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U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Three Mile Island Nuclear Station
Units 1 and 2 (TMI-1 & TMI-2)
Operating License Nos. DPR-50 and DPR-73
Docket Nos. 50-289 and 50-320
1995 Radiological Environmental Monitoring Report

Dear Sir:

In accordance with TMI-1 Technical Specification 6.9.3.1 and TMI-2 Technical Specification 6.8.1.1, enclosed is the 1995 Radiological Environmental Monitoring Report for the Three Mile Island Nuclear Station.

Please contact J. Schork, TMI Regulatory Affairs at (717) 948-8832 if you have any questions regarding this submittal.

Sincerely,

Robert L Long

R. L. Long
Vice President and Director,
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Enclosure

cc: TMI Senior Resident Inspector
NRC Region 1 Regional Administrator

GPU Nuclear

Radiological Environmental Monitoring Report

Three Mile Island Nuclear Generating Station

1995

Prepared by Three Mile Island Environmental Affairs

GPU Nuclear

Radiological Environmental Monitoring Report

Three Mile Island Nuclear Generating Station

1995

Prepared by Three Mile Island Environmental Affairs

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LIST OF ABBREVIATIONS, SYMBOLS AND ACRONYMS

ABBREVIATIONS

cubic feet per second	cfs
cubic meter(s)	m^3
curie(s)	Ci
curie(s) per year	Ci/yr
east	E
east-northeast	ENE
east-southeast	ESE
gram(s)	g
hour(s)	h
liter(s)	L
meter(s)	m
microroentgen(s) per hour	μR/h
mile per hour	mph
millirem(s)	mrem
millirem(s) per hour	mrem/h
millirem(s) per standard month	mrem/std month
millirem(s) per year	mrem/yr
milliroentgen(s)	mR
milliroentgen(s) per hour	mR/h
milliroentgen(s) per standard month	mR/std month
north	N
northeast	NE
northwest	NW
north-northeast	NNE
north-northwest	NNW
percent	%
picocurie(s)	pCi
picocurie(s) per cubic meter	pCi/m^3
picocurie(s) per gram	pCi/g
picocurie(s) per liter	pCi/L
reference(s)	Ref. (Refs.)
rem(s) per year	rem/yr
Roentgen(s)	R
Roentgen(s) equivalent man	rem
south	S
southeast	SE
southwest	SW
south-southeast	SSE
south-southwest	SSW
standard deviation	std dev
standard month	std month
west	W
west-northwest	WNW
west-southwest	WSW
year(s)	yr

ELEMENT SYMBOLS

actinium	Ac
antimony	Sb
argon	Ar
barium	Ba
beryllium	Be
carbon	C
cesium	Cs
chromium	Cr
cobalt	Co
curium	Cm
hydrogen (tritium)	H-3
iodine	I
iron	Fe
krypton	Kr
lanthanum	La
manganese	Mn
niobium	Nb
nitrogen	N
oxygen	O
plutonium	Pu
potassium	K
radium	Ra
radon	Rn
ruthenium	Ru
silver	Ag
strontium	Sr
thorium	Th
tritiated water vapor	HTO
uranium	U
xenon	Xe
zinc	Zn
zirconium	Zr

ACRONYMS

American National Standards Institute . . . . . ANSI

Accident Generated Water . . . . . AGW

as low as reasonably achievable . . . . . ALARA

biological effects of atomic radiation . . . . . BEAR

biological effects of ionizing radiation . . . . . BEIR

borated water storage tank . . . . . BWST

Building 48 . . . . . 48s

Department of Energy . . . . . DOE

East Dike Catch Basin . . . . . EDCB

Federal Radiation Council . . . . . FRC

Final Safety Analysis Report . . . . . FSAR

General Public Utilities Nuclear Corporation . . . . . GPU Nuclear

Groundwater Monitoring Program . . . . GMP

high efficiency particulate air . . . . . HEPA

International Committee on Radiation Protection . . . . . ICRP

lower limit of detection . . . . . LLD

maximum permissible concentration . . . . . MPC

mean sea level . . . . . msl

National Academy of Sciences . . . . . NAS

National Council on Radiation Protection and Measurements . . . . . NCRP

National Institute of Standards and Technology . . . . . NIST

National Voluntary Laboratory Accreditation Program . . . . . NVLAP

Offsite Dose Calculation Manual . . . . ODCM

Operations Support Facility . . . . . OSF

Pennsylvania State Bureau of Radiation Protection . . . . . PaBRP

Post Defueling Monitored Storage . . . PDMS

pressurized water reactor . . . . . PWR

quality assurance . . . . . QA

quality control . . . . . QC

radiological environmental monitoring program . . . . . REMP

Safe Harbor Dam . . . . . SHD

simplified environmental effluent dosimetry system . . . . . SEEDS

thermoluminescent dosimeter . . . . . TLD

Three Mile Island . . . . . TMI

Three Mile Island Nuclear Station . . . . . TMINS

Three Mile Island - Unit 1 . . . . . TMI-1

Three Mile Island - Unit 2 . . . . . TMI-2

Title 10 of the Code of Federal Regulations, Part 20 . . . . . 10 CFR 20

ACRONYMS

Title 10 of the Code of Federal Regulations, Part 50, Appendix I . . . . . 10 CFR 50 App. I

Title 40 of the Code of Federal Regulations, Part 190 . . . . . 40 CFR 190

United Nations Scientific Committee on the Effects of Atomic Radiation . . . . . UNSCEAR

United States Environmental Protection Agency . . . . . USEPA

United States Nuclear Regulatory Commission . . . . . USNRC

York Haven Dam . . . . . YHD

York Haven Pond . . . . . YHP

SUMMARY AND CONCLUSIONS

The radiological environmental monitoring performed in 1995 by GPU Nuclear for Three Mile Island Nuclear Station (TMINS) is discussed in this report. The environmental sample results and the doses calculated from measured effluents indicated that TMINS operations in 1995 had no adverse effect on the health of the public or the environment.

The operation of a nuclear power station results in the release of small amounts of radioactive materials to the environment. A radiological environmental monitoring program (REMP) has been established to monitor radiation and radioactive materials in the environment around TMINS. The results of environmental measurements are used to assess the impact of TMINS operations, to demonstrate compliance with the TMI-1 and TMI-2 Technical Specifications (Refs. 1 and 2) and applicable Federal and State regulations, and to verify the adequacy of containment and radioactive effluent control systems. The program also evaluates the relationship between amounts of radioactive material released in effluents to the environment and resultant radiation doses to individuals.

Summaries and interpretations of the data are published annually in the Radiological Environmental Monitoring Report. Previous reports in this series are referenced at the end of the report (Refs. 3 through 17 and 39 through 46). Additional information concerning releases of radioactive materials to the environment is contained in the Radiological Effluent Release Reports. These reports are submitted annually to the United States Nuclear Regulatory Commission (USNRC).

Many of the radioactive materials discussed in this report are normally present in the environment, either from natural processes or as a result of non-TMINS activities such as prior atmospheric nuclear weapon tests and medical industry activities. To determine the impact of TMINS operations, if any, on the environment and the public, results from samples collected close to TMINS (indicator stations) are compared to results from samples obtained at distant sites (control or background stations). Comparisons with historical data also are performed, as appropriate.

During 1995, samples of air, surface, effluent and drinking water, sediment, fruits, vegetables, game meat, fish, groundwater, milk and rodent carcasses were collected. Direct radiation exposure measurements also were made in the vicinity of TMINS. Samples were analyzed for gross beta and gross alpha radioactivity, tritium (H-3), strontium-89 (Sr-89) and strontium-90 (Sr-90), iodine-131 (I-131) and/or gamma-emitting radionuclides. The results are discussed in the various sections of this report. Additionally, radiological impacts in terms of radiation dose as a result of TMINS radioactive releases were calculated and are discussed in this report **(Radiological Impact of TMINS Operations)**.

The results provided in this report are summarized in the following highlights:

- There were nearly 1800 samples collected in 1995 from the aquatic, atmospheric and terrestrial environments around TMINS. More than 2700 analyses were performed on these samples. Also, approximately 3000 exposure measurements were taken using thermoluminescent dosimeters (TLDs). Finally, nearly 150 groundwater samples were collected and more than 250 analyses were performed on these samples. The monitoring performed in 1995 met or exceeded the sample collection and analysis requirements of the TMI-1 and TMI-2 Technical Specifications.

- In addition to natural radioactivity, low concentrations of radionuclides such as H-3, cobalt-58 (Co-58), cobalt-60 (Co-60), Sr-90, antimony-125 (Sb-125), cesium-137 (Cs-137), cesium-134 (Cs-134) and I-131 were detected in various media and were attributed to either fallout from prior nuclear weapon tests, the medical industry or TMINS operations.

- The raw surface water collected downstream of the TMINS liquid discharge outfall typically had H-3 concentrations greater than those detected in control samples as a result of routine TMINS operations. This was

expected because the samples were collected from a site where mixing of liquid effluents (e.g., H-3) with Susquehanna River water was incomplete.

- Several indicator drinking water samples contained H-3 at concentrations above those detected in control samples. A portion of the H-3 detected in the indicator samples was attributable to routine TMINS operations. The concentrations were well below the United States Environmental Protection Agency's (USEPA) Primary Drinking Water Standard of 20,000 picocuries per liter (pCi/L).

- Low concentrations of Co-58, Co-60, Sb-125, Cs-134 and Cs-137 were detected in aquatic sediment samples collected proximal to the TMINS liquid discharge outfall. These radionuclides were released in TMINS liquid effluents and adsorbed by suspended particles in the water column and bottom sediments. A temporary buildup was evident in 1995 due to low river flows.

- Groundwater samples collected from onsite monitoring wells contained H-3 above ambient concentrations primarily as a result of routine operations at TMI-1. Also, samples from two onsite wells had elevated H-3 concentrations due to leakage from system components. All H-3 concentrations detected in onsite groundwater were below the effluent concentration specified in USNRC 10 CFR 20 (Appendix B, Table 2).

- Tritium was detected in onsite groundwater used for drinking. The presence of H-3 in these samples was due to routine TMI-1 operations and possibly prior operations of the TMI-2 evaporator. All of the H-3 concentrations measured in the onsite drinking water were well below the USEPA Primary Drinking Water Standard of 20,000 pCi/L.

- Gamma radiation exposure rates recorded at the offsite indicator TLD and real-time monitoring stations averaged 55 and 66 milliroentgens per year (mR/yr), respectively. The exposure rates were consistent with those presented by the National Council on Radiation Protection and Measurements (Ref. 19). No increase in ambient gamma radiation levels was detected.

- The calculated doses to the public from TMINS operations in 1995 were well below all applicable regulatory limits and significantly less than doses received from other common sources of radiation. The hypothetical maximum whole body dose potentially received by an individual from TMI-1 and TMI-2 liquid and airborne effluents combined was conservatively calculated to be 0.72 mrem. This dose is equivalent to 0.24% of the dose that an individual living in the TMI area receives each year from natural background radiation.

- The hypothetical maximum whole body dose to the surrounding population from all 1995 liquid and airborne effluents was calculated to be 6.42 person-rem.

This dose is equivalent to 0.00097% of the dose that the total population in the TMI area receives each year from natural background radiation.

In conclusion, radioactive materials related to TMINS operations were detected in environmental samples, but the measured concentrations were low and consistent with measured effluents. The environmental sample results verified that the doses received by the public from TMINS effluents in 1995 were well below applicable dose limits and only a small fraction of the doses received from natural background radiation. Additionally, the results indicated that there was no permanent buildup of radioactive materials in the environment and no increase in background radiation levels. Therefore, based on the results of the radiological environmental monitoring program (REMP) and the doses calculated from measured effluents, TMINS operations in 1995 did not have any adverse effects on the health of the public or on the environment.

INTRODUCTION

Characteristics of Radiation

Instability within the nucleus of radioactive atoms results in the release of energy in the form of radiation. Radiation is classified according to its nature -- particulate and electromagnetic. Particulate radiation consists of energetic subatomic particles such as electrons (beta particles), protons, neutrons, and alpha particles. Because of its limited ability to penetrate the human body, particulate radiation in the environment contributes primarily to internal radiation exposure resulting from inhalation and ingestion of radioactivity.

Electromagnetic radiation in the form of x-rays and gamma rays has characteristics similar to visible light but is more energetic and, hence, more penetrating. Although x-rays and gamma rays are penetrating and can pass through varying thicknesses of materials, once they are absorbed they produce energetic electrons which release their energy in a manner that is identical to beta particles. The principal concern for gamma radiation from radionuclides in the environment is their contribution to external radiation exposure.

The rate with which atoms undergo disintegration (radioactive decay) varies among radioactive elements, but is uniquely constant for each specific radionuclide. The term "half-life" defines the time it takes for half of any amount of an element to decay and can vary from a fraction of a second for some radionuclides to millions of years for others. In fact, the natural background radiation to which all mankind has been exposed is largely due to the radionuclides of uranium (U), thorium (Th), and potassium (K). These radioactive elements were formed with the creation of the universe and, owing to their long half-lives, will continue to be present for millions of years to come. For example, potassium-40 (K-40) has a half-life of 1.3 billion years and exists naturally within our bodies. As a result, approximately 4000 atoms of potassium emit radiation internally within each of us every second of our lives.

In assessing the impact of radioactivity on the environment, it is important to know the quantity of radioactivity released and the resultant radiation doses. The common unit of radioactivity is the curie (Ci). It represents the radioactivity in one gram (g) of natural radium (Ra), which is also equal to a decay rate of 37 billion radiation emissions every second. Because of the extremely small amounts of radioactive material in the environment, it is more convenient to use fractions of a curie. Subunits like picocurie, pCi, (one trillionth of a curie) are frequently used to express the radioactivity present in environmental and biological samples.

The biological effects of a whole body equivalent dose of radiation are the same whether the radiation source is external or internal to the body. The important factor is how much radiation energy or dose was deposited. The unit of radiation dose is the Roentgen equivalent man (rem), which also incorporates the variable effectiveness of different forms of radiation to produce biological change. For environmental radiation exposures, it is convenient to use the smaller unit of millirem (mrem) to express dose (1000 mrem equals 1 rem). When radiation exposure occurs over periods of time, it is appropriate to refer to the dose rate. Dose rates, therefore, define the total dose for a fixed interval of time, and for environmental exposures are usually expressed with reference to one year (mrem/yr).

Sources of Radiation

Life on earth has evolved amid the constant exposure to natural radiation. In fact, the single major source of radiation to which the general population is exposed comes from natural sources. Although everyone on the planet is exposed to natural radiation, some people receive more than others. Radiation exposure from natural background has three components (i.e., cosmic, terrestrial, and internal) and varies with altitude and geographic location, as well as with living habits.

For example, cosmic radiation originating from deep interstellar space and the sun increases with altitude, since there is less

air which acts as a shield. Similarly, terrestrial radiation resulting from the presence of naturally-occurring radionuclides in the soil and rocks varies and may be significantly higher in some areas of the country than in others. Even the use of particular building materials for houses, cooking with natural gas, and home insulation affect exposure to natural radiation.

The presence of radioactivity in the human body results from the inhalation and ingestion of air, food, and water containing naturally-occurring radionuclides. For example, drinking water contains trace amounts of uranium and radium and milk contains radioactive potassium. Table 1 summarizes the common sources of radiation and their average annual doses.

The average person in the United States receives about 300 mrem/yr (0.3 rem/yr) from natural background radiation sources (Ref. 19). This estimate was revised from about 100 to 300 mrem because of the inclusion of radon gas which was always present but was not been previously included in the calculations. In some regions of the country, the amount of natural radiation is significantly higher. Residents of Colorado, for example, receive an additional 60 mrem/yr due to the increase in cosmic and terrestrial radiation levels. In fact, for every 100 feet above sea level, a person will receive an additional 1 mrem/yr from cosmic radiation. In several regions of the world, naturally high concentrations of uranium and radium deposits result in doses of several thousand mrem/yr to their residents (Ref. 20).

Recently, public attention has focused on radon (Rn), a naturally-occurring radioactive gas produced from uranium and radium decay. These elements are widely distributed in trace amounts in the earth's crust. Unusually high concentrations have been found in certain parts of eastern Pennsylvania and northern New Jersey. Radon levels in some homes in these areas are hundreds of times greater than levels found elsewhere in the United States. However, additional surveys are needed to determine the full extent of the problem nationwide. Radon is the largest component of natural background radiation and may be responsible for a substantial number of lung cancer deaths annually. The National Council on Radiation Protection and Measurements (NCRP) estimates that the average individual in the United States receives an annual dose of about 2,400 mrem to the lung from natural radon gas (Ref. 19). This lung dose is considered to be equivalent to a whole body dose of 200 mrem. The NCRP has recommended actions to control indoor radon sources and reduce exposures.

When radioactive substances are inhaled or swallowed, they are not uniformly distributed within the body. For example, radioactive iodine selectively concentrates in the thyroid gland, radioactive cesium is distributed throughout the body water and muscles, and radioactive strontium concentrates in the bones. The total dose to organs by a given radionuclide also is influenced by the quantity and the duration

TABLE 1

Sources and Doses of Radiation*

Natural (82%)		Manmade (18%)	
Source	Radiation Dose (mrem/yr)	Source	Radiation Dose (mrem/yr)
Radon	200 (55%)	Medical X-rays	39 (11%)
Cosmic rays	27 (8%)	Nuclear Medicine	14 (4%)
Terrestrial	28 (8%)	Consumer products	10 (3%)
Internal	40 (11%)	Other (releases from nat. gas, phosphate mining, burning of coal, weapons fallout, & nuclear fuel cycle)	<1 (<1%)
APPROXIMATE TOTAL	300	APPROXIMATE TOTAL	60

* Percentage contribution of the total dose is shown in parentheses.

Source: Ref. 19

of time that the radionuclide remains in the body, including its physical, biological and chemical characteristics. Depending on their rate of radioactive decay and biological elimination from the body, some radionuclides stay in the body for very short times while others remain for years.

In addition to natural radiation, we are exposed to radiation from a number of manmade sources. The single largest of these sources comes from diagnostic medical x-rays, and nuclear medicine procedures. Some 180 million Americans receive medical x-rays each year. The annual dose to an individual from such radiation averages about 53 mrem. Much smaller doses come from nuclear weapon fallout and consumer products such as televisions, smoke detectors, and fertilizers. Production of commercial nuclear power and its associated fuel cycle contributes less than 1 mrem to the annual dose of about 360 mrem for the average individual living in the United States.

Fallout commonly refers to the radioactive debris that settles to the surface of the earth following the detonation of a nuclear weapon. It is dispersed throughout the

environment either by dry deposition or washed down to the earth's surface by precipitation. There are approximately 200 radionuclides produced in the nuclear weapon detonation process; a number of these are detected in fallout. The radionuclides found in fallout which produce most of the fallout radiation exposures to humans are I-131, Sr-89, Cs-137, and Sr-90. There has been no atmospheric nuclear weapon testing since 1980 and many of the radionuclides, still present in our environment, have decayed significantly. Consequently, doses to the public from fallout have been decreasing.

As a result of the nuclear accident at Chernobyl, Ukraine, on April 26, 1986, radioactive materials were dispersed throughout the environment and detected in various media such as air, milk, and soil. Cesium-134, Cs-137, I-131 and other radionuclides were detected in the weeks following the Chernobyl accident.

Nuclear Reactor Operations

Common to the commercial production of electricity is the consumption of fuel to produce heat and steam. The steam turns the turbine which generates electricity. Unlike the burning of coal, oil, or gas in fossil-fuel powered plants to generate heat, the fuel of most nuclear reactors is comprised of the element uranium in the form of uranium oxide. The fuel produces heat by the process called fission. In fission, the uranium atom absorbs a neutron (an atomic particle found in nature and also produced by the fissioning of uranium in the reactor) and splits to produce smaller atoms termed fission products, along with heat, radiation and free neutrons. The free neutrons travel through the reactor and are similarly absorbed by the uranium, permitting the fission process to continue. As this process continues, more fission products, radiation, heat and neutrons are produced and a sustained reaction occurs. The heat produced is transferred -- via reactor coolant water -- from the fuel to produce steam which drives a turbine generator to produce electricity. The fission products are mostly radioactive; that is, they are unstable atoms which emit radiation as they decay to stable atoms. Neutrons which are not absorbed by the uranium fuel may be absorbed by stable atoms in the materials which make up the components and structures of the reactor. In such cases, stable atoms often become radioactive. This process is called activation and the radioactive atoms which result are called activation products.

The TMINS reactors (TMI-1 and TMI-2) are pressurized water reactors (PWR). Only TMI-1 is an operating reactor. At the end of 1993, TMI-2 was placed in a condition called Post-Defueling Monitored Storage (PDMS). As the name implies, TMI-2 will continue to be monitored until operations at TMI-1 cease. At that time, both TMI-1 and TMI-2 will be decommissioned.

The nuclear fuel used in an operating reactor such as TMI-1 is contained within sealed fuel rods arranged in arrays called bundles. The bundles are located within a

massive steel reactor vessel. Pressurized water reactors utilize steam generators to transfer the heat of the coolant water to the secondary steam loop; thus, the steam generators serve as a boundary between the radioactive primary loop and the secondary steam loop.

As depicted in Figure 1, heat is added to the water as it is pumped around and through the fuel bundles in the reactor vessel. The hot primary coolant then passes inside thousands of sealed tubes within the steam generator. Heat is transferred through the tube walls into the secondary water which flows around the tubes, thereby creating steam for use in the turbine. After the energy is extracted from the steam in the turbine, it is cooled and condensed back into water by a third loop which circulates water between the condenser and the cooling towers.

Several hundred radionuclides of some 40 different elements are created during the process of generating electricity. And, because of reactor engineering designs, the short half-lives of many radionuclides, and their chemical and physical properties, nearly all radioactivity is contained.

Pressurized water reactors have five independent barriers that confine radioactive materials given off by the reactor fuel as it heats the water. Under normal operating conditions, essentially all radioactivity is contained within the first two barriers.

The ceramic uranium fuel pellets provide the first barrier. Most of the fission products are either trapped or chemically bound in the fuel where they remain. However, a few fission products which are volatile or gaseous at normal operating temperatures may not be contained in the fuel.

The second barrier consists of zirconium (Zr) alloy tubes (cladding) that resist corrosion and high temperatures. The fuel pellets are contained within these tubes. There is a small gap between the fuel and the cladding, in which the noble gases and other volatile radionuclides collect and are contained.

The primary coolant water is the third barrier. Many of the fission products, including radioactive iodine, strontium and cesium are soluble and are retained in water in an ionic (electrically charged) form. These materials can be removed in the primary coolant purification system. However, krypton (Kr) and xenon (Xe) do not readily dissolve in the coolant, particularly at high temperatures. Krypton and xenon collect as a gas above the coolant when the water is depressurized.

The fourth barrier consists of the reactor pressure vessel and the steel piping of the primary coolant system. The reactor pressure vessel is a 36-foot high tank with steel walls about 9 inches thick. It encases the reactor core. The remainder of the primary coolant system includes the pressurizer, steam generators and associated piping. This system provides containment for radioactivity in the primary coolant.

The reactor building (or containment building) provides the fifth barrier. It has steel-lined concrete walls about 4 feet thick that enclose the reactor pressure vessel and the primary coolant system.

Sources of Liquid and Airborne Effluents

Although the previously described barriers contain radioactivity with high efficiency, small amounts of radioactive fission products diffuse or migrate through minor flaws in the fuel cladding and into the primary coolant. Trace quantities of reactor system component and structure surfaces which have been activated also get into the primary coolant water. Many of the soluble fission and activation products such as iodines, strontiums, cobalts, and cesiums are removed by demineralizers in the purification system of the primary coolant. The physical and chemical properties of noble gas fission products in the primary coolant prevent their removal by the demineralizers.

Because the reactor system has many valves and fittings, an absolute seal cannot be achieved. Small amounts of noble gases and trace quantities of residual fission and activation products have the potential for escape into the reactor building and associated buildings. A portion of the airborne effluents comes from the atmosphere around the primary coolant system, which receives steam and liquid leakage from valves and pumps on systems carrying primary coolant. Environmental release of airborne radioactivity is reduced by simply holding the radioactivity inside the reactor building for a period of time which allows for the natural radioactive decay of some radionuclides. Radioactive gases from purification systems also contribute to airborne effluents and are collected and stored in tanks for radioactive decay before being released.

Airborne effluents pass through a two-stage filtration system prior to environmental release. High efficiency particulate air (HEPA) filters effectively remove radionuclides such as strontium and cesium with a 99 percent (%) efficiency. Activated charcoal filters remove radioiodines with a 90 to 95 % efficiency. Noble gases and tritium, however, cannot be removed by either of these filtration processes because of their chemical and physical properties.

Ventilation systems throughout the plant are designed to maintain a negative pressure (suction) with respect to the outside atmosphere. This pressure differential assures that all building air and air exhausted from potentially radioactive areas of the buildings is filtered by HEPA and charcoal filters prior to release to the environment.

Liquid wastes are generated from the primary coolant purification system and from small amounts of liquids which escape from valves, piping, and equipment associated with the primary coolant system during normal operations. Liquids are treated using filters, demineralizers, and evaporators to remove radioactivity from the water prior to release. Purified water is

reused or released to the river and the process wastes are concentrated for offsite burial at approved, licensed facilities. Tritium, because of its chemical behavior, is not removed from liquid wastes.

As a result of minor leakage in the steam generators, small amounts of radioactive materials are present in the secondary (steam loop) water. Although not all of the water is treated, all of the water is monitored and diluted with nonradioactive water prior to being released.

GPU Nuclear conducts operations such that releases of liquid and gaseous wastes are a small percentage of the Federal limits. Consequently, the doses associated with these releases are a small fraction of the dose limits established by the Federal Government.

Nuclear Three Mile Island Nuclear Station

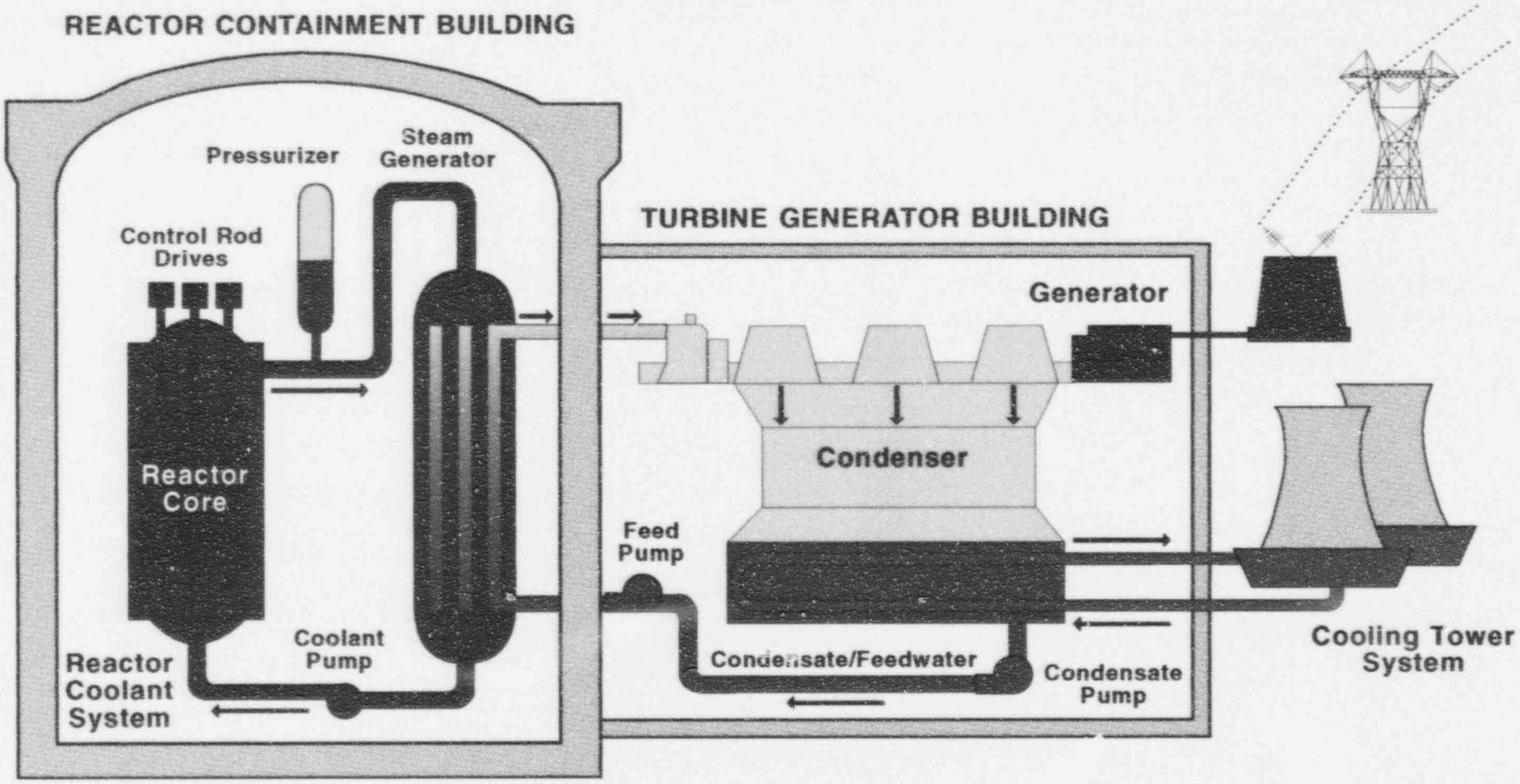

Figure 1

DESCRIPTION OF THE TMINS SITE

General Information

Three Mile Island Nuclear Station is located in Londonderry Township of Dauphin County, Pennsylvania. It lies approximately 2.5 miles north of the southern tip of the county, where the county borders of Dauphin, Lancaster, and York all meet. The site is part of an 814 acre tract of Company-owned land which encompasses TMI and several adjacent islands in the Susquehanna River (Refs. 21 and 22). Aligned north to south, TMI is approximately 11,000 feet long and 1700 feet wide. The eastern and western riverbanks are 900 and 6500 feet, respectively, from the site. Situated on the northern one-half of the island, the Station covers about 200 acres of land. The island is relatively flat with elevations ranging from about 280 feet above mean sea level (msl) at the water's edge to slightly more than 300 feet above msl in the north-central portion. The topography of the area immediately surrounding TMI is characterized by rolling terrain which slopes to the river valley floor. The hills within a two mile radius of the site have a maximum relief of about 200 feet with the highest elevation seldom exceeding 500 feet above msl. The Susquehanna River at the site drains a watershed area of approximately 25,000 square miles.

With the exception of the southern border of TMINS, the plant site is bounded by the part of the Susquehanna River known as York Haven Pond or Lake Frederick. The pond, which is 1.5 miles wide at the site, is formed by the York Haven and Red Hill Dams. Three Mile Island and Shelley Island divide the river into three main channels. Several lesser channels also are formed by smaller islands.

The historical average annual flow of the Susquehanna River in the TMI region is 34,000 cubic feet per second (cfs). During 1995, however, the annual average flow was lower than the historical average. The flow in 1995 averaged about 28,220 for the TMI region. The historical average annual maximum flow is about 300,000 cfs while the minimum daily flow for the region is recorded at 1,700 cfs (Ref. 21). A flood protection dike completely surrounds TMINS and was designed based upon a flow of 1,100,000 cfs. For comparison, the maximum flow/flood of record occurred in June 1972 as a result of tropical storm "Agnes". This event produced a flow of 1,020,000 cfs.

Present uses of the Susquehanna River include public and industrial water supply, power generation, and recreation such as boating and fishing. While there is no commercial fishing done in the Susquehanna, recreational fisherman can expect to catch several different species of fish that inhabit the river.

Based on 1990 census data (Ref. 23), approximately 175,000 people reside within a ten-mile radius of TMINS. The nearest population center is Goldsboro with a population of 458 people (Ref. 23). It lies approximately one mile to the west of the site. About 2.5 miles to the north, 9,254 people reside in the town of Middletown (Ref. 23). Harrisburg, situated 12 miles to the northwest, is the nearest major city with a population of 52,376 (Ref. 23). Land within a 10 mile radius of the site is used primarily for farming. Farm products include poultry, meat, fruit, dairy products, vegetables, corn, wheat, alfalfa, tobacco, and other crops of lesser importance.

Climatological Summary - 1995*

The Appalachian Mountains, located about 20 miles to the north of TMI, protect the area somewhat from the cold winter outbreaks of Arctic air that invade central and western Pennsylvania. However, the site is too far inland to derive the full benefits of a coastal climate like that of the southeastern region of Pennsylvania. Summers tend to be warm and humid and winters are cool, with frequent periods of precipitation. Summer rainfall typically comes from thunderstorm activity, while most of the precipitation in the winter is a result of coastal winter storms. Normal yearly rainfall for the TMI region is 40.5 inches. Winds at TMI primarily are from the northwesterly direction. The 1995 annual average wind speed in the TMI region was 9.7 miles per hour (mph). Monthly averages ranged from 7.0 mph in August to 11.6 mph in January, April and December (Ref. 24).

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*Sources:

1) Onsite Meteorological Data.
2) Local Climatological Data, Harrisburg, PA.
3) National Climatic Data Center, Asheville, NC.

During 1995, the average monthly temperatures ranged from 29.1°F in February to 77.9°F in July. The maximum monthly deviation occurred in January when the temperatures averaged 6.2°F above the normal monthly average. The lowest temperature of the year occurred on February 6 when it dropped to 5°F. On July 15, the temperature rose to 99°F, marking the year's highest temperature. The overall annual average temperature was 53.6°F which is within 1° of the normal annual average for the area.

A total of 42.4 (water equivalent) inches of precipitation was recorded during 1995. This amount was about 1.9 inches above the normal annual average. Monthly precipitation totals ranged from a low of 0.8 inches in March to a high of 8.5 inches in July. The amount of precipitation which fell in July exceeded the normal total for the month by approximately 4.8 inches. The most significant rain event occurred on October 20 and 21 when 3.5 inches fell. The year's greatest snowfall recorded over a 24-hour period (7.3 inches) occurred on December 19 and 20. December's total snowfall was recorded at 17.4 inches which was the greatest monthly total for the year. Compared to 1994 which was highlighted by record snowfall and record low temperatures, 1995 was a more typical year. No extraordinary climatological events occurred.

A wind rose and joint frequency tables for the TMINS site, which summarize wind and dispersion information used for offsite dose calculations, are provided in Appendix K. The data normally are generated from meteorological parameters recorded by onsite instrumentation. When real-time data are missing or invalid, default values are entered into the data base. The default values are consistent with actual meteorology for the TMINS vicinity. During 1995, only 33 hours of real-time data (0.4%) were missing or invalid.

EFFLUENTS

Historical Background

Almost from the outset of the discovery of x-rays in 1895 by Wilhelm Roentgen, the potential hazard of ionizing radiation was recognized and efforts were made to establish radiation protection standards. The International Commission on Radiological Protection (ICRP) and the NCRP were established in 1928 and 1929, respectively. These organizations have the longest continuous experience in the review of radiation health effects and with making recommendations on guidelines for radiological protection and radiation exposure limits. In 1955, the United Nations created a Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to summarize reports received on radiation levels and the effects on man and his environment. The National Academy of Sciences (NAS) formed a committee in 1956 to review the biological effects of atomic radiation (BEAR). A series of reports have been issued by this and succeeding NAS committees on the biological effects of ionizing radiation (BEIR), the most recent being 1990 (known as BEIR V). The Federal Radiation Council (FRC) was

formed in 1959 to provide a federal policy on human radiation exposures. These federal policies are approved by the President of the United States.

These committees and commissions of nationally and internationally recognized scientific experts have been dedicated to the understanding of the health effects of radiation by investigating all sources of relevant knowledge and scientific data and by providing guidance for radiological protection. Their members are selected from universities, scientific research centers and other national and international research organizations. The committee reports contain scientific data obtained from physical, biological, and epidemiological studies on radiation health effects and serve as scientific references for information presented in this report.

Since its inception, the USNRC has depended upon the recommendations of the ICRP, the NCRP, and the FRC (incorporated in the USEPA in 1970) for basic radiation protection standards and guidance in establishing regulations for the nuclear industry (Refs. 25 through 28).

Effluent Release Limits

As part of routine plant operations, limited quantities of radioactive materials are released to the environment in liquid and airborne effluents. An effluent control program is implemented by GPU Nuclear to ensure that the amount of radioactive material released to the environment is minimal.

The Federal government establishes limits on radioactive materials released to the environment. These limits are set at levels to protect the health and safety of the public and are specified in the Technical Specifications for TMI-1 and TMI-2 and the Offsite Dose Calculation Manual, ODCM, (Ref. 32). GPU Nuclear conducts operations such that releases of radioactive effluents are a small percentage of the Federal limits.

A recommendation of the ICRP, NCRP, and FRC is that radiation exposures should be maintained at levels which are "as low as reasonably achievable" (ALARA) and commensurate with the societal benefit derived from the activities resulting in such exposures. For this reason, dose limit guidelines were established by the USNRC for releases of radioactive effluents from nuclear power plants. These guidelines are presented in Title 10 of the Code of Federal Regulations, Part 50, Appendix I (10 CFR 50, App. I). Maintaining doses within these operational guidelines demonstrates that releases of radioactive effluents are being maintained "as low as reasonably achievable". These USNRC ALARA guidelines are a fraction of the dose limits established by the USEPA.

The USNRC 10 CFR 50, App. I guidelines are as follows:

- The dose to a member of the public from radioactive materials released in liquid effluents is limited to ≤ 3 mrem/yr to the total body or ≤ 10 mrem/yr to any organ.

- The air dose due to noble gases at a location which would be occupied by a member of the public is limited to ≤ 10 mrad/yr for gamma radiation or ≤ 20 mrad/yr for beta radiation.

- The dose to a member of the public from noble gases released in gaseous effluents is limited to ≤ 5 mrem/yr to the total body or ≤ 15 mrem/yr to the skin.

- The dose to a member of the public from airborne iodines, tritium and particulates is limited to ≤ 15 mrem/yr to any organ.

The USEPA dose limits as defined in Title 40 of the Code of Federal Regulations, Part 190 (40 CFR 190), are as follows:

- The dose to a member of the public shall not exceed in a year 25 mrem to the total body, 75 mrem to the thyroid, and 25 mrem to any other organ as a result of uranium fuel cycle operations.

Effluent Control Program

Effluent control includes plant components such as the ventilation system and filters, waste gas holdup tanks, demineralizers and evaporator systems. In addition to minimizing the release of radioactivity, the effluent control program includes all aspects of effluent monitoring. This includes the operation and data analysis associated with a complex radiation monitoring system, collection and analysis of effluent samples, and a comprehensive quality assurance (QA) program. Over the years, the program has evolved in response to changing regulatory requirements and plant conditions. For example, additional instruments and samplers have been installed to ensure that measurements of effluents remain onscale in the event of any accidental release of radioactivity.

Effluent Instrumentation: Liquid and airborne effluent measuring instrumentation is designed to monitor the presence and the amount of radioactivity in effluents. The instruments provide continuous surveillance of radioactivity releases. Calibrations of effluent instruments are performed using reference standards certified by the National Institute of Standards and Technology (NIST). The instruments are calibrated to respond to specific radionuclides and are sensitive enough to measure 100 to 1,000 times below the applicable release limits.

Each instrument is equipped with alarms which are connected to the Control Room. The alarm setpoints are set to ensure that effluent release limits will not be exceeded. If radiation monitor alarm setpoints are reached, liquid and airborne releases are automatically terminated.

Effluent Sampling and Analysis: In addition to continuous radiation monitoring instruments, samples of effluents are taken and subjected to laboratory analysis to identify the specific radionuclide quantities being released. A sample must be representative of the effluent from which it is taken. Sampling and analysis provide a sensitive and precise method of determining effluent composition. Samples are analyzed using state-of-the-art laboratory counting equipment. Radiation instrument readings

and sample results are compared to ensure correct correlation.

Effluent Data

The amount of radioactivity released from TMINS varies and is dependent upon operating conditions, power levels, fuel conditions, efficiency of liquid and gas processing systems, and proper functioning of plant equipment. The largest variations occur in the airborne effluents of fission and activation gases which are particularly sensitive to the holdup time capability in the gas processing system and to the integrity of the fuel cladding.

During 1995, the radioactive liquid and airborne releases from TMI-1 and TMI-2 resulted in doses that were well below Federal regulatory, Technical Specification and ODCM limits. The predominant radionuclides released were Xe-133 in gases and H-3 in liquids. The amount of radioactivity released as well as the associated calculated doses to the public are summarized and reported annually to the USNRC. A summary of TMI-1 and TMI-2 liquid and airborne effluents for 1995 is provided in Table 2. Radioactive constituents of these effluents are discussed in the following sections.

Noble Gases: The predominant radioactive materials released in TMI-1 airborne effluents were the noble gases xenon and krypton. Small amounts of noble gases also were released in TMI-1 liquid effluents. During 1995, noble gases were not detected in TMI-2 liquid or gaseous effluents.

Noble gases are inert, which means they do not react chemically or biologically. Xenon-133 with a half-life of five days was the predominant noble gas released. It is readily dispersed in the atmosphere when released, and because of its short half-life, quickly decays into a stable nonradioactive form. Total xenon radioactivity released to the atmosphere in 1995 was approximately 580 Ci. Lesser amounts (about 33 Ci) of krypton also were released.

Iodines and Particulates: The discharge of iodines and particulates to the environment is minimized by factors such as their high chemical reactivity, solubility in water, and the high efficiency of removal in airborne and liquid processing systems.

During 1995, iodines were not detected in TMI-2 liquid or gaseous effluents. For TMI-1, I-131 and I-133 are the predominant radioiodines released in liquid and gaseous effluents. Most of the other isotopes of iodine are not released either because of a very short half-life or the negligible quantities produced. For example, I-129 has a 17 million year half-life but its production in the nuclear fission process is so low that it cannot be detected routinely in effluents.

During 1995, the principal radioactive particulates released as result of TMI-1 operations were the radiocesiums (Cs-134 and Cs-137), radiostrontiums (Sr-89 and Sr-90) and activation products Fe-55, Co-58, Co-60, Ag-110m and Sb-125. For TMI-2, only small amounts of Sr-90, Cs-134 and Cs-137 were released in liquid effluents. The total amount of iodines and particulates released from TMI-1 and TMI-2

in 1995 was approximately 0.024 Ci in airborne effluents and approximately 0.069 Ci in liquid effluents.

Tritium: Tritium was the predominant radionuclide released in 1995 TMI-1 liquid effluents. This radionuclide also was released in TMI-1 gaseous effluents and TMI-2 liquid and gaseous effluents, but at much lower amounts. Tritium is a radioactive isotope of hydrogen. It is produced in the reactor coolant as a result of neutron interaction with the naturally-occurring deuterium (also a hydrogen isotope) present in water and with the boron used for reactivity control of the reactor.

During 1995, the amounts of H-3 released in TMI-1 liquid and gaseous effluents were approximately 530 Ci and 17 Ci, respectively. For TMI-2, H-3 releases were approximately 0.015 Ci and 1.4 Ci for liquids and gases, respectively.

To put these amounts of H-3 into perspective, the world inventory of natural cosmic ray produced H-3 is 70 million Ci, which corresponds to a production rate of 4 million Ci/yr (Ref. 29). Tritium contributions to the environment from nuclear power production are too small to have any measurable effect on the existing global environmental concentrations.

Transuranics: Transuranics are produced by neutron capture in the fuel, and typically emit alpha and beta particles as they decay. Important transuranic isotopes produced in reactors are U-239, plutonium-238 (Pu-238), Pu-239, Pu-240, Pu-241, americium-241 (Am-241), Pu-243, plus other isotopes of americium and curium (Cm). They have half-lives ranging from hundreds of days to millions of years. Transuranics are mostly retained within the nuclear fuel. Because they are so insoluble and non-volatile, they are not readily transported from inplant pathways to the environment. Gas and liquid processing systems remove greater than 90% of any transuranics outside the reactor coolant. Since greater than 99% of all transuranics are retained within the fuel and transuranic removal processes are extremely efficient, releases in airborne and liquid effluents are not routinely detected.

During 1995, transuranics were not detected in TMI-1 or TMI-2 effluents.

Carbon-14: Production of carbon-14 (C-14) in reactors is small. This radionuclide is produced in the reactor coolant as a result of neutron interactions with oxygen (O) and nitrogen (N). For all nuclear power production worldwide, an estimated 235,000 Ci were released from 1970 through 1990 (Ref. 30).

Carbon-14 also is produced naturally by the interactions of cosmic radiation with oxygen and nitrogen in the upper atmosphere. The worldwide inventory of natural C-14 is estimated at 241 million Ci (Ref. 30). Since the inventory of natural C-14 is so large, releases from nuclear power plants do not result in a measurable change in the background concentration of C-14. Consequently, C-14 is not routinely monitored in plant effluents.

TABLE 2

Radionuclide Composition of TMINS Effluents for 1995 [1]

Radionuclide [2]	Half-Life [3]	Liquid Effluents (Ci) TMI-1	Liquid Effluents (Ci) TMI-2	Airborne Effluents (Ci) TMI-1	Airborne Effluents (Ci) TMI-2
H-3	1.23E+1 yr	5.28E+2	1.51E-2	1.74E+1	1.35E+0
Ar-41	1.83E+0 h			3.39E-1	
Mn-54	3.13E+2 day	1.15E-6			
Fe-55	2.70E+0 yr	6.95E-3			
Co-58	7.08E+1 day	1.16E-3		7.91E-7	
Co-60	5.27E+0 yr	3.75E-5			
Kr-85	1.07E+1 yr			1.92E+1	
Kr-85m	4.48E+0 h			3.70E+0	
Kr-87	7.63E+1 min			3.60E+0	
Kr-88	2.84E+0 day			6.75E+0	
Sr-89	5.05E+1 day	1.95E-5			
Sr-90	2.86E+1 yr	1.20E-5	3.29E-6	8.41E-7	
Nb-95	3.50E+0 day	1.21E-6			
Ag-110m	2.50E+2 day	6.01E-5			
Sb-125	2.77E+0 yr	4.04E-5			
I-131	8.04E+0 day	1.46E-2		5.43E-3	
Xe-131m	1.18E+1 day			6.96E+0	
I-132	2.30E+0 h			2.58E-7	
I-133	2.08E+1 h	2.62E-2		1.88E-2	
Xe-133	5.25E+0 day	8.25E-3		5.26E+2	
Xe-133m	2.19E+0 day	3.68E-4		4.83E+0	
Cs-134	2.06E+0 yr	6.64E-3	1.66E-7	5.73E-8	
Xe-135	9.11E+0 h	3.22E-2		2.81E+1	
Xe-135m	1.54E+1 min			7.31E+0	
Cs-136	1.32E+1 day	1.18E-4			
Cs-137	3.02E+1 yr	1.30E-2	5.08E-5	2.41E-6	
Xe-138	1.41E+1 min			2.98E+0	

(1) The results are expressed in exponential form (i.e., 1.2E-2 = 0.012).

(2) Refer to List of Abbreviations, Symbols and Acronyms (p. v) for nomenclature of the radionuclides/elements.

(3) yr = year, h = hour, min = minute

RADIOLOGICAL ENVIRONMENTAL MONITORING

GPU Nuclear conducts a comprehensive radiological environmental monitoring program (REMP) at TMINS to measure levels of radiation and radioactive materials in the environment. The information obtained from the REMP is then used to determine the effect of TMINS operations, if any, on the environment and the public.

The USNRC has established regulatory guides which contain acceptable monitoring practices. The TMINS REMP was designed on the basis of these regulatory guides along with the guidance provided by the USNRC Radiological Assessment Branch Technical Position for an acceptable radiological environmental monitoring program (Ref. 31). The TMINS REMP meets or exceeds the monitoring requirements set forth by the USNRC.

The important objectives of the REMP are:

- To assess dose impacts to the public from TMINS operations.
- To verify inplant controls for the containment of radioactive materials.
- To determine buildup of long-lived radionuclides in the environment and changes in background radiation levels.
- To provide reassurance to the public that the program is capable of adequately assessing impacts and identifying noteworthy changes in the radiological status of the environment.
- To fulfill the requirements of the TMI-1 and TMI-2 Technical Specifications.

Environmental Exposure Pathways to Humans from Airborne and Liquid Effluents

As previously discussed (**Effluents**), small amounts of radioactive materials are released to the environment as a result of operating a nuclear power station. Once released, these materials move through the environment in a variety of ways and may eventually reach humans via breathing, drinking, eating and direct exposure. These routes of exposure are referred to as environmental exposure pathways. Figure 16 illustrates the important exposure routes.

As can be seen from this figure, these exposure pathways are both numerous and varied. While some pathways are relatively simple, such as inhalation of airborne radioactive materials, others may be complex. For example, radioactive airborne particulates may deposit onto forage which when eaten by cows may be transferred into milk, which is subsequently consumed by man. This route of exposure is referred to as the air-grass-cow-milk-human pathway.

Although radionuclides can reach humans by a number of pathways, some are more important than others. The critical pathway for a given radionuclide is the one that produces the greatest dose to a population, or to a specific segment of the population. This segment of the population is termed the critical group, and may be defined by age, diet, or other cultural factors. The dose may be delivered to the whole body or confined to a specific organ; the organ receiving the greatest fraction of the dose is termed as the critical organ. This information was used to develop the TMINS REMP.

Sampling

The TMINS REMP consists of two phases -- the preoperational and the operational. Data gathered in the preoperational phase is used as a basis for evaluating radiation levels and radioactivity in the vicinity of the plant after the plant becomes operational. The operational phase began in 1974 at the time TMI-1 became operational.

The program consists of taking radiation measurements and collecting samples from the environment, analyzing them for radioactivity content, and then interpreting the results. With emphasis on the critical exposure pathways to humans, samples

from the aquatic, atmospheric, and terrestrial environments are collected. These samples include, but are not limited to, air, soil, water, sediment, finfish, milk, fruits, vegetables, and groundwater. Thermoluminescent dosimeters (TLDs) are placed in the environment to measure gamma radiation levels.

The Offsite Dose Calculation Manual, ODCM, (Ref. 32) implements the TMI-1 and TMI-2 Technical Specifications and defines the sample types to be collected and the analyses to be performed. As appropriate, changes to the REMP are initiated by the recommendations from the scientific staff of GPU Nuclear Environmental Affairs of TMINS. However, the minimum sampling and analysis requirements specified in the ODCM are maintained.

Sampling locations were established by considering topography, meteorology, population distribution, hydrology, areas of public interest and land use characteristics of the local area. The sampling locations are divided into two classes, indicator and control. Indicator locations are those which are expected to show effects from TMINS operations, if any exist. These locations were selected primarily on the basis of where the highest predicted environmental concentrations would occur. The indicator locations are typically within a few miles of TMINS and the control stations are generally at distances greater than 10 miles from TMINS. Therefore, control samples are collected at locations which are expected to be unaffected by operations. They provide a basis for evaluating fluctuations at indicator locations relative to natural background radioactivity and fallout from prior nuclear weapon tests. Figures 2, 3 and 4 show the current sampling locations around TMI. Table A-1 in Appendix A describes the sampling locations by distance and azimuth along with the type(s) of samples collected at each sampling location.

Analysis

In addition to specifying the media to be collected and the number of sampling locations, the ODCM also specifies the frequency of sample collection and the types and frequency of analyses to be performed. Also specified are analytical sensitivities (detection limits) and reporting levels. Table A-2 in Appendix A provides a synopsis of the sample types, number of sampling locations, collection frequencies, number of samples collected, types and frequencies of analyses, and number of samples analyzed. Table A-3 in Appendix A lists samples which were not collected or analyzed per the requirements of the ODCM. Sample analyses which did not meet the required analytical sensitivities are presented in Appendix B. Changes in sample collection and analysis are described in Appendix C.

Measurement of low radionuclide concentrations in environmental media requires special analysis techniques. Analytical laboratories use state-of-the-art laboratory equipment designed to detect all three types of radiation emitted (alpha, beta, and gamma). This equipment must meet the analytical sensitivities required by the ODCM. Examples of the specialized laboratory equipment used are germanium detectors with multichannel analyzers for

determining specific gamma-emitting radionuclides, liquid scintillation counters for detecting H-3 and low level proportional counters for detecting gross alpha and beta radioactivity. Computer hardware and software used in conjunction with the counting equipment perform calculations and provide data management. Analysis methods are described in Appendix L.

Data Review

The analytical results are routinely reviewed by GPU Nuclear scientists to assure that sensitivities have been achieved and that the proper analyses have been performed. Investigations are conducted when action levels or USNRC reporting levels are reached or when anomalous values are discovered. The action levels were established by GPU Nuclear and are typically 10 percent of the USNRC reporting levels specified in the ODCM. These levels are purposely set low so that corrective action can be initiated before a reporting level is reached. This review process is discussed in more detail in Appendix D.

Table 3 provides a summary of radionuclide concentrations detected in the primary environmental samples for 1995. Statistical methods used to derive this table along with other statistical conclusions are detailed in Appendix H. Quality control (QC) sample results were used mainly to verify the primary sample result or the first result in the case of a duplicate analysis. Therefore, the QC results were excluded from Table 3 and the main text of this report to avoid biasing the results.

Quality Assurance Program

A quality assurance (QA) program is conducted in accordance with guidelines provided in Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs" (Ref. 33) and as required by the Technical Specifications. It is documented by GPU Nuclear written policies, procedures, and records. These documents encompass all aspects of the REMP including sample collection, equipment calibration, laboratory analysis and data review.

The QA program is designed to identify possible deficiencies so that immediate corrective action can be taken. It also provides a measure of confidence in the results of the monitoring program in order to assure the regulatory agencies and the public that the results are valid. The QA program for the measurement of radioactivity in environmental samples is implemented by:

- Auditing all REMP-related activities including analytical laboratories.
- Requiring analytical laboratories to participate in the USEPA Cross-Check Program.
- Requiring analytical laboratories to split samples for separate analysis (recounts are performed when samples cannot be split).
- Splitting samples, having the samples analyzed by independent laboratories, and then comparing the results for agreement.

- Reviewing QC results of the analytical laboratories including spike and blank sample results and duplicate analysis results.

The QA program and the results of the USEPA Cross-Check Program are outlined in Appendix E and F, respectively.

The TLD readers are calibrated monthly against standard TLDs to within five percent of the standard TLD values. Also, each group of TLDs processed by a reader contains control TLDs that are used to correct for minor variations in the reader. The accuracy and variability of the results for the control TLDs are examined for each group of TLDs to assure the reader is functioning properly. In addition, each element (TLD) has an individual correction factor based on its response to a known exposure.

Other cross-checks, calibrations, and certifications are in-place to assure the accuracy of the TLD program:

- Semiannually, randomly selected TLDs are sent to an independent laboratory where they are irradiated to set doses not known to GPU Nuclear. The GPU Nuclear dosimetry laboratory processes the TLDs and the results are compared against established limits.

- Every two years, each TLD is checked for response within 10 percent of a known value.

- Every two years, GPU Nuclear's dosimetry program is examined and recertified by the NIST National Voluntary Laboratory Accreditation Program (NVLAP).

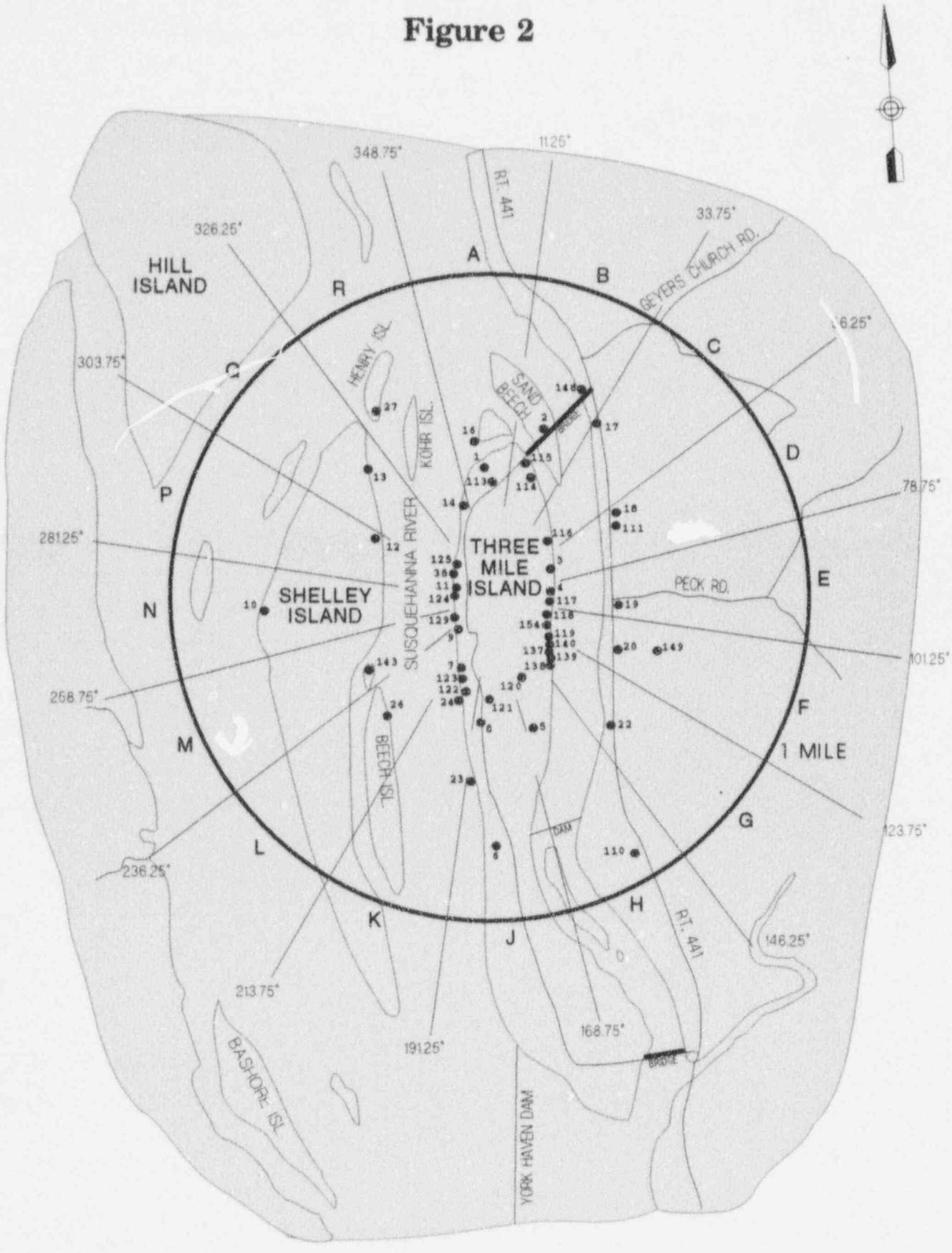
- Ten environmental TLD stations have vendor-supplied quality control badges which are processed by the vendor. The results are compared against GPU Nuclear TLD results.

The environmental dosimeters were tested and qualified to the American National Standard Institutes (ANSI) publication N545-1975 and the USNRC Regulatory Guide 4.13 (Refs. 34 and 35). The results for some of these tests were published in the Health Physics Journal (Ref. 36).

In addition to the GPU Nuclear REMP, the USNRC and the Pennsylvania State Bureau of Radiation Protection (PaBRP) also maintain surveillance programs in the TMI area. These programs provide independent assessments of radioactive releases and the radiological impact on the surrounding environment. The results from these programs have compared favorably with those from the GPU Nuclear program.

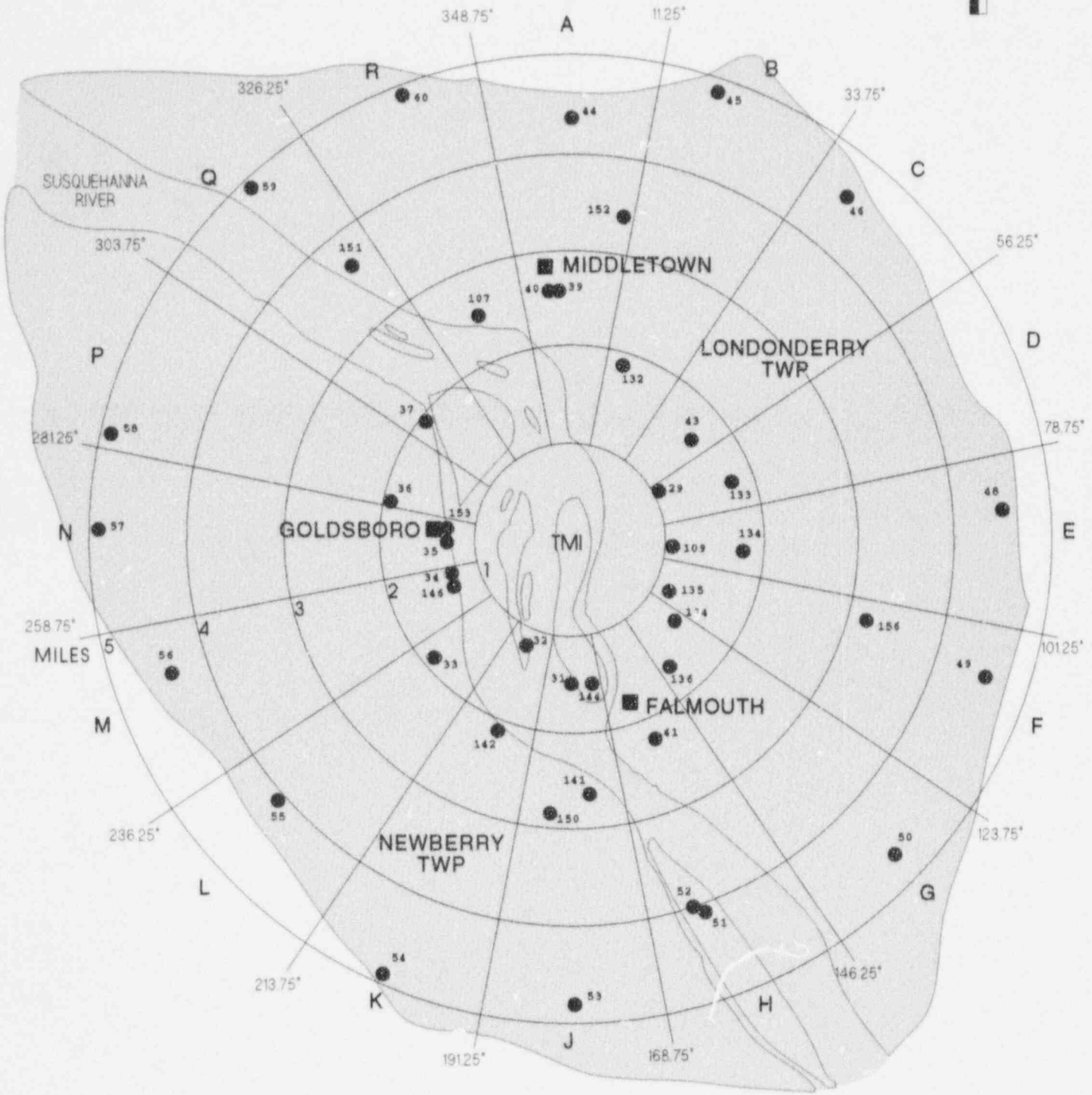
GPU Nuclear Three Mile Island Environmental Affairs Department collects and analyzes samples of the TMINS liquid discharge as a QC check for the inplant effluent sampling program. Results from these samples were consistent with the radioactivity measured inplant prior to release.

Figure 2



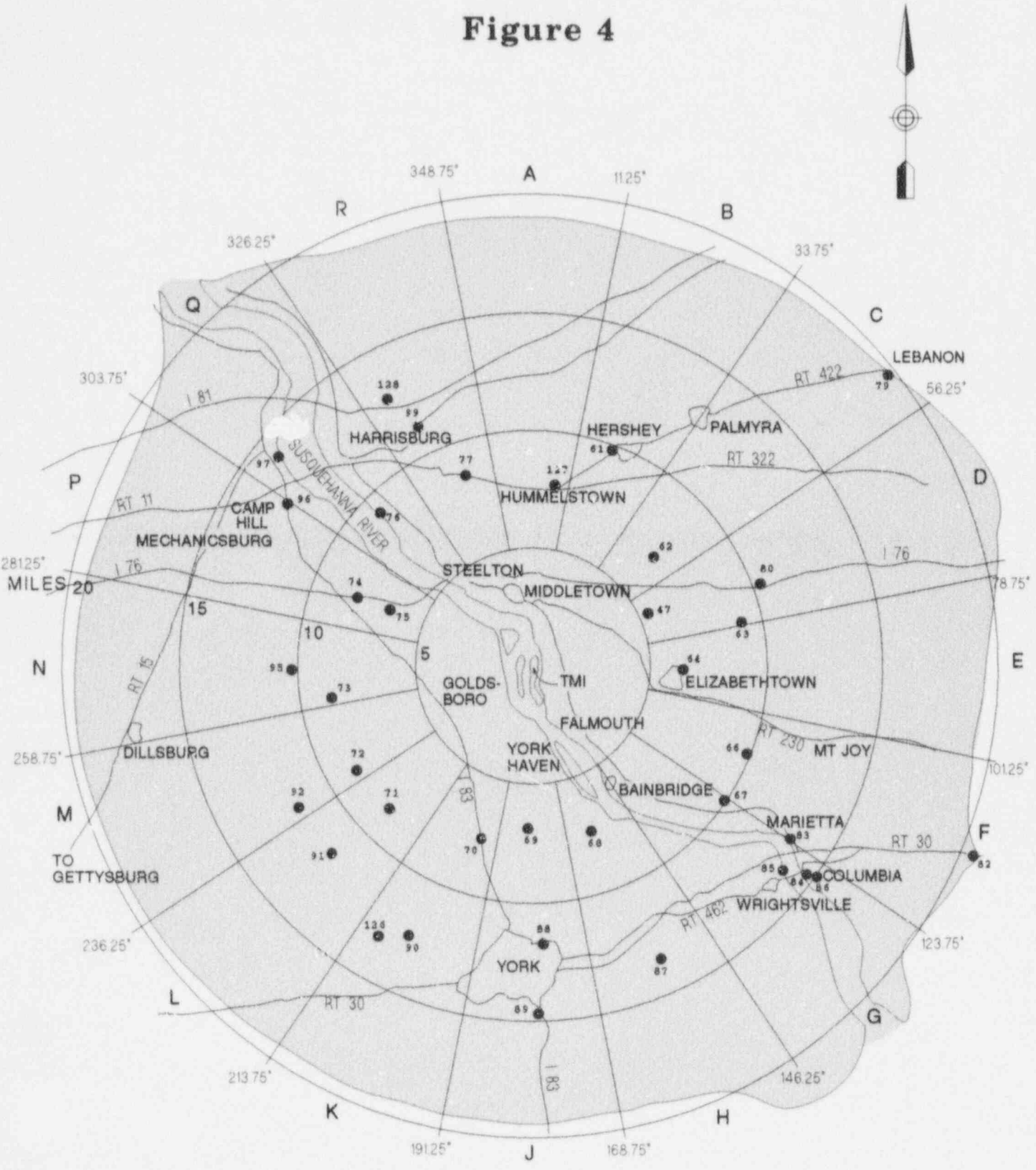
Locations of REMP Stations Within 1 Mile of TMINS

Figure 3



Locations of REMP Stations
1 to 5 Miles from TMINS

Figure 4



Locations of REMP Stations Greater Than 5 Miles From TMINS

TABLE 3

Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station[1]

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Air Iodine (pCi/m3)	I-131	623	0.07	ND(8)	---	---	ND	0
Air Particulates (pCi/m3)	Gr-Alpha	311	0.0015	1.4E-03 (132/207) (6.9E-04 - 2.8E-03)	J15-1, 12.6 mi S York Substation	1.5E-03 (29/52) (8.8E-04 - 3.1E-03)	1.4E-03 (60/104) (8.8E-04 - 3.1E-03)	0
	Gr-Beta	623	0.01	1.6E-02 (467/467) (3.7E-03 - 3.1E-02)	Q4-1, 3.7 mi NW Hbg Int Airport	1.7E-02 (52/52) (6.9E-03 - 2.7E-02)	1.6E-02(156/156) (5.6E-03 - 2.8E-02)	0
	Sr-89	24	0.0005	ND	---	---	ND	0
	Sr-90	24	0.0003	ND	---	---	ND	0
	Gamma Spec.	48						0
	Be-7		0.05	7.1E-02 (36/36) (4.2E-02 - 9.4E-02)	B1-4, 0.8 mi NNE N Gate Guard Shack, TMI	7.8E-02 (4/4) (6.1E-02 - 9.4E-02)	6.7E-02 (12/12) (4.0E-02 - 8.8E-02)	0
	Cs-134		0.01	ND	---	---	ND	0
	Cs-137		0.01	ND	---	---	ND	0
	K-40		0.02	1.1E-02 (1/36)	A3-1, 2.6 mi N Middletown Substation	1.1E-02 (1/4)	ND	0

Note: See footnotes at end of table.

TABLE 3

Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station[1]

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Fish (pCi/g, wet)	H-3	7	0.2	1.5E-01 (3/4) (8.9E-02 - 1.8E-01)	Indb, Indicator Bottom Feeder Below Discharge	1.7E-01 (1/2)	ND	0
	Sr-89	7	0.025	ND	---	---	ND	0
	Sr-90	7	0.005	2.3E-03 (2/4) (1.6E-03 - 3.1E-03)	Indp, Indicator Predator Below Discharge	2.3E-03 (2/2) (1.6E-03 - 3.1E-03)	1.4E-03 (2/3) (1.2E-03 - 1.6E-03)	0
	Gamma Spec.	7						0
	Co-58		0.13	ND	---	---	ND	0
	Co-60		0.13	ND	---	---	ND	0
	Cs-134		0.13	ND	---	---	ND	0
	Cs-137		0.13	ND	---	---	ND	0
	Fe-59		0.26	ND	---	---	ND	0

Note: See footnotes at end of table.

TABLE 3
Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station(1)

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Fish (pCi/g, wet)	K-40		0.50	2.9E+00 (4/4) (2.2E+00 -3.3E+00)	Bkgp, Control Predator Above Discharge	3.3E+00 (2/2) (3.3E+00 - 3.4E+00)	3.2E+00 (3/3) (2.8E+00 - 3.4E+00)	0
	Mn-54		0.13	ND	---	---	ND	0
	Zn-65		0.26	ND	---	---	ND	0
Aquatic Sediment (pCi/g, dry)	Sr-89	4	0.10	ND	---	---	ND	0
	Sr-90	4	0.05	ND	---	---	ND	0
	Gamma Spec.	10						0
	Sb-125		0.1	7.6E-02 (1/7)	K1-3, 0.3 mi SSW West Shore of TMI	7.6E-02 (1/3)	ND	0
	Th-232		0.2	1.3E+00 (7/7) (1.1E+00 - 1.5E+00)	J2-1, 1.5 mi S Above York Haven Dam	1.5E+00 (3/3) (1.4E+00 - 1.5E+00)	1.3E+00 (3/3) (1.1E+00 - 1.4E+00)	0
	Be-7		0.2	1.5E+00 (6/7) (1.2E+00 - 2.0E+00)	K1-3, 0.3 mi SSW West Shore of TMI	1.6E+00 (3/3) (1.3E+00 - 2.0E+00)	1.6E+00 (3/3) (6.5E-01 - 2.4E+00)	0

Note: See footnotes at end of table.

TABLE 3

Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station[1]

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Aquatic Sediment (pCi/g, dry)	Co-58		0.10	1.6E-02 (1/7)	K1-3, 0.3 mi SSW West Shore of TMI	1.6E-02 (1/3)	ND	0
	Co-60			8.0E-02 (4/7) (4.7E-02 - 1.4E-01)	K1-3, 0.3 mi SSW West Shore of TMI	9.1E-02 (3/3) (5.4E-02 - 1.4E-01)	ND	0
	Cs-134		0.15	1.4E-01 (7/7) (5.9E-02 - 3.3E-01)	K1-3, 0.3 mi SSW West Shore of TMI	2.0E-01 (3/3) (1.3E-01 - 3.3E-01)	ND	0
	Cs-137		0.15	6.7E-01 (7/7) (2.7E-01 - 1.4E+00)	K1-3, 0.3 mi SSW West Shore of TMI	1.0E+00 (3/3) (7.5E-01 - 1.4E+00)	1.2E-01 (3/3) (6.8E-02 - 1.7E-01)	0
	I-131		0.02	4.4E-02 (2/7) (2.6E-02 - 6.2E-02)	K1-3, 0.3 mi SSW West Shore of TMI	4.4E-02 (2/3) (2.6E-02 - 6.2E-02)	ND	0
	K-40		0.2	1.5E+01 (7/7) (1.1E+01 - 1.9E+01)	J2-1, 1.5 mi S Above York Haven Dam	1.7E+01 (3/3) (1.6E+01 - 1.9E+01)	1.3E+01 (3/3) (1.1E+01 - 1.5E+01)	0
	Ra-226		0.3	2.5E+00 (7/7) (2.1E+00 - 3.0E+00)	J2-1, 1.5 mi S Above York Haven Dam	2.7E+00 (3/3) (2.5E+00 - 3.0E+00)	2.2E+00 (3/3) (1.8E+00 - 2.6E+00)	0
Drinking Water (pCi/L)	Gr-Beta	60	2.0	2.8E+00 (30/36) (1.5E+00 - 4.4E+00)	G15-2, 13.6 mi SE Wrightsville Water Treatment Plant	2.9E+00 (12/12) (1.9E+00 - 4.4E+00)	2.6E+00 (19/24) (1.5E+00 - 4.1E+00)	0
	H-3	60	200	2.0E+02 (8/36) (1.1E+02 - 3.2E+02)	G15-1, 14.4 mi SE Columbia Water Treatment Plant	2.0E+02 (3/12) (1.2E+02 - 3.2E+02)	ND	0

Note: See footnotes at end of table.

TABLE 3

Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station[1]

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Drinking Water (pCi/L)	I-131	84	0.5	ND	---	---	ND	0
	Sr-89	10	1.0	ND	---	---	ND	0
	Sr-90	10	1.0	ND	---	---	ND	0
	Gamma Spec.	60						0
	Ba-140		60	ND	---	---	ND	0
	Co-58		15	ND	---	---	ND	0
	Co-60		15	ND	---	---	ND	0
	Cs-134		15	ND	---	---	ND	0
	Cs-137		15	ND	---	---	ND	0
	Fe-59		30	ND	---	---	ND	0
	La-140		15	ND	---	---	ND	0

Note: See footnotes at end of table.

TABLE 3

Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station[1]

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Drinking Water (pCi/L)	Mn-54		15	ND	---	---	ND	0
	Nb-95		15	ND	---	---	ND	0
	Zn-65		30	ND	---	---	ND	0
	Zr-95		30	ND	---	---	ND	0
Fruits (pCi/g, wet)	Gamma Spec.	13						0
	Cs-134		0.02	ND	---	---	ND	0
	Cs-137		0.02	ND	---	---	ND	0
	I-131		0.025	ND	---	---	ND	0
	K-40		0.4	2.0E+00 (11/11) (1.6E+00 - 2.6E+00)	A15-1, 10.5 mi N Farm on Route 39, Hummelstown	2.8E+00 (1/1)	2.5E+00 (2/2) (2.3E+00 - 2.8E+00)	0
Broad Leaf Vegetation (pCi/g, wet)	Sr-89	5	0.025	ND	---	---	ND	0

Note: See footnotes at end of table.

TABLE 3

Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station[1]

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Broad Leaf Vegetation (pCi/g, wet)	Sr-90	5	0.005	6.1E-03 (4/4) (2.8E-03 - 1.3E-02)	A15-1, 10.5 mi N Farm on Route 39, Hummelstown	2.9E-02 (1/1)	2.9E-02 (1/1)	0
	Gamma Spec.	5						0
	Be-7		0.1	1.6E-01(3/4) (6.3E-02 - 2.6E-01)	J2-2, 1.5 mi S South End of TMI	2.6E-01 (1/1)	1.9E-01 (1/1)	0
	Cs-134		0.02	ND	---	---	ND	0
	Cs-137		0.02	ND	---	---	ND	0
	I-131		0.025	ND	---	---	ND	0
	K-40		0.4	2.6E+00 (4/4) (1.5E+00 - 3.1E+00)	A15-1, 10.5 mi N Farm on Route 39, Hummelstown	3.7E+00 (1/1)	3.7E+00 (1/1)	0
Vegetables (pCi/g, wet)	Gamma Spec.	16						0
	Be-7		0.1	1.3E-01 (1/13)	F1-1, 0.5 mi ESE 500 kV Substation	1.3E-01 (1/2)	1.1E-01 (1/3)	0
	Cs-134		0.02	ND	---	---	ND	0

Note: See footnotes at end of table.

TABLE 3

Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station[1]

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Vegetables (pCi/g, wet)	Cs-137		0.02	ND	---	---	ND	0
	I-131		0.025	ND	---	---	ND	0
	K-40		0.4	3.3E+00 (13/13) (1.9E+00 - 5.4E+00)	F1-1, 0.5 mi ESE 500 kV Substation	3.9E+00 (2/2) (2.4E+00 - 5.4E+00)	3.3E+00 (3/3) (2.2E+00 - 3.9E+00)	0
Meat (Deer) (pCi/g, wet)	Gamma Spec.	3						0
	Cs-134		0.02	ND	---	---	ND	0
	Cs-137		0.02	ND	Bkg, Samples Obtained > 10 mi Away From TMI	5.5E-02 (1/1)	5.5E-02 (1/1)	0
	K-40		0.2	3.4E+00 (2/2) (3.4E+00 - 3.5E+00)	Ind, Samples Collected Within 10 miles of TMI	3.4E+00 (2/2) (3.4E+00 - 3.5E+00)	3.1E+00 (1/1)	0
Direct Radiation TLD (mR/std month)	Gamma	3042 (5)	--	4.4E+00 (2594/2594) (2.9E+00 - 7.5E+00)	H8-1, 7.4 mi SSE Saginaw Road Starview	7.2E+00 (32/32) (6.8E+00 - 7.5E+00)	4.9E+00 (448/448) 3.4E+00 - 6.9E+00)	0 0
Milk (cow) (pCi/L)	I-131	182	0.5	ND	---	---	ND	0

Note: See footnotes at end of table.

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Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station(1)

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Milk (cow) (pCi/L)	Sr-89	28	5.0	ND	---	---	ND	0
	Sr-90	28	1.0	1.4E+00 (24/24) (8.8E-01 - 2.8E+00)	A4-1, 3.3 mi N Dairy Farm	2.4E+00 (4/4) (2.0E+00 - 2.8E+00)	1.2E+00 (4/4) (8.2E-01 - 1.7E+00)	0
	Gamma Spec.	182						0
	Ba-140		60	ND	---	---	ND	0
	Cs-134		15	ND	---	---	ND	0
	Cs-137		15	ND	---	---	ND	0
	K-40		80	1.4E+03 (156/156) (1.2E+03 - 1.5E+03)	F4-1, 3.2 mi ESE Dairy Farm	1.4E+03 (26/26) (1.2E+03 - 1.5E+03)	1.4E+03 (26/26) (1.3E+03 - 1.5E+03)	0
	La-140		15	ND	---	---	ND	0
Surface Water (11) (pCi/L)	Gr-Beta	12	2.0	(10)	P1-3, 0.1 mi WNW TMI-1 Pretreatment Building, TMI	3.8E+00 (12/12) (1.9E+00 - 6.3E+00)	3.8E+00 (12/12) (1.9E+00 - 6.3E+00)	0
	H-3	48	200	4.5E+03 (12/12) (4.0E+02 - 3.0E+04)	J1-2, 0.5 mi S West Shore of TMI	4.5E+03 (12/12) (4.0E+02 - 3.0E+04)	ND	0

Note: See footnotes at end of table.

TABLE 3

Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station[1]

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Surface Water (11) (pCi/L)	I-131	84	0.5	ND	F15-1, 12.6 mi ESE Chickies Creek	7.5E-01 (4/28) (2.5E-01 - 2.1E+00)	6.4E-01 (23/84) (2.5E-01 - 2.1E+00)	0
	Sr-89	8	1.0	ND	---	---	ND	0
	Sr-90	8	1.0	ND	---	---	ND	0
	Gamma Spec.	48						0
	Ba-140		60	ND	---	---	ND	0
	Co-58		15	ND	---	---	ND	0
	Co-60		15	ND	---	---	ND	0
	Cs-134		15	ND	---	---	ND	0
	Cs-137		15	ND	---	---	ND	0
	Fe-59		30	ND	---	---	ND	0

Note: See footnotes at end of table.

TABLE 3

Summary of Radionuclide Concentrations in 1995 Environmental Samples from Three Mile Island Nuclear Station[1]

Media or Pathway Sampled (Unit of Measurement)	Analyses	Total Number of Analyses Performed(2)	Lower Limit of Detection LLD(3)	Indicator Locations Mean (F)(4) (Range)	Location with Highest Mean(9) Station Name Distance, Direction, and Description(6)	Mean (F)(4) (Range)	Control Locations Mean (F)(4) (Range)	Number of Reportable Results(7)
Surface Water (11) (pCi/L)	K-40		80	3.4E+01 (1/12)	P1-3, 0.1 mi WNW TMI-1 Pretreatment Building, TMI	5.0E+01 (1/12)	5.0E+01 (1/36)	0
	La-140		15	ND	---	---	ND	0
	Mn-54		15	ND	---	---	ND	0
	Nb-95		15	ND	---	---	ND	0
	Zn-65		30	ND	---	---	ND	0
	Zr-95		30	ND	---	---	ND	0

Notes:

(1) This table represents results from the primary (base) program. It does not include Quality Control (QC) results. The results listed are expressed in exponential form (i.e., 1.2E-2 = .012). Results from recounts supersede original results; reanalysis results supersede both original and/or recount results.

(2) The total number of analyses does not include duplicate analyses, recounts, or reanalyses.

(3) Technical Specification LLD is given when applicable. It should be noted that, in some cases, the TMINS REMP uses lower detection limits than required.

(4) (F) is the ratio of positive results to the number of samples analyzed. Means and ranges are based on detectable activities only.

(5) The number of analyses performed is the number of phosphors, (elements) analyzed. Each badge consists of two phosphors.

(6) All distances are measured from a point that is midway between the TMI-1 and TMI-2 reactor buildings.

(7) USNRC reporting levels as specified in the Technical Specifications.

(8) ND= Not Detected. All net sample concentrations were equal to or less than the minimum detectable concentrations (MDC).

(9) The location with the highest mean was determined using more than two significant figures.

(10) Analysis not performed.

(11) Sample results from TMINS liquid discharge point (Station K1-1A) were used as a check for the inplant effluent sampling program and therefore were not included in this table.

DIRECT RADIATION MONITORING

Radiation is a normal component of the environment resulting primarily from natural sources, such as cosmic radiation and naturally-occurring radionuclides, and to a lesser extent from manmade sources, such as fallout from prior nuclear weapon tests. The cessation of atmospheric nuclear weapon tests and the decay of fallout products have resulted in a gradual decrease in environmental radiation levels. Direct radiation monitoring measures ionizing radiation primarily from cosmic and terrestrial sources.

Gamma radiation exposure rates near TMINS were measured using thermoluminescent dosimeters (TLDs) and a real-time gamma radiation monitoring system. Over 100 TLD stations were arranged in roughly concentric rings around TMINS, with at least one station in each of the 16 compass sectors, at the site boundary; 1 mile; 2 miles; 5 miles; 8 miles; and 10 miles from the site. Those TLD stations more than 10 miles from the site were control stations, while those less than 10 miles from the site were indicator stations. Indicator stations were located to detect any potential effect of TMINS operations on environmental radiation

levels. The TLD network was supplemented by 16 real-time gamma radiation monitors located on and around the site. The TLDs were processed each calendar quarter, while the real-time gamma radiation monitors provided continuous 15 minute averages.

All gamma radiation exposure rates recorded during 1995 were within normal ranges and were consistent with previous results, except that slightly lower exposure rates were observed at some stations during the fourth quarter as compared to previous quarters. The lower exposure rates were attributed to the unusually heavy and persistent snow cover which was prevalent in December 1995 and January 1996 (the sampling period for the fourth quarter extended into January 1996). Snow cover can shield radiation emanating from the soil and rocks, reducing exposures observed at environmental TLD stations. Overall exposure rates were 0.2 to 0.4 mR/std month lower in the fourth quarter as compared to previous quarters.

For 1995, a change in the method used to calculate transit exposure for environmental TLDs was implemeted. Transit exposure is the radiation that the TLDs absorb while in storage or transit, awaiting deployment in the field or analysis in the lab. Transit exposure is substracted from the gross exposure as measured by the TLDs to yield the net exposure, which is presented in this report. This change was implemented to more closely conform to guidance given in ANSI N545 (Ref. 34). Details of this change are contained in the quarterly TLD reports. The net effect was a slight increase (approximately 0.2 mR/std month) in reported net exposure rates for 1995.

No relationship between TMINS operations and offsite exposure rates was detected at any station. The 1995 quarterly exposure rates for the individual TLD stations and a map showing onsite TLD station locations are contained in Appendix M.

Sample Collection and Analysis

A thermoluminescent dosimeter (TLD) is composed of a crystal (phosphor) which absorbs and stores energy in traps when exposed to ionizing radiation. These traps are so stable that they do not decay appreciably over time. When heated, the crystal emits light proportional to the amount of radiation received, and the light is measured to determine the integrated exposure. This process is referred to as thermoluminescence. The reading process 'rezeros' (anneals) the TLD and prepares it for reuse. The TLDs in use for environmental monitoring at TMINS are capable of accurately measuring exposures between 1 mR (well below normal environmental exposures for the quarterly monitoring periods) and 200 R.

Each TLD station consists of 4 TLD badges, each of which has 4 phosphors or elements. Since each TLD responds to radiation independently, this provides 16 independent detectors at each station. In addition, 10 stations have a vendor-supplied quality control TLD badge which has 4 independent detectors, for a total of 20 detectors at each station. The quality control badges are used as an independent check on the accuracy of the GPU Nuclear TLD results.

Of the 4 elements in GPU Nuclear's TLDs, 2 are composed of calcium sulfate and 2 are lithium borate. The calcium sulfate elements are shielded with a thin layer of lead making the response to different energies of gamma radiation more linear. The lead also shields the elements from beta radiation, making them sensitive to gamma radiation only. The 2 lithium borate elements are shielded differently to permit the detection of beta radiation as well as gamma. The combination of different phosphor materials, shielding, and multiple phosphors per badge permit quantification of both gamma and beta radiation. Only the calcium sulfate phosphors are used for environmental monitoring; however, the lithium borate elements can be used to evaluate beta exposures or as a backup to the calcium sulfate elements should more data be required.

Data from the TLDs were evaluated by obtaining the average of the usable element results at each station, and comparing the result to historical averages and ranges for the period of TMINS shutdown between the first quarter of 1980 and the third quarter of 1985. The averages and overall trends of the indicator and control stations were also compared with each other and with averages and trends obtained for the five year shutdown period.

All TLD exposure rate data presented in this report were normalized to a standard month (std month) to adjust for variable field exposure periods. A std month is 30.4 days. Several badges were used to quantify transit exposure during storage and handling of TLDs. Transit exposures were subtracted from gross field exposures to produce net field exposures.

The real-time gamma radiation monitors (Reuter-Stokes) are positioned around TMINS, one in each of the 16 compass sectors. They are located 0.1 to 3.5 miles from TMINS. The detectors are sensitive to gamma radiation only, and can detect exposure rates from 1 microroentgen per hour (μR/h) to 100 mR/h. At each station, exposure rate information is displayed continuously and recorded in a data logger. A microprocessor at each monitoring location collects and stores 15 minute averages from the detector. These 15 minute averages are then automatically collected every 4 hours (or more frequently if required) by a computer located in Harrisburg.

Since this is a real-time system, short-term variations in exposure rates can be measured. The system involves the use of sensitive and complex electronics, and data are occasionally lost or inaccurate due to electronic, electrical, or mechanical failures in system components. Since TLDs are not subject to these variables, the real-time gamma monitoring system is used only to supplement and backup the TLD monitoring program.

Results

In 1995, the average annual exposure rate for offsite indicator stations, which excludes stations located on the TMINS site boundary fence, was 4.6 $\pm$ 1.4 mR/std month. Quarterly exposure rates at offsite indicator stations ranged from 3.1 to 7.5 mR/std month. The average annual exposure rate for all control stations, those

stations farther than 10 miles from TMINS, was 4.9 ± 1.6 mR/std month. Quarterly exposure rates at control stations ranged from 3.4 to 6.9 mR/std month.

The 1995 exposure data are consistent with previous results, as average exposures at control stations typically have been slightly higher than average exposures at offsite indicator stations. This is a result of variation in the natural radioactive characteristics of rock and soil near the stations. The historical average exposure rate (for the period from 1980 to 1985, when TMINS did not operate) was 5.2 mR/std month for indicator stations and 5.7 mR/std month for control stations. Exposure rates at both indicator and control stations have been decreasing gradually due to the cessation of atmospheric nuclear weapon testing and the decay of fallout products.

Some indicator stations located on the site boundary fence can show elevated exposure rates, especially in Sectors E, F, and G. Stations in these sectors are located close enough to radioactive material transit and storage areas to be affected to some degree. In 1995, the average annual exposure rate for all indicator stations, including those stations located on the TMINS site boundary fence, was 4.4 ± 1.5 mR/std month. Quarterly average exposure rates ranged from 2.9 to 7.5 mR/std month.

Some onsite stations in Sections E, F, and G did show slightly elevated exposure rates for some of 1995, but average onsite exposure rates still were lower than is typical for offsite stations. This is consistent with previous results and is a function of the differing characteristics of the land surface and geology in the immediate vicinity of the TLD stations. Many onsite stations are located on or above manmade surfaces or structures, which may shield the TLDs from terrestial sources of radiation.

Exposure rates at stations on the site boundary fence vary with the movement of onsite radioactive materials, and with the number and placement of stations on the fence. Occasionally, stations on the fence may be moved or added to ensure comprehensive coverage of some areas. For these reasons, year-to-year comparisons between stations on the site boundary fence and other indicator or control stations usually are not appropriate.

In 1995, the highest annual average exposure rate of 7.2 mR/std month was measured at indicator Station H8-1. This annual average exposure rate of 7.2 mR/std month is typical for Station H8-1, and is consistent with the historical (1980-1985) exposure rate of 7.9 ± 1.4 mR/std month for Station H8-1.

Comparisons of exposure rates by distance ring and radial sector also were performed to test for potential effects of TMINS operations. Any effect of TMINS operations on offsite exposure rates should be evidenced by an increase in the ring averages closer to TMINS, or in the sector averages in predominant wind directions. For the 1995 data, ring or sector differences were not evident when compared to historical data.

TABLE 4

1995 Monthly Average Exposure Rates for Offsite Real-Time Gamma Radiation Monitoring Stations

Month	mR/std Month
January	5.6
February	5.5
March	5.5
April	5.6
May	5.5
June	5.5
July	5.5
August	5.5
September	5.7
October	5.6
November	5.6
December	5.3

Figure 5 is a plot of gamma exposure rates (as measured by TLDs) in the vicinity of TMINS from 1974 through 1995. Based on Figure 5, the trends in exposure rates at indicator stations were similar to those of control stations with the exception of 1979. As a result of the TMI-2 accident, a transitory increase in exposure rates from the release of noble gases was observed. Increases also were observed in both indicator and control stations in 1976, 1977, and 1978 as a result of nuclear weapon tests.

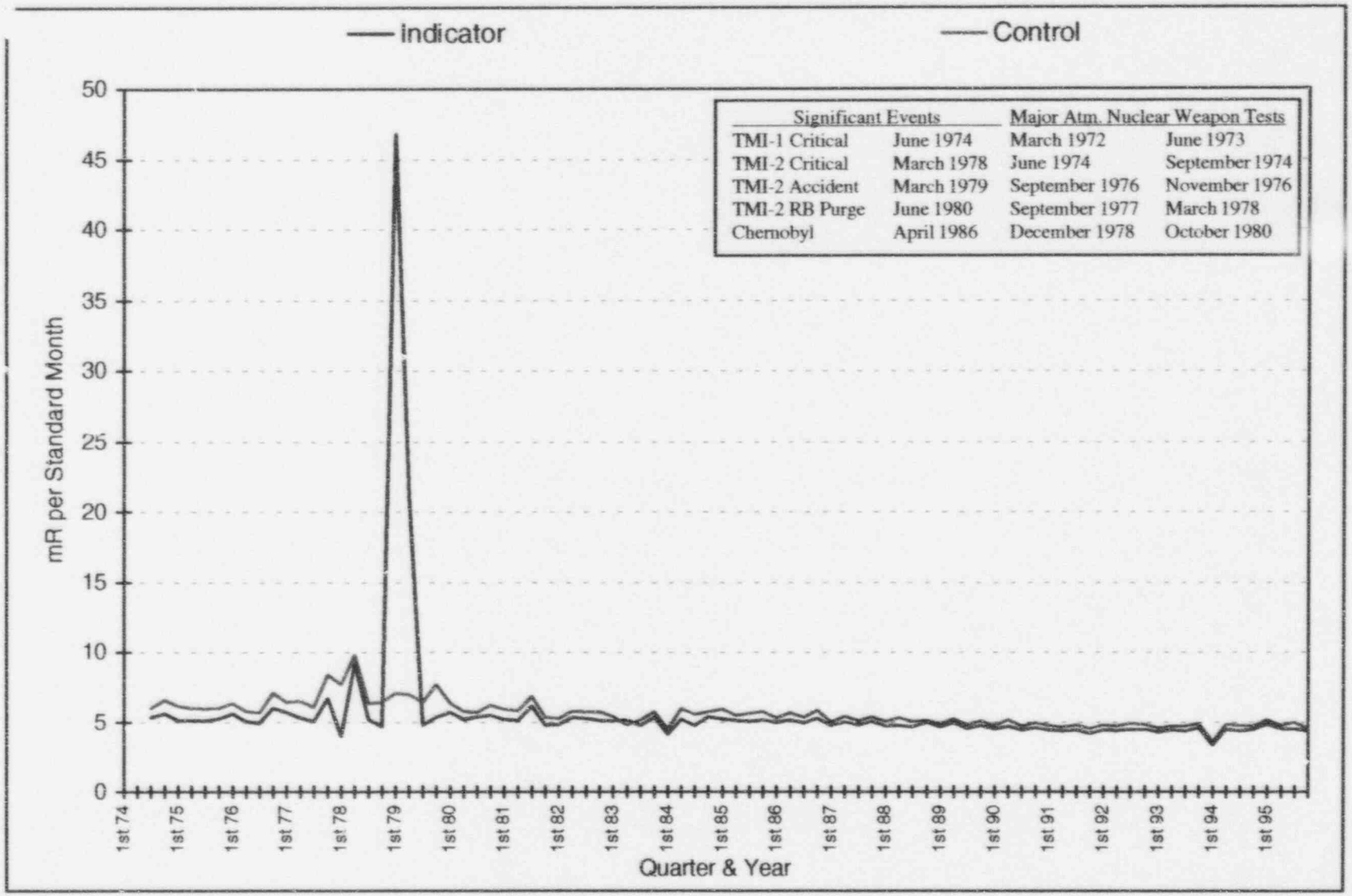
In 1995, the real-time gamma radiation monitoring system recorded an average exposure rate at offsite locations of 5.5 mR/std month, which is consistent with the 1994 offsite average of 5.3 mR/std month, but higher than the corresponding offsite TLD averages for 1995. Some difference between these two sets of results is expected because TLDs and the real-time monitors measure gamma radiation at different locations. Table 4 shows the monthly average exposure rates recorded by offsite real-time gamma radiation monitors.

For both TLDs and the real-time monitoring system, no elevated exposure rates as a result of TMINS operations were observed at any offsite station. Both TLDs and the real-time monitoring system are sensitive and accurate mechanisms for measuring the low exposure rates characteristic of environmental levels. Effects of normal TMINS operations, however, are too small to be discernible outside the normal range of background radiation levels.

The annual average gamma radiation exposure rates recorded at all offsite indicator TLD and real-time monitoring stations ranged from 4.6 to 5.5 mR/std month, which equates to an annual exposure of between 55 mR/yr and 66 mR/yr. Exposures of these magnitudes are consistent with the annual average radiation dose a person receives from cosmic and terrestrial sources (**Table 1, "Sources and Doses of Radiation"**).

Historical Gamma Exposure Rates

mR per Standard Month by Quarter



Significant Events		Major Atm. Nuclear Weapon Tests	
TMI-1 Critical	June 1974	March 1972	June 1973
TMI-2 Critical	March 1978	June 1974	September 1974
TMI-2 Accident	March 1979	September 1976	November 1976
TMI-2 RB Purge	June 1980	September 1977	March 1978
Chernobyl	April 1986	December 1978	October 1980

Figure 5

ATMOSPHERIC MONITORING

A potential exposure pathway to humans is inhalation of airborne radioactive materials. To monitor this exposure pathway, ambient air was sampled by a network of continuously operating samplers and then analyzed for radioactivity content. Based on the analytical results, no contribution to the general levels of airborne radioactivity was attributed to TMINS operations during 1995.

The indicator air sampling stations were located primarily in the prevailing downwind directions to the east (TMINS Visitors Center, Station E1-2), the east-southeast (500 kV Substation, Station F1-3), the southeast (dairy farm near Falmouth, Station G2-1), and the south-southeast (Falmouth, Station H3-1) of TMINS and in the nearby communities of Goldsboro (Station M2-1) and Middletown (Station A3-1). There were also indicator air sampling sites to the north-northeast (TMINS North Gate, Station E1-4), the south (Cly, Station J3-2) and the northwest (Harrisburg International Airport, Station Q4-1). The control air sampling stations, which were located greater than 9.5 miles from the site, provided background airborne radioactivity data for comparison. These stations were located in the distant communities of Marietta (Station G10-1), York

(Station J15-1) and West Fairview (Station Q15-1).

Sample Collection and Analysis

Mechanical air samplers were used to continuously draw a known volume of air through glass fiber filters and charcoal cartridges. To maintain a constant flow rate throughout the collection period, each sampler was equipped with an electronic mass flow controller. This device automatically adjusted the flow rate to compensate for dust loading and changes in atmospheric pressure and temperature. Total air volumes were measured and recorded with dry gas meters. Air volumes were then adjusted based on vacuum readings over the collection period. All air samplers were calibrated semiannually and maintained by instrumentation technicians.

The glass fiber filters were used to collect airborne particulate matter. The filters were collected weekly and analyzed for gross beta radioactivity. Six of these filters also were analyzed weekly for gross alpha radioactivity. The filters were then combined quarterly by individual station locations and analyzed for gamma-emitting radionuclides. Semiannually, the quarterly composites for each station were combined and analyzed for Sr-89 and Sr-90.

Cartridges containing activated charcoal were used for monitoring gaseous radioiodines. These cartridges were placed downstream of the particulate filter at each of the air sampling stations. Charcoal cartridges were collected weekly and analyzed separately from the particulate filters for I-131.

Air Results

During 1995, more than 600 air particulate samples (filters) were collected and analyzed for gross beta radioactivity. The particulate matter (dust particles) collected weekly on all indicator and control filters contained gross beta radioactivity above the minimum detectable concentration (MDC). The gross beta concentrations measured on the filters collected from indicator sites ranged from 0.0037 ± 0.0022 pCi/m^3 to 0.031 ± 0.004 pCi/m^3 and averaged 0.016 ± 0.009 pCi/m^3. The air particulate samples collected from the control locations had gross beta concentrations which ranged from 0.0056 ± 0.0023 pCi/m^3 to 0.028 ± 0.003 pCi/m^3 and also averaged 0.016 ± 0.009 pCi/m^3. These annual average gross beta concentrations were consistent with the 1994 averages of 0.016 ± 0.009 pCi/m^3 and 0.016 ± 0.008 pCi/m^3 for indicator and control air particulate samples, respectively.

The air sampling location with the highest annual average gross beta concentration (based on more than two significant figures) was indicator Station Q4-1 (Harrisburg International Airport). The average gross beta concentration for airborne particulates collected at this station was 0.017 ± 0.009 pCi/m^3. This average concentration was well below the preoperational average concentration of 0.15 ± 0.16 pCi/m^3 and, as shown on Table 5, was similar to the annual average gross beta concentrations calculated for particulate samples collected at the other air sampling sites.

As depicted in Figure 6, average weekly gross beta concentrations at indicator and control air monitoring locations were

analogous and trended similarly throughout the monitoring period. The weekly gross beta concentrations and trends at individual air sampling sites also were similar. The 1995 data indicated that gross beta radioactivity levels did not change as a result of TMINS operations. Additionally, the gross beta radioactivity associated with airborne particulates was due to naturally-occurring radionuclides.

Historical trends of average quarterly gross beta concentrations associated with airborne particulates from 1974 to 1995 are depicted in Figure 7. Generally, the gross beta concentrations have decreased with time. The 1995 average gross beta concentration of 0.016 pCi/m^3 is approximately 10% of the 1974 preoperational average concentration (0.15 pCi/m^3). The overall diminution in gross beta concentrations is a direct result of the ban on atmospheric nuclear weapon tests and the radioactive decay of fallout products from previous detonations. Elevated concentrations at both indicator and control air monitoring stations were noted after each major nuclear weapon test, the TMI-2 accident, and the Chernobyl accident. The trends for indicator and control stations were similar for the entire TMINS operational period.

The particulate filters collected weekly from six air sampling sites (Stations B1-4, H3-1, M2-1, Q4-1, J15-1 and Q15-1) also were analyzed for gross alpha radioactivity. During 1995, the particulate matter on approximately 62% of the filters (192 of 311) contained gross alpha radioactivity above the MDC. Air particulate gross alpha concentrations (detected above the MDC) at indicator stations ranged from 0.00069 $\pm$ 0.00053 pCi/m^3 to 0.0028 $\pm$ 0.0009 pCi/m^3 and averaged 0.0014 $\pm$ 0.0008 pCi/m^3. Control samples also averaged 0.0014 $\pm$ 0.0008 pCi/m^3 and ranged from 0.00088 $\pm$ 0.00059 pCi/m^3 to 0.0031 $\pm$ 0.0009 pCi/m^3. For comparison, gross alpha concentrations in 1994 indicator and control samples averaged 0.0014 $\pm$ 0.0008 pCi/m^3 and 0.0014 $\pm$ 0.0009 pCi/m^3, respectively.

The air sampling location with the highest annual average gross alpha concentration (based on more than two significant figures) was control Station J15-1 (York). The average gross alpha concentration for particulate samples collected at this site was 0.0015 $\pm$ 0.0008 pCi/m^3. As shown on Table 6, similar annual average gross alpha concentrations were calculated for the other five air particulate sampling sites.

As depicted in Figure 8 (upper), average weekly gross alpha concentrations at indicator and control stations remained relatively constant throughout the monitoring period. However, the weekly trends of gross alpha concentrations at indicator and control sites were not similar. This was caused by averaging only gross alpha concentrations which were above the MDC. When all sample concentrations were averaged, including those reported below the MDC (whether positive, negative or zero), the trends of average weekly gross alpha concentrations at indicator and control sites were more similar (Figure 8, lower).

The data obtained in 1995 indicated that gross alpha radioactivity levels did not change as a result of TMINS operations. Also, the gross alpha radioactivity

associated with airborne particulates was due to naturally-occurring radionuclides.

Historical trends of average quarterly gross alpha concentrations from 1972 through 1995 are displayed in Figure 9. Gross alpha concentrations during the preoperational period (1972-1974) averaged 0.001 pCi/m^3 with maximum concentrations up to 0.006 pCi/m^3. Although some of the operational concentrations were slightly higher than the preoperational average concentration, control sample concentrations were comparable to indicator sample concentrations. The overall trends for gross alpha concentrations in air particulates at indicator and control stations were similar throughout the TMINS operational period.

Gamma-emitting radionuclides related to TMINS operations were not detected on any of the quarterly composites (of weekly samples) that were analyzed in 1995. As expected, all of the quarterly composite samples contained naturally-occurring beryllium-7 (Be-7). Concentrations detected on indicator samples were similar to those detected on control filters. Also, naturally-occurring K-40 was detected on one primary program sample and three quality control samples.

Semiannual strontium analyses were performed on a total of 26 air particulate composite samples (including QC filters) during 1995. Neither Sr-89 nor Sr-90 was detected.

During 1995, more than 600 charcoal cartridges were collected weekly and analyzed for I-131. None of the weekly samples contained I-131 above the MDC.

TABLE 5

1995 Average Gross Beta Concentrations in Airborne Particulates (pCi/m^3)

Station	Description	Average +/- 2 std dev*
A3-1(I)	Middletown	0.017 ± 0.010
B1-4(I)	TMINS North Gate	0.017 ± 0.009
E1-2(I)	TMINS Visitors Center	0.017 ± 0.009
F1-3 (I)	500 kV Substation	0.015 ± 0.008
G2-1(I)	Dairy Farm (Near Falmouth)	0.015 ± 0.008
H3-1(I)	Falmouth	0.016 ± 0.010
J3-2(I)	Cly	0.016 ± 0.010
M2-1(I)	Goldsboro	0.016 ± 0.010
Q4-1(I)	Hbg. International Airport	0.017 ± 0.009
G10-1(C)	Dairy Farm (Marietta)	0.016 ± 0.008
J15-1(C)	York	0.016 ± 0.009
Q15-1(C)	West Fairview	0.017 ± 0.010

* Averages and standard deviations are based on concentrations > MDC.
(I) = Indicator Station (C) = Control Station

TABLE 6

1995 Average Gross Alpha Concentrations in Airborne Particulates (pCi/m^3)

Station	Description	Average +/- 2 std dev*
B1-4(I)	TMINS North Gate	0.0015 ± 0.0008
H3-1(I)	Falmouth	0.0014 ± 0.0009
M2-1(I)	Goldsboro	0.0014 ± 0.0008
Q4-1(I)	Hbg. International Airport	0.0015 ± 0.0007
J15-1(C)	York	0.0015 ± 0.0008
Q15-1(C)	West Fairview	0.0014 ± 0.0007

* Averages and standard deviations are based on concentrations > MDC.

(I) = Indicator Station (C) = Control Station

1995 Gross Beta Concentrations in Air Particulates

Picocuries per Cubic Meter by Week

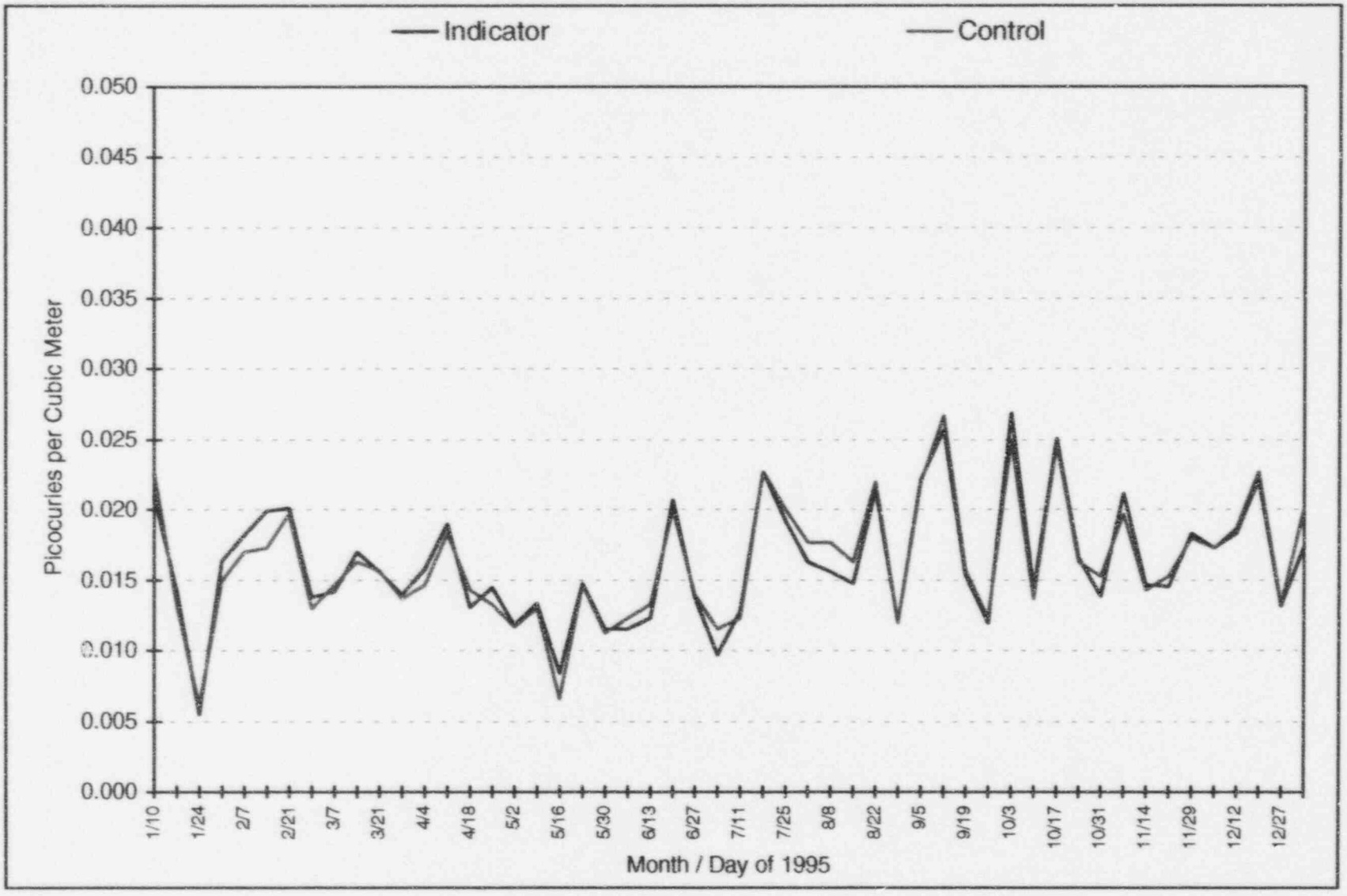


Figure 6

Historical Gross Beta Concentrations in Air Particulates

Picocuries per Cubic Meter by Quarter

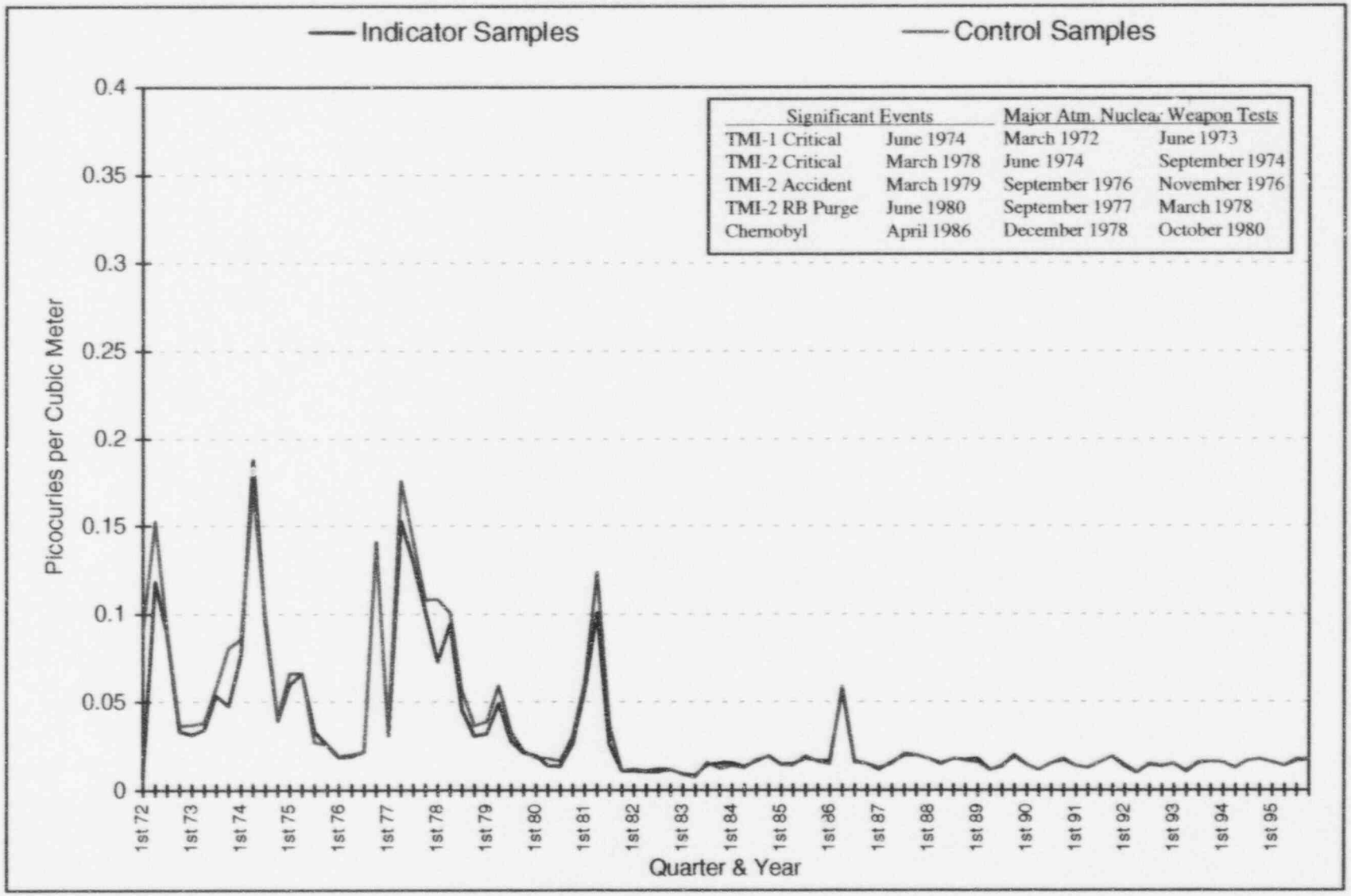


Figure 7

1995 Gross Alpha Concentrations in Air Particulates

Picocuries per Cubic Meter by Week

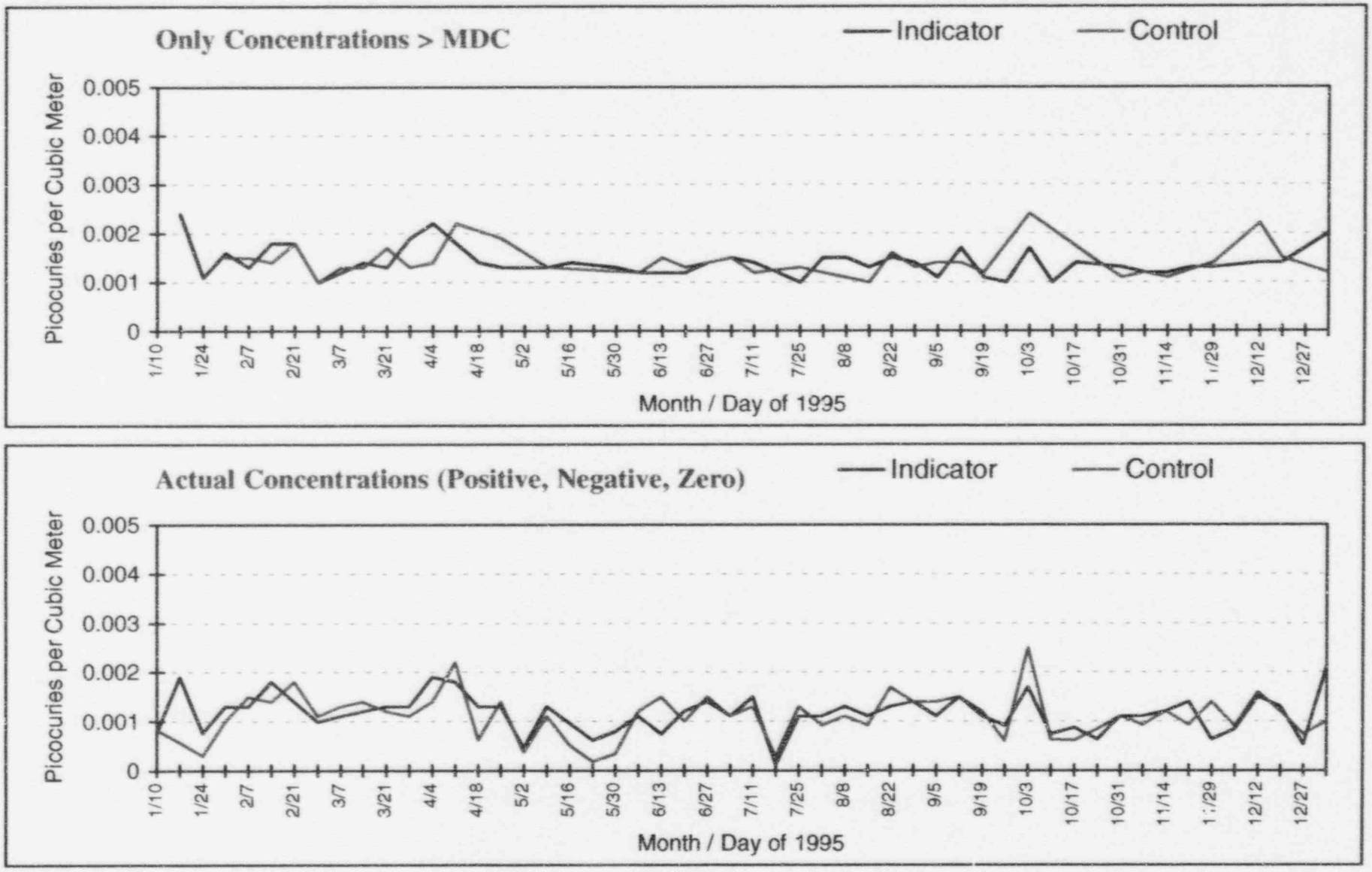


Figure 8

Historical Gross Alpha Concentrations in Air Particulates

Picocuries per Cubic Meter by Quarter

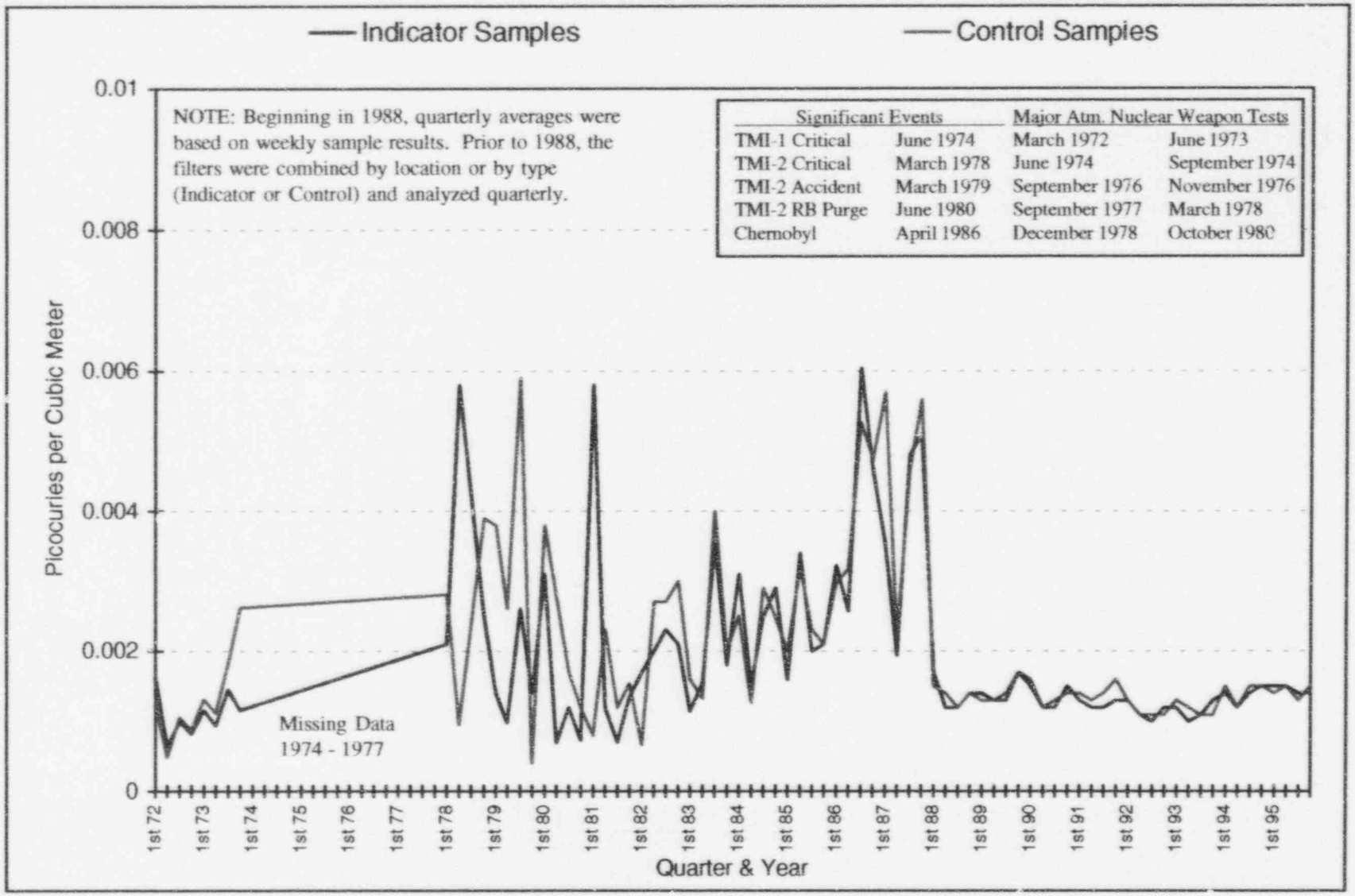


Figure 9

AQUATIC MONITORING

Since radioactive materials are released to the Susquehanna River from routine operations at TMINS and this watershed is used as a source for drinking water and recreational activities, the aquatic environment is monitored extensively for radionuclides of potential TMINS origin. Recreational activities in the TMI reach of the Susquehanna River include fishing, boating, swimming and other water sports.

Monitoring of the aquatic environment in the vicinity of TMINS was accomplished by collecting and analyzing samples of surface water, drinking water, finfish and river sediments. The indicator (downstream) sampling sites were chosen based on studies of travel time and mixing characteristics for the Susquehanna River. Control samples were collected from locations which were not expected to be affected by TMINS operations. The impact of TMINS operations was assessed by comparing control sample concentrations to those identified in indicator samples. As applicable, comparisons with results from previous years also were performed.

During 1995, samples from the aquatic environment were found to contain low concentrations of radioactive materials attributable to routine TMINS operations. They included H-3 in fish, surface water and drinking water and Co-58, Co-60, Sb-125, Cs-134 and Cs-137 in sediments. However, the concentrations found in these samples were too low to adversely impact humans or the environment. Radionuclides attributable to medical facilities, natural production in the atmosphere and fallout from prior nuclear weapon tests also were identified in various aquatic media.

Sample Collection and Analysis

Surface (raw/unfinished) and drinking (finished) water samples were collected at nine stations (four indicators and five controls) and analyzed during 1995. Samples of the TMINS liquid discharge (Station K1-1) also were collected and analyzed. As appropriate, data from the liquid discharge samples were compared with data obtained from samples collected as part of the TMINS Effluent Monitoring Program.

Indicator samples were collected from locations along the Susquehanna River which were downstream of the TMINS liquid discharge outfall. Indicator surface water samples were collected at one location, Station J1-2 (west shore of TMI). Indicator drinking water samples were collected at three water treatment facilities: Station G15-1 (Columbia Water Company, Columbia, PA), Station G15-2 (Wrightsville Water Supply, Wrightsville, PA) and Station G15-3 (Lancaster Water Authority, Columbia, PA).

Control samples were collected from the Susquehanna River upstream of the TMINS liquid discharge outfall or from its tributaries. Control surface water samples were collected from three locations: Station A3-2 (Swatara Creek, Middletown, PA), Station F15-1 (Chickies Creek, Marietta, PA) and Station P1-3 (TMI-1 Pretreatment Building). Control drinking water samples were obtained at two water treatment facilities: Station J15-2 (York Water Company, York, PA) and Station Q9-1 (Steelton Water Authority, Steelton, PA).

Except for those collected at Station F15-1 (Chickies Creek), all surface and drinking water samples normally were obtained by an automatic water compositor. Samples of the TMINS liquid discharge also were collected by an automatic water compositor. The water compositors collected a measured volume of water at a preset interval of time (30 or 60 minutes). These samplers were maintained and calibrated by instrumentation technicians.

The composite samples normally were retrieved biweekly (every two weeks). Occasionally, composite samples were retrieved weekly to close out a calendar quarter. The samples from Chickies Creek (Station F15-1) were collected twice per week as grabs and then composited into weekly or biweekly samples.

The weekly and biweekly composite samples from indicator Stations G15-3 and G15-2 along with those collected from control Stations Q9-1, F15-1, A3-2 and P1-3 were analyzed for low-level I-131

using a chemical separation/concentration technique. Samples of the TMINS liquid discharge also were analyzed for low-level I-131 employing the same technique.

All water samples retrieved weekly and biweekly were combined by station into monthly composites and analyzed for H-3 and gamma-emitting radionuclides, including I-131. Monthly gross beta analyses also were performed on all drinking water samples and the samples collected from Stations P1-3 and K1-1. Semiannual composite samples were prepared for each station from the monthly samples and then analyzed for Sr-89 and Sr-90.

Hook and line and/or trapnets were used to collect finfish samples in the Spring (May) and Fall (October). To monitor the progression of radionuclides through the food chain, bottom feeding finfish as well as predator species were collected. Indicator samples were collected from zones or areas immediately downstream of the TMINS liquid discharge outfall, while control specimens were gathered from locations greater than ten miles upstream of TMI. The edible portions were analyzed for Sr-89, Sr-90, H-3 and gamma-emitting radionuclides.

River sediments from three locations (two indicators and one control) were collected in the Spring (May) of 1995. In the Fall, sediments were collected at four locations (three indicators and one control) in October and at three locations (two indicators and one control) in November. In previous years, sediment samples were collected twice per year. A third collection was performed in November of 1995 to determine the scouring effects of an increased river flow. All 1995 sediment samples were collected using a dredge designed for this purpose.

Indicator sediment samples were collected at a site just downstream of the TMINS liquid discharge outfall (Station K1-3) and at the York Haven Dam (YHD), Station J2-1. A third indicator site, Station J1-2 (West Shore of TMI), was sampled in October. The control samples were obtained from the Susquehanna River just upstream of TMI (Station A1-3). All sediment samples were dried and analyzed for gamma-emitting radionuclides. The samples collected in October also were analyzed for Sr-89 and Sr-90.

As part of a special study, sediment samples also were collected in the vicinity of the Safe Harbor Dam (SHD). Obtained in November, these samples were dried and analyzed for gamma-emitting radionuclides.

Water Results

Iodine-131 is a constituent of TMI-1 liquid effluents. This radionuclide also is discharged to the Susquehanna River or its tributaries by medical facilities and their patients via the municipal sewage system. Institutions such as hospitals utilize this material for diagnostic studies of the thyroid and thyroid therapy.

During 1995, I-131 was detected in 23 control surface water samples and 1 quality control (QC) drinking water sample collected at a control location. Iodine-131 above the MDC also was identified in 17

samples collected from Station K1-1, the TMINS liquid discharge. None of the indicator surface or drinking water samples collected in 1995 contained I-131 above the MDC.

The I-131 concentrations measured in control surface water samples ranged from 0.25 ± 0.17 pCi/L to 2.1 ± 0.4 pCi/L and averaged 0.64 ± 0.91 pCi/L. For comparison, the average I-131 concentration for 1994 control surface water samples was 0.68 ± 0.59 pCi/L. The QC drinking water sample collected from control Station Q9-1 contained I-131 at a concentration of 0.33 ± 0.16 pCi/L. Medical sources were responsible for the presence of I-131 in all 1995 control surface and drinking water samples.

During 1995, 17 of 28 TMINS liquid discharge samples (weekly or biweekly composites) contained I-131 above the MDC. The I-131 concentrations ranged from 0.30 ± 0.24 pCi/L to 1.6 ± 0.4 pCi/L and averaged 0.78 ± 0.76 pCi/L. Several times throughout the monitoring period, I-131 was detected concurrently in control and liquid discharge samples at similar concentrations. The presence of I-131 during these periods was attributable to medical facilities and/or their patients.

Occasionally, I-131 was detected in a liquid discharge sample without being detected in a control sample or at a concentration which was somewhat higher than that measured in a control sample. The presence of I-131 in these samples was partially or wholly attributable to TMINS operations.

Although detected in liquid discharge samples, I-131 was not detected above the MDC in any of the indicator surface or drinking water samples collected during 1995. The indicator samples were obtained at locations where mixing with river water has occurred. Since none of the 1995 indicator drinking water samples contained I-131 above the MDC, a dose estimate for consuming water with I-131 was not performed.

Tritium above the MDC was identified in only one monthly (composite) control surface water sample. A duplicate analysis of the control surface water sample collected in December at Station P1-3 yielded an H-3 concentration of 150 ± 80 pCi/L. This H-3 concentration was consistent with those measured previously in control surface and drinking water samples. The presence of H-3 in the control sample was attributed to fallout from prior nuclear weapon tests and natural production of this material in the atmosphere.

As expected, H-3, a component of TMINS liquid effluents, was detected in all monthly surface water samples collected at indicator Station J1-2. This station is located just downstream of the TMINS liquid discharge outfall where mixing of liquid effluents with river water is incomplete. More complete mixing is not achieved until liquid effluents pass over the York Haven Dam (YHD).

The annual average H-3 concentration for the samples collected at Station J1-2 was 5000 ± 17000 pCi/L. The results ranged from 400 ± 80 pCi/L to 30000 ± 3000 pCi/L. For comparison, the H-3 concentrations detected in the samples collected at Station J1-2 in 1994 ranged

from 220 ± 90 pCi/L to 5700 ± 600 pCi/L and averaged 1500 ± 3900 pCi/L.

The yearly average concentration and monthly maximum concentration were biased high by a grab sample with a relatively high concentration of H-3. Collected in January during a TMI-1 liquid release, the grab sample was obtained because the sample line of the automatic water compositor was frozen. Although representing only a snapshot of time, the grab sample was about 20% of the January composite sample.

If the automatic compositor had been operating, the amount of water collected during the TMI-1 liquid release would have constituted only about 1.5% of the monthly volume. Consequently, the H-3 concentration in the January sample collected at Station J1-2 would have been much lower. Also, the annual average H-3 concentration for samples collected at this station during 1995 would have been lower.

Figure 10 depicts the 1995 monthly trends of H-3 concentrations in surface water samples collected at Station J1-2. For comparison, the monthly H-3 concentrations detected in the TMINS liquid discharge samples also are depicted in Figure 10. Like the January J1-2 result, the January K1-1 result was biased high by a grab sample which was collected during the release of a relatively high amount of H-3. As shown by Figure 10, the H-3 concentrations found in the samples obtained from Station J1-2 were directly related to those detected in the TMINS liquid discharge samples (Station K1-1). Historical trends of H-3 concentrations in surface water are shown in Figure 11.

A dose estimate was not performed for H-3 in surface water because this medium normally is not consumed by humans. All but one of the H-3 concentrations measured in surface water during 1995 were below the USEPA Primary Drinking Water Standard of 20,000 pCi/L. The lone exception was the sample collected in January at Station J1-2. As mentioned previously, the sample concentration was biased high by a grab taken during a release.

The H-3 concentrations measured in drinking water (8 indicators and 1 control sample) during 1995 were similar to those from previous years. Tritium above the MDC was measured only in one control drinking water sample. The quality control (QC) sample collected at control Station Q9-1 contained H-3 at a concentration of 230 ± 120 pCi/L. The presence of H-3 in this sample was attributed to fallout from prior weapon tests and natural production of this material in the atmosphere.

Indicator drinking water samples collected from Stations G15-1 (3 of 12 samples) and G15-3 (5 of 12 samples) contained H-3 above the MDC. The H-3 concentrations averaged 200 ± 160 pCi/L and ranged from 110 ± 70 pCi/L to 320 ± 90 pCi/L. The 1995 sample results were consistent with 1994 results which averaged 230 ± 220 pCi/L and ranged from 120 ± 70 pCi/L to 400 ± 100 pCi/L.

Figure 12 displays the monthly H-3 concentrations measured in the 1995 indicator drinking water samples. For

comparison, monthly H-3 results from samples collected at Station K1-1 (TMINS liquid discharge) also are included. Table 7 lists the annual average H-3 concentrations for the samples collected at each surface and drinking water station. For comparison, annual average concentrations based on actual sample concentrations (whether positive, negative or zero) also are included in Table 7.

Except for the H 3 which was detected in the July samples, most or all of the H-3 identified in indicator drinking water samples was attributed to fallout and natural production since similar H-3 concentrations were detected in control water samples collected in 1995 or in previous years. However, since H-3 was released routinely in TMINS liquid effluents and not detected routinely in 1995 control samples, a portion of the H-3 detected in the indicator drinking water samples also may have been due to TMINS operations.

As shown in Figure 12, the samples collected in July from indicator Stations G15-1 and G15-3 contained the highest H-3 concentrations (320 $\pm$ 90 pCi/L and 310 $\pm$ 90 pCi/L, respectively) for the monitoring period. A portion of the H-3 detected in these samples was attributable to TMINS operations; a portion also was attributable to fallout and natural production. The higher concentrations in the July samples were expected because relatively high amounts of H-3 were released in TMINS liquid effluents and river flows were low. Low river flows minimize the amount of mixing between liquid effluents and river water.

To put these results into perspective, the highest H-3 concentration measured in an indicator drinking water sample represented less than 2% of the USEPA Primary Drinking Water Standard. Furthermore, if an individual consumed water at this concentration for an entire year, the whole body dose (0.033 mrem) would be equivalent to 0.011% of the dose that an individual living in the TMI area receives in one year from natural background radiation (300 mrem).

The monthly composites of all drinking water, surface water from Station P1-3 (TMI-1 Pretreatment Building) and the TMINS liquid discharge were analyzed for gross beta activity. Table 8 lists the annual average gross beta concentrations for drinking and surface water stations. The indicator drinking water samples collected in 1995 had an annual average gross beta concentration of 2.8 $\pm$ 1.6 pCi/L, while the average concentration for 1995 control drinking water samples was 2.6 $\pm$ 1.6 pCi/L. The 1995 averages were consistent with the 1994 averages of 2.7 $\pm$ 1.1 pCi/L and 2.4 $\pm$ 1.6 pCi/L for indicators and controls, respectively.

The monthly gross beta averages for indicator and control drinking water are plotted in Figure 13. Indicator and control sample concentrations trended similarly throughout the year. All of the drinking water results for 1995 were well below the Federal and State Primary Drinking Water Standard of 50 pCi/L for gross beta radioactivity.

The 1995 average gross beta concentration for samples collected from Station P1-3 (TMI-1 Pretreatment Building) was similar

to the average concentration calculated for samples collected from Station K1-1 (TMINS Liquid Discharge). The average gross beta concentrations were 3.8 ± 3.0 pCi/L and 5.3 ± 5.1 pCi/L, respectively. Similar average concentrations were calculated in 1994 for samples collected from Station P1-3 (3.6 ± 3.5 pCi/L) and Station K1-1 (4.7 ± 3.5 pCi/L). Like drinking water, all samples collected from Stations P1-3 and K1-1 had gross beta concentrations well below the Federal and State Primary Drinking Water Standard of 50 pCi/L.

Monthly composite samples of surface and drinking water were analyzed for the presence of gamma-emitting radionuclides. Monthly samples of the TMINS liquid discharge also were analyzed for gamma-emitting radionuclides. None of the 1995 samples contained detectable levels of reactor-produced gamma-emitting radionuclides. Only naturally-occurring K-40 was detected.

Semiannual composite samples were prepared from monthly composites and then analyzed for the presence of Sr-89 and Sr-90. During 1995, none of the surface or drinking water samples contained detectable levels of Sr-89 or Sr-90. Additionally, Sr-89 and Sr-90 were not detected in semiannual composite samples which were prepared from the monthly TMINS liquid discharge samples.

Fish Results

In May and October of 1995, fish samples were collected at indicator and control locations. They included recreationally important predators (smallmouth bass, rock bass and white crappie) and bottom feeders (yellow bullhead and channel catfish). Control bottom feeders were unavailable in the Fall. All samples were analyzed for gamma-emitting radionuclides, Sr-89, Sr-90, and H-3.

As expected, naturally-occurring K-40 was detected in all of the fish samples. Reactor-related gamma-emitting radionuclides were not present above the MDC in any of the 1995 fish samples.

Strontium-89 was not detected above the MDC in any of the 1995 fish samples. Strontium-90 was measured in two indicator (Spring and Fall predators) and two control samples (Spring and Fall predators). Indicator sample concentrations averaged 0.0023 ± 0.0021 pCi/g (wet) and ranged from 0.0016 ± 0.0004 pCi/g (wet) to 0.0031 ± 0.0010 pCi/g (wet). Strontium-90 concentrations in control samples averaged 0.0014 ± 0.0006 pCi/g (wet) and ranged from 0.0012 ± 0.0007 pCi/g (wet) to 0.0016 ± 0.0009 pCi/g (wet). Since the indicator and control sample concentrations were similar, the presence of Sr-90 in all 1995 fish samples was attributed to fallout from past nuclear weapon tests.

Tritium was detected in the indicator samples collected in the Spring (predators and bottom feeders) and Fall (predators only). The H-3 concentrations ranged from 0.089 ± 0.032 pCi/g (wet) to 0.18 ± 0.07 pCi/g (wet) and averaged 0.15 ± 0.10 pCi/g (wet).

Since H-3 was identified in indicator

samples and not in the controls, a portion of the H-3 measured in the indicator samples possibly was attributable to routine TMINS operations. A portion of the H-3 detectable in these samples was attributable to fallout and natural production in the atmosphere.

A conservative dose estimate was performed assuming that an individual consumed fish flesh with the highest H-3 concentration for one year. The maximum hypothetical whole body dose was 0.00040 mrem. This dose is equivalent to 0.00013% of the dose that an individual living in the TMI area receives each year from natural background radiation.

Sediment Results

In May, October, and November of 1995, aquatic sediment samples were taken from the Susquehanna River upstream and downstream of the TMINS liquid discharge outfall. All samples were analyzed for gamma-emitting radionuclides. The samples collected in October also were analyzed for Sr-89 and Sr-90.

Strontium-89 and Sr-90 were not detected above the MDC in any of the 1995 sediment samples.

Naturally-occurring Be-7, Ra-226, K-40, thorium-232 (Th-232) as well as fallout Cs-137 were identified in both indicator and control samples. Indicator samples also contained radionuclides associated with TMINS operations. They included Co-58, Co-60, Sb-125, Cs-134 and Cs-137.

Iodine-131, another reactor-produced material, also was detected in several indicator samples collected in 1995. Its presence, however, probably was unrelated to TMINS operations because control water samples collected during the same time period also contained I-131. Rather, the presence of this material in the indicator sediment samples more likely was due to medical facilities and/or their patients.

Annual average Cs-137 concentrations for indicator and control samples were 0.67 $\pm$ 0.83 pCi/g (dry) and 0.12 $\pm$ 0.10 pCi/g (dry), respectively. Indicator sample concentrations ranged from 0.27 $\pm$ 0.03 pCi/g (dry) to 1.4 $\pm$ 0.1 pCi/g (dry). Control sample concentrations were somewhat lower and ranged from 0.068 $\pm$ 0.020 pCi/g (dry) to 0.17 $\pm$ 0.04 pCi/g (dry). For comparison, 1994 average Cs-137 concentrations were 0.22 $\pm$ 0.07 pCi/g (dry) and 0.090 $\pm$ 0.055 pCi/g (dry), for indicators and controls, respectively.

As expected, the samples collected just downstream of the TMINS liquid discharge outfall (Station K1-3) contained the highest concentrations of Cs-137 as well as Co-58, Co-60, Sb-125 and Cs-134. The Cs-137 concentrations averaged 1.0 $\pm$ 0.7 pCi/g (dry) and ranged from 0.75 $\pm$ 0.07 pCi/g (dry) to 1.4 $\pm$ 0.1 pCi/g (dry).

Cesium-137 is a fallout product of weapons testing as well as a constituent of TMINS liquid effluents. Since the 1995 indicator sample concentrations were higher than those measured in the control samples and other reactor-related materials (e.g. Co-58, Co-60 and/or Cs-134) also were present, an increment of the Cs-137 detected in the

indicator samples was attributable to TMINS operations.

Figure 14 depicts Cs-137 concentrations in river sediments from 1984 through 1995. As shown in this figure, no discernible buildup of Cs-137 occurred at indicator locations prior to 1995. This was primarily due to periodic scouring or removal of bottom sediments during high river flows (Ref. 18). High river flows typically are caused by snow melts in the Spring and large amounts of rainfall.

Even though the amounts of Cs-137 and Cs-134 released in TMINS liquid effluents were similar to or below that released in 1993 and 1994, a buildup of Cs-137 and Cs-134 occurred in 1995 (Figure 14). Considered to be temporary, the buildup was caused primarily by lower than normal river flows during 1995 and especially in the spring months when most of the scouring occurs.

As shown in Figure 14, the average Cs-137 concentration in November indicator samples trended downward. The reduction was due to a moderately high river flow which occurred just prior to the collection of the November samples. A very high river flow, such as the one experienced in January of 1996, should scour bottom sediments more completely in the York Haven Pond (YHP) and should further reduce the amount of TMINS-related materials detected in indicator sediments. Sediments which are scoured from the YHP and then transported downstream, will be diluted or mixed with sediments not impacted by TMINS operations.

Cesium-134 was detected consistently above the MDC in all indicator sediment samples collected during 1995 and was attributable to TMINS operations. This radionuclide was not measured above the MDC in any of the 1995 control samples. The indicator results averaged 0.14 $\pm$ 0.18 pCi/g (dry) and ranged from 0.059 $\pm$ 0.017 pCi/g (dry) to 0.33 $\pm$ 0.03 pCi/g (dry). For comparison, the 1994 sample results averaged 0.062 $\pm$ 0.050 pCi/g (dry) and ranged from 0.038 $\pm$ 0.015 pCi/g (dry) to 0.089 $\pm$ 0.013 pCi/g (dry). As explained previously, the higher Cs-134 concentrations measured in 1995 indicator samples resulted from lower river flows which minimized scouring of bottom sediments.

Cobalt-58 and Sb-125 at concentrations of 0.016 $\pm$ 0.009 pCi/g (dry) and 0.076 $\pm$ 0.038 pCi/g (dry) were measured only in the Spring (May) sample collected at Station K1-3. All three samples collected from Station K1-3 and one sample collected in October from Station J2-1 contained Co-60 above the MDC. The Co-60 concentrations averaged 0.080 $\pm$ 0.084 pCi/g (dry) and ranged from 0.047 $\pm$ 0.020 pCi/g (dry) to 0.14 $\pm$ 0.02 pCi/g (dry). The presence of Co-58, Co-60 and Sb-125 in the 1995 indicator samples was attributable to TMINS operations.

Based on average concentrations of Co-58, Co-60, Sb-125, Cs-134 and Cs-137 in samples collected from Station K1-3, an estimate of the shoreline exposure to the maximally exposed individual was calculated. For this calculation, Cs-137 results were adjusted to account for fallout present in the samples. The calculated

exposure of 0.0044 mrem/yr was a small percentage (0.0015%) of the dose received by an individual from natural background radiation (300 mrem/yr).

As part of an ongoing special study which began in 1993, sediment samples also were collected in 1995 at the Safe Harbor Dam (SHD). The purpose of this study is to determine if radionuclides released into the Susquehanna River by TMINS are present at SHD - the first major sediment trap downstream of TMINS. To date, the results of the study have indicated that a portion of the Cs-137 detected in the samples collected proximal to the SHD may be due to TMINS operations since the Cs-137 concentrations were higher than those collected at control sample locations. However, the absence of detectable Co-58, Co-60 and especially Cs-134 has indicated that recent TMINS discharges were not present at significant levels and most of the detectable Cs-137 was attributable to fallout from prior nuclear weapon tests and/or the Chernobyl Accident of 1986. The results also indicated that a buildup of TMINS-related materials is not occurring at the SHD.

TABLE 7

1995 Average Tritium Concentrations in Surface and Drinking Water (pCi/L)

Station	Description	Sample Concentrations > MDC [1] Average +/- 2 std dev	Sample Concentrations > MDC [1] Range	Actual Sample Concentrations [2] Average +/- 2 std dev	Actual Sample Concentrations [2] Range
	Surface Water				
A3-2 (C)	Swatara Creek (Middletown, PA)	[3]	[3]	30 ± 120	(-62) - 100
P1-3 (C)	TMI-1 Pretreatment Building	[3]	[3]	30 ± 110	(-83) - 100
F15-1 (C)	Chickies Creek (Marietta, PA)	[3]	[3]	30 ± 130	(-110) - 130
J1-2 (I)	West shore of TMI	5000 ± 17000	400 - 30000	5000 ± 17000	400 - 30000
	Drinking Water				
Q9-1 (C)	Steelton Water Authority (Steelton, PA)	[3]	[3]	34 ± 68	(-24) - 82
J15-2 (C)	York Water Company (York, PA)	[3]	[3]	30 ± 110	(-69) - 110
G15-1 (I)	Columbia Water Company (Columbia, PA)	200 ± 210	120 - 320	80 ± 190	(- 1) - 320
G15-2 (I)	Wrightsville Water Supply (Wrightsville, PA)	[3]	[3]	42 ± 87	(-57) - 99
G15-3 (I)	Lancaster Water Authority (Columbia, PA)	190 ± 150	110 - 310	120 ± 180	(- 2) - 310

[1] Averages and ranges are based on sample results above the minimum detectable concentration (MDC). Duplicate analysis results and quality control sample results are not included.

[2] Averages and ranges are based on actual (net) sample concentrations (whether positive, negative or zero). Negative sample concentrations are enclosed in parentheses. Using actual sample concentrations (sample count rate minus background or blank count rate) eliminates biases such as those caused by averaging only sample concentrations above the MDC. Negative sample concentrations are important to the overall average, but have no physical significance. Duplicate analysis results and quality control sample results are not included.

[3] All monthly sample results were less than the MDC.

(C) = Control (I) = Indicator

TABLE 8

1995 Average Gross Beta Concentrations in Surface and Drinking Water (pCi/L)

Station	Description	Sample Concentrations > MDC [1] Average +/- 2 std dev	Range	Actual Sample Concentrations [2] Average +/- 2 std dev	Range
		Surface Water			
P1-3 (C)	TMI-1 Pretreatment Building	3.8 ± 3.0	1.9 - 6.3	3.8 ± 3.0	1.9 - 6.3
		Drinking Water			
Q9-1 (C)	Steelton Water Authority (Steelton, PA)	2.9 ± 1.8	1.6 - 4.1	2.3 ± 2.4	0.8 - 4.1
J15-2 (C)	York Water Company (York, PA)	2.4 ± 1.2	1.5 - 3.4	2.3 ± 1.3	1.4 - 3.4
G15-1 (I)	Columbia Water Company (Columbia, PA)	2.5 ± 1.5	1.5 - 3.8	2.2 ± 1.8	1.0 - 3.8
G15-2 (I)	Wrightsville Water Supply (Wrightsville, PA)	2.9 ± 1.7	1.9 - 4.4	2.9 ± 1.7	1.9 - 4.4
G15-3 (I)	Lancaster Water Authority (Columbia, PA)	2.7 ± 1.5	2.0 - 4.3	2.3 ± 2.1	0.7 - 4.3

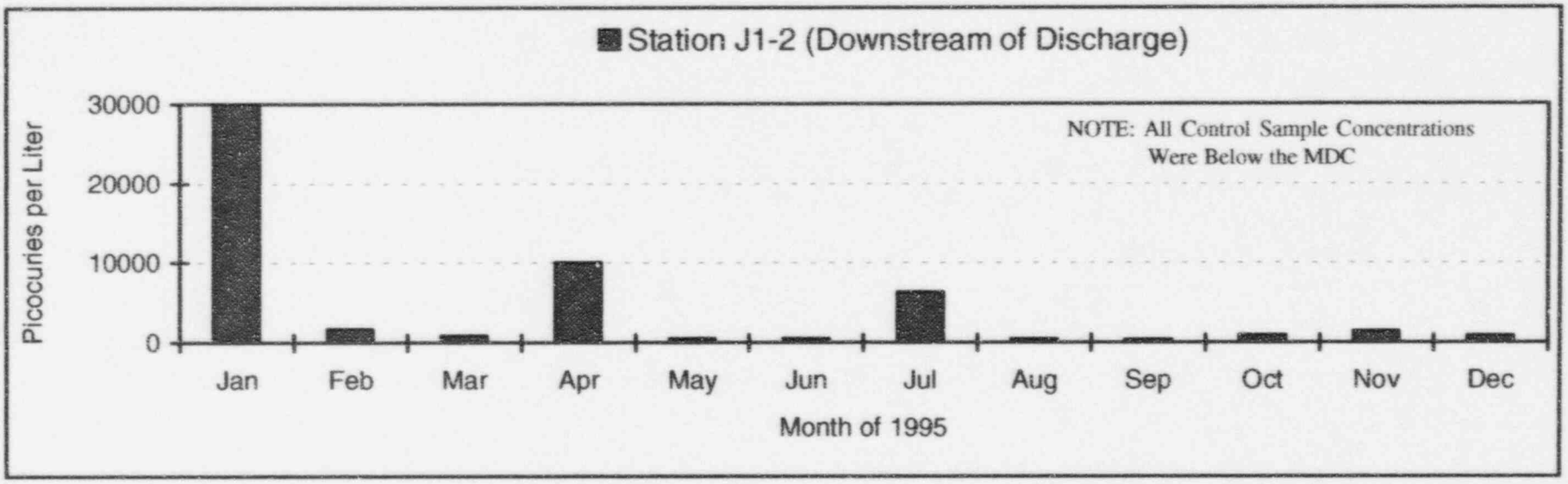
(1) Averages and ranges are based on sample results above the minimum detectable concentration (MDC). Duplicate analysis results and quality control sample results are not included.

(2) Averages and ranges are based on actual (net) sample concentrations (whether positive, negative or zero). Using actual sample concentrations (sample count rate minus background or blank count rate) to calculate annual averages eliminates biases such as those caused averaging only sample concentrations above the MDC. Negative sample concentrations are important to the overall average, but have no physical significance. Duplicate analysis results and quality control sample results are not included.

(C) = Control (I) = Indicator

1995 Tritium Concentrations in Surface Water

Picocuries per Liter by Month



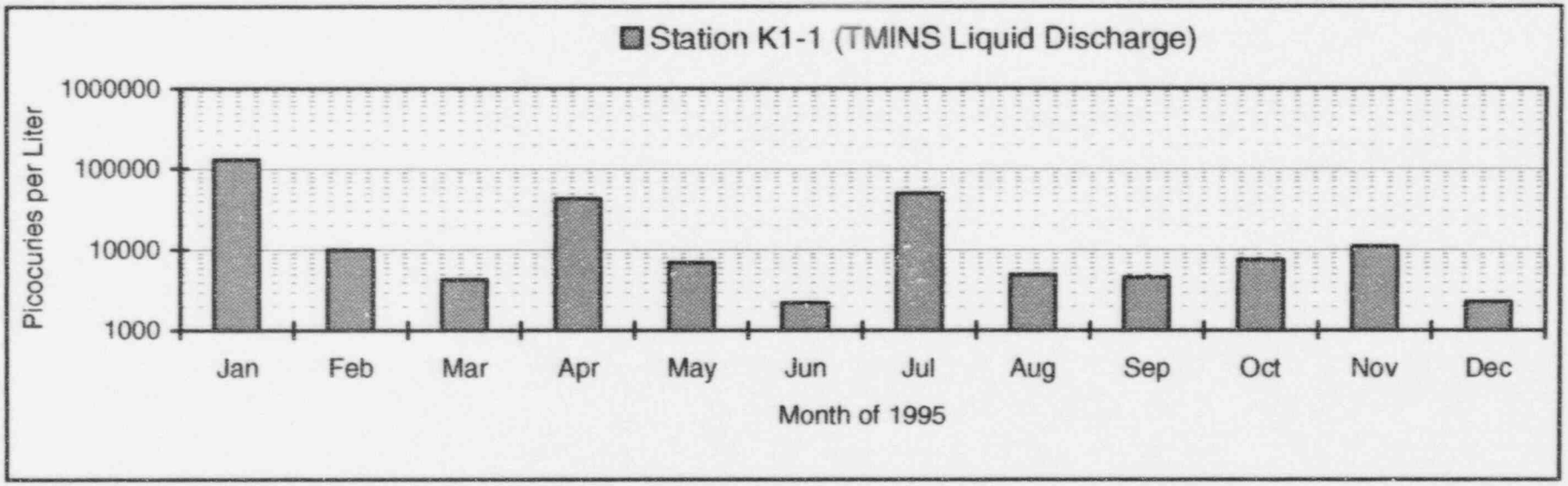


Figure 10

Historical Tritium Concentrations in Surface Water

Picocuries per Liter by Quarter

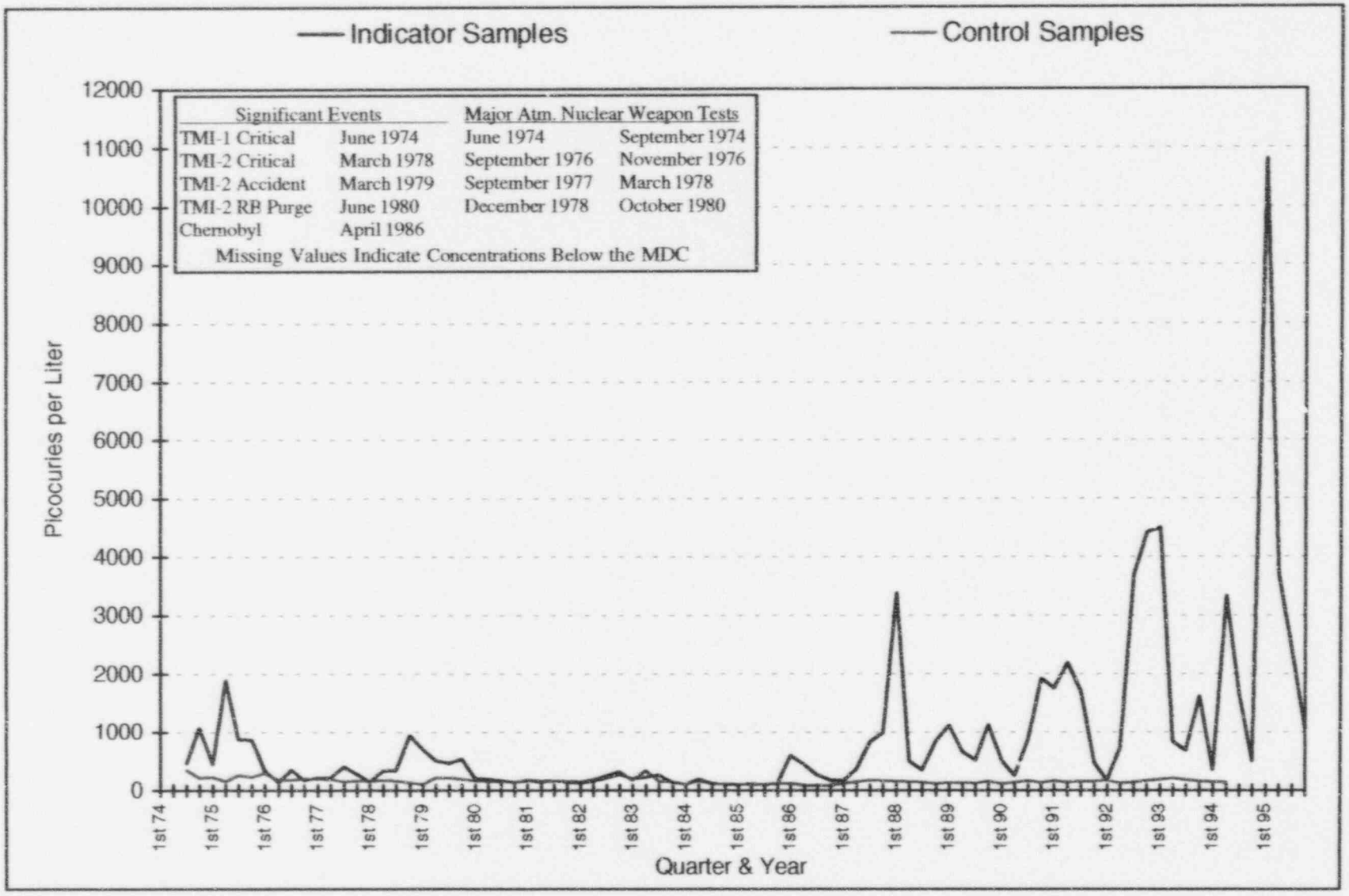
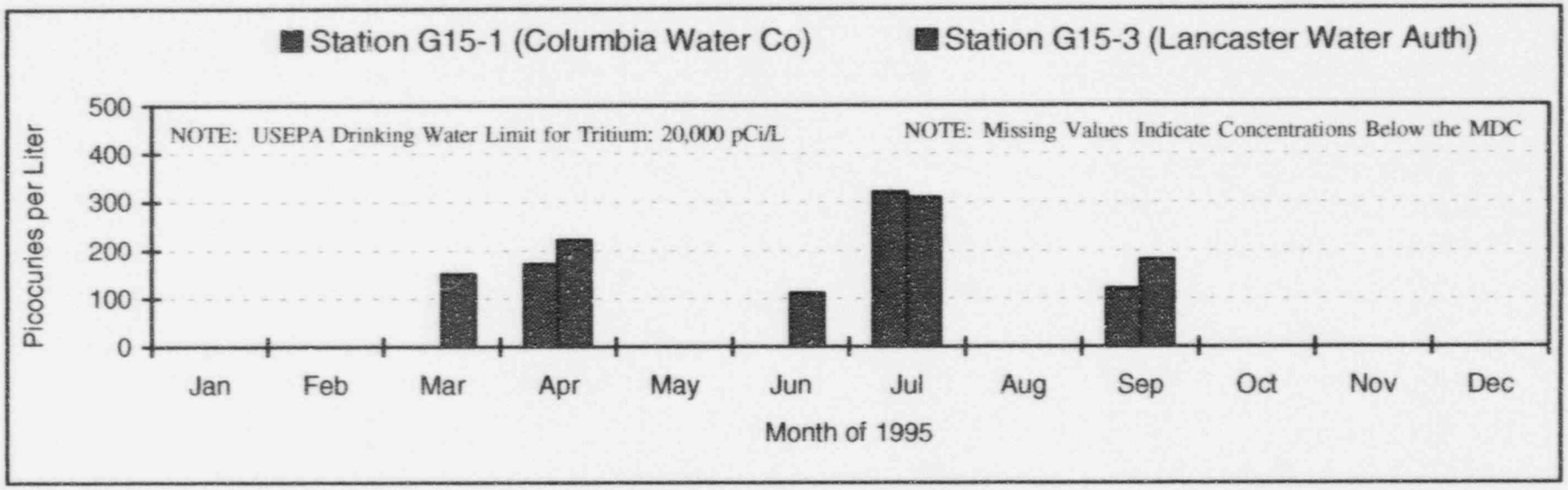


Figure 11

1995 Tritium Concentrations in Drinking Water

Picocuries per Liter by Month



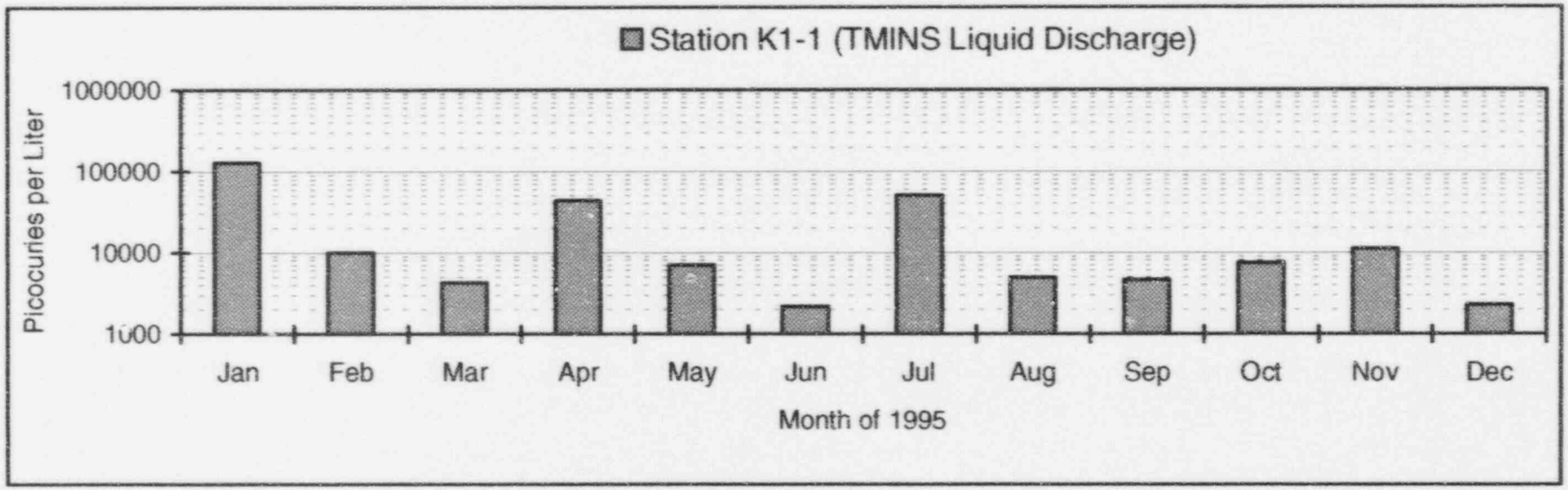


Figure 12

1995 Gross Beta Concentrations in Drinking Water

Picocuries per Liter by Month

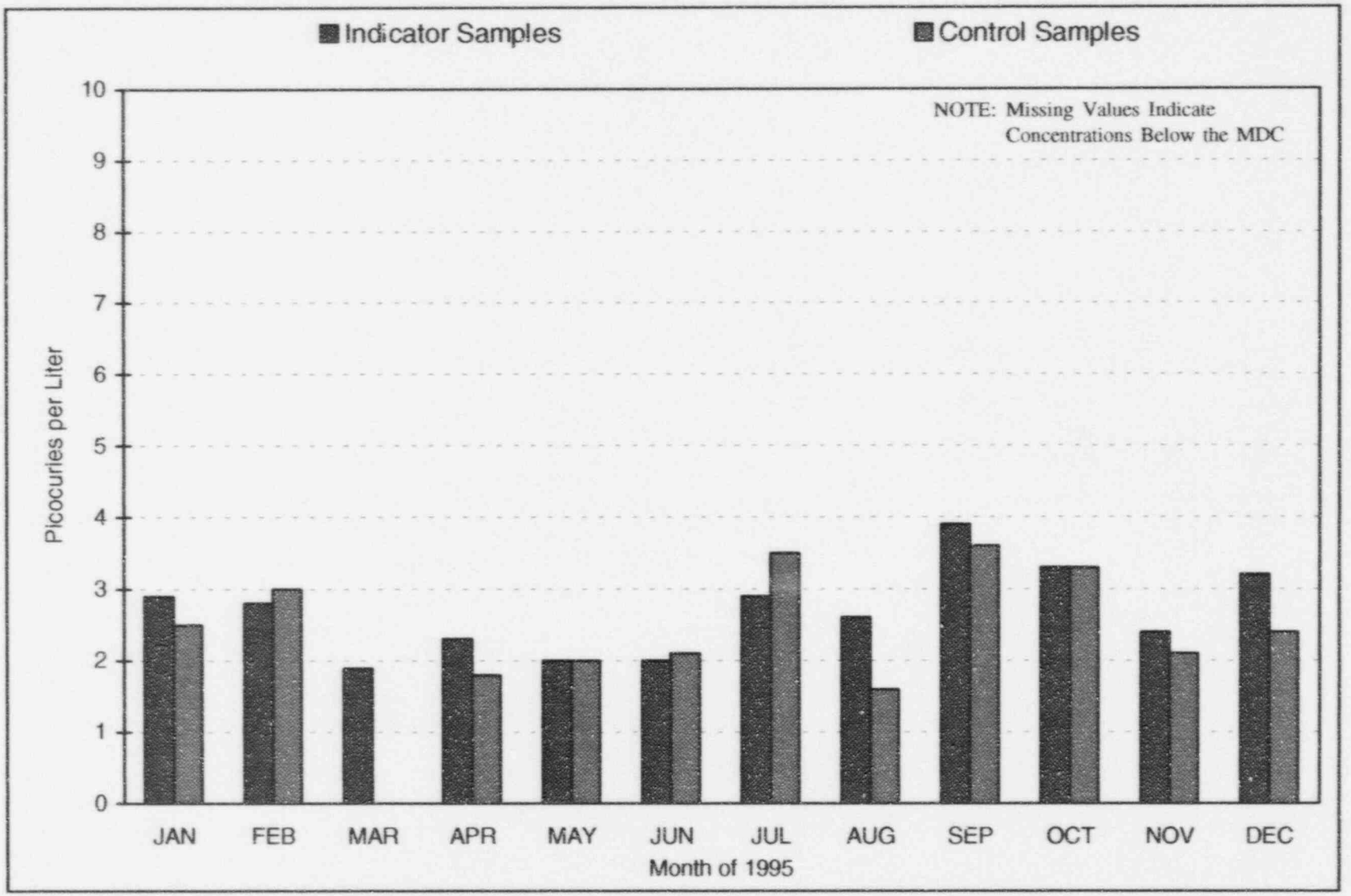


Figure 13

Historical Cesium-137 Concentrations in Aquatic Sediments

Picocuries per Gram (dry)

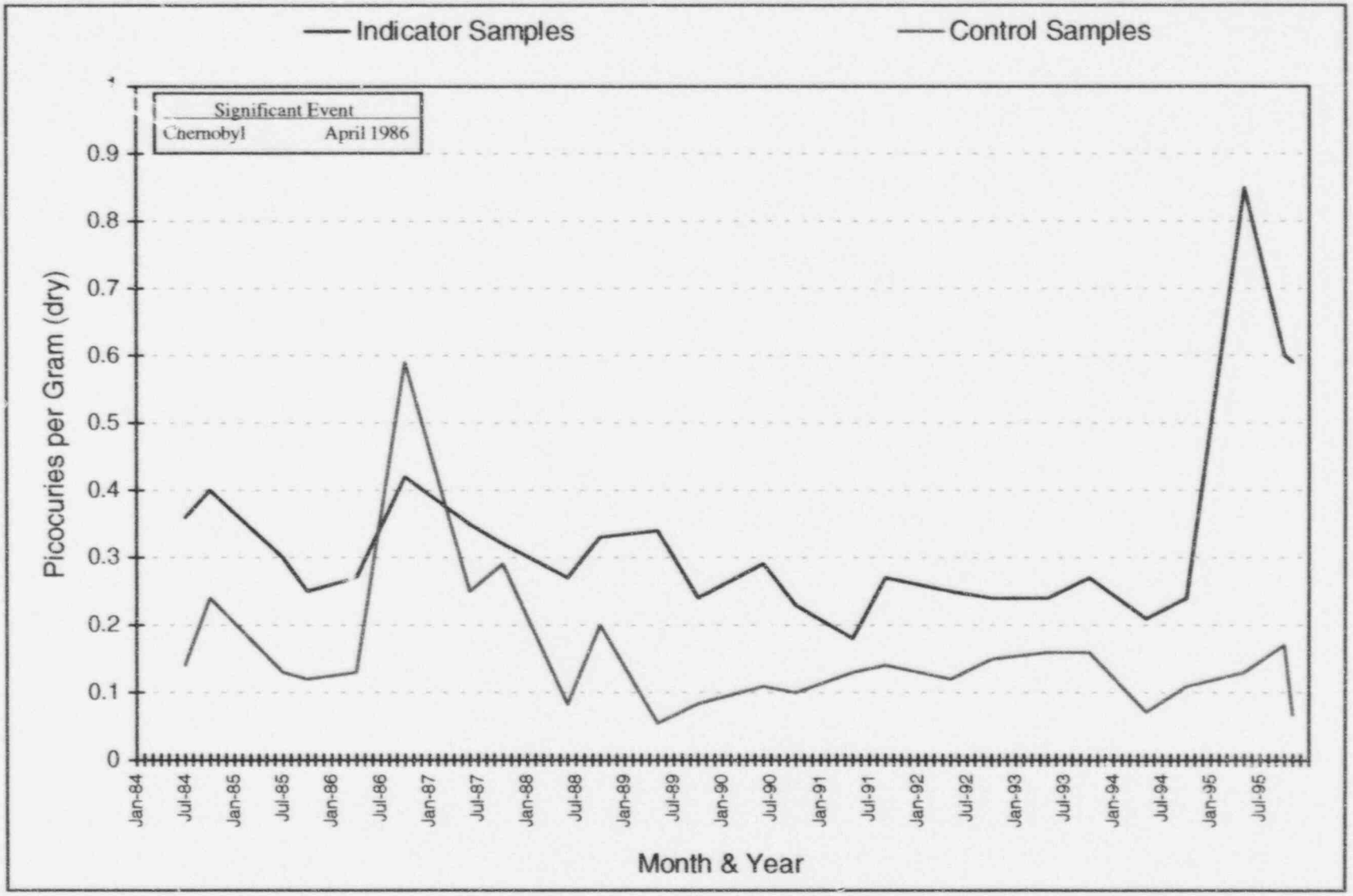


Figure 14

TERRESTRIAL MONITORING

Radionuclides released to the atmosphere may deposit on soil and vegetation. They may eventually be incorporated into milk, meat, fruits, vegetables, or other food products. To assess the impact of TMINS operations to humans from the ingestion pathway, primary food product samples such as green leafy vegetables, root vegetables, fruits, and milk were collected and analyzed during 1995. The ingestion pathway also was assessed by collecting and analyzing deer meat.

In addition to edible products, surface soil samples are collected and analyzed every other year to monitor the potential buildup of atmospherically deposited radionuclides. Soil samples were not scheduled for collection during 1995. Finally, rodent carcasses were analyzed/frisked as part of the TMI-2 Post-Defueling Monitored Storage (PDMS) Rodent Collection and Analysis Program. The purpose of this program is to determine if radioactive materials have been transported by the movement of animals from radiologically-controlled areas to unrestricted areas.

The radiological contribution of TMINS operations was determined by comparing the results of samples collected in prevalent downwind locations, primarily to the south and east of the site, with control samples collected from distant or generally upwind directions. Comparisons with results from previous years also were performed, as applicable.

The analytical results of samples collected during 1995 indicated that there was no discernible TMINS contribution to radioactivity levels in locally-produced food products or game meat. As expected, Sr-90 was found in milk and broad leaf vegetable samples. The concentrations observed in samples collected near TMINS (indicators) were similar to levels observed in samples collected distant from the site (controls) and consistent with data from prior years. Also, Cs-137 was detected in the control deer meat sample. The presence of Sr-90 and Cs-137 was attributable to fallout from prior atmospheric nuclear weapon tests.

As part of the REMP, a surveillance was performed to identify relevant changes in the use of land (unrestricted areas) around TMI. This land use surveillance consisted of a dairy census, a garden census and a residence census.

The dairy census was performed to determine the locations of the nearest milk animals within five miles of TMINS in each of the sixteen meteorological sectors. Also, information on other livestock (beef cattle, chickens, etc.) within five miles of TMINS was gathered. The results are listed in Table G-1 of Appendix G.

The purpose of the garden and residence censuses was to locate the nearest garden and residence in each of the meteorological sectors, respectively. Only gardens of greater than 500 square feet producing broad leaf vegetation were included in the garden census. The results of the residence and garden censuses are listed in Tables G-2 and G-3 of Appendix G, respectively.

The results of these censuses provide a basis for modifying the environmental monitoring program and the models used for calculating offsite doses. Based on the 1995 land use surveillance, changes to the REMP and the dose model were not required.

Sample Collection and Analysis

During 1995, samples of raw cow milk were collected biweekly from local farmers at one control and six indicator locations. Indicator samples were collected at locations having the highest dose potential. These locations generally were proximate to TMINS and in dominant wind directions. Conversely, the control station was located greater than 10 miles from TMINS in a non-prevalent wind direction.

A gamma isotopic analysis and a low-level I-131 analysis were performed on each biweekly milk sample. The biweekly milk samples were then composited quarterly by station and analyzed for Sr-89 and Sr-90.

Ripened fruits and vegetables were collected from local farms and residences and from gardens maintained by GPU Nuclear Environmental Affairs. A total of nine

locations (seven indicators and two controls) were sampled in 1995. Like milk samples, indicator produce samples were collected at locations having the highest dose potential, while controls were obtained from distant sites. Tomatoes, green peppers, red beets, potatoes, cabbages, and sweet corn were collected. All samples were analyzed for gamma-emitting radionuclides, including I-131. Cabbage samples also were analyzed for Sr-89 and Sr-90.

Three deer meat samples (two indicators and one control) were obtained and analyzed in 1995. With the permission of the Pennsylvania Game Commission, the indicator samples were obtained from deer which resided, at least temporarily, on TMI. Both indicator deer sustained self-inflicted injuries. One was found dead; the other was humanely destroyed by the Pennsylvania Game Commission. The control sample was obtained from a deer harvested greater than 10 miles from TMINS. A gamma isotopic analysis was performed on each deer meat sample.

Soil samples were not collected during the monitoring period. Beginning in 1995, the soil collection frequency was changed from semiannually (twice per year) to once every other year. Soil samples are scheduled to be collected and analyzed in the Fall of 1996.

When available, GPU Nuclear analyzes a limited number of rodent carcasses as part of the non-routine REMP. During 1995, two carcasses (two mice) were frisked and/or analyzed for gamma-emitting radionuclides. No other rodent carcasses were found in 1995.

Milk Results

Iodine-131 was not detected above the minimum detectable concentration (MDC) in any of the milk samples collected in 1995. Gamma isotopic analyses of 1995 milk samples yielded only naturally-occurring K-40. Similar K-40 concentrations were measured in both indicator and control samples.

Strontium analyses of milk samples yielded no Sr-89 above the MDC. As expected, Sr-90 was measured in all of the quarterly milk composite samples. Strontium-90 concentrations in 1995 indicator samples ranged from 0.88 $\pm$ 0.17 pCi/L to 2.8 $\pm$ 0.3 pCi/L and averaged 1.4 $\pm$ 1.1 pCi/L. Control sample concentrations for 1995 were similar, ranging from 0.82 $\pm$ 0.20 pCi/L to 1.7 $\pm$ 0.3 pCi/L and averaging 1.2 $\pm$ 0.7 pCi/L. These annual average concentrations were consistent with the 1994 average concentrations of 1.5 $\pm$ 0.9 pCi/L and 1.3 $\pm$ 0.4 pCi/L for indicators and controls, respectively.

The station with the highest annual average was the dairy farm located approximately 3.3 miles north of TMINS (Station A4-1). The samples from this station contained an annual average Sr-90 concentration of 2.4 $\pm$ 0.7 pCi/L which was consistent with the average concentration calculated for this station in 1994 (2.2 $\pm$ 0.5 pCi/L).

The presence of Sr-90 in milk primarily resulted from the transfer of this long-lived fallout product from soil to animal feed (fresh or stored) to cow to milk. Figure 15 depicts the trends of Sr-90 concentrations in

indicator and control cow milk samples since 1979. Generally, the Sr-90 concentrations have trended downward. This decrease is related to the cessation of atmospheric nuclear weapon testing and the radioactive decay and depletion of both atmospheric and terrestrial Sr-90 associated with prior weapon testing.

Terrestrial Vegetation Results

Samples of broad leaf vegetables (cabbages), fruits (tomatoes, sweet corn and green peppers) and root vegetables (red beets and potatoes) were collected in 1995. Naturally-occurring K-40 was detected in all of these samples. Two red beet samples (one indicator and one control) and four cabbage samples (three indicators and one control) also contained naturally-occurring Be-7. No gamma-emitting radionuclides (including I-131) attributable to TMINS operations were detected above the MDC.

Strontium may become incorporated into plants by either uptake from soil or direct deposition on foliar surfaces. In 1995, strontium analyses of leafy vegetable samples (cabbages) revealed no Sr-89, but low-level Sr-90 was detected in all of these samples. This was expected because cabbages have a relatively high Sr-90 concentration factor (soil to plant).

The annual average Sr-90 concentration for all indicator samples was 0.0061 $\pm$ 0.0095 pCi/g (wet). The concentrations ranged from 0.0028 $\pm$ 0.0005 pCi/g (wet) to 0.013 $\pm$ 0.001 pCi/g (wet).

Strontium-90 also was measured in the control sample. The 1995 control sample concentration of 0.029 $\pm$ 0.002 pCi/g, (wet) was similar to those detected in the 1995 indicator samples.

All of the 1995 results were consistent with Sr-90 concentrations detected in indicator and control broad leaf vegetable samples from prior years. The presence of Sr-90 in the 1995 cabbage samples was attributed to fallout from past atmospheric nuclear weapon tests.

Meat Results

Gamma analyses of three deer meat samples (two indicators and one control) revealed naturally-occurring K-40. Cesium-137 also was detected in the control sample at a concentration of 0.055 $\pm$ 0.010 pCi/g (wet). A similar Cs-137 concentration (0.048 $\pm$ 0.008 pCi/g, wet) was measured in the 1994 control deer meat sample. The presence of Cs-137 in the deer flesh was attributable to fallout from prior nuclear weapon tests. No radionuclides attributable to TMINS operations were detected in the 1995 deer meat samples.

Soil Results

As a result of changing the collection frequency from twice per year to once every other year, soil samples were not collected in 1995. The next collection of soil is scheduled for the Fall of 1996.

Rodent Results

Two rodent carcasses were frisked and/or analyzed in 1995. A mouse found dead in the TMI-1 Circulating Water Pump House (a radiologically unrestricted area) was frisked and analyzed for gamma-emitting radionuclides. Reactor-related materials were not identified.

A second mouse carcass was found in the Miscellaneous Waste Evaporator Room. A frisk of the carcass indicated that the mouse was radiologically contaminated. The gamma analysis identified Cs-134 and Cs-137. The results were expected because the area where the mouse was found contains radioactive materials.

No definitive conclusion can be made on whether radioactive materials are being transported by rodents since the mouse which contained radioactive materials was found dead inside a contaminated building and not outside in an uncontaminated area. However, the absence of reactor-related materials in the mouse found in the TMI-1 Circulating Water Pump House suggested that rodents are not transporting radioactive materials to unrestricted areas.

A pest control program is in place at TMINS. This program minimizes the potential for any rodents to transport radioactive materials to unrestricted areas.

Historical Strontium-90 Concentrations in Cow Milk

Picocuries per Liter by Quarter

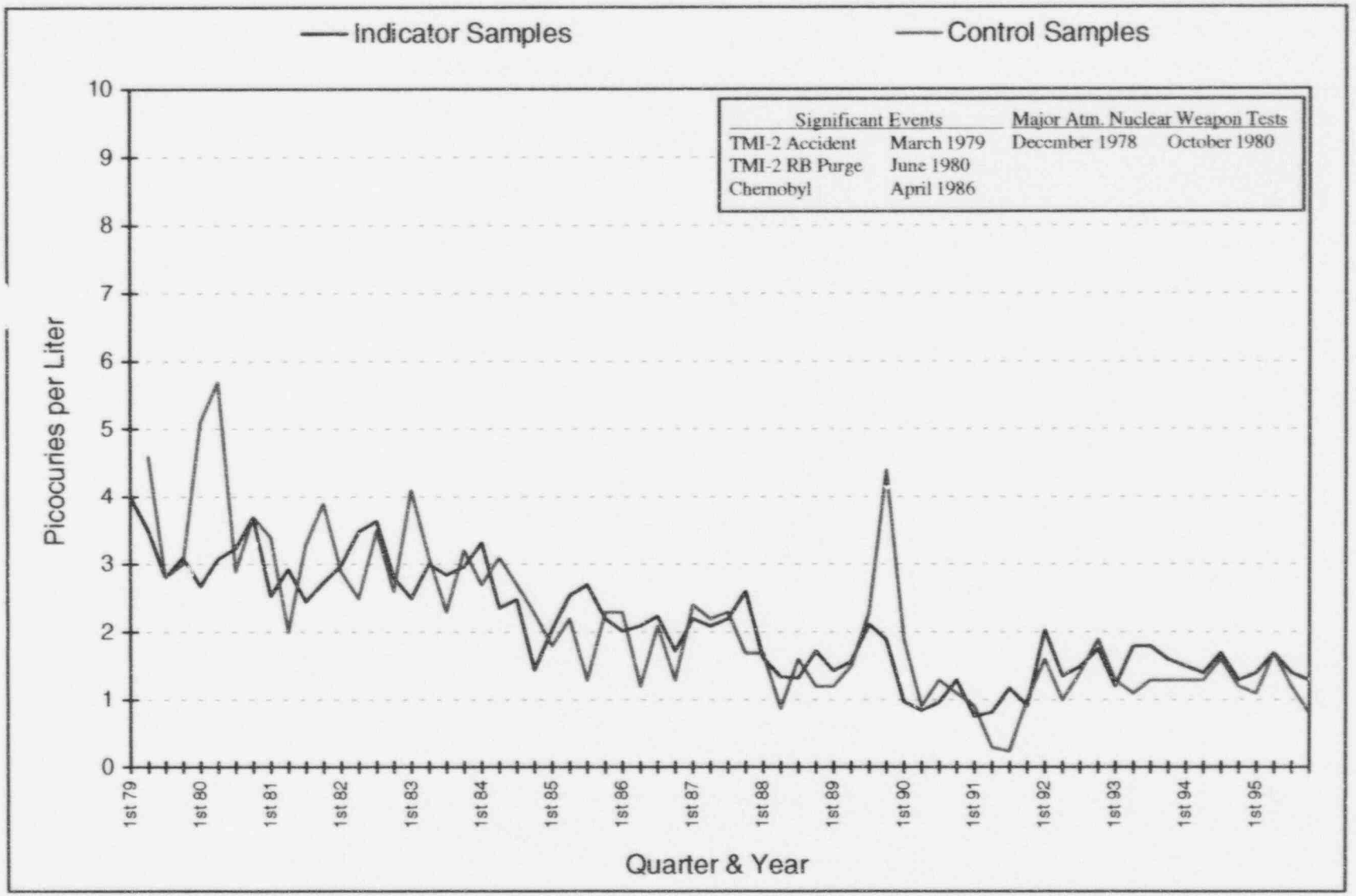


Figure 15

GROUNDWATER MONITORING

Three Mile Island Nuclear Station is located in the Triassic lowland of Pennsylvania, a region often referred to as the Gettysburg Basin. The island was formed as a result of fluvial deposition by the Susquehanna River. It is composed of sub-rounded to rounded sand and gravel, containing varying amounts of silt and clay. Soil depths vary from approximately six feet at the south end of the island to about 30 feet at the center of the island. The site is underlain by Gettysburg shale which lies at an elevation of approximately 277 feet (Refs. 21 and 22). There are two different water-bearing zones at TMINS. One is composed of the soils overlying the Gettysburg shale (bedrock), and the other is the bedrock. Relative to the natural soils, the movement of groundwater is much quicker through the bedrock. Groundwater from TMI flows into the Susquehanna River but does not impact onshore groundwater supplies. The migration of TMI groundwater to onshore supplies is prevented by the higher levels and the opposing flows of groundwater which exit beneath the surrounding terrain on the opposite sides of the Susquehanna River. The estimated travel time for groundwater to reach the river from the central portion of TMI is approximately 12 years of (Ref. 38).

A groundwater monitoring program (GMP) was initiated around TMI-2 in 1980 to detect leakage of water, if any, from the TMI-2 Reactor and Auxiliary Buildings and outside storage tanks. Since 1980, the TMI GMP has been expanded and now monitors activities associated with both TMI-1 and TMI-2.

Fourteen onsite monitoring wells and two onsite drinking water wells were sampled rountinely in 1995. Groundwater from the monitoring wells was not used for drinking. Two offsite wells, Stations E1-2 (TMI Visitors Center) and N2-1 (Goldsboro Marina) also were included in the GMP. On a non-routine basis, groundwater samples were collected from four monitoring wells (MW-1, MW-2, MW-3 and MW-4) located around an onsite landfill. Locations of the onsite groundwater sampling stations are shown in Figures J-1 and J-2 (Appendix J).

During the last two weeks of 1995, three new monitoring wells were installed around the north end of TMINS. Since these wells were not sampled until 1996, the data were not included in this report. The installation of these wells will provide better coverage around TMI-1.

During 1995, onsite groundwater samples were found to contain H-3 above the minimum detectable concentration (MDC). The presence of this material in these samples was attributed to routine TMI-1 operations, past operations of the TMI-2 Evaporator and/or leakage from system components.

All H-3 concentrations were below the USNRC 10 CFR 20 effluent concentration limit. For onsite groundwater used for drinking, all H-3 concentrations were well below the USEPA Primary Drinking Water Standard.

Strontium-90 (Sr-90) also was detected in one onsite groundwater sample and was attributed to past leaks from a tank which has since been drained. The Sr-90 concentration was a small fraction of the standard specified by the USEPA.

Based on the concentrations of H-3 and Sr-90 detected in the 1995 groundwater samples, no adverse impact to humans or the environment resulted.

Sample Collection and Analysis

All groundwater samples were collected using standard plumbing, a dedicated, in-well pumping system or a bailing device. Most groundwater stations were sampled quarterly and analyzed for H-3 and gamma-emitting radionuclides. The quarterly samples were then combined into semiannual composites and analyzed for Sr-90.

The samples collected from the East Dike Catch Basin (EDCB), the Operations Support Facility (OSF), Building 48 (48s) and RW-1 were collected monthly and analyzed for H-3. Except for those collected from RW-1, the monthly samples were combined by station into quarterly composites and analyzed for gamma-emitting radionuclides. The quarterly composites were then combined into

semiannual composites and analyzed for Sr-90. Samples collected from RW-1 were analyzed only for H-3.

Beginning on September 1, 1995, Stations RW-1 and RW-2 were sampled biweekly to monitor leakage from onsite system components. On September 19, 1995, the sampling frequency was increased to weekly. These special weekly and biweekly samples were analyzed only for H-3.

Results

During 1995, H-3 was the only radionuclide consistently detected in onsite groundwater samples. The 1995 sample results are summarized in Appendix J. For comparison, Table J-1 also includes station averages for 1994.

Generally, the H-3 concentrations in most samples collected from onsite monitoring wells trended downward in 1995. Additionally, the annual average concentrations generally were similar to or below those calculated prior to the operations of the TMI-2 Evaporator (January 1991 through August 1993). The presence of H-3 in onsite groundwater collected from monitoring wells during 1995 primarily was attributed to TMI-1 operations (i.e. routine atmospheric releases of this material).

Groundwater samples from two onsite monitoring wells had elevated H-3 concentrations. The groundwater collected from Stations RW-1 and RW-2 was impacted from leakage of system components which then migrated to the ground near these wells. The average H-3 concentration for samples collected in 1995 from RW-2 was 50,000 ± 86,000 pCi/L. The maximum concentration (150,000 ± 10,000 pCi/L) was measured in late September. Subsequent sample results indicated a decline through the remainder of 1995.

Station RW-1 is a pumped recovery well located near Station RW-2. The 1995 average H-3 concentration for samples collected from Station RW-2 was 390,000 ± 380,000 pCi/L. The maximum concentration of 690,000 ± 70,000 pCi/L occurred in early September. Tritium concentrations remained near this level for the remainder of the year.

The higher concentrations of H-3 in samples from RW-1 were expected since grounwater was drawn to this well by pumping. The water pumped out from this well is routed directly to the Turbine Building Sump (TBS). The H-3 activity in the TBS is accounted for in TMINS liquid effluents. And prior to release, this water is diluted to acceptable concentrations.

All of the H-3 concentrations found in groundwater collected from onsite monitoring wells were below the USNRC 10 CFR 20 (Appendix B, Table 2) effluent concentration of 1,000,000 pCi/L.

Tritium concentrations in onsite groundwater used for drinking decreased only slightly during the monitoring period. The presence of H-3 in these samples was due primarily to routine airborne releases from TMI-1. A portion of the H-3 measured in these samples also was possibly

related to prior releases of this material from the TMI-2 Evaporator.

The onsite drinking water wells were located at the Operations Support Facility (OSF) and Building 48 (48s). The annual average H-3 concentration for samples collected from the OSF well was 1500 ± 640 pCi/L, with a maximum concentration of 1800 ± 200 pCi/L. Compared to results from 1994, the H-3 concentrations measured in 1995 were slightly lower.

The annual average H-3 concentration for the samples collected from the 48s well was 450 ± 1000 pCi/L, with a maximum concentration of 1600 ± 200 pCi/L. The maximum H-3 concentration was caused by a pump failure. This allowed water from the OSF well (with a higher H-3 concentration) to fill the 48s holding tank. When these nonrepresentative results were excluded, the average H-3 concentration from 48s samples was 240 ± 60 pCi/L. This compares well to the 1994 average of 270 ± 85 pCi/L.

As mentioned previously, a portion of the H-3 measured in onsite drinking water samples may still be related to past operations of the TMI-2 Evaporator. A slower recovery was expected since the drinking water wells are much deeper than the onsite monitoring wells. Additionally, the onsite drinking water wells are equipped with a pump that draws water toward the well. Thus, a wider area of groundwater (and H-3) is drawn into these wells.

All of the H-3 concentrations detected in the water from these onsite drinking water stations were a small fraction of the USEPA Primary Drinking Water Standard of 20,000 pCi/L.

Tritium was not detected above the MDC in offsite well water collected in 1995 from Stations E1-2 (TMI Visitors Center) and N2-1 (Golsboro Marina).

During 1995, reactor-produced gamma-emitting radionuclides were not detected in any of the onsite or offsite groundwater samples.

Strontium-90 was detected in one groundwater sample collected from an onsite monitoring well during 1995. The second semiannual composite sample from Station OS-16, which is proximal to the Borated Water Storage Tank (BWST), contained Sr-90 at a concentration of 0.87 ± 0.44 pCi/L. A reanalysis was performed and the result (0.55 ± 0.34 pCi/L) confirmed the original concentration.

The Sr-90 concentration measured in Station OS-16 was consistent with those from previous years and well below the USEPA Primary Drinking Water Standard of 8 pCi/L. The presence of this radionuclide was attributed to previous spills/leaks from the BWST. To prepare TMI-2 for PDMS, the BWST was drained in 1993. The contents were processed through the TMI-2 evaporator.

Also in 1995, four monitoring wells around the site landfill were occasionally sampled and analyzed for H-3. The results are listed in Appendix J. All results were within expected concentrations. The presence of H-3 in these samples was attributed to routine TMI-1 operations.

RADIOLOGICAL IMPACT OF TMINS OPERATIONS

An assessment of potential radiological impact indicated that radiation doses to the public from 1995 operations at TMINS were well below all applicable regulatory limits and were significantly less than doses received from natural sources of radiation. The 1995 whole body dose potentially received by an assumed maximum exposed individual from TMI-1 and TMI-2 liquid and airborne effluents was conservatively calculated to be about 0.72 mrem. This dose is equivalent to 0.24% of the dose that an individual living in the TMI area receives each year from natural background radiation.

The 1995 whole body dose to the surrounding population from TMI-1 and TMI-2 liquid and airborne effluents was calculated to be 6.42 person-rem. This is equivalent to 0.00097% of the dose that the total population living within 50 miles of TMI receives each year from natural background radiation.

Determination of Radiation Doses to the Public

Dose assessments can be performed by using either effluent data and an environmental transport model or environmental sample data. To the extent possible, doses to the public are based on the direct measurement of dose rates from external sources and the measurement of radionuclide concentrations in environmental media which may contribute to an internal dose of radiation. Thermoluminescent dosimeters (TLDs) positioned in the environment around TMINS provide measurements to determine external radiation doses to humans. Samples of air, water and food products are used to determine internal doses.

The quantity of radioactive materials released during normal operations are typically too small to be measured once distributed in the offsite environment. Therefore, the potential offsite doses are more effectively calculated for TMINS operations using a computerized model that predicts concentrations of radioactive materials in the environment and subsequent radiation doses based on measured effluents. Another reason for using effluent data and a transport model is that environmental sampling data cannot provide enough information to calculate population doses.

GPU Nuclear calculates doses using an advanced "class A" dispersion model. This model incorporates the guidelines and methodology set forth by the USNRC in Regulatory Guide 1.109. Due to the conservative assumptions that are used in the model, the calculated doses are generally higher than the doses based on actual environmental sample concentrations. Therefore, the model predicts doses which are higher than actual doses received by people.

The type and amount of radioactivity released from TMINS is calculated using measurements from effluent radiation instruments and effluent sample analyses. Once released, the dispersion of radionuclides in the environment is readily determined by computer modelling. Airborne releases are diluted and carried away from the site by atmospheric diffusion which continuously acts to disperse radioactivity. Variables which affect atmospheric dispersion include wind speed, temperature at different elevations, terrain, and shift in wind direction. A weather station on the north end of TMI is linked to a computer terminal which permanently records the meteorological data. Computer models also are used to predict the downstream dilution and travel times for liquid releases into the Susquehanna River.

The pathways to human exposure also are included in the model and are depicted in Figure 16. The exposure pathways considered for the discharge of TMINS liquid effluents are consumption of drinking water and finfish, and shoreline exposure. The exposure pathways considered for the discharge of TMINS airborne effluents are plume exposure, inhalation, cow milk consumption, goat milk consumption, fruit and vegetable consumption, meat consumption and land deposition. Numerous data files are used in the calculations which describe the area around TMI in terms of population distribution and foodstuffs production. Data files include such information as the distance from the plant

stack to the site boundary in each sector, the population groupings, milk cows, milk goats, gardens of more than 500 square feet, meat animals, downstream drinking water users, and crop yields.

When determining the dose to humans, it is necessary to consider all applicable pathways and all exposed tissues, summing the dose from each to provide the total dose for each organ as well as the whole body from a given radionuclide in the environment. Dose calculations involve determining the energy absorbed per unit mass in the various tissues. Thus, for radionuclides taken into the body, the metabolism of the radionuclide in the body must be known along with the physical characteristics of the nuclide such as energies, types of radiations emitted and half-life. The dose assessment model also contains dose conversion factors for the radionuclides for each of four age groups (adults, teenagers, children and infants) and eight organs (total body, thyroid, liver, skin, kidney, lung, bone and GI tract).

Doses are calculated for what is termed the "maximum hypothetical individual". This individual is assumed to be affected by the combined maximum environmental concentrations wherever they occur. For liquid releases, the maximum hypothetical individual would consume 193 gallons of water per year from the Susquehanna River, eat 46 pounds of fish each year that reside in the plant discharge area and stand on the shoreline (influenced by the plant discharge) 67 hours per year. For airborne releases, the maximum hypothetical individual would live at the location of highest radionuclide concentration for inhalation and direct plume exposure. Additionally, this individual each year would consume 106 gallons of cow milk, 141 pounds of leafy vegetables, 1389 pounds of non-leafy vegetables and fruits and 243 pounds of meat produced at the locations with the highest predicted radionuclide concentrations. Consumption of goat milk is not included since this exposure pathway does not currently exist. Doses to the population within 50 miles of TMI for airborne effluents and the entire population using Susquehanna River water downstream of the plant also are calculated.

Results of Dose Calculations

Doses from natural background radiation provide a baseline for assessing the potential public health significance of radioactive effluents. The average person in the United States receives about 300 mrem/yr from natural background radiation sources. Natural background radiation from cosmic, terrestrial and natural radionuclides in the human body (not including radon), averages about 100 mrem/yr. The natural background radiation from cosmic and terrestrial sources varies with geographical location, ranging from a low of about 65 mrem/yr on the Atlantic and Gulf coastal plains to as much as 350 mrem/yr on the Colorado Plateau (Ref. 20). The NCRP now estimates that the average individual in the United States receives an annual dose of about 2,400 mrem to the lung from natural radon gas. This lung dose is considered to be equivalent to a whole body dose of 200 mrem (Ref. 19). Effluent releases from TMINS and other nuclear power plants contribute but a very small percentage to the natural radioactivity which has always been present in the air, water, soil and even in our bodies. In general, the

annual population doses from natural background radiation (excluding radon) are 1,000 to 1,000,000 times larger than the doses to the same population resulting from nuclear power plant operations (Ref. 37).

Dose calculations based on airborne and liquid radioactive effluents from normal operations for 1995, showed that the maximum doses were well below Federal regulatory dose limits and the guidelines of 10 CFR 50 App. I. This conclusion was supported by radionuclide concentrations detected in actual environmental samples. These low doses are the result of efforts by GPU Nuclear to maintain releases "as low as reasonably achievable" (ALARA).

Results of the dose calculations are summarized in Tables 9 and 10. Table 9 compares the calculated maximum dose to an individual of the public to the 10 CFR 50, App. I dose guidelines. Table 10 presents the maximum calculated total body radiation doses to the total population within 50 miles of the plant from airborne releases and the entire population using Susquehanna River water downstream of TMINS for liquid releases. These doses are compared to population doses from natural background radiation.

As shown by the data, conservative calculations of the doses to members of the public from TMINS operations are less than the limits specified in 10 CFR 50, App. I, 40 CFR 190 (25 mrem/site) and 10 CFR 20 (100 mrem/yr) and the dose from natural background radiation. Appendix I of this report contains a more detailed discussion of these dose calculations.

TABLE 9

Calculated Maximum Hypothetical Doses to an Individual for Liquid and Airborne Effluent Releases from TMI-1 and TMI-2 for 1995

	Maximum Hypothetical Dose To An Individual		
	USNRC 10 CFR 50 APP. I Guidelines (mrem/yr)	Calculated Dose (mrem/yr) TMI-1	TMI-2
From Radionuclides In Liquid Releases	3 total body, or	5.79E-1	1.33E-3
	10 any organ	8.20E-1	2.07E-3
From Radionuclides In Airborne Releases (Noble Gases)	5 total body, or	1.29E-1	0
	15 skin	2.60E-1	0
From Radionuclides In Airborne Releases (Iodines and Particulates)	15 any organ	4.33E-1	3.37E-5

	40 CFR 190 Limits (mrem/yr)	Calculated Dose (mrem/yr) TMI-1 and TMI-2 Combined*
Total from Site	75 thyroid	1.04E0
	25 total body or other organs	1.33E0

* This sums together doses from TMI-1 and TMI-2 and includes the maximum regardless of age group for different pathways. It is further estimated that based on the maximum net fenceline dose rate of 4.0 mrem/std month, a person residing at the fenceline for the duration specified in Regulatory Guide 1.109 for shoreline exposure, would receive no more than 0.37 mrem direct dose, for a maximum potential dose of 1.33 mrem (to any organ or the total body) for both TMI-1 and TMI-2.

TABLE 10

Calculated Maximum Whole Body Doses to the Population for Liquid and Airborne Effluent Releases from TMI-1 and TMI-2 for 1995

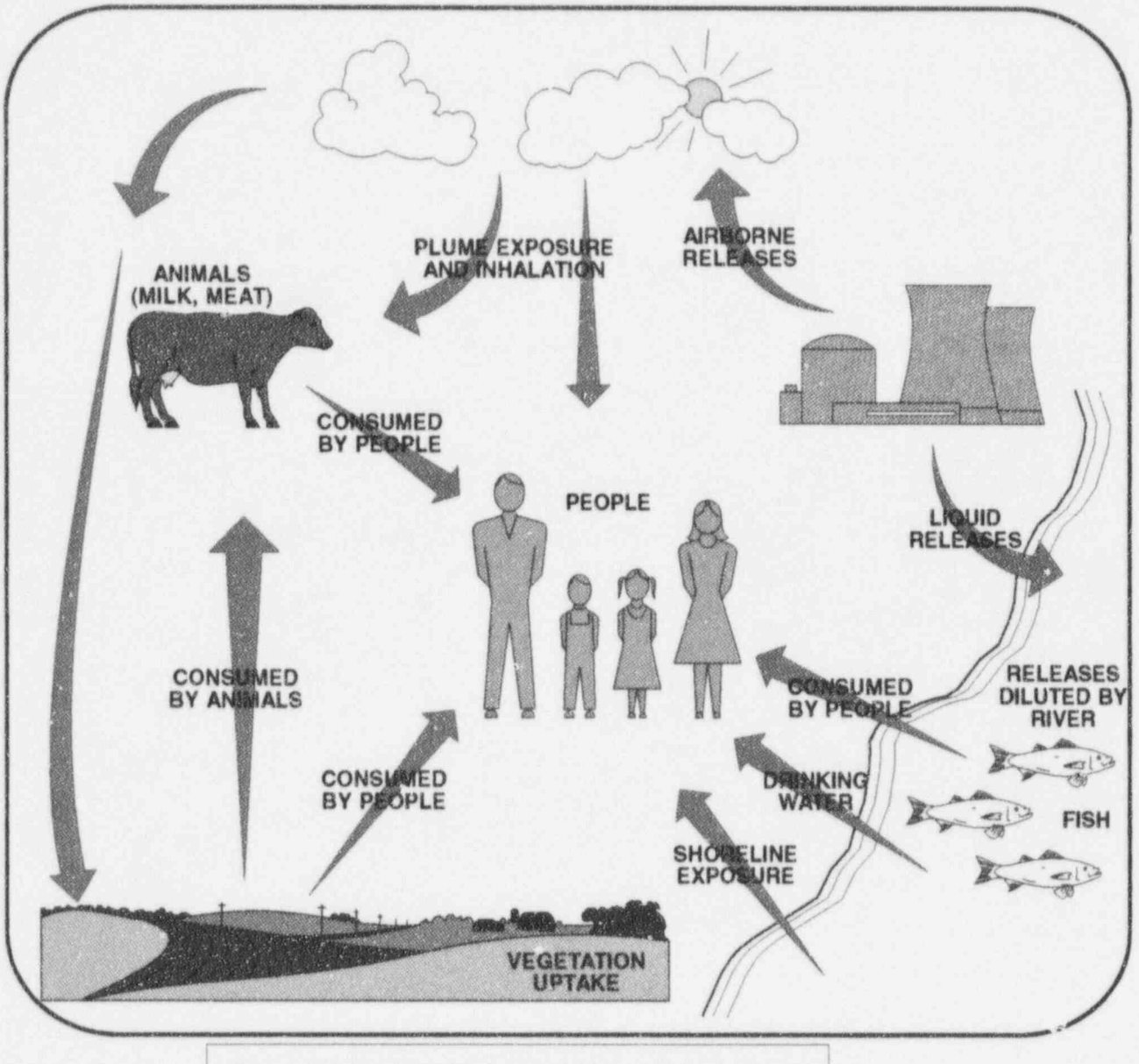
	Calculated Population Total Body Dose Person-rem/yr	
	TMI-1	TMI-2
From Radionuclides In Liquid Releases (Downstream Susquehanna River Water Users)	6.01E0	3.03E-3
From Radionuclides In Airborne Releases (Within 50 Mile Radius of TMINS)	4.03E-1	1.97E-3

Population Dose Due to Natural Background Radiation

Approximately 660,000 person-rem/yr

Figure 16

Exposure Pathways For Radionuclides Routinely Released From TMINS



PREDOMINANT RADIONUCLIDES

NOBLE GASES (Xe,Kr)
Plume exposure

RADIOIODINES (I-131, I-133)
Inhalation and consumption of milk, water, fruits, and vegetables

RADIOSTRONTIUMS (Sr-89, Sr-90)
Consumption of milk, meat, fruits, and vegetables

ACTIVATION PRODUCTS (Co-60, Mn-54)
Shoreline exposure

RADIOCESIUMS (Cs-134, Cs-137)
Shoreline exposure and consumption of milk, meat, fish, water, fruits, and vegetables

TRITIUM (H-3)
Inhalation and consumption of water, milk, fruits, and vegetables

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APPENDIX A

1995 REMP Sampling Locations and Descriptions, Synopsis of REMP, and Sampling and Analysis Exceptions

TABLE A-1

TMINS Radiological Enviornmental Monitoring Program Sample Locations - 1995

Sample Medium	Station Code	Map Number	Distance*	Azimuth	Description
ID	AI-1	1	0.4 mi	0°	N of site at North Weather Station, TMI
AQS	A1-3	16	0.5	0	N of site off north tip of TMI in Susquehanna River
ID	A1-4	113	0.3	5	N of Reactor Building on W fence adjacent to North Weather Station, TMI
AP,AI,ID	A3-1	39	2.6	358	N of site at Middletown Substation
SW	A3-2	40	2.5	355	N of site at Swatara Creek, Middletown
M	A4-1	152	3.3	10	N of site at farm along Rt. 230
ID	A5-1	44	4.3	3	N of site on Vine Street Exit off Route 283
ID	A9-3	127	8.1	3	N of site at Duke Street Pumping Station, Hummelstown
ID	B1-1	2	0.6	25	NNE of site on light pole in middle of North Bridge, TMI
ID	B1-2	114	0.4	26	NNE of Reactor Building on top of dike, TMI
ID	B1-3	115	0.5	15	NNE of Reactor Building on fence adjacent to S end of North Bridge, TMI
AP,AI	B1-4	148	0.8	28	NNE of site at North Gate, TMI
ID	B2-1	132	1.9	16	NNE of site on Sunset Dr. (off Hillsdale Rd.)
ID	B5-1	45	4.8	18	NNE of site at intersection of School House and Miller Roads
ID	B10-1	61	9.4	21	NNE of site at intersection of West Areba Avenue and Mill Street, Hershey
ID	C1-1	17	0.7	35	NE of site along Route 441 N
ID	C1-2	116	0.3	54	NE of Reactor Building on top of dike, TMI
ID	C2-1	43	1.6	48	NE of site at Middletown Junction
ID	C5-1	46	4.5	42	NE of site on Kennedy Lane
ID	C8-1	62	7.2	48	NE of site at Schenk's Church on School House Road
ID	C20-1	79	19.6	47	NE of site in Met-Ed Substation off of Cumberland Street, Lebanon
AQF	Control	-	-	-	All locations where finfish are collected upstream of the TMINS liquid discharge outfall (above Dock St. Dam, Harrisburg) are grouped together and referred to as "control"
GAD	Control	-	-	-	All locations greater than 10 miles from TMINS
ID	D1-1	3	0.2	74	ENE of Reactor Building on top of dike, TMI
ID	D1-2	18	0.6	60	ENE of site on Laurel Road
FP	D1-3	111	0.5	65	ENE of site at residence next to commercial greenhouse on Route 441 N
M	D2-1	29	1.1	65	ENE of site at farm on Gingrich Road
ID	D2-2	133	1.7	73	ENE of site along Hillsdale Rd. (S of Zion Rd.)
ID	D6-1	47	5.2	65°	ENE of site off Beagle Road
ID	D9-1	63	8.5	72	ENE of site along Mt. Gretna Road, Bellaire

TABLE A-1 (Continued)

TMINS Radiological Environmental Monitoring Program Sample Locations - 1995

Sample Medium	Station Code	Map Number	Distance*	Azimuth	Description
ID	D15-1	80	10.9 mi	63°	ENE of site along Route 241, Lawn, PA
ID	E1-1	4	0.2	95	E of Reactor Building on top of dike, TMI
AP,AI,ID,S,GW,FP	E1-2	19	0.4	95	E of site at Visitor's Center
ID	E1-4	117	0.2	98	E of Reactor Building on top of dike, TMI
M	E2-2	109	1.1	93	E of site at farm on Pecks Road
ID	E2-3	134	1.9	96	E of site along Hillsdale Rd. (N of Creek Rd.)
ID	E5-1	48	4.6	81	E of site at intersection of North Market Street and Zeager Road
ID	E7-1	64	6.8	86	E of site along Hummelstown Street, Elizabethtown
ID,FP,S	F1-1	20	0.5	117	ESE of site near entrance to 500 kV Substation
ID	F1-2	118	0.2	109	ESE of Reactor Building on top of dike midway within Interim Solid Waste Staging Facility, TMI
AP,AI	F1-3	149	0.6	105	ESE of site in 500 kV Substation
ID	F1-4	154	0.3	115	ESE of Reactor Building on top of dike, TMI
ID	F2-1	135	1.2	120	ESE of site along Engle Road
M	F4-1	156	3.2	104	ESE of site at farm on Turnpike Road
ID	F5-1	49	4.7	107	ESE of site along Amosite Road
ID	F10-1	66	9.4	112	ESE of site along Donegal Springs Road, Donegal Springs
SW	F15-1	83	12.6	122	ESE of site at Chickies Creek, Marietta
ID	F25-1	82	21.1	113	ESE of site at intersection of Steel Way and Loop Roads, Lancaster
ID	G1-2	22	0.6	143	SE of site along Route 441 S
ID	G1-3	119	0.3	129	SE of Reactor Building on top of dike, TMI
ID	G1-4	138	0.3	146	SE of Reactor Building on top of dike, TMI
ID	G1-5	139	0.3	144	SE of Reactor Building on top of dike, TMI
ID	G1-6	140	0.3	141	SE of Reactor Building on top of dike, TMI
ID	G1-7	137	0.3	144	SE of site on the East Shore, TMI
AI,AP,M	G2-1	104	1.4	125	SE of site at farm on Becker Road
ID	G2-4	136	1.7	135	SE of site on Becker Road
ID	G5-1	50	4.8	131	SE of site at intersection of Bainbridge and Risser Roads
AP,AI,ID	G10-1	67	9.8	127	SE of site at farm along Engles Tollgate Road, Marietta
SW,ID	G15-1	84	14.4	124	SE of site at Columbia Water Treatment Plant

TABLE A-1 (Continued)

TMINS Radiological Environmental Monitoring Program Sample Locations - 1995

Sample Medium	Station Code	Map Number	Distance*	Azimuth	Description
SW	G15-2	85	13.6	128	SE of site at Wrightsville Water Treatment Plant
SW	G15-3	86	14.8 mi	124°	SE of site at Lancaster Water Treatment Plant
ID	H1-1	5	0.5	167	SSE of site, TMI
FP	H1-2	110	0.9	150	SSE of site at produce stand off of Route 441 S.
ID	H1-9	120	0.3	167	SSE of Reactor Building on top of dike, TMI
AP,AI,ID	H3-1	41	2.3	159	SSE of site in Falmouth-Collins Substation
ID	H5-1	52	4.1	157	SSE of site by Guard Shack at Brunner Island Steam Electric Station
ID	H8-1	68	7.4	163	SSE of site along Saginaw Road, Starview
ID	H15-1	87	13.2	157	SSE of site at intersection of Orchard and Stonewood Roads, Wilshire Hills
AQF	Indicator	-	-	-	All locations where finfish are collected downstream of the TMINS liquid discharge outfall are grouped together and referred to as "indicator"
GAD	Indicator	-	-	-	All locations within ten miles of TMINS
ID	J1-1	6	0.8	184	S of site, TMI
SW	J1-2	23	0.5	188	S of site downstream of the TMINS liquid discharge outfall in Susquehanna River
ID	J1-3	121	0.3	189	S of Reactor Building on wooden post of Building 221, just S of Unit 2 Admin. Building, TMI
ID	J1-4	8	0.4	188	SSW of site, TMI
AQS	J2-1	31	1.5	182	S of site in Susquehanna River just upstream of the York Haven Dam
FP,S	J2-2	144	1.5	178	S of site near York Haven Dam, TMI
ID	J3-1	141	2.7	178	S of site at York Haven/Cly
AP,AI	J3-2	150	2.9	181	S of site in Met-Ed Cly Substation
ID	J5-1	53	4.9	182	S of site along Canal Road, Conewago Heights
ID	J7-1	69	6.5	177	S of site off of Maple Street, Manchester
AP,AI,ID	J15-1	88	12.6	180	S of site in Met-Ed York Load Dispatch Station
SW	J15-2	89	14.7	178	S of site at York Water Company
EW	K1-1	7	0.2	209	On site at RML-7 Main Station Discharge Building
AQS	K1-3	24	0.3	202	SSW of site in Susquehanna River
ID	K1-4	123	0.2	208	SSW of Reactor Building on top of dike behind Warehouse 2, TMI
ID	K1-5	122	0.2	202	SSW of Reactor Building on top of dike behind Warehouse 3, TMI
ID	K2-1	32	1.1	200	SSW of site on S Shelley Island
ID	K3-1	142	2.1	202	SSW of site along Rt. 262, N of Cly

TABLE A-1 (Continued)

TMINS Radiological Environmental Monitoring Program Sample Locations - 1995

Sample Medium	Station Code	Map Number	Distance*	Azimuth	Description
ID	K5-1	54	5.0 mi	200°	SSW of site along Conewago Creek Road, Strinestown
ID	K8-1	70	7.4	196	SSW of site at intersection of Coppenhaffer Road and Route 295, Zions View
ID	K15-1	90	12.7	204	SSW of site on the Bird's Nest Child Care Center Building, Weiglestown
M	K15-2	126	12.8	208	SSW of site at farm along Route 74 N
ID	L1-1	9	0.1	235	SW of site on top of dike W of Mech. Draft Cooling Tower, TMI
ID	L1-2	26	0.5	221	SW of site on Beech Island
ID	L2-1	33	1.9	227	SW of site along Route 262
ID	L5-1	55	4.1	228	SW of site at intersection of Stevens and Wilson Roads
ID	L8-1	71	8.0	225	SW of site along Rohlers Church Rd., Andersontown
ID	L15-1	91	11.7	225	SW of site on W side of Route 74, rear of church, Mt. Royal
ID	M1-1	129	0.1	249	WSW of Reactor Building on SE corner of U-2 Screenhouse fence, TMI
ID	M1-2	143	0.5	241	WSW of site on W side of unnamed island between N tip of Beech Island and Shelley Island
AP,AI,ID	M2-1	34	1.3	253	WSW of site adjacent to Fishing Creek, Goldsboro
FP	M2-2	146	1.3	252	WSW of site along Route 262, Goldsboro
ID	M5-1	56	4.3	249	WSW of site at intersection of Lewisberry and Roxberry Roads, Newberrytown
ID	M9-1	72	8.6	242	WSW of site along Alpine Road, Maytown
ID	M15-1	92	11.9	237	WSW of site on W side of Route 74, in front of Earth Crafts, Rossville
ID	N1-1	10	0.7	270	W of site on Shelley Island
ID	N1-3	124	0.1	270	W of Reactor Building on fence adjacent to Screenhouse entrance gate, TMI
ID,GW	N2-1	35	1.2	262	W of site at Goldsboro Marina
FP	N2-2	153	1.3	265	W of site at private residence in Goldsboro
ID	N5-1	57	4.9	268	W of site off of Old York Road along Robin Hood Drive
ID	N8-1	73	7.8	260	W of site along Route 382, 1/2 mile north of Lewisberry
ID	N15-2	95	10.4	274	W of site at intersection of Lisburn Road and Main Street, Lisburn
ID	P1-1	12	0.4	293	WNW of site on Shelley Island
ID	P1-2	38	0.2	290	WNW of Reactor Building on fence N of Unit 1 Screenhouse, TMI
SW	P1-3	11	0.1	284	WNW of Reactor Building in the Pretreatment Bulding, Influent Water, TMI
ID	P2-1	36	1.9	283	WNW of site along Route 262
ID	P5-1	58	4.9	285	WNW of site at intersection of Route 262 and Beinhower Road

TABLE A-1 (Continued)

TMINS Radiological Environmental Monitoring Program Sample Locations - 1995

Sample Medium	Station Code	Map Number	Distance*	Azimuth	Description
M	P7-1	75	6.7 mi	293°	WNW of site at farm along Old York Road, New Cumberland
ID	P8-1	74	8.0	292	WNW of site along Evergreen Road, Reesers Summit
ID	P15-1	96	12.2	300	WNW of site along Erford Road in front of Penn Harris Motor Inn, Camp Hill
ID	Q1-1	13	0.5	317	NW of site on Shelley Island
ID	Q1-2	125	0.2	318	NW of Reactor Building on fence W of Warehouse 1, TMI
ID	Q2-1	37	1.8	310	NW of site along access road along river
AP,AI	Q4-1	151	3.7	325	NW of site at airport near control tower
ID	Q5-1	59	5.0	3[illegible]3	NW of site along Lumber Street, Highspire
SW,ID	Q9-1	76	8.5	308	NW of site at the Steelton Water Company
AP,AI,ID	Q15-1	97	13.5	305	NW of site behind West Fairview Fire Dept. Social Hall
ID	R1-1	14	0.2	335	NNW of Reactor Building along W fence, TMI
ID	R1-2	27	0.7	332	NNW of site on Hi[illegible]ary Island
ID	R3-1	107	2.6	338	NNW of site at Crawford Station, Middletown
ID	R5-1	60	4.9	339	NNW of site at interstection of Spring Garden Drive and Route 441
ID	R9-1	77	8.1	340	NNW of site at intersection of Derry and 66th Streets, Rutherford Heights
ID	R15-1	99	11.2	330	NNW of site at intersection of Route 22 and Colonial Road, Colonial Park
ID,FP,S	R15-2	128	12.4	329	NNW of site at GPUN Building, Commerce Park, Harrisburg

IDENTIFICATION KEY

ID = Immersion Dose (TLD)
SW = Surface Water
M = Milk (Cow)
AP = Air Particulate
GW = Ground Water (offsite)
AQS = Aquatic Sediment
EW = Effluent Water
S = Soil
AQF = Finfish
AI = Air Iodine
FP = Food Products (Green Leafy Vegetation, Fruits, Vegetables)
GAD = Meat (Game)

* All distances are measured from a point that is midway between the reactor buildings of TMI-1 and TMI-2.

TABLE A-2

Synopsis of the Operational Radiological Environmental Monitoring Program and Other Radiological Monitoring Programs Conducted by GPUN Environmental Affairs for Three Mile Island Nuclear Station 1995 [1]

Sample Type	Number of Sampling Locations	Collection Frequency[6]	Number of Samples Collected	Type of Analysis	Analysis Frequency	Number of Samples Analyzed [2]
Air Iodine	12	Weekly	623	I-131	Weekly	623
Air Particulate (Low Volume)	12	Weekly	623	Gr-Beta	Weekly	623
				Gr-Alpha	Weekly	311
				Gamma	Quarterly	48
				Sr-89	Semiannually	24
				Sr-90	Semiannually	24
Finfish	2	Semiannually	7	Gamma	Semiannually	7
				H-3	Semiannually	7
				Sr-89	Semiannually	7
				Sr-90	Semiannually	7
Aquatic Sediment	4	Semiannually	10	Gamma	Semiannually	10
				Sr-89	Annually	4
				Sr-90	Annually	4
Discharge Water	1	Weekly	4	I-131	Weekly	4
		Biweekly	24	I-131	Biweekly	24
				Gamma	Monthly	12
				Gr-Beta	Monthly	12
				H-3	Monthly	12
				Sr-89	Semiannually	2
				Sr-90	Semiannually	2
Fruits	8	Annually	13	Gamma	Annually	13
Broad Leaf Vegetation	5	Annually	5	Gamma	Annually	5
				Sr-89	Annually	5
				Sr-90	Annually	5
Vegetables	6	Annually	16	Gamma	Annually	16
Groundwater	4	Monthly	48	H-3	Monthly	48
	8(7)	As Needed	44	H-3	As Needed	44
	14	Quarterly	54	H-3	Quarterly	54
				Gamma	Quarterly	74
				Sr-90	Semiannually	37
Meat (Deer)	2	Annually	3	Gamma	Annually	3
Dosimeters (TLD) [3]	102	Quarterly	3042	Immersion Dose	Quarterly	2981 [4]

NOTE: See Notes at end of table.

TABLE A-2

Synopsis of the Operational Radiological Environmental Monitoring Programs and Other Radiological Monitoring Programs Conducted by GPUN Environmental Affairs for Three Mile Island Nuclear Station 1995 [1]

Sample Type	Number of Sampling Locations	Collection Frequency[6]	Number of Samples Collected	Type of Analysis	Analysis Frequency	Number of Samples Analyzed [2]
Milk	7	Biweekly	182	Gamma	Biweekly	182
				I-131	Biweekly	182
				Sr-89	Quarterly	28
				Sr-90	Quarterly	28
Surface/Drinking Water	9	Weekly	36 [5]	I-131	Weekly	24
		Biweekly	216 [5]	I-131	Biweekly	
				Gamma	Monthly	108
				Gr-Beta	Monthly	72
				H-3	Monthly	108
				Sr-89	Semiannually	18
				Sr-90	Semiannually	18
Rodent	2 (TMI)	When Available	2	Radiological Frisk or Gamma	When Available	2

NOTES:

(1) This table represents results from the primary (base) program. It does not include quality control (QC) results.
(2) The total number of analyses does not include duplicate analyses, recounts, or reanalyses.
(3) For the purposes of this table a dosimeter is considered to be a phosphor (element).
(4) This is the total number of elements used for data analysis.
(5) Water from Stations J1-2, J15-2, and G15-1 was not analyzed for low level I-131.
(6) Biweekly means once every two weeks.
(7) Nonroutine samples were collected from RW-1, RW-2, OSF, MS-1, MW-1, MW-2, MW-3 and MW-4.

TABLE A-3

Sampling and Analysis Exceptions 1995*

Period of Deviation	Description of Deviation and Corrective Action
December 28, 1994 to January 9, 1995**	The inlet line to the downstream (indicator) surface water sampling station located along the west shore of TMI (J1-2) became blocked during the end of this period. The blockage most likely was due to a frozen line. A grab sample (0.5L) was collected and added to the available time composited sample (7.5L) to account for this period. Instrument technicians were notified for correcting this problem.
January 9, 1995 to January 23, 1995	The prior blockage problem at indicator surface water Station J1-2 was corrected early during this period. However, the instrument technician inadvertently left the automatic compositor in "STANDBY" mode. After one week into this biweekly period, the problem was realized and a grab sample was collected. The grab sample was combined with the second week's time composited sample to account for this period.
January 30, 1995 to February 13, 1995**	The inlet line at indicator surface water Station J1-2 was intermittently frozen during this period. However, a sufficient total volume was composited for both the first and second weeks of this period to perform the required analyses. Similar to the above anomaly, the inlet line also was intermittently frozen at the closest indicator drinking water station downstream of TMI (G15-2) during this period. Again, a sufficient volume of composited sample was available.
February 13, 1995 to March 13, 1995**	During this period, two biweekly sample collections were performed. During both of these collection periods, the automatic compositor at indicator surface water Station J1-2 was malfunctioning. The compositor was either pulling too much of a sample, in which case the collection tub had to be partially emptied, or no sample was being collected. By the last week of the second collection period, instrument technicians were able to properly correct this malfunction.

TABLE A-3 (Continued)

Sampling and Analysis Exceptions 1995*

Period of Deviation	Description of Deviation and Corrective Action
April 10, 1995 to April 24, 1995	The valve supplying source water at the upstream control surface water sampling station which collects intake water at TMI (P1-3) became blocked at the end of this collection period. The exact stop time of sampling could not be determined. Connections to a new valve promptly were made because the original valve no longer would function properly.
May 1, 1995 to May 15, 1995**	The sensor unit in the automatic compositor at indicator surface water Station J1-2 malfunctioned. This caused an interruption in the routine sampling for a short duration while repairs were in progress.
July 31, 1995 to August 14, 1995	The supply line to control surface water Station P1-3 became blocked at the end of this period. The exact stop time of sampling could not be determined. Instrument technicians promptly cleared out the blockage.
September 1, 1995***	An adequate volume of water was not available from the well at groundwater Station OS-13B. This station normally is a low yielding well and at certain times of the year, a sufficient volume of water for analyses cannot be obtained. All other routinely sampled groundwater stations contained sufficient volumes of water for analyses.
October 9, 1995 to October 23, 1995**	The supply line to control surface water Station P1-3 again became blocked. The exact stop time of sampling could not be determined. Instrument technicians promptly were notified to correct the problem. During the same collection period, mechanical failure caused the compositor at indicator surface water Station J1-2 to collect too much water. This caused the float mechanism to terminate sampling. Hence, no samples were collected at the end of the period and the exact stop time could not be determined. Instrument technicians promptly corrected this problem.

TABLE A-3 (Continued)

Sampling and Analysis Exceptions 1995*

Period of Deviation	Description of Deviation and Corrective Action
October 23, 1995 to October 30, 1995	The blocked supply line at control surface water Station P1-3 was not cleared until October 25, 1995. Hence, two days of sampling were missed in the beginning of this period.
Fall, 1995	Upstream (Control) bottom-feeder fish (catfish) were not collected during this period. Numerous attempts were made to collect the fish, using various collection techniques. The deficiency in collection of this group of fish was attributed to early cold weather which may have reduced their metabolic activity (no response with hook and line techniques) and caused the catfish to move into deeper pools (ineffective for electro-shocking techniques).
December 1, 1995***	Water was not available from the well at groundwater Station OS-13B. This station normally is a low yielding well and at certain times of the year, a sufficient volume of water for analyses cannot be obtained. All other routinely sampled groundwater stations contained sufficient volumes of water for analyses.

* The exceptions described in this table are those which are considered deviations from radiological environmental monitoring as required by the Technical Specifications. Reports describing all sampling and analysis exceptions are on file at Three Mile Island Environmental Affairs.

** For these collection periods, deviations occurred to the routine sampling by the automatic water compositor at indicator surface water Station J1-2. However, the TMINS liquid discharge station (K1-1) was continually sampled as an indication of plant liquid releases.

*** The TMINS Groundwater Monitoring Program is not required by the Technical Specifications. However, GPUN has made a commitment to the USNRC to collect and analyze onsite groundwater samples.

APPENDIX B

1995 Lower Limit of Detection (LLD) Exceptions

TABLE B

Analytical Results Which Failed to Meet the USNRC Required LLD During 1995

Sample Media	Analysis	Required LLD	No. of Samples Which Failed to Meet the LLD	Comments
Food Product (FPL) (Cabbage)	I-131	60 pCi/kg, wet	4	The cabbage samples were analyzed for gamma-emitting radionuclides (including I-131) by the primary analysis laboratory. The samples were then sent to the quality control (QC) laboratory for Sr analyses. In addition to the Sr analyses, the QC laboratory also performed a gamma analysis (which included I-131) on each sample. The I-131 LLDs reported for these samples (<80 pCi/kg, wet to <100 pCi/kg, wet) exceeded the LLD required by the USNRC. This was expected since sufficient time had elapsed between the collection date and the analysis date (by the QC lab). The USNRC required LLD was achieved by the primary laboratory for all of the cabbage samples.

TABLE B (Continued)

Analytical Results Which Failed to Meet the USNRC Required LLD During 1995

Sample Media	Analysis	Required LLD	No. of Samples Which Failed to Meet the LLD	Comments
Groundwater (GW)	Mn-54	15 pCi/L	1	The USNRC required LLDs (for water) were not achieved because an adequate sample volume was not available. Collection and analysis of groundwater is not specified in the ODCM (TMI REMP). However, a commitment (by GPUN to the USNRC) was made to collect and analyze this medium.
	Fe-59	30 pCi/L	1	
	Co-58	15 pCi/L	1	
	Co-60	15 pCi/L	1	
	Zn-65	30 pCi/L	1	
	Nb-95	15 pCi/L	1	
	Cs-134	15 pCi/L	1	
	Ba-140	60 pCi/L	1	
	La-140	15 pCi/L	1	

APPENDIX C

1995 REMP Changes

1995 REMP CHANGES

January, 1995	The collection and analysis of offsite precipitation samples (e.g., rain and snow) was discontinued. Since this medium is not consumed by humans in the TMI area, no information relative to the potential dose to humans is obtained from collecting and analyzing precipitation samples. The collection and analysis of precipitation samples are not specified in the ODCM and, therefore, are not required by the USNRC.
January, 1995	The collection and analysis of soil samples was changed from twice per year to once every other year. The reduction was justified because past data have indicated no buildup of radioactive materials in soil and this medium provides insignificant exposures to humans. Soil samples were not collected in 1995, but are scheduled for collection during the Fall of 1996. The collection and analysis of soil samples are not specified in the ODCM and, therefore, are not required by the USNRC.
January, 1995	The number of air particulate filters analyzed for gross alpha radioactivity was reduced from 13 to 6 (4 indicators and 2 controls). The reduction was justified because alpha-emitting radionuclides are not routinely detected in TMI-1 and TMI-2 gaseous effluents. For the purpose of comparing data with other monitoring programs in the TMI area, six samples/filters continue to be analyzed weekly for gross alpha radioactivity. The analysis of air particulate filters for gross alpha radioactivity is not specified in the ODCM and, therefore, is not required by USNRC.
January, 1995	The frequency for measuring gamma-emitting radionuclides on the air particulate filters was changed from monthly to quarterly. This change is consistent with the frequency specified by the ODCM and, therefore, is in compliance with the USNRC requirement.
January, 1995	The collection frequency for onsite groundwater samples (except Building 48, EDCB and OSF) was changed from monthly to quarterly. Each sample was analyzed for H-3 and gamma-emitting radionuclides. Samples from Building 48, EDCB and OSF continued to be collected monthly and analyzed monthly for H-3 and quarterly for gamma-emitting radionuclides.

Groundwater stations MS-7 and RW-2 were added to the Groundwater Monitoring Program (GPM) to provide additional coverage of the TMI site. The samples were collected quarterly and analyzed for H-3 and gamma-emitting radionuclides.

The frequency for measuring Sr-90 in onsite and offsite groundwater samples was changed from quarterly to semiannually.

Although not specified in the ODCM, the collection and analysis of groundwater samples continue to be performed as a result of a commitment made by GPUN to the USNRC. None of the changes made to the GMP will adversely affect the health and safety of the workers, the public or the environment.

July, 1995

TLD Station R15-2, located at the Emergency Operations Facility (EOF), was deleted from the REMP. The station was dropped because laboratory operations at the EOF may impact gamma exposures at this site. A replacement site was not located since an adequate number of control stations continue to be monitored.

November, 1995

Sediment samples normally are collected twice per year (Spring and Fall). To determine the scouring effects of an increased river flow, a third collection (and analysis) was performed in 1995 (November).

APPENDIX D

1995 Action Levels

Analytical results of environmental samples were routinely reviewed and evaluated by the GPU Nuclear Three Mile Island Environmental Affairs staff. The results were checked for LLD violations, anomalous values, USNRC reporting levels, main sample and quality control (QC) sample agreement (Appendix E), and action levels.

Established by GPU Nuclear, the action level is defined as that level of reactor-related radioactivity which when detected in environmental samples initiates an investigation and subsequent actions, as necessary. An action level is reached if either of the following two criteria is met:

- The radioactivity concentration at an indicator station reaches or exceeds those concentrations listed in Table D-1. (With the exception of I-131 in food products and water and Sr-90 in milk, water, fish, food products and airborne particulates, all concentrations listed correspond to 10% of the USNRC reporting levels.)

- The radioactivity concentration at the indicator station reaches or exceeds 10 times the mean concentration for the control locations. (This criteria applies only to those media and analyses which are not listed in Table D-1.)

Action levels for gamma exposure rates measured by TLDs have also been established. For TLDs, an action level is reached if any of the following three criteria is met:

- The exposure rate at an indicator station not on the owner controlled area fence exceeds three times the mean of the control stations.

- The exposure rate at an indicator station on the owner controlled area fence exceeds 135 mR/std month (50% of the 40 CFR 190 limit of 25 mR/yr adjusted by a 67 hour recreational factor).

- The exposure rate at an indicator station not on the owner controlled area fence exceeds either two times the previous quarterly result or two times the historical average for the station.

If an action level is reached, an investigation is initiated which consists of some or all of the following actions:

- Examine the collection sheets for an indication of any equipment malfunctions, collection or delivery errors.
- Examine the running tables (prior data) for trends.
- Review control station data.
- Review QC or duplicate sample data (if available).

- Review TMI-1 and TMI-2 effluent data.
- Recount and/or reanalyze the sample.
- Collect and analyze an additional sample.

The results of the investigation are then documented on the form provided in the TMI Environmental Affairs procedure 6510-SUR-4523.05. As appropriate, site personnel are apprised of plant-related radioactivity which exceeds the GPU Nuclear action level. If it is concluded that the detected activity is related to TMINS operations and also exceeds the USNRC reporting limits as defined in the ODCM, a detailed report will be issued to the USNRC.

During 1995, 6 indicator sample concentrations equalled or exceeded an action level. They are summarized in Table D-2. For each investigation conducted in 1995, it was concluded that the action level concentration was caused by normal TMINS operations (H-3 in surface water and Cs-134 and Cs-137 in sediments). However, none of the 1995 results were reportable to the USNRC.

Three monthly surface water samples collected at Station J1-2 contained H-3 at concentrations greater than 2000 pCi/L, the GPUN action level concentration for H-3 in surface water. The presence of H-3 in these samples was attributed to TMINS operations. Tritium at concentrations greater than background levels is not unexpected in this medium since the samples are collected just downstream of the TMINS liquid discharge outfall where mixing is incomplete. Complete mixing of liquid effluents with river water is not usually achieved until the water passes over the York Haven Dam which is downstream of the sampling site. Dose estimates for ingesting water were not performed because these samples are non-potable water.

The remaining three action level concentrations (Cs-134 and Cs-137 in sediments) also were attributable to routine TMINS operations. Cesium-134 (once) and Cs-137 (twice) were detected in an indicator sample at a concentration which was 10 times greater than the control sample concentration. Since Cs-137 also was measured in the control samples, a portion of the Cs-137 present in the indicator samples was due to fall-3
out from previous atmospheric nuclear weapon tests. The estimated dose from standing on these sediments was insignificant and a small fraction of the dose received by natural background radiation.

TABLE D-1

TMINS REMP Action Levels for Positive Radioactivity Concentrations in Environmental Samples

Analysis	Water(a) (pCi/L)	Airborne Particulate or Gases (pCi/m³)	Fish (pCi/g - wet)	Milk (pCi/L)	Food Products (pCi/g - wet)
H-3	2000				
Mn-54	100		3		
Fe-59	40		1		
Co-58	100		3		
Co-60	30		1		
Zn-65	30		2		
Sr-90	4(b)	.05 (b)	.05 (b)	4(b)	.05(b)
Zr-Nb-95	40				
I-131	1(b)	.09		.3	.05(b)
Cs-134	3	1	.1	6	.1
Cs-137	5	2	.2	7	.2
Ba-La-40	20			30	

(a) Includes surface and drinking water and precipitation.
(b) 50% of USNRC reporting level.

TABLE D-2

Investigations Conducted During 1995

Collection Date	Reason for Investigation	# of Indicator Samples Exceeding the Action Level	Conclusion of Investigation
1. December 28, 1994 to January 30, 1995	The composite surface water sample collected at indicator Station J1-2, located just downstream of the TMINS liquid discharge outfall, contained an H-3 concentration (30,000 ± 3,000 pCi/L) which equalled or exceeded the GPUN action level of 2000 pCi/L.	1	The H-3 identified in the water sample resulted from the discharge of this material from TMINS into the Susquehanna River. The H-3 concentration was biased high by a grab which was collected during a release of this material. Concentrations of H-3 above background levels are expected in this sample because the collection site is located proximate to the TMINS liquid discharge outfall where mixing of effluents and river water is incomplete. Since the sample is raw (nonpotable) river water, a dose due to ingestion was not calculated. The result was not reportable to the USNRC.
2. March 27, 1995 to May 1, 1995	The composite surface water sample collected at indicator Station J1-2, located just downstream of the TMINS liquid discharge outfall, contained an H-3 concentration (10,000 ± 1,000 pCi/L) which equalled or exceeded the GPUN action level of 2000 pCi/L.	1	The H-3 identified in the water sample resulted from the discharge of this material from TMINS into the Susquehanna River. Concentrations of H-3 above background levels are expected in this sample because the collection site is located proximate to the TMINS liquid discharge outfall where mixing of effluents and river water is incomplete. Since the sample is raw (nonpotable) river water, a dose due to ingestion was not calculated. The result was not reportable to the USNRC.
3. May 11, 1995	The sediment sample collected at indicator Station K1-3, located just downstream of the TMINS liquid discharge outfall, contained Cs-137 at a concentration of 1.4 ± 0.1 pCi/g (dry). This result was greater than 10 times the control sample concentration (0.13 ± 0.02 pCi/g, dry).	1	A portion of the Cs-137 detected in the indicator sediment sample was due to TMINS operations because 1) Cs-137 was released routinely in liquid effluents, 2) the Cs-137 concentration in the subject sample was significantly higher than that measured in the control sample and 3) other radioactive materials (Co-58, Co-60, Sb-125 and Cs-134) were identified in the subject sample. A portion of the Cs-137 identified in the K1-3 sample also was related to fallout from prior nuclear weapon tests. The estimated dose from standing on these sediments was insignificant and a small fraction of the dose received from natural background radiation. The result was not reportable to the USNRC.

TABLE D-2

Investigations Conducted During 1995

Collection Date	Reason for Investigation	# of Indicator Samples Exceeding the Action Level	Conclusion of Investigation
4. June 26, 1995 to July 31, 1995	The composite surface water sample collected at indicator Station J1-2, located just downstream of the TMINS liquid discharge outfall, contained an H-3 concentration (6,300 ± 600 pCi/L) which equalled or exceeded the GPUN action level of 2000 pCi/L.	1	The H-3 identified in the water sample resulted from the discharge of this material from TMINS into the Susquehanna River. Concentrations of H-3 above background levels are expected in this sample because the collection site is located proximate to the TMINS liquid discharge outfall where mixing of effluents and river water is incomplete. Since the sample is raw (non-potable) river water, a dose due to ingestion was not calculated. The result was not reportable to the USNRC.
5. October 13, 1995	The sediment sample collected at indicator Station K1-3, located just downstream of the TMINS liquid discharge outfall, contained Cs-134 at a concentration of 0.33 ± 0.03 pCi/g (dry). This result was greater than 10 times the control sample concentration (<0.03 pCi/g, dry).	1	The presence of Cs-134 in the indicator sediment sample was attributed to TMINS operations because 1) this radionuclide was release routinely in TMI-1 liquid effluents, 2) Cs-134 was not detected above the MDC in the control sample and 3) other radionuclides (Co-60 and Cs-137) associated with TMI-1 operations also were detected in the subject sample. The estimated dose from standing on these sediments was insignificant and a small fraction of the dose received from natural background radiation. The result was not reportable to the USNRC.
6. November 3, 1995	The sediment sample collected at indicator Station K1-3, located just downstream of the TMINS liquid discharge outfall, contained Cs-137 at a concentration of 0.75 ± 0.07 pCi/g (dry). This result was greater than 10 times the control sample concentration (0.068 ± 0.020 pCi/g, dry).		A portion of the Cs-137 detected in the indicator sediment sample was due to TMINS operations because 1) Cs-137 was released routinely in liquid effluents, 2) the Cs-137 concentration in the subject sample was significantly higher than that measured in the control sample and 3) other radioactive materials (Co-60, and Cs-134) were identified in the subject sample. A portion of the Cs-137 identified in the K1-3 sample also was related to fallout from prior nuclear weapon tests. The estimated dose from standing on these sediments was insignificant and a small fraction of the dose received from natural background radiation. The result was not reportable to the USNRC.

APPENDIX E

1995 Quality Control Results

A quality assurance (QA) program is an essential part of any radiological environmental monitoring program (REMP). It provides reasonable assurance that the results of radiation measurements are valid. To be effective, elements of quality assurance must be evident in all phases of the monitoring program. These include, but are not limited to, sample collection, preservation and shipment, receipt of samples by the analysis laboratory, preparation and analysis of samples and data review and reporting. An effective QA program will allow for the identification of deficiencies in all monitoring processes so that appropriate investigative and corrective actions can be implemented.

The USNRC published Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment", which defines an acceptable QA program (Ref. 33). The guidance contained in Regulatory Guide 4.15 has been adopted by GPU Nuclear. To meet the objectives of this position document, procedures and plans have been written and implemented.

In the laboratory, samples are typically analyzed one time. Therefore, laboratory personnel must be reasonably confident with the analytical results which are generated. One means of achieving confidence in the results is through the analysis of quality control (QC) samples.

Three types of QC samples are routinely analyzed by the laboratories as part of the GPU Nuclear Three Mile Island Environmental Affairs REMP QA Program. They include intralaboratory split samples, USEPA Cross-check Program samples, and interlaboratory split samples. A discussion of each QC sample type is provided below.

Intralaboratory Split Samples

Each laboratory is required to split at a minimum every twentieth sample and perform an analysis (or analyses) on each portion. The samples which can not be split (e.g., air particulate filters) are counted twice. The results of the two analyses are then checked by staff scientists for agreement using the criteria defined in procedure 6510-SUR-4523.03. Agreement is considered acceptable if the coefficient of variation for the two values is eighty-five percent or less. Nonagreement of the sample concentrations may result in recounting or reanalyzing the sample(s) in question.

During 1995, all of the paired intralaboratory split sample results were found to agree.

USEPA Crosscheck Program Samples

The GPU Nuclear Three Mile Island Environmental Affairs Department requires each analytical laboratory to participate in the USNRC-approved USEPA Environmental Radioactivity Laboratory Intercomparison Studies (Cross-check) Program. The participation

in this program provides an independent check on the ability of each laboratory to perform analyses on various kinds of samples containing detectable concentrations of radioactivity.

The results submitted by each participating laboratory are evaluated statistically by the USEPA for accuracy as well as precision. Laboratories which submit results outside the USEPA control limits are requested to perform an investigation and take corrective action as necessary.

The 1995 results from each laboratory analyzing environmental samples for GPU Nuclear are listed in Appendix F. Explanations are provided for those results which were not submitted and/or which were not within the established control limits.

Interlaboratory Split Samples

The third type of QC sample is the interlaboratory split sample. These samples are the ones which are collected routinely for the REMP. After or during the collection process, the sample is thoroughly mixed (as necessary) to ensure that, as much as possible, the distribution of radioactivity in the sample is homogeneous. The sample is then split into two portions. One portion is sent to the primary (main) lab and the other portion is sent to the QC laboratory.

Since it is impractical to split airborne materials (filters, charcoal cartridges, etc.) separate samples from independent, but colocated, samplers are collected and then sent to the analysis laboratories. Unfortunately, this practice of using distinctly different samples may result in higher than normal concentration differences for the two samples.

Analysis results from the QC laboratory are then compared to those from the primary laboratory. The agreement criteria is the same as that used for the intralaboratory split samples. Corrective action for disagreements may include recounting or reanalyzing the sample(s).

Table E-1 outlines the interlaboratory split sample program for 1995. There were five interlaboratory nonagreements during the entire year. An explanation is provided in Table E-2 for each nonagreement.

TABLE E-1

1995 Interlaboratory Split Sample Program

Sample Medium	No. of Primary Stations	No. of QC Stations	Percentage of Primary Samples Submitted for QC Analysis
Air Particulate (AP)	12	1	8 percent
Air Iodine (AI)	12	1	8 percent
Surface/Drinking Water (SW)	9	1	11 percent
Milk (M)	7	1	14 percent
TLDs Quarterly (ID)	103	10	10 percent
Groundwater (GW)	17(1)	1	6 percent
Aquatic Sediment (AQS)	10(2)	2(2)	20 percent
Fish (AQF)	7(2)	1(2)	14 percent
Food Products (FPV,FPF,FPL)	34(2)	4(2)	12 percent
Soil (S)	0(3)	0(3)	Not applicable
Meat (GAD)	3(2)	1(2)	33 percent
Rodent (ROD)	2(2)	0(2)	0 percent

(1) Refers to the total number of stations routinely sampled and analyzed in 1995.

(2) Refers to the total number of samples collected and analyzed.

(3) Soil was not collected in 1995. The next collection of soil is scheduled for the Fall of 1996.

TABLE E-2

1995 Interlaboratory Split Sample Nonagreements

Sample Medium	Collection Date	Station	Analysis	Action and/or Resolution
1. AP	01/03/95 - 03/28/95	E1-2	Gamma (K-40)	The primary and QC sample results were <0.02 pCi/m^3 and 0.0036 ± 0.0020 pCi/m^3, respectively. The nonagreement was due to counting the QC sample five times longer than the primary sample. No further action was taken because the QC sample concentration was below the estimated minimum detectable concentration (MDC) reported for the primary sample. Potassium-40 is a naturally-occurring radionuclide. Its presence in the QC sample was unrelated to TMINS operations.
2. GW	06/08/95	MS-2	Gamma (K-40)	The primary and QC sample results were 39 ± 19 pCi/L and 201 ± 35 pCi/L, respectively. The nonagreement was due to the method used for collecting and splitting the sample. The practice in 1995 for splitting the samples resulted in a QC sample with more sediment and, therefore, more K-40. To ensure that both samples (primary and QC) are similar in content, additional guidance will be provided, as appropriate, in the collection procedure. Also, the labs will begin to analyze only the sediment-free, liquid portion of the sample. Potassium-40 is a naturally-occurring radionuclide. Its presence in both samples was unrelated to TMINS operations.
3. SW	06/26/95 - 07/31/95	Q9-1F	H-3	The primary and QC sample results were <130 pCi/L and 550 ± 170 pCi/L, respectively. A reanalysis of the QC sample yielded a result of 230 ± 120 pCi/L which agreed with the primary sample result. The initial QC sample result may have been artificially elevated due to an analysis problem. No further action was taken.
4. SW	07/31/95 - 08/28/95	Q9-1F	Gr Beta	The primary and QC sample results were 1.6 ± 1.0 pCi/L and 8.0 ± 1.9 pCi/L, respectively. Since the QC sample result was elevated compared to historic concentrations, a recount by the QC lab was requested. The recount yielded a lower result (5.8 ± 1.9 pCi/L) which agreed (by GPUN criteria) with the primary sample result. A review of the raw data indicated that the QC sample contained about twice as much particulate matter. This was the most likely cause for the higher QC results. No further action was taken.
5. GW	12/01/95	MS-2	Gamma (K-40)	The primary and QC sample results were 30 ± 21 pCi/L and 229 ± 26 pCi/L, respectively. Refer to #2 above for an explanation of the nonagreement.

APPENDIX F

1995 USEPA Cross-Check Program Results

TABLE F-1

1995 USEPA Cross-Check Program Results

Collection Date	Media	Nuclide	EPA Results (A)	GPUN-ERL Results (B)	Teledyne Isotopes Results (B)
01/13/95	Water	Sr-89	20.0 ± 8.7	(C)	19.00 ± 2.65
		Sr-90	15.0 ± 8.7	(C)	14.00 ± 0.00
01/27/95	Water	Alpha	5.0 ± 8.7	(D)	5.00 ± 1.00
		Beta	5.0 ± 8.7	(D)	6.00 ± 1.00
02/03/95	Water	I-131	100.0 ± 17.3	97.33 ± 2.52	88.33 ± 2.31
03/10/95	Water	H-3	7435.0 ± 1290.8	(E)	7066.67 ± 115.47
04/18/95	Water	Alpha	47.5 ± 20.6	31.67 ± 3.21	39.67 ± 2.52
		Beta	86.6 ± 17.3	75.00 ± 2.00	80.33 ± 2.52
		Co-60	29.0 ± 8.7	29.67 ± 0.58	31.67 ± 2.08
		Sr-89	20.0 ± 8.7	(C)	20.67 ± 1.15
		Sr-90	15.0 ± 8.7	(C)	14.67 ± 0.58
		Cs-134	20.0 ± 8.7	18.67 ± 0.58	19.67 ± 2.08
		Cs-137	11.0 ± 8.7	10.00 ± 1.00	11.67 ± 1.53
06/09/95	Water	Co-60	40.0 ± 8.7	40.33 ± 1.53	42.33 ± 2.52
		Zn-65	76.0 ± 13.9	76.00 ± 5.57	82.33 ± 3.51
		Ba-133	79.0 ± 13.9	79.67 ± 2.08	74.33 ± 2.08
		Cs-134	50.0 ± 8.7	46.00 ± 1.73	46.67 ± 2.08
		Cs-137	35.0 ± 8.7	35.00 ± 2.65	37.67 ± 1.15
07/14/95	Water	Sr-89	20.0 ± 8.7	(C)	18.33 ± 1.53
		Sr-90	8.0 ± 8.7	(C)	8.00 ± 0.00
07/21/95	Water	Alpha	27.5 ± 12.0	12.33 ± 2.08	18.33 ± 1.53
		Beta	19.4 ± 8.7	(F) 20.67 ± 3.51	19.33 ± 1.53
08/04/95	Water	H-3	4872.0 ± 844.9	4933.33 ± 57.74	4866.67 ± 152.75
08/25/95	Filter	Alpha	25.0 ± 10.9	25.00 ± 1.73	23.67 ± 1.53
		Beta	86.6 ± 17.3	76.67 ± 2.89	84.67 ± 1.53
		Sr-90	30.0 ± 8.7	(C)	25.33 ± 0.58
		Cs-137	25.0 ± 8.7	28.00 ± 0.00	27.00 ± 1.00
09/29/95	Milk	Sr-89	20.0 ± 8.7	(C)	23.33 ± 3.06
		Sr-90	15.0 ± 8.7	(C)	16.33 ± 0.58
		I-131	99.0 ± 17.3	98.33 ± 1.53	103.33 ± 5.77
		Cs-137	50.0 ± 8.7	51.33 ± 2.89	54.67 ± 2.52
		K-Nat	1654.0 ± 144.0	1733.33 ± 57.74	1683.33 ± 136.50

TABLE F-1

1995 USEPA Cross-Check Program Results

Collection Date	Media	Nuclide	EPA Results (A)	GPUN-ERL Results (B)	Teledyne Isotopes Results (B)
10/06/95	Water	I-131	148.0 ± 26.0	156.67 ± 5.77	150.00 ± 0.00
10/17/95	Water	Alpha	99.4 ± 43.1	103.33 ± 5.77	94.67 ± 6.00
		Beta	141.8 ± 36.9	120.00 ± 10.00	120.00 ± 10.00
		Co-60	49.0 ± 8.7	49.33 ± 2.08	53.33 ± 5.37
		Sr-89	20.0 ± 8.7	(C)	20.67 ± 3.00
		Sr-90	10.0 ± 8.7	(C)	9.30 ± 1.20
		Cs-134	40.0 ± 8.7	33.33 ± 0.58	34.37 ± 4.03
		Cs-137	30.0 ± 8.7	29.00 ± 1.73	35.10 ± 3.93
10/27/95	Water	Alpha	51.2 ± 22.2	32.00 ± 0.00	37.00 ± 3.00
		Beta	24.8 ± 8.7	28.67 ± 1.53	25.33 ± 1.53
11/03/95	Water	Co-60	60.0 ± 8.7	57.33 ± 3.79	58.00 ± 7.00
		Zn-65	125.0 ± 22.6	133.33 ± 5.77	131.33 ± 19.14
		Ba-133	99.0 ± 17.3	94.67 ± 1.53	91.33 ± 3.06
		Cs-134	40.0 ± 8.7	35.67 ± 2.31	36.33 ± 2.08
		Cs-137	49.0 ± 8.7	49.33 ± 1.53	50.33 ± 4.62

A. EPA Results - Expected Laboratory precision (control limit, ± 3 sigma, n = 3). Units are pCi/L for water and milk except K-Nat is in mg/L. Units are total pCi for air particulate filters.

B. Results - Average ± one standard deviation. Units are pCi/L for water and milk except K-Nat is in mg/L. Units are total pCi for air particulate filters.

C. No data available. Analysis not performed by laboratory.

D. The ERL results were not reported to the EPA. The sample was analyzed six times and the precision of the individual results was not acceptable. The ERL policy is to report only highly confident results and since the confidence level could not be achieved from this sample the results were not submitted to the EPA.

E. The ERL tritium results were not reported to the EPA in time for the report. The ERL result (average 3 determinations) was 7533.33 ± 208.17 pCi/L. The value is within all limits (0.23 sigma of known). Also the precision (R.A. = 0.318) is acceptable.

F. The ERL result was below the control limit (-3.81 normalized deviation from the known). A reanalysis was performed and the result (28.33 ± 4.08 pCi/L) was within all limits.

APPENDIX G

1995 Land Use Census

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
1.9km (1.2mi) N 1	5° A		--	--	--	6 Nannies	0	--	--	All year but mainly store bought feed
3.3km (2.1mi) N 2	3° A		Cows, goats, sheep and horses are periodically kept here for quarantine from a few days to a few weeks. Animals are then shipped interstate or to foreign countries. If milked, milk is used as animal feed.							Animals graze for short periods prior to exportation. Occasionally they receive feed
5.3km (3.3mi) N [3]	10° A		Holstein	44 Cows 90 Heifers & Calves	44	--	--	3 Hens 1 Rooster 3 Rabbits	Atlantic Dairy Co-Op	Cows are confined to silage and grains which are partially grown on farm. Calves graze duirng favorable weather
8.5km (5.3mi) N 4	3° A		Holstein	135 Cows 160 Heifers	135	--	--	--	Atlantic Dairy Co-Op & Own Use	April 15 to October. Silage & grains are home grown
8.6km (5.3mi) N 5	358° A		--	--	--	--	--	32 Beef Cattle	Sold at Lebanon Valley Auction	April to October. Feed is home grown
6.4km (4.0mi) NNE 6	24° B		--	--	--	--	--	8 Chickens	Eggs are for Own Use	Store bought feed plus out all year

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
6.3km (3.9mi) NE 7	35° C		--	--	--	--	--	70 Beef Cattle (Simmentals & Angus)	Some sold at Lebanon Valley Auction & Own Use. Some Show Animals Sold at 4-H. Breeding stock sold in western PA.	May to October. Feed is home grown
6.6km (4.1mi) NE 8	35° C		Holstein	120 Cows 100 Heifers	120	--	--	75 Steers	Atlantic Dairy Co-Op & Own Use	Milk cows are on home grown feed. Heifers graze June to October
7.0km (4.4mi) NE 9	48° C		Holstein	140 Cows 135 Heifers	125	--	--	--	Atlantic Dairy Co-Op & Own Use	Confined to their own silage (Heifers graze May 15 - Oct.1)
1.7km (1.1mi) ENE [10]	65° D		Holstein	96 Cows 60 Heifers	75	--	--	1 Steer 20 Sheep	Mt. Joy Co-op & Own Use. Steer is for Own Use	May 1 to November 1 plus hay & corn
2.0km (1.3mi) ENE 11	75° D		--	--	--	--		2 Steers 2 Hogs 50 Chickens	Sold Privately & Own Use	All Summer/Hay in Winter
4.5km (2.8mi) ENE 12	72° D		--	--	--	1	0	8 Sheep	Own Use	Store bought feed & graze most of year

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
6.7km (4.2mi) ENE 13	59° D		Holstein	58 Cows 60 Heifers & Calves	58	--	--	--	Harrisburg Dairy & Own Use	May 1 to November 1. Feed is home grown
7.2km (4.2mi) ENE 14	57° D		Holstein	80 Cows 80 Heifers & Calves	70	--	--	--	Mt. Joy Co-Op & Own Use	April to November
7.5km (4.7mi) ENE 15	71° D		Holstein	75 Cows 45 Heifers	65	--	--	--	Mt.Joy Co-op & Own Use	May to October
1.8km (1.1mi) E [16]	93° E		Holstein	100 Cows 80 Heifers & Calves	100	--	--	--	Mt.Joy Co-op	April to November plus home-grown feed
5.6km (3.5mi) E 17	96° E		Holstein	56 Cows 48 Heifers	45	--	--	--	Mt.Joy Co-op & Own Use	April to October/ Winter on Silage & Hay
4.0km (2.5mi) ESE 18	112° F		--	--	--	--	--	200 Pigs	Pigs are raised & then transported to Hatfield or Groff's Meat Market	Store Bought feed

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
4.5km (2.8mi) ESE 19	107° F		--	--	--	2	0	20 Chickens 18 Sheep	Own Use + eggs to neighbors & friends. Lambs will go to Lancaster Stock Yard, neighbors & friends. Sheep meat sold to neighbors	All year
5.2km (3.2mi) ESE [20]	104° F		Holstein	75 Cows 50 Heifers	64	--	--	78,000 Chickens	Mt.Joy Co-op & Chickens to Wengert Feeds	May to November/ Winter on stored silage & hay
5.7km (3.6mi) ESE 21	117° F		Holstein	32 Cows 12 Heifers & Calves	30	--	--	1 Bulls	Atlantic Dairy Co-Op & Neighbors	May to November
6.1km (3.8mi) ESE 22	113° F		Holstein	100 Cows 55 Heifers	100	--	--	1500 Hogs 75 Steers	Atlantic Dairy Co-Op. Beef Cows & Hogs Sold at Hatfield and at the Stock Yards	May to October. Dairy Cows are on silage
6.6m (4.1mi) ESE 23	113° F		--	--	--	--	--	34 Beef Cattle 40 Sheep	Lancaster Stock Yards	May to November Winter on Silage & Hay
6.9km (4.3mi) ESE 24	114° F		--	--	--	--	--	41 Beef Cattle (Angus, Hereford & Holstein)	Sold Locally, Own Use & Steers Sold at Lanc. Stock Yards & New Holland Auction	All Year

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
7.6km (4.7mi) ESE 25	121° F		--	--	--	--	--	32 Steers (Angus & Holstein) 40,000 Chickens	Steers sold at New Holland Auction & Vintage Sales Stable. Chickens sold to Falls Poultry in NY	Confined to home-grown hay & corn
8.1km (5.0mi) ESE 26	115° F		Holstein	52 Cows 40 Heifers	49	--	--	28,000 Chickens (Broilers) & 2 Steers	Atlantic Dairy Co-Op. Chickens sold commercially to Pennfield, Rohrerstown. Steer Own Use	April to October/ Winter on silage
8.1km (5.0mi) ESE 27	119° F		--	--	--	--	--	25 Steers (Angus & Holstein)	Sold Locally & at Lancaster Stock Yard	May to November. Winter on silage & hay
8.2km (5.1mi) ESE 28	113° F		--	--	--	--	--	85,000 Chickens (Broilers)	Sold to Tyson	--
8.2km (5.1mi) ESE 29	122° F		--	--	--	--	--	30 Sheep 1600 Hogs 1 Steer	Groffs & Sold at Lancaster Stock Yard. Livestock sold at Groffs	Sheep graze April to October/Store-bought feed & 4 acres of field corn in winter
8.3km (5.1mi) ESE 30	123° F		Holstein	150 Cows 90 Heifers	125	--	--	105,000 Chickens (Broilers)	Atlantic Dairy Co-Op & Chickens Sold Commercially to Tyson	Dairy Cows con- fined to own feed/Heifers graze May to October

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
8.5km (5.3mi) ESE 31	103° F		Ayrshire & Holstein	145 Cows 100 Heifers	125	--	--	70 Steers 90 BeefCattle 1200 Hogs 9,000 Chickens	Harrisburg Dairy & Livestock sold at local markets. Hogs go to Groff's Meat Market. Eggs sold at Souders	May to November Winter on silage & hay
1.8km (1.1mi) SE 32	124° G		--	--	--	2	0	100 Beef Cattle (Holstein) 350,000 Chickens 10 Sheep 110,000 Pullets	Eggs sold to Quaker State. Beef sold at Moyers (Mo Pac). Sheep for Own Use. Also sold locally.	Cattle confined to home-grown hay & silage. Chickens on store-bought feed
2.3km (1.4mi) SE [33]	130° G		Holstein Ayrshire	60 Cows 20 Heifers	55	--	--	10 Steers	National Farmers Organization & Steers Sold at Lancaster Stock Yard	April to November/Winter on silage & hay
4.1km (2.6mi) SE 34	144° G		--	--	--	--	--	1 Goose	Own Use	Confined to Barn Yard.
4.4km (2.8mi) SE 35	134° G		--	--	--	--	--	40 Beef Cattle (Angus, Hereford & Charlais)	Lancaster Stock Yard	All year

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
6.0km (3.8mi) SE 36	141° G		--	--	--	--	--	70 Beef Cattle (Charlais) 150 Pigs	Sold at New Holland Vintage, Lancaster & pigs sold at various markets including Groff's Meat Market.	Cattle on pasture all year plus feed/Calves on feed (hay & silage) in winter
6.5km (4.0mi) SE 37	141° G		Holstein	60 Cows 50 Heifers & Calves	48	3	0	6 Bulls (calves)	Mt.Joy Co-op & Own Use plus shared with friends	April to November plus silage all year/Milking cows only on silage & hay
6.6km (4.0mi) SE 38	129° G		Holstein	160 Cows 150 Heifers	130	--	--	110 Steers	Mt.Joy Co-op & Steers Sold at Auction (New Holland & Vintage)	April to October but mostly silage Milk Cows only on silage & hay
7.2km (4.5mi) SE 39	137° G	***	--	--	--	--	--	2 Steers (Angus)	Own Use	All year
7.4km (4.6 mi) SE 40	136° G		--	--	--	--	--	25 Chickens	Own Use	Store bought feed & scraps
7.9km (4.9mi) SE 41	131° G		--	--	--	--	--	90,000 Chickens 70 Steers	Eggs are Sold Commercially to Quaker State Farms & Own Use. Beef to Lancaster Stock Yard or New Holland	Silage plus 50 steers on pasture April to October

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
5.3km (3.3mi) S 42	180° J		--	--	--	--	--	60 Beef Cattle (Hereford, Black Angus & Holstein)	Sold at Auction in Lancaster & Own Use	May to December. Store bought feed & silage rest of the year
3.9km (2.4mi) SSW 43	192° K		--	--	--	--	--	2 Hogs 6 Rabbits	Own Use	Mainly store bought feed
4.0km (2.5mi) SSW 44	192° K	***	--	--	--	--	--	2 Steers	Own Use	Graze year round plus store bought feed
7.8km (4.9 mi) SSW 45	200° K		Holstein	65 Cows 45 Heifers	55	--	--	1 Sheep (Pet)	Atlantic Dairy Co-Op	April 15 to October 15
20.6km (12.8mi) SSW [46]	208° K		Jersey Holstein Ayrshire Brown Swiss Guernsey Milking Shorthorn	188 Cows 24 Heifers & Calves	155	--	--	13 Hens 1 Rooster 18 Turkeys 4 Rabbits	Atlantic Dairy Co-Op	Cows on store bought feed. Other animals graze April to November plus haylage, silage and grain year round.
4.3km (2.8mi) SW 47	226° L		--	--	--	--	--	12 Beef Cattle (Angus, Hereford & Charlais)	Lancaster Stock Yard	May to November

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
6.0km (3.7mi) SW 48	233° L		--	--	--	2 Nannies	0	2 Sheep 4 Chickens 1 Rabbit	Own Use	Goats graze all year. Other animals use feed.
6.5km (4.0mi) WSW 49	242° M		--	--	--	--	--	300 Chickens 30 Guineas	Distributed Locally & Own Use	Most confined to chicken house for feeding. Some run loose.
7.1km (4.4mi) WSW 50	238° M		--	--	--	2 Nannies	0	20 Chickens 12 Geese 3 Ducklings	Own Use	Goats graze May to October
7.7km (4.8mi) WSW 51	237° M		--	--	--	1 Nanny 1 Billy	0	5 Chickens 4 Rabbits	Own Use	All Year plus supplemental feed
5.0km (3.1mi) WNW 52	286° P		--	--	--	--	--	6 Steers 12 Cows (Black Angus) 1 Bull 12 Calves	Own Use & Occasionally Distributed Locally	April to December
6.0km (3.7mi) WNW 53	295° P		Holstein Jersey Brown Swiss	80 Cows	50	11 Nannies	0	15 Geese 7 Ducks	Atlantic Dairy Co-Op	May to October
10.8km (6.7mi) WNW [54]	293° P		Holstein	47 Cows 44 Calves & Heifers	46	--	--	--	Rutters Dairy & Own Use	May to October plus stored feed

TABLE G-1
1995 ANNUAL DAIRY AND LIVESTOCK CENSUS*

Distance & Direction	Azimuth & Sector Code	**Name, Address & Phone Number	Breed	No. Cows	No. Cows Milked	No. Goats	No. Goats Milked	Livestock	Dairy Used	Grazing Period
TOTALS			Holstein, Jersey, Ayrshire, Brown Swiss, Guernsey, Milking Shorthorn	2,118 Cows 1,538 Heifers & Calves	1,869	31	0	1,056 Beef Cattle (Includes Steers, Cows, & Calves) 8 Bulls 4,654 Pigs & Hogs 895,450 Chickens 28 Geese 10 Ducks 18 Rabbits 129 Sheep 30 Guineas 18 Turkeys	Atlantic Dairy Co-Op, Mt.Joy Co-op, Harrisburg Dairy, Rutters Dairy, National Farmers Organization	Various

* Includes livestock which are used only for human consumption and all dairy farms within approximately five miles of TMINS plus regularly sampled milk farms.

** Names and addresses are on file at Three Mile Island Environmental Affairs.

*** Indicates new farm/livestock owner this census.

In lower right-hand corner of the first column indicates running total of farms surveyed.

[#] Bracketed #'s indicate regularly sampled milk farms.

TABLE G-2

1995 Annual Residence Census*

Distance and Direction	Azimuth and Sector Code	Name, Address** & Telephone No.	Distance and Direction	Azimuth and Sector Code	Name, Address** & Telephone No.
6,000 ft. (1,839 m) N	5° A		12,000 ft. (3,658 m) S	186° J	
3,800 ft. (1,158 m) NNE	28° B		3,400 ft. (1,036 m) SSW	213.7° K	
2,800 ft. (853 m) NE	48° C		2,850 ft. (869 m) SW	226° L	
2,450 ft. (747 m) ENE	67.5° D		2,500 ft. (777 m) WSW	250° M	
2,300 ft. (700 m) E	80° E		1,850 ft. (564 m) W	272° N	
5,800 ft. (1,770 m) ESE	123° F		1,900 ft. (579 m) WNW	293° P	
3,750 ft. (1,143 m) SE	145° G		2,150 ft. (655 m) NW	306° Q	
3,750 ft. (1,143 m) SSE	152° H		2,150 ft. (655 m) NNW	337.56° R	

* Census identifies nearest residence in each of the sixteen meteorological sectors.

** Names and addresses are on file at Three Mile Island Environmental Affairs.

TABLE G-3

Annual Garden Census 1995*

Meteorological Sector Designation	Distance and Direction	Azimuth	**Name, Address & Phone Number	Type of Vegetation	How Used and Distribution of Consumers
A (1)	2.4km (1.5mi) N	4°		Pumpkins, Tomatoes, Squash, Lettuce, Garlic, Zucchini, Corn, Potatoes	Own Use 3 Adults Also given away to other family members, friends & neighbors
B (2)	1.4km (0.9mi) NNE	24°		Corn, Peppers, Cabbage, Tomatoes, Asparagus, Horse Radish, Onions, Blueberries, Rhubarb, Strawberries, Broccoli, Beans, Peas, Potatoes	Own Use 3 Adults Also given away to friends & neighbors
C (3)	1.3km (0.8mi) NE	34°		Tomatoes, Peppers, Corn, Lettuce, Peas, Asparagus, Cantaloupes, Strawberries, Apples	Own Use 2 Adults
D (4)	0.8km (0.5mi) ENE	57°		Asparagus, Rhubarb, Grapes, Apples, Blueberries, Tomatoes, Peppers, Winter Squash, Summer Squash, Carrots, Lettuce	Own Use 2 Adults Also given away to friends & neighbors
E (5)	0.7km (0.5mi) E	94°		Cabbage, Tomatoes, Peppers, Red Beets, Potatoes, Corn, Yellow Wax Beans	Grown primarily for GPUN Environmental Monitoring Program. Excess consumed by GPUN personnel & their families.
F (6)	0.8km (0.5mi) ESE	120°		See "E"	See "E"
G (7)	1.0km (0.6mi) SE	135°		Wide assortment of food products including broad-leaf vegetables (cabbage)	Own Use 2 Adults. Also given away to relatives & sold along Rt. 441 at the Red Hill Farm Produce Stand, at the Farm Show Building Farmers Market & at the Hometown Market in Hazelton. Excess goes to Leola Produce Auction.
H (8)	1.1km (0.7mi) SSE	152°		Green Beans, Tomatoes, Onions, Cucumbers, Peppers, Rhubarb, Strawberries, Asparagus, Radishes, Yellow Potatoes, Turnips	Own Use 2 Adults Also given away to neighbors & friends
J (9)	3.7km (2.3mi) S	186°		Tomatoes, Peppers, Squash, Cabbage, Beets, Strawberries, Potatoes, Zucchini, Beans, Onions, Cucumbers, Sugar Peas, Radishes, Corn, Apples, Peaches, Pears	Own Use 2 Adults 2 Children Also given away to friends

TABLE G-3

Annual Garden Census 1995*

Meteorological Sector Designation	Distance and Direction	Azimuth	**Name, Address & Phone Number	Type of Vegetation	How Used and Distribution of Consumers
K (10)	3.4km (2.1mi) SSW (Garden located behind house along River)	196°		Parsley, Tomatoes, Peppers, Cucumbers, Corn, Lettuce, Beets, Broccoli	Own Use 2 Adults Also given away to friends and neighbors
L (11)	3.2km (2.0mi) SW	225°		Lettuce, Okra, Brussel Sprouts, Tomatoes, Peppers, Cucumbers, Pumpkins, Melons	Own Use 2 Adults 1 Child Also shared with neighbors (2 adults & 1 child)
M (12)	2.1km (1.3mi) WSW	253°		Endive, Potatoes, Beans, Cabbage, Turnips, Peas, Cucumbers, Corn, Zucchini, Onions, Lettuce, Tomatoes, Peppers, Egg Plant, Strawberries, Neck Pumpkins	Own Use 2 Adults Also infrequently sold locally & some given away to friends & neighbors.
N (13)	2.1km (1.3mi) W	265°		Tomatoes, Potatoes, Red Beets, Peppers, Onions, String Beans, Cabbage, Cucumbers, Rhubarb	Own Use 2 Adults Also some given away to friends, neighbors & family
P (14)	2.4km (1.5mi) WNW	287°		Brussel Sprouts, Radishes, Peppers, Zucchini, Tomatoes, Lettuce, Potatoes, Carrots, Watermelon, Cantaloupes, Raspberries, Pumpkins	Own Use 2 Adults 1 Teen 2 Children Also given away to family
Q (15)	2.4km (1.5mi) NW	310°		Red Beets, Cabbage, Corn, Peppers, Potatoes, Carrots, Neck Pumpkins, Pumpkins, Tomatoes, Onions, Green Beans, Sugar Peas, Strawberries, Cantaloupes, Raspberries, Asparagus,	Own Use 2 Adults Also some sold locally & given away to friends
R (16)	3.9km (2.4mi) NNW	346°		Tomatoes, Parsley, Peppers, Onions, Leaf Lettuce	Own Use 2 Adults Also shared with family & neighbors

* Census identifies nearest garden (greater than 500 ft^2 and having a portion of broad-leaf vegetation) in each of the sixteen meteorological sectors.

** Names and addresses are on file at Three Mile Island Environmental Affairs.

APPENDIX H

Data Reporting and Analysis

Environmental samples frequently contain very little, if any, radioactivity. Even when state-of-the-art counting equipment is used, many of the sample count rates can not be differentiated from the background count rate or the count rate of the blank sample. When this occurs, the sample is said to have a radioactivity level or concentration at or below the sensitivity of the analyses method. In this case, the analysis result is reported as less than a numerical value which corresponds to the sensitivity of the analysis method. Sensitivities are influenced by parameters such as sample volume, background or blank sample count rate and efficiency of the counting device.

The terms used to describe the sensitivity are the lower limit of detection (LLD) and minimum detectable concentration (MDC). For this report, these two terms are considered to be synonymous. They are defined as:

$$\text{LLD (MDC)} = \frac{4.66\ Sb}{E * V * 2.22 * Y * \exp(-\lambda\ \Delta t)}$$

where:

Sb	=	the standard deviation of the background counting rate or the counting rate of a blank sample, as counts per minute,
E	=	the counting efficiency of the equipment, as counts per disintegration,
V	=	the volume or mass of the sample, such as L, g or m^3,
2.22	=	the number of disintegrations per minute per picocurie,
Y	=	the chemical yield, if applicable,
λ	=	the radioactive decay constant for the particular radionuclide and
Δt	=	the elapsed time between sample collection (or end of sample collection period) and counting.

A large percentage of the 1995 sample results were reported as less than the LLD or MDC. The applicable LLD or MDC for each radionuclide and analysis is listed in Table 3. Results which were reported as less than the LLD or MDC were not included in the calculations for averages (by station or group) in the text and tables of this report.

The samples which contained measurable concentrations above the LLD or MDC were used in the calculations contained in this report. The individual results were generally reported to two significant figures. Each result also included a two-sigma counting uncertainty (95% confidence interval) to the same decimal place. At a minimum, a counting uncertainty equal to 10 percent of the measured concentration was reported. The counting uncertainties were not used in any statistical calculations in this report.

The data from samples with measurable concentrations were analyzed using SAS, a statistical analysis package developed by SAS Institute, Inc. The data were grouped by station, time period and by control and indicator status. Minimum, maximum and average values were calculated for each of these groups as well as standard deviations (2σ, 95% confidence interval).

Quality control results (interlaboratory and intralaboratory) were not statistically analyzed with other data. Including quality control data would introduce a bias at selected stations while providing little additional interpretive information.

APPENDIX I

1995 Dose Calculation Methodology and Results

To the extent possible, radiological impacts were evaluated based on the measurement of exposure rates or radionuclide concentrations in environmental samples. However, the radioactive materials released from TMINS during 1995 were often too small to be measured once dispersed in the offsite environment. As a result, the potential offsite doses were estimated by using computerized models that predict concentrations of radioactive materials in the environment and subsequent radiation doses on the basis of radionuclides released to the environment. GPU Nuclear calculates doses using an advanced class "A" dispersion model called SEEDS (simplified environmental effluent dosimetry system).

This model incorporates the guidelines and methodology set forth in USNRC Regulatory Guide 1.109, and uses actual monthly Susquehanna River flow data and hourly meteorological information matched to the time of releases to assess the dispersion of effluents in the river and the atmosphere. Combining this assessment of dispersion and dilution with TMINS effluent data for each unit, postulated maximum hypothetical doses to the public are calculated. The maximum individual dose is calculated as well as the population dose to the total population within 50 miles of TMINS for gaseous effluents and the entire population using Susquehanna River water downstream of the station for liquid effluents. Values of environmental parameters and radionuclide concentration factors were chosen to provide conservative results. As a result, the doses calculated using this model are conservative estimates (i.e., overestimated).

The dose summary tables, Table I-1 and I-2, present the maximum hypothetical doses to an individual resulting from TMI-1 and TMI-2 effluents, respectively, during the 1995 reporting period. Population doses for both units also are presented in Table I-1 and Table I-2.

Liquid (Individual)

The first two lines of Table I-1 and Table I-2 present the maximum hypothetical dose to an individual from liquids. Presented are the total body and critical organ doses due to the radionuclides in the liquid effluents. As recommended in USNRC Regulatory Guide 1.109, calculations are performed on the four age groups and eight organs. The pathways considered were water ingestion, shoreline exposure, and fresh water sportfish ingestion. The latter two pathways are considered to be the primary recreational activities associated with the Susquehanna River in the vicinity of TMINS. The "receptor" would be that individual who drinks water from the Susquehanna River, eats fish that reside in the plant discharge, and stands on the shoreline influenced by the plant discharge. The tables present the maximum total body dose and critical organ dose for the age group most effected.

For the 1995 reporting period, the calculated maximum hypothetical total body dose received by anyone from TMINS liquid effluents would have been 0.579 mrem (TMI-1) and 0.00133 mrem (TMI-2) to an adult. These represent 19.3 percent and 0.0443 percent, respectively, of the USNRC 10 CFR 50 App. I annual guidelines. The maximum hypothetical organ dose

from TMI-1 and TMI-2 liquid effluents would have been 0.820 mrem and 0.00207 mrem, respectively, to the liver of a teenager. These represent 8.20 percent and 0.0207 percent, respectively, of the USNRC 10 CFR 50 App. I annual guidelines.

Gaseous (Individual)

There were six major pathways considered in the dose calculation for gaseous effluents. These are: (1) plume exposure, (2) inhalation, consumption of (3) cow milk, (4) fruits and vegetables, (5) meat, and (6) standing on contaminated ground. Ingestion of goat milk was not considered because this pathway did not exist in 1995. Real-time meteorology (the actual conditions that existed at the time of releases) was used in dose calculations for gaseous effluents. Default values were used if data were missing or invalid.

Lines 3 and 4 of Table I-1 and Table I-2 present the maximum plume exposures from noble gases at the site boundary. The notation of "air dose" is interpreted to mean that these doses are not to an individual but are considered to be the maximum dose at a location. The location is not necessarily a receptor. The tables present the distance in meters and the affected sector (compass point). With respect to the noble gas releases for the 1995 reporting period, the maximum plume exposure (air dose) would have been 0.196 and 0.203 millirads (mrad) for TMI-1, gamma and beta, respectively. The TMI-1 exposures represent 1.96 and 1.02 percent of the USNRC 10 CFR 50 App. I annual guidelines, respectively. Since TMI-2 released no noble gases, the gamma and beta air doses are zero.

Lines 5 and 6 present the calculated dose from noble gases to the closest receptor (individual) in the maximally affected sector(s). The location of the receptor is described by both distance (meters) and direction from the site. Plume doses to an individual, regardless of age, from gaseous effluents (noble gases only) during the 1995 reporting period were 0.129 mrem and 0.260 mrem for TMI-1 total body and skin dose, respectively. These represent equal to or less than 2.58 percent of the USNRC 10 CFR 50 App. I annual guidelines. Since TMI-2 released no noble gases, the total body and skin doses were zero.

Line 7 represents the dose to the maximally exposed organ due to airborne releases of iodine, tritium and particulates. This does not include the whole body plume dose which was separated out on line 5. The doses presented in this section again reflect the maximum exposed organ for the appropriate age group.

During 1995, iodines, tritium and particulates released into the atmosphere from TMI-1 would have resulted in a maximum dose of 0.433 mrem to the thyroid of an infant. The corresponding dose from TMI-2 was 0.0000337 mrem to the liver, total body, thyroid, kidney, lung and GI-LLI of a child. No other organ of any age group would have received a dose greater than this from either TMI-1 or TMI-2. Both of these doses represent equal to or less than 2.89 percent of the USNRC 10 CFR 50 App. I annual guidelines.

Liquid and Gaseous (Population)

Lines 8-11 of Tables I-1 and Table I-2 present the person-rem dose resulting from the liquid and gaseous effluents. These doses are summed over all pathways and the affected population. Liquid person-rem is based upon the population encompassed within the region from the TMINS outfall extending down to the Chesapeake Bay (approximately 5,000,000 people). The population dose due to gaseous effluents includes the population out to a distance of 50 miles around TMINS (approximately 2,200,000) as well as the much larger total population which can be fed by foodstuffs grown in the 50 mile radius (up to approximately 13,000,000). Population doses are summed over all distances and sectors to give an aggregate dose.

Based upon the calculations performed for the 1995 reporting period, total TMI-1 and TMI-2 liquid and gaseous effluents resulted in a population dose of 6.42 person-rem to the total body. This is more than 100,000 times lower than the dose that the population living within 50 miles of TMINS receives each year from natural background radiation.

TABLE I-1

Summary of Maximum Individual and Population Doses from TMI-1 Effluents for 1995

Individual Doses

Effluent	Organ	Estimated Dose/year (mrem)	Age Group	Location Dist (m)	Dir (Toward)	Percent of 10 CFR 50 App. I Annual Guideline	10 CFR 50 App I Annual Guideline (mrem/yr)
1 Liquid	Total Body	5.79E-1	Adult	Receptor 1		1.93E1	3
2 Liquid	Liver	8.20E-1	Teenager	Receptor 1		8.20E0	10
3 Noble Gas	Air Dose (Gamma-mrad)	1.96E-1	--	580	WNW	1.96E0	10
4 Noble Gas	Air Dose (Beta-mrad)	2.03E-1	---	580	WNW	1.02E0	20
5 Noble Gas	Total Body	1.29E-1	All	580	WNW	2.58E0	5
6 Noble Gas	Skin	2.60E-1	All	580	WNW	1.73E0	15
7 Iodine & Particulates	Thyroid	4.33E-1	Infant	580	WNW	2.89E0	15

Population Doses

Effluent	Applicable Organ	Estimated Population Dose (Person-rem)
8 Liquid	Total Body	6.01E+0
9 Liquid	Thyroid	1.51E+1
10 Gaseous	Total Body	4.03E-1
11 Gaseous	Thyroid	2.82E+0

TABLE I-2

Summary of Maximum Individual and Population Doses from TMI-2 Effluents for 1995

Individual Doses

Effluent	Organ	Estimated Dose/year (mrem)	Age Group	Location Dist (m)	Location Dir (Toward)	Percent of 10 CFR 50 App. I Annual Guideline	10 CFR 50 App. I Annual Guideline (mrem/yr)
1 Liquid	Total Body	1.33E-3	Adult	Receptor 1		4.43E-2	3
2 Liquid	Liver	2.07E-3	Teenager	Receptor 1		2.07E-2	10
3 Noble Gas	Air Dose (Gamma-mrad)	0	---	---	---	0	10
4 Noble Gas	Air Dose (Beta-mrad)	0	---	---	---	0	20
5 Noble Gas	Total Body	0	---	---	---	0	5
6 Noble Gas	Skin	0	---	---	---	0	15
7 Iodine & Particulates	Liver, total body, thyroid, kidney, lung & GI-LLI	3.37E-5	Child	2000	SE	2.25E-4	15

Population Doses

Effluent	Applicable Organ	Estimated Population Dose (Person-rem)
8 Liquid	Total Body	3.03E-3
9 Liquid	Bone	9.14E-3
10 Gaseous	Total Body	1.97E-3
11 Gaseous	Liver, thyroid, kidney, lung & GI-LLI	1.97E-3

APPENDIX J

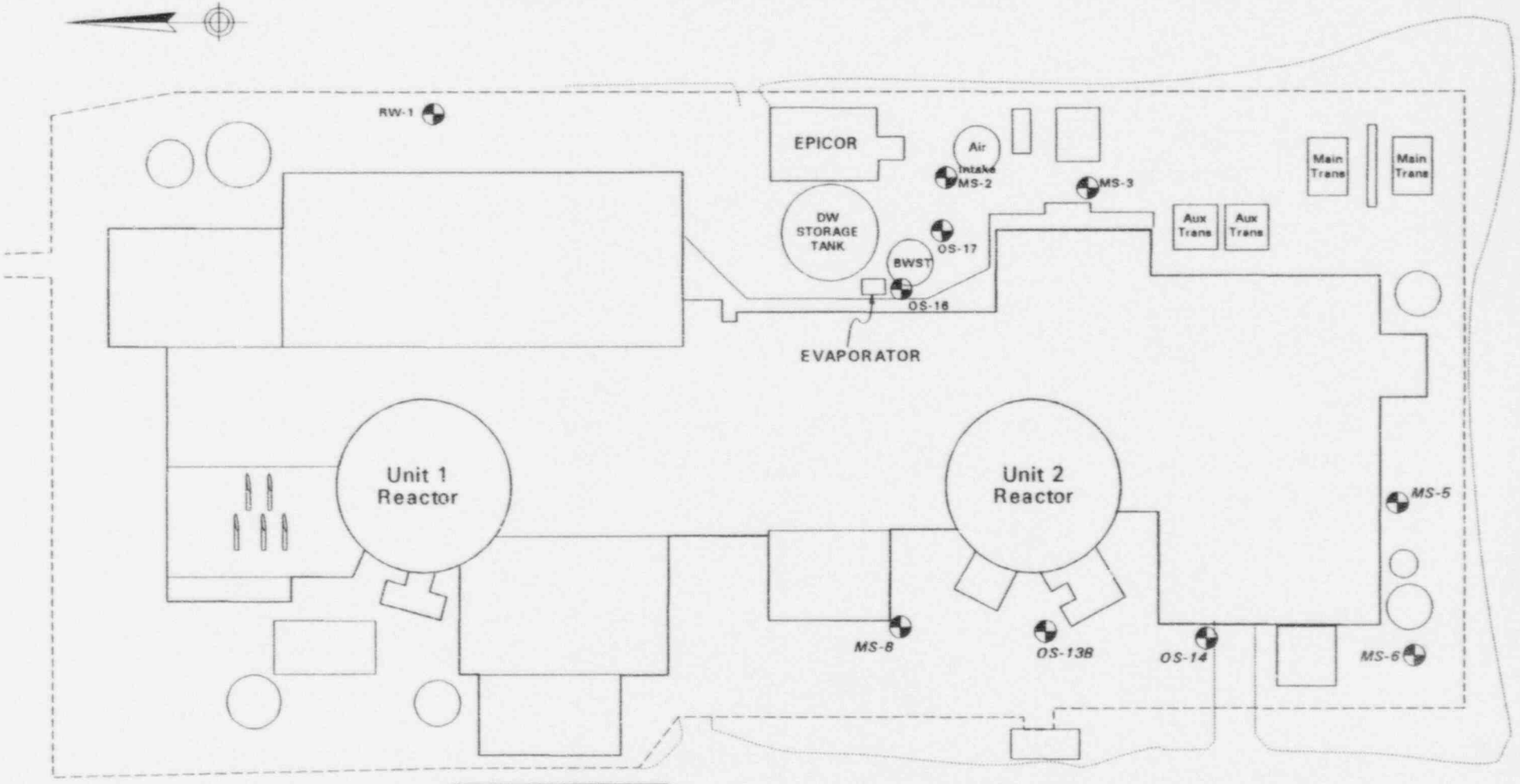
1995 Groundwater Monitoring Results

TABLE J
TMI Groundwater Monitoring Tritium Concentrations
(pCi/L)

Station	1994 Average * ± 2 std dev	1995 Average * ± 2 std dev	1995 Range
OSF	1700 ± 490	1500 ± 640	460 - 1800
MS-1	540 ± 590	380 ± 310	290 - 650
MS-2	1500 ± 1300	800 ± 240	680 - 950
MS-3	2500 ± 2700	1400 ± 850	950 - 1800
MS-4	1500 ± 1100	1100 ± 930	480 - 1500
MS-5	350 ± 240	370 ± 190	290 - 470
MS-7	350 ± 420	230 ± 83	180 - 260
MS-8	1300 ± 810	660 ± 370	500 - 870
OS-13B	840 ± 710	340 ± 42	330 - 360
OS-14	520 ± 330	280 ± 68	250 - 320
OS-16	4600 ± 4200	2300 ± 1700	1500 - 3300
OS-17	4600 ± 3300	1900 ± 930	1500 - 2500
E1-2	ND	ND	---
N2-1	170 ± 100	ND	---
EDCB	260 ± 180	260 ± 150	140 - 330
48s	270 ± 85	450 ± 1000	150 - 1600
RW-1	87,000 ± 91,000	390,000 ± 380,000	32,000 - 660,000
RW-2	7300 ± 5000	50,000 ± 86,000	3400 - 150,000
MW-1	NS	1400 ± 1200	540 - 1900
MW-2	NS	250	**
MW-3	NS	440 ± 319	350 - 620
MW-4	NS	210 ± 140	120 - 270

* Average of detectable results
** Only one positive result for this station
ND = No detectable activity
NS = Not sampled, no data available
(Refer to Figures J-1 and J-2 for locations of groundwater stations.)

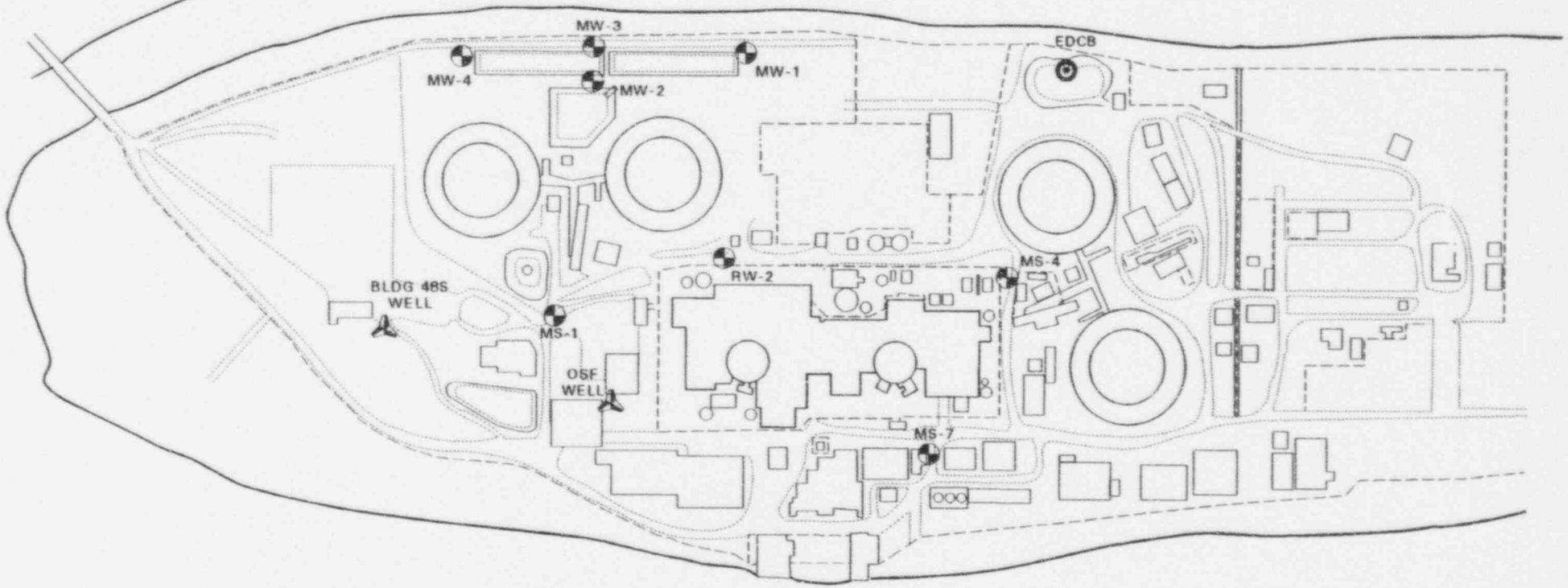
Figure J-1
TMINS Groundwater Stations
Inside the Protected Area



NO SCALE

TMI-EA (2/95)

Figure J-2
TMINS Groundwater Stations
Outside the Protected Area



LEGEND

- Monitoring Well
- Drinking Water Well
- Surface Water Station

Offsite Groundwater Wells: E1-2 at the TMI Visitor's Center and N2-1 at the Goldsboro Marina.

NO SCALE

TMI-EA (2/95)

APPENDIX K

1995 Meteorological Summary

TABLE K-1

Meteorological Data
1995 Joint Frequency Tables

Hours at Each Wind Speed and Direction
Period of Record: 95010100 - 95123123
Stability Class: **A**
Sensor Height: 100 ft.

Winds From	Wind Speed (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	22	44	18	0	0	0	84
NNE	2	5	2	0	0	0	9
NE	5	10	0	0	0	0	15
ENE	8	13	1	0	0	0	22
E	6	15	0	0	0	0	21
ESE	3	12	9	0	0	0	24
SE	10	24	8	0	0	0	42
SSE	8	8	0	0	0	0	16
S	2	8	5	0	0	0	15
SSW	20	54	42	2	0	0	118
SW	25	77	19	1	0	0	122
WSW	29	29	9	1	0	0	68
W	28	35	25	3	2	0	93
WNW	32	30	29	13	3	0	107
NW	50	65	54	17	4	0	190
NNW	67	91	31	7	2	0	198
TOTAL	317	520	252	44	11	0	1144

TABLE K-1
(Continued)

Meteorological Data
1995 Joint Frequency Tables

Hours at Each Wind Speed and Direction
Period of Record: 95010100 - 95123123
Stability Class: **B**
Sensor Height: 100 ft.

Winds From	Wind Speed (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	6	11	5	2	0	0	24
NNE	5	0	0	0	0	0	5
NE	3	2	0	0	0	0	5
ENE	3	3	1	0	0	0	7
E	2	9	1	0	0	0	12
ESE	2	8	7	1	0	0	18
SE	2	11	4	0	0	0	17
SSE	1	4	2	0	0	0	7
S	1	2	4	1	0	0	8
SSW	5	21	17	0	0	0	43
SW	5	10	8	2	0	0	25
WSW	8	8	3	0	0	0	19
W	6	4	11	6	2	0	29
WNW	1	4	16	19	2	0	42
NW	11	11	31	20	6	2	81
NNW	1	8	14	9	3	0	35
TOTAL	62	116	124	60	13	2	377

TABLE K-1
(Continued)

Meteorological Data
1995 Joint Frequency Tables

Hours at Each Wind Speed and Direction
Period of Record: 95010100 - 95123123
Stability Class: C
Sensor Height: 100 ft.

Winds From	Wind Speed (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	3	2	0	0	0	5
NNE	2	0	0	0	0	0	2
NE	3	1	0	0	0	0	4
ENE	3	5	0	0	0	0	8
E	3	8	7	0	0	0	18
ESE	2	1	1	0	0	0	4
SE	0	9	2	0	0	0	11
SSE	1	2	1	0	0	0	4
S	2	5	2	0	0	0	9
SSW	1	7	3	1	0	0	12
SW	3	3	1	4	0	0	11
WSW	3	5	2	1	0	0	11
W	3	1	5	1	2	0	12
WNW	3	4	9	10	1	0	27
NW	3	2	17	11	5	1	39
NNW	6	6	6	4	0	0	22
TOTAL	38	62	58	32	8	1	199

TABLE K-1
(Continued)

Meteorological Data
1995 Joint Frequency Tables

Hours at Each Wind Speed and Direction
Period of Record: 95010100 - 95123123
Stability Class: **D**
Sensor Height: 100 ft.

Winds From	Wind Speed (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	28	47	24	5	0	0	104
NNE	24	40	4	0	0	0	68
NE	36	59	6	0	0	0	101
ENE	28	80	19	0	0	0	127
E	25	85	57	4	0	0	171
ESE	23	84	108	4	0	0	219
SE	20	56	66	8	0	0	150
SSE	9	56	23	2	0	0	90
S	7	35	22	4	0	0	68
SSW	10	78	36	2	0	0	126
SW	16	45	16	6	0	0	83
WSW	14	28	11	3	0	0	56
W	15	53	103	42	6	0	219
WNW	12	44	133	114	26	1	330
NW	22	47	134	167	39	3	412
NNW	32	68	56	35	4	0	195
TOTAL	321	905	818	396	75	4	2519

TABLE K-1
(Continued)

Meteorological Data
1995 Joint Frequency Tables

Hours at Each Wind Speed and Direction
Period of Record: 95010100 - 95123123
Stability Class: **E**
Sensor Height: 100 ft.

Winds From	Wind Speed (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	60	113	17	1	0	0	191
NNE	34	51	9	0	0	0	94
NE	47	46	1	0	0	0	94
ENE	47	49	2	1	0	0	99
E	59	70	13	1	0	0	143
ESE	72	60	26	2	0	0	160
SE	42	52	30	7	0	0	131
SSE	35	54	18	7	0	0	114
S	32	142	31	1	0	0	206
SSW	33	120	29	10	0	0	192
SW	61	114	24	4	0	0	203
WSW	51	104	19	1	0	0	175
W	49	126	53	8	0	0	236
WNW	41	100	133	41	2	0	317
NW	69	82	116	78	13	1	359
NNW	70	80	34	15	2	0	201
TOTAL	802	1363	555	177	17	1	2915

TABLE K-1
(Continued)

Meteorological Data
1995 Joint Frequency Tables

Hours at Each Wind Speed and Direction
Period of Record: 95010100 - 95123123
Stability Class: **F**
Sensor Height: 100 ft.

Winds From	Wind Speed (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	44	47	0	0	0	0	91
NNE	20	14	0	0	0	0	34
NE	21	6	0	0	0	0	27
ENE	31	5	1	0	0	0	37
E	56	19	0	0	0	0	75
ESE	54	13	1	1	0	0	69
SE	39	2	2	1	0	0	44
SSE	42	7	1	2	2	0	54
S	46	13	1	0	0	0	60
SSW	42	16	6	0	0	0	64
SW	69	10	2	0	0	0	81
WSW	42	27	1	0	0	0	70
W	61	34	3	0	0	0	98
WNW	61	19	4	1	0	0	85
NW	48	24	4	1	1	0	78
NNW	41	49	5	0	0	0	95
TOTAL	717	305	31	6	3	0	1062

TABLE K-1
(Continued)

Meteorological Data
1995 Joint Frequency Tables

Hours at Each Wind Speed and Direction
Period of Record: 95010100 - 95123123
Stability Class: G
Sensor Height: 100 ft.

Winds From	Wind Speed (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	18	21	1	0	0	0	40
NNE	7	3	0	0	0	0	10
NE	13	1	0	0	0	0	14
ENE	19	2	0	0	0	0	21
E	24	11	1	0	0	0	36
ESE	41	5	0	0	0	0	46
SE	26	5	0	0	0	0	31
SSE	27	0	0	0	0	0	27
S	33	4	0	0	1	0	38
SSW	26	9	0	0	0	0	35
SW	38	8	0	0	0	0	46
WSW	34	3	0	0	0	0	37
W	25	7	1	0	0	0	33
WNW	20	6	0	0	0	0	26
NW	21	8	0	0	0	0	29
NNW	23	19	0	0	0	0	42
TOTAL	395	112	3	0	1	0	511

TABLE K-1
(Continued)

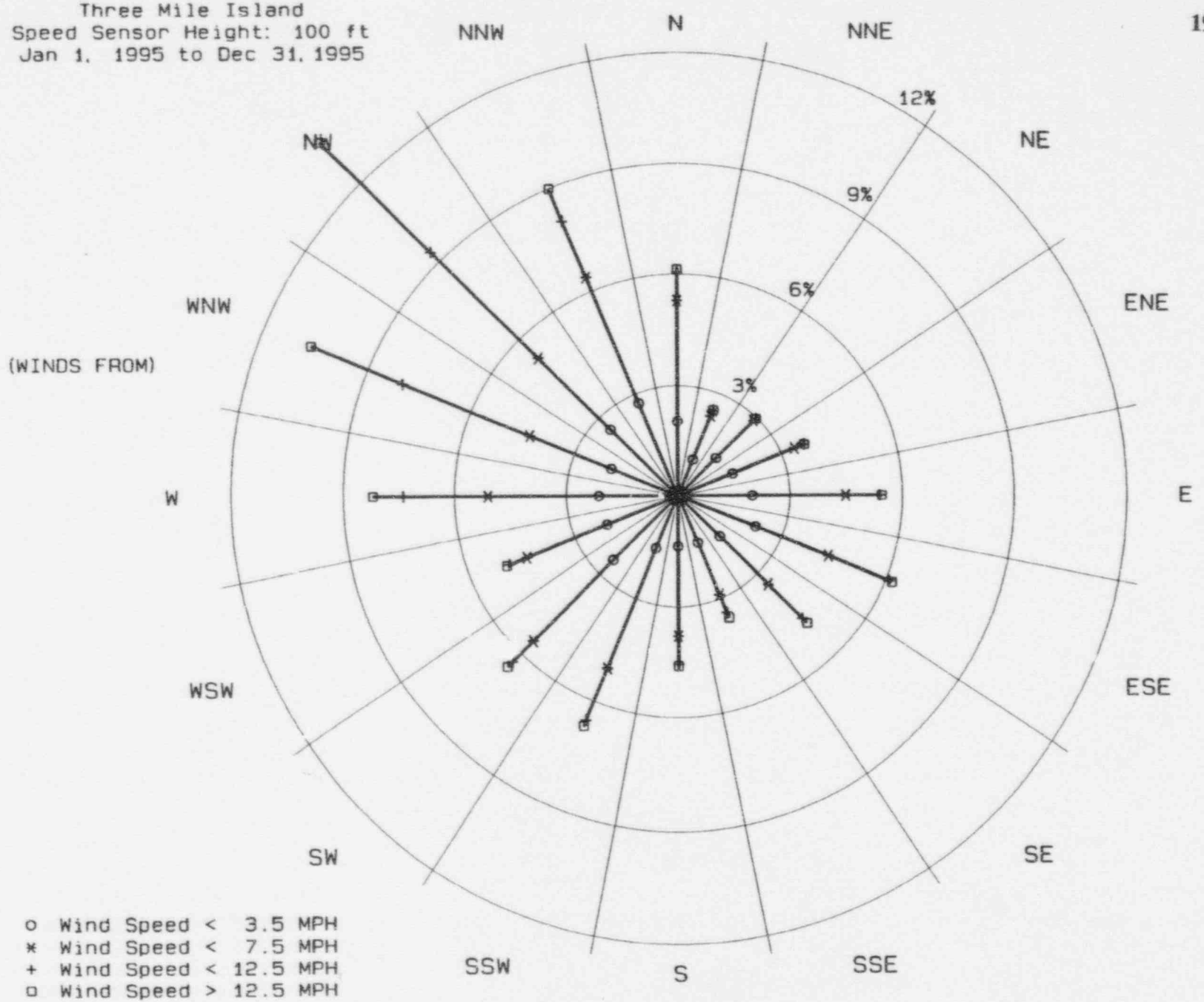
Meteorological Data
1995 Joint Frequency Tables

Hours at Each Wind Speed and Direction
Period of Record: 95010100 - 95123123
Stability Class: **ALL**
Sensor Height: 100 ft.

Winds From	Wind Speed (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	178	286	67	8	0	0	539
NNE	94	113	15	0	0	0	222
NE	128	125	7	0	0	0	260
ENE	139	157	24	1	0	0	321
E	175	217	79	5	0	0	476
ESE	197	183	152	8	0	0	540
SE	139	159	112	16	0	0	426
SSE	123	131	45	11	2	0	312
S	123	209	65	6	1	0	404
SSW	137	305	133	15	0	0	590
SW	217	267	70	17	0	0	571
WSW	181	204	45	6	0	0	436
W	187	260	201	60	12	0	720
WNW	170	207	324	198	34	1	934
NW	224	239	356	294	68	7	1188
NNW	240	321	146	70	11	0	788
TOTAL	2652	3383	1841	715	128	8	8727

HOURS OF MISSING/INVALID DATA : 33

Figure K-1
1995 Wind Rose



APPENDIX L

1995 REMP Sample Collection and Analysis Methods

TABLE L

TMINS Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 1995

Analysis	Sample* Medium	Sampling Method	Approximate Sample Size Analyzed	Analysis Procedure Number	Procedure Abstract
Gr-Alpha	AP	Continuous weekly air sampling through filter paper	1 filter (570 Cubic Meters)	TMI-EA 6510-IMP-4592.05	Low background gas flow proportional counting
			1 filter (570 Cubic Meters)	TI-Westwood PRO-032-10	Same as above
Gr-Beta	AP	Continuous weekly air sampling through filter paper	1 filter (570 Cubic Meters)	TMI-EA 6510-IMP-4592.05	Low background gas flow proportional counting
			1 filter (570 Cubic Meters)	TI-Westwood PRO-032-10	Same as above
	SW, EW	Monthly composite of grabs or biweekly or weekly samples which are automatically composited on a timed frequency	500 mL	TMI-EA 6510-IMP-4592.01	Sample evaporated on stainless steel planchet for low background gas flow proportional counting
			1 liter	TI-Westwood PRO-032-1	Same as above
Gamma Spectros-copy	AP	Quarterly composite of filter paper collected weekly	12 to 15 filters (6,900 - 9,300 Cubic Meters)	TMI-EA 6510-IMP-4592.05 6510-OPS-4591.04	Sample placed in counting container for gamma isotopic analysis
			12 to 15 filters (6,900 - 9,300 Cubic Meters)	TI- Westwood PRO-042-5	Same as above
	AI	Continuous weekly air sampling through charcoal cartridges	1 cartridge (570 Cubic Meters)	TMI-EA 6510-OPS-4591.04	Sample counted for gamma isotopic analysis
			1 cartridge (570 Cubic Meters)	TI- Westwood PRO-042-5	Same as above

TABLE L

TMINS Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 1995

Analysis	Sample* Medium	Sampling Method	Approximate Sample Size Analyzed	Analysis Procedure Number	Procedure Abstract
Gamma Spectro-scopy (Cont'd)	M	Biweekly grab sample of one or more milkings	3.5 liters	TMI-EA 6510-IMP-4592.06 6510-OPS-4591.04	Sample placed in counting container for gamma isotopic analysis
			1 liter	TI-Westwood PRO-042-5	Same as above
	SW, EW	Monthly composite of grabs or biweekly or weekly samples which are automatically composited on a timed frequency	3.5 liters	TMI-EA 6510-IMP-4592.06 6510-OPS-4591.04	Sample placed in counting container for gamma isotopic analysis
			1 liter	TI-Westwood PRO-042-5	Same as above
	AQF	Composite sample semiannually by feeding types (bottom feeder and predator) collected by either electrofishing, trapnet or hook and line	1 kg (if possible)	TMI-EA 6510-IMP-4592.03 6510-OPS-4591.04	Edible portion placed in counting container for gamma isotopic analysis
			1 kg (if possible)	TI-Westwood PRO-042-5	Same as above

TABLE L

TMINS Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 1995

Analysis	Sample* Medium	Sampling Method	Approximate Sample Size Analyzed	Analysis Procedure Number	Procedure Abstract
Gamma Spectro-scopy (Cont'd)	GW	Quarterly grab sample or quarterly composite of monthly grab samples which are collected with a hand bailer or from a faucet	3.5 liters (if possible)	TMI-EA 6510-IMP-4592.06 6510-OPS-4591.04	Sample decanted and liquid portion placed in counting container for gamma isotopic analysis. Potable samples are mixed (not decanted) prior to anlysis
			1 liter (if possible)	TI-Westwood PRO-042-5	Same as above
	AQS	Semiannual composite of three or more grab samples collected with a dredge sampler	1 kg (if possible)	TMI-EA 6510-IMP-4592.04 6510-OPS-4591.04	Dried and seived sample placed in counting container for gamma isotopic analysis
			1 kg (if possible)	TI-Westwood PRO-042-5	Same as above
	FP, GAD	Grab sample annually or more frequently	1 kg (if possible)	TMI-EA 6510-IMP-4592.03 6510-OPS-4591.04	Edible portion placed in counting container for gamma isotopic analysis. Only root vegetables and fruits washed prior to analysis
			1 kg (if possible)	TI-Westwood PRO-042-5	Same as above
Tritium	SW, EW	Monthly composite of grabs or biweekly or weekly samples which are automatically composited on a timed frequency	7-10 mL	TMI-EA 6510-IMP-4592.02 6510-OPS-4591.05 6510-OPS-4591.08	Sample filtered, mixed with scintillation fluid for scintillation counting
			2 mL	TI-Westwood PRO-052-35	Same as above except distillation may be performed if impurities are found to be present

TABLE L

TMINS Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 1995

Analysis	Sample* Medium	Sampling Method	Approximate Sample Size Analyzed	Analysis Procedure Number	Procedure Abstract
Tritium (Cont'd)	AQF	Composite sample semiannually by feeding types (bottom feeder and predator) collected by either electrofishing, trapnet or hook and line	7-10 mL	TMI-EA 6510-IMP-4592.02 6510-IMP-4592.03 6510-OPS-4591.05 6510-OPS-4591.08	Edible portion is freeze-dried in order to extract liquid for counting by liquid scintillation
			2 mL	TI-Westwood PRO-052-2 PRO-052-57	Same as above
	GW	Monthly or quarterly grab or more frequent sample according to sampling site using a hand bailer, a faucet or a dedicated bladder-type pump	7-10 mL	TMI-EA 6510-IMP-4592.02 6510-IMP-4591.05 6510-IMP-4591.08	Sample is filtered, mixed with scintillation fluid for scintillation counting.
			2 mL or 10 mL	TI-Westwood PRO-052-2 PRO-052-35	Same as above except distillation may be performed if impurities are found to be present

TABLE L

TMINS Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 1995

Analysis	Sample* Medium	Sampling Method	Approximate Sample Size Analyzed	Analysis Procedure Number	Procedure Abstract
I-131	SW, EW	Biweekly or weekly composite using an automatic compositor set for sampling on a preset timed frequency. One SW station is a biweekly or weekly composite of grab samples collected twice per week	1 liter	TI-Westwood PRO-032-11	Anion-exchange, chemical reduction, CCl_4 extraction, palladium precipitation, low-level beta counting
			3.5 liters	TMI-EA 6510-IMP-4592.06	Sample is concentrated on anion exchange resin, the resin is analyzed by gamma spectroscopy
	FP	Grab sample annually or more frequently	1 kg (if possible)	TMI-EA 6510-IMP-4592.03 6510-OPS-4591.04	Edible portion placed in counting container for gamma isotopic analysis
			1 kg (if possible)	TI-Westwood PRO-032-12	Carrier added, leached, evaporated and fused, residue dissolved, filtered and reduced with hydroxylamine hydrochloride, precipitated as palladium iodide for counting on low-level beta counter
	M	Biweekly grab sample of one or more milkings	1 liter	TI-Westwood PRO-032-11	Same as I-131 in SW, EW
			3.5 liters	TMI-EA 6510-IMP-4592.06 6510-OPS-4591.04	Same as I-131 in SW, EW

TABLE L

TMINS Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 1995

Analysis	Sample* Medium	Sampling Method	Approximate Sample Size Analyzed	Analysis Procedure Number	Procedure Abstract
Sr-89, Sr-90	AP	Semiannual composite of filter paper collected weekly	26 weeks of filters per sampling site (14,800 Cubic Meters)	TI-Westwood PRO-032-24	Sample is leached and strontium in sample is separated through a series of precipitations, Sr-90 inferred Y-90 on yttrium oxalate precipitate after 5 days or more ingrowth, low-level beta counting follows. After yttrium separation sample is precipitated with $SrCO_3$ mounted on nylon planchet for counting on low background beta counter for Sr-89 activity
	AQF	Composite sample semiannually by feeding types (bottom feeders and predators) collected by either electrofishing, trapnet or hook and line	1 kg (if possible)	TI-Westwood PRO-032-85	Similar to Sr-89, Sr-90 in AP except sample (edible portion) is dried and ashed prior to separation
	AQS	Composite of at least three grab samples collected annually using a dredge sampler	1 kg	TI-Westwood PRO-032-25	Similar to Sr-89, Sr-90 in AP except sample is dried prior to separation
	SW, EW	Semiannual composite of grabs or biweekly or weekly samples which are automatically composited on a timed frequency	1 liter	TI-Westwood PRO-032-16	Similar to Sr-89, Sr-90 in AP
	FP (Broad Leaf Veg. only)	Grab sample annually or more frequently	1 kg (if possible)	TI-Westwood PRO-032-23	Similar to Sr-89, Sr-90 in AP except sample (edible portion) is dried and ashed prior to separation

TABLE L

TMINS Radiological Environmental Monitoring Program
Summary of Sample Collection and Analysis Methods 1995

Analysis	Sample* Medium	Sampling Method	Approximate Sample Size Analyzed	Analysis Procedure Number	Procedure Abstract
Sr-89, Sr-90 (Cont'd)	GW	Semiannual composite of monthly grab samples or quarterly grab samples all of which are collected with a hand bailer or by a faucet	1 liter	TI-Westwood PRO-032-16	Similar to Sr-89, Sr-90 but sample analyzed for Sr-90 only
	M	Quarterly composite of biweekly grab samples	1 liter	TI-Westwood PRO-032-105	The method adds a stable strontium carrier, ashes the sample in a mufile furnace and precipitates the phosphates. Strontium then is purified using an extraction material in a chromatographic column. Sample mounting and counting are similar to Sr-89, Sr-90 in AP.
Gamma (Direct Radiation)	ID	Dosimeters exchanged quarterly	4 TLDs/8 Elements	TMI-Dosimetry 6610-OPS-4243.01	Thermoluminescent dosimetry using optical heating of crystals and PM tube for light measurement.
			1 TLD/4 Elements	TI-Westwood PRO-342-17	Same as above

* Identificaton Key

	Approximate Sample Size Collected per Station **
AI = Air Iodine	1 Cartridge (570 Cubic Meters) per week
AP = Air Particulate	1 Filter (570 Cubic Meters) per week
AQF = Finfish	1 kg semiannually
AQS = Aquatic Sediment	1 kg semiannually
EW = Effluent Water	4 liters biweekly or weekly
FP = Food Products (Fruits & Vegetables)	1 kg annually or more frequently
GAD = Game (Deer)	1 kg annually or more frequently (if possible)
GW = Ground Water	4 liters (if available) monthly or quarterly. 250 mL as needed for tritium analysis only
ID = Immersion Dose (TLD)	4 TLDs/8 Elements quarterly
M = Milk	4 liters biweekly
SW = Surface/Drinking Water	4 liters biweekly or weekly

** Sample size is for the main laboratory samples. An additional sample of the same size (except for TLDs) is collected at those stations which also are analyzed for quality control (QC) purposes. The QC TLD stations only have one additional dosimeter (4 elements) for QC purposes.

APPENDIX M

1995 TLD Quarterly Data

TABLE M
1995 TLD Quarterly Data
mR Per Std Month ± 2σ

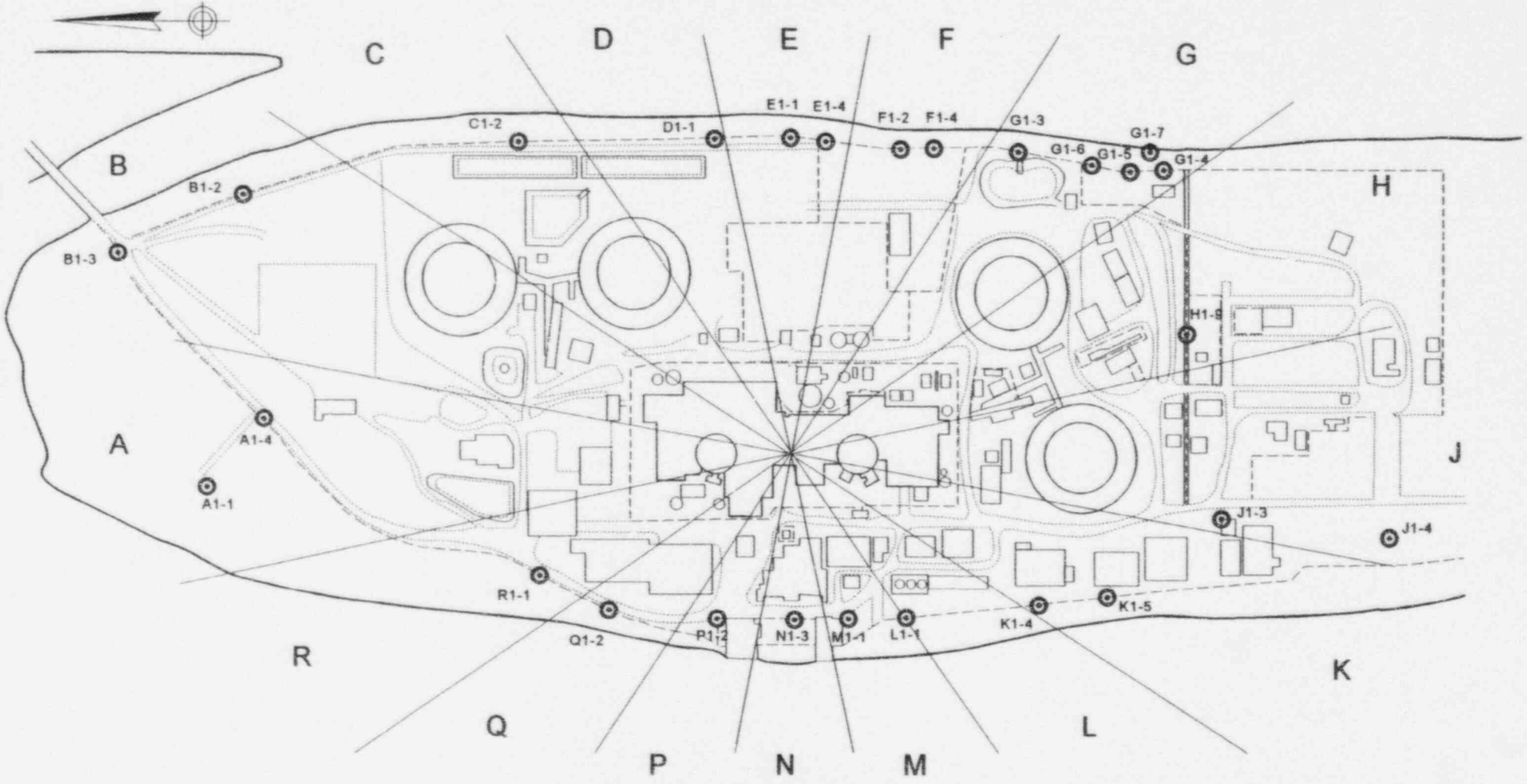
Station	Historical	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
A1-1	5.1±1.4	4.3±0.5	4.1±0.3	4.0±0.3	4.0±0.3
A1-4	4.3±0.3	3.7±0.3	3.5±0.3	3.6±0.3	3.6±0.2
A3-1	4.3±1.6	3.8±0.2	3.5±0.2	3.5±0.1	3.6±0.2
A5-1	5.5±0.9	5.0±0.2	4.8±0.1	4.8±0.2	4.6±0.1
A9-3	0.0±0.0	4.1±0.1	3.8±0.1	3.6±0.3	3.6±0.3
B1-1	4.4±1.4	4.0±0.1	3.9±0.3	3.6±0.2	3.6±0.2
B1-2	4.3±0.7	4.0±0.2	3.9±0.3	3.6±0.1	3.7±0.3
B1-3	4.1±0.9	3.7±0.3	3.6±0.2	3.4±0.2	3.5±0.1
B2-1	0.0±0.0	4.0±0.3	4.0±0.3	3.8±0.4	3.7±0.4
B5-1	5.3±1.0	4.8±0.3	4.9±0.4	4.7±0.5	4.4±0.1
B10-1	5.1±0.8	4.8±0.2	4.7±0.3	4.7±0.3	4.3±0.3
C1-1	5.2±0.9	4.7±0.4	4.7±0.4	4.6±0.6	4.4±0.2
C1-2	4.3±0.9	4.1±0.2	3.7±0.2	3.7±0.5	3.7±0.3
C2-1	0.0±0.0	4.8±0.2	4.5±0.3	4.2±0.7	4.2±0.2
C5-1	5.1±0.9	5.0±0.3	4.8±0.4	4.5±0.2	4.4±0.2
C8-1	5.9±0.9	5.3±0.3	4.9±0.3	4.8±0.4	4.6±0.3
C20-1	4.7±0.9	4.2±0.3	3.9±0.2	3.6±0.2	3.8±0.2
D1-1	4.6±0.8	4.1±0.2	3.9±0.1	3.7±0.2	3.9±0.3
D1-2	5.4±2.1	4.8±0.1	4.5±0.2	4.3±0.4	4.2±0.3
D2-2	0.0±0.0	5.6±0.5	5.5±0.4	5.2±0.3	5.1±0.2
D6-1	6.4±1.3	5.5±0.2	5.4±0.1	5.2±0.2	4.9±0.3
D9-1	6.4±1.2	6.3±0.3	6.0±0.4	5.8±0.4	5.6±0.3
D15-1	5.7±1.3	5.1±0.3	4.9±0.4	4.6±0.6	4.2±0.2
E1-1	4.9±1.2	3.9±0.2	3.9±0.2	4.0±0.3	4.1±0.3
E1-2	4.9±1.7	4.5±0.2	4.2±0.2	4.0±0.5	4.2±0.2
E1-4	5.7±1.3	4.0±0.2	3.9±0.3	3.9±0.5	4.4±0.2
E2-3	0.0±0.0	5.2±0.3	5.1±0.3	4.9±0.3	4.7±0.4
E5-1	5.3±0.8	5.0±0.3	0.0±0.0	0.0±0.0	4.5±0.3
E7-1	5.2±1.0	5.0±0.2	4.8±0.4	4.6±0.5	4.6±0.1
F1-1	5.0±1.1	4.5±0.2	0.0±0.0	4.1±0.5	4.1±0.3
F1-2	0.0±0.0	4.2±0.2	4.5±0.2	4.9±0.4	5.4±0.4
F1-4	0.0±0.0	3.9±0.3	4.3±0.3	4.9±0.5	5.6±0.2
F2-1	0.0±0.0	5.4±0.5	5.4±0.4	5.2±0.4	5.1±0.1
F5-1	6.0±1.1	5.4±0.3	0.0±0.0	5.0±1.0	4.8±0.3
F10-1	6.3±1.1	5.9±0.4	5.8±0.4	5.3±1.1	5.6±0.2
F25-1	5.6±1.0	5.1±0.4	4.8±0.4	4.7±0.5	4.5±0.3
G1-2	4.9±1.0	4.3±0.3	4.3±0.1	3.7±1.2	4.0±0.3
G1-3	6.9±3.6	3.7±0.3	3.8±0.2	3.6±0.6	4.8±0.3
G1-4	0.0±0.0	4.2±0.3	4.2±0.4	3.2±0.3	4.0±0.2
G1-5	0.0±0.0	4.4±0.5	4.2±0.4	3.3±0.5	4.3±0.3
G1-6	0.0±0.0	6.9±0.7	6.6±0.5	6.1±0.8	6.7±0.4
G1-7	0.0±0.0	4.5±0.4	4.5±0.5	4.2±0.2	4.0±0.5
G2-4	0.0±0.0	5.9±0.4	5.8±0.4	5.5±0.3	5.3±0.2
G5-1	5.1±2.0	4.5±0.5	4.3±0.4	4.3±0.3	4.2±0.4
G10-1	7.6±1.6	6.9±0.5	6.7±0.4	6.6±0.4	6.1±0.2
G15-1	6.4±2.3	5.3±0.6	4.7±0.2	5.0±0.3	4.7±0.4
H1-1	5.3±2.0	4.6±0.4	4.5±0.3	4.3±0.2	4.3±0.4
H1-9	5.0±0.7	4.5±0.4	4.2±0.4	4.2±0.5	4.1±0.5
H3-1	4.1±1.1	3.7±0.4	3.5±0.3	3.4±0.2	3.4±0.3
H5-1	4.1±0.9	3.8±0.2	3.7±0.4	3.5±0.4	3.6±0.3
H8-1	7.9±1.4	7.5±0.3	7.2±0.3	7.2±0.5	6.8±0.6
H15-1	5.8±1.1	5.8±0.7	5.5±0.4	0.0±0.0	5.1±0.4
J1-1	5.3±1.4	4.9±0.5	4.6±0.2	4.5±0.5	4.4±0.3

TABLE M
1995 TLD Quarterly Data
mR Per Std Month ± 2σ

Station	Historical	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
J1-3	3.7±0.4	3.4±0.2	3.2±0.2	2.9±0.1	3.3±0.3
J1-4	0.0±0.0	3.6±0.3	3.2±0.2	3.1±0.3	3.3±0.3
J3-1	0.0±0.0	4.3±0.4	4.2±0.3	4.3±0.5	4.1±0.4
J5-1	5.7±1.3	5.3±0.2	5.1±0.2	5.0±0.5	0.0±0.0
J7-1	4.7±1.1	5.6±0.3	5.2±0.3	5.2±0.6	5.1±0.2
J15-1	6.1±1.7	5.5±0.4	5.1±0.4	4.9±0.3	5.0±0.3
K1-4	4.7±1.5	4.1±0.3	3.7±0.4	3.7±0.3	3.8±0.3
K1-5	4.6±1.3	3.9±0.4	3.7±0.3	3.5±0.3	3.6±0.3
K2-1	5.8±1.2	0.0±0.0	4.9±0.3	4.8±0.3	0.0±0.0
K3-1	0.0±0.0	4.0±0.2	3.9±0.4	3.7±0.3	3.6±0.3
K5-1	6.9±1.2	5.6±0.5	5.1±0.4	5.1±0.1	4.8±0.5
K8-1	5.4±1.3	5.0±0.2	4.7±0.2	4.7±0.2	4.7±0.3
K15-1	4.8±1.3	4.1±0.2	3.6±0.2	0.0±0.0	3.4±0.2
L1-1	5.1±1.9	4.4±0.2	3.9±0.4	3.9±0.3	4.1±0.3
L1-2	4.3±1.1	0.0±0.0	3.7±0.3	3.7±0.3	0.0±0.0
L2-1	5.5±1.3	4.9±0.3	4.5±0.2	4.7±0.7	4.4±0.2
L5-1	4.5±1.0	4.4±0.4	4.1±0.3	4.1±0.6	3.8±0.3
L8-1	5.0±0.9	4.5±0.2	4.2±0.3	4.3±0.5	4.0±0.2
L15-1	5.2±1.4	4.7±0.2	4.6±0.3	4.5±0.3	4.4±0.2
M1-1	0.0±0.0	4.0±0.1	3.7±0.3	3.7±0.4	3.8±0.1
M1-2	0.0±0.0	0.0±0.0	3.9±0.4	4.1±0.5	0.0±0.0
M2-1	4.3±1.5	3.9±0.2	3.5±0.2	3.5±0.4	3.5±0.3
M5-1	5.2±1.1	4.5±0.2	4.0±0.2	4.2±0.1	3.9±0.2
M9-1	6.5±1.2	6.2±0.1	5.5±0.3	5.7±0.4	5.1±0.6
M15-1	5.4±1.1	4.9±0.3	4.5±0.3	4.6±0.6	4.2±0.3
N1-1	4.8±1.4	0.0±0.0	4.1±0.4	4.4±0.3	0.0±0.0
N1-3	4.6±1.2	4.0±0.2	3.7±0.1	3.9±0.4	3.9±0.2
N2-1	5.3±1.0	5.1±0.3	4.5±0.4	4.8±0.3	4.3±0.3
N5-1	5.3±1.3	3.9±0.1	3.5±0.2	3.8±0.3	3.6±0.2
N8-1	5.4±1.2	5.2±0.3	4.8±0.3	5.0±0.4	4.6±0.2
N15-2	5.9±0.9	5.5±0.2	5.2±0.4	5.6±0.3	4.7±0.4
P1-1	4.7±1.3	0.0±0.0	4.1±0.3	4.5±0.1	0.0±0.0
P1-2	0.0±0.0	4.0±0.1	3.7±0.2	4.2±0.4	3.9±0.4
P2-1	5.4±1.2	5.5±0.4	5.1±0.4	5.4±0.5	4.6±0.3
P5-1	4.8±1.0	4.6±0.3	4.2±0.3	4.4±0.3	3.9±0.4
P8-1	4.7±1.0	4.7±0.1	4.0±0.3	4.5±0.3	3.8±0.3
P15-1	6.5±1.0	6.0±0.7	5.6±0.6	6.1±0.8	5.1±0.6
Q1-1	4.6±1.0	0.0±0.0	3.7±0.3	3.9±0.3	0.0±0.0
Q1-2	4.4±0.8	3.7±0.5	3.3±0.2	3.6±0.3	0.0±0.0
Q2-1	5.4±1.1	4.5±0.2	4.3±0.4	4.9±0.3	0.0±0.0
Q5-1	4.9±1.2	4.5±0.5	3.9±0.1	4.3±0.2	4.0±0.3
Q9-1	5.3±1.2	4.5±0.5	4.0±0.2	4.5±0.5	4.0±0.4
Q15-1	5.9±1.1	5.1±0.4	4.4±0.3	5.6±0.5	4.6±0.3
R1-1	4.8±1.2	4.0±0.3	3.5±0.2	4.0±0.3	3.7±0.3
R1-2	4.2±1.2	0.0±0.0	3.7±0.3	4.1±0.4	0.0±0.0
R3-1	0.0±0.0	5.4±0.5	4.9±0.3	5.3±0.3	4.8±0.4
R5-1	5.1±0.9	5.2±0.4	4.6±0.4	5.2±0.5	4.5±0.6
R9-1	5.2±0.9	5.0±0.4	4.5±0.3	5.1±0.2	4.4±0.4
R15-1	4.4±1.0	4.1±0.5	3.6±0.4	4.0±0.3	3.8±0.4
R15-2	0.0±0.0	0.0±0.0	4.7±0.2	0.0±0.0	0.0±0.0

NOTES: 1) A Value of Zero Indicates No Data
2) Some Newer Stations Have No Historical Data

Figure M-1
Onsite TLD Station Locations at TMINS



Stations H1-1 and J1-1 are located off the map to the south.

NO SCALE