evaporate the solution to dryness. Cool; then add 50 ml 16N HNO_3 and repeat the acid addition and evaporation until the residue is colorless.

7. Transfer the residue to a 40 ml centrifuge tube, rinsing with a minimum volume of 16N HNO_3. Cover with parafilm and cool in an ice bath. Centrifuge at 1500 - 1800 rpm for 10 minutes, and discard the supernate to waste.

8. Dissolve the precipitate in 5 ml of 6N HNO_3 and then add 30 ml of fuming nitric acid. Cover with parafilm, cool in the ice bath, centrifuge, and discard the supernate to waste.

9. Dissolve the nitrate precipitate in about 10 ml of D.I. water (perform under the hood). Add 1 ml of scavenger solution. Adjust the pH of the mixture to 7 with 6N HN_4OH. Heat in hot water bath for 10 minutes, stir, and filter through a Whatman No. 541 filter into another 40 ml centrifuge tube. Discard the mixed hydroxide precipitate (filter paper).

10. To the filtrate, add 5 ml of ammonium acetate buffer. Adjust the pH with 3N HNO_3 or NH_4OH to pH 5.5.

    NOTE: The pH of the solution at this point is critical.

    Add dropwise with stirring 1 ml of 3N Na_2CrO_4 solution, stir, and heat in a water bath.

11. Cool and centrifuge. Decant the supernate into another 40 ml centrifuge tube. (Save the precipitate for Ba analysis if needed.)

Procedure

12. Heat the supernate in a water bath. Adjust the pH to 8 - 8.5 with NH_4OH. With continuous stirring, cautiously add 5 ml of 3N Na_2CO_3 solution. Heat gently for 10 minutes. Cool, centrifuge, and decant the supernate to waste. Wash the precipitate with 0.1N Na_2CO_3. Centrifuge again and decant the supernate to waste.

13. Dissolve the precipitate in no more than 4 ml of 3N HNO_3. Then add 20 - 30 ml of fuming HNO_3, cover with parafilm, cool in a water bath, and centrifuge. Decant and discard the supernate.

14. Repeat Step 13. Then RECORD THE TIME AND DATE AS THE BEGINNING OF YTTRIUM-90 INTROWTH.

15. Dissolve precipitate in 4 ml of 6N HNO_3 and add 1 ml of yttrium carrier solution.

16. Cover with parafilm and store for 7 - 14 days.

    NOTE: At this point, the sample can be transferred to a glass scintillation vial for the ingrowth storage. Use several portions of 6N HNO^3 (a total of not more than 4 ml); then add 1 ml of yttrium carrier to the vial.)

Separation

NOTE: If the sample was stored in the scintillation vial, transfer back into 40 ml centrifuge tube using a few drops of 6N HNO_3 as a rinse.

1. After storage (ingrowth period), heat the 40 ml centrifuge tube containing the samle in the hot water bath (approximately 90°C) for 10 minutes.

2. Adjust pH to 8 with NH_4OH, stirring continuously.

3. Cool in a cold water bath and centrifuge for 5 minutes.

4. Decant the supernate into a 40 ml centrifuge tube marked with the sample number and "SR-89." RECORD THE DATE AND TIME OF DECANTATION AS THE END OF Y-90 ingrowth in SR fraction and the beginning of its decay in Y-90 fraction.

5. Redissolve the precipitate by adding 3 - 4 drops of 6N HCl and add 5 - 10 ml of D.I. water with stirring.

6. Repeat Steps 1, 2, and 3.

7. Combine supernate with the one in Step 4.

Determination

A. Strontium-90 (Yttrium-90)

1. Add 3 drops of 6N HCl to dissolve the precipitate; then add 5 - 10 ml of water. Heat in a water bath at approximately 90°C. Add 1 ml of saturated oxalic acid solution dropwise with vigorous stirring. Adjust to a pH of 2 - 3 with NH_4OH. Allow the precipitate to digest for about an hour.

   NOTE: Do Part "B" while precipitate is digesting.

2. Cool to room temperature in a cold wate bath. Centrifuge for 10 minutes and decant most of the supernate. filter by suction on a weighed 2.5 cm filter paper. Wash the precipitate with water and alcohol.

3. Dry the precipitate under the lamp for 30 minutes. Cool and weigh. Mount and count without delay in a proportional counter. (See Part C for mounting.)

B. Strontium-89 (Total Strontium)

1. Heat the solution from Step 7 in water bath.

2. Adjust the pH to 8 - 8.5 using NH_4OH.

3. With continuous stirring, add 5 ml of 3N Na_2CO_3 solution. Stir until precipitate appears. Heat gently for 10 minutes.

4. Cool and filter on a weighed No. 42 (2.4 cm) Whatman filter paper.

5. Wash thoroughly with water and alcohol.

6. Mount and count without delay its beta activity as "total radiostrontium" in a proportional counter.

C. Filtering and Mounting

1. Place filters under heat lamps for 30 minutes before weighing.

2. Use Mettler balance (Serial No. 343112) for weighing.

3. Label a clean petri dish with the weight of the filter paper. (After samples are filtered, the filter paper will again be dried and weighed to determine weight of precipitate before mounting.)

C. Filtering and Mounting (continued)

4. Mount weighed filter paper and precipitate on nylon disk using 1" transparent tape to hold filter paper and 2" mylar foil placed over precipitate and held in place with slip-ring. Trim off excess mylar foil and place the mounted sample in a labeled petri dish.

5. Fill out corresponding loading sheets and place samples in counting room.

Calculations

Part A

$$\text{Strontium-90 Concentration (pCi/liter)} = \frac{A}{B \times C \times D \times E \times F}$$

Where:

A = Net beta count rate of yttrium 90 (cpm)

B = Recovery of yttrium carrier

C = Counter efficiency for counting yttrium-90 or yttrium oxalate mounted on a 2.4 cm diameter filter paper (cpm/pCi)

D = Sample volume (liters)

E = Correction factor $e^{-\lambda t}$ for yttrium-90 decay, where t is the time from the time of cdecantation (Step 4, Separation) to the time of counting

F. Correction factor $1-e^{-\lambda t}$ for the degree of equilibrium attained during the yttrium-90 ingrowth period, where t is the time from collection of the water sample to the time of decantation (Step 4, Separation)

Part B

Strontium-89 Concentration (pCi/liter) = $\frac{1}{B \times C} \cdot \frac{A}{D \times E} - F\ (G \times H + I\ X\ J)$

Where:

A = Net beta count rate of "total radiostrontium" (cpm)

B = Counter efficiency for counting strontium-89 as strontium carbonate mounted on a 2.4 cm diameter filter paper (cpm/pCi)

C = Correction factor $e^{-\lambda t}$ for strontium-89 decay, where t is the time from sample collection to the time of counting

D = Recovery of strontium carrier

E = Volume of water sample (liters)

F = Strontium-90 concentration (pCi/liter) from Part A

G = Self-absorption factor for strontium-90 as strontium carbonate mounted on a 2.4 cm diameter filter, obtained from a self-absorption curve prepared by plotting the fraction of a standard activity absorbed against density thickness of the sample (mg/cm^2)

H = Counter efficiency for counting strontium-90 as strontium carbonate mounted on a 2.4 cm diameter filter paper (cpm/pCi)

I = Counter efficiency for counting yttrium-90 as yttrium oxalate mounted on a a2.4 cm diameter filter paper (cpm/pCi)

J = Correction factor $1-e^{-\lambda t}$ for yttrium-90 ingrowth, where it is the time from the last decantation of the nitric acid (Step 4, Separation)

REFERENCE: Radioassay Procedures for Environmental Samples, U. S. Department of Health, Education, and Welfare. Environmental Health Series, January 1967.

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DETERMINATION OF SR-89 AND SR-90 IN ASHED SAMPLES (VEGETATION, FISH, ETC.)

PROCEDURE NO. TIML-SR-05

Prepared by
Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revision No.	Date	Pages	Prepared by	Approved by
0	07-23-86	7	P. Grob	L. J. Huebner

DETERMINATION OF SR-89 AND SR-90 IN ASHED SAMPLES (VEGETATION, FISH, ETC.)

Principle of Method

The sample with stable strontium and barium carriers added is leached in nitric acid and filtered. After filtration, filtrate is reduced in volume by evaporation. The residue is purified by adding iron and rare earth carriers and precipitating them as hydroxides. After a second strontium nitrate precipitation from 70% nitric acid, the nitrates are dissolved in acid again with added yttrium carrier and are stored for ingrowth of yttrium-90. The yttrium is precipitated as hydroxide and separated from strontium with the strontium being in the supernate. Each fraction is precipitated separately as an oxalate (yttrium) and carbonate (strontium) and collected on No. 42 (2.4 cm) Whatman filter for counting.

Reagents

Ammonium acetate buffer: pH 5.0
Ammonium hydroxide, NH_4OH: concentrated (15N), 6 N
Carrier solutions: Ba^{+2} as barium nitrate, $Ba(NO_3)2$: 20 mgBa^{+2} per ml
  Sr^{+2} as strontium nitrate, $Sr(NO_3)_2$: 20 mg Sr^{+2} per ml
  Y^{+3} as yttrium nitrate, $Y(NO_3)$: 10 mg $^{+3}$ per ml
Hydrochloric acid, HCl: 6 N
Nitric acid, HNO_3: Fuming (90%), concentrated (16 N), 6 N
Oxalic acid, $H_2C_2O_2$. $2H_2O$: Saturated at room temperature
Scavenger solutions: 20 mg Fe^{+3} per ml, 10 mg each Ce^{+3} and Zr^{+4} per ml
  Fe^+ as ferric chloride, $FeCl_3.6H_2O$
  Ce^{+3} as cerous nitrate, $Ce(NO_3)_3.6H_2O$
  Zr^4 as zirconyl chloride, $ZrOCl_2.8H_2O$
Sodium carbonate, Na_2CO_3:3N, 0.1N
Sodium chromate, Na_2CrO_4:3N

Apparatus

Analytical balance
Low background beta counter
pH meter

Procedure

1. Weigh 3 g of ash and transfer to the 250 ml beaker.
2. Add 50 ml concentrated nitric acid.
3. Add 1 ml strontium and 1 ml barium carrier solutions.
4. Place the sample on the moderate hot plate under the hood and cover with the watch glass.
5. Allow to leach for 2 hours or longer.
6. Remove sample beaker from the hot plate and allow to cool to room temperature.
7. Add deionized water, filling to 100 ml; mark on the beaker.
8. Filter the sample through Whatman No. 541 filter paper.
9. Place the filtrate on the moderate hot plate under the hood and gently evaporate to 5 ml.
10. Transfer the sample into 40 ml centrifuge tube. Rinse the beaker with 16N HNO_3. Add rinsing to the tube.
11. Centrifuge for 10 minutes and discard the supernate to waste.
12. Carefully add 30 ml of concentrated HNO_3 to the precipitate. Heat in a hot water bath for about 30 minutes, stirring occassionally. Cool the sample in an ice water bath for about 5 minutes. Centrifuge and discard the supernate.
13. Repeat Step 12.
14. Dissolve the nitrate precipitate in about 10 ml of D.I. water (perform under the hood). Add 1 ml of scavenger solution. Adjust the pH of the mixture to 7 with 6N NH_4OH. Heat in hot water bath for 10 minutes, stir, and filter through a Whatman No. 541 filter into another 40 ml centrifuge tube. Discard the mixed hydroxide precipitate (filter paper).
15. To the filtrate, add 5 ml of ammonium acetate buffer. Adjust the pH with 6N HNO_3 or NH_4OH to pH 5.5.

    NOTE: The pH of the solution at this point is critical.

    Add dropwise with stirring 1 ml of 3N Na_2CrO_4 solution, stir, and heat in a water bath.
16. Cool and centrifuge. Decant the supernate into another 40 ml centrifuge tube. (Save the precipitate for Ba analysis if needed.)

Procedure (continued)

17. Heat the supernate in a water bath. Adjust the pH to 8 - 8.5 with NH_4OH. With continuous stirring, add 5 ml of 3N Na_2CO_3 solution. Heat gently for 10 minutes. Cool, centrifuge, and decant the supernate to waste. Wash the precipitate with 0.1N Na_2CO_3. Centrifuge again and decant the supernate to waste.

18. Dissolve the precipitate in no more than 4 ml of 3N HNO_3. Then add 20 - 30 ml of fuming HNO_3, cover with parafilm, cool in a water bath, and centrifuge. Decant and discard the supernate.

19. Repeat Step 13. Then RECORD THE TIME AND DATE AS THE BEGINNING OF YTTRIUM-90 INTROWTH.

20. Dissolve precipitate in 4 ml of 6N HNO_3 and add 1 ml of yttrium carrier solution.

21. Cover with parafilm and store for 7 - 14 days.

    NOTE: At this point, the sample can be transferred to a glass scintillation vial for the ingrowth storage. Use several portions of 6N HNO_3 (a total of not more than 4 ml); then add 1 ml of yttrium carrier to the vial.)

Separation

NOTE: If the sample was stored in the scintillation vial, transfer back into 40 ml centrifuge tube using a few drops of 6N HNO_3 as a rinse.

1. After storage (ingrowth period), heat the 40 ml centrifuge tube containing the sample in the hot water bath (approximately 90°C) for 10 minutes.

2. Adjust pH to 8 with NH_4OH, stirring continuously.

3. Cool in a cold water bath and centrifuge for 5 minutes.

4. Decant the supernate into a 40 ml centrifuge tube marked with the sample number and "SR-89." RECORD THE DATE AND TIME OF DECANTATION AS THE END OF Y-90 INGROWTH in SR fraction and the beginning of its decay in Y-90 fraction.

5. Redissolve the precipitate by adding 3 - 4 drops of 6N HCl and add 5 - 10 ml of D.I. water with stirring.

6. Repeat Steps 1, 2, and 3.

7. Combine supernate with the one in Step 4.

Determination

A. Strontium-90 (Yttrium-90)

1. Add 3 drops of 6N HCl to dissolve the precipitate; then add 5 - 10 ml of water. Heat in a water bath at approximately 90°C. Add 1 ml of saturated oxalic acid solution dropwise with vigorous stirring. Adjust to a pH of 2 - 3 with NH_4OH. Allow the precipitate to digest for about an hour.

   NOTE: Do Part "B" while precipitate is digesting.

2. Cool to room temperature in a cold water bath. Centrifuge for 10 minutes and decant most of the supernate. Filter by suction on a weighed 2.5 cm filter paper. Wash the precipitate with water and alcohol.

3. Dry the precipitate under the lamp for 30 minutes. Cool and weigh. Mount and count without delay in a proportional counter. (See Part C for mounting.)

B. Strontium-89 (Total Strontium)

1. Heat the solution from Step 7 in water bath.

2. Adjust the pH to 8 - 8.5 using NH_4OH.

3. With continuous stirring, add 5 ml of 3N Na_2CO_3 solution. Stir until precipitate appears. Heat gently for 10 minutes.

4. Cool and filter on a weighed No. 42 (2.4 cm) Whatman filter paper.

5. Wash thoroughly with water and alcohol.

6. Mount and count without delay its beta activity as "total radiostrontium" in a proportional counter.

C. Filtering and Mounting

1. Place filters under heat lamps for 30 minutes before weighing.

2. Use Mettler balance (Serial No. 343112) for weighing.

3. Label a clean petri dish with the weight of the filter paper. (After samples are filtered, the filter paper will again be dried and weighed to determine weight of precipitate before mounting.)

C. Filtering and Mounting (continued)

4. Mount weighed filter paper and precipitate on nylon disk using 1" transparent tape to hold filter paper and 2" mylar foil placed over precipitate and held in place with slip-ring. Trim off excess mylar foil and place the mounted sample in a labeled petri dish.

5. Fill out corresponding loading sheets and place samples in counting room.

Calculations

Part A

Strontium-90 Concentration (pCi/g wet) =

$$\frac{A}{2.22 \times B \times C \times D \times E \times F \times G} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{2.22 \times B \times C \times D \times E \times F \times G}$$

Where:

A = Net beta count rate of yttrium 90 (cpm)

B = Recovery of yttrium carrier

C = Counter efficiency for counting yttrium-90 or yttrium oxalate mounted on a 2.4 cm diameter filter paper (cpm/dpm)

D = Sample size (grams), ash

E = Correction factor $e^{-\lambda t}$ for yttrium-90 decay, where t is the time from the time of decantation (Step 4, Separation) to the time of counting

F = Correction factor $1-e^{-\lambda t}$ for the degree of equilibrium attained during the yttrium-90 ingrowth period, where t is the time from collection of the water sample to the time of decantation (Step 4, Separation)

G = Ratio of wet weight to ashed weight

E_{sb} = Counting error of sample plus background

E_b = Counting error of background

Part B

Strontium-89 Concentration (pCi/g wet) =

$$\frac{1}{2.22 \times B \times C}\left[\frac{A}{D \times E \times K} - F\,(G \times H + I \times J)\right] \pm \frac{2\sqrt{E_{sb}^{2} + E_{b}^{2}}}{2.22 \times B \times C \times D \times E \times F \times K}$$

Where:

A = Net beta count rate of "total radiostrontium" (cpm)

B = Counter efficiency for counting strontium-89 as strontium carbonate mounted on a 2.4 cm diameter filter paper (cpm/dpm)

C = Correction factor $e^{-\lambda t}$ for strontium-89 decay, where t is the time from sample collection to the time of counting

D.= Recovery of strontium carrier

E = Sample size (grams), ash

F = Strontium-90 concentration (pCi/g wet) from Part A

G = Self-absorption factor for strontium-90 as strontium carbonate mounted on a 2.4 cm diameter filter, obtained from a self-absorption curve prepared by plotting the fraction of a standard activity absorbed against density thickness of the sample (mg/cm^2)

H = Counter efficiency for counting strontium-90 as strontium carbonate mounted on a 2.4 cm diameter filter paper (cpm/ dpm)

I = Counter efficiency for counting yttrium-90 as yttrium oxalate mounted on a 2.4 cm diameter filter paper (cpm/ dpm)

J = Correction factor $1-e^{-\lambda t}$ for yttrium-90 ingrowth, where it is the time from the last decantation of the nitric acid (Step 4, Separation)

K = Ratio of wet weight to ashed weight

REFERENCE: Radioassay Procedures for Environmental Samples, U. S. Department of Health, Education, and Welfare. Environmental Health Series, January 1967.

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DETERMINATION OF SR-89 AND SR-90 IN SOIL AND BOTTOM SEDIMENTS

PROCEDURE NO. TIML-SR-06

Prepared by
Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revision No.	Date	Pages	Prepared by	Approved by
0	07-23-86	9	B. Grob	

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DETERMINATION OF SR-89 AND SR-90 IN SOIL AND BOTTOM SEDIMENTS

Principle of Method

The sample with stable strontium and barium carriers added is leached in hydrochloric acid. After separation from calcium, the residue is purified by adding iron and rare earth carriers and precipitating them as hydroxides. After a second strontium nitrate precipitation from 70% nitric acid, the nitrates are dissolved in acid again with added yttrium carrier and are stored for ingrowth of yttrium-90. The yttrium is precipitated as hydroxide and separated from strontium with the strontium being in the supernate. Each fraction is precipitated separately as an oxalate (yttrium) and carbonate (strontium) and collected on No. 42 (2.4 cm) Whatman filter for counting.

Reagents

Ammonium acetate buffer: pH 5.0
Ammonium hydroxide, NH_4OH: concentrated (15N), 6N
Carrier solutions: Ba^{+2} as barium nitrate, $Ba(NO_3)2$: 20 mgBa^{+2} per ml
    Sr^{+2} as strontium nitrate, $Sr(NO_3)_2$: 20 mg Sr^{+2} per ml
    Y^{+3} as yttrium nitrate, $Y(NO_3)$: 10 mg $^{+3}$ per ml
Hydrochloric acid, HCl: 6 N
Nitric acid, HNO_3: Fuming (90%), concentrated (16N), 6N, 1:1
Oxalic acid, $H_2C_2O_2$. $2H_2O$: Saturated at room temperature
Scavenger solutions: 20 mg Fe^{+3} per ml, 10 mg each Ce^{+3} and Zr^{+4} per ml
    Fe^{+} as ferric chloride, $FeCl_3.6H_2O$
    Ce^{+3} as cerous nitrate, $Ce(NO_3)_3.6H_2O$
    Zr^4 as zirconyl chloride, $ZrOCl_2.8H_2O$
Sodium carbonate, Na_2CO_3:3N, 0.1N
Sodium chromate, Na_2CrO_4:3N

Apparatus

Analytical balance
Centrifuge
Hot plate
Low background beta counter
pH meter
Plastic disc and ring
Stirrer

Procedure

1. Weigh out a 100 g sample into a 1 liter beaker. Add 1 ml of strontium carrier and 1 ml of Ba carrier.
2. Stir mechanically while slowly adding 200 ml of 6N HCl. (It may be necessary to add a few drops of octyl alcohol to prevent excessive frothing.) Continue stirring for about 30 minutes. Allow a minimum of two hours for the insoluble material to settle.
3. Stir the mixture and filter with suction through a 24 cm Whatman No. 42 filter paper using a Buchner funnel. Wash the residue with hot water. Wash with 6N HCl and again with hot water until the yellow color of ferric chloride is removed. Discard the residue.
4. Transfer the filtrate to a 1 liter beaker and evaporate to approximately 200 ml. Cool and slowly add 200 ml of concentrated HNO_3. (If there is excessive frothing, add a few drops of octyl alcohol.) Evaporate to 100-200 ml.
5. Add 500 ml of water and stir.
6. Add 25 grams of oxalic acid with magnetic stirring until it is completely dissolved.
7. Adjust the pH to 5.5 - 6.0 with concentrated NH_4OH. (If the brown color of ferric hydroxide persists, add more oxalic acid and readjust the pH.) The optimum condition is an excess of oxalic acid in solution without causing crystallization of ammonium oxalate upon cooling.
8. Allow precipitate to settle for 5 - 6 hours or overnight.
9. Decant most of the supernate (liquid) and transfer the precipitate to a 250 ml centrifuge tube using deionized water for rinsing. Add rinsing to the tube. Centrifuge and decant supernate.
10. Wash the precipitate with 50 - 100 ml portion of water and centrifuge again.
11. Repeat washing as needed until all the yellow color of the solution has been removed.
12. Cool the precipitate and dissolve it with 6N HNO_3 and transfer it in a 250 ml beaker. Rinse the tube with 6N HNO_3, making the total volume to 50 - 100 ml. Add about 6 drops of H_2O_2 (30%) to facilitate dissolution.
13. Cool to room temperature. If insoluble material is present at this point, filter by suction through a glass fiber filter. Discard the filter and residue.

Procedure (continued)

14. Transfer the solution to an appropriate size beaker and evaporate to dryness. The evaporation must be done slowly to avoid spattering.

15. Dissolve the salt in water and perform successive fuming nitric acid separations (the first two separations at concentration slightly greater than 75%) until the strontium has been separated from the bulk of the calcium. Samples with a high calcium content will require five or more separations.

16. The volumes of 75% HNO_3 vary (fuming solutions may be changed as required by the mass of calcium present, keeping in mind that minimum volumes are always best).

17. If calcium content is still thick, evaporate the solution to dryness and bake.

18. Dissolve the residue with 50 ml boiling water and filter. Discard residue.

19. Evaporate the solution to dryness again.

20. Cool and dissolve the residue in a minimum amount of water and add 50 ml of fuming HNO_3.

21. Continue the fuming nitric acid separations until the strontium has been separated from the bulk of calcium.

22. Transfer the solution to a 40 ml conical, heavy-duty centrifuge tube, using a minimum of concentrated HNO_3 to effect the transfer. Cool the centrifuge tube in an ice bath for about 10 minutes. Centrifuge and discard the supernatant.

    NOTE: The precipitate consists of calcium, strontium, and barium-radium nitrate.

    The supernatant contains part of the sample's calcium and phosphate content.

23. Add 30 ml of concentrated HNO_3 to the precipitate. Heat in a hot water bath with stirring for about 10 minutes. Cool the solution in an ice bath, stirring for about 5 minutes. Centrifuge and discard the supernatant.

    NOTE: Additional calcium is removed from the sample.

    Nitrate precipitations with 70% HNO_3 will afford a partial decontamination from soluble calcium, while strontium, barium, and radium are completely precipitated.

Procedure (continued)

23. NOTE: (continued)

The separation of calcium is best at 60% HNO_3; however, at 60% the precipitation of strontium is not complete. Therefore, it is common practice to precipitate $Sr(No_3)_2$ with 70% HNO_3, which is the concentration of commercially available 16N HNO_3.

Most of the other fission products, induced acitivities, and actinides are soluble in concentrated HNO_3, affording a good "gross" decontamination step from a wide spectrum of radionuclides. The precipitation is usually repeated several times.

24. Repeat Step 23 two (2) more times.

25. Dissolve the nitrate precipitate in about 20 ml distilled water. Add 1 ml of scavenger solution. Adjust the pH of the mixture to 7 with 6N NH_4OH. Heat, stir, and filter through a Whatman No. 541 filter. Discard the mixed hydroxide precipitate.

26. To the filtrate, add 5 ml of ammonium acetate buffer. Adjust the pH with 6 N HNO_3 or NH_4OH to pH 5.5.

NOTE: The pH of the solution at this point is critical.

Add dropwise with stirring 1 ml of 3N Na_2CrO_4 solution, stir, and heat in a water bath.

27. Cool and centrifuge. Decant the supernate into another 40 ml centrifuge tube. (Save the precipitate for barium analysis if needed.)

28. Heat the supernate in a water bath. Adjust the pH to 8 - 8.5 with NH_4OH. With continuous stirring, add 5 ml of 3N Na_2CO_3 solution. Heat gently for 10 minutes. Cool, centrifuge, and decant the supernate to waste. Wash the precipitate with 0.1N Na_2CO_3. Centrifuge again and decant the supernate to waste.

29. Dissolve the precipitate in no more than 4 ml of 3N HNO_3. Then add 20 - 30 ml of fuming HNO_3, cover with parafilm, cool in a water bath, and centrifuge. Decant and discard the supernate.

30. Repeat Step 13. Then RECORD THE TIME AND DATE AS THE BEGINNING OF YTTRIUM-90 INTROWTH.

31. Dissolve precipitate in 4 ml of 6N HNO_3 and add 1 ml of yttrium carrier solution.

Procedure (continued)

32. Cover with parafilm and store for 7 - 14 days.

    NOTE: At this point, the sample can be transferred to a glass scintillation vial for the ingrowth storage. Use several portions of 6N HNO_3 (a total of not more than 4 ml); then add 1 ml of yttrium carrier to the vial.)

Separation

NOTE: If the sample was stored in the scintillation vial, transfer back into 40 ml centrifuge tube using a few drops of 6N HNO_3 as a rinse.

1. After storage (ingrowth period), heat the 40 ml centrifuge tube containing the sample in the hot water bath (approximately 90°C) for 10 minutes.
2. Adjust pH to 8 with concentrated NH_4OH, stirring continuously.
3. Cool in a cold water bath and centrifuge for 5 minutes.
4. Decant the supernate into a 40 ml centrifuge tube marked with the sample number and "SR-89." RECORD THE DATE AND TIME OF DECANTATION AS THE END OF Y-90 INGROWTH in SR fraction and the beginning of its decay in Y-90 fraction.
5. Redissolve the precipitate by adding 3 - 4 drops of 6N HCl and add 5 - 10 ml of D.I. water with stirring.
6. Repeat Steps 1, 2, and 3.
7. Combine supernate with the one in Step 4.

Determination

A. Strontium-90 (Yttrium-90)

1. Add 3 drops of 6N HCl to dissolve the precipitate; then add 5 - 10 ml of water. Heat in a water bath at approximately 90°C. Add 1 ml of saturated oxalic acid solution dropwise with vigorous stirring. Adjust to a pH of 2 - 3 with concentrated NH_4OH. Allow the precipitate to digest for about an hour.

   NOTE: Do Part "B" while precipitate is digesting.

Determination (continued)

A. Strontium-90 (Yttrium-90) (continued)

2. Cool to room temperature in a cold water bath. Centrifuge for 10 minutes and decant most of the supernate. Filter by suction on a weighed 2.5 cm filter paper. Wash the precipitate with water and alcohol.
3. Dry the precipitate under the lamp for 30 minutes. Cool and weigh. Mount and count without delay in a proportional counter. (See Part C for mounting.)

B. Strontium-89 (Total Strontium)

1. Heat the solution from Step 7 in water bath.
2. Adjust the pH to 8 - 8.5 using concentrated NH_4OH.
3. With continuous stirring, add 5 ml of 3N Na_2CO_3 solution. Stir until precipitate appears. Heat gently for 10 minutes.
4. Cool and filter on a weighed No. 42 (2.4 cm) Whatman filter paper.
5. Wash thoroughly with water and alcohol.
6. Mount and count without delay its beta activity as "total radiostrontium" in a proportional counter.

C. Filtering and Mounting

1. Place filters under heat lamps for 30 minutes before weighing.
2. Use Mettler balance (Serial No. 343112) for weighing.
3. Label a clean petri dish with the weight of the filter paper. (After samples are filtered, the filter paper will again be dried and weighed to determine weight of precipitate before mounting.)
4. Mount weighed filter paper and precipitate on nylon disk using 1" transparent tape to hold filter paper and 2" mylar foil placed over precipitate and held in place with slip-ring. Trim off excess mylar foil and place the mounted sample in a labeled petri dish.
5. Fill out corresponding loading sheets and place samples in counting room.

Calculations

Part A

Strontium-90 Concentration (pCi/g dry) =

$$\frac{A}{2.22 \times B \times C \times D \times E \times F} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{2.22 \times B \times C \times D \times E \times F}$$

Where:

A = Net beta count rate of yttrium 90 (cpm)

B = Recovery of yttrium carrier

C = Counter efficiency for counting yttrium-90 or yttrium oxalate mounted on a 2.4 cm diameter filter paper (cpm/dpm)

D = Sample weight (grams), dry

E = Correction factor $e^{-\lambda t}$ for yttrium-90 decay, where t is the time from the time of decantation (Step 4, Separation) to the time of counting

F = Correction factor $1-e^{-\lambda t}$ for the degree of equilibrium attained during the yttrium-90 ingrowth period, where t is the time from collection of the water sample to the time of decantation (Step 4, Separation)

E_{sb} = Counting error of sample plus background

E_b = Counting error of background

Part B

Strontium-89 Concentration (pCi/g dry) =

$$\frac{1}{2.22 \times B \times C}\left[\frac{A}{D \times E} - F\,(G \times H + I \times J)\right] \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{2.22 \times B \times C \times D \times E \times F}$$

Where:

A = Net beta count rate of "total radiostrontium" (cpm)

B = Counter efficiency for counting strontium-89 as strontium carbonate mounted on a 2.4 cm diameter filter paper (cpm/dpm)

C = Correction factor $e^{-\lambda t}$ for strontium-89 decay, where t is the time from sample collection to the time of counting

D = Recovery of strontium carrier

E = Sample weight (grams), dry

F = Strontium-90 concentration (pCi/g dry) from Part A

G = Self-absorption factor for strontium-90 as strontium carbonate mounted on a 2.4 cm diameter filter, obtained from a self-absorption curve prepared by plotting the fraction of a standard activity absorbed against density thickness of the sample (mg/cm^2)

H = Counter efficiency for counting strontium-90 as strontium carbonate mounted on a 2.4 cm diameter filter paper (cpm/dpm)

I = Counter efficiency for counting yttrium-90 as yttrium oxalate mounted on a 2.4 cm diameter filter paper (cpm/dpm)

J = Correction factor $1-e^{-\lambda t}$ for yttrium-90 ingrowth, where it is the time from the last decantation of the nitric acid (Step 4, Separation).

REFERENCE: Radioassay Procedures for Environmental Samples, U. S. Department of Health, Education, and Welfare. Environmental Health Series, January 1967.

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DETERMINATION OF SR-89 AND SR-90 IN MILK
(ION EXCHANGE BATCH METHOD)

PROCEDURE NO. TIML-SR-07

Prepared by
Teledyne Isotopes Midwest Laboratory

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Revision #	Date	Pages	Prepared by	Approved by
0	06-15-88	9		LG Huebner
1	11-20-90	10		LG Huebner
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3	12-07-93	10		LG Huebner
4	08-18-94	10		LG Huebner

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DETERMINATION OF SR-89 AND SR-90 IN MILK (ION EXCHANGE BATCH METHOD)

Principle of Method

A citrate complex of strontium carrier at the pH of milk is added to the milk sample. Strontium, barium, and calcium are absorbed on the cation-exchange resin.

Strontium, barium, and calcium are eluted from the cation-exchange resin with sodium chloride solution. Following dilution of the eluate, the alkaline earths are precipitated as carbonates. The carbonates are then converted to nitrates. Strontium is purified by Argonne method (modified at Teledyne Isotopes Laboratory in Westwood, NJ, and TIML) using three grams of extraction material in a chromatographic column. Yttrium carrier is added and a sample is stored for ingrowth of yttrium-90. The yttrium is again precipitated as hydroxide and separated 3 from strontium with the strontium being in the supernate. Each fraction is precipitated separately as an oxalate (yttrium) and carbonate (strontium) and collected on No. 42 (2.4 cm) Whatman filter for counting.

The concentration of Sr-89 is calculated as the difference between the activity for "total radiostrontium" and the activity due to Sr-90.

Reagents

Ammonium hydroxide, NH_4OH: concentrated (15N)
Carrier solutions:
    Sr^{+2} as strontium nitrate, $Sr(NO_3)_2$: 20mg Sr^{+2} per mL
    Y^{+3} as yttrium nitrate, $Y(NO_3)_3$: 10 mg Y^{+3} per mL
Cation-exchange resin: Dowex 50W-X8 (Na^+ form, 50-100 mesh)
Citrate solution: pH 6.5
DI water
Ethyl alcohol, C_2H_5OH: 95%
Hydrochloric acid, HCl: 6N
Nitric acid, HNO_3: 3N
Oxalic acid, $H_2C_2O_2 \cdot 2H_2O$: 2N
Sodium carbonate, Na_2CO_3: 3N
Sodium chloride, NaCl: 4N
Silver nitrate, $AgNO_3$: 1N
Strontium Spec Resin

Apparatus

Ion-exchange system: The apparatus for this system is illustrated in Figure Sr-07-1. At the top is a 1-liter glass separatory funnel which serves as the reservoir. Below it is connected a 250 mL glass column, 5 cm in diameter and 25 cm long, which services as the cation column. Column has extra coarse, fritted glass disc at the bottom.

Millipore filtering apparatus (Pyrex Hydrosol Microanalysis Filter Holder)

Chromatographic Column |3

Preparation and regeneration of cation resin:

1. Wash 170 mL of Dowex 50W resin to fill the cation column.
2. Pass 500 mL of 1N NaOH through the column at a flow rate of 10 mL/minute.
3. Rinse with 500-1000 mL of H_2O.
4. Test effluent with $AgNO_3$. If effluent is clear, the resin is ready for milk.

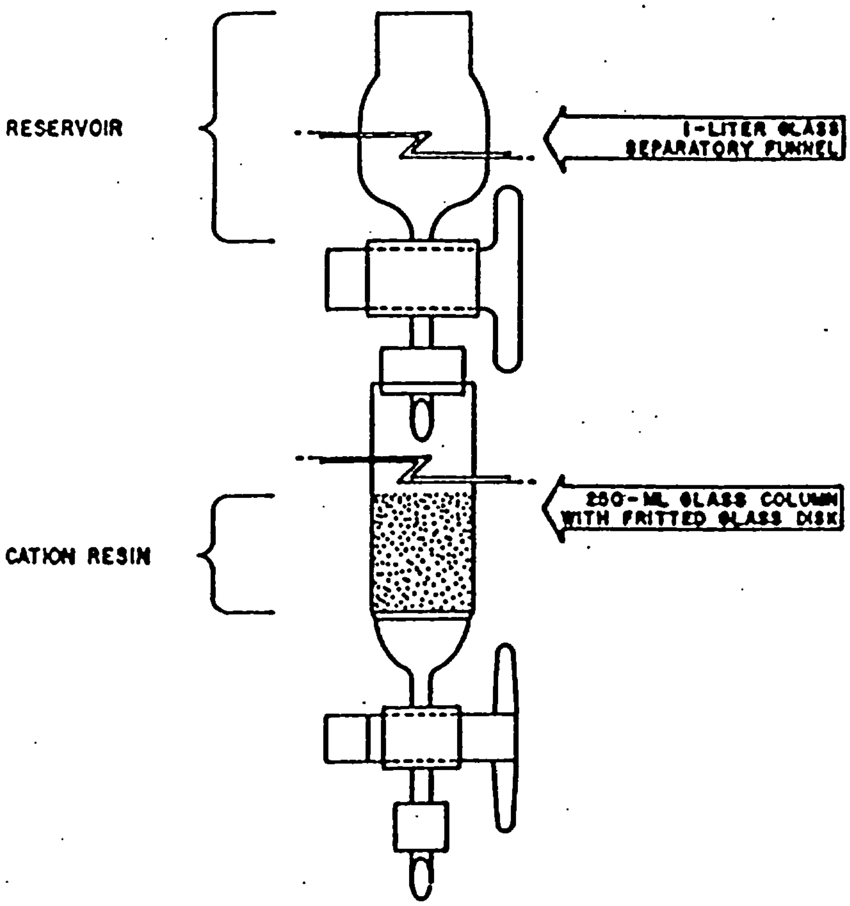

Figure SR-07-01

Part A

Total Radiostrontium (Sr-89, -90 Separation)

Procedure

1. Place 1 liter of milk in 4 liter beaker.
2. Pipette 1.0 mL of strontium carrier solution into 10 mL of citrate solution. Swirl to mix. 3
3. Transfer the mixture quantitatively to the milk with 5 mL of DI water.
4. Add a clean magnetic stirring bar to each sample beaker. Stir each sample for 5 minutes or longer on a magnetic stirrer. Allow sample to equilibrate at least 1/2 hour. If a milk sample is curdled or lumpy, vacuum filter the sample through a Buchner funnel using a cheesecloth filter. Wash the curd thoroughly with deionized water, collecting the washings with the filtrate. Pour the filtrate back into the original washed and labeled 4-liter beaker and discard the curd.
5. Add approximately 170 mL of Dowex 50Wx8 (50-100 mesh) cation resin to each sample beaker and stir on a magnetic stirrer for 2 hours. Turn off the stirrer and allow the resin to settle for 10 minutes. 3
6. Gently decant and discard the milk sample, taking care to retain as much resin as possible in the beaker. Add approximately 1 liter of deionized water to rinse the resin, allow to settle 2 minutes, and pour off the rinse. Repeat rinsing until all traces of milk are removed from the resin.
7. Using a DI water wash bottle, transfer the resin to the column marked with the sample number. Allow resin to settle 2 minutes and drain the standing water.
8. Connect 1-liter separatory funnel containing 1 liter of 4N NaCl to the cation column. Allow the solution to flow at 10 mL/minute to elute the alkali metal and alkaline earth ions and to recharge the column. Collect 1 liter of eluate into a 2-liter beaker, but leave the resin covered with 2-3 mL of solution.
9. Wash the column with 500 mL of H_2O or more to remove excess NaCl. Discard the wash.
10. Remove 20 mL of the NaCl eluate into a small bottle for the determination of stable calcium, if required (see procedure on calcium determination).
11. Dilute the eluate to 1500 mL with DI water. 3
12. Heat the solution to 85-90°C (near boiling on a hot plate) and add, with constant stirring, 100 mL of 3N Na_2CO_3. Cover with watch glass. Let stand overnight.
13. Decant most of the supernate to waste. Transfer the precipitate to a 250 mL centrifuge bottle with DI water.
14. Centrifuge. Pour off the supernate to waste. Dry the precipitate in an oven at 100°C for 1-2 hours. 3
    Cool.
15. Dissolve the precipitate in 30 mL 3M HNO_3.

16. Place each sample centrifuge tube in front of a SR extraction column. Write sample numbers on gummed labels and attach to the corresponding columns.

17. Condition columns by passing 30 mL 3M HNO_3 through them with the stopcocks fully open. Catch effluent in a waste beaker.

18. Add sample from the beaker into the correspondingly numbered column.

    NOTE: Use no water to make this transfer. Use only 3M HNO_3 to rinse out the beaker.

    Allow the sample to pass through the column. Catch effluent in a waste beaker.

19. When the column reservoir is drained, measure 70 mL 3M HNO_3 in a graduated cylinder and pass through the column to rinse. Catch effluent in a waste beaker. When the column is drained, RECORD THE DATE AND TIME ON THE WORK SHEET AS THE BEGINNING OF Y-90 INGROWTH.

20. Write the sample number on a clean 150 mL beaker. Place it under the column after the rinse solution has drained. Discard the contents of the waste beaker.

21. Elute strontium by adding 70 mL DI water to the column. Catch effluent in the 150 mL beaker. 3

22. When the elution is complete, add 1.00 mL standardized yttrium carrier to the numbered sample beaker using an Eppendorf pipet.

23. Place sample beaker on a moderate hotplate and evaporate gently to approximately 10 mL volume. Remove beaker from hotplate and allow to cool.

    NOTE: If the sample accidentally evaporates to dryness, allow it to cool, then add a few drops HNO_3 and approximately 10 mL DI water. Warm gently and swirl to dissolve residue.

24. Mark the sample number on a 40 mL centrifuge tube. Transfer the sample using the minimum amount of DI water.

25. Seal the sample tube with parafilm and place in a rack to stand for a minimum 5-day period for Y-90 ingrowth.

26. Rinse the SR extraction columns with an additional 70 mL DI water. Catch effluent in a waste beaker. Leave the columns wet with DI water, with the stopcocks closed.

27. Enter column number, date, and sample number in the SR Column Log.

Separation

1. After storage (ingrowth period), heat the 40mL centrifuge tube containing the sample in the hot water bath (approximately 90°C) for 10 minutes.
2. Adjust pH to 8.0-8.5 with NH_4OH, stirring continuously.
3. Cool in a cold water bath and centrifuge for 5 minutes.
4. Decant the supernate into a 40mL centrifuge tube marked with the sample number and "SR-89." RECORD THE DATE AND TIME OF DECANTATION AS THE END OF Y-90 INGROWTH IN SR FRACTION AND THE BEGINNING OF ITS DECAY IN Y-90 FRACTION.
5. Redissolve the precipitate by adding 3-4 drops of 6N HCl and add 5-10 mL of DI water with stirring.
6. Repeat Steps 1, 2, and 3.
7. Combine supernate with the one in Step 4.
8. Wash the precipitate twice with 20mL portions of DI Water. Centrifuge each time and discard supernate. 4
9. Proceed with determination.

Determination

A. Strontium-90 (Yttrium-90)

1. Add 3 drops of $6\underline{N}$ HCl to dissolve the precipitate from Step 4, Separation; then add 5-10 mL of DI water. Heat in a water bath at approximately 90°C for about 10 minutes. Add 1 ml of saturated oxalic acid solution dropwise with vigorous stirring. Adjust to a pH of 2-3 with NH_4OH. Allow the precipitate to digest for approximately one hour. 3

   NOTE: Do Part "B" while precipitate is digesting.

2. Cool to room temperature in a cold water bath. Centrifuge for 10 minutes and decant most of the supernate to waste. Filter by suction on a weighed 2.5 cm filter paper. Wash the precipitate with water and alcohol. 3
3. Dry the precipitate under the lamp for 30 minutes. Cool and weigh. Mount and count in a proportional counter. (See Part C for mounting.)

B. Strontium-89 (Total Strontium)

1. Heat the solution from Step 7, Separation, in water bath.
2. Adjust the pH to 8-8.5 using NH_4OH.
3. With continuous stirring, add 5 mL of $3\underline{N}$ Na_2CO_3 solution. Stir until precipitate appears. Heat gently for 10 minutes.
4. Cool and filter on a weighed No. 42 (2.4 cm) Whatman filter paper.
5. Wash precipitate with water and alcohol. 3
6. Dry the precipitate under the lamp for 30 minutes. Cool and weigh. Mount and count in a proportional counter. (See Part C for mounting.)

C. Filtering and Mounting

1. Place filters under heat lamps for 30 minutes before weighing.
2. Use Mettler balance (Serial No. 343112) for weighing.
3. Label a clean petri dish with the weight of the filter paper. (After samples are filtered, the filter paper will again be dried and weighed to determine weight of precipitate before mounting.)
4. Mount weighed filter paper and precipitate on nylon disc using 1" transparent tape to hold filter paper and 2" mylar foil placed over precipitate and held in place with slip-ring. Trim off excess mylar foil and place the mounted sample in a labeled petri dish.
5. Fill out corresponding loading sheets and place samples in counting room.

Calculations

Part A

$$\text{Strontium-90 Concentration (pCi/L)} = \frac{A}{2.22 \times B \times C \times D \times E \times F \times G}$$

Where:

2.22 = dpm/pCi

A = Net beta count rate of yttrium-90 (cpm)

B = Recovery of yttrium carrier

C = Recovery of strontium carrier

D = Counter efficiency for counting yttrium-90 as yttrium oxalate mounted on a 2.4 cm diameter filter paper (cpm/dpm) | 4

E = Sample volume (liters)

F = Correction factor $e^{-\lambda t}$ for yttrium-90 decay, where t is the time from the time of decantation (Step 4, Separation) to the time of counting

G = Correction factor $1-e^{-\lambda t}$ for the degree of equilibrium attained during the yttrium-90 ingrowth period, where t is the time from the beginning of ingrowth (Step 19, Total Radiostrontium Separation) to the time of decantation (Step 4, Separation) | 4

Lower Limit of Detection (LLD), at 4.66 sigma

LLD for Sr-90: 1 pCi/L. LLD is based on the following typical parameters:
Sample Size: 1 L
Recovery (Sr and Y): 0.6
Decay Factor (Y-90): 0.8
Ingrowth Factor (Y-90): 0.6
Counter Efficiency: 0.4
Counter Background: 0.3cpm | 4
Counting Time: 100 minutes

(Changes in any of the above parameters will change LLD correspondingly.)

Part B:

$$\text{Strontium-89 Concentration (pCi/L)} = \frac{1}{2.22\times B\times C}\left[\frac{A}{D\times E}-2.22\times F(G+H\times I)\right]$$

Where:

2.22 = dpm/pCi

A = Net beta count rate of "total radiostrontium" (cpm)

B = Counter efficiency for counting strontium-89 as strontium carbonate mounted on a 2.4 cm diameter filter paper (cpm/dpm) 4

C = Correction factor $e^{-\lambda t}$ for strontium-89 decay, where t is the time from sample collection to the time of counting

D = Recovery of strontium carrier

E = Sample volume (liters)

F = Strontium-90 concentration (pCi/liter) from Part A

G = Counter efficiency for counting strontium-90 as strontium carbonate mounted on a 2.4 cm diameter filter paper (cpm/dpm) 4

H = Counter efficiency for counting yttrium-90 as yttrium oxalate mounted on a 2.4 cm diameter filter paper (cpm/dpm) 4

I = Correction factor $1-e^{-\lambda t}$ for yttrium-90 ingrowth, where t is the time from the last decantation of the nitric acid (Step 4, Separation) to the time of counting

Lower Limit of Detection (LLD), at 4.66 sigma

LLD for Sr-89: 2.0 pCi/L. LLD is based on the following typical parameters:
Sample Size: 1 L
Recovery: 0.7
Decay Factor: 0.5
Counter Efficiency: 0.3
Counter Background: 0.3 cpm 4
Counting Time: 100 minutes
LLD for Sr-90: 1 pCi/L

(Changes in any of the above parameters will change LLD correspondingly.)

REFERENCES: Radioassay Procedures for Environmental Samples, U. S. Department of Health, Education, and Welfare. Environmental Health Series, January 1967.

Horwitz, Dietz, Fisher, Analytical Chemistry, 63 (5), March 1991.

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PROCEDURE FOR COMPOSITING WATER AND MILK SAMPLES

PROCEDURE NO. TIML-COMP-01

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revised Pages	Revision No.	Date	Pages	Prepared by	Approved by
	0	11-07-88	2	B. Grob	LG Huebner

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TIML-COMP-01

Procedure for Compositing Water and Milk Samples

1. At the beginning of each composite period, (month, quarter, semi-annual), prepare a one-gallon cubitainer for a specific location and time-period.

2. Remove an equal aliquot of original sample (for example, one liter) and transfer to prepared cubitainer. Do this for each week, month, etc. Mark date of original sample on prepared cubitainer.

3. When prepared container is complete, give the sample to the recording clerk for assigning a number.

4. Analyze according to the client requirement.

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DETERMINATION OF STABLE CALCIUM IN MILK

PROCEDURE NO. TIML-CA-01

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revision No.	Date	Pages	Prepared by	Approved by
0	07-08-88	4	B. Grob	L G Huebner

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Determination of Stable Calcium in Milk

Principle of Method

Strontium, barium, and calcium are absorbed on the cation-exchange resin, then eluted with sodium chloride solution. An aliquot of the eluate is diluted to reduce the high sodium ion concentration. From this diluted aliquot, calcium oxalate is precipitated, dissolved in dilute hydrochloric acid, and the oxalate is titrated with standardized potassium permaganate.

Reagents

Ammonium hydroxide, NH_4OH: 6N
Ammonium oxalate, $(NH_4)_2C_2O_4 \cdot H_2O$: 0.03N
Carrier solutions:
  Ba^{+2} as barium nitrate, $Ba(NO_3)2$: 20 mgBa^{+2} per ml
  Sr^{+2} as strontium nitrate, $Sr(NO_3)_2$: 20 mg Sr^{+2} per ml
Cation-exchange resin: Dowex 50W-X8 (Na^+ form, 50-100 mesh)
Citrate solution: 3N (pH 6.5)
Hydrochloric acid, HCl: 6N
Oxalic acid, $H_2C_2O_4 \cdot 2H_2$: 1N
Potassium permanganate, $KMnO_4$: 0.05N standardized
Sodium chloride, NaCl: 4N
Sodium oxalate, $Na_2C_2O_4$:

Apparatus

Burette

Procedure

1. Follow the TIML-SR-01 or SR-07 procedures, Steps 1-10.
2. Into a 40 ml glass centrifuge tube, pipette 10 ml aliquot of the initial eluate collected in Step 10.
3. Dilute the 10 ml aliquot to approximately 20 ml with D.I. water.
4. Heat in a hot water bath. Add 5 ml of 1N oxalic acid, and stir. While hot, adjust to pH 3 with 6N NH_4OH (use a pH meter) to precipitate calcium oxalate. Cool slowly to room temperature, centrifuge, and discard the supernate.

Procedure (continued)

5. Thoroughly wash the precipitate and the wall of the centrifuge tube, using not more than 5 ml of 0.03N ammonium oxalate. Centrifuge, and discard the supernatant.

6. Wash the precipitate with 10 ml of hot D.I. water. Cool to room temperature, centrifuge, and discard the supernate. (A stirring rod may be used to agitate the precipitate while it is being washed. It is important to remove all excess oxalic acid from the precipitate.)

7. Dissolve the precipitate in approximately 2.5 ml of 6N HCl. Heat in hot water bath for 5 minutes.

8. Dilute the acid solution to approximately 10 ml with D.I. water. Quantitatively transfer it to a 125 ml Erlenmeyer flask, rinsing the centrifuge tube with D.I. water.

9. Add an additional 1 ml of 6N HCl, and adjust the volume of solution to approximately 25 ml with D.I. water. Heat to near boiling.

10. While hot, titrate with standardized 0.05N $KMnO_4$ to the first faint pink endpoint which persists for at least 30 seconds.

Calculations

$$\text{Calcium (g/liter)} = \frac{A \times B \times C}{D}$$

Where:

A = Volume of $KMnO_4$ solution used for titration (ml)
B = Normality of standardized KMn_4 solution (mg/ml)
C = Milli-equivalent weight of calcium (mg/meg)
D = Sample volume (ml)

Since the sample size is 10 ml and the milli-equivalent weight of calcium is 20 mg, the equation reduces to:

$$\text{Calcium (g/liter)} - A \times B \times 2$$

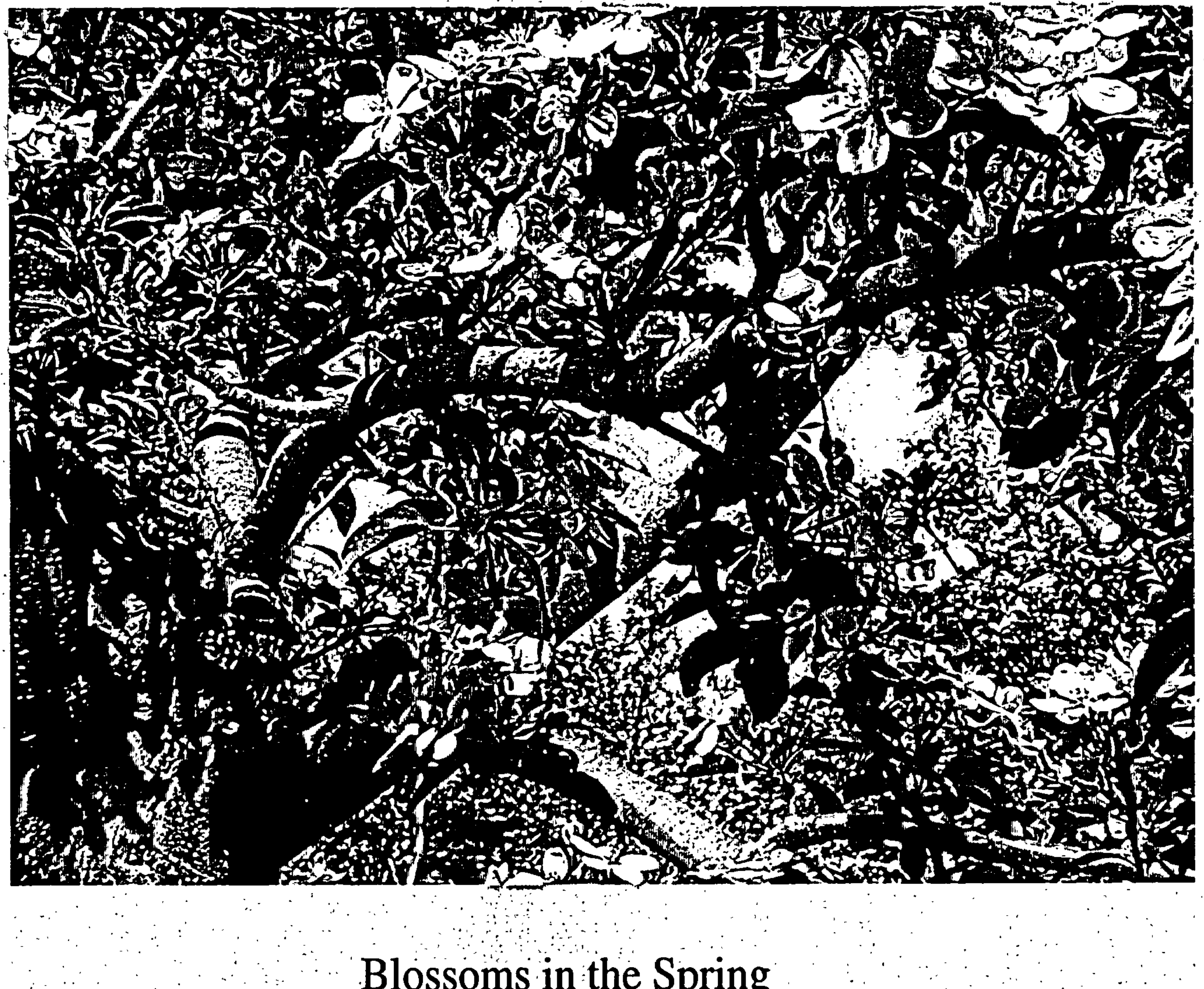
Evaluation of Data

The standard deviation of replicate analyses has been determined to be ±0.02 g/liter.

Reference: Radioassay Procedures for Environmental Samples, U.S. Department of Health, Education and Welfare. Environmental Health Series, January 1967.

KEWAUNEE NUCLEAR POWER PLANT

ANNUAL REPORT PART III
PROGRAM SELF-ASSESSMENT
AND
PROGRAM CHANGES



Blossoms in the Spring

Kewaunee Nuclear Power Plant

Radiological Environmental Monitoring Manual (REMM)

Revision 8
09-30-2003

Reviewed by: ______________________ Date: 9/26/03
Plant Operations Review Committee

Approved by: ______________________ Date: 9/26/03
Regulatory Affairs Manager

Approved by: ______________________ Date: 9-25-03
Radiation Protection Manager

Approved by: ______________________ Date: 9/26/03
Chemistry Manager

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Figure 1 Environmental Sampling Location

1.0 Introduction

1.1 Purpose

The purpose of this document is to define the Radiological Environmental Monitoring Program (REMP) for the Kewaunee Nuclear Power Plant (KNPP). The REMP is required by KNPP Technical Specification (TS) 6.16.b.2, "Radiological Environmental Monitoring Program."

This document is known as the Radiological Environmental Monitoring Manual (REMM) and is intended to serve as a tool for program administration and as a guidance document for contractors which implement the monitoring program.

1.2 Scope

This program defines the sampling and analysis schedule which was developed to provide representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the high potential radiation exposures of MEMBERS OF THE PUBLIC resulting from plant operation. This monitoring program implements Section IV.B.2 of Appendix I to 10CFR Part 50 and thereby verifies that the measurable concentrations of radioactivity and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for the development of this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. This program has been developed in accordance with NUREG 0472.

The program will provide field and analytical data on the air, aquatic, and terrestrial radioecology of the area near the Kewaunee Nuclear Power Plant so as to:

1. Determine the effects of the operation of the Kewaunee Nuclear Power Plant on the environment;
2. Serve as a gauge of the operating effectiveness of in-plant control of waste discharges; and
3. Provide data on the radiation dose to the public by direct or indirect pathways of exposure.

1.3 Implementation

This document is considered, by reference, to be part of the Offsite Dose Calculation Manual. This is as required by KNPP TS 6.16.b.2. The REMM is controlled as a separate document for ease of revision, use in the field and use by contractors. This format was approved by the NRC as part of TS Amendment No. 64, which provided Radiological Effluent Technical Specifications (RETS) for KNPP.

The REMP is setup to be implemented by a vendor and controlled by the Kewaunee Nuclear Power Plant (KNPP) in accordance with Nuclear Administrative Directive NAD-1.20, "Radiological Environmental Monitoring Program." Monthly reviews of the vendor's progress report are checked and approved by KNPP in accordance with Surveillance Procedure SP-63-276. Annual reviews and submittals of the vendor's report and raw data are checked and approved by KNPP in accordance with Surveillance Procedure SP-63-280. All sample collection, preparation, and analysis are performed by the vendor except where noted. Surveillance Procedure SP-63-164 outlines the environmental sample collection performed by KNPP. Current vendor Quality Control Program Manuals and implementing procedures shall be kept on file at KNPP.

Periodic reviews of monitoring data and an annual land use census will be used to develop modifications to the existing monitoring program. Upon approval, these modifications will be incorporated into this document so that it will accurately reflect the current radiological environmental monitoring program in effect for the Kewaunee Nuclear Power Plant.

The remainder of this document is divided into two sections. The first section, 2.0 REMP Requirements, describes the different TS and REMM requirements associated with the REMP. The second section, 3.0 REMP Implementation, describes the specific requirements used to implement the REMP.

2.0 REMP Requirements

KNPP TS Amendment No. 104 implemented the guidance provided in Generic Letter 89-01, "Implementation of Programmatic Controls for Radiological Effluent Technical Specifications (RETS)." These changes included:

1. Incorporation of *programmatic controls* in the Administrative Controls section of the TS to satisfy existing regulatory requirements for RETS, and
2. Relocation of the *procedural details* on radioactive effluents monitoring, radiological environmental monitoring, reporting details, and other related specifications from the TS to the ODCM.

Relocating the procedural details to the ODCM allows for revising these requirements using the 10CFR50.59 process instead of requiring prior NRC approval using the TS Amendment process.

The RETS requirements were incorporated verbatim into the ODCM, Revision 6. Several of these requirements pertain only to the environmental monitoring program and therefore have been relocated into this document (REMM, Revision 3 and 4) and are identified as REMM requirements.

2.1 Technical Specification Requirements

Technical Specification 6.16.b.2 provides the programmatic control, which requires a program to monitor the radiation and radionuclides in the environs of the plant. This is the reason for the existence of the REMP. TS 6.16.b.2 also provides the programmatic control which requires:

a. The program to perform the monitoring, sampling, analysis, and reporting in accordance with the methodology and parameters in the ODCM,

b. A land use census to be performed, and

c. Participation in an Interlaboratory Comparison Program.

The details of each requirement are described in the REMM requirements stated below.

Technical Specification 6.9.b.1 requires an "Annual Radiological Environmental Monitoring Report" be submitted to the NRC each year. The specific contents of this report are detailed in REMM 2.4.1. Additional specific reporting requirements are listed in the other REMM requirements.

2.2 REMM Requirements

The following REMM requirements include the procedural details that were originally located in the KNPP RETS section and then relocated into Revision 6 of the ODCM, as discussed above. These requirements are specific to the radiological environmental monitoring program and have been relocated into this document for ease of use and completeness.

The REMM requirements for the Monitoring Program, Land Use Census, and the Interlaboratory Comparison Program include a detailed specification (numbered 2.2.1, 2.2.2, and 2.2.3 respectively) and an associated surveillance requirement (numbered 2.3.1, 2.3.2, and 2.3.3 respectively), along with the basis for the requirement. Reporting requirements are listed in specification REMM 2.4.1.

General requirements also apply to all ODCM and REMM requirements (specifications 3.01, 3.02, 3.03, 4.01, 4.02, and 4.03). The requirements are located in the ODCM and are repeated here for convenience.

GENERAL SPECIFICATIONS

3.0.1 Compliance with the specifications contained in the succeeding text is required during the conditions specified therein; except that upon failure to meet the specifications, the associated ACTION requirements shall be met.

3.0.2 Noncompliance with a Specification shall exist when its requirements and associated ACTION requirements are not met within the specified time intervals. If the Specification is restored prior to expiration of the specified time intervals, completion of the Action requirements is not required.

3.0.3 When a Specification is not met, except as provided in the associated ACTION requirements, reporting pursuant to TS 6.9.b and REMM 2.4.1 will be initiated.

SURVEILLANCE REQUIREMENTS

4.0.1 Surveillance Requirements shall be met during the conditions specified for individual Specifications unless otherwise stated in an individual Surveillance Requirement.

4.0.2 Each Surveillance Requirement shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the surveillance interval.

4.0.3 Failure to perform a Surveillance Requirement within the specified time interval shall constitute a failure to meet the OPERABILITY requirements for a Specification. Exceptions to these requirements are stated in the individual Specification. Surveillance Requirements do not have to be performed on inoperable equipment.

REMM 2.2.1/2.3.1 Monitoring Program

SPECIFICATION

2.2.1 The radiological environmental monitoring program shall be conducted as specified in Table 2.2.1-A.

APPLICABILITY

At all times.

ACTION

a. With the radiological environmental monitoring program not being conducted as specified in Table 2.2.1-A, in lieu of a Licensee Event Report, prepare and submit to the Commission, in the Annual Radiological Environmental Monitoring Report required by TS 6.9.b.1 and REMM 2.4.1, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. With the level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table 2.2.1-D when averaged over any calendar quarter in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days, pursuant to TS 6.9.b.3, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose[1] to A MEMBER OF THE PUBLIC is less than the calendar year limits of specifications ODCM 3.3.2, 3.4.2, and 3.4.3. When more than one of the radionuclides in Table 2.2.1-D are detected in the sampling medium, this report shall be submitted if:

$$\frac{concentration\,(1)}{reporting\;level\,(1)}+\frac{concentration\,(2)}{reporting\;level\,(2)}+\ldots\geq 1.0$$

When radionuclides other than those in Table 2.2.1-D are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose[1] to a MEMBER OF THE PUBLIC is equal to or greater than the calendar year limits of specifications ODCM 3.3.2, 3.4.2, and 3.4.3. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event the condition shall be reported and described in the Annual Radiological Environmental Monitoring Report.

---

[1] The methodology and parameters used to estimate the potential annual dose to a member of the public shall be indicated in this report.

c. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 2.2.1-A, a sample from an alternative location will be substituted, noting the reason for the unavailability in the Annual Radiological Environmental Monitoring Report. When changes in sampling locations are permanent, the sampling schedule in the RADIOLOGICAL ENVIRONMENTAL MONITORING MANUAL (REMM) will be updated to reflect the new routine and alternative sampling locations and this revision will be described in the Annual Radiological Environmental Monitoring Report.

SURVEILLANCE REQUIREMENTS

2.3.1 The radiological environmental monitoring samples shall be collected pursuant to Table 2.2.1-A from the specific locations given in the table and figure(s) in the REMM, and shall be analyzed pursuant to the requirements of Table 2.2.1-A and the detection capabilities required by Table 2.3.1-A.

BASIS

The radiological environmental monitoring program required by this specification provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10CFR Part 50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. Program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 2.3.1-A are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

Discussion

KNPP TS 6.16.b.2(a) requires that the monitoring, sampling, analysis, and reporting of radiation and radionuclides in the environment be done in accordance with the methodology and parameters in the ODCM.

REMM 2.2.2/2.3.2 Land Use Census

SPECIFICATIONS

2.2.2 A land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 10 meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden[2] of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation.

APPLICABILITY

At all times.

ACTION

a. With a land use census identifying a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in specification ODCM 4.4.3, in lieu of a Licensee Event Report, identify the new location(s) in the next Annual Radiological Environmental Monitoring Report pursuant to TS 6.9.b.1 and REMM 2.4.1.

b. With a land use census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with specification REMM 2.2.1, add the new location(s) to the radiological environmental monitoring program within 30 days. The sampling location(s), excluding the control station location, having a lower calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program. In lieu of a Licensee Event Report, identify the new location(s) in the next Annual Radiological Environmental Monitoring Report pursuant to TS 6.9.b.1 and REMM 2.4.1 and also include in the report a revised figure(s) and table for the REMM reflecting the new location(s).

SURVEILLANCE REQUIREMENT

2.3.2 The land use census shall be conducted during the growing season once per 12 months using reasonable survey methods, such as by a door-to-door survey, aerial survey, or by consulting local agriculture authorities. The results of the land use census shall be included in the Annual Radiological Environmental Monitoring Report pursuant to TS 6.9.b.1 and REMM 2.4.1.

---

[2] Sampling of leaf vegetation may be performed at the site boundary in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Specifications for broad leaf vegetation sampling in Table 2.2.1-A item 4c shall be followed, including analysis of control samples.

BASIS

This specification is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the radiological environmental monitoring program are made if required by the door-to-door survey, from aerial survey or from consulting with local agricultural authorities. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10CFR Part 50. Restricting the census to gardens of greater than 50 m^2 provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/yr) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made:

1. 20% of the garden was used for growing leafy vegetation (i.e., similar to lettuce and cabbage), and
2. A vegetation yield of 2 kg/m^2.

Discussion

KNPP TS 6.16.b.2(b) requires that a land use census be performed to ensure that changes in the use of areas at and beyond site boundary are identified and that modifications to the radiological environmental monitoring program are made if required by the results of this census.

REMM 2.2.3/2.3.3 Interlaboratory Comparison Program

SPECIFICATIONS

2.2.3 Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that has been approved by the Commission.

APPLICABILITY

At all times.

ACTION

a. With analyses not being performed as required above, report corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Monitoring Report pursuant to TS 6.9.b.1 and REMM 2.4.1.

SURVEILLANCE REQUIREMENTS

2.3.3 The Interlaboratory Comparison Program shall be described in the REMM. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Monitoring Report pursuant to TS 6.9.b.1 and REMM 2.4.1.

BASIS

The requirement for participation in an approved Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10CFR Part 50.

Discussion

KNPP TS 6.16.b.2(c) requires participation in an approved Interlaboratory Comparison Program to ensure that an independent check is performed of the precision and accuracy of radioactive materials measurements. This will demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10CFR Part 50.

REMM 2.4.1 Reporting Requirements

2.4.1 The Annual Radiological Environmental Monitoring Report shall include:

a. Summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with pre-operational studies, with operational controls as appropriate, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by specification REMM 2.2.2.

b. The results of analyses of radiological environmental samples and of environmental radiation measurements taken during the period pursuant to the locations specified in the table and figures in the Radiological Environmental Monitoring Manual (REMM), as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report when applicable.

c. A summary description of the radiological environmental monitoring program; legible maps covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor; the results of licensee participation in the Interlaboratory Comparison Program, required by specification REMM 2.2.3; discussion of all deviations from the sampling schedule of Table 2.2.1-A; and discussion of all analyses in which the LLD required by Table 2.3.1-A was not achievable.

Discussion

KNPP TS 6.9.b.1 provides the programmatic control, which requires that an Annual Radiological Environmental Monitoring Report be submitted to the NRC. It also states that this report shall include summaries, interpretations, and analysis of trends of the results of the REMP for the reporting period.

The procedural details of this report are included in this specification. Specifications REMM 2.2.1, 2.2.2/2.3.2, and 2.2.3/2.3.3 also include specific reporting requirements. These specifications reference this REMM specification, along with TS 6.9.b.1, as the method for reporting deviations from the current program during the reporting period, and require that this information be included in the Annual Radiological Environmental Monitoring Report.

3.0 REMP Implementation

The Radiological Environmental Monitoring Program for KNPP is currently under the direction of Environmental, Inc. Midwest Laboratory (EIML). This section describes this program, as required by REMM 2.2.1 and the process EIML uses to perform it.

3.1 Sampling Requirements

Table 2.2.1-A identifies the various samples required by the REMP. Identified in the "available sample locations" column in Table 2.2.1-A are the sample locations selected, in conjunction with the vendor, to meet or exceed the REMP requirements. Table 2.2.1-B includes the same requirements as in Table 2.2.1-A but presents the information in a different format by identifying the type of samples required at each location and the collection frequency. Table 2.2.1-C identifies the location and description of each sample location. Figure 1 shows the physical location of each sample point on an area map.

3.2 Analysis Methodology

Analytical procedures and counting methods employed by EIML will follow those recommended by the U.S. Public Health Service publication, Radioassay Procedures for Environmental Samples, January 1967; and the U.S. Atomic Energy Commission Health and Safety Laboratory, HASL Procedures Manual (HASL-300), 1972. The manual is also available on-line at www.eml.doe.gov/publications/procman.

Updated copies will be maintained in KNPP's vault.

3.3 Detection Capability (LLD) Requirements

The required detection capabilities for environmental sample and analysis are tabulated in terms of lower limits of detection (LLDs) in Table 2.3.1-A. The LLDs required by Table 2.3.1-A are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J.K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

3.4 Environmental, Inc. Midwest Laboratory (EIML) Reporting Requirements

Monthly Progress Reports

Monthly progress reports will include a tabulation of completed analytical data on samples obtained during the previous 30 day period together with graphic representations where trends are evident, and the status of field collections. One copy of the reports will be submitted within 30 days of the reporting month.

Annual Reports

Annual reports will be submitted in two parts. Part I, to be submitted to the NRC, will be prepared in accordance with NRC Regulatory Guide 4.8. It will contain an introductory statement, a summary of results, description of the program, discussion of the results, and summary table. Part II of the annual report will include tables of analytical data for all samples collected during the reporting period, together with graphic presentation where trends are evident and statistical evaluation of the results. Gamma scan data will be complemented by figures of representative spectra. Draft copies of each annual report will be due 60 days after completion of the annual period. After final review of the draft document, one photoready copy of the revised annual report will be sent to KNPP for printing.

Non-Routine Reports

If analyses of any samples collected show abnormally high levels of radioactivity, KNPP will be notified by telephone immediately after data becomes available.

Action Limits

EIML should report any radioactive concentrations found in the environmental samples which exceed the reporting levels shown in Table 2.2.1-D, EIML to KNPP column. These levels are set below the NRC required reporting levels (KNPP to NRC column) so actions can be initiated to prevent exceeding the NRC concentration limits.

3.5 Quality Control Program

To insure the validity of the data, EIML maintains a quality control (QC) program, which employs quality control checks, with documentation, of the analytical phase of its environmental monitoring studies. The program is defined in the EIML QC Program Manual, and procedures are presented in the EIML QC Procedures Manual. The program shall be reviewed and meet the requirements of 10CFR50 Appendix B and 10CFR21. All data related to quality control will be available for review by WPS upon reasonable prior notification. Proprietary information will be identified so that it may be treated accordingly.

Updated copies of the Quality Control Program Manual and the Quality Assurance Program Manual will be maintained in KNPP's vault.

3.6 Sample Descriptions

A description of each of the samples required by this program follows:

Airborne Particulates

Airborne particulates are collected at six locations (K-1f, K-2, K-7, K-8, K-16, K-31) on a continuous basis on a 47 mm diameter membrane filter of 0.8 micron porosity at a volumetric rate of approximately one cubic foot per minute (CFM). The filters are changed weekly, placed in glassine protective envelopes, and dispatched by U.S. Mail to EIML for Gamma Isotopic Analysis (ref. SP-63-164). Filter samples are analyzed weekly for gross beta activity after sufficient time (usually 3 to 5 days) has elapsed to allow decay of Radon and Thoron daughters. If gross beta concentration in air particulate samples are greater than ten (10) times the yearly mean of the control samples, gamma isotopic analysis shall be performed on the individual samples. Quarterly composites from each location receive Gamma Isotopic Analysis using a Germanium detector. All identifiable gamma-emitters are quantified. Reporting units are pCi/m^3.

Airborne Iodine

All air samplers are equipped with charcoal traps installed behind the particulate filters for collection of airborne I-131. The traps are changed once every two weeks. Iodine-131 is measured by Gamma Isotopic Analysis.

Periphyton (Slime) or Aquatic Vegetation

Periphyton (slime) or aquatic plant samples are collected at or near locations used for surface water sampling. They are collected twice during the year (2nd and 3rd quarter), if available. The samples are analyzed for gross beta activity and, if available in sufficient quantity, for Sr-89, Sr-90, and by Gamma Isotopic Analysis. Reporting units are pCi/g wet weight.

Fish

Fish is collected three times per year (second, third, and fourth quarters) near the discharge area (K-1d) (ref. RC-C-207). Flesh is separated from the bones and analyzed for gross beta activity and by Gamma Isotopic Analysis. The bones are analyzed for gross beta activity and Sr-89 and Sr-90. Reporting units are pCi/g wet weight.

Domestic Meat

Domestic meat (chickens) is collected once a year during the 3rd quarter, at five locations in the vicinity of the plant (K-20, K-24, K-27, K-29, and K-32). Samples may not be available every year at every location due to farmer preference. At least one control and one indicator should be collected. The flesh is analyzed for gross alpha, gross beta, and by Gamma Isotopic Analysis to identify and quantify gamma-emitting radionuclides. Reporting units are pCi/g wet weight.

Ambient Radiation

Two packets of thermoluminescent dosimeters ($CaSO_4$: Dy cards) are placed at fifteen locations, six of which are air sampling locations (K-1f, K-2, K-7, K-8, K-16, and K-31) and five of which are milk sampling locations (K-3, K-5, K-25, K-38, and K-39); the remaining four locations are K -15, K-17, K-27, and K-30. One packet is changed quarterly and one annually. Annual TLDs will serve as an emergency set to be read when needed. They will be exchanged annually (without reading) if not read during the year. To insure the precision of the measurement, each packet will contain two cards with four dosimeters each (four sensitive areas each for a total of eight). For protection against moisture each set of cards is sealed in a plastic bag and placed in a plastic container.

Each card is individually calibrated for self-irradiation and light response. Fading is guaranteed by the manufacturer (Teledyne Isotopes) not to exceed 20% in one year. Minimum sensitivity for the multi-area dosimeter is 0.5 mR defined as 3 times the standard deviation of the background. Maximum Error (1 standard deviation) - ^{60}Co Gamma +/-0.2 mR or +/-3%, whichever is greater. The maximum spread between areas on the same dosimeter is 3.5% at 1 standard deviation.

Reporting units for TLDs are mR/91 days for quarterly TLDs and mR/exposure period for annual TLDs.

Tests for uniformity and reproducibility of TLDs as specified in ANSI N545-1981 and NRC Regulatory Guide 4.13, are performed annually.

Well Water

One gallon water samples are taken once every three months from four off-site wells, (K-10, K-11, K-13, and K-25) and two on-site wells (K-1h and K-1g). All samples are analyzed for gross beta in the total residue, K-40 and by Gamma Isotopic Analysis. Samples from one on-site well are analyzed for Sr-89, Sr-90, and for tritium. Samples from K-1h and K-1g are also analyzed for gross alpha. Reporting units are pCi/l.

Precipitation

A monthly cumulative sample of precipitation is taken at Location K-11. This sample is analyzed for tritium. Reporting units are pCi/l.

Milk

Milk samples are collected from two herds that graze within three miles of the reactor site (K-25 and K-34); from four herds that graze between 3-7 miles of the reactor site (K-3, K-5, K-38, and K-39); and one from a dairy in Green Bay (K-28), 26 miles from the reactor site.

The samples are collected twice per month during the grazing period (May through October) and monthly for the rest of the year. To prevent spoilage the samples are treated with preservative. All samples are analyzed by Gamma Isotopic Analysis and for iodine -131 immediately after they are received at the laboratory. To achieve required minimum sensitivity of 0.5 pCi/l, iodine is separated on an ion exchange column, precipitated as palladium iodide and beta counted. Monthly samples and monthly composites of semimonthly samples are then analyzed for Sr-89 and Sr-90. Potassium and calcium are determined and the ^{137}Cs/gK and ^{90}Sr/gCa ratios are calculated. Reporting units are pCi/l except for stable potassium and calcium, which are reported in g/l.

If milk samples are not available, green leafy vegetables will be collected on a monthly basis (when available) from Locations K-10, K-11, and K-26.

Grass

Grass is collected three times per year (2nd, 3rd, and 4th quarters) from the six dairy farms (K-3, K-5, K-25, K-34, K-38, and K-39) and from two on-site locations (K-1b and K-1f). The samples are analyzed for gross beta activity, for Sr-89 and Sr-90, and Gamma Isotopic Analysis to identify and quantify gamma-emitting radionuclides. Reporting units are pCi/g wet weight.

Cattlefeed

Once per year, during the first quarter when grass is not available, cattlefeed (such as hay or silage) is collected from the six dairy farms. The analyses performed are the same as for grass. Reporting units are pCi/g wet weight.

Vegetables and Grain

Annually, during the 3rd quarter, samples of five varieties of vegetables grown and marketed for human consumption are collected from K-17 and/or K-26, depending upon the availability of samples. In addition, two varieties of grain, if available, are collected annually from the farmland owned by WPS (K-23) and rented to a private individual for growing crops. The analyses performed are the same as for grass. Reporting units are pCi/g wet weight.

Eggs

Quarterly samples of eggs can be taken from K-24, K-27, and K-32. At least one control and one indicator should be collected. The samples are analyzed for gross beta activity, for Sr-89 and Sr-90, and Gamma Isotopic Analysis to identify and quantify gamma-emitting radionuclides. Reporting units are pCi/g wet weight.

Soil

Twice during the growing season samples of the top two inches of soil are collected from the six dairy farms and from an on-site location (K-1f). The soil is analyzed for gross alpha and gross beta activities, for Sr-89 and Sr-90, and Gamma Isotopic Analysis to identify and quantify gamma-emitting manmade radionuclides. Reporting units are pCi/g dry weight.

Surface Water

Surface water is sampled monthly from Lake Michigan at the KNPP discharge (K-1d), and at Two Creeks Park, 2.5 miles south of the reactor site (K-14). Samples are collected monthly at the Green

Bay Municipal Pumping station between Kewaunee and Green Bay (K-9). Raw and treated water is collected. Monthly samples are also taken, when available, from each of the three creeks (K-1a, K-1b, K-1e) that pass through the reactor site and from the drainage pond (K-1k) south of the plant. The samples are taken at a point near the mouth of each creek and at the shore of the drainage pond. The water is analyzed for gross beta activity in:

a. The total residue,
b. The dissolved solids, and
c. The suspended solids.

The samples are also analyzed for K-40 and by Gamma Isotopic Analysis. Quarterly composites from all locations are analyzed for tritium, Sr-89 and Sr-90. Reporting units are pCi/l.

Bottom Sediments

Five samples of Lake Michigan bottom sediments, one at the discharge (K-1d), one from 500 feet north of the discharge (K-1c), one from 500 feet south of the discharge (K-1j), and one at the Two Creeks Park (K-14), one at the Green Bay Municipal Pumping Station (K-9) are collected semi-annually (May and November). The samples are collected at the beach in about 2-3 feet of water. All samples are analyzed for gross beta activity, for Sr-89 and Sr-90 and by Gamma isotopic Analysis. Since it is known that the specific activity of the sediments (i.e., the amount of radioactivity per unit mass of sediment) increases with decreasing particle size, the sampling procedure will assure collection of very fine particles. Reporting units are pCi/g dry weight.

Table 2.2.1-A
Radiological Environmental Monitoring Program

Exposure Pathway And/Or Sample	Minimum Required Samples [a]	Available Sample Locations [b]	Sampling, Collection and Analysis Frequency	Type of Analysis
1. Direct Radiation[c]	5 Inner Ring locations	K-5, K-25, K-27, K-7, K-1F, K-30	See Table 2.2.1-B	Gamma dose
	6 Outer Ring locations	K-2, K-3, K-15, K-17, K-8, K-31, K-39		
	1 Control location	K-16		
	1 Population center	K-7		
	1 Special interest location	K-8		
	1 Nearby resident	K-27		
2. Airborne Radioiodine and Particulates	3 samples close to the site boundary in highest average X/Q	K-1f, K-2, K-7, K-8, K-31	See Table 2.2.1.B Continuous sampler operation Iodine; charcoal	Iodine (I-131) by Gamma Isotopic[f]
	1 sample from the closest community having the highest X/Q	K-7	Particulates See Table 2.2.1-B	Particulates; gross beta analysis[e] Gamma isotopic of composite (by location) [f]
	1 sample from a control location	K-16[d]	See Table 2.2.1-B	
3. Waterborne				
a. Surface[g]	1 Upstream sample 1 Downstream sample	K-1a, K-9, K-1d K-1e, K-14, K-1k, K-1b	Grab sample See Table 2.2.1-B	Gross Beta, Sr 89/90Gamma isotopic [f] Composite of grab samples for tritium
b. Ground	1-2 location likely to be affected [d]	K-1g, K-1h[h]	Grab sample See Table 2.2.1-B	Gamma isotopic [f], tritium analysis Gross Beta, Sr 89/90
c. Drinking	1-3 samples of nearest water supply	K-10, K-11, K-12, K-13	Grab sample See Table 2.2.1-B	Gross beta and gamma isotopic [f] analysis. Tritium analysis of the composite of monthly grab samples.
d. Sediment from shoreline	1 sample from downstream area with potential for recreational value	K-14, K-1c, K-1d, K-1j, K-9	Grab sample See Table 2.2.1-B	Gamma isotopic [f] analysis Gross Beta, Sr 89/90

Table 2.2.1-A
Radiological Environmental Monitoring Program

Exposure Pathway And/Or Sample	Minimum Required Samples [a]	Available Sample Locations [b]	Sampling, Collection and Analysis Frequency	Type of Analysis
4. Ingestion				
a. Milk	Samples from milking animals in 3 locations within 5 km having the highest dose potential.	K-5, K-25, K-34	See Table 2.2.1-B	I-131 Gamma Isotopic [f] SR 89/90
	1 alternate location.	K-38, K-39		
	1 control location	K-3, K-28		
b. Fish	3 random samplings of commercially and recreationally important species in the vicinity of the discharge.	K-1d	See Table 2.2.1-B	Gamma isotopic [f] and edible portions Gross Beta Sr 89/90 on bones
c. Food Products	Samples of leaf vegetables grown nearest each of two different offsite locations within 5 miles of the plant if milk sampling is not performed.	2 samples nearest highest predicted annual average ground level D/Q. K-10, K-11 1 sample 15-30 km distant if milk sampling is not performed. K-26	See Table 2.2.1-B	Gamma isotopic [f] and I-131 Analysis.
5. Miscellaneous samples not identified in NUREG-0472				
a. Aquatic Slime	None required	K-1k K-1a, K-1b, K-1e K-14, K-1d K-9 (control)	See Table 2.2.1-B	Gross Beta activity and if available Sr-89, Sr-90 and Gamma Isotopic[f]
b. Soil	None required	K-1f, K-5, K-25, K-39 K-34 K-3, (control)	See Table 2.2.1-B	Gross Alpha/Beta Sr-89 and Sr-90 Gamma Isotopic[f]
c. Cattlefeed	None required	K-5, K-25, K-39 K-34 K-3,(control)	See Table 2.2.1-B	Gross Beta Sr-89 and Sr-90 Gamma Isotopic[f]
d. Grass	None required	K-1b, K-1f, K-25, K-39 K-5, K-12, K-34 K-3,(control)	See Table 2.2.1-B	Gross Beta Sr-89 and Sr-90 Gamma Isotopic[f]
e. Domestic Meat	None required	K-20, K-24, K-27, K-29 K-32 (control)	See Table 2.2.1-B	Gross Alpha/Beta Gamma Isotopic[f]

Table 2.2.1-A
Radiological Environmental Monitoring Program

Exposure Pathway And/Or Sample	Minimum Required Samples [a]	Available Sample Locations [b]	Sampling, Collection and Analysis Frequency	Type of Analysis
f. Eggs	None required	K-27,K-33 K-32 K-24	See Table 2.2.1-B	Gross Beta Sr-89/90 Gamma Isotopic[f]
g. Precipitation	None required	K-11	See Table 2.2.1-B	Tritium
h. Vegetables/Grain	None required	K-17, K-23 K-26 (control)	See Table 2.2.1-B	Gross Beta Sr-89/90 Gamma Isotopic[f]

Table Notations

a. The samples listed in this column describe the minimum sampling required to meet REMP requirements.

b. Additional details of sample locations are provided in Table 2.2.1-C and Figure 1. The REMP requires that samples to be taken from each of the "available sample locations" listed (see section 3.1). Deviations from the required sampling schedule will occur if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, reasonable efforts shall be made to complete corrective actions prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented, as required by REMM 2.4.1.c, in the Annual Radiological Environmental Monitoring Report. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the REMM. The cause of the unavailability of samples for that pathway and the new location(s) for obtaining replacement samples will be identified in the Annual Radiological Environmental Monitoring Report.

c. For the purposes of this table, each location will have 2 packets of thermoluminescent dosimeters (TLDs). The TLDs are CaSO4: Dy cards with 2 cards/packet and 4 dosimeters/card (four sensitive areas each for a total of eight dosimeters/packet). The NRC guidance of 40 stations is not an absolute number. The number of direct radiation monitoring stations has been reduced according to geographical limitations; e.g., Lake Michigan. The frequency of analysis or readout for TLD systems depends upon the characteristics of the specific system used and selection is made to obtain optimum dose information with minimal fading.

d. The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites that provide valid background data may be substituted.

e. Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

f. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

g. The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area near the mixing zone.

h. Ground water samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

Table 2.2.1-B
Type and Frequency of Collection

Location	Weekly	Biweekly	Monthly	Quarterly	Semi-Annually		Annually
K-1a			SW			SL	
K-1b			SW	GR[a]		SL	
K-1c					BS[b]		
K-1d			SW	FI[a]	BS[b]	SL	
K-1e			SW			SL	
K-1f	AP	AI		GR[a] TLD	SO		
K-1g				WW			
K-1h				WW			
K-1j					BS[b]		
K-1k			SW			SL	
K-2	AP	AI		TLD			
K-3			MI[c]	GR[a] TLD CF[d]	SO		
K-4							
K-5			MI[c]	GR[a] TLD CF[d]	SO		
K-6							
K-7	AP	AI		TLD			
K-8	AP	AI		TLD			
K-9			SW		BS[b]	SL	
K-10			GLV[f]	WW			
K-11			PR, GLV[f]	WW			
K-12							
K-13				WW			
K-14			SW		BS[b]	SL	
K-15				TLD			
K-16	AP	AI		TLD			
K-17				TLD			VE
K-19							
K-20							DM
K-23							GRN
K-24				EG			DM
K-25[e]			MI[c]	GR[a] TLD CF[d]	SO		
K-26			GLV[f]				VE
K-27			EG	TLD			DM
K-28			MI[c]				
K-29							DM

Table 2.2.1-B
Type and Frequency of Collection

Location	Weekly	Biweekly	Monthly	Quarterly	Semi-Annually		Annually
K-30				TLD			
K-31	AP	AI		TLD			
K-32				EG			DM
K-33							
K-34			MI[c]	GR[a] CF[d]	SO		
K-35							
K-36							
K-38			MI[c]	TLD GR[a] CF[d]	SO		
K-39			MI[c]	TLD GR[a] CF[d]	SO		

a Three times a year, second (April, May, June), third (July, August, September), and fourth (October, November, December) quarters

b To be collected in May and November

c Monthly from November through April; semimonthly from May through October

d First (January, February, March) quarter only

e Replaced by K-29 in summer of 1990

f Alternate if milk is not available

Code	**Description**	**Code**	**Description**	**Code**	**Description**
AI	Airborne Iodine	FI	Fish	SO	Soil
AP	Airborne Particulate	GR	Grass	SW	Surface Water
BS	Bottom Sediment	GRN	Grain	TLD	Thermoluminescent Dosimeter
CF	Cattlefeed	MI	Milk	VE	Vegetables
DM	Domestic Meat	PR	Precipitation	WW	Well Water
EG	Eggs	SL	Slime	GLV	Green Leafy Vegetables

Table 2.2.1-C
Sampling Locations, Kewaunee Nuclear Power Plant

Code	Type[a]	Distance (Miles)[b] and Sector	Location
K-1			Onsite
K-1a	I	0.62 N	North Creek
K-1b	I	0.12 N	Middle Creek
K-1c	I	0.10 N	500′ North of Condenser Discharge
K-1d	I	0.10 E	Condenser Discharge
K-1e	I	0.12 S	South Creek
K-1f	I	0.12 S	Meteorological Tower
K-1g	I	0.06 W	South Well
K-1h	I	0.12 NW	North Well
K-1j	I	0.10 S	500′ south of Condenser Discharge
K-1k	I	0.60 SW	Drainage Pond, south of plant
K-2	C	9.5 NNE	WPS Operations Building in Kewaunee
K-3	C	6.0 N	Lyle and John Siegmund Farm, N2815 Hy 42, Kewaunee
K-4(h)	I	3.0 N	Tom Stangel Farm, E4804 Old Settlers Rd, Kewaunee
K-5	I	3.5 NNW	Ed Paplham Farm, E4160 Old Settlers Rd, Kewaunee
K-6(e)	C	6.7 WSW	Novitsky Farm, E1870 Cty Tk BB, Denmark
K-7	I	2.75 SSW	Ron Zimmerman Farm, 17620 Nero Rd, Two Rivers
K-8	C	5.0 WSW	Saint Mary's Church, 18424 Tisch Mills Rd, Tisch Mills
K-9	C	11.5 NNE	Green Bay Municipal Pumping Station, six miles east of Green Bay (sample source is Lake Michigan from Rostok Intake 2 miles north of Kewaunee)
K-10	I	1.5 NNE	Turner Farm, Kewaunee Site
K-11	I	1.0 NW	Harlan Ihlenfeld Farm, N879 Hy 42, Kewaunee
K-12(i)	I	1.5 WSW	LeCaptain Farm, N491 Woodside Rd, Kewaunee
K-13	C	3.0 SSW	Rand's General Store, Two Creeks
K-14	I	2.5 S	Two Creeks Park, 2.5 miles south of site
K-15	C	9.25 NW	Gas Substation, 1.5 miles north of Stangelville
K-16	C	26 NW	WPS Division Office Building, Green Bay, Wisconsin
K-17	I	4.25 W	Jansky's Farm, N885 Cty Tk B, Kewaunee
K-19(f)	I	1.75 NNE	Wayne Paral Farm, N1048 Lakeview Dr., Kewaunee
K-20	I	2.5 N	Carl Struck Farm, N1596 Lakeshore Dr., Kewaunee
K-23	I	0.5 W	0.5 miles west of plant, Kewaunee site

Table 2.2.1-C

Sampling Locations, Kewaunee Nuclear Power Plant

Code	Type[a]	Distance (Miles)[b] and Sector	Location
K-24	I	5.45 N	Fectum Farm, N2653 Hy 42, Kewaunee
K-25	I	2.75 SW	Wotachek Farm, E3968 Cty Tk BB, Two Rivers
K-26(d)	C	10.7 SSW	Bertler's Fruit Stand (8.0 miles south of "BB")
K-27	I	1.5 NW	Schlies Farm, E4298 Sandy Bay Rd
K-28	C	26 NW	Hansen Dairy, 1742 University Ave., Green Bay, Wisconsin
K-29	I	5.75 W	Kunesh Farm, E3873 Cty Tk G, Kewaunee
K-30	I	1.00 N	End of site boundary
K-31	I	6.25 NNW	E. Krok Substation, Krok Road
K-32	C	11.50 N	Piggly Wiggly, 931 Marquette Dr., Kewaunee
K-33(g)	I	4.25 W	Gary and Lynn Holly Farm, E2885 Holly Lane, Tisch Mills
K-34	I	2.5 N	Leon and Vicky Struck Farm, N1549 Lakeshore Drive, Kewaunee
K-35(j)	C	6.75 WNW	Jean Ducat Farm, N1215 Sleepy Hollow, Kewaunee
K-36(j)	I		Fiala's Fish Market, 216 Milwaukee, Kewaunee
K-37 (k)	I	4.00 N	Gary and Ann Hardtke Farm, E4282 Old Settlers Road, Kewaunee
K-38	I	3.8 WNW	Dave Sinkula Farm, N890 Town Hall Road, Kewaunee
K-39	I	4.00 N	Francis Wotja Farm, N1859 Lakeshore Road, Kewaunee

a I = indicator; C = control.
b Distances are measured from reactor stack.
c Deleted
d Location K-18 was changed because Schmidt's Food Stand went out of business. It was replaced by Bertler's Fruit Stand (K-26).
e Replaced by K-33 in summer of 2000. Retired from farming.
f Replaced by K-34 in summer of 2000. Retired from farming.
g. Replaced by K-35 in fall of 2000.
h. Sold farm in summer of 2000, replaced by K-25
i. Retired from farming in summer of 2000
j. Removed from the program in Fall of 2001
k. Removed from the program in Fall of 2002

Table 2.2.1-D
Reporting Levels for Radioactivity Concentrations in Environmental Samples

Medium	**Radionuclide**	**Reporting Levels**	
		EIML to KNPP[a]	**KNPP to NRC**[b]
Airborne Particulate or Gases (pCi/m3)	Gross Beta	1	--
	I-131 (Charcoal)	0.1	0.9
	Cs-134	1	10
	Cs-137	1	20
Precipitation (pCi/l)	H-3	1,000	--
Water (pCi/l)	Gross Alpha	10	--
	Gross Beta	30	--
	H-3	10,000	20,000[c]
	Mn-54	100	1,000
	Fe-59	40	400
	Co-58	100	1,000
	Co-60	30	300
	Zr-Nb-95	40	400
	Cs-134	10	30
	Cs-137	20	50
	Ba-La-140	100	200
	Sr-89	10	- -
	Sr-90	10	- -
	Zn-65	30	300
Milk (pCi/l)	I-131	1.0	3
	Cs-134	20	60
	Cs-137	20	70
	Ba-La-140	100	300
	Sr-89	10	- -
Grass, Cattle Feed, and Vegetables (pCi/g wet)	Gross Beta	30	- -
	I-131	0.1	0.1
	Cs-134	0.2	1
	Cs-137	0.2	2
	Sr-89	1	- -
	Sr-90	1	- -

Table 2.2.1-D

Reporting Levels for Radioactivity Concentrations in Environmental Samples

Medium	Radionuclide	Reporting Levels	
		EIML to KNPP[a]	KNPP to NRC[b]
Eggs (pCi/g wet)	Gross Beta	30	--
	Cs-134	0.2	1
	Cs-137	0.2	2
	Sr-89	1	--
	Sr-90	1	--
Soil, Bottom Sediments (pCi/g)	Gross Beta	50	--
	Cs-134	5	--
	Cs-137	5	--
	Sr-89	5	--
	Sr-90	5	--
Meat (pCi/g wet)	Gross Beta (Flesh, Bones)	10	--
	Cs-134 (Flesh)	1.0	1.0
	Cs-137 (Flesh)	2	2.0
	Sr-89 (Bones)	2	--
	Sr-90 (Bones)	2	--
Fish (pCi/g wet)	Gross Beta (Flesh, Bones)	10	--
	Mn-54	--	30.0
	Fe-59	--	10.0
	Co-58	--	30.0
	Co-60	--	10.0
	Cs-134 (Flesh)	1	1.0
	Cs-137 (Flesh)	2	2.0
	Sr-89 (Bones)	2	--
	Sr-90 (Bones)	2	--
	Zn-65 (Bones)	--	20

a) Radionuclides will be monitored by EIML and concentrations above the listed limits will be reported to KNPP.

b) Concentrations above the listed limits will be reported to NRC as required by REMM 2.4.1.

c) For drinking water samples, this is 40CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.

Table 2.3.1-A
Detection Capabilities for Environmental Sample Analysis[a]
Lower Limit of Detection (LLD)[b,c]

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2000[d]					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zr-Nb-95	15					
I-131	1[e]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		
Zn-65	30		260			

Table Notations for Table 2.3.1-A

a. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environment Monitoring Report.

b. Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

c. The LLD is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66 s_b}{E \times V \times 2.22 \times Y \times \exp(-\gamma \Delta t)}$$

Where:

LLD is the <u>a priori</u> lower limit of detection as defined above, as picocuries per unit mass or volume,

S_b is the standard deviation of the background counting rate or of the counting rate of blank sample as appropriate, as counts per minute,

E is the counting efficiency, as counts per disintegration,

V is the sample size in units of mass or volume,

2.22 is the number of disintegrations per minute per picocurie,

Y is the fractional radiochemical yield, when applicable,

γ is the radioactive decay constant for the particular radionuclide, and

Δt for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting,

Typical values of E, V, Y, and Δt should be used in calculation.

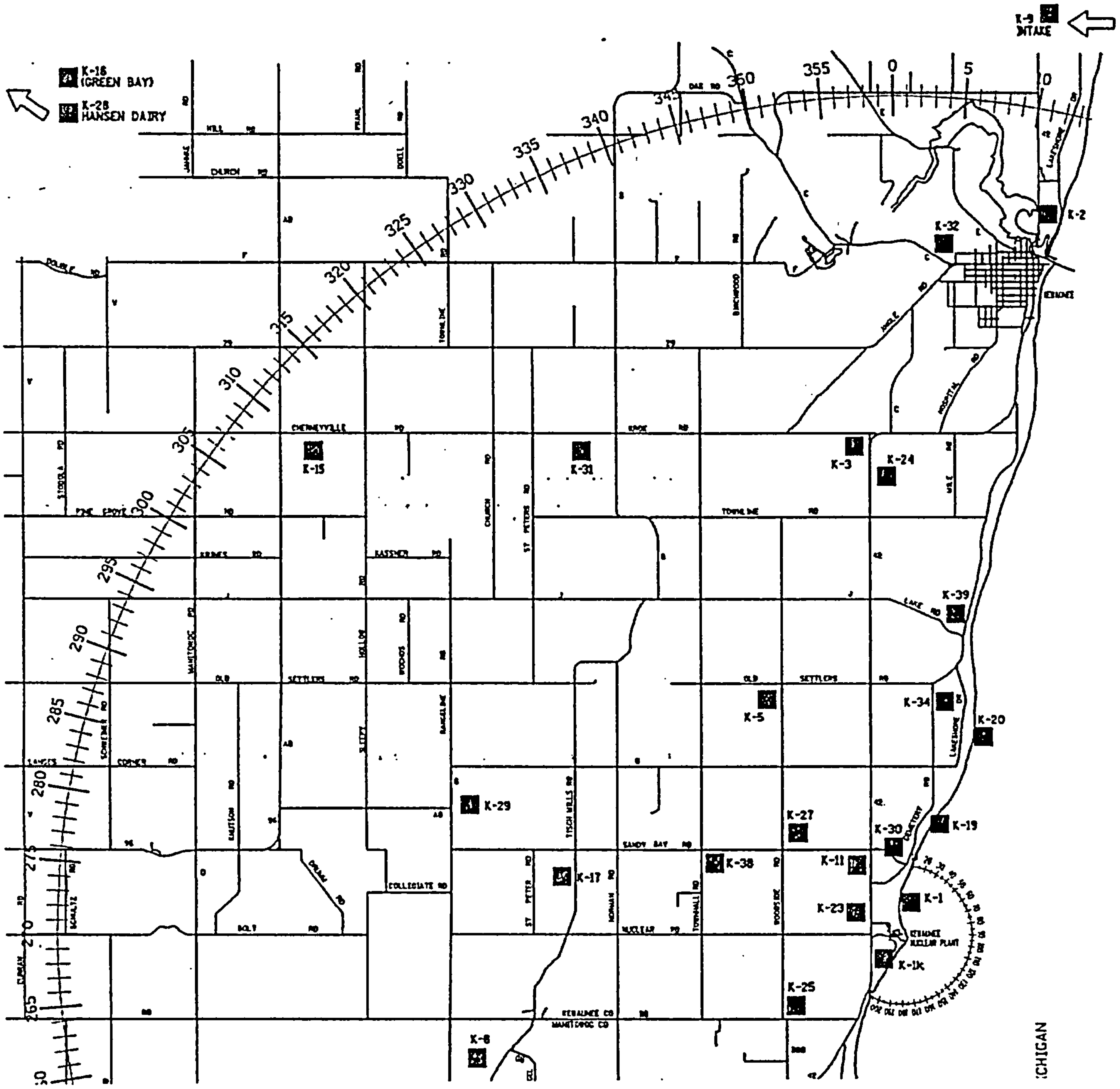
Table Notations for Table 2.3.1-A (con't)

It should be recognized that the LLD is defined as a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Monitoring Report.

d. If no drinking water pathway exists, a value of 3,000 pCi/l may be used.

e. LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

FIGURE 1


K-9
INTAKE
K-16
(GREEN BAY)
K-28
HANSEN DAIRY
K-2
K-32
KEWAUNEE
K-15
K-31
K-3
K-24
K-39
K-5
K-34
K-20
K-29
K-27
K-30
K-19
K-38
K-11
K-17
K-23
K-1
KEWAUNEE
NUCLEAR PLANT
K-1k
K-25
K-8
CHURCH RD
CHERNEYVILLE RD
PINE GROVE RD
TOWNLINE RD
OLD SETTLERS RD
SANDY BAY RD
NUCLEAR RD
COLLEGIATE RD
DRUM RD
BOLT RD
KEWAUNEE CO
MANITOWOC CO
ST PETERS RD
TISCH MILLS RD
WOODSIDE RD
CEMETERY
LAKESHORE
LAKE RD
HOSPITAL
DOUBLE F RD
ICHIGAN
0
5
10
350
355
345
340
335
330
325
320
315
310
305
300
295
290
285
280
275
270
265

TRACKING AND PROCESSING RECORD

A

Initiated By: Rick Adams **Date:** 8/8/03 **Dept:** RP **Ext.:** 8360

Document No.: REMM **Current Rev. No.:** 7 **New Rev. No.:** 8

Title: REMM

Requested Due /Required Date →

B

Describe Change(s) (New Document or Revision- attach commitments, Action Request, markup, etc.)	**Describe Reason(s)**
REmoved reference to sample location K-37 and replaced with K-39 in the following locations: Pg 3-4, ~~Amnient~~ 9-16-03 Ambient Radiation and Milk, pg. 3-5 Grass, Table 2.2.1-A, Table 2.2.1-B, and Table 2.2.1-C	Sample location K-37 was discontinued and replaced with sample location K-39.
Page 3-5 Cattelfeed ad soil - changed number of dairy farms to the correct value of six.	Correct the number of dairy farms we take samples at.

Page 1 of 2 Continued on Next Page ☒

C

Expiration Requirement (if applicable) **Expiration Date** (IPTE, Vendor, Other) →

D

Activity: ☐ New ☒ Revision ☐ Admin Hold ☐ Vendor ☐ NMC ☐ Deletion

Priority: ☒ Immediate Action ☐ Non-Urgent - Perform Later ☐ Rejected - See Comments

Safety Related ☐ Yes ☐ No **PORC Review** ☐ Yes ☐ No **SRO Approval - Temp Changes** ☐ Yes ☐ No ☒ NA

Level of Use: ☐ Continuous Use ☐ Reference Use ☐ Information Use ☒ NA

Formal Training Affected: ☐ Yes (Send Copy to Training) ☒ No

Comments: (add pages as necessary)

E

Reviewers Required – Signatures/Dates:

		Date			Date
☒ Technical	Thomas P. Schmidt	/ 9-16-03	☐ Cross Discipline		/
☐ Minor		/	☐ Oversight (QC)		/
☐ Editorial		/	☐ Other		/
☐ Validation		/			

F

50.59 Applicability Form Attached? ☒ Yes **50.59 Screen Form Attached?** ☐ Yes ☒ No

50.59 Pre-Screen Form Attached? ☐ Yes ☒ No **50.59 Evaluation Attached?** ☐ Yes ☒ No

G

1) ☐ ⇒ Process Owner Review Recommendation

☒ Approval ☐ Disapproval

Waive Validation Review ☒ Yes ☐ No

Stanley F. Baker 9-25-03

Process Owner Signature **Date**

2) ☐ ⇒ PORC Review Recommendation

☒ Approval ☐ Disapproval

Meeting No. 03-172

9/25/03

Plant Manager Signature **Date**

H

Effective Date:

Responsible Manager Review - Directives

TRACKING AND PROCESSING RECORD

CONTINUATION SHEET

Document No.: REMM **Current Rev. No.:** 7 **New Rev. No.:** 8

Page 2 of 2

Describe Change (New Document or Revision)	**Describe Reason**
Updated the sample location map	Due to new sample and removal of another, i.e., K-39 and K-37 respectively.
Revised format to Word.	

50.59 APPLICABILITY REVIEW

(Is the activity excluded from 50.59 review?)

1. Document/Activity number: Revision of the REMM - Rev 8

2. Brief description of proposed activity (what is being changed and why):

3. Does the proposed activity involve or change any of the following documents or processes? Check YES or NO for EACH applicability review item. Explain in comments if necessary. [Ref. NMC 50.59 Resource Manual, Section 4]

NOTE: If you are unsure if a document or process may be affected, contact the process owner.

	Yes ✓	No ✓	Document or Process	Applicable Regulation	Contact/Action
a	☐	☑	Technical Specifications or Operating License	10CFR50.92	Process change per NAD-05.14. Contact Licensing.
b	☐	☑	Activity/change previously approved by NRC in license amendment or NRC SER	10CFR50.90	Identify NRC letter in comments below. Process change. Contact Licensing for assistance.
c	☐	☑	Activity/change covered by an existing approved 10CFR50.59 review, screening, or evaluation.	10CFR50 Appendix B	Identify screening or evaluation in comments below. Process change.
d	☐	☑	Quality Assurance Program (OQAPD/OQAP)	10CFR50.54(a)	Contact QA. Refer to NAD-01.07.
e	☐	☑	Emergency Plan	10CFR50.54(q)	Contact EP. Refer to NAD-05.15.
f	☐	☑	Security Plan	10CFR50.54(p)	Contact Security. Refer to NAD-05.17.
g	☐	☑	IST Plan	10CFR50.55a(f)	Contact IST process owner. Refer to NAD-01.24.
h	☐	☑	ISI Plan	10CFR50.55a(g)	Contact ISI process owner. Refer to NADs 01.03, 01.05, and 05.11.
i	☐	☑	ECCS Acceptance Criteria	10CFR50.46	Contact Licensing.
j	☐	☑	USAR or any document incorporated by reference - Check YES only if change is editorial (see Attachment A).	10CFR50.71	Process USAR change per NEP-05.02. Contact USAR process owner for assistance.
k	☐	☑	Commitment - Commitment changes associated with a response to Generic Letters and Bulletins, or if described in the USAR require a pre-screening.	10CFR50 Appendix B	Contact Licensing. Refer to NAD-05.25.
l	☐	☑	Maintenance activity or new/revised maintenance procedure - Check YES only if clearly maintenance and equipment will be restored to its as-designed condition within 90 days (see Attachment C).	10CFR50.65	Evaluate under Maintenance Rule. Refer to NAD-08.20 and NAD-08.21.
m	☐	☑	Degraded/Non-conforming plant condition - Check YES if returned to as-designed condition in a timely manner consistent with safety.	10CFR50 Appendix B	Initiate an Action Request (AR) and evaluate under GL 91-18, Revision 1. Contact licensing for assistance. Refer to GNP 11.08.03.
n	☑	☐	New/revised administrative or managerial directive/procedure (e.g., NAD, GNP, Fleet Procedure) or a change to any procedure or other controlled document (e.g., plant drawing) which is clearly editorial/administrative. See Attachments A and B.	10CFR50 Appendix B	Process procedure/document revision.

4. Conclusion. Check one of the following:

☐ All documents/processes listed above are checked NO. 10CFR50.59 applies to the proposed activity. A 50.59 pre-screening shall be performed.

☑ One or more of the documents/processes listed above are checked YES, AND controls all aspects of the proposed activity. 10CFR50.59 does NOT apply. Process the change under the applicable program/process/procedure.

☐ One or more of the documents/processes listed above are checked YES, however, some portion of the proposed activity is not controlled by any of the above processes. 10CFR50.59 applies to that portion. A 50.59 pre-screening shall be performed.

5. Comments:

6. Print name followed by signature. Attach completed form to document/activity/change package.

Prepared by: (print/sign) Rick Adams , Rick Adams Date: 9/4/03

Reviewed by: (print/sign) THOMAS P. SCHMIDL , Thomas P. Schmidl Date: 9-16-03

STATE CHANGE HISTORY

Initiate
by ADAMS, RICHARD

AR Pre-Screen
10/13/2003 11:36:44 AM
Owner (None)

Submit to Screening Team
by TREPTOW, ETHAN

AR Screening Que
10/13/2003 1:49:52 PM
Owner KNPP CAP Admin

SECTION 1

Activity Request Id: CAP018430

Activity Type: CAP

Submit Date: 10/13/2003 11:36:44 AM

One Line Description: Annual Environmental Monitoring Report Sample Location Maps Not Updated

Detailed Description: 10/13/2003 11:36:44 AM - ADAMS, RICHARD :

The 2002 Annual Environmental Monitoring Report Sample Location Map, page 15 of the report, did not contain one sample location that had been added to the program. The site was added to the program in March of 2002. The site was noted in Revision 7 of the REMM, which was also submitted as part of the annual report. This report is submitted to the NRC each year. The rest of the report appropriately lists the sample location and shows the results of the sampling during 2002.

In addition, four inactive sample points were still shown on the map on page 15 of the report. These are still valid sample locations, but are no longer being used due to the location owner not participating in the program.

Initiator: ADAMS, RICHARD

Initiator Department: KK Radiation Protection KE

Date/Time of Discovery: 10/13/2003 10:13:20 AM

Date/Time of Occurrence: 10/13/2003 10:13:20 AM

Identified By: Site-identified

System: (None)

Equipment # (1st): (None)

Equipment Type (1st): (None)

Equipment # (2nd): (None)

Equipment Type (2nd) : (None)

Equipment # (3rd): (None)

Equipment Type (3rd) : (None)

Site/Unit: Kewaunee

Why did this occur?: 10/13/2003 11:36:44 AM - ADAMS, RICHARD :

The vendor was not provided with an updated copy of the sample location map and their year end report, with the errant map, was included in the annual report. The monthly review of the vendor results did not identify the need for the vendor to have the updated map. During this time, the responsible person in the RP organization had changed twice.

Immediate Action Taken: 10/13/2003 11:36:44 AM - ADAMS, RICHARD :

The RP Supervisor-ALARA forwarded a copy of the updated map to the vendor with instructions to incorporate the map into their reports.

Recommendations: 10/13/2003 11:36:44 AM - ADAMS, RICHARD :

The initiator contacted Licensing personnel regarding reportability of this issue. It was discussed that this is not reportable due to the fact that the consequences of the inaccurate information does not have a significant implication for public health and safety or common defense and security (10 CFR 50.9).

An action will be needed to note the erred map from the 2002 report during the submission of the 203 report.

Notify Me During Eval?: N

SRO Review Required?: N

SECTION 2

Operability Status: NA

Compensatory Actions: N

Basis for Operability: 10/13/2003 1:49:52 PM - TREPTOW, ETHAN :
Administrative issue with errors on the sample location maps. No affect on plant equipment or operation. No operability concerns. Not immediately reportable to the NRC.

Unplanned TSAC Entry:	N	**External Notification:**	N

SECTION 3

Screened?:	Y	**Significance Level:**	C
INPO OE Reqd?:	N	**Potential MRFF?:**	N
QA/Nuclear Oversight?:	N	**Licensing Review?:**	N
Good Catch/Well Doc'd?:	NA		

SECTION 4

Inappropriate Action:

Process:	(None)	**Activity:**	(None)
Human Error Type:	(None)	**Human Perf Fail Mode:**	(None)
Equip Failure Mode:	(None)	**Process Fail Mode:**	(None)
Org/Mgt Failure Mode:	(None)	**Group Causing Prob:**	(None)
Hot Buttons:	(None)		

ATTACHMENTS AND PARENT/CHILD LINKS

Principal to CA013923: Annual Environmental Monitoring Report Sample Location Maps Not Updated

CHANGE HISTORY

10/13/2003 4:17:26 PM by VANVALKENBURG, TERRY
Last Modifier Changed From TREPTOW, ETHAN To VANVALKENBURG, TERRY
Prescreen Comments Changed From " To '[Appended:] CA to RP'
10/14/2003 9:18:19 AM by WALESH, DEBRA
Last Modified Date Changed From 10/13/2003 4:17:26 PM To 10/14/2003 9:18:19 AM
Last Modifier Changed From VANVALKENBURG, TERRY To WALESH, DEBRA
original_project_id Changed From 0 To 51
original_issue_id Changed From " To '018430'
10/14/2003 9:18:50 AM by WALESH, DEBRA
Last Modified Date Changed From 10/14/2003 9:18:19 AM To 10/14/2003 9:18:50 AM
Attachment Added: Principal to CA013923: Annual Environmental Monitoring Report Sample Location Maps Not Updated
10/14/2003 10:42:00 AM by WALESH, DEBRA
Screened? Changed From N To Y
Last Modified Date Changed From 10/14/2003 9:18:50 AM To 10/14/2003 10:42:00 AM

STATE CHANGE HISTORY

Initiate ⇨ by WALESH, DEBRA

Assign Work
10/14/2003 9:18:50 AM
Owner SCHMIDLI, THOMAS

Assign ⇨ by SCHMIDLI, THOMAS

Conduct Work
10/14/2003 9:25:47 AM
Owner ADAMS, RICHARD

SECTION 1

Activity Request Id:	CA013923		
Activity Type:	Corrective Action	**Submit Date:**	10/14/2003 9:18:50 AM
Site/Unit:	Kewaunee		
One Line Description:	Annual Environmental Monitoring Report Sample Location Maps Not Updated		
Activity Requested:	Take corrective actions as required to resolve condition identified in CAP 18430.		
CATPR:	N	**Mode Change Restraint:**	(None)
Initiator:	ADAMS, RICHARD	**Initiator Department:**	KK Radiation Protection KE
Responsible Group Code:	KKO Rad Protection Field Ops KE	**Responsible Department:**	Plant
Activity Supervisor:	SCHMIDLI, THOMAS	**Activity Performer:**	ADAMS, RICHARD

SECTION 2

Priority:	4	**Due Date:**	8/9/2004
Management Exception From PI?:	N	**QA/Nuclear Oversight?:**	N
Licensing Review?:	N	**NRC Commitment?:**	N
NRC Commitment Date:		**Significance Level:**	C

SECTION 3

Activity Completed:	
Hot Buttons:	(None)

SECTION 4

QA Supervisor:	(None)	**Licensing Supervisor:**	(None)

ATTACHMENTS AND PARENT/CHILD LINKS

Subtask from CAP018430: Annual Environmental Monitoring Report Sample Location Maps Not Updated

CHANGE HISTORY

10/14/2003 9:25:47 AM by SCHMIDLI, THOMAS
Activity Performer Changed From (None) To ADAMS, RICHARD

Priority Changed From (None) To 4
Due Date Changed From Unassigned To 8/9/2004
State Changed From Assign Work To Conduct Work Via Transition: Assign
Owner Changed From SCHMIDLI, THOMAS To ADAMS, RICHARD
Assigned Date Changed From Unassigned To 10/14/2003
Last Modified Date Changed From 10/14/2003 9:18:51 AM To 10/14/2003 9:25:47 AM
Last Modifier Changed From WALESH, DEBRA To SCHMIDLI, THOMAS
Last State Change Date Changed From 10/14/2003 9:18:50 AM To 10/14/2003 9:25:47 AM
Last State Changer Changed From WALESH, DEBRA To SCHMIDLI, THOMAS