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Subject: **SUPPLY SYSTEM NUCLEAR PLANT NO. 2**
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
1995 ANNUAL REPORT

References: 1) WNP-2 (Operating License No. NPF-21), Technical Specification 6.9.1.10
2) EFSEC Resolution No. 260, January 13, 1992

Enclosed are three (3) copies of the subject report which are submitted per the referenced requirements.

Sincerely,

R.L. Webring (Mail Drop PE08)
Vice President, Operations Support/PIO

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L Albin (WDOH)	KE Perkins, Jr (NRC RIV, WCFO)
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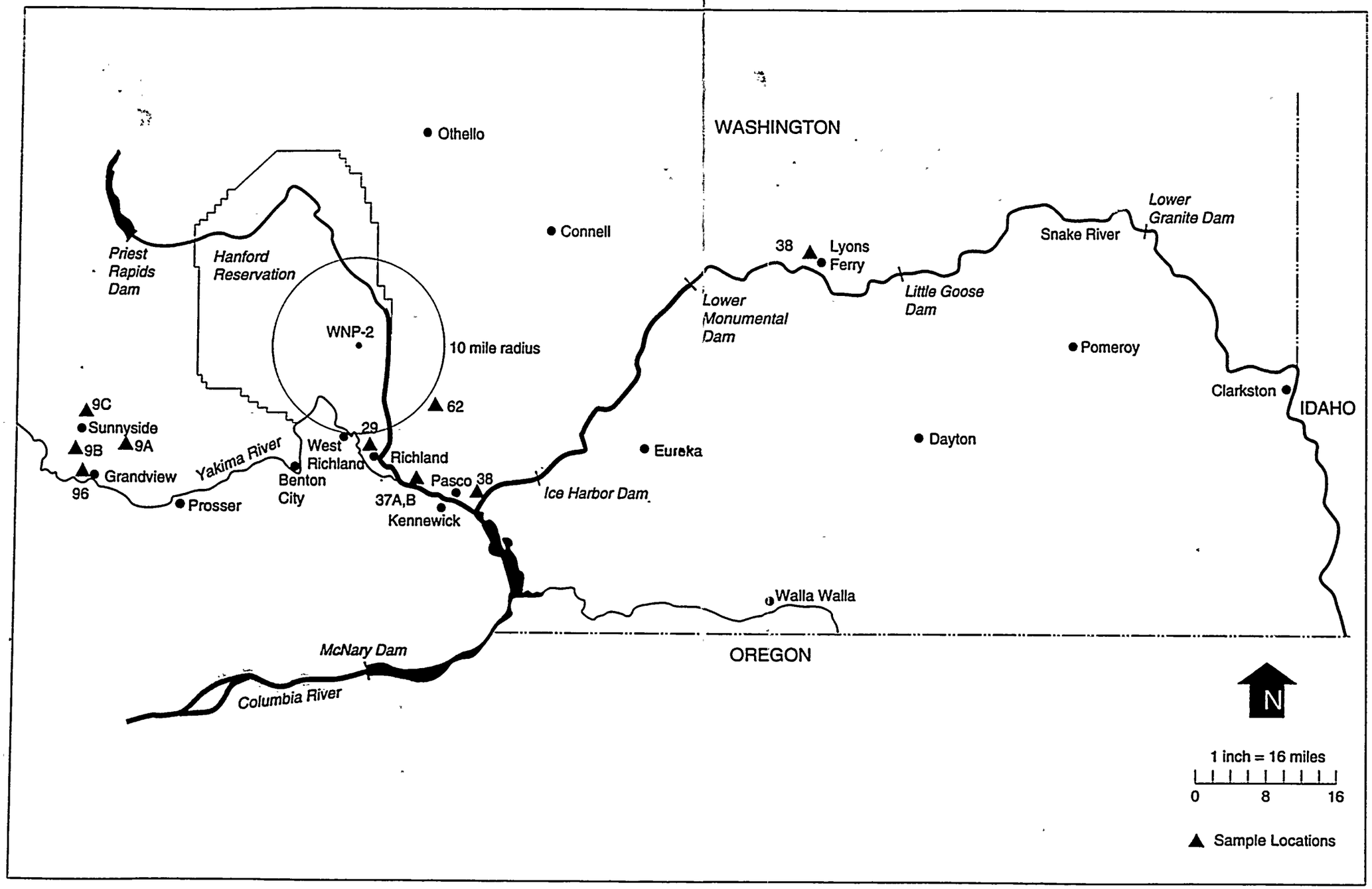

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FIGURE 4-2 REMP SAMPLING LOCATIONS OUTSIDE THE 10-MILE RADIUS

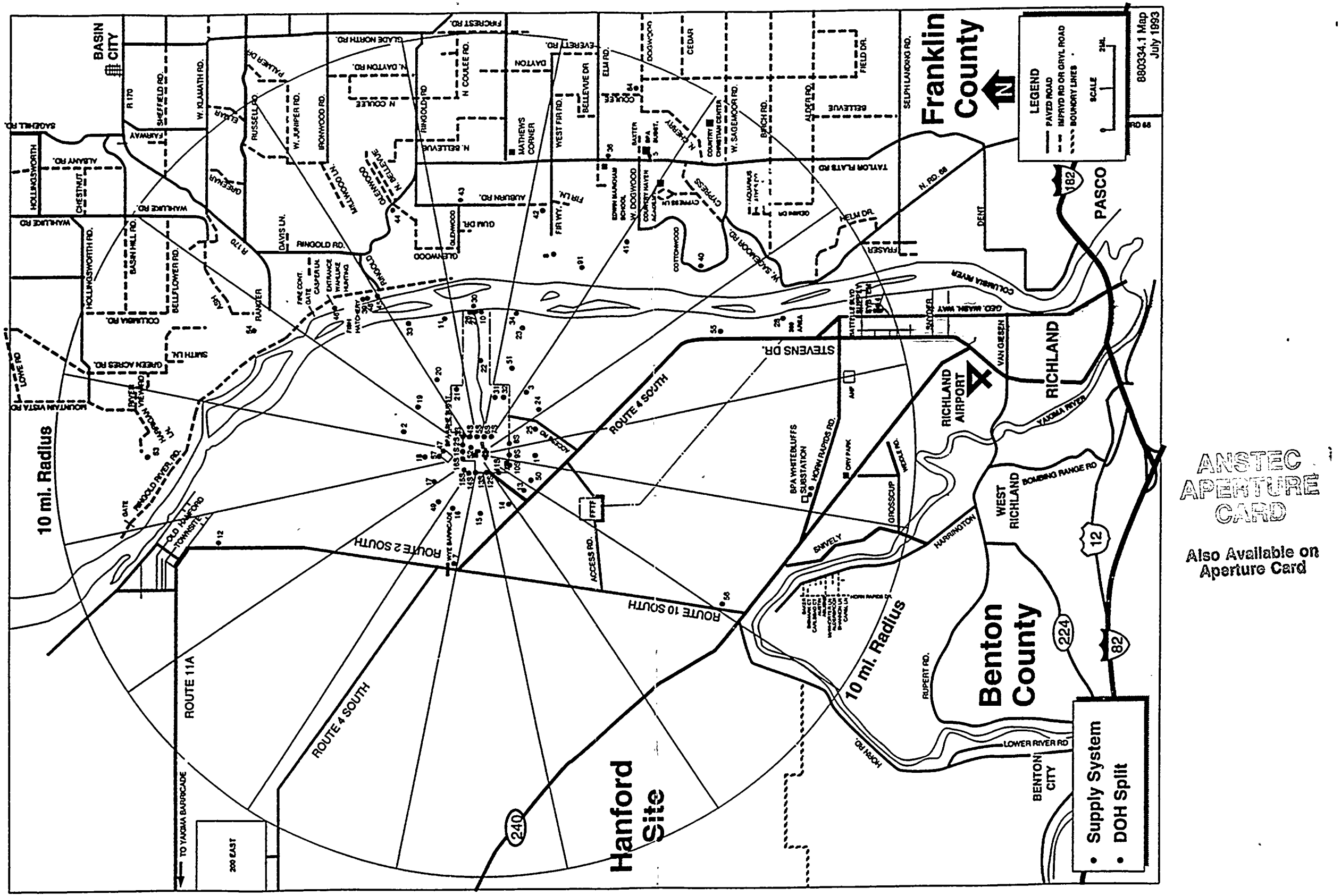

FIGURE 4-1 REMP SAMPLING LOCATIONS WITHIN THE 10-MILE RADIUS

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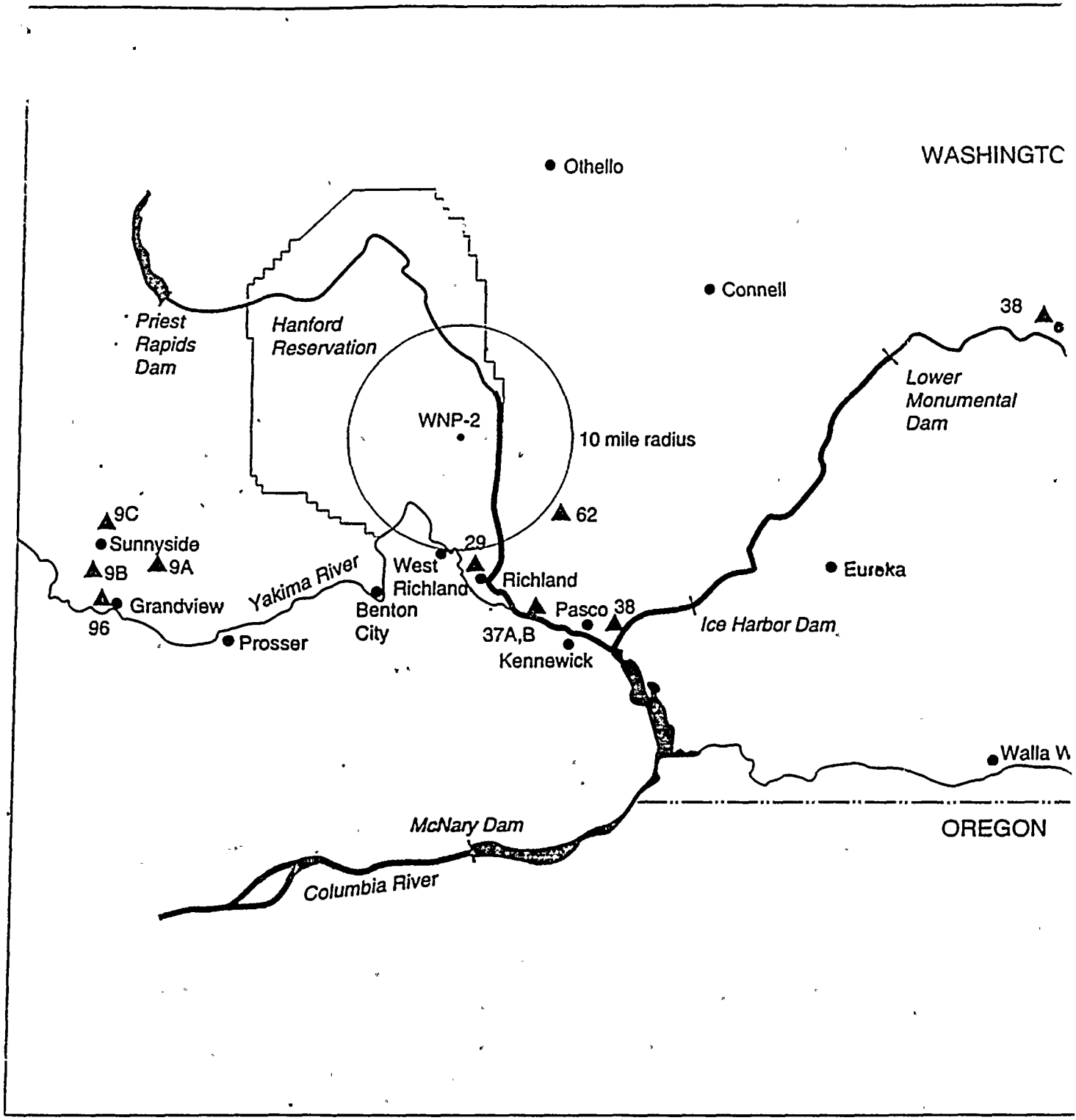
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Othello
Connell
Priest
Rapids
Dam
Hanford
Reservation
WNP-2
10 mile radius
38
Lower
Monumental
Dam
62
9C
Sunnyside
9B
9A
29
West
Richland
Richland
Eureka
Yakima River
Grandview
96
Benton
City
Pasco
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Ice Harbor Dam
37A,B
Kennewick
Prosser
Walla W
McNary Dam
OREGON
Columbia River

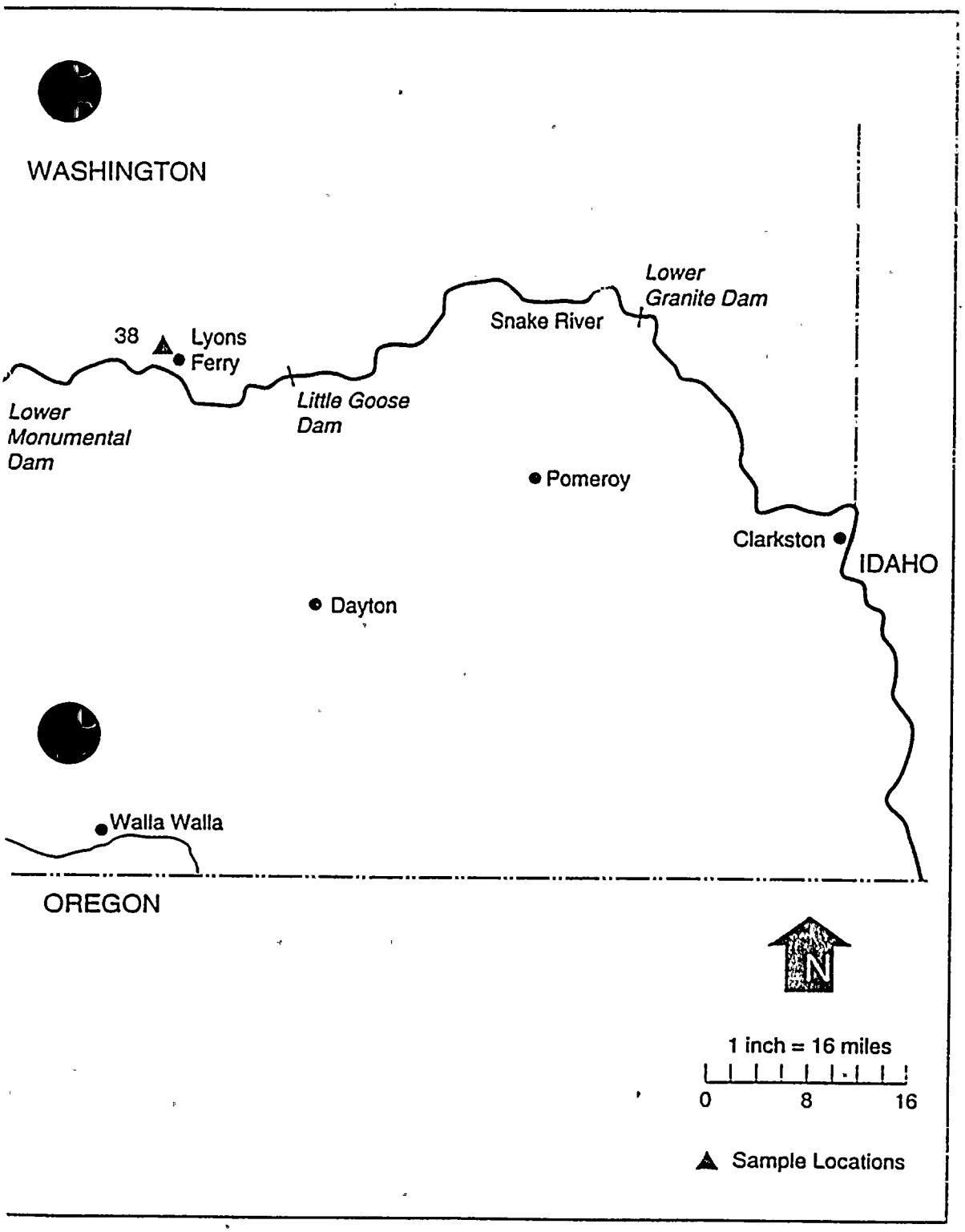

FIGURE 4-2 REMP SAMPLING LOCATIONS OUTSIDE THE 10-MILE RADIUS

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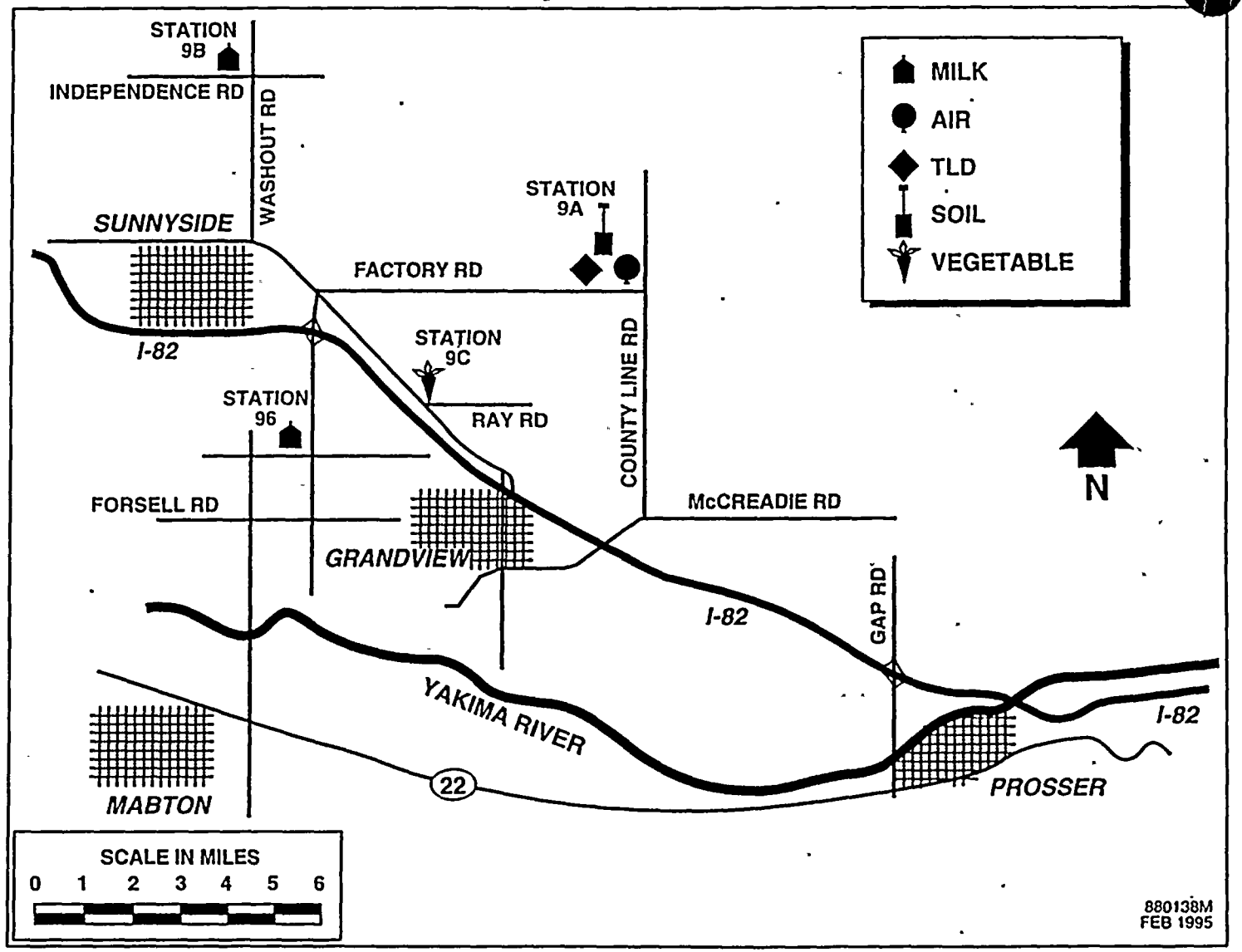

FIGURE 4-3 REMP SAMPLING LOCATIONS SUNNYSIDE/GRANDVIEW AREA

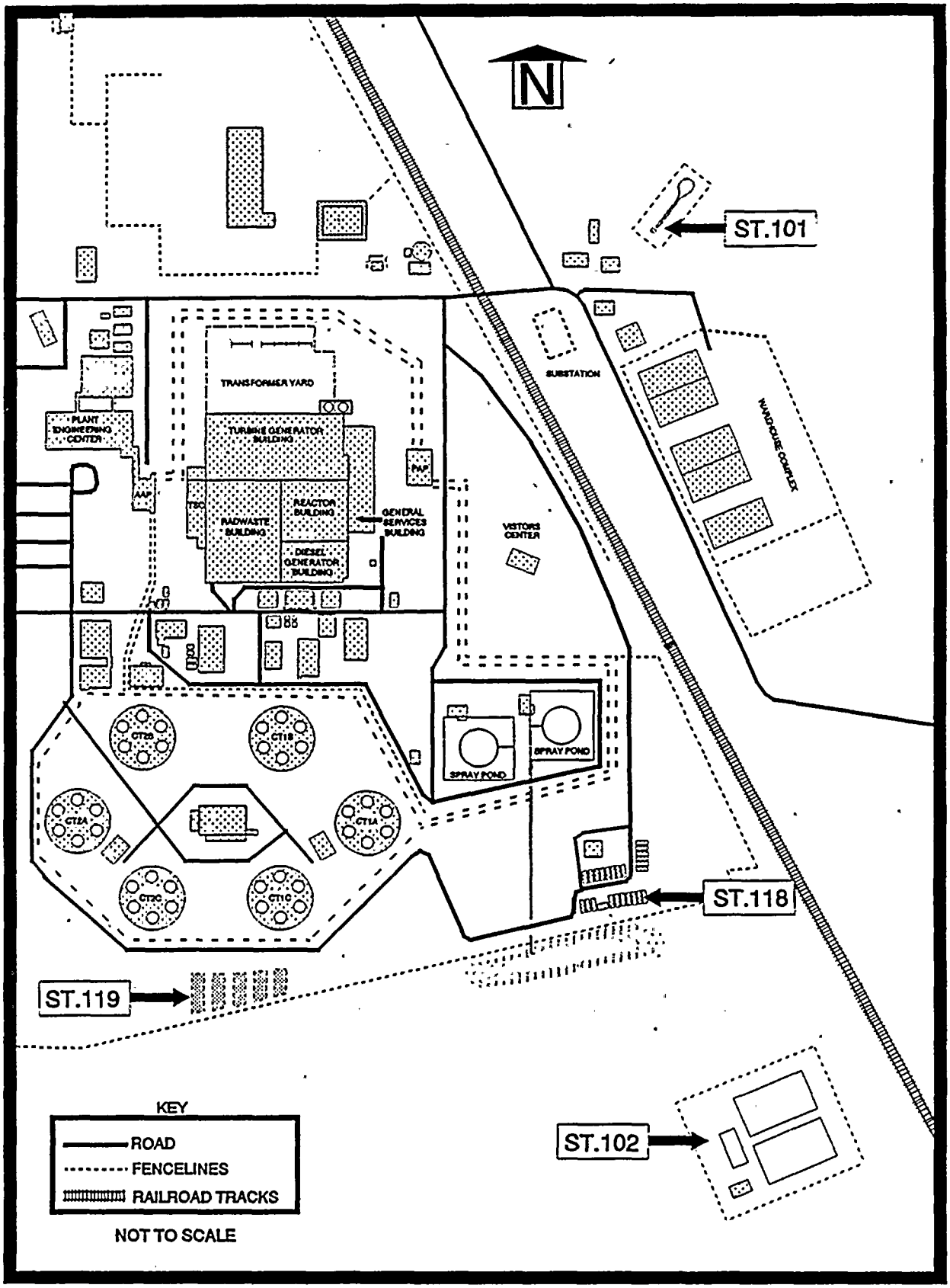

FIGURE 4-4 REMP NEAR PLANT SAMPLING LOCATIONS

5.0 RESULTS AND DISCUSSION

During 1995, the analyses of REMP samples were performed by Teledyne Brown Engineering Environmental Services in Westwood, New Jersey. The thermoluminescent dosimeters were processed by the Supply System External Dosimetry Laboratory. Table 5-1 presents the means and ranges of selected 1995 results for each type of sample collected and Table 5-3 provides a summary of detectable results. The means and ranges of the preoperational and the previous operational data from 1984 to 1994 are also included in the table for comparison. The data tables of 1995 results comprise a separate volume that is available to interested parties.

The data for the preoperational period and the first six months of 1984 included "less than" (<) designations for results below the actual LLD, the contractual LLD, or the two-sigma error, depending upon the convention employed by the analytical contractor. Consequently, the data averages using "less than" values are biased high. The use of the "less than" values was discontinued in mid-1984. Since then, REMP data have been reported as net (total results minus the detector counting background).

Since the primary focus of the REMP is to determine whether Plant 2 operations had an impact on the environment, the 1995 results are compared in this report to the results during the preoperational period and the results obtained during the previous years of Plant 2 operation. They are also compared to state and federal regulatory limits. Because of the use of "less than" values, rather than net results, during the preoperational period and during the first year of operation, and because of the impact of the 1986 Chernobyl accident on environmental radiation levels, the interpretation of the 1995 measurements relative to previous measurements must bear this in mind. Some of the parameters considered in the evaluations discussed in this report are the means, ranges and standard deviations or standard errors of the results. Comparative plots and frequency distributions of the data are some of the tools that have been employed in the interpretation of the 1995 REMP data.

The 1995 analytical results for the REMP sampling locations established since the preoperational period are very similar to the results reported for previous years. The 1995 annual and quarterly TLD results were also very much like those observed previously. No significant trends indicating an environmental impact or unexpected change in the environmental concentrations or exposure rates at REMP monitoring stations were observed.

5.1 Direct Radiation

Summaries of the environmental radiation exposure rates, determined by thermoluminescent dosimeters (TLDs) are presented in Tables 5-4 and 5-5, and 5-6.

Figure 5-1 presents a plot of the mean 1995 quarterly TLD results for each of the sixteen meteorological sectors at the site boundary ("S" stations). The chart also includes preoperational and previous operational periods.

The relationship of the mean 1995 results to the results for the preoperational and previous operational periods is very similar for each sector. This indicates that there were no significant directional effects observed in the 1995 TLD results.

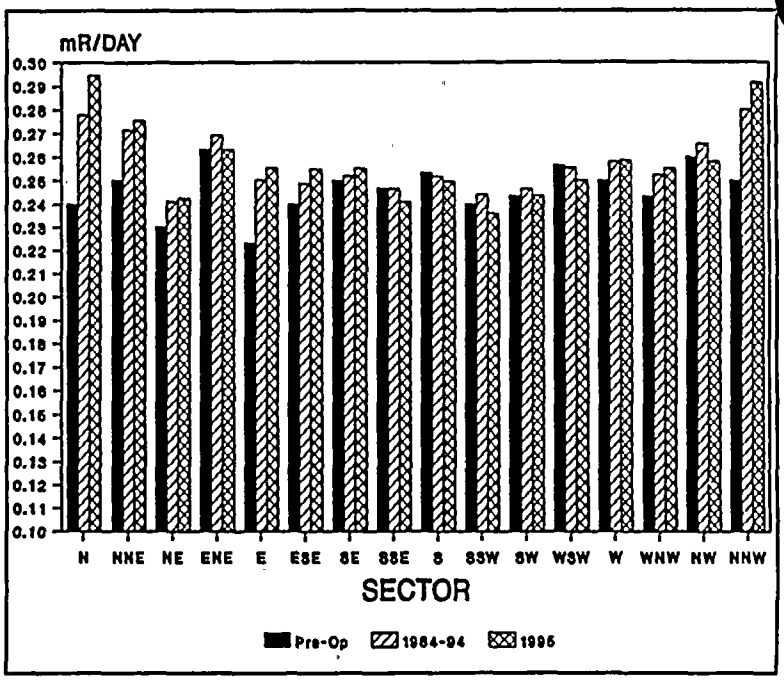

Figure 5-1 Site Boundary Quarterly TLDs - Annual Mean by Sector

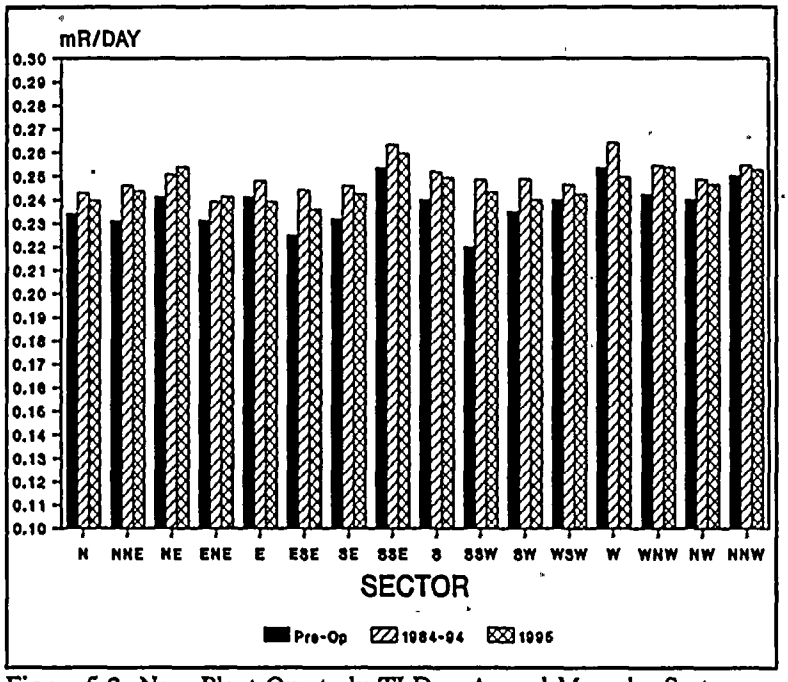

Figure 5-2 Near-Plant Quarterly TLDs - Annual Mean by Sector

The higher exposures in the N, NNE, and NNW sectors for the "S" stations is a result of those TLDs being physically closer to the plant than those of the "S" station TLDs. It also reflects the more operational days and the power uprate of the plant. Compare the data presented in Figure 5-1 with that of Figure 5-2, where the near-plant TLDs are of more an evenly placed distance from the plant.

Because there are fewer data points to average in a year than in the preoperational or previous operational periods, the 1995 results tend to average slightly higher. Overall, the results were within ranges observed previously.

For the remote TLDs, Station 46 in the Wahluke Reserve (NE sector) remained the location with the highest mean exposure rate, as shown in Figure 5-3.

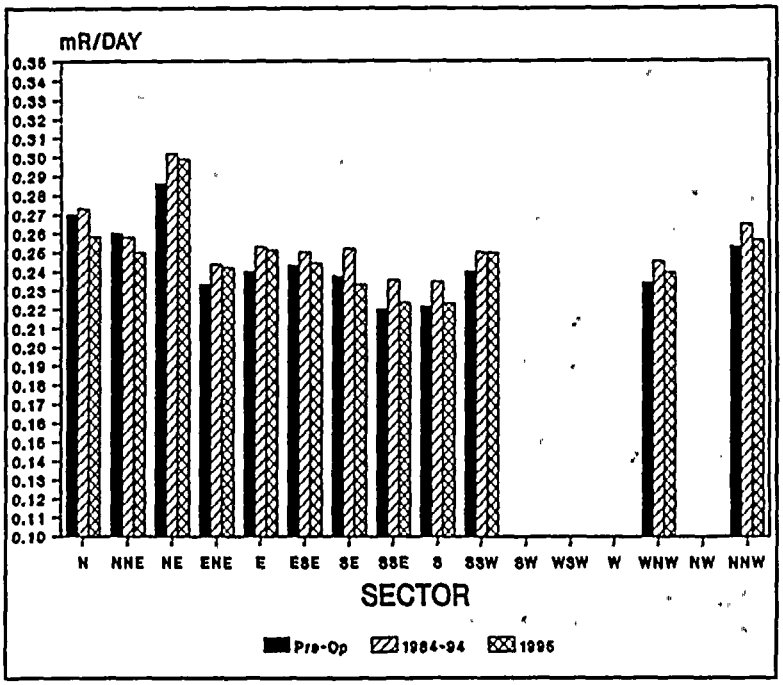

Figure 5-3 Remote Quarterly TLDs - Annual Mean by Sector

Since the preoperational measurement phase, the results for this location have exceeded the results for all other locations. Variations in the soil and underlying rock composition most likely account for localized differences such as shown in the TLD results for Station 46.

Frequency distribution plots of the 1995 quarterly TLD results are presented in Figure 5-4. The plots are very similar from quarter to quarter, with 0.26 mR/day being the most frequent result and with the Station 46 results being upscale and separate from the main distribution. The frequency distributions for the previous operational TLD results are shown in Figure 5-5.

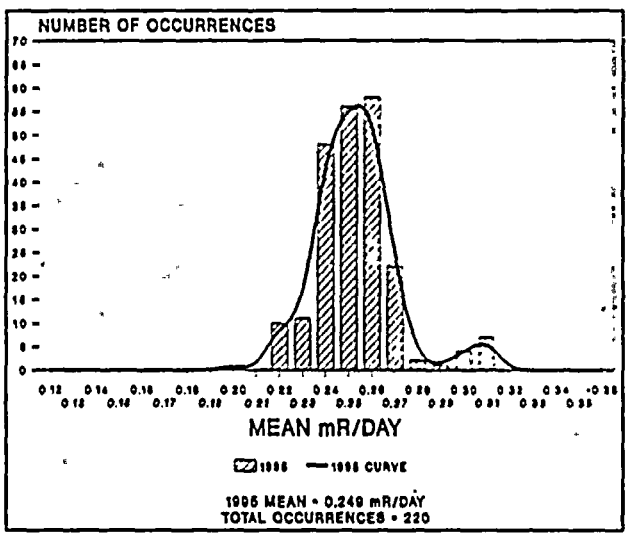

Figure 5-4 Frequency Distribution for 1995 Quarterly TLDs

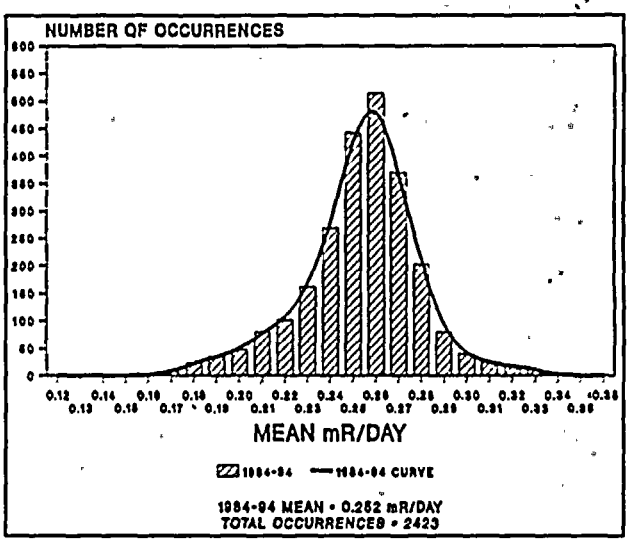

Figure 5-5 Frequency Distribution for 1984-94 Quarterly TLDs

5.2 Airborne Particulate/Iodine

The 1995 mean weekly gross beta on particulate filter results for selected indicator stations near Plant 2 are plotted in Figure 5-6. The gross beta in air results for 1995 were within the ranges observed during the preoperational period and during previous operational periods, as shown in Table 5-1. In Figure 5-7, the similarity between results from near-plant locations and those from remote locations can be seen. The control location (Station 9A) results follow a very similar pattern to the remote and near-plant indicator locations. As observed previously, gross beta levels increased during periods of inversion occurring in the fall and winter months. In fact, the gross beta results plotted over a period of several years show a cyclic pattern of fall and winter increases. The increase, which was evident in the results of all the air sampling locations, is due to an increase in radon and radon daughter concentrations during the inversions.

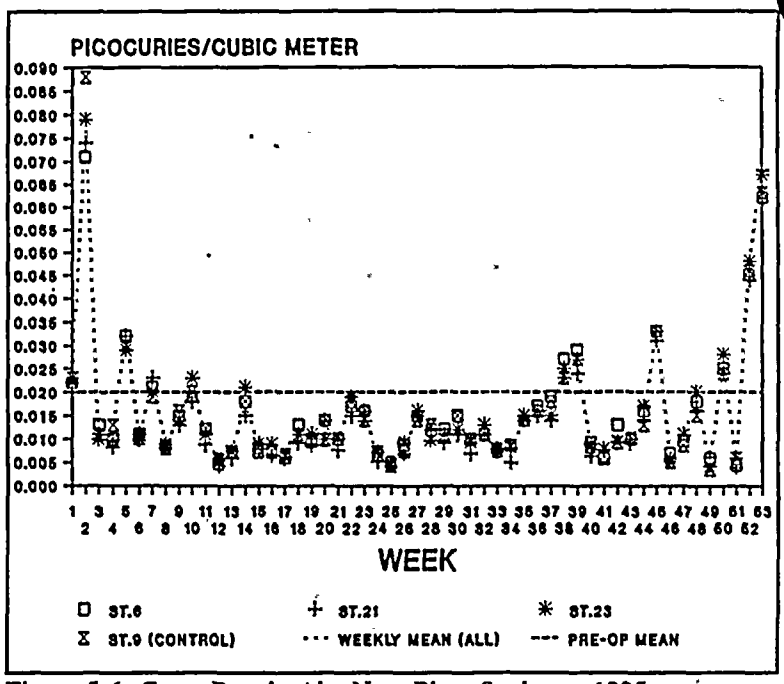

Figure 5-6 Gross Beta in Air, Near-Plant Stations - 1995

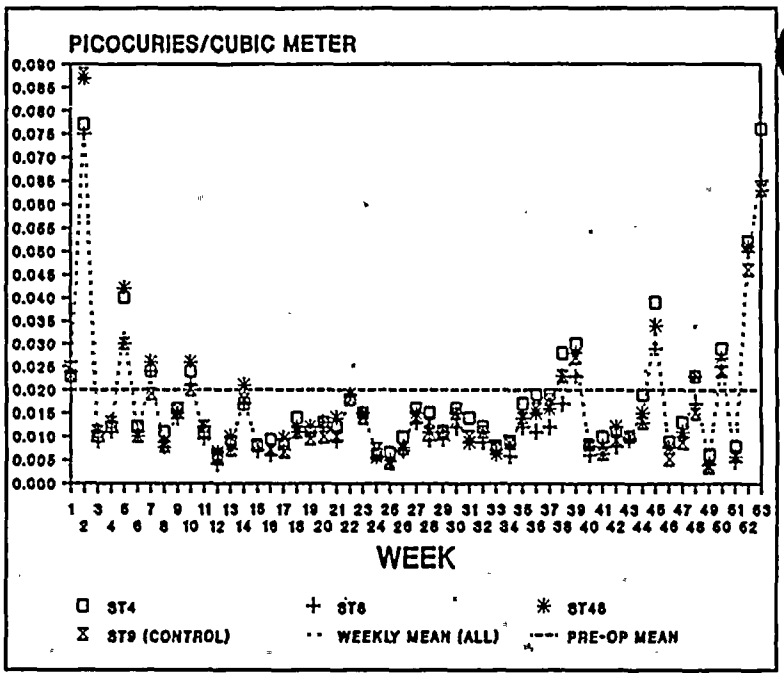

Figure 5-7 Gross Beta in Air, Remote Stations - 1995

The quarterly gamma analyses of the particulate filter composites indicated only the presence of two naturally-occurring radionuclides, beryllium-7 and potassium-40, at levels above detection limits at indicator locations and the control location. All iodine-131 in air results for 1995 were less than 0.02 picocuries/cubic meter (pCi/m^3) LLD.

No evidence of any impact of plant operations on the environment was apparent in the particulate filter and charcoal cartridge results for 1995.

5.3 Water

All river/drinking water results for gross beta were within the ranges normally observed and less than 8 picocuries/liter (pCi/l), the level at which a strontium analysis is performed to verify compliance with the Washington State drinking water standard for strontium-90*. The 1995 gross beta concentrations in river/drinking water, relative to the state annual average concentration limit[11], are presented in Figure 5-8. The mean gross beta results in discharge water, for 1995 are presented in Figure 5-9. The 1995 average results compare well to the averages from previous periods.

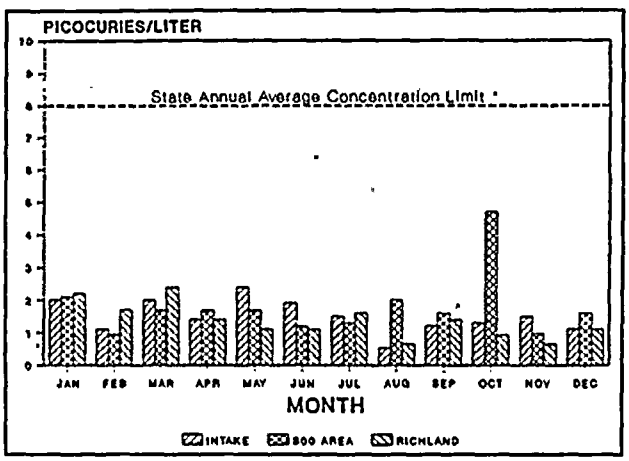

Figure 5-8 Gross Beta in River/Drinking Water-1995

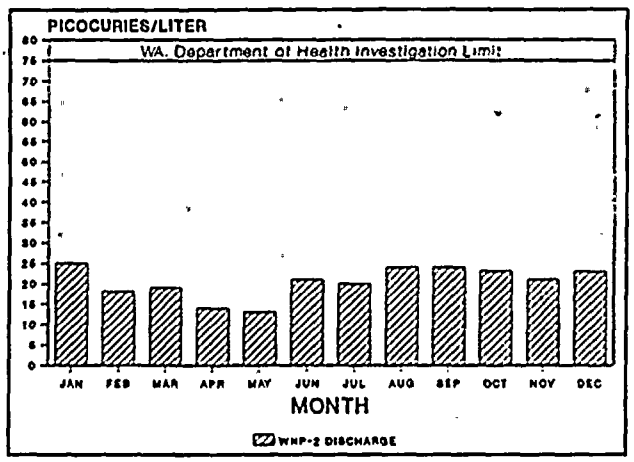

Figure 5-9 Gross Beta in Cooling Tower Discharge Water-1995

The gross beta levels in the discharge sample reflect the concentrations of naturally-occurring radionuclides, principally potassium-40, and any radionuclides from upstream sources of past Hanford activities present in the makeup water, in addition to radionuclides from Plant 2 discharges. The discharge sample results are representative of the radioactivity present in plant discharges before any mixing with river water occurs. All results were below the level Washington Department of Health's (WDOH) investigation level, which is the point the Supply System would notify WDOH of the result.

The 1995 tritium levels in the river/drinking water and groundwater were comparable with results obtained for prior years. Tritium levels in the discharge water were higher than the levels observed for the river/drinking water samples because of plant releases and because discharge water samples are taken prior to the water reaching the river and becoming diluted. As shown in Figure 5-10, the concentration of tritium was lower than the mean levels observed for the 1992 through 1994 periods. This reduction is due to an overall reduction in the volume of the radwaste discharges and the finding that a corrosion inhibitor used in Plant 2 (now discontinued) had been introducing small amounts of boron into the primary system, which helped to increase tritium levels.

Tritium concentrations in the discharge water for 1995 ranged from 87 to 4100 pCi/l, which is low when compared to the NRC reporting level of 20,000 pCi/l for a quarterly average concentration in drinking water.

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*Strontium-90 is assumed to account for the gross beta result.

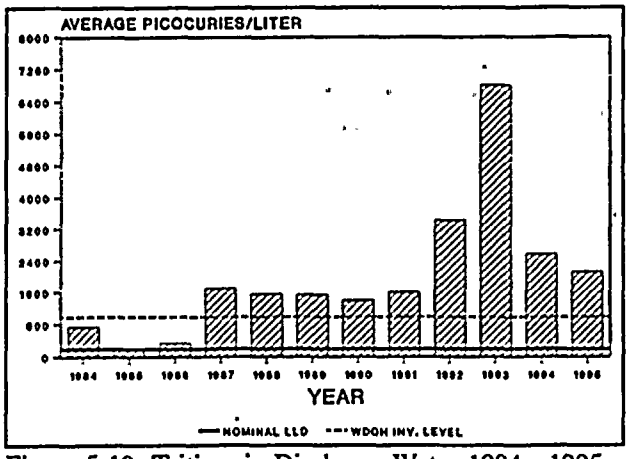

Figure 5-10 Tritium in Discharge Water 1984 - 1995

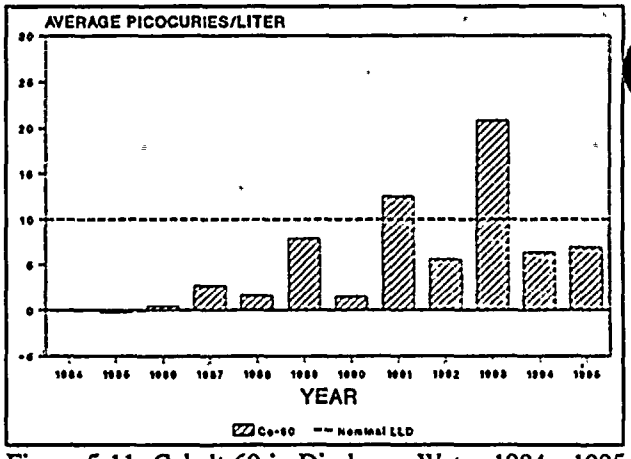

Figure 5-11 Cobalt-60 in Discharge Water 1984 - 1995

Figures 5-11, 5-12, and 5-13 show the annual averages for cobalt-60, zinc-65 and cesium-137 in discharge water from 1984 to 1995. As can be seen, the averages compare well with those of previous years.

For gamma in discharge water, only cobalt-60 and cesium-137 were detected in samples during 1995. The detectable cobalt-60 results ranged from 6.5 to 28.6 pCi/l, detectable cesium-137 results were 6.8 and 7.8 pCi/l. Although above detection levels, these results were low and did not exceed any reporting levels.

There were no detectable nuclides in the river/drinking water samples during 1995. In groundwater samples, potassium-40, a natural occurring radionuclide, was detected at a level of 66.5 pCi/l once at Station 31 in 1995.

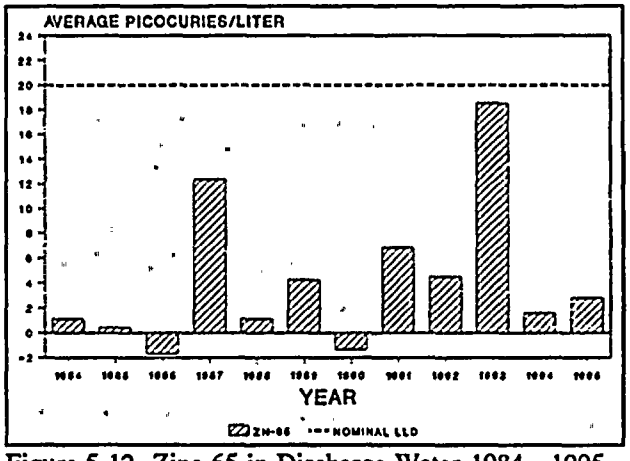

Figure 5-12 Zinc-65 in Discharge Water 1984 - 1995

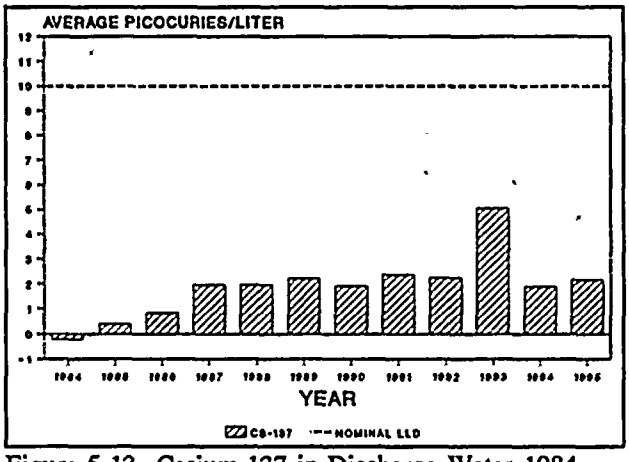

Figure 5-13 Cesium-137 in Discharge Water 1984 - 1995

5.4 Soil

Gamma spectrometry performed on soil samples in 1995 indicated a range of cesium-137 from 13.1 picocuries/kilogram (pCi/kg) to 195 pCi/kg at the indicator stations. As shown in Table 5-1, and presented in Figures 5-14 and 5-15, the cesium-137 levels in the soil samples were well within the range observed during preoperational and previous operational sampling. The gamma spectrometry results for the soil samples did not indicate any impact from Plant 2 operations on the environment.

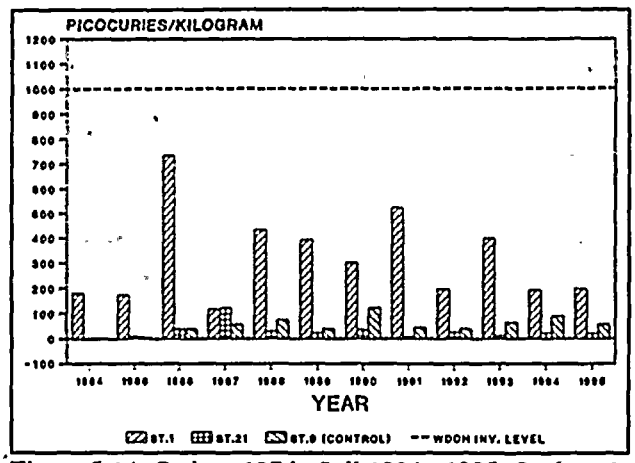

Figure 5-14 Cesium-137 in Soil 1984 - 1995, Stations 1, 21 and 9

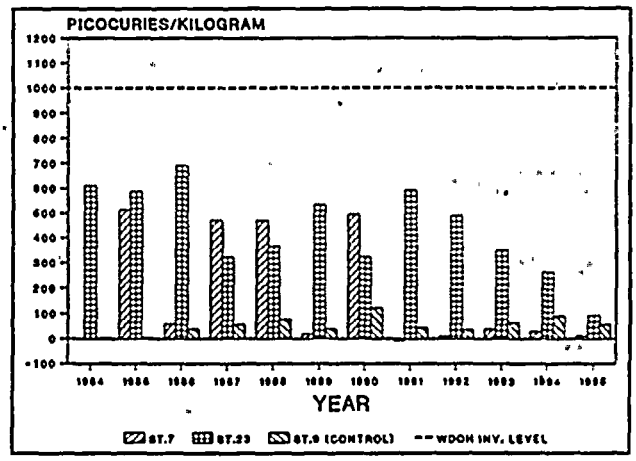

Figure 5-15 Cesium-137 in Soil 1984 - 1995, Stations 7, 23 and 9

No strontium analysis was required in 1995. Aside from cesium-137, the only radionuclides detected in the samples were potassium-40, radium-226 and thorium-228. These are part of the natural radioactivity typically found in soils.

5.5 River Sediment

The results of gamma spectrometry of river sediment indicated that aside from the naturally-occurring radionuclides (potassium-40, radium-226 and thorium-228), only cesium-137 was detected downstream of the plant (Station 34). Cesium-137 and cobalt-60 were detected in the control location (Station 33) sample. The cesium-137 concentrations upstream from the plant discharge were 91.2 and 122 pCi/kg dry weight; the concentrations downstream from the discharge were 136 and 151 pCi/kg dry weight. The upstream detectable cobalt-60 concentration was 30.1 pCi/kg dry weight. Cobalt-60 levels downstream were below the detection limit.

Cesium-137 and cobalt-60 have been detected in preoperational samples and in samples taken since plant operation began. They have also been previously identified as components of the Columbia River sediment originating from the operation of the old Hanford Reservation reactors.[14]

5.6 Fish

The gamma spectrometry results of fish samples collected in the vicinity of the Plant 2 discharge and at the control location on the Snake River were below detection limits, except for potassium-40, a naturally-occurring radionuclide. Figure 5-16 compares the cesium-137 levels for fish taken from the Columbia River to fish from Snake River by year.

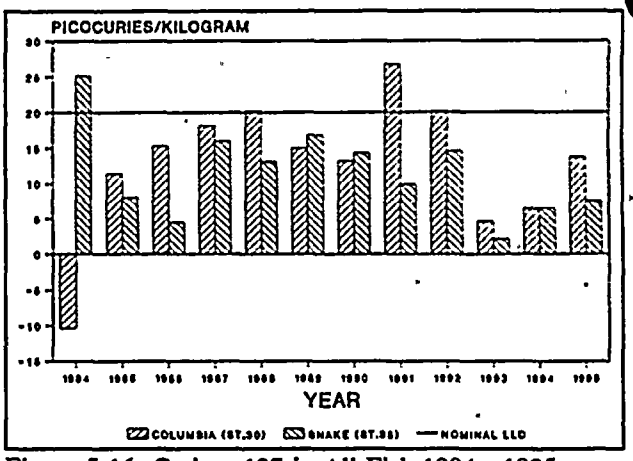

Figure 5-16 Cesium-137 in All Fish 1984 - 1995

5.7 Milk

All the results of iodine-131 analyses of milk samples collected during 1995 were less than detection limits. All milk sample results for the indicator and control locations were less than the detection limits, except for potassium-40, which is naturally-occurring.

5.8 Garden Produce

The gamma isotopic analysis results for all root, fruit and leafy vegetables collected in 1995 were below detection limits other than potassium-40, which occurs naturally.

5.9 Special Interest Stations

The storm drain pond, Sanitary Waste Treatment Facility (SWTF) and the containerized storage area were incorporated into the routine sampling schedule in 1992. The cooling tower sediment disposal area was added in 1995. Discussions of the results from each of the locations are given in the following sections.

Until incorporated into the REMP, the sediment samples collected during previous years at the storm drain and SWTF were analyzed by the Supply System. The storm drain and SWTF sediment samples were analyzed wet, so the results were in terms of wet weight instead of the dry weight concentrations determined by Teledyne. Consequently, direct comparison of the wet sample results with the dried sample results is difficult since the percent solids can vary from sample to sample.

5.9.1 Storm Drain Pond (Station 101)

The storm drain pond is located within the Plant 2 restricted area approximately 1500 feet northeast of Plant 2. Water is conveyed to the pond via a 18-inch diameter pipe which discharges into a 300-foot long earthen channel that leads to a 100-foot diameter pond. The pond is a shallow, unlined percolation/evaporation basin.

REMP personnel collected water, sediment, soil and vegetation samples at the outfall during 1995. Additional monthly water grab samples and sediment samples were taken from the pond area beginning in July of 1994. At the outfall, flow proportional composite water samples were collected

from an automatic sampler and sediment samples were collected monthly. Vegetation was sampled annually near the outfall.

Tritium was the only isotope detected during 1995. Figure 5-17 shows the monthly average for 1992-94 monthly averages versus the 1995 monthly average. The tritium comes primarily from moisture in building exhaust ventilation condensing outside and then entering the storm drains. Sample results for 1995 indicate the measures taken by the plant have resulted in significant curtailment of the release of tritium to the pond.

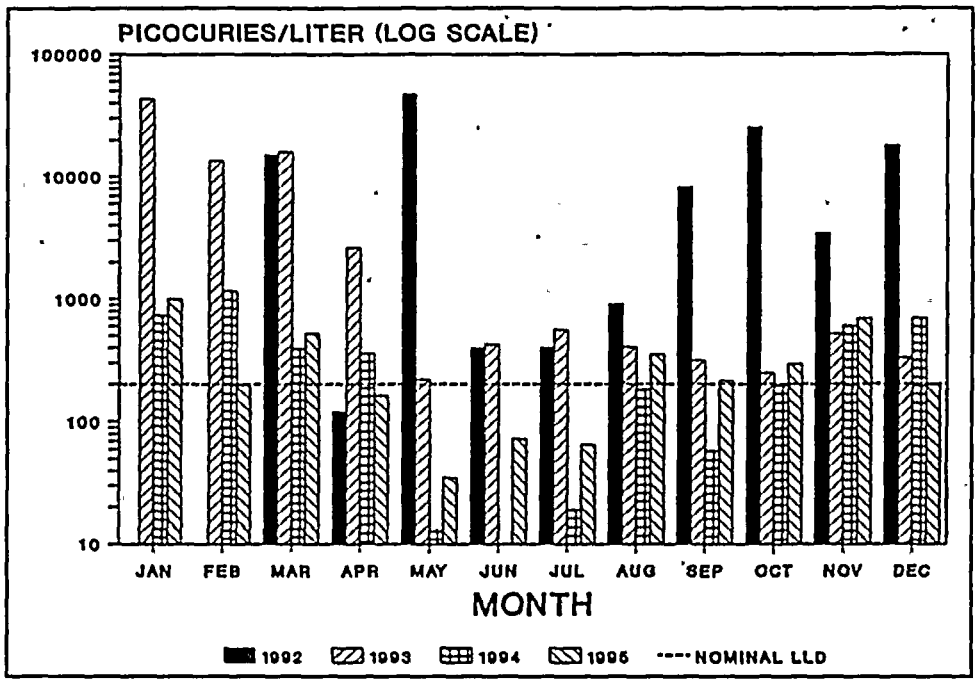

Figure 5-17 Average Monthly Tritium at Storm Drain Outfall - 1992-95

The range for positive tritium results at the outfall was from 200 pCi/l to 1500 pCi/l. At the pond, the range for positive results was 210 pCi/l to 1000 pCi/l. Gross beta activity at the outfall averaged 3.3 pCi/l with a range of 0.69 to 7 pCi/l. Gross beta at the pond ranged from 1.2 pCi/l to 5.1 pCi/l and averaged 3.2 pCi/l.

Sediment at ST101 is sampled monthly at two location, at the outfall and the other at the pond. In the sediment samples from the outfall, cobalt-60, cesium-137, manganese-54 and zinc-65 were detected along with the natural-occurring nuclide potassium-40, radium-226 and thorium-228. Detectable cobalt-60 averaged 327.8 pCi/kg dry and ranged from 21.6 pCi/kg dry to 703.6 pCi/kg dry. The detectable cesium-137 ranged from 15.9 pCi/kg dry to 306 pCi/kg dry and averaged 118.3 pCi/kg dry. Manganese-54 and zinc-65 were detected in single samples and measured 10.1 pCi/kg dry and 24 pCi/kg dry respectively.

Samples collected at the pond had detectable amounts of cesium-134 and -137, cobalt-60 and manganese-54. Cesium-137 results ranged from 13.4 pCi/kg dry to 616.5 pCi/kg dry and averaged 127.9 pCi/kg dry. Cobalt-60 averaged 774.1 pCi/kg dry and ranged from 81 pCi/kg dry to 4308 pCi/kg dry. The cesium-134 result was 112.8 pCi/kg dry and the manganese-54 result was 15.7

pCi/kg dry. The gamma spectrometry results for both the outfall and the pond were within level seen in previous years.

All the quarterly soil samples, taken on the east and west banks, had detectable amounts of cesium-137 in them. The natural radionuclides of potassium-40, radium-226 and thorium-228 were also detected. Cesium-137 averaged 43.7 pCi/kg on the east bank and ranged from 35.4 pCi/kg to 51.1 pCi/kg. On the west bank, cesium-137 averaged 42.1 pCi/kg and ranged from 29.5 pCi/kg to 57.8 pCi/kg. These results are within the ranges observed in previous years.

In the annual vegetation sample taken in the stream, no detectable radionuclides were found other than potassium-40 and beryllium-7, which occur naturally.

5.9.2 Sanitary Waste Treatment Facility (Station 102)

The Sanitary Waste Treatment Facility (SWTF), located approximately 0.3 mile south of Plant 2, processes the sanitary waste from Plant 2, the WNP-1 and WNP-4 sites and the Plant Support Facility (PSF). Discharge standards and monitoring requirements for the SWTF are established in EFSEC Resolution No. 259[15]. Until April 1992, the SWTF sediment was sampled semiannually and analyzed in the Support Services radiation laboratory and the radionuclide concentrations were given in terms of wet weight.

The average quarterly tritium and gross beta results for water samples taken in the south stabilization pond prior to discharge (ST102C) for 1992 through 1995 are presented in Figure 5-18 and Figure 5-19. An investigation into the source of gross beta indicated potassium-40, a natural isotope, was the major contributor. Other contributors to the beta appear to be natural isotopes and no fission or activation products were detected that would indicate Plant 2 as a source.

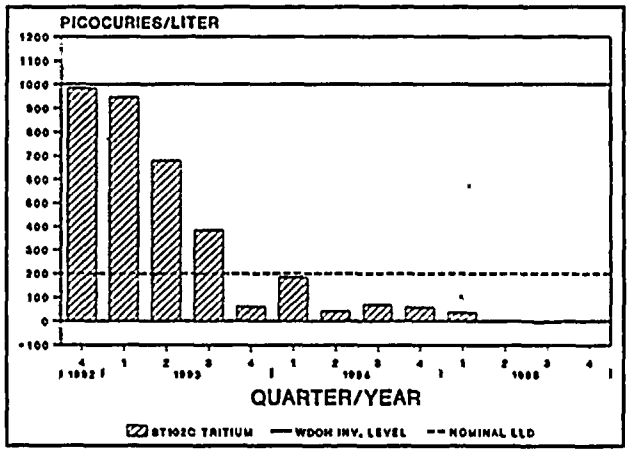

Figure 5-18 Average Tritium in Water 1992 - 1995, ST102C

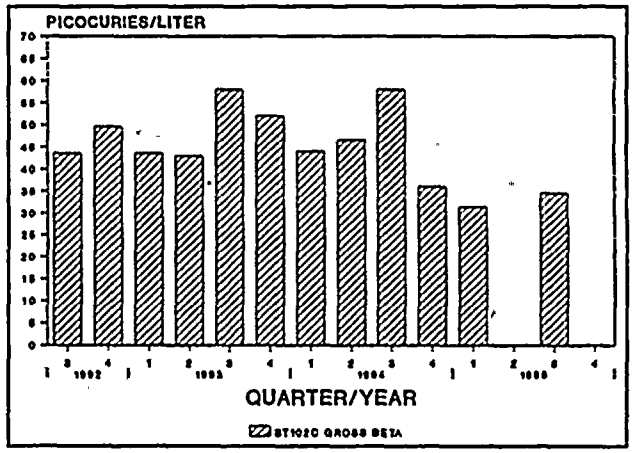

Figure 5-19 Average Gross Beta in Water 1992 - 1995, ST102C

Gamma analysis of sediment collected from the north pond reveals detectable cobalt-60 and cesium-137 in addition to the naturally occurring radionuclide potassium-40, radium-226 and thorium-228. The results for cobalt-60 during 1995 were 185 pCi/kg dry and 331 pCi/kg dry. Cesium-137 results were 137 pCi/kg dry and 146 pCi/kg dry. The results for both nuclides are within ranges observed since 1992.

5.9.3 Containerized Storage Area (Station 118)

Station 118, consists of twenty-nine large metal storage containers holding the low-pressure turbine rotor parts removed from the plant during the 1992 maintenance outage. Soil samples and ionization chamber readings were taken at Station 118. Beginning in September 1994, samples from different areas were composited and sent to Teledyne Brown for analysis

Soil samples taken at Station 118 before the storage of the low pressure turbine rotor parts contained no detectable radioactivity except that from naturally-occurring radionuclides, such as potassium-40 and radium-226. The first quarter composite had detectable cobalt-60 at 14.6 pCi/kg, but the isotope was not detected in subsequent samples.

5.9.4 Cooling Tower Sediment Disposal Area (Station 119)

On May 8, 1995, EFSEC approved Resolution No. 278[16] that authorized the onsite disposal of cooling tower sediments containing low levels of radionuclides. This area is located just south of the cooling towers in the landfill area. According to Resolution No. 278, the REMP is to monitor the area's direct radiation exposure rate with annual pressurized ion chamber measurements. Direct radiation dose is measured by a quarterly TLDs and a dry composite sediment sample is taken from the disposal cell within thirty days following each cleaning to confirm that the disposal criteria outlined in the resolution has not been exceeded.

An estimated 50 cubic yards of material was disposed of during the 1995 cleaning. This material had an in-place density range of 1.1 grams/cubic centimeter (g/cm^3) to 1.4 g/cm^3. Using the volume and the density of 1.4 g/cm^3, along with the activity, it is calculated that the following quantities of nuclides were placed in the disposal area:

Cobalt-60	3.73E-06 curies
Manganese-54	7.97E-07 curies
Zinc-65	7.81E-07 curies
Cesium-134	1.67E-06 curies
Cesium-137	1.27E-05 curies

Of the above nuclides, only cobalt-60 and cesium-137 were above detection levels with results of 69.6 pCi/kg dry and 237 pCi/kg dry respectively. Since the results for manganese-54, zinc-65 and cesium-134 were lower the detection limit, the calculated quantities disposed of those nuclides are estimates of maximum possible concentration.

Measurements of direct radiation were taken using TLDs and a Reuter Stokes pressurized ion chamber. The TLDs are collected quarterly and were first placed during the third quarter of 1995. Two locations are used, one next to the collection area and the other approximately 100 yards to the east as the control. The mean result for the station next to the collection area was 0.26 mR/day

while the control was 0.27 mR/day. The pressurized ion chamber readings were taken monthly for 1995. The mean results for readings taken for the January through April period, which was prior to disposal of new sediment to the area, was 0.0105 mR/hr with the plant at 100% power. The May reading, also before disposal, was 0.0099 mR/hr with the plant at 0% power. After disposal and with the plant at 100% (July through October), the mean result was 0.0103 mR/hr. The June reading, taken after disposal and with the plant at 0% power was 0.0090 mR/hr.

5.10 1995 Sample Deviations

Air sampler outages made up the majority of sample deviations for 1995. Problems ranged from pump failure to power outages. Sampler problems at ST101 account for the majority of deviation listed for water samples. Deviations are shown in Table 5-2.

TABLE 5-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1995[d] MEAN	(RANGE)
Air: pCi/m³						
Gross Beta	<0.02	(<0.003 - 0.130)	0.021	(0.001 - 0.741)	0.015	(0.003 - 0.087)
I-131[e]	<0.05	(<0.01 - 0.11)	0.00	(-0.07 - 0.82)	0.00	(-0.02 - 0.02)
Gamma						
Cs-134	<0.01	(<0.001 - 0.040)	0.0004	(-0.0021 - 0.0149)	0.0000	(-0.0001 - 0.0001)
Cs-137	<0.01	(<0.001 - 0.040)	0.0008	(-0.0011 - 0.0356)	0.0000	(-0.0001 - 0.0001)
River/Drinking Water: pCi/l						
Gross Beta	<3	(<1 - <6)	2	(-0.2 - 9.1)	1.6	(0.7 - 4.7)
Gamma						
Cs-134	<3.8	(<1 - <12)	0.3	(-5.4 - 5.2)	-0.3	(-3.0 - 1.4)
Cs-137	<4.1	(<1 - <13)	1	(-5.7 - 6.2)	0.9	(-1.0 - 2.8)
Co-58	<5.1	(<1 - <25)	-0.1	(-3.3 - 2.9)	-0.6	(-2.7 - 1.4)
Co-60	<4.7	(<1 - <13)	0.8	(-4.9 - 7.1)	0.2	(-1.3 - 2.4)
Fe-59	<13.3	(<2 - <93)	0.7	(-8.9 - 6.9)	0.5	(-4.7 - 4.6)
Zn-65	<8.3	(<2 - <27)	-1.3	(-16.2 - 8.2)	0.1	(-5.9 - 8.1)
H-3	<481.7	(220 - <820)	127.9	(-500 - 596)	25.8	(-68 - 160)
Groundwater: pCi/l						
Gamma						
Cs-134	<4	(<1 - <12)	0.4	(-4.1 - 5.4)	0.1	(-1.8 - 2)
Cs-137	<3.8	(0.8 - <8)	1.1	(-4.1 - 4.9)	-0.2	(-6 - 3.6)
Co-58	<4.7	(<1 - <12)	-0.3	(-3.3 - 1.9)	-1.2	(-3.2 - 0.1)
Co-60	<4.1	(0.1 - <9)	1	(-2.4 - 8.4)	0.7	(-1.8 - 3.1)
Fe-59	<11.6	(<2 - <33)	0.8	(-4.5 - 5.7)	0.5	(-3 - 4.3)
Zn-65	<8.6	(<2 - 17)	-1.0	(-46.8 - 15)	0.7	(-5.2 - 5.5)
H-3	<467.8	(<10 - 2600)	31	(-516 - 324)	21.4	(-270 - 170)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1993. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Charcoal cartridge results.

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b,c,e] MEAN	(RANGE)	1995[d] MEAN	(RANGE)
Discharge Water: pCi/l						
Gross Beta	<2.8	(<1.9 - 4)	17.6	(0.6 - 56)	20.4	(13 - 25)
Gamma						
Cs-134	<3.7	(<1 - <8)	0.6	(-3.9 - 10.1)	0.4	(-1.2 - 2.2)
Cs-137	<4.7	(<1 - 16)	2	(-5.3 - 23.1)	2.2	(-0.9 - 7.8)
Co-58	<1.4	(1 - 13)	0.0	(-2.6 - 4.6)	-0.2	(-2.6 - 2)
Co-60	<5.0	(<1.9 - <13)	5.8	(-8.7 - 57.6)	6.9	(1 - 28.6)
Fe-59	<11.9	(<3 - <38)	0.8	(-4.1 - 13)	0.9	(-5.9 - 4.7)
Zn-65	<8.6	(<2 - 27)	4.6	(-8.2 - 86.7)	2.8	(-2.6 - 13.6)
H-3	<420	(<80 - 700)	2048	(55 - 12000)	2121.8	(87 - 4100)
Sr-90	<3		0.8	(0.5 - 1.1)	Analysis Not Performed	
Storm Drain Water: pCi/l						
Gross Beta	Analysis Not Performed		20.2	(0.3 - 1100)	3.3	(0.7 - 7)
Gamma	Analysis Not Performed					
Cs-134			0.1	(-9.6 - 8.1)	-0.3	(-6.5 - 2.5)
Cs-137			1.5	(-11 - 252)	0.2	(-5.4 - 3.1)
Co-58			-0.5	(-7.6 - 3.4)	-0.2	(-2.2 - 2.2)
Co-60			1	(-4.2 - 125)	0.4	(-2.3 - 2.6)
Fe-59			0.8	(-14 - 12)	0.7	(-3.6 - 5.4)
Zn-65			0.8	(-13 - 53)	0.8	(-5 - 10.9)
Mn-54			0.6	(-6.2 - 6.7)	0.5	(-2.6 - 3)
I-131			-0.2	(-17 - 21.1)	0.1	(-4.3 - 4.2)
Ce-141			-0.9	(-441 - 707)	-0.8	(-4.7 - 3.4)
I-131[e]			0.4	(-0.2 - 8.3)	Analysis Not Performed	
H-3	Analysis Not Performed		7169.9	(-170 - 270000)	290.7	(-84 - 1500)
Sanitary Waste Water: pCi/l						
Gross Alpha	Analysis Not Performed		0.3	(-0.7 - 1.6)	1.1	(0.5 - 1.9)
Gross Beta	Analysis Not Performed		42.9	(13 - 61)	24.6	(9.1 - 38)
Cs-134			0.3	(-2.6 - 4.9)	0.1	(-2.1 - 2.3)
Cs-137			1	(-5.1 - 4.2)	0.4	(-3.9 - 2.9)
Co-58			-0.2	(-2.7 - 1.8)	-0.5	(-2.9 - 0.8)
Co-60			0.4	(-12.9 - 4)	0.2	(-1.4 - 2)
H-3	Analyses Not Performed		307.6	(-120 - 1700)	29.8	(-120 - 230)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1993. Some of the data means and ranges are biased high due to Chernobyl in 1986
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Resin method

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1995[d] MEAN	(RANGE)
River Sediment: pCi/kg (dry)						
Gamma						
Cs-134	<112.5	(<50 - <150)	50.8	(7 - 172)	85.1	(66.2 - 104)
Cs-137	<287	(<50.0 - <560.0)	334.3	(153 - 1890)	143.7	(136.5 - 150.9)
Co-60	<254.6	(130 - 610)	41.4	(11 - 129)	9.2	(9.0 - 9.5)
Storm Drain Sediment: pCi/kg (dry)						
Gamma:	Analysis Not Performed[e]					
Cs-134			68.4	(4.1 - 1140)	32.2	(15.7 - 112.8)
Cs-137			176.3	(-3.6 - 2900)	109.5	(1.9 - 616.5)
Co-58			-1.1	(-27.0 - 58)	-6.3	(-20.1 - 0.7)
Co-60			824.1	(-6.4 - 25400)	537.5	(5.4 - 4308)
Fe-59			0.1	(-55 - 280)	-8.4	(-61.9 - 31)
Zn-65			141	(-25 - 4650)	21.3	(-14.6 - 67.9)
Mn-54			28.8	(-9.6 - 670)	7.6	(0 - 15.7)
Ce-141			43.3	(-29 - 3740)	2.9	(-22.2 - 20.2)
Sanitary Waste Sediment: pCi/kg (dry)						
Gamma:	Analysis Not Performed[e]					
Cs-134			27.8	(-15.6 - 55.2)	30.5	(22.1 - 38.8)
Cs-137			149.8	(0.0 - 255.1)	141.3	(137.1 - 145.5)
Co-60			223.5	(-3.4 - 728.2)	257.8	(184.7 - 330.9)
Zn-65			12.2	(-106 - 125)	11.9	(7.6 - 16.1)
Mn-54			5.6	(-26 - 95)	7.1	(-4.6 - 18.9)
Soil: pCi/kg (dry)						
Gamma						
Cs-134	<65.3	(<20 - <150)	26.6	(1 - 53.2)	22.7	(16.5 - 32.6)
Cs-137	364.3	(<20.0 - <1880.0)	265.7	(-7.3 - 735)	79.5	(13.1 - 195)
Sr-90	Analysis Not Performed		178.8	(0.2 - 455)	Analysis Not Performed	

(a) All stations all years.
(b) Indicator stations only for the years 1984 to 1993. Some of the data means and ranges are biased high due to Chernobyl in 1986
(c) The data used for these averages does not include the "less the" values reported in 1984.
(d) Indicator stations only.
(e) Prior to February 1992, these samples were analyzed as wet weight. These numbers are for the samples analyzed as dry weight.

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1995[d] MEAN	(RANGE)
ST 118 Soil: pCi/kg (dry)						
Gamma	Analysis Not Performed					
Cs-134			22.8	(-2.9 - 45.6)	18.6	(9.5 - 26.5)
Cs-137			14.6	(-8.2 - 47.6)	12.1	(6.1 - 21.7)
Storm Drain Soil: pCi/kg (dry)						
Gamma	Analysis Not Performed					
Cs-134			21.4	(-1.4 - 38)	24	(18.2 - 33.2)
Cs-137			42.6	(12.5 - 77.3)	42.9	(29.5 - 57.8)
Milk: pCi/l						
Gamma						
Cs-134	<3.7	(<0.9 - <14)	0.8	(-8.7 - 22.6)	0.4	(-2.7 - 4.1)
Cs-137	<3.8	(<1 - <12)	2.5	(-6.6 - 47.3)	0.9	(-3.9 - 3.6)
Ba-140	<72.1	(<6 - <2000)	0.2	(-44.3 - 55)	0.9	(-9.5 - 12)
La-140	<33.3	(<5 - 1000)	-0.4	(-24.2 - 9.7)	-0.1	(-4 - 6.1)
I-131[e]	<0.5	(<0.1 - <1)	0.8	(-0.8 - 143.6)	0.0	(-0.2 - 0.3)
Sr-90	Analysis Not Performed		1.9	(1.3 - 3.9)	Analysis Not Performed	
Fish: pCi/kg (wet)						
Gamma						
Cs-134	<61.2	(<6 - <130)	1.8	(-20.4 - 24)	3.3	(0.3 - 8.7)
Cs-137	<88.8	(<10 - <130)	14.8	(-35.1 - 57)	13.7	(-10 - 14.2)
Co-58	<87.7	(<9 - <130)	0.6	(-16.8 - 25.8)	1.4	(-0.6 - 3.2)
Co-60	<80.6	(<9 - <130)	1.5	(-18.4 - 21)	1.9	(-1.6 - 7.1)
Fe-59	<130	(<30 - <260)	-0.2	(-34.2 - 30)	2.3	(-5.3 - 21.2)
Mn-54	<88.3	(<8 - <130)	1.4	(-20 - 30.9)	3.7	(0 - 7.2)
Produce: pCi/kg (wet)						
Gamma						
Cs-134	<49.1	(<10 - <140)	0.8	(-24.8 - 19.8)	0.7	(-1.6 - 5.2)
Cs-137	<69.8	(<10 - <140)	3.4	(-9.8 - 20.9)	2.1	(-3 - 9.1)
I-131	<105.6	(<10 - <1000)	-0.4	(-26 - 59)	-1	(-9.3 - 9.7)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1993. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Resin method.

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN (RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN (RANGE)	1995[d] MEAN (RANGE)
Storm Drain Vegetation[e]: pCi/kg (wet)			
Gamma	Analysis Not Performed		
Mn-54		13.6 (-2 - 32.2)	-27.9
Co-60		21.2 (-3.7 - 48.2)	20
Zn-65		26 (-4.3 - 57.4)	26.7
Cs-134		8 (-6.5 - 45.8)	3.3
Cs-137		28 (3.9 - 93.5)	17.6
Cooling Tower			
Gamma	Analysis Not Performed	Analysis Not Performed	
Mn-54			14.9
Co-60			69.6
Zn-65			14.6
Cs-134			31.2
Cs-137			237
TLD: mR/day			
Quarterly	0.24 (0.17 - 0.31)	0.25 (0.16 - 0.35)	0.25 (0.20 - 0.31)
Annual	0.23 (0.20 - 0.29)	0.23 (0.18 - 0.32)	0.24 (0.21 - 0.29)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1993. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator Stations only.
(e) Routine samples from the outfall only.

TABLE 5-2

1995 SAMPLE DEVIATIONS

SAMPLE MEDIA	DATE	LOCATION	PROBLEM
Air Particulate/Iodine	02/07 - 02/14	Station 40	Unit Failure, Reduced hours
	02/28 - 03/07	Station 4	Unit Failure, Reduced hours
	05/02 - 05/09	Station 7	Power Outage, Reduced hours
	05/16 - 05/23	Station 48	Power Outage, Reduced hours
	06/06 - 06/13	Station 48	Pump Failure, Reduced hours
	06/13 - 06/20	Station 8	Power Outage, Reduced hours
	07/05 - 07/11	Station 4	Pump Failure, Reduced hours
	07/18 - 07/25	Station 7	Pump Failure, Reduced hours
	08/15 - 08/22	Station 40	Power Outage, Reduced Hours
	08/22 - 08/29	Station 5	Pump Failure, Acceptable Hours
	08/22 - 08/29	Station 23	Pump Failure, Reduced hours
	08/22 - 08/29	Station 40	Power Outage, Reduced Hours
	09/12 - 09/19	Station 5	Pump Failure, Reduced Hours
	09/12 - 09/19	Station 40	Pump Failure, Reduced Hours
	10/17 - 10/24	Station 5	Pump Failure, Reduced Hours
	10/31 - 11/07	Station 5	Pump Failure, Reduced Hours
	11/07 - 11/14	Station 40	Power Outage, Reduced Hours
	11/14 - 11/21	Station 40	Power Outage, Reduced Hours
	11/21 - 11/28	Station 40	Power Outage, Reduced Hours
	11/21 - 11/28	Station 57	Pump Failure, Reduced Hours
	12/19 - 12/27	Station 40	Pump Failure, Reduced Hours
Water	05/20 - 06/01	Station 27	Timed Mode for Plant Outage Work.
	06/06	Station 52	No Sample, Maintenance Outage.
	06/08 - 06/16	ST101	Calibration Off, Bottles Overflowed.
	06/16 - 06/23	ST101	Sampler not Sampling.
	09/01 - 09/19	Station 28	Sampler Off, Pipe Repair and Water System Update.

TABLE 5-2 (Cont.)

1995 SAMPLE DEVIATIONS

SAMPLE MEDIA	DATE	LOCATION	PROBLEM
Water (cont.)	11/23 - 12/15	ST101	Sampler Malfunction.
Soil	03/31	ST101	No Soil Sample collected. Date missed.
Fruits and Vegetables	05/23	Station 9C, Station 37	No Fruits or Root Vegetables Available, Leafy Vegetable collected.

TABLE 5-3

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1995

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Air Particulates (pCi/m3)	Gross Beta 632	0.003	0.016(579/579) (0.003-0.091)	4 9.3 mi SSE	0.018(53/53) (0.006-0.077)	0.015(53/53) (0.004-0.088)	0
	Gamma (Quarterly) 48						
	Be-7	0.01	0.119(44/44) (0.066-0.163)	9A 30.0 mi WSW	0.141(4/4) (0.098-0.183)	0.141(4/4) (0.098-0.183)	0
	K-40	0.01	0.011(6/44) (0.004-0.034)	8 4.5 mi ESE	0.019(3/4) (0.011-0.034)	0.051(2/4) (0.004-0.007)	0
Air Iodine (pCi/m3)	I-131 632	0.01	-(0/579)			-(0/53)	0
Soil (pCi/kg dry)	Gamma 5						
	K-40	700	12700(4/4) (12200-13900)	23 3.0 mi ESE	14000(1/1)	11500(1/1)	0
	Cs-137	40	102(3/4) (19.1-195)	01 1.3 mi S	195(1/1)	55.0(1/1)	0
	Ra-226	400	806(4/4) (669-1020)	01 1.3 mi S	1020(1/1)	1110(1/1)	0
	Th-228	50	557(4/4) (406-697)	09 30.0 mi WSW	711(1/1)	711(1/1)	0

(a) Mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Exact LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1995

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Water (River/Drinking) (pCi/liter)	Gross Beta	36 4	1.77(19/24) (1.1-4.7)	28 7.4 mi SSE	1.96(10/12) (1.2-4.7)	1.58(11/12) (1.1-2.4)	0
	Tritium	12 200	-(0/8)			-(0/4)	0
	Gamma	36					
	K-40	200	-(0/24)			-(0/12)	0
Water (Discharge) (pCi/liter)	Gross Beta	12 12	20.4(12/12) (13-25)	27 3.2 mi E	20.4(12/12) (13-25)	-(0/0)	0
	Tritium	4 200	2800(3/4) (1900-4100)	27 3.2 mi E	2800(4/4) (1900-4100)	-(0/0)	0
	Gamma	12					
	Co-60	10	13.2(5/12) (6.49-28.6)	27 3.2 mi E	13.2(5/12) (6.49-28.6)	-(0/0)	0
	Cs-137	10	7.28(1/12) (6.75-7.82)	27 3.2 mi E	7.28(1/12) (6.75-7.82)	-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1995

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Water (Ground) (pCi/liter)	Tritium 11	200	-(0/11)			-(0/0)	0
	Gamma 11						
	K-40		66.5(1/11)	31 1.1 mi ESE	66.5(1/11)	-(0/0)	0
Sediment (pCi/kg dry)	Gamma 4						
	K-40	700	13250(2/2) (13000-13500)	33 3.6 mi ENE	14650(2/2) (14200-15100)	14650(2/2) (14200-15100)	0
	Co-60	30	-(0/2)	33 3.6 mi ENE	30.1(1/2)	30.1(1/2)	0
	Cs-137	40	144(2/2) (136-151)	34 3.5 mi ESE	144(2/2) (136-151)	107(2/2) (91.2-122)	0
	Ra-226	400	1925(2/2) (1550-2300)	34 3.5 mi ESE	1925(2/2) (1550-2300)	1007(2/2) (954-1060)	0
	Th-228	50	1660(2/2) (1200-2120)	34 3.5 mi ESE	1660(2/2) (1200-2120)	861(2/2) (818-904)	0

(a) [redacted] mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) [redacted]ract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1995

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (b) (LLD)	ALL INDICATOR LOCATIONS MEAN (RATIO) [a] (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RATIO)[a] (RANGE)	CONTROL LOCATION MEAN (RATIO) [a] (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Fish (pCi/kg wet)	Gamma 8						
	K-40	1000	3578(4/4) (3240-3820)	38 27 mi ESE	3643(4/4) (3380-3780)	3643(4/4) (3380-3780)	0
Milk (pCi/liter)	I-131 70	1	-(0/52)			-(0/18)	0
	Gamma 70						
	K-40	200	1373(57/57) (1100-1650)	96 36.0 mi SW	1428(18/18) (1300-1520)	1428(18/18) (1300-1520)	0
Roots (pCi/kg wet)	Gamma 8		-(0/4)			-(0/4)	0
Fruits (pCi/kg wet)	Gamma 9		-(0/5)			-(0/4)	0
Vegetables (pCi/kg wet)	Gamma 10		-(0/5)			-(0/5)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1995

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (b) (LLD)	ALL INDICATOR LOCATIONS MEAN (RATIO) [a] (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RATIO)[a] (RANGE)	CONTROL LOCATION MEAN (RATIO) [a] (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Direct Radiation Quarterly TLD's (mR/day)	TLD 224	-	0.25(220/220) (0.20-0.31)	46 5.0 mi NE	0.30(4/4) (0.29-0.30)	0.22(4/4) (0.21-0.24)	0
Direct Radiation Annual TLD's (mR/day)	TLD 56	-	0.24(54/55) (0.21-0.29)	46 5.0 mi NE	0.29(1/1) -	0.21(1/1) -	0
Storm Drain Water Station 101 (pCi/liter)	Gr-Beta 43		4.23(26/43) (3.0-7.0)	101 0.3 mi ENE	4.23(26/43) (3.0-7.0)	-(0/0)	0
	Tritium 43	200	518(19/43) (200-1500)	101 0.3 mi ENE	518(19/43) (200-1500)	-(0/0)	0
	Gamma 43						
	K-40	200	68.1(1/43) -	101 0.3 mi ENE	68.1(1/43) -	-(0/0)	0
	Cs-137	10	-(0/43) -			-(0/0)	0
	Th-228	10	-(0/43) -			-(0/0)	0
Storm Drain Water Station 101E (pCi/liter)	Gr-Beta 12		3.18(12/12) (1.2-5.1)	101 0.3 mi ENE	3.18(12/12) (1.2-5.1)	-(0/0)	0
	Tritium 12	200	504(7/12) (210-1000)	101 0.3 mi ENE	504(7/12) (210-1000)	-(0/0)	0
	Gamma 12		-(0/12)			-(0/0)	0

(a) [redacted]mean of positive results above the LLD and ratio of those results to the number [redacted]amples analyzed for the parameter of interest.
(b) [redacted]act LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1995

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Sediment Station 101-Outfall							
(pCi/kg)	Gamma 12						
	K-40	700	11898(12/12) (8560-16200)	101 0.3 mi ENE	11898(12/12) (8560-16200)	-(0/0)	0
	Mn-54	40	10.1(1/12)	101 0.3 mi ENE	10.1(1/12)	-(0/0)	0
	Co-60	30	328(11/12) (21.6-704)	101 0.3 mi ENE	328(11/12) (21.6-704)	-(0/0)	0
	Zn-65	100	24.0(1/12)	101 0.3 mi ENE	24.0(1/12)	-(0/0)	0
	Cs-137	40	118(9/12) (15.9-306)	101 0.3 mi ENE	118(9/12) (15.9-306)	-(0/0)	0
	Ra-226	400	985(12/12) (670-1610)	101 0.3 mi ENE	985(12/12) (670-1610)	-(0/0)	0
	Th-228	50	544(12/12) (372-1120)	101 0.3 mi ENE	544(11/12) (372-1120)	-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1995

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) (a) (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio(a) (Range)	Control Location MEAN (RATIO) (a) (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Sediment Station 101C-Pond (pCi/kg)	Gamma 12						
	K-40	700	14550(12/12) (11900-16900)	101 0.3 mi ENE	14550(12/12) (11900-16900)	-(0/0)	0
	Mn-54	40	15.7(1/12)	101 0.3 mi ENE	15.7(1/12)	-(0/0)	0
	Co-60	30	774(12/12) (81.0-4310)	101 0.3 mi ENE	774(12/12) (81.0-4310)	-(0/0)	0
	Cs-134	30	113(1/12)	101 0.3 mi ENE	113(1/12)	-(0/0)	0
	Cs-137	40	128(12/12) (13.4-617)	101 0.3 mi ENE	128(12/12) (13.4-617)	-(0/0)	0
	Ra-226	400	1462(12/12) (770-2630)	101 0.3 mi ENE	1462(12/12) (770-2630)	-(0/0)	0
	Th-228	50	713(12/12) (465-817)	101 0.3 mi ENE	713(12/12) (465-817)	-(0/0)	0

(a) [redacted]ean of positive results above the LLD and ratio of those results to the number [redacted]mples analyzed for the parameter of interest.
(b) [redacted]ct LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1995

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Vegetation (pCi/kg wet)	Gamma	1					
	Be-7	-	831(1/1)	101 0.3 mi ENE	831(1/1)	-(0/0)	0
	K-40	-	7520(1/1)	101 0.3 mi ENE	7520(1/1)	-(0/0)	0
Sanitary Waste Treatment Facility Water (pCi/l)	Gross Alpha	6 3	-(0/6)			-(0/0)	0
	Gross Beta	21 1	24.6(21/21) (9.1-38)	102C 0.3 mi ENE	24.0(21/21) (21-27)	-(0/0)	0
	Tritium	21 200	-(0/21)	N/A	N/A	-(0/0)	0
	Gamma	21					
	K-40	200	53.3(1/21)	102B 0.3 mi ENE	53.3(1/21)	-(0/0)	0
Sanitary Waste Treatment Facility Sediment (pCi/kg)	Gamma	2					
	K-40	700	10575(2/2) (7050-14100)	102 0.3 mi ENE	(10575(2/2) (7050-14100)	-(0/0)	0
	Co-60	30	258(2/2) (185-331)	102 0.3 mi ENE	258(2/2) (185-331)	-(0/0)	0
	Cs-137	40	142(2/2) (137-146)	102 0.3 mi ENE	142(2/2) (137-146)	-(0/0)	0
	Ra-226	400	1203(2/2) (936-1470)	102 0.3 mi ENE	1203(2/2) (936-1470)	-(0/0)	0
	Th-228	50	530(2/2) (365-694)	102 0.3 mi ENE	530(2/2) (365-694)	-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1995

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio[a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Soil (pCi/kg)	Gamma 6						
	K-40	700	14950(6/6) (12500-16500)	101 0.3 mi ENE	14950(6/6) (12500-16500)	-(0/0)	0
	Cs-137	40	42.9(6/6) (29.5-57.8)	101 0.3 mi ENE	42.9((6/6) (29.5-57.8)	-(0/0)	0
	Ra-226	400	820(6/6) (657-940)	101 0.3 mi ENE	820(6/6) (657-940)	-(0/0)	0
	Th-228	50	533(6/6) (410-616)	101 0.3 mi ENE	533(6/6) (410-616)	-(0/0)	0
Station 118 Soil (pCi/kg dry)	Gamma 4						
	K-40	700	12900(4/4) (12200-13700)	118 0.3 mi S	12900(4/4) (12200-13700)	-(0/0)	0
	Cs-137	40	10.2(1/4)	118 0.3 mi S	10.2(1/4)	-(0/0)	0
	Th-228	50	520(4/4) (473-587)	118 0.3 mi S	520(4/4) (473-587)	-(0/0)	0

(a) [redacted]ean of positive results above the LLD and ratio of those results to the number [redacted]mples analyzed for the parameter of interest.
(b) [redacted]act LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1995

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (b) (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Station 119 Sediment (pCi/kg dry)							
	Gamma	1					
	Co-60	-	69.6(1/1)	119 0.2 mi S	69.6(1/1)	-(0/0)	0
	Cs-137	-	237(1/1)	119 0.2 mi S	237(1/1)	-(0/0)	0

(a) The mean of positive results above the LLD and ratio of those results to the number of samples analyzed for the parameter of interest.
(b) Contract LLDs. Actual LLDs may be lower for specific samples.

TABLE 5-4

MEAN QUARTERLY TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1994 OPERATIONAL		1995 OPERATIONAL	
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	MEAN	STANDARD ERROR
1	0.24	0.02	0.25	0.01	0.25	0.01
2	0.23	0.02	0.25	0.01	0.24	0.01
3	0.22	0.01	0.24	0.01	0.24	0.00
4	0.22	0.02	0.23	0.01	0.21	0.01
5	0.23	0.01	0.23	0.01	0.22	0.01
6	0.22	0.01	0.23	0.01	0.22	0.01
7	0.23	0.01	0.25	0.01	0.24	0.01
8	0.26	0.01	0.27	0.01	0.26	0.00
9	0.22	0.01	0.23	0.01	0.22	0.01
10	0.23	0.01	0.24	0.01	0.24	0.01
11	0.24	0.01	0.24	0.01	0.24	0.00
12	0.25	0.01	0.26	0.01	0.26	0.01
13	0.24	0.01	0.25	0.01	0.24	0.01
14	0.24	0.02	0.25	0.01	0.24	0.01
15	0.25	0.01	0.26	0.01	0.25	0.01
16	0.24	0.01	0.25	0.01	0.25	0.01
17	0.25	0.01	0.25	0.01	0.25	0.01
18	0.24	0.01	0.25	0.01	0.25	0.01
19	0.24	0.01	0.25	0.01	0.25	0.00
20	0.24	0.01	0.25	0.01	0.25	0.00
21	0.23	0.01	0.23	0.01	0.23	0.00
22	0.24	0.01	0.25	0.01	0.24	0.01
23	0.24	0.01	0.24	0.01	0.24	0.01
24	0.24	0.01	0.25	0.01	0.25	0.01
25	0.25	0.01	0.26	0.01	0.26	0.01
40	0.22	0.01	0.23	0.01	0.22	0.00
41	0.26	0.02	0.26	0.01	0.25	0.01
42	0.25	0.01	0.25	0.01	0.26	0.00
43	0.25	0.01	0.26	0.01	0.26	0.00
44	0.23	0.01	0.24	0.01	0.24	0.01
45	0.23	0.01	0.24	0.01	0.24	0.00
46	0.28	0.02	0.30	0.01	0.30	0.00
47	0.22	0.02	0.23	0.01	0.23	0.01
49	0.24	0.00	0.25	0.01	0.25	0.01
50	0.22	0.00	0.25	0.01	0.24	0.01
51	0.23	0.01	0.24	0.01	0.24	0.00

(a) This preoperational mean is for the 1982-1983 data only.

TABLE 5-4 (Cont.)

MEAN QUARTERLY TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1994 OPERATIONAL		1995 OPERATIONAL	
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	MEAN	STANDARD ERROR
53	0.27	0.00	0.27	0.01	0.26	0.01
54	0.26	0.00	0.26	0.01	0.25	0.00
55	0.23	0.00	0.24	0.01	0.23	0.01
56	0.24	0.00	0.25	0.01	0.25	0.01
61	(b)		0.27	0.01	(b)	
71(1S)	0.24	0.02	0.28	0.01	0.29	0.03
72(2S)	0.25	0.01	0.27	0.01	0.28	0.02
73(3S)	0.23	0.01	0.24	0.01	0.24	0.01
74(4S)	0.26	0.01	0.27	0.01	0.26	0.01
75(5S)	0.22	0.02	0.25	0.01	0.26	0.01
76(6S)	0.24	0.01	0.25	0.01	0.26	0.01
77(7S)	0.25	0.01	0.25	0.01	0.26	0.01
78(8S)	0.25	0.01	0.25	0.01	0.24	0.00
79(9S)	0.25	0.01	0.25	0.01	0.25	0.00
80(10S)	0.24	0.01	0.24	0.01	0.24	0.01
81(11S)	0.24	0.02	0.25	0.01	0.24	0.00
82(12S)	0.25	0.02	0.26	0.01	0.25	0.00
83(13S)	0.25	0.01	0.26	0.01	0.26	0.01
84(14S)	0.24	0.01	0.25	0.01	0.26	0.00
85(15S)	0.26	0.01	0.27	0.01	0.26	0.00
86(16S)	0.25	0.01	0.28	0.01	0.29	0.02
All	0.24	0.00	0.25	0.00	0.25	0.00

(a) This preoperational mean is for 1982-1983 data only.
(b) Station 61 was added in 1989 and discontinued in 1992.

TABLE 5-5

ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1994 OPERATIONAL		1995 OPERATIONAL
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	RESULT
1	0.23	0.04	0.23	0.01	0.24
2	0.22	0.04	0.23	0.01	0.23
3	0.21	0.04	0.22	0.01	0.22
4	0.22	0.06	0.21	0.01	0.21
5	0.22	0.04	0.21	0.01	0.21
6	0.21	0.04	0.21	0.01	0.22
7	0.22	0.02	0.23[b]	0.01	0.23
8	0.25	0.04	0.25[b]	0.01	0.26
9	0.20	0.02	0.21	0.01	0.21
10	0.22	0.04	0.22	0.01	0.23
11	0.22	0.04	0.23	0.01	0.23
12	0.24	0.04	0.24	0.01	[e]
13	0.22	0.04	0.23	0.01	0.24
14	0.22	0.04	0.22	0.01	0.23
15	0.23	0.06	0.24	0.01	0.25
16	0.23	0.04	0.23	0.01	0.24
17	0.23	0.02	0.24[b]	0.01	0.24
18	0.25	0.02	0.23	0.01	0.24
19	0.22	0.04	0.23	0.01	0.24
20	0.23	0.04	0.23	0.01	0.24
21	0.23	0.02	0.21	0.01	0.22
22	0.22	0.02	0.23	0.01	0.23
23	0.24	0.02	0.23	0.01	0.23
24	0.22	0.02	0.23	0.01	0.24
25	0.24	0.02	0.24	0.01	0.24
40	0.21(c)	0.02	0.22	0.01	0.21
41	0.26(c)	0.04	0.24	0.01	0.25
42	0.24(c)	0.02	0.23	0.01	0.24
43	0.24(c)	0.02	0.24	0.01	0.25
44	0.24	0.02	0.22	0.01	0.22
45	0.24	0.01	0.23	0.01	0.23
46	0.29	0.01	0.28	0.01	0.29
47	0.22(c)	0.03	0.22	0.01	0.21
49	(d)		0.23	0.01	0.24

(a) This preoperational mean is for 1982 - 1983 data only.
(b) 1985 TLD missing.
(c) There was only one annual exchange during the preoperational period.
(d) Stations 49-56 were first monitored during Fourth Quarter 1983. Station 61 was added in 1989 and discontinued in 1992.
(e) TLD missing.

TABLE 5-5 (Cont.)

ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1994 OPERATIONAL		1995 OPERATIONAL
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	RESULT
50	(d)		0.23	0.01	0.23
51	(d)		0.22	0.01	0.23
53	(d)		0.25	0.01	0.24
54	(d)		0.24	0.01	0.24
55	(d)		0.22	0.01	0.23
56	(d)		0.23	0.01	0.24
61	(d)		0.26[d]	0.01	(e)
71 (1S)	0.24[c]	0.02	0.26	0.01	0.28
72 (2S)	0.25[c]	0.02	0.26	0.01	0.27
73 (3S)	0.23[c]	0.01	0.22	0.01	0.23
74 (4S)	0.24[c]	0.01	0.25	0.01	0.25
75(5S)	0.24[c]	0.01	0.23	0.01	0.24
76(6S)	0.24[c]	0.02	0.23	0.01	0.23
77 (7S)	0.25[c]	0.02	0.23	0.01	0.24
78 (8S)	0.25[c]	0.04	0.23	0.01	0.23
79 (9S)	0.25[c]	0.02	0.23	0.01	0.24
80 (10S)	0.23[c]	0.05	0.22	0.01	0.23
81 (11S)	0.23[c]	0.02	0.23	0.01	0.23
82 (12S)	0.25[c]	0.03	0.24	0.01	0.24
83 (13S)	0.25[c]	0.02	0.24	0.01	0.25
84 (14S)	0.23[c]	0.02	0.23	0.01	0.24
85 (15S)	0.26[c]	0.02	0.25	0.01	0.26
86 (16S)	0.24[c]	0.02	0.26	0.01	0.28
All	0.23	0.02	0.23	0.00	0.24

(a) This preoperational mean is for 1982 - 1983 data only.
(b) 1985 TLD missing.
(c) There was only one annual exchange during the preoperational period.
(d) Stations 49-56 were first monitored during Fourth Quarter 1983. Station 61 was added in 1989.
(e) Station 61 discontinued on June 29, 1992

TABLE 5-6

1995 MEAN QUARTERLY VERSUS ANNUAL TLD DATA

Results in mR/day

	1984-94 TLDs			1995 TLDs		
STATION	QUARTERLY MEAN[a]	ANNUAL MEAN	RATIO[b]	QUARTERLY MEAN[a]	ANNUAL RESULTS	RATIO[b]
1	0.25	0.23	1.07	0.25	0.24	1.04
2	0.25	0.23	1.08	0.24	0.23	1.04
3	0.24	0.22	1.10	0.24	0.22	1.05
4	0.23	0.21	1.09	0.21	0.21	1.01
5	0.23	0.21	1.09	0.22	0.21	1.04
6	0.23	0.21	1.09	0.22	0.22	1.04
7	0.25	0.23	1.07	0.24	0.23	1.03
8	0.27	0.25	1.07	0.26	0.26	1.01
9	0.23	0.21	1.10	0.22	0.21	1.04
10	0.24	0.22	1.09	0.24	0.23	1.07
11	0.24	0.23	1.09	0.24	0.23	1.05
12	0.26	0.24	1.08	0.26	(c)	
13	0.25	0.23	1.08	0.24	0.24	1.02
14	0.25	0.22	1.10	0.24	0.23	1.06
15	0.26	0.24	1.08	0.25	0.25	1.00
16	0.25	0.23	1.09	0.25	0.24	1.06
17	0.25	0.24	1.07	0.25	0.24	1.03
18	0.25	0.23	1.08	0.25	0.24	1.02
19	0.25	0.23	1.09	0.25	0.24	1.08
20	0.25	0.23	1.08	0.25	0.24	1.05
21	0.23	0.21	1.09	0.23	0.22	1.05
22	0.25	0.23	1.08	0.24	0.23	1.03
23	0.24	0.23	1.08	0.24	0.23	1.06
24	0.25	0.23	1.08	0.25	0.24	1.04
25	0.26	0.24	1.07	0.26	0.24	1.07
40	0.23	0.22	1.09	0.22	0.21	1.05
41	0.26	0.24	1.09	0.25	0.25	1.02
42	0.25	0.23	1.09	0.26	0.24	1.08
43	0.26	0.24	1.08	0.26	0.25	1.04
44	0.24	0.22	1.08	0.24	0.22	1.09
45	0.24	0.23	1.08	0.24	0.23	1.06
46	0.30	0.28	1.07	0.30	0.29	1.03
47	0.23	0.22	1.07	0.23	0.21	1.09
49	0.25	0.23	1.10	0.25	0.24	1.01
50	0.25	0.23	1.09	0.24	0.23	1.07

(a) Mean of the quarterly results.
(b) Quarterly result/Annual result
(c) TLD missing.

TABLE 5-6 (Cont.)

1995 MEAN QUARTERLY VERSUS ANNUAL TLD DATA
Results in mR/day

	1984-94 TLDs			1995 TLDs		
STATION	QUARTERLY MEAN[a]	ANNUAL MEAN	RATIO[b]	QUARTERLY MEAN[a]	ANNUAL RESULTS	RATIO[b]
51	0.24	0.22	1.10	0.24	0.23	1.04
53	0.27	0.25	1.07	0.26	0.24	1.08
54	0.26	0.24	1.07	0.25	0.24	1.06
55	0.24	0.22	1.08	0.23	0.23	1.04
56	0.25	0.23	1.09	0.25	0.24	1.05
61[c]	0.27	0.26	1.06			
71 (1S)	0.28	0.26	1.07	0.29	0.28	1.04
72 (2S)	0.27	0.26	1.06	0.28	0.27	1.02
73 (3S)	0.24	0.22	1.09	0.24	0.23	1.08
74 (4S)	0.27	0.25	1.09	0.26	0.25	1.04
75 (5S)	0.25	0.23	1.08	0.26	0.24	1.06
76 (6S)	0.25	0.23	1.07	0.26	0.23	1.09
77 (7S)	0.25	0.23	1.08	0.26	0.24	1.05
78 (8S)	0.25	0.23	1.07	0.24	0.23	1.06
79 (9S)	0.25	0.23	1.10	0.25	0.24	1.06
80 (10S)	0.24	0.22	1.09	0.24	0.23	1.02
81 (11S)	0.25	0.23	1.08	0.24	0.23	1.05
82 (12S)	0.26	0.24	1.07	0.25	0.24	1.04
83 (13S)	0.26	0.24	1.06	0.26	0.25	1.05
84 (14S)	0.25	0.23	1.08	0.26	0.24	1.06
85 (15S)	0.27	0.25	1.08	0.26	0.26	1.01
86 (16S)	0.28	0.26	1.06	0.29	0.28	1.04
ALL	0.25	0.23	1.08	0.25	0.24	1.05

(a) Mean of the quarterly results.
(b) Quarterly result/Annual result.
(c) Station 61 was added in 1989 and discontinued in 1992.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

The REMP is designed to meet the quality assurance and quality control criteria of Regulatory Guide 4.15[4]. To accomplish this, the REMP requires that its analytical contractors meet these criteria also. In-depth audits are performed of the REMP records and activities and the records and activities of its support organizations at least annually by the Supply System Quality Assurance group.

Quality assurance and technical audits of the analytical contractor (Teledyne Brown Engineering) are also conducted periodically to verify their compliance to regulatory and contractual requirements. The adequacy of their quality assurance program is also assessed during the audits.

Intercomparison programs, which involve the comparison of Supply System analytical results for samples containing known concentrations of various radionuclides with the known values and with the results reported by other monitoring programs, are also a major component of the quality assurance activities of the REMP. The program participates in the Environmental Protection Agency (EPA) and Environmental Measurements Laboratory (EML) intercomparison programs. It also participates in local and regional intercomparison studies. The following sections summarize the quality assurance and quality control aspects of the TLD and analytical components of the REMP.

6.1 Quality Control For the Supply System Environmental TLD Program

The Quality Control Program includes the preparation, processing and evaluation of environmental TLDs. QA dosimeters, which are annealed just prior to being given a known exposure to cesium-137 gamma radiation and processed among the field dosimeters, serve as indicators that the readout, calibration and evaluation of the field dosimeters were properly performed. The number of QA dosimeters used during each processing is generally 10% of the number of field dosimeters. Since 1987, the same QA dosimeters have been used repeatedly throughout the year in order to track their sensitivity and to provide consistency from run to run.

If the mean QA dosimeter results are greater than $\pm$ 5% (or 5 mR) of the given exposure, an investigation into the source of the discrepancy is initiated. Evaluation of the 1995 QA dosimeter results indicated only small biases for the four quarters.

Control dosimeters (trip controls) are used for each set of field dosimeters to monitor the contribution of the exposure received by the field TLDs while in transit. The radiation background in the storage area is also monitored by a separate set of control dosimeters (building controls). If the trip control results are significantly greater than the building control results, the difference between the two is subtracted from the field dosimeters.

Spiked dosimeters, which are exposed to known levels of radiation below the 100 mR given to the QA dosimeters, were processed with the field dosimeters during each run to verify the accuracy of the environmental TLD evaluations. All results were within $\pm$5% of the given exposure and are provided in Table 6-1.

During each environmental TLD processing, individual calibration factors are determined for each TLD by exposing the TLDs to 100 mR from an encapsulated cesium-137 source. The calibration exposure is determined from the exposure duration and the assessed source strength at 55 centimeters. As a quality control check for each calibration exposure, an NIST-traceable ionization chamber is also used to determine the calibration exposure. If the ionization chamber measurement does not agree with the calibration exposure to within $\pm$ 5 % of the calculated value, an investigation is performed into the discrepancy and the TLD calibration is repeated, if necessary.

6.2 Quality Control For the Analytical Program

Quality control for the analytical program involves two components: the quality control activities performed by the Supply System and the quality control program of the analytical contractor, Teledyne Brown Engineering. Both of these components are described in the following sections.

6.2.1 Supply System Quality Control Activities

The Supply System has participated in the U.S. Department of Energy's Environmental Measurements Laboratory (EML) Quality Assessment Program since 1987. In general, the Teledyne Brown results agreed with the EML values as seen in Table 6-2. There were no analyses in which the level of performance was Not Acceptable.

Duplicate samples were also submitted to Teledyne Brown for analysis during 1995. These duplicates consisted of two sets of milk samples and one set of air filters from EML. The milk duplicates were marked Station 37 and were submitted for analysis at the same time as the milk samples from Station 36.

6.2.2 Teledyne Brown Engineering Quality Control Program

The goal of the quality control program at Teledyne Brown Engineering is to produce analytical results which are accurate, precise and supported by adequate documentation. The program is based on the requirements of 10CFR50, Appendix B, Regulatory Guide 4.15 and the implemented program, as described in Teledyne's Quality Assurance Manual IWL-0032-395 and Quality Control Manual IWL-0032-365.

All measuring equipment is calibrated for efficiency at least annually using standard reference material traceable to the National Institute of Standards and Technology (NIST). For alpha and beta counting, check sources are prepared and counted every day the counter is in use. Control charts are maintained with three-sigma limits specified. Backgrounds are usually measured at least once per week.

The efficiency of the gamma spectrometers is determined annually with a NIST-traceable standard reference material selected to cover the energy range of the nuclides to be monitored and to include all of the geometries measured. Backgrounds are determined every other week and check sources are counted weekly. The energy resolution and efficiency are plotted at two energy levels (125.1 and 1274.4 KeV) on charts and held within three-sigma control limits.

The efficiency of the tritium liquid scintillations was determined at least annually by counting a NIST-traceable standard which had been diluted in a known amount of distilled water so that the activity level loaded into the counter is sufficient to provide good counting statistics. If the efficiency measurement does not agree within two standard deviations of the average of the previous six measurements, corrective action is taken. The background of each counter is measured for each batch of samples. A control chart is maintained for the background and check source measurements as a stability check.

Control of sample identity is maintained by the assignment of a unique five-digit number which is maintained throughout the sample's history from sample receipt, log-in number assignment, and designation of analysis to reporting the final analytical result. Besides ensuring sample accountability, Teledyne procedures also ensure the maintenance of sample integrity by controlling sample storage and taking steps to prevent contamination of samples.

Results are reviewed for reasonableness before being entered into the data system. Any results which are suspect, i.e., which are higher or lower than results in the past, are returned to the laboratory for recount. If a longer count, decay check, recount on another system or recalculation does not give acceptable results based on experience, a new aliquot is analyzed. The complete information about the sample is contained on the worksheets accompanying the sample results.

Teledyne Brown also participates in the EPA intercomparison program. Table 6-3 presents the results of the 1995 intercomparison as reported to the Supply System. Footnotes in the table refer to investigations of problems encountered in a few cases and the steps taken by Teledyne Brown to prevent reoccurrence.

Iodine-131 Cartridges

A blank charcoal filter was analyzed with each group of samples assayed except for one blank lost in transit. Fifty-one samples were analyzed in 1995. The average activity was 1.8 ± 11.3 E-01 total pCi. Activities were calculated without considering detection limits.

Gross-Beta - Filters

One blank filter was measured with each set of filters assayed. Fifty-two blanks were counted. The average activity of the blanks in total pCi was 6.4 ± 1.8 E-01. This indicated a relatively stable background for the filter and the gross beta proportional counters.

I-131 - Milk

A blank milk was analyzed with each group of samples analyzed. The results showed that there was no contamination in the laboratory or counting area. The measurements of the blank samples indicated that there was no bias on the low background counters. Sixteen blank samples were counted in 1995 with an average activity of 4.7 ± 9.4 E-02 pCi/liter without considering detection limits. An additional 52 blanks were analyzed as part of the Teledyne Brown Engineering Quality Assurance program. The average result for blanks in 1995 was -2.4 ± 4.6 E-02 pCi/liter.

Sr-90 - Milk and Water

Blank water samples were analyzed on a weekly basis. The average activity of the fifty-two samples in 1995 was 5.7 ± 11.0 E-02 pCi/liter. Fifty-two spiked water samples were analyzed with an average value of 3.5 ± 0.1 E+01 pCi/l versus a spike value of 3.7 ± 0.6 E+01 pCi/l. A total of twenty-four spiked milk samples were analyzed in 1995. The average value of the samples was 3.5 ± 0.2 E+01 pCi/liter compared to a spike value of 3.7 ± 0.6 E+01 pCi/l. Twenty-four blank milk samples were analyzed with an average activity of 1.4 ± 0.6 E+00 pCi/liter of Sr-90, which is the natural content of milk.

Gross Beta - Water

Fifty-two blanks were prepared from distilled water. The average result was 1.4 ± 1.8 E-01 pCi/l without considering detection limits. In 1995, fifty-two spike samples were also analyzed with an average result of 2.0 ± 0.1 E+01 pCi/liter. The spike level was 2.1 ± 0.5 E+01 pCi/l. The results were well within the guidelines outlined in the EPA Intercomparison Studies Program.

Tritium in Water

Fifty-two blank samples were analyzed by liquid scintillation. The average result, without considering detection levels, was 4.7 ± 4.1 E+01 pCi/l. Forty-two spiked samples with a level of 1.3 ± 0.2 E+03 pCi/l and ten samples with a spike level of 1.5 ± 0.5 E+03 pCi/l were analyzed during 1995. The average result was 1.3 ± 0.1 E+03 pCi/l and 1.4 ± 0.1 E+03 pCi/l respectively.

Gamma Spectroscopy

A blank water sample was analyzed on a weekly basis in the gamma spectroscopy laboratory. All nuclides were below the normal level of detection indicating no contamination. Weekly spike samples were analyzed using the Cs-137 peak at 662 KeV. The spike value was 2.2 ± 0.3 E+04 pCi/l and the average result of the fifty-two spike samples was 2.2 ± 0.05 E+04 pCi/l.

TABLE 6-1

1995 ENVIRONMENTAL SPIKED DOSIMETER RESULTS

DISTRIBUTION PERIOD	GIVEN EXPOSURE (mR)	REPORTED EXPOSURE (mR)	BIAS (%)
First Quarter	25.0	24.6	1.6
		24.6	1.6
		24.6	1.6
		24.7	1.2
Second Quarter	25.0	24.7	1.2
		24.1	3.7
		23.7	5.5
		24.3	2.9
Third Quarter	26.0	25.6	1.6
		25.9	0.4
		25.7	1.2
		25.6	1.6
		25.6	1.6
Fourth Quarter	23.0	23.4	1.7
		22.5	2.2
		22.0	4.5
Annual	87.0	84.3	3.2
		84.4	3.1
		88.8	2.0
		84.9	2.5

TABLE 6-2

1995 ENVIRONMENTAL MEASUREMENTS LABORATORY (EML)
QUALITY ASSESSMENT PROGRAM RESULTS

DATE	SAMPLE TYPE	NUCLIDE	REPORTED RESULT	ERROR	EML VALUE	RATIO REPORTED/EML
03/94	Air (Bq/filter)[a]	Mn-54	4.18E+00	0.410	4.71E+00	0.89
		Co-57	8.51E+00	0.850	1.27E+01	0.67
		Co-60	2.99E+00	0.300	3.76E+00	0.80
		Sb-125	8.65E+00	0.855	9.42E+00	0.92
		Cs-137	4.89E+00	0.480	5.28E+00	0.93
		Ce-144	5.77E+01	5.900	9.12E+01	0.63
03/94	Soil (Bq/kg)	K-40	4.10E+02	40.000	3.84E+02	1.07
		Sr-90	1.10E+01	2.200	1.13E+01	0.97
		Cs-137	2.95E+02	30.000	2.66E+02	1.11
03/94	Vegetation (Bq/kg)	K-40	1.30E+03	130.000	1.03E+03	1.26
		Co-60	1.03E+01	2.000	9.60E+00	1.07
		Cs-137	1.60E+02	16.000	1.17E+02	1.37
03/94	Water (Bq/l)	H-3	4.40E+01	7.000	6.03E+01	0.73
		Mn-54	4.53E+01	4.400	4.35E+01	1.04
		Co-60	2.11E+02	21.000	1.96E+02	1.08
		Sr-90	2.60E+00	0.410	2.40E+00	1.08
		Cs-134	8.73E+01	8.900	8.35E+01	1.05
		Cs-137	8.51E+01	8.500	7.68E+01	1.11

[a] Bq = becquerel; the EML results are reported in becquerel instead of picocuries. One picocurie equals 0.03 becquerel.

TABLE 6-3

1995 EPA INTERCOMPARISON PROGRAM RESULTS

ISOTOPE	COLLECTION DATE	TI RESULTS[a]	EPA RESULTS[b]	OTHER LABS[c]
		MEDIUM - WATER (pCi/liter)		
Sr-89	01/13/95	19.00 ± 2.65	20.0 ± 5.0	18.77 ± 3.77
Sr-90	01/13/95	14.00 ± 0.00	15.0 ± 5.0	14.27 ± 1.86
Sr-89	04/18/95	20.67 ± 1.15	20.0 ± 5.0	19.09 ± 3.23
Sr-90	04/18/95	14.67 ± 0.58	15.0 ± 5.0	14.16 ± 2.74
Sr-89	07/14/95	18.33 ± 1.53	20.0 ± 5.0	18.07 ± 3.98
Sr-90	07/14/95	8.0 ± 0.00	8.0 ± 5.0	7.72 ± 1.67
Gr-Alpha	01/27/95	5.00 ± 1.00	5.0 ± 5.0	5.68 ± 2.04
Gr-Alpha	04/18/95	39.67 ± 2.52	47.5 ± 11.9	50.90 ± 10.06
Gr-Alpha	07/21/95	18.33 ± 1.53	27.5 ± 6.9	19.75 ± 5.46[d]
Gr-Alpha	10/27/95	37.00 ± 3.00	51.2 ± 12.8	29.99 ± 8.68
Gr-Beta	01/27/95	6.00 ± 1.00	5.0 ± 5.0	6.62 ± 1.93
Gr-Beta	04/18/95	80.33 ± 2.52	86.6 ± 10.0	86.03 ± 10.42
Gr-Beta	07/21/95	19.33 ± 1.53	19.4 ± 5.0	21.67 ± 3.88
Gr-Beta	10/27/95	25.33 ± 1.53	24.8 ± 5.0	27.09 ± 4.43
I-131	02/03/95	88.33 ± 2.31	100.0 ± 10.0	98.53 ± 5.69[e]
Ra-226	02/10/95	20.67 ± 0.58	19.1 ± 2.9	18.62 ± 2.71
Ra-228	02/10/95	18.67 ± 0.58	20.0 ± 5.0	19.64 ± 2.65
Pu-239	03/17/95	10.33 ± 0.58	11.1 ± 1.1	10.61 ± 0.69
Co-60	04/18/95	31.67 ± 2.08	29.0 ± 5.0	29.39 ± 2.24
Cs-134	04/18/95	19.67 ± 1.73	20.0 ± 5.0	18.33 ± 2.38
Cs-137	04/18/95	11.67 ± 1.53	11.0 ± 5.0	11.78 ± 1.68
Ra-226	04/18/95	15.67 ± 0.58	14.9 ± 2.2	14.66 ± 1.96
Ra-228	04/18/95	13.00 ± 1.73	15.8 ± 4.0	15.42 ± 2.49
Co-60	06/09/95	42.33 ± 2.52	40.0 ± 5.0	39.71 ± 2.52
Zn-65	06/09/95	82.33 ± 3.51	76.0 ± 8.0	78.75 ± 5.52
Cs-134	06/09/95	46.67 ± 2.08	50.0 ± 5.0	45.65 ± 3.99
Cs-137	06/09/95	37.67 ± 1.15	35.0 ± 5.0	35.49 ± 2.90
Ba-133	06/09/95	74.33 ± 2.08	79.0 ± 8.0	76.16 ± 5.46
Ra-226	06/16/95	15.00 ± 0.00	14.8 ± 2.2	14.32 ± 2.44
Ra-228	06/16/95	14.00 ± 0.00	15.0 ± 3.8	14.98 ± 2.59
Ra-226	09/15/95	27.33 ± 1.15	24.8 ± 3.7	23.69 ± 3.19

TABLE 6-3

1995 EPA INTERCOMPARISON PROGRAM RESULTS

ISOTOPE	COLLECTION DATE	TI RESULTS[a]	EPA RESULTS[b]	OTHER LABS[c]
Ra-228	09/15/95	14.67 ± 0.58	20.0 ± 5.0	19.56 ± 3.55
I-131	10/06/95	150.00 ± 0.00	148.0 ± 15.0	152.90 ± 10.71
H-3	03/10/95	7066.67 ± 115.47	7435.0 ± 744.0	7299.15 ± 682.97
H-3	08/04/95	4866.67 ± 152.75	4872.0 ± 487.0	4788.09 ± 374.05
		MEDIUM - AIR FILTERS (pCi/F)		
Gr-Alpha	08/25/95	23.67 ± 1.53	25.0 ± 6.3	26.65 ± 3.98
Gr-Beta	08/25/95	84.67 ± 1.53	86.6 ± 10.0	87.38 ± 8.81
Sr-90	08/25/95	25.33 ± 30.0	30.0 ± 5.0	28.45 ± 2.57
Cs-137	08/25/95	27.00 ± 1.00	25.0 ± 5.0	26.85 ± 3.88
		MEDIUM - MILK (pCi/liter)		
Sr-89	09/25/95	23.33 ± 3.06	20.0 ± 5.0	17.97 ± 4.21
Sr-90	09/25/95	16.33 ± 0.58	15.0 ± 5.0	13.97 ± 2.41
I-131	09/25/95	103.33 ± 5.77	99.0 ± 10.0	101.23 ± 7.25
Cs-137	09/25/95	54.67 ± 2.52	50.0 ± 5.0	50.99 ± 2.87
Total K	09/25/95	1683.33 ± 136.50	1654.0 ± 83.0	1665.47 ± 119.41

Footnotes:

(a) Teledyne Results - Average ± one sigma. Units are pCi/liter for water and milk except K is in mg/liter. Units are total pCi for air particulate filters.

(b) EPA Results - Expected laboratory precision (1 sigma). Units are pCi/liter for water, and milk except K is in mg/liter. Units are total pCi for air particulate filters.

(c) Average concentration plus or minus one sigma, based on range of values encountered.

(d) The mineral salt content of the water used by the EPA to prepare the samples has been shown to vary substantially throughout the year. Absorption curves to account for mount weight may vary from the true absorption characteristics of a specific sample. Previous results do not indicate a trend toward "out of control" for gross alpha/beta analysis and the normalized deviation from the grand average is only -0.36. The normalized deviation from the known for TBE-ES does not exceed three standard deviations and internal spikes have been in control. No corrective action is planned at this time.

Footnotes (cont.):

(e) The normalized deviation marginally exceeded the warning level and an apparent trend in the results appeared. The cause was a probable high bias in the beta counting efficiency. Check source control chars did not indicate any changes in the counting equipment, so the I-131 calibration was suspected. New I-131 calibrations were performed July 3 through 6, 1995 after receiving a new standard from the EPA. The intercomparison sample data sheets were recalculated with the new efficiencies and the average result was in excellent agreement with the EPA (96 pCi/l versus the EPA value of 100 pCi/l). The discrepancy in the I-131 efficiency between the current calibration and the previous one (aside from the uncertainty in the standard) appears to be an abnormally low yield in the preparation of the standard for the older calibration which created a high bias in the counter efficiencies. The bias was less than ten percent, therefore further corrective action or revision of previously reported data is deemed not necessary.

7.0 REFERENCES

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4. U.S. Nuclear Regulatory Commission, "Quality Assurance For Radiological Environmental Monitoring Program (Normal Operations), Effluent Streams and the Environment", Regulatory Guide 4.15, Revision 1, February 1979.

5. U.S. Nuclear Regulatory Commission, "Performance, Testing and Procedural Specifications For Thermoluminescence Dosimetry-Environmental Applications", Regulatory Guide 4.13, Revision 1, July 1977.

6. Energy Facility Site Evaluation Council, Resolution No. 260, January 1992.

7. Washington Public Power Supply System Nuclear Plant No. 2, Operating License NSF-21, Technical Specifications 3/4.12.1, Table 3.13.1.

8. WNP-2 Offsite Dose Calculation Manual (ODCM).

9. Code of Federal Regulations, Title 10 Part 20. "Standards For Protection Against Radiation".

10. Code of Federal Regulations, Title 10 Part 50. "Domestic Licensing of Production and Utilization Facilities".

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12. Washington Administrative Code 173-200. "Water Quality Standards for Ground Water of the State of Washington".

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14. Robertson, D. E., and J. J. Fix. Association of Hanford Origin Radionuclides With Columbia River Sediment, BNWL-2305, August 1977.

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16. Energy Facility Site Evaluation Council. Resolution 278, approved May 8, 1995.

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

NUCLEAR PLANT 2

1993 ANNUAL REPORT

JANUARY 1 to DECEMBER 31, 1993

Prepared by

Washington Public Power Supply Sytstem

and

Teledyne Brown Engineering Environmental Services

1.0 EXECUTIVE SUMMARY

1.0 EXECUTIVE SUMMARY

The Washington Public Power Supply System Radiological Environmental Monitoring Program activities conducted during 1993 are discussed in this report. The objective of the Radiological Environmental Monitoring Program (REMP) is to provide data for evaluating radiological impact of Plant 2 operations on the environment in the **Airborne, Direct Radiation, Waterborne, and Ingestion** pathways as specified by the Offsite Dose Calculation Manual (ODCM) for Plant 2. The plant is a 3323 Mwth (1150 Mwe) General Electric boiling water reactor.

To accomplish the REMP objective of determining whether Plant 2 operations affected the environment, samples of air, water, milk, soil, sediment, fish and garden produce were collected and analyzed for radionuclides specific to plant operations throughout the year. Radiation levels were also monitored continously during 1993 with thermoluminescent dosimeters (TLDs).

The samples were collected at preselected areas near the plant and at other locations which could be impacted by Plant 2 effluents. This information was compared to samples taken in areas that were unlikely to be affected by plant operations. The 1993 REMP data were compared to data collected during previous periods of plant operation and also compared to the data collected prior to initial plant operation. The sampling results for 1993 were consistent with the results for previous years and are presented in Table 1-1. No significant new trends or changes in the environmental levels around the plant were evident.

The REMP analytical results and TLD results were demonstrated to be accurate through intercomparison programs which are provided as part of the quality assurance activities conducted during 1993. Such intercomparisons tested the performance of the Supply System monitoring program to other monitoring programs using known radioactive standards. The Supply System REMP performed well in the Environmental Measurements Laboratory (EML) and Environmental Protection Agency Intercomparison Studies conducted during 1993.

TABLE 1-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	PREOPERATIONAL[a] (RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	PREVIOUS OPERATIONAL[b][c] (RANGE)	1993[d] MEAN	1993[d] (RANGE)
Air: pCi/m³						
Gross Beta	<0.02	(<0.003 - 0.130)	0.02	(0.00 - 0.74)	0.02	(0.00 - 0.07)
I-131[e]	<0.05	(<0.01 - 0.11)	0.00	(-0.07 - 0.82)	0.00	(-0.02 - 0.02)
Gamma						
Cs-134	<0.01	(<0.001 - 0.040)	0.000	(-0.002 - 0.015)	0.000	(-0.000 - 0.000)
Cs-137	<0.01	(<0.001 - 0.040)	0.001	(-0.001 - 0.036)	0.000	(0.000 - 0.001)
Ru-103	Not Reported		0.001	(-0.001 - 0.019)	-0.000	(-0.001 - 0.001)
River/Drinking Water: pCi/l						
Gross Beta	<3.0	(<1.0 - <6.0)	2.0	(-0.2 - 9.1)	2.1	(0.6 - 4.5)
Gamma						
Cs-134	<3.8	(<1.0 - <12.0)	0.3	(-5.4 - 5.2)	-0.1	(-3.4 - 1.7)
Cs-137	<4.1	(<1.0 - <13.0)	1.1	(-5.7 - 6.2)	0.6	(-3.6 - 3.1)
Co-58	<5.1	(<1.0 - <25.0)	-0.1	(-3.3 - 2.9)	-0.3	(-1.8 - 1.7)
Co-60	<4.7	(<1.0 - <13.0)	1.0	(-4.9 - 7.1)	0.2	(-1.2 - 1.2)
Fe-59	<13.3	(<2.0 - <93.0)	0.7	(-8.9 - 6.9)	0.8	(-1.1 - 3.3)
Zn-65	<8.3	(<2.0 - <27.0)	-1.6	(-16.2 - 8.2)	0.0	(-4.4 - 8.0)
H-3	<481.7	(220 - <820)	137.5	(-500.0 - 596.0)	74.2	(-76.0 - 190.0)
Sr-90	<2.0		0.4	(0.3 - 0.7)	Analysis Not Performed	
Groundwater: pCi/l						
Gamma						
Cs-134	<4.0	(<1.0 - <12.0)	0.4	(-4.1 - 5.4)	0.4	(-2.0 - 2.8)
Cs-137	<3.8	(0.8 - <8.0)	1.1	(-3.1 - 4.9)	0.7	(-0.5 - 1.8)
Co-58	<4.7	(<1.0 - <12.0)	-0.2	(-2.8 - 1.9)	-0.9	(-3.3 - 0.6)
Co-60	<4.1	(0.1 - <9.0)	1.2	(-2.4 - 8.4)	0.1	(-1.1 - 0.9)
Fe-59	<11.6	(<2.0 - <33.0)	0.6	(-4.5 - 5.7)	1.6	(0.0 - 4.1)
Zn-65	<8.6	(<2.0 - 17.0)	-1.5	(-46.8 - 15.0)	0.9	(-5.6 - 6.2)
H-3	<467.8	(<10.0 - 2600.0)	42.9	(-516.0 - 470.0)	-16.5	(-110.0 - 60.0)
Sr-90	<0.4	(<0.1 - 0.7)	Analysis Not Performed		Analysis Not Performed	

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Charcoal cartridge results.

TABLE 1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1993[d] MEAN	(RANGE)
Discharge Water: pCi/l						
Gross Beta	<2.8	(<1.9 - 4.0)	16.8	(0.6 - 48.0)	26.4	(10.0 - 56.0)
Gamma						
Cs-134	<3.7	(<1.0 - <8.0)	0.6	(-3.9 - 5.4)	1.7	(-1.8 - 10.1)
Cs-137	<4.7	(<1.0 - 16.0)	1.7	(-5.3 - 10.0)	5.0	(-1.9 - 23.1)
Co-58	<1.4	(1.0 - 13.0)	-0.0	(-2.6 - 4.6)	0.3	(-0.7 - 1.1)
Co-60	<5.0	(<1.9 - <13.0)	3.9	(-8.7 - 57.6)	20.1	(0.0 - 41.3)
Fe-59	<11.9	(<3.0 - <38.0)	0.8	(-4.1 - 6.0)	1.0	(-4.2 - 13.0)
Zn-65	<8.6	(<2.0 - 27.0)	3.2	(-8.2 - 86.7)	18.6	(-1.7 - 57.3)
H-3	<420.0	(<80.0 - 700.0)	1425.5	(55.0 - 5400.0)	6812.5	(150.0 - 12000.0)
Sr-90	<3.0		0.8	(0.5 - 1.1)	Analysis Not Performed	
Storm Drain Water: pCi/l						
Gross Beta	Analysis Not Performed		37.9	(1.6 - 1100.0)	Analysis Not Performed	
Gamma	Analysis Not Performed					
Cs-134			0.0	(-4.8 - 8.3)	0.0	(-9.6 - 8.1)
Cs-137			1.0	(-6.2 - 6.4)	1.7	(-11.0 - 252.0)
Co-58			-0.3	(-4.9 - 3.4)	-0.5	(-7.6 - 3.3)
Co-60			2.6	(-1.9 - 125.0)	0.6	(-4.2 - 9.5)
Fe-59			0.5	(-14.0 - 8.3)	0.9	(-11.0 - 9.9)
Zn-65			1.6	(-13.0 - 53.0)	0.7	(-11.0 - 16.0)
Mn-54			0.5	(-3.2 - 6.5)	0.7	(-2.9 - 6.7)
I-131			0.8	(-6.0 - 21.1)	-0.5	(-17.0 - 15.0)
Ce-141			6.4	(-11.0 - 707.0)	-1.7	(-19.0 - 9.0)
Sb-124			11.5		Analysis Not Performed	
Sb-125			20.8		Analysis Not Performed	
I-131[e]			0.4	(-0.2 - 8.3)	Analysis Not Performed	
H-3	Analysis Not Performed		13045.0	(-93.0 - 270000.0)	5520.0	(-170.0 - 140000.0)
Sr-89	Analysis Not Performed		0.9	(-0.1 - 1.8)	Analysis Not Performed	
Sr-90	Analysis Not Performed		0.4	(-0.1 - 0.9)	Analysis Not Performed	
Sanitary Waste Water: pCi/l						
Gross Alpha	Analysis Not Performed		0.2	(-0.4 - 0.6)	0.3	(-0.4 - 1.5)
Gross Beta	Analysis Not Performed		45.4	(41.0 - 51.0)	50.1	(35.0 - 61.0)
Cs-134			-0.3	(-4.9 - 2.1)	0.4	(-1.7 - 2.9)
Cs-137			0.4	(-5.1 - 4.2)	0.8	(-4.4 - 4.1)
Co-58			-0.3	(-2.7 - 1.7)	-0.3	(-2.6 - 1.8)
Co-60			0.8	(-1.1 - 4.0)	0.4	(-1.7 - 2.4)
H-3	Analyses Not Performed		666.6	(50.0 - 1700.0)	322.0	(-110.0 - 950.0)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Resin method

TABLE 1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN (RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN (RANGE)	1993[d] MEAN (RANGE)
River Sediment: pCi/kg (dry)			
Gamma			
Cs-134	<112.5 (<50.0 - <150.0)	51.5 (7.0 - 172.0)	54.0 (42.0 - 66.0)
Cs-137	<287.0 (<50.0 - <560.0)	337.4 (153.0 - 1890.0)	408.0 (296.0 - 520.0)
Co-60	<254.6 (130.0 - 610.0)	43.7 (11.0 - 129.0)	32.9 (21.7 - 44.1)
Co-57	Not Reported	29.3 (-11.6 - 54.0)	19.0 (19.0 - 19.0)
Eu-152	Not Reported	124.3 (5.6 - 279.0)	112.0 (88.8 - 136.0)
Storm Drain Sediment: pCi/kg (dry)			
Gamma:	Analysis Not Performed[e]		
Cs-134		95.3 (4.1 - 1140.0)	54.6 (21.5 - 98.5)
Cs-137		242.0 (-3.6 - 2900.0)	129.0 (47.4 - 250.0)
Co-58		1.8 (-27.0 - 58.0)	-3.4 (-10.0 - 19.0)
Co-60		1370.0 (-6.4 - 25400.0)	517.0 (99.9 - 13400.0)
Fe-59		1.3 (-44.0 - 37.0)	-3.1 (-23.0 - 17.0)
Zn-65		270.0 (-25.0 - 4650.0)	62.1 (1.9 - 481.0)
Mn-54		46.9 (-9.6 - 670.0)	12.4 (0.3 - 65.6)
Ce-141		96.3 (-29.0 - 3740.0)	3.4 (-19.0 - 29.0)
Sanitary Waste Sediment: pCi/kg (dry)			
Gamma:	Analysis Not Performed[e]		
Cs-134		31.0 (-11.0 - 55.2)	15.0 (-15.6 - 45.5)
Cs-137		121.9 (0.0 - 254.0)	177.1 (105.0 - 255.0)
Co-60		158.3 (-3.4 - 728.0)	392.5 (182.0 - 683.0)
Zn-65		1.3 (-69.0 - 60.0)	8.2 (-106.0 - 77.4)
Mn-54		12.9 (5.7 - 25.0)	-1.3 (-24.0 - 17.0)
Sr-90	Analysis Not Performed	83.0 (26.0 - 130.0)	Analysis Not Performed
Soil: pCi/kg (dry)			
Gamma			
Cs-134	<65.3 (<20.0 - <150.0)	27.3 (1.0 - 53.2)	25.0 (22.0 - 28.0)
Cs-137	364.3 (<20.0 - <1880.0)	290.0 (-7.3 - 735.0)	199.1 (11.7 - 398.0)
Sr-90	Analysis Not Performed	178.8 (0.2 - 455.0)	Analysis Not Performed

(a) All stations all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are based high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less the" values reported in 1984.
(d) Indicator stations only.
(e) Prior to February 1992, these samples were analyzed as wet weight. These numbers are for the samples analyzed as dry weight.

TABLE 1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1993[d] MEAN	(RANGE)
ST 118 Soil: pCi/kg dry						
Gamma	Analysis Not Performed					
Cs-134			23.2	(-2.9 - 46.0)	21.5	(3.5 - 35.0)
Cs-137			14.9	(-8.8 - 48.0)	14.2	(3.5 - 31.7)
Storm Drain Soil: pCi/kg dry						
Gamma	Analysis Not Performed					
Cs-134			20.5	(0.7 - 38.0)	18.8	(-1.4 - 35.0)
Cs-137			60.2	(49.3 - 77.3)	41.8	(24.6 - 54.8)
Sr-90	Analysis Not Performed		Analysis Not Performed		Analysis Not Performed	
Milk: pCi/l						
Gamma						
Cs-134	<3.7	(<0.9 - <14.0)	0.9	(-7.4 - 22.6)	0.1	(-2.4 - 2.2)
Cs-137	<3.8	(<1.0 - <12.0)	2.8	(-7.4 - 47.3)	0.7	(-6.6 - 3.7)
Ba-140	<72.1	(<6.0 - <2000.0)	0.2	(-44.3 - 55.0)	0.3	(-9.5 - 11.8)
La-140	<33.3	(<5.0 - 1000.0)	-0.5	(-24.2 - 9.7)	-0.2	(-7.5 - 5.6)
I-131[e]	<0.5	(<0.1 - <1.0)	1.0	(-0.8 - 143.6)	0.0	(-0.2 - 0.2)
Sr-90	Analysis Not Performed		1.9	(1.3 - 3.9)	Analysis Not Performed	
Fish: pCi/kg (wet)						
Gamma						
Cs-134	<61.2	(<6.0 - <130.0)	2.1	(-20.4 - 24.0)	0.4	(-1.5 - 1.8)
Cs-137	<88.8	(<10.0 - <130.0)	15.8	(-35.1 - 57.0)	4.7	(-4.5 - 11.9)
Co-58	<87.7	(<9.0 - <130.0)	0.8	(-16.8 - 25.8)	-1.8	(-4.8 - 2.4)
Co-60	<80.6	(<9.0 - <130.0)	1.5	(-18.4 - 21.0)	3.8	(0.2 - 8.0)
Fe-59	<130.0	(<30.0 - <260.0)	-0.5	(-34.2 - 30.0)	2.1	(-4.3 - 6.8)
Mn-54	<88.3	(<8.0 - <130.0)	1.3	(-20.0 - 30.9)	1.5	(-1.7 - 3.5)
Produce: pCi/kg (wet)						
Gamma						
Cs-134	<49.1	(<10.0 - < 140.0)	1.2	(-24.8 - 19.8)	0.1	(-2.1 - 2.3)
Cs-137	<69.8	(<10.0 - < 140.0)	3.8	(-9.8 - 20.9)	2.2	(-0.8 - 4.2)
I-131	<105.6	(<10.0 - <1000.0)	-0.4	(-26.0 - 59.0)	0.2	(-2.8 - 4.2)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Resin method.

TABLE 1-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1993[d] MEAN	(RANGE)
Storm Drain Vegetation[d] pCi/kg (wet)						
Gamma	Analysis Not Performed					
Mn-54			17.7	(4.7 - 32.2)	4.2	(-2.0 - 10.5)
Co-60			19.1	(-3.7 - 46.1)	40.2	(32.2 - 48.2)
Zn-65			34.6	(4.1 - 57.4)	10.9	(6.9 - 14.9)
Cs-134			10.4	(-6.5 - 45.8)	4.2	(3.8 - 4.6)
Cs-137			29.5	(3.9 - 93.5)	31.6	(26.2 - 36.9)
TLD: mR/day						
Quarterly	0.24	(0.11 - 0.32)	0.25	(0.16 - 0.35)	0.26	(0.21 - 0.33)
Annual	0.23	(0.20 - 0.31)	0.23	(0.18 - 0.32)	0.24	(0.21 - 0.29)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Routine samples from the outfall only.

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2.0 DEFINITIONS

2.0 DEFINITIONS

Airborne Activity Sampling: Continous sampling of air through the colection of particulates and radionuclides on filter media.

Periodic soil samples are collected for gamma isotopic analysis to provide information on deposition to the soil from airborne releases.

Alpha Particle (α): A charged particle emited from the nucleus of an atom having a mass and charge equal in magnitude of a helium nucleus.

Becquerel (Bq): One disintegration per second. One picocurie (pCi) equals 0.037 becquerel.

Beta Particle (β): Charged particle emited from the nucleus of an atom, with a mass and charge equal in magnitude to that of an electron.

Blank Sample: A sample of the same media as the field sample being analyzed but without the radionuclide(s) being measured. It enables correction for the inherent sample background.

Composite Sample: A series of single collected portions (aliquots) analyzed as one sample. The aliquots making up the sample are collected at time intervals that are very short compared to the composite period.

Control Station: A background sampling location, i.e., a location not likely to be affected by plant effluents due to its distance and/or direction from Plant 2.

Counting Error: An estimate of the two-sigma uncertainty associated with the sample results based respective count times.

$$+/-2\sqrt{(SampleCPM/CountTime+BkgCpm/CountTime)}$$

Curie (Ci): 3.7×10^{10} disintegrations per second, or 2.22×10^{12} disintegrations per minute.

Direct Radiation Monitoring: The measurement of radiation dose at various distances from the plant is assessed through the use of thermoluminescent dosimeters and pressurized ionization chambers.

DOH: Washington State Department of Health.

EFSEC: Energy Facility Site Evaluation Council.

FFTF: U.S Department of Energy's Fast Flux Test Facility near Plant 2.

Flow Proportional Sampling: Sample collection volume or frequency determined as a function of the flow rate of the water being sampled.

Grab Sample: A single discrete sample drawn at one point in time.

Indicator Station: A sampling location that could be affected by plant effluents due to its proximity and/or direction from Plant 2.

Ingestion Pathway Monitoring: The ingestion pathway includes milk, soil, fish, garden produce. Also sampled (under special circumstances) are other media such as vegetation and animal products such as eggs and meat when additional information about particular radionuclides is needed.

Lower Limit of Detection (LLD): The smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with a 5% probability of a false conclusion that a blank observation represents "real" signal.

$$LLD=4.66Sb/(2.22*Vol*Eff*Yield*e^{(-\lambda t)})$$

Where LLD is the "a priori" or 'before-the-fact' measurement and not "a posteriori" or 'after-the-fact' measurement.

Mean: The average, i.e., the sum of results divided by the number of results.

Microcurie: 3.7×10^{4} disintegrations per second, or 2.22×10^{6} disintegrations per minute.

Milliroentgen (mR): 1/1000 Roentgen; a unit of exposure to X or gamma radiation.

NIST: National Institute of Standards and Technology.

NRC: U.S. Nuclear Regulatory Commission.

ODCM: Offsite Dose Calculation Manual, which contains the program requirements formerly contained in the Technical Specifications.

Picocurie (pCi): 1 x 10^{-12} Curie or 2.22 disintegrations per minute; one millionth of a microcurie.

REMP: Radiological Environmental Monitoring Program.

Range: The difference between the smallest and largest results.

Restricted Area: Any area to which access is controlled for purposes of protection of individuals from exposure to radiation and radioactive materials.

Results: The results of sample collection are discussed and interpreted by comparing them to similar measurements made during the preoperational and previous operational periods and to the detection capabilities associated with the current methods of analysis.

Roentgen: Unit of exposure to X or gamma (γ) radiation in air.

Site Certification Agreement (SCA): The Plant 2 licensing agreement with the State of Washington.

Spike Sample: A sample containing a known concentration of the radionuclide(s) being measured.

Standard Deviation: A measure of the scatter of a set of observations (or samples) around their mean value. Indicated by (σ).

Standard Error of the Mean: An estimate of the uncertainty associated with the mean of observation (or sample) averages.

$$SE=\sqrt{(\frac{S^2}{n})}$$

where S^2, the variance is

$$S_m^2=1(n-1)\sum^n (Xl-X)^2$$

SWTF: Sanitary Waste Treatment Facility; sanitary waste processing facility for Plant 2 and WNP-1 and WNP-4 sites.

TEDA: triethylene diamine

TLD: a Thermoluminescent dosimeter contains a phosphor which stores energy from exposure to radiation and emits that energy in the form of light when heated.

3.0 INTRODUCTION

3.0 INTRODUCTION

3.1 Site Description

The Washington Public Power Supply System's Plant 2 is located in a sparsely populated shrub-steppe region within the Department of Energy-operated Hanford Site in southeastern Washington. The plant is approximately three miles west of the Columbia River and is surrounded on all sides by uninhabited desert land. The nearest population centers are Richland, Kennewick and Pasco, which are 12 miles south, 21 miles southeast, and 18 miles southeast, respectively. The nearest privately-owned lands are located approximately four miles ENE of the plant, across the Columbia River. Given the prevailing wind directions, shown in the 1993 wind frequency distribution in Figure 3-1, the focus of REMP sampling is the farming region east of the river.

Because Plant 2 is located on the Hanford Site, other potential sources of radioactive materials are in close proximity to Plant 2. A Department of Energy (DOE) burial site (618-11) for high level waste is located adjacent to the plant. For this reason, sampling locations near the plant (near-plant locations) provide useful information for separating the potential environmental effects of Plant 2 from the effects of the other sources on the Hanford Site.

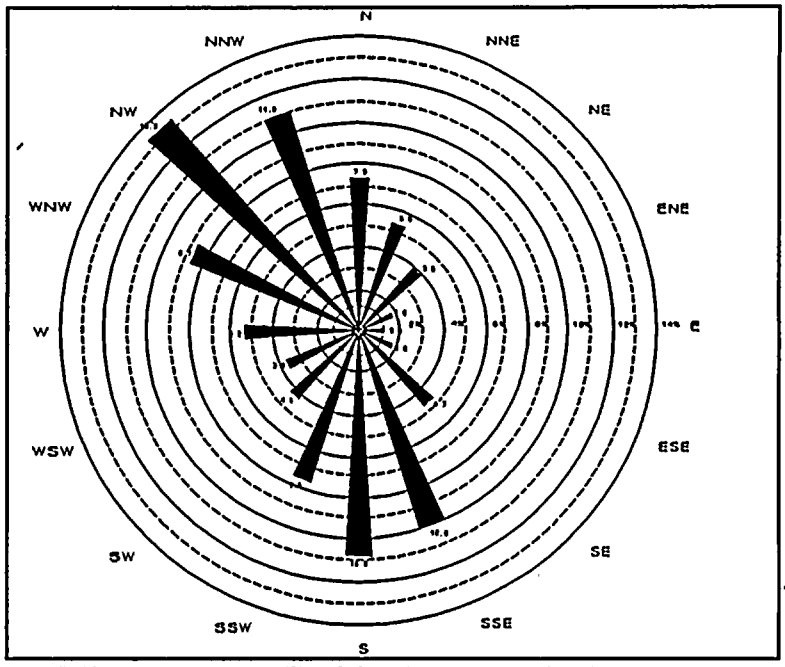

FIGURE 3-1 Average Wind Direction (percent) During 1993

3.2 Program Background

The REMP is designed to conform to the regulatory guidance provided by Regulatory Guides 4.1[1] and 4.8[2], including the Radiological Assessment Branch Technical Position[3].

The quality assurance aspects of the program and the thermoluminescent dosimetry are conducted in accordance with Regulatory Guides 4.15[4] and 4.13.[5] The REMP also must adhere to the requirements of the Washington Energy Facility Site Evaluation Council[6] and the Plant 2 Technical Specifications[7] and the Offsite Dose Calculation Manual (ODCM)[8]. These requirements cover not only the environmental sampling and sample analysis aspects of the program, but also the reporting and quality assurance requirements of the program.

The preoperational phase of the program, which lasted from March 1978 to January 1984, the date of initial criticality, provided a baseline of environmental data. Variability in the background levels of radioactivity due to differences in geologic composition, nuclear weapons test fallout, meteorological conditions and seasonal changes is reflected in that preoperational data.

REMP environmental samples have always been analyzed by a contract analytical laboratory. Since June 1986, Teledyne Isotopes, Inc. in Westwood, New Jersey has performed the analysis of REMP samples. The thermoluminescent dosimeters used in the REMP to assess the direct radiation are processed by the Supply System External Dosimetry Laboratory within the Health Physics Department.

3.3 Program Objectives

The REMP provides a mechanism for determining whether the levels of radioactivity in the plant environs are within established limits and for ensuring that the accumulation of radionuclides in the environment will not become significant as a result of plant operations.

While in-plant monitoring programs are used to ensure that 10CFR20[9] and 10CFR50[10] criteria for releases of radioactive effluents are met, the REMP provides supplemental verification that the concentrations of radionuclides in the environment are not greater than anticipated.

Any radiological effect of Plant 2 on the environment must be distinguished from the normal variation in background radiation levels and from the effects of other sources of radioactive effluents in the area.

The monitoring results obtained during each year of the plant's operation are compared to the preoperational data and to data from previous operating years, in order to determine whether a significant accumulation of plant-produced radionuclides has occurred in the environment. Quarterly averages of the results are also compared to the Nuclear Regulatory Commission (NRC) non-routine reporting levels listed in the ODCM. In addition to evaluating the environmental concentrations against federal standards or limits, the REMP also compares the results to state standards.[11][12][13] The results are discussed and interpreted by comparing them to similar measurements made during the preoperational and previous operational periods and to the detection capabilities associated with the current methods of analysis. The quality assurance and quality control aspects of the program are also discussed in this report.

4.0 PROGRAM DESCRIPTION

4.0 PROGRAM DESCRIPTION

The requirement for the Radiological Environmental Monitoring Program (REMP) is defined by the WNP-2 Offsite Dose Calculation Manual (ODCM). The sampling plan to meet ODCM requirements is presented as Table 4-1 in this report and provides a summary of the sample locations, collection frequency and types of analyses performed. The methods of sampling and sampling frequencies utilized in the program have been determined by such factors as the half-lives and major exposure pathways for the radionuclides potentially released from the plant to the surrounding environment.

The REMP staff reports to the Manager, Health Physics who reports to the Manager, Support Services. The REMP staff consists of one supervisor and two scientists. The scientists role are to monitor the environment, collect samples, send the samples to the contractor (Teledyne) for analysis, and when results are received; reviewed for accuracy, and filed in permanent auditable record storage. The data is tracked utilizing various software that can provide the reports and graphs necessary for the program.

4.1 Sample Locations

Eighty sample locations were included in the 1993 monitoring program. Seventy-three indicator and two control, i.e. background, locations were within 10 miles (16 kilometers) of Plant 2. Three additional control stations and two indicator stations were outside the 10-mile radius from the plant. Sample stations are listed in Table 4-2 by meteorological sector, sample media and approximate distance from the plant. The numbers and locations of sample stations are based not only on factors such as population distribution and meteorological conditions, but also on station accessibility, security throughout the year and the requirements of applicable regulations. Other factors such as the need to monitor locations which potentially could be impacted by Plant 2 operations, influence the location of REMP sampling sites.

The REMP sampling locations listed in Tables 4-1 and 4-2 are shown in Figure 4-1. Figure 4-3 provides a more detailed map of sampling locations in the Sunnyside/Grandview area. Figure 4-4 shows the locations of the storm drain (Station 101), the Sanitary Waste Treatment Facility (Station 102) and the containerized storage area (Station 118), which are special interest stations.

4.2 Land Use Census

The land use census for areas within 5 miles of Plant 2 was performed in August. The objectives of the land use census are to identify the locations of the nearest milk animal, residence, and garden greater than 50 m^2 (500 ft^2) producing broadleaf vegetation and to determine whether any site located during the census has a calculated dose or dose commitment greater than the sites currently monitored for the same exposure pathway. If a new location with a higher dose commitment is found, routine sampling of that dose pathway would be initiated at that new site.

The results of the 1993 land use census within 5 miles of Plant 2 are given in Table 4-3. No significant changes from the 1992 land use census were observed. No milk animals are located within the 5-mile radius. The closest milk locations were at 6.4 miles SE and 7.2 miles ESE.

4.3 Sampling Methods

Environmental samples were collected according to the schedule in Table 4-1. All samples were collected by Supply System personnel. Documented procedures for sample collection and TLD analyses are in the Supply System's Health Physics Instruction Manual (HPI). The sample analyses procedures are prepared and maintained by the analytical contractor (Teledyne), and reviewed by the Supply System prior to implementation.

The following sections describe the sampling and preparation methods.

4.3.1 Direct Radiation

During 1993, thermoluminescent dosimeters (TLDs) were used to determine the direct radiation levels at fifty-six (56) monitoring locations listed in Table 4-1. No new TLD locations were added to the program this year, however, Station 55 which consists of an annual and quarterly TLD and located at the Department of Energy's 300 Area was moved as a result of heavy construction in the area. The TLD was lost for a period of time in June, and was later found buried in a pile of construction dirt. The TLD had adequate information concerning the importance of the station. The station was then moved approximately one mile north of the original station, but still in the same sector. The control station TLD (background) is located at Station 9A in Sunnyside. The remaining TLDs served as indicator TLDs throughout the year.

Two sets of TLDs placed three feet above ground were employed at each location. One set of TLDs was exchanged on a quarterly basis (Quarterly TLDs) and the other exchanged on an annual basis (Annual TLDs). Exposure of the field TLDs received during transport to the TLD sites was monitored by a set of field control, or trip control, dosimeters that accompanied the field dosimeters to and from the field locations. Another set of TLDs was used as building control TLDs which were used to determine the exposure of the TLDs at the controlled storage location during the quarter. The TLD exposure during transport to and from the field was determined by subtracting the difference between the building control results and the trip control results.

The environmental dosimeters were processed on a Teledyne Isotopes Model 9100 Automatic Reader. Following the initial processing, the field dosimeters were annealed and given a calibration exposure of 100 mR of cesium-137 gamma, in order to determine response (i.e, calibration) factors for each dosimeter. The calibration factors were then used to determine the total exposure received by each TLD.

The exposure values determined for calibration exposures, as well as the exposures of the QA dosimeters (processing control dosimeters) and audit dosimeters (spiked dosimeters), were based on the calculated field strength of the encapsulated cesium-137 source. The calculated field

strength of the source was determined from National Institute of Standards and Technology (NIST)-traceable ionization chamber measurements made over a period of several years during the routine use and calibration of the source. Ionization chamber measurements made during TLD calibration were used to confirm the calculated exposure. If the calculated exposure and the ionization chamber reading differed by 5% or more, an investigation was performed to resolve the difference.

Three Reuter Stokes pressurized ionization chambers (PICs) provided additional capability for measuring direct radiation exposure. These units are no longer part of the routine monitoring program, but they are used in special monitoring situations and maintained as back-up monitoring systems.

4.3.2 Airborne Particulate/Iodine

Air particulate and air iodine (I-131) samples were obtained through the use of portable, low volume (1.5 cfm) constant flow-rate sampling units at each of twelve locations. The samples drawn at Station 9A (Figure 4-3) were considered control samples; the ones drawn at the other locations (Figure 4-10) were indicator samples. Air particulates were collected by drawing air through a 47mm diameter glass fiber filter. Air iodine was collected by drawing air through a 57mm diameter TEDA impregnated charcoal cartridge. The particulate air filter and charcoal cartridge were placed in tandem, particulate filter first, in a holder that attached to the air inlet of the sampler unit. The sampler units were placed in ventilated metal weatherproof housings mounted on elevated platforms at each air sample location. The filter media are changed weekly and shipped to the analytical contractor for analysis within one or two days of collection.

4.3.3 Water

There were nine sampling locations for water sampling: three for the evaluation of river/drinking water, one for plant discharge water, three for groundwater, one for the storm drain water, and one for sanitary waste water. One river/drinking water location, Station 26, was used for evaluation of the plant intake water, i.e., the river water taken upstream of the plant discharge point. This Station 26 sample can be considered a drinking water sample since the site draws its drinking water from the intake water. It is considered the river/drinking water control sample because of its upstream location. Two additional locations, Stations 28 and 29, were used to evaluate the water at the two nearest drinking water locations, the Department of Energy 300 Area and the Richland Water Treatment Plant. These two stations were considered indicator stations.

The ODCM requirement for a downstream water sample "near but beyond the mixing zone" was met by sampling water from Station 27, the plant discharge line to the Columbia River. This sample reflects the radioactivity present in the plant discharge prior to any river dilution, rather than the concentrations that would be found after dilution in the mixing zone. Water is drawn at this location because it was not feasible to perform flow-proportional composite sampling in

the mixing zone area of the river downstream from the plant discharge point. Station 27 sample is also considered as an indicator sample.

Composite samplers are installed at the Columbia River pumphouse to monitor the cooling tower discharge line (Station 27). There are composite samplers at two drinking water locations (Stations 28 and 29), and the control location (Station 26). Samples collected are 25-ml aliquots of water at regular intervals of time or flow.

Nonroutine analyses on the drinking water samples include strontium-90 analysis, when the gross beta activity exceeds 8 pCi/liter or ten times the mean of the previous three months' activity for a specific location, and iodine-131 analysis, when the dose calculated for the consumption of water exceeds one mrem per year. Neither of these analyses were required during 1993.

The three groundwater stations are located on Supply System property: one well on the Plant 2 site (0.1 mile north of the Reactor Building) and two wells on the WNP-1 site (1.2 miles downgradient from Plant 2). Water from the Plant 2 well can be used as a backup source for drinking and fire protection. Water from the WNP-1 wells supplies the drinking and fire protection water for the WNP-1 site. All three groundwater samples are considered indicator samples. Quarterly grab samples were taken from each of these wells. One gallon (3785 ml) was collected from each well for gamma analysis and 250 ml was drawn for tritium analysis.

Water samples were also collected from the storm drain (ST-101) for Plant 2, and at the Sanitary Waste Treatment Facility (SWTF; ST-102).

4.3.4 Soil

Soil samples were collected once during 1993, from four locations as required by the Site Certification Agreement. The four locations are Stations 1, 7, 21 and 23. One sample was taken at the control location, Station 9A (Figure 4-3). Quarterly soil samples were collected at two special interest locations, Station 101 and Station 118, as shown in Figures 4-4.

Each sample was taken from an area of approximately one square foot to a depth of approximately one inch. Approximately two kilograms of soil were collected in each sample. Soil samples were shipped to the analytical contractor after collection and analyzed for gamma activity.

If the gamma isotopic analysis indicated that cesium levels in any of the indicator samples exceeded ten (10) times the level in the control sample, a strontium analysis was performed on the sample(s).

4.3.5 Sediment

Sediment samples were collected twice during 1993 from two sampling locations along the Columbia River. The upstream sediment sample (Station 33) was collected from a location

approximately two miles upriver from the plant discharge. The downstream sample location (Station 34) was collected approximately one mile downstream of the plant discharge. Each sample consisted of approximately two kilograms of the shallow surface sediment scooped from below the waterline. The samples were shipped to the analytical contractor.

Sediment samples were also taken from the storm drain (ST-101) outfall and storm drain pond and the SWTF (ST-102) stabilization ponds, dosing pond, and percolation beds. Sediment sampling in these locations was performed in a manner similar to river sediment sampling. Special care was taken to prevent loss of the fine particulates in the sediment. In addition, formalin was added to the sanitary pond sediment prior to shipping, to inhibit gas formation within the sample container.

4.3.6 Fish

Fish sampling was performed during October, when the likelihood of obtaining anadromous species was high. Fish samples collected from the Columbia River (Station 30 in Figure 4-1) were indicator samples, while the fish collected on the Snake River (Stations 38 and 38A in Figure 4-2) were control samples.

Four separate fish samples, consisting of an anadromous species and three other species generally considered edible or potentially edible (such as carp, catfish and whitefish) were collected at each location. Most of the fish were collected through the use of electro-shock, but samples of the anadromous species were also collected from the Ringold hatchery on the Columbia River and at the Lyons Ferry Fish Hatchery on the Snake River. The fish were filleted to obtain one kilogram of edible flesh per sample. The fillets were placed in clean plastic bags and frozen until shipment to the analytical contractor. The Site Certification Agreement was changed to require only annual fish sampling, unless elevated radiation levels related to plant operations are observed in which case semiannual sampling would resume.

4.3.7 Milk

Milk samples were collected monthly during January, February, March, October, November and December and semimonthly during the remaining six months when the cows were likely to be grazing. One gallon of raw milk was collected from each sampling location. The milk samples were chilled thoroughly and shipped to the analytical contractor within a day of collection.

Routine samples were collected from four indicator locations (Stations 36, 59, 62 and 64) across the Columbia River in Franklin County. Milk samples for Station 59 were only taken until April at which time milk production ceased at this farm.

Milk samples were also collected at one indicator station (Station 9B) and one control location (Station 96) in the Sunnyside/Grandview area (in Figure 4-3). Station 9B in Sunnyside continued to serve as an indicator station in 1993 because a portion of the feed for the cows at that location is hay from Franklin County north of Pasco. That factor makes it unsuitable for use as a control

location.

4.3.8 Garden Produce

Samples of local garden produce were collected monthly from April to September, when the produce was readily available. When possible, three types of produce samples, a root crop, fruit and a leafy vegetable, were collected at each location.

The indicator samples were collected from a region in a predominant downwind direction (Station 37 in Figure 4-2) where crops are irrigated with Columbia River waMwr. The control samples were obtained from produce stands in the Sunnyside area (Station 9C in Figure 4-3), the direction least likely to be affected by plant effluents. Apples were collected in September from Station 91, the Rio Vista Farms orchard, which is irrigated with Columbia River water.

4.3.9 Vegetation

Samples of vegetation growing in the storm drain pond were collected periodically during 1993. Cattails and grasses were the principal types of vegetation collected. Approximately two kilograms of sample were collected each time. Care was taken to avoid including the roots or soil from around the roots in the samples.

4.3.10 Snow

Snow is not routinely sampled by the REMP, however, snow samples were taken in to gather information concerning tritium levels in the environment around Plant 2. Each sample consisted of fresh snow collected in a plastic or teflon container placed outside during snowfalls or collected by shoveling all the snow, from ground level to the top, in a designated area. The volume of snow collected was sufficient to provide at least a one-liter water sample for analysis.

4.4 Analytical Procedures

The analytical procedures used for the 1993 REMP samples are described below. Teledyne Isotopes performed all routine analyses of REMP samples during 1993.

4.4.1 Gross Beta Activity on Particulate Filters

The particulate filters were counted in a gas flow-proportional counter after a delay of five or more days to allow for the radon-222 and radon-220 (thoron) daughter products to decay. An unused air particulate filter was counted as the blank with each Mwekly set of filters.

4.4.2 Measurement of Gamma Emitters

A shielded Ge(Li) detector system was coupled to a computer-based data acquisition system which performed pulse height and gamma energy anlysis. The information collected about each peak was compared to a library of known peaks. Isotopic identification was performed as was the radioactivity calculation which used the appropriate fractional gamma ray abundance, half-life, detector efficiency, and net counts in the peak region.

Milk and Water
A 1-liter Marinelli beaker was filled with a representative aliquot of the sample. The sample was then counted for at least 1000 minutes (16.7 hours).

Foodstuff
As much of the edible portion of the sample as possible was loaded into a tared Marinelli beaker and weighed. The sample was then counted for at least 1000 minutes (16.7 hours).

Vegetation
As much sample as possible is placed in a 1-liter Marinelli beaker and counted for approximately 1000 minutes (16.7 hours). The sample is not dried prior to counting, so the results are given in terms of wet weight.

Soils and Sediments
A large quantity of the sample was dried at a temperature below 100°C. As much sample as possible was loaded into a tared 1-liter Marinelli beaker and weighed. The sample was then counted for at least 360 minutes (6 hours).

Charcoal Cartridges (Air Iodine)
Charcoal filters were counted up to five at a time, with one positioned on the face and up to four on the side of the calibrated Ge(Li) detector. The detection limit for a charcoal cartridge was uniquely determined for each filter and by using its position. In the event that iodine-131 would have been observed in the initial counting of a set, each charcoal cartridge in the set was then positioned separately on the face of the detector and counted.

Air Particulate Filters

Four air particulate filters for a quarterly composite for each field station were aligned one in front of another and counted for at least 360 minutes (6 hours).

4.4.3 Gross Beta Activity in Water

A one-liter aliquot of each sample was evaporated to a small volume and transferred to a stainless steel planchet. The sample was dried under heat lamps, cooled, then counted on an automatic beta proportional counter. The results were calculated using empirical self-absorption curves which enabled the correction of effective counting efficiency based on the sample residue mass.

4.4.4 Iodine-131 in Water

Two liters of sample were first equilibrated with stable iodide carrier. A batch treatment with anion exchange resin was used to remove iodine from the sample. The iodine was then stripped from the resin with sodium hypochlorite solution, reduced with hydroxylamine hydrochloride, and extracted into carbon tetrachloride as free iodine. It was then back-extracted as iodide into sodium bisulfite solution and precipitated as palladium iodide. The precipitate was weighed for chemical yield and mounted on a nylon planchet for low-level beta counting. The chemical yield was corrected by measuring the stable iodide content of the water with a specific ion electrode. During 1993, this procedure was used only on intercomparison samples, since the doses calculated via ODCM methodology for the consumption of drinking water did not exceed one mrem per year.

4.4.5 Tritium in Water

Tritium in water analysis is performed utilizing using liquid scintillation. Liquid scintillation requires 10 milliliters of water mixed with 10 milliliters of liquid scintillation "cocktail." The mixture is then counted in an automatic liquid scintillation detector.

4.4.6 Strontium-89 and 90 in Water, Milk and Soil

During 1993, strontium analyses were not required for any routine REMP water or milk samples. It was also used for special and intercomparison water and sediment analyses. The techniques used to analyze for strontium in the various media are described below.

Water

Stable strontium carrier is added to one liter of sample and the volume was reduced by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid.

Milk

Stable strontium carrier is added to one liter of sample. The sample was then evaporated and ashed in a muffle furnace. The ash is dissolved and strontium precipitated as a phosphate. The sample then redissolved and strontium precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid.

Soil and Sediment

The sample was first dried under heat lamps and a 10-gram aliquot was taken. Stable strontium carrier was added and the sample was leached in hydrochloric acid. The mixture was filtered. Phosphates were then precipitated, collected by filtration and dissolved in nitric acid. Strontium was precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge were then performed. Stable yttrium carrier was added and the sample was allowed to stand for five days or more for yttrium ingrowth. Yttrium was then precipitated as hydroxide, dissolved and reprecipitated as oxalate. The yttrium oxalate was mounted on a nylon planchet and counted in a low-level beta counter to infer strontium-90 activity. Strontium-89 activity was determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate was mounted on a nylon planchet and covered with an 80 mg/cm^2 aluminum absorber for low-level beta counting.

4.4.7 Iodine-131 in Milk

Two liters of sample were first equilibrated with stable iodide carrier. A batch treatment with anion exchange resin was used to remove iodine from the sample. The iodine was then stripped from the resin with sodium hypochlorite solution, reduced with hydroxylamine hydrochloride, and extracted into carbon tetrachloride as free iodine. It was then back-extracted as iodide into sodium bisulfite solution and precipitated as palladium iodide. The precipitate was weighed for chemical yield and mounted on a nylon planchet for low-level beta counting. The chemical yield was corrected by measuring the stable iodide content of the milk with a specific ion electrode.

4.5 Data Analysis Methods

Since mid-1984, the results of the REMP analyses have been given as net results calculated from the gross or total counts determined for each radionuclide minus the background counts of the counting or detection instrument. Consequently, for several sample types, the results range from negative to positive numbers. This manner of presenting environmental data prevents the bias and loss of individual results inherent in the use of "less than" (<) values, where the "less than" numbers can have a variety of meanings, such as "less than the lower limit of detection (LLD)." The net results for REMP samples are presented with an asterisk (*) in front, if the results are less than the LLD. A listing of the LLDs determined for each analysis is provided in Table 4-4 as a reference when reviewing the sample results.

Plots of the sample results versus time are used to represent the results for analyses such as gross beta on air particulate filters, where the results are normally above the lower limits of

detection. In such cases, the indicator station results are plotted with the control station results for easy comparison. Other data analysis techniques, such as frequency distributions, are also used to represent the data and to determine whether trends that could be attributed to Plant 2 operations are evident. Thermoluminescent dosimeter (TLD) data is presented in terms of the net mR/day exposure rate. These results are determined from the total exposure (in mR) calculated for each TLD from its total thermoluminescent output minus the TLD background, minus any transit (or trip) exposure received during distribution and retrieval, and divided by the number of days the TLD was in the field. Circular plots, frequency distributions and graphs of TLD data by meteorological sector and distance from the plant are used to interpret trends in the results.

TLD data summaries include the term "standard error," along with "standard deviation." The standard error, which is the estimate of the precision of the mean, is used for the means of quarterly and annual data. The standard deviation is used for the TLD data involving a single dosimeter result that has been determined from the four reader areas of the TLD. Both terms provide an indicator of the uncertainty associated with the results.

TABLE 4-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM PLAN

	SAMPLE TYPE[a]	SAMPLE STATION [b] NUMBER	SAMPLING AND COLLECTION FREQUENCY[c]	TYPE AND FREQUENCY OF ANALYSIS
1.	**AIRBORNE**			
	Particulates and radioiodine (6/12)[d]	1, 4-9A, 21, 23, 40, 48, and 57	Continuous sampling; weekly collection	Particulate: Weekly gross beta[e]; gamma isotopic[f] of quarterly composite (by location)
				Iodine: Weekly gamma analysis.
	Soil[g](0/7)	9A, 1,7,21 and 23, 101, 118	Annually Quarterly or more often as needed.	Gamma isotopic[f]; strontium-90[h] Gamma isotopic
2.	**DIRECT RADIATION**			
	TLD[i](34/57)	1-9A, 10-25, 40-47, 49-51, 53-56, 61, 71-86 (1S-16S)[j]	Quarterly, annually	Thermoluminescent output; quarterly and annual processing.
	PIC	Various locations, as needed [k]	Continuous recording, as needed	Exposure rate accumulated on mag card and in internal memory
3.	**WATERBORNE**			
	River/Drinking Water[l] (3/4)	26, 27, 28 and 29	Composite aliquots[m]; monthly collection	Gamma isotopic[f], gross beta, quarterly; tritium composite; strontium-90[n]; I-131[o]
	Storm Drain Water (1/1)	101	Composite aliquots[m], daily collection; grab samples	Gamma isotopic[f], tritium
	Sanitary Waste Treatment Facility Water (1/1)	102	Monthly, annually, pre-discharge and as needed.	Gamma isotopic[f], gross beta, gross alpha, strontium-90[n], tritium
	Ground Water (2/3)[p]	31, 32, and 52	Quarterly	Gamma isotopic[f]; quarterly tritium
	River Sediment (1/2)[q]	33 and 34	Semiannually	Gamma isotopic[f]
	Sanitary Waste Treatment Facility Sediment (1/1)	102	Monthly or more often as needed	Gamma Isotopic[f]

TABLE 4-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM PLAN

	SAMPLE TYPE[a]	SAMPLE STATION [b] NUMBER	SAMPLING AND COLLECTION FREQUENCY[c]	TYPE AND FREQUENCY OF ANALYSIS
4.	INGESTION			
	Milk[r] (4/4)	9B, 36, 59[s], 62, 64 and 96[s]	Semimonthly during grazing season, monthly at other times	Gamma isotopic[f]; iodine-131; strontium-90[t]
	Fish[u] (2/2)	30 and 38	Semiannually [v]	Gamma isotopic[f]
	Garden Produce[w](1/3)	9C, 91[x] and 37	Monthly during growing season in the Riverview area of Pasco and a control near Grandview; annual collection at Station 91.	Gamma isotopic[f]
	Vegetation	101	Quarterly, as available	Gamma isotopic[f]

(a) The fraction in parentheses for each sample type indicates the ratio of ODCM-required sample locations to the total number of sample locations currently being monitored in the surveillance program. The SCA also requires certain numbers of sampling stations for each type of media.

(b) The underlined sample location designates a control station.

(c) Deviations are permitted if samples are unobtainable due to hazardous conditions, seasonal availability, malfunction of automatic sampling equipment, or other legitimate reasons. Such deviations are documented in Section 5

(d) The SCA requires nine or more air sampling stations.

(e) Particulate sample filters will be analyzed for gross beta after at least 24 to 48 hours to allow for the decay of radon daughter products. If gross beta activity is greater than 10 times the mean of the result for the control, Station 9A, gamma isotopic analysis shall be performed on the individual sample.

(f) Gamma isotopic means identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents of Plant 2.

(g) Soil samples are collected to satisfy the requirements of the Site Certification Agreement (SCA)[5] for Plant 2. The SCA requires that soil samples be collected

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at five air sampling locations.

(h) Strontium-90 analysis shall be performed on any indicator soil sample having cesium results greater than ten times the results for the control location. During 1993, strontium 90 analysis was performed on the Station 23 soil.

(i) TLD refers to thermoluminescent dosimeter. For purposes of the REMP, a TLD is a phosphor card (31.75mm x 44.75mm x 0.4mm) with eight individual read-out areas (four main dosimeter areas and four back-up dosimeter areas) in each badge case. TLDs used in the REMP meet the requirements of Reg Guide 4.13[5] and ANSI N545-1975, except for specified energy-dependence response. Correlation factors are available for energy ranges with response outside of specified tolerances.

(j) TLD Stations 71-86 are special interest stations and are not included among the 34 routine TLD stations required by the ODCM Table 6.3.1.1-1 (3.12-1). Their alternate designations are 1S-16S. Station 61, a special interest location, was discontinued in June. The SCA requires that 25 or more TLD stations are located within a 10-mile radius of the plant.

(k) Pressurized ion chambers (PICs) are not required as part of the routine monitoring program, but they are required by the SCA to be maintained as a supplemental or backup system. PICs were used routinely at various locations during 1993 to provide supplemental information.

(l) The term "river/drinking water", instead of "surface/drinking water", is used throughout this report because the surface water is taken from the Columbia River. Station 26, Plant 2 makeup water intake from the Columbia River is both an upstream surface, or river, water sample and the drinking water control sample location. Station 28 (300 Area) and Station 29 samples are drinking water samples. The Station 27 sample, which is drawn from the plant discharge line, is taken in place of a "downstream" water sample near but beyond the mixing zone. It reflects the radioactivity present in the plant discharge prior to any river dilution. The SCA requires two drinking water locations downstream from the plant discharge and requires sampling from the plant intake and discharge water. Station 101, the storm drain pond, and Station 102, the Sanitary Waste Treatment Facility, are represented individually because they are unique sampling locations requiring special attention.

(m) Composite (integrated grab) samples are collected with equipment which collects an aliquot at time intervals that are short relative to the compositing period.

(n) When the gross beta activity in drinking water exceeds 8 pCi/liter, a strontium-90 analysis is performed.

(o) When the dose calculated via ODCM methodology for consumption of water exceeds 1 mrem per year, iodine-131 analyses are performed on the drinking water samples.

(p) The SCA requires sampling from wells used for fire protection and as backup drinking water sources.

(q) The SCA requires sediment sample collection upstream and downstream of the plant discharge.

(r) Milk samples will be obtained from farms or individual milk animals which are located in the most prevalent wind directions from Plant 2. Routine milk samples are collected in areas of high dose potential instead of within 5 kilometers, due to the locations of milk animals. The SCA requires at least three milk locations within the 10-mile radius of the plant and one in a control location.

(s) Station 96 is the control station for milk samples because it was determined that the cows at Station 9B in Sunnyside were given feed grown in the Franklin County area across the Columbia River from Plant 2. Station 59 was removed as a milk location in April 1993.

(t) If cesium-134 or cesium-137 is measured in an individual milk sample in excess of 30 pCi/l, then the strontium-90 analysis will be performed.

(u) There are no commercially important species in the Hanford Reach of the Columbia River. Most recreationally important species in the area are anadromous (primarily salmonids), which ascend rivers from the sea for breeding. Four fish specimen will normally be collected by electroshock technique in the vicinity of the plant discharge (Station 30) and from the Snake River (Station 38). If electroshocking produces insufficient anadromous fish samples from the Snake River, samples may be obtained from the fish trap at Ice Harbor Dam, Lyons Ferry Fish Hatchery, or other similar facility (Station 38A). If insufficient anadromous fish samples are produced through electroshocking on the Columbia River, samples may be obtained at the Ringold Fish Hatchery (Station 39).

(v) The SCA requirement for semiannual fish sampling was changed to annual sampling. This change was be implemented in 1993.

(w) Garden produce will routinely be obtained from farms or gardens using Columbia River water for irrigation. One sample of a root crop, leafy vegetable, and a fruit is collected each sample period, if available. The variety of the produce obtained will be dependent on seasonal availability.

(x) Station 91 is an apple orchard irrigated by the Columbia River. The apple crop from Station 91 is sampled annually.

TABLE 4-2

REMP SAMPLE LOCATIONS BY SECTOR

SECTOR[a]		STATION[b] NUMBER	ESTIMATED DISTANCE[c] MILES	METERS	SAMPLE TYPE[d]
N	(1)	52	0.1	161	GW
		71(1S)	0.3	483	TLD
		47	0.5	805	TLD
		57	0.8	1201	AP/AI
		18	1.1	1770	TLD
		53	7.5	12068	TLD
NNE	(2)	72(2S)[e]	0.4	644	TLD
		2	1.8	2896	TLD
		54	6.5	10459	TLD
NE	(3)	73(3S)	0.5	805	TLD
		19	1.8	2896	TLD
		48	4.5	7241	AP/AI
		39	4.4	7084	FI
		46	5.0	8045	TLD
ENE	(4)	101	0.3	483	SDW/SE/SO/VE
		74(4s)	0.4	644	TLD
		21	1.5	2414	AP/AI/SO/TLD
		20	1.9	3057	TLD
		11	3.1	4988	TLD
		33	3.6	5792	SE
		45	4.3	6919	TLD
		44	5.8	9332	TLS
E	(5)	75(5S)	0.4	644	TLD
		22	2.1	3379	TLD
		10	3.1	4988	TLD
		26	3.2	5149	PW
		27	3.2	5149	DW
		30	3.3	5311	FI
		43	5.8	9332	TLD
ESE	(6)	76(6S)	0.4	644	TLD
		31	1.1	1770	GW
		32	1.2	1931	GW
		51	2.1	3379	TLD
		23	3.0	4827	AP/AI/TLD
		34	3.5	5632	SE
		91	4.4	7079	FR
		8	4.5	7241	AP/AI/TLD
		42	5.6	9010	TLD
		36[e]	7.2	11585	MI
		5	7.7	12389	AP/AI/TLD
		64	9.7	15610	MI
		38	26.5	42639	FI

TABLE 4-2

REMP SAMPLE LOCATIONS BY SECTOR

SECTOR[a]		STATION[b] NUMBER	ESTIMATED DISTANCE[c] MILES	METERS	SAMPLE TYPE[d]
SE	(7)	102	0.3	483	SSW/SE
		77(7S)	0.5	805	TLD
		24	1.9	3057	TLD
		3	2.0	3218	TLD
		41	5.8	9332	TLD
		40	6.4	10298	AP/AI/MI/TLD
		59	9.6	15443	MI
		62	10.9	16730	MI
SSE	(8)	78(8S)	0.7	1126	TLD
		25	1.6	2574	TLD
		55[e]	7.0/5.5	11263/8850	TLD
		28	7.4	11907	PW
		4	9.3	14964	AI/AP/TLD
		29	11.0	17699	PW
		37[f]	16.0	25744	GP
S	(9)	118	0.3	483	SO
		79(9S)	0.7	1126	TLD
		1	1.3	2092	AP/AI/SO/TLD
		6	7.7	12389	AP/AI/TLD
SSW	(10)	80(10S)	0.8	1287	TLD
		50	1.2	1931	TLD
		56	7.0	11263	TLD
SW	(11)	81(11S)	0.7	1126	TLD
		13	1.4	2253	TLD
		96	36.0	49250	TLD
WSW	(12)	82(12S)	0.5	805	TLD
		14	1.4	2253	TLD
		9A, 9B, 9C[f]	30.0	48270	AP/AI/MI/GP/TLD/SO
W	(13)	83(13S)	0.5	805	TLD
		15	1.4	2253	TLD
WNW	(14)	84(14S)	0.5	805	TLD
		16	1.4	2253	TLD
		7	2.7	4344	AP/AI/SO/TLD
NW	(15)	85(15S)	0.5	805	TLD
		49	1.2	1931	TLD
NNW	(16)	86(16S)	0.4	644	TLD
		17	1.2	1931	TLD
		12	3.1	9815	TLD

TABLE 4-2 (CONT)

(a) The area in the vicinity of Plant 2 is separated into 16 separate sectors for reporting purposes. The 16 sectors cover 360 degrees in equal 22.5 degree sections, beginning with Sector 1 (N) at 348.75 to 11.25 degrees and continuing clockwise through Sector 16 (NNW).

(b) The alternate designations for TLD Stations 71-86 are given in parentheses, i.e., 1S-16S.

(c) Distances are estimated from map positions for each location as a radial distance from Plant 2 containment.

(d) Sample Type Key:

AI	- Air Iodine	AP	- Air Particulate
DW	- Discharge Water	FI	- Fish
FR	- Fruit	GP	- Garden Produce
GW	- Ground Water	MI	- Milk
PW	- Surface (River)/Drinking Water	SDW	- Storm Drain Water
SE	- Sediment	SO	- Soil
SWW	- Sanitary Waste Water	TLD	- Thermoluminescent Dosimeter
VE	- Vegetation		

Station 9 designates the Sunnyside-Grandview control area. It is actually three separate stations (Stations 9A for TLD, AI/AP and SO, 9B for milk, and 9C for GP) within a few miles of each other and all within 30-35 miles of Plant 2. Station 96, which is the control station for milk, is also located within the control area. It is 36 miles from Plant 2. Station 9B, which was the control location for milk until 1986, is now an indicator milk location.

(e) TLD station 55 moved from the US Department of Energy's 300 a Area due to construction at site in June. The annual and second quarter TLDs were found buried under a dirt pile. Old coordinates were SSE 7.0 miles (11263 meters)

(f) Duplicate samples, i.e., samples drawn at the same time as the routine samples and submitted for analysis as a quality assurance check, are collected at this location. The station designation for the duplicate of Station 27 is Station 72. The station designation for the duplicate of Station 36 is Station 37.

TABLE 4-3

DISTANCES[a] IN MILES TO NEAREST POINTS OF INTEREST WITHIN FIVE MILES OF PLANT 2

SECTOR[b] PARAMETER	NEAREST RESIDENT	GARDEN (>50M^2)	DAIRY[c] ANIMALS	LIVESTOCK
NE	4.3	none	none	4.8
ENE	4.1	4.1[d]	none	none
E	4.5	none	none	none
ESE	4.1	none	none	none

(a) These are estimated distances.

(b) Eleven of the sixteen meteorological sectors within the five-mile radius of Plant 2 are on the federally-owned Hanford Site; the remaining land is comprised of 4.5 sq. miles of privately-owned farm land. Only those sectors containing points of interest are presented here.

(c) The closest dairy animal locations are at 6.4, 8.3, 9.6 (reestablished in June) and 10.9 miles SE and 7.2 and 9.7 miles ESE. The dairy at 8.3 miles SE is not used for milk sample collection due to the owner's reluctance to participate in the sampling program.

(d) Small garden with broadleaf; samples were not available due to the small amounts grown.

TABLE 4-4

COMPARISON OF TELEDYNE NOMINAL LOWER LIMITS OF DETECTION WITH BRANCH TECHNICAL POSITION[3] REQUIREMENTS

MEDIA (UNITS)	ANALYSIS	TELEDYNE LLDs	BTP REQUIRED LLDs
Air	Gross Beta	0.003	0.01
(pCi/m^3)	Gamma Spectrometry		
	Cs-134	0.001	0.05
	Cs-137	0.001	0.06
	I-131	0.01	0.07
Water:	Gross Beta	4	4
(pCi/l)	Tritium	100-200	2000
	I-131	1	1
	Sr-90	1	—
	Gamma Spectrometry		
	Mn-54	10	15
	Fe-59	20	30
	Co-58	10	15
	Co-60	10	15
	Zn-65	20	30
	Zr-95	20	30
	Nb-95	10	15
	Cs-134	10	15
	Cs-137	10	18
	Ba-140	20	60
	La-140	10	15
Soil/Sediment:	Gamma Spectrometry		
(pCi/kg dry)	Co-57	120	—
	Co-60	30	—
	Zn-65	100	—
	Cs-134	30	150
	Cs-137	40	180
	Sr-90	10	—
Fish:	Gamma Spectrometry		
(pCi/kg wet)	Mn-54	20	130
	Fe-59	30	260
	Co-58	20	130
	Co-60	20	130
	Zn-65	30	260
	Cs-134	20	130
	Cs-137	20	150
Milk:	I-131	0.5	1
(pCi/l)	Gamma Spectrometry		
	Cs-134	10	15
	Cs-137	10	18
	Ba-140	20	60
	La-140	10	15
	Sr-90	1	—
Garden Produce:	Gamma Spectrometry		
(pCi/kg wet)	Cs-134	20	60
	Cs-137	20	80
	I-131	30	60

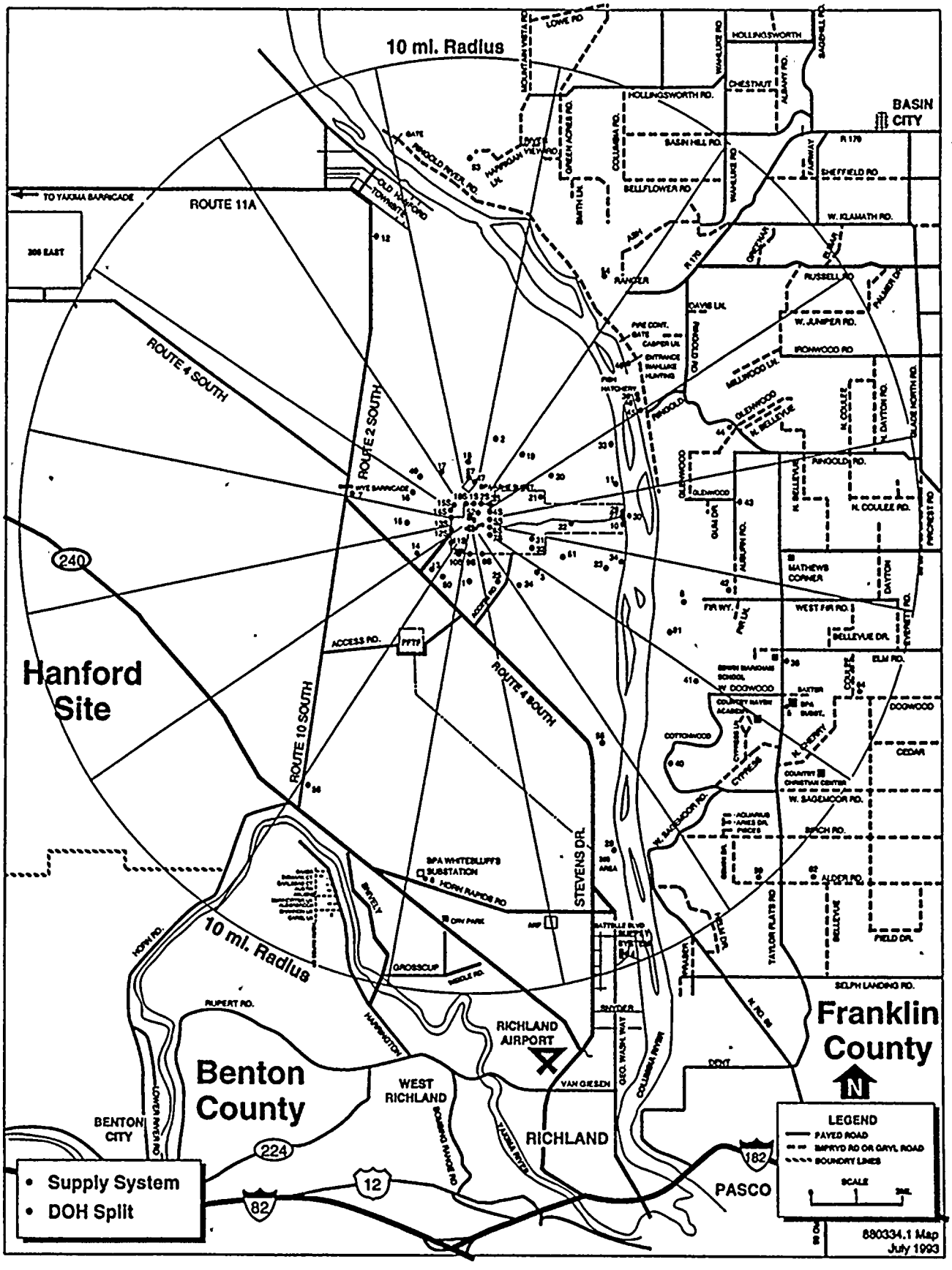

FIGURE 4-1 REMP SAMPLING LOCATIONS WITHIN THE 10-MILE RADIUS

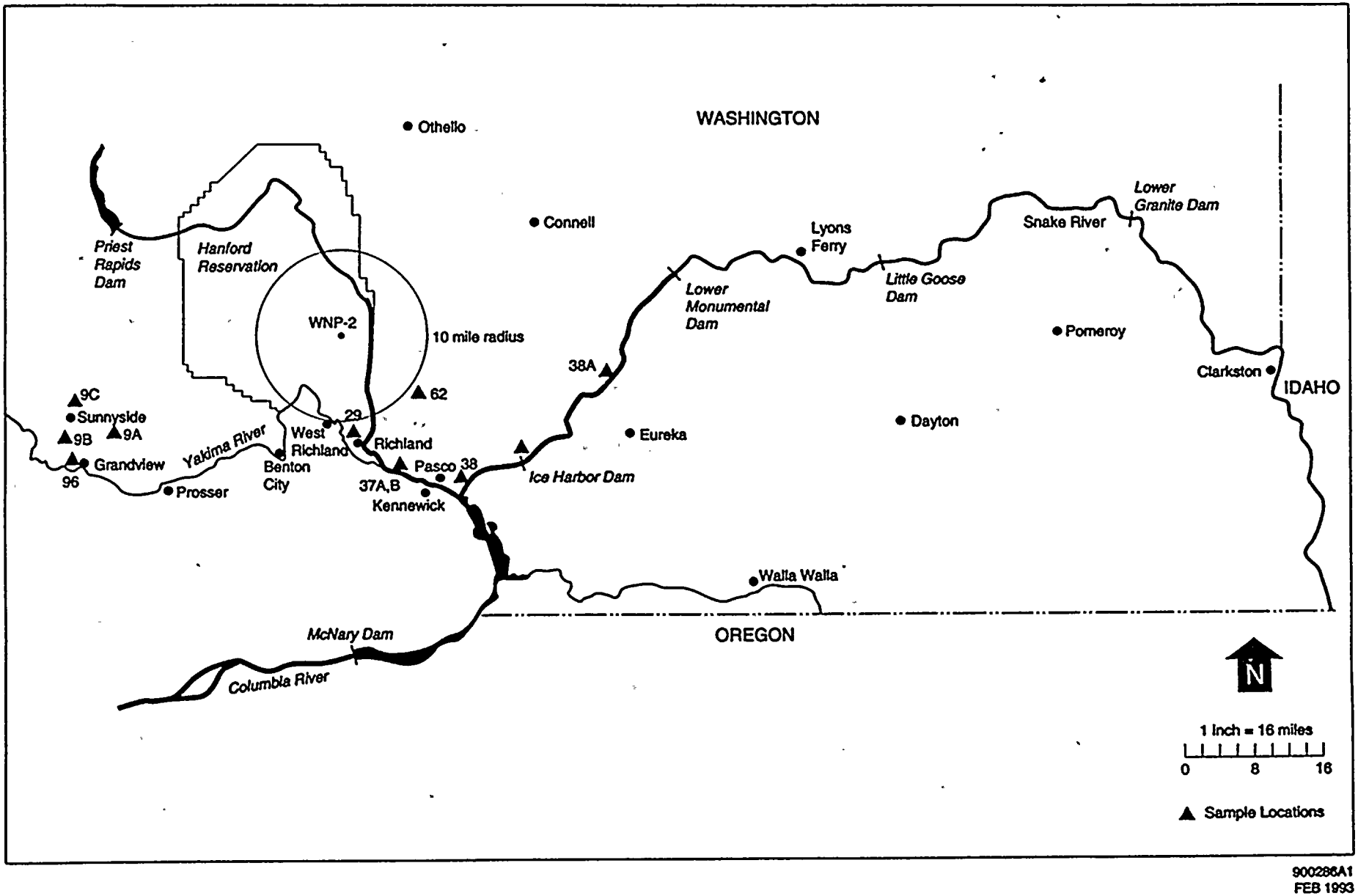

FIGURE 4-2 REMP SAMPLING LOCATIONS OUTSIDE THE 10-MILE RADIUS

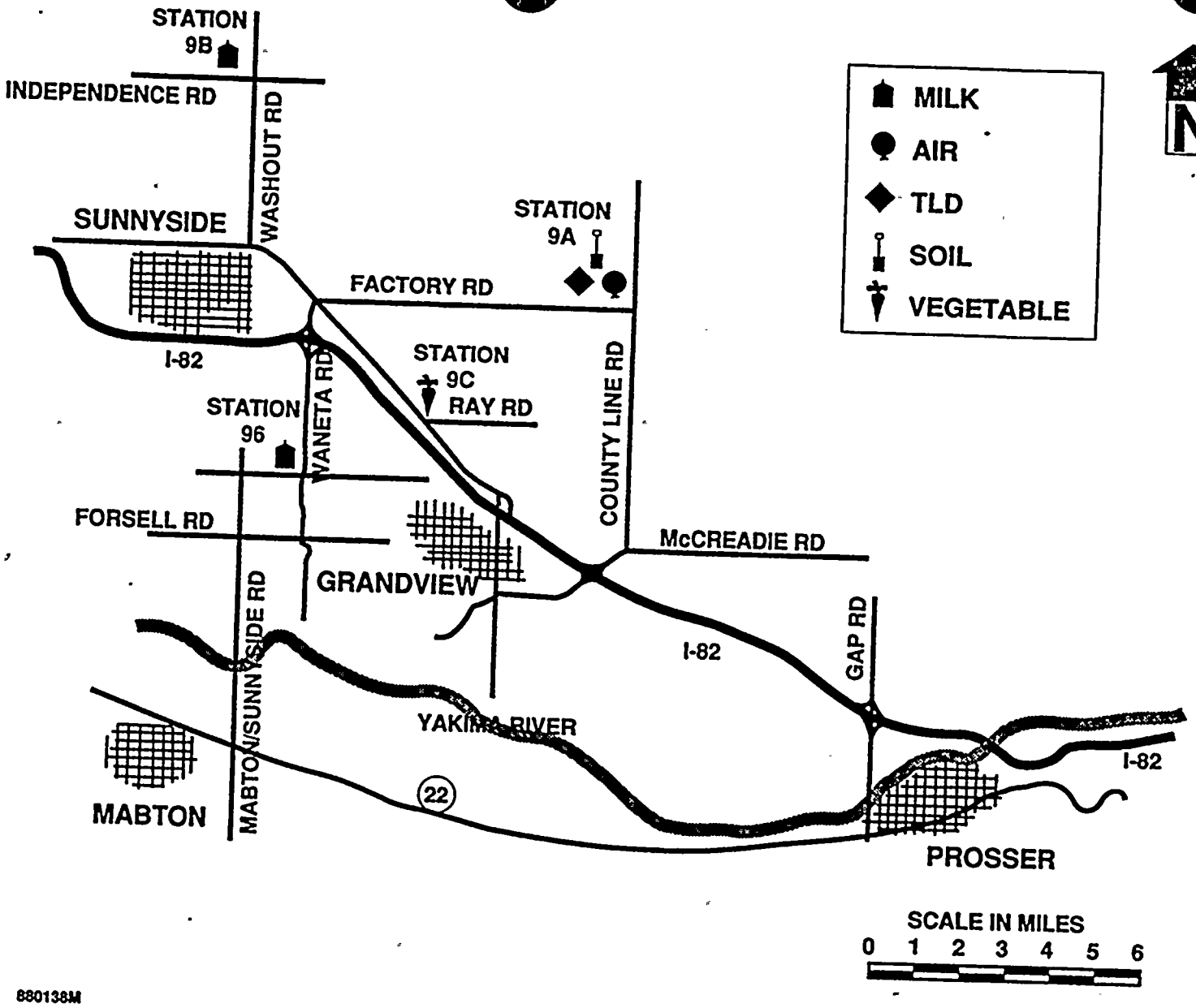

FIGURE 4-3 REMP SAMPLING LOCATIONS SUNNYSIDE/GRANDVIEW AREA

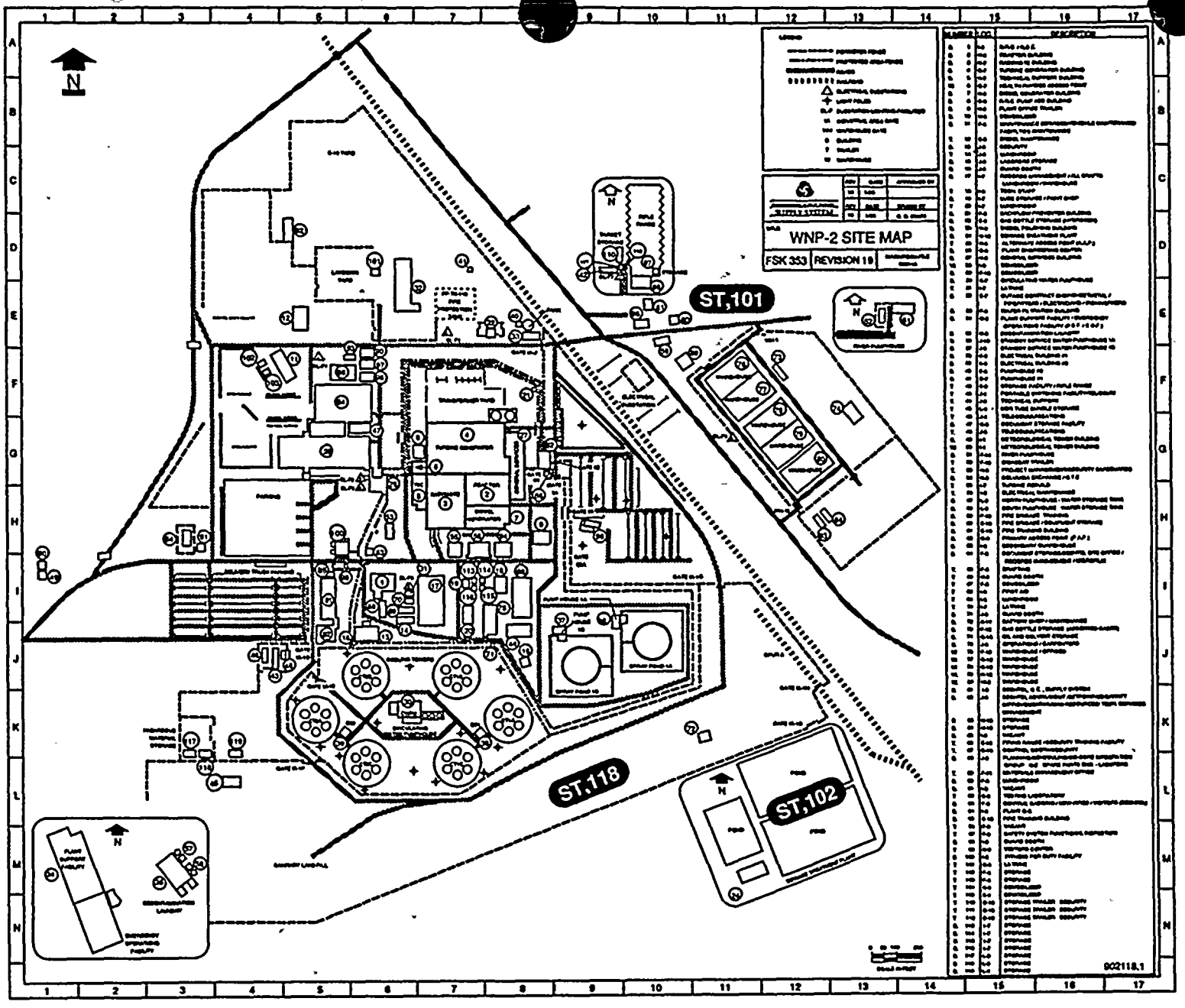

FIGURE 4-4 REMP NEAR PLANT SAMPLING LOCATIONS

5.0 RESULTS AND DISCUSSION

5.0 RESULTS AND DISCUSSION

During 1993 the analyses of REMP samples were performed by Teledyne Isotopes, Inc in Westwood, New Jersey. The thermoluminescent dosimeters were processed by the Supply System External Dosimetry Laboratory. Table 5-1 presents the means and ranges of the 1993 results for each type of sample collected and Table 5-3 provides a program summary. The means and ranges of the preoperational and the previous operational data from 1984 to 1992 are also included in the table for comparison. The data tables comprise a separate volume that are available to interested parties.

The data for the preoperational period and the first six months of 1984 included "less than" (<) designations for results below the actual LLD, the contractual LLD, or the two-sigma error, depending upon the convention employed by the analytical contractor. Consequently, the data averages using "less than" values are biased high. The use of the "less than" values was discontinued in mid 1984. Since then, REMP data have been reported as net (total results minus the detector counting background).

Since the primary focus of the REMP is to determine whether Plant 2 operations had an impact on the environment, the 1993 results are compared in this report to the results during the preoperational period and the results obtained during the previous years of Plant 2 operation. They are also compared to state and federal regulatory limits. Because of the use of "less than" values, rather than net results, during the preoperational period and during the first year of operation, and because of the impact of the 1986 Chernobyl accident on environmental radiation levels, the interpretation of the 1993 measurements relative to previous measurements must be this in mind. Some of the parameters considered in the evaluations discussed in this report are the means, ranges and standard deviations or standard errors of the results. Comparative plots and frequency distributions of the data are some of the tools that have been employed in the interpretation of the 1993 REMP data.

The 1993 analytical results for the REMP sampling locations established since the preoperational period are very similar to the results reported for previous years. The 1993 annual and quarterly TLD results were also very much like those observed previously. No significant trends indicating an environmental impact or unexpected change in the environmental concentrations or exposure rates at REMP monitoring stations was observed.

5.1 Direct Radiation

Summaries of the environmental radiation exposure rates, determined by thermoluminescent dosimeters (TLDs) are presented in Tables 5-4 and 5-5, and 5-6.

Figure 5-1 presents a circular plot of the mean 1993 quarterly TLD results for each of the sixteen meteorological sectors for the site boundary. The chart also includes preoperational and previous operational periods.

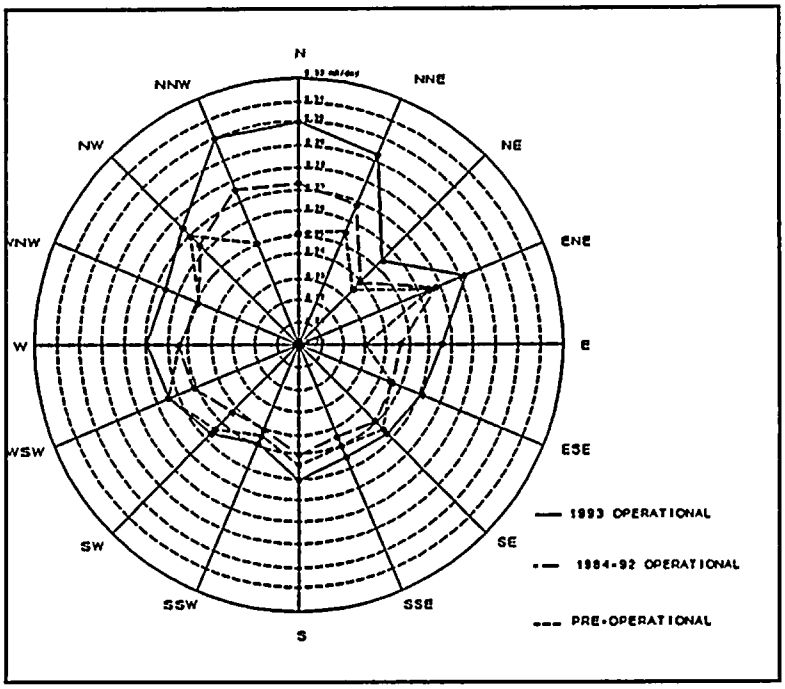

Figure 5-1 Sector TLDs (0 - 0.3 mR/day)

The relationship of the mean 1993 results to the results for the preoperational and previous operational periods is very similar for each sector. This indicates that there were no significant directional effects observed in the 1993 TLD results.

The increase in the mean 1993 TLD results over the means of the preoperational and previous operational periods is due to the effect of averaging only the four quarters of 1993 data, versus averaging numerous quarters for the other two sets of results.

The shift to the north is a result of those sector TLDs being physically closer to the plant than the rest of the near-plant TLDs. Compare the data presented in Figure 5-1 with that of Figure 5-2, where the TLDs are more evenly placed from the plant.

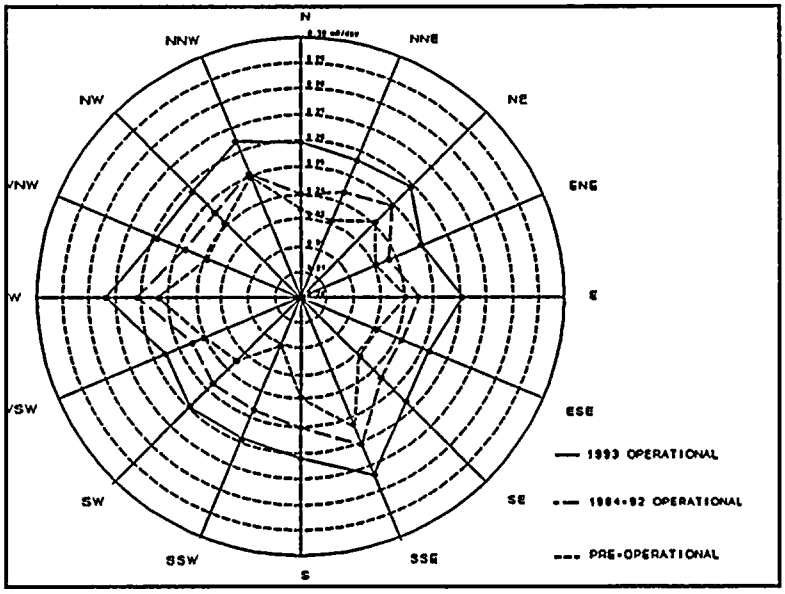

Figure 5-2 Near-Plant TLDs

For the remote TLDs, Station 46 in the Wahluke Reserve remained the location with the highest mean exposure rate, and is shown on Figure 5-3. This is consistent with the mean exposure rates determined for that station in prior years.

Since the preoperational measurement phase, the results for this location have exceeded the results for all other locations. Variations in the ambient background due to differences in the soil and underlying rock composition account for such local differences in Station 46 TLD results.

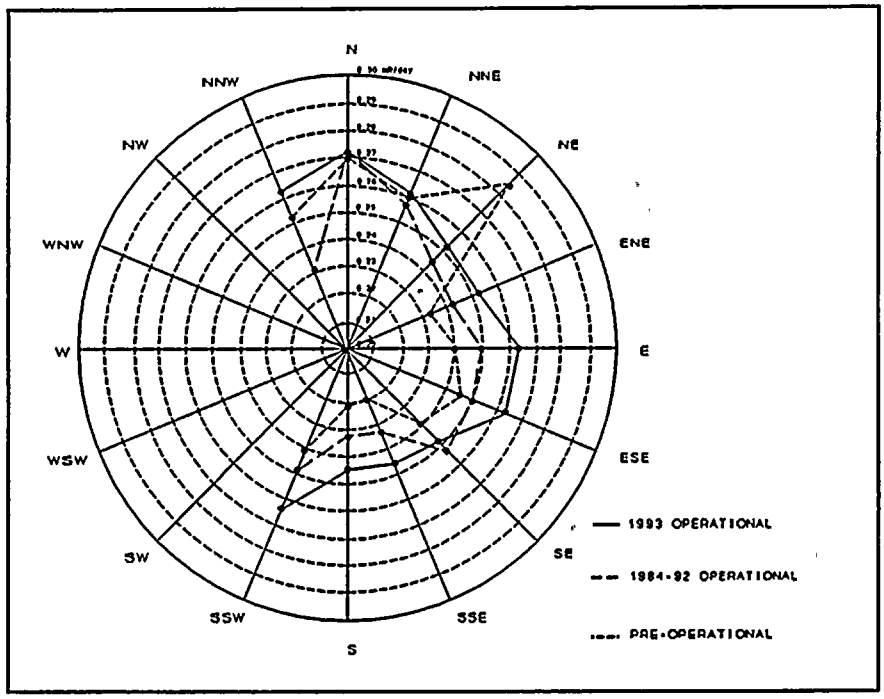

Figure 5-3 Remote TLDs

Frequency distribution plots of the 1993 quarterly TLD results are presented in Figure 5-4. The plots are very similar from quarter to quarter, with 0.26 mR/day being the most frequent result and with the Station 46 results being upscale and separate from the main distribution. The frequency distributions for the quarterly preoperational, previous operational and 1993 TLD results are compared in Figure 5-5. The distributions agree well.

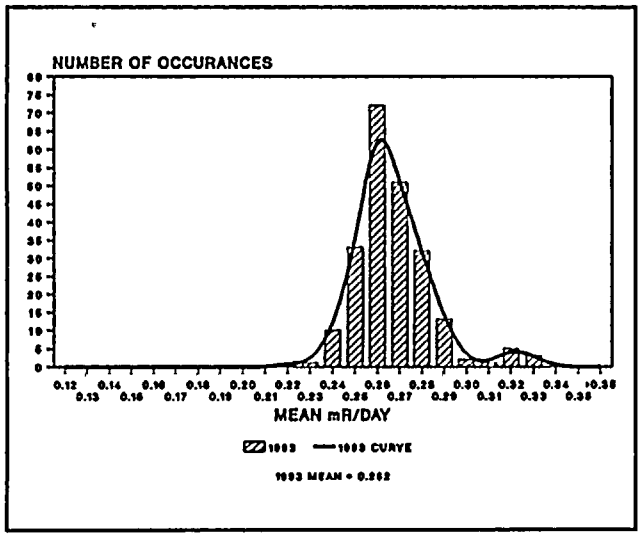

Figure 5-4 TLD Frequency Distribution 1993

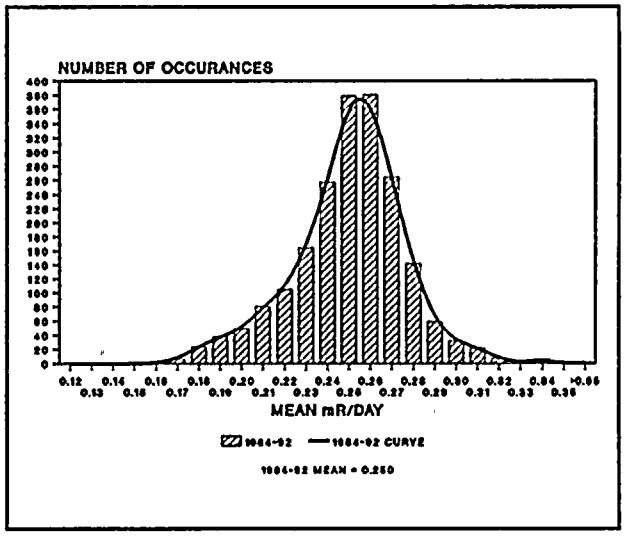

Figure 5-5 TLD Frequency Distribution 1984 - 1993

5.2 Airborne Particulate/Iodine

The 1993 mean weekly particulate results of all indicator stations near Plant 2 are plotted in Figure 5-6. The gross beta in air results for 1993 were within the ranges observed during the preoperational period and during previous operational periods, as shown in Table 5-1. In Figure 5-7 the similarity between results from near-plant locations and those from remote locations can be seen. The control location (Station 9A) results follow a very similar pattern to the remote and near-plant indicator locations. As observed previously, gross beta levels increased during periods of inversion occurring in the fall and winter months. In fact, the gross beta results plotted over a period of several years show a cyclic pattern of fall and winter increases. The increase, which was evident in the results of all the air sampling locations, is due to an increase in radon and radon daughter concentrations during the inversions.

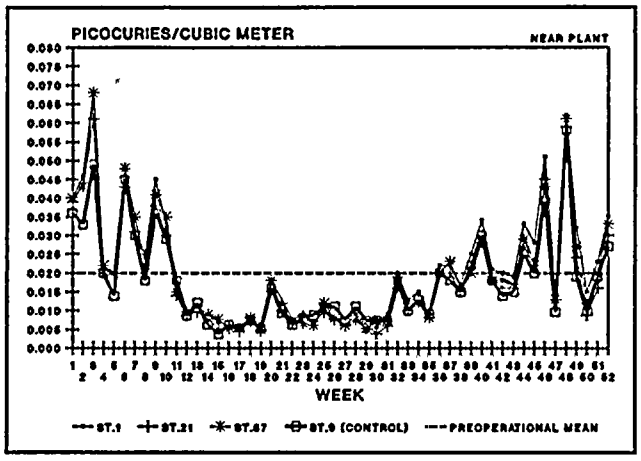

Figure 5-6 Gross Beta in Air @ Near-Plant Stations - 1993

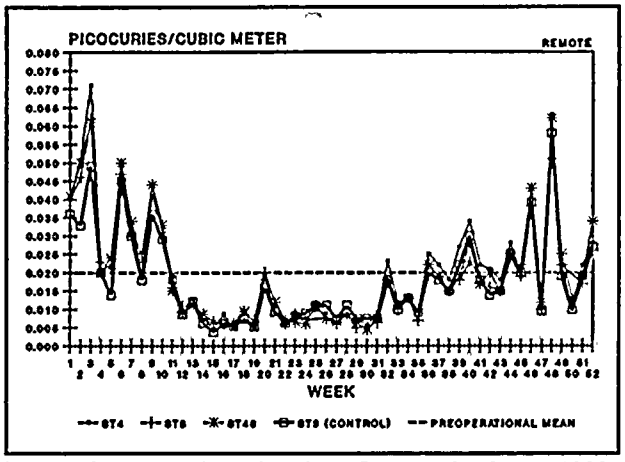

Figure 5-7 Gross Beta in Air @ Remote Stations - 1993

The quarterly gamma analyses of the particulate filter composites indicated only the presence of two naturally-occurring radionuclides, beryllium-7 and potassium-40, at levels above detection limits at indicator locations and the control location. All iodine-131 in air results for 1993 were less than 0.01 pCi/m^3 LLD.

No evidence of any impact of plant operations on the environment was apparent in the particulate filter and charcoal cartridge results for 1993.

5.3 Water

All river/drinking water results were within the ranges normally observed and less than 8 pCi/liter, the level at which a strontium analysis is performed to verify compliance with the Washington State drinking water standard for strontium-90*. The 1993 gross beta concentrations in river/drinking water, relative to the state annual average concentration limit[11], are presented in Figure 5-8. The mean gross beta results in discharge water, for 1993 are presented in Figure 5-9. The 1993 average results compare well to the averages from previous periods.

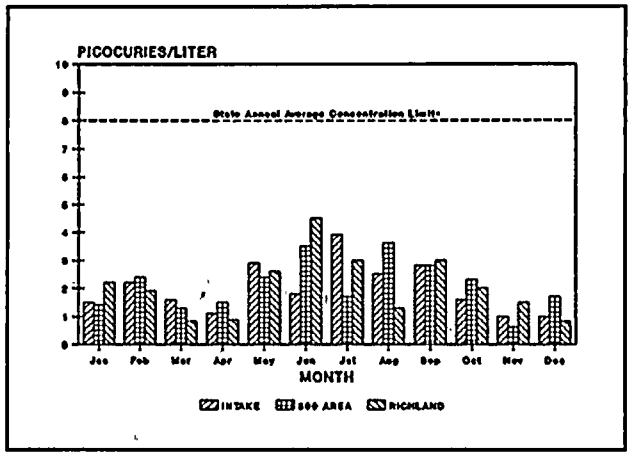

Figure 5-8 Gross Beta in River/Drinking Water -1993

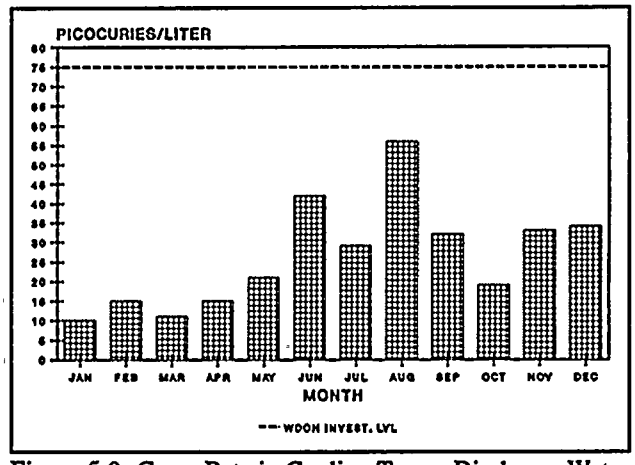

Figure 5-9 Gross Beta in Cooling Tower Discharge Water

The gross beta levels in the discharge sample reflect the concentrations of naturally-occurring radionuclides, principally potassium-40, and any radionuclides from upstream sources of past Hanford activities present in the makeup water, in addition to radionuclides from Plant 2 discharges. The discharge sample results are representative of the radioactivity present in plant discharges before any mixing with river water occurs. The tritium levels in the river/drinking water were comparable with results obtained for prior years.

Tritium levels in the discharge water were higher than the levels observed for the river/drinking water samples because of plant releases and because discharge water samples are taken prior to the water reaching the river and becoming diluted. As shown in Figure 5-10, the concentration of tritium was higher than the mean levels observed for 1992 and the 1984-1991 periods.

The tritium concentration in the discharge water ranged from 150 to 12,000 pCi/liter, which is still low when compared to the NRC reporting level of 20,000 pCi/liter for a quarterly average concentration in drinking water.

*Strontium-90 is assumed to account for the gross beta result.

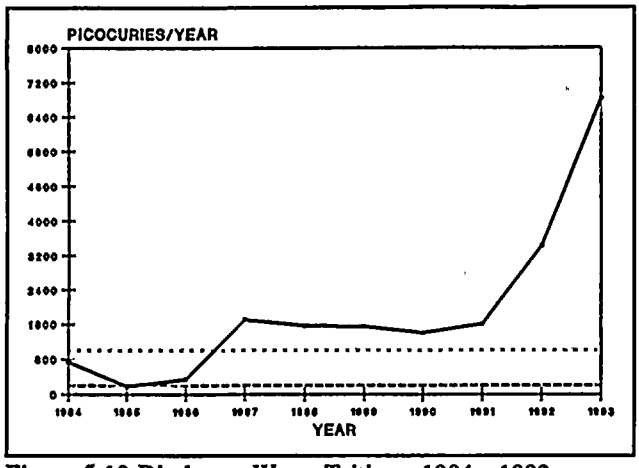

Figure 5-10 Discharge Water Tritium 1984 - 1993

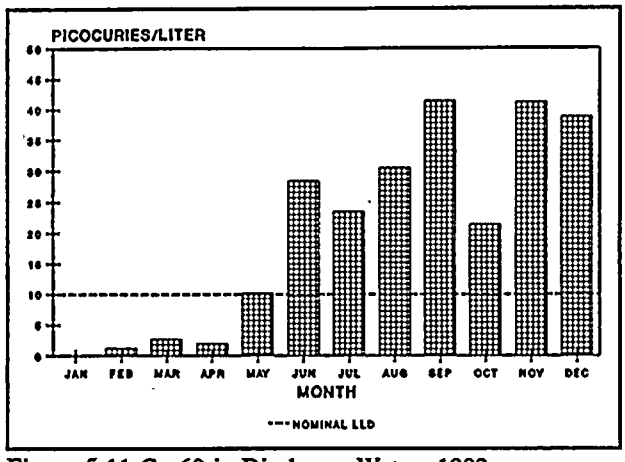

Figure 5-11 Co-60 in Discharge Water -1993

Cobalt-60, zinc-65 and cesium-137 were detected in some discharge samples during and following the plant outage are shown in Figures 5-11, 5-12, and 5-13. The detectable cobalt-60 results ranged from 10.2 to 41.3 pCi/liter, the zinc-65 results ranged from 16.2 to 57.3 pCi/liter, and the cesium-137 results range was 7.2 to 23.1 pCi/liter.

Although above detection levels, these results were low and did not exceed any reporting levels.

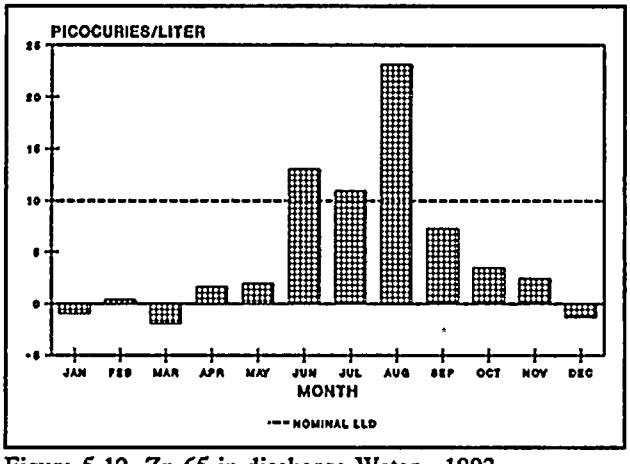

Figure 5-12 Zn-65 in discharge Water - 1993

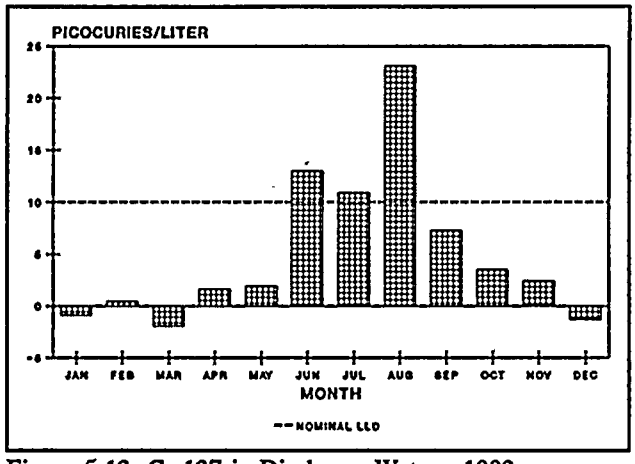

Figure 5-13 Cs-137 in Discharge Water - 1993

5.4 Soil

Gamma spectrometry performed in 1993 indicated a range of cesium-137 from from 37.2 pCi/kilogram to 398 pCi/kilogram. As shown in Table 5-1, and presented in Figures 5-14 and 5-15, the cesium-137 levels in the soil samples were well within the range observed during preoperational and previous operational sampling. The gamma spectrometry results for the soil samples did not indicate any impact from Plant 2 operations on the environment.

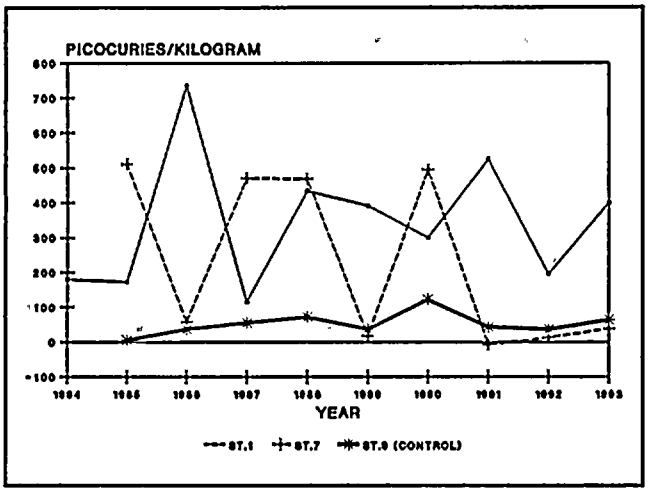

Figure 5-14 Cs-137 in Soil 1984 - 1993

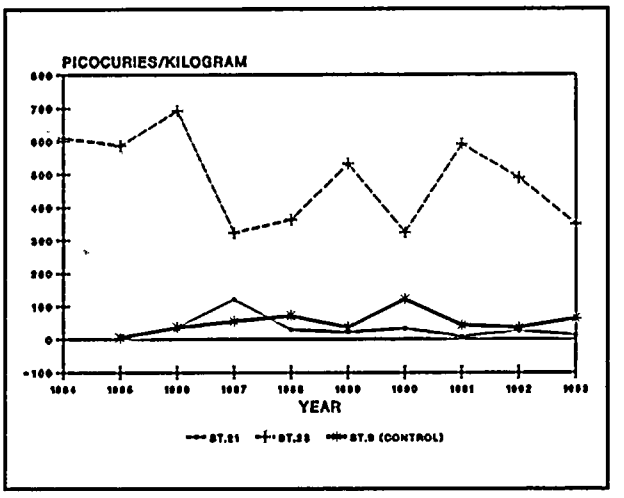

Figure 5-15 Cs-137 in Soil 1984 - 1993

No strontium analysis was required in 1993. Aside from cesium-137, the only radionuclides detected in the samples were potassium-40, radium-226 and thorium-228. These are part of the natural radioactivity typically found in soils.

No indication of impact of Plant 2 operations on the environment was evident in these results.

5.5 River Sediment

The results of gamma spectrometry of river sediment indicate that aside from the naturally-occurring radionuclides (potassium-40, radium-226 and thorium-228), cobolt-60 and cesium-137 were detected downstream of the plant (Station 34). Cesium-137 was also detected in the control location (Station 33) sample. The cesium-137 concentrations upstream from the plant discharge were 42 and 112 pCi/kilogram; the concentrations downstream from the discharge were 296 and 520 pCi/kilogram. Downstream cobolt-60 concentrations were 21.7 and 44.1 pCi/kilogram. These are consistent with the concentrations observed previously.

Cesium-137 has been detected in preoperational samples and in samples taken since plant operation began. It has also been previously identified as a component of the Columbia River sediment originating from the operation of the old Hanford Reservation reactors.[16]

5.6 Fish

The gamma spectrometry results of fish samples collected in the vicinity of the Plant 2 discharge and at the control location on the Snake River were below detection limits, except for potassium-40, a naturally-occurring radionuclide. The cesium-137 levels for the fish taken from the Columbia River were low and within the range observed during the preoperational and previous operational periods and shown in Figure 5-16.

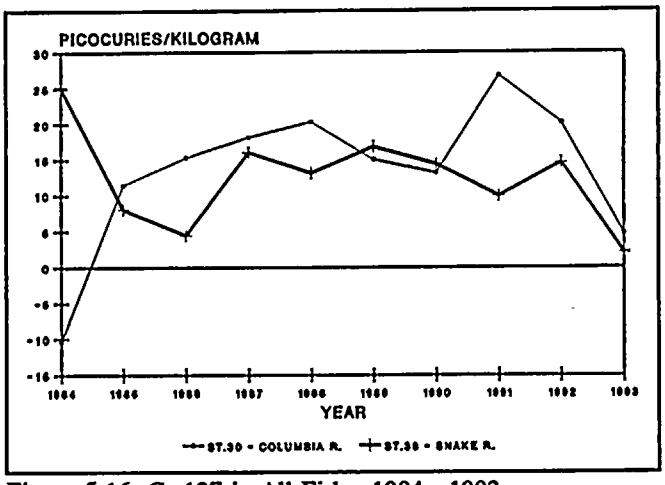

Figure 5-16 Cs-137 in All Fish 1984 - 1993

The Cs-137 levels are lower than in previous years.

5.7 Milk

All the results of iodine-131 analyses of milk samples collected during 1993 were less than detection limits. All milk sample results for the indicator and control locations were less than the detection limits, except for potassium-40, which is naturally-occurring.

5.8 Garden Produce

The gamma isotopic analysis results for all root, fruit and leafy vegetables collected in 1993 were below detection limits, except that one sample had thorium-228 of 11.8 pCi/kilogram.

5.9 Special Interest Samples

Three special interest sampling locations were incorporated into the REMP during 1992. Discussions of the results from each of the three locations are given in the following sections.

None of these locations, the storm drain pond, the Sanitary Waste Treatment Facility (SWTF), containerized storage area, were a part of the routine sampling program for the REMP until 1992. Until incorporated into the REMP, the sediment samples collected during previous years at the storm drain and SWTF were analyzed in the Support Services radiochemical laboratory in-house. The storm drain and SWTF sediment samples were analyzed wet, so the results were in terms of wet weight instead of the dry weight concentrations determined by Teledyne. Consequently, direct comparison of the wet sample results with the dried sample results is difficult since the percent solids can vary from sample to sample. This report includes only the samples collected during 1993.

The data for containerized storage area, Station 118, consists of twenty-nine large metal storage containers holding the low-pressure turbine rotor parts removed from the plant during the 1992 maintenance outage. Soil samples and ionization chamber readings were taken at Station 118.

5.9.1 Storm Drain Pond (Station 101)

The storm drain pond is a drain field designed to collect site effluents from several sources which include the plant building roof drains, the Service Building floor drain sump, the Diesel Generator Building floor drains, air handling unit drains, backwash effluent from gravity and carbon filters in the Service Building, and Turbine Building nonradioactive floor drains. The liquids leave Plant 2 via the storm drain pipe. The storm drain pond is located within the Plant 2 retricted area approximately 1500 feet northeast of Plant 2. Water is conveyed to the pond via a 18-inch diameter pipe and which discharges into a 300-foot long earthen channel which empties into the 100-foot diameter storm drain pond. The pond is a shallow, unlined percolation/evaporation basin.

There is some soil contamination in the pond as a result of previous plant operations relating to the Turbine Building Sumps and the discharge of low levels of radioactive materials from the sumps. This has necessitated that the pond be posted as a radioactive materials storage area. The initiating problem is described in detail in the Radiological Environmental Monitoring Program 1992 Annual Report for Plant 2.

The REMP collected water, sediment and vegetation samples at the pond during 1993. Because flow proportional samples were not available, samples were collected daily for analysis.

The predominate isotope being detected during release during 1993 was tritium and the trend for 1993 is shown in Figure 5-17. Sample results for 1993 indicate the measures taken by the plant have resulted in significant curtailment of the release of tritium to the pond.

In November 1992, a portable composite sampler was installed at the storm drain outfall. This sampler operated automatically to collect an aliquot of liquid hourly which combines to form a daily composite. The composite is sent to the analytical contractor for analyses. Work continued throughout 1993 to upgrade this sampling system.

A flume to allow proportional sampling based upon flow was ordered, and installed, but was found to be undersized for the intended purpose. A new flume was ordered and installation completed in January 1994.

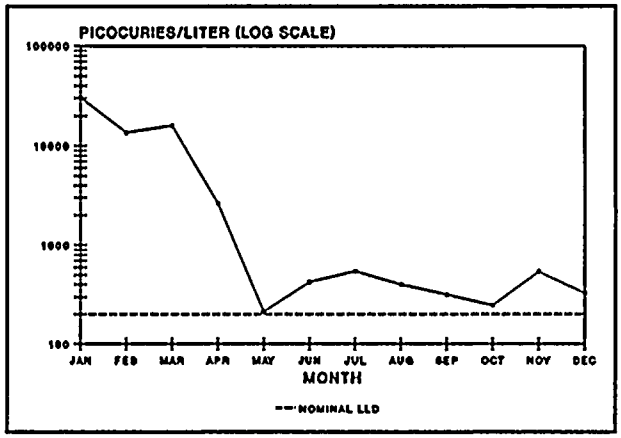

Figure 5-17 Monthly Storm Drain Outfall Tritium - 1993

5.9.2 Sanitary Waste Treatment Facility (Station 102)

The Sanitary Waste Treatment Facility (SWTF), located approximately 0.3 mile south of Plant 2 processes the sanitary waste from Plant 2, the WNP-1 and WNP-4 sites and the Plant Support Facility (PSF). In April 1991 a pipeline was installed from the Department of Energy's Fast Flux Test Facility (FFTF) to the SWTF to permit sanitary waste flow from FFTF. The effluent pipe was to be isolated at the FFTF source to prevent flow of wastes from FFTF until agreements for processing the wastes were finalized. The results of monitoring inadvertent discharge of FFTF waste in 1992 are included in the 1992 Annual REMP report. In November of 1992 EFSEC approved Resolution No. 259[17], which allowed the introduction of FFTF wastes into the SWTF and established discharge standards and monitoring requirements. Until April 1992, the SWTF sediment was sampled semiannually and analyzed in the Support Services radiation laboratory and the radionuclide concentrations were given in terms of wet weight.

Graphs of the average quarterly tritium and gross beta results for 1992 and 1993 are presented in Figure 5-18 and Figure 5-19. The pond indicated gross beta levels at or above the 50 pCi/l EPA drinking water limit. An investigation into the source of gross beta indicated potassium-40, a natural isotope, was the major contribuitor. Other contributors to the beta appear to be natural isotopes and no fission or activation products were detected that would indicate Plant 2 as a source.

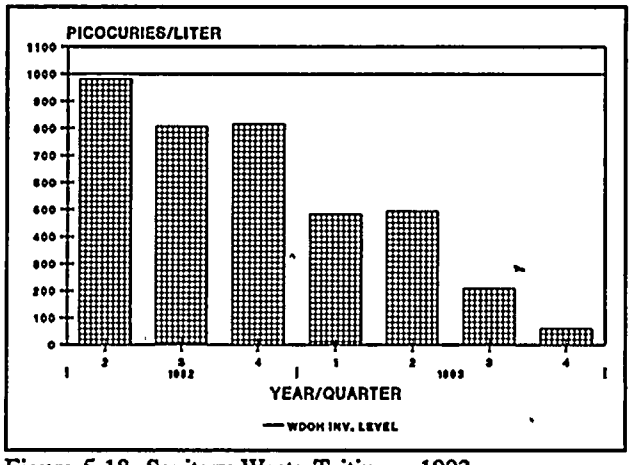

Figure 5-18 Sanitary Waste Tritium - 1993

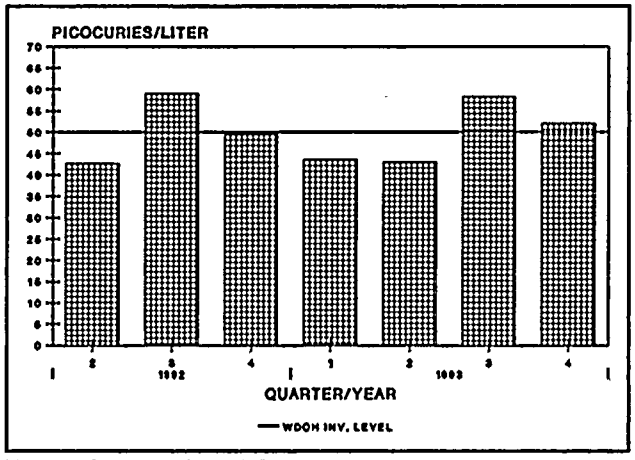

Figure 5-19 Sanitary Waste Gross Beta 1992 - 1993

5.9.3 Containerized Storage Area (Station 118)

Soil samples taken at Station 118 before and after storage of the low pressure turbine rotor parts contained no detectable radioactivity except that from naturally-occurring radionuclides, such as potassium-40 and radium-226.

5.9.4 Other Samples

Cooling Tower Sediment

Cooling tower sludge (sediment and organic) was removed from the cooling tower basins was periodically removed from the tower basins. The sludge was sampled for radioactivity on two occasions by the REMP.

618-11 Burial site

The 618-11 burial site located adjacent to Plant 2, was identified by the Department of Energy (DOE) for remediation. This burial site belongs to the DOE and contains waste that is both chemical and radioactive in nature. The radioactive material is high level radioactive waste and is from the production of nuclear weapons and may contain transuranics. In anticipation of the remediation process the REMP began monitoring activities which included pressurized ion chamber readings, soil samples and direct reading radiation measurements (TLDs). The data collected would be to baseline the site prior to remediation. In late 1993 the DOE placed the remediation on hold and the REMP has reduced the sampling requirements at this site to an annual requirement from the original quarterly requirement.

5.10 1993 Sample Deviations

Air sampler outages made up the majority of sample deviations for 1993. Problems ranged from pump failure to power outages. Composite sampling equipment outages at Station 27 accounted for a small portion of the deviations. Deviations are shown in Table 5-2.

TABLE 5-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1993[d] MEAN	(RANGE)
Air: pCi/m³						
Gross Beta	<0.02	(<0.003 - 0.130)	0.02	(0.00 - 0.74)	0.02	(0.00 - 0.07)
I-131[e]	<0.05	(<0.01 - 0.11)	0.00	(-0.07 - 0.82)	0.00	(-0.02 - 0.02)
Gamma						
Cs-134	<0.01	(<0.001 - 0.040)	0.000	(-0.002 - 0.015)	0.000	(-0.000 - 0.000)
Cs-137	<0.01	(<0.001 - 0.040)	0.001	(-0.001 - 0.036)	0.000	(0.000 - 0.001)
Ru-103	Not Reported		0.001	(-0.001 - 0.019)	-0.000	(-0.001 - 0.001)
River/Drinking Water: pCi/l						
Gross Beta	<3.0	(<1.0 - <6.0)	2.0	(-0.2 - 9.1)	2.1	(0.6 - 4.5)
Gamma						
Cs-134	<3.8	(<1.0 - <12.0)	0.3	(-5.4 - 5.2)	-0.1	(-3.4 - 1.7)
Cs-137	<4.1	(<1.0 - <13.0)	1.1	(-5.7 - 6.2)	0.6	(-3.6 - 3.1)
Co-58	<5.1	(<1.0 - <25.0)	-0.1	(-3.3 - 2.9)	-0.3	(-1.8 - 1.7)
Co-60	<4.7	(<1.0 - <13.0)	1.0	(-4.9 - 7.1)	0.2	(-1.2 - 1.2)
Fe-59	<13.3	(<2.0 - <93.0)	0.7	(-8.9 - 6.9)	0.8	(-1.1 - 3.3)
Zn-65	<8.3	(<2.0 - <27.0)	-1.6	(-16.2 - 8.2)	0.0	(-4.4 - 8.0)
H-3	<481.7	(220 - <820)	137.5	(-500.0 - 596.0)	74.2	(-76.0 - 190.0)
Sr-90	<2.0		0.4	(0.3 - 0.7)	Analysis Not Performed	
Groundwater: pCi/l						
Gamma						
Cs-134	<4.0	(<1.0 - <12.0)	0.4	(-4.1 - 5.4)	0.4	(-2.0 - 2.8)
Cs-137	<3.8	(0.8 - <8.0)	1.1	(-3.1 - 4.9)	0.7	(-0.5 - 1.8)
Co-58	<4.7	(<1.0 - <12.0)	-0.2	(-2.8 - 1.9)	-0.9	(-3.3 - 0.6)
Co-60	<4.1	(0.1 - <9.0)	1.2	(-2.4 - 8.4)	0.1	(-1.1 - 0.9)
Fe-59	<11.6	(<2.0 - <33.0)	0.6	(-4.5 - 5.7)	1.6	(0.0 - 4.1)
Zn-65	<8.6	(<2.0 - 17.0)	-1.5	(-46.8 - 15.0)	0.9	(-5.6 - 6.2)
H-3	<467.8	(<10.0 - 2600.0)	42.9	(-516.0 - 470.0)	-16.5	(-110.0 - 60.0)
Sr-90	<0.4	(<0.1 - 0.7)	Analysis Not Performed		Analysis Not Performed	

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Charcoal cartridge results.

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1993[d] MEAN	(RANGE)
Discharge Water: pCi/l						
Gross Beta	<2.8	(<1.9 - 4.0)	16.8	(0.6 - 48.0)	26.4	(10.0 - 56.0)
Gamma						
Cs-134	<3.7	(<1.0 - <8.0)	0.6	(-3.9 - 5.4)	1.7	(-1.8 - 10.1)
Cs-137	<4.7	(<1.0 - 16.0)	1.7	(-5.3 - 10.0)	5.0	(-1.9 - 23.1)
Co-58	<1.4	(1.0 - 13.0)	-0.0	(-2.6 - 4.6)	0.3	(-0.7 - 1.1)
Co-60	<5.0	(<1.9 - <13.0)	3.9	(-8.7 - 57.6)	20.1	(0.0 - 41.3)
Fe-59	<11.9	(<3.0 - <38.0)	0.8	(-4.1 - 6.0)	1.0	(-4.2 - 13.0)
Zn-65	<8.6	(<2.0 - 27.0)	3.2	(-8.2 - 86.7)	18.6	(-1.7 - 57.3)
H-3	<420.0	(<80.0 - 700.0)	1425.5	(55.0 - 5400.0)	6812.5	(150.0 - 12000.0)
Sr-90	<3.0		0.8	(0.5 - 1.1)	Analysis Not Performed	
Storm Drain Water: pCi/l						
Gross Beta	Analysis Not Performed		37.9	(1.6 - 1100.0)	Analysis Not Performed	
Gamma	Analysis Not Performed					
Cs-134			0.0	(-4.8 - 8.3)	0.0	(-9.6 - 8.1)
Cs-137			1.0	(-6.2 - 6.4)	1.7	(-11.0 - 252.0)
Co-58			-0.3	(-4.9 - 3.4)	-0.5	(-7.6 - 3.3)
Co-60			2.6	(-1.9 - 125.0)	0.6	(-4.2 - 9.5)
Fe-59			0.5	(-14.0 - 8.3)	0.9	(-11.0 - 9.9)
Zn-65			1.6	(-13.0 - 53.0)	0.7	(-11.0 - 16.0)
Mn-54			0.5	(-3.2 - 6.5)	0.7	(-2.9 - 6.7)
I-131			0.8	(-6.0 - 21.1)	-0.5	(-17.0 - 15.0)
Ce-141			6.4	(-11.0 - 707.0)	-1.7	(-19.0 - 9.0)
Sb-124			11.5		Analysis Not Performed	
Sb-125			20.8		Analysis Not Performed	
I-131[e]			0.4	(-0.2 - 8.3)	Analysis Not Performed	
H-3	Analysis Not Performed		13045.0	(-93.0 - 270000.0)	5520.0	(-170.0 - 140000.0)
Sr-89	Analysis Not Performed		0.9	(-0.1 - 1.8)	Analysis Not Performed	
Sr-90	Analysis Not Performed		0.4	(-0.1 - 0.9)	Analysis Not Performed	
Sanitary Waste Water; pCi/l						
Gross Alpha	Analysis Not Performed		0.2	(-0.4 - 0.6)	0.3	(-0.4 - 1.5)
Gross Beta	Analysis Not Performed		45.4	(41.0 - 51.0)	50.1	(35.0 - 61.0)
Cs-134			-0.3	(-4.9 - 2.1)	0.4	(-1.7 - 2.9)
Cs-137			0.4	(-5.1 - 4.2)	0.8	(-4.4 - 4.1)
Co-58			-0.3	(-2.7 - 1.7)	-0.3	(-2.6 - 1.8)
Co-60			0.8	(-1.1 - 4.0)	0.4	(-1.7 - 2.4)
H-3	Analyses Not Performed		666.6	(50.0 - 1700.0)	322.0	(-110.0 - 950.0)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are biased high due to Chernobyl in 1986
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Resin method

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1993[d] MEAN	(RANGE)
River Sediment: pCi/kg (dry)						
Gamma						
Cs-134	<112.5	(<50.0 - <150.0)	51.5	(7.0 - 172.0)	54.0	(42.0 - 66.0)
Cs-137	<287.0	(<50.0 - <560.0)	337.4	(153.0 - 1890.0)	408.0	(296.0 - 520.0)
Co-60	<254.6	(130.0 - 610.0)	43.7	(11.0 - 129.0)	32.9	(21.7 - 44.1)
Co-57	Not Reported		29.3	(-11.6 - 54.0)	19.0	(19.0 - 19.0)
Eu-152	Not Reported		124.3	(5.6 - 279.0)	112.0	(88.8 - 136.0)
Storm Drain Sediment: pCi/kg (dry)						
Gamma:	Analysis Not Performed[e]					
Cs-134			95.3	(4.1 - 1140.0)	54.6	(21.5 - 98.5)
Cs-137			242.0	(-3.6 - 2900.0)	129.0	(47.4 - 250.0)
Co-58			1.8	(-27.0 - 58.0)	-3.4	(-10.0 - 19.0)
Co-60			1370.0	(-6.4 - 25400.0)	517.0	(99.9 - 13400.0)
Fe-59			1.3	(-44.0 - 37.0)	-3.1	(-23.0 - 17.0)
Zn-65			270.0	(-25.0 - 4650.0)	62.1	(1.9 - 481.0)
Mn-54			46.9	(-9.6 - 670.0)	12.4	(0.3 - 65.6)
Ce-141			96.3	(-29.0 - 3740.0)	3.4	(-19.0 - 29.0)
Sanitary Waste Sediment: pCi/kg (dry)						
Gamma:	Analysis Not Performed[e]					
Cs-134			31.0	(-11.0 - 55.2)	15.0	(-15.6 - 45.5)
Cs-137			121.9	(0.0 - 254.0)	177.1	(105.0 - 255.0)
Co-60			158.3	(-3.4 - 728.0)	392.5	(182.0 - 683.0)
Zn-65			1.3	(-69.0 - 60.0)	8.2	(-106.0 - 77.4)
Mn-54			12.9	(5.7 - 25.0)	-1.3	(-24.0 - 17.0)
Sr-90	Analysis Not Performed		83.0	(26.0 - 130.0)	Analysis Not Performed	
Soil: pCi/kg (dry)						
Gamma						
Cs-134	<65.3	(<20.0 - <150.0)	27.3	(1.0 - 53.2)	25.0	(22.0 - 28.0)
Cs-137	364.3	(<20.0 - <1880.0)	290.0	(-7.3 - 735.0)	199.1	(11.7 - 398.0)
Sr-90	Analysis Not Performed		178.8	(0.2 - 455.0)	Analysis Not Performed	

(a) All stations all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are biased high due to Chernobyl in 1986
(c) The data used for these averages does not include the "less the" values reported in 1984.
(d) Indicator stations only.
(e) Prior to February 1992, these samples were analyzed as wet weight. These numbers are for the samples analyzed as dry weight.

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1993[d] MEAN	(RANGE)
ST 118 Soil: pCi/kg dry						
Gamma	Analysis Not Performed					
Cs-134			23.2	(-2.9 - 46.0)	21.5	(3.5 - 35.0)
Cs-137			14.9	(-8.8 - 48.0)	14.2	(3.5 - 31.7)
Storm Drain Soil: pCi/kg dry						
Gamma	Analysis Not Performed					
Cs-134			20.5	(0.7 - 38.0)	18.8	(-1.4 - 35.0)
Cs-137			60.2	(49.3 - 77.3)	41.8	(24.6 - 54.8)
Sr-90	Analysis Not Performed		Analysis Not Performed		Analysis Not Performed	
Milk: pCi/l						
Gamma						
Cs-134	<3.7	(<0.9 - <14.0)	0.9	(-7.4 - 22.6)	0.1	(-2.4 - 2.2)
Cs-137	<3.8	(<1.0 - <12.0)	2.8	(-7.4 - 47.3)	0.7	(-6.6 - 3.7)
Ba-140	<72.1	(<6.0 - <2000.0)	0.2	(-44.3 - 55.0)	0.3	(-9.5 - 11.8)
La-140	<33.3	(<5.0 - 1000.0)	-0.5	(-24.2 - 9.7)	-0.2	(-7.5 - 5.6)
I-131[e]	<0.5	(<0.1 - <1.0)	1.0	(-0.8 - 143.6)	0.0	(-0.2 - 0.2)
Sr-90	Analysis Not Performed		1.9	(1.3 - 3.9)	Analysis Not Performed	
Fish: pCi/kg (wet)						
Gamma						
Cs-134	<61.2	(<6.0 - <130.0)	2.1	(-20.4 - 24.0)	0.4	(-1.5 - 1.8)
Cs-137	<88.8	(<10.0 - <130.0)	15.8	(-35.1 - 57.0)	4.7	(-4.5 - 11.9)
Co-58	<87.7	(<9.0 - <130.0)	0.8	(-16.8 - 25.8)	-1.8	(-4.8 - 2.4)
Co-60	<80.6	(<9.0 - <130.0)	1.5	(-18.4 - 21.0)	3.8	(0.2 - 8.0)
Fe-59	<130.0	(<30.0 - <260.0)	-0.5	(-34.2 - 30.0)	2.1	(-4.3 - 6.8)
Mn-54	<88.3	(<8.0 - <130.0)	1.3	(-20.0 - 30.9)	1.5	(-1.7 - 3.5)
Produce: pCi/kg (wet)						
Gamma						
Cs-134	<49.1	(<10.0 - < 140.0)	1.2	(-24.8 - 19.8)	0.1	(-2.1 - 2.3)
Cs-137	<69.8	(<10.0 - < 140.0)	3.8	(-9.8 - 20.9)	2.2	(-0.8 - 4.2)
I-131	<105.6	(<10.0 - <1000.0)	-0.4	(-26.0 - 59.0)	0.2	(-2.8 - 4.2)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Indicator stations only.
(e) Resin method.

TABLE 5-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN	(RANGE)	1993[d] MEAN	(RANGE)
Storm Drain Vegetation[d] pCi/kg (wet)						
Gamma	Analysis Not Performed					
Mn-54			17.7	(4.7 - 32.2)	4.2	(-2.0 - 10.5)
Co-60			19.1	(-3.7 - 46.1)	40.2	(32.2 - 48.2)
Zn-65			34.6	(4.1 - 57.4)	10.9	(6.9 - 14.9)
Cs-134			10.4	(-6.5 - 45.8)	4.2	(3.8 - 4.6)
Cs-137			29.5	(3.9 - 93.5)	31.6	(26.2 - 36.9)
TLD: mR/day						
Quarterly	0.24	(0.11 - 0.32)	0.25	(0.16 - 0.35)	0.26	(0.21 - 0.33)
Annual	0.23	(0.20 - 0.31)	0.23	(0.18 - 0.32)	0.24	(0.21 - 0.29)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 1992. Some of the data means and ranges are biased high due to Chernobyl in 1986.
(c) The data used for these averages does not include the "less than" values reported in 1984.
(d) Routine samples from the outfall only.

TABLE 5-2
1993 SAMPLE DEVIATIONS

SAMPLE MEDIA	DATE	LOCATION	PROBLEM
Air Particulate/Iodine	01/25 to 02/01	Station 40	Pump Failure, Reduced hours
	03/01 - 03/08	Station 7	Blown Fuse, Reduced hours
	03/22 - 03/29	Station 5	Pump Failure, Reduced hours
	03/29 - 04/05	Station 5	Pump Failure, Reduced hours
	03/29 - 04/05	Station 6	Substation Power Outage, reduced hours
	04/05 - 04/12	Station 6	Substation Power Outage, Reduced Hours
	04/05 - 04/12	Station 40	Power Outage at Petit Farm, Reduced Hours
	05/17 - 05/24	Station 1	Power Outage, Reduced Hours
	05/24 - 06/01	Station 48	Power Outage, Reduced Hours
	05/24 - 06/01	Station 1	Power Outage, Reduced Hours
	06/01 - 06/07	Station 48	Power Outage, Reduced Hours
	06/07 - 06/14	Station 4	Blown Fuse, Reduced Hours
	06/14 - 06/21	Station 8	Pump Failure, Reduced Hours
	07/19 - 07/26	Station 21	Pump Failure, Reduced Hours
	08/02 - 08/09	Station 57	Pump Failure, Reduced Hours
	10/04 - 10/11	Station 23	Pump Failure, Reduced Hours
	10/11 - 10/18	Station 8	Pump Failure, Reduced Hours
	12/06 - 12/13	Station 8	Pump Failure, Reduced Hours
Water	01/25 - 02/16	Station 26	Power Outage for one week
	05/08 - 05/14	Station 27	Maintenance Being Performed, No Sample Collected; No Flow
	05/14 - 06/09	Station 27	Timed Mode for Plant Outage Work
	Jan, Feb, Nov	ST 101	No Sample, Ponds Frozen Over
Milk	04/27	Station 59	Stopped Milking Operation
Produce	Spring	Station 37	No leafy Vegetables, or root
		Station 37	No leafy vegetables, too late in season

TABLE 5-3

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1993

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Air Particulates (pCi/m^3)	Gross Beta 624	0.003	0.020(570/572) (0.003-0.071)	01 1.3 mi S	0.021(52/52) (0.005-0.068)	0.018(52/52) (0.004-0.058)	0
	Gamma (Quarterly) 48						
	Be-7	0.01	(0.111(44/44) (0.075-0.168)	6 7.7 mi S	0.126(4/4) (0.113-0.152)	0.0114(4/4) (0.085-0.149)	0
	K-40	0.01	0.011(10/44) (0.003-0.029)	5 7.7 mi ESE	0.026(2/4) (0.023-0.029)	0.007(1/4)	0
Air Iodine (pCi/m^3)	I-131 624	0.01	-(0/572)			-(0/52)	0
Soil (pCi/kg dry)	Gamma 5						
	K-40	700	12925(4/4) (12200-13800)	1. 1.3 mi S	13800(1/1)	11000(1/1)	0
	Cs-137	40	261(3/4) (37.2-398)	1 1.3 mi S	398(1/1)	63.4(1/1)	0
	Ra-226	400	755(4/4) (527-903)	23 3.0 mi ESE	903(1/1)	786(1/1)	0
	Th-228	50	519(4/4) (412-605)	7 2.7 mi WNW	605(1/1)	518(1/1)	0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1993

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Water (River/Drinking) (pCi/liter)	Gross Beta	36 4	2.1(20/24) (0.62-4.5)	28 7.4 mi SSE	2.1(11/12) (0.62-3.6)	2.0(9/12) (1.0-3.9)	0
	Tritium	12 200	170(2/8) (150-190)	28 7.4 mi SSE	170(2/4) (150-190)	-(0/4)	0
	Gamma	36					
	K-40	200	-(0/24)	26 3.2 mi E	63.2(1/12)	63.2(1/12)	0
Water (Discharge) (pCi/liter)	Gross Beta	12 12	26.4(12/12) (7.5-30.0)	27 3.2 mi E	26.4(12/12) (7.5-30.0)	None	0
	Tritium	4 200	6813(4/4) (150-1200)	27 3.2 mi E	6813(4/4) (150-1200)		0
	Gamma	12					
	K-40	10	123(2/12) (54.7-190)	27 3.2 mi E	123(2/12) (54.7-190)		0
	Mn-54	10	8.40(5/12) (5.67-10.4)	27 3.2 mi E	(8.40(5/12) (5.67-10.4)		0
	Co-60	10	(27.7(7/12) (10.2-41.3)	27 3.2 mi E	(27.7(7/12) (10.2-41.3)		0
	Zn-65	10	41.7(5/12) (16.2-57.3)	27 3.2 mi E	41.7(5/12) (16.2-57.3)		0
	Cs-134	10	10.1(1/12)	27 3.2 mi E	10.1(1/12)		0
	Cs-137	10	13.6(4/12) (7.24-23.1)	27 3.2 mi E	13.6(4/12) (7.24-23.1)		0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1993

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio)[a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Water (Ground) (pCi/liter)	Tritium	12 200	-(0/12)			None	0
	Gamma	12					
	K-40		(52.3(1/12)	32 1.2 mi ESE	52.3(1/12)		0
Sediment (pCi/kg dry)	Gamma	4					
	K-40	700	16000(2/2) (14900-17100)	33 3.6 mi ENE	17650(2/2) (17200-18100)	17650(2/2) (17200-18100)	0
	Co-60	30	32.9(2/2) (21.7-44.1)	34 3.5 mi ESE	32.9(2/2) (21.7-44.1)	-(0/2)	0
	Cs-137	40	408(2/2) (296-520)	34 3.5 mi ESE	408(2/2) (296-520)	102(2/2) (92.0-112)	0
	Ra-226	400	1475(2/2) (1230-1470)	34 3.5 mi ESE	1475(2/2) (1230-1720)	1225(2/2) (1180-1270)	0
	Th-228	50	1037(2/2) (774-1300)	34 3.5 mi ESE	1037(2/2) (774-1300)	778(2/2) (747-809)	0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 — DOCKET NO. 50-397
HANFORD WASHINGTON — JANUARY 1 to DECEMBER 31, 1993

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD)	ALL INDICATOR LOCATIONS MEAN (RATIO) [a] (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RATIO)[a] (RANGE)	CONTROL LOCATION MEAN (RATIO) [a] (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Fish (pCi/kg wet)	Gamma 8						
	K-40	1000	3088(4/4) (2470-3920)	38 27 mi ESE	3213(4/4) (2970-3640)	3213(4/4) (2970-3640)	0
Milk (pCi/liter)	I-131 94	1	-(0/76)			-(0/18)	0
	Gamma 94						
	K-40 94	200	1383(76/76) (1080-1570)	36 7.2 mi ESE	1441(18/18) (1160-1570)	1404(18/18) (1020-1630)	0
Roots (pCi/kg wet)	Gamma 8		-(0/4)	N/A		-(0/4)	0
Fruits (pCi/kg wet)	Gamma 9		-(0/5			-(0/4)	0
Vegetables (pCi/kg wet)	Gamma 12						
	Th-228 12		-(0/6)	9C 30.0 mi WSW	11.8(1/6)	11.8(1/6)	0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1993

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD)	ALL INDICATOR LOCATIONS MEAN (RATIO) [a] (RANGE)	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN (RATIO)[a] (RANGE)	CONTROL LOCATION MEAN (RATIO) [a] (RANGE)	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Direct Radiation Quarterly TLD's (mR/day)	TLD 224	-	0.26(220/220) (0.21-0.33)	46 5.0 mi NE	0.31(4/4) (0.29-0.33)	0.24(4/4) (0.23-0.24)	0
Direct Radiation Annual TLD's (mR/day)	TLD 56	-	0.25(55/55) (0.21-0.29)	46 5.0 mi NE	0.29(1/1) -	0.22(1/1) -	0
Storm Drain Water (pCi/liter)							
	Tritium 289	200	6770(235/289) (34-140000)	101 0.3 mi ENE	6770(235/289) (34-140000)	None	0
	Gamma 298						
	K-40	200	91.0(11/298) (64.7-120)	101 0.3 mi ENE	91.0(11/298) (64.7-120)	None	0
	Cs-137	10	252(1/298) -	101 0.3 mi ENE	252(1/298) -	None	0
	Th-228		15.4(2/298) (14.8-16.0)	101 0.3 mi ENE	15.4(2/298) (14.8-16.0)	None	0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1993

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Sediment (pCi/kg)							
	Gamma 54						
	K-40	700	9477(54/54) (3250-13500)	101 0.3 mi ENE	9477(54/54) (3250-13500)	None	0
	Mn-54	40	21.5(18/54) (9.39-34.3)	101 0.3 mi ENE	21.5(18/54) (9.39-34.3)	None	0
	Co-60	30	517(54/54) (99.9-13400)	101 0.3 mi ENE	517(54/54) (99.9-13400)	None	0
	Zn-65	100	89.1(26/54) (27.5-481)	101 0.3 mi ENE	89.1(26/54) (27.5-481)	None	0
	Zr-95		17.0(1/54) -	101 0.3 mi ENE	17.0(1/54) -	None	0
	Nb-95		32.3(1/54) -	101 0.3 mi ENE	32.3(1/54) -	None	0
	Cs-134	30	54.6(54/54) (21.5-98.5)	101 0.3 mi ENE	54.6(42/54) (21.5-98.5)	None	0
	Cs-137	40	129(54/54) (47.4-250)	101 0.3 mi ENE	129(54/54) (47.4-250)	None	0
	Ce-141		14.0(1/54) -	101 0.3 mi ENE	14.1(1/54) -	None	0
	Ra-226	400	902(50/54) (612-1310)	101 0.3 mi ENE	902(50/54) (612-1310)	None	0
	Th-228	50	452(54/54) (367-744)	101 0.3 mi ENE	452(54/54) (367-744)	None	0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1993

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Soil (pCi/kg)							
	Gamma	6					
	K-40	700	14883(6/6) (13700-15400)	101 0.3 mi ENE	14883(6/6) (13700-15400)	None	0
	Cs-137	40	41.8(6/6) (24.6-54.8)	101 0.3 mi ENE	41.8(6/6) (24.6-54.8)		0
	Ra-226	400	723(6/6) (649-964)	101 0.3 mi ENE	723(6/6) (649-964)		0
	Th-228	50	491(6/6) (438-551)	101 0.3 mi ENE	491(6/6) (438-551)		0
Storm Drain Vegetation (pCi/kg wet)							
	Gamma	2					
	Be-7		415(2/2) (346-484)	101 0.3 mi ENE	(415(2/2) (346-484)	None	0
	K-40		3960(2/2) (2900-5020)	101 0.3 mi ENE	3960(2/2) (2900-5020)		0
	Co-60		40.2(2/2) (32.2-48.2)	101 0.3 mi ENE	40.2(2/2) (32.2-48.2)		0
	Cs-137		31.6(2/2) (26.2-36.9)	101 0.3 mi ENE	31.6(2/2) (26.2-36.9)		0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1993

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Sanitary Waste Treatment Facility Water (pCi/l)							
	Gross Alpha 18	3	-(0/18)			None	0
	Gross Beta 18	1	50.1(18/18) (35-61)	102C 0.3 mi ENE	50.1(18/18) (35-61)		0
	Tritium 39	200	512(23/39) (120-950)	102C 0.3 mi ENE	626(14/18) (260-950)		0
	Gamma 34						
	K-40		58.6(5/34) (44.0-84.3)	102C 0.3 mi ENE	45.0(2/14) (44.0-45.9)		0
Sanitary Waste Treatment Facility Sediment (pCi/kg)	Gamma 10						
	K-40	700	6970(10/10) (4690-11300)	102 0.3 mi ENE	6970(10/10) (4690-11300)		0
	Co-60	30	393(10/10) (182-683)	102 0.3 mi ENE	393(10/10) (182-683)		0
	Cs-137	40	180(9/10) (105-255	102 0.3 mi ENE	180(9/10) (105-255)		0
	Ra-226	400	1558(5/10) (1130-2480)	102 0.3 mi ENE	1558(5/10) (1130-2480)		0
	Th-228	50	470(9/10) (233-702)	102 0.3 mi ENE	470(9/10) (233-702)		0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1993

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Storm Drain Core (pCi/kg)							
	Gamma 112						
	K-40	700	1380(112/112) (9730-42300)	101K 0.3 mi ENE	15702(11/11) (9730-42300)	None	0
	Mn-54	40	13.5(23/112) (6.97-41.4)	101A 0.3 mi ENE	27.3(3/11) (13.9-41.4)	None	0
	Co-58		13.2(1/112)	101K 0.3 mi ENE	13.2(1/11)	None	0
	Co-60	30	215(60/112) (10.2-3050)	101A 0.3 mi ENE	1007(7/11) (104-3050)	None	0
	Zn-65	100	117(5/112) (17.1-246)	10C 0.3 mi ENE	246(1/10)	None	0
	Cs-134	30	301(6/112) (36.7-1420)	101A 0.3 mi ENE	410(4/11) (45.9-1420)	None	0
	Cs-137	40	73.9(26/112) (4.9-405)	101A 0.3 mi ENE	174(6/11) (16.7-405)	None	0
	Ra-226	400	928(108/112) (522-3410)	101K 0.3 mi ENE	611(11/11) (372-1590)	None	0
	Th-228	50	546(112/112) (372-1590)	101E 0.3 mi ENE	1184(8/8) (674-3410)	None	0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-3 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2 DOCKET NO. 50-397
HANFORD WASHINGTON JANUARY 1 to DECEMBER 31, 1993

Medium Or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analyses Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Ratio) [a] (Range)	Location With Highest Mean Name Distance and Direction	Mean Ratio [a] (Range)	Control Location MEAN (RATIO) [a] (RANGE)	Number of Nonroutine Reported Measurements
Station 118 Soil (pCi/kg dry)							
	Gamma 28						
	K-40	700	12075(28/28) (10300-14300)	118 0.3 mi S	12075(28/28) (10300-14300)	None	0
	Cs-137	40	21.7(10/28) (10.7-31.7)	118 0.3 mi S	21.7(10/28) (10.7-31.7)		0
	Ra-226	700	705(28/28) (430-887)	118 0.3 mi S	705(28/28) (430-887)		0
	Th-228	50	494(28/28) (434-632)	118 0.3 mi S	494(28/28) (434-632)		0

(a) The ratio of positive results above the LLD to the number of samples analyzed for the parameter of interest.

TABLE 5-4

MEAN QUARTERLY TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1992 OPERATIONAL		1993 OPERATIONAL	
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	MEAN	STANDARD ERROR
1	0.24	0.02	0.25	0.01	0.26	0.01
2	0.23	0.02	0.24	0.00	0.26	0.01
3	0.22	0.01	0.24	0.01	0.24	0.01
4	0.22	0.02	0.22	0.01	0.24	0.01
5	0.23	0.01	0.23	0.01	0.24	0.01
6	0.22	0.01	0.23	0.01	0.24	0.01
7	0.23	0.01	0.24	0.01	0.25	0.01
8	0.26	0.01	0.27	0.01	0.28	0.01
9	0.22	0.01	0.23	0.01	0.24	0.01
10	0.23	0.01	0.24	0.01	0.25	0.01
11	0.24	0.01	0.24	0.01	0.25	0.00
12	0.25	0.01	0.26	0.01	0.27	0.01
13	0.24	0.01	0.25	0.01	0.26	0.01
14	0.24	0.02	0.24	0.01	0.25	0.00
15	0.25	0.01	0.26	0.01	0.27	0.01
16	0.24	0.01	0.25	0.01	0.26	0.01
17	0.25	0.01	0.25	0.01	0.26	0.01
18	0.24	0.01	0.25	0.01	0.26	0.01
19	0.24	0.01	0.25	0.01	0.25	0.01
20	0.24	0.01	0.24	0.01	0.25	0.01
21	0.23	0.01	0.23	0.01	0.23	0.01
22	0.24	0.01	0.24	0.01	0.25	0.01
23	0.24	0.01	0.24	0.01	0.25	0.01
24	0.24	0.01	0.25	0.01	0.26	0.01
25	0.25	0.01	0.26	0.01	0.27	0.01
40	0.22	0.01	0.24	0.01	0.23	0.01
41	0.26	0.02	0.26	0.01	0.27	0.01
42	0.25	0.01	0.25	0.01	0.26	0.01
43	0.25	0.01	0.26	0.01	0.27	0.01
44	0.23	0.01	0.24	0.01	0.25	0.01
45	0.23	0.01	0.24	0.01	0.25	0.01
46	0.28	0.02	0.30	0.02	0.31	0.01
47	0.22	0.02	0.23	0.01	0.24	0.01
49	0.24	0.00	0.25	0.01	0.26	0.01
50	0.22	0.00	0.25	0.01	0.25	0.01
51	0.23	0.01	0.24	0.01	0.25	0.01

(a) This preoperational mean is for the 1982-1983 data only.

TABLE 5-4 (Cont.)

MEAN QUARTERLY TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1992 OPERATIONAL		1993 OPERATIONAL	
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	MEAN	STANDARD ERROR
53	0.27	0.00	0.27	0.01	0.29	0.01
54	0.26	0.00	0.26	0.01	0.26	0.01
55	0.23	0.00	0.24	0.01	0.25	0.01
56	0.24	0.00	0.25	0.01	0.26	0.01
61	(b)		0.28	0.01	(b)	
71(1S)	0.24	0.02	0.27	0.01	0.29	0.02
72(2S)	0.25	0.01	0.27	0.01	0.28	0.01
73(3S)	0.23	0.01	0.24	0.01	0.25	0.01
74(4S)	0.26	0.01	0.27	0.01	0.28	0.01
75(5S)	0.22	0.02	0.25	0.01	0.26	0.02
76(6S)	0.24	0.01	0.25	0.01	0.25	0.01
77(7S)	0.25	0.01	0.25	0.01	0.26	0.01
78(8S)	0.25	0.01	0.24	0.01	0.25	0.01
79(9S)	0.25	0.01	0.25	0.01	0.26	0.01
80(10S)	0.24	0.01	0.24	0.01	0.25	0.01
81(11S)	0.24	0.02	0.24	0.01	0.25	0.01
82(12S)	0.25	0.02	0.25	0.01	0.26	0.01
83(13S)	0.25	0.01	0.25	0.01	0.27	0.01
84(14S)	0.24	0.01	0.25	0.01	0.26	0.01
85(15S)	0.26	0.01	0.26	0.01	0.27	0.01
86(16S)	0.25	0.01	0.27	0.01	0.29	0.02
All	0.24	0.00	0.25	0.00	0.26	0.02

(a) This preoperational mean is for 1982-1983 data only.
(b) Station 61 was added in 1989 and discontinued in 1992.

TABLE 5-5

ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1992 OPERATIONAL		1993 OPERATIONAL	
STATION	MEAN(a)	STANDARD ERROR	MEAN	STANDARD ERROR	MEAN	STANDARD DEVIATION(2σ)
1	0.23	0.04	0.23	0.02	0.24	0.01
2	0.22	0.04	0.23	0.02	0.24	0.01
3	0.21	0.04	0.22	0.02	0.23	0.01
4	0.22	0.06	0.20	0.02	0.22	0.01
5	0.22	0.04	0.21	0.02	0.22	0.00
6	0.21	0.04	0.21	0.02	0.23	0.01
7	0.22	0.02	0.23(b)	0.01	0.24	0.01
8	0.25	0.04	0.25(b)	0.02	0.26	0.01
9	0.20	0.02	0.21	0.02	0.22	0.01
10	0.22	0.04	0.22	0.02	0.23	0.01
11	0.22	0.04	0.22	0.02	0.24	0.01
12	0.24	0.04	0.24	0.02	0.26	0.01
13	0.22	0.04	0.23	0.01	0.24	0.01
14	0.22	0.04	0.22	0.02	0.23	0.01
15	0.23	0.06	0.24	0.02	0.26	0.01
16	0.23	0.04	0.23	0.02	0.25	0.01
17	0.23	0.02	0.23(b)	0.02	0.25	0.01
18	0.25	0.02	0.23	0.02	0.24	0.01
19	0.22	0.04	0.23	0.01	0.24	0.01
20	0.23	0.04	0.23	0.02	0.23	0.01
21	0.23	0.02	0.21	0.02	0.22	0.01
22	0.22	0.02	0.23	0.02	0.24	0.01
23	0.24	0.02	0.22	0.02	0.23	0.01
24	0.22	0.02	0.23	0.02	0.24	0.01
25	0.24	0.02	0.24	0.02	0.25	0.01
40	0.21(c)	0.02	0.22	0.02	0.21	0.00
41	0.26(c)	0.04	0.24	0.02	0.25	0.01
42	0.24(c)	0.02	0.23	0.02	0.25	0.00
43	0.24(c)	0.02	0.24	0.02	0.25	0.01
44	0.24	0.02	0.22	0.02	0.23	0.01
45	0.24	0.01	0.22	0.02	0.23	0.01
46	0.29	0.01	0.28	0.02	(e)	
47	0.22(c)	0.03	0.21	0.02	0.22	0.01
49	(d)		0.22	0.01	0.24	0.01

(a) This preoperational mean is for 1982 - 1983 data only.
(b) 1985 TLD missing.
(c) There was only one annual exchange during the preoperational period.
(d) Stations 49-56 were first monitored during Fourth Quarter 1983. Station 61 was added in 1989 and discontinured in 1992.
(e) TLD missing.

TABLE 5-5 (Cont.)

ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 1992 OPERATIONAL		1993 OPERATIONAL	
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	MEAN	STANDARD DEVIATION(2σ)
50	(d)		0.23	0.02	0.22	0.00
51	(d)		0.22	0.02	0.23	0.01
53	(d)		0.25	0.02	0.23	0.01
54	(d)		0.24	0.02	0.23	0.01
55	(d)		0.22	0.02	0.23	0.01
56	(d)		0.23	0.02	0.24	0.01
61	(d)		0.27[d]	0.02	(e)	
71	0.24[c]	0.02	0.25	0.02	0.27	0.01
72	0.25[c]	0.02	0.25	0.02	0.27	0.01
73	0.23[c]	0.01	0.22	0.02	0.23	0.01
74	0.24[c]	0.01	0.24	0.02	0.26	0.01
75	0.24[c]	0.01	0.23	0.02	0.24	0.01
76	0.24[c]	0.02	0.23	0.02	0.24	0.01
77	0.25[c]	0.02	0.23	0.02	0.24	0.01
78	0.25[c]	0.04	0.23	0.02	0.23	0.00
79	0.25[c]	0.02	0.23	0.02	0.24	0.01
80	0.23[c]	0.05	0.22	0.02	0.23	0.01
81	0.23[c]	0.02	0.23	0.02	0.24	0.00
82	0.25[c]	0.03	0.24	0.01	0.24	0.01
83	0.25[c]	0.02	0.24	0.02	0.24	0.01
84	0.23[c]	0.02	0.23	0.02	0.25	0.01
85	0.26[c]	0.02	0.24	0.02	0.26	0.01
86	0.24	0.02	0.26	0.02	0.27	0.01
All	0.23	0.02	0.23	0.01	0.24	0.01

(a) This preoperational mean is for 1982 - 1983 data only.
(b) 1985 TLD missing.
(c) There was only one annual exchange during the preoperational period.
(d) Stations 49-56 were first monitored during Fourth Quarter 1983. Station 61 was added in 1989.
(e) Station 61 discontinued on June 29, 1992

TABLE 5-6

1993 MEAN QUARTERLY VERSUS ANNUAL TLD DATA
Results in mR/day

	QUARTERLY TLDs		ANNUAL TLDs	
STATION	MEAN[a]	STANDARD ERROR	MEAN[b]	STANDARD DEVIATION(2σ)
1	0.26	0.01	0.24	0.01
2	0.26	0.01	0.24	0.01
3	0.24	0.01	0.23	0.01
4	0.24	0.01	0.22	0.01
5	0.24	0.01	0.22	0.00
6	0.24	0.01	0.23	0.01
7	0.25	0.01	0.24	0.01
8	0.28	0.01	0.26	0.01
9	0.24	0.01	0.22	0.01
10	0.25	0.01	0.23	0.01
11	0.25	0.00	0.24	0.01
12	0.27	0.01	0.26	0.01
13	0.26	0.01	0.24	0.01
14	0.25	0.00	0.23	0.01
15	0.27	0.01	0.26	0.01
16	0.26	0.01	0.25	0.01
17	0.26	0.01	0.25	0.01
18	0.26	0.01	0.24	0.01
19	0.25	0.01	0.24	0.01
20	0.25	0.01	0.23	0.01
21	0.23	0.01	0.22	0.01
22	0.25	0.01	0.24	0.01
23	0.25	0.01	0.23	0.01
24	0.26	0.01	0.24	0.01
25	0.27	0.01	0.25	0.01
40	0.23	0.01	0.21	0.00
41	0.27	0.01	0.25	0.01
42	0.26	0.01	0.25	0.00
43	0.27	0.01	0.25	0.01
44	0.25	0.01	0.23	0.01
45	0.25	0.01	0.23	0.01
46	0.31	0.01	(c)	
47	0.24	0.01	0.22	0.01
49	0.26	0.01	0.24	0.01
50	0.25	0.01	0.224	0.00

(a) Mean of the quarterly results.
(b) Mean of four readout areas on each TLD.
(c) TLD missing.

TABLE 5-6 (Cont.)

1993 MEAN QUARTERLY VERSUS ANNUAL TLD DATA
Results in mR/day

	QUARTERLY TLDS		ANNUAL TLDS	
STATION	MEAN[a]	STANDARD ERROR	MEAN[b]	STANDARD DEVIATION(2σ)
51	0.25	0.01	0.23	0.01
53	0.29	0.02	0.23	0.01
54	0.26	0.01	0.23	0.01
55	0.25	0.01	0.23	0.01
56	0.26	0.01	0.24	0.01
61	(c)		(c)	
71 (1S)	0.29	0.02	0.27	0.01
72 (2S)	0.28	0.01	0.27	0.01
73 (3S)	0.25	0.01	0.23	0.01
74 (4S)	0.28	0.01	0.26	0.01
75 (5S)	0.26	0.02	0.24	0.01
76 (6S)	0.25	0.01	0.24	0.01
77 (7S)	0.26	0.01	0.24	0.01
78 (8S)	0.25	0.01	0.23	0.00
79 (9S)	0.26	0.01	0.24	0.01
80 (10S)	0.25	0.01	0.23	0.01
81 (11S)	0.25	0.01	0.24	0.00
82 (12S)	0.26	0.01	0.24	0.01
83 (13S)	0.27	0.01	0.24	0.01
84 (14S)	0.26	0.01	0.25	0.01
85 (15S)	0.27	0.01	0.26	0.01
86 (16S)	0.29	0.02	0.27	0.01

(a) Mean of the quarterly mean results.
(b) Mean of four readout areas on each TLD.
(c) Station 61 was discontinued on June 29, 1992.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

The REMP is designed to meet the quality assurance and quality control criteria of Regulatory Guide 4.15. To accomplish this, the REMP requires that its analytical contractors meet these criteria also. In-depth audits are performed of the REMP records and activities and the records and activities of its support organizations at least annually by the Supply System Quality Assurance group.

Quality assurance and technical audits of the analytical contractor (Teledyne Isotopes) are also conducted annually to verify their compliance to regulatory and contractual requirements. The adequacy of their quality assurance program is also assessed during the audits.

Intercomparison programs, which involve the comparison of Supply System analytical results for samples containing known concentrations of various radionuclides with the known values and with the results reported by other monitoring programs, are also a major component of the quality assurance activities of the REMP. The program participates in the Environmental Protection Agency (EPA) and Environmental Measurements Laboratory (EML) intercomparison programs. It also participates in local and regional intercomparison studies. The following sections summarize the quality assurance and quality control aspects of the TLD and analytical components of the REMP.

6.1 Quality Control For the Supply System Environmental TLD Program

The Quality Control Program includes the preparation, processing and evaluation of environmental TLDs. QA dosimeters, which are annealed just prior to being given a known exposure to cesium-137 gamma radiation and processed among the field dosimeters, serve as indicators that the readout, calibration and evaluation of the field dosimeters were properly performed. The number of QA dosimeters used during each processing is generally 10% of the number of field dosimeters. Since 1987 the same QA dosimeters have been used repeatedly throughout the year in order to track their sensitivity and to provide consistency from run to run.

If the mean QA dosimeter results are greater than $\pm$ 5% (or 5 mR) of the given exposure, an investigation into the source of the discrepancy is initiated. Evaluation of the 1993 QA dosimeter results indicated only small biases for the four quarters.

Control dosimeters (trip controls) are used for each set of field dosimeters to monitor the contribution of the exposure received by the field TLDs while in transit. The radiation background in the storage area is also monitored by a separate set of control dosimeters (building controls). If the trip control results are significantly greater than the building control results, the difference between the two is subtracted from the field dosimeters.

Spiked dosimeters, which are exposed to known levels of radiation below the 100 mR given to the QA dosimeters, were processed with the field dosimeters during each run to verify the accuracy of the environmental TLD evaluations. All results were well within $\pm$5% of the given exposure and provided in Table 6-1.

During each environmental TLD processing, individual calibration factors are determined for each TLD by exposing the TLDs to 100 mR from an encapsulated cesium-137 source. The calibration exposure is determined from the exposure duration and the assessed source strength at 55 centimeters. As a quality control check for each calibration exposure, an NIST-traceable ionization chamber is also used to determine the calibration exposure. If the ionization chamber measurement does not agree with the calibration exposure to within $\pm$5% of the calculated value, an investigation is performed into the discrepancy and the TLD calibration is repeated, if necessary.

6.2 Quality Control For the Analytical Program

Quality control for the analytical program involves two components: the quality control activities performed by the Supply System and the quality control program of the analytical contractor, Teledyne Isotopes. Both of these components are described in the following sections.

6.2.1 Supply System Quality Control Activities

The Supply System has participated in the U.S. Department of Energy's Environmental Measurements Laboratory (EML) Quality Assessment Program since 1987. In general the Teledyne results agreed with the EML values.

In addition to participating in the EML Intercomparison Program, the Supply System participates in the Environmental Radiation Quality Assurance Task Force of the Pacific Northwest (QATF) intercomparison program.

Duplicate samples were also submitted to Teledyne for analysis during 1993. These duplicates consisted of two sets of milk samples and one set of air filters from EML. The milk duplicates were marked Station 37 and were submitted for analysis at the same time as the milk samples from Station 36.

6.2.2 Teledyne Isotopes Quality Control Program

The goal of the quality control program at Teledyne Isotopes is to produce analytical results which are accurate, precise and supported by adequate documentation. The program is based on the requirements of 10CFR50, Appendix B, Regulatory Guide 4.15 and the implemented program, as described in Teledyne's Quality Assurance Manual IWL-0032-395 and Quality Control Manual IWL-0032-365.

All measuring equipment is calibrated for efficiency at least annually using standard reference material traceable to the National Institute of Standards and Technology (NIST). For alpha and beta counting, check sources are prepared and counted every weekday except holidays. Control charts are maintained with three-sigma limits specified. Backgrounds are usually measured at least once per week.

The efficiency of the gamma spectrometers is determined annually with a NIST traceable standard reference material selected to cover the energy range of the nuclides to be monitored and to include all of the geometries measured. Backgrounds are determined every other week and check sources are counted weekly. The energy resolution and efficiency are plotted at two energy levels (125.1 and 1274.4 kev) on charts and held within three-sigma control limits.

The efficiency of the tritium liquid scintillations was determined every month by counting a NIST traceable standard which had been diluted in a known amount of distilled water so that the activity level loaded into the counter is sufficient to provide good counting statistics. If the efficiency measurement does not agree within two standard deviations of the average of the previous six measurements, corrective action is taken. The background of each counter is measured after each sample measurement. A control chart is maintained for the background measurements as a stability check.

Control of sample identity is maintained by the assignment of a unique five-digit number which is maintained throughout the sample's history from sample receipt, log-in number assignment, and designation of analysis to reporting the final analytical result. Besides ensuring sample accountability, Teledyne procedures also ensure the maintenance of sample integrity by controlling sample storage and taking steps to prevent contamination of samples.

Results are reviewed for reasonableness before being entered into the data system. Any results which are suspect, i.e., which are higher or lower than results in the past, are returned to the laboratory for recount. If a longer count, decay check, recount on another system or recalculation does not give acceptable results based on experience, a new aliquot is analyzed. The complete information about the sample is contained on the worksheets accompanying the sample results.

Iodine-131 Cartridges

One blank charcoal cartridge was analyzed on a weekly basis with each set of cartridges, for a total of fifty-two blanks.

Gross-Beta - Filters

One blank filter was measured with each set of filters analyzed. Fifty-two blanks were counted.

I-131 - Milk

A blank milk was analyzed with each group of samples analyzed. The results showed that there was no contamination in the laboratory or counting area.

Sr-90 - Milk and Water

Blank water samples were analyzed on a weekly basis. Fifty-two spiked water samples were analyzed.

Gross Beta - Water

Fifty-two blanks were prepared from distilled water. No contamination was indicated and the background level was low and stable.

Tritium in Water

Fifty-two blank samples were analyzed by liquid scintillation.

Gamma Spectroscopy

A blank water sample was analyzed on a weekly basis in the gamma spectroscopy laboratory. pCi/liter.

TABLE 6-1

1993 ENVIRONMENTAL SPIKED DOSIMETER RESULTS

TLD DISTRIBUTION	GIVEN EXPOSURE (mR)	REPORTED EXPOSURE (mR)	BIAS (%)
First Quarter	20.0	20.4	2.0
		20.3	1.5
		19.9	-0.5
Second Quarter	25.0	25.2	0.8
		25.3	1.2
		25.2	0.8
Third Quarter	20.0	20.7	3.5
		20.9	4.5
		20.3	1.5
Fourth Quarter	30.0	29.9	-0.3
		30.7	2.3
		30.5	1.7
Annual	70.0	70.0	0.0
		71.0	1.2
		69.6	-0.6

EPA INTERLABORATORY COMPARISON PROGRAM

Teledyne Isotopes participates in the EPA Interlaboratory Comparison Program to the fullest extent possible. -That is, we participate in the program for all radioactive isotopes prepared and at the maximum frequency of availability. In this section trending graphs (since 1981) and the 1993 data summary tables are presented for isotopes in the various sample media applicable to the Washington Public Power Plant's Radiological Environmental Monitoring Program. The footnotes of the table discuss investigations of problems encountered in a few cases and the steps taken to prevent reoccurrence.

1993 EPA INTERCOMPARISON PROGRAM RESULTS

ISOTOPE	COLLECTION DATE	TI RESULTS (a)	EPA RESULTS (b)	OTHER LABS (c)	
		MEDIUM - WATER (pCi/liter)			
Sr-89	930115	12.67 ± 1.15	15.0 ± 5.0	14.53 ± 3.12	
Sr-90	"	8.33 ± 1.15	10.0 ± 5.0	9.66 ± 2.20	
Sr-89	930420	35.33 ± 1.53	41.0 ± 5.0	37.59 ± 8.32	
Sr-90	"	27.33 ± 0.58	29.0 ± 5.0	27.82 ± 3.45	
Sr-89	930716	31.67 ± 2.52	34.0 ± 5.0	34.20 ± 6.66	
Sr-90	"	24.00 ± 0.00	25.0 ± 5.0	24.02 ± 3.15	
Sr-89	931019	15.00 ± 1.00	15.0 ± 5.0	13.96 ± 3.03	
Sr-90	"	10.00 ± 0.00	10.0 ± 5.0	10.26 ± 2.02	
Gr-Beta	930129	52.00 ± 1.00	44.0 ± 5.0	41.99 ± 7.41	(e)
Gr-Beta	930420	150.0 ± 0.00	177.0 ± 27.0	155.52 ± 18.41	
Gr-Beta	930723	42.67 ± 2.52	43.0 ± 6.9	37.65 ± 8.49	
Gr-Beta	931029	15.67 ± 2.08	15.0 ± 5.0	17.01 ± 4.80	
Gr-Beta	931019	51.33 ± 3.21	58.0 ± 10.0	53.40 ± 6.43	
I-131	930205	106.67 ± 5.77	100.0 ± 10.0	101.36 ± 8.20	
Ra-226	930305	7.67 ± 0.12	9.8 ± 1.5	9.81 ± 1.26	(f)
Ra-228	"	19.33 ± 2.31	18.5 ± 4.6	17.81 ± 3.54	
Co-60	"	40.67 ± 3.51	39.0 ± 5.0	39.36 ± 2.90	
Cs-134	"	23.67 ± 1.53	27.0 ± 5.0	25.40 ± 2.14	
Cs-137	"	34.33 ± 2.08	32.0 ± 5.0	32.60 ± 2.81	
Ra-226	"	19.00 ± 1.00	24.9 ± 3.7	24.41 ± 3.14	(f)
Co-60	930611	16.33 ± 1.53	15.0 ± 5.0	14.90 ± 2.08	
Zn-65	"	121.33 ± 2.08	103.0 ± 10.0	107.54 ± 7.83	(g)
Ru-106	"	106.33 ± 15.89	119.0 ± 12.0	103.87 ± 12.87	
Cs-134	"	5.67 ± 0.58	5.0 ± 5.0	5.39 ± 1.57	
Cs-137	"	6.67 ± 0.58	5.0 ± 5.0	5.76 ± 1.47	
Ba-133	"	104.33 ± 9.29	99.0 ± 10.0	96.74 ± 6.87	
Ra-226	930909	15.33 ± 0.58	14.9 ± 2.2	14.73 ± 1.84	
Ra-228	"	20.67 ± 1.15	20.4 ± 5.1	19.57 ± 5.09	
I-131	931008	103.33 ± 5.77	117.0 ± 12.0	117.68 ± 10.62	
Co-60	931112	28.67 ± 2.89	30.0 ± 5.0	29.72 ± 2.33	
Zn-65	"	152.00 ± 9.17	150.00 ± 9.17	156.07 ± 9.24	
Ru-106	"	177.33 ± 5.51	201.0 ± 20.0	175.18 ± 18.32	
Cs-134	"	53.33 ± 4.93	59.0 ± 5.0	54.42 ± 4.53	
Cs-137	"	41.33 ± 3.06	40.0 ± 5.0	42.14 ± 3.04	
Ba-133	"	79.0 ± 8.0	69.33 ± 3.06	76.45 ± 6.31	
Ra-226	931019	10.10 ± 0.79	9.9 ± 1.5	9.90 ± 1.67	
Ra-228	"	14.67 ± 1.15	12.5 ± 3.1	12.81 ± 2.15	
Co-60	931019	12.00 ± 1.00	10.0 ± 5.0	10.41 ± 1.63	
Cs-134	"	9.00 ± 1.00	12.0 ± 5.0	9.78 ± 1.86	
Cs-137	"	12.67 ± 2.52	10.0 ± 5.0	10.93 ± 1.72	
H-3	930604	9366.67 ± 152.75	9844.0 ± 984.0	9591.82 ± 689.10	
H-3	931105	6900.00 ± 100.00	7398.0 ± 740.0	7215.65 ± 574.68	

1993 EPA INTERCOMPARISON PROGRAM RESULTS

ISOTOPE	COLLECTION DATE	TI RESULTS (a)	EPA RESULTS (b)	OTHER LABS (c)
MEDIUM - MILK (pCi/liter)				
Sr-89	930924	35.67 ± 3.51	30.0 ± 5.0	24.03 ± 7.52
Sr-90	"	24.00 ± 1.73	25.00 ± 5.0	19.97 ± 5.23
I-131	"	126.67 ± 5.77	120.0 ± 12.0	120.12 ± 8.37
Cs-137	"	50.67 ± 1.15	49.0 ± 5.0	50.02 ± 3.00
K	"	1620.00 ± 17.32	1679.0 ± 84.0	1674.07 ± 95.22
MEDIUM - AIR FILTERS (pCi/cubic meter)				
Gr-Alpha	930827	17.00 ± 0.00	19.0 ± 5.0	20.00 ± 3.27
Gr-Beta	"	49.00 ± 1.73	47.0 ± 5.0	49.32 ± 4.62
Sr-90	"	17.67 ± 0.58	19.0 ± 5.0	18.17 ± 3.16
Cs-137	"	9.67 ± 0.58	9.0 ± 5.0	10.00 ± 1.62

Footnotes:

(a) Teledyne Results - Average ± one sigma. Units are pCi/liter for water and milk except K is in mg/liter. Units are total pCi for air particulate filters

(b) EPA Results - Expected laboratory precision (1 sigma). Units are pCi/liter for water, and milk except K is in mg/liter. Units are total pCi for air particulate filters

(c) Average concentration plus or minus one sigma, based on range of values encountered.

(d) The EPA switched from Am-241 to Th-230 alpha spike. We calibrated with Th-230, using sodium nitrate to generate a self-absorption curve. The EPA water, however has minerals which have greater self-absorption that the sodium nitrate matrix. The EPA has agreed to send us a gallon of their water which we can use to prepare a self-absorption curve with Th-230.

(e) By oversight, we did not use the special self-absorption curve which we had previously derived using EPA water and Cs-137 standard. We will use the EPA curve in the future. We may also re-derive this curve using a water sample which the EPA has agreed to send us.

(f) The counting data and backgrounds were verified. Possibly some efficiencies used were erroneously high, causing low values. A less likely cause is an error in dilution. New Ra-226 standards will be prepared. Closer monitoring of out of control efficiencies will be done and extra care in preparation of the sample will be maintained.

1993 EPA INTERCOMPARISON PROGRAM RESULTS

ISOTOPE	COLLECTION DATE	TI RESULTS (a)	EPA RESULTS (b)	OTHER LABS (c)

(g) The calculations were checked and found to be correct. The results of six gamma emitting isotopes were reported to the EPA. The results of four were within 1 normalized deviation; a fifth, within 2 normalized deviations. Only the Zn-65 average was outside the control limits. There is no obvious reason why one isotope should be outside the control limits, while five other isotopes were within control limits.

7.0 REFERENCES

7.0 REFERENCES

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