2.4 HYDROLOGIC ENGINEERING

This section of the U.S. EPR FSAR is incorporated by reference with the following departures and supplements.

2.4.1 HYDROLOGIC DESCRIPTION

The U.S. EPR FSAR includes the following COL Item for Section 2.4.1:

> A COL applicant that references the U.S. EPR design certification will provide a site-specific description of the hydrologic characteristics of the plant site.

This COL Item is addressed as follows:

{This section identifies the interface of the Nine Mile Point 3 Nuclear Power Plant (NMP3NPP) with the hydrosphere. It also identifies the hydrologic causal mechanisms that will establish the design basis with respect to floods and water supply requirements. Information on surface water and groundwater uses that may be affected by plant operation is also included in this section.

References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless stated otherwise.

Section 2.4.1.1 through 2.4.1.8 are added as a supplement to the U.S. EPR FSAR.

2.4.1.1 Site and Facilities

NMP3NPP is to be located west of the existing Nine Mile Point (NMP) Unit 1 and Unit 2 as shown in Figure 2.4-1. The project site is located on the southeastern shore of Lake Ontario in Oswego County, New York. It covers an area of approximately 144 acres (58.3 hectares) (approximately 2,500 ft (762 m) by 2,500 ft (762 m)) bounded to the north by Lake Ontario and to the east by NMP Unit 1 and Unit 2. To the south it extends 1,000 ft (305 m) south of Lake Road and to the west it extends 1,300 ft (396 m) west of Lakeview Road.

2.4.1.2 Existing Conditions

The existing site topography is fairly flat, ranging from an approximate elevation of 250 ft (76 m) to 290 ft (88m). At the lake shore there is a small bluff that drops from the site to the normal lake level of an approximate elevation of 245 ft (75m) (as measured by NOAA buoy 45012, which is approximately 20 nautical miles (37 km) northeast of Rochester and about 45 nautical miles (83 km) west-southwest of the site).

During the construction of NMP Unit 1 and Unit 2, two baseball fields were constructed and fenced. While now abandoned, these two fields are still recognizable. A gravel road traverses the property from Lake Road northeast to a meteorological tower located on the northwest corner of the site. A communication tower is located just north of Lake Road. The site is generally covered by upland forest with some woody shrub undergrowth underlain by glacial till soils. Areas of the site that were cleared during construction of NMP Unit 1 and Unit 2 are generally covered with grass and woody shrubs. Several areas of wetlands exist south of Lake Road.

There are no perennial streams on the project site. Runoff from the site generally drains toward Lake Ontario to the north via overland flow. A small perennial stream, Lakeview Creek, traverses along the southwestern periphery of the site. Historical flooding along Lakeview

Creek is limited to the downstream portion of the Creek around the Hamlet of Lakeview, west of the NMP3NPP site (FEMA, 2001).

2.4.1.3 NMP3NPP Developed Conditions

The existing elevations at the NMP3NPP power block site will be re-graded for safety related structures, systems and components (SSCs) as shown on Figure 2.4-5. Safety-related SSCs for NMP3NPP include the following: nuclear island (consisting of the reactor building, safeguard buildings, and the fuel building), two emergency diesel generator buildings, and the essential service water system (ESWS) cooling towers. The safety-related SSCs in the power block area will be contained within the protected area boundary, which is shown in Figure 2.4-2. All personnel entrances to safety-related structures are at elevation 270.0 ft (82.3 m) or higher. The proposed NMP3NPP will be served by a storm water collection system consisting of a series of drainage swales, drainage ditches and storm water detention basins. The power block will be located in the Lake Ontario watershed (e.g., drainage from the power block will runoff directly to the lake). A portion of the site's ancillary structures such as the switchyard will drain to Lakeview Creek. Further details of the post-construction site drainage design will be developed during the detailed design phase. The flood analysis for the site under conditions of the Probable Maximum Flood is provided in Section 2.4.2. The effects of wave surge and seiche are discussed in Section 2.4.5.

NMP3NPP will use a mechanical draft cooling tower for plant non-safety-related Circulating Water Supply System (CWS) cooling with makeup water supplied from Lake Ontario. For safety-related ESWS cooling, mechanical draft towers will also be used. The makeup water for the ESWS cooling towers will normally be supplied from the non-safety related raw water system. ESWS cooling tower basins will also serve as the Ultimate Heat Sink (UHS) cooling water storage volumes for use during design basis accidents (DBA). UHS tower basin inventory will provide cooling water for safety-related heat removal for the first 72 hours during DBA conditions. UHS makeup water after the first 72 hours under DBA conditions will be supplied directly from Lake Ontario. The top of grade elevation of the UHS intake system will be at approximately elevation 270 ft (82.3 m). The UHS makeup water will be pumped directly to the safety-related ESWS (UHS) cooling water basins using flow conduits. The safety-related pipeline system will be buried underground from the intake end to the ESWS (UHS) cooling tower end.

2.4.1.4 Hydrosphere

The NMP3NPP site is located on southeastern shore of Lake Ontario. The average annual precipitation in the site area is about 42.9 in (109 mm) (NOAA, 2002). Relatively high runoff rates are anticipated due to the low permeability of the glacial soils and rock formations. The maximum recorded hourly rainfall rate in the vicinity of the site is 1.4 in/hr (3.6 cm/hr), based on 51 years of record (NOAA, 2005). The area is also prone to receiving lake effect snowfall and has an annual average snowfall of about 107 in (272 cm), and a maximum recorded snowfall of 220 in (559 cm) (NOAA, 2007).

2.4.1.5 Lake Ontario Watershed

Lake Ontario is an international body of water forming part of the border between the United States and Canada, and constitutes the main water body influencing the NMP3NPP site. Lake Ontario has a total drainage area of 244,160 mi^2 (632,371 km^2) that includes the upstream lakes and connecting rivers. Lake Ontario is approximately 193 mi (311 km) long and 53 mi (85 km) wide at its largest points, and has a surface area of 7,340 mi^2 (19,011 km^2) or 4.7 million acres (1.9 million hectares). It has a maximum depth of 802 ft (244 m) and an average depth of approximately 283 ft (86 m) (GLERL, 2004).

Water storage in Lake Ontario at chart datum is 393 mi^3 (1,638 km^3). Maximum recorded water storage was 400 mi^3 (1,667 km^3) in June 1952, and the minimum was 391 mi^3 (1,630 km^3) in November 1934, both prior to lake-level regulation. The variability in storage has been reduced by regulation, with a difference of only 6 mi^3 (25 km^3) between the recent high in May 1993 and the low in December 1998. The average change in storage of the regulated lake is 2.4 mi^3 (10 km^3) between wintertime low and summertime high. (USGS, 2007)

Prior to the beginning of flow regulation, the elevation of the lake surface was controlled by a natural rock weir located about 4 mi (6.4 km) downstream from Ogdensburg, NY, in the Galop Rapids reach of the St. Lawrence River. Lake Ontario outflows have been regulated since 1960, primarily through the Moses-Saunders power dam near Cornwall and Massena, New York about 100 mi (161 km) from the outlet of Lake Ontario. Long Sault Dam, located near Long Sault, Ontario Canada, acts as a spillway when outflows are larger than the capacity of the Moses-Saunders power dam. A third structure at Iroquois, Ontario, is principally used to help to form a stable ice cover and regulate water levels at the power dam. These facilities are under the authority of the International St. Lawrence River Board of Control (IJC, 2006) and were designed to withstand seismic and flood events as per the applicable federal standards as described in the Federal Energy Regulatory Commission's "Enginering Guidelines for the Evaluation of Hydropower Projects," revised 2002.

Prior to lake-level regulation, Lake Ontario levels ranged from a maximum of 249.2 ft (75.9 m) in June 1952 to a minimum of 242.6 ft (73.9 m) in November 1934, a range of 6.6 ft. (2.0 m). Over the past three decades of lake-level regulation, that range has been reduced to 4.3 ft (1.3 m). If not regulated, projected lake levels would reach a maximum of approximately 250.2 ft (76.2 m) elevation. As currently regulated, the mean annual variability is 1.7 ft (0.5 m), with lake levels ranging from 245.0 ft to 246.7 ft (74.7 m to 75.2 m). (USGS, 2007)

The Lake Ontario Regulation Plan 1958-D (IJC, 1963) (IJC, 2006) specifies weekly outflows based on the water level of Lake Ontario and the water supplies to the lake. Generally, higher levels and greater water supplies result in higher outflows, and vice versa. The plan has a number of flow limitations to protect various interests in the St. Lawrence River that may be affected by extreme flows or levels. These include adequate flows for hydropower production, minimum depths for navigation and protection against flooding.

Inflow into the western end of Lake Ontario averages approximately 205,000 ft^3/sec (cfs) (5,810 m^3/sec). Runoff directly into Lake Ontario from the 27,300 mi^2 (70,710 km^2) watershed in New York State and the province of Ontario, Canada, amounts to an additional 36,000 cfs (1,000 m^3/sec). 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 241,000 cfs (6,820 m^3/sec).

During the winter, maximum accumulated freezing degree-days, as defined in Section 2.4.7.6, have historically occurred in February, and maximum seasonal accumulation of freezing degree days has typically occurred in March and April (NOAA, 2002). Ice cover on Lake Ontario varies from about 10% of the total lake area during a mild winter to about 95% during a severe winter (Canadian Ice Service, 2004). For more information about ice effects, refer to Section 2.4.7.

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

(2.5 cm). (NMPC, 1998) For more information about wave surge and seiche, refer to Section 2.4.5.

2.4.1.6 Lakeview Creek Watershed

Lakeview Creek flows for about 4 mi (2.5 km) from Hammonds Corner to its confluence with Lake Ontario at the Hamlet of Lakeview. Lakeview Creek passes along the southwestern periphery of the NMP3NPP site about 4,000 ft (1,200 m) upstream of Lake Ontario. Lakeview Creek has a watershed area of 5 mi^2 (13 km^2), which is predominated by glacial till soils and covered by woodlands with some low-density residential development (FEMA, 2001). At its confluence with Lake Ontario, Lakeview Creek has an estimated peak 100-year discharge of 810 cfs (23 m^3/sec) and an estimated peak 500-year discharge of 1,090 cfs (31 m^3/sec) There are no U.S. Geological Survey or other stream gauging stations located in Lakeview Creek. The Federal Emergency Management Agency (FEMA) Flood Insurance Study for the Town of Scriba limited its analysis of flooding along Lakeview Creek to the low-lying areas near the Hamlet of Lakeview, and does not include any portion of the NMP3NPP site. (FEMA, 2001) Applicable portions of the FEMA Flood Insurance Rate Maps (FIRM) are included as Figure 2.4-3 and Figure 2.4-4. The effects of the Probable Maximum Flood at Lakeview Creek are addressed in Section 2.4.3.

2.4.1.7 Water Users

The only major public water supplies within a 30 mi (48 km) radius of the site that draw water from the lake through a common intake are the city of Oswego and the Metropolitan Water Board. All water supply systems and industrial users drawing from U.S. waters and Canadian waters on Lake Ontario are listed in Table 2.4-5. Canadian locations are identified in Table 2.4-6. The local and regional groundwater characteristics are described in Section 2.4.12. A detailed list of current groundwater users, groundwater well locations, and the withdrawal rates in the vicinity of the NMP3NPP is presented in Section 2.4.12.3.

2.4.1.8 References

Canadian Ice Service, 2004. Lake Ice Climatic Atlas - Great Lakes 1973-2002, Canadian Ice Service, Website:
http://ice-glaces.ec.gc.ca/App/WsvPageDsp.cfm?Lang=eng&inid=28&ScndLvl=yes&ID=11677, Date accessed: March 26, 2008.

FEMA, 2001. Flood Insurance Study, Town of Scriba, Oswego County, New York, Community Number 360663, Federal Emergency Management Agency, Revised June 6, 2001.

GLERL, 2004. About our Great Lakes, National Oceanic and Atmospheric Administration - Great Lakes Environmental Research Laboratory, Website: http://www.glerl.noaa.gov/pr/ourlakes/, Date accessed: March 10, 2008.

NMPC, 1998. Nine Mile Point Unit 2 Updated Final Safety Analysis Report, Niagara Mohawk Power Corporation, November, 1998.

NOAA, 2002. Climatography of the United States No. 81, Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, National Oceanic and Atmospheric Administration, Revised February, 2002.

NOAA, 2005. Hourly Precipitation Data Rainfall Event Statistics, Station 306314 - Oswego East, New York, , National Oceanic and Atmospheric Administration, Website:
http://hurricane.ncdc.noaa.gov/cgi-bin/HPD/HPDStats.pl, Date accessed, April 1, 2008.

NOAA, 2007. United States Snow Climatography, State Snow Climatography and Extremes, National Oceanic and Atmospheric Administration, Website: http://www.ncdc.noaa.gov/ussc/USSCAppController?action=option&state=30, Date accessed: March 27,2008.

IJC, 1963. Regulation of Lake Ontario - Plan 1958D, Report to International Joint Commission, Prepared by The International St Lawrence River Board of Control, July 1963.

IJC, 2006. Options for Managing Lake Ontario and St. Lawrence River Water Levels and Flows. Final Report by the International Lake Ontario- St. Lawrence River Study Board to the International Joint Commission, March 2006.

USGS, 2007. Lake-Level Variability and Water Availability in the Great Lakes, Circular 1311, United States Geological Society, Wilcox, Douglas A., Thompson, Todd A., Booth, Robert K., and Nicholas, J.R., 2007.}

2.4.2 FLOODS

The U.S. EPR FSAR includes the following COL Item in Section 2.4.2:

> A COL applicant that references the U.S. EPR design certification will identify site-specific information related to flood history, flood design considerations, and effects of local intense precipitation.

This COL Item is addressed as follows:

{This section identifies historical flooding at the site and in the region of the site. It summarizes and identifies individual flood types and combinations of flood producing phenomena in establishing the flood design basis for safety-related plant features. This section also covers the potential effects of local intense precipitation. Although topical information is discussed in Section 2.4.3 through Section 2.4.7 and Section 2.4.9, the types of events considered and the controlling event are reviewed in this section.

References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless stated otherwise.

Section 2.4.2.1 through 2.4.2.4 are added as a supplement to the U.S. EPR FSAR.

2.4.2.1 Flood History

The Lakeview Creek and the Oswego River are the streams or rivers near the NMP3NPP site area. Lakeview Creek, traverses near the southwestern periphery of the NMP3NPP site. It has a drainage area of approximately 5 mi^2 (13 km^2). No published information was found regarding historical stream or river flooding at the site as a result of flooding within Lakeview Creek. There is no information available to indicate that overland drainage (i.e., surface water) of the site area has resulted in significant flooding situations. The FEMA Flood Insurance Study (FIS) for the Town of Scriba limited its analysis of flooding along Lakeview Creek to the low-lying areas near the Hamlet of Lakeview, located along the shore of Lake Ontario about 0.8 mi (1.3 km) down-gradient of the site. The FIS does not include any portion of the NMP3NPP site. The applicable portions of the FEMA Flood Insurance Rate Maps (FIRM) are included in Section 2.4.1.

Oswego River is the largest major river near the site. It has a drainage area of about 5,100 mi^2 (13,200 km^2). Its outlet to Lake Ontario is located about 6.5 miles (10.5 km) west of the site. FEMA FIRM data (Figure 2.4-3 and Figure 2.4-4) shows the anticipated extent of flooding areas in the Oswego River watershed are well west of the NMP3NPP site.

The maximum instantaneous monthly levels of Lake Ontario at Oswego, NY, for the historical period of record, 1900 to 1982, are presented in Table 2.4.7. The historical maximum level was elevation 249.2 ft (76.0 m), which occurred in June 1952.

2.4.2.2 Flood Design Considerations

NMP3NPP is designed to prevent the loss or failure of safety-related equipment required for safe shutdown under the most severe flood conditions predicted for the site. The possibilities applicable and investigated for the site include the probable maximum flood (PMF) on streams and rivers, potential dam failures, probable maximum surge and seiche flooding, probable maximum tsunami, and ice effect flooding. Each of these flooding scenarios was investigated in conjunction with other flooding and meteorological events, such as wind generated waves, as required, in accordance with guidelines presented in ANSI/ANS 2.8-1992 (ANS, 1992). Detailed discussions on each of these flooding events and how they were estimated are found in FSAR Section 2.4.3 through Section 2.4.7.

All safety-related facilities, systems, and equipment are protected against flood damage resulting from the following combinations of events:

1. PMP and historical maximum lake level for estimates of flooding induced by locally intense precipitation and for the estimation of the PMF level in nearby Lakeview Creek (Section 2.4.3).

2. Dams whose failure would affect the NMP3NPP site (Section 2.4.4).

3. Historical maximum precipitation and probable maximum lake level (Section 2.4.5).

4. Surge with wind-wave action from Probable Maximum Wind Storm (PMWS) (Section 2.4.5).

5. Tsunami threat within the inland Lake Ontario, which is insignificant (Section 2.4.6).

6. The affects of ice are negligible with respect to its potential to exacerbate flooding at NMP3NPP (Section 2.4.7).

External flood protection is provided to prevent flood damage due to high lake water levels and precipitation runoff from the drainage basin encompassing the NMP3NPP site. Section 2.4.10 provides a description of these structures.

2.4.2.3 Effects of Local Intense Precipitation

The natural ground elevation at the NMP3NPP site generally slopes toward Lake Ontario, and the natural drainage is into the lake. In the immediate vicinity of the proposed plant's power block, the proposed grade is at elevation 270.0 ft (82.3 m) and is sloped to a series of storm sewers, collection ditches, and storm water detention basins. The roof drainage system and the storm sewer system convey the runoff to the lake. The storm sewer is designed to convey flows resulting from the 50-year flood. The detention ponds are designed for the 100-year flood. The site in the immediate vicinity of the plant is also generally graded to carry the PMP runoff overland to the lake without the use of the storm drainage system. Elevations of the plant grade, roads, railroads, and exterior barriers are shown on Figure 2.4-2.

The containment, fuel and safeguards buildings are located in the center portion of the site (e.g., power block area). From the power block, site grading falls at a 1% slope to bio-retention drainage ditches located along the northern, eastern, and southern edges of the NMP3NPP area. The southern ditch also receives runoff from the switchyard area, which is at a higher elevation than the power block. The southern ditch conveys flow to a detention basin located southwest of the power block and at an elevation several feet lower than the power block. The northern ditch conveys flow to a detention basin located west-northwest of the power block and at an elevation several feet lower than the power block. The eastern ditch conveys flow to an existing surface water canal associated with NMP Unit 1 and Unit 2, also at an elevation several feet lower than the power block. Runoff from the western portion of the power block discharges via overland flow to adjacent parking areas and ultimately to wetland areas near Lakeview Creek.

Consideration of appropriate combinations of individual flooding mechanisms in addition to the most severe effects from individual mechanisms themselves was considered in the development of the PMF. Flooding at the NMP3NPP site due to locally intense precipitation may result from a warm-season probable maximum precipitation (PMP), winter PMP upon frozen ground and combined with snowmelt, or the PMP in combination with backwater flooding due to culvert blockages. Stream culvert blockages may result from accumulation of debris, ice jams, or other material caused to move due to landslides and seismic events. For the assessment of the local PMF levels, the overflow pipes and culverts in the drainage system are assumed to be clogged as a result of or debris blockage, or other events such as landslides, seismic events in combination with the PMF. In that case, PMP storm runoff from the area collected in the northern and eastern ditches would overflow along the northern and eastern edges, respectively, spilling out to the areas north and east of the NMP3NPP power block down the bluff to Lake Ontario. Drainage within the south ditch is confined by the power block at elevation 270.0 ft (82.3 m) to the north and the switchyard at elevation 287.5 ft (87.6 m) to the south.

Grading in the vicinity of the safety-related structures is provided that slopes away from the individual structures, such that PMP ground and roof runoff will sheet flow away from each of these structures. Thus, sheet flows are prevented from entering the structures. The effect of potential and debris blockage of storm drains, roof drains, culverts, and outlet pipes has been considered in the site PMP runoff analyses. As mentioned previously, all storm drains, outlet pipes, and culverts are considered blocked or otherwise ineffective for the PMP runoff analysis. Since roof drains are considered blocked, runoff from roofs is assumed to be sheet flow over the edge of the roofs and contributing to the sheet flow runoff from each sub-basin. The runoff model does not consider any detention or storage for roof runoff. All runoff from roofs is included as direct runoff from the sub-basin drainage areas. Water loading on structural roof design is not discussed in Section 2.4. Snow and ice design loading on safety related structures is bounded by the U.S. EPR design value as discussed in Section 2.3.1.2.2.

The U.S. Army Corps of Engineers (USACE) computer program HEC-HMS (USACE, 2000) (USACE, 2006) was used to develop the hydrologic model and determine peak discharges in the site drainage ditches. Ground cover in the power block consists of primarily two types of surface characteristics: 1) developed impervious area, and 2) gravel surface on compacted fills. The drainage area for the power block area was subdivided into two sub-basins for the site drainage evaluations. The drainage areas for these sub-basins are shown in Figure 2.4-5 and presented in Table 2.4-7. Basin 1 drains generally to the northeast and into Lake Ontario. Basin 2 drains generally to the west-northwest and into Lake Ontario.

The methodologies suggested by the U.S. National Resources Conservation Service (NRCS) as given in TR-55 Manual (NRCS, 1986) were used to estimate the times of concentration (Tc) for the various sub-basins. To account for non-linearity effects during extreme flood condition, the computed Tc was reduced by 25% in accordance with guidance from EM-1110-2-1417 (USACE, 1994). The lag time, estimated as 60% of Tc, (USACE, 2000; USACE, 2006) and the local intense precipitation presented in Table 2.4-8 were input to the USACE Computer program HEC-HMS. A runoff curve number of 98, representing impervious surfaces (NRCS, 1986), is conservatively used for the entire drainage area and also input into the HEC-HMS computer model. The NRCS dimensionless unit hydrograph option for the development of the peak discharges from the various sub-basins in HEC-HMS was utilized.

One-hour PMP values were computed using two publications of the National Oceanic and Atomospheric Administration (NOAA), U.S. Department of Commerce: Hydrometeorological Report (HMR) No. 51, Probable Maximum Precipitation - United States East of the 105th Meridian (NOAA, 1978) and HMR No. 52, Application of Probable Maximum Precipitation - United States East of the 105th Meridian (NOAA, 1982). The all-season PMP values for the site location for various durations, seasons, and drainage areas are shown in Table 2.4-8. Values in the table are the worst-case conditions for the entire year. The winter PMP was considered separately from the all-season. The winter season PMP is significantly less than the all-season PMP (Table 2.4-9). The discrepancy in 1-hour PMP amounts is not practicably compensated for by considering reasonable 1-hour snowmelt rates. A typical snowmelt rate for a rainy, windy day as may be anticipated during PMP conditions is about 3.2 in / day (26.0 cm/day) per EM-1110-2-1406 (USACE, 1998). Conservatively applying this snow melt rate over the course of one hour instead of one day, resulting in a corresponding increase in runoff volume of 3.2 in/day (26.0 cm/day), would not result in the October PMP of 13.4 in (34.0 cm) (e.g., 10.2 in plus 3.2 in) exceeding the all-season PMP of 16 in (40.6 cm)(NOAA, 1980). Furthermore, the maximum observed October snow depth in the 76 years of record at the Oswego East gauge is only 2 in (5.1 cm). It is therefore concluded that the all-season PMP, which typically occurs during non-snowmelt and non-snowfall months of July or August, is the probable maximum flood (PMF) for NMP3NPP.

PMP values used in site water level analyses were also dependent on the applicable duration of the rainfall. The 1-hour PMP was used in the analysis and distributed based on guidelines within HMR 51 (NOAA, 1978) and HMR 52 (NOAA, 1982). Distributed PMP quantities as high as 8.6 in (21.8 cm) in 15 minutes were used in computing water levels at the plant.

The results indicate that the all-season, 1-hour duration, "point" PMP of 16.0 in. (40.6 cm) results in a total PMF peak flow rate of about 7,000 cfs (198.2 m^3/s) from the site drainage area of approximately 0.32 mi^2 (0.83 km^2). The total drainage area was further sub-divided to account for two separate basin outflow locations. Basin 1 drains generally to the northeast and into Lake Ontario and has a PMF peak flow rate of about 3,970 cfs (112.4 m^3/s). Basin 2 drains generally to the west-northwest and into Lake Ontario and has a PMF peak flow rate of about 3,030 cfs (85.8 m^3/s).

Cross-sections were developed along drainage swales north, south, and east of the power block at locations as shown in Figure 2.4-5 using grading information provided in the Overall Grading and Drainage Plan. The cross section geometry data was input into the HEC-RAS model assuming steady-state and mixed (i.e. subcritical and critical) flow regimes. The HEC-RAS model starts at the upstream limits of Basin 1 and ends in Lake Ontario. The model utilized three stream reaches as shown in Figure 2.4-5. The inflow peak discharges shown in Table 2.4-10 were input into the HEC-RAS model at the locations indicated. The peak discharges were developed from the HEC-HMS results and adjusted within the HEC-RAS model based on: a) drainage area proportion and b) locations where flow leaves one reach and enters another.

The hydraulic model contains three structures, including two diversions (i.e. lateral structure) and an inline structure (i.e. road embankment). The lateral structure located at the upstream portion of the swale between the power block and the switchyard (know as reach "South Power Block") discharges over the Stormwater Pond #3 toward Lakeview Creek. The lateral structure emanating from Basin 1 discharges into Basin 2, and it is located on reach "Main-2" between the power block and the cooling tower. It appears based on proposed grading in this area that PMP runoff would travel as unconfined, overland flow to the Lake. The lateral outflows were modeled as a simple lateral structure within HEC-RAS, represented as weir flow overtopping the control section. The inline structure was used to represent the existing access road embankment northeast of the power block near the former information center that is assumed to have its culvert blocked. The embankment is located about 515 ft (157 m) upstream of Lake Ontario and acts as a hydraulic control for a portion of Basin 1.

The water surface profile (backwater) analysis was executed utilizing a conservative Mannings' "n" of 0.142 for the channel (i.e., ditches) and overbank areas. A sensitivity model check using a Mannings' "n" of 0.035 indicated that the peak water surface elevations are not significantly influenced by the channel and overbank roughness.

The optimized peak flow rates and computed peak water surface elevations for the PMF profile are summarized in Table 2.4-10. The computed peak water surface elevations for the safety-related facilities under PMP conditions are summarized in Table 2.4-11. The results indicate that flow from Basin 1 drains generally to the northeast and into Lake Ontario and has a PMF peak flow rate of about 2,900 cfs (82.1 m^3/s). Basin 1 also contributes about 708 cfs (20 m^3/s) to Basin 2 via lateral flows flow and diverts about 579 cfs (16.4 m^3/s) from backwater on reach "South Power Block" (swale between the power block and the switch yard) to Lakeview Creek via lateral flow already depicted. Note that HEC-RAS estimates the outflow from the modeled "lateral structure" located between the power block and the cooling tower using the weir flow equation based on the upstream water surface elevation. As shown in Table 2.4-11 flood levels approach elevation 269 ft (82 m) in the southern portion of the power block due to the constriction formed by the power block and switch yard facility.

Area of Basin 2 near the power block is controlled by overland flow (as opposed to channel flow in drainage swales and depressed areas). PMF runoff would be conveyed as sheet flow overland within Basin 2 and would overflow the roadway north of the parking lot.

Water surface profiles were estimated by use of the weir equation:

$$Q = CLH^{1.5}$$

Where: Q = Flow (cfs) (m^3/s)

C = Weir Coefficient, assumed to be 2.5 (dimensionless)

L = Weir Length (ft) (m)

H = Head (ft) (m)

The head over the "weir" was estimated as 0.6 ft (0.18 m). The Overall Grading and Drainage Plan indicates the invert elevation of the control section varies between 265.0 ft (80.8 m) to 265.5 ft (80.9 m). Therefore, the peak elevation in Basin 2 was conservatively estimated based on the upper range limit (265.5 ft (80.9 m)) as about 266.1 ft (81.1 m), which corresponds to a minimum freeboard of 3.9 ft (1.2 m) from the safety-related structures finished floor (at elevation 270.0 ft (82.3 m)).

The safety-related structures in the NMP3NPP power block consist of two ESWS cooling tower structures located in the northeast corner, two ESWS cooling tower structures located in the southwest corner, emergency diesel generator buildings located east and west of the reactor complex and the reactor complex, which consists of the reactor building, fuel building, and safeguards building. The locations of the building are shown on Figure 2.4-5. The entrances (e.g., first floor elevation) to each of these structures are located at Elevation 271.0 ft (82.3 m) for each structure. Table 2.4-11 summarizes the entrance elevations at the various safety-related facilities and compares them with PMP water level near those facilities. Table 2.4-12 provides an acronym list for the buildings. The maximum computed PMP water level in the power block area is elevation 269.0 ft (82 m), 1.0 ft (0.3 m) below the finished first floor elevation.

Flood protection measures are addressed in Section 2.4.10.

2.4.2.4 References

ANS, 1992. Determining Design Basis Flooding at Power Reactor Sites, ANSI/ANS-2.8-1992, American National Standard Institute/American Nuclear Society, July 1992.

NOAA, 1978. Probable Maximum Precipitation Estimates, United States East of the 105th Meridian, Hydrometeorological Report Number 51, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, June 1978.

NOAA, 1982. Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian, Hydrometeorological Report Number 52, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, August 1982.

NRCS, 1986. Urban Hydrology for Small Watersheds, Technical Release 55, U.S. Department of Agriculture, National Resources Conservation Service, June 1986.

USACE, 1994. Flood-Runoff Analysis, EM 1110-2-1417, U.S. Army Corps of Engineers, August 1994.

USACE, 1998. Runoff from Snowmelt, EM-1110-2-1406, U.S. Army Corps of Engineers, March 1998.

USACE, 2000. HEC-HMS, Version 3.1.0, Hydrologic Modeling System Technical Reference Manual, CPD-74B, U.S. Army Corps of Engineers, March, 2000.

USACE, 2006. HEC-HMS, Version 3.1.0, Hydrologic Modeling System User's Manual - CPD-74A, U.S. Army Corps of Engineers, November 2006.}

2.4.3 PROBABLE MAXIMUM FLOOD (PMF) ON STREAMS AND RIVERS

The U.S. EPR FSAR includes the following COL Item in Section 2.4.3:

A COL applicant that references the U.S. EPR design certification will provide site-specific information to describe the probable maximum flood of streams and rivers and the effect of flooding on the design.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless stated otherwise.

The NMP3NPP site is located on the southeastern shore of Lake Ontario as shown on Figure 2.4-6. Sources of potential flooding at the proposed site are the Lake Ontario to the north, Lakeview Creek to the southwest, and local intense precipitation directly over the site. This section discusses the probable maximum flood (PMF) on streams and rivers as a result of the probable maximum precipitation (PMP) over the watershed. The effects of locally intense precipitation upon the NMP3NPP are discussed in Section 2.4.2.

Lake Ontario is an international body of water forming part of the border between the United States and Canada, and constitutes the main water body influencing the siting of NMP3NPP. Lake Ontario, the easternmost (downstream) of the Great Lakes, drainage area includes the upstream lakes and connecting rivers. 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. Moses-Saunders power dam located on the St. Lawrence River near Cornwall and Massena, New York about 100 mi (161 km) down gradient from the outlet of Lake Ontario regulates the lake outflows. Water surface setup and seiche are produced by winds and atmospheric pressure gradients. For information about wave surge and seiche, refer to Section 2.4.5.

Lakeview Creek is the only stream that may impact the flood level at the NMP3NPP site. Lakeview Creek passes along the southwestern periphery of the NMP3NPP site about 4,000 ft (1,200 m) upstream of Lake Ontario and passes 1,400 ft (426 m) southwest of the power block.

Lakeview Creek flows for about 4 mi (2.5 km) from its headwater at Hammonds Corner to its confluence with Lake Ontario at the Hamlet of Lakeview. Lakeview Creek has a watershed area of about 5 mi^2 (13 km^2), which is predominated by glacial till (NRCS Soil Type C) and covered by woodlands with some low-density residential development. At its confluence with Lake Ontario, Lakeview Creek has an estimated peak 100-year discharge (FEMA, 2001) of 810 cfs (22.9 m^3/sec) and an estimated peak 500-year discharge of 1,090 cfs (30.9 m^3/sec). There are no U.S. Geological Survey or other stream gauging stations located in Lakeview Creek. The Flood Insurance Study for the Town of Scriba (FEMA, 2001) limited its analysis of flooding along Lakeview Creek to the low-lying areas near the Hamlet of Lakeview, and does not include any portion of the NMP3NPP site.

The results of the analysis indicate a maximum PMF elevation in the vicinity of the NMP3NPP power block (safety related structures) as about 268.5 ft (81.8 m) or 2.5 ft (0.8 m) below the finished first floor elevation of the safety related structures. Therefore, safety related structures are not expected to be flooded due to the Lakeview Creek PMF.

Section 2.4.3.1 through Section 2.4.3.7 are added as a supplement to the U.S. EPR FSAR.

2.4.3.1 Probable Maximum Precipitation

The Probable Maximum Precipitation (PMP) was developed according to procedures outlined in the Hydrometeorological Report (HMR) Numbers 51 (NOAA, 1978) and 52 (NOAA, 1982) as incorporated into the HMR52 computer program (Boss International, 1988). The HMR52 program was used to develop the incremental 72-hour PMP distribution for the Lakeview Creek watershed. Figure 2.4-8 shows the accumulated PMP distribution for Lakeview watershed. The Lakeview watershed shown on Figure 2.4-7 was considered as a single basin due to the absence of significant irregularity (i.e. reservoir, dam, land use) within the watershed.

A sensitivity analysis of the PMP center location and storm orientation was performed within HMR52 computer program to optimize the peak runoff. The optimized input parameters are as follow:

Storm Orientation: 149 degrees from North;

Storm Center: Watershed centroid.

The PMP time distribution was set up according with the American National Standard ANSI/ANS-2.8 (ANS, 1992) which includes the following guidelines:

- Group the four heaviest 6-hour increments of the probable maximum precipitations in a 24-hour sequence, the next highest four increments in a 24-hour sequence, etc.
- For the maximum 24-hour sequence, arrange the four 6-hour increments ranked 1, 2, 3, and 4 (maximum to minimum) in the order 4, 2, 1, 3. Other days may be arranged in similar order.
- Arrange the 24-hour sequences so that the highest period is near the center of the storm and the second, third, etc, are distributed in a manner similar to (2) above.
- The maximum 6-hour increments may further be distributed into smaller time increments as recommended in the reference.

For the runoff analysis, an antecedent storm condition is assumed as indicated in ANSI/ANS-2.8-1992 (ANS, 1992). This condition assumes a rainstorm equivalent to 40% of the PMP, followed by three days with no precipitation, and then the full PMP storm is modeled. Based on "Runoff from Snowmelt, EM-1110-2-1406" (USACE, 1998), snowmelt does not make a significant contribution to flooding situations. Therefore, antecedent snowpack conditions have not been considered in the PMF analysis.

2.4.3.2 Precipitation Losses

Precipitation losses for the Lakeview Creek watershed are determined using the Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service, runoff methodology (NRCS, 1986). For this method, a composite runoff curve number (RCN) is assigned to the watershed. The RCN is used to describe the basin's capacity to absorb and retain precipitation or produce runoff. Runoff curve numbers range from about 30 to 100, with higher numbers producing more runoff. The composite RCN is determined based on the basin's surface soils, land cover, and antecedent moisture condition (dry, average, or wet).

Even after development of NMP3NPP, most of the Lakeview Creek watershed will consist of wooded areas. As a measure of conservatism and to reflect the presence of saturated soils that would exist with a PMP storm following a 40%, PMP the entire watershed drainage area is conservatively assumed to be impervious for determining precipitation losses and runoff. The RCN for impervious surfaces is 98 regardless of the soil type (USACE, 1994) and thus soil classifications for the watershed have not been determined for runoff determination purposes.

Using an RCN of 98 results in very little precipitation losses. Thus, nearly all of the precipitation is converted to runoff.

2.4.3.3 Runoff and Stream Course Model

The NRCS dimensionless unit hydrograph method (NRCS, 1986) in the computer program HEC-HMS (USACE, 2000; USACE, 2006) is used to transform the runoff calculated to a discharge hydrograph for Lakeview Creek. There are no stream gauges or historical flood records for Lakeview Creek or any of its tributaries. Thus, there are no historical records available to verify the results of the runoff analysis. However, the NRCS curve number and unit hydrograph methods are widely used for estimating floods on small to medium-sized ungauged drainage basins in the United States. The high RCN used in the analysis adds significant conservatism to the results.

The steps involved in the NRCS methodology are summarized below:

- The runoff volume over the watershed is computed for time increment (10 minutes) of the computation duration, using the incremental precipitation depths described in Section 2.4.3.1 and the RCN.
- The incremental peak discharges are computed for each time step using the runoff volume calculated in the step above, the NRCS unit hydrograph, and a time of concentration and lag values calculated for the watershed.
- The incremental discharges are then used to create a discharge hydrograph. The time of concentration value for the watershed is estimated using methods developed by the NRCS (NRCS, 1986). To account for nonlinear basin response to high rainfall rates, the time of concentration values have been reduced by 25% (USACE, 1994). For the NRCS transformation option, HEC-HMS requires the input of "lag time" rather than the time of concentration. Lag time are estimated as 0.6 times the time of concentration (USACE, 2000; USACE, 2006).

Base flow was not incorporated in the runoff model, as it is insignificant compared to PMF flows.

There are no upstream or downstream dams or reservoirs which affect Lakeview Creek; thus, there are no effects from dam breach or upstream reservoir storage considered in the PMP runoff analysis.

2.4.3.4 Probable Maximum Flood Flow

The PMP peak flood flow rate was estimated as about 19,000 cfs (538 m^3/s) for the entire Lakeview Creek watershed (extending to Lake Ontario). Figure 2.4-9 depicts the Probable Maximum Flood Flow (PMF) hydrograph for Lakeview Creek Watershed.

2.4.3.5 Water Level Determinations

Maximum water levels along Lakeview Creek between a construction access road located at the south (upstream) portion of the NMP3NPP site and Lake Ontario (downstream of NMP3NPP) were estimated utilizing the standard step backwater method for natural channels as implemented in the HEC-RAS computer program developed by the U.S. Army Corps of Engineers (USACE, 2005). Required input for HEC-RAS includes geometric cross section data, flow rates, roughness data, and boundary conditions.

Since no historic flood information is available for Lakeview Creek and calibration of the standard step backwater model is not possible, conservative values were estimated for roughness and weir coefficients.

The cross section data was obtained from topographic maps which were developed for the site, and USGS topographic maps (USGS; 1978, 1980 and 1982). The HEC-RAS (USACE, 2005) computer model cross section locations are shown on Figure 2.4-10.

The backwater analysis assumed Mannings' "n" to be 0.035 for the channel, concrete and paved areas and 0.142 for vegetated or densely developed over bank areas.(USGS, 1989)

The normal depth option, which computes the normal depth water level based on the cross section dimensions, flow rate, and user defined channel slope (slope = 0.01), is used to set the upstream boundary condition at the most upstream cross section. The downstream boundary condition of the model was the Probable Maximum Surge and Seiche Flooding elevation of 259.8 ft (79.2 m) as discussed in Section 2.4.5.3.

The HEC-RAS model starts at the downstream end of the culvert beneath a construction access road located at the south portion of the site depicted in Figure 2.4-10. This culvert and a second culvert located on a upstream road which leads to the NMP Unit 1 and Unit 2 Security Check Points are assumed to be clear (i.e. not blocked). This assumption reflects the worst site flood condition because it accounts for runoff freely conveyed through these culverts from the upstream portion of the Lakeview Creek watershed to the stream reach nearest to the site.

The HEC-RAS model includes one inline structure which represents the NMP3NPP Security Checkpoint road that extends from the NMP3NPP west property border (Lakeview Road) to the Power Block area. The natural course of Lakeview Creek leaves the NMP3NPP site, crossing Lakeview Road and then Lake Road (County Route 1A). The top of Lake Road is at about elevation 271 ft (82.6 m). The culverts beneath these roads are assumed to be filled with sediment of otherwise blocked re-directing the flow over the NMP3NPP Security Checkpoint road (top elevation of 267 ft (81.4 m)) and then leaving the NMP3NPP site in the direction of Lake Ontario. A weir coefficient of 2.6 was used within the model to account for the NMP3NPP Security Checkpoint road overflow.

The mixed flow option, which computes both sub-critical and super-critical flow regimes, is used to model the flood profile. The computed peak water surface elevations for the PMF profile for the Lakeview Creek are summarized in Table 2.4-10 and depicted in Figure 2.4-11.

The maximum computed PMP water level in the power block area is about elevation 268.7. ft (81.9 m) which is approximately 2.3 ft (0.7 m) below the finished first floor elevation and 1.3 ft (0.4 m) below the slab elevations of the safety related structures. Maximum flow velocities are anticipated at low-lying channel areas, which are designed to include protective riprap and/or paving to address erosion concerns. Slopes subject to flood flows are protected with appropriately sized riprap, thus erosion is not anticipated.

Flood elevations resulted from Lakeview Creek PMF are independent of results as estimated in Section 2.4.2, floods from local PMF, due to difference in time of concentration of the drainage areas.

Flood protection measures are addressed in FSAR Section 2.4.10

2.4.3.6 Coincident Wind Wave Activity

Given the relatively narrow water surface width and the shallow PMF water depth in Lakeview Creek, the opportunity for significant wave height development does not exist. Thus, wave height estimation is not performed for the PMF elevations on Lakeview Creek.

2.4.3.7 References

ANS, 1992. Determining Design Basis Flooding at Power Reactor Sites, ANSI/ANS-2.8-1992, American National Standard Institute/American Nuclear Society, July 1992.

BOSS International, 1988. Boss HMR52 User's Manual, Version 1.10, Boss International, Inc., 1988.

FEMA, 2001. Flood Insurance Study, Town of Scriba, Oswego County, New York, Community Number 360663, Federal Emergency Management Agency, Revised June 6, 2001.

NOAA, 1978. Probable Maximum Precipitation Estimates, United States East of the 105th Meridian, Hydrometeorological Report Number 51, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, June 1978.

NOAA, 1982. Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian, Hydrometeorological Report Number 52, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, August 1982.

NRCS, 1986. Urban Hydrology for Small Watersheds, Technical Release 55, U.S. Department of Agriculture, National Resources Conservation Service, June 1986.

USACE, 1994. Flood-Runoff Analysis, EM 1110-2-1417, U.S. Army Corps of Engineers, August 1994.

USACE, 1998. Runoff from Snowmelt, EM-1110-2-1406, U.S. Army Corps of Engineers, March 1998.

USACE, 2000. HEC-HMS, Version 3.1.0, Hydrologic Modeling System Technical Reference Manual, CPD-74B, March, 2000.

USACE, 2005. HEC-RAS, River Analysis System, Version 3.1.3, U.S. Army Corps of Engineers, Hydrologic Engineering Center, May 2005.

USACE, 2006. HEC-HMS, Version 3.1.0, Hydrologic Modeling System User's Manual - CPD-74A, U.S. Army Corps of Engineers, November 2006.

USGS; 1978, 1980 and 1982. USGS Topographic 7.5 Minutes Series West of Texas (1982), Texas (1980), New Haven (1982), and Oswego East (1978), NY Quadrangles, U.S. Geological Survey .}

2.4.4 POTENTIAL DAM FAILURES

The U.S. EPR FSAR includes the following COL Item for Section 2.4.4:

> A COL applicant that references the U.S. EPR design certification will verify that the site-specific potential hazards to safety-related facilities due to the seismically-induced failure of upstream and downstream water control structures are within the hydrogeologic design basis.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless stated otherwise.

Section 2.4.4.1 through 2.4.4.4 are added as a supplement to the U.S. EPR FSAR.

2.4.4.1 Dam Failure Permutations

NMP3NPP is to be located west of the existing NMP Unit 1 and Unit 2 as shown in Figure 2.4-6. The project site is located on the southeastern shore of Lake Ontario in Oswego County, NY. Although a perennial stream, Lakeview Creek, traverses along the southwestern periphery of the site; there are no perennial streams on the site. Lakeview Creek has a drainage area of about 5 mi^2 (13 km^2). (FEMA, 2001) There are no dams located on Lakeview Creek. Runoff from the site generally drains toward Lake Ontario to the north via overland flow.

The site design includes two storm water detention basins and one combined waste water retention basin which are located several feet below the elevation of SSCs as described in Section 2.4.1. Storm Water Basin No. 1 is located northeast of the power block and would flow into Lake Ontario if its small (e.g., less than 4 ft (1.2 m) in height) raised embankment running along its northern perimeter at elevation 265 ft (80.8 m) were breached. Storm Water Basin No. 2 is located east of the power block with a top of embankment elevation of 268 ft (81.7 m), or 2 ft (0.6 m) below the top of power block at 270 ft (82.3 m) elevation. The maximum height of the embankment is about 5 ft (1.5 m) at the northern portion of the basin, which faces away from the power block. The embankment breach flow would follow the surface grading in this area which also slopes northerly, toward Lake Ontario. The combined waste water retention basin is located north of the power block with a top of embankment elevation of 265 ft (80.7 m), or about 5 ft (1.5 m) below the power block elevation. The surface grading adjacent to the pond is sloped northerly, toward Lake Ontario. Failures of any of the embankments associated with these ponds does not result in flooding of the power block due to the adjacent site grading around these structures, which slopes toward the Lake and away from the power block area.

The nearest dams to NMP3NPP which may affect Lake Ontario are a series of locks on the Oswego River and the dams which regulate the level of Lake Ontario on the Saint Lawrence River. The Saint Lawrence River drains into the Gulf of Saint Lawrence and then into the Atlantic Ocean.

Prior to Lake Ontario flow regulation, the elevation of the lake surface was controlled by a natural rock weir located about 4 mi (6.4 km) downstream from Ogdensburg, NY, in the Galop Rapids reach of the St. Lawrence River. Lake Ontario outflows have been regulated since 1960, primarily through the Moses-Saunders power dam near Cornwall and Massena, New York about 100 mi (161 km) from the outlet of Lake Ontario. Long Sault Dam, located near Long Sault, Ontario, acts as a spillway when outflows are larger than the capacity of the Moses-Saunders power dam. A third structure at Iroquois, Ontario, is principally used to help to form a stable ice cover and regulate water levels at the power dam. These facilities are under the authority of the International St. Lawrence River Board of Control.

The effects resulting from failure of the two dams in the St Lawrence River 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 elevation 247.7 ft (75.5 m) U.S. Lake Survey datum (USLS) to elevation 240.6 ft (73.3 m) USLS approximately 1 year following the assumed failure. The study concluded that once the lake level had declined to about elevation 240.6 ft (73.3 m) 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. Low water considerations are discussed in Section 2.4.11.

The Oswego River in Central New York State drains 5,100 mi^2 (8,207 km^2) into Lake Ontario, but does not include any portion of the contributory drainage area of NMP3NPP. The mouth of the Oswego River, the closest point of the river to the NMP3NPP site, is approximately 6.5 mi (10.5 km) from the site. The Oswego River is used for navigational purposes and carries the Oswego Canal its entire length, controlled via a series of dams and locks. Figure 2.4-12 shows the location of these six dams/locks and a description of the location and main characteristics of these dams/locks is shown in Table 2.4-13.

The combined maximum storage for the six dams/locks is approximately 91,500 acre-ft (113 million m^3) (USACE, 2008). Lake Ontario has a surface area of 4.7 million acres (1.9 million hectares) (GLERL, 2004). If the total volume of these 6 reservoirs were to be instantly added to the lake without consideration of flow attenuation, the water level increase in the lake would be approximately 0.2 inches (0.5 cm). Therefore, NMP3NPP would not be affected by the increase in the water level on Lake Ontario produced by the hypothetical failure of the dams on the Oswego River.

2.4.4.2 Unsteady flow analysis of potential dam failures

Unsteady flow analyses have not been performed because there are no dam failures which impact NMP3NPP.

2.4.4.3 Water level at the plant site

As discussed in Section 2.4.4.1, the instantaneous application of the entire storage volume of the locks within the Oswego River would have insignificant effects on the water levels of Lake Ontario. The dam breach flood wave from such a series of domino failures would be attenuated somewhat by available floodplain storage in the Oswego River and likely more significantly by Lake Ontario itself, leading to a lesser increase in water levels near the plant site.

Failure of the dams at the outlet of Lake Ontario in the St. Lawrence River may result in slightly lower than normal water levels. These are addressed in Section 2.4.4.1.

2.4.4.4 References

FEMA, 2001, Flood Insurance Study, Town of Scriba, Oswego County, New York, Community Number 360663, Federal Emergency Management Agency, Revised June 6, 2001.

GLERL, 2004. About our Great Lakes, National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory, Website: http://www.glerl.noaa.gov/pr/ourlakes/, Date accessed: March 10, 2008.

USACE, 2008. National Inventory of Dams, U.S. Army Topographic Engineering Center, Website: http://crunch.tec.army.mil/nidpublic/webpages/nid.cfm, Date Accessed: September, 2008.}

2.4.5 PROBABLE MAXIMUM SURGE AND SEICHE FLOODING

The U.S. EPR FSAR includes the following COL Item for Section 2.4.5:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information on the probable maximum surge and seiche flooding and determine the

extent to which safety-related plant systems require protection. The applicant will also verify that the site-parameter envelope is within the design maximum flood level, including consideration of wind effects.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless stated otherwise.

Section 2.4.5.1 through Section 2.4.5.6 are added as a supplement to the U.S. EPR FSAR.

2.4.5.1 Probable Maximum Winds and Associated Meteorological Parameters

Meteorological events that can cause severe coastal flooding generally fall into three categories: hurricanes, extratropical cyclones, and squall lines. Because the NMP3NPP site is located on the shoreline of Lake Ontario, far from the Atlantic coastline, an extratropical storm will produce higher winds than a hurricane. ANSI/ANS 2.8-1992 states that the region of occurance of the Probable Maximum Hurricane (PMH) is within 100 to 200 miles bordering the Pacific Ocean, Atlantic Ocean, Gulf of Mexico, and possessions in the Caribbean Sea (ANS, 1992). Since the NMP3NPP site is well over 200 mi (321.9 km) from the Atlantic Coast, a PMH is not considered in this analysis.

Squall lines are a consideration in the Great Lakes region, particularly along the shores of Lake Michigan; ANSI/ANS-2.8-1992 states that, "A moving squall line should be considered for the locations along Lake Michigan where significant surges have been observed because of such a meteorological event. The possible region of occurrence includes others of the Great Lakes." Based on the possibility of a squall line induced storm on Lake Ontario in the vicinity of Oswego, NY, a thorough analysis of squall line induced storm surge was performed for the NMP Unit 2 site. This study maximized the wind speeds and pressure gradients of the squall line. To maximize the pressure gradient, the maximum pressure gradient recorded in the US, in Nebraska, was increased by 30%.

Since squall lines in Lake Ontario are reguarded as less severe than those in the midwest, the use of this pressure gradient to maximize the pressure gradient of the squall line model was considered extremely conservative. To maximize the wind speed, the sustained wind speed from the same Nebraska storm was used and increased by 8 kph to account for gaps in the data network. This value was then increased by 50% for input into the squall line model. Using the maximized squall line model it was found that squall line-induced surge is considerably less than extratropical cyclone induced surge and thus squall line-induced surge is not critical to the design of the site (NMPC, 1976). For these reasons, only an extratropical cyclone is considered at the NMP3NPP site.

This section defines the Probable Maximum Wind Storm (PMWS) on Lake Ontario which includes spatially and time varying pressure and wind fields for the period that the windstorm affects the lake. To generate the pressure and wind fields the PMWS model presented in ANSI/ANS-2.8-1992 is used (ANS, 1992). This model is based on historical storms causing surges on Lake Ontario. Table 2.4-1 lists 19 such storms for which there are both wind speed and water level records (NOAA 2008a) (NOAA, 2008b).

Two hurricanes that have affected the NMP3NPP site in recent years include Hurricane Hazel in 1954 and Hurricane Isabel in September 2003. Storm surge records for Hurricane Hazel are no longer available, and this event was not considered in the 1972 analysis of NMP Unit 2. Reports of the hurricane indicate that damages on Lake Ontario were along the western shore (EC, 2008a; NOAA, 2008c). Any surge from Hurricane Isabel along the southern shore of Lake Ontario would be apparent in Figure 2.4-18, which does not show a significant event during this time period. Any record of high winds which caused a surge at the NMP3NPP site would be summarized in Table 2.4-1, which also does not show any event during September 2003 time period. Therefore, Hurricane Isabel did not have a significant affect on the NMP3NPP site. (EC, 2008b).

Based on the list provided in Table 2.4-1, the most severe, recent storm for which three-hour pressure maps were available was selected and modified to produce the PMWS. This storm occurred on February 17, 2006 and caused more than 1.74 ft (0.53 m) of surge in the eastern end of Lake Ontario. The three-hour pressure maps were obtained from the National Climatic Data Center (NOAA, 2006). These maps were analyzed for pressure and wind speed during the time the storm affected the lake. The pressure fields from 1500 GMT on February 17, 2006 were identified as the most critical as shown in Figure 2.4-13. Since the storm is assumed to be quasi-steady state, these isobar patterns were used to develop the PMWS model using the methods outlined in ANSI/ANS-2.8-1992 (ANS, 1992).

The path of the original storm was approximately northeast and its translational speed was between 40 and 50 mph (64.4 and 80.5 kph). This path was smoothed for the PMWS and the storm's translational speed was slowed down to a constant speed of 40 mph (64.6 kph) so that it would affect the lake for a longer period. This translational speed was chosen as the most critical based on the analysis performed for NMP Unit 2 (NMPC, 1998). Because the PMWS was based on the actual storm causing the largest surge on Lake Ontario the original storm track was not adjusted beyond the smoothing. The storm track is shown in Figure 2.4-14. This storm track is also very similar to the critical storm track chosen in the NMP Unit 2 PMWS analysis (NMPC, 1998).

To derive wind speeds from the isobars, the methods outlined in the U.S. Army Corps of Engineers (USACE) Coastal Engineering Manual (USACE, 2006) were applied. The following assumptions, based on recommendations for the Great Lakes region in the ANSI/ANS-2.8-1992 standards (ANS, 1992), were introduced into the PMWS model to provide for simplicity and conservativeness.

- The maximum over-water wind speed was set to 100 mph (161 kph).
- The lowest pressure was set to 13.8 psi (950 millibars (mb)).
- The PMWS center moves at a constant translational speed of 40 mph (64.4 kph) which is the same as the translational speed used for the NMP Unit 2 PMWS analysis.
- All winds blow 10 degrees across the isobars over the lake. Decreased friction over the water will cause the wind to approach the isobars, but gradient flow will not be reached because of the imbalance of forces.
- A quasi-steady state exists within the storm during the entire time that it affects Lake Ontario.
- The center of the storm moves along a critical path north of the lake so that the zone of maximum wind travels along the major axis of the lake from west to east.
- The storm does not occlude during the time that it affects the lake.

Lake Ontario was divided into three zones (western, central, and eastern) to generate a spatially varying wind field as the storm moved across each zone as shown in Figure 2.4-15. The isobars were used to generate time-varying wind speeds, directions, and pressure gradients for each zone. The maximum 1-hour wind speed estimated from the pressure maps occurred in the eastern zone 20 hours into the storm's influence on Lake Ontario and was 77.6 mph (124.9 kph). The lowest pressure occurred in the central zone 16 hours into the storm and was 14.4 psi (993 mb). The predominant wind direction during the height of the storm was from approximately 300 degrees. The maximum wind speed in each zone during the storm was scaled up to 100 mph (161 kph) and all other wind speeds in each zone were scaled by the same factor.

Hourly values of pressure, wind speed, and wind direction for each of the three zones in Figure 2.4-15 are listed in Table 2.4-2. Figure 2.4-16 shows a time series of wind speed and direction in the eastern zone (i.e., Zone 3 on Figure 2.4-15) of the lake which is closest to NMP3NPP.

2.4.5.2 Surge and Seiche Water Levels

2.4.5.2.1 Historical Surges

Water level data for the Great Lakes dates back to the 1840's, however, the current network of gages on the lakes has only been in operation since 1918. The National Oceanic and Atmospheric Administration maintains historic water level data for the Great Lakes and provides monthly average lake levels. A hydrograph for Lake Ontario is provided in Figure 2.4-17 (NOAA, 2008d). In 108 years of data, the monthly mean elevation of Lake Ontario never exceeded the level of 249.3 ft (76.0 m) NGVD29, gathered in June 1952. In 75 years of data, the maximum elevation never exceeded the level of 250.2 ft (76.3 m) NGVD29, also gathered in June 1952 before regulation of lake water levels.

Lake Ontario has been regulated by the International St. Lawrence River Board of Control under Regulation Plan 1958-D since 1960 (IJC, 1963). The target maximum regulated level is 248 ft (75.6 m) (IJC, 1952). As recommended by the ANSI/ANS-2.8-1992 standards (ANS, 1992), the maximum controlled water level is used as the ambient water level in the surge and wave calculations.

Water level data from four stations around Lake Ontario, Olcott, NY, Rochester, NY, Oswego, NY, and Cape Vincent, NY was used to investigate historic water level trends. Figure 2.4-18 shows storm surges extracted from these datasets. Historically surges have not surpassed 1.6 ft (0.5 m) and the most pronounced surges have occurred at the eastern end of the lake (e.g. the Cape Vincent station).

Analysis of the water levels indicates that the annual variation of lake level overwhelms short-term variations such as surges and seiches. This analysis also suggests that five hours is the primary seiche period. A literature review indicated that the seiche period is approximately five hours (Simpson, 1964) (Li, 1975) (Hamblin, 1982). These studies also indicate that the amplitudes of seiche on Lake Ontario are small suggesting that surge elevations will cause more extreme increases in water level elevation.

Table 2.4-1 shows storms causing high recorded surges in eastern Lake Ontario over the last 12 years. The historic water level records indicate that surge elevations in Lake Ontario rarely reach 1.6 ft (0.5 m). The maximum surge that occurred during this time was, 1.74 ft (53 cm).

2.4.5.2.2 Estimation of Probable Maximum Storm Surge

The Probable Maximum Storm Surge (PMSS) elevation was calculated using two independent methods. The first method used a regression analysis based on the historical water elevation record. The second method used a two-dimensional storm surge model based on the NOAA Great Lakes Storm Surge Planning Program (SSPP) (Schwab, 1987).

The regression model employed a least squares regression technique to relate historic water level elevations and associated wind speeds at four gauges along the shore of Lake Ontario. Table 2.4-3 is a subset of storms causing high recorded surges on Lake Ontario over the last 12 years. These seven storms were selected because of their distinct setup pattern with surge levels increasing from west to east along the long axis of the lake, shown in Figure 2.4-19, and because of the availability of wind and water level data at all stations across the lake. The regression model was used to predict lake surface elevation slope from wind speed. The relationship has a regression coefficient of 0.91 which indicates a strong relationship between wind speed and surface slope. Extrapolating the relationship to a wind speed of 100 mph (161 kph), the maximum wind speed recommended by ANSI/ANS-2.8-1992 for the Great Lakes (ANS, 1992), yields a surface slope of 6.76E-4 degrees. Assuming that the wind set-down evolves into wind setup at the mid-point of the lake, the wind setup at NMP3NPP can be calculated by multiplying the surface slope by the distance to the center of the lake 75.8 mi (122 km), giving an expected surge elevation of 4.7 ft (1.43 m).

The two dimensional storm surge model, SSPP, was also applied to Lake Ontario for the PMS analysis. This model provides expected minimum and maximum water level elevations given a wind speed and direction. The water levels are predicted using the unit wind impulse response of Lake Ontario which is based on a full numerical storm surge model.

The model was verified against actual storms by running it for the average range of wind speeds of the storms in Table 2.4-3, i.e., 45 mph -78 mph (20 m/s - 35 m/s). The results of these SSPP model runs are plotted against the observed storm surge profiles in Figure 2.4-20. The predicted and observed surface slopes are very similar. The SSPP is slightly over predicting the storm surge elevations at mid-lake locations. At the ends of the lakes the SSPP predictions fall within the range of observed water level elevations.

Since the SSPP requires a critical wind speed and direction, the maximum wind speed from the PMWS, 100 mph (160.9 kph) was used. The wind direction used in the SSPP was varied between 250 degrees and 300 degrees at 10 degree intervals to find the direction which causes the greatest impact at the NMP3NPP site. It was found that the critical wind direction for this analysis was 280 degrees, which falls within the range of expected wind speeds during the height of the PMWS impact on Lake Ontario. Running the SSPP for a 100 mph (160.9 kph) wind event with a direction of 280 degrees gives a maximum predicted water level setup of 4.8 ft (1.46 m) at the NMP3NPP site.

Table 2.4-4 gives an overview of the PMSS results from both the least-squares regression method and the two-dimensional model of the Great Lakes. Figure 2.4-21 shows a comparison of the predicted setup values along the long axis of the lake.

Adding the PMSS elevation of 4.8 ft (1.46 m) to an ambient water level of 248 ft (75.6 m) based on the maximum controlled water level of Lake Ontario (IJC, 1952) results in a maximum probable still water level at the NMP3NPP site of 252.8 ft (77.1 m).

The evaluation of historic water level elevations and surge events presented in Section 2.4.5.2.1 shows that surge elevations rarely exceed 1.6 ft (0.5 m). Given the historical records, the surge elevations predicted by a 100 mph (161 kph) wind are extremely conservative for the NMP3NPP site.

All safety related water supply structures are located at or above elevation 270 ft (82.3 m) which is well above the predicted maximum still water level of 252.8 ft (77.1 m) and wave runup elevation of 259.4 ft (79.1 m). The exceptions are the intake tunnels and underwater intake structures. The intake tunnels will be constructed under the Lake Ontario lake bed and thus will not be subject to sedimentation or erosion. Intake Cribhouses A and B will be located 1167 ft (356 m) and 1275 ft (389 m) offshore repectively. Bar grating on the covers will prevent infiltration of lake debris. Suspended sediments stirred up by a storm event and entering the structure will be mitigated by the 1% slope towards shore, allowing the sediments to collect in a pit to prevent buildup. The location of the opening to each cribhouse is 9 ft (2.7 m) above the lake bottom. This elevated design precludes blockage of the cribhouses during a storm event.

2.4.5.3 Wave Action

Expected wave action at the site was calculated using Delft University of Technology's Simulating Waves Nearshore (SWAN) model, a numerical wave model for deep, intermediate, and nearshore wave simulation. SWAN describes the evolution of waves in coastal regions based on wind inputs, energy dissipation, wave-wave interactions, current effects, and water depth changes. It automatically accounts for the effects of shoaling, energy loss due to friction, refraction, diffraction, and reflection. The SWAN model has been tested extensively and validated with analytical solutions, laboratory observations, and field observations (Booij, 1999; Ris, 1999). The model is used in over 50 countries to predict wave characteristics. It is also integrated into the U.S. Navy's Distributed Integrated Ocean Prediction System where it is used to predict nearshore wave conditions.

Lake Ontario bathymetric input to the SWAN model was obtained from the NOAA National Geophysical Data Center's Great Lakes Bathymetry dataset (Virden, 1999). This bathymetry was used to generate two nested grids, a coarser grid covering the entire extent of Lake Ontario and a finer grid for the area offshore of NMP3NPP as shown in Figure 2.4-22. Water depths were calculated for both grids based on the maximum probable still water elevation of 252.8 ft (77.1 m). The PMWS was then applied over the lake surface to simulate potential wave action.

SWAN was applied to predict wave characteristics in deep water, before they are affected by the lake bottom. The significant wave height, Hs, and period, Ts, are used to calculate the maximum wave height, Hmax, and period, Tmax, based on guidelines in ANSI/ANS-2.8-1992 (ANS, 1992). These guidelines recommend a Hmax equal to 1.67 times Hs, and a Tmax equal to 1.2 times Ts.

The results of the SWAN analysis for Lake Ontario using the spatially and time varying wind speeds and directions from the PMWS predicts a Hs of 23.3 ft (7.1 m) and a Ts of 12 seconds yielding a Hmax of 38.9 ft (11.9 m) and a Tmax of 14.4 seconds offshore of the NMP3NPP site. Figure 2.4-23 shows a time series of winds speeds, Hmax and Tmax.

Using the methods outlined in the USACE Shore Protection Manual (SPM) the deep water wave characteristics were used to calculate the breaking wave characteristics (USACE, 1984) offshore of the NMP3NPP site. The local bathymetry was used to calculate the bottom slope leading up to the NMP3NPP site. Using the deep water wave characteristics, the local slope, and Figure 7-3 of the SPM, the expected breaker height was calculated as 46.7 ft (14.2 m). Figure 7-2 of the SPM allows the calculation of breaking wave depth from breaking wave height. The breaking wave depth is estimated as 53.6 ft (16.3 m). The breaking wave height can be used to calculate the design breaker height for a given structure (e.g., the NMP3NPP intake).

Runup methods from the USACE SPM were used instead of the USACE CEM methods because the SPM provides a clear methodology for calculating runup for a single monochromatic wave on a mixed slope (combination of offshore slope and riprapped slope). Because the waves analysis requires calculation of the largest breaking wave height, the runup analysis procedure outlined in the SPM is more appropriate.

Wave runup on the bluff fronting at the NMP3NPP site was calculated using the composite slope method and by applying extrapolated runup values from Figure 7-10 and Figure 7-11 in the SPM (USACE, 1984). The offshore slope of 0.03 was calculated from the CAD file of local bathymetry. The riprapped shoreline slope of 2:1 was determined from the Grading and Drainage Plan for NMP3NPP (Sargent and Lundy, 2008). According to the Grading and Drainage Plan for NMP3NPP, the slope varies between 3:1 and 2:1, but the 2:1 slope gives the worst case initial conditions for the runup calculation.

The composite slope method assumes that a composite slope can be replaced with a hypothetical slope running from the lake bottom at the point where the wave breaks to the point of maximum runup on the shoreline. Since the maximum runup is also the value being calculated this is an iterative method. The initial iteration in this application uses the slope between the breaking wave depth and an initial runup estimation determined by assuming that the deep water wave breaks directly on the riprapped slope. The solution converged after four iterations. The final runup estimation on the bluff is 6.6 ft (2.0 m) above the maximum probable stillwater elevation. It should be noted that the riprapped slope is not constant (varying from 2:1 to 3:1), but that the slope giving the worst case initial conditions, 2:1, was used for the calculations. Given a maximum probable stillwater elevation of 252.8 ft (77.1 m) NGVD29, this wave is expected to reach an elevation of 259.4 ft (79.1 m) NGVD29. Since the top of the riprap is at least 261 ft (79.6m) NGVD29, the impacts of this wave are not expected to overtop the riprap. All safety related structures at the site are being graded at 270 ft (82.3 m) which is well above the level that the maximum breaking wave can be expected to reach. To simulate worst case conditions, the face of the riprapped slope is assumed to be smooth. Depending on the final construction material, the predicted runup estimation could be reduced by up to 55%. The effects of overtopping in relation to safety related facilities are not discussed because the runup analysis concluded that overtopping is not an issue at NMP3NPP.

2.4.5.4 Resonance

Resonance is the phenomenon of wave amplification due to reflection and oscillation of waves within partially closed basins of water (e.g. harbors). No such bodies of water exist at the NMP3NPP site therefore there will be no resonance effects at the site.

2.4.5.5 Protective Structures

All safety related structures at the NMP3NPP site with the exception of the underwater intake are being graded to an elevation of 270 ft (82.3 m). This elevation is well above the maximum runup that a breaking wave will attain, even if the runup is applied on top of the maximum still water elevation computed by adding the maximum ambient lake level and, the probable maximum surge, and the probable maximum precipitation.

2.4.5.6 References

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2.4.6 PROBABLE MAXIMUM TSUNAMI FLOODING

The U.S. EPR FSAR includes the following COL Item in Section 2.4.6:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information and determine the extent to which the plant safety-related facilities require protection from tsunami effects.

This COL Item is addressed as follows:

{This section develops the geohydrological design basis to ensure that any potential hazards to the structures, systems, and components important to safety due to the effects of a probable maximum tsunami are considered in the plant design.

Section 2.4.6.1 through Section 2.4.6.12 are added as a supplement to the U.S. EPR FSAR.

2.4.6.1 Probable Maximum Tsunami

As shown by the historic data record in Section 2.4.6.2, Lake Ontario is not at risk to tsunamis and tsunami flooding will not occur at the NMP3NPP.

Lake Ontario is connected to the Atlantic Ocean, over 1000 mi (1610 km) away**,** by the Saint Lawrence River and therefore will not be affected by distant tsunamigenic source mechanisms such as fault displacements, submarine landslides, and volcanic eruptions in the Atlantic Ocean.

Local tsunamigenic sources such as submarine or subaerial landslides in Lake Ontario have not historically resulted in tsunami-wave generation as shown by the tsunami records discussed in Section 2.4.6.2.

2.4.6.2 Historical Tsunami Record

The National Oceanographic and Atmospheric Administration (NOAA) National Geophysical Data Center (NGDC) maintains a historical tsunami database which catalogs tsunami events. Records of historical tsunamis along the east coast of the U.S. and Canada from 1775 to 2006 are shown in Table 2.4-14 (NOAA, 2008). This data has been filtered by the NGDC to exclude questionable tsunami events.

Fourteen valid tsunami events have occurred since 1755, none of which have affected Lake Ontario or any of the Great Lakes. The closest tsunami causing sources are the New Madrid, Missouri earthquakes that occurred between 1811 and 1812 and caused waves in nearby rivers. These events had no effect on any of the Great Lakes.

Unfiltered historical tsunami records for the eastern US are also available from the NGDC. This record set contains 133 events, seven of which have occurred in the Great Lakes region. Of these seven events, three are flagged as questionable and four are flagged as very doubtful. One of the questionable events occurred on Lake Ontario. The Lake Ontario event occurred on October 4, 1755 and no associated shock was reported.

2.4.6.3 Tsunami Source Generator Characteristics

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.4 Tsunami Analysis

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.5 Tsunami Water Levels

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.6 Hydrography And Harbor Or Breakwater Influences On Tsunami

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.7 Effects On Safety Related Facilities

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.8 Hydrostatic And Hydrodynamic Forces

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.9 Debris And Water-borne Projectiles

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.10 Effects Of Sediment Erosion And Deposition

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.11 Consideration Of Other Site-related Evaluation Criteria

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.12 References

NOAA, 2008. National Geophysical Data Center Historical Tsunami Record, National Oceanic and Atmospheric Administration, Website: http://www.ngdc.noaa.gov/hazards/tsu_db.shtml, Date accessed: March 31, 2008.}

2.4.7 ICE EFFECTS

The U.S. EPR FSAR includes the following COL Items for Section 2.4.7:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information regarding ice effects and design criteria for protecting safety-related facilities from ice-produced effects and forces with respect to adjacent water bodies.
>
> A COL applicant that references the U.S. EPR design certification will evaluate the potential for freezing temperatures that may affect the performance of the ultimate heat sink makeup, including the potential for frazil and anchor ice, maximum ice thickness, and maximum cumulative degree-days below freezing.

These COL Items are addressed as follows:

{As discussed in Section 2.4.1, the Nine Mile Point Nuclear Station (NMPNS) site is located on the southern shore of Lake Ontario, in the Town of Scriba, Oswego County, New York. Figure 2.4-1 indicates the location of the site.

Reference to elevation values in this section are based of the National Geodetic Vertical Datum of 1929 (NGVD), values unless otherwise stated.

Section 2.4.7.1 through 2.4.7.10 are added as a supplement to the U.S. EPR FSAR.

2.4.7.1 Ice Conditions

Ice at a nuclear power plant site could occur in any one of the following forms:

- Surface ice and its associated forces
- Anchor ice formation on components
- Frazil ice that could clog intake flow passages
- Ice jams that could affect flow path to the water supply intake
- Breach of ice jams causing flooding at site
- Ice accumulation on roofs of safety-related structures and components
- Ice blockage of the drainage system causing flooding
- Ice accumulation causing reduction in water storage volume

Historical data characterizing ice conditions at the NMPNS site have been collected and the effects evaluated for NMP3NPP. These data include ice cover and thickness evaluations in Lake Ontario developed by the National Oceanic and Atmospheric Administration (NOAA), ice jam records from the Unites States Army Corps of Engineering (USACE), and long term air temperature measurements from the nearby Oswego East meteorological station (NCDC Cooperative ID #306314). The Oswego East meteorological station is located in the City of Oswego on the same (southern) shore of Lake Ontario as the NMPNS site.

2.4.7.2 Description of the Cooling Water Systems

The Ultimate Heat Sink (UHS) and Essential Service Water System (ESWS) mechanical draft cooling towers are described in Section 9.2.5. The water temperature in each of the four ESWS cooling tower basins is monitored and in the event that basin water temperature drops to 40°F (4.4°C), an alarm alerts the operator to place the associated train in operation to prevent the formation of ice in the basin. Under extended low load/low ambient temperature conditions, it may be necessary to have all four ESWS trains operating. Chemicals may also be added to the ESWS to lower the point at which cooling water freezes. The ESWS cooling tower fans are also capable of operation in reverse direction for short periods to minimize ice buildup at the air inlets.

The NMP3NPP Circulating Water Supply System (CWS) uses a closed-cycle wet cooling tower system as its normal heat sink. CWS makeup water is withdrawn from Lake Ontario through the makeup water intake structure located west of the existing shoreline intakes for NMP Unit 1 and Unit 2. Blowdown flow from the cooling tower is sent to a common retention basin for water quality treatment prior to discharging to a new offshore outfall in Lake Ontario. The CWS for NMP3NPP is a non-safety-related system.

NMP3NPP also has a safety-related ESWS to provide cooling water to the Component Cooling Water System heat exchangers and to ESW pump room coolers, and the emergency diesel generator heat exchangers to dissipate heat. The ESWS is a closed-cycle system that uses mechanical draft cooling towers for heat removal. These cooling towers provide the UHS function. The basins of the ESWS cooling towers are sized to provide sufficient water to permit the ESWS to perform its safety-related heat removal function for up to 3 days (72 hours) post accident under the worst anticipated environmental conditions without inventory replenishment. Beyond the 72-hour post-accident period, UHS makeup water is supplied from the safety-related portion of the Makeup Water Intake Structure that houses the UHS makeup water pumps. Blowdown from the ESWS cooling towers discharges to the common retention basin and eventually to the offshore outfall.

2.4.7.3 Intake and Discharge Structures

Makeup water to the ESWS cooling towers is withdrawn from Lake Ontario through the Makeup Water Intake Structure on the shoreline west of the existing shoreline intakes for NMP Unit 1 and Unit 2. Makeup water to the non-safety related CWS cooling tower is provided by CWS makeup water pumps that are located in a non-safety related portion of Makeup Water Intake Structure. makeup water to the ESW cooling towers is provided by UHS makeup water pumps that are located in the safety related portion of the makeup water intake structure. The makeup water intake structure is located on the shoreline approximately 0.5 mi (0.8 km) west of the existing intake structure of NMP Unit 2. Two intake tunnels, extending approximately 1,280 ft (389 m) and 1,580 ft (482 m) into Lake Ontario, will supply water to the intake structure. The Makeup Water Intake Structure houses a total of three CWS makeup pumps, and four UHS makeup pumps. All CWS and UHS makeup pumps are installed in individual pump bays, each with a set of dedicated trash racks and traveling water screens to filter out debris and foreign objects.

Plant effluent going back to Lake Ontario from NMP3NPP consists of cooling tower blowdown from the CWS cooling tower and the ESWS cooling towers, and non-radioactive wastewater streams from the domestic water treatment and circulating water treatment systems. An outfall pipe routed through Intake Tunnel A is used to discharge the plant effluent to a submerged diffuser located approximately 1167 ft (355.7 m) offshore and approximately 416 ft (126.8 m) south of the new intake structure. The water depth at the discharge outfall is approximately 21 ft (6.4 m).

Figure 10.4-8 shows the CWS intake structure and outfall for NMP3NPP. Figure 10.4-3, Figure 10.4-4, Figure 10.4-6 and Figure 10.4-7 show the layout of the CWS intake and outfall structures. Figure 9.2-4 shows the plan view of the UHS Makeup Water Intake Structure and forebay, and Figure 9.2-5 shows a section view of the UHS Makeup Water Intake Structure.

2.4.7.4 Historical Ice Formation

The climate at the NMP3NPP site is part of the Lake Ontario climate system. Based on air temperature data summaries collected at the Oswego East meteorological station from 1971 through 2000, the monthly average air temperature in the region ranges from about 24.4°F (-4.22°C) in January to 70.7°F (21.5°C) in July, while the monthly minimum air temperature for January is 16.7°F (-8.50°C) and for February is 18.2°F (-7.67°C). Daily air temperatures measured at the Oswego East meteorological station indicate that below freezing temperatures typically occur between the months of November and April (Assel, 2003a).

Maximum accumulated freezing degree-days, as defined in Section 2.4.7.6, have historically occurred in February, and maximum seasonal accumulation of freezing degree days has typically occurred in March and April (Assel, 2003a). Surface ice formation is typical on Lake Ontario. The amount of surface ice on the lake is typically reported as the ice concentration or ice cover of the lake, which is the percentage of lake area covered by surface ice: 0% representing no surface ice cover and 100% representing complete surface ice cover. Ice cover on Lake Ontario varies from about 10% of the lake area during a mild winter to about 95% of the lake area during a severe winter (Canadian Ice Service, 2004). The average annual maximum ice cover on Lake Ontario is 28% (Assel, 2003b). The average annual maximum ice thickness on Lake Ontario is 16.5 in (42 cm), and the maximum recorded ice thickness on Lake Ontario is 20 in (51 cm) (ASCE, 1999) (Bilello, 1966).

The NOAA Great Lakes Environmental Research Laboratory (GLERL) developed composite ice cover images of the Great Lakes for the years 1977-2002. The ice cover images graphically display the percentage of lake area covered by ice for each day of the winter season, and show regional variations in ice cover within each of the Great Lakes. GLERL ice cover images indicate that icing conditions on Lake Ontario were more severe than normal during the winters of 1977, 1978, and 1981. The ice coverage of the eastern portion of Lake Ontario adjacent to the NMPNS site reached 100% in the winters of 1977 and 1978 and reached 95% as recently as February, 1994. The GLERL ice cover images of March 2, 1977, March 1, 1978, January 7, 1981, and February 14, 1995, shown in Figure 2.4-24 to Figure 2.4-27, show 95% to 100% ice cover in the area adjacent to the NMPNS site (Assel, 2002) (Assel, 2003b).

Ice accumulation on the transmission towers and switchyard of the existing NMP Unit 1 and Unit 2 has occurred during freezing rainfall. To date, events such as these have not affected the operation of NMP Unit 1 and Unit 2.

2.4.7.5 Frazil and Anchor Ice

Research on the properties of frazil ice indicates that the nature and quantities of ice produced depends on the rate of cooling within a critical temperature range. Frazil ice forms when the water temperature is below 32°F (0°C), the rate of super cooling is greater than 0.018°F (0.01°C) per hour in turbulent flows, and there is no surface ice sheet to prevent the cooling (USACE, 1991) (Griffen, 1973). This type of ice, which is in the shape of discoids and spicules (Griffen, 1973) typically forms in shallow flowing water, such as in rivers and lakes, when the flow velocity is approximately 2 ft/s (0.61 m/s) or higher (IAHR, 1970).

A stable ice cover prevents the formation of frazil ice by insulating the underlying water from supercooling. Frazil ice forms as small crystals, which can then accumulate into ice masses including flocs, anchor ice, and floes. Large masses of frazil ice can form into a stationary, floating ice cover. Frazil ice can adhere to the stream channel bottom, lake bed, or other structures underwater, and cause problems by restricting flow or causing ice jams. Frazil ice that forms directly on underwater structures is referred to as anchor ice. Floating frazil ice or stationary anchor ice can form on or adhere to intake structures such as trash racks, and cause problems by restricting or blocking flow into the intake structures. (USACE, 2002) (USACE, 1991)

Frazil and anchor ice will not form on, or adhere to structures that are at a temperature slightly above freezing. Ice buildup is not expected to affect the normal operation of NMP3NPP based on the historical experience at NMP Unit 1 and Unit 2, James A. FitzPatrick Nuclear Power Plant (JAFNPP), and Oswego steam station power plants (NMPC, 1998). Similar to the NMP Unit 2 intake structures, NMP3NPP intake structures will be equipped with electrical heating elements to prevent the formation of frazil and anchor ice. Stray frazil ice that may pass through the trash rack bars is melted by tempering water from the CWS. As discussed in Section 2.4.7.7, NMP3NPP intake structures will be equipped with electrical heating elements to prevent the formation of frazil and anchor ice.

2.4.7.6 Surface Ice Sheet

As discussed in Section 2.4.7.5, a surface ice sheet typically forms on Lake Ontario, with an average annual maximum ice concentration of 28% (Assel, 2003b). Surface ice cover on Lake Ontario typically forms in sheltered bays and along the perimeter of the lake. The average annual maximum bay and harbor ice thickness for Lake Ontario is 17 in (42 cm), which typically occurs in mid to late February (ASCE, 1999). Ice ridging, rafting, and hummocking can also increase ice thickness when the ice sheet is under pressure. (Canadian Ice Service, 2004) Ice ridge formation has been observed on Lake Ontario near the NMPNS site, but has not had an impact on operations at NMP Unit 1 or Unit 2.

The maximum surface ice thickness that could form at the NMPNS site was estimated using accumulated freezing degree-day data from the NOAA GLERL. Monthly and seasonal accumulations of freezing degree days were calculated by NOAA GLERL for Oswego, New York for the years 1898-2002 using temperature records from meteorological stations in the Great Lakes area. Freezing degree-days (FDD) are calculated for each day by subtracting the freezing temperature of water (32° F or 0° C) from the average daily air temperature recorded at a specific location. Positive FDD values indicate air temperatures that are below freezing and negative FDD values indicate air temperatures that are above freezing. Accumulated freezing degree-days (AFDD) are calculated for each winter season by summing the daily FDD values for the winter season, beginning when FDD values are consistently positive and ending just before FDD value become negative. The maximum seasonal AFDD value for Oswego, New York was 1373, from April 1, 1904 (Assel, 2003a).

Surface ice thickness can be estimated as a function of accumulated freezing degree-days (AFDD) using the modified Stefan equation presented by the U.S. Army Corps of Engineers (USACE 2004):

$$\text{Ice Thickness (in)},\ t = C\sqrt{AFDD}$$

Where: t = Ice thickness, in inches

C = Coefficient to account for lake size, snow cover, and wind conditions

AFDD = Accumulated Freezing Degree-Days

The modified Stefan equation uses a coefficient, C, to account for the water body size, wind conditions, and snow cover. The C value ranges from 0.12 to 0.8, with typical values between 0.3 and 0.6. (USACE, 2004) A conservative coefficient value of 0.8 was used to estimate the maximum Lake Ontario ice thickness, representing a windy lake with no snow cover. Using the maximum AFDD value of 1373 gives an estimated ice thickness of 2.5 ft (0.76 m).

This thickness of ice cover is not expected to impact operations at the NMP3NPP site. The intake structures are located at an elevation of 188ft (57.2 m), or 47 ft (14.3 m) below the low water elevation of 235 ft (71.6 m). The discharge diffuser is located at an elevation of 204 ft (62.2 m), or 31 ft (9.4 m) below the low water elevation of 235 ft. The UHS Makeup Water Intake Structure is located on the shore of Lake Ontario, separated from the lake by an earthen embankment and a concrete parapet wall. The floor of the UHS Makeup Water Intake Structure is located at elevation 225.5 ft (68.7 m), or 9.5 ft (2.9 m) below the low water elevation of 235 ft (71.6 m). In the event that the maximum estimated ice thickness of 2.5 ft (0.76 m) was to develop in the intake forebay, a clearance of 7 ft (2.1 m) would remain for flow passage.

Note that the surface ice layer on Lake Ontario, when present, insulates and provides protection against the formation of frazil ice.

2.4.7.7 Ice Accumulation on the Intake and ESWS Cooling Tower Basin and Preventive Measures

The intake structures for NMP3NPP have been located to minimize against the formation of a surface current that could cause ice floes around the intake structure to be withdrawn or moved by the water. The UHS Makeup Water Intake Structure design incorporates deep skimmer walls and trash racks in order to prevent ice from reaching the pump bays. However, accumulation of ice at the trash racks and the traveling screens could clog and reduce the flow capacity of the intake. The trash racks and/or the traveling water screens are equipped with heat tracing to mitigate the ice accumulation. Additionally, automatic and continuous raking of trash racks is used to further ensure the trash racks are free of ice buildup. For the ESWS cooling tower basins, measures will be taken to ensure that the basins underneath the cooling tower cells have a minimum of 72 hours water supply without the need for any makeup water during a design basis accident. As indicated in Section 2.4.7.2, any makeup water to the basin needed beyond the 72 hour, post accident period will be supplied from the NMP3NPP UHS Makeup Water Intake Structure. To assure the availability of a minimum of 72 hours water supply in the ESWS cooling tower basins, the minimum volume in each basin will be established by considering: (a) losses due to evaporation and drift under design basis accident conditions and design environmental conditions; (b) minimum submergence to avoid formation of harmful vortices at the pump suction; and (c) the operating range for basin water level control. During extreme cold weather conditions, operational controls will be implemented, as required, to assure the availability of the required volume. Tower operations during cold weather will mitigate ice buildup consistent with vendor recommendations (e.g., periodic fan operation in the reverse direction). Therefore, operational controls, together with system design features, will prevent ice formation in the ESWS cooling tower basins as discussed in Section 9.2.5.

2.4.7.8 Effect of Ice on High and Low Water Levels and Potential for Ice Jam

Cooling water will be drawn from Lake Ontario through the intake tunnels to the intake forebay. The water surface level in the intake forebay will fluctuate based on the water surface level in Lake Ontario. The design of the intake structures prevents ice and waves from entering the forebay. As discussed in Section 2.4.7.6, up to 2.5 ft (0.76 m) of surface ice formation is possible in open water near the NMPNS site. In the event that the maximum estimated ice thickness of 2.5 ft (0.76 m) was to develop in the intake forebay, a clearance of 7.0 ft (2.1m) would remain for flow passage. Since cooling water will be drawn from Lake Ontario, reduction of the reservoir water volume due to surface ice sheet formation would not be of concern. The intake cribhouse will be located 47 ft (14 m) below the low water elevation of 235 ft (71.6 m), therefore surface ice cover on Lake Ontario will not reduce the water volume available for intake.

Although most tributaries to Lake Ontario are prone to ice formation, there has been no ice jam formation or flooding on Lake Ontario due to breaching of ice jams on upstream tributaries or the downstream Saint Lawrence River. The USACE Ice Jam Database maintains records of current and historical ice jams within the United States. The nearest historical ice jams on record occurred on the Oswego River in January of 1952 and January of 2004. However, the mouth of the Oswego River is about 6.5 mi (10 km) by water from the NMP3NPP site, and the impact of any Oswego River ice jam formation or breaching could not have an effect on the NMPNS site. (USACE, 2008)

There are no records of ice jam formation on the Saint Lawrence River causing flooding on Lake Ontario. The International Saint Lawrence River Board of Control (ISLRBC) regulates Lake Ontario outflow to the Saint Lawrence River and thereby controls lake levels in Lake Ontario. Following the close of the navigation season, ISLRBC reduces the Lake Ontario outflow to promote the formation of a smooth, stable ice cover on the St. Lawrence River. The stable ice cover formation is beneficial in that it reduces the risk of ice jams on the river. (USACE Detroit, 2004) Ice jam formation or breaching on the Saint Lawrence River is unlikely, and would not have an effect on the NMPNS site.

In addition, there are no major streams close to the site which would pose the potential of ice flooding at the site. Section 2.4.1 discusses the streams and rivers in the vicinity of the site.

2.4.7.9 Effect of Ice and Snow Accumulation on Site Drainage

Air temperature measurements at the Oswego East meteorological station indicate that mean daily temperatures at the site can fall below freezing for several months during the winter (NOAA, 2002). As discussed in Section 2.4.7.6, up to 2.5 ft (0.76 m) of surface ice formation is possible in open water near the NMPNS site. This introduces the possibility of ice blockage of small catch basins; storm drains; culverts and roof drains. The flood protection design of the NMP3NPP safety-related facilities assumed that all catch basins, storm drains, and culverts are blocked by ice, snow or other obstructions, rendering them inoperative during a local probable maximum precipitation (PMP) event. Details of the local PMP analyses and flood protection requirements for the site are discussed in Section 2.4.2 and Section 2.4.10. Therefore, temporary blockage of site drainage areas will not affect the operation of safety-related facilities.

2.4.7.10 References

ASCE, 1999. Potential Climate Change Effects on Great Lakes Hydrodynamics and Water Quality - Chapter 6, Raymond A. Assel, American Society of Civil Engineers Publication 0-7844-0413-5, May 1999.

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Bilello, 1966. Special Report 43, Ice Thickness Observations, North American Arctic and Subarctic, 1962-63, 1963-64, Pt. III, Bilello, M. A., and Bates, R. E., U.S. Army Material Command, Cold Regions Research and Engineering Laboratory, Hanover, NH, July 1966.

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Griffen, 1973. The Occurrence and Prevention of Frazil Ice at Water Supply Intakes, Research Branch Publication Number W43, Toronto Ministry of the Environment, A. Griffen, 1973.

IAHR, 1970. International Association of Hydraulic Engineering and Research, ICE Symposium, Heat Exchange and Frazil Formation, Reykjavik, T. Carstens, 1970.

NOAA, 2002. Climatography of the United States No. 81, Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, National Oceanic and Atmospheric Administration, Revised February, 2002.

USACE, 1991. Frazil Blockage of Intake Trash Racks, Cold Regions Technical Digest No. 91-1, Steven F. Daly, March 1991.

USACE, 2002. Engineering and Design: Ice Engineering. U.S. Army Corps of Engineers Engineer Manual 1110-2-1612, October, 2002.

USACE Detroit, 2004. Great Lakes Update, 2003 Annual Summary, Vol. No. 154, U.S. Army Corps of Engineers Detroit District, January 2004.

USACE, 2004. Ice Engineering: Method to Estimate River Ice Thickness Based on Meteorological Data, ERDC/CRREL Technical Note 04-3, U.S. Army Engineering Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, June 2004.

USACE, 2008. Ice Jams Database, Engineering and Research Development Center, U.S. Army Corp of Engineers, Website: rsgis.crrel.usace.army.mil/icejam/, Date accessed: March, 2008.}

2.4.8 COOLING WATER CANALS AND RESERVOIRS

The U.S. EPR FSAR includes the following COL Item for Section 2.4.8:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information and describe the design basis for cooling water canals and reservoirs used for makeup to the UHS cooling tower basins.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless otherwise stated.

Section 2.4.8.1 through 2.4.8.2 are added as a supplement to the U.S. EPR FSAR.

2.4.8.1 Cooling Water Design

NMP3NPP does not include any safety-related canals or reservoirs used to transport or impound plant cooling water. The makeup water intake structure for NMP3NPP, which includes bnoth a safety-related UHS makeup portion and a non-safety-related CWS makeup water portion, will be located on the Lake Ontario shoreline to the west of the existing NMP Unit 1 and Unit 2 Intake Structures. Makeup water will be supplied to NMP3NPP through two intake tunnels extending approximately 1,280 ft (389 m) and 1,580 ft (482 m) into Lake Ontario. The intake tunnels will supply water to the on-shore UHS Makeup Water Intake Structure, which is protected by an earthen embankment and concrete retaining walls.

The floor of the UHS Makeup Water Intake Structure is located at elevation 225.5 ft (68.73 m), which is 9.5 ft (2.9 m) below the design low water elevation of 235 ft (71.6 m), as established in Section 2.4.11. The UHS Makeup Water Intake Structure concrete retaining walls have a top elevation of 272 ft (82.9 m), which is 18 ft (5.5 m) above the design high water elevation of 254 ft (77.4 m), as established in Section 2.4.3. Figure 9.2-4 shows the general arrangement profile of the UHS Makeup Water Intake Structure. The bases for the maximum UHS and CWS makeup water flow rates and design high and low water elevations are discussed in Section 9.2.5 and Section 10.4.5, respectively. Section 2.4.11 provides the basis for the minimum operating level.

Because the UHS Makeup Water Intake Structure is located on shore, and protected by concrete retaining walls, no additional measures will be necessary to protect against wind waves, erosion, and current actions. As discussed in Section 2.4.7, potential ice effects cannot block the intake structures or interrupt the water supply to the UHS intake. The maximum water level in the forebay is controlled by the probable maximum storm surge, which is discussed in Section 2.4.5. The design of the UHS Makeup Water Intake Structure will comply with the requirements of Regulatory Guide 1.27 (NRC, 1976).

2.4.8.2 References

NRC, 1976. Ultimate Heat Sink for Nuclear Power Plants, Regulatory Guide 1.27, Revision 2, U.S. Nuclear Regulatory Commission, January 1976.}

2.4.9 CHANNEL DIVERSIONS

The U.S. EPR FSAR includes the following COL Item for Section 2.4.9:

A COL applicant that references the U.S. EPR design certification will provide site-specific information and demonstrate that in the event of upstream diversion or rerouting of the source of cooling water, alternate water supplies will be available to safety-related equipment.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless stated otherwise.

The NMP3NPP site area is located along the southern shore of Lake Ontario. The natural ground elevation at the site generally slopes towards Lake Ontario, and natural drainage is towards the lake. The nearest stream to the NMP3NPP site is Lakeview Creek, which passes along the southwestern periphery of the NMP3NPP site about 4,000 ft (1,200 m) upstream of Lake Ontario and passes 1,400 ft (426.7 m) southwest of the NMP3NPP power block. NMP3NPP site drainage is directed to the north into Lake Ontario and to the west into Lakeview Creek, which discharges into Lake Ontario just west of the NMP3NPP site boundary. The NMP3NPP site and surrounding areas are shown in Figure 2.4-1.

Section 2.4.9.1 through 2.4.9.8 are added as a supplement to the U.S. EPR FSAR.

2.4.9.1 Historical Channel Diversions

Lake Ontario will be used to supply makeup water to the safety-related Ultimate Heat Sink (UHS) and non-safety-related Circulating Water Supply (CWS) System. Lake Ontario is part of the Laurentian Great Lakes, which began to form about 20,000 years ago during the Last Glacial Maximum. The lake basins were formed by glacial scouring of the underlying earth surface. The basins were filled by meltwater from the receding glaciers, and attained their modern configuration approximately 3,500 - 4,000 years ago (USACE, 1999). Section 2.5.1 provides further description of the geologic history of the site area.

Given the seismic, topographical, geologic, and thermal evidence in the region, there is very limited potential for upstream diversion or rerouting of Lake Ontario (due to channel migration, river cutoffs, ice jams, or subsidence) to adversely impact safety-related facilities or water supplies.

The NMP3NPP site is located along the southern shore of Lake Ontario. The natural ground elevation at the site generally slopes towards Lake Ontario, and the natural drainage is towards the lake. The nearest stream to the NMP3NPP site is Lakeview Creek, which passes along the southwestern periphery of the NMP3NPP site about 4,000 ft (1,200 m) upstream of Lake Ontario and passes 1,400 ft (426.7 m) southwest of the power block. NMP3NPP site drainage is directed to the north into Lake Ontario and to the west into Lakeview Creek, which discharges into Lake Ontario just west of the NMPNS site boundary. The NMP3NPP site and surrounding area are shown in Figure 2.4-2.

2.4.9.2 Regional Topographic Evidence

The makeup water intake for the safety-related ESW system and UHS, and the non-safety-related CWS, will be located on the southeast shore of Lake Ontario about 0.5 mi (0.8 km) west of the existing intake structure of NMP Unit 2. Two new intake tunnels extending into Lake Ontario will supply water to the on-shore UHS Makeup Water Intake Structure, which will be set back about 50 ft (15 m) from the shore of the lake at an elevation of 272 ft (82.9 m), or 18 ft (5.5 m) above the design high water elevation of 254 ft (77.4 m).

Shoreline erosion along Lake Ontario can occur as the result of wind, currents, waves, and/or water level fluctuations (USACE, 1999). The NMP3NPP site will be stabilized against shoreline erosion from wind, currents and water fluctuations. The NMP3NPP site will be regraded and raised with earthen fill, and earthen berms will be constructed to stablize the shoreline against erosive forces. The raised shoreline will be graded at a 3:1 (3 Horizontal :1 Vertical) slope, and protected with a 3 ft (0.9 m) thick layer of 2 ft (0.6 m) diameter stone riprap. The riprap slope cover will provide protection against the erosive forces caused by wind driven waves, currents, and water level fluctuations. The riprap cover will protect the shoreline structures by preventing the erosion or failure of the underlying soils, and will ensure a stable shoreline. The shoreline structures are shown in Figure 2.4-41.

Based on topographic evidence, there is no apparent history of significant shoreline erosion on Lake Ontario in the vicinity of the NMPNS site. Detailed maps of the Lake Ontario shoreline in the vicinity of the NMPNS site are available from as early as 1802. A historic map of the State of New York from 1802, showing the eastern portion of Lake Ontario, is shown in Figure 2.4-28 (Dewitt, 1802). Selections from the United States Geological Survey (USGS) Quadrangle Maps from 1900 and 1956 are shown in Figure 2.4-29 and Figure 2.4-30 (USGS, 1900 and USGS, 1956). New York Geographic Information Systems (NYGIS) aerial photography of the site from 2007 is shown in Figure 2.4-31 (NYGIS, 2007). The historic map, USGS topographic maps, and recent aerial photography show that the shoreline in the vicinity of the NMPNS site has not changed significantly over the past two centuries.

It is therefore unlikely that the shoreline at the NMP3NPP site will experience changes due to shoreline erosion processes. The raised elevation of safety related structures combined with the shoreline slope protection will prevent shoreline eronsion at the site. Furthermore, any potential adverse impacts on safety-related facilities or water supplies should come from extremely slow changes, which can be remedied as they occur.

2.4.9.3 Ice Causes

Although surface ice occurs during the winter months on portions of Lake Ontario, ice jams causing channel diversions and interruption of the cooling supply for NMP Unit 1 and Unit 2 have not been reported. As discussed in Section 2.4.7, a maximum 2.5 ft (0.76 m) thick surface ice cover may form on Lake Ontario. However, this maximum ice sheet will not affect the submerged intake structure piping for NMP3NPP. The submerged intake structure piping will be located at an elevation of 188 ft (57.2m); 47 ft (14.3 m) below the low water level elevation of 235 ft (71.6m). A further discussion on the formation of surface ice and the potential for an ice jam is provided in Section 2.4.7.

2.4.9.4 Site Flooding Due to Channel Diversion

The NMP3NPP site has small streams and proposed drainage ditches near the site that could overflow and cause local flooding. Lakeview Creek flows along the southwest perimeter of the site and there are no plans to divert the creek from its current location. Flood water from Lakeview Creek could pose a risk to NMP3NPP structures should the flood waters exceed the site elevation in the power block area of 270 ft (82.3 m). As discussed in Section 2.4.3, the probable maximum precipitation (PMP) water surface elevation in Lakeview Creek in the vicinity of the NMP3NPP power block (safety related structure) is 268.7 ft (81.9 m); 1.3 ft (0.4 m) below the finished first floor elevation of 270 ft (82.3 m) for safety related structures. The PMP water surface elevation assumes that all culverts at road crossings are completely blocked due to ice formation or debris. Therefore, ice or debris blockage is not expected to cause a further increase in flood levels on site. In the event that ice or debris causes a blockage along the stream channel, flood waters will flow around any partial blockage as Lakeview Creek rises beyond the channel banks. A further discussion of streams and rivers in the vicinity is provided in Section 2.4.1.

As indicated on the Site Layout, Figure 2.4-2, the containment, fuel and safeguards buildings are located in the center and along the high point of the power block area, with a grade elevation of 270 ft (82.3 m). The area to the south of the power block, which includes the switchyard, site roads, and construction laydown areas, has drainage ditches that drain to Stormwater Pond No. 3 located just south of the power block area. The area to the east of the power block, which includes the mechanical draft cooling tower, the concrete batch plant, and railroad tracks, has drainage ditches that drain to Stormwater Pond No. 2 located northeast of the power block near the dike along the western perimeter of NMP Unit 2. The area to the west of the power block, which includes the UHS Makeup Water Intake Structure, water treatment plants, construction offices, and parking areas, has drainage ditches that drain to Stormwater Pond No. 1 located to the northwest of the power block adjacent to the Lake Ontario shoreline. A portion of the site to the northeast of the mechanical draft cooling tower has drainage ditches that drain to a channel leading directly to Lake Ontario.

For the assessment of the local PMF levels, the drainage ditches and culverts in the drainage system are assumed to be clogged as a result of ice or debris blockage, as covered in Section 2.4.2. Grading in the vicinity of the safety-related structures slopes away from the individual structures such that PMP ground and roof runoff will sheet flow away from each of these structures towards the drainage collection ditches. Thus, sheet flows are prevented from entering the structures. The maximum computed PMP water level associated with safety-related structures is elevation 269 ft (82 m) which is 1.0 ft (0.5 m) below the finished first floor elevation of 270 ft (82.3 m). Based on the power block grading, entrance locations, and peak PMP water levels in the site ditches, all safety-related facility entrances are located above peak PMP drainage ditch water levels and PMP sheet flows are prevented from reaching safety-related entrances.

2.4.9.5 Human-Induced Channel Flooding

Human-induced channel flooding along Lake Ontario is not assumed because the lake levels are regulated by the International Saint Lawrence River Board of Control (ISLRBC). The ISLRBC regulates Lake Ontario outflow to the Saint Lawrence River and thereby controls lake levels in Lake Ontario. Outflow is controlled by a series of dams along the Saint Lawrence River that are used for hydropower, navigation, and surface ice control. (USACE, 1999)

The NMP3NPP site grading discussed above will need to be maintained to direct stormwater and drainage ditch overflows away from the site and towards the surrounding wetland areas and Lake Ontario.

2.4.9.6 Alternate Water Sources

An alternate water source is not required for the NMP3NPP design. The emergency safety related water supply to the ESWS cooling tower basins is makeup water from Lake Ontario. In the event normal water supply is lost, there is a 72-hour volume of water available at the tower basin to deal with system losses before the UHS Makeup Water System is required to be initiated. After that time, a safety-related train of makeup water will be available to feed the basin with water drawn from Lake Ontario. As discussed in Section 2.4.9.4, there is no potential of blockage of the safety-related UHS makeup water intake due to channel diversions. Non-safety related water sources, such as water from the non-safety related intake structure; the raw water supply system or groundwater wells are also available, if needed.

2.4.9.7 Other Site-Related Evaluation Criteria

The potential for channel diversion from seismic or severe weather events is not considered to result in a loss of cooling water supply. The portion of the UHS makeup water intake structure that house UHS makeup water system components is a seismic Category I structure. Offshore intake structures are located in Lake Ontario at an elevation of 188 ft (57.2 m), or 47 ft (14.3 m) below the low water elevation of 235 ft (71.6 m). The discharge structure is located off-shore in Lake Ontario at an elevation of 204 ft (62.2 m), or 30 ft (9.1 m) below the safety-related design low water elevation of 235 ft (71.6 m). Intake and discharge tunnels will be drilled into the lake bottom and encased in concrete. The UHS Makeup Water Intake Structure is located on the shore of Lake Ontario, separated from the lake by an earthen embankment and a concrete parapet wall. The floor of the UHS Makeup Water Intake Structure is located at elevation 225.5 ft (68.7 m), or 9.5 ft (2.9 m) below the low water elevation of 235 ft (71.6 m). Because the intake pumphouse will be protected by vertical concrete retaining walls, no additional measures are necessary to protect against a potential channel diversion due to seismic events.

The shoreline to the west of the NMP3NPP site is moderately sloped. The shoreline to the east of the NMP3NPP site is stabilized along the NMP Unit 1 and Unit 2 sites. Shoreline slope failures to the east and west of the NMPNS site, due to seismic events or erosion, will not have an effect on the NMP3NPP intake structures or site structures.

2.4.9.8 References

Dewitt, 1802. Selection from: “A Map of the State of New York” by SImeon Dewitt, Surveyor General, from State University of New York at Stony Brook University Libraries.

NYGIS, 2007. New York State High Resolution Orthophoto Imagery for Oswego, New York, Spring 2007, New York Geographic Information Systems Clearinghouse, New York State Ofice of Cyber Security & Critical Infrastructure Coordination.

USACE, 1999. Living with the Lakes: Understanding and Adapting to Great Lakes Water Level Changes, U.S. Army Corps of Engineers Detroit District and Great Lakes Commission, 1999.

USGS, 1900. Selection from Fulton, New York USGS Quadrangle Map, 15 Minute Series, United States Geological Survey, 1900, Reprinted 1930.

USGS, 1956. Selection from Fulton, New York USGS Quadrangle Map, 15 Minute Series, United Staes Geological Survey, 1956.}

2.4.10 FLOODING PROTECTION REQUIREMENTS

The U.S. EPR FSAR includes the following COL Item in Section 2.4.10:

> A COL applicant that references the U.S. EPR design certification will use site-specific information to compare the location and elevations of safety-related facilities, and of structures and components required for protection of safety-related facilities, with the estimated static and dynamic effects of the design basis flood conditions.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless stated otherwise.

This section discusses the locations and elevations of safety-related facilities to identify the structures and components exposed to flooding. The safety-related facilities are compared to design basis flood conditions to determine if flood effects need to be considered in plant design or in emergency procedures.

All safety-related facilities for NMP3NPP are located in the power block area with the exception of the UHS Makeup Water Intake Structure, which is located adjacent to the NMP3NPP CWS Makeup Water Intake. As discussed in Section 2.4.2, the maximum water level in the power block area due to a local PMP is Elevation 269.0 ft (82.0 m). All safety-related structures have a minimum grade slab at Elevation 270.0 ft (82.3 m) and entrance at Elevation 270.0 ft (82.3 ft) or higher. Grading in the power block area around the safety-related facilities is such that all grades slope away from the structures at a minimum of 1% towards collection ditches.

Additionally, the maximum estimated water surface elevations resulting from all design basis flood considerations discussed in Section 2.4.2 through Section 2.4.7 are below the entrance and grade slab elevations for the power block safety-related facilities. Therefore, flood

Both the non-safety related Circulating Water Supply System (CWS) and safety-related Ulitmate Heat Sink (UHS) are provided with makeup water from the UHS Makeup Water Intake Structure, which is located on the Lake Ontario shoreline to the west of the existing NMP Unit 1 and Unit 2 intake structures. According to Section 2.4.2, the maximum water level in the vicinity of the UHS due to a local probable maximum precipitation (PMP) is at an elevation of 261.8 ft (79.8 m). Because the intake pump house is protected by concrete retaining walls that have a top elevation of 272 ft (82.9 m), which is 10.2 ft (3.1 m) above the peak water elevation due to a local PMP, and the finished floor where the pump motors and electrical equipment are set is at an elevation of 272 ft (82.9 m), no additional measures will be necessary to protect against wind driven waves, erosion, and current actions (i.e., static and dynamic effects).}

2.4.11 LOW WATER CONSIDERATIONS

The U.S. EPR FSAR includes the following COL Item in Section 2.4.11:

> A COL applicant that references the U.S. EPR design certification will identify natural events that may reduce or limit the available cooling water supply, and will verify that an adequate water supply exists for operation or shutdown of the plant in normal operation, anticipated operational occurrences, and in low water conditions.

This COL Item is addressed as follows:

{This section investigates natural events that may reduce or limit the available cooling water supply to ensure that an adequate water supply exists to shut down the plant under conditions requiring safety-related cooling. Specifically, any issues due to a low water level in the Lake Ontario are investigated in this section.

References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless stated otherwise.

Section 2.4.11.1 through 2.4.11.7 are added as a supplement to the U.S. EPR FSAR.

2.4.11.1 Low Flow in Rivers and Streams

There are no major streams or rivers within the NMP3NPP site area and none that will serve as a water supply for the site. Therefore, low water conditions resulting from low flow in rivers and streams does not apply. A description of the hydrologic setting of the site and facilities is provided in Section 2.4.1. The NMP3NPP will obtain water from Lake Ontario.

2.4.11.2 Low Water Resulting From Surges, Seiches, Tsunami, or Ice Effects

Section 2.4.5 describes Probable Maximum surge and seiche flooding. Due to its inland location, extra tropical cyclones are anticipated to produce higher winds than hurricanes. For the purpose of estimating low water effects, the storm described in Section 2.4.5 which resulted in a total surge (due to wind and pressure effects) of 4.8 ft (1.5 m) is considered to also have potential to result in a total setdown of 4.8 ft (1.5 m). The minimum low water is estimated as elevation 237.9 ft (72.5 m) by applying the setdown to the minimum ambient lake level of 242.7 ft (74.0 m), which is estimated as described in Section 2.4.11.3. Section 2.4.6 describes Probable Maximum tsunami flooding. As discussed in Section 2.4.6, tsunami hazards for Lake Ontario are insignificant. Therefore, low water effects resulting from tsunami are also negligible.

Section 2.4.7 includes a description of cases of ice formation or ice-jams that may result in low water level. Ice effects do not result in low water issues at the NMP3NPP site.

2.4.11.3 Historical Low Water

The minimum stillwater level of Lake Ontario, observed during the 145-yr period of record beginning in 1860, was elevation 242.7 ft (74 m) in 1934 (Wilcox, 2007). Figure 2.4-32 delineates the historic fluctuations in Lake Superior, Michigan-Huron, Erie, and Ontario.

Prior to the beginning of flow regulation around 1960, the elevation of the lake surface was controlled by a natural rock weir located about 4 mi (6.4 km) downstream from Ogdensburg, NY, in the Galop Rapids reach of the St. Lawrence River. Lake Ontario outflows have been regulated since 1960, primarily through the Moses-Saunders power dam near Cornwall and Massena, New York about 100 miles (161 km) from the outlet of Lake Ontario. Long Sault Dam, located near Long Sault, Ontario, acts as a spillway when outflows are larger than the capacity of the Moses-Saunders power dam. A third structure at Iroquois, Ontario, is principally used to help to form a stable ice cover and regulate water levels at the power dam. These facilities are under the authority of the International St. Lawrence River Board of Control. The effects resulting from failure of the aforementioned dams have been analyzed by the St. Lawrence Study Office of the Canadian Department of Energy, Mines, and Resources (currently known as Department of Natural Resources Canada). The study showed that the lake level would decline gradually from elevation 242.7 ft (74 m) to elevation 240.6 ft (73.3 m) approximately one year following the assumed failure. Once the lake level had declined to about elevation 240.6 ft (73.3 m), 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 (NMPC, 1998). Therefore, potential dam failures on the St. Lawrence River will result in a lowered lake level which has been considered in the design on NMP3NPP.

As discussed in Section 2.4.5, two hurricanes that could have potentially affected the NMP3NPP site in recent years include Hurricane Hazel in 1954 and Hurricane Isabel in September 2003. Storm surge records for Hurricane Hazel are no longer available. However, this event was not considered in the 1972 analysis of NMP Unit 2. Any storm related setdown or surge from Hurricane Isabel along the southern shore of Lake Ontario would be apparent in the data presented in Figure 2.4-18 and Table 2.4-1 which does not show a significant event during this time period.

2.4.11.4 Future Controls

New regulation plans for Lake Ontario are currently being evaluated by the International Joint Commission (IJC, 2006). However, regulation plans are not anticipated to include low water elevations below the historical lowest monthly mean stillwater level before lake regulation, which was elevation 242.0 ft (73.8 m). Therefore, there would be no change in the design low water elevation, which is 235 ft (71.6 m).

2.4.11.5 Plant Requirements

Plant flow requirements for the UHS are discussed in Section 9.2.5. Plant flow requirements for Essential Service Water System are discussed in U.S. EPR FSAR Section 9.2.1.

In terms of plant requirements, the ESWS provides flow for normal operating conditions, for shutdown/cooldown and for DBA conditions. The ESWS pump in each train obtains water from the ESWS cooling tower basin of that train and circulates the water through the ESWS. Heated cooling water returns to the ESWS cooling tower to dissipate its heat load to the environment. Makeup water is required to compensate for ESWS cooling tower water inventory losses due to evaporation, drift, and blowdown associated with cooling tower operation. Makeup water to the ESWS cooling tower basins under normal operating and shutdown/cooldown conditions is provided by the plant Raw Water Supply System. Water is stored in the ESWS cooling tower basin, which provides at least 72 hours of makeup water for the ESWS cooling tower following a DBA. After 72 hours have elapsed under DBA conditions, emergency makeup water to the ESWS tower basins is provided by the safety-related UHS makeup water pumps housed in the UHS Makeup Water Intake Structure.

The safety-related UHS Makeup Water Intake Structure is located in the northern portion of the site, near the southern shore of Lake Ontario. Four 100% capacity, vertical turbine, wet-pit UHS makeup water pumps are provided to supply makeup water to the ESWS cooling tower basins, one per train, with a capacity per pump of approximately 600 gpm (2,271 lpm). The intake structure is located at an elevation of 188 ft (57.2 m), or 47 ft (14.3 m) below the design low water elevation of 235 ft (71.6 m). The UHS Makeup Water Intake Structure is located on the shore of Lake Ontario, separated from the lake by an earthen embankment and a concrete parapet wall. The floor of the UHS Makeup Water Intake Structure is located at elevation 225.5ft (68.7 m), or 9.5 ft (2.9 m) below the low water elevation of 235 ft (71.6 m). The available water depth under the minimum design water level is more than adequate to satisfy the pump submergence, pump intake head loss through screens, and Net Positive Suction Head (NPSH) requirements even when the four UHS makeup pumps are each concurrently operating at 600 gpm (2,271 lpm). The discharge flow, from NMP3NPP to Lake Ontario, is from a retention basin that collects all site non-radioactive wastewater and cooling tower blowdown. Details of the outfall structure are provided in Section 10.4.5.

The minimum design operating level of 235.0 ft (71.6 m) is 7.0 ft (2.1 m) below the 145-year minimum, pre-regulation water level of 242.0 ft (73.8 m) and 2.2 ft (0.67 m) below the estimated probable minimum low water level due to surge of 237.2 ft (72.3 m).

Nine Mile Point Nuclear Station, LLC holds a Great Lakes Water Withdrawal Registration, issued by the New York State Department of Environmental Conservation (NYSDEC), allowing withdrawal of water from Lake Ontario. Additional withdrawals for NMP3NPP beyond the existing Great Lakes Water Withdrawal Registration will be subject to NYSDEC approval. Both the safety-related and non-safety-related makeup water intakes will comply with the Section 316(b) requirements for existing power plants of the Federal Water Pollution Control Act (USC, 2007), which requires an intake screen through-slot velocity of less than 0.5 fps (0.15 mps).

2.4.11.6 Heat Sink Dependability Requirements

The normal non-safety-related water supply to the ESWS cooling tower basins is from Lake Ontario. The emergency safety-related water supply to the ESWS cooling tower basins is water from Lake Ontario from the UHS Makeup Water System (approximately 470 gpm (1,179 lpm) maximum anticipated per train). In the event normal water supply is lost, there is a 72 hour volume of water available at the ESWS tower basin to deal with system losses before the UHS Makeup Water System is required to be initiated.

The ESWS cooling tower basin design considers that the basin is operating just above the low operating water level at the start of an accident and that the normal non-safety-related makeup water supply is lost. At the end of 72 hours following the initiation of an accident, enough water will remain in the basin to provide minimum submergence depth for vortex suppression and to maintain sufficient NPSH for the pumps, plus some margin. At the 72 hour point, the safety related UHS Makeup Water System at Lake Ontario would begin supplying makeup water to the basins of the operating ESWS cooling towers (Section 9.2.5). For cases of severe accidents, the ESWS also has a dedicated, non-safety-related 100% train with one pump. This train provides approximately 2,050 gpm (7,760 lpm) of ESWS flow (1.205×10^6 lbm/hr) (5.466×10^5 kg/hr) to deal with severe accident heat loads (U.S. EPR FSAR Table 9.2.5-1).

Details of the ESWS design bases for operation and normal or accidental shutdown and cooldown, as well as the water sources and the related retaining and conveyance systems, are provided in Section 9.2.5 and U.S. EPR FSAR Section 9.2.5.

The UHS makeup water intake structure is designed to withstand the extreme meteorological and geo-seismic events, such as the probable maximum storm surge, probable maximum tsunami and tornadoes. Specifically, the invert elevation of the UHS makeup pump sump is set at a level to provide sufficient submergence depth to suppress harmful vortex formation and to maintain sufficient NPSH for the pump, under the design water level (which is 235 ft (71.6 m)). Due to its inland location, extratropical cyclones are anticipated to produce higher winds than hurricanes. Extreme low water level can persist at most for about one day since the forward speed of the extratropical storm system around the site is estimated to be about 40 mph (64 kmph). With this speed, the storm system would have traveled around 960 miles (1,544 km) in 24 hours and its effect on the site will diminish. Therefore, the site area can be out of the severe-influence area of the storm system after 24 hours. Because the minimum design level is based on this storm system, there is no need to switch to the UHS Makeup Water System.

Design basis heat loads for various plant modes are provided in U.S. EPR FSAR Section 9.2.5. Makeup water flow rate requirements for the UHS trains are based not only on providing sufficient inventory in the ESWS cooling tower basins for safe operation of the ESWS pumps but also on maintaining basin water chemistry, and takes into consideration maximum ESWS cooling tower evaporation, drift, and seepage losses. The criteria in Regulatory Guide 1.27 (NRC, 1976) to provide water inventory for UHS operation during the 30 day post accident period have been incorporated into the NMP3NPP UHS design. Each ESWS cooling tower basin will have sufficient inventory to permit operation of the associated ESWS train for 72 hours following an accident without the need for additional makeup water. At the end of 72 hours, a safety-related train of makeup water will be put in operation to feed the basin (each train of UHS has a dedicated safety-related makeup water train as a backup to the normal non-safety source). The safety-related UHS Makeup Water System draws from Lake Ontario, therefore it will be able to provide water for the 30 day period following an accident (Section 9.2.5).

There are no other uses of water drawn from the UHS, such as fire water or system charging requirements. There are no other interdependent safety-related water supply systems to the

UHS, like reservoirs or cooling lakes. There is no potential of blockage of the safety-related UHS makeup water intake due to ice or channel diversions as discussed in Section 2.4.7 and Section 2.4.8. In addition, the forebay will be dredged as necessary to avoid any sedimentation issues.

2.4.11.7 References

NMPC, 1998. Nine Mile Point Unit 2 Updated Final Safety Analysis Report, Niagara Mohawk Power Corporation, November, 1998.

IJC, 2006. Options for Managing Lake Ontario and St. Lawrence River Water Levels and Flows. Final Report by the International Lake Ontario- St. Lawrence River Study Board to the International Joint Commission, March 2006

NRC, 1976. Ultimate Heat Sink for Nuclear Power Plants, Regulatory Guide 1.27, Revision 2, Nuclear Regulatory Commission, January 1976.

USC, 2007. Title 33, United States Code, Chapter 26, Part 1251, Federal Water Pollution Control Act, 2007.

Wilcox, 2007. Lake-Level Variability and Water Availability in the Great Lakes: U.S. Geological Survey Circular 1311, D. A. Wilcox, T.A. Thompson, R.K. Booth, J.R. Nicholas, 2007.}

2.4.12 GROUNDWATER

The U.S. EPR FSAR includes the following COL Item in Section 2.4.12:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information to identify local and regional groundwater reservoirs, subsurface pathways, onsite use, monitoring or safeguard measures, and to establish the effects of groundwater on plant structures.

This COL Item is addressed as follows:

{This section provides a description of the hydrogeologic conditions present at, and in the vicinity of the NMP3NPP site. This section describes the regional and local ground water resources that could be affected by the construction and operation of NMP3NPP. The regional and site-specific data on the physical and hydrologic characteristics of these ground water resources are summarized to provide the basic data for an evaluation of potential impacts on the aquifers of the area.

Sections 2.4.12.1 through 2.4.12.6 are added as a supplement to the U. S. EPR FSAR.

2.4.12.1 Description and Use

This section provides a description of local area (within a 5-mi (8 km) radius) and site vicinity (within a 25-mi (40 km) radius) hydrogeologic conditions at NMP3NPP, which is located in the village of Scriba, Oswego County, New York (USGS, 1985a; USGS, 1985b). Figure 2.4-34 is a site map illustrating the area within a 5-mi (8 km) radius of the NMP3NPP site and Figure 2.4-35 is a map illustrating the area within a 25-mi (40 km) radius of the site (USGS, 1985c; USGS, 1985d). The section describes the regional and local groundwater resources that could be affected by the construction and operation of NMP3NPP and the physical and hydrologic characteristics of these groundwater resources. These basic data can then be used for an evaluation of potential impacts of NMP3NPP operations on the aquifers of the area.

2.4.12.1.1 Hydrogeologic Setting

The site is within Section 12, New England and New York, of the USGS Ground Water Atlas of the United States (USGS, 1995). The physiographic province in which the site is located is shown on Figure 2.4-33. The site is located in Oswego County, NY and the county lies within what the USGS Ground Water Atlas refers to broadly as the Eastern Lake Section of the Central Lowland and the Mohawk Section of the Appalachian Plateau Physiographic Provinces. The physiographic province in which the NMP3NPP site is located is also referred to as (variously): the Erie-Ontario Plain (USGS, 1982a), the Ontario Lowlands (NYGS, 2000) and the Lake Ontario Plain (USGS, 2002a) (Figure 2.4-36).

The site is approximately 35 miles (56 km) north-northwest of Syracuse, NY. The 5-mile (8 km) site radius encompasses only Oswego County; however, the 25-mile (40 km) radius also includes small portions of Jefferson, Onondaga, Cayuga, and Wayne Counties (Figure 2.4-35). The NMPNS site is 921 acres (373 hectares). The NMP3NPP site is bounded to the north by Lake Ontario, to the east by NMP Unit 1 and Unit 2, to the south by Lake Road and by Constellation property south of Lake Road, and to the west by private property.

Ground elevations in Oswego County range from approximately 250 ft (76 m) above msl at Lake Ontario to greater than 1,700 ft (518 m) msl on the Tug Hill Plateau (CNYRP, 1979). The local site topography is fairly flat, ranging from approximately El. 280 ft (85.4 m) msl (on the south) to El. 260 feet (79.2 m) msl (on the north). At the lake shore there is a small bluff that drops from the site to lake level of approximately El. 245 feet (74.7 m) msl (as measured at NOAA Station 9052030 in Oswego New York, which is approximately 8 nautical miles (15 km) west-southwest of the site).

The NMP3NPP site lies in the Erie-Ontario Plain and the Tug Hill Plateau portion of the Appalachian Plateau (USGS, 1982a; USGS, 1982b). The Erie-Ontario Plain is a relatively low and flat area that borders Lake Erie and Lake Ontario on the south and extends up to the Tug Hill Plateau, an outlier of the Appalachian Plateau (USGS, 1995; SUNY, 1976). The general surface topography rises eastward and southward from Lake Erie and from Lake Ontario to about 1,000 to 1,500 ft (305 to 457 m) msl along the Allegheny Plateau, which forms the boundary with the Appalachian Uplands to the south (USGS, 1988a; USGS, 1989). The Tug Hill Plateau is an isolated upland located on the eastern part of the Erie-Ontario Lowlands (Figure 2.4-36). The Tug Hill Aquifer is an approximately north-south trending ridge of glacial drift materials at the base of the western edge of the Tug Hill Plateau (USGS, 2007). The Tug Hill Aquifer is the only Sole Source Aquifer in the region (USEPA, 2008). The Tug Hill Aquifer is upgradient of the NMP3NPP site and is not hydrologically connected to the site.

2.4.12.1.2 Regional Hydrogeologic Description

In general, the geologic formations of hydrogeologic importance in the region are either recent unconsolidated Pleistocene glacial deposits, or certain bedrock formations of Paleozoic age, specifically the Middle to Lower Silurian and Upper Ordovician (USGS, 1995; USGS, 1988a). Figure 2.4-37 illustrates the major groundwater sources in New England and New York from the unconsolidated deposits. For purposes of water resource description, the bedrock formations in the region are divided into three units:

- The lower siltstone and shale of the Whetstone Gulf formation,
- The interbedded shale-siltstone- sandstone of the Pulaski Formation, and
- The Oswego Sandstone.

A stratigraphic column for the NMP3NPP site, identifying geologic units and confining units at the site is illustrated in Figure 2.4-38.

The unconsolidated Pleistocene deposits of the region are the most important units with respect to groundwater resources, in particular the Tug Hill Aquifer (USGS, 1993; NYWRC, 1970). Depending on their location and composition, their water-bearing characteristics may vary substantially, with the stratified drift deposits serving as the most productive aquifers (USGS, 1995). None are present within 5 mi. (8 km) of the site and any such deposits are upgradient of the site.

In general, the regional groundwater piezometric surfaces in both the bedrock formations and in the Pleistocene deposits slope northward toward Lake Ontario, their natural discharge area USGS, 2002b; USGS, 1993). Groundwater recharge areas and topography may affect localized groundwater movement and may affect, to some extent, the direction of aquifer flow. Investigations performed during the NMP3NPP site characterization studies indicate that a hydraulic connection exists between the unconsolidated deposits and the upper fractured bedrock formations, however the presence of perched water above competent bedrock indicates the connection is limited.

A conceptual cross-section, illustrating flow through both unconsolidated and bedrock aquifers is presented on Figure 2.4-39 (USGS, 2002a). This figure illustrates the relationship between overburden, shallow (fractured) bedrock and deeper bedrock. In the Tug Hill Plateau, recharge is relative rapid and groundwater does not typically recharge to bedrock. As one moves down-slope, off the plateau, the overburden can penetrate shallow fractured bedrock, but does not typically recharge deeper bedrock rock before discharging to Lake Ontario (USGS, 2002a).

2.4.12.1.2.1 Pleistocene Glacial Deposits

The region is underlain by unconsolidated deposits of stratified sands, gravel, and glacial till, varying in thickness from approximately 10 ft (3.04 m) thick to up to 150 ft (45.7 m) (USGS, 1982a; USGS, 1982c; OCWA, 1967).

Glacial till deposits are composed of relatively impervious sand, gravel, and silt and clay mixtures. Till deposits cover most of the upland, a large part of the lowland south of Lake Ontario (the Ontario Lowland Province), and underlie other unconsolidated deposits in much of the region. Thickness of the till varies from 30 to 40 ft (9.1 m to 12.2 m) to as much as 200 ft (60.8 m) (USGS, 1982a; USGS, 1982b; USGS, 1982c). Generally, tills are not suitable for adequate groundwater yield due to their relatively low hydraulic conductivity values, estimated at 7×10^{-2} to 1.4 ft/day (3×10^{-5} to 6×10^{-4} cm/sec) for tills at the NMP3NPP site, with well yields of 0.25 to 1 gpm (0.95 to 3.79 l/min) (USGS, 1982a; USGS, 1982b; USGS, 1982c, USGS, 1988b). Lake sediments of sand, silt and clay are of highly variable hydraulic conductivity. Wells at locations where larger amounts of well-sorted fine sand may have well yields of up to 50 gpm (189 l/min), while lake-related silts and clays are highly impermeable (USGS, 1982a; USGS, 1982b; USGS, 1982c, USGS, 1988b).

With respect to groundwater, two types of stratified drift deposits generally serve as good groundwater sources in the region: outwash sediments, deposited by melt waters of the ice front, and ice contact deposits (eskers and kame terraces), formed by running water at the contact of ice and valley walls. Both types of deposits are found with limited extent throughout the region (USGS, 1982a; USGS, 1982b; USGS, 1982c); however they are not identified within 5 mi. (8 km) of the site.

The glacial outwash deposits (sands and gravels) are the major water-bearing sources in the region (USGS, 1995). Several areas of the region contain considerable quantities of this sand and gravel. These deposits are generally well sorted and have a high porosity, between 20 and 30%, while some localized deposit areas may have porosity as high as 40% (USGS, 1993). Well yields of up to 800 gpm (3 m^3/day/m) can be obtained from wells installed in the sand and gravel deposits with a saturated thickness of 15 to 200 feet (4.6 to 60.8 m) (USGS, 1982c). Representative transmissivity values for these wells range from 60,000 to 100,000 gpd/ft (745 to 1,240 m^3/day/m), as recorded at a fish hatchery at Altmar, Oswego County, New York (USGS, 1982c).

Transmissivity values of the outwash deposits in the region range from about 30,000 to 800,000 gpd/ft (375 to 9,935 m^3/day/m) (USGS, 1982a; USGS, 1982c, USGS, 1988a). Fine sand aquifers have transmissivity values ranging from 1,000 to 10,500 gpd/ft (12 to 130 m^3/day/m) (USGS, 1982a; USGS, 1982b; USGS, 1982c). 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 10,000 to 50,000 gpd/ft (125 to 620 m^3/day/m) (USGS, 1995). The generally finer-grained sand and gravel in the mixed deposits in the Tug Hill Upland probably have transmissivity values up to as much as 30,000 gpd/ft (375 m^3/day/m) (USGS, 1982c; USGS, 1989). Specific capacities of wells installed in sand and gravel in the Oswego River basin, approximately 10 mi (16 km) range from about 2 to in excess of 500 gpm/ft (0.4 to in excess of 103 l/sec/m) of drawdown (NMPC, 1998).

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 (Figure 2.4-39) (USGS, 2002a). Groundwater moves from areas of recharge (higher hydraulic head) to areas of discharge (lower hydraulic head). Regional discharge, both via surface water flow and in the unconsolidated glacial deposits, is toward Lake Ontario (USGS, 2002a; USGS 2002b).

On a yearly basis in portions of the central New York, 25% of the precipitation falling on the unconsolidated sand and gravel deposits is estimated to be able to infiltrate into the groundwater system (NYWRC, 1970; USGS, 1989). This amount of infiltration is equivalent to a recharge rate of up to 1.65 Mgpd/mi^2 (2400 m^3/day/sq km) the Tug Hill Aquifer (USGS, 1989). Recharge rates of 0.5 Mgpd/mi^2 (730 m^3/day/sq km) have been estimated in the other overburden aquifers of the region, where infiltration is estimated at 25% (NMP Unit 2 USAR, 1998).

Relict sand and gravel deposits located beneath less permeable deposits such as glacial till cannot receive direct recharge from precipitation, runoff, or induced streamflow infiltration (USGS, 1989). These ground water sources must be recharged by adjacent unconsolidated deposits or adjacent saturated bedrock formations.

Water levels in regional 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 (USGS, 1995; USGS, 2002b). 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 (USGS, 1981). Because lake levels are controlled by a system of locks on the St. Lawrence River, only minor variations in regional groundwater levels occur due to lake level change (USGS, 2002b).

2.4.12.1.2.2 Paleozoic Bedrock Formations

Oswego County and the surrounding region are underlain by several types of water-bearing sedimentary bedrock of Late Ordovician-Early Silurian ages (SUNY, 1976; NYGS, 2000). These Paleozoic formations can generally be divided into three hydrogeologic units in the region: 1) lower shales, sandstones (Lorraine Group), 2) sandstone (Oswego Formation) and 3) upper shales (Median and Clinton Groups) (NYGS, 2000). These bedrock units crop out at the surface as bands that trend predominantly east-west across the region with bedding inclined toward the south at a regional dip of approximately 50 ft/mi (9.5 m/km) (USGS, 1982c). Generally, within the region, the bedrock units are suitable groundwater sources only within their outcrop band. The yields of the deeper buried units are often low and the rocks usually contain highly mineralized water (USGS, 1982c). 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 (USGS, 1982b).

2.4.12.1.2.3 Lorraine Group: Whetstone Gulf and Pulaski Formations

The Lorraine Group is a fossiliferous sequence of alternating black siltstone and shale, gray sandstone, and dark-gray argillaceous sandstone (NYGS, 2000). It underlies the northern portion of Oswego County and is reported to have an average regional thickness of approximately 800 ft (245 m) (NMPC, 1998). Generally, groundwater in this formation occurs along joints and plains of bedding. Average groundwater yields are approximately 3 gpm (0.2 l/sec) (NMPC, 1998).

The Lorraine Group sequence comprises two intergrading rock units, namely, the Pulaski and the Whetstone Gulf Formations (Figure 2.4-38). No major change in lithology occurs throughout this sequence except for a gradual upward increase in arenaceous material and bedding thickness and a change in fossil composition, from graptolites and trilobites in the Whetstone Gulf Formation to clams and brachiopods in the Pulaski Formation (NYGS, 2000).

The Pulaski Formation may be subdivided into three units at the site based on prior site investigations (NMPC, 1998). These divisions were used for the investigations done for NMP3NPP as cited in Section 2.5.1.2.3. The uppermost unit consists of a dark gray greywacke 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.

The Whetstone Gulf Formation may be subdivided into two units at the site. The formation generally consists of well-bedded dark gray shale, siltstone, and light gray sandstone (NYGS, 2000). The uppermost unit consists of shale with occasional sandstone beds. The lowermost unit consists of shale with interbedded sandstone. Limited data are available on wells installed in the lower shales. These shales and sandstones are reported to have a median yield of 3 gpm (0.2 l/sec) or a low of 1 gpm (0.06 l/sec) and a high yield of 5 gpm (0.3 l/sec) (NMPC, 1998).

2.4.12.1.2.4 Oswego Sandstone

The Oswego Sandstone is composed of non-fossiliferous, greenish-gray, medium- to fine-grained, massive sandstone. The Oswego Sandstone and the lower Clinton Group sandstone and shale occupy the middle and southern parts of Oswego County. The average regional thickness of the Oswego Sandstone is approximately 100 ft (30.4 m) (NYGS, 2000). Groundwater in this formation occurs generally in joints and bedding planes, and possibly in very small amounts in intergranular pore spaces. Wells installed in the Oswego Sandstone yield an average of 10 gpm (37.8 l/m); however, yields of as much as 35 gpm (132.5 l/m) have been reported (USGS, 1995; USGS, 1982b). However, given the lower hydraulic conductivities of the Oswego measured at the NMP3NPP site, we would expect well yields to be lower there.

2.4.12.1.2.4.1 Medina Group and Clinton Group

The Medina Group/Queenston Formation and the Clinton Group are located at the surface in the western and southern portions of the NMP3NPP regional study area, although not at the site. The Medina/Queenston consists of red shale, siltstone and sandstone and averages between 70 to 980 ft (21 to 300 m) in thickness (NYGS, 2000; USGS, 1982b).

The Clinton Group consists of a broad suite of rocks, including limestone, dolostone, shale, sandstone, and conglomerate and is up to 245 ft (74.5 m) thick (NYGS, 2000). The portion of the Clinton Group exposed in Oswego County consists of green-gray sandstone and siltstone alternating with shale (NYGS, 2000). The red and green-gray shales and sandstones of the Medina and Clinton Groups yield an average supply of 3 gpm (0.2 l/sec), with a low of 1 gpm (0.06 l/sec), and a high of 28 gpm (1.8 l/sec) (NMPC, 1998).

2.4.12.1.2.4.2 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 (USGS, 2002a; USGS, 2007). 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 (NYWRC, 1970; USGS, 1981). During this recharge season, approximately 30% of the total precipitation results in runoff, as much as 10% is lost through evapotranspiration from the land surface and approximately 60% of the total can be left to recharge the formations. Of this 60%, 10% remains as soil moisture and so 50% replenishes the groundwater aquifer (NYWRC, 1970). During the non-recharge season, May through October, evaporation increases and only approximately 40% of the total precipitation is available to seep into the soil zone, where the majority is eventually evaporated or transpired (NYWRC, 1970; USGS, 1989). Thus, little to no groundwater recharge occurs during the warm part of the year.

2.4.12.2 Sources

2.4.12.2.1 Site-Specific Hydrogeology: Surface Water

The significant surface water body at the NMP3NPP site is Lake Ontario. Surface water and groundwater in the NMP3NPP site area flow towards the lake, with some minor seasonal drainage across the northern part of the site from northeast to southwest due to natural pre-construction grading. Surface water and groundwater flow across the site towards or to the lake. Some surface water collects in pools, which make up the local wetlands. During the current investigation, the lake level has ranged from approximately El. 243 to 247 ft (74.1 to 75.2 m) (msl, as measured by NOAA Station ID 9052030 in Oswego, NY, which is approximately 8 miles (13 km) west of the NMP3NPP site). Low lake levels were recorded in late summer and high lake levels were recorded in spring, as would be expected, considering the spring runoff. Groundwater elevations in Oswego County show a similar trend of low levels in late summer and high levels in spring (USGS, 2008). Groundwater discharges to Lake Ontario.

2.4.12.2.2 Site-Specific Hydrogeology: Groundwater in Soils

A Site Plan, presenting the overall layout of the facility, is presented on Figure 2.4-41. The soil borings and monitoring wells installed as part of the site investigation are presented on Figure 2.4-42 to Figure 2.4-45. Installation details are further described in Section 2.5.4.2.

Table 2.4-15 and Table 2.4-16 are summaries of the onshore (100, 200, and 300 series) and offshore (400 series) soil borings advanced for the subsurface investigation. Table 2.4-17 is a summary of the soil boring and monitoring well construction details. This information is used in the following discussions.

Glacial till and miscellaneous fill were the two soil types encountered during drilling, with the latter limited in volume and distribution. During wet seasons, the glacial till holds some water which supports the wooded wetlands on site, but during dry seasons the glacial till may hold very little water and can be completely dry. Fill was encountered during drilling in the lower (southerly) ball field on the site (see Section 2.5.1.2, Site Geology). The fill is significantly more permeable than the glacial till. On the Lake Ontario shoreline, groundwater seeps are observable at the site within and near the base of the glacial till as it overlies the Oswego Sandstone bedrock.

Measured values of hydraulic conductivity in the glacial till ranged from 8.6×10^{-2} to 1.6 ft/day (3×10^{-5} to 6×10^{-4} cm/sec). Surface percolation tests indicated an average vertical hydraulic conductivity of 2.8×10^{-2} ft/day (1×10^{-5} cm/sec) (NMPC, 1998). Figure 2.4-46 is an illustration of measured hydraulic conductivities in several of the onshore boreholes across the NMP3NPP site and Figure 2.4-47 is an illustration of the measured hydraulic conductivites in several offshore borings in the bedrock. The primary porosity of the glacial till is low, on the order of 5 to 15% (NMPC, 1998). The heterogeneity of the till at the site, as determined by the permeability tests conducted as part of the NMP Unit 2 investigation, precluded assigning a representative value.

Table 2.4-18 is a summary of the monitoring well elevation data collected at the NMP3NPP site through August 2008. The data points used for water level contouring were the March 2008 groundwater level measurement readings. These data are considered the most representative collected through August 2008. Groundwater elevations measured from September through February 2008 indicated many wells had not reached equilibrium due to the low permeability bedrock and that some wells were disturbed due to quarterly purging and sampling. Groundwater elevations collected during April and May 2008 were also disturbed by quarterly purging and sampling. Groundwater elevations from March 2008 are higher than those measured during previous months, as would be expected due to equilibrium of the wells over time and due to spring months recharge. Elevations measured during June, July, and August 2008 show groundwater elevations patterns similar to those observed in March, but at slightly lower elevations.

Groundwater elevations measured in five overburden groundwater monitoring wells at the site during March 2008 ranged from El. 262.4 to El. 282.2 ft (80.0 to 86.0 m). The high reading of El. 282.2 ft (86.0 m) was measured in B122 (MW), which is located in the center of the lower ball field, just to the south of the proposed reactor building (Figure 2.4-49). Groundwater level data from B124 (MW) was considered an outlier and was not used in developing the March contours. This may represent a seasonal mounding of groundwater due to higher hydraulic conductivities and infiltration rates in the fill. Contours of the approximate groundwater surface indicate an overall northwesterly groundwater flow direction in the Oswego Sandstone toward Lake Ontario (Figure 2.4-48).

Professional engineering judgment was used to select representative horizontal permeabilities from rising head tests and water pressure test results for the glacial till. Using a representative horizontal gradient of 0.022, a representative horizontal permeability of 021, estimated from the March 2008 groundwater contour map, a hydraulic conductivity of 2.9×10^{-1} ft/day (1×10^{-4} cm/sec), and an estimated effective porosity of 5%, an approximate horizontal velocity of 1.3×10^{-1} ft/day (4.4×10^{-5} cm/sec) was calculated for the glacial till. A groundwater travel time of approximately 29.7 years was calculated using the seepage velocity and a distance of 1,300 feet (400 m) from the center of the NMP3NPP power block to the nearest point on the shore of Lake Ontario (NMPC, 1998).

2.4.12.2.3 Site-Specific Hydrogeology: Bedrock Groundwater

The following sections discuss the details of the local bedrock conditions. Figure 2.4-50 to Figure 2.4-56 are subsurface profiles prepared across the NMP3NPP site investigation area, including offshore locations. They illustrate soil and bedrock conditions across the NMP3NPP site.

Most of the bedrock drilled consisted of medium- to fine-grained sandstone, siltstone, and argillite with very little porosity and low intrinsic permeability. Therefore, wells were screened based on zones of fracture density, hydraulic conductivities calculated from pressure testing, and the data interpretation that stratigraphy influenced fracturing and hydraulic conductivity.

2.4.12.2.3.1 Oswego Sandstone

The Oswego Sandstone at the NMP3NPP site ranged in thickness from 29 to 79 ft (8.8 to 24 m) with typical thicknesses of about 45 to 60 ft (13.7 to 18.2 m). The Oswego Sandstone consists of hard, fresh to slightly weathered, non-fossiliferous, greenish-gray, fine to medium grained, massive to cross-bedded sandstone. Thin dark gray siltstone and shale beds were minor and siltstone clasts were common. The sandstone was typically composed of subangular to subrounded quartz grains, sometimes with well-rounded lithic fragments, feldspar crystals, and a clay matrix. As noted in the Field Logs, near vertical fractures were encountered in the Oswego Sandstone. These fractures are most likely associated with regional jointing patterns (Stillwell, 2005). The dominant regional joint orientations strike north-northwest and east-northeast and fractures in these orientations are visible in bedrock exposures at NMP3NPP and NMP Unit 2 (NMPC, 1998). Spacing between the parallel joints is on the order of a few feet to tens of feet (few meters to tens of meters). The fractures are approximately 5 ft (1.5 m) to 100 ft (30 m) long, are significant above the Oswego Transition Zone, but are less common in the shale units. Figure 2.4-57 is a conceptual cross-section illustrating overall hydraulic conductivities across the major units at the NMP3NPP site.

The lower portion of the Oswego Sandstone has been informally designated as the Oswego Transition Zone (NMPC, 1998) and this nomenclature is used for the NMP3NPP site investigation. This sub-unit was found to range from 9 to 60 ft (2.7 to 18.2 m) thick in the borings with typical thicknesses of 15 to 30 feet (4.6 to 9.12 m). The Oswego Transition Zone consists of medium hard to hard, slightly weathered to fresh, alternating, laminated to thickly bedded, fine to medium-grained sandstone, argillaceous sandstone, and siltstone. Trace fossils are present. There is a general trend toward bed thinning and increasing clay content, downward through the sub-unit. A 3- to 12-inch (8 to 30 cm) thick shale bed was typically noted as a marker bed near the base of the Oswego Transition Zone. Figure 2.4-58 is a contour map of the top of the Oswego Sandstone across the NMP3NPP site.

Twelve groundwater monitoring wells were screened predominantly in the Oswego Sandstone. Four of the twelve wells (B105 (MW), B107 (MW), B113 (MW), and B115 (MW) are very slow to equilibrate. The water levels in these four wells rose from the Fall of 2007 through 2008, and the March 2008 levels are not representative of the static groundwater conditions for the massive zones of the Oswego Sandstone.

The data points used for water level contouring were the March 2008 groundwater level measurement readings. These data are considered the most representative collected through

August 2008. Groundwater elevations measured from September through February 2008 indicated many wells had not reached equilibrium due to the low permeability bedrock and that some wells were disturbed due to quarterly purging and sampling. Groundwater elevations collected during April and May 2008 were also disturbed by quarterly purging and sampling. Groundwater elevations from March 2008 are higher than those measured during previous months, as would be expected due to equilibrium of the wells over time and due to spring months recharge. Elevations measured during June 2008 show groundwater elevations patterns similar to those observed in March, but at slightly lower elevations while elevations measured in July and August 2008 varied, both months data were higher and lower than March 2008 values and may have been affected by the June 2008 sampling round.

Groundwater elevations measured in March 2008 in the remaining eight wells installed in the Oswego Sandstone ranged from El. 253.2 ft. (77.1 m) to the north near Lake Ontario to El. 281 ft. (85.6 m) to the south near the old Strike Road. Groundwater elevations in the Oswego Sandstone in the NMP3NPP nuclear island area ranged from about El. 265 ft. (80.8 m) to about El. 255 ft. (77.7 m) moving south to north (Figure 2.4-59; Figure 2.4-60).

Intrinsic permeability of the bedrock was measured in place using variable head tests and pressure tests with packers in boreholes. The results of in-situ permeability tests for the Oswego Sandstone indicated horizontal hydraulic conductivity in the range from <2.9×10^{-3} ft/day to 2.2 ft/day (<1×10^{-6} cm/sec to 8×10^{-4} cm/sec) with a typical value of about 2.9×10^{-2} ft/day (1×10^{-5} cm/sec) (Figure 2.4-46). Table 2.4-19 presents the minimum, maximum, maximum mean, and geometric mean of the hydraulic conductivities in the onshore borings measured during the geotechnical investigation at the NMP3NPP site. Table 2.4-20 presents the minimum, maximum, mean, and geometric mean of the offshore boring hydraulic conductivity. Previous work at NMP Unit 2 calculated average hydraulic conductivities of 2.9×10^{-2} to 5.8×10^{-1} ft/day (1×10^{-5} to 2×10^{-4}) for bedrock (NMPC, 1998).

The primary porosity of the Oswego Sandstone has been calculated to range between 2.2 and 5.6% (NMPC, 1998). The Oswego Transition Zone had a slightly higher porosity (6.6 %). Those results fall within a range of 0.5 and 10% for effective porosities of sandstones (Domenico, 1990).

Contours of March 2008 groundwater elevations (Table 2.4-18), indicate an overall northwesterly groundwater flow direction in the Oswego Sandstone toward Lake Ontario, consistent with ground surface topography (Figure 2.4-61).

Professional engineering judgment was used to select representative horizontal permeabilities from rising head tests and water pressure test results for the Oswego Sandstone. Using a representative horizontal gradient of 0.013, a representative horizontal permeability of 2.9×10^{-2} ft/day (1×10^{-5} cm/sec), and an estimated effective porosity of 3%, an approximate horizontal velocity of 1.2×10^{-2} ft/day (4.3×10^{-6} cm/sec) was calculated for the Oswego Sandstone. A groundwater travel time of approximately 296.6 years was calculated using the seepage velocity and a distance of 1,300 ft (400 m) from the center of the NMP3NPP power block to the nearest point on the shore of Lake Ontario.

2.4.12.2.3.2 Pulaski Formation

The Pulaski Formation averaged approximately 100 ft (30.5 m) thick in NMP3NPP site characterization borings. The Pulaski Formation was informally subdivided into Units A, B, and C during the investigation for NMP Unit 2 (NMPC, 1998) and for the NMP3NPP site characterization studies. Each unit was typically in the range of 20 to 35 ft (6 to 10.6 m) thick at the NM3NPP site. All three units consisted of interbedded sandstone, siltstone, and shale.

Lithologic contacts are gradational and the relative amount of siltstone and shale increased in the lower portions of the Pulaski Formation. All three units contained marine fossil shell debris. Figure 2.4-62 is a contour map of the top of the Pulaski Formation.

Unit A is the uppermost unit and consisted of slightly weathered, medium hard, dark gray argillaceous sandstone interbedded with light gray sandstone and a few beds of dark gray shale and siltstone. Unit A had abundant marine fossil debris and disturbed bedding layers indicating soft sediment deformation. A distinctive 1/2-inch to 2-inch (1.3 to 5.1 cm) thick green layer of smectite and chlorite was noted near the base of Unit A or near the top of Unit B as a marker bed in many of the borings.

Unit B consisted of slightly weathered, medium hard, interbedded light gray sandstone, dark gray siltstone, and shale. Unit B had relatively more sandstone than Unit A and relatively less fossil debris than Unit A.

Natural gas was encountered during the subsurface investigation in at least 17 site borings. In general, gas was detected by either visual observations of drill water bubbling or being forced out of the drill casing under pressure or by measurement with a hand held gas multi-meter. Gas was typically encountered between El. 150 and 118 ft (45.7 and 36.0 m), which corresponds to the elevation range of the Pulaski Formation, Unit B. The trapped natural gas in Unit B of the Pulaski Formation indicates that the Unit B is a confined aquifer and that the overlying Unit A of the Pulaski Formation is a confining layer. The NMP Unit 2 USAR also concludes that Unit B is a confined unit (NMPC, 1998).

Unit C consisted of slightly weathered, medium hard dark gray siltstone and shale, interbedded with light gray sandstone. Unit C was darker and had more siltstone and shale than Units A and B. Unit C of the Pulaski Formation had the lowest average calculated value of primary porosity (3%).

Twelve groundwater monitoring wells were screened in the Pulaski Formation at the site. Table 2.4-15 and Table 2.4-16 are summaries of borings and wells installed as part of the NMP3NPP geotechnical investigation. Groundwater elevations measured in March 2008 in these wells ranged from El. 239.7 ft. (73.1 m) near the center of the site to El. 271.5 ft. (82.8 m) to the south near the existing firing range. Groundwater elevations in the Pulaski in the plant area ranged from El. 239.7 ft (73.1 m) to El. 253.0 ft. (77.1 m) (Figure 2.4-63).

The Pulaski Formation was subdivided into units A, B, and C, where A and C were classified as aquitards that significantly inhibited hydraulic communication with the Oswego Formation above and the Whetstone Gulf Formation below. If a well was screened across units A and B, or B and C, the screen was effectively sampling the more permeable and conductive unit B, and was deemed representative of the Pulaski Formation. Likewise, a well screen crossing Pulaski C and Whetstone Gulf effectively sampled the Whetstone Gulf Formation.

These hydrogeologic regimes are similar to those encountered at NMP Unit 2, and using the above criteria, produce reasonably consistent flow patterns.

Intrinsic permeability of the bedrock was measured in-place using variable head tests and using water pressure tests with packers (Figure 2.4-46). The results of in-situ intrinsic permeability tests in Units A and B indicated horizontal hydraulic conductivities in the range from $<2.8 \times 10^{-3}$ ft/day to 5.7×10^{-1} ft/day ($<1 \times 10^{-6}$ cm/sec to 2×10^{-4} cm/sec) with a typical value of about 2.8×10^{-2} ft/day (1×10^{-5} cm/sec). The results of in-situ intrinsic permeability tests in Unit C indicated horizontal hydraulic conductivity in the range from $<2.8 \times 10^{-3}$ ft/day to

2.0×10^{-1} ft/day (<1 x 10^{-6} cm/sec. to 7 x 10^{-5} cm/sec) with a typical value of about 2.9×10^{-3} ft/day (1 x 10^{-6} cm/sec).

Calculated primary porosities for all Pulaski units ranged between 2.2 and 7.6% (NMPC, 1998). Representative effective porosities for shales range between 0.5 and 5% (Domenico, 1990).

The data points used for water level contouring were the March 2008 groundwater level measurement readings. These data are considered the most representative collected through June 2008. Groundwater elevations measured from September through February 2008 indicated many wells had not reached equilibrium due to the low permeability bedrock and that some wells were disturbed due to quarterly purging and sampling. Groundwater elevations collected during April and May 2008 were also disturbed by quarterly purging and sampling. Groundwater elevations from March 2008 are higher than those measured during previous months, as would be expected due to equilibrium of the wells over time and due to spring months recharge. Elevations measured during June 2008 show groundwater elevations patterns similar to those observed in March, but at slightly lower elevations. Elevation measurements made in July 2008 and August 2008 were generally lower than those in March2008 and appear to have been affected by the June 2008 groundwater sampling round.

Contours of March 2008 groundwater elevations indicate an overall northerly groundwater flow direction in the Pulaski Formation toward NMP Unit 1 and Unit 2 and Lake Ontario, consistent with ground surface topography (Figure 2.4-64).

Professional engineering judgment was used to select representative horizontal permeabilities from rising head tests and water pressure test results for the Pulaski Formation. Using a representative horizontal gradient estimated from the March 2008 groundwater contour map, of 0.016, a representative horizontal permeability of 2.8×10^{-3} ft/day (1 x 10^{-6} cm/sec), and an estimated effective porosity of 4%, an approximate horizontal velocity of 1.1×10^{-3} (4.0×10^{-7} cm/sec) was calculated for the Pulaski Formation. A groundwater travel time of approximately 3,559.3 years was calculated using the seepage velocity and a distance of 1,300 ft (400 m) from the center of the NMP3NPP power block to the nearest point on the shore of Lake Ontario.

2.4.12.2.3.3 Whetstone Gulf Formation

The Whetstone Gulf Formation is estimated to be approximately 770 ft (234 m) thick at the NMP3NPP site. Seventeen of the NMP3NPP site characterization borings extended into the Whetstone Gulf Formation. The deepest boring (B101) extended to a depth of 255 feet (77.7 m), which penetrated 73 feet (22.3 m) into the Whetstone Gulf Formation.

The top of the Whetstone Gulf Formation is lithologically very similar to the Pulaski C. The differentiation among the formations is made in the literature based on the types of fossils in the rock. There are also more sandstone units in the Whetstone Gulf relative to the Pulaski C.

The Whetstone Gulf Formation was informally subdivided into Units A and B during the investigation for NMP Unit 2 (NMPC, 1998). The upper unit (Unit A) consisted of dark gray siltstone and shale with occasional light gray sandstone beds.

The lower unit (Unit B) consisted of siltstone and shale interbedded with sandstone. Sandstone interbeds became more common in Unit B. One boring for Unit 3 (B102) penetrated through Unit A into the top of Unit B. In B102, Unit A was observed to be 60 ft (18.2 m) thick.

Nine groundwater monitoring wells were screened in the Whetstone Gulf Formation at the site (Table 2.4-18 and Table 2.4-21). Three of the nine wells (B106 (MW), B110 (MW), and B216

(MW)) are very slow to equilibrate and it is unlikely that the March 2008 levels are yet representative of the static groundwater conditions in the Whetstone Gulf Formation. Groundwater elevations measured in the remaining six wells installed in the Whetstone Gulf Formation ranged from El. 233.6 ft. (71.2 m) to the north near Lake Ontario to El. 284.7 ft. (86.8 m) to the south near the old Strike Road. Groundwater elevations in the Whetstone Gulf Formation in the plant area ranged from about El. 240 ft (73.2 m) to about El. 270 ft (82.3 m) (Figure 2.4-65). The relatively high groundwater elevations in the Whetstone Gulf Formation indicate that it is a confined aquifer and that the overlying Unit C of the Pulaski Formation is a confining unit. The NMP Unit 2 USAR also concludes that the Whetstone Gulf Formation is a confined unit (NMPC, 1998).

These hydrogeologic regimes are similar to those encountered at NMP Unit 2, and using the above criteria, produce reasonably consistent flow patterns.

Intrinsic permeability of the bedrock was measured in-place using variable head tests and using water pressure tests using packers in boreholes (Figure 2.4-46). The results of in-situ intrinsic permeability tests in the Whetstone Gulf Formation indicate horizontal hydraulic conductivities in the range from $<2.9 \times 10^{-3}$ ft/day to 5.8×10^{-3} ft/day ($<1 \times 10^{-6}$ cm/sec to 2×10^{-5} cm/sec) with a typical value of about 2.9×10^{-3} ft/day (1×10^{-6} cm/sec). Representative effective porosities for shales range between 0.5 and 5% (Domenico, 1990), consistent with these site data.

The data points to for water level contouring used were the March 2008 groundwater level measurement readings. These data are considered the most representative collected through June 2008. Groundwater elevations measured from September through February 2008 indicated many wells had not reached equilibrium due to the low permeability bedrock and that some wells were disturbed due to quarterly purging and sampling. Groundwater elevations collected during April and May 2008 were also disturbed by quarterly purging and sampling. Groundwater elevations from March 2008 are higher than those measured during previous months, as would be expected due to equilibrium of the wells over time and due to spring recharge. Elevations measured during June 2008 show groundwater elevations patterns similar to those observed in March, but at slightly lower elevations. Elevation measurements made in July 2008 and August 2008 were generally lower than those in March 2008 and appear to have been affected by the June 2008 groundwater sampling round.

Contours of March 2008 groundwater elevations indicate an overall northerly groundwater flow direction in the Whetstone Gulf Formation toward NMP Unit 1 and Unit 2 and Lake Ontario, consistent with ground surface topography (Figure 2.4-65).

Professional engineering judgment was used to select representative horizontal permeabilities from rising head tests and water pressure test results for the Whetstone Gulf Formation. Using a representative horizontal gradient estimated from the March 2008 groundwater contour map, of 0.009, a representative horizontal permeability of 2.8×10^{-3} ft/day (1×10^{-6} cm/sec), and an estimated effective porosity of 4%, an approximate horizontal velocity of 6.5×10^{-4} ft/day (2.3×10^{-7} cm/sec) was calculated for the Whetstone Gulf Formation. A groundwater travel time of approximately 5,932 years was calculated using the seepage velocity and a distance of 1,300 ft (400 m) from the center of the NMP3NPP power block to the nearest point on the shore of Lake Ontario.

2.4.12.2.3.4 Vertical Groundwater Gradients

At twelve locations, groundwater monitoring wells were installed in two separate boreholes drilled within 10 feet (3 m) of each other (couplets). The monitoring well couplets were installed with their screened intervals in different rock formations (Table 2.4-21). At six couplet locations the monitoring wells were screened in the Oswego Sandstone and the Pulaski Formation and at the remaining six locations the wells were screened in the Oswego Sandstone and Whetstone Gulf Formation.

Groundwater level measurements in one of the wells (B115 (MW) installed as part of a couplet screened in the Oswego Sandstone and Pulaski Formation is very slow to equilibrate and the March 2008 levels are not representative of the static groundwater conditions. The groundwater levels observed at the five other Oswego/Pulaski couplet locations indicated that the groundwater level in the Oswego Sandstone is higher than the groundwater level in the Pulaski Formation. Table 2.4-18 contains groundwater level measurements across the NMP3NPP site. The difference in groundwater levels measured in corresponding couplet wells ranged from 5.5 feet to 25.8 feet (1.7 to 7.9 m). The average difference in water levels measured at the five Oswego/Pulaski couplet locations was 11.7 feet (3.6 m). These observations suggest a downward vertical hydraulic gradient from the Oswego Sandstone to the Pulaski Formation.

Groundwater level measurements in wells installed as part of four of the couplets screened in the Oswego Sandstone and Whetstone Gulf Formation are very slow to equilibrate and the March 2008 levels are not representative of static groundwater conditions. At one location near the southern edge of the plant footprint (B112 (MW)/B113 (MW)) the groundwater level measured in the well screened in the Oswego Sandstone was 6.2 feet (1.8 m) above the groundwater level measured in the well screened in the Whetstone Gulf Formation. At the second couplet location on the very southern end of the site (B118 (MW)/B119 (MW)) the groundwater level measured in the well screened in the Oswego Sandstone was 3.7 feet (1.1 m) below the groundwater level measured in the well screened in the Whetstone Gulf Formation (Table 2.4-18).

Vertical gradients have been calculated between the Oswego Sandstone and Pulaski Formation at five monitoring well pairs at the NMP3NPP site. These data were averaged to obtain the overall site vertical gradient of 0.14 in a downward direction from the Oswego to the Pulaski. The groundwater levels observed at the two remaining Oswego/Whetstone Gulf couplet locations are inconclusive. These observations suggest a possible local minor upward vertical hydraulic gradient from the Whetstone Gulf Formation to the Pulaski Formation.

2.4.12.2.3.5 Bedrock Groundwater Characteristics

Horizontal hydraulic conductivities are thought to be representative of the combined primary and secondary effective porosities. Primary effective porosities are thought to be low due to the fine-grained nature of the siltstone and shale. Secondary porosity is attributed the parallel, horizontal bedding fractures observed in the Pulaski and Whetstone Gulf Formations. Secondary porosity in the Oswego Sandstone is attributed to horizontal fractures and to vertical fractures observed in the shallow Oswego Sandstone. The orientations of vertical joint sets in the shallow Oswego Sandstone have been mapped elsewhere in Oswego County (Stillwell, 2005) as discussed in Section 2.5.1, Basic Beologic and Seismic Information.

Vertical hydraulic conductivities are assumed to be one-ninth of the horizontal hydraulic conductivities. This assumption is based on the dominant horizontal bedding and fracturing parallel to bedding observed in the Pulaski and Whetstone Gulf Formations.

Groundwater seeps observed at the Lake Ontario shoreline at and near the base of the glacial till overlying the Oswego Sandstone indicate that the soil/bedrock interface is also a groundwater migration pathway. The observation of more vertical fractures in the uppermost 20 ft (6.1 m) of the Oswego Sandstone, lower seismic velocities in the shallow Oswego

Sandstone, and the higher horizontal hydraulic conductivity presented for the Oswego Sandstone in the NMP Unit 2 USAR all suggest that the upper Oswego Sandstone is a groundwater migration pathway.

The lower horizontal hydraulic conductivity measured for Pulaski Formation Unit A and the confinement of natural gas beneath Unit A indicate that Pulaski Formation Unit A is a significant aquitard inhibiting vertical groundwater migration from the Oswego Formation to Pulaski Formation Unit B. This result agrees with the conclusions regarding local aquitards presented in the NMP Unit 2 USAR (NMPC, 1998).

2.4.12.2.3.6 Groundwater Quality

Yields from the regional bedrock aquifers are low and the groundwater is highly mineralized and of poor quality with elevated levels of iron, hydrogen sulfide, chlorides and hardness (USGS, 1995; USGS, 1982c; NYWRC, 1970). Shale units contain excessive amount of highly-soluble halite and gypsum and abundant limestone and dolomites add soluble minerals (calcium carbonate and magnesium carbonate) to groundwater. Dissolved solids in the first 50 to 100 ft (15.2 to 30.4 m) of the saturated zone range from 100 to 1,500 parts per million (NYWRC, 1970). Hardness in the water samples collected in the county ranged from 50 to 2,000 ppm. Thus the groundwater has a high sulfate, chloride and TDS content, is typically "hard" and is generally unsuited for drinking water (NYWRC, 1970).

Groundwater in the deeper bedrock formations, below the Oswego Formation, Pulaski and Whetstone Gulf Formations, usually occurs under artesian conditions due to lack of hydraulic interconnection between the overlying unconsolidated aquifers and the underlying bedrock units (NMPC, 1998). These results are consistent with reports of bedrock groundwater quality from other parts of Oswego County (USGS, 2002a).

2.4.12.2.3.7 Groundwater Use Projections

No use of groundwater resources is planned at the NMP3NPP site and no permanent dewatering system is provided for this plant. Therefore, there are no groundwater use projections.

2.4.12.3 Subsurface Pathways

2.4.12.3.1 Resources: Regional Groundwater Use

Along with Lake Ontario, groundwater is extensively used as a source of drinking water. Therefore, an objective of this section is to review U.S. Environmental Protection Agency (U.S. EPA) sole source aquifers within the region, to identify and determine impacts to these aquifers due to the construction and operation of NMP3NPP, and to describe the following: groundwater use in the area, current users in the study area, current groundwater use, and expected future groundwater demand for the study area.

2.4.12.3.2 Sole Source Aquifers

The Sole Source Aquifer (SSA) Program, which is authorized by the Safe Drinking Water Act, allows for protection when a community is dependent on a single source of drinking water and there is no possibility of a replacement water supply to be found. The U.S. EPA defines a sole or principal source aquifer as one which supplies at least 50% of the drinking water consumed in the area overlying the aquifer.

The Tug Hill Aquifer, northeast of the site and within the 25-mile (40 km) radius, is located in EPA Region 2 (New York). The Tug Hill Aquifer, located 20 mi. (33 km) east-northeast of the NMP3NPP site was designated a Sole-Source Aquifer by the U.S. EPA in 2006 (USEPA, 2008) (Figure 2.4-36). At its closest the Tug Hill Aquifer is located approximately 17 miles (28.9 km) east and upgradient of the NMP3NPP site. Based on the evaluation of both the regional and local hydrogeologic systems presented in Section 2.4.12.1.2 and Section 2.4.12.2, the construction and operation of NMP3NPP will not impact the Tug Hill Aquifer.

2.4.12.3.3 Groundwater Use In the Vicinity of NMP3NPP

Public groundwater supply data and locations of public groundwater supplies within 25 miles (40 km) of the NMP3NPP site are shown on Table 2.4-22. Selected public water supplies are shown on Figure 2.4-65 and Figure 2.4-66.

There are 15 public water systems within Oswego County. Seven communities currently use Lake Ontario as their potable water source: Oswego, Scriba, Volney, West Monroe, Minetto, Hastings, and Central Square. Eight communities in Oswego County have groundwater wells and/or spring-fed reservoirs as their drinking water sources: Fulton, Phoenix, Sandy Creek, Pulaski, Mexico, Orwell, Constantia, and Cleveland; Cleveland and Constantia are more than 25 mi. (40 km) from NMP3NPP. The town of New Haven is being connected to the surface water supply in 2008 (it currently relies entirely on private groundwater wells for drinking water). Table 2.4-22 lists public groundwater supplies within a 25-mile (40-km) radius of the NMP3NPP site.

Public water supply systems serve an estimated Oswego County population of approximately 82,393. The population for Oswego County based upon the federal census is estimated at 122,377 for 2000 (US Census, 2000). Thus, 67% of the population is serviced by public water systems. Approximately 33% or 39,984 people rely on privately-owned wells for water supplies (US Census, 2000).

Public water supplies in Onondaga County are entire surface water supplied from either Lake Ontario or Oneida Lake. The towns of Baldwinville, population 7,053, and Lysander, population 19,285, in Onondaga County, 24.5 miles (39 km) from the site, which formerly used groundwater, now use surface water supplied from Lake Ontario.

The other public groundwater supplies within 25 miles (40 km) of the NMP3NPP site include: Mannsville, Pierrepont Manor, and Belleville, in Jefferson County, Cato and Fair Haven, in Cayuga County, and Red Creek, in Wayne County (WCHD, 2008; JCHD, 2008, CCHD, 2008) (Table 2.4-23 and Table 2.4-24). These supplies serve approximately 7,959 people (US Census, 2000).

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 10 mi (16 km) distant from, and in different groundwater basins than the NMP3NPP site. Consequently, no impact is anticipated for these water resources by the operation of the NMP3NPP facility.

The nearest public groundwater supply system is located in the village of Mexico, approximately 10 mi (16 km) east-southeast of the site, supplying an estimated population of 1,572 with an average output of 0.3 Mgd (1,130 cu m/day). The village of Mexico operates three wells: two, 40 ft (12 m) deep and one, 38 ft (11.5 m) deep, presumed to be installed in alluvium deposits. The city of Fulton operates 12 wells, 30 to 70 ft (9 to 21 m) deep, all of which are installed in alluvium deposits producing an average total output of 2.5 Mgd (7,570 cu m/day) for an estimated population of 11,855. The Fulton wells are located 14 mi (23 km) south of the site. The village of Sandy Creek (population 3,863) operates two wells approximately 18 mi (29 km) northeast of the site, both 21 ft (6.4 m) deep, installed in alluvium deposits. The Sandy Creek wells produce an average output of 0.45 Mgd (1,700 cu m/day). The villages of Phoenix and West Phoenix (population 2,251) operates three wells: one, 25 ft (7.6 m) deep, one, 45 ft (14 m) and one 52 ft (15.8 m) deep, installed in alluvium deposits. Two of these wells are located approximately 21 mi (34 km) south-southeast of the site and produce an average output of 1.0 Mgd (3,785 cu m/day) (CNYRP 1979).

The town of Orwell serves 1,254 people from an approximately 20 ft (6.1m) deep sand and gravel well (USGS, 2002). The town of Cleveland (population 758) obtains its water from a spring-fed reservoir; with an average daily consumption of. 0.144 Mgd (545 cu m/day) (CNYRP, 1979).

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 (USGS, 1995). Present development of these groundwater resources in the central New York region is relatively small compared to the total amount available. Most of the areas in the region with excess groundwater supply occur to the south, in counties adjacent to Oswego County. Estimated yields of at least 240 Mgd (908,400 cu m/day) can be obtained from these aquifers, compared to an estimated use of 27 Mgd (102,200 cu m/day) from all groundwater sources in the central New York region (USGS, 1995; NMPC, 1998).

There are about 100 private water groundwater supplies located throughout the 25-mile (40 km) site radius (OC, 1992; OCWA, 2008). These water supplies serve mobile home parks, campgrounds, and apartment buildings throughout the region. Table 2.4-23 and Table 2.4-24 summarize information on commercial ground water supply systems.

Neither Oswego County nor the state requires submission of private well records or permits for wells producing less than 40 gpm (2.5 l/sec). The NMP Unit 2 USAR identified 102 private wells within the 1-2 mile (1.6-3.2 km) radius from the NMP Unit 2 site and none within one mile (1.6 km) of the NMP Unit 2 site (NMPC, 1998). 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 37 ft (11 m) and an average depth to water of approximately 12 ft (3.7 m) below land surface. Wells installed in consolidated bedrock have an average depth of approximately 84 ft (26 m) and an average depth to water of approximately 27 ft (8.2 m) below land surface (USGS, 1989; NMPC, 1998).

No public or domestic groundwater supply systems are located downgradient (toward Lake Ontario) from the site; however, several communities obtain surface water supplies from Lake Ontario, distributed by the city of Oswego and the Onondaga County Water Authority, through a 8-ft (2.4-m) diameter tunnel and an intake structure located 6,250ft (1,905 m) offshore in Lake Ontario, some 8 mi (13 km) west of the site (NMPC, 1998).

2.4.12.3.4 Regional Groundwater Quality

The general quality of groundwater in the bedrock in the central New York region is consistently poor. This poor quality is imparted to each of the bedrock units by 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 (USGS, 1995; NYWRC, 1970).

The upper shale and sandstone-shale units are composed of relatively insoluble minerals. Soluble carbonates in Devonian limestones that are interbedded with the upper shale may slightly degrade groundwater quality. The sandstone (Oswego) and lower shale units (Pulaski and Whetstone Gulf Formations) consist almost entirely of insoluble minerals and have the lowest dissolved solids in the region (NYWRC, 1970). The median dissolved solids concentration for sandstone aquifers in New York is 300 mg/L and the median chloride concentration is 100 mg/L (USGS, 1995).

The general chemical constituents of the groundwater in the unconsolidated deposits are similar to those in the consolidated bedrock formations, but with lower mineral concentrations. Median dissolved solids concentrations in the unconsolidated sand and gravel aquifers in the NMP3NPP region can be as high as 200 mg/L, due to the presence of calcium carbonate derived from limestone fragments carried by advancing historic glaciers (USGS, 1995).

The unconsolidated deposits in the northeastern part of the Oswego Sandstone unit outcrop area, outside the 25-mi (40 km) radius, are free of limestone fragments carried by the advancing glacier over the Tug Hill Upland. As a result, overall groundwater quality differs from that of the Erie-Ontario Lowlands (NMPC, 1998).

In general, groundwater obtained from wells installed in regional 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. Glacial till is not a significant groundwater source in the region.

2.4.12.3.5 Current Groundwater Demands

Groundwater withdrawals from the region are associated with water supply wells for the smaller communities and private residents across the NMP3NPP regional study area. There are no large withdrawal sources. The USGS provides water level trends for two selected wells (one screened in unconsolidated material, one screened in the Oswego Sandstone) in its network, located in Volney New York (USGS, 2007). These wells are shown on Figure 2.4-67 and Figure 2.4-68.

Based on the USGS data, groundwater levels were relatively constant from 1999 to 2007. Data from both the well screened in the sand and gravel aquifer (Figure 2.4-67) and the well screened in the Oswego Sandstone (Figure 2.4-68) showed season fluctuations in groundwater level, with an overall increase in groundwater elevation during periods of greater groundwater recharge (November through April). No groundwater withdrawals are planned for the NMP3NPP site.

2.4.12.4 Monitoring or Safeguard Requirements

Groundwater monitoring (water level observation) of the NMP3NPP area is currently being implemented through the use of the groundwater observation wells installed at the site in 2007 for the NMP3NPP site subsurface investigation and through the periodic review of regional water levels from selected wells within the USGS Ground-Water Level Monitoring Network (Figure 2.4-67 and Figure 2.4-68). Prior to construction activities, the NMP3NPP site monitoring wells will be evaluated to determine any further groundwater monitoring needs and proper abandonment of those wells.

Safeguards will be used to minimize the potential of adverse impacts to the groundwater by construction and operation of NMP3NPP. These safeguards would include the use of lined containment structures around storage tanks (where appropriate), hazardous materials storage areas, emergency cleanup procedures to capture and remove surface containments, and other measures deemed necessary to prevent or minimize adverse impacts to the groundwater beneath the NMP3NPP site. No groundwater production or dewatering wells are planned for safety-related or any other purposes related to plant operation.

2.4.12.5 Site Characteristics for Subsurface Hydrostatic Loading and Dewatering

As previously stated, there is no planned future use of groundwater at NMP3NPP. There is no current use of groundwater at NMP Unit 1 and Unit 2. The static elevation of groundwater in the Oswego Sandstone at NMP3NPP is more than 3.3 ft (1.0 m) below the proposed grade elevation of 270 ft (82.3 m) in the area of the power block, thus a dewatering system for NMP3NPP structures is not required.

As part of the NMP3NPP construction a drainage ditch is constructed approximately 350 ft (109 m) south of the plant. The drainage ditch is cut into the Oswego Sandstone bedrock and intercepts groundwater flowing toward the Nuclear Island. Since the top of bedrock in the ditch is at or below elevation 266 ft (81 m), and the top of rock around the Nuclear Island is below elevation 264 ft (80 m), the groundwater level is maintained below elevation 266.7 ft (81.3 m) which is 3.3 ft (1 m) below final plant grade. Pavement and cohesive soil around the Nuclear Island limits infiltration from precipitation, and final grading promotes proper drainage away from the structures.

Probable maximum flood calculations demonstrate that the minimum freeboard between maximum flood elevation and the first floor entrance elevation ranges from 2.0 ft (0.6 m) to 2.7 ft (0.8 m). Thus, during flooding conditions, transient groundwater levels remain below final grade elevation. Refer to Section 2.4.2, Floods, for a more detailed discussion.

In the event construction dewatering is necessary at the NMP3NPP site, similar conditions to those described for NMP Unit 2 are anticipated. The NMP Unit 2 USAR (Sections 2.4-35 to 2.4-36) states that approximately 110 gpm (6.9 l/sec) was dewatered from the screenwell shaft, while approximately 200 gpm (12.6 l/sec) was dewatered from the reactor building excavation.

The northerly flow direction observed in the Pulaski Formation is in the direction of Lake Ontario and NMP Unit 2. This flow direction suggests that active dewatering may be slightly influencing the direction of groundwater flow at NMP3NPP. Currently, pumping is done at the NMP Unit 2 containment foundation level, at approximately El. 164 ft (50 m). Annual daily flow from 2004 to 2007 has ranged from a minimum of 69,000 gpd (262 m^3/day) (in 2007) to a maximum of 133,000 gpd (504 m^3/day (in 2005). Discharge is into a plant storm drain system that discharges to Lake Ontario. The system is non-safety related and is referred to as "The Unit 2 Mat Drain." It operates using two or four sumps with float switches and is located in the basements of the Control Building and the Nitrogen Yard.

The cone of depression surrounding the NMP Unit 2 reactor building associated with this dewatering system is shown on Figure 2.4-71. The cone of depression is steep; the groundwater table is estimated to reach El. 215 ft (65.5 m) within a radius of 200 to 225 feet (61.0 to 68.6 m) of the reactor building. The cone of depression reaches approximately El. 254 ft (77.4 m) within 600 feet (183 m) of the NMP Unit 2 reactor building, and the normal groundwater table at the NMP Unit 2 complex is El. 255 ft (77.7 m). Therefore dewatering activities at NMP Unit 2 have resulted in a groundwater table drawdown of one foot (0.3 m) or less beyond the 600 feet (182.9 m) radius around the reactor building . Given these data, groundwater extraction at NMP Unit 2 is not expected to influence NMP3NPP site structures.

2.4.12.6 References

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2.4.13 PATHWAYS OF LIQUID EFFLUENTS IN GROUND AND SURFACE WATERS

The U.S. EPR FSAR includes the following COL Item in Section 2.4.13:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information on the ability of the groundwater and surface water environment to delay, disperse, dilute or concentrate accidental radioactive liquid effluent releases, regarding the effects that such releases might have on existing and known future uses of groundwater and surface water resources.

This COL Item is addressed as follows:

{Sections 2.4.13.1 through 2.4.13.3 are added as a supplement to the U.S. EPR FSAR.

2.4.13.1 Ground Water

This section provides a conservative analysis of a postulated, accidental liquid release of effluents to the ground water associated with the operation of NMP3NPP. The accident scenario is described, and the conceptual model used to evaluate radionuclide transport is presented, along with potential pathways of contamination to water users. The radionuclide concentrations that a water user might be exposed to are compared against the regulatory limits.

2.4.13.1.1 Accident Scenario

This section describes the ability of ground water and surface water systems to delay, disperse, or dilute a liquid effluent if accidentally released from the site. The U.S. EPR General Arrangement Drawings were reviewed to determine which component in each of the main areas of the nuclear island outside the reactor building could contain the maximum radionuclide concentration/volume. This review also determined that the proposed design includes no buildings, facilities, or tanks containing radionuclides outside of the nuclear island. Components were evaluated based on their respective volumes and whether they could contain reactor coolant activity. Except for the Reactor Building, there is no secondary containment in the nuclear island compartments/buildings. The tanks and components that are designed to contain or process radioactive liquids are within the nuclear island. These components include:

- Reactor Coolant Storage Tanks (total of six, each 4061 ft^3 (115 m^3)) in the Nuclear Auxiliary Building
- Liquid Waste Storage Tanks (total of five, each approximately 2,473 ft^3 (70 m^3)) in the Waste Building
- Volume Control Tank (600 ft^3 (17 m^3)) in the Fuel Building
- LHSI Heat Exchanger (total of four, each 33 ft^3 (0.93 m^3)) in the Safeguards Building

As defined by NUREG-0800, Standard Review Plan 2.4.13 (NRC, 2007a), the source term is determined from a postulated release from a single tank or pipe rupture outside of the containment. The postulated source of the liquid effluent would be a tank rupture in a Reactor Coolant Storage Tank in the Nuclear Auxiliary Building, because these tanks contain the largest volume of reactor coolant water. An instantaneous release from a tank would discharge the contents faster than from a pipe rupture that is connected to the tank and based on the piping configuration discharge more contents to the environment. The piping configuration may cause more contents to be held up in the tank by the nozzle locations and pipe routing than a tank failure. Therefore, modeling a tank failure will result in a more conservative analysis.

The inventory of radionuclides in reactor coolant water, and their analyzed activities in the Reactor Coolant Storage Tanks are shown on Table 2.4-26 (half-life values provided are consistent with values provided in references NRC, 1992 and ICRP, 1983). The reactor coolant activity levels represent the maximum activity levels without radioactive decay based on a 0.25 percent defective fuel rate, as shown on Table 2.4-26. Reactor coolant activity level values used in this evaluation represent the maximum (most conservative) value observed in two reactor coolant analyses. The 0.25 percent defective fuel rate was selected to be consistent with the fuel failure rate prescribed by the U.S. EPR FSAR. This fuel failure rate is two times the failure rate prescribed by Branch Technical Position 11-6 (0.12 percent) (NRC, 2007b) and provides a conservative bounding estimate of the radionuclide inventory and associated activity levels in the postulated release.

2.4.13.1.2 Ground Water Pathway

The ground water pathway evaluation includes the components of advection, decay, and retardation. The advective component is discussed in Section 2.4.12.3. A radionuclide assumed to be undergoing purely advective transport travels at the same velocity as ground water. This approach is conservative because advective flow does not account for hydrodynamic dispersion, which would normally dilute radionuclide concentrations in ground water through the processes of molecular diffusion and mechanical dispersion. For conservatism, the effects of hydrodynamic dispersion were not considered.

Radionuclides in ground water flow systems are subject to radioactive decay, the rate of which depends on the half-life of the radionuclide. Table 2.4-27 includes the half-lives of the radionuclides of concern.

Retardation considers chemical interactions between dissolved constituents in the ground water and the aquifer matrix. Contaminants that react with the aquifer matrix are retarded relative to the ground water velocity. Reactions with the aquifer matrix include cation/anion exchange, complexation, oxidation-reduction reactions, and surface sorption.

2.4.13.1.3 Conceptual Model

This section describes the conceptual model used to evaluate an accidental release of liquid effluent to ground water, or to surface water via the ground water pathway. The conceptual model of the site ground water system is based on information presented in Section 2.4.12. The key elements and assumptions embodied in the conceptual model are described below.

As previously indicated, a Reactor Coolant Storage Tank with a capacity of 4,061 ft^3 (115 m^3) is assumed to be the source of the release. The tank is located within the Nuclear Auxiliary Building, which has a building slab top depth of approximately 41.3 ft below grade (12.6 m), at an Elevation of approximately 228.7 ft (69.7 m) msl. The Reactor Coolant Storage Tank is postulated to rupture, and 80% of its liquid volume (3,248.8 ft^3 (92.0 m^3)) is assumed to be released in accordance with Branch Technical Position 11-6 (NRC, 2007b). Flow from the tank rupture is postulated to flood the building and migrate past the building containment structure and sump collection system and enter the subsurface at the top of the building slab at an elevation of approximately 250.7 ft (76.4 m) msl. This assumption is very conservative because it requires failure of the containment systems and sump pumps. Also, since the top of the slab elevation is approximately 36 ft (11m) below the pieziometric elevation of the primary water bearing unit of concern (Oswego Sandstone unit), breaches of the containment would be expected to result in an inflow of groundwater rather than an outflow of the accidental release.

The following summarizes the conceptual groundwater model and subsurface flow paths relative to potential accidental releases to groundwater in the vicinity of the Nuclear Island (including the Nuclear Auxiliary Building). The hydrogeologic parameters incorporated within this model are presented in Section 2.4.12. As indicated on Figure 2.4-72, the Nuclear Auxiliary Building is located in upland areas, approximately 700 to 1,300 feet south (referencing Plant North) of Lake Ontario shoreline. The only major surface water body at NMP3NPP is Lake Ontario. Surface waters and groundwater flow (regionally and locally) toward the lake.

As shown on Figure 2.4-73, the pre-construction ground surface within the Nuclear Island ranged from about Elevation 280 ft (99.7 m) (south of the Nuclear Auxiliary Building) to about Elevation 260 ft (79.2 m). The site grades are being modified to construct the Nuclear Island. The design ground surface elevation in the vicinity of the Nuclear Auxiliary Building is about Elevation 270 ft (82.3 m). The lowest level finish floor elevation within the building is Elevation 228.7 ft (69.7 m). The depth to the bottom of the reinforced concrete mat foundation is 49.25 ft (15 m) below grade, at approximately Elevation 220.7 ft (67.3 m) msl. The topography to the north (downgradient) of the Nuclear Island is relatively flat. The ground surface elevations formerly ranged from Elevation 260 ft (79.2 m) to Elevation 250 ft (76.2 m) (near the shoreline of Lake Ontario), where there is a small bluff at the shoreline, which slopes from Elevation 250 ft (76.2 m) to the lake elevation (approximately Elevation 245 ft (74.7 m)). The site grades within this area are being raised, with the new grades ranging from Elevations 260 to 269 ft (79.2 to 82.3 m).

As summarized in Section 2.5 and Section 2.4.12, the subsurface materials in the vicinity of the Nuclear Island and downgradient areas (to a depth of approximately 1,000 ft (305 m)) consist of the following:

Existing fill and glacial till soils. Unconsolidated deposits consist primarily of fill and glacial till. The fill consist of silts, sands and gravel with cobbles and boulders and is very limited in location and volume. All existing fill will be removed during plant construction. The glacial till consists of silty or clayey sand with gravel and occasional cobbles and boulders and mantles much of the site. The thickness of the fill and glacial till in the vicinity of the Nuclear Island and downgradient areas ranges from approximately 4 to 13.5 ft (1.2 to 4.1 m) and 2.1 to 21.3 ft (0.6 to 6.5 m), respectively. The horizontal hydraulic conductivity of the glacial till has been measured ranging from 0.09 ft/day ($3x10^{-5}$ cm/s) to 1.7 ft/day ($6x10^{-4}$ cm/sec).

The Oswego Sandstone bedrock underlies the existing fill and glacial till. The Oswego Sandstone consists principally of fresh to slightly weathered, fine to medium-grained sandstone. Horizontal bedding plane fractures dominate the Oswego Sandstone; some near vertical fractures were also observed in the Oswego Sandstone, most likely associated with regional jointing patterns. The dominant regional joint orientations strike north-northwest and east-northeast. Spacing between parallel joints is on the order of a few feet to tens of feet. The lower portion of the Oswego Sandstone is designated as the Oswego Transition Zone and consists of fine to medium-grained sandstone, argillaceous sandstone and siltstone, consisting of fresh hard and unweathered rock. The thickness of the Oswego Sandstone within the area downgradient of the Nuclear Island ranges from approximately 45 to 79 ft (14 to 24 m). The surface of the Oswego Sandstone generally slopes down to the north, towards the lake while bedding dips at a shallow angle to the south. The elevation of the top of the Oswego Sandstone ranges from about Elevation 263 ft (80.2 m) at the Nuclear Island to about Elevation 240 ft (73.2 m) at the lake shoreline. The horizontal hydraulic conductivity of the Oswego Sandstone (as a unit) has been measured ranging from less than 0.003 ft/day ($1x10^{-6}$ cm/sec) to 2.27 ft/day ($8x10^{-4}$ cm/sec). The upper portion of the Oswego Sandstone (approximately upper 20 ft (6.1 m)) was observed to be more fractured (and likely has a greater hydraulic conductivity) than the lower portions of the formation.

The bedrock of the Pulaski Formation underlies the Oswego Sandstone. The Pulaksi Formation consists of interbedded sandstone, siltstone and shale. The formation is subdivided into three units: A, B and C. Unit A is the uppermost unit and consists of fresh hard and unweatherd argillaceous sandstone interbedded with shale and siltstone. Unit B also consists of fresh hard and unweathered sandstone interbedded with siltstone and shale, only characterized by relatively more sandstone that Unit A. Unit C consists of fresh hard and unweathered siltstone and shale interbedded with sandstone. The thickness of the Pulaksi Formation in the vicinity of the Nuclear Island and downgradient areas ranges from about 65 to 95 ft (20 to 29 m). The surface of the Pulaski Formation slopes upward to the north, towards the lake. The elevation of the top of the Pulaski Sandstone ranges from about Elevation 175 ft (53.3 m) at the Nuclear Island to about 190 ft (57.9 m) at the lake shoreline. The horizontal hydraulic conductivity of the Pulaski Formation has been measured ranging from less than 0.003 ft/day ($1x10^{-6}$ cm/sec) to 0.57 ft/day ($2x10^{-4}$ cm/sec), with greater hydraulic conductivities observed within Unit B.

The bedrock of the Whetstone Gulf Formation underlies the Pulaski Formation and consists of siltstone and shale. The formation is informally divided into two units: A and B. The upper unit (Unit A) consists of fresh hard and unweathered siltstone and shale with occasional sandstone beds. Unit B consists of siltstone and shale with a greater frequency of sandstone beds. The surface of the Whetstone Gulf Formation slopes upward to the north, towards the lake. The elevation of the top of the Whetstone Gulf Formation ranges from about Elevation 100 ft (30.5 m) at the Nuclear Island to about 180 ft (54.9 m) at the lake shoreline. The thickness of the Whetstone Formation is approximately 800 ft (244 m). The horizontal hydraulic conductivity of the Whetstone Formation has been measured ranging from less than 0.003 ft/day ($1x10^{-6}$ cm/sec) to 0.06 ft/day ($2x10^{-5}$ cm/sec).

Groundwater was encountered in the existing fill and glacial till at shallow depths (near the ground surface). Groundwater elevation contours for the bedrock formations are described in Section 2.4.12. Groundwater elevations in the Oswego Sandstone range from Elevation 265 ft (80.8 m) in the vicinity of the Nuclear Island to about 245 ft (74.7 m) at the lake shoreline. Groundwater flow within the Oswego Sandstone is to the northwest, toward the lake. Lateral groundwater elevations in the Pulaski Formation are as low as Elevation 240 ft (73.2 m) in the vicinity of the Nuclear Island and groundwater flow within the Pulaski Formation is to the north, toward NMP Unit 1 and Unit 2 and Lake Ontario. Groundwater elevations in the Whetstone Formation range from about Elevation 240 ft (73.2 m) to Elevation 275 ft (83.8 m) in the vicinity of the Nuclear Island and groundwater flow within the Whetstone Formation is to the north, toward NMP Unit 1 and Unit 2 and Lake Ontario.

Vertical groundwater hydraulic gradients exist between the unconsolidated materials and the bedrock, and within the bedrock units. The groundwater potentials in the unconsolidated materials are generally higher than the bedrock, indicating a downward vertical gradient. The groundwater potentials in the Oswego Sandstone are higher than groundwater elevations in the Pulaski Formation, indicating a vertical downward gradient between these two bedrock formations. A vertical upward gradient appears to exist between the Pulaski Formation and the underlying Whetstone Gulf Formation.

Groundwater flow in the bedrock occurs predominantly within fractures. At the site, fractures are generally associated with regional joint patterns. The dominant regional joint orientations in the Oswego Sandstone strike north-northwest and east-northeast (relative to true north). Joints are typically parallel with spacing on the order of a few feet to tens of feet. A potential influence on groundwater flow in bedrock (in particular in Pulaski and Whetstone Formations) is the active groundwater dewatering of the NMP Unit 2 containment structure foundation, which is located approximately 3,500 ft (1,067 m) to the northeast of the NMP3NPP site.

The construction of NMP3NPP includes excavation (including removal of the existing fill), placement of new engineered fill and construction of foundations (at depths of up to about 50 ft (15.2 m) below site grade). These alterations are expected to modify groundwater elevations and flow directions within the unconsolidated materials (engineered fill and glacial till) and upper bedrock proximate to the Nuclear Island. In addition to engineered backfill around foundations, several other features of the NMP3NPP construction may locally influence shallow groundwater flow. Underground utilities have the potential to influence groundwater elevation, in the vicinity of the Nuclear Island, in particular the large stormwater pipelines (with trench bottom elevations on the order of Elevation 260 ft (79.2 m)) located immediately north (hydraulically downgradient) of the Nuclear Auxiliary Building. In addition, two drainage trenches are also likely to impact groundwater flow. A stormwater drainage swale (with invert elevations ranging from Elevation 258 ft (78.6 m) to 256 ft (78 m)) is located to the north (downgradient) of the Nuclear Auxiliary Building. A groundwater collection trench (referred to on the plans as the 50-ft wide cut-off trench) will be constructed to the south (upgradient) of the Nuclear Island, for the purpose of lowering the elevation of groundwater in the vicinity of the Nuclear Island. The trench will be excavated into the Oswego Sandstone, with invert elevations ranging from Elevations 266 to 265 ft (81.1 to 80.8 m). Figure 2.4-73 shows the locations of these features. As indicated on this figure, the drainage swale and stormwater pipeline discharge to Stormwater Pond Number 1. The groundwater collection trench discharges to a drainage swale, which in turn discharges to a stormwater detention pond located northeast of the Nuclear Island.

Figure 2.4-72 presents a conceptual model for releases of dissolved radionuclides to the groundwater in the vicinity of the Nuclear Auxiliary Building. The evaluation of the potential accidental release to groundwater assumes that a Reactor Coolant Storage Tank discharges directly to the subsurface. Conservatively, no credit is assumed for containment of the discharge within the building structure. An effluent volume equal to 80 percent of the tank capacity is assumed as the release volume. It is assumed that the release initially discharges to the engineered backfill around the Nuclear Auxiliary Building. The dissolved radionuclides will be transported with the groundwater (to a large extent within the upper more permeable, portion of the Oswego Sandstone) and will discharge to the surface waters of Lake Ontario at a location hydraulically downgradient of the Nuclear Auxiliary Building. Some portion of groundwater containing dissolved radionuclides may also discharge to the drainage swale or utility trench engineered backfill, depending on the hydraulic conductivity and thickness of the foundation backfill, the interconnectedness of the utility and foundation backfills, the depth of the utility trench backfill and/or the elevation of groundwater in the unconsolidated and bedrock materials.

No public or private water supply wells are located in the vicinity of the Nuclear Island, including the areas of the postulated accidental release pathway. As described in Section 2.4.12.3.3, public water supplies located within 25 mi (40.2 km) of the site that utilize groundwater are located upgradient from, and in different groundwater basins than the NMP3NPP site. Additionally, private and commercial water supplies in the site vicinity that utilize groundwater are similarly located upgradient from, and in different groundwater basins than, the NMP3NPP site. As such, the NMP3NPP property is also located outside the recharge zones of the public, private and commercial water supply wells. However, several communities obtain surface water supplies from Lake Ontario, distributed by the City of Oswego and the Onondaga Water Authority, through an 8-ft (2.4 m) diameter tunnel extending about 6,000 ft (1,829 m) offshore and an intake structure located about 8 mi (12.9 km) to the west of the NMP3NPP site. Therefore, the receptor of concern for the postulated accidental release is the surface waters of Lake Ontario.

2.4.13.1.4 Analysis of Accidental Releases to Ground Water

The analysis of accidental release of liquid effluents to ground water was accomplished in two steps. The first step was to screen the listing of source term radionuclides in Table 2.4-26, assuming only advective transport and radioactive decay. Radioactive decay data were taken from Table E.1 of NUREG/CR-5512, Vol. 1 (NRC, 1992). Radioactive decay data for some of the shorter-lived radionuclides were taken from International Commission on Radiological Protection (ICRP) Publication 38 (ICRP, 1983). This step allows the screening out of radionuclides that decay to activities below a level of concern before reaching the discharge point in Lake Ontario. Those radionuclides that remain above activity levels of concern are evaluated considering the added effect of retardation. This analysis accounts for the parent radionuclides expected to be present in the Reactor Coolant Storage Tank plus progeny radionuclides that would be generated during subsequent ground water transport. The analysis considered all progeny in the decay chain sequences that are important for dosimetric purposes. ICRP Publication 38 (ICRP, 1983) was used to identify the progeny for which the decay chain sequences can be truncated. For several of the radionuclides expected to be present in the Reactor Coolant Storage Tank, consideration of up to three members of the decay chain was required. The derivation of the equations governing the transport of the parent and progeny radionuclides follows.

One-dimensional radionuclide transport along a ground water pathway is governed by the advection-dispersion-reaction equation (Javandel, 1984), which is given as:

$$R\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial x^2} - v\frac{\partial C}{\partial x} - \lambda RC \qquad \text{(Eq. 2.4.13-1)}$$

where:

C	=	radionuclide concentration
R	=	retardation factor
D	=	coefficient of longitudinal hydrodynamic dispersion
n	=	average linear ground water velocity
λ	=	radioactive decay constant
t	=	ground water travel time
x	=	travel distance

The retardation factor is determined from (Equation 6 of Javendal et al., 1984):

$$R = 1 + \frac{\rho_b K_d}{n_e} \quad \text{(Eq. 2.4.13-2)}$$

where:

ρ_b = bulk density (g/cm^3)

K_d = distribution coefficient (cm^3/g or mL/g)

n_e = effective porosity (unitless)

The inverse of the retardation factor represents the fraction of the total radionuclide inventory that is dissolved in the water and thus considered mobile, as follows:

$$C_1 = C_0/R = C_0/[1 + \rho_b (1 - n_e) K_d / n_e] \quad \text{(Eq. 2.4.13-3)}$$

where:

C_0 = the concentration of radionuclides dissolved in water before adsorption

C_1 = the concentration of radionuclides dissolved in water after adsorption

The average linear ground water velocity (v) is determined using Darcy's law:

$$v = -\frac{K}{n_e}\frac{dh}{dx} \quad \text{(Eq. 2.4.13-4)}$$

where:

K = hydraulic conductivity

dh/dx = hydraulic gradient

n_e as previously defined

The radioactive decay constant (λ) can be written as:

$$\lambda = \frac{\ln 2}{t_{1/2}} \quad \text{(Eq. 2.4.13-5)}$$

where:

$t_{1/2}$ = radionuclide half-life

A method of characteristics approach can be used on Equation 2.4.13-1 to determine the material derivative of concentration:

$$\frac{dC}{dt} = \frac{\partial C}{\partial t} + \frac{dx}{dt}\frac{\partial C}{\partial x} \quad \text{(Eq. 2.4.13-6)}$$

Conservatively neglecting the coefficient of longitudinal hydrodynamic dispersion, the characteristic equations for Equation 2.4.13-1 can be expressed as follows:

$$\frac{dC}{dt} = -\lambda C \quad \text{(Eq. 2.4.13-7)}$$

$$\frac{dx}{dt} = \frac{v}{R} \quad \text{(Eq. 2.4.13-8)}$$

The solutions of the system of equations comprising Equations 2.4.13-7 and 2.4.13-8 can be obtained by integration to yield the characteristic curves of Equation 2.4.13-1. For transport of a parent radionuclide, the equations representing the characteristic curves are:

$$C_{P1} = C_{P0}\exp(-\lambda_1 t) \quad \text{(Eq. 2.4.13-9)}$$

$$t = R_1 \frac{L}{v} \quad \text{(Eq. 2.4.13-10)}$$

where:

C_{P1} = parent radionuclide concentration at time t

C_{P0} = initial bounding parent concentration (Table 2.4-27)

λ_1 = radioactive decay constant for parent from Equation 2.4.13-5

t = travel time from source to receptor

R_1 = retardation factor for parent radionuclide

L = flow path length from source to receptor

ν = average linear ground water velocity

Similar relationships exist for progeny radionuclides. For the first progeny in the decay chain, the advection-dispersion-reaction equation is:

$$R_2 \frac{\partial C_2}{\partial t} = D \frac{\partial^2 C_2}{\partial x^2} - v \frac{\partial C_2}{\partial x} + d_{12} \lambda_1 R_1 C_1 - \lambda_2 R_2 C_2 \qquad \text{(Eq. 2.4.13-11)}$$

where:

subscript 2 denotes properties/concentration of first progeny

d_{12} = fraction of parent radionuclide transitions that result in production of progeny

The characteristic equations for Equation 2.4.13-11, conservatively neglecting the coefficient of longitudinal hydrodynamic dispersion, can be derived as:

$$\frac{dC_2}{dt} = d_{12} \lambda_1^{'} C_1 - \lambda_2 C_2 \qquad \text{(Eq. 2.4.13-12)}$$

$$\frac{dx}{dt} = \frac{v}{R_2} \qquad \text{(Eq. 2.4.13-13)}$$

where:

$$\lambda_1^{'} = \lambda_1 \frac{R_1}{R_2}$$

Recognizing that Equation 2.4.13-12 is formally similar to Equation B.43 in NUREG/CR-5512 (NRC, 1992), these equations can be integrated to yield:

$$C_2 = K_1 \exp(-\lambda_1^{'} t) + K_2 \exp(-\lambda_2 t) \qquad \text{(Eq. 2.4.13-14)}$$

$$t = R_2 \frac{L}{v} \qquad \text{(Eq. 2.4.13-15)}$$

for which

$$K_1 = \frac{d_{12} \lambda_2 C_{P0}}{\lambda_2 - \lambda_1^{'}}$$

$$K_2 = C_{20} - \frac{d_{12} \lambda_2 C_{P0}}{\lambda_2 - \lambda_1^{'}}$$

The advection-dispersion-reaction equation for the second progeny in the decay chain is:

$$R_3 \frac{\partial C_3}{\partial t} = D \frac{\partial^2 C_3}{\partial x^2} - v \frac{\partial C_3}{\partial x} + d_{13}\lambda_1 R_1 C_1 + d_{23}\lambda_2 R_2 C_2 - \lambda_3 R_3 C_3 \qquad \text{(Eq. 2.4.13-16)}$$

where:

subscript 3 denotes properties/concentration of second progeny radionuclide

d_{13} = fraction of parent radionuclide transitions that result in production of second progeny

d_{23} = fraction of first progeny transitions that result in production of second progeny

The characteristic equations for Equation 2.4.13-16, conservatively neglecting the coefficient of longitudinal hydrodynamic dispersion, can be derived as:

$$\frac{dC_3}{dt} = d_{13}\lambda_1^{'} C_1 + d_{23}\lambda_2^{'} C_2 - \lambda_3 C_3 \qquad \text{(Eq. 2.4.13-17)}$$

$$\frac{dx}{dt} = \frac{v}{R_3} \qquad \text{(Eq. 2.4.13-18)}$$

where:

$$\lambda_1^{'} = \lambda_1 \frac{R_1}{R_3}$$

$$\lambda_2^{'} = \lambda_2 \frac{R_2}{R_3}$$

Considering the formal similarity of Equation 2.4.13-17 to Equation B.54 in NUREG/CR-5512 (NRC, 1992), Equations 2.4.13-17 and 2.4.13-18 can be integrated to yield:

$$C_3 = K_1 \exp(-\lambda_1^{'} t) + K_2 \exp(-\lambda_2^{'} t) + K_3 \exp(-\lambda_3 t) \qquad \text{(Eq. 2.4.13-19)}$$

$$t = R_3 \frac{L}{v} \qquad \text{(Eq. 2.4.13-20)}$$

for which:

$$K_1 = \frac{d_{13}\lambda_3 C_{P0}}{\lambda_3 - \lambda_1^{'}} + \frac{d_{23}\lambda_2^{'} d_{12}\lambda_3 C_{P0}}{\left(\lambda_3 - \lambda_1^{'}\right)\left(\lambda_2^{'} - \lambda_1^{'}\right)}$$

$$K_2 = \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2^{'}} - \frac{d_{23}\lambda_2^{'} d_{12}\lambda_3 C_{10}}{\left(\lambda_3 - \lambda_2^{'}\right)\left(\lambda_2^{'} - \lambda_1^{'}\right)}$$

$$K_3 = C_{30} - \frac{d_{13}\lambda_3 C_{P0}}{\lambda_3 - \lambda_1^{'}} - \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2^{'}} + \frac{d_{23}\lambda_2^{'} d_{12}\lambda_3 C_{10}}{\left(\lambda_3 - \lambda_1^{'}\right)\left(\lambda_3 - \lambda_2^{'}\right)}$$

To estimate the radionuclide concentrations in ground water, Equations 2.4.13-9, 2.4.13-14, and 2.4.13-19 were applied as appropriate along the ground water transport pathway originating at the Nuclear Auxiliary Building at NMP3NPP. The analysis was performed as described below.

2.4.13.1.4.1 Transport Considering Advection and Radioactive Decay Only

The analysis considered a single pathway from the Nuclear Auxiliary Building to the projected discharge point at Lake Ontario (Figure 2.4-72 and Figure 2.4-73). A conservative travel time, t, in Equations 2.4.13-9, 2.4.13-14, and 2.4.13-19, was used in this evaluation. The travel time was derived from information presented in Section 2.4.12.2.3. The calculated radionuclide activities using the conservative estimate of travel time were compared with the 10 CFR, Part 20, Appendix B, Table 2, Effluent Concentration Limits (ECLs) (CFR, 2007)(Table 2.4-31). As indicated on Table 2.4-27, the ECLs are exceeded for six of the radionuclides, including H-3, Co-60, Sr-90, Y-90, Cs-134 and Cs-137.

2.4.13.1.4.2 Transport Considering Advection, Radioactive Decay, and Retardation

The radionuclides of concern identified by the radioactive decay screening analysis were further evaluated considering retardation and the effects of adsorption to the engineered backfill in addition to radioactive decay. Distribution coefficients for these elements were assigned using site-specific laboratory derived values.

Site-specific distribution coefficients (Kd) were used for Co, Sr, and Cs. These values were based on the laboratory Kd analysis of 3 soil samples obtained from the proposed engineered backfill to be used at NMP3NPP site. The Kd values were measured for the sample fraction finer than 2 mm (0.08 in) in diameter. Gradation tests performed on representative samples of the proposed engineered backfill indicate that about 31% of the sample is finer (by weight) than 2mm (0.08 in), with the remainder consisting of coarser sand and gravel. Therefore, the Kd values have been reduced by 31%. This reduction conservatively assumes a Kd value of 0 ml/g for all particles greater than 2mm in diameter. These modified Kd values for the engineered backfill are presented on Table 2.4-28. ASTM D 4646-03, Standard Test Method for 24-h Batch-Type Measurement of Contaminant Sorption by Soils and Sediments (ASTM, 2003), was used to determine laboratory K_d values using site ground water. Soil samples were spiked with radioactive (Mn, Co, Zn, Sr, Cs, and Ce) and non-radioactive (Fe and Ru) isotopes for the analytes of concern. Follow on analyses were performed using gamma pulse height analysis for the radioactive isotopes and either inductively-coupled plasma emission spectroscopy (Fe) or inductively-coupled plasma mass spectrometry (Ru) for the non-radioactive isotopes. For the refined analysis, the concentrations after adsorption, calculated above, provide the initial concentrations entering the Oswego Sandstone in the vicinity of the Nuclear Island. The radionuclide concentrations discharging to Lake Ontario were calculated (using the concentration after adsorption as the initial concentration) for advection and decay in a manner similar to that described previously in Section 2.4.13.1.4. In this regard, radionuclide reductions attributable to adsorption on bedrock fracture surfaces and that associated with matrix diffusion were not included, and the analysis is therefore considered conservative. As indicated in Table 2.4-28, three radionuclides, H-3, Sr-90 and Cs-137 exceed the ECLs prior to surface water dilution.

The predicted activities of the radionuclides considering the combined effects of advection, decay, and retardation using a conservative travel time of 7862 days (21.5 years) are summarized on Table 2.4-27 and Table 2.4-28. From this evaluation, it is seen that H-3, Sr-90, and Cs-137 exceed the ECLs. Additionally, the radionuclides Co-60, Y-90, and Cs-134 exceed one percent of the ECLs.

2.4.13.1.4.3 Transport Considering Advection, Radioactive Decay, Retardation, and Dilution

The radionuclides discharging with the groundwater would mix with uncontaminated water in Lake Ontario, leading to further reduction of activity levels prior to reaching the intake of the closest potable water supply intake. A dilution factor of 700 is applied to the H-3, Co-60, Sr-90, Y-90, Cs-134, and Cs-137 activity levels reported in Table 2.4-29. Table 2.4-30 summarizes the resulting activity levels, which would represent the diluted activity levels at the point of potable water supply intake. No radionuclides exceed their individual ECLs at the point of potable water supply intake.

2.4.13.1.5 Compliance with 10 CFR Part 20

The radionuclide transport analysis presented for the Oswego Sandstone pathway indicates that all but three radionuclides accidentally released to the groundwater are below their ECL upon release to the unrestricted area of Lake Ontario. The nearest intake for a potable water supply is at a distance of 6 mi (9.66 km) at the City of Oswego. Based upon dilution within Lake Ontario, all radionuclides are below their ECLs at the intake of the potable water supply. 10 CFR Part 20, Appendix B, Table 2 imposes additional requirements when the identity and activities of each radionuclide in a mixture are known. In this case, the sum of the ratios representing the radionuclide activity level present in the mixture divided by the ECL activities otherwise established in Appendix B for the specified radionuclides not in a mixture may not exceed "1" (i.e., "unity"). The sum of fractions approach has been applied to the radionuclide concentrations conservatively estimated above. Results are summarized in Table 2.4-31. The sum of the mixture ratios is 8.70×10^{-1}, which is below unity. Therefore, it is concluded that an accidental liquid release of effluents to ground water would not exceed 10 CFR Part 20 limits at the public water supply intake. The radionuclide mixture ratios used in this analysis represent the minimum calculated value observed for each radionuclide as they are carried through the advection/decay retardation/dilution screening process. Individual radionuclides are carried through subsequent screening steps if their calculated values exceed one percent of the ECL. If individual radionuclide concentrations do not exceed one percent of their respective ECLs, the screening process stops and that calculated value is used in the sum of the fractions evaluation. This approach adds an additional level of conservatism since most radionuclides are not carried through the entire screening process.

2.4.13.2 Surface Water Pathway

2.4.13.2.1 Direct Releases to Surface Waters

All tanks/components containing radioactive liquids are located within buildings and all buildings/facilities containing radionuclide inventories are located within the Nuclear Island. In general, the buildings/facilities are designed to direct water released from potential sources of internal flooding to the lower building levels. Specifically, the Reactor Coolant Storage Tanks and Liquid Waste Storage Tanks are located below-grade. Liquid releases from these tanks are diverted to the lowest levels of the building, with adequate building volume to keep the release from reaching the exterior grade level, and thus are precluded from directly impacting surface water.

Because there are no outdoor tanks that could release radioactive effluent, no accident scenario is postulated that could result in the release of effluent directly to the surface water from outdoor tanks.

2.4.13.3 References

ASTM, 2003. Standard Test Method for 24-h Batch-Type Measurement of Contaminant Sorption by Soils and Sediments, ASTM D 4646-03, American Society for Testing and Materials, November 2003.

CFR, 2007. Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations, Concentrations for Release to Sewerage, Title 10, Code of Federal Regulation, Part 20, Appendix B, 2007.

ICRP, 1983. Radionuclide Transformations – Energy and Intensity Emissions, International Commission on Radiation Protection, ICRP Publication 38, 11-13, ICRP 1983, Pergamon Press, 1983.

Javandel, 1984. Groundwater Transport: Handbook of Mathematical Models, Water Resources Monograph 10, American Geophysical Union, I. Javandel, C. Doughty, and C. Tsang, 1984.

NRC, 1992. Residual Radioactive Contamination from Decommissioning, NUREG/CR-5512, Volume 1, Pacific Northwest Laboratory, W. Kennedy and D. Strenge, October, 1992.

NRC, 2007a. Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters, NUREG-0800, Standard Review Plan, Section 2.4.13, Revision 3, U.S. Nuclear Regulatory Commission, March 2007.

NRC, 2007b. Postulated Radioactive Releases due to Liquid-Containing Tank Failures, Branch Technical Position 11-6, NUREG-0800, Standard Review Plan, U.S. Nuclear Regulatory Commission, March, 2007.}

2.4.14 TECHNICAL SPECIFICATION AND EMERGENCY OPERATION REQUIREMENTS

The U.S. EPR FSAR includes the following COL Item in Section 2.4.14:

> A COL applicant that references the U.S. EPR design certification will describe any emergency measures required to implement flood protection in safety-related facilities and to verify that there is an adequate water supply for shutdown purposes.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), unless stated otherwise.

Sections 2.4.14.1 and 2.4.14.2 are added as a supplement to the U.S. EPR FSAR.

2.4.14.1 Need for Technical Specifications and Emergency Operations Requirements

The preceding subsections of Section 2.4 provide an in-depth evaluation of the site's hydrologic acceptability for locating NMP3NPP. The information provided below concludes that there is no need for emergency protective measures designed to minimize the impact of hydrology-related events on safety-related facilities. Therefore, the requirements of 10 CFR 50.36 (CFR, 2007a), 10 CFR Part 50, Appendix A, General Design Criteria 2 (CFR, 2007b), and 10 CFR Part 100 (CFR, 2007c) are met with respect to determining the acceptability of the site.

Section 2.4.1 through Section 2.4.11present a comprehensive discussion of the potential for flooding and low water at the site, including details of each potential cause and the resulting effects. These evaluations conclude that the probable maximum flood (PMF) elevation from local probable maximum precipitation (PMP) at about elevation 269.0 ft (82.0 m) and the PMF elevation from local streams at about elevation 268.5 ft (81.8 m) are below the proposed power block grade and finished first floor of safety-related structures at elevations 270.0 ft (82.3 m). They also conclude that potential flooding associated with on-site basin embankment breaches and area dam failures will not impact the power block and the NMP3NPP site and that the maximum breaking wave at elevation 259.8 ft (79.2 m) is below the top of the site's shoreline bluff at elevation 262.0 ft (80.0 m). Considering that NMP3NPP will be situated on the shore of Lake Ontario, tsunami flooding considerations are not applicable. Grading around the power block will be sloped to a series of storm sewers, collection ditches, and storm water detention basins; site grading will carry PMP runoff overland to Lake Ontario without the use of the storm drainage system. Furthermore, flood protection design considerations assumed that all catch basins, storm drains and culverts are blocked by ice, snow or other obstructions. Since power block safety-related structures are above design basis flood conditions as described in Section 2.4.10, flood protection measures are not required.

There will be no safety-related canals or reservoirs for transporting or impounding plant cooling water. The Ultimate Heat Sink (UHS) Makeup Intake Structure will be situated on the Lake Ontario shoreline. Non safety-related and safety-related make-up water will be drawn from the lake. As indicated in the preceding evaluations, the design low water elevation for UHS makeup water intake is 235.0 ft (71.6 m), which is 7.0 ft (2.1 m) below the 145-year minimum, pre-regulated Lake Ontario water level of 242.0 ft (73.8 m), and 2.2 ft (0.67 m) below the estimated probable minimum low water level due to surge of 237.2 ft (72.3 m). The floor of the pump house is at elevation 231.0 ft (70.4 m) and the submerged intake tunnels/structures are at elevation 188.0 ft (57.3 m), 3.0 ft (0.9 m) and 46.0 ft (14.0 m) below the design low water elevation, respectively. Although design measures, as described in Section 2.4.7 and Section 2.4.11, prevent ice formation within the intake forebay, the design low water level, coupled with potential ice effects, is adequate for pump operation and will not interrupt cooling water supply. With respect to the limiting high water level, the intake pump house is protected by an earthen embankment and concrete retaining walls at elevation 272.0 ft (82.9 m), 18.0 ft (5.5 m) above the design high water elevation of 254.0 ft (77.4 m). The concrete retaining walls provide protection against a potential channel diversion due to a seismic event. In addition, there is no potential for blockage of the UHS makeup water intake due to channel diversions.

No dewatering system is planned for plant structures since the static elevation of groundwater is greater than 3.3 ft (1.0 m) below the finished first floor of safety related structures in the power block. As stated in Section 2.4.13.1, a groundwater collection trench will be constructed near the power block for the purpose of lowering the groundwater elevation in this area.

The supply of the Essential Service Water System (ESWS) is designed to provide cooling water during power operation and shutdown of the plant. The ESWS UHS cooling tower basin inventory will provide cooling water for safety-related heat removal for the first 72 hours during design basis accident (DBA) conditions, including during extreme cold weather conditions. Thereafter, UHS makeup water will be supplied directly from Lake Ontario under post accident conditions. The UHS design for NMP3NPP incorporates Regulatory Guide 1.27 criteria to provide water inventory for UHS operation during the 30 day post accident period. Considering that safety-related UHS makeup water is drawn from Lake Ontario, it will be able to provide water for the 30 day period following an accident. Additionally, there are no other uses of water drawn from the UHS such as fire water or system charging requirements and there are no other interdependent safety-related water supply systems to the UHS. Operational controls, system design features, and plant flow requirements for the ESWS are discussed further in Section 9.2.5.

Accordingly, no emergency protective measures are required to minimize the impact of hydrology-related events on safety-related facilities and no technical specifications are required for plant shutdown to minimize the consequences of an accident resulting from hydrologic phenomena.

2.4.14.2 References

CFR, 2007a. Technical Specifications, Title 10, Code of Federal Regulations, Part 50.36, 2007.

CFR, 2007b. General Design Criteria for Nuclear Power Plants, Criteria 2, Design Bases for Protection Against Natural Phenomena, Title 10, Code of Federal Regulations, Part 50, Appendix A, 2007.

CFR, 2007c. Reactor Site Criteria, Title 10, Code of Federal Regulations, Part 100, 2007.}

Table 2.4-1—{Storms Causing High Recorded Surges on Lake Ontario}

Date	Wind Speed	Setup/down
03/25/1996 - 03/26/1996	57.5 mph (92.6 kph)	5.5 in (14 cm)
2/22/1997	70.2 mph (113 kph)	18.5 in (47 cm)
03/28/1998 - 03/29/1998	71.3 mph (114.8 kph)	9.8 in (25 cm)
5/31/1998	79.4 mph (127.8 kph)	9.1 in (23 cm)
8/24/1998	58.7 mph (94.5 kph)	9.4 in (24 cm)
11/10/1998 - 11/11/1998	62.1 mph (100 kph)	6.3 in (16 cm)
12/11/2000 - 12/12/2000	63.3 mph (101.9 kph)	9.8 in (25 cm)
2/10/2001	76 mph (122.2 kph)	13 in (33 cm)
10/25/2001	71.3 mph (114.8 kph)	6.3 in (16 cm)
2/1/2002	72.5 mph (116.7 kph)	15.7 in (40 cm)
03/9/2002 - 03/10/2002	65.6 mph (105.6 kph)	13 in (33 cm)
2/4/2003	78.3 mph (125.9 kph)	5.1 in (13 cm)
10/15/2003	74.8 mph (120.4 kph)	5.5 in (14 cm)
11/13/2003	65.5 mph (105.6 kph)	11.4 in (29 cm)
11/5/2004	44.7 mph (71.9 kph)	7.9 in (20 cm)
12/24/2004	67.1 mph (108.0 kph)	16.5 in (42 cm)
9/29/2005	44.7 mph (71.9 kph)	10.6 in (27 cm)
2/17/2006	80.6 mph (129.6 kph)	20.9 in (53 cm)
11/27/2007	40.2 mph (64.7 kph)	11.4 in (29 cm)

Table 2.4-2—{Predicted PMWS Pressure, Wind Speed, and Wind Direction on Lake Ontario}

(Page 1 of 2)

	Z1				Z2				Z3				
Time	P (mb)	S (mph)	S (kph)	D (deg)	P (mbar)	S (mph)	S (kph)	D (deg)	P (mbar)	S (mph)	S (kph)	D (deg)	P (mbar)
0	971	50	81	120	973	60	96	130	977	44	72	130	979
1	969	52	84	110	972	49	80	110	975	46	74	110	977
2	967	55	89	100	970	49	79	100	973	46	74	90	975
3	965	51	81	110	968	50	80	110	971	47	75	100	973
4	964	44	71	130	966	50	80	120	969	48	78	120	971
5	962	41	66	130	965	47	75	120	967	45	73	110	969
6	961	43	69	110	963	42	68	110	966	44	70	100	967
7	959	45	73	110	962	42	68	110	964	38	60	100	966
8	958	44	71	110	960	45	73	110	963	37	60	110	964
9	956	44	71	100	958	46	74	110	961	39	62	110	963
10	954	46	74	90	957	47	76	110	960	41	66	110	961
11	953	37	60	120	955	48	77	140	958	40	64	140	960
12	952	29	47	140	954	46	73	140	956	41	66	160	958
13	951	27	43	130	953	39	62	160	955	43	69	160	957
14	951	25	40	210	952	28	44	190	954	36	58	180	955
15	951	34	54	190	951	34	55	185	953	27	43	180	954
16	954	58	94	300	951	36	57	190	953	28	45	190	953
17	958	76	122	290	953	36	58	280	952	30	49	190	953
18	961	100	161	300	956	66	106	300	952	47	76	200	950
19	965	95	152	300	960	100	161	300	954	94	151	290	950
20	968	94	152	300	963	83	134	300	958	100	161	290	954
21	971	89	143	300	966	87	141	300	961	84	135	290	958
22	974	81	130	300	970	90	145	300	964	82	131	300	961
23	976	73	117	300	972	88	142	300	967	83	134	300	964
24	978	64	103	300	975	75	121	300	971	84	136	300	967
25	980	56	90	290	977	67	108	290	973	65	104	290	971
26	982	52	84	290	979	62	100	290	976	62	99	290	973
27	983	44	71	300	981	58	93	290	978	58	94	290	975
28	985	39	62	300	983	49	79	300	980	57	91	300	978
29	986	38	61	300	984	38	61	300	982	52	84	300	980
30	987	34	54	300	986	38	62	300	983	36	58	300	982
31	988	30	49	310	987	37	59	300	985	35	56	300	983

Table 2.4-2—{Predicted PMWS Pressure, Wind Speed, and Wind Direction on Lake Ontario}

(Page 2 of 2)

	Z1				Z2				Z3				
Time	**P (mb)**	**S (mph)**	**S (kph)**	**D (deg)**	**P (mbar)**	**S (mph)**	**S (kph)**	**D (deg)**	**P (mbar)**	**S (mph)**	**S (kph)**	**D (deg)**	**P (mbar)**
32	989	29	46	330	988	29	47	310	986	36	58	300	985
33	990	28	46	350	989	29	47	325	987	27	43	300	986
34	991	26	41	340	990	28	45	320	988	24	39	300	87
35	992	23	38	340	990	28	44	340	989	24	38	320	988
36	992	23	38	340	991	24	39	340	990	22	35	320	989

Legend: P = Pressure, S = Wind Speed, D = Wind Direction

Note:

Z1, Z2, and Z3 indicate zone of Lake Ontario shown in Figure 2.4-15

Table 2.4-3—{Storms Causing High Recorded Surges in Eastern Lake Ontario}

Date			Wind Speed			Setup	
Year	Month	Day	mph	kph	m/s	m	ft
2002	3	10	65.6	105.6	29.3	0.3	0.98
2003	11	13	67.1	108.0	30.0	0.28	0.92
2004	11	5	44.7	71.9	20.0	0.2	0.66
2004	12	24	67.1	108.0	30.0	0.42	1.38
2005	9	29	44.7	71.9	20.0	0.27	0.89
2006	2	17	80.5	129.6	36.0	0.52	1.71
2007	11	27	40.2	64.7	18.0	0.29	0.95

Table 2.4-4—{Summary of Surge Elevation Analyses}

Method	Surge Elevation		Maximum Probable Still Water Elevation	
Regression Analysis	4.7 ft	1.43 m	252.7 ft	77.02 m
Two-Dimensional Model	4.8 ft	1.46 m	252.8 ft	77.05 m

Table 2.4-5—{Public and Private Water Supply Systems in the United States Drawing from Lake Ontario within 50 mi (80 km) of NMP3NPP}

(Page 1 of 2)

Name of the System (Intake County)	Approximate Distance (mi/km) and Direction from NMP3NPP	Approximate Distance (mi/km) by Water from NMP3NPP	Average Withdrawal Rate 1980-81		Type of Use	Population Served	Production Capacity	
			mgpd	m^3/day			mgpd	m^3/day
Rochester Gas & Electric- Robert E. Ginna Nuclear Power Plant (Wayne county)	49/78 WSW	49/78	576	2,180,160	Industrial Cooling	-	576	2,180,160
Ontario Town Water District (Wayne County)	46/74 WSW	46/76	3	11,355	Domestic; Industrial	5,000	3	11,355
Williamson Water District (Wayne County)	41/66 WSW	41/66	1.8	6,813	Domestic; Industrial	4,700	3.9	14,762
Sodus Village (Wayne County)	36/58 WSW	36/58	0.26	984	Domestic; Industrial	1,800	1	3,785
Sodus Point (Wayne County)	33/53 SWS	33/53	0.2	757	Domestic	4,500	0.75	2,839
Wolcott (Wayne County)	25/41 WSW	25/41	0.24	908	Domestic; Industrial	2,500	1	3,785
NMPC Oswego Steam Station - Unit 5 (Oswego County)	10/15 WSW	10/15	411.84	1,558,814	Industrial Cooling	-	411.84	1,558,814
NMPC Oswego Steam Station - Unit I-4 (Oswego County)	10/15 WSW	10/15	119.52	452,383	Industrial Cooling	-	119.52	452,383
NMPC Oswego Steam Station - Unit 6 (Oswego County)	10/15 WSW	10/15	468	1,771,380	Industrial Cooling	-	468	1,771,380
City of Oswego (Oswego County)	8/13 WSW	13/8	10	37,850	Domestic; Industrial	32,000	16	60,560
Metropolitan Water Board of Onondaga County, Syracuse, NY (Oswego County)	8/13 WSW	13/8	24	90,840	Domestic; Industrial	120,000	36	136,260
NMP3NPP Scriba, NY, NMP Unit 1 (Oswego County)	0.5/1 NNW	750 ft (230 m) (NMP Unit 2 discharges to NMP Unit 1 intake)	381.6	1,444,356	Industrial Cooling	-	381.6	1,444,356
NMP3NPP Scriba, NY, NMP Unit 2(Oswego County)	0.5/1 NNW	3300 ft (1000 m) (NMP3NPP discharges to NMP Unit 1 intake)	77.2	292,000	Industrial Cooling	-	570.24	2,158,358
Power Authority of the State of New York, Scriba, NY (Oswego County)	0.5/1 NNW	3500 ft (1070 m)(NMP Unit 2 discharge to JAFNPP intake)	570.24	2,158,358	Industrial Cooling	-	570.24	2,158,358

Table 2.4-5—{Public and Private Water Supply Systems in the United States Drawing from Lake Ontario within 50 mi (80 km) of NMP3NPP}
(Page 2 of 2)

Name of the System (Intake County)	Approximate Distance (mi/km) and Direction from NMP3NPP	Approximate Distance (mi/km) by Water from NMP3NPP	Average Withdrawal Rate 1980-81		Type of Use	Population Served	Production Capacity	
			mgpd	m^3/day			mgpd	m^3/day
Sacketts Harbor Village (Jeffereson County)	31/49NNE	32/55	0.15	568	Domestic	1,200	0.5	1,893
Chaumont Village (Jefferson County)	37/60 NNE	38/61	0.07	265	Domestic	550	0.24	908
Cape Vincent Village (Jefferson County)	41/65 N	41/65	2	757	Domestic	750	0.24	908

Table 2.4-6—{Canadian Water Suppliers and Industrial Users Drawing From Lake Ontario Within 50 Mi (80 Km) Of NMP3NPP}

Name of the System (Intake County)	Approximate Distance (mi/km) and Direction from NMP3NPP	Approximate Distance (mi/km) by Water from NMP3NPP	Permitted Withdrawal Rate (gpm)	Permitted Withdrawal Amount		Type of Use
				mgpd	m^3/day	
R. J. Sweezey (Township of Pittsburgh, Frontenac County)	47/75 N	49/79	120	0.03	114	Domestic
Public Utilities Commission of the City of Kinston (Frontenac County)	47/75 N	47/75	18,358	21.62	81,832	Domestic
Township of Kingston (Frontenac County)	46/74 N	46/74	10,008	7.21	27,290	Domestic
DuPont of Canada (Kingston township, Frontenac County)	46/74 N	46/74	15,006	21.53	81,491	Industrial, air conditioning, and cooling
Township of Ernestown (Lennox and Addington County)	47/75 NNW	48/77	120	0.19	719	Domestic
Canada Cement LaFarge Ltd (Earnestown Township, Lennox and Addington County)	47/75 NNW	48/77	2,252	3.24	12,263	Industrial, cooling, processing, and sanitary purposes
Milhaven Fibres Ltd (Ernestown Township, Lennox and Addington County)	47/75 NNW	48/77	20,021	28.82	109,084	Industrial
Permanent Concrete Ltd. (Earnestown Township, Lennox and Addington County)	47/75 NNW	48/77	60	0.04	151	Industrial
Sandhurst Water Works Ltd (South Fredericksburgh)	47/75 NNW	48/77	120	0.07	265	Domestic
Picton Public Utility (Prince Edward County)	48/77 NW	97/61	NA	2.88	10,901	Domestic

Table 2.4-7—{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)	
	Meters	Feet	Meters	Feet
January	75.74	248.50	75.50	247.73
February	75.74	248.50	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

Note:

* USLS measurements

Table 2.4-8—{Point (1 mi^2) Probable Maximum Precipitation Depths}

Duration min	PMP Depth	
	in	(cm)
60	16.0	40.6
30	12.3	31.2
15	8.6	21.8
5	5.4	3.7

Table 2.4-9—{Comparison of the PMP with the Winter PMP Variation by Month inches (cm)}

	OCT	NOV	DEC	JAN/FEB	MAR	APR	MAY
HMR-51 (All-Season)				16.0 (40.6)			
HMR-53	10.2 (25.9)	6.1 (15.5)	4.2 (10.7)	3.5 (8.9)	4.1 (10.4)	5.4 (13.7)	8.2 (20.8)
Difference	5.8 (14.7)	9.9 (25.1)	11.8 (30.0)	12.5 (31.8)	11.9 (30.2)	10.6 (26.9)	7.8 (19.8)

Table 2.4-10—{Summary of HEC-RAS Results}

Reach ID	River Station	Discharge		PMF Flood Elevation		Channel Velocity		Maximum Depth		Froude No
		ft^3/sec	(m^3/s)	ft	(m)	ft/sec	(m/s)	ft	(m)	
Main	3,946	294	8	277.3	84.5	1.6	0.5	1.3	0.4	0.3
Main	3,129	1,371	39	269.0	82.0	0.5	0.1	6.0	1.8	0.1
South Power Block	1,336	580	16	270.4	82.4	2.1	0.6	2.4	0.7	0.3
South Power Block	984	1	0	269.0	82.0	0.0	0.0	3.0	0.9	0.0
South Power Block	422	1	0	269.0	82.0	0.0	0.0	3.0	0.9	0.0
South Power Block	0	1	0	269.0	82.0	0.0	0.0	2.0	0.6	0.0
Main2	2,738	1,835	52	269.0	82.0	0.8	0.2	6.5	2.0	0.1
Main2	2,457	2,119	60	268.8	81.9	0.9	0.3	6.8	2.1	0.1
Main2	1,931	2,677	76	268.3	81.8	1.5	0.5	13.3	4.1	0.1
Main2	1,642	2,778	79	267.4	81.5	2.5	0.8	14.4	4.4	0.2
Main2	1,280	2,685	76	261.8	79.8	1.8	0.6	10.8	3.3	0.2
Main2	515	2,685	76	259.9	79.2	1.3	0.4	11.9	3.6	0.1
Main2	330	2,685	76	259.9	79.2	0.8	0.2	9.9	3.0	0.1
Main2	0	2,685	76	259.8	79.2	0.7	0.2	13.8	4.2	0.0
Main2	-500	2,685	76	259.8	79.2	0.0	0.0	29.8	9.1	0.0

Note:

River station numbers are in feet upstream of reach outlet.

Table 2.4-11—{Safety-Related Facility Flood Elevation Summary}

Safety Related Facility	Entrance Elevation ft, (m)	Associated Cross Section	HEC-RAS Reach ID	PMF Peak Water Elevation ft (m)	Minimum Freeboard ft (m)
URB 1,2	270.0 (82.3)	1,931	Main-2	268.3 (81.8)	1.7 (0.5)
URB 3,4	270.0 (82.3)	984	South Power Block	269.0 (82.0)	1.0 (0.3)
UBP 1, 2	270.0 (82.3)	2,457	Main-2	268.8 (81.9)	1.2 (0.4)
UBP 3, 4	270.0 (82.3)	984	South Power Block	269.0 (82.0)	1.0 (0.3)

Note:

Minimum freeboard is presented above as defined by the vertical difference between the maximum flood elevation and the first floor entrance elevation.

Table 2.4-12—{Safety Related Building Acronym List}

ID	Description
URB 1,2	Essential Service Water Cooling Tower Structures No. 1 and 2
URB 3,4	Essential Service Water Cooling Tower Structures No. 3 and 4
UBP 1, 2	Emergency Diesel Generator Buildings No. 1 and 2
UBP 3, 4	Emergency Diesel Generator Buildings No. 3 and 4

Table 2.4-13—{Locks and Dams in the Oswego River}

Dam Name	Other Dam Name	Federal ID No.	Longitude	Latitude	Length (ft)	Dam Height (ft)	Maximum Storage (acre-ft)	Distance to Lake Ontario (mi)
Phoenix Lock & Dam No. 1	East Sidney Lake	NY00773	-76.3011	43.2269	1,014	11	21,968	21.2
Upper Fulton Lock & Dam No. 2	Oswego Falls East & West Dams	NY00408	-76.4158	43.3147	316	15	5,540	12.2
Lock & Dam No. 4	Lower Fulton, NYS #4	NY00406	-76.4198	43.3241	509	15	821	11.5
Lock & Dam No. 5	Minetto	NY00402	-76.4725	43.4	500	22.5	6,905	5.2
High Dam	Lock #6	NY00401	-76.496	43.4439	900	35	55,536	1.9
Lock & Dam No. 7	Varick	NY00398	-76.5042	43.45	730	13	723	1.5

Note:

There is no Lock No. 3.

Table 2.4-14—{Historic Tsunamis Affecting the East Coast of the US and Canada}

Date	Source Location	Latitude	Longitude	Earthquake Magnitude	Tsunami Cause	Maximum Tsunami Water Height
11/01/1755	Lisbon, Portugal	36	-11	-	Earthquake	98.4 ft (30.00 m) Lagos 9.8 ft (3 m) East Coast
12/16/1811	New Madrid, MO	35.6	-90.4	8.5 (Ms)	Earthquake	-
12/16/1811	New Madrid, MO	35.6	-90.4	8 (Ms)	Earthquake	-
1/23/1812	New Madrid, MO	36.3	-89.6	8.4 (Ms)	Earthquake	-
2/7/1812	New Madrid, MO	36.5	-89.6	8.8 (Ms)	Earthquake	-
6/27/1864	Avalon Peninsula, Newfoundland	46.5	-53.7	-	Earthquake	-
9/1/1886	Charleston, SC	32.9	-80	7.7 (Mw)	Earthquake	-
9/1/1895	High Bridge, NJ	40.667	-74.883	4.3 (Mfa)	Earthquake	-
10/11/1918	Mona Passage, Puerto Rico	18.5	-67.5	7.3 (Mw)	Earthquake	20 ft (6.1 m) Punta Agujereada 0.2 ft (0.06 m) Atlantic City
11/18/1929	Grand Banks, Newfoundland	44.69	-56	7.4 (Mw)	Earthquake and Landslide	23.0 ft (7 m) Taylor's Bay 2.2 ft (0.68 m) Atlantic City
8/4/1946	Northeast Coast, Dominican Republic	19.3	-68.9	8.1 (Ms)	Earthquake	16.4 ft (5.00 m) Rio Boba
8/8/1946	Northeast Coast, Dominican Republic	19.71	-69.51	7.9 (Unk)	Earthquake	2 ft (0.60 m) San Juan
5/19/1964	Long Island, NY	-	-	-	Landslide	0.92 ft (0.28 m) Plum Island, NY
12/26/2004	Off West Coast of Sumatra, Indonesia	3.295	95.982	9 (Mw)	Earthquake	167 ft (50.9 m) Labuhan 0.75 ft (0.23 m) Atlantic City

Notes:

1. Ms is the surface wave magnitude, Mw is the moment magnitude scale, Mfa is computed from felt area, Unk is unknown scale

Table 2.4-15—{Summary of Geologic Units 100, 200, and 300 Series Borings}
(Page 1 of 4)

Boring No.	Ground Surface Elevation (f)	Elevation Top of Geologic Unit (ft)							Bottom of Boring Elevation (ft)
		Glacial Till	Oswego Sandstone	Oswego Transition Zone	Pulaski Formation			Whetstone Gulf Formation	
					Unit A	Unit B	Unit C		
B101 (MW)	265.3	262.3	242.8	202.8	180.3	150.3	137.8	83.3	10.3
B102 (MW)	255.6	252.1	240.0	205.6	193.1	151.1	115.6	83.1	10.0
B103 (MW)	256.0	NM	240.4	NM	NM	NM	NM	NM	192.4
B104 (MW)	255.9	253.4	238.4	205.9	195.4	139.4	118.4	82.9	52.4
B105 (MW)	255.9	NM	238.4	NM	NM	NM	NM	NM	194.9
B106 (MW)	256.0	NE	248.0	201.0	185.0	153.5	136.5	91.0	61.0
B107 (MW)	256.2	NM	248.7	NM	NM	NM	NM	NM	187.2
B108 (MW)	259.8	259.8	257.6	209.8	183.8	128.8	NE	NE	109.8
B109 (MW)	262.5	261.5	260.0	206.5	197.5	149.5	130.0	NE	112.5
B110 (MW)	267.1	267.1	264.6	199.6	179.6	146.1	111.6	67.6	41.9
B111 (MW)	266.9	NM	264.4	NM	NM	NM	NM	NM	179.4
B112 (MW)	282.9	279.4	264.9	225.4	165.4	132.4	115.9	98.9	79.4
B113 (MW)	283.0	NM	265.0	NM	NM	NM	NM	NM	172.0
B114 (MW)	274.0	NE	273.2	195.0	183.5	141.5	130.0	84.0	80.5
B115 (MW)	274.3	NM	273.5	NE	NE	NE	NE	NE	180.8
B116 (MW)	294.8	282.3	275.9	239.8	214.8	184.8	149.8	NE	139.3
B117 (MW)	279.0	279.0	277.0	229.0	186.5	141.0	98.5	NE	94.5
B118 (MW)	293.5	293.0	283.2	243.5	213.5	178.0	148.0	118.0	88.0
B119 (MW)	293.5	NM	283.2	NM	NM	NM	NM	NM	223.3
B120 (MW)	267.0	NM	252.5	NE	NE	NE	NE	NE	252.5
B121 (MW)	266.6	NM	249.1	NE	NE	NE	NE	NE	249.1
B122 (MW)	282.5	NM	262.9	NE	NE	NE	NE	NE	262.9
B123 (MW)	272.2	NM	264.2	NE	NE	NE	NE	NE	264.2
B124 (MW)	263.3	NM	251.3	NE	NE	NE	NE	NE	251.3
B201 (MW)	255.9	254.9	249.1	219.9	175.4	150.9	110.9	77.9	55.9
B202 (MW)	256.2	NM	250.2	NM	NM	NM	NM	NM	225.2

Table 2.4-15—{Summary of Geologic Units 100, 200, and 300 Series Borings}

(Page 2 of 4)

Boring No.	Ground Surface Elevation (f)	Elevation Top of Geologic Unit (ft)							Bottom of Boring Elevation (ft)
		Glacial Till	Oswego Sandstone	Oswego Transition Zone	Pulaski Formation			Whetstone Gulf Formation	
					Unit A	Unit B	Unit C		
B203	257.2	NE	250.5	196.7	171.7	151.7	122.2	NE	107.2
B204	259.8	256.3	248.3	189.3	172.3	149.3	113.3	NE	109.8
B205	261.2	260.7	252.7	190.7	173.2	151.2	120.7	NE	110.2
B206	260.5	260.0	251.6	203.5	177.0	151.5	113.5	NE	110.5
B207	262.1	261.6	251.5	194.6	173.6	151.1	117.1	NE	111.1
B208 (MW)	265.3	264.3	250.3	218.8	176.3	159.3	121.3	NE	114.3
B209 (MW)	266.0	NM	251.0	NM	NM	NM	NM	NM	214.0
B210	266.7	266.7	247.7	213.7	184.7	152.2	123.2	NE	116.7
B211	268.3	268.3	246.3	198.3	179.8	153.3	122.3	NE	118.3
B212	269.4	268.4	251.9	214.4	181.9	128.9	NE	NE	119.4
B213	265.6	264.6	251.6	203.1	180.6	148.1	125.1	NE	115.1
B214	267.8	264.3	253.3	210.8	187.8	153.8	127.8	NE	117.8
B215	262.5	261.5	257.5	202.0	181.5	147.5	127.5	NE	112.5
B216 (MW)	265.8	265.8	258.8	203.3	185.3	156.8	130.8	85.8	60.8
B217 (MW)	265.1	NM	258.1	NM	NM	NM	NM	NM	215.1
B218	265.2	264.7	249.2	197.2	171.2	149.2	120.2	NE	115.2
B219 (MW)	274.4	273.4	256.4	211.9	186.9	147.9	NE	NE	120.2
B220 (MW)	275.0	NM	257.0	NM	NM	NM	NM	NM	194.0
B221 (MW)	280.2	267.7	253.6	214.2	175.7	149.2	118.7	79.7	64.2
B222	281.3	273.3	255.3	210.3	174.8	150.8	140.3	NE	130.3
B223	280.4	266.9	250.4	205.4	175.9	150.4	NE	NE	130.4
B224	274.2	270.2	258.3	205.7	178.2	143.2	123.7	83.7	64.21
B225	275.8	NM	257.8	NM	NM	NM	NM	NM	65.8
B226	275.8	275.8	258.3	210.8	187.8	154.8	130.8	78.3	65.8
B227	281.7	269.2	260.6	199.2	176.7	NE	NE	NE	131.4
B228	281.7	271.2	259.2	207.7	176.2	149.2	NE	NE	131.7

Table 2.4-15—{Summary of Geologic Units 100, 200, and 300 Series Borings}

(Page 3 of 4)

Boring No.	Ground Surface Elevation (f)	Elevation Top of Geologic Unit (ft)							Bottom of Boring Elevation (ft)
		Glacial Till	Oswego Sandstone	Oswego Transition Zone	Pulaski Formation			Whetstone Gulf Formation	
					Unit A	Unit B	Unit C		
B229	282.8	269.3	257.3	195.3	177.8	147.8	NE	NE	132.8
B230 (MW)	282.6	270.1	263.1	199.1	175.1	149.6	128.1	98.6	78.6
B231	280.9	272.4	262.6	197.4	179.4	153.4	NE	NE	130.9
B232	282.1	274.1	263.6	207.1	175.6	149.6	128.1	101.6	82.1
B233 (MW)	275.5	275.5	259.5	212.0	179.0	154.5	146.5	NE	125.3
B234	271.8	269.8	263.3	198.3	180.8	157.3	127.8	NE	121.8
B235 (MW)	271.9	268.4	261.9	201.9	181.9	155.9	128.4	NE	118.4
B236 (MW)	272.1	NM	262.1	NM	NM	NM	NM	NM	236.1
B237	272.5	271.5	258.9	194.5	171.0	147.5	123.5	NE	122.5
B238 (MW)	279.2	276.2	260.5	197.2	173.2	148.2	119.2	90.2	63.4
B239	280.3	280.3	259.0	199.8	174.3	146.8	NE	NE	125.0
B240	283.0	282.0	261.0	208.0	172.5	NE	NE	NE	128.0
B241	272.5	NM	258.5	NM	NM	NM	NM	NM	62.5
B242	272.4	NM	259.4	NM	NM	NM	NM	NM	62.4
B243	270.5	270.5	259.4	195.5	175.0	147.5	117.0	73.0	60.5
B301	262.1	261.6	244.1	202.6	187.6	NE	NE	NE	142.1
B302	262.5	259.0	242.0	202.5	187.5	162.5	NE	NE	142.5
B304	262.5	259.0	249.0	207.5	NE	NE	NE	NE	187.5
B305	260.9	260.4	250.3	205.9	NE	NE	NE	NE	185.9
B306	256.3	255.8	249.1	203.8	186.3	NE	NE	NE	181.3
B307	254.7	253.7	241.7	202.2	185.7	NE	NE	NE	179.7
B308	254.4	244.9	242.8	203.9	184.9	NE	NE	NE	179.4
B311	255.4	245.4	244.9	200.4	183.4	NE	NE	NE	180.4
B312	256.2	248.7	241.7	200.7	182.2	NE	NE	NE	181.2

Table 2.4-15—{Summary of Geologic Units 100, 200, and 300 Series Borings}
(Page 4 of 4)

Boring No.	Ground Surface Elevation (f)	Elevation Top of Geologic Unit (ft)							Bottom of Boring Elevation (ft)
		Glacial Till	Oswego Sandstone	Oswego Transition Zone	Pulaski Formation			Whetstone Gulf Formation	
					Unit A	Unit B	Unit C		
B313	257.2	NE	244.7	202.2	183.2	NE	NE	NE	182.2
B314	258.4	254.9	245.9	207.9	190.9	NE	NE	NE	183.4
B315	262.7	261.2	248.4	207.7	193.7	NE	NE	NE	187.7

Notes:

Elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD 29).

Abbreviations:

MW - Monitoring Well
NM - Not measured. Boring drilled without sampling using rotary percussion tools. Only the top of bedrock was identified.
NE - Not encountered. Where glacial till was not encountered, other soils were present above the bedrock. Where rock formaations were not encountered, the boring was terminated before encountering the formation.

Table 2.4-16—{Summary of Geologic Units 400 Series Borings}

(Page 1 of 2)

Boring No.	Ground Surface Elevation (ft)	Elevation Top of Geologic Unit (ft)							Bottom of Boring Elevation (ft)
		Oswego Sandstone	Oswego Transition Zone	Pulaski Formation			Whetstone Gulf Formation		
				Unit A	Unit B	Unit C	Unit A	Unit B	
B401	262.7	243.7	205.4	191.3	150.8	134.2	103.9	65.7	13.7
B402a	263.5	243.6	207.5	192.2	156.2	141.9	105.8	70.8	49.2
B403	Not Drilled								
B404	241.3	241.3	224.4	204.7	165.8	153.8	115.3	69.3	38.8
B405	238.3	238.3	226.6	208.1	166.3	149.8	111.2	78.0	39.8
B406	237.3	237.3	227.9	200.1	163.5	149.8	113.9	88.9	49.8
B407	236.6	236.6	217.1	199.8	168.9	155.5	117.9	84.0	40.6
B408	237.1	235.8	214.8	200.3	171.7	156.0	116.0	90.8	39.3
B409	232.8	232.8	218.3	201.3	169.3	156.8	117.8	84.8	48.8
B410	229.6	226.4	216.4	202.7	174.2	157.6	120.1	92.1	47.6
B411	226.0	226.0	217.7	203.5	170.9	153.2	121.0	88.0	48.0
B412	222.0	222.0	219.8	203.7	161.7	151.0	118.3	83.0	43.3
B413	217.3	NE	216.0	206.6	177.0	161.3	120.8	87.3	57.3
B414	214.1	NE	212.6	206.1	168.6	157.0	121.3	85.9	52.1
B415	210.7	NE	208.7	206.6	179.0	158.6	121.4	92.9	51.7
B416	207.5	NE	NE	206.8	165.0	149.7	111.7	77.5	52.5
B417	204.3	NE	NE	204.3	176.7	163.0	120.9	88.6	54.3
B428	260.7	243.2	203.1	188.7	154.4	136.5	100.6	62.2	21.4
B429a	261.3	238.3	198.1	184.6	150.1	135.0	91.0	66.3	53.6
B430	Not Drilled								
B431	240.1	238.1	220.6	200.3	167.8	153.1	116.6	88.3	40.1
B432	239.4	239.4	222.4	203.3	164.6	144.9	117.5	79.9	39.4
B433	237.3	233.8	227.0	209.8	167.8	150.1	110.0	77.8	48.8

Table 2.4-16—{Summary of Geologic Units 400 Series Borings}

(Page 2 of 2)

Boring No.	Ground Surface Elevation (ft)	Elevation Top of Geologic Unit (ft)							Bottom of Boring Elevation (ft)
		Oswego Sandstone	Oswego Transition Zone	Pulaski Formation			Whetstone Gulf Formation		
				Unit A	Unit B	Unit C	Unit A	Unit B	
B434	238.3	238.3	224.9	208.3	172.2	153.8	120.4	93.6	42.2
See last page for notes.									
B435	236.4	234.5	221.6	198.8	161.5	150.3	120.0	93.6	46.5
B436	234.8	234.3	225.2	198.0	172.6	155.3	117.1	94.5	50.8
B437	233.2	233.2	223.4	197.7	167.3	148.9	108.2	72.0	57.3
B438	230.1	227.8	215.8	198.4	161.9	147.8	114.0	84.1	51.8
B439	227.5	227.5	217.0	200.4	172.0	153.0	120.8	96.4	52.5
B440	223.1	221.6	218.4	201.6	169.2	150.2	120.7	96.6	52.1
B441	218.7	NE	218.7	205.5	167.4	152.2	123.9	83.7	60.7

Notes:

Elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD 29).
B402a and B429a were drilled at angles and elevations are corrected.
B401, B402a, B428, and B429a were drilled onshore. All other 400 Series Borings were drilled offshore.
Ground surface elevation corresponds with mudline for offsore borings.

Abbreviations:

NE - Not encountered.

Table 2.4-17—{Well Construction Details}

(Page 1 of 3)

Well ID	Northing (ft)	Easting (ft)	Ground Surface Elevation (ft)	Top of Casing Elevation (ft)	Boring Depth (ft)	Well Depth (ft)	Screen Diameter & Slot Size (in)	Screen Interval Depth(ft) Top	Screen Interval Depth(ft) Bottom	Screen Interval Elevation(ft) Top	Screen Interval Elevation(ft) Bottom	Filterpack Interval Depth(ft) Top	Filterpack Interval Depth(ft) Bottom	Hydrostratigraphic Unit
B101 (MW)	1,282,173.9	543,489.0	265.3	267.51	255.0	134.5	2 / 0.010	117.9	134.5	147.4	130.8	117.9	134.5	Pulaski B & C
B102 (MW)	1,281,119.1	542,988.4	255.6	257.98	245.6	125	2 / 0.010	104.0	125.0	151.6	130.6	104	125	Pulaski A & B
B103 (MW)	1,281,133.2	542,986.1	256.0	258.05	63.6	63.6	2 / 0.010	45.5	63.6	210.5	192.4	45.5	63.6	Oswego Sandstone, Oswego Transition & Pulaski A
B104 (MW)	1,281,396.9	543,483.1	255.9	258.1	203.5	200.1	2 / 0.010	176.5	200.1	79.4	55.9	176.5	200.1	Whetstone Gulf
B105 (MW)	1,281,404.3	543,488.9	255.9	258.3	61.0	60	2 / 0.010	41.0	60.0	214.9	195.9	41	60	Oswego Sandstone & Oswego Transition
B106 (MW)	1,282,272.9	544,173.3	256.0	258.2	195.0	195	2 / 0.010	170.0	195.0	86.0	61.0	170	195	Whetstone Gulf
B107 (MW)	1,282,275.5	544,161.8	256.2	258.41	69.0	69	2 / 0.010	53.8	69.0	202.4	187.2	53.8	69	Oswego Sandstone & Oswego Transition
B108 (MW)	1,280,487.7	543,437.5	259.8	262.37	150.0	150	2 / 0.010	136.6	150.0	123.2	109.8	136.6	150	Pulaski B
B109 (MW)	1,281,864.9	544,562.3	262.5	264.99	150.0	132	2 / 0.010	113.0	132.0	149.5	130.5	113	132	Pulaski B
B110 (MW)	1,279,838.6	543,552.2	267.1	270.02	225.2	225.2	2 / 0.010	201.8	225.2	65.3	41.9	201.8	225.2	Whetstone Gulf
B111 (MW)	1,279,841.1	543,563.3	266.9	269.81	87.5	87.5	2 / 0.010	71.0	87.5	195.9	179.4	71	87.5	Oswego Transition & Pulaski A
B112 (MW)	1,280,382.8	544,368.5	282.9	285.11	203.5	191.8	2 / 0.010	167.7	191.8	115.2	91.1	167.7	191.8	Pulaski C & Whetstone Gulf
B113 (MW)	1,280,379.7	544,381.4	283.0	284.42	111.0	91.5	2 / 0.010	78.2	91.5	204.8	191.5	78.2	91.5	Oswego Transtion
B114 (MW)	1,280,763.3	544,983.0	274.0	275.81	193.5	146	2 / 0.010	130.4	146.0	143.6	128.0	130.4	146	Pulaski A, B & C
B115 (MW)	1,280,775.0	544,989.7	274.3	276.78	93.5	93.5	2 / 0.010	80.0	93.5	194.3	180.8	80	93.5	Oswego Transition & Pulaski A
B116 (MW)	1,279,550.8	544,655.3	294.8	296.98	155.5	142	2 / 0.010	118.0	142.0	176.8	152.8	118	142	Pulaski B
B117 (MW)	1,280,280.0	545,532.7	279.0	281.34	184.5	167	2 / 0.010	140.0	167.0	139.0	112.0	140	167	Pulaski B
B118 (MW)	1,279,283.8	545,652.1	293.5	295.95	205.5	203	2 / 0.010	177.5	203.0	116.0	90.5	177.5	203	Whetstone Gulf
B119 (MW)	1,279,282.6	545,639.9	293.5	295.98	70.2	70.2	2 / 0.010	47.5	70.2	246.0	223.3	47.5	70.2	Oswego Sandstone & Oswego Transition
B120 (MW)	1,281,137.8	544,051.0	267.0	269.32	14.5	14.5	2 / 0.010	4.5	14.5	262.5	252.5	4.5	14.5	Soil
B121 (MW)	1,280,926.9	543,909.4	266.6	269.36	17.5	17.5	2 / 0.010	4.5	17.5	262.1	249.1	4.5	17.5	Soil
B122 (MW)	1,280,694.8	544,110.8	282.5	284.92	19.6	19.6	2 / 0.010	4.5	19.6	278.0	262.9	4.5	19.6	Soil
B123 (MW)	1,280,883.9	544,313.3	272.2	274.61	8.0	8	2 / 0.010	4.2	8.0	268.0	264.2	4.2	8	Soil
B124 (MW)	1,280,799.2	543,866.6	263.3	265.59	12.0	12	2 / 0.010	5.0	12.0	258.3	251.3	5	12	Soil
B201 (MW)	1,280,776.2	543,669.7	255.9	258.87	200.0	138	2 / 0.010	112.0	138.0	143.9	117.9	112	138	Pulaski B
B202 (MW)	1,280,779.1	543,673.3	256.2	258.81	31.0	31	2 / 0.010	17.0	31.0	239.2	225.2	17	31	Oswego Sandstone
B203	1,280,824.6	543,738.8	257.2		150.0									
B204	1,280,695.3	543,724.7	259.8		150.0									

Table 2.4-17—{Well Construction Details}
(Page 2 of 3)

Well ID	Northing (ft)	Easting (ft)	Ground Surface Elevation (ft)	Top of Casing Elevation (ft)	Boring Depth (ft)	Well Depth (ft)	Screen Diameter & Slot Size (in)	Screen Interval Depth(ft) Top	Screen Interval Depth(ft) Bottom	Screen Interval Elevation(ft) Top	Screen Interval Elevation(ft) Bottom	Filterpack Interval Depth(ft) Top	Filterpack Interval Depth(ft) Bottom	Hydrostratigraphic Unit
B205	1,280,754.1	543,806.7	261.2		151.0									
B206	1,280,860.5	543,825.2	260.5		150.0									
B207	1,280,806.6	543,863.7	262.1		151.0									
B208 (MW)	1,280,921.3	543,897.4	265.3	267.38	151.0	151	2 / 0.010	135.5	151.0	129.8	114.3	135.5	151	Pulaski B & C
B209 (MW)	1,280,924.5	543,901.5	266.0	268.18	52.0	52	2 / 0.010	22.5	52.0	243.5	214.0	22.5	52	Oswego Sandstone & Oswego Transition
B210	1,280,878.4	543,932.8	266.7		150.0									
B211	1,280,976.9	543,972.8	268.3		150.0									
B212	1,280,938.8	544,013.9	269.4		150.0									
B213	1,281,129.8	544,047.2	265.6		150.5									
B214	1,281,058.0	544,085.3	267.8		150.0									
B215	1,281,214.5	544,162.3	262.5		150.0									
B216 (MW)	1,281,146.8	544,210.4	265.8	268.34	205.0	205	2 / 0.010	182.0	205.0	83.8	60.8	182	205	Whetstone Gulf
B217 (MW)	1,281,155.3	544,206.5	265.1	267.7	50.0	50	2 / 0.010	26.0	50.0	239.1	215.1	26	50	Oswego Sandstone
B218	1,280,643.2	543,825.0	265.2		150.0		2 / 0.010							
B219 (MW)	1,280,570.9	543,875.9	274.4	276.55	154.2	146.4	2 / 0.010	127.5	146.4	146.9	128.0	127.5	146.4	Pulaski B
B220 (MW)	1,280,574.3	543,880.2	275.0	277.09	81.0	81	2 / 0.010	65.5	81.0	209.5	194.0	65.5	81	Oswego Transition
B221 (MW)	1,280,735.3	543,922.7	280.2	282.43	216.0	211	2 / 0.010	197.0	211.0	83.2	69.2	197	211	Pulaski C & Whetstone Gulf
B222	1,280,655.1	543,963.9	281.3		151.0									
B223	1,280,778.6	543,968.0	280.4		150.0									
B224	1,280,831.1	544,021.9	274.2		210.0									
B225	1,280,843.5	544,036.7	275.8		210.0									
B226	1,280,869.8	544,068.6	275.8		210.0									
B227	1,280,769.4	544,067.8	281.7		150.3									
B228	1,280,728.2	543,999.7	281.7		150.0									
B229	1,280,653.5	544,055.4	282.8		150.0									
B230 (MW)	1,280,698.5	544,118.4	282.6	284.77	204.0	204	2 / 0.010	183.0	204.0	99.6	78.6	183	204	Pulaski C & Whetstone Gulf
B231	1,280,831.5	544,126.6	280.9		150.0									
B232	1,280,743.1	544,178.7	282.1		200.0									
B233 (MW)	1,280,918.8	544,142.4	275.5	277.68	150.2	150	2 / 0.010	135.0	150.0	140.5	125.5	135	150	Pulaski C

Table 2.4-17—{Well Construction Details}

(Page 3 of 3)

Well ID	Northing (ft)	Easting (ft)	Ground Surface Elevation (ft)	Top of Casing Elevation (ft)	Boring Depth (ft)	Well Depth (ft)	Screen Diameter & Slot Size (in)	Screen Interval Depth(ft) Top	Screen Interval Depth(ft) Bottom	Screen Interval Elevation(ft) Top	Screen Interval Elevation(ft) Bottom	Filterpack Interval Depth(ft) Top	Filterpack Interval Depth(ft) Bottom	Hydrostratigraphic Unit
B234	1,280,964.0	544,262.5	271.8		150.0									
B235 (MW)	1,280,889.9	544,316.3	271.9	274.43	153.5	146.9	2 / 0.010	131.9	146.9	140.1	125.0		146.9	Pulaski B & C
B236 (MW)	1,280,883.8	544,319.0	272.1	274.31	36.0	36	2 / 0.010	23.0	36.0	249.1	236.1	23	36	Oswego Sandstone
B237	1,280,357.7	543,838.5	272.5		150.0									
B238 (MW)	1,280,285.2	543,890.3	279.2	281.33	215.8	211	2 / 0.010	187.5	211.0	91.7	68.2	187.5	211	Pulaski C & Whetstone Gulf
B239	1,280,444.2	543,957.5	280.3		155.3									
B240	1,280,372.3	544,008.8	283.0		155.0									
B241	1,280,399.3	543,844.8	272.5		210.0									
B242	1,280,416.0	543,833.6	272.4		210.0									
B243	1,280,448.1	543,810.1	270.5		210.0									
B301	1,282,261.0	543,340.8	262.1		120.0									
B302	1,282,204.9	543,374.5	262.5		120.0									
B303					75.0									
B304	1,282,115.9	543,438.4	262.5		75.0									
B305	1,282,032.5	543,496.0	260.9		75.0									
B306	1,281,951.5	543,551.8	256.3		75.0									
B307	1,281,868.2	543,609.7	254.7		75.0									
B308	1,281,785.2	543,665.4	254.4		75.0									
B309					75.0									
B310					75.0									
B311	1,281,531.2	543,835.6	255.4		75.0									
B312	1,281,454.1	543,892.3	256.2		75.0									
B313	1,281,372.8	543,946.0	257.2		75.0									
B314	1,281,291.5	543,995.6	258.4		75.0									
B315	1,281,197.5	544,059.5	262.7		75.0									

Table 2.4-18—{Monitoring Well Elevations}

(Page 1 of 4)

Well ID	Aquifer Unit/ Geologic Formation	Ground Surface Elevation (ft)	Top of Casing Elevation (ft)	Depth to Water (ft)											Water Level Elevation (ft)										
				October 2007	November 2007	December2007	January 2008	February2008	March 2008	April 2008	May 2008	June 2008	July 2008	August 2008	October 2007	November 2007	December 2007	January 2008	February 2008	March 2008	April 2008	May 2008	June 2008	July 2008	August 2008
B-101 (MW)	Pulaski B & C	265.3	267.51	24	25.9	22.6	26.4	24.8	24.6	24.3	23.3	23.3	23.6	23.6	243.5	241.6	244.9	241.1	242.7	242.9	243.2	244.2	244.2	244.0	243.9
B-102 (MW)	Pulaski A & B	255.6	257.98	17.2	15.5	16.5	16	10	10.3	11.9	10.1	9.7	13.3	12.4	240.8	242.5	241.4	242	247.9	247.7	246.1	247.9	248.3	244.7	245.6
B-103 (MW)	Oswego Sandstone, Oswego Transition & Pulaski A	256	258.05	51.7	42.7	33.3	7.2	4.4	4.9	4.6	4.6	6.0	7.1	6.4	206.4	215.4	224.8	250.8	253.7	253.2	253.4	253.4	252.1	251.0	251.6
B-104 (MW)	Whetstone Gulf	255.9	258.1	23.5	51.8	37.9	28.8	25.8	24.6	23.7	23.1	22.5	22.3	22.2	234.6	206.3	220.2	229.3	232.3	233.6	234.4	235.0	235.6	235.8	235.9
B-105 (MW)	Oswego Sandstone & Oswego Transition	255.9	258.3	55.7	54	52.3	49.5	46.7	44	40.0	37.4	34.7	32.4	30.0	202.6	204.3	206.1	208.9	211.6	214.3	218.3	220.9	223.6	226.0	228.3
B-106 (MW)	Whetsone Gulf	256	258.2	78.8	128	116.5	89.2	61.3	50.8	86.1	76.8	64.6	131.0	94.7	179.4	130.2	141.7	169.1	197	207.4	172.1	181.4	193.6	127.2	163.5
B-107 (MW)	Oswego Sandstone & Oswego Transition	256.2	258.41	59.5	53	46.5	60.9	49.2	40.8	62.9	53.2	43.7	63.2	52.1	198.9	205.4	211.9	197.5	209.2	217.6	195.5	205.2	214.7	195.2	206.3
B-108 (MW)	Pulaski B	259.8	262.37	26.4	18.4	17.3	17.9	16.6	16.6	16.3	15.5	15.3	15.4	15.5	236	244	245	244.5	245.8	245.8	246.1	246.9	247.0	247.0	246.9
B-109 (MW)	Pulaski B	262.5	264.99	23.5	23	25.4	25	23.5	23.2	23.1	22.4	22.1	22.3	22.2	241.5	242	239.6	240	241.5	241.8	241.9	242.6	242.9	242.7	242.8
B-110 (MW)	Whetstone Gulf	267.1	270.02	179.3	161.8	145.3	187.6	163.5	146.3	168.6	151.2	134.5	146.1	131.5	90.7	108.2	124.7	82.5	106.5	123.8	101.5	118.8	135.6	123.9	138.5
B-111 (MW)	Oswego Transition & Pulaski A	266.9	269.81	8.2	7.4	6.9	6.3	5.5	5.9	5.9	6.1	6.7	8.5	6.4	261.6	262.4	262.9	263.5	264.3	263.9	263.9	263.7	263.1	261.3	263.4

Table 2.4-18—{Monitoring Well Elevations}

(Page 2 of 4)

Well ID	Aquifer Unit/ Geologic Formation	Ground Surface Elevation (ft)	Top of Casing Elevation (ft)	Depth to Water (ft)											Water Level Elevation (ft)										
				October 2007	November 2007	December2007	January 2008	February2008	March 2008	April 2008	May 2008	June 2008	July 2008	August 2008	October 2007	November 2007	December 2007	January 2008	February 2008	March 2008	April 2008	May 2008	June 2008	July 2008	August 2008
B-112 (MW)	Pulaski C & Whetstone Gulf	282.9	285.11	42.9	76.8	48.8	45.4	44.1	43.9	43.8	43.1	42.7	42.6	42.3	242.2	208.3	236.3	239.7	241	241.2	241.4	242.0	242.4	242.5	242.8
B-113 (MW)	Oswego Transition	283	284.42	87	88.3	85.2	70.4	51.4	37.1	19.0	13.1	10.6	11.1	11.2	197.4	196.1	199.3	214	233	247.4	265.5	271.3	273.8	273.4	273.2
B-114 (MW)	Pulaski A, B & C	274	275.81	14	11.1	9.9	9.8	9.8	9.9	9.7	9.9	10.3	10.8	9.8	261.8	264.7	265.9	266	266	265.9	266.1	265.9	265.5	265.0	266.0
B-115 (MW)	Oswego Transition & Pulaski A	274.3	276.78	88	93.2	92.8	92	91.3	90.8	90.1	88.7	89.2	88.7	88.3	188.8	183.6	184	184.7	185.5	186	186.7	188.1	187.6	188.0	188.5
B-116 (MW)	Pulaski B	294.8	296.98	30.8	30	29.5	28.1	26.4	25.5	25.2	25.6	26.1	26.9	26.6	266.2	267	267.5	268.9	270.6	271.5	271.8	271.4	270.9	270.1	270.4
B-117 (MW)	Pulaski B	279	281.34	25.5	24.9	25.1	24.9	23.7	23.6	23.8	23.7	24.0	32.0	23.1	255.8	256.4	256.2	256.4	257.6	257.7	257.6	257.6	257.4	249.4	258.2
B-118 (MW)	Whetstone Gulf	293.5	295.95	19.3	16.6	12.6	11.2	11.2	11.2	11.1	11.5	12.7	13.4	11.7	276.7	279.4	283.4	284.8	284.8	284.7	284.9	284.4	283.3	282.5	284.3
B-119 (MW)	Oswego Sandstone & Oswego Transition	293.5	295.98	20.8	19.6	18.1	15.2	14.7	14.9	15.7	16.4	18.0	18.7	17.8	275.2	276.4	277.9	280.8	281.2	281	280.2	279.6	278.0	277.3	278.2
B-120 (MW)	Soil	267	269.32	NA	Dry	Dry	4.4	4.2	4.7	4.9	4.7	6.1	5.3	6.0	NA	Dry	Dry	264.9	265.2	264.6	264.4	264.6	263.2	264.1	263.3
B-121 (MW)	Soil	266.6	269.36	NA	17.6	15.5	5.8	4.7	5.4	4.5	4.9	6.7	5.2	6.0	NA	251.8	253.9	263.5	264.7	263.9	264.9	264.5	262.7	264.2	263.3
B-122 (MW)	Soil	282.5	284.92	NA	3.6	3.5	3.2	2.6	2.7	3.3	3.1	7.2	5.8	5.0	NA	281.3	281.5	281.7	282.3	282.2	281.6	281.8	277.8	279.2	279.9
B-123 (MW)	Soil	272.2	274.61	NA	Dry	9.9	4.4	3.2	4.7	4.5	4.6	7.3	6.8	6.6	NA	Dry	264.7	270.2	271.4	269.9	270.1	270.1	267.3	267.8	268.0
B-124 (MW)	Soil	263.3	265.59	NA	9.9	3.4	3.4	2.5	3.2	3.5	2.9	4.4	3.2	4.1	NA	255.7	262.2	262.2	263.1	262.4	262.1	262.7	261.2	262.4	261.5

Table 2.4-18—{Monitoring Well Elevations}
(Page 3 of 4)

Well ID	Aquifer Unit/ Geologic Formation	Ground Surface Elevation (ft)	Top of Casing Elevation (ft)	Depth to Water (ft)											Water Level Elevation (ft)										
				October 2007	November 2007	December2007	January 2008	February2008	March 2008	April 2008	May 2008	June 2008	July 2008	August 2008	October 2007	November 2007	December 2007	January 2008	February 2008	March 2008	April 2008	May 2008	June 2008	July 2008	August 2008
B-201 (MW)	Pulaski B	255.9	258.87	15.8	17.7	18.1	16.4	14.1	13.7	13.7	12.9	12.6	13.8	12.7	243.1	241.2	240.8	242.4	244.7	245.2	245.2	246.0	246.3	245.1	246.2
B-202 (MW)	Oswego Sandstone	256.2	258.81	8.5	7.6	4.9	4.4	3.6	3.8	3.8	4.0	4.4	4.4	4.4	250.3	251.2	253.9	254.4	255.2	255.1	255.0	254.9	254.4	254.4	254.5
B-208 (MW)	Pulaski B & C	265.3	267.38	29	28.2	28.4	28.6	27	26.6	27.7	27.0	26.6	27.1	27.0	238.4	239.2	239	238.8	240.4	240.8	239.7	240.4	240.8	240.3	240.4
B-209 (MW)	Oswego Sandstone & Oswego Transition	266	268.18	41.1	29	19.3	7.6	7.1	7.4	7.3	20.2	8.2	8.1	7.3	227.1	239.2	248.9	260.6	261.1	260.8	260.9	248.0	260.0	260.1	260.9
B-216 (MW)	Whetstone Gulf	265.8	268.34	171.1	158.9	148.8	187.1	169	155.7	191.9	174.4	155.4	154.7	136.0	97.2	109.4	119.5	81.2	99.4	112.7	76.5	93.9	112.9	113.6	132.4
B-217 (MW)	Oswego Sandstone	265.1	267.7	11.4	10.3	8.9	8.8	8.3	8.7	8.7	8.7	9.5	9.4	9.1	256.3	257.4	258.9	258.9	259.4	259	259.0	259.0	258.2	258.4	258.6
B-219 (MW)	Pulaski B	274.4	276.55	26.1	22.7	22	22.1	23.8	23.5	18.7	17.3	18.1	37.7	16.8	250.5	253.9	254.5	254.5	252.7	253	257.9	259.2	258.5	238.8	259.8
B-220 (MW)	Oswego Transition	275.0	277.09	71.1	18.7	17.6	16.2	15.5	15.2	15.3	15.3	15.4	16.1	15.8	206	258.4	259.5	260.9	261.6	261.9	261.8	261.8	261.7	261.0	261.3
B-221 (MW)	Pulaski C & Whetstone Gulf	280.2	282.43	48.7	19.3	14.5	12.6	10.8	10.4	8.9	10.9	14.2	13.3	11.7	233.7	263.1	267.9	269.8	271.7	272	273.5	271.5	268.2	269.1	270.7
B-230 (MW)	Pulaski C & Whetstone Gulf	282.6	284.77	43.3	42.2	41.6	49	45.1	44	50.2	47.3	46.3	69.0	48.6	241.5	242.6	243.2	235.8	239.7	240.8	234.6	237.5	238.5	215.8	236.2
B-233 (MW)	Pulaski C	275.5	277.68	51.4	64.7	64.7	34.2	32.9	32.6	32.7	32.1	31.9	32.0	32.0	226.3	213	242.3	243.5	244.8	245.1	245.0	245.6	245.8	245.7	245.7

Table 2.4-18—{Monitoring Well Elevations}

(Page 4 of 4)

Well ID	Aquifer Unit/ Geologic Formation	Ground Surface Elevation (ft)	Top of Casing Elevation (ft)	Depth to Water (ft)											Water Level Elevation (ft)										
				October 2007	November 2007	December2007	January 2008	February2008	March 2008	April 2008	May 2008	June 2008	July 2008	August 2008	October 2007	November 2007	December 2007	January 2008	February 2008	March 2008	April 2008	May 2008	June 2008	July 2008	August 2008
B-235 (MW)	Pulaski B & C	271.9	274.43	35.4	34.7	34.7	36.1	34.9	34.7	34.8	34.4	34.1	34.1	34.0	239	239.7	238.5	238.4	239.5	239.7	239.6	240.0	240.4	240.3	240.4
B-236 (MW)	Oswego Sandstone	272.1	274.31	12.4	11.3	11.3	8.9	8.4	8.8	8.6	8.6	9.2	9.0	8.9	261.9	263	265.1	265.4	265.9	265.5	265.7	265.7	265.2	265.3	265.4
B-238 (MW)	Pulaski C & Whetstone Gulf	279.2	281.33	97.2	68	68	5.2	3.3	4.8	4.5	3.7	6.1	5.0	5.1	184.1	213.3	247.8	276.2	278	276.6	276.8	277.6	275.2	276.4	276.3

Table 2.4-19—{Summary of Hydraulic Conductivities Onshore}

Geologic Formation	Parameter	Kh (ft/sec)	Kh (cm/sec)	Kh (ft/day)
Glacial Till	Max	2.0E-06	6.1E-05	1.7E-01
	Min	2.1E-07	6.3E-06	1.8E-02
	Mean	8.5E-07	2.6E-05	7.4E-02
	Geo Mean	5.5E-07	1.7E-05	4.7E-02
Oswego Sandstone	Max	3.2E-05	9.6E-04	2.7E+00
	Min	3.4E-10	1.0E-08	2.9E-05
	Mean	5.9E-06	1.8E-04	5.1E-01
	Geo Mean	6.7E-07	2.0E-05	5.8E-02
Oswego Transition Zone	Max	7.0E-07	2.1E-05	6.1E-02
	Min	6.4E-08	1.9E-06	5.5E-03
	Mean	2.7E-07	8.3E-06	2.3E-02
	Geo Mean	1.6E-07	5.0E-06	1.4E-02
Pulaski Formation Unit A	Max	5.9E-07	1.8E-05	5.1E-02
	Min	3.5E-08	1.1E-06	3.1E-03
	Mean	1.8E-07	5.6E-06	1.6E-02
	Geo Mean	1.3E-07	3.9E-06	1.1E-02
Pulaski Formation Unit B	Max	5.9E-06	1.8E-04	5.1E-01
	Min	2.2E-08	6.6E-07	1.9E-03
	Mean	1.5E-06	4.7E-05	1.3E-01
	Geo Mean	3.6E-07	1.1E-05	3.1E-02
Pulaski Formation Unit C	Max	3.4E-06	1.0E-04	2.9E-01
	Min	3.1E-08	9.4E-07	2.7E-03
	Mean	4.3E-07	1.3E-05	3.7E-02
	Geo Mean	9.8E-08	3.0E-06	8.5E-03
Whetstone Gulf Formation Unit A	Max	1.1E-07	3.2E-06	9.2E-03
	Min	2.9E-08	9.0E-07	2.5E-03
	Mean	5.8E-08	1.8E-06	5.0E-03
	Geo Mean	5.4E-08	1.6E-06	4.6E-03
Whetstone Gulf Formation Unit B	Max	9.5E-08	2.9E-06	8.2E-03
	Min	3.5E-08	1.1E-06	3.1E-03
	Mean	6.7E-08	2.1E-06	5.8E-03
	Geo Mean	6.4E-08	2.0E-06	5.5E-03

Table 2.4-20—{Summary of Hydraulic Conductivities Offshore}

Geologic Formation	Parameter	Kh (ft/sec)	Kh (cm/sec)	Kh (ft/day)
Pulaski Formation Units A, B, & C	Max	2.0E-05	6.2E-04	1.8E+00
	Min	1.1E-08	3.3E-07	9.3E-04
	Mean	2.5E-06	7.5E-05	2.1E-01
Pulaski Unit C	Max	7.7E-06	2.3E-04	6.6E-01
	Min	1.1E-08	3.3E-07	9.3E-04
	Mean	2.4E-06	7.4E-05	2.1E-01
	Geo Mean	1.3E-06	3.8E-05	1.1E-01
Whetstone Gulf Formation Unit A	Max	6.7E-07	2.1E-05	5.8E-02
	Min	3.2E-07	9.8E-06	2.8E-02
	Mean	4.6E-07	1.4E-05	4.0E-02
	Geo Mean	4.5E-07	1.4E-05	3.9E-02
Whetstone Gulf Formation Unit B	Max	1.8E-06	5.5E-05	1.6E-01
	Min	2.5E-08	7.7E-07	2.2E-03
	Mean	8.0E-07	2.4E-05	6.9E-02
	Geo Mean	4.1E-07	1.2E-05	3.5E-02

Table 2.4-21—{Monitoring Well Data: Geologic Units}

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		Top of Geologic Units - Elevations						MW Installation Sanded Zone - Depths		MW Installation Sanded Zone - Elevations				
Boring Number	Ground Elevation	Oswego Formation	Oswego Transition Zone	Pulaski Formation Unit A	Pulaski Formation Unit B	Pulaksi Formation Unit C	Whetstone Gulf Formation Unit A	Top of Sanded Zone	Bottom of Sanded Zone	Top of Sanded Zone	Bottom of Sanded Zone	Formation		
B-101 (MW)	265.34	242.84	202.84	180.34	150.34	137.84	83.34	117.9	134.5	147.44	130.84	9.6 Feet of Pulaski B	7.0 Feet of Pulaski C	
B-102 (MW)	255.58	240.58	205.58	193.08	151.08	115.58	80.6 20.6	104	125	151.58	130.58	0.5 Feet of Pulaski A	20.5 Feet of Pulaski B	
B-103 (MW)	255.95	240.58	NA	NA	NA	NA	NA	45.5	63.6	210.45	192.35	4.9 Feet of Oswego SS	12.5 Feet of Oswego Trans.	0.7 Feet of Pulaski A
B-104 (MW)	255.94	236.94	205.94	195.94	135.94	114.94	83.44	176.5	200.1	79.44	55.84	23.6 Feet of Whetstone Gulf A		
B-105 (MW)	255.94	236.94	NA	NA	NA	NA	NA	41	60	214.94	195.94	9.0 Feet of Oswego SS	10.0 Feet of Oswego Trans.	
B-106 (MW)	256.01	245.51	201.01	185.01	153.51	136.51	91.01	170	195	86.01	61.01	25.0 Feet of Whetstone Gulf A		
B-107 (MW)	256.18	245.51	NA	NA	NA	NA	NA	53.8	69	202.38	187.18	1.4 Feet of Oswego SS	13.8 Feet of Oswego Trans.	
B-108 (MW)	259.77	254.77	209.77	182.27	124.77	NA	NA	136.6	150	123.17	109.77	13.4 Feet of Pulaski B		
B-109 (MW)	262.51	257.51	210.01	192.51	150.01	130.01	NA	113	132	149.51	130.51	19.0 Feet of Pulaski B		
B-110 (MW)	267.10	263.1	199.6	179.6	146.1	117.1	67.6	201.8	225.2	65.30	41.90	23.4 Feet of Whetstone Gulf A		
B-111 (MW)	266.94	263.1	NA	NA	NA	NA	NA	71	87.5	195.94	179.44	16.3 Feet of Oswego Trans.	0.2 Feet of Pulaski A	
B-112 (MW)	282.85	263.85	225.35	165.35	132.35	115.85	98.85	167.7	191.8	115.15	91.05	16.3 Feet of Pulaski C	7.8 Feet of Whetstone Gulf A	

Table 2.4-21—{Monitoring Well Data: Geologic Units}

(Page 2 of 3)

		Top of Geologic Units - Elevations						MW Installation Sanded Zone - Depths		MW Installation Sanded Zone - Elevations				
Boring Number	Ground Elevation	Oswego Formation	Oswego Transition Zone	Pulaski Formation Unit A	Pulaski Formation Unit B	Pulaksi Formation Unit C	Whetstone Gulf Formation Unit A	Top of Sanded Zone	Bottom of Sanded Zone	Top of Sanded Zone	Bottom of Sanded Zone	Formation		
B-113 (MW)	283.04	263.85	NA	NA	NA	NA	NA	78.2	91.5	204.84	191.54	13.3 Feet of Oswego SS		
B-114 (MW)	273.98	269.98	194.98	178.98	141.4	129.98	83.98	130.4	146	143.58	127.98	2.2 Feet of Pulaski A	11.4 Feet of Pulaski B	2.0 Feet of Pulaski C
B-115 (MW)	274.28	269.98	NA	NA	NA	NA	NA	80	93.5	194.28	180.78	13.5 Feet of Oswego Trans.		
B-116 (MW)	294.82	275.82	239.82	NA	NA	149.82	NA	118	142	176.82	152.82			
B-117 (MW)	279.02	275.02	229.02	186.52	141.02	98.52	NA	140	167	139.02	112.02	27.0 Feet of Pulaski B		
B-118 (MW)	293.47	283.47	243.47	NA	NA	NA	NA	177.5	203	115.97	90.47			
B-119 (MW)	293.53	283.47	NA	NA	NA	NA	NA	47.5	70.2	246.03	223.33	2.6 Feet of Oswego SS	20.1 Feet of Oswego Trans.	
B-120 (MW)	266.96	NA	NA	NA	NA	NA	NA	4.5	14.5	262.46	252.46	In Soil		
B-121 (MW)	266.63	NA	NA	NA	NA	NA	NA	4.5	17.5	262.13	249.13	In Soil		
B-122 (MW)	282.54	NA	NA	NA	NA	NA	NA	4.5	19.6	278.04	262.94	In Soil		
B-123 (MW)	272.15	NA	NA	NA	NA	NA	NA	4.2	8	267.95	264.15	In Soil		
B-124 (MW)	263.25	NA	NA	NA	NA	NA	NA	5	12	258.25	251.25	In Soil		
B-201 (MW)	255.90	249.4	219.9	175.4	150.9	110.9	77.9	112	138	143.90	117.90	26.0 Feet of Pulaski B		
B-202 (MW)	256.16	249.4	NA	NA	NA	NA	NA	17	31	239.16	225.16	14.0 Feet of Oswego SS		
B-208 (MW)	265.26	249.26	218.76	176.26	155.26	121.26	NA	135.5	151	129.76	114.26	8.5 Feet of Pulaski B	7.0 Feet of Pulaski C	

Table 2.4-21—{Monitoring Well Data: Geologic Units}
(Page 3 of 3)

		Top of Geologic Units - Elevations						MW Installation Sanded Zone - Depths		MW Installation Sanded Zone - Elevations			
Boring Number	**Ground Elevation**	**Oswego Formation**	**Oswego Transition Zone**	**Pulaski Formation Unit A**	**Pulaski Formation Unit B**	**Pulaksi Formation Unit C**	**Whetstone Gulf Formation Unit A**	**Top of Sanded Zone**	**Bottom of Sanded Zone**	**Top of Sanded Zone**	**Bottom of Sanded Zone**	**Formation**	
B-209 (MW)	266.03	249.26	NA	NA	NA	NA	NA	22.5	52	243.53	214.03	24.8 Feet of Oswego SS	4.7 Feet of Oswego Trans.
B-216 (MW)	265.84	257.34	203.34	185.34	156.84	NA	NA	182	205	83.84	60.84		
B-217 (MW)	265.13	257.34	NA	NA	NA	NA	NA	26	50	239.13	215.13	24.0 Feet of Oswego SS	
B-219 (MW)	274.39	255.89	211.89	186.89	NA	NA	NA	127.5	146.4	146.89	127.99		
B-220 (MW)	275.03	255.89	NA	NA	NA	NA	NA	65.5	81	209.53	194.03		
B-221 (MW)	280.15	253.65	207.65	175.65	149.15	118.65	79.65	197	211	83.15	69.15	3.5 Feet of Pulaski C	10.5 Feet of Whetstone Gulf A
B-230 (MW)	282.64	261.14	199.64	175.14	149.64	128.14	98.64	183	204	99.64	78.64	1.0 Feet of Pulaski C	20.0 Feet of Whetstone Gulf A
B-233 (MW)	275.47	259.47	211.97	178.97	154.47	146.47	NA	135	150	140.47	125.47	15.0 Feet of Pulaski C	
B-235 (MW)	271.94	261.94	201.94	181.94	155.94	128.44	NA		146.9		125.04		
B-236 (MW)	272.08	261.94	NA	NA	NA	NA	NA	23	36	249.08	236.08	13.0 Feet of Oswego SS	
B-238 (MW)	279.21	260.21	197.21	173.21	148.21	119.21	90.21	187.5	211	91.71	68.21	1.5 Feet of Pulaski C	22.0 Feet of Whetstone Gulf A

Table 2.4-22—{Public Groundwater Supplies within a 25-mile Radius of the NMP3NPP Site}

Water System Name	County Served	Population Served	Depth of Well (ft)	Aquifer Unit	Yield (gpm)
West Phoenix Co., Inc.	Oswego	2,251	52	NA	NA
Village of Phoenix	Oswego	NA	25	Sand Ridge	700
Village of Phoenix - Kline Well	Oswego	NA	44	Sand Ridge	400
Village of New Haven	Oswego	2,930	53	NA	25
Town of Sandy Creek	Oswego	3,863	25	Lacona-Williamstown	400
Town of Sandy Creek	Oswego	NA	32	Lacona-Williamstown	200
Village of Central Square	Oswego	1,646	21	NA	425
Orwell Public Water Supply	Oswego	1,254	20	Lacona-Williamstown	NA
Village of Mexico Well #2	Oswego	1,572	35	Alluvium	0.3 Mgpd
Village of Mexico Well	Oswego	NA	40	Alluvium	NA
Village of Mexico Well	Oswego	NA	40	Alluvium	Na
Town of Fulton	Oswego	11,855	30 to 70	Alluvium	2.5 Mgpd
Town of Pulaski	Oswego	2,938	15	Lacona-Williamstown	NA
Village of Mannsville	Jefferson	400	NA	Lacona-Williamstown	NA
Ellesburg #1 (Pierrepont Manor)	Jefferson	269	NA	Lacona-Williamstown	NA
Ellesburg #2 (Belleville)	Jefferson	3,541	NA	NA	NA
Village of Cato	Cayuga	2,744	55	NA	0.033 Mgpd
Village of Cato	Cayuga	NA	55	NA	NA
Village of Cato	Cayuga	NA	40	NA	NA
Village of Fair Haven	Cayuga	884	NA	NA	NA
Red Creek Village	Wayne	521	NA	NA	NA
Red Creek North WD	Wayne	NA	NA	NA	NA
Town of Lysander	Onondaga	19,285	NA	NA	NA
Town of Lysander	Onondaga	NA	NA	NA	NA
Town of Baldswinsville	Onondaga	7,053	93	Bedrock	1 Mgpd
Town of Baldswinsville	Onondaga	NA	NA	Alluvium	NA
Town of Baldswinsville	Onondaga	NA	NA	Alluvium	NA
Town of Baldswinsville	Onondaga	NA	NA	Alluvium	NA
Population Served (approx.):		35,022			

Notes:

1. The Town of Fulton operates 12 wells which are 30 to 70 feet deep.
2. The village of New Haven is planning to switch to surface water supplies in 2008.
3. The village of Central Square has switched to surface water supplies; it is not known whether this well has been decommisisoned or is held in reserve.
4. The Towns of Lysanders and Baldswinsville now use surface water from Lake Ontario as their water supply. For this reason we did not include them in the groundwater population total. It is not known whether these wells have been decommissioned.
5. The towns of Cleveland and Constantia also have groundwater or spring-fed water supplies; however they are more than 25 miles from the NMP3NPP site.

References: OC, 1992; USGS, 1989, USGS, 2002a, CNYRP, 1979; WCHD, 2008; OCHD, 2008; OCWA, 2008; US Census, 2000.

Table 2.4-23—{Commercial Water Supplies: Oswego County within a 25-mile Radius of the NMP3NPP Site}
(Page 1 of 2)

Water System Name	Population Served	Depth of Well (ft)	Aquifer Unit	Yield (gpm)
Amboy School	NA	55	NA	NA
American Tel	NA	189	NA	8
Andel Mobile Home Park	100	NA	NA	NA
Bear's Sleepy Hollow Campground	NA	90	NA	NA
Best Mobile Home Park	15	NA	NA	NA
Billytown Café	NA	100	NA	NA
Bisbo's Mobile Home Park	100	NA	NA	NA
Brady's Trailer Park	18	NA	NA	NA
Camp Glengarra	NA	45	Lacona-Williamstown	NA
Camp Zerbe	NA	15	Lacona-Williamstown	NA
Cedar Village Apartments	48	NA	NA	NA
Century House	NA	15	NA	NA
Clark Lane Mobile Home Sites	NA	NA	NA	NA
Conifer Mobile Village	375	NA	NA	NA
Courty Acres Mobile Home Park	20	NA	NA	NA
Crestview Mobile Home Park	44	NA	NA	NA
Crisafulli Mobile Home Park	60	NA	NA	NA
Dairyman's League	NA	80	NA	NA
Deer Run Mobile Home Park	200	NA	NA	NA
Eason Mobile Home Park	80	NA	NA	NA
Egan Mobile Home Park	48	NA	NA	NA
Emerald Crest Golf Course	NA	10	Sand Ridge	NA
Fischer	NA	88	NA	8
Freeman's Motel	NA	12	NA	NA
Fulton Great Bear 3B	NA	90	NA	NA
Furlong Mobile Home Park	12	NA	NA	NA
Gilbert Mobile Home Park	18	NA	NA	NA
Great Bear Spring Co.	NA	10	NA	50
Green Acres Mobile Court	126	NA	NA	NA
Groman Shores, Inc.	NA	NA	NA	NA
Hastings Inn	NA	NA	NA	NA
Holly Park Mobile Home Park	39	NA	NA	NA
Idle Wheels Trailer Park, Inc.	150	NA	NA	NA
Indian Hills Mobile Home Park	300	180	NA	NA
Island Road Mobile Home Park	25	NA	NA	NA
J and J Trailer Lodge	160	NA	NA	NA
J&W Mobile Home Park	18	NA	NA	NA
Ken's Quiet Acres	39	NA	NA	NA
Ken's Trailer Court	100	NA	NA	NA
Kerfien Mobile Home Park	100	NA	NA	NA
Kozy Kort Trailer Park	45	NA	NA	NA
Lake Effect Inn	NA	NA	NA	NA
Locust Grove Trailer Park	150	18	NA	NA
Lydon Lawns Mobile Park #1	250	127	NA	NA
Lydon Lawns Mobile Park #2	NA	74	NA	NA
Lynart Enterprises	25	NA	NA	NA
Maple Grove Trailer Park	100	NA	NA	NA

Table 2.4-23—{Commercial Water Supplies: Oswego County within a 25-mile Radius of the NMP3NPP Site}
(Page 2 of 2)

Water System Name	Population Served	Depth of Well (ft)	Aquifer Unit	Yield (gpm)
Mapleview Trailer Park	27	NA	NA	NA
Mexico Center School District	NA	29	NA	10
Mobile City Trailer Park	180	NA	NA	NA
NIMO Howard Rd Facility	NA	180	NA	NA
Northridge Acres	100	NA	NA	NA
Northway Manor Mobile Home Park #1	175	200	NA	NA
Northway Manor Mobile Home Park #2	NA	200	NA	NA
Palermo Trailer Park	NA	18	Sand Ridge	NA
Partridge Mobile Home Village	175	NA	NA	NA
Ponderosa Mobile Home Park	NA	40	NA	NA
Powell Mobile Home Park - Rte 3	72	NA	NA	NA
Powell's 85 Mobile Home Park	20	NA	NA	NA
Rainbow Shores Hotel	NA	NA	NA	NA
Riverview Mobile Court	54	NA	NA	NA
Rural Acres Mobile Home Park	18	NA	NA	NA
S & E Mobile Home Park	80	75	NA	NA
S & E Mobile Home Park	NA	85	NA	NA
Sandbridge Mobile Court	600	NA	NA	NA
Schoeller Well B7	NA	60	Lacona-Williamstown	NA
Scholler Paper Company	NA	49	NA	NA
Scruton's Mobile Home Park	18	NA	NA	NA
Silver rock Mobile Home park	84	NA	NA	NA
Spruce Grove Mobile Home Park	165	85	NA	NA
Sundown Mobile Home Park	50	NA	NA	NA
Wildwood Mobile Home Estates	36	NA	NA	NA
Williams Mobile Home Park	54	130	NA	NA
Winn's Trailer Park	63	57	NA	NA
Wooded Acres Mobile Home Park	144	NA	NA	NA
Woodland Mobile Home Haven	25	NA	NA	NA
Yellow Rose Mobile Home Park	30	NA	NA	NA

Note:

1. NA = Information was not available.

References:

OC, 1992; USGS, 1989; USGS, 2002a; CNYRP, 1979

Table 2.4-24—{Commercial Water Supplies Cayuga, Wayne, Jefferson and Onondaga Counties within a 25-mile radius of the NMP3NPP Site}

Water System Name	County	Town
Barbs Goodies	Cayuga	Sterling
Dudley Water Supply	Cayuga	Cato
Express Mart 360	Cayuga	Cato
Pit Stop #9	Cayuga	Sterling
Shady Shores Campground	Cayuga	Fair Haven
Sterling Creek Campground	Cayuga	Sterling
Sterling Pines	Cayuga	Sterling
Sterling Renaissance Festival	Cayuga	Sterling
Sutter Creek Campground	Cayuga	Sterling
Holiday Harbor Resort	Wayne	Red Creek
Lake Bluff Campgrounds	Wayne	Red Creek
Main Street Tavern	Wayne	Red Creek
Route 104 Store	Wayne	Red Creek
Baldwinsville Christian Academy	Onondaga	Baldwinsville
Flo Jo's	Onondaga	Baldwinsville
Little Utica Hotel	Onondaga	Little Utica
Old Lamson Station	Onondaga	Phoenix
81-11 Motel	Jefferson	Mannsville
Alexander Corners General Store	Jefferson	Alexander Corners
Aspinwall Motel	Jefferson	Aspinwall
Belleville-Henderson Central School	Jefferson	Belleville
Fram Pride	Jefferson	Belleville
Manor House	Jefferson	Pierrepont Manor
Manor Inn	Jefferson	Pierrepont Manor
Pierrepont General Store	Jefferson	Pierrepont Manor
Sharps Bulk Food	Jefferson	Pierrepont Manor
Wayside Inn-Jefferson County	Jefferson	Mannsville

References:

OC, 1992; USGS, 1989; USGS, 2002a; CNYRP, 1979; WCHD, 2008; OCHD, 2008; OCWA, 2008; CCHD, 2008

Table 2.4-25—{NMP3NPP Summary of Accidental Release Sources}

Component Name	Location	Tank Description / Purpose	No. of Tanks	Component Volume (ft^3)	Total Storage Volume (ft^3)	Approximate Building Bottom Elevation (ft)	Subsurface Material at Building Bottom	Bottom Tank Elevation (ft)
Reactor Coolant Storage Tanks	Nuclear Auxiliary Building	Provide storage of Reactor Coolant (RC) from the Reactor Coolant System (RCS) so that un-delayed return to full power can be accomplished from a xenon-free cold shutdown state. Also provide two days of load follow operations if the Coolant treatment system is not available. Two RCSTs tanks also provide blowdown retention from the Nuclear Island Drain and Vent System (NIDVS) safety valves discharge so that RC can be recovered and subsequently processed in the CTS.	6	4,061	24,366	221	Mid-Oswego Sandstone Formation	251
Liquid Waste Storage Tank	Radioactive Waste Building	Storage of radioactive effluents produced throughout the plant	5	2,473	12,365	230	Mid-Oswego Sandstone Formation	249

Table 2.4-26—{Reactor Coolant Storage Tank Bounding Values for Component Radionuclide Inventory}

Radioisotope	Concentration (µCi/mL)	Radioisotope	Concentration (µCi/mL)
H-3	1.0E+00	Te-127m	4.4E-04
Na-24	3.7E-02	Te-127*	0.0E+00
Cr-51	2.0E-03	I-129	4.6E-08
Mn-54	1.0E-03	I-130	5.0E-02
Fe-55	7.6E-04	Te-129m	1.5E-03
Fe-59	1.9E-04	Te-129*	2.4E-03
Co-58	2.9E-03	Te-131m	3.7E-03
Co-60	3.4E-04	Te-131*	2.6E-03
Zn-65	3.2E-04	I-131*	7.4E-01
Br-83	3.2E-02	Te-132	4.1E-02
Kr-83m*	0.0E+00	I-132*	3.7E-01
Br-84	1.7E-02	I-133	1.3E+00
Br-85	2.0E-03	Xe-133m*	0.0E+00
Kr-85*	0.0E+00	Xe-133*	0.0E+00
Rb-88	1.0E+00	Te-134	6.7E-03
Rb-89	4.7E-02	I-134*	2.4E-01
Sr-89*	6.3E-04	I-135	7.9E-01
Sr-90	3.3E-05	Xe-135m*	0.0E+00
Y-90*	7.7E-06	Xe-135*	0.0E+00
Sr-91	1.0E-03	Cs-134	1.7E-01
Y-91m*	5.2E-04	Cs-136	5.3E-02
Y-91*	8.1E-05	Cs-137	1.1E-01
Sr-92	1.7E-04	Ba-137m*	1.0E-01
Y-92*	1.4E-04	Cs-138	2.2E-01
Y-93	6.5E-05	Ba-140	6.2E-04
Zr-95	9.3E-05	La-140*	1.6E-04
Nb-95m*	0.0E+00	Ce-141	8.9E-05
Nb-95*	9.3E-05	Ce-143	7.6E-05
Mo-99	1.1E-01	Pr-143*	8.8E-05
Tc-99m*	4.6E-02	Ce-144	6.9E-05
Ru-103	7.7E-05	Pr-144m*	0.0E+00
Rh-103m	6.8E-05	Pr-144*	6.9E-05
Ru-106	2.7E-05	W-187	1.8E-03
Rh-106*	2.7E-05	Np-239	8.7E-03
Ag-110m	2.0E-07	Pu-239*	0.0E+00
Ag-110*	0.0+00		

Note:

* Decay chain progeny

Table 2.4-27—{Transport Analysis Considering Advection and Radioactive Decay}

(Page 1 of 3)

Radioisotope	Decay Products	Half-life $t_{1/2}$ (days)	d_{12}	d_{13}	d_{23}	Decay Rate (days^{-1})	Bounding Concentration (µCi/mL)	K1	K2	K3	Groundwater Concentration (µCi/mL)	ECL (µCi/mL)	Exceedance
H-3		4.51E+03				1.54E-04	1.0E+00				3.0E-01	1.00E-03	Exceeds
Na-24		6.25E-01				1.11E+00	3.7E-02				0.0E+00	5.00E-05	Does not Exceeed
Cr-51		2.77E+01				2.50E-02	2.0E-03				7.3E-89	5.00E-04	Does not Exceeed
Mn-54		3.13E+02				2.21E-03	1.0E-03				2.7E-11	3.00E-05	Does not Exceeed
Fe-55		9.86E+02				7.03E-04	7.6E-04				3.0E-06	1.00E-04	Does not Exceeed
Fe-59		4.45E+01				1.56E-02	1.9E-04				1.2E-57	1.00E-05	Does not Exceeed
Co-58		7.08E+01				9.79E-03	2.9E-03				1.1E-36	2.00E-05	Does not Exceeed
Co-60		1.93E+03				3.59E-04	3.4E-04				2.0E-05	3.00E-06	Exceeds
Zn-65		2.44E+02				2.84E-03	3.2E-04				6.4E-14	5.00E-06	Does not Exceeed
Br-83		9.96E-02				6.96E+00	3.2E-02				0.0E+00	9.00E-04	Does not Exceeed
	Kr-83m	7.63E-02	1.0000			9.08E+00	0.0E+00	1.37E-01	-1.37E-01		0.0E+00	NA[3]	
Br-84		2.21E-02				3.14E+01	1.7E-02				0.0E+00	4.00E-04	Does not Exceeed
Br-85		2.01E-03				3.44E+02	2.0E-03				0.0E+00	NA	
	Kr-85m	1.87E-01	0.9984			3.71E+00	0.0E+00	-2.17E-05	2.17E-05		0.0E+00	NA	
	Kr-85	3.92E+03		0.0163	0.2110	1.77E-04	0.0E+00	-1.44E-11	-2.19E-10	2.33E-10	5.8E-11	NA	
Rb-88		1.24E-02				5.59E+01	1.0E+00				0.0E+00	4.00E-04	Does not Exceeed
Rb-89		1.06E-02				6.54E+01	4.7E-02				0.0E+00	9.00E-04	Does not Exceeed
	Sr-89	5.05E+01	1.0000			1.37E-02	6.3E-04	-9.87E-06	6.40E-04		8.7E-51	8.00E-06	Does not Exceeed
Sr-90		1.06E+04				6.54E-05	3.3E-05				2.0E-05	5.00E-07	Exceeds
	Y-90	2.67E+00	1.0000			2.60E-01	7.7E-06	3.30E-05	-2.53E-05		2.0E-05	7.00E-06	Exceeds
Sr-91		3.96E-01				1.75E+00	1.0E-03				0.0E+00	2.00E-05	Does not Exceeed
	Y-91m	3.45E-02	0.5780			2.01E+01	5.2E-04	6.33E-04	-1.13E-04		0.0E+00	2.00E-03	Does not Exceeed
	Y-91	5.85E+01		0.4220	1.0000	1.18E-02	8.1E-05	-7.19E-06	6.68E-08	8.81E-05	3.1E-45	8.00E-06	Does not Exceeed
Sr-92		1.13E-01				6.13E+00	1.7E-04				0.0E+00	4.00E-05	Does not Exceeed
	Y-92	1.48E-01	1.0000			4.68E+00	1.4E-04	-5.47E-04	6.87E-04		0.0E+00	4.00E-05	Does not Exceeed
Y-93		4.21E-01				1.65E+00	6.5E-05				0.0E+00	2.00E-05	Does not Exceeed
Zr-95		6.40E+01				1.08E-02	9.3E-05				9.8E-42	2.00E-05	Does not Exceeed

Hydrogeologic Parameters:
- Hydraulic Conductivity: 0.28 ft/day
- Effective Fracture Porosity: 3%
- Ground Gradient: 0.014 ft/ft
- Travel Length: 1040 ft
- Travel Time: 7862 days

Table 2.4-27—{Transport Analysis Considering Advection and Radioactive Decay}

(Page 2 of 3)

Radioisotope	Decay Products	Half-life $t_{1/2}$ (days)	d_{12}	d_{13}	d_{23}	Decay Rate (days^{-1})	Bounding Concentration (µCi/mL)	K1	K2	K3	Groundwater Concentration (µCi/mL)	ECL (µCi/mL)	Exceedance
	Nb-95m	3.61E+00	0.0070			1.92E-01	0.0E+00	6.90E-07	-6.90E-07		7.2E-44	3.00E-05	Does not Exceeed
	Nb-95	3.52E+01		0.9930	1.0000	1.97E-02	9.3E-05	2.07E-04	7.88E-08	-1.14E-04	2.2E-41	3.00E-05	Does not Exceeed
Mo-99		2.75E+00				2.52E-01	1.1E-01				0.0E+00	2.00E-05	Does not Exceeed
	Tc-99m	2.51E-01	0.8760			2.76E+00	4.6E-02	1.06E-01	-6.00E-02		0.0E+00	1.00E-03	Does not Exceeed
Ru-103		3.93E+01				1.76E-02	7.7E-05				4.6E-65	3.00E-05	Does not Exceeed
	Rh-103m	3.90E-02	0.9970			1.78E+01	6.8E-05	7.68E-05	-8.85E-06		4.6E-65	6.00E-03	Does not Exceeed
Ru-106		3.68E+02				1.88E-03	2.7E-05				1.0E-11	3.00E-06	Does not Exceeed
	Rh-106	3.45E-04	1.0000			2.01E+03	2.7E-05	2.70E-05	-2.53E-11		1.0E-11	NA	
Ag-110m		2.50E+02				2.77E-03	2.0E-07				6.8E-17	6.00E-06	Does not Exceeed
	Ag-110	2.85E-04	0.0133			2.43E+03	0.0E+00	2.66E-09	-2.66E-09		9.1E-19	NA	
Te-127m		1.09E+02				6.36E-03	4.4E-04				8.5E-26	9.00E-06	Does not Exceeed
	Te-127	3.90E-01	0.9760			1.78E+00	0.0E+00	4.31E-04	-4.31E-04		8.4E-26	1.00E-04	Does not Exceeed
I-129		5.73E+09				1.21E-10	4.6E-08				4.6E-08	2.00E-07	Does not Exceeed
I-130		5.15E-01				1.35E+00	5.0E-02				0.0E+00	2.00E-05	Does not Exceeed
Te-129m		3.36E+01				2.06E-02	1.5E-03				5.5E-74	7.00E-06	Does not Exceeed
	Te-129	4.83E-02	0.6500			1.44E+01	2.4E-03	9.76E-04	1.42E-03		3.6E-74	4.00E-04	Does not Exceeed
Te-131m		1.25E+00				5.55E-01	3.7E-03				0.0E+00	8.00E-06	Does not Exceeed
	Te-131	1.74E-02	0.2220			3.98E+01	2.6E-03	8.33E-04	1.77E-03		0.0E+00	8.00E-05	Does not Exceeed
	I-131	8.04E+00		0.7780	1.0000	8.62E-02	7.4E-01	-6.83E-04	-3.83E-06	7.41E-01	3.2E-295	1.00E-06	Does not Exceeed
Te-132		3.26E+00				2.13E-01	4.1E-02				0.0E+00	9.00E-06	Does not Exceeed
	I-132	9.58E-02	1.0000			7.24E+00	3.7E-01	4.22E-02	3.28E-01		0.0E+00	1.00E-04	Does not Exceeed
I-133		8.67E-01				7.99E-01	1.3E+00				0.0E+00	7.00E-06	Does not Exceeed
	Xe-133m	2.19E+00	0.0290			3.17E-01	0.0E+00	-2.47E-02	2.47E-02		0.0E+00	NA	
	Xe-133	5.25E+00		0.9710	1.0000	1.32E-01	0.0E+00	-2.45E-01	-1.77E-02	2.63E-01	0.0E+00	NA	
Te-134		2.90E-02				2.39E+01	6.7E-03				0.0E+00	3.00E-04	Does not Exceeed
	I-134	3.65E-02	1.0000			1.90E+01	2.4E-01	-2.59E-02	2.66E-01		0.0E+00	4.00E-04	Does not Exceeed
I-135		2.75E-01				2.52E+00	7.9E-01				0.0E+00	3.00E-05	Does not Exceeed

Hydrogeologic Parameters:

- Hydraulic Conductivity: 0.28 ft/day
- Effective Fracture Porosity: 3%
- Ground Gradient: 0.014 ft/ft
- Travel Length: 1040 ft
- Travel Time: 7862 days

Table 2.4-27—{Transport Analysis Considering Advection and Radioactive Decay}

(Page 3 of 3)

Radioisotope	Decay Products	Half-life $t_{1/2}$ (days)	d_{12}	d_{13}	d_{23}	Decay Rate (days^{-1})	Bounding Concentration (µCi/mL)	K1	K2	K3	Groundwater Concentration (µCi/mL)	ECL (µCi/mL)	Exceedance
	Xe-135m	1.06E-02	0.1540			6.53E+01	0.0E+00	1.27E-01	-1.27E-01		0.0E+00	NA	
	Xe-135	3.79E-01		0.8460	1.0000	1.83E+00	0.0E+00	-2.10E+00	3.65E-03	2.10E+00	0.0E+00	NA	
Cs-134		7.53E+02				9.21E-04	1.7E-01				1.2E-04	9.00E-07	Exceeds
Cs-136		1.31E+01				5.29E-02	5.3E-02				1.2E-182	6.00E-06	Does not Exceeed
Cs-137		1.10E+04				6.30E-05	1.1E-01				6.7E-02	1.00E-06	Exceeds
	Ba-137m	1.77E-03	0.9460			3.92E+02	1.0E-01	1.04E-01	-4.06E-03		6.3E-02	NA	
Cs-138		2.24E-02				3.09E+01	2.2E-01				0.0E+00	4.00E-04	Does not Exceeed
Ba-140		1.27E+01				5.46E-02	6.2E-04				2.8E-190	8.00E-06	Does not Exceeed
	La-140	1.68E+00	1.0000			4.13E-01	1.6E-04	7.15E-04	-5.55E-04		3.2E-190	9.00E-06	Does not Exceeed
Ce-141		3.25E+01				2.13E-02	8.9E-05				1.3E-77	3.00E-05	Does not Exceeed
Ce-143		1.38E+00				5.02E-01	7.6E-05				0.0E+00	2.00E-05	Does not Exceeed
	Pr-143	1.36E+01	1.0000			5.11E-02	8.8E-05	-8.60E-06	9.66E-05		3.8E-179	2.00E-05	Does not Exceeed
Ce-144		2.84E+02				2.44E-03	6.9E-05				3.2E-13	3.00E-06	Does not Exceeed
	Pr-144m	5.00E-03	0.0178			1.39E+02	0.0E+00	1.23E-06	-1.23E-06		5.7E-15	NA	
	Pr-144	1.20E-02		0.9822	0.9990	5.78E+01	6.9E-05	6.90E-05	8.76E-07	-8.78E-07	3.2E-13	6.00E-04	Does not Exceeed
W-187		9.96E-01				6.96E-01	1.8E-03				0.0E+00	3.00E-05	Does not Exceeed
Np-239		2.36E+00				2.94E-01	8.7E-04				0.0E+00	2.00E-05	Does not Exceeed
	Pu-239	8.79E+06	1.0000			7.89E-08	0.0E+00	-2.34E-10	2.34E-10		2.3E-10	2.00E-08	Does not Exceeed

Hydrogeologic Parameters:

- Hydraulic Conductivity: 0.28 ft/day
- Effective Fracture Porosity: 3%
- Ground Gradient: 0.014 ft/ft
- Travel Length: 1040 ft
- Travel Time: 7862 days

Notes:

1. See Table Table 2.4-26 for reference bounding concentrations.
2. Half-lives and decay products are from NUREG/CR-5512 (NRC, 1992) and ORNL/TM-9452 (ORNL, 1985).
3. NA indicates Effluent Concentration Limit (ECL) is not available.

Table 2.4-28—{Transport Analysis Considering Adsorption, Advection and Radioactive Decay}

Radioisotope	Decay Products	Half-life $t_{1/2}$ (days)	d_{12}	Decay Rate (days^{-1})	Bounding Concentration (µCi/mL)	Distribution Coefficient, Kd (mL/g)	Concentration after adsorption			Travel Time (days)	Groundwater Concentration (µCi/mL)	ECL (µCi/mL)	Exceedance
							(µCi/mL)	K1	K2				
H-3		4.51E+03		1.54E-04	1.0E+00	NA[4]	1.0E+00			7862	3.0E-01	1.00E-03	Exceeds
Co-60		1.93E+03		3.59E-04	3.4E-04	349	1.2E-07			7862	7.4E-09	3.00E-06	Does not Exceeed
Sr-90		1.06E+04		6.54E-05	3.3E-05	1	4.9E-06			7862	2.9E-06	5.00E-07	Exceeds
	Y-90	2.67E+00	1.0000	2.60E-01	7.7E-06	NA[4]	7.7E-06	4.85E-06	2.85E-06	7862	2.9E-06	7.00E-06	Does not Exceeed
Cs-134		7.53E+02		9.21E-04	1.7E-01	401	5.4E-05			7862	3.9E-08	9.00E-07	Does not Exceeed
Cs-137		1.10E+04		6.30E-05	1.1E-01	432	3.3E-05			7862	2.0E-05	1.00E-06	Exceeds

Hydrogeologic Parameters:

Hydraulic Conductivity: 0.28 ft/ft
Effective Fracture Porosity: 3%
Groundwater Gradient: 0.014 ft/ft
Travel Length: 1040 ft
Travel Time: 7862 days

Adsorption:

Specific Gravity of Engineered Fill: 2.6
Porosity of Engineered Fill: 0.25
Density of Water: 1 g/ml

Notes:

1. See Table 2.4-26 for reference bounding concentrations.
2. Half-lives and decay products are from NUREG/CR-5512 (NRC, 1992) and ORNL/TM-9452 (ORNL, 1985).
3. Distribution coefficients are based on averages of values measured from laboratory batch tests of Streeter-Rathburn engineered backfill samples, corrected for sample gradation
4. H-3 and Y-90 are not considered to be readily adsorbed.

Table 2.4-29—{Transport Analysis Considering Advection, Radioactive Decay, and Retardation}

Radionuclide	Groundwater Concentration due to Advection/Decay Retardation (µCi/ml)	ECL (µCi/ml)	Above ECL?
H-3	2.99E-01	1.00E-03	Yes
Co-60	7.41E-09	3.00E-06	No
Sr-90	2.90E-06	5.00E-07	Yes
Y-90	2.90E-06	7.00E-06	No
Cs-134	3.91E-08	9.00E-07	No
Cs-137	1.99E-05	1.00E-06	Yes

Table 2.4-30—{Nuclide Activities at Potable Water Supply}

Radionuclide	Groundwater Concentration upon Entrance to Lake Ontario (µCi/ml) [1]	Concentration at Potable Water Supply Intake (µCi/ml) [2]	ECL (µCi/ml) [3]	Potable Water Supply Concentration / ECL
H-3	2.99E-01	4.27E-04	1.00E-03	4.27E-01
Sr-90	2.90E-06	4.14E-09	5.00E-07	8.29E-03
Y-90	2.90E-06	4.15E-09	7.00E-06	5.92E-04
Cs-137	1.99E-05	2.84E-08	1.00E-06	2.84E-04

Notes:

1. Values from Table 2.4-29
2. Potable Water Supply Intake Concentration = groundwater concentration/ dilution factor
3. Values from 10 CFR 20, Appendix B, Table 2, Column 2

Table 2.4-31—{Compliance with 10 CFR 20, Appendix B, Table 2}
(Page 1 of 2)

Radioisotope	Concentration due to Advection/Decay (µCi/ml)	Concentration due to Advection/Decay/ Retardation (µCi/ml)	Concentration due to Advection/Decay/ Retardation/ Dilution (µCi/ml)	Minimum Value (µCi/ml)
H-3	3.0E-01	2.99E-01	4.27E-04	4.27E-04
Na-24	0.0E+00			0.0E+00
Cr-51	7.3E-89			7.3E-89
Mn-54	2.7E-11			2.7E-11
Fe-55	3.0E-06			3.0E-06
Fe-59	1.2E-57			1.2E-57
Co-58	1.1E-36			1.1E-36
Co-60	2.0E-05	7.41E-09		2.30E-09
Zn-65	6.4E-14			6.4E-14
Br-83	0.0E+00			0.0E+00
Kr-83m	0.0E+00			0.0E+00
Br-84	0.0E+00			0.0E+00
Br-85	0.0E+00			0.0E+00
Kr-85m	0.0E+00			0.0E+00
Kr-85	5.8E-11			5.8E-11
Rb-88	0.0E+00			0.0E+00
Rb-89	0.0E+00			0.0E+00
Sr-89	8.7E-51			8.7E-51
Sr-90	2.0E-05	2.90E-06	4.14E-09	4.14E-09
Y-90	2.0E-05	2.90E-06	4.15E-09	4.15E-09
Sr-91	0.0E+00			0.0E+00
Y-91m	0.0E+00			0.0E+00
Y-91	3.1E-45			3.1E-45
Sr-92	0.0E+00			0.0E+00
Y-92	0.0E+00			0.0E+00
Y-93	0.0E+00			0.0E+00
Zr-95	9.8E-42			9.8E-42
Nb-95m	7.2E-44			7.2E-44
Nb-95	2.2E-41			2.2E-41
Mo-99	0.0E+00			0.0E+00
Tc-99m	0.0E+00			0.0E+00
Ru-103	4.6E-65			4.6E-65
Rh-103m	4.6E-65			4.6E-65
Ru-106	1.0E-11			1.0E-11
Rh-106	1.0E-11			1.0E-11
Ag-110m	6.8E-17			6.8E-17
Ag-110	9.1E-19			9.1E-19
Te-127m	8.5E-26			8.5E-26
Te-127	8.4E-26			8.4E-26
I-129	4.6E-08			4.6E-08
I-130	0.0E+00			0.0E+00
Te-129m	5.5E-74			5.5E-74
Te-129	3.6E-74			3.6E-74
Te-131m	0.0E+00			0.0E+00
Te-131	0.0E+00			0.0E+00
I-131	3.2E-295			3.2E-295
Te-132	0.0E+00			0.0E+00

Table 2.4-31—{Compliance with 10 CFR 20, Appendix B, Table 2}
(Page 2 of 2)

Radioisotope	Concentration due to Advection/Decay (μCi/ml)	Concentration due to Advection/Decay/ Retardation (μCi/ml)	Concentration due to Advection/Decay/ Retardation/ Dilution (μCi/ml)	Minimum Value (μCi/ml)
I-132	0.0E+00			0.0E+00
I-133	0.0E+00			0.0E+00
Xe-133m	0.0E+00			0.0E+00
Xe-133	0.0E+00			0.0E+00
Te-134	0.0E+00			0.0E+00
I-134	0.0E+00			0.0E+00
I-135	0.0E+00			0.0E+00
Xe-135m	0.0E+00			0.0E+00
Xe-135	0.0E+00			0.0E+00
Cs-134	1.2E-04	3.91E-08		3.91E-08
Cs-136	1.2E-182			1.2E-182
Cs-137	6.7E-02	1.99E-05	2.84E-08	2.84E-08
Ba-137m	6.3E-02			6.3E-02
Cs-138	0.0E+00			0.0E+00
Ba-140	2.8E-190			2.8E-190
La-140	3.2E-190			3.2E-190
Ce-141	1.3E-77			1.3E-77
Ce-143	0.0E+00			0.0E+00
Pr-143	3.8E-179			3.8E-179
Ce-144	3.2E-13			3.2E-13
Pr-144m	5.7E-15			5.7E-15
Pr-144	3.2E-13			3.2E-13
W-187	0.0E+00			0.0E+00
Np-239	0.0E+00			0.0E+00
Pu-239	2.3E-10			2.3E-10

Figure 2.4-1—{NMP3NPP Site Vicinity}

Figure 2.4-2—{Site Layout}

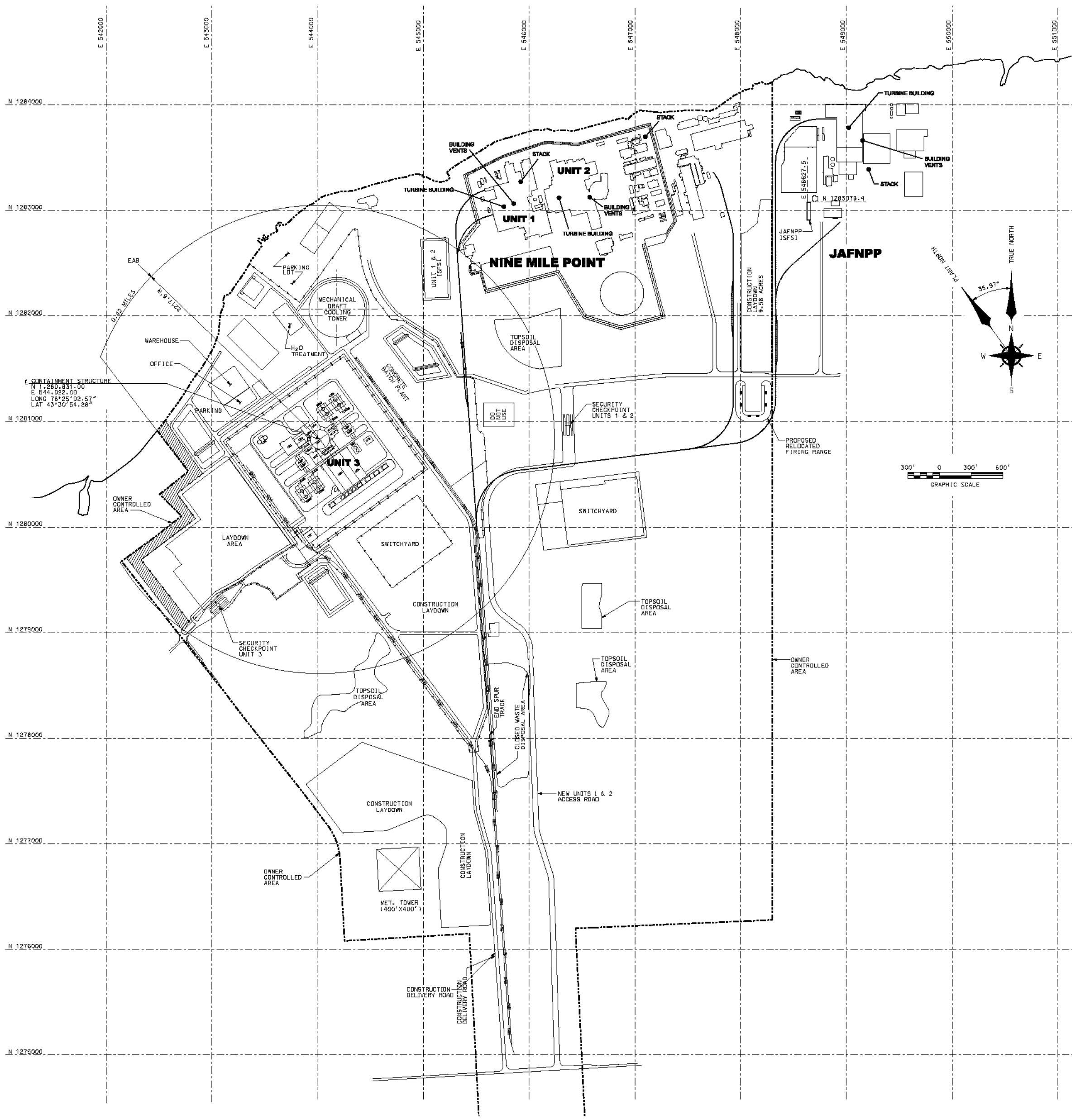


Figure 2.4-3—{FEMA Flood Insurance Rate Map for the Site (Lakeview Creek)}

Figure 2.4-4—{FEMA Flood Insurance Rate Map for the Site (Lake Ontario)}

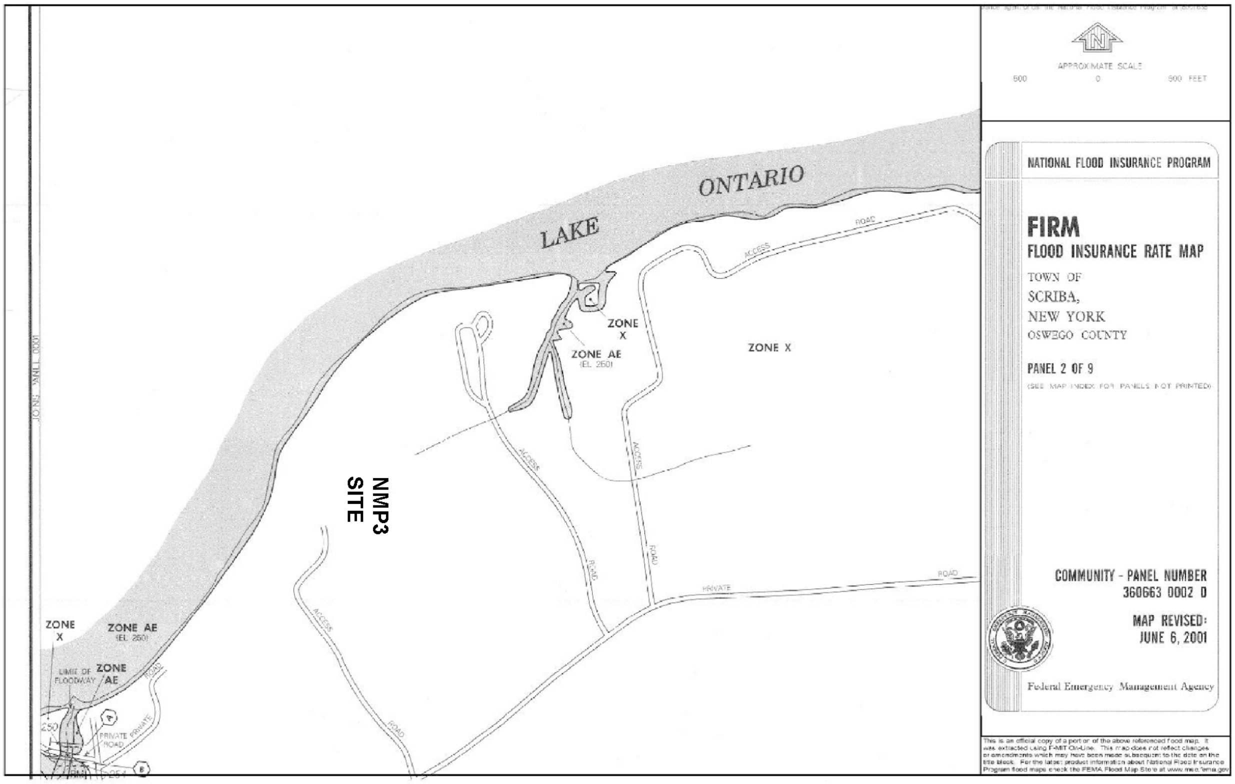


Figure 2.4-5—{Proposed NMP3NPP Grading Plan and Summary of Hydrologic and Hydraulic Analyses Results}

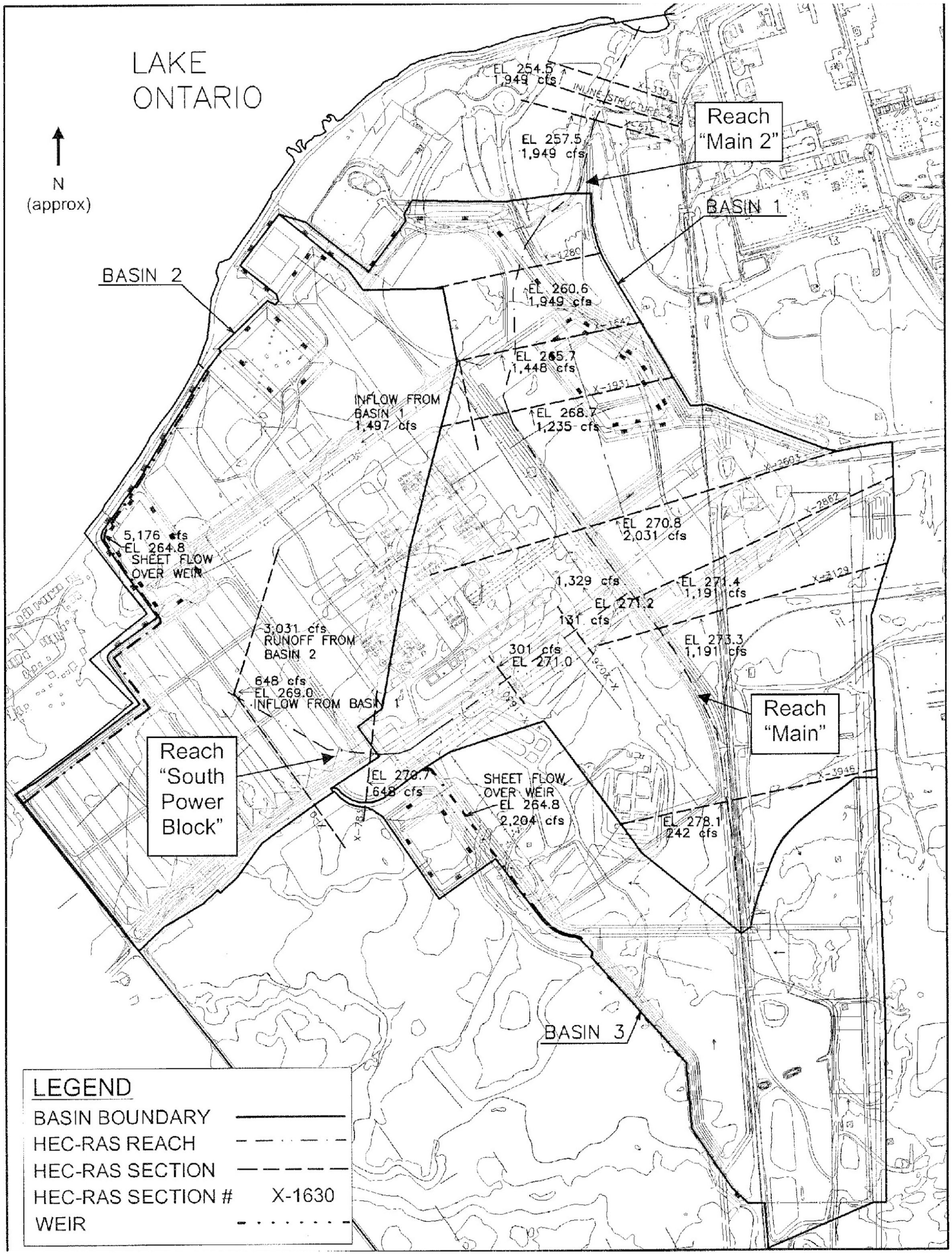


Figure 2.4-6—{Site Location}

Figure 2.4-7—{Lakeview Creek Watershed}

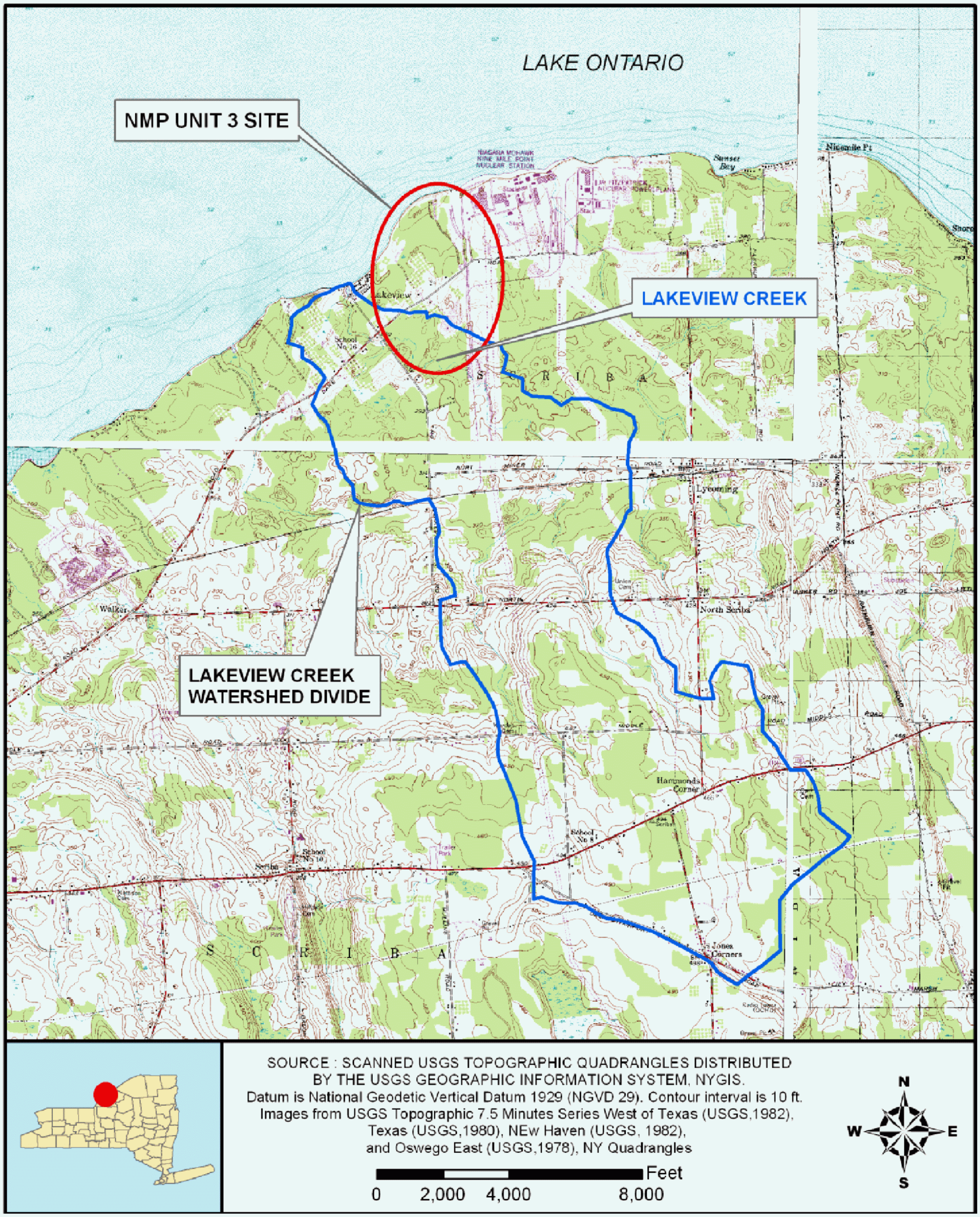


Figure 2.4-8—{Accumulated PMP }

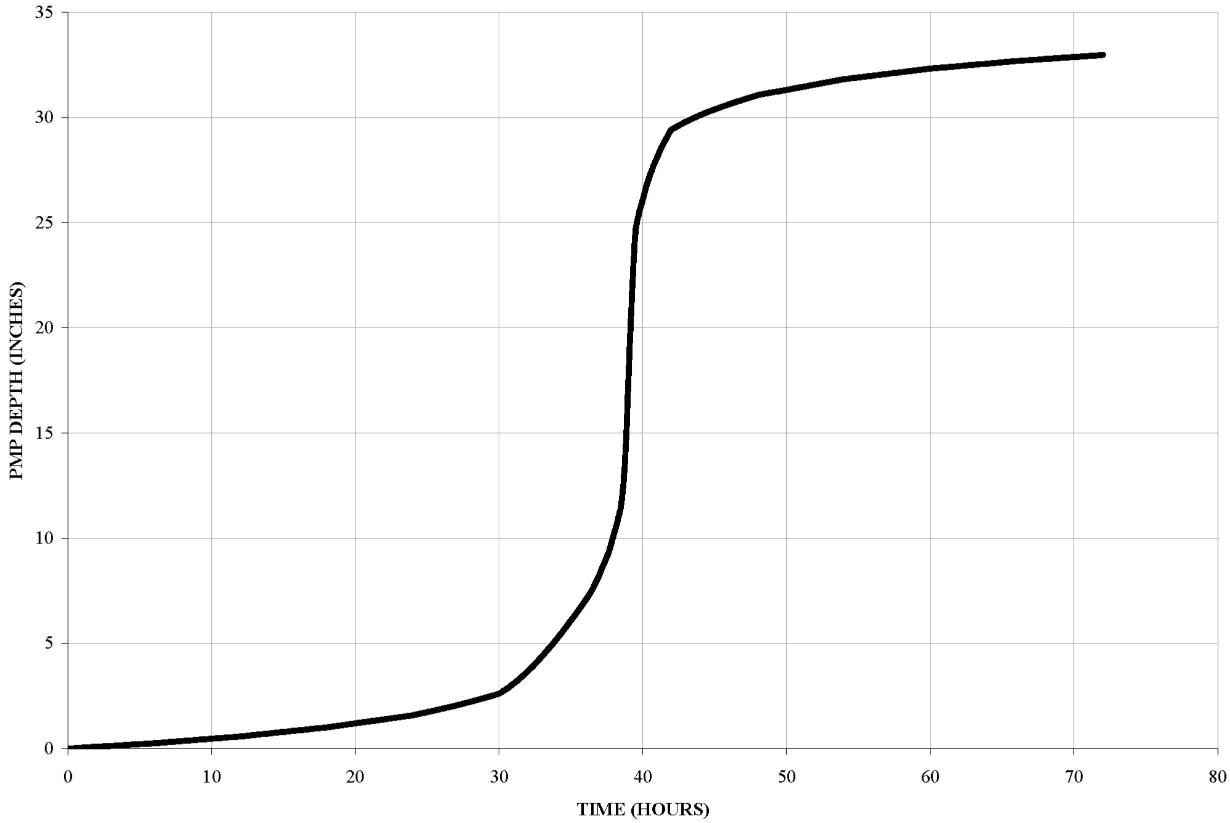


Figure 2.4-9—{Watershed Hydrograph}

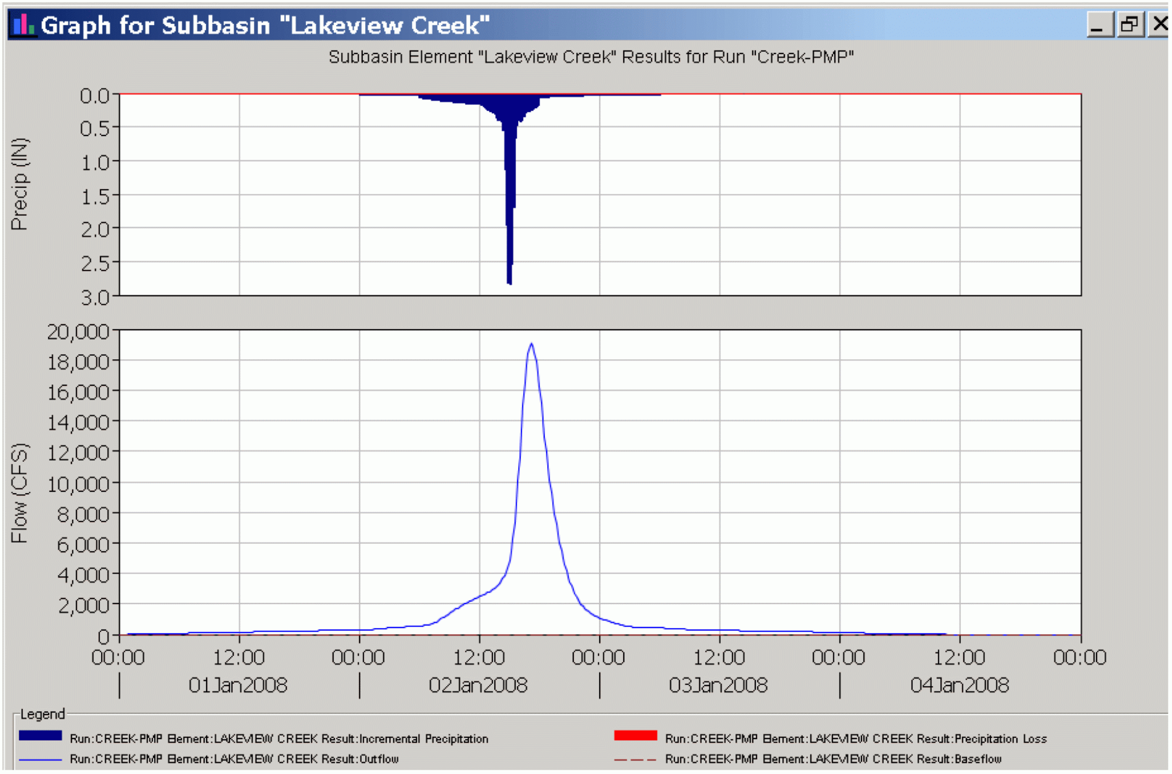


Figure 2.4-10—{HEC-RAS Cross Section Locations}

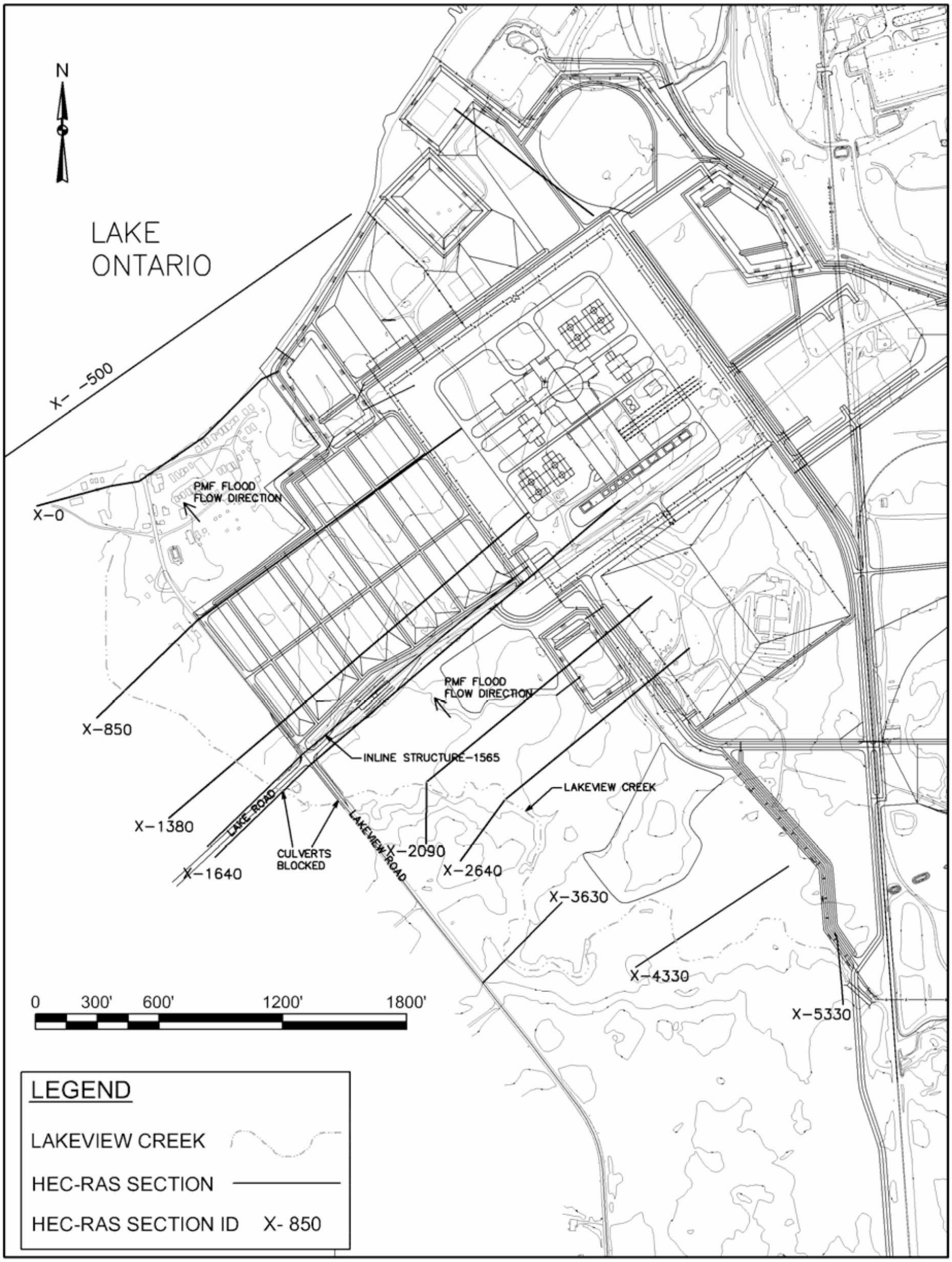


Figure 2.4-11—{Lakeview Creek PMF Water Surface Profile}

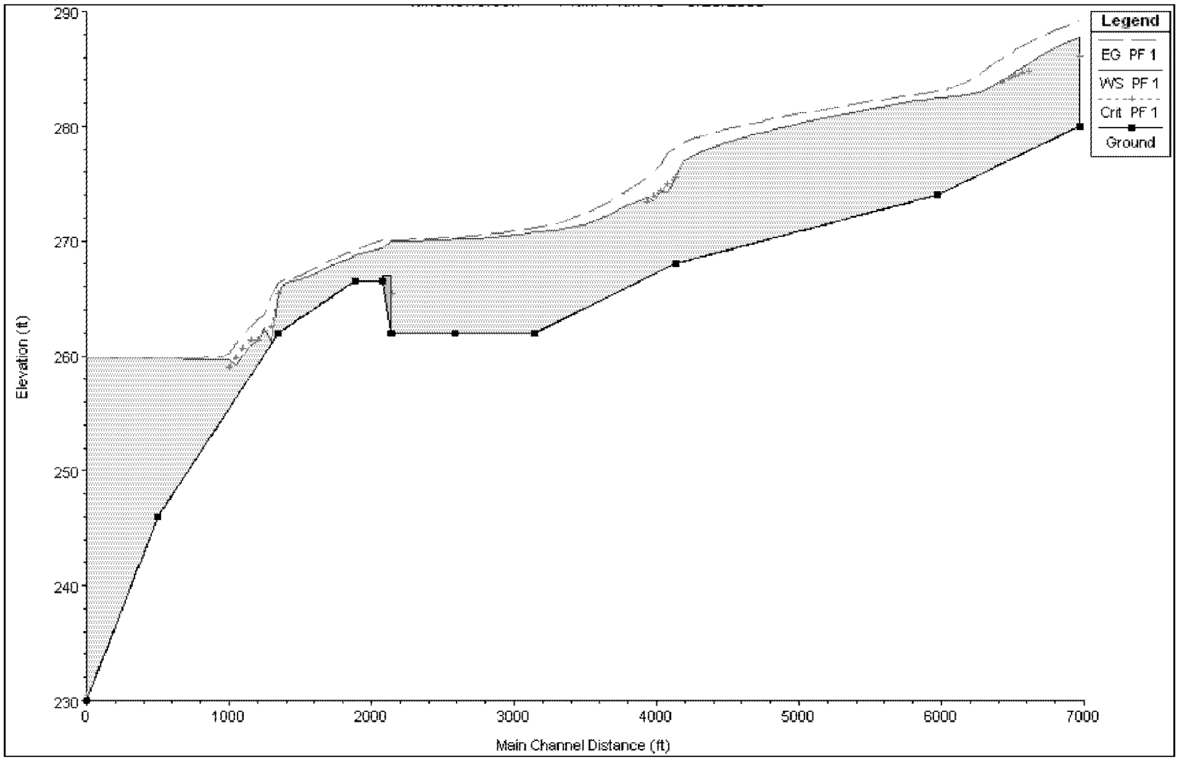


Figure 2.4-12—{Location of Locks and Dams in the Oswego River}

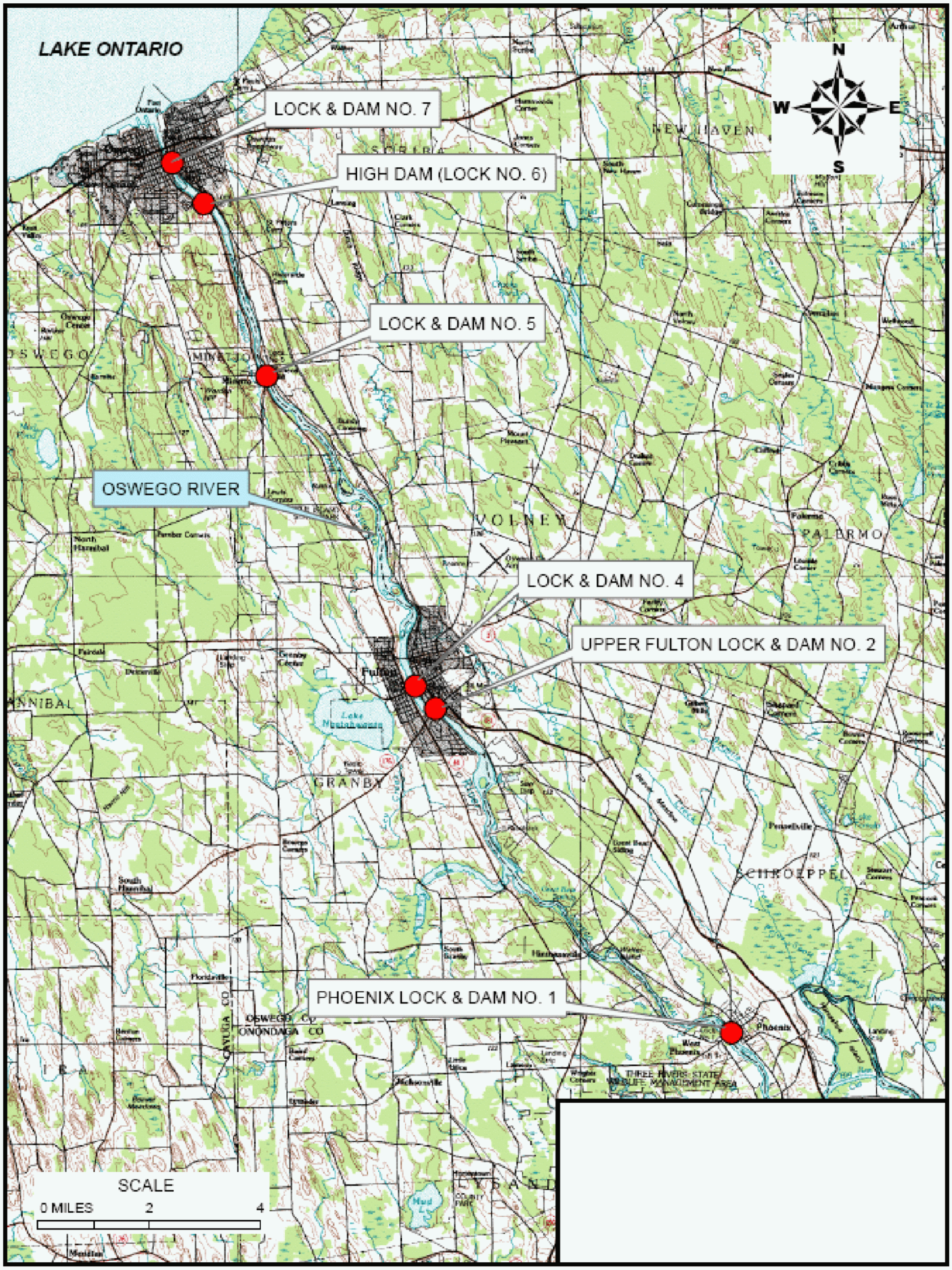


Figure 2.4-13—{Surface Analysis Map for 17 February 2006 at 15:00 GMT}

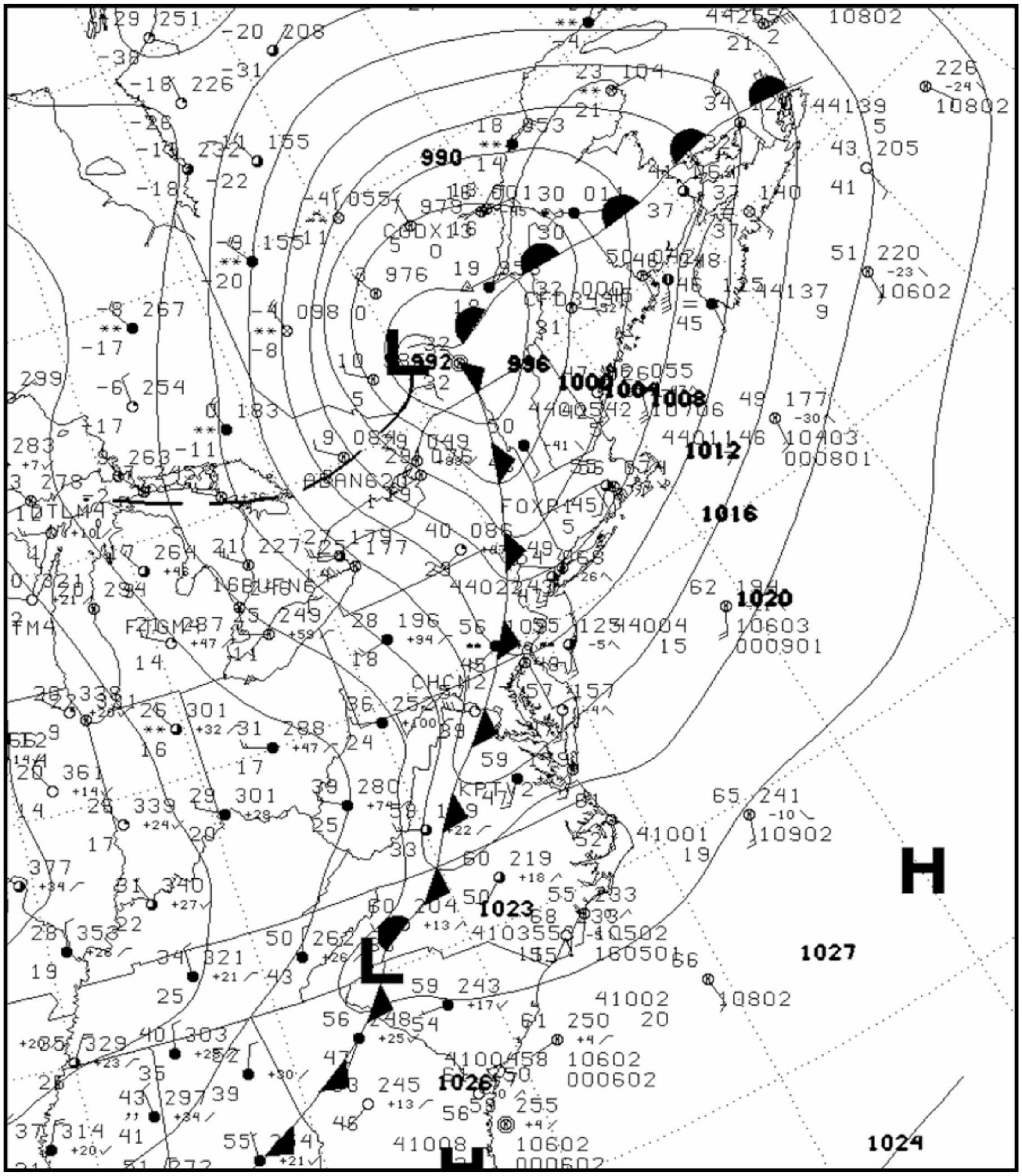


Figure 2.4-14—{Probable Maximum Wind Storm Track}

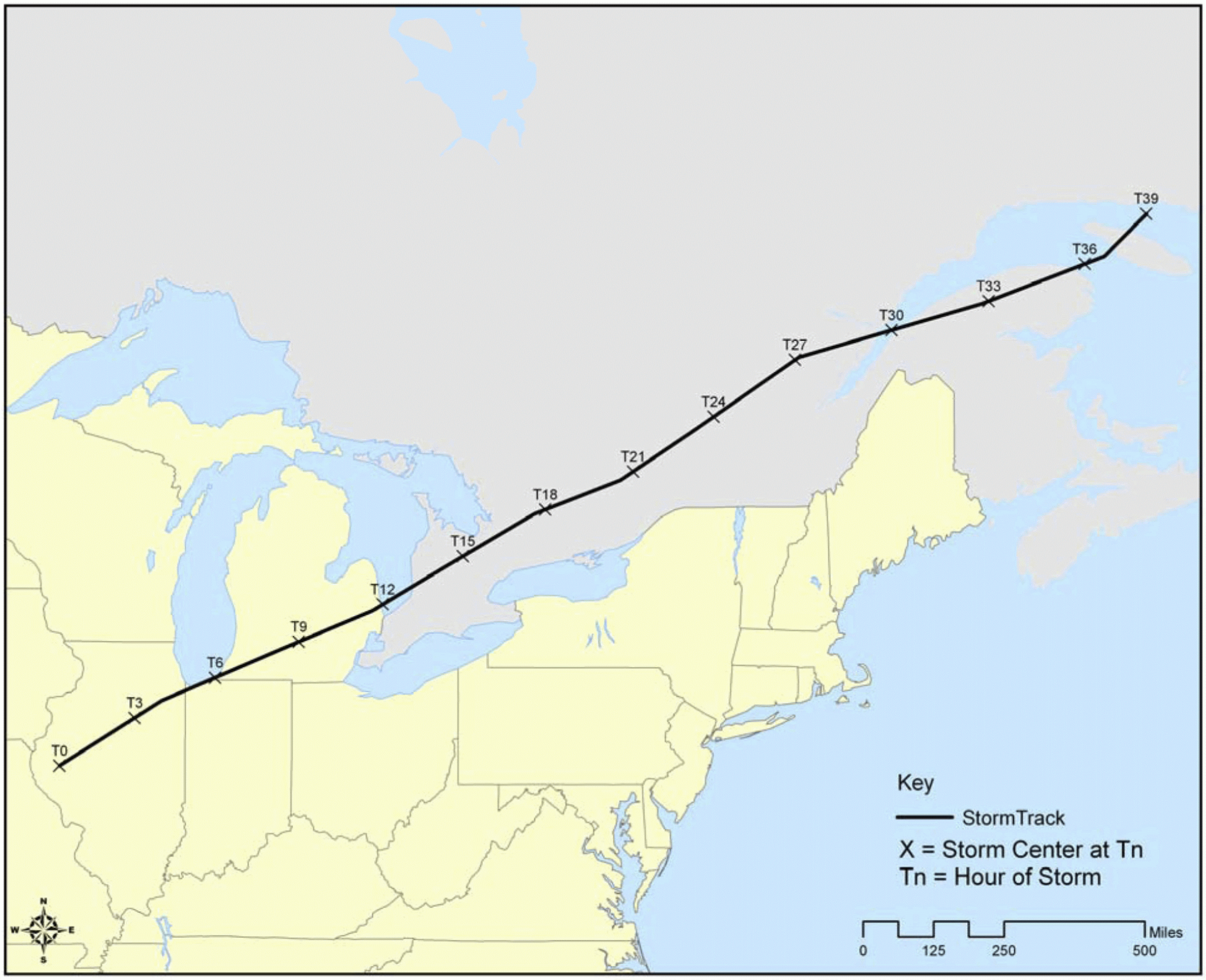


Figure 2.4-15—{Zones for PMWS on Lake Ontario}

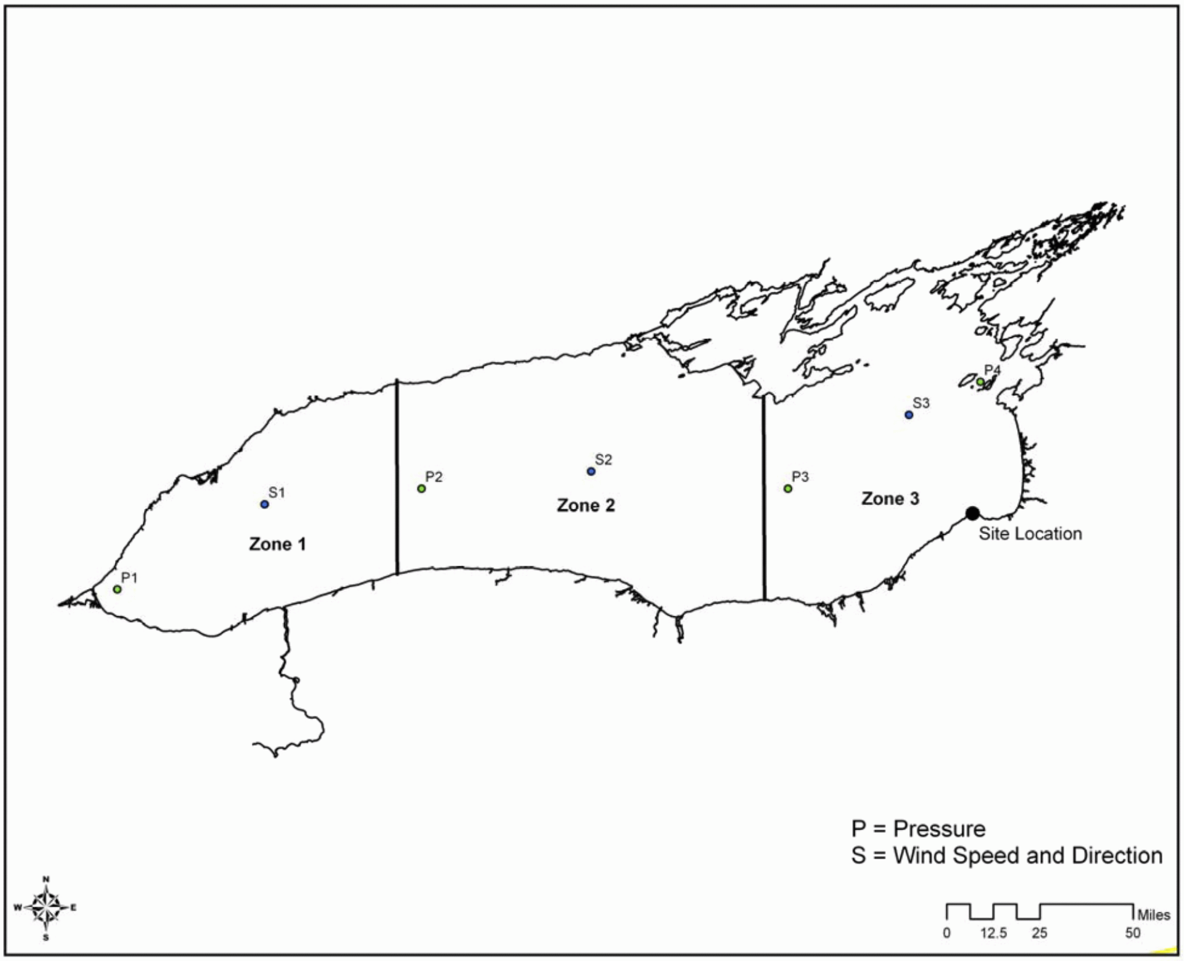


Figure 2.4-16—{Predicted Wind Speed and Direction for the Eastern Zone of Lake Ontario during the PMWS}

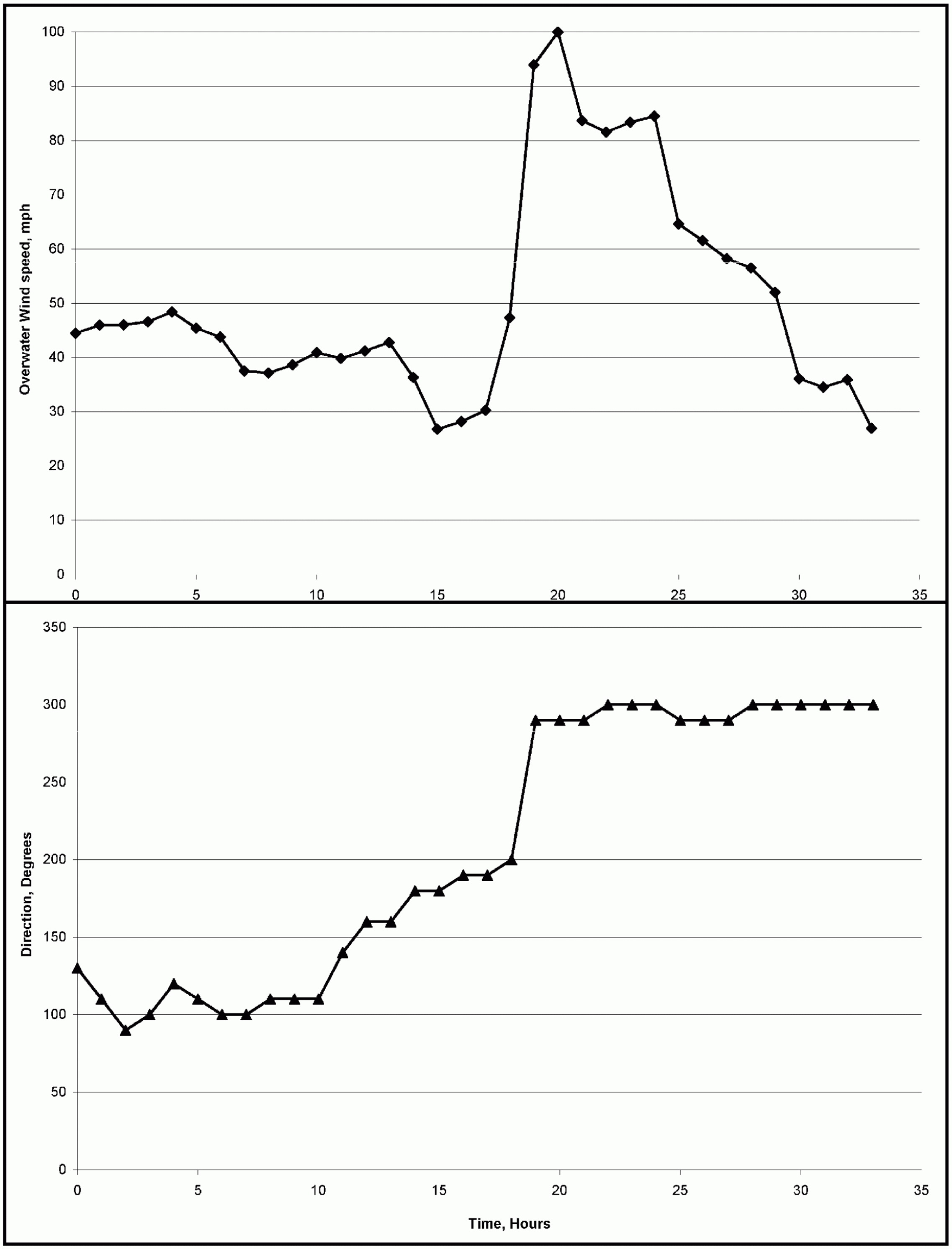


Figure 2.4-17—{Lake Ontario Hydrograph}

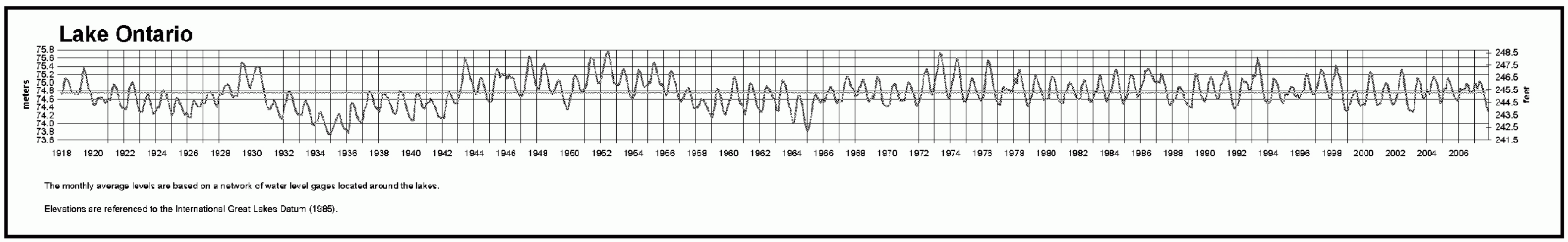


Figure 2.4-18—{Storm Surges on Lake Ontario}

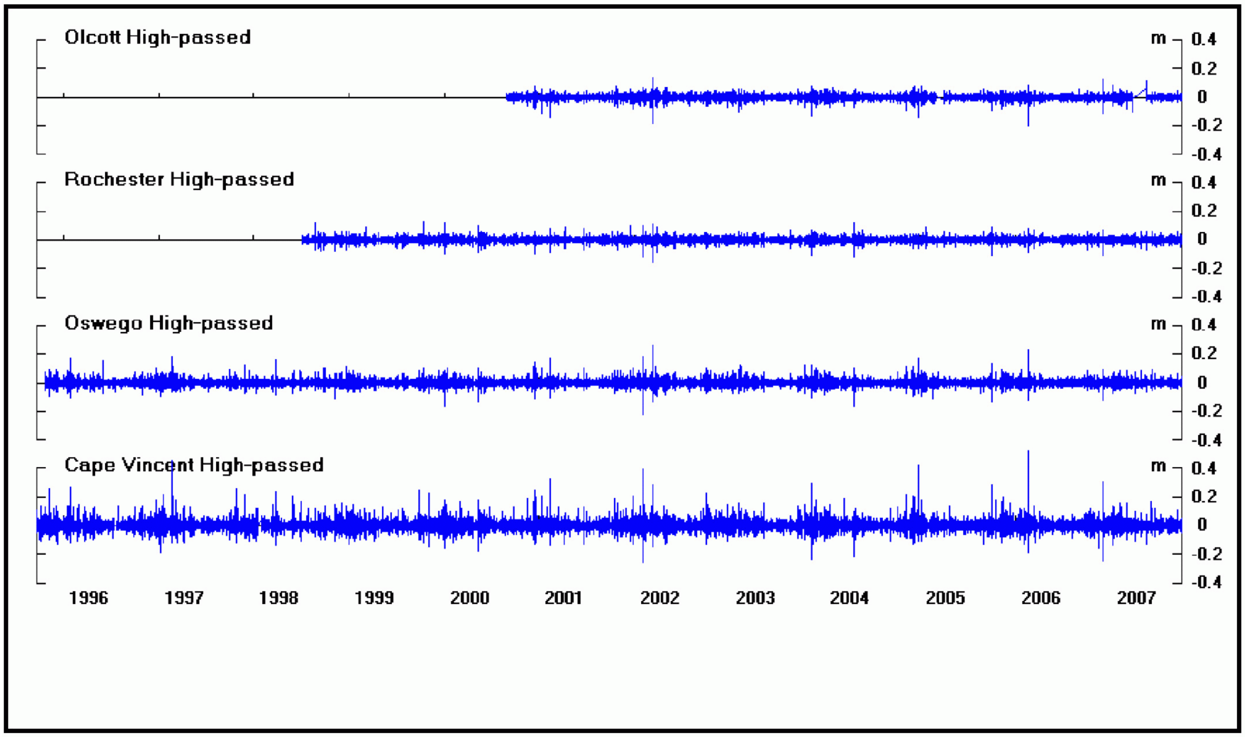


Figure 2.4-19—{Setup Pattern of Storms Causing High Surges in Eastern lake Ontario}

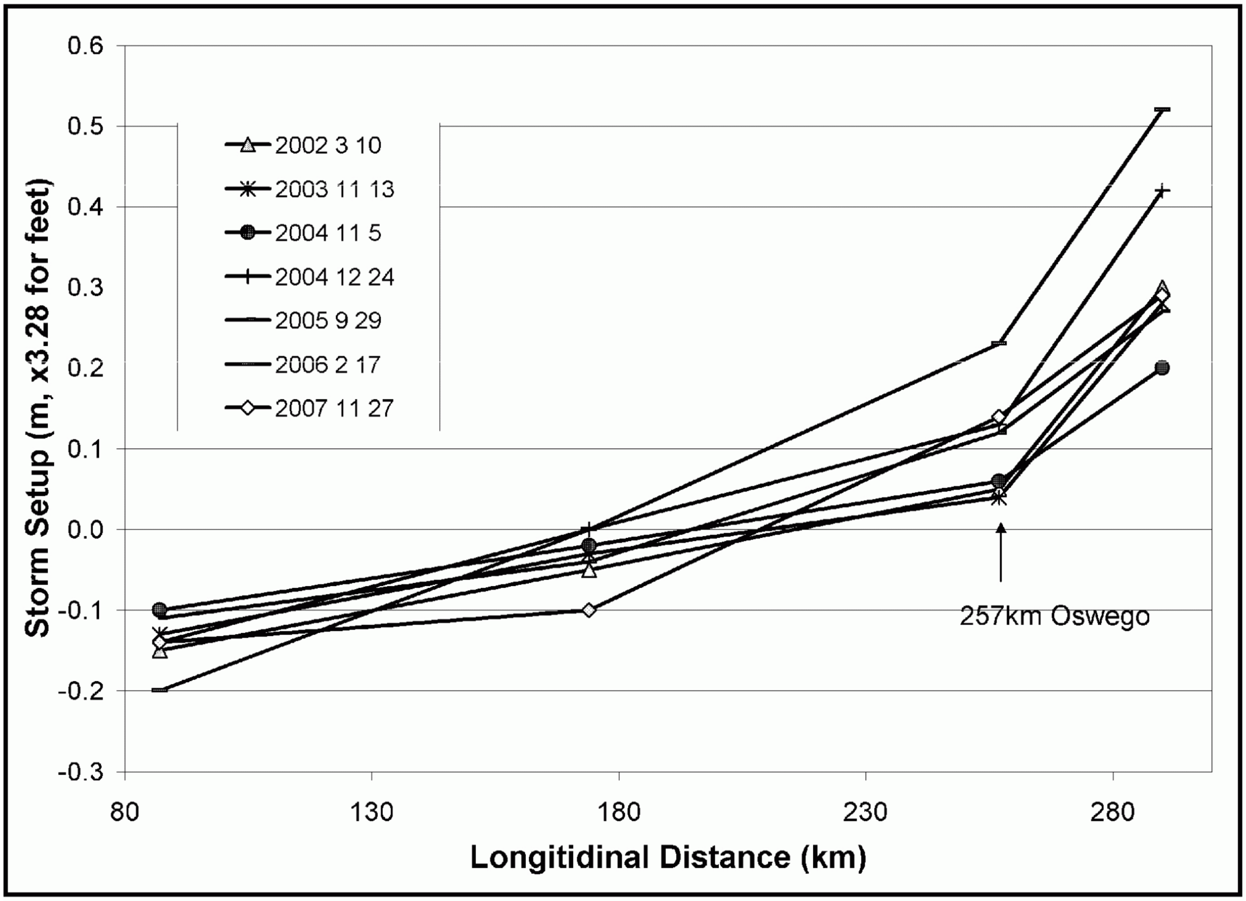


Figure 2.4-20—{Verification of SSPP using Historic Storms}

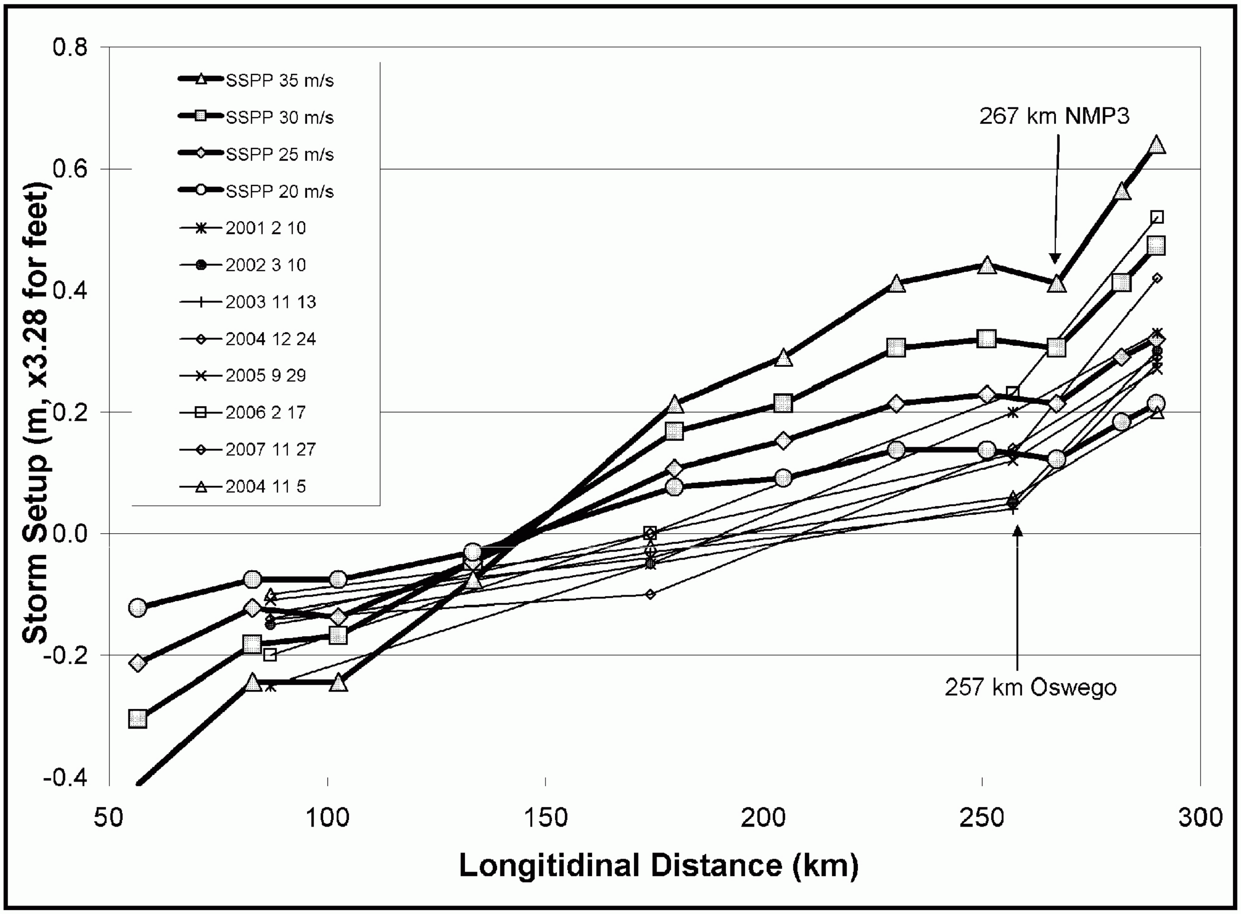


Figure 2.4-21—{Comparison of Regression and Two Dimensional Models}

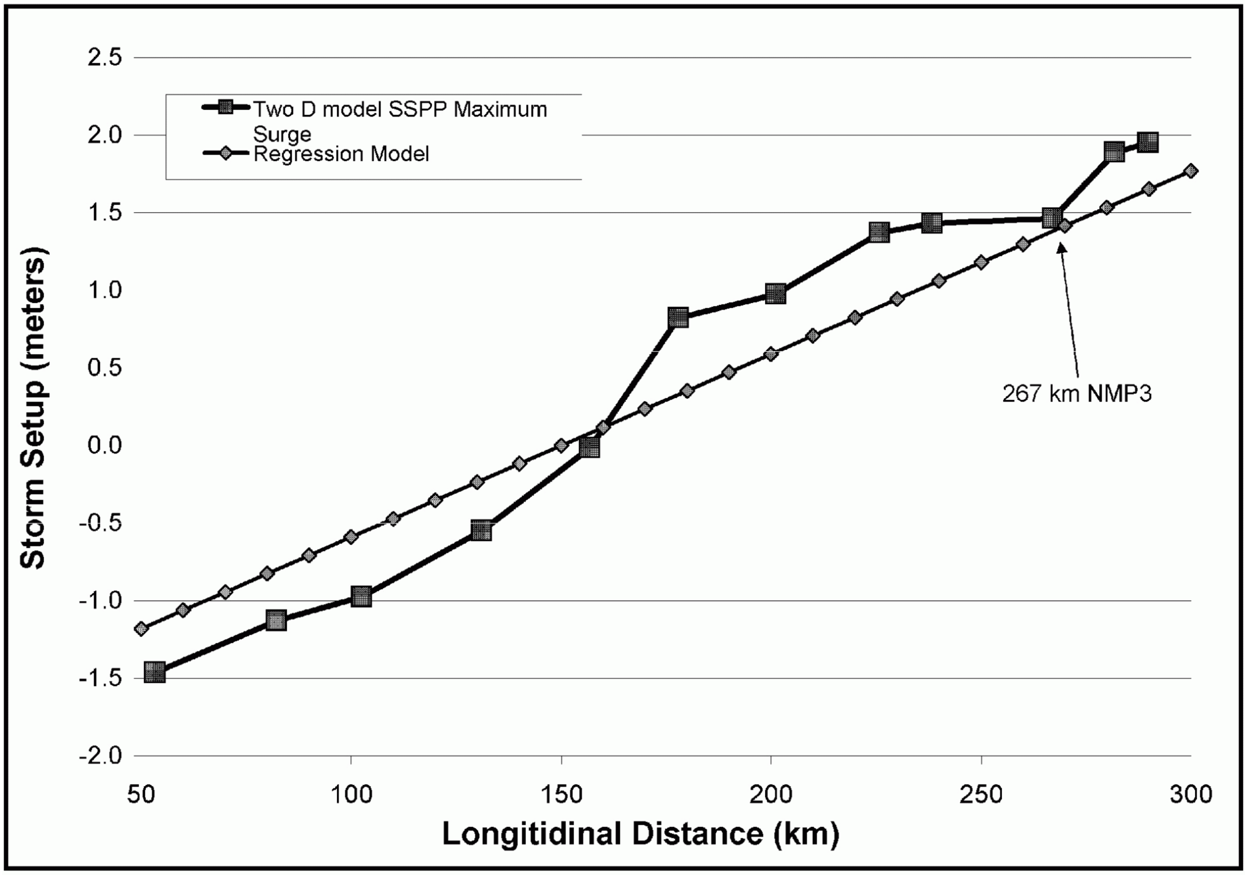


Figure 2.4-22—{Lake Ontario Bathymetry - Nested Grids for SWAN Implementation}

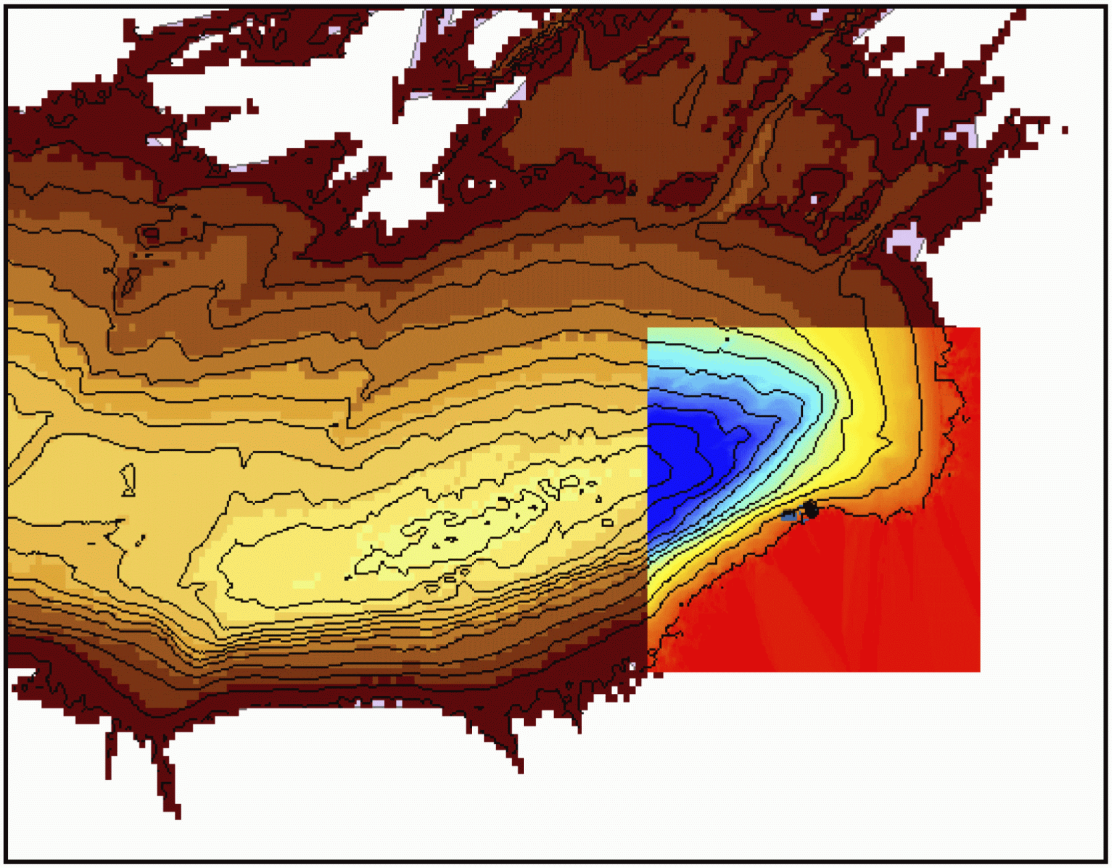


Figure 2.4-23—{Time Series of Significant Wave Heights and Periods}

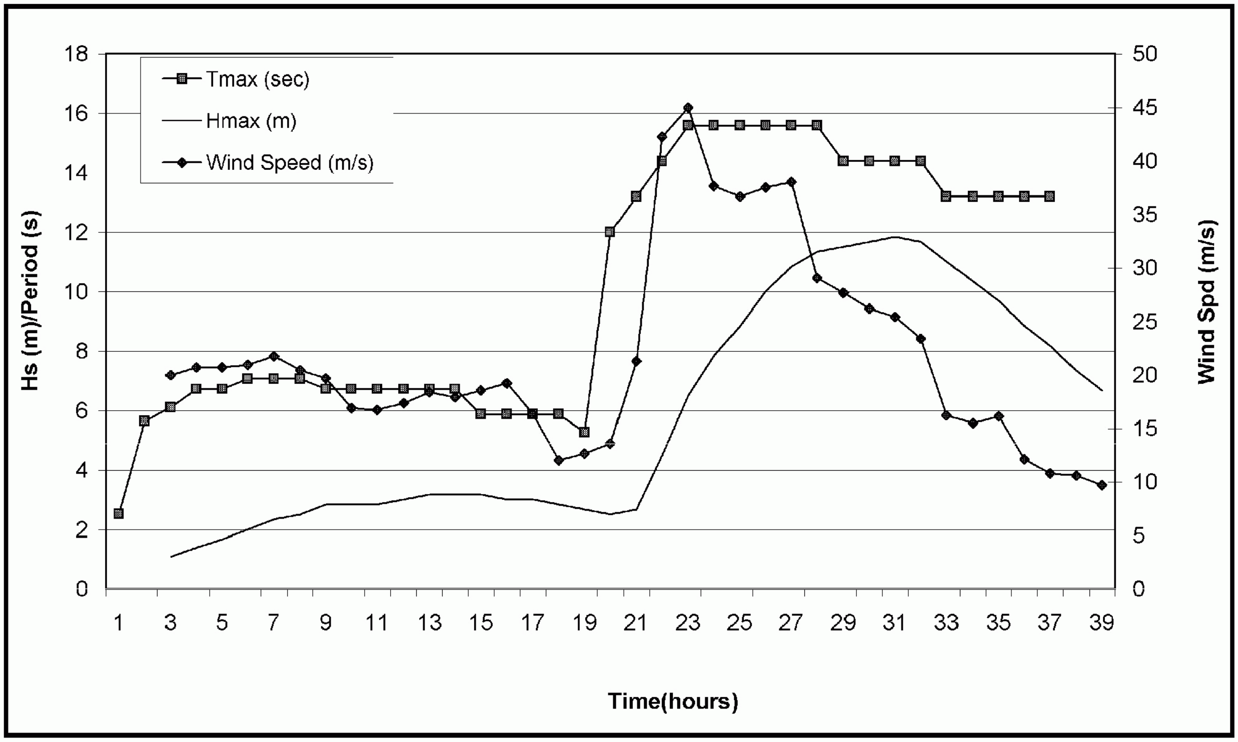


Figure 2.4-24—{NOAA GLERL Digital Ice Chart for March 2, 1977}

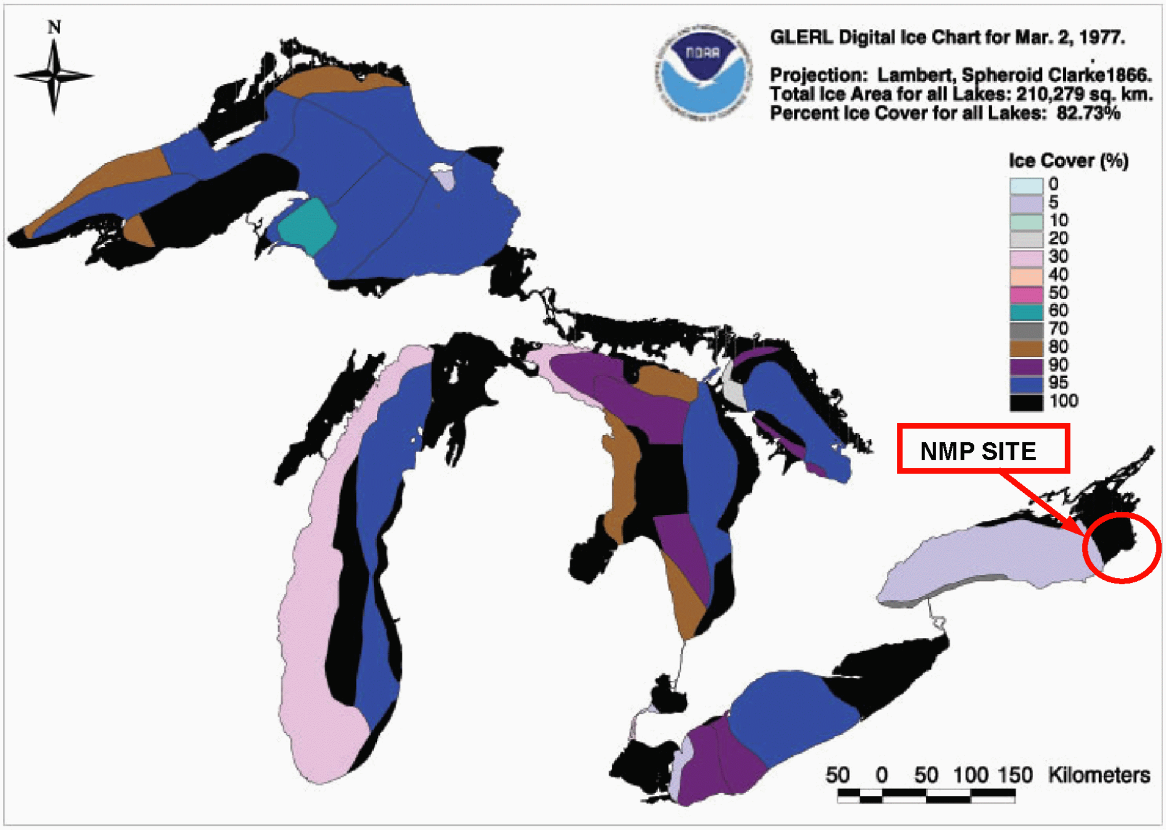


Figure 2.4-25—{NOAA GLERL Digital Ice Chart for March 1, 1978}

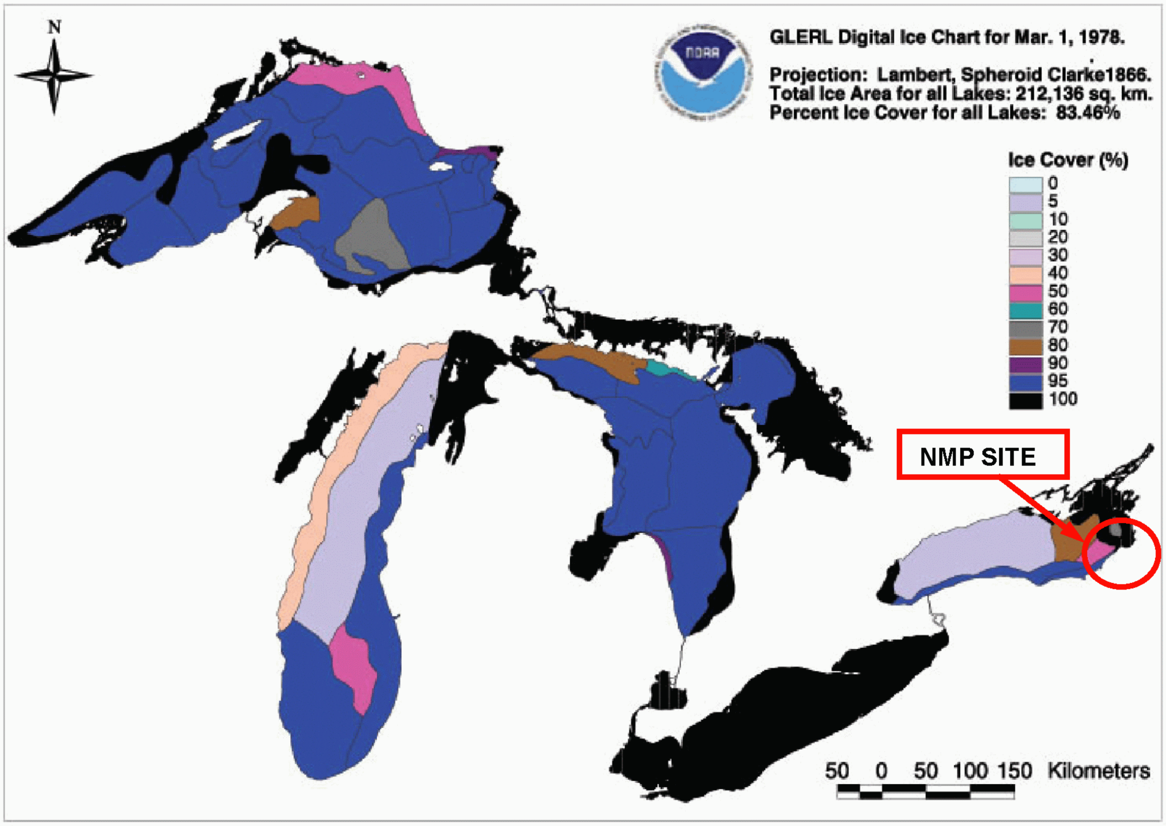


Figure 2.4-26—{NOAA GLERL Digital Ice Chart for January 7, 1981}

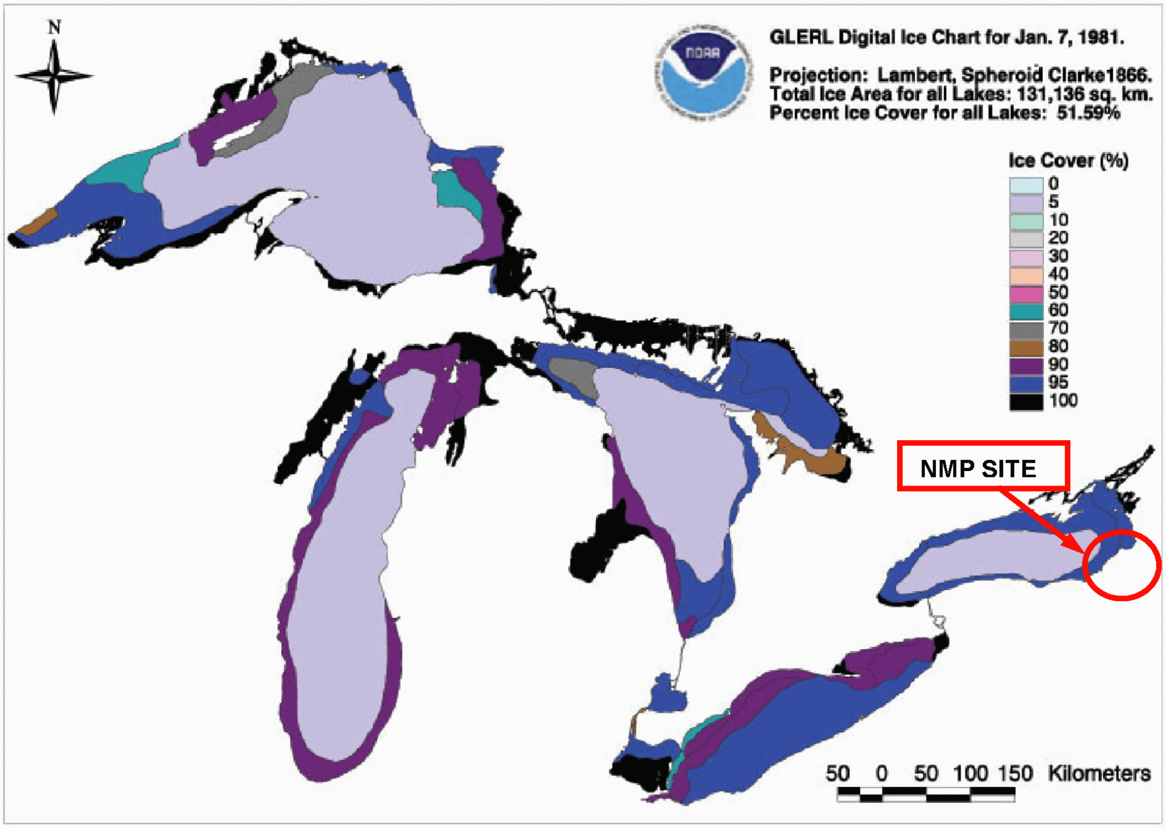


Figure 2.4-27—{NOAA GLERL Digital Ice Chart for February 14, 1994}

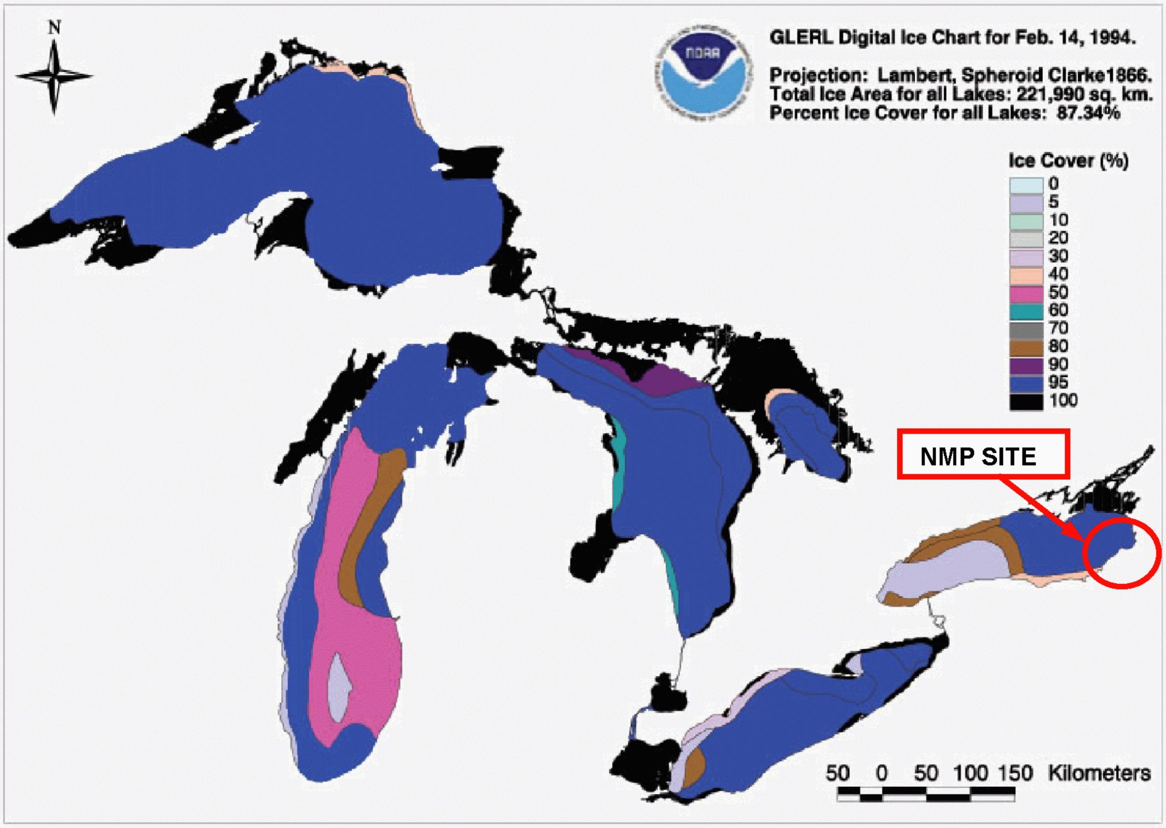


Figure 2.4-28—{1802 Historic Map of the State of New York}

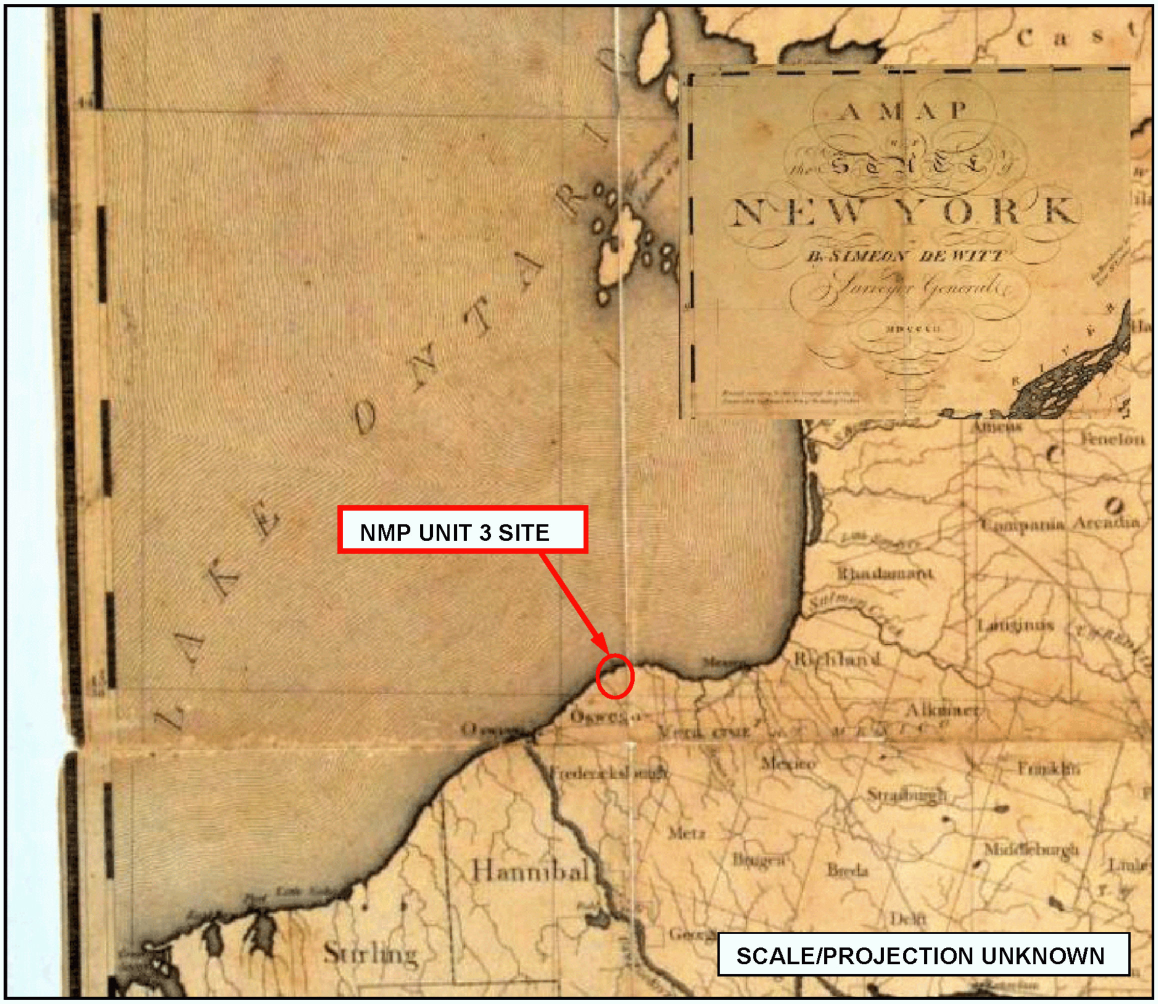


Figure 2.4-29—{1900 USGS Fulton Quadrangle Map}

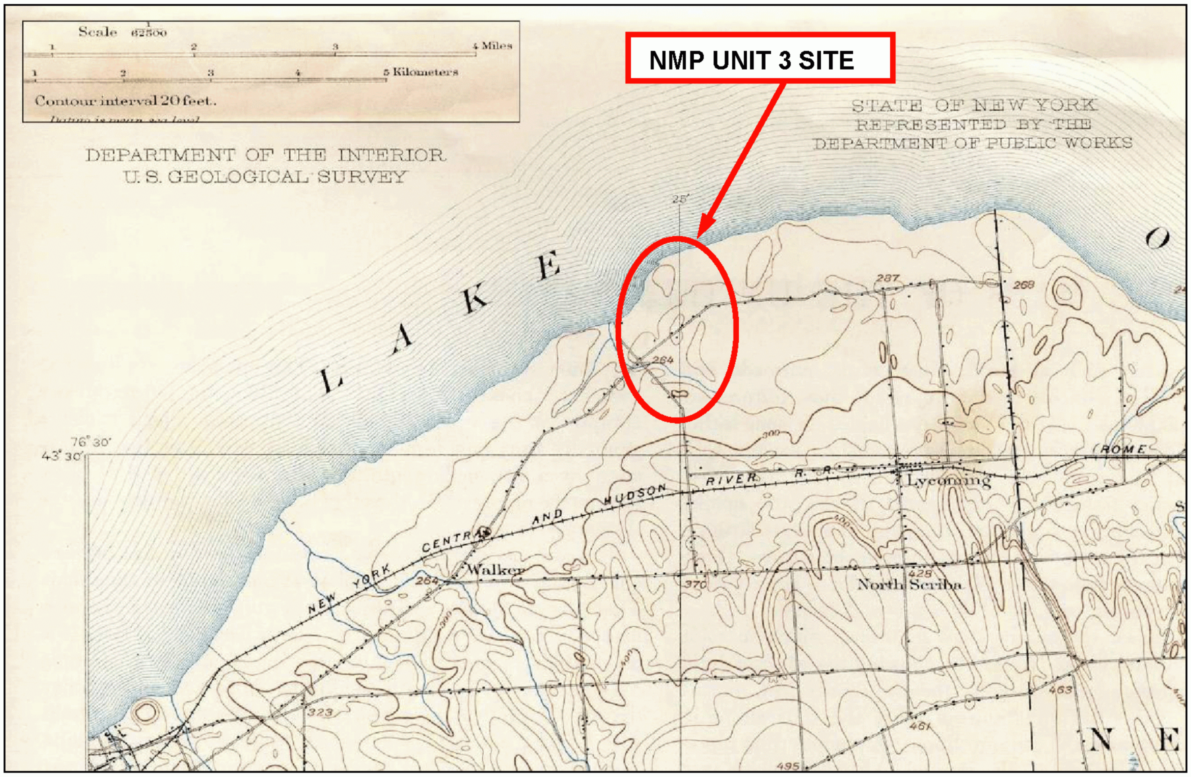


Figure 2.4-30—{1956 USGS Fulton Quadrangle Map}

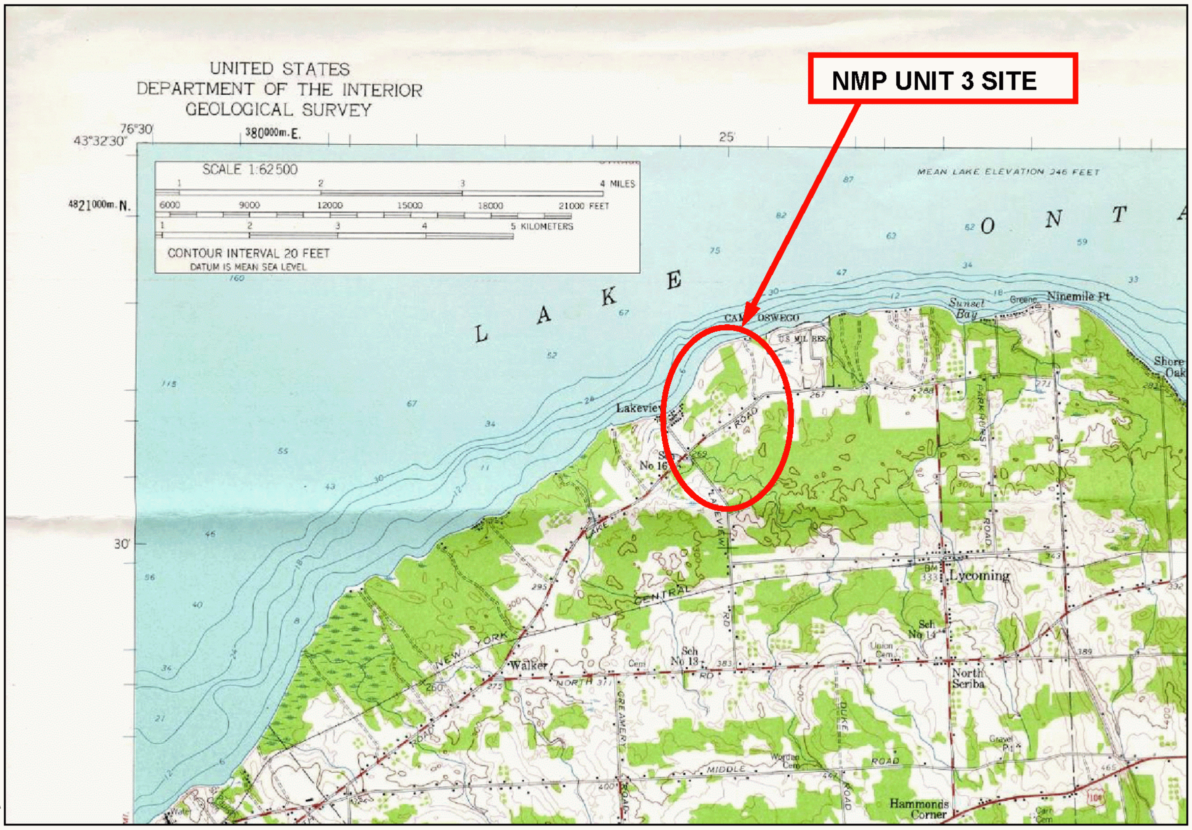


Figure 2.4-31—{2007 NYGIS Aerial Photography}

Figure 2.4-32—{Historical Elevations of the Great Lakes from 1860 to 2005}

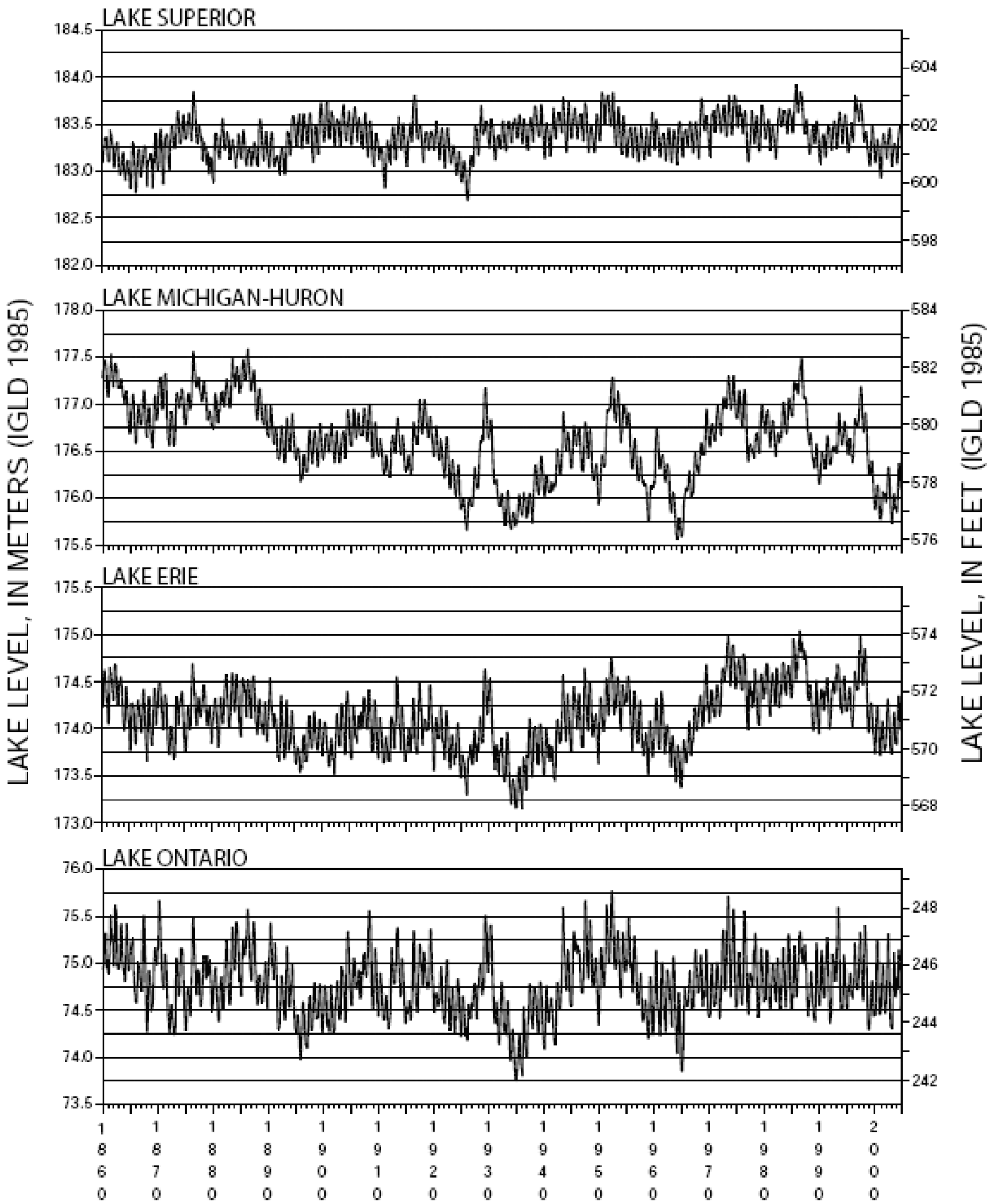
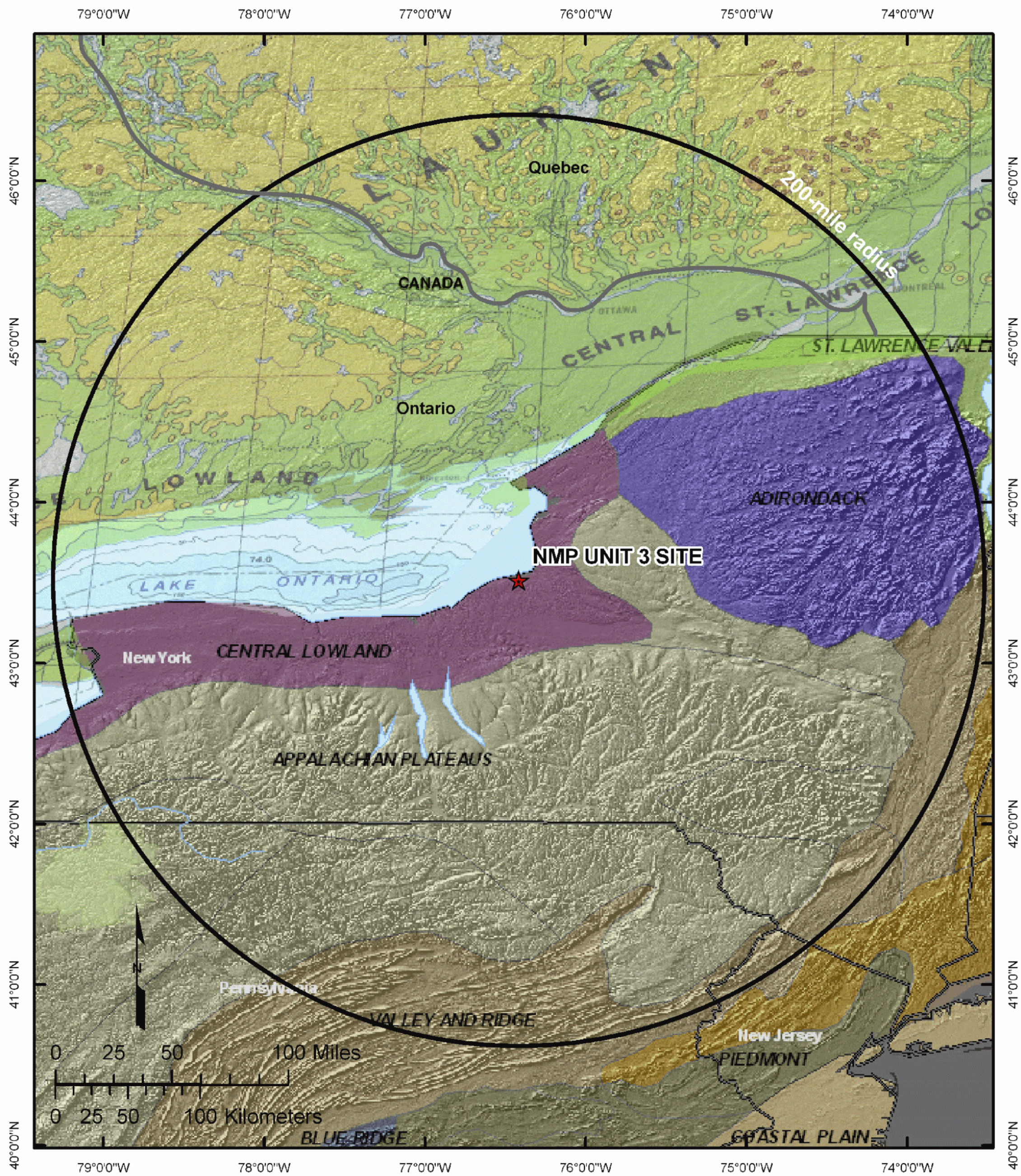


Figure 2.4-33—{Map of Physiographic Provinces}



US: Fenneman and Johnson, 1946
Canada: Geological Survey of Canada, Surveys and Mapping Branch, 1975.

Figure 2.4-34—{Site Vicinity Topography Map 5-Mile (8-km) Radius}

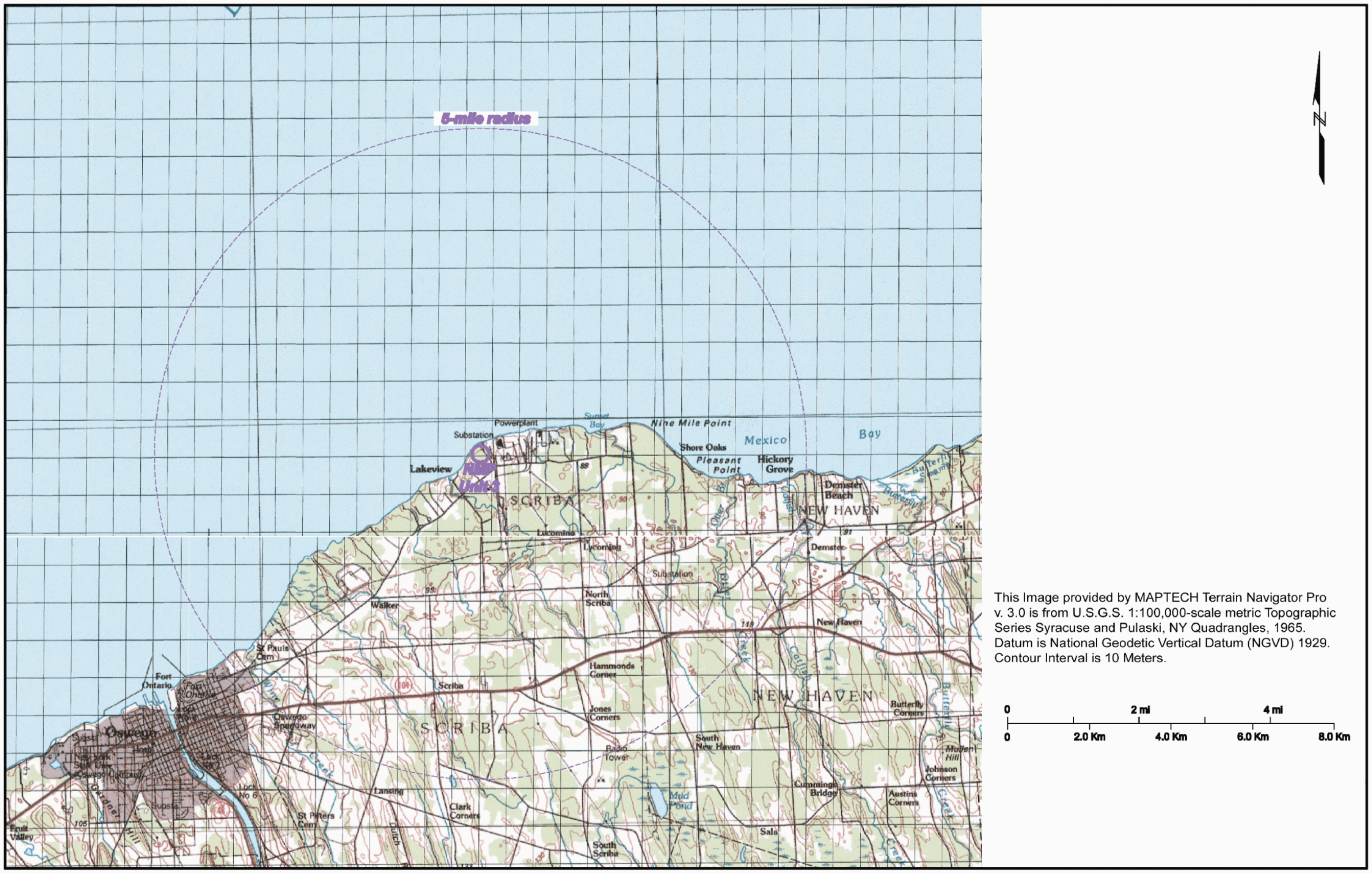


Figure 2.4-35—{Site Topography Map 25 Mile (40 km) Radius}

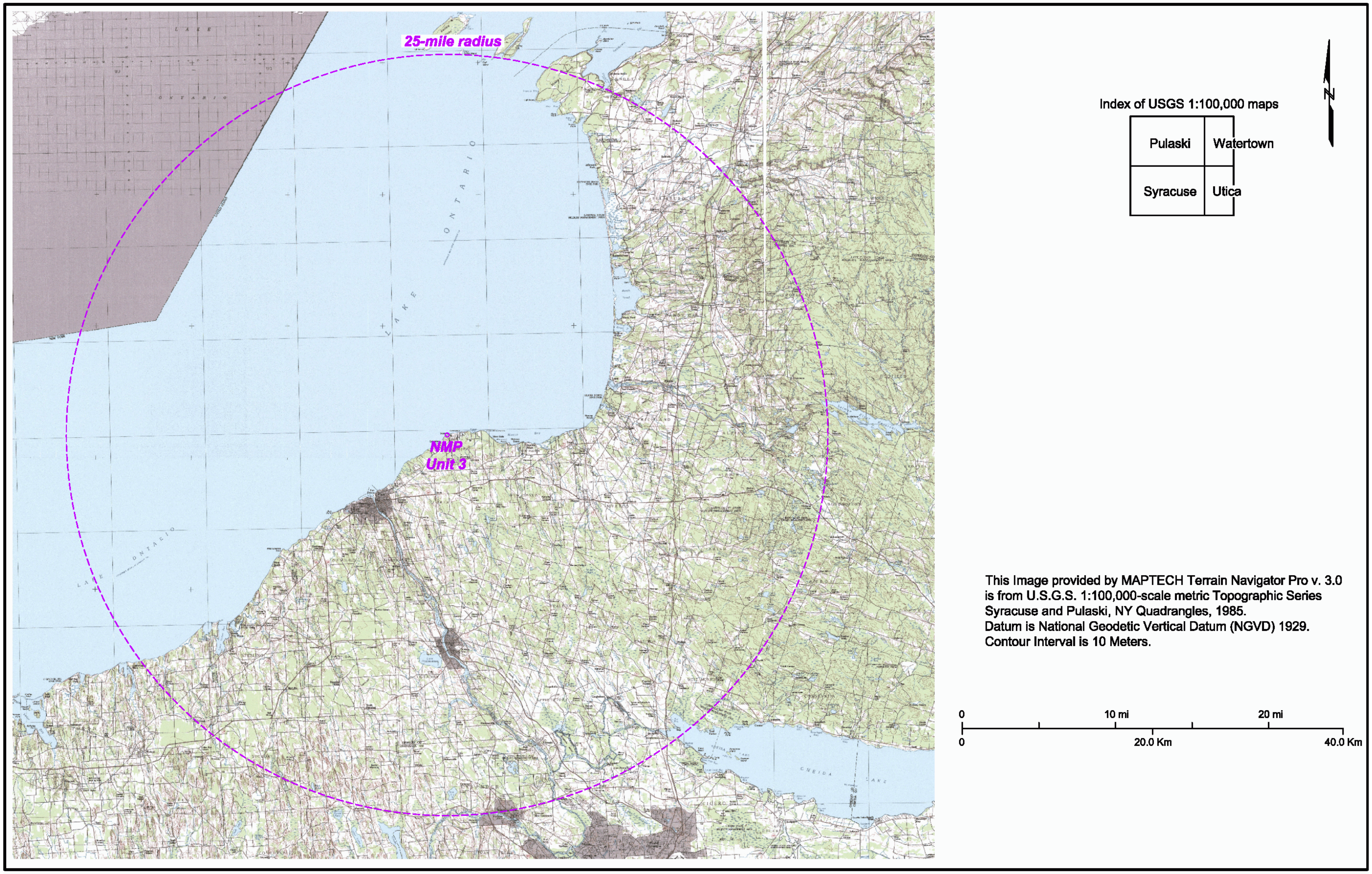


Figure 2.4-36—{Tug Hill Area and Major Physiographic Provinces of New York}

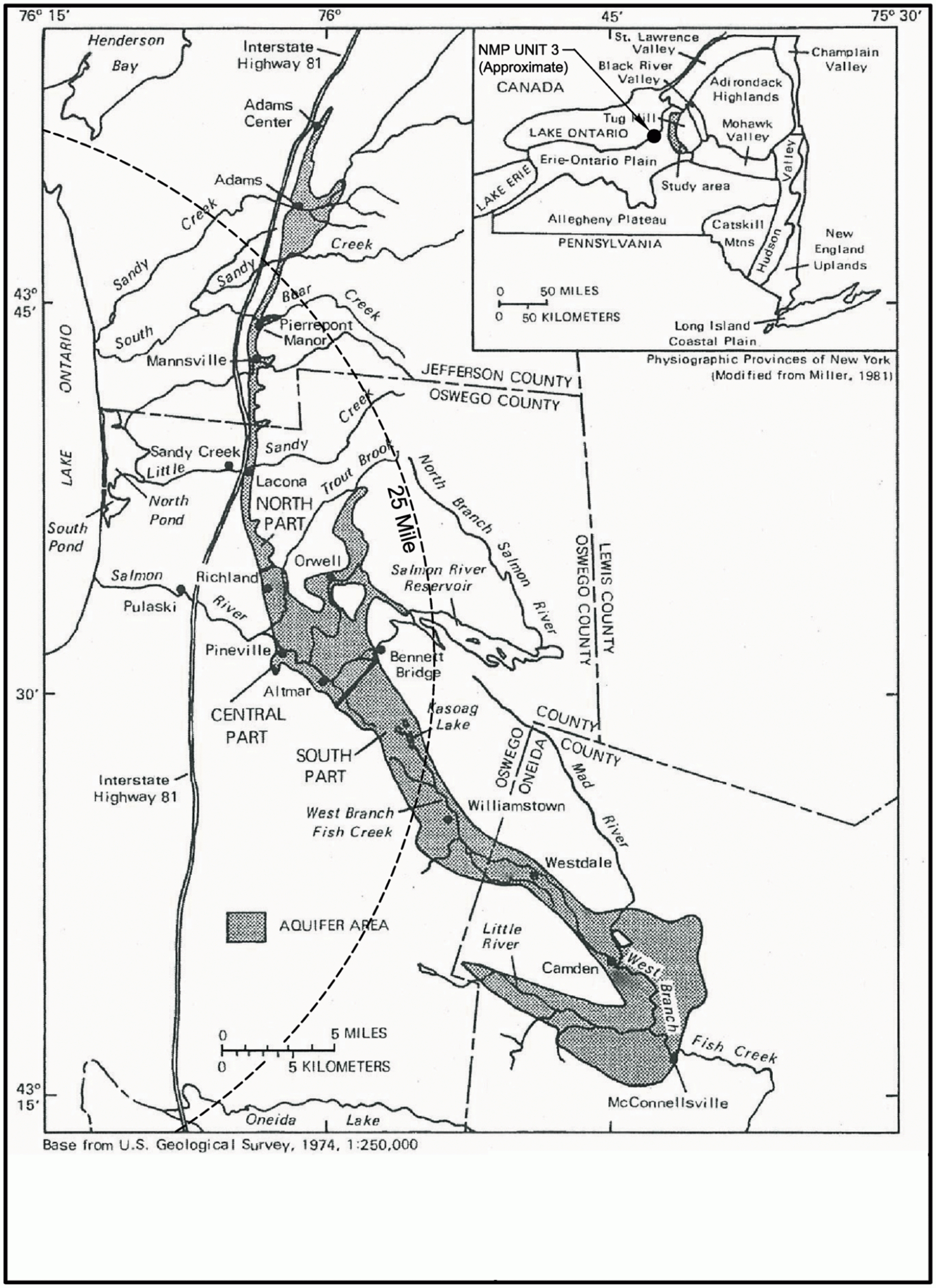


Figure 2.4-37—{Surficial Glacial Aquifers of New England and New York}

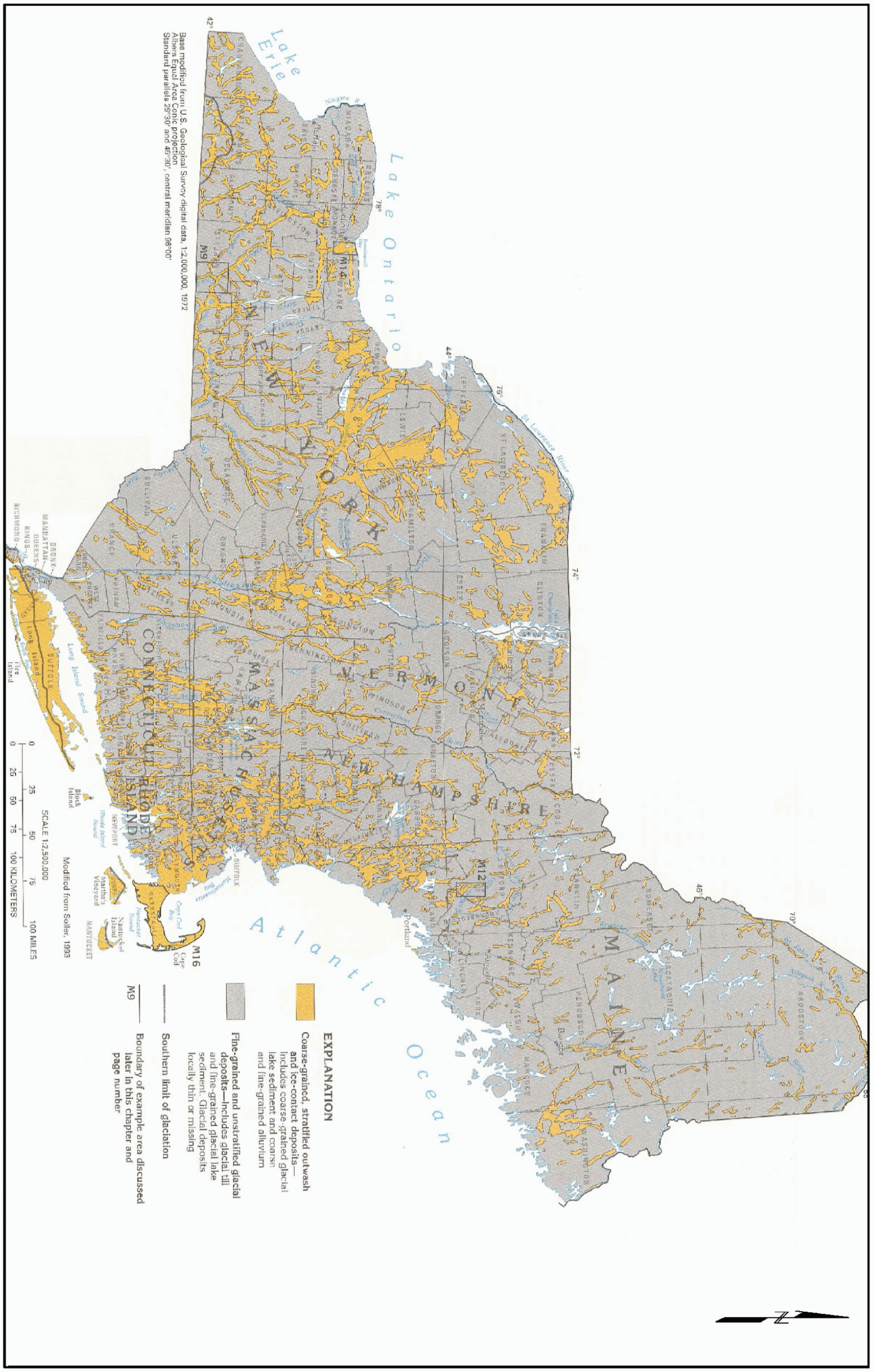


Figure 2.4-38—{Site Stratigraphy}

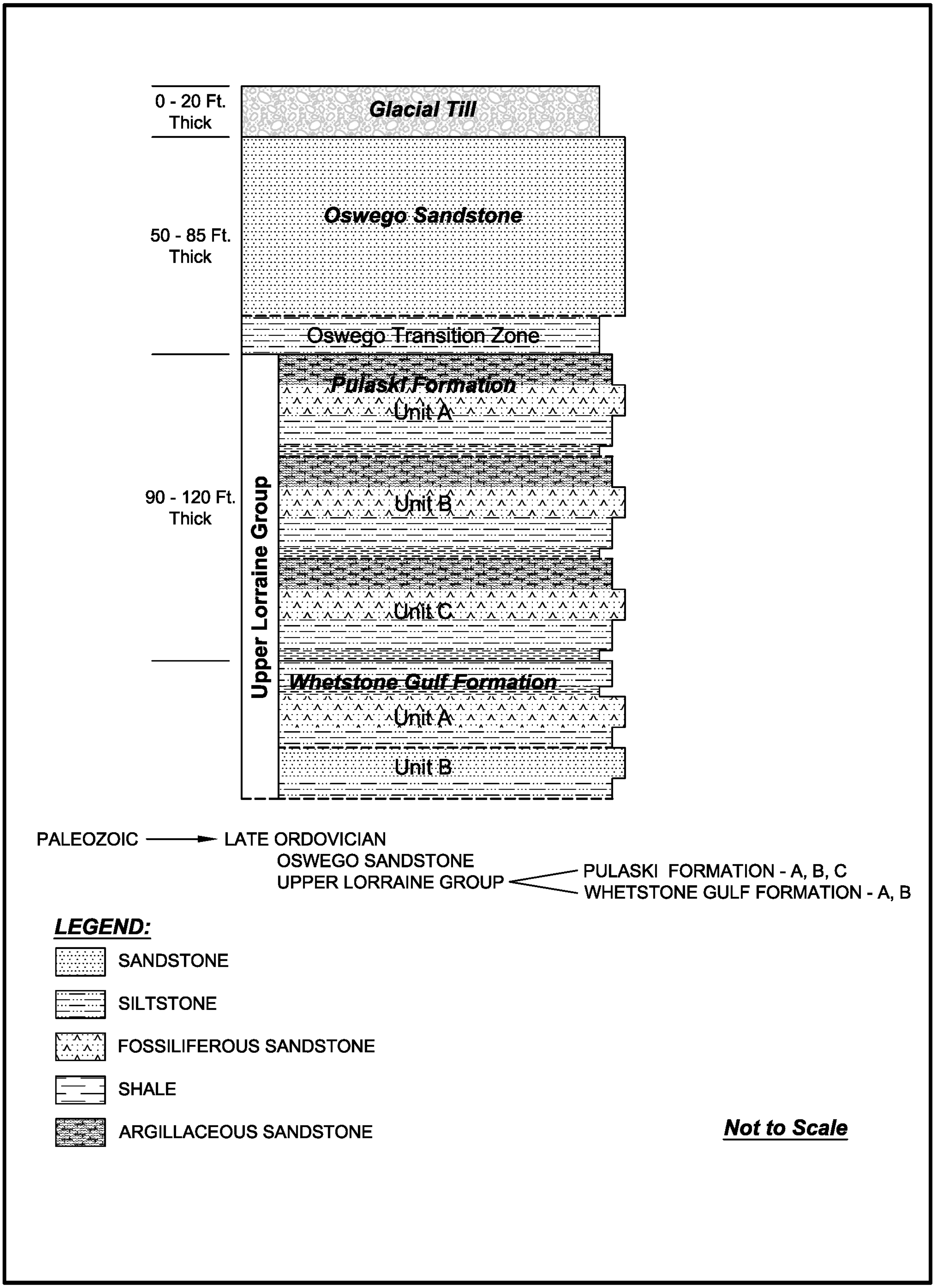
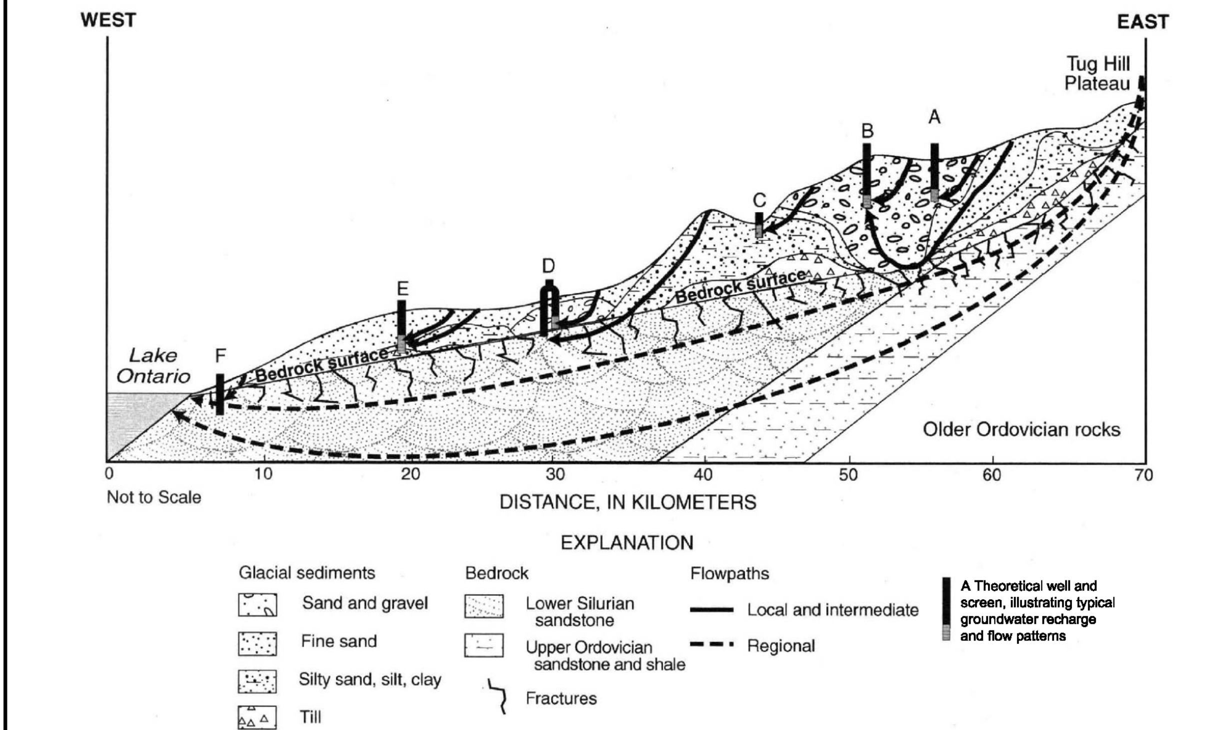


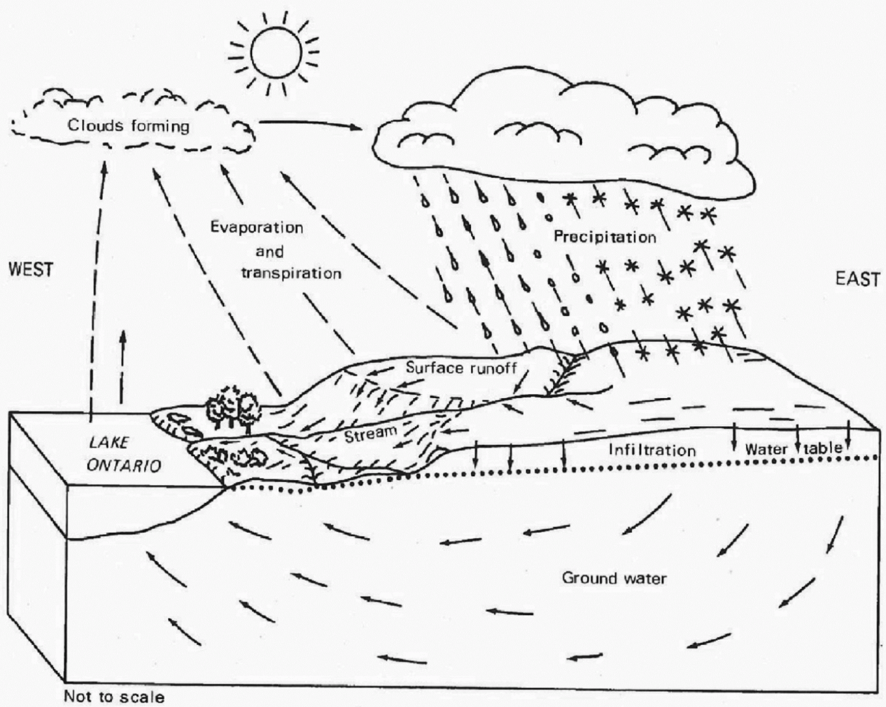
Figure 2.4-39—{Conceptual Cross Section through Oswego County}



NOTES:

1. Figure from Report titled "Ground-Water Age Dating in Community Wells in Oswego county, New York," Open File Report 01-232, U.S. Department of the Interior, U.S. Geological Survey, in cooperation with the Oswgo County Department of Health.

Figure 2.4-40—{Simplified Ground Water Recharge From Surface Water (Tug Hill Aquifer)}



NOTE

1. Figure adapted from: Hydrogeology and Water Quality of Tug Hill Glacial Aquifer in Northern New York.

Ref: USGS, 1989

Figure 2.4-41—{Site Plan}

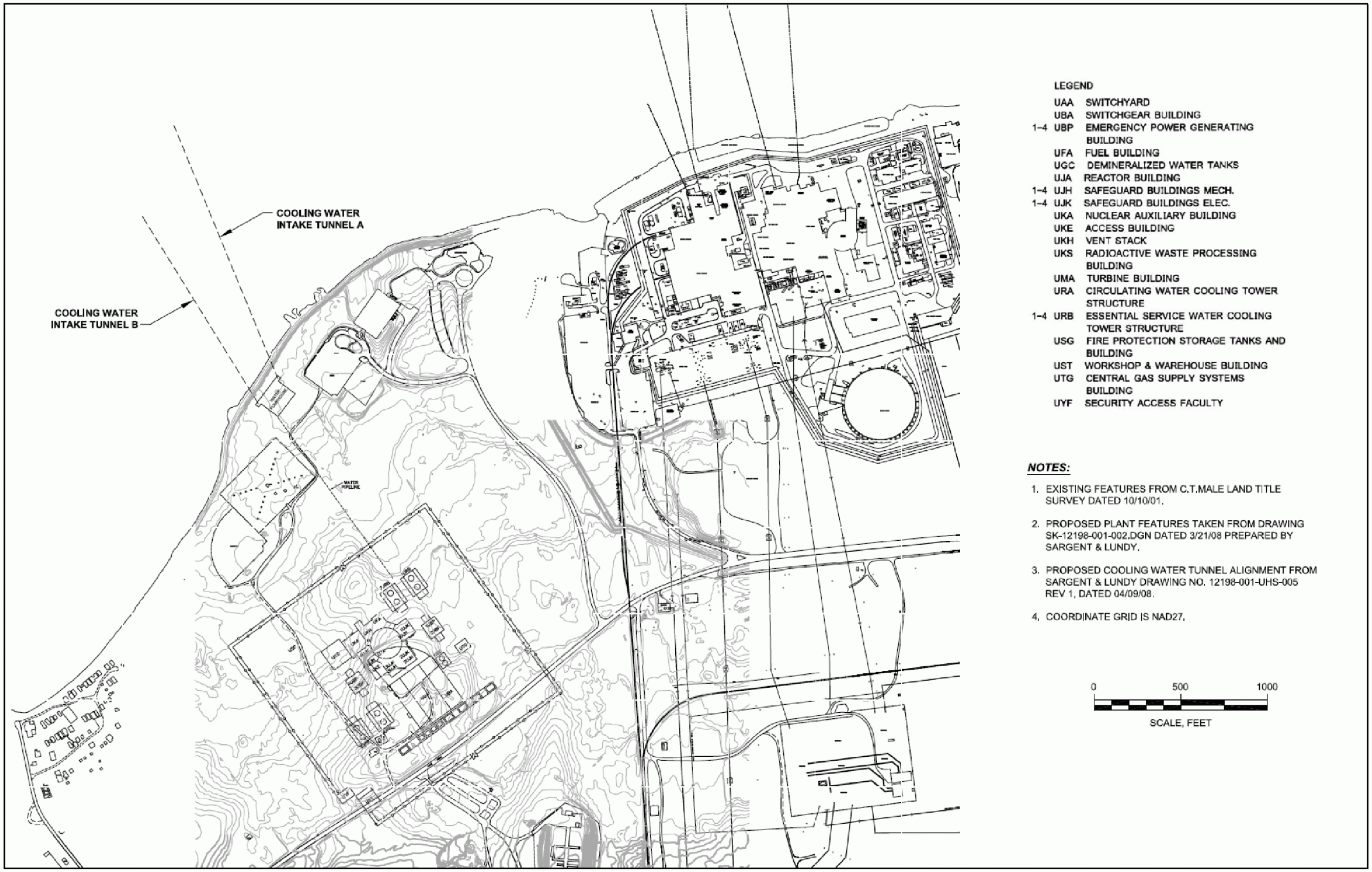


Figure 2.4-42—{100 and 300 Series Borings and Test Pits (North)}

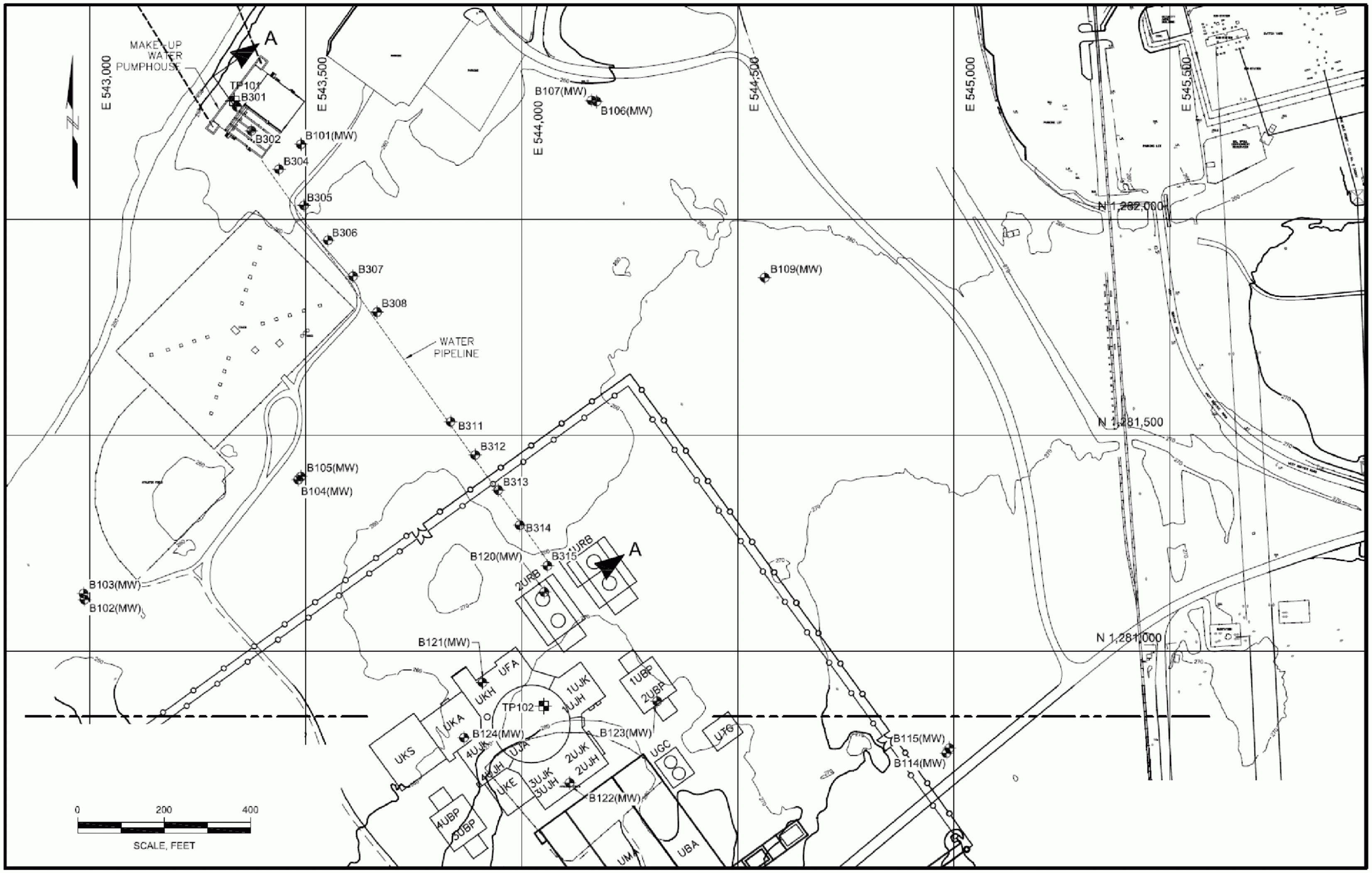


Figure 2.4-43—{100 and 300 Series Borings and Test Pits (South)}

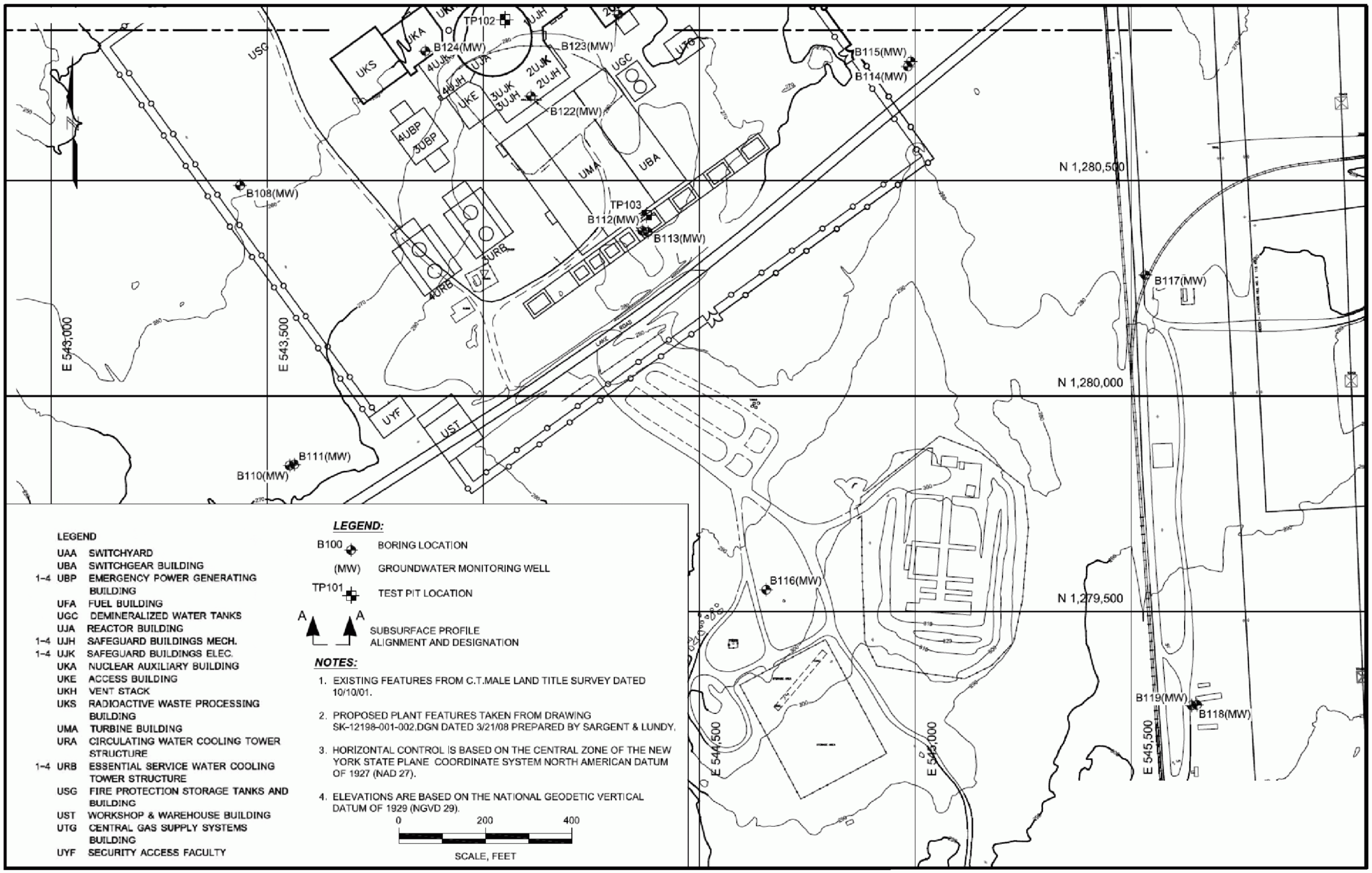


Figure 2.4-44—{200 Series Borings}

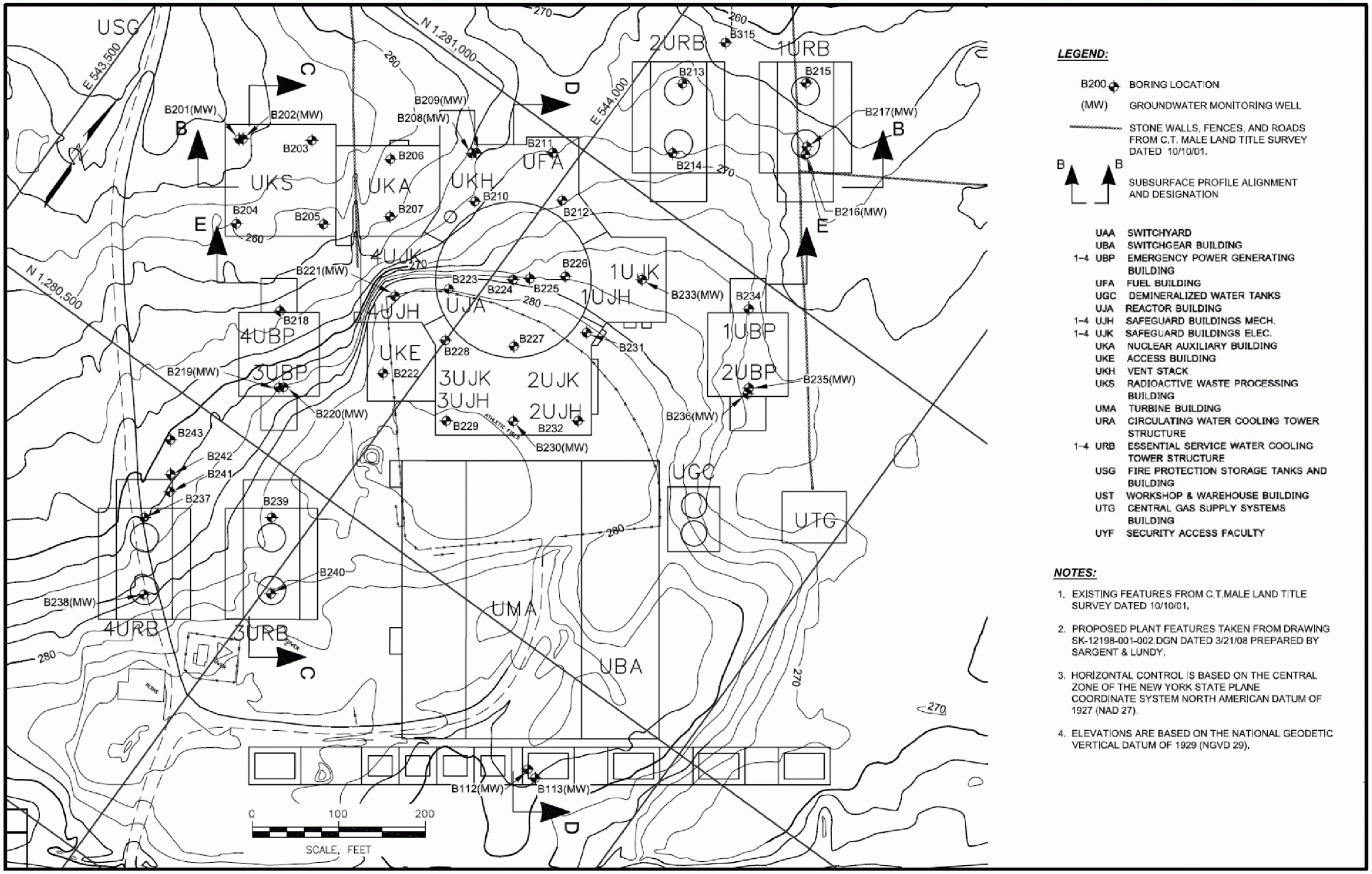


Figure 2.4-45—{400 Series Borings}

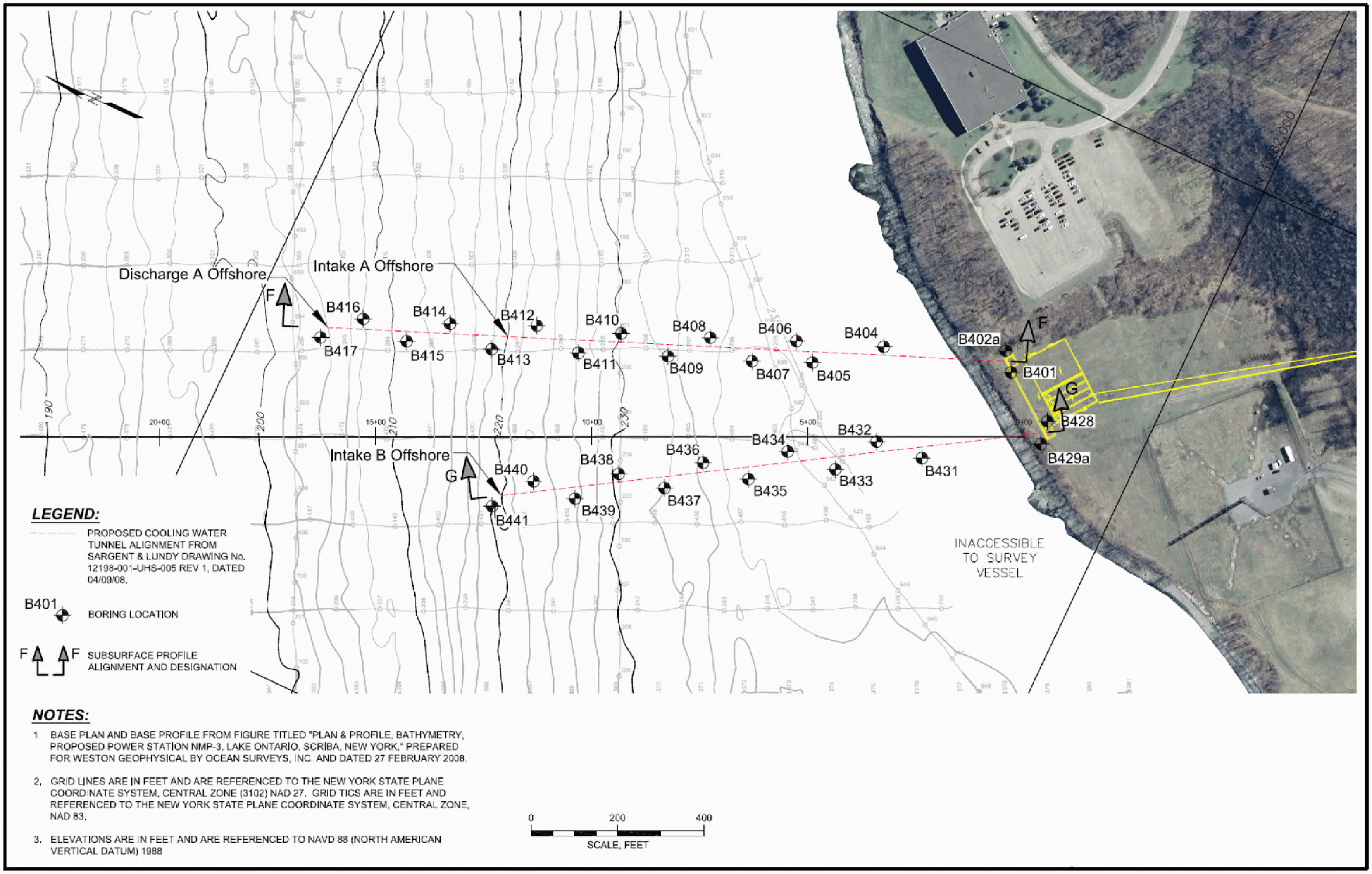


Figure 2.4-46—{On-shore Permeability Tests in Rock}

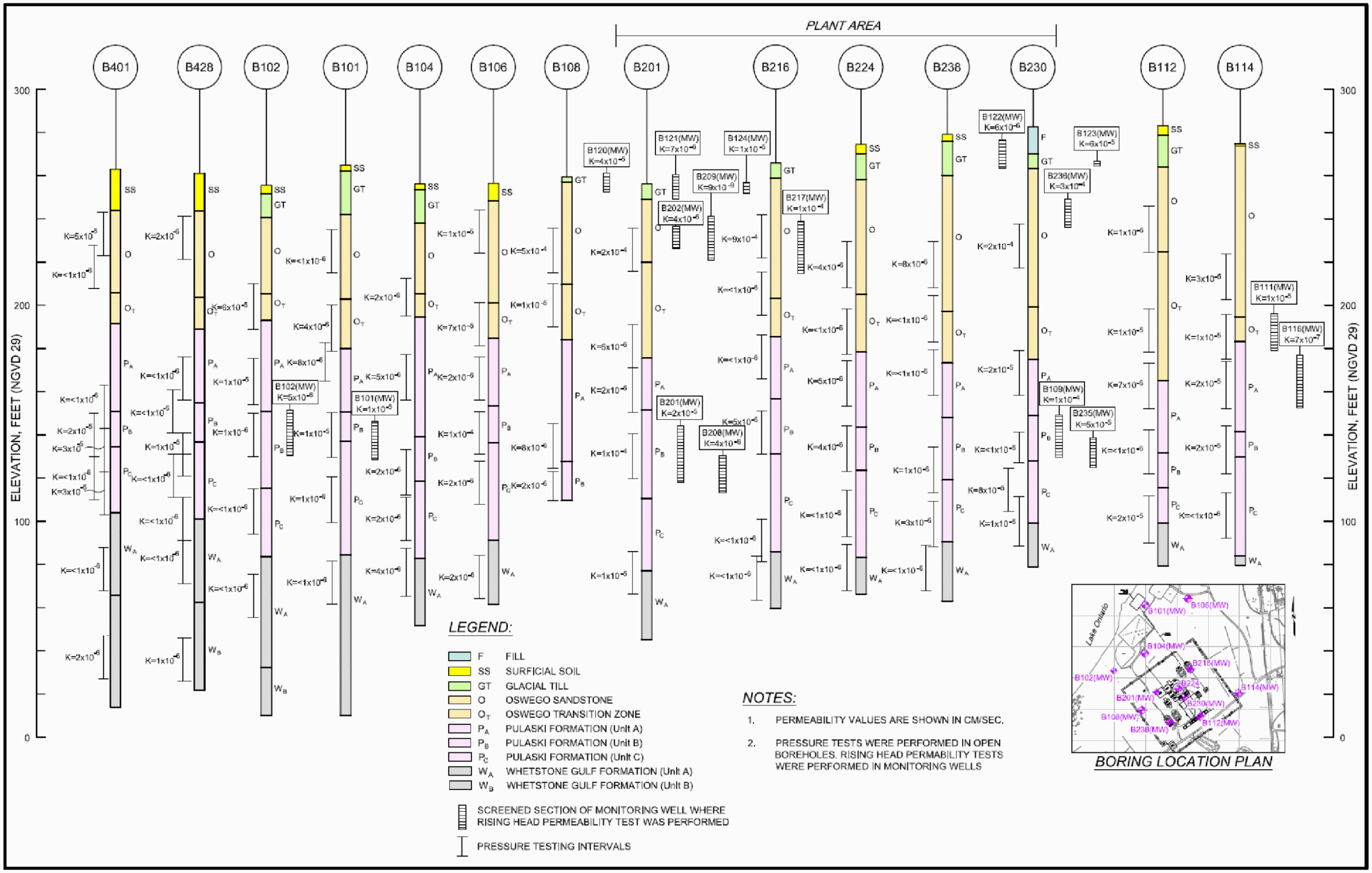


Figure 2.4-47—{Off-shore Permeability Tests in Rock}

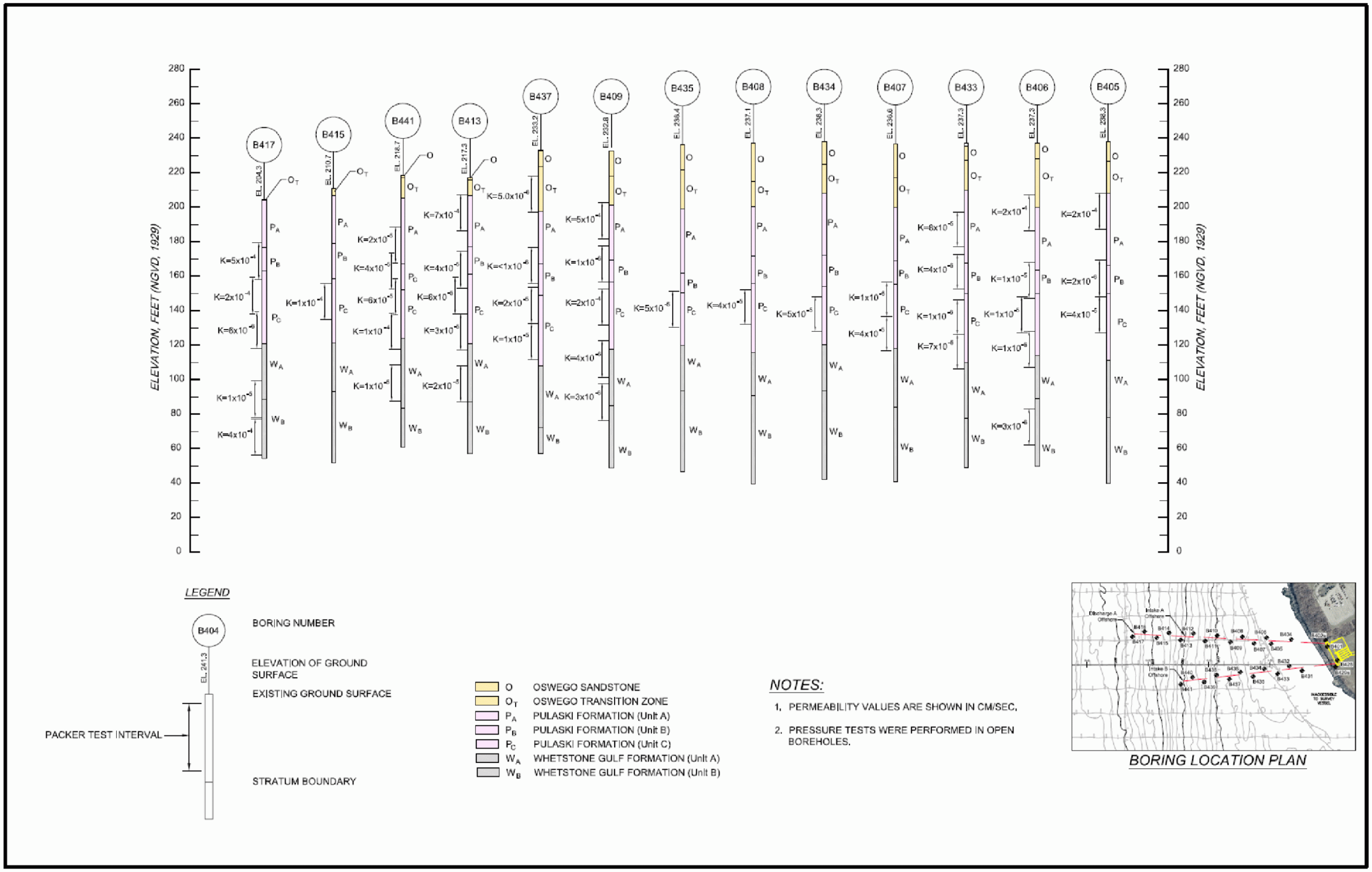


Figure 2.4-48—{Groundwater Contours Soil - March 2008}

WELLS USED FOR CONTOURING

BORING #	FORMATION	GW_ELEV	N	E
B120 (MW)	Soil	264.64	1281136.76	544052.3
B121 (MW)	Soil	263.92	1280926.86	543909.45
B122 (MW)	Soil	282.22	1280694.76	544110.77
B123 (MW)	Soil	269.9	1280883.92	544313.33

WELLS NOT USED FOR CONTOURING BECAUSE THEY DO NOT FIT THE GENERAL TREND

BORING #	FORMATION	GW_ELEV	N	E
B124 (MW)	Soil	262.44	1280799.17	543866.61

LEGEND

B100 Soil Borings

Proposed Plant

Soil Groundwater Contours: Interval 2 Feet

NOTES:

1. Existing features from C. T. Male Land Title Survey Dated 10/10/01.
2. Proposed Plant features taken from drawing SK-12198-001-002.dgn dated 3/21/08 prepared by Sargent & Lundy.
3. Horizontal control is based on the Central Zone of the New York State Plane Coordinate System North American Datum of 1927 (NAD 27).
4. Elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD 29).
5. Lake Ontario elevations based on Interational Great Lakes Datum of 1985 (IGLD85).

0 200 400 Feet
1" = 200'

Figure 2.4-49—{Groundwater Elevations Soil}

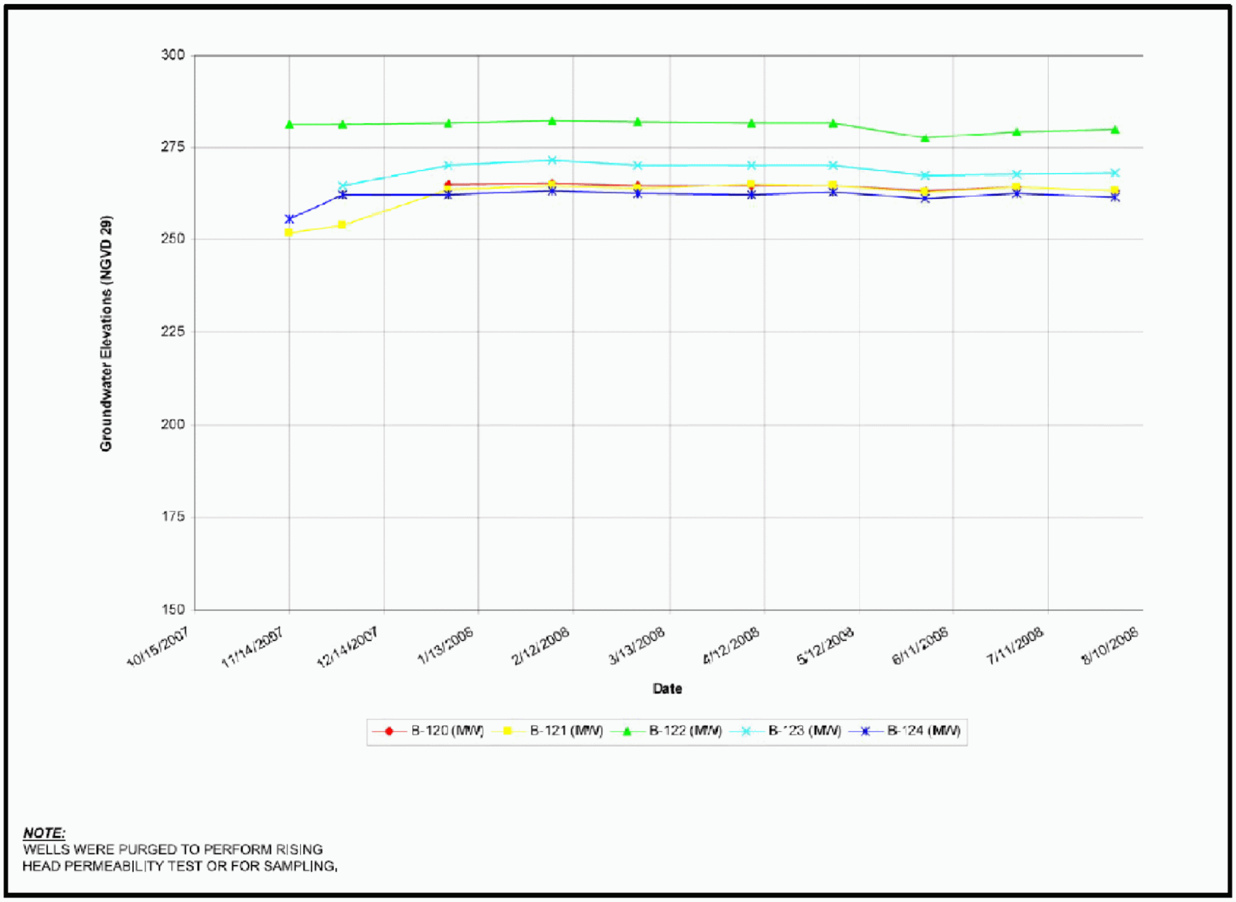


Figure 2.4-50—{Subsurface Profile A-A}

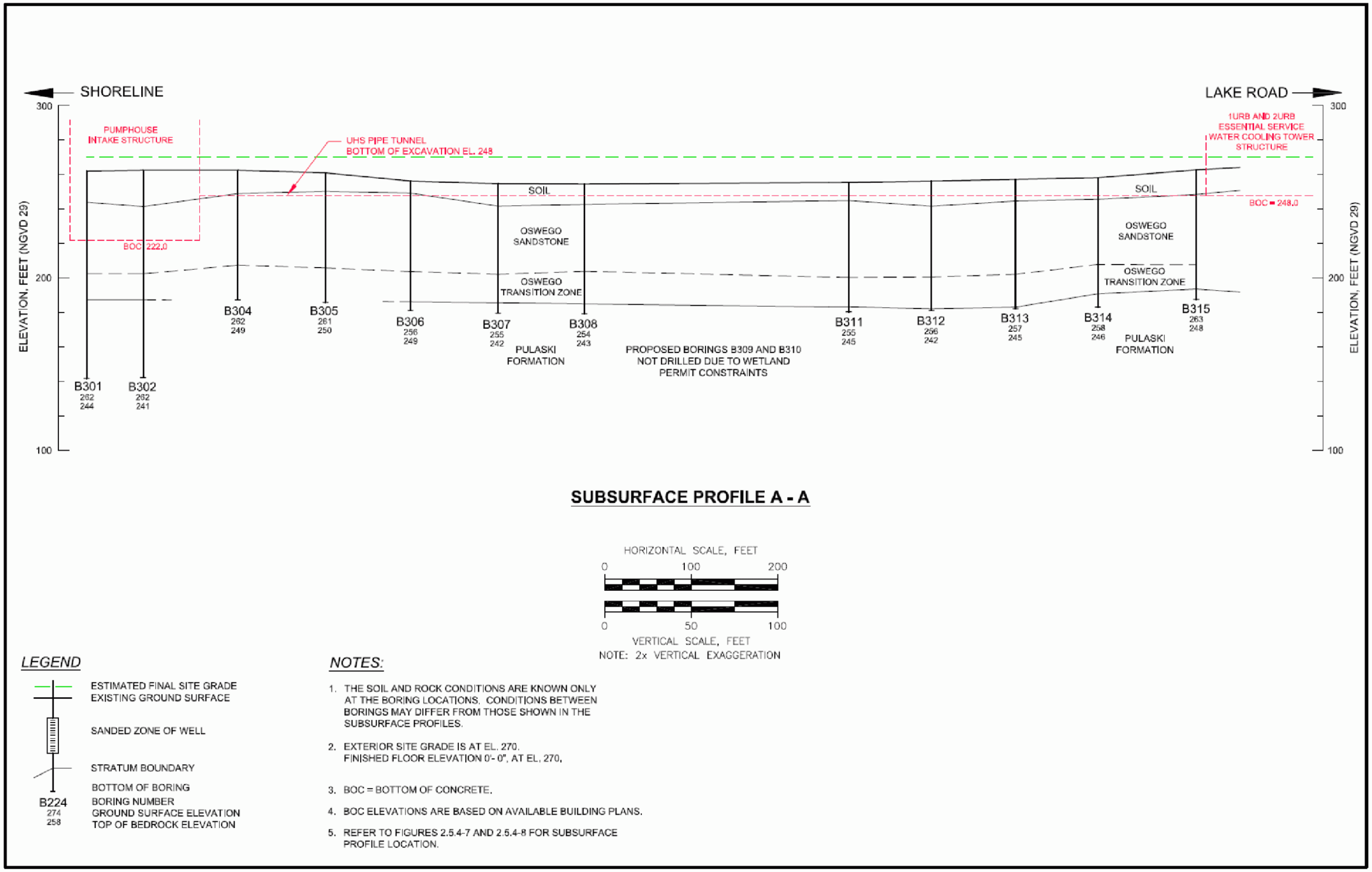


Figure 2.4-51—{Subsurface Profile B-B}

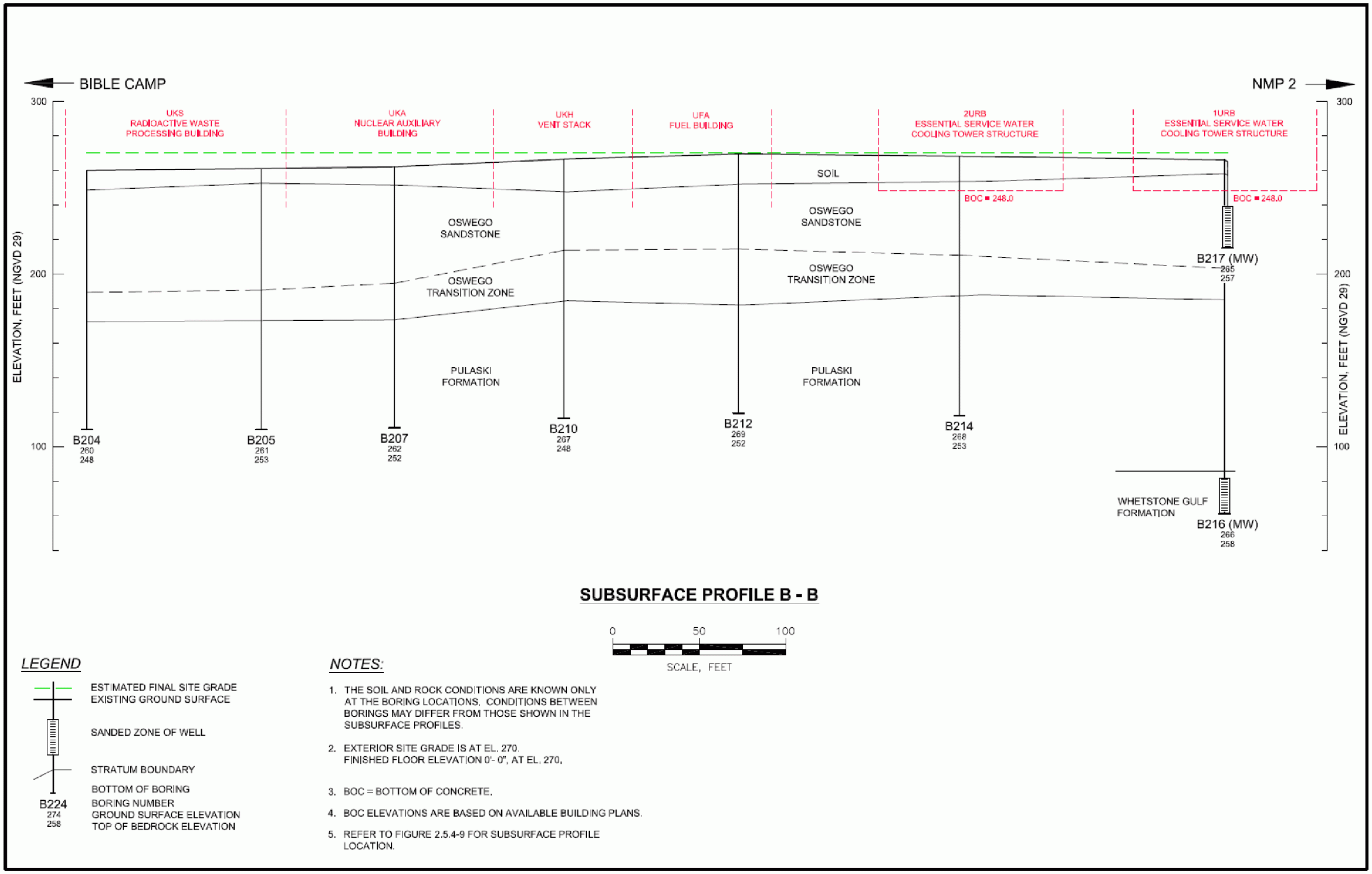
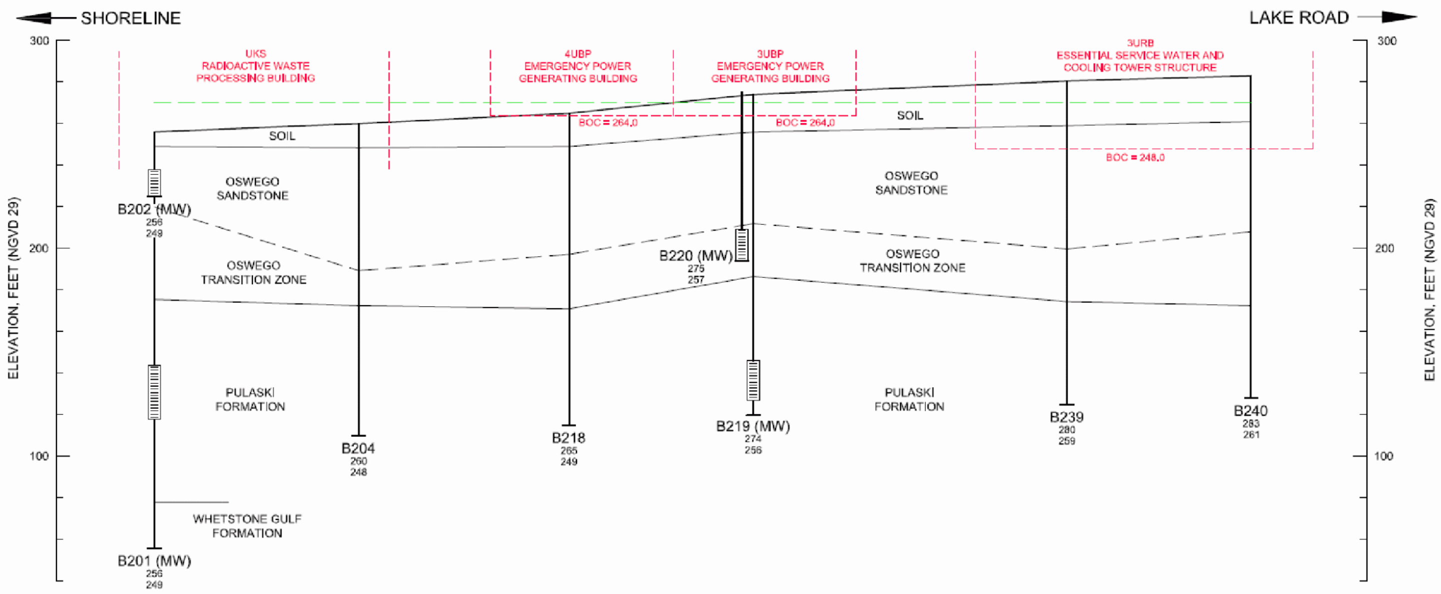
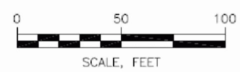


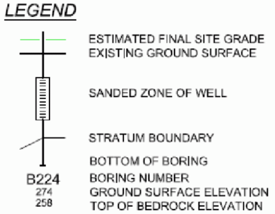
Figure 2.4-52—{Subsurface Profile C-C}



SUBSURFACE PROFILE C - C



LEGEND



NOTES:

1. THE SOIL AND ROCK CONDITIONS ARE KNOWN ONLY AT THE BORING LOCATIONS. CONDITIONS BETWEEN BORINGS MAY DIFFER FROM THOSE SHOWN IN THE SUBSURFACE PROFILES.
2. EXTERIOR SITE GRADE IS AT EL. 270. FINISHED FLOOR ELEVATION 0'- 0", AT EL. 270.
3. BOC = BOTTOM OF CONCRETE.
4. BOC ELEVATIONS ARE BASED ON AVAILABLE BUILDING PLANS.
5. REFER TO FIGURE 2.5.4-9 FOR SUBSURFACE PROFILE LOCATION.

Figure 2.4-53—{Subsurface Profile D-D}

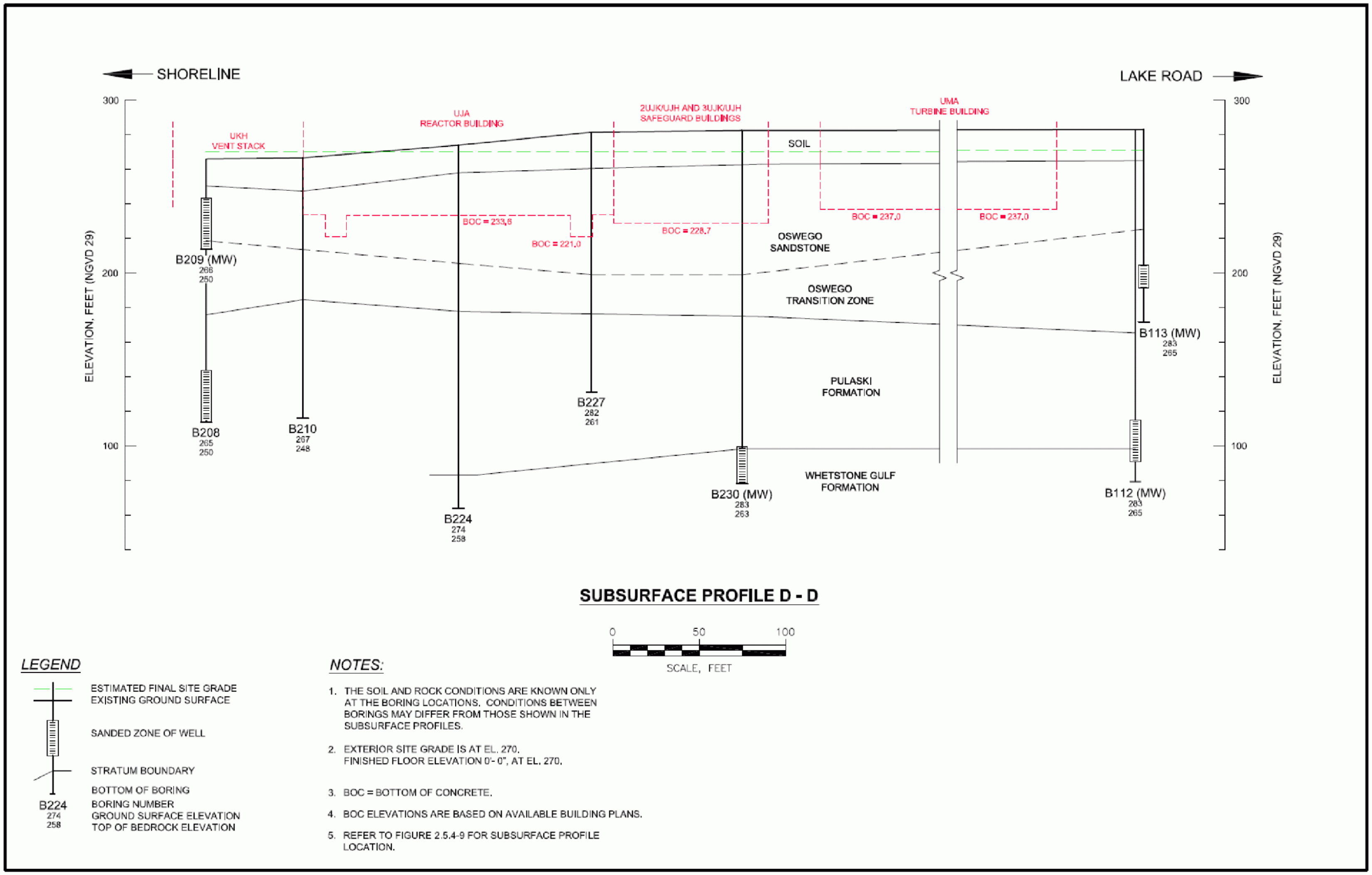


Figure 2.4-54—{Subsurface Profile E-E}

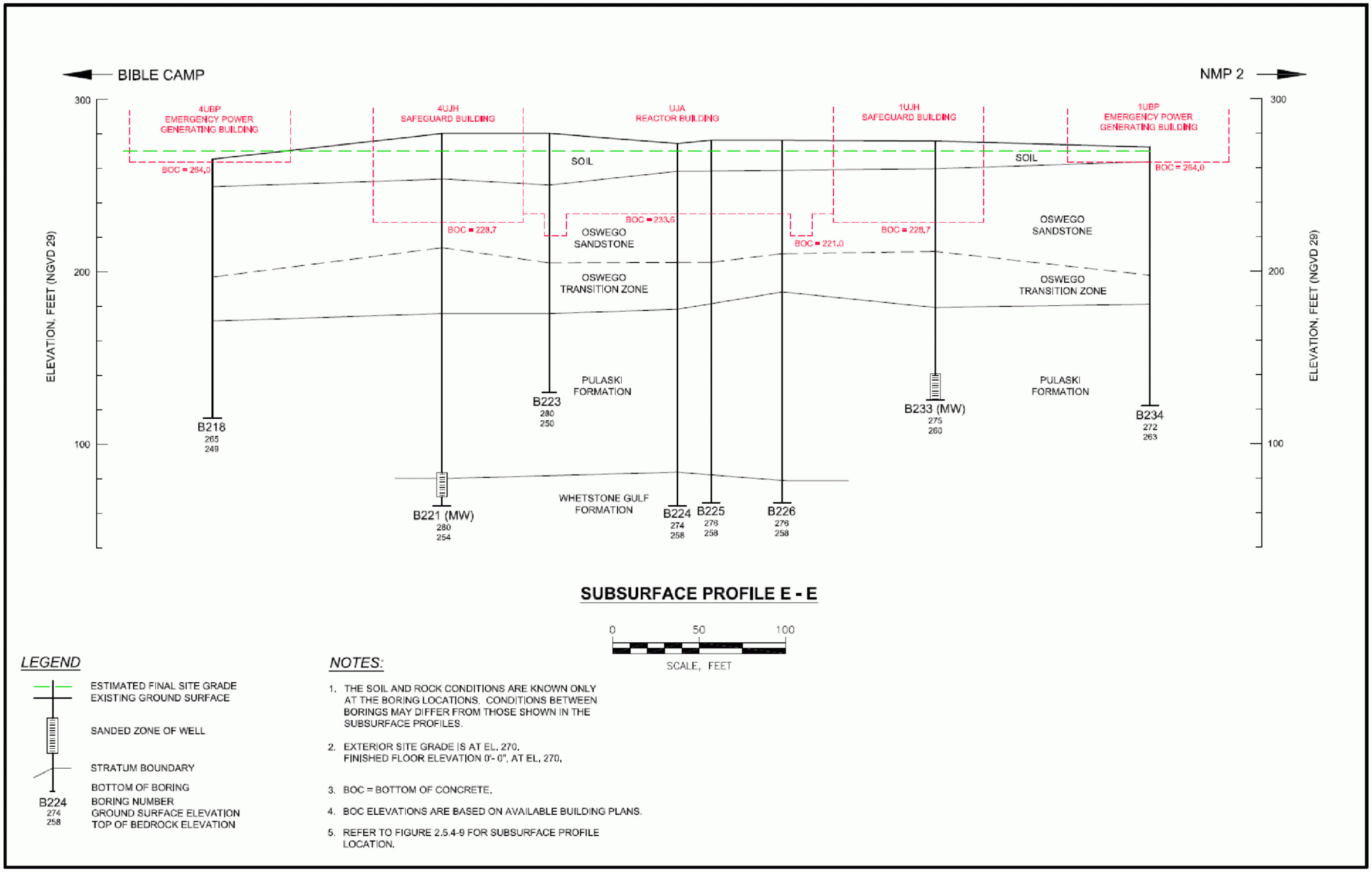


Figure 2.4-55—{Subsurface Profile F-F}

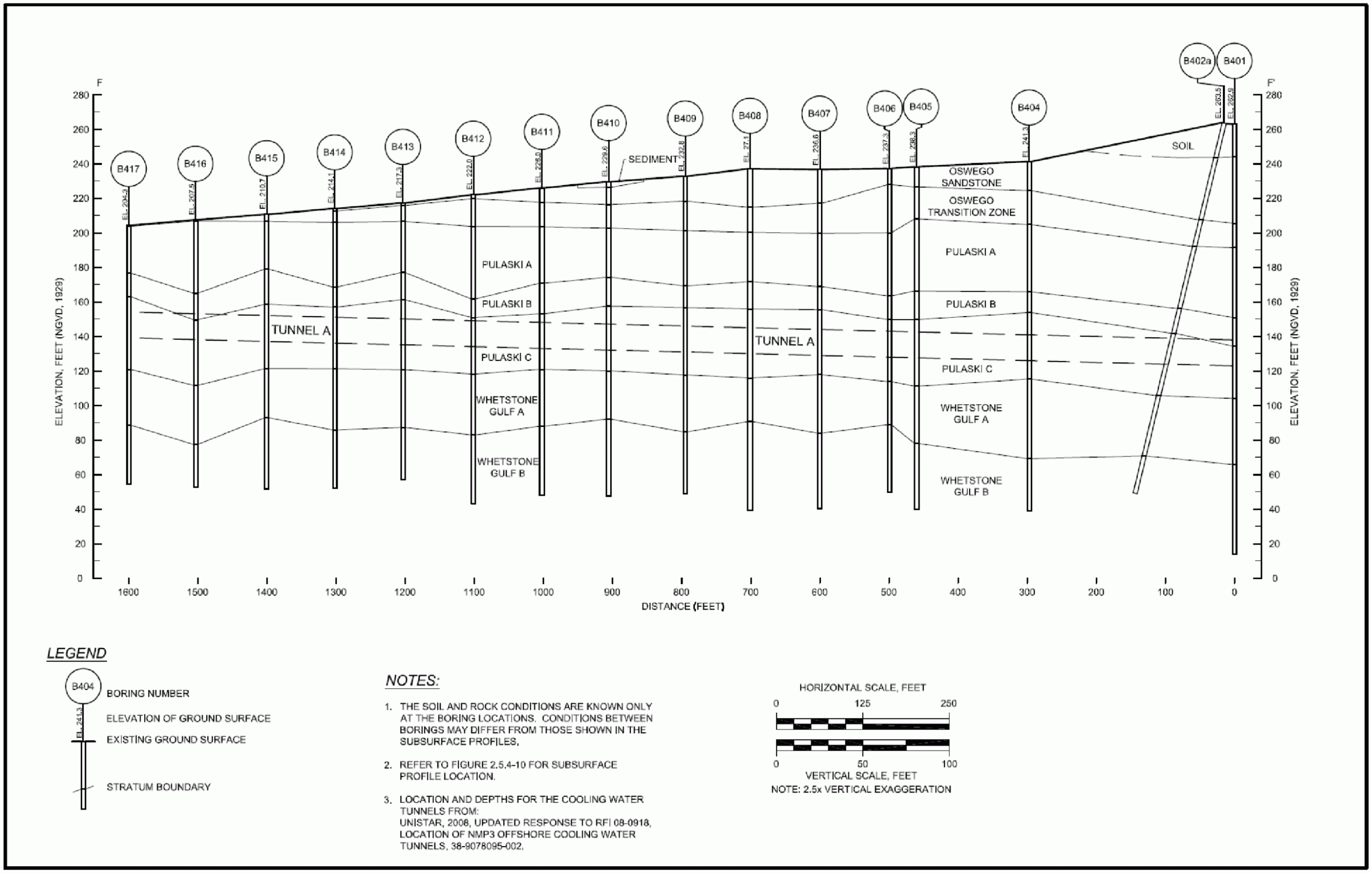


Figure 2.4-56—{Subsurface Profile G-G}

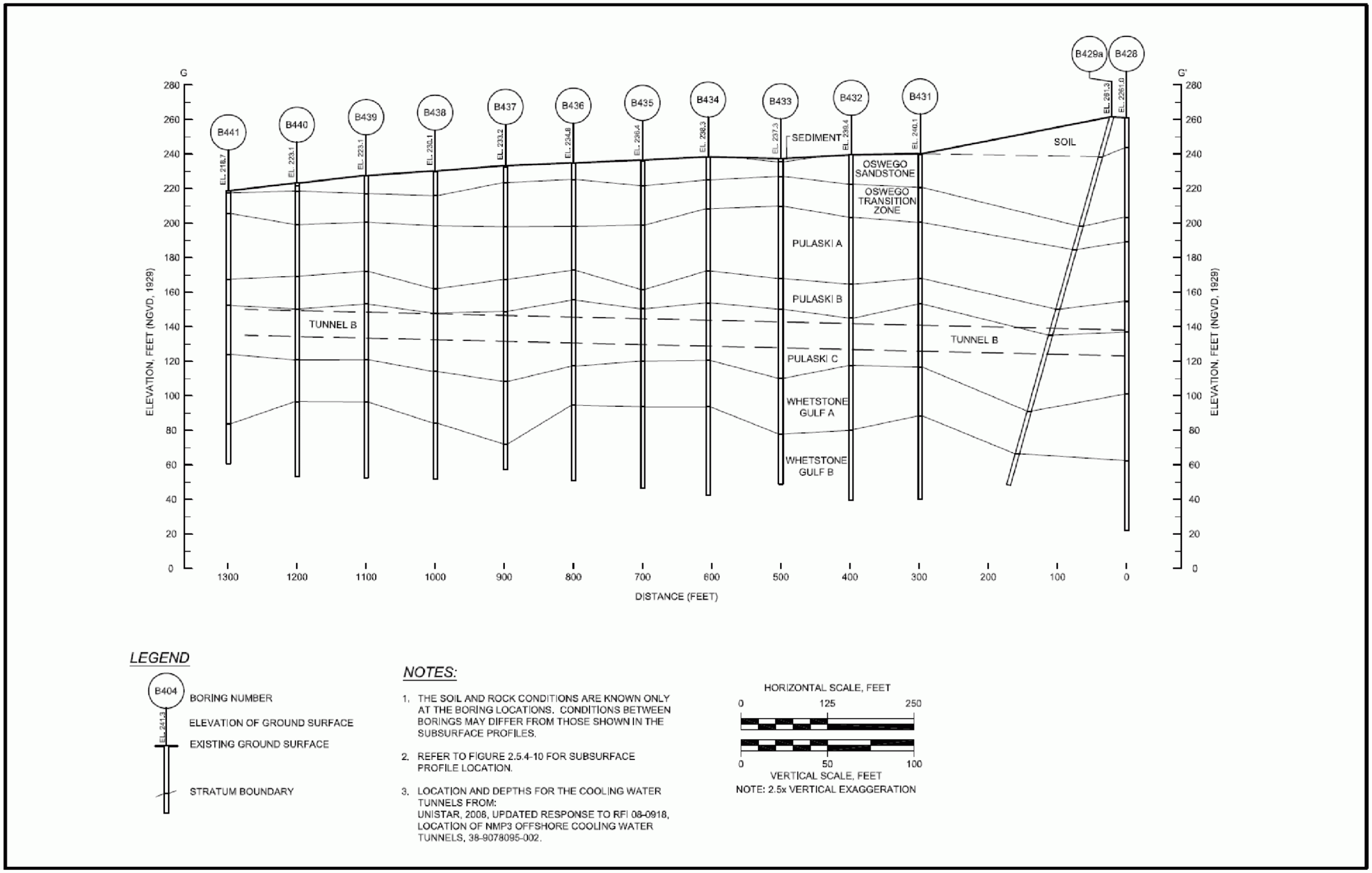
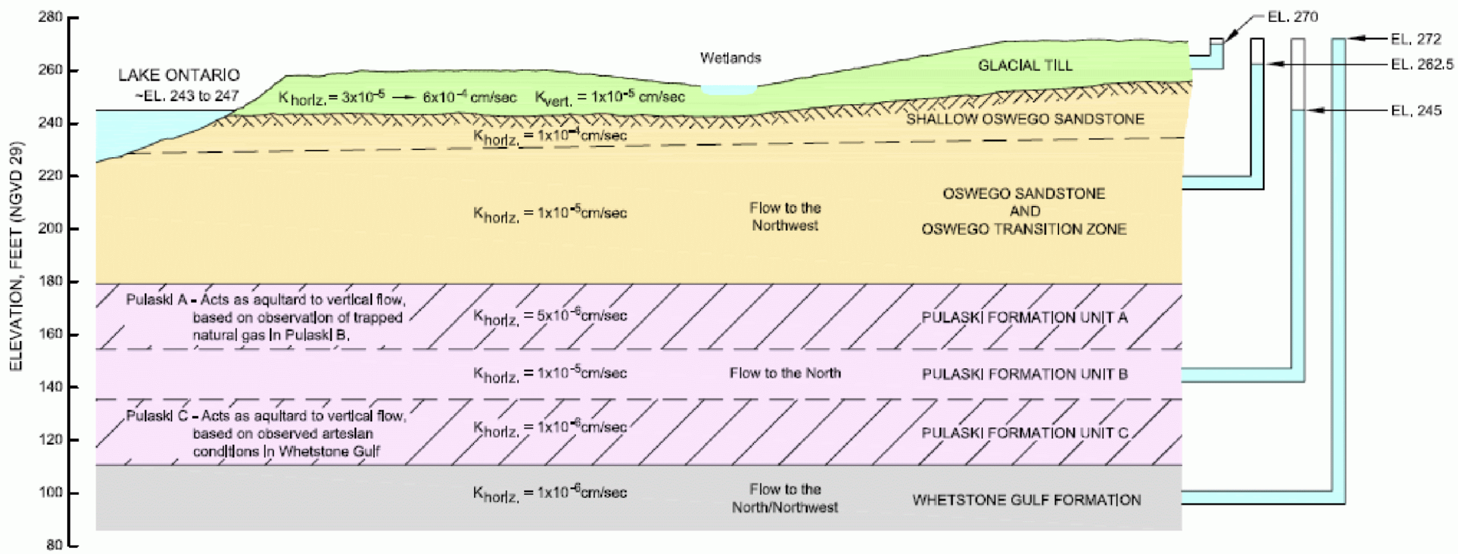


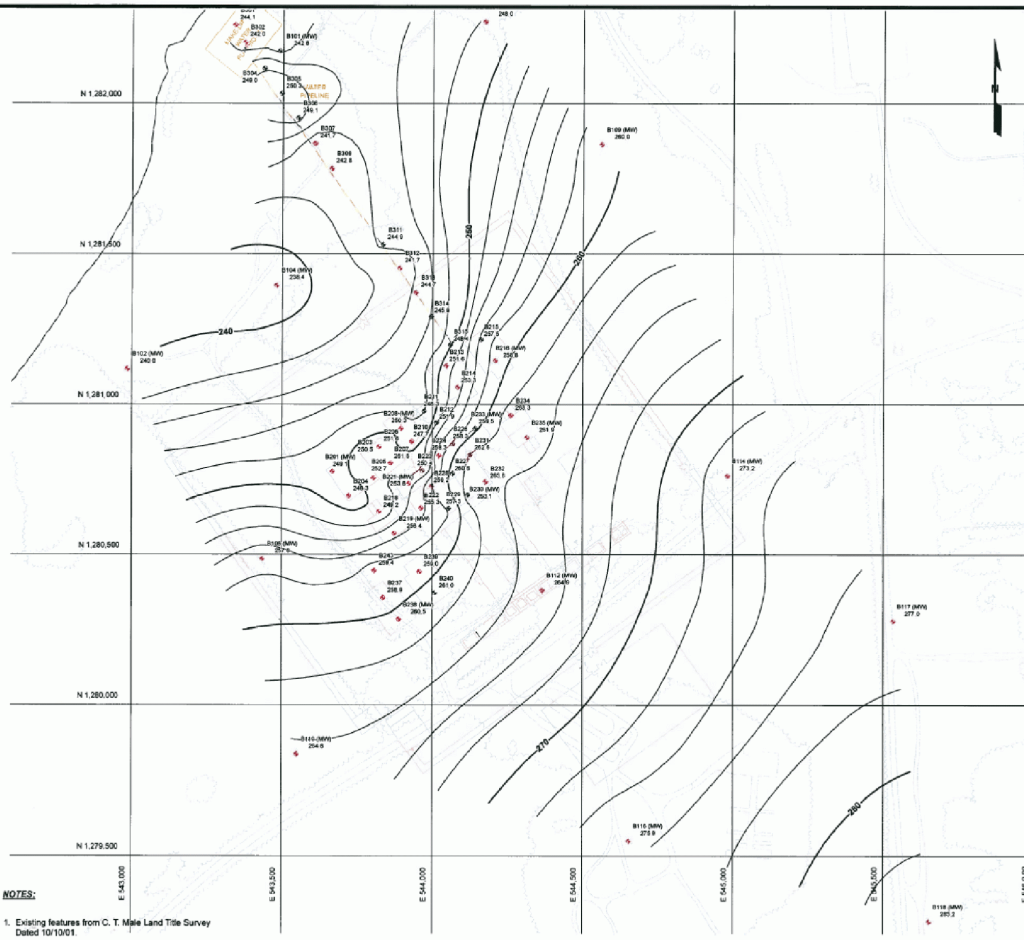
Figure 2.4-57—{Conceptual Cross Section and Groundwater Model}



NOTES:

1. K_{vert} is considered to be one ninth of $K_{horiz.}$ based on observed horizontal bedding and fracturing.
2. The soil and rock stratigraphy shown represents boring B224 which is located at the center of the reactor building.
3. The groundwater elevations shown are estimated from the groundwater contour plans at the center of the reactor building for the Glacial Till, Oswego Sandstone, and the Pulaski Formation. The groundwater elevation for the Whetstone Gulf Formation represents the groundwater level measured in B221 (MW) located at the Safe Guard Building within the Nuclear Island Common Basemat.

Figure 2.4-58—{Oswego Sandstone Topography}



Number	Boring Number	NORTHING	EASTING	Top of Oswego Sandstone (Feet)
1	B101 (MW)	1282173.9	543489.0	242.8
2	B102 (MW)	1281119.1	542988.4	240.0
3	B104 (MW)	1281396.9	543483.1	238.4
4	B106 (MW)	1282272.9	544173.3	248.0
5	B108 (MW)	1280487.7	543437.5	257.6
6	B109 (MW)	1281864.9	544562.3	260.0
7	B110 (MW)	1279838.6	543552.2	264.6
8	B112 (MW)	1280382.8	544368.5	264.9
9	B114 (MW)	1280763.3	544983.0	273.2
10	B116 (MW)	1279550.8	544655.3	275.9
11	B117 (MW)	1280280.0	545532.7	277.0
12	B118 (MW)	1279283.8	545652.1	283.2
13	B201 (MW)	1280776.2	543669.7	249.1
14	B203	1280824.6	543738.8	250.5
15	B204	1280695.3	543724.7	248.3
16	B205	1280754.1	543806.7	252.7
17	B206	1280860.5	543825.2	251.6
18	B207	1280806.6	543863.7	251.5
19	B208 (MW)	1280921.3	543897.4	250.3
20	B210	1280878.4	543932.8	247.7
21	B211	1280976.9	543972.8	246.3
22	B212	1280938.8	544013.9	251.9
23	B213	1281129.8	544047.2	251.6
24	B214	1281058.0	544085.3	253.3
25	B215	1281214.5	544162.3	257.5
26	B216 (MW)	1281146.8	544210.4	258.8
27	B218	1280643.2	543825.0	249.2
28	B219 (MW)	1280570.9	543875.9	256.4
29	B221 (MW)	1280735.3	543922.7	253.6
30	B222	1280655.1	543963.9	255.3
31	B223	1280778.6	543968.0	250.4
32	B224	1280831.1	544021.9	258.3
33	B226	1280869.8	544068.6	258.3
34	B227	1280769.4	544067.8	260.6
35	B228	1280728.2	543999.7	259.2
36	B229	1280653.5	544055.4	257.3
37	B230 (MW)	1280698.5	544118.4	263.1
38	B231	1280831.5	544126.6	262.6
39	B232	1280743.1	544178.7	263.6
40	B233 (MW)	1280918.6	544142.4	259.5
41	B234	1280964.0	544262.5	263.3
42	B235 (MW)	1280889.9	544316.3	261.9
43	B237	1280357.7	543838.5	258.9
44	B238 (MW)	1280285.2	543890.3	260.5
45	B239	1280444.2	543957.5	259.0
46	B240	1280372.3	544008.6	261.0
47	B243	1280448.1	543810.1	259.4
48	B301	1282261.0	543340.8	244.1
49	B302	1282204.9	543374.5	242.0
50	B304	1282115.9	543438.4	249.0
51	B305	1282032.5	543496.0	250.3
52	B306	1281951.5	543551.8	249.1
53	B307	1281868.2	543609.7	241.7
54	B308	1281785.2	543665.4	242.8
55	B311	1281531.2	543835.6	244.9
56	B312	1281454.1	543892.3	241.7
57	B313	1281372.8	543946.0	244.7
58	B314	1281291.5	543995.6	245.9
59	B315	1281197.5	544059.5	248.4

LEGEND

B100 Boring Location

Proposed Plant

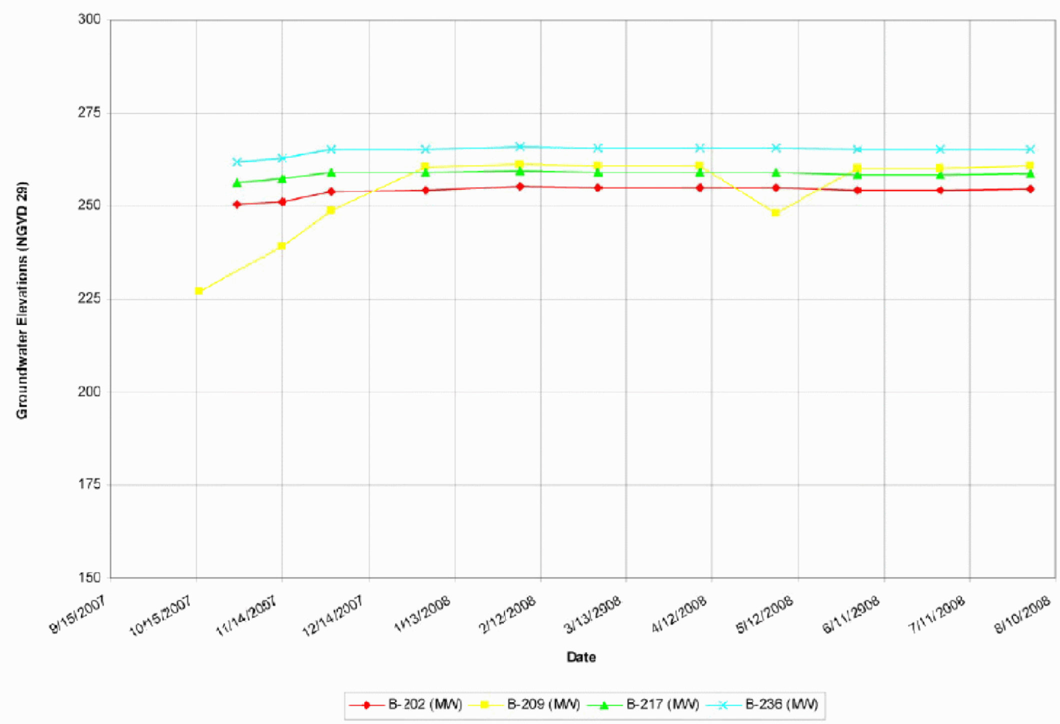
Top of Oswego Sandstone Elevation Contours - Interval: 2 Feet

NOTES:

1. Existing features from C. T. Male Land Title Survey Dated 10/10/01.
2. Proposed Plant features taken from drawing SK-12198-001-002.dgn dated 3/21/08 prepared by Sargent & Lundy.
3. Horizontal control is based on the Central Zone of the New York State Plane Coordinate System North American Datum of 1927 (NAD 27).
4. Elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD 29).

0 200 400 Feet

Figure 2.4-59—{Shallow Groundwater Elevations Oswego}



NOTE:
WELLS WERE PURGED TO PERFORM RISING HEAD PERMEABILITY TEST OR FOR SAMPLING.

Figure 2.4-60—{Deep Groundwater Elevations Oswego}

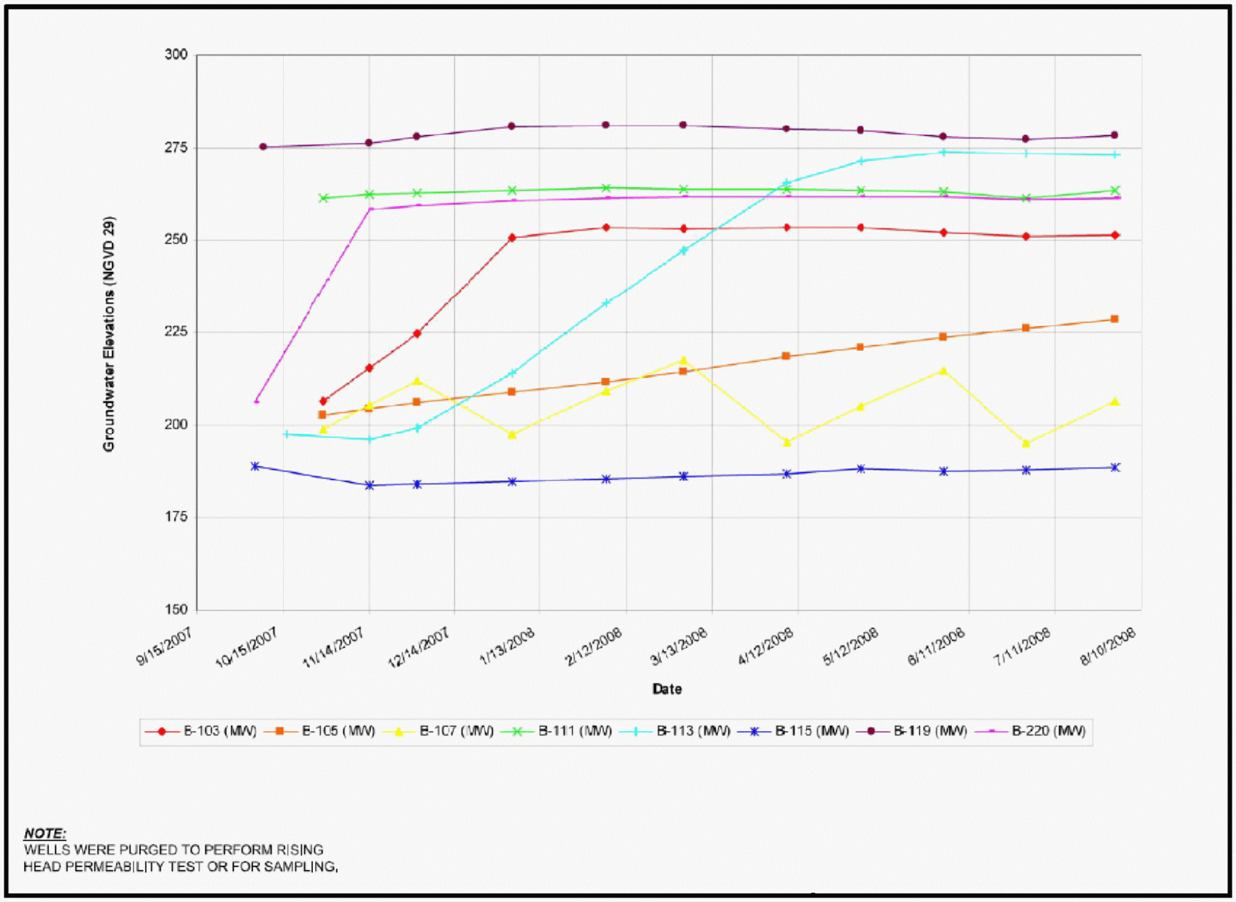
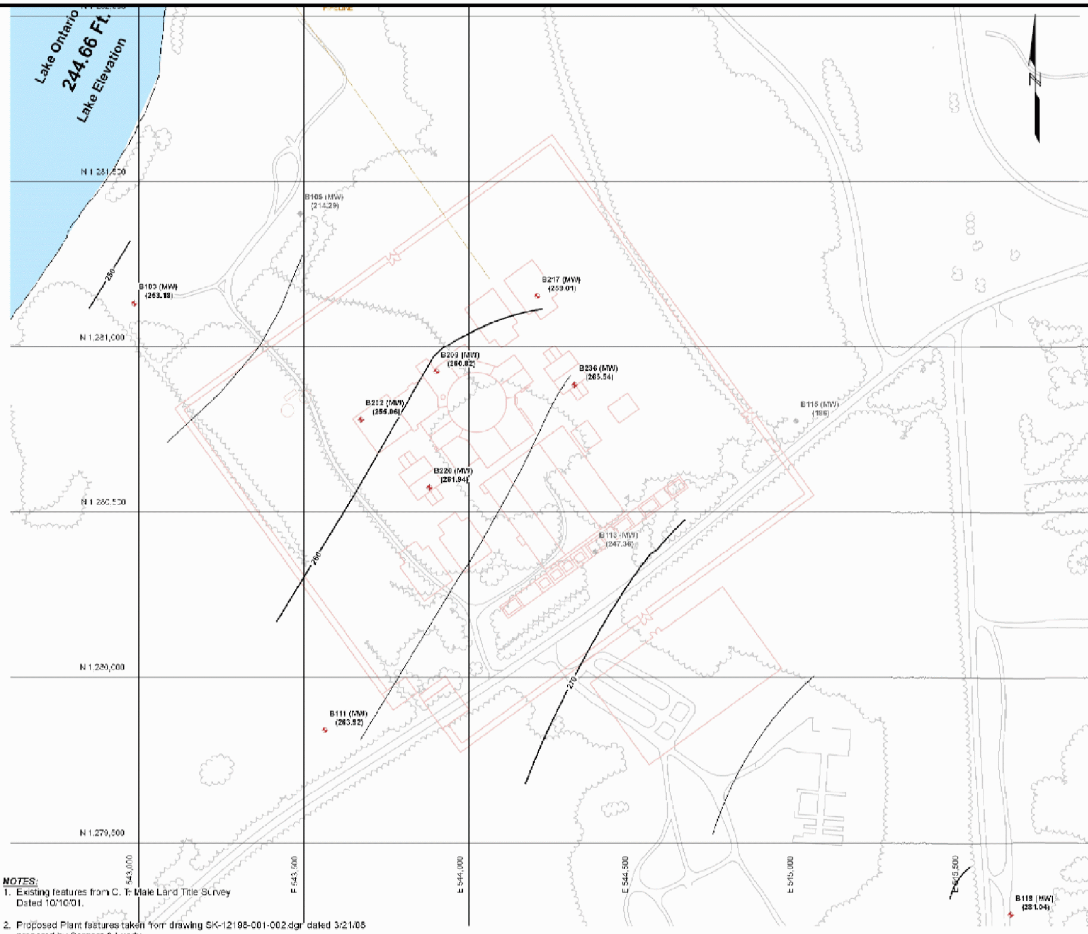


Figure 2.4-61—{Groundwater Contours Oswego Sandstone}



WELLS USED FOR CONTOURING

Boring #	FORMATION	GW_ELEV	N	E
B103 (MW)	Oswego Sandstone, Oswego Transition, & Pulaski A	253.18	1281133.22	542986.14
B111 (MW)	Oswego Transition & Pulaski A	263.92	1279841.05	543563.3
B119 (MW)	Oswego Sandstone & Oswego Transition	281.04	1279282.64	545639.91
B202 (MW)	Oswego Sandstone	255.06	1280779.11	543673.3
B209 (MW)	Oswego Sandstone & Oswego Transition	260.82	1280924.53	543901.52
B217 (MW)	Oswego Sandstone	259.01	1281155.33	544206.49
B220 (MW)	Oswego Transition	261.94	1280574.31	543880.23
B236 (MW)	Oswego Sandstone	265.54	1280883.82	544318.99

WELLS NOT USED FOR CONTOURING BECAUSE THEY DO NOT FIT THE GENERAL TREND

BORING #	FORMATION	GW_ELEV	N	E
B105 (MW)	Oswego Sandstone & Oswego Transition	214.29	1281404.26	543488.91
B107 (MW)	Oswego Sandstone & Oswego Transition	217.6	1282275.48	544161.76
B113 (MW)	Oswego Transition	247.36	1280379.65	544381.42
B115 (MW)	Oswego Transition & Pulaski A	186	1280775.02	544989.75

LEGEND

B100 Borings & Wells

Proposed Plant

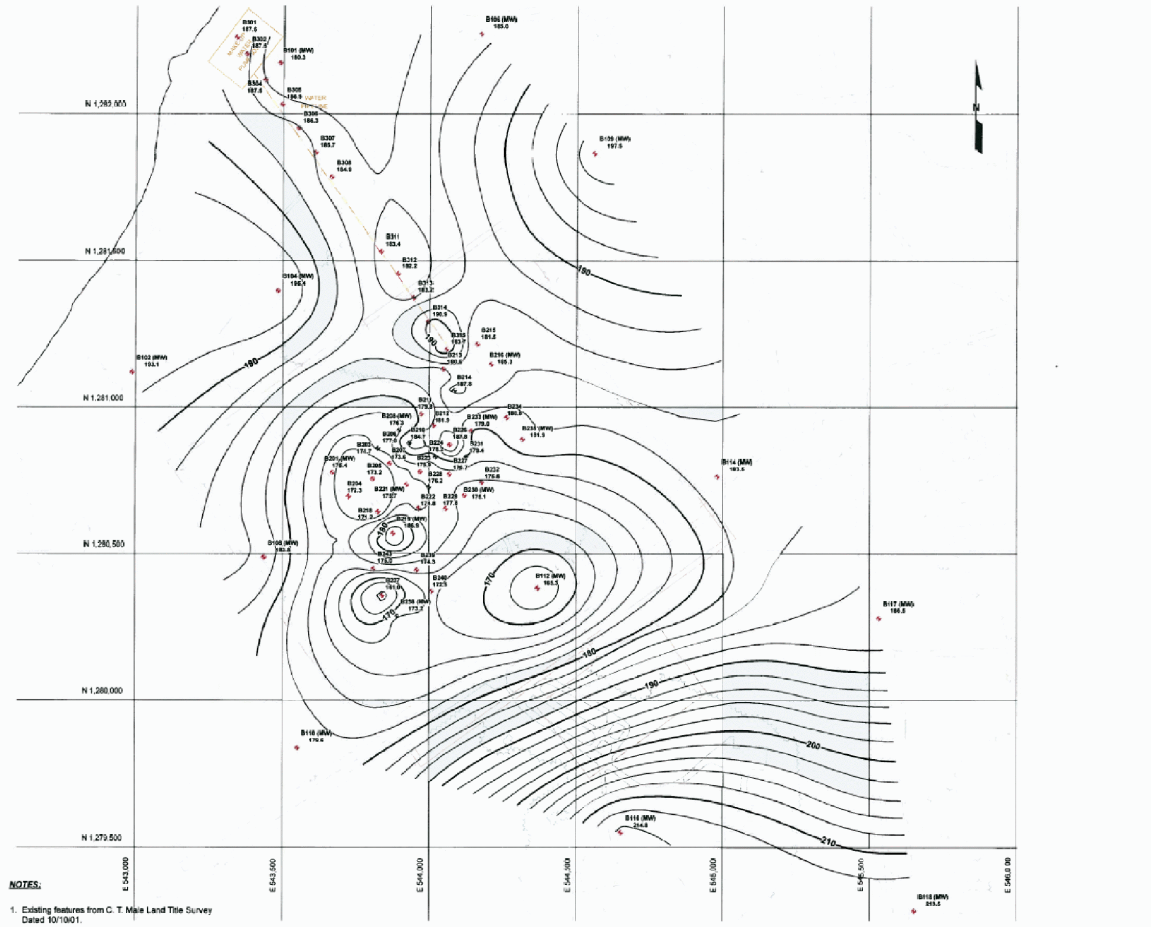
Oswego Sandstone Groundwater Contours: Interval 5 Feet

0 200 400 Feet

NOTES:

1. Existing features from C. T. Male Land Title Survey Dated 10/10/01.
2. Proposed Plant features taken from drawing SK-12198-001-002.dgn dated 3/21/08 prepared by Sargent & Lundy.
3. Horizontal control is based on the Central Zone of the New York State Plane Coordinate System North American Datum of 1927 (NAD 27).
4. Elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD 29).
5. Lake Ontario Water Level data for March 3, 2008 from NOAA Oswego, New York Station 9052030. Lake Ontario elevations are converted from the International Great Lakes Datum of 1985 (IGLD85) to NGVD29.

Figure 2.4-62—{Pulaski Topography}



Number	Boring Number	NORTHING	EASTING	Top of Pulaski Elevation (Feet)
1	B101 (MW)	1282173.9	543489.0	180.3
2	B102 (MW)	1281119.1	542988.4	193.1
3	B104 (MW)	1281396.9	543483.1	195.4
4	B106 (MW)	1282272.9	544173.3	185.0
5	B108 (MW)	1280487.7	543437.5	183.8
6	B109 (MW)	1281864.9	544562.3	197.5
7	B110 (MW)	1279838.6	543552.2	179.6
8	B112 (MW)	1280382.8	544368.5	165.3
9	B114 (MW)	1280763.3	544983.0	183.5
10	B116 (MW)	1279550.8	544655.3	214.8
11	B117 (MW)	1280280.0	545532.7	186.5
12	B118 (MW)	1279283.8	545652.1	213.5
13	B201 (MW)	1280776.2	543669.7	175.4
14	B203	1280824.6	543738.8	171.7
15	B204	1280695.3	543724.7	172.3
16	B205	1280754.1	543806.7	173.2
17	B206	1280860.5	543825.2	177.0
18	B207	1280806.6	543863.7	173.6
19	B208 (MW)	1280921.3	543897.4	176.3
20	B210	1280878.4	543932.8	184.7
21	B211	1280976.9	543972.8	179.8
22	B212	1280938.8	544013.9	181.9
23	B213	1281129.8	544047.2	180.6
24	B214	1281058.0	544085.3	187.8
25	B215	1281214.5	544162.3	181.5
26	B216 (MW)	1281146.8	544210.4	185.3
27	B218	1280643.2	543825.0	171.2
28	B219 (MW)	1280570.9	543875.9	186.9
29	B221 (MW)	1280735.3	543922.7	175.7
30	B222	1280655.1	543963.9	174.8
31	B223	1280778.6	543968.0	175.9
32	B224	1280831.1	544021.9	178.2
33	B226	1280869.8	544068.6	187.8
34	B227	1280769.4	544067.8	176.7
35	B228	1280728.2	543999.7	176.2
36	B229	1280653.5	544055.4	177.8
37	B230 (MW)	1280698.5	544118.4	175.1
38	B231	1280831.5	544126.6	179.4
39	B232	1280743.1	544178.7	175.6
40	B233 (MW)	1280918.8	544142.4	179.0
41	B234	1280964.0	544262.5	180.8
42	B235 (MW)	1280889.9	544316.3	181.9
43	B237	1280357.7	543838.5	161.0
44	B238 (MW)	1280285.2	543890.3	173.2
45	B239	1280444.2	543957.5	174.3
46	B240	1280372.3	544008.8	172.5
47	B243	1280448.1	543810.1	175.0
48	B301	1282261.0	543340.8	187.6
49	B302	1282204.9	543374.5	187.5
50	B304	1282115.9	543438.4	187.5
51	B305	1282032.5	543496.0	186.9
52	B306	1281951.5	543551.8	186.3
53	B307	1281868.2	543609.7	185.7
54	B308	1281785.2	543665.4	184.9
55	B311	1281531.2	543835.6	183.4
56	B312	1281454.1	543892.3	182.2
57	B313	1281372.8	543946.0	183.2
58	B314	1281291.5	543995.6	190.9
59	B315	1281197.5	544059.5	193.7

LEGEND

B100 — Boring Location

Proposed Plant

Pulaski A Elevation Contours - Interval: 2 Feet

NOTES:

1. Existing features from C. T. Male Land Title Survey Dated 10/10/01.
2. Proposed Plant features taken from drawing SK-12198-001-002.dgn dated 3/21/08 prepared by Sargent & Lundy.
3. Horizontal control is based on the Central Zone of the New York State Plane Coordinate System North American Datum of 1927 (NAD 27).
4. Elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD 29).

Figure 2.4-63—{Groundwater Elevations Pulaski Information}

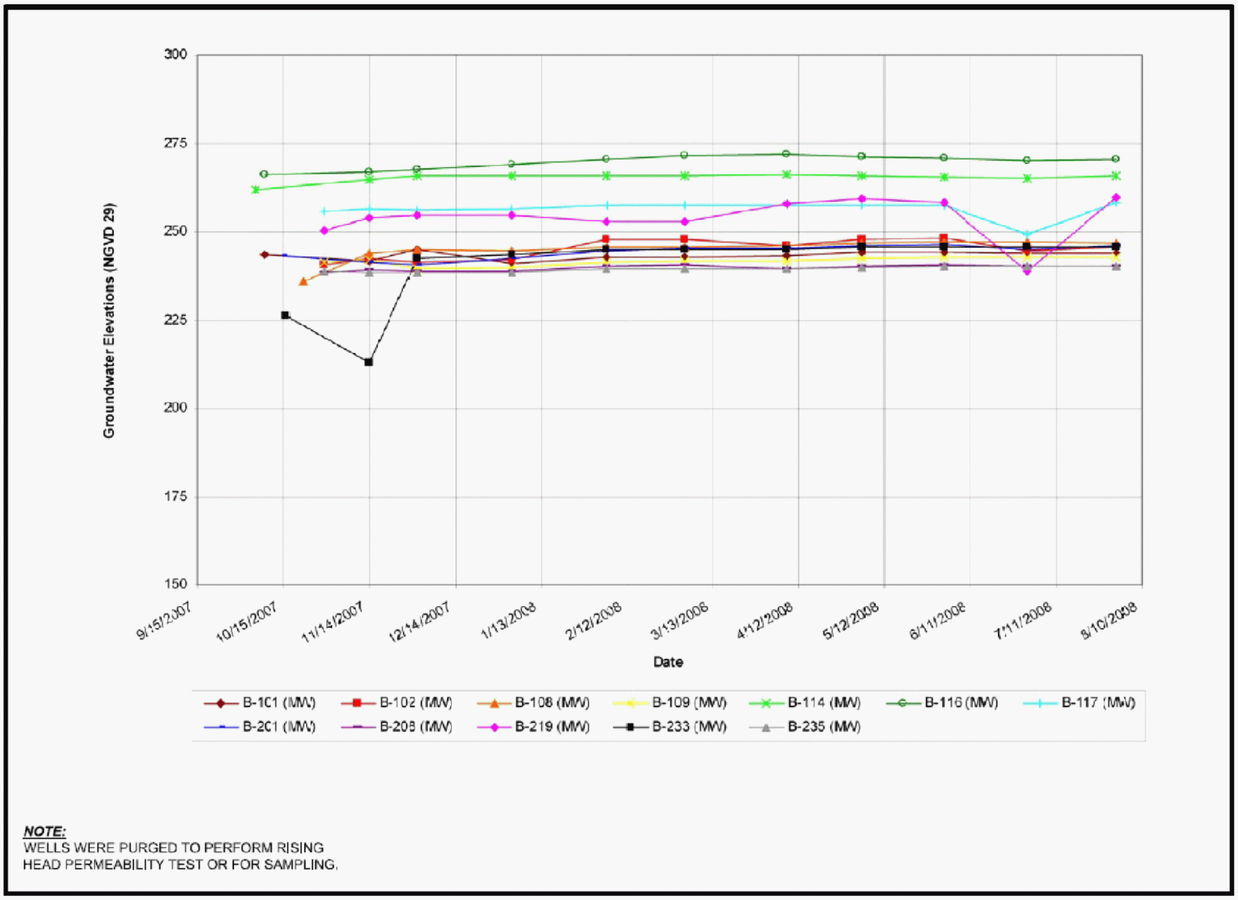
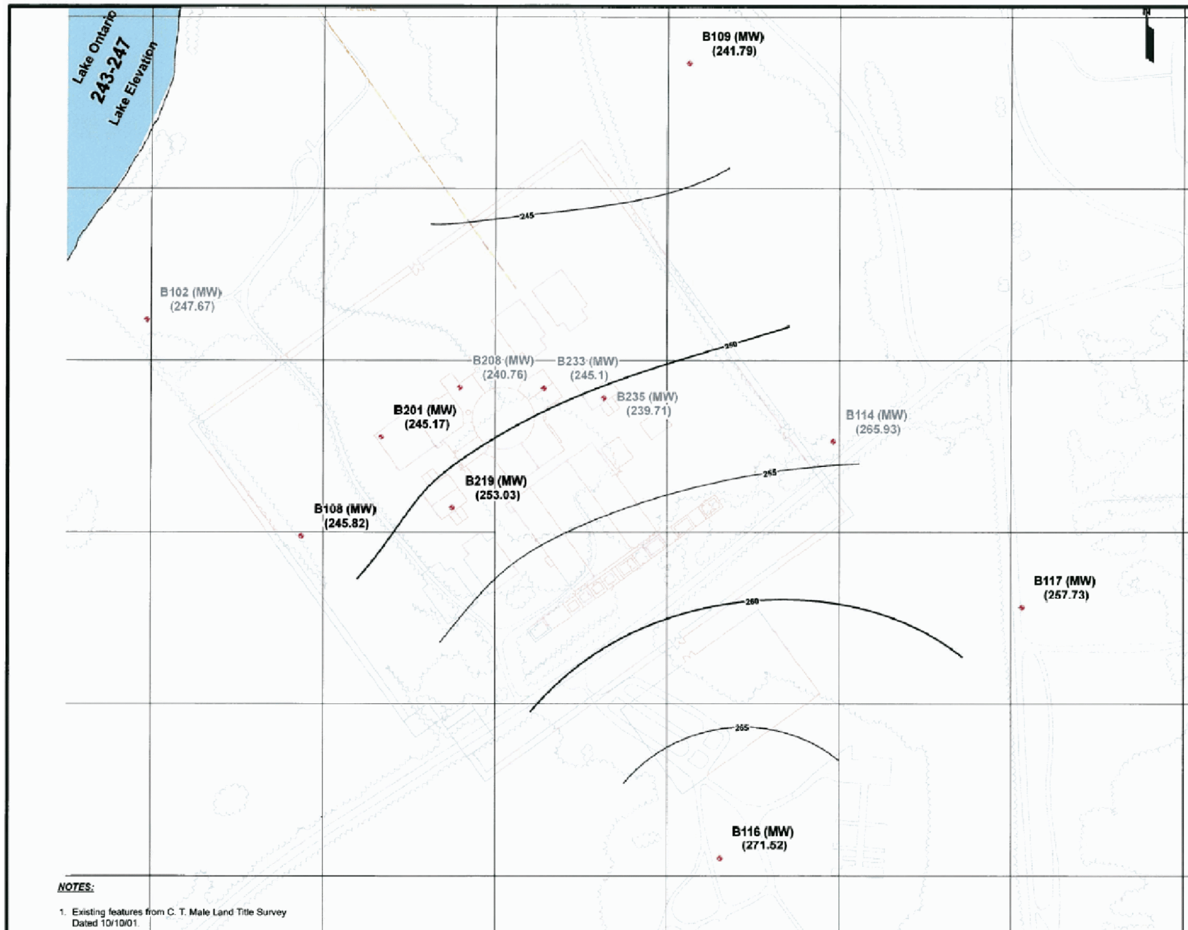


Figure 2.4-64—{Groundwater Contours Pulaski Information}



WELLS USED FOR CONTOURING

Boring #	FORMATION	GW_ELEV	N	E
B108 (MW)	Pulaski B	245.82	1280487.69	543437.49
B109 (MW)	Pulaski B	241.79	1281864.87	544562.3
B116 (MW)	Pulaski B	271.52	1279550.81	544655.28
B117 (MW)	Pulaski B	257.73	1280280.02	545532.72
B201 (MW)	Pulaski B	245.17	1280776.23	543669.68
B219 (MW)	Pulaski B	253.03	1280570.9	543875.86

WELLS NOT USED FOR CONTOURING BECAUSE SCREENED INTERVAL INCLUDES PULASKI UNITS A and/or C

Boring #	FORMATION	GW_ELEV	N	E
B101 (MW)	Pulaski B & C	242.89	1282173.94	543489.04
B102 (MW)	Pulaski A & B	247.67	1281119.14	542988.42
B114 (MW)	Pulaski A, B, & C	265.93	1280763.34	544983.02
B208 (MW)	Pulaski B & C	240.76	1280921.25	543897.37
B233 (MW)	Pulaski C	245.1	1280918.76	544142.44
B235 (MW)	Pulaski B & C	239.71	1280889.94	544316.31

NOTES:

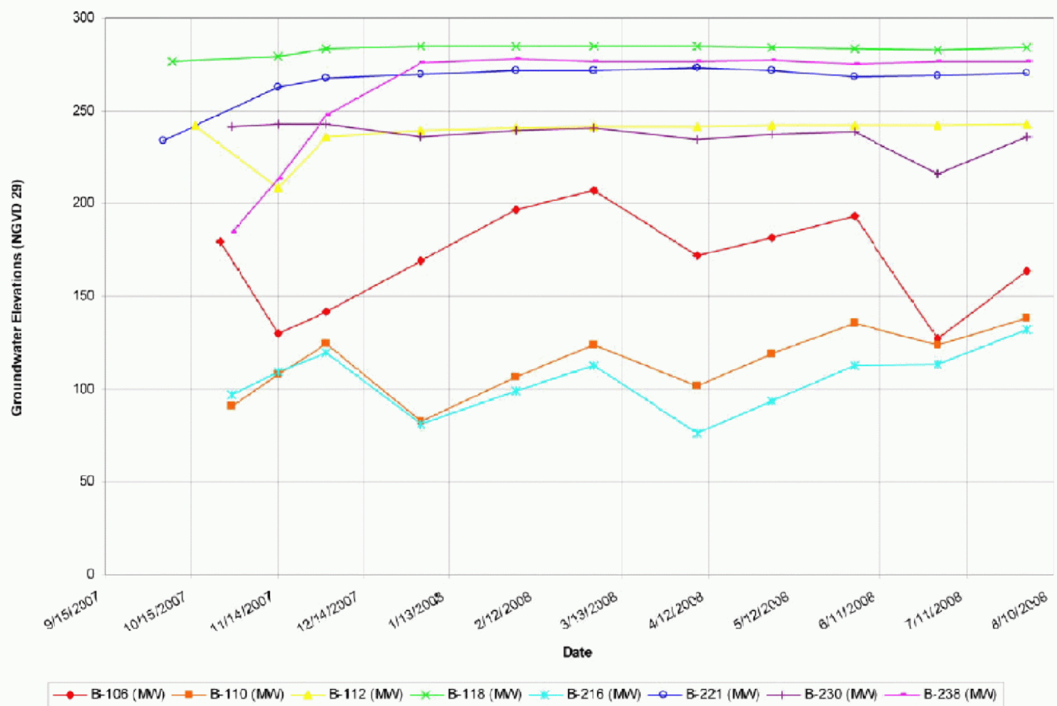
1. Existing features from C. T. Male Land Title Survey Dated 10/10/01.
2. Proposed Plant features taken from drawing SK-12198-001-002.dgn dated 3/21/08 prepared by Sargent & Lundy.
3. Horizontal control is based on the Central Zone of the New York State Plane Coordinate System North American Datum of 1927 (NAD 27).
4. Elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD 29).
5. Lake Ontario elevations based on Interational Great Lakes Datum of 1985 (IGLD85).

0 200 400 Feet
1" = 200'

LEGEND

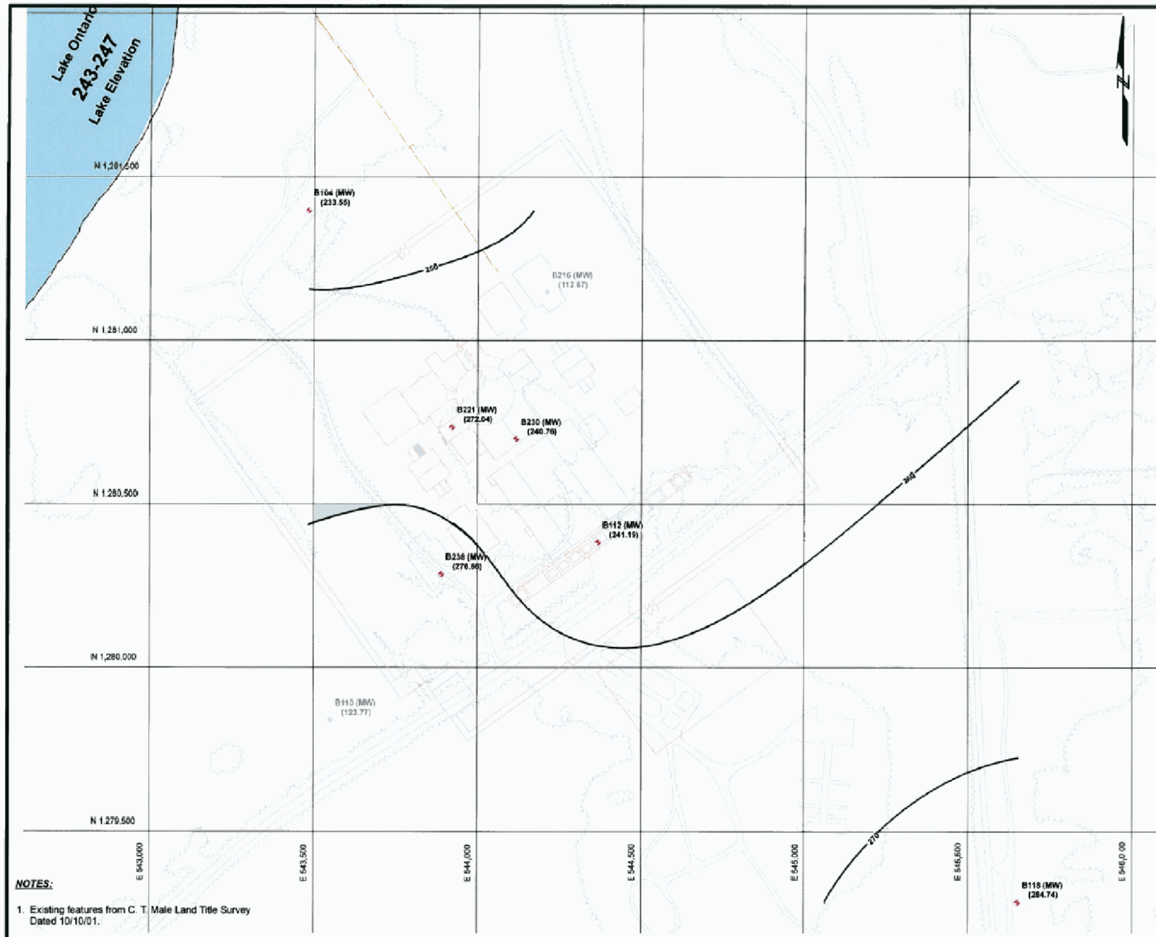
B100 Borings & Wells
Proposed Plant
Pulaski Formation Groundwater Contours: Interval 5 Feet

Figure 2.4-65—{Groundwater Elevations Whetstone Gulf Formation}



NOTE:
WELLS WERE PURGED TO PERFORM RISING HEAD PERMEABILITY TEST OR FOR SAMPLING.

Figure 2.4-66—{Groundwater Contours Whetstone Gulf Formation}



WELLS USED FOR CONTOURING

Boring #	FORMATION	GW_ELEV	N	E
B104 (MW)	Whetstone Gulf	233.55	1281396.9	543483.08
B112 (MW)	Pulaski C & Whetstone Gulf	241.19	1280382.77	544368.55
B118 (MW)	Whetstone Gulf	284.74	1279283.81	545652.05
B221 (MW)	Pulaski C & Whetstone Gulf	272.04	1280735.28	543922.69
B230 (MW)	Pulaski C & Whetstone Gulf	240.76	1280698.54	544118.35
B238 (MW)	Pulaski C & Whetstone Gulf	276.56	1280285.19	543890.26

WELLS NOT USED FOR CONTOURING BECAUSE THEY DO NOT FIT THE GENERAL TREND

BORING #	FORMATION	GW_ELEV	N	E
B106 (MW)	Whetstone Gulf	207.44	1282272.87	544173.29
B110 (MW)	Whetstone Gulf Formation	123.77	1279838.6	543552.18
B216 (MW)	Whetstone Gulf	112.67	1281146.84	544210.44

LEGEND

B100 Borings & Wells

Proposed Plant

Whetstone Gulf Formation Groundwater Contours: Interval 10 Feet

NOTES:

1. Existing features from C. T. Male Land Title Survey Dated 10/10/01.
2. Proposed Plant features taken from drawing SK-12198-001-002.dgn dated 3/21/08 prepared by Sargent & Lundy.
3. Horizontal control is based on the Central Zone of the New York State Plane Coordinate System North American Datum of 1927 (NAD 27).
4. Elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD 29).
5. Lake Ontario elevations based on Interational Great Lakes Datum of 1985 (IGLD85).

0 200 400 Feet

1" = 200'

Figure 2.4-67—{Selected Public and Private Groundwater Supply Wells - Oswego County}

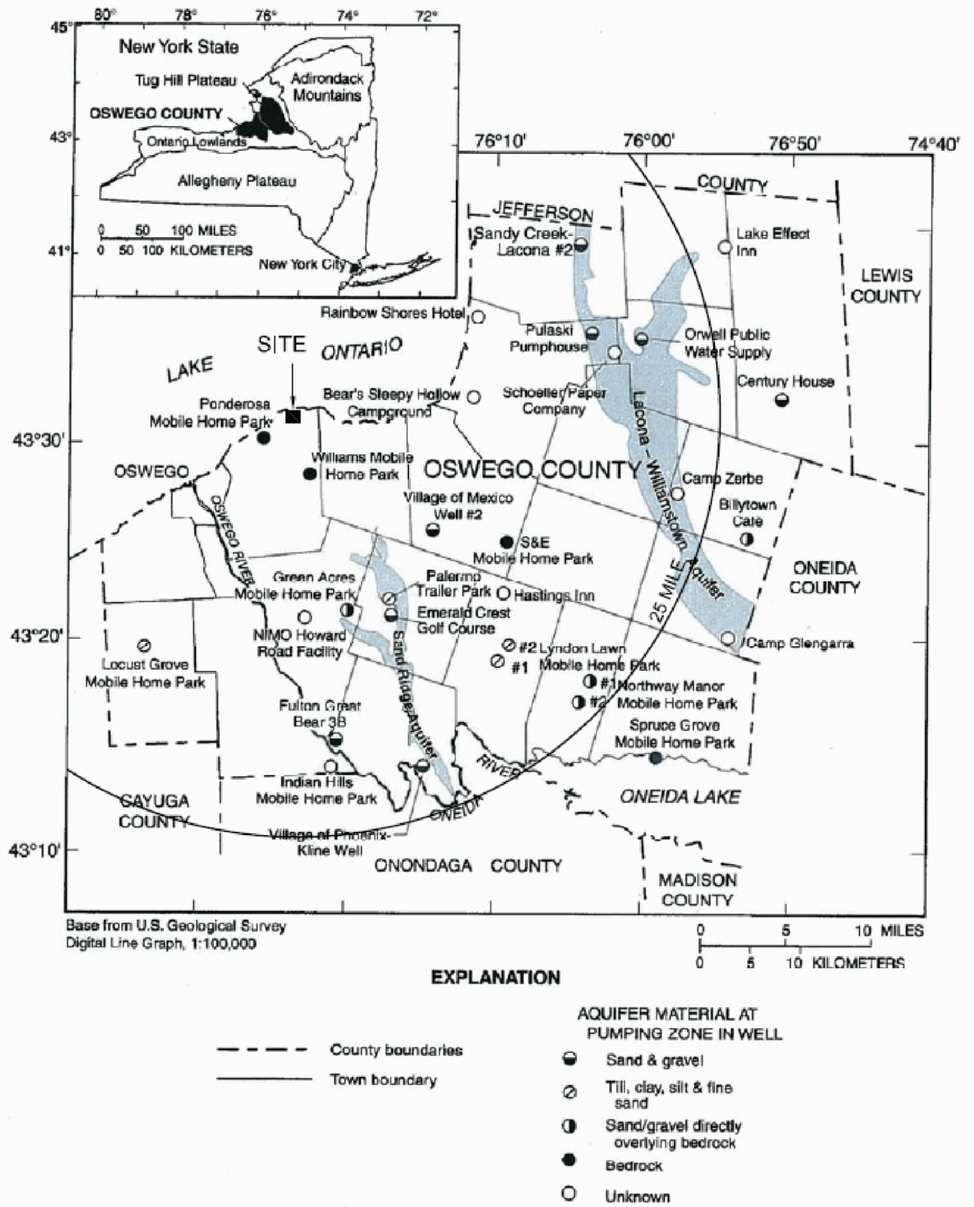


Figure 1. Principal geographic features of Oswego County, N.Y., locations of ground-water sampling sites, and aquifer lithology at well-completion depths of wells sampled in 1999. (Lithology data from drillers' logs and owners' comments.)

Ref: USGS, 2002a

Figure 2.4-68—{Public Water Supplies in Vicinity of NMP3NPP Site}

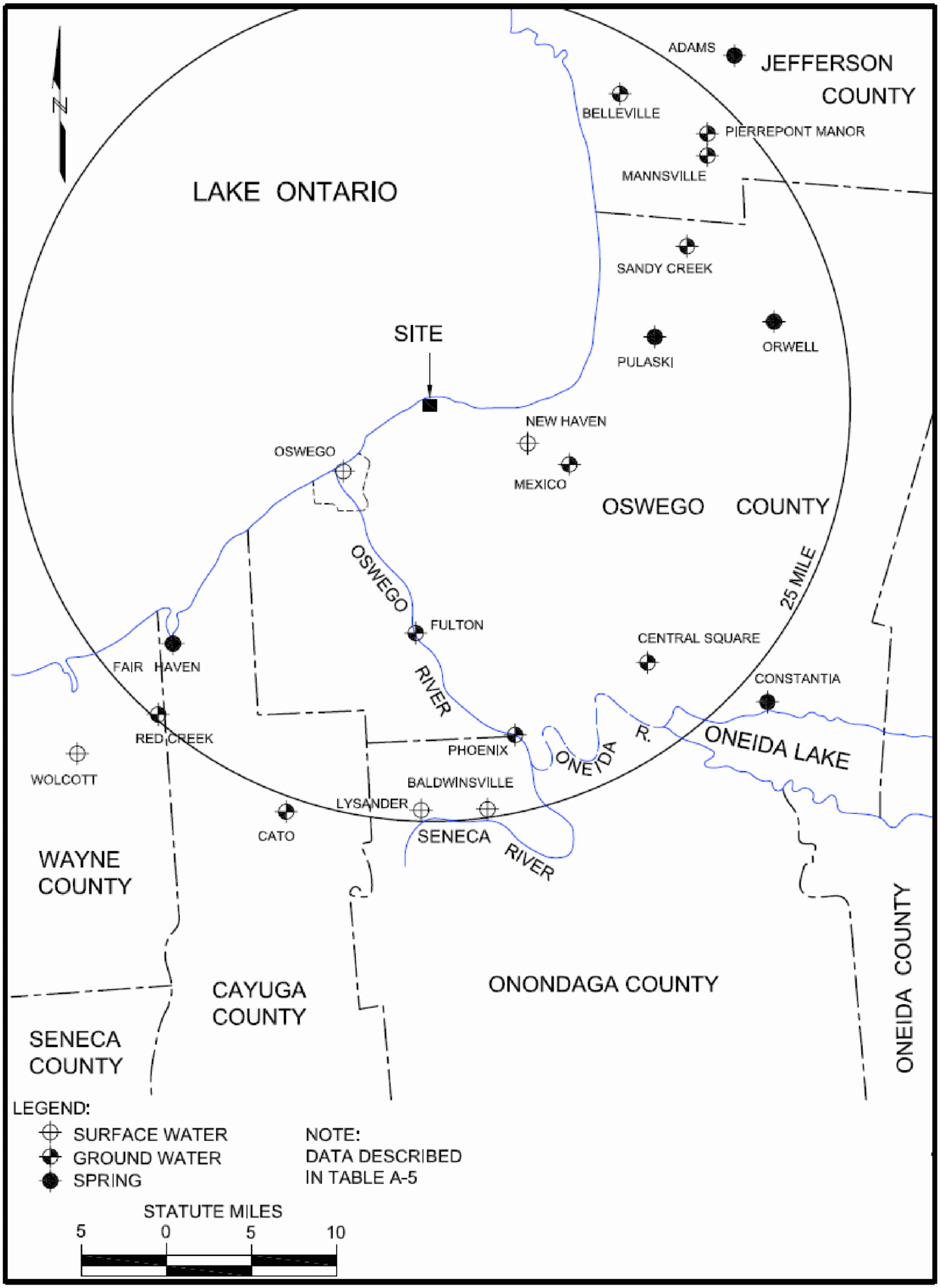


Figure 2.4-69—{Well Hydrograph for Monitoring Well OW-5014 Screened in Sand and Gravel - Volney, NY}

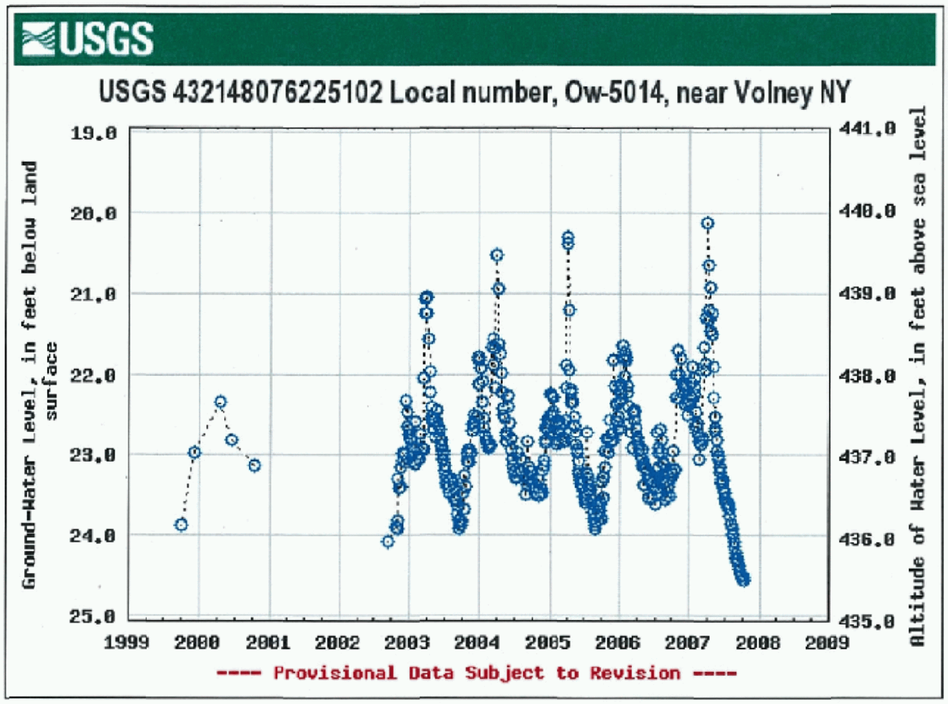


Figure 2.4-70—{Well Hydrograph for Monitoring Well OW-5013 Screened in Oswego Sandstone - Volney, NY}

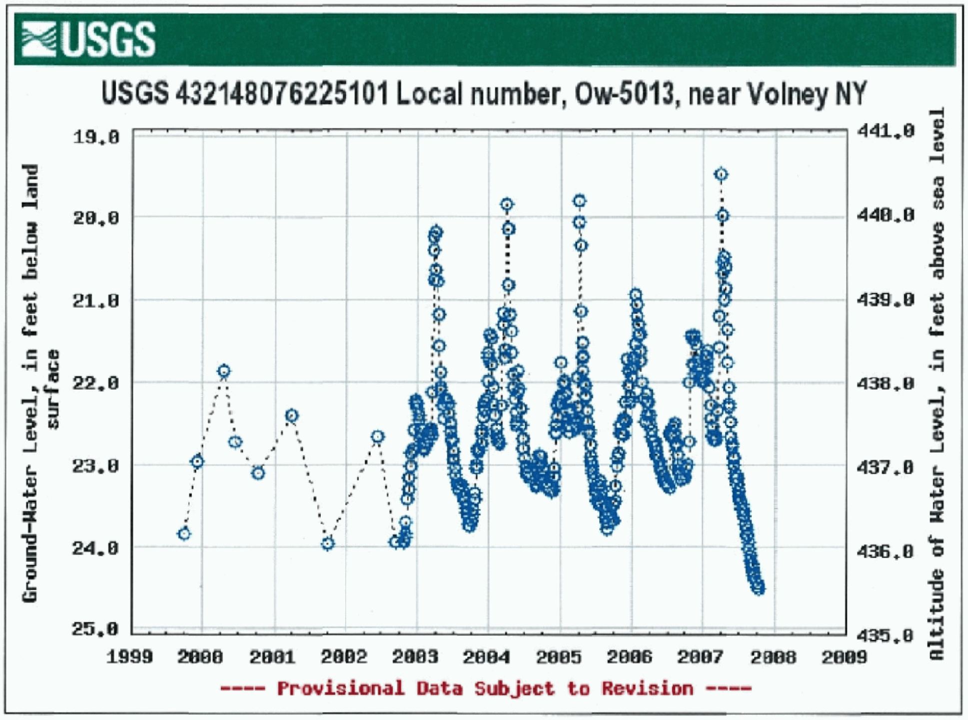
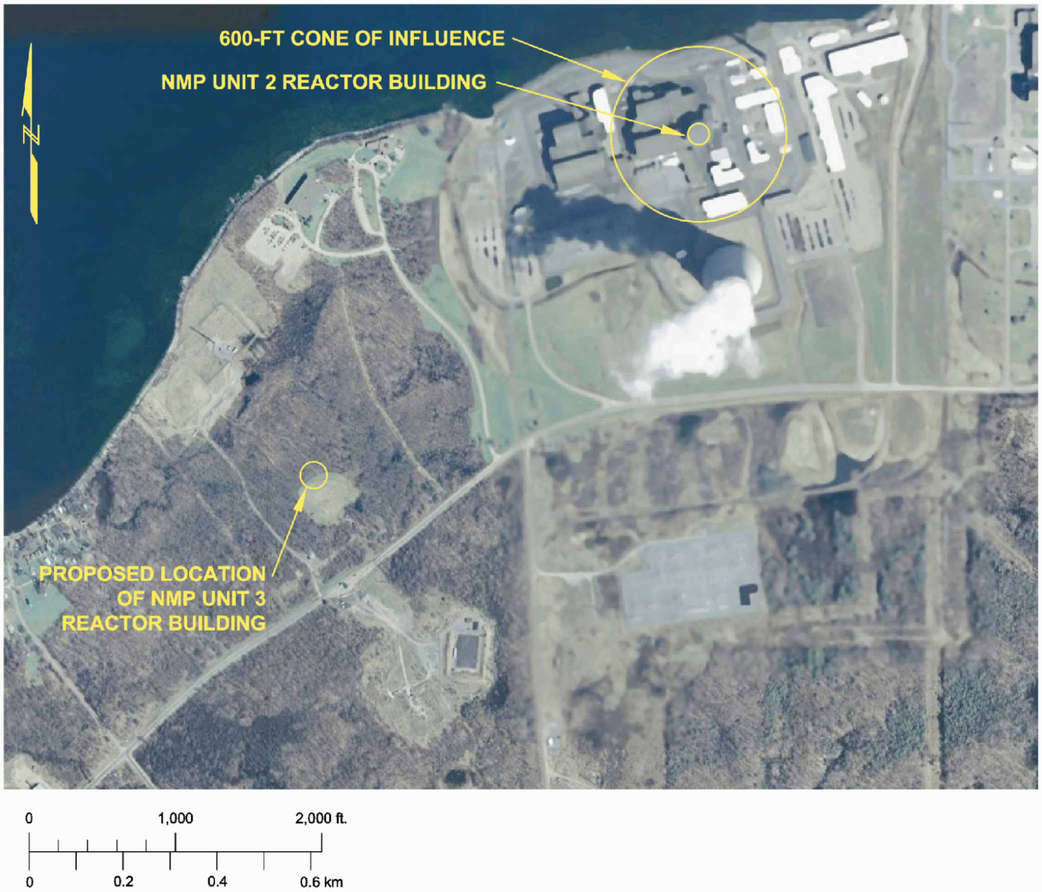


Figure 2.4-71—{NMP Unit 2 Dewatering 600-ft Cone of Influence}



Basemap: Provided by Google Earth.

Source: Applicant's Environmental Report - Operation License Renewal Stage, Nine Mile Point Nuclear Station Docket No. 50-220 and 50-410, License Nos. DPR-63 and NPF-69, May 2004

Figure 2.4-72—{Oswego Sandstone Groundwater Flowpath From Nuclear Auxiliary Building to Lake Ontario}

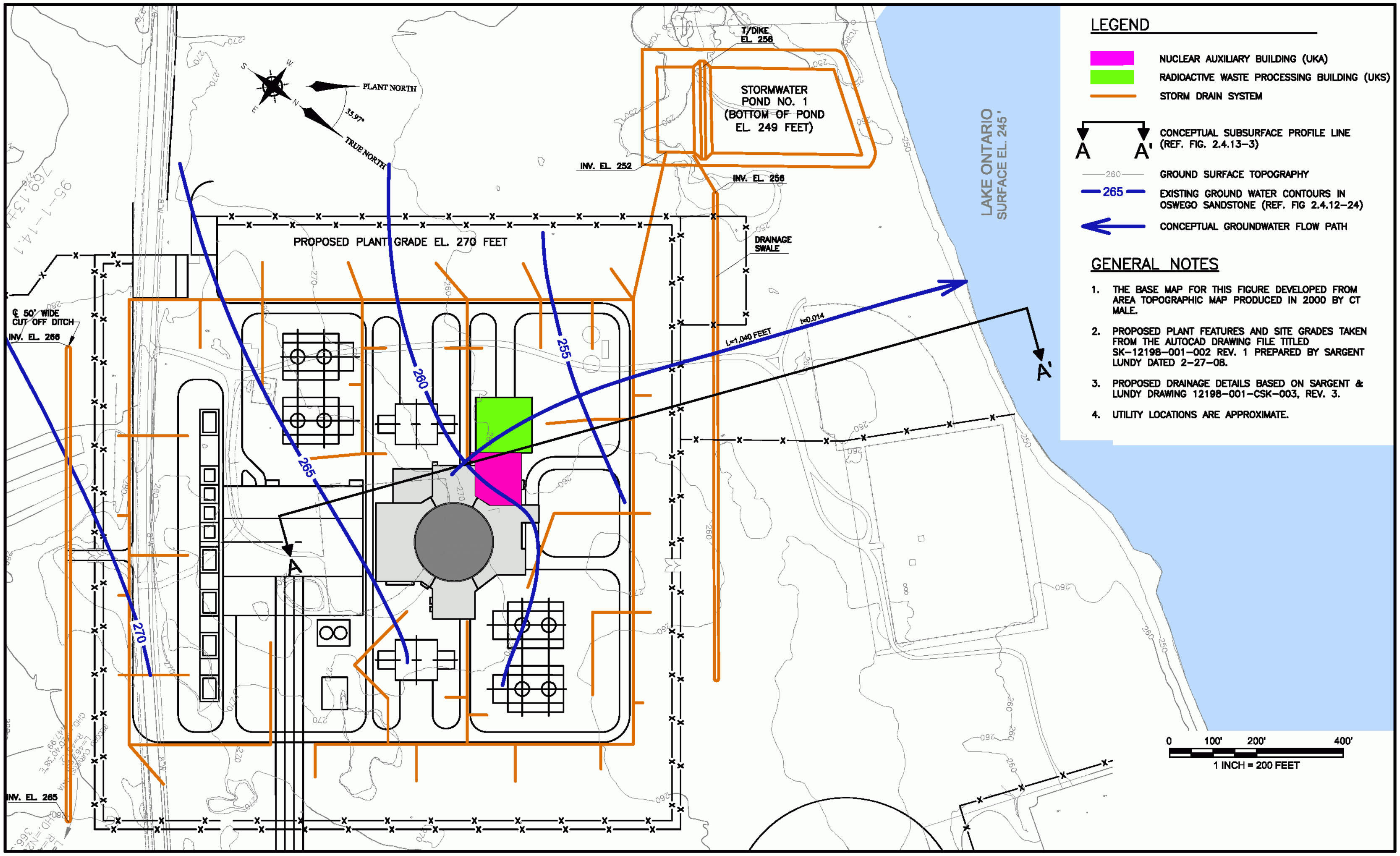


Figure 2.4-73—{Conceptual Model Transport Cross-Section}