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May 14, 2002
GO2-02-089

Docket No. 50-397

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Energy Facility Site Evaluation Council
Attn: EFSEC Manager
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Olympia, WA 98504-3172

Subject: **COLUMBIA GENERATING STATION, OPERATING LICENSE NPF-21 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL REPORT FOR 2001**

References: 1) Columbia Generating Station Technical Specification 5.6.2
2) EFSEC Resolution No. 260, dated January 1992

Enclosed are three copies of the subject report and separate data volume that are submitted pursuant to the requirements of References 1 and 2.

If you have any questions regarding this information, they may be directed to JE McDonald at (509) 377-8137.

Respectfully,

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2001
Annual Radiological Environmental Operating Report

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COLUMBIA GENERATING STATION

2001 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

JANUARY 1 to DECEMBER 31, 2001

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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The Energy Northwest Radiological Environmental Monitoring Program (REMP) evaluates the radiological impact of Columbia Generating Station operations on the environment in the Airborne, Direct Radiation, Waterborne, and Ingestion pathways as specified in the Offsite Dose Calculation Manual (ODCM). Additional samples are collected at locations specified by the Site Certification Agreement (SCA) with the State of Washington Energy Facility Site Evaluation Council (EFSEC). Energy Northwest's Columbia Generating Station is a 1200 MW commercial nuclear power plant that achieved initial criticality on January 19, 1984.

Prior to 1999, Columbia Generating Station was on an annual refueling cycle. The outages usually occurred from the middle of April to early June. In 1999, Columbia Generating Station began the transition to a 24-month refueling cycle. The R-15 refueling outage took place from May to July 2001.

Samples of air, water, milk, soil, sediment, fish and garden produce were collected throughout the year and analyzed for radionuclides specific to plant operations. Radiation levels were also monitored continuously during 2001 with thermoluminescent dosimeters (TLDs).

Samples were collected in established areas near the plant and at other locations that could be affected by Columbia Generating Station effluents. This information was compared to samples taken in areas that were unlikely to be affected by plant operations. The 2001 REMP data was also compared to data collected during previous years of plant operation and to the data collected prior to initial plant operation.

Most of the results of samples collected by the REMP during 2001 were below detection levels. Some analyses, such as gross beta in air and water, were above the detection level for nearly all samples. This is due to the low detection limit for the gross beta analysis and to the abundance of beta-emitting radionuclides that occur naturally in the environment. Other results above detection levels, such as cesium-137 in soil and sediment, reflect the effect of past Hanford activities or fallout from Chernobyl and past nuclear weapons testing.

Tritium and other radionuclides in river/drinking, well and discharge water were in concentrations below detectable levels in almost all samples. During 2001, Columbia Generating Station did not have a liquid radwaste discharge to the Columbia River.

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 2001. Such intercomparisons tested the performance of Energy Northwest's monitoring program to other monitoring programs using known radioactive standards. Energy Northwest's REMP analytical contractor performed well in the Environmental Measurements Laboratory (EML) Quality Assessment Program, the Analytics, Inc. Cross Check Comparison Program, and other intercomparison studies conducted during 2001.

The analytical results from samples collected by the REMP in 2001 remained consistent with the results of environmental samples collected during the preoperational period and prior operational years. Based on the data, no significant new trends or changes in the environmental radiological levels around the plant were observed.

2.0 DEFINITIONS

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Airborne Activity Sampling: Continuous sampling of air through the collection 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 emitted 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 emitted 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 the Columbia Generating Station.

Counting Error: An estimate of the two-sigma uncertainty associated with the sample results based on 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 using thermoluminescent dosimeters and pressurized ionization chambers.

DOE: U.S. Department of Energy

DOH: Washington State Department of Health.

EFSEC: Energy Facility Site Evaluation Council.

FFTF: U.S. Department of Energy's Fast Flux Test Facility near the Columbia Generating Station. Also known as the 400 Area.

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 the Columbia Generating Station.

Ingestion Pathway Monitoring: The ingestion pathway includes milk, soil, fish, and 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.

ISFSI: Independent Spent Fuel Storage Installation

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.

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.

NPDES: National Pollutant Discharge Elimination System

NRC: U.S. Nuclear Regulatory Commission.

ODCM: Offsite Dose Calculation Manual. Licensing document that 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 Columbia Generating Station 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

$$S^2_m = \frac{1}{(n-1)} \sum^n (Xi - X)^2$$

SWTF: Sanitary Waste Treatment Facility; sanitary waste processing facility for the Columbia Generating Station, WNP-1 and Department of Energy's 400 Area.

TEDA: triethylene diamine

Thermoluminescent Dosimeter (TLD): A TLD contains a phosphor that stores energy from exposure to radiation and emits that energy in the form of light when heated.

3.0 INTRODUCTION

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3.1 Site Description

Energy Northwest's Columbia Generating Station is located in a sparsely populated shrub-steppe region within the Department of Energy's 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, Pasco and Kennewick, which are 12 miles south, 18 miles southeast, and 21 miles southeast, respectively. The nearest privately owned lands are located approximately four miles east-northeast of the plant, across the Columbia River. The site has a bimodal wind pattern with winds primarily from the northwest and south directions[21]. Based on this, the focus of REMP sampling is the farming region east of the plant.

Because Columbia Generating Station is located on the Hanford Site, other potential sources of radioactive materials are in close proximity to Columbia Generating Station. For this reason, sampling locations near the plant provide useful information for separating the potential effects of Columbia Generating Station from those of the other sources on the Hanford Site.

3.2 Program Background

The REMP is designed to conform to the regulatory guidance of the Nuclear Regulatory Commission (NRC) as 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 (EFSEC)[6], the Columbia Generating Station 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 until initial criticality in January 1984, provided a baseline of background environmental data. The variability in the background levels of radioactivity is due to differences in geologic composition, Chernobyl and nuclear weapons test fallout, meteorological conditions and seasonal changes.

A contract analytical laboratory is used in the analyses of REMP environmental samples. Teledyne Brown Engineering Environmental Services has performed the analysis of REMP samples since June 1986. Energy Northwest, until contracted to an outside vendor in 1996, processed the thermoluminescent dosimeters used in the REMP to assess the direct radiation. In 1997, Battelle Pacific Northwest National Laboratory became the environmental TLD processor. The TLDs are processed at its Richland, Washington laboratory.

Any radiological effects of Columbia Generating Station 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 plant operation are compared to the preoperational data and to data from previous operating years 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 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.

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 to ensure 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 10 CFR 20[9] and 10 CFR 50[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.

4.0 PROGRAM DESCRIPTION

4.0 PROGRAM DESCRIPTION

The Columbia Generating Station Offsite Dose Calculation Manual (ODCM) defines the requirement for the Radiological Environmental Monitoring Program (REMP). The sampling plan presented in Table 4-1 in this report shows which samples are required by the ODCM and the Site Certification Agreement (SCA). The table also 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.

4.1 Sample Locations

Eighty-five sample locations were included in the 2001 monitoring program. Seventy-eight indicator and two control (i.e. background) stations were located within a 10-mile (16-kilometer) radius of Columbia Generating Station. 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 primarily on factors such as population distribution and meteorological conditions and also on station accessibility, security, and the requirements of applicable regulations. Other factors, such as the need to monitor locations that could be impacted by Columbia Generating Station operations, influence the location of REMP sampling sites.

The REMP sampling locations listed in Tables 4-1 and 4-2 are shown in Figures 4-1 and 4-2. Figure 4-3 provides a more detailed map of sampling locations in the Sunnyside/Grandview area. Figure 4-4 shows the relative locations of the storm drain outfall and pond (Station 101) and the Sanitary Waste Treatment Facility (Station 102). Also shown are the cooling tower sediment disposal area (Station 119B and Station 119-Control) and the spray pond drainfield (Station 120), which are special interest stations.

4.2 Land Use Census

The land use census for areas within five miles of Columbia Generating Station 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. This information is used 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 were found, routine sampling of that dose pathway would be initiated at that new site.

The results of the 2001 land use census within five miles of Columbia Generating Station are presented in Table 4-3. No changes from the 2000 land use census were observed. No milk animals are located within the 5-mile radius. The nearest milk location is located 7.2 miles east-southeast of Columbia Generating Station.

4.3 Sampling Methods

Energy Northwest personnel collected environmental samples in accordance to the program plan in Table 4-1. Documented procedures for sample collection and TLD handling are contained in the departmental instruction manual. The analytical contractor prepares and maintains the sample analyses procedures. Energy Northwest receives copies of the analytical procedures used.

The following sections describe the sampling and preparation methods.

4.3.1 Direct Radiation

During 2001, thermoluminescent dosimeters (TLDs) were used to determine the direct radiation levels at sixty-two (62) monitoring locations listed in Table 4-1. Control station TLDs (background) are located at Station 9A in Sunnyside and Station 119-Control, 0.2 mile south-southeast of the plant. The remaining TLDs served as indicator TLDs throughout the year.

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

Since 1995, the REMP has used Harshaw Model 8807 TLDs. Battelle Pacific Northwest National Laboratory (PNNL) took over the program in 1997 and processes the environmental dosimeters on a Harshaw Model 8800 Hot Gas TLD Reader. This reader is calibrated weekly and immediately prior (same day) to processing environmental TLDs. The reader is calibrated in generic units (gU) using calibration dosimeters irradiated to known exposures of Cs-137. Each group of environmental TLDs that is processed includes "blank" unirradiated TLDs and processing control dosimeters irradiated by Battelle Northwest to a known quantity of Cs-137. In addition, "blind spiked" irradiated TLDs are submitted by Energy Northwest for processing along with the environmental TLDs. The processing results from these QA TLDs are used to demonstrate reader performance during environmental TLD processing and to trend reader performance over time.

A file containing "raw" element readings in gU is generated when the Harshaw TLD reader processes the environmental TLDs. This file is used by Energy Northwest to calculate environmental doses. A relative response factor of 1 gU/mR is applied to convert the element 3 and 4 TLD readings to the Roentgen equivalent reading, then background and transit doses measured by control TLDs are subtracted. Since the TLD reader is calibrated to provide 1 gU = 1 mR, reported doses are the background corrected average of the element 3 and 4 readings for each station. Doses are reported in mR and no correction to dose equivalent is applied.

The exposure values determined for calibration dosimeters, as well as the exposures of QA dosimeters (processing control dosimeters), are based on a National Institute of Standards and

Technology (NIST) traceable Cs-137 source. The exposure values for the audit dosimeters (spiked dosimeters) are based on the calculated field strength of an Energy Northwest Cs-137 source. Ionization chamber measurements made during TLD exposure are used to confirm the calculated exposure. If the calculated exposure and the ionization chamber reading differ by 5% or more, an investigation is performed to resolve the difference.

Two Reuter Stokes pressurized ionization chambers (PICs) provide 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 12 locations. The samples drawn at Station 9A (Figure 4-3) were considered control samples; the ones drawn at the other locations (Figure 4-1) were indicator samples. Air particulate samples were collected by drawing air through a 47-mm diameter glass fiber filter. Air iodine samples were collected by drawing air through a 57-mm 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 eight locations for water sampling in 2001: two 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. This sample location is also a drinking water sample since Columbia Generating Station draws its drinking water from the intake water. It is the river/drinking water control sample because of its location upstream of the plant discharge. Station 29 was used to evaluate the water at the nearest drinking water location, the Richland Water Treatment Plant. This station, 11 miles downstream of the discharge, is the indicator station for river/drinking water.

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. The Station 27 sample is also an indicator sample.

Composite samplers are installed at the Columbia River pumphouse to monitor the plant intake water (Control Station 26), and the cooling tower discharge line (Station 27). There is also a

composite sampler at the other drinking water location (Station 29). The samplers collect 25-ml aliquots of water at regular intervals of time or flow. Non-routine analyses of the drinking water samples include strontium-90 and iodine-131 analyses. Strontium-90 analysis is required when the gross beta activity exceeds either eight pCi/liter or ten times the mean of the previous three months' activity for a specific location. Iodine-131 analysis is required when the dose calculated for the consumption of water exceeds one millirem per year. During 2001, neither of these analyses was required.

Three wells within the vicinity of Columbia Generating Station are used as groundwater sampling locations. These include a deep well on the Columbia Generating Station site (0.1 mile north of the Reactor Building) and two wells on the WNP-1 site (1.2 mile downgradient from Columbia Generating Station). Water from the Columbia Generating Station 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. Although none of these wells draw from the unconfined aquifer, they are considered indicator samples. Quarterly grab samples were collected from each of these wells. One gallon (3.8 liters) was collected from each well for gamma analysis and one liter was drawn for tritium analysis.

Water samples were collected from the storm drain outfall (Station 101) using a flow-proportional composite sampler. These samples were analyzed for gross beta, gamma and tritium.

Since April of 1997, the SWTF has been receiving sanitary waste from the DOE 400 Area. Energy Northwest installed a flow meter and composite sampler on the 400 Area sewer line just above where the 400 Area/Plant Support Facility (PSF) intertie is located. This sampler (Station 102A) takes a flow-proportional composite sample that was collected and analyzed monthly as required by EFSEC Resolution No. 259[16]. Gross alpha and beta analysis, tritium analysis, and gamma analysis were performed on each sample. This sample was analyzed for gross alpha, gross beta, gamma and tritium. A monthly sample was also required, which was analyzed for gamma and tritium. Two samples collected prior to each discharge (102C) were required, which were collected at the discharge weir of the south pond. Those samples were analyzed for gross alpha, gross beta, gamma and tritium. Grab samples were taken from the west end of the ponds until 1999, when they were discontinued due to the monthly sampling at the headworks. In September 2001, EFSEC approved Resolution No. 300, which will require a monthly composite sample at the headworks. No prior to discharge sampling will be required.

4.3.4 Soil

As required by the Site Certification Agreement (EFSEC Resolution No. 260[6]), an annual soil sample was collected at the indicator stations 1, 7, 21 and 23. One sample was collected at the control location, Station 9A (Figure 4-3). Soil samples were also collected at Station 101 as shown in Figure 4-4.

Each sample was collected 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 indicates that cesium levels in any of the indicator samples exceeds ten (10) times the level in the control sample, a strontium analysis is performed on the sample(s). Strontium analysis was required for Station 1, Station 7, and Station 23 during 2001.

4.3.5 Sediment

The collection of river sediment samples occurred in March and again in October. The collection of the upstream sediment sample (Station 33) was from a location approximately two miles upriver from the plant discharge. The downstream sample (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.

A sediment sample was also collected from the SWTF (Station 102) north stabilization pond. Sediment sampling in this location 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.

A two-kilogram sample of dried cooling tower sediment was collected from the sediment disposal cell (Station 119) within thirty days of the completion of cleaning the cooling towers. In 2001, the cooling towers were cleaned once, hence, only one sample was collected for gamma spectrometry analysis.

4.3.6 Fish

The annual fish sampling was performed in late September and early October. Fish samples collected from the Columbia River (Station 30 in Figure 4-1) were indicator samples, whereas the fish collected on the Snake River (Stations 38 and 38A in Figure 4-2) were control samples.

Three separate fish samples, consisting of an anadromous species such as salmon, and two other species generally considered edible or potentially edible (such as carp, catfish and whitefish) were collected at each location. The fish were collected using electro-shocking except for the samples of the anadromous species, which were collected from the Ringold Fish Hatchery on the Columbia River and at the Lyons Ferry Fish Hatchery on the Snake River. The fish were filleted to obtain approximately one kilogram of edible flesh per sample. The fillets were placed in clean plastic bags and frozen until shipment to the analytical contractor. Fish are sampled annually unless elevated radiation levels related to plant operations are observed, in which case sampling is conducted semiannually.

4.3.7 Milk

Milk samples were collected monthly January through March and October through December and twice a month during the spring and summer months when cows were likely to be grazing or on fresh feed. Enough raw milk was collected from each sampling location to obtain a one-gallon sample after the cream had been skimmed off. The samples were refrigerated overnight and the cream skimmed off the next morning. The milk samples were chilled and shipped to the analytical contractor within a day of collection.

Routine samples were collected from two indicator locations (Stations 36 and 64) across the Columbia River in Franklin County. Milk samples were also collected at one indicator station (Station 9B) in the Sunnyside/Grandview area (Figure 4-3). Station 9B in Sunnyside serves as an indicator station because a portion of the feed for the cows at that location is hay from Franklin County north of Pasco and downwind from Columbia Generating Station. That factor makes it unsuitable for use as a control location. Beginning in August 1998, samples of feed grown at Station 9B were collected monthly as a substitute for the lost control station, which ceased operation in March 1998. Other dairies in the area have been checked for suitability as a new control location and were eliminated due to their use of feed grown in Franklin County.

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 water. 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.

4.4 Analytical Procedures

Described below are the analytical procedures used for analysis of the 2001 REMP samples. Teledyne Brown Engineering Environmental Services performed all routine analyses of REMP samples during 2001.

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 weekly 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 analysis. The information collected about each peak was compared to a library of known peaks. Isotopic identification was performed, as was

the radioactivity calculation, using the appropriate fractional gamma ray abundance, half-life, detector efficiency, and net counts in the peak region.

Milk and Water

A one-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 placed 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 was placed in a one-liter Marinelli beaker and counted for approximately 1000 minutes (16.7 hours). The sample was 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 one-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 from 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, and 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 a 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 a 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 2001, this procedure was used only on intercomparison samples, since the doses calculated by means of ODCM methodology for the consumption of drinking water did not exceed one millirem per year.

4.4.5 Tritium in Water

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

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

During 2001, strontium analysis was required for soil samples at Station 1, Station 7, and Station 23. No strontium analyses were required for any water or milk sample. It was also used in laboratory intercomparison programs for water and sediment analyses. The techniques used to analyze for strontium in the various media are described below.

Water

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

Milk

Stable strontium carrier was added to one liter of sample. The sample was then evaporated and ashed in a muffle furnace. The ash was dissolved and strontium precipitated as a phosphate. The sample was 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 ten-gram aliquot was taken. Stable strontium carrier was added and the sample was leached in hydrochloric acid. After filtering the mixture, 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 presented 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)." 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 Columbia Generating Station 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. Frequency distributions and graphs of TLD data by meteorological sector and distance from the plant are used to interpret trends in the results.

The TLD data summaries include the term "standard error." The standard error, which is the estimate of the precision of the mean, is used for the means of quarterly and annual data and is an indicator of the uncertainty associated with the results. The mean results of the quarterly TLDs are compared with the results of annual TLDs and expressed as a ratio by dividing the quarterly results by the annual result.

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, 4-8, 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	Annually Quarterly or more often as needed.	Gamma isotopic[f]; strontium-90[h] Gamma isotopic
2. DIRECT RADIATION			
TLD[i](34/62)	1-8, 9A, 10-25, 40-47, 49-51, 53-56, 65, 71-86 (1S-16S)[j], 119B, 119-Control, 120, 121, 122	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 and 29	Composite aliquots[m]; monthly collection	Gamma isotopic[f], gross beta, quarterly; tritium composite; strontium-90[n]; I-131[o]
Storm Drain Water (0/1)	101	Composite aliquots[m], weekly collection; grab samples	Gamma isotopic[f], tritium, gross beta
Sanitary Waste Treatment Facility Water (0/3)	102A, 102B, 102C	Monthly, annually, pre-discharge and as needed.	Gamma isotopic[f], gross beta, gross alpha, tritium
Ground Water (2/3)[p]	31, 32, and 52	Quarterly	Gamma isotopic[f]; tritium
River Sediment (1/2)[q]	33 and 34	Semiannually	Gamma isotopic[f]
Sanitary Waste Treatment Facility Sediment (0/1)	102	Annually	Gamma Isotopic[f]
Cooling Tower Sediment Disposal Area	119	Within 30 days following Cooling Tower cleaning event	Gamma Isotopic[f]
4. INGESTION			
Milk[r] (3/3)	9B, 9G[s] 36, 64	Semimonthly during grazing season, monthly at other times	Gamma isotopic[f]; iodine-131; strontium-90[t]
Fish[u] (0/2)	30, 38	Annually [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]

(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 Columbia Generating Station.

(g) Soil samples are collected to satisfy the requirements of the SCA for Columbia Generating Station. The SCA requires that soil samples be collected 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.

(i) TLD refers to thermoluminescent dosimeter. For purposes of the REMP, a TLD is a phosphor card with multiple read-out 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. 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 required as part of the routine monitoring program (EFSEC Resolution No. 278, condition 5.c.1) and by the SCA to be maintained as a supplemental or backup system. PICs were used at various locations during 2001 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, Columbia Generating Station makeup water intake from the Columbia River is both an upstream surface, or river, water sample and the drinking water control sample location. The Station 29 sample is a downstream drinking water sample. 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. Only one drinking water station is now sampled after DOE closed the intake at the 300 Area (Station 28) in 1998. Station 101, the storm drain pond, and Station 102, the Sanitary Waste Treatment Facility, are unique sampling locations.

TABLE 4-1 (cont.)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM PLAN

(m) Composite (integrated grab) samples are collected with equipment that 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 that are located in the most prevalent wind directions from Columbia Generating Station. 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) Samples of feed for dairy animals are collected at Station 9G in lieu of milk at a control station. The dairy cattle at Station 9B are not suitable for use as a control because a portion of their feed comes from the Franklin County area across the Columbia River from Columbia Generating Station.

(t) If cesium-134 or cesium-137 is measured in an individual milk sample in excess of 30 pCi/1, then the strontium-90 analysis will be performed.

(u) There are no species fished commercially while in the Hanford Reach of the Columbia River. The most recreationally and commercially important species in the area are anadromous (primarily salmonids), which ascend rivers from the sea for breeding. Three fish species will normally be collected by the electroshock technique in the vicinity of the plant discharge (Station 30) and from the Snake River (Station 38). If electro-shocking produces insufficient anadromous fish samples from the Snake River, samples may be obtained from the Lyons Ferry Fish Hatchery. If insufficient anadromous fish samples are produced through electro-shocking on the Columbia River, samples may be obtained at the Ringold Fish Hatchery.

(v) If an impact is indicated, sampling will be conducted semiannually.

(w) Garden produce will routinely be obtained from farms or gardens using Columbia River water for irrigation when available. 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 with Columbia River water. The apple crop from Station 91 is sampled annually.

TABLE 4-2
REMP SAMPLE STATIONS AND REQUIREMENTS

SECTOR[a]	STATION[b] NUMBER	DISTANCE[c]	ODCM[d]	STATE[e]	OTHER[f]
N (1)	52	0.1	GW		
	71(1S)	0.3			TLD
	47	0.9		TLD	
	57	0.9	AP/AI		
	18	1.1	TLD	TLD	
	53	7.5	TLD		
NNE (2)	72(2S)	0.4			TLD
	2	1.8	TLD	TLD	
	54	6.5	TLD		
NE (3)	73(3S)	0.5			TLD
	19	1.8	TLD	TLD	
	48	4.5	AP/AI		
	46	5.0	TLD		
ENE (4)	101	0.3			SW, SE
	74(4S)	0.4			TLD
	21	1.5		TLD,AP/AI, SO	
	20	1.9	TLD	TLD	
	11	3.1		TLD	
	33	3.6		SE	
	45	4.3	TLD		
	44	5.8	TLD		
E (5)	75(5S)	0.4			TLD
	22	2.1	TLD		
	10	3.1	TLD	TLD	
	26	3.2	SW, DW	SW	
	27	3.2		DIS W	
	30	3.3	FI	FI	
	43	5.8	TLD		
ESE (6)	76(6S)	0.4			TLD
	31	1.1	GW	GW	
	32	1.2		GW	
	51	2.1	TLD		
	23	3.0		TLD,AP/AI, SO	
	34	3.5	SE	SE	
	91	4.4		GP	
	8	4.5	TLD. AP/AI	TLD, AP/AI	
	42	5.6	TLD		
	36[g]	7.2	MI	MI	

TABLE 4-2 (cont.)
REMP SAMPLE STATIONS AND REQUIREMENTS

SECTOR[a]	STATION[b] NUMBER	DISTANCE[c]	ODCM[d]	STATE[e]	OTHER[f]
ESE (6	5	7.7	TLD	AP/AI	
	64	9.7	MI	MI	
	38	26.5	FI	FI	
SE (7)	118	0.3			SO
	77(7S)	0.5			TLD
	24	1.9	TLD	TLD	
	3	2.0		TLD	
	41	5.8	TLD		
	40	6.4	TLD, AP/AI		
SSE (8)	119-Control	0.2		TLD	
	120	0.3			TLD, SE
	102A	0.4		SFW	
	102B	0.4		SFW	
	102C	0.4		SFW	
	102D	0.4			SFW, SE
	78(8S)	0.7			TLD
	25	1.6	TLD	TLD	
	55	6.2	TLD		
	4	9.3	TLD, AP/AI	TLD,AP/AI	
	29	11.0	DW	DW	
	37B	16.0	GP	GP	
	37A	17.0		GP	
S (9)	119B	0.2		TLD, SE, PIC	
	79(9S)	0.7			TLD
	1	1.3	TLD	TLD,AP/AI, SO	
	6	7.7	TLD	AP/AI	
	65	8.7			TLD
SSW (10)	80(10S)	0.8			TLD
	50	1.2	TLD	TLD	
	56	7.0	TLD		
SW (11)	81(11S)	0.7			TLD
WSW (12)	82(12S)	0.5			TLD
	83(13S)	0.5			TLD
	14	1.4	TLD	TLD	
	9A,	30.0	TLD, AP/AI	TLD, AI/AP	
	9C,	35.0	GP	GP	
	9B, 9G	33.0	MI, VE[h]	MI, VE[h]	

TABLE 4-2 (cont.)
REMP SAMPLE STATIONS AND REQUIREMENTS

SECTOR[a]	STATION[b] NUMBER	DISTANCE[c]	ODCM[d]	STATE[e]	OTHER[f]
W (13)	13	1.4	TLD	TLD	
	15	1.4	TLD	TLD	
WNW (14)	84(14S)	0.5			TLD
	16	1.4	TLD	TLD	
	7	2.7	TLD	TLD, AP/AI, SO	
NW (15)	85 (15S)	0.5			TLD
	49	1.2	TLD	TLD	
NNW (16)	121	0.1		TLD	
	122	0.3		TLD	
	86(16S)	0.4			TLD
	17	1.2	TLD	TLD	
	12	6.1		TLD	

FOOTNOTES:

(a) The area in the vicinity of Columbia Generating Station is separated into 16 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 Columbia Generating Station reactor building.

(d) ODCM - Offsite Dose Calculation Manual Table 6.3.1.1-1 requirement.

(e) State of Washington Site Certification Agreement requirements.

(f) OTHER –Special study stations.

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

(h) Broadleaf vegetation collected in lieu of milk from a control station.

Sample Type Key:

AI/AP	-Air Iodine/Air Particulate	DW	-Drinking Water
FI	-Fish	GP	-Garden/Orchard Produce
GW	-Ground Water	MI	-Milk
PIC	-Pressurized Ion Chamber	SE	-Sediment
SFW	-Sanitation Facility Water	SO	-Soil
SW	-Surface Water	TLD	-Thermoluminescent Dosimeter
VE	-Vegetation	Dis W	-Discharge Water

TABLE 4-3
2001 FIVE-MILE LAND USE CENSUS RESULTS

SECTOR[a]	NEAREST RESIDENT[b]	GARDEN (>50M^2)	DAIRY[c] ANIMALS	LIVESTOCK
NE	4.3	none	none	4.3
ENE	4.1	4.1[d]	none	none
E	4.5	none	none	none
ESE	4.2	4.3[d]	none	none
SE	4.5	none	none	none

(a) Within a five-mile radius of the plant, only 4.5 sq. miles of the land in the sixteen meteorological sectors is privately owned farmland. The remainder of the land is on the federally owned Hanford Site. Only those sectors containing points of interest are presented here. The WNP-1 and WNP-4 sites are not part of the five-mile land use census due to the fact that the REMP sample stations were originally sited to incorporate all three sites.

(b) Estimated distances in miles from Columbia Generating Station Reactor Building.

(c) The closest dairy animal locations are at 8.3 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 OFFSITE DOSE CALCULATION MANUAL[8] REQUIREMENTS

MEDIA (UNITS)	ANALYSIS	TELEDYNE LLDs[a]	BTP REQUIRED LLDs
Air	Gross Beta	0.003	0.01
(pCi/m³)	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	300	2000[b]
	I-131	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

[a] These are the contract LLDs. Actual LLDs may be lower for specific samples.

[b] If no drinking water pathway exists, a value of 3,000 pCi/l may be used.

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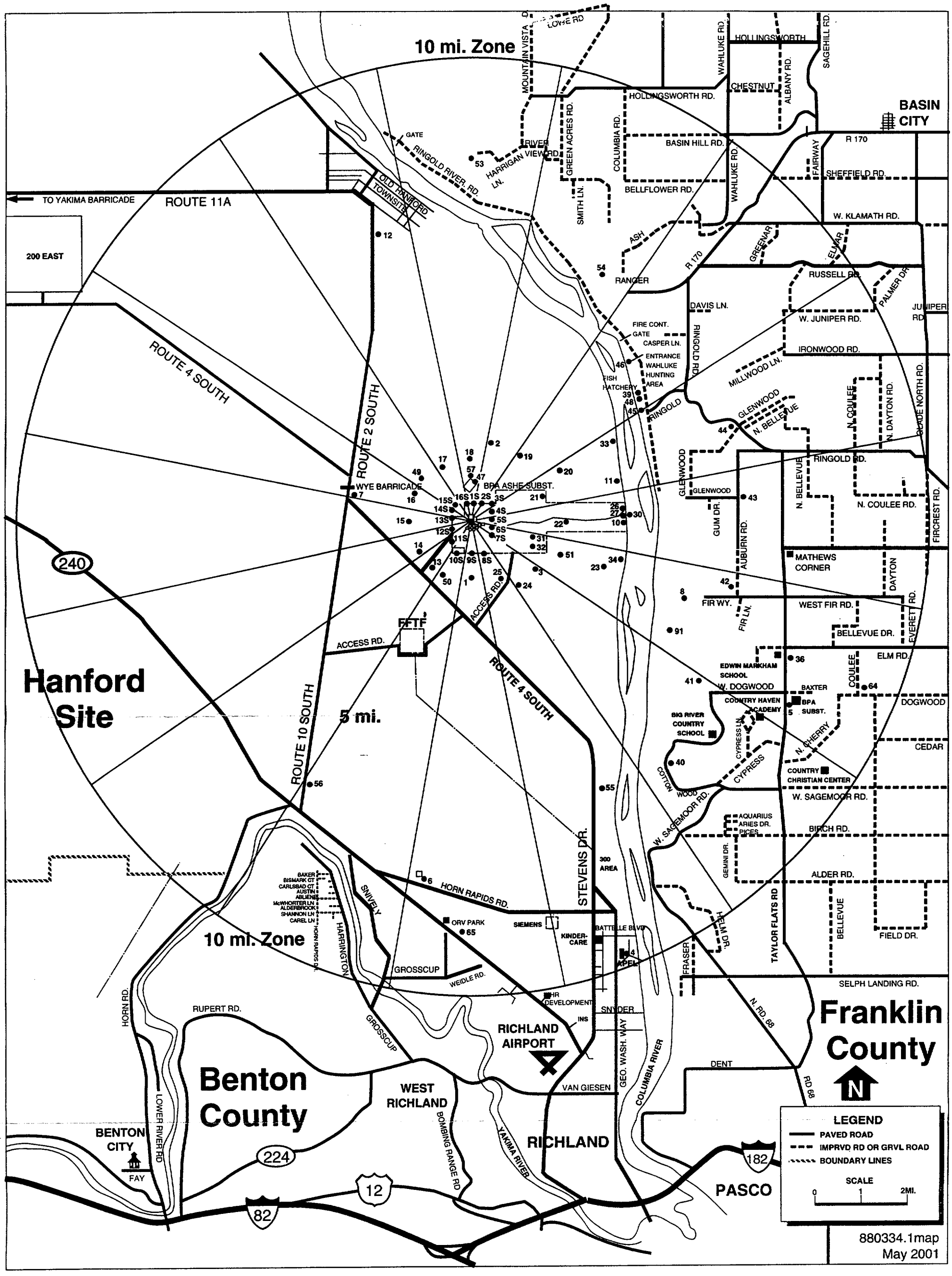

Figure 4-1 REMP Sampling Locations Within the 10-Mile Radius

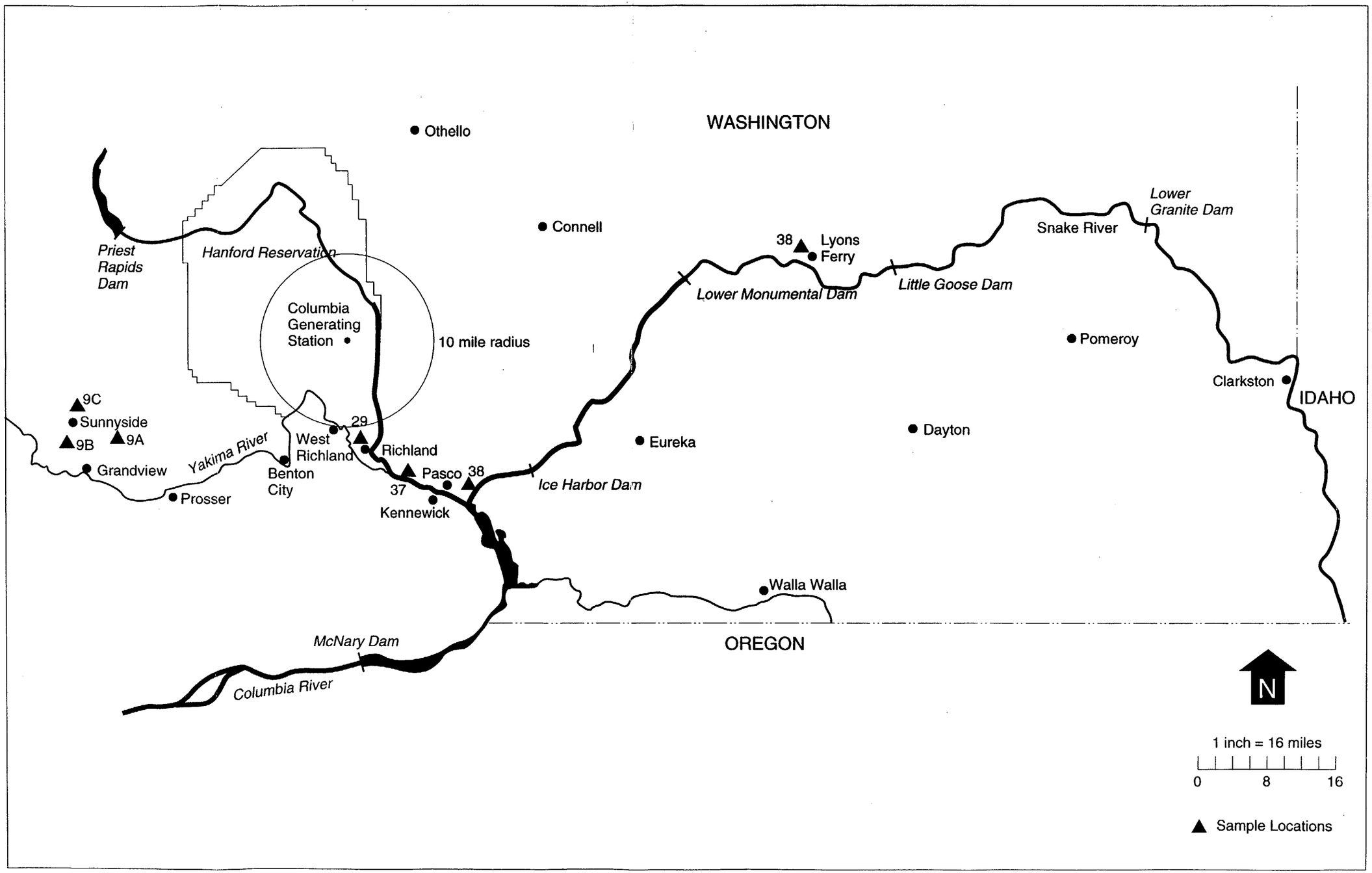

Figure 4-2 REMP Sampling Locations Outside the 10-Mile Radius

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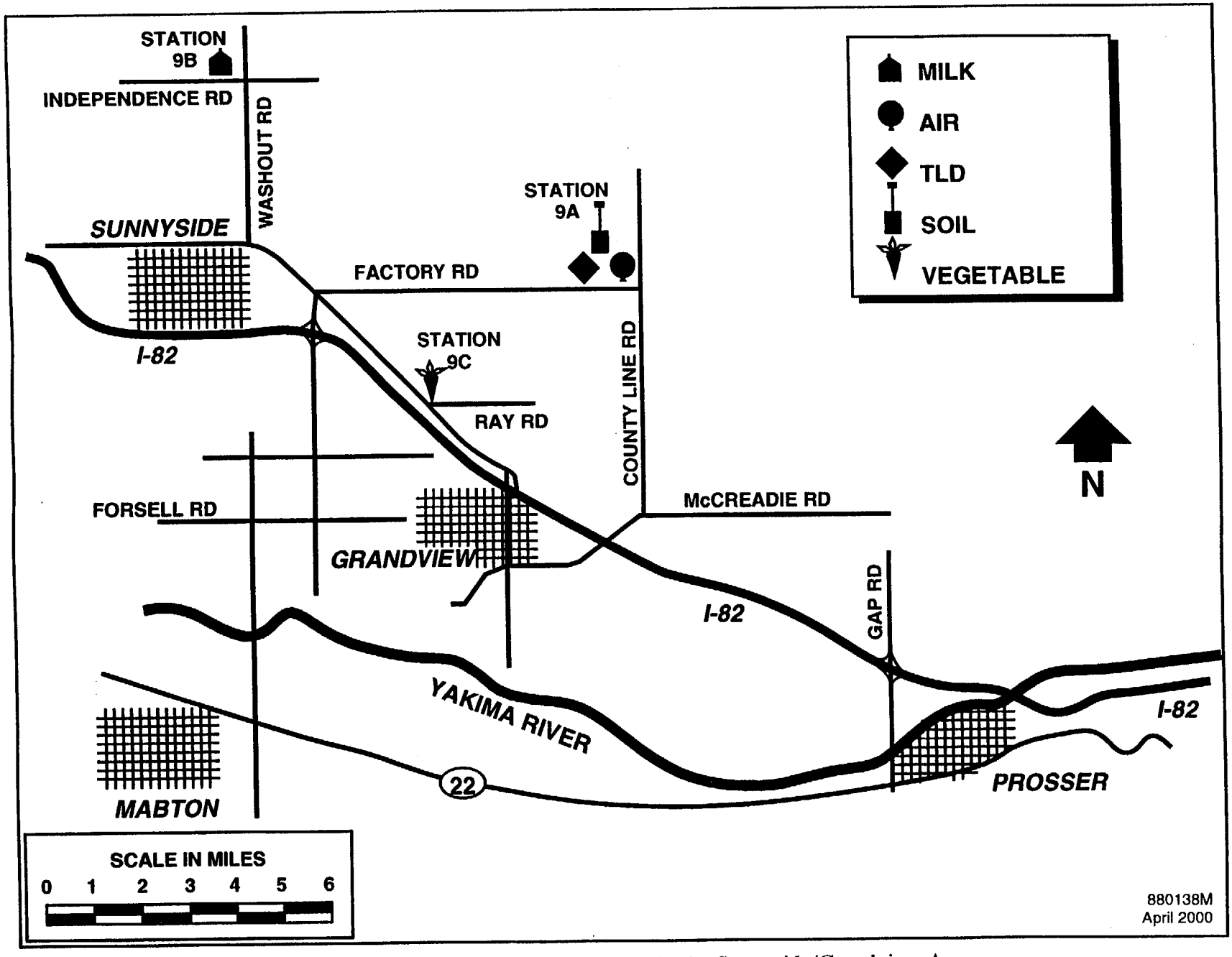

Figure 4-3 REMP Sampling Locations in the Sunnyside/Grandview Area

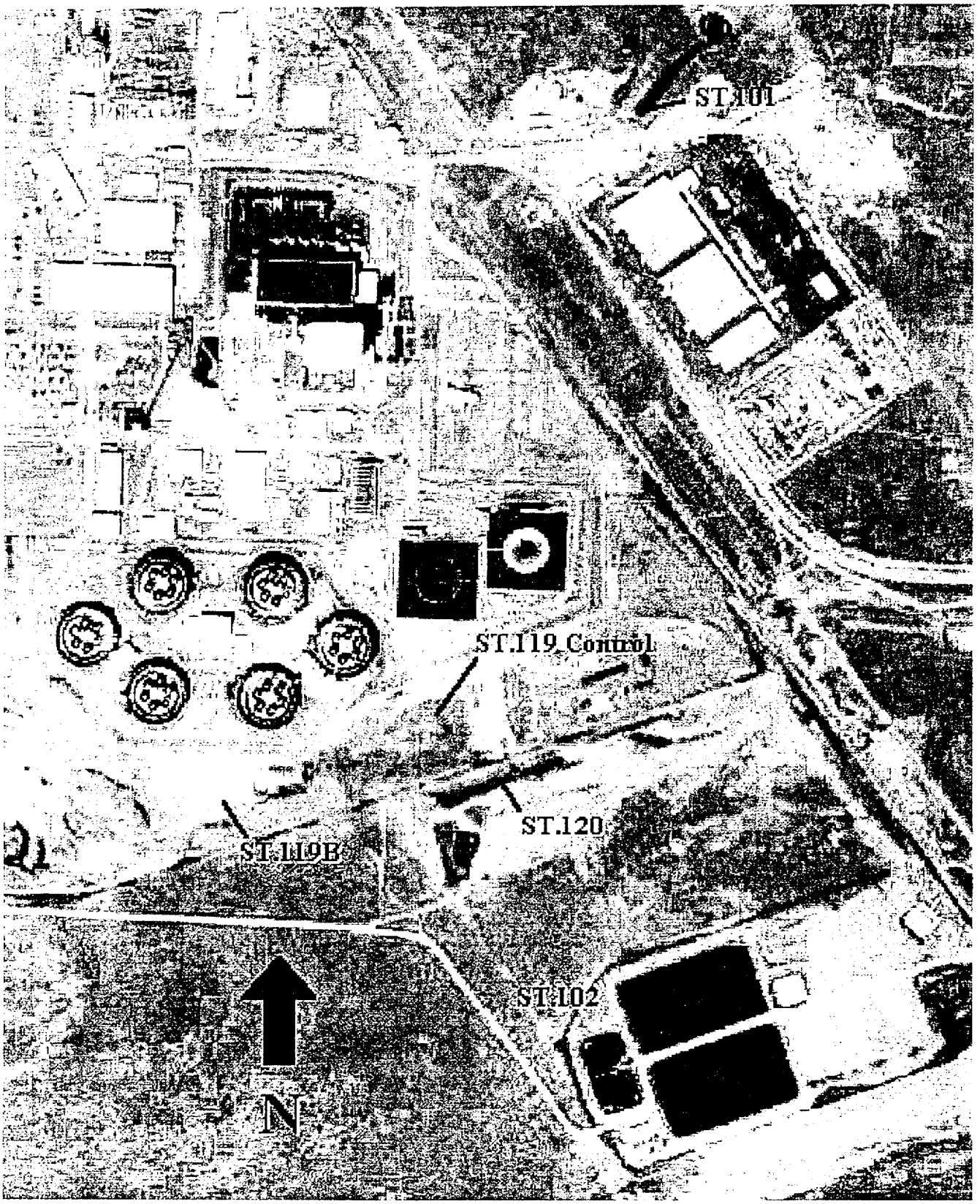

FIGURE 4-4 REMP NEAR PLANT SAMPLING LOCATIONS

5.0 RESULTS AND DISCUSSION

5.0 RESULTS AND DISCUSSION

The analyses of REMP samples were performed by Teledyne Brown Engineering Environmental Services in Knoxville, Tennessee. Battelle Pacific Northwest National Laboratory in Richland, Washington processed the environmental TLDs. Table 5-1 presents the means and ranges of selected 2001 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 are also included in the table for comparison. The data tables of 2001 results comprise a separate volume that is available to interested parties.

The analytical 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. Since mid-1984, REMP data have been reported as net results (i.e. the detector counting background is subtracted from the gross results).

The primary focus of the REMP is to determine whether Columbia Generating Station operations had an impact on the environment. The 2001 results are compared in this report to the results from the preoperational period and to results from previous years of Columbia Generating Station's operation. Results 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 2001 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 2001 REMP data.

The analytical results for the REMP sampling locations during 2001 are very similar to the results reported for previous years. The 2001 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

Environmental radiation exposure rates at near plant and remote stations, as determined using thermoluminescent dosimeters (TLDs), remained consistent with data from previous years.

Figure 5-1 presents a plot of the 2001 mean quarterly TLD results for each of the sixteen meteorological sectors at the property boundary of the plant ("S" stations). The chart also includes the high, low and mean result in each sector for 1984 through 2000.

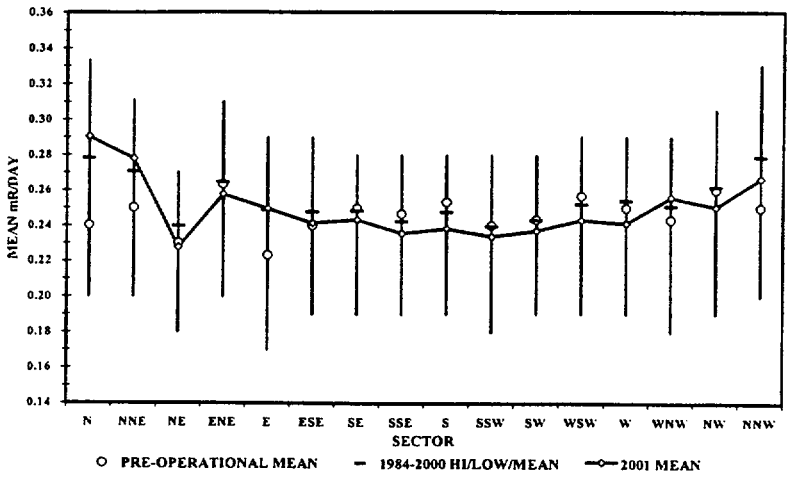

Figure 5-1 Site Boundary Quarterly TLDs 1984-2000 Hi/Low/Mean vs. 2001 Mean by Sector

The relationship of the mean 2001 results to the results for the previous operational periods is very similar for each sector. This indicates that there were no significant directional effects observed in the 2001 TLD results. The environmental radiation exposure rates, as determined by TLDs are summarized in Tables 5-4 and 5-5.

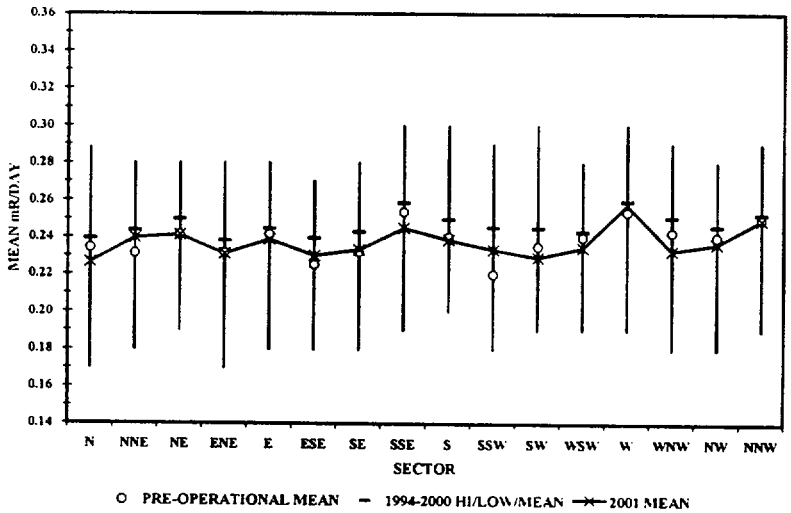

Figure 5-2 Inner Circle Quarterly TLDs 1984-2000 Hi/Low/Mean vs. 2001 Mean by Sector

The higher exposures rates in the N, NNE, and NNW sectors for the "S" stations are a result of those stations being physically closer to the plant than the TLDs of the other "S" station TLDs. Exposure rates from the inner circle of TLDs are presented in Figure 5-2. The exposure rates observed in the 2001 inner circle data closely follows the preoperational mean in most sectors.

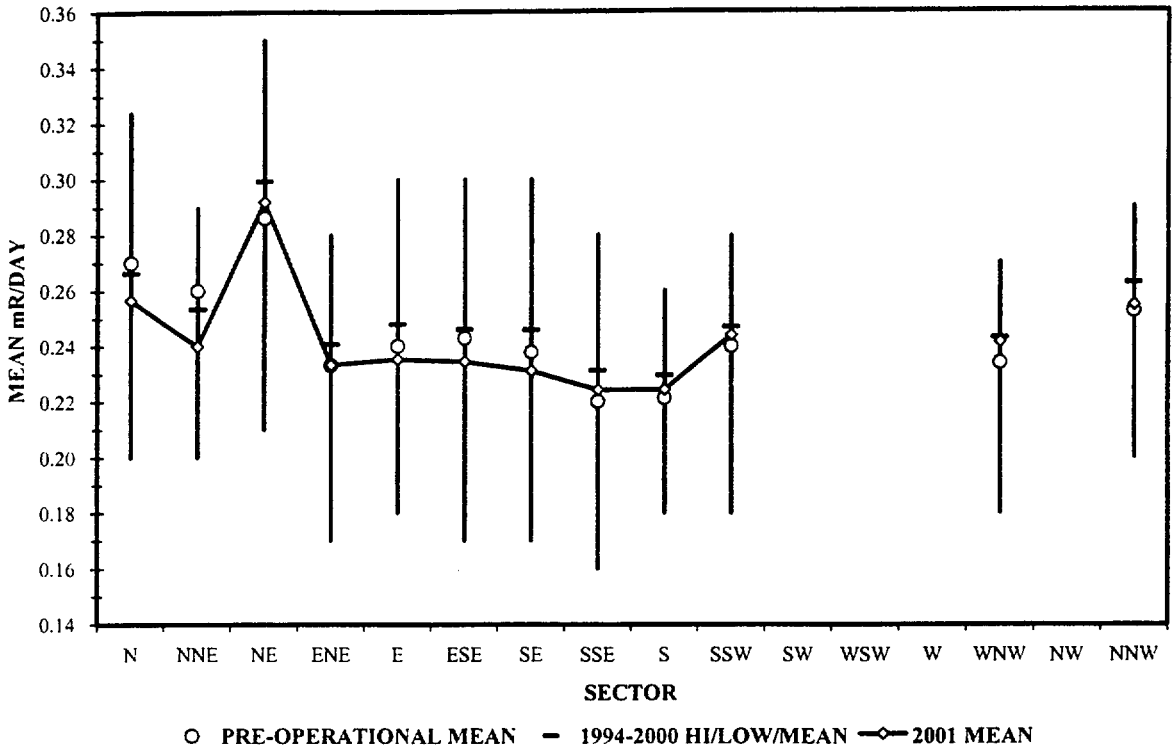

Figure 5-3 Remote Quarterly TLDs 1984-2000 Hi/Low/Mean vs. 2001 Mean By Sector

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. 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 those shown in the TLD results for Station 46. The mean of the four quarterly results for Station 46 was 0.29 mR/day, with a range of 0.27 mR/day to 0.31 mR/day.

Frequency distribution plots of the 2001 quarterly TLD results are presented in Figure 5-4. The plots varied slightly from quarter to quarter, with 0.24 mR/day being the most frequent result, followed by 0.23 mR/day and 0.25 mR/day. The most frequent result for the period 1984 to 2000 was 0.25 mR/day, followed by 0.26 mR/day and 0.24 mR/day. The frequency distributions for the previous operational TLD results are shown in Figure 5-5.

Presented in Table 5-6 is a comparison of the 2001 annual and mean quarterly TLD results. The 2001 annual TLD results are generally 5-10% lower than the mean quarterly results because of signal fade. This difference is not significant, in light of the variability commonly observed in TLD results. In most cases, the annual result is within the uncertainty associated with the quarterly TLD results.

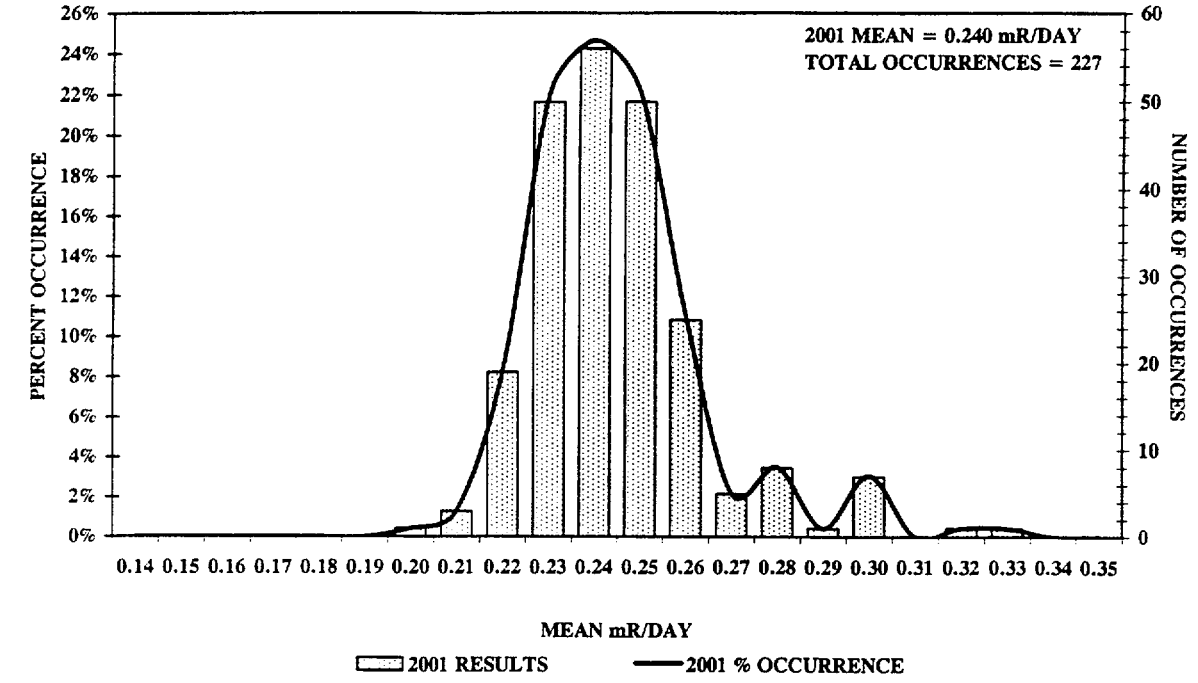

Figure 5-4 Frequency Distribution for 2001 Quarterly TLDs

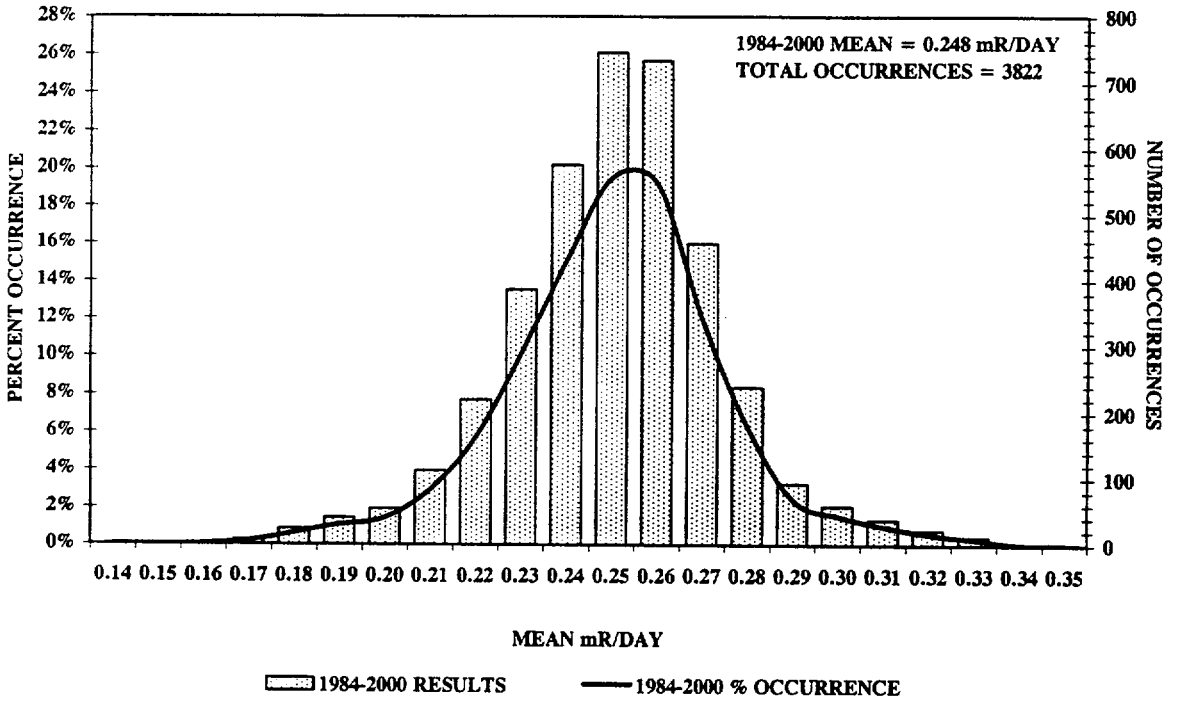

Figure 5-5 Frequency Distribution for 1984-2000 Quarterly TLDs

5.2 Airborne Particulate/Iodine

The 2001 mean weekly gross beta on particulate filter results for the inner ring indicator stations (within three miles) for Columbia Generating Station are plotted in Figure 5-6. The gross beta in air results for 2001 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. 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.

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 2001 were less than the 0.02 picocuries/cubic meter (pCi/m^3) LLD.

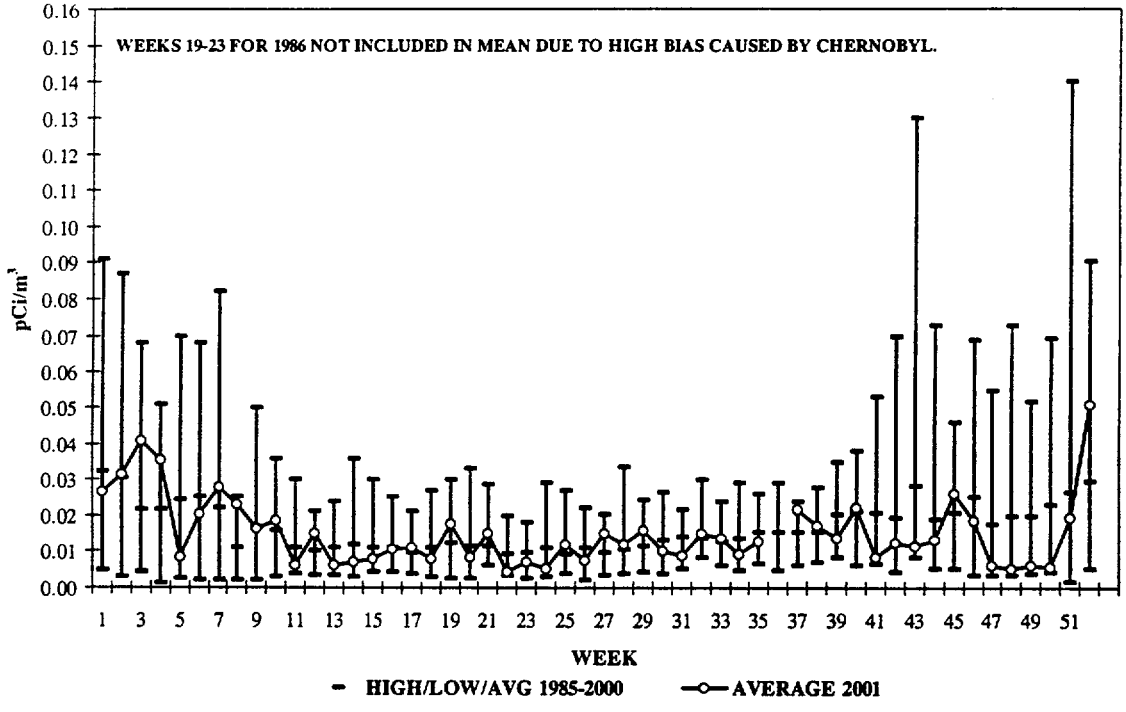

Figure 5-6 1985-2000 Weekly Hi/Low/Mean vs. 2001 Weekly Mean Gross Beta in Air - Near Plant Stations

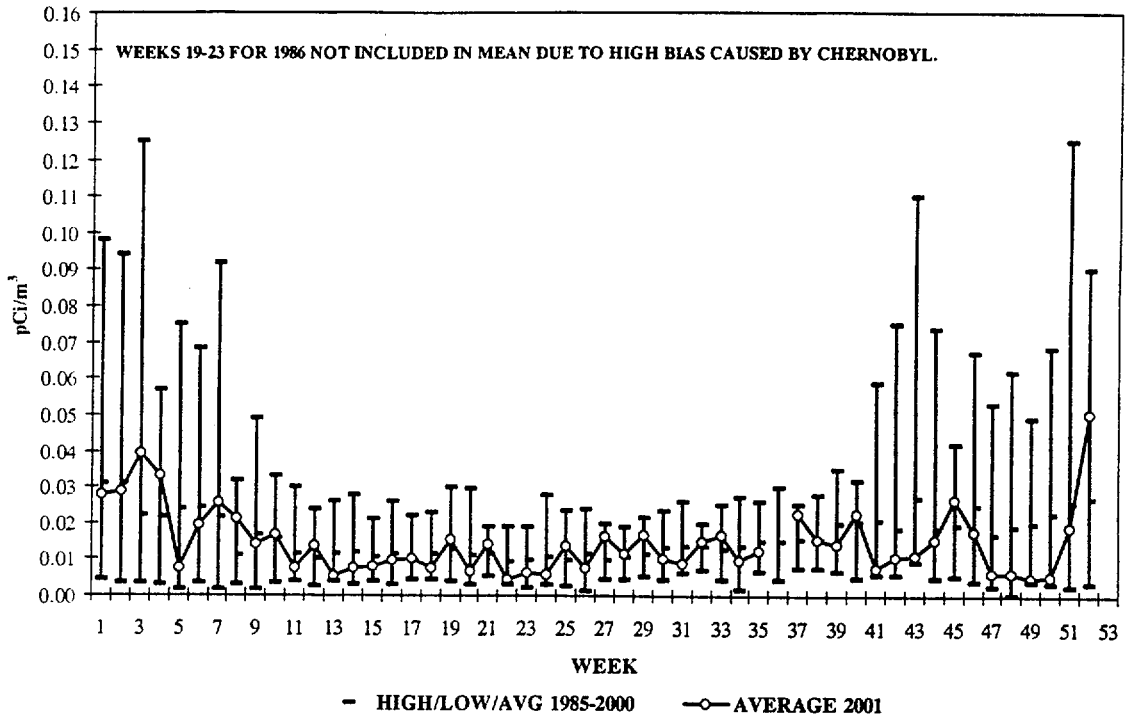

Figure 5-7 1985-2000 Weekly Hi/Low/Mean vs. 2001 Weekly Mean Gross Beta in Air - Remote Stations

No evidence of any impact of plant operations on the environment was apparent in the particulate filter and charcoal cartridge results for 2001.

5.3 Water

The gross beta results for river/drinking water were within the normally observed ranges. These results were less than the eight picocuries/liter (pCi/l) level at which a strontium analysis is performed to verify compliance with the Washington State drinking water standard for strontium-90. The 2001 gross beta concentrations in river/drinking water, relative to the state annual average concentration limit[11], compare well to the averages from previous periods. Gross beta levels for 2001 averaged 1.2 pCi/l at both Station 26, the control station, and at Station 29 approximately 11 miles downstream from the discharge.

The gross beta levels in the discharge sample reflect the concentrations of radionuclides that occur naturally in the environment, principally potassium-40, and any radionuclides from upstream sources of past Hanford activities present in the makeup water, in addition to radionuclides from Columbia Generating Station discharges. The water discharged from Columbia Generating Station was typically concentrated 5 to 10 cycles. The discharge sample results are representative of the radioactivity present in plant discharges before any mixing with river water occurs. All results, which averaged 8.3 pCi/l, were below the Washington Department of Health's (WDOH) investigation level of 75 pCi/l, which is the point at which Energy Northwest would notify WDOH of the result.

The tritium levels in the river/drinking water and groundwater for 2001 were below the nominal detection level of 300 pCi/l and were comparable with results obtained for prior years.

The mean tritium concentration in discharge effluent during 2001 continued to be in the same low ranges observed since 1989. Columbia Generating Station has reduced the volume of liquid radwaste discharges from a high of over three million gallons in 1993 to no liquid radwaste discharges since September 1998. This has resulted in a comparable decline in tritium levels from a high of 12,000 pCi/l in 1993 to less than the nominal detection level. In 2001, all results were below the nominal detection level of 300 pCi/l and far below the 20,000 pCi/l drinking water standard.

Other than radium-226, a natural-occurring nuclide detected at Station 26 there were no detectable nuclides in the river/drinking, plant discharge or ground water samples during 2001.

5.4 Soil

The results of the gamma spectrometry performed on soil samples in 2001 indicated detectable cesium-137. The cesium-137 results ranged from 13.7 picocuries/kilogram (pCi/kg) to 307 pCi/kg at the indicator stations. The result for cesium-137 at the control station was 51 pCi/kg. As shown in Table 5-1, 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 Columbia Generating Station operations on the environment.

Strontium analysis was required for Stations 1, 7, and 23. The result for both Station 1 and Station 23 was 150 pCi/kg, while Station 7 was below the detection level. The strontium-90 level observed at both stations is consistent with levels typically found on the Hanford Site.[14] Aside from cesium-137 and strontium-90, the only radionuclides detected in the samples were beryllium-7, 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 (actinium-228, potassium-40, radium-226 and thorium-228), cesium-137 was detected both upstream (Station 33) and downstream (Station 34) of the plant. The cesium-137 concentrations in the upstream samples were 85 pCi/kg and 77 pCi/kg dry weight. The concentrations of cesium-137 in the downstream samples were 224 pCi/kg and 233 pCi/kg dry weight. This radionuclide has been detected in similar quantities in preoperational samples and operational samples has also been previously identified as a component of the Columbia River sediment originating from operation of the old Hanford Site reactors.[15] Cobalt-57 was detected in the downstream sample taken in the spring. The result, 15 pCi/kg, was just above the detection level of 14 pCi/kg. This is within levels seen previously and the detection is a result of a lower detection level for this sample.

5.6 Fish

The gamma spectrometry results of fish samples collected in the vicinity of the Columbia Generating Station discharge and at the control location on the Snake River were below detection limits, except for potassium-40, a naturally-occurring radionuclide.

5.7 Milk

There were no detectable iodine-131 results for 2001. All gamma spectrometry milk sample results were less than the detection limits, except for potassium-40, which is a naturally occurring radionuclide.

Since August 1998, samples of feed grown by the owners of the dairy at Station 9 have been collected as a substitute for the control station. No dairy in the area of the control was located that didn't use some feed grown downwind of the plant as supplemental feed. No radionuclides were detected in the feed samples collected during 2001 other than the naturally occurring beryllium-7, potassium-40, and thorium-228.

5.8 Garden Produce

The gamma isotopic analysis results for all root crops, fruit and leafy vegetables collected in 2001 were below detection limits other than potassium-40, which occurs naturally.

5.9 Special Interest Stations

The storm drain pond and the Sanitary Waste Treatment Facility (SWTF) were incorporated into the routine sampling schedule in 1992. In 1995, the cooling tower sediment disposal area was added. Thermoluminescent dosimeters were placed around the spray pond drainfield (Station 120) in June 1995. TLDs were hung in the vicinity of the planned Independent Spent Fuel Storage Installation (ISFSI) during the first quarter of 1998 to collect background data. 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 Energy Northwest. 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 approximately 1500 feet northeast of Columbia Generating Station. Water is conveyed to the pond by means of an 18-inch diameter pipe that 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 at the outfall using a flow proportional automatic sampler to collect composite samples.

Tritium was detected in many of the outfall water samples during 2001. The range for positive tritium results at the outfall was from 110 pCi/l to 7400 pCi/l and averaged 1320 pCi/l. Detectable gross beta activity at the outfall averaged 5.2 pCi/l with a range of 2 to 15 pCi/l. Beryllium-7, potassium-40 and thorium-228, naturally occurring nuclides were detected in several samples.

5.9.2 Sanitary Waste Treatment Facility (Station 102)

The Sanitary Waste Treatment Facility (SWTF) is located approximately 0.4 miles south-southeast of Columbia Generating Station. The facility processes the sanitary waste from Columbia Generating Station, the WNP-1 and WNP-4 sites, the Kootenai Building and the Department of Energy's 400 Area (since April 1997). Discharge standards and monitoring requirements for the SWTF are established in EFSEC Resolution No. 259[16]. Until April 1992, the SWTF sediment was sampled semiannually and analyzed in the Energy Northwest radiation laboratory and the radionuclide concentrations were given in terms of wet weight. Since that time, the samples have been sent to the analytical contractor where they are dried prior to analysis and the results reported in pCi/kg dry weight.

Gross beta results for wastewater sampled prior to discharge to the percolation beds was 33 pCi/l. Monthly composite water samples of the 400 Area effluent had gross beta results ranging from 11 pCi/l to 39 pCi/l and averaged 31.3 pCi/l.

Prior to discharge samples and 400 Area effluent samples were also analyzed for gross alpha. There were no detectable gross alpha results for 2001.

Due to contributions from the 400 Area effluent, tritium concentrations in SWTF samples continued to be higher than might otherwise be expected. The 400 Area draws part of its water from the unconfined aquifer that is high in tritium due to historical chemical separations processes at the 200 East Area on the Hanford Site. In 2001 the mean for tritium in the 400 Area effluent (Station 102A) was 2940 pCi/l and ranged from 620 pCi/l to 3900 pCi/l. The mean at the headworks (Station 102B) was 1114 pCi/l and the results ranged from 140 pCi/l to 2300 pCi/l. Tritium in the pond (Station 102C) averaged 535 pCi/l and ranged from 490 pCi/l to 580 pCi/l.

Gamma analysis was done on all water samples collected at the SWTF. The results of the December Station 102B sample collected at the headworks showed detectable iodine-131. The activity of the iodine-131 was 14.6 pCi/l for the first analysis and 4.9 pCi/l when reanalyzed. A low-level iodine analysis was requested and the result was 6.4 pCi/l. An investigation into the cause of the detectable iodine-131 revealed that two individuals had received medical isotopes in late November. Grab samples taken from the north pond later in December did not show any detectable levels of iodine-131.

Gamma analysis of the sediment sample collected from the north stabilization pond revealed detectable cobalt-60 and cesium-137 in addition to naturally occurring nuclides. The activity of

the cobalt-60 was 163 pCi/kg dry and the cesium-137 activity was 171 pCi/kg dry. These are well within the range of results observed in the past.

5.9.3 Cooling Tower Sediment Disposal Area (Station 119)

On August 13, 2001, EFSEC approved Resolution No. 299[17] that authorized the onsite disposal of sediments from plant cooling systems containing low levels of radionuclides. The approval of this resolution closed out EFSEC Resolution No. 278 that authorized onsite disposal of cooling tower sediment only. The disposal area for these sediments is located just south of the cooling towers. According to Resolution No. 299, the REMP is to monitor the area's direct radiation dose using quarterly and annual TLDs and by collecting a dry composite sediment sample from the disposal cell within thirty days following each cleaning to confirm that the disposal criteria outlined in the resolution have not been exceeded.

Cleaning of the cooling towers was done during the refueling outage in 2001. An estimated 100 cubic yards of sediment was placed in the disposal area. This material had an estimated density of 1.6 grams/cubic centimeter (g/cm^3). Using the volume and the density of 1.6 g/cm^3, along with the activity, it was calculated that the following quantities of nuclides were placed in the disposal area:

Cobalt-60	1.96E-06 curies
Manganese-54	3.07E-06 curies
Zinc-65	7.73E-07 curies
Cesium-137	2.39E-05 curies

Of the above nuclides, only the cesium-137 result was above the detection limit. The result for cesium-137 was 192 pCi/kg dry. Since the results for the other nuclides were lower than the detection level, the calculated quantities disposed of those nuclides are estimates of the maximum possible concentration.

Measurements of direct radiation were taken using TLDs. The TLDs were collected quarterly and annually. Two locations were used, one next to the collection area (Station 119B) and the other approximately 100 yards to the east as the control (Station 119-Control). The mean quarterly TLD result for both Station 119B and Station. 119-Control was 0.25 mR/day. The annual TLD results were 0.22 mR/day for Station 119B and 0.23 mR/day for Station.119-Control.

5.9.4 Spray Pond Drain Field (Station 120)

Sediment from spray pond cleanings had been discharged to a trench located approximately 500 feet south of the spray ponds. In 1995, soil samples taken in the trench indicated detectable amounts of cesium-137 and cobalt-60. In 1996, the deposited sediment was removed to a disposal cell south of the cooling towers. The trench has continued to be the discharge location for spray pond filter backwash water.

In 2001, the mean for the quarterly TLD inside the trench was 0.25 mR/day. The quarterly mean for the control location was also 0.25 mR/day. The annual results for both Station 120 and for Station 119-Control were 0.23 mR/day.

5.9.5 Independent Spent Fuel Storage Installation (Stations 121 and 122)

Energy Northwest made the decision in 1998 to construct the Independent Spent Fuel Storage Installation (ISFSI) area just north of Columbia Generating Station. In 1998, the REMP placed two TLD stations consisting of one annual and one quarterly TLD at the planned site for baseline data. Co-located with the Energy Northwest TLDs are Washington Department of Health TLDs. Station 121 is located approximately 0.1 miles north of the plant. It was moved to its current location in October 2000 from a location approximately 140 feet farther north. This was done because of construction at the old location. This resulted in a noticeable increase in the readings for the station. Station 122 is on the fenceline approximately 0.3 miles north of the plant. The mean of the quarterly TLDs at Station 121 was 1.00 mR/day while the annual TLD result was also 1.00 mR/day. Station 122 had a mean of 0.25 mR/day for the quarterly TLDs and an annual result of 0.24 mR/day. The higher results at Station 121 are caused by the closer proximity of the station to the plant. Also, Columbia Generating Station began adding noble metals addition in 2001, which increased the amount of direct radiation from the plant before beginning to taper off.

5.10 2001 Sample Deviations

The majority of deviations for sampling were connected with air sampling. Most of the deviations consisted of loss of power to the samplers. Station 40 had the power off for parts of February and March while the farmer who had purchased the land on which the sampler is located made improvements to the buildings on the farm. There were five sets of samples that did not meet the contract LLD. Because of the analytical contractor's move late in 2000, there were some delays in counting samples during the first month of 2001. Also, Teledyne Brown switched to 4-liter sample geometry for the gamma scan of liquids. Deviations are listed in Table 5-2.

In early November 2001 the automatic composite sampler on the sanitary waste line to the SWTF from the 400 Area was inadvertently left in the "pause" mode. For an approximate 30-day period this wastewater stream was not sampled. A grab sample was taken and analyzed and a sign reminding operators to return the sampler to sampling mode was posted.

Teledyne Brown reviewed the 1999 Interlaboratory Comparison Program and notified clients that it had not performed iodine-131, strontium-89, strontium-90, or gamma analyses on milk samples. The 2001 Interlaboratory Comparison Program included all contractually required analyses with the exception of iodine-131 in water.

TABLE 5-1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN (RANGE)	PREVIOUS OPERATIONAL[b][c] MEAN (RANGE)	2001 MEAN (RANGE)
Air: pCi/m^3			
Gross Beta	<0.02 (<0.003 - 0.130)	0.019 (0.001 - 0.741)	0.015 (0.000 - 0.055)
I-131[e]	<0.05 (<0.01 - 0.11)	0.00 (-0.07 - 0.82)	0.00 (-0.03 - 0.03)
Gamma			
Cs-134	<0.01 (<0.001 - 0.040)	0.0002 (-0.0021 - 0.0149)	0.0000 (-0.0007 - 0.0013)
Cs-137	<0.01 (<0.001 - 0.040)	0.0005 (-0.0011 - 0.0356)	0.0000 (-0.0002 - 0.0003)
River/Drinking Water: pCi/l			
Gross Beta	<3 (<1 - <6)	1.8 (-0.8 - 9.1)	1.2 (-0.8 – 3.6)
Gamma			
Cs-134	<3.8 (<1 - <12)	0.0 (-25.2 - 5.2)	-3.1 (-25.7 – 1.5)
Cs-137	<4.1 (<1 - <13)	1 (-6.8 - 6.2)	2.5 (-0.6 - 11.9)
Co-58	<5.1 (<1 - <25)	-0.1 (-4.8 - 2.9)	0.5 (-2.5 – 5.8)
Co-60	<4.7 (<1 - <13)	0.7 (-4.9 - 7.1)	-1 (-8.4 – 2.8)
Fe-59	<13.3 (<2 - <93)	0.7 (-43.9 - 6.9)	2.2 (-6.7 – 8.2)
Zn-65	<8.3 (<2 - <27)	-1 (-41.8 – 11)	-0.5 (-2.9 – 2.1)
H-3	<481.7 (220 - <820)	105.4 (-500 - 596)	126.5 (-87 – 93)
Groundwater: pCi/l			
Gamma			
Cs-134	<4 (<1 - <12)	0.3 (-4.1 - 5.4)	-1.2 (-8.9 – 4.5)
Cs-137	<3.8 (0.8 - <8)	0.9 (-6 - 4.9)	1.4 (-2.4 – 4)
Co-58	<4.7 (<1 - <12)	-0.4 (-3.3 – 2.5)	-1.9 (-4.1 – 0.6)
Co-60	<4.1 (0.1 - <9)	0.8 (-2.4 - 8.4)	-0.6 (-3.1 – 2.1)
Fe-59	<11.6 (<2 - <33)	0.7 (-4.5 - 5.7)	1.7 (-6.6 – 11.4)
Zn-65	<8.6 (<2 - 17)	-0.2 (-46.8 - 15)	-2.3 (-10.5 – 1.9)
H-3	<467.8 (<10 - 2600)	13.9 (-516 - 324)	-149.8 (-600 - 0)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 2000. 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)	2001[d] MEAN	(RANGE)
Discharge Water: pCi/l						
Gross Beta	<2.8	(<1.9 - 4)	16	(0.6 – 56.0)	8.3	(4.3 – 14)
Gamma						
Cs-134	<3.7	(<1 - <8)	0.4	(-8.9 - 10.1)	1.7	(-1.9 – 5.8)
Cs-137	<4.7	(<1 - 16)	1.9	(-5.3 - 23.1)	4.9	(-21.8 – 37.3)
Co-58	<1.4	(1 - 13)	0.0	(-2.6 - 4.6)	2.6	(-2.4 – 7.9)
Co-60	<5.0	(<1.9 - <13)	4.5	(-8.7 - 57.6)	-1.3	(-7.2 – 1.6)
Fe-59	<11.9	(<3 - <38)	1.0	(-5.9 - 13)	0.0	(-2 – 2.6)
Zn-65	<8.6	(<2 - 27)	3.1	(-27.9 - 86.7)	0.1	(-3.1 – 3.3)
H-3	<420	(<80 - 700)	1610	(-270 - 12000)	140	(120 - 160)
Sr-90	<3		0.8	(0.5 - 1.1)	Analysis Not Performed	
Storm Drain Water: pCi/l						
Gross Beta	Analysis Not Performed		7.1	(-1.2 - 1100)	4.9	(0.1 – 86)
Gamma	Analysis Not Performed					
Cs-134			0.0	(-12.8 – 23.3)	0.1	(-46.2 – 20.2)
Cs-137			1.2	(-11 - 252)	1.2	(-2.6 – 6.1)
Co-58			-0.5	(-17.7 - 3.4)	-0.3	(-5.8 – 19.9)
Co-60			0.8	(-10.9 - 125)	0.5	(-4.5 – 12.4)
Fe-59			0.9	(-33.9 – 97.3)	1.8	(-15.4 – 14.5)
Zn-65			0.9	(-36.2 – 77.5)	-1.6	(-27.5 – 47.7)
Mn-54			0.5	(-6.2 - 10)	0.6	(-4.8 – 6.8)
I-131			0.0	(-26.2 – 53.8)	-38.8	(-1540 – 8.6)
Ce-141			-1.4	(-441 - 707)	1.4	(-28.1 – 116)
I-131[e]			0.4	(-0.2 - 8.3)	Analysis Not Performed	
H-3	Analysis Not Performed		4654	(-420 - 270000)	1059	(-270 - 7853)
Sanitary Waste Water: pCi/l						
Gross Alpha	Analysis Not Performed		0.6	(-1 -.3)	0.6	(-0.5 – 2.6)
Gross Beta	Analysis Not Performed		33.7	(5.9 - 61)	31.5	(15 – 40)
Cs-134			0.1	(-4.4 - 14.8)	0.5	(-4.9 – 1.5)
Cs-137			1	(-5.1 - 4.8)	0.8	(-1.3 – 3.5)
Co-58			-0.3	(-5.9 - 2.4)	-1.5	(-8.7 – 2.7)
Co-60			0.3	(-12.9 – 4.4)	-0.1	(-3 – 3)
H-3	Analysis Not Performed		1313	(-170 - 20000)	1863	(-92 - 3900)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 2000. 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)	2001[d] MEAN	(RANGE)
River Sediment: pCi/kg (dry)						
Gamma						
Cs-134	<112.5	(<50 - <150)	47.4	(1.8 - 172)	3.2	(-0.5 - 6.8)
Cs-137	<287	(<50 - <560)	301.6	(136.5 - 1890)	228.5	(224 - 233)
Co-60	<254.6	(130 - 610)	33.3	(1.4 - 129)	17.2	(-4.9 - 46)
Storm Drain Sediment: pCi/kg (dry)						
Gamma:	Analysis Not Performed[e]					
Cs-134			60.7	(4.1 - 1140)	-1970	
Cs-137			158.1	(-3.6 - 2900)	26.3	
Co-58			-2.1	(-27.5 - 58)	-42.8	
Co-60			739.5	(-6.4 - 25400)	102	
Zn-65			114.2	(-34.5 - 4650)	223	
Mn-54			22.4	(-9.6 - 670)	21.4	
Ce-141			34.7	(-28.8 - 3740)	93.7	
Sanitary Waste Sediment: pCi/kg (dry)						
Gamma:	Analysis Not Performed[e]					
Cs-134			25.9	(-107 - 55.2)	-6.6	
Cs-137			145	(0 - 255.1)	171	
Co-60			250.2	(-3.4 - 2110)	163	
Zn-65			11.3	(-106 - 125)	-14	
Mn-54			5.2	(-72.1 - 95)	-1.5	
Annual Soil: pCi/kg (dry)						
Gamma						
Cs-134	<65.3	(<20 - <150)	25.2	(1 - 53.2)	-2	(-3.6 - 2)
Cs-137	364.3	(<20 - <1880)	203.1	(-7.3 - 735)	116.9	(13.7 - 307)
Sr-90	Analysis Not Performed		178.8	(0.2 - 455)	120.7	(62 - 150)
Produce: pCi/kg (wet)						
Gamma						
Cs-134	<49.1	(<10 - <140)	0.5	(-24.8 - 19.8)	-2.1	(-13.9 - 3)
Cs-137	<69.8	(<10 - <140)	2.8	(-9.8 - 20.9)	0.9	(-8.5 - 7)
I-131	<105.6	(<10 - <1000)	-0.2	(-26 - 59)	-1.8	(-17.2 - 12)

(a) All stations all years.
(b) Indicator stations only for the years 1984 to 2000. 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.
(f) Sample had high LLD. Not included in average.

TABLE 5-1 (cont.)
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
COMPARATIVE SUMMARY

MEDIA/ ANALYSIS	PREOPERATIONAL[a] MEAN	(RANGE)	PREVIOUS OPERATIONAL[b,c] MEAN	(RANGE)	2001[d] MEAN	(RANGE)
Milk: pCi/l						
Gamma						
Cs-134	<3.7	(<0.9 - <14)	0.6	(-8.7 - 22.6)	0.0	(-16.6 – 14.7)
Cs-137	<3.8	(<1 - <12)	2	(-7.4 - 47.3)	1.2	(-3.9 – 6.7)
Ba-140	<72.1	(<6 - <2000)	0.3	(-44.3 - 55)	5	(-12 – 35.8)
La-140	<33.3	(<5 - 1000)	-0.4	(-24.2 - 9.7)	1.3	(-6.9 – 8.5)
I-131[e]	<0.5	(<0.1 - <1)	0.6	(-0.8 - 143.6)	0.2	(-0.3 - 1.3)
Sr-90	Analysis Not Performed		1.9	(1.3 - 3.9)	Analysis Not Performed	
Broadleaf feed: pCi/kg (wet)						
Gamma						
Cs-134	Analysis Not Performed		-0.6	(-7.5 – 3.3)	-0.7	(-19.6 – 17.5)
Cs-137			1.8	(-7.8 - 11.8)	9.7	(-5.5 – 44.5)
I-131[e]			3.8	(-25.0 – 23.0)	10	(0.7 – 71)
Fish: pCi/kg (wet)						
Gamma						
Cs-134	<61.2	(<6 - <130)	2	(-20.4 – 30.2)	-7.1	(-28 – 6.4)
Cs-137	<88.8	(<10 - <130)	13.5	(-35.1 - 57)	4.5	(4 – 5.3)
Co-58	<87.7	(<9 - <130)	0.5	(-16.8 - 25.8)	-8.6	(-19.1 – -3)
Co-60	<80.6	(<9 - <130)	1.4	(-18.4 - 21)	3.7	(2.7 – 5.1)
Fe-59	<130	(<30 - <260)	1.3	(-34.2 - 30)	9.4	(1.3 – 20.2)
Mn-54	<88.3	(<8 - <130)	1.6	(-20 - 30.9)	-5	(-12.2 – 3)
Cooling Tower Sediment: pCi/kg (dry)						
Gamma	Analysis Not Performed					
Mn-54			9.5	(2.8 - 16.6)	24.6	
Co-60			52.3	(3.3 - 92.3)	15.7	
Zn-65			15.6	(2.1 - 34.7)	6.2	
Cs-134			31.5	(16 - 43.2)	-2.7	
Cs-137			202.8	(206 - 236.9)	192	
TLD: mR/day						
Quarterly	0.24	(0.17 - 0.31)	0.25	(0.16 - 0.35)	0.24	(0.20- 0.33)
Annual	0.24	(0.20 - 0.29)	0.23	(0.18 - 0.34)	0.22	(0.20 - 0.27)

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 2000. 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)	2001[d] MEAN (RANGE)
TLD: mR/day			
ST119 Quarterly	Analysis Not Performed	0.25 (0.22 - 0.28)	0.25 (0.24 - 0.27)
ST119 Annual	Analysis Not Performed	0.24 (0.21 - 0.30)	0.22
ST120 Quarterly	Analysis Not Performed	0.27 (0.22 - 0.34)	0.25 (0.24 - 0.27)
ST120 Annual	Analysis Not Performed	0.25 (0.21 - 0.31)	0.23
ST121 Quarterly	Analysis Not Performed	0.53 (0.23 - 0.72)	1.00 (0.59 - 1.21)
ST121 Annual	Analysis Not Performed	0.56 (0.49 - 0.63)	1.00
ST122 Quarterly	Analysis Not Performed	0.24 (0.22 - 0.27)	0.25 (0.22 - 0.29)
ST122 Annual	Analysis Not Performed	0.22 (0.21 - 0.23)	0.24

(a) All stations, all years.
(b) Indicator stations only for the years 1984 to 2000. 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.

TABLE 5-2
2001 SAMPLE DEVIATIONS

SAMPLE MEDIA	DATE	LOCATION	PROBLEM
Air Particulate/Iodine	03/05-03/12	Station 5	Power off due to work at substation.
	03/12-03/19	Station 6	Power off due to work at substation.
	03/19-03/26	Station 6	Power off due to work at substation.
	03/26-04/02	Station 7	Dept. of Energy maintenance outage.
	04/02-04/09	Station 40	Unit failure. Sample volume acceptable.
	04/09-04/16	Station 40	Unit replaced late. Sample volume acceptable.
	06/11-06/18	Station 1	Power off. Sample volume acceptable
	06/18-06/25	Station 48	Unit failure. Sample volume acceptable.
	08/06-08/13	Station 40	Unit failure. Sample volume acceptable.
	08/13-09/20	Station 23	Power off during period for annual maintenance by BPA.
	09/03-09/10	All	Samples lost in shipping due to 09/11 restrictions.
	09/20-09/24	Station 23	Outage ends, low hours. Sample volume acceptable
	10/29-11/05	Station 7	Unit failure. Sample volume acceptable.
	11/05-12/01	Station 7	Unit replaced late. Sample volume acceptable.
Vegetable	April and May	9C and 37	Asparagus substituted for leafy vegetable.
TLD	Third quarter	24	TLD missing.
Water	01/03-02/06	29	Outage at Richland Water Plant.
	09/05-10/02	26	Sampler pump problems. Sample volume acceptable.
	11/06-12/05	102A	Sampler inoperable. Sampler in pause mode.
Analytical	01/16	36	Contract LLD for BA-LA 140 exceeded. Delay in counting
	01/03-02/06	27	Contract LLD for BA-LA 140 exceeded. Delay in counting
	03/06-04/03	29	Several nuclide LLDs exceeded due to limited sample volume
	07/03-08/01	26, 27, 29	Contract LLD exceeded due to decay correction calculation.
	08/01-09/05	26, 27, 29	Contract LLD exceeded due to decay correction calculation.

TABLE 5-3

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

ENERGY NORTHWEST COLUMBIA GENERATING STATIOI DOCKET NO. 50-397
BENTON WASHINGTON JANUARY 1 TO DECEMBER 31, 2001

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	Direction	Mean (Ratio)[a] (Range)	Control Location Mean (Ratio)[a] (Range)	Number of Nonroutine Reported Measurements
Air Particulate (pCi/m^3)	Gross Beta	608	0.003	0.015(554/557) (0.004-0.055)	23	3.0 mi.	ESE	0.016(47/48) (0.004-0.052)	0.014(51/51) (0.004-0.061)	0
	Gamma (Quarterly)	48								
	Be-7		0.01	0.090(40/44) (0.038-0.188)	57	0.9 mi.	N	0.101(4/4) (0.038-0.188)	0.080(4/4) (0.044-0.123)	0
	K-40		0.01	-(0/44)				-(0/44)	-(0/4)	0
	Th-228			0.002(4/44) (0.0006-0.003)	04	9.3 mi.	SSE	0.003(1/44)	-(0/4)	0
Air Iodine (pCi/m^3)	I-131	558	0.01	-(0/507)					-(0/51)	0
Soil (pCi/kg dry)	Gamma	5								
	K-40		700	13700(4/4) (11000-15000)	01	1.3 mi.	S	15000(1/1)	1250(1/1)	0
	Cs-137		40	136(4/4) (13.7-307)	01	1.3 mi.	S	307(1/1)	-(0/1)	0
	Ra-226		400	707(3/4) (519-924)	09A	30 mi.	WSW	946(1/1)	946(1/1)	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

ENERGY NORTHWEST COLUMBIA GENERATING STATIOI DOCKET NO. 50-397
BENTON WASHINGTON JANUARY 1 TO DECEMBER 31, 2001

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	Direction	Mean (Ratio)[a] (Range)	Control Location Mean (Ratio)[a] (Range)	Number of Nonroutine Reported Measurements
Soil (pCi/kg dry)	Gamma Th-228	5	50	507(4/4) (393-569)	23	3.0 mi.	ESE	569(1/1)	558(1/1)	0
Water (River/Drinking) (pCi/liter)	Gross Beta	23	4	2.07(3/11) (1.20-2.80)	29	11 mi.	SSE	2.07(3/11) (1.20-2.80)	1.87(6/12) (1.1-2.6)	0
	Tritium	8	300	143(3/4) (100-180)	26	3.2 mi.	E	170(1/4)	170(1/4)	0
	Gamma	24		-(0/12)				-(0/12)		0
Water (Discharge) (pCi/liter)	Gross Beta	12	12	8.32(12/12) (4.3-14)	27	3.2 mi	E	8.32(12/12) (4.3-14)	-(0/0)	0
	Tritium	4	300	140(4/4) (120-160)	27	3.2 mi.	E	140(4/4) (120-160)	-(0/0)	0
Water (Discharge) (pCi/liter)	Gamma Cs-134	12	15	18.9(1/12)	27	3.2 mi.	E	18.9(1/12)	-(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

ENERGY NORTHWEST COLUMBIA GENERATING STATIOI DOCKET NO. 50-397
BENTON WASHINGTON JANUARY 1 TO DECEMBER 31, 2001

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	Direction	Mean (Ratio)[a] (Range)	Control Location Mean (Ratio)[a] (Range)	Number of Nonroutine Reported Measurements
Fish	Gamma	6								
(pCi/kg wet)	K-40		1000	3260(3/3) (2890-3920)	30	3.3 mi.	E	3260(3/3) (2890-3920)	3230(3/3) (2920-3490)	0
Milk	I-131	54	0.5	-(0/51)					-(0/0)	0
(pCi/liter)	Gamma	54								
	K-40		200	1311(51/51) (619-2090)	36	7.2 mi.	ESE	1397(17/17) (1260-2090)	-(0/0)	0
Broadleaf	Gamma	12								
In Lieu of Milk	Be-7			267(4/12) (70.8-504)	9G	36 mi.	WSW	267(4/12) (70.8-504)	-(0/0)	0
(pCi/kg wet)	K-40		200	7118(12/12) (3480-15500)	9G	36 mi.	WSW	7118(12/12) (3480-15500)	-(0/0)	0
	Th-228			205(3/12) (130-248)	9G	36 mi.	WSW	205(3/12) (130-248)	-(0/0)	0
	I-131	11		-(0/11)					-(0/0)	0
Roots	Gamma	8								
(pCi/kg wet)	K-40		200	2838(4/4) (1220-4380)	37	16 mi.	SSE	2838(4/4) (1220-4380)	2458(4/4) (1070-4560)	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

ENERGY NORTHWEST COLUMBIA GENERATING STATIOI DOCKET NO. 50-397
BENTON WASHINGTON JANUARY 1 TO DECEMBER 31, 2001

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	Direction	Mean (Ratio)[a] (Range)	Control Location Mean (Ratio)[a] (Range)	Number of Nonroutine Reported Measurements
Fruits (pCi/kg wet)	Gamma K-40	9		1656(5/5) (472-3000)	9C	35 mi.	WSW	1758(4/4) (892-2660)	1758(4/4) (892-2660)	0
Vegetables (pCi/kg wet)	Gamma K-40	12		1972(6/6) (620-2700)	9C	35 mi.	WSW	2070(6/6) (1280-2500)	2070(6/6) (1280-2500)	0
Storm Drain Water Station 101 (pCi/liter)	Gross Beta	48	4	8.89(21/48) (2-86)	101	0.3 mi.	ENE	8.89(21/48) (2-86)	-(0/0)	0
	Tritium	48	300	1320(37/48) (110-7400)	101	0.3 mi.	ENE	1320(37/48) (110-7400)	-(0/0)	0
	Gamma	48								
	Be-7			54.5(1/48)	101	0.3 mi.	ENE	54.5(1/48)	-(0/0)	0
	K-40			234(3/48) (126-305)	101	0.3 mi.	ENE	234(3/48) (126-305)	-(0/0)	0
	Ra-226			63.2(2/48) (23-103)	101	0.3 mi.	ENE	63.2(2/48) (23-103)	-(0/0)	0
	Th-228			18.2(1/48)	101	0.3 mi.	ENE	18.2(1/48)	-(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

ENERGY NORTHWEST COLUMBIA GENERATING STATIOI DOCKET NO. 50-397
BENTON WASHINGTON JANUARY 1 TO DECEMBER 31, 2001

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	Direction	Mean (Ratio)[a] (Range)	Control Location Mean (Ratio)[a] (Range)	Number of Nonroutine Reported Measurements
Storm Drain Sediment Station 101 (pCi/kg)	Gamma	1								
	Be-7			7770(1/1)	101	0.3 mi.	ENE	7770(1/1)	-(0/0)	0
	K-40			4840(1/1)	101	0.3 mi.	ENE	4840(1/1)	-(0/0)	0
	Mn-54			21.4(1/1)	101	0.3 mi.	ENE	21.4(1/1)	-(0/0)	0
	Ra-226			488(1/1)	101	0.3 mi.	ENE	488(1/1)	-(0/0)	0
	Th-228			473(1/1)	101	0.3 mi.	ENE	473(1/1)	-(0/0)	0
Sanitary Waste Treatment Facility Water (pCi/liter)	Gross Alpha	14		(-0/14)					-(0/0)	0
	Gross Beta	14	1	31.5(14/14) (11-39)	102C	0.4 mi.	SSE	33.0(2/2) (33.0-33.0)	-(0/0)	0
	Tritium	26	2000	1940(25/26) (140-3900)	102A	0.4 mi.	SSE	2940(12/12) (620-3900)	-(0/0)	0
	Gamma	26								
	Th-228			17.9(2/26) (15.7-20)	102A	0.4 mi.	SSE	20(1/26)	-(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

ENERGY NORTHWEST COLUMBIA GENERATING STATIOI DOCKET NO. 50-397
BENTON WASHINGTON JANUARY 1 TO DECEMBER 31, 2001

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	Direction	Mean (Ratio)[a] (Range)	Control Location Mean (Ratio)[a] (Range)	Number of Nonroutine Reported Measurements
Sanitary Waste Treatment Facility Sediment (pCi/liter)	Gamma 1								
	K-40	700	8090(1/1)	102D	0.4 mi.	SSE	8090(1/1)	-(0/0)	0
	Co-60	40	163(1/1)	102D	0.4 mi.	SSE	163(1/1)	-(0/0)	0
	Cs-137	40	171(1/1)	102D	0.4 mi.	SSE	171(1/1)	-(0/0)	0
	Ra-226	400	1780(1/1)	102D	0.4 mi.	SSE	1780(1/1)	-(0/0)	0
	Th-228	50	398(1/1)	102D	0.4 mi.	SSE	398(1/1)	-(0/0)	0
Cooling Tower Sediment (pCi/kg dry)	Gamma 1								
	Be-7		9810(1/1)	119B	0.02 mi.	S	9810(1/1)	-(0/0)	0
	K-40	700	11600(1/1)	119B	0.02 mi.	S	11600(1/1)	-(0/0)	0
	Cs-137	40	192(1/1)	119B	0.02 mi.	S	192(1/1)	-(0/0)	0
	Ra-226	400	1760(1/1)	119B	0.02 mi.	S	1760(1/1)	-(0/0)	0
	Th-228	50	811(1/1)	119B	0.02 mi.	S	811(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 5-3 (Cont)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

ENERGY NORTHWEST COLUMBIA GENERATING STATIOI DOCKET NO. 50-397
BENTON WASHINGTON JANUARY 1 TO DECEMBER 31, 2001

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	Direction	Mean (Ratio)[a] (Range)	Control Location Mean (Ratio)[a] (Range)	Number of Nonroutine Reported Measurements
Quarterly TLDs (mR/day)				(0.19-0.298)				(0.265-0.296)	(0.194-0.211)	
Direct Radiation Annual TLDs (mR/day)	TLD	57		0.212(56/56) (0.191-0.271)	46	5 mi.	NE	0.267(1/1)	0.189(1/1)	0
St 119 Direct Radiation (mR/day)	TLD	8		0.241(4/4) (0.227-0.270)	119B	0.2 mi.	SSE	0.241(4/4) (0.227-0.270)	0.237(4/4) (0.223-0.257)	0
St 119 Direct Radiation Annual TLDs (mR/day)	TLD	2		0.208(1/1)	119B	0.2 mi.	SSE	0.213(1/1)	0.213(1/1)	0
St 120 Direct Radiation Quarterly TLDs (mR/day)	TLD	4		0.238(4/4) (0.227-0.256)	120	0.2 mi.	S	0.238(4/4) (0.227-0.256)	-(0/0)	0
St 120 Direct Radiation Annual TLDs (mR/day)	TLD	1		0.214(1/1)	120	0.2 mi.	S	0.214(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 5-3 (Cont)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

ENERGY NORTHWEST COLUMBIA GENERATING STATIOI DOCKET NO. 50-397
BENTON WASHINGTON JANUARY 1 TO DECEMBER 31, 2001

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				Control Location Mean (Ratio)[a] (Range)	Number of Nonroutine Reported Measurements
					Name	Distance	Direction	Mean (Ratio)[a] (Range)		
ISFSI Direct Radiation Quarterly TLDs (mR/day)	TLD	8		0.453(8/8) (0.219-0.953)	121	0.1 mi.	N	0.671(4/4) (0.483-0.953)	-(0/0)	0
ISFSI Direct Radiation Annual TLDs (mR/day)	TLD	2		0.421(2/2) (0.212-0.630)	121	0.1 mi.	N	0.630(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 - 2000 OPERATIONAL		2001 OPERATIONAL	
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	MEAN	STANDARD ERROR
1	0.24	0.02	0.25	0.00	0.24	0.01
2	0.23	0.02	0.24	0.00	0.24	0.00
3	0.22	0.01	0.24	0.00	0.23	0.00
4	0.22	0.02	0.22	0.00	0.22	0.01
5	0.23	0.01	0.23	0.00	0.22	0.01
6	0.22	0.01	0.23	0.00	0.22	0.01
7	0.23	0.01	0.24	0.00	0.23	0.01
8	0.26	0.01	0.26	0.01	0.25	0.01
9	0.22	0.02	0.22	0.00	0.21	0.01
10	0.23	0.01	0.24	0.00	0.23	0.01
11	0.24	0.01	0.24	0.00	0.24	0.01
12	0.25	0.01	0.26	0.00	0.26	0.01
13	0.24	0.01	0.24	0.00	0.23	0.00
14	0.24	0.02	0.24	0.00	0.23	0.01
15	0.25	0.01	0.26	0.00	0.26	0.01
16	0.24	0.01	0.25	0.00	0.23	0.00
17	0.25	0.01	0.25	0.00	0.25	0.01
18	0.24	0.01	0.25	0.00	0.24	0.01
19	0.24	0.01	0.25	0.00	0.24	0.01
20	0.24	0.01	0.25	0.00	0.24	0.01
21	0.23	0.01	0.23	0.00	0.23	0.01
22	0.24	0.01	0.24	0.00	0.24	0.01
23	0.24	0.01	0.24	0.00	0.23	0.01
24	0.24	0.01	0.25	0.00	0.24	0.01
25	0.25	0.01	0.26	0.01	0.24	0.01
40	0.22	0.01	0.23	0.00	0.22	0.01
41	0.26	0.02	0.26	0.00	0.24	0.01
42	0.25	0.01	0.25	0.00	0.24	0.01
43	0.25	0.01	0.26	0.01	0.24	0.00
44	0.23	0.01	0.24	0.00	0.23	0.02
45	0.23	0.01	0.24	0.00	0.23	0.01
46	0.29	0.02	0.30	0.01	0.29	0.02
47	0.22	0.02	0.23	0.00	0.22	0.01
49	0.24	0.00	0.25	0.00	0.24	0.01
50	0.22	0.00	0.25	0.00	0.23	0.01
51	0.23	0.01	0.24	0.00	0.23	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 - 2000 OPERATIONAL		2001 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	0.25	0.00	0.24	0.01
55	0.23	0.00	0.24	0.00	0.23	0.01
56	0.24	0.00	0.25	0.00	0.24	0.01
61	(b)		0.27	0.01		
65	(c)		0.23	0.01	0.23	0.01
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	0.00	0.23	0.01
74(4S)	0.26	0.01	0.26	0.01	0.26	0.01
75(5S)	0.22	0.02	0.25	0.01	0.25	0.01
76(6S)	0.24	0.01	0.25	0.00	0.24	0.01
77(7S)	0.25	0.01	0.25	0.00	0.24	0.01
78(8S)	0.25	0.01	0.24	0.00	0.24	0.01
79(9S)	0.25	0.01	0.25	0.00	0.24	0.01
80(10S)	0.24	0.01	0.24	0.00	0.23	0.01
81(11S)	0.24	0.02	0.24	0.00	0.24	0.01
82(12S)	0.26	0.02	0.25	0.00	0.24	0.01
83(13S)	0.25	0.01	0.25	0.00	0.24	0.01
84(14S)	0.24	0.01	0.25	0.00	0.26	0.03
85(15S)	0.26	0.02	0.26	0.00	0.25	0.01
86(16S)	0.25	0.01	0.28	0.01	0.27	0.02
119B	(d)		0.25	0.01	0.25	0.02
119Ctrl	(d)		0.25	0.01	0.25	0.01
120East	(d)		0.26	0.01	0.25	0.01
120West	(d)		0.28	0.04		
120Ctrl	(d)		0.25	0.01		
121 (ISFSI)	(e)		0.58	0.11	1.00	0.29
122 (ISFSI)	(e)		0.24	0.01	0.25	0.03
All	0.25	0.00	0.25	0.00	0.25	0.01

(a) This preoperational mean is for 1982-1983 data only.
(b) Station 61 was added in 1989 and discontinued in 1992.
(c) Station 65 added in 1997.
(d) Stations 119B, 119Ctrl, 120East, 120West and 120Ctrl added in 1995. Stations 120West and 120Ctrl discontinued in 1997.
(e) Stations 121 and 122 were added in 1998 to gather baseline data for the ISFSI.

TABLE 5-5
ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATION PERIOD

Results in mR/day

	PREOPERATIONAL		1984 - 2000 OPERATIONAL		2001 OPERATIONAL
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	RESULT
1	0.25	0.04	0.24	0.01	0.22
2	0.23	0.00	0.23	0.01	0.22
3	0.23	0.01	0.22	0.01	0.20
4	0.24	0.07	0.21	0.01	0.20
5	0.24	0.03	0.21	0.01	0.20
6	0.22	0.01	0.21	0.01	0.20
7	0.23	0.01	0.23	0.01	0.20
8	0.26	0.01	0.25	0.01	0.23
9	0.22	0.01	0.21	0.01	0.20
10	0.23	0.01	0.22	0.01	0.22
11	0.24	0.01	0.23	0.01	0.21
12	0.26	0.00	0.25	0.01	0.23
13	0.24	0.01	0.23	0.01	0.22
14	0.23	0.00	0.23	0.01	0.22
15	0.25	0.03	0.25	0.01	0.23
16	0.25	0.01	0.24	0.01	0.23
17	0.24	0.02	0.24	0.01	0.22
18	0.25	0.03	0.24	0.01	0.22
19	0.24[b]		0.24	0.01	0.22
20	0.24	0.01	0.23	0.01	0.22
21	0.22	0.01	0.21	0.01	0.20
22	0.24	0.01	0.23	0.01	0.21
23	0.23	0.01	0.23	0.01	0.21
24	0.24	0.01	0.23	0.01	0.22
25	0.25	0.01	0.25	0.01	0.24
40	0.21[b]		0.21	0.01	0.20
41	0.26	0.01	0.24	0.01	0.22
42	0.24[b]		0.24	0.01	0.21
43	0.24[b]		0.24	0.01	0.21
44	0.24	0.02	0.22	0.01	0.21
45	0.23	0.01	0.23	0.01	0.22
46	0.29	0.01	0.29	0.01	0.27
47	0.22[b]		0.22	0.01	0.20
49	(c)		0.23	0.01	0.22

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

(b) There was only one annual exchange during the preoperational period.

(c) Stations 49-56 were first monitored during Fourth Quarter 1983.

TABLE 5-5 (cont.)
ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mR/day

	PREOPERATIONAL		1984 - 2000 OPERATIONAL		2001 OPERATIONAL
STATION	MEAN[a]	STANDARD ERROR	MEAN	STANDARD ERROR	RESULT
50	(c)		0.23	0.01	0.21
51	(c)		0.23	0.01	0.21
53	(c)		0.25	0.01	0.23
54	(c)		0.24	0.01	0.22
55	(c)		0.23	0.01	0.21
56	(c)		0.23	0.01	0.22
61	(c)		0.26[c]	0.01	(d)
65	(e)		0.22	0.01	0.21
71 (1S)	0.24[b]		0.26	0.01	0.27
72 (2S)	0.25[b]		0.26	0.01	0.25
73 (3S)	0.23[b]		0.22	0.01	0.21
74 (4S)	0.24[b]		0.25	0.01	0.24
75(5S)	0.24[b]		0.23	0.01	0.23
76(6S)	0.24[b]		0.24	0.01	0.23
77 (7S)	0.25[b]		0.23	0.01	0.22
78 (8S)	0.25[b]		0.23	0.01	0.22
79 (9S)	0.25[b]		0.23	0.01	0.22
80 (10S)	0.23[b]		0.23	0.01	0.21
81 (11S)	0.23[b]		0.23	0.01	0.21
82 (12S)	0.25[b]		0.24	0.01	0.22
83 (13S)	0.25[b]		0.24	0.01	0.23
84 (14S)	0.23[b]		0.24	0.01	0.22
85 (15S)	0.25[b]		0.25	0.01	0.24
86 (16S)	0.24[b]		0.27	0.01	0.26
119B	(f)		0.24	0.03	0.22
119Ctrl	(f)		0.24	0.03	0.23
120East	(f)		0.25	0.04	0.23
120West	(f)		0.33		
120Ctrl	(f)		0.29		
121 (ISFSI)	(g)		0.56	0.08	1.00
122 (ISFSI)	(g)		0.22	0.01	0.24
All	0.24	0.00	0.24	0.00	0.23

(a) This preoperational mean is for 1982 - 1983 data only.
(b) There was only one annual exchange during the preoperational period.
(c) Stations 49-56 were first monitored during Fourth Quarter 1983. Station 61 was added in 1989.
(d) Station 61 discontinued on June 29, 1992.
(e) Station 65 added in 1997.
(f) Stations 119B, 119Ctrl, 120East, 120West and 120Ctrl added in 1995. Stations 120West and 120Ctrl discontinued in 1997.
(g) Station 121 and 122 were added in 1998 to gather baseline data for the ISFSI.

TABLE 5-6
2001 MEAN QUARTERLY VERSUS ANNUAL TLD DATA
Results in mR/day

STATION	1984-2000 TLDs QUARTERLY MEAN[a]	1984-2000 TLDs ANNUAL MEAN	1984-2000 TLDs RATIO[b]	2001 TLDs QUARTERLY MEAN[a]	2001 TLDs ANNUAL RESULTS	2001 TLDs RATIO[b]
1	0.25	0.24	1.06	0.24	0.22	1.08
2	0.24	0.23	1.06	0.24	0.22	1.10
3	0.24	0.22	1.08	0.23	0.20	1.13
4	0.22	0.21	1.06	0.22	0.20	1.08
5	0.23	0.21	1.07	0.22	0.20	1.10
6	0.23	0.21	1.07	0.22	0.20	1.12
7	0.24	0.23	1.06	0.23	0.20	1.11
8	0.26	0.25	1.04	0.25	0.23	1.10
9	0.22	0.21	1.07	0.21	0.20	1.05
10	0.24	0.22	1.07	0.23	0.22	1.05
11	0.24	0.23	1.06	0.24	0.21	1.12
12	0.26	0.24	1.07	0.26	0.23	1.10
13	0.25	0.23	1.06	0.23	0.22	1.06
14	0.24	0.23	1.07	0.23	0.22	1.09
15	0.26	0.25	1.06	0.26	0.23	1.11
16	0.25	0.24	1.06	0.23	0.23	1.02
17	0.25	0.24	1.06	0.25	0.22	1.11
18	0.25	0.24	1.05	0.24	0.22	1.06
19	0.25	0.24	1.06	0.24	0.22	1.09
20	0.25	0.23	1.05	0.24	0.22	1.06
21	0.23	0.21	1.07	0.23	0.20	1.13
22	0.25	0.23	1.06	0.24	0.21	1.12
23	0.24	0.23	1.06	0.23	0.21	1.12
24	0.25	0.23	1.07	0.24	0.22	1.09
25	0.26	0.25	1.06	0.24	0.24	1.04
40	0.23	0.21	1.08	0.22	0.20	1.10
41	0.26	0.24	1.07	0.24	0.22	1.11
42	0.25	0.24	1.07	0.24	0.21	1.12
43	0.26	0.24	1.07	0.24	0.21	1.15
44	0.24	0.22	1.07	0.23	0.21	1.09
45	0.24	0.23	1.07	0.23	0.22	1.06
46	0.30	0.29	1.04	0.29	0.27	1.07
47	0.23	0.22	1.05	0.22	0.20	1.08
49	0.25	0.23	1.07	0.24	0.22	1.10
50	0.25	0.23	1.07	0.23	0.21	1.13

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

TABLE 5-6 (cont.)
2001 MEAN QUARTERLY VERSUS ANNUAL TLD DATA
Results in mR/day

	1984-2000 TLDs			2001 TLDs		
STATION	QUARTERLY MEAN[a]	ANNUAL MEAN	RATIO[b]	QUARTERLY MEAN[a]	ANNUAL RESULTS	RATIO[b]
51	0.24	0.23	1.07	0.23	0.21	1.07
53	0.27	0.25	1.06	0.26	0.23	1.11
54	0.25	0.24	1.05	0.24	0.22	1.10
55	0.24	0.23	1.07	0.23	0.21	1.10
56	0.25	0.23	1.06	0.24	0.22	1.10
61[c]	0.27	0.26	1.06			
65[d]	0.23	0.22	1.06	0.23	0.21	1.11
71 (1S)	0.28	0.26	1.05	0.29	0.27	1.08
72 (2S)	0.27	0.26	1.04	0.28	0.25	1.12
73 (3S)	0.24	0.22	1.07	0.23	0.21	1.09
74 (4S)	0.27	0.25	1.06	0.26	0.24	1.07
75 (5S)	0.25	0.23	1.06	0.25	0.23	1.10
76 (6S)	0.25	0.23	1.06	0.24	0.23	1.05
77 (7S)	0.25	0.23	1.06	0.24	0.22	1.10
78 (8S)	0.24	0.23	1.05	0.24	0.22	1.07
79 (9S)	0.25	0.23	1.07	0.24	0.22	1.08
80 (10S)	0.24	0.23	1.06	0.23	0.21	1.11
81 (11S)	0.24	0.23	1.06	0.24	0.21	1.13
82 (12S)	0.25	0.24	1.06	0.24	0.22	1.10
83 (13S)	0.25	0.24	1.05	0.24	0.23	1.07
84 (14S)	0.25	0.24	1.07	0.26	0.22	1.16
85 (15S)	0.26	0.25	1.05	0.25	0.24	1.05
86 (16S)	0.28	0.27	1.04	0.27	0.26	1.03
119B	0.25	0.24	1.05	0.25	0.22	1.15
119Ctrl	0.25	0.24	1.02	0.25	0.23	1.07
120East	0.26	0.25	1.02	0.25	0.23	1.09
120West	0.28	0.33	0.86	(e)		
120Ctrl	0.25	0.29	0.86	(e)		
121 (ISFSI)[f]	0.53	0.56	0.95	1.00	1.00	1.00
122 (ISFSI)[f]	0.24	0.22	1.12	0.25	0.24	1.06
ALL	0.25	0.24	1.05	0.25	0.23	1.09

(a) Mean of the quarterly results.
(b) Quarterly result/Annual result.
(c) Station 61 was added in 1989 and discontinued in 1992.
(d) Station 65 added in 1997.
(e) Stations discontinued in 1997.
(f) Station 121 and 122 were added in 1998 to gather baseline data for the ISFSI.

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[4]. To accomplish this, the REMP requires that its analytical contractors also meet these criteria. The Energy Northwest Quality group performs in-depth audits of the REMP records and activities and the records and activities of its support organizations at least annually.

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 Energy Northwest analytical results of samples containing known concentrations of various radionuclides, to the known values and also with the results reported by other monitoring programs, are a major component of the quality assurance activities of the REMP. The analytical contractor participates in Environmental Measurements Laboratory (EML) intercomparison program. The REMP 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 Energy Northwest Environmental TLD Program

The Quality Control Program includes the preparation, processing and evaluation of environmental TLDs. To begin with, all environmental TLDs, including controls, which are to be used in the same quarter (or year for annuals), are annealed at the same time. This allows for uniform accumulation of and correction for background radiation. From the time the TLDs are annealed to the time they are placed in the field, they are stored and transported with a set of control TLDs. Once the field TLDs are collected, they are again stored together with the controls until processed.

Reader QC dosimeters are prepared by the TLD processor and serve as indicators that the reader calibration is satisfactory and that the TLDs were processed correctly. These TLDs are annealed just prior to being given a known exposure (typically 100 mR) to cesium-137 and processed among the field dosimeters. The number of QA dosimeters used during each processing is generally 10% of the number of field dosimeters.

If the mean reader QC dosimeter results vary by more than $\pm$ 5% from the given exposure, the processor is contacted and an investigation into the source of the discrepancy is initiated. Evaluation of the 2001 reader QC dosimeter results indicated satisfactory agreement for all four quarters and the annual processing results.

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 greater than the building control results, the difference between the two is subtracted from the field dosimeters to account for exposure during transit.

Spiked dosimeters, which are exposed by Energy Northwest, are irradiated with up to 25 mR cesium-137 to an exposure value equivalent to 10 mR/hr during the field cycle. These spiked dosimeters are also processed with the field dosimeters during each run to verify the accuracy and consistency of the environmental TLD evaluations. All results were within $\pm 10\%$ of the known exposure and are provided in Table 6-1.

Extra sets of control dosimeters, known as zero dose dosimeters, are also included with the field dosimeters for processing. These zero dose TLDs are stored in a shielded container throughout the quarter (or year for annuals) and are used as an additional indication of reader performance. These TLDs may also be used as replacements if a field TLD is lost.

6.2 Quality Control For the Analytical Program

Quality control for the analytical program involves two components: the quality control activities performed by Energy Northwest 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 Energy Northwest Quality Control Activities

Duplicate samples were submitted to Teledyne Brown for analysis during 2001. These duplicates consisted of two sets of milk samples. The milk duplicates were marked Station 37 and were submitted for analysis at the same time as the milk samples from Station 36.

Energy Northwest also split samples with the Washington State Department of Health (WDOH) at selected stations. Tables 6-2 and 6-3 present comparisons of detectable nuclides found in the various media split between Energy Northwest and WDOH.

6.2.2 Teledyne Brown Engineering Quality Control Program

The goal of the quality control program at Teledyne Brown Engineering - Environmental Services is to produce analytical results that are accurate, precise and supported by adequate documentation. The program is based on the requirements of 10CFR50, Appendix B, Nuclear Regulatory Guide 4.15 and the 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 each weekday the counter is in use. Control charts are maintained with three-sigma limits specified. Backgrounds are usually measured at least once per week[18].

The gamma spectrometers are calibrated annually with a NIST-traceable standard reference material selected to cover the energy range of the nuclides to be monitored for 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 (59.5 and 1332 KeV) and held within three-sigma control limits[19].

The efficiency of the liquid scintillation counters is determined at least annually by counting NIST traceable standards which have been diluted in a known amount of distilled water and various amounts of quenching agent[20]. The background of each counter is measured with each batch of samples. A control chart is maintained for the background and check source measurements as a stability check.

Results are reviewed before being entered into the data system by the Quality Assurance and/or the Department Manager for reasonableness of the parameters (background, efficiency, decay, etc.). Any results that are suspect, being 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.

The U.S. Environmental Protection Agency (EPA) discontinued its Interlaboratory Comparison Program in December 1998. Consequently, there are no "approved" laboratories for intercomparison studies; however, Teledyne participates in the Analytics, Inc. and Environmental Resource Associates (ERA) programs to the fullest extent possible. Teledyne's participation in the programs is for all radioactive isotopes prepared and at the maximum frequency of availability.

NIST is the approval authority for laboratory providers participating in intercomparison study programs. At this time, there are no approved laboratories for environmental and/or radiochemical isotope analyses.

Teledyne Brown participates in the U.S. Department of Energy's Environmental Measurements Laboratory (EML) intercomparison. The results of the two intercomparisons done in 2001 are shown in Table 6-4.

Tables 6-5 and 6-6 present the Teledyne Brown quality control data results for blanks and spikes, respectively. Table 6-7 presents the results of the 2001 ERA Intercomparison as reported to Energy Northwest. Footnotes in the table refer to investigations of problems encountered in a few cases and the steps taken by Teledyne Brown to prevent recurrence. Table 6-8 presents the Analytics Cross Check Comparison results for 2001.

No deviations from written procedures occurred during 2001. A summary of the quality control blank and spiked sample results follow.

Iodine-131 Cartridges

A blank charcoal filter was analyzed with each group of samples assayed. Fifty-two blanks were analyzed in 2001. The blanks were below the detection level.

Gross-Beta - Filters

One blank filter was measured with each set of filters assayed. Fifty-two blanks were counted for 2001. The blanks were all below the detection limit, which 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 assayed. 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. The average activity for two blank samples in 2001 was 2.45E-01 pCi/liter without considering detection limits.

Sr-90 - Milk and Water

Two blank milk samples were analyzed during 2001. The average result, without considering the detection limits, was 6.70E-01 pCi/liter. Two spiked milk samples were analyzed during 2001. The average value of the samples was 3.40E+01 pCi/liter. This is the natural strontium-90 content of milk. During 2001, a total of eighteen blank water samples were analyzed. The average value for the samples was 1.18E-01 pCi/liter. Eighteen spike water samples were analyzed with an average activity of 4.04E+01 pCi/liter of strontium-90.

Gross Beta - Water

Forty-four blanks were prepared from distilled water. The average result without considering detection limits for 2001 was -1.06E-01 pCi/l. Forty-four gross beta spike samples were analyzed during 2001. The average result was 2.47E+01 pCi/l. The results were well within the guidelines outlined in Table 2 of the document, "Environmental Radioactivity Laboratory Intercomparison Studies Program," EPA-600/4-81-004.

Tritium in Water

Seventy blank samples were analyzed by liquid scintillation counting during 2001. The average result without considering detection limits was 1.28E-02 pCi/liter. Seventy tritium spike samples were analyzed by liquid scintillation counting during 2001. The average result was 1.15E+03 pCi/liter.

Gamma Spectroscopy

A blank water sample was analyzed weekly in the gamma spectroscopy laboratory. All nuclides were less than the normal level of detection indicating no contamination. Spike samples were measured using the Cs-137 peak at 662 KeV. The Cs-137 results were within the $\pm$ 3 sigma limits.

TABLE 6-1
2001 ENVIRONMENTAL SPIKED DOSIMETER RESULTS

DISTRIBUTION PERIOD	GIVEN EXPOSURE (mR)	REPORTED EXPOSURE (mR)	BIAS (%)
First Quarter	25	23.6	-5.6
		23.2	-7.2
		23.3	-6.8
Second Quarter	22.5	22.5	0
		23.4	4
		22.5	0
Third Quarter	24.1	22.7	-5.8
		22.3	-7.5
		22.5	-6.6
Fourth Quarter	23.4	24.7	5.6
		24.1	3
		22.9	-2.1
Annual	74.1	67.8	-8.5
		68.2	-8
		65.8	-11.2

TABLE 6-2
2001 ENERGY NORTHWEST/WA. DEPARTMENT OF HEALTH
SPLIT SAMPLE RESULTS

Radionuclide	Energy Northwest Result	Error	WA. Department. of Health Result	Error	Ratio
Matrix: Discharge Water (pCi/l)					
ST.27 02/06/01 Gross Beta	14	4	11	2	1.27
ST.27 03/06/01 Gross Beta	12	3	19	3	0.63
ST.27 04/03/01 Gross Beta	9	2.4	9	1	1.00
ST. 27 05/01/01 Gross Beta	4.3	2.5	7	1	0.61
ST.27 06/05/01 Gross Beta	6.9	2	6.4	1.3	1.08
ST.27 07/03/01 Gross Beta	4.8	1.5	3.2	1.1	1.50
ST.27 08/01/01 Gross Beta	7	2	6.4	1.3	1.09
ST.27 09/05/01 Gross Beta	8.3	2	8	1	1.04
ST.27 10/02/01 Gross Beta	6.4	1.9	7	1	0.91
ST.27 11/06/01 Gross Beta	7.6	2.1	7	1	1.09
ST.27 12/04/01 Gross Beta	7.5	1.5	8	2	0.94
Matrix: Leafy Vegetable (pCi/kg)					
ST.37 06/26/01 K-40	2260	97	2700	100	0.84
ST.37 09/25/01 K-40	620	210	1560	120	0.40
Matrix: Milk (pCi/l)					
ST.36 01/16/01 K-40	1550	127	1350	60	1.15

TABLE 6-2 (cont.)
2001 ENERGY NORTHWEST/WA. DEPARTMENT OF HEALTH
SPLIT SAMPLE RESULTS

Radionuclide	Energy Northwest Result	Energy Northwest Error	WA. Department. of Health Result	WA. Department. of Health Error	Ratio
Matrix: Milk (pCi/l)					
ST.36 02/13/01					
K-40	1380	96	1380	60	1.00
ST.9 03/13/01					
K-40	1230	77	1340	70	0.92
ST.36 03/13/01					
K-40	1400	70	1390	50	1.01
ST.64 03/13/01					
K-40	1370	82	1400	60	0.98
ST.36 04/10/01					
K-40	1330	79	1320	60	1.01
ST.36 05/15/01					
K-40	1270	80	1350	30	0.94
ST.9 06/12/01					
K-40	1230	76	1360	30	0.90
ST.36 06/12/01					
K-40	1350	67	1430	60	0.94
ST.64 06/12/01					
K-40	1330	82	1430	50	0.93
ST.36 08/07/01					
K-40	1390	71	1380	70	1.01
ST.9 09/11/01					
K-40	1240	78	1330	50	0.93
ST.36 09/11/01					
K-40	1330	78	1400	80	0.95
ST.64 09/11/01					
K-40	1380	111	1360	60	1.01
ST.36 10/16/01					
K-40	1260	63	1370	30	0.92
ST.36 11/27/01					
K-40	1370	79	1310	70	1.05
ST.9 12/11/01					

TABLE 6-2 (cont.)
2001 ENERGY NORTHWEST/WA. DEPARTMENT OF HEALTH
SPLIT SAMPLE RESULTS

	Energy Northwest		WA. Department. of Health		
Radionuclide	Result	Error	Result	Error	Ratio
K-40	1220	68	1280	30	0.95
Matrix: Milk (pCi/l)					
ST.36 12/11/01 K-40	2090	132	1350	60	1.55
ST.64 12/11/01 K-40	1280	75	1450	60	0.88
Matrix: Sediment (pCi/kg)					
ST.33 03/21/01 Cs-137	84.8	11.5	62	8	1.37
ST.33 03/21/01 K-40	14800	580	18600	300	0.80
ST.34 03/21/01 Cs-137	224	14.9	240	30	0.93
ST.34 03/21/01 K-40	15300	580	18800	700	0.81
Matrix: Soil (pCi/kg)					
ST.1 06/14/01 Cs-137	307	16.8	760	20	0.40
ST.1 06/14/01 K-40	15000	580	17000	200	0.88
ST.21 06/14/01 Cs-137	5	5.4	30	8	0.17
ST.21 06/14/01 K-40	11000	440	16000	600	0.69
ST.23 06/14/01 Cs-137	91.1	9.9	120	20	0.76
ST.23 06/14/01 K-40	14300	550	17200	700	0.83
Matrix: Fish (pCi/kg)					
ST.30 10/02/01 K-40	2890	285	3500	100	0.83

TABLE 6-3
2001 ENERGY NORTHWEST/WA. DEPARTMENT OF HEALTH
GROSS BETA IN AIR SPLIT SAMPLE RESULTS

	Station 4					Station 8				
	Energy Northwest		WA. Dept. of Health			Energy Northwest		WA. Dept. of Health		
Date	Result	Error	Result	Error	Ratio (DOH/EN)	Result	Error	Result	Error	Ratio (DOH/EN)
01/08/01	0.025	0.003	0.036	0.002	0.69	0.029	0.003	0.031	0.002	0.94
01/15/01	0.027	0.003	0.044	0.003	0.61	0.031	0.003	0.043	0.003	0.72
01/22/01	0.040	0.003	0.050	0.003	0.80	0.042	0.003	0.057	0.009	0.74
01/29/01	0.031	0.003	0.035	0.002	0.89	0.037	0.003	(a)	-	-
02/05/01	0.007	0.002	0.007	0.001	1.01	0.007	0.002	0.007	0.001	0.89
02/12/01	0.018	0.002	0.021	0.002	0.86	0.021	0.002	0.020	0.002	1.05
02/20/01	0.024	0.002	0.035	0.002	0.69	0.027	0.002	0.033	0.002	0.82
02/26/01	0.020	0.003	0.025	0.002	0.80	0.024	0.003	0.023	0.002	1.04
03/05/01	0.013	0.002	0.016	0.001	0.81	0.013	0.002	0.015	0.001	0.87
03/12/01	0.017	0.002	0.019	0.002	0.89	0.017	0.002	0.017	0.001	1.00
03/19/01	0.007	0.002	0.007	0.001	1.04	0.006	0.002	0.005	0.001	1.06
03/26/01	0.013	0.002	0.017	0.001	0.76	0.013	0.002	0.009	0.001	1.44
04/02/01	0.006	0.002	0.007	0.001	0.90	0.006	0.002	0.006	0.001	1.15
04/09/01	0.006	0.002	0.006	0.001	0.98	0.008	0.002	0.004	0.001	1.93
04/16/01	0.007	0.002	0.007	0.001	1.00	0.010	0.002	0.006	0.001	1.64
04/23/01	0.008	0.002	0.009	0.001	0.90	0.011	0.002	0.006	0.001	1.77
04/30/01	0.010	0.002	0.011	0.001	0.91	0.011	0.002	0.008	0.001	1.38
05/07/01	0.009	0.002	0.009	0.001	0.98	0.007	0.002	0.006	0.001	1.06
05/14/01	0.015	0.002	0.019	0.001	0.79	0.018	0.002	0.015	0.001	1.20
05/21/01	0.006	0.002	0.007	0.001	0.86	0.007	0.002	0.004	0.001	1.48
05/29/01	0.015	0.002	0.017	0.001	0.88	0.013	0.002	0.012	0.001	1.08
06/04/01	0.004	0.002	0.005	0.001	0.80	0.005	0.002	0.003	0.001	1.42
06/11/01	0.006	0.002	0.007	0.001	0.79	0.007	0.002	0.005	0.001	1.38
06/18/01	0.006	0.002	0.006	0.001	0.90	0.005	0.002	0.004	0.001	1.33
06/25/01	0.013	0.002	0.012	0.001	1.08	0.014	0.002	0.007	0.001	2.00
07/02/01	0.005	0.002	0.008	0.001	0.66	0.009	0.002	0.005	0.001	1.83
07/09/01	0.017	0.002	0.016	0.001	1.06	0.014	0.002	0.010	0.001	1.40
07/16/01	0.008	0.002	0.012	0.001	0.68	0.012	0.002	0.008	0.001	1.50
07/23/01	0.014	0.002	0.006	0.001	2.33	0.019	0.002	0.003	0.001	6.33
07/30/01	0.008	0.002	0.011	0.001	0.75	0.011	0.002	0.006	0.001	1.77
08/06/01	0.009	0.002	0.011	0.001	0.85	0.008	0.002	0.005	0.001	1.48

TABLE 6-3 (cont.)
2001 ENERGY NORTHWEST/WA. DEPARTMENT OF HEALTH
GROSS BETA IN AIR SPLIT SAMPLE RESULTS

	Station 4					Station 8				
	Energy Northwest		WA. Dept. of Health			Energy Northwest		WA. Dept. of Health		
Date	Result	Error	Result	Error	Ratio (DOH/EN)	Result	Error	Result	Error	Ratio (DOH/EN)
08/13/01	0.017	0.002	0.020	0.002	0.85	0.015	0.002	0.009	0.001	1.67
08/20/01	0.017	0.002	0.022	0.002	0.77	0.019	0.002	0.012	0.001	1.58
08/27/01	0.009	0.002	0.013	0.001	0.67	0.011	0.002	0.006	0.001	1.72
09/04/01	0.013	0.002	0.017	0.001	0.76	0.011	0.002	0.008	0.001	1.39
09/10/01	(b)	-	0.013	0.001	-	(b)	-	0.005	0.001	-
09/17/01	0.026	0.003	0.028	0.002	0.93	0.021	0.002	0.012	0.001	1.75
09/24/01	0.015	0.002	0.025	0.002	0.60	0.014	0.002	0.012	0.001	1.17
10/01/01	0.015	0.002	0.022	0.002	0.68	0.012	0.002	0.015	0.002	0.80
10/08/01	0.024	0.003	0.033	0.002	0.73	0.023	0.002	0.024	0.002	0.96
10/15/01	0.009	0.002	0.012	0.001	0.72	0.006	0.002	0.010	0.001	0.63
10/22/01	0.011	0.002	0.017	0.002	0.65	0.010	0.002	0.014	0.001	0.71
10/29/01	0.011	0.002	0.017	0.002	0.65	0.012	0.002	0.013	0.001	0.92
11/05/01	0.015	0.002	0.023	0.002	0.65	0.014	0.002	0.016	0.002	0.88
11/12/01	0.028	0.003	0.052	0.002	0.54	0.028	0.003	0.035	0.002	0.80
11/19/01	0.017	0.002	0.029	0.002	0.59	0.017	0.002	0.022	0.002	0.77
11/26/01	0.007	0.002	0.010	0.001	0.65	0.006	0.002	0.007	0.001	0.85
12/03/01	0.007	0.002	0.009	0.001	0.76	0.007	0.002	0.006	0.001	1.15
12/10/01	0.005	0.002	0.006	0.001	0.86	0.005	0.002	0.004	0.001	1.12
12/17/01	0.006	0.002	0.004	0.001	1.44	0.006	0.002	0.005	0.001	1.36
12/26/01	0.020	0.002	0.025	0.002	0.80	0.021	0.002	0.022	0.002	0.95
12/31/01	0.050	0.004	(c)	-	-	0.054	0.004	(c)	-	-

Footnotes
(a) Sampler out of service. No sample collected.
(b) Sample lost in shipment.
(c) No data received.

TABLE 6-4
2001 ENVIRONMENTAL MEASUREMENTS LABORATORY (EML)
QUALITY ASSESSMENT PROGRAM RESULTS

DATE	SAMPLE TYPE[a]	NUCLIDE	REPORTED RESULT	ERROR	EML VALUE	EML ERROR	RATIO REPORTED/EML
03/01	Air	Co-60	19.400	0.130	19.440	0.500	0.998
	(Bq/filter)	Cs-134	2.590	0.770	2.830	0.160	0.915
		Cs-137	9.520	0.060	8.760	0.340	1.087
		Gr-β	2.260	0.150	2.580	0.150	0.876
		Mn-54	6.960	0.080	6.520	0.280	1.067
		Sr-90	7.460	0.230	7.100	0.220	1.051
03/01	Soil	Cs-137	1696.000	116.700	1740.000	90.000	0.975
	(Bq/kg)	K-40	464.800	27.000	468.000	25.000	0.993
		Sr-90	80.800	2.670	69.000	5.700	1.171
03/01	Vegetation	Co-60	34.000	0.900	30.400	1.200	1.118
	(Bq/kg)	Cs-137	1005.000	35.700	842.000	42.000	1.194
		K-40	728.000	68.400	603.000	32.000	1.207
		Sr-90	1283.000	88.300	1330.000	70.000	0.965
03/01	Water	Co-60	100.300	6.930	98.200	3.600	1.021
		Cs-137	75.800	2.800	73.000	3.700	1.038
		Gr-α	1600.000	100.000	1900.000	190.000	0.842
		Gr-β	1200.000	100.000	1297.000	100.000	0.925
		H-3	61.000	23.000	79.300	2.000	0.769
		Sr-90	4.570	0.220	4.400	0.200	1.039
09/01	Air	Co-60	18.800	0.300	17.500	0.470	1.074
	(Bq/filter)	Cs-134	12.700	0.700	12.950	0.362	0.981
		Cs-137	20.800	0.500	17.100	0.580	1.216
		Gr-β	12.000	0.200	12.770	1.277	0.940
		Mn-54	97.100	1.660	81.150	4.760	1.197
		Sr-90	2.560	0.340	3.481	0.233	0.735
09/01	Soil	Cs-137	680.500	11.900	612.330	30.620	1.111
	(Bq/kg)	K-40	673.000	21.000	623.330	33.040	1.080
		Sr-90	29.600	6.300	30.596	1.065	0.967
09/01	Vegetation	Co-60	39.800	1.000	35.300	1.436	1.127
	(Bq/kg)	Cs-137	1235.000	15.000	1030.000	51.800	1.199
		K-40	1090.000	27.000	898.670	48.230	1.213
		Sr-90	1253.000	23.300	1612.800	48.600	0.777
09/01	Water	Co-60	207.300	3.500	209.000	7.590	0.992
	(Bq/l)	Cs-137	47.700	1.800	45.133	2.467	1.057
		Gr-α	1333.000	100.000	1150.000	115.000	1.159
		Gr-β	8533.000	200.000	7970.000	800.000	1.071
		H-3	212.300	30.300	207.000	2.690	1.026
		Sr-90	4.760	2.220	3.729	0.364	1.276

Footnote:
(a) Bq = Becquerel. One picocurie equals 0.037 Becquerel

TABLE 6-5
2001 TELEDYNE BROWN QUALITY CONTROL DATA - BLANKS

NUCLIDE	MEDIUM	NUMBER	AVERAGE RESULT (pCi/l)
I-131	Milk	2	2.45E-01
Sr-90	Milk	2	6.70E-01
Sr-90	Water	18	1.18E-01*
Tritium	Water	70	1.28E-02*
Gross Beta	Water	44	-1.06E-01*

Footnote:

* All nuclides less than minimum detection level

TABLE 6-6
2001 TELEDYNE BROWN QUALITY CONTROL DATA - SPIKES

NUCLIDE	MEDIUM	NUMBER	AVERAGE RESULT (pCi/l)	ACCEPTABLE SPIKE RANGE
Gross Beta	Water	44	2.47E+01	2.21-2.53E+01
Tritium	Water	70	1.15E+03	1.13E+03
Sr-90	Water	18	4.04E+01	1.28-5.80E+01
Sr-90	Milk	2	3.40E+01	1.5-5.3E+01

TABLE 6-7
2001 ERA CROSS CHECK COMPARISON PROGRAM

Date	Media	Nuclide	ERA Known Value[a] (pCi/l)	TBE Result[b] (pCi/l)	Ratio TBE/EML[c]	Performance Evaluation[d]
02/01	Water	Co-60	91.1	95.5	1.05	A
		Cs-134	59.8	60.5	1.01	A
		Cs-137	45	48	1.07	
08/01	Water	Total U	52.9	60.3	1.14	A
		Ra-226	15.4	14.7	0.95	A
08/01	Water	Gr-Alpha	17.8	15.2	0.85	A
		Gr-Beta	53	52	0.98	A
09/01	Water	Ba-133	36	35.5	0.99	A
		Co-60	46.8	47.6	1.02	A
		Cs-134	15.9	15.5	0.97	A
		Cs137	197	206	1.05	A
		Zn-65	36.2	35.4	0.98	A
09/01	Water	Sr-89	31.2	26.4	0.85	A
		Sr-90	25.9	28.2	1.09	A
08/01	Water	H-3	2730	2370	0.87	A
12/01	Water	I-131	4.38	3.77	0.86	A

Footnotes:

(a) The ERA Known Value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(b) Average $\pm$ 1 sigma.

(c) Ratio of Teledyne Brown Engineering to ERA results.

(d) A= Acceptable. Reported Result falls within the Warning Limits.
NA = Not Acceptable. Reported Result falls outside of the Control Limits.
CE = Check for Error. Reported Result falls within the Control Limits and outside of the Warning Limits.

TABLE 6-8
2001 ANALYTICS, INC. CROSS CHECK COMPARISON PROGRAM

Month/Year	Matrix	Nuclide	Teledyne Brown Engineering Result[a]	Analytics Result	Ratio[b]	Evaluation[d]
03/01	Milk	I-131 (pCi/l)	75	77	0.97	A
		Ce-141 (pCi/l)	166	162	1.03	A
		Cr-51 (pCi/l)	433	418	1.04	A
		Cs-134 (pCi/l)	212	223	0.95	A
		Cs-137 (pCi/l)	165	176	0.94	A
		Co-58 (pCi/l)	81	82	0.99	A
		Mn-54 (pCi/l)	172	175	0.98	A
		Fe-59 (pCi/l)	151	146	1.03	A
		Zn-65 (pCi/l)	314	322	0.98	A
		Co-60 (pCi/l)	254	254	1.00	A
05/01	Water	Sr-89 (μCi/ml)	2.50E-03	2.95E-03	0.85	A
		Sr-90 (μCi/ml)	2.00E-04	2.27E-04	0.88	A
	Water	Gr-α (μCi/ml)	1.70E-04	1.45E-04	1.17	A
	Water	Fe-55 (μCi/ml)	2.40E-04	2.53E-04	0.95	A
06/01	Charcoal	I-131 (pCi)	104.5	81	1.29	W
	Charcoal	I-131 (pCi)	84.8	72	1.18	A
	Charcoal	I-131 (pCi)	99.6	92	1.08	A
08/01	Milk	Mn-54 (pCi/l)	131	124	1.06	A
		Co-58 (pCi/l)	68	68	1.00	A
		Fe-59 (pCi/l)	53	50	1.06	A
		Co-60 (pCi/l)	134	132	1.02	A
		Zn-65 (pCi/l)	172	162	1.06	A
		I-131 (pCi/l)	76	86	0.88	A
		Cs-134 (pCi/l)	141	128	1.10	A
		Cs-137 (pCi/l)	126	120	1.05	A
		Ce-141 (pCi/l)	75	76	0.95	A
08/01	AP Filter	Ce-141 (pCi)	79	74	1.07	A
		Cr-51 (pCi)	100	90	1.11	A
		Cs-134 (pCi)	109	125	0.87	A
		Cs-137 (pCi)	140	116	1.21	W
		Co-58 (pCi)	72	66	1.09	A
		Mn-54 (pCi)	161	134	1.20	A
		Fe-59 (pCi)	51	49	1.04	A
		Zn-65 (pCi)	200	158	1.27	W
		Co-60 (pCi)	148	128	1.16	A
08/01	Charcoal	I-131 (pCi)	87	93	0.94	A
09/01	Liquid	Sr-89 (Total μCi)	1.30E-03	1.55E-03	0.84	A
		Sr-90 (Total μCi)	1.00E-04	1.12E-04	0.89	A

TABLE 6-8 (cont.)
2001 ANALYTICS, INC. CROSS CHECK COMPARISON PROGRAM

Month/Year	Matrix	Nuclide	Teledyne Brown Engineering Result[a]	Analytics Result	Ratio[b]	Evaluation[d]
09/01	Charcoal	I-131 (Total μCi)	0.483	0.495	0.98	A
09/01	Air Filter	Ce-141 (pCi)	4.99E-02	5.25E-02	0.95	A
		Cr-51 (pCi)	1.68E-01	1.85E-01	0.91	A
		Cs-134 (pCi)	2.47E-02	2.97E-02	0.83	A
		Cs-137 (pCi)	5.18E-02	5.73E-02	0.90	A
		Co-58 (pCi)	4.60E-02	4.75E-02	0.97	A
		Mn-54 (pCi)	3.96E-02	4.02E-02	0.99	A
		Fe-59 (pCi)	2.99E-02	2.92E-02	1.02	A
		Zn-65 (pCi)	5.22E-02	5.12E-02	1.02	A
		Co-60 (pCi)	4.71E-02	4.83E-02	0.98	A
09/01	Liquid	Gr-α (Total μCi)	5.80E-04	4.67E-04	1.24	A
09/01	Liquid	Gr-α (μCi/cc)	1.70E-04	1.45E-04	1.17	A
		H-3 (μCi/cc)	2.92E-03	1.77E-03	1.65	A
09/01	Milk	I-131 (pCi/l)	100	91	1.10	A
		Ce-141 (pCi/l)	126	121	1.04	A
		Cr-51 (pCi/l)	349	366	0.95	A
		Cs-134 (pCi/l)	147	160	0.92	A
		Cs-137 (pCi/l)	321	319	1.01	A
		Co-58 (pCi/l)	190	177	1.07	A
		Mn-54 (pCi/l)	205	205	1.00	A
		Fe-59 (pCi/l)	85	86	0.99	A
		Zn-65 (pCi/l)	246	254	0.98	A
		Co-60 (pCi/l)	261	266	0.98	A
09/01	Charcoal	I-131 (pCi)	68.6	67	1.02	A
09/01	Air Filter	Ce-141 (pCi)	118	116	1.02	A
		Cr-51 (pCi)	362	351	1.03	A
		Cs-134 (pCi)	135	153	0.88	A
		Cs-137 (pCi)	350	307	1.14	A
		Co-58 (pCi)	184	170	1.08	A
		Mn-54 (pCi)	230	197	1.17	A
		Fe-59 (pCi)	100	82	1.22	W
		Zn-65 (pCi)	305	244	1.25	W
		Co-60 (pCi/l)	267	255	1.05	A
12/01	Milk	Sr-89 (pCi/l)	75	85	0.96	A
		Sr-90 (pCi/l)	44	59	1.27	W
		Fe-55 (pCi/l)	108	99	1.09	A

TABLE 6-8 (cont.)
2001 ANALYTICS, INC. CROSS CHECK COMPARISON PROGRAM

Month/Year	Matrix	Nuclide	Teledyne Brown Engineering Result[a]	Analytics Result	Ratio[b]	Evaluation[d]
12/01	Milk	I-131 (pCi/l)	50	61	0.82	A
		Ce-141 (pCi/l)	352	379	0.93	A
		Cr-51 (pCi/l)	468	497	0.94	A
		Cs-134 (pCi/l)	173	199	0.87	A
		Cs-137 (pCi/l)	312	318	0.98	A
		Co-58 (pCi/l)	92	90	1.02	A
		Mn-54 (pCi/l)	148	149	0.99	A
		Fe-59 (pCi/l)	101	102	0.99	A
		Zn-65 (pCi/l)	192	206	0.93	A
		Co-60 (pCi/l)	322	353	0.93	A
12/01	Air Filter	Ce-141 (pCi)	185	181	1.02	A
		Cr-51 (pCi)	190	237	0.80	A
		Cs-134 (pCi)	74	95	0.78	W
		Cs-137 (pCi)	163	152	1.07	A
		Co-58 (pCi)	46	43	1.07	A
		Mn-54 (pCi)	80	71	1.13	A
		Fe-59 (pCi)	57	49	1.16	A
		Zn-65 (pCi)	119	99	1.20	A
		Co-60 (pCi/l)	165	169	0.98	A
12/01	Charcoal	I-131 (pCi)	89	92	0.93	A

Footnotes:

(a) The Analytics Known Value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(b) Average ± 1 sigma.

(c) A=Acceptable. Reported result falls within ratio limits of 0.80-1.20

W=Acceptable with warning. Report result falls within ratio limits of 0.70-0.79 and 1.21-1.30.

7.0 REFERENCES

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7. Energy Northwest Nuclear Columbia Generating Station, Operating License NPF-21, "Technical Specifications" Sections 5.5.1, 5.5.4, and 5.6.2

8. Columbia Generating Station 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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15. Robertson, D. E., and J. J. Fix, "Association of Hanford Origin Radionuclides With Columbia River Sediment," BNWL-2305, August 1977.

16. Energy Facility Site Evaluation Council, Resolution No. 259, amended November 1994.

17. Energy Facility Site Evaluation Council, Resolution No. 299, approved August 13, 2001.

18. Teledyne Brown Engineering - Environmental Services PRO-032-27, "Calibration and Control of Alpha/Beta Counters."

19. Teledyne Brown Engineering - Environmental Services PRO-042-44, "Calibration and Control of Gamma Ray Spectrometers."

20. Teledyne Brown Engineering - Environmental Services PRO-052-35, "Determination of Tritium by Liquid Scintillation."

21. Energy Northwest, "Columbia Generating Station Final Safety Analysis Report," Section 2.3.1.1.

8.0 2000 REMP REPORT ERRATA

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Corrections to errors found in the 2000 Radiological Environmental Monitoring Program Annual Report are listed below.

Page 4-13, Table 4-2: Stations 121 and 122 should be in the NNW sector.

Page 4-14, Table 4-2: Station 13 should be in the W sector.