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CHAPTER 11
ENVIRONMENTAL RADIOLOGICAL MONITORING

The parameters of the environmental radiological monitoring program to be performed in the environs around Quad-Cities Station are presented in Table 11-1.

Figure 11-1 shows the 16 fixed air sampling sites and TLD locations; also shown are the outer ring (approximately 5 miles distant) TLD locations. Figure 11-2 shows the inner ring TLD locations. The TLDs are code numbered as follows:

XYY-N

X = 1 means inner ring,

X = 2 means outer ring, and

YY-N is an identification code.

Figure 11-3 shows the milk, fish, water, and sediment sample locations.

The reporting levels for radioactivity concentrations in environmental samples are given in Table 11-2. The practical lower limits of detection for this program are given in Table 11-3.

QUAD CITIES

Table 11-1
Environmental Radiological Monitoring Program

<u>Exposure Pathway and/or Sample</u>	<u>Sampling or Monitoring Locations^a</u>	<u>Sampling or Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
1. <u>Airborne</u>	a. <u>Onsite and Near Field^b</u>	Continuous sampler operation with particulate filter collection weekly and radioiodine canister collection biweekly ^c	<u>Particulate Sampler:</u> Gross beta analysis following filter change ^d
	Q-01 Onsite No. 1 0.5 mi N (0.8 km A) Q-02 Onsite No. 2 0.5 mi ENE (0.8 km D) Q-03 Onsite No. 3 0.6 mi S (1.0 km J) Q-04 Nitrin 1.5 mi NE (2.4 km C) Q-05 Saddle Club Dairy Farm 1.8 mi SSE (2.9 km H) Q-06 Hanson's Boat Landing 1.8 mi NNW (2.9 km R)		<u>Radioiodine Canister:</u> I-131 analysis biweekly
	b. <u>Far Field^b</u>	Continuous sampler operation with particulate filter exchange weekly and radioiodine canister exchange biweekly ^c	<u>Sampling Train:</u> Test and maintenance weekly <u>Particulate Sampler:</u> Gross beta when analyses are made ^{d,e}
	Q-07 Clinton 9.0 mi NE (14.5 km C) Q-08 Sikkema Farm 7.0 mi ENE (11.3 km D) Q-09 Erie 13.0 mi ESE (20.9 km F)		

Table 11-1 (Cont'd)

Exposure Pathway and/or Sample	Sampling or Monitoring Locations ^a	Sampling or Collection Frequency	Type and Frequency of Analysis
	Q-10 Hillsdale 10.0 mi SE (16.1 km G) Q-11 Port Byron 8.0 mi S (12.9 km J) Q-12 Bettendorf 13.0 mi SW (20.9 km L) Q-13 Princeton 4.8 mi SA (7.7 km L) Q-14 Utica Ridge Road 11.0 mi W (17.7 km N) Q-15 DeWitt 13.0 mi WNW (20.9 km P) Q-16 Low Moor 6.0 mi NNW (9.7 km R)		Radioiodine Canister: I-131 when analyses are made ^e Sampling Train: Test and maintenance weekly
2. <u>Direct Radiation</u>	a. <u>At Air Sampler Sites^b</u> Same location as fixed air sampling locations in Item 1.	Quarterly	Gamma dose quarterly
	b. <u>Inner Ring^f</u> Q-101-1, 0.7 mi N 1.1 km A Q-101-2, 0.7 mi N 1.1 km A Q-102-1, 1.7 mi NNE 2.7 km B Q-102-2, 1.7 mi NNE 2.7 km B Q-103-1, 1.2 mi ENE 1.9 km D Q-103-2, 1.2 mi ENE 1.9 km D Q-104-1, 1.1 mi ENE 1.8 km D Q-104-2, 1.0 mi ENE 1.6 km D Q-104-3, 0.6 mi ENE 1.0 km D Q-105-1, 0.8 mi E 1.3 km E Q-105-2, 0.8 mi E 1.3 km E	Quarterly	Gamma dose quarterly

Table 11-1 (Cont'd)

Exposure Pathway and/or Sample	Sampling or Monitoring Locations ^a	Sampling or Collection Frequency	Type and Frequency of Analysis
2. <u>Direct Radiation</u> (Cont'd)	Q-106-1, 0.7 mi ESE 1.1 km F Q-106-2, 0.7 mi ESE 1.1 km F Q-107-1, 0.7 mi SE 1.1 km G Q-107-2, 0.7 mi SE 1.2 km G Q-107-3, 0.8 mi SE 1.3 km G Q-108-1, 0.9 mi SSE 1.4 km H Q-108-2, 0.9 mi SSE 1.4 km H Q-109-1, 0.9 mi S 1.4 km J Q-109-2, 0.9 mi S 1.4 km J Q-111-1, 2.6 mi SW 4.2 km L Q-111-2, 2.6 mi SW 4.2 km L Q-112-1, 2.4 mi WSW 3.9 km M Q-112-2, 2.4 mi WSW 3.9 km M Q-113-1, 2.5 mi W 4.0 km N Q-113-2, 2.5 mi W 4.0 km N Q-114-1, 2.6 mi NNW 4.2 km P Q-114-2, 2.5 mi NNW 4.2 km P Q-115-1, 2.3 mi NW 3.7 km Q Q-115-2, 2.3 mi NW 3.7 km Q Q-116-1, 2.2 mi NNW 3.5 km R Q-116-2, 2.2 mi NNW 3.5 km R	Quarterly	Gamma dose quarterly
	c. <u>Outer Ring^b</u>		
	Q-201-1, 4.0 mi N 6.4 km A Q-201-2, 4.0 mi N 6.4 km A Q-202-1, 4.4 mi NNE 7.1 km B Q-202-2, 4.4 mi NNE 7.1 km B Q-203-1, 5.5 mi NE 8.8 km C Q-203-2, 5.5 mi NE 8.8 km C		

Table 11-1 (Cont'd)

Exposure Pathway and/or Sample	Sampling or Monitoring Locations ^a	Sampling or Collection Frequency	Type and Frequency of Analysis
2. <u>Direct Radiation</u> <u>(Cont'd)</u>	Q-204-1, 4.5 mi ENE 7.2 km D		
	Q-204-2, 4.5 mi ENE 7.2 km D		
	Q-205-1, 4.5 mi E 7.2 km E		
	Q-205-2, 4.5 mi E 7.2 km E		
	Q-206-1, 4.8 mi ESE 7.7 km F		
	Q-206-2, 4.8 mi ESE 7.7 km F		
	Q-207-1, 4.8 mi SE 7.7 km G		
	Q-207-2, 4.8 mi SE 7.7 km G		
	Q-208-1, 4.4 mi SSE 7.1 km H		
	Q-208-2, 4.4 mi SSE 7.1 km H		
	Q-209-1, 4.8 mi S 7.7 km J		
	Q-209-2, 4.8 mi S 7.7 km J		
	Q-210-1, 4.4 mi SSW 7.1 km K		
	Q-210-2, 4.4 mi SSW 7.1 km K		
	Q-211-1, 5.0 mi SW 8.0 km L		
	Q-211-2, 5.0 mi SW 8.0 km L		
	Q-212-1, 4.8 mi WSW 7.7 km M		
	Q-212-2, 4.8 mi WSW 7.7 km M		
	Q-213-1, 4.7 mi W 7.6 km N		
	Q-213-2, 4.7 mi W 7.6 km N		
	Q-214-1, 4.8 mi NW 7.7 km Q		
	Q-214-2, 4.8 mi NW 7.7 km Q		
	Q-215-1, 4.8 mi NW 7.7 km Q		
	Q-215-2, 4.8 mi NW 7.7 km Q		
	Q-216-1, 4.5 mi NNW 7.2 km R		
	Q-216-2, 4.5 mi NNW 7.2 km R		

QUAD CITIES

3. Waterborne^g

- | | | | |
|--|--|---|-------------------------------------|
| a. <u>Public Water</u> | Q-19 East Moline Water Works, 16.0 mi SSW
(25.8 km K)
Q-20 Davenport Water Works, 18.0 mi SSW
(29.0 km L) | Weekly collection composited
monthly | Gamma isotopic
analysis monthly |
| b. <u>Cooling Water</u> | Q-21 Intake Canal, 0.1 mi W (0.2 km N)
Q-22 Discharge Canal, 0.1 mi SW (0.2 km L) | Weekly | Gross beta analysis
weekly |
| c. <u>Shoreline
Sediments</u> ^g | Q-27 Albany, Upstream on Mississippi River,
5.5 mi NE (8.8 km C)
Q-28 Cordova, Downstream on Mississippi River,
3.3 mi SSW (5.3 km K) | Annually | Gamma isotopic
analysis annually |

4. Ingestion^h

- | | | | |
|-----------------------------|--|--|---|
| a. <u>Milk</u> ⁱ | Q-18 Musal Dairy, 5.5 mi SW (8.9 km L)
Q-25 Donald Waite Dairy, 13.0 mi E
(20.9 km E)
Q-26 Bill Stanley Dairy, 3.0 mi ENE
(4.8 km D) | Weekly: May to October
Monthly: November to April | I-131 analysis on each
sample |
| b. <u>Fish</u> ^j | Q-24 Pool #14 of Miss. River | Semiannually | Gamma isotopic on
edible portions of
each sample. |

5. Land Use Census

- | | | | |
|--------------------------------------|--------------------------|--------------------------------|--|
| a. <u>Milch Animals</u> ^l | Site boundary to 2 miles | Annually during grazing season | Enumeration by a door-
to-door or equivalent
counting technique. |
|--------------------------------------|--------------------------|--------------------------------|--|

Table 11-1 (Cont'd)

<u>Exposure Pathway and/or Sample</u>	<u>Sampling or Monitoring Locations^a</u>	<u>Sampling or Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
5. <u>Land Use Census (Cont'd)</u>	2. 2 to 5 miles	Annually during grazing season	Enumeration by using referenced information from county agricultural agencies or other reliable sources.
	3. At dairies listed in Item 4.a.	Annually during grazing season	Inquire as to feeding practices: a. Pasture only. b. Feed and chop only. c. Pasture and feed; If both, ask farmer to estimate fraction of food from pasture: <25%, 25-50%, 50-75%, or >75%.

Table 11-1 (Cont'd)

<u>Exposure Pathway and/or Sample</u>	<u>Sampling or Monitoring Locations^a</u>	<u>Sampling or Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
b. <u>Nearest Resident</u>	In all 16 sectors up to 5 miles.	Annually	

- ^a See Table D-16 of Appendix D for definitions of sector codes used with kilometer distances.
- ^b See Figure 11-1.
- ^c Biweekly means every two weeks.
- ^d A gamma isotopic analysis shall be performed whenever the gross beta concentration in a sample exceeds by five times (5x) the average concentration of the preceding calendar quarter for the sample location.
- ^e Far field samples are analyzed when near field results are inconsistent with previous measurements and radioactivity is confirmed as having its origin in airborne effluents released from the station or at the discretion of the Emergency Preparedness Director.
- ^f See Figure 11-2.
- ^g Upstream shoreline sediment monitoring location is not required, serves as control only.
- ^h See Figure 11-3.
- ⁱ Milk samples are required from two monitoring locations only. Three dairies are listed to ensure the minimum criteria.
- ^j The fish monitoring location is not identified exactly on the map, the point, Q-24, represents the area of the station discharge, Pool #14.

TABLE 11-2

REPORTING LEVELS FOR RADIOACTIVITY
CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m ³)	Fish (pCi/Kg, wet)	Milk (pCi/l)	Food Products (pCi/Kg, wet)
H-3	2 x 10 ⁴ (a)				
Mn-54	1 x 10 ³		3 x 10 ⁴		
Fe-59	4 x 10 ²		1 x 10 ⁴		
Co-58	1 x 10 ³		3 x 10 ⁴		
Co-60	3 x 10 ²		1 x 10 ⁴		
Zn-65	3 x 10 ²		2 x 10 ⁴		
Zr-Nb-95	4 x 10 ² (b)				
I-131	2	0.9		3	1 x 10 ²
Cs-134	30	10	1 x 10 ³	50	1 x 10 ³
Cs-137	50	20	1 x 10 ³	70	2 x 10 ³
Ba-La-140	2 x 10 ² (b)			3 x 10 ²	

a) For drinking water samples. This is 40 CFR Part 141 value.

b) Total for parent and daughter.

TABLE 11-3

PRACTICAL LOWER LIMITS OF DETECTION (LLD)
FOR STANDARD ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

<u>Sample Media</u>	<u>Analysis</u>	<u>LLD^{A,B}</u> <u>(4.66 σ)</u>	<u>Units</u>
Airborne "Particulate"	Gross Beta +	0.01	pCi/m ³
	Gamma Isotopic	0.01	pCi/m ³
Airborne I-131	Iodine 131	0.10	pCi/m ³
Milk/Public Water	I-131	5 ^o	pCi/l
	Cs-134	10	pCi/l
	Cs-137	10 Δ	pCi/l
	Tritium	200	pCi/l
	Gross Beta +	5	pCi/l
	Gamma Isotopic	20	pCi/l/nuclide
Sediment	Gross Beta +	2	pCi/g dry
	Gamma Isotopic	0.2	pCi/g dry
Fish Tissue	I-131 Thyroid	0.1	pCi/g wet
	Cs-134, 137	0.1	pCi/g wet
	Gross Beta +	1.0	pCi/g wet
	Gamma Isotopic	0.2	pCi/g wet

^o 0.5 pCi/l on milk samples collected during the pasture season.

+ Referenced to Cs-137

Δ 5.0 pCi/l on milk samples

Table 11-3 (Cont'd)

General Notes:

1. Other radionuclides which are measurable and identifiable by gamma ray spectrometry, together with the nuclides indicated in Table 11-3, shall also be identified and reported when an actual analysis is performed on a sample. Nuclides which are below the LLD for the analyses shall not be reported as being present at the LLD level for that nuclide.
2. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a real signal. For a particular measurement system (which may include radiochemical separation).

$$LLD = \frac{4.66 \cdot (S_b)}{(A) \cdot (E) \cdot (V) \cdot (2.22) \cdot (Y) \cdot (\exp(-\lambda \Delta t)) \cdot (t)}$$

- LLD The a priori lower limit of detection for a blank sample or background analysis as defined above (as pCi per unit mass or volume).
- S_b The square root of the background count or of a blank sample count; it is the estimated standard error of a background count or a blank sample count as appropriate (in units of counts).
- E The counting efficiency (as counts per disintegration).
- A The number of gamma-rays emitted per disintegration for gamma-ray radionuclide analysis (A = 1.0 for gross alpha and tritium measurements).
- V The sample size (in units of mass or volume).
- 2.22 The number of disintegrations per minute per picocurie.
- Y The fractional radiochemical yield when applicable (otherwise Y = 1.0).

Table 11-3 (Cont'd)

- λ The radioactive decay constant for the particular radionuclide (in units of reciprocal minutes).
- Δt The elapsed time between the midpoint of sample collection and the start time of counting ($\Delta t = 0.0$ for environmental samples and for gross alpha measurements).
- t The duration of the count (in units of minutes).

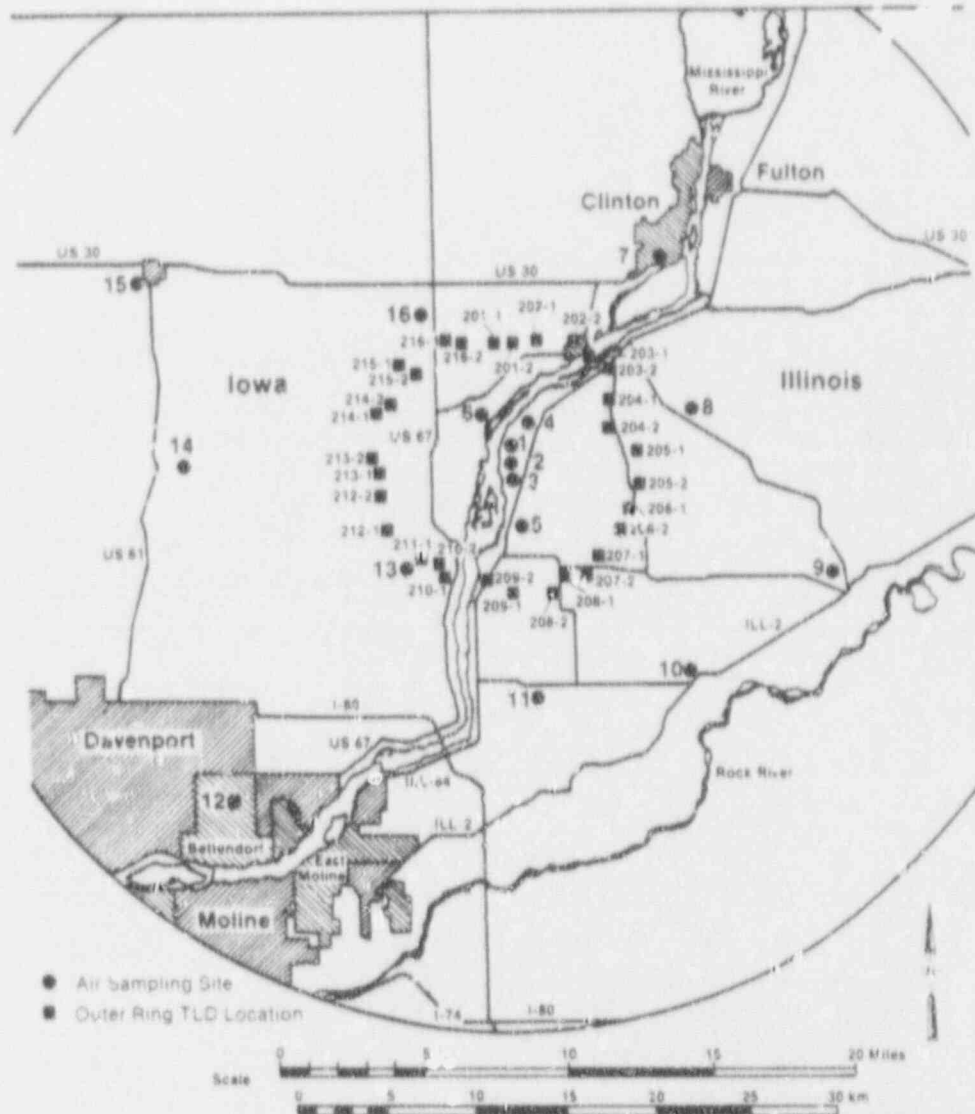
The value of S_b used in the calculation of the LLD for a detection system shall be based on an actual observed background count or a blank sample count (as appropriate) rather than on an unverified theoretically predicted value. Typical values of E , V , Y , t , and Δt shall be used in the calculation.

For gamma-ray radionuclide analyses the background counts are determined from the total counts in the channels which are within plus or minus one FWHM (Full Width at Half Maximum) of the gamma-ray photopeak energy normally used for the quantitative analysis for that radionuclide. Typical values of the FWHM shall be used in the calculation.

The LLD for all measurements is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Footnotes:

- a Referenced to Cs-137.
- b For thyroid.
- c 0.5 pCi/L on samples collected during the pasture season.

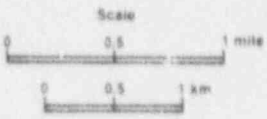
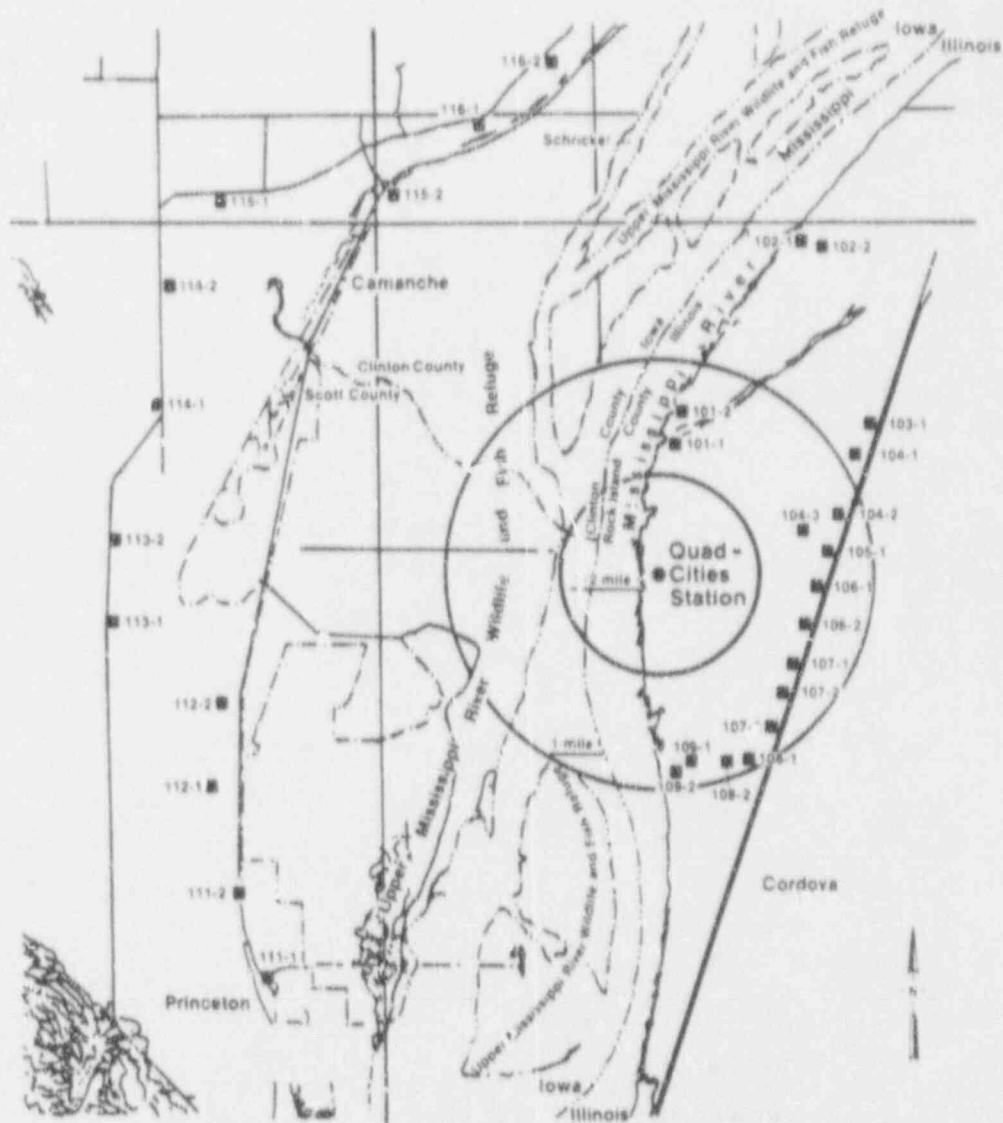


OFFSITE DOSE CALCULATION MANUAL
QUAD CITIES STATION

FIGURE 11-1

FIXED AIR SAMPLING SITES AND
OUTER RING TLD LOCATIONS

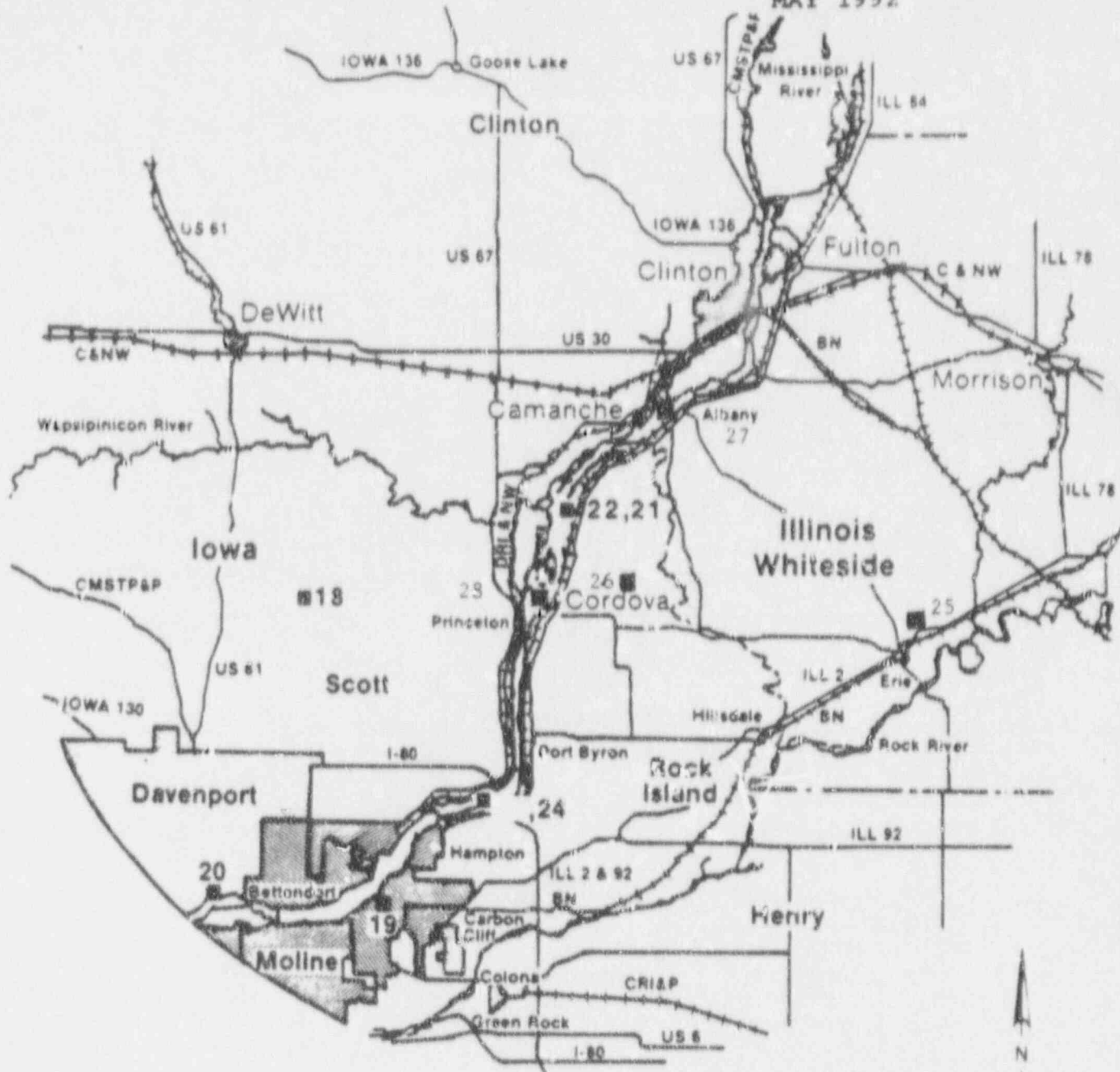
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OFFSITE DOSE CALCULATION MANUAL
QUAD-CITIES STATION

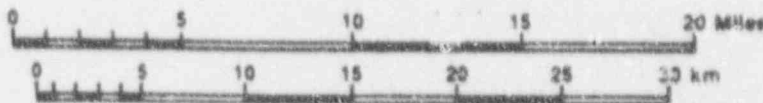
FIGURE 11-2
INNER RING TLD LOCATIONS

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■ Sampling Station

Scale



**OFFSITE DOSE CALCULATION MANUAL
QUAD-CITIES STATION**

FIGURE 11-3

**MILK, FISH, WATER, AND SEDIMENT
SAMPLE LOCATIONS**