# 3.0 SITE CHARACTERISTICS

## 3.1 INTRODUCTION

This section provides descriptions of geographical, demographic, meteorological, hydrological, seismological, and geological characteristics of the GE-MO site and vicinity. This information has been derived from various documents submitted during MFRP licensing activities[1] and site studies performed as part of actual and proposed capacity expansions. Applicable information from the history of experience in receipt, storage and transfer of irradiated nuclear fuel dating back to 1972 is also included.

## 3.2 GEOGRAPHY AND DEMOGRAPHY OF SITE

This section includes a description of site geography, population and land use considerations as applicable to the fuel storage facility.

### 3.2.1 Site Location

GE-MO facilities are located on a tract of about 886 acres owned by General Electric Company (GE or the Company) in Gooselake Township, Grundy County, Illinois, near the confluence of the Kankakee and Des Plaines Rivers. The tract is located 41°22'53" N latitude, 88°16'32" W longitude; about 15 air-miles southwest of Joliet and about 50 miles southwest of the Chicago, Illinois - Gary, Indiana area. Aurora is located about 25 miles north, and Kankakee is about 25 miles to the southeast. Morris, the county seat of Grundy County, is about 7 miles to the west. Interstate Highway 55 (I-55) is about 4 miles east, and Interstate Highway 80 (I-80) is about 5 miles to the north. Figures 1-1 through 1-3 depict the tract general location, and Figures 3-1 and 3-2 depict general plot arrangement and neighboring structures and activities.

### 3.2.2 Site Description

Figure 1-3 is a map of the site, showing the site, OCA, and other details, including transmission lines, gas lines, and other features. The GE-MO site is in a developing industrial area of typically "rolling prairie" terrain. In general, land in the area has been farmed for many years but the GE-MO buildings are in an area of rocky outcroppings and thin top soil, unsuited to economical, large-scale farming of crops.

#### 3.2.2.1 GE-Morris Operation Boundary

GE-MO boundaries and surrounding lands and waters are shown in Figure 3-1. The tract's northern boundary is formed by Collins Road and the eastern boundary by Dresden Road. The Illinois and Kankakee Rivers are separated from the tract to the north and east by lands of Commonwealth Edison Company's (CECo), Dresden Nuclear Power Station (DNPS) and related facilities, and a privately owned plot of about 50 acres. To the south, the tract is bordered by discontinued clay mining operations now privately owned. Other lands bordering the GE tract include industrial areas to the northwest, and Goose Lake Prairie State Park

Figure Withheld Under 10 CFR 2.390

Figure 3-1. TOPOGRAPHIC MAP: GE Tract and Vicinity

Figure Withheld Under 10 CFR 2.390

Figure 3-2. Contour Map – GE Morris Operation

#### 3.2.2.2 Property Ownership

GE is the sole owner of the entire 886 acre tract, subject to easements which have been granted for power lines, and natural gas lines, as shown in Figure 1-2. The tract, as originally purchased, totaled about 1,380 acres and included that portion of Section 1, Township 33 North, Range 8 East that is south of the Kankakee River, all of Section 2, Township 33 North, Range 8 East and that portion of Section 35, Township 34 North, Range 8 East that was south of the DNPS site.

Since that time, about 70 acres located in the southwest corner of Section 1, Township 33 North, Range 8 East and about 50 acres in a 400 ft. wide strip along the south edge of Section 2, Township 33 North, Range 8 East were sold to A. P. Green Refractory Company, Illinois Products Division, for use in connection with clay mining and clay products manufacturing activities. Subsequently, the remainder of Section 1, Township 33 North, Range 8 East and a 525 ft. wide strip along the east edge of Section 35, Township 33 North, Range 8 East and extending into Section 2, Township 33 North, Range 8 East for a short distance have been sold to CECo for flume access to and from the DNPS cooling lake.

#### 3.2.2.3 Access Control

Access to the GE-MO tract is controlled. GE-MO facilities occupy about 52 acres in the north portion of the tract, adjoining the DNPS site. Principal plant structures, including the ventilation stack, are located within an area of about 15 acres, fenced with chain-link-type fencing topped by multiple strands of barbed wire with an overall height of 8 ft. Access to the site is controlled by gates. The remainder of the tract is enclosed by an agricultural fence with posting advising unauthorized persons to keep out. In the conveyance of parcels previously described, provisions have been included to ensure their subsequent use and access will continue to be appropriately controlled. CECo similarly controls access to the DNPS site and security areas.

A lease agreement permits limited farming and beef cattle grazing on the tract outside the OCA.

#### 3.2.2.4 Boundaries for Establishing Effluent Release Limits

The OCA boundary (the tract boundary shown in Figure 1-2) is the boundary for establishing dose equivalents as defined in 10 CFR 72.104 and 72.106.

No credible acts of nature, man-induced events or accidents have been identified that would result in biologically significant release of radioactive material or direct radiation dose in excess of limits of 10 CFR 72.106 outside the OCA boundary. Therefore, the Emergency Planning Zone (EPZ) for GE-MO coincides with the OCA boundary.

### 3.2.3 Population, Distribution and Trends

The data base for the following sections is founded on information developed by agencies of the States of Illinois and Indiana, as well as information developed by GE and CECo [2,3,4].

### 3.2.3.1 Population 0 and 5 Miles (Figures 3-3 and 3-4)

The population in the immediate vicinity of GE-MO is very low. Within a radius of 5 miles the population is about 14,700 including 5,256 (1993) in the village of Channahon, about 4 miles to the northeast. Included in this accounting are several residences at the Dresden Lock and Dam. The 1990 population figures within a 5 mile radius are based on local community estimates and are not intended to represent U.S. census data.

The population within 5 miles of the site is projected to increase to 30,000 by the year 2015[5].

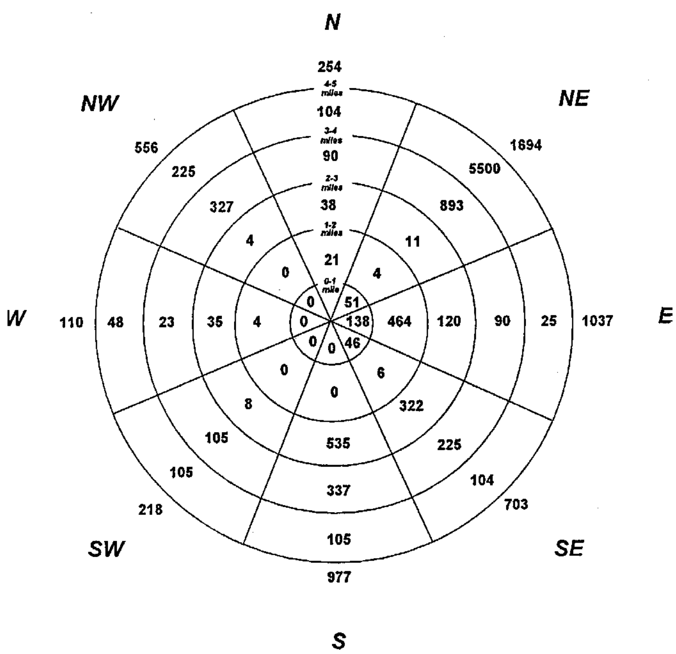



Figure 3-3. Estimated population within a five mile radius of GE-MO, 1990

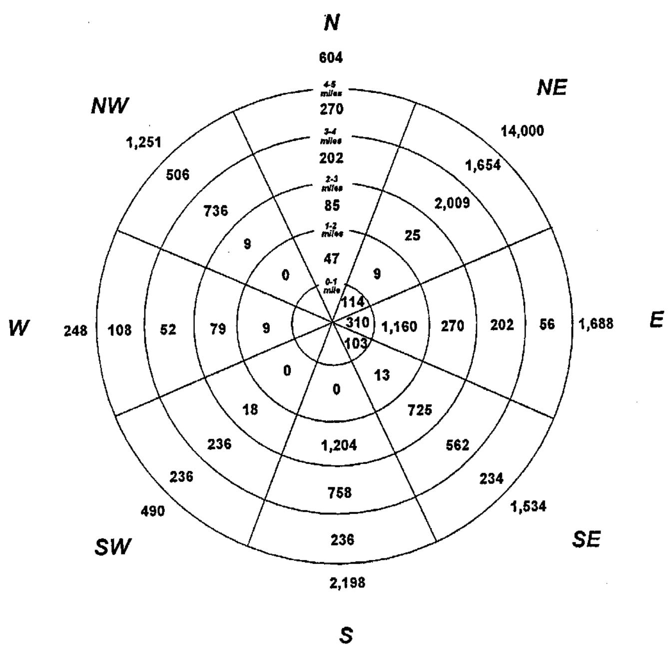



Figure 3-4. Estimated population in a five mile radius of GE-MO, 2015

### 3.2.3.2 Population Within 50 Miles (Figures 3-5 and 3-6)

The total population within the 50 mile radius was about 7,000,000 in 1990 and is projected to reach 8,000,000 by 2015 with about 91% of the total beyond the 30 mile radius[6,7].

Studies by CECo's Industrial Development Department indicate that since 1946, 82% of the new industries locating within the CECo's system are located within 25 miles of downtown Chicago. In 1965, 80% of the new industries also located according to this pattern. Current indications are that this industrial growth pattern is slowing but continuing within the 25 mile belt. Thus, the growth adjacent to the GE-MO-DNPS sites (which are outside of the 25 mile belt) should continue but at relatively low rates. Joliet and Aurora are the closest areas likely to experience significant population increases.

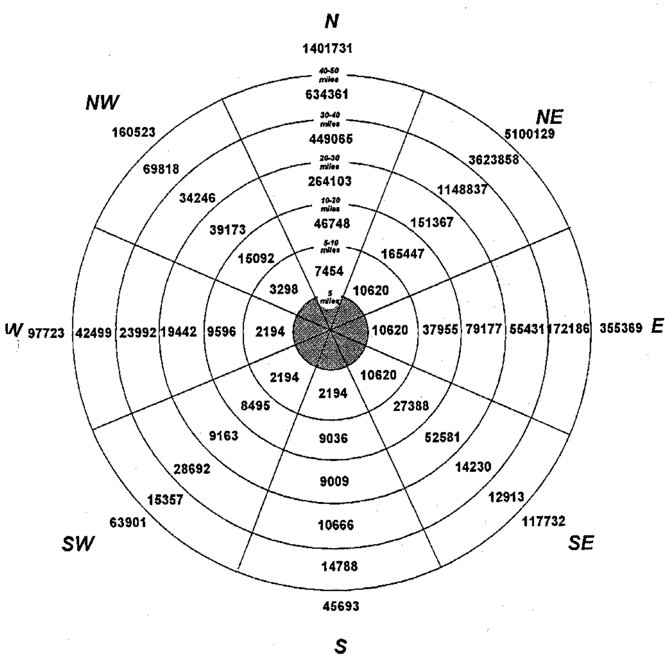



Figure 3-5. Estimated population within a 5-50 mile radius of GE-MO, 1990

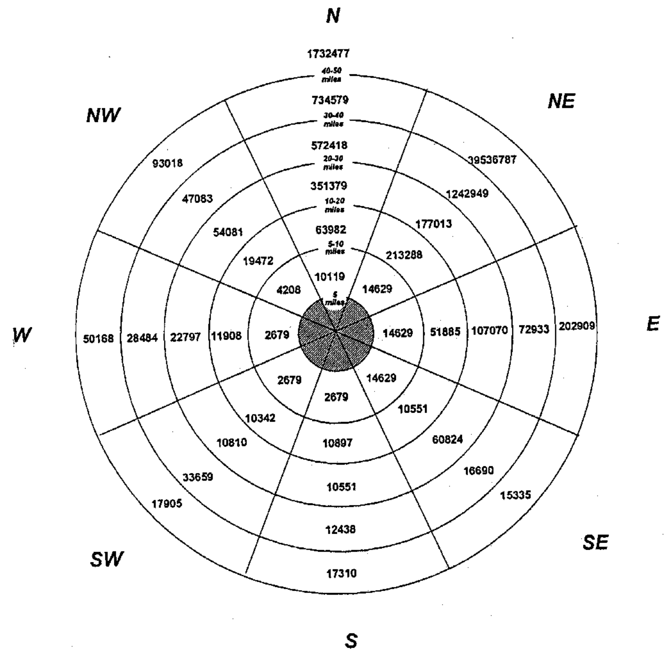



Figure 3-6. Estimated population in a 5-50 mile radius of GE-MO, 2015.

### 3.2.3.3 Transient Population

There are small seasonal variations in population in the area farm lands because of harvest personnel requirements. Unlike some farm areas, harvest activities are highly mechanized and relatively few additional workers are required.

Almost all manufacturing and other industrial activity is nonseasonal and draws upon a population base that resides in the same general area. For example, with the largest part of Chicago's industrial and residential areas within the 50 mile radius, daily movements of people within Chicago and environs result in a relatively insignificant statistical change from the viewpoint of considerations applicable to the GE-MO site.

As discussed elsewhere in this Section, recreational uses of lands and water in the area result in small seasonal changes in population in cottages, etc.

### 3.2.4 Users of Nearby Land and Waters

Immediate GE-MO neighbors (Figure 3-2) are the DNPS site on the north, abandoned clay pits and open farm land on the south and Goose Lake Prairie State Park to the west. To the east is the Dresden cooling lake and a privately owned property of about 50 acres, divided into about 30 cottage sites. Collins Station, a fossil-fired plant is to the west-southwest of GE-MO.

Present land use patterns in the area seem likely to continue for some time to come. The Northeastern Illinois Planning Commission does not expect a change in the pattern in the southwestern corner of adjacent Will County, either. (The county line is approximately 1.5 miles east of the GE tract.)

#### 3.2.4.1 Industrial

In addition to CECo's holdings to the east, north, and northwest, another industrial area is located along Interstate Highway 55 (I-55). This highway runs north and south, about 4.5 miles directly east of the tract (Figure 1-1). Two miles east of I-55 is the inactive Joliet Army Ammunition Plant. A large Mobil Oil petroleum refinery is located where I-55 crosses the Des Plaines River. Industrial sites are also located on the north bank of the Illinois River.

#### 3.2.4.2 Residential Use and Population Centers

Residential occupancy in the immediate vicinity of GE-MO is low. There is a cluster of about 30 cottages on the west shore of the Kankakee River, about 0.5 miles from the GE-MO stack. These are located between Dresden Road and the Kankakee River on a tract of about 50 acres adjacent to the GE-MO and DNPS sites. Residential development in the immediate vicinity of GE-MO would be limited to this tract which is now nearing saturation.

There is a similar group of cottages on the Kankakee River east bank greater than 1 mile from the GE-MO stack. Some homes in this area are permanent residences, although most have been developed for part-time recreational purposes. Surveys by CECo indicate that within 2.5 miles of the DNPS site there are a total of 129 permanent homes and 191 part-time recreational cottages along the Kankakee River. Other residences in the area include several at Dresden Dam about 1.2 miles to the north. There are no major residential centers developing south of the Kankakee and Illinois Rivers in the vicinity of the GE tract.

Cities and towns having populations greater than 1,000 located within 30 miles of GE-MO are listed in Table 3-1.

Other areas and sites involving intermittent and temporary congregations of persons within 5 miles of area are as follows (data as of July 2003):

a. Schools - Enrollment[8]

| | | | |
|---|---|---|---|
| Minooka High School | 1,500 | Channahon School | 1,437 |
| Minooka Jr High & Grade School | 1,700 | Illinois Youth Center[9] | Closed |

b. Churches - average attendance of largest service

| | | | |
|---|---|---|---|
| Minooka Catholic | 300 | Minooka Methodist | 170 |
| Channahon Baptist | 250 | Channahon Methodist | 150 |
| Channahon Catholic | 500 | Goose Lake Baptist | 125 |
| Phelan Acres Bible | 65 | | |

c. There are no hospitals within the 5 mile area.

**Table 3-1**

CITIES GREATER THEN 1,000 POPULATION WITHIN 30 MILES OF GE-MORRIS OPERATION

| Area | Name | Population (1990 Census) |
|---|---|---|
| 0-5 Miles | Channahon | 7,344 |
| | | |
| 5-10 Miles | Braidwood | 5,203 |
| | Coal City | 4,797 |
| | Morris | 11,928 |
| | Wilmington | 5,134 |
| | Minooka | 3,971 |
| | | |
| 10-20 Miles | Crest Hill | 13,329 |
| | Gardner | 1,406 |
| | Joliet | 106,221 |
| | Lockport | 15,191 |
| | Manhattan | 3,330 |
| | Marseilles | 4,655 |
| | New Lenox | 17,771 |
| | Plainfield | 13,038 |
| | Rockdale | 1,888 |
| | Seneca | 2,053 |
| | Shorewood | 7,686 |
| | | |
| 20-30 Miles | Aurora | 142,990 |
| | Bolingbrook | 56,321 |
| | Bourbonnais | 15,256 |
| | Bradley | 12,784 |
| | Dwight | 4,363 |
| | Frankfort | 10,391 |
| | Kankakee | 27,491 |
| | Lemont | 13,098 |
| | Manteno | 6,414 |
| | Matteson | 12,298 |
| | Mokena | 14,583 |
| | Montgomery | 5,471 |
| | Naperville | 128,358 |
| | North Aurora | 10,585 |
| | Odell | 1,014 |
| | Orland Park | 51,077 |
| | Oswego | 13,326 |
| | Ottawa | 18,307 |
| | Peotone | 3,385 |
| | Plano | 5,633 |
| | Richton Park | 12,533 |
| | Romeoville | 21,153 |
| | Sandwich | 6,509 |
| | Somonauk | 1,295 |
| | Sugar Grove | 3,909 |
| | Tinley Park | 48,401 |
| | Woodridge | 30,394 |
| | Yorkville | 6,289 |

### 3.2.4.3 Agricultural

There is no land suitable for large-scale farming operations within two miles of the GE tract. There are home gardens and some truck farms located near Plainfield and Joliet. Crops from truck farming in this area are generally for local consumption. Most farming operations raise corn, soy beans and grains. There is some farming and beef cattle grazing permitted on the GE-MO tract under a lease arrangement. The closest dairy herd is about seven miles south.

### 3.2.4.4 Recreational

Principal recreational activities in the area include swimming, boating, hunting and fishing. Most activities involve the Kankakee River and the "finger lakes" which have been left from earlier strip mining operations. Goose Lake Prairie State Park is located to the west of the tract. There is little sport activity, other than boating, on the Illinois and Des Plaines Rivers because of pollution of the Des Plaines River as it flows through the Chicago area.

### 3.2.4.5 Adjacent Waters

The only waters near the GE tract are the Kankakee and Illinois Rivers, DNPS cooling lake, Collins Station cooling lake, and small "finger Lakes”.

CECo does not allow access to the Dresden cooling lake for recreational uses. A portion of the Collins Station cooling lake is managed by the Illinois Department of Conservation for fishing and waterfowl hunting. The Illinois Waterway, one of the major inland waterways, is adjacent to the DNPS site. An agreement between GE and CECo provides for access to the Illinois Waterway through the DNPS site so that facilities for boat docking and access roads to the waterway could be developed at some future time if required.

There are two small "finger lakes" about 2.5 miles south of the GE tract where homes have been built, while other lakes on which houses are being built are located about 3.5 miles southwest. Some houses are solely for recreational purposes.

## 3.3 NEARBY INDUSTRIAL, TRANSPORTATION AND MILITARY FACILITIES

None of the industrial, military, or transportation activities in the area present a credible hazard to the fuel storage facility nor to the transport of irradiated nuclear fuel. Fuel in storage is located well below ground level in a stainless steel-lined, reinforced concrete water basin, and held in stainless steel baskets latched in a supporting grid. Explosions or fires at "nearby" industrial facilities would be too far away to have any influence on fuel in storage. Even the explosion of a passing tank truck would not affect the safety of stored fuel. Likewise, the structural characteristics of fuel casks and the nature of nearby activities result in minimum hazard to transportation of spent fuel.

### 3.3.1 Nearby Nuclear Facilities

The location and identification of nuclear facilities within 50 miles of GE-MO site are shown in Table 3-2. The closest facilities are the DNPS Units 1, 2 and 3, located about 0.7 miles north of the GE-MO stack. The combined radiological impacts from GE-MO and DNPS are within requirements of 10 CFR 72.104 as indicated by calculations and environmental monitoring results. Calculated dose commitments from GE-MO are a small fraction of the dose commitments from DNPS, even considering design basis accidents evaluated in Section 8.

Table 3-2

NUCLEAR REACTORS WITHIN 50 MILES OF GE-MORRIS OPERATION

| Type | Capacity (MWe) | On Line | Latitude | Longitude | Airline Miles to GE-MO | |
|---|---|---|---|---|---|---|
| BWR | 200 | 1960 | 41°22’ | 88°14’ | 0.7 | Dresden 1* |
| BWR | 809 | 1970 | 41°22’ | 88°14’ | 0.7 | Dresden 2 |
| BWR | 809 | 1971 | 41°22’ | 88°14’ | 0.7 | Dresden 3 |
| BWR | 1,078 | 1983 | 41°21’ | 88°36’ | 20 | LaSalle 1 |
| BWR | 1,078 | 1984 | 41°21’ | 88°36’ | 20 | LaSalle 2 |
| PWR | 1,100 | 1986 | 41°16’ | 88°13’ | 10 | Braidwood 1 |
| PWR | 1,100 | 1988 | 41°16’ | 88°13’ | 10 | Braidwood 2 |

* Dresden 1 was shutdown in 1978

### 3.3.2 Industrial and Military

The GE tract is near several industrial sites along the Illinois River (Figures 1-1 and 1-2). Most development is north of the Illinois River over 1 mile from GE-MO. The development of the last few years is slowing as most suitable industrial sites are already occupied and Goose Lake Prairie State Park now occupies most of the remaining land south of the river.

In addition to DNPS immediately to the north, other industry in a 6 mile radius of GE-MO is listed in Table 3-3.

Table 3-3

INDUSTRIAL, TRANSPORTATION, AND MILITARY ACTIVITIES
(6-mile radius)

| Installation | Function | Proximity |
|---|---|---|
| EXCELON DNPP | Electricity | 0.7 NE |
| Reichold Chemical Plant | Resins and chemicals | 1.6 mi NW |
| Cardox Air Liquide | Carbon Dioxide | 3.5 mi NW |
| Northern Illinois Gas Co. | Natural Gas | 2.5 mi NW |
| Alumax Mill Products | Aliminum sheet and coil | 2.8 mi NW |
| Quantum, USI Division | Ethylene, ethylene oxide, glycol | 3.3 mi NW |
| Van Den Bergh Foods | Edible Oil | 3.2 mi ENE |
| Dow Chemicals | Polystyrene plastic | 3.7 mi E |
| Exxon (chemical plant) | Under construction | 3.9 mi ENE |
| Mobil Plastics | Chemical Plant | 4 mi ENE |
| Enron Liquids Pipeline, Inc. | Propane | 4.0 mi NW |
| Mobil Chemical Co | Polystyrene sheets and crystal | 4.1 mi NE |
| Exxon-Mobil Oil Refinery | Petroleum Products | 4.5 mi NE |
| Collins Power Station | Electricity generation (fossil-fired) | 5.0 mi WSW |
| ARMAK Co. | Mfg of fatty Acid | 4 mi WNW |
| Diversified Chemicals and Propellants Co. | | 3.3 mi ENE |
| Demert and Dougherty | Filling aerosol cans | 6 mi S |

### 3.3.3 Transportation

One principal factor in the original selection of the GE-MO site was the ready availability of excellent rail and highway access to all parts of the United States and water transportation that could be developed if required in the future.

Highway access to the tract is via a paved county road, known as Dresden Road, extending south from the DNPS site parallel to the GE-MO tract and intersecting Pine Bluff Road (Figure 1-2). Pine Bluff Road (named Lorenzo Road in Will Country) runs in an east-west direction approximately 1 mile south of the GE tract boundary and provides access to I-55 approximately 4 miles east of the site, and Illinois 47 to the west. I-55 is a limited access highway between Chicago and St. Louis. Another limited-access highway, Interstate Highway 80, which traverses the State from east to west, is approximately 5 miles north of the GE lands and is accessible either from I-55 or from State Highway 47.

Railroad access to the tract is provided by a spur from the Elgin, Joliet and Eastern (EJ&E) Railway through the DNPS site. The EJ&E is a belt line which circles Chicago from near Wisconsin on the north to Indiana on the east, and connects with every major railroad serving Chicago. Through these connecting lines direct rail services to all parts of the United States are available.

There are no airports within 8 miles of the site and the closest major airports are Chicago O'Hare International Airport and Chicago Midway Airport, situated approximately 50 miles and 40 miles, respectively, to the north and northeast of the site. Commercial flights approach Chicago airports from the southwest, so that most flights pass to the west of the GE-MO site. Data for aircraft flying the Visual Omni Range (VOR) - Joliet for the 37th busiest day (used for statistical purposes by the Federal Aeronautics Administration (FAA) to represent an above average day) in September 1979 are shown in Table 3-4.

Table 3-4

VOR - JOLIET FLIGHTS[a]
September 1979

| Time Periods | Civilian Flights | Air Carriers |
|---|---|---|
| 0800 - 1600 hrs. | 124 (3000 - 9000 ft.) | 111 10,000 ft. or above |
| 1600 - 2200 hrs. | 85 (same) | 96 (same) |
| 2200 - 0800 hrs.[b] | 14 | 21 |

a. Track is about 3 miles west, 5 miles north of Minooka.
b Data for 2200-0800 hrs. is typical.

## 3.4 METEOROLOGY

The climate of Illinois is typically continental, with cold winters and warm humid summers. There are frequent short-period fluctuations in temperature, humidity, cloud cover, wind speed and direction. Winds are controlled primarily by storm systems and weather fronts which move eastward and northeastward through the area. Southeasterly and easterly winds usually bring mild and wet weather. The southerly winds are warm and showery while westerly winds are dry with moderate temperatures. Winds from the northwest and north are usually cool and dry. With the exception of tornadoes, there are no severe weather extremes in the area[10,11,12].

### 3.4.1 Regional Climatology

Topography of the area is not significant in affecting regional climatology except for some localized fog situations related to the rivers, strip-mine lakes, and the DNPS cooling lakes. The land is commonly referred to as rolling prairie and is without significant topographical features. Even Lake Michigan, the topographical feature of the area having the most meteorological significance, has only a general effect on the region's climate, and no specific effect on GE-MO.

#### 3.4.1.1 Temperature and Precipitation

Temperature data for Morris, Illinois, is shown in Table 3-5. Annually, there are usually 28 days with temperatures above 90 °F occurring from May through October and 141 days with temperatures below 32 °F occurring from September through April. Average precipitation, including snowfall, and average snowfall data for Morris and Joliet, Illinois, are shown in Table 3-6[13]. The ANL record for June 1950 to June 1964 shows an annual average precipitation of 31.49 in. with a 24 hr. maximum of 6.24 in. A maximum annual snowfall of 100+ in. was recorded during the 1978-79 winter[14].

**Table 3-5**

LOCAL TEMPERATURE DATA (°F) FOR MORRIS, ILLINOIS

| Month | Average | Low | High |
|---|---|---|---|
| January | 25.8[a] | -22 | 68 |
| February | 27.5[b] | -22 | 67 |
| March | 37.3 | -19 | 82 |
| April | 50.2 | 17 | 90 |
| May | 61.2 | 25 | 103 |
| June | 70.8 | 34 | 106 |
| July | 74.9 | 41 | 109 |
| August | 73.3 | 49 | 107 |
| September | 65.9 | 26 | 103 |
| October | 54.9 | 14 | 92 |
| November | 40.1 | -9 | 82 |
| December | 28.7 | -22 | 64 |

[a] Record period of 29 years [b] Record period of 28 years

**Table 3-6**

NORMAL & EXTREME PRECIPITATION[a] & SNOWFALL (IN.) FOR MORRIS & JOLIET, ILLINOIS

Normal Precipitation Amounts

| Element | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Precip (in) | 1.58 | 1.64 | 2.46 | 3.75 | 3.87 | 4.22 | 4.34 | 3.92 | 3.14 | 2.70 | 3.00 | 2.44 | 36.96 |

Precipitation Extremes 1948-2001

| Month | High (in) | Year | Low (in) | Year | 1-Day Max (in) | Date |
|---|---|---|---|---|---|---|
| JAN | 3.89 | 1950 | 0.05 | 1981 | 1.90 | 01-14-1995 |
| FEB | 5.59 | 1997 | 0.00 | 1987 | 2.75 | 12-21-1997 |
| MAR | 4.84 | 1954 | 0.26 | 1958 | 2.32 | 03-25-1954 |
| APR | 7.37 | 1975 | 0.53 | 1971 | 2.20 | 04-12-1954 |
| MAY | 7.62 | 1975 | 0.67 | 1992 | 2.73 | 05-10-1990 |
| JUN | 11.69 | 1993 | 0.38 | 1988 | 5.13 | 06-13-1981 |
| JUL | 17.37 | 1996 | 0.13 | 1991 | 13.60 | 07-18-1996 |
| AUG | 10.05 | 1972 | 0.47 | 1996 | 4.00 | 08-15-1958 |
| SEP | 13.20 | 1961 | 0.04 | 1979 | 3.67 | 09-01-1977 |
| OCT | 8.71 | 1954 | 0.16 | 1964 | 3.75 | 10-11-1954 |
| NOV | 8.18 | 1985 | 0.52 | 1999 | 2.54 | 11-18-1990 |
| DEC | 7.28 | 1982 | 0.27 | 1995 | 3.34 | 12-03-1982 |

[a] Amounts shown include equivalent inches of water for snowfall

#### 3.4.1.2 Humidity and Fog

Average relative humidity in January is 85% at 8 a.m., 75% at noon and 80% at 8 p.m. (CST). Average relative humidity in July is 77% at 8 a.m., 55% at noon and 62% at 8 p.m. The 1% summer design wet bulb temperature is 78 °F[15].

Fog is more frequent in the region than at continental locations of similar latitude across North America. This is because of the influence of Lake Michigan, local rivers, and the DNPS cooling lake and related systems. The main physical processes causing radiation, advection, orographic and steam (ground) fog are evident in the region[16]. This natural fog occurs most frequently and persists the longest in winter. On the average, dense fog (visibility less than 0.4 km) occurs during less than 15% of the 300 to 450 hours of winter fog. Dense fog is recorded most frequently in the early morning. Winter fog occurs most frequently with temperatures between 14 °F and 40 °F and summer fogs with temperatures between 59 °F and 69 °F. Dense fog in winter occurs almost exclusively with surface saturation deficits of 0.5g per kilogram day air or less[17].

The closest meteorological station that has collected fog data is the Joliet Municipal Airport (about 12 miles NNE). Meteorological observations representing 99,165 hrs. (about 11 years) indicate that a total of 12,284 hrs. (12.4%) of fog with visibilities of 6 miles or less occurred at the airport. Dense fog having "zero" visibility (less than 330 feet) occurred 0.25% of the time, or about 23 hours per year. These critical cases occurred most often in winter, least in summer (most often in January and least in June) and most often in the early morning hours (0500-0900 CST). The "zero" visibility fogs had a median persistence of up to 3 consecutive hours. However, one occurrence lasted for 12 consecutive hours, with an estimated reoccurrence in 10-20 years[18].

#### 3.4.1.3 Tornadoes

Information from the U.S. Weather Bureau indicates that over a period of approximately 40 years, there was an average of 4.8 tornadoes per year in Illinois, which is very close to the average for all states east of the Rocky Mountains. Of 192 tornadoes reported in the state, 52 were considered to have been "destructive" (i.e., damage of $50,000 or more and/or at least one death). The average area covered by reported tornadoes is about 8 square miles. Reported path widths range from 34 yards to 4 miles[19].

Several tornadoes have been reported near the DNPS site since 1965. On November 12, 1965, a tornado passed 4 miles west of the site while moving toward the east-northeast at approximately 70 mph. Several electrical transmission lines to the site were interrupted and, as a result, DNPS Unit 1 was shut down for about 24 hr. A second tornado, on May 24, 1966, passed near the site resulting in one transmission line being lost. However, the load was carried by other electrical transmission lines and DNPS Unit 1 operated normally. On July 17, 1972, a tornado passed northwest of the GE-MO site, and on April 3, 1974, a tornado touched down just north of Morris, Illinois. Neither caused damage in the GE-MO area.

## 3.4.2 Local Meteorology

Data and sources of data for site temperature, water vapor, precipitation and fog conditions are contained in Section 3.4.1.

### 3.4.2.1 Wind Data

Annual wind frequencies show a rather uniform distribution of wind direction (Figure 3-8). The most frequent wind directions are from the west and south sectors (based on 22.5 degree sectors). Average wind speed at the 300 ft. level is about 15 mph and at the 125 ft. level is about 11 mph. These observations are based on 1968 data taken from the DNPS meteorological tower. Maximum wind velocity reported in the area of the site is 109 mph, unofficially reported at Joliet on April 3, 1956, and on April 30, 1962, as the fastest gust during heavy thunderstorms and scattered tornadic activity. The fastest windspeed reported at various locations in the site area is 87 mph at Chicago and 75 mph at Peoria[20].

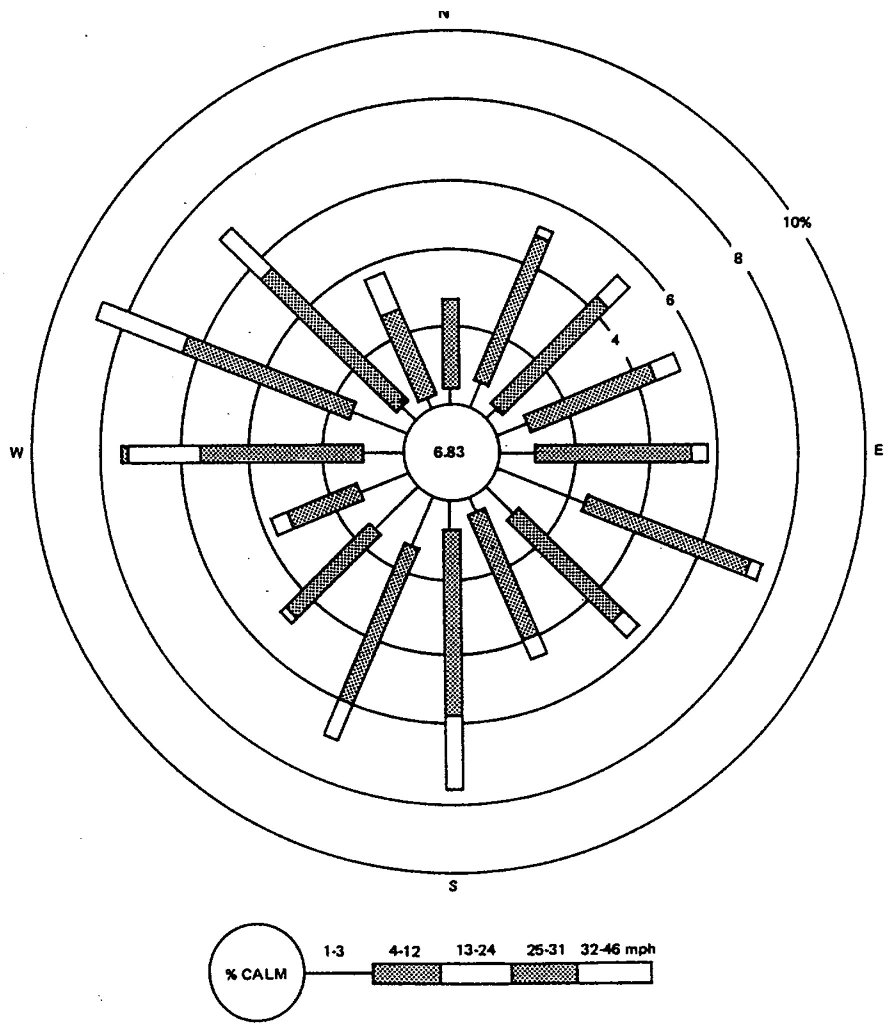



Figure 3-8. Annual Wind Rose at 35 foot Level at DNPS Site.

### 3.4.2.2 Topography

The only major topographic influence in the area is Lake Michigan which is 45 miles to the northeast and is considered to have an insignificant effect on site climatology. The only potentially significant topographical features around the site are the Dresden Heights, located on the north side of the Des Plaines River, about 1.5 miles northeast of the site ventilation stack. These bluffs rise to an elevation of 630 ft., compared to the elevation at the site of 530 ft. Since the stack extends 300 ft. above the grade, the perturbation in the flow of the plume over the bluffs located some 1.5 miles away is quite small.

These bluffs are the only significant topographical features near the GE-MO site or, in fact, in most of northeastern Illinois. The only other topographical disturbances in the area are spoil piles which remain from abandoned strip mines. These are located farther from the site and are not as high as the bluffs across the river. The highest topographical elevation in Illinois is Charles Mound, elevation 1,241 ft., located on the Illinois-Wisconsin border. The average elevation of the state is 600 ft.

### 3.4.2.3 Electrical Storms

Thunderstorm activity in the Chicago area for the years 1970 through 1975 is presented in Table 3-7 in terms of thunderstorm days per month. The incidence of thunderstorms over a 33 year period is about 39 per year[21].

Table 3-7

THUNDERSTORM ACTIVITY

| | | | YEAR | | | | 33 Year |
|---|---|---|---|---|---|---|---|
| **Month** | **70** | **71** | **72** | **73** | **74** | **75** | **Average** |
| 1 | 0 | 0 | 0 | 0 | 0 | 4 | <0.5 |
| 2 | 0 | 1 | 0 | 1 | 0 | 1 | <0.5 |
| 3 | 2 | 4 | 5 | 4 | 7 | 4 | 3 |
| 4 | 10 | 3 | 6 | 4 | 7 | 8 | 5 |
| 5 | 10 | 6 | 5 | 4 | 8 | 9 | 5 |
| 6 | 9 | 10 | 7 | 10 | 10 | 13 | 7 |
| 7 | 10 | 9 | 7 | 7 | 6 | 7 | 6 |
| 8 | 7 | 4 | 8 | 3 | 4 | 9 | 5 |
| 9 | 11 | 4 | 6 | 6 | 3 | 3 | 4 |
| 10 | 3 | 2 | 1 | 4 | 1 | 2 | 2 |
| 11 | 1 | 2 | 0 | 3 | 0 | 3 | 1 |
| 12 | 1 | 2 | 1 | 1 | 1 | 3 | 1 |
| Total | 64 | 46 | 46 | 47 | 47 | 66 | 39 |

### 3.4.3 On-Site Meteorological Measurement Program

In late 1967, a 400 ft., fully instrumented meteorological tower was placed in operation at the DNPS site. Actual data collected at levels from 35 ft. above ground to 400 ft. above ground has verified favorable atmospheric diffusion conditions exist at the site. Data obtained from the tower during the first year of operation was correlated hour for hour with atmospheric stability measurements taken at ANL and applied on a preliminary basis to calculations for Dresden reactors. Since ANL is not too distant (27 miles northeast), and located in similar terrain, the two locations are climatologically similar and joint use of data from the two sites is a valid technique.

Meteorological data used to model dispersion characteristics of gaseous emissions from GE-MO are based on data collected from 1971 through 1993 at the Dresden meteorological tower.

#### 3.4.3.1 Diffusion Climatology

Hourly wind direction variability at the site shows that average direction range (angular change in direction) is 120 degrees in a 1 hr. period, for all wind speed conditions combined. During 0-3 mph wind speeds, the average range in direction is 100 degrees. Approximately 87% of the time when the wind speed is 0-3 mph (or 98.3% of all wind speeds) the wind direction range is 60 degrees or more which corresponds to a value of the diffusion parameter ($\sigma_\theta u_h$) of 20 degree-mph or 0.16 radian-meter per sec.

Environment surveys of the site and surrounding areas conducted by CECo, ANL, and the State of Illinois show that meteorological diffusion characteristics would cause a dispersion of small amounts of effluent emitted during normal operation to a degree such that these effluents have been undetectable off-site.

#### 3.4.3.2 Wind Speed, Direction and Atmospheric Stability

At the 400 ft. meteorological tower on the adjacent DNPS site, wind speed, direction and persistence are measured at the 35 ft., 150 ft. and 300 ft. levels. In addition, temperature measurements are made at the same levels and dewpoint temperatures are recorded at these levels continuously. A weighing-bucket rain gage is used to measure precipitation. An example of winds at the site is shown in Figure 3-8[22], which is an annual wind rose for the 35 ft. level.

Dresden 1971 through 1974, 150 ft. wind data has been used to estimate dispersion rates and calculate radiation doses from GE-MO. Table 3-8 shows relative frequency of winds from a given direction by Pasquill stability classes. Variability of the 300 ft. wind direction is determined by computing standard deviation of the most recent 60 wind direction values (one value is reported each minute). The 300 ft. to 35 ft. differential temperature was used to determine the stability class. One year of wind data (1974) was used to prepare the table, with a data recovery rate of 85.0%.

Table 3-9 gives the frequency of each stability class and average wind speed at 150 ft. for that class, based on the 1974 data.

Table 3-8

JOINT FREQUENCY DISTRIBUTION OF PASQUILL

STABILITY CLASS AND WIND DIRECTION, DRESDEN

150-foot level

(percent of total observations)[a]

| Class | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | CALM | TOTAL | Number of Observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 0.08 | 0.01 | 0.03 | 0.01 | 0.04 | 0.04 | 0.04 | 0.05 | 0.19 | 0.15 | 0.24 | 0.21 | 0.27 | 0.09 | 0.05 | 0.07 | | 1.58 | 118 |
| B | 0.46 | 0.20 | 0.11 | 0.24 | 0.50 | 0.52 | 0.46 | 0.60 | 0.71 | 0.75 | 1.38 | 0.83 | 0.75 | 0.48 | 0.35 | 0.60 | 0.08 | 9.03 | 673 |
| C | 0.56 | 0.35 | 0.16 | 0.27 | 0.68 | 0.82 | 0.64 | 0.87 | 0.98 | 1.48 | 0.98 | 0.78 | 0.60 | 0.60 | 0.43 | 0.38 | 0.04 | 10.63 | 792 |
| D | 2.70 | 2.63 | 2.54 | 2.74 | 3.41 | 3.05 | 3.29 | 4.44 | 6.27 | 6.01 | 4.31 | 3.76 | 4.87 | 5.25 | 4.20 | 2.74 | 0.09 | 62.30 | 4641 |
| E | 0.21 | 0.12 | 0.13 | 0.16 | 0.19 | 0.27 | 0.20 | 0.23 | 0.30 | 0.36 | 0.40 | 0.21 | 0.31 | 0.46 | 0.50 | 0.27 | 0.00 | 4.32 | 322 |
| F | 0.28 | 0.17 | 0.26 | 0.12 | 0.09 | 0.21 | 0.31 | 0.17 | 0.26 | 0.46 | 0.19 | 0.27 | 0.15 | 0.51 | 0.36 | 0.38 | 0.00 | 4.19 | 312 |
| G | 0.59 | 0.62 | 0.72 | 0.50 | 0.36 | 0.51 | 0.34 | 0.35 | 0.27 | 0.52 | 0.48 | 0.26 | 0.46 | 0.82 | 0.50 | 0.64 | 0.01 | 7.95 | 592 |
| Total | 4.88 | 4.10 | 3.95 | 4.04 | 5.27 | 5.42 | 5.28 | 6.71 | 8.98 | 9.73 | 7.98 | 6.32 | 7.41 | 8.21 | 6.39 | 5.08 | 0.22 | 100 | 7450 |

[a] 7450 valid observations

Source: Joint wind speeds and frequency reported for the year 1974 at the Dresden Nuclear Power Station meteorological tower.

Table 3-9

STABILITY, FREQUENCY, AND WIND SPEED

| Class | Frequency (%) | Wind Speed (mph) |
|---|---|---|
| A | 1.58 | 7.7 |
| B | 9.03 | 8.8 |
| C | 10.63 | 9.8 |
| D | 62.30 | 12.8 |
| E | 4.32 | 12.6 |
| F | 4.19 | 13.6 |
| G | 7.95 | 13.4 |

| | As Planned | As Operated |
|---|---|---|
| Stack Height | 300 ft (91 m) | 300 ft (91 m) |
| Discharge Volume | 25,000 cfm | 14,000 cfm |

### 3.4.4 Atmospheric Diffusion Characteristics

A general discussion of techniques used in calculating atmospheric diffusion characteristics and the resulting off-site doses from normal operation of GE-MO is given in Appendix A-3. These same methods and characteristics have been applied to nearby Dresden reactors[23]. Application of these methods for GE-MO is described below and in Section 7.

Diffusion calculations are based on annual wind direction, frequency, and stability distribution around the stack. Exposures and concentrations are calculated for all areas off-site from the plant based on actual site meteorology, thus ensuring that points with the highest potential exposures and concentrations are identified. These calculations extend to distances of several miles from the site, providing a good profile of the distribution of the dose versus location and distance from the site.

The height of release of effluent is the physical stack height plus effluent rise due to momentum. No credit was taken for possible thermal buoyancy of the plume. The stack and ventilation system design characteristics used in the analysis are listed below.

Meteorological data used in calculating doses and concentrations from radioactive materials released via the stack are a combination of data gathered at the Dresden site and data taken at ANL. Wind speed and direction data taken at the Dresden site were used in the calculation. Atmospheric stability measurements taken at ANL were correlated hour for hour to determine joint wind frequency, stability and velocity distribution at the site.

Data obtained from the GE-MO/DNPS tower during the first year of operation was correlated and applied on a preliminary basis to calculations for the Dresden reactors. These meteorological data verified the validity of the earlier approach and indicated that application of site data to calculation of maximum effects from releases would reduce calculated effects. Since actual data gathered served to verify the approach which had been taken earlier, calculations were not repeated[24]. In summary, data collected from the meteorological tower at the Dresden site verifies predicted excellent atmospheric diffusion characteristics typical of the northern Illinois site.

#### 3.4.4.1 Meteorological Diffusion Evaluation

Radiological effects of stack releases were evaluated at six points in the atmospheric diffusion spectrum, which should encompass conditions encountered at GE-MO. These are: (1) poor diffusion conditions caused by inversion (stable), at a wind speed of about 1 m/sec., typical of warm nights; (2) very stable and moderately stable conditions; (3) better diffusion conditions, typical of daytime, represented by neutral and unstable (lapse) diffusion, both at wind speeds of 1 m/sec. and 5 m/sec. Atmospheric diffusion methods reported by Watson and Gamertsfelder[25] and calculations for the site are described in Appendix A.

## 3.5 SURFACE HYDROLOGY

### 3.5.1 Surface Features and Drainage Patterns

GE-MO is located in the Illinois River Drainage basin, just south of the DNPS in eastern Grundy County, Illinois (Figure 1-1). The Kankakee River is 0.5 miles east of the site, flowing north until it meets the Des Plaines River 2 miles northeast of the site.

The two rivers join to form the Illinois River which flows west and south about 270 miles to the Mississippi. The GE-MO site is on a relatively high area about 30 ft. above normal pool level in the Kankakee River and between the flood plains of the two rivers.

The Illinois River and its tributaries are the primary surface water resources near the site. The Illinois and Des Plaines Rivers form part of the Illinois waterway which is a series of eight navigable pools (with the headwaters above a lock and dam) extending 327.2 miles from its confluence with the Mississippi River at Grafton, Illinois to the Chicago River outlet at Lake Michigan. The Illinois River is the stretch of the waterway from the confluence of the Kankakee and Des Plaines Rivers to the Mississippi River. The stretch of the Illinois River north of the site is part of the Dresden Island Pool of the waterway and includes the Dresden Island Lock and Dam which is almost due north of the site.

The Illinois River and tributaries drain an area of 32,081 square miles. The river is unique in the sense that during dry weather (low flow) its headwaters are essentially treated liquid wastes from about 5.5 million people and various industries in the metropolitan Chicago area mixed with water diverted from Lake Michigan.

Approximately 1.5 miles southeast of the GE-MO site, CECo has constructed a 1,275 acre cooling lake for DNPS. The intake/discharge flumes are located along the east boundary of the GE tract. The lake is confined by an encircling earth dam (or berm) with the top of the dam at an elevation of 527 ft. The elevation of the cooling lake is approximately 522 ft. No recreational use of this lake is planned.

A series of small marshes and ponds, primarily located in the Goose Lake Prairie Preserve, comprise the remaining surface water of the area. The ponds are approximately 1.5 miles southwest of the GE-MO boundary.

#### 3.5.1.1 Stream Flows

Stream flows on the Illinois Waterway fluctuate significantly due to seasonal effects and water flow regulation by means of Lake Michigan diversion and the lock-and-dam system. For example, on September 20, 1971, flows in the Dresden Pool dropped to 2,400 cfs from about 17,000 cfs on the preceding day. Average flow rate over the period 1921 to 1945 measured at Marseilles (20 miles downstream of the Dresden Pool) was 12,050 cfs (5,400,000 gpm). A 7 day 10 year low flow of 3,300 cfs was determined from data collected from 1940 to 1965 at Marseilles. A maximum flow of 93,900 cfs occurred at Marseilles in April of 1957. The flow of the Illinois River at Marseilles is greater than 3,000 cfs 98% of the time. The average flow of the Illinois River (1920-1963) at Dresden Island Lock and Dam was approximately 10,900 cfs.

The normal pool elevation in the Illinois River, controlled at the Dresden Island Lock and Dam, is 505 ft., with a maximum historical flood elevation of 506.4 ft. (1957). The estimated maximum flood elevation is 520 ft.; the GE-MO site elevation is higher than 532 ft. Spillway capacity at the Dresden Island Lock and Dam is well in excess of the estimated maximum instantaneous flow of the Illinois River (1,000,000 cfs, based on the assumption that maximum flows for all contributory streams occur simultaneously). The site elevation is well above the valley storage upstream from the dam.

Compared to the Illinois River, the Kankakee River is a relatively small river, with an average flow rate of 3,810 cfs (1,710,000 gpm), a minimum of 204 cfs (91,600 gpm), and a maximum of 75,900 cfs (measured at Wilmington, Illinois).

### 3.5.2 Site Flood Potential

The highest flood of record in the region occurred in 1957 and involved flows of less than 100,000 cfs, and created far below the 532 ft. minimum elevation of the GE-MO site as referenced to mean sea level. A study has been performed to develop rating curves for discharges of up to 600,000 cfs where the water level would rise to less than 520 ft. or more than 10 ft. below the GE-MO site. This study is summarized in Appendix A.6.

There are no other credible flood situations affecting GE-MO.

### 3.5.3 Surface Water Quality

Agricultural activity, boat traffic, and dredging have increased the Illinois River silt load over the past years and keep it in a continuously turbid condition. Water quality data collected at Morris, Illinois, including temperature and dissolved oxygen values, are presented in Table 3-10.

The Kankakee is usually several degrees cooler than the Illinois (see Table 3-11) and is not disturbed by barge traffic or dredging, as is the Illinois. These are probably the major factors for the existence of a more diverse fish population in the Kankakee than in the Illinois. Water quality of the Kankakee is not spectacularly better than that of the Illinois, however, and in some aspects is even poorer (compare Table 3-10 and Table 3-11) based on data from the sampling station on the Kankakee I-55 bridge.

Table 3-10

CHARACTERISTICS OF THE ILLINOIS RIVER AT MORRIS, ILLINOIS[a]

| PARAMETER | 1957 - 1971 | | 1990 - 1993 | |
|---|---|---|---|---|
| | Range | Average | Range | Average |
| Water Temperature (°C) | 1.1 - 29.4 | 15.6 | 0.7 - 26.9 | 13.3 |
| Turbidity (mg/l) | 16 - 330 | 67 | 0.3 - 150.0 | 24.6 |
| Dissolved Oxygen (mg/l) | N/A | N/A | 6.1 - 14.2 | 10.0 |
| Alkalinity (mg/l) | 96 - 208 | 174 | 104 - 206 | 160 |
| Hardness (mg/l) | 144 - 388 | 283 | 201 - 347 | 273 |
| Total Suspended Solids (mg/l) | N/A | N/A | 412 - 580 | 447.5 |
| Chloride (mg/l) | 23 - 162 | 58 | 42 - 110 | 67 |
| Sulfate (mg/l) | 11 - 125 | 48 | 51 - 125 | 75 |
| Nitrite & Nitrate (mg/l) as $NO_3$ | 0 - 35 | 6 | 2.60 - 7.80 | 4.64 |
| Ammonia (mg/l) as N | 0 - 11 | 3.9 | 0.05 - 0.80 | 0.31 |
| Total P (mg/l) as $PO_4$ | 0.1 - 37.0 | 3.8 | 0.22 - 0.57 | 0.35 |
| pH | 7.2 - 8.2 | 7.6 | 6.1 - 13.7 | 7.60 |
| Fluoride (mg/l) | 0.4 - 2.1 | 0.9 | 0.22 - 0.54 | 0.33 |
| Dissolved Iron (μg/l) | 0 - 500 | 100 | 23 - 5K | 61 |
| Specific Conductivity (μmhos) | 410 - 1050 | 700 | 540 - 933 | 729 |
| Fecal Coliform/100 ml | 10 - 2000 | 977 | 60 - 4900 | 1094 |
| Totals Dissolved Solids (mg/l) | 250 - 670 | 448 | 332 - 927 | 448 |

[a] Compiled from Water Quality Network, 1971 and 1993, Illinois EPA

Table 3-11

CHARACTERISTICS OF THE KANKAKEE RIVER AT WILMINGTON, ILLINOIS[a]

| PARAMETER | 1957 - 1971 Range | 1957 - 1971 Average | 1990 - 1993 Range | 1990 - 1993 Average |
|---|---|---|---|---|
| Water Temperature (°C) | 0.6 - 30 | 13.9 | 0.7 - 26.0 | 13.1 |
| Turbidity (mg/l) | 1 - 400 | 58 | 2.5 - 210.0 | 29.0 |
| Dissolved Oxygen (mg/l) | 5.4 - 14.6 | 10.1 | 5.0 - 13.0 | 9.4 |
| Alkalinity (mg/l) | 116 - 220 | 178 | 104 - 228 | 184 |
| Hardness (mg/l) | 116 - 576 | 308 | 208 - 382 | 307 |
| Total Suspended Solids (mg/l) | N/A | N/A | 7 - 188 | 42.0 |
| Chloride (mg/l) | 9 - 56 | 21 | 17 - 33 | 24.3 |
| Sulfate (mg/l) | 20 - 152 | 78 | 35 - 123 | 82.3 |
| Nitrite & Nitrate (mg/l) as $NO_3$ | 0 - 24 | 6 | 0.5 - 8.4 | 4.80 |
| Ammonia (mg/l) as N | 0 - 10.1 | 1.0 | 0.01 - 0.20 | 0.07 |
| Total P (mg/l) as $PO_4$ | 0.0 - 10.0 | 1.1 | 0.04 - 0.39 | 0.12 |
| pH | 7.1 - 8.8 | 7.9 | 6.9 - 9.1 | 7.80 |
| Fluoride (mg/l) | 0.0 - 0.4 | 0.2 | 0.11 - 0.23 | 0.18 |
| Dissolved Iron (μg/l) | 0.0 - 12.0 | 1.1 | 5 - 5K | 56.6 |
| Specific Conductivity (μmhos) | N/A | N/A | 432 - 773 | 615 |
| Fecal Coliform/100 ml | 10 - 800,000 | 31,848 | 10 - 2,750 | 136.6 |
| Totals Dissolved Solids (mg/l) | 170 - 530 | 362 | N/A | N/A |

[a] Compiled from Water Quality Network, 1971 and 1993, Illinois Environmental Protection Agency

## 3.6 SUBSURFACE HYDROLOGY

### 3.6.1 Regional and Area Characteristics

Groundwater in northeastern Illinois is drawn from four aquifer systems:

a. Sand and gravel deposits in the glacial drift;

b. Shallow dolomite formations mainly of the Silurian age;

c. Cambrian-Ordovician aquifers of which the Ironton-Galesville dolomite and the Galena-St. Peter sandstones are the most productive formations; and

d. The Mt. Simon aquifer consisting of the sandstone of the Mt. Simon and lower Eau Claire formations of the Cambrian age.

In the vicinity of GE-MO, glacial drift thickness ranges from none, with outcropping bedrock, to at most a few feet of drift. There is no evidence of the Silurian dolomite. As a result, groundwater in the vicinity of the site is drawn from the Cambrian-Ordovician aquifer which is used almost exclusively as the groundwater supply for municipal and industrial use in the area.

Glacial drift in the area is underlain by the Pennsylvanian-Spoon formation sandstone or the Ordovician-Fort Atkinson limestone, or both. Beneath these formations and directly over the Cambrian-Ordovician aquifers is a layer of Ordovician-Maquoketa shale approximately 65 ft. thick. The top of the Cambrian-Ordovician aquifers at the site is approximately 100 to 150 ft. beneath the surface and the piezometric surface of the Cambrian-Ordovician aquifers is about 100 ft. further down. The major source of near-surface groundwater in the area is from rainfall which seeps down through the alluvial overburden and upper strata of weathered and fractured rock to collect over relatively impermeable areas (clay seams, underlying shale).

#### 3.6.1.1 Water Quality

Water from the glacial drift and Silurian dolomite aquifers ranges in hardness from 100 to 1,000 ppm, although the majority of samples analyzed for hardness ranged from 100 to 450 ppm. Temperatures range from 46 °F to 54 °F (Suter, et al., 1959). Hardness of water from the Cambrian-Ordovician aquifers ranges from 260 to 880 ppm. Both hardness and temperature increase eastward, and water quality noticeably deteriorates south of the Illinois River (Suter, et al., 1959). Mt. Simon waters are of poor quality in this region because of their brackish nature. This characteristic increases rapidly eastward across northeastern Illinois.

### 3.6.2 Site Characteristics

Geological structure under the GE-MO site is typical of the region, presenting no anomaly significant in hydrological considerations. In general, the upper 10 to 20 ft. of Fort Atkinson Limestone has high but variable permeabilities with permeabilities decreasing to less than 100 ft. per year near the base of the formation.

Water-level measurements from piezometers installed in the Fort Atkinson, Scales, and Galena formations indicate that the Scales Shale acts as an effective aquitard between the Fort Atkinson Limestone and the dolomite of the Galena group.

The historical record of groundwater variations within the Galena Dolomite (the upper unit in the Cambrian-Ordovician aquifer) shows a cone of depression has developed near Joliet and that the piezometric surface has dropped over 100 ft. from 1915 to 1958 to an elevation of about 400 ft. above mean sea level.

While the regional piezometric surface of the Galena at the present time is unknown, the number of wells which penetrate this aquifer has increased since 1958 and it is probable the surface has further dropped. During drilling of the water supple well on the GE-MO site in 1968, the static water level within the Galena Dolomite was at about 370 ft. while the static water level of the Cambrian-Ordovician aquifer as a unit was at about 395 ft. The piezometric level in the Fort Atkinson Limestone parallels the ground surface, is 3 to 5 ft. deep and reacts rapidly to precipitation. The piezometric level in the Scales Shale is also near the ground surface, but reacts slowly to precipitation.

During LAW Vault construction, serious groundwater intrusion problems were encountered. The results of the investigation[26] indicated a complex groundwater system with several potential sources:

a. direct percolation from rainfall and runoff;

b. lateral seepage and flow from perched or confining zones in response to percolation from rainfall; and

c. lateral flow along joints, faults or fractured rocks.

#### 3.6.2.1 On-Site Well

There is a single deep well on site into the Cambrian-Ordovician aquifer, and is equipped with a 100 gpm submersible vertical turbine pump. Principal use of water from this source is potable, sanitary and basin makeup water. Well water could also be used for fire fighting. Characteristics of water from this well are contained in Table 3-12 & 3-13.

There is no release of liquids from GE-MO to potable ground water since site structures do not penetrate any principal aquifers. Even a major rupture of concrete basin walls could impact only on local on-site sample wells and would not penetrate to the Cambrian-Ordovician strata. (See Sec 8 and B.12, Ground Water Investigations by Dames & Moore, dated August 1977.)

### 3.6.3 Groundwater Investigation - 1977

As a part of a study of potential expansion of GE-MO facilities, a groundwater investigation was conducted in the spring and summer of 1977 by Dames and Moore[27]. The study included:

a. A review of previous site investigations
b. A review of literature
c. Evaluation of site boring data, groundwater level data, and pressure testing results
d. Evaluation of groundwater regime in the site area
e. Evaluation of groundwater movement and use at the site and in the region

Conclusions from this study (August 1977) are consistent with past studies, showing good availability of water for plant operations with negligible impact on aquifer performance. The more detailed analysis of permeabilities performed under this study further emphasize the suitability of the site for basin storage of irradiated fuel.

Table 3-12

WATER ANALYSIS - MORRIS OPERATION WELL

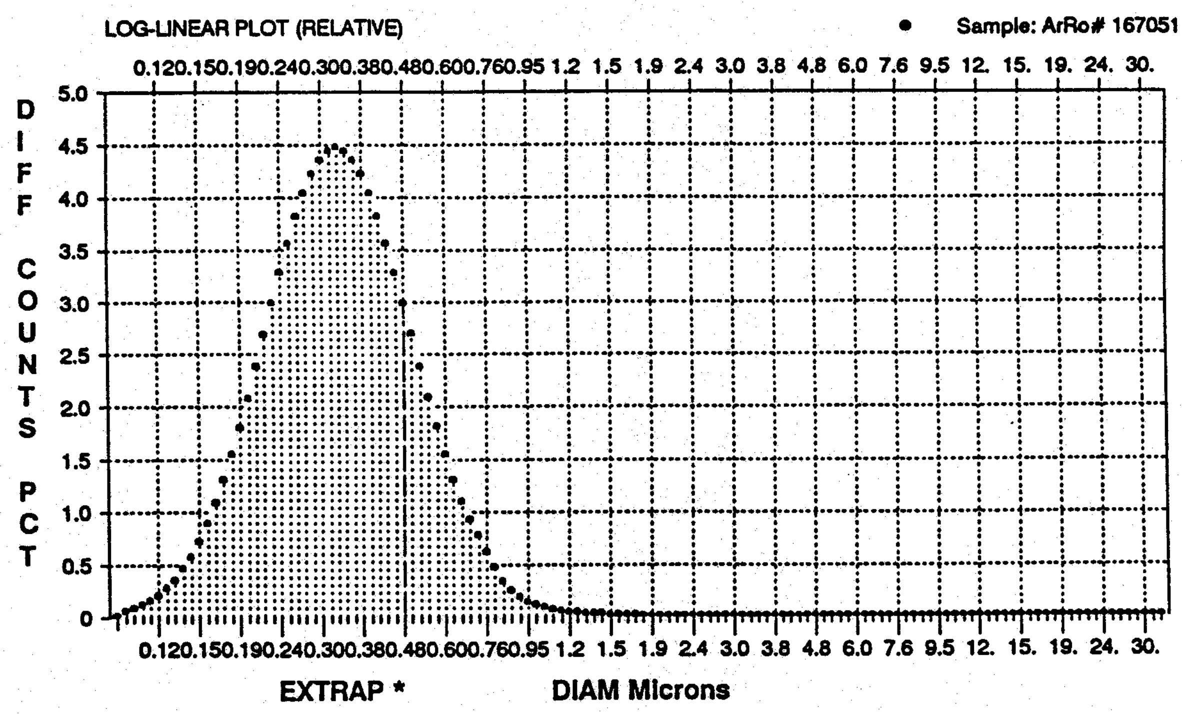
| **Material** | **Parts per Million** |
|---|---|
| Chloride | 100 ± 10 |
| Nitrate | 4.2 |
| Iron | < 0.4 |
| Silica (as Silicon) | 5 |
| Sulfate | 225 |
| Calcium | 58 |
| Magnesium | 25 |
| Sodium | 159 |
| Phosphate | None Detected |
| Manganese | < 0.1 |
| Sulfide | None Detected[a] |
| Bicarbonate | 295 |
| Potassium | 16 |
| Tin | 3 |
| $CO_2$ | 11.6 |
| pH | 8.0 |
| Conductivity | $1.1 \times 10^4$ mhos/cm |
| Dissolved Solids | 706 |
| Total Suspended Solids | 5 |
| Turbidity | 0.3[b] |
| Total Organic Carbon | 2.8 |

[a] As much as 2.2 ppm $H_2S$ (expressed as $CaCO_3$ equivalents) was present in 1968.

[b] NTU Units

Table 3-13

MICROSCOPIC PARTICLE SIZE DISTRIBUTION – MORRIS OPERATION WELL WATER




| | | | |
|---|---|---|---|
| Geometric Mean Size: | 0.333 um | -- PERCENTILES -- | |
| Geom. Std Deviation: | 1.517 um | 0.100% Counts above | 1.745 um |
| Geom. Skewness: | 0.002 | 1.000% Counts above | 0.907 um |
| Geom. Coeff Variation: | 455.6 | 6.000% Counts above | 0.633 um |
| | | 22.00% Counts above | 0.456 um |
| Arithmetic Mean Size: | 0.364 um | 50.00% Counts above | 0.331 um |
| Median Size: | 0.324 um | 78.00% Counts above | 0.241 um |
| Mode Size: | 0.330 um | 94.00% Counts above | 0.175 um |
| Kurtosis: | 24.791 | 99.00% Counts above | 0.130 um |
| Arith Std Deviation | 0.176 um | 99.90% Counts above | 0.104 um |

Source: Analysis by ARRO Laboratories, Inc., Joliet, Illinois.

## 3.7 GEOLOGY AND SEISMOLOGY

### 3.7.1 Geologic Studies

Geologic studies of the site have been performed by Dames & Moore. Studies were also performed by these consultants for DNPS and for the MFRP facilities. These studies are listed in Table 3-14. Reports of recent investigations, unique to fuel storage at GE-MO, are noted in Table 3-14 and are contained in the microfiche packet (Appendix B).

Table 3-14
MORRIS OPERATION SITE INVESTIGATIONS

M Report, Site Evaluation Study, Phase I - Part 1, Proposed Dresden Unit 2, Grundy County, Illinois, For General Electric Company Dated: April 13, 1965

M Report of Foundation Investigation, Proposed FRO Plant Project, Near Morris, Grundy County, Illinois, For General Electric Company Dated: December 13, 1967

Report, Subsurface Water Investigation, FRO Plant Project, Morris, Illinois, Fluor P.O. 4204-0-014, For General Electric Company Dated: February 25, 1970

Report of Drainage Well Pumping Tests, FRO Plant Project, Midwest Fuel Recovery Plant, Near Morris, Illinois, For General Electric Company Dated: January 11, 1971

M Report, Fault Investigation, Midwest Fuel Reprocessing Plant, Near Morris, Illinois, For General Electric Company Dated: October 1, 1974

M Report, Geological and Ground Water Investigation, Proposed Spent Fuel Storage Facility, Near Morris, Illinois, For General Electric Company Dated: September 3, 1975

M Letter Report, Evaluation of Foundation Recommendations, Project IV - Fuel Storage Capacity Expansion, Near Morris, Illinois, For General Electric Company Dated: May 12, 1977

M Report, Geophysical Investigations, Project IV - Fuel Storage Capacity Expansion, Near Morris, Illinois, For General Electric Company Dated: June 10. 1977

M Report, Ground Water Investigations, Project IV - Fuel Storage Capacity Expansion, Near Morris, Illinois, For General Electric Company Dated: June 17, 1977

Report, "Proposed Approach for Evaluate the Adequacy of Ground Water Monitoring System at Nuclear Spent Fuel Storage Plant - Morris, Illinois, Grundy County for General Electric Company" Dated: February 10, 1993

Report, "Groundwater Modeling and Specifications for Monitoring Wells at Morris, Illinois Operation for General Electric Company" Dated: August 18, 1993

Report, "Preliminary Estimates of Evaporation From Fuel Storage Basin at Morris, Illinois Facility for General Electric Company" Dated: September 29, 1993

Report, “Transport Modeling for Accidentally Released Water from Spent Fuel Storage Basin at Morris, Illinois Facility of General Electric Company” Dated: October 26, 1993

Report, “Groundwater Monitoring Well Network Summary and Installation Report – Morris, Illinois Facility for General Electric Company” Dated: January 28, 1994

Report, “Well No. DM-8, Groundwater Monitoring Well Network Installation Report, Morris, IL Facility, General Electric Company” Dated: January 4, 1995

M – Microfiche in Appendix B
Source : Dames & Moore, Consultants – Environmental and Earth Sciences, Park Ridge, Illinois

### 3.7.2 Regional and Tract Geology

The GE tract is situated in the Morris Basin, a relatively low area of slight topographic relief. Elevations range from 532 ft. on the site to about 500 ft. at the Illinois River bottom. The general appearance varies from flat to very gently rolling with slopes greater than 3% being rare. Surface topography is characterized by very shallow topsoils, with frequent outcroppings of bedrock. Dresden Heights is the dominant topographical feature and is located on the north side of the Des Plaines River about 1.5 miles northeast of the tract. Elevation of these bluffs is 630 ft. There are vestiges of abandoned strip mines in many parts of the area.

Regional structures in north and northeastern Illinois trend northwesterly and are characterized by asymmetrical folds with steep southwestern limbs and by vertical faults and joints that trend northwesterly. Fracture sets trending northeasterly also occur. Major regional geologic structures around the tract are shown in Figure 3-9.

A major structural zone of the underlying Illinois Basin is the LaSalle Anticlinal Belt, a north-northwesterly trending band of en echelon folds. Within the northern two-thirds of the basin this folded zone separates the shallow eastern shelf of the basin from the larger and deeper western shelf. The rocks of the eastern shelf - the area of the GE tract - are nearly flat-lying. Initial deformation along the LaSalle Anticlinal Belt began in the northern end during the post-Mississippian, pre-Pennsylvanian period, and migrated southward with time[28].

Cambrian and Lower Ordovician rocks are exposed along the trend of the Ashton Arch, an anticline that merges with the northern portion of the LaSalle Anticlinal Belt. Uplift along the Ashton Arch was at least post-Silurian, probably occurring in the same period as along the LaSalle Anticlinal Belt[29].

The Ashton Arch is bounded to the north by the Sandwich Fault Zone, trending west-northwest across northern Illinois to within 6 miles of the Morris site. It is mapped on the surface and subsurface for nearly 90 miles. The fault zone is essentially vertical, with the northeastern block downthrown a maximum of 900 ft. by the main fault, with numerous associated short faults near the northwestern end. The throw decreases toward the southeastern end of the zone and a scissors effect causes the southwestern block along a subsidiary fault to be downthrown more than 100 ft.[30]. Movements along the Sandwich Fault Zone are dated as post-Silurian, pre-Pleistocene, but major movements along the fault may have occurred when the LaSalle Anticlinal Belt was uplifted in post-Mississippian, pre-Pennsylvanian time[31].

The attitude of folds and faults in the region indicate that compressive forces acted along northeast-southwest lines during deformation in the Paleozoic Era. Extension fractures from parallel to maximum compression and shear fractures are symmetrically inclined (angles less than 45 degrees) about the compressive force axis. Such fracturing has been mapped at the DNPS site by the Illinois State Geological Survey[32].

The locations of these faults and others between the LaSalle Anticlinal Belt and the Sandwich Fault provide strong evidence of direct relationship between faults mapped adjacent to the Morris site and regional structures[33].

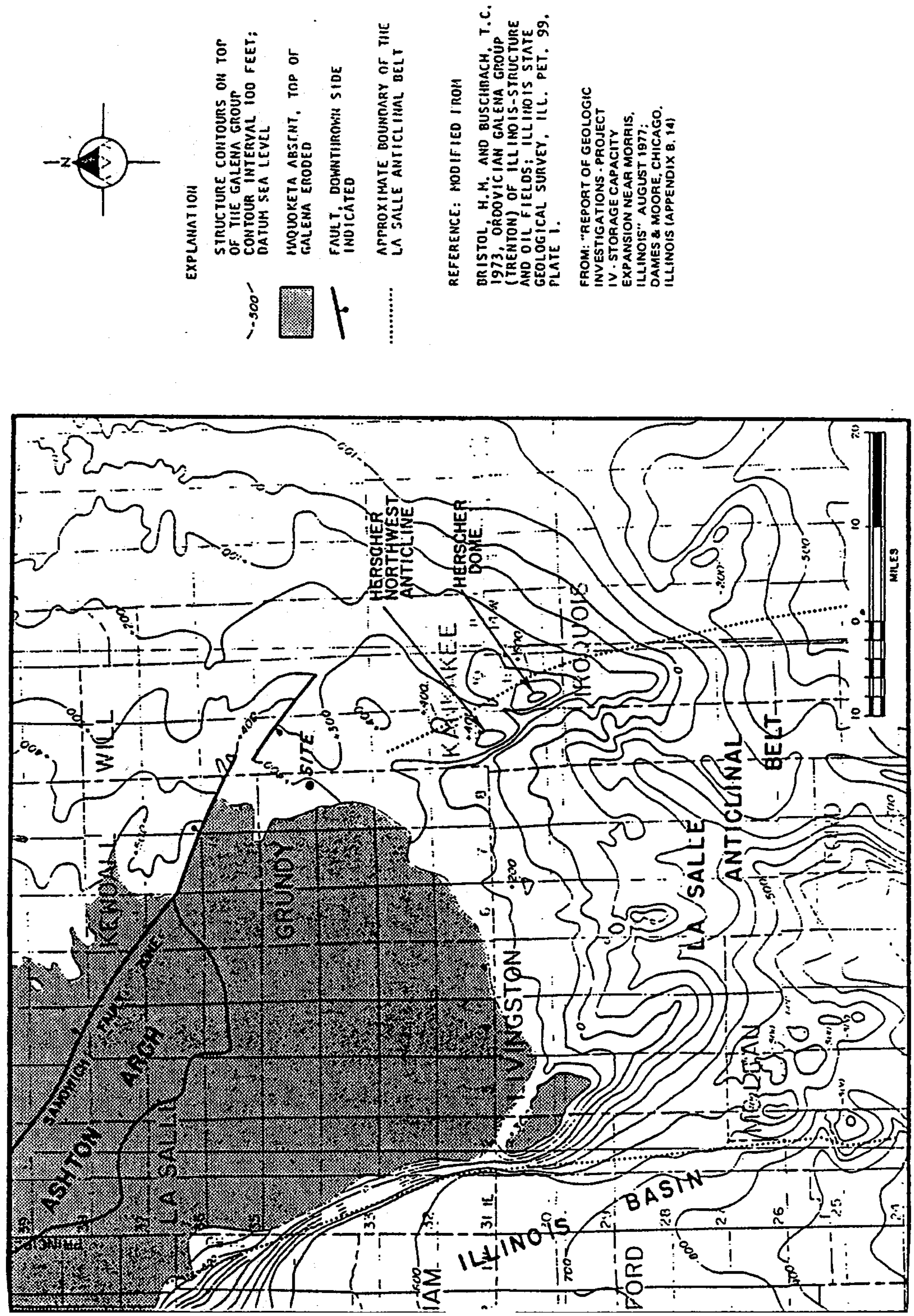



Figure 3-9. Major Regional Geologic Structures

### 3.7.2.1 Site Geology

Stratigraphy was determined by test borings and trenching performed during several geologic studies[34] of the area, with the most recent study completed in August 1977. The spatial relationships found at the site are complex, but can be explained in terms of glacial erosion, deposition, and post-glacial erosion. The generalized stratigraphic column for GE-MO (Figure 3-10) consists of an upper layer Spoon Formation sandstone of varying thicknesses, underlain by Fort Atkinson Limestone about 46 ft. thick. Scales formation shale is beneath the limestone. The site is overlain with a thin topsoil. The Ordovician system has a thickness of about 1,000 ft., overlaying the Cambrian system. Brecciated rock is found in some cross sections, indicating ancient faulting.

Surface drainage is rather poor since the bedrock surface is undulating and entraps surface water. A perched water condition exists because of relatively impermeable limestone and shale underlying the site. This condition is encountered only a few feet below the surface (4 or 5 ft.). True groundwater occurs in the Cambrian-Ordovician aquifers at depths of about 120 ft. at GE-MO. Maximum frost penetration is about 4 ft. Clay is the known mineral deposit of value at the site, and this is limited to the shallow overburden.

### 3.7.3 Investigation of Faults

A northwest-trending fault passing southwest of the main building was originally identified by Dames & Moore from borings made for a foundation investigation in 1967. Another northwest-trending fault was inferred in 1971 during investigation of effectiveness of drainage wells but could not be otherwise confirmed.

The northwest-trending fault was studied by Dames & Moore in 1974, in more detail in 1975, and again in 1977.

The 1974 study identified the fault, showing it to have an offset of 35 to 40 ft. with the southwest side dropped in relation to the northeast side. It was concluded at the end of the 1974 study that the most probable time of faulting occurred between the late Ordovician and early Pennsylvanian periods. The 1975 study included a seismic refraction survey of the site and a site stratigraphic survey through use of test borings and trenching. Conclusions from the 1975 study placed the major movement of the fault contemporaneous or precontemporaneous with major development of the northern portion of the LaSalle Anticlinal Belt, which is generally accepted to be about 300,000 to 400,000 years ago.

### 3.7.3.1 1977 Fault Study

A geological investigation was conducted in the spring and summer of 1977 to determine structural and stratigraphic relationships of the northwest-trending fault zone and to substantiate age of faulting at the site.

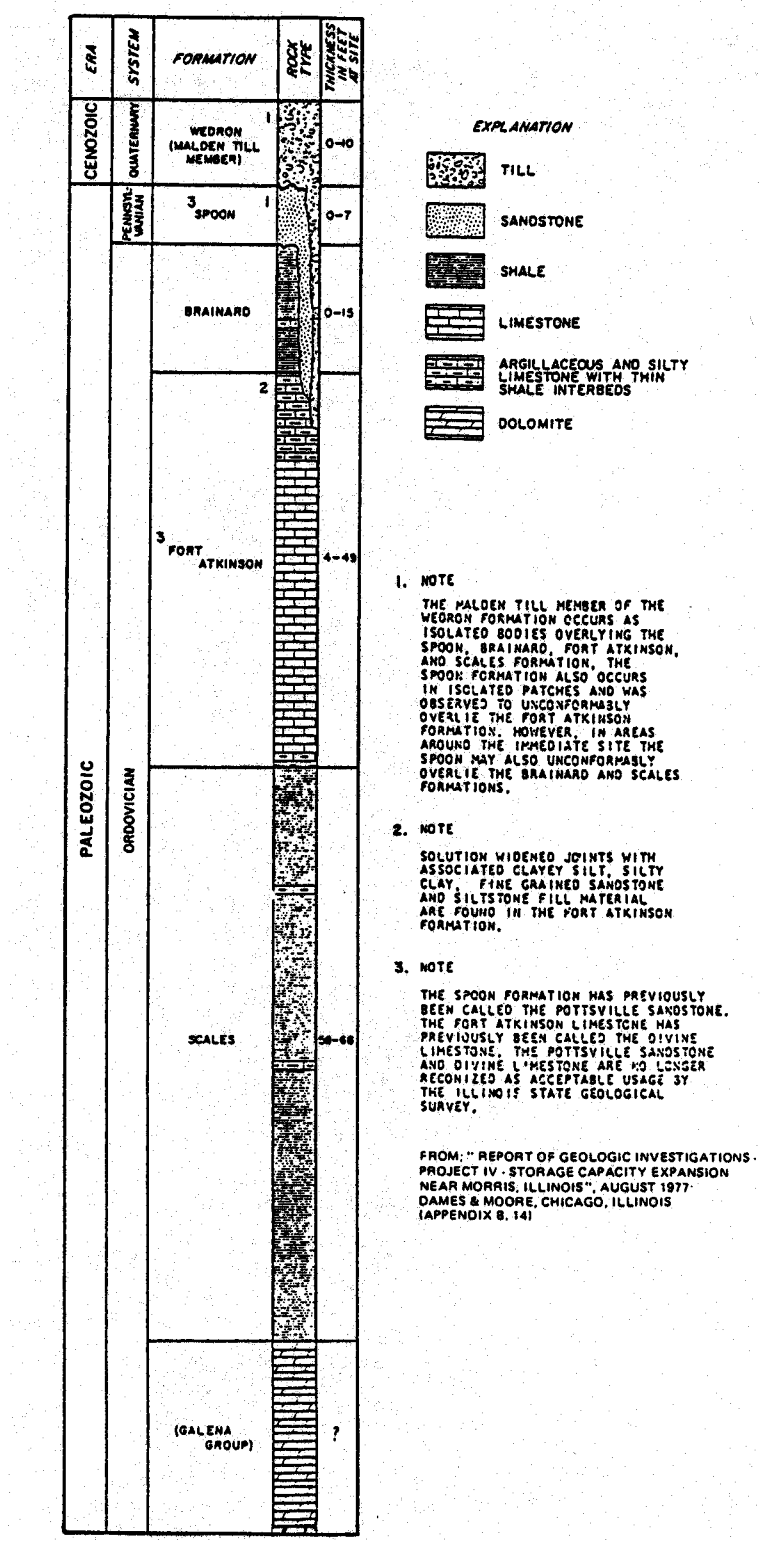



Figure 3-10. Generalized Stratigraphic Column for the GE Morris Operation Site.

Field investigations included soil and rock core drilling, borehole water pressure testing, piezometer installation, geophysical surveys, trenching across the fault zone, and geological mapping of the trenches.

The investigation showed multiple northwest-trending faults are present in an en echelon pattern instead of a single fault as previously interpreted. Furthermore, it was interpreted that cross faults trend northeasterly and also occur in an en echelon pattern.

Relative movement of the northwest-trending fault zone is down-to-the southwest. Several faults exposed in trenches have downward displacement to the northeast, however. Most individual faults also are displaced down-to-the-southwest. The faults probably converge with depth creating step-like extensional blocks that have variable displacements relative to adjacent blocks as well as rotational displacements. The variability of displacements of fault blocks is characteristic of en echelon gravity faults produced by antithetic tensional forces. The excavations provided comprehensive information regarding detailed structural relationships of the fault zone including displacement of faults, orientation of faults and joints, and continuity of fault blocks. Faults mapped within the trenches correlated well with fracture zones measured in the angle borings (Figure 3-11; note shaded areas).

### 3.7.3.2 Conclusions - 1977 Study

Evidence of the Spoon Formation sandstone directly overlying a fault and fault block of Fort Atkinson Limestone conclusively dates the fault as having occurred no later than pre-early or early Desmoisian. Presence of clay-limestone rubble as a colluvial wedge-shaped deposit along the fault block supports a probable post-Chesterian age of faulting. Age of faulting (post-Chesterian/early-Desmoisian) at the site is supported further by the regional geologic history. Initial deformation along the LaSalle Anticlinal Belt and major movements of the Sandwich Fault occurrence during post-Mississippian/pre-Pennsylvanian time[35] is equivalent to the age of site deformation.

Continued uplift within the area occurred after Pennsylvanian time but this renewed activity was of less magnitude[36] and may be partially responsible for warping or increased inclination of bedding planes within the Spoon Formation during its unlithified, unconsolidated state. No displacement of offset is found within beds of the Spoon Formation at the site.

Criteria for faulting, as defined at 10 CFR 100, Appendix A, require that a fault has not moved in the last 35,000 years or has no history of recurrent movement in the last 500,000 years. The statigraphic evidence found throughout the site, both in this and previous investigations, indicates a pre-Spoon deposition age for faulting. Relationships observed in Trench CT-7 (Appendix B.14) provide substantiated evidence that faulting occurred in post-Chesterian to early Desmoisian time (approximately 280 million years before the present). Therefore, faulting at the site is not capable.

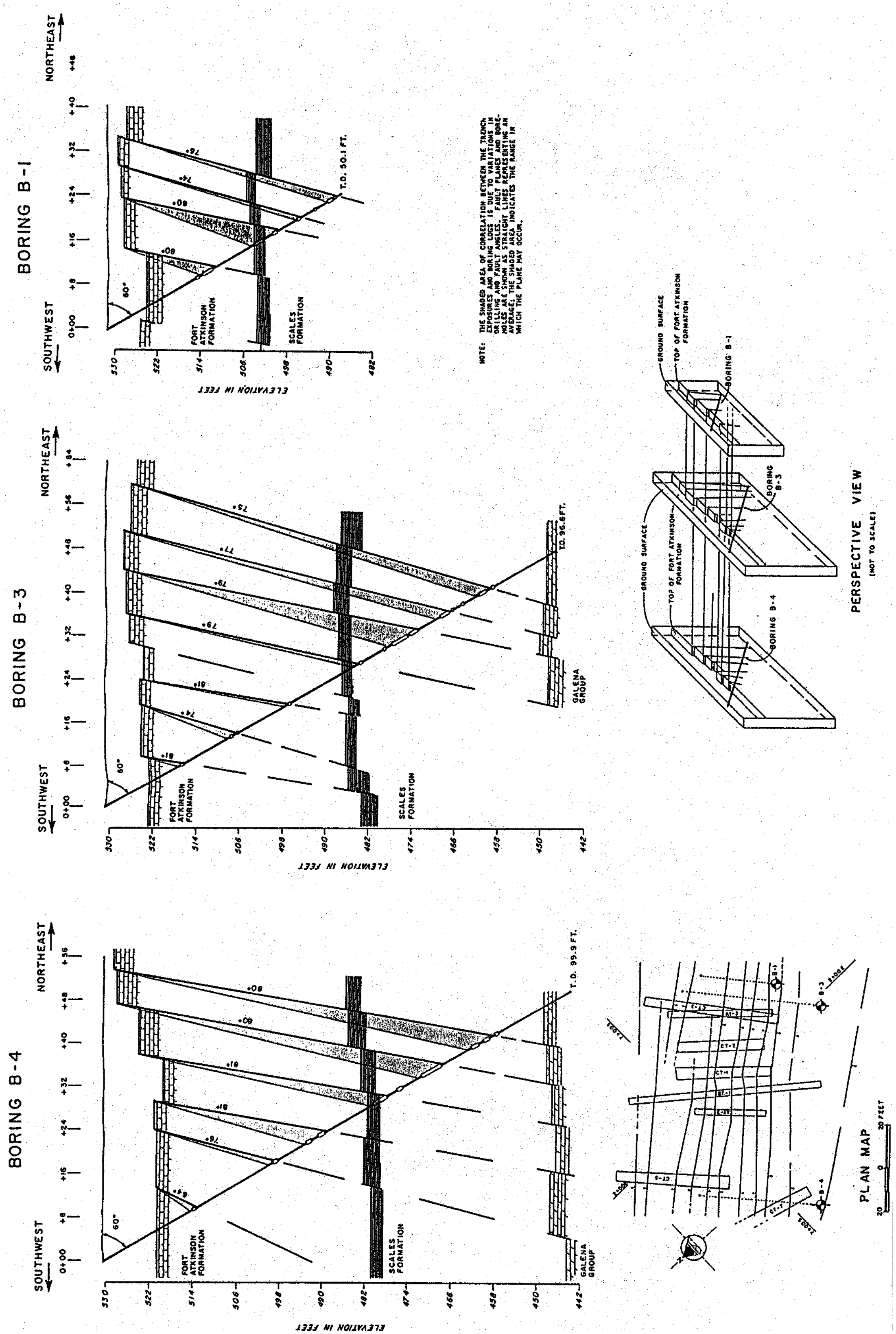



Figure 3-11. Correlation of Angle Boring and Trench Data.

### 3.7.4 Earthquake and Seismicity

Historical data shows seismic events in the vicinity of the site are relatively infrequent and are characterized by fairly low intensities and magnitudes.

#### 3.7.4.1 Engineering Properties of Materials Underlying the Site

Static and dynamic properties of materials underlying the site have been summarized in a report of a foundation investigation[37]. In general, underlying materials have been found very suitable for heavy facility construction.

#### 3.7.4.2 Seismic History

Several earthquakes of intensity MM V (Modified Mercalli (MM) scale) or higher have been listed as having epicenters in Illinois, including four of intensity MM VII. Only one significant earthquake has been centered within 50 miles of the site (intensity MM V or greater). It occurred on January 2, 1912, and was centered about 15 miles northwest of the site. It is described in "Earthquake History of the United States" (1973) as having an intensity of MM VI at Aurora, Freeport, Morris and Yorkville, and of V at Chicago. The shock was felt at Milwaukee and Madison, Wisconsin, and in Iowa, Indiana, and Fulton County, Kentucky. An intensity of MM VI was probably felt in the vicinity of the site as a result of this earthquake.

On September 15, 1972, an earthquake of epicentral intensity MM VI was centered about 55 miles northwest of the site. Press reports indicate the shock caused cracked plaster at Morris and Ottawa and a broken window at Rockton.

Only one earthquake of intensity MM VII has been centered within 100 miles of the site area. It occurred on May 26, 1909, about 88 miles NW of the site and according to "Earthquake History of the U.S.," it was felt from Missouri to Michigan and Minnesota to Indiana. A shock of intensity MM VII was noted over a considerable area from Bloomington, Illinois, to Platteville, Wisconsin[38].

The maximum intensity X-XII (MM) New Madrid, Missouri, earthquakes of 1811-1812 whose epicenters were approximately 350 miles to the south probably resulted in an intensity no greater than MM VI in the site area[39].

Another distant shock felt over a large area during historical times was the Charleston, South Carolina, earthquake of August 31, 1886. This shock may have been felt with about intensity MM III in the site area though it was reportedly not felt at Joliet and Kankakee.

The seismic risk map (Figure 3-12) of the conterminous United States was prepared by a group of research geophysicists headed by Dr. S. F. Algermissen of the United States Coast and Geodetic Survey and issued in January 1969. The site area lies well within zone 1 where minor earthquake damage can be expected. According to this map, zone 1 corresponds to intensities V and VI on the modified Mercalli (MM) scale.

MM VI seems to be the greatest intensity experienced historically in the site area. This was the result of the 1912 earthquake which was centered approximately 15 miles from the site, and may also have been the result of the 1811-1812 New Madrid, Missouri, earthquakes. MM VI, with its corresponding acceleration (according to Newmann's curve) of 0.01 G may be reasonably expected to occur again within the lifetime of the facility.

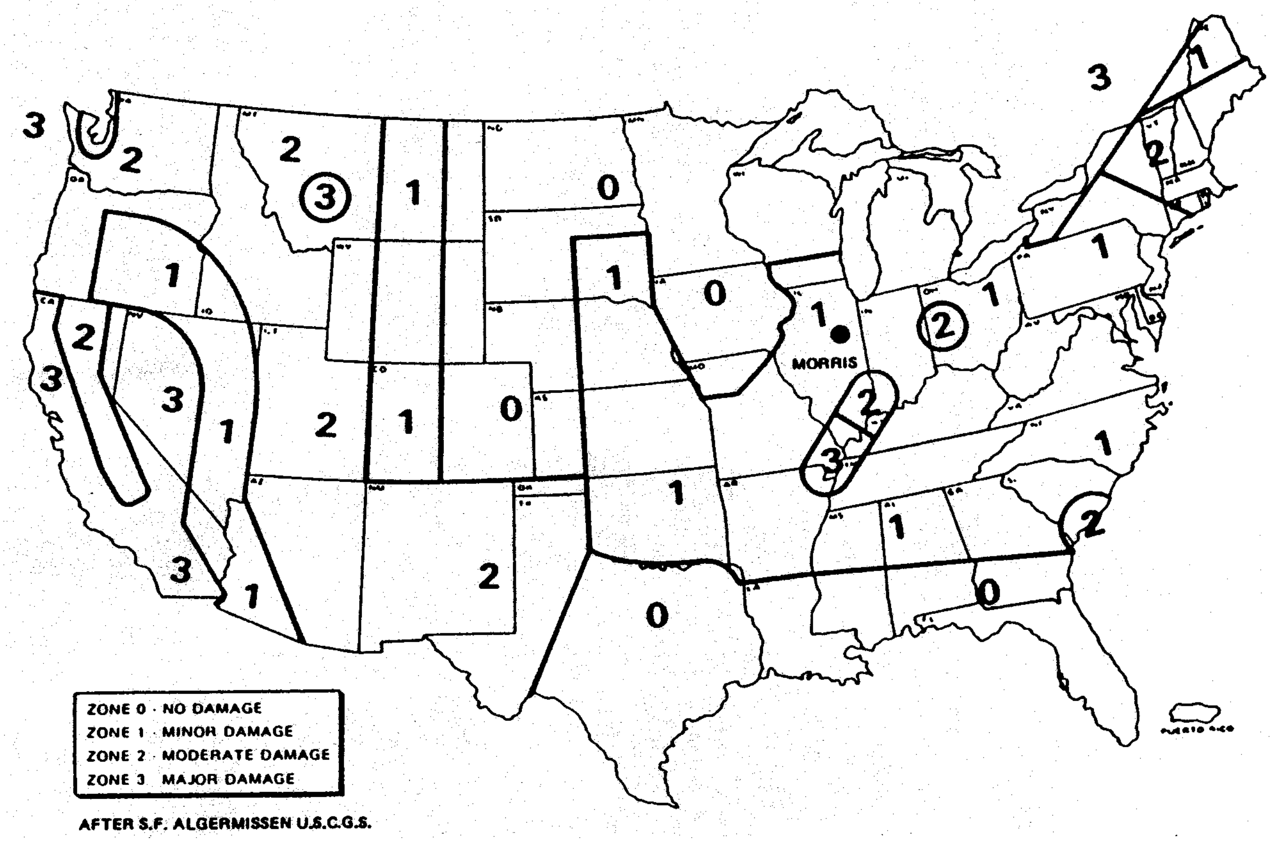



Figure 3-12. Map of the U.S. Showing Zones of Approximate Equal Seismic Probability.

### 3.7.5 Earthquake Design Basis

The design earthquake basis for the basin was a horizontal ground motion of 0.1 G. The basin structure and fuel storage system are designed to withstand the design basis earthquake without damage to structures or components essential to the integrity of stored fuel or fuel being moved in the normal process of storing or shipping fuel. The design earthquake is defined as a seismic event that has a reasonable probability of occurrence during the life of the facility, based on studies of seismic history and geology. A maximum earthquake with ground accelerations of 0.2 G is also considered in the seismic analyses. The design bases are discussed in Section 4.

## 3.8 TRANSPORTATION OF IRRADIATED FUEL

Irradiated fuel was received by truck or rail at GE-MO in casks certified to comply with applicable U.S. Nuclear Regulatory Commission (NRC) regulations[40].

As of the end of 1989, 737 shipments of fuel had been completed, moving about 750 tonnes - heavy metal in 3,450 fuel bundles. Shipments to GE-MO have been completed without highway or rail accidents over about 744,300 miles.

Environmental impact of these transportation operations has been negligible, thus supporting conclusions of various studies and analyses[41,42].

Nonradiological and radiological impacts of transportation are analyzed in the literature[43]. Environmental impact assessments of GE-MO by the NRC staff have also found no significant environmental impact from spent fuel transport[44,45].

## 3.9 SUMMARY OF SITE CONDITIONS AFFECTING FACILITY OPERATING REQUIREMENTS

Irradiated fuel storage operations have been conducted at GE-MO since January 1972 when the first shipment of irradiated fuel was received under Materials License No. SNM-1265, Docket 70-1308, issued December 1971. Throughout this period of operating experience and during on-going environmental studies and monitoring programs, no condition has been found to detract from the desirability of this site as a fuel storage location. Factors significant in selection of design bases for GE-MO follow.

### 3.9.1 Meteorology

The climate at the site offers no severe extremes except tornadoes. Analysis of tornado activity, including official and unofficial records, indicates a frequency close to the average for all states east of the Rocky Mountains.

Site topography introduces little perturbation in diffusion calculations; only the 630 ft. elevation of Dresden Heights, about 1.5 miles north of the GE-MO stack is of concern in selecting stack design bases. Local fog conditions are involved in dispersion considerations. Diffusion climatology and characteristics have been firmly established and confirmed by the meteorological measurement program.

### 3.9.2 Hydrology

Site surface hydrology offers no characteristics significant to selection of design bases (except for usual consideration of natural drainage pathways, etc.). Subsurface hydrology shows excellent separation between upper strata and deeper aquifers that provide water for municipal and industrial use.

Intrusion of groundwater was of concern during construction. These flows indicate a complex near-surface groundwater system that becomes significant because of localized fracturing induced during construction.

### 3.9.3 Geology and Seismology

The site is located in a stable area which has experienced historically low seismic activity. The existing construction is founded on bedrock of Ordovician (Paleozoic) age. Design of the facility and its fuel storage equipment for horizontal ground motion of 0.10 G is considered conservative.

## 3.10 REFERENCES

1. See Appendix A.1 for document list.

2. State of Illinois, Bureau of the Budget, Illinois Population Projections (Revised 1977), Springfield, September 1977.

3. State of Indiana, State Board of Health, Indiana County Population-Projections, Indianapolis, 1978.

4. Northeastern Illinois Planning Commission, Regional Data Report, Chicago, June 1978.

5. The 5% growth in the 0 - 5 mile area was developed from the assumption that farmland will not experience growth (urbanization) except in a few selected areas. This growth was estimated and the overall area growth integrated. Most people working in local industries live in the Western Joliet and Morris areas; there has been little growth in smaller communities.

6. The USNRC staff reported an adjusted estimated 1980 population for the area within the 50 mile radius of about 9,169,337 (Environmental Impact Appraisal, Docket 70-1308m NR-FM-002).

7. During research for these data, differences were noted between (for example) the Northeastern Illinois Planning Commission data and Federal census figures. In general, however, the data appear mutually supportive, particularly at the county level.

8 . Within 5 miles of the site the total school population is about 3,200.

9. Correctional institution (juvenile) at Channahon, 3 miles WNW. (Closed)

10. Climatography of the United States, No. 60-11, revised and reprinted June 1969.

11. H. E. Landsberg, "Climates of North America," World Survey of Climatology, Vol. 11, edited by Bryson, et al., Elsevier Scientific Publication Co. (1974)

12. S. S. Visher, Climatic Atlas of the United States, Harvard University Press, Cambridge (1966).

13. U.S. Department of Commerce, Climatography of the United States No. 86-9, "Decennial Census of United States Climate," for Illinois, Washington, D.C. (1964).

14. "Final Environmental Statement related to operation of the Midwest Fuel Recovery Plant by the General Electric Co.," Doc. 50-268, USAEC (December 1972).

15. Fluor Cooling Products Company, "Evaluated Weather Data for Cooling Equipment Design," Addendum No. 1, Winter and Summer Data, Santa Rose, CA (1964).

16. D. W. Phillips, et al., "The Climate of the Great Lakes Basin," Climatological Studies Number 20, Environment Canada, Toronto (1972).

17. J.L. Vogel, et al., "Fog Effects Resulting from Power Plant Cooling Lakes," Journal of Applied Meteorology. Vol. 14 (August 1975).

18. Final Environmental Statement related to the operation of Dresden Nuclear Power Station Units 2 and 3 by the Commonwealth Edison Co., Docket No. 50-237 and 50-249, AEC (November 1973).

19. Applicants Environmental Statement, Dresden Nuclear Power Station Unit 3, Commonwealth Edison Co., Docket No. 50-249 (July 1970).

20. Thom suggests an annual extreme-mile (fastest mile) wind speed of 82 mph for 30 ft. above ground and for a 100 yr. mean recurrence interval. Thom, H.C.S., "New Distributions of Extreme Winds in the United States, "Journal of the Structural Division,, Proc. ASCE, Vol. 94 No. St. 7 (1968) Applicants Environmental Report, Midwest Fuel Recovery Plant Morris, Illinois, June 1971.

21. Murray and Trettel, Inc. Consulting Meteorologist, Chicago, IL. Letter, Literski (M&T) to Eger (GE), September 23, 1976.

22. From Braidwood Station Environmental Report, Commonwealth Edison Co., Chicago, IL. Year of record: July 1971 - June 1972.

23. The application of these methods to the Dresden reactors and the description of the techniques used there can be found in Appendix A of the Final Safety Analysis Report for Dresden 2 and 3, Docket 50-237.

24. The description of the first year's data taken at the site can be found in Amendment No. 13, Question B-11, to the Dresden Unit No. 2 Final Safety Analysis Report, Docket 50-237.

25. E. C. Watson and C. C. Gamertsfelder, "Environmental Radioactive Contamination as a Factor in Nuclear Plant Siting Criteria," February 14, 1963, HW-SA-2809.

26. NEDO 10178-1, Water Intrusion Consideration, July 1971.

27. Dames & Moore report, "Ground-Water Investigations," (Appendix B.12).

28. Payne, 1940, page 7; and Eardley, 1962, page 45.

29. Willman and Templeton, 1951, page 123.

30. Bristol and Buschbach, 1973, Plate 1.

31. Willman and Templeton, 1952; also Bristol and Buschbach, 1971, Figure 3.

32. Ekblau, 1956; Dames & Moore, 1965.

33. Kempton, 1975.

34. See Table 3-14 for studies referenced in this section.

35. Payne, 1940; Willman and Templeton, 1951.

36. Willman and Templeton, 1951.

37. Dames & Moore, report dated December 1967 (Appendix B.2).

38. J. A. Udden prepared a report describing observations of this earthquake. He presents an isoseismal map for this earthquake and, according to his map, the site was in the area which experienced Rossi-Forel intensity VI (about V-VI on the modified Mercalli scale).

39. This intensity is based on an isoseismal map prepared by O. W. Nuttli and presented in the Bull. Seis. Soc. Am., Vol. 63, No. 1, 1973.

40. K. Eger, Operating Experience Report - Irradiated Fuel Storage at Morris Operation - January 1972 to December 1982, General Electric Company, (NEDO-20969B).

41. 10 CFR 51, Summary Table S-4, "Environmental Impact of Transportation of Fuel and Waste To and From One Light-Water Cooled Nuclear Power Reactor," U.S. Nuclear Regulatory Commission, especially Note 4, "Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site."

42. Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, U.S. Atomic Energy Commission, December 1972 (WASH-1238); and U.S. Nuclear Regulatory Commission, April 1975 (Supplement 1, NUREG-75/038).

43. Final Environmental Statement of the Transportation of Radioactive Material by Air and Other Modes, U.S. Nuclear Regulatory Commission, December 1977 (NUREG-0170).

44. Environmental Impact Appraisal by the Division of Fuel Cycle and Material Safety Related to License Amendment for Materials License Amendment for Materials License No. SNM-1265 Morris Operation Facility - Grundy County, Illinois for General Electric Company - Docket No. 70-1308, Nuclear Regulatory Commission, December 1975 (NR-FM-002), especially Section 6.

45. Environmental Impact Appraisal related to the Renewal of Materials License No. SNM-1265 for the Receipt, Storage and Transfer of Spent Fuel at Morris Operation - General Electric Company - Docket No. 70-1308, U.S. Nuclear Regulatory Commission, June 1980, especially Sections 7.5 and 8.2.