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2.0 SITE CHARACTERISTICS

Chapter 2 provides information on the site and environs of the Quad Cities Station, summarizes the pertinent analyses and conclusions confirming the suitability of the site. [2.1.1]

The Quad Cities Station is suitable as a site for Units 1 and 2. Studies and investigations by independent, qualified expert firms in the areas of meteorology, geology, seismology, and hydrology and further evaluation of population densities and land usage in the site environs were prepared and submitted for review by the AEC staff and other governmental agencies. It was concluded, in the proceedings in such dockets, that the Quad Cities Station satisfies the site criteria contained in 10 CFR 100 and that Units 1 and 2 could be constructed at that site without undue risk to the health and safety of the public.

The Quad Cities site meets the reactor site criteria described in 10 CFR 100 (or 10 CFR 50.67 as applicable) for Units 1 and 2 for the following reasons: [2.1.2]

A. Exelon Generation Company's ownership of the 784-acre tract provides the requisite exclusion area for power reactors such as Units 1 and 2.

B. There are no residences on the site or within a radius of 0.5 miles of Units 1 or 2.

C. Units 1 and 2 are independent of each other to the extent that an accident in one would not initiate an accident in the other and the simultaneous operation of the two units will not result in total radioactive effluent releases beyond allowable limits.

D. The calculated total radiation doses under postulated hypothetical accident conditions to an individual at the boundary of the exclusion area or at the outer boundary of the "low population zone" are within the limits prescribed by 10 CFR 100 (or 10 CFR 50.67 as applicable), as discussed in Chapter 15.

E. Activities which are permitted on the site unrelated to the operation of any unit do not present any hazards to the public.

F. There are numerous roads, which provide adequate access to and from the site as well as within the "low population zone."

G. The population density and use characteristics of the site environs in the "low population zone" are compatible with the combined operation of the two units.

H. As discussed in subsequent sections, the geological, hydrological, meteorological, and seismological characteristics of the site and environs are suitable for the location of Units 1 and 2 on such a site.

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site Location and Description

The site of the Quad Cities Station is in Rock Island County, Illinois, in parts of sections 7, 8, 17, 18, 19 and 20, Township; 20 North, Range; 2 East. It is on the east bank of the Mississippi River opposite the mouth of the Wapsipinicon River, and about 3 miles north of Cordova, Illinois. The site is about 20 miles northeast of the Quad Cities (Davenport, Iowa; Rock Island, Moline, and East Moline, Illinois). [2.1.3]

The site is at Mile 507 above the mouth of the Ohio River. Topographic relief at the site is low and relatively flat. The station elevation represented by the ground floor level of the reactor building, is 595 feet above mean sea level datum. The ground surface drops off abruptly at the bank of the river, forming a bluff about 30 feet high.

The 784-acre tract of land, which comprises the site is shown on Figure 2.1-1. The nearest land in an unrestricted area is about 2360 feet west of the 310-foot concrete chimney as indicated in Figure 2.1-1 which shows that the 310-foot stack is located approximately 375 feet from the nearest point on the Mississippi River shore and approximately 2360 feet from the nearest point on the opposite shore. There are no residences on the site. [2.1.4]

2.1.2 Exclusion Area Authority and Control

Exelon Generation Company (EGC) and MidAmerican Energy Company own as tenants in common (EGC owning a 75% undivided interest and Iowa a 25% undivided interest), the entire plant exclusion area which is the 784-acre site, and therefore have complete authority to regulate any and all access and activity within that area. [2.1.5]

EGC's Iowa and Illinois ownership rights extend to the thread (middle) of the river adjacent to the plant. Additionally, plant fencing exists along the river and extends across both the intake and discharge canals to deter access to plant property. Since full time occupancy at the plant fence line would not result in personnel exposures beyond those set forth in 10 CFR 20, there is no need to control river traffic during periods of normal plant operation.

The authority to control the river adjacent to the plant is vested with the U.S. Army Corps of Engineers. Should the need to control river traffic arise, the Quad Cities emergency procedures detail the process of making the required notification to the States of Illinois and Iowa. The States will coordinate the closure of river traffic in accordance with State Emergency Plans. [2.1.6]

2.1.3 Population Distribution

The population distribution around the site is quite low with typical rural characteristics. Within a five mile radius of the site, the 1980 population density is approximately 72 people per square mile and is less than 10 people per square mile in some areas. [2.1.7]

The site is bordered on the west by the Mississippi River and is opposite the outlet of the Wapsipinicon River. To the west there are no residences within a mile of the reactor building. Within the 2 mile radius of the reactor building on the Iowa side of the river, there are less than 10 residences. The nearest residence is approximately 3170 feet north of the 310-foot concrete chimney. [2.1.8]

The nearest developed community is the village of Cordova, Illinois, located approximately 3 miles south of the site. Population of this community in 1980 was 697. [2.1.9]

The nearest population center is Clinton, Iowa (population approximately 32,828) located 8.5 miles to the northeast. Southwest of the site at distances of 15-20 miles are the Quad-Cities of Rock Island, Moline, and East Moline, Illinois, and Davenport, Iowa. Total population and density from the site out to a distance of 25 miles are approximately 449,082 and 229 people per square mile respectively. [2.1.10]

Population growth near the plant since the time of PSAR filing has been slow and generally consistent with the rural population growth rate in the Quad Cities area of about 1% per year maximum. There are no known factors which would change the 1% maximum rural growth rate in the foreseeable future. [2.1.11]

Population growth for urban centers in Iowa and Illinois is shown in Table 2.1-1. The 1980 population distribution, for each 22 1/2 degree sector out to a distance of 50 miles is shown in Table 2.1-2. [2.1.12]

The Low Population Zone is a 3 mile radius from the site. The areas included within the Low Population Zone are shown in Figure 2.1-2. [2.1.13]

Table 2.1-1

POPULATION GROWTH – URBAN CENTERS

	Illinois				Iowa	
Year	Rock Island	Moline	East Moline	Davenport	Bettendorf	Clinton
1940 Actual	42,775	34,608	12,359	66,039	3,143	26,270
1950 Actual	48,710	37,397	13,913	74,549	5,132	30,379
1960 Actual	51,863	42,705	16,732	88,981	11,534	33,589
1970 PSAR Estimate	55,000	51,500	21,000	103,500	20,500	36,900
1970 Actual	50,166	46,237	20,956	98,469	22,126	34,719
1980 PSAR Estimate	62,000	60,000	26,000	119,500	35,000	40,600
1980 Actual	47,036	45,709	20,907	103,264	27,376	32,828
1990 Projected	55,967	56,388	28,544	129,676	81,251	42,631
1990 Actual	40,552	43,202	20,147	95,333	28,132	29,201
2000 Projected	40,510	43,150	20,120	101,280	29,890	26,530

Table 2.1-2

SECTORS AND ZONE DESIGNATORS AND CALCULATED 1980 POPULATION DISTRIBUTION WITHIN 50 MILES OF QUAD CITIES STATION

Sector Centerline in Degrees from True North from Facility	22 1/2* Sector	Miles from Facility										
		0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	Sector Total
0 + 360	A	97	24	3	27	945	6,916	945	2,155	5,906	7,893	24,911
22 1/2	B	0	8	12	236	1,418	8,502	19,513	6,920	4,086	6,703	47,398
45	C	0	8	16	5	14	4,500	6,880	2,883	2,000	6,899	23,205
67 1/2	D	5	5	19	5	14	243	6,966	3,997	7,440	7,458	26,152
90	E	0	5	16	0	41	170	3,432	4,849	19,131	19,498	47,142
112 1/2	F	0	0	8	11	14	111	4,040	3,965	4,539	5,547	18,235
135	G	0	5	11	24	19	251	2,361	3,421	4,861	3,458	14,411
157 1/2	H	0	5	11	24	19	265	1,964	9,765	19,017	8,054	39,124
180	J	30	73	30	489	19	1,859	9,109	3,582	4,846	6,086	26,123
202 1/2	K	0	0	0	407	259	3,238	58,235	11,552	4,265	7,940	85,896
225	L	0	0	19	113	494	337	135,056	81,669	7,707	4,361	229,756
247 1/2	M	0	0	30	19	46	157	5,290	6,192	5,524	30,059	47,317
270	N	0	0	14	8	49	311	2,896	3,592	2,699	5,759	15,328
292 1/2	P	0	0	68	216	14	399	6,074	2,758	4,033	5,728	19,290

Table 2.1-2 (continued)

SECTORS AND ZONE DESIGNATORS AND CALCULATED 1980 POPULATION DISTRIBUTION WITHIN 50 MILES OF QUAD CITIES STATION

Sector Centerline in Degrees from True North from Facility	22 1/2* Sector	Miles from Facility										
		0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	Sector Total
315	Q	0	0	46	27	38	176	957	5,035	6,933	3,295	16,507
337 1/2	R	0	0	24	11	24	2,127	1,554	1,726	2,952	4,556	12,974
Radial Zone Total		132	133	327	1,622	3,427	29,562	265,272	154,061	105,939	133,294	693,769

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

Within a 5-mile radius of the Quad Cities plant, the general character of land use is rural, comprised of scattered villages and homes, except for two industrial areas. There are six transportation routes within a 5-mile radius of the plant: the Mississippi River, U.S. Route 67, State Route 84, and three railroad lines. There are no military facilities within a 5-mile radius of the Quad Cities plant. [2.2-1]

2.2.1 Location and Routes

The industrial areas located within a 5-mile radius of the plant are the Cordova Industrial Park, located northeast of the site with its nearest boundary approximately 4600 feet from the reactor site, and the CF Industries Chemical complex, located 3.1 miles north of the site.

The Mississippi River is located west of the site as shown in Figure 2.1-1, with its navigation channel about 1/2-mile from the reactor building. U.S. Route 67 runs west of, and parallel to, the Mississippi River with a point of closest approach to the plant of 2.4 miles. State Route 84 is located east of the plant about 1 mile from the reactor building, and the nearest railroad line is about 50 feet west of Route 84. The other two railroad lines are approximately 3 and 5 miles distant from the plant.

2.2.1.1 Hazardous Materials Transported by Barge or Ship

Potentially toxic chemicals transported by barges within a 5-mile radius of Quad Cities are listed in Table 2.2-1. [2.2-2]

The only hazardous materials routinely shipped by barge on the Mississippi River are gasoline and anhydrous ammonia. Gasoline shipments average 40,000 tons per month during the shipping season, which runs from May to October. Anhydrous ammonia shipments during that time average 12,000 tons per month. The anhydrous ammonia is shipped in refrigerated barges that maintain the solution at a temperature of -35˚F and a pressure of 1-2 psig. All barges pass the plant in the river's navigation channel.

2.2.1.2 Hazardous Materials Transported by Highways and Railroads

Potentially toxic chemicals transported within a 5-mile radius of Quad Cities on highways and railroads are listed in Tables 2.2-2 and 2.2-3[1] respectively.

Route 84 is the closest road to the plant carrying truck traffic. Since this is not a primary highway, truck traffic is minimal. Other than the toxic chemicals, the only hazardous material known to be shipped past the plant on this route is gasoline, delivered at the rate of one or two trucks per week to stations in the small towns along the river.

Apart from the potentially toxic chemical shipments reported in Table 2.2-3, the railroad closest to the plant transports, on the average three shipments of nitrogen fertilizer chemicals per week past the plant. Occasionally, liquid propane (LP) gas is shipped to a

customer in Port Byron, Illinois, in a tank car containing 30,000 gallons at 25-75 psig depending on the outdoor temperature. [2.2-3]

2.2.2 Descriptions

The Cordova Industrial Park has the nearest major industrial tenant, a chemical company whose plant is situated 1 1/2 miles from the site. This is the Minnesota Mining and Manufacturing (3M) plant which had 340 employees at the time of original Operating License application and is the largest plant nearby. It is a chemical intermediate plant operating at atmospheric or low pressures, and at or below the boiling point of common industrial solvents and chemicals. For waste treatment, 3M uses a 20,000-gallon ammonia system that operates between 0 and 60 psig. For process blanketing, a liquid nitrogen system is used, which operates at 100 psig with pressure relief at 300 psig, and is rated at 350,000 standard ft^3. Steam at pressures less than 150 psi is also used for processing. [2.2-4]

A second industrial site houses a chemical complex producing nitrogen fertilizers and agricultural chemicals. This is the CF Industries chemical complex, which produces diammonium phosphate and triple-super phosphate for use as agricultural fertilizers. This facility has a storage capacity of 30,000 gallons for diammonium phosphate and 20,000 gallons for triple-super phosphate. These chemicals are transported by barge, truck, and rail.

None of the operations at Cordova Industrial Park pose any threat to the Quad Cities Station, from explosion, explosive shock, resulting missiles, or toxic fumes release. Furthermore, there is no chlorine gas used in the area. [2.2-5]

2.2.3 Evaluation of Potential Accidents

The potentially toxic chemicals stored at fixed facilities within a 5-mile radius of Quad Cities Station are listed in Table 2.2-4. Much of this information is based on a survey of toxic chemicals and an analysis of their potential effects on control room operators provided in the "Control Room Habitability Study for Quad Cities Units 1 and 2, Commonwealth Edison Company."[1] Potentially toxic chemicals stored within the Quad Cities site boundary are listed in an inventory of onsite toxic substance prepared for the Superfund Amendments and Reauthorization Act of 1986 (SARA), Title III filing. In addition, breathing air equipment is readily available to operators in the control room as described in Section 6.4. [2.2-6]

2.2.3.1 Noxious Material Used at the Site

The circulating water and service water systems are chlorinated using a sodium hypochlorite solution. The sodium hypochlorite is stored in an above ground tank adjacent to the north side of the intake structure. [2.2-7]

Sulfuric acid and sodium hydroxide are used to regenerate the makeup demineralizer resins. A 5,000-gallon sulfuric acid tank and 10,000-gallon sodium hydroxide tank are located in the turbine building trackway in close proximity to the makeup demineralizer. These tanks were being refilled by truck approximately once every two months. An acid-caustic floor drain tank collected the contents from these two tanks, as well as their two respective day tanks. The chemicals were neutralized, diluted, and then discharged to the river. However, this makeup demineralization system is currently not in use at the Quad Cities plants. Instead, a vendor supplied system for offsite makeup demineralization is being used.

2.2.3.2 Hydrogen and Oxygen Used at the Site

As part of the hydrogen injection system modification, liquid hydrogen and liquid oxygen storage facilities were installed at the site. The liquid hydrogen storage facility, consisting of a 20,000-gallon tank, is located 1500 feet south of the control room. Six gaseous hydrogen storage tubes, each with a capacity of 8300 standard ft^3, are provided to serve as a gaseous surge volume for the liquid hydrogen tank. Additionally, two gaseous tube trailer discharge stanchions are provided for backup hydrogen supply. The liquid oxygen storage facility, consisting of an 11,000-gallon tank, is located 1000 feet south of the control room. Compliance with EPRI guidelines[2] ensures that the system installation and operation will not produce a safety concern. Additionally, the onsite delivery routes for transporting hydrogen and oxygen to their respective storage facilities comply with EPRI guidelines and therefore will not produce a safety concern. [2.2-8]

2.2.4 References

1. "Control Room Habitability Study for Quad Cities Units 1 and 2, Commonwealth Edison Company," Bechtel Power Corp., Ann Arbor, Rev. 2, June 14, 1982.

2. "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations," BWR Owners Group for IGSCC and Electric Power Research Institute, December 1985.

Table 2.2-1

POTENTIALLY TOXIC CHEMICALS TRANSPORTED ON BARGES WITHIN A 5-MILE RADIUS[Note 1]

Chemical Category[Note 2]	Yearly Shipment (tons)
Alcohols	375,945
Basic Chemicals	2,087,975
Benzene and toluene	165,739
Nitrogenous fertilizers	1,113,720
Other fertilizers	1,061,097
Sodium hydroxide	431,942

Note 1 Data is based on barge traffic along the Mississippi River from the mouth of the Missouri River to Minneapolis, Minnesota, 0.55 mile from the Quad Cities site. The source of the information is "Waterborne Commerce of the U.S.", U.S. Army Corps of Engineers, 1978.

Note 2 The chemical categories listed above are those which were determined to pass by the Quad Cities site with a minimum frequency of 50 times per year. Shipment frequencies were calculated using a 2,500-ton barge capacity.

Table 2.2-2

POTENTIALLY TOXIC CHEMICALS TRANSPORTED
ON HIGHWAYS WITHIN A 5-MILE RADIUS [Note 1]

Highway	Distance (miles) [Note 2]	Chemical	Quantity [Note 3]
Illinois State Route 84	0.70	Anhydrous ammonia	20 tons
		28% Ammonium nitrate	24 tons
		Chlorine	1 ton
		Cyclohexamines	20 tons
		Ketones	20 tons
		Liquid halogenated organic	20 tons
		Organic isocyanate	20 tons
		Sulfuric acid	45,500 lb.
U.S. Route 67 (in Iowa)	2.40	Anhydrous ammonia	18 tons
		Aqua ammonia	23 tons
		Carbon dioxide	18 tons
		Ethyl alcohol	55 gal.
		Ethylenedyamine	55 gal.
		Hydrobromic acid 48%	55 gal.
		Isopropyl alcohol	55 gal.
		Muriatic acid	15 gal.
		Nitric acid	23 tons
		Nonpressure nitrogen	23 tons
		Prilled ammonium nitrate	23 tons
		Sodium hydroxide	45,500 tons
		50 or 70% Urea	23 tons
U.S. Route 67 (in Iowa)	3.60	Propane	4,000 gal.
		Muriatic acid	4,000 gal.

Note 1 The chemicals listed above pass by the Quad Cities site with a minimum frequency of 10 times per year.

Note 2 Closest potential approach for the transport vehicle to the Quad Cities site.

Note 3 Wherever multiple container sizes of the same chemical are transported, the quantity of the largest container is provided.

Table 2.2-3

POTENTIALLY TOXIC CHEMICALS TRANSPORTED
ON RAILROADS WITHIN A 5-MILE RADIUS [Notes 1 & 3]

Railroad	Distance (miles)	Chemical	Quantity (per container)
Chicago, Milwaukee, St. Paul, and Pacific (Soo Line)	0.70	Chlorine	18,100 gal.
		Phosphatic fertilizer	14,500 gal.
		Sulfur dioxide	11,000 gal.
Transported on the Chicago, Milwaukee, St. Paul, and Pacific (Soo Line) by 3M Company	0.70	Alkanes	140,000 lb.
		Hydrofluoric acid	80,000 lb.
Chicago & Northwestern [Note 2]	4.95	Anhydrous ammonia	30,000 gal.
		LP gas	30,000 gal.
Transported on the Chicago & Northwestern by the Chemplex Company	4.95	Ethylene	130,000 lb.
		Isobutane	30,000 liquid gal.
		Propylene	30,000 gal.
		Mixed C_4 hydrocarbons	30,000 gal.
Transported on the Chicago & Northwestern by Hawkeye Chemical	4.95	Aqua ammonia	50 tons
		83% ammonium nitrate solution	50 tons
		Nonpressure nitrogen	50 tons
		Prilled ammonium nitrate	93 tons

Note 1 The chemicals listed above pass by the Quad Cities site with a minimum frequency of 30 times per year.

Note 2 The Chicago & Northwestern indicated that its records were not sufficient to provide an inclusive list of the toxic chemicals it transports with a minimum frequency of 30 times per year.

Note 3 The Davenport, Rock Island, and Northwestern Railroad operates a line through the Quad Cities 5-mile radius; however, no toxic chemicals are shipped on it.

Table 2.2-4

POTENTIALLY TOXIC CHEMICALS STORED AT FIXED FACILITIES WITHIN A 5-MILE RADIUS [Note 1]

Facility	Distance (miles)	Chemical	Quantity [Notes 2 & 4]
C.F. Industries	3.10	Anhydrous ammonia	20,000 tons
Comanche Wastewater Treatment	4.00	Chlorine	150 lb.[Note 3]
Dome Pipeline (pipeline)	3.00	Ethane	12[Note 4]
	3.00	Ethylene	12[Note 4]
	3.00	Propane	12[Note 4]
Hydrocarbon Transportation	1.90	Ammonium nitrate (28%)	1,000,000 gal.
MidAmerican Energy Company (pipeline)	1.00	Natural gas	3[Note 4]
	1.00	Natural gas	12[Note 4]
Interstate Power (pipeline)	4.90	Natural gas	12[Note 4]
Johnson Manufacturing	3.60	Muriatic acid	8,000 gal.
		Propane	1,000 gal.
Mid-America Pipeline (pipeline)	3.00	Ethane/propane (70%/30%)	10[Note 4]
3M Company	1.50	Alkanes	1,000,000 lb.
		Ammonia	250,000 lb.
		Chlorine	2,000 lb.
		Cyclohexamines	150,000 lb.
		Fluorinated organic	250,000 lb.
		Halogenated organic	250,000 lb.
		Hydrofluoric acid	120,000 lb.
		Ketones	300,000 lb.
		Organic isocyanate	200,000 lb.
Williams Pipeline (pipeline)	3.30	LP gas	12[Note 4]

Note 1 Includes pipelines.
Note 2 Wherever multiple containers of the same chemical are stored at the same facility, the quantity of the larger container is provided.
Note 3 Standard type gas bottles.
Note 4 Quantities for pipelines are expressed as pipe diameter.

2.3 METEOROLOGY

This section provides a meteorological description of the site and its surrounding areas. This includes a description of the general climate, local meteorological conditions, and the meteorological measurement program onsite. [2.3-1]

2.3.1 Regional Climatology

The regional meteorological characteristics of the Quad Cities site were studied by Murray and Trettel, Certified Consulting Meteorologists, Northfield, Illinois. Their report, given in the Unit 1 PDAR (Docket 50-254), remains complete and valid.

The site is located in rolling prairie terrain typical of much of Illinois. There are no topographical features which significantly affect the local meteorology.

In the 52-year period, 1914 to 1965, eight tornadoes were reported in Rock Island County. Within the state of Illinois, a total of 140 were reported in this same period with 52 being classified as "destructive," i.e., causing at least $50,000 damage or one death.

A tornado covers an average area of about 8 square miles once it touches down. Widths of tornado paths range from about 100 feet to a maximum of about 4 miles. Tornadoes have been known to touch down repetitively in erratic patterns. Path lengths, however, range from about 1 mile to 163 miles, the longest recorded.

The article "Tornado Probabilities" published in the U.S. Weather Bureau's Monthly Weather Review[1] divides the United States into one degree squares and determines the tornado frequency for any point within each square. Using data from 1948 to 1965, the article records 18 tornadoes occurring within a 1-degree square (about 2.3 million acres) encompassing the site. A mean recurrence interval for a tornado striking a point was calculated to be 1250 years using the method detailed in the article.

Even though the occurrence of a tornado touching down at the Quad Cities site may be considered very remote, each unit has been designed so it can be shut down and maintained in a safe shutdown condition if such an event were to occur.

2.3.2 Local Meteorology

On March 13, 1990, a tornado touched down at the Quad Cities site. At the time Unit 1 was operating was operating at 50% power and Unit 2 was shut down. The General Station Emergency Plan (GSEP) was implemented. The tornado caused minor damage to portions of the security fence, parts of the turbine building and radwaste ventilation systems, and some parts of the outside fire protection system. One person sustained minor injuries. [2.3-2]

Appropriate response measures were taken by the plant, including initiating a load drop to less than 40% power, once the tornado was sighted. Compensatory measures were taken

to ensure no breach of security occurred, temporary repair of damaged structures and components was completed, back-up fire protection was established, and the areas outside the turbine building and radwaste building ventilation systems were surveyed for radioactivity releases. The GSEP was terminated approximately five hours after the event, and Unit 1 resumed normal operation.

The following precipitation, temperature and wind speed values comprise the original data used to license the plant.

At the time of original plant licensing, the normal annual precipitation in the area was 32.79 inches. A 24-hour maximum rainfall of 6.29 inches was recorded. The average annual snowfall was 27.9 inches. [2.3-3]

Maximum temperature in the area was 106°F and the minimum was -26°F based on nearby weather bureau data.

Annual wind frequencies showed a rather uniform distribution of direction which is typical of mid-continent locations. The most frequent wind directions were from the southwest and northwest compass sectors (a sector is defined as 22- 1/2 degrees). The highest wind velocities officially reported in the geographic area were 87 mph at Chicago and 75 mph at Peoria. Higher gusts were reported unofficially, up to 109 mph during heavy thunderstorms and scattered tornadic activity. A structural design capable of withstanding wind loadings of 110 mph was considered appropriate for withstanding the sustained winds which can be reasonably anticipated.

It was concluded that, from a meteorological standpoint, the site is suitable for the combined operation of Units 1 and 2. The environmental surveys of the site and surrounding areas conducted by Commonwealth Edison Company (CECo), Argonne National Laboratory, and the State of Illinois demonstrated that meteorological diffusion characteristics provide a means for dispersion of gaseous wastes emitted during normal operation to a degree that they are almost undetectable in the environs of the site. There was nothing in the meteorological or topographical data which indicate that the diffusion mechanism would not be operative during assumed hypothetical accident conditions.

2.3.3 Onsite Meteorological Measurements Program

The meteorological measurements program at the Quad Cities Station site consists of monitoring wind direction, wind speed, temperature, and precipitation. Two methods of determining atmospheric stability are used: delta T (vertical temperature difference) is the principal method; sigma theta (standard deviation of the horizontal WD) is available for use when delta T is not available. These data, referenced in ANSI/ANS 2.5 (1984), are used to determine the meteorological conditions prevailing at the plant site. The meteorological program includes site-specific information and calibration procedures. The meteorological program meets the requirements of the Offsite Dose Calculation Manual (ODCM). [2.3-4]

The meteorological tower is equipped with instrumentation that conforms with the system accuracy recommendations of Regulatory Guide 1.23 and ANSI/ANS 2.5 (1984). The equipment is placed on booms oriented into the generally prevailing wind at the site.

Equipment signals are brought to an instrument shack with controlled environmental conditions. The shack at the base of the tower houses the recording equipment, signal conditioners, etc., used to process and retransmit the data to the end-point users.

Recorded meteorological data are used to generate wind roses and to provide estimates of airborne concentrations of gaseous effluents and projected offsite radiation dose. Instrument calibrations and data consistency evaluations are performed routinely to ensure maximum data integrity. Data recovery objective is to attain better than 90% from each measuring and recording system. Data storage and records retention are also maintained in compliance with ANSI/ANS 2.5 (1984).

2.3.4 Short-Term Diffusion Estimates

The data and methodology used to calculate the distribution of relative concentration factors is provided in site specific procedures.

2.3.5 Long-Term Diffusion Estimates

The data and model used to calculate annual average values of relative concentration factors is described in site specific procedures.

2.3.6 Accident Diffusion Estimates (Alternative Source Term χ/Q Analysis)

Atmospheric diffusion (χ/Q) at the Exclusion Area Boundary (EAB), the outer boundary of the Low Population Zone (LPZ) and the Control Room Intakes are calculated for the regulated short-term (i.e., accident) time-averaging periods of 0-2 hrs, 2-8 hrs, 8-24 hrs, 1-4 days and 4-30 days. χ/Q was calculated at the EAB (380 m) and LPZ (4828 m) for releases from the Unit 1 and 2 MSIVs, the Station Chimney, and the Reactor Building Vent Exhaust Stack, using the NRC-recommended model PAVAN (Reference 2), in accordance with NRC Regulatory Guide 1.145 (Reference 3). Estimates of atmospheric diffusion (χ/Q) are made for the Control Room Intake for releases from the Unit 1 and Unit 2 MSIVs, the Station Chimney and the Reactor Building Vent Exhaust Stack. The NRC-sponsored computer codes ARCON96 (Reference 4) and PAVAN are utilized consistent with the procedures in Regulatory Guide 1.194 (Reference 5). The results of these analyses are presented in Reference 6.

2.3.7 References

1. Thom, H.C.S., "Tornado Probabilities," Monthly Weather Review, U.S. Weather Bureau, Washington, D.C., October - December 1963, pp 730-736.

2. Atmospheric Dispersion Code System for Evaluating Accidental Radioactivity Releases from Nuclear Power Stations; PAVAN, Version 2; Oak Ridge National Laboratory; U.S. Nuclear Regulatory Commission; December 1997.

3. NRC Regulatory Guide 1.145; Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants (Revision 1); U.S. Nuclear Regulatory Commission; November 1982.

4. Atmospheric Relative Concentrations in Building Wakes; NUREG/CR-6331, PNNL-10521, Rev. 1; prepared by J. V. Ramsdell, Jr., C. A. Simmons, Pacific Northwest National Laboratory; prepared for U.S. Nuclear Regulatory Commission; May 1997 (Errata, July 1997).

5. NRC Regulatory Guide 1.194; Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants; U.S. Nuclear Regulatory Commission; June 2003.

6. QDC-0000-M-1408, “Atmospheric Dispersion Factors (χ/Q) For Accident Release.”

2.4 HYDROLOGIC ENGINEERING

2.4.1 Hydrologic Description

The site is located on the bank of the Mississippi River 506.8 miles upstream of the confluence of the Ohio River with the Mississippi River. Topographic relief at the site is low and relatively flat, with a mean station elevation of about 595 feet, mean sea level datum. [2.4.1]

The Upper Mississippi River, in this area, is composed of a series of slack-water pools during low flow. These pools are formed by locks and dams to maintain a navigable channel. The site is located on the east bank of the pool formed by Lock and Dam No. 14. The normal elevation of this pool is 572 feet, mean sea level. The site is about midway between Lock and Dam No. 14 and Lock and Dam No. 13.

The average discharge of the Mississippi and Wapsipinicon Rivers near De Witt, Iowa, is 47,160 and 1472 ft^3/s respectively. The maximum instantaneous discharge was 370,000 and 29,900 ft^3/s respectively and the minimum daily discharge was 6500 and 46 ft^3/s respectively.

2.4.2 Floods

The flood of April 1965 was the greatest flood during the 92 years of record along this reach of the Mississippi River. The flood reached an elevation of 586 feet at the site. This is 14 feet higher than the normal pool elevation, 19 feet lower than the surrounding land at the site, and 9 feet lower than the station elevation of 595 feet.

2.4.3 Probable Maximum Flood (PMF) on Streams and Rivers

A flow of 587,000 ft^3/s in the Mississippi River at the power plant site would produce a flood stage of 594.5 feet (above mean sea level, 1912 adjustment). This is the elevation of the power plant grade. This flow was derived from a stage-discharge curve of the Mississippi River at the plant site. The stage discharge curve was plotted by calculating the river stages for 225,000 (1951 flood), 307,000 (1965 flood), 347,000 (100-year flood), 385,000 (200-year flood), 465,000; 500,000; 600,000; and 700,000 ft^3/s flows. Figure 2.4-1 shows the water surface profiles for these flows and the stage discharge curve. [2.4.2]

The 100-year and 200-year floods would reach elevations of 588 and 589 feet, respectively. The 200-year flood is considered to be the probable maximum flood, and is six feet below station elevation of 595 feet. [2.4.3]

2.4.4 Potential Dam Failures

The normal river level is elevation 572 feet with the expected low water to be elevation 570 feet. The river level at the station, it is assumed, would drop to elevation 561 feet if Dam No. 14 were to fail. Elevation 561 feet is the normal river level downstream of Dam

No. 14 (see Figure 2.4-2). The heat sink that is available in case of a postulated failure of Dam No. 14 is discussed in Section 9.2.5. This postulated failure of the Lock & Dam is not considered to occur simultaneously with any other event (such as LOOP/LOCA).

The entire intake flume from the crib house to the river's edge is stripped out to the natural rock which is approximately elevation 557 feet. The natural river bottom between the river's edge and the main river channel varies in elevation from elevation 557 feet to elevation 565 feet, thus preventing a direct flow of water from the main channel to the crib house during a broken dam condition. Sounding data indicates part of the river's edge may be as low as elevation 564 feet.

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A hydraulic study of the Mississippi river stage at the Quad Cities station was performed by Ashton Engineering[1] to evaluate the effect of failure of Lock & Dam 14. This study predicted that during periods where historic low flow rates exist in the river, 90 hours are required to draw the river stage down to elevation 565' from 572' at the station following a catastrophic loss of the lock miter gates. During the first 40 hours following the failure, the river stage would drop from elevation 572' to 568' at the station. A continuing drop to 565' would occur over the next 50 hour period

2.4.5 Probable Maximum Surge and Seiche Flooding

Flooding due to surges or seiches is not applicable to Quad Cities Station.

2.4.6 Probable Maximum Tsunami Flooding

Flooding due to tsunamis is not applicable to Quad Cities Station.

2.4.7 Ice Effects

An ice-melting line is tied into the side of the discharge flume upstream of a weir with a top elevation at 574.75 feet. This line is a 96-inch diameter pipe with a bottom elevation at that point of 557 feet. A gate is provided in this line for shutoff. The ice-melting line runs into and across the intake flume and is provided with four outlets having a bottom elevation of 558 feet.

During frozen conditions the circulating water system would be in service and the ice melting line would normally be opened enough to keep the intake forebay free of ice. [2.4.4]

2.4.8 Cooling Water Canals and Reservoirs

Refer to Sections 2.4.4 and 2.4.7 for discussion of intake and discharge flumes.

2.4.9 Channel Diversions

The authority to control the river is vested in the U.S. Army Corps of Engineers. Should the need to control the river arise, Exelon Generation Company will make the required notification to the Corps of Engineers. These arrangements have been made and are detailed in the Quad Cities emergency procedures. [2.4.5]

2.4.10 Flooding Protection Requirements

External flood design levels and the design resistance and the emergency response plans of the plant against external flood sources are discussed in Section 3.4.1.1.

2.4.11 Low Water Considerations

The total design flow of Mississippi River water for Units 1 and 2 through the plant for condenser circulating water and service water is 2,160 ft^3/s. The total additional flow that could be brought into the plant and returned to the river for the RHR service water pumps is 62 ft^3/s. The normally experienced minimum river flow is 14,000 ft^3/s; however, the minimum recorded flow, which was recorded in 1933 before the first downstream dam, Dam No. 14, was built, was 6,500 ft^3/s. The 7-day low river flow for the 10-year period from 1958 to 1968 was 11,900 ft^3/s. The heat sink that is available in case of a postulated failure of Dam No. 14 is discussed in Section 9.2.5. [2.4.6]

2.4.12 Dispersion, Dilution, and Travel Times of Accidental Releases of Liquid Effluents in Surface Waters

Liquid radioactive wastes are emitted to either the 16'0 south diffuser line or the discharge flume through a header. Site Engineering has performed a calculation to ensure adequate mixing and dispersal of the plant liquid radioactive wastes in the circulating water flow. [2.4.7]

No liquid radioactive wastes can be introduced into the circulating water system during the ice melting mode of operation of the circulating water system. The suctions for the ice-melting lines are all upstream of the radioactive liquid waste release points, which precludes introducing radioactive materials into the circulating water systems.

No recirculation is expected to occur between the discharge and intake canals during low river flows, nor will concentrations build up around the wing dams. The intake and discharge canals are about 900 feet apart. The intake velocity is about 1 ft/s and the discharge velocity is about 2 ft/s, which assures a relatively slow intake with a more rapid expulsion of discharge water in the downstream direction. The circulating water used by the plant and the 7-day low river flow amounts given in Subsection 2.4.11 show that the percentage of river flow used for cooling, even during periods of low flow, is small. The possibility for recirculation is greater on rivers where plant flow takes a greater portion of river flow. Wing Dam 31 is also located between the intake and discharge canals and tends to form a recirculation barrier. However, the top of this wing dam is about 2 feet below the river surface which creates some downstream water flow to prevent stagnant water areas from forming.

Further information regarding radioactive effluents released to the Mississippi River is contained in Section 11.2.

2.4.13 References

1. "Study of Mississippi River Water Stage at Quad Cities Nuclear Power Station", Ashton Engineering Inc., April 1998.

2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

2.5.1 Basic Geologic and Seismic Information

The plant is supported on Niagaran dolomite. A detailed description of the regional and site geology is provided in the Quad Cities Plant Design Analysis Report (PDAR), Volume I, Section 2-5.0. [2.5-1]

2.5.2 Vibratory Ground Motion

Studies were conducted to determine the effects at the site of possible significant seismic disturbances. The studies considered local and regional geology, seismology, and seismic history. The design basis is derived from the seismic design report of John A. Blume and Associates, Engineers, included in the Quad Cities Unit 1 Plant Design Analysis Report, and is further discussed in Section 3.7.1. [2.5-2]

It is concluded that the seismic design basis is sufficiently conservative so that the severity of any design basis accident will not be augmented by any design seismic event.

2.5.3 Surface Faulting

Little, if any, of the Paleozoic strata underlying the plant is disturbed by faulting, therefore, surface faulting is not an issue that required evaluation for the Quad Cities Station. [2.5-3]

2.5.4 Stability of Subsurface Materials and Foundations

Core borings at the site revealed the presence of some cavities and crevices in the rock underlying the site. When the overburden was removed, the extent of the crevices was disclosed. Where practical, these voids were cleaned out and filled with concrete in accordance with a grouting procedure. Where this was not practical, foundations were specially designed and constructed to span questionable support areas. [2.5-4]

Two Sargent and Lundy engineers were resident supervisors during the grouting program, and daily progress was reviewed at the home office. The grouting records were examined to verify that grout quantities correlated well with anticipated quantities determined from the exploratory drilling reports.

The grouted rock under all portions of Quad Cities Station is completely satisfactory and the combined rock-concrete foundations will adequately support all design loads without undue settlement or question of safety. A foundation grouting report establishing the capability of the rock strata is documented in Reference 1. This report describes in detail the program undertaken to improve strata underlying the plant site and the foundation modifications to assure satisfactory plant operation.

2.5.5 Stability of Slopes

The evaluation of the slope stability of the intake flume earth embankment is discussed in 3.7.3.3.4.

2.5.6 Embankments and Dams

The evaluations of the retaining wall structure and the earth embankment for the intake flume are discussed in 3.7.3.3.3 and 3.7.3.3.4 respectively.

2.5.7 References

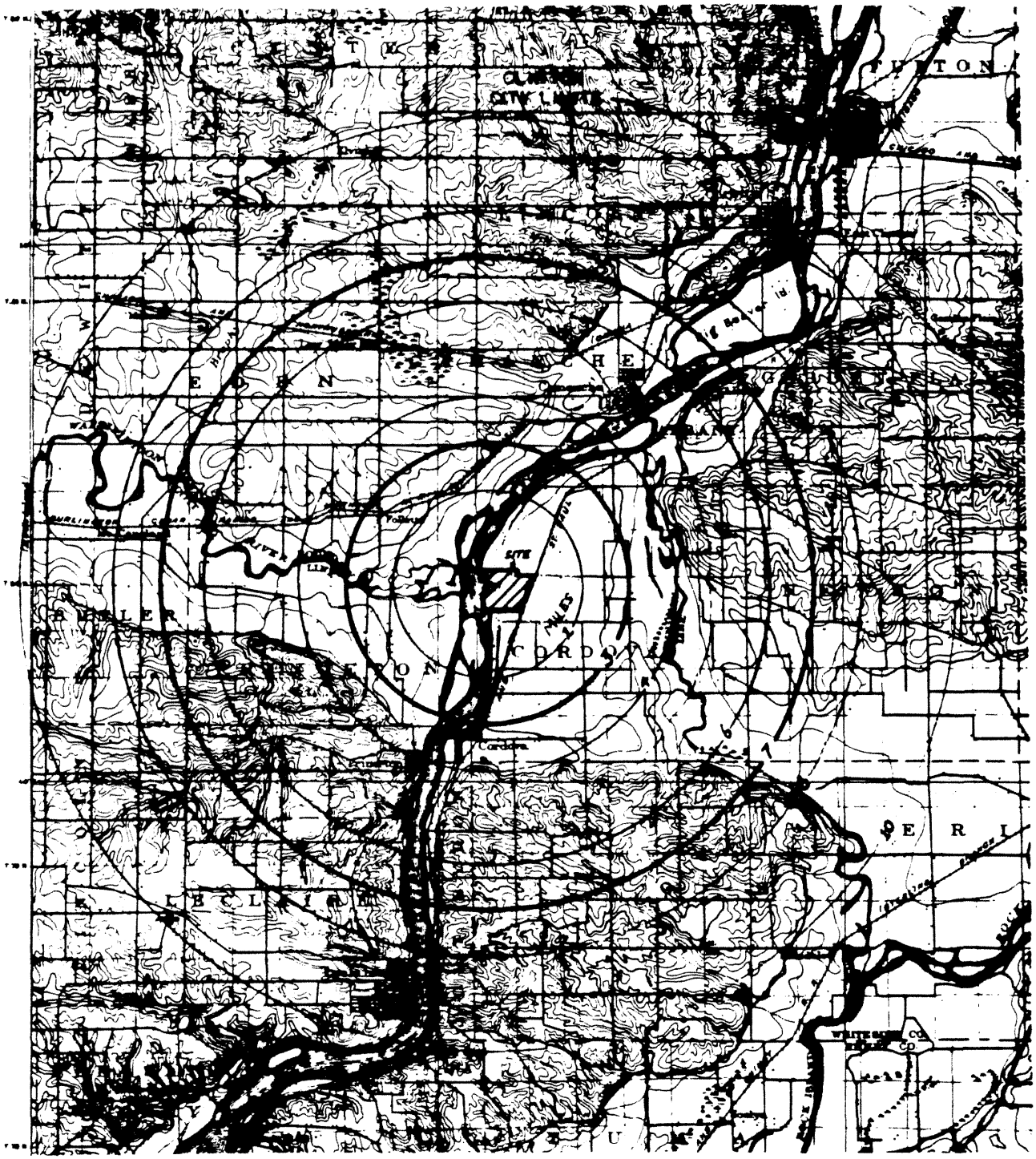
1. Quad Cities Station Units 1 and 2 Foundation Grouting Report (including Supplementary Information).

Information withheld in accordance with 10 CFR 2.390

QUAD CITIES STATION
UNITS 1 & 2

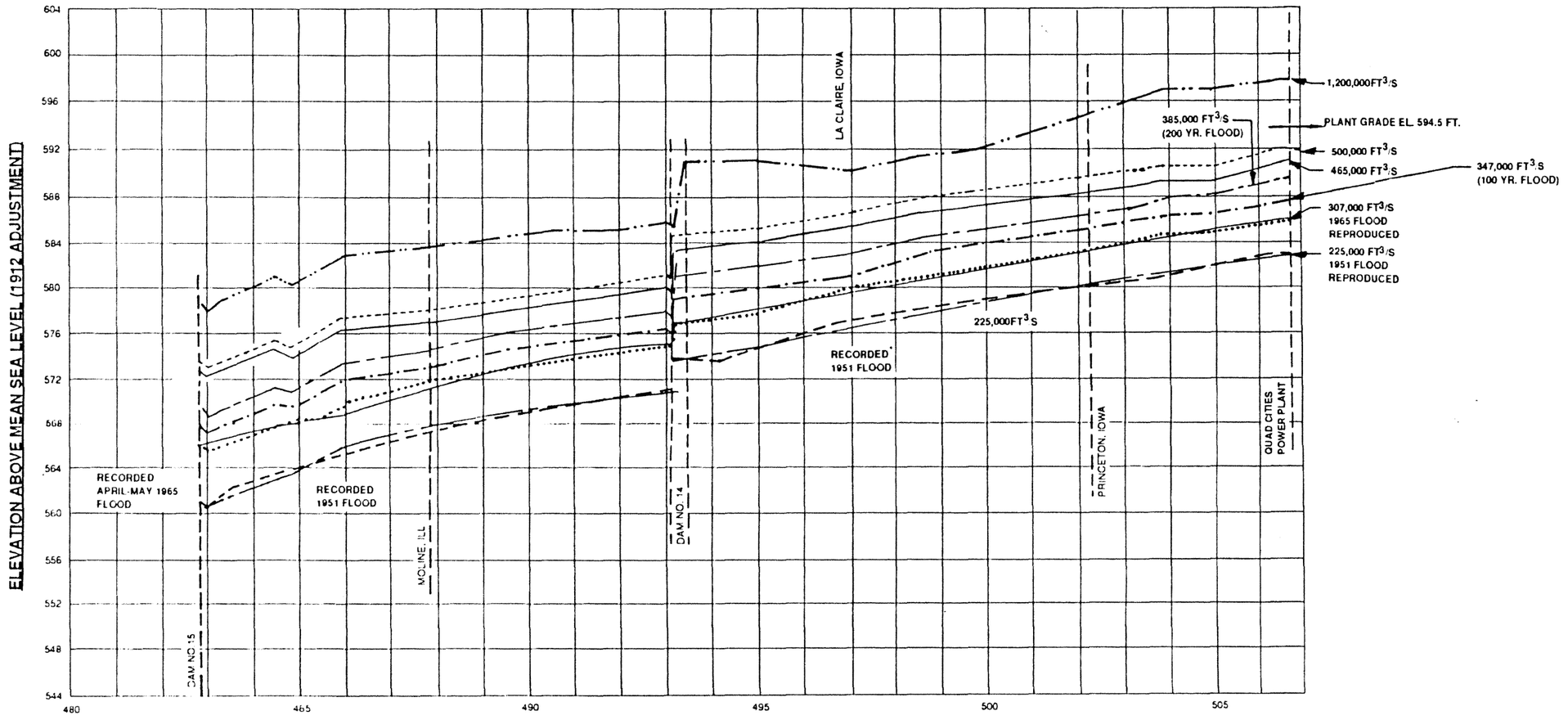
SITE MAP

FIGURE 2.1-1

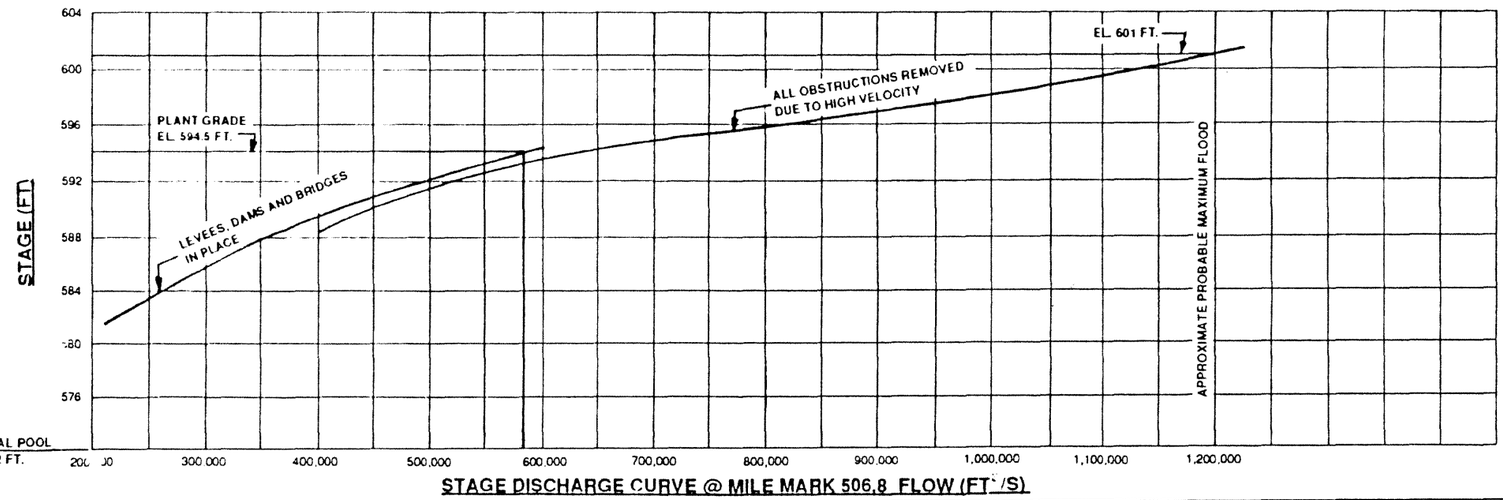


POPULATION CENTER DISTANCE, 7 MILE RADIUS
LOW POPULATION ZONE, 3 MILE RADIUS

QUAD CITIES STATION UNITS 1 & 2
POPULATION CENTER RADIUS MAP
FIGURE 2.1-2

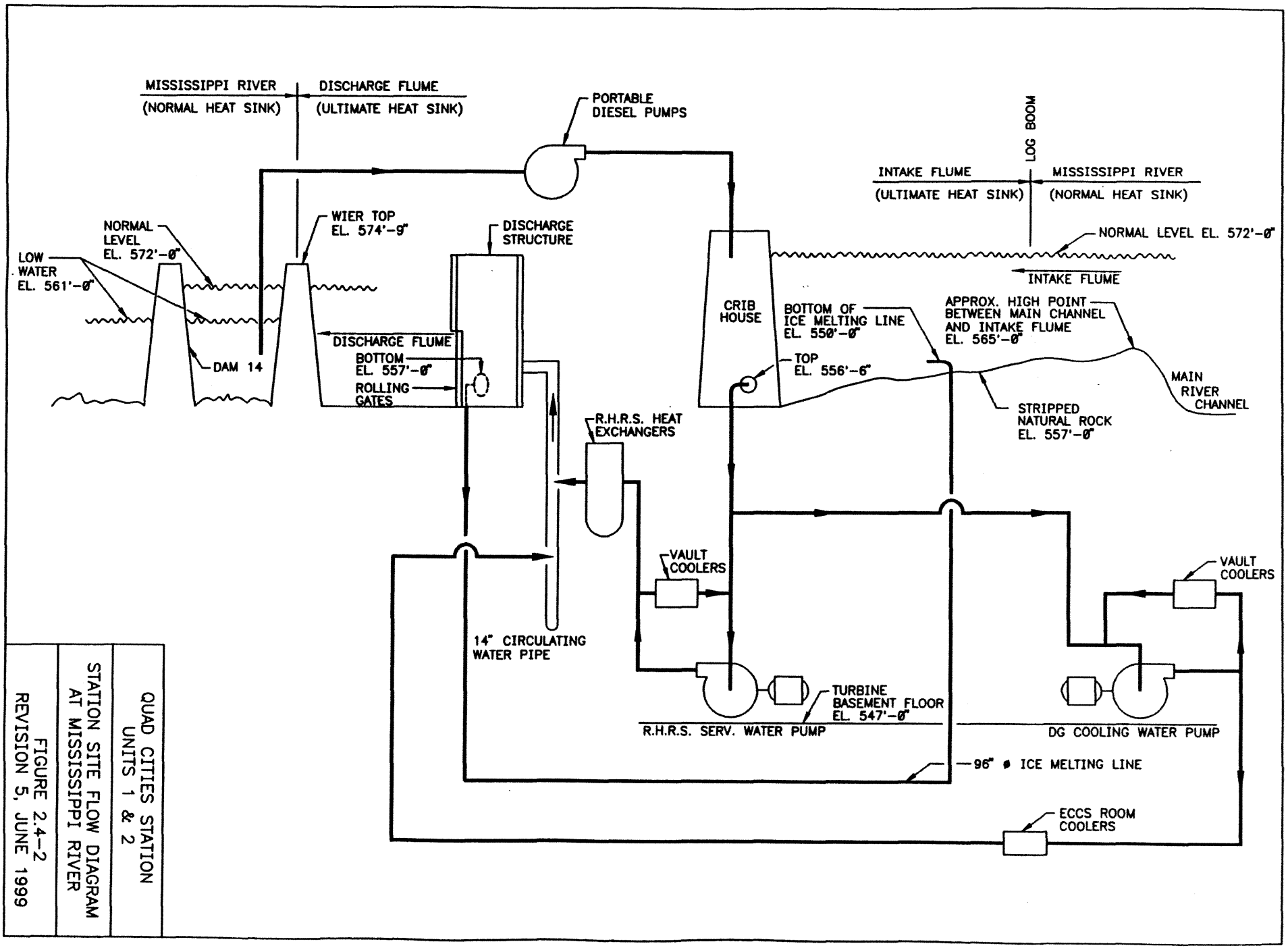


UPPER MISSISSIPPI RIVER WATER SURFACE PROFILE-MILES ABOVE OHIO RIVER



STAGE DISCHARGE CURVE @ MILE MARK 506.8 FLOW (FT³/S)

QUAD CITIES STATION UNITS 1 & 2
UPPER MISSISSIPPI RIVER FLOOD STUDY
FIGURE 2.4-1



QUAD CITIES STATION
UNITS 1 & 2

STATION SITE FLOW DIAGRAM
AT MISSISSIPPI RIVER

FIGURE 2.4-2
REVISION 5, JUNE 1999