MINNESOTA DEPARTMENT OF HEALTH

2006 ENVIRONMENTAL RADIATION DATA REPORT

Prepared by
Tim Donakowski

	Radiation Control Unit **Indoor Environments & Radiation Section** **Division of Environmental Health** **Minnesota Department of Health**

Table of Contents

The table of contents is empty because none of the paragraph styles selected in the Document Inspector are used in the document.

Tables

MEDIAN STRONTIUM-90 LEVELS IN MILK 4
MEDIAN GROSS BETA CONCENTRATION IN AIR SAMPLES 5
MEDIAN GROSS BETA CONCENTRATION IN MISSISSIPPI RIVER WATER 8
NEAR MONTICELLO AND PRAIRIE ISLAND NUCLEAR POWER PLANTS 8
POTASSIUM-40 CONCENTRATION IN VEGETATION/CROPS 9
NEAR MONTICELLO AND PRAIRIE ISLAND NUCLEAR POWER PLANTS 9
RADIONUCLIDE LEVELS IN SEDIMENT 9
DOWNSTREAM OF MONTICELLO 9
DOWNSTREAM OF PRAIRIE ISLAND 10
MEDIAN GAMMA EXPOSURE RATES NEAR MONTICELLO 10
MEDIAN TRITIUM VALUES IN WELL WATER NEAR THE PRAIRIE ISLAND PLANT 11
MEDIAN GAMMA EXPOSURE RATES NEAR PRAIRIE ISLAND 12
ANNUAL PRESSURIZED ION CHAMBER (PIC) READINGS 13
AVERAGE DOSE ESTIMATE FROM HUMAN-MADE RADIOACTIVITY 14
MEASURED IN MINNESOTA ENVIRONMENTAL SAMPLES 14

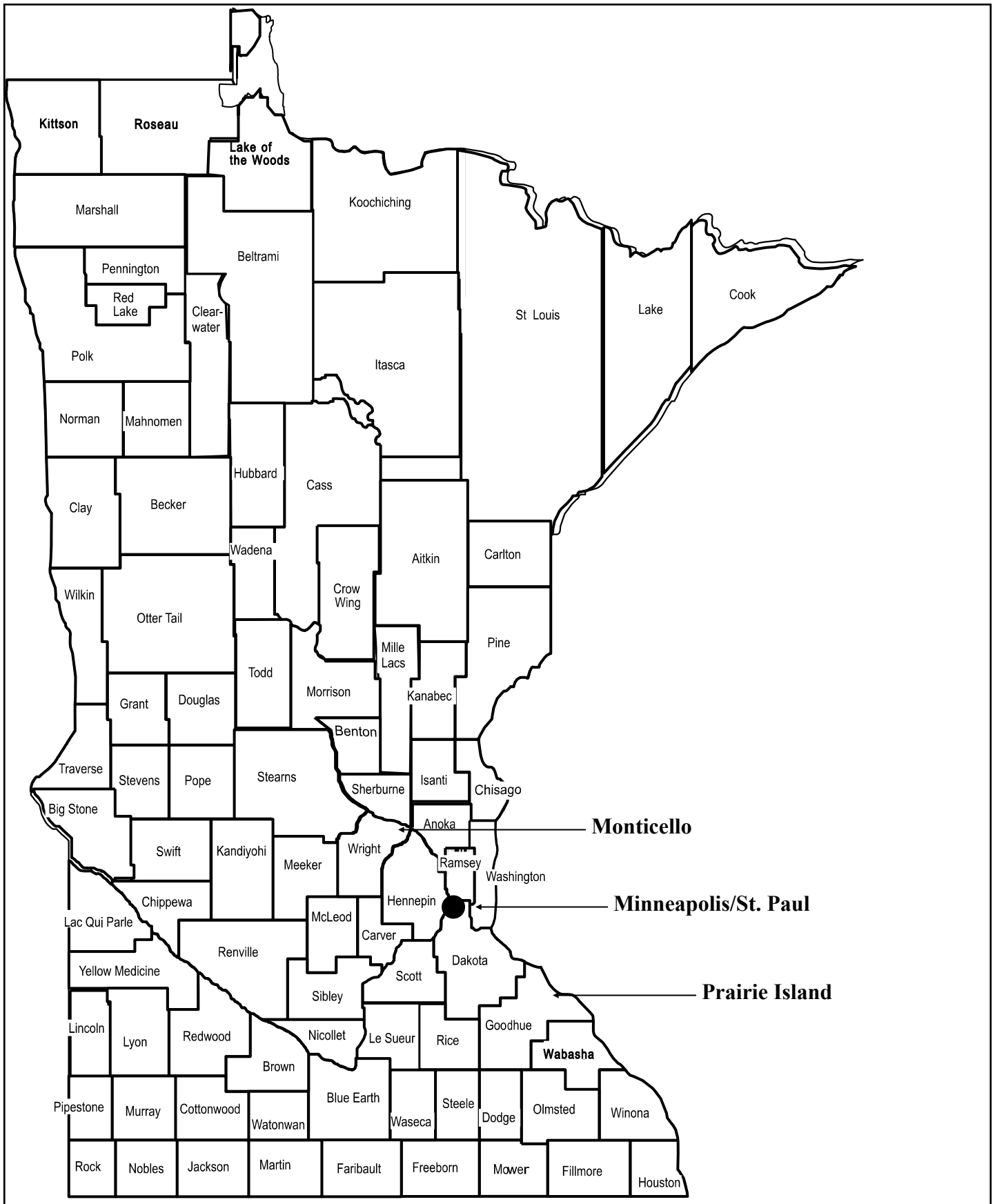


Figure 1. Monticello and Prairie Island Nuclear Power Generating Plants

Summary and Conclusion

The Minnesota Department of Health (MDH) Radioactive Materials Unit in the Indoor Environments and Radiation Section monitors environmental radioactivity in Minnesota. Monitoring allows the MDH to develop a database on radioactivity within the state that can be used as a baseline during emergencies.

The environmental monitoring program consists of:

- sample collection around the two nuclear power generating plants (see Figure 1 for locations);
- measurement of gamma radiation near the nuclear power generating plants;
- surveying of spent fuel storage casks;
- radiochemical analysis of the samples by the MDH Public Health Laboratory; interpretation of the data; and
- estimation of doses from the nuclear power plants.

In 2006, no federal or state standards or guidelines were exceeded anywhere in the state, including near the nuclear power generating plants.

Data shows that levels of Strontium-90 in milk, which resulted from previous above ground nuclear testing, are low and now below the detection limit of the isotopic analysis equipment. The median values for Strontium-90 were well within recommended safe levels according to the U.S. Food and Drug Administration (FDA) emergency guidelines for milk. However, because there is no specific standard for Strontium-90 in milk, the standard for Strontium-90 in drinking water is used. Analysis of the milk samples collected from farms in the vicinity of the nuclear power generating plants indicated that the values for Strontium-90 did not exceed National Primary *Drinking Water* Regulations (40 CFR 141) of 8.0 pCi per liter.

Data from radiation detection equipment at Prairie Island indicate that neutron levels increased since last year. The increase is attributed to that fact that two casks were added to the Independent Spent Fuel Storage Installation (ISFSI) in 2006.

Dose calculations indicate that individuals in Minnesota receive less than one millirem per year from human-made radiation detected in the environment. The National Council on Radiation Protection and Measurements (NCRP) considers an annual dose of one mrem to be negligible.

Interpretation of Results

MDH Radiation Control staff routinely compares the levels of radionuclides identified by the MDH Public Health Laboratory with data from the previous five-years. If higher than usual levels are observed, they are compared to regulations and guides issued by state and federal agencies (including the maximum permissible effluent concentrations for radioactive materials licensees in MDH *Radioactive Materials Rules*, Chapter 4731.2750) to determine the health risks.

The National Primary Drinking Water Regulations (40 CFR 141) establish the standards for water. MDH *Radioactive Materials Rules*, Chapter 4731.2750, which mirrors 10 CFR 20 Appendix B, establish the maximum permitted limit for concentrations of radioactivity in air at 100 picocuries of beta activity per cubic meter for unrestricted areas.

Annually, sampling results are plotted on a lognormal scale. (See Figure 4 for an example). Plotting natural background radiation results in a straight line plot. If emissions from a nuclear power generating plant were present, the plot would not be a straight line.

Average Dose to an Individual

Radiation dose estimates are made using exposure-to-dose conversion factors from two reference sources:

- *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, 1988; and
- *The Shultis Report for Neutrons* (J. K. Shultis and R. E. Faw, "Neutron Skyshine Analysis," July 15, 1998).

Only exposures to human-made radioactivity are used for the radiation dose estimates. Examples include fallout from atmospheric nuclear tests and emissions and effluents from nuclear power generating plants. Exposures from naturally occurring radioactivity (for example, Potassium-40 in milk) are not considered.

Data Analyses Results

Findings from the environmental monitoring program during 2006 are presented and compared with findings from the previous four years.

Statewide Sampling Results

Milk

In 2006, milk was sampled near the two nuclear power generating plants. As was mentioned, the values for Strontium-90 did not exceed National Primary *Drinking Water* Regulations of 8.0 pCi per liter (see Table 1) or the median values for Strontium-90 for safe levels established in The U.S. Food and Drug Administration (FDA) emergency guidelines for milk. The FDA recommends that during an emergency, protective actions be taken only when levels exceed 4,000 pCi per liter[1].

Previous atmospheric weapons testing resulted in deposition of Strontium-90 throughout much of the Midwest. The physical half-life of Strontium-90 is 28 years. The average Strontium-90 level in Minnesota has been slowly decreasing. However, the Strontium-90 levels appear to fluctuate due to sampling errors, measurement errors, and the statistical nature of the isotopic analyses.

TABLE 1
MEDIAN STRONTIUM-90 LEVELS IN MILK
2004 - 2006

pCi/L			
Nuclear Power Generating Plant	2004	2005	2006
Monticello	2.0	2.1	2.0
Prairie Island	1.6	<2.0	<2.0
Median	1.8	2.0	2.0

Air

The median gross beta activity collected at the air sampler in St. Paul[2] was 0.019 pCi per cubic meter in 2006. The previous year the activity was 0.021 pCi per cubic meter. Plotting the data on a lognormal scale resulted in a straight line, which indicates that the radioactivity was from natural background radiation. No reactor-produced isotopes (e.g., Iodine-131) were detected.

1 Accidental Radioactive Contamination of Human Food and Animal Feeds: Recommendations for State and Local Agencies, Food and Drug Administration, August 13, 1998

2 In December 2005, the air sampler was moved to the new Freeman Office Building, 625 North Robert Street in St. Paul when MDH vacated the 717 Delaware Street SE Minneapolis building. The new location is in a similar urban environment and is not expected to bias future data.

Sampling locations for the area around the Monticello plant are shown on Figure 2. Figure 3 indicates the sampling locations around the Prairie Island facility.

Biweekly air samples were collected near the Monticello Xcel Training Center. For the Prairie Island facility, biweekly air samples were collected near Lock and Dam No. 3. The median gross beta activities are presented in Table 2 along with the air sample analysis for concentrations in St. Paul.

Data from the air samplers near the nuclear power generating plants was plotted on a lognormal scale. The plot followed a straight line, indicating natural background radioactivity.

TABLE 2
MEDIAN GROSS BETA CONCENTRATION IN AIR SAMPLES
2002 - 2006

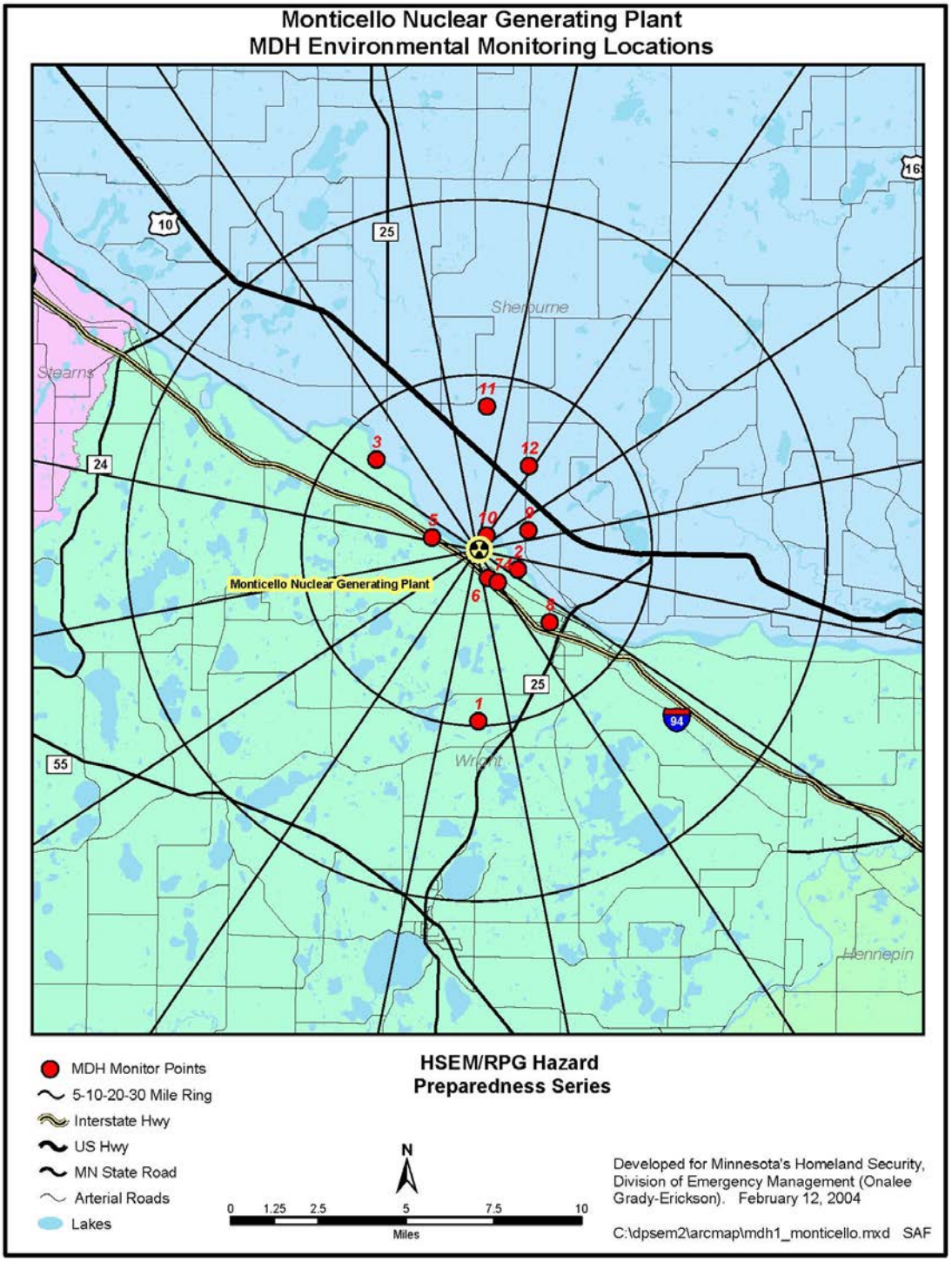
pCi/m^3

	2002	2003	2004	2005	2006
Monticello (MDH)	0.022	0.026	0.019	0.019	0.018
Monticello (NMC)	0.027	0.027	0.024	0.025	Unavailable
Prairie Island (MDH)	0.024	0.025	0.020	0.018	0.017
Prairie Island (NMC)	0.028	0.027	0.025	0.027	Unavailable
Saint Paul (MDH)	0.029	0.028	0.024	0.021	0.019

Note: NMC air sampling results are typically not available until the April or May time frame.

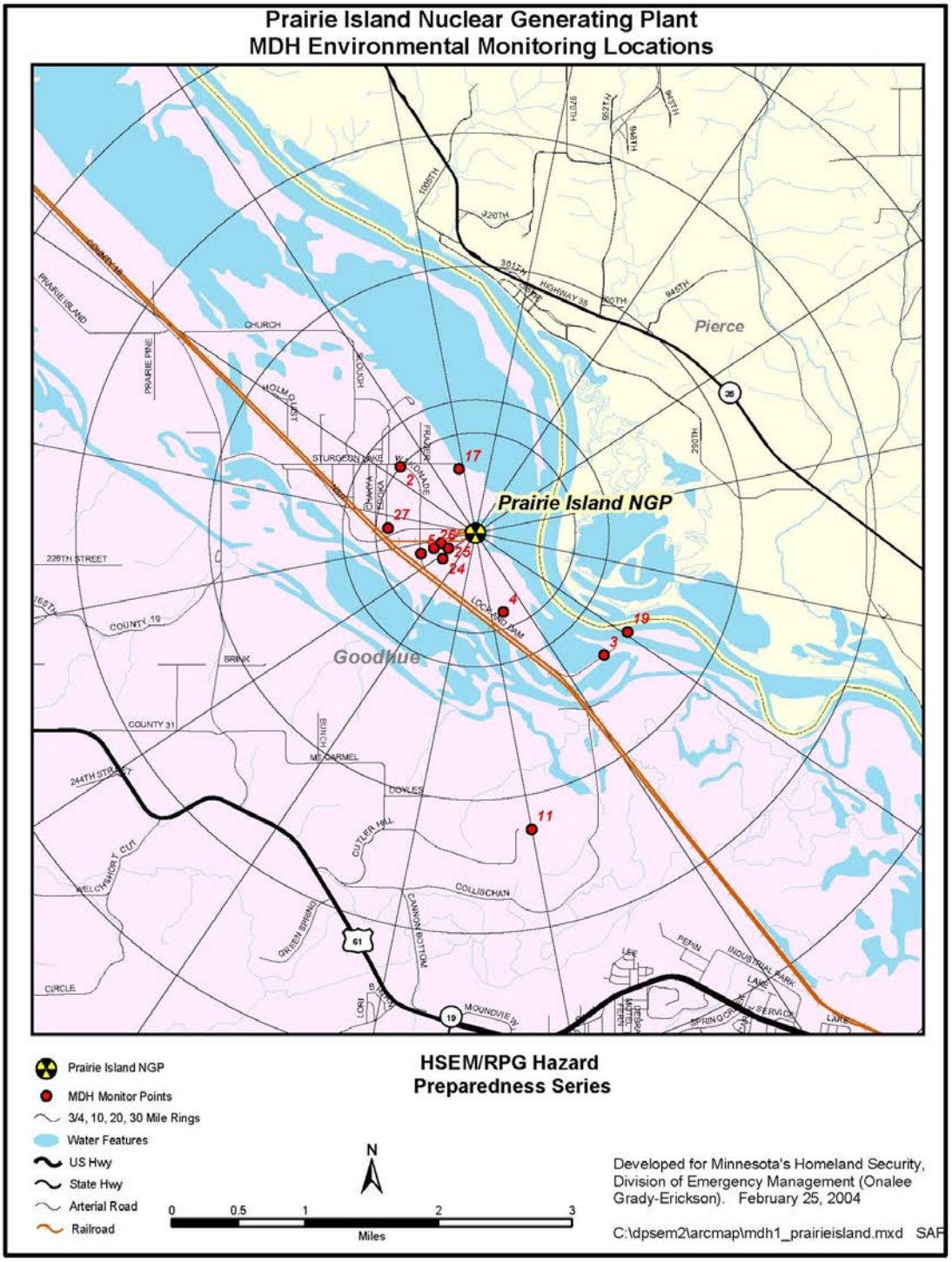
River Water

Median gross beta concentrations for upstream and downstream water samples are shown in Table 3. The data for Prairie Island was plotted in Figure 4. The plot followed a straight line, indicating that the source of radioactivity was natural background.



1. Milk Sampling
2. Downstream Water Sampling
3. Upstream Water Sampling
4. Air Sampling
5. TLD
6. TLD
7. TLD
8. TLD
9. TLD
10. TLD
11. TLD
12. TLD

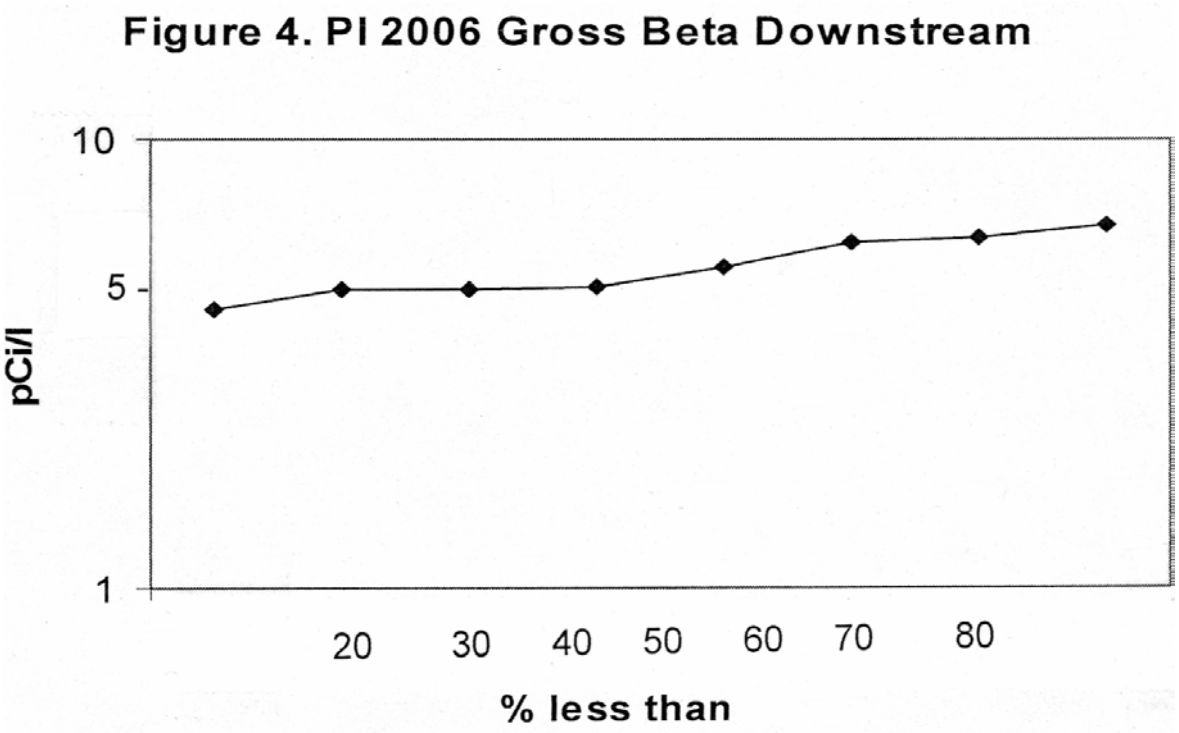
Figure 2. Monticello Monitoring Locations.



1. TLD – Hastings (Not shown)
2. TLD
3. TLD and Air Sampling
4. TLD and Groundwater
5. TLD
11. TLD and Milk Sampling
12. TLD - Red Wing (Not shown)
19. Downstream Water Sampling
22. Upstream Water Sampling
23. TLD
24. TLD
25. TLD
26. TLD
27. TLD
28. Sediment Sampling – Red Wing (Not shown)

Figure 3. Prairie Island Monitoring Locations

TABLE 3 MEDIAN GROSS BETA CONCENTRATION IN MISSISSIPPI RIVER WATER NEAR MONTICELLO AND PRAIRIE ISLAND NUCLEAR POWER PLANTS 2002-2006					
pCi/L					
	2002	2003	2004	2005	2006
	Monticello				
Upstream	3.3	4.2	3.0	5.3	2.6
Downstream	3.0	3.9	2.9	4.4	3.2
	Prairie Island				
Upstream	5.3	7.4	6.6	10.0	7.1
Downstream	5.1	4.9	4.8	6.8	5.0



Crops/Vegetation

During the growing season, apples grown near the plants were sampled; small amounts of Potassium-40 (K-40) were detected. Potassium-40 occurs naturally in crops and is not an indicator of a nuclear power generating plant effect; but rather a laboratory calibration control. Table 4 summarizes the K-40 levels. Cow feed at the indicator dairy farm was collected year round.

TABLE 4
POTASSIUM-40 CONCENTRATION IN VEGETATION/CROPS
NEAR MONTICELLO AND PRAIRIE ISLAND NUCLEAR POWER PLANTS
2002 - 2006

pCi/gram

	2002	2003	2004	2005	2006
	Monticello				
Apples	1.5	1.2	1.2	1.5	1.7
Cow Feed	na	na	5.9	5.2	5.7
	Prairie Island				
Apples	1.5	1.2	1.5	1.7	1.3
Cow Feed	na	na	3.7	3.9	3.3

Note: MDH's sampling program did not include cow feed prior to 2004.

Sediment

Samples were collected downstream in September. The radioactivity in the sediments samples could be attributed to naturally occurring radioactivity, small amounts of fallout radioactivity, or radioactivity resulting from fertilizer runoff. Table 5 summarizes the isotopes and activities identified. Radionuclides associated with nuclear plant generating operations (for example, Cesium-134) were not detected.

TABLE 5
RADIONUCLIDE LEVELS IN SEDIMENT

pCi/gram

	2002	2003	2004	2005	2006
DOWNSTREAM OF MONTICELLO					

Beryllium-7	0.2	0.2	<0.2	<0.4	<0.09
Potassium-40	10	10	10	11	8.1
Cesium-137	0.05	0.04	0.02	0.01	0.02
Lead-210	<0.7	0.7	<0.4	<0.6	<0.7
Lead-212	0.3	0.3	0.3	0.3	0.2
Lead-214	0.2	0.3	0.2	0.3	0.1
Bismuth-212	0.3	0.4	0.4	0.3	0.2
Bismuth-214	0.2	0.3	0.2	0.3	0.1
Thallium-208	0.1	0.1	0.1	0.1	0.05
Radium-224	0.2	<0.2	0.3	0.2	0.1
Radium-226	0.4	0.5	0.4	0.5	0.3
DOWNSTREAM OF PRAIRIE ISLAND					
Beryllium-7	<0.1	<0.06	<0.2	<0.3	<0.1
Potassium-40	8	6	6	7	7
Cesium-137	0.01	<0.006	<0.006	<0.004	0.03
Lead-210	<0.3	0.4	<0.3	<0.8	<0.9
Lead-212	0.2	0.2	0.2	0.3	0.2
Lead-214	0.2	0.1	0.1	0.2	0.2
Bismuth-212	0.3	0.3	0.2	0.3	0.3
Bismuth-214	0.2	0.1	0.1	0.2	0.2
Thallium-208	0.1	0.09	0.06	0.1	0.08
Radium-224	0.2	0.2	0.2	0.3	<0.1
Radium-226	0.4	<0.2	0.3	0.4	0.4

Site Specific Information - Monticello Nuclear Power Generating Plant

Thermoluminescent Dosimetry (TLD)

The radiation monitoring devices (TLDs) adjacent to the nuclear power generating plants were exchanged quarterly. Figure 2 shows locations of TLDs. Median values for exposure (milliroentgens per 13-week quarter) are presented in Table 6 for each location. The results indicate that there were no measurable effects from the Monticello facility.

TABLE 6
MEDIAN GAMMA EXPOSURE RATES NEAR MONTICELLO
2002 - 2006

mR/quarter

Location	2002	2003	2004	2005	2006
Monticello Training Ctr.	14.7	15.2	15	14.4	15.3
South Sector	13.4	13.6	13.1	13.2	14.1
Deer Street	13.7	14.2	13.9	13.4	14.4
Municipal Building	14.6	15.2	15	14.8	15.4
Orrock (Control)	12.8	13.3	13.3	12.9	13.5

Northwest Pines	13.2	13	13.1	13	13.4
Pole #F85	14.9	14.3	14.7	14.1	15.2
Pole #F33	13.5	13.5	13.2	13.7	14.3

Site Specific Information - Prairie Island Nuclear Power Generating Plant

Groundwater

In 2006, four quarterly samples of well water were collected from the nearest resident to the Prairie Island nuclear power generating plant. The results are shown in Table 7.

TABLE 7
MEDIAN TRITIUM VALUES IN WELL WATER NEAR THE PRAIRIE ISLAND PLANT
1998 – 2006

pCi/L

1998	1999	2000	2001	2002	2003	2004	2005	2006
<32	36	42	45	<500	<180	<185	<200	<200

For reference, the annual average established by the National Primary Drinking Water Regulations (40 CFR 141) for tritium is 20,000 pCi per liter.

Thermoluminescent Dosimetry (TLD)

TLD were changed quarterly during 2006. Median values for exposure (milliroentgen per quarter) are presented in Table 8 for each location.

Beginning in 1993, the Department began background monitoring at the Prairie Island Independent Spent Fuel Storage Installation (ISFSI) in anticipation of dry cask storage monitoring in 1995. Two TLD are located inside the earthen berm and four TLD are located outside the berm. The two inside, ISFSI #3 and ISFSI #4, show above background gamma exposures that are consistent with the NMC computer model. Two TLD on Xcel Energy property but outside the berm (ISFSI #1, ISFSI #2) indicated above background levels of radiation that are also consistent with the computer model. The Prairie Island Community and ISFSI #6 TLD indicate exposures that are normal (natural background).

TABLE 8 MEDIAN GAMMA EXPOSURE RATES NEAR PRAIRIE ISLAND 2002 - 2006					
mR/quarter					
Location	2002	2003	2004	2005	2006
Nearest Resident	12.9	13.5	13.2	13.4	13.5
Northwest Sector	11.4	11.3	12.6	11.2	11.3
Lock and Dam No. 3	12.1	12.2	11.9	11.8	11.9
Mount Carmel Road	13.7	13.7	13.5	12.2	13.5
Red Wing	13.7	14.3	14.1	13.3	14.6
Hastings (Control)	13.8	13.2	13.4	13	12.6
ISFSI #1 (Outside Berm)	17.3	16.4	17.8	17.5	19.8
ISFSI #2 (Outside Berm)	17.1	19	18.4	18.7	18.8
ISFSI #3 (Inside Berm)	43.6	49	48.5	79.8	75.7
ISFSI #4 (Inside Berm)	18	18	19	18.2	21.9
Prairie Island Community	12	12.5	12.4	12.7	14
ISFSI #6 (Outside Berm)	13.8	14.2	13.2	14.8	15.3

Prairie Island Independent Spent Fuel Storage Installation (ISFSI)

Pressurized Ionization Chambers (PIC)

Throughout 2006, radiation data near the ISFSI were collected by the PIC system, which was installed in January 1995. PIC No. 1 is located about 100 feet north of the spent-fuel casks and PIC No. 2 is located about 100 feet south. The system consists of two ion chambers that measure and transmit radiation levels to computers. Every 15 minutes, modems transmit the data via telephone lines to MDH computers in St. Paul. In addition to the data transmission, the computers automatically notify MDH staff if readings that exceed the preset threshold occur or if there are system problems (e.g., loss of power or modem failure). At the time of installation, the normal background level was recorded and ranged from 5 to 15 μR/hr.

In the third quarter of 2006, the 21st and 22nd casks were placed in the Prairie Island Independent Spent Fuel Storage Installation.

The annual average readings for PIC #1 and PIC #2 are shown in Table 9.

TABLE 9
ANNUAL PRESSURIZED ION CHAMBER (PIC) READINGS
2002 - 2006

	μR/hr				
	2002	2003	2004	2005	2006
PIC #1	100.1	99.2	93.6	92.1	94.9
PIC #2	93.9	91.2	86.9	90.3	99.8
Number of Casks	17	17	17	20	22

Dose to Average Individual

Estimates of dose resulting from human activities include exposure from Strontium-90, which still exists from atmospheric nuclear testing in the 1950's. The Strontium-90 concentrations in the environment vary depending on the deposition. When Strontium-90 was deposited on the soil, plant life absorbed the radionuclide and the activity was transferred to animals that ingested the forage. Most grazing animals in areas impacted by fallout were effected. Ultimately, the most significant exposures for humans occurred via the milk pathway. For milk, MDH assumed a consumption of two liters per day. Because MDH continues to find Strontium-90 in milk, average annual dose has been estimated to be 0.20 mrem per year (committed effective dose equivalent) for 2006. The dose estimates are presented in Table 11.

As noted, the levels of Strontium-90 in the environment continue to decline due to decay. In addition to the very low exposure that results from the remaining Strontium-90 levels, some human exposure results from neutrons as scatter radiation from the Prairie Island ISFSI. The amount of exposure has been mitigated by the berms that were created when the ISFSI was established and remains dependant on the time spent near the ISFSI. For the purposes of determining dose, MDH assumed continuous presence of an individual at 700 meters from the center of the ISFSI.

TABLE 11 AVERAGE DOSE ESTIMATE FROM HUMAN-MADE RADIOACTIVITY MEASURED IN MINNESOTA ENVIRONMENTAL SAMPLES 2002 - 2006					
Committed Effective Dose Equivalent (mrem per year)					
Media & Source	2002	2003	2004	2005	2006
Milk--Strontium-90	0.09	0.10	0.18	0.20	0.20
Scatter--ISFSI	0.03	0.03	0.03	0.04	0.04
Total	0.12	0.13	0.21	0.24	0.24

These estimates are based on an exposure-to-dose conversion factor of 142.5 mrem per microcurie of Strontium-90[3]. The doses in Table 11 are below the Negligible Individual Dose of 1 mrem per year, as defined by the NCRP Report No. 116, 1993.

3 EPA Federal Guidance Report No. 11, 1988 and *The Shultis Report for Neutrons* (J. K. Shultis and R. E. Faw, "Neutron Skyshine Analysis," Contractor report submitted to Northern States Power Company, July 15, 1998)