CHAPTER 2

SITE CHARACTERISTICS

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site Location and Description

Nine Mile Point Nuclear Station - Unit 2 (Unit 2) is located on the western portion of the Nine Mile Point promontory approximately 274 m (900 ft) due east of Nine Mile Point Nuclear Station - Unit 1 (Unit 1). The eastern portion of the promontory is owned by Entergy Nuclear FitzPatrick, LLC, which owns the James A. FitzPatrick Nuclear Power Plant.

2.1.1.1 Specification of Location

The site is adjacent to Lake Ontario in Oswego County, NY, approximately 10 km (6.2 mi) northeast of the city of Oswego. The Unit 2 reactor is located at latitude 43 deg, 31 min, 17 sec north and longitude 76 deg, 24 min, 27 sec west. The Universal Transverse Mercator (UTM) coordinates are N 4,819,478 m and E 386,254 m. Figure 2.1-1 shows the area surrounding the site within an 80-km (50-mi) radius.

Lake Road, a private, hard-surfaced, east-west road, crosses the site and provides a connection with County Route 1A. County Route 1A connects to County Route 1 and extends to the city of Oswego to the west. On the east, Lake Road joins County Route 29 which connects with State Highway 104 6.2 km (3.9 mi) southeast of the site. A spur of the Consolidated Railroad Corporation (Conrail) provided rail service to the Station(2) during the construction phase. There are no residential, agricultural, or industrial developments on the site other than Unit 1 and the James A. FitzPatrick plant, which are both operating nuclear power plants. The site area is posted as private property, and access to the Station buildings is controlled.

2.1.1.2 Site Area Map

Main plant structures and the cooling tower occupy approximately 9.3 ha (22.9 acres) of the total site area of 364 ha (900 acres).

Figures 1.2-1 and 2.1-2 show the Unit 2 site plan including property and exclusion area boundaries (EABs), principal structures for Units 1 and 2, railroads, highways, and transmission lines in the site area.

2.1.1.3 Boundaries for Establishing Effluent Release Limits

The minimum distance from Unit 2 to the EAB is approximately 1.4 km (0.87 mi) to the southwest. Exclusion area distances for the site are shown on Figure 2.1-2.

The restricted area for the Station follows the same boundary as the exclusion area. Lake Road provides access from Lakeview Road and County Road 29 to Units 1 and 2 and to the FitzPatrick plant. Lake Road is privately owned between Lakeview Road and County Road 29 and public use is not permitted. Miner Road provides an alternate route between Lakeview Road and County Road 29. This road is in the town of Scriba. No public use restrictions affect public use along Miner Road. There are no state or other roads, shipping lanes, or rail lines crossing the restricted area. The Oswego River is located approximately 8.8 km (5.5 mi) west of the restricted area boundary at its closest point.

North of the plant, the restricted area boundary follows the shoreline of Lake Ontario. A fence along the shoreline prevents unauthorized access to Unit 2. Local authorities will notify persons on the lake in the vicinity of the plant of the need to leave the area in the event of an emergency.

The boundary of the restricted area is posted with signs to assure public awareness of access restrictions. During emergency conditions, public access to the restricted area, including the Visitors Center, will not be permitted. The necessary authorities will be contacted to enforce access restrictions from local roads (Section 13.3). The radiation dose outside the restricted area will be within the guidelines of 10CFR20, 10CFR50, Appendix I (Appendix 11B), and 40CFR190.10.

Dose estimates for persons within the restricted area are presented in Section 12.4. There are two gaseous release points for routine airborne radioactive emissions: the combined radwaste/reactor building vent and the stack. Radwaste and reactor vents are combined on the reactor building to form one release point (Figure 1.2-2). Distances from the stack and from the vent to the restricted area boundary are shown in Table 2.1-1 as a function of direction.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 Authority

Distances from the plant to the EAB are measured from the centerline of the reactor and approximately 1.6 km (1 mi) to the east, 1.4 km (0.87 mi) to the southwest, and over 2.1 km (1.3 mi) to the southern site boundary. Exclusion area distances for the site are shown on Figure 2.1-2.

Nine Mile Point Nuclear Station, LLC (NMPNS), is owner in fee of the property within the exclusion area except for that portion encompassed by the James A. FitzPatrick site owned by Entergy Nuclear FitzPatrick, LLC. The authority which permits NMPNS to control activities over that portion of the Unit 2 EAB owned by Entergy Nuclear FitzPatrick, LLC, is a formal agreement between NMPNS and NYPA, which provides for reciprocal inclusion of each party's project property in the exclusion area for Units 1 and 2 and the James A. FitzPatrick Nuclear Power Plant. No one resides in the exclusion area and no easements have been granted within the EAB, except: 1) such agreements between NMPNS and Entergy Nuclear Operations, Inc., for joint use of facilities and access to them for that purpose; and 2) an easement granted to the Town of Scriba for the purpose of delivering domestic water via a pipe line up to the backflow preventer assemblies, with a right-of-way extending across the site from west of Unit 1 to County Route 29. The Emergency Plan (Section 13.3) discusses the means of control of this area in the event of an accident.

A private, hard-surfaced, east-west road crosses the site connecting with Oswego County Highway Route 29. Access to the Owner Controlled Area via this road is restricted to members of the public. A spur of Conrail provided rail service to the Station. It has been disabled. Since the site is located on a navigable portion of Lake Ontario, the Station is accessible by barge for construction and supply purposes.

2.1.2.2 Control of Activities Unrelated to Plant Operation

The Energy Center is owned by NMPNS and Entergy Nuclear FitzPatrick, LLC, and is located on the site west of Unit 1. The center had averaged more than 30,000 visitors annually since its official opening in 1967. The center provided visitor facilities including educational exhibits, picnic and ground areas. These areas are currently restricted areas within the site boundary that are not accessible to members of the public. Control of recreational activities in the vicinity of the plant is discussed in the Emergency Plan (Section 13.3).

As discussed in Section 13.3, a study for evacuation of area population surrounding the plant was performed. Calculated doses received by any individual in this area in the event of an accident are within allowable limits (Chapter 15).

2.1.2.3 Arrangements for Traffic Control

The exclusion area is traversed by one road and a rail spur (Section 2.1.2.1). Under emergency conditions, the appropriate authority (Section 13.3) is contacted in the event that it becomes necessary to control traffic on Lake Road. When requested, the Consolidated Railroad Corporation controls railroad traffic through the exclusion area.

2.1.2.4 Abandonment or Relocation of Roads

No public roads within the exclusion area have been abandoned or relocated.

2.1.3 Population Distribution

2.1.3.1 Population Within 16 km (10 mi)

In 1980, Oswego County had an estimated population of 113,901 at an average density of 43 people/sq km (111 people/sq mi)(3). This population density is considerably lower than the state average of 137 people/sq km (356 people/sq mi). The 1980 population and population density for the eight towns and one city within 16 km (10 mi) of Unit 2 are listed in Table 2.1-2.

The total 1980 population within 16 km (10 mi) of Unit 2 is estimated to be 35,467. This population is projected to increase to approximately 74,082 by the year 2030(4). The 16-km (10-mi) area contains all or portions of one city and eight towns: the City of Oswego, and the towns of Minetto, Scriba, New Haven, Oswego, Mexico, Palermo, Volney, and Richland. City and town boundaries are shown on Figure 2.1-3.

Of the eight towns and one city in the 16-km (10-mi) area, the City of Oswego is the largest in population, containing approximately 19,793 people in 1980. Following the City of Oswego in population size are Granby, Scriba, and Volney with estimated 1980 populations of 6,341, 5,455, and 5,358, respectively(3). Population and the 1970-1980 percent change in population for the towns and city within the 16-km (10-mi) area are listed in Table 2.1-3.

It is expected that a large portion of the population growth in the 16-km (10-mi) area will occur around the southeastern fringes of the City of Oswego, with the surrounding towns absorbing much of the city's satellite growth(5).

Population distribution within 6 km (3.7 mi) of the Station is based on the results of a field survey conducted in May 1982. Population distribution between 6 km (3.7 mi) and 16 km (10 mi) is based on a house count from U.S. Geological Survey maps, photorevised in 1978, on which houses have been symbolically identified and on field verification. Houses were used to estimate the area population by applying town-specific people per household factors which were derived from 1980 census data(3). Population projections within 16 km of the site were then adjusted by multiplying populations by Oswego County growth factor, supplied by the New York State Department of Commerce, Economic Development Board, which used the cohort-component method to obtain projections(4). Population distribution within a 16-km radius of the site is listed by distance and direction for the years 1980, 1986, 1990, 2000, 2010, 2020, and 2030 in Appendix 2L.

2.1.3.2 Population Within 80 km (50 mi)

The area within 80 km of Unit 2, containing a total population of approximately 927,624 in 1980, is expected to grow to approximately 1,082,865 in the year 2000 and to reach a total of approximately 1,558,957 by the year 2030(3,4,6,7,8,9). Figure 2.1-1 shows counties within the 80-km area. Population distribution in the 80-km area for the years 1980, 1986, 1990, 2000, 2010, 2020, and 2030 is listed in Appendix 2L.

The 80-km area contains portions of three Canadian Census Divisions located in the Province of Ontario: Prince Edward, Frontenac, and Addington and Lennox. For these census divisions 1981 population is included.
The 80-km region is moderately populated. In 1980, only the population in the city of Syracuse and its satellite towns exceeded 100,000, and only seven other population centers contained more than 10,000 people(3). Table 2.1-4 lists cities within 80 km with more than 25,000 people.

Three Standard Metropolitan Statistical Areas (SMSAs) are located partially within an 80-km radius of the Station: Syracuse SMSA, Rochester SMSA, and Utica-Rome SMSA. The Syracuse SMSA, including the counties of Onondaga, Oswego, and Madison, contained a total of approximately 643,000 people in 1980 at a density of 103 people/sq km (265 people/sq mi). This SMSA is expected to reach a total population of approximately 782,000 by the year 2000(4). The Rochester SMSA includes five counties, only one of which (Wayne County) falls within the 80-km region. In 1980, 971,000 people resided in the Rochester SMSA at a density of 126 people/sq km (327 people/sq mi)(6). By the year 2000 the Rochester SMSA is expected to support approximately 1,194,000 people(4). Finally, the Utica-Rome SMSA contains only two counties, Oneida and Herkimer. Of the two, only Oneida County is located in part in the 80-km region. In 1980, 320,000 people lived in the Utica-Rome SMSA at a density of 47 people/sq km (120 people/sq mi)(6). This SMSA is expected to decline to, and stabilize at, a population of approximately 327,000 by the year 2000(4).

Polar-grid sector populations between 16 and 80 km are based on 1980 U.S. Census data and New York State and Canadian population projections. Sector populations were determined by assuming that the population of a minor civil division (i.e., town) is evenly distributed over its geographic area. The proportion of each civil division's area in each grid sector was then determined and applied to each civil division's total population, yielding the population in each grid sector. Population projections, based on 1978 projections supplied by the New York State Department of Commerce, Economic Development Board, were applied to each civil division assuming that each portion would maintain its relative share of any population change. Population density was calculated by dividing the population in each sector by its land area. Population distributions for rings corresponding to Regulatory Guide (RG) 1.70 are presented in Appendix 2L.

2.1.3.3 Transient Population

Transient population within 16 km of the Station is limited due to the predominantly rural, undeveloped character of the area. There are, however, a number of school, industry, and recreational facilities that create small daily and seasonal changes in sector populations. Detailed information on transient populations is presented in Section 2.5 of the Environmental Report-Operating License Stage (ER-OLS).

2.1.3.4 Low Population Zone

The low population zone (LPZ) surrounding Unit 2 encompasses an area within a 6.4-km (4-mi) radius from the Unit 1 stack. LPZ boundary accident doses for Unit 2 are calculated at a distance of approximately 6.1 km (3.8 mi) from the Unit 2 stack, which is 6.4 km, adjusted for the distance between the Unit 1 and Unit 2 stacks. Figure 2.1-4 depicts the LPZ. The distance for the LPZ was chosen based on the requirements of 10CFR100.11.

The LPZ is expected to contain approximately 2,315 people in the year 1985 at an average density of 48 people/sq km (125 people/sq mi). By the year 2030, the LPZ population is expected to have increased to approximately 4,372 at an average density of 91 people/sq km (236 people/sq mi).

The only facility in the LPZ that attracts a transient population is the Ontario Bible Campground at Lakeview, located approximately 1.5 km (1.0 mi) west-southwest of the Station. This campground is a privately-owned facility operated on a 52-acre lakeshore plot. Groups of up to 500 persons use this camp during the summer and as many as 1,500 people may gather there for short periods on Sundays throughout the summer. The facility is unused during the balance of the year except for an occasional weekend in the spring and fall.

2.1.3.5 Population Centers

In 1980, the closest population center, as defined by 10CFR100, to Unit 2 was the city of Syracuse, which contained approximately 170,105 people. The city's closest corporate boundary to Unit 2 is approximately 53 km (33 mi) south-southeast. The city of Syracuse is part of the Syracuse SMSA, which encompasses Onondaga, Oswego, and Madison Counties.

Based on county-level population projections provided by the New York Department of Commerce, the population of the city of Oswego will exceed 25,000 people and become the nearest population center in the year 2000(4). This estimate may prove to be somewhat high based on historical growth in the city; however, the estimate is useful because it provides a conservative estimate for use in calculating doses from potential accidents.

The population of the city of Oswego was projected, using Oswego County growth factors, under the assumption that the city would maintain its relative proportion of the county's population in the future. Oswego County projections were used since no specific projections or estimates were available for Oswego City.

Oswego County projections for the years 1990 and 2000 were obtained from the New York State Department of Commerce. These projections, along with actual 1970 and 1980 census counts, were used to project the 2010, 2020, and 2030 populations. Although Oswego City's closest political boundary is approximately 7.24 km (4.5 mi) from the site, no conflict exists with the LPZ/population center distance requirements defined in 10CFR100 since the boundary of the city's residential area is located approximately 8.85 km (5.5 mi) away, over 1.33 times the distance of the LPZ. Future residential growth is not anticipated to decrease this distance since the area between the residential and political boundaries is used and zoned for industry. It is most likely that residential growth will occur to the south and southeast where land is available and more desirable from a residential perspective, rather than into an area of strong industrial character. A zoning map for the city is provided on Figure 2.1-5 which shows the difference between the industrial and residential boundaries closest to the site.

The 80-km region is moderately populated. In 1980 only the population of the city of Syracuse and its satellite towns exceeded 100,000, and only three other population centers contained more than 25,000 people. Population centers within 80 km with populations larger than 25,000 are listed in Table 2.1-4.

2.1.3.6 Population Density

The area within 48 km (30 mi) of Unit 2 is expected to contain approximately 251,295 people at an average density of 62 people/sq km (161 people/sq mi) in 1986. The density is considerably lower than the Nuclear Regulatory Commission (NRC) comparison figure of 193 people/sq km (500 people/sq mi) given in RG 1.70. Population within the area is expected to increase to a total of approximately 769,585 by the year 2030. Population density in 2030 will reach an average of approximately 117 people/sq km (304 people/sq mi), also well below the NRC comparison for the end year of plant life of 386 people/sq km (1,000 people/sq mi).

Population density in the years 1986 and 2030 is listed by distance and direction in Appendix 2L.

2.1.4 References

1. Niagara Mohawk Power Corporation. Preliminary Safety Analysis Report - Volume I, Nine Mile Point Nuclear Station - Unit 2, June 1972. Docket 50-410.

2. Niagara Mohawk Power Corporation. Environmental Report (Construction Permit Stage), Nine Mile Point Nuclear Station - Unit 2, June 1972. Docket 50-410.

3. U.S. Department of Commerce, Bureau of the Census. Number of Inhabitants, New York. PH080-I-34, February 1982.

4. 1978 Official Population Projections for New York State Counties. New York State Department of Commerce, Economic Development Board, September 1980.

5. Oswego County Data Book, Oswego County Planning Board, 1977.

6. County and City Data Book 1977. U.S. Department of Commerce, Bureau of the Census, 1978.

7. Statistics Canada, 1976 Final Population, 1981 Population and Dwellings, Canada, Provinces, Census Divisions and Subdivisions. Ottawa, Canada, 1982.

8. Ministry of Treasury and Economics. Central Statistical Services, Ontario: Population Projections by Regions and Counties for Years 1981, 1986, 1996, 2001. Toronto, Canada, February 1979.

9. Ministry of Treasury and Economics. Central Statistical Services, Ontario: Population Projections for Counties of 10,000 Population and over (in 1976) 1981, 1986, 1991, 1996, 2001 (Concluded). Toronto, Canada, April 1980.

TABLE 2.1-1
Sheet 1 of 1
MINIMUM DISTANCE BY SECTOR
BETWEEN RESTRICTED AREA BOUNDARY
AND ROUTINE RELEASE POINTS(1)

	Stack		Radwaste/Reactor Building Vent(2)	
Sector	m	mi	m	mi
N(3)	75	0.05	192	0.12
NNE(3)	75	0.05	207	0.13
NE(3)	91	0.06	285	0.18
ENE(3)	139	0.09	419	0.26
E	1,554	0.97	1,686(4)	1.05(4)
ESE	1,600	0.99	1,686(4)	1.05(4)
SE	1,783	1.11	1,743(4)	1.08(4)
SSE	2,286	1.42	2,094(4)	1.30(4)
S	2,256	1.40	1,945(4)	1.21(4)
SSW	2,027	1.26	1,695(4)	1.05(4)
SW	1,615	1.00	1,381(4)	0.86(4)
WSW(3)	1,013	0.63	988	0.61
W(3)	187	0.12	402	0.25
WNW(3)	98	0.06	293	0.18
NW(3)	81	0.05	227	0.14
NNW(3)	75	0.05	187	0.12

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(1) For routine releases, the minimum distance is the shortest length from the release point to the boundary within a 22 1/2-deg sector centered on the 16 cardinal compass directions.

(2) Locations of release points are shown on Figure 1.2-2, and the restricted area boundary is shown on Figure 2.1-2.

(3) Restricted area boundary is located on the shoreline of Lake Ontario.

(4) These distances are calculated using accident release methods. For accident releases, the minimum distance is the shortest length from the release point to the boundary within a 45-deg sector centered on the 16 cardinal compass directions.

TABLE 2.1-2
Sheet 1 of 1
1980 POPULATION AND POPULATION DENSITIES
FOR TOWNS AND CITIES WITHIN 16 KM (10 MI) OF UNIT 2*

	1980 Population	Population Density (people/sq km)
City of Oswego	19,793	1,029.0
Oswego (town)	7,865	116.9
Scriba	5,455	52.9
Volney	5,358	46.0
Mexico	4,790	41.8
Palermo	3,253	31.6
New Haven	2,421	31.7
Minetto	1,905	125.5
Richland	5,594	40.2

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* These numbers are based on the entire town and not just the portion within the 16-km (10-mi) radius.

TABLE 2.1-3
Sheet 1 of 1
1970-1980 POPULATION GROWTH FOR TOWNS AND CITIES
WITHIN 16 KM (10 MI) OF UNIT 2*

	1970	1980	1970-1980 Percent Change
City Of Oswego	20,913	19,793	-5.4
Oswego (town)	6,514	7,865	20.7
Scriba	3,619	5,455	50.7
Volney	4,520	5,358	18.5
Mexico	4,174	4,790	14.8
Palermo	2,321	3,253	40.2
New Haven	1,845	2,421	31.2
Minetto	1,688	1,905	12.9
Richland	5,324	5,594	5.1

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* Based on total town population.

TABLE 2.1-4
Sheet 1 of 1
POPULATION CENTERS WITH OVER 25,000 PEOPLE IN 1980

City	County	Distance from Unit 2 km	(mi)	Population
Auburn	Cayuga	69.2	(43)	32,548
Syracuse	Onondaga	53	(32.8)	170,105
Rome	Oneida	90.1	(56)	43,826
Watertown	Jefferson	74.0	(46)	27,861

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

2.2.1 Locations and Routes

Only two manufacturing or industrial plants, Novelis (formerly Alcan) and Oswego Wire Inc., are located within 8 km (5 mi) of Unit 2. There are also three electrical power generation facilities, the J. A. FitzPatrick Nuclear Power Plant operated by Entergy Nuclear Operations, Inc., Unit 1 operated by NMPNS, and Independence Generation Plant operated by Sithe Energies USA, located within 8 km (5 mi) of Unit 2. Figure 2.1-2 shows the location of these three facilities relative to Unit 2.

The principal products of the Novelis plant are aluminum sheet and plate. The principal products of the Oswego Wire facility are wire and rolled components. There are no chemical plants, refineries, military bases, or underground gas storage facilities within 8 km of the plant. In addition, no fuel storage facilities lie within the 8-km radius except those storage facilities associated with the Novelis plant, the Oswego Wire facility, the FitzPatrick plant, Sithe plant, and Units 1 and 2. Two natural gas pipelines lie within 8 km of the plant; one pipeline supplies the Sithe plant and the other supplies INDECK Energy. Both are located on the north-south and east-west transmission line corridors. Finally, there are no hazardous waste storage or disposal sites permitted by the state in the 8-km radius from the plant.

Major transportation facilities are shown on Figure 2.2-1. The principal roadway within 8 km of Unit 2 is U.S. Route 104 which passes 6.2 km (3.9 mi) south of the plant and connects the city of Oswego and Mexico Village. Daily traffic volume for U.S. Route 104 was 5,841 vehicles in 1979. Highway access to the site is via two county routes, Route 1A to the southwest and Route 29 to the east. A private east-west road crosses the site and connects these two county routes. Other local roads in the vicinity generally had average daily traffic counts of fewer than 2,000 vehicles in 1978-1979, the most current survey dates(1). Table 2.2-1 presents daily traffic volume counts for county highways within 8 km of the plant.

One railroad company, Conrail, transports freight in the vicinity of the plant. The rail lines and spurs that served Unit 2, as well as the J. A. FitzPatrick plant and Unit 1, during construction are shown on Figure 2.1-2. The closest rail line to Unit 2 is the Oswego-Mexico branch of Conrail located approximately 2.5 km (1.5 mi) from the Nine Mile Point site. This branch line has daily service on demand and averages one train daily, 5 days a week. A rail spur was constructed to serve Unit 2 during construction and operation of the plant. Possible sources of traffic or hazardous materials utilizing ground transportation routes within 8 km of the plant are identified and detailed in Section 2.2.3.

The Oswego River passes within 11 to 12 km (6.6 to 7.2 mi) of Unit 2 at its nearest point and serves as a major route for waterborne commerce on Lake Ontario. Freight traffic statistics are maintained by the U.S. Army Corps of Engineers. Totals for the river section from New York State Barge Canal Lock No. 8 to the port of the City of Oswego are the only statistics applicable for the nearest reach of river to the Station. Table 2.2-2 details the 1978 freight traffic for this reach of river. The Port of Oswego, the easternmost port on Lake Ontario, is located approximately 11 km (6.6 mi) southwest of Unit 2 and provides a link with all ports on the Great Lakes and St. Lawrence River. Ships in normal commercial lanes bound to and from the Port of Oswego pass no closer than 11.3 km (7 mi) to the intake structures of Unit 2.

Regular commercial air service is provided at the Clarence E. Hancock Airport, located 49.8 km (31 mi) southeast of Unit 2 near Syracuse, NY. The nearest flight corridor associated with this airport is 22.2 km (13.8 mi) from the Nine Mile Point Station. Light plane traffic is handled at the Oswego County Airport in the town of Volney, approximately 19.3 km (12 mi) south of the Nine Mile Point site. Lakeside Airstrip, a private facility which operates primarily as a maintenance facility with very little air traffic, is located along Route 176 approximately 10 km (6.2 mi) south of the Nine Mile Point site. Access to aircraft and helicopter services from local and regional airports is available in support of the Nine Mile Point Emergency Plan. A helicopter landing location is available onsite adjacent to the Main Security Access road.

It is not anticipated that there will be any significant increase in the number of industrial, transportation, and military facilities located within an 8-km radius of Unit 2 over the plant lifetime. There are also no significant changes expected in the nature of existing facilities or the extent of their activities within the designated area over the projected lifetime of Unit 2.

2.2.2 Description

2.2.2.1 Description of Facilities

Major industrial facilities within 8 km of Unit 2 are listed in Table 2.2-3. Alcan Rolled Products, located approximately 4.5 km (2.7 mi) southwest of Nine Mile Point Station, is the largest employer with approximately 1,000 workers manufacturing aluminum sheet and plating. No hazardous materials are manufactured within the 8-km radius. Hazardous materials stored or used are discussed in Section 2.2.2.2. The New York State Department of Environmental Conservation records the type, amount, and route of hazardous materials carried in the state.

One rail line passes through the 8-km radius. Conrail has a branch line serving Alcan Aluminum, Units 1 and 2, and the James A. FitzPatrick Nuclear Power Plant. The main line is located approximately 3.5 km (2.1 mi) at its nearest point from Unit 2. Waterborne commerce statistics prepared by the U.S. Army Corps of Engineers only partially identify specific hazardous materials on Lake Ontario. Commerce is recorded by general commodity(2). A listing of hazardous materials identified and their commodity designations is provided in Table 2.2-4.

Hazardous materials transported by air have not been identified because of the distance of airways and facilities from Unit 2.

2.2.2.2 Description of Products and Materials

To identify hazardous materials regularly stored or used within 8 km of Unit 2, surveys were conducted of industrial firms, pipeline companies, and distributors that might be expected to handle toxic chemicals or explosives. Appendix 2A describes the method used to collect data regarding hazardous materials used by various industries near the site. Hazardous materials considered are included in Table 2.2-4. Toxic chemicals and explosives stored or used by industries or distributors in the vicinity of the Station are summarized in Table 2.2-5. Two natural gas pipelines and a small propane distribution company are located within 8 km of Unit 2.

Waterborne commerce for 1978 Lake Ontario traffic is described in Tables 2.2-2 and 2.2-6. Approximately 1.2 million tons of cargo were transported on Lake Ontario. Since more specific commodity categories are not used in data collection, there are no means of identifying types, frequency, and amounts of hazardous material shipments past the site.

The nearest passage of commercial vessels to Unit 2 occurs when navigating to and from the City of Oswego harbor, located approximately 10 km (6.2 mi) from Nine Mile Point Station. The Port of Oswego Authority indicates that none of the hazardous materials listed in Table 2.2-5 have been transported on Lake Ontario, either originating at or destined to the Port of Oswego. All industries reported receiving hazardous material shipments via U.S. Highway 104 and County Route 1 by truck.

2.2.2.3 Projections of Industrial Growth

There are no plans for major expansion in transportation, storage, or industrial facilities in the vicinity of Unit 2.

2.2.3 Evaluation of Potential Accidents

The consideration of a variety of potential accidents, and their effects on the plant or plant operation, is included in this section. Types of accidents considered include explosions, flammable vapor clouds, toxic chemicals, fires, collisions with intake structures, and liquid spills.

2.2.3.1 Determination of Design Basis Events

2.2.3.1.1 Explosions

Based on a comprehensive survey of industries within a 10-km (6.2-mi) radius of Unit 2, the nearest highway on which explosive materials can be transported is Route 104, which is a distance of about 6.2 km (3.9 mi) from safety-related structures. This separation distance far exceeds the safe distance for truck traffic (approximately 548.6 m, 1,800 ft) given on Figure 1 of RG 1.91.

In discussions with Conrail, it was determined that no explosive or flammable materials are transported to the Oswego terminal of the rail line between Oswego and Mexico, NY. In any event, the distance from this rail line to Unit 2 is much greater than the safe distance for rail traffic given in RG 1.91.

Since the nearest commercial shipping lanes on Lake Ontario are more than 10 km (6.2 mi) from Unit 2 (according to the U.S. Coast Guard), potential explosions on a ship or barge are not considered a design basis event(3). This distance is well beyond the radius of the peak incident pressure of 1 psi as given in RG 1.91. Therefore, according to guidance contained in RG 1.91, explosions on nearby transportation routes are not considered design basis events due to the separation distances of potential sources of explosions from Unit 2.

2.2.3.1.2 Flammable Vapor Clouds (Delayed Ignition)

Propane stored at the James A. FitzPatrick plant is the only potential source of a flammable vapor cloud that might affect the Unit 2 site(4). Approximately 3,785 l (1,000 gal) of propane at the James A. FitzPatrick plant is stored about 700 m (2,297 ft) from the Unit 2 containment building. An analysis has been performed to assess the potential of a 1-psi overpressure occurring at the Unit 2 containment building as a result of the delayed ignition of a flammable vapor cloud of propane. A 1-psi overpressure is that pressure below which no significant damage to critical plant structures is expected, as determined by the U.S. NRC in RG 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants."

The delayed ignition analysis was performed utilizing a computer program (GASBLAST) that calculates the extent and volume of the mixture of air and gaseous explosive for a given set of meteorological conditions and rich and lean concentration detonability limits. The TNT equivalent and incident blast pressure isobars, represented by concentric circles emanating from the center of the plume, are then determined. The program assumes that the gas is released at ground level at a constant release rate. The analytical method that forms the basis of the program follows the computational model established by Burgess and Zabetakes(12). The blast effect is determined by using the heat of combustion and an algorithm-relating pressure to distance from the detonation point and to the equivalent weight of TNT, as given by Glasstone(13).

Several conservative assumptions have been made in applying this computer program to calculate blast overpressures from the propane cloud. A catastrophic rupture of the propane tank is assumed, resulting in a fraction of the contents becoming instantly vaporized and the remainder forming a puddle on the ground. Both the puff (vaporized propane) and the plume from the evaporation of the puddle are assumed to move directly toward the Unit 2 containment building under worst-case meteorological conditions (1 m/sec wind speed and F-stability). It is also assumed that an ignition source exists at the closest distance to the Unit 2 containment building at which an explosive mixture of propane and air can occur.

The emission rate of propane used in the GASBLAST program to evaluate the blast effect of the evaporating puddle was calculated using another computer program. This program (VAPOR) is used in Section 2.2.3.1.3 to evaluate control room habitability after an accidental toxic gas release and is based on the methodology outlined in NUREG-0570. Based on the chemical properties of propane and an assumed air temperature of 33°C (see Table 2.2-9), the VAPOR program determined that 53 percent of the contents of the tank is instantly vaporized, with the remaining 47 percent forming a puddle on the ground. The spreading of the puddle and subsequent evaporation rate are based on the NUREG-0570 methodology.

Using the maximum evaporation rate as the propane release rate, along with rich and lean detonability limits of 0.094 and 0.021(14), respectively, and a heat of combustion of 2266 Btu/ft^3, the GASBLAST program calculated a 1-psi overpressure occurring at a distance of 491 m from the blast center. It also calculated that the vapor cloud had drifted 168 m from the release point when it detonated. Therefore, since the propane tank is located 700 m from the Unit 2 containment building, the 1-psi overpressure from the detonation of the propane cloud from the evaporating puddle will not adversely affect the Station.

Since the GASBLAST program assesses a continuous release of explosive gas and not an instantaneous release, the potential effect of the flashed portion of the propane was determined by first calculating a critical explosive gas concentration below which a 1-psi overpressure could not occur at the Unit 2 containment building. Using the GASBLAST program, it was determined that a centerline vapor cloud concentration of 0.07 (ratio of the volume of explosive gas over the volume of the mixture) detonating at a distance of 172 m from the release point would result in a 1-psi overpressure at a distance of 511 m from the detonation point. Thus, a puff centerline concentration of less than 0.07 could not cause a 1-psi overpressure to reach the Unit 2 containment building since it is greater than 683 m from the stored propane.

The puff concentration was then calculated using the Gaussian dispersion equation in the GASBLAST program, along with the program assumption that the continuous release is uniformly mixed in an elliptical cylinder whose length is the product of the wind speed and elapsed time after the release. The minor axis of the cylinder is twice the vertical dispersion coefficient, and the major axis is twice the horizontal dispersion coefficient. Therefore, the puff concentration at the critical distance of 172 m was calculated by assuming that the flashed propane is dispersed in a 172-m long cylinder, based on a 1 m/sec wind speed.

This results in an effective release rate of 6,802 g/sec (1.17×10^6g/172 sec), thereby yielding a centerline puff concentration of 0.04 which is less than the critical value of 0.07.

Therefore, the delayed ignition of the puff or plume release from the propane tank at the FitzPatrick station will not cause a 1-psi overpressure to reach the Unit 2 containment building.

2.2.3.1.3 Toxic Chemicals

Potential Sources of Toxic Chemicals

According to RG 1.78, both onsite and offsite potential toxic gas hazards must be considered. Any toxic substance stored onsite in a quantity greater than 45 kg (100 lb) must be evaluated. Offsite sources to be evaluated include stationary facilities and frequent transportation of toxic substances (truck, rail, and barge) within 8 km (5 mi) of the site. Frequent shipments are defined as exceeding 10/yr for truck shipments, 30/yr for rail shipments, and 50/yr for barge shipments.

For the Nine Mile Point site, sources of potential toxic chemical hazards include chemicals stored onsite, as well as four stationary and two transportation sources within 8 km of the site. Table 2.2-7 lists the chemicals associated with each source along with their quantities and distances from the Unit 2 control room air intake. The three stationary sources include the James A. FitzPatrick plant, the ALCAN Rolled Products Division, Oswego Wire Inc., and Unit 1. One transportation source of possible hazardous materials is truck traffic along Route 104, which passes within 6.2 km (3.9 mi) of the site. The second transportation source is the railroad line between Oswego and Mexico, NY. Discussions with Conrail indicate that on an average, only one hazardous chemical shipment during an 18-month period passes through the Oswego terminal. Traffic on a spur to the site is not frequent enough (<30/yr) to warrant consideration.

Only those chemicals that have the potential to form a toxic vapor cloud or plume after release to the environment need to be evaluated. This criterion is met by all chemicals listed in Table 2.2-7.

Control Room Habitability Determination

The effect of an accidental release of each of the chemicals described in the previous section on control room habitability is evaluated by calculating vapor concentrations inside the control room as a function of time following the accident. This calculation is performed using the conservative methodology outlined in NUREG-0570 and utilizing the assumptions described in RG 1.78.

In a postulated accident, the entire content of the largest single storage container is released, resulting in a toxic vapor cloud and/or plume that is conservatively assumed to be transported by the wind directly toward the control room intake. The formation of the toxic cloud and/or plume is dependent on the characteristics of the chemical and the environment. The entire amount of a chemical stored as a gas is treated as a puff or cloud that has a finite volume determined from the quantity and density of the stored chemical. A substance stored as a liquid with a boiling point below the ambient temperature forms an instantaneous puff due to flashing (rapid gas formation) of some fraction of the stored quantity. The remaining liquid forms a puddle that quickly spreads into a thin layer on the ground, subsequently vaporizing and forming a ground-level vapor plume. A high boiling point liquid (above ambient temperature) forms a puddle that evaporates by forced convection with no flashing involved.

The calculations are done by a computer program (VAPOR) based on NUREG-0570 methodology that requires the following input information: chemical physical properties, control room parameters, meteorology, distance from the spill to the control room intake, quantity of chemical released, and toxicity limits. The following Unit 2 control room parameters are used: ventilation rate of 0.708 m^3/sec (1,500 ft^3/min), and net free volume of 5,935 m^3 (209,600 ft^3). The most conservative meteorological condition is assumed for the calculation, consisting of Pasquill Class D stability for sodium bisulfite solution stored onsite and Class G stability for all others, a wind speed of 0.5 m/sec (1.6 ft/sec), and an ambient temperature of 33°C (91°F).

The criteria for determining chemical toxicity and setting limits for habitability determinations are taken from regulatory guidance documents. According to RG 1.78, the toxicity limit of a chemical is the maximum concentration that can be tolerated by an average human for 2 min without physical incapacitation (severe coughing, eye burn, severe skin irritation). Standard Review Plan (SRP) Section 6.4 states that acute effects should be reversible within a short period of time (several minutes) without the benefit of medication other than the use of self-contained breathing apparatus (SCBA). The acute toxicity limits listed in RG 1.78 are used in this study except that, where more appropriate, documented sources are available(5-9, 22).

Nonguideline toxicity limits are based on concentrations that produce no effects or minor irritation affecting mental alertness and physical coordination, assuming a 15-min exposure time. In cases where appropriate human data are not available, data are used by applying a conservative factor of 10 to lower the acute exposure limit.

The effect of the continuous outside venting of the onsite sodium bisulfite storage tank on control room habitability is evaluated by calculating the maximum sulfur dioxide vapor concentration at the control room intake. The evaluation is performed using the guidance described in Regulatory Guide 1.78. The toxicity limit is set at the TLV-TWA limit established in NUREG/CR-5669(22) for sulfur dioxide.

Results and Conclusions

The results of the analysis are summarized in Table 2.2-8, which indicates that none of the toxic chemicals evaluated have the potential to incapacitate the Control Room Operators.

2.2.3.1.4 Fires

The production of high heat fluxes and smoke from fires at industrial or storage facilities, oil and gas pipelines, transportation routes, or homes in the site vicinity does not present a hazard to the safe operation of the plant due to the large separation distances of these potential fires from the site. The nearest storage facilities of flammable materials in large quantities and the nearest oil pipeline are over 10 km (6.2 mi) from the Nine Mile Point site. The nearest gas pipeline is over 3.2 km (2 mi) from Nine Mile Point site. The nearest truck route (Route 104) passes the site at a distance of about 6.2 km (3.9 mi) from the plant. There are no known regular shipments of flammable materials on Route 104 with the exception of possible local gasoline deliveries. The nearest residence is approximately 1.6 km (1 mi) from the site.

The site is sufficiently cleared in areas adjacent to the plant that forest or brush fires pose no safety hazards. Onsite fuel storage fires do not jeopardize plant safety since these facilities are designed in accordance with applicable fire codes. A detailed description of the plant fire protection system is presented in Section 9.5.1.

2.2.3.1.5 Collisions with Intake and Discharge Structures

Oswego Harbor is located approximately 12 km (7.5 mi) southwest of the intake structures. The intake structures are located approximately 305 m (1,000 ft) offshore in a water depth of 6 m (20 ft) at the minimum controlled lake level.

In accordance with Coast Guard recommendations, the intake structures are constructed with the tops 3 m (10 ft) below the minimum controlled lake level during the navigational season. Even greater protection is afforded the discharge structure since it is located 1,500 ft offshore and covered by approximately an additional 12 ft of water.

If a barge should drift or break loose in the shipping lane, the distance of the structures from that lane should provide sufficient maneuvering area for retrieval. In the case where a ship or barge should break up, any nonfloating load would sink before reaching the intake or discharge structures. The location of these structures, approximately 6 mi to nearest commercial shipping lane, minimizes the potential for being struck by passing commercial traffic and their depths minimize the potential for damage by any pleasure craft that may frequent the area.

In the unlikely event that a ship or barge were to collide with and completely incapacitate one of the intake structures, Station safety would not be jeopardized because there are two intake structures, each one independently connected to the onshore screenwell and each one sized to individually provide sufficient safe shutdown cooling.

2.2.3.1.6 Liquid Spills

The locations and design of the intake structures are described in Section 9.2.5. No oil and liquids that may be corrosive, cryogenic, or coagulant are stored at, delivered to, or transported through the area of the intake structure in Lake Ontario (Section 2.2.2). All oil and liquids used at Unit 1 and the James A. FitzPatrick plant are transported by truck or rail (Section 2.2.2). All oil and liquids that may be corrosive, cryogenic, or coagulable, which are transported within the 8 km radius, are moved on land (Section 2.2.2). There is, at most, an extremely remote possibility of occurrence of liquid spills in the area of the intake structures, originating from land-based storage or transport. The intake structures are located at a 3-m (10-ft) depth below the minimum controlled lake level during the navigational season, and service water is drawn in at low velocities through the sides of the structures. These provisions prevent the formation of vortices. Surface spills of liquids with sufficient density to reach the intakes must pass the region of induced turbulence and would be subject to dilution effects. The top of the intake structures will remain over 0.7 m (2.3 ft) below the minimum postulated low water surface elevation of el 72 m (236.3 ft).

Any accidental liquid spills to Lake Ontario would be further diluted because of the distance between the origin of spills from either commercial shipping or land-based transport, and the intake structures. Liquids from land-based spills would have to travel approximately 305 m (1,000 ft) to reach the intake structures and would be subject to dilution during transport. Any liquid spills originating during common commercial ship transport would have to travel approximately 10 km (6.2 mi) to reach the intake location. Due to the combined effects of the submerged intake structures' design and the distance between intake structure location and origin of the potential liquid spill, the risk of entrainment of any significant quantities of oil, or corrosive, cryogenic, or coagulable liquids by the intake structures, is negligible.

2.2.3.1.7 Airplane Crashes

The nearest air corridor is approximately 22.5 km (14 mi) east of the site (Section 3.5.1.6). There are only two airfields between the 8-km (5-mi) and 24-km (15-mi) radii of the site; the Lakeside Airpark and Oswego County Airport are about 12 km (7.5 mi) and 19 km (12 mi) south of the site, respectively. The aircraft approaches to these airports are not near the plant site. The general aviation movements at these airports total approximately 1,460/yr and 19,900/yr, respectively. The annual movements are below the critical number at which a probability analysis for aircraft accidents would be required according to RG 1.70. Therefore, the probability of aircraft crashing into the site is considered to be remote, and airplane crashes need not be considered design basis events.

Similarly, for helicopter operations to and from the site, the probability of a helicopter crash resulting in radiological releases in excess of 10CFR100 guidelines has been conservatively estimated to be approximately 1×10^{-6}, using the methodology of NRC SRP 3.5.1.6. In accordance with SRP 2.2.3, additional qualitative arguments could be made which would substantially lower this probability to less than about 10^{-7} per year. This satisfies the requirements of RG 1.70 such that helicopter crashes need not be considered as design basis events.

2.2.3.2 Effects of Design Basis Events

Potential design basis events are identified in Section 2.2.3.1. The effects of these events on the safety-related components of the plant are insignificant. The potential for toxic chemical accidents affecting main control room personnel has been evaluated. This shows no potential impact on main control room habitability. Self-contained breathing apparatus, however, will be provided for main Control Room Operators.

2.2.4 References

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11. Transmittal from T. J. Perkins, Niagara Mohawk Power Corporation, August 3, 1981, to K. A. Baraniak, Stone & Webster Engineering Corporation.
12. Burgess, D. S. and Zabetakes, M. G. Detonation of a Flammable Cloud Following a Propane Pipeline Break. U.S. Bureau of Mines Report of Investigations, (RI7752), 1973.
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14. Handbook of Chemistry and Physics, 44th Edition.
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18. Personal communication between W. A. Mosher (NMPC) and H. J. Flanagan (NMPC).

19. Personal communication between C. A. Gerber (NMPC) and H. J. Flanagan (NMPC).

20. Personal communication between A. Anderson (NMPC) and H. J. Flanagan (NMPC).

21. Personal communication between A. Heath (NYPA) and H. J. Flanagan (NMPC).

22. NUREG/CR-5669, “Evaluation of Exposure Limits to Toxic Gases for Nuclear Reactor Control Room Operators,” July 1991.

TABLE 2.2-1
Sheet 1 of 1
DAILY TRAFFIC VOLUME OF COUNTY HIGHWAYS IN THE VICINITY OF UNIT 2

Highway	Daily Traffic Volume	Date of Survey	Distance and Direction from Unit 2		
			km	Direction	mi
County Rte 29					
Between Lake Rd and Rte 1	1,729	April 1978	2	ESE	1.2
Between Rte 1 and 104	2,856	May 1978	3	SE	1.9
Between Rte 51A and 4	1,229	April 1979	7	SSE	4.3
County Rte 63 at Miner Rd	671	June 1978	4	SE	2.5
County Rte 1					
Between Lake Rd and Cremery Rd	1,341	April 1978	5	SW	3.1
Between Cremery Rd and Lakeview Rd	1,305	April 1978	4	SSW	2.5
Between Lakeview Rd and Rte 29	972	April 1978	4	S	2.5
Between Rte 29 and 44	1,312	July 1978	5	SE	3.1
Between Rte 44 and Hickory Grove Dr	1,312	July 1978	7	SSE	4.3
Between Hickory Grove Dr and Rte 104B	964	September 1978	8	SSE	5.0
Middle Rd between Rte 1 and Cremery Rd	885	April 1979	6	SW	3.7
Cremery Rd					
Between Rte 1 and Middle Rd	1,011	April 1979	4	SW	2.5
Between Middle Rd and Rte 104	1,558	October 1979	6	SW	3.7
Kocher Rd between Rte 1 and 104	3,063	April 1978	7	SSW	4.3
County Rte 53 between Rte 104 and 4	702	May 1980	7	SSW	4.3
Klocks Corner Rd between Rte 104 and 4	826	April 1979	7	SSW	4.3
County Rte 51A					
Between Rte 104 and 29	792	October 1979	6	S	3.7
Between Rte 29 and 51	595	October 1979	7	SSE	4.3
County Rte 51					
Between Rte 104 and 51A	205	October 1979	6	SW	3.7
Between Rte 51A and Mud Lake Rd	402	October 1979	9	SSE	5.6
County Rte 6					
Between Rte 1 and 104B	602	April 1979	8	ESE	5.0
Between Rte 104 and 64	702	April 1979	8	SE	5.0

SOURCE: Reference 1

TABLE 2.2-2
Sheet 1 of 1
1978 FREIGHT TRAFFIC FOR LAKE ONTARIO AROUND OSWEGO HARBOR
(short tons)

Commodity	Total	Foreign		Domestic	
		Overseas Imports	Canadian Imports	Lakewise Receipts	Local
Barley and rye	5,880			5,880	
Rice	5	5			
Wheat	22,515			22,515	
Cocoa beans	559	559			
Fresh and frozen vegetables	6	6			
Animals and animal products	11	11			
Fresh fish, except shellfish	86		52		34
Crude petroleum	155,745	155,745			
Nonmetallic minerals	40,189		40,189		
Alcoholic beverages	131	131			
Miscellaneous food products	93	93			
Basic textile products	1,700	1,700			
Printed matter	14	2	12		
Radioactive materials, wastes	60	60			
Basic chemicals and products	37	37			
Paints	18	18			
Phosphatic chemical fertilizers	19,953		19,953		
Residual fuel oil	857,677		857,677		
Building cement	72,335	912	71,423		
Nonmetallic mineral products	2	2			
Iron and steel pipe and tube	62	62			
Unworked aluminum and alloys	37,949	15,958	21,991		
Fabricated metal products	40	40			
Machinery, except electrical	188	181	7		
Electrical machinery and equipment	3		3		
Motor vehicles, parts, and equipment	20	20			
Iron and steel scrap	581		581		
Nonferrous metal scrap	120	120			
TOTAL	1,215,979	175,662	1,011,888	28,395	34

SOURCE: Reference 2

TABLE 2.2-3
Sheet 1 of 1
INDUSTRIAL FIRMS WITHIN 8 KM (5 MI) OF UNIT 2

Firm	Distance/ Direction from Site (km)	Products	Employment
Novelis	4.5/SW	Aluminum sheet and plate	1,000
James A. FitzPatrick Nuclear Power Plant	<1/E	Electrical generation	515
Nine Mile Point Unit 1	Adjacent to Unit 2	Electrical generation	450
Sithe Energies USA Independence Generation Plant	3.5/SW	Electrical generation	75
Oswego Wire Inc.	7.0/SW	Wire and rolled component production	50

SOURCE: References 4, 10, 11, 17, 18

TABLE 2.2-4
Sheet 1 of 2
ARMY CORPS OF ENGINEERS
HAZARDOUS MATERIAL COMMODITY DESIGNATION
FOR WATERBORNE COMMERCE

Designation Number	Commodity Description	Hazardous Materials Included
1311	Crude petroleum	Crude petroleum
2810	Sodium hydroxide	Sodium hydroxide
2811	Crude products from coal tar, petroleum, and natural gas, excluding benzene and toluene	Xylene
2812	Dyes, organic pigment, dyeing and tanning materials	Aniline
2813	Alcohols	Methanol, ethanol
2817	Benzene and toluene, crude and commercially pure	Benzene
2818	Sulfuric acid	Sulfuric acid
2819	Basic chemicals and chemical products	Acetaldehyde, acetone, acrolein, acrylonitrile, ammonia, ammonium nitrate, anhydrous ammonia, aniline (salts), butadiene, butenes, CO_2 (liquid), CO_2-O_2 mix, CO, chlorine, chlorobenzene, ethyl acetate, ethyl chloride, ethyl ether, ethylene dichloride, ethylene oxide, formaldehyde, liquid hydrogen, methyl methacrylate monomer, helium, hydrogen cyanide, hydrogen sulfide, nitrogen (compressed or liquid), sulfur dioxide, sulfuric acid, vinyl chloride
2841	Soap, detergents, and cleaning preparations; perfumes, cosmetics, and other toilet preparations	Sodium oxide
2861	Gum and wood chemicals	
2871	Nitrogenous chemical fertilizers	
2872	Potassic chemical fertilizers	
2873	Phosphatic chemical fertilizers	
2879	Fertilizer and materials not elsewhere classified	
2891	Miscellaneous chemical products	TNT, dynamite, explosive water gels, other explosive materials

TABLE 2.2-4
Sheet 2 of 2

Designation Number	Commodity Description	Hazardous Materials Included
2911	Gasoline	
2912	Jet fuel	
2913	Kerosene	
2914	Fuel oil	Distillate fuel oil (No. 1, 2, 3, 4 and light)
2915	Fuel oil	Distillate fuel oil (No. 5, 6) and residual fuel oil (heavy)
2916	Lubricating oils and greases	
2917	Naptha, petroleum solvents	
2918	Asphalt, tar, and pitches	
2920	Coke, petroleum coke	
2921	Liquefied petroleum gases, coal gases, natural gas, and natural gas liquids	LPG, propane
2991	Petroleum and coal products	

SOURCE: Reference 2

TABLE 2.2-5
Sheet 1 of 2
HAZARDOUS MATERIALS STORED/USED BY INDUSTRIES WITHIN 8 KM (5 MI)

Material	Industrial User	Storage on Premises (Max. at One Time)	Shipment				
			Mode	Average Size	Maximum Quantity Shipped	Frequency	Average Quantity Shipped/yr
Carbon dioxide	Novelis	99,999 lb	Truck	6 tons	10 tons	Weekly	250 tons
	FitzPatrick	20,000 lb	Truck	6,900 gal	6,900 gal	Infrequently, as needed system	Small quantities used to recharge
	NMP Unit 1	20,000 lb	Truck	5,000 lb	6,300 gal	Monthly	56,000 gal
Chlorine	Novelis	9,999 lb	Truck	1 (1 ton) cylinder	12 tons	Biweekly	350 cylinders
Helium	Novelis	1,917 ft^3	Truck	213 ft^3	9 cylinders (213 ft^3 each)	As needed	94 cylinders (20,022 ft^3)
Hydrochloric acid	Novelis	500 gal	Truck	55 gal	385 gal	Weekly	16,000 gal
	Oswego Wire	99 lb	Truck	4 gal	4 gal	Biannually	8 gal
Hydrogen	FitzPatrick	9,999 lb	Truck	128,000 ft^3	128,000 ft^3	Biweekly	5,881,928 ft^3
	NMP Unit 1	12,000 ft^3	Truck	24,000 ft^3	24,000 ft^3	Bimonthly	72,000 ft^3
	NMP Common	278,000 ft^3	Truck	139,000 ft^3	139,000 ft^3	Three times per week	21,684,000 ft^3
	Oswego Wire	6,450 ft^3	Truck	215 ft^3	5,375 ft^3	10 Weeks	27,305 ft^3
Nitrogen	Novelis	99,999 lb	Truck	6,000 lb	6,000 lb	Triannually	18,000 lb
	FitzPatrick	99,999 lb	Truck	6,900 gal	6,900 gal	Monthly	129,000 gal
	NMP Unit 1	15,300 gal	Truck	6,300 gal	6,300 gal	Monthly	56,000 gal
	Oswego Wire	160,000 ft^3	Truck	145,000 ft^3	160,000 ft^3	Weekly	8,000,000 ft^3

TABLE 2.2-5
Sheet 2 of 2

Material	Industrial User	Storage on Premises (Max. at One Time)	Shipment				
			Mode	Average Size	Maximum Quantity Shipped	Frequency	Average Quantity Shipped/yr
Propane	FitzPatrick	1,000 gal	Truck	22,500 lb	22,500 lb	Monthly	3,000 gal
	Novelis	999,999 lb	Truck	7,000 lb	7,000 lb	Biweekly	200,000 gal
	Oswego Wire	500 gal	Truck	275 gal	450 gal	Biweekly	7,000 gal
Sodium hydroxide	FitzPatrick	5,000 gal	Truck	3,000 lb	3,000 lb	Monthly	246,000 lb
	Novelis	99,999 lb	Truck	55 gal	1,000 gal	Monthly	10,000 gal
	NMP Unit 1	165 gal	Truck	55 gal	55 gal	As needed	100 gal
	Oswego Wire	9,999 lb	Truck	55 gal	55 gal	Monthly	660 gal
Sulfuric Acid	Novelis	800 lb	Truck	375 gal	375 gal	As needed	4,875 gal
	FitzPatrick	5,000 gal	Truck	3,000 lb	3,000 lb	Monthly	396,000 lb
	NMP Unit 1	165 gal	Truck	55 gal	55 gal	As needed	100 gal
	Oswego Wire	9,999 lb	Truck	55 gal	55 gal	Bimonthly	1,320 gal
Isopropyl alcohol	Oswego Wire	110 gal	Truck	55 gal	55 gal	Biweekly	1,430 gal

TABLE 2.2-6
Sheet 1 of 1
1978 LAKE ONTARIO CARGO TRANSPORT FOR OSWEGO HARBOR
(short tons)

Hazardous Commodity Designation	Commodity Description	Total	Foreign Imports	Domestic Receipts
1311	Crude petroleum	155,745	155,745	
2810	Sodium hydroxide			
2811	Crude products from coal tar, petroleum, and natural gas			
2812	Dyes, organic pigment, tanning materials			
2813	Alcohols			
2817	Benzene and toluene			
2818	Sulfuric acid			
2819	Basic chemicals and products	37	37	
2841	Soap, detergents, and cleaning preparations			
2861	Gum and wood chemicals			
2871	Nitrogenous chemical fertilizers			
2872	Potassic chemical fertilizers			
2873	Phosphatic chemical fertilizers	19,953	19,953	
2879	Fertilizers not elsewhere classified			
2891	Miscellaneous chemical products			
2911	Gasoline			
2912	Jet fuel			
2913	Kerosene			
2914	Distillate fuel oil			
2915	Residual fuel oil	857,677	857,677	
2916	Lubricating oils and greases			
2917	Naphtha, solvents			
2918	Asphalt, tar, pitches			
2920	Coke			
2921	Liquefied petroleum gases, natural gases			
2991	Petroleum and coal products not elsewhere classified			
Hazardous commodities		1,033,412	1,033,412	0
All commodities		1,215,979	1,187,550	28,429
All commodities for entire Lake Ontario		49,887,155	49,501,197	385,958

TABLE 2.2-7
Sheet 1 of 2
SOURCES OF TOXIC CHEMICALS WITHIN 8 KM (5 MI) OF UNIT 2 SITE

Chemical Location	Chemical	Amount (g)	Distance to Intake (m)
James A. FitzPatrick Plant	CO_2	1.18E+07	620
	N_2	4.54E+07	620
	Propane	<4.54E+06	620
	Halon 1301	2.72E+06	620
	NaOCl	2.06E+06	620
	NaOH	7.68E+05	620
	Gasoline	4.54E+06	620
	H_2	4.54E+06	620
	Freon R12	7.69E+05	620
	Freon R-22	2.73E+06	620
Novelis	Cl_2	4.54E+06	4990
	Propane	4.54E+08	4990
	N_2	4.53E+08	4990
	HCl	5.40E+06	4990
	CO_2	5.90E+07	4990
	H_2SO_4	4.15E+07	4990
	NaOH (50%)	4.54E+07	4990
	Argon	4.54E+07	4990
	Gasoline	4.54E+07	4990
Route 104	HCl	5.44E+06	5470
	N_2	1.81E+07	5470
	CO_2	2.72E+06	5470
	Cl_2	9.07E+05	5470
Oswego Wire	Isopropyl Alcohol	1.93E+05	7080
	N_2	4.54E+07	7080
	Propane	1.11E+06	7080
	H_2SO_4	4.54E+06	7080
	HCl	6.76E+04	7080

TABLE 2.2-7
Sheet 2 of 2

Chemical Location	Chemical	Amount (g)	Distance to Intake (m)
Sithe Energy	CO_2	2.90E+07	3500
	H_2	2.55E+05	3500
	N_2	1.22E+09	3500
	NaOH	4.54E+07	3500
	NaOCl	5.17E+06	3500
	H_2SO_4	4.54E+08	3500
	Ammonium Hydroxide	1.02E+08	3500
Nine Mile Point Unit 1	CO_2	9.07E+06	Onsite
	N_2	4.68E+07	Onsite
	H_2SO_4	1.14E+06	Onsite
	HCl	4.54E+04	Onsite
	Halon 1301	2.27E+05	Onsite
	NaOCl	2.28E+07	Onsite
	NaOH	9.53E+05	Onsite
	H_2	7.12E+04	Onsite
	$NaHSO_3$	1.41E+07	Onsite
Nine Mile Point Unit 2	CO_2	1.18E+07	Onsite
	N_2	7.20E+07	Onsite
	H_2SO_4	1.59E+08	Onsite
	$NaHSO_3$	1.27E+08	Onsite
	Halon 1301	7.77E+05	Onsite
	NaOCl	9.98E+06	Onsite
	NaOH	3.40E+07	Onsite
	H_2	1.60E+05	Onsite
	Propane	5.54E+05	Onsite
	Ethylene Glycol	5.44E+06	Onsite

TABLE 2.2-8
Sheet 1 of 1
PREDICTED VAPOR CONCENTRATION
IN THE UNIT 2 CONTROL ROOM

Chemical Location	Chemical	Maximum Control Room Concentration (g/m^3)	Toxic Limit (g/m^3)	Allowable Time Period (min)
James A. FitzPatrick plant	N_2	11.2	274	15
	H_2SO_4	6.6×10^{-5}	0.002	2
	CO_2	6.2	54.8	15
	Propane	1.29	43.1	15
	Halon 1301	1.73	432	15
Alcan	Cl_2	0.038	0.045	2
	Propane	1.1	43.1	15
	N_2	0.09	274	15
	HCL	0.003	0.05	15
	CO_2	2.5×10^{-6}	54.8	15
Route 104	HCl	0.009	0.050	15
	N_2	0.54	274	15
	CO_2	0.0	54.8	15
Nine Mile Point Unit 1	N_2	22.2	274	15
	CO_2	14.7	54.8	15
	H_2SO_4	1.3×10^{-5}	0.002	2
	Halon 1301	0.57	432	15
	HCl	0.009	0.05	15
	$NaHSO_3$	1.95 ppm	100 ppm	2
	NaOCl	0.40 ppm	10 ppm	2
Nine Mile Point Unit 2	H_2SO_4	6.6×10^{-4}	0.002	2
	CO_2	46.8	54.8	15
	Halon 1301	3.88	432	15
	N_2	32.1	274	15
	$NaHS0_3$asSO_2	0.108*	0.262	2
		1.69×10^{-3}**	5.24×10^{-3}	480
Oswego Wire Incorporated	Isopropyl Alcohol	2.2×10^{-4}	1.2	15
	N_2	1.2×10^{-3}	274	15
	Propane	2.1×10^{-3}	43.1	15
	H_2SO_4	1.0×10^{-8}	0.002	2

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* For a release of sodium bisulfite solution to the containment berm.

** For continuous outside venting of the sodium bisulfite storage tank.

TABLE 2.2-9
Sheet 1 of 1
INPUT DATA FOR VAPOR RUN

Ambient temperature	32.8°C
Wind speed	1 m/sec
Liquid density of propane	0.585 g/cm^3
Boiling point	-42.2°C
Vapor density	1.55 x 10^{-3} g/cm^3
Heat of vaporization	81.7 cal/g
Specific heat	0.576 cal/g °C

2.3 METEOROLOGY

2.3.1 Regional Climatology

2.3.1.1 Data Sources

The analysis of the regional climatology of the area surrounding Nine Mile Point is based primarily upon the following sources:

2. Climatic Atlas of the United States(1).

2. Climates of the States, Climate of New York(2).

3. Local Climatological Data - Annual Summary with Comparative Data, Syracuse, New York(3).

These documents provide an overview as well as specific long-term records of climatic parameters, such as temperature, precipitation, and wind.

2.3.1.2 General Climate

The Nine Mile Point site is located in north-central New York State on the southeastern shoreline of Lake Ontario. The site is in Oswego County, 53 km (32.8 mi) northwest of Syracuse and 10 km (6.2 mi) northeast of Oswego. For a considerable distance to the west, east and south of the site, the topography is characterized by gently rolling terrain. The terrain rises gradually from the shoreline until it meets the Tug Hill Plateau, over 40 km (25 mi) east of the site, and the Onondaga Hills, approximately 65 km (40 mi) south of the site. These major terrain features and, more importantly, Lake Ontario have pronounced effects on the climate of the north-central New York region.

The prevailing humid continental climate is representative of the northeastern United States region. The planetary atmospheric circulation results in frequent changes of air masses in the region during all seasons. Masses of cold dry air arriving from the northern interior of the continent alternate with warm moist air masses arriving from the south and southwest. These two air masses dominate the continental characteristics of the climate. The cold dry air masses dominate in the winter months, while the moist warmer air masses prevail from late spring through early fall.

Nearly all storm systems and their associated fronts moving eastward across the continent pass through or near the north-central New York State region. The region lies close to the normal storm track through the St. Lawrence Valley and therefore is subject to frequent frontal passages and changes in weather especially during the winter. Occasionally, storms moving northward along the Atlantic Coast directly affect the region. These storm tracks and the influence of the Great Lakes produce the characteristically cloudy climate of the region from late fall through spring.

2.3.1.2.1 Local Climatic Effects

The influence of Lake Ontario on the weather is most apparent during two periods of the year. The first is during the spring through late summer when lake breezes occur in the immediate vicinity of the lakeshore. During the late fall and winter, the presence of Lake Ontario to the north frequently induces locally heavy snowfalls. Throughout the entire year the lake’s influence suppresses the temperature extremes near the lakeshore compared to strictly continental locations. The following sections provide more detail on these mesoscale climatic effects.

Temperature

Areas bordering the lake tend to have warmer minimum daily temperatures in the fall and winter months and cooler spring and summer maximum daily temperatures. The overall diurnal temperature range is also suppressed during the year. These temperature modifications arise because the lake warms the air flowing inland during the colder months and cools the air during the warmer months.

Precipitation and Humidity

Lake Ontario may either enhance or suppress precipitation in the region, depending on the season. During the summer, especially during the daytime hours, when the lake is cooler than the land, the lake cools the air flowing over it. This cooling of the lowest layer of the atmosphere has a stabilizing effect that suppresses convection. Since most summertime precipitation at these latitudes is associated with convective activity, regions in the immediate Lake Ontario vicinity tend to receive less precipitation than inland areas.

During colder months, the opposite effect operates. The relatively warm lake surface releases latent heat and moisture, increasing the humidity of the colder air as it flows over the lake. The cold air heated from below becomes unstable and rises, condensing the moisture into clouds and snow. This process often creates heavy lake-effect snow squalls(4). Twenty-four hour snowfalls of greater than 102 cm (40 in) can occur in the region during these snow squalls(5).

Wind

The shoreline areas of Lake Ontario experience higher wind speeds than those inland due to the fetch over the lake as well as the reduced surface roughness of the lake. This condition is especially noticeable in winter when winds generally blow off the lake.

During the spring through late summer, areas within several miles of Lake Ontario, under certain conditions, can experience lake breezes. A lake breeze occurs during the daytime hours when the sun heats the ground, which in turn warms the adjacent air until it is considerably warmer than the air over the cool lake. This temperature difference results in the cooler air over the lake having higher atmospheric pressure, which causes it to move inland, displacing the relatively light warm air. A true lake breeze occurs when generally light offshore winds are transposed into onshore winds by the temperature-pressure differences. If the winds are already onshore, this temperature-pressure difference increases the wind speeds near the shoreline. The number of hours in which a lake breeze occurs is highest near the shoreline becoming less frequent as one progresses inland.

2.3.1.2.2 Climatological Normals and Extremes

The National Weather Service (NWS) station at Hancock International Airport, north of Syracuse, is the closest and most representative Weather Service station. The representativeness of the Syracuse NWS station data has been shown in documents prepared for this site as well as others nearby(6,7). The following sections give the normal ranges and extremes of climatic variables in the region as well as the extremes measured at the Syracuse NWS station.

Temperature

The normal daily temperatures in the region are typical of those observed throughout the northeast United States. Summertime maximum temperatures normally range between 24° and 29°C (75° and 85°F), while minimum temperatures range from 13° to 18°C (55° to 65°F). In the winter, the maximum temperatures are generally between -1° and 2°C (30° and 35°F), while the daily minimum temperatures are normally between -12° and -7°C (10° and 20°F).

The maximum temperature observed at the current Syracuse NWS station location was 37°C (98°F) in June 1953. However, in July 1936, the highest temperature ever recorded by the Weather Service was 39°C (102°F) at a previous NWS location (Municipal Airport, Amboy). The lowest temperature recorded at Syracuse was -32°C (-26°F) in both January 1966 and February 1979.

Precipitation

In the region, precipitation is evenly distributed over all seasons with measurable amounts recorded approximately 150 days/yr. Annual precipitation totals range from just over 76 cm (30 in) in the western part of the region to approximately 127 cm (50 in) in the Tug Hill Plateau to the east.

The maximum precipitation for a 24-hr period recorded at the present NWS location in Syracuse was 10.85 cm (4.27 in) during August 1954. At a previous NWS location (Syracuse University) in downtown Syracuse, a 24-hr total of 12.17 cm (4.79 in) was recorded in June 1922.

Average seasonal snowfall amounts are at least 178 cm (70 in) throughout the entire region. The increase in elevation towards the east has a profound effect on snowfall totals. Normal snowfall amounts in the eastern part of the region exceed 381 cm (150 in).

The maximum total snowfall of 62.2 cm (24.5 in) during a 24-hr period occurred in January 1966 at the current NWS location. A slightly higher 24-hr snowfall of 69.1 cm (27.2 in) occurred during January 1925 at the Syracuse University location.

Atmospheric Moisture Content

Winter mean dew point temperatures are fairly uniform throughout the region and vary from -9° to -4°C (15° to 25°F). Spring and fall mean dew point temperatures are quite similar ranging between 2° to 7°C (35° to 45°F). The warmer summer months have mean dew point temperatures less than 16° (60°F).

The highest hourly dew point temperature was 26°C (78°F) in June 1945 and July 1969. The lowest dew point was -44°C (-47°F) which occurred in February 1948 and December 1945(6).

Mean monthly relative humidity values show little seasonal variation from the annual mean of 75 percent for the region.

Wind

The prevailing wind direction during the year is westerly throughout the region. The southwest component becomes evident in winds during the warmer months, while the northwest component is characteristic of the colder months.

Surface wind speeds average about 4 m/sec (10 mph). Higher wind speeds are often associated with the winter months, especially after the passage of strong cyclonic systems. Light winds are more often experienced during the summer and early fall, especially when stagnant high pressure systems dominate the weather pattern.

The fastest-mile wind recorded at Hancock Airport reported by the National Climatic Center is 28 m/sec (63 mph) at a height of 22 m (72 ft) in October 1954, while the Syracuse University station recorded a 31-m/sec (69-mph) fastest-mile at a height of 34 m (113 ft) during December 1921.(55) The more distant Rochester – Monroe County Airport recorded a 33-m/sec (73 mph) fastest-mile at a height of 21 m (69 ft) during January 1950.(56) The fastest-mile is defined as the fastest speed, in miles per hour, of any mile of wind.(8)

In addition, Changery in NUREG/CR-2890 has examined and adjusted many of the U.S. Weather Bureau and NWS records for the fastest mile of wind.(57) This document reports the fastest-mile wind at standard heights of 10 m (33 ft) for NWS stations and 30 m (98 ft) for Weather Bureau Offices. A summary of the wind records for Syracuse, Rochester and Oswego is presented in Table 2.3-6 which lists the true speed (fastest-mile), the height of the wind measurement, and the fastest-mile corrected to the standard height of 10 or 30 m (33 or 98 ft). Since the wind instrument heights have changed in time, both the highest true speed and the highest speed corrected to a standard height are reported, as necessary for clarification.

2.3.1.3 Regional Meteorological Conditions for Design and Operating Bases

2.3.1.3.1 Seasonal and Annual Frequencies of Severe Weather

Severe weather is defined as any destructive storm, such as tropical cyclones (hurricanes), tornadoes, waterspouts, thunderstorms, hail, and freezing rainstorms. The frequency and severity of these storms in north-central New York is assessed in the following sections.

Tropical Cyclones

Tropical cyclones originate over the tropical waters of the Atlantic Ocean, Caribbean Sea, and the Gulf of Mexico from early summer through fall. The most intense form is called a hurricane, which has sustained wind speeds greater than 33 m/sec (73 mph); however, several other less destructive stages can exist. These are tropical disturbances, tropical depressions and tropical storms. The remnants of these cyclones which dissipate over land often become extratropical cyclones. The north-central New York State region is so far inland from the Atlantic Ocean that it is shielded from the most destructive forces of tropical cyclones. A review of Tropical Cyclones of the North Atlantic Ocean shows that from 1900 through 1980, 11 extratropical cyclones, 1 tropical storm and no hurricanes passed through the region(9). The average annual frequency of destructive tropical cyclones is less than 0.1 (less than 1 storm per 11 yr)(2).

Tornadoes

Tornadoes, although rare, do occur in the region during the spring and summer. Summaries prepared by Pearson indicate that there were 14 tornadoes (of which one had multiple touchdowns) reported within a 2° latitude by 2° longitude area centered on the site (43° 31′ latitude, 76° 23′ longitude, rounded to the nearest minute) during the period 1951 through 1980(10). All of these tornadoes occurred during May through September. This 2° by 2° area represents approximately 36,000 sq km (14,000 sq mi). Of these 14 tornadoes, none had an estimated Fujita-Pearson force scale exceeding F1, 50 m/sec (112 mph).

The two closest tornadoes reported were within 9.0 km (5.6 mi) of the rounded latitude and longitude values used. These occurred on August 10, 1958, and May 30, 1972, to the south-southwest of the site. Both had maximum path areas of 0.08 sq km (0.03 sq mi).

Using the statistical methods of Thom, the probability of a tornado striking any given point in the 1° latitude-longitude square surrounding the Unit 2 site is once in every 28,000 yr(11). This probability estimate is based upon a frequency of 0.3 tornadoes/yr in the 1° square. The annual frequency of tornadoes was obtained from Pearson's summary which showed that nine tornadoes occurred in the 1° latitude-longitude square encompassing the site from 1951 to 1980. The average path area for these nine tornadoes was 1.04 sq km (0.41 sq mi).

Waterspouts

The waterspout has been defined as an intense columnar vortex of limited horizontal extent, existing over a body of water, but not necessarily containing a funnel cloud. The basic differences between tornadoes and waterspouts are that tornadoes are more intense, larger, and longer lived(12).

The data set of waterspouts is limited and consists of events occurring in the vicinity of the Florida Keys. Several studies on their size, duration, intensity, associated phenomena and effects have been made in the Keys area, yet little information is available to relate these storms to those occurring elsewhere(12,13).

The largest and most intense waterspouts can be of tornadic size. The upper limit to the rotational velocity is presently estimated as approaching 89 m/sec (200 mph) with typical translational velocities approaching 7-9 m/sec (15-20 mph). However, since waterspouts are generally weaker than tornadoes, and the most intense tornado documented near the site is F1, 50 m/sec (112 mph), the upper limit to the rotational velocity should be considerably less than 89 m/sec (200 mph) at the site.

Estimates of the frequency of waterspouts at Nine Mile Point site are extremely difficult to project. Waterspouts rarely leave evidence of their occurrence.

The frequency of waterspouts in this area with any possible impact on plant integrity probably approaches that of the tornado, once in every 28,000 yr.

The only documented waterspout observations on Lake Ontario are reported by Sykes, Pack, and Loveridge(14). From mid-August into October, waterspouts are occasionally observed in connection with cold and unstable air passing over the relatively warm lake surface.

Thunderstorms and Lightning

Thunderstorms are a seasonal phenomenon in the region of the Nine Mile Point site. The Syracuse NWS records from 1950 through 1980 show an average of 29 thunderstorm days per year, with 27 of these days occurring during the spring and summer months(3). A summary of the Syracuse NWS records from 1948 through 1977 shows that there are an average of 40 thunderstorms observed per year(15). The highest frequency of thunderstorms occurs during July.

Direct observation of lightning strikes is not a routine function at any of the standard observing stations. However, Uman has developed a statistic that indicates that the number of lightning flashes (cloud to ground) per square mile per year is equal to between 0.05 to 0.8 times the number of thunderstorm days per year(16). A conservative estimate of the number of lightning strikes per year in the area containing the Nine Mile Point site is 9/sq km (23/sq mi).

Hail

Hail storms are a relatively rare phenomenon in the region. Pautz reports that there were 49 occurrences of hail with diameters greater than or equal to 1.91 cm (0.75 in) in New York State in the 13-yr period from 1955 through 1967(17). This converts to approximately four severe hail storms per year. However, hail frequency is not uniform throughout the state. Baldwin and Changnon both report an annual frequency of one to two hail storms per year in north central New York(18,19). Changnon indicates that these storms are most likely to occur in the late spring. A review of the Monthly Climatological Data for Syracuse shows four occurrences of hail during the period 1976 through 1980(28).

Ice Storms

A survey by Bennett for 1928 through 1937 indicates that ice or freezing rain may occur up to one to three times per year in the site region(21). These occurrences are most frequent during the winter. However, glaze accumulations greater than 0.64 cm (0.25 in) could be expected only once per year. A more recent summary of glaze statistics in Baldwin indicates that during the 20-yr period (1950 through 1969), 8 to 12 days of glaze annually occur over the region(18). Glaze has occurred on 49 days during 1976 through 1980 at the Syracuse NWS station(20). The longest duration of freezing rain at the Syracuse NWS station during this period occurred for 30 hr between March 2 and March 3 of 1976(20).

High Air Pollution Potential

Episodes of limited atmospheric dispersion in the U.S. have been studied by Holzworth in terms of urban and area pollutant source problems(22). Holzworth has estimated approximately 10 forecast days of high potential for air pollution in a 5-yr period in the vicinity of the site. Using a pressure gradient technique to define stagnating conditions, Korshover found between 75 to 125 stagnation days in the region during the 40-yr period from 1936 through 1975(23). This converts to 2 to 3 stagnation days per yr, which agrees with Holzworth's estimate. The summer and fall experience the highest potential for stagnation days.

2.3.1.3.2 Maximum Snow Load

The appropriate weight of snow derived from established references for consideration as an extreme environmental load yields a ground level snow load of less than 100 psf. Three different analytical approaches have been used, and each one results in values of less than 100 psf for the extreme snow load.

All three approaches use the weight of the 100-yr return period snowpack of 40 psf for the site area developed from ANSI A58.1-1972(25). The approaches differ on how they calculate the weight of the 48-hr PMWP, but all yield similar results.

Approach 1

The first methodology determines the weight of the 48-hr PMWP considered as an all snow event with the aid of Hydrometeorological Reports No. 33 and 53(63,64). Examination of 1983 Local Climatological Data Summaries for the record 24-hr snowfalls in the northeast quadrant of the U.S. yields a record snowfall of 30.4 in at Albany, New York, during the March 1888 blizzard(65). To translate this 24-hr snowfall amount to a 48-hr duration storm, the maximum March Depth-Area Duration curve adjustment from Hydrometeorological Report No. 33 for Zone 1 (which includes the site area as well as Albany) of 1.6 is utilized. Thus, the record Albany snowfall translates into a 48-hr storm of 48.6 in.

To maximize the moisture and adjust for transposition of the storm to the site, Hydrometeorological Report No. 53 is used. The highest total storm adjustment factor is 1.5 for any of the controlling storms during any time of the year. Therefore, the application of this conservative factor of 1.5 results in a calculated maximum of 72.9 in for a 48-hr period.

For comparison purposes, record snowfalls from Ludlum's The American Weather book are listed in Table 2.3-7 for the Northeast based on 24-hr storms as well as record snowstorm amounts(66). The 24-hr snowfall at Barnes Corners, New York, would translate into the greatest 48-hr snowfall estimate. However, Kenneth Dewey of the NWS reported in Weatherwise that the 24-hr lake-effect snowfall record appears to have been set at Adams, New York, on January 9, 1976, with a 68.0-in accumulation(67). The Adams storm translates into a maximum 48-hr PMWP snowfall of 163.2 in based on the preceding discussion.

Calculation of the load of the 48-hr PMWP requires an appropriate snow depth to water equivalent ratio. The snowfall amounts recorded at the NWS station at Hancock Airport provide the best long-term historical data readily available. The six winter seasons from 1977 through 1983 are examined counting only those days with snowfall amounts in excess of 4.0 in(68). The 4.0-in amount is chosen to determine a reliable ratio. Any days with mixed precipitation types such as sleet, freezing rain, etc., are not chosen. Based on 24 days during this 6-yr period, the weighted average snow to water equivalent ratio is 18.6. The data are considered conservative, since extreme Great Lakes-effect snowstorms generally have snow to water equivalent ratios of from 20:1 to 40:1(69).

Applying this average weighted conversion factor to the 48-hr PMWP snowfall of 163.2 in yields a water equivalent amount of 8.77 in or 45.6 psf. Therefore, the total extreme ground level snow load is 40 psf plus 45.6 psf or 85.6 psf.

Approach 2

An equally reliable methodology uses the maximum observed 24-hr water equivalent precipitation value translated into a 48-hr PMWP. To be conservative, the maximum daily precipitation during any time of the year is employed. In the Syracuse area, based on 82 yr of historical weather data, a maximum 24-hr accumulation of 4.79 in of precipitation fell during a June 1922 storm. This record 24-hr rainfall agrees with the 4.7-in estimate for the 24-hr 100-yr return period rainfall for the site area shown on the isohyet map in Technical Report No. 40(70). These 24-hr precipitation values are more than twice the maximum 24-hr water equivalent winter precipitation amounts which have been recorded during the 34-yr history of the current NWS station at Hancock Field. Using the conservative factor of 1.6 for wintertime, the 24-hr total of 4.79 in converts to 7.66 in. Further correction for moisture and transposition is accomplished by multiplying by the 1.5 adjustment factor.

Thus, the 48-hr PMWP is equivalent to 11.49 in or 59.3 psf, a highly conservative value. Adding this value to the 100-yr return period snowpack yields an extreme ground-level snow load of 99.3 psf.

Approach 3

Finally, a derivation of an appropriate PMWP can be ascertained from Hydrometeorological Report No. 53 from the probable maximum precipitation depth/duration curves derived for the site. The location yields a winter 48-hr PMWP of 10.8 in or 56 psf. Therefore, a summation of the 100-yr return period snowpack and the 48-hr PMWP yield an extreme ground-level snow load of 96 psf.

Therefore, based on these three different evaluations of the PMWP, the highest value of 59.3 psf, when combined with the 100-yr return period snowpack of 40 psf, yields an extreme ground-level snow load of 99.3 psf.

Roof Design Criteria

Using the above calculated values for normal snow loads and extreme snow loads, the roofs of seismic Category I structures are designed as follows:

2. Normal Operating (or severe environmental) Condition

   During these events, a conservative design snow load of 45 psf is considered concurrently with dead load, live load, effects of temperature, pipe reactions, seismic, etc. Additional snow loads, in accordance with ANSI A58.1, are also considered for a portion of the roof that is immediately adjacent to a taller structure.

2. Abnormal/Extreme Environmental Conditions

   During this event, a ground level snow load of 99.3 psf (see Approach 2) is postulated using a factor of 0.8 in accordance with ANSI A58.1 for converting ground level snow load into roof level snow load, an extreme value of 80 psf is obtained. (The roofs of safety-related structures are found capable of withstanding 80 psf snow loads in conjunction with dead load only.)

Section 3.8.4.3 provides the necessary loading combinations for designing Category I roofs.

2.3.1.3.3 Design Basis Tornado

The design basis tornado parameters at the Unit 2 site have been determined in accordance with the criteria given in RG 1.76. These parameters are presented in Table 2.3-1.

2.3.1.3.4 Fastest Mile of Wind

The 100-yr recurrence interval fastest mile of wind expected at the Nine Mile Point site is 36.7 m/sec (82 mph). This value has been obtained from the work of Thom and is representative of winds occurring 9 m (30 ft) above the ground(28). The vertical distribution of the fastest mile of wind is computed using the common power law, in the form:

$$U_z = U_1 \left(\frac{z}{z_1}\right) b$$

(2.3-1)

Where:

U = Wind speed at height z

U_1 = Wind speed at lower height, z_1

b = Stability dependent exponent

Thom indicates that a value for b of 1/7 is appropriate for high wind speeds in flat to rolling rural terrain such as that at Nine Mile Point.

Table 2.3-2 presents the vertical distribution of the fastest mile.

A gust factor of 1.1 is used at the 9-m (30-ft) level. Since the gust factor is known to decrease both as a function of height and increasing wind speed, the use of 1.1 is appropriate at higher heights.

Furthermore, the recent work by Changery confirms Thom's earlier estimates. Changery has estimated the 100-yr return period fastest-mile using both the airport and city office exposure wind data. From Figure 2 of NUREG/CR-2890, data from city office exposures yield a 38-m/sec (85-mph) fastest-mile at 30 m (98 ft) aboveground, while data from airport-type exposures (Figure 3) yield 41 m/sec (91 mph) at 30 m (98 ft) or 80 mph (Figure 3) at 10 m (33 ft) aboveground for Unit 2.

2.3.1.3.5 Ultimate Heat Sink

The ultimate heat sink (UHS) for Unit 2 is Lake Ontario. Therefore, a climatological analysis of maximum evaporation, drift loss, and minimum heat transfer as indicated in RG 1.27 is not necessary.

2.3.2 Local Meteorology

The analysis of the local meteorology at the Unit 2 site is based upon 5 yr of data (January 1974 through December 1976 and November 1978 through October 1980) collected at the onsite meteorological installation. The 61-m (200-ft) meteorological tower is located 1 km (0.6 mi) west-southwest of Unit 2. A full description of the meteorological installation is given in Section 2.3.3.

The analysis of regional meteorology for the Nine Mile Point area is based on data from the Syracuse NWS first order station at Hancock International Airport, 58 km (36 mi) southeast of the site. This station provides both representative long-term data for the region and meteorological data concurrent with the onsite period of record.

The other first order NWS stations in upstate New York are listed with the approximate distances from Nine Mile Point in Appendix 2B, Table 2B-1.

The representativeness of the meteorological data from the site tower and from the Syracuse NWS station to that over the long term at Nine Mile Point has been demonstrated by comparing the extremes and distributions of the key meteorological parameters. The differences between the data sets have been assessed to assure that the onsite and/or long-term data set reasonably represents the conditions that would be expected over the approximate 40-yr life of the plant.

The assessment uses the onsite data set for the 5-yr period and either the concurrent Syracuse NWS data or the Syracuse long-term climatological records. In addition, studies on this site and another nearby site (New Haven) support the reasonableness of the Syracuse NWS data for comparison purposes(6,7).

2.3.2.1 Data Sources

Meteorological data collected at the Nine Mile Point tower from January 1, 1974, through December 31, 1976, and November 1, 1978, through October 31, 1980, compose the onsite data base. This 5-yr data set includes the latest annual cycle of meteorology.

Table 2B-2 lists the 5-yr data availability for each meteorological parameter with the incorporation of appropriate backup data. The substitution of backup data is limited to wind directions at the three tower levels. Concurrent Aerovane wind direction data from the 30-m (100-ft) and 61-m (200-ft) levels are interchanged in all summaries, if either is missing. Since there are two instruments at the 9-m (30-ft) level, the Aerovane direction is substituted in all distributions when the Climatronics vane direction is missing.

The data recovery for the short- and long-term diffusion calculations is, therefore, improved with the substitution of wind directions and meets the 90-percent recovery recommended in RG 1.23. The joint data recovery for the 61-m (200-ft) level wind and the 61-8m (200-27 ft) delta temperature is 96.2 percent for the 5-yr period as computed from Table 2B-5. The short-term diffusion calculations which use the 9-m (30-ft) level wind and the 61-8m (200-27 ft) delta temperature have a data recovery calculated from Table 2B-3 of 97.1 percent.

The 5-yr finalized data set, prior to any substitutions, has 9 time periods when the individual parameters used in the dispersion calculations are missing for more than 120 consecutive hours. These time periods are listed in Table 2B-2A along with the reason why the parameter is missing. Table 2B-2B lists the time periods longer than 120 consecutive hours after modification of the data set with the direction substitutions previously discussed when each of the parameters used in the diffusion calculations is missing.

The Syracuse NWS data concurrent with the onsite data have been obtained from the National Climatic Center in several publications(3,29,30). Summaries of the Syracuse NWS data over extended time periods of 10 yr or more have also been obtained from the National Climatic Center(3,31).

2.3.2.2 Normal and Extreme Values of Meteorological Parameters

This section presents onsite meteorological summaries of the 5-yr data base for wind, stability, temperature, precipitation, and atmospheric moisture variables. These variables are summarized for the entire period as well as monthly.

Wind direction, speed, and stability distributions for the onsite concurrent period, as well as long-term time periods, are also presented for the Syracuse NWS station. In addition, the climatological distributions of those meteorological variables that are not routinely monitored at the site are summarized, based upon long-term climatological data.

2.3.2.2.1 Wind Direction and Speed

Onsite wind measurements are made at three heights on the tower, 9 m (30 ft), 30 m (100 ft), and 61 m (200 ft). Annual wind direction and speed distributions have been computed by atmospheric stability class according to the classification system recommended in RG 1.23. These distributions are used in the diffusion models discussed in Sections 2.3.4 and 2.3.5 and are presented in Tables 2B-3 through 2B-5. In addition to the seven stability class wind direction and speed distributions, a summary for all stabilities and a summary independent of stability are presented for each level directly following the individual stability distributions. Monthly distributions of wind direction and speed by atmospheric stability for each level are given in Tables 2B-6 through 2B-8 for the 9-m (30-ft), 30-m (100-ft), and 61-m (200-ft) levels, respectively.

A summary of the annual wind direction distributions independent of stability for the three tower levels is presented in Table 2B-9. These frequency distributions are extremely similar. The annual sector frequencies show differences of less than 2.2 percent between any two levels with two-thirds of the comparisons having less than a 1.0-percent difference. The predominant wind directions at all three levels are from the southeast, south-southeast, south, west-southwest, and west.

The Syracuse NWS wind direction and speed distributions are categorized by atmospheric stability class devised by Pasquill and modified by Turner in the STAR program(32). The STAR program distributions are tabulated for the concurrent onsite data period (January 1974 through December 1976 and November 1978 through

October 1980) in Table 2B-10(29). The all-stability distribution is bimodal with a primary peak in the west-southwest through west-northwest sectors and a secondary peak in the east sector. A summary of the wind direction frequencies for the 5 yr is compared with the onsite wind direction frequencies in Table 2B-11.

Although the onsite and NWS concurrent data are reasonably similar, there are some differences worth noting. The Syracuse NWS records for the concurrent time period, as well as the 10-yr climatologies also presented in this table, show a higher frequency of winds from the east-northeast and east compared to the site(29,33). However, the site distributions show a considerably higher frequency of winds from southeast and south-southeast. The frequencies in all other sectors at the site are within 4 percent, and most are within 2 percent of the concurrent and long-term records at Syracuse. The higher frequency of calms for the concurrent and 1965 through 1974 periods are expected at Syracuse due to its inland location compared to the exposed shoreline location of the site.

The earlier long-term data set shows that the west-southwest through northwest winds have the highest frequencies of occurrence. However, the 1965 through 1974 data set shows the wind direction frequencies are bimodal, with peak frequencies in the west-southwest through west-northwest and east sectors. Both data sets show the north-northeast and northeast sectors have the lowest frequencies of occurrence.

Onsite monthly average wind speeds from the three tower levels are summarized in Table 2B-12. The highest average wind speeds occur during the winter, while the lowest average wind speeds predominate in the summer months. The higher wind speeds measured at the tower usually occur with west-southwest through northwest winds. The maximum hourly wind speed measured during the 5-yr period was 22 m/sec (49 mph) at the 9-m (30-ft) level, 25 m/sec (55 mph) at the 30-m (100-ft) level, and 29 m/sec (64 mph) at the 61-m (200-ft) level.

The monthly average wind speed distributions presented in Table 2B-12 for the onsite data and Table 2B-13 for the long-term Syracuse NWS data are very similar. Both locations report higher average wind speeds during the winter and spring months, about 4.9 m/sec (11 mph), while the summer months record the lowest seasonal wind speeds. Annual mean wind speeds at the two locations are within 0.5 m/sec (1 mph) of each other at a height of about 10 m (30 ft).

2.3.2.2.2 Wind Direction Persistence

Wind direction persistence at the Nine Mile Point site has been analyzed using a technique that determines the number of consecutive hours during which the wind direction at a given level remains within the same 22 1/2-deg sector. This analysis is performed using a sliding technique so that the longest persistence is obtained incorporating a given hour. The results are summarized in tabulations of the number of times the wind direction at each level remains in the same sector for various time periods ranging from 2 to 3 hr to longer than 48 hr.

The 5-yr annual summary of wind direction persistence is given in Tables 2B-14 through 2B-16 for the three tower levels.

The wind persistence distributions in these tables are categorized by stability in addition to those independent of stability. The unstable and neutral classes are combined as well as the slightly to very stable classes. The stability is defined in accordance with RG 1.23 and is based on the 61-8 m (200-27 ft) temperature difference measured on the tower.

These tables indicate that unstable and neutral conditions are more frequently associated with wind persistence of longer than 12 hr in duration. Numerous cases in all sectors and stabilities are associated with shorter persistence periods. The predominant wind sectors at the 61-m (200-ft) level show the highest frequencies of persistence. However, during the 5 yr, all three levels recorded one or two cases of wind direction persistence between 37 and 48 hr in duration.

The combined monthly distributions of persistence by level are presented in Tables 2B-17 through 2B-19. The monthly summaries for the 5 yr indicate no significant differences in persistence frequency throughout the year. The highest frequencies of upper-level persistent winds of 12 hr or more in length occur during January, May, November, and December.

2.3.2.2.3 Atmospheric Stability

Determinations of atmospheric stability are made from the temperature difference measured between the 61-m (200-ft) and the 8-m (27-ft) levels of the onsite tower. These temperature difference data are grouped into seven stability classes (A through G) according to the NRC lapse rate criteria of RG 1.23.

Monthly and annual summaries of atmospheric stability have been incorporated into the wind roses previously presented in Tables 2B-3 through 2B-8. The onsite distribution of atmospheric stability for the 5-yr record is summarized in Table 2B-20.

The temperature difference scheme classifies 51 percent of the hours as unstable-neutral (Pasquill Classes A through D) and 49 percent of the hours as stable (Pasquill Classes E through G).

Table 2B-20 also shows the Syracuse stability distributions for the concurrent onsite data period as well as the long-term 1955 through 1964 record. The Syracuse NWS stability is determined from the STAR program methodology consistent with Turner's scheme(32). The stability distributions in Table 2B-20 are different because differing techniques are used to determine atmospheric stability and because of the influence of Lake Ontario. Differences between measurement technique (temperature difference method for onsite data and the STAR method for the Syracuse data) have been documented in several papers(34,35).

Only the unstable group (Classes A, B, and C) shows reasonably good agreement between data sets. Lake Ontario also influences stability differences by creating more inversions at the site than at Syracuse. This effect is described in the next section.

2.3.2.2.4 Temperature Inversions

Monthly and annual summaries of the frequency of temperature inversions at Nine Mile Point are presented in Table 2B-21.

A temperature lapse rate of greater than 0°C/100 m, corresponding to 0°F/1,000 ft, defines inversion conditions based on the 61-8 m (200-27 ft) temperature difference. Strong inversions with lapse rates greater than 1.5°C/100 m, corresponding to 8.2°F/1,000 ft, Pasquill Classes F and G, are also tabulated in this table.

These inversions are associated with nocturnal cooling or cooling of the lower atmospheric layer by Lake Ontario’s influence from spring through fall. The higher frequency of inversions, by a factor of 2, from May through October is clearly evident from this table for all inversions, as well as the strong inversions compared to the other months. May has the highest frequency of temperature inversions, occurring almost 50 percent of the hours, while December has inversions only 15 percent of the time. Annually, temperature inversions are present at the site about one-third of the time.

Table 2B-22 summarizes the persistence of temperature inversions by month as well as for the overall 5-yr period. Temperature inversions with lapse rates greater than 1.5°C/100 m, corresponding to 8.2°F/1,000 ft, did not occur in any month for longer than 24 consecutive hours. Temperature inversions rarely last over 48 hr in length and average less than two cases per year longer than 36 hr.

2.3.2.2.5 Mixing Heights

No measurements of mixing height are made at the Nine Mile Point site. The two nearest NWS upper air stations, both over 160 km (100 mi) away, are located at the Albany County and the Greater Buffalo International Airports. Therefore, in the absence of onsite measurements, and a definitive determination of which NWS station is the most representative, the mean seasonal, as well as annual, morning and afternoon mixing heights reported by Holzworth are shown in Table 2B-23(22). These data are extracted from the plots in the Holzworth report, and are the best climatological approximations available for mixing heights at Nine Mile Point. Holzworth employs the Albany and Buffalo mixing height climatologies in his analysis. The resultant mean seasonal heights for both stations are also presented in this table.

2.3.2.2.6 Temperature

The onsite monthly and annual means and extremes of temperature are summarized in Table 2B-24. February had the lowest mean monthly temperature of -5°C (23°F), and July had the highest mean monthly temperature of 19°C (67°F). The overall maximum hourly temperature at the site was 32°C (89°F), recorded on July 15, 1979. The lowest hourly temperature during the period was -27°C (-16°F), recorded on February 18, 1979.

Monthly and annual frequency distributions of the temperature data are shown in Table 2B-25. These distributions demonstrate that larger temperature ranges exist during the winter months, compared to the relatively small temperature ranges of the summer months. Annually, temperatures below -18°C (0°F) occur less than 0.5 percent of the time, and temperatures above 27°C (80°F) occur less than 1.0 percent of the time.

The diurnal range of hourly temperatures for the period is summarized in Table 2B-26. The average temperature for each hour of the day is listed on an annual and monthly basis.

The amplitudes of the annual and diurnal temperature cycles at Nine Mile Point are less than those found at Syracuse due to the moderating effect of Lake Ontario. The thermal inertia of the lake serves to cool the site during the spring and summer and, conversely, warm the site in the autumn and winter. Table 2B-27 compares the monthly and annual mean temperatures at the site and Syracuse for the 5-yr onsite data period.

This table confirms the tendency that summer temperatures at the site are slightly lower than at Syracuse. Specifically, the maximum temperature at the site was 3°C (5°F) cooler than that at Syracuse, while the minimum temperature at the site was 6°C (10°F) warmer. During this concurrent period, the mean monthly temperatures at the site, except for December, were cooler than that at Syracuse. The largest difference in mean temperatures occurred in May and was 3.4°C (6.1°F).

Table 2B-28 lists the Syracuse NWS long-term temperature means and extremes. These means are quite similar to the concurrent 5-yr period mean temperatures measured at Syracuse. The long-term extreme temperatures are comparable to those measured during the 5-yr period.

2.3.2.2.7 Precipitation

Onsite precipitation measurements are summarized monthly for the five 1-yr periods as well as annually in Table 2B-29. Combined monthly and the overall precipitation distributions for the 5 yr are also tabulated in Table 2B-30. The hourly measurements are categorized by the amount of water-equivalent precipitation which fell during each hour. In addition, maximum hourly, daily, and monthly total precipitation amounts are highlighted in the summarizations.

The maximum hourly precipitation recorded at the site was 5.08 cm (2.00 in) on October 5, 1979. During the same month, the maximum daily and 24-hr amounts of 14.99 cm (5.90 in) and 16.10 cm (6.34 in) were recorded. The maximum monthly precipitation of 26.97 cm (10.62 in) fell in July 1974. Table 2B-31 lists the maximum water-equivalent precipitation measured at the site over various time periods during the 5 yr.

During the 5-yr period, the summer and fall months were generally wetter than the spring and winter months. The precipitation intensity was generally light. More than 75 percent of the recorded precipitation hours during the 5 yr occurred at rates of less than or equal to 0.25 cm/hr (0.10 in/hr).

The duration of precipitation and the accumulated amounts are shown in Tables 2B-32 and 2B-33 as frequency distributions by month and for the entire 5-yr period. The majority of precipitation events last less than 6 consecutive hr. However, there were six cases of precipitation lasting between 12 and 23 consecutive hours during the 5 yr.

Those hours with precipitation are distributed by wind direction and speed recorded at the three tower levels and categorized by precipitation rates. In addition, all precipitation hours are grouped into frequency distributions by wind speed and direction. Eight hourly rate categories are used and range from the smallest amounts equal to 0.03 cm (0.01 in) to the largest amounts exceeding 2.54 cm (1.00 in). Tables 2B-34 through 2B-36 present the distributions for the entire period and Tables 2B-37 through 2B-39 list the combined monthly distributions.

These distributions indicate that southeasterly flow is more often associated with higher precipitation rates than the other wind direction sectors. Furthermore, east-southeast through south winds are associated with the highest frequencies of precipitation with a secondary maximum associated with west-southwesterly and westerly flows.

A comparison of the onsite and Syracuse precipitation extremes during January 1974 through December 1976 and November 1978 through October 1980 reveals that the onsite extremes are greater than those at Syracuse. The 1-hr, 24-hr, and 1-month maximum precipitation totals are shown in Table 2B-40.

The maximum 24-hr and monthly precipitation totals measured at the Syracuse NWS for the period of record 1902 to 1980 are 12.17 cm (4.79 in) and 40.44 cm (15.92 in), respectively. Both of these occurred in June 1922. The monthly maximum significantly exceeds the maximum measured at the site. However, the 24-hr total falls short by 32 percent.

The monthly and annual means, along with the monthly extremes and 24-hr maximums, of precipitation at the Syracuse NWS station are given in Table 2B-41. The mean monthly precipitation totals are fairly uniform through the year ranging from a minimum of 6.81 cm (2.68 in) in January to a maximum of 8.89 cm (3.50 in) in August. The mean annual total precipitation for the 1941 through 1970 period was 92.48 cm (36.41 in).

These long-term climatological means compare favorably with those measured at the site and shown in Table 2B-30.

Since snowfall is not measured at the site, the Syracuse NWS records are presented. Monthly and annual means, and the monthly and 24-hr maximum snowfall are given in Table 2B-42. January had the highest mean monthly snowfall of 70.6 cm (27.8 in). The maximum monthly snowfall of 184.4 cm (72.6 in) occurred in February 1958. The maximum 24-hr snowfall of 62.2 cm (24.5 in) was recorded in January 1966.

2.3.2.2.8 Atmospheric Moisture

Onsite summaries of atmospheric moisture content are compiled from the 1974 through 1976 tower data. These include relative and absolute humidity, as well as dew point temperature. These summaries are obtained by using the derived temperature at 61 m (200 ft) and the 61-m relative humidity. The dry-bulb temperature at 61 m is calculated by adding the 61-8 m (200-27 ft) temperature difference to the 8-m (27-ft) temperature. No variable substitutions are used in the generation of any of the moisture summaries, as data recovery for the 61-m (200-ft) relative humidity is over 99 percent for the 3-yr period (1974-1976). Table 2B-42A tabulates the monthly relative humidity data recoveries at the 61-m (200-ft) and 9-m (30-ft) levels for the period January 1974 through December 1976.

Relative Humidity

The monthly and annual means and extremes of onsite relative humidity are given in Table 2B-43. There is very little variation in the monthly mean relative humidities. The lowest monthly mean value, 67 percent, occurs in March, April, and October; the highest mean value is 75 percent in January and December. The lowest hourly relative humidity, 11 percent, occurred during April 1974.

Onsite monthly and annual frequency distributions of relative humidity are shown in Table 2B-44. The annual frequency distribution shows 13.4 percent of the hourly relative humidities were greater than or equal to 90 percent, with less than 1 percent of the relative humidities under 30 percent. The monthly frequency distributions show a slight tendency towards higher relative humidities during the winter. April has the highest frequency of low relative humidities.

The diurnal ranges of relative humidity on a monthly and annual basis are presented in Table 2B-45. These summaries show that the highest relative humidities occur during the morning hours around the time of sunrise. The minimum relative humidity values are recorded during the afternoon hours.

The mean annual and monthly relative humidities at Nine Mile Point, listed in Table 2B-45, and Syracuse, listed in Table 2B-46, are compatible when the difference in measurement heights is taken into consideration. The Nine Mile Point data are measured at 61 m (200 ft), while the Syracuse NWS measurements are made at 2 m (5 ft).

The Nine Mile Point mean relative humidity values at 0100, 0700, and 1900 local time are generally lower than those at Syracuse, while the 1300 local time values are higher than at Syracuse.

Absolute Humidity

Absolute humidity is summarized into monthly and annual means and extremes in Table 2B-47. Frequency distributions of absolute humidity are given in Table 2B-48. Absolute humidity is defined as the ratio of the mass of water vapor present to the volume occupied by the mixture, the density of the water vapor component(8). The maximum absolute humidity of 20.3 g/cu m (8.9 grains/cu ft) occurred in August, and the minimum of 0.5 g/cu m (0.2 grains/cu ft) in January. The maximum annual frequency distribution is skewed toward the lower absolute humidity categories. There is also a large seasonal variation of absolute humidity, as the monthly distributions show. This is expected since the ability of air to hold water vapor is temperature dependent. Warmer air can hold more water vapor than cold air. Table 2B-49 shows there is very little diurnal variation of absolute humidity within each month.

Dew Point Temperature

The means and extremes of dew point temperature are shown in Table 2B-50. The highest dew point temperatures occur during the summer, with the overall maximum hourly dew point of 23°C (73°F) being recorded in August. The overall minimum hourly dew point temperature of -27°C (-16°F) occurred in January.

The monthly and annual frequency distributions of dew point temperature are given in Table 2B-51. On an annual basis, only 2.8 percent of the hours recorded had dew point temperatures greater than or equal to 18°C (65°F), and 3.8 percent of the hours had dew point temperatures less than or equal to -18°C (0°F).

Table 2B-52 shows the monthly and annual diurnal range of dew point temperature. There is very little diurnal variation of the dew point temperatures within each month.

In addition, dew point temperatures were measured from November 1978 through October 1980. Table 2B-52A lists the data recovery for these monthly dew point temperatures.

2.3.2.2.9 Fog and Haze

At Syracuse, between 1965 and 1974, fog (visibility less than 11.2 km [7.0 mi]) occurred on an average of 113 days/yr and is rather evenly distributed throughout the year with the exception of a slight relative minimum in late winter(31). Heavy fog (visibility less than or equal to 0.40 km [0.25 mi]) is infrequent, however, occurring on an average of only 9 days/yr.

Haze and/or smoke are reported on an average of 91 days/yr(30). Most of these days are between June and September and are associated with stationary high pressure systems over the eastern U.S.

Table 2B-53 presents the monthly and annual summary of fog, haze, and/or smoke for Syracuse.

2.3.2.2.10 Hourly Data Tape

The validated meteorological data set has been copied to magnetic tape for the 5-yr period: January 1, 1974, through December 31, 1976, and November 1, 1978, through October 31, 1980. The format and content of the onsite, hourly meteorological data tape are listed in Table 2B-54. This tape has been forwarded directly to the NRC.

2.3.2.3 Potential Influence of the Plant and Its Facilities on Local Meteorology

The natural-draft cooling tower planned for use at the Unit 2 site is expected to provide the only plant effluents capable of influencing local meteorology. The effluent types of concern are commonly described as visible plumes and cooling tower drift. Each of these effluent types and their impacts on local weather are described in the following sections.

2.3.2.3.1 Visible Plume Occurrence

Ambient air becomes heated and moisture-laden when induced through natural-draft cooling towers. This air is discharged from the towers as a plume, which occasionally may be visible. The frequency of visible plume occurrence and its extent depend on the meteorological conditions existing at the time and the design and physical parameters of the tower.

A mathematical model, using as input simultaneous observations of wind speed, wind direction, ambient dry-bulb temperature, ambient wet-bulb temperature, and relative humidity, was used to determine the configuration and the extent of visible plumes from the natural-draft cooling tower at the Unit 2 site. Onsite meteorological data for the period January 1, 1974, through December 31, 1976, was used for the visible plume predictions. The mathematical model used in this analysis is described in detail in Appendix 2C.

The results of these model predictions are illustrated on Figures 2.3-1 through 2.3-25, which depict the frequency of occurrence of various plume extents in each of the four primary wind direction quadrants for each season of the year and for the entire 3-yr period. These contours do not represent individual plume outlines, but the combination of many individual plumes in order to show the maximum horizontal and vertical extent of the visible plume for each given frequency of occurrence. As can be seen from these figures, the visible plume rarely (<0.2 percent) descends below heights of 91 m (300 ft) aboveground. In 90 percent of the cases, plumes do not extend beyond 1,372 m (4,500 ft). The plume remains aloft because it is initially injected into the atmosphere at a height of approximately 165 m (541 ft) with an exit velocity of 3.0 to 6 m/sec (10 to 20 ft/sec) and it is buoyant because its temperature exceeds that of the ambient air. Occurrences of visible plumes below the height of the tower are due to strong winds and the associated tower-induced turbulence in the wind field. As can be seen from Figure 2.3-25, less than 1 percent of the visible plumes fall below the tower height at a distance of 762 m (2,500 ft) or greater.

2.3.2.3.2 Ground Level Fogging and Icing

Since the visible plume rarely descends below heights of 91 m (300 ft) aboveground, and does not impinge the ground surface, it will not contribute to ground fogging or icing. In addition, ground icing due to cooling tower drift was assessed and found to be of little consequence. This conclusion was based on the results of the modeling analysis presented in Section 2.3.2.3.1 in which a maximum annual surface accumulation of water due to drift was estimated to be 0.08 mm (0.003 in). Assuming that this entire accumulation of water occurred during freezing conditions, it is still an insignificant amount compared with a light ice storm which is defined as one that deposits less than 2.5 mm (0.1 in) of ice per hour(36). Therefore, no significant impacts to highway or lake traffic are expected.

2.3.2.3.3 Cooling Tower Drift

When the heated circulating water falls through the fill section of the cooling tower, small water droplets are entrained by the relatively high velocity of the air flowing through the tower. The entrained water droplets, called cooling tower drift, are carried from the tower and, subsequently, fall to the ground downwind from the tower.

In order to determine the environmental effects of the cooling tower drift, a mathematical model was developed to determine the downwind distribution of salt and water deposition and the airborne salt concentration resulting from cooling tower operation. A detailed description of the model and results is contained in Appendix 2D. The model takes the following into account:

2. Configuration and performance of the towers.
2. Drift rate.
3. Exit velocity.
4. Total dissolved solids (TDS) level.
5. Droplet size distribution.
6. Evaporation rate.
7. Plume buoyancy.
8. Wind speed.
9. Wind direction.
10. Wet-bulb temperature.
11. Relative humidity.

The maximum amount of drift leaving the cooling tower is assumed to be 0.002 percent of the circulating water flow through the tower. Monthly average TDS concentrations in the blowdown and 3 yr of onsite, hourly average meteorological data (January 1, 1974, through December 31, 1976) were used as input to the salt drift model. Since actual TDS levels in the cooling tower are approximately 2 times higher than those assumed in the drift model, salt deposition and airborne salt concentration results presented in this section and on Figures 2.3-26 and 2.3-28 through 2.3-39 are correspondingly low.

The meteorological input data used in the model consisted of wind speed, wind direction, dry-bulb temperature, wet-bulb temperature, and relative humidity at the 61-m (200-ft) level. The difference between the dry-bulb temperature at 61 m (200 ft) and at 8 m (27 ft) (ΔT) was also used. Normally, the low-level relative humidity would be used to determine tower performance, but due to the large amount of missing data for this parameter, the upper level relative humidity was chosen. A comparison of the relative humidities at these two levels showed an average difference of only 4.6 percent, which has little effect on the salt drift model results. The results of a sensitivity test of the drift model to relative humidity, using 1 month (December 1974) of meteorological data, showed an 11-percent decrease in the maximum salt deposition rate and an 8.7-percent decrease in the maximum water deposition rate by using the 61-m (200-ft) relative humidity in place of the 9-m (30-ft) relative humidity.

There was also a substitution of the 30-m (100-ft) wind direction when the 61-m (200-ft) wind direction was missing to ensure that a high percentage of data was used. This practice does not significantly affect the salt drift results because of the very small changes in wind direction with height between these levels.

Average annual salt deposition rates in lb/acre/yr are shown on Figure 2.3-26. The maximum salt deposition rate was predicted to be 0.03 g/sq m/yr (0.27 lb/acre/yr), occurring approximately 2,000 m (6,562 ft) northwest of the tower. This location is over water. The maximum salt deposition rate predicted to occur over land is 0.011 g/sq m/yr (0.099 lb/acre/yr) at a distance approximately 990 m (3,248 ft) west-southwest of the tower.

Figure 2.3-27 presents annual water deposition rates in lb/acre/yr with a maximum value of 77.4 g/sq m/yr (690.6 lb/acre/yr) occurring 2,000 m (6,562 ft) northwest of the tower. This amount corresponds to 0.08 mm (0.003 in) of water per year.

Average monthly salt deposition rates in lb/acre/month are shown on Figures 2.3-28 through 2.3-39. Monthly and seasonal water deposition rates are not shown because the maximum annual amount of 0.08 mm is insignificant compared to annual precipitation at the site.

In addition to the drift deposition rates, airborne salt concentrations at ground level were also calculated. The maximum annual average airborne salt concentration was predicted to be 0.83×10^{-6} mg/cu m (5.18×10^{-14} lb/cu ft) at a distance of 2,400 m (7,874 ft) northwest of the tower, and the highest value over land is predicted to be 0.56×10^{-6} mg/cu m (350×10^{-14} lb/cu ft) at 1,067 m (3,500 ft) south of the tower. A value of 1.22×10^{-3} mg/cu m (7.62×10^{-11} lb/cu ft) was predicted for the maximum hourly airborne salt concentration which occurs over the lake at a distance of 500 m (1,640 ft) west-northwest from the tower. The maximum hourly airborne salt concentration over land is predicted to be 1.19×10^{-3} mg/cu m (7.43×10^{-11} lb/cu ft) at a distance of 1,067 m (3,500 ft) west-southwest of the tower.

2.3.2.3.4 Cloud Development and Cloud Shadowing

The extent to which natural-draft cooling tower plumes contribute to cloud formation can be qualitatively assessed based on observational studies conducted at three operating natural-draft cooling tower sites(37). At each of these sites, cooling tower plumes were observed to occasionally cause broken cloud decks to become overcast and to make thin clouds thicker. Separate cloud formations were sometimes observed to result from visible plume formation from the cooling towers but usually at altitudes of several thousand feet aboveground. Based on the above observations, the potential for increased cloud development due to cooling tower operation appears to be minimal compared to the potential for development due to natural causes.

The impact of plume shadowing depends highly on the extent and duration of visible plume formation. The results of the analysis presented in Section 2.3.2.3.1 provide a quantitative assessment of the configuration and frequency of occurrence of visible plumes resulting from the operation of the Unit 2 tower. Figure 2.3-25 indicates that any shadowing effects of the visible plumes on the region would be very localized, with less than 10 percent of the plumes extending beyond a mile from the tower which, for the most part, is land owned by NMPNS or Entergy Nuclear FitzPatrick, LLC. In this light, it is highly unlikely that cooling tower plume shadowing would have an adverse impact on any offsite locations.

2.3.2.3.5 Vapor Plume Interaction

There are no significant sources of pollutants within the immediate vicinity of the Unit 2 site to interact with the vapor plume from the natural-draft cooling tower. As can be seen on Figures 2.3-1 through 2.3-25, the predicted vapor plume infrequently extends beyond 1.6 km (1 mi) from the cooling towers.

2.3.2.3.6 Humidity Increases

The amounts of moisture emitted from cooling towers may contribute to visible plume formation and also may increase ambient ground-level relative humidities, even if the plume remains aloft. In order to evaluate the potential augmentation of ambient relative humidities due to cooling tower operation, a mathematical diffusion model, which incorporates tower-specific information and onsite meteorological data, was developed. A detailed description of this model is provided in Appendix 2E.

The model described above was used to determine relative humidity increases due to the operation of the Unit 2 natural-draft cooling tower. Using tower-specific information on evaporation rate and other performance characteristics, along with local topographic information, the model was run with a 3-yr onsite meteorological data base (1974-1976) to arrive at long- and short-term increases in relative humidity as a function of distance and direction from the tower. The results of this model run are presented in Table 2.3-3, which contains maximum hourly, daily, monthly, and annual average increases in ground-level relative humidity for each 22.5-deg sector from the tower. This table also includes the average ambient diurnal changes in relative humidity at the site as a basis for comparison. The projected maximum 1-hr relative humidity increase of 3.3 percent points out the insignificant impact of the cooling tower when compared with the diurnal fluctuations of relative humidity. The reason for such a small increase can be related to the large discharge height of the cooling tower (165 m, 541 ft) which allows the moisture to effectively disperse before reaching the ground. Therefore, no significant humidity changes are expected from this cooling tower.

2.3.2.3.7 Topography

The Nine Mile Point site is a generally flat, featureless plain located on the south shore of Lake Ontario. The site area land elevation ranges from 79 m (260 ft) above mean sea level (AMSL) at the Station area to 94 m (310 ft) AMSL at the southern extremity, about one mile distant. The terrain rises gradually from the site, reaching an elevation of 305 m (1,000 ft) AMSL approximately 30 km (19 mi) east of the site. A terrain elevation of 610 m (2,000 ft) is reached at a distance of approximately 80 km (50 mi) east of the site.

A map showing the topographic features of the site within a 5-mi radius is shown on Figure 2.3-41. A smaller scale map showing topographic features within a 50-mi radius of Unit 2 and plots showing the maximum topographic elevation versus distance from the center of the plant are shown on Figures 2.3-42 and 2.3-43 through 2.3-46, respectively.

2.3.2.4 Local Meteorological Conditions for Design and Operating Bases

There are no significant differences between the local meteorology in the vicinity of the site and the regional climatology of central New York State that would influence conditions for design and operating bases.

2.3.3 Onsite Meteorological Measurements Program

2.3.3.1 Preoperational Measurements Program

2.3.3.1.1 Description

An onsite meteorological tower is in operation at Nine Mile Point to provide accurate documentation of the local meteorological conditions. The facility began test operations in December 1973, and has been in routine operation since January 1974. The program provides meteorological data to develop transport and diffusion estimates for use in assessing accidental and routine releases of radioactive material to the atmosphere.

The meteorological tower is steel open-lattice construction and is located approximately 1.0 km (0.6 mi) west-southwest of Unit 2 near the shore of Lake Ontario, as shown on Figure 2.3-40.

The tower is 61-m (200-ft) high and instrumented at three levels; 9 m (30 ft), 30 m (100 ft), and 61 m (200 ft). Wind speed and direction are measured at all three levels. Ambient air temperature is measured at 8 m (27 ft). Temperature differences are measured between 8 m (27 ft) and 30 m (100 ft), and between 8 m (27 ft) and 61 m (200 ft). Relative humidity was originally measured at 9 m (30 ft) and 61 m (200 ft). Since June 1978, a dew point system has operated at the 8-m (27-ft) level, replacing the two relative humidity measurements.

In addition to the measurements on the tower, barometric pressure and precipitation are also recorded at appropriate locations near the base of the tower.

2.3.3.1.2 Instrument Siting

The tower is located in terrain characteristic of the area and at approximately the same elevation as finished plant grade. The area around the tower is level, clear of underbrush, and covered with bluestone. The terrain is predominantly flat throughout the area and in the vicinity of the tower.

The wind and temperature instruments are located on booms that are extended southwest from the tower. Wind instruments are located above the booms, with the majority of the instrumentation selected for its durability rather than extreme sensitivity, commensurate with the exposure and meteorology of the site. Temperature and dew point instruments are mounted under the booms.

Processing instrumentation is located in a temperature-controlled instrument shelter approximately 23 m (75 ft) from the base of the tower.

2.3.3.1.3 Meteorological Instrumentation

Performance Specifications

The instrumentation systems installed at Nine Mile Point were designed to meet the NRC requirements at the time of installation and they generally meet those of RG 1.23. The only deviation from RG 1.23 is described in the following section entitled Bendix Aerovanes.

The manufacturers' specifications for all the sensors and associated equipment are shown in Table 2.3-4. Deviation from Paragraph C4 of RG 1.23 is discussed and justified in the following sections on each type of measurement. System accuracies are computed and shown in Table 2.3-5.

Wind Instruments

Bendix Aerovanes Bendix Model 120 Aerovanes are used at each of the three tower levels for wind speed and direction measurements.

The Aerovane is a dual-purpose instrument that combines wind speed and wind direction measurement. Wind speed is measured by a rotor that drives a dc magneto that generates a voltage directly proportional to wind speed. The synchro motor mounted in the vane housing transmits the vane position to a synchro to dc converter.

The Bendix Aerovane does not meet the starting threshold speed suggested in RG 1.23. This presents no problem because actual calm conditions with absolutely no airflow are extremely rare. Measured calms can be more frequent, depending on the threshold speed of the instrument. At Nine Mile Point, the redundant instrumentation at the 9-m (30-ft) level permits a comparison of the frequency of calms recorded by the Aerovane and the Climatronics anemometer. During the 5-yr period, the low-level Aerovane recorded 1,198 and the light wind instrument 165 calm hours. Both of these frequencies are low, as are the frequencies of calms at the higher elevations on the tower (about 0.4 percent).

Experience with both types of instruments indicates that the continued durability and accuracy of the Aerovane far outweighs the advantage of the slightly lower threshold speed offered by the light wind instruments in this rugged climate.

Climatronics F-460 Vane and Anemometer In addition to the Aerovane at the 9-m (30-ft) level, a Climatronics F-460 vane and anemometer are mounted on the boom. The anemometer is the three-cup type using a light beam chopper. The vane employs a precision potentiometer.

Temperature

The ambient and difference temperature systems use thermistor sensors in Climatronics Model TS-10 aspirated temperature shields. The electrical resistance of the thermistor elements is inversely proportional to temperature.

Relative Humidity

Relative humidity was measured until June 1978 at the upper and lower levels of the tower using Xeritron humidity sensors. These are assemblies of organic and inorganic crystals that sense moisture by the hygromechanical stress of a small cellulose crystallite structure acting on a pair of thermally matched unbonded silicon strain gauges connected as a half Wheatstone bridge.

Dew Point

Dew point has been measured since June 1978 by an EG&G Model 220 dew point sensor. The dew point temperature measurement is made with a direct-measuring sensor utilizing a Peltier-cooled gold-surfaced mirror, automatically held at the dew point temperature by a photo-sensing, condensate-detecting, optical system incorporating a solid state LED light source and direct and bias photo detectors. The mirror temperature, if above freezing, measures the true dew point temperature and, if below, measures the frost point temperature. The temperature is measured by an embedded linear thermistor sensor.

Precipitation

Precipitation is measured with a Weathermeasure P511E rain gauge designed to indicate when a predetermined amount of precipitation has fallen. The precipitation can be either liquid or solid form. When the liquid content in one of the two buckets is equal to the preset amount, the bucket tips, causing a mercury switch to make momentary contact. Each tip of the bucket indicates that a preset calibration increment of precipitation has fallen.

Solid forms of precipitation are melted by electric heaters in the base and in the outer case of the instrument.

2.3.3.1.4 Methodologies

Recording and Processing of Meteorological Sensor Output

Digital Recording System The primary recording system is a John Fluke Company Model 2240B data logger and Kennedy Company Model 1600/360 incremental magnetic tape recorder. These instruments form an integrated data conversion and recording system that converts the output of the modular translator system to digital code and records the digital data on the incremental tape recorder.

Strip Chart Recorders The secondary method of recording is by analog strip chart. The Bendix Aerovane wind direction and speed are recorded on Leeds and Northrup Model 880 dual-channel strip chart recorders. Their accuracy is ±0.5 percent of span and their response time is 1 sec(38).

Dew point temperature is recorded on a Leeds and Northrup Model H multipoint strip chart recorder. The accuracy of the recorder is ±0.3 percent of span and the step-response-time is 1 sec(38).

Precipitation is recorded on a Weathermeasure Model P521 event recorder. Each time the rain gauge bucket tips, an event mark is recorded indicating that 0.25 mm (0.01 in) of precipitation has been collected.

Sensor Signal Processing The outputs of all sensors are processed by a modular translator system designed to convert the sensor outputs into a standardized voltage/current output for recording. Each input channel is allotted a circuit card designed for a particular sensor, such as wind speed, wind direction, or temperature. The necessary signal processing and scaling are contained in each card to provide an electrical output of uniform range for recording. Each translator card has internal zero and full-scale calibration features.

2.3.3.1.5 Instrumentation Surveillance

Surveillance and calibration schedules are specified to comply with RG 1.23 recommendations. Surveillance, including inking and routine preventive maintenance, is performed at least twice weekly. Charts are changed at 2-week intervals. Calibrations occur at least every 6 months with component checks and adjustments performed when required. All meters and other equipment used in calibrations are, in turn, calibrated at scheduled intervals.

Inspection and maintenance of all equipment is accomplished in accordance with procedures in the instrument manufacturer's manuals. Inspection is carried out by qualified technicians capable of performing the maintenance, if required. The results of the inspections and maintenance performed are kept in a log.

2.3.3.1.6 Data Acquisition and Reduction

From January 1974 to October 1980, analog strip charts were changed every 2 weeks and processed. After each chart was scanned for instrument malfunctions, hourly values were read. The data were routinely keypunched on a monthly basis. After keypunch verification, a computer listing and quality control summary was generated of hourly readings. The data were again checked for inconsistencies by an instrument specialist and a qualified meteorologist. After incorporating any calibrations from site personnel, a final listing was generated. The data were then transferred to magnetic tape and a copy was made.

2.3.3.1.7 Data Analysis Procedures

All data were subject to quality control checks prior to finalization into monthly listings. At the end of each quarter, routine summaries of wind direction, speed, and stability were computed. Monthly and annual data analyses were performed as warranted for special projects in addition to the routine submittal of the data for Nine Mile Point Unit 1 to the NRC.

2.3.3.2 Operational Measurements Program

2.3.3.2.1 Description

The preoperational onsite meteorological measurements program has been upgraded and expanded to meet the intent and recommendations of RG 1.23 and NUREG-0654 for the operational measurements program(39). The preoperational, steel, open-lattice 61-m (200-ft) meteorological tower serves as the primary installation. New meteorological sensors were installed at the facility starting in July 1982 and the entire replacement was completed by February 1983. Supplemental inland measurements are obtained from instrumentation at the Oswego County Airport near Fulton. Backup instrumentation is located east of the J. A. FitzPatrick plant. A map showing the detailed relationship of Unit 2 to the primary meteorological tower and the backup tower is shown on Figure 2.3-40. Figure 2.3-40A shows the location of the inland tower, the primary tower, and the backup tower with respect to Unit 2 on a larger-scale map.

The primary tower is instrumented with wind direction and speed sensors at three levels: 9 m (30 ft), 30 m (100 ft), and 61 m (200 ft). Sigma theta is derived for each of the three wind levels. In addition, ambient temperature is measured at the 9 m (30 ft) level and temperature differences are determined between the 61-m (200-ft) and 9-m (30-ft) levels. Actual instrument elevations for these levels can be found in plant design documents(74).

Dew point temperature is obtained at the 9-m (30-ft) level. Near the base of the tower, precipitation and barometric pressure are also measured.

The inland 9-m (30-ft) meteorological tower is located with good exposure in all directions and is situated away from all runways and buildings at the Oswego County Airport. The instrumentation provides wind speed and direction from which sigma theta values are calculated.

The backup wind direction and speed instrumentation is located east of the J. A. FitzPatrick plant on a 27-m (90-ft) utility pole. Data collected coincidentally over a three-year period from the main tower and backup tower have been analyzed(72). Based upon this analysis and with an earlier study(71,73) by Meteorological Environmental Services, Inc., the backup tower measurements are in general agreement with the main tower and are adequate for use during emergency situations.

2.3.3.2.2 Meteorological Instrumentation

The operability of the meteorological monitoring instrumentation ensures that sufficient meteorological data are available for estimating potential radiation doses to the public as a result of routine or accidental release of radioactive materials to the atmosphere. This capability is required to evaluate the need for initiating protective measures to protect the health and safety of the public.

The operational meteorological measurements program is designed to meet the NRC recommendations at the time of installation in midsummer 1982 and is in accordance with RG 1.23, February 1972. Manufacturers’ model numbers and specifications for the sensors are shown in Table 2.3-4A. Component errors, as well as sensor and system accuracies, are listed in Table 2.3-5A. Accuracy requirements are in accordance with Section C.4 of proposed Revision 1 to RG 1.23 (September 1980).

Wind Instruments All monitoring locations employ the Teledyne Geotech or Met One Instruments three-cup anemometer and vane.

Temperature The ambient and temperature difference systems consist of Teledyne Geotech or Met One Instruments platinum resistance temperature devices in aspirated housings.

Dew Point The dew point temperature is measured by General Eastern chilled mirror system.

Precipitation Solid and liquid forms of precipitation are measured by a Belfort Instrument Company tipping bucket rain gauge with a heater for subfreezing operations.

Pressure A Yellow Spring Instrument Company aneroid barometer measures Station atmospheric pressure.

2.3.3.2.3 Processing, Storage, Display, and Recording of Meteorological Data

Data Processing and Storage

Digital data processing at each meteorological tower is accomplished by a remote data acquisition system (RDAS) computer. These RDAS computers sample each sensor’s analog processor at a rate of once per second and process the data into 1-, 15-, and 60-min averages. Averaged data are transmitted via modem to a central processing system (CPS) computer for access and storage. Each RDAS computer is housed in an environmentally-controlled instrument cabinet at the meteorological towers. The CPS computer is housed in an environmentally-controlled meteorological computer building located at the north end of the Unit 1 parking lot.

Display and Recording

Computer terminals are the interface of the meteorological data acquisition system (MDAS) for the display of digital data. Strip chart recorders display and record analog data. One set of strip chart recorders, which display the parameters from all meteorological towers, is located at the meteorological computer building. The control room at Unit 1, Unit 2, and the J. A. FitzPatrick plant have strip chart recorders for the key parameters: the 61-m (200-ft), 27-m (90-ft) backup, and either the 9-m (30-ft) or 30-m (100-ft) wind direction and speed, as well as sigma theta, temperature, and both temperature differences. In addition, the Technical Support Center has strip chart recorders for the 61-m (200-ft) and either the 9-m (30-ft) or 30-m (100-ft) wind direction and speed.

Wind direction, speed, and sigma theta data from the backup J. A. FitzPatrick tower are displayed in both digital and analog form in the Unit 2 control room. These data will be used as backup to the primary 200-ft tower in the unlikely event that data are unavailable from this system.

2.3.3.2.4 Instrument Calibration and Maintenance

Calibration schedules are specified to comply with RG 1.23 recommendations. Equipment checks are performed at least weekly. Charts are changed as required. Component checks and adjustments are performed when required. All meters and other equipment used in calibrations are, in turn, calibrated at scheduled intervals.

Inspection and maintenance of all equipment is accomplished in accordance with procedures in the instrument manufacturer's manuals. Inspection is implemented by qualified technicians that are capable of performing the maintenance, if required. The results of the inspections and maintenance performed are recorded in a log book.

2.3.3.2.5 Data Analysis

All data are subject to quality control checks by a meteorologist prior to tabulation of routine summaries of wind direction, speed, and stability. Other analyses are performed as warranted for special projects, in addition to the routine submittal of data for scheduled reports.

2.3.4 Short-Term (Accident) Diffusion Estimates

2.3.4.1 Objective

The objective is to provide conservative and realistic short-term estimates of relative concentration, X/Q, at specific locations such as the EAB and the outer boundary of the LPZ following a hypothetical release of radioactivity from Unit 2. The assessment is based on the results of atmospheric diffusion modeling and onsite meteorological data.

2.3.4.2 X/Q Estimates

Five possible locations where accidental radionuclide releases can occur from Unit 2 are the tall main plant stack, the combined radwaste/reactor building vent, standby gas treatment building, the post-accident sampling system (PASS) panel, and the main steam tunnel blowout panels. Accident X/Q values are assessed at the distances and locations shown in Appendix 2F, Tables 2F-1, 2F-1a, and 2F-1b. Both conservative and realistic accident results are reported for the EAB and the LPZ. In addition, accident X/Q values are reported for the Technical Support Center as well as the control room air intakes. Conservative X/Q estimates are made for emergency planning due to a hypothetical release of radioactivity from the main stack. Furthermore, realistic estimates of X/Q values due to a hypothetical release from the main stack and the combined radwaste/reactor building vent are given at the population distances. As part of the implementation of the alternative source term (AST) for Chapter 15 accident analyses, the accident X/Q values were updated. The emergency planning realistic values were retained for historical purposes only since they do not affect the design basis. The accident X/Q values are summarized in the following tables:

2. Table 2F-2 Conservative Short-Term Diffusion Estimates at the EAB, LPZ, the Control Room and TSC Air Intakes for Releases from the Main Stack, the Main Steam Tunnel Blowout Panels, SGT Building, PASS Panel, and the Combined Radwaste/Reactor Building Vent.

2. Table 2F-3 Realistic Short-Term Diffusion Estimates at the EAB by Sector for Releases from the Main Stack.

3. Table 2F-4 Realistic Short-Term Diffusion Estimates at the LPZ by Sector for Releases from the Main Stack.

4. Table 2F-6 Emergency Planning Short-Term Diffusion Estimates for Releases from the Main Stack.

5. Table 2F-7 Realistic Short-Term Diffusion Estimates for Releases from the Main Stack at the Population Distances.
6. Table 2F-8 Realistic Short-Term Diffusion Estimates at the EAB by Sector for Releases from the Combined Radwaste/Reactor Building Vent.

7. Table 2F-9 Realistic Short-Term Diffusion Estimates at the LPZ by Sector for Releases from the Combined Radwaste/Reactor Building Vent.

8. Table 2F-11 Realistic Short-Term Diffusion Estimates for Releases from Combined Radwaste/Reactor Building Vent at the Population Distances.

2.3.4.3 Accident Assessment

The short-term 0- to 2-hr X/Q values for elevated and ground-level releases are calculated with the sector-dependent model described in RG 1.145, as implemented in the computer code PAVAN(59). Control room and TSC X/Q values are calculated using the computer code ARCON96(60) for various source/receptor scenarios using the guidance contained in RG 1.194. The accident X/Q values were analyzed using the hourly-averaged meteorological joint wind and stability database for the 5-yr period from 1997 through 2001.

2.3.4.3.1 Methodology

The procedures used to estimate the X/Q values for the appropriate time periods following a postulated accident are described in Regulatory Guide 1.145 for distances beyond 100 m (328 ft) from the release point. The diffusion model generates a cumulative frequency distribution of X/Q values for each sector-distance combination representing the first 2 hr after the postulated accident. These 2-hr X/Q values are based on 1-hr averaged data, but are assumed to apply for 2 hr. The frequency distributions are plotted on log-probability coordinates for each sector-distance combination and are then enveloped.

The X/Q value that is equaled or exceeded 0.5 percent of the time at each sector-distance combination is then determined from the intersection of the envelope and the 0.5-percent probability level. The highest sector-dependent X/Q value is then compared with the overall 5-percent accident X/Q value. For elevated stack releases, a fumigation X/Q value is also computed. This value is compared with the 0- to 2-hr value derived from the 0.5- and 5-percent probability levels. The highest value represents the conservative 0- to 2-hr accident X/Q.
The realistic 0- to 2-hr accident X/Q is evaluated at the 50-percent probability level. The X/Q value that is equaled or exceeded 50 percent of the time at each sector-distance combination is determined from the intersection of the envelope and the normalized (probability normalized to 100 percent in each sector) 50-percent probability level. The highest sector-dependent X/Q value is then compared with the overall 50-percent accident X/Q. The highest value represents the realistic 0- to 2-hr accident X/Q. The overall 5- and 50-percent X/Q values are determined by summing the 16 sector-dependent X/Q distributions for each distance into a cumulative frequency distribution representing all sectors and again enveloping the data points.

The 5- and 50-percent values are determined by the intersection of the envelope with the 5- and 50-percent probability levels, respectively.

The accident X/Q values for time periods of up to 30 days following an accident are derived by logarithmic interpolation between the 0- to 2-hr nonfumigation 0.5- and 50-percent accident X/Q values and the annual average accident X/Q value at each sector-distance combination. The intermediate time periods for the overall 5- and 50-percent X/Q values are determined by logarithmic interpolation between the overall 0- to 2-hr, 5- and 50-percent X/Q values and the maximum annual average X/Q. The maximum X/Q value for a given distance is the maximum sector 0.5-percent X/Q value or the overall 5-percent X/Q value, whichever is higher for the conservative assessment. The realistic assessment compares the maximum sector 50-percent X/Q value and the overall 50-percent X/Q value. Again, the higher value is chosen to represent the realistic accident X/Q.

Control room and TSC X/Q values are calculated using the computer code ARCON96 for various source/receptor scenarios using the guidance contained in RG 1.194. The accident X/Q values were analyzed using the hourly-averaged meteorological joint wind and stability database for the 5-yr period from 1997 through 2001.

All of the assumed release points listed in Table 2F-1a, except the main stack, were modeled as ground-level (vent) releases in accordance with RG 1.145 because their height is less than 2.5 times the highest adjacent structure. Conservative building wake areas, calculated considering the complexity of the geometry of the structures, were input into ARCON96 to account for wake effects.

2.3.4.3.2 Meteorological Data

Representativeness With Local Climatology

The Nine Mile Point meteorological tower data from January 1974 through December 1976, and November 1978 through October 1980, are employed in the original accident assessment. This 5-yr data period is representative of the local climatology. The data collected at the tower are quite representative of the meteorological conditions under which effluents are released since both the tower and the release points are located on the Lake Ontario shoreline. Furthermore, the proximity of the 61-m (200-ft) tower 1.0 km (0.6 mi) to Unit 2 assures that the data used in an accident evaluation are representative of the conditions at the release points, both at ground level and for an elevated release.

The tower is sited within the lake-land/air transition zone. The location of the tower in relation to the plant and the shoreline is shown on Figure 2.3-40. As the tower is situated on the Lake Ontario shoreline, the data reflect the turbulence of the air in the direction from which the wind blows. Therefore, the transition from a stable air mass over the lake to an unstable air mass over the land has been accounted for in the diffusion model by conservatively assuming fumigation for the 0- to 2-hr accident X/Q for the main stack. The reverse flow of stable air over the land flowing into unstable air over the water has also been treated conservatively by the 2-hr fumigation calculations.

Joint Frequency Distributions

Joint frequency distributions of wind speed and direction by atmospheric stability class are used as input to the diffusion calculations. Wind speed and direction data from the 61-m (200-ft) and 9-m (30-ft) levels are used in the original assessment of diffusion for elevated and ground-level releases, respectively. The 30-m (100-ft) Aerovane direction is substituted for the 61-m Aerovane direction if it is missing. Similarly, if the 9-m F-460 Climatronics direction is missing, the 9-m Aerovane direction is substituted.

Atmospheric stability is determined for both the 9-m and 61-m distributions by the vertical temperature difference between the 61-m and 8-m (27-ft) levels. Original joint frequency distributions of wind speed and direction by atmospheric stability class are computed for 22.5-deg sectors using the wind speed groups and atmospheric stability classes suggested in RG 1.23. The 5-yr joint frequency distributions are shown in Appendix 2B, Table 2B-3, for the 9-m level, and Table 2B-5 for the 61-m level. The joint wind direction, speed, and stability data recovery is above 95 percent for the accident calculations. There are only 164 calms (hours with wind speed below the threshold speed of the instrumentation) at the 9-m level and 147 hr at the 61-m level during the 5-yr period. Wind directions are assigned to calms when wind direction data are not available. The procedure normalizes all such calm hours in proportion to the frequency of occurrence of each direction for the lowest noncalm wind speed group within each atmospheric stability class, as suggested by RG 1.111(42).

With the exception of the calm and 11+ m/sec (24+ mph) wind speed groups, the highest wind speed in each group is used to represent that group in the diffusion calculations. For conservatism, a wind speed of 0.5 m/sec (1.0 mph) is used to represent calms at the 61-m level and 0.3 m/sec (0.6 mph) for calms at the 9-m level. These values for calms represent a conservative threshold wind speed for the Aerovane at the 61-m level and one-half the threshold wind speed for the F-460 Climatronics cup and anemometer system at the 9-m level. Due to the very high wind speeds associated with this site, a wind speed of 18 m/sec (40 mph) is used to represent the 11+ m/sec wind speed group for the 61-m level and 16 m/sec (36 mph) is chosen for the 9-m level.

Updated Meteorological Data

Design basis accident (DBA) assessments based on the AST use meteorological data collected by the NMP onsite meteorological measurements program for the 5-yr period from 1997 through 2001. The joint frequency table based on 200 ft measurements, as shown in Table 2B-55, is used in the PAVAN calculations for the EAB and LPZ. Hourly meteorological readings from both the 30 ft and 200 ft measurements are used as input to the ARCON96 computer code for the control room and TSC.

2.3.4.4 Atmospheric Diffusion Models

2.3.4.4.1 Main Stack X/Q Calculations

Releases from the Unit 2 main stack are treated as elevated (131 m, 429 ft above grade), except when calculating X/Q values for the control room. In order to assure conservatism for postulated main stack accidents, no plume rise is assumed.

Changes in terrain elevation, though small in the immediate vicinity of the plant, are applied at each receptor. Terrain heights relative to the plant grade, 80 m (261 ft) msl, are used. The terrain height correction applied to any particular receptor is subtracted from the effective plume height (release height).

The dispersion coefficients, Sy and Sz for each stability class are computed using analytical approximations to the Pasquill-Gifford curves given in RG 1.111. These curves are appropriate since they were developed for use over flat terrain, similar to the area assessed for the accident diffusion estimates. There are no severe terrain features such as valleys or mountains to complicate the diffusion of radionuclides released from the plant.

Nonfumigation

For the nonfumigation conditions, the equation presented in RG 1.145 is used:

$$X/Q = \frac{1}{\pi \bar{u}_h \sigma_y \sigma_z} \quad .e^{-}\left(\frac{h_e^2}{2\sigma_z^2}\right) \tag{2.3-2}$$

Where:

X/Q = Relative concentration, sec/m^3

$\bar{u}_h$ = Wind speed at release point, m/sec

σ_y = Lateral plume spread, m

σ_z = Vertical plume spread, m

h_e = Effective stack height (stack height minus terrain), m

Fumigation

Fumigation X/Q values for the main stack are calculated in accordance with RG 1.145. A stable atmospheric stability and a wind speed of 2.0 m/sec (4.5 mph) are used to evaluate stack fumigation. The stack fumigation equation is:

$$X/Q = \frac{1}{(2\pi)^{1/2} \bar{u}_{h_e} \sigma_y h_e}, \; h_e > O \tag{2.3-3}$$

Where:

$\bar{u}_{he}$ = Wind speed throughout the fumigation depth h assumed to be 2.0 m/sec (4.5 mph)

σ_y = The lateral plume spread, representative of the layer at a given distance, assuming a stable (Pasquill F) atmospheric stability class, m

The fumigation X/Q values calculated with Equation 2.3-3 are compared with the X/Q values calculated with Equation 2.3-2, assuming h = 0 and stable atmospheric conditions. If the X/Q values calculated with Equation 2.3-3 are higher than those calculated with Equation 2.3-2 with the aforementioned conditions, the X/Q values calculated with Equation 2.3-2 are used to represent conservative fumigation conditions.

Exclusion Area Boundary (EAB)

The maximum conservative 0- to 2-hr X/Q at the EAB resulting from a postulated accidental release from the Unit 2 main stack is 2.96×10^{-5} sec/cu m for the eight downwind land sectors based on updated meteorological data.

The Unit 2 site is located within 3,200 m (10,500 ft) of Lake Ontario and is thus considered a coastal site. Fumigation is assumed to occur for the entire 2-hr period after the postulated accident, as recommended by RG 1.145 for coastal sites.

For the 0- to 2-hr period, fumigation in the east-southeast and southeast sectors resulted in the maximum X/Q at the EAB.

Table 2F-1 shows the distance from the main stack to the EAB that is evaluated in each of the eight downwind land sectors as well as the nine coastline sectors. Distances to the EAB are based on the shortest distance within each of the 16 sectors centered on the 22 1/2-deg cardinal compass directions derived from both 22 1/2-deg and 45-deg sector widths.

The realistic X/Q values at the EAB for the eight downwind land sectors by the various time periods of assessment based on the original meteorological data are listed in Table 2F-3.

Low Population Zone (LPZ)

The maximum conservative X/Q values at the LPZ boundary, 6,116 m (3.8 mi), resulting from a postulated accidental release from the Unit 2 main stack, based on updated meteorological data, are shown in Table 2F-2. Since the site is coastal, fumigation is assumed to occur for the first 4 hr following a postulated accident as stated in RG 1.145. The fumigation X/Q value is assumed to apply to the 0- to 8-hr time period.

The 0.5-percent X/Q values for the 8- to 24-hr, 1- to 4-day, and 4- to 30-day periods are calculated by interpolating between the sector-dependent nonfumigation 0- to 2-hr values and the appropriate annual values. The annual X/Q values are calculated according to the method described in RG 1.111 for long-term (routine) X/Q calculations. Plume rise is not considered in line with the conservatism of the short-term (accident) calculations.

The 8- to 24-hr, 1- to 4-day, and 4- to 30-day 5-percent X/Q values are determined by interpolating between the overall 0- to 2-hr 5 percent X/Q and the maximum sector annual X/Q at the LPZ. These 5-percent X/Q values are compared to those obtained by interpolating between the sector-dependent nonfumigation 0- to 2-hr values and the sector annual X/Q values. The higher of the X/Q values is chosen to represent conditions at the LPZ boundary for the appropriate time periods.

The realistic accident X/Q values at the LPZ, based on the original meteorological data, are shown in Table 2F-4.

Control Room and Technical Support Center Air Intakes

The control room and Technical Support Center release point/intake distances and elevations used to determine atmospheric dispersion coefficients are shown in Tables 2F-1a and 2F-1b.

Main stack releases to control room intakes building wake area are conservatively assumed to be equal to the reactor building cross-sectional area. This assumption is taken since the reactor building is the dominant structure between the release point and the receptor location. This assumption is conservative because the actual building wake area may be larger due to neighboring structures.

The main stack displacement from the reactor and turbine building is sufficient such that the building wake area for the main stack to the Technical Support Center includes both the entire area of the reactor building and the north-south cross-sectional area of the turbine building.

Main stack release is assumed to be a ground-level release as opposed to an elevated release in ARCON96. This assumption is made because the NMP stacks are generally located in close proximity to the site building cluster. The height of the stacks is close to or below 2.5 times the height of the site building structures. Also, regulatory guidance documents indicate that proper qualification of stack configurations must be made in order to assume a stack release. The X/Q results from this assumption will be conservatively higher than those calculated as an elevated release.

The X/Q values for the control room and Technical Support Center are based on updated meteorological data and are shown in Table 2F-2.

Emergency Planning Assessment

The conservative X/Q values at the emergency planning distances shown in Table 2F-1 are listed in Table 2F-6 by sector. These X/Q values are based on the original meteorological data.

Population Distances

The realistic X/Q values at the population distances by sector due to a hypothetical accidental release of radioactivity from the main stack are given in Table 2F-7. These X/Q values are based on the original meteorological data.

2.3.4.4.2 Vent X/Q Calculations

The combined radwaste/reactor building vent is treated conservatively as a ground-level source without plume rise for both short-term and long-term calculations. A building wake correction factor of 2,844 sq m (30,612 sq ft) is used in accordance with the methodology discussed in RG 1.145 for vent-type releases to account for plume enhancement due to its entrainment in the aerodynamic wake of the building. The Pasquill-Gifford dispersion coefficients are appropriate for the accident assessment of diffusion from the vent, which is treated as a ground-level source.

The vent release X/Q values are calculated with the following equations from RG 1.145:

$$X/Q = \frac{1}{\bar{u}_{10}\left(\pi\sigma_y\ \sigma_z + A/2\right)} \tag{2.3-4}$$

$$X/Q = \frac{1}{\bar{u}_{10}\left(3\pi\sigma_y\sigma_z\right)} \tag{2.3-5}$$

$$X/Q = \frac{1}{\bar{u}_{10}\,\pi\Sigma_y\sigma_z} \tag{2.3-6}$$

Where:

$\bar{u}_{10}$ = Wind speed at 10-m (30-ft) level, m/sec

Σy = Lateral plume spread with meander and building wake effects, m

A = Smallest vertical-plane cross-sectional area of the reactor building, m^2

For neutral or stable conditions combined with wind speeds less than 6 m/sec (14 mph), a calculation of the X/Q values is made with Equation 2.3-6. For all other meteorological conditions, X/Q values are calculated with Equations 2.3-4 and 2.3-5.

The values computed from Equations 2.3-4 and 2.3-5 are compared and the higher value is selected. For neutral and stable conditions with a wind speed less than 6 m/sec (14 mph), the value from Equation 2.3-6 is compared with the value chosen from Equations 2.3-4 and 2.3-5, and the lower value is chosen to represent these conditions.

Exclusion Area Boundary

Table 2F-1 lists the distance to the EAB in each of the eight downwind land as well as the nine coastline sectors evaluated for a postulated accidental release from the combined radwaste/reactor building vent.

The maximum conservative 0- to 2-hr X/Q at the EAB from the combined radwaste/reactor building vent is 1.19×10^{-4} sec/cu m based on the eight downwind land sector distances. This value represents the overall 5-percent 0- to 2-hr X/Q at 1,381 m (4,530 ft) and is based on updated meteorological data. The realistic X/Q values at the EAB for each of the eight downwind land sectors based on the original meteorological data are given in Table 2F-8.

Low Population Zone

The conservative accident X/Q values given in Table 2F-2 represent the maximum values for the combined radwaste/reactor building vent at the LPZ boundary, 6,116 m (3.8 mi), based on downwind land sectors only and updated meteorological data. The overall 5-percent values are higher than any of the downwind land 0.5-percent sector-dependent X/Q values for each of the time scales.

The realistic X/Q values for the combined radwaste/reactor building vent at the LPZ by sector based on the original meteorological data are given in Table 2F-9.

Control Room and Technical Support Center Air Intakes

Combined radwaste and reactor building vent releases to the Technical Support Center building wake area are conservatively assumed to be equal to the north-south cross-sectional area of the turbine building. As the building wake area is difficult to accurately characterize, this assumed area is a best estimate. The actual cross-sectional area from the release point to the receptor may be slightly greater than the value determined from this assumption. Therefore, this assumption conservatively results in higher X/Q values.

Combined radwaste and reactor building vent releases to control room intakes building wake area is assumed to be zero. This assumption is made because the combined radwaste and reactor building vent release points are in close proximity to the intakes. A zero wake term assumption conservatively results in higher X/Q values.

The X/Q values for the control room and Technical Support Center are based on updated meteorological data and are shown in Table 2F-2.

Population Distances

The realistic X/Q values for the original meteorological data at the population distances by sector are listed in Table 2F-11 for the combined radwaste/reactor building vent.

2.3.4.4.3 Additional Release Points X/Q Calculations

Release points for X/Q calculations also exist at several additional locations. These locations include the main steam tunnel, standby gas treatment building, and the PASS panel. Releases from these locations are treated as ground-level releases.

Exclusion Area Boundary

The calculated X/Q values at the EAB from these additional release points are identical to those obtained from the radwaste/reactor building vent. The X/Q values are based on updated meteorological data and are shown in Table 2F-2.

Control Room and Technical Support Center Air Intakes

Standby gas treatment system building releases to control room intakes building wake area are conservatively assumed to be equal to the reactor building cross-sectional area. This assumption is made since the reactor building is the dominant structure between the release point and the receptor location. This assumption is conservative because the actual building wake area may be larger due to neighboring structures.

Main steam tunnel releases to control room intakes building wake area are assumed to be 0.01 m^2 for a zero wake term. This assumption is made because the main steam tunnel release points are in close proximity to the intakes. A zero wake term assumption conservatively results in higher X/Q values.

PASS panel vent release to control room intakes building wake area is conservatively assumed to be equal to one half of the reactor building cross-sectional area. This assumption is to account for the complexity of the dense building cluster at the NMP site for which it is difficult to accurately characterize the building wake area. This assumption conservatively results in higher X/Q values.

Main steam tunnel and PASS panel releases to the Technical Support Center building wake area is conservatively assumed to be equal to the north-south cross-sectional area of the turbine building. As the building wake area is difficult to accurately characterize, this assumed area is a best estimate. The actual cross-sectional area from the release point to the receptor may be slightly greater than the value determined from this assumption. Therefore, this assumption conservatively results in higher X/Q values.

The X/Q values for the control room and Technical Support Center are based on updated meteorological data and are shown in Table 2F-2.

2.3.5 Long-Term (Routine) Diffusion Estimates

2.3.5.1 Objective

The objective is to provide realistic annual average estimates of relative concentration (X/Q) and relative deposition per unit area (D/Q) at appropriate distances from all routine gaseous releases of radioactive materials from Unit 2. The assessment is made with the use of an atmospheric diffusion model.

2.3.5.2 X/Q and D/Q Estimates

Radionuclides are routinely emitted to the atmosphere from two locations at Unit 2, the main stack and the combined radwaste and reactor building vent. Estimates of annual average X/Q (undecayed and undepleted) and D/Q have been made for receptor locations in each of 16 radial sectors for the population distances shown in Appendix 2G, Table 2G-1. These annual average values are presented in the following tables for compliance with 10CFR50 Appendix I:

1. Table 2G-2 – main stack – X/Q.
2. Table 2G-3 – combined radwaste and reactor building vent – X/Q.
3. Table 2G-4 – main stack – D/Q.
4. Table 2G-5 – combined radwaste and reactor building vent – D/Q.

Additional annual average values have been assessed at the site boundary, the EAB, and the restricted area boundary, which are all the same for Unit 2. These distances are given by sector in Table 2G-6. The X/Q and D/Q values for the eight downwind land sectors only are given in Tables 2G-7, 2G-7a, and 2G-8 for the main stack, main stack-mechanical vacuum pump, and the combined radwaste and reactor building vent, respectively.

2.3.5.3 Methodology

The analysis of the atmospheric transport and diffusion properties is based on the onsite meteorological data, source configuration, terrain, and a sector average diffusion model.

See Appendix 2P, NRC Questions F451.13 and F451.14, for additional discussions of wind speed and direction.

2.3.5.3.1 Meteorological Input

Joint frequency distributions of wind speed and direction by atmospheric stability class are used for the diffusion calculations. The location of the meteorological tower in relation to the plant is shown on Figure 2.3-40. All meteorological data are from the Nine Mile Point meteorological tower. Wind speed and direction data from the 61-m (200-ft) level are used as input for the joint frequency distributions. The 30-m (100-ft) direction is substituted for the 61-m direction in the event it is missing. Atmospheric stability is determined by the vertical temperature difference between the 61-m and the 8-m (27-ft) levels. Data recovery for the joint distribution of wind direction, speed, and stability is over 95 percent.

Joint frequency distributions of wind speed and direction by atmospheric stability class are computed for 22.5-deg sectors using the wind speed groups and atmospheric stability classes suggested in RG 1.23. The 5-yr joint frequency distributions of wind direction, speed, and stability from the 61-m (200-ft) level are used as input for the main stack and combined radwaste and reactor building vent diffusion calculations. The January 1974 through December 1976 and November 1978 through October 1980 joint frequency distributions for the 61-m level wind are shown in Appendix 2B, Table 2B-5.

Wind directions are assigned to calms (hours with zero wind speed) when wind direction data are not available. The procedure normalized all such calm hours in proportion to the frequency of each direction for the lowest noncalm wind speed group within each atmospheric stability class, as suggested by RG 1.111.

With the exception of the calm and the 10.7+ m/sec (24.0+ mph) groups, the mean speed from each wind speed group is used to represent that group in the diffusion calculations. A wind speed of 0.5 m/sec (1.0 mph), less than one-half of the threshold of both the vane and propeller, is assigned to the calms. Due to the very high wind speeds associated with this site, a speed of 15.7 m/sec (35.0 mph) is used to represent the 10.7+ m/sec (24.0+ mph) group.

2.3.5.3.2 Source Configuration

Radionuclides are routinely released in gaseous effluents from two sources: the main stack and the combined radwaste and reactor building vent. Their source characteristics are given in Table 2G-9.

2.3.5.3.2.1 Main Stack Release

The main stack is more than twice as high as all adjacent structures so that no building downwash is included. However, a correction for the stack tip downwash is made in accordance with RG 1.111 when the vertical exit velocity is less than 1.5 times the horizontal wind speed. This correction for stack tip downwash is given by:

$$C = 3D\left(1.5 - W_o / \overline{u}\right) \tag{2.3-11}$$

Where:

C = Downwash correction factor, m

D = Diameter of the release, m

W_o = Vertical exit velocity, m/sec

$\overline{u}$ = Mean wind speed at release height, m/sec

2.3.5.3.2.2 Vent Release

The combined radwaste and reactor building vent pointing upward is in a rectangular structure between the reactor and turbine buildings and is 4 m (13.2 ft) higher than the top of the reactor building. Therefore, the vent is affected by the nearby building aerodynamics with moderate to strong winds and is treated differently than the main stack.

The entrainment coefficients of RG 1.111 are used to determine the portion of the vent's effluent entrained into the turbine-reactor building wake. The entrainment coefficients are given by the following equations:

$$E_T = 2.58 - 1.58\left(W_o / \overline{u}\right) for 1 < W_o / \overline{u} \le 1.5 \tag{2.3-12}$$

$$E_T = 0.30 - 0.06\left(W_o / \overline{u}\right) for 1.5 < W_o / \overline{u} \le 5.0 \tag{2.3-13}$$

Where:

E_T = Entrainment coefficient, dimensionless

When entrainment occurs, the entrained position of the release is assumed to be at ground level and a building wake correction factor (reactor building height squared) of 2,685 sq m (28,900 sq ft) is used in accordance with the methodology of RG 1.111. The building wake correction factor takes into consideration the initial mixing of the plume within the building cavity.

2.3.5.3.2.3 Site Impacts on the Main Stack and Vent Releases

The final consideration of the source configuration is to determine the effects, if any, of the natural-draft cooling tower on the effluent released from the main stack and combined radwaste and reactor building vent. The natural-draft cooling tower is located 454 m (1,490 ft) south of the main stack and 304 m (996 ft) south of the combined radwaste and reactor building vent. The physical dimensions of the natural-draft cooling tower are:

2. Height above grade = 539.36 ft

2. Base diameter = 415 ft 8 in

3. Throat diameter = 259 ft 10 in

4. Exit diameter = 272 ft 11 in

Field data obtained at Rancho Seco, especially during stable conditions, were used to determine the flow perturbations generated by natural-draft cooling towers. The report states, "The overall interpretation of ground-level concentrations (i.e., crosswind integrated concentrations and sigma-y values) are probably not severely distorted even when the observations are influenced by the cooling tower wakes."(44)

Thus, the effects of the natural-draft cooling tower for both the main stack and the combined radwaste and reactor building vent releases during stable conditions are neglected.

The effect of the cooling tower on the main stack or the combined radwaste and reactor building vent releases during neutral and unstable atmospheric conditions would be to enhance the vertical diffusion through increased mechanical turbulence and thus reduce ground-level concentrations. Therefore, to be conservative in the estimation of ground-level concentrations for neutral and unstable conditions, the wake effect of the cooling tower has been neglected.

2.3.5.3.3 Plume Rise

Plume rise is calculated according to the procedures outlined in RG 1.111. For neutral or unstable conditions the following equation is used:

$$h_p = 1.44 \left(\frac{W_o}{\bar{u}}\right)^{2/3} \left(\frac{x}{D}\right)^{1/3} D \qquad (2.3\text{-}14)$$

Where:

h_p = Plume rise, m

W_o = Exit velocity, m/sec

x = Downwind distance, m

$\bar{u}$ = Mean wind speed at release height, m/sec

D = Release diameter, m

When the exit velocity is less than 1.5 times the wind speed, a correction factor for downwash is subtracted from h_p by Equation 2.3-11.

The result from Equation 2.3-14 corrected by Equation 2.3-11, if necessary, is compared with:

$$h_p = 3 \left(\frac{W_o}{\bar{u}} \right) D \qquad (2.3\text{-}15)$$

The lowest plume rise is chosen for the modeling.

For stable conditions, the results from Equation 2.3-14, corrected by Equation 2.3-11 if necessary, and Equation 2.3-15 are compared with the results from the following two equations:

$$h_p = 4 \left(\frac{F_m}{S} \right)^{1/4} \qquad (2.3\text{-}16)$$

$$h_p = 1.5 \left(\frac{F_m}{\bar{u}} \right)^{1/3} (S)^{-116} \qquad (2.3\text{-}17)$$

Where:

$$F_m = W_o^2 \left(\frac{D}{2} \right)^2 \qquad (2.3\text{-}18)$$

F_m = Momentum flux parameter, m^4/sec^2

S = 8.70×10^{-4} E Stability, $1/sec^2$

S = 1.75×10^{-3} F Stability, $1/sec^2$

S = 2.45×10^{-3} G Stability, $1/sec^2$

As in the unstable-neutral cases, the lowest plume rise is used.

Main Stack

The stack is approximately 2.5 times the height of all adjacent structures (with the exception of the cooling tower). Taking into account the stack's relative isolation and high exit velocity 10.7 m/sec (35.0 ft/sec), there is little likelihood of downwash associated with adjacent structures(45).

Mechanical Vacuum Pump

The X/Q and D/Q values for the main stack for 320 hr (four short-term outages of the mechanical vacuum pump for 80 hr each) for the annual time frame are calculated with the methodology described in Section 2.3.5 for the main stack. However, the calculation for the mechanical vacuum pump outages assumes no plume rise and follows the methodology of an NRC memorandum dated May 13, 1976.

The methodology uses the annual average X/Q and D/Q values, as well as a 15-percentile sector-distance dependent X/Q value (normalized 15-percent value in each sector) based on the methodology of RG 1.145. This 15-percentile X/Q value is set equal to the 1-hr X/Q. Logarithmic interpolation between the 1-hr X/Q and the annual X/Q at a particular distance-sector combination yields the 320-hr X/Q. The ratio of the 320-hr X/Q value to the annual average X/Q is then multiplied by the annual D/Q value to obtain the desired D/Q.

Combined Radwaste and Reactor Building Vent

During the portion of the time that the combined radwaste and reactor building vent release is considered elevated, plume rise is computed according to the equations in Section 2.3.5.3.3. When entrainment occurs, as determined by Equations 2.3-12 and 2.3-13, the entrained portion of the vent plume is assumed to be released at ground level.

The wind speed during these conditions is adjusted from the 61-m (200-ft) level to the 10-m (33-ft) level to be representative of a ground-level release.

2.3.5.3.4 Diffusion Model

The sector average Gaussian plume equation, as expressed in RG 1.111, is used for all X/Q calculations. The basic equation is:

$$X/Q = \frac{360f}{x\phi\pi^{3/2}\,2^{1/2}\,\overline{u}\left(\sigma_z^2 + 0.5\frac{D^2}{\pi}\right)^{1/2}} \,.\, e^{\frac{-(h_e - Z_{corr})^2}{2\sigma_z^2}} \qquad (2.3\text{-}19)$$

Where:

X/Q = Relative concentration at receptor point, sec/m^3

ϕ = Sector width, 22.5 deg

x = Distance of receptor point, m

$\overline{u}$ = Mean wind speed at release height, m/sec

h_e = Effective release height, m

σ_z = Vertical standard deviation of the plume at distance x, m

Z_{corr} = Terrain height of receptor points relative to plant grade, m

f = Frequency of occurrence of wind speed and stability combination, dimensionless

D^2 = Maximum adjacent building height squared either up or downwind from the release point, m^2

2.3.5.3.5 Terrain Corrections

Changes in terrain elevation, though small in the immediate vicinity of the plant, have been applied at each receptor. Terrain heights above plant grade, 80 m (261 ft) msl, are used in the calculation whereby the terrain height correction applied to any particular receptor is the highest terrain between the source and the receptor. These terrain corrections are subtracted from the calculated effective plume height (release height plus plume rise).

2.3.5.3.6 Wind Speed Adjustment

Wind speeds taken from the 61-m (200-ft) level of the Nine Mile Point meteorological tower are adjusted to the stack or vent or 10-m (30-ft) release height according to the formula in the ASME Guide(46):

$$\bar{u}_2 = \bar{u}_1 \left(z_2 / z_1\right)^q \qquad (2.3\text{-}20)$$

Where:

$\bar{u}_1$ = Mean wind speed at 61-m (200-ft) level, m/sec

$\bar{u}_2$ = Mean wind speed at release height, m/sec

z_1 = Height of measured wind speed, m

z_2 = Height of release, m

q = Power which ranges from 0.1 to 0.3 for very unstable to very stable conditions, dimensionless

Increase in speed for sources higher than the wind instrument is logical and in accord with observational data. Therefore, the 61-m (200-ft) level winds are adjusted upward for stack calculations, and slightly downward for the elevated vent release.

2.3.5.3.7 Atmospheric Stability

Atmospheric stability classes have been determined using the vertical temperature difference between the 61-m (200-ft) and the 8-m (27-ft) levels of the Nine Mile Point meteorological tower. The seven lapse rate classes are those recommended in RG 1.23 for stability classification.

2.3.5.3.8 Dispersion Coefficients

The vertical dispersion coefficients, sigma z for each turbulence class, are computed using analytical approximations to the Pasquill-Gifford sigma curves given in RG 1.111.

These dispersion coefficients are appropriate for use in predicting the atmospheric diffusion for the Unit 2 releases. The Pasquill-Gifford dispersion coefficients were derived from data measured over flat terrain. Unit 2 is located on the flat Lake Ontario plain. The topography of the surrounding area, for which long-term diffusion estimates are made, varies from predominantly flat to rolling terrain. There are no severe terrain features, such as deep valleys or mountains, to complicate the atmospheric diffusion of radionuclides released from the plant.

2.3.5.3.9 Land/Lake Breeze

The land/lake breeze circulation at the site and its relation to air flow trajectories over the region on an annual basis are considered. The evaluation centered on whether or not the lake breeze could affect the X/Q values significantly and whether or not the lake breeze is frequent enough to warrant a special analysis.

The following sections show that it is not necessary to adjust either the meteorological data or the X/Q values to account for the small effects involved.

See Appendix 2P, NRC Question F451.15, for additional discussion of the land/lake breeze influences on dispersion.

Lake Breeze

When a lake breeze exists, the flow of air from Lake Ontario over the land is more stable (having less diffusive capacity) than it is after the flow has moved inland far enough to become heated. This implies that an estimate of X/Q, which assumes that the relatively stable conditions existing at the site tower remain unchanged as the effluent moves inland, would tend to make X/Q an overestimate progressively with time and distance. Fumigation of the stack plume during onshore flow would insignificantly affect the annual average X/Q values since any given location will rarely be affected.

In addition to this change in the diffusive capacity of the atmosphere, one of two other effects could be present. If the wind gradient is also onshore, the influence of the lake breeze would simply increase the speed of the flow within the range of the lake breeze, also favoring greater diffusion. If the gradient flow is in opposition to the lake breeze, the onshore flow would proceed inland and then tend to rise before flowing back out over the lake. Both of these effects would tend to decrease X/Q below the estimates made for inland locations distant from the plant.

Another consideration is whether the lake breeze might cause changes in the air flow trajectory so that the apparent wind direction at the site is nonrepresentative of the plume travel. In a given situation this might be true; therefore, the X/Q predicted at a given location might really be found somewhere else.

On a long-term climatological basis, it is highly unlikely that such changes would significantly affect the X/Q estimates. The lake breeze frequency represents no more than 5 percent of all hours. This is confirmed by a 2-yr field study on lake breeze circulation in the proximity of Lake Ontario by Guski and Miller that showed that lake breezes are observed on 10 percent of the days on an annual basis(47). In addition, the initial direction of the onshore breeze itself varies over a wide arc and downwind aberrations of these directions are quite likely to smooth out over a number of cases.

Land Breeze

The reverse flow pattern occurring at night is known as a land breeze. This flow would carry effluent from the plant over the lake where it might remain concentrated in relatively stable air; however, the effluent could be carried back inland at a later time. Such a recirculation could bring radioactivity back over land after it has passed out over the lake, and might add an increment to the X/Q values. If one assumes, for example, that the effluent moved out over the lake and eventually returned over the land, the X/Q values in the immediate shore area might be increased on that day. However, the number of hours on an annual average during which this would occur is less than 5 percent.

2.3.5.3.10 Deposition

Relative dry deposition has been estimated in accordance with RG 1.111. The relative deposition per unit area, D/Q, is obtained by:

2. Determining the relative deposition rate at each receptor, which is a function of distance from the source, source height, and atmospheric stability. This rate is obtained from RG 1.111 on Figures 8 and 9 for the vent and stack, respectively.

2. Multiplying the relative deposition rate by the fraction of the release transported into the sector.

3. Taking this product and dividing by the appropriate crosswind distance, which is the arc length of the sector at the point being considered.

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TABLE 2.3-1
Sheet 1 of 1
DESIGN BASIS TORNADO PARAMETERS

Maximum wind speed	161 m/sec	360 mph
Rotational speed	130 m/sec	290 mph
Translational speed		
Maximum	31 m/sec	70 mph
Minimum	2 m/sec	5 mph
Radius of maximum		
Rotational speed	46 m	150 ft
Pressure drop	2,109 kg/m^2	3 psi
Rate of pressure drop	1,406 $kg/m^2/sec$	2 psi/sec

TABLE 2.3-2
Sheet 1 of 1
VERTICAL PROFILE OF THE 100-YEAR RECURRENCE INTERVAL FASTEST MILE OF WIND

Height Above Ground		Fastest Mile	
m	ft	m/sec	mph
9.1	30	36.7	82
30.5	100	43.4	97
61.0⁽¹⁾	200⁽¹⁾	48.3	108
91.5	300	51.0	114
121.9⁽²⁾	400⁽²⁾	53.2	119
152.4⁽³⁾	500⁽³⁾	55.0	123
182.9	600	56.3	126

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(1) Approximate height of reactor building.
(2) Approximate height of stack.
(3) Approximate height of cooling tower.

TABLE 2.3-3
Sheet 1 of 1
GROUND-LEVEL INCREASES IN AMBIENT RELATIVE HUMIDITY (RH) DUE TO
OPERATION OF THE NATURAL-DRAFT COOLING TOWER AT NINE MILE POINT

Downwind Sector	Max Annual RH Increase (%)	Distance		Max Monthly RH Increase (%)	Distance		Max Daily RH Increase (%)	Distance		Max Hourly RH Increase (%)	Distance	
		ft	m		ft	m		ft	m		ft	M
N	0.002	3,250	991	0.010	4,000	1,219	0.22	3,250	991	1.40	3,250	991
NNE	0.0009	3,750	1,143	0.013	3,750	1,143	0.10	4,500	1,372	1.60	3,500	1,067
NE	0.0008	3,000	914	0.015	3,000	914	0.44	3,000	914	2.00	3,250	991
ENE	0.002	2,750	838	0.020	2,500	762	0.58	2,500	762	1.60	4,000	1,219
E	0.005	2,500	762	0.043	2,500	762	1.70	2,750	838	2.10	2,750	838
ESE	0.012	2,750	838	0.230	2,750	838	1.80	2,750	838	2.80	2,500	762
SE	0.018	3,000	914	0.160	2,750	838	3.30	2,750	838	3.30	3,000	914
SSE	0.014	3,000	914	0.088	3,000	914	1.00	2,750	838	2.20	3,500	1,067
S	0.012	3,250	991	0.053	3,500	1,067	0.52	3,000	914	2.40	3,000	914
SSW	0.005	3,500	1,067	0.070	3,000	914	0.68	3,000	914	2.50	3,250	991
SW	0.003	3,500	1,067	0.039	3,250	991	0.85	3,250	991	2.50	3,250	991
WSW	0.0001	4,750	1,448	0.004	4,250	1,295	0.11	4,250	1,295	1.10	4,000	1,219
W	0.005	4,500	1,372	0.014	4,250	1,295	0.38	4,000	1,219	1.50	3,750	1,143
WNW	0.001	3,500	1,067	0.017	3,500	1,067	0.26	3,750	1,143	1.60	3,750	1,143
NW	0.002	3,500	1,067	0.010	3,250	991	0.29	3,250	991	1.40	4,000	1,219
NNW	0.003	3,250	991	0.013	3,000	914	0.21	3,500	1,067	1.80	3,250	991
Worst Sector	0.018	3,000 (SE)	914	0.230	2,750 (ESE)	838	3.30	2,750 (SE)	838	3.30	3,000 (SE)	914

<u>Ambient Diurnal RH Changes at Nine Mile Point</u>*

01	07	13	19	(LST)
78%	81%	71%	71%	

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* Based on 3 yr (1974-1976) of onsite meteorological data.

TABLE 2.3-4
Sheet 1 of 2
METEOROLOGICAL INSTRUMENTATION SPECIFICATIONS

Preoperational Measurements Program

Parameter	Instrument	Specification	Value
Wind direction	Bendix Aerovane	Damping ratio Distance constant Range Accuracy	0.29 10 m (34 ft) 0-540 deg ±2 deg
	Climatronics F-460	Damping ratio Distance constant Starting threshold Range Accuracy	0.4 1.1 m (3.7 ft) 0.3 m/sec (0.6 mph) 0-540 deg ±3.0 deg
Wind speed	Bendix Aerovane	Distance constant Starting threshold Range Accuracy	5 m (15 ft) 1.1-1.3 m/sec (2.5-3.0 mph) 0-45 m/sec (0-100 mph) ±0.5 m/sec (±1.0 mph)
	Climatronics F-460	Distance constant Threshold Range Accuracy	1.5 m (5.0 ft) 0.3 m/sec (0.6 mph) 0 to 45 m/sec (0 to 100 mph) ±0.07 m/sec (±0.15 mph)
Temperature	Climatronics F-460 thermistor probes	Time constant Linearity Range Accuracy-ambient temperature Accuracy-difference temperature	10 sec ±0.2°C (±0.4°F) -30°C to 50°C (-22°F to 122°F) ±0.2°C (±0.4°F) ±0.1°C (±0.2°F)
	Climatronics TS-10 temperature shields	Error Temperature range	0.1°C (0.2°F) or less under radiation of 1.6 gm-cal/cm^2/min (353.8 Btu/ft^2/hr) -54°C to 66°C (-65°F to 150°F)
Relative humidity	Hygrometrix Xeritron relative humidity sensor	Accuracy Range Linearity Repeatability	±2% 0-100% relative humidity 2% 0.5%

TABLE 2.3-4
Sheet 2 of 2

Parameter	Instrument	Specification	Value
Dew point	EG&G Model 220	Range Accuracy	-50°C to +50°C (-58°F to 122°F) ±0.4°C (±0.7°F)
Precipitation	Weathermeasure	Accuracy Calibration increment	±0.5% 0.25 mm (0.01 in)
Barometric pressure	Climatronics	Linearity Sensitivity Repeatability	±0.3% 0.2% Within 0.2% (Btu/ft^2/hr)
Recording system	Kennedy tape recorder	Tape used Tape format Tape reels Write mode Recording speed Density Record gap time Slew rate	0.5 in wide, 1.5 mil thick computer tape Nine-track NRZI Up to 8.5 in diameter 0-500 msec 800 bpi 550 msec 1,000 characters/sec
	John Fluke data logger	System accuracy Resolution	±0.02% of reading 40,000:1

Sources: References 48-54

TABLE 2.3-4A
Sheet 1 of 1
METEOROLOGICAL INSTRUMENTATION SPECIFICATIONS

Operational Measurements Program

Parameter	Instrument	Specification	Value
Wind direction	Teledyne Geotech/Met One Instruments Sensor – 50.2C/50.2D Vane – 53.2 Processor – 21.21, 21.210 & 21.211	Accuracy Damping ratio Distance constant Range Threshold	±2 deg 0.4 1.1 m (3.7 ft) 0-360/540 deg 0.30 m/sec (0.7 mph)
Wind speed	Teledyne Geotech/Met One Instruments Sensor – 50.1B Cups – 52.1 Processor – 40.12c, 21.11, & 21.110	Accuracy Distance constant Starting threshold Range	±0.67 m/sec (±0.15 mph) or 1% 1.5 m (5.0 ft) 0.27 m/sec (0.6 mph) 0-45 m/sec (0-100 mph)
Temperature	Teledyne Geotech/Met One Instruments Sensor – Platinum RTD Processor – 21.32 & 21.320 Aspirated Thermal Radiation Shield 327	Ambient temperature range Temperature difference Range Linearity Error	-40 to 43°C (-40 to 110°F) -4 to 11°C (-8 to 20°F) ±0.2°C (±0.4°F) 0.1°C (0.2°F) under radiation of 1.6 cal/cm^2/min (353.8 Btu/ft^2/hr)
Dew point	General Eastern 1200EPS or E1	Range	-40 to 43°C (-40 to 110°F)
Precipitation	Belfort Instrument Company Tipping Bucket	Calibration increment	0.25 mm (0.01 in)
Barometric Pressure	Yellow Springs Instrument Company Sensor – 2014-28/32-HA-3WH Teledyne Geotech Processor – 40.61 & 21.61	Range	948 to 1084 mb (28.00 to 32.00 in Hg)

TABLE 2.3-5
Sheet 1 of 3
METEOROLOGICAL INSTRUMENTATION SYSTEM ACCURACIES

Preoperational Measurements Program

Parameter	Component	Component Error	Analog System Accuracy	Digital System Accuracy
Aerovane wind direction	Sensor	±2.00 deg	±3.40 deg	±2.05 deg
	Synchro to dc converter	±0.25 deg		
	Translator	±0.37 deg		
	Recorder	±2.70 deg		
	Data logger	±0.11 deg		
Aerovane wind speed	Sensor	±0.50 m/sec (±1.12 mph)	±0.55 m/sec (±1.23 mph)	±0.50 m/sec (±1.12 mph)
	Translator	±0.02 m/sec (±0.04 mph)		
	Recorder	±0.23 m/sec (±0.52 mph)		
	Data logger	±0.01 m/sec (±0.02 mph)		
F-460 wind direction	Sensor	±3.00 deg	±6.18 deg	±3.01 deg
	Translator	±0.27 deg		
	Recorder	±5.40 deg		
	Data logger	±0.11 deg		

TABLE 2.3-5
Sheet 2 of 3

Parameter	Component	Component Error	Analog System Accuracy	Digital System Accuracy
F-460 wind speed	Sensor	±0.07 m/sec (±0.16 mph)	±0.46 m/sec (±1.03 mph)	±0.09 m/sec (±0.20 mph)
	Translator	±0.02 m/sec (±0.04 mph)		
	Recorder	±0.45 m/sec (±1.01 mph)		
	Data logger	±0.05 m/sec (±0.11 mph)		
Temperature (ambient)	Sensor	±0.20°C (±0.36°F)	±0.83°C (±1.49°F)	±0.22°C (±0.39°F)
	Translator	±0.04°C (±0.07°F)		
	Recorder	±0.80°C (±1.44°F)		
	Data logger	±0.08°C (±0.14°F)		
Temperature (difference)	Sensor	±0.10°C (±0.18°F)	±0.32°C (±0.58°F)	±0.10°C (±0.18°F)
	Translator	±0.02°C (0.04°F)		
	Recorder	±0.30°C (±0.54°F)		
	Data logger	±0.01°C (±0.02°F)		

TABLE 2.3-5
Sheet 3 of 3

Parameter	Component	Component Error	Analog System Accuracy	Digital System Accuracy
Relative humidity	Sensor	±2.00%	±2.24%	±2.00%
	Translator	±0.05%		
	Recorder	±1.00%		
	Data logger	±0.02%		
Dew point (ambient)	Sensor and translator electronics	±0.40°C (±0.72°F)	±0.50°C (±0.90°F)	±0.40°C (±0.72°F)
	Recorder	±0.30°C (±0.54°F)		
	Data logger	±0.02°C (±0.04°F)		

NOTE: Analog and digital system accuracies listed in this table were determined by statistical methods, for design purposes, on meteorological instrumentation used prior to midsummer 1982.

TABLE 2.3-5A
Sheet 1 of 3
METEOROLOGICAL INSTRUMENTATION SYSTEM ACCURACIES

Operational Measurements Program

Parameter	Component	Component Error	Analog System Accuracy	Digital System Accuracy
Wind direction	Sensor	±2.00 deg	±3.06 deg	±2.09 deg
	Processor	±0.54 deg		
	Recorder	±2.25 deg		
	Data acquisition	±0.27 deg		
Wind speed	Sensor	±0.07 m/sec (±0.15 mph)	±0.23 m/sec (±0.53 mph)	±0.08 m/sec (±0.19 mph)
	Processor	±0.04 m/sec (±0.10 mph)		
	Recorder	±0.22 m/sec (±0.50 mph)		
	Data acquisition	±0.022 m/sec (±0.05 mph)		
Ambient temperature	Sensor	±0.05°C (±0.09°F)	±0.22°C (±0.41°F)	±0.08°C (±0.15°F)
	Processor	±0.05°C (±0.09°F)		
	Recorder	±0.21°C (±0.385°F)		
	Data acquisition	±0.042°C (±0.075°F)		

TABLE 2.3-5A
Sheet 2 of 3

Parameter	Component	Component Error	Analog System Accuracy	Digital System Accuracy
Temperature difference	Sensor	±0.05°C (±0.09°F)	±0.08°C (±0.15°F)	±0.07°C (±0.13°F)
	Processor	±0.05°C (±0.09°F)		
	Recorder	±0.043°C (±0.077°F)		
	Data acquisition	±0.008°C (±0.014°F)		
Dew point system	Sensor	±0.22°C (±0.40°F)	±0.30°C (±0.56°F)	±0.22°C (±0.41°F)
	Recorder	±0.21°C (±0.385°F)		
	Data acquisition	±0.042°C (±0.075°F)		
Pressure	Sensor	±0.406 mb (±0.012 in)	±0.546 mb (±0.016 in)	±0.433 mb (±0.013 in)
	Processor	±0.135 mb (±0.004 in)		
	Recorder	±0.339 mb (±0.01 in)		
	Data acquisition	±0.068 mb (±0.002 in)		

TABLE 2.3-5A
Sheet 3 of 3

Parameter	Component	Component Error	Analog System Accuracy	Digital System Accuracy
Precipitation	Sensor	±0.254 mm (±0.01 in)	±0.2910 mm (±0.0115 in)	±0.2843 mm (±0.0112 in)
	Processor	±0.127 mm (±0.005 in)		
	Recorder	±0.0635 mm (±0.0025 in)		
	Data acquisition	±0.0127 mm (±0.0005 in)		

NOTE: Analog and digital system accuracies listed in this table are for design purposes. For in-service operational accuracies, include information from proposed Revision 1 to RG 1.23. Refer to specific accuracies of time averaged values by parameter listed in Sections C.4.a and C.4.b of proposed Revision 1 to RG 1.23.

TABLE 2.3-6
Sheet 1 of 1
FASTEST MILE WIND SPEEDS AT OSWEGO, SYRACUSE, AND ROCHESTER

		True Speed (Fastest Mile)		Anemometer Height		Fastest Mile			
						10 m (33 ft) or 30 m (98 ft)			
Station	Year	m/sec	mph	m	ft	m/sec	mph	m/sec	mph
Oswego Weather Bureau Office(1)	1893	28	62	26	84			38	84
	1926	28	62	26	85			37	83
Oswego NWS Station(2)	1964	38	85	20	65	34	77		
Rochester Weather Bureau Office(3)	1922	27	60	31	102			34	76
Rochester NWS Rochester Airport(4)	1950	33	73	21	69	29	65		
	1979	27	60	6	20	30	66		
Syracuse Weather Bureau Office(5)	1921	34	75	34	113			41	92
Syracuse NWS Hancock Airport(6)	1954	28	63	22	72	25	56		
	1967	28	62	6	21	30	67		

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(1) Period of record 1887 through 1952
(2) Period of record 1953 through 1967, generally April 10 through December 15
(3) Period of record 1887 through 1940
(4) Period of record 1941 through 1979
(5) Period of record 1903 through 1940
(6) Period of record 1941 through 1979

Source: Reference 57

TABLE 2.3-7
Sheet 1 of 1
NORTHEAST STATE SNOWFALL RECORDS ABSTRACTED BY LUDLUM

Location	Storm Duration	Snow Amount (in)
New Haven, CT	24 hr	28.0
Middletown, CT	3 days	50.0
Blue Hill, MA	24 hr	28.2
Peru, MA	4 days	47.0
Randolph, NH	24 hr	56.0
Pinkham Notch, NH	5 days	77.0
Long Branch, NJ	24 hr	29.7
Cape May, NJ	4 days	34.0
Barnes Corners, NY	24 hr	54.0*
Watertown, NY	5 days	69.0
Morgantown, PA	24 hr	38.0
Morgantown, PA	3 days	50.0
St. Johnsburg, VT	24 hr	33.0
Readsboro, VT	5 days	50.0

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* Limiting case for deriving the highest 48-hr snowfall.

2.4 HYDROLOGIC ENGINEERING

2.4.3 Hydrologic Description

2.4.3.0 Site and Facilities

Unit 2 is located on the western portion of the Nine Mile Point promontory on the southeastern shore of Lake Ontario in Oswego County, NY. All elevations in this report refer to the USLS 1935 Data.

2. To convert elevations from USLS 1935 to 1955 International Great Lakes Data, subtract 0.375 m (1.23 ft).

2. To convert elevations from USLS 1935 to 1985 International Great Lakes Data, subtract 0.217 m (0.71 ft).

The natural grade elevation of the Nine Mile Point site varies between el 78.03 m (256 ft) and el 80.77 m (265 ft). There are no perennial streams located on the site. Precipitation at the site is carried to Lake Ontario via drainage ditches, storm sewers, and groundwater flow.

A revetment ditch system is constructed along the lakeshore in front of Unit 2. The top of the revetment is at el 80.16 m (263 ft) and prevents possible plant flooding due to lake wave action (Section 2.4.5). A ditch located immediately south of the revetment collects rainfall runoff flowing north toward the lake and conveys the flow to both ends of the revetment.

All personnel entrances to Category I structures are at el 79.55 m (261 ft) or higher. A detailed description of the water level (flood) design is found in Section 3.4.

2.4.3.0 Hydrosphere

Lake Ontario, the easternmost of the Great Lakes, is an international body of water forming part of the border between the United States and Canada. The lake is 310.6 km (193 mi) long and 85.3 km (53 mi) wide at its largest points, and has a surface area of 19,010.6 sq km (7,340 sq mi) or 1.901 million ha (4.7 million acres). It has a maximum depth of 244.4 m (802 ft), an average depth of approximately 86.3 m (283 ft), and a volume of 1,638 cu km (393 cu mi) or 0.164 billion ha-m (1.34 billion acre-ft).

Inflow into the western end of Lake Ontario averages approximately 5,806 cu m/sec (205,000 cu ft/sec [cfs]). Runoff directly into Lake Ontario from 70,707 sq km (27,300 sq mi) of watershed in New York State and the province of Ontario amounts to an additional 1,020 cu m/sec (36,000 cfs). The main feeder is the Niagara River; other large rivers draining into the lake are the Genesee and the Oswego from the south shore, the Black River from the east shore, and the Trent River from the north shore. The outflow from the lake into the St. Lawrence River averages about 6,824 cu m/sec (241,000 cfs).

During the winter, ice cover forms in the slack water bays, but the lake itself is seldom more than 25 percent ice-covered. Lake Ontario’s outflow river, the St. Lawrence, is ice-covered from late December until the end of March, all the way from the lake to the international boundary at Massena, NY.

Prior to the beginning of flow regulation, the elevation of the lake surface was controlled by a natural rock weir located about 6.4 km (4 mi) downstream from Ogdensburg, NY, in the Galop Rapids reach of the St. Lawrence River. The 111-yr record of the USLS (1860 to 1970) indicates a mean lake surface elevation of 75 m (246 ft). Over this period, the maximum monthly lake surface elevation was 75.98 m (249.29 ft) and the minimum was 73.97 m (242.68 ft), a range of 2.01 m (6.61 ft). The annual range of elevations varies between 1.09 and 0.21 m (3.58 and 0.69 ft).

Dams on the St. Lawrence River, under the authority of the International St. Lawrence River Board of Control, are now used to regulate the lake level. The low limit is set for el 74.37 m (244 ft) on April 1 and is maintained at or above that elevation during the entire navigation season (April 1 to November 30). The upper limit of the lake level is el 75.59 m (248 ft).

Water surface setup and seiche are produced by winds and atmospheric pressure gradients. These short-term lake fluctuations are generally less than 0.6 m (2 ft) in amplitude. Winds are directly related to the formation of surface waves, the magnitude of which varies between 0 and 4.6 m (15 ft) in height during a given year. Tide magnitudes amount to less than 2.5 cm (1 in).

The average annual precipitation in the site area is about 92 cm (36 in). It is estimated that approximately 46 cm (18 in) are lost as runoff into stream flow. Of the remaining 46 cm (18 in), approximately 41 cm (16 in) are lost via evaporation from land and water surfaces and transpiration by plants, referred to together as evapotranspiration. The remaining 5 cm (2 in) are available for groundwater recharge. The relatively high runoff can be attributed to the low permeability of the glacial soils and rock formations. The historical maximum precipitation in the vicinity of the site(1) is listed in Table 2.4-1.

Unit 2 is located between two surface water users employing once-through cooling water systems. Unit 1 is located immediately west of Unit 2 and recirculates an average of 1,011 cu m/min (268,000 gpm) of Lake Ontario. James A. FitzPatrick Nuclear Power Plant, located immediately east of Unit 2, recirculates an average of 1,401 cu m/min (370,200 gpm).

The only major public water supplies within a 50-km (30-mi) radius of the site that draw water from the lake through a common intake are the city of Oswego and the OCWD. All water supply systems and industrial users drawing from U.S. waters on Lake Ontario are listed in Table 2.4-11. Data on Canadian water suppliers and industrial users are provided in Table 2.4-12. The 16 U.S. and 10 Canadian municipal water supplies and industrial users within 80 km (50 mi) of the site that withdraw water directly from Lake Ontario are shown on Figure 2.4-16. United States irrigation intakes are identified and located in Table 2.4-13. Canadian irrigation intake locations are identified in Table 2.4-14. A tabulation of groundwater users is in Section 2.4.13.2.

2.4.3 Floods

2.4.3.0 Flood History

There are no major streams or rivers within the drainage area that contains the site. Therefore, there has been no historical stream or river flooding at the site. There is no information available to indicate that overland drainage of the site area has resulted in any flooding situations.

The maximum instantaneous monthly levels of Lake Ontario at Oswego, NY, for the historical period of record, 1900 to 1978, are presented in Table 2.4-2. The historical maximum level was 76.25 m (250.19 ft) USLS measured in June 1952. The maximum instantaneous monthly levels of Lake Ontario at Oswego since the current plan of lake regulation (Plan 1958-D) began (October 1963) are also presented in Table 2.4-2. The maximum level for this period (October 1963 to December 1978) was 76.07 m (249.58 ft) USLS measured in June 1973.

2.4.3.0 Flood Design Considerations

Unit 2 is designed to prevent the loss or failure of safety-related equipment required for cold shutdown resulting from the most severe flood conditions predicted for the site. All safety-related facilities, systems, and equipment are protected against flood damage resulting from the following combinations of events:

2. PMP (Section 2.4.2.3.1) and historical maximum lake level (Section 2.4.2.1).

2. Historical maximum precipitation (Section 2.4.1.2) and probable maximum lake level (Section 2.4.5.1).

2. Surge with wind-wave action from PMW.

External flood protection (Section 2.4.2.3.3) is provided to prevent flood damage due to high lake water levels and precipitation runoff from the drainage basin encompassing the

Unit 2 site. The shorefront revetment is designed to protect the plant from surge and wind-wave activity from Lake Ontario (Section 2.4.5.5).

2.4.3.0 Effects of Local Intense Precipitation

The natural ground elevation at the Unit 2 site generally slopes toward Lake Ontario, and the natural drainage is into the lake. In the immediate vicinity of the plant, the grade is at el 79.25 m (260 ft) and is sloped to a series of collection ditches and a storm sewer system. The storm sewer system is designed to remove runoff from a locally intense precipitation rate of 16.5 cm (6.5 in) per hour without ponding. Roof drainage is designed for a slightly higher locally intense precipitation rate of 21.3 cm (8.4 in) per hour, based upon calculated rainfall from a PMP developed from National Oceanic and Atmospheric Administration (NOAA) Hydrometeorological Report No. 33. The roof drainage system and the storm sewer system convey the runoff to the lake.

The roofs of seismic Category I structures have also been evaluated to assess the impact of the PMP rainfall based upon Hydrometeorological Reports No. 51 and 52. The roof drainage system is designed in accordance with detailed requirements of the National Plumbing Code, including roof drain size, type, and coverage, and the sizing of horizontal and vertical drain lines.

Plugging of roof drains is generally not assumed. The code requires that each roof drain be equipped with a strainer basket extending not less than 4 in above the adjacent roof surface. Therefore, any buildup of debris on a roof would have to exceed the height of the strainer baskets before total plugging could occur. Appreciable plugging of the strainer could be accommodated prior to degradation of the drain capacity. However, for purposes of analysis, the plant has been evaluated for blocked roof drains under PMP conditions.

The evaluation indicated that except for the built-up roof of the reactor building, the reinforced concrete roofs of all other safety-related structures are capable of supporting the loading due to the PMP without loss of function. Concrete roofs can structurally withstand the water buildup on the roof up to the height of the roof’s parapets. Scuppers are provided through the parapet of the reactor building to release excess runoff water. In addition, scuppers are also installed in the screenwell building’s parapet. While the screenwell superstructure is not designated safety related, scuppers will ensure release of excess water on the built-up roof.

The site in the immediate vicinity of the plant is also graded to carry the PMP runoff overland to the lake without the use of the storm sewer system. Exterior barriers around the plant buildings divert PMP surface flows from the drainage basin encompassing the site. Elevations of the plant grade, roads, railroads, and exterior barriers are shown on Figure 2.4-1.

2.4.3.0.5 Probable Maximum Precipitation

The all-season PMP values for the site location for various durations and drainage areas are shown in Table 2.4-3. Values in the table are the worst-case conditions for the entire year. The winter PMP is not considered separately from the all-season PMP. Since the winter rainfall in the site locality does not normally produce the annual maximum rainfall, the winter PMP is expected to be less than the all-season PMP.

Water levels were determined using PMP rainfall intensities drainage areas applicable to the area of the site being analyzed. For areas between 1.34 sq mi (the size of the entire watershed surrounding the site) and 1 sq mi, the PMP values for the entire watershed area were used. For drainage areas of 1 sq mi or less, the 1 sq mi values were used.

PMP values used in site water level analyses were also dependent on the applicable duration of the rainfall. Appropriate durations were chosen based on the time of concentration for each subbasin making up the watershed. PMP quantities as high as 7.1 in in 10 min (rainfall intensity of 42.8 in/hr) were used in computing water levels at the plant. The analysis shows that the maximum 20-min, 9.9-in PMP is the most critical rainfall for the plant area and the area between the west entrance road and the east flood protection berm.

PMP values were computed using two publications of the NOAA, U.S. Department of Commerce: Hydrometeorological Report No. 51, Probable Maximum Precipitation – United States East of the 105th Meridian and HMR No. 52, Application of Probable Maximum Precipitation – United States East of the 105th Meridian, June 1978 and August 1982, respectively.

2.4.3.0.5 Precipitation Losses

The coefficient of runoff used in the determination of the PMF level is based on procedures issued by the Bureau of Reclamation(2).

The major portion of the watershed within which the site is located is densely wooded. The remainder is covered with brush and grass. The soil in this watershed is classified as Hydrological Soil Group C, having a slow infiltration rate when thoroughly wetted. Therefore, a runoff curve number (CN) of 72 for watershed Antecedent Moisture Condition II (AMC-II) is used for that portion of the watershed south of Lake Road. The area north of Lake Road is covered by grass, roads, and hard surfaces, and its CN designation is 82. AMC-II assumes that the soil moisture conditions are similar to the average conditions present before a maximum annual flood. Precipitation runoff quantities for the watershed area surrounding the site were determined using the AMC-II curves.

For certain portions of the site area north of Lake Road but outside the immediate plant area, a runoff coefficient of 0.75 was used to determine runoff flows. Runoff from plant structures, facilities, and roadways, as well as areas immediately adjacent to these items, was assumed to be equal to precipitation (i.e., a runoff coefficient of 1.0 was assigned).

2.4.3.0.5 Probable Maximum Flood Flow

The drainage basin in which the site is located covers approximately 3.4 sq km (1.3 sq mi). The watershed slopes generally from el 97.5 m (320 ft) at the extreme southern end to el 76.2 m (250 ft) at the lakeshore. The drainage basin and the subbasin drainage areas are shown on Figure 2.4-2.

Flood flows and resulting water elevations for the site were computed in two parts:

2. Outside the flood control berms surrounding the site (Figure 2.4-1).

2. Inside the flood control berms.

The U.S. Army Corps of Engineers HEC-1, Flood Hydrograph Package, was used to compute peak runoff flow rates from the watershed areas south of Lake Road and outside the flood control berms east and west of the site area. Input to the HEC-1 computer program consists of runoff quantities computed as described above and of various drainage basin characteristics, such as drainage areas and storage volume and/or flow rate at key flow control structures (such as roadways and railroad beds) versus water surface elevation. Peak flow rates at various locations outside the flood control berms are shown on Figure 2.4-1. Peak water surface elevations were then determined using the U.S. COE HEC-2, Water Surface Profiles Program. Peak water surface elevations at various locations outside the flood control berms are shown on Figure 2.4-1.

The flood control berms which protect offsite PMF runoff from entering the site area also prevent onsite PMF runoff from leaving the site in most directions. The water elevations inside the flood control berms, and directly adjacent to plant facilities, due to the PMP, are basically controlled by two outlets: the culverts under the railroad tracks and the access road southwest of the Unit 1 switchyard, and overland flow to the north, next to the structures. These pathways are shown on Figure 2.4-1. To support construction activities, permanent and temporary buildings are used at the site. The areas of building concentration are also shown on Figure 2.4-1.

Runoff flow rates onsite were computed using applicable PMP intensities as described in Section 2.4.2.3.1, the runoff coefficients determined as described in Section 2.4.2.3.2, and the rational formula:

$Q = C\ I\ A$

Where:

Q = Flow, cfs
C = Runoff coefficient
I = Runoff intensity, in/hr
A = Drainage area, acres

An iterative process was used to determine how much runoff left the site at the culverts and how much ran off to the northeast next to the plant structures. Because of higher velocity in the culverts, no source of significant debris, and no evidence of trash or sediment buildup on the culverts, the culverts are not expected to be blocked by debris. The culverts were assumed to be 100 percent open during a PMF. At this location, water also flowed over the roadbeds above the top of the culverts. By choosing an arbitrary dividing line between the two flow directions, determining the flow rates associated with the two drainage areas, and computing the water levels using the HEC-2 computer program, the iterative process eventually produced the same water level at the dividing line.

The maximum PMP flood level in the vicinity of the plant buildings is el 262.5 ft (80.1 m), based on the conservative assumption that the storm sewer is inoperable and the culverts southwest of the Unit 1 switchyard are not blocked. Since this peak elevation is above the plant floor at el 261 ft (79.6 m), further analyses were performed to determine the effect of leakage into the plant facilities. The analyses are described in Section 2.4.10.

In the area between the west entrance road and the east flood protection berm, there are permanent and temporary construction buildings and security fences (Figure 2.4-1). To study the PMF water level in this area, the flow was calculated using the rational formula; HEC-2 program was used to calculate the water surface profile. The ground elevations, buildings, and fences were incorporated into the cross sections. The fences were assumed 30-percent blocked. The results show that the water elevations east of the west entrance road are below the design elevations of the road. The water elevations and the design elevations are shown on Figure 2.4-1. The PMF in this area will not impact the plant area.

The historical maximum precipitation combined with the probable maximum lake level, including wave action, results in a constant water level of 79.14 m (259.7 ft) in the ditch immediately south of the revetment. This combination of events creates a maximum flood level at the north side of the plant buildings of el 79.4 m (260.4 ft). Since the PMF flows are greater than the historical maximum precipitation flood flows, the flood elevations are not as high as the PMF water levels.

The west berm, Lake Road berm, southeast berm, and east berm (Figure 2.4-1) direct the majority of the PMP flood flows around the plant perimeter. Typical cross sections of the berms are shown on Figure 2.5-209. The berms are constructed of Category I structural fill (Section 2.5.6). The allowable seepage through the berms is 17.03 cu m (4,500 gal) per min (10 cfs). The berms are designed for the static and dynamic loads discussed in Section 2.5.6.

Reinforced concrete retaining walls and wood stop logs are placed at the Unit 1 railroad track where the west berm crosses to prevent the flood water from flowing down the railroad tracks into the immediate plant area. The concrete retaining walls are 18-in thick and are placed to provide a clear opening of 15 ft with the top elevation at 275.5 ft. The walls hold 8-in x 8-in pressure-treated wooden stop logs in steel-lined slots from el 271.56 ft to el 275.2 ft (minimum). Steel hold-down angles are provided at both retaining walls to secure these logs in place. The stop logs extend from the track, el 271.56 ft, to the top of the flood control berm, el 275.2 ft.

The winter PMF would be less than the all-season PMF. However, during the winter season, the ice piling on the shore of Lake Ontario near the site might block local drainage and cause potential site flooding.

Records of ice cover in the lake indicate that the initial stage of the nearshore ice is developed in February along the shore near the site. Observation of ice development in the Great Lakes indicates that the initial stage of lake ice development is the formation of a frozen beach. This is usually followed by the buildup of a small ridge or icefoot at or near the water’s edge. Subsequent to the icefoot development is the formation of a tabular ice lagoon which terminates at the first ice ridge. Development of ice ridges is commonly associated with breaking waves. In general, the height of icefoot is much less than the height of ice ridges and the ice ridge closest to the shore is the smallest. Pictures taken in the vicinity of the site (Figure 2.4-3) show ice ridges developed at a distance from the shore on the ice cover in the lake; however, detailed information of ice piling at the site is not available. Current information indicates that adjacent nuclear power plants, Unit 1 and James A. FitzPatrick, have not experienced any site flooding due to ice blockage.

The icefoot developed on the shoreline is usually small and the ice ridges are developed at some distances from the shore. Therefore, it can be concluded that the possibility of ice blockage of the overland drainage outlets is very remote. Furthermore, since the winter PMF is smaller than the all-season

PMF, the winter PMF, in conjunction with ice accumulation near the site, would not cause flooding to safety-related facilities.

2.4.3 Probable Maximum Flood on Streams and Rivers

No major streams or rivers are located within the related watershed. Therefore, the PMF on streams and rivers is not applicable to Unit 2. Further, PMP and precipitation losses are discussed in Sections 2.4.2.3.1 and 2.4.2.3.2, respectively.

Unit 2 complies with RG 1.59 as discussed in Section 1.8.

2.4.3 Potential Dam Failures

There are no dams on water courses upstream of the site. However, there are two dams on the St. Lawrence River, the outlet to Lake Ontario. As discussed in Section 9.2.5.3.3, the effects resulting from failure of the two dams have been analyzed by the St. Lawrence Study Office of the Canadian Department of Energy, Mines and Resources. The study showed that the lake level would decline gradually from el 242.7 ft USLS to el 240.6 ft USLS approximately 1 yr following the assumed failure. The study concluded that once the lake level had declined to about el 240.6 ft USLS, natural control, such as existed before the project, would be reestablished and the lake levels would rise and fall thereafter in accordance with natural inflows delivered to Lake Ontario from the Great Lakes watershed. Therefore, potential dam failures will result in a lowered lake level which has been considered in plant design.

2.4.3 Probable Maximum Surge and Seiche Flooding

This section discusses the determination of flood levels at the plant site due to surge and seiche flooding with coincident wave activity, as required by RG 1.59.

2.4.3.0 Probable Maximum Winds and Associated Meteorological Parameters

This section defines a PMWS on Lake Ontario and models the pressure and wind fields as the windstorm affects the lake. Because the lake is located inland relative to the Atlantic coastline, an extratropical cyclone will produce higher winds than a hurricane. For this reason, only an extratropical cyclone is considered.

A thorough literature search revealed many models of extratropical cyclones. However, none of these are mesoscale models. They present only basic synoptics rather than time dependence of pressure, wind, and moisture fields over areas of several hundred square miles. Without an accepted cyclone model that could be modified, it was necessary to develop a mesoscale model using either dynamics or climatology. The latter approach was selected because dynamic consistency between wind and pressure fields could not be attained by modeling and probably will not exist in the atmosphere in a cyclone that has an extremely low probability of occurrence. High winds, small radii of curvature, and strong pressure gradient forces will result in various accelerations for which no ready accounting can be provided.

The PMWS model presented here is the same model presented in the proposed American Nuclear Society (ANS) Standards for Determining Design Basis Flooding at Power Reactor Sites(3). The PMWS model is based on historical storms that caused surges on Lake Ontario. Table 2.4-4 lists 12 such storms for which there are records (from 1900 to 1978). Rather than to synthesize a single storm from this list, the January 30, 1971, cyclone was chosen and modified to produce the PMWS. This cyclone produced a high surge on Lake Ontario during the early morning hours of January 30, and had a low central pressure index compared to the other surge-producing storms.

Three-hour NWS surface maps (eight maps per day) of the January 29-30, 1971, storm were analyzed for pressure and wind speed during the period when the storm was near the eastern end of Lake Ontario. The 0400 EST pressure and wind speed fields for January 30 (the time of maximum surge) were smoothed slightly, and the isobar and isotach patterns from these two maps were used throughout the remainder of the model development.

Two basic assumptions were employed to determine the severity of the PMWS. The maximum overwater wind speed was set at 160.9 km/hr (100 mph)(4). The lowest pressure within the PMWS was assumed to be 950 mb. This pressure is slightly below the lowest pressure ever observed in the U.S. outside of a hurricane, and is 954.96 mb recorded in Canton, NY, on January 2 and 3, 1913(5).

Six additional assumptions were introduced into the model for simplification and to provide conservativeness.

2. A steady state exists within the PMWS during the entire time that the storm affects Lake Ontario. A decrease in intensity would cause a lower surge, and an increase in intensity is not possible since the storm is already maximized.

2. The PMWS center moves north of the lake so that the zone of maximum wind travels along the major axis of the lake from approximately west to east. This orientation allows the maximum winds to blow over the longest fetch, producing the largest waves at the site.

2. The PMWS does not occlude, which would begin the dissipation process, at any time while affecting the lake.

4. The PMWS center moves at a constant speed of 64.4 km/hr (40 mph), which is the same translation speed as that of the 1971 storm during the time the 1971 storm was nearest to Lake Ontario.

5. Wind speeds over the water vary diurnally from 1.3 to 1.6 times the overland speed, as shown in Table 2.4-5. This assumption is based on work by Lemire(6).

6. All winds blow 10 deg across the isobars over the lake. Decreased friction over the water will cause the wind to approach a direction parallel to the isobars, but gradient flow will not be reached because of the dynamic inconsistency between the wind and pressure fields.

These assumptions were applied to the isobar and isotach fields from the January 1971 storm. In order for the maximum overwater wind speed to equal 160.9 km/hr (100 mph) in the PMWS, the observed winds were multiplied by two factors. The highest overland wind speed in the historical storm, 55.7 km/hr (34.6 mph), was multiplied by 1.6, the highest ratio in Table 2.4-5. The resulting overwater wind speed of 89.5 km/hr (55.6 mph) was then multiplied by a factor of 1.8 to obtain the desired 160.9 km/hr. To maintain consistency with the PMWS model, the pressure gradients were also multiplied by 1.8.

The derived isobar-isotach fields within the basic PMWS model are depicted on Figure 2.4-4; for illustrative purposes, only overland isotachs above 50 km/hr (31.1 mph) are shown. Figure 2.4-5 shows the path of the PMWS. In keeping with the assumptions listed above, the PMWS was assumed to travel along its trajectory while maintaining a steady state and a constant translational speed. The PMWS wind speeds include both rotational and translational components, since the PMWS was derived from a storm where actual winds were available.

Hourly values of pressure, wind speed, and wind direction were estimated for each of the Lake Ontario zones shown on Figure 2.4-6. Table 2.4-6 lists these parameters for the 28 hr that the PMWS directly affected the lake. Figure 2.4-7 is a plot of the wind speed and direction in the eastern zone of the lake encompassing the Unit 2 site.

2.4.3.0 Surge and Seiche Water Levels

Historical maximum lake levels in the site vicinity are discussed in Section 2.4.2.1. This section discusses probable maximum 11reywacke11 lake level condition due to storm surge and seiche.

The results of the PMWS model discussed in Section 2.4.5.1 were input to a two-dimensional storm surge model. Both models are presented in the design analysis methods for revetment ditch system report(7). Section 2.1 of that report describes the theoretical development, calculational method, and historical verification of the storm surge model. Additional information was provided in the responses to the NRC Requests of July 14, 1976, which were submitted in two parts, one on September 8, 1976, and the other on September 19, 1976. This material concluded that 76.50 m (251.0 ft) USLS was a conservative value for the probable maximum 12reywacke12 lake level at the site. However, the NRC considers the probable maximum 12reywacke12 level to be 77.42 m (254.0 ft) USLS(4). The plant design is based on the extremely conservative 77.42 m (254.0 ft) USLS value.

2.4.3.0 Wave Action

In general, the most commonly used method for wave prediction in deep water is the empirical Sverdrump-Munk-Bretschneider method(8). Wave characteristics are related to fetch and wind speed. Bretschneider developed a computational method for predicting wind waves over the continental shelf(9). Wave heights and wave periods can be calculated based on successive approximations in which energy is added due to wind stress and subtracted due to bottom friction and percolation.

In inland waters such as lakes, fetches are limited by land boundaries. Waves generated in a relatively confined water body are usually found to be significantly lower than the waves expected from the same wind condition over more open water. Saville has proposed a method to determine the effective fetch for complicated inland water bodies(8). Use of Saville's method on Lake Ontario showed that the longest overwater distance to Unit 2 is 254.3 km (158 mi) and the effective fetch is 107.8 km (67 mi).

In this study, Bretschneider's numerical method for wave calculation was modified to incorporate the transient wind field during the PMWS (Section 2.4.5.1) and the effective fetch. The longest open water distance between the land boundary and the site was selected as the transect and divided into subsections. Waves were allowed to be generated at any subsection point and at any time during the PMWS. After the location and time were selected, the transient wind speed, forward speed of the windstorm, and bottom bathymetry were input to the numerical model.

The effective fetch of the first subsection was computed. The wave height and period at the end of the first subsection due to the effective fetch and the concurrent wind speed were computed by the deep-water wave relationship. The wave was then corrected for bottom friction and shoaling effects. At the beginning of the next subsection, a fetch that would generate the wave at the end of the first subsection was back-calculated. The wave at the end of the next subsection was computed by the effective fetch for a distance that equaled the sum of the back-calculated fetch of the first subsection and the length of the second subsection. The wave correction by bottom friction and shoaling effect was performed subsequently. The above computational steps were repeated as the wave moved toward the site. In each subsection computation, the group celerity of the wave was used to calculate the time required for the wave to travel a subsection length. Based on the traveling time of the wave and the information on the wind field, the relative positions of the windstorm and wave were computed. Whenever the wave moved from one wind speed zone to the other, the wind speed of the next zone (Figure 2.4-6) was used. The computer model developed to perform these calculations generated an envelope of significant wave heights and periods describing the waves expected at the site(10). Results for significant waves generated by the PMWS at the Unit 2 site are shown on Figure 2.4-8. The maximum height occurs at hour 20, slightly lagging the peak wind.

Proposed ANS Standards on Determining Design Basis Flooding at Power Reactor Sites state that the 1-percent highest wave or 1.67 times the significant wave height should be used as the maximum design wave height, and that the maximum wave period is 1.2 times the significant wave period(3,11). At Unit 2, the maximum wave condition is H = 13.1 m (43 ft) and T = 15 sec. The revetment ditch response tests discussed in Section 2.4.5.5 were conducted for wave heights up to 40 ft (prototype dimension) and wave periods of 10, 13, and 16 sec. The maximum ditch water levels occurred for the 16-sec wave period with wave heights of 10 to 20 ft. For the stability tests, the maximum breaker wave is the critical design condition. At the probable maximum lake level, 77.4 m (254.0 ft) USLS, the maximum breaker waves are 3.5 m (11.7 ft), 3.7 m (12.0 ft), and 3.7 m (12.2 ft) for wave periods of 10, 13, and 16 sec, respectively.

Under actual storm conditions, the site will be subjected to a spectrum of random waves instead of monochromatic waves. Assuming zero correlation for a well-developed wave field, the wave height and the wave period can be approximated by a distribution (Table 2.4-7) developed by Bretschneider. The use of Table 2.4-7 for estimating water elevations in the ditch under the PMWS condition is discussed in Section 2.4.5.5.

2.4.3.0.5 Wave Action Effect on Main Stack

The safety function of the main stack is to provide an elevated release point for the standby gas treatment system in the event of a LOCA. Therefore, the main stack need not be designed to withstand the effects of the PMWS or resulting flood. However, the effects of the PMWS and resulting flood have been evaluated, and it has been determined that the stack is designed to withstand these effects.

The main stack is located east of the revetment structure and about 79 m (260 ft) south of the shoreline, as shown on Figure

2.4-8A. An analysis was made to analyze the wave change and wave force/moment at the structure.

Wave Height and Wave Period

The most critical wave height and wave period affecting the main stack are those associated with the PMWS. The most critical wave is generated along the major axis of Lake Ontario and refracted toward the site. The maximum wave height and wave period of 13.1 m (43 ft) and 15 sec, which were used for the revetment structure design, were used for the wave runup analysis. The wave is assured to be coincidental with the maximum still water elevation of el 254 ft. Surges and waves due to the northerly and northeasterly winds crossing the lake and Mexico Bay are less critical due to much shorter fetches along these directions (see Figure 2.4-6) and were not considered in the analysis.

Transect Bathymetry

The refracted wave will approach the site from the northwest direction. However, for conservation, the wave is assumed to approach the site from the north direction, as shown on Figure 2.4-8A. The bathymetry is shown on Figures 2.4-8A and 2.4-8B.

Wave Runup

The wave runup at the main stack was calculated by using the composite slope method in the U.S. Army Corps of Engineers Shore Protection Manual (SPM), 1973.

For Ho’ = 13.1 m (43 ft) and T = 15 sec, the breaker height (Hb) and breaking depth (dp) were determined to be 15 m (50.5 ft) and 16 m (53 ft), respectively, using Figures 7.3 and 7.2 of the SPM for a slope of 1.25. The wave breaks at el 201 ft at X = 610 m (2,000 ft). The wave runup was then calculated by the composite slope method, using the extrapolated runup values from Figures 7-10 and 7-11 of the SPM. The runup values from these two figures are averaged. A few iterations yield a runup of 2.1 m (7 ft) to el 261 ft.

Wave Force/Moment

The wave force and moment were then calculated assuming hydrostatic force. With 0.3 m (1 ft) of water depth, the wave force and moment were calculated to be 31.2 lb/ft-width and 10.4 ft-lb/ft-width, or 1,060.8 lb and 353.6 ft-lb, respectively, for a 10.4 m (34-ft) projected main stack width. This force/moment is negligible when compared with the actual force/moment used to design the main stack.

2.4.3.0 Resonance

Resonance is a phenomenon whereby reflection and oscillation of waves within a partially closed body of water such as a harbor can act to amplify the waves above an expected value. As there are no such bodies of water at the site, there will be no resonance effects of Lake Ontario at the site.

2.4.3.0 Protective Structures

All safety-related facilities except the intake structure are protected from flooding during the occurrence of the PMS and the associated wind wave activity of Lake Ontario due to the PMWS by a revetment ditch system. Physical hydraulic prototype testing of the design of this system assured both that the structure is stable and that adequate capacity is provided in the ditch behind the revetment for PMS and PMWS conditions. Detailed test procedures and results of these tests were provided to the NRC(12). The revetment ditch system was subsequently approved by the NRC in their December 1977 letter(13). This section summarizes the results of the tests. A detailed description of the structure and its construction is presented in Section 3.4. A discussion of the ability of the intake structure to withstand the worst-case wind wave action is discussed in Section 3.4.2.

Three types of testing of the revetment ditch system were conducted:

2. Stability tests, designed to assess the adequacy of the revetment armor layers.

2. Response tests, designed to assess the effectiveness of the system for flood protection.

2. The sediment clogging tests were designed to assess the behavior of the revetment structure when the voids in the lower portion of the structure were completely filled with sediments.

The stability tests simulated the ability of the revetment to withstand the most critical breaking waves exerting their maximum force. It was concluded that the revetment is stable under conditions of the PMS level of 77.4 m (254.0 ft) USLS and the critical breaking waves: wave heights of 3.6 m (11.7 ft), 3.7 m (12.0 ft), and 3.7 m (12.2 ft) for wave periods of 10, 13, and 16 sec, respectively.

Response tests were conducted under conditions of the PMS level and several combinations of wave period and height. The highest water level in the ditch was found to be el 79.2 m (259.8 ft) USLS with a 16-sec wave period and a 3.5-m (11.6-ft) wave height. However, storm waves actually consist of different wave periods and amplitudes, and the use of monochromatic waves, as in the model test, does not reflect the actual situation. It is more realistic to estimate the water elevation in the ditch using the combined contribution from all wave components with their respective percentages in the wave train. A wave distribution under the PMWS condition was assumed to be approximated by

Bretschneider's distribution (Table 2.4-7), the number of waves per 1,000 waves of various heights for wave periods of 10, 13, and 16 sec at the maximum wave (significant wave = 10.1 m [33 ft]; significant wave period = 12.5 sec as shown on Figure 2.4-5) can be obtained, as shown in Table 2.4-8.

Using ditch water elevation values induced by monochromatic waves and the wave joint distribution shown in Table 2.4-8, the water elevation in the ditch due to the joint distribution can be calculated. Using this method, the maximum water level in the ditch under PMWS conditions was determined to be 78.6 m (257.9 ft) USLS.

Testing indicated that wave transmission through the revetment was an important factor in the determination of water level in the ditch. Thus, further testing was performed to determine the effects of sediment clogging the voids of the ditch on the water level in the ditch. Results of these tests indicated that even in the unlikely possibility that the voids in the revetment become clogged with sediment up to el 75.59 m (248.0 ft) USLS, the maximum water level in the ditch will be 79.43 m (260.6 ft) USLS, still below the plant grade at el 79.55 m (261.0 ft) USLS.

A severe storm that could affect the functional capability of the revetment ditch is determined by three variable parameters:

2\. Still water elevation greater than 250 ft (this will be the parameter monitored once a month to determine a severe storm).

2\. A wind out of the northerly direction (240 deg to 90 deg).

2\. A wind speed/duration shown on Figure 2.4-18.

When a severe storm occurs, visual inspections for the revetment will include the following:

2\. Inspection of deterioration of the dolosse.

2\. Inspection of the interlocking of the dolosse.

2\. Inspection of the buildup of debris or silt in the lower revetment sections.

2\. Inspection of any obvious movement of the ditch or erosion.

2.4.3 Probable Maximum Tsunami Flooding

Tsunami flooding will not occur at the site.

2.4.3 Ice Effects

The Unit 2 design incorporates features to minimize the potential for cooling water blockage by ice. Two intake structures are located approximately 305 m (1,000 ft) offshore on the lake bottom in 6.1 m (20 ft) of water relative to the minimum controlled lake level (74 m [244 ft]) during navigation season. This location was chosen in lieu of the conventional shoreline intake because of large masses of ice buildup along the south shore of Lake Ontario every year. Ice buildup or ice jam is not expected to affect the normal operation of Unit 2 based on historical experience at the Unit 1, FitzPatrick, and Oswego steam station power plants. Section 2.4.2.3 discusses winter flooding concurrent with ice ridge conditions.

Each intake is a roofed structure that draws water in through six side openings protected with electrically-heated rack bars spaced at 0.3 m (1 ft) centers to block the entrance of large debris. Drawing water through side openings results in water being taken at lower levels, and prevents the formation of vortices at the surface, thus minimizing the possibility of floating ice being drawn down from the surface. Since the intake velocity is 0.15 m/sec (0.5 fps) maximum and the structure is covered by a roof, no floating ice is expected to be drawn through the structure. In the event floating ice is drawn through one face, sufficient flow can be maintained with the remaining open faces.

The formation of frazil ice on intake structure openings can occur in northern climates. This is ice formed when meteorological conditions are such that the water is subcooled below its freezing point due to radiation cooling. Under these conditions, frazil ice can form on intake bar racks; or spongy masses of this ice, formed in other parts of the lake and carried past an intake by wind-driven currents, can adhere to the bar racks.

Frazil ice neither forms on, nor adheres to, racks that are at a temperature slightly above the freezing point (Section 9.2.5.3). Therefore, electrical heating elements are installed in each of the 84 bars at the Unit 2 intake structures to prevent formation of frazil ice. The capacity of these heaters is sufficient to keep the temperature of the bars at least 1°C (34°F) during periods when subcooling occurs. Stray frazil ice would be drawn past the intake racks to the screenwell structure where it can be melted by tempering water from the circulating water system (CWS). Section 9.2.5.2.1 describes in detail the design of the bar rack heating elements. Evaluation of the potential effects of frazil ice formation on operation of the service water intake system is provided in Section 9.2.5.3.1.

Ice forces on the intake structure due to windblown ice from a snow pack along the immediate shoreline should not present a problem because of the physical location of the safety-related structure. The intake structure is located 1,000 ft from the shoreline and at a depth of 20 ft 0 in below the water surface.

Sheet ice will not present a problem, as demonstrated by Stefan's equation:

$$\text{Stefan equation}^{(37)}: \quad x = 0.0853\ \sqrt{\Theta}$$

Where:

X = ice thickness in ft
Θ = freezing index in freezing degree-days

The expected ice thickness is 2.5 ft. The maximum recorded ice thickness for Lake Ontario was 20 in(35,36). Therefore, it was determined that no significant forces would be produced on the structure. In addition, the Oswego 6 and J. A. FitzPatrick plants have never experienced any significant problems at the intakes' structures from ice forces due to windblown or sheet ice.

2.4.3 Cooling Water Canals and Reservoirs

This section is not applicable to Unit 2.

2.4.3 Channel Diversions

This section is not applicable to Unit 2.

2.4.3 Flooding Protection Requirements

The offshore intake structures are designed to sustain the most critical wave forces under various combinations of water levels and the coincidental waves, including those of the PMWS conditions. A detailed description of the design forces is presented in Section 3.4.2.

The site is protected from flooding during the combined event of the PMS and the coincidental wind-wave activity on Lake Ontario due to the PMWS by a revetment ditch system. Physical modeling of this system was performed to assure that the design is adequate. A detailed description of the conditions under which the system was tested is provided in Section 2.4.5.5.

The site is also protected from the local PMF, resulting from the PMP. The site, in the immediate vicinity of the plant, is graded to carry the runoff of the PMP to the lake. In addition, exterior barriers (e.g., berms) located on all three land sides of the immediate plant area divert PMF flow from the watershed adjacent to the plant to prevent the PMF flow from reaching the plant site. The exterior barriers are designed to take the summer and winter PMF with ice effect (Section 2.4.2). Elevations of the plant grade, roads, railroads, and exterior barriers are shown on Figure 2.4-1. Walls and foundations of all Category I structures are designed for a flooding elevation of 79.6 m (261 ft). Since the PMF level calculated from PMP values developed using Hydrometeorological Reports No. 51 and 52 exceeds this elevation for a brief period, further analyses were carried out to determine the effect of the higher water surface elevation on the Category I structures. The additional analyses included a determination of the storm water inflow quantity into each building during a PMF event and an evaluation of the impact of the inflow to the building equipment. These analyses considered the building drains and sumps to be inoperable, as summarized in Table 2.4-15. In only one case, the diesel generator building, was the inflow significant. In this case, the inflow was postulated to pass through the stop logs which have been designed for equipment removal. To remedy this situation, a flexible caulking material (19reywac or equivalent) has been installed in all horizontal and vertical joints of the concrete stoplogs of the diesel generator building below el 263 ft. This material is compatible with concrete and can withstand mechanically-induced vibration and movement and the temperature extremes expected at Unit 2 (see Section 2.3). The design life expectancy of such caulking exceeds 20 yr under the conditions to which it will be exposed; however, it will be replaced after 20 yr of service or when the concrete stoplogs are removed, whichever occurs first. Any equivalent caulking utilized which has a different life expectancy than 19reywac will be replaced when that life expectancy is exceeded. All caulking will be applied in accordance with the manufacturer’s instructions.

Since the site is adequately designed for all postulated flooding conditions, no emergency procedures are required for flood effects.

2.4.3 Low Water Considerations

2.4.3.0 Low Flow in Streams

There are no water supplies at the site that depend on streams.

2.4.3.0 Low Water Resulting from Surges, Seiches, or Tsunami

The probable minimum low water level of Lake Ontario at the site has been determined to be 72.0 m (236.3 ft) USLS resulting from a setdown caused by a PMWS concurrent with the lowest probable lake level. The lowest probable lake level is 73.3 m (240.6 ft) USLS (Section 2.4.11.3). The setdown of 1.3 m (4.3 ft) was adopted as equal to a setup caused by a PMWS(14).

2.4.3.0 Historical Low Water

Minimum 19reywacke19 levels of Lake Ontario, observed during the period of record beginning in 1860, were el 74.0 m (242.8 ft) USLS for the following:

2. Lowest monthly mean water surface level recorded prior to construction of the St. Lawrence Power Project.

2. Lowest mean water surface level for a quarter-month recorded prior to construction of the St. Lawrence Power Project (third quarter of February 1936).

2. Lowest monthly mean water surface level recorded subsequent to the commencement of regulation of Lake Ontario by the St. Lawrence Power Project (December 1964).

The effects of failure of the St. Lawrence Power Project on low lake levels is summarized in Section 2.4.4 and discussed in greater detail in Section 9.2.5.3.3.

2.4.3.0 Future Controls

It is expected that the current plan of regulation of Lake Ontario will continue throughout the plant lifetime of Unit 2. In addition, even if an unexpected alteration were made in the regulation of the lake, there would be no change in the design low water, which is the probable minimum low water level of 72.0 m (236.2 ft) USLS.

2.4.3.0 Plant Requirements

The required minimum safety-related cooling water flow is 82,130 l/min (21,700 gpm) at the design maximum cooling water inlet temperature of 29°C (84°F). The maximum required service water flow during normal operation is 137,010 l/min (36,200 gpm) at the maximum expected cooling water inlet temperature of 25°C (77°F). As discussed in Section 9.2.5, the minimum postulated intake bay water elevation is 71.0 m (233.1 ft), occurring with the minimum postulated lake elevation of 72.0 m (236.3 ft) which is lower than the water level resulting from the 100-yr drought. The suction of the service water pumps is at el 68.9 m (226 ft 2 in). The minimum design operating water level is el 70.4 m (231.0 ft) which provides sufficient suction head to prevent vortexing in the service water pump intake bay. Therefore, low lake levels do not affect the capability of the service water pumps to provide the required cooling water flows.

The discharge system is designed to diffuse and dilute all thermal discharges so that the maximum rise in the ambient temperature at the lake surface is less than 1.7°C (3°F) with the lake at the minimum controlled level of 74.1 m (243 ft). Therefore, the temperature rise at the lake surface will be less than 1.7°C under any condition. A detailed description of the plant discharge system is in Section 9.2.5.

2.4.3.0 Heat Sink Dependability Requirements

The source and discharge point of all the cooling water required by Unit 2 is Lake Ontario. In addition to the cooling water, the lake intake system is designed to supply a maximum of 18,900 l/min (5,000 gpm) of water for the fire protection system (Section 9.5.1).

The required cooling water flow is conveyed through two submerged intake structures independently connected to the screenwell by two intake tunnels below the lake bottom. The lake intake system structures are Category I to ensure a connection to the ultimate heat sink during the combination of events detailed in Section 9.2.5. The lake intake system is designed to meet all the requirements of RG 1.27. The capability of this system has previously been described in detail(15).

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

The most significant source of accidental releases of radioactive liquid directly to surface waters is the rupture of condensate storage tanks (CST) in the CST building. This analysis conservatively assumes that any spillage will proceed directly to the lake with no dilution.

Water users along the shoreline of Lake Ontario are identified in Section 2.4.1. The nearest domestic use of Lake Ontario water is from the common Oswego and Metropolitan Water Board intake, about 13 km (8 mi) west of the site. The average water pumpage at the water supply intake is about 0.88 cu m/sec (20 mgd).

The concentration of an accidental release of radioactive material to the lake near the Nine Mile Point site was analyzed. The method for the determination of the dilution factor in the lake follows the transient release model in RG 1.113.

The equation utilized for calculating dilution is:

$$D = \frac{C_O}{C} \qquad (2.4\text{-}2)$$

Where:

D = Dilution factor

C_o = Concentration in CST, Ci/m^3

C = Concentration at Oswego intake, Ci/m^3

The concentration of radioactive liquid at the common Oswego and Metropolitan Water Board intake is determined by the use of Equation 19 in RG 1.113. For an instantaneous release of a finite quantity of material from a vertical line source positioned at $x = 0$, $y = y_s$ into a lake of known steady longshore current u, the concentration, C, can be expressed as:

$$C = \frac{M}{4\pi \sqrt{K_x K_y}\ td} \exp\left[-\frac{(x-ut)^2}{4K_x t}\right]$$

$$\exp\left[-\frac{(y-y_s)^2}{4K_y t}\right] + \exp\left[-\frac{(y+y_s)^2}{4K_y t}\right] \qquad (2.4\text{-}3)$$

Where:

M = Amount of activity released, Ci

t = Travel time from release to point of interest, sec

K_x = Longitudinal dispersion coefficient, m^2/sec

K_y = Lateral dispersion coefficient, m^2/sec

d = Average lake depth, m

u = Longshore current velocity, m/sec

x = Longitudinal distance from release to point of interest, m

y = Lateral distance from shoreline to point of interest, m

y_s = Lateral distance from shoreline to point of release, m

The factor of radwaste decay is not considered in the equation. The amount of radioactive liquid released can be expressed as:

$$M = C_O V \qquad (2.4\text{-}4)$$

Where:

V = Volume of CST

Therefore, the value of (C/C_o) can be estimated by Equation 2.4-3. Application of the transient release model requires specification of the longitudinal and lateral dispersion coefficients K_x and K_y, longshore current velocity u, average lake depth d, and total volume of the CST. RG 1.113 indicates that the near shore value of K_y in the Great Lakes is approximately in the range of 500 to 1,000 sq cm/sec (0.5 to 1.1 sq ft/sec). For conservatism, the smallest dispersion coefficient value that would result in the largest concentration is used, i.e., K_y = 500 sq cm/sec. Although K_x is known to be larger than K_y, due to the lack of information about K_x in the Great Lakes, it is conservatively assumed that K_x is equal to K_y.

It is also indicated in RG 1.113 that typical speeds of 10 to 20 cm/sec (0.3 to 0.6 ft/sec) for longshore currents have been observed in the Great Lakes. A stable longshore current of 12 cm/sec (0.4 ft/sec) is assumed(16). Normal current flow near the site is predominately west to east. For conservatism, the flow is assumed to be westward in computing concentration at the water supply intake.

The solution of the transient release model in RG 1.113 does not account for the case when the depth of the lake changes. Therefore, it is assumed that there is no difference in lake depths for the pathways. An average lake depth of 4.6 m (15 ft) is assumed in the analysis. There are two CSTs in the condensate storage building. Each tank has a capacity of 1,704 cu m (450,000 gal). For further conservatism, it is assumed that the rupture of two tanks occurs at the same time. The total volume of 3,407 cu m (900,000 gal) is used in the estimation of concentration.

A shoreline release was assumed ($y_s = 0$) and the concentration was estimated along the centerline. The dilution factor at the water supply intake for the peak concentration is estimated to be 45.3. The associated travel time at the water supply intake is estimated to be 29.6 hr. Radiological consequences as a result of this release are described in Section 15.7.3.

2.4.3 Groundwater

2.4.3.0 Description and Onsite Use

2.4.3.0.5 Regional Groundwater Conditions

The area for which regional groundwater conditions are described in this section is defined as the area within a 50-km (30-mi) radius of Unit 2 in Scriba, NY, located on the south shore of Lake Ontario, approximately 56 km (35 mi) north-northwest of Syracuse, NY. Included in this region are Oswego County and portions of Jefferson, Lewis, Oneida, Onondaga, Cayuga, and Wayne Counties, the northwest corner of Madison County, and the northeast corner of Seneca County.

The region lies in the Erie-Ontario Lowlands, the Tug Hill Uplands, and the Black River Valley of the same province. The Erie-Ontario Lowlands is a relatively low and flat area that borders Lake Erie and Lake Ontario on the south and extends up to the Black River Valley. The surface topography rises eastward and southward from Lake Erie at 570 ft AMSL and from Lake Ontario at 244 ft AMSL, to about 1,000 to 1,500 ft AMSL along the Allegheny Escarpment, which forms the boundary with the Appalachian Uplands to the south(17). Tug Hill is an isolated upland located on the eastern part of the Erie-Ontario Lowlands and the Black River Valley. Elevations range from approximately 1,800 to 2,000 ft AMSL and the topographic relief is very low.

The Black River Valley is bordered by rock terraces of the Tug Hill Uplands on the west side of the valley and Adirondack Highlands on the east. A detailed description of the regional physiography is found in Section 2.5.1.1.

In the region, the geologic formations of hydrogeologic importance are either consolidated formations of Paleozoic age, specifically the Middle to Lower Silurian and Upper Ordovician, or recent Pleistocene unconsolidated glacial deposits. For purposes of water resources investigations, the consolidated Paleozoic formations in the region can generally be divided into three hydrologic units: lower shale, sandstone, and sandstone and upper shale. With the exception of one sandstone unit (Clinton), porosity and permeability of the consolidated water-bearing units are relatively low. The unconsolidated Pleistocene deposits of the region are the most important units with respect to water resources. However, depending on their location and composition, their water-bearing characteristics may vary substantially.

In general, the regional groundwater piezometric surface in the Paleozoic formations and in the Pleistocene deposits slopes northward toward Lake Ontario, its natural base discharge. Groundwater recharge areas and topography may affect localized groundwater movement and may vary, to some extent, the direction of aquifer flow. Previous investigations performed during the Unit 2 Preliminary Safety Analysis Report (PSAR) investigation indicate that a hydraulic connection exists between the unconsolidated Pleistocene deposits and the upper consolidated Paleozoic formations(18).

Few of the bedrock formations in the region around Unit 2 have regularly yielded 6 l/sec (100 gpm) or more to an individual well. For the purposes of this section, yield is defined as the quantity of water flow to a well per unit of time. Most wells installed in the bedrock formations yield only sufficient quantities for domestic use. Several wells installed in well-sorted sand and gravel deposits have yielded in excess of 32 l/sec (500 gpm)(19).

The aquifers or water-bearing formations prevalent in the region include:

Glacial deposits	Pleistocene unconsolidated deposits
Bedrock formations	Clinton Group sandstone and upper shale
	Oswego sandstone
	Lorraine Group, containing the Pulaski Formation and the Whetstone Gulf Formation

Figure 2.5-7 shows the generalized lithologic units beneath the site.

Pleistocene Glacial Deposits

The region is underlain by unconsolidated deposits of stratified sands, gravel, and till, varying in thickness from a few meters to in excess of 88 m (290 ft) in major valleys(20).

With respect to groundwater, two types of stratified drift deposits generally serve as good aquifers: outwash sediments, laid down by melt waters of the ice front, and ice contact deposits, formed by running water at the contact of ice and valley walls. Outwash sediments in the region are found along many of the rivers and creeks that drain into Lake Ontario. Kame terraces occur along the margins of the Black River Valley and in smaller tributary valleys(20).

The glacial outwash deposits (sands and gravels) are the major water-bearing sources in the region. These deposits are generally well sorted and have a high porosity, between 20 and 30 percent, while some localized deposit areas may have a porosity as high as 40 percent(20). Several areas of the region contain considerable quantities of this sand and gravel.

Yields of 32 l/sec (500 gpm) or more generally can be obtained from wells installed in the sand and gravel deposits having a saturated thickness of 12 m (40 ft) or more. Several wells in Syracuse are reported to yield 500 gpm; many other wells installed in the sand and gravel deposits in the region are reported to yield 100 to 500 gpm(20).

Till deposits are composed of sand, gravel, and silt and clay mixtures and are relatively impervious. Till deposits cover most of the upland, a large part of the lowland south of Lake Ontario, and underlie other unconsolidated deposits in much of the region. Thickness of the till varies from 9 to 12 m (30 to 40 ft) to as much as 61 m (200 ft). Generally, tills are not suitable for adequate groundwater yield due to their relatively low permeability values. Permeabilities of 2×10^{-5} cm/sec (7×10^{-7} ft/sec) have been estimated for tills in the region(21).

Transmissivity values of the sand and gravel deposits in the region range from about 375 to 9,935 cu m/day/m (30,000 to 800,000 gpd/ft). Fine sand aquifers have transmissivity values ranging from 12 to 130 cu m/day/m (1,000 to 10,500 gpd/ft). No data are available to determine aquifer transmissivity coefficients of mixed deposits. The gravel and coarse sand deposits that compose much of the mixed deposits in the Appalachian Upland probably have coefficients of transmissivity values ranging from 125 to 620 cu m/day/m (10,000 to 50,000 gpd/ft). The generally finer-grained sand and gravel in the mixed deposits in the Tug Hill Upland probably have transmissivity values ranging from near 12 (1,000) to perhaps as much as 375 cu m/day/m (30,000 gpd/ft)(19). Specific capacities of wells installed in sand and gravel in the Oswego River basin ange from about 0.4 to in excess of 103 l/sec/m (2 to 500 gpm/ft) of drawdown(19).

Recharge to the Pleistocene sand and gravel deposits of the region occurs primarily by direct infiltration of precipitation and by infiltration from streams and riverbeds. Groundwater moves from areas of recharge (higher hydraulic head) to areas of discharge (lower hydraulic head). Regional discharge, both surficially and in the unconsolidated glacial deposits, is toward Lake Ontario.

It is generally assumed that in the central New York region, 25 percent of the precipitation falling on the unconsolidated sand and gravel deposits is able to infiltrate into the groundwater system. This amount of infiltration is equivalent to a recharge rate of 877 cu m/day/sq km (0.6 mgd/sq mi) of aquifer surface in the Tug Hill Upland region and 730 cu m/day/sq km (0.5 mgd/sq mi) in the remainder of the region(19).

Sand and gravel deposits located beneath less permeable deposits such as glacial till cannot receive direct recharge from precipitation, runoff, or induced streamflow infiltration. These aquifers must be recharged by adjacent unconsolidated deposits or adjacent saturated bedrock formations.

Water levels in the sand and gravel deposits are responsive to both recharge from precipitation and the river or stream stage of the water body in the valley in which they are located. As previously mentioned, both surface water and groundwater discharge to the west-northwest into Lake Ontario. Lake level elevations generally follow a cyclical pattern, varying only a few meters during the year, reaching their highest levels in May, June, and July(22). Also, lake levels are controlled by a system of locks on the St. Lawrence River. Consequently, only slight variations in regional groundwater levels occur.

Paleozoic Bedrock Formations

As previously mentioned, Oswego County and the surrounding region are underlain by several types of consolidated water-bearing sedimentary bedrock of the Middle to Lower Silurian and the Upper Ordovician ages. These consolidated Paleozoic formations can generally be divided into three hydrogeologic units in the region: lower shales, sandstones, and sandstone and upper shales.

These bedrock units occur as bands that trend predominantly east-west across the region and are inclined toward the south at a regional dip of approximately 9.5 m/km (50 ft/mi). Generally, within the region, the bedrock units are suitable aquifers only within their outcrop band. The yields of the deeper buried units are often low and the rocks usually contain highly mineralized water(19).

Water in the deeper bedrock formations in this region usually occurs under artesian pressure, due to a lack of hydraulic interconnection between the overlying unconsolidated deposits and the other bedrock units.

Lorraine Group The Lorraine Group is a fossiliferous sequence of alternating black siltstone and shale, gray sandstone, and dark-gray argillaceous sandstone(23). Lorraine shale underlies the northern portion of Oswego County and is reported to have an average thickness of approximately 245 m (800 ft)(19). Generally, groundwater in the Lorraine Group occurs along joints and plains of bedding. Average groundwater yields are approximately 0.2 l/sec (3 gpm)(19).

The Lorraine Group sequence comprises two intergrading rock units, namely, the Pulaski and the Whetstone Gulf Formations. No major change in lithology occurs throughout this sequence except for a gradual upward increase in arenaceous material and bedding thickness(23).

The Pulaski Formation may be subdivided into three units. The uppermost unit consists of a dark gray 27reywacke interbedded with light gray sandstone, and few beds of dark gray shale and siltstone. The second unit consists of interbedded light gray sandstone, black siltstone, and shale. The lowermost unit consists of dark gray to black siltstone and shale, interbedded with light gray sandstone(23).

The Whetstone Gulf Formation may be subdivided into two units. The formation generally consists of well-bedded dark gray shale, siltstone, and light gray sandstone. The uppermost unit consists of shale with occasional sandstone beds. The lowermost unit consists of shale with interbedded sandstone(23). Only limited data are available on wells installed in the lower (Lorraine Group) shales. These shales and sandstones are reported to yield a median supply of 0.2 l/sec (3 gpm) or a low of 1 gpm and a high yield of 0.3 l/sec (5 gpm)(19).

Oswego Sandstone, Medina Group, and Clinton Group The Oswego Sandstones are composed of unfossiliferous, greenish-gray, medium- to fine-grained, massive sandstone. The Oswego Sandstones and the lower Clinton Group sandstone and shale occupy the middle and southern parts of Oswego County. The average thickness of the Oswego Sandstone is approximately 30 m (100 ft), while the Clinton Group sandstone and shale generally average between 75 to 120 m (250 to 400 ft) in thickness. Groundwater in these formations occurs generally in joints and bedding planes, and possibly in intergranular pore spaces. Wells installed in the Oswego Sandstone yield an average of 0.6 l/sec (10 gpm); however, yields of as much as 7.9 l/sec (125 gpm) have been reported. The red and green-gray shales and sandstones of the

Medina and Clinton Groups yield an average supply of 0.2 l/sec (3 gpm), with a low of 0.06 l/sec (1 gpm), and a high of 1.8 l/sec (28 gpm)(19).

Bedrock Formation Recharge

Recharge is the entry into the saturated zone of water made available at the water table surface, together with the associated flow away from the water table within the saturated zone(24). Changes in the quantity of water available through precipitation and runoff result directly in water level fluctuations within the aquifers.

The recharge season for the region is during November through April. Approximately 30 percent of the total precipitation results in runoff, and as much as 10 percent is evaporated from the land surface. Approximately 60 percent of the total is left to recharge the formations. During the nonrecharge season, May through October, evaporation increases and only approximately 40 percent of the total precipitation remains to seep into the soil zone, where the majority is eventually evaporated or transpired. Thus, very little groundwater recharge occurs during the warm part of the year(19).

Based on yearly precipitation distribution, approximately 25 percent flows directly to surface-water bodies as runoff, approximately 50 percent is returned to the atmosphere through transpiration and evaporation, and approximately 25 percent recharges the groundwater formations. The average precipitation in the region is approximately 89 cm/g (35 in/yr), resulting in an average groundwater recharge rate of 22 cm/yr (8.5 in/yr). Using these figures, an estimated 0.4 mgd/day/sq mi may be available for recharge(19).

As mentioned in Section 2.4.13.1.1, the region is underlain by unconsolidated materials consisting mostly of till, but with some outwash, alluvium, and lacustrine deposits in varying thicknesses and distribution. For the most part, the till is relatively impermeable, with permeabilities estimated to be approximately 2×10^{-5} cm/sec (7×10^{-6} in/sec).

Recharge of the bedrock formations may also occur by streamflow infiltration in areas where the bedrock formations come directly in contact with, or are close to, highly-permeable materials within a stream valley. Streamflow infiltration is reported to occur in one area in the eastern Oswego River Basin along Skaneateles Creek. Here, a middle shale unit is crossed by the creek. Approximately 2 mgd are pumped from wells installed in the shale unit along a 2.4-km (1.5-mi) stretch of the creek(19).

Regional Groundwater Use

Regional groundwater use for this report will be defined to be the area within a 30-mi radius of Unit 2 (Figure 2.4-9).

There are presently 15 public water supply systems within a 30-mi radius of the site. Three systems obtain water supplies from Lake Ontario, five from springs or spring-fed reservoirs, and even from public production wells. Public water supply data and locations of public water supplies in the vicinity of the site are presented in Table 2.4-9 and shown on Figure 2.4-9(25).

Public water supply systems serve an estimated Oswego County population of 58,467. Projected population for Oswego County based upon the 1970 federal census is estimated at 108,900 for 1980. Thus, 54 percent of the population is serviced by public water systems. Approximately 46 percent or 50,433 people rely on domestic or private wells for water supplies(26).

Neither Oswego County nor the state requires submission of private well records or permits for wells producing less than 2.5 l/sec (40 gpm). Based upon the limited data that are currently available on wells throughout the country, wells installed in the unconsolidated glacial deposits have an average depth of 11 m (37 ft) and an average depth to water of approximately 3.7 m (12 ft) below land surface. Wells installed in consolidated bedrock have an average depth of approximately 26 m (84 ft) and an average depth to water of approximately 8.2 m (27 ft) below land surface.

The primary source of groundwater for high-yielding wells in the region is the coarse-grained sand and gravel deposits found principally in the valleys and in scattered deposits in the lowlands. Present development of groundwater resources in the central New York region is relatively small compared to the total amount available. Most of these areas in the region occur to the south, in counties adjacent to Oswego County. Estimated yields of at least 908,400 cu m/day (240 mgd) can be obtained from these aquifers, compared to an estimated use of 102,200 cu m/day (27 mgd) from all groundwater sources in the central New York region(20).

Public water supply systems that utilize wells within a 30-mi radius of the site produce an average output of approximately 21,200 cu m/day (5.6 mgd)(26). No average output data for private wells are presently available. No public or domestic groundwater supply systems are located downgradient (toward Lake Ontario) from the site; however, several communities obtain surface water supplies, distributed by the city of Oswego and the Onondaga County Water Authority, through a 2.4-m (8-ft) diameter tunnel and an intake structure located 1,905 m (6,250 ft) offshore in Lake Ontario, some 13 km (8 mi) west of the site(25).

As stated in this section, regional groundwater in the unconfined Paleozoic formations and Pleistocene deposits discharges westward toward Lake Ontario, its natural base discharge. Therefore, all public groundwater supplies are upgradient of, at least 16 km (10 mi) distant from, and in different groundwater basins than the site. Consequently, no impact is envisioned on these water resources by the operation of the Nine Mile Point plant.

The nearest public groundwater supply system is located in the village of Mexico, approximately 10 mi east-southeast of the site, supplying an estimated population of 1,725 with an average output of 908 cu m/day (0.24 mgd). The village of Mexico operates three wells: two 12 m (40 ft) deep and one 11.5 m (38 ft) deep, presumed to be installed in alluvium deposits. The city of Fulton operates 12 wells, 9 to 21 m (30 to 70 ft) deep, all of which are installed in alluvium deposits producing an average total output of 7,570 cu m/day (2.0 mgd) for an estimated population of 15,000. The Fulton wells are located 23 km (14 mi) south of the site. The village of Sandy Creek operates two wells approximately 29 km (18 mi) northeast of the site, both 6.4 m (21 ft) deep, presumed to be installed in alluvium deposits. The Sandy Creek wells produce an average output of 1,250 cu m/day (0.33 mgd) for an estimated population of 1,435. The village of Central Square operates two wells: one 7.3 m (24 ft) deep and one 3.0 m (10 ft) deep installed in alluvium deposits. These wells are located approximately 33 km (20.5 mi) southeast of the site and produce an average output of 3,635 cu m/day (0.96 mgd) for an estimated population of 1,427. The village of Phoenix operates 2 wells: one 7.6 m (25 ft) deep and one 14 m (45 ft) deep, both installed in alluvium deposits. These wells are located approximately 34 km (21 mi) south-southeast of the site and produce an average output of 3,785 cu m/day (1.0 mgd) for an estimated population of 2,600. Baldwinsville operates four wells: one 28 m (93 ft) deep, presumably in bedrock, and three shallow wells installed in alluvium deposits, producing a total of 3,785 cu m/day (1.0 mgd) for an estimated population of 10,000. The Baldwinsville wells are located approximately 39.4 km (24.5 mi) south of the site. The town of Cato operates three wells approximately 42 km (26 mi) south-southeast of the site: two 17 m (55 ft) deep and one 21 m (70 ft) deep, producing an average output of 125 cu m/day (0.033 mgd) for an estimated population of 500(25).

Regional Groundwater Quality

The general quality of groundwater in the bedrock in the central New York region is often poor. Each of the bedrock units is composed of a distinctive group of minerals with varying degrees of solubility. The Paleozoic shales contain excessive amounts of highly-soluble salt and gypsum (hydrated calcium sulfate). Water flowing through these units has dissolved much of the salt and gypsum, causing a high sulfate, chloride, and TDS content in the local water(19).

The upper shale and sandstone-shale units are composed of relatively insoluble minerals. Soluble carbonates in limestones that are interbedded with the upper shale may slightly degrade groundwater quality. The sandstone (Oswego) and lower shale units (Lorraine Group) consist almost entirely of insoluble minerals and have the lowest dissolved solids in the region(19). The general chemical constituents of the groundwater in the unconsolidated deposits are similar to, but of lower mineral concentrations than, that in the consolidated bedrock formations. Unconsolidated deposits in the southern part of the Oswego River Basin are composed mostly of limestone fragments, which may also affect groundwater quality. This material was carried southward to the upper shale outcrop area by advancing glaciers. The groundwater quality in this valley is more closely related to the groundwater quality in the limestone unit(24).

The unconsolidated deposits in the northeastern part of the Oswego Sandstone unit outcrop area are free of limestone fragments carried by the advancing glacier over the Tug Hill Upland(19). As a result, overall groundwater quality differs from that of the Erie-Ontario Lowlands.

In general, groundwater obtained from wells installed in bedrock formations is of poor quality. Elevated levels of iron, hydrogen sulfide, chlorides, and hardness are common. On the other hand, groundwater obtained from wells screened in the Pleistocene unconsolidated glacial deposits is generally of better quality and is favorable for resource development.

2.4.3.0.5 Local Aquifers

Water Table Aquifer

The local area, for purposes of this section, is defined as the area within a 32-km (2-mi) radius of Unit 2. There are one unconfined aquifer and numerous confined aquifers under the site. The unconfined aquifer is composed of the glacial till and fill material and the Oswego Sandstone beneath the soil. The unconsolidated deposits are connected to the Oswego bedrock through a weathered fracture zone at the top of the bedrock(18). The number of fractures decreases with depth in the sandstone, the latter becoming relatively impermeable after approximately 6 m (20 ft). The local water table ranges from el 91 m (300 ft) in the southeast to the lake level of 75 m (246 ft), with annual variations of approximately 0.6 m (2 ft)(27). The average gradient is approximately 0.7 percent to the north-northwest.

Local Groundwater Use

The unconfined water table aquifer is generally of sufficient yield capacity for domestic use only. Maximum yield rates have been estimated at 0.3 to 0.5 l/sec (5 to 8 gpm) in the unconsolidated deposits, and up to 0.6 l/sec (10 gpm) in the bedrock(17). A local well inventory in 1972 revealed the existence of 102 domestic wells, but only 70 were in use(28). The average pumping rate of those wells in use was 2,460 l/day (650 gpd). The nearest domestic well is 1.6 km (1 mi) from the site. Figure 2.4-10 shows the distribution of domestic wells around the site and Table 2.4-10 presents pertinent data on these wells.

Deep Aquifers

The transition zone between the Oswego Sandstone and Unit A of the Pulaski Formation (Section 2.5.1.2) is a more permeable zone than the overlying and underlying strata(29). It appears to have a higher piezometric head (based on measurements in Boring TD-1) than the unconfined water table(27). Flow in this zone is confined. Another confined zone of relatively higher permeability occurs in the Pulaski Unit B. The overlying Unit A may be acting as an aquitard. Below, the Unit C zone has a very low permeability and separates the confined Unit B zone of the Pulaski Formation from the Whetstone Gulf Formation. (The Whetstone Gulf Formation has localized zones of buckling, and the lowest piezometric pressure of the deep strata investigated.) All of the deep aquifers are confined and are characterized by artesian pressures.

2.4.3.0.5 Recharge and Discharge

Recharge may occur locally to the unconfined aquifer as a result of infiltration of precipitation and local seepage from ponds and swamps through the unconsolidated deposits and bedrock outcrops. Exposed outcrops of Oswego Sandstone may be found along the lakeshore to the north, and on Station property to the south and southwest of the site. Recharge of the Pulaski and Whetstone Gulf zones most probably occurs through outcrops of these formations not local to the site. Some recharge may occur through fault zones, such as the Cooling Tower fault, the Drainage Ditch fault, the Barge Slip fault, and the Radwaste fault.

2.4.3.0.5 Onsite Use

Presently no groundwater is being used onsite. No provisions have been made for future onsite use.

2.4.3.0 Sources

2.4.3.0.5 Groundwater Elevations

Local Groundwater Elevations

Groundwater elevations in the unconfined till and Oswego Sandstone aquifer range from 91 m (300 ft) in the southeastern part of the local area to lake level in the north. The level at the construction site ranges from el 75 to 76 m (247 to 249 ft) during the dry months of the year, to el 76 to 77 m (249 to 251 ft) during the wet months. The yearly fluctuation of the water table is approximately 0.6 m (2 ft)(29). Wells screened in the Oswego Sandstone have levels similar to those in the unconsolidated deposits. The piezometric level of the transition zone between the Oswego and Pulaski Formation is higher onsite than the upper zones, indicating that flow is confined by relatively impermeable beds in the lower Oswego Sandstone zone.

During the detailed geotechnical investigation at the Nine Mile Point site from 1976 through 1978, the distribution of groundwater pressures in the subsurface at the site, particularly in proximity to the Cooling Tower fault, was investigated. Six 1.9-cm (0.75-in) internal diameter observation wells were installed in boreholes previously drilled for other purposes at the Nine Mile Point site. The average length of the screen in these wells was approximately 1.5 m (5 ft). Two groups of boreholes were used for the observation well installations. Observation wells were installed in Borings T-4-7, T-4-9, T-4-10, and T-4-11 to obtain measurements of groundwater head in the immediate vicinity of the Cooling Tower fault. Boreholes OC-4 and TD-1, which are remote from both the Cooling Tower fault and the existing excavations for Unit 2, were selected for additional observation well installations. A cross section showing these boreholes is shown on Figure 2.4-11.

Groundwater Levels in the Cooling Tower Fault

Two piezometers (T-4-7 and T-4-9) installed directly in the Cooling Tower fault during 1977 indicate the fault acts as a subsurface vertical drain. The piezometric level in the Whetstone Gulf Formation at the fault (Boring T-4-9) was 4 m (13 ft) lower than the lake level. One possible explanation, perhaps the most plausible, is that there is available additional storage within the Whetstone Gulf Formation created by localized progressive folding and buckling of the strata. The Cooling Tower fault may act as a connecting channel, allowing limited vertical drainage from the upper strata down to the Whetstone Gulf Formation. Vertical drainage is indicated by a local depression of the piezometric level of the Pulaski Formation Unit B zone observed in the vicinity of the fault in Boring T-4-9. The drainage rate could not be estimated. A detailed discussion of this monitoring program and interpretive conclusions are found in Reference 27.

Groundwater Elevations Near Dewatered Excavations

Groundwater elevations in the immediate vicinity of the reactor, radwaste, and intake shaft excavations are lower than those 46 m (150 ft) away. The piezometric levels measured in borings within 15 m (50 ft) of the excavations were below 61 m (200 ft) in elevation. A thrust fault that crops out in the radwaste excavation appears to have become dilated so that it acts as a horizontal drain to the excavation, as evidenced by water levels measured in borings that intersect the thrust fault(27). The water levels coincide with the thrust fault zone. Groundwater flow in this area may be controlled, therefore, by the dilation of the strata.

Prior to dewatering the intake shaft in December 1979, four piezometers were installed in the vicinity of the shaft (Figure 2.4-12). The piezometers were of the pore pressure transducer type with a sensitivity of ±0.1 psi(30). Figure 2.4-13 shows the progression of dewatering around the intake shaft. A discussion related to dewatering the shaft is found in Section 2.5.4.6.

2.4.3.0.5 Permeability and Porosity

Estimated Permeabilities

Several tests have been performed on the glacial till and bedrock to measure the permeability and porosities of these deposits. Although the heterogeneity of the till makes it difficult to assign a representative permeability, measured values range from 3×10^{-5} cm/sec (1.2×10^{-5} in/sec) to 6×10^{-4} cm/sec (2.4×10^{-4} in/sec)(18). Most tests performed in the till indicated the lower values. Surface percolation tests indicated an average vertical permeability of 1×10^{-5} cm/sec (3.9×10^{-6} in/sec) in the till(21).

The permeability of the bedrock was measured through a series of packer tests(18). These tests indicated that the most permeable zones were in the transition zone, the Pulaski Unit B, and the Whetstone Gulf Formation Unit A. The Pulaski Formation Unit A had moderate permeability. The values calculated from these tests have been found to be disproportionately high, because injection pressures used in the tests were great enough to lift the rock, and resulted in high estimates of permeability. Calculations using the measured flow into the construction excavations have indicated average permeabilities for the rock on the order of 1×10^{-5} to 2×10^{-4} cm/sec(23). The less permeable zones of the bedrock most probably have permeabilities one or two orders of magnitude lower.

Porosity

Primary porosities were calculated according to the relationship between laboratory-determined values for the mean density of mineral grains and dry density. Values ranged from 5.6 to 2.2 percent for the Oswego Sandstone, and from 2.2 to 7.6 percent for all strata tested(23). The Transition Zone had a slightly higher porosity (6 percent) and the Unit C of the Pulaski Formation had the lowest average calculated value (3 percent). No calculations were made for the Whetstone Gulf Formation.

The porosity of the till is low, on the order of 5 to 15 percent(28). The heterogeneity of the till precludes assigning a representative value.

The secondary (fracture) porosities for rocks at the Unit 2 site have not been measured.

2.4.3.0.5 Effects of Local Groundwater Use Upon Water Level at the Site

The only local groundwater use within 3.2 km (2 mi) of the site is domestic. The estimated maximum yield from a well is 0.6 l/sec (10 gpm) from the bedrock. A 1972 survey revealed 102 wells exist in the local area, 70 of which were each pumping an average of 2,460 l/day (650 gpd)(28). The maximum reported depth of any of the wells was 30 m (100 ft). Even if all 102 wells(the nearest of these wells is 1.6 km [1 mi] from the site, but most are 3.2 km [2 mi] away) were pumping continuously at 2,460 l/day (650 gpd) (approximately 0.03 l/sec or 0.50 gpm), it is unlikely that groundwater levels at the site would be measurably influenced.

2.4.3.0.5 Recharge Within the Influence of the Station

Recharge in the vicinity of the Unit 2 site most likely occurs as a result of infiltration from ponds, swamps, and precipitation. Due to the low permeability of the surficial soils, most of the precipitation runs off toward the lake. Approximately 5 cm/yr (2 in/yr) is available for recharge(20). The Oswego Sandstone is recharged through local outcrops and by seepage from the unconsolidated deposits. There are outcrops to the south and southeast of the site. Recharge of the lower zones of rock beneath the surface occurs through outcrops that are not local to the site, or possibly through fractures.

Groundwater flow velocities, considering the low hydraulic conductivities, are expected to be very slow. Regional velocities in the unconfined aquifer are at most a few meters per year, based on the regional gradient of 0.7 percent and an assumed average permeability of 1×10^{-5} cm/sec (4×10^{-6} in/sec). Flow velocities could not be estimated for the lower zones.

2.4.3.0.5 Effects of Temporary Dewatering of Construction Excavations

The excavations for the reactor building, the radwaste building, and the screenwell shaft have been dewatered by channeling seepage water into a sump and pumping it out. Estimates of the pumping rates are at 6.9 l/sec (110 gpm) from the screenwell shaft, and 12.6 l/sec (200 gpm) from the reactor building excavation(23). It is impossible to predict the effect of the dewatering on each aquifer. An estimate of the radius of influence was made, therefore, for a continuous idealized aquifer with the same average properties. Such an aquifer represents worst-case conditions. The radius of influence was estimated to be 3.2 km (2 mi) for a 2-yr period. The radius of influence was also estimated assuming that all the seepage was from the unconfined aquifer, and that no additional contribution to the seepage was caused by the proximity of the lake. The estimated radius of influence for 1 yr was less than 1.6 km (1 mi). The lower aquifers are confined, separate, and have individual seepage rates less than the 20 l/sec (310 gpm) total estimated seepage. The influence zone of each aquifer is not expected to reach local wells. The radius of influence was estimated on the basis of 2 cm (0.8 in) of drawdown at the limits of the cone of depression of the hypothetical pumping well. No offsite effect has been observed or reported as a consequence of the onsite dewatering.

2.4.3.0 Accident Effects

The tanks holding radioactive waste are located in the radwaste building, turbine building, and the CST building. A steel liner is provided in those areas of the buildings necessary to prevent unacceptable radioactive liquid leakage to the groundwater due to accidental failure of any of these tanks. The following radwaste tanks are located in the radwaste building in the areas lined with a steel liner.

2. Floor drain collection surge tank

2. Waste collection surge tank

2. Waste sludge tank

Additionally, all tanks in the radwaste building containing radioactive fluid are located above the area that is lined with a steel liner. During a potential rupturing of any one of these tanks, the steel liner at el ±240 ft 0 in is designed to contain the liquid inventory within the building.

There are only two possible sources of liquid radioactivity leakage to the groundwater from the plant: the waste solidification tank and the tanks associated with the demineralizer/regeneration system. The effects of CST rupture are described in Section 2.4.12. An analysis was performed to determine if these sources could present an environmental radioactivity problem should they be involved in an accident resulting in leakage of radioactive liquid. The analysis conservatively assumed that radioactive liquid would percolate downward through the foundation slab and enter the groundwater system under the building. As shown on Figure 2.4-10, all domestic wells are located upgradient and at least 1 mi from Nine Mile Point Station. Therefore, contaminated groundwater would not reach these wells. The postulated spill would travel along the direction of the hydraulic gradient toward the reactor building.

The plant dewatering system consists of perimeter drains and two sumps located below the reactor building. Pumping from these sumps will be continuous during plant operation, and the groundwater table in the reactor building area will be maintained slightly above the reactor mat bottom elevation. The estimated groundwater contours in the vicinity of the reactor building are shown on Figures 2.4-14 and 2.4-15. This water is then discharged to Lake Ontario through a storm drain system.

The nearest potable water intake in the lake that could be contaminated by the accidental failure of the radwaste tanks is at Oswego, approximately 12.8 km (8 mi) west of the site.

The spill volume is conservatively assumed to instantaneously enter the groundwater system on occurrence of the postulated tank failure, with no associated vertical travel time. Since the distance between the reactor building and the radwaste building is less than 15.2 m (50 ft), dilution of the radioactive liquid in the groundwater is neglected until it mixes in the reactor building sump. The groundwater table contours shown on Figure 2.4-14 indicate that the groundwater surrounding the reactor building would flow uniformly to the perimeter of the building and into the sumps. The radioactive liquid would fully mix with uncontaminated groundwater that had entered the sumps from other points along the perimeter. The diluted contaminated groundwater would then be pumped to the drain pipe system and discharged to Lake Ontario. It is conservatively assumed that further dilution of the radioactive liquid would not occur in the drain pipe. After the radwaste is discharged to Lake Ontario, it would be diluted by the lake water. The effect of adsorption and decay is conservatively neglected in the computation of the dilution factor and associated travel time. Under the postulated accident conditions, the minimum dilution factor and the associated travel time are predicted to be 2.75×10^6 and 29.6 hr, respectively. Refer to Section 15.7 for the dose assessment of this accident.

Mathematical Model of Dilution and Dispersion

The groundwater table contours surrounding the reactor building reveal that the seepage velocity is uniform at the perimeter of the building. Full mixing of the spilled radioactive liquid and groundwater is expected to occur at the sumps. The dilution factor at the sumps is estimated by comparing the seepage rates of the radioactive liquid and groundwater at the reactor building.

If the approaching seepage velocity at the perimeter of the reactor building is U, the entire length of the perimeter is P, and the thickness of the aquifer under the building is H, then the seepage rate of the groundwater under the building is PHU. The seepage rate of the mass of the radioactive liquid under the building is C P_1HU, where C is the original concentration of the radwaste and P_1 is the length of the perimeter where the radioactive liquid seeps under the building. The concentration of the radioactive liquid after full mixture with the groundwater at the sumps can be estimated as:

$$C = \frac{C_o P_1 HU}{PHU} = C_o \ \frac{p_1}{p} \qquad (2.4\text{-}5)$$

The dilution factor, DF_1, at the sump is:

$$DF_1 = \frac{C_o}{C} = \frac{P}{P_1} \quad (2.4\text{-}6)$$

P_1 is assumed to be the same as the width of the radwaste building.

After entering the storm drain pipe, the postulated spill would flow along the pipe and be discharged into Lake Ontario. The dilution factor at the water supply intake in the lake was computed utilizing a steady-state dispersion model in the lake as outlined in RG 1.113, Revision 1, April 1977. The nondecaying concentration χ for a point source located at a distance y_s from the shoreline and z_s beneath the water surface can be expressed as:

$$\chi = \frac{w}{2\pi\sigma_y\sigma_z} f\ (\sigma_z, Z, Z_s, d)\ f\ (\sigma_y, y, y_s) \quad (2.4\text{-}7)$$

Where:

$$f\ (\sigma_z, Z, Z_s, d) = \sum_{m \approx -\infty}^{\infty} \exp\left[-\frac{(2md + Z_s - Z)^2}{2\sigma_z^2}\right]$$

$$+ \exp\left[-\frac{(2md - Z_s - Z)^2}{2\sigma_z^2}\right]$$

$$f\ (\sigma_y, y, y_s) = \exp\left[-\frac{(y_s - y)^2}{2\sigma_y^2}\right] + \exp\left[-\frac{(y_s + y)^2}{2\sigma_y^2}\right]$$

$$\sigma_y = \left(\frac{2\varepsilon_y\chi}{u}\right)^{1/2}$$

$$\sigma_z = \left(\frac{2\varepsilon_z\chi}{u}\right)^{1/2}$$

x = Distance between discharge point and receptor point along shoreline, m

y = Distance offshore of receptor point, m

z = Distance below water surface of discharge point, m

d = Average lake depth, m

u = Average longshore current velocity, m/sec

ε_y = Lateral diffusion coefficient, m^2/sec

ε_z = Vertical diffusion coefficient, m^2/sec

χ = Concentration of liquid effluent at receptor point, Ci/m^3

w = Source of strength, Ci/sec

The dilution factor at the water supply intake can be expressed as:

$$DF = \frac{1}{\left(\frac{\chi}{w}\right) Q} \qquad (2.4\text{-}8)$$

Where:

Q = Total discharge rate of the drain pipe, m^3/sec

The total dilution factor at the water supply intake is:

$$DF = DF_1, x\ DF_2$$

Further details of the model used, including input parameters for this application, are presented in Section 2.4.12.

2.4.3.0 Monitoring or Safeguard Requirements

Local groundwater users will not be affected by Unit 2 for the reasons outlined in Section 2.4.13.1. Therefore, there are no plans to monitor the chemical and/or radionuclide content of the groundwater.

2.4.3.0 Design Bases for Hydrostatic Loading

The design groundwater levels used to determine static and dynamic loadings on subsurface portions of safety-related structures are as follows:

Groundwater Level	Elevation

Flood	77.7 m (261 ft)
Normal	79.6 m (255 ft)
Low	Variable (Section 2.5.4.10)

The determination of the flood groundwater level is discussed in detail in Section 3.4.1.1. The basis for the normal groundwater level is discussed in Section 2.4.13.2. The low groundwater level is described in Section 2.5.4.10.

For all Category I external walls and mats, each of the three groundwater levels listed above were combined with other applicable loads (see Section 3.8.4.3) to determine the maximum subsurface loading case. Loading magnitudes for both static and dynamic cases were computed according to Figure 2.5-110.

2.4.14 Technical Specification, Technical Requirements Manual, and Emergency Operation Requirements

There are no Technical Specification or emergency operation requirements at Unit 2 as a result of adverse hydrological events. As discussed in Sections 2.4.5.5 and 3.4.1.3, safety-related facilities are protected from the maximum postulated lake level as a result of PMWS by a revetment ditch system. As also discussed in Sections 2.4.2.3 and 3.4.1.3, the site in the immediate vicinity of the plant is properly graded to safely divert the local PMP runoff overland to Lake Ontario. Exterior barriers around the plant buildings are used to divert PMP flood from the immediate watershed encompassing the site.

The discussion in Sections 2.4.11.5 and 9.2.5 indicates that the postulated lake elevation of 72.0 m (236.3 ft) is the hydrologic design base for the intake structure. Therefore, low lake water levels do not affect the function of the intake to provide the required water supply for shutdown and cooldown purposes.

To ensure the integrity of the revetment ditch structure, the revetment ditch is included in TRM Section 3.7.6.

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TABLE 2.4-1
Sheet 1 of 1
HISTORICAL MAXIMUM PRECIPITATION

Duration, min	10	15	30	60
Rainfall, cm	3.07	3.25	3.35	4.14
in	1.21	1.28	1.32	1.63

TABLE 2.4-2
Sheet 1 of 1
MAXIMUM INSTANTANEOUS WATER LEVELS OF LAKE ONTARIO
AT OSWEGO, NEW YORK

	Lake Level Historical Period of Record* (1900-1982)		Period of Current Lake Regulation (October 1963-1982)	
	m	ft	m	ft
January	75.74	248.50	75.50	247.73
February	75.74	248.20	75.54	247.84
March	75.76	248.57	75.76	248.57
April	75.98	249.29	75.98	249.29
May	76.06	249.55	76.06	249.55
June	76.25	250.19	76.07	249.58
July	76.01	249.38	75.95	249.18
August	75.90	249.03	75.64	248.19
September	75.77	248.59	75.46	247.59
October	75.70	248.36	75.30	247.06
November	75.67	248.26	75.21	246.76
December	75.83	248.80	75.28	247.00

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* USLS measurements.

TABLE 2.4-3
Sheet 1 of 1
PROBABLE MAXIMUM PRECIPITATION (PMP)

Duration (hr)	Cumulative All-Season PMP cm	Cumulative All-Season PMP in	Area (sq mi)
0.17 (10 min)		7.1	1.00
0.25 (15 min)		8.6	1.00
0.33 (20 min)		9.9	1.00
0.50 (30 min)		12.3	1.00
1		16.0	1.00
6		27.5	1.00
0.50 (30 min)		12.0	1.34
1		15.7	1.34
2		20.0	1.34
3		22.9	1.34
4		24.9	1.34
5		26.2	1.34
6		27.1	1.34
6		23.5	10.0

SOURCES: References 31 and 32

TABLE 2.4-4
Sheet 1 of 1
STORMS CAUSING HIGH RECORDED SURGES
ON LAKE ERIE AND LAKE ONTARIO

Date	Time of Maximum Surge (EST)
November 16, 1955	2000
February 25, 1956	1700
July 1, 1956	2200
November 8, 1957	2300
January 22, 1959	0700
October 17, 1965	1500
October 31, 1965	2000
February 16, 1967	1100
January 30, 1971	0400
January 25, 1972	1600
February 4, 1972	1300
December 6, 1973	1400

SOURCE: Reference 33

TABLE 2.4-5
Sheet 1 of 1
DIURNAL VARIATION OF RATIO OF OVERWATER SPEED TO OVERLAND SPEED

Hour	Ratio
1700-0700	1.6
0800, 1600	1.5
0900, 1500	1.4
1000-1400	1.3

SOURCE: Reference 6

TABLE 2.4-6
Sheet 1 of 1
PREDICTED HOURLY VALUES OF PRESSURE, WIND SPEED, AND WIND DIRECTION FOR PMWS ON LAKE ONTARIO

Sequential Time During Storm (hr)	Time (EST)	P1 (mb)	S1		D1 (deg)	P2 (mb)	S2		D2 (deg)	P3 (mb)	S3		D3 (deg)	P4 (mb)
			km/hr	mph			km/hr	mph			km/hr	mph		
0	0800	989	21	13	170	996	11	7	170	1005	11	7	170	1011
1	0900	983	32	20	170	992	19	12	170	1000	11	7	170	1006
2	1000	2980	55	34	170	987	22	14	170	995	10	6	170	1003
3	1100	977	77	48	170	982	37	23	170	986	18	11	170	992
4	1200	978	64	40	160	979	71	44	170	986	31	19	160	993
5	1300	970	53	33	160	975	72	45	170	981	64	40	170	990
6	1400	966	53	33	170	972	42	26	170	978	87	54	170	984
7	1500	964	64	40	200	968	53	33	170	974	58	36	160	983
8	1600	962	69	43	210	966	61	38	190	972	55	34	170	978
9	1700	961	79	49	220	964	64	40	210	968	63	39	170	974
10	1800	961	113	70	230	963	74	46	210	964	63	39	200	970
11	1900	964	124	77	260	964	108	67	220	963	74	46	210	966
12	2000	968	143	89	270	961	117	73	260	961	79	49	250	961
13	2100	971	148	92	270	964	130	81	280	961	108	67	260	959
14	2200	972	158	98	270	968	148	92	280	962	127	79	270	958
15	2300	976	161	100	280	972	151	94	280	968	140	87	280	957
16	2400	982	161	100	280	972	161	100	290	970	146	91	290	958
17	0100	986	148	92	290	979	161	100	280	973	161	100	270	962
18	0200	990	143	89	290	983	148	92	280	975	161	100	290	965
19	0300	993	143	89	300	988	148	92	290	982	156	97	290	968
20	0400	997	132	82	300	991	137	85	290	986	148	92	290	972
21	0500	999	119	74	290	993	135	84	290	989	145	90	280	979
22	0600	1000	113	70	300	999	130	81	290	993	142	88	290	984
23	0700	1002	111	69	310	1000	122	76	310	997	132	82	300	988
24	0800	1004	74	46	330	1001	100	62	310	999	116	72	300	990
25	0900	1006	60	37	320	1003	72	45	330	1000	93	58	330	995
26	1000	1009	63	39	340	1006	60	37	320	1002	69	43	320	999
27	1100	1011	48	30	320	1008	56	35	330	1005	64	40	320	1000

KEY: P = Pressure
S = Wind speed
D = Wind direction

NOTE: Numbers shown in pressure, speed, and distance columns indicate region of Lake Ontario shown on Figure 2.4-6.

TABLE 2.4-7
Sheet 1 of 1
BRETSCHNEIDER’S JOINT DISTRIBUTION OF H AND T FOR ZERO CORRELATION

Number of Waves per 1,000 Consecutive Waves for Various Ranges in Height and Period

	Range in Relative Period T/T											
Range in Relative Height (H/H)	0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	1.0-1.2	1.2-1.4	1.4-1.6	1.6-1.8	1.8-2.0	0-2.0	Accumulative
0-0.2	0.03	0.50	2.05	4.86	7.68	8.09	5.31	1.92	0.34	0.03	30.81	30.8
0.2-0.4	0.10	1.41	5.81	13.78	21.76	23.92	15.05	5.44	0.98	0.07	88.32	119.13
0.4-0.6	0.14	2.06	8.54	20.23	31.95	33.65	22.10	7.99	1.44	0.11	128.21	247.34
0.6-0.8	0.16	2.40	9.91	23.48	37.08	39.06	25.65	9.27	1.67	0.12	148.80	396.14
0.8-1.0	0.16	2.40	9.92	23.51	37.13	39.11	25.69	9.28	1.67	0.12	148.99	545.13
1.0-1.2	0.15	2.14	8.87	21.02	33.19	34.97	22.96	8.30	1.49	0.11	133.20	678.33
1.2-1.4	0.12	1.74	7.21	17.07	26.96	28.40	18.65	6.74	1.21	0.09	108.19	786.52
1.4-1.6	0.09	1.30	5.37	12.72	20.09	21.16	13.90	5.02	0.90	0.07	80.62	867.14
1.6-1.8	0.06	0.90	3.72	8.82	13.93	14.67	9.64	3.48	0.63	0.05	55.90	923.04
1.8-2.0	0.03	0.48	1.99	4.72	7.45	7.85	5.15	1.86	0.33	0.03	29.89	952.93
2.0-2.2	0.03	0.42	1.72	4.09	6.45	6.80	4.47	1.61	0.29	0.02	25.90	978.83
2.2-2.4	0.01	0.18	0.76	1.80	2.84	2.99	1.97	0.71	0.13	0.01	11.40	990.23
2.4-2.6	0.01	0.09	0.39	0.93	1.47	1.55	1.02	0.37	0.07		5.90	996.13
2.6-2.8		0.04	0.18	0.43	0.67	0.71	0.47	0.17	0.03		2.70	998.83
2.8-3.0												
0-3.0	1.09	16.06	66.44	157.46	248.65	262.93	172.03	62.16	11.18	0.83		
Accumulative	1.09	17.15	83.59	241.05	489.70	752.63	924.66	986.82	998.00	998.83		

KEY:
T = Wave period
$\bar{T}$ = Mean wave period
H = Wave height
$\bar{H}$ = Mean wave period

SOURCE: Reference 8

TABLE 2.4-8
Sheet 1 of 1
JOINT DISTRIBUTION OF WAVE HEIGHT AND WAVE PERIOD AT
THE MAXIMUM WAVE DURING PMWS

Relative Wave Height	Representative Wave Height		Representative Wave Period* (sec)		
(H/H)	m	ft	10	13	16
0-0.2	0.63	2.06	7.44	15.77	7.6
0.2-0.4	1.88	6.18	21.1	45.68	21.54
0.4-0.6	3.14	10.3	30.97	65.60	31.64
0.6-0.8	4.40	14.42	35.95	76.14	36.71
0.8-1.0	5.65	18.54	35.99	76.24	36.76
1.0-1.2	6.91	22.66	32.18	68.16	32.86
1.2-1.4	8.16	26.78	26.14	55.36	26.69
1.4-1.6	9.42	30.9	19.48	41.25	19.89
1.6-1.7	10.67	35.02	13.50	28.60	13.80
1.8-3.0	11.93	39.14	18.3	38.78	18.71

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* Relative wave period $T/\bar{T}$:

10 sec	0-0.8
13 sec	0.8-1.2
15 sec	1.2-2.0

KEY: $\bar{H} = 0.625\ H_s = 6.3$ m (20.6 ft)

$\bar{T} = T_s = 12.5$ sec

NOTE: Total number of waves = 998.83

TABLE 2.4-9
Sheet 1 of 1
PUBLIC WATER SUPPLY DATA

Distance From Site (mi)	Number[1]	Town	Estimated Population Served (1980)	Average Output (mgd)	Source of Water Supply
0 to 10	1	Onondaga County Water Authority	40,000	22-24[2]	Lake Ontario (intake at Oswego)
	2	Oswego	30,270	14[2]	Lake Ontario (intake at Oswego)
10 to 20	3	Village of Mexico	1,725	0.24[3]	3 wells: 2 40-ft deep, 1 38-ft deep; average yield 275 gpm; probably in alluvium
	4	Village of Pulaski	2,700	0.025[3]	Springs
	5	City of Fulton	15,000	2.0[3]	12 wells: 30- to 70-ft deep; in alluvium
	6	Village of Sandy Creek	1,435	0.33[3]	2 wells: 21-ft deep, average yield 275 gpm; probably in alluvium
20 to 30	7	Village of Central Square	1,427	0.96[3]	2 wells: 1 24-ft deep, 1 10-ft deep; in alluvium
	8	Town of Orwell	250	0.015[3]	Spring
	9	Village of Phoenix	2,600	1.0[3]	2 wells: 1 25-ft deep, 1 45-ft deep; average yield 400 gpm; probably in alluvium
	10	Baldwinsville	10,000	1.0	4 wells: 1 93-ft deep, yield 1,500 gpm; 3 shallow wells, in alluvium
	11	Fairhaven	765	0.15	Spring; 1 well 46-ft deep, yield 300 gpm
	12	Cato	500	0.033	3 wells: 2 55-ft deep, 1 70-ft deep; average yield 350 gpm
	13	Wolcott	1,640	0.220	Lake Ontario
	14	Adams	1,735	0.3	Spring, infiltration gallery
	15[4]	Red Creek[4]		0.03	Wells and springs
	16	Constantia	3,060	0.20	Spring-fed reservoir

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[1] Refer to Figure 2.4-9.
[2] Average output for 1982; current design capacity is 36 mgd for both Onondaga County Water Authority and City of Oswego.
[3] Average output based upon currently available data, Oswego County Public Health Department.
[4] Red Creek is an industrial, not public, supply source.

TABLE 2.4-10
Sheet 1 of 3
DOMESTIC WELLS WITHIN 2-MI RADIUS OF PLANT*

Well No.	Well Depth (ft)	Approx. Land Surface El (ft)	Depth to Water Level (ft)	Approx. El of Water Level (ft)	Type of Well	Estimated Pumpage Rate (gpd)	Name of Owner
1	18	275	10	265	Dug, 3’ diam.	Not in use	Jack Timon
2	43	275			Drilled	150	Jack Timon
3	43	275	7	268	Drilled	300	E. Roy
4	25	280	8	272	Drilled	300	J. Roy
5	28	280	4	278	Drilled	100	Mason
6	30	275			Drilled	225	Barns
7	45	275	8	267	Drilled, 6”	150	Malone
8	40	270	8	262	Drilled, 6”	(For lawn only)	Malone
9	30	270	8	262	Drilled, 6”	(For lawn only)	Malone
10	35	270	8	262	Drilled, 6”	975	Malone
11	40	270	8	262	Drilled, 6”	975	Malone
12	60	285			Drilled	Not in use	Hudson
13	60	275			Drilled	375	Upcraft
14	25	275	Near to Surface		Drilled	Not in use	R. Fauata
15	80	280			Drilled	150	R. Dickenson-Brown
16	20	285			Dug	225	R. Dickenson-Brown
17	38	275	11	264	Drilled	1,000	J. E. Reardon
18	60	285	25	260	Drilled	375	J. Murray
19		280				500	Donahue
20		275				Not in use	Ketchem
21	12	260	5	255	Dug	400	R. Palmateer
22	25	255	8	247	Drilled, 6”	Up to 1,500	Malone (campground)
23	70	310	10	300	Drilled	Not in use	D. Stevens
24	70	310			Drilled	Not in use	D. Stevens
25	30	290			Dug	Not in use	Simineau
26	12	290	5	285	Dug	100	Simineau
27	80	285			Drilled	Not in use	Simineau
28	15	285	5	280	Dug	Not in use	Simineau
29		285	0	285	Dug	Not in use	Simineau
30	20	285	0	265	Dug	100	Whiting
31	40	285	0	285	Drilled	Not in use	Whiting
32		290	0	290	Dug	Not in use	J. McLean
33	42	330	30	300	Dug	375	Adkins
34		330			Dug	Not in use	C. Upcraft
35		330			Dug	Not in use	C. Upcraft
36		340				Not in use	Pryor
37	60	350	7	343	Dug	Not in use	R. W. Rasmussen
38	18	310			Dug	225	J. O’Conner

Table 2.4-10
Sheet 2 of 3

Well No.	Well Depth (ft)	Approx. Land Surface El (ft)	Depth to Water Level (ft)	Approx. El of Water Level (ft)	Type of Well	Estimated Pumpage Rate (gpd)	Name of Owner
39	22	320	18	302	Dug	100	100
40		330			Drilled	150	150
41	42	330	12	318	Drilled	150	150
42	100	330			Drilled	300	300
43	45	330	17	312	Drilled	700	700
44		325			Drilled	Not in use	Unknown
45	15	325	10	315	Dug	100	E. Whaley
46		325	5	320	Drilled	50	L. Whaley
47	12	325			Dug	300	L. Whaley
48	25	325	12	313	Drilled	375	Dickenson
49	6	325	3	322	Dug	300	R. LaBouef
50	38	340	21	319	Drilled	375	Carpenter
51	28	330	11	319	Drilled	375	Nelson
52		330				Not in use	Unknown
53	22	335	9	327	Dug	450	M. Coe
54	60	340	25	315	Drilled	375	Upcraft
55	27	335			Dug	100	F. A. Newstead
56	30	340	12	328	Drilled	150	L. F. Dillenbeck
57	30	340	15	325	Drilled, 6”	150	Lawton
58	30	340	15	325	Drilled, 6”	300	Woods
59		340			Dug	150	Unknown
60	30	340	15	325	Drilled	600	Goodness
61	30	345	27	318	Drilled	50	Vandish
62	39	340	15	325	Drilled, 4”	500	Richardson
63	30	335	24	311	Drilled	300	Albright
64	15	325			Drilled	Not in use	Unknown
65	25	340			Dug	Not in use	Prosser (temp. vacant)
66	65	325			Drilled	500	Read and Ocheebein
67		325	3	320	Drilled, 6”	500	LaBouef
68		325			Dug	375	Wills
69	58	330	8	322	Drilled, 6”	200	G. Drake
70	25	335	0	335	Dug	300	C. Drake
71	30	325	3	322	Dug	Not in use	Brandon (temp. vacant)
72	15	330	3	327	Dug	Not in use	Klesinger (temp. vacant)
73	65	335			Drilled	400	Conroy
74	32	340	15	325	Dug	400	S. McLean
75	44	330	14	316	Drilled	50	E. Patrick
76	22	335	10	325	Dug	800	France
77	30	315	25	290	Drilled, 6”	300	Whaley
78		290			Drilled, 3”	150	F. O’Conner

Table 2.4-10
Sheet 3 of 3

Well No.	Well Depth (ft)	Approx. Land Surface El (ft)	Depth to Water Level (ft)	Approx. El of Water Level (ft)	Type of Well	Estimated Pumpage Rate (gpd)	Name of Owner
79	9	290	4	286	Dug	Not in use	F. O'Conner
80	42	290			Drilled	225	L. Whaley
81		75				Not in use	Unknown
82	54	275	12	263	Drilled	375	J. O'Conner
83	45	270	8	262	Drilled	100	J. T. O'Conner
84	18	280	8	272	Dug	100	E. Henry
85	6	275	4	271	Dug	Not in use	E. Hutchins
86		280			Dug	10,500+	C. Parkhurst
87	26	300	15	285	Dug	8,500+	K. Parkhurst
88		315	20	295	Dug	100	M. Goewey
89	6	320	0	320	Dug	850+	J. Parkhurst
90	10	325	3	322	Dug	4,200+	Woolson
91	90	325			Drilled	150	W. Woolson
92	90	290	25	275	Dug	300+	King
93	31	295	2	278	Drilled	375	King
94	12	300			Drilled	400	Barton
95		280	0	270	Dug	225	Parkhurst
96	8	280	3	270		Not in use	Unknown
97	24	270	15	265	Dug	225	Bellemo
98	30	275			Dug	150	R. Fox
99		280	3	297	Dug	375	Fox
100	10	265				Not in use	Jansen
101		300				Not in use	Unknown (summer home)
102		285				Not in use	Unknown (summer home)

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* For location of wells, see Figure 2.4-10.

TABLE 2.4-11
Sheet 1 of 3
PUBLIC AND PRIVATE WATER SUPPLY SYSTEMS IN THE UNITED STATES
DRAWING FROM LAKE ONTARIO WITHIN 80 KM (50 MI) OF UNIT 2

Map No.*	Name of System (Intake County)	Distance (km/mi) and Direction from Unit 2	Distance (km/mi) by Water from Unit 2	Average Withdrawal Rate 1980-81		Type of Use	Population Served	Production Capacity		Comments
				cu m/day	mgd			cu m/day	Mgd	
1	Rochester Gas & Electric - Robert E. Ginna Nuclear Power Plant (Wayne County)	78/49 WSW	78/49	2,180,160	576.00	Industrial cooling	-	2,180,160	576.00	
2	Ontario Town Water District (Wayne County)	74/46 WSW	74/46	11,355	3.00	Domestic, industrial	5,000	11,355	3.00	Expanded system startup summer 1981
3	Williamson Water District (Wayne County)	66/41 WSW	66/41	6,813	1.80	Domestic, industrial	4,700	14,762	3.90	Apr-Jun (avg) 4,921 cu m/day (1.3 mgd); Sep-Dec can reach 9,463 cu m/day (2.5 mgd)
4	Sodus Village (Wayne County)	58/36 WSW	58/36	984	0.26	Domestic, industrial	1,800	3,785	1.00	Jan-Jun lows of 265 to 492 cu m/day (0.07 to 0.13 mgd); Aug-Nov 1 highs of 3,747 cu m/day (0.99 mgd)
5	Sodus Point (Wayne County)	53/33 SWS	53/33	757	0.20	Domestic	4,500	2,839	0.75	Winter min. 454 cu m/day (0.12 mgd); peak in dry summer weather 1,703 cu m/day (0.45 mgd)
6	Wolcott Village (Wayne County)	41/25 WSW	41/25	908	0.24	Domestic, industrial	2,500	3,785	1.00	Avg. winter usage (Jan-Mar) approx. 681 cu m/day (0.18 mgd); avg. peak usage Jun-Nov 1,363 cu m/day (0.36 mgd)

TABLE 2.4-11
Sheet 2 of 3

Map No.*	Name of System (Intake County)	Distance (km/mi) and Direction from Unit 2	Distance (km/mi) by Water from Unit 2	Average Withdrawal Rate 1980-81		Type of Use	Population Served	Production Capacity		Comments
				cu m/day	mgd			cu m/day	Mgd	
7	NMPC Oswego Steam Station – Unit 5 (Oswego County)	15/10 WSW	15/10	1,558,814	411.84	Industrial cooling	-	1,558,814	411.84	
8	NMPC Oswego Steam Station – Units 1-4 (Oswego County)	15/10 WSW	15/10	452,383	119.52	Industrial cooling	-	452,383	119.52	
9	NMPC Oswego Steam Station – Unit 6 (Oswego County)	15/10 WSW	15/10	1,771,380	468.00	Industrial cooling	-	1,771,380	468.00	
10	City of Oswego (Oswego County)	13/8 WSW	13/8	37,850	10.00	Domestic, industrial	32,000	60,560	16.00	Winter, 30,280 cu m/day (8 mgd); summer, 37,850 cu m/day (10 mgd)
11	Metropolitan Water Board of Onondaga County, Syracuse, NY (Oswego County)	13/8 WSW	13/8	90,840	24.00	Domestic, industrial	120,000	136,260	36.00	Winter 75,700 cu m/day (20.0 mgd); summer, 98,410-105,980 cu m/day (26.0-28.0 mgd); to Onondaga County Water Authority; remainder to city of Syracuse
12	NMPNS Scriba, NY, Unit 1 (Oswego County)	-	750 ft (Unit 2 discharge to Unit 1 intake)	1,444,356	381.60	Industrial cooling	-	1,444,356	381.60	
13	Power Authority of the State of New York, Scriba, NY (Oswego County)	-	3,500 ft (Unit 2 discharge to FitzPatrick intake)	2,158,358	570.24	Industrial cooling	-	2,158,358	570.24	

TABLE 2.4-11
Sheet 3 of 3

Map No.*	Name of System (Intake County)	Distance (km/mi) and Direction from Unit 2	Distance (km/mi) by Water from Unit 2	Average Withdrawal Rate 1980-81		Type of Use	Population Served	Production Capacity		Comments
				cu m/day	mgd			cu m/day	Mgd	
14	Sacketts Harbor Village (Jefferson County)	49/31 NNE	51/32	568	0.15	Domestic	1,200	1,893	0.50	Withdrawals fluctuate in summer from 492 cu m/day (0.13 mgd) in Jun to 681 cu m/day (0.18 mgd) in Aug and Sep
15	Chaumont Village (Jefferson County)	60/37 NNE	61/38	265	0.07	Domestic	550	908	0.24	Winter (Dec-Mar) usage is approx. 189 cu m/day (0.05 mgd); summer usage (Jun-Sep) avg. 341 cu m/day (0.09 mgd)
16	Cape Vincent Village (Jefferson County)	65/41 N	65/41	757	0.20	Domestic	750	908	0.24	Withdrawals fluctuate between Jun and Sep from 473 to 1,136 cu m/day (0.125 to 0.3 mgd)

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* Locations corresponding to map numbers are shown on Figure 2.3-17.

SOURCES

1. New York State Department of Health. Selected Public Water Supply Inventory. Albany, NY, July 22, 1981.
2. Personal communication between C. Gaye, Metropolitan Water Board of Onondaga County, Syracuse, NY, and C. S. Ellis, Stone & Webster Engineering Corporation, Boston, MA, August 11, 1981; February 2, 1982; and June 1, 1982.
3. Personal communication between Mrs. Frantz, Ontario Town Water District, Ontario, NY, and C. S. Ellis, Stone & Webster Engineering Corporation, Boston, MA, August 11, 1981.
4. Personal communication between R. Walvoord, Williamson Water District, Williamson, NY, and C. S. Ellis, Stone & Webster Engineering Corporation, Boston, MA, August 11, 1981.
5. Personal communication between Mr. Wilkinson, City of Oswego Water Supply, Oswego, NY, and C. S. Ellis, Stone & Webster Engineering Corporation, Boston, MA, August 11, 1981.

TABLE 2.4-12
Sheet 1 of 1
CANADIAN WATER SUPPLIERS AND INDUSTRIAL USERS
DRAWING FROM LAKE ONTARIO WITHIN 80 KM (50 MI) OF UNIT 2

Map No.*	Name of System (Intake Location)	Approximate Distance (km/mi) and Direction from Unit 2	Approximate Distance (km/mi) by Water from Unit 2	Permitted Withdrawal Rate (gpm)	Permitted Withdrawal Amount		Type of Use
					cu m/day	mgd	
17	R. J. Sweezey (Township of Pittsburgh, Frontenac County)	75/47 N	79/49	120	114	0.03	Domestic
18	Public Utilities Commission of the City of Kingston (Frontenac County)	75/47 N	75/47	18,358	81,832	21.62	Domestic
19	Township of Kingston (Frontenac County)	74/46 N	74/46	10,008	27,290	7.21	Domestic
20	DuPont of Canada (Kingston Township, Frontenac County)	74/46 N	74/46	15,006	81,491	21.53	Industrial, air conditioning, and cooling
21	Township of Ernestown (Lennox and Addington County)	75/47 NNW	77/48	120	719	0.19	Domestic
22	Canada Cement LaFarge Ltd. (Ernestown Township, Lennox and Addington County)	75/47 NNW	77/48	2,252	12,263	3.24	Industrial, cooling, processing, and sanitary purposes
23	Millhaven Fibres Ltd. (Ernestown Township, Lennox and Addington County)	75/47 NNW	77/48	20,021	109,084	28.82	Industrial
24	Permanent Concrete Ltd. (Ernestown Township, Lennox and Addington County)	75/47 NNW	77/48	60	151	0.04	Industrial
25	Sandhurst Water Works Ltd. (South Fredericksburgh Township, Lennox and Addington County)	75/47 NNW	77/48	120	265	0.07	Domestic
26	Picton Public Utilities (Prince Edward County)	77/48 NW	97/61	NA	10,901	2.88	Domestic

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* Map numbers refer to Figure 2.4-16.

SOURCE: Ontario Ministry of the Environment. Data on Public and Private Water Supply Systems Drawing From Lake Ontario. Kingston, Ontario, July 24 and August 20, 1981.

TABLE 2.4-13
Sheet 1 of 1
UNITED STATES IRRIGATION INTAKES ON LAKE ONTARIO WITHIN 80 KM (50 MI) OF UNIT 2

Farmer	Location of Intake (County)	Distance in km (mi) by Water from Discharge	Area in ha (acres)	Average Water Use		Total Water Use/ Application cu m (mgd)	Frequency of Application
				cm/ha (in/acre)	l/ha (gal/acre)		
J. Simplaar Mexico, NY	On Lake Ontario, between Demster Beach Road and Hickory Grove Road (Oswego County)	8.2 (5.1)	24.3 (60)	7.6 (3)	762,000 (81,463)	18,510 (4.89)	Once per year, 1 year in 4
L. Hurlbutt Mexico, NY	South side of Butterfly Swamp (Oswego County)	9.9 (6.2)	8.1 (20)	7.6(3)	762,000 (81,463)	6,170 (1.63)	Once per year, dry weather only
D. Ouellette Sterling, NY	East Branch of Sterling Creek (Cayuga County)	38.6 (24.1)	28.3 (70)	5.1(2)	508,000 (54,308)	14,380 (3.80)	Once per year, 1 year in 5

NOTE: Irrigated crop at each location, apples.

SOURCES: Personal communication between J. Simplaar, Mexico, NY, and C. S. Ellis, Stone & Webster Engineering Corporation, Boston, MA, June 10, 1981.

Personal communication between L. Hurlbutt, Mexico, NY, and C. S. Ellis, Stone & Webster Engineering Corporation, Boston, MA, June 9, 1981.

Personal communication between D. Ouellette, Sterling, NY, and C. S. Ellis, Stone & Webster Engineering Corporation, Boston, MA, June 15, 1981.

TABLE 2.4-14
Sheet 1 of 1
CANADIAN IRRIGATION INTAKES ON LAKE ONTARIO WITHIN 80 KM (50 MI) OF UNIT 2

Name	Location	Rate Not to Be Exceeded		Amount Not to Be Exceeded	
		lpm	gpm	cu m/day	mgd
Picton Golf and Country Club	Hallowell Township	454	120	189	0.05
G. Vader	Athol Township	2,044	540	1,136	0.30
K. Perry	Athol Township	1,249	330	1,173	0.31
R. K. Hicks	North Marysburgh Township	1,423	376	2,044	0.54
Windy Acres Farms	Hallowell Township	1,635	432	1,363	0.36
B. McArthur (West Lake Farms Ltd.)	Hallowell Township	908	240	984	0.26
C. Foster	Hallowell Township	1,703	450	1,438	0.38
G. Bosma	South Marysburgh Township	568	150	530	0.14
Point Pleasant Farms, Ltd.	North Marysburgh Township	1,703	450	2,460	0.65
Waupoos Canning Co., Ltd.	North Marysburgh Township	1,703	450	2,044	0.54
J. Carter	North Marysburgh Township	2,502	661	2,233	0.59
R. & K. Carson	North Marysburgh Township	1,703	450	1,438	0.38
E. Vowinckel	South Marysburgh Township	2,275	601	3,255	0.86
R. R. Dodokin	South Marysburgh Township	454	120	681	0.18
W. Hicks	South Marysburgh Township	908	240	227	0.06
C. A. McCormack	South Marysburgh Township	840	222	757	0.20
Cataraqui Golf and Country Club	Kingston	1,590	420	2,271	0.60

SOURCE: Ontario Ministry of the Environment. Data on Public and Private Water Supply Systems Drawing From Lake Ontario. Kingston, Ontario, July 24 and August 20, 1981.

TABLE 2.4-15
Sheet 1 of 2
SUMMARY OF RESULTS ANALYSIS OF BUILDING FLOODING DUE TO PMP BASED ON HYDROMET 51 AND 52

Building	Door	Length (ft)	Total Flow (ft^3)	Bldg. Depth (in)	Distribution of Flow/Flux
Diesel generator	Stop logs	11 15	404.2 551.1	9	Evenly over floor; provided caulking material to make stop logs watertight.
Control building	C261-29 C261-24 C261-31	7 3 3	257 1400 110	<2.5	All flow is assumed to spread evenly through the control building El 214 ft, and then the water will eventually drain into the electrical tunnel – west area at El 210 ft. There is no impact to any equipment required for safe shutdown at control building El 214 ft.
Auxiliary bay south	SA262-3	3	63.6	1	Flow will be confined to auxiliary bay stairwell area. No fix is required.
Electrical tunnel – south area	ET262-4 ET262-3	3 3	695 0	<3.3	All flow is assumed to spread evenly through the tunnel at El 214.5 ft, and then eventually drain into the electrical tunnel – west area at El 210 ft. There is no impact to any equipment required for safe shutdown. Door ET262-4 is located in the access control building linkway and is no longer considered an exterior door.
Electrical tunnel – north area	ET261-1	3	1400	<5	All flow is assumed to be spread evenly through the tunnel at El 214.5 ft, and then eventually drain into the electrical tunnel – west area at El 210 ft. There is no impact to any equipment required for safe shutdown.
Electrical tunnel – west area	C261-29 C261-24 C261-31 ET261-1 ET261-2 ET262-3	7 3 3 3 3 3	257 1400 110 1400 1400 695	~24	All water in the control building, and electrical tunnels (north and south) will eventually drain into the electrical tunnel – west area at El 210 ft from the higher building elevations. The flood depth in the electrical tunnel – west area will submerge cable trays, 2TX0028 and 2TX0048, which are located 11 inches above the floor grade. The cables in these trays support Reactor Protection System (RPS, D4) and the Neutron Monitoring System (NMS, Channel ND). Although these systems are classified as Safety Related, these systems are not required for plant safe shutdown as stated in FSAR

TABLE 2.4-15
Sheet 2 of 2
SUMMARY OF RESULTS ANALYSIS OF BUILDING FLOODING DUE TO PMP BASED ON HYDROMET 51 AND 52

Building	Door	Length (ft)	Total Flow (ft^3)	Bldg. Depth (in)	Distribution of Flow/Flux
					Section 7.1.1.3. Safety related electrical cable, cable trays and electrical penetrations located in the electrical tunnels are capable of performing their normal function, while partially or completely flooded as stated in FSAR Section 3.4.1.1.5.
Auxiliary bay north	NA262-1	3	63.6	1	Flow will be confined to auxiliary bay stairwell area. No fix is required.
RB railroad track bay	RR-261-1	17	581.5	4	Doors are equipped with weatherstrip and 1/16" neoprene loop. The doors are airtight; water leakage will be negligible. No safety-related equipment is in this area.
Standby gas treatment	SG261-2 SG261-1 SG261-6	8 8 3	273.6 273.6 102.6	4	Flow is spread evenly throughout the building (see Note 5).
Service water pump room (north) from auxiliary boiler room	AB261-3	3	408.1	4.4	Flow into auxiliary boiler building is distributed into the pumphouse if AB261-3 is open.

NOTES:

1. Use hydrographs from Calculation No. 12177-WH(B)-062 for water surface elevations.
2. Door sill elevation is in the door identification number, e.g., SG261-1, where "261" is the door sill elevation.
3. Calculation method for in-flow through doorways from PMF submerged orifice discharge equation:

   $Q = CA\sqrt{2gh}$
   Q = Flow (cfs)
   C = Discharge coefficient = 0.6
   A = Cross-sectional area of flow = length of door (L) x crack width of door opening
   g = Gravity
   h = Headwater surface elevation on exterior of door
4. No credit has been taken in the analysis for sump water retainage or sump pump operation.
5. Since equipment structural pad height is 6 in, resultant building water depths less than this are acceptable.