SUSQUEHANNA STEAM ELECTRIC STATION

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

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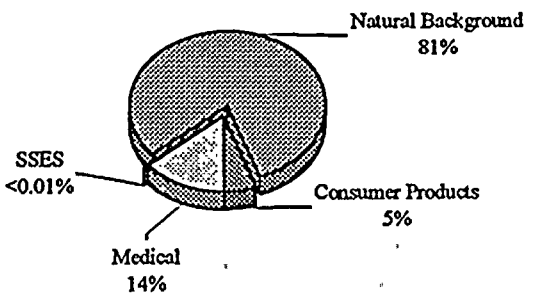
SUMMARY AND CONCLUSIONS

Radiological Dose Impact

The extent of the 1998 Radiological Environmental Monitoring Program (REMP) sampling met or exceeded the requirements of the Susquehanna Steam Electric Station (SSES) Technical Requirements. The types of analyses that were performed on these samples for the identification and quantification of radioactivity also met or exceeded the SSES Technical Requirements during the 1998 REMP. The result of this effort was the verification of the SSES Effluent Monitoring Program data that indicate that the SSES operation has no deleterious effect on the health and safety of the public or the environment.

The amounts of the radionuclides detected in environmental samples during 1998 were very small, as in past years. Based on the radionuclide levels measured by the REMP, the maximum whole body dose or maximum organ dose to a member of the public from SSES operation is estimated to be less than one-tenth of one percent of the per unit dose limits established by the Nuclear Regulatory Commission (NRC) as stated in 10 CFR 50, Appendix I. The maximum hypothetical off-site whole body and organ doses from radionuclides detected by the REMP and attributable to the SSES operations were each calculated to be approximately 0.00076 mrem/year.

COMPARISON OF PERCENT OF AVERAGE ANNUAL PUBLIC EFFECTIVE DOSE-EQUIVALENT FROM OTHER SOURCES WITH THAT FROM THE SSES



Sources for the values provided, with the exception of Susquehanna, are the following from NCRP Report #93 (1987): Tables 2.4 (Natural Background), 5.1 (Consumer Products), and 7.4 (Medical).

By contrast, potassium-40, a very long-lived, naturally occurring radionuclide found in the human body, is estimated to deliver an average annual dose to the blood forming organs of individuals in the United States of about 27 millirem. While a small portion of the background dose from natural radiation sources, the potassium-40 dose is still more than 35,000 times the estimated maximum whole body and organ doses to a hypothetical member of the public from ingestion of radionuclides attributable to the SSES.

The maximum direct radiation dose from SSES operation to a member of the public was determined to be 0.0045 millirem/year. The total whole body dose from both ingested radionuclides and direct radiation is negligible compared to the public's exposure from natural background radiation, medical irradiation, and radiation from consumer products of more than 300 millirem/year effective dose-equivalent.

Identified Radionuclides and Their Dose Contributions

Naturally Occurring Radionuclides

In 1998, the SSES REMP reported the naturally occurring radionuclides beryllium-7, potassium-40, radium-226, and thorium-228 in the environment at levels exceeding the minimum detectable concentrations (MDCs) for their respective gamma spectroscopic analyses. Beryllium-7 was identified in sediment, air, and lettuce. Potassium-40 was observed in fish, sediment, air, milk, soil, and fruit and vegetables. Thorium-228 was found in sediment and soil. Radium-226 also was seen in sediment and soil. None of these results were unexpected, and they are not related to the operation of the SSES. Doses from the presence of these radionuclides were not included in the estimate of the dose from SSES attributable radionuclides.

Man-made Radionuclides

Although not all due to SSES operation, the following man-made radionuclides were reported at levels in the environment in excess of the MDCs for their respective analyses: tritium, iodine-131, and cesium-137. These radionuclides, with the exception of cesium-137, were identified in surface water. Tritium was measured above minimum detectable concentrations in some surface water and drinking water analyzed. Iodine-131 was identified in surface water and drinking water. Cesium-137 was observed in sediment and soil.

Tritium was the only man-made radionuclide attributed to the SSES operation. Tritium in media other than Susquehanna River water downstream of the SSES was attributed to both natural production by the interaction of cosmic radiation with the upper atmosphere and previous atmospheric testing of nuclear weapons. The presence of cesium-137 was attributed to non-SSES sources. Cesium-137 was considered to be present only as residual fallout from atmospheric weapons testing. Iodine-131 was believed to be found in the aquatic pathway only as the result of the discharge of medical waste to the Susquehanna or Lackawanna Rivers through sewage treatment plants upstream of the SSES.

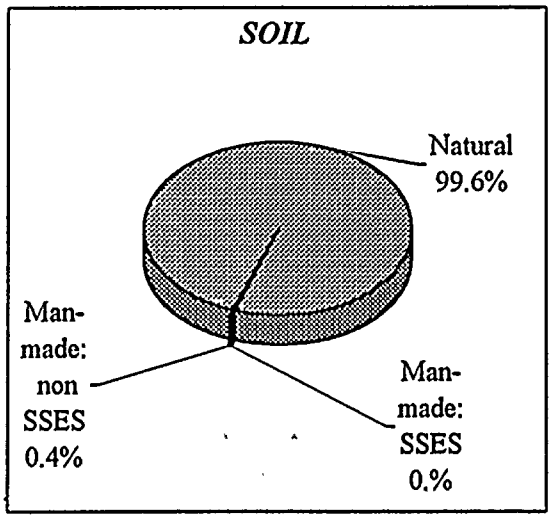
All of the man-made radionuclides mentioned above were not analyzed for in all media. For example, no analyses were performed in an effort to determine iodine-131 levels in ground water. When selecting the types of analyses that would be performed, consideration was given to the potential importance of different radionuclides in the pathways to man and the regulatory analysis requirements for various environmental media.

Relative Radionuclide Activity Levels in Selected Media

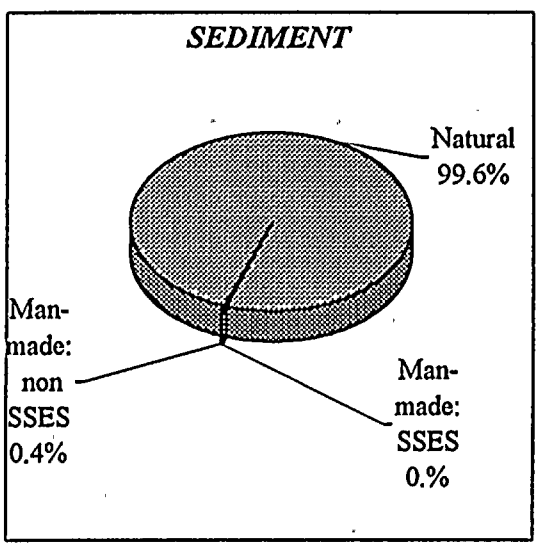
Some media monitored in the environment are significant for the numbers of gamma-emitting radionuclides routinely measured at levels exceeding analysis MDCs. Sediment in the aquatic pathway and soil in the terrestrial pathway are two such media.

The following pie graphs show the relative activity contributions for the types of gamma-emitting radionuclides reported at levels above the analysis MDCs in sediment and soil at indicator locations during 1998.

AQUATIC PATHWAY PERCENT TOTAL GAMMA ACTIVITY



TERRESTRIAL PATHWAY PERCENT TOTAL GAMMA ACTIVITY



Naturally occurring radionuclides account for 99.6% of the gamma-emitting activity in sediment and in soil in 1998. Man-made radionuclides of non-SSES origin account for all the rest of the gamma-emitting activity in

sediment and in soil during 1998. Generally, the activity for naturally occurring radionuclides reported in sediment and soil dwarfs the activity of the man-made radionuclides also reported, especially those originating from the SSES.

Dose Significance of Radionuclides

Of the three man-made radionuclides reported in the environment by the SSES REMP, tritium is the only radionuclide attributable to the SSES operation.

Because tritium was the only radionuclide attributable to the SSES operation, the dose to members of the public from REMP-identified radionuclides was based on the amount of this radionuclide estimated to have been released from the SSES. This radionuclide was included in the dose calculation because it was identified in the REMP samples of water being discharged to the river. The concentration of tritium in the water and the volume of water discharged were used to determine the amount of tritium released. The presumed exposure pathways to the public from this radionuclide were drinking water taken from the Susquehanna River at Danville, PA, and eating fish caught near the SSES discharge to the river. Exposure from tritium was only assumed to occur through the eating of fish and the consumption of drinking water. This assumption is based on the fact that tritium does not emit gamma radiation and the beta radiation emitted by tritium is not sufficiently penetrating to reach an individual on the shore.

Radioactive Materials Releases

Radioactive Materials Generation

The SSES produces the thermal power to generate electricity using two boiling water reactors (BWRs). Radioactive materials are produced at the SSES by the fissioning of uranium and the activation of materials inside the cores of these nuclear reactors. When very small quantities of fission products escape through the cladding of the core's fuel rods, they enter the water with the activation products circulating through the reactor.

Since the mid-1980s, improvements in the following have all contributed to minimization of the escape of radioactive materials from the fuel to the reactor core's circulating water: the manufacture of nuclear fuel, PP&L Inc.'s fuel conditioning (to minimize heat stresses on the fuel), reductions in the numbers of reactor scrams (rapid control rod insertions) that put stresses on the fuel, and maintenance of good water chemistry in the reactors. This has been responsible for significant reductions in the already relatively small amounts of some radioactive materials released in both gaseous and liquid effluents from the SSES.

Gaseous Effluents

In boiling water reactors (BWRs), such as the SSES Units 1 and 2, some fraction of the radioactive materials that enter the circulating water are vaporized and others are entrained in the steam, carrying over to the turbines and eventually the condensers. In turn, some fraction of the radioactive materials in the condensers are removed from them with the offgas. Offgas is eventually released to the atmosphere through turbine building vents. Other pathways also exist for the release of gases through each of five continuously monitored rooftop vents at the SSES.

The radioactive material released as gaseous effluent from the SSES may be divided into the following three categories: noble gases (xenons and kryptons), iodines and particulates, and tritium (a radioactive isotope of hydrogen). These categories are used for the purposes of tracking the amounts of radioactive material being released from the SSES and monitoring the SSES release performance. Reduction of the amounts of radioactivity otherwise destined to be released with the gaseous effluent depends on the category into which the radioactive material fits.

Short-lived noble gas activity is reduced by radioactive waste processing systems which delay the release of gases to the environment to permit them to decay prior to release. Iodine and particulate radioactivity in the gaseous effluent are reduced by adsorption in charcoal beds and capture in particulate filters, respectively. There is a total of 74 tons of charcoal distributed in five beds that the gaseous effluent must pass through prior to release. A delay time of over 30 days for some of the gases is expected

as a result of the charcoal beds, providing a significant amount of decay time prior to release. This provides for a significant reduction in the radioactivity levels of the gases before release. The charcoal is typically very efficient at capturing the iodine. Similarly, the particulate filters are expected to have capture efficiencies of more than 99.7% for particles 0.3 microns or larger in size.

Unfortunately, no practical means yet exists to eliminate tritium from the gaseous effluent. Some elimination of tritium in the form of tritiated water vapor by chilling of the offgas and subsequent collection of the condensate prior to passage through the charcoal adsorbers does occur. But, the primary purpose of this chilling is to reduce the moisture entering the charcoal beds so that they will maintain their efficiency for the removal of iodine.

Liquid Effluents

Maintaining the quality of water circulating through the reactor core at acceptable levels and capturing water that leaks from reactor systems, results in the generation of waste water at the SSES. This waste water also contains radioactivity that has escaped from fuel rod cladding. In order to minimize the release of this water to the environment, as much of it as is practical is cleaned up and recycled. Because this water sometimes contains chemicals that may be harmful to the reactor if recycled, some water must be released in batches to the Susquehanna River.

For the purpose of tracking radioactive releases and monitoring SSES release performance, liquid effluent radioactive materials are divided into two groups, tritium being one group, and all other radioactive materials constituting the other. Prior to releasing water to the river, a significant effort is made to reduce the level of radioactivity in waste water to levels which are as low as practicable by filtering the water through media, such as diatomaceous earth, and passing it through ion exchange material, similar in function to household water softeners. These methods are effective to varying degrees with all of the radioactive materials except tritium, which can't be removed from water by either method. For most radionuclides, the ion exchange media may be expected to have a removal efficiency of roughly 99%.

Controlling Radioactive Releases

NRC regulations (10 CFR 50.34 and 10 CFR 20.1101b) require that nuclear power plants be designed, constructed, and operated to keep levels of radioactive materials in effluents to areas unrestricted to the public as low as reasonably achievable (ALARA). To ensure that these criteria are met, each license authorizing reactor operation includes technical specifications (10 CFR 50.36a) that contain requirements governing radioactive effluents. Instantaneous, as well as quarterly and annual limits, have been set based on the dose that the maximally exposed individual in the public could be expected to receive. During routine operation of the SSES, doses are kept as much below these actual limits as possible.

The NRC release limits are far below the approximately 300 millirem dose received on average each year by

residents of the United States from all natural background sources. On the other hand, the allowable limits are far above the doses estimated for the levels of radioactivity actually being released from the SSES. The actual doses are typically small fractions of one millirem or less per year of SSES operation. Such doses are far below the levels at which any health effects would be expected to be observed in the exposed population.

Monitoring Releases

Roof top vents from which gaseous releases take place are continuously monitored to detect any excessive rates of radioactivity release that might occur well before any release limits are reached. Also, discharge rates of radioactively contaminated water to the Susquehanna River are carefully controlled to remain as far below the discharge limits as possible. Discharges are monitored by radiation detectors so that if levels of radioactivity in the water would inadvertently approach the limits of permissible levels, the discharges could be stopped quickly.

Radiological Environmental Monitoring

In addition to the steps taken to control and to monitor radioactive effluents from the SSES, the SSES Technical Specifications also require a program for the radiological monitoring of the environment in the vicinity of the SSES. The objectives of the SSES REMP are as follows:

- Fulfillment of SSES Technical Requirements' radiological environmental surveillance obligations,
- Verification of no detrimental effects on public health and safety and the environment from SSES operations,
- Assessment of dose impacts to the public, if any,
- Verification of adequate SSES radiological effluent controls, and
- Identification, measurement, trending, and evaluation of radionuclides and their concentrations in critical environmental pathways near the SSES.

PP&L has maintained a Radiological Environmental Monitoring Program (REMP) in the vicinity of the existing Susquehanna Steam Electric Station Units 1 and 2 since April, 1972, prior to construction of both units and ten years prior to the initial operation of Unit 1 in September, 1982. The SSES is located on an approximately 1500 acre tract along the Susquehanna River, five miles northeast of Berwick in Salem Township, Luzerne County, Pennsylvania. The area around the site is primarily rural, consisting predominately of forest and agricultural lands. (More specific information on the demography, hydrology, meteorology, and land use characteristics of the area in the vicinity of the SSES can be found in the Environmental Report (14), the Final Safety Analysis Report (15), and the Final Environmental Statement (16) for the SSES.) The purpose of the preoperational REMP (April, 1972 to

September, 1982) was to establish a baseline for radioactivity in the local environment that could be compared with the radioactivity levels observed in various environmental media throughout the operational lifetime of the SSES. This comparison facilitates assessments to be made of the radiological impact of the SSES operation.

The SSES REMP was designed on the basis of the NRC's Radiological Assessment Branch Technical Position on radiological environmental monitoring, as described in Revision 1, November 1979.(17) However, the REMP conducted by PP&L for the SSES exceeds the monitoring suggested by the NRC's branch technical position, as well as the SSES Technical Requirements in terms of the number of monitoring locations, the frequency of certain monitoring, the types of analyses required for the samples, and the achievable analysis sensitivities.

Potential Exposure Pathways

The three pathways through which radioactive material may reach the public from nuclear power plants are the atmospheric, terrestrial, and aquatic pathways. (Figure 1 depicts these pathways for the intake of radioactive materials.) Comprehensive radiological environmental monitoring must sample media from all of these pathways.

Mechanisms by which people may be exposed to radioactivity and radiation in the environment vary with the pathway. Three mechanisms by which a member of the public has the potential to be exposed to radioactivity or radiation from nuclear power plants such as the SSES are as follows:

- inhalation (breathing)
- ingestion (eating and drinking), and
- whole body irradiation directly from a plant or from immersion in the radioactive effluents.

REMP Scope

During the operational period of the SSES, it has been important to establish two different categories of monitoring locations, called control and indicator locations, to further assist in assessing the impact of the station operation. So-called control monitoring locations have been situated at sites where it is considered unlikely that radiation or radioactive material from normal station operation would be detected. Indicator monitoring locations are sited where it is expected that radiation and radioactive material that might originate from the station would be most readily detectable.

Control locations for the atmospheric and terrestrial pathways are more than 10 miles from the station. Preferably, the controls also are in directions from the station less likely to be exposed to wind blowing from the station than are the indicator locations. Control monitoring locations for the aquatic pathway, the Susquehanna River, are upstream of the station's discharge to the river.

Indicator monitoring locations are selected primarily on the basis of proximity to the station, although factors such as meteorology, topography, and sampling practicality also are considered. Indicator locations

for the atmospheric and terrestrial pathways are typically less than 10 miles from the station. Most often, they are within 5 miles of the station. Indicator locations in the Susquehanna River are downstream of the station's discharge. Monitoring results from indicator locations are compared with results from control locations. These comparisons are made to discern any differences in the levels and/or types of radioactive material and/or radiation that might exist between indicators and controls and that could be attributable to the station.

In 1998, the SSES REMP collected more than 900 samples at more than 40 locations and performed nearly 1,700 analyses. In addition, the REMP monitors ambient radiation levels using thermoluminescent dosimeters (TLDs) at 86 indicator and control locations, making as many as 344 radiation level measurements each year. The media monitored and analyses performed are summarized in the table above. Figures 2 through 7 display the REMP TLDs and sampling locations in the vicinity of the SSES. Appendix C provides directions, distances, and a brief description of each of the locations in Figures 2 through 7.

Regulatory agencies also participate in monitoring the SSES environment and also oversee PP&L Inc.'s monitoring efforts. The State of Pennsylvania's Department of Environmental Protection (PADEP) monitors air for radioactive particulates and radioactive iodine, milk, fruits and vegetables, surface and drinking water, fish, river sediments, and ambient radiation levels. PADEP makes this data available to the NRC. The NRC also conducts an independent monitoring program of the ambient radiation levels near the SSES. Inspectors from the NRC regularly visit both PP&L Inc.'s Corporate Office and the SSES to review procedures and records, conduct personnel interviews, observe activities first-hand, and generally examine the programs supporting the effluent and environmental monitoring for the SSES.

SSES REMP	
Type of Monitoring	**Media Monitored**
Gross Alpha Activity	Drinking Water
Gross Beta Activity	All Waters except Ground Water and Air Particulates
Gamma-Emitting Radionuclide Activities	All Media
Tritium Activity	All Waters
Iodine-131 Activity	Surface Water, Drinking Water, Air & Milk
Exposure Rates (by TLD)	Ambient Radiation Levels

REMP Monitoring Sensitivity

The sensitivity of the SSES REMP was demonstrated in 1986, following the problem with the Chernobyl reactor in the former Soviet Union. When the Chernobyl incident occurred, the SSES REMP was able to detect a relatively small increase in the level of gross beta activity in air samples at both control and indicator locations, as well as the presence of some specific radioactive materials that are not normally observed. Detection of radiation and radioactive material from the SSES in the environment is complicated by the presence of naturally occurring radiation and radioactive materials from both terrestrial and cosmic sources. Man-made radiation and radioactive material from non-SSES sources, such as nuclear fallout from previous nuclear weapons tests and medical wastes, also can make identification of SSES radiation and radioactive material difficult. Together, this radiation and radioactive material present background levels from which an attempt is made to distinguish relatively small contributions from the SSES. This effort is further complicated by the natural variations that typically occur from both monitoring location to location and with time at the same locations.

The naturally occurring radionuclides potassium-40, beryllium-7, radium-226, and thorium-228 are routinely observed in certain environmental media. Potassium-40 has been observed in all monitored media and is routinely seen at readily detectable levels in such media as milk, meat, fish, and fruits and vegetables. Seasonal variations in beryllium-7 in air samples are regularly observed. Man-made radionuclides, such as cesium-137 and strontium-90 left over from nuclear weapons testing are often observed as well. In addition, the radionuclide tritium, produced by both cosmic radiation interactions in the upper atmosphere as well as man-made (nuclear weapons), is another radionuclide typically observed.

Radioactivity levels in environmental media are usually so low that their measurements, even with state-of-the-art measurement methods, typically have significant degrees of uncertainty associated with them.(18) As a result, expressions are often used when referring to these measurements that convey information about the levels being measured relative to the measurement sensitivities. Terms such as "minimum detectable concentration" (MDC) are used for this purpose. When the value of the MDC for a specific measurement is compared to the value of the actual measurement, the comparison provides information about the difficulty in differentiating the activity being measured from background activity. The formulas used to calculate MDCs may be found in Appendix E.

The methods of measurement for sample radioactivity levels used by PP&L Inc.'s contracted REMP radioanalytical laboratory are capable of meeting the analysis sensitivity requirements found in the SSES Technical Requirements. Summary descriptions of the analytical procedures and the accompanying calculational methods used by the laboratory can be found in Appendix E.

Exposure Pathways to Humans

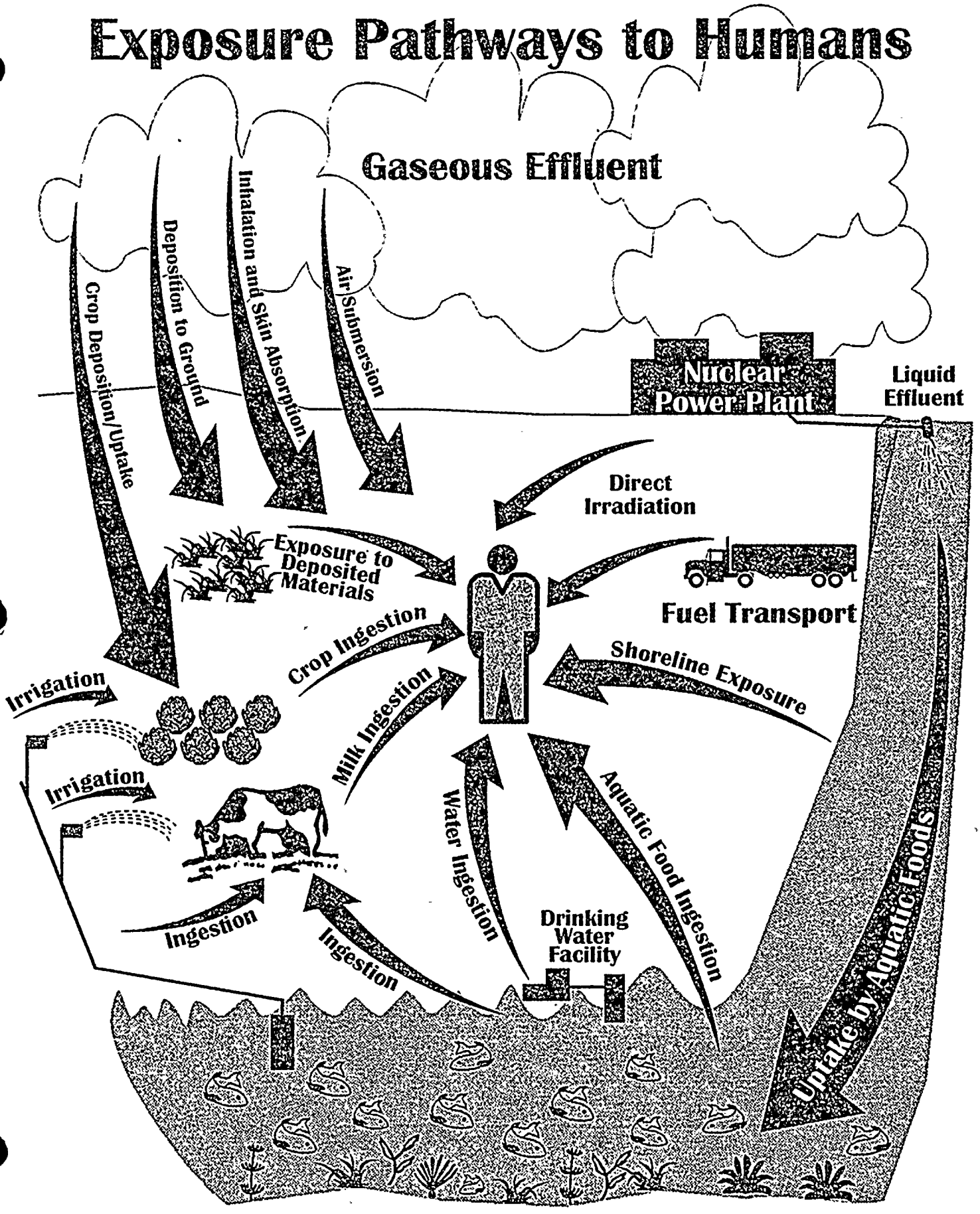


Figure 1

FIGURE 2
1998 TLD MONITORING LOCATIONS
WITHIN ONE MILE OF THE SSES

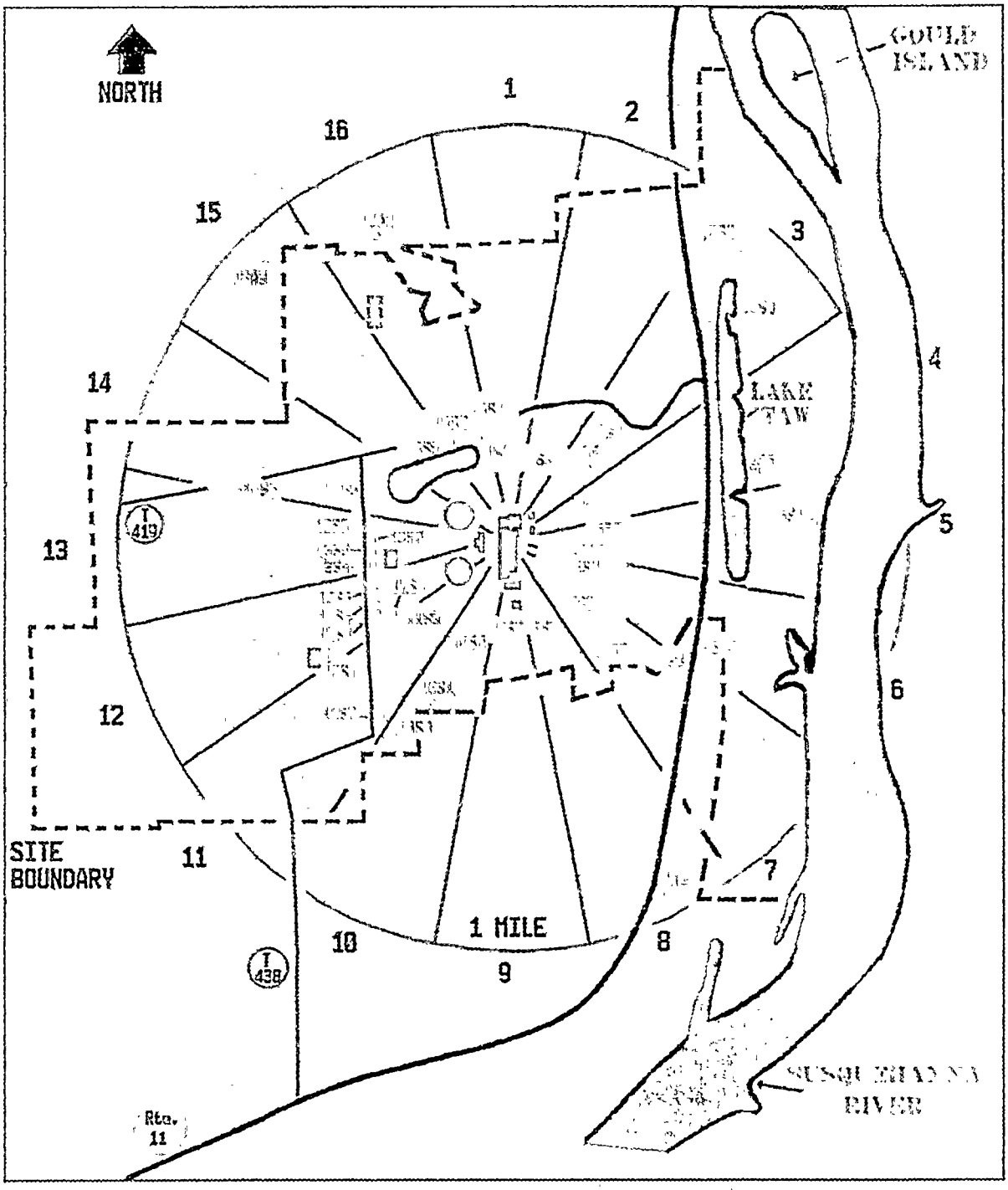


FIGURE 3
1998 TLD MONITORING LOCATIONS
FROM ONE TO FIVE MILES FROM THE SSES

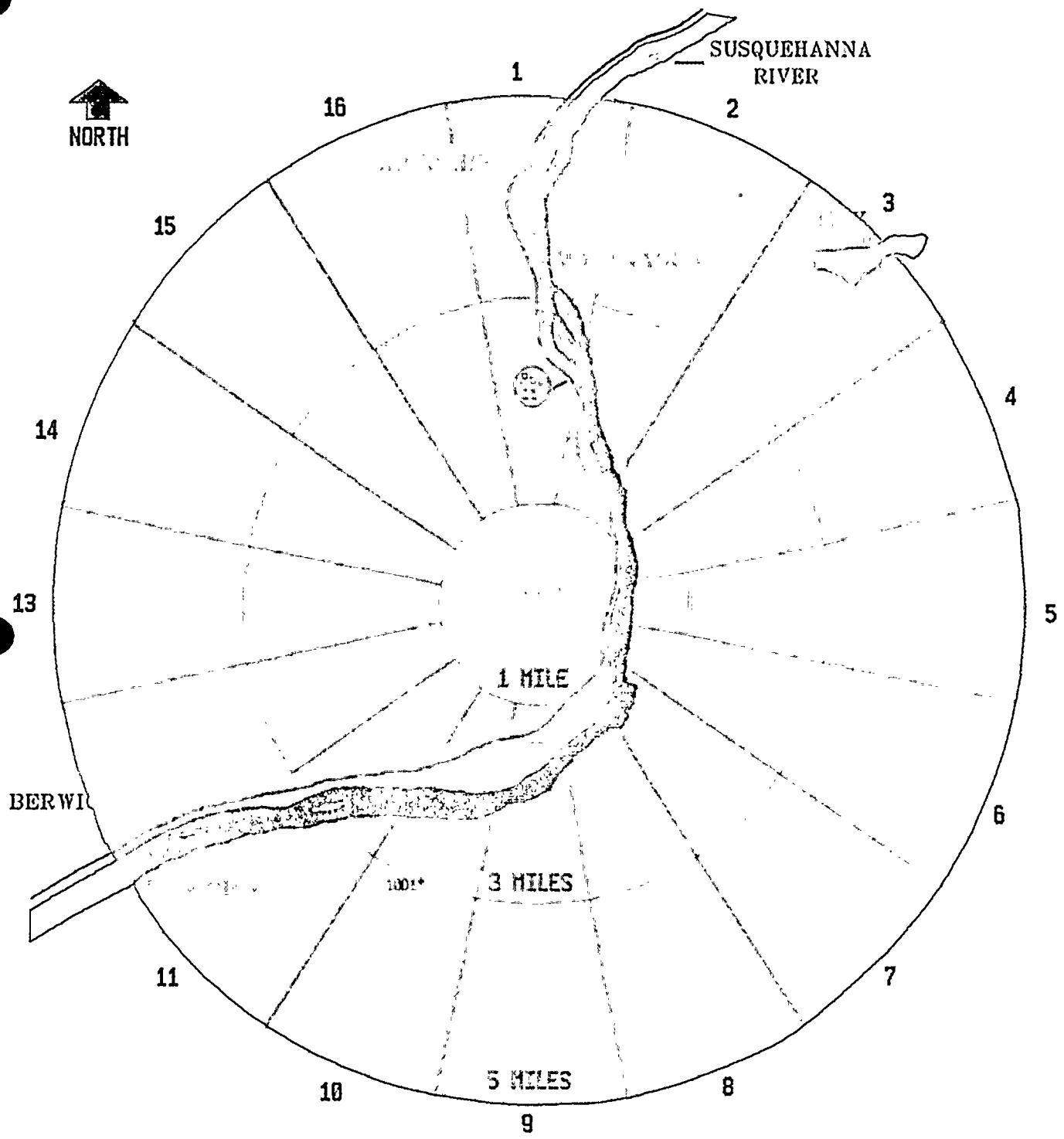


FIGURE 4
1998 TLD MONITORING LOCATIONS
GREATER THAN FIVE MILES FROM THE SSES

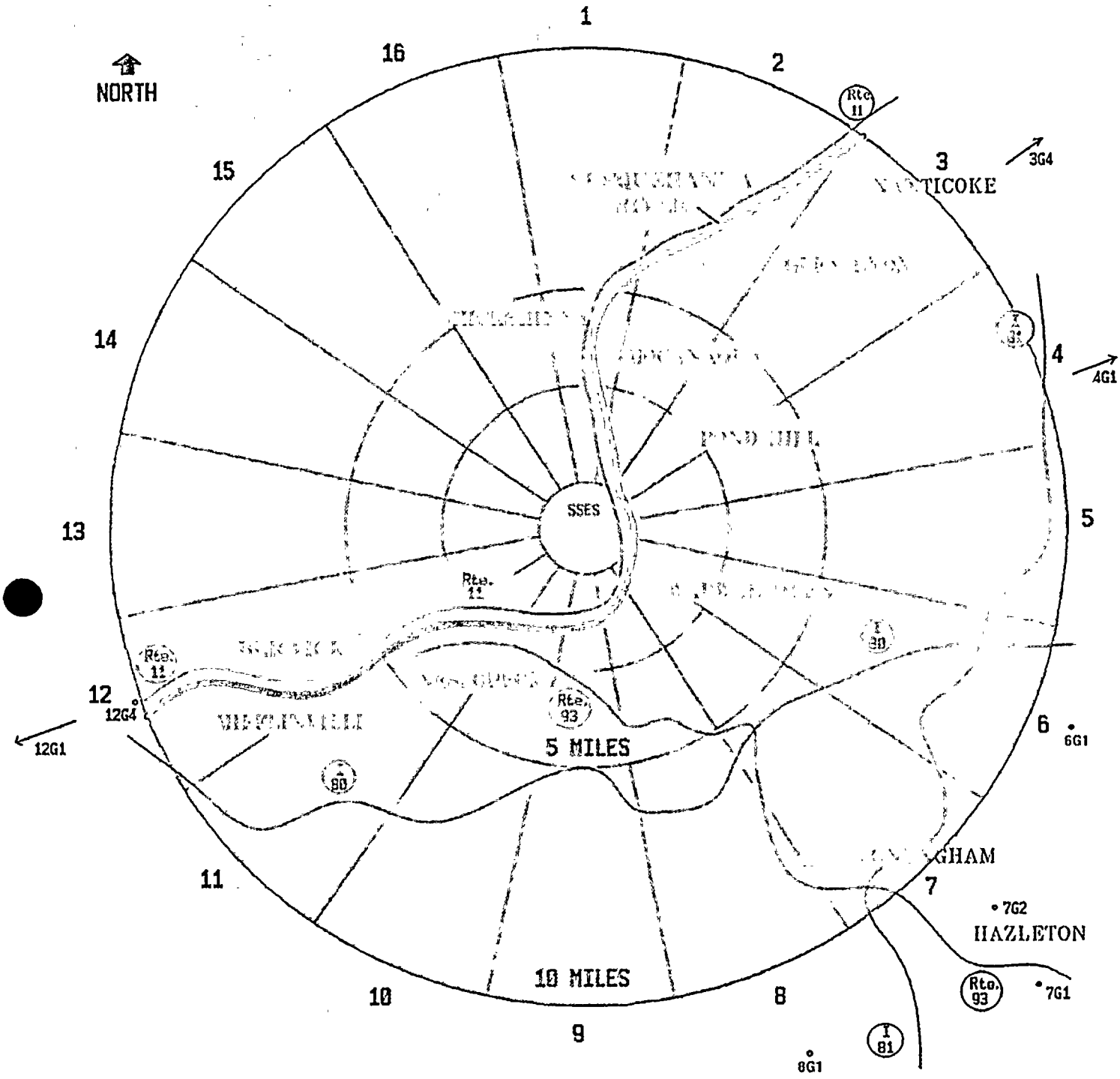


FIGURE 5
1998 ENVIRONMENTAL SAMPLING LOCATIONS
WITHIN ONE MILE OF THE SSES

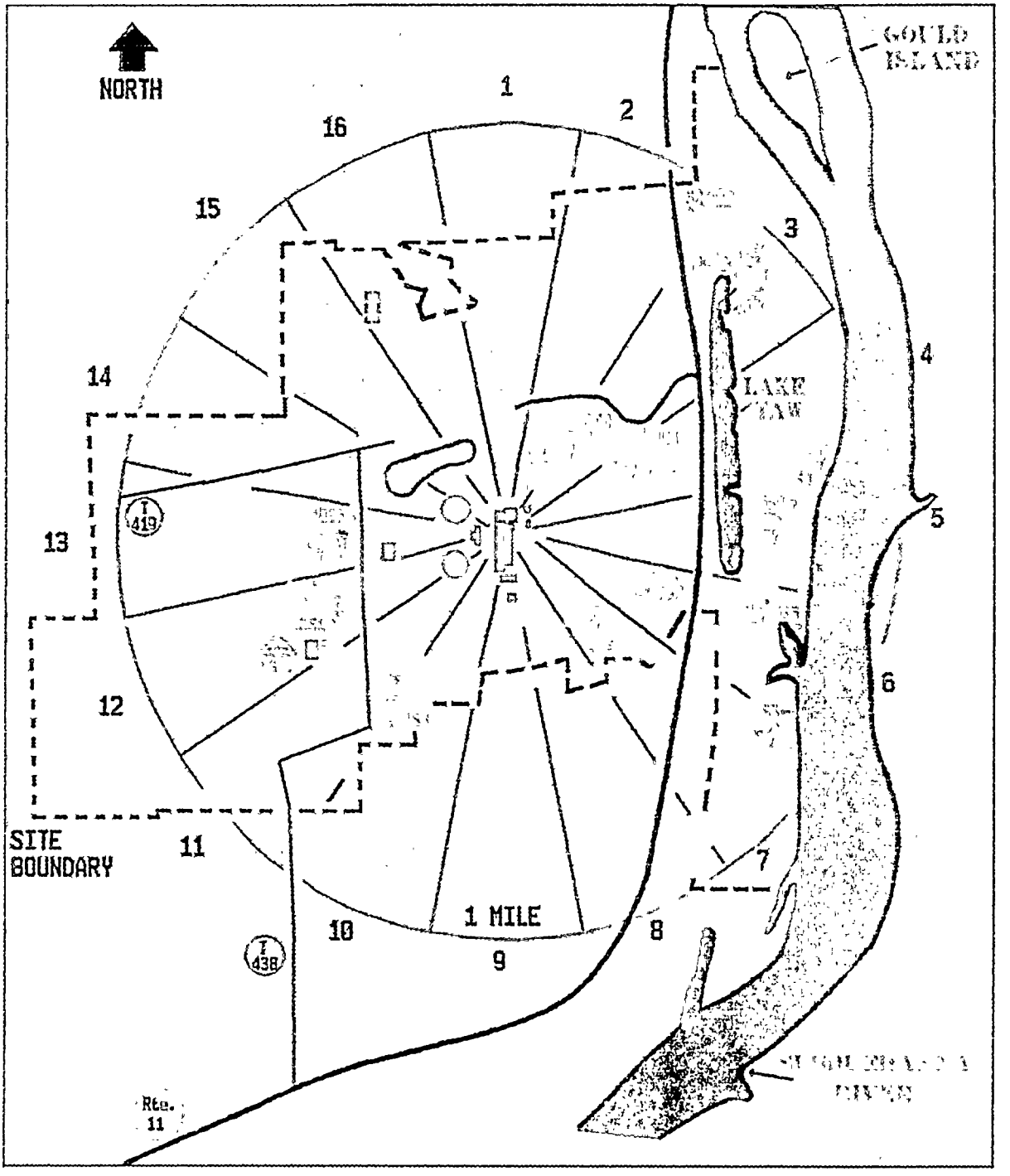


FIGURE 6
1998 ENVIRONMENTAL SAMPLING LOCATIONS
FROM ONE TO FIVE MILES FROM THE SSES

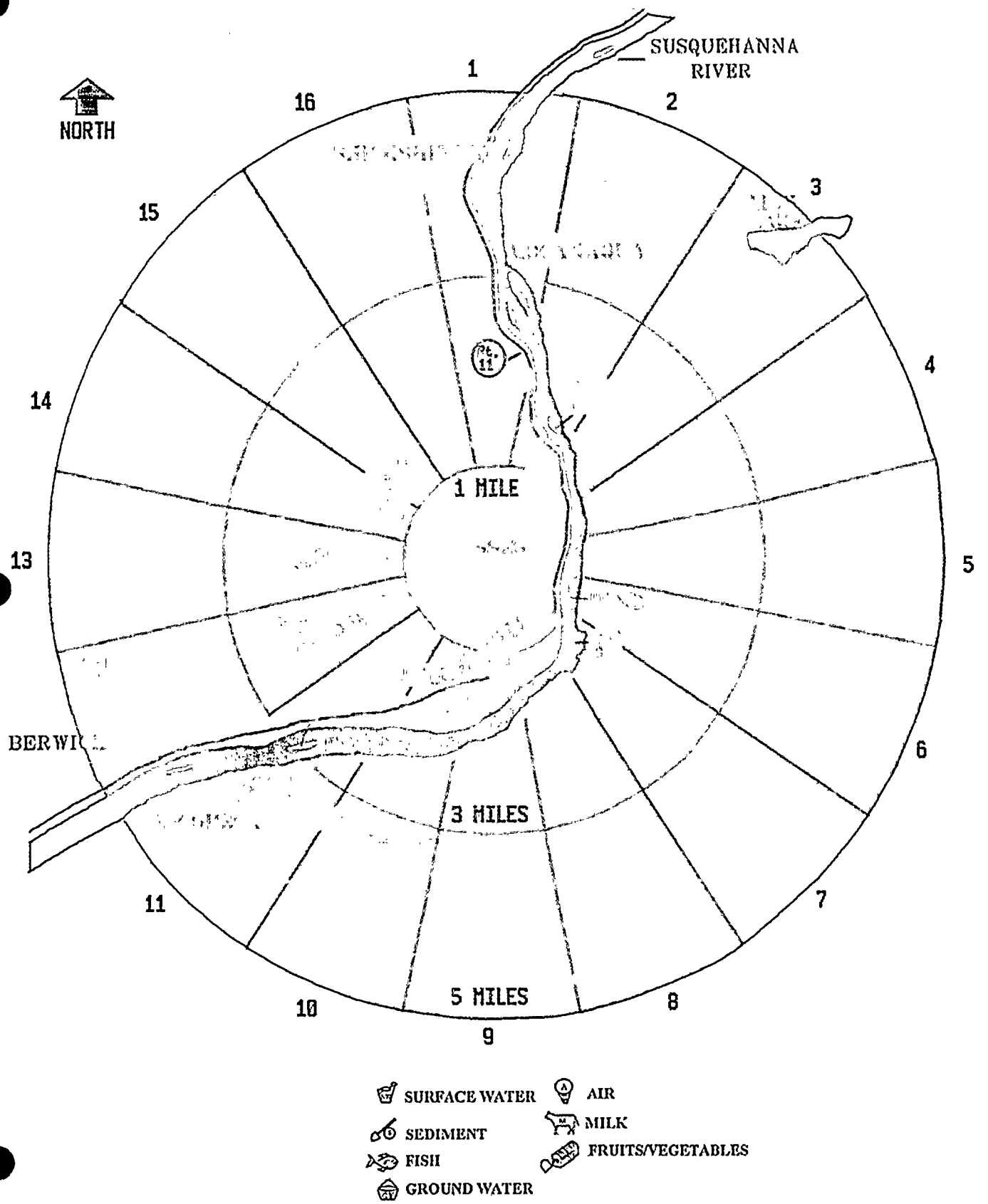
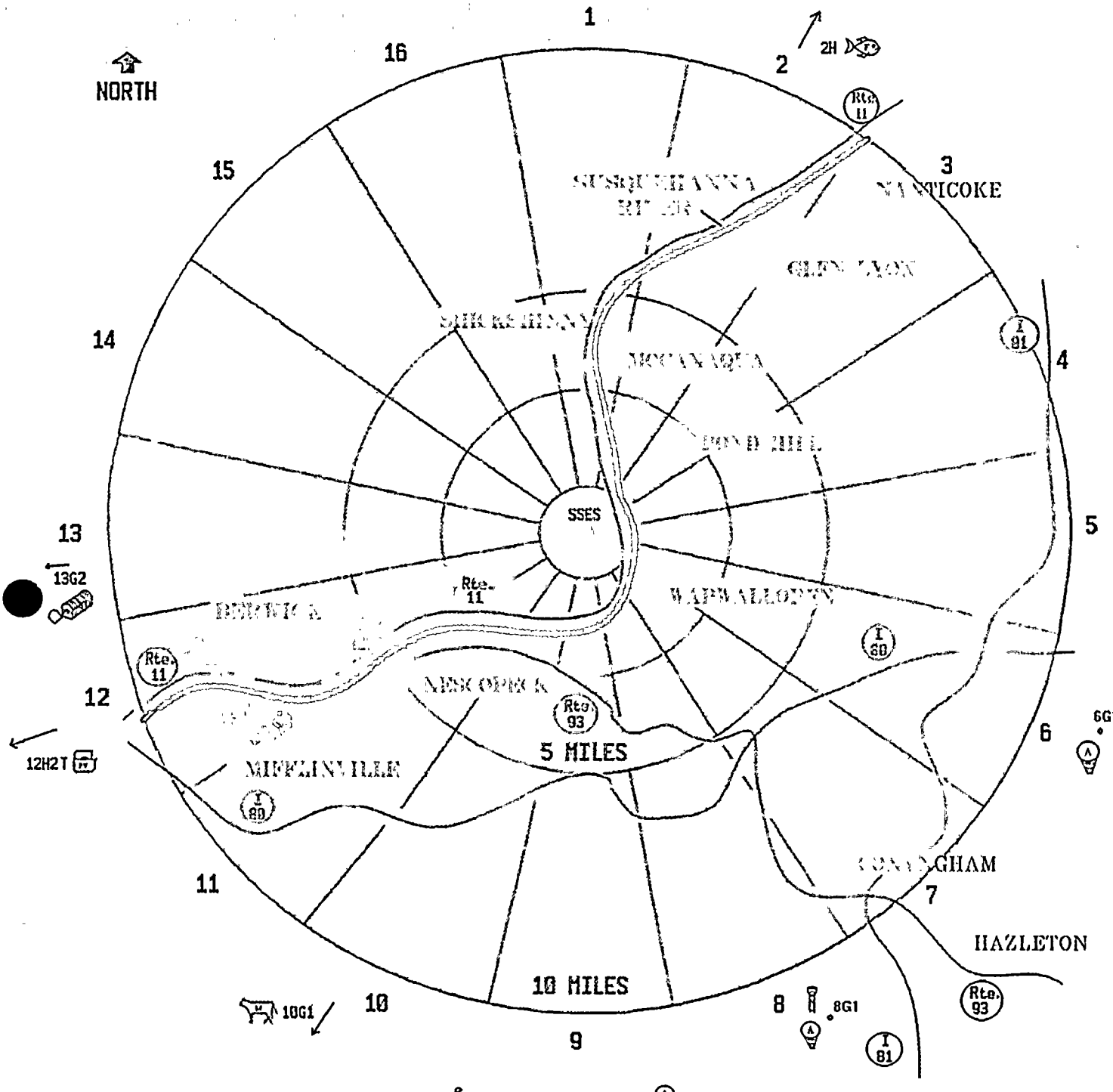


FIGURE 7
1998 ENVIRONMENTAL SAMPLING LOCATIONS
GREATER THAN FIVE MILES FROM THE SSES



AMBIENT RADIATION MONITORING

INTRODUCTION

The principal or primary method for the SSES REMP's measurement of ambient radiation levels is the use of thermoluminescent dosimeters (TLDs). The TLDs are crystals (calcium sulfate) capable of detecting and measuring low levels of radiation by absorbing a portion of the radiation's energy that is incident upon them and storing the captured energy until the TLDs are processed (read). Processing involves heating the TLDs to release their stored energy in the form of light and measuring the intensity of the light that they emit. The intensity of the emitted light is proportional to the amount of radiation to which they were exposed. Calibration of the TLD processors permits a reliable relationship to be established between the light emitted and the amount of radiation dose received by the TLDs; the result permits accurate measurements of the ambient radiation in the environment.

Environmental TLDs are continually exposed to natural radiation from the ground (terrestrial radiation) and from the sky (cosmic) radiation. In addition, they also may be exposed to man-made radiation. Most of the environmental TLD's natural radiation exposure comes from sources in the ground. These terrestrial sources vary naturally with time due to changes in soil moisture, snow cover, etc. The natural-radiation picture is complicated because these factors affecting radiation reaching the TLDs from the ground vary differently with time from one location to another due to locational differences in such factors as soil characteristics (amounts of organic matter, particle size, etc.), drainage opportunities, and exposure to sunlight. Environmental TLDs can also be affected by direct radiation (shine) from the SSES turbine buildings during operation, radwaste transfer and storage, and radioactive gaseous effluents from the SSES.

Unfortunately, TLDs do not have any inherent ability to indicate the source of the radiation to which they are exposed. The placement of numerous TLDs in the environment can facilitate decision-making about the possible radiation sources to which TLDs are exposed. However, a method for evaluating TLD data is still required. The SSES REMP relies on a statistically based approach to simultaneously compare indicator TLD data with control TLD data and operational TLD data with preoperational TLD data. This approach permits the flagging of environmental TLD doses that might have been produced by both man-made sources of radiation, as well as natural radiation sources. It also provides a means for attributing a portion of the total TLD dose to SSES operation if appropriate. Appendix E, pages E-6 through E-10, provides a description of the process for evaluating the results of TLD measurements.

Scope

TLDs

The area around the SSES was divided for monitoring purposes into sixteen sectors radiating outwards from the plant site, each encompassing an area described by an arc of 22.5 degrees. TLDs were placed in all 16 sectors at varying distances from the plant. Monitoring locations were chosen according to the criteria presented in the NRC Branch Technical Position on Radiological Monitoring (Revision 1, November, 1979).(17) The locations for the TLDs were selected by considering factors such as local meteorological, topographical, and population distribution characteristics.

At the end of 1998, the SSES REMP had 78 indicator TLD locations and eight control TLD locations. This level of monitoring exceeds that which is required by the Nuclear Regulatory Commission. The indicator TLDs nearest the SSES are positioned at the security or perimeter fences surrounding the site. This is the closest that a member of the public would be able to approach the station. The control TLDs are the most distant from the SSES, ranging from 10 to 20 miles from the site.

Monitoring Results

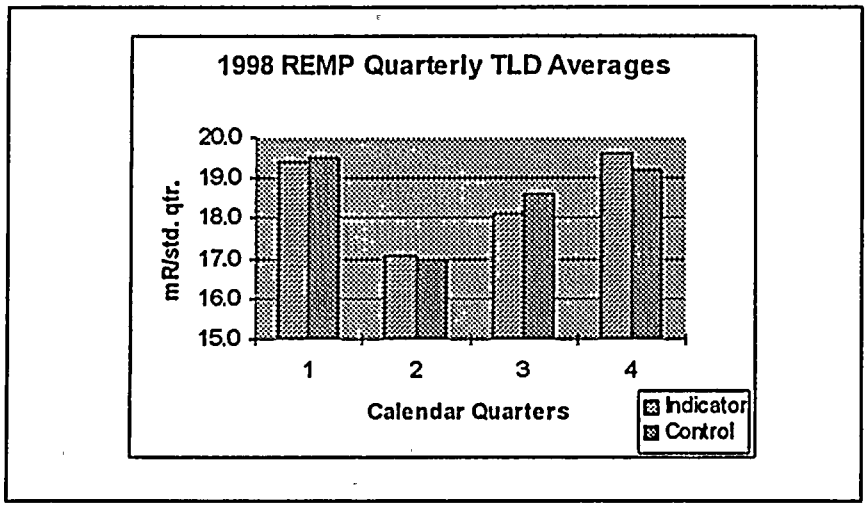
TLDs

TLDs were retrieved and processed quarterly in 1998. Average ambient radiation levels measured by environmental TLDs were noticeably lower in the second and third quarters of 1998, as shown in the bar graph on the following page. Refer to Figure 8 which trends both indicator and control data quarterly from 1973 through 1998.

The 1998 annual average exposures for indicator and control locations were the same at 18.6 mR/std. qtr. The 1998 annual average exposure for indicator locations is 0.5 mR/std. qtr. greater than the 1997 annual average. The 1998 annual average exposure for control locations is greater than the corresponding 1997 annual average exposure by 0.3 mR/std. qtr. The 1998 annual average exposures at both indicator and control locations are within the ranges of annual averages for the prior operational period at each type of monitoring location. However, the 1998 control average is above the corresponding range of averages for the preoperational period. Refer to Figure 8 at the end of this section which trends quarterly TLD results for both preoperational and operational periods at the SSES. Refer to Appendix H, Table H 1, page H 3 for a comparison of the 1998 mean indicator and control TLD results with the means for the preoperational and prior operational periods at the SSES.

Indicator environmental TLD results for 1998 were examined quarterly on an individual location basis and compared with both current control location results and preoperational data. Very small SSES exposure contributions were suggested at onsite location 9S2 in quarters 1, 2, and 4 and onsite locations 11S3 in all four quarters of 1998 and 12S5 in the 1998 second quarter. It is possible that these SSES attributable exposures were actually not the result of SSES operations, but, in fact, resulted

from fluctuations in background radiation levels. Refer to Appendix E, page E-6, for a discussion of "TLD Data Interpretation." TLD results for all locations for each quarter of 1998 may be found in Appendix I, Table I-1, beginning at page I-2.



The estimated quarterly exposure contributions were summed by location for the entire year. The largest dose suggested was approximately 4.5E-3 millirem at an onsite monitoring location, 11S3, 0.3 mile southwest of the SSES. This dose was used for determining compliance with SSES Technical Requirement Limit 3.11.3 for annual effluent reporting purposes. This dose amounts to only 0.018% of the 25 mrem whole-body dose limit of SSES Technical Requirement 3.11.3.

AMBIENT RADIATION LEVELS
BASED ON TLD DATA

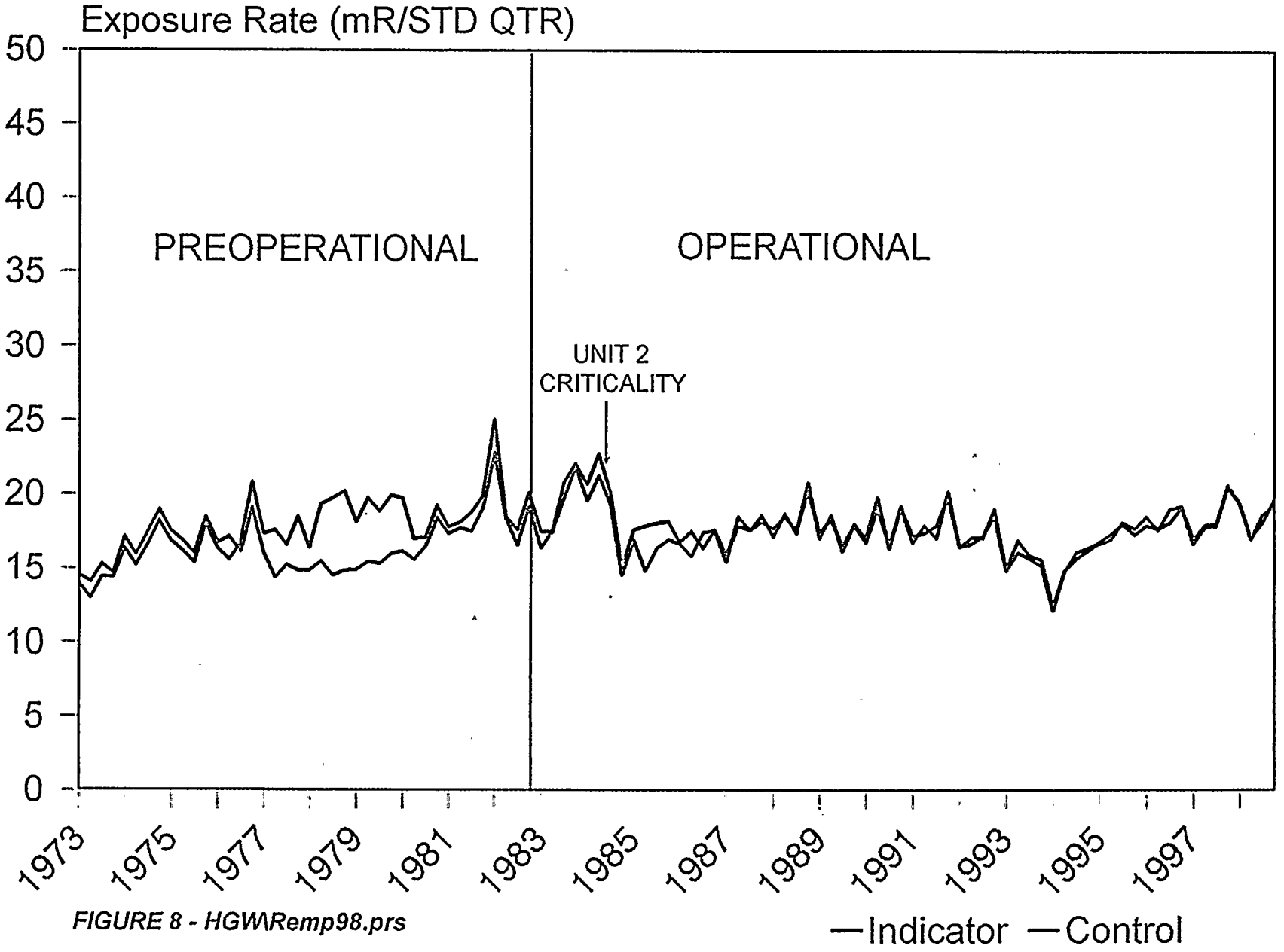


FIGURE 8 - HGW\Remp98.prs

AQUATIC PATHWAY MONITORING

INTRODUCTION

The following media were monitored in 1998 by the SSES REMP in the aquatic pathway: surface water, drinking water, fish, and sediment. Some of the media (e.g., drinking water and fish) provide information that can be especially useful to the estimation of possible dose to the public from potentially ingested radioactivity, if detected. Other media, such as sediment, can be useful for trending radioactivity levels in the aquatic pathway, primarily because of their tendency to assimilate certain materials that might enter the surface water to which they are exposed. The results from monitoring all of these media provide a picture of the aquatic pathway that is more clear than that which could be obtained if one or more were not included in the REMP.

Fruits or vegetables that are grown in fields irrigated with surface water would also be in the aquatic pathway. The land use census (Reference 61) conducted in 1998 looked at farms within 10 miles downstream of the SSES. Two farms were found to have irrigated during the 1998 growing season.

The aquatic pathway in the vicinity of the SSES is the Susquehanna River. Monitoring of all of the aquatic media, except drinking water, is conducted both downstream and upstream of the location from which occasional SSES low-level radioactive discharges enter the river. The upstream monitoring locations serve as controls to provide data for comparison with downstream monitoring results. The potential exists for radioactive material that might be present in SSES airborne releases to enter the Susquehanna River upstream of the plant through either direct deposition (e.g., settling or washout) or by way of runoff from deposition on land adjacent to the river. However, direct deposition and runoff are considered to be potentially insignificant as means of entry for SSES radioactivity into the Susquehanna River when compared to liquid discharges under normal conditions.

Lake Took-a-While (LTAW), which is located in PP&L Inc.'s Riverlands Recreation Area adjacent to the Susquehanna River, is also considered to be part of the aquatic pathway for monitoring purposes. Although it is not in a position to receive water discharged to the river from the SSES, it can receive storm runoff from the SSES. Storm runoff from the SSES site should not normally contain any measurable radioactivity from the plant. However, the SSES REMP, consistent with other aspects of aquatic monitoring and the REMP, in general, goes beyond its requirements by monitoring LTAW.

Scope

Surface Water

Surface water was routinely sampled from the Susquehanna River at one indicator location (6S5) and one control location (6S6) at the SSES River Water Intake during 1998. Sampling also took place at the following additional indicator locations: the SSES discharge line to the river (2S7/6S7) and Lake Took-A-While (LTAW).

Drinking Water

Drinking water samples were collected at location 12H2, the Danville Municipal Water Authority's treatment facility on the Susquehanna River, in 1998. Treated water is collected from the end of the processing flowpath, representing finished water that is suitable for drinking. This is the nearest point downstream of the SSES discharge to the River at which drinking water is obtained. No drinking water control location is sampled. For all intents and purposes, control surface water sampling locations would be suitable for comparison.

Fish

Fish were sampled from the Susquehanna River in the spring and fall of 1998 at one indicator location, IND, downstream of the SSES liquid discharge to the River and one control location, 2H, sufficiently upstream to essentially preclude the likelihood that the fish caught there would spend any time below the SSES discharge. In addition, fish were also sampled from PP&L Inc.'s Lake Took-a-While, location LTAW. This location is not downstream of the SSES discharge. It is sampled because of its potential for receiving runoff from the SSES. LTAW is considered an indicator location.

Sediment

Sediment sampling was performed in the spring and fall at indicator locations 7B and 12F and control location 2B on the Susquehanna River. In addition, sediment was also obtained from location LTAW.

Sampling

Surface Water

Weekly grab sampling was performed at the indicator location 6S5. Weekly grab samples were composited both monthly and biweekly at this location. Location 6S5 was considered a backup for locations 2S7 and 6S7 in the event that water could not be obtained from the automatic samplers at these locations. Nevertheless, 6S5 was sampled routinely throughout 1998, since it is the closest downstream sampling point to the SSES discharge.

Indicator locations 2S7 and 6S7, the SSES Cooling Tower Blowdown Discharge (CTBD) line, and control location 6S6, the SSES River Water Intake structure, were sampled time proportionally using automatic continuous samplers. The samplers were typically set to obtain 30-60 ml aliquots every 20-25 minutes. Weekly, the water obtained by these samplers was retrieved for either biweekly or monthly compositing.

The other surface water monitoring location, LTAW, was grab sampled once each month.

Drinking Water
Treated water was sampled time proportionally by an automatic sampler. The sampler was typically set to obtain 30-60 ml aliquots every twenty minutes. Weekly, the water obtained by this sampler was retrieved for either biweekly or monthly compositing.

Fish
Fish were obtained by electrofishing. Electrofishing stuns the fish and allows them to float to the surface so that those of the desired species and sufficient size can be sampled. Sampled fish include recreationally important species, such as smallmouth bass, and also channel catfish and white suckers. The fish are filleted and the edible portions are kept for analysis.

Sediment
Shoreline sediment was collected to depths of four feet of water.

Sample Preservation and Analysis

Surface and Drinking Water
Surface and drinking water samples were analyzed monthly for beta activities, the activities of gamma-emitting radionuclides, and tritium activities. Iodine-131 was analyzed biweekly for composite samples and monthly for the grab samples. In addition, drinking water samples were analyzed for gross alpha activity.

To optimize the accuracy of these sample analyses, preservatives were added to the samples as soon after collection as practical. Nitric acid was added to sample aliquots destined for gross alpha and beta activity analysis and the analysis of gamma-emitting radionuclide activity analysis. Sufficient acid was added to reduce the pH of these sample aliquots to nearly two in order to reduce the potential for radionuclides leaving the water and depositing on the sides of the sample containers.

Sodium bisulfite was added to sample aliquots destined for iodine-131 analysis in amounts equivalent to one gram per each gallon of water. This amount was recommended by the radioanalytical laboratory (Teledyne Brown Engineering) analyzing the samples. The purpose for sodium bisulfite addition is to reduce the potential for volatilization and loss of iodine from samples by maintaining it in a chemically reduced form.

Sediment and Fish
Fish are frozen until shipment. All samples are analyzed by gamma spectroscopy for the activities of any gamma emitting radionuclides that may be present.

Monitoring Results

Surface Water
Results from specific sample analyses of surface water may be found in Tables I-2 and I-3 of Appendix I. A summary of the 1998 surface water data may be located in Table G of Appendix G. Comparisons of 1998 monitoring results with those of past years may be found in Tables H 2 through H 4 of Appendix H.

The Nuclear Regulatory Commission (NRC) requires that averages of the

activity levels for indicator environmental monitoring locations and for control environmental monitoring locations of surface water, as well as other monitored media, be reported to the NRC annually. Data from the following three surface water monitoring locations were averaged together as indicators for reporting purposes: one location (6S5) on the Susquehanna River downstream of the SSES, Lake-Took-a While (LTAW) adjacent to the river, and the SSES cooling tower blowdown discharge (CTBD) line to the river (2S7).

Technically, the CTBD line is not part of the environment. The CTBD line is a below ground pipe to which the public has no access, contrary to the other environmental monitoring locations on the Susquehanna River to which the public does have access. However, it currently is required that the water that is discharged to the Susquehanna River through the CTBD line from the SSES be included as an indicator monitoring location in the radiological environmental monitoring program.

Most of the water entering the Susquehanna River through the SSES CTBD line is simply water that was taken from the river upstream of the SSES, used for cooling purposes without being radioactively contaminated by SSES operation, and returned to the river. Nevertheless, batch discharges of relatively small volumes of slightly radioactively contaminated water are made to the river through the SSES CTBD at times throughout each year. The water is released from tanks of radioactively contaminated water on site to the CTBD and mixes with the noncontaminated water already present in the CTBD. Flow rates from the tanks containing radioactively contaminated water being discharged to the CTBD are limited to a maximum of 200 gpm. In addition, the minimum flow rate for the returning water in the CTBD is maintained at a flow rate of 5,000 gpm or higher. These requirements are in place to ensure adequate dilution of radioactively contaminated water by the returning noncontaminated water in the CTBD prior to entering the river.

At the point that CTBD water enters the river, additional, rapid dilution of the discharged water by the river is promoted by releasing it through a diffuser. The diffuser is a large pipe with numerous holes in it that is positioned near the bottom of the river. CTBD discharges exit the diffuser through the many holes, enhancing the mixing of the discharge and river waters. The concentrations of contaminants are reduced significantly as the discharged water mixes with the much larger flow of river water. The mean flow rate of the Susquehanna River in 1998 was approximately 7,049,000 gpm. This is more than 1,400 times the required minimum flow rate through the CTBD for discharges to be permitted.

The amounts of radioactively contaminated water being discharged are small. Nevertheless, sensitive analyses of the water samples can often detect the low levels of certain types of radioactivity in the CTBD water following dilution. Though the levels of radioactivity measured in the CTBD water are generally quite low, they tend to be higher than those in the river

downstream of the SSES. Most radionuclides discharged from the SSES CTBD are at such low levels in the downstream river water that, even with the sensitive analyses performed, they cannot be detected.

When the radioactivity levels from the CTBD samples throughout the year are averaged with those obtained from actual downstream monitoring locations, the result is an overall indicator location average that is too high to be representative of the actual average radioactivity levels of the downstream river water. As the following discussions are reviewed, consideration should be given to this inflation of average radioactivity levels from the inclusion of CTBD (location 257/6S7) results in the indicator data that is averaged.

The 1998 data for gross beta activity analyses of surface water are higher than those of 1997. The 1998 mean gross beta activity of 6.1 pCi/liter for indicator locations is greater than the 1997 indicator mean gross beta activity of 5.3 pCi/liter. The 1998 indicator activity is above the average of the annual means for the previous operational period of the SSES. The 1998 mean gross beta activity of 6.7 pCi/liter for control locations is higher than the 2.8 pCi/liter for the 1997 control mean gross beta activity. It is also above the range of the annual means for the previous operational and preoperational periods. Refer to Figure 9 which trends gross beta activities separately for surface water indicator and control locations quarterly from 1975 through 1998.

Comparison of the 1998 indicator mean (6.1 pCi/l) to the 1998 control mean (6.7 pCi/l) does not suggest a contribution of beta activity from the SSES. The 1998 data is different in this regard than the averages of annual means for indicator and control locations for the prior operational period. During the prior operational period, the average of annual indicator means exceeds the average of annual control means for gross beta activity.

The 1998 means for iodine-131 activity at indicator and control surface water monitoring locations were 0.33 pCi/liter and 0.34 pCi/liter, respectively. Both the 1998 indicator and control means for iodine-131 activity are less than 1997's corresponding activity means. However, both 1998's indicator and control mean activities are still greater than the averages of the annual means for both indicator and control locations for the prior operational period of the SSES.

Throughout the course of a year, iodine-131 is typically measured at levels in excess of analysis MDCs in some samples obtained from control surface water monitoring locations on the Susquehanna River upstream of the SSES as well as indicator locations downstream of the SSES. As determined by measurements of samples obtained by the SSES REMP, the mean iodine-131 activity level from the CTBD for all of 1998 was approximately 0.68 pCi/liter. This may be compared to the activity level of 0.34 pCi/liter for control surface water monitoring locations in 1998.

Iodine-131 from the discharge of medical wastes into the Susquehanna River upstream of the SSES is drawn into the SSES cooling tower basins through the SSES River Water Intake Structure. It is not unreasonable to assume that concentration of the already existing iodine-131 in the cooling tower basins occurs as it does for other substances found in the river. For example, the SSES routinely assumes concentration factors in the basin for calcium of four to five times the concentrations in the river water entering the basins, based on past measurements. This concentrating effect occurs because of the evaporation of the water in the basins, leaving behind most dissolved and suspended materials in the unevaporated water remaining in the basins. If a concentration factor of four for iodine-131 were to be applied to the 1998 mean iodine-131 activity level for the control samples from the Susquehanna River, a mean concentration of 1.36 pCi/liter for iodine-131 in the basin water and the water being discharged from the basins would be expected. The actual 1998 mean for the CTBD iodine-131 activity level was less than this.

Because iodine-131 is radioactive, unlike the calcium that has been measured, iodine-131 is removed from the water while it is in the basins through the radioactive decay process. Thus, it might be expected that the net concentration factor for iodine-131 would be somewhat less than that for calcium, considering this additional removal process. The extent to which the iodine-131 concentration factor is less than that for calcium would depend on the mean residence time for the water in the basins compared to iodine-131's radioactive half-life - the greater the ratio of the mean residence time to the half-life, the smaller the concentration factor. A mean residence time for water in the basins is expected to be about two days. This is only about one-fourth of the approximately eight-day half-life of iodine-131. Thus, radioactive decay would not be expected to reduce the concentration factor for iodine-131 by a large amount. Therefore, the difference between the 1998 mean iodine-131 activity of about 0.68 pCi/liter in the CTBD and the 1998 mean iodine-131 activity for the control location of 0.34 pCi/liter should be the result of concentration in the basins. Iodine-131 was not reported to have been discharged with water released from the SSES to the Susquehanna River during 1998.

The 1998 mean tritium activity for indicator locations was significantly more than the corresponding 1997 mean. The 1998 and 1997 mean tritium activities for control locations were both negative values (less than background). The 1998 means for tritium activity at indicator and control locations were 1217 pCi/liter and -11 pCi/liter, respectively. The 1998 indicator mean is greater than the range of the annual means reported for the prior operational period of the SSES. The 1998 control mean is lower than the average of the annual means reported for both prior operational and preoperational monitoring periods. Refer to Figure 10 which trends tritium activity levels separately for surface water indicator and control locations from 1972 through 1998.

The 1998 indicator mean tritium level for all surface water locations can be misleading for those interested in the mean tritium level in the Susquehanna River downstream of the SSES for 1998. The much higher levels of tritium observed in the CTBD (location 2S7/6S7), when averaged with the low levels from the downstream location 6S5 sample analysis results distort the real environmental picture. The mean tritium activity from indicator location 6S5 for 1998 was -24 pCi/liter, which is essentially indistinguishable from the mean tritium activity, -11 pCi/liter, for the control location, both of which represent actual river water levels.

In spite of the fact that the tritium activity levels reported for 2S7/6S7 are from the discharge line prior to dilution in the river, the highest quarterly average tritium activity reported at 2S7/6S7 during 1998 was 8,908 pCi/liter for the second quarter, well below the NRC non-routine reporting levels for quarterly average activity levels of 20,000 pCi/liter when a drinking pathway exists or 30,000 pCi/liter when no drinking water pathway exists.

The tritium activity reported in the CTBD line from location 2S7/6S7 is attributable to the SSES. Refer to the "Dose from the Aquatic Pathway" discussion at the end of this section for additional information on the projected dose to the population from tritium and other radionuclides in the aquatic pathway attributable to the SSES.

With the exception of iodine-131, no gamma-emitting radionuclides were measured in surface water at an activity level exceeding an analysis MDC in 1998.

Drinking Water

Drinking water was monitored during 1998 at the Danville Water Company's facility 26 miles WSW of the SSES on the Susquehanna River. From 1977 (when drinking water samples were first collected) through 1984, drinking water samples were also obtained from the Berwick Water Company at location 12F3, 5.2 miles WSW of the SSES. The drinking water supply for the Berwick Water Company is not, however, water from the Susquehanna River; it is actually well water.

There are no known drinking water supplies in Pennsylvania on the Susquehanna River upstream of the SSES and therefore no drinking water control monitoring locations. Danville drinking water analysis results may be compared to the results for surface water control monitoring locations.

Results from specific sample analyses of drinking water may be found in Table I-4 of Appendix I. A summary of the 1998 drinking water data may be located in Table G of Appendix G. Comparisons of 1998 monitoring results with those of past years may be found in Tables H 5 through H 7 of Appendix H.

Gross alpha activity has been monitored in drinking water since 1980. Gross alpha activity has been observed at levels above the analysis MDCs in a small minority of the samples during most years since 1980. In 1998, as in 1996 and 1997, no samples were reported with gross alpha activity levels above the analysis MDCs. The 1998

mean gross alpha activity level for drinking water was 0.29 pCi/liter. The 1998 mean alpha activity is significantly below the average of the corresponding annual means for both the prior operational years as well as the preoperational period. The mean gross alpha activity is lower than the means of many of the previous years. This is primarily because of the averaging method used since 1991. But, it may also be the result of discontinuing the sampling of untreated drinking water in July, 1995. Generally the untreated water may have contributed more naturally occurring alpha activity due to higher levels of sediment than the treated water. No gross alpha activity in drinking water during 1998 is attributed to liquid discharges from the SSES to the Susquehanna River.

Gross beta activity has been monitored in drinking water since 1977. Gross beta activity is typically measured at levels exceeding the MDCs in drinking water samples. The 1998 mean gross beta activity level for drinking water was 3.3 pCi/liter. The 1998 mean is above the 1997 mean gross beta activity level for drinking water but within the range of the corresponding annual means for the prior operational period of the SSES. Refer to Figure 11 which trends gross beta activity levels separately for drinking water indicator and control locations from 1977 through 1998.

The 1998 mean gross beta activity for drinking water is less than the 1998 gross beta activity level for surface water control locations. Drinking water samples were analyzed for gross beta activity by a different laboratory than surface water samples in 1998. This may have contributed somewhat to differences in gross beta activity between the two media. However, treated drinking water may be expected to have less naturally occurring beta activity due to lower levels of sediment than the surface water. No gross beta activity in drinking water during 1998 is attributed to liquid discharges from the SSES to the Susquehanna River.

Iodine-131 was measured in excess of analysis MDCs in five out of 27 drinking water samples in 1998. This compares with results from eight samples for which analysis MDCs were exceeded in 1997. The 1998 mean iodine-131 activity level in drinking water samples was 0.13 pCi/liter. This is less than the 1997 mean drinking water activity level of 0.22 pCi/liter and less than the 1998 mean of 0.34 pCi/liter for surface water control locations. No iodine-131 activity in drinking water during 1998 is attributed to liquid discharges from the SSES to the Susquehanna River.

Tritium was measured in excess of analysis MDCs twice in 1998 in drinking water. The 1998 mean tritium activity level for drinking water was -10 pCi/liter. The 1997 and 1998 mean tritium activity levels are both less than background. The 1998 mean also is well below the averages of the corresponding annual means for both the prior operational and preoperational periods of the SSES. The low 1998 mean tritium activity level for drinking water is essentially the same as the 1998 mean tritium activity level for surface water control locations.

No gamma-emitting radionuclides were measured above the analysis MDCs for

gamma spectroscopic analyses of drinking water samples during 1998.

Fish

Results from specific sample analyses of fish may be found in Table I 5 of Appendix I. A summary of the 1998 fish data may be located in Table G of Appendix G. A comparison of 1998 monitoring results with those of past years may be found in Table H 8 of Appendix H.

Four species of fish were sampled at each of one indicator location and one control location on the Susquehanna River in May and June, 1998 and again in October, 1998. The species included the following: white sucker, smallmouth bass, channel catfish, and shorthead redhorse. In addition, one largemouth bass was sampled from PP&L Inc.'s LTAW in November, 1998. A total of 13 fish were collected and analyzed.

The only gamma-emitting radionuclide measured in excess of analysis MDCs in fish during 1998 was naturally occurring potassium-40. The 1998 indicator and control means for the activity levels of potassium-40 in fish are 3.8 pCi/gram and 3.7 pCi/gram, respectively. The 1998 indicator and control means are slightly larger than the 1997 indicator and control means. Both the 1998 indicator and control means are within the ranges of their corresponding annual means for prior operational and preoperational years. Naturally occurring potassium-40 in fish is not attributable to the liquid discharges from the SSES to the Susquehanna River.

Sediment

Shoreline sediment was sampled in May, 1998 and again in October, 1998. Results from specific sample analyses of sediment may be found in Table I-6 of Appendix I. A summary of the 1998 sediment data may be located in Table G of Appendix G. Comparisons of 1998 monitoring results with those of past years may be found in Tables H 9 through H 12 of Appendix H.

Naturally occurring potassium-40, radium-226, and thorium-228 were measured at activity levels above analysis MDCs in all shoreline sediment samples in 1998. Naturally occurring beryllium-7 was found above analysis MDCs in two 1998 samples.

The 1998 indicator and control means for potassium-40 activity levels in shoreline sediment were 11.7 pCi/gram and 11.1 pCi/gram, respectively. The 1998 indicator and control means for potassium-40 activity are greater than their corresponding 1997 means. These 1998 means were within the ranges of the corresponding annual means for all prior operational years.

The 1998 indicator and control means for radium-226 activity levels in shoreline sediment were 1.5 pCi/gram and 1.3 pCi/gram, respectively. The 1998 indicator and control mean radium-226 activities are essentially the same as the corresponding 1997 means. These 1998 radium-226 means were within the ranges of the corresponding annual means for all prior operational years.

The 1998 indicator and control means for thorium-228 activity levels in

shoreline sediment were 1.1 pCi/gram and 1.0 pCi/gram, respectively. These means are essentially the same as the averages of the corresponding means for 1997 and for prior operational years. The naturally occurring radionuclides in sediment discussed above are not attributable to the liquid discharges from the SSES to the Susquehanna River.

Cesium-137 was the only man-made radionuclide measured at activity levels in shoreline sediment exceeding analysis MDCs during 1998. The 1998 indicator and control means for cesium-137 activity levels in sediment were 0.055 pCi/gram and 0.100 pCi/gram, respectively. The 1998 indicator and control means are slightly greater than the 1997 indicator and control means. The 1998 indicator and control means are less than the averages of corresponding annual means for both prior operational as well as preoperational years. This cesium-137 in the sediment is attributed to residual fallout from past atmospheric nuclear weapons tests.

Dose from the Aquatic Pathway

Tritium was the only radionuclide identified in 1998 by the SSES REMP in the aquatic pathway that was attributable to SSES operation and also included in the pathway to man.

The maximum whole-body and organ doses to hypothetical maximally exposed individuals in four age groups (adult, teenager, child, and infant) were determined according to the methodology of the Offsite Dose Calculation manual using the LADTAP II code. This is in accordance with SSES Technical Specification 3.11.1.2 which requires consistency in liquid effluent dose calculations with NRC Regulatory Guide 1.109.

For the purpose of performing the dose calculation, tritium was assumed to be present continuously in the CTBD line throughout 1998 at a level equivalent to the annual mean activity level of 3,648 pCi/liter for the CTBD line. The annual mean flow rate for the CTBD line during releases of 8,750 gpm was multiplied times this mean activity level to obtain an equivalent annual discharge of about 64 curies of tritium in 1998. (This is almost 9 curies less than the total amount of tritium reported to have been released in 1998 from SSES effluent monitoring.) Because no positive annual mean activity level for tritium was obtained for the control in 1998, no subtraction of control annual mean activity was performed prior to multiplying by the annual CTBD mean flow rate.

Doses were estimated at the nearest downriver municipal water supplier via the drinking water pathway and near the outfall of the SSES discharge to the Susquehanna River via the fish pathway. The maximum whole body and organ doses were each estimated to be less than 0.0008 mrem.

GROSS BETA ACTIVITY IN SURFACE WATER

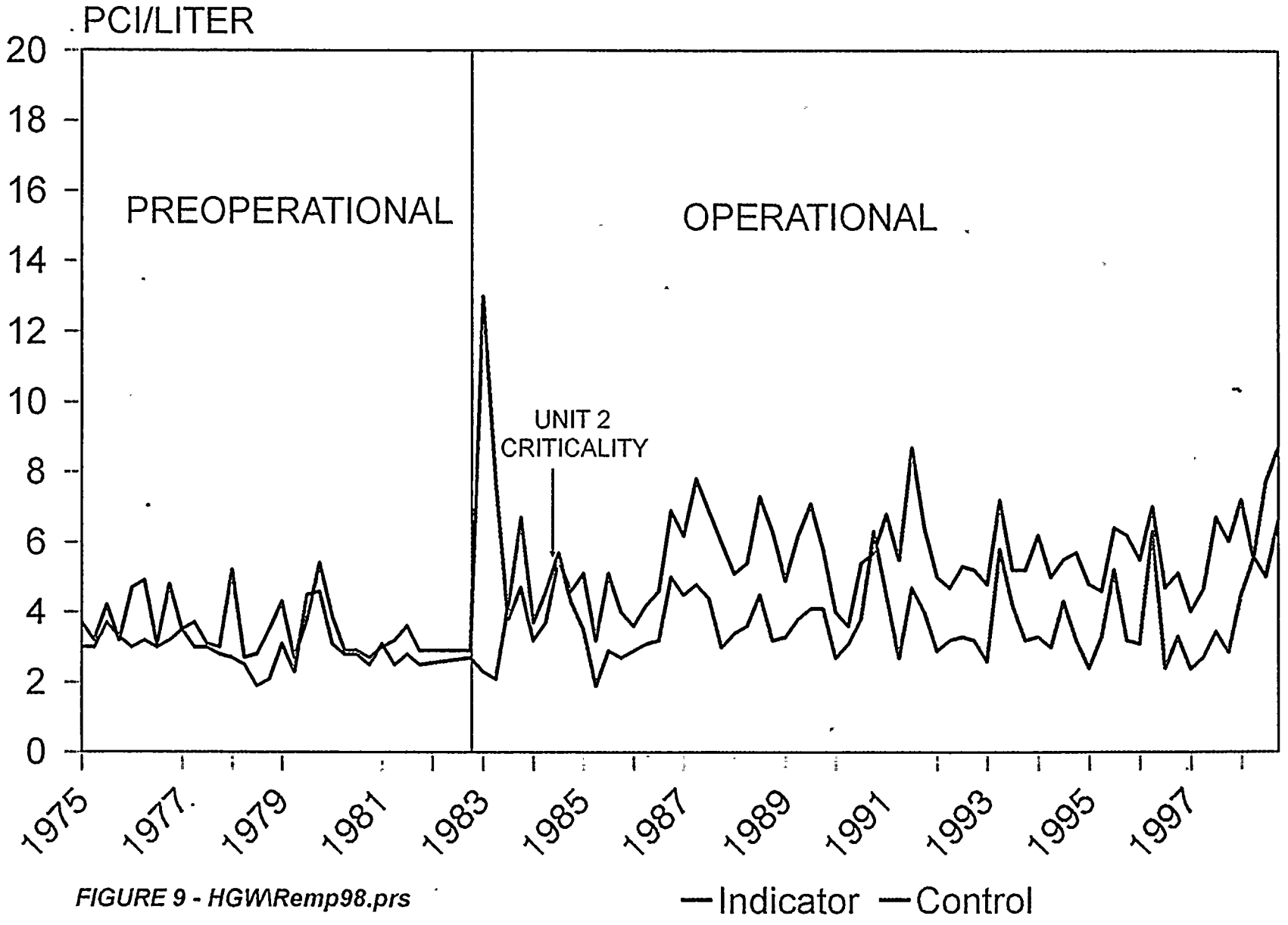
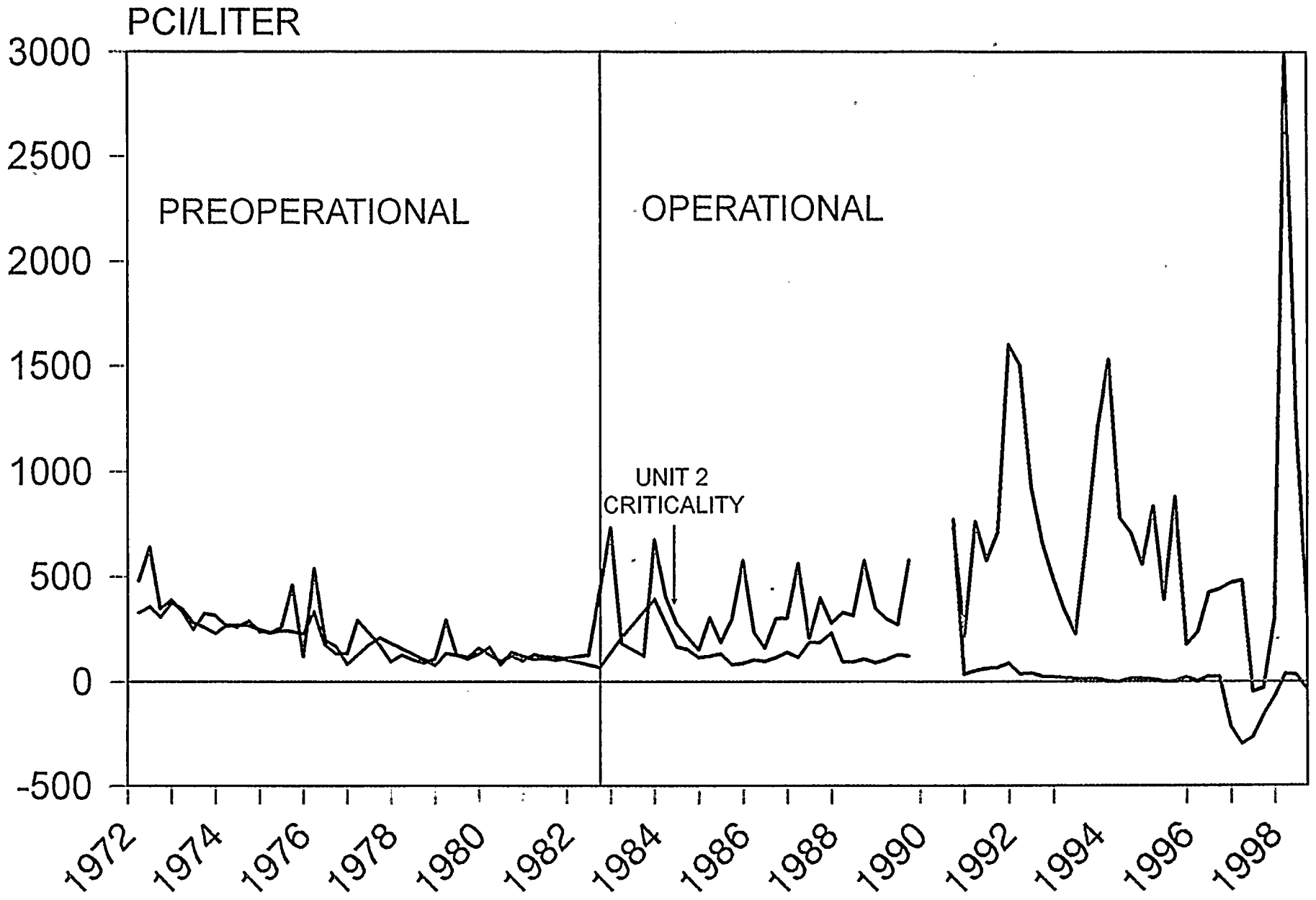


FIGURE 9 - HGW\Remp98.prs

TRITIUM ACTIVITY IN SURFACE WATER



1990 Data is not included in this figure because the data was suspect.

FIGURE 10 - HGW\Remp98.prs

GROSS BETA ACTIVITY IN DRINKING WATER

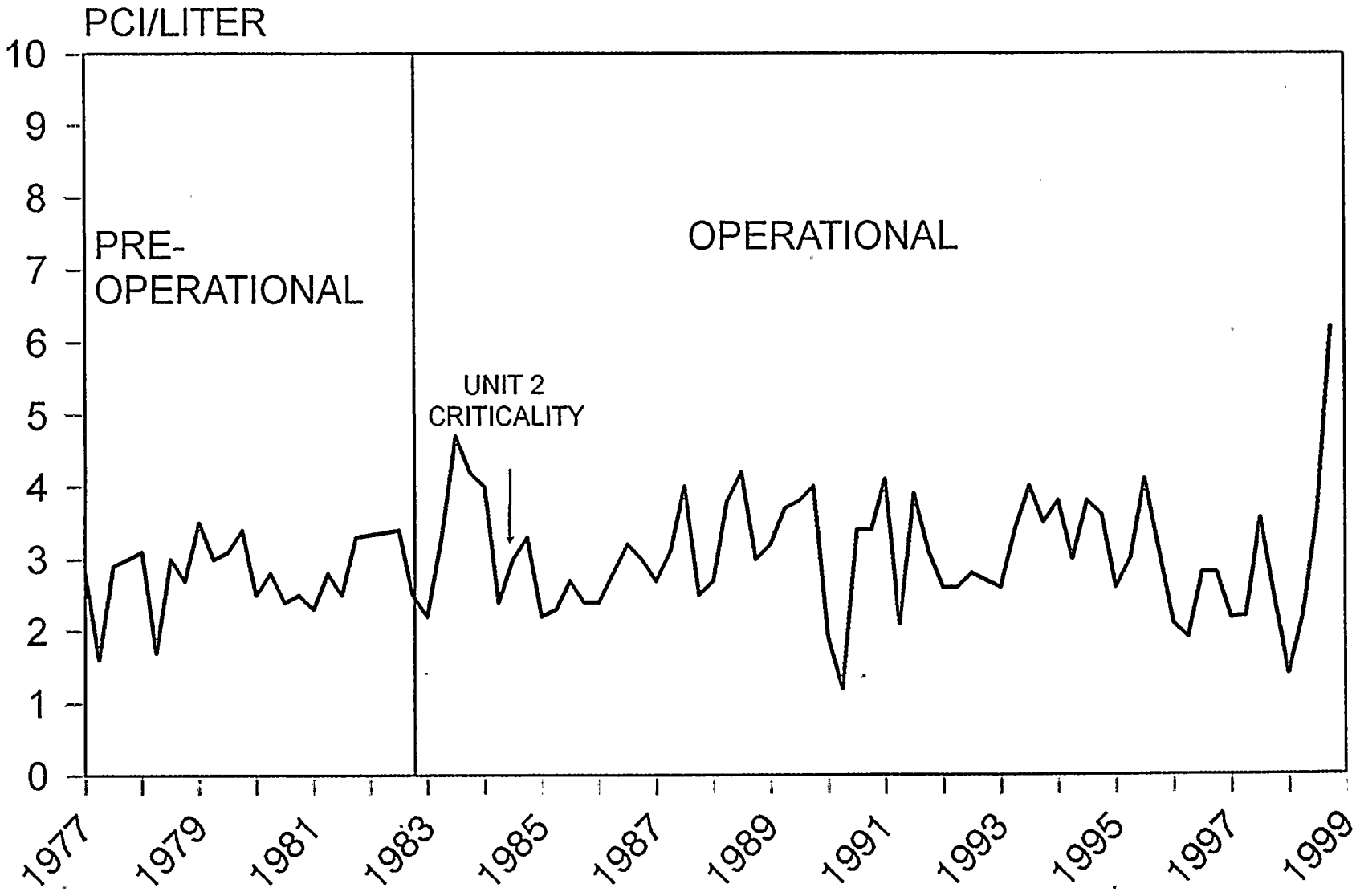


FIGURE 11 - HGW\Remp98.prs

ATMOSPHERIC PATHWAY MONITORING

INTRODUCTION

Atmospheric monitoring by the SSES REMP involves the sampling and analysis of air. Because the air is the first medium that SSES vent releases enter in the pathway to man, it is fundamental that it be monitored. Mechanisms do exist for the transport of airborne contaminants to other media and their concentration in them. For example, airborne contaminants may move to the terrestrial environment and concentrate in milk. Concentrations of radionuclides can make the sampling and analysis of media like milk more sensitive approaches for the detection of radionuclides, such as iodine-131, in the pathway to man than the monitoring of air directly. (PP&L also samples milk; refer to the Terrestrial Pathway Monitoring section of this report.) Nevertheless, the sensitivity of air monitoring can be optimized by the proper selection of sampling techniques and the choice of the proper types of analyses for the collected samples.

Scope

Air samples were collected on particulate filters and charcoal cartridges at indicator locations 3S2, 5S4, 7S7, 10S3, 12S1, 13S6, 9B1, and 12E1 and control locations 6G1 and 8G1.

Sampling and Analysis

Air

At all times during the year, the SSES REMP was monitoring the air at eight indicator locations and two control locations. The SSES Technical Requirements require monitoring at only a total of five sites. Monitoring is required at three locations at the SSES site boundary in different sectors with the greatest predicted sensitivities for the detection of SSES releases. Also, monitoring must be performed at the community in the vicinity of the SSES with the greatest predicted sensitivity and a control monitoring location that is expected to be unaffected by any routine SSES releases.

Airborne particulates were collected on glass fiber filters using low volume (typically 2.0 to 2.5 cfm sampling rates) air samplers that run continuously. Air iodine samples were collected on charcoal cartridges, placed downstream of the particulate filters.

Particulate filters and charcoal cartridges were exchanged weekly at the air monitoring sites. Sampling times were recorded on elapsed-time meters. Air sample volumes for particulate filters and charcoal cartridges were measured with dry-gas meters.

Air filters were analyzed weekly for gross beta activity, then composited quarterly and analyzed for the activities of gamma-emitting radionuclides. The charcoal cartridges were analyzed weekly for iodine-131.

Monitoring Results

Air Particulates

Gross beta activity is always measured at levels in excess of the analysis MDCs on the fiber filters. The highest gross beta activity levels that have been measured during the operational period of the SSES were obtained in 1986 following the Chernobyl accident in the former Soviet Union. Figure 12 trends the quarterly mean indicator and control location gross beta activities separately from 1974 through 1998. Note that prior to SSES operation, before 1982, the unusually high gross beta activities were generally attributable to fallout from atmospheric nuclear weapons tests. Typical gross beta activities measured on air particulate filters are the result of naturally occurring radionuclides associated with dust particles suspended in the sampled air. They are thus terrestrial in origin.

Particulate gross beta activity levels for each monitoring location and monitoring period in 1998 are presented in Table I-8 of Appendix I. Comparisons of 1998 gross beta analysis results with those of previous years may be found in Table H 13 of Appendix H. Annual means for the beta activities of the indicator and control locations in 1998 of 15.0E-3 pCi/m^3 and 13.9E-3 pCi/m^3, respectively, are near the low end of the corresponding ranges of previous operational yearly averages. 1998 annual means are significantly below the corresponding lower ends of their preoperational yearly averages. No contribution of radioactivity from the SSES is discernible from 1998 airborne gross beta data.

Quarterly gamma spectroscopic measurements of composited filters often show the naturally occurring radionuclide beryllium-7. Occasionally, other naturally occurring radionuclides, potassium-40 and radium-226 are also observed. Beryllium-7 is cosmogenic in origin, being produced by the interaction of cosmic radiation with the earth's atmosphere. The other two gamma-emitting radionuclides originate from soil and rock.

Beryllium-7 was measured above analysis MDCs for all quarterly composite samples in 1998. The 1998 indicator and control means for beryllium-7 activity were 121 E-3 pCi/m^3, and 116E-3 pCi/m^3, respectively. The 1998 indicator and control means were higher than the averages of the corresponding annual means for both prior operational and preoperational periods. The 1998 means are similar to the corresponding 1997 means. Beryllium-7 activity levels for each 1998 calendar quarter at each monitoring location are presented in Table I-9 of Appendix I. Comparisons of 1998 beryllium-7 analysis results with previous years may be found in Table H 14 of Appendix H.

Potassium-40 was seen in excess of analysis MDCs in some quarterly composites during 1998. The 1998 indicator and control means for potassium-40 activity were 6.7E-4 and -1.2E-4 pCi/m^3, respectively. No other gamma-emitting radionuclides were reported for air in 1998. Beryllium-7 and potassium-40 are not attributable to SSES operation.

Air Iodine

Iodine-131 has been detected infrequently from 1976, when it was first monitored, through 1998. Since operation of the SSES began in 1982, iodine-131 has only been positively detected in air samples in 1986 due to the Chernobyl accident. No iodine-131 was reported for the 1998 air monitoring results.

GROSS BETA ACTIVITY IN AIR PARTICULATES

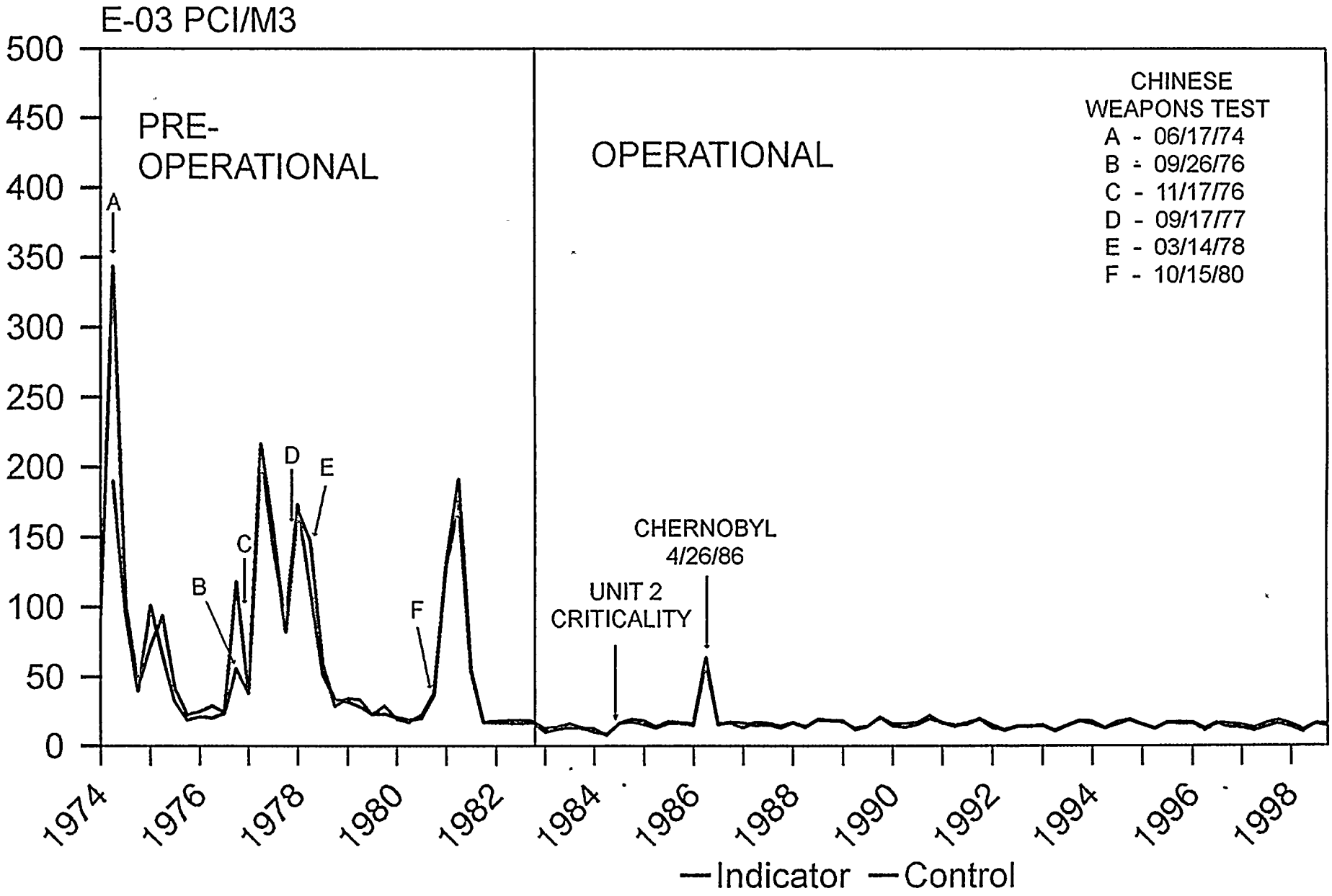


FIGURE 12 - HGW\Remp98.prs

TERRESTRIAL PATHWAY MONITORING

INTRODUCTION

The following media were monitored in the Terrestrial Pathway in 1998: soil, milk, fruits and vegetables.

Soil can be a great accumulator of man-made radionuclides that enter it. The extent of the accumulation in the soil depends of course on the amount of the radionuclides reaching it, but it also depends on the chemical nature of those radionuclides and the particular characteristics of the soil. For example, the element cesium, and, therefore, cesium-137 can be bound very tightly to clay in soils. The amount of clay in soil can vary greatly from one location to another. In highly clay soils, cesium-137 may move very slowly and also may be taken up very slowly in plants as they absorb soil moisture.

Any medium, such as soil, that tends to accumulate radioactive materials can also provide more sensitivity for radionuclide detection in the environment than those media that don't. Such a medium facilitates the early identification of radionuclides in the environment, as well as awareness of changes that subsequently may occur in the environmental levels of the identified radionuclides.

The SSES REMP samples soil near four of the ten REMP air sampling stations. The purpose for soil sampling near the air sampling sites is to make it easier to correlate air sampling results with soil sampling results if any SSES related radioactive material were found in either medium. Sampling is performed at different depths near the surface to help provide information on how recently certain radioactive materials may have entered the soil. Sampling at more than one depth also may help ensure the detection of materials that move relatively quickly through the soil. Such quick-moving materials may have already passed through the topmost layer of soil at the time of sampling.

Milk was sampled at four locations and fruit and vegetable samples were obtained at six more locations than required in 1998. SSES Technical Requirements only require that the SSES REMP sample milk at the three most sensitive monitoring locations near the SSES and one control location distant from the SSES. SSES Technical Requirements only require that fruit and vegetables be sampled at locations irrigated by Susquehanna River from points downstream of the SSES discharge to the River. There are only two locations within ten miles downstream of the SSES that have been known to irrigate with water from the Susquehanna River during unusually dry periods. These locations do not irrigate every year. Irrigation was performed at both the Zehner Brothers Farm (11D1) and the Lupini Farm (12F7) during 1998 which were surveyed in the 1998 Land Use Census (reference 61).

No requirement exists for the SSES REMP to monitor soil. All monitoring of the terrestrial pathway that is conducted by the SSES REMP in

addition to milk and certain fruit and vegetables is voluntary and reflects PP&L, Inc.'s willingness to exceed regulatory requirements, if necessary, to ensure that the public and the environment are protected.

Scope

Soil

Soil was sampled once, in accordance with its scheduled annual sampling frequency, at each of the four REMP air sampling locations, 3S2, 12S1, 13S6, and 8G1 in September 1998. Location 8G1 was a control sampling location; the remaining sampling sites were indicator locations.

Top and bottom soil plugs were taken, representing soil to a depth of two inches in the first case and soil from a depth of two inches to six inches in the second case, at a total of four monitoring locations in 1998. Twelve plugs from each layer were composited for analysis at each location, as is routine. A total of eight soil samples were analyzed in 1998.

Milk

Milk was sampled at least monthly at the following four locations in 1998: 10D1, 10D2, 10G1, and 12B3. The only exception was that milk could not be sampled from location 12B3 in December, 1998 because the farmer sold his cows.

Milk was sampled semi-monthly from April through October when cows were more likely to be in the pastures. These locations are believed to be the most sensitive monitoring sites available for the detection of any radionuclides that might be released from the SSES and find their way into milk from local dairy farms. Location 10G1 is the one control location that is sampled by the SSES REMP. A total of 75 milk samples from both indicator and control locations were analyzed in 1998.

Fruits and Vegetables

Fruits and vegetables were sampled at eight locations in seven different sectors surrounding the SSES during the harvest season. Thirteen different kinds of fruits and vegetables were obtained for a total of 35 samples. Samples were obtained from the following locations: 9B4, 10B5, 11D1, 12S7, 12F7, 13B2, 13G2, and 14B3. Location 13G2 was the control location.

The availability of fruits and vegetables from growers typically varies from one year to the next. For example, gardeners may grow different plants or choose not to plant gardens. An attempt is made each year to obtain samples from the most sensitive locations. This leads to the intentional substitution of some gardens for others based on consideration of annual meteorological data and available gardens as indicated in the Land Use Census from the previous year.

Two growers at locations 11D1 and 12F7 are required to be monitored every year because they have been identified as having irrigated with Susquehanna River water from downstream of the SSES at some time in the past. These growers are sampled each year even though there are often years with adequate rainfall when no irrigation is performed.

Sample Preservation and Analysis

The only sample medium monitored in the terrestrial pathway in which preservatives are used is milk. Sodium bisulfite is added to milk samples at the rate of 40 grams per gallon. This both helps maintain iodine in a reduced form and reduces the spoilage rate.

All media in the terrestrial pathway are analyzed for the activities of gamma-emitting radionuclides using gamma spectroscopy. The other analysis that is routinely performed is the radiochemical analysis for iodine-131 in milk.

Monitoring Results

The only man-made radionuclides normally measured at levels in excess of analysis MDCs in the terrestrial pathway are strontium-90 and cesium-137. Strontium-90 analyses are not now routinely performed for any media samples in the terrestrial pathway. Strontium-90 activity would be expected to be found routinely in milk as the result of fallout from previous nuclear weapons tests if analyses were being performed for it. SSES Technical Requirements do not require that milk be analyzed for strontium-90. Strontium-90 analyses may be performed at any time if the results of other milk analyses would show detectable levels of fission product activity which might suggest the SSES as the source. Cesium-137 normally has been measured in excess of analysis MDCs in most soil samples. Although game is not currently being monitored, cesium-137 has also been seen often at levels above the MDCs in game in the past. This radionuclide also is present in the environment as a residual from previous atmospheric nuclear weapons testing.

Certain naturally occurring radionuclides are also routinely found above analysis MDCs in terrestrial pathway media. Potassium-40, a primordial and very long-lived radionuclide, which is terrestrial in origin, is observed in all terrestrial pathway media exceeding analysis MDCs. Other naturally-occurring radionuclides often observed above MDCs are thorium-228 and radium-226 in soil, and beryllium-7 in fruits and vegetables.

The results of the 1998 terrestrial pathway monitoring resemble those of the past. Results for specific sample analyses of terrestrial pathway media may be found in Tables I-10 through I-12 of Appendix I. A summary of the 1998 terrestrial monitoring data may be located in Appendix G. Comparisons of 1998 monitoring results with those of past years may be found in Tables H 15 through H 20 of Appendix H.

Soil

The 1998 analysis results for all gamma-emitting radionuclides, naturally occurring potassium-40, radium-226, and thorium-228 and man-made cesium-137, that are routinely measured in soil at levels exceeding analysis MDCs were similar to those for previous years. No other gamma-emitting radionuclides were reported at levels above analysis MDCs in soil in 1998.

The 1998 means for indicator and control location sample potassium-40 activity were 12.6 pCi/gram and 9.4 pCi/gram, respectively. Both means were within the ranges of corresponding means for prior operational years. The indicator mean was higher than the corresponding range of preoperational means. This is not the result of SSES operation because the potassium-40 is naturally occurring. The 1998 indicator mean for potassium-40 was lower than the corresponding 1997 mean, while the 1998 control mean was the same as corresponding 1997 mean.

The 1998 means for indicator and control location sample radium-226 activity were 1.3 pCi/gram and 1.6 pCi/gram, respectively. These means are within the ranges of the annual means for the previous operational period of the SSES, although the control mean is above the corresponding range of annual means obtained during the preoperational period. This is not the result of SSES operation because the radium-226 is naturally occurring.

The 1998 means for indicator and control location sample thorium-228 activity were 0.9 pCi/gram and 0.7 pCi/gram, respectively. The 1998 indicator mean for thorium-228 is the same as the corresponding 1997 mean. The 1998 indicator mean is within the range of corresponding means for the previous operational period of the SSES. However, the 1998 control mean is below the range of its corresponding means for the previous operational period. Thorium-228 in soil is not the result of SSES operation because it is naturally occurring.

The 1998 means for indicator and control location sample cesium-137 activity were 0.05 pCi/g and 0.2 pCi/g, respectively. The 1998 indicator mean is below the range of the corresponding annual means for both prior operational and preoperational years. The 1998 control mean is at the low end of the range of the corresponding annual means for both prior operational and preoperational years. Cesium-137 levels in soil samples typically vary widely from sample to sample. Levels of cesium-137 activity in 1998 samples varied by more than a factor of ten over the entire range. Cesium-137 in soil, although man-made, is not from the operation of the SSES. It is residual fallout from previous atmospheric nuclear weapons testing.

Milk

Iodine-131 has been chemically separated in milk samples and counted routinely since 1977. Refer to Figure 13 which trends iodine-131 activity in milk separately for indicator and control locations from 1977 through 1998. Typically, iodine-131 is not reported at levels exceeding the MDCs for the analyses in any milk samples during a monitored year. The 1998 monitoring year was no exception; no iodine-131 above the analysis MDCs was observed in either indicator or control samples.

The preoperational years 1976, 1978, and 1980 were exceptional years in the sense that iodine-131 activity was observed in excess of MDCs due to fallout from atmospheric nuclear weapons testing. Iodine-131 activity was also measured at levels exceeding MDCs in milk samples in 1986 in the

vicinity of the SSES as a result of the Chernobyl incident. Subsequent levels observed near the baseline of Figure 13 in 1991 and 1992 represent background fluctuations in data that appear as a result of averaging methods. No iodine-131 levels exceeding analysis MDCs were observed in milk during these years.

With the exception of the naturally occurring potassium-40, no gamma-emitting radionuclides were measured in excess of analysis MDCs in 1998. The 1998 means for indicator and control location sample potassium-40 activity were 1306 pCi/liter and 1355 pCi/liter, respectively. The 1998 indicator mean is the same as the 1997 mean. However, the 1998 control mean is greater than the corresponding 1997 mean. The 1998 indicator and control means for potassium-40 activity are within the ranges of annual means for both previous operational years and preoperational years. The potassium-40 activity in milk is not attributable to the SSES operation because it is naturally occurring.

Fruits and Vegetables

With the exception of the measurement of naturally occurring beryllium-7 in one fruit and vegetable sample, naturally occurring potassium-40 was the only gamma-emitting radionuclide reported in fruits and vegetables at activity levels in excess of analysis MDCs during 1998. The 1998 means for indicator and control location sample potassium-40 activity were 2.3 pCi/gram and 2.4 pCi/gram, respectively. The 1998 indicator mean is the same as the corresponding 1997 mean. The 1998 means are within the ranges of the corresponding annual means for prior operational years. But, the 1998 indicator mean is below the range of corresponding annual means for preoperational years. Potassium-40 in fruits and vegetables is not attributable to SSES operation because it is a naturally occurring radionuclide.

IODINE-131 ACTIVITY IN MILK

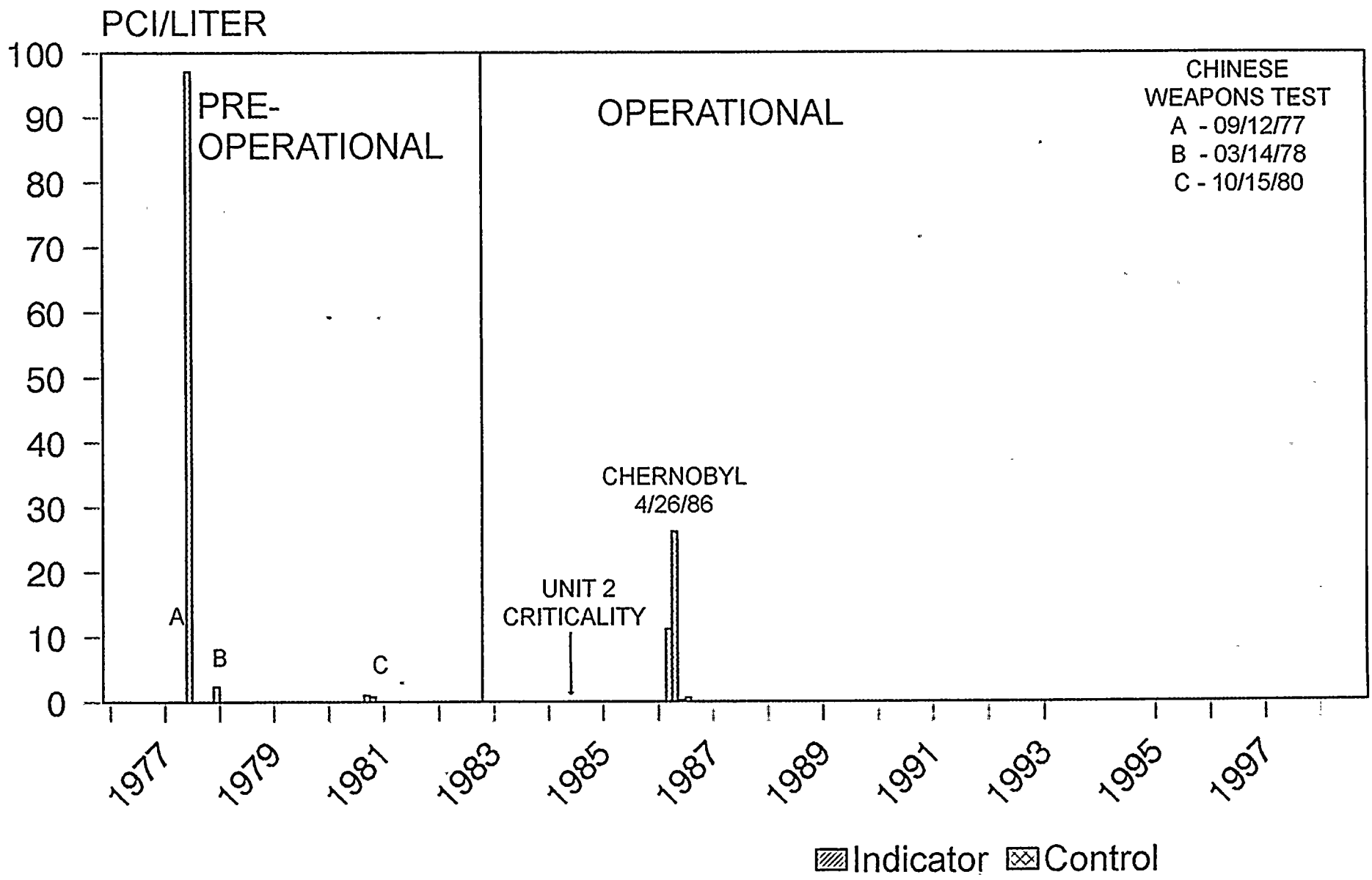


FIGURE 13 - HGW\Remp98.prs

GROUND WATER MONITORING

INTRODUCTION

Normal operation of the SSES does not involve the release of radioactive material to ground water directly or indirectly through the ground. As a result, there are no effluent monitoring data to verify or to compare with REMP ground water monitoring results. Ground water could conceivably become contaminated by the washout or deposition of radioactive material that might be airborne. If deposited on the ground, precipitation/soil moisture could aid in the movement of radioactive materials through the ground to water that could conceivably be pumped for drinking purposes. (No use of ground water for irrigation near the SSES has been identified.)

Because routine SSES operation releases primarily isotopes of xenon and krypton and tritium to the air, no radionuclides attributable to SSES operation are expected to be observed in ground water. Iodine and particulate releases to the air are negligible. Gaseous xenon and krypton tend to remain airborne; deposition or washout of these would be expected to be very minimal. Tritium would be the most likely radionuclide to reach the ground with precipitation and, if not lost to streams (surface water) by runoff, move readily through the soil to the ground water.

Scope

In spite of the improbability of measuring any radioactivity attributable to SSES operation in the ground water in the SSES vicinity, it was sampled monthly at four indicator locations (2S6, 4S4, 4S5, and 12S1) and one control location (12F3) during 1998.

With the exception of location 4S4, untreated ground water was sampled. (Untreated means that the water has not undergone any processing such as filtration, chlorination, or softening.) At location 4S4, the SSES Training Center, well water actually is obtained from on-site and piped to the Training Center after treatment. This sampling is performed as a check to ensure that this water has not been radioactively contaminated. Sampling is performed at the Training Center to facilitate the sample collection process.

Sample Preservation & Analysis

All samples (except the aliquots assigned for tritium analyses) were preserved with nitric acid, the same as described in the section of this report on Aquatic Pathway Monitoring.

Ground water samples were analyzed for the activities of gamma-emitting radionuclides and tritium activity. Gamma spectrometric analyses of ground water were begun in 1979 and tritium analyses in 1972, both prior to SSES operation.

Monitoring Results

Tritium activity levels in ground water have typically been observed to be lower than surface water tritium levels. A noticeable decline occurred between 1992 and 1993 in the ground water tritium levels. Fewer measurements of tritium resulted in levels above the analysis sensitivities in 1993 than in 1992.

Gamma spectrometric analyses have identified and measured gamma-emitting radionuclides in excess of MDCs in only a few samples in all the years that these analyses have been being performed. The naturally occurring radionuclides potassium-40 and thorium-228 have been measured above their MDCs occasionally in ground water. Potassium-40 has been measured above MDCs in 1979, 1981, 1985, 1991, 1992, 1993, and 1997. Thorium-228 has been observed above MDCs in 1985 and 1986. The man-made radionuclide cesium-137 has been measured above MDCs only occasionally since 1979. Its presence has always been attributed to residual fallout from previous atmospheric nuclear weapons tests.

The results of the 1998 REMP ground water surveillance resemble those of the past. Results for specific ground water sample analyses may be found in Table I-7 of Appendix I. A summary of the 1998 ground water monitoring data may be located in Appendix G. Comparisons of 1998 monitoring results for tritium with those of past years may be found in Table H 21 of Appendix H.

During 1998, tritium levels were measured in excess of analysis MDCs in ground water samples on only two occasions. The 1998 mean tritium activity levels for indicator and control ground water monitoring locations were -37 pCi/liter and -71 pCi/liter, respectively. These levels are similar to those for 1997 when the indicator and control ground water monitoring location means also were less than background. Both the 1997 and 1998 indicator and control mean tritium activity levels are significantly below the corresponding averages of annual means for prior operational and preoperational years. A decline in tritium averages for various waters, including ground water, first occurred in 1991 when data averaging methods changed. Another decline in tritium averages was noted in 1993 for waters generally. In 1997, another significant decline in tritium levels from the previous years was observed.

Naturally occurring potassium-40 was not measured in excess of an analysis MDC for any ground water samples during 1998. No man-made gamma-emitting radionuclides were measured at levels in excess of analysis MDCs in 1998 in ground water samples. The results from gamma spectroscopic analyses indicated that no radioactivity contributions to ground water from the SSES were identifiable in 1998.

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APPENDIX A

1998 REMP CHANGES

Aquatic Pathway Monitoring

Surface water sampling was discontinued at monitoring location 12H1 in 1998. Monitoring at this location was not required. Location 12H1 was the furthest downstream indicator location intended to show any radiological impact that might result from SSES operation. Location 12H1 was at the Merck chemical company in Danville, PA, 26 miles west southwest of the SSES and downstream of the SSES discharge. Monitoring of the Susquehanna River downstream of the SSES discharge to the river will continue following the elimination of location 12H1, as will monitoring of processed water from the Danville Municipal Drinking Water facility. Any activity in the water of the Susquehanna River downstream of the SSES should be detectable prior to getting to the Merck facility with the remaining monitoring. Location 6S5, nearer the SSES discharge to the river, continues to be monitored by weekly grab sampling and sample compositing for analyses at biweekly and monthly intervals. In addition, an automatic continuous sampler (ACS) is maintained for continuous monitoring of the Cooling Tower Blowdown Discharge (CTBD) line through which potentially radioactively contaminated water is discharged to the Susquehanna River.

Flocculated sediment sampling was discontinued in 1998 at sampling locations 2B and 7B. Sampling location 2B is a control monitoring location upstream of the SSES, about 1.6 miles north northeast of the plant near Gould Island. Sampling location 7B is an indicator monitoring location downstream of the SSES discharge to the river, about 1.2 miles southeast of the plant at Bell Bend. Coarse sediment continued to be sampled at locations 2B and 7B during 1998. No significant differences have been observed in past analysis results between the flocculated and coarse sediment samples.

The coarse sediment sampling locations eliminated from the program in 1998 were control location (2F) upstream of the SSES discharge to the Susquehanna River and indicator location (11C) downstream of the discharge. Location 2F was 6.4 miles north northeast of the plant, between Shickshinny and the Retreat State Correctional Institution. Location 11C was 2.6 miles southwest of the plant near Hess Island. Sediment monitoring in the Susquehanna River will continue with one control location and two indicator locations, indicator location (7B) closer to the discharge than 11C and one (12F) further away. No buildup of activity attributable to SSES operation has been observed at any of the current sediment sampling locations. If any future buildup of such sediment activity is identified at the remaining locations, consideration can be given to increasing the monitoring effort at that time.

None of the above changes to the REMP reduce the environmental monitoring required by Technical Requirements.

REMP Gross Beta Analyses of Surface Water

PP&L Inc.'s Corporate Environmental Radioactivity Measurements Laboratory (CERML) became the primary laboratory for the gross beta analyses of samples from the following surface water monitoring locations: 6S6 (5S9), 2S7(6S7), 6S5, and LTAW. Teledyne Brown Engineering's laboratory became the quality control laboratory for the gross beta analyses of surface water, routinely performing gross beta analyses on surface water samples from monitoring location 2S7(6S7).

APPENDIX B

1998 REMP MONITORING SCHEDULE (SAMPLING AND ANALYSIS)

TABLE 1
(Page 1 of 2)

Annual Analytical Schedule for the
PP&L Susquehanna Steam Electric Station
Radiological Environmental Monitoring Program - 1998

Media & Code	No. of Locations	Sample Freq.(a)	Analyses Required	Analysis Freq. (b)
Airborne Particulates	10	W	Gross Beta (c) Gamma Spectrometry	W QC
Airborne Iodine	10	W	I-131	W
Sediment	4	SA	Gamma Spectrometry	SA
Fish	2 1	SA A	Gamma Spectrometry (on edible portion)	SA
Surface Water (d)	5	MC, M, or BWC	Gross Beta I-131 Gamma Spectroscopy Tritium	M BW M M
Well (ground) Water	5	M	Gamma Spectroscopy Tritium	M M
Drinking Water (e)	1	MC, BWC	Gross Alpha Gross Beta I-131 Gamma Spectrometry Tritium	M M BW M M
Cow Milk	4	M, SM(f)	I-131 Gamma Spectrometry	SM, M SM, M
Food Products (Various Fruits and Vegetables)	8	A	Gamma Spectrometry	A
Soil	4	A	Gamma Spectrometry	A
Direct Radiation	86	Q	TLD	Q

Note: See footnotes at end of table.

(a) W = weekly, BW = bi-weekly, BWC = bi-weekly composite, M = monthly, SM = semi-monthly, Q = quarterly, QC = quarterly composite, SA = semi-annually, A = annually, MC = monthly composite.

(b) Codes are the same as for sample frequency.

(c) If the gross beta activity were greater than 10 times the yearly mean of the control sample, gamma analysis would be performed on the individual filter. Gross beta analysis was performed 24 hours or more following filter change to allow for radon and thoron daughter decay.

(d) Stations 6S6, 6S7, and 2S7 were checked at least weekly to ensure that the automatic composite samplers were operational. Time proportional sampling was performed at locations 6S6, 6S7 and 2S7 the entire year. Station 6S5 was grab sampled weekly. Individual composites of the weekly samples were made both monthly (MC) and biweekly for analysis.

(e) Water from station 12H2 TREATED was retrieved weekly. Composite samples of the weekly collections at this location were made both monthly (MC) and biweekly (BWC) for analysis. Sampling at 12H2 TREATED was performed using an automatic continuous sampler (ACS) that was operated in the time proportional mode.

(f) Stations 12B3, 10D1, 10D2, and 10G1 were sampled semi-monthly from April through October.

APPENDIX C

1998 REMP MONITORING LOCATION DESCRIPTIONS

TABLE C 1
(Page 1 of 5)

TLD Locations for the SSES
Radiological Environmental Monitoring Program – 1998

Less Than One Mile from the SSES[a] - See Figure 2

Location Code(b)	Distance (miles)	Direction	Description
1S2	0.2	N	Perimeter Fence
2S2	0.9	NNE	Energy Information Center
2S3	0.2	NNE	Perimeter Fence
3S2	0.5	NE	SSES Backup Met Tower
3S3	0.9	NE	ANSP Riverlands Garden
3S4	0.3	NE	Perimeter Fence
4S3	0.2	ENE	Post, West of SSES APF
4S6	0.7	ENE	Riverlands (Birdhouse Post)
5S4	0.8	E	West of Environmental Laboratory
5S7	0.3	E	Perimeter Fence
6S4	0.2	ESE	Perimeter Fence
6S9	0.2	ESE	Perimeter Fence (south)
7S6	0.2	SE	Perimeter Fence
7S7	0.4	SE	End of Kline's Road
7S8	0.4	SE	Kline Residence
8S2	0.2	SSE	Perimeter Fence
9S2	0.2	S	Security Fence
10S1	0.4	SSW	Post - south of switching station
10S2	0.2	SSW	Security Fence
10S3	0.6	SSW	Confer's Lane – south of Towers Club
11S3	0.3	SW	Security Fence
11S7	0.4	SW	SSES Access Road Gate #50
12S1	0.4	WSW	SSES West Building

TABLE C 1.
(Page 2 of 5)

TLD Locations for the SSES
Radiological Environmental Monitoring Program – 1998

Less Than One Mile from the SSES[a] - See Figure 2

Location Code (b)	Distance (miles)	Direction	Description
12S3	0.4	WSW	Perimeter Fence
12S4	0.4	WSW	Perimeter Fence
12S5	0.4	WSW	Perimeter Fence
12S6	0.4	WSW	Perimeter Fence
13S2	0.4	W	Perimeter Fence
13S4	0.4	W	Perimeter Fence
13S5	0.4	W	Perimeter Fence
13S6	0.4	W	Former Laydown Area - west of Confer's Lane
14S5	0.5	WNW	Beach Grove Road/Confer's Lane (Pole)
14S6	0.7	WNW	Beach Grove Road (pole)
15S5	0.4	NW	Perimeter Fence
16S1	0.3	NNW	Perimeter Fence (east)
16S2	0.3	NNW	Perimeter Fence (west)
6A4	0.6	ESE	Restaurant (U.S. Route 11)
8A3	0.9	SSE	PP&L Wetlands Sign (U. S. Route 11)
15A3	0.9	NW	Krisanda Residence
16A2	0.8	NNW	Rupinski Residence

From One to Five Miles from the SSES[a] - See Figure 3

12S7	1.1	WSW	Kisner Residence
1B1	1.4	N	Mingle Inn Road
2B3	1.3	NNE	Durabond Corporation
2B4	1.4	NNE	U.S. Route 11/Mingle Inn Road Intersection
5B3	1.6	E	PP&L Switchyard
7B2	1.5	SE	Heller's Orchard Store
8B2	1.4	SSE	Lawall Residence
8B3	1.5	SSE	Wapwallopen Post Office

TABLE C 1
(Page 3 of 5)

TLD Locations for the SSES
Radiological Environmental Monitoring Program – 1998

From One to Five Miles from the SSES[a] - See Figure 3

Location Code (b)	Distance (miles)	Direction	Description
9B1	1.3	S	Transmission Line - east of Route 11
10B2	2.0	SSW	Algatt Residence
10B3	1.7	SSW	Castek Inc.
10B4	1.4	SSW	U. S. Route 11/River Road Intersection
12B4	1.7	WSW	Shultz Farm
13B1	1.3	W	Walker Run Creek (Tele. Pole #36)
14B3	1.3	WNW	Moskaluk Residence
15B1	1.7	NW	Country Estates Trailer Park
16B2	1.7	NNW	Walton Power Line
11C1	2.0	SW	Salem Township Fire Company
1D5	4.0	N	Shickshinny/Mocanaqua Sewage Treatment Plt.
6D1	3.5	ESE	St. Peters Church – Hobbie
8D3	4.0	SSE	Mowry Residence
9D4	3.6	S	Country Folk Store
10D1	3.0	SSW	R. & C. Ryman Farm
12D2	3.7	WSW	Dagostin Residence
14D1	3.6	WNW	Moore's Hill/Mingle Inn Roads Intersection
3E1	4.7	NE	Webb Residence - Lilly Lake
4E2	4.7	ENE	Ruckles Hill/Pond Hill Roads Intersection
5E2	4.5	E	Bloss Farm
6E1	4.7	ESE	St. James Church

TABLE C1
(Page 4 of 5)

TLD Locations for the SSES
Radiological Environmental Monitoring Program – 1998

From One to Five Miles from the SSES[a] - See Figure 3

Location Code (b)	Distance (miles)	Direction	Description
7E1	4.2	SE	Harwood Transmission Line Pole #2
11E1	4.7	SW	Thomas Residence
12E1	4.7	WSW	Berwick Hospital
13E4	4.1	W	Kessler Farm

Greater than Five Miles from the SSES[a] - See Figure 4

2F1	5.9	NNE	St. Adalberts Cemetery
8F2	8.5	SSE	Huff Residence
12F2	5.2	WSW	Berwick Substation
15F1	5.4	NW	Zatwatski Farm
16F1	7.8	NNW	Hidlay Residence
3G4	17	NE	Wilkes Barre Service Center
4G1	14	ENE	Mountaintop - Crestwood Industrial Park
6G1	13.5	ESE	Freeland Substation
7G1	14	SE	Hazleton PP&L Complex
7G2	12	SE	Hazleton Cemetery - 14th Street (Pole #21852-H)
8G1	12	SSE	PP&L SFC - Humbolt Industrial Park
12G1	15	WSW	PP&L Service Center, Bloomsburg
12G4	10	WSW	Naus Residence

TABLE C 1
(Page 5 of 5)

TLD Locations for the SSES
Radiological Environmental Monitoring Program – 1998

a) All distances from the SSES to monitoring locations are measured from the standby gas treatment vent at 44200/N34117 (Pa. Grid System). The location codes are based on both distance and direction from the SSES. The letters in the location codes indicate if the monitoring locations are on site (within the site boundary) or, if they are not on site, the approximate distances of the locations from the SSES as described below:

S - on site	E - 4-5 miles
A - <1 mile	F - 5-10 miles
B - 1-2 miles	G - 10-20 miles
C - 2-3 miles	H - >20 miles
D - 3-4 miles	

The numbers preceding the letters in the location codes provide the directions of the monitoring locations from the SSES by indicating the sectors in which they are located. A total of 16 sectors (numbered 1 through 16) equally divide an imaginary circle on a map of the SSES and its vicinity, with the SSES at the center of the circle. The middle of sector 1 is directed due north (N). Moving clockwise from sector 1, the sector immediately adjacent to sector 1 is sector 2, the middle of which is directed due north, northeast (NNE). Continuing to move clockwise, the sector numbers increase to 16, which is the north, northwest sector.

The numbers following the letters in the location codes are used to differentiate sampling locations found in the same sectors at approximately the same distances from the SSES.

TABLE C 2
(Page 1 of 4)

Sampling Locations for the SSES Radiological Environmental Monitoring Program – 1998

Less Than One Mile from the SSES[a] - See Figure 5

Location Code	Distance (miles)	Direction	Description
SURFACE WATER			
2S7	0.1	NNE	Cooling Tower Blowdown Line
5S9	0.8	E	Environmental Lab Boat Ramp (Alternate for 6S6)
6S5	0.9	ESE	Outfall Area
6S6	0.8	ESE	River Water Intake Line
6S7	0.4	ESE	Cooling Tower Blowdown Line
LTAW		NE - ESE	Lake Took-A-While (on site)
FISH			
LTAW		NE - ESE	Lake Took-A-While (on site)
SEDIMENT[c]			
LTAW		NE - ESE	Lake Took-A-While (on site)
AIR			
3S2	0.5	NE	SSES Backup Meteorological Tower
5S4	0.8	E	West of SSES Environmental Laboratory
7S7	0.4	SE	End of Kline's Road
10S3	0.6	SSW	East of Confer's Lane, South of Towers Club
12S1	0.4	WSW	West Building
13S6	0.4	W	Former Laydown Area, West of Confers Lane
SOIL			
3S2	0.5	NE	SSES Backup Meteorological Tower
12S1	0.4	WSW	West Building
13S6	0.4	W	Former Laydown Area, West of Confers Lane

TABLE C2
(Page 2 of 4)

Sampling Locations for the SSES
Radiological Environmental Monitoring Program – 1998

Less Than One Mile from the SSES[a] - See Figure 5

Location Code	Distance (miles)	Direction	Description
			GROUND WATER
2S2	0.9	NNE	Energy Information Center
4S4	0.5	ENE	Training Center
4S5	0.5	ENE	White House
12S1	0.5	SW	West Building
From One to Five Miles From the SSES - See Figure 6			
			FISH[b]
IND	0.9 - 1.4	ESE	At or Below the SSES Discharge Diffuser
			SEDIMENT[c]
2B	1.6	NNE	Gould Island
7B	1.2	SE	Bell Bend
			AIR
9B1	1.3	S	Transmission Line - East of Route 11
12E1	4.7	WSW	Berwick Hospital
			MILK
10D1	3.0	SSW	R. & C. Ryman Farm
10D2	3.1	SSW	Russell Ryman Farm
12B3	2.0	WSW	Young Farm
			FRUITS/VEGETABLES
12S7	1.1	WSW	Kisner Residence
9B4	1.1	S	Cope Residence
10B5	1.2	SSW	Bodnar Residence
13B2	1.2	W	Seely/Hummel Residence
14B3	1.3	WNW	Moskaluk Residence
11D1	3.3	SW	Zehner Farm

TABLE C 2
(Page 3 of 4)

Sampling Locations for the SSES
Radiological Environmental Monitoring Program – 1998

Greater than Five Miles from the SSES[a] - See Figure 7

Location Code	Distance (miles)	Direction	Description
DRINKING WATER			
12H2T	26	WSW	Danville Water Co. (treated)
FISH[b]			
2H	30	30	Near Falls, Pa.
SEDIMENT[c]			
12F	6.9	WSW	Old Berwick Test Track
AIR			
6G1	13.5	ESE	Freeland Substation
8G1	12	SSE	PP&L SFC - Humbolt Industrial Park
SOIL			
8G1	12	SSE	PP&L SFC - Humbolt Industrial Park
MILK			
10G1	14	SSW	Davis Farm
FRUITS/VEGETABLES			
12F7	8.3	WSW	Lupini Farm
13G2	16	W	Kile Farm
GROUND WATER			
12F3	5.2	WSW	Berwick Water Company

TABLE C 2
(Page 4 of 4)

Sampling Locations for the SSES
Radiological Environmental Monitoring Program - 1998

a) All distances from the SSES to monitoring locations are measured from the standby gas treatment vent at 44200/N34117 (Pa. Grid System. The location codes are based on both distance and direction from the SSES. The letters in the location codes indicate if the monitoring locations are on site (within the site boundary) or, if they are not on site, the approximate distances of the locations from the SSES as described below:

S - on site	E - 4-5 miles
A - <1 mile	F - 5-10 miles
B - 1-2 miles	G - 10-20 miles
C - 2-3 miles	H - >20 miles
D - 3-4 miles	

The numbers preceding the letters in the location codes provide the directions of the monitoring locations from the SSES by indicating the sectors in which they are located. A total of 16 sectors (numbered 1 through 16) equally divide an imaginary circle on a map of the SSES and its vicinity, with the SSES at the center of the circle. The middle of sector 1 is directed due north (N). Moving clockwise from sector 1, the sector immediately adjacent to sector 1 is sector 2, the middle of which is directed due north, northeast (NNE). Continuing to move clockwise, the sector numbers increase to 16, which is the north, northwest sector.

The numbers following the letters in the location codes are used to differentiate sampling locations found in the same sectors at approximately the same distances from the SSES.

b) No actual location is indicated since fish are sampled over an area which extends through 3 sectors (5, 6, 7) near the outfall area.

c) No permanent locations exist; samples are taken based on availability. Consequently, it is not necessary to assign a number following the letter in the location code.

APPENDIX D

1998 LAND USE CENSUS RESULTS

1998 LAND USE CENSUS RESULTS

The SSES Technical Requirements require that a census be conducted annually during the growing season to determine the location of the nearest milk animal, residence, and garden greater than 50 m^2 (≈500 ft^2) producing broad leaf vegetation in each of the 16 meteorological sectors within a distance of 8 km (≈5 miles) in each of the 16 meteorological sectors surrounding the SSES. To comply with this requirement, a land-use survey was conducted for the SSES during 1998. The closest qualified gardens and residences and all dairy animals within five miles of SSES in each of the 16 sectors were identified.

Table 5 lists the results of the census. The results are used in conjunction with the most recent year's meteorological data to determine if any changes in required REMP sampling locations for milk must be made. These results are also used to determine the optimum sampling locations for fruits and vegetables and to make changes in such sampling locations if warranted and practical. Such changes ensure that the most sensitive monitoring locations are included in the REMP. Land use census results are also used in the assessment of potential radiological doses to individuals and populations living in the vicinity of the SSES.

A comparison of the 1997 and 1998 Land Use Census results for the Susquehanna SES indicates the changes described below. Changes occurred in the locations of two of the nearest residences, four of the nearest gardens and the two locations for dairy animals from 1997 to 1998. Refer to the summary of these changes in the following table.

CHANGES FROM 1997 TO 1998 IN NEAREST RESIDENCES, GARDENS, AND DAIRY ANIMALS AS DETERMINED BY THE 1998 LAND USE CENSUS

Exposure Pathway	Sector/ Direction	1997		1998	
		Name	Distance	Name	Distance
Residence	5/E	E. Yanulewicz	1.4 mi.	P. Faux	1.7 mi.
	7/SE	D. Stelmach	0.4 mi.	J. Futoma	0.5 mi.
Garden	2/NNE	V. Woodruff	1.1 mi.	R. Chapin	2.3 mi.
	5/E	E. Yanulewicz	1.4 mi.	W. Daily	1.8 mi.
	8/SSE	R. Allen	0.8 mi.	D. Dawson	1.5 mi.
	15/NW	L. Gensil	0.8 mi.	D. Goff	1.8 mi.
Dairy Animal	9/S	A. Broyan	3.9 mi.	None < 5 mi.	--
	15/NW	None < 5 mi.	--	D. Goff	1.8 mi.

Changes in meat usage from 1997 to 1998 also were identified by the 1998 Land Use Census. Refer to the summary of these changes in the following table. Note that, in 1998, the Census identified the raising of steers at the P. Young dairy farm for consumption that were not identified in 1997.

CHANGES FROM 1997 TO 1998 IN MEAT USAGE AT THE NEAREST GARDEN & DAIRY ANIMAL LOCATIONS					
Exposure Pathway	Sector/ Direction	Name	Distance	Meat Usage	
				1997	1998
Garden	4/ENE	G. Dennis	2.4 mi.	Chickens, Geese, & Ducks	Pigs, Chickens, Goats, & Pheasants
Dairy Animal	12/WSW	P. Young	2.0 mi.	None	Steers
	15/NW	D. Goff	1.8 mi.	None	Chicken & Beef Cattle

TABLE 5

Nearest residence, garden, and dairy animal in each of the 16 meteorological sectors within a 5-mile radius of the Susquehanna Steam Electric Station, 1998.

SECTOR	DIRECTION	NEAREST RESIDENCE	NEAREST GARDEN	NEAREST DAIRY ANIMAL
1	N	1.3 mi	3.2 mi	>5.0 mi
2	NNE	1.0 mi	2.3 mi	>5.0 mi
3	NE	2.3 mi	2.3 mi	>5.0 mi
4	ENE	2.1 mi	2.4 mi[a,c,j,k]	>5.0 mi
5	E	1.7 mi	1.8 mi	4.5 mi[g,i]
6	ESE	0.5 mi	2.5 mi	2.7 mi[g]
7	SE	0.5 mi	0.6 mi	2.6 mi[g]
8	SSE	0.6 mi	1.5 mi	>5.0 mi
9	S	1.0 mi	1.1 mi	>5.0 mi
10	SSW	0.9 mi	1.2 mi	3.0 mi[a,b,c,d,e,g]
11	SW	1.5 mi	1.9 mi	>5.0 mi
12	WSW	1.1 mi	1.1 mi	2.0 mi[g,i]
13	W	1.2 mi	1.2 mi	5.0 mi[g]
14	WNW	0.8 mi	1.3 mi	>5.0 mi
15	NW	0.8 mi	1.8 mi	1.8 mi[a,i]
16	NNW	0.6 mi	4.0 mi	4.2 mi

[a] Chickens raised for consumption at this location.
[b] Ducks raised for consumption at this location.
[c] Eggs consumed from chickens raised at this location.
[d] Geese raised for consumption at this location.
[e] Pigs raised for consumption at this location.
[f] Turkeys raised for consumption at this location.*
[g] Fruits/vegetables grown for consumption at this location.
[h] Rabbits raised for consumption at this location*
[i] Beef cattle raised for consumption at this location.
[j] Goats raised for consumption at this location.
[k] Pheasants raised for consumption at this location.

*No locations were identified as raising turkeys and rabbits during 1998.

APPENDIX E

SUMMARY DESCRIPTION OF SSES REMP ANALYTICAL METHODS

TLD MEASUREMENTS

The PP&L Inc. dosimetry system used for monitoring ambient radiation levels in the environment consists of Panasonic 710A readers and Panasonic UD-814 TLDs. The UD-814 TLD badges each contain four elements. Elements 2, 3, and 4 in each badge are made of calcium sulfate with 800 mg/cm^2 of filtering and element 1 is composed of lithium tetraborate with filtering of 25 mg/cm^2. Only the calcium sulfate elements are normally used for environmental measurements because of their higher light output per unit of radiation exposure relative to the lithium tetraborate and, consequently, greater sensitivity for the detection and measurement of radiation.

Note: Element 1 would be of value in the event of an unusually large release of noble gases, especially xenon, that would produce relatively low-energy X-ray or gamma emissions. This is because the lithium tetraborate does not over-respond to such low-energy emissions as does the calcium sulfate.

The TLD element manufacturers' attempt to make each element as similar as possible to each of the other elements in each batch that is produced. Nevertheless, each element ends up somewhat different in its response to radiation. In order to minimize the effect of these inherent differences when comparing actual monitoring results for different elements, Element Correction Factors (ECFs) are determined for each element. The ECFs are used to effectively normalize the readings of the field elements placed at particular monitoring locations for given monitoring periods to the average of the readings that would be expected if so-called reference elements were to be placed simultaneously at those individual locations. Reference elements are elements that have been demonstrated to display superior measurement performance.

The selection process for reference elements involves repeatedly irradiating a large set of elements, processing them, calculating the mean response for each set of elements, and evaluating the deviation of each individual element response from the mean response. After this process has been repeated at least several times, the elements with the least variability in their responses and with mean responses nearest to the mean response of the entire population of elements are chosen as reference elements.

To determine ECFs for individual field elements, the elements are first exposed to known amounts of radiation (100 mR) and processed, a minimum of three times each. Each element reading is then divided by the mean of the readings obtained from reference elements (typically 30 to 35) that were exposed to the same amounts of radiation as the elements for which the ECFs are being determined and that were processed at the same time as these elements. The mean quotient (ratio) is then calculated for each element by summing the quotients obtained for each processing and then dividing by the total number of the processings performed.

The following equation shows how ECFs are calculated:

$$ECF = \left[\frac{\sum_{i=1}^{n} \frac{E_i}{\overline{E}_{ref}}}{n} \right]$$

where

E_i an uncorrected exposure reading for the element.

$n =$ the total number of individual element exposures averaged.

$\overline{E}_{ref} =$ the mean of the ECF-corrected exposure readings of the reference elements.

Irradiated control TLDs are processed (read) with the batches of TLDs from the field to provide both processing calibration information and quality control. Field control TLDs, which accompany the field TLDs when they are being taken to their monitoring locations and subsequently retrieved from these locations, and cave control TLDs, which are stored with the field TLDs for the periods between annealing and field distribution and between retrieval from the field and processing, are also read with the field TLDs to provide checks on the exposures that the field TLDs might receive on their way to and from their monitoring locations and while in storage, respectively.

The raw data from the field TLD processings is Run Calibration Factor (RCF) corrected using the irradiated control TLD data. The irradiated control TLDs are exposed to 100 mR from a cesium-137 source at the University of Michigan. The irradiated TLDs are accompanied enroute to and from the University of Michigan by transit control TLDs. An estimate of the exposures received by the irradiated TLDs in-transit is obtained by processing the transit controls and determining the transit control mean by the following equation:

$$\overline{E}_{tc} = \frac{\sum_{i=1}^{n} \left[\frac{E_i}{ECF_i} \right]_{tc}}{n}$$

where

$\overline{E}_{tc} =$ the mean of the elementally corrected exposure readings of all the transit control elements.

$E_i =$ the uncorrected exposure reading of each individual transit control element.

ECF_t = the elemental correction factor of each individual transit control element.

n = the total number of individual element exposures averaged.

The mean of the transit control exposures is then subtracted from each of the elementally corrected exposures of the irradiated elements to obtain the net exposures for each element resulting from the irradiation. The mean of these net exposures is then divided by the known exposure (100 mR) from the irradiation to determine the RCF. The following equation describes the calculations performed:

$$RCF = \frac{\left[\frac{\sum_{i=1}^{n}\left(\frac{E_i}{ECF_i} - \overline{E}_{ic}\right)_{ic}}{n}\right]}{KE_{ic}}$$

where

RCF = the run correction factor for an individual field monitoring element.

E_i = the exposure reading of each individual irradiated control element.

ECF_i = the elemental correction factor of each individual irradiated control element.

n = the total number of individual element exposures averaged.

KE_{ic} = the known exposure for each of the irradiated control elements.

Exposure readings for individual field monitoring elements are corrected using the appropriate mean transit exposure and the elemental and run correction factors as follows:

$$CE_x = \frac{UE_x - \overline{E}_{TC}}{ECF_x \times RCF_x}$$

where

CE_x = the corrected exposure reading for field monitoring element x.

UE_x = the uncorrected exposure reading for field monitoring element x.

ECF_x = the elemental correction factor for field monitoring element x.

$\overline{E}_{TC}$ = mean transit exposure

RCF_x = the run correction factor for field monitoring element x.

NOTE: The mean transit exposure is determined from the elements of the TLDs that accompany the field TLDs during transportation to and from the field locations.

The exposure representing each environmental monitoring location and monitoring period is normally the mean of the corrected exposure readings for a total of six calcium sulfate elements, three from each of two different TLDs at each location. The following equation shows the calculation of this exposure:

$$\overline{E}_c = \frac{\sum_{i=1}^{n} CE_i}{n}$$

where

$\overline{E}_c$ = the mean of the corrected exposure readings for a given monitoring location and period.

CE_i = the corrected exposure reading of an individual element for a given monitoring location and period.

n = the total number of individual element exposures averaged.

The mean of the corrected exposure readings for a given location and period may be calculated using less than the six calcium sulfate elements if the reading from one of the elements is more than two standard deviations from the mean. In this situation, the mean would be recalculated with only five element readings, excluding the element reading that was more than two standard deviations from the originally calculated mean. The mean may be automatically calculated by the dosimetry software with as few as four element readings before the data is flagged. The following calculation is used to determine the standard deviation of the corrected elemental exposure readings:

$$S_{ce} = \sqrt{\frac{\sum_{i=1}^{n} \left(CE_i - \overline{E}_c\right)^2}{n-1}}$$

where

S_{ce} = the standard deviation of the corrected exposure readings from a given monitoring location and period for (n-1) degrees of freedom.

$\overline{E}_c$ = the mean of the corrected exposure readings for a given monitoring location and period.

CE_i = the corrected exposure reading of an individual element for a given monitoring location and period.

n = the total number of individual element exposures averaged.

The standard monitoring period for the reporting of TLD exposures is the calendar quarter. The calendar quarter is defined as a period of 91.25 days. The actual monitoring periods for TLDs in the field are often for times other than 91.25 days. The means of the corrected exposures for these nonstandard periods must be normalized to the standard calendar quarter. The following equation shows how the normalization is performed:

$$NE = \frac{\overline{E}_c \times 91.25}{MP}$$

where

NE = mean corrected exposure normalized to a standard calendar quarter of 91.25 days.

$\overline{E}_c$ = the mean of the corrected exposure readings for a given monitoring location and period.

MP = the actual TLD monitoring period (time in the field) in days.

TLD DATA INTERPRETATION

Pre-operational and operational data are compared for the purpose of determining whether or not TLD data may indicate a dose contribution from SSES operation. Between 1979 and 1994, both TLD types and TLD processing systems changed more than once. In order to avoid possible confusion in data interpretation as a result of these changes, ratios of TLD doses for specific indicator locations to the average of the TLD doses for control locations from operational periods compared to their counterparts from the preoperational period. Comparison of these ratios is performed in lieu of comparing the actual operational and preoperational doses. The following equation shows how these ratios are calculated:

$$r_i = d_i \div \bar{d}_c$$

where

r_i - is the indicator-to-control-average dose ratio for a particular location and calendar quarter,

d_i - is the quarterly dose for a particular indicator location, and

$\bar{d}_c$ - is the average quarterly dose for certain control locations.

Note:

The r_i are the quotients of the indicator doses to the average doses of the following control locations: 3G4, 4G1, 7G1, 12G1, and 12G4. Only these control locations are used because they were the only ones existing during the preoperational period.

Operational r_i for indicator locations that do not have preoperational histories are compared with the range of preoperational control-to-control-average dose ratios (r_c) experienced at control locations. It can be safely assumed that the preoperational range of these r_c at control locations are the result of variations in the levels of background radiation at those locations. Any operational indicator r_i for an indicator location without a preoperational history that is above the uppermost range expected at control locations based on preoperational data is assumed to suggest a possible contribution from the SSES operation. The following equation shows how r_c is calculated:

$$r_c = d_c \div \bar{d}_c$$

where

r_c - is the control-to-control-average dose ratio for a particular location and calendar quarter,

d_c - is the quarterly dose for a particular control location, and

$\bar{d}_c$ - is the average quarterly dose for certain control locations.

Flagging Environmental TLD Measurements for Possible Non-Natural Dose Contributions

Confidence ranges, within which 95% of environmental TLD doses resulting from natural, background radiation are expected to be, have been derived for each location

with a preoperational history by multiplying the standard deviation (S) of the r_i for the location by the appropriate t score (t) based on the applicable degrees of freedom for each location. (Degrees of freedom (df) are equal to the number of ratios that were averaged less one.) The product of the t score and the standard deviation (tS) was then subtracted from the mean ($\bar{x}$) to determine the lower end of the 95% confidence range (R) and added to the mean to obtain the upper end of the range (R) as indicated by the following equation:

$$R = \left(\bar{x} - t*S\right) to \left(\bar{x} + t*S\right)$$

The following t scores were used in the range calculations:

t SCORES	
df	$t_{0.05}$
1	12.706
2	4.303
3	3.182
4	2.776
5	2.571
6	2.447
7	2.365

For indicator locations with no preoperational history, TLD results are flagged for potential non-natural dose contributions to TLD measurements based on comparisons to the maximum expected variation in control-to-control-average dose ratios (r_c) for control locations. The expected ranges of r_c for each control location for each calendar quarter during the 1980-81 preoperational period have been calculated. The highest expected r_c for all the preoperational control locations is 1.22.
Ratios for indicator locations greater than 1.22 are flagged for possible SSES direct radiation dose contributions.

Calculation of SSES Attributable Direct Radiation Dose based on Onsite Indicator TLD Measurements

For TLD locations where direct radiation dose contributions from the SSES are indicated, these calendar quarter doses are estimated based on the amounts referred to as the excess ratios. Excess ratio for each location's r_i for a particular calendar quarter is the amount by which that r_i exceeds the high end of its range of preoperational r_i. The excess ratio at a specific location is multiplied times both the average dose for control locations measured during that calendar quarter and an occupancy factor based on a

reasonable estimate of the portion of the calendar quarter that a MEMBER OF THE PUBLIC might spend near an onsite TLD location. The following is a table of occupancy factors that are used:

Environmental TLD Monitoring Locations	Occupancy Factors
Onsite	4.56E-4
Offsite (other than Private Residences)	3.65E-3
Private Residences	1

The following equation is used for obtaining direct radiation doses attributable to the SSES at indicator TLD locations when preoperational data exists for those locations:

$$D_{SSES}=(r_i-r_u)\times D_{CA}\times OF$$

where

D_{SSES} - is the dose attributable to SSES fuel cycle operations,

r_i - is the indicator-to-control average ratio for a particular location and calendar quarter,

r_u - is the indicator-to-control average ratio corresponding to the upper end of the 95% confidence range for a particular location for the preoperational period, and

D_{CA} - is the average quarterly dose for control locations.

OF - is the occupancy factor.

The equation below is used for obtaining direct radiation doses attributable to the SSES at indicator locations when preoperational data **does not** exist for those locations:

$$D_{SSES}=(r_i-1.22)\times D_{CA}\times OF$$

where

D_{SSES} - is the dose attributable to SSES fuel cycle operations,

where

D_{SSES} - is the dose attributable to SSES fuel cycle operations,

r_i - is the indicator-to-control average ratio for a particular location and calendar quarter,

1.22 - is the highest expected r_c for control locations due to variations in natural radiation levels based on preoperational data. Refer to location 12G4 in Attachment 1.

D_{CA} - is the average quarterly dose for control locations.

OF - is the occupancy factor.

Each year, the SSES attributable doses calculated for each calendar quarter are summed for all calendar quarters at each location to obtain annual doses by location.

DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA ACTIVITY

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES & PP&L INC.'S CORPORATE ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS LABORATORY

Aliquots of water samples are evaporated to near dryness in beakers. The remaining volumes (approximately five milliliters or less) are transferred to stainless steel planchets and evaporated to dryness.

All planchets are counted in low background gas-flow proportional counters. Calculations of both gross alpha and beta activities include the use of empirical self-absorption correction curves to account for changes in effective counting efficiency occurring as a result of changes in the masses of residue being counted.

Weekly air particulate filters are placed into planchets as received and counted in low background gas-flow proportional counters. No corrections are made for beta self-absorption when calculating the gross beta activities of the air particulate filters because of the impracticality of weighing the deposit and because the penetration depth of the deposit into the filter is unknown.

CALCULATION OF THE SAMPLE ACTIVITY

$$\frac{pCi}{unit\ volume\ or\ mass} = \underbrace{\frac{\left[\frac{C}{t} - R_b\right]}{2.22\,(V)(E)}}_{\text{net activity}} \pm \underbrace{\frac{2\sqrt{\frac{C}{t} + R_b}}{2.22\,(V)\,(E)}}_{\text{random uncertainty}}$$

where: C = total counts for sample

t = count time for sample/background (minutes)

R_b = background count rate of counter (cpm)

2.22 = $\frac{\text{dpm}}{\text{pCi}}$

V(M) = volume or mass of sample analyzed

E = efficiency of the counter (cpm/dpm)

Calculation of the Minimum Detectable Concentration (MDC) Value

$$MDC = \frac{4.66\sqrt{\frac{R_b}{t}}}{2.22\,(V)\,(E)}$$

RADIOCHEMICAL DETERMINATION OF I-131 IN MILK AND WATER SAMPLES

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

A four-liter aliquot of sample is first equilibrated with stable iodide carrier. Following a period of time sufficient for equilibration, anion exchange resin is added to the aliquot to capture the iodide ions present. The iodide ion is subsequently removed from the resin using sodium hypochlorite. Hydroylamine hydrochloride is then used to produce free iodine. The resulting free iodine is then extracted from the aqueous phase by dissolution in toluene. This is followed by a reduction back to the iodide form using sodium bisulfite and back-extraction to the aqueous phase. Once in the aqueous phase again, the iodide is precipitated as palladium iodide following the addition of palladium chloride.

Another aliquot of the sample is used to determine the stable iodide content of the milk by the use of a specific-ion electrode. This information is then used to correct the chemical yield determined from the mass of the dried precipitate obtained.

The dried precipitate is beta counted on a low-level counter.

CALCULATION OF THE SAMPLE ACTIVITY

$$\frac{pCi}{\ell} = \frac{\left[\frac{C}{t} - R_b\right]}{2.22(v)(y)(DF)(E)} \pm \frac{2\sqrt{\frac{C}{t} + R_b}}{2.22(V)(y)(DF)(E)}$$

net activity | random uncertainty

where:
- C = total counts from sample
- t = counting time for sample (min)
- R_b = background count rate of counter (cpm)
- 2.22 = $\frac{dpm}{pCi}$
- V = volume of sample analyzed (liters)
- y = chemical yield of the mount or sample counted
- DF = decay factor from the collection to the mid-count time

E = efficiency of the counter for the I-131 betas.

Note: Efficiency is determined by counting an I-131 standard.

Calculation of the MDC

$$MDC = \frac{4.66\sqrt{\frac{R_b}{T}}}{2.22(V)(y)(DF)(E)}$$

DETERMINATION OF TRITIUM IN WATER BY LIQUID SCINTILLATION COUNTING

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES & PP&L INC.'S CORPORATE ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS LABORATORY

Ten milliliters of water is mixed with liquid scintillation material and counted for typically 200 minutes to determine its activity.

CALCULATION OF THE SAMPLE ACTIVITY FOR TRITIUM

$$\frac{pCi}{\ell} = \frac{\left[\frac{C}{t} - R_b\right]}{2.22(V)(E)^*} \pm \frac{2\sqrt{\frac{\frac{C}{t} + R_b}{t}}}{2.22(V)(E)^*}$$

net activity — random uncertainty

where:
- C = total counts from sample
- t = count time for sample (minutes)
- R_b = background count rate of counter (cpm)
- 2.22 = $\frac{\text{dpm}}{\text{pCi}}$
- V = initial volume before enrichment (liters)
- E = efficiency of the counter for tritium (cpm/dpm)

Calculation of the MDC

$$MDC = \frac{4.66\sqrt{\frac{R_b}{t}}}{(2.22)(V)(E)^*}$$

*Note that PP&L Inc.'s Corporate Environmental Radioactivity Measurements Laboratory incorporates a decay factor (D) in the denominators of these expressions to account for the small amount of radioactive decay between sample collection and sample counting.

DETERMINATION OF GAMMA EMITTING RADIOISOTOPES

TELEDYNE BROWN ENGINEERING
ENVIRONMENTAL SERVICES

Gamma emitting radionuclides are determined with the use of a lithium-drifted germanium (Ge(Li)) and high purity germanium detectors with high resolution spectrometry in specific media, such as, air particulate filters, charcoal filters, milk, water, vegetation, soil/sediments, biological media, etc. Each sample is prepared and counted in standard geometries such as one liter or four liter wrap-around Marinelli containers, 300 ml or 150 ml bottles, two-inch filter paper source geometries, etc.

Samples are counted on large (55 cc volume) germanium detectors connected to Nuclear Data 6620 data acquisition and computation systems. All resultant spectra are stored on magnetic tape.

The analysis of each sample consists of calculating the specific activities of all detected* radionuclides as well as the minimum detectable concentration for a standard list of nuclides. The germanium detection systems are calibrated for each standard geometry using certified radionuclide standards traceable to the National Institute of Standards and Technology.

CALCULATION OF THE SAMPLE ACTIVITY

$$\text{Net pCi / vol or mass} = \frac{[C-B]}{2.22(V)(E)(GA)DF)(t)} \pm \frac{2\sqrt{C+B}}{2.22(V)(E)(GA)(DF)(t)}$$

net activity — random uncertainty

where: C = area, in counts, of a spectral region containing a gamma emission of the nuclide of interest

Note (1): If the detector exhibits a peak in this region when counting a blank , the counts from that peak are subtracted from C before using the above equation.

Note (2): If no peaks are exhibited, the counts in the channels where the predominant peaks for gammas from selected radionuclides would be expected are summed for C and used in the calculation of "net" activity.

B = background counts in the region of interest, calculated by fitting a straight line across the region connecting the two adjacent regions.

Note: If no peak exists in a region from which a "net" activity is being calculated, background is represented by the average of the counts in one channel from each side of that region.

t = counting interval of sample (minutes)

2.22 = dpm/pCi

V = volume or mass of sample analyzed

E = efficiency of counter at the energy region of interest

GA = gamma abundance of the nuclide at the gamma emission energy under consideration

DF = decay factor from sample collection time to midpoint of the counting interval

Calculation of the MDC

$$MDC\ (pCi\ /\ vol\ or\ mass) = \frac{4.66\sqrt{C}}{2.22(V)(E)(GA)(DF)(t)}$$

The width of the region around the energy where an emission is expected is calculated differently for MDCs than it is for the width of a peak that is actually identified. Consequently, the value of C used in the two equations may differ.

*The analyst's judgment is exercised in the decision to report an activity. The agreement between various spectral lines of the same nuclide, and possible interference from other nuclides, are considered in this decision.

DETERMINATION OF RADIOSTRONTIUM IN MILK* AND WATER

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Strontium-89/90 analyses may be performed on water samples for PP&L. The first step in the preparation of milk and water for analysis is the addition of strontium carrier. The addition of stable strontium facilitates the precipitation of any radioactive strontium that may be present and provides sufficient quantities of strontium to be able to reliably determine the amount of radioactive strontium recovered from the samples for counting.

Subsequent steps in the preparation of both the water and the milk samples for counting involves a number of physical and chemical separations to isolate any radioactive strontium that might be in the samples originally, as well as the stable strontium that is added to the sample aliquots to be analyzed. The isolation removes other metallic elements that may be present in both the water and the milk and organic materials that are present in the milk in significant quantities.

Strontium is precipitated twice, first as strontium nitrate and second as strontium sulfate, in the preparation of the water samples. This permits the removal of radium and other naturally occurring radioactive materials as the result of the first precipitation and iron by way of the second precipitation.

Milk is first evaporated and ashed to remove organic materials. The residue is then redissolved with an aqueous solution of hydrochloric acid and filtered to remove insoluble materials, after which strontium is precipitated as a phosphate to remove other unwanted materials. The phosphate precipitate then is redissolved with an aqueous solution of nitric acid and the resulting solution is passed through a chromatographic column. The strontium is retained on the column, allowing other unwanted material to pass through. The strontium is later removed from the column by passing deionized water through it.

Following all of the purification steps for both water and milk, stable yttrium carrier is added to the purified portions remaining to facilitate the precipitation of any radioactive yttrium-90 that appears in the processed sample from the radioactive decay of strontium-90. The yttrium carrier also aids in the yield determination for yttrium-90. These portions are then allowed to stand for at least five days to permit yttrium-90 ingrowth. After the yttrium-90 ingrowth period, yttrium is precipitated as an oxalate and strontium is precipitated as a carbonate. Each is then collected on separate filter discs for gravimetric yielding and beta counting.

*No milk was analyzed for strontiums 89 and 90 in 1998.

The filter discs are mounted on planchets prior to counting. Strontium-89 activity is determined by counting the strontium planchets while they are covered with 80 mg/cm^2 aluminum absorbers to eliminate interference from the strontium-90 betas. Strontium-90 activity is inferred by counting the yttrium planchets.

CALCULATION OF THE SAMPLE ACTIVITY

$$\frac{pCi}{unit\ volume\ mass} = \frac{\left[\frac{C}{t} - R_b\right] f}{2.22(V)(y_1)(y_2)(DF)(IF)(E)} \pm \frac{2\sqrt{\frac{C}{t} + \frac{R_b}{t}}}{2.22(V)(y_1)(y_2)(DF)(IF)(E)}$$

C	=	total counts from sample
t	=	counting time for sample (background)
R_b	=	background count rate
f	=	ash fraction (gm ash/gm milk)
V	=	volume of sample analyzed
y_1	=	chemical yield of yttrium
y_2	=	chemical yield of strontium
DF	=	decay factor of yttrium from the milking time to the mid-count time
IF	=	Ingrowth factor for Y-90 from scavenge time to milking time
E	=	efficiency of the counter for Y-90

Calculation of the Minimum Detectable Concentration Value

$$MDC = \frac{4.66 f \sqrt{\frac{R_b}{t}}}{2.22(V)(y_1)(y_2)(DF)(IF)(E)}$$

CALCULATION OF THE SAMPLE SR-89 ACTIVITY

$$\frac{pCi}{unit\ volume\ (mass)} = \frac{\left[\frac{C}{t} - B_C - B_A\right]f}{2.22(V)(Y_s)(DF_{Sr-89})(E_{Sr-89})} \pm \frac{2f\sqrt{\left[\frac{C}{t} + B_C + B_A\right]/t}}{2.22(V)(Y_s)(DF_{Sr-89})(E_{Sr-89})}$$

where

C	=	total counts from sample
t	=	counting time for sample
B_C	=	background rate of counter using absorber configuration
B_A	=	background addition from Sr-90 and Y-90 ingrowth (cpm)*
f	=	ash fraction (gm ash/gm milk)
V	=	volume of sample analyzed
Y_S	=	chemical yield of strontium
DF_{Sr-89}	=	decay factor from the mid-collection date to the counting date for Sr-89
E_{Sr-89}	=	efficiency of the counter for SR-89 with the 80 mg/cm^2 aluminum absorber

*Note that B_A is a calculated value.

Calculation of the Minimum Detectable Concentration Value

$$MDC = \frac{4.66f\sqrt{\frac{[B_C + B_A]}{t}}}{2.22(V)(Y_s)(DF_{Sr-89})}$$

APPENDIX F

1998 EXCEPTIONS TO THE SSES TECHNICAL REQUIREMENTS SAMPLE SCHEDULE, METHODS AND ANALYSIS SENSITIVITIES

Exceptions to the SSES Technical Requirements occurred in the monitoring of the following media: surface water, drinking water, air, milk, and ambient radiation levels. These exceptions involved sample collections that did not take place for the required periods and sampling that was performed in a manner not stated in the Technical Requirements. Generally, they were caused by equipment malfunctions and events taking place in the vicinity of monitoring stations that interfered in some way with the normal course of sampling. These exceptions are discussed in this appendix and specifically documented in the tables of Appendix I.

Surface Water

Monitoring at control location 6S6, the SSES River Water Intake Structure, and indicator location 2S7 or its alternate location 6S7, the SSES Cooling Tower Blowdown Discharge (CTBD) to the Susquehanna River, are the only environmental surveillances of surface water required by SSES Technical Requirements. The other SSES REMP routine indicator surface water monitoring location on the Susquehanna River, which is downstream from the SSES discharge to the river, and the monitoring location at LTAW are not required. They have been monitored to provide added assurance that the environment is not being compromised by radiological releases resulting from the SSES operation.

Sampling at locations 6S6 and 2S7 or 6S7 is required to be performed by the collection of aliquots at time intervals that are small compared to the compositing period. Composite samples from these locations are required to be analyzed monthly and are expected to be representative of the streams from which they are collected. Problems in 1998 with the automatic composite sampler (ACS) at sampling location 6S6 led to periods when no water was being collected and to periods when water was being collected at an uncontrolled and indeterminate rate, resulting in samples that were not as representative of the water flowing in the sampled stream as desired. In some cases, the ACS at location 6S6 was deliberately removed from service to permit performing maintenance on the samplers. Grab samples were obtained at the required locations or alternate locations at least weekly when an ACS was known to be inoperative or operating in an uncontrollable or indeterminate fashion and automatic sampling could not be performed using other equipment.

Approximately 94% of 1998 was represented by composited samples collected by routine operation of the ACS at location 6S6. Grab samples were collected in 1998 at control monitoring location 6S6 on the following three occasions: March 9 and 16 and April 27. The sample collection container for the ACS at location 6S6 was overflowing on the following four occasions during 1998: March 9 and 16, April 27, and July 1. following the performance of cleaning/preventative maintenance. Subsequently, adjustments to the ACS were made in each instance to reduce flow and prevent the containers from continuing to overflow. In an effort to reduce future occurrences in which the ACS sample collection container overflows following cleaning, the sample collection procedure used for the ACS at location 6S6 was revised in November 1998. This revision limits the extent by which the ACS controls can be manipulated to compensate for reduced flow in the ACS supply lines due to clogging before a non-routine cleaning of the lines is requested. Also, steps have been taken to ensure that cleaning and preventative maintenance will be performed, whenever possible, at times when the ACS will be

able to be attended by sampling personnel soon after completion of the work. This will facilitate any changes that may be appropriate to compensate for increased flow rates in the water being supplied to the ACS.

The ACS at location 6S6 was inoperative for brief periods while preventative maintenance was performed on the following days in 1998: 1/9/98, 2/20/98, 3/19/98, 4/24/98, 5/28/98, 6/29/98, 7/30/98, 8/24/98, 9/29/98, 10/26/98, 11/23/98, and 12/29/98. On two occasions, 5/28/98 and 9/29/98, when preventative maintenance was performed, excess amounts of water entered the sample collection container of the ACS. Steps also have been taken to ensure that such excess water resulting from the performance of preventative maintenance in the future does not enter the sample collection containers and is appropriately discarded.

As the result of changes made during 1997 in the power supply and the programmed operation of the ACS at location 2S7, there was a significant improvement in the operating record of the ACS at that location in 1998. No grab samples had to be collected at location 2S7 during 1998, nor did any samples have to be obtained from location 2S7's alternate sampling location, 6S7. Samples from monitoring location 2S7 for every monitoring period of 1998 were composited samples collected by routine operation of the ACS. These samples all were considered to be representative samples for the intended mode of ACS operation. Monitoring at location 2S7 in 1998 was considered to be excellent, with no exceptions to the Technical Requirements.

Drinking Water

Approximately 92% of 1998 was represented by composited samples collected by routine operation of the ACS at monitoring location 12H2T. Only one grab sample was collected at location 12H2T in 1998. This grab sample was obtained on September 21 because the sample collection container at the ACS was overflowing. The reason for the overflowing container was that the ACS's solenoid arm was jammed in the collecting position. The return spring for the solenoid was removed, and the solenoid arm was returned to its non-activated (non-collecting) position. The solenoid arm subsequently operated properly.

In addition, the ACS at location 12H2T was inoperative for brief periods of time on 1/12/98 and 9/9/98 as well as an indeterminate amount of time between 8/31/98 and 9/8/98. On 1/12/98, the sampling by the ACS was interrupted for four hours because the Danville Municipal Water Authority shut off the water supply to the ACS to clean silt deposited as the result of increased water levels in the Susquehanna River. On 9/9/98, the water supply to the ACS again was interrupted for less than an hour to permit the installation of a new solenoid. The need to replace the solenoid was recognized on 9/8/98 when the ACS was found to be inoperative.

Air

Out of 520 station-weeks (10 different stations collecting 52 weekly samples) of air sampling in 1998, no interruptions in sampling occurred during more than 99% of those station-weeks. All three of the interruptions in the collection of air samples in 1998 were attributable to a loss of electrical power supplying the air sampling stations. The following instances of electrical power

loss occurred in 1998: on January 23 and June 3 at control monitoring location 8G1 and on November 9 at indicator monitoring location 5S4. The longest duration for loss of power was from January 23 until January 29 at monitoring location 8G1. Reduced volumes of air were sampled for the sampling periods affected by the losses of electrical power at these monitoring locations. Reductions in the volumes of air sampled also occurred because of pump problems in two instances during 1998. Lower than normal volumes of air were sampled in 1998 at the following locations for the periods shown because of poor pump operation: 13S6 for the period February 18 through February 25 and 7S7 for the period November 11 through November 18. Both pumps were promptly replaced. Required analysis sensitivities for gross beta and iodine-131 analyses were met in all instances where electrical power was lost or pump problems were experienced.

Milk

Milk was not sampled at the required monitoring location 12B3 in December 1998 because the farmer sold his cows. A replacement monitoring location, 7C1, was selected at the beginning of 1999 for this lost sampling location.

Ambient Radiation Levels

Three instances occurred in 1998 in which ambient radiation levels for certain required monitoring locations could not be measured because the TLDs were not retrieved at the end of the respective quarterly monitoring periods. The TLDs from monitoring location 10S1 were missing when sample collection personnel arrived at the end of the 1998 first quarter monitoring period from January 12 through April 14, 1998. Also, the TLDs from monitoring locations 2B3 and 2F1 were not able to be collected at the end of the third quarterly monitoring period from July 21 through October 15, 1998. Environmental sampling personnel observed that the containers for the TLDs for these two locations had been vandalized.

Missing environmental TLDs resulting from vandalism are a very infrequent observance. For example, no environmental TLD results were unobtainable for the previous year (1997) for required monitoring locations. Nevertheless, the standards for positioning environmental TLDs in the field require that they be relatively close to the ground, making them relatively accessible to passersby at remote monitoring locations. However, enclosing many of the TLDs in locked boxes or within fenced areas with locked gates reduces the possibility that someone may tamper with them.

REMP Interlaboratory Comparison Program (ICP)

An internal audit of the REMP determined on September 26, 1997 that, contrary to the requirements of the SSES Technical Specifications, no objective evidence could be produced to verify that the REMP's Interlaboratory Comparison Program has been approved by the NRC. The audit concluded that the ICP is acceptable, but that the Technical Specifications should be revised to replace the requirement for approval with a requirement for acceptance of the program. A change to the requirement for NRC approval of the ICP was approved in 1998. This change

was made to the SSES Technical Requirements where the requirements for the SSES REMP now reside.

The NRC's position, as stated in its 1979 Branch Technical Position entitled "An Acceptable Radiological Environmental Monitoring Program," says that laboratories of its licensees or its licensee's contractors performing analyses for radiological environmental monitoring programs shall participate in the Environmental Protection Agency's (EPA's) ICP or equivalent program. In 1998, the laboratories performing analyses for the SSES REMP participated in the EPA's ICP to the extent possible. Teledyne Brown Engineering is the primary laboratory analyzing samples for the SSES REMP. Because Teledyne is a commercial laboratory that is certified to perform drinking water analyses, it was eligible to participate in the EPA's program, and it has done so to the fullest extent. The other laboratory analyzing SSES REMP samples is PP&L Inc.'s Corporate Environmental Radioactivity Measurements Laboratory (CERML). CERML was ineligible to participate in the EPA's ICP because it is neither a commercial laboratory nor certified to perform drinking water analyses.

Both Teledyne Brown Engineering and PP&L Inc.'s CERML also routinely received additional radioactively spiked samples supplied by Analytics Inc. as part of a supplementary REMP Laboratory Spike Program conducted by PP&L. This program provided spiked glass fiber filters, charcoal cartridges, milk, and sediment to Teledyne and CERML as an additional quality control measure for the REMP. CERML also received a water sample spiked with tritium from Analytics in 1998 because it provided the tritium analyses of record for the REMP for a portion of 1998. The radioactive sources used to spike the samples that were provided by PP&L Inc.'s supplementary REMP Laboratory Spike Program were traceable to NIST. The results of Teledyne's analysis of spiked samples provided by Analytics and CERML's analysis of spiked tritium samples also provided by Analytics are presented in Appendix J of this report.

APPENDIX G

1998 SSES REMP SUMMARY OF DATA

The averages for indicator and control locations reported in the Summary of Data Table, which summarizes the entire year's results for the SSES REMP, were calculated using all measured values, whether or not they were reported in Appendix I tables. Values below the MPCs, even zeroes and negatives, were part of the averaging process for these analysis results.

Preferably, the averages reported in the Summary of Data table for analysis results of sample media that are normally collected continuously are determined using only those results from continuously collected samples. Occasionally, grab samples are taken for these media when equipment malfunctions or some other anomaly precludes or otherwise perturbs routine continuous sampling. These grab samples are taken to minimize the time periods when no sampling is being performed, or, in some instances, when continuous sampling is considered to be nonrepresentative.

Because grab samples best represent snapshots of the sampled media for the relatively brief periods during which they are typically collected, it is normally preferable not to average the analysis results of these samples with those for continuously collected composite samples. However, when equipment malfunctions are protracted, relatively large periods of time could be entirely unrepresented by averages if the results from grab sample analyses are not considered together with those representing continuously sampled periods.

Allowing analysis results for grab samples to be weighted equally with those representing relatively large periods of time would tend to bias the resulting averages unjustifiably towards the conditions at the times that the grabs are obtained. Averages obtained in this way might less accurately reflect the conditions for the combined period of continuous sampling and grab sampling than if only the results from continuous sampling were used. On the other hand, using weighting factors for the analysis results of grab samples derived from the actual time it takes to collect those samples would lead to the grab sample analysis results having a negligible effect on the overall average and not justifying the effort involved.

Grab samples collected in lieu of normal continuous sampling are typically obtained at regular intervals corresponding to the intervals at which the continuously collected samples would usually be retrieved for eventual compositing. For example, grab samples are collected once a week and composited monthly in place of continuously collected samples that would normally be retrieved weekly and composited monthly. Since each grab sample is used to represent an entire week, albeit imperfect, it is reasonable to weight the analysis results the same. Thus, the results of one weekly grab are given approximately one-fourth the weight of the results for a monthly composite sample collected continuously for each of the four weeks in a month. Similarly, the analysis results of a composite of four weekly grab samples would carry the same weight as the analysis results for a composite of four weeks of continuously collected sample.

TABLE G
SUMMARY OF DATA FOR THE SSES
OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM - 1998
NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION
LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA
REPORTING PERIOD: DECEMBER 29, 1997 TO JANUARY 19, 1999

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1)		LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN(3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(3) RANGE	CONTROL LOCATION MEAN(3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4)
Ambient Radiation (mR/std. qtr.)	TLD	341		18.6(309) (13.0 - 25.4)	11S3 On site	23.9(4) (22.5- 25.4)	18.6(32) (13.8 - 21.7)	0
Surface Water (pCi/l)	Gross Beta	52	4	6.1(36) (1.2 - 17.3)	2S7 Discharge	10.3(12) (5.0 - 17.3)	6.7(16) (1.1 - 18.8)	0
	Tritium	52	2000	1217(36) (-505 - 13000)	2S7 Discharge	3648(12) (220 - 13000)	-11(16) (-350 - 231)	0
	Iodine-131	92	1	0.3 (64) (-0.1 - 2.3)	2S7 Discharge	0.7(26) (0.04 - 2.3)	0.3(28) (-0.08 - 1.4)	0
	Strontium-89	2		-2.0(1) (-2.0 - -2.0)	2S7 Discharge	-2.0(1) (-2.0 - -2.0)	-0.8(1) (-0.8 - -0.8)	0
	Strontium-90	2		0.5(1) (0.5 - 0.5)	2S7 Discharge	0.5(1) (0.5 - 0.5)	0.5(1) (0.5 - 0.5)	0
	Gamma Spec K-40	52		-42(36) (-240 - 31)	6S5 0.9 mi ESE	-28(12) (-130 - 4.2)	-52(16) (-210 - -2.6)	0
	Mn-54	52	15	0.3(36) (-2.2 - 2.2)	6S5 0.9 mi ESE	0.5(12) (-0.6 - 2.2)	0.3(16) (-1.1 - 1.5)	0
	Co-58	52	15	0.06(36) (-1.4 - 1.7)	LTAW NE - ESE	0.09(12) (-1.0 - 1.6)	-0.2(16) (-1.7 - 1.6)	0
	Fe-59	52	30	1.0(36) (-2.9 - 5.8)	2S7 Discharge	1.5(12) (-2.1 - 5.8)	1.3(16) (-1.9 - 5.1)	0
	Co-60	52	15	0.6(36) (-1.6 - 1.9)	6S5 0.9 mi ESE	0.7(12) (-0.2 - 1.7)	0.2(16) (-1.5 - 1.7)	0
	Zn-65	52	30	0.9(36) (-5.1 - 6.1)	2S7 Discharge	1.6(12) (-1.0 - 6.1)	0.03(16) (-4.8 - 6.8)	0

TABLE G
SUMMARY OF DATA FOR THE SSES
OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM - 1998
NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION
LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA
REPORTING PERIOD: DECEMBER 29, 1997 TO JANUARY 19, 1999

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1)		LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN(3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(3) RANGE	CONTROL LOCATION MEAN(3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4)
Surface Water Cont.	Zr-95	52	30	-0.007(36) (-9.6 - 7.0)	6S6 0.8 mi ESE	0.7(16) (-2.3 - 6.7)	0.7(16) (-2.3 - 6.7)	0
	Nb-95	52	15	1.3(36) (-2.1 - 3.0)	6S5 Discharge	1.5(12) (0.5 - 2.7)	1.0(16) (-1.9 - 2.4)	0
	Cs-134	52	15	-0.003(36) (-1.5 - 2.6)	6S5 0.9 mi ESE	0.2(12) (-1.5 - 1.9)	-0.05(16) (-1.9 -1.1)	0
	Cs-137	52	18	1.1(36) (-3.0 - 3.9)	LTAW NE-ESE	1.3(12) (-2.9 - 2.8)	1.0(16) (-1.5 - 3.3)	0
	Ba-140	52	60	-0.5(36) (-11 - 4.8)	2S7 Discharge	0.04(12) (-5.2 - 4.8)	-0.2(16) (-5.1 -8.8)	0
	La-140	52	15	-0.3(36) (-4.3 - 4.0)	2S7 Discharge	-0.05(12) (-2.1 - 4.0)	-0.2(16) (-4.4 - 4.0)	0
Potable Water (pCi/l)	Gross Alpha	14		0.3(14) (-0.8 - 0.9)	12H2T 26 mi WSW	0.3(14) (-0.8 - 0.9)	Only indicator stations sampled for this medium.	0
	Gross Beta	14	4	3.3(14) (0.9 - 11)	12H2T 26 mi WSW	3.3(14) (0.9 - 11)		0
	Iodine-131	27	1	0.1(27) (-0.02 - 0.4)	12H2T 26 mi WSW	0.1(27) (-0.02 - 0.4)		0
	Tritium	14	2000	-10(14) (-544 - 340)	12H2T 26 mi WSW	-10(14) (-544 - 340)		0
	Gamma Spec K-40	14		-13(14) (-73 - 29)	12H2T 26 mi WSW	-13(14) (-73 - 29)		0
	Mn-54	14	15	0.5(14) (-0.6 - 1.9)	12H2T 26 mi WSW	0.5(14) (-0.6 - 1.9)		0

TABLE G
SUMMARY OF DATA FOR THE SSES
OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM - 1998
NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION
LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA
REPORTING PERIOD: DECEMBER 29, 1997 TO JANUARY 19, 1999

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1)		LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN(3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(3) RANGE	CONTROL LOCATION MEAN(3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4)
Potable Water Cont. (pCi/l)	Co-58	14	15	-0.2(14) (-1.6 - 1.0)	12H2T 26 mi WSW	-0.2(14) (-1.6 - 1.0)		0
	Fe-59	14	30	0.4(14) (-2.2 - 4.3)	12H2T 26 mi WSW	0.4(14) (-2.2 - 4.3)		0
	Co-60	14	15	0.4(14) (-1.5 - 3.7)	12H2T 26 mi WSW	0.4(14) (-1.5 - 3.7)		0
	Zn-65	14	30	-0.5(14) (-6.2 - 5.5)	12H2T 26 mi WSW	-0.5(14) (-6.2 - 5.5)		0
	Zr-95	14	30	-1.0(14) (-11 - 4.3)	12H2T 26 mi WSW	-1.0(14) (-11 - 4.3)		0
	Nb-95	14	15	0.8(14) (-1.2 - 3.2)	12H2T 26 mi WSW	0.8(14) (-1.2 - 3.2)		0
	Cs-134	14	15	0.1(14) (-3.0 - 1.7)	12H2T 26 mi WSW	0.1(14) (-3.0 - 1.7)		0
	Cs-137	14	18	1.1(14) (-1.0 - 3.2)	12H2T 26 mi WSW	1.1(14) (-1.0 - 3.2)		0
	Ba-140	14	60	0.9(14) (-2.9 - 7.3)	12H2T 26 mi WSW	0.9(14) (-2.9 - 7.3)		0
	La-140	14	15	-0.2(14) (-10 - 2.4)	12H2T 26 mi WSW	-0.2(14) (-10 - 2.4)		0

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NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION
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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1)	LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN(3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(3) RANGE	CONTROL LOCATION MEAN(3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4)
Fish (pCi/g wet)	Gamma Spec						
	K-40 13		3.8(7) (3.5 - 4.6)	IND 0.9-1.4 mi ESE	3.9(6) (3.5 - 4.6)	3.7(6) (3.4 - 4.0)	0
	Mn-54 13	0.13	0.004(7) (-0.001 - 0.01)	LTAW On site NE-ESE	0.006(1) (0.006 - 0.006)	0.002(6) (-0.006 - 0.01)	0
	Co-58 13	0.13	0.0007(7) (-0.006 - 0.008)	2H 30 mi NNE	0.002(6) (-0.002- 0.008)	0.002(6) (-0.002 - 0.008)	0
	Fe-59 13	0.26	-0.004(7) (-0.03- 0.02)	2H 30 mi NNE	0.005(6) (-0.004 - 0.02)	0.005(6) (-0.004 - 0.02)	0
	Co-60 13	0.13	-0.002(7) (-0.008 - 0.004)	2H 30 mi NNE	0.0005(6) (-0.006 - 0.007)	0.0005(6) (-0.006 - 0.007)	0
	Zn-65 13	0.26	0.004(7) (-0.005 - 0.02)	LTAW On site NE-ESE	0.01(1) (0.01 - 0.01)	0.006(6) (-0.008 - 0.02)	0
	Zr-95 13		-0.001(7) (-0.03 - 0.02)	LTAW On site NE-ESE	0.02(1) (0.02 - 0.02)	-0.01(6) (-0.03 - 0.009)	0
	Nb-95 13		0.004(7) (-0.01 - 0.01)	LTAW On site NE-ESE	0.005(1) (0.005 - 0.005)	0.005(6) (0.002 - 0.009)	0
	Cs-134 13	0.13	-0.002(7) (-0.01 - 0.006)	LTAW On site NE-ESE	0.0008(1) (0.0008 - 0.0008)	-0.0001(6) (-0.004 - 0.004)	0
	Cs-137 13	0.15	0.005(7) (-0.004 - 0.02)	IND 0.9-1.4 mi ESE	0.005(6) (-0.004 - 0.02)	0.004(6) (-0.001- 0.008)	0
	Ba-140 13		0.0002(7) (-0.02 - 0.03)	LTAW On site NE-ESE	0.004(1) (0.004 - 0.004)	0.002(6) (-0.02 - 0.02)	0
	La-140 13		0.006(7) (-0.001 - 0.01)	IND 0.9-1.4 mi ESE	0.007(6) (0.001 - 0.01)	-0.0007(6) (-0.01 - 0.01)	0

TABLE G
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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1)	LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN(3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(3) RANGE	CONTROL LOCATION MEAN(3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4)
Sediment (pCi/g dry)	Gamma Spec						
	Be-7	8	0.2(6) (0.03 - 0.4)	2B 1.6 mi NNE	0.6(2) (0.5 - 0.8)	0.6(2) (0.5 - 0.8)	0
	K-40	8	12(6) (7.5 - 15)	LTAW On site NE-ESE	14(2) (13 - 14)	11(2) (11 - 11)	0
	Mn-54	8	0.004(6) (-0.02 - 0.02)	2B 1.6 mi NNE	0.02(2) (0.01 - 0.04)	0.02(2) (0.01 - 0.04)	0
	Co-58	8	-0.009(6) (-0.02 - 0.0)	12F 6.9 mi WSW	-0.004(2) (-0.007 - 0.0)	-0.005(2) (-0.01 - 0.02)	0
	Fe-59	8	-0.005(6) (-0.02 - 0.0)	2B 1.6 mi NNE	0.02(2) (-0.009 - 0.05)	0.02(2) (-0.009 - 0.05)	0
	Co-60	8	0.004(6) (-0.02 - 0.02)	LTAW On site NE-ESE	0.01(2) (0.007 - 0.02)	-0.009(2) (-0.01 - -0.005)	0
	Zn-65	8	0.03(6) (-0.2 - 0.2)	LTAW On site NE-ESE	0.06(2) (0.03 - 0.1)	0.01(2) (0.001 - 0.02)	0
	Zr-95	8	0.03(6) (-0.05 - 0.07)	2B 1.6 mi NNE	0.1(2) (0.09 - 0.2)	0.1(2) (0.09 - 0.2)	0
	Nb-95	8	0.02(6) (0.004 - 0.04)	2B 1.6 mi NNE	0.03(2) (0.02 - 0.05)	0.03(2) (0.02 - 0.05)	0
	Cs-134	8	0.15 0.06(6) (0.03 - 0.08)	LTAW On site NE-ESE	0.07(2) (0.07 - 0.08)	0.04(2) (0.02 - 0.06)	0
	Cs-137	8	0.18 0.06(6) (-0.003 - 0.1)	2B 1.6 mi NNE	0.1(2) (0.09 - 0.1)	0.1 (2) (0.09 - 0.1)	0
	Ba-140	8	0.02(6) (-0.02 - 0.08)	12F 6.9 mi WSW	0.05(2) (0.03 - 0.08)	0.03(2) (0.004 - 0.06)	0
	La-140	8	-0.02(6) (-0.07 - 0.005)	2B 1.6 mi NNE	-0.008(2) (-0.01 - -0.002)	-0.008(2) (-0.01 - -0.002)	0

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Sediment Cont. (pCi/g dry)	Ra-226 8		1.5(6) (0.9 - 2.2)	LTAW On site NE-ESE	1.8(2) (1.4 - 2.2)	1.3(2) (1.1 - 1.6)	0
	Th-228 8		1.1(6) (0.7 - 1.5)	LTAW On site NE-ESE	1.3(2) (1.1 - 1.5)	1.0(2) (0.9 - 1.1)	0
Ground Water (pCi/l)	Gamma Spec K-40 60		-67(48) (-270 - 23)	2S2 0.9 mi NNE	-52(12) (-120 - 11)	-62(12) (-170 - 13)	0
	Mn-54 60	15	0.3(48) (-1.2 - 1.3)	2S2 0.9 mi NNE	0.5(12) (-1.2- 1.3)	0.4(12) (-1.4 - 2.8)	0
	Co-58 60	15	-0.7(48) (-3.6 - 1.6)	12S1 0.4 mi WSW	-0.4(12) (-2.3 - 1.6)	-0.5(12) (-2.6 - 1.0)	0
	Fe-59 60	30	1.2(48) (-6.2 - 5.0)	12S1 0.4 mi WSW	1.8(12) (0.5 - 2.9)	1.3(12) (-2.5 - 5.3)	0
	Co-60 60	15	0.05(48) (-3.4 - 2.0)	2S2 0.9 mi NNE	0.3(12) (-1.0 - 1.2)	0.2(12) (-1.7 - 1.8)	0
	Zn-65 60	30	1.3(48) (-9.8 - 9.8)	12F3 5.2 mi WSW	3.6(12) (-1.2 - 9.5)	3.6(12) (-1.2 - 9.5)	0
	Zr-95 60	30	1.0(48) (-9.7 - 6.2)	12F3 5.2 mi WSW	2.0(12) (-4.7 - 10)	2.0(12) (-4.7 - 10)	0
	Nb-95 60	15	2.4(48) (-0.4 - 6.2)	12F3 5.2 mi WSW	4.0(12) (-0.8 - 8.1)	4.0(12) (-0.8 - 8.1)	0
	Cs-134 60	15	-0.2(48) (-2.8 - 2.8)	12F3 5.2 mi WSW	0.2(12) (-1.8 - 2.0)	0.2(12) (-1.8 - 2.0)	0
	Cs-137 60	18	0.8(48) (-3.7 - 4.2)	12F3 5.2 mi WSW	1.5(12) (0.0 - 3.3)	1.5(12) (0.0 - 3.3)	0

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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1)		LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN(3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(3) RANGE	CONTROL LOCATION MEAN(3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4)
Ground Water Cont.	Ba-140	60	60	0.4(48) (-9.0 - 8.2)	4S4 0.5 mi ENE	0.8(12) (-9.0 - 8.2)	-1.0(12) (-6.5 - 5.7)	0
	La-140	60	15	0.1(48) (-4.4 - 3.0)	4S4 0.5 mi ENE	0.7(12) (-1.3 - 2.7)	0.08(12) (-1.7 - 4.2)	0
	H-3	60	2000	-37(48) (-456 - 155)	4S4 0.5 mi ENE	-12(12) (-342 - 79)	-71(12) (-494 - 55)	0
Air Particulates (E-03 pCi/m^3)	Gross Beta	520	10	15(416) (4.0 - 46)	13S6 0.4 mi W	16(52) (5.3 - 40)	14(104) (4.1 - 37)	0
Air Iodine (E-03 pCi/m^3)	I-131	520	70	1.3(416) (-1.8 - 5.6)	5S4 0.8 mi E	1.4(52) (0.0 - 4.4)	1.2(104) (-1.8 - 5.6)	0
Air Particulates Quarterly Composite (E-03 pCi/m^3)	Gamma Spec							
	Be-7	40		121 (32) (92 - 157)	9B1 1.3 mi S	131(4) (121 - 143)	116(8) (83 - 158)	0
	K-40	40		0.7(32) (-5.3 - 3.7)	3S2 0.6 mi SSW	2.1(4) (0.3 - 3.7)	-0.1(8) (-2.6 - 3.5)	0
	Mn-54	40		0.04(32) (-0.1 - 0.2)	10S3 0.6 mi SSW	0.1(4) (0.05 - 0.2)	0.02(8) (-0.08 - 0.1)	0
	Co-58	40		0.007(32) (-0.4 - 0.3)	3S2 0.6 mi SSW	0.1(4) (-0.01 - 0.3)	-0.07(8) (-0.3 - 0.1)	0
	Fe-59	40		-0.009(32) (-0.6 - 0.7)	8G1 12 mi SSE	0.5(4) (0.05 - 1.0)	0.1(8) (-1.0 - 1.0)	0
	Co-60	40		0.02(32) (-0.09 - 0.1)	12S1 0.4 mi WSW	0.04(4) (-0.02 - 0.1)	0.02(8) (-0.09 - 0.1)	0
	Zn-65	40		-0.02(32) (-0.3 - 0.3)	8G1 12 mi SSE	0.1(4) (-0.09 - 0.2)	0.03(8) (-0.4 - 0.2)	0

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Air Particulates Cont. Quarterly Composite (E-03 pCi/m^3)	Zr-95	40		0.1(32) (-0.5 - 0.7)	6G1 13.5 mi ESE	0.4(4) (0.0- 0.6)	0.3(8) (0.0 - 0.7)	0
	Nb-95	40		0.1(32) (0.0 - 0.4)	12E1 4.7 mi WSW	0.2(4) (0.08 - 0.4)	0.1(8) (-0.09 - 0.3)	0
	Cs-134	40	50	-0.02(32) (-0.2 - 0.2)	8G1 13.5 mi SSE	0.04(4) (-0.03 - 0.08)	0.02(8) (-0.04 - 0.08)	0
	Cs-137	40	60	0.06(32) (-0.1 - 0.3)	5S4 0.8 mi E	0.1(4) (0.04 - 0.2)	0.03(8) (-0.04 - 0.2)	0
	Ba-140	40		1.6(32) (-130 - 110)	5S4 0.8 mi E	24(4) (-18 - 110)	-6.5(8) (-46 - 5.8)	0
	La-140	40		-3.6(32) (-62 - 36)	3S2 0.5 mi NE	9.1(4) (-2.1 - 36)	-3.7(8) (-30 - 3.7)	0
Milk (pCi/l)	I-131	75	1	-0.01(56) (-0.1 - 0.09)	10G1 14 mi SSW	-0.001(19) (-0.08 - 0.08)	-0.001(19) (-0.08 - 0.08)	0
	Gamma Spec K-40	75		1306(56) (1090 - 1530)	10G1 14 mi SSW	1355(19) (1240 - 1510)	1355(19) (1240 - 1510)	0
	Mn-54	75		0.2(56) (-3.4 - 2.2)	12B3 2.0mi WSW	0.4(18) (-1.8 - 2.2)	-0.03(19) (-3.4 - 2.1)	0
	Co-58	75		-0.3(56) (-3.9 - 2.1)	10D2 2.0 mi WSW	0.3(19) (-1.2 - 1.1)	-0.6(19) (-1.5 - 1.8)	0
	Fe-59	75		0.8(56) (-5.9 - 5.2)	10D2 2.0 mi WSW	1.3(19) (-1.7 - 5.0)	1.2(19) (-1.6 - 3.3)	0
	Co-60	75		0.1(56) (-4.0 - 2.4)	10G1 14 mi SSW	0.5(19) (-0.4 - 2.1)	0.5(19) (-0.4 - 2.1)	0

TABLE G
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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1)	LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN(3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(3) RANGE	CONTROL LOCATION MEAN(3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4)
Milk Cont. (pCi/l)	Zn-65 75		0.7(56) (-5.8 - 8.0)	12B3 20 mi WSW	1.7(18) (-5.8 - 8.0)	0.6(19) (-13 - 5.0)	0
	Zr-95 75		1.8(56) (-3.8 - 10)	12B3 2.0 mi WSW	2.4(18) (-3.8 - 6.1)	0.09(19) (-5.7 - 3.8)	0
	Nb-95 75		1.3(56) (-1.5 - 4.8)	12B3 2.0 mi WSW	1.5(18) (-0.4 - 4.8)	0.5(19) (-4.3 - 2.9)	0
	Cs-134 75	15	-0.3(56) (-6.0 - 2.2)	10G1 14 mi SSW	0.5(19) (-1.7 - 3.7)	0.5(19) (-1.7 - 3.7)	0
	Cs-137 75	18	1.4(56) (-4.5 - 3.9)	10D1 3.0 mi SSW	1.9(19) (-0.8 - 3.9)	1.4(19) (-1.3 - 3.8)	0
	Ba-140 75	60	-0.3(56) (-8.9 - 6.6)	10G1 14 mi SSW	0.3(19) (-15 - 8.8)	0.3(19) (-15 - 8.8)	0
	La-140 75	15	-0.6(56) (-5.6 - 1.9)	10D2 3.1 mi SSW	-0.1(19) (-1.7 - 1.7)	-0.2(19) (-4.9 - 2.1)	0
Soil (pCi/g dry)	Gamma Spec K-40 8		13(6) (8.9 - 16)	3S2 0.5 mi NE	16(2) (16 - 16)	9.4(2) (9.1 - 9.7)	0
	Mn-54 8		0.007(6) (-0.006 - 0.02)	3S2 0.5 mi NE	0.01(2) (0.007 - 0.01)	0.006(2) (0.004 - 0.007)	0
	Co-58 8		-0.006(6) (-0.01 - 0.0)	13S6 0.4 mi W	-0.003(2) (-0.007 - 0.0)	-0.007(2) (-0.01 - -0.004)	0
	Fe-59 8		-0.007(6) (-0.04 - 0.02)	13S6 0.4 mi W	0.006(2) (-0.008 - 0.02)	0.001(2) (-0.003 - 0.005)	0
	Co-60 8		-0.001(6) (-0.02 - 0.01)	13S6 0.4 mi W	0.004(2) (0.002 - 0.007)	-0.0007(2) (-0.004 - 0.002)	0

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OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM - 1998
NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION
LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA
REPORTING PERIOD: DECEMBER 29, 1997 TO JANUARY 19, 1999

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1)		LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN(3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(3) RANGE	CONTROL LOCATION MEAN(3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4)
Soil Cont. (pCi/g dry)	Zn-65	8		0.03(6) (-0.006- 0.1)	13S6 0.4 mi W	0.05(2) (-0.005 - 0.1)	0.01(2) (-0.008 - 0.04)	0
	Zr-95	8		0.06(6) (-0.006 - 0.1)	3S2 0.5 mi NE	0.09(2) (0.07 - 0.1)	0.04(2) (0.03 - 0.05)	0
	Nb-95	8		0.03(6) (0.01 - 0.06)	3S2 0.5 mi NE	0.05(2) (0.04 - 0.06)	0.02(2) (0.01 - 0.03)	0
	Cs-134	8		0.04(6) (0.02 - 0.05)	3S2 0.5 mi NE	0.05(2) (0.05 - 0.05)	0.04(2) (0.03 - 0.04)	0
	Cs-137	8		0.05(6) (0.02 - 0.1)	8G1 12 mi SSE	0.2(2) (0.1 - 0.2)	0.2(2) (0.1 - 0.2)	0
	Ba-140	8		0.008(6) (-0.04 - 0.03)	12S1 0.4 mi WSW	0.02(2) (0.02 - 0.02)	0.0 (2) (0.0 - 0.0)	0
	La-140	8		-0.01(6) (-0.05 - 0.01)	12S1 0.4 mi WSW	0.0005(2) (-0.01 - 0.01)	-0.02(2) (-0.03 - -0.01)	0
	Ra-226	8		1.3(6) (1.0 - 1.7)	3S2 0.5 mi NE	1.7(2) (1.6 - 1.7)	1.6(2) (1.5 - 1.6)	0
	Th-228	8		0.9(6) (0.7 - 1.2)	3S2 0.5 mi NE	1.1(2) (0.9 - 1.2)	0.7(2) (0.7 - 0.7)	0
Food/Garden Crops (pCi/g wet)	Gamma Spec Be-7	35		0.01(26) (-0.04 - 0.2)	10B5 1.5 mi SSW	0.03(7) (-0.03 - 0.2)	0.003(9) (-0.01 - 0.03)	0
	K-40	35		2.3(26) (0.9 - 4.4)	12F7 8.3 mi WSW	3.4(1) (3.4 - 3.4)	2.4(9) (1.3 - 4.2)	0
	Mn-54	35		-0.00008(26) (-0.004 - 0.002)	12F7 8.3 mi WSW	0.002(1) (0.002 - 0.002)	0.00003(9) (-0.003 - 0.001)	0

TABLE G
SUMMARY OF DATA FOR THE SSES
OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM - 1998
NAME OF FACILITY: SUSQUEHANNA STEAM ELECTRIC STATION
LOCATION OF FACILITY: LUZERNE COUNTY, PENNSYLVANIA
REPORTING PERIOD: DECEMBER 29, 1997 TO JANUARY 19, 1999

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED(1)	LOWER LIMIT OF DETECTION (LLD) (2)	ALL INDICATOR LOCATIONS MEAN(3) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(3) RANGE	CONTROL LOCATION MEAN(3) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS(4)
Food/Garden Cont. **Crops** (pCi/g wet)	Co-58	35	-0.001(26) (-0.007 - 0.003)	12F7 8.3 mi WSW	0.003(1) (0.003 - 0.003)	-0.0004(9) (-0.001 - 0.0009)	0
	Fe-59	35	0.002(26) (-0.01 - 0.01)	12F7 8.3 mi WSW	0.008(1) (0.008 - 0.008)	0.001(9) (-0.003 - 0.007)	0
	Co-60	35	-0.0005(26) (-0.01 - 0.004)	12F7 8.3 mi WSW	0.002(1) (0.002 - 0.002)	0.001(9) (-0.0004 - 0.002)	0
	Zn-65	35	0.002(26) (-0.009 - 0.02)	12F7 8.3 mi WSW	0.02(1) (0.02 - 0.02)	0.0009(9) (-0.006 - 0.01)	0
	Zr-95	35	0.003(26) (-0.02 - 0.02)	12F7 8.3 mi WSW	0.01(1) (0.01 - 0.01)	0.004(9) (-0.003 - 0.01)	0
	Nb-95	35	0.002(26) (-0.001 - 0.006)	10B5 1.5 mi WSW	0.004(7) (0.001 - 0.006)	0.002(9) (0.001 - 0.004)	0
	I-131	35	0.06 0.0006(26) (-0.005 - 0.006)	12F7 8.3 mi WSW	0.002(1) (0.002 - 0.002)	0.002(9) (-0.002 - 0.006)	0
	Cs-134	35	0.06 -0.0007(26) (-0.01 - 0.006)	14B3 1.3 mi WNW	0.001(5) (-0.001 - 0.003)	-0.0008(9) (-0.002 - 0.0005)	0
	Cs-137	35	0.08 0.003(26) (-0.003 - 0.008)	12F7 8.3 mi WSW	0.004(1) (0.004 - 0.004)	0.002(9) (-0.002 - 0.005)	0
	Ba-140	35	-0.008(26) (-0.01 - 0.02)	12S7 1.1 mi WSW	0.01(3) (-0.0009 - 0.02)	-0.005(9) (-0.03 - 0.009)	0
	La-140	35	0.0003(26) (-0.008- 0.008)	12F7 8.3 mi WSW	0.004(1) (0.004 - 0.004)	-0.0005(9) (-0.003 - 0.004)	0

1. The total number of analyses does not include duplicates, splits or repeated analyses.
2. The Technical Requirements LLD's are shown when applicable.
3. The means are based on all analysis results.
4. USNRC reporting levels are specified in the Technical Requirements.

APPENDIX H

COMPARISON OF INDICATOR AND CONTROL 1998 REMP ANNUAL MEANS FOR SELECTED MEDIA ANALYSIS RESULTS WITH MEANS FROM PREOPERATIONAL AND PRIOR OPERATIONAL PERIODS

The data presented in the following tables were included if specific analysis results routinely exceeded the applicable MDCs in 1998 and/or routinely may have done so in previous years. While the comparisons may be useful for observing any step changes that may occur in the environment over a wide area, the importance attached to these comparisons should be tempered by the understanding that changes in methods of analysis, typical MDCs achieved by the analyses, and averaging methods over the years may tend to blur the picture in some cases.

Note that medians are presented in these tables in addition to means only when there appears to be a significant difference between them.

AMBIENT RADIATION MONITORING

TABLE H 1

AMBIENT RADIATION LEVELS AS MEASURED BY TLDS (mR/STD QTR)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1978-81	1982-97	1998	1978-81	1982-97	1998
Range	18.5-19.2	14.1-19.2	--	15.0-17.9	14.8-19.2	--
Mean	18.9	17.7	18.6	16.3	17.6	18.6

AQUATIC PATHWAY MONITORING

TABLE H 2

SURFACE WATER GROSS BETA ACTIVITIES (pCi/l)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1978-81	1982-97	1998	1978-81	1982-97	1998
Range	3.2-4.9	3.0-7.7	--	2.9-5.2	2.8-4.8	--
Mean	3.8	5.5	6.1	4.0	3.6	6.7

TABLE H 3

SURFACE WATER IODINE-131 ACTIVITIES (pCi/l)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1979-81	1982-97	1998	1979-81	1982-97	1998
Range	0.24-0.37	0.06-0.60	--	0.29-0.43	0.03-1.0	--
Mean	0.29	0.28	0.33	0.36	0.27	0.34

TABLE H 4

SURFACE WATER TRITIUM ACTIVITIES (pCi/l)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1978-81	1982-97	1998	1978-81	1982-97	1998
Range	101-122	126-1068	--	119-319	-239-212	--
Mean	109	454	1217	171	62	-11

*1990 results were not averaged with 1982-97 data because the validity of the 1990 values is questionable in some instances. Laboratory analysis error is suspected. See the 1990 Annual Report.

TABLE H 5

DRINKING WATER GROSS ALPHA ACTIVITIES (pCi/l)			
Period	Preoperational	Operational	
	1980 - 81	1982 - 97	1998
Range	--	0.1 – 10.0	--
Mean (median)**	1.3	1.8 (0.2)	0.3

TABLE H 6

DRINKING WATER GROSS BETA ACTIVITIES (pCi/l)			
Period	Preoperational	Operational	
	1977 - 81	1982 - 97	1998
Range	2.2 - 3.2	2.4 - 5.4	--
Mean	2.7	3.2	3.3

TABLE H 7

DRINKING WATER TRITIUM ACTIVITIES (pCi/l)			
Period	Preoperational	Operational	
	1977 - 81	1982 - 97	1998
Range	101 - 194	-247 - 220	--
Mean	132	70	-10

TABLE H 8

FISH POTASSIUM-40 ACTIVITIES (pCi/g wet)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1977-81	1982-97	1998	1977-81	1982-97	1998
Range	2.7 - 3.5	3.1 - 5.3	--	2.8 - 3.6	3.1 - 4.2	--
Mean	3.2	3.8	3.8	3.2	3.7	3.7

TABLE H 9

SEDIMENT POTASSIUM-40 ACTIVITIES (pCi/g dry)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1978-81	1982-97	1998	1978-81	1982-97	1998
Range	8.6-10.4	7.4-13.2	--	7.5-11.0	6.2-13.0	--
Mean	9.3	10.4	11.7	9.4	10.5	11.1

TABLE H 10

SEDIMENT RADIUM-226 ACTIVITIES (pCi/g dry)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1978-81	1982-97	1998	1978-81	1982-97	1998
Range	0.5-0.7	0.5-1.9	--	0.6-1.9	0.4-2.1	--
Mean	0.6	1.3	1.5	0.7	1.5	1.3

TABLE H 11

SEDIMENT THORIUM-228 ACTIVITIES (pCi/g dry)				
Location	Indicator		Control	
Period	1984 - 97*	1998	1984 - 97*	1998
Range	1.0 - 1.3	--	1.0 - 1.4	--
Mean	1.1	1.1	1.1	1.0

*Th-232 was reported instead of Th-228 in 1990.

TABLE H 12

SEDIMENT CESIUM-137 ACTIVITIES (pCi/g dry)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1978-81	1982-97	1998	1978-81	1982-97	1998
Range	0.08-0.15	0.04-0.17	--	0.08-0.21	0.06-0.21	--
Mean	0.10	0.09	0.06	0.12	0.11	0.10

ATMOSPHERIC PATHWAY MONITORING

TABLE H 13

AIR PARTICULATE GROSS BETA ACTIVITIES (E-3 pCi/m^3)						
Location	**Indicator**			**Control**		
Period	**Pre-Op**	**Operational**		**Pre-Op**	**Operational**	
	1978-81	**1982-97**	**1998**	**1978-81**	**1982-97**	**1998**
Range	24 - 97	13 - 29	--	24 - 102	12 - 28	--
Mean	61	17	15	62	16	14

TABLE H 14

AIR PARTICULATE BERYLLIUM-7 ACTIVITIES (E-3 pCi/m^3)						
Location	**Indicator**			**Control**		
Period	**Pre-Op**	**Operational**		**Pre-Op**	**Operational**	
	1978-81	**1982-97**	**1998**	**1978-81**	**1982-97**	**1998**
Range	69 - 81	62 - 132	--	59 - 85	53 - 126	--
Mean	76	89	121	72	84	116

*1990 results were not averaged with 1982-97 data because the validity of the 1990 values is questionable in some instances. Laboratory analysis error is suspected. See the 1990 Annual Report.

TERRESTRIAL PATHWAY MONITORING

TABLE H 15

SOIL POTASSIUM-40 ACTIVITIES (pCi/g dry)						
Location	**Indicator**			**Control**		
Period	**Pre-Op**	**Operational**		**Pre-Op**	**Operational**	
	1979&81	**1984-97**	**1998**	**1979&81**	**1984-97**	**1998**
Range	9.2 - 9.7	9.4-14.3	--	9.1-11.0	7.4-14.1	--
Mean	9.5	11.3	12.6	10.1	10.7	9.4

TABLE H 16

SOIL RADIUM-226 ACTIVITIES (pCi/g dry)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1979&81	1984-97	1998	1979&81	1984-97	1998
Range	0.8 - 1.3	0.8 - 2.5	--	0.8 - 1.2	1.0 - 2.1	--
Mean	1.1	1.6	1.3	1.0	1.8	1.6

TABLE H 17

SOIL THORIUM-228 ACTIVITIES (pCi/g dry)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1979&81	1984-97	1998	1979&81	1984-97	1998
Range	0.9 - 1.3	0.8 - 1.3	--	--	0.8 - 1.2	--
Mean	1.1	0.9	0.9	1.0	1.0	0.7

TABLE H 18

SOIL CESIUM-137 ACTIVITIES (pCi/g dry)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1979&81	1982-97	1998	1979&81	1982-97	1998
Range	0.5 - 0.7	0.08 - 0.5	--	0.2 - 1.2	0.2 - 1.2	--
Mean	0.6	0.3	0.05	0.7	0.5	0.15

TABLE H 19

MILK POTASSIUM-40 ACTIVITIES (pCi/l)						
Location	Indicator			Control		
Period	Pre-Op	Operational		Pre-Op	Operational	
	1978-81	1985-97	1998	1978-81	1985-97	1998
Range	1222-1500	1241-1357	--	1273-1500	1247-1363	--
Mean	1325	1324	1306	1390	1333	1355

TABLE H 20

FRUITS/VEGETABLES POTASSIUM-40 ACTIVITIES (pCi/g wet)						
Location	**Indicator**			**Control**		
Period	**Pre-Op**	**Operational**		**Pre-Op**	**Operational**	
	1980-81	**1982-97**	**1998**	**1980-81**	**1982-97**	**1998**
Range	2.5 - 3.0	2.0-4.2	--	3.0 - 3.1	2.2 - 2.8	--
Mean	2.8	2.8	2.3	3.1	2.4	2.4

*1990 results were not average with 1982-97 data because the validity of the 1990 values is questionable in some instances. Laboratory analysis error is suspected. See the 1990 Annual Report.

TABLE H 21

GROUND WATER TRITIUM ACTIVITIES (pCi/l)						
Location	**Indicator**			**Control**		
Period	**Pre-Op**	**Operational**		**Pre-Op**	**Operational**	
	1980-81	**1982-97**	**1998**	**1980-81**	**1982-97**	**1998**
Range	94-109	-206 - 180	--	117 - 119	-206 - 260	--
Mean	101	68	-37	118	85	-71

APPENDIX I

SPECIFIC ANALYSIS RESULTS TABULATED BY MEDIA AND SAMPLING PERIOD

Results of analyses are generally reported in the following tables to two significant figures. Random uncertainties of counting are reported to the same decimal place as the result.

Calculated values for analysis results in the tables that follow are reported with the random uncertainty of counting at two standard deviations (2S), determined by considering both the sample and background count rates. The uncertainty of an activity is influenced by the volume or mass of the sample, the background count rate, the count times, the method used to round off the value obtained to reflect its degree of significance, and other factors. The uncertainties of activities determined by gamma spectrometric analyses are also influenced by the relative concentrations of the radionuclides in the sample, the energies and intensities of the gammas emitted by those radionuclides, and the assumptions used in selecting the radionuclides to be quantitatively determined.

Results reported as less than (<) in these tables are below the minimum detectable concentrations (MDCs). The MDC is an estimate of the detection capabilities of the overall measurement method, taking into account not only the counting system, but also the characteristics of the sample being counted. When the MDC is used as the level to decide whether or not to enter a measured value into a table, there is a 50% chance that the value will be entered when the actual sample activity is equivalent to the MDC. There is only a five percent chance that a value representing a fluctuation in background activity will be entered as sample activity in such an instance.

Measured values for the activities of specific radionuclides, such as the man-made gamma-emitting radionuclides beryllium-7 and cesium-137, only appear in the following tables for each specific medium when the levels that are measured exceed the MDC values for those measurements and those radionuclides are actually identified as present in the samples. Measured values for the analyses that are not radionuclide specific, such as gross alpha and beta analyses, also are presented in the tables for specific media only when the levels that are measured actually exceed the MDCs.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results (1) are in mR/std. qtr. (2) ± 2S (3)

Location	First Quarter 01/12/98 to 04/14/98	Second Quarter 04/13/98 to 07/23/98	Third Quarter 07/21/98 to 10/15/98	Fourth Quarter 10/12/98 to 01/19/99
ONSITE				
1S2 +	19.3 ± 1.1	16.9 ± 1.3	17.8 ± 1.7	19.2 ± 0.8
2S2	19.5 ± 1.3	17.1 ± 1.1	17.6 ± 0.6	20.2 ± 0.6
2S3 +	18.1 ± 1.0	16.3 ± 0.8	16.7 ± 0.9	18.4 ± 0.6
3S2	18.0 ± 1.7	15.8 ± 1.4	16.7 ± 0.7	18.5 ± 1.0
3S3	17.5 ± 0.9	15.5 ± 0.6	16.2 ± 0.6	19.0 ± 1.0
3S4 +	16.9 ± 1.3	14.5 ± 1.1	15.4 ± 0.9	17.2 ± 1.6
4S3 +	21.9 ± 0.8	19.1 ± 1.4	19.8 ± 2.0	21.4 ± 1.0
4S6	18.2 ± 1.7	16.3 ± 1.0	17.3 ± 0.8	19.6 ± 1.2
5S4	16.9 ± 1.6	14.9 ± 0.7	14.9 ± 0.9	16.8 ± 0.6
5S7 +	17.5 ± 1.1	15.2 ± 0.5	16.0 ± 0.9	17.4 ± 1.0
6S4 +	23.3 ± 0.8	20.3 ± 1.9	21.2 ± 2.2	23.3 ± 1.0
6S9 +	20.6 ± 1.6	18.1 ± 0.9	20.0 ± 1.1	20.6 ± 0.6
7S6 +	21.0 ± 0.7	17.6 ± 1.1	19.4 ± 1.7	20.8 ± 0.8
7S7	17.7 ± 0.7	15.5 ± 1.0	16.6 ± 0.6	18.5 ± 0.4
7S8	17.5 ± 0.5	15.4 ± 0.5	16.7 ± 1.1	18.4 ± 1.0
8S2 +	20.7 ± 1.2	17.6 ± 1.8	18.7 ± 1.7	20.9 ± 1.0
9S2 +	24.3 ± 2.0	21.9 ± 0.8	22.7 ± 1.1	25.1 ± 1.2

See the comments at the end of the table.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results (1) are in mR/std. qtr. (2) ± 2S (3)

Location	First Quarter 01/12/1998 to 04/14/1998	Second Quarter 04/13/1998 to 07/23/1998	Third Quarter 07/21/1998 to 10/15/1998	Fourth Quarter 10/12/1998 to 01/19/1999
10S1 +	(5)	14.4 ± 0.6	16.2 ± 0.7	17.3 ± 0.6
10S2	23.0 ± 0.9	20.4 ± 0.9	22.1 ± 1.1	23.6 ± 1.6
10S3	17.4 ± 1.4	15.1 ± 0.5	15.1 ± 0.7	17.3 ± 1.2
11S3 +	24.7 ± 1.5	22.5 ± 0.7	23.1 ± 2.6	25.4 ± 0.6
11S7	19.6 ± 1.6	17.2 ± 0.6	18.0 ± 0.4	19.7 ± 1.2
12S1	20.3 ± 0.8	17.0 ± 1.1	17.9 ± 1.1	20.3 ± 1.0
12S3 +	23.6 ± 2.0	21.0 ± 1.4	21.8 ± 2.6	24.0 ± 1.0
12S4	23.9 ± 1.4	21.2 ± 0.6	21.8 ± 1.5	23.5 ± 1.0
12S5	20.4 ± 1.1	18.9 ± 1.4	19.6 ± 0.4	20.9 ± 0.6
12S6	20.3 ± 1.4	18.2 ± 1.2	19.2 ± 2.0	20.7 ± 1.2
12S7	17.1 ± 0.9	15.2 ± 0.9	16.3 ± 1.3	17.4 ± 0.6
13S2 +	21.1 ± 1.6	18.9 ± 1.2	19.7 ± 2.0	21.7 ± 0.8
13S4	22.5 ± 1.2	20.0 ± 0.9	20.6 ± 1.7	22.6 ± 1.2
13S5	23.1 ± 1.0	21.0 ± 1.8	21.5 ± 2.0	23.8 ± 0.6
13S6	21.8 ± 1.4	19.8 ± 0.8	20.2 ± 2.0	22.1 ± 1.2
14S5 +	21.1 ± 1.3	19.5 ± 1.2	20.0 ± 1.1	22.8 ± 1.1
14S6	20.7 ± 1.3	18.5 ± 0.4	18.9 ± 0.4	21.0 ± 1.0
15S5 +	19.1 ± 1.1	17.6 ± 1.1	18.0 ± 1.7	19.5 ± 0.8
16S1 +	19.7 ± 1.9	17.4 ± 0.9	18.1 ± 2.0	19.9 ± 0.8
16S2 +	21.8 ± 1.7	19.0 ± 1.4	19.0 ± 2.2	22.3 ± 1.2

See the comments at the end of this table.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results (1) are in mR/std. qtr. (2) ± 2S (3)

Location	First Quarter 01/12/1998 to 04/14/1998	Second Quarter 04/13/1998 to 07/23/1998	Third Quarter 07/21/1998 to 10/15/1998	Fourth Quarter 10/12/1998 to 01/19/1999
0-1 MILE OFFSITE				
6A4 +	19.4 ± 1.1	18.2 ± 0.9	18.4 ± 1.3	20.6 ± 0.8
8A3	18.0 ± 0.6	16.3 ± 0.5	16.4 ± 1.5	18.7 ± 0.6
15A3	19.5 ± 1.2	17.3 ± 0.8	18.4 ± 1.7	20.0 ± 1.0
16A2	16.4 ± 1.5	14.8 ± 0.7	15.3 ± 1.3	16.8 ± 0.8
1-2 MILES OFFSITE				
1B1	19.4 ± 0.7	17.4 ± 0.6	18.3 ± 1.3	20.6 ± 0.4
2B3 +	18.6 ± 1.2	16.2 ± 1.3	(5)	19.5 ± 1.4
2B4	18.9 ± 0.7	17.2 ± 1.1	17.4 ± 1.3	20.0 ± 0.6
5B3	17.0 ± 1.0	13.7 ± 1.2	15.9 ± 0.7	15.7 ± 0.7
7B2	18.3 ± 0.9	15.6 ± 1.0	18.5 ± 1.1	17.5 ± 1.3

See the comments at the end of this table.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1997

Results (1) are in mR/std. qtr. (2) ± 2S (3)

Location	First Quarter 01/12/1998 to 04/14/1998	Second Quarter 04/13/1998 to 07/23/1998	Third Quarter 07/21/1998 to 10/15/1998	Fourth Quarter 10/12/1998 to 01/19/1999
8B2 +	17.0 ± 1.4	15.2 ± 0.9	17.0 ± 1.4	17.2 ± 0.9
8B3	19.2 ± 0.5	15.8 ± 1.5	17.9 ± 0.9	18.2 ± 0.6
9B1	17.1 ± 0.8	15.2 ± 0.9	16.1 ± 0.4	18.0 ± 1.2
10B2	15.0 ± 0.4	13.0 ± 1.0	13.3 ± 1.1	15.2 ± 1.0
10B3	16.4 ± 0.3	14.7 ± 0.9	15.0 ± 0.8	17.2 ± 0.8
10B4	19.9 ± 1.0	17.9 ± 1.2	18.1 ± 1.5	20.7 ± 1.4
12B4	18.4 ± 0.9	16.1 ± 0.7	17.1 ± 0.6	19.1 ± 1.2
13B1	18.2 ± 1.0	16.3 ± 0.9	16.6 ± 1.5	19.2 ± 0.6
14B3 +	18.4 ± 0.4	16.1 ± 1.1	16.8 ± 1.3	19.4 ± 0.8
15B1	18.7 ± 1.7	16.2 ± 0.5	17.4 ± 1.9	19.0 ± 0.8
16B2	14.6 ± 5.0	15.1 ± 0.9	16.0 ± 1.5	17.5 ± 1.2
2-3 MILES OFFSITE				
11C1	21.0 ± 1.5	19.4 ± 0.5	20.4 ± 0.6	22.0 ± 1.2

See the comments at the end of this table.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results (1) are in mR/std. qtr. (2) ± 2S (3)

Location	First Quarter 01/12/1998 to 04/14/1998	Second Quarter 04/13/1998 to 07/23/1998	Third Quarter 07/21/1998 to 10/15/1998	Fourth Quarter 10/12/1998 to 01/19/1999
3-4 MILES OFFSITE				
1D5 +	21.4 ± 0.9	18.6 ± 0.8	19.9 ± 1.1	19.9 ± 0.7
6D1	20.8 ± 1.8	17.8 ± 1.1	19.8 ± 1.6	20.7 ± 0.6
8D3 +	19.1 ± 1.6	16.5 ± 0.7	18.4 ± 0.7	18.2 ± 0.9
9D4 +	19.1 ± 1.5	16.6 ± 1.1	18.6 ± 1.1	19.0 ± 1.1
10D1 +	18.6 ± 1.4	15.7 ± 0.9	18.0 ± 1.1	17.7 ± 0.6
12D2	21.7 ± 1.7	19.5 ± 1.1	21.0 ± 1.1	22.2 ± 1.0
14D1	20.3 ± 0.9	18.4 ± 0.4	19.2 ± 0.8	20.4 ± 1.0
4-5 MILES OFFSITE				
3E1	16.6 ± 1.0	13.7 ± 1.0	15.7 ± 0.7	15.9 ± 0.7
4E2	20.0 ± 0.8	17.0 ± 1.5	18.9 ± 1.4	19.4 ± 0.9
5E2 +	18.6 ± 1.6	16.1 ± 0.7	17.8 ± 0.9	18.7 ± 0.6
6E1 +	21.1 ± 1.1	18.8 ± 1.4	20.6 ± 1.1	21.7 ± 1.3
7E1 +	19.2 ± 1.1	16.6 ± 1.2	18.0 ± 1.4	18.6 ± 0.9
11E1 +	15.7 ± 1.4	13.7 ± 1.5	15.1 ± 0.9	15.7 ± 0.4
12E1 +	17.5 ± 0.7	15.5 ± 1.0	16.9 ± 1.3	18.4 ± 1.2
13E4 +	18.7 ± 1.2	16.7 ± 1.2	17.7 ± 0.6	19.2 ± 0.4

See the comments at the end of this table.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results (1) are in mR/std. qtr. (2) ± 2S (3)

Location	First Quarter 01/12/1998 to 04/14/1998	Second Quarter 04/13/1998 to 07/23/1998	Third Quarter 07/21/1998 to 10/15/1998	Fourth Quarter 10/12/1998 to 01/19/1999
5-10 MILES OFFSITE				
2F1 +	18.8 ± 1.3	15.6 ± 1.4	(5)	18.2 ± 0.7
8F2	17.9 ± 1.4	15.3 ± 0.8	17.5 ± 0.2	16.8 ± 0.7
12F2	19.9 ± 1.3	18.1 ± 0.9	18.0 ± 1.1	20.0 ± 1.4
15F1 +	20.5 ± 1.0	18.9 ± 0.4	19.0 ± 1.9	21.2 ± 1.2
16F1 +	21.6 ± 1.2	19.4 ± 0.6	19.8 ± 1.7	23.1 ± 1.6
10-20 MILES				
3G4	20.7 ± 1.3	17.5 ± 0.5	19.2 ± 1.1	20.0 ± 1.3
4G1 +	21.6 ± 0.9	18.7 ± 1.4	20.2 ± 1.8	20.6 ± 0.7
6G1	21.7 ± 1.5	19.7 ± 2.2	21.0 ± 2.0	21.2 ± 0.6
7G1 +	18.9 ± 1.1	16.3 ± 0.6	18.0 ± 1.4	18.1 ± 0.9
7G2	18.5 ± 0.7	16.5 ± 1.3	18.3 ± 1.4	18.1 ± 0.9
8G1	16.4 ± 1.0	13.8 ± 0.7	15.8 ± 1.6	16.0 ± 0.7
12G1 +	17.4 ± 0.5	14.9 ± 0.9	15.8 ± 0.8	18.0 ± 0.2
12G4	20.5 ± 1.1	18.7 ± 0.8	20.3 ± 1.7	21.5 ± 0.4

See the comments at the end of this table.

TABLE I-1

ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY RESULTS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results (1) are in mR/std. qtr. (2) ± 2S (3)

Location	First Quarter 01/12/1998 to 04/14/1998	Second Quarter 04/13/1998 to 07/23/1998	Third Quarter 07/21/1998 to 10/15/1998	Fourth Quarter 10/12/1998 to 01/19/1999
Indicator				
Average (6)	19.4 ± 11.9	17.1 ± 9.1	18.1 ± 11.7	19.7 ± 8.5
Control				
Average (6)	19.5 ± 3.0	17.0 ± 3.3	18.6 ± 4.3	19.2 ± 2.2

COMMENTS

(1) Individual monitor location results are normally the average of the elemental doses of six calcium elements from the two TLDs assigned to each monitoring location.

(2) A standard (std.) quarter (qtr.) is considered to be 91.25 days. Results obtained for monitoring periods of other durations are normalized by multiplying them by 91.25/x, where x is the actual duration in days of the period.

(3) Uncertainties for individual monitoring location results are two standard deviations of the elemental doses of six calcium elements from the two TLDs assigned to each monitoring location, representing the variability between the elemental doses of each of the six TLD elements.

(4) TLDs were not in the field at this monitoring location during this quarter. Refer to Appendix A of this report for an explanation of program changes to the REMP.

(5) No measurement could be made because the TLDs were lost, stolen, or damaged.

(6) Uncertainties associated with quarterly indicator and control averages are two standard deviations, representing the variability between the results of the individual monitoring locations.

(7) Data were invalidated for this period because of an unacceptably high coefficient of variation among element readings.

\+ ODCM -listed locations.

TABLE I-2

GROSS BETA, TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF SURFACE WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	GR-BETA	TRITIUM	OTHER ACTIVITY	COMMENTS
6S6	01/05/98-02/02/98	2.6 ± 06	< 197		(1)
2S7	01/05/98-02/02/98	15.2 ± 1.4	1748 ± 141		
6S5	01/12/98-02/02/98	8.6 ± 0.8	< 197		
LTAW	01/13/98	5.9 ± 0.7	< 197		
6S6	02/02/98-03/02/98	10.0 ± 0.8	< 164		(2)
2S7	02/02/98-03/02/98	11.5 ± 1.4	1258 ± 118		
6S5	02/09/98-03/02/98	5.8 ± 0.7	< 164		
LTAW	02/09/98	2.8 ± 0.6	< 187		
6S6	03/09/98-03/16/98	1.5 ± 0.5	< 140		(3)
6S6	03/16/98-04/06/98	1.6 ± 0.5	< 140		(4)
2S7	03/02/98-04/06/98	8.7 ± 1.5	740 ± 70		
6S5	03/09/98-04/06/98	3.5 ± 0.6	< 140		
LTAW	03/09/98	3.2 ± 0.6	< 174		
6S6	04/06/98-4/20/98	2.2 ± 0.6	231 ± 84		
6S6	04/27/98	1.1 ± 0.5	< 134		(5)
6S6	04/27/98-05/04/98	4.1 ± 0.6	< 133		
2S7	04/06/98-05/04/98	16.4 ± 1.6	5700 ± 100		
6S5	04/13/98-05/04/98	1.2 ± 0.5	< 133		
LTAW	04/14/98	4.5 ± 0.7	158 ± 88		

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-2

GROSS BETA, TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF SURFACE WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	GR-BETA	TRITIUM	OTHER ACTIVITY	COMMENTS
6S6	05/04/98-06/01/98	5.0 ± 0.6	< 80		(6)
2S7	05/04/98-06/01/98	12.7 ± 0.9	7000 ± 100		
6S5	05/11/98-06/01/98	1.3 ± 0.5	< 80		
LTAW	05/11/98	1.9 ± 0.6	124 ± 66		
6S6	06/01/98-06/29/98	9.1 ± 0.8	< 80		(7)
6S6	07/01/98-07/06/98	4.2 ± 0.6	< 80		
2S7	06/01/98-07/06/98	5.7 ± 0.7	13000 ± 1000		
6S5	06/08/98-07/06/98	1.6 ± 0.6	< 80		
LTAW	06/08/98	6.7 ± 0.7	110 ± 50		
6S6	07/06/98-08/03/98	5.7 ± 0.7	< 70		(8)
2S7	07/06/98-08/03/98	5.0 ± 0.6	6100 ± 100		
6S5	07/13/98-08/03/98	3.2 ± 0.6	< 70		
LTAW	07/13/98	3.2 ± 0.6	100 ± 50		
6S6	08/03/98-08/31/98	5.6 ± 0.8	< 80		
2S7	08/03/98-08/31/98	7.5 ± 0.8	330 ± 50		
6S5	08/10/98-08/31/98	2.6 ± 0.6	< 80		
LTAW	08/10/98	3.1 ± 0.6	76 ± 43		

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-2

GROSS BETA, TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF SURFACE WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	GR-BETA	TRITIUM	OTHER ACTIVITY	COMMENTS
6S6	08/31/98-10/05/98	11.6 ± 0.9	< 100		(9)
2S7	08/31/98-10/05/98	8.5 ± 0.8	4500 ± 100		
6S5	09/08/98-10/05/98	5.9 ± 0.7	< 100		
LTAW	09/14/98	5.9 ± 0.7	< 80		
6S6	10/05/98-11/02/98	2.5 ± 0.6	< 90		
2S7	10/05/98-11/02/98	6.8 ± 0.8	1800 ± 100		
6S5	10/12/98-11/02/98	2.3 ± 0.6	500 ± 60		
LTAW	10/12/98	3.7 ± 0.6	< 100		
6S6	11/02/98-11/30/98	2.1 ± 1.0	< 100		(10)
2S7	11/02/98-11/30/98	8.3 ± 0.8	590 ± 70		
6S5	11/09/98-11/30/98	3.9 ± 0.6	< 100		
LTAW	11/09/98	9.8 ± 0.8	< 90		
6S6	11/30/98-01/04/99	18.8 ± 1.0	< 90		
2S7	11/30/98-01/04/99	17.3 ± 1.0	220 ± 60		
6S5	12/07/98-01/04/99	2.3 ± 0.6	< 90		(11)
LTAW	12/14/98	3.1 ± 0.6	< 100		

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

GROSS BETA, TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF SURFACE WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Comments

1. Sampling personnel observed a low flow rate of water through the ACS at monitoring location 6S6. The sampling lines at this location were cleaned on 1/9/98. A low rate of water flow was observed again at the ACS on 1/12/98. The reduced flow rates appear to be caused by clogging of the lines from larger than normal amounts of silt which often accompany increases in the water level in the Susquehanna River.

2. Sampling personnel observed low and erratic flow rates of water through the ACS at monitoring location 6S6. Preventative maintenance was performed at this monitoring location on 2/20/98.

3. Sampling personnel observed a low flow rate of water through the ACS at monitoring location 6S6 on 3/5/98. Valves were adjusted at the 6S6 ACS on 3/5/98 to increase the flow rate through the ACS. The ACS sample collection tank at this location was found overflowing on 3/9/98 and 3/16/98. The sample representing the period 3/9/98 through 3/16/98 was a composite of two grab samples collected on 3/9/98 and 3/16/98.

4. A new valve was installed on the sampling line for the ACS at location 6S6 and the lines were cleaned on 3/19/98. Routine sampling was interrupted for the valve installation and cleaning from 0856 through 1110.

5. The sampling collection tank for the ACS at monitoring location 6S6 was observed to be overflowing on 4/27/98. A grab sample was collected. Cleaning of the sampling lines of the ACS at this location on 4/24/98 without the appropriate valve adjustments probably contributed to the overflowing condition.

6. A larger than normal amount of water entered the ACS sample collection tank at monitoring location 6S6 on 5/28/98 as the result of flushing of the sampling lines that took place during preventative maintenance.

7. The ACS at monitoring location 6S6 was inoperative for preventative maintenance from 1310 through 1330 on 6/29/98. Sample collection personnel adjusted the valves controlling flow through the ACS following the maintenance. The ACS collection tank at this location was found to be overflowing on 7/1/98.

8. Sampling personnel observed a variable flow rate for the water at the 6S6 ACS from 7/16/98 through 7/30/98. The sampling lines for the ACS at location 6S6 were cleaned on 7/30/98.

9. The ACS at monitoring location 6S6 was inoperative from 0920 through 1050 on 9/29/98 for preventative maintenance. A larger than normal amount of water entered the ACS sample collection tank at monitoring location 6S6 on 9/29/98 as the result of flushing of the sampling lines.

10. The ACS at monitoring location 6S6 was inoperative from 0850 through 0925 on 11/23/98 for preventative maintenance.

11. The weekly sample for location 6S5 was collected from the shoreline on 1/4/99 because of seasonal river conditions making it unsafe to collect from the normal location by boat.

TABLE I-3

IODINE-131 ANALYSES OF SURFACE WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	I-131	COMMENTS
6S6	01/05/98-01/19/98	< 0.2	(1)
6S6	01/19/98-02/02/98	< 0.2	
2S7	01/05/98-01/19/98	< 0.1	
2S7	01/19/98-02/02/98	0.37 ± 0.13	
6S5	01/12/98-01/19/98	< 0.09	
6S5	01/26/98-02/02/98	< 0.1	
LTAW	01/13/98	< 0.1	
12H1	01/05/98-01/19/98	Sample not collected.	
6S6	02/02/98-02/17/98	< 0.2	(2)
6S6	02/17/98-03/02/98	< 0.1	
2S7	02/02/98-02/17/98	0.41 ± 0.14	
2S7	02/17/98-03/02/98	0.20 ± 0.0.09	
6S5	02/09/98-02/17/98	< 0.2	
6S5	02/23/98-03/02/98	< 0.2	
LTAW	02/09/98	< 0.07	
6S6	03/09/98-03/16/98	< 0.1	(3)
6S6	03/16/98-03/30/98	0.19 ± 0.11	(4)
6S6	03/30/98-04/13/98	< 0.2	
2S7	03/02/98-03/16/98	< 0.2	
2S7	03/16/98-03/30/98	0.69 ± 0.13	
2S7	03/30/98-04/13/98	0.26 ± 0.10	
6S5	03/09/98-03/16/98	< 0.1	
6S5	03/23/98-03/30/98	< 0.1	
LTAW	03/09/98	< 0.06	
6S6	04/13/98-04/20/98	< 0.2	
6S6	04/27/98	< 0.08	(5)
2S7	04/13/98-04/27/98	0.20 ± 0.10	
6S5	04/06/98-04/13/98	< 0.1	
6S5	04/20/98-04/27/98	< 0.1	
LTAW	04/14/98	< 0.08	

TABLE I-3

IODINE-131 ANALYSES OF SURFACE WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	I-131	COMMENTS
6S6	04/27/98-05/11/98	< 0.3	
2S7	04/27/97-05/11/98	0.36 ± 0.23	
6S5	05/04/98-05/11/98	< 0.2	
LTAW	05/11/98	< 0.1	
6S6	05/11/98-05/26/98	< 0.3	
6S6	05/26/98-06/08/98	0.73 ± 0.13	(6)
2S7	05/11/98-05/26/98	0.34 ± 0.15	
2S7	05/26/98-06/08/98	1.3 ± 0.2	
6S5	05/18/98-05/26/98	0.32 ± 0.1	
6S5	06/01/98-06/08/98	0.48 ± 0.11	
LTAW	06/08/98	< 0.08	
6S6	06/08/98-06/22/98	0.30 ± 0.14	
6S6	06/22/98-06/29/98	0.19 ± 0.10	(7)
2S7	06/08/98-06/22/98	1.2 ± 0.2	
2S7	06/22/98-07/06/98	0.44 ± 0.11	
6S5	06/15/98-06/22/98	< 0.2	
6S5	06/29/98-07/06/98	< 0.1	
6S6	07/01/98-07/06/98	0.15 ± 0.06	
6S6	07/06/98-07/20/98	< 0.3	(8)
6S6	07/20/98-08/03/98	< 0.3	(8)
2S7	07/06/98-07/20/98	< 0.3	
2S7	07/20/98-08/03/98	0.61 ± 0.19	
6S5	07/13/98-07/20/98	0.49 ± 0.16	
6S5	07/27/98-08/03/98	< 0.2	
LTAW	07/13/98	< 0.1	

TABLE I-3

IODINE-131 ANALYSES OF SURFACE WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	I-131	COMMENTS
6S6	08/03/98-08/17/98	0.70 ± 0.17	
2S7	08/03/98-08/17/98	1.6 ± 0.2	
6S5	08/10/98-08/17/98	0.75 ± 0.17	
LTAW	08/10/98	< 0.1	
6S6	08/17/98-08/31/98	0.48 ± 0.12	
2S7	08/17/98-08/31/98	1.2 ± 0.1	
6S5	08/24/98-08/31/98	0.80 ± 0.12	
6S6	08/31/98-09/14/98	1.4 ± 0.3	
2S7	08/31/98-09/14/98	2.3 ± 0.2	
6S5	09/08/98-09/14/98	0.92 ± 0.15	
LTAW	09/14/98	< 0.1	
6S6	09/14/98-09/28/98	< 0.2	
6S6	09/28/98-10/12/98	0.41 ± 0.15	(9)
2S7	09/14/98-09/28/98	0.27 ± 0.12	
2S7	09/28/98-10/12/98	0.28 ± 0.15	
6S5	09/21/98-09/28/98	< 0.1	
6S5	10/05/98-10/12/98	< 0.2	
6S6	10/12/98-10/26/98	0.48 ± 0.16	
2S7	10/12/98-10/26/98	0.85 ± 0.16	
6S5	10/19/98-10/26/98	< 0.2	
LTAW	10/12/98	< 0.1	
6S6	10/26/98-11/09/98	0.54 ± 0.11	
2S7	10/26/98-11/09/98	0.75 ± 0.11	
6S5	11/02/98-11/09/98	0.22 ± 0.08	
LTAW	11/09/98	< 0.08	
6S6	11/09/98-11/23/98	0.40 ± 0.17	(10)
2S7	11/09/98-11/23/98	0.50 ± 0.22	
6S5	11/09/98-11/23/98	0.47 ± 0.17	

TABLE I-3

IODINE-131 ANALYSES OF SURFACE WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	I-131	COMMENTS
6S6	11/23/98-12/07/98	0.27 ± 0.11	
2S7	11/23/98-12/07/98	0.73 ± 0.13	
6S5	11/23/98-12/07/98	0.30 ± 0.08	
LTAW	12/14/98	<0.2	
6S6	12/07/98-12/21/98	0.58 ± 0.16	
2S7	12/07/98-12/21/98	1.1 ± 0.2	
6S5	12/07/98-12/21/98	0.80 ± 0.14	
6S6	12/21/98-01/04/99	0.63 ± 0.16	
2S7	12/21/98-01/04/99	1.3 ± 0.2	
6S5	12/21/98-01/04/99	1.1 ± 0.2	(11)

Comments

1. Sampling personnel observed a low flow rate of water through the ACS at monitoring location 6S6. The sampling lines at this location were cleaned on 1/9/98. A low rate of water flow was observed again at the ACS on 1/12/98. The reduced flow rates appear to be caused by clogging of the lines from larger than normal amounts of silt which often accompany increases in the water level in the Susquehanna River.

2. Sampling personnel observed low and erratic flow rates of water through the ACS at monitoring location 6S6. Preventative maintenance was performed at this monitoring location on 2/20/98.

3. Sampling personnel observed a low flow rate of water through the ACS at monitoring location 6S6 on 3/5/98. Valves were adjusted at the 6S6 ACS on 3/5/98 to increase the flow rate through the ACS. The ACS sample collection tank at this location was found overflowing on 3/9/98 and 3/16/98. The sample representing the period 3/9/98 through 3/16/98 was a composite of two grab samples collected on 3/9/98 and 3/16/98.

4. A new valve was installed on the sampling line for the ACS at location 6S6 and the lines were cleaned on 3/19/98. Routine sampling was interrupted for the valve installation and cleaning from 0856 through 1110.

5. The sampling collection tank for the ACS at monitoring location 6S6 was observed to be overflowing on 4/27/98. A grab sample was collected. Cleaning of the sampling lines of the ACS at this location of 4/24/98 without the appropriate valve adjustments probably contributed to the overflowing condition.

6. A larger than normal amount of water entered the ACS sample collection tank at monitoring location 6S6 on 5/28/98 as the result of flushing of the sampling lines that took place during the preventative maintenance.

7. The ACS at monitoring location 6S6 was inoperative for preventative maintenance from 1310 through 1330 on 6/29/98. Sample collection personnel adjusted the valves controlling flow through the ACS following the maintenance. The ACS collection tank that this location was found to be overflowing on 7/1/98.

8. Sampling personnel observed a variable flow for the water at 6S6 ACS from 7/16/98 through 7/30/98. The sampling lines for the ACS at location 6S6 were cleaned on 7/30/98.

9. The ACS at monitoring location 6S6 was inoperative from 0920 through 1050 on 9/29/98 for preventative maintenance. A larger than normal amount of water entered the ACS sample collection tank at monitoring location 6S6 on 5/28/98 as the result of flushing of the sampling lines.

10. The ACS at monitoring location 6S6 was inoperative from 0850 through 0925 on 11/23/98 for preventative maintenance.

11. The weekly sample for location 6S5 was collected from the shoreline on 1/4/99 because of seasonal river conditions making it unsafe to collect from the normal location by boat.

TABLE I-4

GROSS ALPHA, GROSS BETA, TRITIUM, IODINE-131 AND GAMMA* SPECTROSCOPIC ANALYSES OF DRINKING WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	GR-ALPHA	GR-BETA	TRITIUM	OTHER ACTIVITY	COMMENTS
12H2 T	01/05/98-02/02/98	<0.7	1.8 ± 0.7	< 197		(1)
12H2 T	02/02/98-03/02/98	<0.9	1.5 ± 0.8	< 164		
12H2 T	03/02/98-04/06/98	<0.7	< 1	< 70		
12H2 T	04/06/98-05/04/98	<1	1.9 ± 0.8	< 70		
12H2 T	05/04/98-06/01/98	<1	1.7 ± 0.8	< 70		
12H2 T	05/26/98-06/08/98				I-131 0.37 ± 0.1	
12H2 T	06/01/98-07/06/98	<1	2.7 ± 0.8	< 70		
12H2 T	06/08/98-06/22/98				I-131 0.28 ± 0.1	
12H2 T	07/06/98-08/03/98	<0.9	3.1 ± 0.8	< 70		
12H2 T	08/03/98-08/17/98				I-131 0.19 ± 0.12	
12H2 T	08/03/98-08/31/98	<1	3.8 ± 1.1	< 70		
12H2 T	08/31/98-09/14/98	<1	2.7 ± 0.9	< 100	I-131 0.33 ± 0.14	(2)
12H2 T (G)	09/21/98	<1	4.5 ± 1.0	340 ± 90		(3)
12H2 T	09/21/98-10/05/98	<2	4.7 ± 1.0	230 ± 90		
12H2 T	10/05/98-11/02/98	<2	4.3 ± 1.1	< 90		
12H2 T	10/26/98-11/09/98				I-131 0.24 ± 0.11	
12H2 T	11/02/98-11/30/98	<0.8	1.8 ± 0.8	< 90		
12H2 T	11/30/98-01/04/99	<1	11 ± 1.0	< 90		

(G) Grab sample

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

GROSS ALPHA, GROSS BETA, TRITIUM, IODINE-131 AND GAMMA* SPECTROSCOPIC ANALYSES OF DRINKING WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Comments

1. Danville water company personnel shut off the water supply to the ACS at monitoring location 12H2T from 0800 through 1200 on 1/12/98 to clean out larger than normal amounts of silt deposited as the result of increases in the water level of the Susquehanna River.

2. Sample collection personnel found the ACS at monitoring location 12H2T to be inoperative at 0951 on 9/8/98. Sampling personnel determined that the solenoid arm was not moving when the solenoid was activated. A new solenoid was installed on 9/9/98. Power was interupted to the ACS from 1005 through 1045 on 9/9/98 to permit the new solenoid's installation.

3. The ACS's sample collection tank at monitoring location 12H2T was found by sampling personnel to be overflowing at 1032 on 9/21/98. A grab sample was collected on 9/21/98 at this monitoring location. The reason for the overflowing tank was that the solenoid arm was jammed in the collecting position. The return spring for the solenoid was removed, the solenoid arm was returned to its non-activitated (non-collecting) position. The solenoid arm was subsequently observed to be functioning properly.

TABLE I-5

GROSS BETA AND GAMMA* SPECTROSCOPIC ANALYSES OF FISH

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/gm (wet) ± 2S

LOCATION	SAMPLE TYPE	COLLECTION DATE	K-40
IND	White Sucker	05/21/98-05/21/98	4.55 ± 0.46
IND	Smallmouth Bass	05/21/98-05/21/98	3.97 ± 0.40
IND	Channel Catfish	05/20/98-05/21/98	3.98 ± 0.40
IND	Shorthead Redhorse	10/21/98-10/21/98	3.56 ± 0.37
IND	Smallmouth Bass	10/21/98-10/21/98	3.77 ± 0.38
IND	Channel Catfish	10/19/98-10/21/98	3.46 ± 0.35
2H	Channel Catfish	06/02/98-06/03/98	3.40 ± 0.34
2H	Smallmouth Bass	06/08/98-06/08/98	4.00 ± 0.40
2H	White Sucker	06/08/98-06/08/98	3.96 ± 0.40
2H	Smallmouth Bass	10/27/98-10/27/98	3.79 ± 0.38
2H	Shorthead Redhorse	10/27/98-10/27/98	3.40 ± 0.34
2H	Channel Catfish	10/27/98-10/28/98	3.78 ± 0.38
LTAW	Largemouth Bass	10/28/98-10/28/98	3.65 ± 0.37

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-6

GAMMA* SPECTROSCOPIC ANALYSES OF SHORELINE SEDIMENT

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/gm (dry) ± 2S

LOCATION	COLLECTION DATE	K-40	Cs-137	Ra-226	Th-228	Other Activity
2B	05/27/98	10.8 ± 1.1	0.11 ± 0.03	1.07 ± 0.50	1.13 ± 0.11	Be-7 0.82 ± 0.27
7B	05/27/98	12.0 ± 1.2	0.11 ± 0.03	1.44 ± 0.44	1.31 ± 0.13	
12F	05/27/98	15.3 ± 1.5	0.09 ± 0.05	2.18 ± 0.77	1.30 ± 0.13	
LTAW	05/27/98	13.3 ± 1.3		1.41 ± 0.59	1.11 ± 0.11	
2B	10/19/98	11.3 ± 1.1	0.09 ± 0.03	1.56 ± 0.47	0.94 ± 0.09	
7B	10/19/98	8.09 ± 0.81		0.95 ± 0.41	0.96 ± 0.10	
12F	10/19/98	7.48 ± 0.75	0.08 ± 0.03	0.92 ± 0.40	0.70 ± 0.07	Be-7 0.39 ± 0.2
LTAW	10/19/98	14.0 ± 1.4		2.19 ± 0.65	1.52 ± 0.15	

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-7

TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF GROUND WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	TRITIUM	OTHER ACTIVITY
12F3	01/13/98	< 191	
2S2	01/13/98	< 191	
4S4 Treated	01/13/98	< 191	
4S5	01/13/98	< 191	
12S1	01/13/98	< 191	
12F3	02/09/98	< 187	
2S2	02/09/98	< 187	
4S4 Treated	02/09/98	< 187	
4S5	02/09/98	< 187	
12S1	02/09/98	< 187	
12F3	03/09/98	< 174	
2S2	03/09/98	< 174	
4S4 Treated	03/09/98	< 174	
4S5	03/09/98	< 174	
12S1	03/09/98	< 174	
12F3	04/14/98	< 141	
2S2	04/14/98	< 141	
4S4 Treated	04/14/98	< 141	
4S5	04/14/98	< 141	
12S1	04/14/98	< 141	
12F3	05/11/98	< 107	
2S2	05/11/98	< 107	
4S4 Treated	05/11/98	< 107	
4S5	05/11/98	< 107	
12S1	05/11/98	< 107	
12F3	06/08/98	< 70	
2S2	06/08/98	< 70	
4S4 Treated	06/08/98	< 70	
4S5	06/08/98	< 70	
12S1	06/08/98	< 70	

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-7

TRITIUM, AND GAMMA* SPECTROSCOPIC ANALYSES OF GROUND WATER

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	TRITIUM	OTHER ACTIVITY
12F3	07/13/98	< 70	
2S2	07/13/98	< 70	
4S4 Treated	07/13/98	< 70	
4S5	07/13/98	< 70	
12S1	07/13/98	< 70	
12F3	08/10/98	< 70	
2S2	08/10/98	< 70	
4S4 Treated	08/10/98	< 70	
4S5	08/10/98	< 70	
12S1	08/10/98	< 70	
12F3	09/14/98	< 70	
2S2	09/14/98	< 70	
4S4 Treated	09/14/98	< 70	
4S5	09/14/98	< 70	
12S1	09/14/98	< 70	
12F3	10/12/98	< 90	
2S2	10/12/98	< 90	
4S4 Treated	10/12/98	< 90	
4S5	10/12/98	< 90	
12S1	10/12/98	< 90	
12F3	11/09/98	< 90	
2S2	11/09/98	< 90	
4S4 Treated	11/09/98	< 90	
4S5	11/09/98	< 90	
12S1	11/09/98	< 90	
12F3	12/14/98	< 90	
2S2	12/14/98	< 90	
4S4 Treated	12/14/98	< 90	
4S5	12/14/98	< 90	
12S1	12/14/98	< 90	

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-8

GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in E-03 pCi/Cu.M. ± 2S

MONTH	COLLECTION DATE (1)	8G1	6G1	3S2	5S4	12S1	13S6	9B1	7S7	10S3	12E1
JAN	12/29-01/06	10 ± 1	11 ± 1	15 ± 2	16 ± 2	12 ± 2	16 ± 2	14 ± 1	15 ± 2	14 ± 2	16 ± 2
	01/06-01/14	10 ± 1	13 ± 2	13 ± 1	13 ± 1	12 ± 2	14 ± 2	13 ± 1	12 ± 1	14 ± 2	15 ± 2
	01/14-01/21	10 ± 1	11 ± 2	12 ± 2	13 ± 2	12 ± 2	13 ± 2	12 ± 2	12 ± 2	11 ± 2	11 ± 1
	01/21-01/28	37 ± 5 (2)	4.1 ± 1.3	15 ± 2	13 ± 2	13 ± 2	15 ± 2	12 ± 2	13 ± 2	13 ± 2	14 ± 2
FEB	01/28-02/04	18 ± 5 (3)	15 ± 2	19 ± 2	20 ± 2	20 ± 2	19 ± 2	16 ± 2	18 ± 2	18 ± 2	19 ± 2
	02/04-02/10	17 ± 2	17 ± 2	18 ± 2	18 ± 2	20 ± 2	18 ± 2	19 ± 2	18 ± 2	18 ± 2	19 ± 2
	02/10-02/18	31 ± 4	37 ± 5	36 ± 4	46 ± 5	38 ± 4	40 ± 5	40 ± 5	37 ± 4	40 ± 5	39 ± 4
	02/18-02/25	4.2 ± 1.1	5.7 ± 1.3	5.3 ± 1.2	6.4 ± 1.3	4.0 ± 1.2	5.8 ± 1.7 (4)	6.6 ± 1.3	6.1 ± 1.2	6.2 ± 1.3	6.2 ± 1.3
MAR	02/25-03/04	11 ± 2	12 ± 2	13 ± 2	16 ± 2	14 ± 2	12 ± 1	14 ± 2	15 ± 2	14 ± 2	14 ± 2
	03/04-03/11	5.6 ± 1.2	6.4 ± 1.4	6.3 ± 1.3	5.8 ± 1.3	7.7 ± 1.4	5.3 ± 1.2	6.7 ± 1.4	6.4 ± 1.3	6.1 ± 1.3	5.7 ± 1.3
	03/11-03/17	17 ± 2	16 ± 2	16 ± 2	18 ± 2	17 ± 2	20 ± 2	18 ± 2	17 ± 2	19 ± 2	17 ± 2
	03/17-03/25	8.1 ± 1.2	7.6 ± 1.1	8.4 ± 1.2	8.9 ± 1.3	10 ± 1	9.5 ± 1.4	8.2 ± 1.3	7.9 ± 1.2	9.2 ± 1.3	8.6 ± 1.3
	03/25-03/31	20 ± 2	19 ± 2	22 ± 2	20 ± 2	21 ± 2	21 ± 2	21 ± 2	20 ± 2	19 ± 2	21 ± 2
APR	03/31-04/07	7.6 ± 1.6	8.4 ± 1.6	8.2 ± 1.7	7.9 ± 1.7	9.1 ± 1.8	11 ± 1	9.5 ± 1.9	8.4 ± 1.7	8.9 ± 1.8	9.4 ± 1.7
	04/07-04/15	15 ± 2	14 ± 1	19 ± 2	17 ± 2	16 ± 2	18 ± 2	16 ± 2	17 ± 2	17 ± 2	16 ± 2
	04/15-04/22	11 ± 2	11 ± 1	13 ± 2	12 ± 2	14 ± 2	13 ± 2	12 ± 2	12 ± 2	11 ± 2	12 ± 2
	04/22-04/29	10 ± 2	12 ± 2	13 ± 2	13 ± 2	13 ± 2	13 ± 2	15 ± 2	11 ± 2	11 ± 2	14 ± 2
MAY	04/29-05/05	10 ± 2	9.9 ± 1.5	11 ± 2	12 ± 2	12 ± 2	13 ± 2	12 ± 2	11 ± 2	13 ± 2	12 ± 2
	05/05-05/13	5.9 ± 1.2	6.5 ± 1.1	6.0 ± 1.2	7.0 ± 1.3	6.0 ± 1.3	7.3 ± 1.2	7.4 ± 1.4	5.8 ± 1.1	5.4 ± 1.2	6.3 ± 1.2
	05/13-05/20	18 ± 2	18 ± 2	18 ± 2	17 ± 2	18 ± 2	19 ± 2	20 ± 2	18 ± 2	18 ± 2	19 ± 2
	05/20-05/27	13 ± 2	11 ± 1	15 ± 2	12 ± 2	13 ± 2	15 ± 2	13 ± 2	11 ± 1	15 ± 2	13 ± 2
	05/27-06/03	14 ± 2 (5)	16 ± 2	16 ± 2	16 ± 2	15 ± 2	17 ± 2	17 ± 2	15 ± 2	15 ± 2	16 ± 2
JUN	06/03-06/10	6.6 ± 1.4 (6)	6.0 ± 1.2	5.6 ± 1.2	6.0 ± 1.3	4.9 ± 1.2	7.3 ± 1.2	5.9 ± 1.3	7.1 ± 1.3	5.5 ± 1.2	6.3 ± 1.3
	06/10-06/17	6.4 ± 1.3	6.8 ± 1.2	6.6 ± 1.3	6.7 ± 1.3	8.0 ± 1.4	7.6 ± 1.3	7.0 ± 1.4	6.7 ± 1.3	7.3 ± 1.4	7.8 ± 1.4
	06/17-06/24	9.1 ± 1.5	8.0 ± 1.5	9.3 ± 1.4	9.9 ± 1.5	10 ± 2	10 ± 1	9.3 ± 1.5	9.1 ± 1.4	8.5 ± 1.4	12 ± 2
	06/24-06/30	12 ± 2	12 ± 2	10 ± 2	12 ± 2	13 ± 2	12 ± 2	12 ± 2	11 ± 2	14 ± 2	13 ± 2

TABLE I-8

GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in E-03 pCi/Cu.M. ±2S

MONTH	COLLECTION DATE (1)	8G1	6G1	3S2	5S4	12S1	13S6	9B1	7S7	10S3	12E1
JUL	06/30-07/08	11 ± 1	11 ± 1	12 ± 1	12 ± 1	10 ± 1	12 ± 1	11 ± 1	12 ± 1	11 ± 1	11 ± 1
	07/08-07/15	12 ± 2	13 ± 1	13 ± 2	13 ± 2	14 ± 2	14 ± 2	14 ± 2	12 ± 2	11 ± 2	13 ± 2
	07/15-07/22	19 ± 2	20 ± 2	18 ± 2	19 ± 2	19 ± 2	21 ± 2	21 ± 2 (7)	20 ± 2	21 ± 2	20 ± 2
	07/22-07/29	16 ± 2	15 ± 2	17 ± 2	15 ± 2	18 ± 2	16 ± 2	15 ± 2	18 ± 2	15 ± 2	16 ± 2
AUG	07/29-08/05	12 ± 2	13 ± 2	14 ± 2	14 ± 2	13 ± 2	12 ± 1	13 ± 2	14 ± 2	12 ± 2	13 ± 2
	08/05-08/12	12 ± 1 (8)	14 ± 2	16 ± 2	14 ± 2	15 ± 2	15 ± 2	16 ± 2	14 ± 2	13 ± 2	14 ± 2
	08/12-08/19	12 ± 2	12 ± 2 (9)	13 ± 2	13 ± 2	13 ± 2	13 ± 1	15 ± 2	13 ± 2	13 ± 2	13 ± 2
	08/19-08/26	19 ± 2	20 ± 2	19 ± 2	18 ± 2	21 ± 2	19 ± 2	18 ± 2	17 ± 2	19 ± 2	22 ± 2
	08/26-09/02	16 ± 2	13 ± 2	13 ± 2	13 ± 2	15 ± 2	15 ± 2 (10)	16 ± 2	14 ± 2	14 ± 2	15 ± 2
SEP	09/02-09/09	20 ± 2	18 ± 2	18 ± 2	16 ± 2	16 ± 2	17 ± 2	17 ± 2	18 ± 2	16 ± 2	18 ± 2
	09/09-09/16	24 ± 2	23 ± 2	22 ± 2	21 ± 2	21 ± 2	27 ± 2	25 ± 2	23 ± 2	22 ± 2	26 ± 2
	09/16-09/23	17 ± 2	17 ± 2	18 ± 2	18 ± 2	17 ± 2	20 ± 2	20 ± 2	16 ± 2	17 ± 2	18 ± 2
	09/23-09/30	20 ± 2	16 ± 2	17 ± 2	16 ± 2	18 ± 2	20 ± 2	18 ± 2	17 ± 2	18 ± 2	18 ± 2
OCT	09/30-10/06	9.7 ± 1.6	11 ± 2	12 ± 2	12 ± 2	13 ± 2	13 ± 2	11 ± 2	11 ± 2	11 ± 2	11 ± 2
	10/06-10/13	5.5 ± 1.3	5.1 ± 1.2	7.3 ± 1.3	6.5 ± 1.3	6.7 ± 1.4	6.4 ± 1.3	6.8 ± 1.4	6.8 ± 1.3	7.3 ± 1.4	6.1 ± 1.3
	10/13-10/20	15 ± 2	16 ± 2	16 ± 2	16 ± 2	15 ± 2	17 ± 2	16 ± 2	16 ± 2	15 ± 2	17 ± 2
	10/20-10/28	14 ± 1	14 ± 1	17 ± 2	16 ± 1	14 ± 2	18 ± 2	16 ± 2	14 ± 1	15 ± 1	17 ± 2
	10/28-11/04	9.1 ± 1.3	9.7 ± 1.3	11 ± 1	11 ± 1	11 ± 1	13 ± 2	11 ± 1	10 ± 1	11 ± 1	11 ± 1
NOV	11/04-11/11	7.7 ± 1.5	5.7 ± 1.4	8.5 ± 1.5	6.4 ± 1.8 (11)	17 ± 1.5	8.9 ± 1.6	8.7 ± 1.6	9.1 ± 1.8	7.4 ± 1.5	8.6 ± 1.5
	11/11-11/18	22 ± 2	23 ± 2	23 ± 2	24 ± 2 (12)	23 ± 2	27 ± 2 (14)	27 ± 2	26 ± 3 (13)	24 ± 2	25 ± 2
	11/18-11/25	4 ± 2	15 ± 2	16 ± 2	18 ± 2	14 ± 2	15 ± 2	15 ± 2	16 ± 2 (15)	14 ± 2	16 ± 2
	11/25-12/02	19 ± 2	22 ± 2	21 ± 2	21 ± 2	21 ± 2	24 ± 2	24 ± 2	22 ± 2	21 ± 2	22 ± 2
DEC	12/02-12/09	6 ± 2	18 ± 2	20 ± 2	19 ± 2	18 ± 2	21 ± 2	20 ± 2	20 ± 2	19 ± 2	16 ± 2
	12/09-12/16	21 ± 2	16 ± 2	17 ± 2	19 ± 2	19 ± 2	21 ± 2	20 ± 2	19 ± 2	19 ± 2	18 ± 2
	12/16-12/22	14 ± 2	13 ± 2	18 ± 2	15 ± 2 (16)	18 ± 2	18 ± 2	19 ± 2	18 ± 2	18 ± 2	17 ± 2
	12/22-12/30	21 ± 2	22 ± 2	25 ± 2	25 ± 2	22 ± 2	26 ± 2	28 ± 2	24 ± 2	23 ± 2	27 ± 2

GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Comments

1. Sampling periods from some sampling locations may vary by a day or two at both the beginnings and ends of the periods from those dates presented in this table. The dates presented in this table were selected because they represented the sampling periods for most of the sampling locations.

2. Electric power to the sampling station at monitoring location 8G1 was lost on 1/23/98 as indicated by the station's electrical timer. An abnormally small volume of air (6900 ft^3) was sampled as a result of the loss of electrical power.

3. Electric power to me sampling station at monitoring location 8G1 was restored on 1/29/98 at 1000. Because of the power failure, only 4910 ft^3 of air was sampled for the period.

4. An abnormally small volume (15330 ft^3) of air was sampled at monitoring location 13S6 from the period from 2/18/98 through 2/25/98 because of poor suction by the air sampling pump. The pump was replaced at the end of the sampling period.

5. Electric power to the sampling station at monitoring location 8G1 for the period 5/27/98 through 6/3/98 was interrupted for maintenance by PP&L personnel. Sampling personnel found the sampling equipment to be inoperative. The electrical timer indicated that sampling occurred for a period of 164.9 hours. The stop date and time for the sampler were estimated from the timer reading and the start date and time.

6. Electricity was restored to the sampling station at monitoring location 8G1 at 1100 on 6/4/98. The start time was calculated based on the timer reading and the stop date and time. Thunderstorms may have led to brief power outages at some of the 10 air sampling locations for the period 6/3/98 through 6/10/98.

7. The actual sampling duration in hours for the sampler at monitoring location 9B1 for the period from 7/15/98 through 7/22/98 was calculated from the start and stop dates and times because the electrical timer was indicating a very high number. The electrical timer was replaced.

8. The duration of sampling at monitoring location 8G1 for the period from 8/4/98 through 8/12/98 was eight days and seven tenths of an hour. This exceeded the acceptable sampling duration of 7 days $\pm$ 1 day required by procedure. This was not an exception to the Technical Specification requirement that permits a grace period of $\pm$ 25% of the required interval.

9. Air sampling was suspended from 1330 to 1430 on 8/19/98 at monitoring location 6G1 for replacement of the air sampling enclosure.

10. Air sampling was suspended from 0950 to 1025 on 8/27/98 at monitoring location 13S6 for replacement of the air sampling enclosure.

11. Air sampling at monitoring location 5S4 was terminated, prematurely, at 1100 on 11/9/98 by an interruption of the electric power to the station. As a result of this, a lower than normal volume (17300 ft^3) of air was sampled for the period.

GROSS BETA ANALYSES OF AIR PARTICULATE FILTERS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Comments continued

12. Electric power to the air sampling station at monitoring location 5S4 was restored at 11:30 on 11/12/98.

13. A lower than normal volume (12420 ft^3) of air was sampled at monitoring location 7S7 for the period 11/11/98 through 11/18/98 due to unsatisfactory operation of the air sampling pump. The pump was replaced.

14. The actual sampling duration in hours for the sampler at monitoring location 13S6 for the period 11/11/98 through 11/18/98 was calculated from the start and stop dates and times because the electrical timer was not operating properly. The electrical timer was replaced.

15. A lower than normal volume (16440 ft^3) of air was sampled at monitoring location 7S7 for the period 11/18/98 through 11/25/98.

16. A lower than normal volume (17200 ft^3) of air was sampled at monitoring location 5S4 for the period 12/16/98 through 12/22/98.

TABLE I-9

GAMMA* SPECTROSCOPIC ANALYSES OF COMPOSITED AIR PARTICULATE FILTERS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in E-03 pCi/Cu. M. ± 2S

LOCATION	COLLECTION DATE	Be-7	K-40	OTHER ACTIVITY
6G1	12/29/97-03/31/98	111 ± 11		
8G1	12/29/97-03/31/98	93.9 ± 9.4		
7S7	12/29/97-03/31/98	122 ± 12		
10S3	12/29/97-03/31/98	107 ± 11		
3S2	12/29/97-03/31/98	96.9 ± 9.7	3.65 ± 1.93	
5S4	12/29/97-03/31/98	99.2 ± 9.9		
9B1	12/29/97-03/31/98	222 ± 22		
12E1	12/29/97-03/31/98	133 ± 13		
12S1	12/29/97-03/31/98	102 ± 10		
13S6	12/29/97-03/31/98	117 ± 12		
6G1	03/31/98-06/30/98	114 ± 11	3.49 ± 1.74	
8G1	03/31/98-06/30/98	136 ± 14	2.53 ± 1.29	
7S7	03/31/98-06/30/98	145 ± 14	3.59 ± 1.81	
10S3	03/31/98-06/30/98	118 ± 12	2.72 ± 1.45	
3S2	03/31/98-06/30/98	108 ± 11		
5S4	03/31/98-06/30/98	114 ± 11		
9B1	03/31/98-06/30/98	135 ± 14		
12E1	03/31/98-06/30/98	121 ± 12		
12S1	03/31/98-06/30/98	150 ± 15		
13S6	03/31/98-06/30/98	113 ± 11		

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-9

GAMMA* SPECTROSCOPIC ANALYSES OF COMPOSITED AIR PARTICULATE FILTERS

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in E-03 pCi/Cu. M. ± 2S

LOCATION	COLLECTION DATE	Be-7	K-40	OTHER ACTIVITY
6G1	06/30/98-09/29/98	137 ± 14		
8G1	06/30/98-09/29/98	158 ± 16		
7S7	06/30/98-09/29/98	138 ± 14		
10S3	06/30/98-09/29/98	136 ± 14		
3S2	06/30/98-09/29/98	127 ± 13	3.03 ± 1.48	
5S4	06/30/98-09/29/98	154 ± 15		
9B1	06/30/98-09/29/98	143 ± 14		
12E1	06/30/98-09/29/98	157 ± 16		
12S1	06/30/98-09/29/98	147 ± 15		
13S6	06/30/98-09/29/98	134 ± 13		
6G1	09/30/98-12/30/98	92.9 ± 9.3		
8G1	09/30/98-12/30/98	83.3 ± 8.3		
7S7	09/30/98-12/30/98	96.4 ± 9.6		
10S3	09/30/98-12/30/98	101 ± 10	3.40± 1.58	
3S2	09/30/98-12/30/98	101 ± 10		
5S4	09/30/98-12/30/98	91.5 ± 9.2		
9B1	09/30/98-12/30/98	124 ± 12		
12E1	09/30/98-12/30/98	109 ± 11		
12S1	09/30/98-12/30/98	99.1 ± 9.9		
13S6	09/30/98-12/30/98	104 ± 10		

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-10

IODINE-131, AND GAMMA* SPECTROSCOPIC ANALYSES OF MILK

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	K-40	OTHER ACTIVITY	COMMENTS
10G1	01/06/98	1390 ± 140		
10D1	01/06/98	1240 ± 120		
10D2	01/06/98	1380 ± 140		
12B3	01/06/98	1290 ± 130		
10G1	02/03/98	1260 ± 130		
10D1	02/03/98	1500 ± 150		
10D2	02/03/98	1410 ± 140		
12B3	02/03/98	1240 ± 120		
10G1	03/03/98	1330 ± 130		
10D1	03/03/98	1350 ± 140		
10D2	03/03/98	1310 ± 130		
12B3	03/03/98	1180 ± 120		
10G1	04/06/98	1440 ± 140		
10D1	04/06/98	1530 ± 150		
10D2	04/06/98	1390 ± 140		
12B3	04/06/98	1270 ± 130		
10G1	04/20/98	1420 ± 140		
10D1	04/20/98	1090 ± 110		
10D2	04/20/98	1420 ± 140		
12B3	04/20/98	1260 ± 130		
10G1	05/04/98	1330 ± 130		
10D1	05/04/98	1260 ± 130		
10D2	05/04/98	1280 ± 130		
12B3	05/04/98	1180 ± 120		
10G1	05/18/98	1370 ± 140		
10D1	05/18/98	1370 ± 140		
10D2	05/18/98	1330 ± 130		
12B3	05/18/98	1310 ± 130		

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-10

IODINE-131, AND GAMMA* SPECTROSCOPIC ANALYSES OF MILK

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	K-40	OTHER ACTIVITY	COMMENTS
10G1	06/01/98	1420 ± 140		
10D1	06/01/98	1390 ± 140		
10D2	06/01/98	1310 ± 130		
12B3	06/01/98	1280 ± 130		
10G1	06/17/98	1340 ± 130		
10D1	06/17/98	1300 ± 130		
10D2	06/18/98	1260 ± 130		
12B3	06/18/98	1230 ± 120		
10G1	07/07/98	1510 ± 150		
10D1	07/07/98	1360 ± 140		
10D2	07/07/98	1470 ± 150		
12B3	07/07/98	1250 ± 130		
10G1	07/21/98	1320 ± 130		
10D1	07/21/98	1260 ± 130		
10D2	07/21/98	1260 ± 130		
12B3	07/21/98	1250 ± 120		
10G1	08/04/98	1350 ± 140		
10D1	08/04/98	1370 ± 140		
10D2	08/04/98	1240 ± 120		
12B3	08/04/98	1120 ± 110		
10G1	08/18/98	1250 ± 130		
10D1	08/18/98	1330 ± 130		
10D2	08/18/98	1220 ± 120		
12B3	08/18/98	1180 ± 120		
10G1	09/01/98	1370 ± 140		
10D1	09/01/98	1400 ± 140		
10D2	09/01/98	1350 ± 140		
12B3	09/01/98	1270 ± 130		

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-10

IODINE-131, AND GAMMA* SPECTROSCOPIC ANALYSES OF MILK

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/liter ± 2S

LOCATION	COLLECTION DATE	K-40	OTHER ACTIVITY	COMMENTS
10G1	09/17/98	1410 ± 140		
10D1	09/16/98	1480 ± 150		
10D2	09/17/98	1260 ± 130		
12B3	09/17/98	1220 ± 120		
10G1	10/05/98	1360 ± 140		
10D1	10/04/98	1230 ± 120		
10D2	10/05/98	1400 ± 140		
12B3	10/05/98	1320 ± 130		
10G1	10/19/98	1240 ± 120		
10D1	10/19/98	1270 ± 130		
10D2	10/19/98	1310 ± 130		
12B3	10/19/98	1310 ± 130		
10G1	11/02/98	1280 ± 130		
10D1	11/02/98	1380 ± 140		
10D2	11/02/98	1270 ± 130		
12B3	11/02/98	1260 ± 130		
10G1	12/08/98	1350 ± 140		
10D1	12/08/98	1350 ± 130		
10D2	12/08/98	1410 ± 140		
12B3	12/08/98	No Sample Collected		(1)

Comments

1. A milk sample could not be collected at monitoring location 12B3 because the farmer sold his cows.

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-11

GAMMA* SPECTROSCOPIC ANALYSES OF SOIL

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/gm (dry) ± 2S

LOCATION	COLLECTION DATE	K-40	Cs-137	Ra-226	Th-228
8G1 TOP	09/21/98	9.66 ± 0.97	0.18 ± 0.03	1.51 ± 0.42	0.72 ± 0.07
8G1 BOT	09/21/98	9.10 ± 0.91	0.13 ± 0.03	1.62 ± 0.47	0.67 ± 0.07
3S2 TOP	09/21/98	15.7 ± 1.6	0.1 ± 0.03	1.73 ± 0.56	1.23 ± 0.12
3S2 BOT	09/21/98	15.7 ± 1.6	0.05 ± 0.02	1.62 ± 0.44	0.92 ± 0.09
12S1 TOP	09/21/98	8.86 ± 0.89	0.06 ± 0.03	1.09 ± 0.44	0.75 ± 0.08
12S1.BOT	09/21/98	9.54 ± 0.95	0.05 ± 0.02	1.25 ± 0.34	0.69 ± 0.07
13S6 TOP	09/21/98	13.1 ± 1.3		0.99 ± 0.51	0.86 ± 0.09
13S6 BOT	09/21/98	12.6 ± 1.3		1.24 ± 0.53	0.77 ± 0.08

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-12

GAMMA* SPECTROSCOPIC ANALYSES OF FOOD PRODUCTS (FRUITS AND VEGETABLES)

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/gm (wet) ± 2S

LOCATION	SAMPLE TYPE	COLLECTION DATE	K-40	OTHER ACTIVITY
13G2	Green Beans	07/14/98	1.52 ± 0.15	
14B3	Beans	07/28/98	3.34 ± 0.33	
13G2	Cabbage	10/06/98	2.04 ± 0.20	
10B5	Cabbage	07/07/98	1.87 ± 0.19	
14B3	Cabbage	07/28/98	1.58 ± 0.16	
11D1	Cabbage	08/24/98	2.52 ± 0.25	
13G2	Corn	08/18/98	3.07 ± 0.31	
11D1	Corn	08/11/98	2.12 ± 0.21	
12S7	Corn	08/11/98	2.39 ± 0.24	
14B3	Corn	08/11/98	2.97 ± 0.30	
9B4	Corn	08/18/98	3.41 ± 0.34	
10B5	Corn	08/18/98	3.26 ± 0.33	
11D1	Cucumber	07/28/98	2.14 ± 0.21	
14B3	Cucumber	07/28/98	1.62 ± 0.16	
10B5	Cucumber	07/28/98	1.58 ± 0.16	
10B5	Lettuce	07/07/98	3.86 ± 0.39	Be-7 0.21 ± 0.08
13G2	Onion	07/14/98	1.26 ± 0.13	
14B3	Onion	08/11/98	1.83 ± 0.18	
10B5	Peppers	09/21/98	1.56 ± 16	
12S7	Peppers	09/21/98	0.89 ± 0.9	
13G2	Potatoes	10/06/98	4.19 ± 0.42	
10B5	Potatoes	07/07/98	4.38 ± 0.44	
12F7	Potatoes	08/24/98	3.43 ± 0.34	

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-12

GAMMA* SPECTROSCOPIC ANALYSES OF FOOD PRODUCTS (FRUITS AND VEGETABLES)

SUSQUEHANNA STEAM ELECTRIC STATION - 1998

Results in pCi/gm (wet) ± 2S

LOCATION	SAMPLE TYPE	COLLECTION DATE	K-40	OTHER ACTIVITY
13G2	Pumpkin	10/06/98	1.56 ± 0.16	
12S7	Pumpkin	09/21/98	2.13 ± 0.21	
11D1	Pumpkin Irr	09/21/98	1.35 ± 0.13	
13G2	Red Beet	07/14/98	4.09 ± 0.41	
13G2	Tomatoes	08/18/98	2.69 ± 0.27	
10B5	Tomatoes	07/28/98	2.77 ± 0.28	
11D1	Tomatoes	08/11/98	2.10 ± 0.21	
13B2	Tomatoes	08/18/98	1.95 ± 0.20	
9B4	Tomatoes	09/21/98	2.68 ± 0.27	
13G2	Zucchini	07/14/98	1.60 ± 0.16	
9B4	Zucchini	07/28/98	1.72 ± 0.17	
13B2	Zucchini	08/11/98	1.40 ± 0.14	

* Gamma emitters are only reported when activities exceed the MDC's: typical MDC values are found in Table I-13.

TABLE I-13

TYPICAL * MINIMUM DETECTABLE CONCENTRATIONS OF NUCLIDES SEARCHED FOR BUT NOT FOUND BY GAMMA SPECTROMETRY

IN THE VICINITY OF SUSQUEHANNA STEAM ELECTRIC STATION, 1998

Nuclide	Fish (pCi/g wet)	Sediment (pCi/g dry)	Surface Water (pCi/l)	Ground Water (pCi/l)	Potable Water (pCi/l)
Mn-54	0.024	0.051	4.0	4.2	3.6
Co-58	0.024	0.047	4.1	4.2	4.2
Fe-59	0.045	0.100	8.8	8.9	8.7
Co-60	0.025	0.050	4.3	4.3	4.4
Zn-65	0.049	0.110	9.0	9.7	8.6
Zr-95	0.042	0.108	8.9	8.8	8.7
Nb-95	0.025	0.061	4.3	4.7	4.3
Ru-103	0.026	0.058	4.9	4.8	4.9
I-131**	0.044	0.117	0.3	8.1	0.3
Cs-134	0.026	0.070	4.6	4.7	4.4
Cs-137	0.026	0.069	4.9	4.9	4.6
Ba-140	0.077	0.241	20	14	20
La-140	0.030	0.095	9.4	6.2	7.2
Ce-141	0.034	0.084	7.9	7.8	8.4

Nuclide	Air Particulate (10-3 pCi/m3)	Milk (pCi/l)	Fruit/Veg. (pCi/g wet)	Soil (pCi/g dry)
Mn-54	0.35	4.3	0.009	0.041
Co-58	0.65	4.4	0.010	0.037
Fe-59	2.59	9.4	0.026	0.085
Co-60	0.32	4.7	0.010	0.041
Zn-65	0.77	10	0.028	0.105
Zr-95	1.39	7.5	0.023	0.090
Nb-95	0.78	4.5	0.010	0.047
Ru-103	1.15	4.6	0.010	0.040
I-131**	0.01	0.2	0.020	0.067
Cs-134	0.30	4.7	0.010	0.047
Cs-137	0.31	4.9	0.010	0.054
Ba-140	233	13	0.038	0.111
La-140	98	5.6	0.016	0.065
Ce-141	3.1	7.7	0.016	0.067

* Typical refers to mean plus two standard deviations.

** Iodine-131 in surface water, potable water and milk is determined by radiochemical methods. Iodine-131 in air is collected on charcoal and measured by gamma spectrometry. See appendix E-13.

APPENDIX J

PERFORMANCE SUMMARY FOR THE RADIOANALYSES OF SPIKED ENVIRONMENTAL SAMPLE MEDIA - 1998

TELEDYNE BROWN ENGINEERING
&
PP&L, INC.
CORPORATE ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS LABORATORY RESULTS

The data in the tables that follows show how well Teledyne performed in the analysis of radioactively spiked environmental sample media. Table J-1 permits an evaluation of Teledyne's performance in the analyses of spiked samples supplied by the EPA relative to the EPA and other participants in the "EPA Environmental Radioactivity Performance Evaluation Studies Program" during 1998.

Table J-2 shows the agreement of Teledyne's analysis results with the levels of radioactivity reported by Analytics, Inc., for spiked samples procured by Teledyne as part of its QC Spike Program. Table J-3 presents the analysis results of Teledyne and the levels of radioactivity reported by Analytics for spiked environmental sample media procured from Analytics by PP&L as part of its quality control for the PP&L Radiological Environmental Monitoring Program (REMP). The spiked samples represented in both Tables J-2 and J-3 are prepared by Analytics as part of its Environmental Radioactivity Cross Check Program. The spiked sample analysis results in Table J-4 are for tritium analyses performed by PP&L's Corporate Environmental Radioactivity Measurements Laboratory (CERML), which performs the primary analyses for tritium in surface water, drinking water and ground water samples collected for the REMP.

TABLE J-1

EPA ENVIRONMENTAL RADIOACTIVITY PERFORMANCE EVALUATION STUDIES PROGRAM - 1998

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

(Page 1 of 2)

Collection Date	Sequence No.	Media	Nuclide	EPA Results(a)	Teledyne Brown Eng. Results(b)	Normalized Deviation Grand Avg.	Normalized Deviation Known	All Participants Mean ± 2 s.d.
01/16/98	708	Water	Sr-89	8.0 ± 8.66	5.00 ± 5.19	-1.50	-1.04	11.78 ± 8.16
			Sr-90	32.0 ± 8.66	31.67 ± 1.74	0.75	0.12	23.52 ± 7.40
01/30/98	707	Water	Gr-Alpha	30.5 ± 13.16	33.0 ± 7.95	2.65	0.57	21.36 ± 11.99
			Gr-Beta	3.9 ± 8.66	5.60 ± 2.7	-0.64	0.59	7.44 ± 5.18
02/06/98	706	Water	I-131	104.9 ± 18.19	110.00 ± 0.00	0.70	0.84	105.74 ± 10.86
03/13/98	710	Water	H-3	2155.0 ± 602.8	1833.33 ± 173.22	-1.62	-1.60	2159.47 ± 468.40
04/21/98	711	Water	Gr-Beta	94.7 ± 17.32	102.00 ± 19.68	0.74	1.26	97.73 ± 19.53
			Sr-89	6.0 ± 8.66	4.67 ± 3.45	-0.51	-0.46	6.15 ± 5.06
			Sr-90	18.0 ± 8.66	21.67 ± 3.45	1.59	1.27	17.06 ± 5.50
			Co-60	50.0 ± 8.66	52.33 ± 4.59	0.93	0.81	49.65 ± 4.50
			Cs-134	22.0 ± 8.66	21.00 ± 3.00	0.09	-0.35	20.74 ± 4.58
			Cs-137	10.0 ± 8.66	11.67 ± 1.74	0.29	0.58	10.82 ± 3.44
			Gr-Alpha	54.4 ± 23.55	50.00 ± 5.19	-0.42	-0.56	53.26 ± 19.46
06/05/98	712	Water	Co-60	12.0 ± 8.66	13.00 ± 3.00	0.09	0.35	12.74 ± 3.62
			Zn-65	104.0 ± 17.32	111.67 ± 7.56	0.56	1.33	108.45 ± 15.08
			Cs-134	31.0 ± 8.66	32.33 ± 1.74	1.35	0.46	28.42 ± 4.32
			Cs-137	35.0 ± 8.66	35.67 ± 6.24	0.53	0.92	36.15 ± 4.12
			Ba-133	40.0 ± 8.66	35.00 ± 7.95	-1.08	-1.73	38.11 ± 5.68
07/24/98	714	Water	Gr-Alpha	7.2 ± 8.66	5.43 ± 1.92	-0.64	-0.61	7.27 ± 3.96
			Gr-Beta	12.8 ± 8.66	14.67 ± 6.24	0.50	0.65	13.23 ± 5.84
07/17/98	716	Water	Sr-89	21.0 ± 8.66	21.00 ± 3.00	0.16	0.00	20.53 ± 7.00
			Sr-90	7.0 ± 8.66	6.33 ± 1.74	-0.17	-0.23	6.82 ± 3.60
08/07/98	715	Water	H-3	17996.0 ± 3117.7	16000.00 ± 0.00	-1.80	-1.92	17874.29 ±2389.17
09/11/98	717	Water	I-131	6.1 ± 3.46	5.93 ± 1.65	-0.66	-0.14	6.70 ± 2.34

TABLE J-1

EPA ENVIRONMENTAL RADIOACTIVITY PERFORMANCE EVALUATION STUDIES PROGRAM - 1998

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Collection Date	Sequence No.	Media	Nuclide	EPA Results(a)	Teledyne Brown Eng. Results(b)	Normalized Deviation Grand Avg.	Normalized Deviation Known	All Participants Mean ± 2 s.d.	
11/13/97	721	Water	Gr-Alpha						(e)
			Gr-Beta						(e)
10/20/98	720	Water	Gr-Beta	94.0 ± 17.32	74.67 ± 22.92	-3.38	-3.35	134.27 ± 29.98	(c)
			Sr-89	19.0 ± 8.66	18.33 ± 4.59	0.03	-0.23	35.30 ± 11.82	
			Sr-90	8.0 ± 8.66	8.33 ± 3.45	0.38	0.12	21.53 ± 6.58	
			Co-60	21.0 ± 8.66	22.33 ± 3.45	0.19	0.46	10.46 ± 3.62	
			Cs-134	6.0 ± 8.66	6.67 ± 3.45	0.09	0.23	37.83 ± 5.74	
			Cs-137	50.0 ± 8.66	56.33 ± 11.37	1.89	2.19	35.51 ± 4.80	(d)
			Gr-Alpha	30.1 ± 12.99	21.67 ± 6.93	-0.93	-1.95	30.01 ± 10.30	
11/11/98	719	Water	Co-60	38.00 ± 8.66	39.67 ± 7.56	0.52	0.58	38.17 ± 4.76	
			Zn-65	131.0 ± 22.51	140.97 ± 32.91	0.46	1.29	137.21 ± 15.30	
			Cs-134	105.0 ± 8.66	103.00 ± 6.00	2.04	-0.69	97.11 ± 12.28	
			Cs-137	111.0 ± 10.39	115.33 ± 4.59	0.56	1.25	113.38 ± 10.84	
			Ba-133	56.0 ± 10.39	46.33 ± 6.65	-1.96	-2.79	53.11 ± 7.28	(d)

Footnotes:

(a) EPA Results - Expected laboratory precision (3 sigma). Units are pCi/liter for water and milk except K is in mg/liter. Units are total pCi for air particulate filters.

(b) Teledyne Results - Average ± 3 sigma. Units are pCi/liter for water and milk except K is in mg/liter. Units are total pCi for air particulate filters.

(c) The special EPA instructions concerning multiple evaporation with concentrated nitric acid (to purge chlorides derived from HCl preservative) were omitted by oversight. The chlorides cause greater self absorption and lead to lower results. Two additional aliquots using two evaporations with concentrated nitric acid were analyzed. The results, when corrected for decay of Sr-89, were 87 and 83 pCi/liter which compare favorably with the EPA result.

(d) An investigation is being conducted; results will be available shortly.

(e) The gross alpha, gross beta in water results sequence number 721 were not published at printing time. Results will be included in the 1999 Annual Report.

TABLE J-2

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1998

TELEDYNE QC SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Collection Date	Identification No.	Media	Nuclide	Analytics Results (b)	Teledyne Brown Eng. Results(a)	Ratio (c)
03/12/98	E1346-396 TI#71657	Milk	I-131	82 ± 4	87 ± 9	1.06
			Ce-141	70 ± 4	66 ± 7	0.94
			Cr-51	201 ± 10	220 ± 30	1.09
			Cs-134	84 ± 4	85 ± 9	1.01
			Cs-137	161 ± 8	180 ± 20	1.12
			Mn-54	133 ± 7	130 ± 10	0.98
			Fe-59	95 ± 5	110 ± 10	1.16
			Zn-65	142 ± 7	160 ± 20	1.13
			Co-60	85 ± 4	82 ± 8	0.96
06/11/98	E1460-396 TI#78921	Milk	I-131	67 ± 3	68 ± 7	1.01
			Ce-141	99 ± 5	94 ± 9	0.95
			Cr-51	132 ± 7	97 ± 31	0.73
			Cs-134	95 ± 5	101 ± 10	1.06
			Cs-137	70 ± 4	79 ± 8	1.13
			Mn-54	106 ± 5	112 ± 11	1.06
			Fe-59	45 ± 2	58 ± 9	1.29
			Zn-65	122 ± 6	143 ± 14	1.17
			Co-60	143 ± 7	157 ± 16	1.10
12/14/98	E1630-396 TI#94881	Milk	I-131	71 ± 4	65 ± 1	0.92
			Ce-141	746 ± 37	647 ± 65	0.87
			Cr-51	979 ± 49	900 ± 90	0.92
			Cs-134	220 ± 11	200 ± 20	0.91
			Cs-137	183 ± 9	177 ± 18	0.97
			Mn-54	142 ± 7	136 ± 14	0.96
			Fe-59	148 ± 7	156 ± 16	1.05
			Zn-65	140 ± 7	132 ± 14	0.94
			Co-60	178 ± 9	169 ± 17	0.95
			Sr-89	69 ± 3	20 ± 2	0.29 (d)
			Sr-90	41 ± 2	16 ± 1	0.39 (d)
12/14/98	E1631-396 TI#94882	Filter	Ce-141	524 ± 26	566 ± 57	1.08
			Cr-51	687 ± 49	800 ± 80	1.16
			Cs-134	154 ± 8	147 ± 15	0.95
			Cs-137	128 ± 6	158 ± 16	1.23
			Mn-54	100 ± 5	122 ± 12	1.22
			Fe-59	104 ± 5	134 ± 13	1.29
			Zn-65	98 ± 5	129 ± 13	1.32
			Co-60	125 ± 6	134 ± 13	1.07

TABLE J-2

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1998

TELEDYNE QC SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Collection Date	Identification No.	Media	Nuclide	Analytics Results (b)	Teledyne Brown Eng. Results(a)	Ratio (c)
12/14/98	E1632-396 TI#94883	Water	H-3	5980 ± 299	5500 ± 200	0.92
12/14/98	E1633-396 TI#94884	Water	Am-241	7.9 ± 0.4	8.3 ± 1.5	1.05
			Pu-239	8.9 ± 0.4	9.8 ± 1.8	1.10

Footnotes:

(a) Teledyne Results - counting error is two standard deviations. Units are pCi/liter for water and milk. For gamma results, if two standard deviations are less than 10%, then a 10% error is reported. Units are total pCi for air particulate filters.

(b) Analytics Results - counting error is three standard deviations. Units are pCi/liter for water and milk. Units are total pCi for air particulate filters.

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

(d) An investigation is being conducted; will be available shortly

TABLE J-3

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1998

PP&L QC SPIKE PROGRAM

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Collection Date	Identification No.	Media	Nuclide	Analytics Calculated Results (b)	Teledyne Brown Eng. Results(a)	Ratio (c)
Sept/1998	E1550-186	Milk	I-131	90 ± 4	100 ± 10	1.11
Dec/1998	E1617-186	Milk	I-131	71 ± 3	72 ± 10	1.01
Sept/1998	E1550-186	Milk	Ce-141	204 ± 7	197 ± 20	0.97
			Cr-51	260 ± 9	232 ± 39	0.89
			Cs-134	115 ± 4	118 ± 12	1.03
			Cs-137	188 ± 6	198 ± 20	1.05
			Mn-54	104 ± 4	109 ± 11	1.05
			Fe-59	88 ± 3	98 ± 11	1.11
			Zn-65	273 ± 9	289 ± 29	1.06
			Co-60	206 ± 7	215 ± 21	1.03
Dec/1998	E1617-186	Milk	Ce-141	746 ± 25	670 ± 70	0.90
			Cr-51	979 ± 33	880 ± 90	0.90
			Cs-134	220 ± 7	210 ± 20	0.95
			Cs-137	183 ± 6	170 ± 20	0.93
			Mn-54	142 ± 5	140 ± 10	0.99
			Fe-59	148 ± 5	150 ± 10	1.01
			Zn-65	140 ± 5	130 ± 10	0.93
			Co-60	178 ± 6	160 ± 20	0.90

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Collection Date	Identification No.	Media	Nuclide	Analytics Calculated Results (b)	Teledyne Brown Eng. Results(a)	Ratio (c)	
Aug/1998	E1495-186	AP Filter	Ce-141	291 ± 10	366 ± 37	1.26	(d)
			Cr-51	418 ± 14	516 ± 52	1.23	
			Cs-134	88 ± 3	96 ± 95	1.09	
			Cs-137	139 ± 5	176 ± 18	1.27	(d)
			Mn-54	82 ± 3	110 ± 11	1.35	(d)
			Fe-59	105 ± 4	146 ± 15	1.39	(d)
			Zn-65	220 ± 7	296 ± 30	1.35	(d)
			Co-60	155 ± 5	178 ± 18	1.15	
Aug/1998	E1496-186	AP Filter	Ce-141	355 ± 12	347 ± 35	0.98	
			Cr-51	510 ± 17	489 ± 49	0.96	
			Cs-134	107 ± 4	91 ± 9	0.85	
			Cs-137	169 ± 6	168 ± 17	0.99	
			Mn-54	100 ± 4	110 ± 11	1.10	
			Fe-59	128 ± 4	130 ± 13	1.02	
			Zn-65	269 ± 9	279 ± 28	1.04	
			Co-60	189 ± 6	177 ± 18	0.94	
Aug/1998	E1497-186	AP Filter	Ce-141	328 ± 11	404 ± 40	1.23	
			Cr-51	471 ± 16	447 ± 45	0.94	
			Cs-134	99 ± 3	102 ± 10	1.03	
			Cs-137	156 ± 5	182 ± 18	1.17	
			Mn-54	93 ± 3	109 ± 11	1.17	
			Fe-59	118 ± 4	148 ± 15	1.25	
			Zn-65	248 ± 8	314 ± 31	1.26	(e)
			Co-60	175 ± 6	201 ± 20	1.15	

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Collection Date	Identification No.	Media	Nuclide	Analytics Calculated Results (b)	Teledyne Brown Eng. Results(a)	Ratio (c)
Mar/1998	E1328-186	Charcoal Filter	I-131	91 ± 4	75 ± 8	0.82
	E1329-186	Charcoal Filter	I-131	94 ± 4	83 ± 8	0.88
	E1330-186	Charcoal Filter	I-131	97 ± 4	84 ± 8	0.87
Aug/1998	E1498-186	Charcoal Filter	I-131	48 ± 2	46 ± 5	0.96
	E1499-186	Charcoal Filter	I-131	55 ± 2	52 ± 5	0.95
	E1500-186	Charcoal Filter	I-131	60 ± 2	65 ± 7	1.08
Dec/1998	E1618-186	Charcoal Filter	I-131	80 ± 3	74 ± 7	0.93
	E1619-186	Charcoal Filter	I-131	87 ± 3	82 ± 8	0.94
	E1620-186	Charcoal Filter	I-131	96 ± 4	85 ± 9	0.89

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TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Collection Date	Identification No.	Media	Nuclide	Analytics Calculated Results (b)	Teledyne Brown Eng. Results(a)	Ratio (c)
Mar/1998	E1331-186	Sediment	Ce-141	134 ± 5	137 ± 34	1.02
			Cr-51	386 ± 13	514 ± 183	1.33 (f)
			Cs-134	162 ± 6	152 ± 25	0.94
			Cs-137	437 ± 15	421 ± 42	0.96
			Mn-54	256 ± 9	244 ± 27	0.95
			Fe-59	183 ± 6	209 ± 46	1.14
			Zn-65	273 ± 9	250 ± 40	0.92
			Co-60	164 ± 6	148 ± 24	0.90

(a) Teledyne Results - counting error is two standard deviations. Units are pCi/liter for water and milk. For gamma results, if two standard deviations are less than 10%, then a 10% error is reported. Units are total pCi for air particulate filters.

(b) Analytics Results - counting error is two standard deviations. Units are pCi/liter for water and milk. Units are total pCi for air particulate filters.

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

(d) No apparent cause for the discrepancy could be determined. Errors in source data were not observed, weekly checks for energy, FWHM and efficiency were in control and the sample was placed in a holder to ensure the geometry was reproduced. This sample was counted twice prior to reporting on another detector. All results from the other detector, except for Zn-65, were in control. Data reviewers have been retrained to request a third analysis if multiple analyses do not provide similar results.

(e) No apparent cause for the discrepancy could be determined. The calibration curve fit was well within the acceptable range. Calibration and sample geometries were reproduced with a sample holder. Results for most nuclides on the filter were in control.

(f) The Cr-51 had a high counting uncertainty (35.6%). If the counting uncertainty is factored into the comparison of the Analytics calculated and Teledyne measured value the results would be in agreement.

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ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM - 1998

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PP&L CORPORATE ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS LABORATORY (CERML)

Collection Date	Identification No.	Media	Nuclide	Analytics Results (b)	CERML Results(a)	Ratio (c)
Sep/1998	E1549-186	Water	H-3	3530 ± 118	3556 ± 102	1.01

Footnotes:

(a) CERML Results - counting error is two standard deviations. Units are pCi/liter for water.

(b) Analytics Results - counting error is two standard deviations. Units are pCi/liter for water.

(c) Ratio of CERML to Analytics results.