

4.0 RADIOLOGICAL DOSE ASSESSMENT

4.1 Methodology

The potential radiological impacts resulting from the release of radioactivity during 1983 have been estimated by calculating radiation doses received by the maximally exposed off-site individual and the population within an 80 km radius of the WVDP facility. The potential pathways of exposure to the general public from radioactive effluents released by the WVDP operations are shown in Figure 7. The exposure modes considered in the dose calculations are:

- o Direct exposure from immersion in air containing radionuclides
- o Direct radiation from ground surfaces contaminated by deposited radionuclides
- o Immersion in contaminated water
- o Inhalation of airborne radionuclides
- o Ingestion of contaminated waters and food produced from the land and surface waters in the area.

The radiation dose commitment to the maximally exposed individual and the collective dose to the population within an 80 km radius of the WVDP facility were calculated using the computer code AIRDOS-EPA for the air pathway (Reference 5) and LADTAP II for the water pathway (Reference 6). The gaseous discharges were assumed to occur from a single vent at 10 meters above the ground level to compensate for the uneven terrain in the vicinity of the WVDP site. Meteorological data were collected from July to December 1983 at the WVDP site; however, it had not become available in usable form by the time the preparation of this report was undertaken. The most representative meteorological data available for dispersion calculations were those collected during November 1974 to September 1975. These data were used in this report. Americium-241 was assumed to represent all the

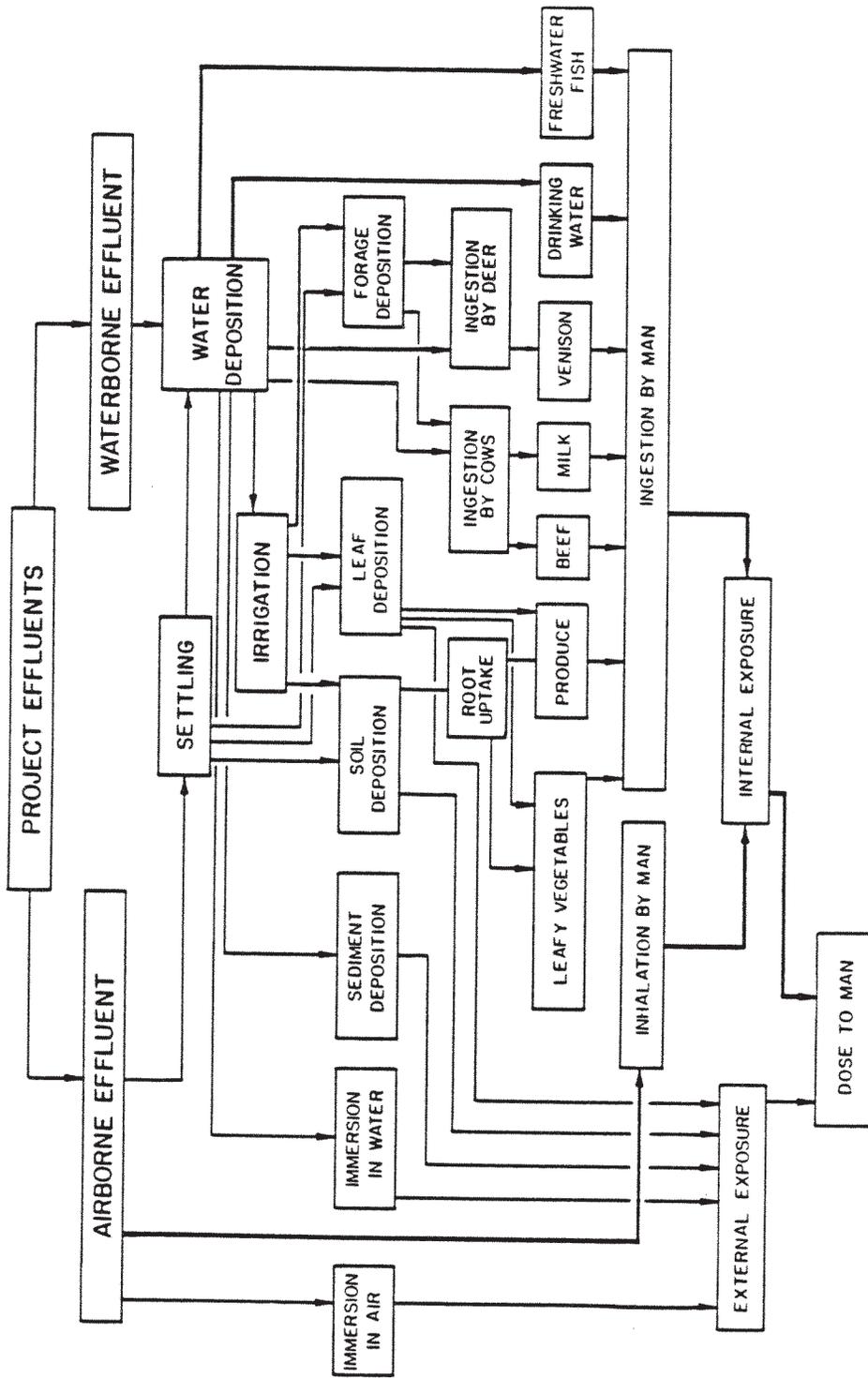


FIGURE 7 - COMPARTMENT MODEL OF PATHWAYS

gross alpha activity in both gaseous and liquid effluents. The gross beta/ gamma activity was assumed to consist of specific radionuclides distributed in the same proportion as the individually identified and measured radionuclides.

The dose estimates were made by calculating radionuclide concentrations in air, rates of deposition on ground surfaces, ground surface concentrations, intake rates via inhalation, and ingestion of meat, milk, and fresh vegetables. Site specific data on production and consumption of milk, meat and agricultural products was used in computing collective population dose.

The area surrounding the facilities is shown in Figure 1. It was overlaid with an 80 km radius grid system with the facility at its center. The grid system was further divided into 10 concentric regions and 16 compass directions. For each sector formed by the grid system, the specific human population, beef and dairy cattle population, and agricultural areas were assumed to be as described in Figures 8 through 15. The values for the sectors within a 10 mile radius are based on data from the FEIS (Reference 7).

For each radionuclide of concern, the inhalation dose conversion factors used are for an activity median aerodynamic diameter (AMAD) of 0.3 micrometer. For alpha emitters, the dose conversion factors are derived by using a quality factor of 20 as per ICRP recommendation (Reference 9). All of the doses from internal exposure are 50-year committed dose equivalents and are calculated for the 50-year period following inhalation or ingestion. The internal dose conversion factors used in this report are from Reference 9.

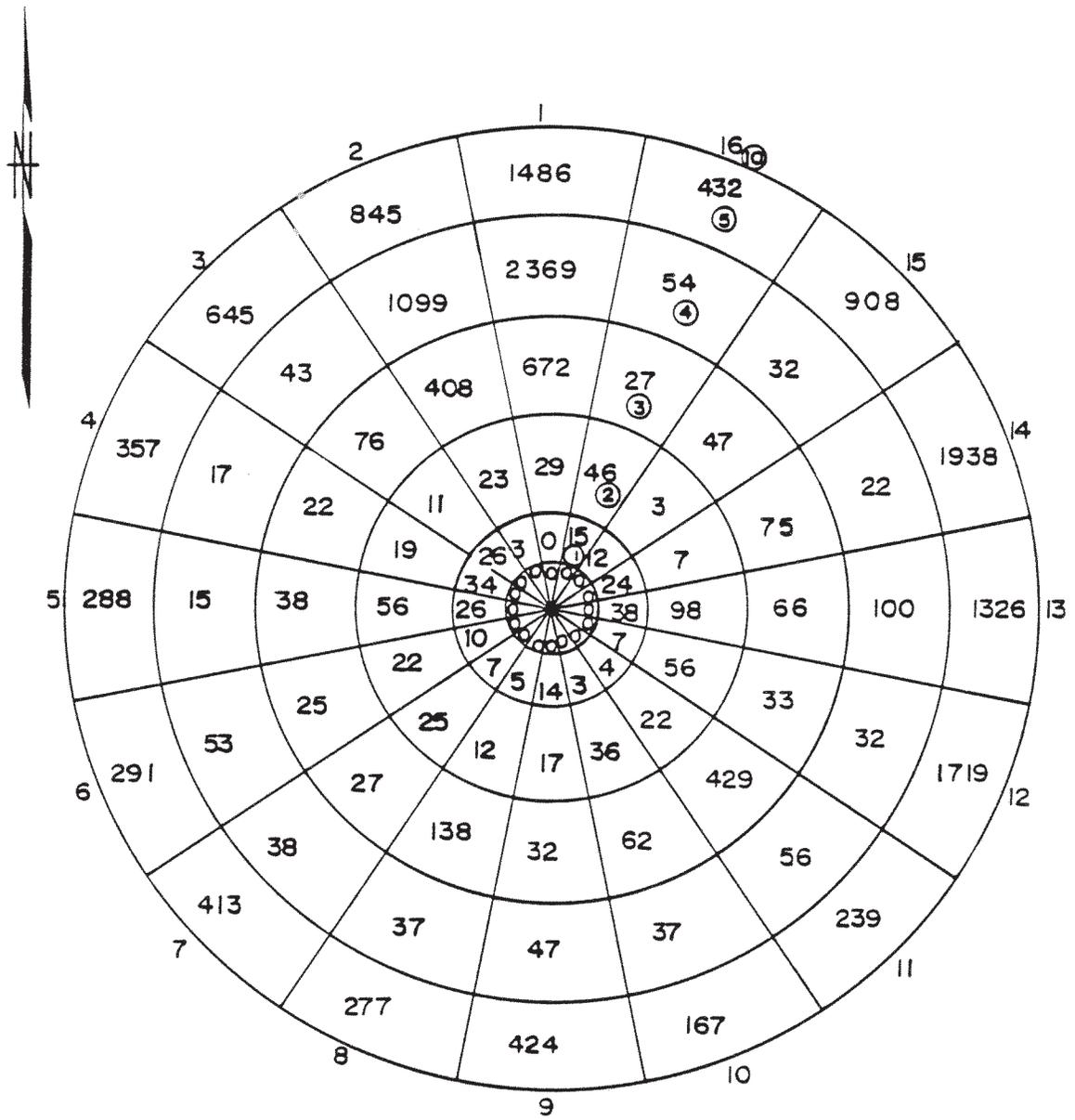


FIG. 8 - POPULATION DISTRIBUTION (0-10 MILES)

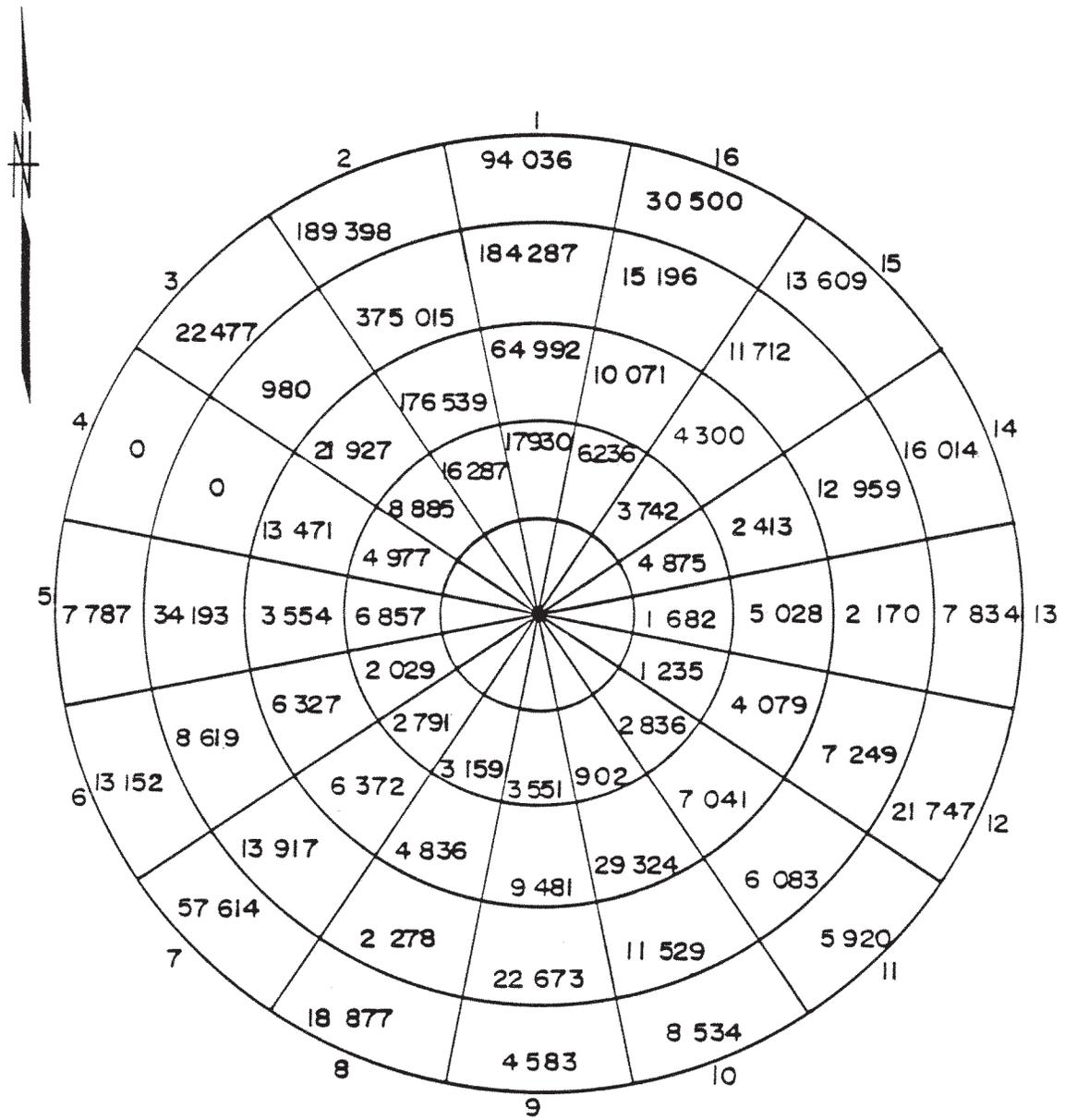


FIG. 9 - POPULATION DISTRIBUTION (10-50 MILES)

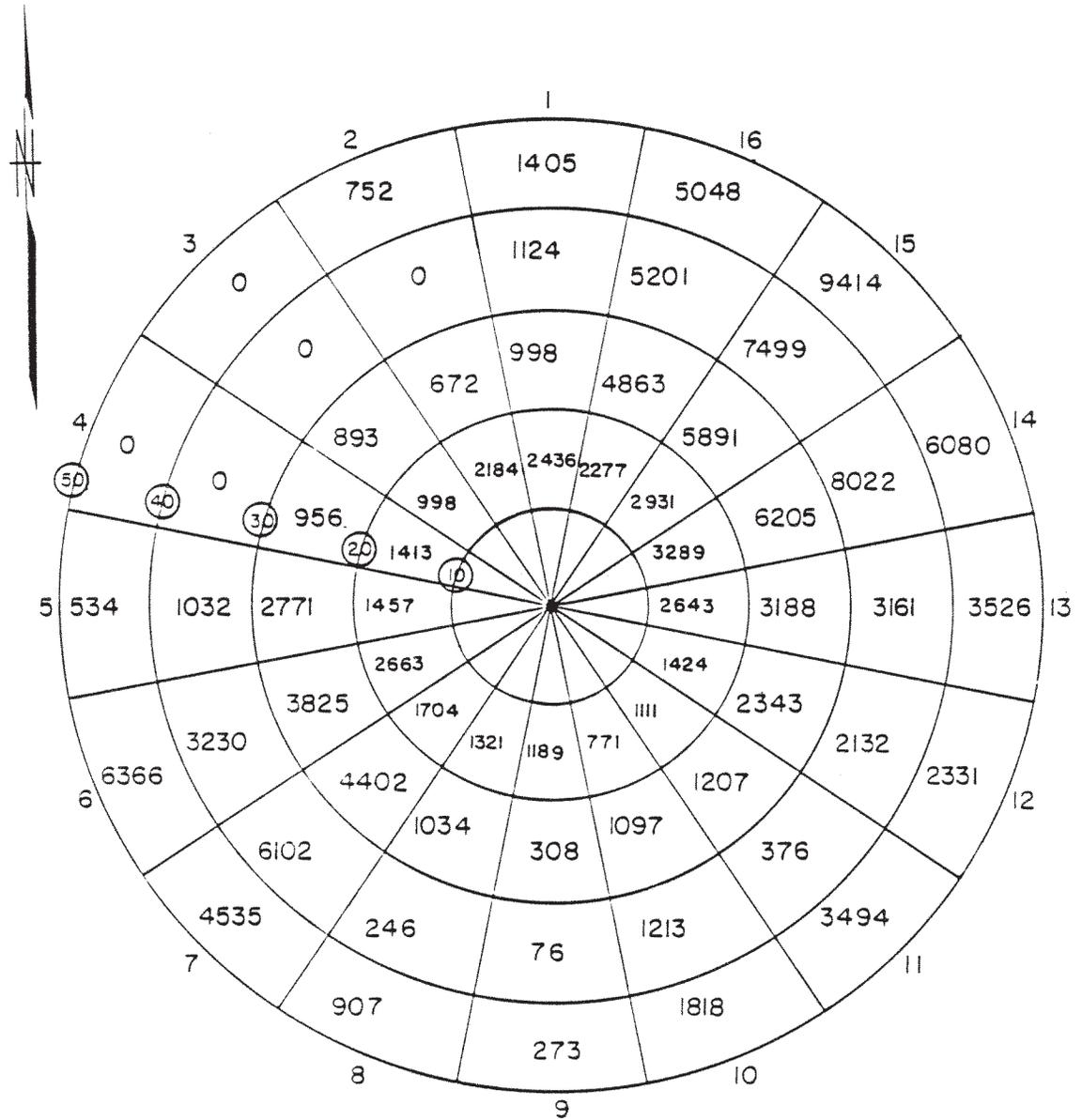


FIG. II - DAIRY COWS (10-50 MILES)

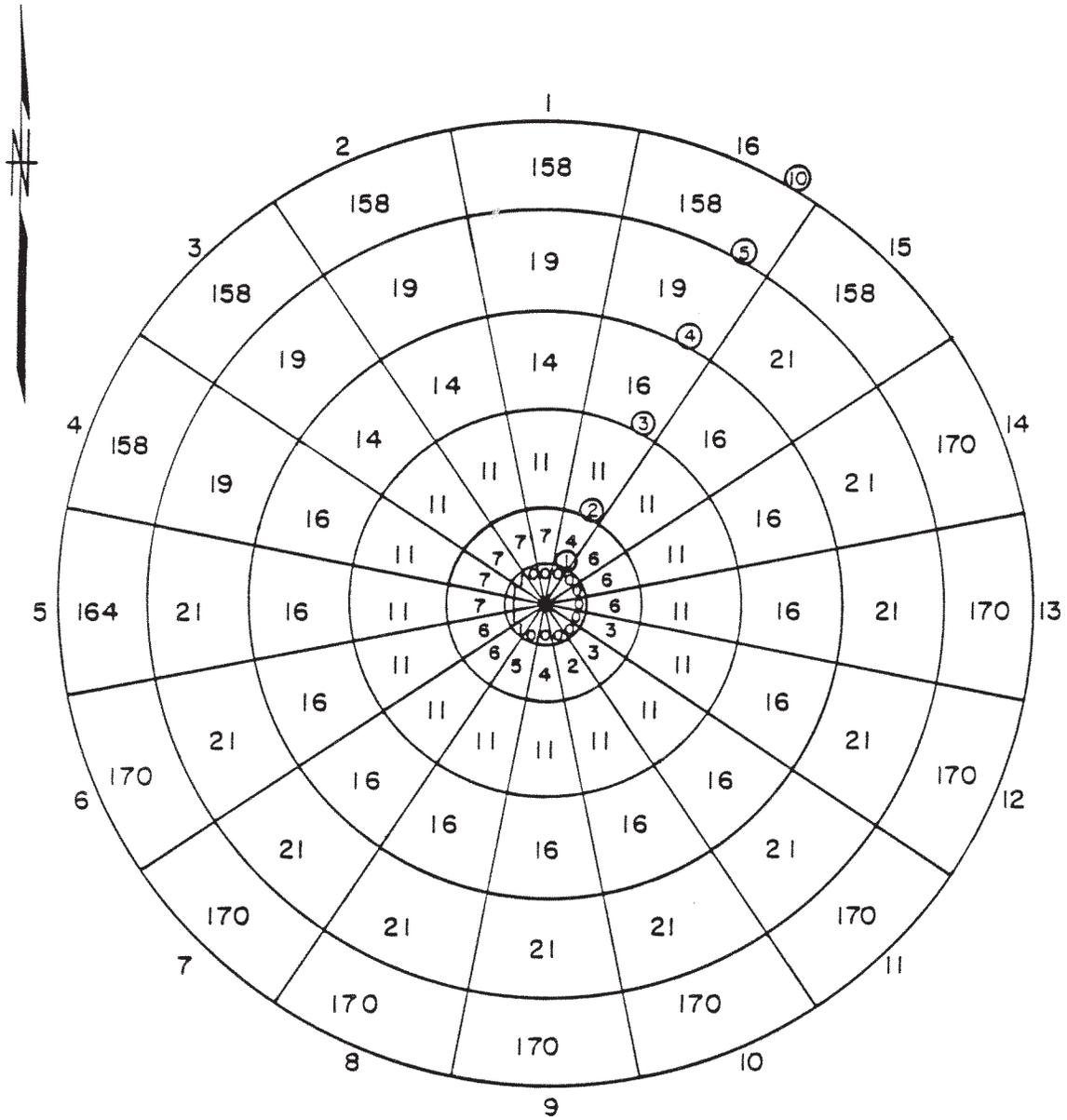


FIG. 12 - MEAT PRODUCING ANIMALS (0-10 MILES)

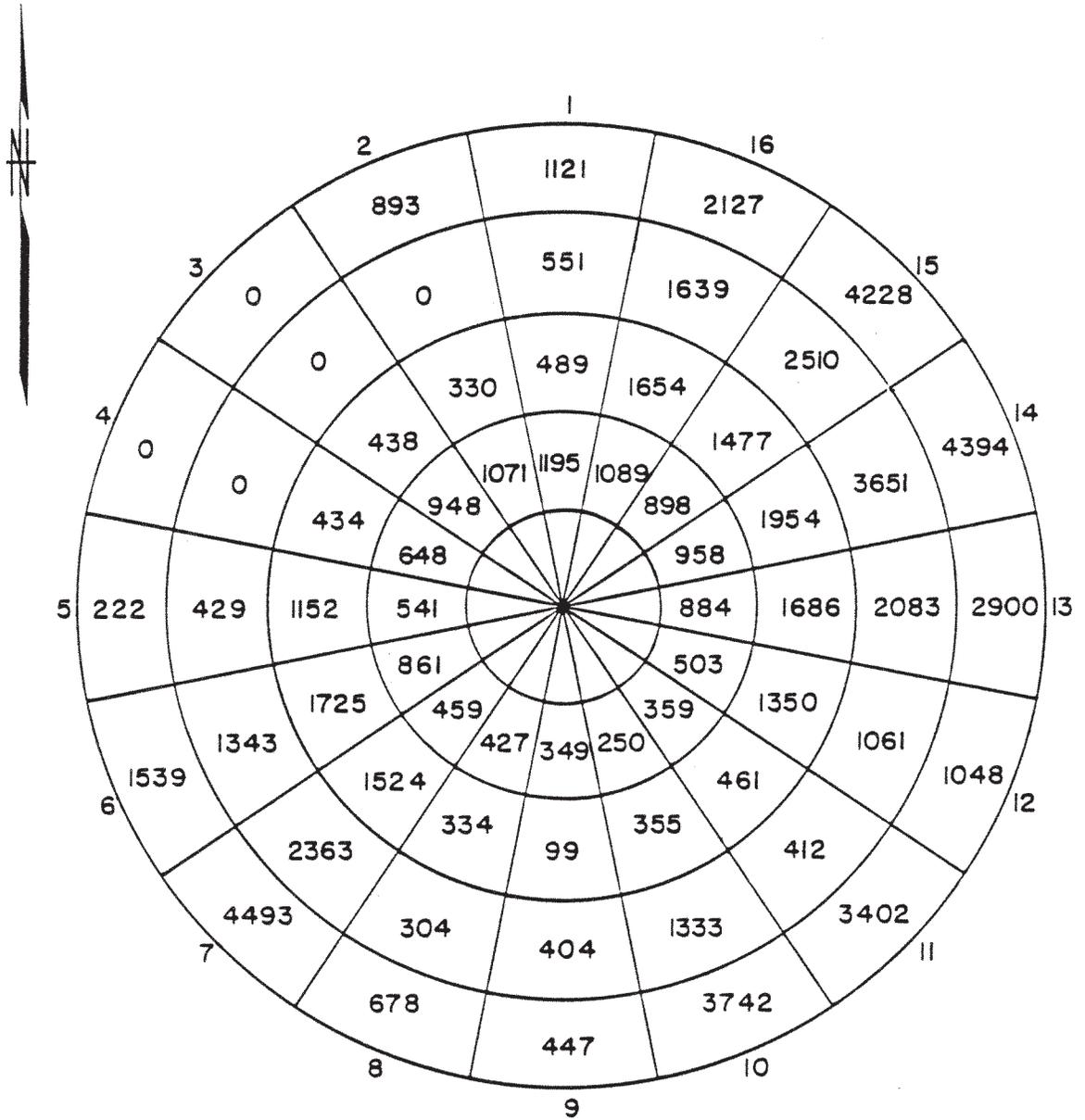


FIG .13- MEAT PRODUCING ANIMALS (10-50 MILES)

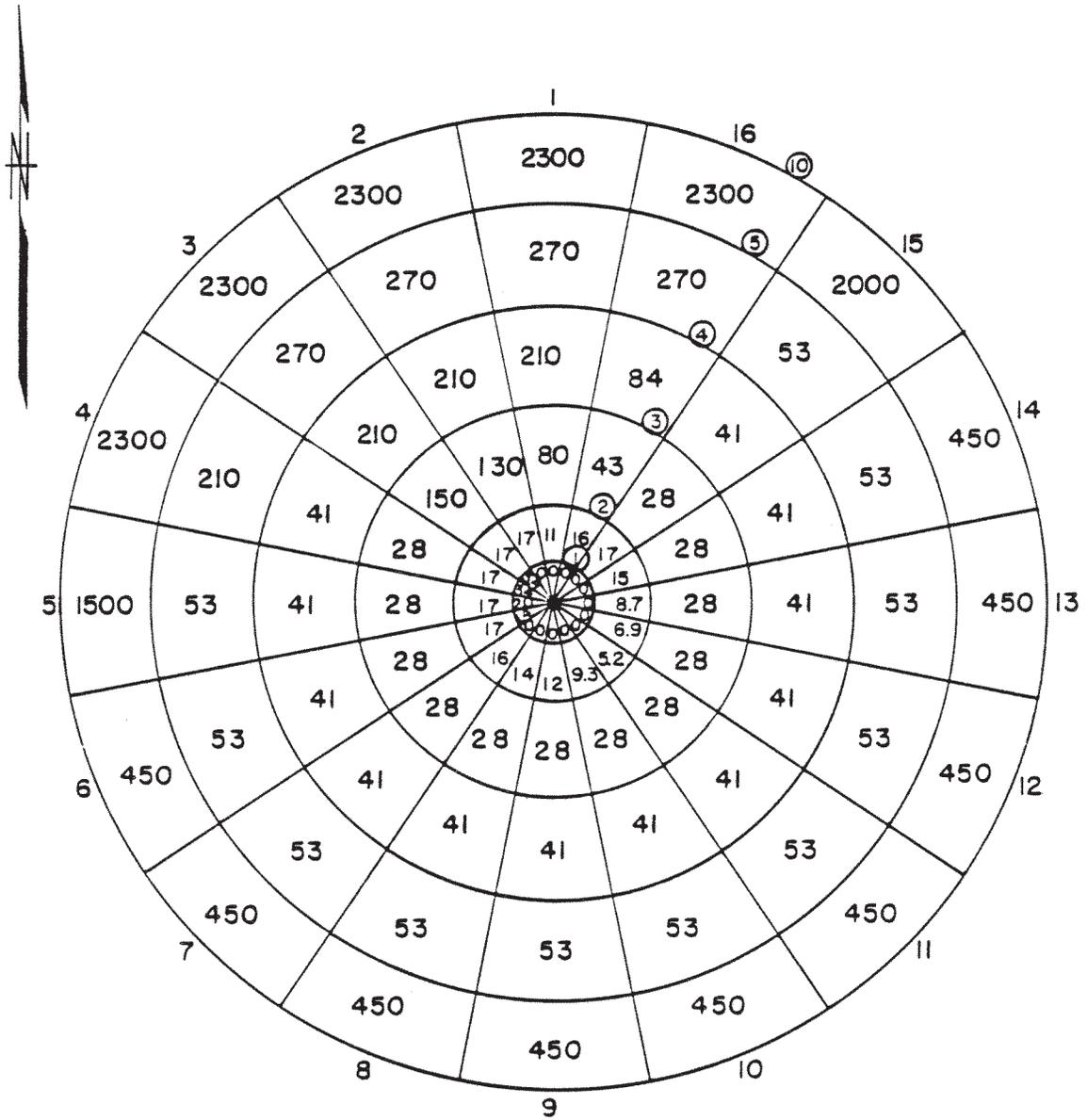


FIG. 14 - AREA USED FOR VEGETABLE CROPS ($\text{Km}^2 \times 10^3$) (0-10 MILES)

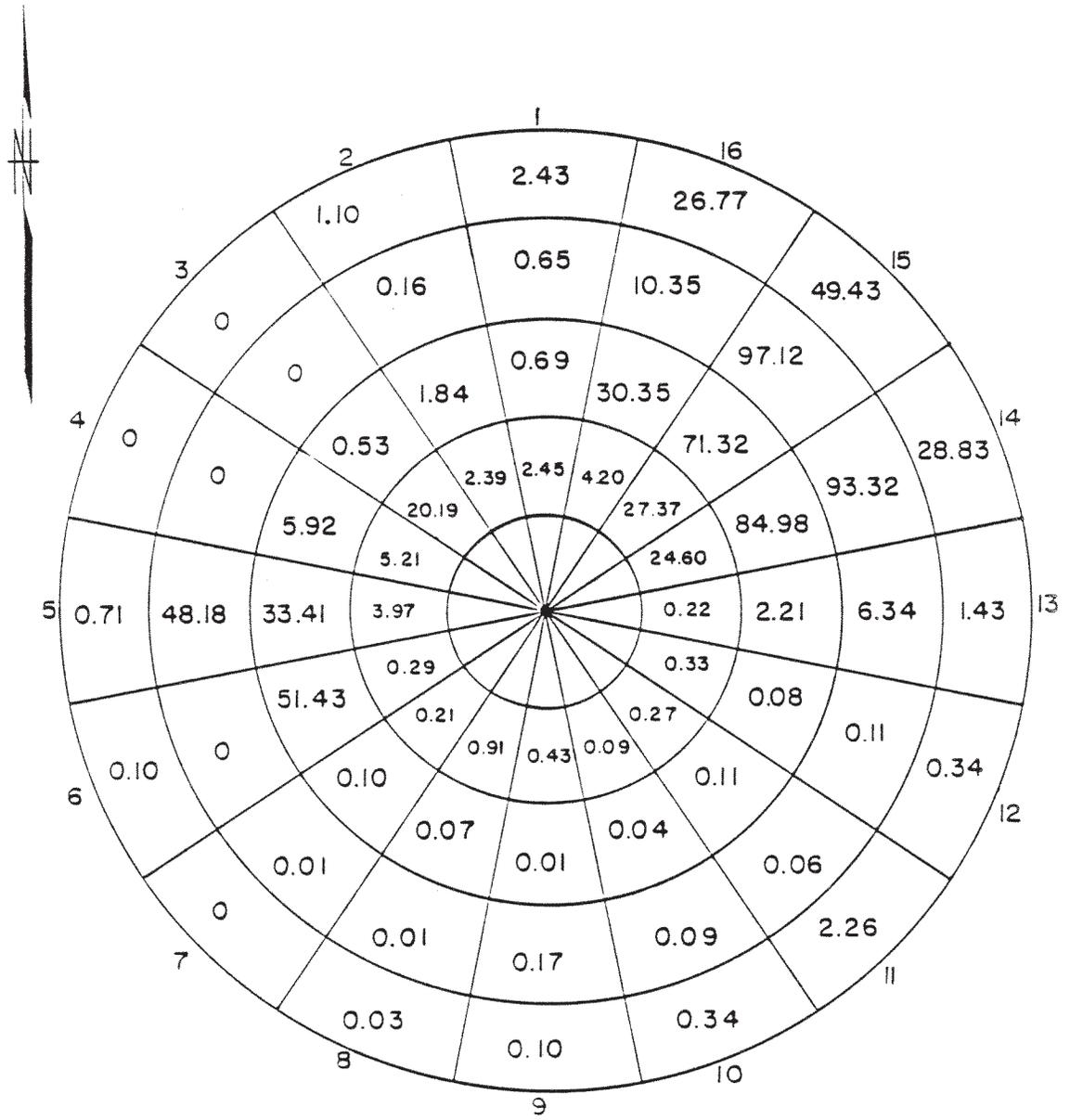


FIG. 15 - AREA USED FOR VEGETABLE CROPS (Km²) (10-50 MILES)

In this report, the effective dose equivalent, as well as the dose equivalent to the thyroid, lungs, bone, liver, kidneys and gastrointestinal tract were considered to determine the critical organs for various potential pathways of exposure. These estimates were based on parameters applicable to an average adult. The collective population dose estimate in man-rem is the effective dose equivalent to the whole body as calculated in accord with the recommendation of the ICRP (Reference 8).

In addition to these estimates of dose commitments based on dispersion modeling, the dose to a hypothetical maximally exposed individual who consumed locally produced milk, fish and venison (deer) was predicted. Measured radionuclide concentrations from samples of milk, fish and venison were used in these calculations. Many of the nuclides which may be present in these samples are often below the detectable limit. In such cases, the radionuclide concentration was assumed to be the limit of detection.

4.2 Source Term Estimates

4.2.1 Airborne Radioactive Effluents

There are three points on the plant site from which ventilation systems release low levels of airborne radioactivity. These three locations are:

- (1) Main plant process stack
- (2) Laundry exhaust vent
- (3) LLWT ventilation exhaust.

The air released from these vents is sampled continuously and the collected particulates are periodically analyzed. The results of measurements during 1983 are summarized in Table 8. A total of 1.2×10^{-5} Ci of gross alpha activity and 7.5×10^{-4} Ci of gross beta/gamma was released from these three vents during the year. More than 99 percent of the activity was discharged through the main plant stack.

4.2.2 Liquid Radioactive Effluents

There were three sources of liquid effluents from WVDP operations in 1983:

- (1) Lagoon No. 3 discharges (in May and November)
- (2) Sewage treatment outfall
- (3) Ground water releases from the swamp drain and french drain.

The volumes of the liquid effluents and the radioactivity they contained (reported in WVDP 1983 Effluent and On-Site Discharge Report, March 30, 1984) are summarized in Table 9. All liquids were discharged via Buttermilk Creek.

4.3 Potential Radiation Doses to the Public

4.3.1 Maximum Hypothetical Individual Radiation Exposure

The point of maximum potential radiation exposure at the site boundary from airborne radioactivity is located about 1 km WNW of the WVDP plant. A hypothetical maximum effective dose equivalent of 0.09 mrem was estimated to result from WVDP airborne releases during 1983 at this location when all possible pathways were considered. The calculated dose commitment to bone surface (the critical organ) at this location was 0.31 mrem. These maximum hypothetical exposures are about 0.02 percent of the allowable standard promulgated in DOE Order 5480.1.

TABLE 8

RADIOACTIVITY RELEASED TO THE ATMOSPHERE DURING 1983

<u>Release Point</u>	<u>Total Curies Released</u>		
	<u>Gross α</u>	<u>Gross β</u>	<u>Specific Nuclides</u>
Main Plant Stack	1.2-05	7.4-04	Sr-90 1.3-04 Ru-106 2.2-05 I-129 3.4-05 Cs-134 4.5-06 Cs-137 8.6-04
Laundry Vent	8.7-08	2.4-06	None Identified
LLWT Vent	1.4-07	4.1-06	None Identified

TABLE 9
RADIOACTIVITY RELEASED IN LIQUID
EFFLUENTS DURING 1983

<u>Release Point</u>	<u>Volume Released (Liters)</u>	<u>Released Radioactivity (Ci)</u>					
		<u>Gross α</u>	<u>Gross β</u>	<u>H-3</u>	<u>Sr-90</u>	<u>I-129</u>	<u>Cs-137</u>
Lagoon 3*	2.9+07	6.7-04	3.4-02	3.9	2.6-03	1.5-04	2.3-02
Sewage Treatment Outfall	6.1+06	1.0-05	2.4-04	5.1-03	3.8-05	3.6-07	--
Swamp Drain	9.0+07	--	--	3.6-01	--	--	--
French Drain	6.8+06	--	--	2.2-01	--	--	--
TOTAL	1.3+08	6.8-04	3.4-02	4.5	2.7-03	1.5-04	2.3-02

* Lagoon 3 discharge included 2.3+05 liters containing 2.0-03 Ci of Sr-90 and 4.2-01 Ci of H-3 which originated from the New York State operated low-level waste disposal area. These quantities have not been included in the values tabulated above.

An important potential contributor to the dose commitment from radioactivity in the terrestrial food-chain is the atmosphere-pasture-cow-milk pathway. Measurements of radioactivity in the milk produced at the nearest dairy farm 4 kilometers northeast of the WVDP facility indicated that no Sr-90, I-129, Cs-134, or Cs-137 was present in concentrations above the limits of detection. The maximum dose to an individual from ingestion of about 1 liter of this milk per day was estimated by assuming that the nuclides were present in amounts equal to the detection limits. This conservative calculation predicts a dose commitment of 30 mrem to the thyroid and an effective dose equivalent commitment of 1.6 mrem. These calculated maximum potential doses are less than 2 percent of the allowable standards in spite of their extreme conservatism. Further improvement in the detection limit will permit more realistic estimates to be made of the dose commitment due to consumption of milk produced in the vicinity of the WVDP. These more realistic estimates undoubtedly will be substantially lower than the small maximum values quoted above.

Estimates were made of the hypothetical maximum dose commitments to an adult from consumption of 21 kg per year of fish caught in the Cattaraugus Creek. From the measured concentrations of radionuclides in the edible parts of the fish (see Table 5), the maximum organ dose commitment to an individual was estimated to be 3.2 mrem to bone surfaces. The maximum effective dose equivalent commitment to an individual was calculated to be 1.7 mrem from consumption of 21 kg of fish.

The hypothetical dose commitment also was estimated for an individual who consumed 45 kg of venison. The measured radionuclide concentrations (Table 5) in the flesh of a deer taken about a kilometer from the WVDP in the fourth quarter of 1983 was used as the basis for this estimate. The dose commitment was calculated to be 0.37 mrem to the bone surface and 0.21 mrem for an effective

dose equivalent commitment. Table 10 summarizes the potential radiation doses to individual adult members of the general public at the points of highest potential exposure from gaseous and liquid effluents from the WVDP facility operations during 1983.

4.3.2 Collective Dose to the Population

The collective effective dose equivalent commitment to the population within an 80-km radius of the WVDP from operations during 1983 was estimated to be 0.05 person-rem and 0.03 person-rem from gaseous effluents and liquid effluents, respectively. These estimates are based on the releases summarized in Tables 8 and 9 and the use of the AIRDOS-EPA and LADTAPII codes as described in Section 4.1.

These collective doses may be compared to an estimated 170,000 person-rem to the same population resulting from natural background radiation. The average effective dose equivalent to individuals residing within 80 km of the WVDP was about 4.7×10^{-5} mrem during 1983 (based on the collective dose given above and a total population of 1.7 million in the region), which is insignificant when compared to the average dose to each individual of approximately 100 mrem per year from natural sources.

TABLE 10

SUMMARY OF HYPOTHETICAL ESTIMATED DOSE COMMITMENTS
TO AN ADULT INDIVIDUAL AT LOCATIONS OF MAXIMUM EXPOSURE DURING 1983

Pathway	Location	50-Year Dose Commitment (mrem)		
		Effective Whole Body Equivalent		Critical Organ
<u>Gaseous Effluents</u>				
All Pathways*	Nearest residence (1 km WNW)	0.09	0.31	Bone Surface
Milk	Produced 4 km NE	<1.6	<30	Thyroid
Venison	Deer taken within 2 km of WVDP	0.21	0.37	Bone Surface
<u>Liquid Effluents</u>				
Fish	Collected in Cattaraugus Creek Below WVDP	1.7	3.2	Bone Surface

* Estimates based on measured radioactivity in airborne effluents (Table 8) and AIRDOS-EPA computer code. All other values based on measured concentrations in food and consumption rates for maximally exposed individuals recommended in U.S. NRC Regulatory Guide 1.109.

Note: Annual average whole body dose from natural background sources in the U.S. is about 100 mrem.