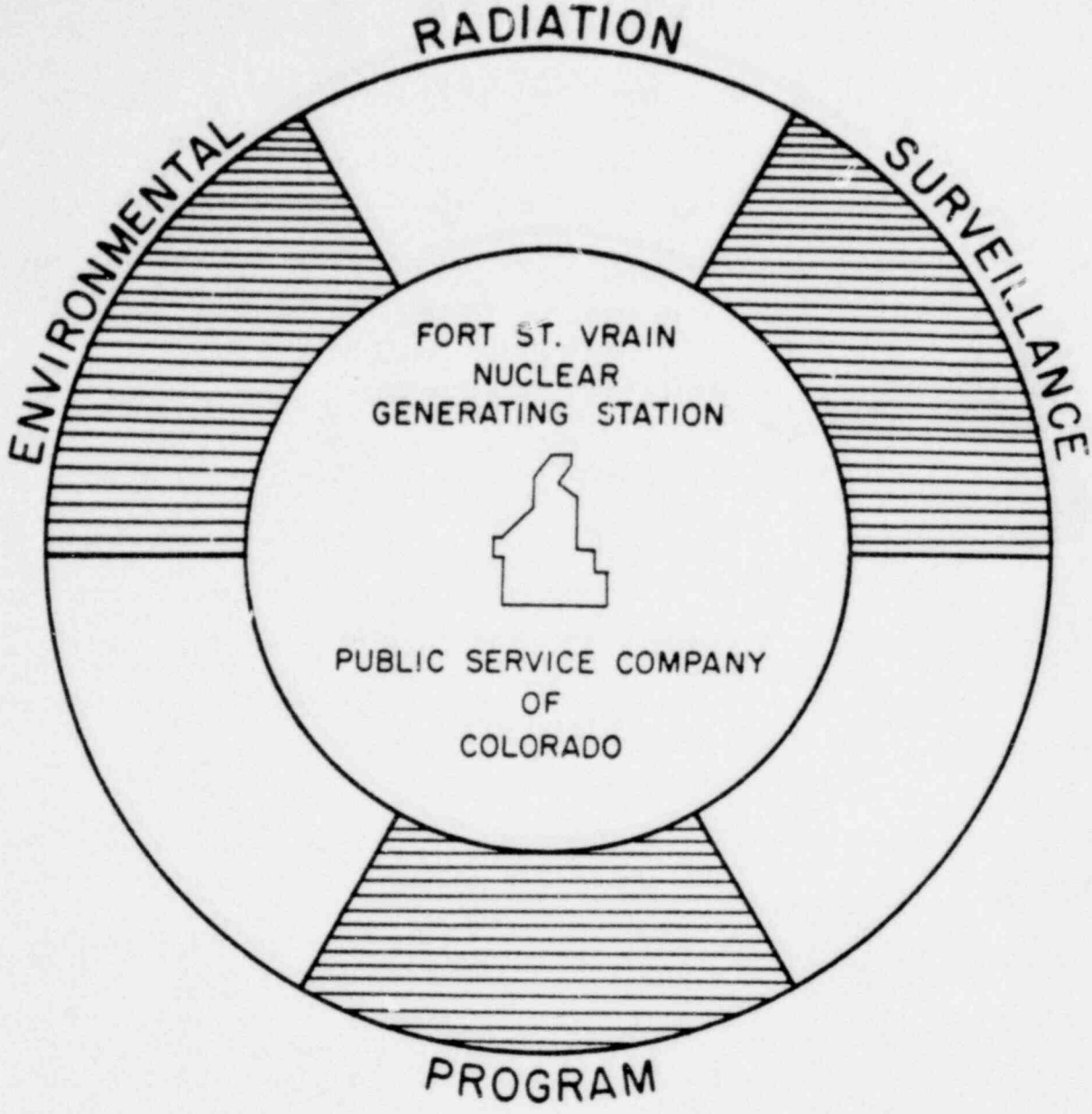

SUMMARY REPORT

THIRD AND FOURTH QUARTERS

1979

PURCHASE ORDER 38951

COLORADO STATE UNIVERSITY

FORT COLLINS, COLORADO 80521

FORT ST. VRAIN NUCLEAR GENERATING STATION

ENVIRONMENTAL RADIATION SURVEILLANCE PROGRAM

Summary Report
for the period

July 1, 1979 - December 31, 1979

Prepared by:/s/ James E. Johnson — 2/4/80
James E. Johnson, Professor, Colorado State University — Date

Reviewed by:/s/ Timothy E. Stebbings — 2/8/80
Health Physics Department, Fort St. Vrain — Date

Reviewed by:/s/ Richard A. Peyke / Jeffrey R. John — 2/11/80
Nuclear Project Department — Date

Approved by:/s/ M. H. Holmes — 2/11/80
Operations Manager, Fort St. Vrain — Date

Approved &
Issued by:/s/ M. H. Holmes — 2/25/80
Nulcear Project Department — Date

ENVIRONMENTAL RADIATION SURVEILLANCE

conducted in the vicinity of the

FORT ST. VRAIN NUCLEAR GENERATING STATION

for the

PUBLIC SERVICE COMPANY OF COLORADO

Purchase Order No. 38951

SUMMARY REPORT

for the period

JULY - DECEMBER 1979

by
James E. Johnson

Department of Radiology and Radiation Biology
Department of Animal Sciences

COLORADO STATE UNIVERSITY

Fort Collins, Colorado

January 1980

Acknowledgements

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Kati Tengerdy

Sara Webber

April Whicker

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I. Introduction to Radiation Surveillance Data for the Second Half of 1979.

During the last six months of 1979 the Fort St. Vrain Nuclear Generating Station produced power as follows:

Month	Dates With Electric Generation	Number Of Days Without Generation	Gross Generation MWH
June	0	30	0
July	23, 26-28, 30, 31	25	4,522
August	3-17, 20-24, 26-31	5	88,079
September	1	29	1,828
October	2-14, 24-26	15	46,367
November	0	30	0
December	0	31	0

From the above it can be observed that the reactor operated for less than one-half of the reporting period. Therefore, radioactive effluents from the reactor were again minimal. A complete listing of radioactivity released by all effluent routes may be found in the semiannual report to the NRC.

No announced atmospheric nuclear weapons tests occurred during the reporting period or the immediate proceeding six month period. Stratospheric radioactive debris from previous tests however, is still apparent and observed generally during spring and early summer months.

The environmental sampling and analysis program was essentially identical to that used in the previous reporting period. A few minor changes in sampling locations occurred and these are given in Section III.

Essentially all radioactivity data measured on this project are near background levels and more importantly near the minimum detectable activity (MDA) levels for each radionuclide and sample type. It has been well

documented that even independent of the above reasons, environmental data exhibit great inherent variability. As a result, the overall variability of the surveillance data is quite large, and it is necessary to use mean values to make any conclusions about the true absolute radioactivity concentrations in any environmental pathway.

Environmental radiation surveillance data commonly exhibit non-normal frequency distributions. More often than not the data can be satisfactorily treated using log-normal statistics. However, when the number of observations is small, i.e. less than 10, log-normal treatment is tentative.

When a high percentage of data points are less than MDA or MDC, (the minimum detectable concentrations of activity in that sample type), calculation of true mean values is impossible. Therefore in this report we have chosen to not include mean values with each data table. At the end of this report in Section II.H., Conclusions and Summary, we have listed the calculated arithmetic means and confidence intervals for the entire reporting period as well as for the last year. We also list the geometric means and standard deviations for the last year of data reporting. If the data point measured resulted in a negative value, this value was used in calculating the true mean value in Table II.H.1. This is the current accepted practice by the U. S. Nuclear Regulatory Commission. It should be noted that we have not used any footnote for values less than MDC. Rather we list the measured value as less than the actual MDC value. Because this value is dependent upon variables such as the background count time and sample size, the MDC value will be different for each sample type and even within sample type.

Many sets of data were compared in this report. The statistical test used was either a "t"-test or a paired "t"-test. If data sets are noted to be significantly different or not significantly different, the confidence for the statement is at the 95% level (α=0.05).

The following is the footnote system used in this report.

a. Sample lost prior to analysis.

b. Sample missing at site.

c. Instrument malfunction.

d. Sample lost during analysis.

e. Insufficient weight or volume for analysis.

f. Sample unavailable.

g. Analysis in progress.

N.A. Not applicable.

II. Surveillance Data for July through December 1979 and Interpretation of Results.

A. External Gamma-ray Exposure Rates

The average gamma-ray exposure rates expressed in mR/day are given in Table II.A.1. The values were determined by CaF_2:Dy (TLD-200) crystals for each of the 37 locations (See Table III.B.1). The total exposure recorded by each TLD was divided by the number of days that elapsed between pre-exposure and post-exposure annealing to obtain the average exposure rate. The TLD devices are changed monthly at each location.

The data are grouped for Facility (F), Adjacent (A) and Reference (R) zones. See Figures III.B.1 and III.B.2 and Table III.B.1, III.B.2, and III.B.3 for the exact TLD locations.

The TLD data indicate that the mean measured exposure rate in the Facility area was approximately 172 mR/year. standard deviation for all facility sites was 19 mR/year. The mean exposure rate was 168 mR/year for the Adjacent area and 175 mR/year for the Reference area. There were no significant differences between the values for the Facility, Adjacent and Reference areas. The exposure rate is due to cosmic rays, to natural gamma-ray emitters in the earth's crust and to surface deposition of fission products from world wide fallout. The variation in measured values is due to true variation of the above plus the variation due to the method.

Inspection of the values recorded for the Adjacent area again show a pattern of high values for the station A-35. This pattern has been observed since June of 1978, and has been extremely regular. In June of 1979, we set out additional TLD devices at the A-35 site and collected one per week.

Figure II.A.1 shows the data for site A-35 and for comparison that of F-4. The bimonthly appearance of peak values in the exposure rate has occurred without fail since May of 1978. A high peak was observed at the end of the collection period. No peak as expected was observed in December of 1979. It should be noted that due to land owner misgivings the site was changed once to the Miller farm and yet the periodicity was maintained. When the air sampler at A-35 was changed again on 10/15/79, the TLD devices were left at the Miller farm site for continuity purposes in studying the exposure rate variation. Therefore the TLD data listed for A-35 in this report is all for the Miller farm site. Additional TLD devices are now located at the new A-35 location. Until the reason for the exposure rate fluctuation is documented TLD devices will be left at the Miller farm site. Figure II.A.2 shows data for 1977 and 1978 for comparison purposes.

Attempts to explain the variation were tried in 1979. There was no correlation of A-35 values between gaseous releases from the reactor when wind direction and stability parameters were included. Film badges placed at the same site did not have sufficient sensitivity to measure the background rate. Lithium fluoride TLD devices at the same location did not show the high peak values. A planned installation of a continuous readout GM detector rate meter system was prevented due to vandalism and lack of owner permission.

It can be concluded that the high values are not due to reactor effluents. It also seems likely that the radiation source is of low photon energy. It can only be speculated therefore that the elevated activities are due to well logging operations. Effort to confirm this, however, by conversation with local residents and well logging company has been to no avail.

We will continue our attempts to explain these apparent phenomena. Starting January 1980, two TLD chips will be placed in each packet to provide duplicate values for exposure rate at each site. The mean value of the two chips will be reported unless the values differ by more than one standard deviation from the mean of other sites on that date. This procedure will also minimize methodological errors in the TLD technique.

Table II. A.1 Gamma Exposure Rates Measured by the TLD Technique (mR/day).

Facility Area Locations	Average Daily Gamma Exposure Rates 1979					
	July	Aug.	Sept.	Oct.	Nov.	Dec.
F 1	.45	.44	.46	.42	.40	.59
F 3	.40	.40	.46	.45	.43	.61
F 4	.49	.38	.46	.43	.41	c
F 7	.43	.43	.48	.39	.41	.60
F 8	.46	.47	.53	.48	.45	.47
F 9	.43	.43	.49	.40	.48	.59
F 11	.42	.37	.49	.43	.41	.58
F 12	c	.42	.48	.52	.48	f
F 13	.42	.43	.53	.57	.46	.62
F 14	.47	.51	.49	.41	.36	.50
F 46	.42	.51	.49	.44	.52	.55
F 47	.41	.39	.50	.44	.47	.60
F 51	.53	c	.50	.47	.61	.54
Adjacent Area Locations						
A 5	.46	.37	.49	.47	.55	.65
A 6	.41	.38	.50	.41	.46	.56
A 27	.42	.41	.48	.41	.49	f
A 28	.41	.39	.48	.44	.45	.52
A 29	.50	.42	.49	.42	.43	.46
A 30	.41	.43	.51	.48	.49	.54
A 31	.38	.37	.45	.40	.42	.46
A 32	.40	.40	.48	.46	.40	.51
A 33	.42	.41	.50	.44	.48	.51
A 34	.46	.49	.58	.48	.50	.51
A 35	.48	.82	.56	.40	.46	.91
A 36	.45	.48	.50	.45	.49	.51
Reference Area Locations						
R 15	.39	.81	.51	.68	.42	.46
R 16	.52	.54	.56	.47	.60	.53
R 17	.40	.39	.41	.42	.49	.54
R 18	.41	.41	.43	.41	c	.45
R 19	.42	.38	.48	.39	c	.47
R 20	.49	.48	.49	.46	c	.46
R 21	.42	.42	.46	.46	c	.48
R 22	.45	.46	.46	.46	.50	.44
R 23	.44	.48	.49	.47	.40	.50
R 24	.56	.50	.55	.54	.50	.45
R 25	.48	.43	.51	.46	.44	.57
R 26	.41	.40	.47	.45	.47	.49

c Instrument malfunction
f Sample unavailable

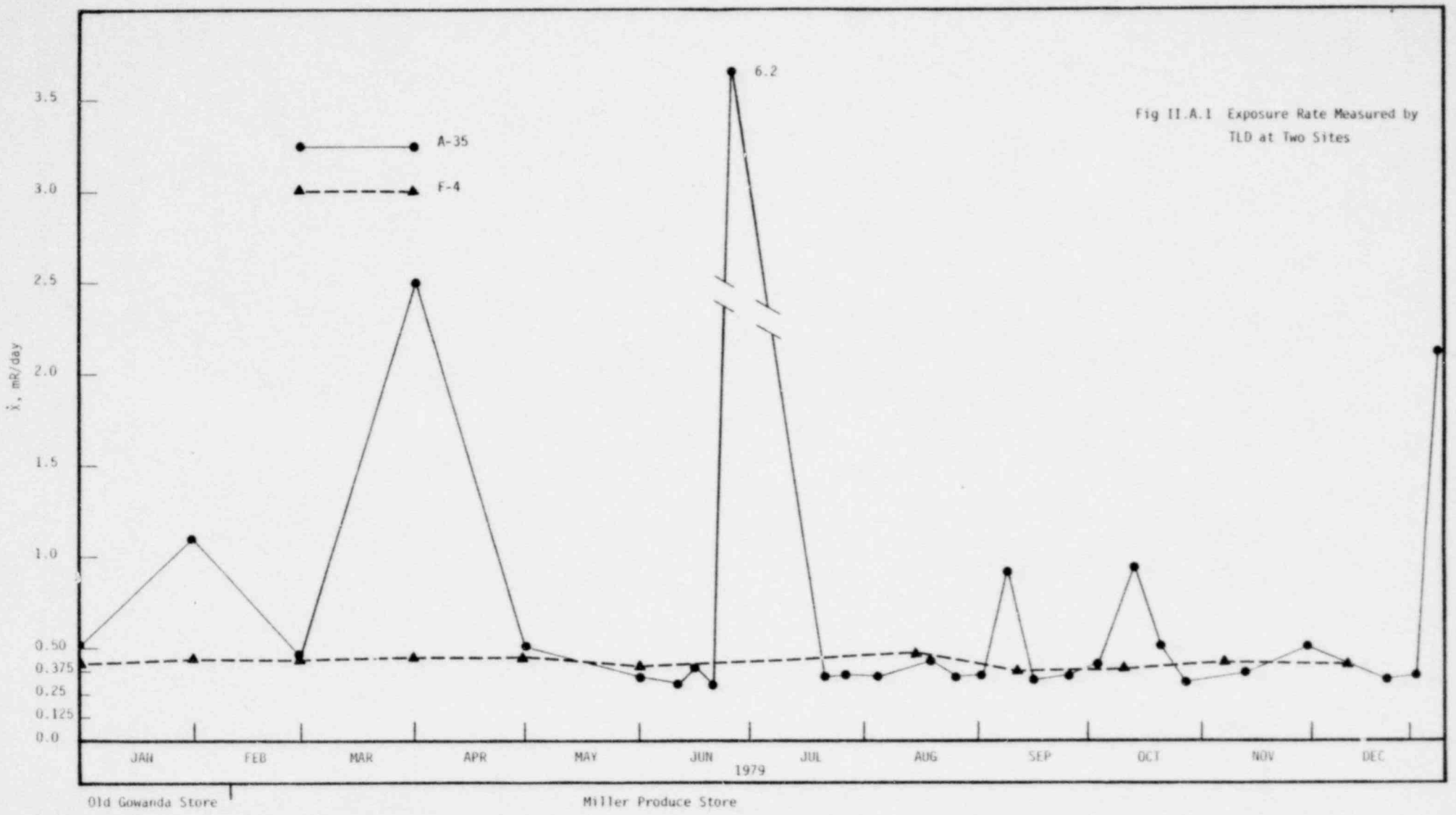

Fig II.A.1 Exposure Rate Measured by TLD at Two Sites

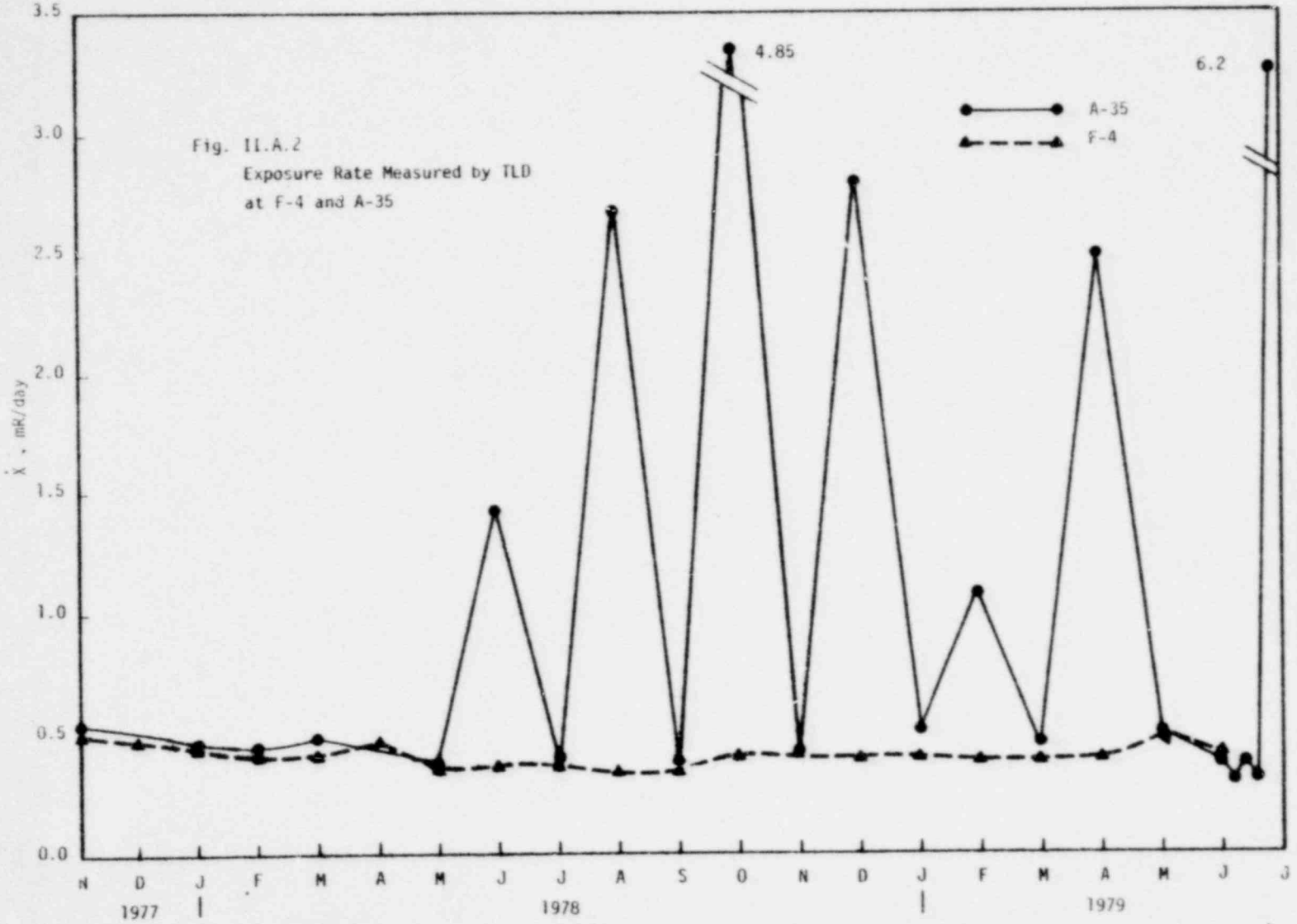

Fig. II.A.2
Exposure Rate Measured by TLD
at F-4 and A-35

II.B. Air Sampling Data

1. Gross alpha and beta activity.

The concentrations of gross alpha and beta activity measured on air particulates for the Facility and Adjacent sampling sites are listed in Tables II.B.1 and II.B.2. Although mean values for the four facility sites are higher than for the three adjacent sites, these differences are not statistically different for either gross alpha or gross beta air concentrations.

The third quarter values showed very little evidence if any of an increase due to injection of stratospheric debris from previous atmospheric weapon testing.

As discussed in the previous section there was no correlation between air concentrations measured at A-35 and the periodic exposure rate values measured there.

Table II. B.1
Concentrations of Long-Lived Gross Alpha Activity in Airborne Particles (fCi/m^3).

a) Third Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
1979							
July 7	12.0 (1.5)*	27.6 (2.4)	25.8 (2.9)	17.6 (2.0)	**	10.4 (1.5)	c
July 14	23.5 (2.3)	40.6 (3.7)	**	14.1 (2.0)	**	11.0 (1.8)	6.6 (1.2)
July 21	7.9 (1.2)	9.0 (3.8)	2.9 (1.2)	12.0 (1.9)	10.6 (2.1)	6.4 (1.2)	5.7 (0.9)
July 28	9.3 (1.4)	c	15.0 (2.1)	27.6 (2.8)	14.6 (2.2)	9.3 (1.6)	5.5 (0.9)
Aug. 4	7.6 (1.3)	15.0 (2.5)	14.6 (2.4)	11.3 (1.8)	11.5 (1.9)	6.5 (1.3)	6.0 (1.3)
Aug. 11	7.5 (1.1)	a	16.6 (2.3)	22.1 (3.3)	10.6 (2.2)	7.3 (1.4)	3.2 (0.7)
Aug. 18	1.8 (0.5)	1.2 (0.6)	3.0 (0.9)	3.8 (1.1)	1.9 (0.6)	4.9 (0.9)	0.8 (0.3)
Aug. 25	2.7 (0.5)	2.7 (0.5)	5.0 (0.8)	7.1 (1.1)	8.4 (1.0)	3.1 (0.7)	24.2 (2.2)
Sept. 1	4.9 (0.8)	14.2 (2.1)	8.5 (1.5)	6.2 (1.1)	5.9 (1.1)	4.8 (0.9)	6.0 (1.0)
Sept. 8	2.5 (0.6)	16.2 (1.9)	23.4 (2.7)	36.9 (2.6)	5.8 (1.4)	3.3 (0.7)	2.1 (0.8)
Sept. 15	7.1 (0.9)	16.8 (1.7)	16.9 (1.9)	7.9 (1.2)	11.1 (1.6)	3.2 (0.6)	***
Sept. 22	***	10.0 (1.4)	22.7 (2.3)	10.4 (1.4)	15.6 (1.9)	7.6 (1.1)	***
Sept. 29	***	2.2 (0.9)	23.0 (2.3)	7.0 (1.3)	**	3.6 (0.7)	9.3 (2.0)
Quarterly (42 samples)			-minimum 1.2 -maximum 40.6 -average 12.8		Quarterly (33 samples)		-minumum 0.8 -maximum 24.2 -average 7.5

All concentrations are expressed in femtocuries per cubic meter of air: 1 $fCi/m^3 = 10^{-15}$ $\mu Ci/ml$.

* Uncertainties (in parentheses) are for the 95% confidence interval (1.96 S.D.)

** Excessive dust loading, analysis uncertain.

*** Electricity turned off

a Sample lost prior to analysis.

c Instrument malfunction.

Table II. B.1
Concentrations of Long-Lived Gross Alpha Activity in Airborne Particles (fCi/m^3).

b) Fourth Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
Oct. 6	c	6.4 (1.0) *	4.8 (1.0)	4.0 (0.8)	9.0 (2.0)	5.1 (1.1)	**
Oct. 1[illegible]	10.7 (1.5)	27.5 (2.4)	8.5 (1.4)	3.3 (0.7)	7.4 (1.5)	3.0 (0.6)	**
Oct. 15	[illegible].8 (1.8)	7.3 (1.9)	9.4 (2.3)	9.0 (2.2)	11.5 (2.5)	3.1 (0.8)	**
Oct. 20	[illegible] (1.4)	9.8 (1.6)	11.0 (1.7)	9.0 (1.5)	8.8 (1.8)	4.9 (1.1)	6.4 (1.0)
Oct. 27	[illegible] (1.1)	7.1 (1.1)	6.8 (1.0)	5.8 (0.9)	7.8 (1.2)	5.6 (1.0)	3.4 (0.6)
Nov. 3	[illegible] (0.7)	3.9).8)	3.2 (0.6)	3.2 (0.6)	3.6 (0.7)	1.8 (0.4)	5.4 (0.6)
Nov. 11	3.2 (0.7)	4.8 (0.9)	2.7 (0.5)	2.7 (0.6)	2.1 (0.5)	1.2 (0.3)	1.7 (0.6)
Nov. 17	3.7 (0.7)	4.9 (0.9)	3.4 (0.6)	3.7 (0.7)	8.5 (1.2)	1.6 (0.4)	2.9 (0.9)
Nov. 25	3.6 (0.7)	2.2 (0.6)	2.0)0.4)	2.1 (0.5)	2.9 (0.6)	2.3 (0.4)	3.0 (0.6)
Dec. 1	3.1 (0.9)	3.7 (1.0)	1.5 (0.4)	3.5 (0.9)	3.5 (0.9)	1.2 (0.5)	6.2 (1.3)
Dec. 9	1.1 (0.3)	0.6 (0.3)	1.2 (0.3)	0.8 (0.4)	3.6 (0.7)	1.4 (0.4)	1.9 (0.6)
Dec. 15	2.6 (0.5)	3.4 (0.8)	4.4 (0.8)	2.7 (0.7)	2.9 (0.6)	2.4 (0.6)	7.7 (1.5)
Dec. 26	3.3 (0.5)	3.0 (0.6)	3.4 (0.6)	3.0 (0.6)	3.4 (0.6)	2.2 (0.4)	4.4 (0.8)
Dec. 30	[illegible] (0.3)	***	0.7 (0.4)	0.8 (0.4)	1.0 (0.4)	0.2 (0.2)	1.6 (0.7)
Quarterly (54 samples)			-minimum 0.6 -maximum 27.5 -average 4.8		Quarterly (39 samples)		-minimum 0.2 -maximum 11.5 -average 4.0

All concentrations are expressed in femtocuries per cubic meter of air: 1 $fCi/m^3 = 10^{-15}$ µCi/ml.
* Uncertainties (in parenthesis) are for the 95% confidence interval, (1.96 S.D.)
** Pump removed from field 9/29/79. New site being located.
*** Sample left in field
a. Sample lost prior to analysis.
c. Instrument malfunction.

Table II.B.2
Concentrations of Long-lived Gross Beta Activity in Airborne Particles (fCi/m^3).
a) Third Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
1979							
July 7	11 (1)	8 (1)	18 (2)	9 (1)	11 (1)	8 (1)	c
July 14	12 (1)	17 (1)	26 (2)	21 (1)	25 (2)	19 (1)	11 (1)
July 21	15 (1)	40 (10)	28 (1)	23 (2)	16 (1)	14 (1)	10 (1)
July 28	14 (1)	c	19 (1)	23 (1)	19 (1)	19 (1)	9 (1)
Aug. 4	16 (1)	26 (2)	25 (2)	20 (1)	21 (1)	11 (1)	11 (1)
Aug. 11	11 (1)	a	23 (1)	32 (2)	16 (2)	9 (1)	7 (1)
Aug. 18	5 (1)	6 (1)	6 (1)	11 (2)	6 (1)	3 (1)	3 (1)
Aug. 25	9 (1)	15 (1)	13 (1)	16 (1)	6 (1)	2 (1)	33 (2)
Sept. 1	13 (1)	26 (2)	21 (1)	17 (1)	16 (1)	11 (1)	12 (1)
Sept. 8	7 (1)	11 (1)	15 (2)	5 (1)	11 (1)	6 (1)	7 (2)
Sept. 15	9 (1)	15 (1)	15 (1)	13 (1)	12 (1)	5 (1)	***
Sept. 22	***	25 (2)	22 (1)	16 (1)	17 (1)	9 (1)	***
Sept. 29	***	30 (2)	23 (1)	16 (1)	26 (1)	10 (1)	20 (3)
Quarterly (48 samples)			-minimum 5 -maximum 40 -average 17		Quarterly (36 samples)		-minimum 2 -maximum 33 -average 12

All concentrations are expressed in femtocuries per cubic meter of air: 1 $fCi/m^3 = 10^{-15}$ $\mu Ci/ml$.
* Uncertainties (in parentheses) are for the 95% confidence interval (1.96 S.D.)

*** Electricity turned off
a Sample lost prior to analysis.
c Instrument malfunction.

Table II.B.2
Concentrations of Long-lived Gross Beta Activity in Airborne Particles (fCi/m^3).

b) Fourth Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
Oct. 6	c	18 (1)*	15 (1)	11 (1)	17 (1)	12 (1)	**
Oct. 13	16 (1)	15 (1)	18 (1)	8 (1)	12 (1)	8 (1)	**
Oct. 15	24 (2)	28 (3)	29 (3)	25 (3)	21 (2)	6 (2)	**
Oct. 20	15 (1)	19 (2)	17 (1)	14 (1)	15 (1)	8 (1)	7 (1)
Oct. 27	16 (1)	17 (1)	12 (1)	12 (1)	12 (1)	10 (1)	8 (1)
Nov. 3	11 (1)	14 (1)	10 (1)	10 (1)	9 (1)	6 (1)	14 (1)
Nov. 11	29 (1)	34 (2)	17 (1)	24 (1)	22 (1)	15 (1)	29 (1)
Nov. 17	14 (1)	14 (1)	9 (1)	13 (1)	8 (1)	5 (1)	13 (1)
Nov. 26	10 (1)	10 (1)	6 (1)	9 (1)	8 (1)	6 (1)	12 (1)
Dec. 1	14 (1)	17 (2)	8 (1)	14 (1)	12 (1)	7 (1)	13 (1)
Dec. 9	8 (1)	4 (1)	8 (1)	6 (1)	9 (1)	5 (1)	9 (1)
Dec. 15	12 (1)	17 (1)	10 (1)	10 (1)	13 (1)	6 (1)	16 (1)
Dec. 26	10 (1)	11 (1)	12 (1)	9 (1)	13 (1)	6 (1)	16 (1)
Dec. 30	9 (1)	***	11 (1)	9 (1)	8 (1)	5 (1)	13 (1)
Quarterly (54 samples)			- minimum 4 - maximum 34 - average 14		Quarterly (39 samples)		- minimum 5 - maximum 29 - average 11

All concentrations are expressed in femtocuries per cubic meter of air: 1 $fCi/m^3 = 10^{-15}$ $\mu Ci/ml$.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

** Pump removed from field 9/29/79. New site being located.

*** Sample left in field.

c Instrument malfunction

Table II. B.3
Tritium Concentrations in Atmospheric Water Vapor (pCi/l).

a) Third Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
7-7-79	741 (276)	851 (277)	f	<290	<290	<290	413 (273)
7-14-79	305 (265)	858 (270)	<283	458 (266)	<283	<283	<283
7-21-79	1,480 (277)	2,680 (290)	<283	<283	<283	<283	<283
7-28-79	293 (264)	620 (268)	353 (265)	<283	294 (264	334 (265)	488 (267)
8-4-79	855 (271)	1,240 (275)	320 (254)	347 (265)	561 (267)	387 (265)	585 (268)
8-11-79	961 (275)	690 (273)	470 (270)	384 (269)	315 (268)	354 (269)	<287
8-18-79	<287	352 (269)	<287	<287	<287	<287	<287
8-25-79	892 (275)	489 (270)	<287	384 (269)	287 (268)	403 (269)	447 (270)
9-1-79	<261	<261	<261	<261	<261	<261	<261
9-8-79	<261	418 (245)	<261	<261	<261	<261	<261
9-15-79	<256	609 (243)	<256	<256	<256	257 (239)	<256
9-22-79	934 (246)	1,100 (248)	353 (240)	555 (242)	334 (240)	512 (242)	204 (239)
9-29-79	876 (245)	2,130 (259)	473 (241)	941 (246)	913 (246)	e	e

*Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

e Insufficient weight or volume for analysis.

f Sample unavailable

Table II. B.3
Tritium Concentrations in Atmospheric Water Vapor (pCi/l).
b) Fourth Quarter, 1979.

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
10-6-79	1,050 (247)*	1,450 (252)	462 (241)	574 (241)	615 (243)	< 623	**
10-13-79	848 (245)	647 (274)	274 (239)	369 (240)	<206	e	**
10-20-79	1,840 (263)	4,250 (287)	<265	<265	<265	459 (250)	287 (248)
10-27-79	540 (251)	267 (248)	343 (248)	<265	<265	<265	<265
11-3-79	<265	586 (251)	<265	<265	<265	490 (250)	<265
11-10-79	<256	<256	357 (240)	<256	<256	<256	<256
11-17-79	<256	626 (243)	718 (235)	<256	<256	<256	<256
11-26-79	264 (239)	419 (241)	272 (239)	<256	375 (241)	<256	<256
12-1-79	<261	< 261	< 261	< 261	< 261	< 261	< 261
12-9-79	<261	< 261	< 261	319 (244)	265 (244)	< 261	< 261
12-15-79	553 (283)	624 (283)	353 (281)	< 300	497 (282)	639 (283)	607 (283)
12-22-79	1,190 (288)	678 (283)	629 (290)	716 (290)	816 (285)	1,350 (290)	940 (286)
12-30-79	615 (283)	e	366 (281)	< 300	< 495	< 300	< 300

*Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
**Pump removed from field 9/29/79. New site being located.
e Insufficient volume for analysis.

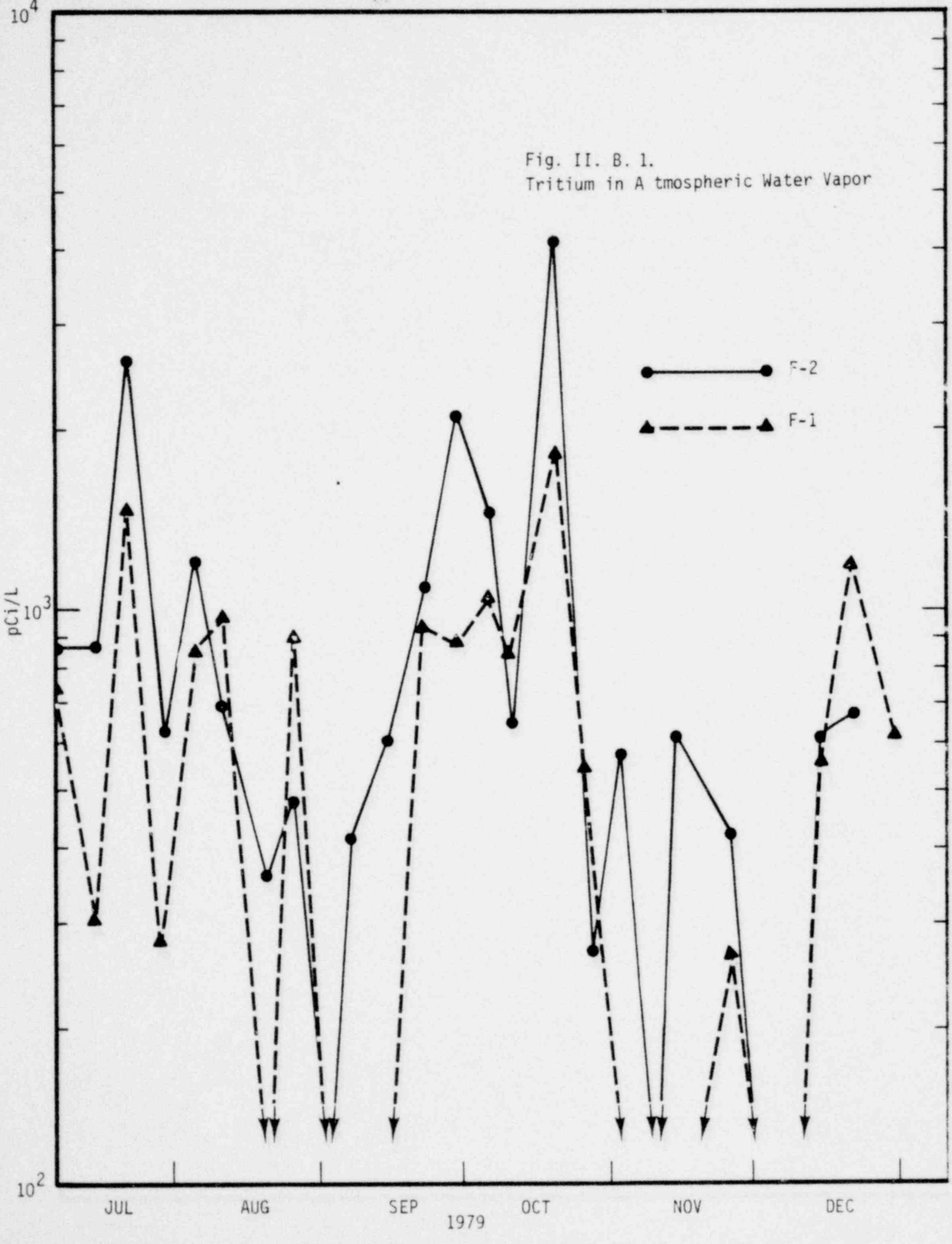
Fig. II. B. 1.
Tritium in A tmospheric Water Vapor
F-2
F-1
pCi/L
10^4
10^3
10^2
JUL
AUG
SEP
OCT
NOV
DEC
1979

2. Tritium Activity. Tropospheric water vapor samples are collected continuously on Silica Gel at all seven air sampling stations (four in the Facility area and three in the Adjacent area). The specific activity of tritium in water in weekly samples from these stations is listed in Table II.B.3. The air concentration of tritium for the same weekly samples is listed in Table II.B.3a.

The variation of the measured tritium specific activity in tropospheric water vapor has consistently been large at all facility and adjacent air sampling sites. Figure II.B.1 shows the values for F-1 and F-2 sites for the second half of 1979.

The facility sites F-1 and F-2 are closest to the main water effluent pathway from the reactor (See Figure III.B.1). Inspection of Table II.B.3 indicate that for a given date, with a few exceptions these two sites show higher values than those not on the liquid batch release route. This observation has been noted for some time, and the high values are assumed to be due to tritiated water evaporation from the discharge ditch or the pond impoundments. The total reactor effluent release of tritium is given in Table II.B.3.b. A high correlation with individual batch release tritium specific activity does not occur, but this is to be expected because of temperature, humidity, flow rate, release time and other variables.

Elevated concentrations of tritium in the local terrestrial or aquatic food chains does not result, however, due to the great dilution from the hydrosphere.

At location F-4 a hygrothermograph has been operational for most of the second half of 1979. Using the temperature and relative humidity data from the hygrothermograph it is possible to convert specific activity of tritiated water collected on Silica Gel (pCi/liter) to activity per unit volume or air (pCi/m^3). This is critical if calculation of immersion dose from tritiated

water vapor were ever necessary.

Two equations are used in the conversion of pCi/liter of water to pCi/m^3 of air. The first equation is used to determine the vapor pressure of water (1):

$\log_{10}P = A - B\ (C+t)$, where: P = vapor pressure (mm Hg)
t = temperature (C)
A = 9.10765
B = 1750.286
C = 235.0

The temperature used is the integrated weekly value taken from the hygrothermograph. The conversion is completed in the second equation which is the "Ideal Gas Equation:"

$PV = nRT$, where:

P = vapor pressure (atmospheres)
V = volume (liters)
n = number of moles of gas
R = 0.08206 liter-atmospheres/mole-^{o}K
T = temperature in ^{o}K

The number of grams of water per cubic meter of air is then determined.

The value of "n" obtained is for saturated air. The relative humidity is therefore integrated over the week and this percentage of the saturated air value is taken. The final value is reported in pCi/m^3. This procedure has been applied to data collected for the third and fourth quarters of 1979 and listed in Table II.B.3a. These values are functions of both specific activity of tritium in water and the concentration of water in the air and show essentially the same location and time variations as the data in Table II.B.3.

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(1) H. A. Lange, Handbook of Chemistry. 19th edition, revised. McGraw-Hill Book Co., New York, 1967. pp. 1436-1450.

Table II.B.3a
Tritium Concentrations in Air (pCi/m^3)

a) Third Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
7-7-79	< 9.25	< 10.6	f	< 3.62	< 3.62	< 3.62	< 5.16
7-14-79	< 3.69	< 10.2	< 3.42	< 5.54	< 3.42	< 3.42	< 3.42
7-21-79	< 19.1	< 34.6	< 3.66	< 3.66	< 3.66	< 3.66	< 3.66
7-28-79	< 3.18	< 6.72	< 3.83	< 3.07	< 3.19	< 3.62	< 5.29
8-4-79	< 7.87	< 11.4	< 2.95	< 3.19	< 5.16	< 3.56	< 5.39
8-11-79	< 12.3	< 8.86	< 6.04	< 4.93	< 4.05	< 4.55	< 3.69
8-18-79	< 3.14	< 3.85	< 3.14	< 3.14	< 3.14	< 3.14	< 3.14
8-25-79	< 9.07	< 4.97	< 2.92	< 3.91	< 2.92	< 4.10	< 4.55
9-1-79	< 2.80	< 2.80	< 2.80	< 2.80	< 2.80	< 2.80	< 2.80
9-8-79	< 2.88	< 4.00	< 2.88	< 2.88	< 2.88	< 2.88	< 2.88
9-15-79	< 2.26	< 5.39	< 2.26	< 2.26	< 2.26	< 2.27	< 2.26
9-22-79	< 8.05	< 9.48	< 3.04	< 4.78	< 2.88	< 4.41	< 1.76
9-29-79	c	c	c	c	c	c	c

c Instrument malfunction
f Sample unavailable

Table II.B.3a
Tritium Concentrations in Air (pCi/m^3)

b) Fourth Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
10-6-79	5.81	8.02	2.36	3.18	3.40	3.45	**
10-13-79	4.53	3.46	1.46	1.97	< 1.36	e	**
10-20-79	8.91	20.5	< 1.28	< 1.28	< 1.28	2.22	1.39
10-27-79	3.02	1.49	1.92	< 1.48	< 1.48	< 1.48	< 1.48
11-3-79	<0.917	2.03	< 0.917	< 0.917	< 0.917	1.70	< 0.917
11-10-79	<0.962	<0.962	1.34	< 0.962	< 0.962	< 0.962	< 0.962
11-17-79	<0.768	1.88	2.15	< 0.768	< 0.768	< 0.768	< 0.768
11-26-79	0.487	0.773	0.502	< 0.473	0.692	< 0.420	< 0.420
12-2-79	c	c	c	c	c	c	c
12-8-79	c	c	c	c	c	c	c
12-15-79	c	c	c	c	c	c	c
12-26-79	c	c	c	c	c	c	c
12-30-79	c	c	c	c	c	c	c

** New site being located

c Instrument in for repair

e Insufficient volume for analysis

Table II.B.3a
Tritium Concentrations in Air (pCi/m^3)

b) Fourth Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
10-6-79	5.81	8.02	2.36	3.18	3.40	3.45	**
10-13-79	4.53	3.46	1.46	1.97	< 1.36	e	**
10-20-79	8.91	20.5	< 1.28	< 1.28	< 1.28	2.22	1.39
10-27-79	3.02	1.49	1.92	< 1.48	< 1.48	< 1.48	< 1.48
11-3-79	<0.917	2.03	< 0.917	< 0.917	< 0.917	1.70	< 0.917
11-10-79	<0.962	<0.962	1.34	< 0.962	< 0.962	< 0.962	< 0.962
11-17-79	<0.768	1.88	2.15	< 0.768	< 0.768	< 0.768	< 0.768
11-26-79	0.487	0.773	0.502	< 0.473	0.692	< 0.420	< 0.420
12-2-79	c	c	c	c	c	c	c
12-8-79	c	c	c	c	c	c	c
12-15-79	c	c	c	c	c	c	c
12-26-79	c	c	c	c	c	c	c
12-30-79	c	c	c	c	c	c	c

** New site being located

c Instrument in for repair

e Insufficient volume for analysis

Table II.B.3b Tritium released (Ci) in Reactor Effluents
2nd Half of 1979

Mode	July	Aug	Sept	Oct	Nov	Dec	Total
Continuous Liquid effluent, turbine sump and reactor sump	0.144	0.888	0.190	2.94	0.082	0.083	4.33
Gaseous, stack	0.157	0.087	0.976	0.381	0.300	0.116	2.02
Batch Liquid	12.1	16.8	16.8	20.8	11.4	1.96	79.9
Total	12.4	17.8	18.0	24.1	11.8	2.16	86.2

3. Activity of gamma-ray emitting radionuclides in air.

Table II.B.4 lists the concentrations of I-131 observed in air by activated charcoal sampling and gamma-ray spectrum analysis. The sample counted is a composite from all seven air sampling stations. All charcoal samples are counted approximately 20 days post collection to allow Rn-222 decay and minimize decay of I-131. The I-131 concentrations presented are the result of decay correction back to the midpoint of the sampling period. Decay correction to the midpoint of the sampling period is appropriate as any I-131 in air does not arrive at the sampling station at a constant rate, but rather in pulses short compared to the collection period. This is the case whether the I-131 source term is weapons testing fallout or reactor stack effluent. The air concentrations of I-131 during the second half of 1979 were generally greater than the first half of 1979. The highest values were in September and October, a period during which the reactor was not operating and I-131 inventories should have been minimal.

Table II.B.5 lists the results of the gamma-ray spectral analyses of weekly composites of the membrane air filters in each sample head. The concentrations of the three radionuclides were generally low and showed no correlation with the I-131 data. All samples are counted after decay of Rn and Tn daughters.

The radioruthenium data is listed in the tables as Ru-106. However, it is true that the activity measured is often a mixture of Ru-103 and Ru-106. Both isotopes have gamma-rays at essentially the same energy and they cannot be separated by Na(I) spectral analysis. No separation by half-life determination was attempted on the data. Since the half-life of Ru-103 is 40 days and that of Ru-106 is one year, in periods soon after an atmospheric test, a high proportion is expected to be Ru-103, and at later times predominately Ru-106. Since the ruthenium isotopes have

negligible biological availability, neither have any consequence in calculation of population dose and efforts to separate them are not warranted.

Table II. B.4
Iodine-131 Concentrations in Air (Taken From Composites of Activated Charcoal at all Air Sampling Stations and Determined by Gamma Spectrometry).

Sample Ending Dates	^{131}I (fCi/m^3)
7-7-79	< 4.76
7-14-79	14.6 (26.5)*
7-21-79	< 4.33
7-28-79	< 4.72
8-4-79	< 4.34
8-11-79	249 (13.3)
8-18-79	< 5.68
8-25-79	< 387
9-1-79	< 3.41
9-8-79	84.3 (25.8)
9-15-79	< 5.17
9-22-79	< 4.60
9-29-79	< 4.59
10-6-79	< 3.98
10-13-79	< 4.27
10-20-79	21.3 (10.6)
10-27-79	322 (26.6)
11-3-79	62.8 (4.30)
11-10-79	51.6 (14.1)
11-17-79	52.6 (11.6)
11-24-79	401 (12.6)
12-1-79	< 4.24
12-9-79	< 3.12
12-15-79	< 3.95
12-26-79	< 1.96
12-30-79	< 5.90

All concentrations are expressed in femtocuries per cubic meter of air: 1 $fCi/m^3 = 10^{-15}$ $\mu Ci/ml$.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. B.5
Gamma-ray Emitting Radionuclide Concentrations in Air (Taken from Composites of all Air Sampling Stations) (fCi/m^3).

Sample Ending Dates	^{106}Ru	^{137}Cs	^{95}Zr & Nb
7-7-79	< 1.60	< 0.356	< 0.154
7-14-79	< 4.91	< 1.09	< 0.42
7-21-79	< 4.49	< 1.01	0.839 (0.946)
7-28-79	< 4.84	< 1.09	< 0.468
8-4-79	< 4.92	< 1.00	< 0.435
8-11-79	< 5.89	< 1.32	< 0.570
8-18-79	101 (10.3)*	12.5 (1.62)	19.4 (1.04)
8-25-79	< 4.05	2.13 (0.816)	0.798 (0.351)
9-1-79	< 3.22	< 0.723	< 0.312
9-8-79	< 4.68	2.26 (0.544)	0.651 (0.489)
9-15-79	14.1 (3.25)	< 0.518	< 0.233
9-22-79	< 1.94	4.83 (0.485)	1.41 (0.381)
9-29-79	< 4.76	2.70 (0.943)	1.32 (0.700)
10-6-79	< 4.74	10.5 (0.894)	2.17 (0.649)
10-13-79	< 4.11	9.36 (0.785)	1.91 (0.525)
10-15-79	< 4.60	29.7 (1.17)	3.46 (0.707)
10-20-79	6.23 (5.75)	2.50 (0.929)	2.10 (0.553)
10-27-79	< 3.45	1.34 (0.726)	1.22 (0.398)
11-3-79	< 3.45	1.18 (0.709)	0.800 (0.359)
11-10-79	16.1 (4.63)	< 0.844	< 0.364
11-17-79	< 1.11	8.56 (0.332)	0.244 (0.151)
11-24-79	17.8 (3.75)	< 0.690	< 0.297
12-1-79	15.6 (5.46)	< 1.02	< 0.438
12-8-79	14.9 (3.92)	< 0.723	0.377 (0.315)
12-15-79	16.3 (5.08)	1.04 (0,873)	1.11 (0.405)
12-26-79	8.81 (2.61)	1.16 (0.455)	0.690 (0.186)
12-29-79	28.5 (3.05)	0.465 (542)	0.398 (0.217)

All concentrations are expressed in femtocuries per cubic meter of air: 1 fCi/m^3 = 10^{-15} µCi/ml.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

II.C.1 Radionuclide Concentrations in Surface Water

Table II.C.1 lists the gross beta activity in surface water and potable water supplies in the vicinity of the reactor. Values are given for both the suspended and dissolved solids fraction of the total water sample. The suspended solids fraction contains algae and sediment particles which have very high concentration factors for radionuclides and consequently is considerably higher than the dissolved solids fraction. These values are given for samples collected monthly. Potable water retains a negligible suspended solids fraction and consequently the gross beta values for potable water are significantly lower.

Values of gross beta concentrations in surface water fluctuated within upstream, downstream and effluent sites but the mean upstream and the mean downstream values were very similar. The mean upstream value was 15 pCi/L and the mean downstream values was 21 pCi/L. There was no significant difference between these mean values. Mean values were slightly greater than those measured during the first half of 1979. The gross beta concentrati in both potable water sources are lower but more variable than in surface water. The concentrations should be lower due to water purification which removes suspended solids and the variation is probably due to mixing of different reservoir sources.

Weekly samples, although not required by the Technical Specifications, were collected at E-38, the farm pond on the Goosequill ditch. This is the principal effluent route for liquid discharges from the reactor and a monthly sample may not be adequate to reflect periodic discharges. Gross beta concentrations are shown in Table II.C.1a. The mean concentration was 19.5 pCi/L and the standard deviation was 6.4. The mean was not significantly different from downstream or upstream values. Although the effluent has high tritium concentrations, the tritium is lost in preparation for gross beta analysis.

Table II.C.2 lists tritium in surface water and potable water supplies for each monthly collection for the second half of 1979. The mean values for Upstream, Downstream and Potable water locations for tritium are not significantly different even though there were wide variations. No reason can be given for these wide variations, particularly for the potable water supplies.

Significantly high tritium values were again observed at effluent sampling sites in the last half of 1979. (See Table II.C.4a). This is directly attributed to liquid effluent releases by Fort St. Vrain. Downstream locations did not reflect any significant increases in tritium concentration, therefore no dose commitment calculations are warranted.

The E-38 weekly grab samples have always been taken at the inlet from the ditch to the Goosequill farm pond. Beginning in early 1980 a continuous water sampler will be installed at the outlet of the farm pond. This procedure will have two distinct advantages. Since the reactor discharge is very periodic a continuous sampler will insure against missing any peak water value and sampling at the outlet will allow dilution and mixing in the pond. The outlet water concentration will be more useful in predicting resultant down stream concentrations.

Table II.C.3 and II.C.4 lists Sr-90 and Sr-89 concentrations in surface water at the same sampling locations. Table II.C.4.a lists the same radionuclides as well as tritium in reactor effluent water samples collected weekly at E-38.

The concentrations of Ru-106, Cs-137 and Zr-Nb-95 in surface and potable water are given in Table II.C.5. The same radionuclides were measured in the weekly samples collected at E-38 and this data is shown in Table II.C.5.a.

The fission product concentrations in all cases over the 6 month period were not significantly different from background and indicate, as expected, negligible release of fission product activity from the reactor by the surface water route.

Table II. C.1
Gross Beta Activity in Water for Samples Collected July 28, 1979.

	Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
	Effluent			
E 38:	Farm Pond (Goosequill)	65,600 (15,100)*	11,200 (3,830)	11.1 (2.30)
E 41:	Slough to St. Vrain Creek	336,000 (87,200)	18,000 (3,840)	14.8 (2.47)
	Downstream			
D 37:	Lower Latham Reservoir	116,000 (25,100)	57,100 (14,000)	7.74 (1.25)
D 40:	S. Platte River Below Confluence	95,600 (20,600))	9,200 (2,400)	13.8 (2.40)
D 45:	St. Vrain Creek	116,000 (25,700)	6,840 (2,060)	12.4 (2.37)
	Upstream			
U 42:	St. Vrain Creek	151,000 (43,000)	8,810 (2,190)	12.8 (2.47)
U 43:	S. Platte River	178,000 (39,200)	14,700 (3,230)	15.5 (2.44)
	Potable			
F 49:	Visitor's Center	N.A.	38,600 (10,200)	1.93 (0.509)
D 39:	Gilcrest City Water	N.A.	7,850 (2,070)	8.14 (2.15)

N.A. Not applicable.
* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.1
Gross Beta Activity in Water for Samples Collected August 25, 1979 .

	Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
	Effluent			
E 38:	Farm Pond (Goosequill)	103,000 (181,300) *	14,800 (2,920)	18.8 (2.47)
E 41:	Slough to St. Vrain Creek	134,000 (14,800)	14,300 (2,310)	27.1 (2.58)
	Downstream			
D 37:	Lower Latham Reservoir	158,000 (36,000)	10,100 (1,980)	17.3 (2.56)
D 40:	S. Platte River Below Confluence	96,300 (121,200)	11,000 (2,430)	19.8 (2.46)
D 45:	St. Vrain Creek	69,800 (11,100)	7,690 (1,930)	17.2 (2.38)
	Upstream			
U 42:	St. Vrain Creek	a	4,870 (1,660)	6.12 (2.08)
U 43:	S. Platte River	106,000 (11,700)	15,500 (3,090)	23.4 (2.44)
	Potable			
F 49:	Visitor's Center	N.A.	31,800 (7,680)	2.17 (0.522)
D 39:	Gilcrest City Water	N.A.	a	a

N.A. Not applicable.
* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

a. Sample lost prior to analysis

Table II. C.1
Gross Beta Activity in Water for Samples Collected September 22, 1979

	Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
	Effluent			
E 38:	Farm Pond (Goosequill)	70,300 (12,400)*	15,500 (2,880)	20.2 (2.46)
E 41:	Slough to St. Vrain Creek	189,000 (30,900)	14,700 (2,720)	20.7 (2.48)
	Downstream			
D 37:	Lower Latham Reservoir	137,000 (28,500)	6,830 (1,910)	13.6 (2.39)
D 40:	S. Platte River Below Confluence	103,000 (17,400)	3,130 (1,840)	11.1 (2.19)
D 45:	St. Vrain Creek	a	a	a
	Upstream			
U 42:	St. Vrain Creek	112,000 (18,000)	8,610 (2,560)	15.3 (2.29)
U 43:	S. Platte River	110,000 (17,900	10,500 (1,930)	22.2 (2.44)
	Potable			
F 49:	Visitor's Center	N.A.	37,600 (10,400)	1.84 (0.508)
D 39:	Gilcrest City Water	N.A.	11,500 (2.16)	12.5 (2.36)

N.A. Not applicable.
* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

a. Sample lost prior to analysis

Table II. C.1
Gross Beta Activity in Water for Samples Collected October 20, 1979 .

	Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
	Effluent			
E 38:	Farm Pond (Goosequill)	44,700 (4,630) *	14,100 (2,420)	30.0 (2,44)
E 41:	Slough to St. Vrain Creek	226,000 (45,000)	12,900 (2,260)	19.8 (2.57)
	Downstream			
D 37:	Lower Latham Reservoir	66,700 (9,190)	7,760 (1,810)	19.8 (2.38)
D 40:	S. Platte River Below Confluence	68,500 (9,240)	9,880 (2,340)	19.8 (2.34)
D 45:	St. Vrain Creek	63,800 (9,960)	5,500 (1,600)	16.1 (2.35)
	Upstream			
U 42:	St. Vrain Creek	304,000 (62,400	10,000 (2,050)	17.3 (2.50)
U 43:	S. Platte River	37,100 (10,600)	29,300 (3,250)	29.8 (2.94)
	Potable			
F 49:	Visitor's Center	N.A.	32,800 (7,770)	2.23 (0.528)
D 39:	Gilcrest City Water	N.A.	9,500 (1,980)	11.1 (2.31)

N.A. Not applicable.
* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.1
Gross Beta Activity in Water for Samples Collected November 17, 1979.

	Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
	Effluent			
E 38:	Farm Pond (Goosequill)	148,000 (32,800)*	14,500 (2,870)	17.2 (2.50)
E 41:	Slough to St. Vrain Creek	553,000 (109,000)	11,300 (2,440)	16.9 (2.45)
	Downstream			
D 37:	Lower Latham Reservoir	26,900 (20,200)	10,100 (2,000)	13.3 (2.68)
D 40:	S. Platte River Below Confluence	80,200 (13,200)	9,910 (2,280)	17.7 (2.40)
D 45:	St. Vrain Creek	186,000 (36,400)	1,640 (1,560)	8.42 (2.18)
	Upstream			
U 42:	St. Vrain Creek	218,000 (38,500)	<1,520	8.38 (2.13)
U 43:	S. Platte River	31,900 (2,100)	12,700 (2,540)	44.6 (2.27)
	Potable			
F 49:	Visitor's Center	N.A.	28,500 (7,150)	2.08 (0.522)
D 39:	Gilcrest City Water	N.A.	2,080 (1,580)	2.49 (1.90)

N.A. Not applicable.
* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.1
Gross Beta Activity in Water for Samples Collected December 30, 1979 .

	Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
	Effluent			
E 38:	Farm Pond ** (Goosequill)	277,000 (65,100)*	14,300 (2,600)	18.2 (2.56)
E 41:	Slough to St. Vrain Creek	269,000 (73,200)	15,000 (2,670)	17.8 (2.60)
	Downstream			
D 37:	Lower Latham Reservoir	117,000 (26,900)	8,680 (1,840)	16.3 (2.53)
D 40:	S. Platte River Below Confluence	f	f	f
D 45	St. Vrain Creek	f	f	f
	Upstream			
U 42:	St. Vrain Creek	34,200 (3,560)	9,680 (2,410)	24.4 (2.28)
U 43:	S. Platte River	46,200 (4,630)	15,800 (2,820)	29.5 (2.40)
	Potable			
F 49:	Visitor's Center	N.A.	41,400 (26,500)	2.82 (12.6)
D 39:	Gilcrest City Water	N.A.	f	f

N.A. Not applicable.
* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
** Collected 12-26-79
f Sample unavailable due to weather

Table II.C.1.[a]
Gross beta activity in effluent water, Goosequill Pond , E-38.

Third Quarter 1979

Collection Date	Suspended Solids pCi/kg*	Dissolved Solids pCi/kg*	Total Water Concentrations pCi/l
7-7-79	99,100 (20,900)*	9,940 (3,270)	7.35 (1.24)
7-14-79	84,300 (23,900)	40,700 (10,600)	11.9 (2.38)
7-21-79	110,000 (23,300)	58,100 (8,450)	22.5 (2.61)
7-28-79	65,600 (15,100)	11,200 (3,830)	11.1 (2.30)
8-4-79	49,100 (12,000)	12,900 (3,000)	14.1 (2.44)
8-11-79	42,100 (6,300)	a	9.15 (1.17)
8-18-79	35,000 (4,820)	23,500 (6,000)	18.4 (2.28)
8-25-79	103,000 (18,300)	14,800 (2,920)	18.0 (2.47)
9-1-79	58,000 (5,820)	15,000 (2,920)	25.6 (2.42)
9-22-79	70,300 (12,400)	15,500 (2,880)	20.2 (2.46)
9-29-79	71,000 (12,500)	13,500 (2,380)	20.8 (2.53)

* Uncertainties (in parentheses) are for the 95% confidence interval.

a Sample lost prior to analysis

Table II.C.1.a.
Gross beta activity in effluent water, Goosequill Pond , E-38.

Fourth Quarter, 1979

Collection Date	Suspended Solids pCi/kg*	Dissolved Solids pCi/kg*	Total Water Concentrations pCi/l
10-6-79	102,000 (18,400)*	15,900 (2,620)	21.9 (2.57)
10-13-79	116,000 (20,400)	15,200 (2,690)	20.7 (2.52)
10-20-79	44,700 (4,630)	14,100 (2.420)	30.0 (2.44)
10-27-79	138,000 (34,400)	13,100 (2,120)	20.1 (2.66)
11-3-79	47,800 (9.220)	18,700 (2.960)	22.2 (2.61)
11-10-79	55,900 (16,500)	23,300 (3,120)	23.5 (2.78)
11-17-79	148,000 (32,800)	14,500 (2,870)	17.2 (2.50)
12-9-79	834,000 (79,500)	25,100 (3,450)	35.4 (2.50)
12-15-79	66,300 (7,9[illegible])	11,800 (2,700)	22.1 (2.32)
12-26-79	277,000 (65,100)	14,300 (2,600)	18.2 (2.56)

* Uncertainties (in parentheses) are for the 95% confidence interval.

Table II. C.2
Tritium Concentrations in Surface Waters (pCi/l).

Sampling Locations	Monthly Collection Dates					
	7-25-79	8-25-79	9-22-79	10-20-79	11-17-79	12-30-79
Effluent						
E 38: Farm Pond (Goosequill)	8,080 (317)	2,570 (263)	4,060 (278)	2,830 (270)	3,960 (281)	648 ** (290)
E 41: Slough to St. Vrain Creek	<261	6,210 (298)	19,728 (405)	2,820 (266)	< 307	498 (288)
Downstream						
D 37: Lower Latham Reservoir	<261	932 (246)	448 (250)	545 (245)	688 (290)	404 (286)
D 40: S. Platte River Below Confluence	332 (244)	923 (246)	1,020 (248)	941 (247)	< 300	f
D 45: St. Vrain Creek	<261	770 (244)	a	309 (244)	< 300	f
Upstream						
U 42: St. Vrain Creek	< 261	< 265	483 (250)	642 (243)	< 300	617 (289)
U 43: S. Platte River	< 261	618 (243)	939 (247)	470 (242)	< 300	< 307
Potable						
F 49: Visitor's Center	< 261	611 (243)	419 (249)	536 (247)	< 300	303 (286)
D 39: Gilcrest City Water	< 261	a	419 (249)	512 (247)	< 300	f

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

a Sample lost prior to analysis
f Sample unavailable due to weather
** Collected 12/26/79

Table II. C.3
Strontium 90 Concentrations in Surface Waters (pCi/1).

Sampling Locations	Monthly Collection Dates					
	7-28-79	8-25-79	9-22-79	10-20-79	11-17-79	12-26-79
Effluent						
E 38: Farm Pond (Goosequill)	2.83 * (2.22)	< 1.79	2.74 (3.26)	1.24 (1.16)	3.00 (0.894)	1.03 ** (0.818)
E 41: Slough to St. Vrain Creek	3.92 (3.19)	< 1.79	< 1.90	1.64 (.980)	8.69 (0.930)	< 0.567
Downstream						
D 37: Lower Latham Reservoir	1.96 (1.20)	< 2.14	6.55 (1.10)	1.57 (1.10)	2.10 (0.693)	0.561 (0.752)
D 40: S. Platte River Below Confluence	0.725 (0.108)	< 0.899	< 2.31	1.38 (1.17)	2.93 (0.848)	f
D 45: St. Vrain Creek	1.96 (1.16)	< 1.22	a	1.81 (1.18)	2.12 (0.911)	f
Upstream						
U 42: St. Vrain Creek	2.59 (1.42)	< 2.51	2.31 (1.05)	3.21 (1.32)	4.61 (1.51)	1.06 (0.818)
U 43: S. Platte River	0.800 (1.40)	< 0.146	< 0.979	2.56 (1.00)	1.77 (1.15)	1.83 (1.09)
Potable						
F 49: Visitor's Center	3.27 (1.35)	3.99 (5.03)	< 1.23	2.08 (1.00)	0.590 (0.679)	1.59 (.905)
D 39: Gilcrest City Water	1.37 (1.42	a	a	2.31 (1.03)	< 0.773	f

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

** Collected 12-26-79
a Sample lost prior to analysis
f Sample unavailable due to weather
d Sample lost in analysis

Table II. C.4
Strontium 89 Concentrations in Surface Waters (pCi/l).

Sampling Locations	Monthly Collection Dates					
	7-28-79	8-25-79	9-22-79	10-20-79	11-17-79	12-26-79
Effluent						
E 38: Farm Pond (Goosequill)	<1.93	<1.24	< 2.14	< 0.816	< 0.868	<0.721 **
E 41: Slough to St. Vrain Creek	<2.72	<1.54	< 1.14	< 0.815	< 1.20	<0.584
Downstream						
D 37: Lower Latham Reservoir	<3.84	<1.91	< 1.52	< 1.03	< 0.737	< 0.670
D 40: S. Platte River Below Confluence	< 0.847	<1.20	< 1.81	< 1.06	< 3.16	f
D 45: St. Vrain Creek	< 0.980	<1.11	a	< 1.05	< 0.833	f
Upstream						
U 42: St. Vrain Creek	<1.23	<2.61	< 0.885	< 1.35	< 1.20	< 0.695
U 43: S. Platte River	<1.05	<1.50	< 0.764	< 0.891	< 0.838	< 0.962
Potable						
F 49: Visitor's Center	<1.18	<3.22	0.881 (3.25)*	< 0.827	< 0.586	< 0.785
D 39: Gilcrest City Water	< 0.800	a	a	< 0.905	< 0.579	f

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
** Collected 12-26-79
a Sample lost prior to analysis
f Sample unavailable due to weather

Table II.C.4.a
Tritium, Strontium 89, and Strontium 90 Concentrations in Effluent Water, Goosequill Pond, E-38.

a) Third and Fourth Quarter, 1979

Collection Date	Tritium (pCi/l)	Strontium 89 (pCi/l)	Strontium 90 (pCi/l)
7-7-79	3,690 (299)*	5.44 (7.40)	< 0.472
7-14-79	1,190 (274)	< 0.0669	1.54 (1.68)
7-21-79	a	1.77 (6.77)	< 0.352
7-28-79	8,080 (317)	< 1.93	< 2.83
8-4-79	10,500 (333)	16.8 (16.7)	< 1.14
8-11-79	36,800 (501)	< 0.884	< 0.155
8-18-79	837 (245)	2.48 (1.17)	< 0.818
8-25-79	2,570 (263)	< 1.54	< 2.60
9-1-79	775 (245	< 1.02	1.38 (1.16)
9-8-79	471 (241)	< 4.29	16.8 (7.80)
9-22-79	4,060 (278)	< 2.14	2.74 (3.26)
9-29-79	27,399 (450)	< 3.45	< 0.567
10-6-79	10,900 (340)	< 0.870	1.31 (0.889)
10-13-79	2,060 (263)	<16.77	23.9 (18.5)
10-20-79	3,830 (270)	< 0.816	1.24 (1.16)
10-27-79	32,200 (478)	< 0.609	< 0.588
11-3-79	2,130 (216)	< 0.816	1.68 (1.08)
11-10-79	1,450 (256)	< 0.801	1.72 (0.992)
11-17-79	3,960 (281)	< 0.868	3.00 (0.894)
12-9-79	1,160 (295)	1.06	2.34 (0.951)
12-15-79	833 (290)	0.985	1.52 (0.811)
12-26-79	648 (290)	0.721	1.03 (0.818)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

a Sample lost prior to analysis

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected July 28,1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	< 25,500	< 7,984	4,430 (2770) *	< 2,730	< 842	< 362	< 4.53	1.13 (1.16)	0.390 (.427)
E 41: Slough to St. Vrain Creek	< 49,500	<15,300	< 6,560	< 2,770	< 860	< 368	< 4.53	< 0.803	0.366 (0.432)
Downstream									
D 37: Lower Latham Reservoir	<41,200	17,900 (10,300	8,050 (4,500)	< 2,260	< 702	< 302	< 4.53	< 0.803	< 0.290
D 40: S. Platte River Below Confluence	<12,400	<3,870	< 1,650	< 2,130	818 (533)	< 282	< 4.53	0.990 (0.598)	< 0.290
D 45: St. Vrain Creek	< 2,190	<12,300	< 5,300	< 2,660	< 821	< 353	< 4.53	< 0.803	< 0.290
Upstream									
U 42: St. Vrain Creek	<76,500	<23,600	< 10,100	< 2,120	< 655	< 281	< 4.53	< 0.803	< 0.290
U 43: S. Platte River	<82,200	< 25,400	< 55,770	< 3,030	<935	< 441	< 4.53	< 0.803	1.83 (0.564)
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	< 39,100	12,700 (9,530)	< 5,190	< 5.86	< 0.968	< 0.350
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	< 3,730	1,290 (904)	648 (535)	< 5.05	1.15 (0.810)	0.581 (0.479)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected August 25, 1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	<14,400	<4,430	4,860 (2,340) *	<3,100	< 958	< 411	< 4.53	< 0.803	4.87 (0.315)
E 41: Slough to St. Vrain Creek	<25,900	<8,000	<3,440	<2,310	<719	< 306	< 4.53	0.879 (0.859)	< 0.290
Downstream									
D 37: Lower Latham Reservoir	<112,000	<34,800	<14,900	<2,100	< 649	< 279	< 4.53	2.05 (0.859)	< 0.290
D 40: S. Platte River Below Confluence	<20,900	14,100 (5,070)	<2,760	<2,780	< 823	<366	< 4.53	1.72 (0.821)	< 0.290
D 45: St. Vrain Creek	a	a	a	<2,530	1,080 (641)	339 (458)	<4.53	1.12 (0.611)	0.349 (0.472)
Upstream									
U 42: St. Vrain Creek	a	a	a	<2,530	1,080 (641)	339 (458)	< 4.53	1.12 (0.611)	0.349 (0.472)
U 43: S. Platte River	<21,400	20,600 (5,240)	<2,820	<3,370	2,640 (799)	< 444	< 4.53	4.16 (0.831)	< 0.290
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	<43,000	<13,300	<5,700	< 5.46	<0.968	< 0.350
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	a	a	a	a	a	a

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected September 22, 1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	< 24,900	18,800 (6,200)*	3,680 (3,000)	2,480 (592)	771 (139)	643 (119)	< 4.53	2.17 (0.594)	< 0.290
E 41: Slough to St. Vrain Creek	< 52,100	< 16,200	< 6,900	4,790 (2,850)	< 841	645 (545)	< 4.53	< 0.803	0.718 (0.885)
Downstream									
D 37: Lower Latham Reservoir	106,000 (50,100)	<15,300	< 6,440	< 2,370	2,530 (610)	1,250 (425)	5.59 (3.66)	3.11 (9.07)	1.20 (0.624)
D 40: S. Platte River Below Confluence	< 25.900	< 8,060	< 3,440	< 770	424 (254)	< 102	<4.53	<0.893 (0.507)	<0.290
D 45: St. Vrain Creek	a	a	a	a	a	a	a	a	a
Upstream									
U 42: St. Vrain Creek	< 33,600	17,100 (8,220)	< 4,460	7,330 (1,540)	1,930 (368)	978 (275)	< 4.53	2.65 (0.833)	0.862 (0.431)
U 43: S. Platte River	< 29,400	< 9,140	< 3,900	4,110 (2,770)	1,800 (673)	1,830 (545)	5.14 (4.14)	2.87 (1.09)	2.29 (0.767)
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	87,900 (61,800)	42,300 (14,900)	26,000 (11,900)	4.21 (2.96)	2.03 (0.713)	1.27 (0.569)
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	< 2,300	1,120 (580)	< 304	< 4.73	1.24 (0.646)	< 0.303

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.
a Sample lost prior to analysis

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected October 20, 1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	21,200 (3,590)*	3,510 (906)	2,580 (498)	< 2,560	< 798	573 (398)	6.97 (2.47)	1.49 (1.24)	1.24 (0.373)
E 41: Slough to St. Vrain Creek	146,000 (82,300)	<25,800	16,100 (12,100)	< 6,220	<1,940	2,610 (1,050)	< 4.53	1.33 (1.06)	1.96 (0.661)
Downstream									
D 37: Lower Latham Reservoir	54,900 (20,100)	< 6,240	4.980 (2,870)	1,430 (728)	769 (171)	360 (111)	8.12 (2.32)	1.68 (0.581)	1.08 (0.315)
D 40: S. Platte River Below Confluence	51,700 (23,500)	< 7,360	<3,120	< 2,600	< [illegible]	< 922	5.95 (3.35)	< 0.803	1.07 (0.516)
D 45: St. Vrain Creek	< 18,300	< 5,690	<2,420	9,600 (2,790)	< 829	< 352	11.3 (3.46)	< 0.803	< 0.290
Upstream									
U 42: St. Vrain Creek	430,000 (84,200)	102,000 (20,100)	23,700 (15,200)	< 2,390	6,140 (615)	1,670 (414)	< 4.53	7.74 (0.635)	2.00 (0.443)
U 43: S. Platte River	<22,400	17,100 (5,970)	5,050 (4,260)	4,130 (2,990)	3,130 (756)	2,030 (489)	< 4.53	4.07 (0.791)	2.11 (0.545)
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	135,000 (36,300)	<10,700	< 4,540	11.5 (3.07)	< 0.968	< 0.350
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	4,450 (2,300)	3,700 (588)	1,900 (374)	5.23 (2.70)	4.34 (0.691)	2.24 (0.440)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected November 17, 1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	<63,600	<19,800	<8,440	3,110* (2,780)	877 (715)	693 (362)	< 4.53	1.24 (0.843)	0.807 (0.449)
E 41: Slough to St. Vrain Creek	101,000 (23,900)	<7,210	10,700 (3,870)	61,300 (20,700)	< 6,330	2,780 (3,530)	16.4 (3.14)	< 0.803	3.08 (2.76)
Downstream									
D 37: Lower Latham Reservoir	144,000 (49,500)	<45,600	<6,630	6,170 (2,080)	<652	< 277	14.4 (3.47)	< 0.803	< 0.290
D 40: S. Platte River Below Confluence	<1,180	< 367	174 (208)	13,600 (3,520)	< 1,080	1,740 (604)	< 4.53	<< 0.803	1.45 (0.209)
D 45: St. Vrain Creek	<33,200	<10,300	< 4,360	< 2.290	< 755	522 (410)	< 4.53	0.804 (0.658)	1.60 (0.421)
Upstream									
U 42: St. Vrain Creek	<29,100	<9,070	9,460 (4,900)	<586	679 (196)	< 77.7	< 4.53	1.01 (0.374)	< 0.290
U 43: S. Platte River	<64,400	30,50) (21,200)	12,500 (11,800)	4,940 (2,410)	< 755	< 321	6.04 (2.26)	0.920 (0.868)	0.614 (0.585)
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	78,600 (17,900)	<4,960	< 2,110	7.12 (1.62)	< 1.07	< 0.389
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	6,740 (1,010)	< 244	324 (173)	8.06 (1.21)	< 0.993	0.388 (0.207)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected December 26, 1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	269,000* (48,300)	< 11,400	6,720 (6,600)	< 2,750	< 898	< 381	< 4.53	< 0.803	0.301 (0.322)
E 41: Slough to St. Vrain Creek	259,000 (86,600)	< 29,000	< 12,200	8,840 (2,760)	< 915	< 389	13.8 (3.45)	< 0.803	< 0.290
Downstream									
D 37: Lower Latham Reservoir	188,000 (57,500)	< 19,000	< 8,100	7,720 (2,520)	< 831	< 353	16.7 (3.75)	< 0.803	< 0.290
D 40: S. Platte River Below Confluence	f	f	f	f	f	f	f	f	f
D 45: St. Vrain Creek	f	f	f	f	f	f	f	f	f
Upstream									
U 42: St. Vrain Creek	< 54,500	< 17,400	< 7,290	5,900 (2,520)	< 823	< 349	5.00 (3,26)	< 0.803	< 0.290
U 43: S. Platte River	16,800 (6,860)	< 2,250	< 957	< 2,530	< 828	< 351	< 4.53	< 0.803	< 0.290
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	34,100 (13,600)	<4,540	< 1,930	10.6 (4.24)	< 0.803	< 0.290
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	f	f	f	f	f	f

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

f Sample unavailable due to weather

Table II.C.5.a
Gamma-ray Emitting Radionuclide Concentrations in Effluent Water, Goosequill Pond , E-38.

Collection Date	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
7-7-79	13,500 (10,300) *	9,100 (2,640)	3,800 (1,390)	<3,360	< 1,040	< 445	< 4.53	< 0.803	< 0.190
7-14-79	< 33,600	42,400 (8,760)	14,400 (4,170)	< 2,800	< 864	< 371	<4.53	3.12 (0.885)	1.05 (0.531)
7-21-79	<19,400	6,400 (5,100)	< 2,570	< 4,830	<1,500	< 639	< 4.53	< 0.803	< 0.290
7-28-79	<25,500	< 7,954	4,430 (2,770)	< 2,730	< 842	< 362	< 4.53	1.13 (1.16)	0.390 (0.427)
8-4-79	<12,100	<3,740	1,710 (1,750)	<2,690	< 832	< 357	< 4.53	0.892 (0.791)	< 0.290
8-11-79	<9,670	4,820 (2,410)	< 4,280	<1,270	840 (422)	<168	< 4.53	1.58 (0.300)	< 0.290
8-18-79	<1,220	< 375	< 161	< 5,020	< 1,550	1,870 (644)	< 4.53	< 0.803	< 0.290
8-25-79	<14,400	<4,430	4,860 (2,340)	< 3,100	< 958	< 411	< 4.53	< 0.803	4.87 (0.315)
9-1-79	<8,570	< 2,680	< 1,140	< 3,100	1,070 (785)	469 (406)	< 4.53	1.03 (0.845)	0.388 (0.450)
9-8-79	<6,130	<1,910	< 814	15,100 (2,920)	< 931	< 417	< 4.53	< 4.53	< 4.53

* Concentrations (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II.C.5.[a]
Gamma-ray Emitting Radionuclide Concentrations in Effluent Water, Goosequill Pond , E-38.

Collection Date	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
9-22-79	<24,900	18,800 (6,200)	3,680 (3,000)	2,480 (592)	771 (139)	643 (119)	< 4.53	2.17 (0.594)	< 0.290
9-29-79	<20,700	<6,440	< 2,750	<3,200	6,300 (762)	1,500 (631)	< 4.53	5.80 (0.803)	1.89 (0.603)
10-6-79	<31,700	<9,860	< 4,200	< 819	520 (273)	914 (204)	< 4.53	< 0.803	0.303 (0.356)
10-13-79	<12,100	11,800 (4,150)	3,870 (2,320)	< 2,840	1,150 (712)	< 377	< 4.53	1.68 (0.636)	< 0.290
10-20-79	21,200 (3,590)	3,510 (906)	2,580 (498)	< 2,560	< 798	573 (398)	6.97 (2.47)	1.49 (1.24)	1.24 (0.373)
10-25-79	<18,000	5,860 (6,420)	< 2,380	< 2,150	1,090 (542)	< 285	< 4.53	1.49 (0.610)	< 0.290
11-3-79	32,500 (16,500)	< 5,110	1,780 (2,170)	< 719	< 224	< 95.2	< 4.53	< 0.803	< 0.290
11-10-79	< 12,000	<3.970	<1,680	2,770 (1,130)	631 (289)	712 (152)	< 4.53	< 0.803	< 0.290
11-17-79	< 63,600	< 19,800	<8,440	3,110 (2,780)	877 (715)	693 (362)	< 4.53	1.24 (0.843)	0.807 (0.449)

* Concentrations (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II.C.5. a
Gamma ray Emitting Radionuclide Concentrations in Effluent Water, Goosequill Pond , E-38.

Collection Date	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
12-9-79	337,000 (112,000)	< 36,500	< 15,500	8,740 (3,290)	< 1,080	893 (462)	14.0 (3.54)	< 0.803	0.918 (0.484)
12-15-79	30,100 (10,400)	< 3,310	1,680 (1,570)	8,020 (2,990)	< 956	< 406	13.3 (3.39)	< 0.803	< 0.290
12-26-79	269,000 (48,300)	< 11,400	6,720 (6,600)	< 2,750	< 898	< 381	< 4.53	< 0.803	0.301 (0.322)

* Concentrations (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

II.C.2. Radionuclide Concentrations in Sediment

Sediment is the major compartment for radionuclide contaminants in fresh water system due to the high concentration factors for fission products in the sediment mineral matrices. Although the samples are always collected at the same point, it is impossible to collect a sample with a known surface area to volume ratio as for soils. The sample itself is a result of sediment movement downstream and is therefore a function of water flowrate which fluctuates greatly during the year. Table II.C.6 lists gross beta activity in sediment samples from the sampling sites in the water courses. The mean values for effluent, upstream, and downstream samples were nearly identical and were not significantly different (See Table II.H.1) and indicate that the sediments sampled are very homogeneous.

Table II.C.7 and II.C.8 list the Sr-90 and Sr-89 concentrations in the same sediment samples respectively. Table II.C.9 shows the concentration in sediment of the fission products Ru-106, Cs-137, and Zr-Nb-95. Although occasional high values appear, the mean values for these sample types (Table II.H.1) indicate no significant difference for any of the fission products in each of the sampling locations.

It should be noted that the sand fraction of the sediment samples is removed and only the silt plus clay mineral fraction is analyzed. These two particle size fractions should contain essentially all of the radioactivity, both natural and any due to reactor effluents.

Table II. C.6
Gross Beta Activity Concentrations in Bottom Sediment (pCi/kg).

	Sampling Locations	Monthly Collection Dates					
		7-14-79	8-25-79	9-22-79	10-20-79	11-17-79	12-30-79
	Effluent						
E 38:	Farm Pond (Goosequill)	31,600 (1,500) *	31,100 (1,400)	30,600 (1,430)	33,200 (1,520)	32,800 (1,500)	f
E 41:	Slough to St. Vrain Creek	34,700 (1,550)	33,400 (1,500)	36,700 (1,530)	29,900 (2,450)	34,900 (1,550)	32,800 (1,420)
	Downstream						
D 37:	Lower Latham Reservoir	29,300 (1,420)	31,100 (1,450)	27,700 (1,380)	29,700 (1,460)	31,100 (1,490)	32,800 (1,530)
D 40:	S. Platte River Below Confluence	34,600 (1,590)	32,400 (1,480)	36,900 (1,530)	38,[illegible]00 (1,620)	37,600 (1,620)	f
D 45:	St. Vrain Creek	33,000 (1,500)	31,200 (1,430)	32,600 (1,460)	30,500 (1,460)	33,000 (1,510)	f
	Upstream						
U 42:	St. Vrain Creek	26,700 (1,350)	30,400 (1,440)	23,600 (1,270)	33,000 (1,530)	29,200 (1,430)	31,100 (1,450)
U 43:	S. Platte River	33,500 (1,530)	33,600 (1,490)	38,000 (547)	36,200 (1,610)	38,300 (1,620)	35,800 (1,560)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
f Sample unavailable due to weather

Table II. C.7
Strontium 90 Activity Concentrations in Bottom Sediment (pCi/kg).

Sampling Locations	Monthly Collection Dates					
	7-14-79	8-25-79	9-22-79	10-20-79	11-17-79	12-30-79
Effluent						
E 38: Farm Pond (Coosequill)	130 (119)	277 (221)	228 (197)	931 (232)	d	f
E 41: Slough to St. Vrain Creek	< 187	< 206	394 (204)	581 (173)	449 (168)	291 (171)
Downstream						
D 37: Lower Latham Reservoir	< 145	391 (386)	< 128	197 (162)	187 (159)	337 (193)
D 40: S. Platte River Below Confluence	< 147	379 (292)	< 182	552 (171)	272 (182)	f
D 45: St. Vrain Creek	489 (858)	< 142	945 (667)	413 (179)	280 (178)	f
Upstream						
U 42: St. Vrain Creek	< 295	< 173	< 186	530 (185)	413 (201)	581 (174)
U 43: S. Platte River	< 243	194 (223)	218 (205)	776 (183)	288 (190)	347 (370)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
d Sample lost during analysis
f Sample unavailable due to weather

Table II. C.8
Strontium 89 Activity Concentrations in Bottom Sediment (pCi/kg).

Sampling Locations	Monthly Collection Dates					
	7-14-79	8-25-79	9-22-79	10-20-79	11-17-79	12-30-79
Effluent						
E 38: Farm Pond (Goosequill)	< 110	<177	< 180	< 268	d	f
E 41: Slough to St. Vrain Creek	< 104	< 144	< 185	< 205	601 (523)	< 160
Downstream						
D 37: Lower Latham Reservoir	391 (635)	< 150	< 120	< 189	1,430 (521)	826 (400)
D 40: S.Platte River Below Confluence	< 115	< 138	< 144	385 (762)	793 (574)	f
D 45: St. Vrain Creek	< 342	204 (462)	< 182	< 189	475 (557)	f
Upstream						
U 42: St. Vrain Creek	< 228	161 (598)	< 159	< 211	<199	875 (299)
U 43: S. Platte River	< 227	< 162	< 147	< 225	1,970 (602)	1,870 (822)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

d Sample lost during analysis
f sample unavailable due to weather

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected July 14,1979 .

	Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
	Effluent			
E 38:	Farm Pond (Goosequill)	< 3,760	< 655	< 235
E 41:	Slough to St. Vrain Creek	<3,760	< 655	265 (586)*
	Downstream			
D 37:	Lower Latham Reservoir	< 3,850	< 671	< 241
D 40:	S. Platte River Below Confluence	< 3,760	< 655	< 235
D 45:	St. Vrain Creek	<3,760	< 655	< 235
	Upstream			
U 42:	St. Vrain Creek	<3,760	< 691	255 (506)
U 43:	S. Platte River	<3,760	< 655	< 235

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected August 25, 1979 .

	Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
	Effluent			
E 38:	Farm Pond (Goosequill)	< 5190	< 994	< 355
E 41:	Slough to St. Vrain Creek	< 6010	< 1000	< 392
	Downstream			
D 37:	Lower Latham Reservoir	< 3740	< 716	< 256
D 40:	S. Platte River Below Confluence	< 4250	< 730	1.300 (514)*
D 45:	St. Vrain Creek	14,700 (7,020)	< 716	< 256
	Upstream			
U 42:	St. Vrain Creek	16,300 (6,980)	< 716	< 256
U 43:	S. Platte River	18,900 (6,930)	< 716	< 256

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected September 22, 1979.

	Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
	Effluent			
E 38:	Farm Pond (Goosequill)	19,900 (6,310)*	777 (838)	< 256
E 41:	Slough to St. Vrain Creek	< 4,200	1,510 (854)	337 (546)
	Downstream			
D 37:	Lower Latham Reservoir	< 4,120	< 729	262
D 40:	S. Platte River Below Confluence	< 4,120	< 729	< 262
D 45:	St. Vrain Creek	17,300 (7,160)	< 777	< 277
	Upstream			
U 42:	St. Vrain Creek	14,300 (6,700)	< 716	315 (464)
U 43:	S. Platte River	< 8,060	< 1,390	945 (856)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected October 20, 1979 .

	Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
	Effluent			
E 38:	Farm Pond (Goosequill)	< 4,800	< 826	< 297
E 41:	Slough to St. Vrain Creek	< 4,200	< 721	619 (403) *
	Downstream			
D 37:	Lower Latham Reservoir	< 7,240	< 1,250	471 (580)
D 40:	S. Platte River Below Confluence	< 4,280	< 736	< 264
D 45:	St. Vrain Creek	< 4,280	< 736	< 262
	Upstream			
U 42:	St. Vrain Creek	4,460 (6,918)	< 729	< 284
U 43:	S. Platte River	< 4,593	< 790	< 284

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected November 17, 1979 .

	Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
	Effluent			
E 38:	Farm Pond (Goosequill)	< 26,600	< 4,420	< 1,610
E 41:	Slough to St. Vrain Creek	< 6,730	< 1,120	< 408
	Downstream			
D 37:	Lower Latham Reservoir	5,210 (7,230)*	< 800	< 287
D 40:	S. Platte River Below Confluence	< 10,200	< 1,710	< 624
D 45:	St. Vrain Creek	< 4,370	867 (852)	280 (543)
	Upstream			
U 42:	St. Vrain Creek	< 4,580	811 (876)	< 278
U 43:	S. Platte River	< 6,600	< 1,100	< 402

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected December 30, 1979 .

	Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
	Effluent			
E 38:	Farm Pond (Goosequill)	f	f	f
E 41:	Slough to St. Vrain Creek	< 4,310	< 743	< 262
	Downstream			
D 37:	Lower Latham Reservoir	< 7,270	< 1,249	< 451
D 40:	S. Platte River Below Confluence	f	f	f
D 45:	St. Vrain Creek	f	f	f
	Upstream			
U 42:	St. Vrain Creek	< 4,780	< 810	< 295
U 43:	S. Platte River	< 4,330	< 734	< 268

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
f Sample unavailable due to weather.

II.C.3 Precipitation

Gross beta and tritium deposition values are given in Table II.C.10. Precipitation collectors of size sufficient to produce a significant sample are located at two locations, F-1 and F-4. Values are expressed as deposition (i.e. pCi/m^2) as only this value can be correlated to food chain transport. Studies of world-wide fallout have shown that forage and subsequent milk or meat values can be reasonably predicted from deposition values. The deposition measured is the sum of dry and precipitation deposition as the collectors are washed down each time. The tritium deposition is calculated as the product of the concentration measured in the water and the total volume. The total deposition then appeared high for this reporting period because of the large total precipitation volumes. In fact the concentrations measured were just above the MDC and less than measured for the first half of 1979. This was true although the tritium released from the reactor was greater in the second half than the first half. The explanation is that the major source of tritium has always been from world wide fallout due to weapons testing. The increment due to reactor effluents is negligible compared to weapons fallout even when the latter is decreasing. The mean deposition for the 6 month period was not statistically significant between the two sites. It should be noted that no significant differences have ever been observed for F-1 and F-4. Since these collection sites are at opposite directions from the reactor this observation supports the fact that observed deposition values are due to world-wide fallout and not to reactor effluents.

Table II.C.11 and II.C.12 list the precipitation deposition of Ru-106, Cs-137 and Zr-Nb-95. The mean values at F-1 and F-4 were not significantly different although there was a noticeable increase in the deposition at both sites during the last quarter of the year. This was not observed for tritium or the strontium radicisotopes.

Note that radioruthenium data is listed in the tables at Ru-106. However, it is true that the activity measured is often a mixture of Ru-103 and Ru-106. Both isotopes have gamma-rays at essentially the same energy and they cannot be separated by NaI(Tl) spectral analysis. No separation by half-life determination was attempted on the data. Since the half-life of Ru-103 is 40 days and that of Ru-106 is one year, in periods soon after an atmospheric test, a high proportion is expected to be Ru-103 and at later times predominately Ru-106. Since the ruthenium isotopes have negligible biological availability, neither has any consequences in calculation of population dose and efforts to separate them is not warranted.

Table II.C.13 lists the deposition of the strontium radioisotopes. There were no significant differences in Sr-90 between the mean values for F-1 and F-4 locations.

Table II. C.10
Gross Beta and Tritium Deposition from Precipitation at Locations F1 and F4.

Sample Ending Dates	Cumulative Volume * (liters)		Gross Beta Deposition (pCi/m^2)						Tritium Deposition (pCi/m^2)	
			Suspended Solids		Dissolved Solids		Total			
	F1	F4	F1	F4	F1	F4	F1	F4	F1	F4
8-11-79	50	50	32.4 (11.2)**	40.2 (13.8)	45.9 (6.18)	16.5 (5.80)	78.3 (12.3)	56.7 13.9)	3,840 (2,751)	3,090 ((2,570)
8-18-79	100	100	112 (17.0)	54.1 (19.4)	33.6 (7.06)	36.4 (8.35)	146 (16.0)	93.5 (19.7)	4,150 (3,860)	4,650 (3,620)
9-29-79	50	50	262 (18.7)	47.7 (14.0)	38.3 (5.98)	50.2 (7.46)	300 (17.5)	97.9 (15.2)	3,013 (2,790)	3,500 (2,630)
12-1-79 ***	50	50	12.3	g	4.92	g	4.92	g	< 3,432	g

* Samples are analyzed at the end of each month if sufficient volume has accumulated.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
*** December sample includes precipitation from October and November
g Analysis in progress

Table II. C.11
Gamma-ray Emitting Radionuclide Deposition from Precipitation at Location F1.

Sample Ending Dates	Total* Volume (liters)	Suspended Solids (pCi/m^2)			Dissolved Solids (pCi/m^2)			Total (pCi/m^2)		
		^{106}Ru	^{137}Cs	^{95}Zr-Nb	^{106}Ru	^{137}Cs	^{95}Zr-Nb	^{106}Ru	^{137}Cs	^{95}Zr-Nb
8-11-79	50	<25.0	< 7.71	<5.34	< 32.2	< 9.93	< 4.27	< 25.0	< 7.71	< 4.27
8-18-79	100	<-24.8	< 21.6	< 3.30	< 11.7	< 36.8	< 15.2	< 10.6	< 58.4	< 16.6
9-29-79	50	55.1 (11.9)	13.4 (2.84)	7.44 (2.02)	116 (36.0)	17.2 (8.70)	13.5 (6.31)	171 (33.9)	30.6 (3.16)	20.9 (5.89)
12-1-79 ***	50	49.9 (25.1)	9.55 (6.47)	<3.39	107 (13.7)	< 3.25	4.79 (2.00)	157 (4.94)	6.69 (7.07)	5.61 (3.88)

* Samples are analyzed at the end of each month if sufficient volume has accumulated.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
*** December sample includes precipitation from October and November

Table II. C.12
Gamma-ray Emitting Radionuclide Deposition from Precipitation at Location F4.

Sample Ending Dates	Total* Volume (liters)	Suspended Solids (pCi/m^2)			Dissolved Solids (pCi/m^2)			Total (pCi/m^2)		
		^{106}Ru	^{137}Cs	^{95}Zr-Nb	^{106}Ru	^{137}Cs	^{95}Zr-Nb	^{106}Ru	^{137}Cs	^{95}Zr-Nb
8-11-79	50	<25.2	12.9 (6.29)	< 3.45	a	a	a	< 25.2	12.9 (6.29)	< 3.45
8-18-79	100	<23.6	26.5 (8.22)	< 23.13	< 30.2	32.7 (10.4)	< 4	< 23.6	59.2 (13.2)	< 3.13
9-29-79	50	104 (10.0)	37.3 (2.45)	36.1 (1.60)	102 (31.3)	24.9 (7.74)	8.97 (5.53)	206 (29.2)	62.2 (7.21)	61.0 (6.26)
12-1-79 ***	50	g	g	g	g	g	g	g	g	g

* Samples are analyzed at the end of each month if sufficient volume has accumulated.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
*** December sample includes precipitation from October and November

a Sample lost prior to analysis
g Analysis in progress

Table II. C.13
Radiostrontium Deposition from Precipitation at Locations F1 and F4 (pCi/m^2).

Sample Ending Dates	Cumulative Volume (liters) *		Strontium 89		Strontium 90	
	F1	F4	F1	F4	F1	F4
8-11-79	50	50	< 8.82	< 10.1	11.1 (18.2)	29.3 (27.0)
8-18-79	100	100	< 9.23	< 7.91	17.9 (12.5)	25.3 (18.8)
9-29-79	50	50	< 7.15	< 10.6	14.8 (11.4)	16.3 (12.3)
12-1-79 ***	50	50	< 9.32	g	23.2 (11.3)	g

* Samples are analyzed at the end of each month if sufficient volume has accumulated.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
*** December sample includes precipitation from October and November.

g Analysis in progress

II.D. Food Chain Data

1. Milk. Tritium concentrations in milk are summarized in Table II.D.1. There was no significant difference in mean tritium values in water extracted from milk at the only dairy in the Facility area (F-44) and the Adjacent Composite and the Reference Composite mean values for the last half of 1979 (see also Table II.H.1). Tritium mean values for Facility, Adjacent and Reference sites were 424, 450 and 497 pCi/l respectively and were similar to values observed the first half of 1979. Tritium concentrations in milk should respond rapidly to changes in tritium concentrations of the water intake to the cow due to the short biological half-life for water in the cow (about three days for the lactating cow). As noted in previous reports, tritium activity per liter reflects the tritium in the water extracted from the milk and not the activity per liter of milk. Whole milk is approximately 87% water (±3-4%, depending on the cow breed, pasture, and feed). Skim milk accordingly has a higher water content. It may be assumed though that the remaining solids in milk (proteins, carbohydrates, and lipids) also contain some tritium due to exchange of tritium with hydrogen on these large molecular structures. This tritium concentration will be very much lower than in the water fraction and is not significant.

Tables II.D.2 and II.D.3 list the Sr-90 and Sr-89 concentrations in milk. There was no significant difference between the three sampling zones. As expected the mean value for Sr-89 was less than the MDC.

The concentrations of I-131, Cs-137 and K-nat in milk are given in Table II.D.4. Although there is some relationship between measured I-131 and Cs-137 concentrations in milk and those in air (Table II.B.4), the correlation is low due to feeding practices discussed below. K-nat, as

measured by K-40 is very constant in milk. The mean literature value is 1.5 g/L. K-nat is measured and reported therefore only as a quality control measure of Cs-137 and I-131 measured in the same sample by gamma-ray spectrometry.

Although high values for I-131 and Cs-137 were observed for the 9-22-79 collection period, the values were high for all three sampling zones. No explanation can be given for these values.

Due to the availability of a large NaI(Tl) scintillation crystal, shield and pulse height analyzer that has been dedicated to only counting project milk samples. we have lowered our MDC for I-131. A counting time of 3000 minutes per sample with a slight reduction in background has achieved a MDC value of approximately 0.6 pCi/L. This is preferable to any chemical concentration process and nearly all milk sample data reported here were for 3000 minutes counting time.

It should be noted here that a close relationship between forage deposition and milk concentrations should be expected for the strontium radioisotopes, for Cs-137 and for I-131 only if the cows are on pasture or fed green cut grass or alfalfa. This unfortunately is not the general feeding practice at the dairies around the reactor. Nearly all cattle feed is hay grown either locally, from Nebraska or the North Park region of Colorado. It can at times be even cuttings from the previous year. This makes correlation of milk concentrations very difficult. On the other hand, if elevated I-131 or tritium concentrations are noted, the surface deposition must have been reasonably related in time and location.

Table II. D.1
Tritium Concentrations in Water Extracted from Milk (pCi/l).

Sample Ending Dates, 197 9	Facility Area 44	Adjacent Composite *	Reference Composite *
Pasture Season			
July 7	< 283	1,220 (274)**	382 (265)
July 14	1,080 (273)	845 (270)	675 (269)
July 21	858 (271)	502 (267)	502 (267)
July 28	836 (270)	< 283	588 (268)
Aug. 9	842 (270)	614 (269)	349 (265)
Aug. 11	796 (245)	684 (243)	484 (241)
Aug. 18	721 (244)	923 (246)	752 (244)
Aug. 25	358 (240)	484 (241)	508 (241)
Sept. 1	325 (246)	< 265	967 (246)
Sept. 8	277 (280)	662 (282)	547 (251)
Sept. 15	f	336 (280)	539 (282)
Sept. 22	245 (280)	334 (281)	539 (282)
Sept. 29	692 (243)	< 300	< 300
Post Pasture Season			
Oct. 6	< 300 ***	< 300	< 300
Nov. 13	< 300	308 (280)	559 (289)
Dec. 9	408 (287) ***	< 307	310 (286)

* Adjacent Composite Locations: A6, A28, A31, A50, A 36, A48.
Reference Composite Locations: R16, R17, R20, R22, R23, R25.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

*** Collected October 4 and December 10

f Sample unavailable

Table II. D.2
Strontium 90 Activity in Milk (pCi/l).

Sample Ending Dates, 1979	Facility Area 44	Adjacent Composite *	Reference Composite *
Pasture Season			
July 7	4.62 (1.35)**	4.55 (1.21)	2.18 (1.20)
July 14	4.90 (1.75)	d	5.52 (2.67)
July 21	5.36 (4.83)	6.88 (4.08)	< 6.13
July 28	15.5 (11.5)	16.9 (9.27)	7.31 (3.07)
August 4	3.46 (2.30)	8.38 (3.94)	5.24 (2.00)
August 11	1.59 (.955)	2.27 (1.52)	3.65 (2.58)
August 18	11.9 (4.27)	14.7 (6.22)	18.5 (8.11)
August 25	13.8 (7.99)	5.12 (4.02)	< 3.04
Sept. 1	< 8.70	4.17 (1.70)	17.0 (12.0)
Sept. 8	4.41 (1.84)	2.06 (1.50)	1.77 (0.888)
Sept 15	f	33.0 (23.7)	1.94 (1.05)
Sept 22	14.9 (12.1)	2.37 (1.41)	12.0 (10.9)
Sept 29	2.44 (1.75)	3.29 (2.03)	3.83 (2.27)
Post Pasture			
Oct. 6	*** 2.86 (0951)	2.82 (1.10)	3.30 (1.00)
Nov. 3	4.00 (1.01)	4.09 (1.10)	3.59 (1.23)
Dec . 9	*** 5.31 (1.10)	3.30 (1.11)	4.67 (1.17)

* Adjacent Composite Locations: A6, A28, A31, A50, A36, A48.
Reference Composite Locations: R16, R17, R20, R22, R23, R25.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
*** Collected 10/4/79 12/10/79
d Sample lost during analysis
f Sample unavailable

Table II. D.3
Strontium 89 Activity in Milk (pCi/l).

Sample Ending Dates, 1979	Facility Area 44	Adjacent Composite *	Reference Composite *
Pasture Season			
July 7	< 1.11	< 1.02	< 0.907
July 14	< 1.30	d	< 1.77
July 21	< 2.67	< 2.49	< 2.37
July 28	< 6.85	< 5.32	< 1.28
August 4	< 1.34	< 2.23	< 1.88
August 11	<0. 816	< 1.03	< 1.47
August 18	< 4.37	< 5.39	< 0.145
August 25	< 6.19	< 3.40	< 2.59
Sept. 1	< 8.52	< 1.56	< 9.53
Sept. 8	< 2.30	< 1.02	< 0.8??
Sept. 15	f	<3.82	< 0,741
Sept. 22	< 7.49	< 1.28	< 7.27
Sept. 29	<1.69	< 1.51	< 1.64
Post Pasture			
Oct. 6 ***	< 0.970	< 0.964	< 1.12
Nov. 3	< 0.779	< 1.118	< 1.13
Dec. 9	< 1.00	<1.03	< 1.28

* Adjacent Composite Locations: A6, A28, A31, A50, A36, A48.
Reference Composite Locations: R16, R17, R20, R22, R23, R25.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
*** Collected 10/4/79 12/10/79
f Sample unavailable
d Sample lost during analysis

Table II. D.4
Gamma-ray Emitting Radionuclide Concentrations in Composite Milk Samples.

Samples Collected	Area *	^{131}I (pCi/1)	^{137}Cs (pCi/1)	Nat. K (g/1)
7-7-79	Facility	11.4 (1.58) **	6.82 (1.13)	1.54 (0.0177)
	Adjacent	8.95 (1.43)	5.24 (0.933)	1.54 (0.0138)
	Reference	2.32 (2.05)	0.624 (1.03)	1.48 (0.016)
7-14-79	Facility	1.08 (1.16)	2.98 (0.823)	1.50 (0.0116)
	Adjacent	8.58 (1.42)	6.26 (1.02)	1.64 (0.0157)
	Reference	11.3 (1.52)	5.92 (0.835)	1.50 (0.0117)
7-21-79	Facility	<0.151	< 0.142	1.51 (0.014)
	Adjacent	14.2 (1.54)	6.17 (0.840)	1.64 (0.0120)
	Reference	< 0.104	< 0.104	1.27 (0.0116)
7-28-79	Facility	5.45 (1.07)	4.49 (0.826)	1.57 (0.0117)
	Adjacent	6.42 (1.49)	5.42 (0.802)	1.40 (0.116)
	Reference	2.82 (1.82)	4.36 (0.915)	1.49 (0.0137)
8-4-79	Facility	< 0.124	< 0.115	1.41 (0.014)
	Adjacent	< 0.106	2.75 (0.792)	1.34 (0.0111)
	Reference	< 0.103	< 0.102	1.49 (0.0111)
8-11-79	Facility	11.2 (1.45)	8.38 (0.784)	0.702 (0.0102)
	Adjacent	< 0.114	1.62 (0.903)	1.68 (0.0123)
	Reference	1.28 (1.40)	3.29 (0.908)	1.39 (0.0135)
8-18-79	Facility	< 0.104	< 0.104	1.36 (0.0115)
	Adjacent	< 0.124	< 0.117	1.59 (0.0121)
	Reference	4.25 (1.54)	< 0.104	1.06 (0.0111)
8-25-79	Facility	4.16 (1.30)	5.07 (0.844)	0.966 (0.0111)
	Adjacent	< 0.149	< 0.140	2.18 (0.0144)
	Reference	< 0.114	1.81 (0.107)	1.54 (0.0116)
9-1-79	Facility	2.68 (1.01)	3.21 (0.850)	1.49 (0.0117)
	Adjacent	< 0.0989	< 0.0928	1.89 (0.0111)
	Reference	< 0.0899	4.00 (0.817)	1.37 (0.0109)

* Adjacent Composite Locations: A6, A28, A31, A50, A36, A48.
Reference Composite Locations: R16, R17, R20, R22, R23, R25.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.4
Gamma-ray Emitting Radionuclide Concentrations in Composite Milk Samples.

Samples Collected	Area *	^{131}I (pCi/l)	^{137}Cs (pCi/l)	Nat. K (g/l)
9-8-79	Facility	<0.104	<0.104	1.23 (0.0114)**
	Adjacent	< 0.140	< 0.131	1.72 (0.0131)
	Reference	< 0.167	< 0.151	1.61 (0.0145)
9-15-79	Facility	f	f	f
	Adjacent	< 1.103	< 0.103	1.43 (0.012)
	Reference	0.235 (1.53)	1.40 (0.906)	1.28 (0.012)
9-22-79	Facility	46.6 (1.98)	3.76 (0.895)	1.62 (0.120)
	Adjacent	51.1 (2.86)	2.49 (1.08)	1.86 (0.0165)
	Reference	50.8 (2.15)	3.76 (0.895)	1.61 (0.0120)
9-29-79	Facility	57.9 (1.96)	15.9 (1.24)	0.897 (0.0153)
	Adjacent	< 0.112	< 0.112	1.60 (0.0145)
	Reference	d	d	d
10-6-79 ***	Facility	< 0.108	21.5 (1.15)	1.43 (0.0142)
	Adjacent	< 0.108	< 0.107	1.54 (0.0143)
	Reference	d	d	d
11-13-79	Facility	< 0.117	< 0.113	1.41 (0.0134)
	Adjacent	< 0.114	< 0.110	1.56 (0.134)
	Reference	< 0.121	< 0.118	1.44 (0.136)
12-9-79 ***	Facility	0.679 (1.23)	0.294 (0.874)	1.59 (0.0128)
	Adjacent	1.63 (1.49)	< 0.124	1.54 (0.0132)
	Reference	20.9 (2.81)	4.31 (8.43)	1.42 (0.0118)

* Adjacent Composite Locations: A6, A28, A31, A50, A36, A48.
* Reference Composite Locations: R16, R17, R20, R22, R23, R25.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
*** Facility milk collected 10-4-79 and 12-10-79.
d Sample lost during analysis.
f Sample unavailable.

II.D. Food Chain Data

2. Forage. Table II.D.5 lists the tritium specific activity in water extracted from forage samples as well as Sr-89 and Sr-90 concentrations in the forage dry matter. Tritium values that were obtained were similar to those reported in past reports. There were no significant differences in mean tritium values between Facility, Adjacent and Reference locations. The tritium in forage water was statistically the same as the concentration in milk.

Table II.D.6 lists Ru-106, Cs-137 and Zr-Nb-95 activities in forage samples for the second half of 1979.

Gross beta concentrations in soil and forage collected at the same locations are given in Table II.D.7.

From Table II.H.1 it is observed that mean values for all radionuclides in each sample type are very close to those measured in the first half of 1979.

Cattle forage samples, i.e. fresh cut grass or alfalfa hay is the sample of choice for several reasons. Forage integrates atmospheric wet and dry deposition over a large surface area per unit weight and also is a direct link in the dairy and beef food chain transport of H-3, Cs-137, and the strontium radioisotopes. Such samples are collected when possible. However, due to feeding practices, vagaries of weather and other factors, often silage or cut hay samples must be collected. These samples may or may not be harvested locally and may represent different fallout periods. This often presents difficulties in data interpretation.

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in Forage for Samples Collected July 21, 1979.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4 +	744 (273)*	< 22.1	109 (26.2)
44 +	681 (272)	167 (124)	226 (42.5)
Adjacent			
6 +	736 (273)	167 (124)	226 (42.5)
28 +	799 (274)	<14.5	98.6 (13.1)
31 +	426 (270)	<32.0	179 (29.6)
36 +	813 (274)	<24.7	241 (18.5)
48 +	695 (273)	<16.2	61.3 (17.1)
50 +	772 (273)	<85.3	283 (90.9)
Reference			
16 +	647 (272)	<23.9	212 (15.4)
17 +	600 (272)	<20.3	254 (18.0)
20 +	669 (272)	<26.5	16.7 (28.6)
22 +	564 (271)	<26.7	225 (22.8)
23 +	695 (273)	<52.7	237 (55.3)
25 +	1,167 (278)	<39.1	92.0 (46.5)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
+ Silage or dry hay

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in Forage for Samples Collected August 18, 1979.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4 +	e	< 25.7	93.6 (32.7) *
44 +	e	< 28.5	213 (27.9)
Adjacent			
6 +	e	< 15.1	114 (16.0)
28 +	e	< 36.8	163 (16.8)
31 +	< 256	< 30.0	92.6 (32.9)
36 +	e	< 25.5	83.2 (32.')
48 +	< 256	< 24.3	92.0 (22.8)
50 +	< 256	< 26.9	33.0 (325)
Reference			
16 +	< 256	< 24.3	189 (23.8)
17 +	3,230 (270)	< 30.9	236 (36.9)
20 +	e	< 23.8	123 (25.8)
22 +	853 (246)	< 22.4	277 (210)
23 +	e	< 18.0	158 (172)
25 +	e	< 15.5	231 (31.8)

+ Silage or dry hay.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

e Insufficient volume for analysis

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in Forage for Samples Collected September 29, 1979.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4 +	e	< 87.8	320 (43.4)
44 +	e	< 12.6	188 (11.1)
Adjacent			
6 +	e	< 20.1	166 (132)
28 +	e	< 12.9	135 (10.8)
31 +	660 (289)	< 15.2	129 (11.6)
36 +	e	< 26.0	280 (18.5)
48 +	e	< 12.1	103 (12.5)
50 +	e	< 12.5	21.8 (15.3)
Reference			
16 +	536 (189)	< 14.0	91.1 (14.9)
17 +	e	745 (1,870)	119 (11.2)
20 +	e	< 22.3	227 (16.6)
22 +	e	< 19.4	163 (13.6)
23 +	e	< 19.6	119 (15.0)
25 +	<169	< 208	183 (21.3)

+Silage or dry hay.
*Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
e Insufficient volume for analysis

Table II. D.6
Gamma-ray Emitting Radionuclide Concentrations in Forage (pCi/kg) for Samples Collected July 21,1979.

Areas	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4 +	< 55.9	106 (17.7) *	54.5 (19.7)
44 +	85.8 (54.7)	72.4 (12.2)	53.7 (15.1)
Adjacent			
6 +	< 56.7	65.6 (16.4)	44.2 (18.5)
28 +	< 43.6	154 (13.8)	57.2 (15.9)
31 +	< 41.0	57.4 (12.5)	62.8 (14.9)
36 +	187 (30.6)	294 (7.27)	84.3 (8.52)
48 +	186 (61.6)	68.4 (14.0)	62.6 (17.7)
50 +	249 (22.8)	53.3 (5.22)	44.8 (5.49)
Reference			
16 +	<69.0	118 (14.1)	60.5 (15.5)
17 +	<19.7	116 (7.42)	26.9 (8.45)
20 +	<63.0	94.3 (18.8)	51.3 (17.1)
22 +	< 42.7	60.5 (12.4)	26.1 (14.0)
23 +	< 65.1	88.1 (18.8)	60.9 (21.5)
25 +	<34.1	43.2 (10.1)	36.2 (11.6)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
+ Silage or dry hay

Table II. D.6
Gamma-ray Emitting Radionuclide Concentrations in Forage (pCi/kg) for Samples Collected August 18,1979.

Areas	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4 +	< 22.7	85.8 (8.41) *	34.3 (7.64)
44 +	< 56.3	< 17.8	< 7.49
Adjacent			
6 +	< 59.4	58.2 (16.4)	28.6 (14.6)
28 +	< 59.7	57.7 (17.1)	20.7 (16.4)
31 +	< 74.7	< 23.6	< 9.94
36 +	< 77.2	32.6 (21.3)	24.9 (20.7)
48 +	165 (33.7)	111 (7.99)	90.2 (7.78)
50 +	< 36.1	81.5 (10.9)	62.4 (9.73)
Reference			
16 +	72.7 (61.8)	132 (15.2)	57.9 (13.1)
17 +	< 44.2	110 (13.2)	49.4 (11.4)
20 +	< 63.0	94.3 (18.8)	51.3 (17.1)
22 +	71.8 (53.7)	106 (12.7)	132 (12.3)
23 +	< 37.9	83.2 (15.3)	53.4 (14.6)
25 +	< 57.7	< 18.2	26.3 (15.8)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

+Silage or dry hay

Table II. D.6
Gamma-ray Emitting Radionuclide Concentrations in Forage (pCi/kg) for Samples Collected September 29, 1979.

Areas	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4 +	420 (109) *	118 (25.2)	179 (32.8)
44 +	79.1 (40.7)	< 10.3	22.1 (12.9)
Adjacent			
6 +	272 (80.6)	< 21.4	32.6 (23.7)
28 +	282 (94.7)	< 24.7	67.3 (28.3)
31 +	92.9 (91.2)	< 24.0	52.0 (26.1)
36 +	217 (67.3)	284 (17.3)	84.0 (21.8)
48 +	< 97.8	< 31.8	23.9 (33.9)
50 +	126 (30.9)	< 6.06	16.9 (8.89)
Reference			
16 +	189 (76.0)	< 19.9	46.4 (21.6)
17 +	176 (92.7)	< 24.5	111 (26.4)
20 +	212 (68.0)	< 16.3	< 6.85
22 +	171 (85.5)	< 22.0	< 9.24
23 +	176 (62.6)	< 15.3	39.6 (17.8)
25 +	291 (95.0)	39.2 (21.9)	43.9 (28.2)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

+ Silage or dry hay

Table II. D.7
Gross Beta Concentrations in Soil and Forage (pCi/kg) for Samples Collected Third Quarter, 1979.

Sampling Location	July **		August **		Setember **	
	Soil	Forage	Soil	Forage	Soil	Forage
Facility						
4	30,800 (1,500)*	32,200 (543)	34,100 (1,490)	15,400 (364)	31,400 (1,440)	32,300 (724)
44	28,200 (1,460)	22,800 (432)	30,200 (1,430)	22,800 (408)	31,500 (1,540)	35,700 (773)
Adjacent						
6	27,000 (1,340)	18,800 (339)	30,400 (1,440)	15,900 (346)	25,700 (1,340)	18,800 (317)
28	24,700 (1,260)	16,800 (282)	27,100 (1,360)	20,700 (394)	26,400 (1,410)	21,400 (358)
31	25,900 (1,400)	11,600 (247)	30,100 (1,400)	15,900 (318)	27,200 (1,400)	20,800 (368)
36	27,300 (1,400)	30,800 (528)	24,500 (1,300)	18,700 (391)	24,800 (1,270)	18,000 (419)
48	31,900 (1,530)	12,900 (296)	30,800 (1,430)	22,800 (408)	30,800 (1,490)	26,700 (427)
50	26,400 (1,400)	15,600 (308)	28,000 (1,370)	17,600 (371)	28,200 (1,340)	27,000 (432)
Reference						
16	20,700 (1,210)	19,100 (364)	23,700 (1,300)	18,000 (390)	23,000 (1,240)	16,400 (307)
17	21,800 (1,280)	19,500 (387)	20,500 (1,200)	16.200 (364)	18,800 (1,190)	20,800 (352)
20	28,100 (1,380)	22,900 (394)	29,500 (1,400)	29,800 (536)	30,500 (1460)	16,900 (316)
22	29,300 (1,430	20,900 (400)	23,200 (1,280)	27,500 (473)	29,700 (1,370)	25,200 (385)
23	23,100 (1,310)	21,900 (400)	27,500 (1,370)	16,000 (472)	28,200 (1,430)	24,700 (417)
25	24,700 (1,360)	20,800 (358)	23,500 (1.290)	18,300 (346)	25,700 (1,390)	25,900 (425)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
** Forage collected 7/21/79, 8/18/79, 9/29/79
Soil Collected 7/14/79, 8/28/79, and 9/29/79

II.D. Food Chain Data

3. Soil. Table II.D.8 presents gross beta activity of soil per unit surface area for the third and fourth quarter of 1979.

Soil samples are collected at the same time and location as forage samples. A core borer is used to collect the sample. The sample depth is 10.3 cm and the area is 102 cm^2. Gross soil density is approximately 1 g/cm^3.

There was no significant difference in the gross beta activity values between the Facility, Adjacent and Reference collection areas. The gross beta concentrations are extremely constant because the measured activity is due primarily to naturally occurring radionuclides.

The activities of the fission products Ru-106, Cs-137 and Zr-Nb-95 per unit surface area are given in Table II.D.9 for the same period. This analysis is performed by Ge(Li) spectrometry due to the predominant concentration of the naturally occurring radionuclides. Essentially only Cs-137 can be measured in the local soil. This is because the recent deposition of Ru-106 and Zr-Nb-95, the short-lived fission products, is minimal compared to the past deposition of Cs-137. Cs-137 has a half-life of 30 years and is trapped by ion exchange in the top 2-3 cm of soils with clay minerals. For this reason soils that are disturbed or turned over for agricultural purposes will have widely varying Cs-137 concentrations. Most of the soil sampling sites in the surveillance program fall in the latter category.

Tritium, Sr-89 and Sr-90 in soil are shown in Table II.D.10. Tritium specific activity in soil is statistically the same as that in other environmental samples, e.g. water, forage and milk. The concentrations of the strontium radioisotopes was quite variable. Sr-89 was essentially zero and the mean concentration of Sr-90 was 243,340 and 382pCi/kg for the Facility, Adjacent and Reference zones respectively. These mean values are not significantly different.

The numbers given in parentheses next to all values above the minimum detectable concentration are the 95% confidence intervals for each measured value. This number is calculated solely on the basis of counting statistics. Obviously this uncertainty is only a part of the total expected variation that must be assigned to any measured analytical value. The total variation must include the true environmental (often called sampling) variation as well as the analytical or methodological variation. The variation due to counting is only part of the methodological variation. While the true environmental variation cannot be determined directly the methodological variation can be measured. An experiment was conducted previously in which a single large soil sample was thoroughly homogenized and 10 aliquots taken for Sr-90 analysis. The standard deviation as a percentage of the mean value (coefficient of variation) was 63%. This is the methodological standard deviation which in the experiment included counting statistics. The environmental variation is expected to be considerably greater. This is due to the fact that Sr-90, like Cs-137, is deposited largely on the soil surface, and when the surface is disturbed the surface layer is often greatly diluted or not even part of the sample collected. For these reasons the variation in reported Sr-90 and Sr-89 soil concentrations, although large, should be expected.

Table II. D.8
Gross Beta Activity in Soil per Unit Surface Area ($\mu Ci/m^2$) for Samples Collected Third Quarter, 1979.

Sampling Locations	July 14	August 25	September 29
Facility			
4	3.97 (0.193) *	4.40 (0.192)	4.05 (0.185)
44	3.63 (0.189)	3.90 (0.185)	4.06 (0.198)
Adjacent			
6	3.48 (0.172)	3.93 (0.185)	3.31 (0.173)
28	3.19 (0.163)	3.50 (0.175)	3.40 (0.182)
31	3.34 (0.180)	3.88 (0.181)	3.51 (0.181)
36	3.52 (0.181)	3.16 (0.169)	3.21 (0.164)
48	4.11 (0.197)	3.94 (0.184)	3.97 (0.192)
50	3.44 (0.180)	3.61 (0.177)	3.64 (0.172)
Reference			
16	2.67 (0.157)	3.06 (0.167)	2.97 (0.160)
17	2.82 (0.165)	2.64 (0.155)	2.43 (0.154)
20	3.62 (0.178)	3.80 (0.182)	3.93 (0.189)
22	3.78 (0.184)	2.99 (0.165)	3.83 (0.177)
23	2.98 (0.169)	3.55 (0.176)	3.64 (0.185)
25	3.19 (0.175)	3.03 (0.166)	3.31 (0.180)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.9
Gamma-ray Emitting Radionuclide Activity per Unit Surface Area of Soil (nCi/m^2) for Samples Collected July 14, 1979.

Sampling Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4	<575	166 (101) *	88.0 (127)
44	376 (742)	84.4 (74.4)	<22.7
Adjacent			
6	1,760 (663)	<61.5	83.1 (82.6)
28	1,080 (755)	76.8 (74.3)	<22.4
31	<365	<62.8	<22.8
36	<592	<93.8	<33.8
48	<716	<126	72.6 (201)
50	< 2,890	< 489	< 178
Reference			
16	<365	<62.8	<22.8
17	<365	<62.8	<22.8
20	<365	<62.8	<22.8
22	<365	<62.8	<22.8
23	<365	78.0 (74.2)	<22.8
25	957 (669)	<61.5	94.4 (81.1)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.9
Gamma-ray Emitting Radionuclide Activity per Unit Surface Area of Soil (nCi/m^2) for Samples Collected August 25, 1979 .

Sampling Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4	<365	87.2 (73.7) *	606 (86.6)
44	375 (704)	<63.5	<22.4
Adjacent			
6	<533	<61.5	<21.9
28	<533	<93.3	378 (109)
31	3700 (1,910)	636 (202)	404 (232)
36	<384	<67.0	<23.7
48	628 (670)	<62.7	<22.6
50	423 (666)	<63.1	<22.6
Reference			
16	< 3,890	< 1,750	341 (730)
17	<365	<63.5	43.4 (84.4)
20	<365	91.2 (73.8)	481 (84.5)
22	<452	196 (92.5)	547 (106)
23	<858	<150	<53.1
2-	453 (725)	<67.5	<23.9

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.9
Gamma-ray Emitting Radionuclide Activity per Unit Surface Area of Soil (nCi/m^2) for Samples Collected September 29, 1979.

Sampling Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4	<586	<100	91.6 (87.2) *
44	711 (819)	123 (91.5)	<31.3
Adjacent			
6	<349	<60.0	42.3 (45.9)
28	<524	96.0 (93.2)	<31.7
31	438 (678)	<64.8	<23.1
36	<372	<64.0	60.9 (44.2)
48	458 (720)	304 (78.8)	<23.5
50	1,960 (830)	<98.2	<35.1
Reference			
16	<380	<66.4	<23.9
17	729 (619)	<62.7	<22.6
20	<304	<52.1	<18.1
22	1,480 (658)	<69.0	<24.6
23	<345	<63.7	28.5 (52.9)
25	645 (826)	<91.2	<32.5

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.10
Tritium, Strontium 89, and Strontium 90 Concentrations in Soil for Samples Collected July 14, 1979 .

Sampling Location	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	515 (271)*	< 124	376 (114)
44	595 (271)	< 96.4	232 (99.2)
Adjacent			
6	487 (270)	< 118	341 (120)
28	e	< 87.1	343 (81.4)
31	769 (273)	< 88.9	276 (96.4)
36	535 (271)	< 124	503 (134)
48	729 (273)	< 112	356 (120)
50	606 (272)	< 199	< 1,480
Reference			
16	686 (272)	< 99.9	469 (110
17	864 (274)	< 97.5	526 (179)
20	669 (272)	< 99.4	506 (172)
22	749 (273)	< 103	247 (160)
23	550 (271)	< 153	640 (163)
25	314 (268)	< 257	844 (475)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
e Insufficient volume for analysis

Table II. D.10
Tritium, Strontium 89, and Strontium 90 Concentrations in Soil for Samples Collected August 25, 1979 .

Sampling Location	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	< 261	< 138	399 (222) *
44	< 261	< 99.6	222 (137)
Adjacent			
6	< 261	< 170	532 (156)
28	< 261	< 105	355 (232)
31	< 261	< 81.9	173 (141)
36	< 261	< 161	575 (213)
48	< 261	142 (264)	137 (102
50	< 261	< 103	436 (146)
Reference			
16	< 261	< 122	367 (171)
17	< 261	< 179	644 (179)
20	< 261	< 99.4	257 (127)
22	< 261	< 127	761 (132)
23	< 261	< 96.7	402 (145)
25	< 261	< 99.2	233 (119)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.10
Tritium, Strontium 89, and Strontium 90 Concentrations in Soil for Samples Collected September 29, 1979 .

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	382 (249) *	< 75.0	141 (92.0)
44	298 (248)	< 75.5	89.4 (80.2)
Adjacent			
6	e	< 81.3	129 (91.1)
28	211 (247)	< 85.1	171 (86.3)
31	220 (247)	< 136	624 (413)
36	562 (251)	< 83.0	197 (86.5)
48	e	< 80.8	107 (103)
50	536 (251)	< 76.9	136 (82.3)
Reference			
16	2,010 (266)	< 82.9	179 (92.2)
17	449 (250)	< 94.0	< 112
20	610 (251)	< 87.4	109 (133)
22	310 (248)	< 92.3	258 (104)
23	482 (250)	< 71.0	93.0 (98.2)
25	371 (249)	< 135	275 (159)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

e Insufficient volume or weight for analysis.

II.E. Aquatic Biota

Table II.E.1 shows gross beta and strontium concentrations observed in aquatic biota collected during the second half of 1979. Sample collection problems were experienced during this reporting period only in June due to high run off. Gross beta concentrations in the sample types are higher than any particular fallout fission product because of the presence of the naturally occurring radionuclides e.g. K-40. Strontium-89 and Sr-90 gross beta concentrations were essentially the same as previous reporting periods and those from the downstream locations were not significantly different from the upstream locations. As expected Sr-89 concentrations were less than MDC in almost all cases.

Table II.E.2 lists Ru-106, Cs-137 and Zr-Nb-95 concentrations. No explanation can be given for the great variation in the measured concentrations but downstream values were not statistically greater than upstream indicating no increase due to reactor effluent.

The high MDC values for seston are due to the fact that such samples are counted by a Ge(Li) spectrometer system rather than the NaI used for most other sample types. This is because seston, which is principally algae, collects and concentrates particulate radioactivity and high resolution is necessary for radionuclide measurement of fission product activity in the presence of Ra-226 and Th-232 natural radioactivity. Note that seston concentrations are higher than for the other sample types for all of the radioactivity analyses.

Table II. E.1

Analysis of Composite* Aquatic Biota
For Samples collected July 1979.**

Sampling locations		Gross Beta pCi/Kg	Strontium 89 pCi/Kg	Strontium 90 pCi/Kg
Fish				
Upstream	7-15-79	1,030 (143)	< 14.8	67.9 (13.2)
Downstream	7-15-79	9,040 (325)	d	d
Effluent	7-15-79	9,780 (350)	< 38.2	94.6 (56.7)
Benthic Organisms				
Upstream	7-15-79	9,360 (532)	< 54.8	185 (38.5)
Downstream	7-15-79	9,040 (487)	< 37.1	184 (43.2)
Effluent	7-15-79	9,110 (488)	< 72.8	223 (94.6)
Vascular Plants				
Upstream	7-21-79	21,000 (360)	< 18.2	95.4 (14.3)
Downstream	7-21-79	24,000 (411)	< 49.1	289 (42.4)
Effluent	7-21-79	22,600 (409)	< 25.4	79.7 (22.6)
Seston				
Upstream	7-15-79	28,600 (1,310)	< 85.7	< 89.1
Downstream	7-15-79	39,800 (958)	< 41.1	186 (42.5)
Effluent	7-15-79	25,400 (1,230)	< 78.0	< 103

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.

** Uncertainties (in parentheses) are for the 95% confidence intervals.

d Sample lost in analysis

Table II. E.1

Analysis of Composite* Aquatic Biota
For Samples collected August, 1979 .**

Sampling locations	Gross Beta pCi/Kg	Strontium 89 pCi/Kg	Strontium 90 pCi/Kg
Fish			
Upstream 8-11-79	10,600 (380)	< 146	169 (146)
Downstream 8-11-79	11,200 (350)	< 35.3	56.4 (44.9)
Effluent 8-11-79	8,570 (96.6)	< 29.4	40.8 (40.0)
Benthic Organisms			
Upstream 8-15-79	8,470 (467)	< 45.7	180 (36.4)
Downstream 8-15-79	8,640 (461)	< 87.6	103 (106)
Effluent 8-15-79	9,500 (476)	< 50.8	179 (47.1)
Vascular Plants			
Upstream 8-25-79	10,000 (242)	< 34.2	216 (26.3)
Downstream 8-25-79	15,700 (338)	< 79.9	544 (63.5)
Effluent 8-25-79	15,200 (354)	< 19.4	72.4 (16.4)
Seston			
Upstream 8-30-79	26,500 (954)	< 43.7	78.4 (62.4)
Downstream 8-30-79	30,900 (125)	< 155	355 (273)
Effluent 8-30-79	27,800 (930)	< 152	151 (183)

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.

** Uncertainties (in parentheses) are for the 95% confidence intervals.

Table II. E.1

Analysis of Composite* Aquatic Biota
For Samples collected September 1979 .**

Sampling locations		Gross Beta pCi/Kg	Strontium 89 pCi/Kg	Strontium 90 pCi/Kg
Fish				
Upstream	9-18-79	12,000 (424)	< 43.3	63.1 (50.4)
Downstream	9-9-79	9.480 (365)	< 96.8	140 (153)
Effluent	9-9-79	9,890 (322)	< 191	< 209
Benthic Organisms				
Upstream	9-12-79	12,300 (676)	< 66.6	211 (63.6)
Downstream	9-9-79	12,400 (379)	< 64.1	176 (59.9)
Effluent	9-9-79	13,800 (647)	< 115	173 (110)
Vascular Plants				
Upstream	9-22-79	13,500 (342)	< 18.8	128 (12.8)
Downstream	9-22-79	13,300 (308)	< 40.9	192 (37.3)
Effluent	9-22-79	17,600 (274)	< 60.8	444 (49.9)
Seston				
Upstream	9-18-79	31,000 (1,280)	< 46.8	127 (119)
Downstream		f	f	f
Effluent	9-9-79	20,600 (754)	< 147	400 (166)

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.

** Uncertainties (in parentheses) are for the 95% confidence intervals.

f Sample unavailable

Table II. E.1

Analysis of Composite* Aquatic Biota
For Samples collected fourth quarter .**

Sampling locations		Gross Beta pCi/Kg	Strontium 89 pCi/Kg	Strontium 90 pCi/Kg
Fish				
Upstream	10-7-79	9,670 (326)	< 188	267 (241)
Downstream	10-7-79	12,000 (401)	< 192	494 (283)
Effluent	10-7-79	134,000 (5,190)	< 58.4	<76.0
Benthic Organisms				
Upstream	11-18-79	11,400 (629)	< 179	261 (246)
Downstream	10-15-79	9,460 (584)	< 72.8	216 (75.2)
Effluent	11-7-79	9,250 (259)	< 151	291 (143)
Vascular Plants				
Upstream	12-30-79	15,200 (427)	<12.8	87.7 (12.5)
Downstream	12-30-79	9,910 (258)	<11.8	59.4 (13.1)
Effluent	12-30-79	16,000 (398)	<15.6	72.5 (20.7)
Seston				
Upstream	11-18-79	33,000 (129)	152 (221)	<84.7
Downstream	10-7-79	28,600 (366)	676 (346)	20.2 (64.2)
Effluent	10-7-79	24,500 (873)	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.

** Uncertainties (in parentheses) are for the 95% confidence intervals.

f Sample unavailable

Table II. E.2
Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected July 1979 . **

Sampling Locations *	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish			
Upstream 7-15-79	< 252	178 (64.4)	67.5 (40.4)
Downstream 7-15-79	< 252	< 77.9	< 33.5
Effluent 7-15-79	< 252	< 77.9	< 33.5
Benthic Organisms			
Upstream 7-15-79	< 252	120 (63.9)	104 (40.0)
Downstream 7-15-79	< 283	150 (71.4)	45.4 (43.9)
Effluent 7-15-79	<336	< 103	< 44.6
Vascular Plants			
Upstream 7-21-79	< 246	96.7 (63.4)	< 32.5
Downstream 7-21-79	< 272	216 (70.0)	59.4 (69.0)
Effluent 7-21-79	181 (48.2)	137 (11.3)	165 (11.1)
Seston			
U eam 7-15-79	< 7,510	< 1,280	< 457
stream 7-15-79	< 12,200	< 2,090	< 745
Effluent 7-15-79	< 7,510	< 1,280	594 (901)

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. E.2
Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples
(pCi/kg) for Samples Collected August 1979 . **

Sampling Locations *	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish			
Upstream 8-11-79	504 (297)	240 (64.2)	498 (92.0)
Downstream 8-11-79	1,290 (310)	< 77.9	281 (110)
Effluent 8-11-79	606 (299)	293 (65.0)	647 (93.0)
Benthic Organisms			
Upstream 8-15-79	8,010 (172)	1,460 (36.6)	3,580 (46.8)
Downstream 8-15-79	1,880 (124)	213 (26.7)	552 (33.5)
Effluent 8-15-79	2,360 (426)	193 (91.1)	684 (115)
Vascular Plants			
Upstream 8-25-79	< 345	< 110	< 46.2
Downstream 8-25-79	< 393	< 125	< 52.5
Effluent 8-25-79	< 337	< 108	< 45.1
Seston			
Upstream 8-30-79	892 (804)***	1,040 (183)	1,580 (207)
Downstream 8-30-79	1,700 (423)***	< 91.5	2,590 (181)
Effluent 8-30-79	< 23,200	< 4,033	< 1,430

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

*** Counted on the 4 x 8 Na I crystal

Table II. E.2
Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples
(pCi/kg) for Samples Collected September 1979. **

Sampling Locations *		^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish				
Upstream	9-18-79	1,890 (407)	<120	< 50.6
Downstream	9-9-79	855 (298)	< 81.5	< 77.9
Effluent	9-9-79	< 79.8	263 (27.0)	119 (29.5)
Benthic Organisms				
Upstream	9-12-79	476 (203)	< 40.6	221 (62.3)
Downstream	9-9-79	1,680 (380)	218 (85.4)	412 (108)
Effluent	9-9-79 ***	31,700 (15,200)	< 1,510	< 539
Vascular Plants				
Upstream	9-22-79	<349	206 (89.7)	291 (137)
Downstream	9-22-79	<370	<118	56.5 (123)
Effluent	9-22-79	<378	<120	< 50.6
Seston				
Upstream	9-18-79	< 8,630	< 1,490	1,470 (2,380)
Downstream		f	f	f
Effluent	9-9-79	1,600 (25,400)	2,390 (718)	1,460 (2,840)

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
*** Counted on the Ge-Li Spectrometer system
f Sample unavailable

Table II. E.2
Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected Fourth Quarter. **

Sampling Locations *		^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish				
Upstream	10-7-79 ***	43,200 (14,400)	< 1,510	< 538
Downstream	10-7-79	<426	< 136	117 (108)
Effluent	10-7-79	< 143	< 45.7	< 19.1
Benthic Organisms				
Upstream	11-18-79	1,480 (282)	81.5	65.5 (46.2)
Downstream	10-15-79	184 (157)	209 (38.0)	171 (29.2)
Effluent	11-7-79	< 505	< 160	< 67.5
Vascular Plants				
Upstream	12-30-79	293 (110)	< 19.4	44.9 (27.8)
Downstream	12-30-79	624 (319)	< 90.3	111 (79.5)
Effluent	12-30-79	1,290 (169)	< 37.5	25.4 (42.7)
Seston				
Upstream	11-18-79	9,230 (14,700)	< 1,580	< 559
Downstream	10-7-79	<23,200	< 4,010	2,960 (3,950)
Effluent	10-7-79	<17,000	< 3,100	1,290 (2,770)

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

*** Counted on the Ge-Li Spectrometer system

II.F. Beef Cattle. Two head of beef cattle that graze the Facility area are counted each quarter in the CSU whole-body counter. The animals are washed carefully and counted for 20 minutes each. This method is far more sensitive than counting meat samples and is the method of choice for detecting Cs-137 in the meat food chain to humans. If thyroid I-131 contamination were significant this would be detected from the whole body count. Detectable I-131 concentrations have never been observed.

Table II.F.1 gives values for the second half of 1979 for whole body counting of beef cattle. The animals are selected each quarter at random; however, the animal number is recorded and the animal may be retrieved and recounted if necessary. The Cs-137 concentrations are nearly identical to those observed during the first half of 1979. Variation in Cs-137 concentration only reflects a different cutting and/or source of hay and pasture for the animals.

The Cs-137 concentration is expressed as pCi per gram of K in the whole animal. This is done to more easily compare the counts between animals. K and Cs are both intracellular cations and by normalizing the Cs-137 activity to K, differences due to fat percentage in the animals are eliminated, i.e. the K concentration of fat free muscle is very constant.

Table II.F.2 shows concentrations of Cs-137 and H-3 in a muscle sample from facility area animal slaughtered at the end of the pasture season. The concentration of Cs-137 in this animal was particularly low and probably indicates a high grain feeding program before slaughter. The biological half-life of Cs-137 in beef or dairy animals is approximately 25 days. Grain is generally lower in Cs-137 than hay or pasture grass. The low tritium concentration shows no effect of the reaction effluents.

Table II.F.1. Radionuclides in Facility Area Beef Cattle

In-vivo Gamma ray activity in Fort St. Vrain Area beef cattle.

September 15, 1979		Third Quarter Values
	^{131}I	^{137}Cs pCi/g K
Cow 1	None Detected	10.4
Cow 2	None Detected	7.07
December 1, 1979		Fourth Quarter Values
Cow 1	None Detected	20.3
Cow 2	None Detected	22.6

Table II.F.2.

Radionuclides in Beef Sample from Local Herd.
Animal Slaughtered, Fourth Quarter, *

Hamburger

^{137}Cs pCi/Kg	K g/kg	Tritium pCi/l
3.76 (0895)	1.62 (0.012)	314 (258)

Bone

^{89}Sr pCi/Kg	^{90}Sr pCi/Kg
<126	368 (151)

* Uncertainties (shown in parentheses) are for the 95% confidence interval (1.96 S.D.).

II.G.1 Sample Cross Check Data

Since 1975 we have participated in a national EPA sponsored laboratory intercomparison analytical program. We analyze air filters as well as milk and water samples for the important radionuclides. The results obtained since the last report are given in Table II.G.1.

Inspection of Table II.G.1 reveals few aberrant measured values i.e. greater than the 3 sigma control limit. Only 7 of the 47 separate determinations exceeded the 3 sigma control limit. We reinvestigated all of those and in most cases determined the source of error.

Other cross check possibilities exist for this program. We have participated with the reactor health physics group in a TLD intercomparison. We analyze many duplicate samples with the state health department and we currently are participating in an international cross check program sponsored by the I.A.E.A. (International Atomic Energy Agency) in Vienna. A major analysis of these cross check values as well as an analysis of all the experience with the EPA program is currently being prepared.

Table II.G.1. EPA Cross-Check Data Summary

Date	Radio nuclide	CSU Value	Actual Value	Precision (1 sigma)	Control Limits (3 Sigma)	% deviation from known
			Air filters, pCi/filter			
6-29-79	^{90}Sr	10	10	1.5	5	0
	^{137}Cs	39	10	5	15	190
	Gross α	10	9	5	15	11
	Gross β	28	30	5	15	7
10-5-79	^{90}Sr	12	10	1.5	5	20
	^{137}Cs	10	12	5	15	17
	Gross α	9	10	5	15	10
	Gross β	29	31	5	15	6
			Milk, pCi/l			
4-27-79	^{89}Sr	17	42	1.5	5	60
	^{90}Sr	44	54	1	3	19
	^{131}I	125	96	1.5	5	30
	^{137}Cs	162	154	2.8	24	5
	^{140}Ba	-	-	--	--	--
	K	1584	1560	26	78	2
7-27-79	^{89}Sr	0	5	5	15	-
	^{90}Sr	7	11	1.5	5	36
	^{131}I	26	17	5	15	53
	^{137}Cs	16	12	5	15	33
	^{140}Ba	0	0	-	--	--
	K	1556	1630	81	250	5
11-2-79	^{89}Sr	0	25	5	15	-
	^{90}Sr	22	17	1.5	5	29
	^{131}I	681	637	32	96	7
	^{137}Cs	51	49	5	15	4
	^{140}Ba	-	-	-	-	-
	K	1830	1470	76	229	25
			Water, tritium pCi/l			
6-15-79	^{3}H	1350	1540	337	1010	12
8-10-79	^{3}H	1376	1480	335	1005	7
10-5-79	^{3}H	1402	1560	337	1010	5

Table II.G.1. EPA Cross-Check Data Summary

Date	Radio nuclide	CSU Value	Actual Value	Precision (1 sigma)	Control Limits (3 Sigma)	% deviation from known
			Water, Alpha and Beta pCi/l			
5-25-79	Gross α	27	18	5	15	50
	Gross β	17	22	5	15	4
7-20-79	Gross α	11	9	5	15	22
	Gross β	9	12	5	15	25
9-21-79	Gross α	10	5	5	15	100
	Gross β	35	40	5	15	13
11-30-79	Gross α	11	12	5	15	8
	Gross β	20	27	5	15	35
			Water, Gamma pCi/l			
6-6-79	^{60}Co	55	47	5	15	17
	^{134}Cs	77	71	5	15	8
10-5-79	^{51}Cr	165	113	5	15	46
	^{60}Co	7	6	5	15	17
	^{65}Zn	4	-	-	-	-
	^{106}Ru	7	-	-	-	-
	^{134}Cs	11	7	5	15	57
	^{137}Cs	21	11	5	15	91
			Water, Sr 89 and 90 pCi/l			
5/4/79	^{89}Sr	3	23	5	15	83
	^{90}Sr	40	30	0.5	1.5	33

II.H. Summary and Conclusions

Table II.H.1 presents the primary summary and analysis of data collected during the second half of 1979. The tabular data may be used for comparison to other operating power reactors. For each sample type the number of samples analyzed in the reporting period and the maximum and minimum values for each sample type are given. From log-normal analysis of each data set for the last 12 month period the geometric mean and standard deviation is presented. The arithmetic mean is also calculated back for the entire year and for the reporting period. It should be noted that the tabular data presented in the body of this report contain only positive calculated values. Any calculated values less than zero or less than the minimum detectable concentration (MDC) are listed as less than the actual MDC for that sample analysis. However, the actual result was used in the calculation for the arithmetic mean values for the last six months. Therefore all values, negative as well as positive, were included. This procedure is now generally accepted and gives a closer approximation to the true mean value. Because of this procedure, however, the values listed in Table II.H.1 cannot be calculated directly from the tabular values in the report. It must be emphasized that while it is true that no sample can contain less than zero radioactivity due to the random nature of radioactive decay it is statistically possible to obtain sample count rates less than the background and hence a negative result.

The log-normal probability treatment is to plot all data for each sample type over the last full year on log-probit coordinates. The samples are ranked by increasing activity concentration and the cumulative percentage of rankings are plotted on the probit abcissa versus the activity concentration on the log ordinate. The geometric mean value $\bar{x}_g$, is determined directly from the 50th percentile point. The geometric standard deviation

is simply the slope of the line, which can be calculated from the ratio between the 84.1 percentile and the 50 percentile. In a normal distribution the arithmetic standard deviation is an additive parameter to the arithmetic mean ($\bar{x} \pm \sigma$), whereas in the log-normal distribution the geometric standard deviation σ_g, is a multiplcative parameter to the geometric mean ($\bar{x}_g \div \sigma_g$), i.e., the area between $\bar{x}_g$ divided by σ_g, and $\bar{x}_g$ multiplied by σ_g should contain 68% of the frequency values. The log-normal statistical treatment is difficult when the number of samples in the group is small. For this reason only the last full year of data points is treated by this method. With the log-normal analysis, no bias results from using less than MDC values.

From the values presented in Table II.H.1 and the tabular data of the report the following observations and conclusions may be drawn:

1. It must be emphasized that the reporting period included a partial operational stage and the first major refueling operation conducted at the reactor. The potential for off-site contamination was obviously high for the latter operation. However there is no evidence that any radioactivity released in reactor effluents produced statistically significant off-site concentrations above background in any of the sample types measured during the period. The principal radionuclide released from the reactor was tritium and this conclusion may be substantiated by observing tritium concentrations in all sample types. Gross beta concentrations also strongly support the conclusion. The specific radionuclide concentrations are considerably more variable due to sampling and methodological error but likewise show no systematic evidence of off-site contamination. The above conclusion implies that radiation dose to nearby inhabitants due to reactor operations was not different from naturally occurring background radiation dose.

2. The log-normal treatment of all the data revealed that for most of the data such analysis is appropriate. However, sigmoid distributions were quite often observed. Sigmoid distributions can be resolved into bimodal or even trimodal log-normal distributions. This is generally interpreted to mean that there is more than one significant activity source. It was again noted that for all of the data analyzed over the past year by the log-normal treatment, those sample types that are reservoirs or sinks for activity, e.g., soil, sediment and TLD, tended to be described by a single distribution. Those sample types which are less stable and fluctuate, e.g., air and precipitation tended to be bimodal or trimodally distributed.

3. As in every previous report, it was again apparent that the variability observed around the mean values was great. This variability is due to counting statistics and methodological error, but principally due to true environmental variation. It must be recognized and accounted for in analysis of any set of environmental data before meaningful conclusions can be drawn.

4. Environmental radioactivity data has been collected on this project since 1969. The radiation surveillance program has not significantly changed since that time. During this period the reactor began power production. Probably no more extensive or complete radiation surveillance program exists for any reactor in the U.S.A. A detailed and thorough analysis of all past data collected at the Fort St. Vrain site has been initiated and will be completed for inclusion in the next semiannual report.

Table II.B.1. Mean Values for all Sample Types.

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\tilde{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
TLD	Facility	74	.36	.61	.445	1.19	.451	.471
External	Adjacent	71	.37	.91	.440	1.21	.448	.474
(mR/day)	Reference	72	.38	0.81	.453	1.32	.479	.545
	Composite	217	.36	0.81	.446	1.24	.459	.497
Air	Facility	92	0.6	40.6	4.66	2.35	6.63	8.56
Gross α	Adjacent	72	0.2	24.2	3.63	2.05	4.60	5.60
(fCi/m^3)	Composite	164	0.2	40.6	4.21	2.25	5.80	7.33
Air	Facility	102	4	40	16.20	1.65	18.2	15.48
Gross β	Adjacent	75	2	33	11.81	1.68	13.53	11.8
(fCi/m^3)	Composite	177	2	40	14.21	1.70	16.28	13.53
Air	Facility	102	16	4,250	390	2.56	533	465
Tritium	Adjacent	73	42.4	1,350	337	2.23	398	231
(pCi/l)	Composite	175	16	4,250	476	2.42	476	367
Air ^{131}I (fCi/m^3)	Composite	26	7.62	540	19.0	4.70	30.4	99.7
Air ^{106}Ru (fCi/m^3)	Composite	27	6.23	101	4.65	2.75	<1.11	< 1.11

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Air ^{137}Cs (fCi/m^3)	Composite	27	.144	29.7	1.27	2.85	2.04	3.00
Air ^{95}Zr (fCi/m^3)	Composite	27	.244	19.4	.467	3.62	.571	.814
Water Gross β (pCi/l)	Effluent	30	7.35	35.4	13.7	1.70	15.2	19.5
	Downstream	15	7.74	19.8	11.4	1.53	12.4	15.0
	Upstream	12	6.12	44.6	13.0	1.78	15.4	20.8
	Potable	10	1.84	12.5	2.93	2.44	4.26	4.73
	Composite	67	1.84	44.6	10.15	2.23	12.8	16.4
Water Tritium (pCi/l)	Effluent	27	109	70,500	3,273	5.93	17,566	9,073
	Downstream	14	17	1,020	420	2.78	553	523
	Upstream	12	81	939	325	2.40	417	348
	Potable	10	94	611	508	2.53	820	291
	Composite	63	17	70,500	1,025	5.61	8,091	4,117
Water ^{90}Sr (pCi/l)	Effluent	28	.187	23.9	1.33	3.21	2.55	3.24
	Downstream	15	.561	6.55	1.12	2.39	1.31	2.10
	Upstream	12	.474	4.61	1.41	2.03	1.62	2.31
	Potable	9	.326	3.99	.821	3.42	1.05	1.71
	Composite	64	.187	23.9	1.20	2,86	1.86	2.58

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\tilde{x}_g$ 1 Year	σ_g	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Water	Effluent	28	.121	16.8	1.15	2.82	< .532	< .584
^{89}Sr	Downstream	15	.736	3.16	1.08	20.01	< .588	< .670
(pCi/l)	Upstream	12	< .695	.452	1.02	1.74	< .560	< .695
	Potable	9	.395	.881	.730	2.36	< .503	< .579
	Composite	64	.121	16.8	1.04	2.40	< .503	< .579
Water	Effluent	28	.031	16.4	3.81	3.16	1.37	<4.53
^{106}Ru	Downstream	15	.795	16.7	3.79	1.98	1.36	2.73
(pCi/l)	Upstream	12	.020	6.04	3.26	3.17	<4.53	<4.53
	Potable	10	3.33	11.5	2.74	2.77	2.17	5.02
	Composite	65	.020	16.7	3.51	2.80	.863	<4.53
Water	Effluent	28	.007	5.80	1.01	3.08	.821	<.803
^{137}Cs	Downstream	15	.104	3.11	.692	3.58	.825	.368
(pCi/l)	Upstream	12	.074	7.74	1.15	3.08	1.78	2.01
	Potable	10	.824	4.34	.873	1.98	.445	.455
	Composite	65	.007	7.74	.924	3.03	.931	.205
Water	Effluent	28	.059	4.87	.589	3.57	1.25	<.290
^{95}Zr	Downstream	15	.286	2.97	.509	2.44	.406	.0137
(pCi/l)	Upstream	12	.071	2.29	.624	2.90	.935	.819
	Potable	10	.388	2.24	.461	1.86	.261	.316
	Composite	65	.059	4.87	.552	2.89	.828	<.290
Sediment	Effluent	11	29,900	34,900	33,600	1.12	33,800	32,900
Gross β	Downstream	16	27,700	38,500	32,500	1.10	32,700	32,600
(pCi/kg)	Upstream	12	23,600	38,300	31,200	1.25	31,800	32,450
	Composite	39	23,600	38,500	32,400	1.17	32,700	32,600

Table II.H.1. Mean Values for all Sample Types (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Sediment ^{90}Sr (pCi/kg)	Effluent	10	27.3	931	185	2.55	261	338
	Downstream	16	30.1	945	190	2.46	202	296
	Upstream	12	144	776	231	1.74	212	335
	Composite	38	27.3	945	200	2.26	222	319
Sediment ^{89}Sr (pCi/kg)	Effluent	10	21.9	601	152	2.34	< 104	< 104
	Downstream	16	21.0	1,430	226	2.83	164	288
	Upstream	12	50.5	1,970	235	2.38	6.33	278
	Composite	38	21.0	1,970	203	2.57	16.0	158
Sediment ^{106}Ru (pCi/kg)	Effluent	11	1124	19,900	3820	2.53	<3720	<3760
	Downstream	16	805	17,300	3720	2.58	<3730	<3740
	Upstream	12	3859	18,900	4070	2.49	1740	3825
	Composite	39	805	19,900	3850	2.51	<3720	<3740
Sediment ^{137}Cs (pCi/kg)	Effluent	11	293	1,510	781	1.67	627	461
	Downstream	16	1.83	951	378	3.96	322	163
	Upstream	12	55.6	811	448	2.57	360	147
	Composite	39	1.83	1,510	495	2.95	426	243
Sediment ^{95}Zr (pCi/kg)	Effluent	11	18.4	619	327	2.81	88.8	<235
	Downstream	16	69.1	1,300	216	2.22	216	199
	Upstream	12	28.4	945	231	2.83	126	30.4
	Composite	39	18.4	1,300	251	2.44	148	6.60
Precipitation Gross β (pCi/m^2)	F-1	4	1.42	300	35.8	7.86	94.0	131
	F-4	3	56.7	97.9	52.8	3.51	89.5	82.7
	Composite	7	1.42	300	43.0	5.43	91.8	110.5

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Precipitation	F-1	4	2,906	4,150	1,650	3.53	3,370	3,480
Tritium	F-4	4	g	g	g	g	g	g
(pCi/m^2)	Composite	8	g	g	g	g	g	g
Precipitation	F-1	4	129	171	35.2	3.48	39.2	81.5
^{106}Ru	F-4	3	8.33	206	10.7	5.66	< 7.39	19.1
(pCi/m^2)	Composite	7	8.33	206	20.1	4.83	20.1	54.8
Precipitation	F-1	4	6.69	58.4	14.8	3.41	24.3	29.0
^{137}Cs	F-4	3	12.9	62.2	13.7	3.18	21.8	44.8
(pCi/m^2)	Composite	7	6.69	62.2	14.3	3.20	23.1	35.8
Precipitation	F-1	4	5.6	20.9	6.55	6.37	8.93	8.41
^{95}Zr	F-4	3	1.99	61.0	5.01	3.15	9.66	18.35
(pCi/m^2)	Composite	7	5.61	20.9	5.77	4.58	9.28	12.67
Precipitation	F-1	g	g	g	g	g	g	g
^{90}Sr	F-4	g	g	g	g	g	g	g
(pCi/m^2)	Composite	g	g	g	g	g	g	g
Precipitation	F-1	g	g	g	g	g	g	g
^{89}Sr	F-4	g	g	g	g	g	g	g
(pCi/m^2)	Composite	g	g	g	g	g	g	g
Milk	Facility	15	59.2	1,080	377	2.75	440	424
Tritium	Adjacent	16	19	1,220	356	2.65	467	450
(pCi/l)	Reference	16	118	967	424	1.67	435	497
	Composite	47	19	1,220	385	2.35	447	458

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Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Milk	Facility	14	1.59	15.5	3.99	2.43	5.35	6.97
^{90}Sr	Adjacent	14	2.06	33.0	3.98	2.54	5.65	7.90
(pCi/l)	Reference	15	1.77	18.5	3.77	2.50	4.51	6.11
	Composite	43	1.59	33.0	3.91	2.46	5.16	5.98
Milk	Facility	14	<.779	<8.52	2.48	2.20	<.779	<.779
^{89}Sr	Adjacent	14	<.964	.131	2.00	2.52	<.840	<.964
(pCi/l)	Reference	15	<.145	<9.53	1.99	2.84	<.145	<.145
	Composite	43	<.145	<9.53	2.14	2.51	<.145	<.145
Milk	Facility	15	.697	57.9	1.62	9.38	2.58	<0.104
^{131}I	Adjacent	16	1.63	51.1	1.20	9.46	1.41	<0.0989
(pCi/l)	Reference	14	.235	50.8	1.16	9.32	.628	<0.0899
	Composite	45	.235	51.9	1.31	9.21	1.53	<0.0899
Milk	Facility	15	.294	21.5	2.81	6.63	5.27	.872
^{137}Cs	Adjacent	16	1.62	6.26	1.35	6.13	2.28	<.0928
(pCi/l)	Reference	14	.624	13.76	1.47	5.16	1.57	.555
	Composite	45	.294	21.5	1.78	6.05	3.07	.324
Milk	Facility	15	.247	1.62	1.43	1.23	1.46	1.41
Nat. K	Adjacent	16	1.40	2.18	1.59	1.10	1.59	1.63
(g/l)	Reference	14	1.06	1.89	1.46	1.10	1.47	1.46
	Composite	45	.247	2.18	1.49	1.16	1.51	1.50
Forage	Facility	2	681	744	346	3.76	504	713
Tritium	Adjacent	10	101	813	491	1.71	506	496
(pCi/l)	Reference	11	282	3,230	543	1.88	609	833
	Composite	23	101	3,230	492	1.98	552	676

Table II.H.1. Mean Values for all Sample Types (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\tilde{x}_g$ 1 Year	σ_g	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Forage	Facility	6	<12.6	167	36.8	2.15	<12.6	<12.6
^{89}Sr	Adjacent	18	<12.1	167	27.5	1.84	<12.1	<12.1
(pCi/kg)	Reference	18	<13.7	745	39.2	2.84	<13.7	<14.0
	Composite	42	<12.1	745	33.4	2.35	<12.1	<12.1
Forage	Facility	6	43.6	320	203	1.61	223	192
^{90}Sr	Adjacent	18	21.8	283	139	1.98	171	145
(pCi/kg)	Reference	18	91.8	277	163	2.08	215	180
	Composite	42	21.8	320	156	1.99	197	166
Forage	Facility	6	2.47	420	41.3	3.62	21.3	26.9
^{106}Ru	Adjacent	18	6.69	282	60.0	2.76	51.5	66.0
(pCi/kg)	Reference	18	26.6	291	55.4	2.46	24.3	34.9
	Composite	42	2.47	420	54.9	2.72	35.5	47.1
Forage	Facility	6	72.4	118	78.8	2.80	104	55.0
^{137}Cs	Adjacent	18	5.62	294	55.0	2.77	82.4	71.1
(pCi/kg)	Reference	18	6.94	132	50.7	2.81	72.1	53.9
	Composite	42	5.62	294	55.9	2.78	81.1	61.4
Forage	Facility	6	22.1	179	60.3	4.49	249	48.7
^{95}Zr	Adjacent	18	16.9	90.2	34.4	1.82	40.1	47.5
(pCi/kg)	Reference	18	26.1	132	31.1	2.14	38.3	46.7
	Composite	42	16.9	179	35.7	2.36	69.1	47.3
Forage	Facility	6	15,400	35,700	22,300	1.39	23,400	26,900
Gross β	Adjacent	18	11,600	30,800	18,900	1.35	19,700	19,500
(pCi/kg)	Reference	18	16,000	29,800	19,700	1.25	20,200	21,200
	Composite	42	15,400	35,700	19,700	1.32	20,500	21,300

Table II.H.1. Mean Values for all Sample Types.(Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\tilde{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Soil	Facility	6	28200	34100	25050	1.94	28100	31030
Gross β	Adjacent	18	24500	31900	27200	1.12	27300	27600
(pCi/kg)	Reference	18	18800	30500	25300	1.18	25600	25080
	Composite	42	18800	34100	26060	1.32	26700	27020
Soil	Facility	6	3.63	4.40	3.92	1.09	3.93	4.00
Gross β	Adjacent	18	3.16	4.11	3.51	1.12	3.53	3.56
(pCi/m^2)	Reference	18	2.43	3.93	3.27	1.18	3.31	3.24
	Composite	42	2.43	4.40	3.46	1.16	3.49	3.49
Soil	Facility	6	37.5	711	350	2.15	<346	109
^{106}Ru	Adjacent	18	6.97	3700	271	5.71	<326	<349
(nCi/m^2)	Reference	18	124	1480	321	2.71	106	137
	Composite	42	6.97	3700	303	3.81	2.53	52.8
Soil	Facility	6	11.9	166	98.3	2.19	121	89.9
^{137}Cs	Adjacent	18	.0606	636	136	4.07	97.0	71.6
(nCi/m^2)	Reference	18	19.7	1750	84.0	2.22	125	133
	Composite	42	.0606	1750	79.2	3.00	112	101
Soil	Facility	6	4.06	606	21.6	4.92	65.1	116
^{95}Zr	Adjacent	18	7.26	404	31.7	2.56	4.69	<21.9
(nCi/m^2)	Reference	18	1.54	547	25.5	3.29	46.3	76.3
	Composite	42	1.54	606	27.3	3.16	31.2	44.4
Soil	Facility	6	97	595	414	1.72	414	270
Tritium	Adjacent	17	211	769	434	1.94	452	248
(pCi/l)	Reference	18	13.7	2,010	453	2.23	523	444
	Composite	41	13.7	2,010	439	2.03	478	342

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Soil	Facility	6	<75	106	107	1.34	< 75.0	< 75.0
^{89}Sr	Adjacent	18	9	142	123	2.12	< 76.9	< 76.9
(pCi/kg)	Reference	18	30	45	106	2.56	< 12	< 71.0
	Composite	42	9	142	113	2.21	< 12	< 71.0
Soil	Facility	6	89	399	262	2.01	335	243
^{90}Sr	Adjacent	18	129	712	228	3.92	441	340
(pCi/kg)	Reference	18	68	644	260	2.27	356	382
	Composite	42	68	712	245	2.89	389	344
Aquatic Biota	Upstream	4	1,030	12,000	7,060	2.59	8,875	8,325
Fish	Downstream	4	9,040	12,000	10,030	1.12	10,090	10,430
Gross β	Effluent	4	8,570	134,000	14,900	2.70	28,200	40,410
(pCi/kg)	Composite	12	1,030	134,000	10,400	2.29	16,400	19,720
Aquatic Biota	Upstream	4	8,470	12,300	9,570	1.24	9,750	10,380
Benthic	Downstream	4	8,670	12,400	9,780	1.18	9,890	9,890
Gross β	Effluent	4	9,110	13,800	9,440	1.29	9,690	10,420
(pCi/kg)	Composite	12	8,470	13,800	9,580	1.22	9,770	10,230
Aquatic Biota	Upstream	4	10,000	21,000	17,100	1.36	17,700	14,900
Vascular Plants	Downstream	4	9,910	24,000	11,700	3.34	16,600	15,900
Gross β	Effluent	4	13,600	22,600	22,100	1.52	23,900	16,900
(pCi/kg)	Composite	12	9,910	24,000	16,400	2.16	19,400	15,900
Aquatic Biota	Upstream	4	26,500	33,000	28,400	1.11	28,600	29,800
Seston	Downstream	3	28,600	39,800	32,400	1.15	32,700	33,100
Gross β	Effluent	4	27,800	20,600	16,100	2.55	20,270	24,600
(pCi/kg)	Composite	11	28,600	39,800	24,400	1.81	26,900	28,800

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Aquatic Biota	Upstream	4	< 14.8	< 188	65.0	2.56	< 14.8	< 14.8
Fish	Downstream	3	< 35.3	< 192	73.5	2.16	< 35.5	< 35.3
^{89}Sr	Effluent	4	< 29.4	< 191	48.5	2.97	< 27.2	< 29.4
(pCi/kg)	Composite	11	< 14.8	< 192	60.0	2.52	< 14.8	< 14.8
Aquatic Biota	Upstream	4	< 45.7	< 179	82.5	1.79	< 45.7	< 45.7
Benthic	Downstream	4	< 37.1	< 87.6	62.4	1.45	< 37.1	< 37.1
^{89}Sr	Effluent	4	< 50.8	< 151	89.5	1.62	< 50.8	< 50.8
(pCi/kg)	Composite	12	< 37.1	< 179	77.6	1.61	< 37.1	< 37.1
Aquatic Biota	Upstream	4	< 12.8	< 34.2	25.6	1.67	< 12.8	< 12.8
Vascular Plants	Downstream	4	< 11.8	< 79.9	58.8	3.59	< 11.8	< 11.8
^{89}Sr	Effluent	4	< 15.6	< 60.8	41.0	3.15	< 15.6	< 15.6
(pCi/kg)	Composite	12	< 11.8	< 79.9	39.5	2.84	< 11.8	< 11.8
Aquatic Biota	Upstream	4	< 43.7	152	53.2	2.38	< 11.8	< 43.7
Seston	Downstream	3	< 41.1	676	18.8	2.20	< 41.1	< 41.1
^{89}Sr	Effluent	3	< 78.0	< 152	82.7	2.25	< 78.0	< 78.0
(pCi/kg)	Composite	10	< 41.1	676	86.6	2.78	< 11.8	< 41.1
Aquatic Biota	Upstream	4	63.1	267	121	1.97	146	142
Fish	Downstream	3	56.4	494	125	2.78	187	230
^{90}Sr	Effluent	4	40.8	209	86.8	1.70	98.3	99.8
(pCi/kg)	Composite	11	40.8	494	107	2.04	139	151
Aquatic Biota	Upstream	4	180	261	211	1.16	213	209
Benthic	Downstream	4	103	216	164	1.38	170	170
^{90}Sr	Effluent	4	173	291	212	1.27	217	217
(pCi/kg)	Composite	12	103	291	195	1.28	201	199
Aquatic Biota	Upstream	4	66.6	127	128	1.90	152	132
Vascular Plants	Downstream	3	20.2	355	189	2.02	231	271
^{90}Sr	Effluent	3	98.8	400	111	2.81	166	167
(pCi/kg)	Composite	10	20.2	400	139	2.24	183	190

Table II.H.1. Mean Values for all Sample Types (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\tilde{x}_g$ 1 Year	σ_g 1 Year	$\tilde{x}$ 1 Year	$\tilde{x}$ 6 Months
Aquatic Biota	Upstream	4	66.6	127	87.3	1.28	64.4	51.4
Seston	Downstream	3	20.2	355	140	3.74	213	187
^{90}Sr	Effluent	3	98.8	400	88.5	4.71	165	217
(pCi/kg)	Composite	10	20.2	400	100	2.76	136	142
Aquatic Biota	Upstream	4	504	43,200	816	6.96	6,558	11,400
Fish	Downstream	4	40.7	1,290	273	3.91	302	454
^{106}Ru	Effluent	4	< 79.8	606	191	2.30	< 79.8	< 79.8
(pCi/kg)	Composite	12	40.7	43,200	349	4.55	2,240	3,830
Aquatic Biota	Upstream	4	476	8,010	786	4.51	2,031	2,490
Benthic	Downstream	4	184	1,880	637	3.32	925	925
^{106}Ru	Effluent	4	230	31,700	702	9.01	5,260	7,830
(pCi/kg)	Composite	12	184	31,700	710	5.15	3,029	3,750
Aquatic Biota	Upstream	4	< 246	293	223	1.91	< 88.5	< 246
Vascular Plant	Downstream	4	< 272	624	385	1.57	< 252	< 272
^{106}Ru	Effluent	4	181	1,290	488	2.72	379	151
(pCi/kg)	Composite	12	181	1,290	348	2.17	< 88.5	< 246
Aquatic Biota	Upstream	4	891	9,230	5,098	2.49	< 6,720	1,110
Seston	Downstream	3	1,700	22,200	3,930	5.69	5,440	7,080
^{106}Ru	Effluent	4	10,000	16,000	7,640	3.49	< 7,510	< 7,510
(pCi/kg)	Composite	11	892	22,200	5,450	3.36	< 6,720	1,680
Aquatic Biota	Upstream	4	178	511	120	2.53	85.7	168
Fish	Downstream	4	<77.9	12.8	22.8	6.58	< 33.9	< 77.9
^{137}Cs	Effluent	4	263	293	39.3	10.4	54.4	88.1
(pCi/kg)	Composite	12	<77.9	511	47.1	6.58	34.3	65.1
Aquatic Biota	Upstream	4	120	1,460	158	3.86	293	325
Benthic	Downstream	4	150	218	195	1.19	198	198
^{137}Cs	Effluent	4	84.8	193	152	3.63	< 103	< 103
(pCi/kg)	Composite	12	84.8	1,460	165	2.90	125	131

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Aquatic Biota	Upstream	4	96.7	206	80.9	2.44	37.4	35.2
Vascular Plant	Downstream	4	< 90.3	216	120.0	1.52	< 79.1	< 90.3
^{137}Cs	Effluent	4	7.19	137	101	4.42	133	< 108
(pCi/kg)	Composite	12	7.19	216	99.5	2.69	50.9	< 90.3
Aquatic Biota	Upstream	4	208	1,040	814	2.25	233	206
Seston	Downstream	3	113	976	274	3.22	371	310
^{137}Cs	Effluent	4	638	947	1,505	2.60	38.6	152
(pCi/kg)	Composite	12	113	1,040	747	3.07	205	215
Aquatic Biota	Upstream	4	23.4	498	80.4	3.48	152	221
Fish	Downstream	4	13.0	287	46.4	3.37	83.4	124
^{95}Zr	Effluent	4	119	647	68.3	3.43	126	177
(pCi/kg)	Composite	12	13.0	647	63.6	3.30	121	174
Aquatic Biota	Upstream	4	65.5	3,580	239	4.84	823	993
Benthic	Downstream	4	45.4	552	205	3.07	295	295
^{95}Zr	Effluent	4	164	684	108	3.19	148	171
(pCi/kg)	Composite	12	45.4	3,580	167	3.54	412	486
Aquatic Biota	Upstream	4	18.0	291	42.4	2.98	61.6	93.5
Vascular Plants	Downstream	4	56.5	111	66.8	2.10	61.8	54.2
^{95}Zr	Effluent	4	25.4	165	74.8	3.69	142	2.65
(pCi/kg)	Composite	12	18.0	291	59.6	2.85	88.6	50.1
Aquatic Biota	Upstream	4	453	1,580	776	1.74	430	815
Seston	Downstream	3	438	2,590	1,025	2.57	1,180	1,696
^{95}Zr	Effluent	4	594	1,460	1,213	1.50	< 91.5	619
(pCi/kg)	Composite	11	438	2,590	970	1.86	422	984
Beef	F-44	4	10.4	22.6	16.8	1.56	18.1	15.1
^{137}Cs								
pCi/g Nat K								

II.I. ERRATA

The following tables have been completed to contain the results of sample analyses that were in progress at the writing of the last report. The addition of these new data did not change any of the conclusions given in the previous report and the values were used in calculating the mean values for the last full year in Table II.H.1.

Table II.D.5 should be replaced in the report for the last half of 1978. The Sr-89 and Sr-90 values for A-50 and all of the reference zone were miscalculated.

Table II. C.7
Strontium 90 Activity Concentrations in Bottom Sediment (pCi/kg).

	Sampling Locations	Monthly Collection Dates					
		1-20-79	2-24-79	3-10-79	4-21-79	5-26-79	6-16-79
	Effluent						
E 38:	Farm Pond (Goosequill)	117 (194)*	<193	a	<228	298 (366)	<166
E 41:	Slough to St. Vrain Creek	212 (189)	<146	708 (272)	<512	298 (366)	281 (296)
	Downstream						
D 37:	Lower Latham Reservoir	<179	<107	a	<215	<248	292 (199)
D 40:	S. Platte River Below Confluence	512 (263)	<130	a	<155	231 (202)	f
D 45:	St. Vrain Creek	f	<144	a	289 (288)	<850	<295
	Upstream						
U 42:	St. Vrain Creek	<198	<144	a	<305	<303	<163
U 43:	S. Platte River	<224	d	a	226 (220)	<261	<257

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
a. Sample lost prior to analysis.
f. Sample unavailable.
d Sample lost during analysis

Table II. C.8
Strontium 89 Activity Concentrations in Bottom Sediment (pCi/kg).

Sampling Locations		Monthly Collection Dates					
		1-20-79	2-24-79	3-10-79	4-21-79	5-26-79	6-16-79
	Effluent						
E 38:	Farm Pond (Goosequill)	<197	898 (401)*	a	<277	<429	<129
E 41:	Slough to St. Vrain Creek	<158	769 (317)	<242	<521	<429	<188
	Downstream						
D 37:	Lower Latham Reservoir	<152	595 (226)	a	<199	<178	<172
D 40:	S.Platte River Below Confluence	<145	733 (288)	a	<139	<189	f
D 45:	St. Vrain Creek	f	809 (314)	a	<233	<502	<231
	Upstream						
U 42:	St. Vrain Creek	<168	624 (366)	a	<276	<195	<144
U 43:	S. Platte River	<152	d	a	<165	<194	<210

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
a Sample lost prior to analysis.
f Sample unavailable.
d Sample lost during analysis

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in Forage for Samples Collected September 16, 1978.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	923 (299)*	20.8 (91.0)	<13.1
44 +	977 (300)	<20.9	131 (18.3)
Adjacent			
6 +	e	794 (861)	<16.8
28 +	516 (295)	<97.3	552 (49.1)
31 +	718 (296)	85.2 (108)	144 (25.3)
36 +	998 (301)	<40.2	102 (50.9)
48 +	1,377 (304)	<1.79	<12.3
50 +	e	<6.48	30.0 (6.36)
Reference			
16 +	476 (295)	<34.0	224 (25.8)
17 +	476 (295)	< 30.6	106 (21.3)
20	982 (300)	<101	275 (71.6)
22 +	e	143 (102)	62.5 (23.6)
23 +	e	178 (126)	209 (29.9)
25 +	e	< 91.5	643 (48.5)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
+ Silage or Dry Hay.
e Insufficient volume or weight for analysis.

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in Forage for Samples Collected May 12, 1979.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	<273	d	d
44	467 (258)*	<31.2	184 (28.9)
Adjacent			
6	334 (256)	<47.0	359 (52.7)
28	861 (262)	<61.4	145 (80.7)
31	570 (257)	<22.1	190 (20.2)
36	406 (257)	<35.8	134 (28.3)
48	e	<21.6	86.0 (23.1)
50	637 (260)	<38.7	185 (30.7)
Reference			
16	393 (257)	<43.3	178 (43.0)
17	673 (260)	<13.7	85.4 (16.4)
20	e	61.8 (26.6)	<12.7
22	<273	<18.9	133 (16.3)
23	527 (257)	<146	1,485 (114)
25	581 (259)	<30.7	115 (25.5)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
e Insufficient weight or volume for analysis.
d Sample lost during analysis

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in Forage for Samples Collected June 9, 1979.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	526 (278) *	<36.1	263 (27.0)
44	583 (277)	<36.8	442 (24.8)
Adjacent			
6	376 (277)	<27.9	267 (19.0)
28	<295	31.5 (39.6)	150 (24.5)
31	572 (277)	<20.2	137 (15.4)
36	891 (282)	<18.7	600 (19.9)
48	617 (279)	d	d
50	465 (278)	<70.2	90.0(17.6)
Reference			
16	426 (277)	<60.5	388 (50.9)
17	<295	<33.5	226 (26.9)
20	482 (278)	<24.6	184 (18.6)
22	416 (277)	38.1 (24.1)	107 (14.8)
23	762 (281)	390 (50.4)	179 (20.3)
25	<295	<18.4	126 (14.1)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

d Sample lost during analysis

Table II. E.1
Gross Beta and Radiostrontium Concentrations in Aquatic Biota
Samples (pCi/kg) for Samples Collected May, 1979 **

Sampling Locations *	Gross Beta	Strontium 89	Strontium 90
Fish			
Upstream 5-16-79	8,650 (384)	<95.8	240 (198)
Downstream 5-16-79	9,270 (388)	<104	205 (152)
Effluent 5-16-79	9,160 (690)	<52.4	114 (74.4)
Benthic Organisms			
Upstream 5-16-79	7,220 (469)	<128	226 (63.4)
Downstream	f	f	f
Effluent 5-16-79	6,800 (431)	d	d
Vascular Plants			
Upstream 5-26-79	23,600 (443)	<52.8	159 (49.5)
Downstream 5-26-79	857 (117)	<58.1	150 (60.6)
Effluent 5-26-79	40,400 (670)	<27.0	201 (33.8)
Seston			
Upstream 5-25-79	27,200 (1,080)	< 72.1	< 77.9
Downstream	f	f	f
Effluent	f	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.),
f Sample unavailable.
d Sample lost during analysis

Table II. E.1
Gross Beta and Radiostrontium Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected June 1979 .**

Sampling Locations *	Gross Beta	Strontium 89	Strontium 90
Fish			
Upstream	f	f	f
Downstream	f	f	f
Effluent 6-15-79	10,300 (415)	< 143	< 132
Benthic Organisms			
Upstream	f	f	f
Downstream	f	f	f
Effluent	f	f	f
Vascular Plants			
Upstream 6-9-79	19,200 (416)	< 23.6	46.4 (31.7)
Downstream 6-9-79	25,400 (492)	< 29.4	122 (26.0)
Effluent 6-9-79	34,400 (596)	< 33.7	270 (16.7)
Seston			
Upstream	f	f	f
Downstream	f	f	f
Effluent	f	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.),
f Sample unavailable.

Table II. E.2
Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples
(pCi/kg) for Samples Collected June, 1979 .**

Sampling Locations *		^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish				
Upstream		f	f	f
Downstream		f	f	f
Effluent	6-15-79	<250	<78.4	107 (75.3)
Benthic Organisms				
Upstream		f	f	f
Downstream		f	f	f
Effluent		f	f	f
Vascular Plants				
Upstream	6-9-79	< 88.5	152 (29.7)	82.2 (16.1)
Downstream	6-9-79	<252	<78.4	<33.2
Effluent	6-9-79	<255	<79.1	<33.5
Seston				
Upstream		f	f	f
Downstream		f	f	f
Effluent		f	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
f Sample unavailable.

Table II. E.2
Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples
(pCi/kg) for Samples Collected May, 1979 .**

Sampling Locations *	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish			
Upstream 5-16-79	<142	<43.9	49.2 (29.5)
Downstream 5-16-79	<98.2	<30.3	50.1 (22.6)
Effluent 5-16-79	<100	<31.1	43.0 (23.2)
Benthic Organisms			
Upstream 5-16-79	<503	169 (127)	146 ((49.9)
Downstream	f	f	f
Effluent 5-16-79	<845	< 261	177 (82.7)
Vascular Plants			
Upstream 5-26-79	<89.7	<27.8	<11.8
Downstream 5-26-79	<255	<79.1	<33.5
Effluent 5-26-79	<297	<92.3	<39.1
Seston			
Upstream 5-25-79	<10,400	<1,790	<650
Downstream	f	f	f
Effluent	f	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

f Sample unavailable.

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ (1 Year)	σ_g (1 Year)	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Aquatic Biota	Upstream	3	<28.8	<28.8	59.7	(1.66)	<28.8	<28.8
Fish	Downstream	3	<31.5	<31.5	75.6	(1.86)	<31.5	<31.5
^{89}Sr	Effluent	3	<27.2	<27.2	33.4	(1.58)	<27.2	<27.2
(pCi/kg)	Composite	9	<27.2	<31.5	53.2	(1.85)	<27.2	<27.2
Aquatic Biota	Upstream	1	<128	< 128	147	(2.12)	< 68.1	<128
Benthic	Downstream	0	NA	NA	148	(2.22)	166	NA
^{89}Sr	Effluent	0	NA	NA	135	(3.36)	< 113	NA
(pCi/kg)	Composite	1	<128	< 128	144	(2.25)	< 68.1	< 128
Aquatic Biota	Upstream	5	<23.6	<23.6	63.7	(2.75)	<23.6	<23.6
Vascular Plants	Downstream	6	<29.4	751	57.2	(2.77)	<29.4	166
^{89}Sr	Effluent	6	<27.6	458	67.4	(3.21)	<27.6	<27.6
(pCi/kg)	Composite	16	<23.6	751	62.6	(2.80)	<23.6	<23.6
Aquatic Biota	Upstream	4	<11.8	1,920	356	(6.27)	384	768
Seston	Downstream	4	<133	1,680	470	(3.18)	504	525
^{89}Sr	Effluent	2	26.9	2,590	150	(5.62)	586	1,310
(pCi/kg)	Composite	10	<11.8	2,590	304	(4.79)	479	745
Aquatic Biota	Upstream	3	68.3	240	150	(2.04)	184	126
Fish	Downstream	3	<38.6	205	127	(1.87)	145	110
^{90}Sr	Effluent	3	71.5	114	114	(1.43)	121	93.0
(pCi/kg)	Composite	9	<38.6	240	129	(1.76)	150	110
Aquatic Biota	Upstream	1	226	226	241	(1.42)	253	226
Benthic	Downstream	0	NA	NA	142	(1.87)	162	NA
^{90}Sr	Effluent	0	NA	NA	369	(1.42)	181	226
(pCi/kg)	Composite	1	226	226	233	(1.79)	198	226
Aquatic Biota	Upstream	4	46.4	331	91.9	(2.00)	112	169
Vascular Plants	Downstream	4	122	258	152	(1.49)	183	158
^{90}Sr	Effluent	4	20.3	270	87.9	(3.98)	119	177
(pCi/kg)	Composite	12	20.3	331	98.5	(2.60)	132	168

Table II.H.1. Mean Values for all Sample Types.(Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Forage	Facility	3	<31.2	<36.8	45.1	(3.29)	<20.9	< 31.2
^{89}Sr	Adjacent	11	<18.7	<31.5	44.0	(3.27	< 6.48	< 18.7
(pCi/kg)	Reference	12	<13.7	390	46.8	(2.33)	<13.7	<13.7
	Composite	26	<13.7	390	45.4	(2.80)	< 13.7	< 13.7
Forage	Facility	3	<13.1	603	5[illegible].6	(5.66)	202	296
^{90}Sr	Adjacent	11	<12.3	552	159	(3.00)	252	213
(pCi/kg)	Reference	12	<12.7	1,485	203	(2.46)	295	267
	Composite	26	<12.3	1,485	166	(3.09)	265	248
Forage	Facility	4	<38.3	29.6	62.4	(1.82)	18.0	13.0
^{106}Ru	Adjacent	12	<11.9	61.0	61.2	(3.20)	107	142
(pCi/kg)	Reference	12	<22.8	90.2	59.3	(2.50)	37.2	8.4
	Composite	28	<11.9	90.2	60.6	(2.67)	74.9	66.5
Forage	Facility	4	92.5	235	152	(1.53)	164	179
^{137}Cs	Adjacent	12	<15.3	430	89.0	(2.42)	124	109
(pCi/kg)	Reference	12	<17.1	327	87.1	(2.52)	125	99.4
	Composite	28	<15.3	430	95.4	(2.37)	130	135
Forage	Facility	4	29.3	2,030	83.8	(3.31)	260	549
^{95}Zr	Adjacent	12	13.3	63.2	43.0	(2.08)	56.2	29.0
(pCi/kg)	Reference	12	8.47	55.5	33.2	(2.66)	46.5	25.7
	Composite	28	13.3	2,030	42.3	(2.60)	81.6	102
Forage	Facility	4	12,900	31,200	17,400	(2.11)	20,600	18,200
Gross β	Adjacent	12	8,860	32,700	16,900	(2.08)	20,200	20,100
(pCi/kg)	Reference	12	12,800	32,100	16,000	(1.63)	17,600	18,800
	Composite	28	8,860	32,700	17,000	(1.99)	20,000	19,200

III. ENVIRONMENTAL RADIATION SURVEILLANCE PROGRAM SCHEDULE

III.A. Environmental Radiation Surveillance Schedule

Table III.A.1 outlines the collection and analysis schedule for the radiation surveillance program. This is identical to Table 5.9-1 in the Technical Specifications.

The surveillance program provides for collection and analysis of environmental samples within an area extending to a twenty-mile radius from the reactor site. A concentrated area of sampling within a one-mile radius is designated the "Facility" zone; the area from one to ten miles, the "Adjacent" zone; while the "Reference" zone extends from ten to twenty miles. The data obtained from the Facility zone are statistically compared to those from the Adjacent and Reference zones to test for any significant differences in values. A similar rationale is used for surface waters and sediments. These are partitioned into "Effluent" (Farm Pond and Slough), "Downstream" and "Upstream" locations for statistical analysis.

The sampling locations are shown in Figures III.B.1 and III.B.2. Table II.B.1, III.B.2, and III.B.3 give some detail of the sampling sites in the Facility, Adjacent and Reference zones respectively.

The following changes in sampling locations were made during the last half of 1979:

1. Effective 10/6/79 A-48 location was changed to the Bill Ray dairy, 17376 Weld County Road 46S. (The previous A-48 dairy went out of business).
2. Effective 10/15/79 air sampling station A-35 was changed to the Walter Maier home 9704 State Highway 66, Platteville, CO. TLD devices have been left at the old A-35 site to document the long standing fluctuations noted there.

TABLE III. A.1. ENVIRONMENTAL RADIATION SURVEILLANCE PROGRAM SCHEDULE

Exposure Routes or Media & Sample Types (No. of Locations)	SAMPLING FREQUENCIES AND ANALYSES - by Action Levels, based upon actual emissions as percentages of release rates authorized by 10 CFR 20		
	Action Level 1: Less than 3%	Action Level 2: 3% to 10%	Action Level 3: Greater than 10%
EXTERNAL EXPOSURE TLD Chips (36 locations)	Average mR/day determined by QUARTERLY cumulative exposures; collection and analysis in rotation of 1/3 of all TLDs MONTHLY.		Average mR/day determined by MONTHLY analysis of all TLDs.
ATMOSPHERE Membrane filters for particulates, charcoal cartridges for iodine. (7 locations)	Gross beta, every filter, WEEKLY; gamma spectrum of filter and cartridge composites, MONTHLY.	Same as for Level 1, plus gross alpha on one weekly set of filters, MONTHLY.	Gross alpha and beta, every filter; gamma spectrum of filter and cartridge composites, all WEEKLY.
Tritium oxide (7 locations)	Specific activity of tritium in atmospheric water vapor by passive absorption and liquid scintillation counting. QUARTERLY	MONTHLY	WEEKLY
WATER Potable water (2 locations: F49 & D39)	Gross beta, tritium and gamma spectrum analyses; Facility area and nearest off-site supply (shallow wells at town of Gilcrest, 6 miles northeast). QUARTERLY	MONTHLY	MONTHLY, plus Sr 89 & 90 analyses
Precipitation (2 locations: F1 & F4)	No collection or analyses of precipitation at Level 1.	Gross beta, MONTHLY	Gross beta, tritium and Sr 89 & 90, MONTHLY; gamma spectrum of composite, QUARTERLY.
Surface water & silt (7 locations)	Gross beta, tritium and gamma spectrum, QUARTERLY.	Same as for Level 1, but MONTHLY.	Same as for Level 2, plus Sr 89 & 90 analyses, MONTHLY.
FOOD CHAINS Soil, forage & crops (14 locations)	Tritium and gamma spectrum analyses of forage and crops in the most probable routes to man. QUARTERLY, as available (i.e., spring, summer and fall).	MONTHLY during growing season (i.e., approx. April to October).	Same as Level 2, plus Sr 89 & 90, plus concurrent soil samples analyzed for the same nuclides, MONTHLY during growing season.
Beef cattle (F-1)	No analysis of beef at Level 1.	Gamma spectrum, tritium and Sr 89 & 90 analyses on one meat sample from beef raised in Facility Area; ANNUALLY, at end of grazing season (i.e., late fall).	Same as for Level 2, plus total body count of 2 to 4 animals from Facility Area, QUARTERLY.
Milk (13 locations)	Tritium, gamma spectrum and Sr 89 & 90 analyses on composite: Facility Area only, QUARTERLY.	Facility, Adjacent and Reference Areas; MONTHLY during pasture season, otherwise QUARTERLY.	Same as for Level 2, but WEEKLY during pasture season, otherwise, MONTHLY.
AQUATIC BIOTA (2 streams, above and below discharge points)	Gross beta and gamma spectrum analyses of composites of each of 4 categories: (1) suspended organisms, (2) benthic organisms, (3) vascular plants and (4) fish. QUARTERLY, as available.	MONTHLY during summer; otherwise QUARTERLY, as available.	Same as for Level 2, plus Sr 89 & 90 analyses.

Table III.8.1. Facility area and effluent sampling locations for environmental media.

Loc. No.	Media Sampled at Location						Location and Description (see Fig. II.8.1) Distance and Direction from Reactor; Comments	
	TLD	AIR	M	S	H_2O	AQB		
F 1	*	**					0.8 mi. N;	potato cellar; TLD on pole at NE corner barn; precipitation on hill E of barn
F 2		*					1.1 mi. NNE;	cabin.
F 3	*	*					0.7 mi. SE;	old dairy barn; TLD on 1st pole N of drive.
F 4	*	**		*			0.8 mi. S;	first shed along drive; precipitation in corral; forage and soil S of shed.
F 7	*						0.8 mi. NNE;	pole by gate at corner of Goosequill Rd.
F 8	*						0.6 mi. NE;	2nd pole S of cattle-guard on hill.
F 9	*						0.8 mi. SSE;	2nd pole W of pump house.
F 11	*						0.9 mi. SSW;	0.3 mi. W of intersection of 19½ and 34.
F 12	*						0.8 mi. SW;	7th pole N of intersection.
F 13	*						0.6 mi. WSW;	pole nearest intersection.
F 14	*						1.0 mi. NW;	pole nearest corner.
F 44			*	*			1.1 mi. E;	Leroy Odenbaugh dairy.
F 51	*						0.3 mi. N;	Ted Horst farm, pole SW of house.
F 46	*						1.0 mi. SW;	2nd pole N of intersection, near Aristocrat Angus office.
F 47	*						0.4 mi. E;	pole near driveway to pump house.
F 49					*		0.1 mi. W;	tap outside Visitors Center (well water)
E 38					*	*	1.3 mi. NNE;	Goosequill pond.
E 41					*		0.2 mi. NW;	Concrete slough above and below point of entry of plant water.

Codes:
- F = Facility area (within one mile).
- E = Effluent surface streams.
- TLD = Thermoluminescent Dosimeter for measuring external gamma exposure.
- AIR = Air sampling location; ** = atmospheric precipitation collected.
- M = Milk sampling locations.
- H_2O = Water sampling locations; silt also sampled from surface sources.
- AQB = Aquatic biota sampling locations.
- S = Soil and Forage sampling locations.

Table III.B.2 Adjacent area sampling locations for environmental media.

Loc. No.	Media Sampled at Location						Location Description (see Figs. II.B.1 and II.B.2) Distance and Direction from Reactor; Comments	
	TLD	AIR	M	S	H_2O	AQB		
A 5	*	*					4.5 mi. NNE;	Lloyd Rumsey farm; 2 mi. N, 1.5 mi. W of Peckham.
A 6	*	*	*	*			5.5 mi. S;	Clifton Wissler farm; 2 mi. W, 2.5 mi. S of Platteville; TLD on pole 30 ft. N of parlor.
A 27	*						5.0 mi. NW;	1 mi. S of Colo. 56, 1 mi. E of I-25, pole on NE corner.
A 28	*		*	*			6.0 mi. NW;	Virgil Podtburg dairy; Colo. 60, 2 mi. W of Johnstown; TLD on last pole on NE corner.
A 29	*						3.5 mi. NNW;	3 mi. S; 1.6 mi. E of Johnstown, TLD on pole by the stand of trees.
A 30	*						3.5 mi. NE;	1 mi. S of Colo. 256 on Colo. 60, pole on NE corner.
A 31	*		*	*			6.0 mi. ENE;	1.5 mi. E of Peckham; TLD on pole in front of house.
A 32	*						4.0 mi. E;	3 mi. N of Platteville; 1.2 mi. E of US 85; NW pole.
A 33	*						5.0 mi. SE;	Niles Miller Dairy; 0.2 mi. S, 0.5 mi. E of Platteville.
A 34	*						6.5 mi. SW;	1 mi. E of I-25 at Colo. 254; pole on SW corner.
A 35	*	*					3.5 mi. SSW;	Walter Maier farm; 9704 State Hwy 66; ¼ mi. w of Jt.Col.66 & Rd 21
A 36	*		*	*			8.0 mi. W;	Bob Johnson dairy; 2 mi. W of I-25 on Colo. 56, then 1.5 mi. S. TLD 0.5 mi. W.
A 48			*	*			6.0 mi. NNE;	Bill Ray Dairy 17376 Weld Cty Rd 46; ½E of US 85 on Rd 46
A 50			*	*			4.5 mi. SE;	0.8 mi. E of Platteville.
D 37					*		12.5 mi. ENE;	Lower Lathan Res.; 2.5 mi. E of LaSalle.
D 39					*		5.0 mi. ENE;	Gilcrest water from U.S. Post Office
D 40					*	*	5.5 mi. ENE;	South Platte River at Colo. 60.
D 45					*	*	1.0 mi. N;	St. Vrain Creek at Jct. Rd. 19½, 0.2 mi. from discharge.

Codes: A = Adjacent area (one to ten miles from reactor).
D = Downstream potable or surface waters.

All other symbols same as for Table III.B.1.

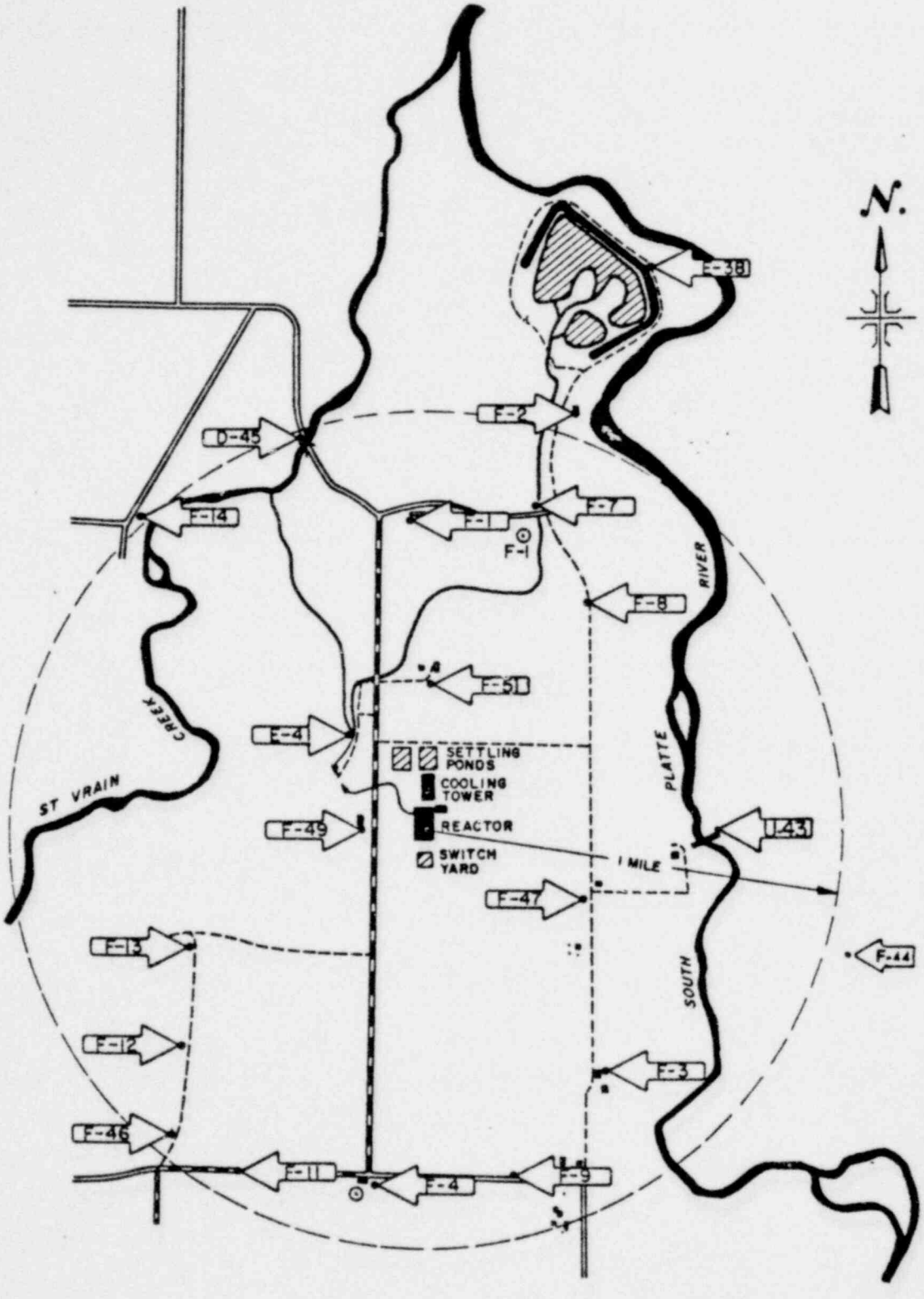
Table III. B.3. Reference area and upstream sampling locations for environmental media

Loc. No.	Media Sampled at Location						Location Description (see Figs. II. B.1. and II. B.2.) Distance and Direction from Reactor; Comments.
	TLD	AIR	M	S	H_2O	AQB	
R 15	*						11.5 mi. NW; 4.2 mi. W of I-25 on Colo. 60; TLD on pole W of farm driveway.
R 16	*	*	*	*			11.8 mi. NNW; Mountain View Farms; N side of Colo. 402 W of I-25.
R 17	*		*	*			11.8 mi. NNE; Bob Schneider Dairy; 1 mi. S of US 34 on RD 25; on pole 0.5 mi. N of parlor on RD 25.
R 18	*						10.0 mi. NNE; on pole on SE corner of intersection of 65th Ave. and 37th Street (Greeley).
R 19	*						1[illegible] mi. NNE; US 34 at 47th Ave. (Greeley); pole on SW corner, opposite golf course.
R 20	*		*	*			11.1 mi. ENE; Wally Kaufman dairy; 0.5 mi. E; 1.6 mi. S of LaSalle; TLD on pole W of parlor.
R 21	*						11.9 mi. E; 5 mi. E of US 85 on Colo. 256; then 1 mi. S; TLD on pole on SW corner.
R 22	*		*	*			11.1 mi. SE; Hagans Bros. Dairy; 4.2 mi. S of Platteville; 4.2 mi. E of US 85; TLD on 1st pole E of drive.
R 23	*		*	*			11.5 mi. S; Alvin Dechant Dairy; 2.2 mi. W; 0.3 mi. S of Ft. Lupton; TLD on 1st pole W on drive.
R 24	*						12.2 mi. SSW; I-25 at Colo. 52; pole W. of the frontage road; NW corner.
R 25	*		*	*			11.7 mi. WSW; Angelo Vendegna Dairy; 4 mi. N of Colo. 52 on RD 1.
R 26	*						12.2 mi. WNW; On US 287, 2.5 mi. of Colo. 56, 2nd pole S on RD 2E.
U 42					*	*	1.5 mi. WSW; St. Vrain Creek at bridge, RD 34.
U 43					*	*	0.6 mi. E South Platte River, at dam and inlet ponds.

Codes: R = Reference area (greater than 10 miles from reactor).
U = Upstream from effluent discharge points.

All other symbols as in Table III B.1.

Figure III.B.1. On-site Sampling Locations.



On-site and close-in sampling locations.
F = facility area, E = effluent stream,
U = upstream, D = downstream.

Figure III.B.2 Off-site Sampling Locations.