NIAGARA POWER PROJECT

RELICENSING

DETERMINE IF THE ICE BOOM HAS CLIMATIC, AQUATIC, LAND MANAGEMENT, OR AESTHETIC EFFECTS

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ABBREVIATIONS

Agencies

CCE	Cornell Cooperative Extension Service
EC	Environment Canada
ECDEP	Erie County Department of Environment and Planning
FERC	Federal Energy Regulatory Commission
FSA	Farm Service Agency (USDA)
IJC	International Joint Commission
INBC	International Niagara Board of Control
INWC	International Niagara Working Committee
NWS	National Weather Service
NFTA	Niagara Frontier Transportation Authority
NOAA	National Oceanic and Atmospheric Administration
NYNHP	New York Natural Heritage Program
NYPA	New York Power Authority
NYSDEC	New York State Department of Environmental Conservation

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NYSDOS	New York State Department of State
OPG	Ontario Power Generation
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

Units of Measure

cfs	cubic feet per second
F	Fahrenheit
FDD	Freezing Degree Days
ft	feet
in	inches
mi	miles
MW	megawatt
MWh	megawatt-hour
TDD	Thawing Degree Days

Regulatory

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ALP	Alternative Licensing Process
CFR	Code of Federal Regulations
FPA	Federal Power Act
NEPA	National Environmental Policy Act

Environmental

EAV	Emergent Aquatic Vegetation
IBA	Important Bird Area
SAV	Submerged Aquatic Vegetation
SCFWH	New York State Significant Coastal Fish and Wildlife Habitat

Miscellaneous

BNIA	Buffalo Niagara International Airport
CDF	Confined Disposal Facility
FSCR	First-Stage Consultation Report
GIP	Chippawa-Grass Island Pool
ICS	International Control Structure
LENRIB	Lake Erie-Niagara River Ice Boom
LPGP	Lewiston Pump Generating Plant

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LWRP	Local Waterfront Revitalization Plan
NPP	Niagara Power Project
NRC	National Research Council
RMNPP	Robert Moses Niagara Power Plant
RTE	Rare, Threatened, and Endangered

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EXECUTIVE SUMMARY

The New York Power Authority (NYPA) is in the process of applying for a new federal license to operate the Niagara Power Project (NPP) in New York. The present operating license of the plant expires in August 2007. As part of this process, NYPA is compiling existing information related to the effects of the Lake Erie-Niagara River ice boom on climate, aquatic resources, land management issues, terrestrial resources, recreation uses, and aesthetic viewsheds. This report assesses potential effects of the Lake Erie-Niagara River Ice Boom on these resources.

A review of existing studies combined with the analyses contained in this report leads to these findings and conclusions regarding the effect of the ice boom on local resources:

1. The studies evaluated for this report examined potential effects of the ice boom on the timing of ice dissipation, water temperature, and local climate. Findings from these reports demonstrate that the potential effects were too small to be distinguished from the natural variability of temperatures observed in the area. Thus, potential impacts of the ice boom on local climate and ice dissipation are negligible.

2. The ice boom has had no measurable effect on the timing of ice dissipation at the eastern end of Lake Erie. There was a delay in ice dissipation between the pre- and post-boom periods, and water temperatures were lower during the post-boom period, but this was the result of a regional cooling trend that began in 1958, six years prior to the first ice boom installation.

3. There are no measurable effects of the boom on air temperatures at the National Weather Service meteorological station located at the Buffalo Airport with regard to either the severity or duration of winter. As with the timing of ice dissipation, air temperatures were lower during the post-boom

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period, but this was also explained by a change to a colder regional climate that occurred in the post-boom period compared to the pre-boom period.

4. The climate in the vicinity of the Great Lakes is affected by the capacity of the lakes to retain heat. This is commonly referred to as the lake effect. The lake effect can impact nearshore surface temperatures to a distance of up to three miles. The exact nature - i.e. whether cooling or warming occurs - and magnitude of the lake effect on nearshore climate depends on the season and varies from year to year. In general, nearshore areas remain cooler in the spring and early summer. In the fall and early winter, temperatures remain elevated in comparison to inland locations. The lake effect is natural and is completely unrelated to the presence or absence of the ice boom.

5. Lake ice also plays a role in keeping lakeside temperatures cooler in spring. As increasing sunshine warms the region, much of this energy is spent on melting the lake ice, rather than on warming the water. Until the ice melts, water temperatures generally do not rise above freezing, although warm water can advect (move horizontally) eastward beneath the ice, which can cause melting at the ice-water interface. The cold surface water temperatures that are associated with the presence of an ice cover prevent the air directly above the lake, and immediately adjacent to the lake, from warming as much as areas farther inland. The lake ice contribution to the lake effect is natural and is completely unrelated to the presence or absence of the ice boom.

6. Theoretically, an ice boom could affect climate by causing a minor alteration of the lake effect at the end of the spring ice melt period. This could occur if the ice boom was kept in place sufficiently late in the season to maintain a portion of the lake ice cover beyond the time that it would have dissipated, through melting or transport downriver, in the absence of the ice boom. During this period, the presence of the ice could potentially result in lower water and air temperatures if the remaining ice is competent.

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7. As a result of recommendations made by the National Research Council (NRC) panel in its 1983 report, the operating procedures for boom removal were modified in 1984, resulting in earlier removal of the boom. Since that time, the boom has been opened by April 1, except when the lake ice area exceeds 250 square miles or when the International Joint Commission (IJC) has determined that other factors warranted a delay in removal of the boom. Based on a number of studies, including a review by the NRC, the modified boom removal policy was expected to eliminate any potential future boom impact on either ice dissipation or local temperatures. The analyses conducted for this report confirm that the conclusions reached by the NRC panel were justified. There is no evidence to suggest that the ice boom has had any effect on local climate since the implementation of the boom removal policy in 1984.

8. The need for mathematical modeling was addressed by previous research teams including Rumer and the NRC. The modeling analyses performed by these groups were sufficient to evaluate the maximum potential impact of the ice boom on the timing of ice dissipation, water temperatures, and air temperatures. They found that the model could not be employed to directly estimate the effect of the boom for any particular year due to the lack of observations required to calibrate and validate this model. The expense and effort that would be required to obtain the requisite data for such a modeling effort would be exorbitant. Furthermore, initiation of a comprehensive modeling effort for the purpose of evaluating the potential impact of the ice boom on the timing of ice dissipation, water temperatures, or air temperatures is unwarranted due to the controls that have been in place since the adoption of the NRC recommendation in 1984.

9. The ice boom decreases both the number and frequency of water level fluctuations caused by ice stoppages in the upper Niagara River. By performing as intended, the boom effectively reduces the volume of ice that

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is discharged from Lake Erie into the Niagara River. This results in decreased risks for ice-induced flooding and erosion. The reduced risks for flooding and erosion primarily occur in the Tonawanda Channel and Chippawa-Grass Island Pool (GIP) reaches of the river. However, the ice boom does not completely eliminate ice from entering the river and does not prevent the occurrence of extreme ice-induced flood events. The boom also decreases the potential for erosion caused by ice scouring. The reduction in erosion is considered to be beneficial to the water quality of the watershed because the amount of sediment introduced into the water is lowered.

10. Potential effects of the ice boom on ecological resources fall into three general categories: (1) a potential delay in spring warming of water and ambient air temperatures, (2) effects of the ice boom on flooding caused by ice jams, and (3) scouring of river bottom and shoreline habitats by ice floes. Delays in spring warming could potentially affect fish spawning and fish eating birds and wildlife that forage in Lake Erie. Results from studies that initially evaluated potential boom impacts on water temperature and local climate indicate that any delay in warming caused by the ice boom would, at most, consist of a period of approximately 2 days. These potential changes in water or ambient temperatures caused by the ice boom prior to 1984 were considered negligible in comparison with year-to-year variability in regional temperatures. Thus, natural variations in regional temperatures were identified as the primary factor affecting the timing of when ice dissipates on Lake Erie. In response to recommendations presented in the 1983 NRC report for earlier removal of the ice boom, the date and conditions for removal of the boom were changed in 1984 to further mitigate potential effects of the boom on water temperature and local climate. Other potential impacts of the boom include effects on flooding and ice scouring. Potential impacts of the boom on flooding and erosion are considered to be largely beneficial. Because the ice boom is effective in reducing the frequency and duration of ice runs into the Niagara River, the potential for negative effects

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to ecological resources due to flooding and scouring in the river is also reduced.

11. Agricultural production in Western New York is not adversely impacted by the ice boom. No significant sources of agricultural production were identified in Erie County that could potentially be impacted by the boom. This is due to a trend that began prior to 1900 in which development in the outlying rural areas has displaced agricultural lands to the extent that there are no known agricultural areas that could potentially be impacted by the ice boom in Erie County. Agricultural lands, currently in use, are physically removed from the boom and any potential impacts. While there is anecdotal evidence that some farmers in the Lake Erie and Lake Ontario regions alter their farming regimes based on proximity to the lake shore, the derived benefits are due to the lake effect and are not considered to be the result of ice boom effects. Local agricultural experts largely agree that agriculture production in areas adjacent to the Great Lakes benefits from the lake effect. Depressed temperatures in the spring prevent premature budding and frost damage to tender fruit trees and other crops. Similarly, farmers near the lake receive the added benefit of an extended growing season in the fall. Many farmers in lakefront areas that are adjacent to the Great Lakes plant and harvest crops in order to take advantage of the nearshore temperature differences created by the lake effect.

12. Examination of land use data and existing zoning classifications indicates that land management practices and use of the NYPA ice boom storage site are consistent with the use of surrounding properties and current zoning designation. The results of the land management analysis reveal no significant effects of the storage area on adjacent properties. While there are several City and County planning initiatives and proposed development projects that could potentially impact land use in the vicinity of the ice boom storage and maintenance facility, these initiatives and projects are not

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expected to be impacted by current use of the NYPA property. Similarly, there are no significant effects on local parks, recreation, and aesthetic viewsheds and the use of these resources.

13. Results of the impact analysis indicate that relocation of the ice boom storage and maintenance facility to a different site is not a viable alternative at this time. Site requirements for the successful installation and operation of the boom are currently met at the existing location. The consistency of use determination indicates the current storage site is compatible with surrounding land uses. Results of the alternatives analysis further indicate that no suitable alternative location has been identified on the U.S. or Canadian shores of Lake Erie that meets the site requirements for the continued successful operation and maintenance of the ice boom. Based on the analyses contained in this report, it is concluded that relocation of the ice boom storage and maintenance to another location is unwarranted and not feasible. Since additional research by Ontario Power Generation (OPG) failed to identify a suitable alternative location for storage and maintenance of the boom on the Canadian shores of Lake Erie, alternative ownership opportunities are currently not available. Nevertheless, NYPA has met with the Erie County Department of Environment and Planning, Erie County Industrial Development Agency, and the Niagara Frontier Transportation Authority and continues to evaluate alternatives to the ice boom storage site.

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1.0 INTRODUCTION

The New York Power Authority (NYPA) is engaged in the relicensing of the Niagara Power Project (NPP) in Lewiston, Niagara County, New York. The present operating license of the plant expires in August 2007. As part of its preparation for the relicensing of the NPP, NYPA is developing information related to the ecological, engineering, recreational, cultural, and socioeconomic aspects of the Project.

The Project has several components. Twin intakes are located approximately 2.6 miles above Niagara Falls. Water entering these intakes is routed around the Falls via two large low-head conduits to a 1.8-billion-gallon forebay, lying on an east-west axis about 4 miles downstream of the Falls. The forebay is located on the east bank of the Niagara River. At the west end of the forebay, between the forebay itself and the river, is the Robert Moses Niagara Power Plant (RMNPP), NYPA's main generating plant at Niagara. This plant has 13 turbines that generate electricity from water stored in the forebay. Head is approximately 300 feet. At the east end of the forebay is the Lewiston Pump Generating Plant (LPGP). Under non-peak-usage conditions (i.e., at night and on weekends), water is pumped from the forebay via the plant's 12 pumps into the 22-billion-gallon Lewiston Reservoir, which lies east of the plant. During peak usage conditions (i.e., daytime Monday through Friday), the pumps are reversed for use as generators, and water is allowed to flow back through the plant, producing electricity. The forebay therefore serves as headwater for the RMNPP and tailwater from the LPGP. South of the forebay is a switchyard, which serves as the electrical interface between the Project and the State's electric grid.

For purposes of generating electricity from Niagara Falls, two seasons are recognized: tourist season and non-tourist season. Pursuant to the 1950 Niagara River Water Diversion Treaty, at least 100,000 cfs must be allowed to flow over Niagara Falls during tourist season hours, and at least 50,000 cfs at all other times. Tourist hours are from 8 a.m. to 10 p.m. EST between April 1 and September 15 and from 8 a.m. to 8 p.m. EST between September 15 and October 31. The non-tourist season is from November 1 to March 31. Canada and the United States are entitled by international treaty to produce hydroelectric power with the remaining flows that are not used to satisfy treaty flow requirements, during

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both tourist and non-tourist hours, sharing equally. The only major exception to this occurs in the winter when flows over the Niagara Falls may need to be increased to help transport ice out of the upper Niagara River.

Water level fluctuations in the Chippawa-Grass Island Pool (GIP), located in the upper Niagara River, caused by operation of hydropower projects by both Ontario Power Generation (OPG) and NYPA, are limited by a 1993 Directive of the International Niagara Board of Control to 1.5 feet per day within a 3-foot normal range. Under extreme conditions (e.g. high flow, low flow, ice) the allowable range of water level fluctuations in the GIP is extended to 4 feet and the 1.5 feet daily fluctuation tolerance can be waived. It is important to note that water level fluctuations in both the upper and lower Niagara River may be caused by a number of factors other than operation of the NPP. These may include wind, natural flow and ice conditions, operation of power plants on the Canadian side of the river, and treaty flows.

Water-level fluctuations in the lower Niagara River at the Ashland Avenue gauge (upstream of the RMNPP tailrace) from all causes can be as great as 12 feet per day. Most of this daily fluctuation is due to the change in the treaty-mandated control of flow over Niagara Falls. Water level fluctuations downstream of the RMNPP tailrace are much less. The average daily water level fluctuation 1.4 miles downstream of the RMNPP tailrace, during the 2002 tourist season, was approximately 1.5 feet.

1.1 Purpose and Description of the Ice Boom

The eastern basin of Lake Erie narrows where the lake drains into the Niagara River. During the years when an ice cover forms on Lake Erie, the funnel-like opening near the head of the river causes the constriction of northeastward ice flow, a subsequent thickening of the ice cover, and the eventual formation of a natural ice arch at a point located just upstream of the river's head. The river itself remains open. The ice formation process tends to restrict ice flow into the river, although breakaway floes are normal. The presence of the ice boom accelerates formation of a stable ice cover in early winter and reduces the risk of arch breakdown during the development of the natural arch. It also supports stability of the ice arch during adverse wind and other weather conditions that tend to destabilize the ice cover. When the ice cover is exposed to severe and sustained winds out of the southwest and west-southwest,

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overtopping of the ice boom can occur. The boom is designed to submerge under these conditions and later resurfaces when the wind begins to subside. Thus, the boom does not prevent all ice runs. Instead, it serves to limit the duration and extent of runs that have the potential to cause ice stoppages and ice jams in the Niagara River. The boom is instrumental in promoting the reformation of a stable ice cover after exposure to severe weather or sustained winds that result in overtopping. The stable ice cover promoted by the boom also insulates the underlying water from heat transfer at the lake surface and restricts the formation of new ice.

The boom has been operated annually since 1964 as a joint works project under a shared cost agreement between NYPA and OPG. Under this agreement, NYPA and OPG are equally responsible for the costs associated with installation, operation, and maintenance of the ice boom. This also includes the parcel of land acquired by NYPA as a site for storage and maintenance of the boom. Although the boom is a joint works project, NYPA has overall management responsibility.

The ice boom is located in Lake Erie, across the head of the Niagara River, and is operated in place solely during the winter and early spring. The boom is deployed approximately two miles upstream of the Peace Bridge and is positioned approximately 1,000 ft southwest of the potable water intake crib for the City of Buffalo. At this location, the currents are mild, typically about 1ft/sec in calm conditions. The deepest water is located near the Canadian shore. Over half of the ice boom, toward the US shore, is positioned over a shoal in shallow water with a depth of 16 ft or less. A map of the eastern end of Lake Erie and upper Niagara River structures and features is attached as Figure 1.1-1. Prior to 1997, the ice boom was constructed of wood timbers 30 ft long, 16 in high and 22 in wide. In 1989, the Federal Energy Regulatory Commission (FERC) requested NYPA to evaluate measures to mitigate ice stoppages and jams in the river. FERC further ordered the establishment of an independent Board of Consultants to provide direction and oversight of the study. The Board of Consultants recommended an “improved design of the Lake-Erie Niagara River ice boom, to increase its overtopping resistance and, hence, promote faster formation of the ice cover on Lake Erie” as the sole structural (physical control) measure to be used in reducing the amount of ice entering the river (NYPA 1998).

In response to the FERC order, NYPA and OPG conducted a series of studies from 1992-1997 to assess potential performance modifications to the boom. The findings and conclusions of these studies

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led to improved boom design and performance characteristics. Thus, the current configuration consists of individual steel pontoons whose dimensions are 30 feet long and 30 inches in diameter (Figure 1.1-2). This design was selected because the increased buoyancy characteristics of the pontoons result in an increased resistance to overtopping; thus serving to further limit the amount of ice entering the Niagara River. The ice boom is constructed in twenty-two spans of 10 or 11 cable-joined pontoons each. Spans are anchored to the lakebed at 400 feet intervals by 2.5 in diameter steel cables. When installed, the ice boom has an overall length of approximately 8,800 feet and stretches from the Old Breakwater near the Buffalo Harbor to approximately 500 ft from the Canadian shoreline.

Beginning in 1998-1999, the number of pontoons in spans A through J was reduced to 10 instead of 11 pontoons. The virtually ice free winter of 1997 resulted in open water conditions that exposed the pontoons to damaging waves and increased wave setup in the shallow waters at the eastern area of boom placement. This resulted in substantial damage to the pontoon ends potentially threatening the integrity of the boom. Thus, the International Niagara Working Committee (INWC) recommended a reduction in the number of pontoons from 11 to 10 in Spans A through J prior to the winter of 1998-1999. The current boom configuration is presented in Figure 1.1-3.

1.2 Study Area

The study area encompasses the ice boom deployment area and its immediate environment, including the ice boom storage and maintenance area. The area used to store and maintain the ice boom consists of 13 acres of NYPA-owned land that is located within the City of Buffalo. The ice boom storage parcel is situated near the entrance to the Buffalo River. There is frontage along Fuhrmann Boulevard to the east and the shores of Lake Erie are to the west.

1.3 Study Objectives

The objectives of this study incorporate the following tasks:

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1. conduct a literature review of relevant documents from existing studies and sources identified during the Alternative Licensing Process (ALP).

2. perform an independent analysis in determining potential effects of the ice boom on climate, aquatics, terrestrial, land management, recreation, and aesthetic resources based on information contained in existing studies;

3. conduct an analysis of: a) alternative ownership opportunities for the ice boom storage and maintenance facility and; b) alternative locations for storing and maintaining the ice boom.

The studies and information sources identified during the public scoping process for desktop review and analysis are included as Appendix A of this report. Pursuant to the ALP approved scope of services, field data were not collected for this study.

In addition to the specific studies identified for inclusion in the assessment, other relevant studies were reviewed in conducting the ice boom impact analysis. The purpose of acquiring and reviewing these studies was to obtain additional information requested by the ALP stakeholders and NYPA in order to determine the effect of the ice boom and associated storage area on:

- local and regional climate;
- aquatic and terrestrial habitat;
- river hydraulics;
- water quality, contaminant transport, and waste assimilation;
- current and potential future use of adjoining land parcels;
- aesthetic viewsheds on a seasonal basis; and
- ice formation

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This material is contained in:
Volume 2
Section: Determine if the Ice Boom Has Climatic, Aquatic, Land Management, or Aesthetic Effects

FIGURE 1.1-1

UPPER NIAGARA RIVER STRUCTURES AND FEATURES

[NIP - General Location Maps]

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FIGURE 1.1-2

STEEL PONTOON CONSTRUCTION

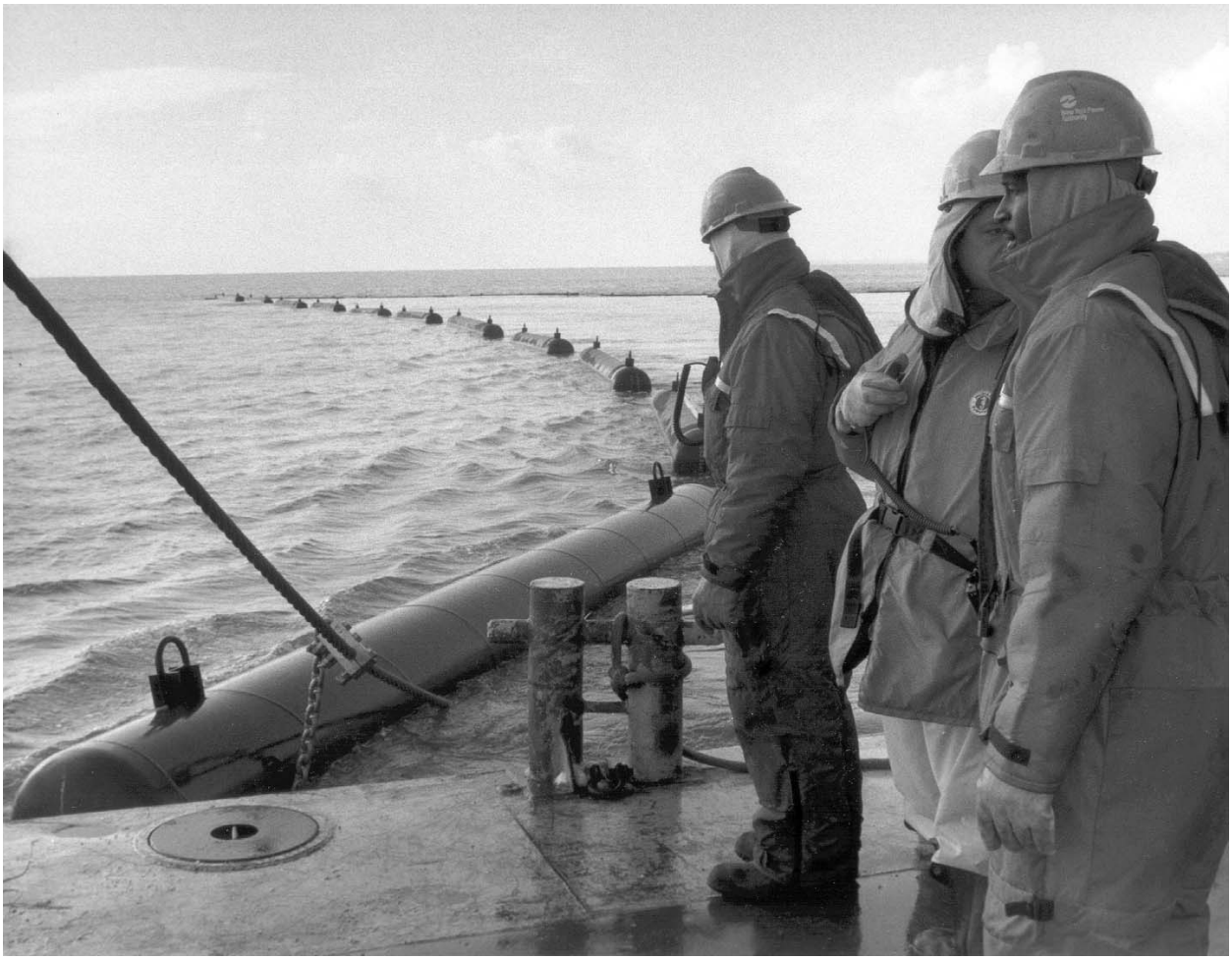

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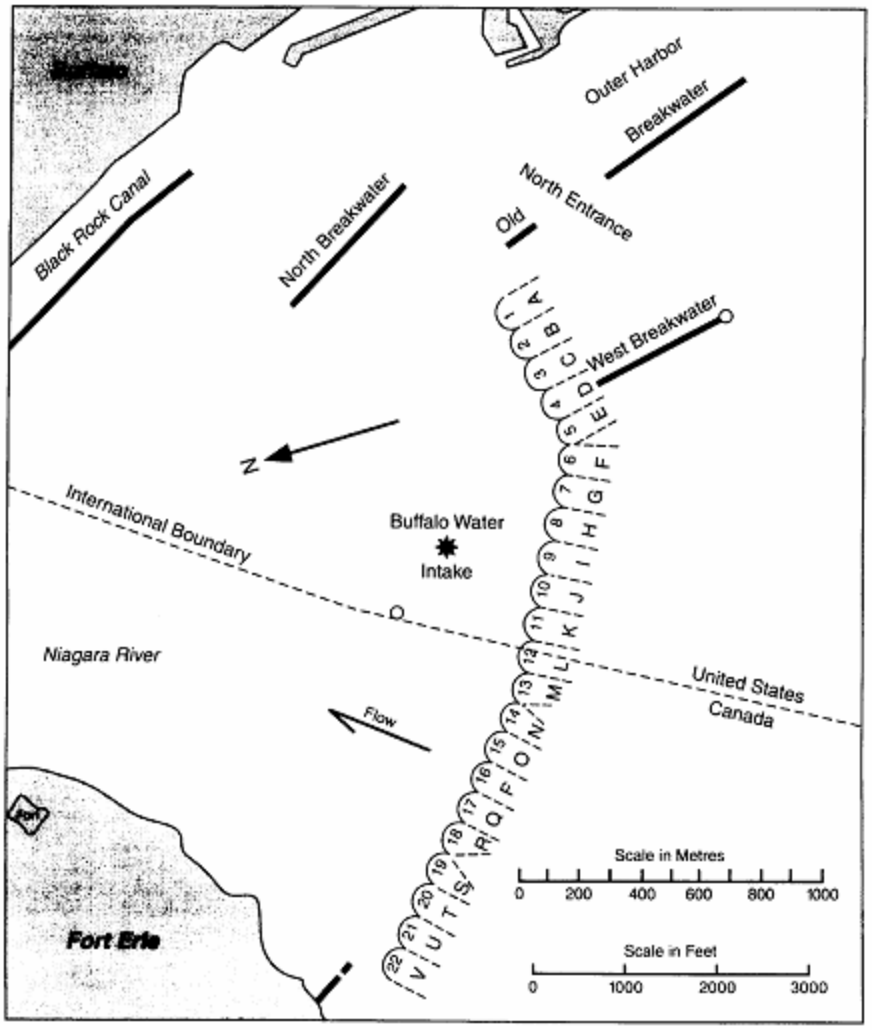
FIGURE 1.1-3

CURRENT ICE BOOM CONFIGURATION



Source: INWC 2003

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2.0 HISTORICAL AND REGULATORY BACKGROUND

2.1 Historical Overview

Ice jams form in temperate-zone rivers when the ice-transport capacity is exceeded by the rate of ice supply into the river. The greatest threats to shoreline property and water intakes occur when large runs of ice choke the river and a bottleneck develops. At the location of the bottleneck, ice transport velocity is reduced and no more than a brief stoppage is enough to trigger a severe ice jam. An ice jam restricts flow and often results in upstream flooding.

Along the Niagara River, major ice jams have historically resulted in damage to both public and private property. An extreme ice jam in 1848 resulted in a temporary stoppage of water flow over the Falls. In another event, the Honeymoon Bridge on the lower Niagara River was destroyed by ice. This occurred in 1938 when a combination of cold weather and a warm south-west wind sent vast masses of Lake Erie ice plunging down the upper Niagara River and over the two falls creating an extremely large ice jam. The ice shattered the docks of the Maid of the Mist and crumpled the Maid of the Mist caretaker's home. The generators in the Ontario Power Generating Plant were also stopped when they were buried by ice flows. Finally, ice began to accumulate against the abutments of the Honeymoon Bridge. On Thursday, January 27, a crushing force of massive ice ended the bridge's 40 years of life high above the waters of the Niagara River.

Most ice runs are less spectacular but still capable of causing extensive flooding and property damage in the upper Niagara River. Major ice runs occurred in the early spring of 1909 and caused extensive flooding and property damage. In 1955, at the behest of the public, dynamite was unsuccessfully used in an attempt to relieve a severe jam on the lower Niagara River. In 1962, one year after its opening, the Robert Moses Niagara Power Plant had to be shut down because of ice blockage at the intakes. In early 1964, another ice jam caused extensive shoreline damage along the Niagara River, and, despite ice removal operations around the intakes, more power generation losses. This event occurred during a severe winter run of ice in January of 1964 that began with strong southwest winds that

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lasted over a 10-day period (INBC 1974). NYPA estimated that approximately 140 square miles of ice were discharged from Lake Erie into the Niagara River during the storm period.

By this time, it was evident that additional measures would be necessary to control ice entering the river and mitigate power generation losses, flooding, erosion, and shoreline property damage in the upper Niagara River. The International Joint Commission (IJC) subsequently granted temporary authority in 1964 for joint installation of the ice boom by NYPA and OPG (Power Entities) in response to both recent and historical severe ice jamming conditions found on the Niagara River.

The ice boom was first installed during the winter of 1964-65. It consisted of a series of wooden timbers linked by steel cables and anchored to the lake bottom. Today, steel pontoons are used in place of timbers. To provide protection for shore installations and power plant intakes positioned downriver, the 8,800 foot-long boom was placed-about 1,000 feet upstream of the Buffalo water intake. The boom did not completely stop the flow of ice into the river, nor does it do so today. During storm events, strong west or southwesterly winds cause ice floes to overtop the boom and enter the river. When winds diminish, however, the boom resurfaces and begins to reduce the ice supply to the river.

The use of the boom became a source of controversy due to a suspicion on the part of the public, widely reported in the local press, that it caused ice to be retained longer than normal in the spring, resulting in a delay in the rise of local air temperatures (Churchill 1985). Concerns were also raised regarding a perceived delay in the opening of Great Lakes shipping to the Port of Buffalo, as well as the potential for shoreline damage and higher than normal water levels along the Lake Erie shoreline. Fears of restrictions on fishing and delay in the use of area beaches were also voiced (INBC 1974). These concerns reached a peak following the spring of 1971, when ice did not leave the lake until May 31. In response, a series of studies was commissioned to evaluate boom impacts.

In examining public perceptions, Churchill (1985) attributed the public outcry to a confluence of events that marked the beginning of public concerns. Winters had been colder in the Buffalo area as a result of a regional cooling trend that began several years prior to the installation of the boom. Scientists had not yet reported the presence of the cooling trend across the region. At the same time, the date of last

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ice out occurred on May 31, 1971. The most recent similar event took place in 1943 and was beyond the extent of the public memory. As Churchill pointed out, the May 31st date of last ice out was not unprecedented since the lake had similarly held ice on May 31st in both 1926 and 1936 and also on May 20th during 1940 and 1943. These events, along with extensive media coverage and other factors led the public to question whether the boom was responsible for colder weather and other environmental effects.

2.2 Regulatory Framework

Both the IJC and FERC have regulatory authority involving the Niagara Power Project. While the IJC has primary jurisdiction over the use and operation of the ice boom, which is not located within the FERC Project boundary, FERC has primary regulatory oversight authority over operations at the Niagara Power Project.

2.2.1 Role of the IJC

The IJC was created in 1909 when the United States and Canada signed a treaty that established a framework for the allocation of boundary waters between the two countries (1909 Treaty). This treaty is commonly referred to as the Boundary Waters Treaty. The 1909 Treaty further established the role of the IJC and granted it broad authority over matters pertaining to "uses or obstructions or diversions, whether temporary or permanent, of boundary waters on either side of the line, affecting the natural level or flow of boundary waters on the other side of the line."

The authority granted to the IJC was not intended to limit or interfere with the existing rights of either government to engage in construction works such as dredging, breakwater design, harbor improvements, and other works for the benefit of commerce and navigation, "provided that such works are wholly on its own side of the line and do not materially affect the level or flow of the boundary waters on the other." IJC authority extends to all boundary waters between the United States and Canada, including the Niagara River.

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The IJC is comprised of six commissioners, three appointed by the United States and three appointed by Canada. For the purposes of authorizing the use and operation of the ice boom, the IJC has quasi-judicial administrative jurisdiction for authorizing the use and operation of the ice boom. This authority was first exercised in 1964 with the temporary Order of Approval for installation of the ice boom as noted in Section 2.1. The IJC may condition its orders of approval "in any case" as noted in Article VIII of the 1909 Treaty. This can include orders related to the operation and deployment of the ice boom. Article VIII further specifies that "in cases involving the elevation of the natural level of waters on either side of the line as a result of the construction or maintenance on the other side of remedial or protective works or dams or other obstructions… the Commission shall require…(that) adequate provision…be made for the protection and indemnity of all interests on the other side of the line".

The IJC relies on various administrative entities for technical support and monitoring for compliance involving the 1909 Treaty in addition to its Orders of Approval. In practice, the IJC delegates routine management authority over the Niagara River to the International Board of Control (INBC) including primary responsibility for oversight and management of the annual installation and removal of the Lake Erie-Niagara River Ice Boom. The INBC was established by a 1953 IJC Directive to provide advice on matters related to water levels and flows in the Niagara River. The Board has four members consisting of a single representative from each of the following agencies: United States Army Corp of Engineers (USACE), FERC, Ontario Ministry of Natural Resources, and Environment Canada (EC).

The INBC, in turn, receives technical support from the INWC. This committee is made up of eight members and includes: a single representative from NYPA, one from OPG, and one representative from each of the following United States or Canadian agencies: USACE Buffalo, USACE Detroit, FERC, Ontario Ministry of the Environment, Environment Canada Burlington, and Environment Canada Guelph.

The INWC provides technical expertise to the INBC on a variety of issues including ice boom operations. In this context, responsibilities include conducting aerial flights to measure ice coverage, thickness, and conditions. It also prepares reports and supports the Board at meetings and appearances before the IJC. One of the functions of the INWC includes preparation of the annual report for operation and maintenance of the ice boom. These reports provide a complete compendium on issues related to the

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ice boom including: ice boom installation, removal, and maintenance; ice and meteorological conditions; estimated power losses and property damage; navigation; and climatological and water temperature data. The INWC provides its findings, conclusions, and recommendations for future operations to the Board in the annual reports (INWC 2002).

2.2.2 Role of FERC

The Federal Energy Regulatory Commission (FERC), pursuant to the Federal Power Act (FPA) is authorized to issue licenses for terms up to 50 years for the construction and operation of hydroelectric developments subject to its jurisdiction.

2.2.3 IJC Orders

The IJC first issued a Temporary Order of Approval in 1964 for installation of the ice boom in the winter of 1964-65 by the Power Entities. Since then, the IJC has issued a variety of orders related to the operation, deployment, and removal of the boom. The Commission required annual approval for boom installation for the first three years of operation in order to evaluate potential effects and performance. In 1967, after the ice boom had been in operation and proven its effectiveness in mitigating the effects of ice runs from Lake Erie, the IJC further extended the Order of Approval for a period of up to five years. The Commission continued to extend its Order of Approval at five-year intervals through 1980 based on the annual reports and recommendations by the INBC indicating the satisfactory performance of the boom in limiting ice runs into the upper Niagara River. In the interim, the Commission further approved the concept of a flexible date for opening and closing of the ice boom. During these approval periods, the IJC has and continues to review ice boom operations "as circumstances require."

In 1980, the Power Entities again petitioned the IJC for an extension of the approval to allow for continued operation of the ice boom. In accordance with its Rules of Procedures, the Commission held a series of public hearings in July of that year. In response to public comments and Board recommendations, an Order of Approval was granted for the continued operation of the ice boom. However, because of lingering debate regarding potential impacts, the IJC established a procedure for

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resolution of public concerns. This led to a study request by the IJC for an independent panel of experts to study the effects of the ice boom. In 1983, a public scoping process ensued where a series of highly publicized open meetings were held in Buffalo and Fort Erie to discuss the scope of the study. In response to public concerns, the IJC nominated the National Research Council, a scientific and technical arm of the prestigious National Academy of Sciences, to serve as the independent panel of experts responsible for conducting the study.

The panel's findings were released in November, 1983 and led to the recommendation that the ice boom operational procedures should change. The NRC found that the ice boom would not cause cooling to local climate and other adverse effects if opened when approximately 250 square miles of ice remained in Lake Erie. The NRC further recommended that the ice boom should be opened by April 1 and removed as soon as practical unless greater than 250 square miles of ice remained on the Lake.

In January of 1984, the IJC subsequently adopted the recommendation of the NRC and directed that "all floating sections of the boom shall be opened by April 1, unless ice cover surveys…show there is more than 250 square miles of ice east of Long Point" and that complete removal of the boom "shall be completed within two weeks thereafter." The Commission further instructed that the opening of the ice boom could be delayed until the amount of ice diminished to the levels recommended by the NRC. The IJC retained the right to alter the installation and removal schedule based on the existence of an emergency situation.

In discussing various IJC orders to date, there are two additional orders that merit attention. First, on April 17, 1996 the Commission issued a Supplemental Order which allowed the Power Entities to conduct field tests and evaluate the performance of steel pontoons as replacement structures for the floating wood timbers. The INBC later concluded that field demonstrations of steel pontoons were successful and the Commission approved the use of the steel pontoons. The purpose of using steel pontoons is to increase the buoyancy of the floating sections which leads to an increase in resistance of the boom to overtopping by ice covers. This facilitates faster formation of a stable ice cover that serves to limit the frequency and magnitude of ice entering into the Niagara River.

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Secondly, in October 1999, the IJC changed the operational procedures for installation of the ice boom and amended its Order of Approval to include language that boom installation "shall not commence prior to December 16 or prior to water temperature…reaching 39°F, whichever comes first, unless otherwise directed by the Commission." This amendment was ordered in response to risks that were identified during the previous winter when the safety of NYPA personnel was called into question and the risk of not completing the installation prior to an ice run occurrence became apparent (NYPA and Ontario Hydro 1999). The IJC decision followed a nearly failed attempt to install the ice boom during the 1998-1999 ice season when severe storm conditions prevented the complete installation until Jan. 9, 1999. The installation was delayed that year because warmer than average water temperatures in Lake Erie prevented the necessary IJC approval until Jan. 2 whereas the historical average for reaching the 39 degree implementation criteria had been around Dec 16th. The proposal to change the installation procedures was prompted by concerns about personnel safety and other associated risks as well as the potential for an occurrence in which installation of the boom could not be completed before a major ice run resulted in discharge to the Niagara River. The Commission recognized that in certain instances, a small window of opportunity exists for boom installation before an early season ice run occurs.

2.2.4 FERC Orders

On November 29, 1984, NYPA filed an application for amendment of its license for the NPP in order to perform project expansion and plant upgrades. In response, FERC issued an order for amending the license on July 21, 1989. The order imposed many requirements upon NYPA. Of particular interest are the Article 305 requirements for NYPA to retain qualified independent consultants to review the development of ice models for the upper Niagara River and to oversee the modeling results. Article 305 included language so that the modeling methodology, plan, and schedule would be based on the recommendations of the board of consultants without limitations regarding the type of modeling to be performed. The order allowed for either a mathematical or physical model to be employed based on the board's assessment and recommendations. The Board could also recommend a combination of physical and numerical modeling in its efforts to gain knowledge of the processes that lead to ice jamming in the river. The purpose of the model(s) was to determine the relationship between project operations and ice flows in the Niagara River. FERC also provided instructions for the board to make recommendations if the model demonstrated that ice passage was adversely influenced by project operations or physical

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features of the river. This included recommendations for structural, operational, and technological alternatives to reduce ice jam formation in an effort to minimize flooding and power outages.

Article 306 established the qualifications of the board including measures aimed at ensuring independence without potential conflicts of interest. The article: 1) directed the Board to perform an initial assessment regarding the merits of modeling the ice jam conditions with either a physical or mathematical model and make recommendations regarding the feasibility of employing either of the methods; 2) provided an advisory capacity for the Board upon selection of the appropriate model. Once the scope and methodology were determined, the Board would review and assess the selected model studies of the upper Niagara River; 3) further instructed the Board to consider previous hydraulic modeling studies of the river, power outages due to ice conditions, ice jam conditions and related flooding on the upper Niagara River, the Niagara Project operations, and the adequacy of, or need for, instrumentation; and 4) required the Board to submit a Final Report upon completion of the modeling.

Article 307 ordered a survey of the scientific community regarding the practicality of developing a physical ice model for the upper Niagara River and required issuance of a formal Request for Comments on the feasibility of constructing a physical ice model by October 1989. FERC required circulation of the request to engineering consulting firms, individual consultants, laboratories, USACE, other government agencies, and both national and international scientific institutions (FERC 1989).

NYPA was also required to coordinate the studies with OPG, in consultation with the IJC, since both entities jointly own and are responsible for the operation and maintenance of the boom, including cost-sharing.

NYPA, with the support of OPG, studied alternative ice boom designs from 1992 to 1997. The objective of the studies was to determine if improved design features could further reduce the amount of ice entering the river. This investigation led to the recommendation for replacement of the floating timbers with steel pontoons as discussed in Section 1.1. With IJC approval (Claman 1997), NYPA conducted field tests on the newly designed boom. The INBC evaluated the performance of the steel pontoons during field demonstrations conducted in 1996-1997 and found that the demonstrations had

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proven successful and the pontoons had performed as intended (INWC 1997). As a result, the steel pontoons were put into operation during the 1997-1998 ice season (INWC 1998).

In April of 1998, NYPA submitted its final report to FERC entitled Hydropower and Ice on the Niagara River. The report recommended changes in ice boom design, hydropower operations, and use of instrumentation to better control the flow of ice entering into the river and improve the ice transport capacity of the river in order to prevent ice jams. In addition, the feasibility of constructing ice-deflecting structures upstream of Grand Island and Navy Island was to be further evaluated but not implemented until after a three-year period in which the effectiveness of the new ice boom could be determined. In 1998, the Board of Consultants released its final report to FERC stating, "The main tangible outcome of these findings is that the likelihood of ice-jam occurrence can be reduced effectively by modifying hydropower operations (with the aid of instrumentation) and by improving the performance of the LENRIB (Lake Erie-Niagara River Ice Boom)" (Board of Consultants 1998).

Upon conclusion of the three-year trial period for evaluating the new boom design, NYPA submitted a letter report to FERC demonstrating the effectiveness of the new boom in reducing generation losses (Lipsky 2002). Table 2.2.4-1 presents annual data on estimated power generation losses due to ice conditions on the Niagara River from 1975 to 2003. On February 22, 2002 FERC issued a letter order that concurred with NYPA's findings and indicated that the requirements of Article 305 had been satisfied and that the new boom sections had performed as intended. Furthermore, FERC determined that no further action or studies were required (Sidoti 2002).

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TABLE 2.2.4-1

ESTIMATED LOSS OF ENERGY DUE TO ICE FOR PERIOD OF RECORD, 1975 TO PRESENT

	POWER LOSSES (in MWH)						
Winter Season of:	**December**	**January**	**February**	**March**	**April**	**May**	**Totals**
1974-1975	*	*	*(2/14-3/5) 150,000	*(3/7-3/26) 15,100	*	*	165,100
1975-1976	*	78,700	36,500	45,800	32,000	*	193,000
1976-1977	*	54,000	23,500	0	0	0	77,500
1977-1978	*	88,000	600	600	0	0	89,200
1978-1979	*	30,000	3,700	0	1,600	0	35,300
1979-1980	*	6,000	30,000	13,000	10,500	0	59,500
1980-1981	14,000	9,000	3,900	1,100	4,100	0	32,100
1981-1982	*	58,000	27,000	10,000	13,000	5,000	113,000
1982-1983	0	0	0	0	0	0	0
1983-1984	53,000	57,000	4,000	25,000	0	0	139,000
1984-1985	0	65,000	25,000	11,000	29,000	0	130,000
1985-1986	10,000	65,000	8,000	5,000	6,000	0	94,000
1986-1987	0	28,000	32,000	4,000	0	0	64,000
1987-1988	0	13,000	24,000	0	4,000	0	41,000
1988-1989	0	0	30,000	1,000	2,000	0	33,000
1989-1990	6,000	7,000	5,000	5,000	0	0	23,000
1990-1991	0	14,000	11,000	6,000	0	0	31,000
1991-1992	0	21,000	3,000	14,000	0	0	38,000
1992-1993	0	0	2,000	2,000	0	0	4,000
1993-1994	0	11,000	12,000	0	1,000	0	24,000
1994-1995	0	0	11,000	2,000	7,000	0	20,000
1995-1996	0	45,000	4,000	13,000	0	0	62,000
1996-1997	0	80,000	4,000	3,000	16,000	0	103,000
1997-1998	0	0	0	0	0	0	0
1998-1999	0	17,000	700	0	0	0	17,700
1999-2000	0	0	1,200	0	0	0	1,200
2000-2001	700	3,600	500	100	0	0	4,900
2001-2002	0	0	0	0	0	0	0
2002-2003	0	35,000	11,500	1,500	0	0	48,000

* No Data Published

Note: No Data Available for Period 1964-1974.

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3.0 STUDY METHODS

3.1 Literature Review

Literature reviews were used to perform the analysis of potential effects of the ice boom. Existing studies were identified in the public scoping process as relevant and important works to be considered in conducting the effects analysis. Twenty-one studies and sources of information were specifically required for review in the ALP approved scope of services for this study (Appendix A).

A gap analysis was performed early in the review process. The purpose of the gap analysis was to identify areas of inquiry that required more information than existed in the studies that CRA was required to review. These areas of inquiry are specified in Exhibit A of the ALP approved scope of services. Based upon the results of the gap analysis, CRA reviewed other relevant studies and information in an attempt to provide answers to questions that were raised during the ALP. Results from these studies are included in our analysis.

3.2 Effects Analysis

This study looked at several factors in determining and weighing results of previous studies. As a rule, more credence and greater emphasis was placed on peer-reviewed articles. A few studies authorized by the ALP document were not peer reviewed. In these cases, we attempted to identify other works published by the relevant authors, which later appeared in professional journals and/or technical publications. In many of these cases, the original works were later submitted for publication in professional journals. The published versions of these studies were incorporated into our evaluation where appropriate.

Task leaders for this study were selected on the basis of several factors including subject matter expertise, project experience in cold water environments, working knowledge of FERC requirements, and experience in working on projects of similar size and scope. Each task leader was assigned responsibility

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for one or more areas of inquiry and was responsible for conducting the impact analysis for that subject area. Task leaders formed a professional opinion related to potential ice boom impacts within their area of responsibility and subject matter expertise. The results of the impact analysis can be found in Section 5.0.

3.3 Alternatives Analysis

Pursuant to the ALP approved Scope of Services, the alternative analysis was limited to:

- Exploring alternative ownership of the ice boom storage and maintenance facility and;
- Considering alternative location(s) for the NYPA owned storage and maintenance facility.

The alternative analyses are discussed in detail in Section 6.0.

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4.0 STUDY AREA RESOURCES

In the following subsections, various resources are identified that could potentially be impacted by the ice boom within the study area. Pursuant to the ALP approved Scope of Services, CRA has included available information regarding the climatic, aquatic, land management, terrestrial, recreational, and aesthetic resources of the study area. In addition, descriptive information is presented on local agriculture, river hydraulics, water quality, current and potential future use of adjoining land parcels, and ice formation. All information presented in this section is derived from existing studies and information sources and represents CRA's attempt to meet the objectives stated in Section 1.3.

4.1 Climate

The region surrounding Buffalo, New York, experiences a continental type climate, although the large annual temperature range and dry conditions typically associated with such climates are somewhat moderated over areas immediately adjacent to Lake Erie. Measurements taken at the National Weather Service Station in Buffalo indicate the mean monthly temperatures between 1971 and 2000 range from 24 °F in January to 71 °F in July (Figure 4.1-1). Mean monthly precipitation is approximately 3-4 inches (Figure 4.1-2). Additional information on Buffalo climate can be found at the National Weather Service web site http://www.wbuf.noaa.gov/climate_information.htm.

A defining feature of climate in areas located at the lakefront is commonly referred to as the lake effect, which is completely natural and is unrelated to any human structures or other influences. The lake effect is the moderating influence of large water bodies on climate and is primarily due to the large heat capacity of water compared to land surfaces. This causes a delay in seasonal temperature variations, resulting in comparatively warmer autumns and cooler springs and early summers. The lake effect also results in seasonal contrasts between air temperatures in the immediate vicinity of the lake and air temperatures in the surrounding regions as well as at higher levels in the atmosphere during all seasons. For example, in autumn, the relatively warm water temperatures compared to surrounding regions keep lakeside air temperatures high and delay the first frost, typically by several weeks. This extends the growing season compared to inland areas. In spring and well into summer, cool waters depress lakeside

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temperatures relative to areas farther inland, delaying the onset of the growing season. Cooler surface conditions over the lake also enhance atmospheric stability, inhibiting cloud formation and resulting in relatively sunny conditions. The effect of the lake during the spring provides the additional benefit of decreasing the likelihood of frost damage to early season crops. The region that experiences the lake effect is believed to extend, at most, three miles inland from the lakefront (NRC 1983).

The presence of ice on the lake affects snowfall downwind from Lake Erie. During late autumn and early winter, the region downwind of the lake experiences considerable snowfall. A significant portion of this snowfall, which is commonly known as lake effect snow, occurs when cold, dry air masses from the west and north move over the relatively warm, moist lake surface. The contrasting temperature and moisture characteristics of the surface and atmosphere enhance atmospheric instability and provide moisture to the atmosphere through evaporation. Winds then carry the moisture-laden air mass, resulting in snowfall over inland areas downwind of the lake. When the lake freezes over, which typically occurs in late January or early February, evaporation from the lake effectively ceases, and a significant source of water to the atmosphere is removed. (Under certain conditions, winds can produce open water and restart the evaporation process.) Thus, lake effect snowfall is greatly reduced after an ice cover forms on Lake Erie. Mean monthly snowfall in Buffalo is greater than 25 inches in December and January, and drops to less than 20 inches in February (Figure 4.1-3).

The date of initial ice formation also varies significantly from year to year. Ice formation can occur as early as mid-December. Occasionally, the lake does not freeze over at all. Satellite photos show lake effect events are also caused or reinforced by open water in the Upper Great Lakes (e.g., Lake Huron).

Lake ice also plays a role in keeping lakeside temperatures cooler in spring. As increasing sunshine warms the region, much of the solar energy is spent on melting the lake ice, rather than on warming the water. Until the ice melts, water temperatures generally do not rise above freezing although warm water can advect (move horizontally) eastward beneath the ice, which can cause melting at the ice-water interface. The cold surface water temperatures that are associated with the presence of an ice cover prevent the air above and adjacent to the lake from warming as much as areas farther inland. The date of last ice varies significantly from year to year. Records available from 1905 to the present indicate

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observed ice-out dates from as early as mid-March to as late as May 31st (INWC 2003). Thus, the year-to-year variability in the timing of ice dissipation is over two months. The effect of lake ice on springtime air temperatures, and the variability in the date of last ice, are completely natural and are unrelated to either the ice boom or to any other human structure or intervention.

Lake Erie water temperature is measured at the City of Buffalo water intakes located just outside the Buffalo Harbor, near the entrance to the Niagara River. Temperatures are recorded near the intake valve at a depth of 18 feet. On average, temperatures reach the freezing point in early February and begin rising in early April. However, significant year-to-year climatic variability can result in freezing temperatures from as early as mid December to as late as May 31st. During some years, little or no ice forms on the lake and water temperatures remain above freezing all winter (e.g. 1952-1953, 1982-1983, 1997-1998 and 2001-2002). Summer surface water temperatures typically peak between late July and mid August at an average of 73 °F, although summer temperatures as high as 78 °F and as low as 67 °F have been observed (Figure 4.1-4). Additional information on historical water temperature observations can be found at the National Weather Service website (www.erh.noaa.gov/buf/laketemps/laketemps.htm).

4.2 Agriculture

The United States Department of Agriculture (USDA), Farm Service Agency (FSA), statistics indicate that total crop production in New York State, including field crops, fruit, and vegetable production, return $1.2 billion to New York farmers. The following sections provide a breakdown of crop production yields and values for 2002 in the State and, more specifically, information on agriculture production in Erie County. Information related to agricultural production was provided by the FSA and the National Agricultural Statistics Service. Some of the information was accessed through the agencies' Internet databases. See Figures 4.2-1, 4.2-2, and 4.2-3

The crop resources of Western New York are diverse and important to the economy of the area. Field crops, such as wheat, corn, oats, soybeans, and potatoes, provide food sources for humans and commercial livestock production. The value of field crops and hay and forage crops grown in the area is enhanced by feeding them to animals. Thus, added value is realized through the sale of milk, eggs, red

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meat and poultry. The Western New York area grows most of the major vegetable varieties grown in the State. Niagara and Erie counties are among the largest producers of potatoes, tomatoes, and cabbage crops in the State. Western New York also produces a variety of fruit crops, but the crops with the highest cash value are grapes and apples.

NY State is 3rd in the nation in grape production and the Lake Erie region is the largest producer of grapes in the State. Erie County is one of the top ten producing counties in the State for grapes, while Niagara County is a top ten producer for both grapes and apples. Grapes are economically important to the region and are considered to be a high value crop. Since the grape industry was worth $43.3 million to the State's economy in 2002, this crop is a major economic contributor to the area.

Table 4.2.5-1 provides information on the major crops produced in Erie County in 2003. These data were provided by the FSA located in Erie County. The data provided by the local FSA is not complete since only the farmers and landowners who participate in FSA programs are required to certify their crop acres, although all farmers are encouraged to report crop production data to the local field office. Field crops such as corn, wheat, potatoes, beans, soybeans and grass crops such as mixed hay, alfalfa and clover take up the majority of the agricultural acreage. Erie County produces economically important quantities of other high value crops, such as flowers and nursery crops, which is demonstrated by the acreage that is dedicated to growing these crops.

4.3 Water Resources

The Niagara Power Project is situated at the Niagara Escarpment, along the east shore of the Niagara River between Lake Ontario and Lake Erie. The Niagara River flows north from Lake Erie to Lake Ontario, over the Niagara Falls, located approximately 5 miles upstream of the Robert Moses Plant of the Niagara Power Project. The river forms the boundary between New York State and the Province of Ontario, Canada. The Niagara River is 36 miles long and serves as the outlet for the four upstream Great Lakes, which combine to form a drainage basin of approximately 264,000 square miles Figure 4.3-1.

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The Niagara River consists of three major reaches including: the upper Niagara River; the Niagara Cascades and Falls; and the lower Niagara River.

The upper Niagara River extends about 22 miles from Lake Erie to the Cascade Rapids which begin 0.6 mile upstream from the Canadian Horseshoe Falls. From Lake Erie to Strawberry Island, a distance of approximately 5 miles, the channel width varies from 9,000 feet at its funnel shaped entrance to 1,500 feet at Squaw Island which is located below the Peace Bridge. The average fall over this reach is around 6 feet. In the upper 2 miles of the river, the maximum depth is about 20 feet, with velocities as high as 12 feet per second (ft/s) in the vicinity of the Peace Bridge. Below Squaw Island, the river widens to approximately 2,000 feet, with velocities in the order of 4 to 5 ft/s.

At Grand Island, the river divides into the Chippawa Channel to the west and the Tonawanda Channel to the east. The Chippawa Channel is approximately 11 miles long and varies from 2,000 to 4,000 feet in width. Water velocities range from 2 to 3 ft/s. The Chippawa Channel carries approximately 58% of the total river flow. The Tonawanda Channel is 15 miles long and varies from 1,500 to 4,000 feet in width. Water velocities also range from 2 to 3 ft/s in the Tonawanda Channel.

At the north end of Grand Island, the channels unite to form the 3 mile long Chippawa-Grass Island Pool (GIP) where the Power Entities withdraw water for power generation. The average fall from Lake Erie to the GIP is about 9 feet. At the downstream end of the pool is the International Control Structure (ICS) which is needed to meet the requirements of the 1993 Directive of the INBC and the 1950 Treaty. The ICS is used to maintain Treaty flows over the Falls and to regulate water levels in the GIP. This structure extends from the Canadian shoreline about halfway across the width of the river. The Niagara Falls are located approximately 4,500 feet downstream of the ICS.

The upper and lower Niagara River are separated by the Niagara Cascades and Falls. This stretch of the river starts below the International Control Structure, with a fall of 50 feet through the Cascade area, and is divided into two channels by Goat Island. The two channels separate to produce the Canadian or Horseshoe Falls, and the American Falls. During non-tourist hours, the combined minimum flow over both falls is 50,000 cfs which produces a drop of about 188 feet at the Canadian Falls. The minimum

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flow during tourist hours is 100,000 cfs which results in a fall of about 177 feet. The American Falls has a smaller drop in elevation with a range of 70 to 110 feet.

The lower Niagara River consists of the Niagara Gorge, which is comprised of the Maid of the Mist Pool, the Whirlpool Rapids, and an additional series of rapids further downstream. The Niagara Gorge extends from the Falls for 7 miles downstream to the foot of the escarpment at Queenston, Ontario. The upper reach of the gorge is known as the Maid of the Mist Pool, with an average fall of about 5 feet, and is navigable over practically its entire length. The Whirlpool Rapids are located at the downstream end of the pool and are not navigable. These rapids are about 1 mile long and the water surface profile drops about 50 feet with water velocities reaching as high as 30 ft/sec. The Whirlpool is a basin that is 1,700 feet long, 1,200 feet wide, and has a depth up to 125 feet and is located further downstream from the rapids. At this location, the river makes a near right-angled turn. Below the Whirlpool, there is another set of rapids that drops approximately 40 feet before the river emerges from the gorge at Queenston, Ontario where the river widens to 2,000 feet. From Queenston, the river is navigable, while undergoing an additional fall of 5 feet, to Lake Ontario.

In the early winter, southwest and west-southwest winds can drive ice floes toward the narrowing at the eastern end of Lake Erie. The narrowing of the lake at its outlet restricts the volume of ice that can flow from Lake Erie and enter the upper Niagara River under normal weather conditions. This constriction leads to the formation of a natural ice arch that spans across the outlet (Figure 4.3-2). The natural arch forms at a specific location because an ice cover is not stable in the high currents found at the approach to the Niagara River where the water velocity increases. During winter storm surges winds from the prevailing southwest direction can cause destabilization of the natural ice formation. Two or three times each winter, this destabilization permits lake ice to enter the river (NYPA 1998). Ice runs can cause large-scale ice blockages and ice jams within the upper Niagara River that have the potential to reduce hydropower generation, flood shoreline property, cause extensive damage to docks and other shoreline structures, and clog the City of Buffalo's water intakes. The ice boom, first installed in 1964, is designed to accelerate the formation of a stable ice cover on the lake and limit the duration and frequency of lake ice runs into the Niagara River. The boom is also designed to submerge and release ice into the Niagara River when exposed to high ice loads. Thus, the boom does not completely eliminate ice discharge into the river but serves to limit the frequency and duration of lake ice runs.

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Besides ice from Lake Erie, various forms of ice are generated within the Niagara River. Active frazil ice and anchor ice are particularly important to river hydraulics. Frazil ice can be formed in large quantities over a short period of time. This type of ice can adhere to and clog diversion intakes which can precipitate reductions in diversion flows. Anchor ice normally forms on cold clear nights and is attached or anchored to the riverbed and submerged objects. The production of anchor ice reduces flows in the river. When anchor ice forms in the river channel at the outlet of the lake, river flows can be reduced as much as 40,610 cfs to 49,440 cfs (NYPA 1998).

The volume of ice generated within the river is much smaller than the ice that is formed in the lake since eighty to ninety percent of the ice in the Niagara River is conveyed from Lake Erie (NYPA 1998). With a surface area of approximately 10,000 square miles, Lake Erie has the capacity to produce an extremely large volume of ice during the winter months. Thus, the major source of ice that contributes to ice jamming in the upper Niagara River is formed in Lake Erie.

The GIP is a critical zone along the upper Niagara River for ice jamming because the area is much shallower than the Chippawa and Tonawanda Channels that discharge into it. Shallow areas in the GIP become covered with grounded ice accumulations during lake ice runs. The GIP is also characterized by the presence of a natural shoal, which leads to a reduction in ice transport capacity along this reach of the river. In the early stages of ice jam formation, ice accumulates through grounding on the shoal. This results in formation of an ice island. The ice buildup results in altered flows within the GIP, which can further diminish the ice transport capacity of the river. If ice continues to enter into the GIP, the ice transport capacity of the river can be exceeded. This is the beginning of ice jam formation. Changes in water level can result from the formation of ice covers and ice accumulations in the Niagara River. In general, an ice cover on a river substantially increases flow resistance and causes an increase in water levels to the point of potentially causing significant upstream flooding. Similarly, ice accumulations typically produce a reduction in the ice transport capacity of the river reach.

Historically, on average, over the past 40 years there has been an ice run event about one or more times per year on the upper Niagara River (Abdelnour et al 1995). Various structural measures, including local channel modifications, have been taken to increase ice transport through the GIP including construction of the U.S. and Canadian ice escape channels. The Power Entities can also vary the amounts

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of water being diverted to increase the ice transport capacity within the GIP when there are significant amounts of ice flowing in the river. Since the vast majority of ice that occurs in the upper Niagara River originates in Lake Erie, the primary method for reducing the potential for ice stoppages, ice jamming, and flooding in the upper Niagara River is to reduce the volume of ice flowing from Lake Erie into the river. This is the primary function of the Lake Erie-Niagara River ice boom.

4.3.1 Hydraulics

The water level at the eastern end of Lake Erie is the primary factor that influences flow into the Niagara River. Lake Erie is relatively shallow and is aligned with the prevailing wind direction from the southwest. Because the lake is aligned with the prevailing wind along its long axis, the eastern end of the lake is subject to unusually large wind setup. Changes in water levels caused by wind setup can occur very quickly in the presence of high winds or storm activity. The large fluctuations in water levels are predominately associated with storm surges that accompany cold fronts to the area during the months of November and December. Late December and January are the months when initial winter ice is forming on the lake. The impact of wind setup on the water level at the eastern end of the lake and the corresponding discharge into the river is substantial. Water levels can rise as much as 8 ft above normal when the wind blows from the southwest or west-southwest toward the entrance to the Niagara River (NRC 1983, NYPA 1998). Thus, water levels at the eastern end of Lake Erie can undergo dramatic changes in a very short period of time and flows into the upper Niagara River can be highly variable.

The flow in a river can be estimated based on the depth, slope and hydraulic roughness of the river channel. In the case of the Niagara River, the slope and roughness are essentially constant. The river channel is not eroding or accreting in any significant amount. Surveys of the river bathymetry were done for the reach upstream of the Grass Island Pool (GIP) by USACE in 1951 and by the Hydroelectric Commission of Ontario in 1962. Twenty-two cross-sections along the same reach, from the GIP through the Tonawanda and Chippawa Channels, were also surveyed in June 1990. NYPA (1998) notes that "(c)omparisons of these surveys with the historic surveys showed few significant changes (excluding those made for the power projects) in the riverbed." Since the slope and hydraulic roughness of the river channel remain essentially unchanged, the discharge into the river partially depends on its channel depth in relation to the elevation of Lake Erie.

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The upper Niagara River displays a number of other characteristics that result in complex river hydraulics. The river is divided by Grand Island to form the Chippawa and Tonawanda Channels and other small channels, islands, and shoals. There are differences in the morphology and conveyance characteristics of the two channels. The greater proportion of the river's flow is in the Chippawa Channel (58%) while the majority of ice enters into the Tonawanda Channel. The Tonawanda Channel is also more susceptible to water level increases and flooding because of its lower freeboard which is the difference between mean water elevation and the elevation at which the riverbanks are overtopped and flooding occurs. In addition, the Niagara River is subject to freezing (in certain bays) and ice runs. Static ice on the surface of a river adds hydraulic roughness to the river which reduces water velocities and, in the most severe case of an ice jam that completely covers the entire width of the river, may increase the depth of the river by as much as a factor of two. If the static ice covers only a portion of the river, then the increase in water level in the river would be less dramatic, but still could result in significant flooding. If the ice is moving, then the river is at or resumes its usual lower depth and higher velocity. Thus, while ice is moving downstream, the ice has, for all practical purposes, no impact on the flow of the river. However, when ice is stopped, by grounding on a shoal or an island or along a shoreline, the water depth increases and the water velocity moving the ice sharply decreases. This reduction in water velocity reduces the ice transport capacity of the river which can lead to more grounding. Eventually, this process of feedback from ice stoppages, decreased water velocities, and the introduction of even more ice stoppages, can result in an ice jam.

NYPA and Ontario Hydro, seasonally, may divert up to three-quarters of the water flowing in the river, consistent with the 1950 Niagara River Water Diversion Treaty, to their hydroelectric generation facilities, with the greatest diversions occurring during the winter months. These diversions represent some loss of ice transport capacity below the locations of the intakes to the power plants. The Power Entities have constructed river works and performed excavation of the riverbed to ameliorate this effect including construction of the U.S. and Canadian ice escape channels, dikes, and excavation around the intakes. The Power Entities own and operate modern state-of-the-art icebreakers to mitigate and remove ice jams as quickly as possible. The use of instrumentation, including forward looking radar in the GIP and permanent video cameras mounted on the top of the HSBC Center in Buffalo, allows the Power Entities to monitor ice conditions and initiate ice jamming mitigation strategies if circumstances warrant. These strategies are based on numerical and physical modeling results obtained from studies conducted

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under FERC guidance. The goal of ice jam mitigation operations is to increase the ice transport capacity in the GIP and to avoid ice stoppages in the ice escape channels through a combination of increased water levels and water velocities that are usually accompanied by voluntary reductions or other alterations in diversion flows. The 1993 INBC Grass Island Pool Directive that limits water level fluctuations and establishes minimum and maximum allowable pool levels in the GIP can be temporarily modified to increase the ice transport capacity and assist in flushing ice over the Niagara Falls. Under this modification, the maximum allowable pool level can be increased by 0.5 ft from 564.22 ft using the USLSD 1935 datum (IGLD 1955 562.5 ft; IGLD 1985 563.02 ft) to 564.75 ft (IGLD 1955 563.03 ft; IGLD 1985 563.55 ft). Further modifications can occur if there is an imminent threat to property or life.

Ice jamming occurs, not only because of a decrease in ice transport capacity in the GIP, but also because the ice transport or discharge capacity of the river has been reached. The ice transport capacity is a measure of the rate of ice that the river can accept from Lake Erie during an ice run. Since ice runs predominately occur under conditions that result in overtopping of the ice boom, the amount of discharged ice corresponds to both a volume and rate of lake ice discharge that must be conveyed down the river and through the GIP. The GIP is a critical location because of its decreased ice transport capacity. This is due to its shallow depth and the presence of numerous shoals which can lead to the formation of grounded ice accumulations in the GIP. Ice stoppages and jams also occur at areas where a river suddenly narrows. If the ice is solid and competent and remains in one or two large sheets, an ice jam is almost certain. If the ice is not entirely competent and consists of smaller floes or ice particles (as is usually the case), the potential for an ice jam is reduced, although an ice jam or stoppage can still occur depending on ice discharge volume, meteorological conditions, water velocity, ice thickness, water flows, ice transport capacity, and other factors.

The flow within the Niagara River during the ice season is a function of the highly variable water level of Lake Erie, the volume and rate of ice discharged into the river and the instantaneous volumes of water being diverted for power generation. The upper Niagara River is a complex hydraulic system and it is highly dynamic.

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4.3.2 Water Quality

There are a number of factors that can affect the quality of surface water in any waterbody. The potential impacts of the ice boom on water quality are largely limited to the ability of the boom to reduce the volume and severity of ice runs into the river. Ice discharges into the Niagara River can lead to flooding, scouring, and erosion. Land use and land management practices at the ice boom storage and maintenance facility also have the potential to impact water quality. Flooding, erosion, and land management practices are discussed in detail in other sections of this report.

Water level fluctuations in both the upper and lower Niagara River are caused by a number of factors including U.S./Canadian power generation, wind, natural flow variations, ice conditions, water levels at Lake Erie, and control of the volume of flow over the Niagara Falls for scenic purposes under the 1950 Treaty. Ice stoppages and ice jamming cause elevated water levels in the areas that are upstream from the location of the jam or stoppage. Flooding can ensue if a sufficient volume of ice is discharged into the river and the duration and volume of ice entering the river is not controlled to some extent. The fluctuation in water levels that results from ice runs in the river can also contribute to shoreline erosion, which introduces sediments into the water column. The corresponding increase in turbidity serves to diminish overall water quality in the watershed. Similarly, ice jams and ice floes can scour the riverbed and riverbanks, particularly in shallow areas. Scouring can also cause erosion and decrease the water quality of the receiving tributary (Baird 2005, URS and Gomez and Sullivan 2005).

Land use and land management practices can affect water quality. Construction and site development activities can lead to the introduction of sediments into the waterbody. Similarly, land use and industrial site activities can produce surface water discharges that impact water quality through the introduction of chemicals and other substances into the environment.

4.4 Ecological Resources

A diversity of ecological resources is present in the eastern end of Lake Erie and the upper Niagara River. This section describes the resources that are potentially affected by the ice boom. Two

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general categories of ecological resources are considered: aquatic resources and terrestrial resources. Aquatic resources include aquatic plants, aquatic invertebrates, and fish. Terrestrial resources include botanical and wildlife resources. For botanical resources, descriptions of wetland plant communities, upland plant communities, significant natural communities, and rare, threatened, and endangered (RTE) species are provided. Descriptions of wildlife communities, RTE species, and NYDOS Significant Coastal Wildlife Habitats are presented for wildlife resources.

4.4.1 Aquatic Resources

4.4.1.1 Aquatic Plants

Submerged aquatic vegetation (SAV) is the primary type of aquatic plant in the upper Niagara River. SAV is a relatively diverse group of plants, with the common characteristic that they typically grow below the surface of permanent water. Figure 4.4.1.1-1, Figure 4.4.1.1-2, and Figure 4.4.1.1-3 identify the locations of SAV beds in the Niagara River between Lake Erie and Grand Island. Stantec et al. (2005) present figures and maps that provide the locations and descriptions of SAV beds in the Niagara River. The results of the field investigations documented the outer limits of SAV in these areas at depths of 16-20 feet.

Beds of SAV generally extend along the entire western shore of the Niagara River from Lake Erie to Grand Island. There is an area approximately 2,000 feet south of the Peace Bridge where SAV is absent. On the eastern shore of the Niagara River, SAV beds extend from Lake Erie to Squaw Island. Along this shore, SAV is generally absent from Squaw Island to Grand Island. Submerged aquatic vegetation, however, is present along both shores of Black Rock Canal. Most of the beds are relatively narrow and adjacent to the banks of the Niagara River. However, there are several relatively large beds where Lake Erie flows into the Niagara River. The SAV beds are generally associated with those areas identified as having a water depth of greater than 2 feet.

Another area of SAV beds occurs from Strawberry Island to Motor Island and the southern end of Grand Island. This area is referred to as the Strawberry Island-Motor Island Shallows. Water depth is

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generally less than six feet, although there are some beds at depths of 6 and 20 feet. A more detailed description of the Strawberry Island-Motor Island Shallows as a Significant Coastal Fish and Wildlife Habitat (SCFWH) is provided in Section 4.4.1.3.

Beds of SAV also exist at the northern end of Grand Island. Bands of SAV are adjacent to Grand Island in both the Tonawanda and Chippawa Channels. Water depth in these beds is generally less than 6 feet, although the depth in some portions of the Tonawanda Channel is up to 20 feet. Another SAV bed is associated with an island in the Tonawanda reach of the river near the confluence of Burnt Ship Creek and the Tonawanda Channel. Water depth in this SAV bed ranges from less than 6 feet to 20 feet. The GIP also contains an area of SAV generally at a depth of less than 6 feet.

Stantec et al. (2005) present several cross-sections through the Niagara River that identify the substrate and dominant species of SAV. The cross sections closest to the location of the ice boom are located within 2,500 ft south of the southern tip of Grand Island. There are no cross sections or detailed description of the SAV in the immediate vicinity of the ice boom. Because water depths and water velocities at the head of the upper Niagara River are similar to those at the southern tip of Grand Island, it is assumed that the characteristics of the SAV beds at these locations are similar. This assumption is used in evaluating the effects of the ice boom on SAV in Section 5.3.

Stantec identify two types of SAV beds: aquatic bed and unconsolidated bottom. Aquatic bed is the predominant type and generally has a higher percent of vegetation coverage than unconsolidated bottom beds, ranging from 50 to 100 percent. Coverage in unconsolidated bottom beds is generally less than 20 percent. Dominant species of submerged aquatic vegetation in aquatic beds include wild celery, Richardson pondweed, fennel-leaved pondweed, curly pondweed, muskgrass, Eurasian water milfoil, hornwort, waterweed, slender naiad, and algae. Wild celery, waterweed, and muskgrass are the dominant species in the unconsolidated bottom beds.

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4.4.1.2 Aquatic Invertebrates

Studies conducted in the mid-1970s, identified several taxonomic groups of aquatic invertebrates in the Niagara River, including midges, caddisflies, and aquatic worms. Midges were the predominant taxonomic group throughout the river, particularly in the Tonawanda Channel. Caddisflies were typically found in the Tonawanda Channel between Tonawanda Creek and the upstream boundary of the City of Niagara Falls. Samples collected south of Strawberry Island from 1976 through 1988 contained a predominance of midges.

A study was conducted in 1983 at four sites near Strawberry Island. Macroinvertebrate communities at these sites were found to contain 15 taxonomic groups, with an average of five taxonomic groups per site. Caddisflies comprised 48.2% of all samples collected; midges and aquatic worms comprised 11.4 and 10.5%, respectively.

4.4.1.3 Fish Community

4.4.1.3.1 Community Description

The fish community of the upper Niagara River is composed of coldwater, coolwater, and warmwater fishes, with the latter two types being the most abundant (NYPA 2002). Although the coldwater fishery has been sustained primarily through a stocking program in Lake Erie, some natural recruitment may occur. Chinook salmon, coho salmon, brown trout, lake trout, and rainbow trout are stocked in Lake Erie. Brown trout and rainbow trout are the primary species stocked in the upper Niagara River.

Information on the fish species inhabiting the upper Niagara River is presented in reports prepared by the National Research Council (NRC 1983) and Stantec et al. (2005). The NRC reported that the U.S. Fish and Wildlife Service (USFWS) collected 27 species in the Buffalo area in May 1983. Of the 27 species, gizzard shad, emerald shiner, common shiner, spottail shiner, and yellow perch were identified as being abundant.

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The NRC provided a list of 66 species historically recorded in the Niagara River that were not collected by the USFWS during their May 1983 sampling event. The NRC report also identified several species of sport fish common in the eastern end of Lake Erie and the upper Niagara River. These species include smallmouth bass, yellow perch, walleye, northern pike, and muskellunge.

In a more recent document, Stantec et al. (2005) identified 92 species of fish that have historically occurred and currently inhabit the Niagara River and Lewiston Reservoir. The three time periods analyzed by Stantec are circa 1927, 1960-2000, and 2001. Of the 92 species, 52 were classified as being present in 2001. This report did not provide a breakdown of species in the upper Niagara River, lower Niagara River, and Lewiston Reservoir. Portions of the text do, however, identify species occurring in the upper Niagara River, where any influences of the ice boom would be expected. A list of the species identified by the NRC (1983) and Stantec et al. (2005) is provided as Table 4.4.1.3.1-1.

The First-Stage Consultation Report (FSCR) (NYPA 2002) provides additional details on the fish community of the upper Niagara River. In particular, the FSCR contains information from several studies that describe the relative abundance of each fish species, estimate population densities for some species, evaluate catch rates, characterize populations, and provide length/weight data for several economically important species, including muskellunge, northern pike, largemouth bass, and smallmouth bass. The FSCR states that 45 species of coolwater and warmwater species were collected during sampling events conducted in 2001. The most common species included bluntnose minnow, brown bullhead, common shiner, emerald shiner, largemouth bass, rock bass, spottail shiner, white sucker, banded killifish, carp, muskellunge, smallmouth bass, and yellow perch. Of these species, emerald shiner was the most abundant. Sampling locations with the highest densities of fish included Strawberry Island, Motor Island, Spicer Creek, Gun Creek, Grass Island, Woods Creek, and the northern shore of the Niagara River north of Woods Creek.

4.4.1.3.2 Spawning and Nursery Areas

The NRC report (1983) identifies several species of sport fish that spawn in eastern Lake Erie and the upper Niagara River. These species include muskellunge, largemouth bass, smallmouth bass, walleye,

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yellow perch, bluntnose minnow, northern pike, brown bullhead, and greater redhorse sucker. In addition to sport fish, the NRC identified common (white) sucker and burbot as spawning in the area. The report also states that lake sturgeon and lake trout may spawn in eastern Lake Erie. Trout and salmon are identified as sport fish that were introduced into eastern Lake Erie and the upper Niagara River.

The FSCR (NYPA 2002) states that numerous shoals, particularly near Grand Island, provide important habitat for recreationally important species, such as rainbow and brown trout, steelhead, muskellunge, and smallmouth bass. The shoals bounded by the southern tip of Grand Island, Strawberry Island, and Motor Island, as well as the shoals near Navy Island and the northern tip of Grand Island, provide spawning habitat for muskellunge and smallmouth bass. Shoals along the western shore of Grand Island provide spawning and nursery areas for smallmouth bass and rock bass. Spawning areas for northern pike are present around Buckhorn Island and in the tributaries draining Grand Island.

Early surveys (NYPA 2002) of the upper Niagara River noted the use of various habitats by nongame fish species, such as blacknose shiner, white sucker, common carp, emerald shiner, blackchin shiner, trout-perch, and white bass. For many species, specific habitat characteristics were not identified in these early surveys, although blackchin shiners were observed spawning in aquatic beds and spottail shiner fry were collected from an area of sand-rock bottom and emergent vegetation off the southwest shore of Beaver Island.

4.4.1.4 New York Department of State Significant Coastal Fish Habitat

The NYSDOS Division of Coastal Resources and Waterfront Revitalization maintains data on Significant Coastal Fish and Wildlife Habitat (SCFWH), including information on habitats identified by the NYSDEC Natural Heritage Program. Five significant aquatic natural communities occur in the upper Niagara River: the Buckhorn Island Wetlands, the Strawberry Island/Motor Island Shallows, the Grand Island Tributaries, the Buckhorn Island-Goat Island Rapids, and the Buckhorn Island Tern Colony. The Buckhorn Island Wetlands and Buckhorn Island Tern Colony are described in Section 4.4.2.2.2 (Terrestrial Resources). The other three significant natural communities are described below.

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The Strawberry Island-Motor Island Shallows SCFWH is a 445-acre area at the southeastern end of Grand Island. This SCFWH is located within and adjacent to Beaver Island State Park. It includes Beaver Island, Strawberry Island, and Motor Island. This area contains SAV beds and patches of emergent vegetation along the shorelines. The Strawberry Island-Motor Island Shallows is the largest area of riverine littoral zone in the Niagara River. The Strawberry Island-Motor Island Shallows is one of the most important fish spawning areas in the upper Niagara River (NYPA 2002). Studies during the mid-1970s indicated that this was one of two principal spawning grounds for muskellunge in the Niagara River, the other being the littoral area between Burnt Ship Creek and Navy Island. This area is also one of the most productive spawning areas in the upper Niagara River for smallmouth bass, yellow perch, and various other resident freshwater fish species. The Strawberry Island-Motor Island Shallows contains relatively large concentrations of many fish species throughout the year.

The Grand Island Tributaries SCFWH includes the lower portions of four tributaries: Gun Creek, Spicer Creek, Woods Creek, and Big Sixmile Creek. It also includes a 10-acre wetland adjacent to Beaver Island State Park. The creeks provide spawning areas for northern pike and warmwater fishes. Studies of Woods Creek, Gun Creek, and Big Sixmile Creek during the mid-1970s documented that these areas contained significant concentrations of spawning northern pike from February through April, with many remaining in the creek until July. Habitat conditions in Spicer Creek and the Beaver Island wetland are similar and provide additional spawning areas for northern pike. The Grand Island Tributaries are also important nursery grounds for one-year-old muskellunge.

The Buckhorn Island – Goat Island Rapids SCFWH is located between Grand Island and Goat Island, in the City of Niagara Falls, Niagara County, and the Town of Grand Island, Erie County. The habitat is an approximately 850-acre area of the upper Niagara River, extending roughly from the Buckhorn Island water diversion structures to the Goat Island Bridge and Three Sisters Islands, above the American Falls and Horseshoe Falls, respectively. This section of the river is wide, fast moving, and relatively shallow (less than 10 feet deep below mean low water), with a sparsely vegetated bedrock substrate. The rapids are bordered to the north by the Robert Moses Parkway and extensive industrial development and to the south by Canadian waters of the Niagara River. In the vicinity of Goat Island, the habitat includes a portion of the Niagara Reservation State Park.

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Although the Buckhorn Island – Goat Island Rapids SCFWH comprises a relatively small segment of the river, it contains some extensive areas of undisturbed, natural habitat. This SCFWH serves as one of the major feeding and resting areas for migratory birds, along with the Strawberry Island-Motor Island Shallows SCFWH. Waterfowl use of the area during winter each year is influenced in part by the extent of ice cover throughout the region. Concentrations of waterfowl also occur in the area during spring and fall migrations (March-April and October-November, respectively).

4.4.1.5 Rare, Threatened, and Endangered Aquatic Species

The FSCR (NYPA 2002) summarizes a literature review and fieldwork to determine the past and present occurrence of rare, threatened, and endangered (RTE) aquatic species in the vicinity of the Niagara Power Project (i.e., Niagara River Corridor). Riveredge Associates found no federally listed threatened or endangered fish species in the Niagara River or in the Lewiston Reservoir and no state-listed endangered fish species in the upper Niagara River. They did find one state-listed threatened species (lake sturgeon) and two special-concern species (redfin shiner and black redhorse). They also identified six rare but unprotected fish species: quillback, Iowa darter, greater redhorse, freshwater drum, blackchin shiner, and brindled madtom. Although freshwater drum is listed on the New York Natural Heritage Program's Rare Animal List, they are relatively abundant in the Niagara River. Freshwater drum represented the fifth highest species observed for total catch by shore anglers (3.4%) and ninth highest by boat anglers (1.8%) in the upper Niagara in a recent study (Normandeau 2005). Similarly, this species had the fifth highest mean daily catch and catch per unit effort, by shore anglers, of the total fish caught in a recent survey of the lower Niagara River in 2002-2003 (Stantec 2005a). A total catch of 33,840 freshwater drum was reported in the survey. This fish was also reported to be the fourth most caught species in yet another survey of the Lewiston Reservoir in 2002 (Stantec 2005b).

Among rare but unprotected species, ten mussel species and one crayfish species were identified for the Project vicinity. Mussel species were the threeridge, Wabash pigtoe, fragile papershell, eastern pondmussel, black sandshell, hickorynut, round pigtoe, pink heelsplitter, kidneyshell, and rainbow. The crayfish species was the burrowing crayfish.

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4.4.2 Terrestrial Resources

4.4.2.1 Botanical Resources

Plant communities of the upper Niagara River fall into two general groups: Wetland Plant Communities and Upland Plant Communities. The FSCR (NYPA 2002) and Stantec et al. (2005) provide descriptions of plant communities of the upper Niagara River.

4.4.2.1.1 Wetland Plant Communities

Stantec et al. (2005) provide a description of wetlands of the Niagara River Corridor Figure 4.4.2.1.1-1. Palustrine wetlands are those wetlands dominated by trees, shrubs, and persistent emergent vegetation. There are no palustrine wetlands of any class (i.e., emergent, forested, scrub-shrub) south of Grand Island. All of the palustrine wetlands are associated with Grand Island, and the vast majority of the palustrine wetlands, are inland rather than coastal.

Palustrine Emergent Wetlands - A small area of palustrine emergent wetlands is identified for Strawberry Island, near the southeastern tip of Grand Island. These wetlands consist of shallow emergent marsh and deep emergent marsh. Dominant species in the shallow emergent marsh are broad-leaved arrowhead, great bulrush, broad-leaved cattail, and sedge. Dominant species of SAV in the shallow marsh are waterweed, Eurasian water milfoil, and algae. Purple loosestrife is the dominant species in the deep emergent marsh.

Another very small area of emergent wetlands is associated with palustrine forested wetlands on the east side of Grand Island, directly opposite of where Tonawanda Creek flows into the Tonawanda Channel. This small area of palustrine emergent wetlands consists of wet meadow and deep emergent marsh. Dominant vegetation in the wet meadow includes blue joint grass, bristly sedge, spotted Joe Pye weed, boneset, and purple loosestrife. Vegetative cover in the wet meadow is 100 percent. The deep marsh supports both emergent vegetation and SAV. Cover of emergent vegetation in the deep marsh ranges from 70 to 80 percent. Dominant emergent vegetation includes white water lily, pickerelweed,

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broad-leaved arrowhead, broad fruited burreed, and broad-leaved cattail. Cover of SAV in the deep marsh is greater than 75 percent. Hornwort and wild celery are the dominant SAV species.

A larger area of emergent wetlands associated with palustrine forested wetlands is at the northern tip of Grand Island where the Chippewa and Tonawanda Channels come together. This is the Buckhorn Island Wetland, described in Section 4.4.2.2.2. The palustrine wetlands in this area consist of wet meadow, shallow emergent marsh, and deep emergent marsh. The wet meadow component has 100 percent vegetative cover with tussock sedge, spotted Joe Pye weed, mild water pepper, and blue vervain as the dominant species. The shallow emergent marsh component is described as having 100 percent vegetative cover with false nettle, swamp smartweed, and broad-leaved cattail as the dominant species. Several areas of deep emergent marsh are present at the northern tip of Grand Island. Dominant emergent species in the deep marsh are narrow-leaved cattail, yellow marsh iris, pickerelweed, and broad-leaved arrowhead. Dominant species of SAV include wild celery and muskgrass. Cover of emergent vegetation in deep marsh ranges from 50 to 100 percent. SAV cover ranges from 0 to 75 percent or greater.

Palustrine Forested Wetlands - Three areas of palustrine forested wetlands are present on Grand Island adjacent to the Niagara River. Two of the three areas are on the east side of Grand Island, directly across from the point where Tonawanda Creek flows into the Tonawanda Channel. The larger of these two areas is associated with palustrine emergent wetlands described above. Green ash and spicebush are the dominant species in the canopy and shrub/sapling strata, respectively. Fowl mannagrass and moneywort are the dominant species in the herbaceous stratum. This forested wetland is located in a depressional area and is separated from the Niagara River by a narrow band of upland hardwood forest. For the smaller forested wetlands, black willow is the dominant canopy species. Goldenrod is the dominant species in the herbaceous stratum. A shrub/sapling stratum is not described for this wetland.

The third area is a relatively narrow band of palustrine forested wetlands associated with the Buckhorn Island Wetlands. Green ash is the dominant canopy species. Dominant species in the herbaceous stratum consists of fowl mannagrass and reed canary grass. A shrub/sampling stratum is not described for this wetland.

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4.4.2.1.2 Upland Plant Communities

The FSCR (NYPA 2002) reports that 11 upland vegetation community types have been identified and mapped within the Niagara River Corridor. The uppermost portion of the upper Niagara River is highly developed and has little potential to support natural vegetative cover. The City of Buffalo and Town of Tonawanda are directly east of the Niagara River from Lake Erie to Grand Island. An examination of land use and cover maps show extensive development in the City of Buffalo, with the exception of Squaw Island.

Figure 4.4.2.1.2-1 provides a map of the plant communities on Grand Island and the eastern side of the Niagara River north of Grand Island. Unlike wetlands, which are fragmented and spread out, upland plant communities (field, forest, and shrubland) are somewhat concentrated form more or less contiguous bands of upland habitat. Figure 4.4.2.1.2-1 identifies forest and shrubland as the predominant upland plant communities on Grand Island. Dominant species within these communities include sycamore, Russian olive, cottonwood, white ash, hickory (*Carya* sp.), red maple, red oak, white oak, tulip tree, rhododendron, and witch hazel.

Stantec et al. (2005) provide some information on the vegetative cover and terrestrial plant communities on Strawberry Island, Motor Island, and Grand Island. The plant communities on Strawberry Island include successional shrubland. Black willow is the dominant canopy species. Red osier dogwood and elderberry are the dominant species of shrub. Riverback grape is the dominant vine in this plant community. Successional shrubland is identified on Motor Island. Green ash and black willow are the dominant species in the canopy. Gray dogwood is the dominant shrub. Virginia creeper and river grape are dominant vines. Stantec also describes a successional shrubland located on Grand Island. Gray dogwood is the dominant shrub. In the herbaceous stratum, white hellebore is the dominant species on Grand Island.

Figure 4.4.2.1.2-1 also identifies successional northern hardwood forest and oak-hickory forest on Grand Island. Successional northern hardwood forest is located on the northern and southern ends, east central edge, and southwestern edge of Grand Island. The successional hardwood forest at the southern

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end of Grand Island is characterized by red maple, green ash, and crack willow in the canopy; tartarian honeysuckle, and staghorn sumac in the shrub/sapling stratum; and goldenrod in the herbaceous stratum. River grape is the dominant vine. The successional northern hardwood forest at the southwestern edge of Grand Island consists of Norway maple, green ash, crack willow, and American elm in the canopy and New England aster, purple loosestrife, goldenrod, and aster in the herbaceous stratum. A shrub/sapling stratum is not identified for this forest.

The successional northern hardwood forest at the east central edge of Grand Island is characterized by green ash and hawthorn in the canopy; gray dogwood, spicebush, black raspberry, and Allegheny blackberry in the shrub/sapling stratum; and garlic mustard, moneywort, common polypody, rough avens, enchanters nightshade, and poison ivy in the herbaceous stratum. River grape and Virginia creeper are the dominant vines. Successional northern hardwood forest at the northern end of Grand Island is characterized by green ash, basswood, and American elm in the canopy; black raspberry and spicebush in the shrub/sapling stratum; and rough avens, enchanters nightshade, and white snakeroot in the herbaceous stratum. River grape and Virginia creeper are the dominant vines.

Stantec et al. (2005) does not provide a description of the oak-hickory forest at the northern portion of Grand Island, other than to identify vegetative cover as 100 percent.

4.4.2.1.3 Significant Occurrences of Natural Communities

In 2001, Riveredge Associates conducted a literature review and fieldwork to determine significant occurrences of natural communities in the vicinity of the Niagara Power Project. The investigation area extended from the southern end of Grand Island to the mouth of the Niagara River. It included lands adjacent to the river (in the United States exclusively), the river proper, and associated tributaries.

Riveredge Associates identified significant occurrences of five natural communities in the Project vicinity (NYPA 2002). In the upper Niagara River, these natural communities include Deep Emergent Marsh, Maple-Basswood Rich Mesic Forest, and three significant occurrences of Silver Maple-Ash

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Swamp. The Deep Emergent Marsh occurs in Buckhorn Island State Park. The Maple-Basswood Rich Mesic Forest is located on the lands of the Tuscarora Nation and on adjacent property near Dickersonville. Significant occurrences of Silver Maple-Ash Swamp are found at Buckhorn Island State Park, Beaver Island State Park, and Gun Creek on Grand Island.

4.4.2.1.4 Rare, Threatened and Endangered Plant Species

Riveredge Associates also conducted a literature review and fieldwork to determine the past and present occurrence of RTE plant species in the Niagara River Corridor (NYPA 2002). No federally listed RTE plant species or unique natural communities were identified. The RTE survey indicated the presence of eight state-listed endangered plant species and seven threatened species. The endangered species are sky-blue aster, elk sedge, lesser fringed gentian, southern blueflag, slender blazing-star, four-flowered loosestrife, ninebark, and woodland bluegrass. The threatened species are yellow giant-hyssop, pawpaw, big shellbark hickory, smooth cliff brake, stiff-leaf goldenrod, Ohio goldenrod, and white camas. One rare but unprotected (and presently unlisted) plant species, Shumard oak, was also identified.

4.4.2.2 Wildlife Resources

4.4.2.2.1 Wildlife Community

An inventory and description of wildlife resources, including wildlife species and their habitats, was conducted by Riveredge Associates in the vicinity of the Niagara Power Project (NYPA 2002). The overall objective of the investigation was to characterize wildlife resources within an approximately 78,600-acre area encompassing lands in the United States that are adjacent to the Niagara River extending from the southern tip of Grand Island to the mouth of the river at Lake Ontario.

The wildlife resources inventory identified a total of 22 species of amphibians, 18 species of reptiles, 293 species of birds, and 49 species of mammals that occur or are likely to occur within the investigation area. According to Breeding Bird Atlas records, 116 of the bird species have been documented as confirmed or probable breeders within the area. The fairly high diversity of wildlife

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species in the area may be attributed to the abundance and diversity of water resources associated with the Niagara River Corridor, augmented by the presence of several large wetland systems and a variety of upland habitats. Another important factor is the presence of several preserves, including Gun Creek Woods and the Buckhorn Island, Whirlpool, and Devil's Hole State Parks. Also, due to the regional geography, large numbers of migratory raptors and songbirds pass through the area during migration.

Knapton and Weseloh (1999) and the IBA Working Group (2002) present information on waterfowl of the Niagara Corridor. In particular, these two documents provide detailed discussions of the Niagara Corridor as an Important Bird Area (IBA) and the utilization of the Corridor by migratory waterfowl.

Over 25 species of waterfowl have been recorded for the Niagara Corridor. Eleven species are known to breed within the Corridor. Species that nest in the Corridor include Double-crested cormorant, Black-crowned night heron, Great egret, Great blue heron, Herring gull, Ring-billed gull, and Common tern (IBA Working Group 2002, Knapton and Weseloh 1999).

Nineteen species of gulls have been recorded in the Niagara Corridor. Nine species have historically occurred each year. Bonaparte's gull, Ring-billed gull, and Herring gull typically occur in the tens of thousands each year. Up to two thousand Great black-backed gulls typically occur each year. Annual numbers of little gull, Thayer's gull, Iceland gull, and Glaucous gull typically range from tens to hundreds. Table 4.4.2.2.1-1 identifies the 19 species of gulls and their relative annual numbers in the Niagara Corridor.

At least 20 species of waterfowl use the Corridor as a migratory stopover or for overwintering. Migration typically occurs from October through January, with most migration occurring in December. As a result of the use of the Niagara River by migratory waterfowl, the Niagara River Corridor was designated as an IBC by the Canadian Nature Federation, Bird Studies Canada, National Audubon Society (New York Chapter), and America Bird Conservancy in December 1996. The entire length of the Niagara River plus a buffer of 3.5 miles on either side of the River is designated as an IBA. Important Bird Areas have international significance for the conservation of birds that (1) are listed as threatened,

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(2) have restricted ranges, (3) are confined to specific habitats, or (4) congregate in large numbers on their breeding grounds, stopover sites during migration, or overwintering grounds. The Niagara Corridor was designated an IBA based on the large numbers that congregate at their overwintering grounds (Knapton and Weseloh 1999). Primary uses of the Niagara Corridor by migratory waterfowl are roosting and feeding (IBA Working Group 2002). The upper Niagara River is identified as a key feeding area for waterfowl.

Four species of waterfowl are global IBA species. Bonaparte's gull, Herring Gull, Canvasback, and Common merganser occur in numbers (greater than one percent of the global population) that merit designation as IBA species. Although not listed as IBA species, Greater scaup, and Common goldeneye occur in numbers approaching one percent of their global populations. Other species of waterfowl regularly cited within the Niagara River Corridor are identified in Table 4.4.2.2.1-2.

The few marshes that remain along the corridor—such as at Buckhorn Island State Park—have supported breeding populations of least bittern, Northern harrier, and Sedge wren. However, more recent studies and information suggest that Northern harrier and Sedge wren no longer breed in the area (Riveredge 2005). Terrestrial species include Ring-necked pheasant, American crow, American robin, European starling, Northern mockingbird, American goldfinch, and Eastern kingbird.

In addition to bird species, several species of mammals are inhabitants of the Niagara Corridor. Because of limited cover, only smaller mammals are commonly found. Species include mice and voles, eastern cottontail, eastern gray squirrel, woodchuck, and little brown myotis, a species of bat. Larger species known to inhabit the general area include coyote, striped skunk, and red fox. In addition, several species of furbearers, including mink, muskrat, and raccoon, have been observed in and around the Niagara Corridor. One large mammal, the white-tailed deer is also found within the region.

Herpetiles (reptiles and amphibians) are also prevalent within the area surrounding the Niagara Corridor. Bullfrog, American toad, snapping turtle, and garter snake are among the species of herpetiles found in the vicinity. Between 1990 and 1998, the New York State Amphibian and Reptile Atlas was

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compiled in order to examine the abundance and distribution of state herpetiles. A list of herpetile species found is provided in Table 4.4.2.2.1-3.

Stantec et al. (2005) developed a list of focus species that were used to evaluate the effects of water level and flow fluctuation on the fish and wildlife of the Niagara River. Although the focus species do not represent an exhaustive list of wildlife, it does provide a representative cross section of species expected to inhabit the Niagara River Corridor and that may be affected by the ice boom. Amphibians identified as focus species include common mudpuppy, northern spring peeper, green frog, and northern leopard frog. Common snapping turtle and midland painted turtle are reptiles identified as focus species. Muskrat is the only mammal identified as a focus species. Stantec et al. (2005) provide detailed descriptions of the life histories and habitat requirements for these focus species.

4.4.2.2.2 New York Department of State Significant Coastal Wildlife Habitat

The FSCR (NYPA 2002) identifies the presence of six NYSDOS Significant Coastal Fish and Wildlife Habitat areas in the Project vicinity. Four are part of NYNHP's riverine system habitat, one is part of the palustrine system habitat, and one is on a manmade channel structure. One SCFWH, the Buckhorn Island Tern Colony, is not currently active. The Strawberry Island-Motor Island Shallows, Grand Island Tributaries, and Buckhorn Island-Goat Rapids are described in Section 4.4.1.3. The Buckhorn Island Wetlands and Buckhorn Island Tern Colony are described below.

The Buckhorn Island Wetlands - The Buckhorn Island Wetlands SCFWH is a 525-acre area at the northwestern tip of Grand Island. It is located within and adjacent to Buckhorn Island State Park. It includes Buckhorn Island, Navy Island (Canada), Burnt Ship Creek, the Chippawa Channel east of Navy Island, and approximately the lower two miles of Woods Creek. This area includes extensive emergent marshes and SAV beds. This area is described as a spawning area for northern pike and smallmouth bass.

Woods Creek, and, to a lesser extent, Burnt Ship Creek, provide extensive littoral areas used by warmwater fishes of the Niagara River. Studies of various Grand Island tributaries during the mid-1970s indicated that Woods Creek contained significant concentrations of spawning northern pike from

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February through April, with many remaining in the creek until July. At that time, it was estimated that approximately 800 individuals entered Woods Creek to spawn, making it the largest documented concentration of northern pike in the Niagara River. A significant proportion of one-year-old muskellunge were collected during the study, suggesting that Woods Creek may be an important nursery ground for this species, as well. Woods and Burnt Ship Creeks support concentrations of other warmwater fish species, including yellow perch, black crappie, bullhead, rock bass, white sucker, and carp. Studies during the mid-1970s identified the littoral area between Burnt Ship Creek and Navy Island as one of two principal spawning grounds in the upper Niagara River, the other being the Strawberry Island-Motor Island Shallows. This area is also one of the most productive spawning areas in the river for smallmouth bass.

Buckhorn Island Tern Colony - The Buckhorn Island Tern Colony SCFWH is located at the northern tip of Grand Island, in the Town of Grand Island, Erie County, and the City of Niagara Falls, Niagara County. The habitat consists of manmade structures located within the Tonawanda Channel of the Niagara River. These include an approximately one-quarter-mile-long rock-and-boulder dike, designed to divert river water toward the intakes of the Robert Moses Niagara Power Plant, and transmission tower footings constructed of steel sheet piling and rock fill material. It should be noted that terns have not nested here for many years due to gull invasion. The Buckhorn Island Tern Colony SCFWH (including both the diversion dike and the tower structures) is located just offshore of the undeveloped Buckhorn Island State Park.

The small group of manmade channel structures comprising the Buckhorn Island Tern Colony does not represent an unusual ecosystem type within the Niagara River. These structures do, however, provide valuable habitat for certain species of wildlife. A critical feature of these structures is their isolation from mammalian predators. Moreover, no significant human-use activities affect the Buckhorn Island Tern Colony. Since the early 1970s or before, these structures have served as a major nesting site for Common terns, Ring-billed gulls, and Herring gulls, although the common tern is believed to have been largely displaced from this area due to competition with an increasing number of gulls. As part of the Investigation of Habitat Improvement Projects for the Niagara Power Project, the historic tern nesting site at Buckhorn Dike would not be reclaimed due to the size of the island and the size of the ring-billed

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gull colony at the site. In 1992, the Buckhorn Island dike was the site of the first attempted nesting of Double-crested cormorants in the Niagara region.

4.4.2.2.3 Rare, Threatened and Endangered Wildlife Species

Several RTE wildlife species are known to occur within the Niagara River Corridor. Many may be transients, particularly along the undeveloped shoreline of the river, but others breed within the area. Riveredge Associates' 2001 RTE survey recorded one federally listed wildlife species, the Bald eagle, in the Project vicinity. A transient in the region, it is listed as threatened. No federally listed mammals or herpetiles are known to occur in the area.

The 2001 RTE survey also identified several state-listed wildlife species in the Project Vicinity. The majority of state-listed species are birds. Of the nine state-listed RTE bird species, two are listed as endangered and seven as threatened. Species listed as endangered are the Short-eared owl and Peregrine falcon. Species listed as threatened are the Upland sandpiper, Northern harrier, Sedge wren, Bald eagle, Least bittern, Pied-billed grebe, and Common tern. In addition, investigators found one special-concern amphibian species and seven special-concern bird species. The amphibian is the Jefferson complex salamander. The bird species are Cooper's hawk, Sharp-shinned hawk, Grasshopper sparrow, Common nighthawk, Horned lark, Red-headed woodpecker, and Golden-winged warbler. Other special-concern avian species such as Common loon, American bittern, and Osprey have been observed in the area investigated, but there are no confirmed reports of breeding by these species.

Among rare but unprotected species, two bird species were identified for the Project vicinity: Great egret and Great blue heron. Review of the NYNHP database revealed seven significant occurrences of five natural communities in the Project vicinity, and ten occurrences of waterfowl and warmwater fish concentration areas or gull nesting colonies. No state-listed mammalian species are known in the area.

Several state-listed species of birds use the Niagara River for breeding, migration stops, or over-wintering. In addition to the Bald eagle which was recently downlisted by NYSDEC from endangered to threatened, the Peregrine falcon (endangered) has been observed breeding in the gorge below the Falls in

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1998, 1999, and 2001. In 1998, the falcon pair successfully fledged three chicks along the Ontario shoreline near the Horseshoe Falls. In 1999, the pair again successfully fledged three chicks, this time on the American shoreline. A pair of Peregrine falcons has also naturally and successfully nested on a building in Buffalo from 1998 to 2000.

4.5 Land Management

The study area for potential land management impacts consists of the ice boom storage area and the facility's immediate environment. The NYPA-owned storage parcel consists of approximately 13 acres and is located near the Outer Harbor area in the City of Buffalo and is fronted by Fuhrmann Boulevard to the east. The land lies at waters edge and is bordered by Lake Erie at the western end of the site (Figure 4.5-1). The inlet located at the waterfront of the storage parcel provides lake access for installation and emergency operations. NYPA stores and maintains the boom on the property when the boom is not in use. The ice boom is stored there from April until early December when the ice boom is prepared for deployment.

The ice boom storage and maintenance site facilitates pre-placement of the boom to forward staging areas located on the outer breakwall prior to boom installation. The site location also facilitates maintenance of the boom during the ice season. Segments of the boom are moved and temporarily stored alongside the outer breakwall in early December, before the criteria for installation are met. The ability to strategically pre-place the boom is an important consideration for minimizing risks associated with not getting the boom in place prior to an early season ice run in Lake Erie.

The nature of ice boom deployment dictates that the boom must be stored in a nearby location so that it is available for installation on short notice. Additional site requirements recognize the need for a storage area that is readily accessible for routine maintenance and emergency operations. Readily available access is the key site requirement for the successful operation and deployment of all types of booms including those used in ice management.

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An analysis of past deployments indicates that there have been occasions when the window for installing the boom is short. Similarly, the need for emergency repair operations is known to occur on an occasional basis. Potential risks associated with the inability to readily deploy the boom or perform emergency operations include the risk of allowing unabated ice runs into the river. This can result in detrimental impacts associated with ice discharge into the Niagara River including flooding, power generation losses, and property damage to shoreline structures and facilities. An inability to gain rapid access to the boom deployment site also exposes employees responsible for ice boom installation, maintenance, and removal to additional safety risks. Section 2.2.3 documents an incident during the 1998-1999 ice season where severe storm conditions prevented boom installation until January 9, 1999. The proximity of the ice boom storage area to the deployment site is considered a critical element in the successful installation of the boom during the 1999 storm event. The advantages offered by the current site location are an important consideration in the analysis of potential alternative locations and ownership opportunities contained in Section 6.0 of this report.

4.5.1 Regulatory Agencies and Planning Authorities

The ice boom storage and maintenance area is currently owned and managed by NYPA. In New York State, traditional planning authority resides with municipal government. While counties influence regional patterns of growth and development in several important ways, their power to directly affect land use and development decisions is limited. The state's Municipal Home Rule, City, Town, and Village Laws delegate the power to regulate land use and authorize land subdivision to municipal governments. These state laws, which enable municipalities to enact regulations to govern land use, are not applicable to land owned by the state or by agencies of the state, including NYPA. Local planning documents generally recognize lands and facilities owned by NYPA and do not recommend land uses that conflict with the continued operation of the NPP.

The public agencies and planning entities with the greatest impact on land use within the immediate environment of the ice boom storage and maintenance facility include:

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- City of Buffalo – Office of Strategic Planning

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- Niagara Frontier Transportation Authority (NFTA)

The Erie County Department of Environment and Planning is involved in a range of land use issues. ECDEP has played a major role in the planning and proposed development of the Times Beach Public Access Project along with the United States Army Corp of Engineers (USACE). The proposed project site is adjacent to the NYPA property where the boom is stored (Figure 4.5-1). The Times Beach project is intended to address ecosystem restoration and public access improvements. Erie County has assumed the lead responsibility for the public access component of the project with the intent that up-front construction of public access can be credited towards the Federal restoration project. The USACE is presently studying ecosystem restoration measures with a scheduled completion date of 2007. Currently, the restoration portion of the project has been placed on hold due to fiscal constraints.

The City of Buffalo's Office of Strategic Planning is in the process of preparing a Local Waterfront Revitalization Plan (LWRP) for the City of Buffalo waterfront, including the Outer Harbor waterfront and the Niagara River, Buffalo River and Scajaqauda Creek waterfront corridors. The main purpose of the LWRP is to serve as a framework for waterfront revitalization, develop a comprehensive plan and vision for the waterfront to maintain and improve waterfront lands and community character, enhance economic prosperity, protect and enhance important natural resources, and improve public access to the waterfront through the refinement of state coastal policies. Planned initiatives and proposed projects that are developed within the context of the LWRP may result in an altered landscape in the waterfront area.

The Niagara Frontier Transportation Authority (NFTA) was created as a public benefit corporation by New York State to promote the development and improvement of transportation services in the Erie-Niagara region. NFTA plays a role in shaping development patterns in the Erie Niagara region both directly and indirectly. Facilities that the NFTA operates include the NFTA Small Boat Harbor (currently in the process of being transferred to the New York State Office of Parks, Recreation, and Historic Preservation), Port of Buffalo Terminal Buildings, Buffalo Niagara International Airport (BNIA), Metro Rail System, Metro Bus System, and the Niagara Falls International Airport. For purposes of this assessment, NFTA is the key landowner responsible for the proposed Outer Harbor Development.

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Proposed development activities at the Outer Harbor Redevelopment site may also result in an alteration to the traditional landscape at the waterfront.

4.5.2 Local and Regional Trends in Growth and Development

Local and regional trends in growth and development are important to this assessment for several reasons including: 1) existing trends in development have resulted in the displacement of agricultural lands which are a part of this assessment; 2) this pattern is not new and is evident over time since before 1900; and 3) there are currently no indications that this trend is subject to reversal. The effect of this trend on agricultural production is discussed in Section 5.1.3.

The Cities of Buffalo and Niagara Falls are located in Erie and Niagara Counties, respectively. These metropolitan areas serve as traditional urban centers for an eight-county region often referred to as Western New York. The region also includes Chautauqua, Cattaraugus, Wyoming, Genesee, Allegany, and Orleans Counties. All of the counties in Western New York have experienced an overall decline in population over the past 20 years, with the exceptions of Wyoming and Orleans County.

The region encompassing Erie and Niagara Counties has experienced an increase in urbanized area despite a decrease in population of about 6% over the last twenty years. This pattern of growth and development has continued the outward expansion from the more traditional and established inner city areas of Buffalo and Niagara Falls toward the relatively low population densities of the rural areas Figure 4.5.2-1 (Erie and Niagara Counties 2003). In the Erie-Niagara region, urbanized area has nearly tripled in size, expanding from 266 square miles in 1980 to 367 square miles in 2000. This represents a 38% increase in development of the bedroom communities and outlying rural areas over the last twenty years. While overall population has decreased and development has continued to spread outward from the urban centers, the number of households has increased by only 5.5%. Thus, development of the rural areas has far outpaced changes in population and households. This pattern of movement from high density development to lower density areas has resulted in fast paced growth in the Towns of Amherst, Clarence, Lancaster, Orchard Park, and Hamburg in Erie County (Erie and Niagara Counties 2003).

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Between 1980 and 2000, the region's developed areas also added households at a much slower rate than rural areas. Erie and Niagara Counties added households at a rate of less than 1% compared to a 33% percent increase in household development in the outlying rural areas. The areas experiencing the fastest increases are located along the boundary between the developed and rural areas. These developing rural sub-areas had increases in household density of 5% or more above the regional average (Erie and Niagara Counties 2003).

The pattern of outward growth and development is not new to the Buffalo area. Figure 4.5.2-1 demonstrates the expansion of development into the rural areas over time beginning in the early 20th century (Erie and Niagara Counties 2003). A result of this long standing trend has been the displacement of agricultural lands by development and conversion to urbanized area. This pattern of displacement is discussed in additional detail in Section 5.1.3.

4.5.3 Existing Land Use and Zoning Classifications

Parcels adjoining the ice boom storage area are primarily owned and/or controlled by various governmental agencies. Landowners include the USCG, NFTA, and the City of Buffalo. Existing land use of properties surrounding the ice boom storage area is primarily categorized as vacant land. Vacant areas include the NYPA ice boom storage parcel, the City of Buffalo's proposed Times Beach restoration project site, and the NFTA proposed Outer Harbor Redevelopment area. The USCG facility is considered a Community Service land use area. Commercial properties include the Ganco Inc. Boat Storage Area and Marina, Buffalo Sailing Marina, City Ship Canal, and Cargill Inc. A series of abandoned grain elevators is located to the east of the NYPA site. An aerial photograph of the NYPA property and land use of adjacent areas is shown in Figure 4.5.3-1.

Surrounding properties are classified as industrial sites for zoning purposes. Existing zoning classifications designate these properties as being located in three distinct districts including a Light Industrial District, General Industrial District, and Heavy Industrial District. A map of existing zoning classifications for the area is included in Figure 4.5.3-2.

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4.5.4 Planning Initiatives and Proposed Development Projects

There are several planning initiatives and proposed development projects that could potentially impact land use in the vicinity of the ice boom storage and maintenance facility. This includes the Times Beach Public Access Project, Outer Harbor Redevelopment site; Outer Harbor Greenbelt; and the Outer Harbor Trail. Proposed planning initiatives and development projects are shown in Figure 4.5.-1 and are discussed in detail in Section 5.3.

The Times Beach project is intended to address ecosystem restoration and public access improvements to the site. ECDEP has assumed the lead responsibility for construction of the public access component that will consist of a series of boardwalks with areas set aside for bird watching. A design consultant has been selected for the project and a final project design has been approved. The basic plan for Phase I includes construction of a small parking facility, an initial approach, a walkway, and two bird watching blinds. Phase I construction was completed in 2004. NYPA has granted a permanent easement that permits encroachment onto a small portion of the ice boom storage parcel for purposes of constructing and maintaining the parking area for the Times Beach project.

The restoration portion of the Times Beach project is the responsibility of USACE. The military branch recently conducted a partial study of ecosystem restoration measures for the Times Beach site location. Potential long-term repairs of the confined disposal facility dike area have similarly been evaluated. Previous schedules called for completion of a Feasibility Study in September 2004; formulation of restoration design plans and specifications in September 2005; startup of remedial construction during the spring of 2006; and project completion in 2007. Currently, the feasibility study and restoration components of the project have been halted due to fiscal constraints within USACE and revamped schedules are presently not available as a result. The feasibility study will ultimately determine the nature and extent of remediation required for the proposed site and will define future use of the site.

The Outer Harbor Trail project, scheduled for construction in October of 2004, will consist of a 2.5 mile Class I bicycle/pedestrian path from the Delaware, Lackawanna & Western Railroad Terminal at the foot of Main St. to the west side of Fuhrmann Boulevard in the City of Buffalo. It will connect the

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Small Boat Harbor, currently being transferred from NFTA to the New York State Office of Parks, Recreation, and Historic Preservation for establishment of a state park and marina, with Lighthouse Park situated at the mouth of the Buffalo River near the USCG station. This proposed trail may provide a connection to secondary links to the waterfront as land is developed within the Outer Harbor area.

The Outer Harbor Redevelopment site consists of 120 acres of waterfront property owned by NFTA. Elements of NFTA's redevelopment plan call for potential land uses that include a: 1) lifestyle waterfront destination; 2) regional tourism/entertainment district; 3) business services district; 4) medical support campus; and 5) international distribution campus. The northern portion of the site consists of an approximately 60 acre Brownfield remediation site that extends southward along the Lake Erie shoreline from the Pier Restaurant to a proposed shoreline protection and stabilization area.

The proposed Outer Harbor Greenbelt project area forms the western edge of NFTA's 120 acre Outer Harbor Redevelopment site. The proposed greenbelt is currently envisioned as an area of green space, approximately 75 to 100 ft wide, that will serve as a bicycle and pedestrian pathway and provide lakefront access to the public.

4.6 Parks and Recreation

A system of 38 sites which include Heritage Parks, Waterfront Parks, Special Purpose Parks and Conservation Parks is maintained by the Erie County Division of Parks., a division of the Erie County Department of Parks, Recreation and Forestry. The impact of the Erie County Department of Parks, Recreation and Forestry on land use and development is usually indirect. First, it is responsible for major open space and recreational features, with the effect of resource conservation. Second, its efforts have an impact on quality of life, and may affect location decisions. The County's parks are also a resource that attracts visitors to the area, helping to support tourism-related economic development efforts.

The recently completed Erie County Parks Master Plan explicitly states that parks planning will be underpinned by four basic principles: economic renewal (tourism); environmental conservation; public accessibility; and recreation enhancement. The focus of the Erie County Division of Parks is on

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upgrading and management of existing facilities, with only a light emphasis on new acquisitions or new park developments.

Over the last several years, Erie County has worked closely with the City of Buffalo, New York State, and various federal agencies to acquire three small park sites along the Buffalo River including Ohio Street Park, Smith Street Park, and Bailey Avenue Park. These three parks are known access points for fishing. The Ohio Street Park is also a popular launch site for canoes and kayaks and is located near the intersection of Ohio Street and Louisiana Street and is near Conway Park, a city owned park active recreation area. Smith Street Park is approximately two blocks south of South Park Avenue and is accessible from I-190 but is the most remote of the three sites. It is hidden from any major views by a former railroad berm and is located between two active railroad lines. Bailey Avenue Park consists of a small triangular land parcel between the Buffalo River, Cazenovia Creek and Bailey Avenue (Parsons and Wendel 2003).

In addition to the Erie County Parks system, the City of Buffalo is home to several parks including the historic Olmsted Parks and Parkways. Effective July 1, 2004, Erie County took over operation of the Buffalo city parks. However, the City retains ownership and responsibility for some of the capital improvements. Similarly, the Buffalo Olmsted Parks Conservancy has entered into an agreement with Erie County whereby the not-for-profit conservancy operates the Olmsted Parks.

The Olmsted Parks were designed in the 1860's to 1890s by Frederick Law Olmsted, Sr. These parks and their associated parkways are listed on the National Register of Historic Places. The Olmsted System makes up 75% of the city's parkland and consists of six parks including Delaware, Martin Luther King, Jr., Front, South, Cazenovia, and Riverside and their connecting parkways and circles. Front Park is the sole park in the Olmsted system that is in visual proximity to the ice boom, when deployed.

LaSalle Park is a 77 acre city owned park located on Lake Erie at the head of the Niagara River. This park lies approximately 1.5 mi northwest of the NYPA owned parcel and is the nearest city-owned waterfront park to the ice boom storage and maintenance site. It parallels the waterfront, the breakwall, and Buffalo Harbor. The park is often used by bird watchers. A variety of ducks are present within and

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outside the breakwalls when boaters are not present on the summertime waters. Terns may also be present on the breakwalls during the summer and fall. In the winter, a variety of gulls can be viewed, including Iceland and Glaucous Gulls. In addition to bird watching, LaSalle Park is home to concerts, festivals, and other activities during the summer that reach a larger regional audience.

The Tifft Nature Preserve is more than two miles southeast of the ice boom storage parcel and is bounded by the Buffalo Outer Harbor to the west. The preserve is a 264 acre natural refuge dedicated to conservation and environmental education. The site is owned by the City of Buffalo and managed by the Buffalo Museum of Science. It includes a 75 acre cattail marsh with open water ponds, a 50 acre upland mound with grassland, and two large ponds in the west and northwest portions of the property. The surrounding areas are forested with cottonwoods and willows in addition to various shrubs and bushes. Over 260 bird species have been recorded at the site. The preserve also provides habitat for many different animals in the region. Recreational activities at the refuge include nature trail hiking, snowshoeing, and cross-country skiing.

4.7 Aesthetics

The City of Buffalo is the urban center of the Buffalo-Niagara region and, like other northeastern cities, has been hit hard in recent years with the decline of the manufacturing industry. Heavy industrial buildings, many of which are vacant or significantly underutilized, characterize much of the landscape on the edges. For the past half century, Buffalo has been steadily losing its predominant position in the region as urbanization spread outwards from the urban core. In June of 2003, the City released a draft Comprehensive Plan that establishes an ambitious vision of the City to regain its status as the "Queen City of the Great Lakes" and envisions Buffalo as a "sustainable Great Lakes community" (City of Buffalo 2003a). The City is also currently engaged in developing a Local Waterfront Revitalization Program and the Waterfront Corridor Initiative, which will develop an action program of project plans and designs.

The City has a rich architectural history. It took decades to implement the various plans that shaped the City, and the architecture, parks, parkways, enterprises, and institutions that came to

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symbolize Buffalo. Piece by piece, layer by layer, the urban fabric was enriched, as well known architects and urban planners such as Richard Upjohn, Louis Sullivan, Daniel H. Burnham, H.H.Richardson, Frank Lloyd Wright, Eero Saarinen, I. M. Pei, Minoru Yamasaki, and many others made their contributions.

Downtown Buffalo is an important part of the region's future success. Downtown is currently being redeveloped under the vision expressed in *The Queen City Hub: A Regional Action Plan for Downtown Buffalo* (City of Buffalo 2003b). It is a plan that recognizes the need to integrate all components of economic, social, and environmental planning. The plan also includes strategies to help revitalize the adjoining neighborhoods.

The City has an extensive array of parks and recreation, exemplified by the numerous Olmsted Parks throughout the City. Buffalo is the home to America's oldest coordinated system of public parks and parkways, designed by the renowned landscape architect Frederick Law Olmsted (1822-1903). An important component of the draft Comprehensive Plan is to restore the Olmsted parks and parkway system, along with the waterfront.

Buffalo possesses an extensive and diverse waterfront along Lake Erie, the Buffalo and Niagara Rivers, and the Erie Canal. The waterfront has many uses and features, ranging from re-naturalized areas such as the Tifft Nature Reserve to the remnants of former industrial activity such as the grain elevators, to the Inner Harbor with its redevelopment plan, and Broderick Park with its connection to the history of the Underground Railway. The mouth of the Buffalo River is located near the NYPA property. In addition, the ice boom parcel is fronted by Lake Erie within the Buffalo Harbor area.

Vehicular traffic, including cars and trucks, are also a key visual presence, although they are so pervasive everywhere that many observers are not affected. As one would expect, expanses of concrete and asphalt support the vehicular-based lifestyle. The transportation network within the Project area includes a combination of highways, regional connectors, and local roads. Rail systems, trains, and buses are also part of the intensely industrialized landscape.

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At present, the key vantage point for the ice boom is Front Park. However, there are proposed planning activities and land development projects that could produce minor alterations to current viewsheds in the area. Examples of proposed developments that could potentially impact area viewsheds include the Times Beach Public Access Project; Southtown Connectors Project; Greenway Trail; and the Outer Harbor Greenbelt.

Front Park is the sole key aesthetic resource that offers a very limited scenic view towards the vicinity of the ice boom when fully deployed.

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TABLE 4.2.5-1

ERIE COUNTY CROP PRODUCTION REPORTED BY ACREAGE

CROP	2003 ACRES
ALFALFA	2,529.9
ASPARAGUS	3.5
BARLEY	664.1
BEANS	1,203.3
BLUEBERRY	14.8
BROCCOLI	17.1
BUCKWHEAT	202.6
CABBAGE	109.0
CANTELOPE	2.7
CAULIFLOWER	2.9
CLOVER	790.6
CORN	18,862.9
CUCUMBER	5.2
FALLOW	3,892.8
FLOWERS	19.2
GRAPES	1,161.2
GRASS	5460.0
MIXED HAY	26,216.9
NURSERY CROP	196.2
OATS	2,321.0
ONIONS	1.8
PEAS	584.4
PEPPERS	8.2
POTATOES	484.7
PUMPKINS	85.5
RYE	231.3
SUNFLOWERS	32.0
SORGHRUM	77.6
SOYBEAN	2,364.7
SPELTZ	471.8
SQUASH	13.8
STRAWBERRIES	143.4
TOMATO	34.4
TRITICAL	95.0
WATERMELON	5.4
WHEAT	1,964.9
WILDLIFE FOOD PLOT	6.5

Source: Erie County Farm Service Agency

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TABLE 4.4.1.3.1-1

FISH TAXA OF THE NIAGARA RIVER

Common Name	Scientific Name	National Academy (1983)		Stantec et al. (2005)		
		USFWS 1983	Historical	Circa 1927	1960-2000	2001
Alewife	*Alosa pseudoharengus*		√	√	√	√
American brook lamprey	*Lethenteron lamottenii*				√	
American eel	*Anguilla rostrata*		√	√	√	√
American shad	*Alosa sapidissima*		√			
Banded killifish	*Fundulus diaphanus*		√	√	√	√
Bigmouth shiner	*Notropis dorsalis*		√			
Black bullhead	*Ameiurus melas*	√			√	
Black crappie	*Pomoxis nigromaculatus*	√			√	√
Black redhorse	*Moxostoma duquesnei*				√	
Blackchin shiner	*Notropis heterodon*		√	√		√
Blacknose dace	*Rhinichthys atratulus*		√		√	
Blacknose shiner	*Notropis heterolepis*		√	√	√	
Blackside darter	*Percina maculata*		√			
Blue pike`	*Stizostedion vitreum glaucum*			√	√	
Bluegill	*Lepomis macrochirus*				√	√
Bluntnose minnow	*Pimephales notatus*	√		√	√	√
Bowfin	*Amia calva*		√		√	√
Bridle shiner	*Notropis bifrenatus*				√	
Brindled madtom	*Noturus miurus*		√		√	√
Brook lamprey	*Lampetra lamottei*		√			
Brook silverside	*Labidesthes sicculus*		√	√	√	√
Brook stickleback	*Culaea inconstans*		√	√	√	√
Brook trout	*Salvelinus fontinalis*		√			
Brown bullhead	*Ameiurus nebulosus*	√		√	√	√
Brown trout	*Salmo trutta*	√			√	
Burbot	*Lota lota*		√		√	
Central mudminnow	*Umbra limi*		√	√	√	√
Central stoneroller	*Campostoma anomalum*		√	√	√	
Channel catfish	*Ictalurus pucntatus*		√	√	√	
Chinook salmon	*Oncorhynchus tshawytscha*				√	
Coho salmon	*Oncorhynchus kisutch*		√		√	
Common carp	*Cyprinus carpio*	√		√	√	√
Common shiner	*Luxilus cornutus*	√		√	√	√
Creek chub	*Semotilus atromaculatus*		√	√	√	√
Emerald shiner	*Notropis atherinoides*	√		√	√	√

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TABLE 4.4.1.3.1-1 (CONT.)

FISH TAXA OF THE NIAGARA RIVER

Common Name	Scientific Name	National Academy (1983)		Stantec et al. (2005)		
		USFWS 1983	Historical	Circa 1927	1960-2000	2001
Fallfish	*Semotilus corporalis*				√	
Fantail darter	*Etheostoma flabellare*		√		√	
Fathead minnow	*Pimephales promelas*		√	√	√	
Freshwater drum	*Aplodinotus grunniens*	√		√	√	√
Gizzard shad	*Dorosoma cepedianum*	√			√	√
Golden redhorse	*Moxostoma erythrurum*				√	
Golden shiner	*Notemigonus crysoleucas*	√		√	√	√
Goldfish	*Carassius auratus*	√			√	√
Grass pickerel	*Esox americanus*		√	√	√	
Greater redhorse	*Moxostoma valenciennesi*				√	√
Green sunfish	*Lepomis cyanellus*				√	
Greenside darter	*Etheostoma blennioides*		√		√	
Hogsucker	*Hypentelium nigricans*		√			
Hornyhead chub	*Nocomis biguttatus*		√	√	√	√
Hybrid Carp x Goldfish	- - -	√			√	
Iowa darter	*Etheostoma exile*		√	√	√	√
Johnny darter	*Etheostoma nigrum*	√		√	√	√
Lake chub	*Couesius plumbeus*		√		√	
Lake chubsucker	*Erimyzon sucetta*		√	√		
Lake Herring	*Coregonus artedii*		√			
Lake sturgeon	*Acipenser fulvescens*		√	√	√	
Lake trout	*Oncorhynchus namaycush*		√		√	
Lake whitefish	*Coregonus clupeaformis*		√			
Largemouth bass	*Micropterus salmoidies*	√			√	√
Log perch	*Percina caprodes*		√	√	√	√
Longear sunfish	*Lepomis megalotis*		√			
Longnose dace	*Rhinichthys cataractae*		√	√	√	
Longnose gar	*Leisosteus osseus*		√	√	√	√
Longnose sucker	*Catostomus catostomus*		√			
Mimic shiner	*Notropis volucellus*		√	√	√	
Mooneye	*Hiodon tergisus*		√		√	
Mottled sculpin	*Copttus bairdi*		√	√	√	√
Muskellunge	*Esox masquinongy*	√		√	√	√
Nine-spine stickleback	*Pungitius pungitius*				√	
Northern hog sucker	*Hypenetelium nigricans*			√	√	√
Northern pike	*Esox lucius*	√		√	√	√

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TABLE 4.4.1.3.1-1 (CONT.)

FISH TAXA OF THE NIAGARA RIVER

Common Name	Scientific Name	National Academy (1983)		Stantac et al. (2004)		
		USFWS 1983	Historical	Circa 1927	1960-2000	2001
Pearl dace	*Semotilus margarita*		√			
Pumpkinseed sunfish	*Lepomis gibbosus*	√		√	√	√
Quillback	*Carpiodes cyprinus*		√		√	√
Rainbow darter	*Etheostoma cearuleum*		√	√	√	
Rainbox smelt	*Osmerus mordax*	√			√	√
Rainbow trout/Steelhead	*Oncorhynchus gairdneri*	√			√	√
Redbelly Dace	*Chrosomus eos*		√			
Redfin shiner	*Notropis umbratilis*			√	√	
River chub	*Nocomis micropogon*		√	√	√	
Rock bass	*Ambloplites rupestris*	√		√	√	√
Rosyface shiner	*Notropis rebellus*		√			
Round goby	*Neogobius melanostomus*				√	
Round whitefish	*Prosopium cylindraceum*		√			
Rudd	*Scardinius erthrophthalamus*				√	√
Sand shiner	*Notropis stramineus*		√	√	√	
Satinfin shiner	*Cyprinella analostana*			√	√	
Sauger	*Stizostedion canadense*		√	√	√	
Sea lampry	*Petromyzon marinus*		√		√	
Shorthead redhorse	*Moxostoma macrolepidotum*		√	√	√	√
Silver chub	*Hybopsis storeriana*		√			
Silver lamprey	*Ichthyomyzon unicuspis*		√			
Silver redhorse	*Moxostoma anisurum*		√	√	√	√
Smallmouth bass	*Micropterus dolomieui*	√		√	√	√
Spoonhead sculpin	*Cottus ricei*		√			
Spotfin shiner	*Notropis spilopterus*		√	√	√	√
Spottail shiner	*Notropis hudsonius*	√		√	√	√
Spotted gar	*Lepisosteus oculatus*		√			
Stonecat	*Noturus flavus*		√	√	√	
Striped shiner	*Luxilus chrysocephalus*			√	√	
Tadpole madtom	*Noturus gyrinus*		√		√	√
Threespine stickleback	*Gasterosteus aculeatus*		√	√		√
Trout perch	*Percopsis omiscomaycus*		√	√	√	
Walleye	*Stizostedion vitreum vitreum*	√		√	√	√
White bass	*Morone chrysops*	√		√	√	√
White crappie	*Pomoxis annularis*		√		√	√
White perch	*Morone americana*		√		√	√

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TABLE 4.4.1.3.1-1 (CONT.)

FISH TAXA OF THE NIAGARA RIVER

Common Name	Scientific Name	National Academy (1983)		Stantec et al. (2005)		
		USFWS 1983	Historical	Circa 1927	1960-2000	2001
White sucker	*Catostomus commersoni*	√		√	√	√
Yellow bullhead	*Ameiurus natalis*				√	
Yellow perch	*Perca flavescens*	√		√	√	√

Source : NRC 1983; Stantec et al. 2005

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TABLE 4.4.2.2.1-1

GULLS OF THE NIAGARA RIVER CORRIDOR AND THEIR RELATIVE NUMBERS

Common Name	Scientific Name	Relative Numbers
Bonaparte's Gull	*Larus philadelphia*	10,000s Annually
Ring-billed Gull	*Larus delawarensis*	10,000s Annually
Herring Gull	*Larus argentatus*	10,000s Annually
Great Black-backed Gull	*Larus marinus*	100s to 2,000 Annually
Little Gull	*Larus minutus*	10s to 100s Annually
Thayer's Gull	*Larus thayeri*	10s to 100s Annually
Iceland Gull	*Larus glaucoides*	10s to 100s Annually
Lesser Black-backed Gull	*Larus fuscus*	10s to 100s Annually
Glaucous Gull	*Larus hyperboreus*	10s to 100s Annually
Franklin's Gull	*Larus pipixcan*	Few in Most Years
Black-headed Gull	*Larus ridibundus*	Few in Most Years
California Gull	*Larus californicus*	Few in Most Years
Black-legged Kittiwake	*Rissa tridactyla*	Few in Most Years
Sabine's Gull	*Xema sabini*	Few in Most Years
Laughing Gull	*Larus atricilla*	Irregular Occurrence
Mew Gull	*Larus canus*	Irregular Occurrence
Ivory Gull	*Pagophila eburnea*	Irregular Occurrence
Slaty-backed Gull	*Larus schistisagus*	Only One or Two Records
Ross'Gull	*Rhodostethia rosea*	Only One or Two Records

Source: Knapton and Weseloch 1999

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TABLE 4.4.2.2.1-2

COMMON WATERFOWL OF THE NIAGARA CORRIDOR

Common Name	Scientific Name	Common Name	Scientific Name
Tundra Swan	*Cygnus columbianus*	Canvasback	*Aythya valisineria*
Mute Swan	*Cygnus olor*	Redhead	*Aythya americana*
Canada Goose	*Branta canadensis*	Ring-necked Duck	*Aythya collaris*
Brant	*Branta bernicla*	Greater Scaup	*Aythya marila*
Wood Duck	*Aix sponsa*	Lesser Scaup	*Aythya affinis*
Green-winged Teal	*Anas crecca*	Oldsquaw	Clangula hyemalis
American Black Duck	*Anas rubripes*	White-winged Scoter	*Melanitta fusca*
Mallard	*Anas platyrhynchos*	Common Goldeneye	*Bucephala clangula*
Northern Pintail	*Anas acuta*	Bufflehead	*Bucephala albeola*
Blue-winged Teal	*Anas discors*	Hooded Merganser	*Lophodytes cucullatus*
Northern Shoveler	*Anas clypeata*	Red-breasted Merganser	*Mergus serrator*
Gadwall	*Anas strepera*	Common Merganser	*Mergus merganser*
American Widgeon	*Anas americana*	Ruddy Duck	*Oxyura jamaicensis*

Source: Knapton and Weseloch 1999

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TABLE 4.4.2.2.1-3

HERPETILES OF THE NIAGARA CORRIDOR

Common Name	Scientific Name
Blanding's Turtle	*Emydoidea blandingi*
Blue-spotted Salamander Complex	*Ambystoma laterale x jeffersonianum*
Bullfrog	*Rana catesbeiana*
Commoner Garter Snake	*Thamnophis sirtalis*
Common Mudpuppy	*Necturus maculosus*
Common Snapping Turtle	*Chelydra serpentina*
Eastern American Toad	*Bufo americanus*
Green Frog	*Rana clamitans melanota*
Jefferson Salamander Complex	*Ambystoma jeffersonianum x laterale*
Northern Brown Snake	*Storeria d. dekayi*
Northern Leopard Frog	*Rana pipiens*
Northern Redbelly Snake	*Storeria occipitomaculata*
Northern Spring Peeper	*Pseudacris crucifer*
Painted Turtle	*Chrysemys picta*
Western Chorus Frog	*Pseudacris triseriata*
Wood Frog	*Rana sylvatica*

Source : NYPA 2002

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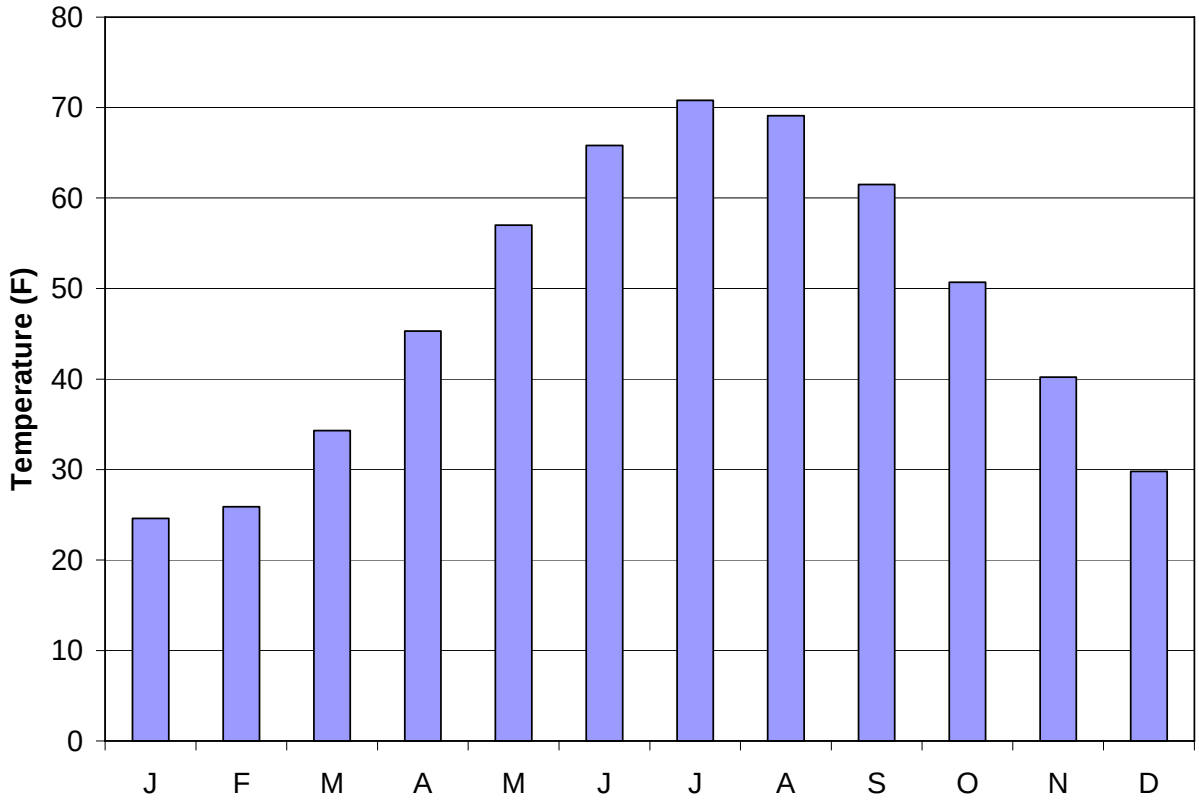
FIGURE 4.1-1

MONTHLY MEAN TEMPERATURE



Monthly mean temperature (°F), 1971-2000, measured at the National Weather Service Station, Buffalo, New York. Source: National Weather Service Forecast Office, Buffalo, New York (www.wbuf.noaa.gov/climate_information.htm)

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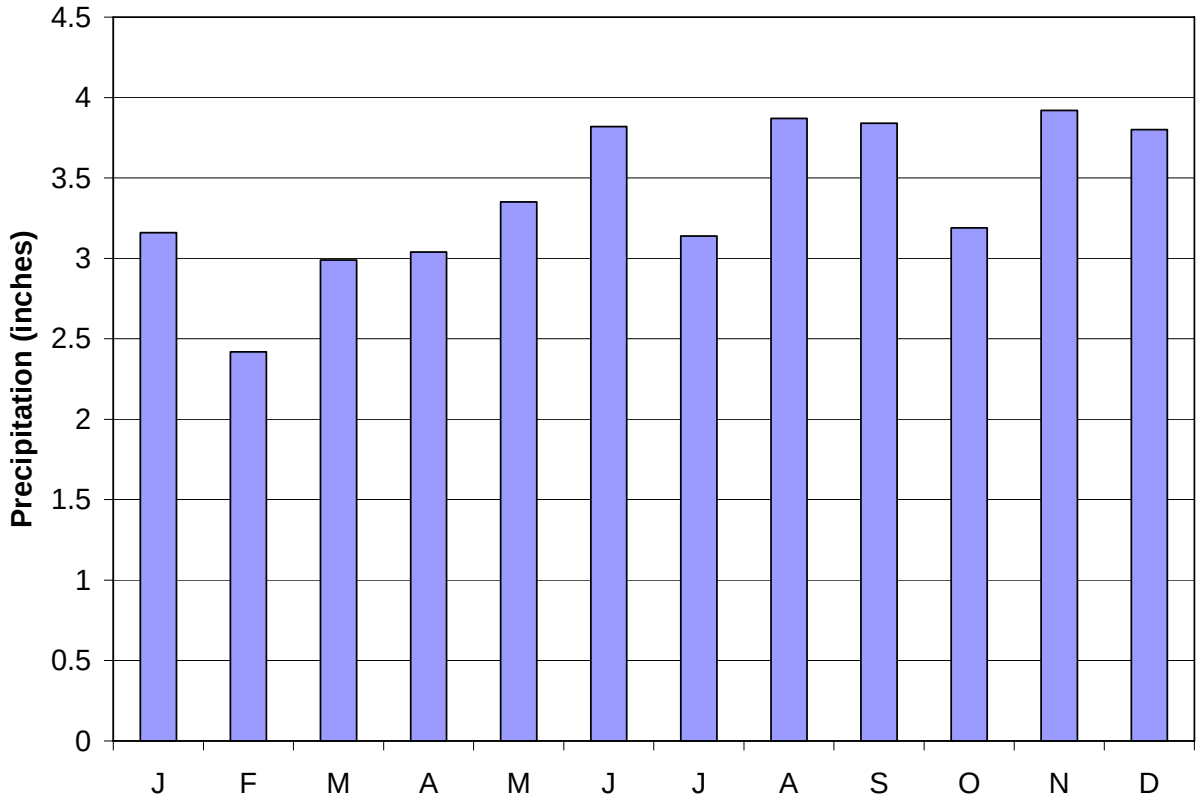
FIGURE 4.1-2

MONTHLY MEAN PRECIPITATION



Monthly mean precipitation (inches), 1971-2000, measured at the National Weather Service Station, Buffalo, New York. Source: National Weather Service Forecast Office, Buffalo, New York (www.wbuf.noaa.gov/climate_information.htm)

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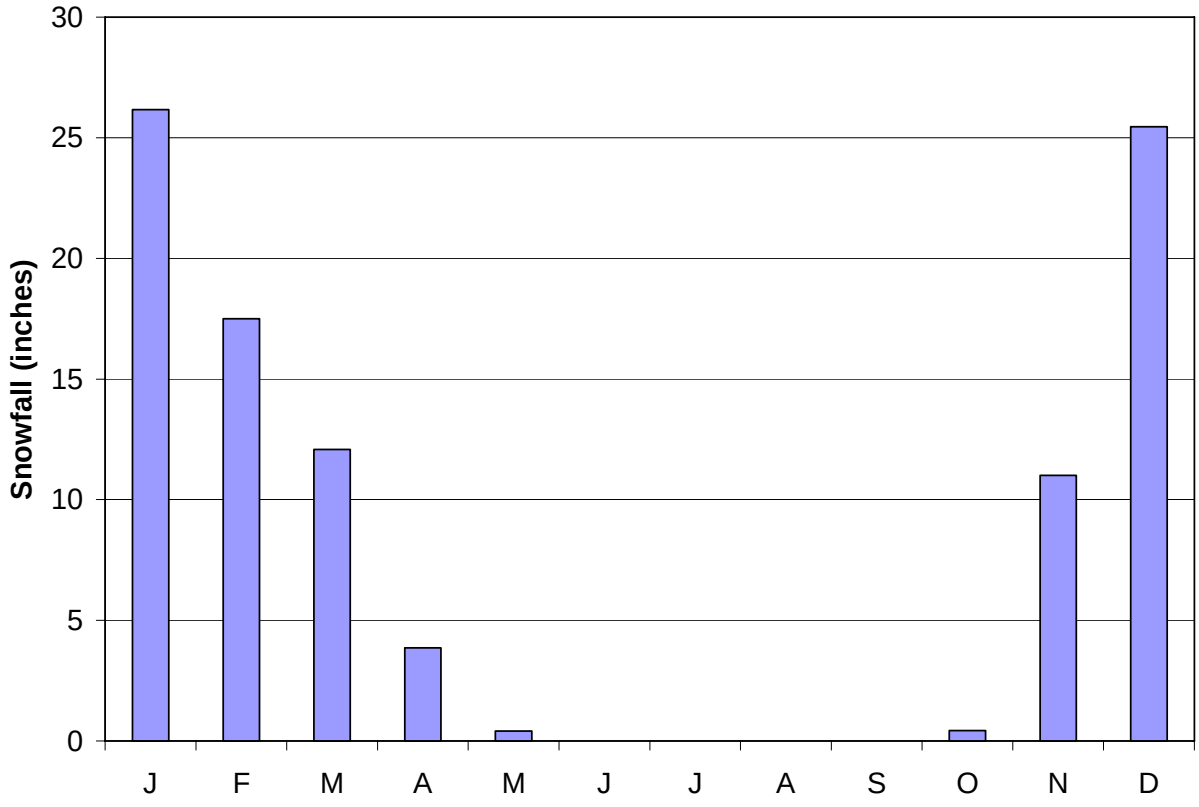
FIGURE 4.1-3

MONTHLY MEAN SNOWFALL



Monthly mean snowfall (inches), winters1971-72 through 2000-01, measured at the National Weather Service Station, Buffalo, New York. Source: National Weather Service Forecast Office, Buffalo, New York (www.wbuf.noaa.gov/climate_information.htm)

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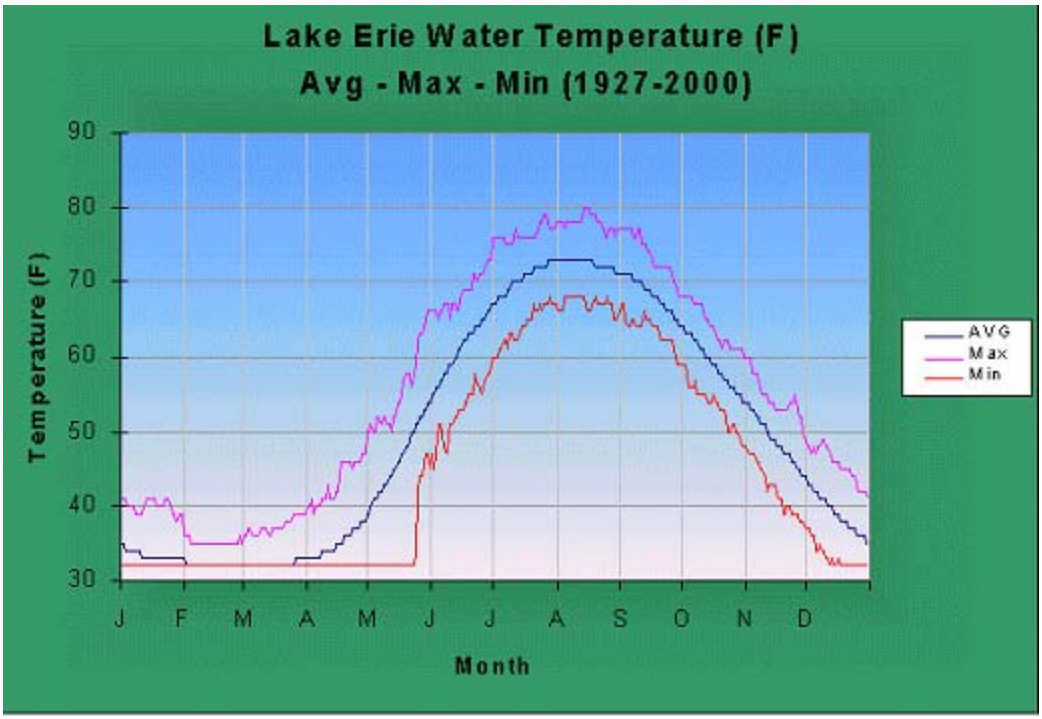
FIGURE 4.1-4

MEAN, MINIMUM, AND MAXIMUM LAKE ERIE WATER TEMPERATURE



Mean, minimum, and maximum Lake Erie water temperature (°F) as measured at the Erie county water treatment plant. Source: National Weather Service, Buffalo, New York (www.erh.noaa.gov/buf/laketemps/TOTAL.htm).

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FIGURE 4.2-1

TOP 10 NEW YORK COUNTIES IN APPLE, GRAPES AND MAPLE SYRUP PRODUCTION

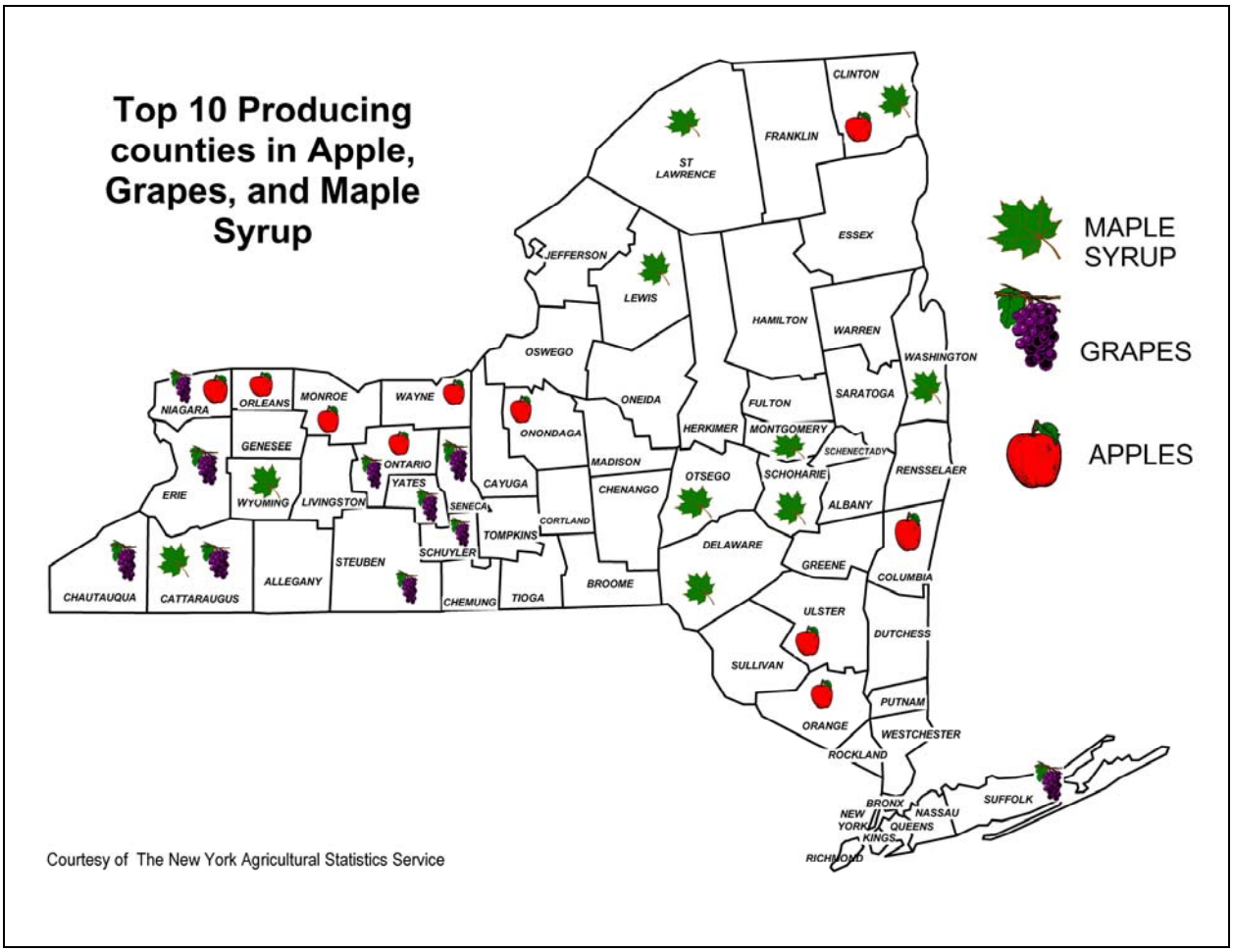

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FIGURE 4.2-2

TOP 10 NEW YORK COUNTIES IN ONIONS, POTATOES, CABBAGE, SWEET CORN, AND TOMATO PRODUCTION

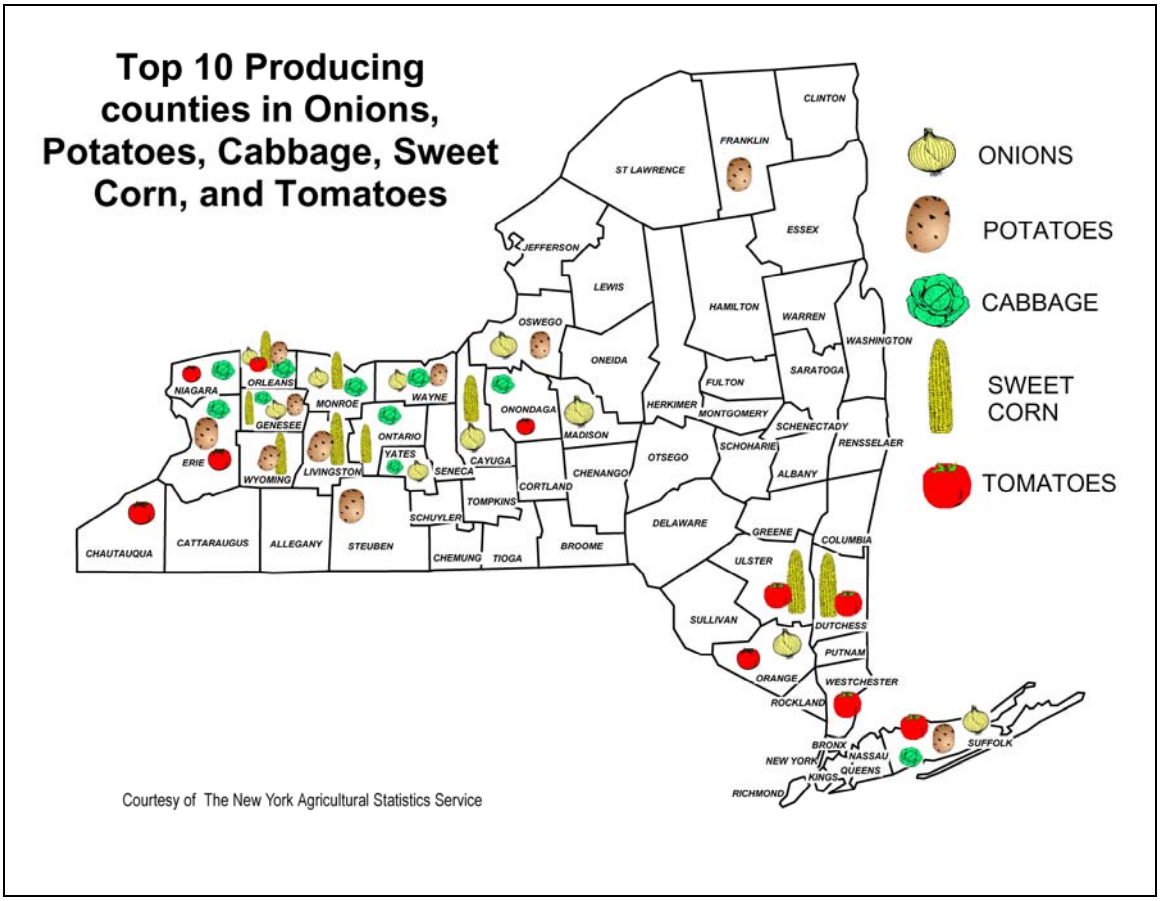

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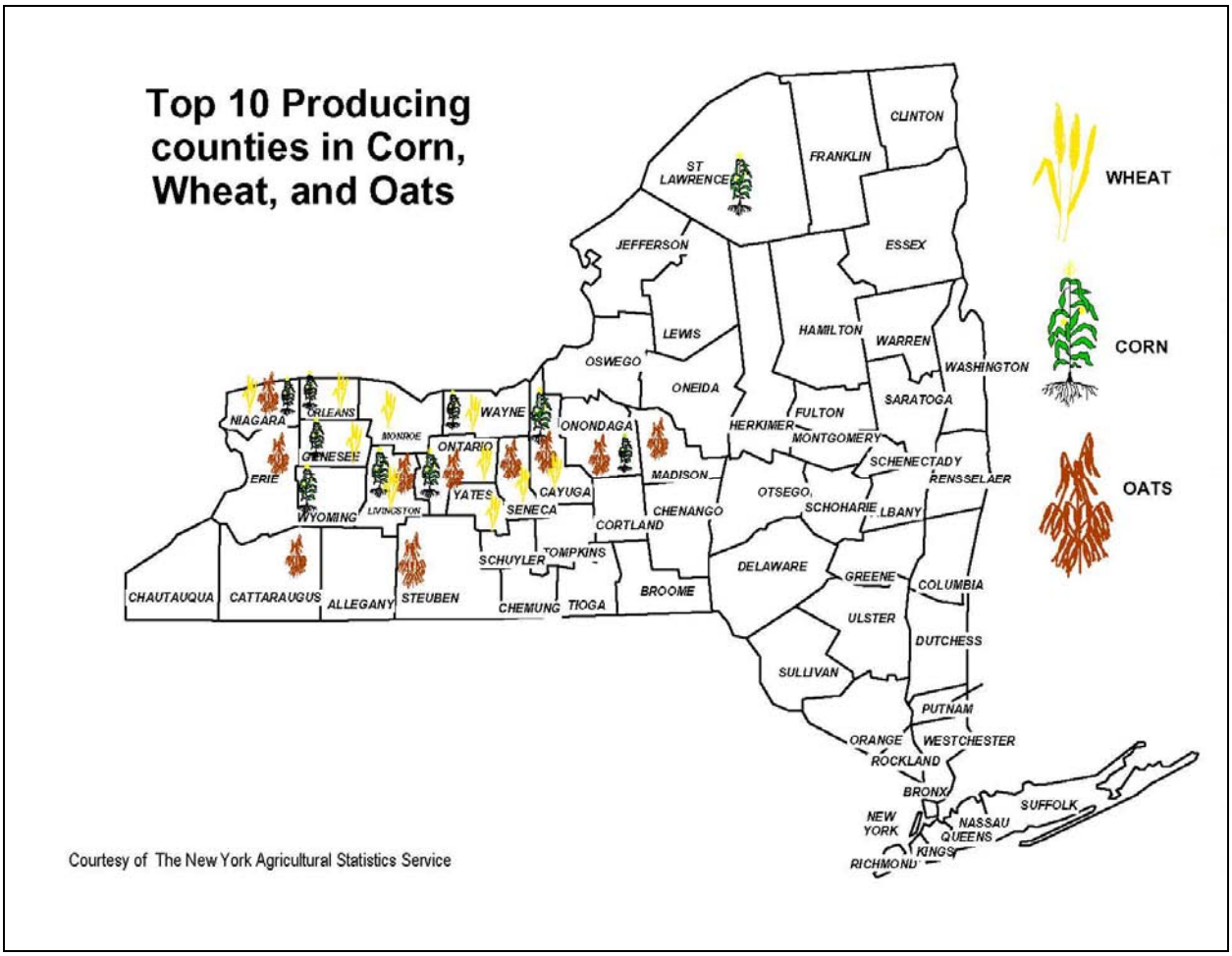
FIGURE 4.2-3

TOP 10 NEW YORK COUNTIES IN CORN, WHEAT, AND OATS PRODUCTION



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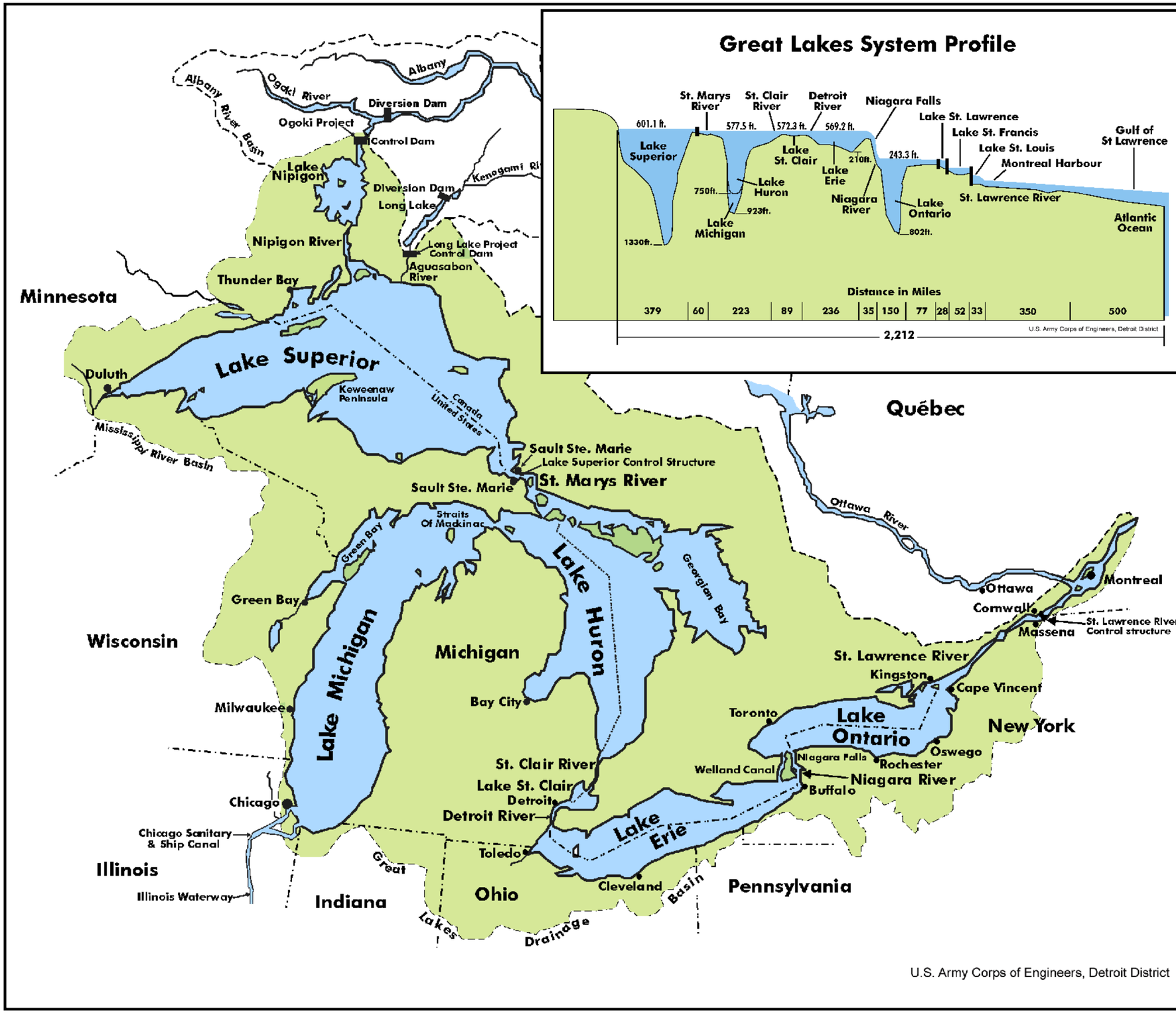

NIAGARA POWER PROJECT (FERC N0. 2216)
LAKE ERIE-NIAGARA RIVER ICE
BOOM EFFECTS ANALYSIS

Great Lakes Drainage Basin

ELEVATION TABULATION

LAKE	IGLD85	USLSD35
SUPERIOR	601.5	601.6
MICHIGAN	577.5	578.5
HURON	577.5	578.5
ERIE	569.2	570.5
ONTARIO	243.3	244.0

NOTE: ELEVATIONS SHOWN IN GREAT LAKES SYSTEM PROFILE ARE REFERENCED TO INTERNATIONAL GREAT LAKES DATUM OF 1985

SOURCE:
U.S. Army Corps of Engineers, Detroit District

N

FIGURE 4.3-1

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NIAGARA POWER PROJECT

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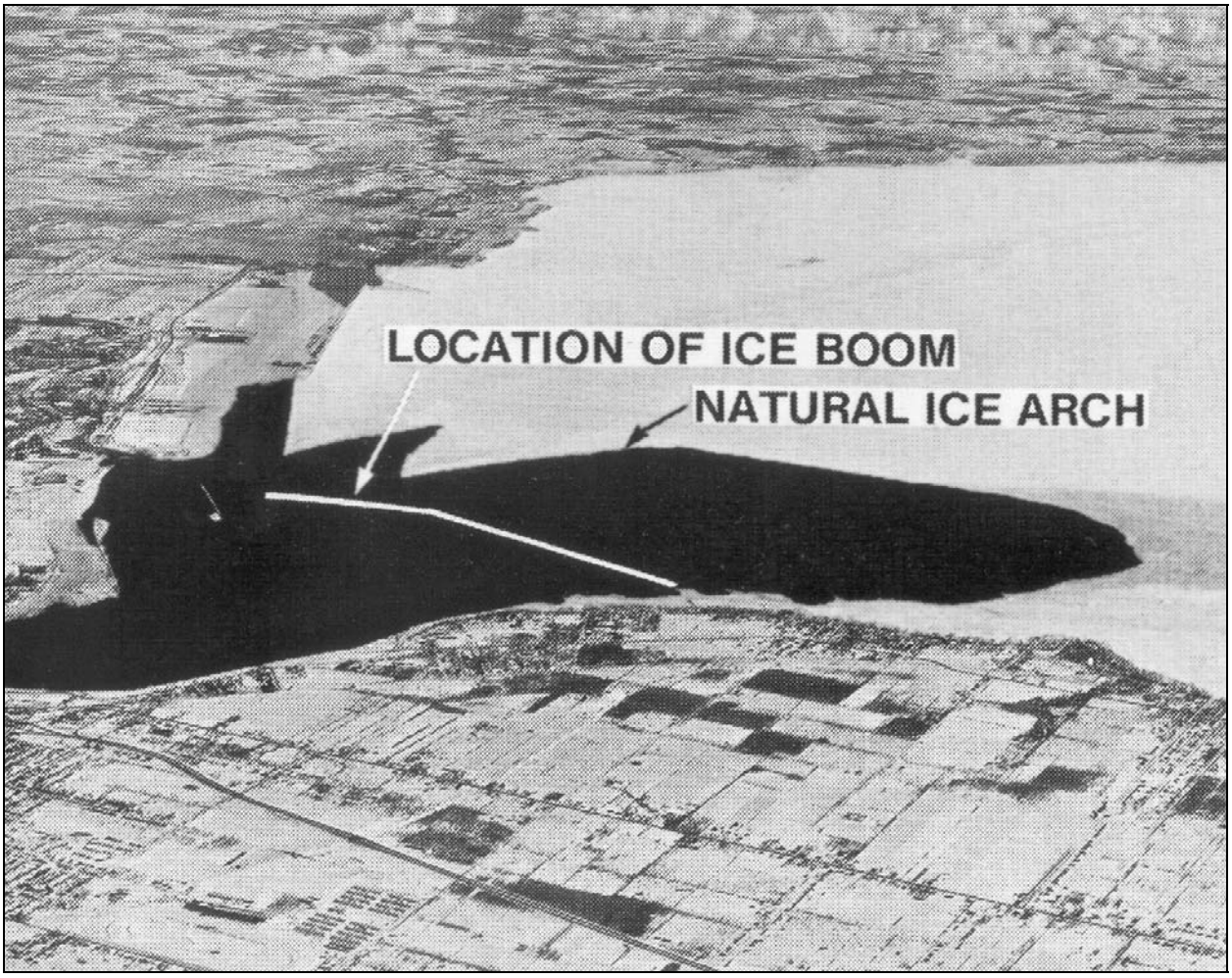
FIGURE 4.3-2

NATURAL ICE ARCH IN LAKE ERIE



Source: NYPA

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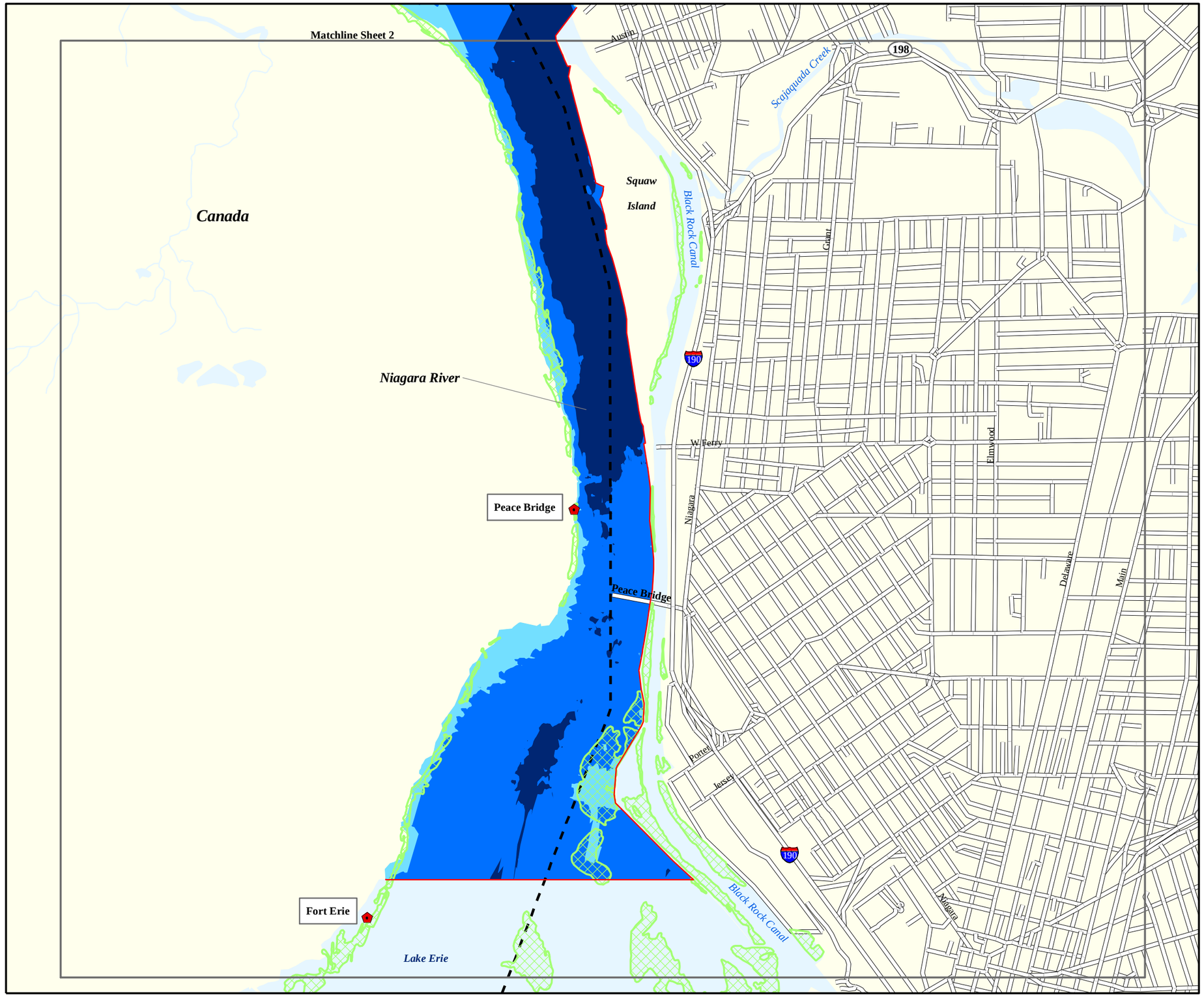


NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER
ICE BOOM EFFECTS ANALYSIS

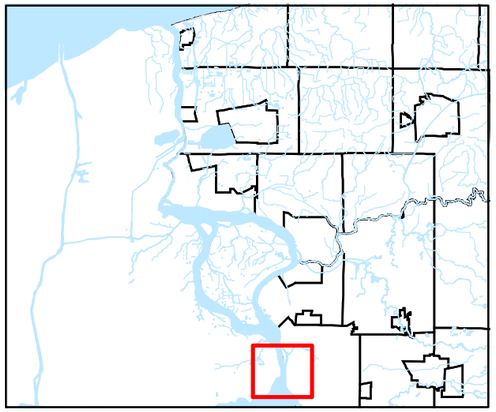
Location of Submerged and Emergent Aquatic Vegetation
Lake Erie Upper Niagara River Outlet

LEGEND

Water Depth at 50% Exceedance levels from a duration analysis of annual water elevation data

- Limit of Bathymetry Data
- < 6 feet
- 6 to 20 feet
- > 20 feet
- Submerged Aquatic Vegetation (SAV)
- Emergent Aquatic Vegetation (EAV)
- Water Gauge
- International Boundary

Data Sources:
The Bathymetry used to develop water depth is based on several sources (USACE, TVGA, and others) with different map accuracy. EAV, SAV, and Lentic data provided by Stantec



0 1,000 2,000 4,000 Feet

N

FIGURE 4.4.1.1-1

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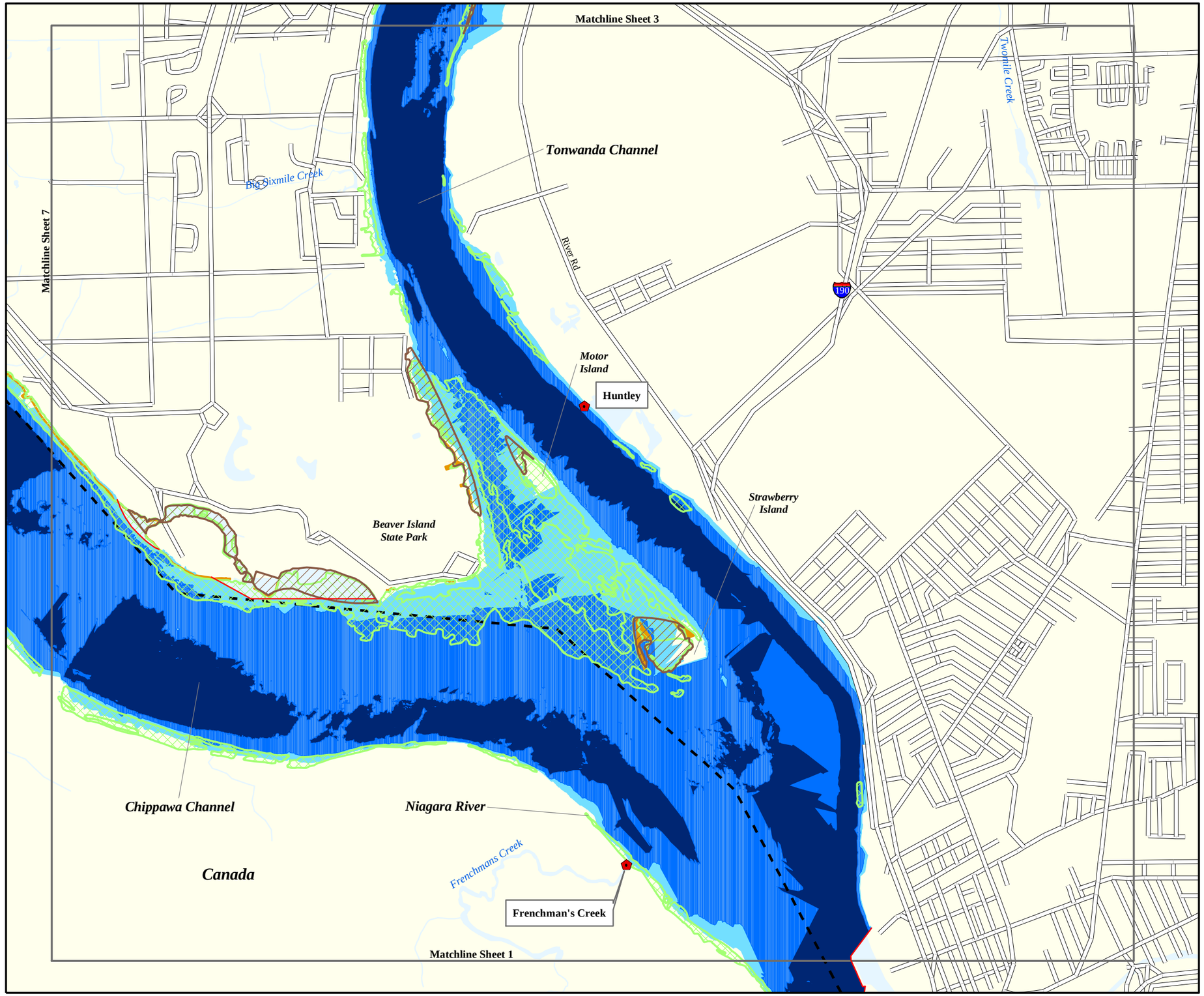


NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER
ICE BOOM EFFECTS ANALYSIS

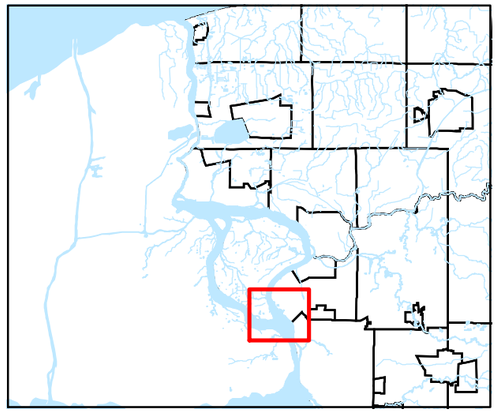
Location of Submerged and Emergent Aquatic Vegetation
Southern Tip Grand Island

LEGEND

Water Depth at 50% Exceedance levels from a duration analysis of annual water elevation data

- Limit of Bathymetry Data
- < 6 feet
- 6 to 20 feet
- > 20 feet
- Little or No Velocity Habitat
- Submerged Aquatic Vegetation (SAV)
- Emergent Aquatic Vegetation (EAV)
- Water Gauge
- International Boundary

Data Sources:
The Bathymetry used to develop water depth is based on several sources (USACE, TVGA, and others) with different map accuracy. EAV, SAV, and Lentic data provided by Stantec



0 1,000 2,000 4,000 Feet

N

FIGURE 4.4.1.1-2

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NIAGARA POWER PROJECT

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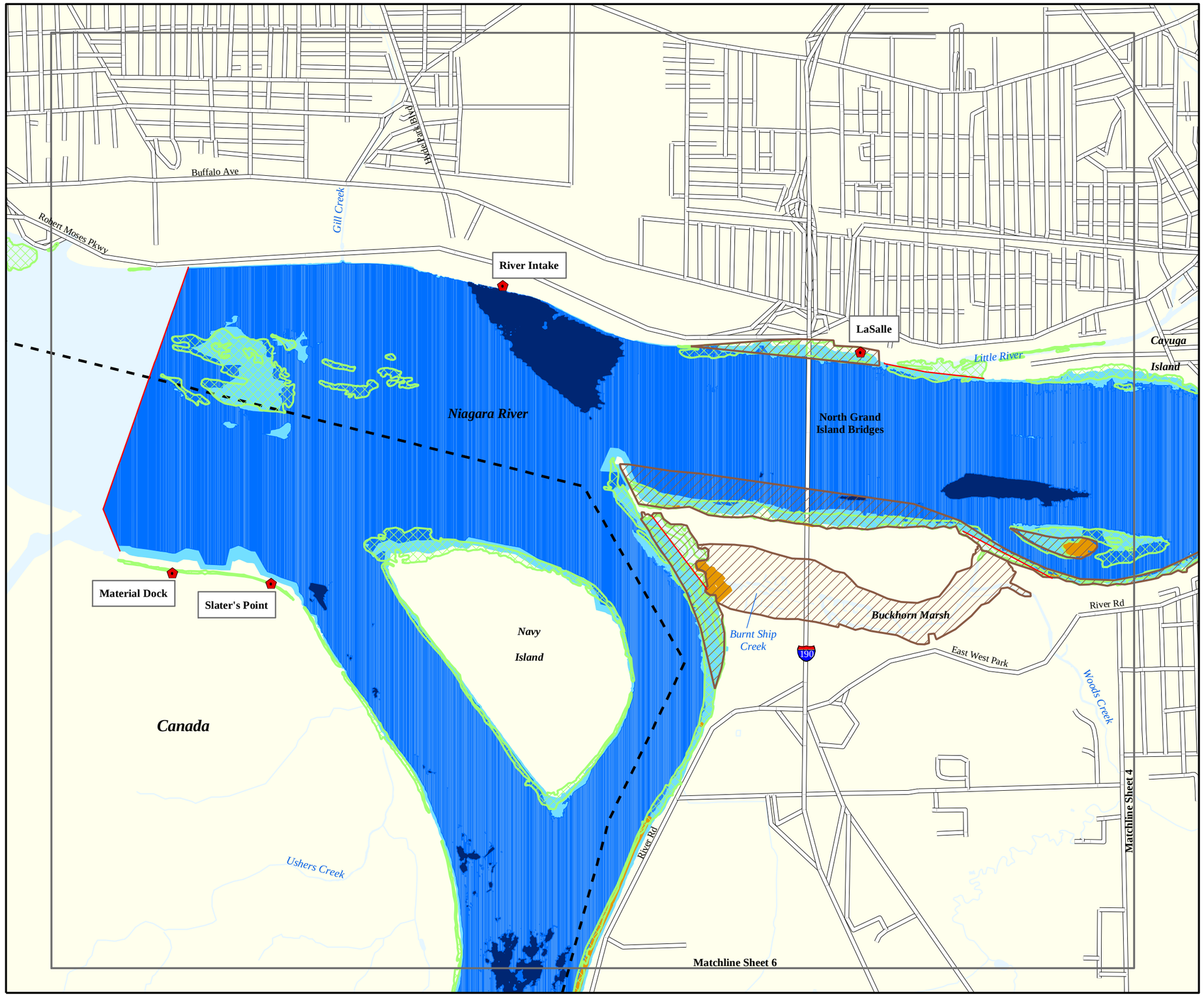


NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER
ICE BOOM EFFECTS ANALYSIS

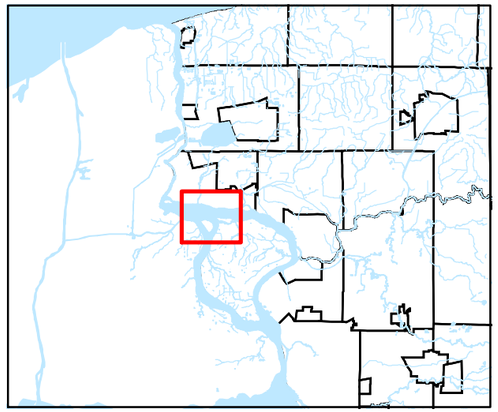
Location of Submerged and Emergent Aquatic Vegetation
Northern Tip Grand Island

LEGEND

Water Depth at 50% Exceedance levels from a duration analysis of annual water elevation data

- Limit of Bathymetry Data
- < 6 feet
- 6 to 20 feet
- > 20 feet
- Little or No Velocity Habitat
- Submerged Aquatic Vegetation (SAV)
- Emergent Aquatic Vegetation (EAV)
- Water Gauge
- International Boundary

Data Sources:
The Bathymetry used to develop water depth is based on several sources (USACE, TVGA, and others) with different map accuracy. EAV, SAV, and Lentic data provided by Stantec



0 1,000 2,000 4,000 Feet

N

FIGURE 4.4.1.1-3

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NIAGARA POWER PROJECT

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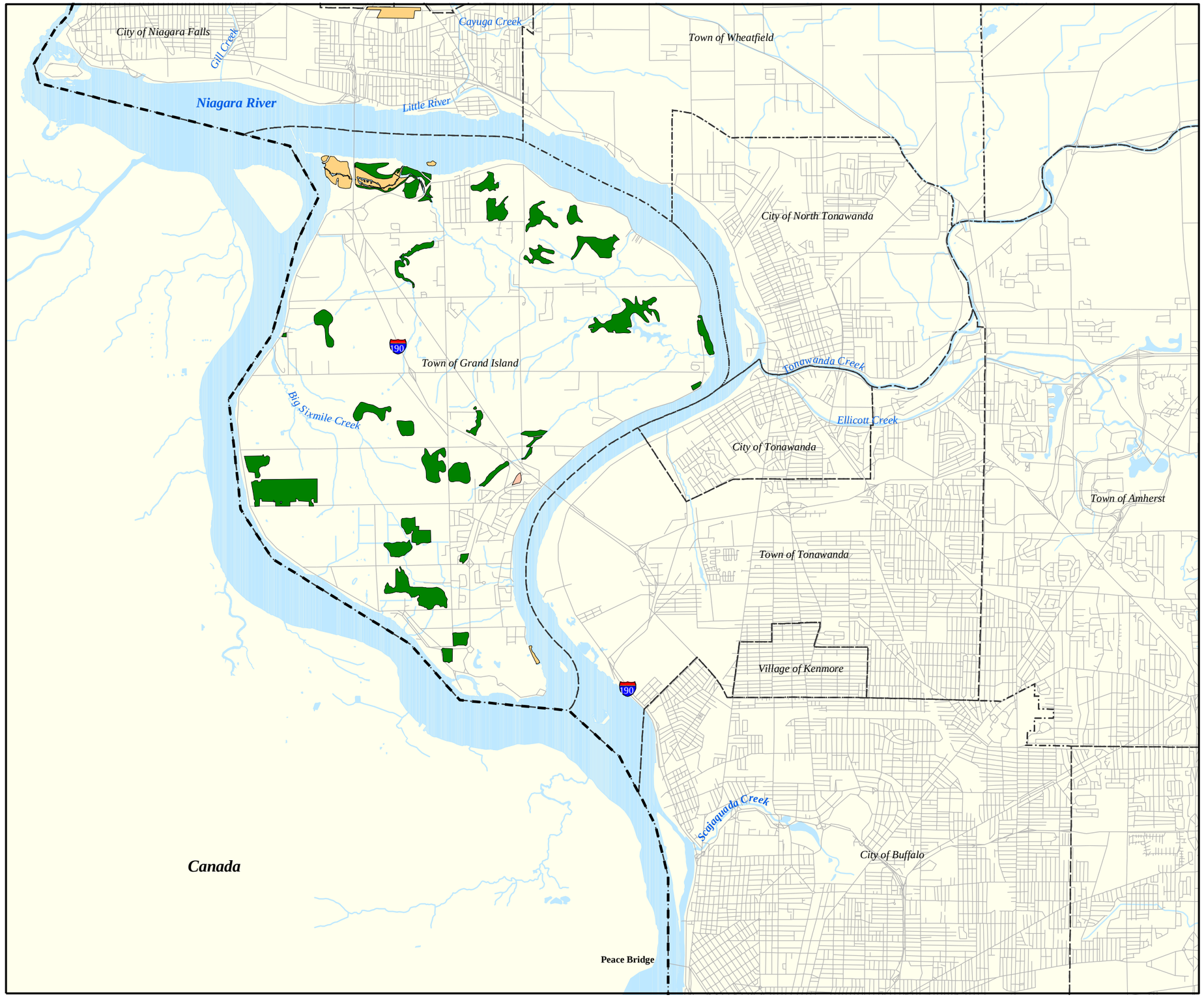


NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER
ICE BOOM EFFECTS ANALYSIS

Wetlands of the Upper Niagara River

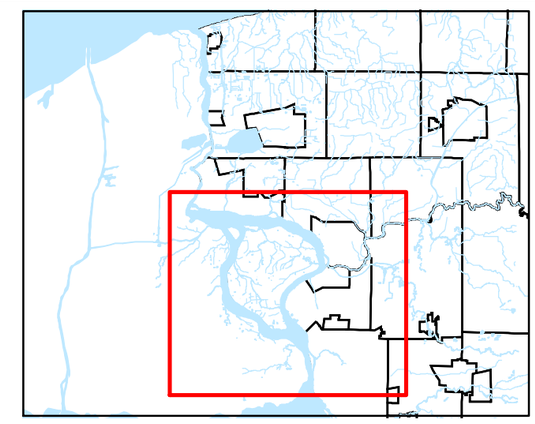
LEGEND

Wetlands
- Emergent Wetland
- Forested Wetland
- Scrub-Shrub Wetland

- International Boundary
- Municipal Boundary

Wetlands were delineated from April 1999 aerial photographs

Wetland habitat assignments were based on the Classification of Wetlands and Deepwater Habitats of the U.S.



0 3,500 7,000 14,000 Feet

N

FIGURE 4.4.2.1.1-1

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NIAGARA POWER PROJECT

Non-Internet Public (NIP) information has been removed from the following page(s).

This material is contained in:
Volume 2
Section: Determine if the Ice Boom Has Climatic, Aquatic, Land Management, or Aesthetic Effects

FIGURE 4.4.2.1.2-1

UPLAND VEGETATION MAP

[NIP - General Location Maps]

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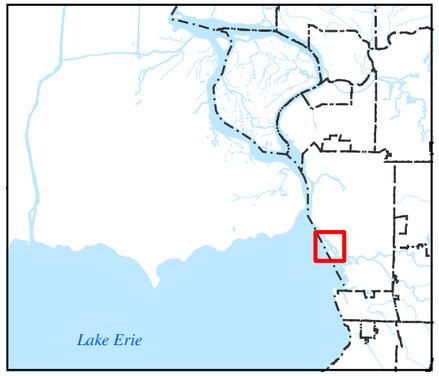

Legend

- Existing Trails
- Proposed Connector Trailway
- Proposed Greenway Trail Project
- Proposed Time Beach Restoration Project
- Proposed Outer Harbor Greenbelt
- Restricted Access
- Property Boundary

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NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER
ICE BOOM EFFECTS ANALYSIS

Planning Initiatives and Proposed Projects

0.25 0.125 0 Miles

N

FIGURE 4.5-1

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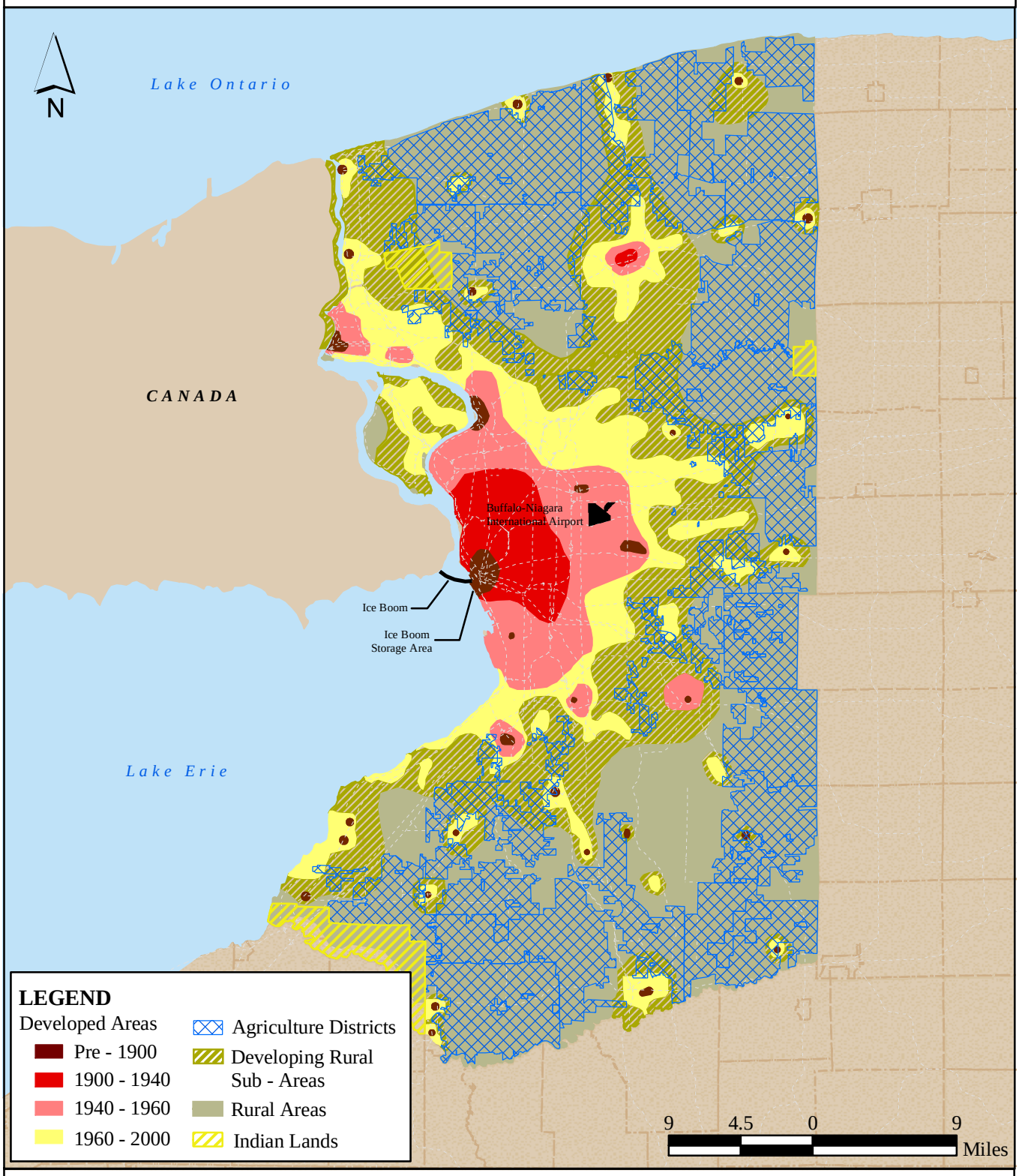
NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER ICE BOOM EFFECTS ANALYSIS



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Regional Growth and Development Trends

NIAGARA POWER PROJECT

FIGURE 4.5.2-1

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BUFFALO INTERMODAL TRANSPORTATION PROJECT

WATERFRONT PARKING STRUCTURE PROJECT

190

Michigan St.

Ohio St.

BUFFALO RIVER

Louisiana St.

Ganson St.

Buffalo Skyway

BUFFALO SAILING MARINA INC

ERIE CANAL HARBOR PROJECT

CITY SHIP CANAL

GANCO INC

GANCO INC

ERIE BASIN MARINA

Fuhrmann Blvd.

CARGILL INC

NIAGARA FRONTIER TRANSPORTATION AUTHORITY

NIAGARA FRONTIER TRANSPORTATION AUTHORITY

NIAGARA FRONTIER TRANSPORTATION AUTHORITY

NIAGARA FRONTIER TRANSPORTATION AUTHORITY

NIAGARA FRONTIER TRANSPORTATION AUTHORITY

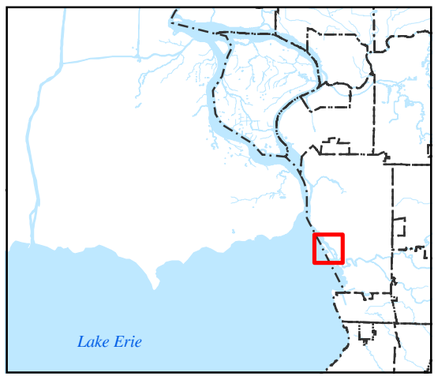
LAKE ERIE

UNITED STATES COAST GUARD

PROPOSED TIMES BEACH RESTORATION PROJECT

OUTER HARBOR REDEVELOPMENT DISTRICTS

NYPA ICE BOOM STORAGE AREA



LEGEND

Land Use

- Commercial
- Community Services
- Industrial
- Public Parks
- Public Services
- Recreation
- Residential
- Unknown
- Vacant Land
- Property Boundary

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NIAGARA POWER PROJECT

NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER
ICE BOOM EFFECTS ANALYSIS

Current Land Use

0.25 0.125 0 Miles

N

FIGURE 4.5.3-1

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BUFFALO INTERMODAL TRANSPORTATION PROJECT

WATERFRONT PARKING STRUCTURE PROJECT

190

Michigan St.

Ohio St.

BUFFALO RIVER

Louisiana St.

Ganson St.

Buffalo Skyway

BUFFALO SAILING MARINA INC

ERIE CANAL HARBOR PROJECT

CITY SHIP CANAL

GANCO INC

GANCO INC

ERIE BASIN MARINA

Fuhrmann Blvd.

NIAGARA FRONTIER TRANSPORTATION AUTHORITY

NIAGARA FRONTIER TRANSPORTATION AUTHORITY

NIAGARA FRONTIER TRANSPORTATION AUTHORITY

NIAGARA FRONTIER TRANSPORTATION AUTHORITY

CARGILL INC

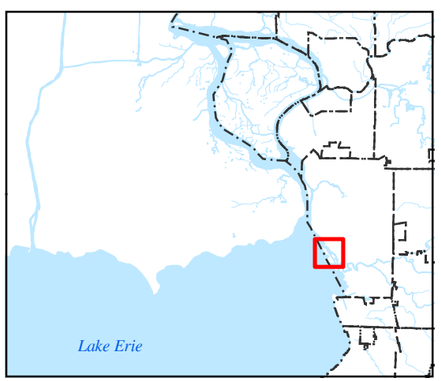
LAKE ERIE

UNITED STATES COAST GUARD

PROPOSED TIMES BEACH RESTORATION PROJECT

OUTER HARBOR REDEVELOPMENT DISTRICT

NYPA ICE BOOM STORAGE AREA



LEGEND

Zoning

- CM - General Commercial District
- M1- Light Industrial District
- M2 - General Industrial District
- M3 - Heavy Industrial District
- R5 Apartment-Hotel District
- Downtown Opportunity District
- Institutional - Light Industrial District
- Property Boundary

NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER
ICE BOOM EFFECTS ANALYSIS

Existing Zoning Classifications

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NIAGARA POWER PROJECT

0.25 0.125 0 Miles

N

FIGURE 4.5.3-2

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5.0 ANALYSIS OF POTENTIAL EFFECTS

In the following subsections, potential effects of the ice boom are discussed. Analyses were performed by using available information contained in existing studies (Appendix A) regarding the climatic, aquatic, land management, terrestrial, recreational, and aesthetic resources of the study area. In addition, analyses and information are presented on local agriculture, river hydraulics, water quality, current and potential future use of adjoining land parcels, and ice formation.

5.1 Climate

Previous studies of the potential ice boom impacts on climate can be divided into two categories: (1) studies of the effects on the timing of ice dissipation, or alternatively on lake-water temperatures which are considered to be a valid indicator of ice-out dates; and (2) studies of the effects on air temperatures. These studies include empirical analyses, using observed data such as water temperatures and air temperatures. They also include a mathematical modeling study. The primary technical analyses evaluated for this report are published in Quinn et al (1980, 1982) and Rumer (1980, 1983). Results from these studies were also evaluated and summarized in the National Research Council report *The Lake Erie-Niagara River Ice Boom: Operations and Impacts* (NRC 1983).

In 1984, based on recommendations contained in the NRC report, the operating procedures for boom removal were changed. Under the new procedures, the boom is removed by April 1st, unless significant ice cover, defined as greater than 250 square miles, remains on the eastern end of Lake Erie. When the ice cover exceeds 250 square miles, boom removal is delayed until the ice cover is reduced to 250 square miles. This procedure is based upon the modeling study by Rumer (1980, 1983) and further analysis by the NRC, which concluded that the ice boom could only delay the dissipation of the ice pack if the ice area is less than 250 square miles. This procedure was adopted by the IJC in 1984 and has been continuously implemented since then. The amended procedures were designed specifically to ensure that the boom would not affect the ice-out date.

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The main conclusions about the effect of the ice boom on climate are: (1) that the effect of the boom on the timing of lake-ice dissipation has not been measurable; (2) that the effect of the boom on air temperatures at the Buffalo airport has not been measureable; and (3) that the maximum spatial extent of any boom impact, if in fact the boom did delay the date of ice dissipation, could be no farther than the normal lake effect, which is at most three miles from the shore (NRC 1983). These conclusions are discussed in detail in the following subsections.

5.1.1 Lake Water Regime

Lake Erie water temperature is measured at the City of Buffalo water intake which is located just outside the Buffalo Harbor at a depth of 18 feet. Water temperatures are considered a valid indicator of the timing of lake-ice dissipation. Empirical analyses reveal that, on average, the potential delay in ice dissipation imposed by the boom is negligible based on comparison of pre- and post-boom water temperatures. These studies did not prove there never was an occasion where the ice boom had an impact on ice dissipation. However, the studies show that if there was an impact it was so limited as to be undetectable using the available data. The natural year-to-year variability of the timing of spring warming is much larger than the potential duration of potential ice boom effects (Section 4.1). Detecting a relatively small change from a signal with a relatively large noise component requires more data than were available at the time of those studies, and may remain so today.

The National Weather Service (NWS 1998) estimated an average pre-boom (1927-1964) ice out date of April 18 and an average post-boom (1965-1997) ice-out date of April 20 using the date of water temperatures rising to 34 °F in spring as in index of ice dissipation. These results indicate an average delay of only two days between pre- and post-boom periods, which is considered to be insignificant compared to the natural variability of ice-out dates with a range of over two months.

Studies conducted by Rumer (1980, 1983) and Quinn (1980, 1982) incorporated controls for climate changes into their statistical comparisons of water temperatures before and after 1964 when the ice boom was first installed. These controls are considered useful because they allow the analyst to compare the ice-out dates for pre- and post-boom years while removing the effect of changes in climate.

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This is important because cities within the region surrounding Lake Erie were under the influence of a regional cooling trend that began in 1958. Without controlling for climatic changes, results from comparison of pre- and post-boom ice-out dates might be misinterpreted. Hence, controls were implemented for these studies that accounted for the regional trend toward colder winters experienced in the Great Lakes region.

Separate analyses were performed by two independent research groups using different indices based on water temperatures. Quinn et al (1980, 1982) used an index based on the number of days after March 15 that water temperatures increase to 3 °F greater than the coldest value between January 1 and March 15, and controlled for changing climatic conditions. These scientists found no change between pre- and post-boom periods when controlling for the effects of the colder winter temperatures created by a regional cooling trend. This indicated that there was no impact on the spring rise in water temperature resulting from the operation of the ice boom. Rumer (1980, 1983) used the date of water temperature reaching 35 °F (WT35) during the spring warming as a proxy for the date of last ice. This research team employed a variety of statistical techniques, including overlaying of time series for pre- and post-boom periods and step-wise multiple regression. These researchers did not identify a statistically significant difference in WT35 between the pre- and post-boom period for years with similar climates. Similar climates in this study were defined according to the number of heating and freezing degree days. The conclusions of both of these studies stated that no statistically significant effect of the boom can be identified within the natural variability of climate in the region.

Rumer (1980, 1983) also developed a model by employing an energy budget study for the eastern end of Lake Erie. This model was based on the physical principles of conservation of energy. He was able to estimate the potential magnitude of the effects of different rates of ice dissipation associated with various wind regimes on surrounding air and water temperatures. Rumer found that as the ice area decreases, the relative effect of the boom on ice discharge rates can become important compared to the rate of ice loss due to melting. Thus, near the end of the ice season, as the ice pack is melting, prevention of ice transport into the Niagara River could delay the date of last ice in the lake and could potentially affect the timing of spring warming. However, Rumer concluded that the magnitude of the effect on water temperature must be small. Variations in the rate of ice dissipation due to natural variability, according to this model, can affect water temperature by approximately 2 °F. The potential impact on air

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temperature is even smaller. Temperature variations of this magnitude are much smaller than natural variability due to meteorological, hydrological, and other natural processes. As a result, the difference is not measurable.

The NRC also used an energy budget equation to estimate the maximum impact of the ice boom on water temperature and climate. The data used to run the model represent extreme meteorological conditions that were designed to simulate the potential maximum effect of the boom on localized water temperatures and climate. The panel found that the ice boom could produce a maximum potential impact of up to 2° F in water temperature over not more than a 5 day period under springtime conditions. The use of conservative (high) estimates also resulted in the conclusion that continued deployment of the boom would correspond to no more than a 1° F difference in localized microclimate over a period of not more than 5 days. By inputting data to produce the maximum potential effect, the NRC effectively overestimated any potential impact the boom could realistically produce under most conditions. This was a deliberate effort by the panel to produce design criteria that would demonstrate to the public, the maximum possible effect of the boom on water temperature and local climate. Under typical conditions, the NRC panel concluded, "the difference between boom and no boom results is smaller in both amount and duration." As part of its analysis, the NRC also evaluated potential impacts on air temperatures. These results are reported in Section 5.1.2.

Researchers have consistently concluded that the potential effects of the ice boom on lake temperature and ice dissipation are undetectable. Furthermore, the current procedures for boom removal are designed to eliminate the possibility of any boom effect under any conceivable meteorological conditions.

5.1.2 Air Temperature Regime

Analyses of the potential effect of the ice boom on air temperatures use observed data from the National Weather Service Station at Buffalo, New York. Researchers have encountered limitations regarding the applicability of available data for quantitatively measuring potential ice boom effects. First, there are discontinuities in the airport data time series. Discontinuities occur when a change is

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implemented in the temperature measurement procedure that could introduce an artificial increase or decrease in the temperature readings. In this case, the discontinuities are associated with changes in the location of the NWS monitoring station in 1943 and 1961. The station was moved in 1943 from downtown Buffalo to the Buffalo International Airport. In the 1940s, many National Weather Service meteorological stations in the United States were moved from locations in towns and cities to airports. These changes were motivated by artificial warming that is introduced to temperature records when an urban area grows significantly around a site. In 1961, the station was moved a second time from one location within the airport to a different location at the airport (Quinn et al. 1980). Since temperature measurements at different locations are not identical, any attempt to evaluate how climate has changed over time using these data could result in incorrect conclusions. These discontinuities constrain time series analyses to the period after 1961, which limits data to the period 1961-1964 for "pre-boom" temperature analyses. Second, as the airport is located approximately eight miles from the lake front, and no additional long-term measurements at the lake front are known to be available, the effect of the boom on lake-front temperatures can not be determined directly.

In spite of this limitation, Quinn et al (1980, 1982), was able to analyze data measured at Buffalo before the 1943 station move. He estimated that the lake effect (without the ice boom) at lake side may be up to 2 °F during spring. No lake effect was identified at the airport station, located approximately eight miles from the shore. This is consistent with the results of the NRC (1983) study which estimate the maximum extent of the lake effect to be no more than approximately three miles.

Quinn et al (1980, 1982) used indexes of winter severity based on daily temperature records. The indexes they chose were Freezing Degree Days (FDD) and Thawing Degree Days (TDD). These indexes are commonly used in a variety of sectors. The energy industry uses Heating Degree Days and Cooling Degree Days to estimate oil usage for energy consumption estimates. A similar index, Growing Degree Days, is widely used for agricultural purposes to determine the timing of crop growth. FDD is simply the number of degrees, accumulated over the winter, in which the temperature fell below freezing. For example, if the mean daily temperature was 30 °F on January 1, this would contribute 2 FDDs; if the mean daily temperature was 28 °F on January 2, this would contribute an additional 4 FDDs. A temperature of 32 °F or greater would not contribute to FDD. The winter FDD value is simply the

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summation of all the daily FDD values. TDD is the summation of mean daily temperatures greater than 32 °F.

The results of the Quinn et al (1980, 1982) analysis indicates that post-boom winter severity has been similar at Buffalo compared to other regional stations. They used a variety of statistical techniques, including regression analysis, which identifies linear relationships between different variables. By comparing the pre-boom relationship between FDD at Buffalo and regional FDD values measured at other Great Lake Stations, they found no difference in the relationship between the pre- and post-boom periods. They did find a difference in the relationship that occurred in 1943 as a result of the first station move. Thus the technique was able to identify the effect of the station move on winter severity. It also showed that the ice boom had no discernable effect on the length or severity of winters at Buffalo. Similar results were found for TDD.

Variations in climate occur naturally over all timescales, ranging from several decades to millions of years. Climatic variations in the Great Lakes Region and Buffalo are relevant in assessing potential impacts of the ice boom. When attempting to evaluate the effect of the ice boom on climate, it is insufficient to simply compare a climatic variable, such as temperature, during the pre-boom and post-boom periods. The climate might have undergone natural fluctuations during those time periods. To identify any potential impact of the ice boom, researchers attempt to isolate the portion of the observed climatic change that is due to natural fluctuations. Only then can an evaluation be made to determine the presence of an ice-boom related impact. A statistical procedure that isolates natural variations in temperature is said to “control” for natural changes in climate.

Quinn et al (1980) and the NRC (1983) examined natural climate variations and found that there had been regional climatic trends during the twentieth century. These researchers evaluated temperature measurements from Buffalo and from 25 other weather stations located in the Great Lakes Region and identified regional trends in winter temperatures. From 1898 through 1920, winters in this region became colder. A warming trend occurred between the late 1920s and the mid-1950s. The trend reversed again in 1958 and winters became more severe until at least 1979. This cooling trend affected regional temperatures, lake ice dissipation dates, and water temperatures on Lake Erie. This trend is important considering that the ice boom was first implemented in 1964, only six years after the onset of the most

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recent cooling trend. The identification of these trends was a critical finding which allowed these researchers to control for the regional cooling and to distinguish effects due to the naturally occurring cooling trend from potential ice boom effects.

The conclusions of these temperature analyses are that for pre- and post-boom years with similar regional weather, there were no statistically significant differences in temperature associated with the presence of the ice-boom. Although temperature differences between pre- and post-boom periods are observed, these differences are caused by larger scale climate fluctuations, as measured by the temperature data at Buffalo and at other stations in the Great Lakes region. Quinn et al (1980, 1982) used a number of methods to compare pre- and post-boom temperatures at Buffalo to temperatures at other stations in the Great Lakes region. They conclude that there is no evidence that the ice boom has extended Buffalo winters or made them more severe. They found no significant cooling at Buffalo compared to nearby inland Lockport, NY. Similar results were obtained from the 24 additional stations that were evaluated.

The modeling analysis performed by the NRC (Section 5.1.1) on water temperature impacts also assessed potential effects of the ice boom on air temperature. The use of conservative (high) estimates resulted in the conclusion that continued deployment of the boom would correspond to no more than a 1° F difference in localized microclimate over a maximum period of 5 days. Furthermore, the panel stated that it believed the effect of air moving over the water surface during the spring breakup period would produce a very slight temperature deficit on the order of a fraction of a Fahrenheit degree and would not likely be measurable within the natural temperature variability due to changing wind speed and vertical mixing of the air. Such a small temperature variation effectively rendered the differences indiscernible, immeasurable, and insignificant. Although theoretically possible to measure small effects, study design criteria would require on the order of 100 years or more of temperature measurement, cost tens of millions of dollars, would be very difficult to perform, and could potentially still not define temperature differences due to the perceived small effect. Thus, the panel concluded, it is not feasible to implement a monitoring program to discern such small temperature effects.

Results from studies that evaluated potential ice boom impacts on air temperatures indicate the following. It is extremely unlikely that up to 1983 there was ever any effect of the ice boom on air

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temperatures at the Buffalo Airport. If there was an effect, it was so small as to be undetectable. There may have been a small effect of the boom on lakeside temperatures prior to 1983, but this effect is considered to have been indistinguishable from the natural lake effect and natural variations in climate and would have lasted only a few days at most. Under the operating procedures adopted in 1984, and that continue to be followed to this day, it is unlikely that the boom has any effect at all on local climatic conditions. These conclusions were also reached by the NRC (1983) study.

The need for mathematical modeling was addressed by Rumer (1980, 1983) and the NRC (1983). The modeling analyses that they performed were sufficient to evaluate the maximum potential impact of the ice boom on ice dissipation, water temperatures, and air temperatures. They also found that the model could not be employed to directly estimate the effect of the boom for any particular year due to the lack of observations required to calibrate and validate this model. The requirements for such calibration and validation would be substantial, due to the complexity of the ice-water-climate system. There was a monitoring program set up to collect the requisite data during the winters 1974-75 through 1976-77, but difficulties in measuring the spatial extent and thickness of the ice prevented the successful application of the model (Churchill 1985; Thomson 1975, 1976).

The expense and effort that would be required to obtain the requisite data for such a modeling effort remain to this day exorbitant. In addition, there is no guarantee that such an effort would result in a model with sufficient capability to accurately estimate a potential impact as small as the one associated with the ice boom under the pre-1984 operating procedures. Furthermore, the updated operating procedures implemented in 1984, and still in effect, were designed to mitigate any potential ice boom impact that might exist.

Initiation of a comprehensive modeling effort for the purpose of evaluating the potential impact of the ice boom on ice dissipation, water temperatures, or air temperatures is unwarranted due to the controls that have been in place since the adoption of the NRC recommendation in 1984. The costs and uncertainty of obtaining new information renders these efforts not feasible.

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5.1.3 Agriculture Production

No published reports were found during the literature review that discussed potential impacts of the ice boom on agricultural crop production in Western New York State. In general, the lake effect is considered to have a positive impact on crop production in the region. As discussed in the climate section of this report (Section 4.2), cooler surface conditions over the lake in late winter and early spring tend to enhance atmospheric stability which inhibits cloud formation resulting in increased sunlight hours. The cooling effect of the lake surface also tends to moderate local air temperatures by preventing daytime temperature spikes that could cause premature onset of growth and budding of tender fruits and other early growth plants such as forage crops. This decreases the likelihood of frost damage that could be detrimental to crop production. Since the growing season is generally longer near the lakeside, these conditions have promoted extensive horticulture and market garden industries.

In the absence of any formal literature, CRA's agriculture staff contacted local agriculture professionals including personnel from the Cornell Cooperative Extension Service (CCE) as part of this assessment. These specialists were consulted about the possible effects of temperature change on local crop production and were experienced with field crop and fruit production in the region. The local experts are not aware of published information related to either the lake effect or potential ice boom effects on market vegetables and field crops such as corn, wheat, oats, forage crops, or soybeans. Neither are they aware of information that late-season ice has increased after the ice boom was implemented in 1964. In addition, CCE representatives indicate that there is no commercial agriculture immediately adjacent to the river downstream from the ice boom location in the area between Buffalo and Niagara Falls, including the Tonawanda/North Tonawanda area and Grand Island. Examination of Figure 5.1.3-1 confirms these observations.

Agriculture professionals suggest that the lake effect tends to give farmers more growing season in the fall due to the proximity of a large body of warm water that tends to cool slower than the land (i.e., the lake effect). Furthermore, local agricultural production benefits from the early spring cooling effects of the lake that creates a delay in growth of perennial crops like alfalfa and grass. This gives dairy farmers located next to the lake the opportunity to obtain the highest quality hay crop silage possible due to staged maturity and harvest times. Some farmers use the lake effect to their advantage by initiating

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harvests on their most southern fields and then completing late fall harvest in areas closer to the lake where crops mature later. Insect development is also delayed in areas within a mile or two of the lake, due to the cooler spring temperatures in the lakeshore vicinity, since insect development is a function of heat accumulation and is not affected by solar radiation or calendar date.

The practice of implementing planting and harvesting schedules in coordination with the lake effect is largely restricted to areas on the Canadian side of Lake Erie, locations along the Lake Erie shoreline that are southwest of and outside the study area and are beyond any potential influence of the ice boom, and farmland along the shoreline of Lake Ontario. Since significant areas of agricultural production are not present within the study area that could be influenced by the lake effect (Figure 5.1.3-1), agricultural producers in Erie County are largely unable to engage in these practices.

Specialists in fruit production indicate no knowledge of perceived negative effects caused by the ice boom to the fruit industry in the region. Any significant cooling effects of the lake are noticeable only for 1 to 2 miles inland from the lake. Early spring cooling would have a potentially positive effect due to delayed budding of tender fruit trees. This delay would reduce the risk of frost damage to developing fruit at pollination time. Pollination time varies with species, but would generally be from late April through mid-May.

A summary of observations from local agricultural experts appear to agree on several relevant points including:

- The agriculture professionals that were consulted are not aware of any published or unpublished controlled scientific studies regarding the potential effects of the ice boom on agricultural production in Western New York State.
- Any potential observable impact on early spring air temperature due to the ice boom would have a sphere of influence of 1 – 2 miles from the lakeshore of the area where the ice is located. There is no significant agriculture in the area immediately adjacent to the Niagara River or Lake Erie shoreline

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downstream or within the potentially affected area (i.e., 1 – 2 mile radius) of the boom on the U.S. side of the lake.

- Farmers generally view the lake effect as beneficial to crop production in the area. The crop that would be potentially most affected by early spring temperatures are tender fruit trees like grapes and apples. There is anecdotal evidence that these crops would actually benefit from lowered early spring daytime temperatures due to late budding which reduces the risk of overnight freezing.

Analyses contained in Section 5.1.2 of this report suggest that there are no significant temperature differences associated with the presence of the ice boom from information contained in the reports reviewed. Most of the observed data in these studies was collected at the Buffalo Airport, which is about eight miles away from the Lake Erie shoreline where the ice boom is located. This is consistent with the anecdotal observations of the local specialists that were consulted. The anecdotal evidence further indicates that the maximum sphere of influence of the lake effect, whether on the Lake Erie or Lake Ontario shoreline, is no more than two miles. This is consistent with the estimate quoted in the NRC (1983) report of a maximum potential lake effect of approximately three miles.

Information contained in the climate section of this report leads to the following conclusions on the potential effects of the ice boom on agricultural production in the region:

- Prior to 1984, any potential observable impact on early spring air temperature due to the ice boom can only be a fraction of the difference between the surface ice temperature and the open water temperature that would exist if the ice were not there.
- Prior to 1984, this early spring air temperature difference would only be applicable for the two or three extra days that the ice was being retained by the ice boom compared to the conditions if the boom were not in place. In addition, these potential effects would extend no further than the lake effect which is estimated to be no more than three miles.

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- The IJC fully implemented the NRC recommendations regarding the removal dates for the ice boom beginning in 1984. Implementation of the new operational procedures is designed to mitigate the potential effects of the ice boom on water temperature and local climate.

A detailed description of the current and historical trends in regional development is presented in Section 4.5.2 for the Erie-Niagara region. Section 5.4 contains additional information relating to development within the local area.

As development has expanded outward from the urban core of Buffalo, traditional rural and agricultural areas have been displaced. This has resulted in increased urbanization of the outlying areas. This pattern of outward growth and development is not new to the Buffalo area. Figure 4.5.2-1 demonstrates the expansion of development into the rural areas over time beginning in the early 20th century. One of the results of this long standing trend has been the displacement of agricultural lands by development and conversion to urbanized area. This has produced a decrease in the number of farms by 19% and 26%, respectively, in Erie and Niagara Counties between 1987 and 1997. This corresponds to the loss of over 42,000 acres or over 13% of farmland that was converted to other use. Erie County lost almost 23,000 (13.5%) acres of its dedicated farmland over the ten year period (Erie and Niagara Counties 2003).

The conversion of agricultural land has resulted in the removal of Erie County farmland from the influence of the lake effect and potential ice boom impacts. A review of climatic data clearly shows that there is no lake effect impact at the NWS meteorological station located at the Buffalo Airport. The airport is approximately 8-miles from Lake Erie. The NRC (1983) provided a conservative (high) estimate of the zone of impact of the lake effect as 3-miles. Similarly, the agricultural experts interviewed for this study suggest that the impact of the lake effect is approximately 1 – 2 miles. Since the potential extent of ice boom impacts is no further than the lake effect, examination of Figure 5.1.3-1 shows that, very little, if any, of the agricultural land in Erie County is potentially affected by the lake effect or the ice cover behind the boom. This, of course, assumes pre-1984 conditions and does not account for current boom removal criteria, recommended by the NRC and implemented by NYPA, which were designed to mitigate the potential for any effect of the ice boom on local climate.

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There is no direct scientific evidence to support the conclusion that there is any negative or positive effect on agricultural production due to the ice boom. Expert opinion suggests that there is an influence from the lake effect in the immediate vicinity of the lakeshore along both the Lake Erie and Lake Ontario shorelines. The lake effect is naturally occurring and exists in the absence of the boom. It influences nearshore temperatures which farmers generally find useful in implementing their planting and harvesting schedules. Furthermore, the anecdotal information provided by local farming experts suggests that any presumed potential impacts would largely be viewed as beneficial to local agricultural production. The lack of specific research and published scientific information on this topic represents a gap in knowledge regarding the potential impacts of the lake effect.

Previous studies indicate that before 1984, potential ice boom impacts would be negligible relative to the lake effect and natural variations in climate experienced in the area. The NRC estimated that the extent of the ice boom's effect on air temperature prior to 1984 would be in the order of a fraction or more of a Fahrenheit degree. This small difference would take more than a century of accurate data to distinguish, if it could be discerned at all, given the natural variability in climate. Implementation of the current boom removal criteria, based on the recommendations contained in the NRC report, serves to mitigate any potential impact of the ice boom on local microclimate.

Examination of local land use and regional growth patterns indicate there are no known areas of commercial agricultural production that could potentially be impacted by the use of the ice boom in Erie County. The loss of agriculture lands as a result of urbanization and development is considered to be the primary factor that negatively influences agriculture production in the region. The reviewed literature indicates that a sphere of influence from the lake effect could exist for up to three miles inland of the ice boom placement area. We conclude that no adverse effects are created by the use of the ice boom on agriculture production in Western New York including Erie County.

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5.2 Water Resources

5.2.1 River Hydraulics

The Niagara River has had a history of ice jamming and ice-induced flooding that damaged shoreline property and caused reductions in power generation before the Niagara Power Project and Sir Adam Beck complex were built. Under FERC direction, NYPA studied the history of Niagara River ice problems. Comparison of pre-project and post-project ice jams and impacts indicates that, over the last 150 years, "the general hydraulic response of Lake Erie and the Niagara River to weather conditions has not changed substantially." Two general categories of ice related events are described that are relevant to the current study: 1) ice jams in the upper Niagara River that substantially reduced flow into the river from Lake Erie; and 2) ice jams that completely covered the Tonawanda Channel of the upper Niagara River. The consequences of these ice jam events were related to both the volume of ice transported into the river from Lake Erie and the total flow of water into the river. Almost all of the ice jams were associated with storms that pushed ice into the river while simultaneously raising water levels and flows in the river (NYPA 1998).

5.2.1.1 Ice Formation and Discharge

Lake Erie is the primary source of ice in the Niagara River. Ice formation on Lake Erie begins when temperatures reach 32°F which typically occurs beginning in late December and early January. The ice cover on Lake Erie is highly variable from year to year and is primarily a result of the natural variability in climate. Winters have occurred where an ice cover did not form. In contrast, there are documented cases where the ice cover has been observed at about 86% of the lake surface area or about 8,600 square miles (NRC 1983). The maximum amount of ice coverage during any one winter will vary depending on weather conditions during that particular year and is due to natural variations in climate.

Ice thickness in Lake Erie is reported to typically reach about 1 ft (Assel 1983), although the NRC notes a documented case where the bottom of Lake Erie was scoured to a depth of 52 ft, presumably due to rafting and ridging. Similarly, NYPA reports that rafting and ridging processes can generate ice

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accumulations up to 33 ft thick even in the early winter when the ice is generally thin. Abdelnour (1995) notes that ice thickness can be predicted by use of a regression equation (Figure 5.2.1.1-1), although the model is considered to be a loose predictor with many variables at work. The data used to develop this equation shows that ice thickness on Lake Erie varies as a function of the accumulation of freezing-degree-days (FDD) after the water reaches 32°F. Measurements typically vary from 2.5 in to 20 in. Ice on Lake Erie thickens through thermal effects and mechanical processes such as ridging and rafting. Ridging occurs when ice is uplifted by thermal or mechanical processes. Rafting occurs when one floe of ice overrides another causing one floe to submerge under the other.

As ice begins to form on Lake Erie, it typically begins to accumulate at the eastern end of the lake under prevailing wind conditions. Ice is transported within the eastern end of the lake and toward the outlet by the prevailing southwest and westerly winds that travel along the dominant axis of the lake. Lake Erie narrows sharply near the entrance to the Niagara River causing additional ice accumulation and consolidation. An ice cover does not form downstream of the boom because the velocity of the downstream current is too high to allow a stable ice cover to freeze in place or to form from smaller ice pans. In years prior to the installation of the ice boom, the result was the formation of a natural ice arch across the entrance to the Niagara River that extended from the Canadian shoreline to the Buffalo breakwaters. Figure 4.3-2 shows a photograph of the natural ice arch that formed in January of 1963. When the accumulation of ice at the eastern end of Lake Erie becomes competent, the natural arch is able to withstand the forces of additional ice that form behind it. The role of the ice boom is to accelerate the formation of this natural ice arch and stabilize unconsolidated ice during the early stages of ice development on Lake Erie. Continued formation and accumulation of ice behind the leading edge of the boom leads to additional consolidation until a stable ice cover is formed. The presence of the ice cover across the outlet limits the volume of ice that is discharged into the Niagara River as well as the production of new ice that would occur in the absence of the surface cover.

During freeze up, before the ice becomes competent, and in the absence of the ice boom, lake ice can be moved by the currents and the prevailing winds into the Niagara River. The discharge of lake ice into the Niagara River contributes to the potential for ice jam formation and elevated water levels in the upper Niagara River. Severe ice jams can result under conditions where large quantities of ice are carried from the lake into the upper Niagara River. The ice boom acts to lessen the severity of ice jams by

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limiting the volume of ice released into the river from Lake Erie and the frequency of lake ice discharges into the river.

5.2.1.2 Ice Boom Performance

Even with the boom in place, ice has bypassed the boom causing ice runs in the Niagara River. Abdelnour et al (1995) notes that there have been "45 ice runs since the ice boom was first installed." Under these circumstances ice stoppages frequently occur at the NYPA intakes, downstream in the GIP, or in the channels leading to the GIP. Minor flooding occurred in these latter events." Abdelnour further notes that ice runs occur when the prevailing wind blows approximately along the axis of the lake producing significant wind setup in the lake at the entrance to the river. The discharge into the river increases, and therefore the velocity of the water at the location of the ice boom also increases. Winds also produce waves and during early freeze up the force of the storm surge may add to breakage of the ice cover and arch behind the ice boom.

The depth of the lake where the ice boom is located varies from about sixteen feet to about 25 feet, with shallow shoals along the eastern half of the location of the ice boom and the deepest part of the channel about three-quarters of the way along the ice boom location toward the Canadian shore. Abdelnour reports observations that spans N through S, located on the west side, are the most susceptible to being overridden or bypassed by ice. This represents the area along the length of the boom where the water depth and currents are at their highest levels.

In attempting to quantify conditions that lead to an ice run, Abdelnour determined whether ice runs occurred in the early freeze-up period, the late freeze-up period, the early breakup period, and/or during the late breakup period. The classification was based on the rate of change of FDD and TDD. Abdelnour noted that three of the four severe ice runs, in which historical data was gathered, occurred in the early freeze-up period and one occurred in the early breakup period. In addition, the USACE has demonstrated a direct correlation between southwesterly and west-southwesterly wind speeds and water elevations at Buffalo Harbor Figure 5.2.1.2-1. While it is well known that the water surface of Lake Erie may oscillate in response to wind setup, the USACE analysis was performed by assuming no significant

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periodicity. In addition, the analysis was relative to the water surface elevation under static conditions immediately prior to the start of the wind event. The correlation established by USACE demonstrates that the water level of Lake Erie, and therefore the discharge within the upper Niagara River, can be predicted based on wind speed alone when winds are parallel to the major axis. Figure 5.2.1.2-2 shows the monthly distribution of probability of a storm surge. The greatest probability of a surge, defined as a surge exceeding 0.5 ft from mean monthly lake levels, occurs in November, December, and early January (NYPA 1998). December and January corresponds to the period of initial ice formation. Therefore, the most critical period for controlling ice on Lake Erie, when the ice boom is the most effective, is in the early freeze-up period.

Abdelnour et al (1995) used a one-dimensional unsteady flow model to simulate conditions leading to ice runs. The model was used to estimate average flow velocity in the cross-section of the ice boom. Depth-averaged velocity necessarily varied with location across the ice boom cross-section, being greatest at boom spans N to S where the river is deepest near the Canadian shoreline. The model showed that average velocities when ice runs occurred were 16% to 27% higher than the average value prior to ice runs. Simulations of three historical ice runs events (February 25, 1975; January, 18, 1985; and January 4, 1986) showed that the average velocities at the N to S spans during these events were 1.25, 1.21 and 1.21 ft/sec. Data from average velocities prior and during the ice run events show that ice runs started when the average velocity exceeded about 1.15 to 1.21 ft/sec and ceased when the average velocity dropped to about 1.15 ft/sec to 0.98 ft/sec.

Abdelnour notes that from average current speeds, the calculated average surface current during early freeze-up ice run events was about 2.0 to 2.6 ft/sec. These values of the surface water velocities are consistent and agree with the values of the depth-averaged water velocities calculated in the Crissman simulations. Abdelnour then calculated water level setup and the average current speed as a function of the maximum wind speed. The water level setup at the eastern end of Lake Erie produces an increase in the discharge to the Niagara River. This higher discharge results in higher water velocities at the location of the ice boom. The data indicates that ice runs would be expected to occur whenever the maximum wind speed normal to the ice boom exceeds about 25 mi/hour. This modeling and data were based on the performance of the timber ice boom in place during these events. Subsequently, the original timber ice boom, with a draft of about 14 inches, has been replaced with a boom comprised of steel pontoons. The

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steel pontoons are 30-inches in diameter, with a draft of about 18 inches. The net result of this change from wood to steel configuration of the boom is a higher performance ice boom and fewer and less severe ice runs.

Figure 5.2.1.2-3 shows that the average duration of lake ice run in the early freeze-up period, about 46 hours, was about double the average duration in the other three periods, which ranged from 19 to 26 hours (NYPA 1998). Abdelnour, et al (1995) noted that the 20-hour duration was the threshold of average duration for all the ice runs that did not lead to an ice stoppage, where ice begins to cause blockage at the power plant intakes. Abdelnour concluded that the average area of ice transported in an ice run during the early freeze-up period is about 10.4 square miles, which was two to three times the area of ice transported in the other three periods. Average ice thickness in the early freeze-up period was only about two inches, compared to 6.7, 10 and 11.4 inches successively in each of the following periods. Abdelnour concluded that severe ice runs are 10 times more likely to occur in the early freeze-up period.

Abdelnour, et al (1995) then examined ice field-ice boom interactions for the critical early freeze-up period. They assumed that the only mechanisms causing ice to bypass the boom were ice overtopping and ice rubble field interactions with the ice boom. Overtopping occurs when ice is pushed by wind or water currents onto an object, such as a shoreline, structure, or boom. "Rubbling" occurs when forces against the ice are so large that the ice is pulverized into blocks or small chunks. Wave action can also cause rupture of the ice field and can increase the forces within the ice causing ice overriding and rubbling. Abdelnour developed a straightforward simple model with assumed drag coefficients calibrated to three ice run events that occurred in 1973. The model predicts ice overtopping by submergence of the ice boom, where it was assumed that the force of the ice sheet on the ice boom caused the boom to submerge. The tethering cable system of the ice boom is 500 ft long, and being in only 25 feet of water at the critical sections of the ice boom, provides no vertical support to the ice boom timbers or pontoons. An ice boom pontoon, with a greater buoyancy reserve has a greater capacity to resist overtopping and submergence. The ice boom, with the replacement steel pontoons, reduces the number of ice runs and the severity of the ice runs compared to the original timber ice boom.

Figure 5.2.1.2-4 provides a comparison of performance characteristics of the former timber ice boom compared to the current ice boom configuration which is constructed using steel pontoons. The

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comparison uses baseline data from a 1975 ice run event to indicate performance differences for the timber boom and steel pontoon construction. The data for the steel pontoons was obtained from numerical model results while the data for the timber boom uses historical data for the 1975 ice run. The effectiveness of the current steel construction is indicated by the reduction in the total volume of ice discharged into the Niagara River compared to the timber boom. The results show a reduction of 33% in the volume of ice entering the river under conditions that were specific for this ice run event. Under less severe meteorological conditions, the modeling results indicated that the boom could reduce the volume of ice discharge by 100% (NYPA 1998).

5.2.1.3 Ice Boom Effect on Hydraulics

The ability of the ice boom to alter river hydraulics is determined by the boom's performance characteristics and effectiveness in lowering the frequency and duration of ice runs. Potential indirect effects on river hydraulics may include a reduction in the number and frequency of water level and flow fluctuations that are created by the presence of ice in the Niagara River. NYPA (1998) examined the performance characteristics of the ice boom as part of studies that were conducted at the direction of FERC in assessing impacts of hydropower operations on ice conditions in the Niagara River. The results are discussed in Section 5.2.1.2 of this report.

NYPA also performed physical and numerical modeling using historical data from previous ice runs that resulted in ice jamming in the upper Niagara River as part of its study to determine the impact of project operations on ice conditions in the river. The conclusions of the independent board indicate that the best method for lowering the risks of ice jam formation and ice-induced flooding in the river is to reduce the volume of ice entering the river. It is clear that the ice boom has an impact on river hydraulics.

Ice runs occur when winds originate from the southwest or west-southwest and travel along the dominant axis of Lake Erie. As it enters the upper Niagara River, the ice moves along the downwind riverbank which causes most of the ice to enter into the Tonawanda Channel. The predominant flow of ice into the Tonawanda Channel is a significant occurrence for several reasons. One reason involves the differing ice transport capacities of the Tonawanda and Chippawa Channels. While most of the ice enters

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the Tonawanda, this reach carries only 42% of the river's flow during open water periods. The Tonawanda has more shallow areas and constrictions than the Chippawa Channel which tends to result in increased ice stoppages and substantially reduced flows at these sections of the river in the presence of ice. An ice jam in the Tonawanda section of the river can reduce flows by half in the channel. This substantially decreases the ice transport capacity within the channel. In addition, the banks of the Tonawanda Channel are more susceptible to water level increases and flooding with a freeboard of approximately 2 feet at Cayuga Island and an average of about 5 ft along the remainder of the Tonawanda Channel. Freeboard is the difference in water level stage at the mean annual flow and the crest of the riverbank where flooding occurs. In contrast, the banks of the Chippawa Channel have a freeboard of approximately 3.5 ft at the lowest point and average about 7 ft along the remainder of the channel. The characteristics of the Tonawanda section of the river result in a much higher susceptibility to and occurrence of ice stoppages and ice jams in the channel with corresponding elevated water levels. The lower freeboard means the Tonawanda Channel is also more susceptible to flooding and erosion. Thus, the ice boom, in limiting the volume, frequency, and duration of ice discharges into the Niagara River, would be expected to have the greatest effect in this reach of the river.

Examination of baseline data obtained from historical ice runs and ice jams that were used to calibrate the physical and numerical models in the NYPA study indicates the manner in which the ice boom influences hydraulics in the upper Niagara River. Figure 5.2.1.3-1 demonstrates the effects of an ice run in the Tonawanda Channel and GIP when the flow of ice into the river creates an ice stoppage in the GIP (NYPA 1998). These conditions produce a temporary decrease in flows within the GIP and in the upstream reach of the Tonawanda Channel. The effect of the flow reduction is to decrease the ice transport capacity in both the GIP and Tonawanda reaches of the river, resulting in an increased risk of the occurrence of a full-scale ice jam in the upper Niagara River, and upstream flooding.

The increase in water levels that is typically associated with ice stoppages in the GIP and Tonawanda Channel is shown in Figure 5.2.1.3-2. The effect of the ice stoppage in the GIP indicates corresponding water level increases that occur upstream. Elevated water levels occur in reaches of the upper Niagara River that include the LaSalle Yacht Club, Tonawanda Island, Huntley Station, and Frenchmans Creek (NYPA 1998). The specific locations of these areas are diagrammed in Figure 1.1-1. Another example of the ice-induced water level increase is presented in Figure 5.2.1.3-3. The data

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provided in this figure is for an ice run event that occurred in February 1975 prior to the introduction of the steel pontoon construction of the ice boom. The data further indicates the effects of ice discharge from Lake Erie on water levels in the upper Niagara River. In this ice run event, water levels increased by almost 5 ft in the upper Niagara River (NYPA 1998). Although data from this event were taken under conditions when the ice boom would likely have little effect (i.e. high flows, high duration discharge), the principles remain the same. Ice discharges into the upper Niagara River can result in elevated water levels in upstream reaches of the river from the location of the ice jam or ice stoppage. The ice boom decreases both the number and frequency of these water level fluctuations and the potential for flooding that can result.

5.2.2 Flooding

Potential impacts of the ice boom on flooding are indirect and secondary. They are indirect since the boom does not affect water flow into the Niagara River. Water flows into the Niagara are partly determined by the energy slope that is created by elevation differences between Lake Erie and the Niagara River. More importantly, the water level at the eastern end of the lake is the predominant factor affecting flow into the river (NYPA 1998). Lake Erie is also the source of ice that produces most jamming in the river. In the early winter, the consequences of ice stoppages and ice jams are related to both the volume of ice transported into the river from Lake Erie and the total flow into the river from Lake Erie. Potential effects of the boom on water level fluctuations and flooding is both determined and limited by the ability of the boom to reduce the volume and duration of ice that is discharged into the Niagara River. By effectively reducing the amount of ice that enters the river, the boom reduces the number and therefore frequency of ice-induced flooding events.

The differences in flow, ice discharge, ice transport capacity, and amount of freeboard in the Tonawanda compared to the Chippawa Channel indicate that the potential effects of the boom in decreasing the risk of flooding events would have the greatest impact on this section of the Niagara River. Since the Tonawanda is more susceptible to the effects of elevated water levels and flooding, the reduction of ice would be expected to benefit this reach of the river the most. Although the impact of the boom in reducing the risk of ice-induced flooding has not been quantified, analysis indicates that the Tonawanda reach benefits to some degree from the reduction in ice that is discharged into the river.

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The National Research Council (1983), in addressing the impacts of the ice boom on flooding, noted that the most vulnerable areas in the Niagara River were Cayuga Island and Grand Island. In most cases where flooding occurs in a river system, the cause is due to excessive seasonal runoff. In the Niagara River, however, floods generally result from the backwater effect of ice buildup in the region around the Grass Island Pool. This results in decreased flows near the area of the ice jam which causes the water level to rise further upstream and can create flooding in the upper Niagara River.

Development demands and potential impacts of power generation losses, shoreline flooding, and property damage has grown over time. The onset of World War II dramatically increased the role of Niagara Falls as an industrial center. In the ensuing years, development has increased dramatically along the Niagara River. The number of homes, docks, and other shoreline structures, as well as the value of these assets, at the riverfront has substantially increased. Similarly, the need for economical power generation has grown.

Thus, the susceptibility to the effects of ice jams and flooding has increased over time and small impacts are more significant and consequential than they were in the past.

The ice boom does not completely eliminate ice from entering the river and does not reduce the magnitude of extreme ice-induced flood events. As noted in other sections of this report, the boom is designed to submerge under severe winds and weather. This design feature prevents complete failure of the ice boom anchoring system when exposed to extreme forces of wind driven ice on Lake Erie. Thus, the ice boom has little effect on ice-induced floods caused by severe wind and other extreme weather events. However, the improved steel pontoon construction of the ice boom, when modeled using data from previous high-volume, high-discharge ice runs, significantly reduces the probability of some of these extreme events (Section 5.2.1.2). The probability of such a reduction is dependent on a number of factors related to each ice run event.

While the boom cannot prevent flooding from large scale ice runs, the NRC concluded that “there is ample reason to believe that more frequent, moderate floods are alleviated in severity or eliminated entirely” (NRC 1983). Since the NRC report was issued, the ice boom performance characteristics and

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design features have improved through the use of steel pontoons as noted in Section 2.2.4. Thus, the boom would be expected to further reduce the flooding potential caused by ice runs into the Niagara River.

5.2.3 Erosion

The potential impacts of the boom on erosion in the upper Niagara River are secondary to other factors that produce erosion. The primary driving forces for erosion are: 1) wind-generated and vessel-generated waves and 2) river currents (Baird 2005). Other processes may play a role in erosion including ice scouring, debris, surface runoff, groundwater flow, and weathering. Because Lake Erie is the primary source of the ice that produces ice jams in the river, indirect effects of the ice boom are limited to the ability of the boom to prevent ice from entering the river thereby attenuating the effects of ice jamming that historically have resulted in upstream and downstream flooding. Since flooding can contribute to shoreline erosion, the effect of the boom would be considered beneficial.

The boom also has an indirect effect by reducing the impacts of ice scouring in the Niagara River. The reduction in the volume of ice discharged into the river decreases the potential for erosion caused by ice scouring. Movement of ice into the upper Niagara River can increase the erosional process through scouring and gouging of the riverbed and shoreline. When combined with high water levels, which typically occurs during lake ice runs and storm surges at the eastern end of Lake Erie, the erosional forces of ice and water can modify river banks, channels, and shorelines and destroy shoreline structures (NRC 1983). Use of the ice boom has the added benefit of reducing the volume of ice formed in Lake Erie. As long as a stable ice cover is present in Lake Erie, new ice is not formed in the underlying water column. The heat retaining capacity provided by the surface cover limits the formation of new ice. The ability of the boom to reduce the effects of scouring is directly related to the boom's effectiveness in reducing both the volume of ice entering the river and the amount of new ice generated within Lake Erie. Since the boom has proven to be effective in reducing ice discharges into the Niagara River and in maintaining a stable ice cover in Lake Erie, the ice boom limits the effects of erosion that is caused by ice-induced flooding and ice scouring.

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The effects of the ice boom on scouring also extends to nearshore areas of Lake Erie. Shorelines in the Buffalo area are frequently composed of soft, easily erodible sediments such as weak shale beds, and unconsolidated materials of glacial origin. The NRC (1983), in response to public concerns that ice retained on Lake Erie by the ice boom may cause increased erosion, noted that the presence of the ice boom reduces shore erosion. By facilitating the formation of a stable ice arch, the boom reduces the movement of ice toward the Niagara River, and it speeds the formation of a solid ice cover, which also reduces wave action in nearshore areas of Lake Erie.

Since the ice boom does not completely prevent ice from entering the river, erosion due to ice scouring and ice-induced flooding continues to occur on the Niagara River. Potential impacts of the boom on erosion are partially limited to areas that are actively eroding or have the potential to be exposed to erosional forces such as flooding and ice scouring. Baird and Associates (2005) conducted a shoreline assessment in order to identify and delineate areas of the upper Niagara River that were experiencing significant erosion. Results of their survey indicate that only 3% of the upper river shoreline has been identified as actively eroding. In addition to assessing the shoreline for erosional areas, Points of Interest (POIs) were also identified by Baird and Associates. POIs are defined as areas that are not presently eroding but have either eroded in the past or appear susceptible to future erosion. Both erosion areas and POIs are diagrammed in Figure 5.2.3-1. These areas would be expected to benefit from the positive impact of the ice boom in the reduction of ice-induced flooding events and erosion processes. As demonstrated in Section 5.2.1.3, the beneficial effects of the boom would primarily occur in the GIP and Tonawanda channels of the river.

Potential positive effects of the ice boom are also limited by the extent and condition of shoreline protection structures that are present in the upper Niagara River. Baird and Associates (2005) conducted a shoreline protection inventory in an effort to acquire preliminary data related to the degree of protection that occurs in the river. Results of their assessment demonstrate that approximately 63% of the upper river shoreline is protected by some form of coastal structure. In general, areas of shore protection are described as being in "fair to good condition." However, the draft assessment does not include an evaluation of whether the protection is well designed or constructed, but refers only to the structures' state of deterioration. Areas of shoreline protection identified by Baird are depicted in Figure 5.2.3-2. The presence of the ice boom can have the added benefit of reducing damage caused by moderate flooding

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and ice conditions to these shoreline structures. Damage to these structures as a result of ice jamming or flooding could potentially increase, in certain instances, the amount of shoreline exposed to erosional forces. This is significant since the presence of these structures is generally viewed as an indicator of the susceptibility of the shoreline to erosion.

5.2.4 Water Quality

There are a number of parameters that can affect the quality of surface waters within the study area. Factors relevant to ice boom use and storage include:

- water level and flow fluctuation;
- impact on ice scouring; and
- land use and surface water discharges

Water level fluctuations can contribute to factors affecting surface water quality, such as riverbed and stream bank erosion. The effects of flooding can similarly affect the rate and the type of shoreline erosion. Scouring of a riverbed or lakebed can occur when ice moves across the bottom of the water body resulting in increased sediment discharge into the receiving waterbody. Each of these factors can influence overall water quality of the area subjected to flooding and erosional forces.

The analyses in Section 5.2.2 and Section 5.2.3 conclude that the ice boom reduces the risk of flooding and erosion caused by ice discharge into the Niagara River. Although not quantified, flooding and erosion introduce sediments into the river which can decrease the overall water quality in the watershed. In this context, the ice boom reduces the amount of suspended sediment in the river.

Land use and stormwater practices can also affect water quality in local watersheds. The ice boom storage area is an undeveloped property and is not subject to construction activities or other land use practices that typically produce sedimentation or erosion. In addition, there are no industrial processes conducted at the site. As a result, the site does not have stormwater control structures, conveyances, or outfalls and does not discharge wastes or other chemicals into the environment. Thus,

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there are no known negative effects on surface water quality from land management and use activities conducted at the storage parcel.

5.3 Ecological Resources

This section provides an evaluation of potential effects of the ice boom on the ecological resources of eastern Lake Erie and the upper Niagara River. Ecological resources that may be affected by the ice boom are aquatic resources. Terrestrial resources, such as wetlands, birds, and fish-eating wildlife may also potentially be affected by the ice boom. The primary sources of information for the evaluation in this section are the 1983 NRC report and Stantec et al. (2005). In their 1983 report, the NRC concluded that any impacts of the ice boom on ecological resources would, under worst-case scenarios, be very minor, if not negligible. Nevertheless, the NRC made recommendations regarding the removal date (April 1) and conditions (250 square miles of ice) under which the ice boom would mitigate potential impacts. The IJC implemented these recommendations in 1984.

5.3.1 Aquatic Resources

Potential impacts of ice floes and ice jams on the aquatic resources of eastern Lake Erie and the upper Niagara River primarily fall into three general categories: (1) delayed warming of spring temperatures, (2) flooding of spawning and feeding habitats, and (3) alteration of habitats due to scouring and erosion (NRC 1983; Stantec et al. 2005). No studies have been conducted to directly assess the impact of the ice boom on aquatic resources. However, the impact of water temperature on aquatic life is well studied and a wealth of information is available on the topic. The NRC report (1983) specifically addresses the potential ecological effects of the ice boom on aquatic organisms due to a delay in the spring warming of water temperatures. Although the NRC concludes that there are insufficient temperature data to directly assess the direction and magnitude of impacts attributable to the ice boom, the report does offer an analysis of the changes that would cause impact.

Section 5.1 of this document provides a discussion of the NRC analysis, as well as statistical analyses of pre-boom and post-boom water temperatures in Lake Erie. The analysis contained in this

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report concurs with the NRC that potential delays in the warming of spring water temperatures and dissipation of lake ice imposed by the ice boom are negligible. In addition, the implementation of the NRC recommendation for earlier removal of the boom was designed to mitigate any potential impacts of the boom on water temperature.

Reports prepared by the NRC (1983) and Stantec et al. (2005) identify lake sturgeon, lake trout, smallmouth bass, largemouth bass, yellow perch, walleye, northern pike, muskellunge, bluntnose minnow, brown bullhead, greater redhorse sucker, common (white) sucker, and burbot as fish species that spawn in the vicinity of the ice boom. As identified by the NRC, a delay in the onset of spring warming of water temperatures may affect spawning and reproductive success of these species. Based on calculations of changes in water temperature, the NRC concluded that if the ice boom caused a water temperature change of less than 1 F and if the rate of change was compensated for within two days, any impacts caused by a delay in spring warming of water temperatures would be negligible under normal circumstances. However, ecologically significant impacts may occur if the effects of the ice boom on spring water temperature were underestimated.

The NRC (1983) identified a more specific, but not quantified, potential effect of the ice boom on fish spawning. This effect is asynchrony of water temperatures in the vicinity of the ice boom and water temperatures in spawning grounds. Some species of fish may spawn in wetlands adjacent to and hydrologically connected to the Niagara River. The NRC did not identify fish species that fall into this category. As discussed in Section 4.4.1, several species of sport fish, including muskellunge, northern pike, smallmouth bass, yellow perch, and rock bass, spawn in the wetlands and/or shoals in the vicinity of Grand Island. Descriptions of life histories provided by Stantec et al. (2005) suggest that other species, such as largemouth bass, bluntnose minnow, brown bullhead, greater redhorse sucker, and white sucker may spawn in wetlands along the upper Niagara River. Water temperatures in the shallower wetlands warm up more quickly than the deeper waters of the upper Niagara River. Because palustrine emergent wetlands are primarily in the vicinity of Grand Island (Stantec et al. 2005), wetlands that serve as spawning grounds are spatially removed from the ice boom and the immediate influence of the boom on water temperatures. Since movement of fish to spawning grounds is triggered by water temperature (NRC 1983), movement of the aforementioned fish species from eastern Lake Erie and the head of the upper Niagara River to the wetland spawning areas would not occur until a critical water temperature is

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reached. If achievement of the critical water temperature at the head of the upper Niagara River is delayed to the point that it is out of synchrony with the water temperature of the wetlands, then conditions in the wetlands may not be optimal for spawning. Fish movement from eastern Lake Erie to the wetlands adjacent to Grand Island was not documented in the performance of this study. Analysis of the listed species indicates that yellow perch would be the most likely of these species to undergo this type of movement. Based on its ecology, yellow perch commonly move large distances downstream to spawn. The analysis contained in the climate section of this report indicates no significant effects to water temperatures. Therefore, spawning by these species is not expected to be impacted by asynchrony.

A delay in spring warming could also reduce the growing season for fishes. According to the NRC, a few days reduction in the growing season would have minor impacts. The NRC did not quantify the extent of impacts that might occur. However, any negative impacts on the growing season are expected to be negligible. As documented in Section 5.1 of this report, the natural year-to-year variability in the timing of spring warming is much larger than any attributable to the ice boom.

The NRC report (1983) identified several potential positive effects of delayed warming of spring water temperatures in the vicinity of the ice boom. For one, a delay in spring warming decreases the probability of negative effects on reproductive success due to temperature reversals, that is, a cool down in water temperature following initial spring warm up. Reproductive success could be significantly affected if delays in spawning occur once fish are ready to spawn. According to the NRC, fish may not spawn at all if one to two weeks are required for the water to re-achieve the critical temperature for spawning. If spawning does occur, egg development may not be successful.

Another potentially positive effect of the ice boom on fish reproduction is compression of the time for spawning activity. By delaying spawning, waters in which eggs are deposited may be warmer than they would without delays caused by the ice boom. This would tend to decrease, or compress, incubation time of eggs and development time of larvae. The decrease in time required for these two critical life stages would also decrease the time eggs and larvae would be vulnerable to predation. However, a compression of spawning time could also have a detrimental effect. If a catastrophic natural event occurred during the compressed spawning period, spawning may be significantly disrupted or not occur at all. Similarly, a delay of spawning for some species may cause encroachment of spawning

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activity and incubation periods of other species. The occurrence of similar spawning and incubation periods, for species that under normal circumstances do not overlap, may lead to more intense competition and possibly predation of eggs and larval. It should be noted that these possible impacts are only identified as possible by the NRC, and are not based on empirical data.

A second type of impact that may affect aquatic resources is flooding caused by ice jams in the upper Niagara River. The NRC (1983) states that flooding occurs as a result of water level increases upstream from ice jams that form in the upper Niagara River. Stantec et al. (2005) did not directly address impacts of the ice boom on water level fluctuations. However, findings related to the effects of water level fluctuations, including flooding, on ecological resources can be extrapolated to the ice boom.

Section 5.2.1.3 of this report discusses the mechanics of flooding caused by ice jams. As discussed in Section 4.3.1, ice jams are most likely to occur in shallow water and areas where the river channel narrows. The Strawberry Island-Motor Island Shallows are susceptible to the effects of ice jams. Water depth in this area is shallower than in other areas of the Niagara River. Furthermore, the Strawberry Island-Grand Island Shallows are in the vicinity where Grand Island separates the Niagara River into the Chippewa and Tonawanda Channels. Ecological resources in this area include SAV beds that provide spawning habitat for several species of fish. The GIP is another area potentially susceptible to ice jams due to the presence of shoals and shallow water.

The ice boom has been effective in reducing the number and severity of ice jams in the upper Niagara River. Replacement of the original timber pontoons with steel pontoons in 1997 has further reduced the number and intensity of ice runs. Therefore, it can be concluded that the ice boom has a positive effect on aquatic resources by reducing the frequency of flooding due to ice jams.

Although the boom has been effective in decreasing the number of ice jams, it cannot mitigate the impacts of severe events Stantec et al. (2005) provide a detailed discussion of the effects of changes in water elevations on fish and other ecological resources of the Niagara River. While the discussion in the Stantec study focuses on impacts due to diversion of water for power generation, the impacts due to raising the water elevation are applicable to flooding that may result from the ice runs.

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Beds of submerged aquatic vegetation (SAV) occur within the upper Niagara River from the head of the river to the area north of Grand Island. Based on cross sections of the Niagara River provided by Stantec et al. (2005), SAV beds primarily occur at depths of 2 to 6 feet, or greater. Because SAV beds occur at water depths unaffected by flooding, the ice boom has little effect, if any, on SAV.

Stantec also evaluated the potential effects of flooding on 13 focus species of fish known to inhabit the upper Niagara River: emerald shiner, lake sturgeon, lake trout, muskellunge, largemouth bass, smallmouth bass, walleye, yellow perch, bluntnose minnow, brown bullhead, greater redhorse sucker, white sucker, and northern pike. These are representative species that use the various habitats in the upper Niagara River. The evaluation was based on known habitat and life history characteristics of the focus species and estimates of fluctuations in water elevation. According to Stantec, water level fluctuations are restricted to the top 2.5 ft of the water column. Stantec concluded that water level and flow fluctuations have the potential to affect the spawning, egg, and larval habitat used by the focus species with the exception of emerald shiner, which is pelagic. However, most of the focus species spawn and have larval habitat within a range of water depths that exceed 2.5 feet. Thus, the potential effects resulting from the loss of use of shallow water habitats are somewhat mitigated by the fact that suitable habitat exists at greater depths and affords opportunities for these species' life stages at depths that are not affected by water level fluctuations. With the exception of white sucker, potential effects of water level fluctuations are restricted to the top of the range of water depths for reproductive activities. White sucker spawn in water depths within 1 ft of the surface over pebble and gravel substrates. These conditions exist along the shoreline of most of the upper Niagara River. Stantec et al (2005) concluded that, of all the focus species, the spawning of white sucker had the greatest potential to be affected because of the limited spawning depth requirements (0.2 - 1 ft), a range of depths that are fully encompassed by the water level fluctuations in the upper Niagara River.

Flooding and water level fluctuations caused by ice passing over the ice boom are not likely to correspond with reproductive activities for most species of fish. For example, Stantec et al. (2005) specifically identify the spawning season of largemouth bass, muskellunge, bluntnose minnow, brown bullhead, and greater redhorse sucker as May through June. Northern Pike are reported to spawn in late March to late April with previous studies indicating that 97% of the northern pike collected during the spawning season in the Upper Niagara were collected in its tributaries despite extensive mainstem river

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sampling. As discussed in Section 5.2.1, the most severe ice runs typically occur during early freeze-up (December-January), which does not coincide with the spawning season of these focus species. Water level fluctuations and flooding caused by spring ice jams is also most likely to occur prior to the spawning season for these species. Furthermore, ice floes released in late spring are typically not of a sufficient size or integrity to cause flooding.

The net impact of the boom on ice-induced flooding is positive. The number of these events is lower with the boom than if the boom were not in operation because the ice boom has reduced the number and intensity of ice jams. In general, the reduction in flooding and water level fluctuations caused by ice discharge into the Niagara River is considered to be beneficial to those species whose habitat and spawning activities coincide with the period of operation of the ice boom.

The NRC report (1983) identifies scouring as a third potential type of impact attributable to the ice boom. The two potential negative effects of scouring on SAV are destruction of vegetation and alteration of substrate, through erosion or other changes in composition of the substrate caused by gouging, which may also affect the abundance and distribution of SAV. The thickness and depth of ice jams is dependent on meteorological and hydraulic conditions. Because aquatic beds generally occur at depths greater than 2 feet, effects of ice jams on submerged aquatic vegetation would be minimal when the maximum depth of ice scour is 2 feet or less. Scouring of bottom and nearshore habitats by ice that has overtopped the boom could also potentially destroy habitat and/or eggs of fish species that spawn prior to complete spring melting of the ice held by the boom. However, as discussed above, spawning for most species in the upper Niagara River occurs after April, when the ice sheets sufficient to cause scouring are not expected in the river.

The NRC report (1983) identifies at least one potentially positive effect caused by ice scouring. Gouges in the soft sediment areas and small fragmented rock areas created by ice scouring of the river bottom and nearshore habitats may actually create new habitat, thus increasing the diversity of habitats in the upper Niagara River. Creation of new habitat by ice scours can provide spawning sites and larval refugia for fish. New habitat created by scouring may also support a greater abundance and diversity of benthic macroinvertebrates.

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The NRC report (1983) acknowledges that the actual effects of the ice boom on scouring the river bottom and nearshore habitats have not been quantified. Both the negative and positive effects discussed above are based on theory and have not been verified by field studies. Another consideration regarding the effects of scouring, negative or positive, is the effects with and without the ice boom. Previous sections of this report document the success of the boom in reducing the number and intensity of the ice jams in the upper Niagara River. Any negative effects created by scouring are likely to be reduced as a result of the boom's effectiveness. Any positive effects of scouring are similarly limited.

5.3.2 Terrestrial Resources

5.3.2.1 Botanical Resources

Potential effects of ice runs on palustrine wetlands include flooding and scouring. The effects of flooding or scouring on wetland communities, other than effects on fish and macroinvertebrates that may inhabit these communities (NRC 1983) are largely unknown. A qualitative assessment of potential impacts is provided below.

Wetlands in the upper Niagara River include an area of palustrine emergent wetlands associated with Strawberry Island, near the southern tip of Grand Island. Other wetlands are located along the Tonawanda Channel on the east side of Grand Island. An area of palustrine emergent wetlands has been identified along the southeastern side of Grand Island. A larger area of palustrine emergent and forested wetlands is located along the east central side of Grand Island, directly across from Tonawanda Creek. Another large wetland complex is found at the northern tip of Grand Island (Buckhorn Island Wetlands). The composition of plant communities in wetlands is largely a function of the tolerance of individual species to specific hydrologic regimes. Some species tolerate extended periods of inundation, whereas other species are able to tolerate only brief periods of submersion. A potential effect of flooding would be inundation beyond the tolerance of species that are able to withstand only brief periods of submersion, resulting in a temporary or permanent loss of flood intolerant species. Impacts of flooding on wetlands in the upper Niagara River are likely to be very minor. First, there are limited areas of wetlands along the shores of the upper Niagara River. Second, the majority of flooding caused by ice runs would occur

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outside of the growing season, when plants tend to be dormant. Any effects of flooding would most likely effect palustrine emergent wetlands, but not palustrine forested wetlands. As documented by Stantec et al. (2005), forested wetlands occur at a higher elevation than emergent wetlands and are, thus, less likely to experience flooding.

Scouring would affect wetlands by physical disturbance of plants. Potential effects may be both negative and positive. Negative effects include destruction or elimination of plants from the wetlands community. Positive effects include creation of new habitats, which would increase the diversity of wetlands communities. Any effects due to scouring are likely to be minimal. The number and area of wetlands within the area of influence of ice runs are limited. As with flooding, palustrine emergent wetlands would be more vulnerable to ice scour than palustrine forested wetlands.

The area of the upper Niagara River most susceptible to ice jams and flooding is the Grass Island Pool area and upstream reaches of the river, particularly within the Tonawanda Channel. The Buckhorn Island Wetlands, located near the GIP, includes palustrine emergent wetlands. These emergent wetlands have the potential to be affected by flooding due to ice jams. However, because the ice boom reduces the number and intensity of ice runs, the net effect of the boom is to reduce the potential for water level fluctuations and flooding caused by ice discharge into the Niagara River.

There is little natural vegetative cover in the immediate vicinity of the ice boom due to the high degree of development at the head of the Niagara River. Stantec et al. (2005) describes vegetative cover on Grand Island, Strawberry Island, and Motor Island. Because terrestrial plant communities generally occur at elevations above the influence of flooding and ice scour, the most likely effect would be changes in temperature regimes caused by the ice boom. Based on the analysis presented in Section 5.1.2, the potential effect of the boom on ambient air temperatures in the vicinity of the ice boom is considered to be negligible. Any changes in ambient air temperatures attributable to the ice boom are insignificant compared to the natural year-to-year variation in local temperatures. As noted throughout this report, implementation of the NRC recommendations in 1984 effectively precludes impacts on local microclimate.

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5.3.2.2 Wildlife Resources

The Niagara River Corridor is a resting and overwintering area for a large number and diversity of migratory waterfowl. Several species of waterfowl also nest within the Niagara River Corridor. Although the NRC acknowledged that information is not available to assess the effects of the boom on wildlife, the NRC report (1983) concluded that the ice boom has negligible impact on waterfowl. The primary impact would be lack of access to food due a delay in the disappearance of the ice cover. The NRC also concluded that a delay of a few days in gaining access to feeding grounds would be insignificant. As discussed in previous sections, year-to-year variability in the timing of spring warming is much larger than any effect attributable to the boom and the boom is released earlier as a result of the NRC recommendations. Furthermore, many of the species of migratory waterfowl are not present in the area during early spring when potential effects of the ice boom on water temperature would occur.

Stantec et al. (2005) assessed the effects of changes in water level fluctuations on several species of amphibians, reptiles, and mammals. Portions of this study are relevant to the ice boom and flooding caused by ice jams. Amphibian species evaluated by Stantec included northern spring peeper, northern leopard frog, green frog, and common mud puppy, all of which deposit eggs in shallow water. Release of ice into the river following deposition of eggs may destroy eggs or transport eggs to habitats where desiccation and/or predation of egg mass may occur. However, increases in water levels caused by ice jams and scouring of critical habitat during the breeding season are unlikely to affect these species because this would have to occur in late spring. Since the most severe ice runs tend to occur during ice formation in December-January, which does not coincide with the breeding season for most species of wildlife, any effects of this type are considered to be negligible.

Stantec et al. (2005) also identifies several species of amphibians and reptiles that reside in aquatic habitats during the winter. In particular, they identify the green frog, northern leopard frog, common snapping turtle, and midland painted turtle as having submerged habitats. The scouring effects of ice may destroy hibernacula or interrupt overwintering, which may have significant ecologically effects on these species.

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Muskrat is another focus species evaluated by Stantec. Muskrat build dens into banks of rivers, which are typically constructed above the waterline. Flooding caused by the ice jams may submerge these streamside dens. Stantec identified a muskrat strategy of building both high elevation and low elevation dens to accommodate fluctuating water levels. Therefore, the impacts of flooding attributable to the ice boom on muskrat is likely negligible.

As is the case for other potential impacts, the net effect of the ice boom on terrestrial wildlife is positive. In the absence of the boom, ice-induced flooding and scouring would be more frequent, resulting in greater impact than with the operation of the ice boom.

5.4 Land Management and Planning

The City of Buffalo and Erie County have comprehensive plans that establish policies and goals for future development. Zoning ordinances to implement comprehensive plans and regulated development exist for most municipalities in New York State. These state laws, which enable municipalities to enact regulations to govern land use, are not applicable to land owned by the state or agencies of the state, including NYPA. Municipal land use planning and regulatory documents generally recognize lands owned by NYPA and do not recommend land uses that conflict with continued operations at these sites. For example, municipalities do not have site plan approval for the development plans of state agencies (e.g. university campus expansion) on their property. Similarly, a state agency does not need a building permit as long as the agency is in compliance with applicable building codes.

The ice boom storage area consists of approximately 13 acres of undeveloped property. Use of the property is described in Section 4.5. Existing land use (Figure 4.5.3-1) of areas adjacent to the ice boom storage area includes commercial properties, community services land, and vacant commercial properties. Parcels adjoining the ice boom storage area are primarily owned and/or controlled by various governmental agencies. Other landowner agencies include the USCG, NFTA, and the City of Buffalo. Most of the properties surrounding the ice boom storage area are categorized as vacant land. Vacant areas include the NYPA ice boom storage site, the City of Buffalo's proposed Times Beach restoration project site, and the NFTA proposed Outer Harbor Redevelopment area. The USCG facility is considered a

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Community Service area. Commercial properties include the Ganco Inc. Boat Storage Area and Marina, Buffalo Sailing Marina, City Ship Canal and Cargill Inc. A brief description of these properties and their current use is provided below.

The City of Buffalo owns a strip of vacant property, Times Beach, which is adjacent to the NYPA parcel where the ice boom is stored. Times Beach is a former Confined Disposal Facility (CDF). The United States Army Corp of Engineers constructs, operates, and maintains CDFs that are used to store contaminated dredge sediments. These facilities are normally turned over to local sponsors for redevelopment after they are filled to capacity. The Times Beach CDF, built in 1972, has been turned over for non-Federal use to the City of Buffalo.

The United States Coast Guard (USCG) maintains a facility at the mouth of the Buffalo River that encompasses approximately 30 acres of waterfront property. The site is adjacent to Times Beach near the ice boom storage area at the end of Fuhrmann Boulevard. The USCG has maintained its presence in Buffalo since the late 1800's. The base provides public services such as search and rescue, law enforcement, aids-to-navigation, recreational boating safety, marine environmental response, and ice operations. Land use of the USCG facility is classified as community service land.

Other properties adjacent to the ice boom storage area house commercial works such as the Buffalo Sailing Marina, Ganco, Inc. Boat Storage Area and Marina, and City Ship Canal. These are commercial sites primarily engaged in recreational boating activities. A series of abandoned grain elevators to the east are a remnant of former industrial activity in the area. Immediately joining the NYPA parcel to the south is an undeveloped parcel of land owned by Cargill Inc. which in recent years has been used as an outdoors storage area for large quantities of salt.

Examination of data used to create Figure 4.5.3-1 indicates that land management practices and use of the NYPA site are consistent with the use of surrounding properties. Figure 4.5.3-2 contains information on the existing zoning classifications for the area. Surrounding properties are primarily classified as industrial sites for zoning purposes. These properties are located in three zoning districts including the Light Industrial District, General Industrial District, and Heavy Industrial District. The

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NYPA property is situated within the General Industrial District. NYPA's property use is considered to be compatible with the current zoning designation.

5.4.1 Waterfront Development

There are several planning initiatives and proposed development projects that could potentially impact land use in the vicinity of the ice boom storage and maintenance facility. This includes the Times Beach Public Access Project, Outer Harbor Redevelopment site, Outer Harbor Greenbelt, and the Outer Harbor Trail. The locations for these projects are shown in Figure 4.5-1. A detailed description of the proposed projects is also provided in Section 4.5.4.

The proposed Times Beach Public Access Project, presently under partial construction, has the potential to impact existing land use in the waterfront area. The site remains largely undeveloped and public access has not been permitted to Times Beach due to site contamination that occurred during its former use as a Confined Disposal Facility by USACE. Similarly, the proposed Outer Harbor Redevelopment site may impact land use in the area at some point in the future, but these effects are difficult to assess because of existing site conditions that may place limits on future development of this site due to geotechnical and restoration considerations.

Limitations imposed by site conditions on waterfront planning initiatives and proposed development projects are fueled by several factors including the presence of contaminated soil and water at the proposed locations for the Times Beach Public Access site and Outer Harbor Redevelopment project. The regulatory requirements for site restoration of the Outer Harbor Brownfield site combined with shallow depth of groundwater, areas of soil destabilization, and other geotechnical considerations make it difficult to assess current planning initiatives with regard to this site. Geotechnical considerations will likely be the primary driver of any proposed development on the NFTA property. Much of the land in the Outer Harbor Area was created as a result of land reclamation, filling, and dredging activities that have occurred over the past 100 years (NFTA 2004). As a result, individual sites within the Outer Harbor Redevelopment district will require extensive geotechnical investigation prior to construction.

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The feasibility study for the remediation component of Times Beach is not complete and has been placed on hold due to budgetary considerations within USACE. Future funding for the restoration project will continue to be dependent on the availability and allocation of adequate funding for project completion. The nature and extent of contamination along with the selected remedy that emerges from the feasibility study will ultimately determine the degree of access to the Times Beach site because of potential human health and environmental risks. Furthermore, the isolated nature of the site physically limits access to the area. As a result, stakeholders have long viewed the site as a limited access facility whose planned primary occupants will consist of birds and migratory bird species.

The proposed Outer Harbor Trail and Outer Harbor Greenbelt are envisioned as pedestrian and bicycle pathways that will increase public access to the waterfront as future development occurs in an effort to create a lifestyle waterfront destination. These proposed projects, when completed, would be expected to result in increased public recreational use of the waterfront.

Since these projects are not currently operational, the adjoining NYPA parcel cannot have an impact on adjacent properties at this time. Regardless of the outcome of the proposed projects, it is reasonable to expect that use of the NYPA property will continue to be consistent with other property uses in the area, including developments within the Outer Harbor Special District, and will remain compatible with local zoning classifications, regulations, and requirements. While definitive information is not available at this time to determine future effects of the planning initiatives and proposed developments, storage and maintenance of the ice boom is expected to continue to be consistent with existing commercial land uses in the immediate area including the USCG facility, Ganco Inc. Boat Storage facility, Buffalo Sailing Marina, and the Cargill Inc. salt storage facility. Potential impacts of future waterfront developments in the area may result in increased recreational traffic by pedestrians and bicyclists as development occurs. However, the undeveloped NYPA property with limited site access is not expected to impact the intended use of or access to proposed waterfront developments.

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5.4.2 Parks and Recreation

Previous analysis involving potential ice boom effects combined with a review of the location and function of Erie County, City of Buffalo, and Olmsted parks systems indicates that the ice boom and associated storage area have no apparent impact on the recreational use of these park systems. Thus, there are no mitigation measures available for recommendation. Analysis of potential climatic effects of the ice boom on the surrounding environment indicate that, prior to 1964, there were no significant impacts to climate and the potential that existed for small impacts has been mitigated by the implementation of the NRC recommendations for boom removal in 1984 (Section 5.1). There is no known potential for impacts to shrubs, flowers, ornamental or delicate trees, and other landscape plantings in these parks. Impacts to the recreational use of park facilities have not been identified based upon the information acquired and the studies reviewed as part of the preparation of this report. It is concluded that these parks are not affected by the ice boom.

5.4.3 Aesthetics

Front Park has been identified as a key visual resource in the area. This park has a limited view of the ice boom from mid-December to early April when the boom is deployed. The Saratoga Associates conducted a preliminary assessment of the potential impacts of the boom on visual resources at Front Park. Preliminary findings indicate that mitigation is not warranted since the boom is not readily visible from this location. Thus, the visual impact of the boom is inconsequential to most observers. (Saratoga Associates 2005.).

Front Park has been identified by the City of Buffalo as a place where deployment of the ice boom in Lake Erie potentially has an adverse aesthetic effect. It is a 26 acre City-owned park designed by the renowned landscape architect, Frederick Law Olmsted. Located north of the downtown area of Buffalo, it is located near the Peace Bridge and U.S Customs Plaza. It is part of the Olmsted Park System and is listed in the National Register of Historic Places. Front Park is considered to be an aesthetic resource of significance within the City of Buffalo.

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The park landscape has been altered over the years due to the highway and bridge encroachments. It is characterized by an expanse of open grassy areas enclosed with mature trees located mainly in the southern area of the park. A commemorative statue, tennis courts, soccer goal posts, and pedestrian pathways are features of the park.

The Niagara Section of the New York State Thruway (I-190) and several other feeder lanes of traffic separate Front Park from Lake Erie. Also separating Front Park from Lake Erie is the Colonel Ward Pumping Station, a major visual presence to the west. The station is about 500 feet long by 300 feet wide by 50 feet high and includes a utility stack. Immediately to the north of the water treatment plant and between the Park and Lake Erie are the USMC Reserve Readiness Center and the Buffalo Yacht Club. Residences line Busti Avenue to the east of Front Park while tollbooths and the entrance to the Peace Bridge are located to the north. The rest of Front Park, including substantial amounts of mature ornamental trees, occupies views to the south.

The ice boom is visible along the western edge of the park. There is no formal overlook at this location. As pedestrians move towards the east and the south, the ice boom disappears behind intervening screens that block visibility of the ice boom. The western edge of the park runs parallel to Busti Avenue and is the highpoint with the most unimpeded views of the deployed boom. The specific key vantage point has been identified as occurring along the western rim near the tennis court area at the northern end of Front Park. This spot is slightly higher in elevation than the southern end. It is also speculated that this area may have the highest winter exposure to pedestrian traffic due to the proximity to nearby Vermont Street. This is the most direct east-west route through the park and has been identified as the key vantage point.

The ice boom does not serve as a point of interest to most observers walking through or standing in Front Park. This is primarily due to the distance from key vantage points within the park. The lack of proximity renders the boom indiscernible to most observers.

During the winter, when the boom is in place, the landscape is mostly gray and white due to the presence of snow and ice. Snow and ice routinely form on Lake Erie and surrounding areas and are a

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natural part of the local climate and landscape. Ice that accumulates behind the boom would occur without the presence of the boom through the formation of a natural ice arch. In addition, ice is so pervasive within the Buffalo area that it is not a logical point of interest for most observers.

During deployment there is another effect from ice and or snow build up. Its gray-white color affords a background of sufficient contrast with the boom's dark rust brown color that the boom becomes somewhat visible, though barely so because the optical effect of size perspective renders it diminished in size so that its visual presence, even with the contrasting colors, is inconsequential (Saratoga Associates 2005).

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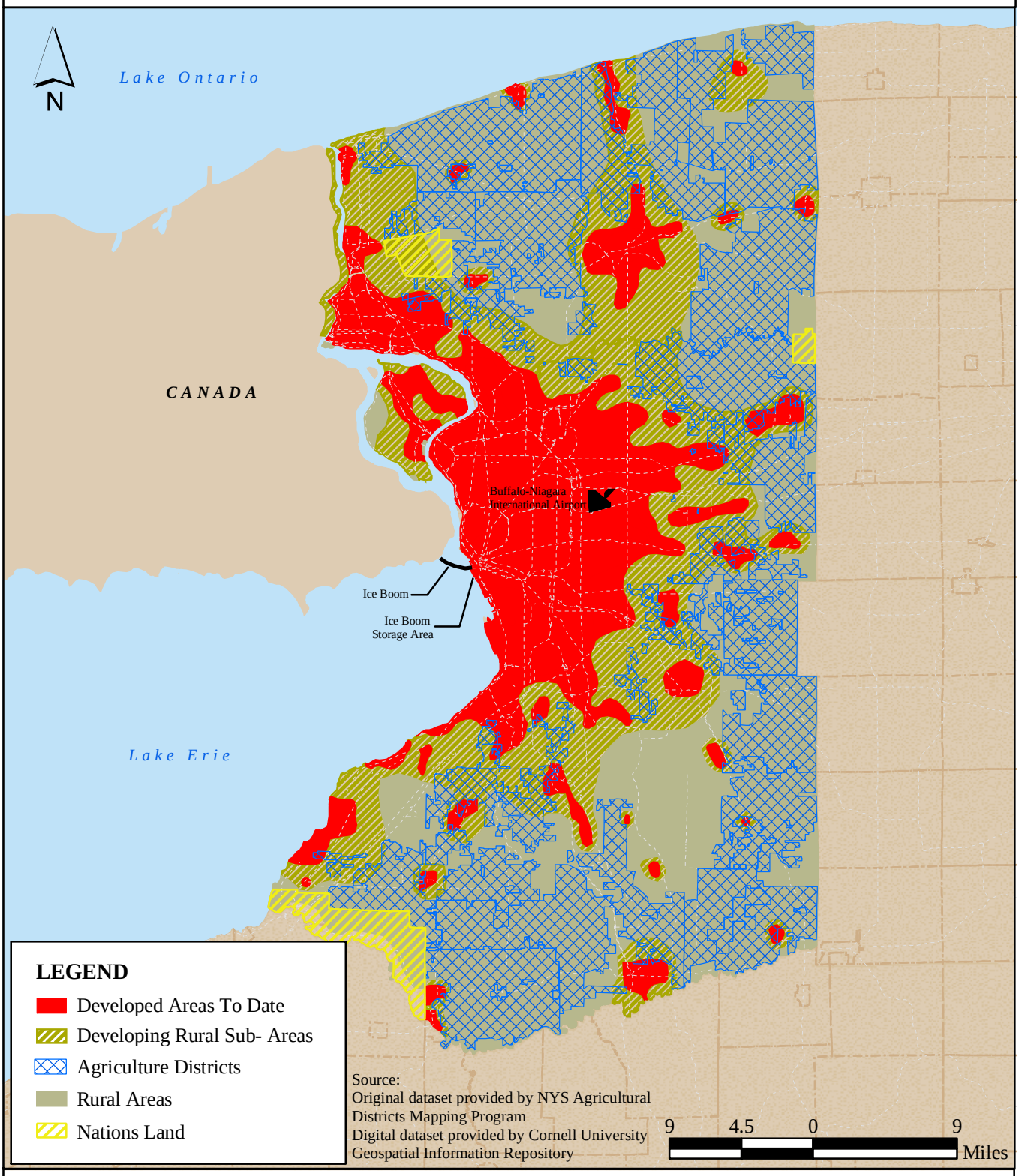
NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER ICE BOOM EFFECTS ANALYSIS



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Agriculture Districts and Developed Areas to Date

NIAGARA POWER PROJECT

FIGURE 5.1.3-1

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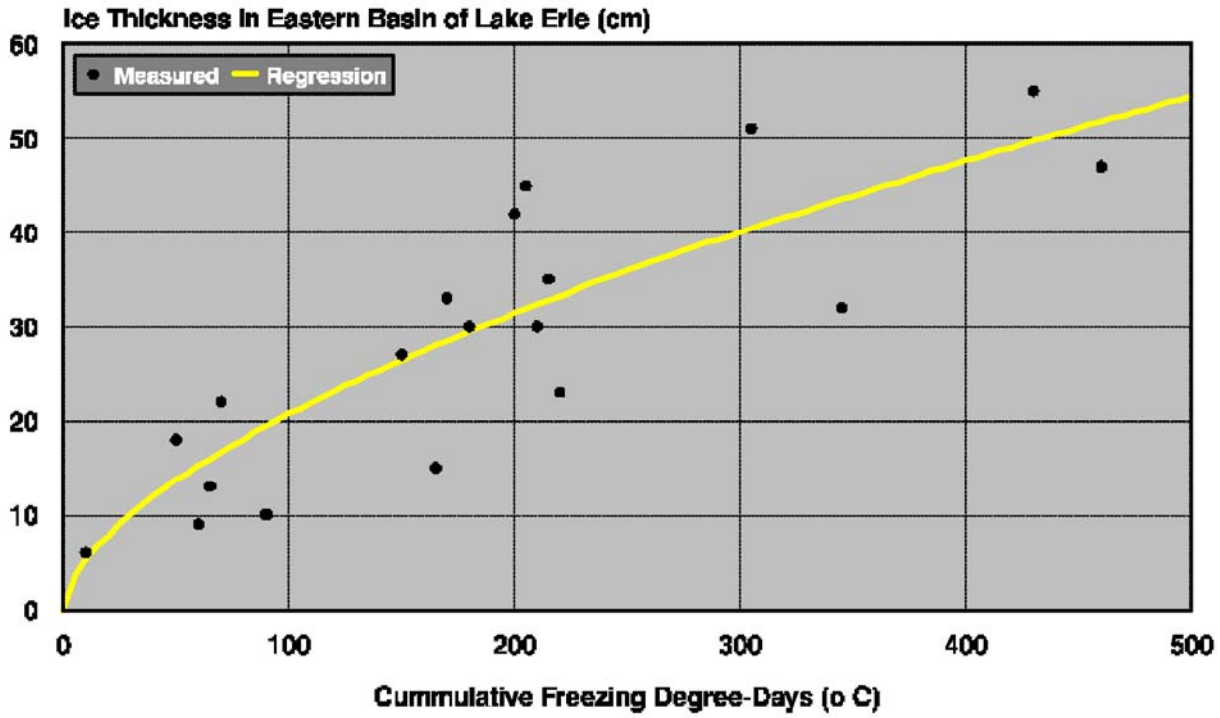
FIGURE 5.2.1.1-1

ICE THICKNESS IN EASTERN BASIN OF LAKE ERIE



Source: (NYPA 1998)

Note: 1 cm = 0.39 in; °F = (°C x 9/5) + 32

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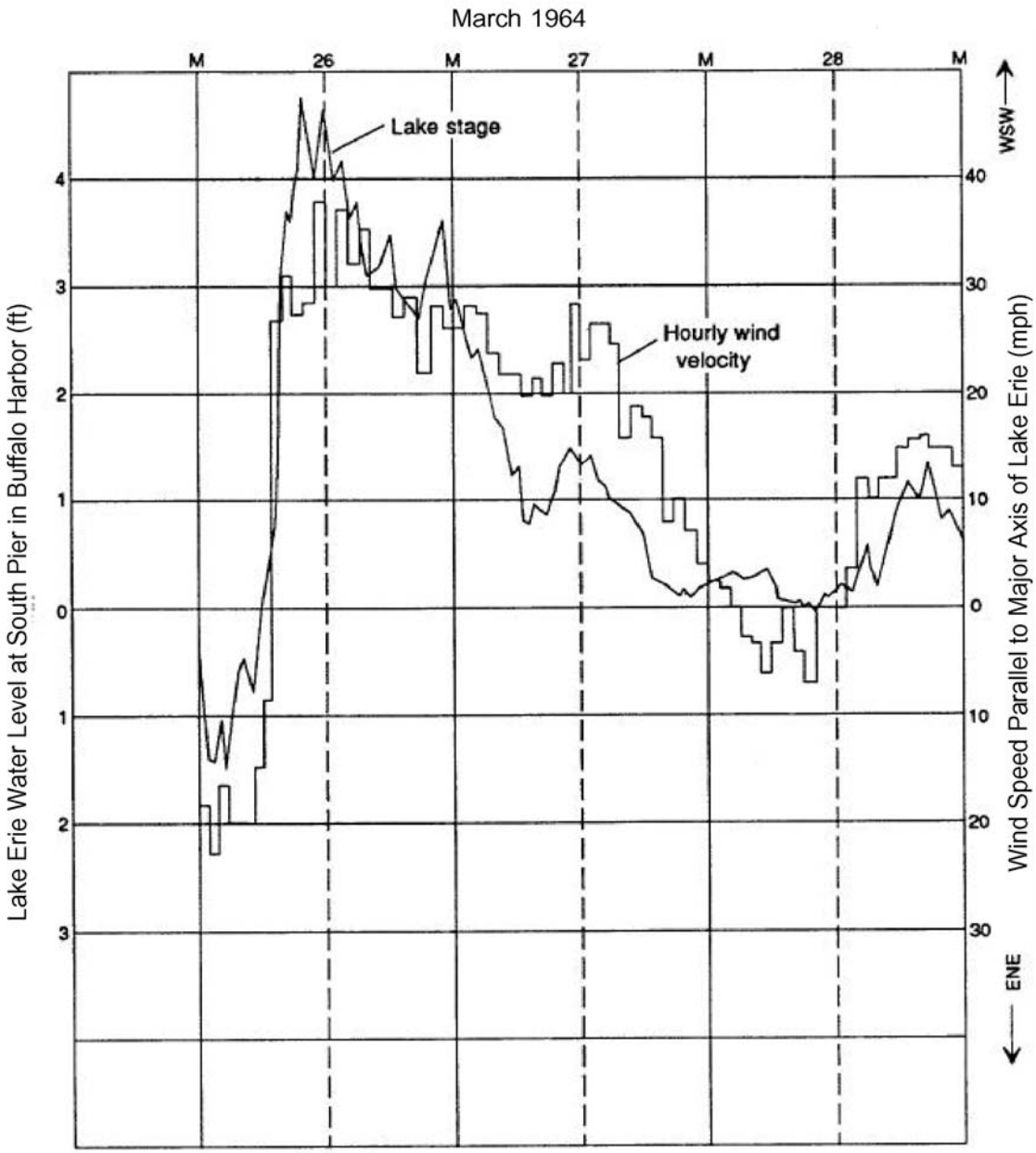
FIGURE 5.2.1.2-1

WIND SPEED AND WAVE SETUP AT THE EASTERN BASIN OF LAKE ERIE



Source: (NYPA 1998)

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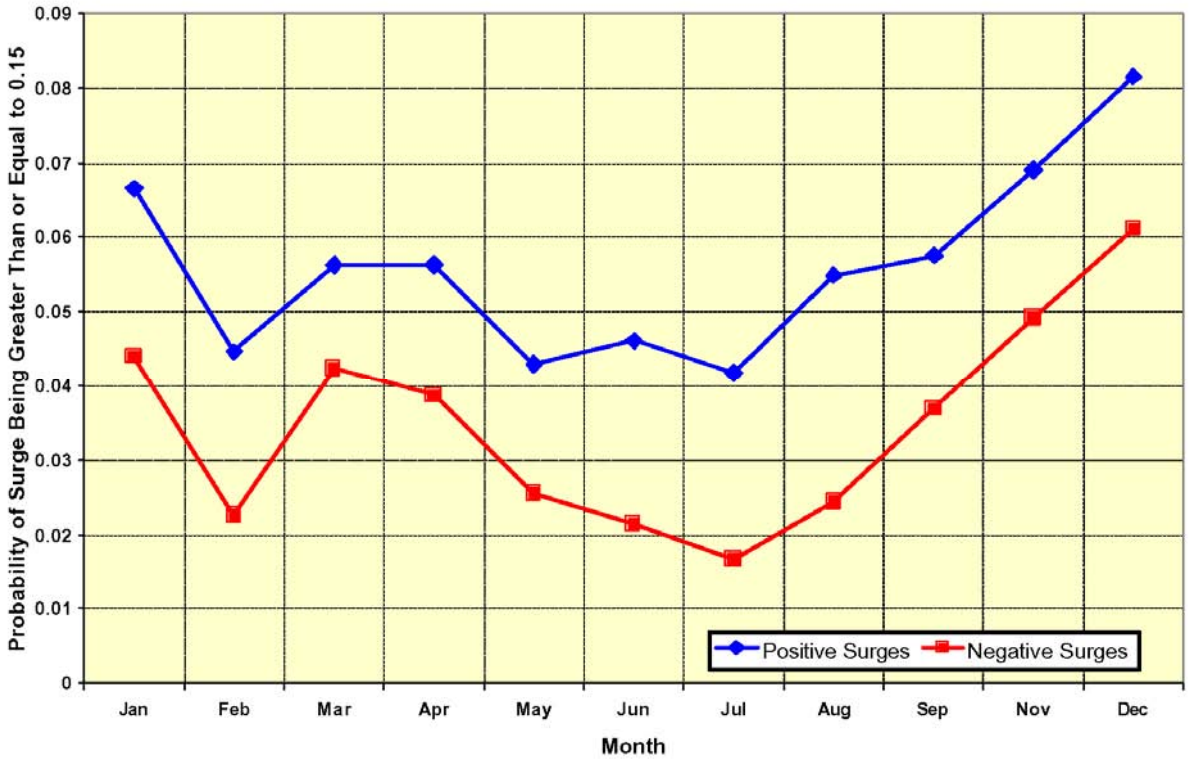
FIGURE 5.2.1.2-2

STORM SURGE PROBABILITY BY MONTH



Source: NYPA 1998 (October missing in original)

Note: 1 meter = 3.28 feet

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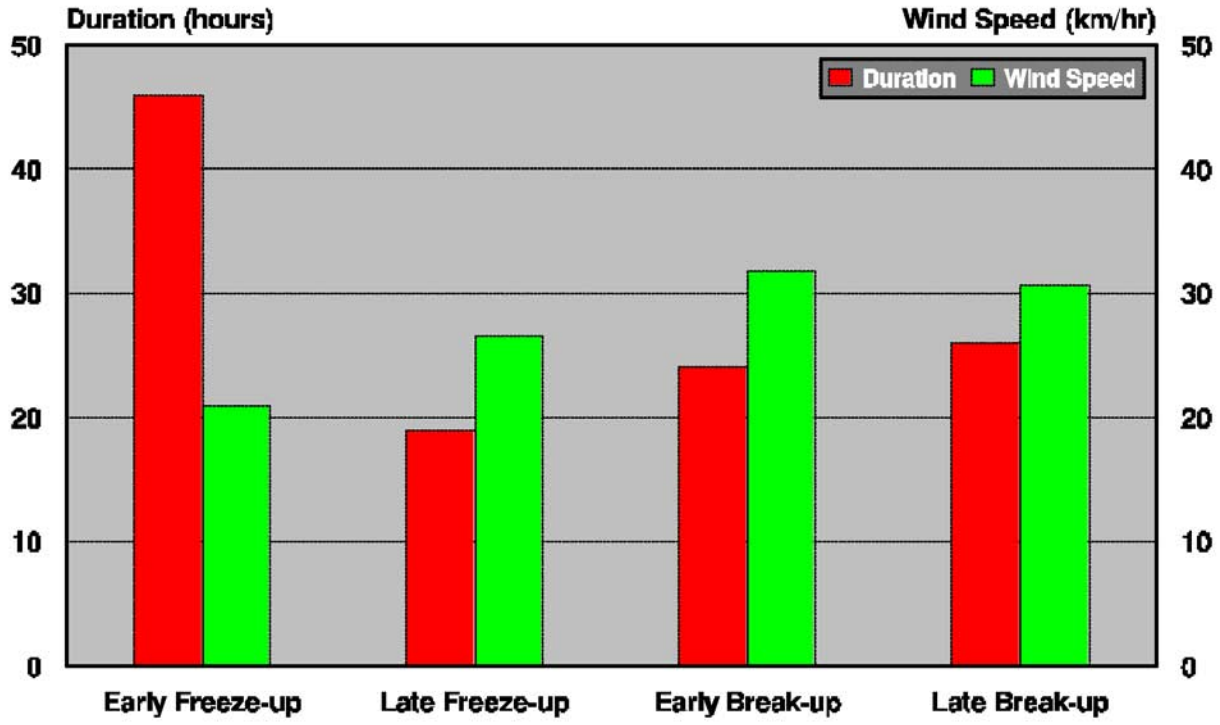
FIGURE 5.2.1.2-3

DURATION, WIND SPEED, AND ICE RUN TYPE



Source: NYPA 1998

Note: 1 km = 0.62 mi

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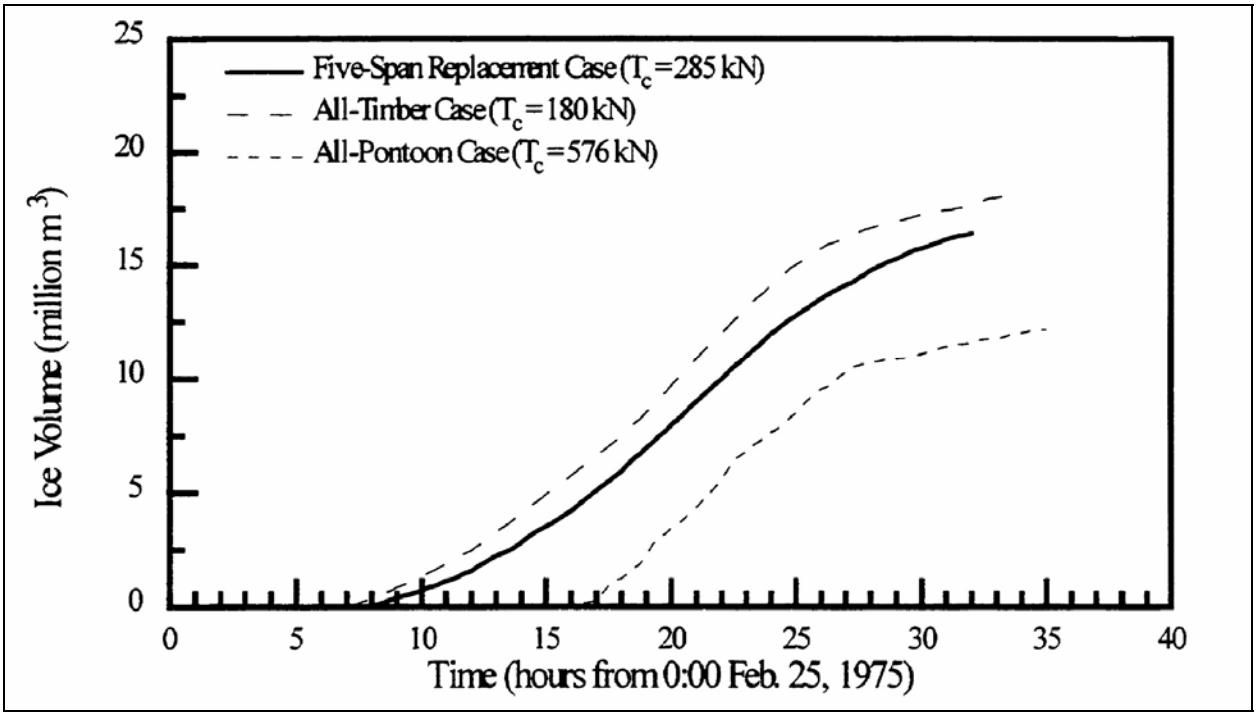
FIGURE 5.2.1.2-4

PERFORMANCE CHARACTERISTICS OF THE ICE BOOM USING STEEL PONTOON CONSTRUCTION



Source: NYPA 1998

Note: Multiply m^3 by 3.531×10^1 to obtain the number of ft^3

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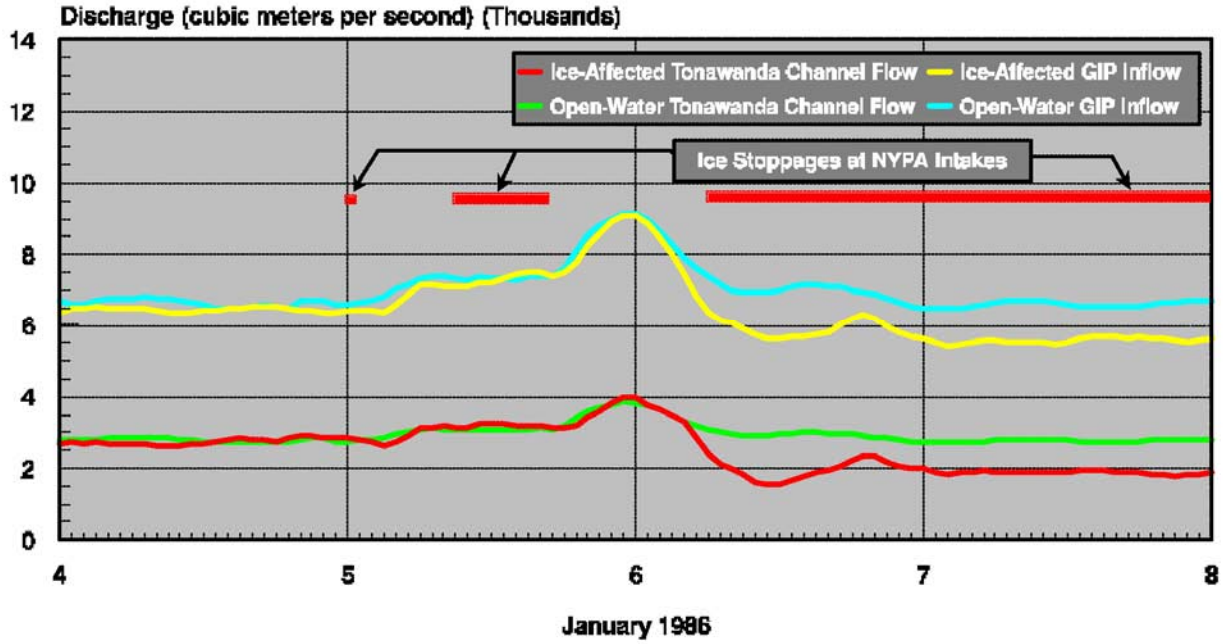
FIGURE 5.2.1.3-1

EFFECT OF LAKE ICE RUN ON RIVER FLOWS



Source: NYPA 1998

Note: Multiply m^3 by 3.531×10^1 to obtain the number of ft^3

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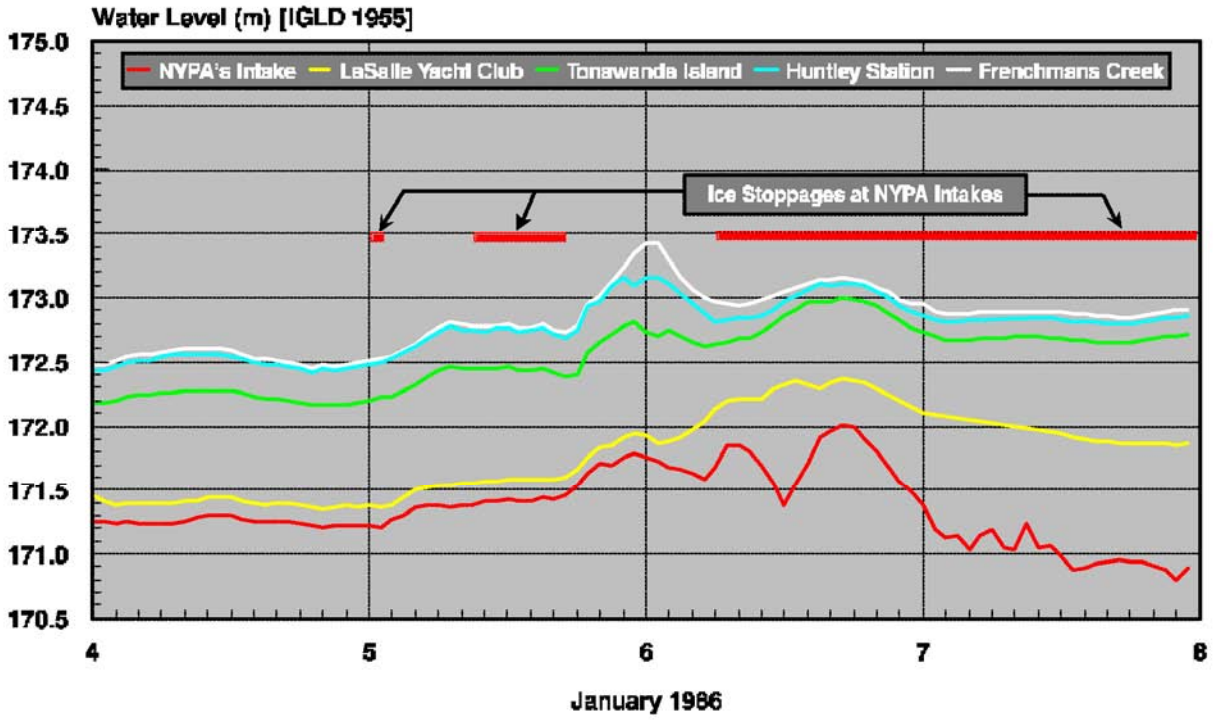
FIGURE 5.2.1.3-2

IMPACT OF ICE STOPPAGE IN GIP ON WATER LEVELS IN THE UPPER NIAGARA RIVER



Source: (NYPA 1998)

Note: 1 meter = 3.28 feet

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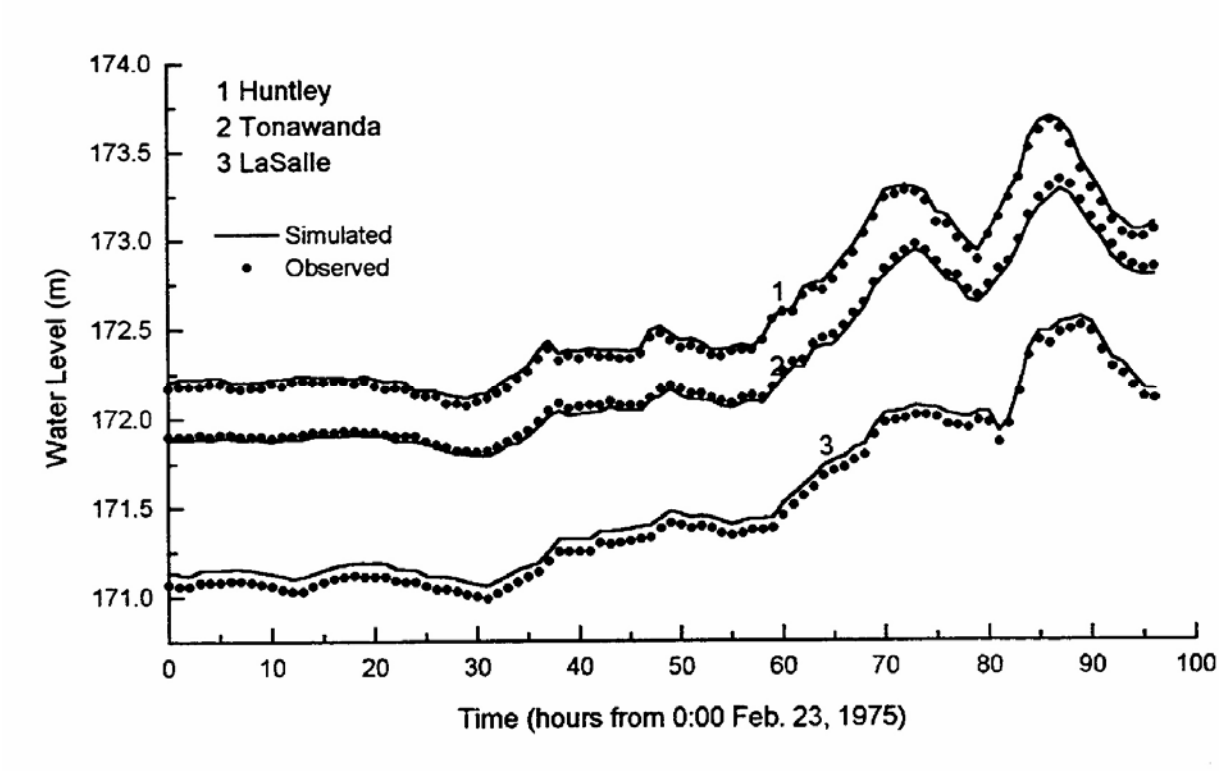
FIGURE 5.2.1.3-3

WATER LEVELS IN THE TONAWANDA CHANNEL DURING FEB 1975 LAKE ICE RUN



Source: (NYPA 1998)

Note: 1 meter = 3.28 feet

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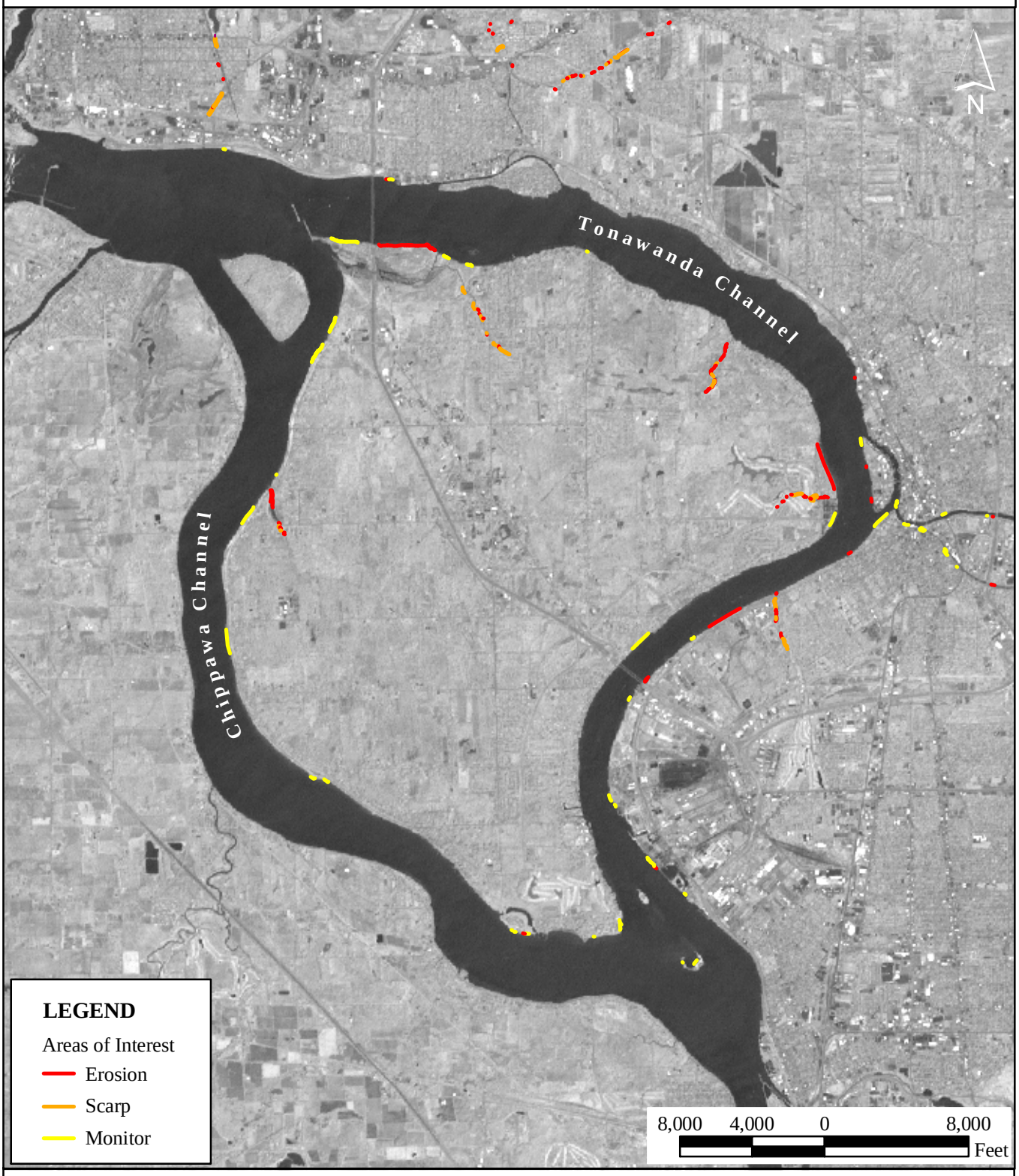

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Erosion Areas and POI's
for the Upper Niagara River

NIAGARA POWER PROJECT

FIGURE 5.2.3-1

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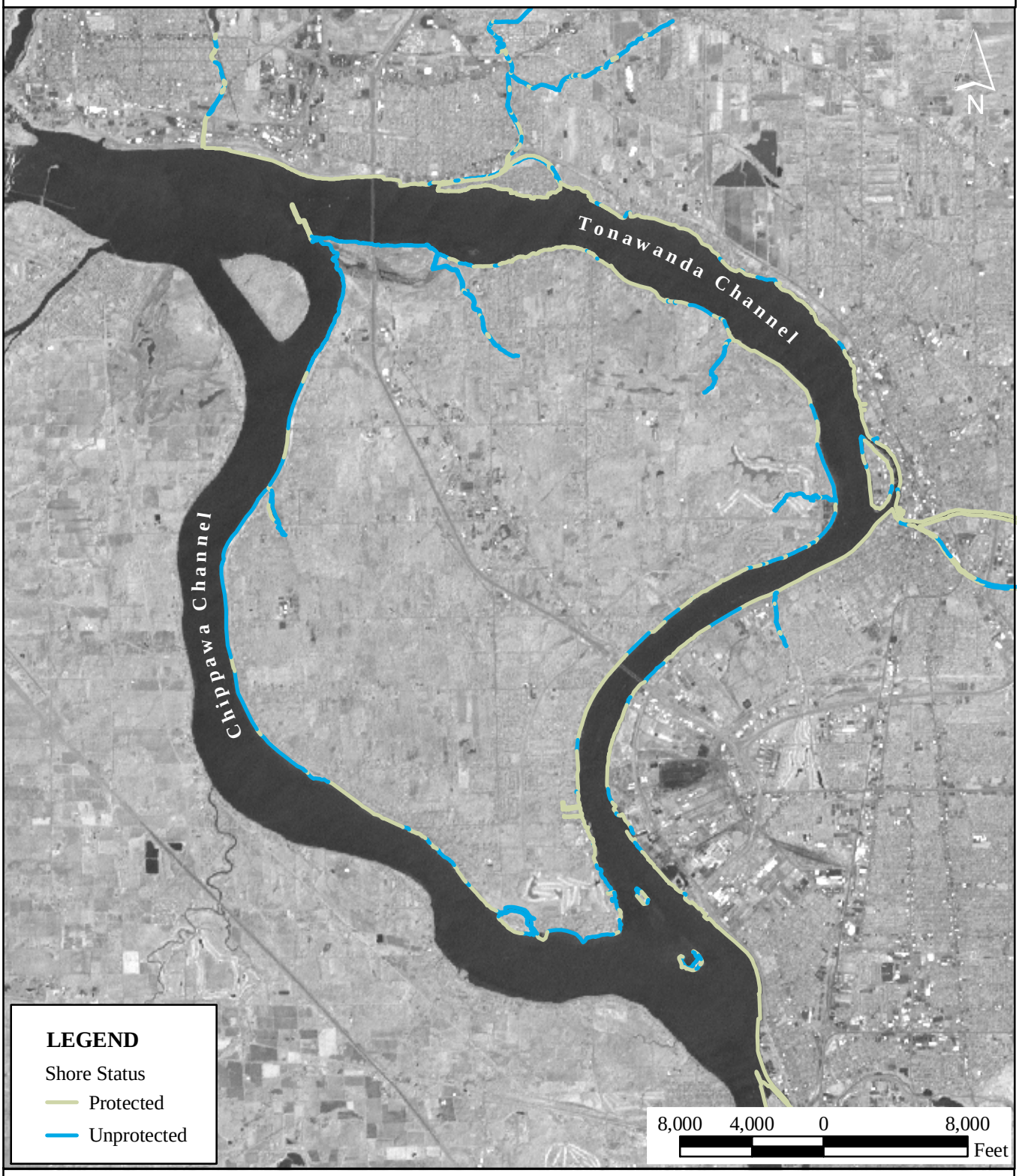
NIAGARA POWER PROJECT (FERC NO. 2216)
LAKE ERIE-NIAGARA RIVER ICE BOOM EFFECTS ANALYSIS



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Areas of Shore Protection for the Upper Niagara River

NIAGARA POWER PROJECT

FIGURE 5.2.3-2

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6.0 ALTERNATIVES ASSESSMENT

6.1 Land Management Practices

As part of the ice boom impact analysis, CRA was requested to explore the potential for alternative location and ownership of the ice boom storage and maintenance facility. The following conclusions summarize the findings of the analyses contained in this report and address the issue of alternative land management practices for the NYPA property.

6.1.1 Alternative Location(s) – Storage and Maintenance Facility

Results of the impact analysis indicate that relocation of the ice boom storage and maintenance facility to a different site is not a viable alternative at this time. Site requirements for the successful installation and operation of the boom are met at the existing location. Furthermore, the land management analysis reveals no significant effects of the storage area on adjacent properties. Existing use of the NYPA property is consistent with adjacent property uses and compatible with existing zoning classifications. No suitable alternative location has been identified on the U.S. or Canadian side of Lake Erie which meets requirements for the continued successful operation and maintenance of the ice boom. Based on the analyses contained in this report, it is concluded that relocation of the ice boom storage and maintenance to another location is unwarranted and not feasible at this time. Nevertheless, NYPA has met with the Erie County Department of Environment and Planning, Erie County Industrial Development Agency, and the Niagara Frontier Transportation Authority and continues to evaluate alternatives to the ice boom storage site.

6.1.2 Alternative Ownership – Storage and Maintenance Facility

Research by OPG indicates that no suitable alternative location has been identified for storage and maintenance of the boom on the Canadian side of Lake Erie. Thus, it is concluded that alternative ownership opportunities are currently not available.

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7.0 SUMMARY AND CONCLUSIONS

Researchers have consistently found no evidence to support claims of potential effects caused by the ice boom. Studies addressing the impact of the ice boom on climate clearly indicate that under typical conditions there has been no measurable effect of the boom on the timing of ice-dissipation at the eastern end of Lake Erie and no measurable effect of the boom on air temperatures at the National Weather Service meteorological station located at the Buffalo International Airport. These studies did not prove there never was an occasion where the ice boom had an impact on ice dissipation. However, the studies show that if there was an impact it was so limited as to be undetectable using the available data. The natural year-to-year variability of the timing of spring warming, and therefore of ice dissipation, is much larger than the maximum delay imposed by the presence of the ice boom.

During the twentieth century the Great Lakes region, including Buffalo, experienced region-wide winter temperature variations, including periods of cooling and warming that lasted several decades. In 1958, a trend towards more severe winters began and continued until at least 1979. This cooling trend affected regional air temperatures, water temperatures, and lake-ice dissipation dates on Lake Erie. Air temperatures and water temperatures were cooler than they had been in the period preceding the trend while ice dissipation dates extended later than they had in the recent past.

Analyses of Buffalo air temperature records lead to the conclusion that there is no discernable impact on air temperatures associated with the presence of the ice boom. This applies to the duration as well as the severity of winters. While there are differences between pre- and post-boom temperatures, these differences are associated with regional climatic changes and not associated with the presence of the ice boom. In fact, the cooler post-boom period was found to have begun in 1958, prior to the installation of the boom in 1964. In addition, the cooling trend was not limited to Buffalo, but was detected at meteorological stations throughout the region, indicating that a regional climatic shift, and not local environmental change, was the cause of the post-1958 cooling.

Since the 1983 NRC report, the potential impact of the ice boom on local climatic conditions can only have diminished. As a result of recommendations made by the NRC panel in its 1983 report, the

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operating procedures for boom removal were modified in 1984 resulting in earlier removal of the boom. The recommendation was made based on the results of a modeling study (Rumer 1980) and further analysis by the NRC. These analyses demonstrated that potential effects of the ice boom on ice dissipation become significant only when the area of the ice pack is reduced to less than approximately 250 square miles. Subsequent to the NRC recommendation, the IJC amended the operational procedures for boom removal. Thus, the boom has been removed by April 1 except under conditions when the lake ice area exceeds 250 square miles on that date. The modified boom removal policy is designed to mitigate potential boom impacts on either ice dissipation or local temperatures.

The need for mathematical modeling was addressed by Rumer (1980, 1983) and the NRC (1983). The modeling analyses that they performed were sufficient to evaluate the maximum potential impact of the ice boom on ice dissipation, water temperatures, and air temperatures. They also found that the model could not be employed to directly estimate the effect of the boom for any particular year due to the lack of observations required to calibrate and validate this model. The expense and effort that would be required to obtain the requisite data for such a modeling effort would be exorbitant and prohibitive. Furthermore, initiation of a comprehensive modeling effort for the purpose of evaluating the potential impact of the ice boom on ice dissipation, water temperatures, or air temperatures is unwarranted due to the controls that have been in place since the adoption of the NRC recommendation in 1984.

There is no direct scientific evidence to support the conclusion that there is any negative or positive effect on agricultural production due to the ice boom. Expert opinion suggests that there is an influence from the lake effect in the immediate vicinity of the lakeshore along both the Lake Erie and Lake Ontario shorelines. The lake effect is naturally occurring and exists in the absence of the boom. It influences nearshore temperatures which farmers generally find useful in implementing their planting and harvesting schedules. The anecdotal information provided by local farming experts suggests that any presumed potential impacts would largely be viewed as beneficial to local agricultural production. The lack of specific research and published scientific information on this topic represents a gap in knowledge regarding the potential impacts of the lake effect.

An examination of local land use and regional growth patterns indicate there are no identified areas of commercial agricultural production that could potentially be impacted by the use of the ice boom

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in Erie County. The displacement of agriculture lands as a result of urbanization and development has resulted in the physical removal of the agricultural lands from the potential impact of an ice cover on Lake Erie within the study area. We conclude that there are no adverse effects caused by the ice boom on agriculture production in Western New York including Erie County.

The ice boom decreases both the number and frequency of water level fluctuations caused by ice stoppages in the upper Niagara River. By performing as intended, the boom effectively reduces the volume of ice that is discharged from Lake Erie into the Niagara River. This results in decreased risks for ice-induced flooding and erosion. However, the ice boom does not completely eliminate ice from entering the river and does not reduce the magnitude of extreme ice-induced flood events. The boom also decreases the potential for erosion caused by ice scouring. The reduction in erosion is considered to be beneficial to the water quality of the watershed because the amount of sediment introduced into the water is lowered.

The reduced risks for flooding and erosion primarily occur in the Tonawanda and GIP reaches of the river. The differences in flow, ice discharge, ice transport capacity, and amount of freeboard in the Tonawanda compared to the Chippawa channel indicate that the potential effects of the boom in decreasing risk of flooding events would have the greatest impact on this reach of the Niagara River. Since the Tonawanda Channel is more susceptible to the effects of elevated water levels and flooding, the reduction of ice would be expected to benefit this reach of the river the most. Although the impact of the boom in reducing the risk of ice-induced-flooding has not been quantified, analysis indicates that the Tonawanda benefits to some degree from the reduction of ice that is discharged into the river.

A diversity of ecological resources resides in the eastern end of Lake Erie and the upper Niagara River. Resources that could potentially be affected by the ice boom include beds of submerged aquatic vegetation, palustrine wetlands, sport fisheries, and migratory birds and waterfowl. Potential impacts of the boom on these ecological resources fall into three general categories: (1) a delay in spring warming of water and air temperatures, (2) flooding caused by ice jams, and (3) scouring of river bottom and shoreline habitats by ice floes.

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Potential negative effects of delayed spring warming on ecological resources include delayed spawning, asynchrony of water temperatures in the vicinity of the ice boom with temperatures in shallow water spawning grounds (e.g. Grand Island), shortening of the biological growing season, and delayed access to food due to retention of ice. Potential positive effects include a decreased probability of temperature reversals and compression of the spawning and development periods. However, the studies available have shown that any effects of the ice boom on the spring warming and therefore on the ecological resources are likely to be negligible. An evaluation conducted by the NRC concluded that, if the change in water temperature was less than 1° F and was compensated within two days, impacts would be negligible. An evaluation of historical water temperatures conducted as part of this report concluded that there have been no statistical changes in water temperatures during pre-boom and post-boom periods. Furthermore, any potential changes in temperature caused by the ice boom are minor relative to the natural year-to-year climate variations in the vicinity of the ice boom. Therefore, it can be concluded that the ice boom has negligible impacts on ecological resources of eastern Lake Erie and the upper Niagara River.

Flooding caused by ice jams and scouring caused by ice flows are also impacted by the ice boom. Changes in water depth caused by flooding could potentially affect reproductive success of aquatic and terrestrial organisms and survival of wetland plants and SAV. Potential negative impacts of scouring include destruction of vegetation, alteration of bottom substrates, and displacement or destruction of egg masses deposited by fish or amphibians. Because the ice boom is effective in reducing the number and intensity of ice runs in the Niagara River, potential impacts to ecological resources caused by ice jams, such as flooding and scouring, is also reduced.

Examination of land use data and existing zoning classifications indicates that land management practices and use of the NYPA ice boom storage area are consistent with the use of surrounding properties and current zoning designation. The results of the land management analysis reveal no significant effects of the storage area on adjacent properties. While there are several planning initiatives and proposed development projects that could potentially impact land use in the vicinity of the ice boom storage and maintenance facility, these initiatives and projects are not expected to be impacted by current use of the NYPA property. Similarly, there are no identified effects on the use of local parks, recreation, and aesthetic viewsheds.

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Results of the impact analysis indicate that relocation of the ice boom storage and maintenance facility to a different site is not a viable alternative at this time. Site requirements for the successful installation and operation of the boom are currently met at the existing location. The consistency of use determination indicates the current storage site is compatible with surrounding land uses. Results from the alternatives analysis further indicate that no suitable alternative location has been identified on the U.S. or Canadian shores of Lake Erie which meets the site requirements for the continued successful operation and maintenance of the ice boom. Based on the analyses contained in this report, it is concluded that relocation of the ice boom storage and maintenance to another location is unwarranted and not feasible. Since additional research by OPG failed to identify a suitable alternative location for storage and maintenance of the boom on the Canadian shores of Lake Erie, alternative ownership opportunities are currently not available. Nevertheless, NYPA has met with the Erie County Department of Environment and Planning, Erie County Industrial Development Agency, and the Niagara Frontier Transportation Authority and continues to evaluate alternatives to the ice boom storage site.

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REFERENCES

Abdelnour, Razek, George Comfort, and Yuxiang Gong. 1995. Phase I: Final Report. Assessment of Ice Boom Technology for Application to the upper Niagara River. Fleet Technology Limited.

Assel, R.A. 1983. Lake Erie Ice Cover Exceedance Study, Preliminary Results. Ann Arbor, MI: Great Lakes Environmental Research Laboratory.

Baird & Associates. 2005. Shoreline Erosion and Sedimentation Study Upstream and Downstream of the Power Project. Prep. for the New York Power Authority.

Board of Consultants to Constantine G. Tjoumas. August 25, 1998. Letter containing Closure Comments of the Board of Consultants, Hydropower and Ice on the upper Niagara River, Final Report.

Churchill, R. R. 1985. Lake Erie-Niagara River Ice Boom. Geographical Review 75(2):111-124.

City of Buffalo. 2003a. Queen City in the 21st Century: Buffalo's Comprehensive Plan.

City of Buffalo. 2003b. The Queen City Hub: A Regional Action Plan for Downtown Buffalo, vols I and II.

Claman, Murray, to Doug Cuthbert. August 11, 1997. Letter from IJC to INBC approving use of steel pontoons in LENRIB.

Erie and Niagara Counties. 2003. Growth and Development in the Erie-Niagara Region, Erie-Niagara Framework for Regional Growth (Draft). www.regionalframework.com.

Federal Energy Regulatory Commission. July 21, 1989. Order amending Order of March 31, 1989.

Copyright © 2005 New York Power Authority

International Niagara Board of Control. 1974. Lake Erie-Niagara River Ice Boom Study.

International Niagara Working Committee. 1997. 1996-1997 Operation of the Lake Erie-Niagara River Ice Boom, a report to the International Niagara Board of Control.

International Niagara Working Committee. 1998. 1997-1998 Operation of the Lake Erie-Niagara River Ice Boom, a report to the International Niagara Board of Control.

International Niagara Working Committee. 2002. 2001-2002 Operation of the Lake Erie-Niagara River Ice Boom, a report to the International Niagara Board of Control.

International Niagara Working Committee. 2003. 2002-2003 Operation of the Lake Erie-Niagara River Ice Boom, a report to the International Niagara Board of Control.

Knapton, Richard, and D.V. Chip Weseloh. 1999. The Niagara River, an Important Bird Area. Environment Canada.

Lipsky, Charles I., to Anton J. Sidoti. January 7, 2002. Letter detailing results of testing of improved LENRIB.

National Research Council. 1983. The Lake Erie-Niagara River Ice Boom - Operations and Impacts. National Academy Press.

National Weather Service. 1998. Public Information Statement, Lake Erie Ice Boom: Buffalo Area Springs.

Niagara Frontier Transportation Authority. 2004. Request for Qualifications, Outer Harbor Redevelopment.

Copyright © 2005 New York Power Authority

New York Power Authority. 1998. Hydropower and Ice on the upper Niagara River: Studies of Measures to Mitigate the Impacts of Ice on Power Generation and Shoreline Property. Niagara Falls, New York: NYPA.

New York Power Authority. 2002. First-Stage Consultation Report, vols. I and II, prep. by URS Corporation, Gomez and Sullivan Engineers, PC, E/PRO Engineering & Environmental Consulting, LLC, and Panamerican Consultants, Inc.

New York Power Authority and Ontario Hydro. 1999. Proposal for Supplementary Order of Approval for Modification of Condition (d) of Order of January 18, 1984, Regarding Dates of Installation and Removal of LENRIB. Submitted to INBC.

Niagara River Corridor IBA Working Group. 2002. Niagara River Important Bird Area Conservation Plan. Bird Studies Canada, BirdLife International, Canadian Nature Federation.

Normandeau Associates, Inc. 2005. Recreational Fishing Survey of the Upper Niagara River. Prep. for the New York Power Authority.

Parsons and Wendel Duchscherer Architects & Engineers, P.C. 2003. Erie County Parks System Master Plan Renewal: A 2020 Vision for the Erie County Parks System. Prep. for the County of Erie.

Quinn, Frank H., Raymond A. Assel, and Daniel W. Gaskill. 1980. An Evaluation of Climatic Impact of the Niagara Ice Boom Relative to Air and Water Temperature and Winter Severity. U.S. Department of Commerce.

Quinn, Frank H., Raymond A. Assel, and Daniel W. Gaskill. 1982. An evaluation of the impact of the Niagara River ice boom on the air temperature regime at Buffalo, New York. Journal of Applied Meteorology 21(3):342-49.

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Riveredge Associates, LLC. 2005. Assessment of the Potential Effects of Water Level and Flow Fluctuations and Land Management Practices on Rare, Threatened, and Endangered Species and Significant Occurrences of Natural Communities at the Niagara Power Project. Prep. for the New York Power Authority.

Rumer, Ralph R., Jr. 1980. Lake Erie - Niagara River Ice Boom Effects on the Environment. Niagara Falls, NY: New York Power Authority.

Rumer, Ralph R., Jr., Wayne F. Bialas, Frank H. Quinn, Raymond A. Assel, and Daniel W. Gaskill. 1983. Niagara River ice boom: effects on environment. Journal of Technical Topics in Civil Engineering 109(2).

Sidoti, Anton J., to Charles I. Lipsky. February 22, 2002. Letter from FERC to NYPA stating that requirements of Article 305 have been satisfied, and that no further action or studies are required.

Stantec Consulting Services, Inc. 2005a. A Recreational Fishing Survey of the Lower Niagara River in 2002 and 2003. Prep. for the New York Power Authority.

Stantec Consulting Services, Inc. 2005b. A Recreational Fishing Survey of Lewiston Reservoir in 2002. Prep. for the New York Power Authority.

Stantec Consulting Services, Inc., URS Corporation, Gomez and Sullivan Engineers, P.C., and E/PRO Engineering & Environmental Consulting, LLC. 2005. Effect of Water Level and Flow Fluctuations on Terrestrial and Aquatic Habitat, prep. for the New York Power Authority.

The Saratoga Associates. 2005. Visual Assessment (Draft). Prep. for the New York Power Authority.

Thomson, C. 1976. Ice Inventory in the upper Niagara River during the 1975-1976 Winter Season. St. Catherines, Ontario: Brock University.

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Thomson, C. 1975. Ice Inventory in the upper Niagara River during the 1974-75 Winter Season. St. Catherines, Ontario: Brock University.

URS Corporation and Gomez and Sullivan Engineers, P.C. 2005. Surface Water Quality of the Niagara River and its U.S. Tributaries, prep. for the New York Power Authority.

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APPENDICES

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APPENDIX A

Existing Information Identified by ALP Stakeholders and NYPA

1. Erie County and City of Buffalo Waterfront Plans.
2. Final Report to the International Niagara Board of Control (September 2002).
3. Olmsted Plans for Buffalo or Erie County-related parks.
4. Acres Consulting Services and Ralph C. Rumer. 1974. Lake Erie-Niagara River Ice Boom Study. Prepared for the International Board of Control.
5. Thomson, C. 1975. Ice Inventory in the upper Niagara River during the 1974-75 Winter Season. St. Catherines, Ont.: Brock University.
6. Rumer, Ralph C. 1980. Lake Erie-Niagara River Ice Boom Effects on Environment. Prepared for the New York Power Authority.
7. Quinn, Frank, Raymond A. Assel, and Daniel W. Gaskill. 1980. An Evaluation of Climatic Impact of the Niagara Ice Boom Relative to Air and Water Temperature and Winter Severity. NOAA Technical Memorandum ERL GLERL-30. Ann Arbor, MI.
8. National Research Council. 1983. The Lake Erie-Niagara River Ice Boom: Operations and Impacts. Washington, DC: National Academy Press.
9. International Joint Commission. January 18, 1984. Order of Approval amending conditions of Order of September 25, 1980 on timing of removal of ice boom in the spring. (Includes chronology of Orders of Approval from June 9, 1964, the date of IJC's Order of Approval regarding construction and operation of ice boom on a trial basis by New York Power Authority and Ontario Hydro.).
10. U.S. District Court, Western District of New York. January 18, 1984. Order dismissing Erie County request (in Rutkowski v. International Joint Commission, Power Authority of the State of New York, Ontario Hydro, and Federal Energy Regulatory Commission) for preliminary injunction enjoining defendants from erecting Lake Erie-Niagara River ice boom.
11. Churchill, R.R. 1985. The Lake Erie-Niagara River ice boom. Geographical Review 75(2):111-24.
12. Federal Energy Regulatory Commission (FERC). March 31, 1989. Order Amending License. Requires NYPA to conduct study on effects of ice boom on ice jamming and flooding in upper river.
13. FERC. July 21, 1989. Order amending Order of March 31, 1989. Offers further direction on conduct of ice study.
14. International Joint Commission. August 11, 1997. Letter Approving Use of Steel Pontoons in Lake Erie-Niagara River Ice Boom. Reference to materials of construction to be removed from Order of January 18, 1984.
15. New York Power Authority. 1998. Hydropower and Ice on the upper Niagara River: Studies of Measures to Mitigate the Impacts of Ice on Power Generation and Shoreline Property. Prepared for FERC.
16. Randy D. Crissman to Constantine G. Tjoumas. April 9, 1998. Letter accompanying submittal of final report, Hydropower and Ice on the upper Niagara River, to FERC.
17. NYPA and Ontario Hydro. March 17, 1999. Proposal for Modification of Condition (d) of Order of January 18, 1984 regarding dates of installation and removal of ice boom. (Subsequently approved).
18. Anton J. Sidoti to Charles I. Lipsky. February 22, 2002. FERC letter stating that NYPA's Hydropower and Ice on the upper Niagara River satisfies the requirements of Article 305 of the FERC license as amended (requiring a study of ice boom effects on ice jamming and flooding), and that no further actions or studies are required.

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19. Final and drafts of the Times Beach studies that have been prepared by the Army Corps of Engineers, Erie County, and/or the City of Buffalo.
20. Management Plan for the Important Bird Areas.
21. Cornell Cooperative Extension Service and NOAA NE Climatic Center studies/reports as applicable.
22. Additional Army Corps of Engineers and Environment Canada reports.

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APPENDIX B

Additional Sources Consulted

Abdelnour, Razek, Bruce Cowper, Yuxiang Gong, Hung Tao Shen, Shunan Lu, and George Comfort. 1996. Assessment of Lake Erie-Niagara River Ice Boom Design Improvements. Vol. 1 of Appendix C to Hydropower and Ice on the Upper Niagara River, prep. for the New York Power Authority. Fleet Technology, Ltd.

Abdelnour, Razek, Bruce Cowper, Yuxiang Gong, Hung Tao Shen, Shunan Lu, and George Comfort. 1997. Performance and Benefit-Cost Assessment of Alternatives. Vol. 2 of App. C to Hydropower and Ice on the Upper Niagara River, prep. for the New York Power Authority. Fleet Technology, Ltd.

Bird Studies Canada. 2001. Canadian Important Bird Area: Niagara River Corridor. http://www.bsc-eoc.org/iba/site.cfm?siteID=ON002&lang=en.

BirdLife International. 2000. Canadian Important Bird Area. http://www.bsc-eoc.org/iba/site.cfm?siteID=ON002&lang=en (3/07/03).

Crissman, Randy D., to Constantine G. Tjoumas. June 25, 1997. Letter re Partial Submission of Hydropower and Ice Final Report.

Erie County Department of Environment and Planning. 2003. Master Plan, Times Beach Public Access Project.

Erie County Department of Environment and Planning and U.S. Army Corps of Engineers. Undated. Times Beach Project Summary.

Copyright © 2005 New York Power Authority

Erie County Industrial Development Agency. 2003. Buffalo Waterfront Projects: Summary and Update Report.

International Niagara Board of Control. 2001. Media Advisory: Delay in Ice Boom Opening.

Kamphuis, J.W., and J.R. Moir. 1983. Ice breakup and jamming operations along the Mackenzie River. Can. J. Civ. Eng. 10: 78-91.

Keil, Karen. 2002. Memorandum to File: Human Health Risk Assessment of Times Beach Soils and Sediment using USACE-LRB 2001 Sampling Results. U.S. Army Corps of Engineers.

Kleinschmidt Associates and Riveredge Associates. 2005. Investigation of Habitat Improvement Projects for the Niagara Power Project. Prep. for the New York Power Authority.

Larsen, Johannes, Jon E. Zufelt, and Randy D. Crissman. 1996. Physical Model Studies of Ice Concerns at the Niagara Power Project Intakes. App. E to Hydropower and Ice on the Upper Niagara River, prep. For the New York Power Authority. Alden Research Laboratory, Inc.

Lipsky, Charles I., to Constantine G. Tjoumas. October 11, 1999. Letter re Article 305 followup.

Lu, Shunan, Hung Tao Shen, and Randy D. Crissman. 1999. Numerical study of ice jam dynamics in upper Niagara River. Journal of Cold Regions Engineering 13(2):78-102.

National Audubon Society of New York State. 2001. Niagara River Corridor Important Bird Area. http://ny.audubon.org/iba/niagara.html.

New York Power Authority. 1981. Ice Boom Studies for International Niagara Board of Control, 1972-1981. Prep. by Dr. R.A. Rumer and Acres Consulting Services Limited.

Copyright © 2005 New York Power Authority

New York Power Authority and Ontario Hydro. 1975. Statement on the Indefinite Extension of the Termination Date of the Order of Approval of the LENRIB.

Riveredge Associates, LLC. 2005. Occurrences of Rare, Threatened, and Endangered Mussel Species in the Vicinity of the Niagara Power Project, prep. for the New York Power Authority.

Rumer, Ralph R., Jr. to Advisory Panel. September 26, 1973. Letter.

Rumer, Ralph R., Jr., and Paul M. Yu. 1977. Modeling Ice Dissipation in Eastern Lake Erie. Reprint, Tenth Conference on Severe Local Storms. American Meteorological Society.

Rumer, Ralph R., Jr., Charles H. Atkinson, and S.T. Lavender. 1975. Effects of Lake Erie-Niagara River Ice Boom on the Ice Regime in Lake Erie. In: Proceedings of the Third International Symposium on Ice Problems, International Association of Hydraulic Research Committee on Ice Problems.

Shen H. T., A.M.W. Lal, and Y.C. Chen. 1990. Simulation of Ice Dynamics in the Upper Niagara River. Potsdam, NY: Clarkson University.

Shen, Hung Tao, Shunan Lu, and Lianwu Liu. 1997. Numerical Model Studies of Ice Transport and Jamming in the Upper Niagara River. Vol. 1 of App. H to Hydropower and Ice on the Upper Niagara River, prep. for the New York Power Authority.

Shen, Hung Tao, Shunan Lu, and Lianwu Liu. 1997. Numerical Model Studies of Ice Transport and Jamming in the Upper Niagara River. Vol. 2 of App. H to Hydropower and Ice on the Upper Niagara River, prep. for the New York Power Authority.

Shen, Hung Tao, and Junshan Su. 1996. Numerical Model Studies of Ice Transport and Jamming in the Grass Island Pool. App. F to Hydropower and Ice on the Upper Niagara River, prep. for the New York Power Authority.

Copyright © 2005 New York Power Authority

Shen, Hung Tao, and De Sheng Wang. 1996. Simulation and Analysis of Upper Niagara River Ice Conditions. App. G to Hydropower and Ice on the Upper Niagara River, prep. for the New York Power Authority.

Shen, Hung Tao, De Sheng Wang, and A.M. Wasantha Lal. 1995. Numerical simulation of river ice processes. Journal of Cold Regions Engineering 9 (3):107-18.

Stilwell, David, to Magalie M. Salas. September 10, 2003. Filing of a Comprehensive Plan.

U.S. Army Corps of Engineers. 2004. Fact Sheet.

U.S. Army Corps of Engineers. 2001. Section 1135 Feasibility Study Information Paper, Times Beach, Buffalo New York.

U.S. Army Corps of Engineers. 2001. Scoping Fact Sheet, Times Beach Dredged Material Disposal Site Feasibility Study.

U.S. Environmental Protection Agency. 1997. Climate Change and New York, EPA 230-F-97-008ff. Office of Policy, Planning, and Evaluation.

URS Corporation, Gomez and Sullivan Engineers, P.C., and E/PRO Environmental & Engineering Consulting, LLC. 2005. Niagara River Water Level and Flow Fluctuation Study, prep. for the New York Power Authority.

Wake, Akio, and Ralph R. Rumer. 1979. Effect of Surface Meltwater Accumulation on the Dissipation of Lake Ice. 15(2).

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