INSTRUCTIONS FOR UPDATING YOUR ER

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BRAIDWOOD NUCLEAR GENERATING STATION - UNITS 1 & 2

ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

CONTENTS

BRAIDWOOD NUCLEAR GENERATING STATION - UNITS 1 & 2

ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

CONTENTS

CHAPTER 1 - PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION

The electrical output of the Braidwood Nuclear Generating Station - Units 1 and 2 (Braidwood Station) will be used to satisfy the power requirements of the Commonwealth Edison Company (CECo) system. Initially this electrical power may supplant power generated by other means such as coal or oil fired units with higher incremental production costs. 1

Chapter 8 of this Environmental Report contains a discussion of socioeconomic benefits from operation of this facility.

CHAPTER 2.0 - THE SITE AND ENVIRONMENTAL INTERFACES

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site Location and Description

2.1.1.1 Specification of Location

The Braidwood Nuclear Generating Station - Units 1 and 2 (Braidwood Station) is located in Reed Township of Will County northeastern Illinois approximately 50 miles southwest of Chicago and 20 miles south-southwest of Joliet. It is adjacent at its northwest corner to the village of Godley and its western and southern borders lie adjacent to the Grundy and Kankakee County boundary lines, respectively. The site is in an area of flat agricultural farmland that has been scarred from coal strip mining, and the site itself is located principally on terrain that has been strip mined.

At its closest approach, the Kankakee River is approximately 3 miles east of the northeastern site boundary; this point is approximately 12 miles upstream of the headwaters of the Illinois River at the confluence of the Kankakee and Des Plaines Rivers. The Braidwood Station is located approximately 8 miles southwest of the Joliet Arsenal.

Figure 2.1-1 shows the location of the site within the State of Illinois, and Figure 2.1-2 outlines the site with respect to the Kankakee River and the county boundaries. The following coordinates of the center of containments are given in both latitude and longitude and Universal Transverse Mercator (UTM) Coordinates. Latitude and longitude are given to the nearest second and UTM Coordinates are given to the nearest 100 meters.

Nuclear Unit	Latitude and Longitude	UTM Coordinates
1	88° 13' 42" W x 41° 14' 38" N	4,565,300 N 397,000 E
2	88° 13' 42" W x 41° 14' 36" N	4,565,200 N 397,000 E

2.1.1.2 Site Area

The roughly rectangular site occupies approximately 4454 acres of
which 2537 acres comprise the cooling pond. The pond has an eleva- 1
tion of 595 feet above mean sea level (MSL) when filled to capacity.
The plant property lines and the site boundary lines are the
same. 1

The site boundary and the general outline of the pond are shown in Figure 2.1-3. As noted in this figure, the nuclear generating

facilities are located at the northwest corner of the site. Figure 2.1-4 shows the location and orientation of the principal plant structures. The makeup and blowdown lines are buried in the ground within a transmission line corridor and have their respective source and terminus at the Kankakee River as shown in Figure 2.1-2. 1

The plant exclusion area, located within the site boundary, is illustrated in Figure 2.1-5. The minimum exclusion boundary distance from the gaseous release point is 1625 feet.

There are no industrial, commercial, institutional, recreational, or residential structures on the site. Illinois State Routes 53 and 129 are adjacent to the northwest boundary of the site. The Illinois Central Gulf Railroad (previously the Gulf Mobile & Ohio Railroad) runs parallel between State Routes 53 and 129 and provides spur track access from the site area to the main line. Interstate 55 is less than 2 miles west-northwest of the site and State Route 113 is approximately 2 miles north of the site. Figure 2.1-6 illustrates these transportation routes. The Kankakee River is approximately 3 miles east of the northeastern site boundary.

2.1.1.3 Boundaries for Establishing Effluent Release Limits

It is required by Title 10 of the Code of Federal Regulations Section 20.106 (10 CFR 20.106) that "a licensee shall not possess, use, or transfer licensed material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix 'B', Table II of this part . . . "; it is further required by 10 CFR 50.34a that "in the case of an application filed on or after January 2, 1971, the application shall also identify the design objectives, and the means to be employed, for keeping levels of radioactive material in effluents to unrestricted areas as low as practicable."

The restricted area boundary, the boundary that separates the restricted area from the unrestricted by 10 CFR 20.106, is specified to be the plant property line for the Braidwood Station. Expected concentrations of radionuclides in effluents are shown in Sections 3.5 and 5.2 to be in compliance with 10 CFR 20.106 criteria.

Figure 2.1-3 illustrates the restricted area boundary and Figure 2.1-2 shows the boundary with respect to the Kankakee River.

The distances from the release point of gaseous effluents (the vent stack) to the restricted area boundary for each of the 16 directional segments are given in Table 2.1-1. The site boundary closest to the release point of gaseous effluents is in the northwestern direction at a distance of 1625 feet.

Liquid effluents are discharged into the cooling pond blowdown line, which subsequently discharges into the Kankakee River. Radionuclides in liquid effluents, therefore, enter the unrestricted area at that point.

The restricted area boundary is posted conspicuously with "Private Property - No Trespassing" signs. In addition, administrative procedures include periodic patrolling to control access to the area.

2.1.2 Population Distribution

2.1.2.1 Population within 10 Miles

In order to assess the population distribution within a 10-mile radius of the Braidwood Station, a detailed analysis was performed. For this purpose, the region surrounding the station was divided into sixteen 22.5° azimuthal sectors centered on the centerline of the reactors with outer radial increments of 1, 2, 3, 4, 5, and 10 miles. The geographical locations of these sectors are identified in Figure 2.1-7. The 1970 and 1980 population densities within these radial-azimuthal sectors were obtained by performing a house count from general highway maps for Will, Grundy, and Kankakee Counties based on 1968, 1969 and 1980 local census data. The population-center data were updated to the reported 1980 U.S. Bureau of Census values. All permanent residences were counted. House counts were converted to population by assuming 3.4 persons per household based on 1970 U.S. Bureau of Census data for Will County. Comparable values for Grundy and Kankakee Counties were 3.17 and 3.15, respectively. | 1

The results of this analysis, as presented in Table 2.1-2, show that the 1980 population out to 10 miles was 28,548 corresponding to an average population density in this area of 91 persons per square mile. The maximum population densities in the near vicinity of the plant occur in the northern sectors, which encompass the cities of Braidwood and Wilmington and the village of Coal City. | 1

The population data were projected over the expected 40-year operating life of the plant by census decade using the modified ratio method. The basic formula used for the population projection by county was:

$$P_t = P_o (1 + r)^T$$ | 1

Where: P_t = population in year t;
P_o = population in base year;
r = average annual rate of population change; and
T = number of years between the base year and the year of the projection (year t).

Based on previous census history (1940-1970), the rural population within 10 miles of the Braidwood Station has tended to remain constant in all the Illinois counties of interest except Will and Grundy. Thus, except for these two counties, population growth was assumed to take place only near present urban centers (those locations with a population greater than 2500).

The county population for the 1970 base year was subdivided into rural and urban components by township. The projected population increase in a county was distributed among townships at a level proportional to the magnitude of urban population in each township for the base year 1970. Rural townships were held constant at the 1970 census level.

Census data of Will and Grundy counties for the previous decade indicate that the population growth rate in rural areas is very similar to the rate characterizing urban areas. Thus, township populations in these two counties were assumed to increase at the same rate as the county population.

The rate of population growth in a particular county during the last decade (1960-1970) was used to obtain the county's annual rate of change, which is utilized for the period up to and including 1990. On the assumption that the increase in population within this region over the period from 1970 to 1990 will be sufficiently large to divert migration from the greater Chicago area to other regions of northern Illinois, the annual population rate of change for all counties within the 10-mile radius after 1990 was tken to be the projected rate for the State of Illinois (about 1% per year) for that perod based on U.S. Census projection data. Onsite residences were not included in the projected data. The projected population for the proposed Finger Lakes Estates mobile home park is included in the north-northeast sector in the 3-to 4-mile segment. This projection was obtained by multiplying the proposed 800 units (U.S. Department of Housing and Urban Development 1977) by 2.3, the average number of persons living in owner-occupied mobile homes in Illinois according to the 1970 Census of Housing (Bureau of the Census 1972).

The results of this analysis of projected population distribution are shown in Table 2.1-2 for the expected 40-year operating life of the plant by census decade. From these projections, it is seen that the population within 10 miles of the site is expected to grow from 22,116 in 1970 to 47,577 in 2020, corresponding to an average population density of 151 persons per square mile.

The projected national age distribution for the year 2000 (midpoint of station operating life) is 17.5% in the 0 to 11 age group, 11.1% in the 12 to 18 age group, and 71.4% in the 19 and over age group

(Bureau of the Census 1975). These percentages correspond to a projected 2000 population of 6,937 persons in the 0 to 11 age group, 4,400 persons in the 12 to 18 age group, and 28,303 persons in the 19 and over age group within 10 miles of the site. The U.S. projected age distribution was used because the area within a 10-mile radius of the site (Will, Kankakee, and Grundy Counties) did not show a significant difference from the 1970 U.S. Census age distribution (Bureau of the Census 1971).

When applying the significance test described in Appendix D of Regulatory Guide 4.2, Will County did vary more than 10% from the 1970 U.S. Census age distribution in one of the three age groups (14.7% in the 0-11 age group). However, Grundy and Kankakee Counties did not significantly differ from the U.S. distribution. The average age distribution for the three counties did not vary more than 10% from the 1970 U.S. Census age distribution. Thus, it is assumed that the area within a 10-mile radius of the site will have a projected age distribution similar to the U.S. projected age distribution.

Figure 2.1-8 locates cities and villages within 10 miles of the site and provides their 1980 populations. Only Braidwood, Coal City and Wilmington can be classified as urban centers (population greater than 2500) within 10 miles of the site. The village of Godley with a 1980 population of 373 is located approximately 0.5 mile southwest and west-southwest of the reactor. The city of Braidwood with a 1980 populaton of 3429 is located approximately 1.5 miles north and north-northeast of the station. 1

2.1.2.2 Population between 10 and 50 Miles

The 1970 and 1980 population distribution and the estimated projected population distributions through 2020 at 10-year intervals for the area between 10 and 50 miles are summarized in Table 2.1-3. The geographical locations of the population sectors are found in Figure 2.1-9. The total population within 50 miles was 4,472,612 in 1980 with an average population density of 570 persons per square mile. By 2020, the population is projected to grow to 7,559,624, which yields a population density of 963 persons per square mile. 1

The most heavily populated sectors within 50 miles of the station lie in the north-northeast and northeast directions. The 1980 populations in those directions are 1,142,815 and 2,145,518, respectively. the high populations in these sectors is primarily due to the inclusion of the City of Joliet (1980 population 77,956) and a portion of Chicago (1980 population 3,005,072). Also included in this area are some suburbs of Chicago. 1

To obtain the population figures by sector, the U.S. Bureau of
Census data for 1980 were used according to township, and the pop- 1
ulatin density within a township was assumed constant. Thus, the
estimated fractional area of a township within a sector was used to
estimate the fraction of the township's population in that sector;
all fractional townships within a sector were summed to give the
population within that sector.

Population projections were generally made according to the same techniques used for the 0- to 10-mile region, including the sectors within Indiana which have exhibited the same growth patterns as Illinois. The exceptions to this basic population projection model as used for the 10- to 50-mile region are:

a. Newton County, Indiana, whose entirely rural population was assumed to remain constant with time, in accord with census patterns that reveal that no significant increase in rural populations can be anticipated;

b. Chicago, in Cook County, Illinois, whose population has actually experienced a decrease in the last decade and was assumed to remain constant at the 1970 census level; and

c. DuPage County, Illinois, whose townships containing small and continually declining rural populations were assumed to exhibit population growth at the same rate as the county.

The projected national age distribution for the year 2000 (midpoint of station operating life) is 17.5% in the 0 to 11 age group, 11.1% in the 12 to 18 age group, and 71.4% in the 19 and over age group (Bureau of the Census 1975). These percentages correspond to a projected 2000 population of 1,093,384 perions in the 0 to 11 age group, 693,518 persons in the 12 to 18 age group, and 4,461,008 persons in the 19 and over age group within 50 miles of the site. The U.S. projected age distribution was used because the area within a 50-mile radius of the station did not vary significantly from the 1970 U.S. Census age distribution described in Appendix D of Regulatory Guide 4.2 to the 50-mile area, six of the 18 counties within 50 miles differed more than 10% from the 1970 U.S. Census age distribution. However, the other 12 counties did not significantly differ from the U.S. distribution. Since the average age distributions for the 18 counties did not vary more than 10% from the 1970 census age distribution, it can be assumed that the area within a 50-mile radius of the site will have a projected age distribution similar to the U.S. projected age distribution.

The nearest population center is Joliet, located approximately 20
miles north-northeast of the site. According to the 1970 popula-
tion census, Joliet had a population of 80,378, and in 1980, 1

77,956, a decrease of 3.1% during the last decade. Its expected 1
population is 150,389 by 2000, and 181,970 by 2020. The city of
Kankakee, located approximately 20 miles eastsoutheast of the site,
had a 1970 population of 30,944, and in 1980, 30,141, and has an
expected population of 44,800 by 2000, and 55,000 by 2020. Table 1
2.1-4 lists the 25 population centers within 50 miles of the site
and Figure 2.1-10 locates them. Most of these centers are located
near the greater Chicago metropolitan area, 40 to 50 miles north-
east of the site.

Table 2.1-5 lists the distance and approximate direction from the
site of all urban centers (those locations with a population
greater than 2500) within a 30-mile radius of the site and gives
their 1980 populations. It should be noted that there are only 22
such urban centers and that only two of these, Joliet and Kankakee, 1
are population centers.

2.1.2.3 Transient Population

The transient population within 10 miles of the site is composed of visitors to recreational facilities, students enrolled at and teaching staff employed by schools, and employees at industrial establishments.

As shown in Table 2.1-6, the state parks and conservation areas within a 10-mile radius of the site include the Des Plaines Conservation Area approximately 8 miles north of the site, the Goose Lake Prairie State Park approximately 9 miles north-northwest of the site, the Kankakee River State Park approximately 9 miles east of the site, and the Illinois and Michigan Canal State Trail (Channahon Park Access) approximately 10 miles north of the site. In 1976, these four parks had a combined annual attendence of 1,699,722 persons (Illinois Department of Conservation 1976). The estimated peak daily attendances for these areas are respectively 1000, 462, 33,000, and 1000 visitors.

The Des Plaines Conservation Area consists of 4253 acres and offers camping, picnicking, fishing, boating, and hunting (Illinois Department of Conservation 1976). The Goose Lake Prairie State Park consists of 2357 acres of which approximately 1513 acres are dedicated as an Illinois Nature Preserve. The park offers picnicking, hiking, and year-round nature study programs (Illinois Department of Conservation 1974). The Kankakee River State Park consists of 2968 acres extending along the Kankakee River and offers camping, picnicking, fishing, boating, hiking, horse trails, hunting, and a summer nature study program (Illinois Department of Conservation 1974). The Illinois and Michigan Canal State Trail is currently being developed for hiking, bicycling, and canoeing. The

portion of the trail near the Channahon access is now completed and offers camping, canoeing, bicycling, and hiking (Illinois Department of Conservation 1975).

In addition to these state recreational facilities, there are several privately owned recreation areas within 10 miles of the Braidwood Station. Table 2.1-6 lists these recreation areas along with their location, their total membership, and their estimated peak daily attendance. These clubs and parks provide a variety of recreational activities and attract people from outside the 10-mile radius.

The estimated peak daily attendance figures in Table 2.1-6 indicate that on a short-term basis, the population within 10 miles of the station could increase by 51,437 persons due to both state and private facilities. Should all these visitors be from outside the 10-mile radius, the total population within the 10-mile area would increase by 233%.

As listed in Table 2.1-7, there are 10 industries within 10 miles of the station. Approximately 860 persons are employed at these industries. Even if all these people come from outside the 10-mile area, which is highly unlikely, the total population of this area would only increase during working hours by about 3%. 1

As shown in Table 2.1-8, the total of 16 schools within 10 miles of the site had a total 1981-1982 enrollment of 5625 students and a staff of 332 teachers. The great majority of students attending these schools reside within a 10-mile radius of the station. 1

The 1970 and projected population distributions within the 10-mile radius are given in Table 2.1-9. This table includes the residential population and the peak daily transient population resulting from recreational activities within the 10-mile area.

2.1.3 Uses of Adjacent Lands and Waters

2.1.3.1 Land Use

2.1.3.1.1 Land Use within 5 Miles

The area within a 5-mile radius of the station includes land in Will, Kankakee, and Grundy Counties. This area as well as the remainder of Will, Kankakee, and Grundy Counties is predominantly agricultural. According to the 1974 farm statistics in Table 2.1-10, 64.8%, 89.7%, and 82.9% of the total land acreage in Will, Kankakee, and Grundy Counties, respectively, is farmland. The percentage of the total county land under cultivation is: Will County--55.1%, Kankakee County--79.3% and Grundy County--71.1%.

The major crops grown in the three counties are corn and soybeans. Hay, oats, and wheat are also grown in the area. Table 2.1-11 gives the 1974 and 1975 acreage, yield, production, and dollar value of these crops for the three counties and the State of Illinois. In general, Grundy and Kankakee counties were more productive in 1975 than the state average, with the exception of corn yield in Kankakee County, which was slightly less than the state average. In 1975 Will County was less productive than the state average, with the exception of wheat yield, which was slightly higher than the state average. In general, the number of acres devoted to corn and soybeans in the three counties decreased between 1974 and 1975 while the number of acres devoted to wheat, oats, and hay increased.

Corn and soybeans are the major crops grown within a 5-mile radius of the site. A "pick your own" christmas tree, blueberry, and strawberry farm is located approximately 3.5 miles southeast of the station.

TABLE 2.1-2 (Cont'd)

SECTOR DESIGNATION	1980 RADIAL INTERVAL (miles) 0-1	1-2	2-3	3-4	4-5	5-10	0-5	0-10
N	83	806	376	28	3	930	1,296	2,226
NNE	69	720	857	1,098	263	526	3,007	3,533
NE	0	208	137	0	576	5,525	921	6,496
ENE	0	25	25	20	263	1,632	333	1,965
E	0	6	14	25	20	790	65	855
ESE	0	6	17	17	45	216	85	301
SE	0	0	56	129	14	202	199	401
SSE	0	0	112	81	234	377	427	804
S	0	0	0	3	6	1,057	9	1,066
SSW	0	3	6	20	64	954	93	1,047
SW	332	291	191	8	11	1,440	833	2,273
WSW	77	120	183	14	22	154	416	570
W	6	11	58	3	11	786	89	875
WNW	8	0	3	14	11	218	36	254
NW	6	8	14	1,525	598	816	2,151	2,967
NNW	11	257	85	1,568	344	650	2,265	2,915
Sum for Radial Interval	592	2,461	2,134	4,553	2,485	16,323	12,225	28,548
Cumulative Total to Outer Radius	592	3,053	5,187	9,740	12,225	28,548	12,225	28,548
Average Density (persons/mi^2) in Radial Region	188	261	136	207	88	69	156	91

1

TABLE 2.1-2 (Cont'd)

SECTOR DESIGNATION	1990 RADIAL INTERVAL (miles) 0-1	1-2	2-3	3-4	4-5	5-10	0-5	0-10
N	151	865	512	41	0	2,162	1,569	3,731
NNE	56	865	843	1,852	92	605	3,708	4,313
NE	0	34	0	53	70	8,012	157	8,169
ENE	0	24	53	29	485	2,063	591	2,654
E	0	0	29	34	507	1,758	570	2,328
ESE	0	0	41	29	70	287	140	427
SE	0	0	5	29	9	272	43	315
SSE	0	0	0	23	260	476	283	759
S	0	0	0	4	9	186	13	199
SSW	0	0	5	20	10	1,345	35	1,380
SW	128	11	390	65	24	1,984	618	2,602
WSW	230	27	515	44	28	244	844	1,088
W	12	14	62	4	24	487	116	603
WNW	17	4	10	20	34	326	85	411
NW	0	14	38	576	3,974	677	4,602	5,279
NNW	12	575	194	874	215	82	1,870	1,952
Sum for Radial Interval	606	2,433	2,697	3,697	5,811	20,966	15,244	36,210
Cumulative Total to Outer Radius	606	3,039	5,736	9,433	15,244	36,210	15,244	36,210
Average Density (persons/mi^2) in Radial Region	193	258	172	168	206	89	194	115

TABLE 2.1-3 (Cont'd)

SECTOR DESIGNATION	1980 RADIAL INTERVAL (miles) 10-20	20-30	30-40	40-50	0-50	
N	16,510	24,771	168,781	212,544	424,832	
NNE	9,709	115,056	179,879	834,638	1,142,815	
NE	9,646	27,315	352,754	1,749,307	2,145,518	
ENE	6,957	16,437	115,365	207,643	348,367	
E	3,416	10,581	9,982	17,724	42,558	
ESE	22,351	40,484	6,865	4,034	74,035	
SE	3,449	4,806	1,992	9,951	20,599	
SSE	3,500	1,790	5,802	3,461	15,357	
S	2,647	2,041	3,035	3,680	12,469	
SSW	1,234	1,911	6,732	2,325	13,249	
SW	5,201	2,531	13,169	7,730	30,904	
WSW	1,440	2,315	17,867	8,113	30,305	
W	2,687	2,384	4,929	32,021	42,896	
WNW	1,447	9,246	21,354	6,087	38,388	
NW	10,383	6,560	10,006	6,580	36,496	1
NWN	2,736	9,279	23,857	15,037	53,824	
Sum for Radial Interval	103,313	277,507	942,369	3,120,875	4,472,612	
Cumulative Total to Outer Radius	131,861	409,368	1,351,737	4,472,612	4,472,612	
Average Density (persons/me^2) in Radial Region	110	177	429	1,104	570	

TABLE 2.1-3 (Cont'd)

SECTOR DESIGNATION	1990 RADIAL INTERVAL (miles) 10-20	20-30	30-40	40-50	0-50
N	18,941	40,891	256,778	325,592	645,933
NNE	20,808	166,172	353,636	1,468,689	2,013,618
NE	4,445	10,270	736,544	1,334,830	2,094,258
ENE	3,410	14,203	153,646	223,879	397,792
E	5,083	10,010	9,175	12,912	39,508
ESE	14,853	57,467	8,029	3,757	84,533
SE	17,727	5,693	3,843	8,270	35,848
SSE	1,583	2,437	3,7[illegible]6	4,150	12,705
S	1,251	1,449	3,745	3,053	9,697
SSW	1,833	1,466	5,528	5,689	15,896
SW	4,014	2,047	14,022	5,414	28,099
WSW	1,149	3,017	12,211	6,011	23,476
W	1,825	1,790	21,417	31,541	57,176
WNW	2,544	7,923	13,493	3,553	27,924
NW	3,552	3,125	15,503	6,666	34,125
NNW	4,321	8,596	49,849	5,035	69,753
Sum for Radial Interval	107,339	336,556	1,661,195	3,449,041	5,590,341
Cumulative Total to Outer Radius	143,549	480,105	2,141,300	5,590,341	5,590,341
Average Density (persons/mi^2) in Radial Region	114	214	755	1,220	712

TABLE 2.1-3 (Cont'd)

SECTOR DESIGNATION	2020 RADIAL INTERVAL (miles) 10-20	20-30	30-40	40-50	0-50
N	25,210	54,621	412,469	433,144	930,408
NNE	27,178	221,285	531,181	1,812,753	2,597,527
NE	5,916	51,141	1,276,877	1,573,061	2,917,867
ENE	4,536	18,907	203,810	312,156	542,940
E	6,277	12,865	10,710	14,848	47,798
ESE	20,295	83.241	8,466	3,757	116,326
SE	25,114	5,830	6,478	12,978	50,818
SSE	1,741	2,437	3,776	4,460	13,425
S	1,376	1,449	3,745	3,053	9,886
SSW	2,581	1,466	7,712	7,873	21,467
SW	6,221	2,047	20,809	5,414	37,953
WSW	1,529	3,124	15,428	6,039	27,570
W	2,429	1,846	29,179	43,602	77,860
WNW	3,387	9,811	18,051	5,627	37,423
NW	4,710	3,171	19,480	6,678	41,067
NNW	5,618	10,698	65,341	5,035	89,289
Sum for Radial Interval	144,118	483,939	2,633,512	4,250,478	7,559,624
Cumulative Total to Outer Radius	191,695	675,634	3,309,146	7,559,624	7,559,624
Average Density (persons/mi^2) in Radial Region	153	308	1,198	1,503	963

TABLE 2.1-4

POPULATION CENTERS WITHIN 50 MILES OF THE BRAIDWOOD STATION

Population Center	County	Distance & Direction From the Site	1980 Population
Joliet	Will (IL)	20 miles NNE	77,956
Kankakee	Kankakee (IL)	20 miles ESE	30,141
Park Forest	Will & Cook (IL)	32 miles ENE	26,272
Bolingbrook	Will & DuPage (IL)	34 miles NNE	37,261
Tinley Park	Cook (IL)	34 miles NE	26,171
Aurora	Kane (IL)	35 miles N	81,293
Chicago Heights	Cook (IL)	35 miles ENE	37,026
Naperville	DuPage & Will (IL)	37 miles N	42,330
Oak Forest	Cook (IL)	37 miles NE	26,096
Downers Grove	Dupage (IL)	29 miles NNE	42,572
Harvey	Cook (IL)	39 miles NE	35,810
Oak Lawn	Cook (IL)	42 miles NE	60,590
Burbank	Cook (IL)	43 miles NNE	28,462
Lansing	Cook (IL)	43 miles NE	29,039
Wheaton	DuPage (IL)	44 miles N	43,043
Calumet City	Cook (IL)	45 miles NE	39,697
Chicago (part)	Cook (IL)	45 miles NE	3,005,072
Lombard	DuPage (IL)	46 miles NNE	37,295
Hammond	Lake (IN)	47 miles ENE	93,714
Highland	Lake (IN)	47 miles ENE	25,935
Elmhurst	DuPage (IL)	48 miles NNE	44,276
Addison	DuPage (IL)	49 miles NNE	29,759
Berwyn	Cook (IL)	49 miles NNE	48,849
Cicero (part)	Cook (IL)	49 miles NNE	61,232
Maywood	Cook (IL)	49 miles NNE	27,998

1

TABLE 2.1-5

URBAN CENTERS WITHIN 30 MILES OF THE BRAIDWOOD STATION

URBAN CENTER[a]	COUNTY[b]	DISTANCE & DIRECTION FROM THE SITE	1980 POPULATION	
Braidwood	Will	1.5 miles NNE	3,429	
Coal City	Grundy	3.5 miles NW	3,028	
Wilmington	Will	6.0 miles NE	4,424	
Morris	Grundy	13 miles NW	8,833	
Channahon	Will	13 miles N	3,734	
Dwight	Livingston	14 miles SW	4,146	
Bourbonnais	Kankakee	19 miles ESE	13,280	
Bradley	Kankakee	20 miles ESE	11,008	
Joliet	Will	20 miles NNE	77,956	
Kankakee	Kankakee	20 miles ESE	30,141	1
Shorewood	Will	20 miles N	4,714	
Manteno	Kankakee	21 miles E	3,155	
Crest Hill	Will	22 miles NNE	9,252	
Peotone	Will	24 miles ENE	2,832	
New Lenox	Will	24 miles NE	5,792	
Frankfort	Will	26 miles NE	4,357	
Lockport	Will	26 miles NNE	9,170	
Marseilles	LaSalle	26 miles WNW	4,766	
Plainfield	Will	26 miles N	3,767	
Mokena	Will	27 miles NE	4,578	
Romeoville	Will	29 miles NNE	15,519	
Yorkville	Kendall	30 miles NNW	3,422	

[a]An urban center is defined as an incoporated or unincorporated place with a population of over 2500 according to the 1980 census.

[b]All counties are in Illinois.

TABLE 2.1-6

MAJOR RECREATIONAL AREAS WITHIN 10 MILES OF THE BRAIDWOOD STATION

RECREATIONAL AREA	DISTANCE & DIRECTION FROM SITE	1976 TOTAL ATTENDANCE[a]	ESTIMATED PEAK DAY ATTENDANCE
State Facilities			
Des Plaines Conservation Area	8 miles N	92,043	1,000[b]
Goose Lake Prairie State Park	9 miles NNW	60,728	462[c]
Kankakee River State Park	9 miles E	1,447,951	33,000[d]
Illinois and Michigan Canal State Trail (Channahon Park Access)	10 miles N	99,000	800-1000[e]
		TOTAL MEMBERSHIP (families)	
Private Parks and Clubs			
Chicago Beagle Club[f]	0.5 mile SW	75	1,500
Braidwood Recreation Club[g]	2 miles NE	2,350	600
South Wilmington Sportsmen's Club[h]	3 miles SSE	1,750	600
Area 1 Outdoor Club	3.5 miles N	*	*
Wilmington Recreation Area Club	3.5 miles NNE	750	3,000
Ponderosa Sportsmen's Club[i]	4 miles S	207	15-25
South Wilmington Fireman Beach and Park Club[f]	4 miles SSW	1,800	2,100
Will County Sportsmen's Club[i]	4 miles NE	550	800
Fossil Rock Recreation Club	4.5 miles NNE	*	*
CECo Employees Recreation Association, Inc.[k]	5 miles NNW	500	1,000
Coal City Area Club[f]	5 miles NNW	1,600	4,500
Sun Recreation Club	5 miles S	*	*
Shannon Shores	6 miles S	*	*
Dresden Lakes Sports Club (Public)[f]	7 miles NNW	*	350
Rainbow Council Scout Reservation[l]	7 miles NW	6,000	1,000
Goose Lake Club[m]	7.5 miles NNW	736	500

Note: Asterisk (*) indicates information not available.

[a]Source: Illinois Department of Conservation (1976c).

[b]Source: Doyle (1977).

[c]Source: Nyhoff (1977).

[d]Source: Classen (1977).

[e]Source: Schwiesow (1977).

[f]Source: Commonwealth Edison Company (1973).

[g]Source: Chilman (1977).

[h]Source: Dvorak (1977).

[i]Source: Woolwine (1977).

[j]Source: Burdick (1977).

[k]Source: Frrek (1977).

[l]Source: Abert (1577).

[m]Source: Sagliatti (1977).

TABLE 2.1-7

INDUSTRIES WITHIN 10 MILES OF THE BRAIDWOOD STATION

NAME OF FIRM	LOCATION	EMPLOYMENT	PRODUCTS
Baily Printing & Publishing	Coal City[a]	15	Commercial and job printing
Bowers-Siemon Chemicals Co.	Coal City	30	Industrial lubricants and chemicals for wire industry
Coal City Ready Mix	Coal City	8	Ready-mix Cement
DeMert & Dougherty Inc.	Coal City	110-115	Aerosols, etc.
Brownie Special Products Co.	Gardner[b]	50	Pizza crusts
WESCOM, INC.	Gardner	189	Small electronic components
Lindamood Sheet Metal	Wilmington[c]	6	Custom sheet metal ducts and fittings
Earl A. Muser & Co.	Wilmington	under 5	Tools and dies
Personal Products Co. Division of Johnson & Johnson	Wilmington	300-350	Hygienic products
Commonwealth Edison Training Center	Wilmington (RR 2, Essex Rd.)	100	Production training average enrollment 150 trainees

1

Source: Commonwealth Edison Company (1982).

[a]Coal City is 3.5 miles northwest of the station.
[b]Gardner is 5.5 miles southwest of the station.
[c]Wilmington is 6.0 miles northeast of the station.

TABLE 2.1-8

EDUCATION INSTITUTIONS WITHIN 10 MILES OF THE BRAIDWOOD STATION

INSTITUTIONS	DISTANCE AND DIRECTION FROM SITE	GRADES	ENROLLMENT 1981-1982	STAFF 1981-1982
Braidwood, Illinois				
Braidwood Elementary and Middle School	1.4 miles NNE	K-8	712	37
Reed Custer High	1.4 miles NNE	9-12	365	23
Braceville, Illinois				
Braceville Elementary	2.0 miles SW	K-8	164	11
Coal City, Illinois				
Coal City Elementary	3.5 miles NW	K-5	742	42
Coal City High	3.5 miles NW	9-12	471	32
Coal City Middle	3.5 miles NW	6-8	369	24
Essex, Illinois				
Essex Elementary	5.0 miles SSE	1-5	75	4
South Wilmington, Illinois				
South Wilmington Consolidated Elementary	5.2 miles SSW	K-8	114	7
Gardner, Illinois				
Gardner Elementary	5.3 miles SW	K-8	256	13
Gardner-South Wilmington Township High School	5.3 miles SW	9-12	264	20
Custer Park, Illinois				
Custer Park Elementary	5.3 miles E	K-8	172	13
Wilmington, Illinois				
Bruning Elementary	6.0 miles NE	K-5	287	13
L. J. Stevens Middle	6.0 miles NE	6-8	390	24
Wilmington High	6.1 miles NE	9-12	556	35
St. Rose School[a]	6.2 miles NE	1-8	222	12
Booth Central Elementary	6.3 miles NE	K-5	466	22

1

Source: Illinois State Board of Education (1982).

[a]Source: Florella (1982).

1

TABLE 2.1-31

REPORTED CATCH OF FISH TAKEN FROM NAVIGATION POOLS OF THE ILLINOIS RIVER WITHIN 50 MILES DOWNSTREAM FROM THE SITE BY COMMERCIAL FISHERMEN

SPECIES	STARVED ROCK POOL[a] 1973	1974	PEORIA POOL (lb) 1973[b]	1974[c]
Carp	-	-	10,310	53,832
Buffalo	-	-	10,098	140,159
Drum	-	-		219
Catfish	-	-		21,313
Bullheads	-	-	5,796	21,237
Paddlefish	-	-		15,200
TOTAL	-	-	26,204	251,960

[a] Not fished commercially in 1973 or 1974.

[b] Source: Illinois Department of Conservation, Fisheries Division (1973).

[c] Source: Illinois Department of Conservation, Fisheries Division (1974).

TABLE 2.1-32
INDUSTRIAL INTAKES WITHIN 50 RADIAL MILES DOWNSTREAM FROM THE BRAIDWOOD STATION

INDUSTRY AND WATER SOURCE	APPROXIMATE RADIAL DISTANCE (MILES) AND DIRECTION FROM THE SITE TO THE INDUSTRY	APPROXIMATE RIVER MILE DISTANCE FROM THE SITE TO THE INTAKE AND DISCHARGE POINTS	AVERAGE WITHDRAWAL RATE (gpm)	AVERAGE RETURN RATE (gpm)	WATER USAGE
Joliet Army Ammunition Plant[a,b] (Kankakee River)	8 NE	13	2,083	1,666	Industrial
Dresden Station Units 1, 2, & 3[c] (intake-Kankakee River discharge-Illinois River)	11 NNW	intake - 14 discharge - 15	232,000	216,006	Industrial
Reichold Chemicals Inc.[d] (Illinois River)	12 NNW	17	160	104	Industrial
Collins Generating Station[e] (Illinois River)	13 NW	discharge - 19 intake - 21	37,000	25,400	Industrial
Becker Industries[f] (Illinois River)	23 WNW	37	1,389	1,389	Industrial
LaSalle County Station Units 1 & 2[g] (Illinois River)	25 W	37	41,517	22,935	Industrial
Kaiser Agricultural Chemicals[h,i] (Illinois River)	24 WNW	38	12,000	12,000	Industrial
National Biscuit Co.[j] (Illinois River)	26 WNW	40	214	75	Industrial
Marseilles Hydroelectric Plant[k] (Illinois River)	26 WNW	40	Negligible	Negligible	Industrial
Westclox Corporation[l] (Illinois River)	48 W	64	300	150	Industrial Sanitary

[a]Intake not currently being used because of standby status of plant.

[b]Source: Forsyth (1977).

[c]Source: U.S. Atomic Energy Commission (1973).

[d]Source: Basil (1977).

[e]Source: U.S. Army Corps of Engineers (1974).

[f]Source: Drill (1977).

[g]Source: Commonwealth Edison Company (1977b).

[h]Source: Kelly (1983).

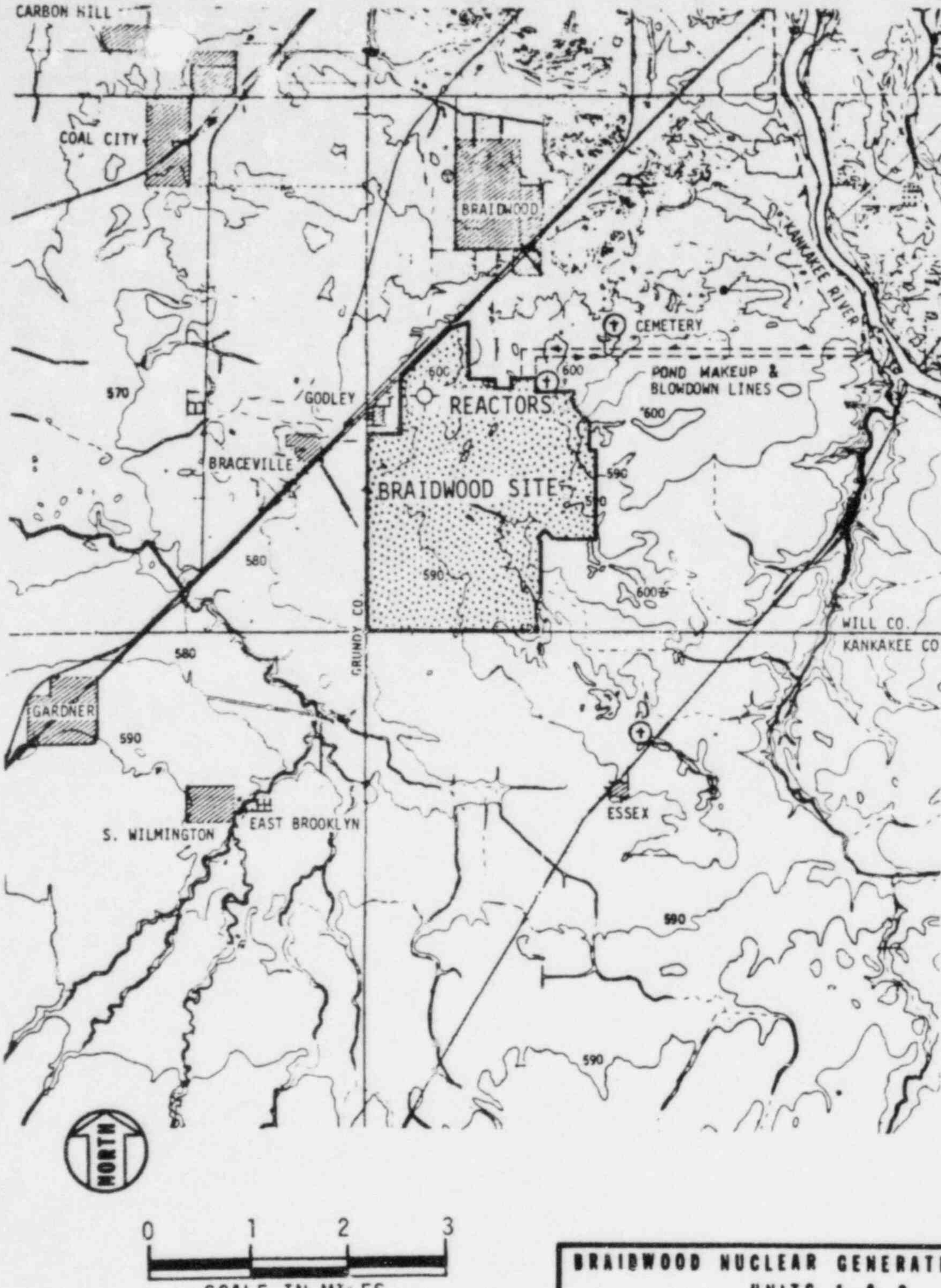
[i]River water purification system deactivated.

[j]Source: Burton (1977).

[k]Source: Walden (1976).

[l]Source: Renkosik (1977).

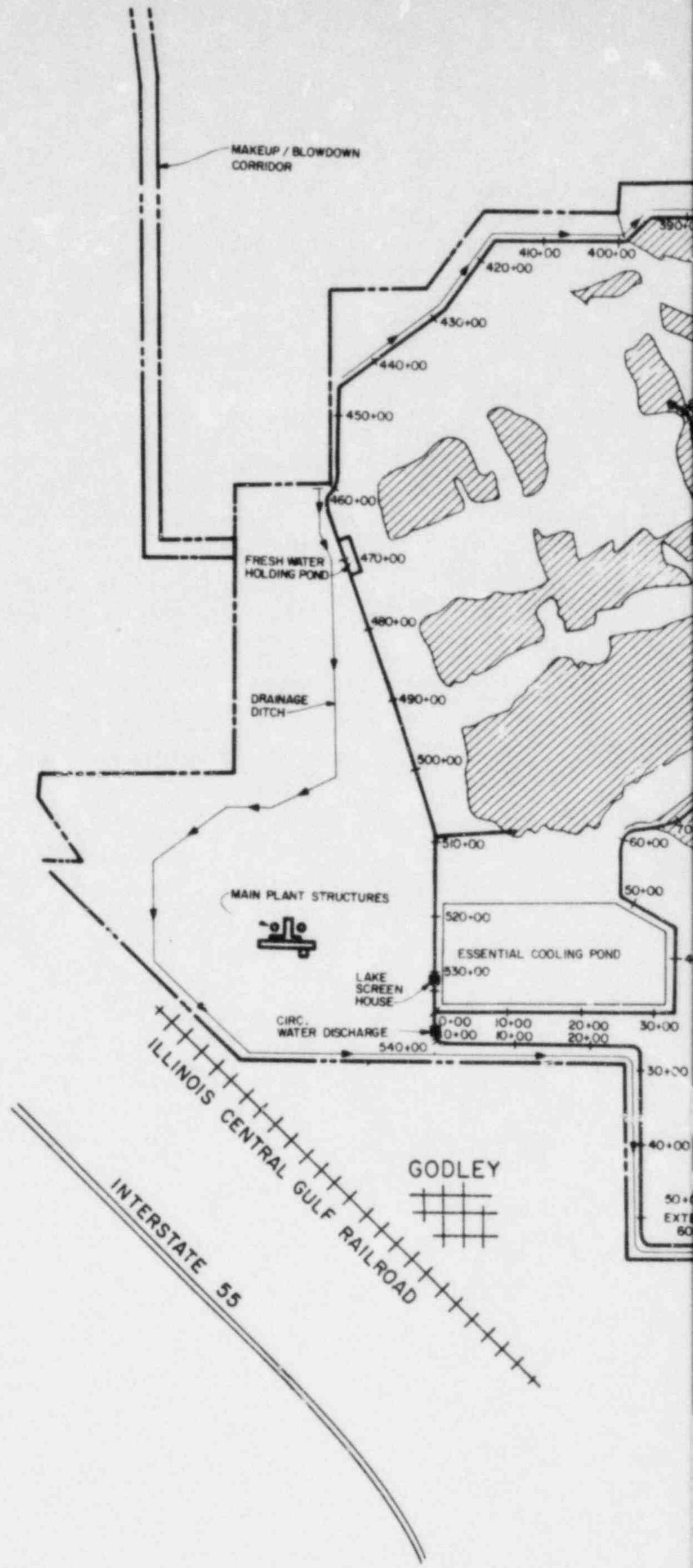
AMENDMENT 1
FEBRUARY 1983

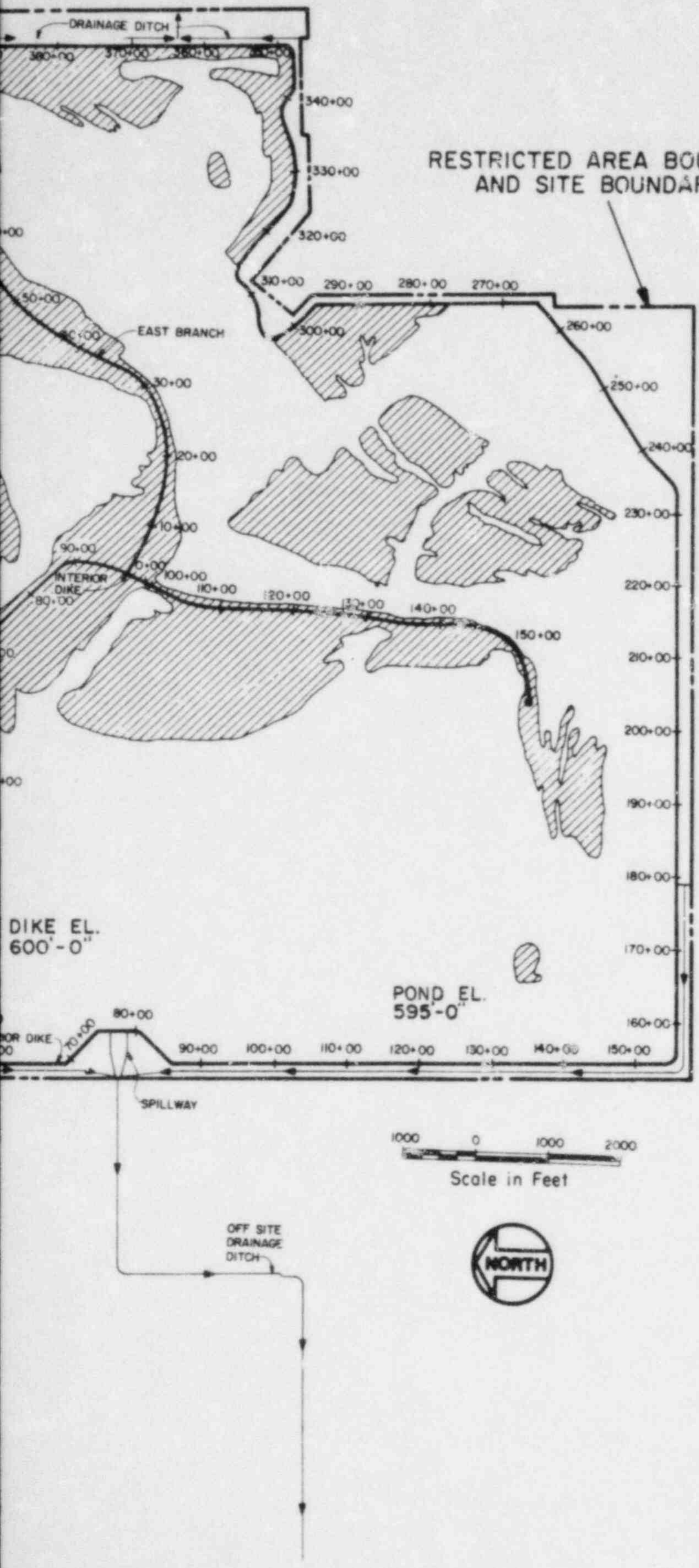


BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

FIGURE 2.1-2

LOCATION OF SITE IN RELATION TO
KANKAKEE RIVER AND COUNTY BOUNDARIES

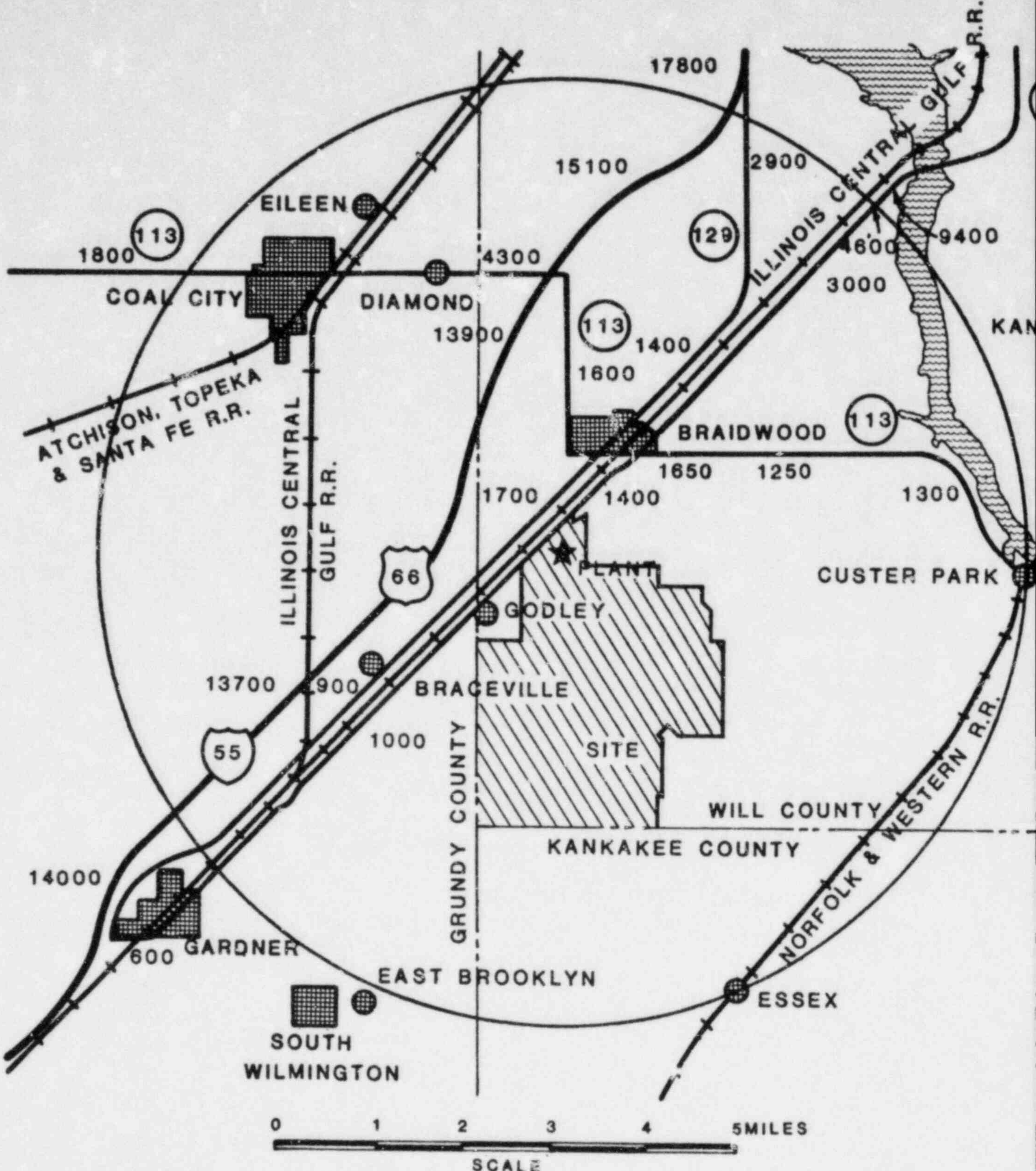

MAKEUP / BLOWDOWN CORRIDOR
410+00
400+00
420+00
430+00
440+00
450+00
460+00
470+00
FRESH WATER HOLDING POND
480+00
DRAINAGE DITCH
490+00
500+00
510+00
60+00
50+00
MAIN PLANT STRUCTURES
520+00
ESSENTIAL COOLING POND
LAKE SCREEN HOUSE
530+00
CIRC. WATER DISCHARGE
540+00
10+00
20+00
30+00
40+00
GODLEY
ILLINOIS CENTRAL GULF RAILROAD
INTERSTATE 55



BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

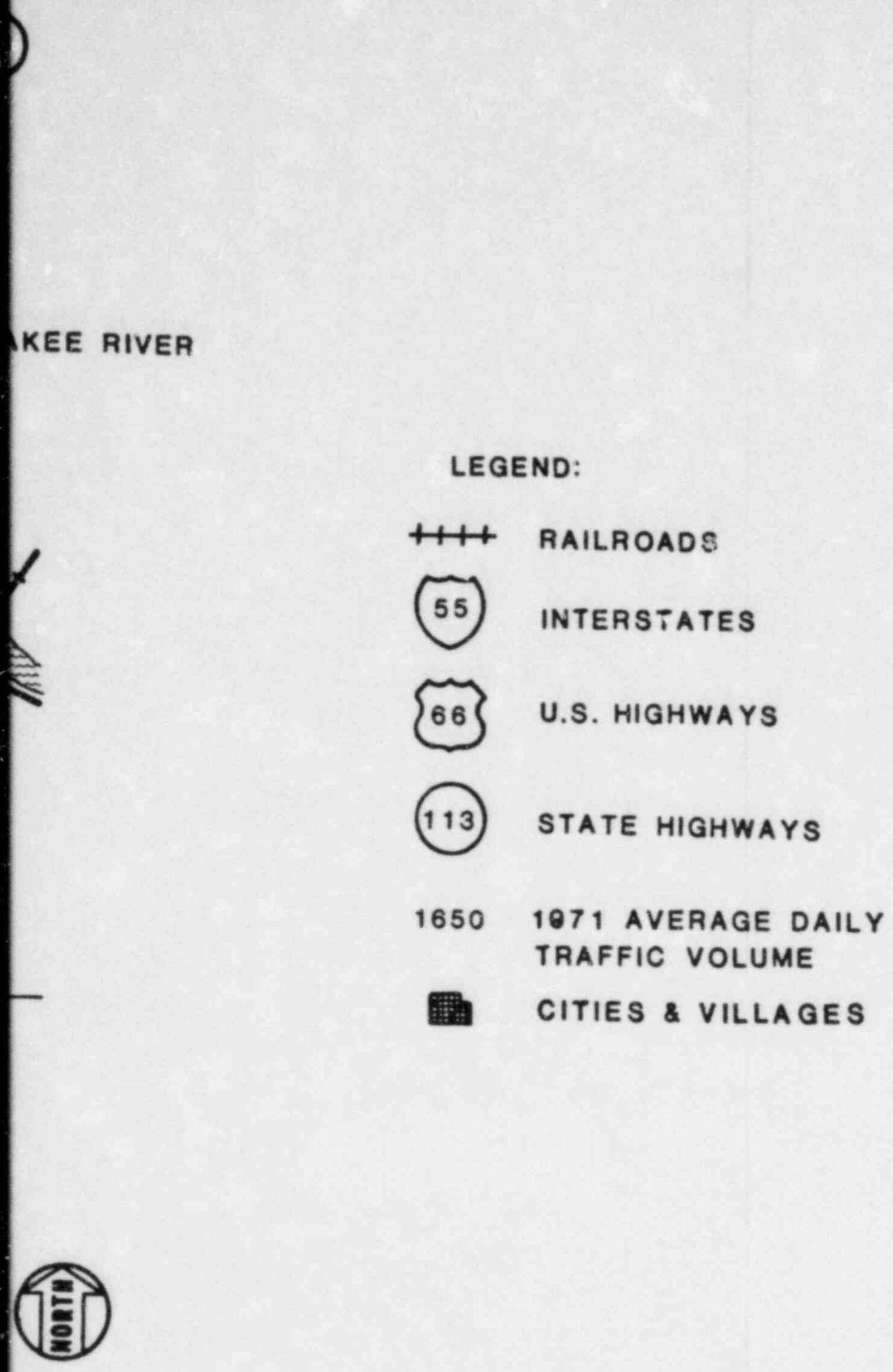
FIGURE 2.1-3

SITE BOUNDARY, RESTRICTED AREA
BOUNDARY, AND COOLING POND



17800
15100
2900
EILEEN
113
1800
129
ILLINOIS CENTRAL GULF R.R.
4300
9400
1600
3000
COAL CITY
DIAMOND
113
13900
1400
1600
ATCHISON, TOPEKA & SANTA FE R.R.
ILLINOIS CENTRAL GULF R.R.
113
BRAIDWOOD
1650
1250
1700
1400
1300
66
PLANT
CUSTER PARK
GODLEY
13700
900
BRACEVILLE
1000
55
SITE
GRUNDY COUNTY
WILL COUNTY
KANKAKEE COUNTY
NORFOLK & WESTERN R.R.
14000
600
GARDNER
EAST BROOKLYN
ESSEX
SOUTH WILMINGTON
0
1
2
3
4
5MILES
SCALE

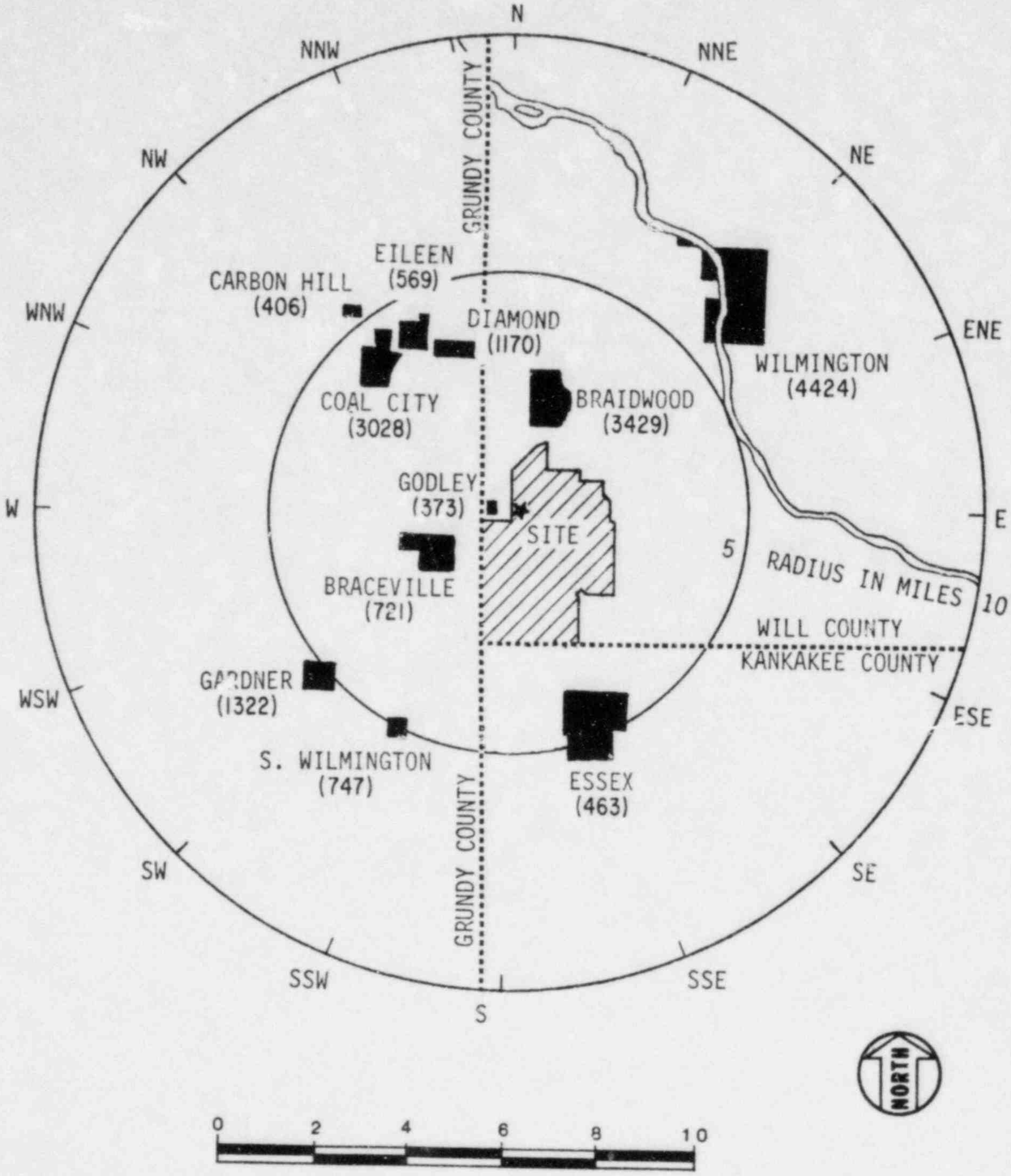
AMENDMENT 1
FEBRUARY 1983



BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

FIGURE 2.1-6

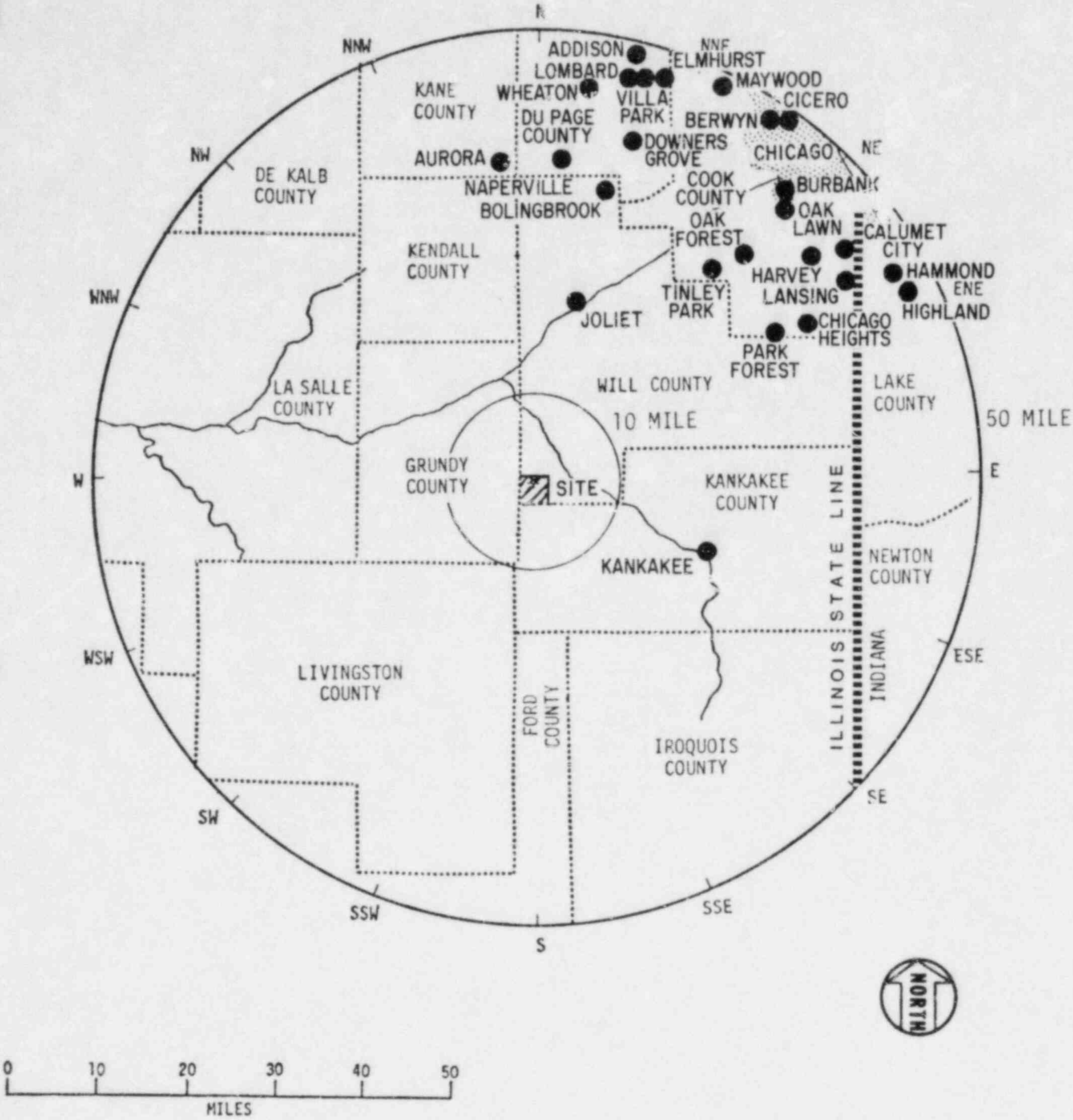
MAJOR ROADS AND RAILROADS
WITHIN 5 MILES OF THE STATION



( ) INDICATES 1980 CENSUS POPULATION

BRAIDWOOD NUCLEAR GENERATING STATION UNITS 1 & 2 ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE
FIGURE 2.1-8 CITIES AND VILLAGES LOCATED WITHIN 10 MILES OF THE STATION

AMENDMENT 1
FEBRUARY 1983



BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

FIGURE 2.1-10

POPULATION CENTERS LOCATED WITHIN 50 MILES OF THE STATION

estimates indicated the presence of relatively large numbers of fish at mid-stream above Transect 3. This mid-stream concentration of fish may have, in part, accounted for the low fish numbers encountered in the near-shore regions of the river.

Population estimates based on the total number of fish captured and recaptured were relatively low when compared with the total number of fish collected during the survey. Although the total number of fish marked and recaptured using this technique does not necessarily have to be large (Ricker 1958), the obvious lack of sufficient numbers of marked and recaptured fish made the results less reliable.

2.2.1.11.4 Select Species

Age, growth, food habits, parasites, and condition factors of rock bass, longear sunfish, smallmouth bass, largemouth bass, and white crappie from the Kankakee River and Horse Creek were studied in 1974. The growth rates of these fish varied from fair to good when compared with those of other fish populations described in literature. Also, except in the case of white crappie, they had relatively higher condition factors (see Table 2.2-49). Annual increments in length varied from year to year. The majority of fish seemed to be growing well in 1974.

Select fish species of the Kankakee River and Horse Creek fed on a wide assortment of aquatic invertebrates and, in several cases, on minnows and other fish (see Figures 2.2-24 through 2.2-27). Aquatic invertebrates were available in the study area throughout the study period. Some invertebrate species were fed upon selectively. In several cases, the changing feeding habits of fish with the season was largely attributed to the seasonal fluctuation of the benthic community.

Fish collected from the Kankakee River and Horse Creek were subject to parasitic infections. The degree of infection varied among species. Parasitic effects were not severe, as indicated by the growth patterns and condition factors (see Table 2.2-50). In several cases fish were shown to host more than one species of parasite at one time. The parasitic organisms encountered in the study area were mostly trematodes (flukes).

2.2.1.11.5 Eggs and Larvae

Fish eggs are commonly classified as being buoyant, semi-buoyant, or demersal (on the bottom) (Ricker 1971). The collection of eggs and larvae during the survey was done using surface and bottom plankton net tows and bottom pumping. These collection methods were used so that the three types of eggs would be represented in the sampling. Eggs collected by plankton nets are most likely buoyant or semi-buoyant, and those collected by bottom pumping are primarily demersal. A limiting or complicating factor in the assessment of fish eggs and larvae in any area is that eggs and larvae may be concentrated in spawning

areas rather than widely distributed. The collection of adequate numbers of demersal eggs using traditional collecting methods was difficult, and the movement of fish between different bodies of water (such as the Kankakee River and Horse Creek) made it almost impossible to define population boundaries during breeding periods.

Fish eggs and larvae were collected during the first sampling period (May 2, 1974) at Transect 3, which indicates that spring spawning had already occurred by this time (see Table 2.2-51). Larvae were collected at Transect 3 as late as June 27, 1974. Thus, the spring spawning period started before May 2 and extended beyond mid-June 1974. Larvae collected during the first part of the sampling probably belonged to early spring spawners, whereas eggs and larvae collected in the latter part of the survey were from early summer spawners.

It is known that different fish species have different temperatures that induce spawning. For example, the spawning temperatures for rock bass, longear sunfish, and smallmouth bass have been reported to be 20° to 21° C, 24° to 30° C, and 13° to 21° C, respectively (Scott and Crossman 1973). It was therefore not unusual that fish eggs and larvae were collected throughout the sampling period.

Bottom plankton tows and bottom pumping produced a small number of eggs (15) and larvae (54); none were collected using surface plankton tows. The number of eggs and larvae collected per cubic meter of water at each sampling location is presented in Table 2.2-51. Although some larvae were collected at each transect, no eggs were obtained from Transects 2 and 5 during the entire sampling period (see Table 2.2-51).

More eggs and larvae were collected from Horse Creek (Transect 4) during May 1974 than at all the Kankakee River transects (Transects 2, 3, and 5) combined, which suggests that spawning was more intensive in Horse Creek in May 1974 than in the Kankakee River at this time. Conditions in Horse Creek appear to be more ecologically favorable for early spawning than the Kankakee River conditions. Horse Creek is shallow (mean depth of 4.6 feet), having relatively warm water (ranging between 2.8° and 24.2° C during March through June) and low flow. Fish movements between the creek and the river were suggested from the observations made during the 1974 through 1975 study. Both the creek and some areas of the river appear to provide nursery grounds for eggs and larvae.

2.2.2 Terrestrial Environment

2.2.2.1 Introduction

The 4454 acres of the Braidwood site included 1021 acres of cultivated fields, 471 acres of fallow fields, 395 acres of open woodlands, and 2567 acres of strip-mine spoil. The ecology of 1

each of these areas is quite distinct. The unmined areas are affected by past agricultural practices and soil types. The mined areas are affected by the acidity and texture of the surface material, slope, ridge heights, and the amount of time elasped since mining occurred. The type of reclamation practiced also affects strip-mined areas.

The flora and fauna observed during the baseline survey and their interactions were summarized by indicating their relative positions within a generalized food web for the Braidwood site (see Figure 2.2-28). This food web schematic considered the site as a whole without distinguishing between the various habitats sampled. It indicates general relationships between vegetation, herbivores, omnivores, insectivores, and carnivores found on the site. Species grouped within boxes are generally similar in food preference, but a broad range of nutrient options may be represented. Although human beings are not included, it should be recognized that they are not only an omnivore in the web, but that they also influence the web by their effects on the habitat of the individual species.

Initial ecological studies at the Braidwood site began in the fall of 1972 and continued on a seasonal basis during the winter, spring, and summer of 1973. The results and projections of the construction inpact concluded from these studies for the fall, winter, and spring surveys are included in Subsections 2.7.1 and 4.1.5 of the Braidwood Station Environmental Report - Construction Permit Stage (ER-CPS). The impact was assessed in the ER-CPS and the Braidwood Final Environmental Statement (FES). The summer 1973 survey confirmed the minimal environmental impact as described in both the ER-CPS and FES.

To augment the initial (1972 through 1973) baseline study, a program was designed for the 1974 through 1975 period. The results and conclusions presented in the 1974 through 1975 Final Terrestrial Monitoring Report further support the impact assessment presented in both the ER-CPS and the FES. The information obtained during these 2 years of baseline monitoring is summarized in the following subsections.

2.2.2.2 Objectives of the 1972 through 1973 Baseline Survey

The major objectives of the terrestrial baseline study (1972 through 1973) were as follows:

a. to record and describe "important" species of flora and fauna in the site area during all four seasons of the year;

b. to provide baseline data that could be used to develop a monitoring program for detecting impacts of plant construction and operation on the environment;

c. to delineate the different types of habitats near the Braidwood site environs;

d. to determine the ecological relationships between the biotic and abiotic parameters present; and

e. to offer recommendations concerning effects of construction on any "unique or unusual" plants or animals found within zones of direct impact.

2.2.2.3 Objectives of the 1974 through 1975 Baseline Survey

The six major study objectives of the terrestrial baseline study (1974 through 1975) were the following:

a. to document existing biota in recently purchased areas that were not evaluated during baseline surveys;

b. to evaluate the biotic components of areas that will be subject to construction activity for station and switchyard facilities;

c. to observe annual fluctuation in the biological density represented within the site;

d. to expand the biological data base for predicting impacts associated within the site;

e. to provide background data for the initiation of a specific program to evaluate the impact of site development on migratory waterfowl; and

f. to identify significant parameters to be measured or monitored in later studies to provide continuing estimates of real and potential impacts.

2.2.2.4 Summary of the 1972 through 1973 Baseline Survey

The following results were based on the field baseline studies conducted from the fall of 1972 through the summer of 1973 in the environs of the Braidwood site.

a. The 4454 acre Braidwood site included 1021 acres of cultivated fields, 471 acres of fallow fields, 395 acres of open woodlands, and 2567 acres of strip-mine spoil. 1

b. The climax community for the site was primarily tall-grass prairie with some areas of deciduous forest. There are now, however, no climax communities remaining within the site boundaries, and all of the unmanaged natural communities are in some stage of succession toward climax. Plant diversity was

Long-term joint frequency distributions of wind direction and wind speed for each Pasquill stability class at Peoria (1966-1975) are summarized in Table 2.3-30.

2.3.5.4 Inversions and High Air Pollution Potential

The 13 years of data (1952-1964) on vertical temperature gradients from Argonne (Moses and Bogner 1967) provide a measure of thermodynamic stability, or mixing potential. Weather records from many stations in United States have also been analyzed with the objective of characterizing atmospheric dispersion potential (Hosler 1961; Holzworth 1972).

The seasonal frequencies of inversions based below 500 feet for the Braidwood Station area are shown by Hosler as follows:

Season	Inversions Below 500 Feet: Percentage of Total Hours	Inversions Below 500 Feet: Percentage of 24-Hour Periods With at Least One Hour of Inversion
Spring	30	63
Summer	31	81
Fall	38	72
Winter	28	48

1

Since northern Illinois has a primarily continental climate, inversion frequencies are closely related to the diurnal cycle. The less frequent occurrence of storms in summer produces a larger frequency of nights with short-duration inversion conditions.

Holzworth's data give estimates of the average depth of vigorous vertical mixing, which give an indication of the vertical depth of atmosphere available for mixing and dispersion of effluents. For the Braidwood Station region, the seasonal values of the mean daily mixing depths (in meters) are as follows:

Season	Mean Daily Mixing Depths: Morning	Mean Daily Mixing Depths: Afternoon
Spring	480	1500
Summer	320	1600
Fall	400	1200
Winter	470	610

When daytime (maximum) mixing depths are shallow, pollution potential is highest.

The following list presents Argonne data on the frequency of inversion conditions in the 5.5- to 144-foot layer above the ground expressed as a percentage of the total observations, and on the average duration of inversion conditions:

Month	Inversion Frequency	First Hour	Final Hour
Jan.	30.5%	5 p.m.	8 a.m.
Apr.	33.1%	6 p.m.	6 a.m.
Jul.	42.4%	6 p.m.	6 a.m.
Oct.	48.4%	5 p.m.	7 a.m.

Nocturnal inversions begin at dusk and normally continue until daylight the next day. The inversion frequency for January at Argonne compares well with Hosler's winter value, and the fall season shows a maximum in both Argonne and Hosler's data. Fall also has the longest period of inversion conditions.

Holzworth has also presented statistics on the frequency of episodes of high air-pollution potential, as indicated by low mixing depth and light winds (Holzworth 1972). His data indicate that, during the 5-year period from 1960 through 1964, the region including the Braidwood Station experienced no episodes of 2 days or longer with mixing depths less than 500 meters and winds less than 2 meters per second. There were two such episodes with winds remaining less than 4 meters per second. For mixing heights less than 1000 meters and winds less than 4 meters per second, there were about nine episodes in the 5-year period lasting 2 days or more, but no episodes lasting 5 days or more. Holzworth's data indicate that northern Illinois is in a relatively favorable dispersion regime with respect to the low frequency of extended periods of high air-pollution potential.

2.3.5.5 Topographical Description

Figure 2.3-22 is a topographic map showing the area surrounding the Braidwood Station. Figures 2.3-23 and 2.3-24 show topographic cross sections in each of the 16 compass-point directions radiating from the site. It can be seen that the station, at an elevation of approximately 600 feet above mean sea level (MSL) is at one of the highest points within a 5-mile radius. The lowest points within 5 miles of the site are about 550 feet above MSL. Terrain in the vicinity of the Braidwood Station falls off except in the northeast clockwise through the south-southeast directions (see Figure 2.3-24). The slope from the station site to the lower points is gradual.

2.4 HYDROLOGY

2.4.1 Surface Water Hydrology

2.4.1.1 Site

The site for the Braidwood Nuclear Generating Station - Units 1 & 2 (Braidwood Station) is about [illegible]s southwest of the town of Custer Park, which is on the Ka[illegible] River. It is in a strip-mined region characterized by many water-filled trenches and ponds. Cooling water for the station is supplied by a cooling pond that covers one of the strip-mined areas. The pond has a normal pool elevation of 595 feet above mean sea level (MSL) with a surface area of 2537 acres or 3.96 square miles. The water surface area constitutes 75% of the pond's total drainage area of 5.3 square miles. The pond is contained by dikes that all have a top elevation of 600 feet MSL except for one part of the dike just south of the station, which has a top elevation of 602.5 feet MSL. The station grade elevation is 600.0 feet MSL. Site characteristics and changes to existing drainage features are shown in Figure 2.4-1. 1

Granary Creek joins the Mazon River 1 mile southwest of the site, and about 4 miles south of the station facilities at the north end of the pond. Crane Creek is a tributary of Granary Creek. Both creeks have an intermittent water flow. According to records for watersheds of similar configuration in the region (U.S. Geological Survey [USGS] 1961-1976), the average annual flow is 0.73 cubic feet per second (cfs) per square mile, or about 38 cfs for both creeks at the Kankakee-Grundy county line. The estimated 100-year peak discharge is 3200 cfs at the same location. Figure 2.4-2 shows the drainage area of Crane and Granary creeks.

Horse Creek lies 2.5 miles east of the site at its closest point. It has a drainage area of 148 square miles at its point of discharge to the Kankakee River at Custer Park. The creek's average annual flow is about 110 cfs, and its 100-year flood peak is approximately 9200 cfs at its junction with the Kankakee River.

The Mazon River lies 5 miles west of the north end of the site. A tributary of the Illinois River, the Mazon River has a drainage area of about 220 square miles at Mazon, 2 miles west of the site. The average annual flow at the gauge is approximately 134 cfs. The estimated 100-year flood peak is 13,600 cfs.

2.4.1.2 Kankakee River Basin Characteristics

The Braidwood Station is on a low ridge southwest of the Kankakee River and east of the Mazon River. The Kankakee River joins the Des Plaines River about 10 miles directly north of the site to form the Illinois River at river mile 273. The Mazon River flows into the Illinois River at river mile 264. There are no ponds or

lakes in the region except for the ponded water in the strip-mined areas around Braidwood and Godley.

The Kankakee River rises near South Bend, Indiana, and flows southwestward 111 miles to Aroma Park, Illinois, where it is joined by its largest tributary, the Iroquois River. The Kankakee River watershed is shown in Figure 2.4-3. The Kankakee then flows northwestward 38 miles to join with the Des Plaines River. The Kankakee basin is 130 miles long and 70 miles wide at its widest point. The Kankakee River drains 5280 square miles, 2155 in Illinois and 3125 in Indiana. The maximum relief in the basin is 375 feet MSL between the mouth of the river and the high point of the drainage divide near Valparaiso, Indiana. Low ridges of glacial origin define most of the drainage divide. Within Illinois, the Kankakee River is 59 miles long, and has widths ranging from 200 to 800 feet and depths ranging from 1 to 15 feet. The total fall from the state line to the river mouth is 127 feet. Channel slopes vary from less than 0.5 foot per mile to over 4 feet per mile. The channel slope in the site area is approximately 2 feet per mile. Most of the riverbed in Illinois is on or near bedrock. Relatively thin layers of sand and gravel overlie the bedrock with some small areas of silt.

There are two dams on the Kankakee River. One dam is at Wilmington, about 4 miles downstream from the intake point; the other dam is at Kankakee, about 15 miles upstream of the intake point.

The Wilmington dam is 11 feet high and forms a pool 2 miles long. The Kankakee dam is 12 feet high and forms a pool 6 miles long. Both dams are constructed of solid concrete on bedrock. Neither dam is used for power production now although both dams were used for power generation at one time. There are no other control structures on the streams in the Braidwood Station vicinity (Barker et al. 1967).

The Kankakee River flow is gauged near Wilmington, 8.78 miles downstream from the Braidwood Station's withdrawal point and 5.5 miles upstream of the river mouth; the drainage area at the gauge is 5150 square miles (USGS 1961-1976). The average flow rate for the Kankakee River at the intake is 3952 cfs. The corresponding elevation is 538 feet MSL and the average river velocity is 2.1 feet per second (fps).

Figure 2.4-4 is a bathymetric chart of the Kankakee River in the area of the Braidwood Station's intake and discharge structures. The data that were used to construct the bottom profiles shown in the figure were obtained from a hydrographic survey conducted by the Illinois Division of Water Resources Management (IDWRM) in April 1970 (Pitkin 1973). The IDWRM study covered a 10-mile section of the Kankakee River above Wilmington, Illinois; Figure 2.4-4 shows 7000 feet of that 10 miles.

TABLE 2.4-14

QUALITY OF GROUNDWATER IN THE GLACIAL DRIFT

(all Values except pH are in mg/liter)

PARAMETER	MAXIMUM CONCEN-TRATION	MINIMUM CONCEN-TRATION	AVERAGE CONCEN-TRATION[a]
pH	8.5	7.3	7.8
Arsenic (total)	0.036	0.001	0.005
Boron (soluble)	1.7	0.2	0.2
Calcium (soluble)	60	21	38
Chloride	6	0.02	2.7
Iron (soluble)	1.11	0.02	0.11
Iron (total)	24.0	0.04	1.2
Magnesium (soluble)	19	7	13
Sulfate	80	13	36
Total Alkalinity (as $CaCO_3$)	176	52	106
Total Dissolved Solids	296	106	192
Total Hardness (as $CaCO_3$)	218	80	146
Total Suspended Solids	457	2	43

Note: Samples were collected from each of eight observation wells around the main plant excavation beginning January 15, 1976. The locations of the observation wells are shown on Figure 2.4-12. Installation details of a typical observation well are shown on Figure 2.4-21.

[a]Values represent an average of 15 tests from each observation well.

TABLE 2.4-15

PUBLIC GROUNDWATER SUPPLIES WITHIN 10 MILES OF THE BRAIDWOOD STATION

PUBLIC WATER SUPPLY[a]	LOCATION (T, R, Sec.)[b]	DISTANCE FROM SITE (miles)	WELL NO.	DATE DRILLED	TOTAL DEPTH (feet)	LOWEST HYDROGELOGIC UNIT PENETRATED	ELEVATION OF POTENTIOMETRIC SURFACE (feet MSL/date)	AVERAGE DAILY USE IN 1979 (gpd)	REMARKS
Braceville	32N, 8E, 26.1f	2.2	1	1963	868	Glenwood-St. Peter sandstone	355/1966; 425/1975	50,000	
Braidwood	32N, 9E, 8.5c	1.6	1	1936	1050	Prairie du Chien dolomites	315/1966; 293/1971; 265/1976		
	32N, 9E, 8.5d	1.7	2	1967	846	Glenwood-St. Peter sandstone	353/1967; 320/1971; 282/1976	340,000	
Carbon Hill	32N, 8E, 34.6f	5.2	2	1942	650	Glenwood-St. Peter sandstone	380 (est.)/1970		Well no. 1 was abandoned in 1962
	32N, 8E, 34.6f	5.2	3	1966	800	Glenwood-St. Peter sandstone	355 (est.)/1975	25,000 (est.)	
Coal City	32N, 8E, 2.8e	3.8	3	1937	360	Shallow Dolomite Aquifers	393/1967		
	32N, 8E, 3.1e	3.8	4	1969	793	Glenwood-St. Peter sandstone	307/1975		
	33N, 8E, 34.1d	3.8	5	1978	1785	Mt. Simon	560/1978	456,000	
Diamond	32N, 8E, 36.5a	3.4	1	1959	723	Glenwood-St. Peter sandstone	400/1966; 370/1971 370/1972		
	32N, 8E, 36.4b	3.4	2	1979	850	Glenwood-St. Peter sandstone	562/1979	70,000 (est.)	
Eileen	32N, 8E, 35.3a	3.8	1	1962	700	Glenwood-St. Peter sandstone	320/1975	60,000 (est.)	
Gardner	31N, 8E, 4.1a	5.5	1	1939	173	Pennsylvanian Aquitard (dolomite)	548/1976		
	31N, 8E, 4.4b	5.7	2	1944	161	Pennsylvanian Aquitard (dolomite)	553/1975		
	31N, 8E, 4.2b	5.5	3	1925	972	Glenwood-St. Peter sandstone	265/1976		
	31N, 8E, 4.1e	5.5	4	1968	1933	Mt. Simon Sandstone	423/1965; 419/1971; 382/1976	110,000[d]	

TABLE 2.4-15 (Cont'd)

PUBLIC WATER SUPPLY[a]	LOCATION (T, R, Sec.)[b]	DISTANCE FROM SITE (miles)	WELL NO.	DATE DRILLED	TOTAL DEPTH (feet)	LOWEST HYDROGELOGIC UNIT PENETRATED	ELEVATION OF POTENTIOMETRIC SURFACE (feet MSL/date)	AVERAGE DAILY USE IN 1979 (gpd)	REMARKS
Lakewood Shores (subdivision)	32N, 9E, 1.7f	5.3	1	1953	700	Glenwood-St. Peter sandstone	NA		
	32N, 9E, 1.7b	5.1	2	before	NA	Dolomite (formation unknown)	NA		
	32N, 9E, 1.6e	5.3	3	before 1953	120	Dolomite (formation unknown)	NA		
	32N, 9E, 1.6d	5.3	4	1961	700	Glenwood-St. Peter sandstone	NA	70,800 (est.)	
Mazon	32N, 7E, 23.7h	8.7	2	1948	26	Glacial Drift Aquifers	566.5(est.)/1971		
	32N, 7E, 23.7h	8.7	5	1963	27	Glacial Drift Aquifers	568 (est)/1971		
	32N, 7E, 23.7h	8.7	6	1974	NA	Glacial Drift Aquifers	NA		
	32N, 7E, 23.7h	8.7	7	1978	27.5	Glacial Drift Aquifers	575/1978		
	32N, 7E, 23.7h	8.7	8	1978	26	Glacial Drift Aquifers	575/1978		
	32N, 7E, 23.7h	8.7	9	1979	26	Glacial Drift Aquifers	575/1979	108,000	
Reddick	30N, 9E, 6.8a	10.3	1	1954	1188	Glenwood-St. Peter sandstone	439/1966, 402/1971 407/1975	14,500	
South Wilmington	31N, 8E, 11.6b	5.4	1	1913	22	Glacial Drift Aquifers	NA		Standby; well no. 2 was abandoned.
	31N, 8E, 11.6b	5.4	3	1950	970	Glenwood-St. Peter sandstone	473/1966; 334/1967; 337/1970; 322/1973		
	31N, 8E, 11.6a	5.4	4	1966	970	Glenwood-St. Peter sandstone	320/1966; 344/1970;	113,000[d]	
Wilmington	33N, 9E, 25.6b	6.3	2	1936	1566	Ironton-Galesville sandstone	326/1966; 295/1968; 289/1971; 227/1975		Well no. 1 was abandoned.
	33N, 9E, 36.7h	6.1	3	1964	1578	Ironton-Galesville sandstone	330/1966; 309/1968; 295/1971; 230/1975	490,000[d]	

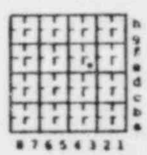
Source: Illinois State Water Survey (no date)

[a]Locations of public water supplies within 10 miles are shown on Figure 2.4-14.

[b]Locations within each section are based upon the system used by the Illinois State Water Survey illustrated below.

[c]NA - Data Not Available.

[d]Average daily use in 1980



Well located in Sec. 17.3e

1

PRIVATE WATER WELLS WITHIN 2 MILES OF THE BRAIDWOOD SITE

WELL NO.	TOWNSHIP-RANGE AND SECTION	CORNER, 1/16 Sec., 1/4 Sec.	USER	WELL TYPE	WELL DEPTH (ft)	STATIC LEVEL DEPTH (ft)	APPROX. ELEVATION	TESTED CAPACITY (gal/min)	USAGE[a] (gal/day)
	T.32N.-R.8E								
1	23	NE, NW, SW	P. Dixon	Drilled	101	10	570		
2	23	SW, NW, SW	Grega	Drilled	102	10	570		
3	23	SE, SW, NW	A. Martis	Drilled	91	10	575		
4	23	SW, SW, SW	Wisneski	Drilled	100		575		50
5	23	NE, SE, SW	P. Yeno	Drilled	90		580		100
6	23	SE, SW, SE	J. Tolbert	Sandpoint	10		575		Livestock
7	23	SW, NW, NE	Francois	Sandpoint			575		200 + Livestock
8	26	NE, SW, SW	R. Huston	Drilled	121	15	575		100
9	26	SW, NW, NW	R. Lissy	Sandpoint	20	20	580		200
10	26	NW, NE, NW	Braceville-Gardner Cemetery	4 Sandpoints	4		580		Watering Plants
11	26	NW, NE, NW	F. Castillo	Drilled	120		580		450
12A	35	NE, NE, NW	O. Rossio	Drilled	198		575		100
12B	35	NE, NE, NW	O. Rossio	Drilled	198		575		150
12C	35	NE, NE, NW	O. Rossio	Drilled	175		575		200
13	35	NW, NE, NW	J. Mack	Drilled	160		575		150
14	35	NW, NW, NE	L. Cirot	Unidentified			575		150
15A	35	NW, NE, NE	L. Girot	Unidentified			580		
15B	11	NW, NE, NE	L. Girot	Unidentified			580		
16	35	SW, NE, NW	Tweedt	Unidentified			575		
17	35	NE, NE, SE	J. Hayes	Unidentified			580		
18	12	SW, SE, SE		Unidentified			580		
19	13	NW, NE, NE	J. Broucek	Drilled	90		580		250
20	13	NW, NW, NW	Berrong	Sandpoint	10		575		250
21	13	SW, SW, NW	Beckman	3 Dug	18	8	575		400 + Livestock
22	13	NW, NW, SW	H. Campbell	Drilled	95		575		400 + Livestock
23	13	SW, NW, SW	Vilt	Drilled	90		575		300
24	24	NW, NW, NW	Wenger	2 Sandpoints	7		575		200
25	24	SE, SE, NE		Unidentified			585		
26	24	SE, SE, SE	G. Urban	Sandpoint	12.5	2.5	580		100
27	24	SW, SW, SE		Unidentified			580		
28	24	SW, SW, SE		Unidentified			580		
29	24	SW, SW, SE		Unidentified			580		
30	24	SW, SW, SE		Unidentified			580		
31	24	SW, SW, SE	Hibner	Unidentified			580		
32	24	SE, SE, SW	Small Bros.	Sandpoint	20	20	560		100
33	24	SE, SE, SW	Tom Favero	Drilled	90		580		50 + Livestock
34	25	NW, NE, NE	F. Yoder	Drilled	142		590		50
35	25	NE, SE, NE	Foster	Unidentified			580		

[a] Usage has been calculated as number of persons using water times 50 gal/day per person.

2.7 NOISE

This section summarizes the ambient noise levels in the vicinity of the communities located within 5 miles of the Braidwood Nuclear Generating Station - Units 1 & 2 (Braidwood Station). Particular attention was also directed toward obtaining acoustic noise levels where high voltage transmission lines are located close to communities. All measurements were made keeping in mind applicable guidelines; i.e., Illinois Environmental Protection Agency (Illinois EPA), the U.S. Environmental Protection Agency (U.S. EPA), and the Department for Housing and Urban Development (HUD). Noise effects in relation to adjacent occupancy are considered in Chapter 5.

2.7.1 Approach

Ambient noise measurements were made at the village limits on the side towards the direction of the station. Where a transmission line ROW passes close to a community, the ambient noise measurements were also taken at the village limits on the side towards the direction of the ROW.

Thirteen communities (Braceville, Braidwood, Carbon Hill, Central City, Coal City, Custer Park, Diamond, Eileen, Essex, Godley, Harrisonville, Lakewood Shores, and Rest Haven) lie within a 5-mile radius of the Braidwood Station. They are identified in Figure 2.7-1. Three of the thirteen communities (Braceville, Central City, and Coal City) are located within 1 mile of a transmission line ROW.

2.7.2 Procedures

In order to be compatible with federal and state noise standards, sound measurements were made with a Type 1 sound level meter while continuous samples of the ambient noise were being tape recorded during the day and night for periods of at least 20 minutes. Care was taken during the recording period to ensure that the recorded sample would be representative of the existing ambient noise levels.

The tape recorded data were analyzed to yield both the cumulative distribution of A-weighted ambient noise levels (see Figures 2.7-2 and 2.7-3) and the L_{eq}, which is the A-weighted Equivalent Sound Level as defined by the U. S. Environmental Protection Agency (U.S. EPA 1974). L_{eq} represents the sound energy averaged over a 24-hour period; the day-night sound level (L_{dn}) represents the L_{eq} with a 10 dB nighttime penalty. L_{dn} may be calculated from daytime (a 15-hour period from 7:00 a.m. to 10:00 p.m.) and nighttime (a 9-hour period from 10:00 p.m. to 7:00 a.m.) Leq levels using the following relationships:

$$L_{dn} = 10 \log \frac{1}{24} \left[15\left(10^{\frac{L_d}{10}}\right) + 9\left(10^{\frac{L_n + 10}{10}}\right) \right] \quad [\text{dB}]$$

Where:

$L_d = L_{eq}$ for daytime and

$L_n = L_{eq}$ for nighttime.

2.7.3 Applicable Guidelines

2.7.3.1 Illinois Environmental Protection Agency

Maximum allowable levels of environmental noise due to the Braidwood Station are established by "State of Illinois Noise Pollution Control Regulation", effective August 9, 1973, published by the Illinois EPA. This document identifies allowable levels based on the land use category of the emitter and the receiver. Noise emitted by the Braidwood Station (land use Class C) to residential areas (land use Class A) is limited by Rule 202 (Sound Emitted to Class A Land During Daytime Hours 7:00 a.m. to 10:00 p.m.) and Rule 203 (Sound Emitted to Class A Land During Nightime Hours, 10:00 p.m. to 7:00 a.m.). Maximum allowable octave band sound pressure levels of the more stringent Rule 203 are shown in Table 2.7-1. This table also includes noise data measured at the village limits of the communities located within a 5-mile radius of the Braidwood Station.

2.7.3.2 U.S. Environmental Protection Agency

The U.S. EPA has also identified a 24-hour $L_{eq} \leq 70$ dB as the level of environmental noise that will prevent any measurable hearing loss over a lifetime for all areas (U.S. EPA 1974). Similarly, undue interference with activitiy and annoyance will not occur if outdoor levels in residential areas are maintained at $L_{dn} \leq 55$ dB. Table 2.7-2 tabulates the L_d, L_n levels at the 13 village limits towards towards the Braidwood Station side and the 3 village limits towards the transmission line ROW side.

2.7.4.3 Department of Housing and Urban Development

On July 12, 1979 HUD published "Environmental Criteria and Standards, Noise Abatement and Control", 24 CFR Part 51 to encourage land use patterns for housing and other noise sensitive urban needs that will provide a suitable separation between them and major noise sources. HUD criteria state that noise levels for residential developments are normally acceptable if they do not exceed a Day-Night average sound level of 65 dB. A Day-Night average sound level, abbreviated as DNL and symbolized as Ldn, is the 24-hour average sound level in decibels, obtained after addition of 10 decibels to the sound levels in the night from 10 p.m. to 7 a.m.. Table 2.7-3 tabulates the Ldn levels at the 13 village limits towards the Braidwood Station side and the 3 village limits towards the transmission line ROW side. 1

TABLE 2.7-3

HUD MAXIMUMS AND MEASURED Leq LEVELS

COMMUNITY AMBIENT NOISE LEVELS (locations)	Leq Levels (dBA) HUD GUIDELINE (maximum)	MEASURED LEVELS Ldn	Ld	Ln
Braidwood Station Side				
Braceville	65	52	49	45
Braidwood	65	50	45	43
Carbon Hill	65	43	43	33
Central City	65	53	43	47
Coal City	65	53	44	47
Custer Park	65	57	59	36
Diamond	65	52	46	46
Eileen	65	50	35	44
Essex	65	37	36	28
Godley	65	51	48	44
Harrisonville	65	46	42	39
Lakewood Shores	65	45	45	37
Rest Haven	65	46	42	39

TABLE 2.7-3 (continued)

HUD MAXIMUMS AND MEASURED Leq LEVELS

COMMUNITY AMBIENT NOISE LEVELS (locations)	Leq Levels (dBA) HUD GUIDELINE (maximum)	MEASURED LEVELS Ldn	Ld	Ln
Transmisson ROW Side				
Braceville	65	59	53	53
Central City	65	49	49	40
Coal City	65	51	39	45

BRAIDWOOD NUCLEAR GENERATING STATION - UNITS 1 & 2

ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

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BRAIDWOOD NUCLEAR GENERATING STATION - UNITS 1 & 2

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CHAPTER 3.0 - THE STATION

3.1 EXTERNAL APPEARANCE

3.1.1 Structures

The principal structures at the Braidwood Nuclear Generating Station - Units 1 & 2 (Braidwood Station), shown in the artist's conception in the frontispiece, consist of:

a. the turbine building (containing two steam turbine-generators and associated equipment);

b. two reactor containment buildings (each housing a pressurized water reactor and associated reactor coolant system);

c. the service and solid radioactive waste storage building (for office use and other related service functions);

d. the auxiliary building (containing auxiliary systems and equipment);

e. the fuel storage and handling building; and

f. an electrical switchyard.

Additional facilities include two vent stacks associated with the auxiliary building, a train washdown shed associated with the fuel storage and handling building, transmission lines, a pond screenhouse, and a river screenhouse and blowdown discharge structure on the Kankakee River, and a 2537-acre cooling pond. 1

3.1.2 Arrangement of Structures

The arrangement of the principal structures is illustrated in the frontispiece. Further details of the layout, including the locations of the plant perimeter and exclusion boundary, are presented in Figure 2.1-4. The switchyard is located near a central group of buildings. This group includes the turbine building, the auxiliary building, the fuel storage and handling building, and the two reactor containment buildings.

The turbine building, auxiliary building, and fuel storage and handling building form a "T" shape. The turbine building is at one end of the "T" and the fuel storage and handling building is at the other. The auxiliary building connects these two buildings and is flanked by the two reactor containment buildings. The train car washdown shed extends from the end of the fuel storage and handling building. Adjoining the turbine building is the service and solid radioactive waste storage building.

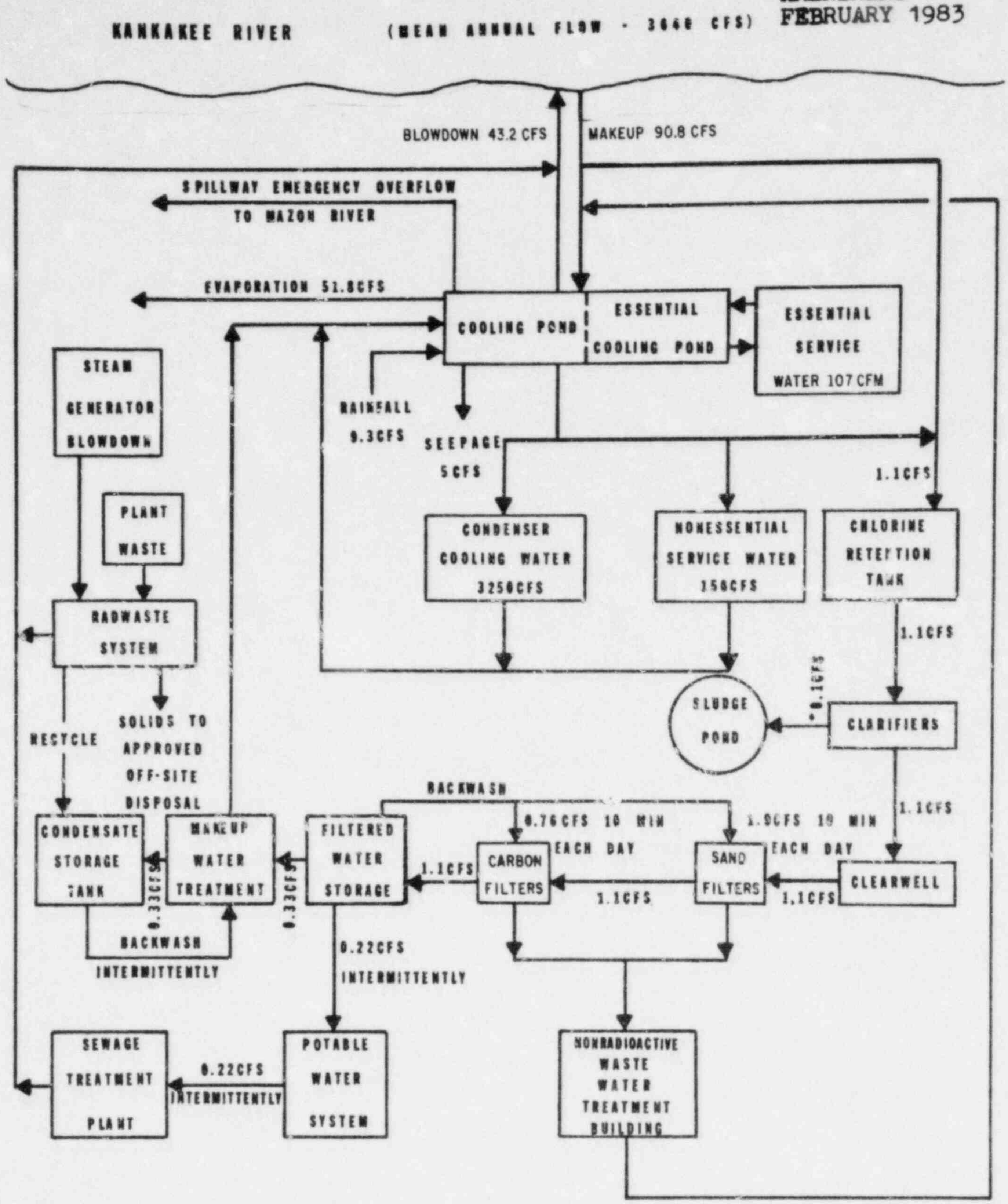
3.1.3 Architectural Features and Aesthetic Considerations

Although the facility is obviously an industrial facility, much effort has been expended to develop a functional design that is aesthetically pleasing. For example, while the major materials of construction are concrete and steel, colored metal siding is employed as part of the architectural treatment to provide variety of texture as well as color. The siding is used on the entire turbine building and on the tendon enclosures of the reactor buildings. The structures are physically contiguous to each other; the grouping provides a balance and symmetry of design and a pleasing variety of roof and corner lines.

3.1.4 Release Points

The release points for gaseous effluents are through vent stacks located on the auxiliary building roof. The vent stacks, described further in Section 3.5, extend above the turbine building to about 200 feet above the plant grade. The Unit 1 vent stack is located at Universal Transverse Mercator (UTM) coordinates 4,565,265 meters north and 396,950 meters east. The Unit 2 vent stack is located at UTM coordinates 4,565,250 meters north and 396,950 meters east.

The release point for liquid effluents is the blowdown discharge structure on the west bank of the Kankakee River at an elevation of 536 feet above mean sea level at UTM coordinates 4,565,887 meters north and 403,568 meters east.



BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
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FIGURE 3.3-1

WATER USAGE FLOW DIAGRAM

3.4 HEAT DISSIPATION SYSTEM

During the operation of the Braidwood Nuclear Generating Station - Units 1 & 2 (Braidwood Station), the condensers and other heat exchange equipment require cooling water. This water is taken from the cooling pond shown in Figure 3.4-1 and circulated through the various cooling equipment; the heated effluent is then returned to the cooling pond. This closed-cycle cooling pond serves as the heat sink to dissipate most of the waste heat to the atmosphere. This heat is dissipated by evaporation and by convective, reflective, and sensible heat transfer mechanisms.

The cooling pond has an overall area of about 3540 acres, with a water surface area of 2537 acres. Approximately 30% of the total | 1
pond area is occupied by islands. The maximum depth of the pond is about 15 feet, and it has an average depth of about 9 feet. Figure 3.4-1 indicates the general layout of the pond.

Earthen dikes having a width of 14 feet at the top form the boundary of the pond. The top elevation of most of the dikes is 600 feet above mean sea level (MSL), 5 feet above the normal pond pool level of 595 feet MSL; the only exception, a portion of the dikes just south of the plant, has a top elevation of 602.5 feet MSL. Interior dikes have been included in the design of the Braidwood Pond in order to assure that the maximum utilization of the pond cooling surface is attained. With the interior dikes, the possibility of channeling or short circuiting of the warm water through portions of the pond is reduced to a minimum, and the cooling performance of the pond is improved. The layout of these internal dikes is shown in Figure 3.4-1. With the arrangement of the pond, no recirculation effects that would be detrimental to the performance of the pond are anticipated.

Channeling does occur in the Braidwood Pond due to stagnant water in deep or side-arm regions, thus shortening the residence time of heated water in the lake. This channeling was considered in the lake performance analysis by using only the effective area and volume instead of total area and volume.

Significant vertical stratification of temperatures and velocities in the pond is expected to occur only in those regions that are deeper than the 10-foot depth of discharge.

The cooling pond is supplied with makeup water from the Kankakee River to compensate for losses due to evaporation, seepage, and blowdown. This makeup water is withdrawn from the river at an expected rate of 90.8 cubic feet per second (cfs) by means of a river intake structure illustrated in Figure 3.4-2. The intake structure operating floor is located at elevation 557 feet above mean sea level (MSL), which is above the 1975 flood (flood of record) elevation of 552 feet MSL. The mean annual flow and 1-day low flow of the Kankakee River at the intake are 3640 cfs and

487 cfs, and the corresponding water surface elevations are 538 and 534 feet MSL.

The intake structure houses three intake pumps; two pumps of 53.5 cfs capacity are used to supply water for normal operation and a third pump of the same capacity serves as a standby and is used for pond filling. The velocity at the river intake structure is between 0.32 and 0.48 feet per second (fps) based on two-unit operation.

At the river intake structure the water flows through bar grills and vertical traveling screens to remove debris from the intake water. The debris removed from the screens is disposed of off the site by an independent contractor.

The blowdown from the cooling pond is released to the Kankakee River from a discharge structure illustrated in Figure 3.4-3. Flow control is provided on the blowdown line so that flow may be terminated when both units are shut down or are being refueled. The location and orientation of the blowdown discharge and the river intake structures are shown in Figure 3.4-4. The orientation of the discharge is approximately perpendicular to the river shoreline. The river intake structure is approximately 2000 feet below the confluence of Horse Creek with the Kankakee River, and the discharge structure is about 500 feet below the intake structure. The discharge is returned to the river at a maximum velocity of 4.3 fps and at an increased temperature, which varies seasonally. Table 3.4-1 shows the median monthly temperatures for the blowdown with both units operating at 100% load factor. The predicted blowdown temperature ranges from 49° F in January to 88° F in July.

As a result of the discharge of the blowdown into the flowing Kankakee River, a thermal plume is established downstream whose detailed temperature profile depends on river conditions and the blowdown characteristics. A discussion of the extent and effect of this plume is in Section 5.1; a description of the model used to estimate these parameters is in Appendix 5.1A.

Three vertical dry pit circulating water pumps per unit draw water from the cooling pond through a pond screen house near the pumps (see Figure 3.4-5). At the pond screen house the water flows through bar grills and vertical traveling screens that remove debris from the intake water. The debris removed from the screens is disposed of off the site by an independent contractor. The water is pumped through a 16-foot diameter pipeline to the condensers, then through another 16-foot diameter pipeline to the discharge outfall structure and back into the pond. The Braidwood Station condenser cooling water requires a continuous flow of about 3250 cfs for the two units. This water is withdrawn from the cooling pond and returned there with a temperature rise of about 22° F. The total heat dissipated to the condenser cooling water is approximately 1.6×10^{10} Btu/hr for the two units.

blowdown demineralizers. These wastes are pumped to a 10,000 gallon tank for collection and sampling.

The recycle evaporator condensate demineralizer, which is shared by both units, is expected to be regenerated three times per calendar year, producing about 4,000 gallons of wastes per regeneration. The radwaste mixed-bed demineralizers which are shared by both units, are regenerated as often as required to maintain a decontamination factor of 10 for soluble ions. Each radwaste mixed bed demineralizer requires regeneration every 1 to 2 weeks depending on usage, and produces about 1800 gallons of waste per regeneration.

Expected sources are given in Table 11.1-6 of the FSAR. | 1

3.5.2.2.4 Turbine Building Floor Drains

The turbine building floor drains are shared by two units. The expected flow rates are an average of 4,200 gal/day, with a maximum of 12,000 gal/ day. The two turbine building floor drain tanks have a capacity of 12,000 gallons each. Turbine building floor drains, which are normally non-radioactive, may be released from the plant without treatment other than filtration after sampling. If sampling indicates that the wastes are not suitable for release, they will be processed through the radwaste evaporators and recycled. The expected sources are given in Table 11.1-6 of the FSAR.

3.5.2.2.5 Turbine Building Equipment Drains

The turbine building equipment drains are shared by both units. The expected flow rates are an average of 4,200 gal/day, with a maximum of 12,000 gal/day. The two turbine building equipment drain tanks have a capacity of 12,000 gallons each.

After sampling, the turbine building equipment drains are normally processed through one of the blowdown mixed bed demineralizer and recycled.

Expected sources are given in Table 11.1-6 of the FSAR.

3.5.2.2.6 Auxiliary Building Equipment Drains

The auxiliary building equipment drains collect an average 5,600 gal/day and a maximum of 16,000 gal/day. The expected sources are given in Table 11.1-6 of the FSAR. Since all equipment in the auxiliary building containing potentially radioactive liquid is

periodically drained into this subsystem, the volume and activity on any given day varies according to the operations in progress, such as replacing filter elements, draining ion exchange vessels, and flushing and cleaning tanks and equipment.

These equipment drains are collected in two 8,000-gallon tanks, which are shared by both units. After sampling, the wastes are processed through filters and the radwaste evaporator.

3.5.2.2.7 Auxiliary Building Floor Drains

The auxiliary building floor drains collect an average of 5,600 gal/day and a maximum of 16,000 gal/day. The expected sources are given in Table 11.1-6 of the FSAR. These drains include pump baseplate drains in the auxiliary building, reactor coolant leakages, pump seal and stuffing box leakages, valve stem packing leakages, and other equipment overflows or spills. Inputs also include waste from operations such as washdown and equipment maintenance. These floor drains collect in two 8000-gallon tanks that are shared by both units. After sampling, the waste is filtered and evaporated.

3.5.2.2.8 Laundry Drains

Laundry wastes are collected directly from the laundry facilities of the two units. The expected average daily flow for this subsystem is 1400 gallons, with a maximum daily flow of 4000 gallons for both units. The expected activities are given in Table 11.1-6 of the FSAR. The laundry wastes are collected in one 4000-gallon tank and two 2000-gallon tanks. After sampling, the waste is filtered and evaporated. Because of potentially high carryover due to the detergent, the laundry waste will be processed separately from other wastes.

3.5.2.3 Liquid Radwaste Discharges

All liquid wastes to be released are analyzed for gross beta, gamma, and tritium activity in one of the five 20,000-gallon monitor tanks after thorough mixing by recirculation. The liquid is then pumped to the 30,000-gallon release tank where a sample is again analyzed for gross beta, gamma, and tritium activity. Based on this analysis, a discharge rate is determined so that, when mixed with circulating water blowdown, the water leaving the plant has a radioactivity level less than the applicable MPC as stated in 10 CFR 20. A key-locked switch may then be manually opened so that water can be discharged. The key for the valve lock is controlled by administrative procedures.

As a further backup, a radiation detector monitors the discharge line before the discharge is mixed with the cooling pond blowdown line. Upon detecting an abnormal level of radiation, a valve on the release tank line immediately ahead of the mixing point closes and an alarm signal is relayed to the control room. Records are maintained of all radioactive wastes discharged to the environs to verify that radioactive releases conform with the requirements of 10 CFR 20 and 10 CFR 50.

Liquid radwaste releases were calculated using the PWR-GALE computer program and the parameters listed in Table 3.5-5. Expected annual activity releases to the discharge canal are given in Table 3.5-3. The radiological impact of these releases is discussed in Section 5.2.

condensers. All radioactive noble gases entering the main condenser are assumed to be removed from the system by the SJAE. The SJAE exhaust exhausts through the plant vent. In the event of high radioiodine activity in the SJAE exhaust, off-gases are released through both HEPA filters and a charcoal filter system affording a DF of 10 for iodine.

3.5.3.4 Gaseous Releases

Releases of radionuclides in gaseous effluents were calculated using the PWR-GALE computer program and the parameters listed in Table 3.5-5. Expected annual releases of radioactive noble gases and particulates are given in Table 3.5-7. The radiological impact of these releases is discussed in Section 5.2.

3.5.3.5 Ventilation Stacks

Two ventilation stacks exhaust air emissions to the atmosphere. Each rectangular stack has inside dimensions of 13 feet 3-3/8 inches by 5 feet 0 inches. The stacks terminate 200 feet above grade at an elevation of 800 feet above sea level.

Each stack (one for each unit) handles the exhaust air from the following:

a. auxiliary building ventilation system exhaust;

b. solid radwaste ventilation system exhaust;

c. normal containment purge system exhaust; and

d. miscellaneous vents collected from various sources such as battery rooms, laboratory facilities, waste-gas decay tank vents, air ejector, and decontamination room.

The following is a list of the approximate ventilation exhaust rates through the vent stack.

a. auxiliary building ventilation exhaust air - 150,000 cfm;

b. solid radwaste ventilation system - 15,000 cfm;

c. normal containment purge system exhaust air - 40,000 cfm; and

d. miscellaneous vents collected from various sources such as battery rooms, laboratory facilities, waste-gas decay tank vents, air ejector, and decontamination room - 8,140 cfm.

Total air capacity exhausted through the exhaust vent is approximately 214,000 cfm, which corresponds to 2,800 ft/min face velocity.

Under all plant operating conditions, a radiation detector in the exhaust vent continuously monitors the radioactivity level of the exhaust air before its release to the atmosphere. At high radioactivity levels, this detector sounds an alarm in the main control room and alerts the operator to initiate corrective action.

Figure 3.5-3 depicts the general arrangement of the plant's roof and shows the location of the vent stacks.

3.5.4 Solid Radwaste System

3.5.4.1 Objectives and Design Basis

The Braidwood Station solid radwaste system is designed to receive,
dewater, solidify with cement, seal in a 55-gallon drum, and tempo-
rarily store the following wastes: demineralizer bead resins,
evaporator concentrates, and spent filter cartridges. The system
also receives, compacts, and temporarily stores radioactive dry
wastes produced during station operation and maintenance. Evapora-
tor concentrates and dry active waste (DAW) residue can also be
solidified by polymer after being processed by the volume reduction 1
system. Closed-top drums approved by the U.S. Department of Trans-
portation (DOT) are used for packaging solidified wastes, and DOT-
approved open-top drums are used for packaging dry solid wastes.
The expected annual weight, volume, and activity of solid radwaste
shipped from the Braidwood Station appear in Table 3.5-8, which
gives values both with and without the use of a volume reduction 1
system. Packaged radioactive solid wastes are shipped off the site
and buried in accordance with applicable Nuclear Regulatory Commis-
sion (NRC) and DOT reguations. The system is designed specifically
for a 40-year service life, maximum reliability, minimum mainten-
ance, and minimum exposure to station personnel and the general
public. The expected solid radwaste system output is 5760 to 6910
drums per year if the volume reduction system is not operational 1
and 900 to 940 drums if it is.

3.5.4.2 System Description

Operation of the solid radwaste system is indicated in Figure 3.5-4
of the ER and Figure 11.4-7 of the FSAR. Table 11.4-1 of the FSAR 1
lists the process equipment and storage design capacities. A more
detailed system description is given in the Braidwood Final Safety
Analysis Report (FSAR) Subsections 11.4.2 and 11.4.3. The solid 1
radwaste system is comprised of the following nine components:

a. drum preparation station,
b. decanting station,
c. drumming station,
d. drum handling equipment,
e. smear test and label station
f. dry waste compactor,
g. volume reduction system,
h. radwaste drum storage areas, and
i. control station. 1

Each is discussed separately in the following subsections.

3.5.4.2.1 Drum Preparation Station

This station consists of cement unloading, storing, feeding, weighing, and conveying equipment used to load 55-gallon drums. A mixing weight is added to the drum to ensure uniform mixing when the drum is tumbled. The unit is designed for dust-free operation, with an exhaust-air filter assembly attached to the side of the fixing material storage tank to capture dust generated within the tank.

3.5.4.2.2 Decanting Station

This station consists of a stainless steel decanting tank that receives spent resins, a progressive cavity decanting pump that removes excess liquid, a piston-type metering pump that transports accurate quantities of waste from the decanting tank to the drum, and all associated valves and instrumentation to provide remote manual operation of the unit. Processing equipment in contact with radioactive materials is located on the radioactive side of a thick machined-steel shield wall. Most drives, limit switches, and instrumentation are located on the low radiation side of the shield wall to minimize the dose to maintenance personnel.

3.5.4.2.3 Drumming Station

This station consists of a drum processing-unit and a heat-traced, pistontype metering pump. The pump transports accurate quantities of waste from the concentrated waste tank to the drum. The drum processing-unit is essentially a stainless steel box with an air-cylinder actuated hatch in the top. The following remotely-performed operations occur within the drum processing-unit: cap removal, drum filling, cap reinsertion, tumbling of the drum for

drum for mixing, and washing the exterior of the drum if required. Two separate fill nozzles are provided, one for spent resins and one for concentrated waste.

A scale and a radiation monitor provide drum weight and activity level readouts on the control console after removal from the drum processing-unit.

3.5.4.2.4 Drum Handling Equipment

This equipment includes three remotely operated cranes with television cameras for visual surveillance, two drum transfer cars, and a filter-cartridge transfer vehicle. The cranes are used to transport preloaded drums to the drumming station, remove and position drums on a scale, transport and position sealed drums in either high or low-level storage, and retrieve and transport them to trucks for offsite disposal. The drum transfer cars transport drums between the process units and the storage area. The filter cartridge transfer vehicle transports drums containing spent filter cartridges from the filter area to a place where the drums may be placed on the drum transfer car.

3.5.4.2.5 Smear Test and Label Station

This station consists of a motor-operated turntable setdown position for drums behind a small shield wall equipped with access plugs and working tools to accomplish remote labeling, smear testing, and radiation monitoring of all external surfaces of sealed drums before offsite disposal.

3.5.4.2.6 Dry Waste Compactor

The dry waste compactor compresses paper, fabrics, plastics, and other wastes into 55-gallon drums. A large-diameter, pneumatically-powered ram drives the platen down into the drum. During compaction, a safety shield encloses the loading areas above the drum and protects the operator from debris that might escape. An air filtration assembly maintains control of contaminated particles during compactor operation. Radioactive dust is captured by means of a roughing filter and two HEPA filters operating in parallel. The filtration system is interconnected to the plant radioactive vent system. The radioactivity of most of the dry waste is low enough to permit manual handling.

3.5.4.2.7 Volume Reduction System

The major components of this system are a fluidized bed dryer, a dry waste processer, a gas-solids separator, a condenser, two 1

scrubbers, and an air filtration unit. The system eliminates the water from the evaporator concentrates and reduces combustible material to ash. The remaining salts and ash are solidified in polymer. The air exhausted from this system is passsed through two HEPA and one charcoal filter before entering the auxiliary building filtered vent exhaust system. 1

3.5.4.2.8 Radwaste Drum Storage Areas

Shielded areas are provided for the storage of low-activity and intermediate-activity waste drums and of compacted dry-waste drums according to the requirements noted in Table 11.4-1 of the FSAR. Storage space is designed to accommodate approximately 20% of the normal yearly output of packaged waste (i.e., without VRS) or 1.3 years of output from the volume reduction system. Visual surveillance for the low-activity and intermediate-activity waste storage areas is provided by the drum handling system television cameras. The intermediate-activity waste storage area capacity is sufficient to allow a decay of 60 days when used on a rotating basis. 1

3.5.4.2.9 Control Room

This room houses equipment for the remote visual monitoring and control of the solid radwaste building system. A liquid/solid interface control panel is provided for transferring waste to the solid radwaste system from the liquid radwaste system. 1

3.5.4.3 Interconnections with Liquid Radwaste Systems

The solid radwaste system is interconnected with the liquid radwaste systems via the spent resin and concentrated waste system comprised of the following tanks:

a. concentrates holding tank, and

b. spent resin tank.

Tank capacities are given in Table 11.2-5 of the FSAR. 1

Spent resins are discharged to the decanting station, dewatered, and then routed to the drumming station for solidification. Concentrates are pumped from the concentrates holding tank directly to the drumming station.

3.5.4.4 Shipment

All wastes are shipped from the site by truck after solidification (compacting for dry compressible wastes). The empty drum storage area for shipping containers is shown on Figure 11.4-3 of the FSAR. 1

Intermediate-level wastes will be shipped with sufficient shielding to meet the regulation governing radioactive shipments.

3.5.5 Process and Effluent Monitoring

The release points described in Subsection 3.1.4 are monitored for potentially radioactive effluents in the following manner:

a. Continuous radiation monitoring of gaseous effluents is provided for each of the two auxiliary building vent stacks. No automatic control action occurs at high radioactivity levels, but alarms alert operating personnel to take corrective action.

b. Potential radioactive release to the circulating water blowdown line is continuously monitored at the injection point from the radwaste system release tank into the blowdown line. If high radioactivity-level setpoints are reached, the monitor automatically closes the release pump discharge valve.

A detailed description of process and effluent radiation monitors is presented in Section 11.5 of the Braidwood Station FSAR.

TABLE 3.5-1

PARAMETERS USED IN THE CALCULATION OF THE INVENTORY OF RADIONUCLIDES IN THE SECONDARY COOLANT

PARAMETER	VALUE
Steam flow rate per steam generator	3.79×10^6 lb/hr
Number of condensate polishers used	none
Mass of water in four steam generators	3.82×10^5 lb
Primary water isotope activities	(see Table 3.5-1)
Carry-over factor from water to steam	
noble gases	1.0
iodines	0.01
all other isotopes	0.001
Primary to secondary leak rate	
design basis	1 gpm for 14 days
expected normal	110 lb/day
Blowdown flow rate	
design basis	135 gpm per unit
expected normal	20 to 60 gpm per unit

TABLE 3.5-2

TRITIUM SOURCE TERMS AND RELEASE PATHS

PER UNIT AT THE STATION

TRITIUM SOURCE	TOTAL PRODUCED (curies/yr)	EXPECTED RELEASE TO REACTOR COOLANT (curies/yr)
Ternary Fission	10,500	1050
Burnable Poison Rods		
Initial Cycle	1,520	152
Soluble Boron		
Initial Cycle	222	222
Equilibrium Cycle	309	309
Lithium and Deuterium Reactions	110	110
Total Initial Cycle	12,352	1540
Total Equilibrium Cycle	10,919	1470

PARAMETERS USED		VALUE
Power Level	3565 MWt	3565 MWt
Load Factor		0.8
Release Fraction from Fuel		10%
Release Fraction from Burnable Poison Rods		10%
Burnable Poison Rod		6160 gm
Reactor Coolant Boron Concentration		
Initial Cycle		860 ppm
Equilibrium Cycle		1200 ppm

RELEASE PATHS (based on equilibrium cycle)

1. Liquid release via radwaste discharge	660 curies/yr per unit
2. Gaseous release via fuel pool evaporation	787
3. Decay in primary coolant	23
TOTAL	1470 curies/yr per unit

PARAMETERS USED	VALUE
Evaporation rate from fuel pool and refueling canal	700,000 lb/yr per unit
Primary coolant volume	466,000 lb per unit

TABLE 3.5-3

EXPECTED ANNUAL AVERAGE RELEASES OF RADIONUCLIDES IN LIQUID EFFLUENTS[a]

		COOLANT CONCENTRATIONS		ANNUAL RELEASES TO DISCHARGE CANAL							
CORROSION AND ACTIVATION PRODUCTS	NUCLIDE HALF-LIFE (days)	PRIMARY (Ci/ml)	SECONDARY (Ci/ml)	BORON RECOVERY SYSTEM (curies)	MISCEL-LANEOUS WASTES (curies)	SECONDARY (curies)	TURBINE BUILDING (curies)	TOTAL LIQUID WASTE (curies)	ADJUSTED TOTAL (Ci/yr)	DETERGENT WASTES (Ci/yr)	TOTAL (Ci/yr)
Cr-51	2.78×10^{1}	1.90×10^{-3}	2.51×10^{-7}	5.36×10^{-6}	6.[illegible]$\times10^{-9}$	0.00	2.48×10^{-6}	7.85×10^{-6}	6.16×10^{-5}	0.00	6.2×10^{-5}
Mn-54	3.03×10^{2}	3.10×10^{-4}	6.08×10^{-8}	9.21×10^{-7}	1.05×10^{-9}	0.00	6.05×10^{-7}	1.53×10^{-6}	1.20×10^{-5}	1.00×10^{-3}	1.0×10^{-3}
Fe-55	9.50×10^{2}	1.60×10^{-3}	2.12×10^{-7}	4.77×10^{-6}	5.44×10^{-9}	0.00	2.11×10^{-6}	6.89×10^{-6}	5.40×10^{-5}	0.00	5.4×10^{-5}
Fe-59	4.50×10^{1}	1.00×10^{-3}	1.55×10^{-7}	2.88×10^{-6}	[illegible]9$\times10^{-9}$	0.00	1.54×10^{-6}	4.42×10^{-6}	3.47×10^{-5}	0.00	3.5×10^{-5}
Co-58	7.13×10^{1}	1.60×10^{-2}	2.15×10^{-6}	4.67×10^{-5}	5.[illegible]4$\times10^{-8}$	0.00	2.14×10^{-5}	6.81×10^{-5}	5.35×10^{-4}	4.00×10^{-3}	4.5×10^{-3}
Co-60	1.92×10^{3}	2.00×10^{-3}	2.73×10^{-7}	5.97×10^{-6}	6.81×10^{-9}	0.00	2.72×10^{-6}	8.69×10^{-6}	6.82×10^{-5}	8.70×10^{-3}	8.8×10^{-3}
Zr-95	6.50×10^{1}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.40×10^{-3}	1.4×10^{-3}
Nb-95	3.50×10^{1}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00×10^{-3}	2.0×10^{-3}
Np-239	2.35×10^{0}	1.20×10^{-3}	1.23×10^{-7}	1.82×10^{-6}	2.32×10^{-9}	0.00	1.14×10^{-6}	2.96×10^{-6}	2.32×10^{-5}	0.00	2.3×10^{-5}
FISSION PRODUCTS											
Br-83	1.00×10^{-1}	4.80×10^{-3}	1.26×10^{-7}	2.11×10^{-9}	2.69×10^{-9}	0.00	2.24×10^{-6}	2.24×10^{-6}	1.76×10^{-5}	0.00	1.8×10^{-5}
Rb-86	1.87×10^{1}	8.50×10^{-5}	1.40×10^{-8}	5.83×10^{-6}	1.34×10^{-8}	0.00	1.38×10^{-7}	5.98×10^{-6}	4.69×10^{-5}	0.00	4.7×10^{-5}
Sr-89	5.20×10^{1}	3.50×10^{-4}	6.17×10^{-8}	1.01×10^{-6}	1.16×10^{-9}	0.00	6.13×10^{-7}	1.63×10^{-6}	1.28×10^{-5}	0.00	1.3×10^{-5}
Mo-99	2.79×10^{0}	8.40×10^{-2}	1.19×10^{-5}	1.42×10^{-4}	1.76×10^{-7}	0.00	1.11×10^{-4}	2.53×10^{-4}	1.98×10^{-3}	0.00	2.0×10^{-3}
Tc-99m	2.50×10^{-1}	4.80×10^{-2}	2.18×10^{-5}	1.35×10^{-4}	1.65×10^{-7}	0.00	1.58×10^{-4}	2.94×10^{-4}	2.31×10^{-3}	0.00	2.3×10^{-3}
Ru-103	3.96×10^{1}	4.50×10^{-5}	6.21×10^{-9}	1.29×10^{-7}	1.68×10^{-10}	0.00	5.16×10^{-8}	1.91×10^{-7}	1.50×10^{-6}	1.40×10^{-4}	1.41×10^{-4}
Ru-106	3.67×10^{2}	1.00×10^{-5}	1.52×10^{-9}	2.97×10^{-8}	3.39×10^{-11}	0.00	1.51×10^{-8}	4.49×10^{8}	3.52×10^{-7}	2.40×10^{-3}	2.40×10^{-3}
Ag-110M	2.53×10^{2}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.40×10^{-4}	4.40×10^{-4}
Te-127	3.92×10^{-1}	8.50×10^{-4}	1.31×10^{-7}	8.46×10^{-7}	1.[illegible]$\times10^{-9}$	0.00	9.37×10^{-7}	1.78×10^{-6}	1.40×10^{-5}	0.00	1.4×10^{-5}
Te-129m	3.40×10^{1}	1.40×10^{-3}	1.87×10^{-7}	3.99×10^{-6}	4.56×10^{-9}	0.00	1.25×10^{-6}	5.85×10^{-6}	4.59×10^{-5}	0.00	4.6×10^{-5}
Te-129	4.79×10^{-2}	1.60×10^{-3}	5.39×10^{-7}	2.56×10^{-6}	2.94$\times10^{-}$[illegible]	0.00	1.30×10^{-6}	3.86×10^{-6}	3.03×10^{-5}	0.00	3.0×10^{-5}
I-130	5.17×10^{-1}	2.10×10^{-3}	1.53×10^{-7}	2.95×10^{-6}	1.18×10^{-8}	0.00	1.09×10^{-5}	1.38×10^{-5}	1.09×10^{-4}	0.00	1.1×10^{-4}
Te-131m	1.25×10^{0}	2.50×10^{-3}	2.39×10^{-7}	2.10×10^{-6}	3.24×10^{-9}	0.00	7.07×10^{-6}	4.17×10^{-6}	3.27×10^{-5}	0.00	3.3×10^{-5}
I-131	8.05×10^{0}	2.70×10^{-1}	3.72×10^{-5}	6.62×10^{-3}	7.69×10^{-5}	0.00	3.63×10^{-3}	1.03×10^{-2}	8.04×10^{-2}	6.20×10^{-5}	8.0×10^{-2}
Te-132	3.25×10^{0}	2.70×10^{-2}	3.07×10^{-6}	4.94×10^{-5}	6.02×10^{-8}	0.00	2.90×10^{-5}	7.85×10^{-5}	6.16×10^{-4}	0.00	6.2×10^{-4}
I-132	9.58×10^{-2}	1.00×10^{-1}	9.32×10^{-6}	5.11×10^{-5}	3.67×10^{-7}	0.00	1.77×10^{-4}	2.28×10^{-4}	1.79×10^{-3}	0.00	1.8×10^{-3}
I-133	8.75×10^{-1}	3.80×10^{-1}	3.43×10^{-5}	1.85×10^{-3}	3.65×10^{-6}	0.00	2.80×10^{-3}	4.66×10^{-3}	3.66×10^{-2}	0.00	3.7×10^{-2}
Cs-134	7.49×10^{2}	2.50×10^{-2}	4.01×10^{-6}	1.86×10^{-3}	4.[illegible]$\times10^{-6}$	0.00	3.99×10^{-5}	1.91×10^{-3}	1.50×10^{-2}	1.30×10^{-2}	2.8×10^{-2}
I-135	2.79×10^{-1}	1.90×10^{-1}	9.96×10^{-6}	2.10×10^{-5}	5.10×10^{-7}	0.00	5.33×10^{-4}	5.54×10^{-4}	4.35×10^{-3}	0.00	4.3×10^{-3}
Cs-136	1.30×10^{1}	1.30×10^{-2}	1.78×10^{-6}	8.59×10^{-4}	1.[illegible]$\times10^{-6}$	0.00	1.75×10^{-5}	8.79×10^{-4}	6.89×10^{-3}	0.00	6.9×10^{-3}
Cs-137	1.10×10^{4}	1.80×10^{-2}	2.67×10^{-6}	1.34×10^{-3}	3.06×10^{-6}	0.00	2.65×10^{-5}	1.37×10^{-3}	1.08×10^{-2}	2.40×10^{-2}	3.5×10^{-2}
Ba-137m	1.77×10^{-3}	1.60×10^{-2}	7.67×10^{-6}	1.26×10^{-3}	2.87×10^{-6}	0.00	2.48×10^{-5}	1.29×10^{-3}	1.01×10^{-2}	0.00	1.0×10^{-2}
Ce-144	2.84×10^{2}	3.30×10^{-5}	6.08×10^{-9}	9.80×10^{-8}	1.12×10^{10}	0.00	6.05×10^{-8}	1.59×10^{-7}	1.24×10^{-6}	5.20×10^{-3}	5.2×10^{-3}
All Others		2.53×10^{-1}	2.02×10^{-6}	3.69×10^{-6}	7.27×10^{-9}	0.00	2.84×10^{-6}	6.54×10^{-6}	5.13×10^{-5}	0.00	5.1×10^{-5}
TOTAL (except tritium)		1.46×10^{0}	1.50×10^{-4}	1.43×10^{-2}	2.49×10^{-5}	0.00	7.60×10^{-3}	2.19×10^{-2}	1.72×10^{-1}	6.23×10^{-2}	2.3×10^{-1}
Tritium Release		300 Ci/yr									

[a]For one unit

TABLE 3.5-4

EXPECTED ANNUAL AVERAGE RELEASE OF AIRBORNE RADIONUCLIDES[a b]

ISOTOPE	PRIMARY COOLANT (μCi/g)	SECONDARY COOLANT (μCi/g)	GASEOUS RELEASE RATE (Ci/yr): GAS STRIPPING		BUILDING VENTILATION			BLOWDOWN VENT OFFGAS	AIR EJECTOR EXHAUST	TOTAL
			SHUTDOWN	CONTINUOUS	REACTOR	AUXILIARY	TURBINE			
Kr-83m	2.265×10^{-2}	6.255×10^{-9}	0.0[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr-85m	1.184×10^{-1}	3.337×10^{-8}	0.0	0.0	0.0	3.0×10^{0}	0.0	0.0	2.0×10^{0}	5.0×10^{0}
Kr-85	1.051×10^{-1}	2.944×10^{-8}	5.1×10^{1}	5.7×10^{2}	7.4×10^{1}	2.0×10^{0}	0.0	0.0	1.0×10^{0}	7.0×10^{2}
Kr-87	8.474×10^{-2}	1.726×10^{-8}	0.0	0.0	0.0	1.0×10^{0}	0.0	0.0	0.0	1.0×10^{0}
Kr-88	2.158×10^{-1}	5.928×10^{-8}	0.0	0.0	0.0	5.0×10^{0}	0.0	0.0	3.0×10^{0}	8.0×10^{0}
Kr-89	5.399×10^{-3}	1.512×10^{-9}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Xe-131m	1.035×10^{-1}	2.917×10^{-8}	4.0×10^{0}	1.5×10^{1}	1.7×10^{1}	2.0×10^{0}	0.0	0.0	1.0×10^{0}	3.9×10^{1}
Xe-133m	2.293×10^{-1}	6.461×10^{-8}	0.0	0.0	7.0×10^{0}	5.0×10^{0}	0.0	0.0	3.0×10^{0}	1.5×10^{1}
Xe-133	1.804×10^{1}	5.010×10^{-6}	2.4×10^{1}	4.7×10^{1}	1.3×10^{3}	3.8×10^{2}	0.0	0.0	2.4×10^{2}	2.0×10^{3}
Xe-135m	1.404×10^{-2}	3.887×10^{-9}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Xe-135	3.755×10^{-1}	1.041×10^{-7}	0.0	0.0	2.0×10^{0}	8.0×10^{0}	0.0	0.0	5.0×10^{0}	1.5×10^{1}
Xe-137	9.719×10^{-3}	2.700×10^{-9}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Xe-138	4.751×10^{-2}	1.296×10^{-8}	0.0	0.0	0.0	1.0×10^{0}	0.0	0.0	0.0	1.0×10^{0}
TOTAL NOBLE GASES										2.8×10^{3}
I-131	2.795×10^{-1}	4.215×10^{-5}	0.0	0.0	1.7×10^{-3}	4.4×10^{-2}	2.3×10^{-3}	0.0	2.8×10^{-3}	5.1×10^{-2}
I-133	3.986×10^{-1}	3.831×10^{-5}	0.0	0.0	7.7×10^{-4}	6.3×10^{-2}	2.1×10^{-3}	0.0	4.0×10^{-3}	7.0×10^{-2}
TRITIUM GASEOUS RELEASE			1000 Ci/yr							

1

[a]The figure 0.0 appearing in the table indicates that the release is less than 1.0 Ci/yr for noble gas, 0.0001 Ci/yr for I.

[b]For one unit.

TABLE 3.5-4 (Cont'd)

NUCLIDE	AIRBORNE PARTICULATE RELEASE RATE (Ci/yr) WASTE GAS SYSTEM	BUILDING VENTILATION REACTOR	BUILDING VENTILATION AUXILIARY	TOTAL
Mn-54	4.5×10^{-3}	6.1×10^{-6}	1.8×10^{-4}	4.7×10^{-3}
Fe-59	1.5×10^{-3}	2.1×10^{-6}	6.0×10^{-5}	1.6×10^{-3}
Co-58	1.5×10^{-2}	2.1×10^{-5}	6.0×10^{-4}	1.6×10^{-2}
Co-60	7.0×10^{-3}	9.5×10^{-6}	2.7×10^{-4}	7.3×10^{-3}
Sr-89	3.3×10^{-4}	4.7×10^{-7}	1.3×10^{-5}	3.4×10^{-4}
Sr-90	6.0×10^{-5}	8.4×10^{-8}	2.4×10^{-6}	6.2×10^{-5}
Cs-134	4.5×10^{-3}	6.1×10^{-6}	1.8×10^{-4}	4.7×10^{-3}
Cs-137	7.5×10^{-3}	1.1×10^{-5}	3.0×10^{-4}	7.8×10^{-3}

Note: In addition to these releases, 25 Ci/yr of argon-41 are released from the containment and 8 Ci/yr of carbon-14 are released from the waste gas processing system.

TABLE 3.5-5

PARAMETERS USED IN THE GALE-PWR COMPUTER PROGRAM

PARAMETER	VALUE	
Reactor type	PWR	
Thermal power level (MWt)	3565.0	
Mass of coolant in the primary system (10^3 lb)	534.0	
Primary system letdown rate (gpm)	75.0	
Letdown cation demineralizer flow (gpm)	7.5	
Number of steam generators	4.0	
Total steam flow (10^6 lb/hr)	15.0	
Mass of steam in each steam generator (10^3 lb)	9.1	
Mass of liquid in each steam generator (10^3 lb)	117.0	
Total mass of secondary coolant (10^3 lb)	2023.0	
Steam generator blowdown rate (10^3 lb/hr) The steam generator blowdown is recycled to the condensate system after treatment in the blowdown system. Condensate demineralizers are not used.	30.0	1
Condensate demineralizer regeneration time (days)	0.0	
Fraction of feedwater through the condensate demineralizers	0.0	
Annual average liquid radwaste dilution flow: cooling lake blowdown (10^3 gpm)	21.0	1
Shimbleed rate (gpd)	2160.0	
Decontamination factors for the shimbleed system:		
Iodine	1×10^3	
Cesium	2×10^3	
Others	1×10^4	
Shimbleed system - Collection time (days)	0.60	
Processing time (days)	2.00	
Fraction discharged	0.10	

TABLE 3.5-5 (Cont'd)

PARAMETER	VALUE	
Equipment drains input (gpd)	2800.0	1
Fraction of primary coolant activity	0.005	
Decontamination factors for equipment drains processing:		
Iodine	1×10^5	
Cesium	2×10^4	
Others	1×10^6	
Equipment drains - Collection time (days)	2.30	
Processing time (days)	0.15	
Fraction discharged	0.10	
Clean waste input (gpd)	2800.0	1
Fraction of primary coolant activity	0.002	
Decontamination factors for clean waste processing:		
Iodine	1×10^5	
Cesium	2×10^4	
Others	1×10^6	
Clean waste - Collection time (days)	2.30	
Processing time (days)	0.15	
Fraction discharged	0.10	
Dirty wastes input (gpd)	2800.0	1
Fraction of primary coolant activity	0.0068	
Decontamination factors for dirty waste processing:		
Iodine	1×10^5	
Cesium	2×10^4	
Others	1×10^6	
Dirty wastes - Collection time (days)	4.60	
Processing time (days)	0.11	
Fraction discharged	0.10	
Blowdown fraction processed	1.00	
Decontamination factors for blowdown processing:		
Iodine	1×10^2	
Cesium	1×10^1	
Others	1×10^2	

TABLE 3.5-7

ADDITIONAL VENTILATION RELEASES FROM PLANT BY ISOTOPE

ISOTOPE	RELEASE RATE (Ci/yr) 1
Containment Purge Release (Two Units)	
I-131	0.015
Kr-85	240.0
Xe-133	980.0
H-3	68 0
Auxiliary Building Ventilation Release (Two Units)	
I-131	0.032
Steam Jet Air Ejector Release[a] (One Unit)	
Kr-85	463.0
Kr-85m	111.0
Kr-87	63.2
Kr-88	195.0
Xe-131m	100.0
Xe-133	14,800.0
Xe-133m	163.2
Xe-135	332.0
Xe-135m	10.5
Xe-138	36.9
I-131	0.0012
H-3	132.0

[a]Resulting from primary to secondary coolant leakage in one unit for 14 equivalent full power days with 1% failed fuel and leakage rate of 1 gal/min. This condition is not expected actually to occur, but is used for the purpose of design basis calculations.

TABLE 3.5-7 (Cont'd)

ISOTOPE	RELEASE RATE (Ci/Yr)	
Volume Reduction System Release (Two Units)		
Gases:		
Xe-131m	5.1×10^{-1}	
Xe-133m	1.2	
Xe-133	2.1×10^{1}	
I-131	2.8×10^{-3}	
I-132	3.7×10^{-3}	
I-133	2.1×10^{-3}	
H-3	2.6×10^{1}	
Particulates:		1
Cu-51	5.3×10^{-8}	
Fe-55	7.0×10^{-7}	
Co-58	6.0×10^{-7}	
Co-60	9.2×10^{-8}	
Ni-63	7.0×10^{-7}	
Y-91	1.5×10^{-9}	
Mo-99	3.5×10^{-7}	
Te-99m	2.1×10^{-9}	
Te-132	1.5×10^{-7}	
Cs-134	1.1×10^{-5}	
Cs-136	1.9×10^{-7}	
Cs-137	7.4×10^{-7}	

TABLE 3.5-8

ANNUAL WEIGHT, VOLUME, AND ACTIVITY OF RADWASTE SHIPPED FROM BOTH UNITS AT THE STATION

TYPE OF WASTE	WEIGHT (lb/yr)	SHIPPED VOLUME (ft^3/yr)	CATEGORY[a]	SHIPPING CONTAINER	CONTAINERS SHIPPED PER YEAR	ACTIVITY (Ci/yr)[b]
Bead Resins[c]	241,900	3,100	SC	DOT 17C 55-gallon drum	413	18,750
Disposable Filter Elements	131,800	1,425	SC	DOT 17H 55-gallon drum	190	177
Evaporator Concentrates						
Without VR[d]	from 3,366,300 to 3,777,900	from 34,350 to 38,550	SC	DOT 17C 55-gallon drum	from 4,580 to 5,140	490
With VR	from 213,150 to 236,350	from 2,205 to 2,445	SP	DOT 17C 55-gallon drum	from 294 to 326	490
Dry Waste						
Without VR	173,500	9,700	C	DOT 17H 55-gallon drum	1,160	Low activity
With VR	5,075	55	SP	DOT-17C 55-gallon drum	7	Low activity
Pre and HEPA Filters plus other Noncompatible and/or Noncombustible Waste	43,800	7,300	N	100 ft^3 boxes	73	Low activity

[a]Key to radwaste category:

SC - Solidified with cement before shipment.
SP - Solidified with polymer before shipment.
L - Liquid waste; none shipped.
G - Gaseous waste; none shipped.
C - Compacted; rags, paper, compressible waste.
N - Not compacted or solidified.

[b]Activity at time of drumming except as noted.

[c]The spent resin activity (bead resins) is calculated at the time the resin is transfered to the spent resin tank. This activity will be less if the resin is stored for significant period of time.

[d]VR = Volume Reduction.

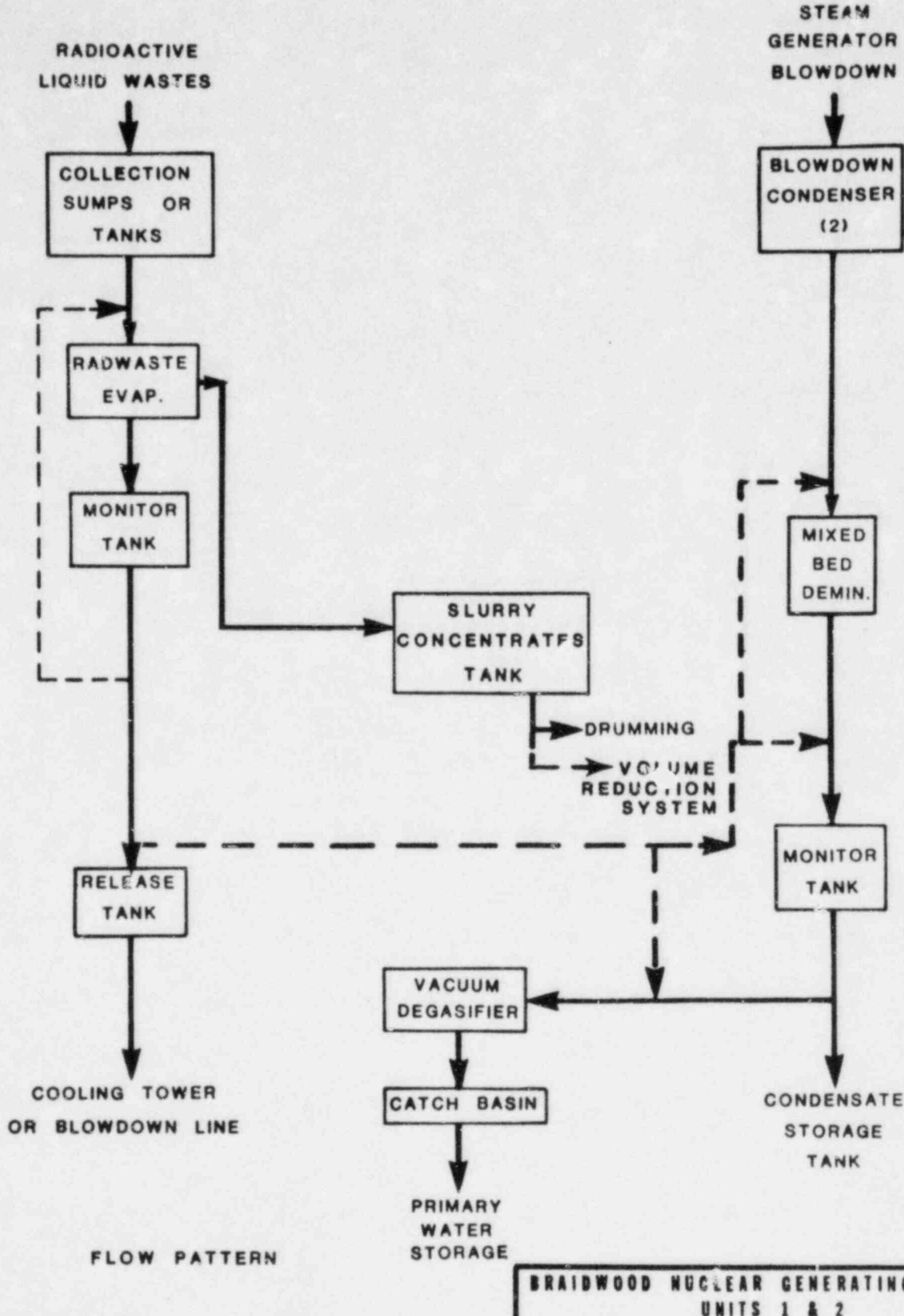

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FIGURE 3.5-1

LIQUID RADWASTE
FLOW DIAGRAM

Response:

The average flow rate (gpm) through the primary coolant purification system cation demineralizers is 7.5 gpm. (The demineralizers are in service 10% of the time, during which the flow rate through them is 75 gpm.)

Request:

4. The average shim bleed flow (gpm).

Response:

The average shim bleed flow is approximately 1.5 gpm.

3.5A.3 SECONDARY SYSTEM

Request:

1. The number and type of steam generators and the carryover factor used in the applicant's evaluation for iodine and nonvolatiles.

Response:

There are four U-tube recirculating type steam generators with a carryover fraction as specified in NUREG-0017, April 1976, of 0.001 for non-volatiles and 0.01 for iodines.

Request:

2. The total steam flow (lb/hr) in the secondary system.

Response:

The total steam flow in the secondary system is 1.51×10^7 lb/hr.

Request:

3. The mass of steam in each steam generator (lb) at full power.

Response:

There are approximately 9000 lb of steam in each steam generator at full power.

Request:

4. The mass of liquid in each steam generator (lb) at full power.

Response:

There are approximately 117,000 lb of liquid in each steam generator at full power.

Request:

5. The total mass of coolant in the secondary system (lb) at full power. For recirculating U-tube steam generators, do not include the coolant in the condenser hotwell.

Response:

The total mass of coolant in the secondary system is 2.02×10^6 lb at full power.

Request:

6. The primary to secondary system leakage rate (lb/day) used in the evaluation.

Response:

The primary to secondary system leakage rate is 100 lb/day. 1

Request:

7. Description of the steam generator blowdown and blowdown purification systems. The average steam generator blowdown rate (lb/hr) used in the applicant's evaluation. The parameters used for steam generator blowdown rate (lb/hr).

Response:

The purpose of the steam generator blowdown subsystem is to provide the means for controlling the water chemistry in the steam generators. Normally, the steam generator blowdown is non-radioactive, and a blowdown rate of 60 gpm (86,400 gal/day per unit) is sufficient. For purposes of conservatism, however, the design of the blowdown subsystem is based on a continuous 1 gpm primary to secondary leak for 14 days. During leak conditions, secondary water becomes radioactive and will reach an isotopic inventory equilibrium inversely proportional to the blowdown rate. The higher the blowdown rate, the lower the radioactive content of the secondary water. With a gross radioactive leak, therefore, blowdown is increased to 135 gpm (194,400 gal/day per unit).

Blowdown is cooled through two blowdown condensers, one per unit, that are cross-tied. The cooled blowdown liquid is filtered and then demineralized.

Each unit has two prefilters so that flow can be processed without interruption when one filter is being replaced.

In the case of a 1-gpm radioactive leak, blowdown through the leaking steam generator is increased while blowdown through the non-leaking unit is decreased correspondingly.

The average steam generator blowdown rate is 30,000 lb/hr. 1

Request:

8. The fraction of the steam generator feedwater processed through the condensate demineralizers and the decontamination factors (DF) used in the evaluation for the condensate demineralizer system.

Response:

Braidwood Station does not have condensate demineralizers.

Request:

9. Condensate demineralizers:

   a. Average flow rate (lb/hr),

   b. Demineralizer type (deep bed or powered resin),

   c. Number and size (ft^3) of demineralizers,

   d. Regeneration frequency,

   e. Indicate whether ultrasonic resin cleaning is used and the waste liquid volume associated with its use, and

   f. Regenerant volume (gal/event) and activity.

Response:

Condensate demineralizers are not used at the Braidwood Station.

3.5A.4 LIQUID WASTE PROCESSING SYSTEM

Request:

1. For each liquid waste processing system (including the shim bleed, steam generator blowdown, and detergent waste processing systems) provide in tabular form the following information:

   a. Sources, flow rates (gpd), and expected activities (fraction of primary coolant activity, PCA) for all inputs to each system,

b. Holdup times associated with collection, processing and discharge of all liquid streams,

c. Capacities of all tanks (gal) and processing equipment (gpd) considered in calculating holdup times,

d. Decontamination factors for each processing step,

e. Fraction of each processing stream expected to be discharged over the life of the station,

f. For demineralizer regeneration provide: time between regenerations, regenerant volumes and activities, treatment of regenerants, and fraction of regenerant discharged (include parameters used in making these determinations), and

g. Liquid source term by radionuclide in Ci/yr for normal operation, including anticipated operational occurrences.

Response:

A. Shim Bleed Waste Stream

a. Source: Boron recovery stream taken from letdown purification flow;

Flow rate: Average shim bleed flow is 2160 gpd; 1

Radioisotope activities: Calculated in on PWR-GALE (NRC, 1976).

b. Hold-up Times and Processing Equipment (all equipment can be shared by both units)

Process and collection time of 73 hours was used for decay purposes.

c. Capacities

1. Boron recycle hold-up tank 125,000 gal each

2. Boron recycle monitor tank 20,000 gal each

d. Decontamination Factors:

c. Capacities (all equipment is shared by both units).

Turbine Building Equipment Drain Tanks (2)	12,000 gal each
Turbine Building Equipment Drain Filter (1)	216,000 gpd
Blowdown Demineralizers (4)	259,200 gpd each

d. Decontamination Factors:

Element	Filters	Demineralizers
I	1	1×10^2
Cs, Rb	1	1×10^1
Others	1	1×10^2

e. Fraction of processed waste stream assumed released to environment after processing - 10%.

f. Not applicable.

g. See Table 3.5-3.

D. Turbine Building Floor Drains Waste Stream

a. Sources:

turbine building floor drain sumps, release tank, essential service water sumps, condensate pit sumps, and tendon tunnel sumps.

Flow Rate: 6000 gpd (maximum), 2100 gpd (annual average) per unit.

Radioisotope activities: Calculated in PWR-GALE (NRC 1976).

b. Hold-up Times and Processing Equipment (all equipment is shared by both units).

Turbine Building Floor Drain Tank	1.3 hours (minimum)
Turbine Building Floor Drain Filter	negligible

c. Capacities
(all equipment is shared by both units).

Turbine Building Floor Drain Tanks (2)	12,000 gal each
Turbine Building Floor Drain Filter (1)	216,000 gpd

d. Decontamination Factors:

Element	Filters	Demineralizers
I	1	1×10^2
Cs, Rb	1	1×10^1
Others	1	1×10^2

e. Fraction of processed waste stream assumed released to environment after processing - 10%.

f. Not applicable.

g. See Table 3.5-3.

E. Chemical Drains Waste Stream

a. Sources: fuel handling building decontamination sump, sample system (secondary), sample system (primary), laboratory drains, drumming station drum processing unit drain, boron recycle system, and primary water storage tank.

Flow rates: 3000 gpd (maximum), 1050 gpd (annual average) per unit.

Radioisotope activities: 8/1000 PCA | 1

b. Hold-up Times and Processing Equipment
(all equipment shared by both units)

Chemical Drain Tank	1 hour
Chemical Drain Filter	negligible
Radwaste Evaporators	1.5 hours
Radwaste Demineralizers	negligible
Radwaste Monitor Tanks	1 hour (minimum)

c. Capacities (all equipment is shared by both units)

Chemical Drain Tank (1)	6,000 gal
Chemical Drain Filter (1)	216,000 gpd
Radwaste Evaporators (3)	43,200 gpd each
Radwaste Demineralizers (3)	64,800 gpd each
Radwaste Monitor Tanks (2)	20,000 gal each

(Radwaste Evaporators, Demineralizers, and Monitor Tanks are also used to process other waste streams.)

d. Decontamination Factors:

Element	Filters	Demineralizers	Evaporators
I	1	1×10^2	1×10^3
Cs	1	1×10^1	1×10^4
Rb	1	1×10^1	1×10^4
Others	1	1×10^2	1×10^4

e. Fraction of process waste stream assumed released to environment after processing - 10%.

f. Not applicable.

g. See Table 3.5-3.

F. Laundry Wastes Waste Stream

a. Sources: laundry washing machine drains and personal shower drains.

Flow rate: 2000 gpd (maximum), 700 gpd (annual average) per unit.

Radioisotope activities: Calculated in PWR-GALE (NRC 1976).

b. Hold-up Times and Processing Equipment (all equipment shared by both units).

Laundry Drain Tank	1.1 hours (minimum)
Laundry Drain Filter	negligible
Permeate Storage Tank	1.3 hours (minimum)
Radwaste Evaporator	1.5 hours
Radwaste Demineralizers	negligible
Radwaste Monitor Tanks	1 hour (minimum)

c. Capacities (all equipment is shared by both units)

Laundry Drain Tank (1)	4,000 gal
Laundry Drain Storage Tanks (2)	2,000 gal. each
Laundry Drain Filter (1)	216,000 gpd
Radwaste Evaporators (3)	43,200 gpd each
Radwaste Demineralizers (3)	64,800 gpd each
Radwaste Monitor Tanks (2)	20,000 gal each

(Radwaste Evaporators, Demineralizers, and Monitor Tanks are also used to process other waste streams.)

d. Not applicable.

e. Fraction of process waste stream assumed discharged to the environment after processing - 100%.

f. Not applicable.

g. See Table 3.5-3.

G. Auxiliary Building Equipment Drains Waste Stream

a. Sources: low conductivity regeneration waste drains, reactor coolant drains, and auxiliary building equipment drain collection sumps.

Flow rate: 8000 gpd (maximum), 2800 gpd (annual average) per unit.

Radioisotope Activities: 5/1000 PCA 1

b. Hold-up Times and Processing Equipment (all equipment is shared by both units).

Auxiliary Building Equipment Drain Tank	2.2 hours (minimum)
Auxiliary Building Equipment Drain Filter	negligible
Radwaste Evaporators	1.5 hours
Radwaste Demineralizers	negligible
Radwaste Monitor Tanks	1 hour (minimum)

c. Capacities (all equipment is shared by both units).

Auxiliary Building Equipment Drain Tanks (2)	8,000 gal each
Auxiliary Building Equipment Drain Filter (1)	216,000 gpd
Radwaste Evaporators (3)	43,200 gpd each
Radwaste Demineralizers (3)	64,800 gpd each
Radwaste Monitor Tanks (2)	20,000 gal each

(Radwaste Evaporators, Demineralizers, and Monitor Tanks are also used to process other waste streams.)

d. Decontamination Factors:

Element	Filters	Demineralizers	Evaporators
I	1	1×10^2	1×10^3
Cs	1	1×10^1	1×10^4
Rb	1	1×10^1	1×10^4
Others	1	1×10^2	1×10^4

e. Fraction of process waste stream assumed discharged to the environment after processing - 10%.

f. Not applicable.

g. See Table 3.5-3.

H. Auxiliary Building Floor Drains Waste Stream

a. Sources: auxiliary building sumps, fuel handling building sumps, reactor cavity sumps, and containment floor drain sumps.

Flow rate: 8000 gpd (maximum), 2800 gpd (annual average)

Radioisotope activities: 2/1000 PCA | 1

b. Hold-up Times and Processing Equipment (all equipment can be shared by both units).

Auxiliary Building Floor Drain Tank	2.2 hours (minimum)
Auxiliary Building Floor Drain Filter	negligible
Radwaste Evaporators	1.5 hours
Radwaste Demineralizers	negligible
Radwaste Monitor Tanks	1 hour (minimum)

c. Capacities (all equipment is shared by both units).

Auxiliary Building Floor Drain Tanks (2)	8,000 gal each
Auxiliary Building Floor Drain Filter (1)	216,000 gpd
Radwaste Evaporators (3)	43,200 gpd each
Radwaste Demineralizers (3)	64,800 gpd each
Radwaste Monitor Tanks (2)	20,000 gal each

d. Decontamination Factors:

Element	Filters	Demineralizers	Evaporators
I	1	1×10^2	1×10^3
Cs	1	1×10^1	1×10^4
Rb	1	1×10^1	1×10^4
Others	1	1×10^2	1×10^4

e. Fraction of process waste stream assumed discharged to environment after processing - 10%.

f. Not applicable.

g. See Table 3.5-3.

I. Regeneration Wastes Waste Stream

a. Sources: drumming station decanting tank overflow, spent resin sluicing drain, recycle evaporator condensate demineralizer, radwaste mixed bed demineralizer, and blowdown mixed bed demineralizer.

Flow rate: 5000 gpd (maximum); 1750 gpd (annual average) per unit.

Radioisotope activities: 6/1000 PCA | 1

b. Hold-up Times and Processing Equipment (all equipment shared by both units).

Regeneration Waste Drain Tank	1.7 hours (minimum)
Regeneration Waste Drain Filter	negligible
Radwaste Evaporators	1.5 hours
Radwaste Demineralizers	negligible
Radwaste Monitor Tank	1 hour (minimum)

reduce airborne concentration of this isotope to approximately 1×10^{-10} Ci/cm³. The containment internal recirculation system will operate approximately 18 hours before purging. The containment is purged at a rate of 40,000 cfm before the admission of workers for refueling, maintenance, or repair of equipment. The design purge frequency is 10 purges/year per unit. The expected purge frequency is approximately 6 purges/year per unit. The containment is purged continuously, however, at a rate of 3000 cfm.

3.5A.7 SOLID WASTE PROCESSING SYSTEMS

Request:

1. In tabular form, provide the following information concerning all inputs to the solid waste processing system: source, volume (ft³/yr per reactor), and activity (Ci/yr per reactor) of principal radionuclides, along with bases for valves used.

Response:

Information concerning inputs to the solid waste processing system are given in Table 3.5-8.

Request:

2. Provide information on onsite storage provisions (location and capacity) and expected onsite storage times for all solid wastes prior to shipment.

Response:

Solid wastes will be stored in the Radwaste Building before shipment (see B/B FSAR Figure 11.4-3). Storage space is designed to accommodate approximately 25% of the normal yearly output of packaged waste. This amount was selected to allow for some decay of drummed material, startups, trucking strikes, unavailability of burial sites, and other contingencies. Information on the solid waste storage area is given in the following list. For other information refer to Section 11.4 of the B/B FSAR.

Storage Area	Number of Storage Areas	Design Capacity Per Storage Area	
Low level	1	570 drums	
Intermediate level	1	640 drums	
Dry compacted waste	1	70 drums	1
Dry uncompacted waste	1	90 ft³	
Empty drum	2	100 drums (total)	1

Request:

3. Provide piping and instrumentation diagrams (P&IDs) for the solid radwaste system.

Response:

The P&ID drawings of the solid radwaste system are shown on B/B FSAR Figures 11.4-5 and 11.4-6. | 1

The formation of monochloramines (Equation 3.6-3) takes precedence over that of di- and trichloramines and is generally instantaneous. The chloramines formed are present as monochloramines due to the small ratio of HOCl to NH_3. The chlorine in chloramines still retains about half of its oxidizing potential and is still effective as a bactericide. The reaction rate of chloramines, however, is lower than that of HOCl.

The small concentrations of chloramines formed and the residual chlorine present are not expected to persist in the water for three reasons. First, the circulating water contains bacteria that assimilate the residual chlorine and chloramines of the nonessential service water. The residual chlorine and chloramines of the essential service water are assimilated when combined with the blowdown from the essential cooling pond, which will still contain bacteria. Second, part of the volatile chloramines are lost due to evaporation. Third, while retaining their oxidizing potential, HOCl and chloramines react with and are destroyed by reducing agents like $S^{=}$, Fe^{++}, and Mn^{++}, as shown in the following equations:

$$H_2S + 4HOCl \longrightarrow H_2SO_4 + 4HCl \qquad (3.6\text{-}6)$$

$$2Fe(HCO_3)_2 + HOCl + HCl + Ca(HCO_3)_2 \rightarrow 2Fe(OH)_3 + CaCl_2 + 6CO_2 + H_2O \qquad (3.6\text{-}7)$$

$$MnSO_4 + HOCl + HCl + 4NaOH \rightarrow MnO_2 + 2NaCl + Na_2SO_4 + 3H_2O \qquad (3.6\text{-}8)$$

Since there is no accurate way to predict the chlorine demand of the pond, the exact quantity of NaOCl used is impossible to predict. The feed rate is carefully monitored. The service water, which may have a small residual chlorine content after chlorination, is returned to the cooling pond. Since the condenser cooling water is chlorinated after the blowdown take-off point, chlorine concentration at the point of blowdown discharge is negligible.

3.6.2 Makeup water Treatment System

Surface water from the cooling pond is used to supply the makeup water required for the steam cycle. As shown in Figure 3.3-1, the water is passed through a chlorine retention tank, clarifiers, and a clear well. From there the water passes through three parallel sand filters. Each filter operates at 3.0 gpm/ft^2 during normal operation and a maximum of 4.5 gpm/ft^2 when one filter is out of service. After each use, each filter is backwashed for 5 to 10 minutes, using 1000 gpm of filtered water for each filter. The filtered water is stored in a 150,000 gallon tank.

Three filtered-water transfer pumps (one a spare) supply water to the demineralizer trains for treatment. There are two identical demineralizer trains, each capable of producing a net daily average of 150 gpm. Each train consists of, in order, a primary,

strong-acid cation unit, a secondary, strong-acid cation unit, a weak-base anion unit, a strong-base anion unit, and a mixed bed unit. After treatment, the water goes to the condensate storage tank or primary storage tank.

3.6.2.1 Regeneration Wastes

After a quantity of water has been processed through the demineralizer train, the ion exchange resin is exhausted and needs chemical regeneration. Regeneration of the exhausted resins may take place once each day. During regeneration, which lasts about 4 hours, the only chemicals added are sulfuric acid (H_2SO_4) and sodium hydroxide (NaOH). Each regeneration require 2240 pounds of 93% H_2SO_4 and 792 pounds of 100% NaOH for regeneration and neutralization. The [illegible]0,095 gallons of waste produced during each regeneration are routed into the circulating water flow.

3.6.2.2 Filter Backwash Effluent

The makeup filter subsystem consists of three parallel sand filters and carbon filters. Each filter is backwashed once each day with water from the filtered water storage tank. The backwash water contains dissolved solids and suspended solids that are collected during the filtering process. The sand filters are backwashed each day for a 10-minute period at a rate of 1.9 cubic feet per second (cfs), and the carbon filters are backwashed each day for a 10-minute period at a rate of 0.76 cfs. The discharge from this backwashing operation is routed to the waste treatment building.

3.6.3 Waste Treatment

Treatment consists of an oil separator, an agitated equalization basin, a Quadricell separator, and filtration, after which the clean water effluent is routed to the circulating water system.

The oil separator is equipped with skimmers to remove oil. The skimmed oil flows to a waste oil holding tank. The waste oil is disposed of, as necessary, by a licensed contractor in an approved manner. 1

Sludge from the Quadricell is pumped by sludge transfer pumps to sludge drying beds. Underflow from the beds is pumped by underflow pumps to the equalization tank. The dried sludge is scraped off and hauled away by a licensed contractor for disposal in a certified landfill site.

3.6.4 Potable Water System

The volume of water used for potable and sanitary purposes is small (about 15,000 gallons per day [gpd]) in comparison with other plant

uses. Water is taken from the filtered water storage tank. The water is chlorinated with hypochlorite, which is fed at a rate proportional to the flow rate. The chlorinated water is then stored for potable and sanitary use.

All sanitary wastes are treated in a sewage treatment system of approved design (for further details see Section 3.7). The discharge from the sewage treatment plant is continuously chlorinated, as indicated in Section 3.7, and is discharged with the cooling pond blowdown. The chlorine dosage is usually 3 to 10 mg/liter. This dose results in a free residual chlorine concentration of about 0.5 ppm. After mixing with the cooling pond blowdown, the chlorine concentration is negligible.

3.6.5 Radwaste System

The discharge from the radwaste system is high-purity distilled water. The radwaste plant receives and decontaminates wastes that result from the operation of the nuclear reactors. After the necessary decontamination, the liquid effluents are batch discharged to the cooling pond blowdown. Section 3.5 discusses the radwaste system in detail.

Table 3.6-2 shows the estimated effluent analysis, and Table 3.6-3 the average analysis, of the final discharge, which in both cases meets all State of Illinois effluent standards.

TABLE 3.6-1

SEASONAL ANALYSIS OF KANKAKEE RIVER WATER

(All Values in mg/liter)

	WINTER	SPRING	SUMMER	FALL	AVERAGE	MAXIMUM
Calcium	71.9	78.7	81.8	77.8	77.6	118
Magnesium	23.9	21.3	24.8	24.0	23.5	31.0
Sodium	16.4	7.2	13.8	14.7	13.0	25.6
Alkalinity (As $CaCO_3$)	178	140	159	202	170	235
Sulfate	62.4	60.4	45.7	93.9	65.6	164
Chloride[a]	23.0	22.5	21.0	21.5	22.0	25
Nitrate	1.7	4.5	2.2	0.9	2.3	6.2
Silica	2.3	3.1	4.2	3.2	3.2	5.3
Filterable Residue	381	361	397	411	388	489

1

Note: pH average 8.2, range 7.0 to 9.0

Samples taken at Location 3, Intake Area

Sources: Illinois Natural History Survey 1977-1979, 1981

[a] Commonwealth Edison 1977-1978

3.9 TRANSMISSION FACILITIES

3.9.1 LOCATION AND DESCRIPTION OF RIGHT-OF-WAY

Figure 3.9-1 shows the transmission connections for the Braidwood Nuclear Station. These consist of existing double circuit 345 kV lines connecting to the LaSalle County Generating Station and the East Frankfort Transmission Substation and of a double circuit 345 kV line constructed on new right-of-way (ROW) to an existing line on the property of the Crete Transmission Substation. One circuit of the double circuiit 345 kV line will connect to the Bloom Transmission Substation with an intermediate connection at the Davis Creek Substation. The other circuit will connect to the Burnham Transmission Substation. No connection will be made to the Crete Transmission Substation.

Figure 3.9-2 shows the detailed route of the new line from the Braidwood Nuclear Generating Station - Units 1 and 2 (Braidwood Station) to the existing Crete Transmission Substation. This route traverses approximately 55 miles and crosses nearly flat agricultural land of low relief. A 330 foot ROW that includes space for a double circuit 345 kV line and a future 765 kV line comprises the first 7.3 miles. The next 15.6 miles is, in general, also 330 feet wide and accommodates a four circuit 345/138 kV transmission line and, for the most part, a future 765 kV line. 1

In Section 36 of Rockville Township in Kankakee County, the four-circuit construction terminates at the Davis Creek Transmission Substation. The double circuit 345 kV line continues north for 7.4 miles on a 315 foot wide ROW that can also accomodate a future 765 kV line. The next 17 miles between Wilton and Washington Townships involves a 180-foot widening of an existing 200-foot ROW. This 380-foot ROW will have a double circuit 345 kV line parallel to and with structures opposite those of an existing 765 kV line. From Washington Township 7.75 miles northward to the Crete Substation, a new 235-foot ROW will accommodate a double circuit 345 kV line and a future four circuit 138/345 kV line (see Figure 3.9-2). Structure types for the 55 mile transmission line will be similar throughout, single shaft structures for tangent and light angles (up to 13°) and lattice steel towers for angles over 13°. The single shaft structures will normally not exceed 6 feet in diameter at the ground line. All tangent structures will either be direct embedded in soil with granular or concrete backfill or will have poured concrete foundations. The tower foundations will normally be 3 foot diameter poured concrete belled caissons on each of the four legs of the towers.

All sections of the line will average no more than six (6) structures per mile. Figure 3.9-2 shows the route and structure profiles for this line.

The route crosses through nearly 48 miles of cleared farmland, 3.38 miles (129 acres) of open woodland and hedge rows, and 2.75 miles (105 acres) of riparian woodland. The lines cross the Kankakee 1
River approximately 7 miles northwest of Kankakee, Illinois. Eleven (11) creeks and eighteen (18) intermittent streams are also crossed. Transportation route crossings include the Norfolk & Western; Illinois Central Gulf; Chicago, Milwaukee, St. Paul & Pacific; and Chicago and Eastern Illinois Railroads, one interstate highway, two U.S. highways, and four state roads (see Table 3.9-1).

3.9.2 LINE DESIGN PARAMETERS

The transmission line will be constructed to meet or exceed all requirements of the Illinois Commerce Commission General Order 160, which is identical to the National Electric Safety Code for the construction of transmission lines. Electrically, the line is designed to minimize adverse effects to the general public. The insulation used for this line will be equal to or greater than that which is common practice in the electrical utility industry. The conductor diameters will be in the range that results in low corona, audible noise, and electrical noise. Wires to be used for this line are one 2156 MCM ACSR (84/19) conductor per phase and one 7#8 alumoweld static wire per circuit. Each conductor is rated 2300 amperes (summer normal) and 2900 amperes (summer emergency).

3.9.3 EXISTING SUBSTATIONS AFFECTED

The transmission substations affected are the Bloom Transmission Substation located east of Chicago Heights, Illinois, in Section 27 of Bloom Township in Cook County, Illinois, and Burnham Transmission Substation located in Burnham, Illinois, in Section 6 of 1
Thornton Township in Cook County, Illinois. Both substations contain 345 kV to 138 kV transformers and no new 345 kV terminal facilities will be added to accommodate the Braidwood transmission lines.

3.9.4 RADIATED ELECTRICAL AND ACOUSTICAL NOISE

The diameter of the conductors used will be in the range that results in low corona, audible noise, and electric noise. Although engineering has not been completed on the transmission line, it is anticipated that the same engineering criteria used on past designs, resulting in few problems, will be duplicated or improved for this transmission line.

3.9.5 INDUCED OR CONDUCTED GROUND CURRENTS

Induced or conducted ground currents can become a significant factor in urban areas where extensive networks of pipes and cables have been placed underground. The magnitudes of currents induced into such underground networks are dependent upon the current in the overhead transmission lines, the distance above the ground, the soil characteristics, and the extent of parallelism between the transmission lines and the underground equipment. Also, during high ground fault conditions, present designs are such that the entire fault current does not pass through the ground. High speed relays at the substations operate to render such situations highly transient, reducing the potential corrosion due to the "battery effect". (The soil can serve as as an electrolyte between the transmission ground and the underground equipment of other systems. As with conventional batteries, corrosion of these "terminals" could result.) A complete analysis of these problems cannot be made until the load currents have been determined and load flow studies have been completed.

3.9.6 ELECTROSTATIC FIELD EFFECTS

Electrostatic fields are present at any voltage level. The field strength is dependent upon voltage, height of conduct, and distance from the centerline of the support structure. Past installations of 138 kV and 345 kV lines have produced few if any complaints. Introduction of 765 kV lines, however, has caused review of these effects and explanations to the public of the electrostatic fields under these lines. The intensity of the field can be calculated before installation and actually checked by measurement after installation. Past experience has shown calculated values to have been conservative. Based on these conservative calculated values, the 345 kV lines, either independently or in conjunction with 138 kV lines, are not expected to cause significant electrostatic effects. Where the 345 kV lines are to be placed parallel to an existing 765 kV lines, calculated values show that the field intensity is increased slightly in some areas and actually decreases in other areas. In either case the incremental difference is so slight as to be hardly measurable. It is planned to measure the field strength before installation and again after installation of the 345 kV lines for comparative analysis. As in the past, CECo. will work cooperatively with landowners to mitigate or correct any adverse effects caused by the electrostatic field. Corrective measures will be in accordance with the following paragraphs.

Fences and other fixed metallic objects in and along transmission line rights-of-way are grounded when CECo. design calculations 1

indicate that the elctrostatically induced drain current would exceed the minimum level of perception (approximately 1 milliampere) of a person touching the fence or metallic object.

Induced voltages on electric fences are drained by the installation of drain coils at appropriate intervals. The grounding technique for non-electric fences on wood posts is to install steel posts at appropriate intervals and connect the fence to them. Fences on steel fence posts do not need additional grounding. 1

With respect to mobile equipment, the ground clearance of the 345 kV lines will be such that under all conditions the current due to electrostatic effects will be less than 5 milliamperes, rms, if the largest anticipated trucks, vehicles or equipment operated under the lines were short circuited to ground.

3.9.7 OZONE PRODUCTION

The generation of gaseous effluents as a result of corona activity on extra high voltage (EHV) transmission lines has been raised as an environmental issue. As a result, CECo. engaged the services of an outside consultant to determine the validity and magnitude of the ozone effect.

Since the ozone has only recently been recognized as a potential pollutant, some background information on the substance may be helpful. Ozone (O_3) is 50% denser than oxygen (O_2) and is a very reactive compound. It is formed naturally in three ways: High in the atmosphere, oxygen reacts with ultraviolet sunlight to form ozone, which circulates to lower altitudes as a result of weather. Sunlight reacting with airborne pollutants can also create ozone. Finally, lightning and other high voltage discharges cause oxygen to disassociate and recombine to form ozone. Generally, the ambient ozone level is proportional to the strength of the sunlight, increasing during the day and decreasing during the night. North winds, however, also bring in ozone from the Arctic. It is possible for high voltage transmission lines to produce ozone if they have high voltage discharges (corona). The U.S. and Illinois Environmental Protection Agencies have set an air quality standard of 8 parts per 100 million as the maximum 1-hour concentration, which is not to be exceeded more than once per year.

A field test program has been completed on the CECo. system. the program provides comparative data for three locations: (a) remote from high voltage transmission lines for the ambient ozone level of the area: (b) adjacent to a 345 kV switchyard; and (c) on the ROW of the existing 765 kV transmission line presently in operation on the CECo. system.

The automatic recording instruments at the three locations were rotated to provide the highest possible reliability for comparitive readings.

Instruments that recorded temperature, dew point, wind direction and velocity and barometric pressure were installed at the ambient location. The weather data obtained were similar to that taken by the Weather Bureau at O'Hare Field. Therefore, the O'Hare weather information was used for this study.

The results of the test program show that transmission lines have no measurable effect on the ozone present in the atmosphere. These results are published in final report form under IEEE Paper T 74 057-6 "Field Investigation of Ozone Adjacent to High-Voltage Transmission Lines" (Brabets and Fern 1974).

3.9.8 ENVIRONMENTAL IMPACT

It is CECo's policy to choose transmission line routes that have the least environmental impact. Since most of the ROW's run through nearly flat and already cleared agricultural land or along an existing transmission line ROW, very little new clearing will be necessary. Woodland will be clearned only to the extent necessary to maintain transmission security. No long term disruption to the wildlife of this region is expected since ROW's are ecologically suited to a mixed type of habitat (hedgerows, open woodland, and cultivated fields).

The more sensitive areas are the riparian zones along the Kankakee River and the intermittent marshland areas. The riparian zone at the crossing of the river is approximately 7.5 acres. The marshlands are small and discontinuous and can be spanned by the lines. Care will be taken in the placement and construction of the structures in these areas so that impact on the existing biota is not expected to be significant.

The aesthetic impact of these transmission lines has been a major consideration in choosing the ROW location. Placing lines in cultivated fields in order to reduce the biotic impact that would result from placement in wooded or marsh areas necessitates an unavoidable visual impact due to the extensiveness of the already cleared agricultural areas. Viewing exposure in these areas, however, is expected to be limited to the low density transient and local populations. Most of the highways will be crossed at acute angles and at no time is a ROW adjacent and parallel to a primary road. By paralleling existing transmission whenever possible, the visual impact of the new transmission line will be greatly reduced.

Visual impact will also occur where the line crosses the Kankakee River. Scattered residential communities are located all along the river. The close proximity (0.25 mile) of the Braidwood to Crete ROW to the southern end of the Kankakee River State Park is not expected to produce a significant visual impact. The immediate area is not influenced by residential communities and visitor viewing from within the park is largely blocked by open woodland vegetation.

The environmental impact of induced or conducted ground currents associated with the transmission of electric power from the Braidwood Station is expected to be very little because the transmission line ROW passes through mainly agricultural areas. The density of underground piping or cable systems existing in these areas is expected to be low, thereby minimizing the potential for induced or conducted ground currents.

It is CECo's policy that no building remain on the ROW. With the use of angle towers most of the buildings can be bypassed, thereby averting residential disruption. The route selection process includes considering the areas where the least amount of residential disruption will occur. In the few cases where the buildings cannot be avoided, the residents may choose either to have CECo. relocate their structures or to have CECo. pay the owners due compensation for their residences.

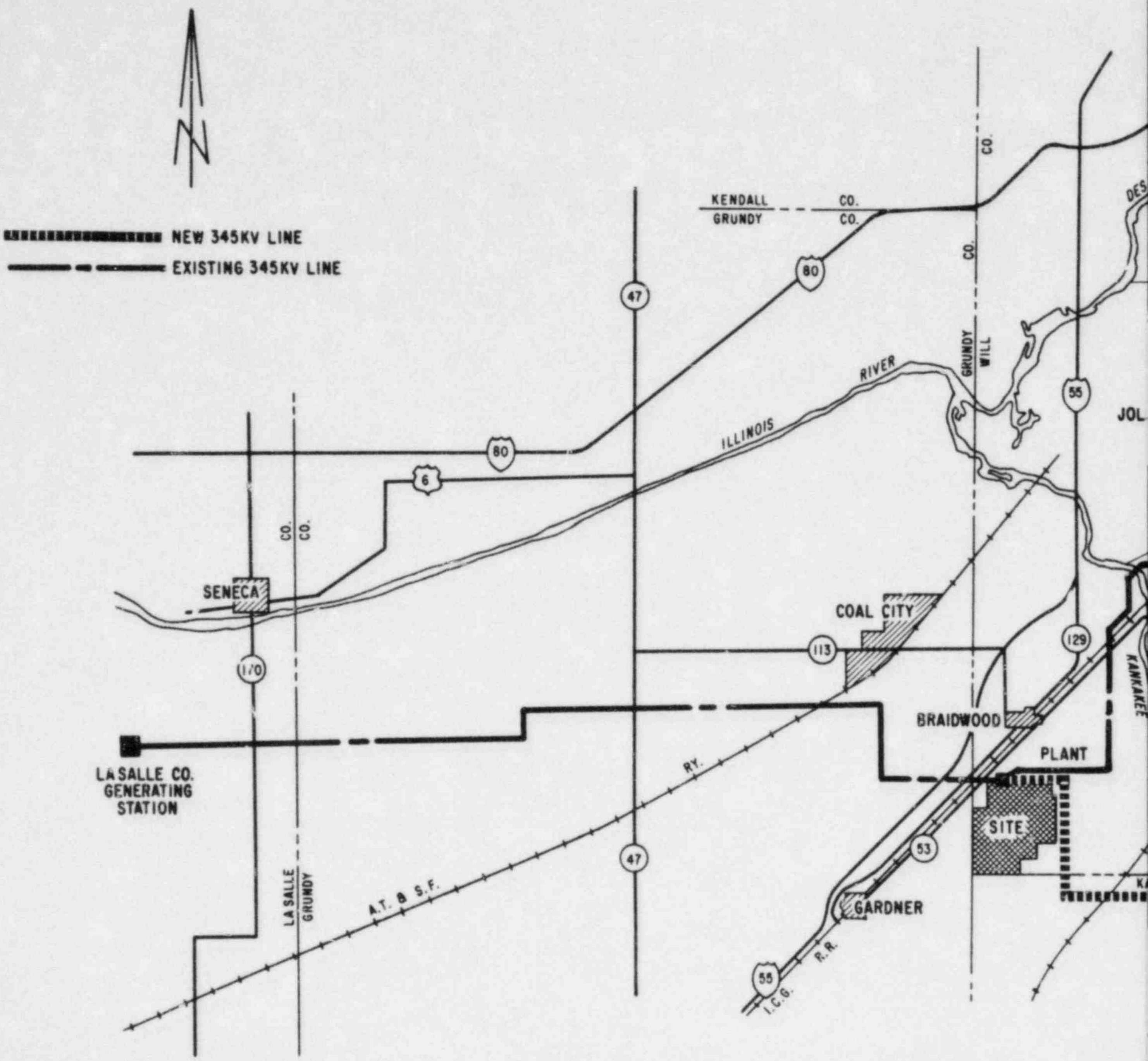
3.9.9 ENVIRONMENTAL CONSIDERATIONS OF TRANSMISSION ROUTING

The transmission system associated with the Braidwood Station will be routed over agricultural land for the majority of its distance. There are several smaller areas of either pure forest lands or mixed forest-field areas. In those areas where agricultural land is crossed, farming will be possible on the ROW after the erection of the structures. Those areas of forest where trees will have to be cut will be small, and the procedure will use proven techniques to selectively eliminate only that vegetation necessary for structure and line clearance and safety. Erosion will be kept to a minimum by using existing elevation grades along the routes, locating structures in crrek areas well back from bank edges, and regarding techniques. Special consideration will be given during construction to allow only minimal environmental degradation.

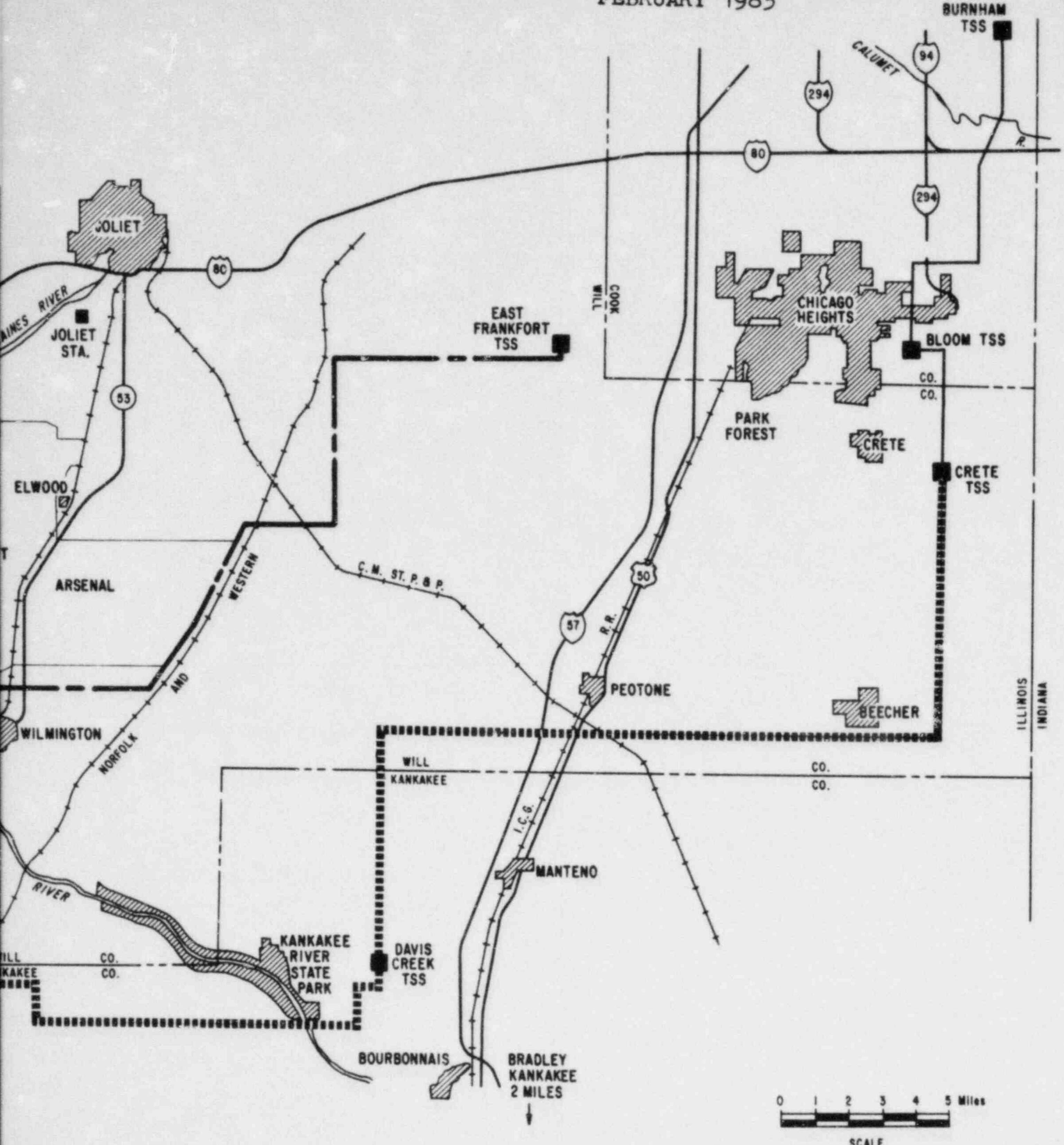
TABLE 3.9-1

ENVIRONMENTAL CONSIDERATIONS OF THE NEW BRAIDWOOD-CRETE TRANSMISSION CORRIDOR

PARAMETER	VALUE (Miles)	VALUE (%)	VALUE (acres)
Length	55.125		2100
Agricultural	48	87	1826
Open Woodland and Hedge Rows	3.375	6	129
Riparian Woodland	2.75	5	105
Intermittent Marshes	1	2	40
Creeks Crossed	11		
Rivers Crossed	Kankakee		
Highways Crossed			
Major	F.A.I. 57 Calumet Expr. - Illinois 394		
Minor	Illinois Route 113 Dixie Hwy. Illinois 1 U.S. Route 45 & 52 Illinois Route 102		
RR's Crossed	Norfolk and Western Illinois Central Gulf Chicago, Milwaukee, St. Paul & Pacific Chicago and Eastern Illinois		

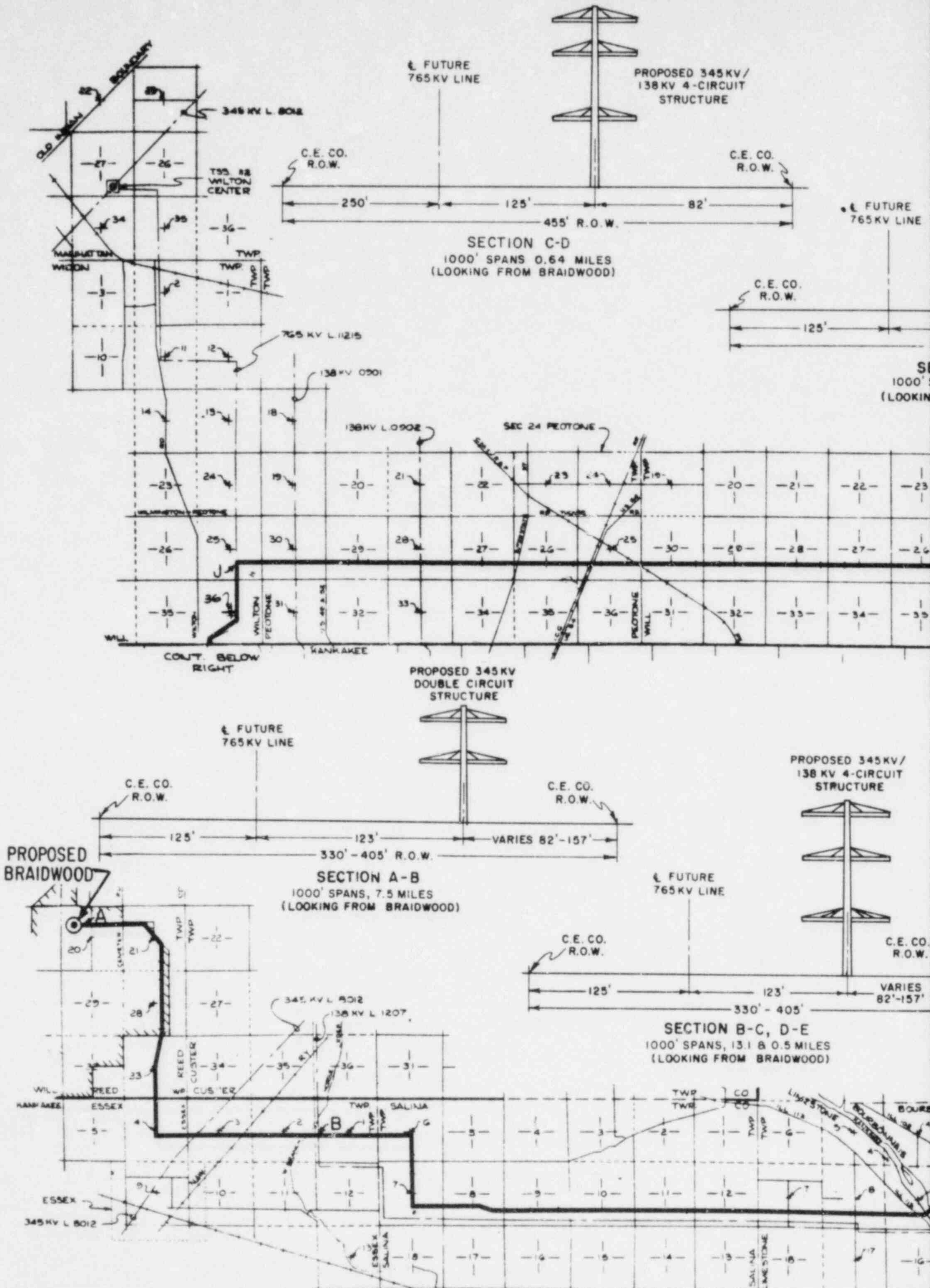

NEW 345KV LINE
EXISTING 345KV LINE
KENDALL CO.
GRUNDY CO.
GRUNDY CO.
WILL CO.
LASALLE CO.
GRUNDY CO.
ILLINOIS RIVER
DES
JOL
SENECA
COAL CITY
BRAIDWOOD
PLANT
SITE
GARDNER
KANKAKEE
LA SALLE CO. GENERATING STATION
A.T. & S.F. RY.
I.C.G. R.R.
80
47
6
55
113
129
170
53

AMENDMENT 1
FEBRUARY 1983



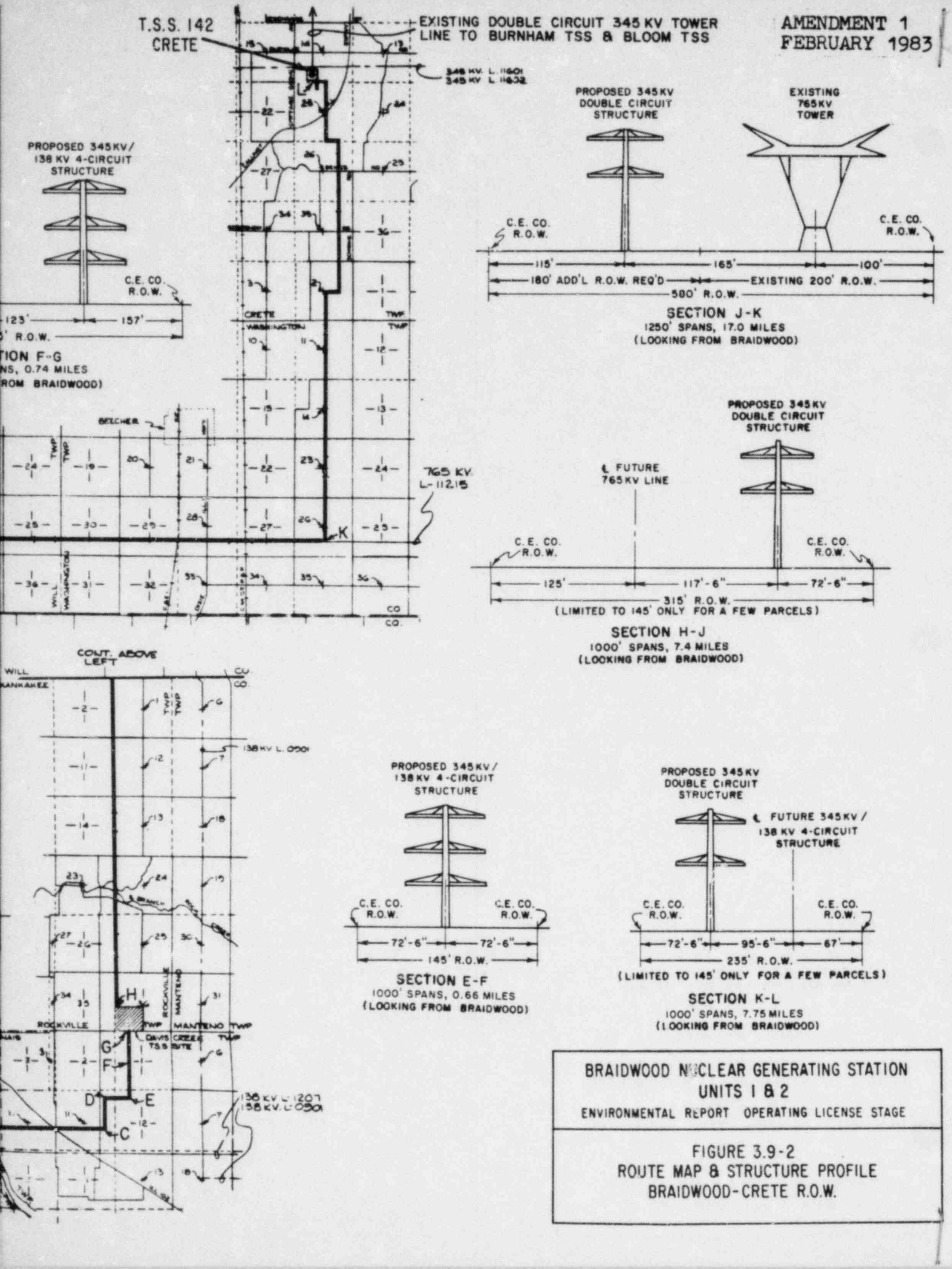
BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT OPERATING LICENSE STAGE

FIGURE 3.9-1
TRANSMISSION CONNECTIONS



℄ FUTURE 765KV LINE
PROPOSED 345KV/138KV 4-CIRCUIT STRUCTURE
C.E. CO. R.O.W.
250'
125'
82'
455' R.O.W.
SECTION C-D
1000' SPANS 0.64 MILES
(LOOKING FROM BRAIDWOOD)
345 KV L. 8012
TSS 88 WILTON CENTER
765 KV L. 11215
138 KV 0901
138KV L.0902
SEC 24 PEOTONE
CONT. BELOW RIGHT
KANKAKEE
PROPOSED 345KV DOUBLE CIRCUIT STRUCTURE
123'
VARIES 82'-157'
330'-405' R.O.W.
SECTION A-B
1000' SPANS, 7.5 MILES
(LOOKING FROM BRAIDWOOD)
PROPOSED BRAIDWOOD
330' - 405'
SECTION B-C, D-E
1000' SPANS, 13.1 & 0.5 MILES
(LOOKING FROM BRAIDWOOD)
345 KV L 8012
138 KV L 1207
ESSEX
345 KV L 8012

AMENDMENT 1
FEBRUARY 1983



BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT OPERATING LICENSE STAGE

FIGURE 3.9-2
ROUTE MAP & STRUCTURE PROFILE
BRAIDWOOD-CRETE R.O.W.

CHAPTER 4.0 - ENVIRONMENTAL EFFECTS OF SITE PREPARATION, STATION CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION

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CHAPTER 4.0 - ENVIRONMENTAL EFFECTS OF SITE PREPARATION, STATION CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION

4.1 SITE PREPARATION AND PLANT CONSTRUCTION

4.1.1 Construction Schedule

A Nuclear Regulatory Commission (NRC) construction permit for the Braidwood Nuclear Generating Station - Units 1 and 2 (Braidwood Station) was issued on December 31, 1975. As of July 1, 1982, 61% of the estimated $1.6 billion capital cost had been expended. Completion dates for Units 1 and 2 have been set for October 1985 1
and October 1986, respectively. The specific conditions for environmental protection attached to the contruction permits are listed in Section 4.5.

The effects of site preparation and construction activities on land and water use are described in the following subsections.

4.1.2 Land Use

In the development of the 4454 acre Braidwood Station site, 130 1
acres are affected for actual plant building activities, including 35 acres of woods and 70 acres of cultivated fields that will be changed during the life of the station from current use. There are also 25 acres of fallow fields within the station construction area. After building construction is completed, 20 acres will be occupied by permanent physical structures (Edmonds 1974).

The exclusion area around the station and switchyards includes approximately 300 acres, of which 120 acres are wooded. Approximately 35 acres of open woodland will be cleared for construction. The other 85 acres will remain standing. This limited clearing will maintain the availability of biotic cover in the Braidwood Station site area (Edmonds 1974).

Aerial photographic measurements conducted by Westinghouse Environmental Systems Department (WESD) during initial site surveys indicated that the proposed cooling pond will encompass 3540 acres, and construction will affect 704 acres of cultivated land, 301 acres of fallow-field vegetation, 222 acres of woods and 2313 acres of strip-mine spoil. Subsequent Commonwealth Edison Company (CECo) projections indicate that after the completion of mining in the area, the affected pond area is expected to comprise 2838 acres of strip-mine spoil, 204 acres of fallow fields, 117 acres of woods,
and 381 acres of agricultural fields. Approximately 784 acres 1
within the site will not be affected by station construction (Edmonds, 1974).

Station and pond construction and operation will reduce the amount of total cultivated land by 651 acres and of fallow fields by 229 acres, but this acreage represents only a small portion (less than 0.1%) of the 908,000 acres of farmland in the

immediate area (Grundy, Kankakee, and Will counties). Some land biota will be displaced from the Braidwood Station site into the surrounding area where selective competition will take place for already occupied niches. New habitats attractive to aquatic biota such as frogs, turtles, and some water fowl will be formed.

The Braidwood Station site is served by both highway and rail transportation facilities. Interstate 55 is less than 2 miles west-northwest, and Illinois State Routes 53 and 129 are less than a mile northwest of the station. The Illinois Central Gulf Railroad, which runs parallel with and between Routes 53 and 129, is used to provide spur track access from the site to the main line.

The initial site preparation work has two stages. The first stage consists of stripping, excavating, and backfilling the areas occupied by structures and roadways. The second consists of developing the site with all necessary facilities to support construction, such as offices, railroad tracks, warehouses, wells, sanitary facilities, and power lines. The actual station construction began while these activities were in progress.

To accommodate the construction force, an onsite parking area was constructed, and a sewage treatment facility was provided. After construction is completed, this parking area will be graded and seeded.

Existing roads on the station site are used as much as possible for construction activities. The only new roads are those within the construction area proper and a service road created for work on the river structures. A township roadway that entered Commonwealth Edison Company (CECo) property was closed with approval of the highway commissioner of Reed Township. The abandoned roadway has no public access or use and is completely controlled by CECo. No county, state, federal, or interstate highway has been rerouted as a result of Braidwood Station construction.

The designated construction areas, access ways, and laydown areas were cleared to permit construction of the permanent station structures and facilities. In order to minimize erosion, a construction drainage system was incorporated into the site development plan. Temporary gravel roads and permanent roads were installed with site grading and drainage facilities to permit all-weather use of the site for movement and storage of materials and equipment during construction.

Areas only temporarily disturbed by construction were stabilized by native vegetation. In all instances, erosion control measures around the construction area were planned and scheduled as part of construction operation. To the extent possible, mechanical disturbances during the construction of any of the associated facilities were limited to the immediate construction site. In construction laydown areas, temporary diversions were constructed

Since there are no projections or encroachments on the Kankakee River flood plain, the Kankakee River was not considered to be adversely affected by the construction of the river structures. The following special provisions were adopted during the construction of the intake and discharge structures:

a. All construction debris is immediately removed to prevent pollution of the Kankakee River.

b. All riprap and seeding work is performed so as to ensure optimum protection against potential soil erosion.

c. Construction is carefully conducted to minimize increases in suspended solids and turbidity, which may degrade water quality and damage aquatic life outside the immediate area of operation.

d. All dredged or excavated materials are placed in a confined area to prevent the return of polluted materials to the watercourse by surface runoff or by leaching.

e. Only clean, properly graded riprap materials are used in order to minimize local turbidity.

f. All cut and fill surfaces are well compacted, smooth, and uniform.

g. Where required, a uniform and dense stand of healthy perennial grass, free from bare spots and gullies formed by erocion, is provided.

The water supply and navigational capabilities of the Kankakee River were not considered to be adversely affected by dredging or other site preparation and construction activities.

Flooding of the cooling pond area will result in a reduction in land species numbers because of the loss of diverse habitats (see Subsection 2.2.2) and the creation of specialized habitats such as marshes and open waters. This should result in an increase of waterfowl and shore-bird species. Although the Braidwood Station site is not situated along any major flyway corridor for migratory waterfowl, except for geese, the possibility exists that as a result of the relatively warm pond water temperatures during winter and early spring migratory periods, waterfowl may be attracted to the pond's ice-free water. Only small numbers of geese normally would be expected to stop at intermittent water areas along their migratory route.

Aquatic vegetation is expected to develop in areas of pond shoreline, island perimeter, and throughout areas of low water depth. Plant development and growth will depend on water turbidity, water quality, and growth substrate. Vegetation may

establish additional supporting factors for waterfowl feeding and nesting areas.

Aquatic mammals, reptiles, and amphibians are also expected to increase in population density as a result of the pond formation for two reasons. First, the pond should provide adequate habitat for these species, and second, the relatively warm air and water temperatures may result in increased winter activities.

The construction of the essential service water cooling pond and pond screenhouse will have no impact on the local groundwater regime since the pond and screenhouse will be built within the area sealed off from the sand aquifer by the dike.

Dewatering operations consist of pumping only from collector ditches and therefore, do not significantly affect groundwater levels. Eight piezometer wells were installed around the Braidwood Station main building excavation and are being monitored to ensure that dewatering operations do not affect local groundwater. Dewatering operations have not affected groundwater level or quality (see Subsection 6.1.2).

4.1.4 Monitoring Program

4.1.4.1 Terrestrial Studies

CECo. conducted 2 years of preconstruction terrestrial monitoring at the Braidwood Station site. The first year (1972-1973) baseline terrestrial surveys began in the fall of 1972 and continued on a seasonal basis during the winter, spring, and summer of 1973. The results and projections of construction impact concluded from these 1972 through 1973 studies were included in Subsection 2.7.1 and 4.1.5 of the "Braidwood Nuclear Generating Station - Units 1&2 Environmental Report - Construction Permit Stage" (ER-CPS). The impact was assessed in this report and in the "Braidwood Final Environmental Statement" (FES).

To augment the 1972 through 1973 baseline survey, a program was designed for the 1974 through 1975 period. The results and conclusions presented in the 1974 through 1975 final terrestrial report further support the impact assessment presented in both the ER-CPS and the FES. The 1974-1975 report summaries are included in Subsection 2.2.5.

A comparison of the 1972 through 1973 and 1974 through 1975 terrestrial survey results indicated no significant differences between these 2 years of baseline monitoring. Similar conclusions

resulted in the elimination of a construction-phase terrestrial monitoring program (see Appendix 4.1A).

In order to detect the effects, if any, of filling the Braidwood cooling pond, a terrestrial monitoring program was developed. This program consists of vegetation documentation before and after the filling of the cooling pond. Consequently, any environmental effects that could possibly be due to the filling of the cooling pond would be detected by the surveys.

4.1.4.1.1 Summary of 1979 through 1982 Terrestrial Monitoring

Cropland is the predominant land use in the vicinity of the Braidwood Station. Vegetation composed of trees, shrubs and herbaceous plants occurs along roadsides and on the borders of the cropland. For the most part, the cooling pond has utilized the area formerly used in strip mining. Vegetation around the cooling pond is characterized by species which invade disturbed soils. The most prominent is cottonwood (*Populus deltoides*).

During the 1979 survey most crops were either harvested or were ready for harvesting. In the following surveys (1980, 1981, 1982) crops were in their late maturation stage.

The surveys indicate insect damage and a number of common plant
diseases on the roadside vegetation. None of the diseases are 1
attributed to act'vities associated with the station. These dis-
eases normally co-exist with the local plant species to some de-
gree. The more representative of the damage and diseases during
the past four years include spider mite injury, oak wilt, Dutch elm
disease, powdery mildew, tent caterpillars, pine-wood nematode and
canker diseases.

The crops in the surrounding area exhibited diseases such as Phytophythoria root rot and nutrient deficiencies. Also, some crops had water related damage. Monitoring of observation wells in the area confirm that the slurry cutoff trench method of seepage control that was used for dike construction has been effective, therefore, water seepage from the cooling pond is not a suspected cause of this problem. Instead above average rainfall and poor farming techniques are more likely responsible.

Inside the site boundaries, some vegetation displayed injury resulting from soil compaction or physical damage. This is attributed to station construction activities. Moreover, other vegetation, both on and outside the site, exhibited inury from natural occurring wood rot or storm damage. There were some isolated cases off of the site where vegetation was injured due to farming operations.

None of the above diseases or injuries are considered to have been exacerbated by the filling of the cooling pond. Furthermore, none of the vegetation problems occurring outside of the station boundary are considered to be a result of activities associated with Braidwood Station. 1

4.1.4.2 Aquatic Studies

CECo conducted 2 years of preconstruction aquatic monitoring at the Braidwood Station site. The first year (1972-1973) baseline aquatic monitoring program on the Kankakee River and Horse Creek began in October 1972 and continued through September 1973. The results and projections of construction impact concluded from the 1972 through 1973 studies were included in Subsections 2.7.2., 5.1.3, and 5.1.4.1 of the ER-CPS and in the FES.

To augment the 1972 through 1973 baseline survey, a program was designed for the 1974 through 1975 period. Field surveys for the 1974 through 1975 program were initiated on the Kankakee River and Horse Creek in March 1974 and were conducted through March 1975. This completed the preconstruction monitoring program. The results of the 1974 through 1975 program are presented in Subsection 2.2.1.

CECo.'s construction phase aquatic monitoring program began in
March, 1977 and included seasonal sampling of Horse Creek and the
Kankakee River during the years of 1977, 1978, 1979 and 1981.
Sampling was suspended in 1980 due to the cessation of station
construction activities. Biological parameters that were monitored 1
during the sampling periods, included periphyton, benthos, fish,
fish eggs and larvae and water chemistry. A summary of the moni-
toring program objectives are contained in Appendix 4.1B. Results
of the construction phase aquatic monitoring are found in section
4.1.4.2.1.

4.1.4.2.1 Results of Construction Phase Aquatic Monitoring

With regard to periphyton collected from artificial sub-
strates, most species identified during the 4-year study were dia-
toms (Bacillariophyta) although considerable accumulations of green
algae (Chlorophyta) and blue-green algae (Cyamophyta) also oc-
curred. The most productive station based on accumulated biomass
was located approximately 1000 feet downstream of the discharge
structure (station 5L). The least productive was located in the
immediate vicinity of the discharge structure (station 4R). Al-
though there was no apparent relationship between accumulated bio- 1
mass and ancillary factors such as light, turbidity, or current,
increased diversities were apparently associated with reduced cur-
rent. Any variances in the periphyton communities was reflective
of natural habitat differences.

Benthic communities in the study area exhibited comparable taxa numbers throughout the study. Communities at three stations (stations 4R, 4L and 6L) remained essentially unchanged since the study began. The stations

(Stations 1R and 6R) shifted from a marginally depositional character to an erosional character. The dominants at these stations changed from Oligochaeta, Hexagenia and Sphaerium to Heptageniidae. Biomass and density of Hexagenia decreased at two stations (Stations 5L and 5R) although they retained their depositional constitution. Communities present in the immediate vicinity of the discharge structure (4R) exhibited no detrimental effects resulting from construction. Any significant differences in the benthic community were the result of natural causes usually related to substrate type or flow rate. Diversity values indicated that the communities were under little environmental stress.

Of the fish collected, no species were on the Illinois list of endangered or threatened species, although the pallid shiner, Notropis amnis is rare in the area studied.

The numbers of fish in seine hauls declined over the study period and was probably due to increased water velocities and water depths. The electrofishing catch in August, 1981 was dominated by redhorse suckers (Moxostoma spp.) accounting for 51 percent of the total biomass which was the highest biomass collected during the 4-year study. Stations on the left side of the river were more productive than those on the right, reflecting habitat differences. The effects of construction on total biomass and abundance 1
of fishes collected at the intake site (Station 3R) were negligible although there was a change in species composition. Most fish collected in 1981 exhibited slow growth and lower than average condition factors, possibly due to high water and turbidity levels.

Water quality was generally good. Phosphorus levels were high, but not unusual for Illinois waters. The trace metals of cadmium and manganese along with the pesticide dieldrin and PCB's exceeded recommended levels in August 1981. However, the presence of the intake and discharge structures had no apparent effect on water quality of the study area.

In summary, any variance in the biota of Horse Creek and the Kankakee River near the Braidwood intake and discharge structures was reflective of natural habitat or seasonal changes in the environment. There was no apparent effect on the environment from station construction activities. This conclusion was supported by the diverse assemblage of fish species which included a widespread distribution of "pollution-intolerent" species, as well as the more common tolerent species. Moreover, the water quality was good with the periphyton and benthos communities exhibiting only variations due to natural ecological conditions. Abstracts detailing the results from each of the four years during which the area was studied are included in Appendix 4.1C.

4.1.4.1 Clam Bed Mapping

A reconnaissance of the pelecypod fauna of the Kankakee River near the Braidwood Station was conducted by Nalco Environmental Sciences on June 23 through 25, 1976. It was found that clam beds were located upstream and downstream of the intake and discharge area and also in the immediate area of the intake and discharge structures. A total of 18 species of clams was collected during this study (see Table 4.1-1). Actinonaisas ligamentina and Lasmigona costata were the two most abundant species collected from the Kankaee River (Nalco 1976).

In response to a request from the United States Department of the Interior, Fish and Wildlife Service, a clam bed mapping program was conducted on November 2 through 4, 1976. The objectives of this sampling were to determine the configuration of clam beds in the area, determine the species composition of the clam beds, and the densities of the clam species. The following subsections describe the materials, methods and results of the November 1976 mapping program (Nalco 1977).

4.1.4.3.1 Materials and Methods

A series of 24 transects was established across the Kankakee River. Twenty-one transects were established upstream and downstream in the vicinity of the proposed intake and discharge structures. An additional set of three transects was established approximately 1 mile downstream. Each transect consisted of four sampling locations, one location near each shore and two midstream locations. Locations were chosen to divide the stream into approximate one-quarter sections. Once a sampling location had been established it was marked using a Hewlett Packard (Model #3810A) electronic distance measuring device. Data generated by this measuring procedure were transformed by computer program and printed out as a map. Figures 4.1-2 and 4.1-3 were based on this computer generated map. Permanent reference points have been established and any location can be re-established using this system.

A 0.5-square meter frame was placed on the substrate and all unionids contained by this area were collected, identified, enumerated, and returned to the river bed. Because of the deep burrowing habits of many species, the substrate section within the frame was searched to a depth of approximately 6 inches. Collections were made either by wading or SCUBA diver.

Taxonomic keys used included Baker (1928); Parmalee (1967); Starrett (1971); and van der Schalie (1938). Dr. Max Matteson of the University of Illinois was also consulted for taxonomic verifications.

4.1.4.3.2 Results and Discussion

4.1.4.3.2.1 Species Composition

A total of 13 species of unionids was collected during this mapping study (see Table 4.1-2). Historical comparisons were made previously (Nalco 1976). The additional species collected during this study indicated that perhaps only two species of unionids have been lost in this section of the river during the last half century (see Table 4.1-3). Three species that were previously collected only as dead shells were collected live. Three other species were collected during the November sampling that had not been found in June 1976. One species (*Pleurobema cordatum*) collected in November was not reported from this area of the river by Wilson and Clark (1912). None of the unionid species collected is considered rare or endangered (U.S. Department of the Interior 1976).

4.1.4.3.2.2 Densities of Unionid Species

Densities of the unionids collected are summarized by location in Table 4.1-4. Maximum densities generally correlated with moderate to high river current and a substrate composed of sand and gravel. One species (*Amblema costata*) however was most

frequently collected from silty substrates in areas of slow current. The most abuindant clam collected was Actinonaias carinata, which composed approximately 75% of the total clams collected.

4.1.4.3.2.3 Configuration of Clam Beds

The almost continguous nature of unionid distribution was quite apparent (see Figure 4.1-2). Maximum densities of Actinonaias carinata closely paralleled maximum unionid densities (see Figure 4.1-3).

4.1.4.4 Clam Bed Mapping - 1981

A mussel survey which duplicated the 1976 mapping study was conducted during October 13-16, 1981 approximately one year after completion of the intake and discharge structures.

4.1.4.4.1 Results and Discussion

4.1.4.4.1.2 Species Composition

A total of 15 species of freshwater mussels (naiades) and the Asiatic clam, Corbicula fluminea were collected during the mapping survey (See Table 4.1-5). The predominant species was Actinonaias carinata (approximately 75 percent of total mussel fauna). Amblema costata ranked a distant second while all other species collected in 1981 were minor components of the total mussel fauna.

Three fresh-dead specimens of Plethobasus cyphyus were found in a
muskrat midden during the present survey. This mussel species is 1
considered uncommon to rare in Illinois but one relic valve of this species was collected by others in a 1976-1978 survey of the Kankakee River. Although Lampsilis higginsii, a federally protected mussel, was last reported in the Kankakee River in 1955, no live individuals or relic valves of this species was observed in the 1981 survey.

The 1981 survey yielded three species, Anodonta grandis grandis, Megalonaias gigantea and Strophitus undulatus, which were not collected in the 1976 survey. Only one species, Lasmigona complanata was present in 1976 but not in 1981. This species is found in quiet water and fine-grained substrata, a habitat not common in the study area.

4.1.4.4.1.2 Densities of Unionid Species

Densities of the unionids collected are summarized by location in Table 4.1-6 and depicted in Figure 4.1-3. Greatest mussel densities

occured in the riffle section of the study area which was approximately 2-4 feet in depth with a fast current velocity (approximately 3 ft/sec). The area was a predominantly rubble and interstitial sand substrate. Actinonaias carinata was the dominant species in this riffle habitat (maximum density: 76 individuals/ m^2). All other species were generally widely scattered and never abundant at any location with the exception of Elliptio dilatatus. Although this species was present at only one site, three individuals (density = $12/m^2$) were collected from a single frame sample.

4.1.4.4.1.3 Configuration of Clam Beds

Maximum densities of freshwater mussels occurred in the riffle habitat near the mouth of Horse Creek. The configuration of this dense mussel assemblage in 1981 was similar to the configuration found in the 1976 survey. Any density difference between the surveys were attributed to the natural variability.

Generally, the area sampled upstream from the riffle near Horse Creek was void of mussels or sparsely populated as was the area immediately downstream from the riffle habitat (near the area of the intake structure). This configuration was comparable to that found in the 1976 survey. 1

The 1981 survey indicated a slightly more widespread mussel assemblage present one mile downstream of the intake and discharge structures. However, relative densities in this area were low during both surveys.

Other mussel species collected in the study area during 1976 and 1981 were generally present in low densities and were sporadically distributed. Most of these species were collected at locations with a constant current and rocky substrate.

4.1.4.4.1.4 Impact of Intake and Discharge Structures Construction

The 1976 and 1981 surveys indicate that the mussels adjacent to the intake and discharge structures were sporadic in distribution and low in density. Construction activities disturbed these mussels but, because of the low density, this impact was considered insignificant when compared to the entire mussel community of the area. No other impacts on the community were detected.

TABLE 4.1-1

UNIONIDAE, SPHAERIIDAE, AND CORBICULIDAE COLLECTED FROM THE KANKAKEE RIVER AND HORSE CREEK NEAR BRAIDWOOD, ILLINOIS, JUNE 1976

Unionidae

Unioninae

Amblema plicata (Say)
Elliptio dilatatus (Rafinesque)[a]
Fusconaia flava complex [b]
Quadrula metanevra (Rafinesque)[b]
Q. pustulosa (Lea)
Q. quadrula (Rafinesque)

Anodontinae

Lasmigona complanata (Barnes)[a]
L. costata (Rafinesque)
Strophitus undulatus (Say)

Lampsilinae

Actinonais ligamentina (Lamarck)
Lampsilis siliquoidea (Barnes)[ab]
L. ventricosa (Barnes)
Ligumia recta (Lamarck)[b]

Sphaeriidae

Pisidium sp. (Pheiffer)
Sphaerium straitinum (Lamarck)
S. sulcatum (Lamarck)
S. transversum (Say)

Corbiculidae

Corbicula manilensis (Philippi)

---

[a]Collected in Horse Creek only.

[b]Species collected as dead shells only.

TABLE 4.1-5

SCIENTIFIC AND COMMON NAMES OF THE FRESHWATER MUSSELS AND CLAMS COLLECTED FROM THE KANKAKEE RIVER NEAR CUSTER PARK, ILLINOIS 13-16 OCTOBER 1981

Species	Common Name
Corbiculidae	
Corbicula fluminea (Muller)	Asiatic Clam
Unionidae	
Ambleminae	
Amblema costata Rafinseque	Three-Ridge
Megalonaias gigantea (Barnes)	Washboard
Quadrula metanevra (Rafinesque)	Monkey-Face
Q. pustulosa (Lea)	Pimple-Back
Q. quadrula Rafinesque	Maple-Leaf
Unioninae	
Actinonaias carinata (Barnes)	Mucket
Alasmidonta marginata (Say	Elk-Toe
Anodonta grandis grandis Say	Floater
Cyclonaias tuberculata (Rafinisque)	Purple Warty-Back
Elliptio dilatatus (Rafinesque)	Spike
Lampsilis radiata siliquoidea (Barnes)	Fat Mucket
Lasmigona costata (Rafinesque)	Fluted Shell
Ligumia recta latissima Rafinesque	Black Sand Shell
Pleurobema cordatum coccineum (Conrad)	Round Pig-Toe
Strophitus undulatus (Say)	Strange Floater

1

TABLE 4.1-6

DENSITIES (no./m^2) AND SPECIES COMPOSITION OF MUSSELS COLLECTED FROM THE KANKAKEE RIVER NEAR CUSTER PARK, ILLINOIS, 13-16 OCTOBER 1981

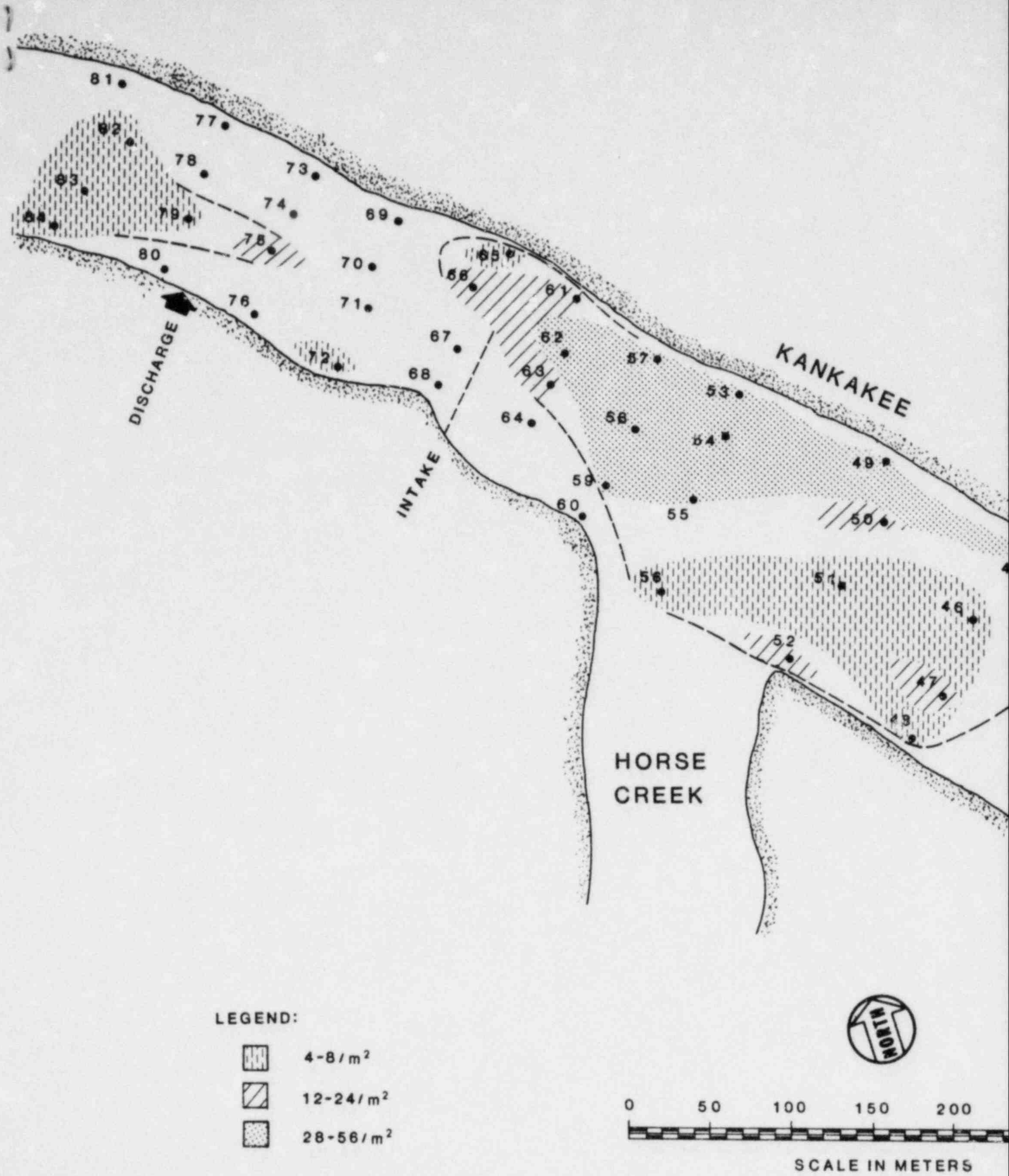
Location	Taxon	No./m^2	Location	Taxon	No./m^2	Location	Taxon	No./m^2	Location	Taxon	No./m^2
1	Lampsilis siliquoidea	4	2	--	-	3	--	-	4	--	-
5	--	-	6	Actinonaias carinata	8	7	--	-	8	Amblema costata	4
9	Amblema costata	4	10	Actinonaias carinata Ligumia recta	12 4	11	--	-	12	--	-
13	Amblema costata	4	14	Actinonaias carinata	32	15	--	-	16	--	-
17	--	-	18	Actinonaias carinata Quadrula metanevra	20 4	19	--	-	20	--	-
21	Anodonta grandis	4	22	Actinonaias carinata	4	23	--	-	24	--	-
25	--	-	26	Actinonaias carinata Quadrula pustulosa	12 4	27	--	-	28	--	-
29	--	-	30	Actinonaias carinata	4	31	Lasmigona costata	4	32	--	-
33	--	-	34	Amblema costata	8	35	--	-	36	--	-
37	Amblema costata	4	38	Actinonaias carinata Quadrula pustulosa	12 4	39	--	-	40	--	-
41	Amblema costata	4	42	Actinonaias carinata	4	43	--	-	44	Lampsilis siliquoidea	4
45	Actinonaias carinata Amblema costata Lampsilis siliquoidea Quadrula pustulosa	20 4 4 8	46	Actinonaias carinata Amblema costata Quadrula pustulosa	20 4 4	47	--	-	48	--	-
49	Actinonaias carinata Amblema costata Cyclonaias tuberculata Lasmigona costata	20 4 4 4	50	Actinonaias carinata	40	51	--	-	52	Actinonaias carinata	8

1

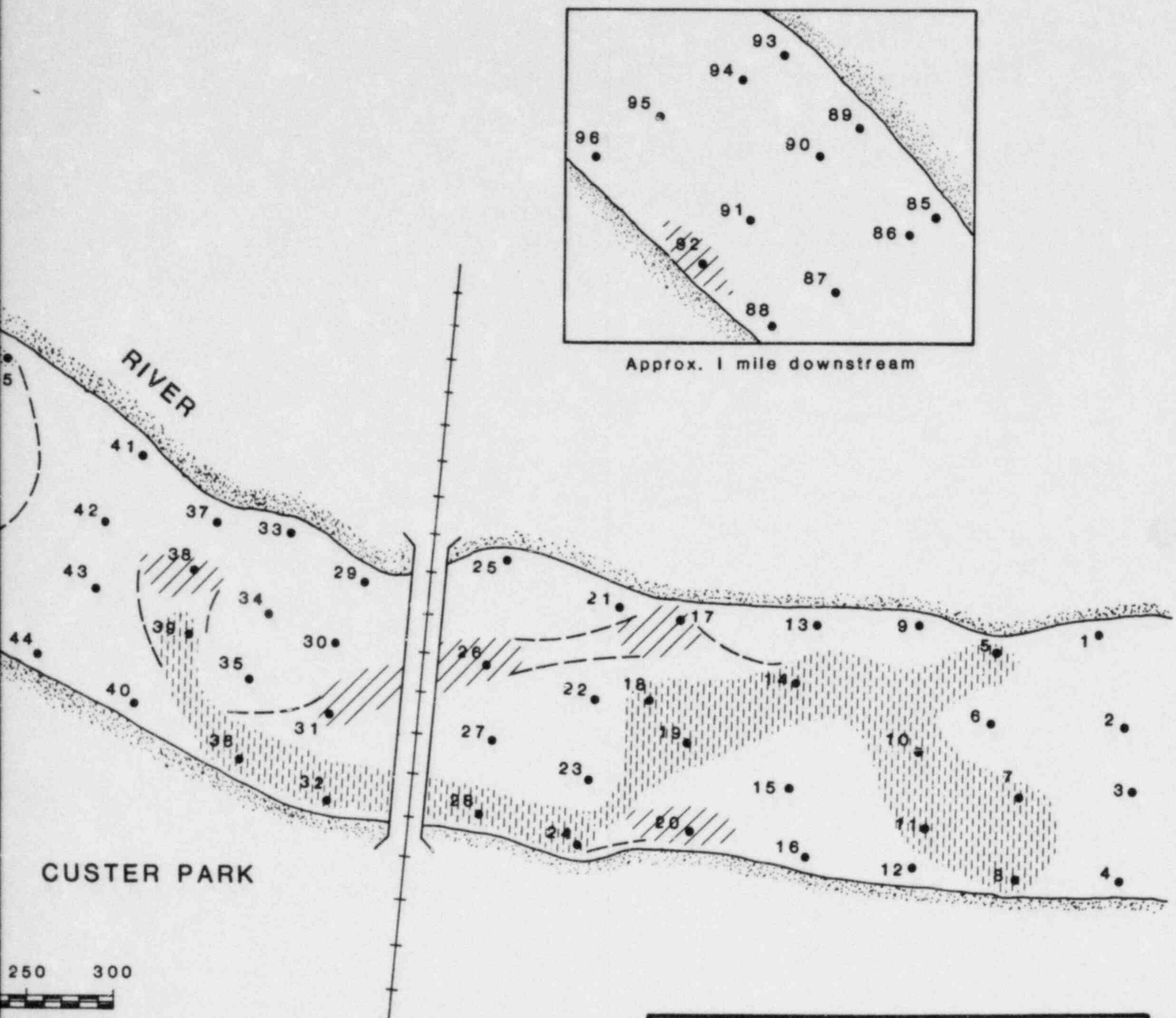
TABLE 4.1-6 (Cont'd)

DENSITIES (no./m^2) AND SPECIES COMPOSITION OF MUSSELS COLLECTED FROM THE KANKAKEE RIVER NEAR CUSTER PARK, ILLINOIS, 13-16 OCTOBER 1981

Location	Taxon	No./m^2	Location	Taxon	No./m^2	Location	Taxon	No./m^2	Location	Taxon	No./m^2
53	Actinonaias carinata	44	54	Actinonaias carinata	16	55	Actinonaias carinata	16	56	Actinonaias carinata	12
	Lampsilis siliquoidea	4								Elliptio dilatatus	13
	Megalonaias gigantea	4									
57	Actinonaias carinata	56	58	Actinonaias carinata	8	59	Actinonaias carinata	76	60	--	-
	Lampsilis siliquoidea	4		Quadrula pustulosa	8		Lasmigona costata	4			
	Corbicula fluminea	4									
61	Actinonaias carinata	12	62	Actinonaias carinata	44	63	Actinonaias carinata	12	64	--	-
				Amblema costata	4		Amblema costata	4			
65	--	-	66	Actinonaias carinata	56	67	--	-	68		
				Quadrula metanevra	4						
69	Actinonaias carinata	4	70	Actinonaias carinata	16	71	--	-	72	--	-
	Alasmidonta marginata	4									
73	--	-	74	Actinonaias carinata	24	75	--	-	76	Strophitus undulatus	4
				Pleurobema cordatum	4						
77	Lampsilis siliquoidea	4	78	--	-	79	--	-	80	--	-
81	--	-	82	--	-	83	--	-	84	--	-
85	--	-	86	--	-	87	Amblema costata	4	88	Amblema costata	8
										Quadrula quadrula	4
89	--	-	90	Amblema costata	4	91	Amblema costata	4	92	Actinonaias carinata	4
				Andonta grandis	4						
93	--	-	94	--	-	95	Amblema costata	8	96	Amblema costata	4
							Quadrula quadrula	4			



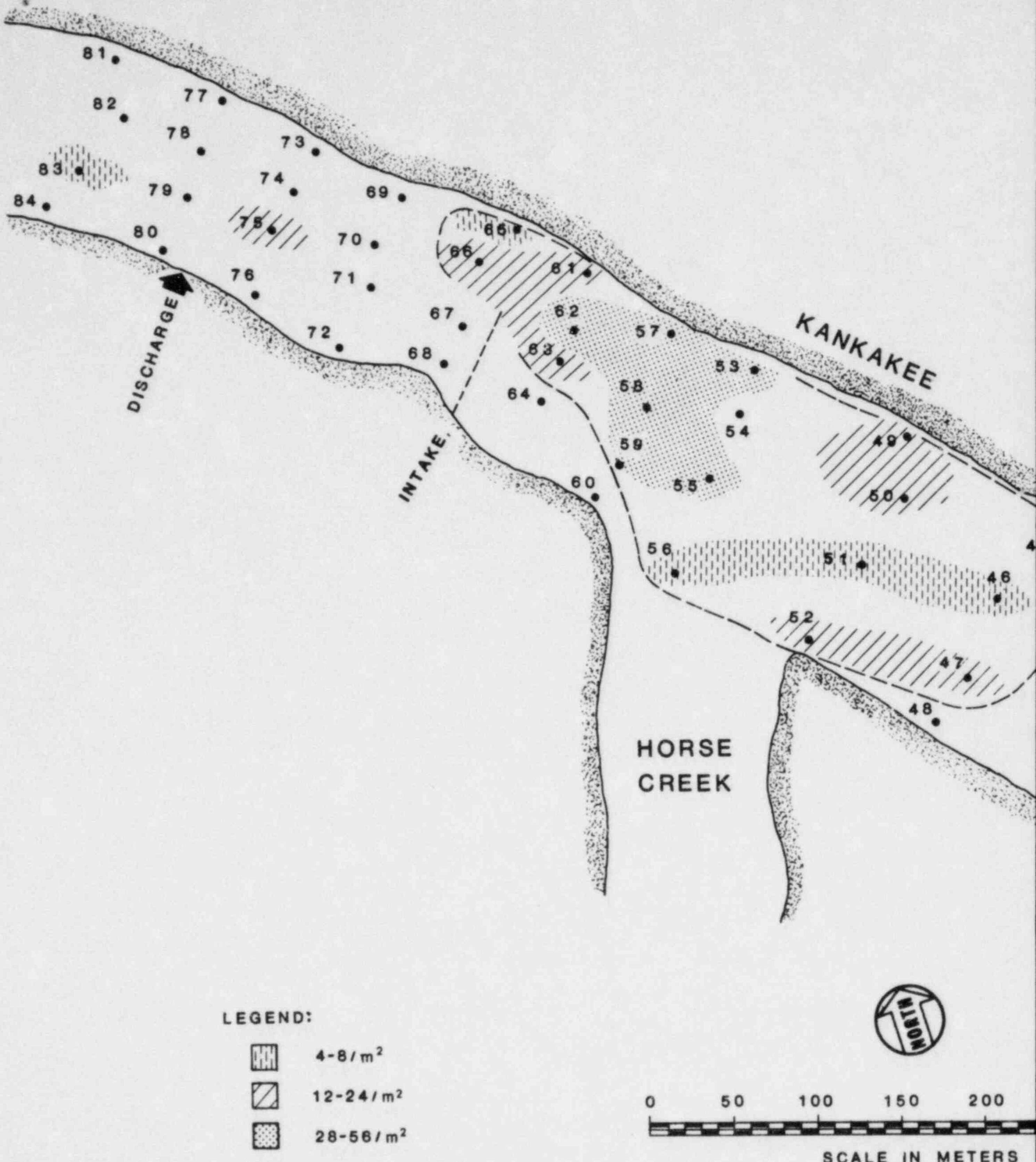
NALCO ENVIRONMENTAL SCIENCES



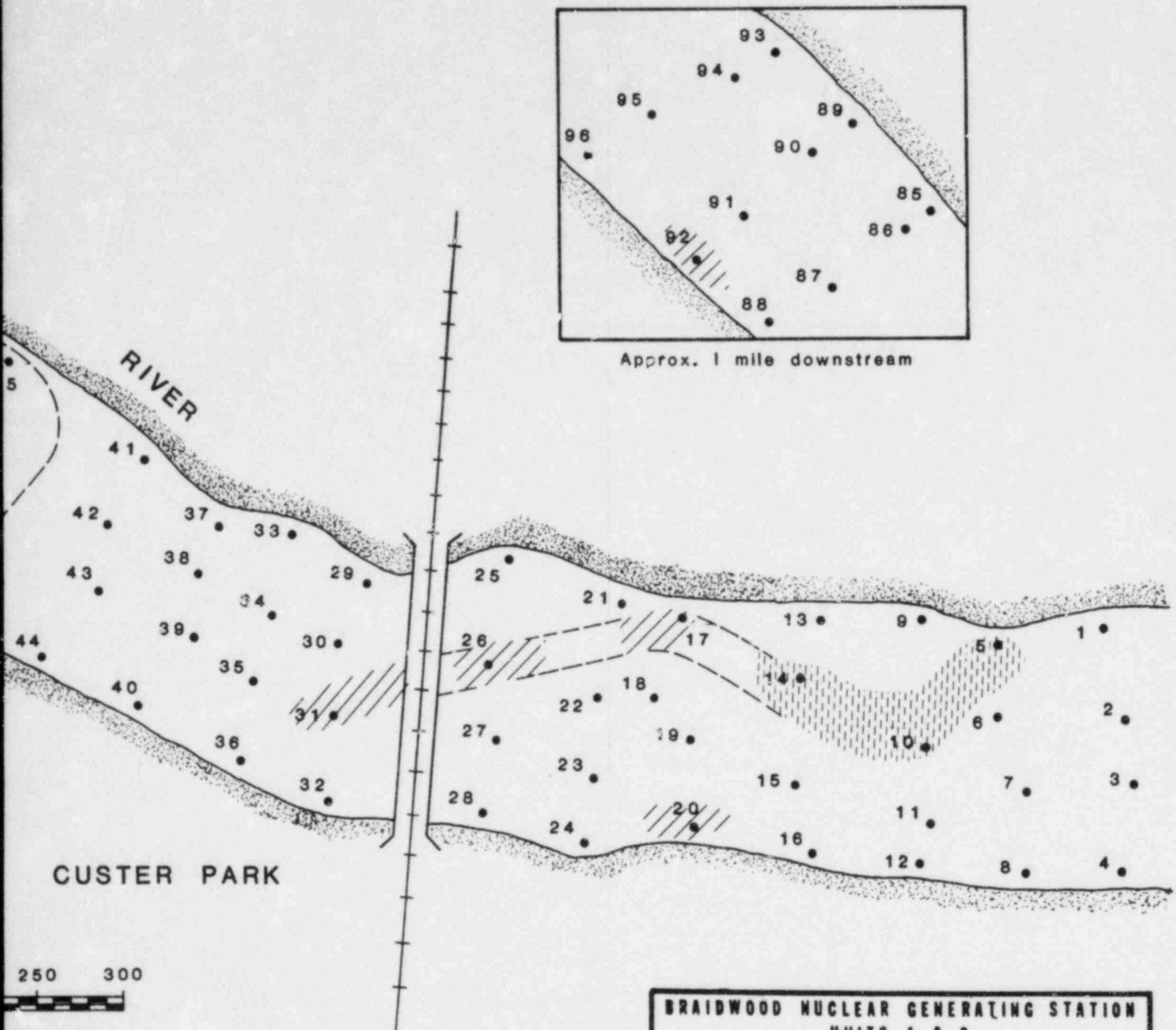
BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

FIGURE 4.1-1

CLAM BED DENSITIES BY LOCATION
FOR TOTAL PELECYPODA IN THE KANKAKEE
RIVER NEAR BRAIDWOOD STATION, NOV. 1976



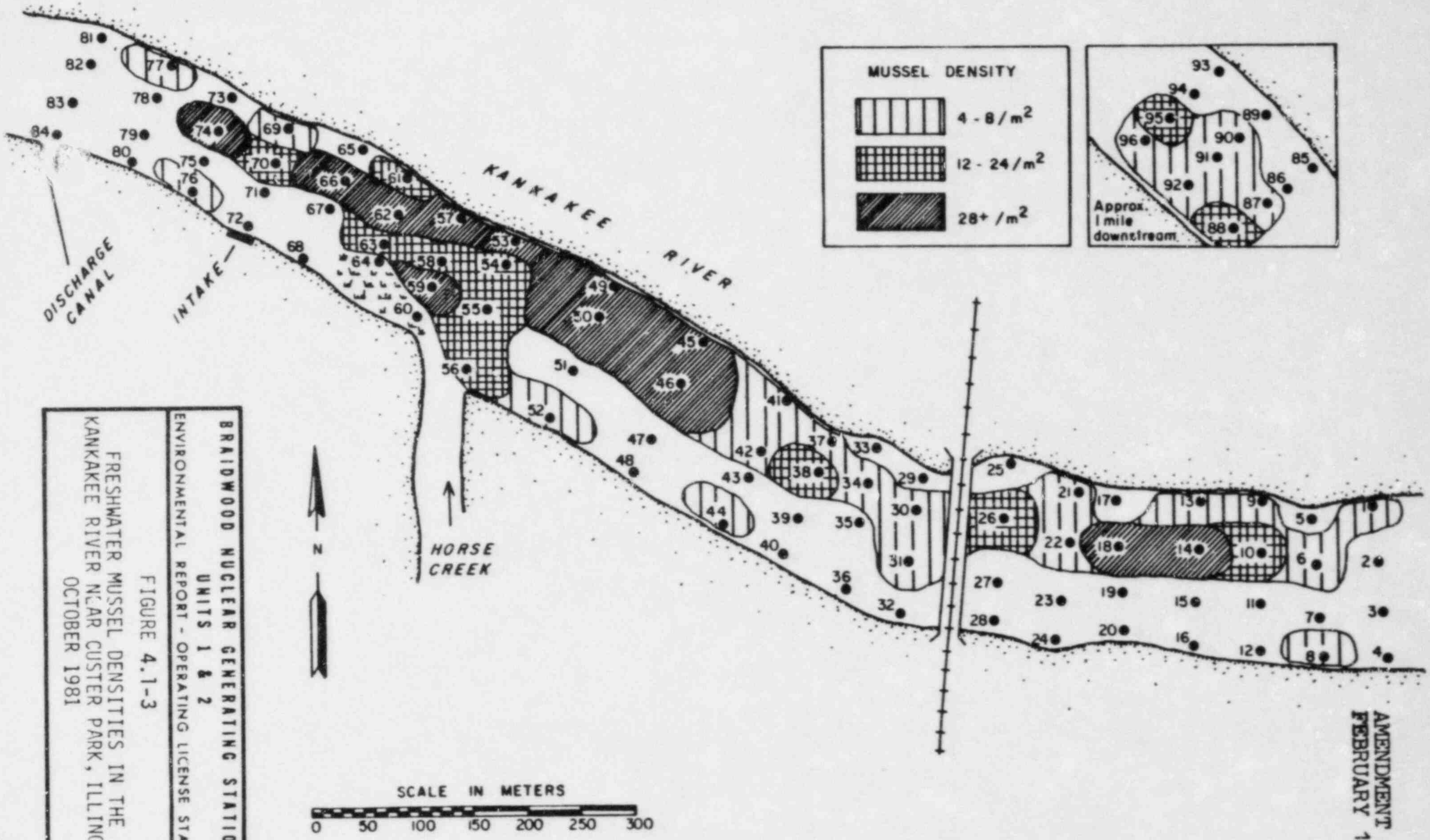
NALCO ENVIRONMENTAL SCIENCES



BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

FIGURE 4.1-2

DENSITIES BY LOCATION FOR ACTINONAIS CARINATA IN THE KANKAKEE RIVER NEAR BRAIDWOOD STATION, NOV. 1976



BRAIDWOOD NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

FIGURE 4.1-3
FRESHWATER MUSSEL DENSITIES IN THE
KANKAKEE RIVER NEAR CUSTER PARK, ILLINOIS
OCTOBER 1981

AMENDMENT 1
FEBRUARY 1983

APPENDIX 4.1A - TERRESTRIAL MONITORING PROGRAM LETTERS

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1

Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

July 13, 1978

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Terrestrial Monitoring Program
at Braidwood Station
NRC Docket Nos. 50-456 and 50-457

Reference (a): August 21, 1975 letter from Daniel R. Muller to Byron Lee, Jr. concerning the Braidwood Station Terrestrial Monitoring Program

Dear Sir:

In Reference (a), the NRC Staff requested Commonwealth Edison Company to submit for review in the Fall of 1978 a proposed program for monitoring the effects of lake filling at Braidwood Station. In accordance with this request, a preoperational and operational terrestrial monitoring program is hereby submitted for your review. This program has been tailored to reflect current land use practices and also information obtained by terrestrial monitoring between 1973 and 1975.

The proposed preoperational phase terrestrial ecological monitoring will consist of a fifteen (15) square mile aerial infrared photogrammetric program which will be implemented on an annual basis using two scales of photography. A scale of 1" to 500' will be employed for detailed examinations and 1" to 2,000' will be used for a comprehensive mosaic of the Braidwood site environs. Ground truthing would verify or discount suspected areas as determined by photographic reconnaissance.

Program objectives include:

(1) Identification of ground cover;

(2) Detection of diseased, injured and/or stressed vegetation; and

(3) Production of a permanent record of the condition, quantity and boundary of each vegetative community.

A readily identified ground cover will enable the station to monitor the revegetation of the dike perimeter, makeup and blowdown corridor, and station areas. This photographic approach will produce a permanent record of the revegetation progress and the status of vegetation in the fifteen (15) square mile area.

The proposed program will commence in the Summer of 1979 before lake fill and will terminate one (1) year after Unit 2 begins commercial operation.

Please address additional questions which you may have to this office.

One (1) signed original and four (4) copies of this letter are provided for your use.

Very truly yours,

W. F. Naughton

W. F. Naughton
Nuclear Licensing Administrator
Pressurized Water Reactors

cc: Region III, NRC

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Docket Nos. STN 50-456
and STN 50-457

AUG 10 1979

Commonwealth Edison Company
ATTN: Mr. Cordell Reed
Vice President
P. O. Box 767
Chicago, Illinois 60690

Gentlemen:

In your letter of July 13, 1978, you submitted for our review a pre-operational terrestrial monitoring program to determine the effects of lake filling at the Braidwood Station site. Our staff has examined your proposed program using aerial infrared photography and finds it satisfactory in most respects. The staff recommends the following clarifications or alterations to your suggested program:

1. Colored infrared film should be used, since it produces more easily interpreted photographs than black and white film.

2. The annual photographs should be taken at approximately the same time of year.

3. The program, commencing in the summer of 1979, should continue for two years after Unit 2 begins commercial operation.

With these modifications, the terrestrial monitoring program outlined in your letter is approved. A description of the results of the program should appear in the Annual Reports for Braidwood Station.

Sincerely,

Wm. H. Regan, Jr., Acting Assistant Director
for Environmental Projects & Technology
Division of Site Safety and
Environmental Analysis

APPENDIX 4.1C AQUATIC MONITORING PROGRAM, CONSTRUCTION PHASE, EXECUTIVE SUMMARIES

1

EXECUTIVE SUMMARY

This report presents the results of the first year of a four-year aquatic monitoring program that was designed to evalute the effects of construction and operation of the Braidwood Generating Station on the biota and water quality of the Kankakee River and its nearby tributary Horse Creek.

The algal taxa found in the Kankakee River and Horse Creek from May through November 1977 were indicative of an alkaline environment and were generally evenly distributed in the study area. The presence of many of the same species in the Kankakee River and Horse Creek would be expected due to the cosmopolitan distribution of many algal taxa. Horse Creek and the right-side stations downstream did, however, occasionally exhibit different trends in composition of dominant organisms which reflected the distinct nature of Horse Creek and its possible impact on the river. Periphyton data did not indicate any adverse effects within the monitoring area due to construction.

A total of 158 taxa of macroinvertebrates were collected from the Kankakee River. The greatest diversity occurred in stations with bedrock-type substrates which yielded over 70 taxa each. Horse Creek samples contained 76 taxa. Substrate type was the most important factor affecting distribution. The predominant groups were Oligochaeta, Ephemeroptera, Trichoptera, Mollusca, and Chironomidae. The density of bottom organisms in the Kankakee River ranged from a low of 3158 organisms m^{-2} in April to 10,889 individuals m^{-2} in October. Horse Creek was represented by a high of 2646 individuals m^{-2} in April and a low of 595 individuals m^{-2} in May. Diversity indices ranged between 2.00 and 4.00 indicating

relatively good water quality and a varied benthic fauna.

Examinations of adult and juvenile fishes indicate a diverse assemblage of species including abundant game species and generally widespread distribution of "pollution-intolerant" species, as well as the more ubiquitous types. Growth, feeding habits, condition factors, and fecundity of most fish species examined from the monitoring area indcated maintainence of good overall conditions. Abundance and biomass shifts in fish populations occurred among collection stations and seasons but indicated no detrimental effects relatable to streamside construction activities. Natural habitat differences were responsible for most of the dissimilarities in fish species composition observed.

Drifting fish eggs and larvae were collected weekly in 1977 beginning on 13 April and terminating on 30 August. A total of 43 fish eggs and 1,374 fish larvae were collected during the 21-week sampling period. The most abundant fish larvae captured included unidentified cyprinids, *Lepomis* spp., unidentified percids, *Ambloplites rupestris*, *Ictalurus punctatus*, and unidentified catostomids, in order of decreasing abundance. The mean density of larval fish during the sampling period was 1.1 larvae/10 m^3 of water filtered. The highest density of fish larvae was measured in Horse Creek (Station 2) when 3.29 larvae were collected per 10 m^3 of water filtered.

Results of quarterly water sampling revealed that the concentrations of the various chemical parameters (forms of phosphorus and nitrogen, biochemical and chemical oxygen demand, total organic carbon, total alkalinity, EDTA hardness, and sulfate) varied seasonally. Differences among the four sampling locations were minimal. Ranking of the mean concentrations from highest to lowest from the Scheffe's

Multiple Comparison Test (0.05 level) was generally by date. The ordering of the sampling dates, however, varied by parameter. This is not uncommon as the date at which a parameter exhibits its highest or lowest concentration depends upon many factors including, importantly, the season. Time of year integrates a number of conditions, especially water temperature and water level.

EXECUTIVE SUMMARY

This report presents the results of the second year of a 4-year program designed to evaluate effects of construction and operation of the Braidwood Nuclear Generating Station on the biota and water quality of the Kankakee River and Horse Creek. Data collected in May, August, and November 1978 primarily documented deviations in communities reflective of natural changes in the environment, since little stream-related construction activity took place during the study period. While documenting the absence of stream disturbance, this year's results also provided another year of background data for the various biological communities of the monitoring area.

Periphyton collected from artificial substrates in the Kankakee River Monitoring Area in 1978 yielded a diverse flora. Horse Creek stations were among the most diverse sampled and some of the taxa common in Horse Creek were of similar abundance immediately downstream from it's confluence with the Kankakee River but were of different abundances at other stations in the study area. Stations with high densities of organisms tended to have smaller organisms while those with the greatest calculated biovolumes had lower densities. All variations in biomass, densities, biovolumes, and diversities between stations were attributable to natural causes since no construction took place in the river during periods when artificial substrates were exposed for periphyton colonization.

A total of 163 macroinvertebrate taxa from the Kankakee River and 48 taxa from Horse Creek were collected by benthic grabs during 1978. The type of substrate present at each station was the most important factor in determining the kinds of benthic organisms that were present. Stations 4L, 4R, and 6L were composed primarily of bedrock. Stations 1L, 1R, and 6R were composed primarily of silt, sand, and gravel. Horse Creek was composed primarily of sand. Stations 5L and 5R were composed primarily of silt and fine sand.

The greatest number of taxa was found at Stations 4L, 4R, and 6L with over 73 taxa at each station; the remaining stations, excluding Station 6R, had 41-55 different taxa. The seasonal relative abundance in the Kankakee River was 763, 1,549, and 1,998 individuals m^{-2} during May, August, and November, respectively. In Horse Creek, the relative abundance was 372, 1,377, and 2,912 individuals m^{-2} during May, August, and November, respectively. The seasonal biomass in the Kankakee River was 4,302, 2,334, and 3,977 mg m^{-2} during May, August, and November, respectively. In Horse Creek, the biomass was 320, 1,062, and 1,914 mg m^{-2} during May, August, and November, respectively.

The diversity index values generally ranged from 3.00 to 4.50, indicating a relatively clean river, with a variety of organisms present.

One hundred fifty-eight macroinvertebrate taxa were collected from artificial substrates in the Kankakee River and 108 taxa were collected from Horse Creek during the three exposure periods of 1978. Spring communities in the Kankakee River were dominated by immature insects of the filter feeding and herbivore trophic levels. Larvae of the black fly, *Simulium*, predominated most stations. The Horse Creek community was dominated in spring by Oligochaeta and Chironomidae. Mayflies of the collecting-scraping family, Heptageniidae, accounted for one-third of the total summer Kankakee River abundance and were predominant at most stations during this period. Summer communities at the two Horse Creek stations differed in many respects, but were both dominated by herbivore-detritivores common in lotic depositional situations. The fall communities at all Kankakee River sampling locations were predominated by midges of the subfamily Orthocladiinae. Diversity values for the three collection periods ranged from 1.81 to 4.70. Analysis of taxonomic compositions, numbers of individuals, numbers of taxa, and diversity values of communities colonizing artificial substrates indicated that the water quality of the Kankakee River and Horse Creek was good during the three exposure periods. Increased levels of suspended solids caused by streamside construction activity during the fall ex-

posure period apparently did not cause communities located downstream of the activity to differ from communities at other sampling locations.

Square frame and bongo samplers were used to collect ichthyoplankton drift from 17 April to 30 August 1978. A total of 5,178 fish larvae were collected with square frame samplers while 5,883 were collected with bongo samplers. For most taxonomic groups, numbers of larvae collected per cubic meter of water sampled were greater in Horse Creek than in the Kankakee River at the N&W Railroad bridge. Group A percid larvae was the only group which had a greater absolute abundance in Horse Creek than at the railroad bridge.

A total of 53 adult and juvenile fish species were collected during 1978, bringing the total number of discrete fishes to 68 for the two years of study of the monitoring area. Many of the common species are noted for their intolerance of polluted conditions and are indicative of the good water quality and diverse habitat that typifies the study site. Differences in species composition and abundance, as measured by seine, electroshocker, and hoop net, were related to habitat variations and changed between sampling sites as natural conditions fluctuated. Some collecting sites were consistantly deviant from others during a period when little relevant construction activity occurred. Location 5 also harbored a different composition of fishes than other areas since it was more lake-like than riverine.

A creel survey of the lower Kankakee River was conducted during the open water season of 1978. Results indicate the majority of fishing effort was expended in those sections of the river open to public use. Most fishermen did not fish for any particular species, though fishing effort expended on channel catfish, smallmouth bass, and walleye was high relative to other species. An estimated 1,205 fish weighing 540.8 kilograms were caught during the survey year. In decreasing order of numbers of fish caught carp, channel catfish, smallmouth bass, shorthead redhorse, freshwater drum, and rock bass were species most frequently

caught. Biomass of the catch was dominated by carp, channel catfish, shorthead redhorse, smallmouth bass, golden redhorse, and freshwater drum, respectively. The mean annual catch rate for all species was 0.097 fish and 43.204 grams of fish per manhour of effort. Fishing success declined as the survey year progressed from spring through fall. Most fishermen still-fished from shore with natural bait and resided 26-50 miles from the section they were fishing.

Water quality of the Kankakee River Monitoring Area was good with respect to most parameters studied in 1978. Turbidity rose downstream of intensive construction activities at the Braidwood intake site, but returned to normal levels in only a short period and remained at normal levels further downstream. Turbidity increases were small compared to natural fluctuations that occurred at all stations due to natural causes. Significant variation in measurements was generally by date, which incorporates river discharge as an important factor. Differences in water chemistry between locations generally involved differences between Horse Creek and the river rather than between stations on the Kankakee River itself.

EXECUTIVE SUMMARY

This report presents the results of the third year of a 4-year program designed to evaluate the effects of construction and operation of the Braidwood Nuclear Generating Station on the Biota and water quality of the Kankakee River and Horse Creek. Data collected in May, August, and November 1979 primarily documented deviations in communities reflective of natural habitat differences and seasonal changes in the environment. No relevant stream-related construction took place during the study period, but dredging occurred before this year's sampling began. The 1979 sampling year, therefore, represented the first year since construction was essentially complete. While documenting the absence of severe stream disturbance from construction, this year's results provided another year of background data for impact comparison during plant operation.

Periphyton collected from artifical substrates in the Kankakee River Monitoring Area after approximately 28 days of exposure yielded a diverse algal flora. The abundance of the periphyton as accumulated biomass differed between stations and seasons in 1979. The periphyton diversities were greatest in Horse Creek in August and November while Stations 1L and 1R had the greatest diversities in May 1979. Some of the taxa most abundant in Horse Creek at times had similar abundance at stations downstream from its confluence with the Kankakee River but lower abundance at other stations in the study area. These trends suggested an influence of Horse Creek on the Kankakee River periphyton. Stations or seasons with high densities of organisms tended to have smaller organisms while stations or seasons with the greatest calculated biovolumes had lower organism densities. No differences were observed in the periphyton community in 1979 which could be attributed to construction activities that occurred in 1977 or 1978.

A total of 163 macroinvertebrate taxa from the Kankakee River and 69 taxa from Horse Creek were collected by benthic grabs in 1979. The predominant taxa were Oligochaeta, Ephemeroptera, Trichoptera, Chironomidae, and Mollusca, accounting for 89% and 93% of the benthic communities in the Kankakee River and Horse Creek, respectively. The substrate composition was the most important factor determining the diversity of organisms represented at each station. The greatest number of taxa were found at Stations 1L, 4L, and 4R, with 82-87 taxa collected; the remaining stations ranged from 66 to 77 different taxa. The average density in the Kankakee River was 2389, 1886, and 5526 individuals m^{-2} and the average biomass was 7023, 2552, and 6437 mg m^{-2} during May, August, and November, respectively. The diversity index values ranged from 2.58 to 4.66 indicating a relatively clean river, under little environmental stress, with a variety of organisms present.

Macroinvertebrate communities colonizing artificial substrates were also used to aid in the assessment of water conditions in the area of the Braidwood Nuclear Power Station and to provide baseline data for use in the future evaluation of plant operation. One hundred forty-six taxa were collected from the Kankakee River and 103 taxa collected from Horse Creek during the three exposure periods of 1979. Spring and summer communities were dominated by organisms at the filter feeding and scraping-gathering trophic levels. Larvae of the caddisfly Cheumatopsyche were predominant at most stations during these two seasons. Other dominant taxa included the midge Rheotanytarsus, the caddisfly Hydropsyche phalerata, and the mayflies Baetis and Stenonema. Midges of the subfamily Orthocladiinae (primarily Chaetocladius and Orthocladius) accounted for 56.5% of the total fall abundance and predominated all but one station during this period. Analysis of community structure and diversity indices indicated that the water quality of the Kankakee River and Horse Creek was good during the three exposure periods of 1979.

The abundance and distribution of ichthyoplankton in the Kankakee River at the Braidwood Station intake site was estimated from data

gathered from two upstream sampling locations. Drift densities of ichthyoplankton were highest in Horse Creek, a nearby small tributary, and indicated its importance as a nursery and spawning area. Drift rates of ichthyoplankton were highest at the railroad transect in the Kankakee River and indicated that although densities of larvae were higher in Horse Creek, larvae were more abundant in the Kankakee River. The spatial-temporal distribution of the total larvae caught indicated that larvae were more abundant along the plant-side shoreline in the Kankakee River and that most larvae drifted during the dusk and night sampling periods. Factors regarding potential entrainment losses were assessed and indicated that ichthyoplankton communities produced in Horse Creek may be preferentially entrained during some flow periods.

A total of 53 different fish species belonging to nine different families was captured during 1979, bringing the total number of species known to occur in the monitoring area from 1977-1979 to 72 fish species and three sunfish hybrids. Many of the common species are noted for their intolerance of silty or polluted conditions and are indicative of the good water quality and diverse habitat which typifies the monitoring area. Major differences in species composition and abundance, as measured by seine, electroshocker, and hoop net, were related to habitat variations and changed between sampling sites as natural conditions fluctuated. Construction replaced the river's bank for a short distance and then deepened the river directly in front of the screenhouse. The effects of bank replacement depended on environmental conditions, alternately attracting and repelling fish from the new bank. Dredging further altered the immediate habitat, averting much of the fish community from that site. The displacement of fish from that small portion of the river was not detrimental to the fish population. Fish tagging results indicated that while sedentary groups of rock bass, smallmouth bass, or other fishes might be forced to abandon the immediate intake area, movement occurred naturally for portions of each species and could not be considered deleterious. Fish were generally in good condition, grew well, and showed no unusual signs of stress, but should not be forced to endure extremely low water levels.

The water quality of the Kankakee River in the Braidwood Aquatic Monitoring Area in 1979 was good with respect to most parameters analyzed. Differences in concentrations by date, station, and the interaction between date and station were evident, but results varied according to parameter. Dissolved oxygen was high at all times except for some periods in August. Phosphorus levels were high, but typical for Illinois rivers. Heavy metals had elevated concentrations in February. The pesticides dieldrin, heptachlor epoxide, and PCBs and fecal coliform bacteria were found in concentrations exceeding recommended levels during certain periods of the year. The presence of the Braidwood Station's intake and discharge structures had no apparent affect on water quality in the Kankakee River.

ABSTRACT

A multidisciplinary environmental monitoring program for the Kankakee River near Wilmington, Illinois was conducted during late summer 1981 by a team of investigators from the Illinois Natural History Survey. This study was the fourth in a series, designed to evaluate construction and preoperational effects on the aquatic ecosystem from Commonwealth Edison's riverside intake and discharge structures for the Braidwood Nuclear Generating Station. The scope of this study included the analyses of the aquatic communities of periphyton, benthic macroinvertebrates and fishes, and water chemical parameters during a single season.

Periphyton collected from artificial substrates in the Kankakee River and Horse Creek during the July-August 1981 exposure period after 28 days of exposure yielded a diverse algal flora which included 99 species most of which were found during July-August of previous study years. Most species identified were members of the Bacillariophyta (diatoms) although considerable accumulations of the Chlorophyta (green algae) and Cyanophyta (blue-green algae) also occurred. The most productive station during the 4-year study was Station 5L and the least productive station was Station 4R based on accumulated biomass of periphyton (ash-free weight). Several taxa were significantly less abundant by densities and/or biovolumes at Station 4R than at other stations; calculated diversities were also lower at that location on the river. Although there was no apparent relationship between accumulated biomass and ancillary factors such as light, turbidity, or current, increased diversities were apparently associated with reduced current at the stations sampled. The most productive years during the study were 1977 and 1978 according to calculated biovolumes for many dominant taxa and major algal divisions; the same trends were evident based on accumulated biomass. Many taxa common to this study have been found by other investigators in the same sampling area. Although Station 4R had significantly lower

diversities, biovolumes, densities, and accumulated biomass than most other stations sampled, the stressed condition was apparently not a result of construction activities that occurred primarily during 1977 and 1978. Greater diversity and biomass accumulations at Station 4R have been observed in other study years at different times of the year (i.e., May and November).

The Kankakee River and Horse Creek were sampled during August 1981 in order to ascertain the post-construction condition of benthic communities and to add to the data base established during 1977-1979. Taxa numbers comparable to the first 3 years of the study were found, but mean densities and biomass were reduced. Erosional communities dominated by heptageniid mayflies were present at Stations 4R, 4L, and 6L. These communities have remained essentially unchanged since the initiation of the Braidwood study. The communities of Stations 1R and 6R, during August 1981, had shifted from the marginally depositional character they exhibited during 1977 through 1979 to an erosional character. Dominants at these locations changed from Oligochaeta, Hexagenia and Sphaerium to Heptageniidae. Communities at Stations 5L and 5R retained their depositional constitution, but biomass and density decreased from previous years. Numbers and biomass of Hexagenia at these locations have declined dramatically throughout the study. Communities present at Station 4R during August 1981 exhibited no detrimental effects resulting from the construction and pumping activities of 1979-1981. Results of statistical analyses revealed significant differences that were the result of natural causes usually related to substrate type or flow rate. Diversity values were generally above 3.00, indicating that the benthic communities of the Kankakee River and Horse Creek were under little environmental stress at the time of the collections.

Forty-nine fish species with representatives from 10 families were collected from the Kankakee River and Horse Creek in the Braidwood Aquatic Monitoring Area in August 1981. None of these

species are on the Illinois list of endangered or threatened species, although the pallid shiner, Notropis amnis, is rare in Illinois waters. More total biomass was collected in August 1981 than in any previous August collection. The electrofishing catch was dominated by redhorse suckers (Moxostoma spp.) accounting for 51.4 percent of the total biomass. Numbers of fish in seine hauls declined over previous years due probably to increased water velocities and water depth. Stations on the left side of the river were more productive than those on the right, reflecting habitat differences. The effects of construction on total biomass and abundance of fishes collected at the intake site (Station 3R) were negligible although a change in species composition was noted. No differences in abundance or biomass of fish could be related to pondfill pumping operations. Potential entrainment losses were avoided by pumping prior to the occurrence of drifting ichthyoplankton. The presence of lentic species was enhanced by high water levels. Most fishes exhibited slow growth and lower than average condition factors, possibly due to high water and turbidity levels. The 1977 year class of fishes was important to the fish community in 1981.

The water quality in the Kankakee river in August 1981 was good with respect to most parameters analyzed. Turbidity and dissolved oxygen values were high throughout the sampling period. Phosphorus levels were high, but not unusual for Illinois waters. Trace metal concentrations were elevated over previous August collections. Cadmium and manganese exceeded standards recommended by U.S.E.P.A. (1976). The pesticides dieldrin and heptachlor epoxide and PCB's were detected in the Kankakee River. Dieldrin and PCB's exceeded recommended levels. The presence of the Braidwood Station's intake and discharge structures had no apparent effect on water quality in the Kankakee River.

4.3 RESOURCES COMMITTED

The construction of the Braidwood Nuclear Generating Station - Units 1 & 2 (Braidwood Station) involves permanent and temporary uses of land, water, and material resources. This section describes the resources committed during plant construction.

4.3.1 Land Resources

In the development of the 4454-acre site, 130 acres will be affected by actual plant building activities including 35 acres of woods and 70 acres of cultivated fields that will be changed permanently from current land use. There are also 25 acres of fallow fields within the plant construction area. After building construction is completed, 20 acres will be occupied by permanent physical structures. 1

The pond will cover 3540 acres and will affect 318 acres of cultivated land, 204 acres of fallow-field vegetation, 117 acres of woods, and 2838 acres of strip-mine spoil (Edmonds 1974). Approximately 784 acres of the site will not be affected by site construction. The expected impact of site construction is described in Section 4.1. 1

The construction of permanent facilities on the site eliminates some wildlife habitat, which results in shifts of wildlife populations to other areas. Those portions of the site not occupied by the permanent facilities or landscaped for aesthetic purposes will be allowed to return to a natural state.

There are some unavoidable animal deaths due to construction activities (e.g., the coverage of nests and dens), particularly in the cooling pond area. During pond filling, small mammals living on the pond site and not able to relocate to a safe area will be lost. Once the filling is completed, however, the pond will provide habitat for both nesting and migrating waterfowl.

The land that will be traversed by the transmission lines for the Braidwood Station is mainly farmland. Except for areas occupied by the tower foundations, there will be no commitment of farmland resources during the proposed period of transmission line use. Any farmland disturbed by construction activities will be restored.

4.3.2 Water Resources

No permanent effect on water resources is expected at the Braidwood Station. The construction of the river intake and discharge structures will permanently alter approximately 250 feet of shoreline on the southern bank of the Kankakee River. No other permanent aquatic disruptions are expected during the construction of the Braidwood Station.

4.3.3 Materials Used

The materials used for the Braidwood Station are of two types: those used for the construction of buildings; and fuel. Construction materials include structural and reinforcing steel, portland cement, electrical cables, paints, coverings, and fixtures. Although these will be permanently committed during the lifetime of the plant, some of them can be at least partially reclaimed if the plant is eventually dismantled. The highly contaminated items will not be reusable. The discussion of fuel consumption and of other resources committed during plant operation is included in Section 5.7. The decommissioning and dismantling of the plant is described in Section 5.8.

CHAPTER 5.0 - ENVIRONMENTAL EFFECTS OF STATION OPERATION

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CHAPTER 5.0 - ENVIRONMENTAL EFFECTS OF STATION OPERATION

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The external submersion dose to small aquatic plants and animals is substantially all due to the beta component of tritium.

5.2.3.3 Dose Effects on Biota

Under field conditions, it cannot be shown that organisms are in any way affected by dose rates lower than 1000 millirads per day (Auerbach et al. 1971). For example, low dose rates seem to have no effect on such commonlyused end points as survivorship, fecundity, growth, development, or susceptibility to infection. It should be noted that when considering the effects of radiation on biota other than persons, populations are of more concern than individuals. Since the dose estimates presented in this report are conservative, it is unlikely that any animal population in the Braidwood Station site vicinity will receive annual doses approaching the computed levels.

5.2.4 Dose Rate Estimates for Man

The calculation of radiation doses to persons from radioactive effluents was performed according to "Models and Computer Codes for Evaluating Environmental Radiation Doses" (Soldat et al. 1974). Examples of dose calculation models may be found in Appendix 5.2A.

5.2.4.1 Liquid Pathways

Expected annual releases of radionuclides are given in Table 3.5-3. Activity concentrations in the discharge canal were calculated assuming an annual cooling pond blowdown flow of 43.2 cfs with 2 unit operation. Dilution of radionuclides in the Kankakee River was not taken into account. 1

Estimated annual average doses to individuals exposed to radioactive liquid effluents from the Braidwood Station were calculated for pathways of fish consumption, drinking water, and recreational exposure.

Recreational use of the Kankakee River in the vicinity of Braidwood Station is discussed in Subsection 2.1.2.3. The estimates of whole-body doses and critical-organ doses made for swimming, boating, and shoreline activities are shown in Table 5.2-7.

An estimate of the expected dose rate to the whole body and critical organs received from drinking water obtained from the discharge canal is shown in Table 5.2-7 even though the canal is not a drinking water source. Presently there is no public drinking water supply within 50 miles downstream from the Braidwood Station. Kaiser Agricultural Chemicals has deactivated its its water purification system and now uses groundwater for drinking water supply. 1

As noted previously, the Kankakee River in the vicinity of the Braidwood Station supports an active sport fishery. Estimates of doses received to whole body and critical organs from the consumption of fish are given in Table 5.2-7. Actual doses will be lower because of the conservative nature of the bioaccumulation factors and because the probability of a fish staying in one location is extremely small.

5.2.4.2 Gaseous Pathways

Expected annual releases of radioactive noble gases and particulates from the Braidwood Station are shown in Table 3.5-6, and estimated offsite doses to individuals from these effluents are given in Table 5.2-4. Doses were calculated using the methodology of NRC Regulatory Guide 1.109 (1977b).

Calculational models are discussed in Appendix 5.2A. Plume immersion, exposure to contaminated surfaces, inhalation, and ingestion pathways were all considered. Consumption factors for the ingestion pathways are given in Table 5.2-8 (Fletcher and Dotson 1971; NRC 1977b). An 8-month grazing period was assumed for milk animals, and a 10-month grazing period was assumed for meat animals.

5.2.4.3 Direct Radiation from Facility

The annual average external dose rates due to direct radiation exposure were estimated assuming normal station operation. Estimated dose rates in the vicinity of the station are given in Table 5.2-9. The sources considered were the nitrogen-16 in the primary coolant and the radioactive contents of the storage tanks holding refueling water, primary water, and secondary water. All other major and potential contained sources are below grade level or surrounded by protective shields and can be considered to contribute a negligible amount to the total dose rate.

Standard techniques of geometric and material attenuation were used in the calculations. Credit was taken for the concrete in the containment walls and the air between the source and dose point, but no credit was taken for partial occupancy or for local shielding provided by buildings and dwellings (etc.) and by steel tank walls and liners.

The population exposure through this pathway, direct radiation from the station, was estimated based on the projected population within 50 miles of the Braidwood Station in the year 2000. This calculation yielded a negligible annual population exposure of 0.018 man-rem/year for Braidwood Station Unit 1.

5.2.4.4 Annual Population Doses

The population dose due to gaseous effluents to all individuals living within a 50-mile radius of the Braidwood Station was calculated using population data projected to the year 2000. The

estimated dose from gaseous effluents for the year 2000 population within a 50-mile radius of the site appears in Table 5.2-10. This table shows whole-body, skin, and thyroid doses resulting from exposure from immersion, inhalation, and ground deposition.

The population dose caused by direct radiation to all individuals living within a 50-mile radius of the Braidwood Station was also calculated using population data projected for the year 2000; it is given in Table 5.2-11.

The population dose resulting from natural background radiation to all individuals living within a 50-mile radius of the Braidwood Station is given in Table 5.2-11. This dose was calculated assuming a dose to individuals of 135 mrem/yr and was based on population data projected for the year 2000.

5.2.5 Summary of Annual Radiation Doses

The estimated radiation doses to the regional population from all station-related sources are summarized in Table 5.2-11.

TABLE 5.2-1

CONCENTRATION OF RADIONUCLIDES IN THE DISCHARGE AND THE CORRESPONDING BIOACCUMULATION FACTORS

ISOTOPE	RELEASED ACTIVITY[a] (Ci/yr)	CONCENTRATION AT DISCHARGE POINT[a] (pCi/liter)	AQUATIC BIOACCUMULATION FACTORS			
			FISH	CRUSTACEAN	MOLLUSK	ALGAE
H-3	3.0×10^{2}	1.6×10^{4}	9.0×10^{-1}	9.0×10^{-1}	9.0×10^{-1}	9.0×10^{-1}
Cr-51	6.2×10^{-5}	3.3×10^{-3}	2.0×10^{1}	2.0×10^{3}	2.0×10^{3}	4.0×10^{3}
Mn-54	1.0×10^{-3}	5.4×10^{-2}	4.0×10^{2}	9.0×10^{4}	9.0×10^{4}	1.0×10^{4}
Fe-55	5.4×10^{-5}	2.9×10^{-3}	1.0×10^{2}	3.2×10^{3}	3.2×10^{3}	1.0×10^{3}
Fe-59	3.5×10^{-5}	1.9×10^{-3}	1.0×10^{2}	3.2×10^{3}	3.2×10^{3}	1.0×10^{3}
Co-58	4.5×10^{-3}	2.4×10^{-1}	5.0×10^{1}	2.0×10^{2}	2.0×10^{2}	2.0×10^{2}
Co-60	8.8×10^{-3}	4.8×10^{-1}	5.0×10^{1}	2.0×10^{2}	2.0×10^{2}	2.0×10^{2}
Br-83+d	1.8×10^{-5}	9.7×10^{-4}	4.2×10^{2}	3.3×10^{2}	3.3×10^{2}	5.0×10^{2}
Rb-86	4.7×10^{-5}	2.5×10^{-3}	2.0×10^{3}	1.0×10^{3}	1.0×10^{3}	1.0×10^{3}
Sr-89	1.3×10^{-5}	7.0×10^{-4}	3.0×10^{1}	1.0×10^{2}	1.0×10^{2}	5.0×10^{2}
Mo-99+d	2.0×10^{-3}	1.1×10^{-1}	1.0×10^{1}	1.0×10^{1}	1.0×10^{1}	1.0×10^{3}
Mo-99d	2.0×10^{-3}	1.1×10^{-1}	1.0×10^{1}	1.0×10^{1}	1.0×10^{1}	1.0×10^{3}
Tc-99m	2.3×10^{-3}	1.2×10^{-1}	1.5×10^{0}	5.0×10^{0}	5.0×10^{0}	4.0×10^{1}
Te-127	1.4×10^{-5}	7.6×10^{-4}	4.0×10^{2}	7.5×10^{1}	7.5×10^{1}	1.0×10^{2}
Te-129m+d	4.6×10^{-5}	2.5×10^{-3}	4.0×10^{2}	7.5×10^{1}	7.5×10^{1}	1.0×10^{2}
Te-129	3.0×10^{-5}	1.6×10^{-3}	4.0×10^{2}	7.5×10^{1}	7.5×10^{1}	1.0×10^{2}
Te-131m	3.3×10^{-5}	1.8×10^{-3}	4.0×10^{2}	7.5×10^{1}	7.5×10^{1}	1.0×10^{2}
Te-132	6.2×10^{-4}	3.3×10^{-2}	4.0×10^{2}	7.5×10^{1}	7.5×10^{1}	1.0×10^{2}
Te-132d	6.2×10^{-4}	3.3×10^{-2}	4.0×10^{2}	7.5×10^{1}	7.5×10^{1}	1.0×10^{2}
I-130	1.1×10^{-4}	5.9×10^{-3}	1.5×10^{1}	5.0×10^{0}	5.0×10^{0}	4.0×10^{1}
I-131	8.0×10^{-2}	4.3×10^{0}	1.5×10^{1}	5.0×10^{1}	5.0×10^{0}	4.0×10^{1}
I-132	1.8×10^{-3}	9.7×10^{-2}	1.5×10^{1}	5.0×10^{0}	5.0×10^{0}	4.0×10^{1}
I-133	3.7×10^{-2}	2.0×10^{0}	1.5×10^{1}	5.0×10^{0}	5.0×10^{0}	4.0×10^{1}
I-135	4.3×10^{-3}	2.3×10^{-1}	1.5×10^{1}	5.0×10^{0}	5.0×10^{0}	4.0×10^{1}
Cs-134	2.8×10^{-2}	1.5×10^{0}	2.0×10^{3}	1.0×10^{2}	1.0×10^{2}	5.0×10^{2}
Cs-136	6.9×10^{-3}	3.7×10^{-1}	2.0×10^{3}	1.0×10^{2}	1.0×10^{2}	5.0×10^{2}
CS-137	3.5×10^{-2}	1.9×10^{0}	2.0×10^{3}	1.0×10^{2}	1.0×10^{2}	5.0×10^{2}
Np-239	2.3×10^{-5}	1.2×10^{-3}	1.0×10^{1}	4.0×10^{2}	4.0×10^{2}	3.0×10^{2}

1

[a]Values based on 1-unit operation.

5.6 OTHER EFFECTS

5.6.1 Introduction

This section describes the actual and predicted noise effects of 1
the Braidwood Nuclear Generating Station - Units 1 & 2 (Braidwood
Station) during plant operation. All other effects of operation
are discussed in other sections sections of Chapter 5.

5.6.2 Approach

Noise due to the operation of Braidwood Station was predicted at
four locations identified in Figure 5.6-1 as Points 1 through 4.
Points 1, 2, and 3 were selected because plant operation noise will 1
be relative maximums for offsite residential areas and because
these locations are the same as ambient measurement points A, B,
and C, shown in Figure 2.7-1. Point 4 was selected to assess maximum offsite noise due to the operation of the screen house. Actual
noise measurements were taken at Point 4 in 1981 shortly after the 1
screen house had become operational.

The noise sources (equipment) considered in predicting continuous plant operation noise were the main power transformers, system auxiliary transformers, unit auxiliary transformers, screen-house transformers, auxiliary building ventilation supply and exhuast fans, and screen-house ventilation supply fans. Experience shows that these are the major sources of continuous exterior noise for this type of station. Intermittent noise due to the operation of unsilenced main-steam power-operated relief valves was also predicted.

5.6.3 Procedures

Maximum expected noise level data for the major exterior sources identified in Subsection 5.6.2 were established based on published prediction schemes and manufacturers' information. Noise data for transformers was obtained from the manufacturer and from the National Electrical Manufacturers Association's Standards for Transformers, TR1-1972, Section 0.06 (1972). Ventilation-fan noise level predictions were based on a prediction technique by J. B. Graham (1975), and used fan operation parameters obtained from station design requirements. Power-operated relief valve noise was predicted using a technique developed by Riley-Beaird (no date).

The noise levels for each source were extrapolated to the various
prediction points, using standard prediction techniques that account for wave divergence and excess attenuation due to atmospheric
absorption, directivity, shielding, and ground effects. The following values were used to account for attenuation due to atmos- 1
pheric absorption:

Octave Band Center Frequency (Hz)	Attenuation (dB/1000 ft)
63	0
125	0
500	0.7
1000	1.4
2000	3.0
4000	7.7
8000	14.4

These values are based on "Standard Day" conditions (i.e.; 59^{O}F, 70% R.H., negligible wind velocity) and were taken from Society of Automotive Engineers, 1975, "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity," ARP 866A.

Credit was taken for the directivity of the supply and exhuast fans based on information supplied by Koppers Company, Inc. (1963), "Directivity Index," Drawing D-98033. Credit for directivity of the mechanical draft cooling towers was not taken separately since sound level predictions were based on the vendor's proposal data, which include the effects of directivity. 1

Shielding or barrier attenuation was accounted for where applicable and was based on the work of Z. Maekawa (1968), "Noise Reduction by Screens," Applied Acoustics, Vol. 1, pp. 157-173.

Because of the variability of ground conditions from season to season, attenuation due to ground effects was considered negligible, and therefore, was not taken into effect in estimating excess noise attenuation.

The resulting octave-band sound pressure levels from each continuous source were then combined to give the resultant overall plant operation noise level at each location. Table 5.6-1 summarizes the predicted levels. Table 5.6-2 summarizes the predicted A-weighted noise levels at each prediction point resulting from relief valve operation.

Actual field measurements at Point 4 were taken in 1981. The noise levels during normal screen house operation can be found in Table 5.6-1.

5.6.4 NOISE EFFECTS

5.6.4.1 Illinois Environmental Protection Agency

To assess the possible effects of noise due to normal continuous operation of the Braidwood Station, the predicted levels were

compared to applicable state of Illinois noise pollution control regulations. Since the predicted points are located near existing residences, station noise at these points is regulated by Rule 203 (Sound Emitted to Class-A Land During Nighttime Hours.) The comparisons of predicted levels with Rule 203, as shown in Figures 5.6-2 through 5.6-5, indicated that the calculated station operation noise levels at all prediction points meet the Illinois regulations.

5.6.4.2 U.S. Environmental Protection Agency

A second method used to assess the possible effects of normal operation of Braidwood Station was to determine how the predicted plant operation noise levels compared with the levels of environmental noise identified by the U.S. Environmental Protection Agency (U.S. EPA) as requisite to protect public health with an adequate margin of safety.

This comparison, summarized in Table 5.6-3, shows that the predicted level at each point meets the requisite level, $L_{dn} \leq 55$ dB, applicable to outdoor levels in residential areas.

5.6.4.3 DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

A comparison of predicted noise due to normal plant operation with the Department of Housing and Urbas Development (HUD) critiera described in Subsection 2.7.3.3 (L_{dn} 65 dBA) is shown in Table 5.6-4. This comparison shows that predicted levels at all locations meet the HUD criteria. 1

5.6.4.4 Preoperational Ambient Levels

To permit comparison of predicted plant operation noise with preoperational abmient noise at the plant site, levels measured at points A, B, and C (see Subsection 5.6.2) are shown in Tables 5.6-3 and 5.6-4. These tables indicate that although levels at points near the Braidwood Station property line will be increased due to station operation, the predicted levels are below all applicable regulations and guidelines. Ambient noise levels measured in the nearest communities (see Subsection 2.7.1), however, are not expected to be signficantly affected by plant operation.

5.6.5 Conclusion

The predicted station operation noise levels at property line points near existing residences meet state of Illinois regulations and federal guidelines for noise emitted to residential receivers. The actual station operation noise levels are expected to be lower

than those presented in this Environmental Report because all predictions were based on the maximum expected equipment noise. The noise impact due to normal operation of the Braidwood Station is therefore expected to be small.

TABLE 5.6-1

PREDICTED NOISE LEVELS DUE TO NORMAL CONTINOUS OPERATION

LOCATION	OCTAVE BAND CENTER PREQUENCIES (Hz)								
	dBA	63	125	250	500	1K	2K	4K	8K
1	36	43	48	40	31	20	6	--	--
2	49	51	59	53	47	38	25	13	--
3	49	57	62	53	44	31	15	--	--
4*	44	47	44	41	43	39	36	25	17

1

*NOTE: Noise levels for location 4 are actual nighttime measurements taken in 1981 in accordance with State of Illinois Noise Regulations, Chapter 8, Part 2, Rule 203. 1

TABLE 5.6-2

PREDICTED NOISE LEVELS DUE TO RELIEF VALVE OPERATION

LOCATION	SOUND LEVEL (dBa)
1	94
2	96
3	91
4	48

TABLE 5.6-3

COMPARISON OF PREDICTED AND MEASURED CONTINUOUS NOISE LEVELS WITH U.S.EPA GUIDELINES

LOCATION	AMBIENT NOISE (Measured Level)	NOISE DUE TO PLANT OPERATION (Predicted Level)	U.S. EPA GUIDELINE	
1	L_{dn}[a] = 43.5	L_{dn} = 42	L_{dn} 55	
2	L_{dn} = 52.1	L_{dn} = 55	L_{dn} 55	
3	L_{dn} = 42.1	L_{dn} = 55	L_{dn} 55	
4	L_{dn} = 44.2	L_{dn} = 51.4*	L_{dn} 55	1

*NOTE: The measured level at location 4 is an actual field measurement taken in 1981 with the river screen house in normal operation, i.e. two of the three circulating water make up pumps operating. 1

Source: U.S. Environmental Protection Agency (U.S. EPA 1974).

[a]The L_{dn} or day-night sound level represents the L_{eq} with a 10 db nighttime penalty (see Subsection 2.7.2).

TABLE 5.6-4

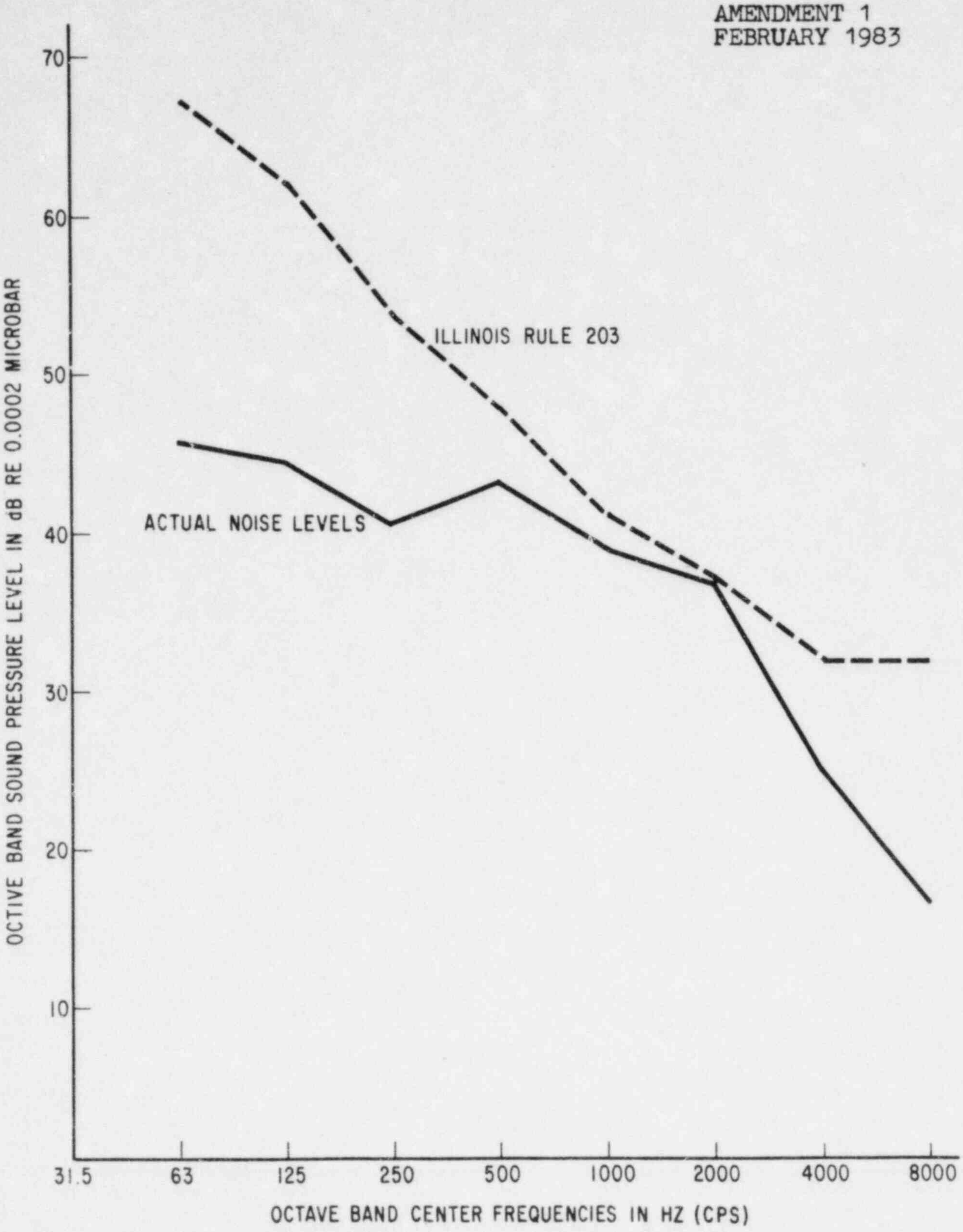
COMPARISON OF PREDICTED AND MEASURED

CONTINOUS NOISE LEVELS WITH HUD GUIDELINES

LOCATION	AMBIENT NOISE (Measured Level Ldn)	NOISE DUE TO PLANT OPERATION (Predicted Level)	HUD GUIDELINE	
1	43.1	L_{dn} = 42	L_{dn} 65	1
2	52.1	L_{dn} = 55	L_{dn} 65	
3	42.1	L_{dn} = 55	L_{dn} 65	
4	44.2	L_{dn} = 51.4*	L_{dn} 65	

*NOTE: The measured level at Location 4 is an actual field measurement taken in 1981 with the river screen house in normal operation, i.e., two of the three circulating water make up pumps operating. 1

Source: Department of Housing and Urban Development (HUD 1979). 1



BRAIDWOOD NUCLEAR GENERATING STATION UNITS 1 & 2 ENVIRONMENTAL REPORT OPERATING LICENSE STAGE
FIGURE 5.6-5 NOISE LEVELS AT POINT 4

5.8 DECOMMISSIONING AND DISMANTLING

The Braidwood Nuclear Generating Station - Units 1 & 2 (Braidwood Station) is designed for an operating life of at least 40 years. Decommissioning of this facility, therefore, is not expected to occur before the year 2025 and probably will not occur until much later. It is anticipated that a signficant body of technology related to the decommissioning of nuclear power stations will have been developed before these reactors are decommissioned. Indeed, the decommissioning of nuclear reactor facilities is already a relatively well developed technology (Smith et al, 1978). The Commonwealth Edison Company (CECo) has not yet developed detailed plans for the decommissioning of the Braidwood reactors in order to retain maximum flexibility to apply future technology when needed.

Decommissioning is defined, for a nuclear facility, as the measures taken at the end of the facility's operating life to assure the continued protection of the public from any residual radioactivity or other potential hazards present in the facility. Three basic approaches to decommissioning have been considered:

a. Immediate Dismantlement - Radioactive materials are removed and the station is disassembled and decontaminated during the 4-year period following final cessation of 1
power production operations. Upon completion, the property is released for unrestricted used.

b. Safe Storage with Deferred Dismantlement - Radioactive materials and contaminated areas are secured and structures and equipment are maintained as necessary to assure the protection of the public from the residual radioactivity. During the period of Safe Storage, the facility remains limited to nuclear uses. Dismantlement is deferred until the radioactivity within the station has decayed to lower levels. Upon completion of dismantlement, the property is released for unrestricted use.

c. Entombment - Another alternative to immediate dismantlement is entombment--the encasement of all radioactive meterials remaining at the site of the power plant, in concrete or other structural material

> that is sufficiently strong and structurally long-lived to ensure retention of the radioactivity until it has decayed to levels that permit unconditional release of the site.

Deferred dismantlement, as used here, is a generic term that includes whatever actions are required at some future time to accomplish termination of the facility's nuclear license and the release of the property for unrestricted use. These actions can range from radiation surveys that show that the residual radioactivity has decayed to releasable levels to disassembly and removal of radioactive material.

A broad span of methods is possible under Safe Storage. These methods range from minimal removal and fixation of residual radioactivity, with maintenance and surveillance using either custodial (layaway) or passive (mothballing) protection systems, to extensive cleanup and decontamination with hardened (temporary entombment) passive protection of highly radioactive areas using limited surveillance and continuing maintenance programs. Each method encompassed within Safe Storage requires some level of continuing care during the holding period, which may vary in length from a few years to about a hundred years. Each method ends with the deferred 1
dismantlement of the facility and the termination of the license for radioactive materials, thus permitting the unrestricted use of the property.

The entombment scenario considered is limited to entombment of the lower portion of the containment building, either with the reactor vessel internals removal or with the internals remaining in-place. The rest of the plant is dismantled and relased for unrestricted use. The entombment structure is used as a repository for most of the contaminated material removed during the dismantlement of the balance of the plant. The operations required for entombment include, basically, chemical decontamination where necessary, and storage, in the containment building below the operating floor level, of as much as possible of the contaminated equipment and material located elsewere in the power plant. A continuous slab of concrete is then poured above the operating floor level in the containment building, and all wall penetrations below the floor level are sealed.

The definitions and descriptions of these specific alternatives can be found in Smith et al. (1978) and in its August 1979 Addendum (Smith and Polentz 1979). It is anticipated that future decommissioning technology will retain these procedures and that various

plant systems and components will utilize different methods of decontamination for economic reasons.

The cost estimates for these three primary decommissioning alternatives are shown in Table 5.8-1. These cost estimates have been derived from information available in Smith et al. (1978) and other documents. Unlike the estimates made in Smith et. al. (1978), a cost for deferred dismantlement and deferred demolition in the entombment cost estimate has been included. 1

Table 5.8-1

ESTIMATES OF THE COSTS OF THE PRIMARY DECOMMISSIONING

ALTERNATIVES FOR EACH OF THE BRAIDWOOD STATION UNITS

	Per Unit Cost in Millions of 1983 Dollars
Immediate Dismantlement	47.6
Safe Storage and deferred dismantlement with 30 year storage	61.0
50 year storage	54.9
100 year storage	60.4
Entombment with deferred dismantlement (100 year storage)	
internals remain	70.4
internals removed	77.0

1

CHAPTER 6.0 - EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

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1

where:

TN = total number of trap nights,

C = number of captures, and

I = trap night index.

Species identification, vigor, sex, and weight estimates were recorded, and relative densities were calculated. Surveys for mammals not included in the other studies were conducted during walking surveys of the three new transect areas (A, B, and C). Identifications were made from actual observation of a species or from tracks, scats, dens, and other signs. The relative abundance of each was estimated.

Birds were observed seasonally during walking surveys of transects in the three study areas, with special attention given to species present during spring and fall migration periods. Identifications were made by observing individuals and recognizing calls. Relative abundance, habitat adequacy for waterfowl, and seasonal fluctuations were estimated for individual species.

Relative use of the new areas was compared with the use of the areas already studied, and the new food chain relationships were incorporated into the generalized food web established for the Braidwood Station site.

6.1.4.3.2.2.3 Marsh-Pond Study Areas

Concentrated herpetofauna studies were carried out on marsh-pond sections of Areas 2, 3, 6, and 9. A variety of methods were used to survey and census herpetofauna. On all trips through study areas, the species observed were recorded.

In order to quantify results for certain species (particularly lizards), surveys were made on each study site during the June through September trips in 1974. The type and number of each species seen were recorded together with the distance walked (as measured by pedometer) on each study site.

Traps of various types were also used to quantify results. Can traps, large juice cans buried in the ground beneath a rock with the opening at surface level, were buried on four study sites for lizards and insects. Can traps were buried on Areas 3 and 9 in June 1974 and on Areas 2 and 6 in July 1974. Baited hoop traps and trammel nets were set in study lakes and ponds for aquatic turtles.

Collected specimens were routinely weighed and measured. Small species were weighed on a triple beam balance, and larger species were weighed by means of a spring scale that weighed to the nearest 0.5 kilogram. The length of species other than turtles

was measured from snout to vent with vernier calipers for turtles, length was expressed as the length of carapace and/or length of the plastron.

Several turtles were radio tagged and located during several survey periods. Birds within sight of marsh-pond areas were observed and recorded, and comparative presence of waterfowl and habitat use by waterfowl were noted. Identifications were made through direct observation and animal calls.

Insect abundance and availability as a food source for reptiles, fish, and birds were assessed in the marsh-pond areas nearer the Braidwood Station during summer surveys, using insect nets, light traps, and can traps.

6.1.4.3.3 Methods for 1979 through 1982 Terrestrial Monitoring Program

This program involves the analysis of low and high level false color infrared aerial photographs (Cibachrome prints). The aerial photographs cover about 13 square miles in and around Braidwood site which is sufficient to document land usage modifications resulting from construction activities.

The photographs are examined for dead or dying foliage caused by injury or disease which is distinguishable from normal foliage on the basis of signature differences in the photographs. Also, soil conditions which adversely affect vegetation are also discernible. Once the photographs are analyzed a field examination is made of suspected vegetation by a plant pathologist.

The 1979 and 1980 surveys were performed before the filling of the Braidwood cooling pond. The 1981 and 1982 surveys were performed after pond filling. The study concentrated on the area in and around the cooling pond to determine effects, if any, caused by lake fill. 1

The dates pertaining to the taking of the aerial photographs and the subsequent field examinations are listed below:

Photographs	Field Examination
September 4, 1979	September 28-30, 1979
July 17, 1980	September 10, 1980
July 10, 1981	August 27, 1981
July 23, 1982	August 31, 1982

6.1.5 Radiological Monitoring

The preoperational radiological monitoring program planned for the Braidwood Station was described in the Environmental Report - Construction Permit Stage (ER-CPS). The monitoring program currently planned incorporates some changes in sample collection and analysis that were made to obtain more useful data. The area to be monitored is essentially the same as that described in the ER-CPS (see ER-CPS Subsection 6.1.5).

CECo plans to start its preoperational radiological monitoring program at least 18 months before fuel loading date. The preoperational monitoring program will provide measurements of natural background and other radiation sources, such as fallout, that are external to Braidwood Station. This program will continue until the plant loads nuclear fuel and the operational-phase monitoring program begins. Details of the proposed monitoring program are discussed in this subsection. 1

6.1.5.1 Sampling Media, Locations, and Frequency

Table 6.1-10 presents the preoperational radiological sampling program contemplated for use at the Braidwood Station. The media to be sampled include the most important dose pathways. Air sampling stations and surface and well water sampling sites that may be in the program are shown in Figure 6.1-7. Air sampling sites were selected on the basis of population and site meteorological conditions. Environmental samples will be collected at these locations with the frequencies specified in the technical specifications.

6.1.5.2 Data Analysis, Analytical Sensitivity, and Data Presentation

The environmental samples will be analyzed by radiochemical methods similar to the procedures of the U.S. Energy Research and Development Administration Health and Safety Laboratory (Harley 1972) and the U.S. Public Health Service (1967). Except where otherwise noted, a germanium-lithium (GeLi) system will be used to make all gamma spectral analyses. These methods achieve the analytical sensitivities listed in Table 6.1-11.

For most sample media, variations in radioactivity levels or concentrations from month to month or from year to year are not expected to be caused solely by random processes. That is, they will not be describable by a normal distribution function. Accordingly, for these long-term values it would not be useful to calculate the standard deviation in the routine manner. Gross beta measurement of air samples, for example, are affected primarily by the degree of weapons testing undertaken during, or just before, the sampling period, and by stratospheric radioactivity from past weapons tests. Increases may be due to recent tests, therefore, and analysis of 1 year's data for a standard deviation may produce an estimate of the variation that is not representative of any other year.

Mean values and standard deviations are, however, appropriate for any set of samples taken at the same locations over identical time periods. For this reason, each single set of analyses will be reported as a mean with a ± 2 standard error.

Analytical procedures specific to the samples collected are described in the following subsections.

6.1.5.2.1 Air Samples

The gross beta content of particles filtered from a measured volume of air will be determined weekly by "low level" counting of the filters. When a gamma scan is required by the specifications, the filters will be composited for analyses on a GeLi detector system.

Charcoal cartridges exposed for 2-week periods at air sampling stations will be analyzed for I-131. An I-131 measurement on these samples will usually be made by gamma counting with a sodium iodide (thallium-activated) crystal and a single-channel pulse height spectrometer.

For data presentation, the weekly gross beta results will be averaged quarterly for each monitoring station. The gamma spectra observed on quarterly composites of air samples will be examined for specific radionuclides. It is expected that the radionuclide composition will vary from year to year if atmospheric testing of nuclear weapons continues.

6.1.5.2.2 Water Samples

Gross beta or gamma spectral analyses of surface, well, or precipitation water samples will be performed by evaporating a measured aliquot of the sample, digesting, and planchetting of the processed sample, and subjecting it to a radiometric assay. Tritium analysis will be performed on water samples to a sensitivity of 200 pCi/liter by isotopic enrichment and liquid scintillation counting.

Strontium-89 and -90 analyses will be performed on the samples by standard radiochemical procedures followed by low-level beta counting of total radiostrontium plus yttrium-90. Sr-89 will then be determined by taking the difference between total strontium (represented by the Sr-89 plus Sr-90 analysis) and Sr-90, computed from the Y-90 analysis.

6.1.5.2.3 Sediment

After being dried in an oven, sediment samples will be analyzed by gamma spectral analysis. Much smaller portions will be analyzed for their gross beta content.

6.1.5.2.4 Fish

Fish and other samples of aquatic life will be analyzed for gross beta, Sr-89, Sr-90, and gamma-emitting radionuclide content according to the procedures used by the U.S. Public Health Service (1967 or Harley (1972).

6.1.5.2.5 Milk

During the time cows are in pasture, May through October, samples 1
of fresh milk will be analyzed for radioiodine (as I-131) immediately upon receipt of the samples in the laboratory. This method provides a sensitivity of 0.5 pCi/liter with an overall error of analysis of $\pm$ 25%. During the rest of the year, I-131 will be determined by gamma spectal analysis. Other gammaemitting radionuclides will be determined by gamma spectral analysis. Strontium-89 and-90 analyses will be made with standard radiochemical techniques followed by beta counting.

The principal natural radionuclide in milk is potassium-40. Fission-product nuclides that may be detected are cesium-137 by gamma spectrometry, I-131 by cation exchange-gamma spectroscopy analysis, and Sr-90 by radiochemical analysis. The mean $\pm$ 2σ value of each nuclide will be noted. These measurements may change slightly with time, and the values observed in any one year are not expected to be identical with those of the following year. The measurements will indicate the typical range of values. In the absence of recent weapons tests, no I-131 in milk is expected to occur.

TABLE 6.1-9

DESCRIPTION OF BRAIDWOOD SUMMER BASELINE TERRESTRIAL SURVEY TRANSECTS 1972-1973

TRAN-SECT NUMBER	AREA DESCRIPTION	SAMPLE DESCRIPTION	LENGTH (ft)
1	Fallow Field	Veg.-point intercept	450
		Mam.-10 stations, 2 nights	500
		Birds-qualitative	450
		Insects and Herpetofauna-qual.	450
2	Recently Strip-mined	Veg.-point intercept	1000
		Mam.-10 stations, 2 nights	500
		Birds-qualitative	1000
		Insects and Herpetofauna-qual.	1000
3	Strip-mined in 1940's	Veg.-point intercept, fixed radius plot	735
		Mam.-10 stations, 2 nights	500
		Birds-qualitative	735
		Insects and Herpetofauna-qual.	735
4	Uncultivated Woodlands and Soybean Fields	Veg.-point intercept, fixed radius plot	1000
		Mam.-10 stations , 2 nights	500
		Birds-qualitative	1000
		Insects and Herpetofauna-qual.	1000
5	Strip-mined in 1950's (offsite area)	Veg.-point intercept	1230
		Mam.-10 stations, 2 nights	500
		Birds-qualitative	1230
		Insects and Herpetofauna-qual.	1230
6	7- to 10-year-old Strip-mined area	Veg.-point intercept	973
		Mam.-10 stations, 2 nights	500
		Birds-qualitative	973
		Insects and Herpetofauna-qual.	973
7	Cultivated Corn and Bean Fields	Veg.-qualitative	500
		Mam.-10 stations, 2 nights	500
		Birds-qualitative	500
		Insects and Herpetofauna-qual.	500
8	Uncultivated Woodlands	Veg.-point intercept, fixed radius plot	945
		Mam.-10 stations, 2 nights	500
		Birds-qualitative	945
		Insects and Herpetofauna-qual.	945
9	Strip-mined in 1940's	Veg.-point intercept, fixed radius plot	1000
		Mam.-10 stations, 2 nights	500
		Birds-qualitative	1000
		Insects and Herpetofauna-qual.	1000
10	Marshland (offsite area)	Veg.-point intercept	850
		Mam.-10 stations, 2 nights	500
		Birds-qualitative	850
		Insects and Herpetofauna-qual.	850

TABLE 6.1-10

PREOPERATIONAL RADIOLOGICAL SAMPLING PROGRAM

SAMPLE MEDIA	COLLECTION SITES	TYPE AND FREQUENCY OF ANALYSIS[a b]	FREQUENCY OF COLLECTION
Airborne Particulate Filter	Braidwood, Custer Park, County Line Road, Essex, Gardner, and Godley	Gross Beta - W Sr-89, Sr-90 - Q Comp. Gamma Spec. - Q Comp.	Weekly
Charcoal Cartridge	Same as for Airborne Particulate Filter Sites	I-131	Every 2 weeks beginning 3 months before fuel loading
Gamma Radiation	Same as for Airborne Particulate Filter Sites	TLD	Quarterly
Surface Water[c]	Downstream at Sampling Station 5	Sr-89, Sr-90 - Q Comp. Gamma Spec. - M Comp. Gross Beta - W Tritium - Q Comp.	Weekly
Intake/Discharge Pipes[c]	I/D Pipes if pumping; if not pumping, at Sampling Stations 3 and 4	Gross Beta - W Sr-89, Sr-90 - M Comp. Tritium - M Comp. Gamma Spec. - M Comp.	Weekly
Precipitation	Two nearby Dairies	Gamma Spec. - Q Comp. Sr-89, Sr-90 - Q Comp. Gross Beta - M Tritium - Q Comp.	Monthly
Well Water (offsite)	Nearest Well	Gamma Spec. Sr-89, Sr-90 Gross Beta Tritium	Quarterly
Vegetables	Farms within 10 miles	Gross Beta S4-89, Sr-90 Gamma Spec. I-131 (leafy vegetable)	As available at harvest time
Cattle Feed and Grass	Two nearby Dairies	Gross Beta Sr-89, Sr-90 Gamma Spec.	Quarterly Grass: May-October Feed: November, December
Milk	Two nearby Dairies	Gamma Spec. Sr-89, Sr-90 - M I-131 (Pasture Season)	Monthly
Sediment Aquatic Plants[c]	Downstream at Sampling Station 5, Upstream at Sampling Station 1	Gross Beta Gamma Spec.	3 times a year if available
Fish[c]	Sampling Station 5	Gross Beta Gamma Spec. Sr-89, Sr-90	3 times a year

1

[a]If frequency of analysis is not given, it is the same as frequency of collection.

[b]Frequency of analysis key: W = Weekly; M = Monthly; Q = Quarterly; Comp. = Composite.

[c]See Figure 6.1-2 for sampling locations.

TABLE 6.1-11

PRACTICAL LOWER LIMITS OF DETECTION (LLD)

FOR STANDARD ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

SAMPLE MEDIA	ANALYSIS	LLD (4.66σ)	UNITS
Airborne "Particulate"	Gross Beta[a]	0.01	pCi/m^3
	Gamma Isotopic	0.01	pCi/m^3
	Sr-89,Sr-90	0.01	pCi/m^3
Airborne I-131	Iodine-131	0.10	pCi/m^3
Liquids	Sr-89	10	pCi/liter
	Sr-90	2	pCi/liter
	I-131	5[b]	pCi/liter
	Cs-134	10	pCi/liter
	Cs-137	10[c]	pCi/liter
	Tritium	0.2	pCi/ml
	Gross Beta[a]	5	pCi/liter
	Gamma Isotopic	20	pCi/liter/nuclide
Vegetation	Gross Beta[a]	2	pCi/g wet
	I-131	0.03	pCi/g wet
	Sr-89,Sr-90	1	pCi/g wet
	Gamma Isotopic	0.2	pCi/g wet
Soil, Sediment	Gross Beta[a]	2	pCi/g dry
	Sr-89,Sr-90	1	pCi/g dry
	Gamma Isotopic	0.2	pCi/g dry
Animal Tissue	Sr-89,Sr-90	0.1	pCi/g wet
	I-131 - Thyroid	0.1	pCi/g wet
	Cs-134,137	0.1	pCi/g wet
	Gross Beta[a]	1.0	pCi/g wet
	Gamma Isotopic	0.2	pCi/g wet 1

[a]Referenced to Cs-137.

[b]0.5 pCi/liter on milk samples collected during the pasture season.

[c]5.0 pCi/liter on milk samples.

TABLE 6.1-12

EXPECTED BRAIDWOOD BACKGROUND RADIATION

LEVELS BASED ON DRESDEN DATA

MEDIUM	ANALYSIS	EXPECTED LEVEL[a] (Dresden Station data)
External Gamma Radiation	TLD	≈60 mrem/year
Airborne Particulate Samples	"Gross Beta"	0.05 to 0.5 pCi/m^3
	Gamma Spectrum	Be-7
Milk	Gamma Spectrum	Cs-137, K-40
	Radiostrontrium	≈5 pCi/liter
	Radiocesium	<5 pCi/liter
Water (surface and wells)	"Gross Beta"	5 to 35 pCi/liter
	Tritium	200-400 pCi/liter
Benthic Organisms, Fish, and Shellfish	"Gross Beta"	10-60 pCi/g (dry)
Sediments	"Gross Beta"	10 to 20 pCi/g (dry)
	Gamma Spectrum	K-40, Uranium Series, Throium Series
Grass and Food Crops	"Gross Beta"	20 to 50 pCi/g (dry)
	Gamma Spectrum	K-40, occasionally Cs-137, Be-7, Nb-95

Source: Commonwealth Edison Company (1976a, 1976b).

[a]Underlined activities will dominate the spectrum. Others will be near the limits of detectability.

6.4 PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING DATA

The preoperational radiological monitoring program for the Braidwood Nuclear Generating Station - Units 1 and 2 will begin at least 18 months before fuel loading date. When 12 months of monitoring data, including data from a crop harvest and a complete growing season, are available, they will be submitted as a supplement to this Environmental Report. 1

CHAPTER 8.0 - ECONOMIC AND SOCIAL EFFECTS OF STATION OPERATION

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CHAPTER 8.0 - ECONOMIC AND SOCIAL EFFECTS OF STATION OPERATION

The Braidwood Nuclear Generating Station - Units 1 & 2 (Braidwood Station) will create a total of 553 permanent new jobs at the station site and an estimated annual payroll of $14.6 million (in 1982 dollars) when the station goes commercial in 1986. 1

The total cultivated agricultural land to be affected by the construction and operation of the Braidwood Station is 270 acres. The construction of the cooling pond required the diversion of 381 acres of cultivated agricultural land. About 90% of the remaining area required for pond construction, or 2838 acres, consisted of strip-mine spoil. The total affected cultivated acreage (651 acres) is less than 0.1% of the total agricultural land in the three-county agricultural region formed by Grundy, Kankakee, and Will Counties (see Section 4.1).

Permanent new residents attracted as a result of the Braidwood Station project will be dispersed throughout the surrounding communities (see Section 8.4), so that there will be little effect on local services. The increased tax revenue attributable to the Braidwood Station project from property taxes is estimated to be $9.3 million in 1986 (see Section 8.2). Local taxing districts 1 should receive more tax dollars than required to provide the additional services for the new residents.

It is not possible to determine the benefit to the local economy from the purchase of local goods and services for operation of the station. The average 1983 budget for contract payments for Commonwealth Edison's three operating nuclear stations, each with two operable units, is $17.3 million. These costs include refueling, maintenance and waste disposal. The procurement of materials and 1 services is based on a competetive bid system, and therefore no estimate can be made as to which suppliers will provide the materials and service, the corresponding monetary value, or the county in which the supplier is located.

There are no historical sites located on the Braidwood site.

8.1 VALUE OF DELIVERED PRODUCTS

Because the generating capacity of the Braidwood Station will be made available throughout the entire Commonwealth Edison Company (CECo) power grid, no attempt has been made to confine the use characteristics within an imaginary radius of the site. The station's electrical output has been estimated for the composition of the entire CECo service territory.

Estimates of the total generating costs for the first year of commercial operation for each unit are $607 million (103 mills per kilowatthour) for Unit 1 and $455 million (77 mills per kilowatthour) for Unit 2 (see Tables 8.1-1 and 8.1-2).

At a lifetime average capacity factor of 65%, the plant will produce 12.75 billion kilowatthours of electricity annually with associated annual revenues of $836 million under the present rate schedules (see Tables 8.1-3 and 8.1-4), assuming that revenue contributions for classes of service for the year ending June 30, 1982, remain constant through the life of the plant. The estimated values of various benefits from the Braidwood Station project are listed on Table 8.1-5. Dollar values listed in this table represent revenues for a 30-year period and indirect benefits for a 30-year period present valued to January 1, 1983 at an effective interest rate of 13% per year. 1

TABLE 8.1-1

ESTIMATED TOTAL GENERATING COST FOR BRAIDWOOD

STATION UNIT 1 FOR FIRST 12 MONTHS OF COMMERCIAL OPERATION

Cost Component	Dollars[a] (thousands)	Mills Per Kilowatthour[a]
Fuel	$ 77,175	13.11
Operating & Maintenance	39,559	6.72
Carrying Charges	471,703	80.13
Other	18,484	3.14
Total Generating Cost	$606,921	103.10

1

Note: Values are based on commercial operation starting October, 1985.

[a]Costs are in 1986 dollars and are based on 60% capacity factor (generating 5,886,720 MWH per year). Cost includes carrying charges on fuel investment.

TABLE 8.1-2

ESTIMATED TOTAL GENERATING COST FOR BRAIDWOOD

STATION UNIT 2 FOR FIRST 12 MONTHS OF COMMERCIAL OPERATION

Cost Component	Dollars[a] (thousands)	Mills Per Kilowatthour[a]
Fuel	$ 84,121	14.29
Operating & Maintenance	43,150	7.33
Carrying Charges	312,526	53.09
Other	14,717	2.50
Total Generating Cost	$454,514	77.21

1

Note: Values are based on commercial operation starting October, 1986.

[a]Costs are in 1987 dollars and are based on 60% capacity factor (generating 5,886,720 MWH per year). Cost includes carrying charges on fuel investment.

Table 8.1-3

COMMONWEALTH EDISON COMPANY

REVENUE AND ENERGY SOLD BY CLASS

OF SERVICE FOR 12 MONTHS ENDED JUNE 30, 1982

Class	Revenue ($ in 000's)	Energy Sold Amount (MWH)	Energy Sold Percentage of Total	Revenue Per KWH (¢)
Residential	1,316,461	17,335,745	29.03	7.59
Small Commercial & Industrial	1,359,441	18,990,773	31.81	7.16
Large Commercial & Industrial	924,955	17,660,955	29.58	5.24
Other	314,971	5,721,822	9.58	5.50
Total	3,915,828	59,709,295	100.00	

1

Table 8.1-4

Estimated Annual Amount of Energy and Revenue

Attributable to the Braidwood Station by Class of Customer

Class of Customer: Type	Class of Customer: Percentage of Total Energy Used	Total Estimated Energy Used (MWH)	Revenue Per KWH (¢)	Total Value (Dollars)
Residential	29.03	3,702,649	7.59	281,031,059
Small Commercial & Industrial	31.81	4,057,225	7.16	290,497,310
Large Commercial & Industrial	29.58	3,772,799	5.24	197,694,668
Other	9.58	1,221,887	5.50	67,203,785
Total	100.00	12,754,560		836,426,822

TABLE 8.1-5

BENEFITS FROM THE BRAIDWOOD STATION

DIRECT BENEFITS	QUANTITATIVE VALUE	
Expected Average Annual Generation in KWH (billions)	12.75	
Capacity in KW (millions)	2.24	
Proportional Distribution of Electrical Energy Expected		
Annual Delivery (KWH) (billions)		
Residential	3.70	
Small Commercial and Industrial	4.06	
Large Commercial and Industrial	3.77	
Other	1.22	1
Revenues from Delivered Benefits		
Electrical Energy Generated (millions of dollars)[a]	8,347.6	
INDIRECT BENEFITS		
Taxes (local, state, federal) (millions of dollars)[a]	1,482.4	

[a]These dollars are for a 30-year period present valued to January 1, 1983 at an effective interest rate of 13%.

8.2 OPERATIONAL PHASE ANNUAL STATION PROPERTY TAX BENEFITS

The annual property tax breakdown for Braidwood Station, both for 1981 and projected to 1986, is listed in Table 8.2-1. 1

TABLE 8.2-1

BRAIDWOOD STATION ANNUAL PROPERTY TAXES

TAXING UNIT	ACTUAL 1981 TAXES	ESTIMAT[illegible] 1986 [illegible]	
County	$ 567,198	[illegible]00	
Forest Preserve	206,209	[illegible]43,000	
Reed Twp.	74,1[illegible]	121,600	
Braidwood Fire Dist.	186,[illegible]	306,800	1
School Dist. U-225	3,641,6[illegible]	6,078,100	
Comm. College Dist. 525	249,426	592,300	
Fossil Ridge Public Library	134,908	221,200	
TOTAL	$5,039,942	$9,281,900	

8.3 OPERATIONAL PHASE EMPLOYMENT

During the estimated 40-year lifetime of the Braidwood Station, gains in local employment will be effected through the creation of 553 new Braidwood Station operating staff jobs. These 553 plant employees will earn a total of $14.6 million annually in 1982 dollars (see Table 8.3-1). This value is based on 1982 CECo. generating station payroll data.

The average income of $26,318 in 1982 for a Braidwood Station operating staff employee can be compared to the projected average income of workers in the local area around Braidwood Station (local area defined as the communities of Braidwood, Gardner, Wilmington, Godley, South Wilmington, and Coal City; see Section 9.4). Table 8.3-2 shows a 1982 projected average wage of $23,846 for local residents based upon 1970 census tract information and the Consumer Price Index for a period extending from 1970 to 1982. The Braidwood Station average wage, however, represents a select group of employees, whereas the local earning figures represent all wage earners, including part-time and fixed income earners. 1

The induced new employment in the east-northeastern Illinois region is estimated to be 498 new jobs based on a local multiplier of 0.90. The local multiplier is defined as the number of service occupation employees in 1974 divided by the number of production occupation employees in the same year. It was calculated using data obtained from the Illinois Department of Business and Economic Development (1976). The total employment generated in the east-northeastern Illinois region, which includes Braidwood Station, is therefore estimated to be the direct employment plus the induced employment, or 1,051 new jobs.

TABLE 8.3-1

BRAIDWOOD STATION OPERATING

STAFF 1986 PAYROLL PROJECTION

PERSONNEL GROUP	PAYROLL
417 Station Employees	$11,987,141
170 Management Employees - $32,354 average	
247 Bargaining Unit Employees - $26,263 average	
3 Quality Assurance Employees - $32,354 average	97,062
3 Nuclear Safety Department Employees $32,354 average	97,062
130 Security Force Employees - $18,252 average	2,372,760
TOTAL PAYROLL	$14,554,025
Average per Employee	$ 26,318

1

Note: Payroll projection in 1982 dollars based on July 1982 CECo. Generating Station data.

TABLE 8.3-2

AVERAGE INCOME FOR

BRAIDWOOD STATION LOCAL AREA

YEAR	AVERAGE INCOME	
1970	$ 9,200[a]	
1982	$23,830[b]	1

[a]Source: U.S. Census information obtained from CACI Site II Program.

[b]Source: Increase of 159% from 1970 to 1982 obtained from Consumer Price Index. 1

CHAPTER 11.0 - SUMMARY COST-BENEFIT ANALYSIS

Information on the summary cost-benefit analysis for the Braidwood Nuclear Generating Station - Units 1 & 2 (Braidwood Station) is presented in Table 11.0-1.

TABLE 11.0-1

SUMMARY OF COST-BENEFIT ANALYSIS OF THE BRAIDWOOD STATION

CONDITIONS AND CHARACTERISTICS	PRESENT BRAIDWOOD STATION ENVIRONMENT	NUCLEAR POWER STATION WITH ASSOCIATED COOLING POND	
Total Anticipated Capital Investment		$1.6 billion	1
Economy of the Braidwood Station Region	Resource-based economy especially oriented toward agriculture and mining	Annual permanent employee payroll: $14.6 million	1
		Annual local taxes on station: $9.3 million estimated for 1986 when the second unit becomes commercial	1
		Taxes (local, state, federal) over 30-year period $1,482.4 million	1
Economy of the Commonwealth Edison Company Service Area	Extremely diverse economy, highly industrialized in Chicago metropolitan area and some outlying centers (Joliet, Rockford), and primarily agriculturally oriented in non-metropolitan areas	Annual value of power produced under present schedules: $836 million	1
Physical and Chemical	Lands: The present land use in the area is primarily strip-mine spoil with some cultivated land	Approximately 4454 acres of land have been acquired for use by the proposed station and cooling pond. Of this acreage, about 820 acres will form the exclusion area. Cropland and residential land in the exclusion area will be changed because no crops will be grown and house and farm buildings have been removed. The actual station structure will occupy 130 acres. Loss	1

TABLE 11.0-1

SUMMARY OF COST-BENEFIT ANALYSIS OF THE BRAIDWOOD STATION

CONDITIONS AND CHARACTERISTICS	PRESENT BRAIDWOOD STATION ENVIRONMENT	NUCLEAR POWER STATION WITH ASSOCIATED COOLING POND
		of wildlife habitat is expected to be small. Construction of the cooling pond requires the diversion of 704 acres of cultivated agricultural land. Of the remaining area required for pond construction, the major portion, 2313 acres, currently consist of strip-mine spoil
	Water: Kankakee River near site: average flow = 4116 cfs	Water consumed through evaporation and seepage loss: approximately 57 cfs
	Temperature ranges: Summer 16.5° to 30.0°C Spring and Fall 0.5° to 26.5°C Winter 0.0° to 9.5°C	The concentration of radio nuclides in the discharge will be much less than the maximum permissible concentration (MPC) of 10 CFR 20 and will meet the design objectives of 10 CFR 50, Appendix I.
	Quality is good, with little effect due to domestic and industrial discharge	Thermal discharge to river is expected to be negligible and in compliance with thermal mixing zone regulations.
		Chemical discharge into the Kankakee River due to operation of the station is not considered significant.
		The only discharge to the groundwater (approximately 5 cfs) will be associated with seepage from the cooling pond.

CHAPTER 12.0 - ENVIRONMENTAL APPROVALS AND CONSULTATIONS

The licenses, permits, and other approvals required by federal, state, and local authorities for the constructin and operation of the Braidwood Nuclear Generating Station - Units 1 and 2 (Braidwood Station) are listed in Table 12.0-1. This table indicates the issuing government agency, the statutory basis of the agency's authority, the activity for which approval is required, the category of environmental impact, and the status of each permit. The table is based on the design of the Braidwood Station, the project schedule, and the statutes and regulations applicable as of December 1982. Should it become necessary in the future to apply for other approvals or permits, Commonwealth Edison Company will take action. 1

Table 12.0-2 lists the state and local authorities contacted in connection with the Braidwood Station.

TABLE 12.0-1

AUTHORIZATIONS REQUIRED FOR CONSTRUCTION AND OPERATION OF THE BRAIDWOOD STATION

AGENCY	PERMIT REQUIRED: DESCRIPTION	PERMIT REQUIRED: STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (DECEMBER 1982)	CATEGORY OF ENVIRONMENTAL IMPACT[a]
U.S. Nuclear Regulatory Commission	Construction Permit	Atomic Energy Act of 1954 and Regulation 10 CFR 50	Construct Units 1 & 2	Granted 12-31-75	Air, Land, Water - CE
U.S. Nuclear Regulatory Commission	Operating Permit	Atomic Energy Act of 1954 and Regulation 10 CFR 50	Operate Units 1 & 2	Submitted 12-01-78	Air, Land, Water - OE
U.S. Nuclear Regulatory Commission	Radiation Materials License	10 CFR 70 10 CFR 30	Possess special nuclear materials prior to operating license	Granted 10-31-80 Amendment to include nuclear fuel to be applied for 1-84.	Radiological - OE
U.S. Army Corps of Engineers	Construction Permit	33 USC Section 403, 404, 565	Construct intake and discharge structures	Granted 8-09-77	Water - CE
Federal Aviation Administration	Approval	Civil Aeronautics Act of 1938 as amended Sections 205 and 1101	Approval of 320-foot meteorological tower	Granted 5-25-73	Land - Planning
U.S. Environmental Protection Agency	NPDES Permit	FWPCA Section 402	Discharge treated plant waste	Granted 5-19-76	Water - CE and OE
Illinois Commerce Commission	Cert. of Convenience and Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 Section 50 et seq	Construct and operate Units 1 & 2	Granted 3-27-74	Land - Planning

[a]CE = Construction Effect; OE = Operational Effect.

TABLE 12.0-1 (Cont'd)

AUTHORIZATIONS REQUIRED FOR CONSTRUCTION AND OPERATION OF THE BRAIDWOOD STATION

AGENCY	PERMIT REQUIRED: DESCRIPTION	PERMIT REQUIRED: STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (DECEMBER 1982)	CATEGORY OF ENVIRONMENTAL IMPACT[a]	
						1
Illinois Commerce Commission	Cert. of Convenience and Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 Section 50 et seq.	La Salle to Braidwood to East Frankfort transmission line right-of-way	Granted 8-24-77 Amended 11-10-77 (Section 50 granted 11-09-77)	Land - Planning	
Illinois Commerce Commission	Cert. of Convenience and Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 Section 50 et seq.	Latham-Frankfort (Line 8012) to Davis Creek transmission line right-of-way	Granted 8-13-75 (Section 50 granted 2-11-76)	Land - Planning	
Illinois Commerce Commission	Cert. of Convenience and Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 Section 50 et seq.	Braidwood to Line 8012 transmission line right-of way	Granted 8-17-77	Land - Planning	
Illinois Commerce Commission	Cert. of Convenience and Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 Section 50 et seq.	Davis Creek-Crete transmission line right-of way	Granted 1-25-78 (Section 50 granted 11-29-78)	Land - Planning	1
Illinois Commerce Commission	General Order 138	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 Section 50 et seq.	Extend railroad spur track across Route 53	Granted 2-13-75	Land - Planning	
Illinois Department of Transportation,	Construction Permit (No. 15039)	Ill. Commerce Act June 10, 1911; (Ill. Rev. Stat. 1969, Ch. 19, 52 et seq.)	Construct intake and discharge structures	Granted 4-29-77	Water - CE	

[a]CE = Construction Effect; OE = Operational Effect.

TABLE 12.0-1 (Cont'd)

AUTHORIZATIONS REQUIRED FOR CONSTRUCTION AND OPERATION OF THE BRAIDWOOD STATION

AGENCY	PERMIT REQUIRED DESCRIPTION	PERMIT REQUIRED STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (DECEMBER 1982)	CATEGORY OF ENVIRONMENTAL IMPACT[a]
Illinois Department of Transportation, Division of Waterways	Revision to Permit 15039	Ill. Commerce Act June 10, 1911; (Ill. Rev. Stat. 1969, Ch. 19, 52 eq seq.)	Construct sheet pile cut-off wall around intake structure	Granted 10-04-77	Water - CE
Illinois Department of Nuclear Safety	Registration	Ill. Public Health and Safety, Radiation Installation Registration Law, July 5, 1957 (Ill. Rev. Stat. 1979, Ch 111-1/2 Section 194-200	Radiation installation registration	Applied for 11-09-79	Radiological - OE
Illinois Department of Mines and Minerals	Permit	Ill. Act of 1941, (Ill. Rev. Stat. 1969 Ch. 104, 62 et seq.)	Drill wells at site for potable water	Granted 9-20-74	Water - CE
Illinois Department of Transportation, Division of Aeronautics	Permit	Ill. Rev. Stat. 1971; Ch. 127 et seq.	To construct 320-foot meteorological tower	Granted 6-04-73	Land - Planning
Illinois EPA, Division of Water Pollution Control	Construction and operating permit	Environmental Prot. Act (Ill. Rev. Stat. 1971; Ch. 111-1/2 10001 et seq.)	To construct and operate the sewage treatment works for one year	Granted 4-17-75	Water - CE and OE

[a]CE = Construction Effect; OE = Operational Effect.

TABLE 12.0-1 (Cont'd)

AUTHORIZATIONS REQUIRED FOR CONSTRUCTION AND OPERATION OF THE BRAIDWOOD STATION

AGENCY	PERMIT REQUIRED		PURPOSE	STATUS OF PERMIT (DECEMBER 1982)	CATEGORY OF ENVIRONMENTAL IMPACT[a]
	DESCRIPTION	STATUTE AUTHORITY			
Illinois EPA, Division of Water Pollution Control	Renew operating permit	Environmental Prot. Act (Ill. Rev. Stat. 1971, Ch. 111-1/2 1001 et seq.)	Renew operating permit for the sewage treatment works	Granted 4-11-77	Water - OE
Illinois EPA, Division of Water Pollution Control	401 Certification	FWPCA Sec. 401	To construct the intake and discharge structures	Granted 6-19-74	Water - CE
Illinois EPA, Division of Water Pollution Control	401 Certification	FWPCA Sec. 401	To discharge into the Kankakee River (needed for NRC construction permit)	Granted 10-31-74	Water - CE
Illinois EPA, Division of Water Pollution Control	401 Certification	FWPCA Sec. 401	To discharge into the Kankakee River (needed for NPDES permit)	Granted 8-18-75	Water - OE
Illinois EPA, Division of Water Pollution Control	Construction permit	Environmental Prot. Act (Ill. Rev. Stat. 1971; Ch. 111-1/2 1001 et seq.)	To construct wastewater treatment facilities (includes the pond)	Granted 8-22-74	Water - CE
Illinois EPA, Division of Air Pollution Control	Construction and operating permit	Environmental Prot. Act (Ill. Rev. Stat. 1971; Ch. 111-1/2 1001 et seq.)	To construct and operate diesel generators	Granted 4-09-80	Air - CE

[a] CE = Construction Effect; OE = Operational Effect.

TABLE 12.0-1 (Cont'd)

AUTHORIZATIONS REQUIRED FOR CONSTRUCTION AND OPERATION OF THE BRAIDWOOD STATION

AGENCY	PERMIT REQUIRED DESCRIPTION	PERMIT REQUIRED STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (DECEMBER 1982)	CATEGORY OF ENVIRONMENTAL IMPACT[a]
Illinois State Fire Marshal	Construction permit	Ill. Act of June 28, 1919, Sec. 2 (Ill. Rev. Stat. 1971; Ch. 127-1/2, Sec. 154)	To construct diesel fuel tanks and turbine oil tanks	Granted 7-78	CE and OE
Illinois EPA, Division of Air Pollution Control	Construction and operating permit	Environmental Prot. Act (Ill. Rev. Stat. 1971; Ch. 111-1/2 1001 et seq.)	To construct and operate diesel fuel tanks and turbine oil tanks	Granted 4-09-80	Air - CE
Illinois EPA, Division of Air Pollution Control	Construction and operating permit	Environmental Prot. Act (Ill. Rev. Stat. 1971; Ch. 111-1/2 1001 et seq.)	To construct and operate volume reduction system	Granted 12-20-82	Air - OE
Illinois Department of Public Safety, Board of Boiler Rules	Registration	Boiler and Pressure Vessel Safety Act and Rules and Regulations (1976 edition), Part III Subsection 1, Part II Pub. 24	Register boiler and pressure vessels with the board	To be applied for	OE
Illinois Department of Public Safety, Board f Boiler Rules	Inspection certificate	Boiler and Pressure Vessel Safety Act and Rules and Regulations (1976 edition), Part III Subsection 1, Part II Pub. II	Certify that boiler pressure vessels comply with regulations	To be applied for	OE

1

[a]CE = Construction Effect; OE = Operational Effect.

TABLE 12.0-1 (Cont'd)

AUTHORIZATIONS REQUIRED FOR CONSTRUCTION AND OPERATION OF THE BRAIDWOOD STATION

AGENCY	PERMIT REQUIRED: DESCRIPTION	PERMIT REQUIRED: STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (DECEMBER 1982)	CATEGORY OF ENVIRONMENTAL IMPACT[a]
Illinois Department of Public Safety, Board of Boiler Rules	ASME, NA and NPT Stamps	Boiler and Pressure Vessel Safety Act and Rules and Regulations (1976 edition), Part III Section 1, Part III Section VIII	Required to conduct maintenance	To be applied for	OE
Grundy/Will Counties Superintendent of Highways	Permit		To do county road work	Granted 9-25-75	Land - Planning
Highway Commission of Reed Towship	Order		To close township roads	Roads Closed 1-05-76	Land - Planning
Will County	Building and Use Permit		To construct Braidwood Station	Granted 10-29-74	Land - Planning
Will County	Building and Use Permit		To construct intake structure	Granted 1-22-76	Land - Planning
Will County	Building and Use Permit		To construct 320-foot meteorological tower	Granted 5-01-73	Land - Planning
Illinois Central Gulf Railroad Company	Agreement		To connect CECo's spur line with the Illinois Central Gulf Railroad	Agreement reached 10-10-75	Land - Planning

[a]CE = Construction Effect; OE = Operational Effect.

TABLE 12.0-2

CONSULTATIONS WITH STATE AND LOCAL OFFICIALS

OFFICIAL	POSITION
Ray Hulbert	Supervisor of Zoning & Building Will County Zoning & Building Department
Paul Abrahamson (deceased)	Road Commissioner Reed Township, Will County
Terry Petersen	District Utility Coordinator, State Highway Department
James Craziano	Permit Engineer State Highway Department
Douglas Spesia	Will County Zoning Board of Appeals
H. E. Schwark	Superintendent of Highways Kankakee County
Bruce Rogers	Illinois Department of Conservation
J. Van Meter	Illinois Department of Conservation
David Mueller	U.S. Fish and Wildlife Service
R. Clem	Illinois Department of Transportation, Division of Water Resources
Allan D. May	Will-South Cook Counties Soil and Water Conservation District

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VOLUNTARY REVISIONS

Amendment 1 consists of voluntary revisions to the following parts of the Braidwood Station Environmental Report - Operating License Stage:

Chapter 1	Purpose of the Proposed Facility and Associated Transmission
Section 2.1	Geography and Demography
Section 2.2	Ecology
Section 2.3	Meteorology
Section 2.4	Hydrology
Section 2.7	Noise
Section 3.1	External Appearance
Section 3.3	Station Water Use
Section 3.4	Heat Dissipation System
Section 3.5	Radwaste Systems and Source Terms
Section 3.6	Chemical and Biocide Systems
Section 3.9	Transmission Facilities
Section 4.1	Site Preparation and Station Construction
Section 4.3	Resources Committed
Section 5.2	Radiological Impact from Routine Operation
Section 5.6	Other Effects
Section 5.8	Decommissioning and Dismantling
Section 6.1	Applicants' Preoperational Monitoring Programs

Section 6.4	Preoperational Environmental Radiological Monitoring Data
Chapter 8	Economic and Social Effects of Station Operation
Chapter 11	Summary Cost Benefit Analysis
Chapter 12	Environmental Approvals and Consultations

These revisions, along with related changes to the tables of contents and references, have been incorporated into the report as change-out pages.