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U.S. Nuclear Regulatory Commission
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Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS)**
Units 1, 2, & 3
Docket Nos. STN 50-528/529/530
Annual Radiological Environmental Operating Report for 1999

Enclosed please find a copy of the Annual Radiological Environmental Operating Report for 1999. This report covers operation of PVNGS Units 1, 2, and 3 during 1999, and is being submitted pursuant to PVNGS Technical Specification 5.6.2. No commitments are being made to the NRC by this letter.

Should you have any questions, please contact Scott A. Bauer at (623) 393-5978.

Sincerely,

Angela K. Krainik

Angela K. Krainik

AKK/SAB/CJJ

Enclosure

cc: E. W. Merschoff
M. B. Fields
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A. V. Godwin (ARRA)

IE25

ENCLOSURE

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT FOR 1999

FOR

PALO VERDE NUCLEAR GENERATING STATION

PALO VERDE

NUCLEAR GENERATING STATION

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT 1999

Prepared by: Louis Drinovsky 3/28/00

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PALO VERDE

NUCLEAR GENERATING STATION

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT 1999

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ABSTRACT

The Radiological Environmental Monitoring Program (REMP) is an ongoing program conducted by Arizona Public Service Company (APS) for the Palo Verde Nuclear Generating Station (PVNGS). Various types of environmental samples are collected near PVNGS and analyzed for radionuclide concentrations.

During 1999, the following categories of samples were collected by APS:

- Broad leaf vegetation
- Groundwater
- Drinking water
- Surface water
- Airborne particulate and radioiodine
- Sludge and sediment
- Soil

Thermoluminescent dosimeters (TLDs) were used to measure environmental gamma radiation. The Environmental TLD program is also conducted by APS.

APS reviews analysis results for trends and anomalies for inclusion in this report.

The Arizona Radiation Regulatory Agency (ARRA) performs radiochemistry analyses on various duplicate samples provided to them by APS. Samples analyzed by ARRA include: Reservoir, Evaporation Ponds 1 and 2, Sheppard well, Berryman well, well 27ddc, and well 34abb. Additionally, ARRA performs air sampling at seven locations identical to APS. ARRA reports the results of their comparisons in a separate report.

Assessment of pre-operational and operational data revealed no changes to environmental radiation levels. There were no observed radiological impacts on the environment due to PVNGS operations in 1999.

(NOTE: Reference to APS throughout this report refers to PVNGS personnel)

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1. Introduction

This report presents the results of the operational radiological environmental monitoring program conducted by Arizona Public Service Company (APS). The Radiological Environmental Monitoring Program (REMP) was established for the Palo Verde Nuclear Generating Station (PVNGS) by APS in 1979. The REMP is performed in accordance with the federal requirements to provide a complete environmental monitoring program for nuclear reactors, and with concern for maintaining the quality of the local environment. The program complies with the requirements of 10 CFR50, Appendix I, PVNGS Technical Specifications, and with the guidance provided by the US Nuclear Regulatory Commission (USNRC) in their Radiological Assessment Branch Technical Position, Revision 1, November 1979.

This report contains the measurements and findings for 1999. All references are specifically identified in Section 12.

The objectives of the REMP are as follows: 1) to determine baseline radiation levels in the environs prior to plant operation and to compare the findings with measurements obtained during reactor operations; 2) to monitor potential critical pathways of radio-effluent to man; and 3) to determine radiological impacts on the environment caused by the operation of PVNGS.

Results from the REMP help to evaluate sources of elevated levels of radiation in the environment, (e.g., atmospheric nuclear detonations or abnormal plant releases).

Results of the PVNGS pre-operational environmental monitoring program are presented in Reference 1.

The initial criticality of Unit 1 occurred May 25, 1985. Initial criticality for Units 2 and 3 were April 18, 1986, and October 25, 1987, respectively. PVNGS operational findings (historical) are presented in Reference 2.

2. Description of the Monitoring Program

The pre-operational radiological environmental monitoring program, which began in 1979, was performed by APS and vendor organizations. APS and vendors continued the program into the operational phase.

2.1. 1999 PVNGS Radiological Environmental Monitoring Program

The assessment program consists of routine measurements of background gamma radiation and of radionuclide concentrations in media such as air, groundwater, drinking water, surface water, vegetation, sludge, sediment, and soil.

Samples were collected by APS at the monitoring sites shown in Figures 2.1 and 2.2. The specific sample types, sampling locations, and sampling frequencies, as set forth in the PVNGS Offsite Dose Calculation Manual (ODCM), Reference 4, are presented in Tables 2.1, 2.2 and 9.1. Additional onsite sampling (outside the scope of the ODCM) is performed to supplement the REMP. All results are included in this report. Sample analyses were performed by APS at the PVNGS Central Chemistry Laboratory.

Background gamma radiation measurements are performed by APS using TLDs at forty-nine locations near PVNGS.

In addition to the monitoring of environmental media, a land use census is performed annually to identify the nearest milk animals, residents, gardens, and/or changes thereto, near PVNGS. This information is used to evaluate the potential dose to members of the public for those exposure pathways that are indicated.

2.2. Radiological Environmental Monitoring Program Changes for 1999

REMP changes occurred as a result of the 1999 Land Use Census. Vegetation sample locations were changed to meet the requirements of the ODCM. Refer to Table 2.1 for a list of current sample locations.

Residence well water sample site #48 (Sheppard Farm, SSW4) became permanently unavailable as of 11-16-99. The Berryman residence (SW1) replaced Sheppard.

2.3. REMP Discrepancy Summary

During calendar year 1999, there were five discrepancies with regard to ODCM requirements. Refer to Table 2.3 for more detail and corrective actions taken.

- Air samples for the week of 7-6-99 at sites #4 and #6A were not collected within the required weekly frequency +25% due to vehicle breakdown in the field.
- Control TLD #44 was missing in the second quarter.
- Air sample particulate (gross beta) result for the week of 11-30-99 from site #4 was invalidated due to excessive filter loading.
- The Sheppard farm well (site #48) became permanently unavailable as of November, 1999.
- Interlaboratory results for gross beta in air and water failed to meet acceptance criteria on three occasions

Table 2.1 SAMPLE COLLECTION LOCATIONS

SAMPLE SITE #	SAMPLE TYPE	LOCATION (a)	LOCATION DESCRIPTION
4	air	E16	APS Office
6A*	air	SSE13	Old US 80
7A	air	SE8	Arlington School
14A	air	NNE2	371st Ave. and Buckeye-Salome Rd.
15	air	NE2	NE Site Boundary
17A	air	E4	351st Ave.
21	air	S3	S Site Boundary
29	air	W1	W Site Boundary
35	air	NNW8	Fire Station
40	air	N3	Transmission Rd
46	drinking water	NW9	McArthur Residence
47	vegetation	ENE3	Steele Residence
48**	drinking water	SSW4 (b)	Sheppard Farm **
49	drinking water	N2	Chowanec Residence
52	vegetation	ESE4	Hallman Residence
55	drinking water (supplemental)	SW3	Gavette Residence
57	groundwater	ONSITE	Well 27ddc
58	groundwater	ONSITE	Well 34abb
59	surface water	ONSITE	Evaporation Pond #1
60	surface water	ONSITE	Reservoir
62*	vegetation	E35	Rousseau Farming Co.
63	surface water	ONSITE	Evaporation Pond #2
64	vegetation (supplemental)	NNE2 (b)	Branch Residence

NOTES:

* Designates a control site
** Site #48 changed to Berryman residence as of 11-16-99 and is located SW1

(a) Distances and direction are from the center-line of Unit 2 containment and rounded to the nearest mile
(b) Denotes a change in location

Air sample sites designated with the letter 'A' are sites which have the same site number as a TLD location, but are not in the same location (e.g. site **#6** TLD location is different from site **#6A** air sample location; site **#4** TLD location is the same as site **#4** air sample location)

Table 2.2 SAMPLE COLLECTION SCHEDULE

SAMPLE SITE #	*AIR PARTICULATE*	*AIRBORNE RADIOIODINE*	*VEGETATION*	*GROUND WATER*	*DRINKING WATER*	*SURFACE WATER*
4	W	W				
6A	W	W				
7A	W	W				
14A	W	W				
15	W	W				
17A	W	W				
21	W	W				
29	W	W				
35	W	W				
40	W	W				
46					W	
47			M/AA			
48					W	
49					W	
52			M/AA			
55					W	
57				Q		
58				Q		
59						W
60						W
62			M/AA			
63						W
64			M/AA			

W = WEEKLY M/AA = MONTHLY AS AVAILABLE Q = QUARTERLY

TABLE 2.3 SUMMARY OF REMP DISCREPANCIES

Discrepancy	Actions taken
Control TLD #44 was missing in the 2nd quarter.	In order to prevent recurrence of vandalism, the TLD was moved to a nearby location that is fenced.
Air samples for week of 7-6-99 at sites #4 and #6A were not collected within the required weekly frequency due to vehicle failure while in route to sample locations.	None required, vehicle maintenance is performed as scheduled and this was an isolated incident.
Particulate sample for the week of 11-30-99 at site #4 was invalidated due to abnormally low result and excessive dust loading. There were no indications of equipment problems and all other sample results were normal.	No action will be taken unless this becomes a recurring problem. This location is at the boundary of a local horse arena. It was evident that there was some work or activity at this location creating dust that loaded the filter excessively.
The drinking water sample from the Sheppard well (site #48) became unavailable as of November 8, 1999. The property was sold and there is no longer a resident at this location. This resulted in no monthly composite being obtained from this location in November.	A replacement sample location was added on 11-16-99 (Berryman well). The new location was selected based on proximity to PVNGS and relative location to the Sheppard well. No other actions are necessary.
Interlaboratory comparison results for gross beta in air and water did not meet acceptance criteria.	During investigation into gross beta crosscheck failures in the central lab several possibilities that could have effected our results were addressed, such as interference, attenuation, self-absorption, and crosstalk. • Since the filter is made with only Cs-137 there should be no interference. • Attenuation was not an issue as our results were higher than expected. • Sample matrix is pure water with only Am-241 and Cs-137 added so self-absorption is unlikely. • Determining crosstalk setting is required only upon initial setup of instrument or when detector is changed out. A pure alpha emitter is needed to perform this crosstalk. The source used initially (Po210) was disposed therefore for this investigation the test was performed for "information only" with Am-241, which is not a pure alpha emitter. This resulted in ~20% of the counts in beta channel which by procedure should be <3% using a pure alpha source. The crosstalk test was performed using two different discriminators, which yielded the same results. The QA/QC checks that are performed on the instrument prior to use have shown no indication of a bias problem. Additional efforts have been made to validate the accuracy of our numbers. • Sent samples to an offsite lab for independent analysis. • Ordering new source (Po210) to perform crosstalk verification. • Ordering new source to calculate efficiency for filter analysis. Based on the fact that the daily check is indicating that the instrument is operating within limits and we can not validate a problem with crosstalk until we get a Po210 source. Based on the Am241 crosstalk, if a problem exists it would be in the conservative direction. Therefore it is recommended that we continue to use the instrument. We will continue to investigate these gross beta failures and continue to evaluate any further improvements to our process, up to and including instrument replacement.

FIGURE 2.1
REMP SAMPLE SITES
(0-10 MILES)

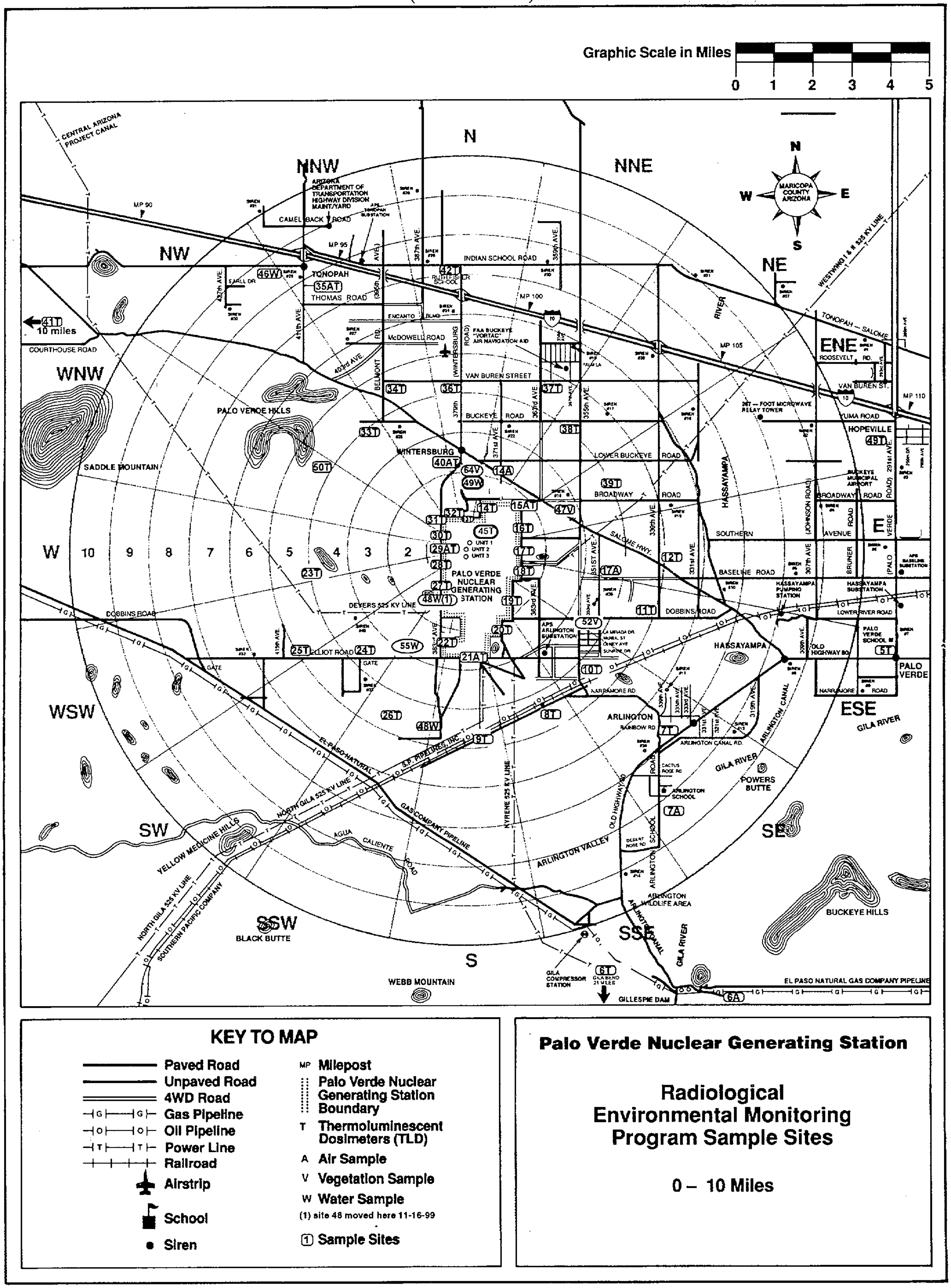
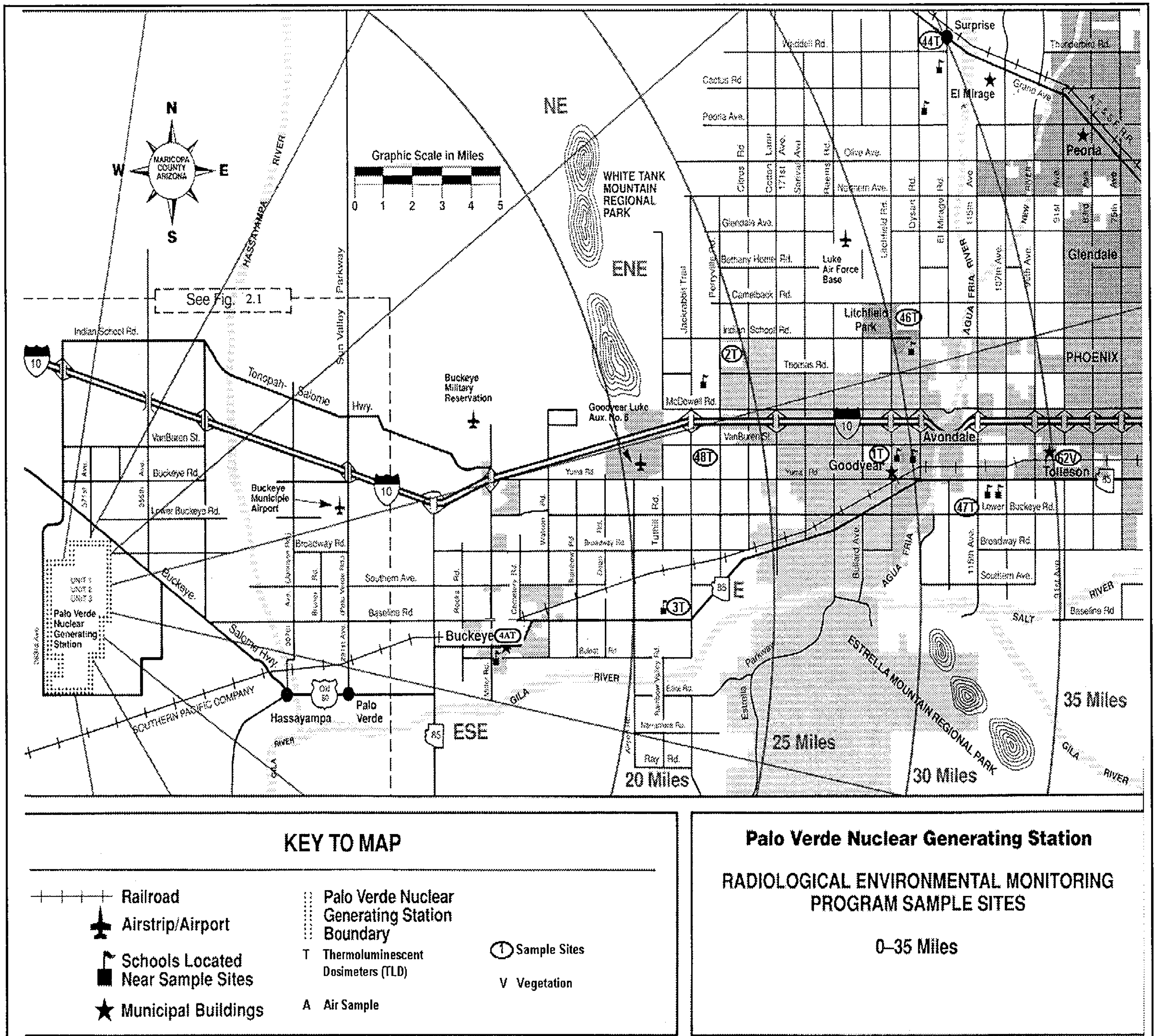


FIGURE 2.2
REMP SAMPLE SITES
(0-35 MILES)



3. Sample Collection Program

All samples were collected by APS personnel using PVNGS procedures.

3.1. Water

Weekly samples were collected from the Reservoir, Evaporation Pond #1, Evaporation Pond #2, and 4 residence wells. Samples were collected in one-gallon cubitainers and 500 ml glass bottles. One liter of each weekly one-gallon sample was added to a monthly composite, which is preserved with nitric acid (HNO_3). The composite samples were then analyzed for gamma-emitters. Residence wells were also analyzed for gross beta activity. Weekly grab samples in glass bottles were composited quarterly and analyzed for tritium.

Quarterly grab samples were collected from onsite wells 34abb and 27ddc. Samples were collected in one-gallon cubitainers and 500 ml glass bottles. Samples were analyzed for gamma-emitters and tritium.

Treated sewage effluent from the City of Phoenix was sampled as a weekly composite at the onsite Water Reclamation Facility (WRF), and analyzed for gamma-emitters. A monthly composite was analyzed for tritium.

3.2. Vegetation

Vegetation samples were collected by APS using PVNGS procedures.

Vegetation samples were scheduled to be collected monthly, as available, and were analyzed for gamma-emitters.

3.3. Milk

Milk sampling was performed from 1979-1995 and discontinued in 1995. This was justified since there were no sample locations identified within 5 miles of PVNGS. The control location sample is also not taken since there would be no valid 'indicator' locations with which to compare results. If milk animals are located within 5 miles during the annual land use census, an evaluation will be initiated to consider re-establishing a milk sample program.

3.4. Air

Air samples were collected by APS using PVNGS procedures.

Air particulate filters and charcoal canisters were exchanged at ten (10) sites on a weekly basis. Particulate filters were analyzed for gross beta. Charcoal canisters were analyzed for I-131. Particulate filters were composited quarterly, by location, and analyzed for gamma-emitters.

3.5. Sludge and Sediment

Sludge and sediment samples were collected by APS using PVNGS procedures.

Sludge samples were obtained from the WRF centrifuge (whenever the plant was operational) and analyzed for gamma-emitters. Samples were collected using 1000 ml plastic bottles.

No cooling tower sludge was disposed of in the onsite landfill in 1999.

Bottom sediment/sludge samples were obtained from Evaporation Pond #1 and #2 and analyzed for gamma-emitters. Samples were collected from a boat at various locations using a bucket to preserve the integrity of the pond liners.

3.6. Soil

Soil samples were collected onsite in 1999. All samples were collected in plastic bags and analyzed for gamma-emitters.

4. Analytical Procedures

The procedures described in this report are those used by APS to routinely analyze samples.

4.1. Air Particulate

4.1.1. Gross Beta

A glass fiber filter sample is placed in a stainless steel planchet and counted for gross beta activity utilizing a low-background gas flow, proportional counter.

4.1.2. Gamma Spectroscopy

The glass fiber filters are placed in a standard geometry container and counted on a multichannel analyzer equipped with a HPGe detector. The resulting spectrum is analyzed by computer and specific nuclides, if present, are identified and quantified.

4.2. Airborne Radioiodine

The charcoal canister is counted on a multichannel analyzer equipped with an HPGe detector. The resulting spectrum is analyzed by computer and I-131, if present, is identified and quantified.

4.3. Vegetation

4.3.1. Gamma Spectroscopy

The sample is pureed in a food processor, placed in a one liter plastic marinelli beaker, weighed, and counted on a multichannel analyzer equipped with a HPGe detector. The resulting spectrum is analyzed by computer and specific nuclides, if present, are identified and quantified.

4.4. Sludge/Sediment

4.4.1. Gamma Spectroscopy

The wet/dry sample is placed in a one-liter plastic marinelli beaker, weighed, and counted on a multichannel analyzer equipped with a HPGe detector. The resulting spectrum is analyzed by computer and specific nuclides, if present, are identified and quantified.

4.5. Water

4.5.1. Gamma Spectroscopy

The sample is placed in a one-liter plastic marinelli beaker, weighed, and counted on a multichannel analyzer equipped with a HPGe detector. The resulting spectrum is analyzed by computer and specific nuclides if present, are identified and quantified.

4.5.2. Tritium

The sample is evaluated to determine the appropriate method of preparation prior to counting. If the sample contains suspended solids or is turbid, it may be filtered, distilled, and/or de-ionized, as appropriate. Eight (8) milliliters of sample are mixed with fifteen (15) milliliters of liquid scintillation cocktail. The mixture is dark adapted and counted for tritium activity using a liquid scintillation counting system.

4.5.3. Gross Beta

A 200-250 milliliter sample is placed in a beaker. Five (5) milliliters of concentrated nitric (HNO_3) acid is added and the sample is evaporated down to about twenty (20) milliliters. The remaining sample is quantitatively transferred to a stainless steel planchet. The sample is heated to dryness and counted for gross beta in a gas flow, proportional counter.

4.6. Soil

4.6.1. Gamma Spectroscopy

The samples are sieved, placed in a one-liter plastic marinelli beaker, and weighed. The samples are then counted on a multichannel analyzer equipped with a HPGe detector. The resulting spectrum is analyzed by computer and specific nuclides if present, are identified and quantified.

5. Nuclear Instrumentation

5.1. Canberra Gamma Spectrometer

The Gamma Spectrometer consists of a Canberra System equipped with two intrinsic detectors having resolutions of 1.81 keV and 1.88 keV (as determined by full width half max with an energy of 0.5 keV per channel) and respective efficiencies of 16.3% and 38.4% (as determined by the manufacturer with Co-60). The Canberra System is used for all gamma counting. The system uses Canberra developed software (automatic radionuclide analysis) to search and identify, as well as quantify, the peaks of interest.

5.2. Beckman Liquid Scintillation Spectrometer

A Beckman LS-3801 Liquid Scintillation Counter is used for tritium determinations. The system background averages approximately 20 cpm with a counting efficiency of about 40% using a quenched standard.

5.3. Tennelec LB5100 Low Background Counting System

The LB5100 is a low background, gas flow proportional counter. The system contains an automatic sample changer capable of counting 50 samples in succession. Average beta background count rate is about 1-2 cpm with a beta efficiency of about 30% (Cs-137).

6. Isotopic Detection Limits and Reporting Criteria

6.1. Lower Limits of Detection

The lower limits of detection (LLD) and the method for calculation are specified in the PVNGS ODCM, Reference 4. The ODCM required *a priori* LLDs are presented in Table 6.1. For reference, *a priori* LLDs are indicated at the top of data tables for samples having required LLD values.

6.2. Data Reporting Criteria

All results that are greater than the Minimum Detectable Activity (MDA) (a posteriori LLD) are reported as positive activity with its associated 2σ counting error. All results that are less than the MDA are reported as less than values at the associated MDA. For example, if the MDA is 12 pCi/liter, the value is reported as <12.

Typical MDA values are presented in Table 6.3.

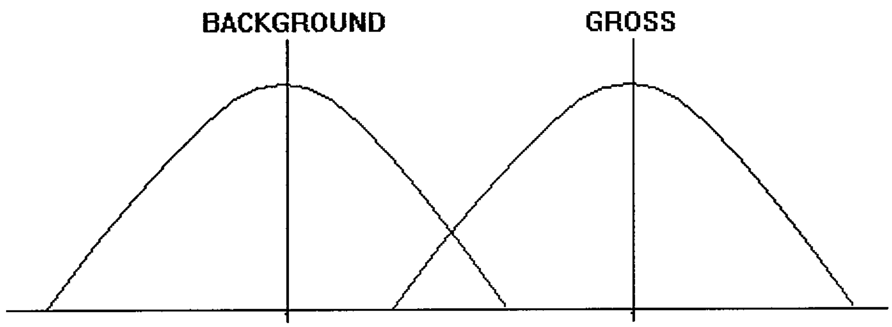
Occasionally the PVNGS ODCM *a priori* LLDs may not be achieved as a result of:

- Background fluctuations
- Unavoidably small sample sizes
- The presence of interfering nuclides
- Self absorption corrections
- Decay corrections for short half-life radionuclides
- Other uncontrollable circumstances

In these instances, the contributing factors will be noted in the table where the data are presented. A summary of REMP discrepancies is presented in Table 2.3.

6.3. LLD and Reporting Criteria Overview

Making a reasonable estimate of the limits of detection for a counting procedure or a radiochemical method is usually complicated by the presence of significant background. It must be considered that the background or blank is not a fixed value but that a series of replicates would be normally distributed. The desired net activity is thus the difference between the gross and background activity distributions. The interpretation of this difference becomes a problem if the two distributions intersect as indicated in the diagram.



If a sufficient number of replicate analyses are run, it is to be expected that the results would fall in a normal Gaussian Distribution. Standard statistics allow an estimate of the probability of any particular deviation from the mean value. It is common practice to report the mean ± one or two standard deviations as the result. In routine analysis, such replication is not carried out, and it is not possible to report a Gaussian standard deviation. With counting procedures, however, it is possible to estimate a Poisson standard deviation directly from the count. Data is commonly reported as the measured value ± one or two Poisson standard deviations. The reported values are then considered to give some indication of the range in which the true value might be expected to occur.

The simplest possible case to consider would be one where the background is negligible and the sample activity is zero. It is sometimes not realized that if a series of counts is taken on such a system, half of the net values should be less than zero. Negative counts are not possible, of course. However, when there is an appreciable background, the entire scale is raised. The resulting situation: half of the sample counts on a zero activity sample would be less than background. The negative net counts occur frequently in low-level measurements, causing considerable concern. Actually, such results are to be expected.

A LLD is the smallest amount of sample activity that will yield a net count for which there is confidence at a predetermined level that activity is present. LLDs are calculated values for individual nuclides based on a number of different factors including sample size, counting efficiency and background count rate of the instrument, the background and sample counting time, the decay time, and the chemical recovery of the analytical procedures. A minimum detectable activity value (MDA) is the smallest amount of activity that can be detected in an actual sample and uses the values obtained from the instrument and outcome of the analytical process. Therefore, the MDA values may differ from the calculated LLD values if the sample size and chemical recovery, decay values, or the instrument efficiency, background, or count time differed from those used in the LLD calculation.

The factors governing the calculation of the LLD and MDA values are discussed below:

1. Sample Size

2. Counting Efficiency

The fundamental quantity in the measurement of a radioactive substance is the number of disintegrations per unit time. As with most physical measurements in analytical chemistry, it is seldom possible to make an absolute measurement of the disintegration rate, but rather it is necessary to compare the sample with one or more standards. The standards determine the counter efficiency that may then be used to convert sample counts per minute (cpm) to disintegrations per minute (dpm).

3. Background Count Rate

Any counter will show a certain counting rate without a sample in position. This background counting rate comes from several sources: 1) natural environmental radiation from the surroundings, 2) cosmic radiation, and 3) the natural radioactivity in the counter material itself. The background counting rate will depend on the amounts of these types of radiation and the sensitivity of the counter to the radiation.

4. Background and Sample Counting Time

The amount of time devoted to the counting of the background depends on the level of activity being measured. In general, with low-level samples, this time should be about equal to that devoted to counting a sample.

5. Time Interval between Sample Collection and Counting

Decay measurements are useful in identifying certain short-lived isotopes. The disintegration constant is one of the basic characteristics of a specific radionuclide and is readily determined, if the half-life is sufficiently short. In order to ensure the required LLDs are achieved, conservative values are used in decay correction to allow for transit time and sample processing.

6. Chemical Recovery of the Analytical Procedures

Most radiochemical analyses are carried out in such a way that losses occur during the separations. These losses occur due to the large number of contaminants that may be present and interfere during chemical separations. Thus, it is necessary to include a technique for estimating these losses in the development of the analytical procedure.

Table 6.1 ODCM REQUIRED LOWER LIMITS OF DETECTION (*a priori*)

ANALYSIS/ NUCLIDE	WATER (pCi/liter)	AIRBORNE PARTICULATE or GAS (pCi/m^3)	MILK (pCi/liter)	VEGETATION (pCi/kg, wet)
gross beta	4	0.01		
tritium	2000*			
Mn-54	15			
Fe-59	30			
Co-58, 60	15			
Zn-65	30			
Zr-95	30			
Nb-95	15			
I-131	1**	0.07	1	60
Cs-134	15	0.05	15	60
Cs-137	18	0.06	18	80
Ba-140	60		60	
La-140	15		15	

<u>NOTES:</u>

* If no drinking water pathway exists, a value of 3000 pCi/liter may be used.

** If no drinking water pathway exists, a value of 15 pCi/liter may be used.

This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

Milk sampling was not required as noted in the land use census (see section 10).

Table 6.2 ODCM REQUIRED REPORTING LEVELS

ANALYSIS/ NUCLIDE	WATER (pCi/liter)	AIRBORNE PARTICULATE or GAS (pCi/m^3)	MILK (pCi/liter)	VEGETATION (pCi/kg, wet)
tritium	20,000*			
Mn-54	1,000			
Fe-59	400			
Co-58	1,000			
Co-60	300			
Zn-65	300			
Zr/Nb-95	400			
I-131	2**	0.9	3	100
Cs-134	30	10	60	1,000
Cs-137	50	20	70	2,000
Ba/La-140	200		300	

NOTES:

* For drinking water samples. This is a 40CFR141 value. If no drinking water pathway exists, a value of 30,000 pCi/liter may be used.
** If no drinking water pathway exists, a reporting level of 20 pCi/liter may be used.

Milk sampling was not required as noted in the land use census (see section 10).

The values in this table are (calendar) quarterly average values, as stated in the ODCM.

Table 6.3 TYPICAL MDA VALUES

ANALYSIS/ NUCLIDE	WATER (pCi/liter)	AIRBORNE PARTICULATE or GAS (pCi/m^3)	VEGETATION (pCi/kg, wet)
gross beta	3	0.008	
tritium	300		
Mn-54	11		
Fe-59	20		
Co-58	10		
Co-60	10		
Zn-65	24		
Zr-95	18		
Nb-95	10		
I-131	12 [a]	0.03 [b]	20
Cs-134	12	0.02 [b]	20
Cs-137	13	0.02 [b]	25
Ba-140	38		
La-140	11		

NOTES:

a - low level I-131 is not required since there is no drinking water pathway
b - based on 433 m^3 volume

Milk sampling was not required as noted in the land use census (see section 10).

7. Interlaboratory Comparison Program

7.1. Quality Control Program

APS maintains an extensive QA/QC Program that provides certainty that samples are collected, handled, tracked, and analyzed to specified requirements. This program includes appropriate elements of USNRC Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment, Rev. 1. Included in the program are procedures for sample collection, preparation and tracking, sample analysis, equipment calibration and checks, and ongoing participation in an interlaboratory comparison program. Duplicate/replicate samples are analyzed routinely to verify analytical precision and sample methodology. Comprehensive data reviews are performed including trending of data where appropriate.

During 1999, APS analyzed the following sample types under the interlaboratory comparison program;

- Beta/Gamma/ in Air Filter
- I-131 in Air
- Beta in Water
- Gamma in Water
- Tritium in Water

7.2. Intercomparison Results

APS participates in a crosscheck program using vendor supplied blind radionuclide samples. Results for the interlaboratory comparison program are presented in Table 7.1.

TABLE 7.1 INTERLABORATORY COMPARISON RESULTS

(All results in pCi/l unless otherwise annotated)

2nd Quarter

Sample Type	Analysis Type	Units	Nuclide	Known Value	PVNGS Value	1 sigma Error	Resolution *	Ratio	ACCEPT/REJECT
Water	Mixed Gamma	pCi/liter	I-131	68	67	6.5	10	0.99	ACCEPT
			Ce-141	134	144	5.5	26	1.07	ACCEPT
			Cr-51	172	191	22.5	8	1.11	ACCEPT
			Cs-134	92	86	3.5	25	0.93	ACCEPT
			Cs-137	151	159	4.0	40	1.05	ACCEPT
			Mn-54	68	69	3.5	20	1.01	ACCEPT
			Fe-59	38	50	6.5	8	1.32	ACCEPT
			Zn-65	98	106	6.5	16	1.08	ACCEPT
			Co-60	171	179	4.5	40	1.05	ACCEPT
	Tritium	pCi/liter	H-3	9349	8510	133.0	64	0.91	ACCEPT
	Gross Beta	**pCi/liter**		**288**	**367**	**3.5**	**105**	**1.27**	**REJECT (b)**
Air	Iodine	pCi/canister	I-131	75	81	2.5	32	1.08	ACCEPT
	Gross Beta	**pCi/filter**		**55**	**75**	**1.0**	**75**	**1.36**	**REJECT (b)**
	Mixed Gamma	pCi/filter	Cr-51	199	199	18.5	11	1.00	ACCEPT
			Mn-54	78	86	3.5	25	1.10	ACCEPT
			Fe-59	44	53	6.0	9	1.20	ACCEPT
			Co-60	198	207	5.0	41	1.05	ACCEPT
			Zn-65	113	132	7.0	19	1.17	ACCEPT
			Cs-134	106	94	3.5	27	0.89	ACCEPT
			Cs-137	174	175	4.0	44	1.01	ACCEPT
			Ce-141	155	147	3.0	49	0.95	ACCEPT

TABLE 7.1 INTERLABORATORY COMPARISON RESULTS

(All results in pCi/l unless otherwise annotated)
4th Quarter

Sample Type	Analysis Type	Units	Nuclide	Known Value	PVNGS Value	1 sigma Error	Resolution *	Ratio	ACCEPT/REJECT
Water	Mixed Gamma	pCi/liter	I-131	96	101	4.5	22	1.05	ACCEPT
			Ce-141	105	112	4.4	25	1.07	ACCEPT
			Cr-51	290	299	20.0	15	1.03	ACCEPT
			Cs-134	125	114	4.3	27	0.91	ACCEPT
			Cs-137	96	105	3.3	32	1.09	ACCEPT
			Mn-54	100	106	3.4	31	1.06	ACCEPT
			Co-58	110	115	4.1	28	1.05	ACCEPT
			Fe-59	94	110	6.3	17	1.17	ACCEPT
			Zn-65	185	191	7.4	26	1.03	ACCEPT
			Co-60	132	135	3.7	36	1.02	ACCEPT
	Tritium	pCi/liter	H-3	8015	6825	113.0	60	0.85	ACCEPT
	Gross Beta	pCi/liter		183	229	3.0	76	1.25	ACCEPT
Air	Iodine	pCi/canister	I-131	86	100	3.0	33	1.16	ACCEPT
	Gross Beta	**pCi/filter**		**43**	**62**	**0.7**	**89**	**1.44**	**REJECT (b)**
	Mixed Gamma	pCi/filter	Cr-51	178	192	29	7	1.08	ACCEPT
			Mn-54	61	69	5	14	1.13	ACCEPT
			Co-58	67	71	5	14	1.06	ACCEPT
			Fe-59	58	73	10	7	1.26	ACCEPT
			Co-60	81	89	6	15	1.10	ACCEPT
			Zn-65	114	135	12	11	1.18	ACCEPT
			Cs-134	76	71	6	12	0.93	ACCEPT
			Cs-137	59	64	5	13	1.08	ACCEPT
			Ce-141	65	60	4	15	0.92	ACCEPT

* calculated from PVNGS value/1 sigma error value

NRC Acceptance Criteria (a)

Resolution	Ratio
4-7	0.5-2.0
8-15	0.6-1.66
16-50	0.75-1.33
51-200	0.80-1.25
>200	0.85-1.18

(a) From NRC Inspection Manual, procedure #84750, "Radioactive Waste Systems; Water Chemistry; Confirmatory Measurements

(b) During investigation into gross beta crosscheck failures in the central lab several possibilities that could have effected our results were addressed, such as interference, attenuation, self-absorption, and crosstalk.

- Since the filter is made with only Cs-137 there should be no interference.
- Attenuation was not an issue as our results were higher than expected.
- Sample matrix is pure water with only Am-241 and Cs-137 added so self-absorption is unlikely.

- Determining crosstalk setting is required only upon initial setup of instrument or when detector is changed out. A pure alpha emitter is needed to perform this crosstalk. The source used initially (Po210) was disposed therefore for this investigation the test was performed for "information only" with Am-241, which is not a pure alpha emitter. This resulted in ~20% of the counts in beta channel which by procedure should be <3% using a pure alpha source. The crosstalk test was performed using two different discriminators, which yielded the same results.

The QA/QC checks that are performed on the instrument prior to use have shown no indication of a bias problem. Additional efforts have been made to validate the accuracy of our numbers.

- Sent samples to an offsite lab for independent analysis.
- Ordering new source (Po210) to perform crosstalk verification.
- Ordering new source to calculate efficiency for filter analysis.

Based on the fact that the daily check is indicating that the instrument is operating within limits and we can not validate a problem with crosstalk until we get a Po210 source. Based on the Am241 crosstalk, if a problem exists it would be in the conservative direction. Therefore it is recommended that we continue to use the instrument. We will continue to investigate these gross beta failures and continue to evaluate any further improvements to our process, up to and including instrument replacement.

8. Data Interpretations and Conclusions

Associated with the analytical process are potential random and systematic errors. Systematic errors can be caused by instrument malfunctions, incomplete precipitation, and back scattering and self-absorption. Random errors are beyond the control of the analyst and are caused by the random nature of radioactive decay.

Efforts are made to eliminate both systematic and random errors in the data reported. Systematic errors are eliminated by performing reviews throughout the analysis. For example, instruments are checked routinely with radioactive sources and recovery and self-absorption factors based on individual sample analyses are incorporated into the calculation equations where necessary. Random errors are reduced by comparing all data to historical data for the same site and performing cross comparisons between analytical results when available. In addition, when data do not appear to match historical results, analyses may be rerun on a separate aliquot of the sample to verify the presence of the activity. The acceptance of data is dependent upon the results of quality control samples and is part of the data review process for all analytical results.

The "plus or minus value" reported with each analytical result represents the counting error associated with the result and gives the 95% confidence (2σ) interval around the data.

Most samples contain radioactivity associated with natural background/cosmic radioactivity (e.g. K-40, Th-234, and Be-7). Gross beta results for drinking water and air are due to natural background. **Gamma-emitting radionuclides, which can be attributed to natural background sources, are not indicated in this report**.

Results and interpretation of the data for all of the samples analyzed during 1999 are presented in the following sections. Assessment of pre-operational and operational data revealed no changes to environmental radiation levels. There were no observed radiological impacts on the environment due to PVNGS operations in 1999.

8.1. Air Particulates

Weekly gross beta results, in quarterly format, are presented in Tables 8.1 and 8.2 and depicted in graphs in Figures 8.1 and 8.2. Gross beta activity ranged from 0.013 to 0.072 pCi/m^3. The associated counting error ranged from 0.001 to 0.004 pCi/m^3. Mean quarterly activities are calculated using all weekly activities except those marked invalid. Also presented in the tables are the weekly mean values of all the sites as well as the percent relative standard deviation (RSD %) of the data. The findings are consistent with pre-operational baseline and previous operational results. Figure 8.2 shows the results of the gross beta in air from the pre-operational phase compared to the 1991-1999 gross beta in air results. As can be seen, the indicator sites trend consistently with the control site.

Table 8.3 displays the results of gamma spectroscopy on the quarterly composites. The results are summarized in Table 11.1. No Cs-134 or Cs-137 was observed.

8.2. Airborne Radioiodine

Tables 8.4 through 8.5 present the quarterly radioiodine results. No radioiodine was detected in any of the samples.

8.3. Vegetation

Table 8.6 presents gamma isotopic data for the vegetation samples. No gamma-emitting nuclides were observed in any of the samples.

8.4. Drinking Water

Samples were analyzed for gross beta, tritium, and gamma-emitting nuclides. Results of these analyses are presented in Table 8.7. No tritium or gamma-emitting nuclides were detected in any samples. Gross beta activity ranged from less than detectable, to a high of 11.6 ± 2.5 pCi/l (Sheppard farm, May composite).

8.5. Groundwater

Groundwater samples were analyzed for tritium and gamma-emitting nuclides. Results obtained from the analysis of the samples are presented in Table 8.8.

No tritium or gamma-emitting nuclides were observed in any of the samples.

8.6. Surface Water

Surface water samples from the Reservoir and Evaporation Ponds were analyzed for tritium and gamma-emitting nuclides. The Reservoir contains processed sewage water from the City of Phoenix and is approximately 80 acres in size. The two Evaporation Ponds receive mostly circulating water from main turbine condenser cooling and are about 250 acres each. Results are presented in Table 8.9. Cs-137 was observed in Evaporation Pond # 2 in five of twelve monthly composite samples. The concentrations were 8 - 18 pCi/l. No other gamma-emitting nuclides were identified. No gamma-emitting nuclides were identified in the Reservoir or Evaporation Pond #1.

Tritium was routinely observed in Evaporation Ponds 1 and 2. The highest concentration in Evaporation Pond #1 was 1319 ± 157 pCi/l and the highest concentration in Evaporation Pond #2 was 1296 ± 159 pCi/l. Tritium was not identified in the Reservoir. The tritium has been attributed to plant gaseous effluent releases.

WRF influent (Phoenix sewage effluent) samples collected by the WRF were analyzed for gamma-emitting nuclides and tritium. The results, presented in Table 8.9, demonstrate that I-131 was observed routinely. The highest I-131 concentration was

54 ± 12 pCi/l (week of February 17). The results are consistent with assays from the previous years. None of the samples analyzed indicated the presence of tritium.

Table 8.9 also presents gamma spectroscopy and tritium measurements of samples collected from Sedimentation Basin #2. This basin collects rain waters from site runoff and was dry for most of the year. No gamma-emitting nuclides were detected in these samples. Tritium was detected in six of ten samples ranging from 326 to 1944 pCi/liter. The tritium in this basin has been attributed to plant gaseous effluent releases.

8.7. Sludge and Sediment

8.7.1. WRF Centrifuge waste sludge

Sludge samples were obtained from the WRF centrifuge and analyzed by gamma spectroscopy. The I-131 in the WRF waste centrifuge sludge is consistent with historical values and, as previously discussed, is due to radiopharmaceuticals in the WRF influent. I-131 was present in all fifty samples ranging from 243 to 1455 pCi/kg.

In-111 was also identified in the sludge on occasion. The highest In-111 concentration was 45 pCi/l (week of May 5). It was previously established that In-111 is in use in the Phoenix area as a radiopharmaceutical. Results for WRF centrifuge waste sludge can be found in Table 8.10.

8.7.2.

8.7.3. Evaporation Ponds #1 and #2 sediment

Evaporation Pond #1 samples indicated no gamma-emitters. Evaporation Pond #2 samples indicated low levels of Cs-137 and Co-60. These radionuclides are evidently due to previous primary-to-secondary leaks that resulted in their transport to the onsite ponds and are consistent with previous results. Sample results can be found in Table 8.10.

8.7.4. Cooling Tower sludge

Sludge was not disposed of in the landfill during 1999.

8.8. Soil

Soil samples were analyzed by gamma spectroscopy. One of five samples contained Cs-137 activity of 306 ± 41 pCi/kg which is within the range of Cs-137 identified in pre-operational soil studies. Sample results can be found in Table 8.11.

8.9. Summary of Results

Sample data are presented in graphic form in Figures 8.1-8.5. When practical, comparisons to pre-operational data are displayed. A summary of the sample results is presented in Table 11.1 (ODCM required samples only).

TABLE 8.1 PARTICULATE GROSS BETA IN AIR 1st - 2nd QUARTER

ODCM required samples denoted by *

units are pCi/m^3

1st Quarter

Week #	START DATE	STOP DATE	Site 4 (control)	Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Mean	RSD (%)
1	28-Dec-98	4-Jan-99	0.046	0.058	0.066	0.040	0.040	0.038	0.048	0.050	0.045	0.036	0.047	20.1
2	4-Jan-99	11-Jan-99	0.032	0.037	0.036	0.031	0.031	0.026	0.032	0.029	0.034	0.026	0.031	11.8
3	11-Jan-99	19-Jan-99	0.029	0.050	0.044	0.041	0.042	0.039	0.044	0.047	0.050	0.038	0.042	14.8
4	19-Jan-99	25-Jan-99	0.024	0.026	0.026	0.020	0.024	0.022	0.026	0.021	0.027	0.021	0.024	10.7
5	25-Jan-99	1-Feb-99	0.029	0.029	0.031	0.028	0.026	0.028	0.029	0.029	0.029	0.023	0.028	7.8
6	1-Feb-99	8-Feb-99	0.032	0.029	0.031	0.030	0.034	0.030	0.029	0.033	0.030	0.025	0.030	8.2
7	8-Feb-99	15-Feb-99	0.031	0.025	0.033	0.024	0.028	0.025	0.031	0.034	0.026	0.029	0.029	12.5
8	15-Feb-99	22-Feb-99	0.038	0.040	0.042	0.033	0.035	0.037	0.038	0.039	0.035	0.034	0.037	7.7
9	22-Feb-99	2-Mar-99	0.032	0.036	0.038	0.022	0.028	0.030	0.026	0.031	0.028	0.024	0.030	17.0
10	2-Mar-99	8-Mar-99	0.024	0.025	0.026	0.017	0.022	0.025	0.026	0.019	0.025	0.021	0.023	13.6
11	8-Mar-99	15-Mar-99	0.028	0.026	0.028	0.028	0.027	0.026	0.026	0.027	0.028	0.024	0.027	4.9
12	15-Mar-99	22-Mar-99	0.024	0.026	0.025	0.024	0.025	0.024	0.025	0.023	0.022	0.023	0.024	5.0
13	22-Mar-99	29-Mar-99	0.015	0.020	0.022	0.019	0.022	0.017	0.019	0.020	0.018	0.015	0.019	13.4
	Mean		0.030	0.033	0.034	0.027	0.030	0.028	0.031	0.031	0.031	0.026	0.030	8.2

2nd Quarter

Week #	START DATE	STOP DATE	Site 4 (control)	Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Mean	RSD (%)
14	29-Mar-99	5-Apr-99	0.019	0.021	0.017	0.019	0.017	0.016	0.014	0.016	0.019	0.018	0.018	11.4
15	5-Apr-99	12-Apr-99	0.019	0.017	0.018	0.015	0.017	0.016	0.014	0.016	0.015	0.013	0.016	11.4
16	12-Apr-99	20-Apr-99	0.021	0.026	0.030	0.028	0.023	0.020	0.026	0.020	0.022	0.020	0.024	15.5
17	20-Apr-99	27-Apr-99	0.027	0.025	0.025	0.026	0.026	0.023	0.023	0.027	0.023	0.021	0.025	8.2
18	27-Apr-99	3-May-99	0.025	0.027	0.025	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	2.2
19	3-May-99	10-May-99	0.032	0.031	0.029	0.032	0.033	0.028	0.028	0.033	0.030	0.031	0.031	6.2
20	10-May-99	17-May-99	0.034	0.034	0.030	0.031	0.033	0.033	0.032	0.035	0.029	0.030	0.032	6.3
21	17-May-99	24-May-99	0.036	0.036	0.034	0.033	0.033	0.029	0.033	0.037	0.033	0.030	0.033	7.6
22	24-May-99	1-Jun-99	0.042	0.036	0.034	0.036	0.041	0.032	0.034	0.034	0.033	0.034	0.036	9.4
23	1-Jun-99	8-Jun-99	0.027	0.024	0.024	0.026	0.026	0.024	0.023	0.023	0.025	0.019	0.024	9.3
24	8-Jun-99	14-Jun-99	0.031	0.031	0.032	0.030	0.028	0.031	0.029	0.017	0.028	0.021	0.028	17.7
25	14-Jun-99	22-Jun-99	0.031	0.035	0.036	0.034	0.035	0.033	0.034	0.035	0.035	0.033	0.034	4.2
26	22-Jun-99	28-Jun-99	0.027	0.027	0.030	0.033	0.031	0.031	0.030	0.026	0.030	0.029	0.029	7.4
	Mean		0.029	0.028	0.028	0.028	0.028	0.026	0.027	0.027	0.027	0.025	0.027	4.5

TABLE 8.2 PARTICULATE GROSS BETA IN AIR 3rd - 4th QUARTER

ODCM required samples denoted by *

units are pCi/m^3

3rd Quarter

Week #	START DATE	STOP DATE	Site 4	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Mean	RSD (%)
27	28-Jun-99	6-Jul-99 (a)	0.028	0.033	0.032	0.033	0.036	0.034	0.031	0.034	0.032	0.030	0.032	7.0
28	6-Jul-99	12-Jul-99	0.017	0.019	0.021	0.018	0.019	0.020	0.019	0.019	0.021	0.017	0.019	7.4
29	12-Jul-99	19-Jul-99	0.030	0.025	0.028	0.031	0.030	0.030	0.029	0.028	0.030	0.024	0.029	8.1
30	19-Jul-99	26-Jul-99	0.026	0.024	0.024	0.022	0.029	0.026	0.029	0.026	0.030	0.026	0.026	9.7
31	26-Jul-99	2-Aug-99	0.032	0.030	0.031	0.030	0.031	0.027	0.029	0.031	0.030	0.024	0.030	8.0
32	2-Aug-99	10-Aug-99	0.032	0.032	0.029	0.031	0.028	0.032	0.030	0.029	0.032	0.030	0.031	4.9
33	10-Aug-99	17-Aug-99	0.027	0.031	0.028	0.032	0.029	0.028	0.027	0.030	0.028	0.022	0.028	9.7
34	17-Aug-99	24-Aug-99	0.037	0.035	0.029	0.026	0.022	0.023	0.030	0.026	0.039	0.040	0.031	21.6
35	24-Aug-99	31-Aug-99	0.030	0.044	0.032	0.035	0.027	0.026	0.031	0.032	0.023	0.026	0.031	19.4
36	31-Aug-99	7-Sep-99	0.032	0.032	0.032	0.030	0.034	0.033	0.034	0.039	0.036	0.031	0.033	7.9
37	7-Sep-99	14-Sep-99	0.026	0.032	0.035	0.033	0.031	0.028	0.025	0.032	0.037	0.027	0.031	13.0
38	14-Sep-99	21-Sep-99	0.037	0.032	0.021	0.034	0.021	0.031	0.028	0.035	0.035	0.028	0.030	18.8
39	21-Sep-99	27-Sep-99	0.035	0.037	0.037	0.036	0.034	0.037	0.036	0.041	0.037	0.028	0.036	9.2
	Mean		0.030	0.031	0.029	0.030	0.029	0.029	0.029	0.031	0.032	0.027	0.030	4.6

4th Quarter

Week #	START DATE	STOP DATE	Site 4	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*	Mean	RSD (%)
40	27-Sep-99	5-Oct-99	0.045	0.035	0.056	0.046	0.045	0.049	0.052	0.051	0.040	0.035	0.045	15.5
41	5-Oct-99	12-Oct-99	0.044	0.048	0.034	0.043	0.039	0.043	0.041	0.046	0.048	0.037	0.042	10.9
42	12-Oct-99	18-Oct-99	0.050	0.050	0.048	0.047	0.046	0.046	0.050	0.053	0.050	0.041	0.048	6.9
43	18-Oct-99	26-Oct-99	0.040	0.055	0.058	0.046	0.050	0.044	0.045	0.054	0.056	0.039	0.049	14.1
44	26-Oct-99	2-Nov-99	0.044	0.038	0.044	0.037	0.036	0.034	0.039	0.046	0.040	0.037	0.040	10.0
45	2-Nov-99	8-Nov-99	0.056	0.064	0.072	0.067	0.064	0.047	0.061	0.065	0.063	0.053	0.061	11.9
46	8-Nov-99	16-Nov-99	0.051	0.065	0.067	0.059	0.059	0.057	0.055	0.057	0.062	0.051	0.058	9.1
47	16-Nov-99	22-Nov-99	0.049	0.047	0.047	0.044	0.044	0.045	0.045	0.048	0.044	0.036	0.045	8.0
48	22-Nov-99	30-Nov-99	(b)	0.045	0.045	0.040	0.036	0.030	0.043	0.035	0.034	0.033	0.038	14.6
49	30-Nov-99	7-Dec-99	0.034	0.036	0.047	0.039	0.042	0.025	0.033	0.037	0.035	0.032	0.036	16.5
50	7-Dec-99	14-Dec-99	0.046	0.045	0.045	0.038	0.041	0.035	0.037	0.034	0.041	0.033	0.040	12.2
51	14-Dec-99	20-Dec-99	0.026	0.029	0.041	0.030	0.031	0.022	0.031	0.031	0.023	0.020	0.028	21.3
52	20-Dec-99	27-Dec-99	0.032	0.029	0.032	0.028	0.030	0.028	0.027	0.025	0.025	0.026	0.028	9.1
	Mean		0.043	0.045	0.049	0.043	0.043	0.039	0.043	0.045	0.043	0.036	0.043	7.9
	Annual Average		***0.033***	***0.034***	***0.035***	***0.032***	***0.032***	***0.031***	***0.032***	***0.033***	***0.033***	***0.029***	***0.032***	***5.6***

(a) Samples were collected from site #4 and #6A on 7-7-99 due to vehicle breakdown during sample collection (exceeded sample collection frequency requirement).

(b) Data invalidated due to abnormally low result (0.011). Sample recounted with same results. Sample was excessively loaded with dust/dirt, which may have contributed to abnormal result.

TABLE 8.3 GAMMA IN AIR FILTER COMPOSITES

ODCM required samples denoted by *
units are pCi/m^3

QUARTER ENDPOINT	NUCLIDE	Site 4	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*
29-Mar-99	Cs-134	<0.0014	<0.0019	<0.0019	<0.0019	<0.0019	<0.0012	<0.0017	<0.0020	<0.0018	<0.0017
	Cs-137	<0.0015	<0.0019	<0.0016	<0.0017	<0.0014	<0.0015	<0.0013	<0.0018	<0.0019	<0.0016
28-Jun-99	Cs-134	<0.0019	<0.0016	<0.0021	<0.0018	<0.0019	<0.0015	<0.0016	<0.0020	<0.0019	<0.0020
	Cs-137	<0.0016	<0.0019	<0.0016	<0.0014	<0.0016	<0.0017	<0.0018	<0.0019	<0.0019	<0.0019
27-Sep-99	Cs-134	<0.0020	<0.0013	<0.0020	<0.0019	<0.0020	<0.0020	<0.0018	<0.0017	<0.0014	<0.0019
	Cs-137	<0.0021	<0.0012	<0.0022	<0.0016	<0.0018	<0.0019	<0.0011	<0.0018	<0.0017	<0.0018
27-Dec-99	Cs-134	<0.0019	<0.0018	<0.0025	<0.0018	<0.0027	<0.0019	<0.0025	<0.0025	<0.0020	<0.0021
	Cs-137	<0.0016	<0.0018	<0.0023	<0.0021	<0.0019	<0.0019	<0.0015	<0.0018	<0.0023	<0.0017

TABLE 8.4 RADIOIODINE IN AIR 1st - 2nd QUARTER

ODCM required samples denoted by *
units are pCi/m^3

1st Quarter

(control) required LLD <0.070

Week #	START DATE	STOP DATE	Site 4	Site 6A* (control)	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*
1	28-Dec-98	4-Jan-99	<0.022	<0.017	<0.028	<0.018	<0.031	<0.016	<0.027	<0.020	<0.028	<0.017
2	4-Jan-99	11-Jan-99	<0.023	<0.030	<0.029	<0.016	<0.027	<0.016	<0.029	<0.026	<0.015	<0.031
3	11-Jan-99	19-Jan-99	<0.018	<0.013	<0.018	<0.011	<0.023	<0.012	<0.022	<0.014	<0.018	<0.014
4	19-Jan-99	25-Jan-99	<0.026	<0.027	<0.030	<0.026	<0.028	<0.026	<0.028	<0.025	<0.032	<0.027
5	25-Jan-99	1-Feb-99	<0.021	<0.014	<0.024	<0.015	<0.023	<0.014	<0.028	<0.013	<0.017	<0.027
6	1-Feb-99	8-Feb-99	<0.026	<0.016	<0.019	<0.013	<0.030	<0.015	<0.014	<0.020	<0.025	<0.017
7	8-Feb-99	15-Feb-99	<0.026	<0.015	<0.026	<0.013	<0.021	<0.016	<0.024	<0.015	<0.022	<0.016
8	15-Feb-99	22-Feb-99	<0.025	<0.025	<0.021	<0.022	<0.025	<0.028	<0.023	<0.017	<0.021	<0.019
9	22-Feb-99	2-Mar-99	<0.017	<0.011	<0.014	<0.020	<0.011	<0.019	<0.013	<0.02	<0.013	<0.013
10	2-Mar-99	8-Mar-99	<0.020	<0.023	<0.018	<0.024	<0.022	<0.021	<0.022	<0.022	<0.025	<0.025
11	8-Mar-99	15-Mar-99	<0.021	<0.013	<0.024	<0.013	<0.024	<0.013	<0.025	<0.013	<0.021	<0.015
12	15-Mar-99	22-Mar-99	<0.017	<0.027	<0.014	<0.020	<0.017	<0.026	<0.016	<0.022	<0.014	<0.022
13	22-Mar-99	29-Mar-99	<0.023	<0.025	<0.025	<0.025	<0.013	<0.027	<0.016	<0.024	<0.017	<0.015

2nd Quarter

(control) required LLD <0.070

Week #	START DATE	STOP DATE	Site 4	Site 6A* (control)	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*
14	29-Mar-99	5-Apr-99	<0.022	<0.020	<0.016	<0.017	<0.021	<0.018	<0.022	<0.023	<0.017	<0.017
15	5-Apr-99	12-Apr-99	<0.018	<0.015	<0.024	<0.014	<0.021	<0.021	<0.015	<0.025	<0.014	<0.025
16	12-Apr-99	20-Apr-99	<0.022	<0.012	<0.012	<0.022	<0.012	<0.018	<0.012	<0.018	<0.013	<0.021
17	20-Apr-99	27-Apr-99	<0.020	<0.019	<0.023	<0.022	<0.021	<0.018	<0.027	<0.018	<0.027	<0.022
18	27-Apr-99	3-May-99	<0.019	<0.027	<0.025	<0.019	<0.030	<0.022	<0.017	<0.022	<0.020	<0.024
19	3-May-99	10-May-99	<0.018	<0.023	<0.017	<0.019	<0.020	<0.018	<0.019	<0.028	<0.026	<0.018
20	10-May-99	17-May-99	<0.025	<0.018	<0.028	<0.018	<0.022	<0.019	<0.015	<0.021	<0.017	<0.016
21	17-May-99	24-May-99	<0.031	<0.019	<0.022	<0.029	<0.026	<0.022	<0.021	<0.021	<0.021	<0.024
22	24-May-99	1-Jun-99	<0.021	<0.014	<0.023	<0.013	<0.019	<0.017	<0.022	<0.015	<0.015	<0.020
23	1-Jun-99	8-Jun-99	<0.027	<0.016	<0.026	<0.015	<0.030	<0.015	<0.030	<0.017	<0.033	<0.015
24	8-Jun-99	14-Jun-99	<0.040	<0.020	<0.026	<0.021	<0.041	<0.027	<0.034	<0.018	<0.021	<0.035
25	14-Jun-99	22-Jun-99	<0.023	<0.012	<0.026	<0.015	<0.023	<0.018	<0.024	<0.018	<0.016	<0.019
26	22-Jun-99	28-Jun-99	<0.034	<0.024	<0.034	<0.027	<0.027	<0.018	<0.031	<0.019	<0.022	<0.021

TABLE 8.5 RADIOIODINE IN AIR 3rd - 4th QUARTER

ODCM required samples denoted by *
units are pCi/m^3

3rd Quarter

required LLD <0.070

Week #	START DATE	STOP DATE	Site 4	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*
27	28-Jun-99	6-Jul-99 (a)	<0.026	<0.013	<0.026	<0.018	<0.030	<0.016	<0.033	<0.016	<0.020	<0.033
28	6-Jul-99	12-Jul-99	<0.024	<0.024	<0.022	<0.022	<0.023	<0.024	<0.022	<0.022	<0.023	<0.028
29	12-Jul-99	19-Jul-99	<0.025	<0.027	<0.031	<0.038	<0.012	<0.027	<0.019	<0.013	<0.025	<0.018
30	19-Jul-99	26-Jul-99	<0.025	<0.029	<0.020	<0.017	<0.037	<0.020	<0.012	<0.021	<0.018	<0.024
31	26-Jul-99	2-Aug-99	<0.030	<0.015	<0.029	<0.020	<0.027	<0.017	<0.028	<0.023	<0.017	<0.016
32	2-Aug-99	10-Aug-99	<0.028	<0.013	<0.021	<0.017	<0.025	<0.017	<0.029	<0.014	<0.016	<0.030
33	10-Aug-99	17-Aug-99	<0.017	<0.017	<0.016	<0.021	<0.021	<0.018	<0.027	<0.030	<0.027	<0.018
34	17-Aug-99	24-Aug-99	<0.027	<0.017	<0.034	<0.021	<0.036	<0.018	<0.032	<0.016	<0.035	<0.037
35	24-Aug-99	31-Aug-99	<0.030	<0.044	<0.019	<0.030	<0.020	<0.029	<0.021	<0.030	<0.029	<0.017
36	31-Aug-99	7-Sep-99	<0.021	<0.020	<0.017	<0.016	<0.020	<0.022	<0.026	<0.034	<0.018	<0.030
37	7-Sep-99	14-Sep-99	<0.027	<0.027	<0.014	<0.032	<0.016	<0.020	<0.017	<0.030	<0.027	<0.027
38	14-Sep-99	21-Sep-99	<0.013	<0.019	<0.015	<0.025	<0.015	<0.018	<0.014	<0.021	<0.015	<0.025
39	21-Sep-99	27-Sep-99	<0.018	<0.021	<0.037	<0.021	<0.035	<0.024	<0.034	<0.024	<0.035	<0.023

4th Quarter

required LLD <0.070

Week #	START DATE	STOP DATE	Site 4	(control) Site 6A*	Site 7A	Site 14A*	Site 15*	Site 17A	Site 21	Site 29*	Site 35	Site 40*
40	27-Sep-99	5-Oct-99	<0.021	<0.014	<0.024	<0.017	<0.034	<0.015	<0.021	<0.015	<0.013	<0.027
41	5-Oct-99	12-Oct-99	<0.021	<0.028	<0.025	<0.011	<0.032	<0.016	<0.028	<0.019	<0.029	<0.033
42	12-Oct-99	18-Oct-99	<0.033	<0.019	<0.033	<0.023	<0.029	<0.022	<0.033	<0.016	<0.044	<0.022
43	18-Oct-99	26-Oct-99	<0.025	<0.029	<0.026	<0.028	<0.025	<0.021	<0.028	<0.025	<0.025	<0.023
44	26-Oct-99	2-Nov-99	<0.036	<0.016	<0.033	<0.033	<0.028	<0.023	<0.036	<0.020	<0.037	<0.030
45	2-Nov-99	8-Nov-99	<0.021	<0.020	<0.033	<0.023	<0.028	<0.022	<0.027	<0.022	<0.021	<0.026
46	8-Nov-99	16-Nov-99	<0.046	<0.035	<0.021	<0.018	<0.017	<0.031	<0.034	<0.054	<0.064	<0.056
47	16-Nov-99	22-Nov-99	<0.023	<0.028	<0.024	<0.041	<0.032	<0.032	<0.039	<0.036	<0.033	<0.022
48	22-Nov-99	30-Nov-99	<0.021	<0.029	<0.028	<0.016	<0.016	<0.029	<0.015	<0.025	<0.016	<0.028
49	30-Nov-99	7-Dec-99	<0.037	<0.017	<0.029	<0.020	<0.026	<0.025	<0.021	<0.028	<0.024	<0.021
50	7-Dec-99	14-Dec-99	<0.040	<0.038	<0.031	<0.027	<0.030	<0.035	<0.026	<0.028	<0.025	<0.037
51	14-Dec-99	20-Dec-99	<0.024	<0.033	<0.030	<0.032	<0.026	<0.028	<0.026	<0.033	<0.030	<0.034
52	20-Dec-99	27-Dec-99	<0.021	<0.023	<0.024	<0.020	<0.018	<0.021	<0.023	<0.025	<0.022	<0.019

(a) Samples were collected from site #4 and #6A on 7-7-99 due to vehicle breakdown during sample collection (exceeded sample collection frequency requirement).

TABLE 8.6 VEGETATION

ODCM required samples denoted by *
units are pCi/kg, wet

LOCATION	TYPE	DATE COLLECTED	<60 I-131	<60 Cs-134	<80 Cs-137
STEELE RESIDENCE (SITE #47)*	No samples available in 1999				
BRANCH RESIDENCE (SITE #64)	No samples available in 1999				
ROUSSEAU FARMS (SITE #62)*	cabbage	14-Jan-99	<29	<30	<27
	bok choy	14-Jan-99	<17	<21	<18
	napa	14-Jan-99	<16	<18	<17
	turnip greens	11-Feb-99	<26	<31	<34
	cabbage	11-Feb-99	<25	<28	<33
	bok choy	11-Feb-99	<15	<21	<15
	spinach	12-Mar-99	<13	<20	<17
	collards	12-Mar-99	<24	<25	<30
	cabbage	12-Mar-99	<12	<15	<14
	cabbage	15-Apr-99	<15	<17	<14
	cabbage	11-May-99	<17	<19	<18
	collards	9-Dec-99	<14	<19	<15
	red cabbage	9-Dec-99	<27	<33	<40
	green cabbage	9-Dec-99	<18	<22	<24
HALLMAN RESIDENCE (SITE #52)*	lettuce	12-May-99	<23	<28	<24
	spinach	11-Jun-99	<20	<28	<23

TABLE 8.7 DRINKING WATER

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	MONTH ENDPOINT	<15 Mn-54	<15 Co-58	<30 Fe-59	<15 Co-60	<30 Zn-65	<15 Nb-95	<30 Zr-95	<15 I-131	<15 Cs-134	<18 Cs-137	<60 Ba-140	<15 La-140	<2000 QTRLY Tritium	<4.0 Gross Beta
	25-Jan-99	<11	<11	<18	<9	<22	<9	<15	<10	<10	<10	<34	<10		<2.7
	22-Feb-99	<10	<8	<17	<10	<22	<11	<18	<11	<10	<11	<40	<10		3.8 ± 1.7
	29-Mar-99	<9	<9	<18	<9	<19	<10	<18	<10	<10	<9	<37	<8	<303	3.0 ± 1.6
	26-Apr-99	<10	<10	<20	<11	<24	<14	<15	<11	<10	<11	<37	<11		2.8 ± 1.8
McARTHUR	24-May-99	<10	<10	<21	<13	<27	<13	<19	<12	<12	<11	<36	<13		3.9 ± 1.7
RESIDENCE	28-Jun-99	<9	<10	<18	<9	<20	<9	<18	<10	<11	<9	<36	<12	<290	<2.9
(SITE #46) *	26-Jul-99	<9	<9	<17	<11	<19	<10	<16	<10	<9	<9	<32	<7		2.8 ± 1.7
	31-Aug-99	<10	<9	<20	<12	<21	<12	<17	<11	<12	<9	<31	<10		<3.1
	27-Sep-99	<10	<9	<17	<10	<22	<11	<16	<9	<9	<10	<32	<10	<282	3.7 ± 1.8
	26-Oct-99	<10	<9	<17	<8	<21	<11	<18	<11	<11	<11	<36	<9		<3.3
	30-Nov-99	<10	<11	<24	<11	<26	<13	<19	<11	<13	<11	<41	<12		<3.6
	27-Dec-99	<10	<9	<21	<8	<19	<12	<17	<11	<12	<11	<42	<12	<281	4.8 ± 1.7
	25-Jan-99	<10	<10	<17	<11	<21	<10	<15	<10	<13	<9	<41	<8		3.0 ± 1.7
	22-Feb-99	<10	<10	<15	<10	<20	<12	<17	<11	<11	<9	<35	<10		4.2 ± 1.7
	29-Mar-99	<9	<10	<19	<12	<18	<11	<18	<10	<11	<10	<35	<9	<297	<2.5
	26-Apr-99	<8	<10	<18	<10	<24	<11	<18	<11	<12	<11	<36	<10		4.8 ± 1.8
GAVETTE	24-May-99	<13	<9	<18	<10	<17	<10	<16	<10	<12	<10	<40	<11		5.7 ± 1.7
RESIDENCE	28-Jun-99	<11	<8	<17	<9	<20	<9	<17	<10	<10	<10	<32	<11	<286	<2.9
(SITE #55)	26-Jul-99	<11	<12	<22	<11	<23	<11	<18	<10	<14	<12	<42	<12		<2.7
	31-Aug-99	<9	<8	<18	<9	<25	<11	<19	<10	<11	<12	<36	<10		<3.1
	27-Sep-99	<10	<10	<20	<8	<23	<10	<17	<10	<11	<10	<33	<9	<280	3.6 ± 1.8
	26-Oct-99	<10	<9	<22	<11	<26	<11	<15	<11	<10	<10	<40	<11		<3.3
	30-Nov-99	<11	<10	<21	<7	<23	<10	<18	<9	<12	<11	<34	<12		<3.6
	27-Dec-99	<13	<10	<19	<14	<27	<12	<21	<11	<14	<11	<41	<11	<278	4.7 ± 1.7

TABLE 8.7 DRINKING WATER

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	MONTH ENDPOINT	<15 Mn-54	<15 Co-58	<30 Fe-59	<15 Co-60	<30 Zn-65	<15 Nb-95	<30 Zr-95	<15 I-131	<15 Cs-134	<18 Cs-137	<60 Ba-140	<15 La-140	<2000 QTRLY Tritium	<4.0 Gross Beta
SHEPPARD RESIDENCE (SITE #48) *	25-Jan-99	<9	<9	<16	<12	<22	<9	<18	<11	<12	<11	<33	<13		3.8 ± 2.1
	22-Feb-99	<9	<10	<18	<10	<22	<10	<17	<10	<11	<9	<32	<9		4.1 ± 1.9
	29-Mar-99	<11	<10	<24	<11	<21	<12	<17	<11	<12	<11	<36	<12	<294	7.4 ± 2.3
	26-Apr-99	<12	<11	<21	<9	<22	<12	<20	<10	<14	<12	<36	<12		8.6 ± 2.5
	24-May-99	<11	<11	<19	<12	<26	<11	<16	<12	<12	<11	<39	<14		11.6 ± 2.5
	28-Jun-99	<11	<11	<21	<10	<17	<11	<18	<10	<10	<9	<31	<12	<286	7.0 ± 2.5
	26-Jul-99	<11	<9	<19	<10	<19	<10	<16	<10	<10	<9	<36	<9		7.5 ± 2.4
	31-Aug-99	<8	<9	<18	<9	<20	<10	<15	<9	<12	<11	<32	<10		11.5 ± 1.9
	27-Sep-99	<11	<11	<21	<11	<19	<10	<21	<11	<13	<11	<36	<12	<283	6.0 ± 2.3
	26-Oct-99	<10	<11	<17	<11	<22	<12	<20	<11	<12	<10	<33	<10		<3.8
BERRYMAN RESIDENCE	30-Nov-99 (b)	<10	<9	<21	<12	<23	<12	<19	<10	<11	<12	<42	<9		<2.7
	27-Dec-99	<10	<10	<16	<9	<23	<11	<18	<10	<13	<9	<33	<7	<278	4.0 ± 2.0
CHOWANEC RESIDENCE (SITE #49) *	25-Jan-99	<10	<9	<19	<10	<24	<8	<15	<10	<12	<9	<37	<11		<2.6
	22-Feb-99	<9	<9	<18	<9	<23	<10	<19	<10	<11	<10	<38	<7		<2.4
	29-Mar-99	<10	<9	<19	<11	<22	<11	<17	<10	<11	<11	<34	<14	<301	<2.4
	26-Apr-99	<13	<11	<24	<13	<24	<12	<19	<8	<12	<12	<35	<11		<2.6
	24-May-99	<11	<10	<20	<11	<19	<10	<18	<10	<11	<10	<33	<10		<2.4
	28-Jun-99	<10	<11	<21	<11	<20	<10	<18	<10	<11	<12	<38	<10	<288	<2.8
	26-Jul-99	<10	<10	<18	<8	<21	<11	<12	<9	<12	<8	<33	<12		<2.5
	31-Aug-99	<12	<8	<20	<12	<18	<11	<16	<11	<11	<11	<38	<7		<2.9
	27-Sep-99	<10	<8	<21	<11	<22	<10	<16	<10	<12	<10	<37	<10	<282	<2.5
	26-Oct-99	<10	<10	<20	<10	<22	<11	<17	<11	<11	<9	<35	<8		<3.1
	30-Nov-99	<9	<10	<22	<11	<23	<12	<20	<10	<13	<12	<31	<11		<3.4
	27-Dec-99	<10	<9	<21	<10	<22	<12	<14	<10	<12	<11	<36	<9	<280	<2.4

(a) Sheppard well no longer in use as of 11-8-99. Sample location was replaced by the Berryman residence well.

(b) Sample composite consists of grab samples from 11-16, 11-22, and 11-30-99.

TABLE 8.8 GROUNDWATER

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	DATE COLLECTED	<15 Mn-54	<15 Co-58	<30 Fe-59	<15 Co-60	<30 Zn-65	<15 Nb-95	<30 Zr-95	<15 I-131	<15 Cs-134	<18 Cs-137	<60 Ba-140	<15 La-140	<2000 Tritium
WELL 27ddc (Site #57)*	1-Feb-99	<10	<9	<17	<9	<18	<10	<14	<11	<10	<9	<37	<11	<293
	26-Apr-99	<8	<8	<16	<8	<17	<11	<14	<10	<8	<8	<30	<10	<300
	26-Jul-99	<10	<13	<27	<10	<26	<12	<22	<13	<14	<12	<43	<13	<280
	2-Nov-99	<9	<9	<19	<10	<22	<11	<16	<11	<10	<9	<36	<10	<283
WELL 34abb (Site #58)*	1-Feb-99	<12	<11	<19	<10	<23	<12	<18	<12	<12	<10	<36	<14	<294
	26-Apr-99	<10	<10	<20	<11	<21	<12	<16	<9	<11	<10	<34	<12	<298
	26-Jul-99	<9	<9	<23	<9	<22	<11	<17	<13	<12	<11	<40	<13	<281
	2-Nov-99	<11	<11	<22	<14	<29	<14	<19	<11	<12	<12	<42	<14	<285

TABLE 8.9 SURFACE WATER

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	MONTH ENDPOINT	<15 Mn-54	<15 Co-58	<30 Fe-59	<15 Co-60	<30 Zn-65	<15 Nb-95	<30 Zr-95	<15 I-131	<15 Cs-134	<18 Cs-137	<60 Ba-140	<15 La-140	<3000 Tritium
RESERVOIR (Site #60) *	25-Jan-99	<12	<11	<19	<10	<25	<11	<19	<12	<13	<10	<39	<11	
	22-Feb-99	<9	<8	<20	<7	<20	<8	<15	<12	<9	<10	<35	<9	
	29-Mar-99	<12	<11	<22	<10	<22	<10	<18	<11	<12	<12	<39	<12	<305
	26-Apr-99	<11	<10	<24	<13	<21	<11	<17	<14	<13	<12	<40	<10	
	24-May-99	<9	<11	<20	<10	<19	<10	<18	<13	<11	<10	<34	<11	
	28-Jun-99	<9	<10	<24	<11	<25	<9	<18	<12	<13	<13	<41	<10	<290
	26-Jul-99	<9	<10	<23	<9	<21	<10	<14	<13	<10	<9	<33	<9	
	31-Aug-99	<10	<9	<17	<11	<22	<10	<17	<11	<12	<11	<32	<6	
	27-Sep-99	<10	<11	<19	<7	<20	<11	<15	<13	<11	<10	<36	<11	<280
	26-Oct-99	<10	<10	<24	<12	<25	<12	<18	<13	<11	<8	<36	<14	
	30-Nov-99	<9	<10	<16	<11	<23	<11	<15	<12	<10	<10	<34	<9	
	27-Dec-99	<11	<12	<20	<9	<24	<9	<15	<12	<11	<10	<34	<13	<281
EVAP POND 1 (Site #59) *	25-Jan-99	<10	<10	<24	<10	<24	<10	<19	<11	<10	<10	<34	<7	
	22-Feb-99	<11	<9	<21	<10	<24	<11	<16	<12	<11	<11	<42	<10	
	29-Mar-99	<10	<10	<23	<11	<26	<10	<16	<11	<12	<12	<38	<9	785 ± 161
	26-Apr-99	<9	<10	<22	<11	<29	<10	<22	<12	<13	<11	<38	<11	
	24-May-99	<11	<9	<21	<12	<25	<11	<21	<12	<13	<11	<43	<12	
	28-Jun-99	<10	<11	<23	<10	<25	<11	<17	<11	<12	<11	<31	<9	929 ± 186
	26-Jul-99	<13	<12	<29	<14	<30	<13	<22	<11	<14	<11	<40	<11	
	31-Aug-99	<11	<11	<22	<13	<25	<11	<23	<12	<12	<12	<39	<12	
	27-Sep-99	<10	<10	<25	<11	<24	<10	<16	<11	<12	<11	<37	<9	1224 ± 156
	26-Oct-99	<10	<11	<26	<12	<26	<11	<19	<10	<13	<12	<33	<11	
	30-Nov-99	<12	<11	<22	<12	<27	<11	<21	<11	<12	<12	<37	<11	
	27-Dec-99	<10	<9	<21	<12	<28	<11	<18	<11	<13	<12	<35	<10	1319 ± 157
EVAP POND 2 (Site #63) *	25-Jan-99	<10	<10	<21	<9	<22	<11	<17	<11	<11	18 ± 10	<40	<9	
	22-Feb-99	<10	<11	<21	<10	<25	<11	<21	<10	<11	<14	<37	<7	
	29-Mar-99	<10	<10	<18	<13	<22	<12	<18	<13	<13	<12	<40	<10	778 ± 159
	26-Apr-99	<12	<14	<24	<11	<29	<11	<18	<11	<15	13 ± 10	<33	<11	
	24-May-99	<9	<11	<24	<15	<19	<12	<22	<14	<15	<16	<37	<13	
	28-Jun-99	<12	<10	<20	<10	<24	<10	<20	<11	<13	<13	<43	<10	1183 ± 191
	26-Jul-99	<9	<11	<22	<10	<27	<11	<16	<11	<11	12 ± 9	<34	<10	
	31-Aug-99	<9	<10	<24	<11	<21	<11	<18	<10	<11	<11	<33	<8	
	27-Sep-99	<10	<10	<24	<11	<29	<13	<19	<14	<14	13 ± 7	<45	<12	1104 ± 154
	26-Oct-99	<10	<11	<22	<12	<24	<9	<17	<10	<12	<13	<34	<8	
	30-Nov-99	<12	<12	<23	<11	<25	<12	<21	<11	<13	8 ± 3	<36	<8	
	27-Dec-99	<11	<10	<22	<14	<30	<11	<17	<11	<13	<15	<40	<11	1296 ± 159

TABLE 8.9 SURFACE WATER

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Tritium **
	6-Jan-99	<11	<9	<20	<12	<22	<10	<17	17 ± 10	<12	<11	<38	<8	
	13-Jan-99	<10	<10	<22	<11	<17	<11	<16	34 ± 13	<11	<10	<35	<12	
	20-Jan-99	<10	<9	<20	<12	<18	<9	<15	48 ± 10	<12	<11	<35	<7	
	27-Jan-99	<11	<11	<20	<9	<25	<10	<19	<11	<12	<11	<39	<11	<307
	3-Feb-99	<11	<7	<15	<13	<25	<10	<17	42 ± 13	<11	<9	<39	<10	
	10-Feb-99	<11	<12	<22	<10	<23	<10	<19	29 ± 11	<11	<11	<41	<12	
	17-Feb-99	<9	<10	<19	<9	<21	<10	<16	54 ± 12	<12	<10	<34	<8	
	24-Feb-99	<12	<11	<22	<10	<21	<11	<18	24 ± 10	<14	<12	<37	<11	<312
WRF	3-Mar-99	<9	<10	<18	<15	<24	<10	<16	14 ± 9	<10	<11	<33	<9	
INFLUENT	10-Mar-99	<11	<10	<20	<11	<21	<11	<18	<11	<12	<12	<38	<11	
	17-Mar-99	<10	<8	<19	<10	<22	<11	<15	18 ± 8	<11	<10	<32	<9	
	24-Mar-99	<9	<8	<18	<10	<23	<10	<18	<10	<11	<9	<40	<10	
	31-Mar-99	<11	<9	<24	<11	<24	<10	<20	<12	<11	<11	<34	<13	<292
	7-Apr-99	<8	<10	<21	<8	<19	<9	<17	<13	<9	<10	<37	<10	
	21-Apr-99	<11	<10	<25	<13	<21	<10	<17	21 ± 11	<11	<12	<35	<7	
	28-Apr-99	<11	<11	<20	<11	<21	<11	<18	31 ± 10	<13	<10	<40	<9	<294
	5-May-99	<10	<10	<24	<12	<24	<10	<18	15 ± 9	<13	<11	<38	<9	
	12-May-99	<11	<11	<18	<8	<23	<11	<19	12 ± 7	<11	<11	<30	<12	
	19-May-99	<9	<10	<24	<11	<27	<11	<18	<12	<13	<12	<35	<12	
	25-May-99	<9	<9	<22	<10	<20	<9	<15	39 ± 13	<13	<10	<39	<11	<290
	2-Jun-99	<11	<10	<17	<9	<21	<10	<15	30 ± 10	<11	<10	<33	<10	
	9-Jun-99	<11	<9	<21	<8	<24	<9	<18	<10	<12	<11	<31	<9	
	15-Jun-99	<10	<11	<17	<8	<26	<9	<14	27 ± 11	<11	<11	<34	<11	
	23-Jun-99	<11	<8	<19	<12	<25	<10	<17	<12	<13	<10	<36	<10	
	30-Jun-99	<10	<10	<20	<10	<18	<9	<15	48 ± 11	<8	<10	<29	<11	<299
	6-Jul-99	<12	<11	<20	<11	<23	<11	<19	<13	<14	<14	<43	<11	
	14-Jul-99	<11	<10	<18	<10	<21	<9	<16	11 ± 10	<12	<10	<36	<8	
	21-Jul-99	<10	<12	<26	<12	<26	<11	<21	<8	<14	<12	<39	<7	
	27-Jul-99	<11	<11	<22	<12	<27	<11	<22	22 ± 8	<12	<12	<38	<11	<289

** Monthly composite

TABLE 8.9 SURFACE WATER

ODCM required samples denoted by *
units are pCi/liter

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140	Tritium **
WRF INFLUENT (continued)	3-Aug-99	<9	<9	<17	<9	<19	<9	<16	23 ± 10	<11	<9	<33	<10	
	10-Aug-99	<12	<10	<19	<11	<25	<12	<19	<11	<12	<12	<37	<11	
	17-Aug-99	<10	<10	<19	<10	<20	<11	<18	<11	<11	<9	<35	<11	
	24-Aug-99	<10	<11	<18	<10	<15	<10	<17	<12	<12	<11	<32	<11	
	31-Aug-99	<10	<10	<19	<10	<21	<8	<18	23 ± 10	<11	<12	<30	<10	<292
	7-Sep-99	<9	<11	<20	<9	<22	<11	<18	33 ± 12	<12	<11	<35	<11	
	14-Sep-99	<9	<8	<14	<9	<20	<10	<17	15 ± 8	<13	<10	<31	<9	
	21-Sep-99	<8	<10	<19	<9	<24	<10	<13	19 ± 6	<13	<10	<34	<9	
	28-Sep-99	<10	<11	<22	<11	<22	<10	<15	<12	<11	<10	<43	<12	<285
	5-Oct-99	<10	<8	<19	<10	<22	<10	<17	<13	<12	<9	<35	<9	
	12-Oct-99	<9	<10	<18	<12	<15	<11	<15	<11	<11	<10	<34	<10	
	19-Oct-99	<10	<13	<22	<11	<20	<11	<18	23 ± 11	<9	<10	<37	<10	
	26-Oct-99	<9	<9	<21	<10	<21	<10	<16	<11	<14	<11	<35	<10	<286
	2-Nov-99	<8	<9	<17	<7	<24	<10	<12	<10	<10	<10	<32	<10	
	9-Nov-99	<9	<10	<18	<10	<20	<8	<16	<12	<11	<10	<34	<11	
	16-Nov-99	<7	<6	<14	<6	<15	<7	<12	23 ± 9	<8	<7	<25	<8	
	23-Nov-99	<11	<10	<19	<9	<25	<10	<17	10 ± 8	<13	<11	<31	<9	
	30-Nov-99	<10	<10	<22	<10	<25	<12	<17	<13	<13	<11	<39	<11	<290
	7-Dec-99	<8	<11	<19	<11	<21	<11	<19	<12	<10	<10	<37	<7	
	14-Dec-99	<11	<10	<22	<12	<21	<11	<19	<11	<12	<11	<35	<14	
	20-Dec-99	<11	<10	<19	<10	<28	<10	<19	<12	<13	<12	<38	<10	
	27-Dec-99	<11	<10	<22	<10	<23	<10	<19	30 ± 11	<12	<12	<41	<10	<289
		** Monthly composite												
SEDIMENT. BASIN #2	5-Apr-99	<9	<7	<24	<8	<20	<9	<15	<11	<11	<11	<37	<11	1058 ± 209
	12-Apr-99	<9	<8	<19	<11	<24	<11	<18	<12	<11	<10	<38	<12	1326 ± 203
	12-Jul-99	<8	<8	<18	<8	<22	<10	<16	<10	<10	<10	<39	<11	<313
	19-Jul-99	<10	<10	<18	<10	<25	<11	<16	<10	<13	<12	<37	<9	416 ± 183
	26-Jul-99	<10	<9	<18	<9	<20	<10	<19	<11	<12	<11	<41	<9	<298
	2-Aug-99	<9	<8	<20	<9	<17	<12	<17	<9	<11	<10	<32	<9	<301
	10-Aug-99	<12	<11	<18	<12	<22	<11	<19	<10	<11	<12	<41	<10	326 ± 186
	17-Aug-99	<11	<9	<19	<9	<23	<11	<17	<10	<12	<11	<35	<10	<315
	21-Sep-99	<10	<11	<20	<11	<25	<10	<16	<10	<14	<10	<34	<13	1944 ± 210
	27-Sep-99	<9	<11	<24	<10	<20	<10	<19	<11	<12	<12	<40	<11	1503 ± 200

TABLE 8.10 SLUDGE/SEDIMENT

ODCM required samples denoted by *
units are pCi/kg, wet

SAMPLE LOCATION	DATE COLLECTED	I-131	Cs-134	Cs-137	In-111
WRF CENTRIFUGE WASTE SLUDGE	6-Jan-99	744 ± 71	<30	<26	
	13-Jan-99	744 ± 29	<10	<9	
	20-Jan-99	477 ± 54	<31	<21	
	27-Jan-99	664 ± 25	<10	<8	
	2-Feb-99	1017 ± 67	<21	<10	
	10-Feb-99	732 ± 69	<33	<29	
	16-Feb-99	646 ± 64	<37	<29	
	23-Feb-99	622 ± 26	<9	<8	
	2-Mar-99	1064 ± 46	<14	<16	
	10-Mar-99	731 ± 66	<24	<23	
	17-Mar-99	754 ± 53	<23	<19	
	24-Mar-99	763 ± 66	<31	<25	
	31-Mar-99	794 ± 54	<23	<15	
	14-Apr-99	786 ± 68	<23	<14	
	21-Apr-99	495 ± 46	<19	<22	
	28-Apr-99	484 ± 21	<9	<8	
	5-May-99	1048 ± 50	<13	<13	45 ± 15
	12-May-99	630 ± 23	<9	<9	18 ± 7
	18-May-99	653 ± 35	<12	<10	
	25-May-99	734 ± 79	<31	<10	
	2-Jun-99	919 ± 76	<24	<28	
	9-Jun-99	522 ± 56	<25	<19	
	16-Jun-99	970 ± 49	<19	<16	
	23-Jun-99	973 ± 76	<18	<29	
	29-Jun-99	1030 ± 82	<32	<20	
	6-Jul-99	802 ± 75	<11	<28	
	14-Jul-99	699 ± 46	<15	<17	
	20-Jul-99	542 ± 52	<25	<17	
	27-Jul-99	847 ± 77	<39	<27	
	3-Aug-99	499 ± 58	<33	<31	
	10-Aug-99	449 ± 49	<27	<26	
	17-Aug-99	438 ± 44	<20	<17	
	24-Aug-99	377 ± 42	<27	<19	
	31-Aug-99	605 ± 74	<16	<35	
	7-Sep-99	662 ± 41	<14	<12	18 ± 14
	14-Sep-99	1000 ± 78	<20	<20	
	21-Sep-99	885 ± 45	<9	<14	
	28-Sep-99	898 ± 78	<26	<16	
	5-Oct-99	776 ± 70	<25	<25	
	12-Oct-99	1455 ± 60	<15	<12	
	26-Oct-99	401 ± 56	<23	<22	
	2-Nov-99	243 ± 26	<14	<12	
	9-Nov-99	519 ± 49	<23	<20	
	16-Nov-99	1069 ± 61	<16	<13	
	23-Nov-99	811 ± 66	<20	<18	
	30-Nov-99	702 ± 77	<32	<32	
	7-Dec-99	694 ± 59	<20	<18	
	14-Dec-99	688 ± 61	<22	<21	
	20-Dec-99	568 ± 59	<16	<23	
	27-Dec-99	624 ± 66	<20	<23	

TABLE 8.11 SOIL

units are pCi/kg

SAMPLE LOCATION	DATE COLLECTED	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
Onsite #1	10-Sep-99	<32	<31	<71	<39	<85	<38	<61	<31	<45	<35	<106	<21
Onsite #2	10-Sep-99	<37	<31	<66	<37	<84	<38	<57	<31	<46	306 ± 41	<115	<30
Onsite #3	10-Sep-99	<37	<25	<73	<31	<84	<41	<56	<29	<42	<40	<100	<31
Onsite #4	10-Sep-99	<33	<24	<71	<38	<87	<41	<62	<29	<43	<33	<106	<26
Onsite #5	10-Sep-99	<33	<25	<69	<38	<81	<35	<53	<30	<45	<34	<100	<23

Soil samples were collected in the most prevalent wind direction (using 1998 meteorological data). The data indicated a southwesterly direction (to the northeast), so samples were collected in the three sectors centered on northeast, covering 45 degrees (22.5 degrees on either side of NE center). Samples were obtained between the protected area boundary and the site boundary to verify no radionuclide buildup since PVNGS became operational.

FIGURE 8.1 HISTORICAL GROSS BETA IN AIR 1989-1999 (WEEKLY SYSTEM AVERAGES)

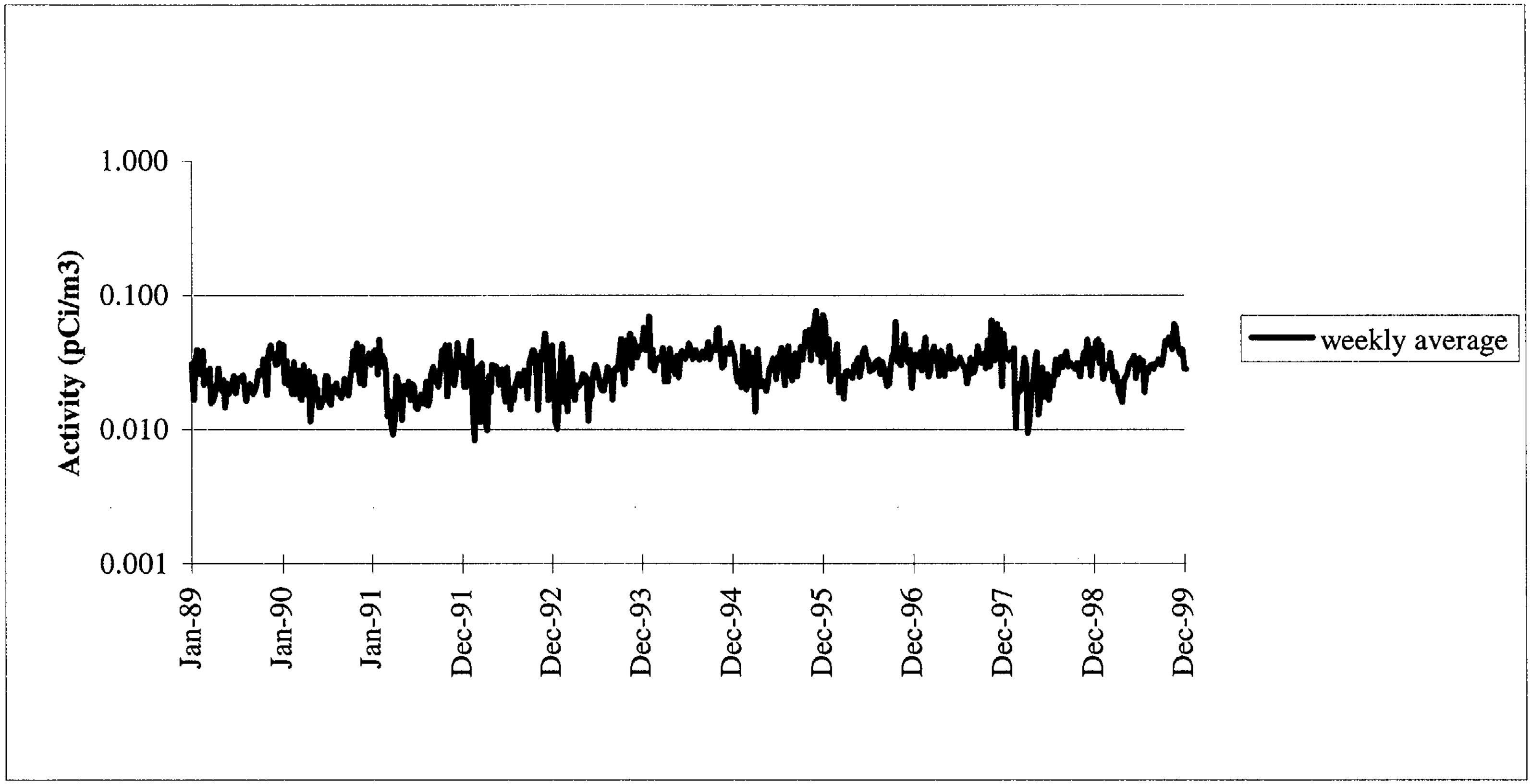


FIGURE 8.2 HISTORICAL GROSS BETA IN AIR (ANNUAL SITE TO SITE COMPARISONS) COMPARED TO PRE-OP

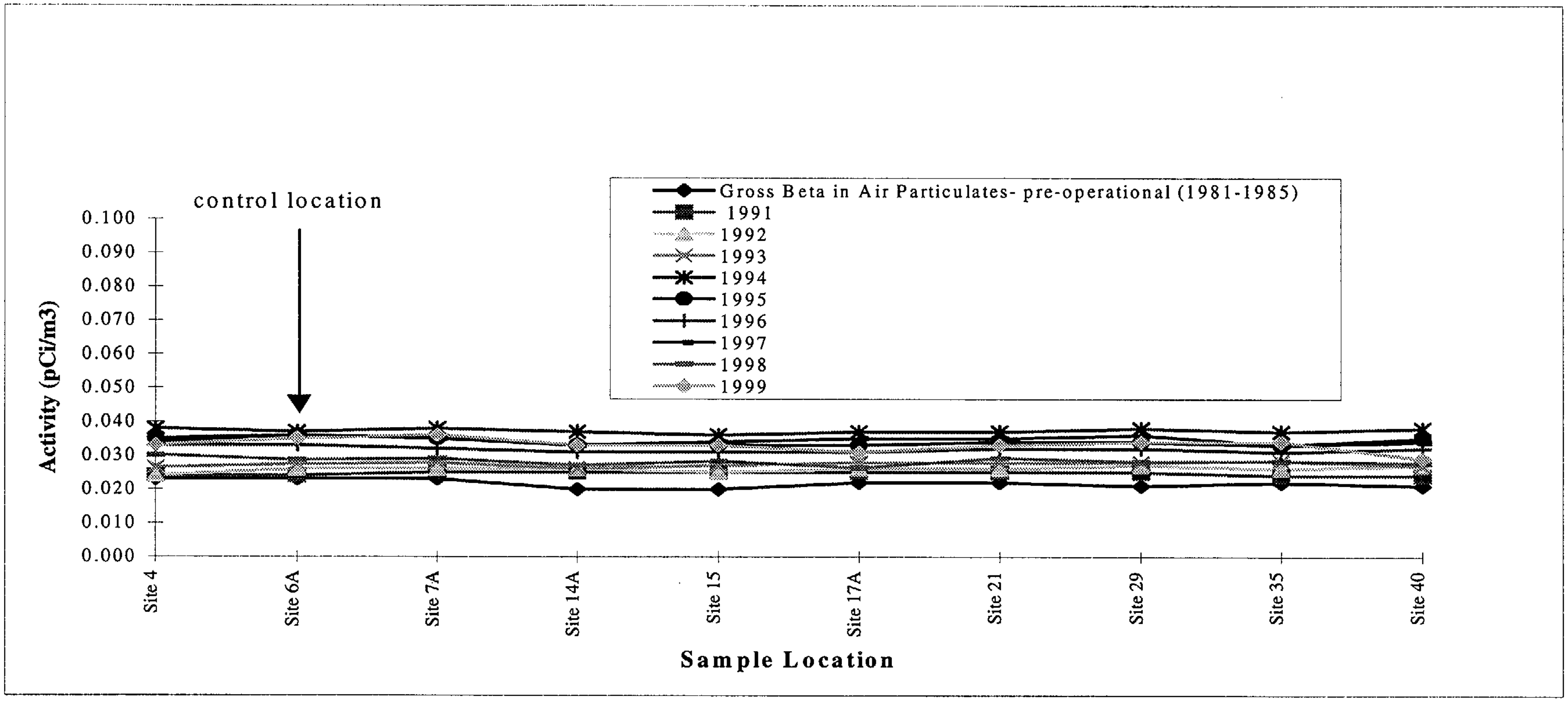


FIGURE 8.3 GROSS BETA IN DRINKING WATER

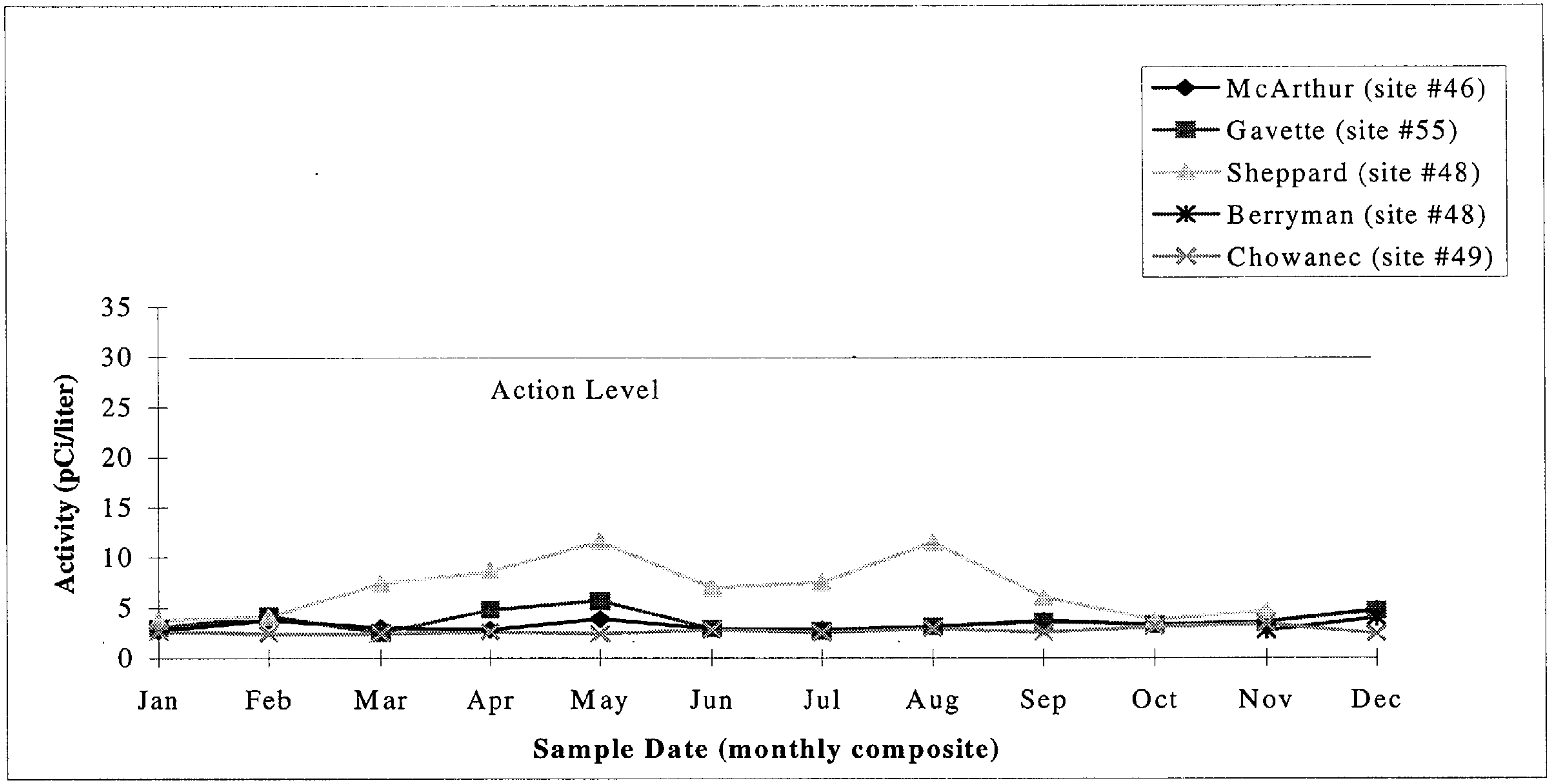
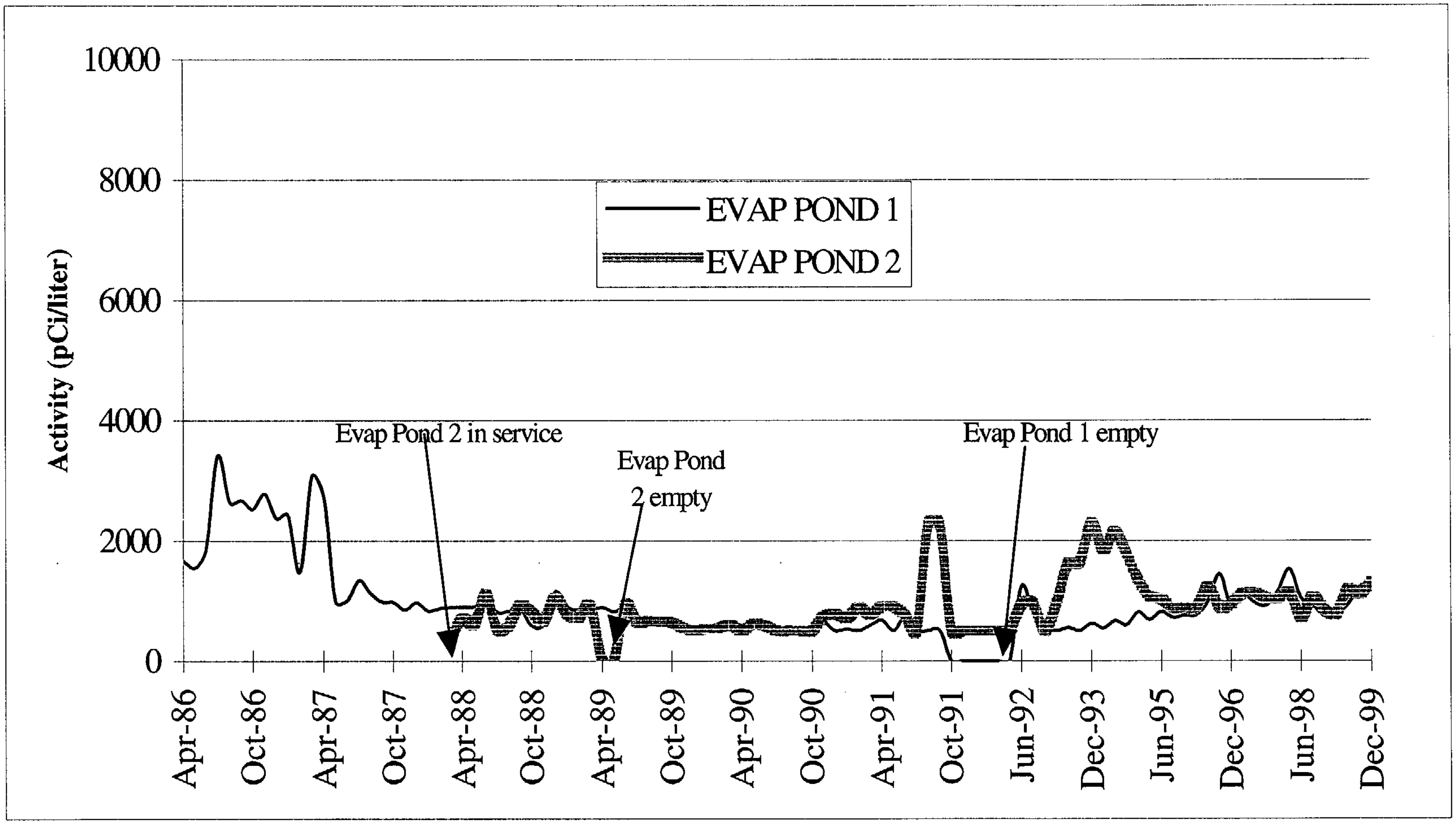


FIGURE 8.4 EVAPORATION POND TRITIUM ACTIVITY



9. Thermoluminescent Dosimeter (TLD) Results and Data

The environmental TLD used at PVNGS is the Panasonic Model 812 Dosimeter. The Model 812 is a multi-element dosimeter combining two elements of lithium borate and two elements of calcium sulfate under various filters.

Thermoluminescent dosimeters were placed in forty-nine locations from one to thirty-five miles from the PVNGS. TLD locations are shown in Figures 2.1 and 2.2. TLD locations are described in Table 9.1. TLD results for 1999 are presented in Table 9.2. TLD results for 1985 through 1999 are presented in graphical form on Figure 9.1 (excluding transit control TLD #45).

Figure 9.2 depicts the environmental TLD results from 1999 as compared to the pre-operational TLD results (excluding indicator location #43 that was deleted and #46-50 due to no pre-op TLD at these locations for comparison). As can be seen, the site to site comparisons indicate a direct correlation with respect to pre-operational results. It is evident that the offsite dose, as measured by TLDs, has not changed since Palo Verde became operational.

TABLE 9.1 TLD SITE LOCATIONS

(distances and directions are relative to Unit 2 in miles)

TLD SITE	LOCATION	LOCATION DESCRIPTION
1	E30	Goodyear
2	ENE24	Scott-Libby School
3	E21	Liberty School
4	E16	Buckeye
5	ESE11	Palo Verde School
6	SSE31	APS Gila Bend substation
7	SE7	Old US 80 and Arlington School Rd
8	SSE4	Southern Pacific Pipeline Rd.
9	S5	Southern Pacific Pipeline Rd.
10	SE5	355th Ave. and Elliot Rd.
11	ESE5	339th Ave. and Dobbins Rd.
12	E5	339th Ave. and Buckeye-Salome Rd.
13	N1	N site boundary
14	NNE2	NNE site boundary
15	NE2	NE site boundary, WRF access road
16	ENE2	ENE site boundary
17	E2	E site boundary
18	ESE2	ESE site boundary
19	SE2	SE site boundary
20	SSE2	SSE site boundary
21	S3	S site boundary
22	SSW3	SSW site boundary
23	W5	N of Elliot Rd
24	SW4	N of Elliot Rd
25	WSW5	N of Elliot Rd
26	SSW4	local farm
27	SW1	SW site boundary
28	WSW1	WSW site boundary
29	W1	W site boundary
30	WNW1	WNW site boundary
31	NW1	NW site boundary
32	NNW1	NNW site boundary
33	NW4	S of Buckeye Rd
34	NNW5	395th Ave. and Van Buren St.
35	NNW8	Tonopah
36	N5	Wintersburg Rd. and Van Buren St.
37	NNE5	363rd Ave. and Van Buren St.
38	NE5	355th Ave. and Buckeye Rd.
39	ENE5	343rd Ave. N of Broadway Rd.
40	N3	Wintersburg
41	WNW20	Harquahala Valley School

TABLE 9.1 TLD SITE LOCATIONS

(distances and directions are relative to Unit 2 in miles)

TLD SITE	LOCATION	LOCATION DESCRIPTION
42	N8	Ruth Fisher School
44*	ENE35	El Mirage
45**	Onsite	Central Laboratory (lead pig)
46	ENE30	Litchfield Park School
47	E35	Littleton School
48	E24	Jackrabbit Trail
49	ENE11	Palo Verde Rd.
50	WNW5	S of Buckeye-Salome Rd.

* Site #6 and site #44 are the control locations.

** Site #45 is the transit control TLD (stored in lead pig).

TABLE 9.2 1999 ENVIRONMENTAL TLD RESULTS

units are mrem/std qtr

TLD Site #	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Average
1	22.7	21.8	22.2	23.2	22.5
2	21.5	20.0	23.3	21.1	21.5
3	23.2	22.9	23.8	22.6	23.1
4	23.3	21.4	23.4	21.9	22.5
5	21.2	22.2	21.2	23.3	22.0
6 (control)	25.7	23.6	25.7	26.1	25.3
7	23.9	24.4	26.5	24.9	24.9
8	23.1	20.5	23.5	23.7	22.7
9	31.8	29.3	30.6	30.5	30.6
10	23.9	24.1	24.5	23.3	24.0
11	26.6	23.5	24.6	24.3	24.8
12	20.9	20.7	23.3	22.5	21.9
13	25.8	22.9	27.4	24.6	25.2
14	22.6	22.0	24.6	23.9	23.3
15	23.0	23.2	24.6	24.0	23.7
16	22.5	19.5	20.1	22.4	21.1
17	23.7	23.3	23.1	24.7	23.7
18	22.8	20.6	24.6	23.3	22.8
19	25.4	22.1	27.2	24.9	24.9
20	24.0	22.1	22.9	24.2	23.3
21	25.7	23.8	26.4	24.9	25.2
22	28.1	25.9	26.4	24.9	26.3
23	21.2	22.6	23.0	22.3	22.3
24	21.2	21.1	20.2	22.8	21.3
25	22.9	21.2	24.5	23.9	23.1
26	28.8	26.3	25.9	26.4	26.9
27	28.5	26.1	27.3	26.5	27.1
28	24.2	24.7	23.8	25.0	24.4
29	25.7	23.3	23.8	25.1	24.5
30	26.3	24.2	26.7	27.1	26.1
31	23.2	20.6	24.4	23.3	22.9
32	24.2	25.9	23.7	25.7	24.9
33	27.1	24.0	25.2	25.8	25.5
34	29.2	24.7	27.1	26.4	26.9
35	31.1	27.3	31.3	28.8	29.6
36	26.3	25.5	25.7	26.8	26.1
37	23.3	23.5	23.8	22.9	23.4
38	26.0	27.0	28.3	26.8	27.0
39	24.2	21.5	24.0	23.1	23.2
40	24.9	22.6	24.2	24.5	24.1
41	27.3	23.7	26.6	26.3	26.0
42	23.2	22.9	24.9	27.5	24.6
44 (control)	19.3	missing	19.1	19.8	19.4
45 (transit control)	4.7	5.2	5.3	5.7	5.2
46	26.0	25.1	27.3	26.2	26.2
47	20.8	22.3	21.7	22.8	21.9
48	22.0	23.7	22.6	23.4	22.9
49	20.6	20.2	21.5	21.1	20.9
50	17.3	16.9	17.6	18.6	17.6

FIGURE 9.1 NETWORK ENVIRONMENTAL TLD EXPOSURE RATES

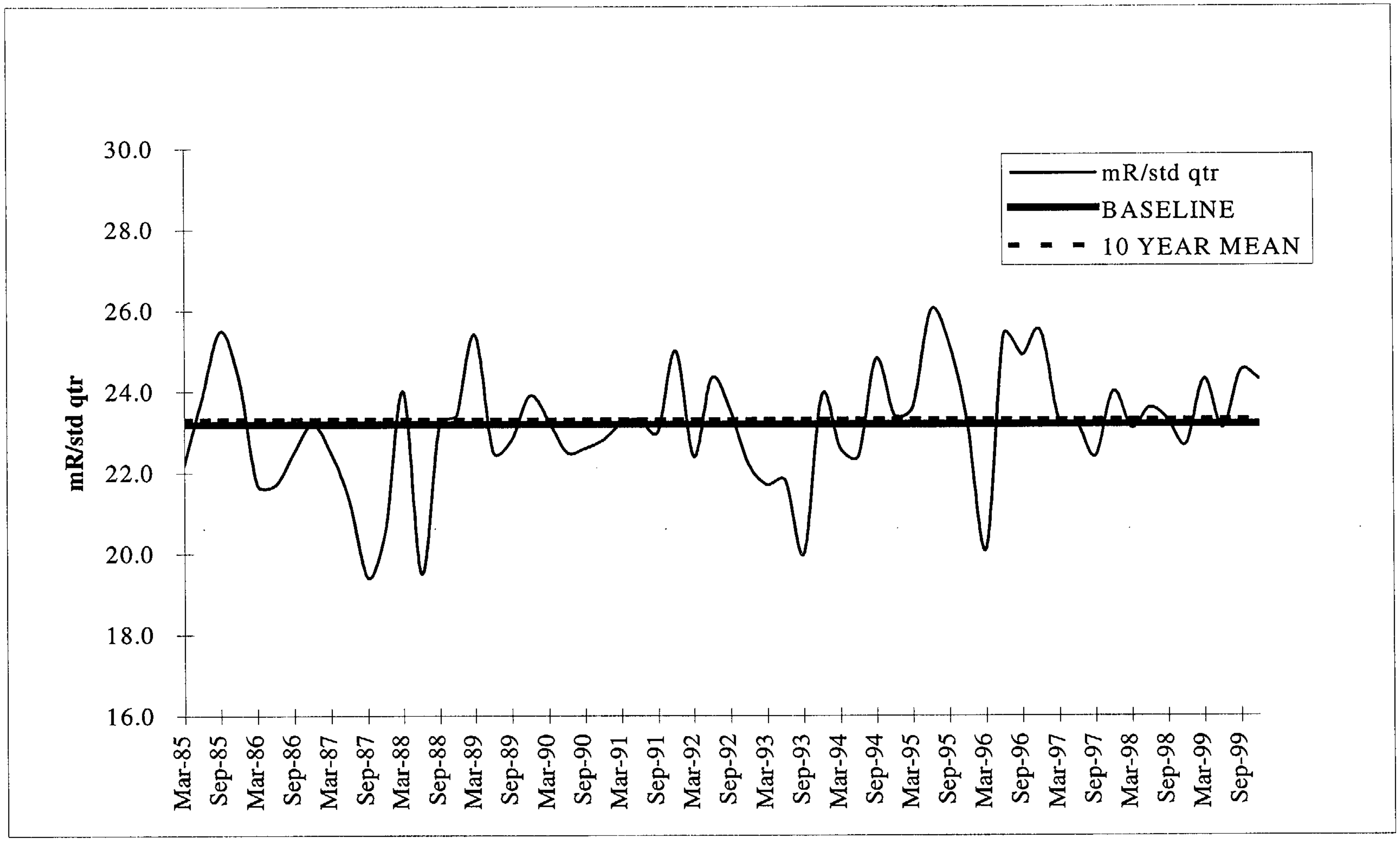
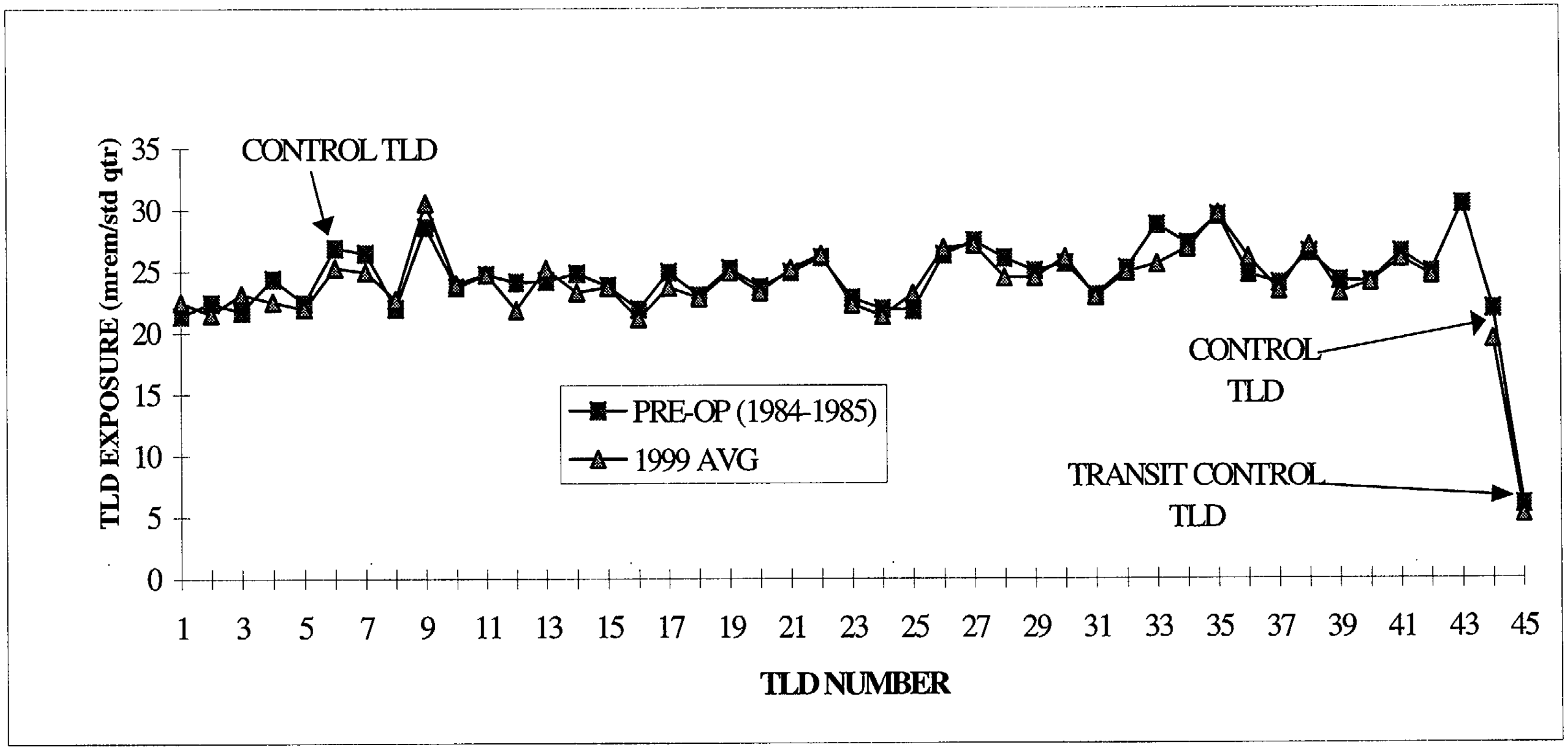


FIGURE 9.2 ENVIRONMENTAL TLD COMPARISON - PRE-OPERATIONAL VS 1999



10. Land Use Census

10.1. Introduction

In accordance with the PVNGS ODCM, Section 6.2, the annual Land Use Census was performed within a five mile radius of the mid-line of Unit 2 containment in April-June, 1999.

Observations were made in each of the 16 meteorological sectors to determine the nearest milking animals, residences, and gardens of greater than 500 square feet. This census was completed by driving the roads and speaking with residents within a five-mile radius of PVNGS.

The results of the Land Use Census are presented in Table 10.1 and discussed below. The directions and distances listed are in sectors and miles from the Unit 2 containment.

10.2. Census Results

Nearest Resident

There were four (4) changes in nearest resident status. Nearer residents were located in the WSW, W, and NNW sectors. The resident who had previously lived in the WNW sector was no longer living there and no new residents were identified in this sector within 5 miles.

Milking Animal

Goats were located in the NNE and ENE sectors. Dose calculations indicated 0.164 mrem to residents (highest dose was infant thyroid) at these locations. Since the locations were both between 3 and 5 miles distant, and calculated doses were <1 mrem, milk sampling was not added to the REMP, as allowed by the ODCM.

Vegetable Gardens

There were two (2) changes in nearest garden status. New gardens were located in the NNE and NNW sectors. One of the new gardens was added to the REMP as a new sample location (replaced one of the existing locations).

See Table 10.1 for a summary of the specific results and Table 2.1 for current sample locations.

TABLE 10.1 1999 LAND USE CENSUS

(Distances and directions are relative to Unit 2 in miles)

SECTOR	NEAREST RESIDENT	NEAREST GARDEN	NEAREST MILK ANIMAL (COW/GOAT)	CALCULATED DOSE (mrem)	CHANGE FROM 1998
N	1.79	NONE	NONE	3.75E-02	NONE
NNE	1.66	**2.05**	**3.78 (goats)**	7.12E-02 (resident) 2.28E-01 (garden) 1.64E-01 (milk)	**GARDEN** **MILK ANIMAL**
NE	2.16	NONE	NONE	1.10E-01	NONE
ENE	2.77	2.87	**4.84 (goats)**	6.21E-02 (resident) 2.88E-01 (garden) 1.64E-01 (milk)	**MILK ANIMAL**
E	2.86	NONE	NONE	7.05E-02	NONE
ESE	3.44	3.78	NONE	8.62E-02 (resident) 3.73E-01 (garden)	NONE
SE	4.18	NONE	NONE	9.27E-02	NONE
SSE	4.21	NONE	NONE	2.12E-01	NONE
S	4.67	NONE	NONE	2.64E-01	NONE
SSW	4.17	NONE	NONE	1.52E-01	NONE
SW	1.39	3.92	NONE	1.29E-01 (resident) 1.60E-01 (garden)	NONE
WSW	**1.59**	NONE	NONE	4.29E-02	**RESIDENT**
W	**1.49**	NONE	NONE	3.93E-02	**RESIDENT**
WNW	**NONE**	NONE	NONE	Not applicable	**RESIDENT**
NW	1.81	NONE	NONE	2.40E-02	NONE
NNW	**2.63**	**4.70**	NONE	2.06E-02 (resident) 4.60E-02 (garden)	**RESIDENT** **GARDEN**

COMMENTS:

Dose calculations were performed using the GASPAR code and 1998 meteorological data and source term. Dose reported for each location is the total for all three PVNGS Units and is the highest individual dose identified (organ, bone, total body, or skin).

11. Summary and Conclusions

The conclusions are based on a review of the radioassay results and background gamma radiation measurements for the 1999 calendar year. Where possible, the data were compared to pre-operational sample data.

All sample results for are presented in Tables 8.1-8.11 and do not include observations of naturally occurring radionuclides, with the exception of gross beta in air and gross beta in drinking water. Table 11.1 summarizes the ODCM required samples and is in the format required by the NRC BTP on Environmental Monitoring.

With the exception of onsite surface water and associated sludge, all sample assays presented in the report reveal no detectable man-made radioactivity that can be attributed to PVNGS. I-131 concentrations identified on occasion in the Evaporation Ponds, WRF Influent, WRF Centrifuge sludge, and Reservoir are the result of offsite sources and appear in the effluent sewage from Phoenix. The levels of I-131 detected in these locations are consistent with levels identified in previous years.

Natural background radiation levels are consistent with measurements reported in previous Pre-operational and Operational Radiological Environmental annual reports, References 1 and 2.

TABLE 11.1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Palo Verde Nuclear Generating Station
Maricopa County, Arizona

Docket Nos. STN 50-528/529/530
Calendar Year 1999

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD) (from Table 6.1)	All Indicator Locations Mean (f)[a] Range	Location with Highest Annual Mean: Name Distance and Direction	Location with Highest Annual Mean: Mean (f)[a] Range	Control Locations Mean (f)[a] Range	Number of Nonroutine Reported Measurements
Direct Radiation (mrem/std. qtr.)	TLD - 195	NA	24.1 (184/184) 16.9 - 31.8	Site #9 5 miles 180°	30.6 (4/4) 29.3 - 31.8	20.9 (7/7) 19.1 - 26.1	0
Air Particulates (pCi/m^3)	Gross Beta - 519	0.010	0.032 (467/467) 0.013 - 0.072	Site #7A 8 miles 140°	0.035 (52/52) 0.017 - 0.072	0.034 (52/52) 0.017 - 0.065	0
	Gamma Spec. Composite- 40						
	Cs-134	0.05	<LLD	NA	<LLD	<LLD	0
	Cs-137	0.06	<LLD	NA	<LLD	<LLD	0
Air Radioiodine (pCi/m^3)	Gamma Spec. - 520						
	I-131	0.07	<LLD	NA	<LLD	<LLD	0
Broadleaf Vegetation (pCi/Kg-wet)	Gamma Spec. - 18						
	I-131	60	<LLD	NA	<LLD	<LLD	0
	Cs-134	60	<LLD	NA	<LLD	<LLD	0
	Cs-137	80	<LLD	NA	<LLD	<LLD	0
Groundwater (pCi/l)	Tritium - 8	2000	<LLD	NA	<LLD	NA	0
	Gamma Spec. - 8						
	Mn-54	15	<LLD	NA	<LLD	NA	0
	Fe-59	30	<LLD	NA	<LLD	NA	0
	Co-58	15	<LLD	NA	<LLD	NA	0
	Co-60	15	<LLD	NA	<LLD	NA	0

TABLE 11.1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Palo Verde Nuclear Generating Station
Maricopa County, Arizona

Docket Nos. STN 50-528/529/530
Calendar Year 1999

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD) (from Table 6.1)	All Indicator Locations Mean (f)[a] Range	Location with Highest Annual Mean: Name Distance and Direction	Location with Highest Annual Mean: Mean (f)[a] Range	Control Locations Mean (f)[a] Range	Number of Nonroutine Reported Measurements
Groundwater (pCi/l) -continued-	Zn-65	30	<LLD	NA	<LLD	NA	0
	Zr-95	30	<LLD	NA	<LLD	NA	0
	Nb-95	15	<LLD	NA	<LLD	NA	0
	I-131	15	<LLD	NA	<LLD	NA	0
	Cs-134	15	<LLD	NA	<LLD	NA	0
	Cs-137	18	<LLD	NA	<LLD	NA	0
	Ba-140	60	<LLD	NA	<LLD	NA	0
	La-140	15	<LLD	NA	<LLD	NA	0
Drinking Water (pCi/l)	Gross Beta - 49	4.0	5.3 (24/49) 2.8 - 11.6	Site #48 5 miles 190°	7.2 (10/11) 3.8 - 11.6	NA	0
	Tritium - 16	2000	<LLD	NA	<LLD	NA	0
	Gamma Spec. - 49						
	Mn-54	15	<LLD	NA	<LLD	NA	0
	Fe-59	30	<LLD	NA	<LLD	NA	0
	Co-58	15	<LLD	NA	<LLD	NA	0
	Co-60	15	<LLD	NA	<LLD	NA	0
	Zn-65	30	<LLD	NA	<LLD	NA	0
	Zr-95	30	<LLD	NA	<LLD	NA	0
	Nb-95	15	<LLD	NA	<LLD	NA	0
	I-131	15	<LLD	NA	<LLD	NA	0
	Cs-134	15	<LLD	NA	<LLD	NA	0
	Cs-137	18	<LLD	NA	<LLD	NA	0
	Ba-140	60	<LLD	NA	<LLD	NA	0
	La-140	15	<LLD	NA	<LLD	NA	0

TABLE 11.1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Palo Verde Nuclear Generating Station
Maricopa County, Arizona

Docket Nos. STN 50-528/529/530
Calendar Year 1999

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection (LLD) (from Table 6.1)	All Indicator Locations Mean (f)[a] Range	Location with Highest Annual Mean: Name Distance and Direction	Location with Highest Annual Mean: Mean (f)[a] Range	Control Locations Mean (f)[a] Range	Number of Nonroutine Reported Measurements
	Gamma Spec. - 36						
	Mn-54	15	<LLD	NA	<LLD	NA	0
	Fe-59	30	<LLD	NA	<LLD	NA	0
	Co-58	15	<LLD	NA	<LLD	NA	0
	Co-60	15	<LLD	NA	<LLD	NA	0
	Zn-65	30	<LLD	NA	<LLD	NA	0
	Zr-95	30	<LLD	NA	<LLD	NA	0
	Nb-95	15	<LLD	NA	<LLD	NA	0
Surface Water (pCi/l)	I-131	15	<LLD	NA	<LLD	NA	0
	Cs-134	15	<LLD	NA	<LLD	NA	0
	Cs-137	18	12 (5/36) 8-18	Site #63 Onsite 180°	13 (5/12) 8-18	NA	0
	Ba-140	60	<LLD	NA	<LLD	NA	0
	La-140	15	<LLD	NA	<LLD	NA	0
	Tritium - 12	3000	1077 (8/12) 778 - 1319	Site #63 Onsite 180°	1090 (4/4) 778 - 1296	NA	0

(a) Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses. (f)

NOTE: Miscellaneous samples which are not listed on Tables 2.1 and 9.1 (not ODCM required) are not included on this table.

12. References

1. Pre-Operational Radiological Monitoring Program, Summary Report 1979-1985.
2. 1985-1998 Annual Radiological Environmental Operating Reports, Palo Verde Nuclear Generating Station.
3. Palo Verde Nuclear Generating Station Technical Specifications and the Technical Reference Manual (TRM).
4. Offsite Dose Calculation Manual, PVNGS Units 1, 2, and 3.
5. Regulatory Guide 4.8, Environmental Technical Specifications for Nuclear Power Plants.
6. Branch Technical Position, Revision 1, November 1979.

13. APPENDIX A - Corrections to the 1998 Annual Radiological Environmental Operating Report

Reservoir monthly composite sample dated 10-26-98 had a reported MDA for La-140 of <17 pCi/liter. This value exceeds the required LLD of 15 pCi/liter. A notation was not included on Table 8.9 that should have explained why the LLD was not met. The following notation is a correction to the 1998 AREOR.

Explanation of deficiency: The sample was counted using the same geometry, count time, and sample decay time as normally used to meet the LLD requirement. The sample should have been re-counted for a longer time in order to meet the LLD. Since all other radionuclides within the sample met the LLD requirements, this is considered an isolated incident (human error) and not an indication of a program deficiency. No additional actions are necessary.