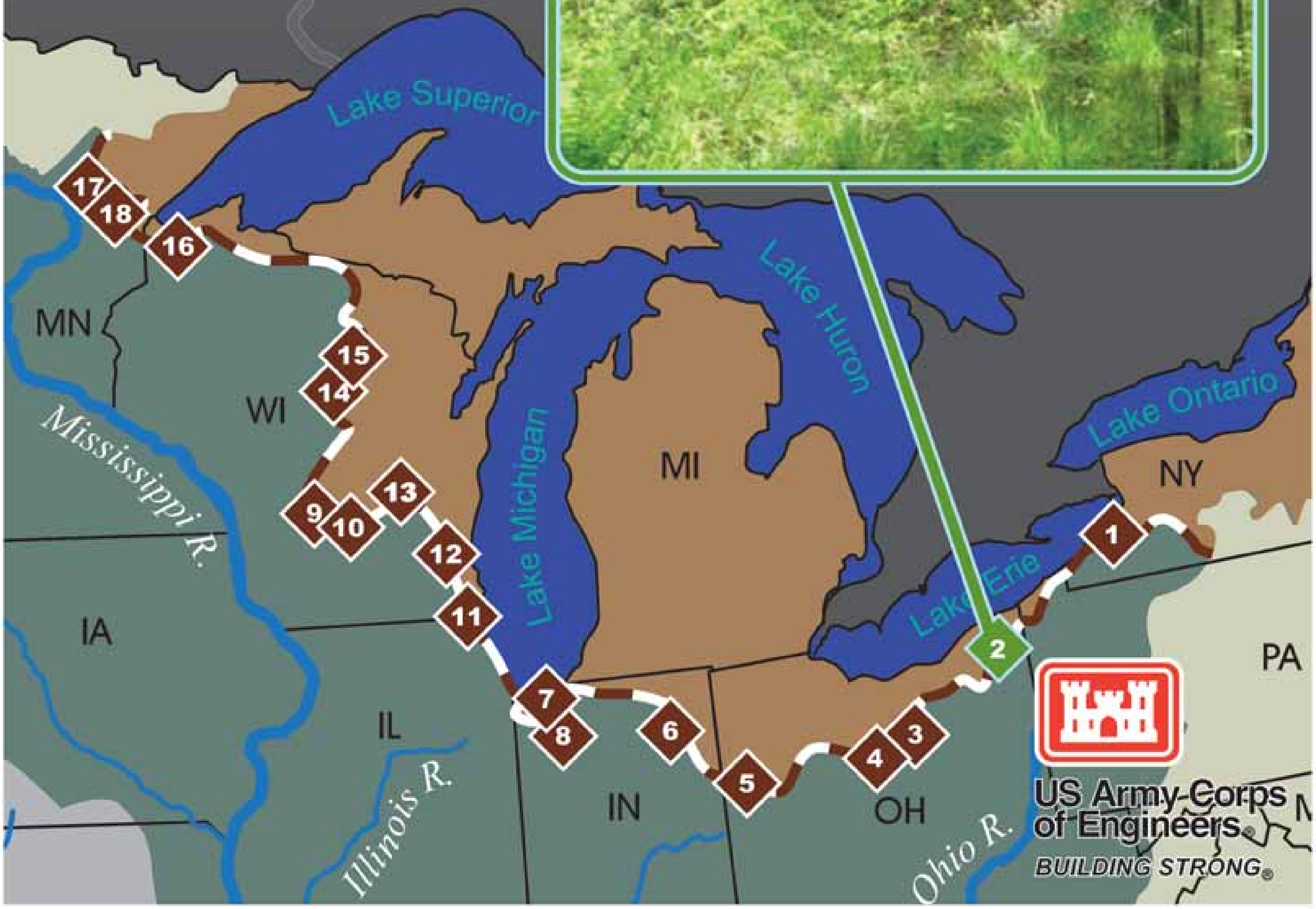
GLMRIS

Great Lakes and Mississippi River Interbasin Study

Focus Area 2 Aquatic Pathway Assessment Report

Mosquito Creek Lake, Ohio



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Executive Summary

The Mosquito Creek Lake potential aquatic pathway between the Great Lakes and Mississippi River Basins is located at a natural auxiliary spillway for Mosquito Creek Lake located in Trumbull County, Ohio. It is situated within an extensive wetland area where the divide between the Great Lakes and Mississippi River Basins extends north-south across the spillway at the northwest corner of the lake. The natural spillway is approximately 1,000 feet (305 meters) wide and slightly more than 904 feet (275 meters) above sea level at the intersection of the spillway with the basin divide.

Available topographic information indicates that ground surface elevations are very flat within the potential aquatic pathway. The spillway extends north and west from Mosquito Creek Lake through forested and emergent wetlands and connects with a tributary to Baughman's Creek to the west. The ground surface falls less than four feet (1.2 meters) over a distance of about 5,000 feet (1,524 meters) in either direction away from the basin divide toward Baughman's Creek or Mosquito Creek Lake. West of the divide, Baughman's Creek flows into the Grand River, which flows into Lake Erie. Mosquito Creek Lake drains the area to the east of the divide at this location and discharges to the Mahoning River in the upper Ohio and Mississippi River Basins.

Constructed in 1944, Mosquito Creek Dam at the south end of the lake is operated by the U.S. Army Corps of Engineers (USACE) to provide flood protection for the Mahoning River Valley, domestic water supply, and to allow a perennial flow from the lake into the Mahoning River for water quality purposes. The lake has substantial storage capacity for surface runoff with the ability to store the equivalent of 29 inches (74 cm) of precipitation from its 97 square mile (251 square kilometer) drainage area. There is no record that the water level of Mosquito Creek Lake has ever reached the elevation where water is backed up north through the natural spillway to the basin divide. However, FEMA flood insurance mapping indicates that the one percent annual recurrence interval flood plain approaches the basin divide from the lake. It is therefore likely that an event somewhere in excess of the one percent annual recurrence interval flood would be necessary for an aquatic pathway to form within the spillway and possibly cross the basin divide. Numerous intermittent pools of standing water were observed during the May 2011 site visit within the spillway at the divide, but no visible channels or surface water flow between these pools was observed.

The Mosquito Creek Dam was determined to be an impassable obstacle to the upstream movement of aquatic nuisance species (ANS) from the Mahoning River toward the Great Lakes Basin. Likewise, a series of dams on the Grand River were determined to be significant obstructions to the upstream transit of ANS from Lake Erie toward the Mississippi River Basin. These circumstances, along with the need for a significant flood event to establish an aquatic pathway within the spillway, led the interagency team comprised of representatives from the USACE, United States Geological Survey, and Ohio Department of Natural Resources to conclude that there is a low likelihood of ANS being able to reach or spread through this potential aquatic pathway in either direction.

Although not a factor in the aquatic pathway viability rating for this location, Mosquito Creek Lake does experience heavy recreational boating and fishing, resulting in there being some potential for anthropogenic introductions and possible transfer of ANS from the Great Lakes Basin to the Mississippi River Basin. Mosquito Creek Lake is the second largest inland lake in Ohio at 7,850 acres (3,177 hectares) of water available for fishing, and 40 miles (64 km) of shoreline with 10 boat launch facilities, 234 campground sites, and is near high population centers. Management of Mosquito Creek Lake and its environs should take into consideration the future potential for anthropogenic introductions of ANS to the lake, especially during extreme high water conditions.

Mosquito Creek Report
May, 2013

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Acronyms

ANS . . . . . . Aquatic Nuisance Species
ANSTF. . . . Aquatic Nuisance Species Task Force
CAWS . . . . Chicago Area Waterway System
CEQ. . . . . . Council on Environmental Quality
FEMA. . . . . Federal Emergency Management Agency
FIRM . . . . . Flood Insurance Rate Map
GIS . . . . . . Geographic Information System
GLB . . . . . . Great Basin
GLFC. . . . . Great Lakes Fishery Commission
GLMRIS. . . Great Lakes and Mississippi River Interbasin Study
HUC. . . . . . Hydrologic Unit Codes
INDNR . . . . Indiana Department of Natural Resources
NAS . . . . . . Nonindigenous Aquatic Species
NEPA . . . . . National Environmental Policy Act
NOAA. . . . . National Oceanic and Atmospheric Administration
NRCS . . . . Natural Resources Conservation Service
ODNR . . . . Ohio Department of Natural Resources
USACE . . . U.S. Army Corps of Engineers
USFWS . . . U.S. Fish and Wildlife Service
USGS . . . . U.S. Geological Survey
WRDA . . . . Water Resources Development Act

1 Introduction

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) was authorized in Section 3061(d) of the Water Resources Development Act (WRDA) of 2007, and therein, it prescribes the following authority to the Secretary of the Army and the U.S. Army Corps of Engineers (USACE):

> *"(d) FEASIBILITY STUDY. - The Secretary, in consultation with appropriate Federal, State, local, and nongovernmental entities, shall conduct, at Federal expense, a feasibility study of the range of options and technologies available to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River Basins through the Chicago Sanitary and Ship Canal and other aquatic pathways."*

This GLMRIS Focus Area 2 Aquatic Pathway Assessment report addresses the Mosquito Creek Lake - Grand River location, in Trumbull County, Ohio. Mosquito Creek Lake - Grand River, Ohio is one of 18 locations identified in the Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization as a potential aquatic pathway spanning the watershed divide between the Great Lakes and Mississippi River Basins outside of the Chicago Area Waterway System (CAWS) (USACE, 2010). This report is downloadable from the GLMRIS web site (glmris.anl.gov/).

The dashed line in Figure 1 depicts the nearly 1,500-mile (2,414 km) basin divide from the New York - Pennsylvania state line to north eastern Minnesota, and it depicts each of the 18 potential aquatic pathway locations that were previously identified. Mosquito Creek Lake - Grand River is shown in Figure 1 as location number 2, in northeast Ohio near the Pennsylvania border.

The GLMRIS is a very large and complicated task involving multiple USACE Districts and Divisions. Program Management of the study is conducted by the Great Lakes and Ohio River Division. The study considers all aquatic nuisance species (ANS) of concern. However, the proximity of Asian carp in the Mississippi River Basin to the basin divide near two locations lends a sense of urgency and national significance to completion of the GLMRIS. These two locations are the CAWS in Chicago, Illinois and Eagle Marsh in Fort Wayne, Indiana. To help accelerate completion of the feasibility study, the Great Lakes and Ohio River Division split management of the GLMRIS into two separate focus areas. Focus Area 1 is managed by the USACE, Chicago District and addresses the CAWS. Focus Area 2 is managed by the USACE, Buffalo District and evaluates all other potential aquatic pathways that exist or are likely to form across the basin divide separating runoff that flows into the Mississippi River and its tributaries from runoff that flows into the Great Lakes and its tributaries.

1.1 Study Purpose

The preliminary report from 2010 and the subsequent analysis contained in this report have been produced for a broad audience ranging from the scientific community to the general public, and are specifically intended to identify any locations where an aquatic pathway exists or may form between the basins, and to evaluate the probability that specific ANS would be able to arrive at that pathway and cross into the new basin. The information in this and the other Focus Area 2 reports are intended to provide a sound scientific basis for helping to prioritize future funding of GLMRIS and/or other actions at these potential aquatic pathway locations.

This interim GLMRIS report is the next step in a tiered approach to assess the risk associated with the spread of ANS between the Great Lakes and Mississippi River Basins, and it was prepared in accordance with the detailed procedures and criteria specified in the GLMRIS Focus Area 2 Study Plan (USACE, 2011a). The primary purpose of this report is to present the evidence and explain the procedures used to estimate the likelihood that a viable aquatic pathway exists at Mosquito Creek Lake that will enable the interbasin spread of ANS. It is also intended to contribute to the accomplishment of each of the four objectives identified in the plan (USACE, 2011a) for any site ultimately rated as medium or high for probability of a viable aquatic pathway existing:

- A definitive determination of whether the Mosquito Creek Lake - Grand River location should be

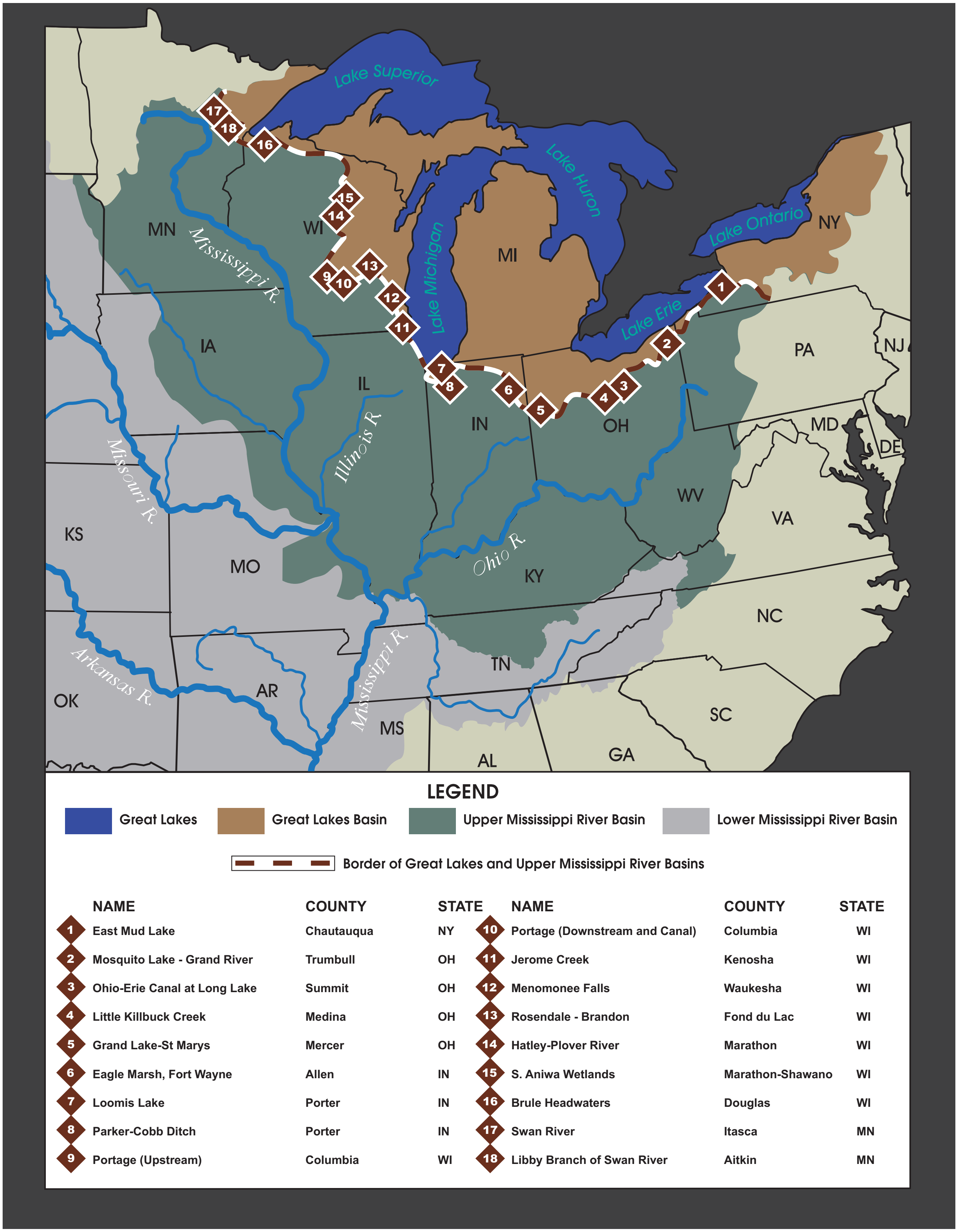

Figure 1. Potential aquatic pathway locations identified in the GLMRIS Preliminary Risk Characterization Study (USACE, 2010).

included in the inventory of locations where a viable surface water connection between headwater streams on both sides of the drainage divide exists or is likely to form between the Great Lakes and Mississippi River Basins;

- A standalone report that characterizes the probability that a viabile aquatic pathway exists at Mosquito Creek Lake-Grand River that may enable the interbasin spread of ANS.;

- If an aquatic pathway is found to exist, development of clear problem statements that frame the means, constraints, and likelihood of the interbasin spread of ANS via the potential aquatic pathway at Mosquito Creek Lake - Grand River; and

- If an aquatic pathway is found to exist, development of clear opportunity statements that illustrate how the collective authorities, resources, and capabilities of USACE and other applicable federal, state, local, and non-governmental stakeholder organizations may best be coordinated and applied to prevent the interbasin spread of ANS through the Mosquito Creek Lake - Grand River location.

1.2 Summary of 2010 Preliminary Risk Characterization for Mosquito Creek Lake - Grand River, OH

The Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization was designed as the first step of a tiered approach to rapidly conduct a study intended to accomplish two objectives (USACE, 2010). The first and primary objective was to determine if there were any locations within the GLMRIS, aside from the CAWS, where a near term risk for the interbasin spread of ANS exists. Near term, in this case, indicates that implementation of some measure(s) might be warranted to reduce the potential for ANS transfer at that particular location in the short term versus setting that site aside for further analysis. The second objective was to refine the scope of the other aquatic pathways portion of the GLMRIS by developing a list of potential aquatic pathways that could form anywhere along the divide separating the Great Lakes and Mississippi River Basins, and help provide a basis for prioritizing future feasibility study efforts based upon relative risk.

The USACE solicited the input and collaborated with the U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), Great Lakes Fishery Commission (GLFC) and the natural resource agencies in the states of Minnesota, Wisconsin, Indiana, Ohio, Pennsylvania, and New York. A total of 36 potential locations were initially identified along the divide where it appeared that interbasin flow could occur. These were locations situated in a mixture of rural, forested, suburban, and urban areas, and included locations where surface water flow patterns have been modified through the building of navigation canals, excavation of ditches, and construction of sewers to facilitate storm water management for agricultural, flood damage reduction, or other water management purposes. Also, many of the potential aquatic pathways identified in 2010 were locations where extensive natural wetlands exist in close proximity to, and in some instances appear to span, the basin divide. The lack of prior hydrologic studies and the level of uncertainty in the hydrology information led to a conservative approach in estimating the individual aquatic pathway risk ratings.

At 18 of these locations the interagency group determined that it would likely require an epic storm and flooding event for an aquatic pathway to ever form across the basin divide. These were not recommended for further investigation because this was considered a low level of risk. However, at the remaining 18 locations the group did recommend that a more detailed assessment be conducted (Figure 1). Only one location, Eagle Marsh in Fort Wayne, Indiana, was determined to pose a near term risk for the potential spread of Asian carp into the Great Lakes Basin, and this led to the installation of a temporary barrier by Indiana Department of Natural Resources (INDNR) until a more complete assessment and remedy could be implemented.

Although the preliminary risk characterization did not identify the Mosquito Creek Lake Pathway as a location where there is a near term risk for the interbasin spread of ANS, there was some uncertainty regarding whether or not an aquatic pathway could form between the basins. The preliminary effort therefore recommended that a more detailed assessment be conducted at this location. This was subsequently done in collaboration with the USACE, USGS, NRCS, Ohio Department of Natural Resources (ODNR), and other government agencies. The following actions were taken:

- Federal, State, and local stakeholders were briefed on the preliminary risk characterization results. A detailed site visit to observe potential transfer locations was conducted and the available topographic mapping and flood hazard information was compiled and reviewed.

- The dams on the connecting streams to the Great Lakes and the Mississippi River were evaluated relative to the potential for ANS passage through, around, or over each in-stream structure in both directions.

- Evaluated habitat and abiotic conditions relative to the needs and preferences of ANS in proximity to each location.

- Evaluated the likelihood of an ANS transfer via the aquatic pathway in both directions.

1.3 Aquatic Pathway Team

Due to the large amount of unknowns and natural variability associated with the hydrology and the biology of such a large geographic area, the Study Plan specified formation of a “team of teams,” combining the best available local, state and national hydrologists and biologists to assess conditions at each potential aquatic pathway (USACE 2011a). The results of this assessment reflect the collective experience, expertise, and focused effort of these biologists and hydrologists from USACE, USGS, and ODNR. The results also reflect the guidance, input, review comments, and concurrence of the multi-organization Agency Technical Review (ATR) team of experts from USACE, USFWS, and NRCS. In addition, the Michigan Department of Natural Resources participated on the ATR team and concluded its review March 23, 2012 by stating that “… at this time [we] have no substantive comments on this report.”

2 Study Methodology

The GLMRIS risk analysis process is an adaptation of the generic model and process described in the Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process (For Estimating Risk Associated with the Introduction of Nonindigenous Aquatic Organisms and How to Manage for that Risk) (ANSTF, 1996). The Aquatic Nuisance Species Task Force (ANSTF) defines the first step in this process as identification of interested parties and solicitation of input.

2.1 Coordination

The USACE identified interested parties and solicited input early in the process for Focus Area 2 and has included individual visits and discussions with the state agencies responsible for water resources, and fish and wildlife management in the eight states bordering the Great Lakes. The process used for the Focus Area 2 assessments has also been discussed in meetings with representatives of the Council on Environmental Quality (CEQ), USGS, USFWS, NOAA, NRCS, and GLFC. Development of this plan also included input from the public and interested non-governmental organizations received during formal National Environmental Policy Act (NEPA) public scoping meetings which were held at 12 locations across the region in both basins between December 2010 and March 2011. The USACE requested the support and participation of the best available experts from the State and Federal agencies responsible for water resources, and fish and wildlife management in the states along the Great Lakes and Mississippi River Basin divide to address the critically important issue of preventing interbasin transfer of ANS. The USGS, NRCS, and each state DNR assigned personnel to assist each USACE pathway assessment team. In addition, a technical review ream comprised of 16 senior level experts from the USACE and external partner agencies, including NOAA and the GLFC, was assembled to review and guide the work of these teams. Overall, extensive collaboration among partner agencies, the review team, and other subject matter experts has led to detailed Focus Area 2 pathway assessments.

2.2 Identification of Potential Pathways

At 18 of the potential aquatic pathways identified during the 2010 Preliminary Risk Characterization, it was determined it would likely require an epic storm and flooding event (i.e., greater than a one percent annual recurrence interval storm event) for an aquatic pathway to ever form across the basin divide. These locations were not recommended for further investigation because areas that might require a flooding event in excess (greater magnitude, less frequency) of the one percent annual recurrence interval flood are less likely, and therefore present a low level of risk. This one percent threshold criteria was established through collaboration with the USGS, USFWS, NRCS, GLFC, and the departments of natural resources in the states of MI, MN, WI, IL, IN, OH, PA, and NY. This threshold is also widely used in flood risk management and is typically aligned with most readily available hydrologic information. The one percent annual recurrence interval threshold only indicates at what level event an aquatic connection can begin to form and would indicate a location that should then be subjected to a more labor intensive evaluation of the probability of ANS to utilize that pathway. At the remaining 18 locations, it was recommended that a more detailed assessment be conducted (Figure 1). This was subsequently done in 2011-2012 in collaboration with USGS, NRCS, USFWS, state natural resource agencies, and county surveyors (where applicable), and the results for the Mosquito Creek Lake location are presented in this report. Although the focus of this assessment is on aquatic pathways, it should also be mentioned that there are other non-aquatic pathways (e.g., anthropogenic, movement by animals) that may enable ANS to transit across the aquatic pathway or across the basin divide but that are not included within this report.

2.3 Aquatic Nuisance Species of Concern

This report addresses the problem of ANS invading, via surface-water pathways, the Great Lakes Basin from the Mississippi River Basin and vice versa. ANS is defined by the ANSTF as "… nonindigenous species that threaten the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters." The USGS Nonindigenous Aquatic Species (NAS) information resource http://nas.er.usgs.gov/about/faq.aspx defines ANS as "…a species that enters a body of water or aquatic ecosystem outside of its historic or native range." (USGS, 2012). Adjectives such as nonindigenous, nuisance, invasive, alien, and exotic are commonly used interchangeably in the biological literature to describe undesirable species. Based on discussions between the USACE, USGS, and the USFWS the following definitions were established for the purposes of the GLMRIS. All nonindigenous aquatic species (per the USGS definition above), that are present in the Great Lakes but not known to be present in the Mississippi River and its tributaries are defined as ANS of concern for GLMRIS. Likewise, all nonindigenous aquatic species present in the Mississippi River or its tributaries but not known to be present in the Great Lakes are also considered as ANS of concern for the GLMRIS. Therefore, the term ANS is synonymous with the term nonindigenous aquatic species in this report.

2.3.1 Lists of Nonindigenous Fish in Great Lakes and Mississippi River Basins

The list of ANS of concern for a particular location was developed by first consulting the USACE white paper titled, Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study released in September 2011 (USACE, 2011b). This technical paper, prepared by a multi-disciplinary USACE natural resources team, took a broad look at the potential range of species that could be of concern to the GLMRIS. The paper is Appendix C of the GLMRIS Focus Area 2 Study Plan and it is an integral component of the plan. This USACE white paper included a review of 254 aquatic species that are either nonindigenous to either basin or native species that occur in one basin or the other. The list of 254 aquatic species were iteratively screened to identify all potential ANS that could be of

Table 1. ANS of Concern for GLMRIS.

Taxon	Scientific Name	Common Name	Basin	Interbasin Dispersal Mechanism
fish	*Alosa aestivalis*	blueback herring	GL	swimmer
fish	*Alosa chrysochloris*	skipjack herring	MS	swimmer
fish	*Alosa psuedoharengus*	alewife	GL	swimmer
crustacean	*Apocorophium lacustre*	a scud	MS	ballast water
algae	*Bangia atropupurea*	red macro-algae	GL	ballast / recreational boating
annelid	*Branchuris sowerbyi*	tubificid worm	GL	sediment transport
crustacean	*Bythotrephes longimanus*	spiny waterflea	GL	ballast water/sediment transport
plant	*Carex acutiformis*	swamp sedge	GL	recreational boating & trailers
crustacean	*Cercopagis pengoi*	fish-hook water flea	GL	ballast / recreational boating
fish	*Channa argus*	northern snakehead	MS	swimmer
algae	*Cyclotella cryptica*	cryptic algae	GL	unknown / any water
algae	*Cyclotella pseudostelligera*	cylindrical algae	GL	unknown / any water
crustacean	*Daphnia galeata galeata*	water flea	GL	ballast water
crustacean	*Echinogammarus ischnus*	a European amphipod	GL	ballast water
algae	*Enteromorpha flexuosa*	grass kelp	GL	ballast / recreational boating
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
plant	*Glyceria maxima*	reed sweetgrass	GL	recreational boating & trailers
fish	*Gymnochephalus cernua*	Ruffe	GL	swimmer
crustacean	*Hemimysis anomala*	bloody red shrimp	GL	ballast water
fish	*Hypophthalmichthys molitrix*	silver carp	MS	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	MS	swimmer
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	MS	recreational boating & trailers
bryozoan	*Lophopodella carteri*	bryozoans	GL	with aquatic plants
fish	*Menidia beryllina*	inland silverside	MS	swimmer
plant	*Murdannia keisak*	marsh dewflower	MS	recreational boating & trailers
fish	*Mylopharyngodon piceus*	black carp	MS	swimmer
crustacean	*Neoergasilus japonicus*	parasitic copepod	GL	parasite to fish
plant	*Oxycaryum cubense*	Cuban bulrush	MS	recreational boating & trailers
fish	*Petromyzon marinus*	sea lamprey	GL	swimmer
mollusk	*Pisidium amnicum*	greater European pea clam	GL	ballast water
fish	*Proterorhinus semilunaris*	tubenose goby	GL	swimmer
protozoan	*Psammonobiotus communis*	testate amoeba	GL	ballast water
protozoan	*Psammonobiotus dziwnowi*	testate amoeba	GL	ballast water
protozoan	*Psammonobiotus linearis*	testate amoeba	GL	ballast water
crustacean	*Schizopera borutzkyi*	parasitic copepod	GL	ballast water
mollusk	*Sphaerium corneum*	European fingernail clam	GL	ballast water
algae	*Stephanodiscus binderanus*	diatom	GL	ballast water
plant	*Trapa natans*	water chestnut	GL	recreational boating & trailers
mollusk	*Valvata piscinalis*	European stream valvata	GL	ships

concern in either basin and to systematically focus the study toward those species judged to pose the highest potential risk of ecological impacts if they became established in the other basin.

In the first screening iteration, 119 of the 254 aquatic species reviewed were determined to pose a potential threat of infiltrating the other basin and were carried into the second iteration of the analysis. The other 135 species were rejected for further analysis for several reasons. Initially, 104 species were dropped from further consideration because they were determined to already be established in both basins. Another 31 species were removed from further analysis because they were not yet located in either basin, could bypass any aquatic control mechanism by terrestrial movement, or had no potential to cause adverse affects to the invaded ecosystem.

2.3.2 List of ANS of Concern for GLMRIS

To determine species of concern that are pertinent for the GLMRIS from the list of 119 species, the USACE natural resources team compiled, reviewed, and analyzed the best available information. Literature reviews, species proximity to aquatic interbasin connections (in particular the CAWS), ecological tolerances and needs, and vagility of the species were all included in the analysis. The team ranked each species as high, medium, or low risk according to these parameters. The result was the establishment of a list of 39 species, each identified as having both a high level of potential risk for both transferring from one basin to another, and potentially a high risk in that if they do disperse, and the invaded ecosystem could be moderately to severely affected by their colonization (Table 1). A fact sheet was developed for each of these species of concern detailing morphological characteristics useful for identification, including color photographs of the species, information on their ecology, habitat, distribution, and current status in the Mississippi River or Great Lakes Basins.

No assessment of specific ANS was completed, if it was determined that there was a low likelihood of an aquatic pathway existing at up to a one percent annual recurrence interval storm event. A recurrence interval relates any given storm, through statistical analysis, to the historical records of rainfall and runoff for a given area. The recurrence interval is based on the statistical probability that a given intensity storm event will be equaled or exceeded in any given year. For instance, a one percent annual recurrence interval storm is a rainfall event that has a one percent probability, one chance in 100, of being equaled or exceeded in any given year. This level of storm event was commonly referred to as a 100-year storm event, but this term has led people to incorrectly conclude that a 100-year storm event is one that only occurs once in any given 100 year period. A ten percent annual recurrence interval storm (formerly referred to as a ten year event) is an event of lower flood elevation event that has a one in ten chance of being exceed during any given year, and a 0.2 percent annual recurrence interval storm (formerly referred to as a 500-year event) is a larger event that has a one in 500 chance of being exceeded in any given year.

2.4 Pathway Assessment Process

The GLMRIS risk analysis process is an adaptation of the generic model and process described in the Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process (For Estimating Risk Associated with the Introduction of Nonindigenous Aquatic Organisms and How to Manage for that Risk) (ANSTF, 1996). ANSTF defines the risk associated with an ANS as:

Equation 1

$R_{Establishment} = P_{Establishment} \times C_{Establishment}$

Where:

$R_{Establishment}$ = Risk of Establishment
$P_{Establishment}$ = Probability of Establishment
$C_{Establishment}$ = Consequence of Establishment

Note the risk is defined as a multiplicative function. That means, if either of these components is zero or low, the overall risk will also be zero or low. In order to work most efficiently for this pathway assessment, the GLMRIS Other Aquatic Pathways Team (Focus Area 2) concentrated its effort on characterizing the probability of establishment, while the GLMRIS Focus Area 1 Team for the CAWS is focusing on both components. An estimate of the consequences of any ANS establishment from the Focus Area 2 aquatic pathways will be deferred until possible future study by USACE or others.

ANSTF divides the probability of establishment component shown in Equation 1 into four basic elements which describe the basic events that must occur for an ANS to establish in the new environment:

Equation 2

$P_{Establishment} = [P_1 \times P_2 \times P_3 \times P_4]$

Where:

$P_1 = P_{\text{ANS associated with pathway}}$

$P_2 = P_{\text{ANS survives transit}}$

$P_3 = P_{\text{ANS colonizes in new environment}}$

$P_4 = P_{\text{ANS spreads beyond colonized area}}$

Each of the four elements of Equation 2 is qualitatively rated a High (H), Medium (M), or Low (L) based on the available evidence. They are also qualitatively assigned a level of certainty [Very Certain (VC), Reasonably Certain (RC), Moderately Certain (MC), Reasonably Uncertain (RU), Very Uncertain (VU)]. The overall probability rating is the rating of the element with the lowest probability. Thus, in a quartet of HLHH the overall probability rating is "L". The multiplicative nature of the function assures this is actually a somewhat conservative estimate. With actual numbers the overall probability would always be smaller than the smallest of the four factors. These elements have been modified for use in GLMRIS (Equation 3) to describe the basic sequence of events that must occur for an ANS to successfully cross the basin divide through an aquatic pathway and establish in the new basin:

Equation 3 [FA1 Model]

$P_{Establishment} = [P_0 \times P_1 \times P_2 \times P_3 \times P_4]$

Where:

$P_0 = P_{\text{Pathway exists}}$

$P_1 = P_{\text{ANS has access to pathway}}$

$P_2 = P_{\text{ANS transits pathway}}$

$P_3 = P_{\text{ANS colonizes in new waterway}}$

$P_4 = P_{\text{ANS spreads in new waterway}}$

This model works well in areas where a viable pathway is already known to exist, such as the CAWS. However, for many of the 18 locations identified in GLMRIS Focus Area 2, it was uncertain at the outset whether or not an aquatic pathway does in fact ever form. The team recognized that formation of a pathway at these locations would likely be infrequent, and with a limited duration and magnitude (width, depth, and rate of surface water flow across the basin divide). Consequently, the model in Equation 3 was modified further for Focus Area 2.

Greater efficiency in analysis can be gained by modifying Equation 3 by eliminating evaluation of the last two elements because if a pathway does not exist there is no reason to collect data on colonization (P_4) and spread (P_3) in the new basin. In addition, the third element of Equation 3, ANS transits pathway (P_2), is broken down into its own sequence of necessary events to characterize in greater detail those variables being evaluated to determine whether or not a viable pathway exists. In setting aside the last two elements in Equation 3 (P_3 and P_4), no attempt is therefore made in this report to assess the probability that an ANS will colonize in or spread through the receiving waterway or basin. USACE or others may assess the last two elements of Equation 3 in the future when evaluating specific measures that could be taken to eliminate the probability of transfer at certain aquatic pathways.

Once again, in order to work efficiently in assessing ANS risk for Focus Area 2, the initial assessment focuses narrowly on the question of whether or not a viable aquatic pathway exists. Equation 4 shows how the third element of Equation 3 has been broken down to provide greater resolution for evaluating the pathway itself:

Equation 4 [Modification of Equation 3 – P2 Element]

$P_2 = [P_{2a} \times P_{2b} \times P_{2c}]$

Where:

$P_2 = P_{\text{ANS transits pathway}}$

$P_{2a} = P_{\text{ANS surviving transit to aquatic pathway}}$

$P_{2b} = P_{\text{ANS establishing in proximity to the aquatic pathway}}$

$P_{2c} = P_{\text{ANS spreading across aquatic pathway into new basin}}$

Delaying consideration of the last two elements of Equation 3 and substituting the more detailed consideration of the third element as expressed in Equation 4 yields the following model used in the GLMRIS Focus Area 2 assessments:

Equation 5 [FA2 Modified]

$P_{Viable\ pathway} = [P_0 \times P_{1'} \times P_{2a} \times P_{2b} \times P_{2c}]$

Where:

P_0 = $P_{Pathway\ exists}$
$P_{1'}$ = $P_{ANS\ occurring\ within\ either\ basin}$
P_{2a} = $P_{ANS\ surviving\ transit\ to\ aquatic\ pathway}$
P_{2b} = $P_{ANS\ establishing\ in\ proximity\ to\ the\ aquatic\ pathway}$
P_{2c} = $P_{ANS\ spreading\ across\ aquatic\ pathway\ into\ new\ basin}$

Notice the overall probability is now the "probability a viable pathway exists" ($P_{Viable\ pathway}$) and is no longer the original "probability of establishment ($P_{Establishment}$)" from Equation 3. The probability of establishment for certain aquatic pathways may be assessed in future studies by USACE or others, but likely only for those pathways with an unacceptable rating for the "probability of a viable pathway" existing. Note also that (P_1), ANS has access to pathway from Equation 3 has been renamed ($P_{1'}$), ANS occurring within either basin". This did not change the element being evaluated but made it clearer to team members what "access to the pathway" actually meant.

This model is illustrated in Figure 2 and it remains consistent with the overall GLMRIS risk assessment approach and the ANSTF methodology, and the refinements enabled the assessors to focus more appropriately on the relevant evidence. At those locations along the basin divide where the first element in Equation 5 (i.e., likelihood that an aquatic pathway exists at up to a one percent annual recurrence interval event) was estimated to be low (such as Mosquito Creek Lake), no further assessment of that location was necessary. The low rating of this initial element assures that the overall probability of a viable pathway existing (Equation 5), the overall probability of establishment (Equation 3), and the ANS risk potential (Equation 1), will all be low because of the multiplicative nature of the model. This approach assured a more prudent use of public resources in data collection and assessment by minimizing the collection of unnecessary data and the conduct of unnecessary analyses. It should also be understood that a low rating for probability of a pathway existing (P_0) is not necessarily the same as there being no probability of a pathway existing. At those locations (not Mosquito Creek Lake) where the probability of a pathway existing (P_0) was determined to be medium or high, the remaining four elements in Equation 5 were evaluated for each ANS of concern specific to that particular location for a 50 year period of analysis.

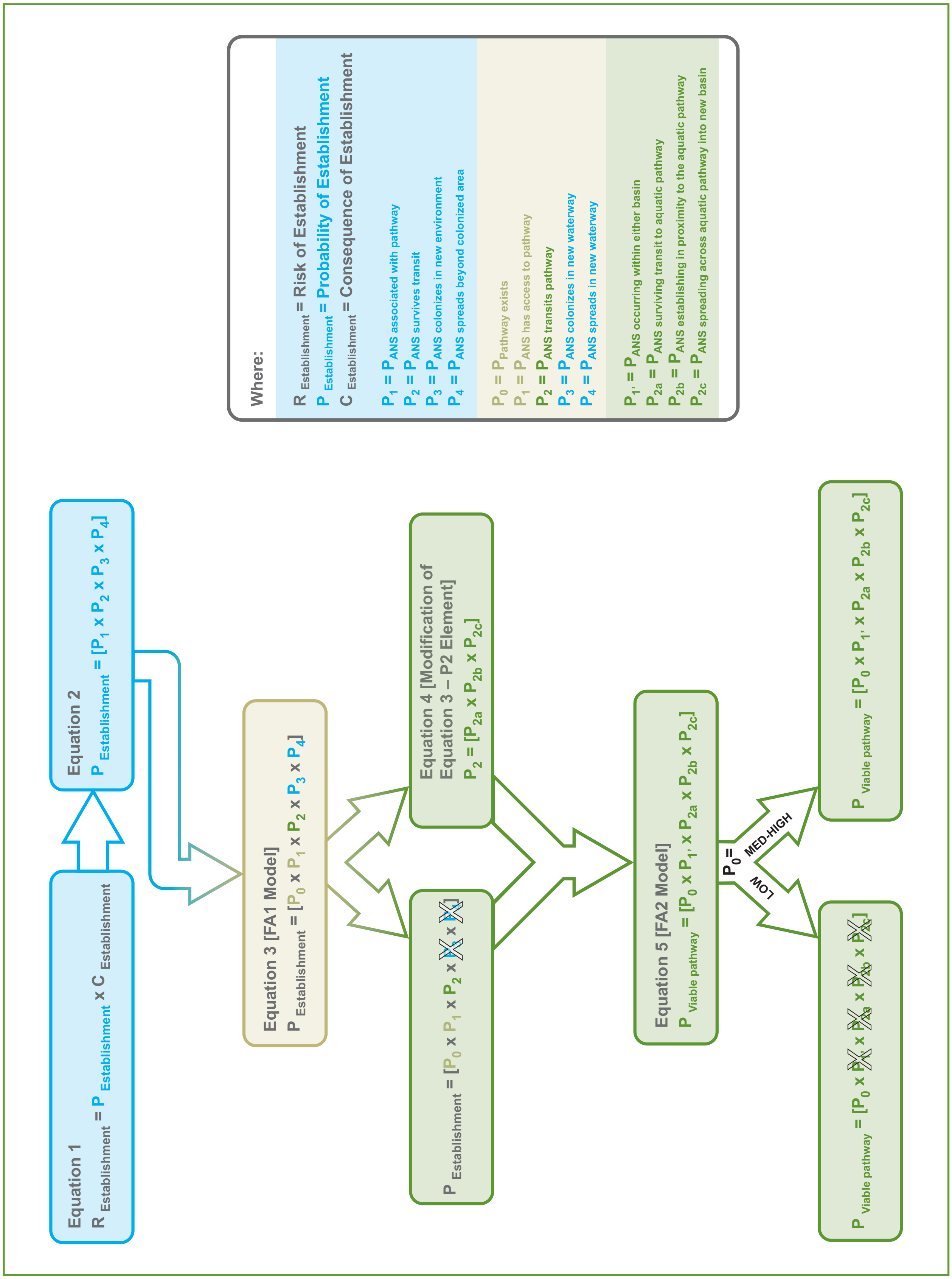

Figure 2. Diagram of the derivation of the GLMRIS Focus Area 2 aquatic pathway assessment model.

3 Aquatic Pathway Characterization

The potential aquatic pathway at the northwest corner of Mosquito Creek Lake consists of an area of low elevation which serves as a natural auxiliary spillway for the lake and extends to the northwest and west across the divide between the Great Lakes and Mississippi River Basins. The spillway has very little topographic relief and frequently contains pools of standing water within forested and emergent wetlands. Some of the pools were inter-connected at the time of the site inspection, but there was no observable water flow between them (Figure 3). There were also no surface water flow channels found in the area or across the basin divide, with the only channelized stream in the vicinity being Divide Run to the east of the basin divide. The flow distance for potential floodwaters from Divide Run north of Mosquito Creek Lake, across the basin divide, to the headwaters of Baughman's Creek is approximately 3.8 miles (6.1 km).

An inspection of the pathway was conducted on May 24, 2011 to document observable site characteristics and help determine if an intermittent hydrologic connection exists or might be able to form between Mosquito Creek Lake and the headwaters of Baughman's Creek. The interagency pathway assessment team walked the pathway in the vicinity of the basin divide and found very little difference in elevation or vegetative composition throughout the area. This made it difficult to identify the specific location of the basin divide in the field. However, best professional judgment by the team members determined the most likely location which was then flagged for future reference (Figure 4).

3.1 Location

The potential aquatic pathway is located at the northwest corner of Mosquito Creek Lake in Trumbull County, Ohio, on USACE property within an outgrant to ODNR (Figure 5). The potential aquatic pathway lies between Mosquito Creek Lake to the southeast and the headwaters of Baughman's Creek to the west. The basin divide runs approximately north-south (indicated by the red-white line in Figure 6 and Figure 7) with its approximate center at latitude 41.437556°, longitude -80.789643°, and at an elevation of approximately 904 feet (275 m) NAVD88.

Constructed in 1944, Mosquito Creek Lake provides flood protection for the Mahoning River Valley and upper Ohio River. The lake has the ability to store the equivalent of 29 inches (74 cm) of precipitation from its 97 square mile (251 square kilometer) drainage area. It therefore has a substantial storage capacity for surface water runoff which is likely part of the reason why there is no record of the natural spillway at the north end of the lake ever having been used. The lake stores water and releases it downstream into the Mahoning River and helps to improve water quality and quantity during dry periods for domestic and industrial uses, recreation, and general support of aquatic life. Therefore the waters of Mosquito Creek Lake have a direct connection for flow toward the Mississippi River Basin. The lake is also highly utilized for recreational activities (USACE, 2012).

Figure 3. Pools of standing water at divide location during May 24, 2011 site reconnaissance. Note stagnant condition of pools, lack of any channels and vegetative obstructions to any potential floating or swimming ANS. Photo by USACE.

Figure 4. Typical habitat conditions within spillway at the basin divide. Ohio DNR and USACE personnel assessing the area which was flagged with orange survey ribbon. Photo by USACE.

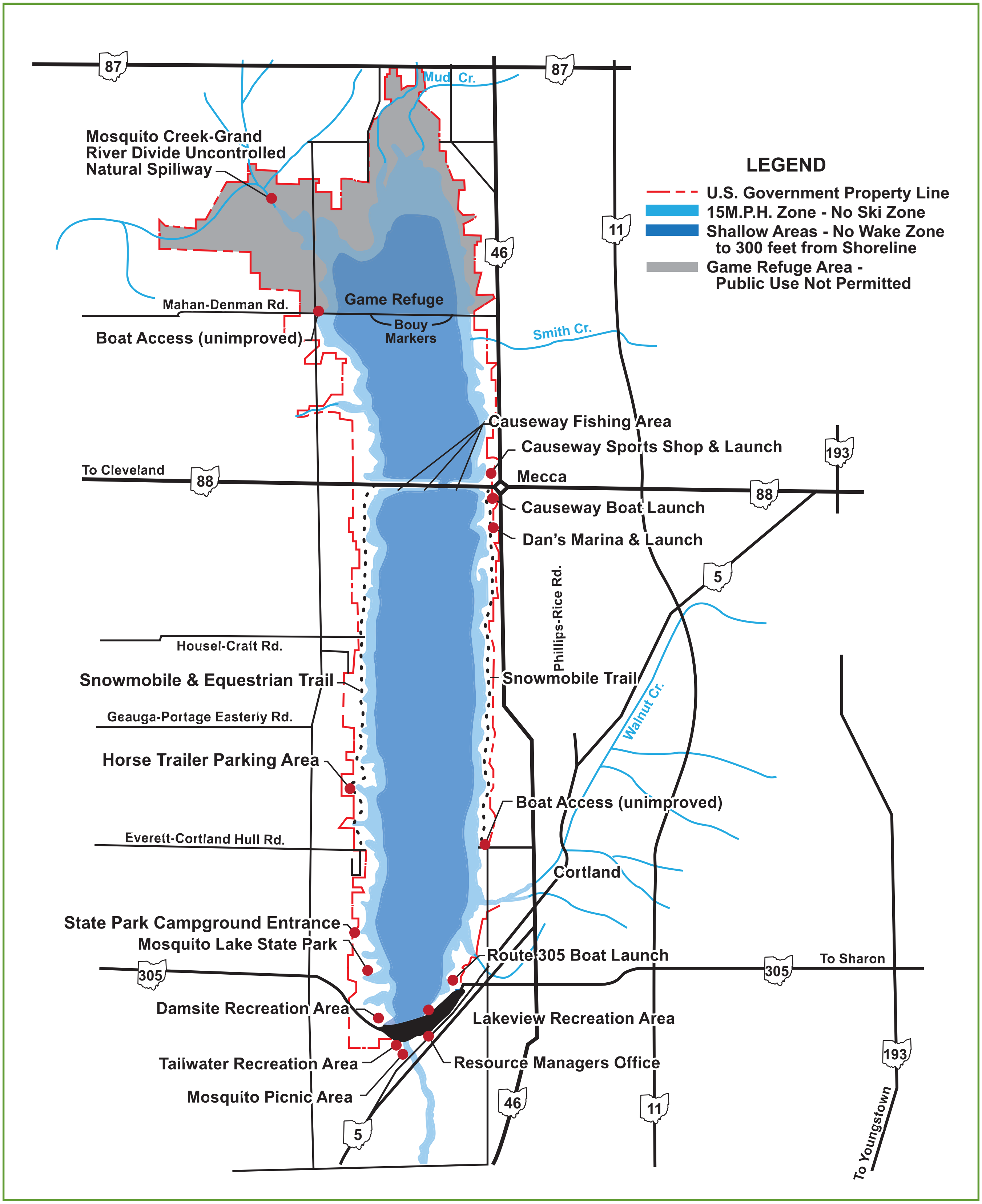

Figure 5. Mosquito Creek Lake vicinity map showing uncontrolled natural spillway at the north end of the lake and other surrounding features.
Figure courtesy of USACE Pittsburg District website: (http://www.lrp.usace.army.mil/rec/lakes/mosquito.htm).

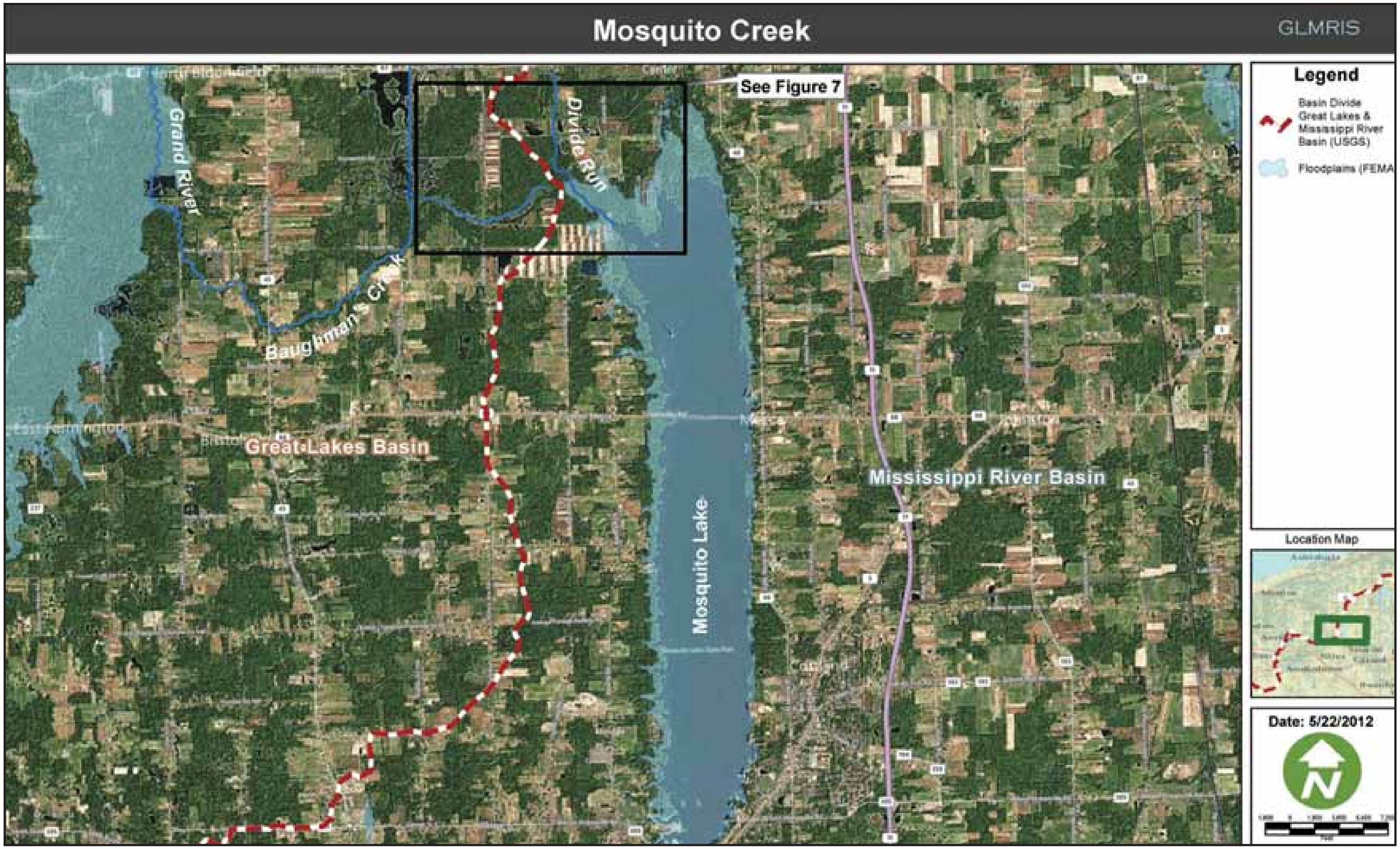

Figure 6. Location of uncontrolled natural spillway overlay on aerial imagery. The red-white line depicts the alignment of the divide between the Great Lakes and Mississippi River Basins, and the intersection of that line with the natural overflow spillway at the northwest corner of Mosquito Creek Lake is the location of the potential aquatic pathway between the basins. The basin divide in the area of interest is depicted as the red/white line. Base imagery courtesy of Bing Maps.

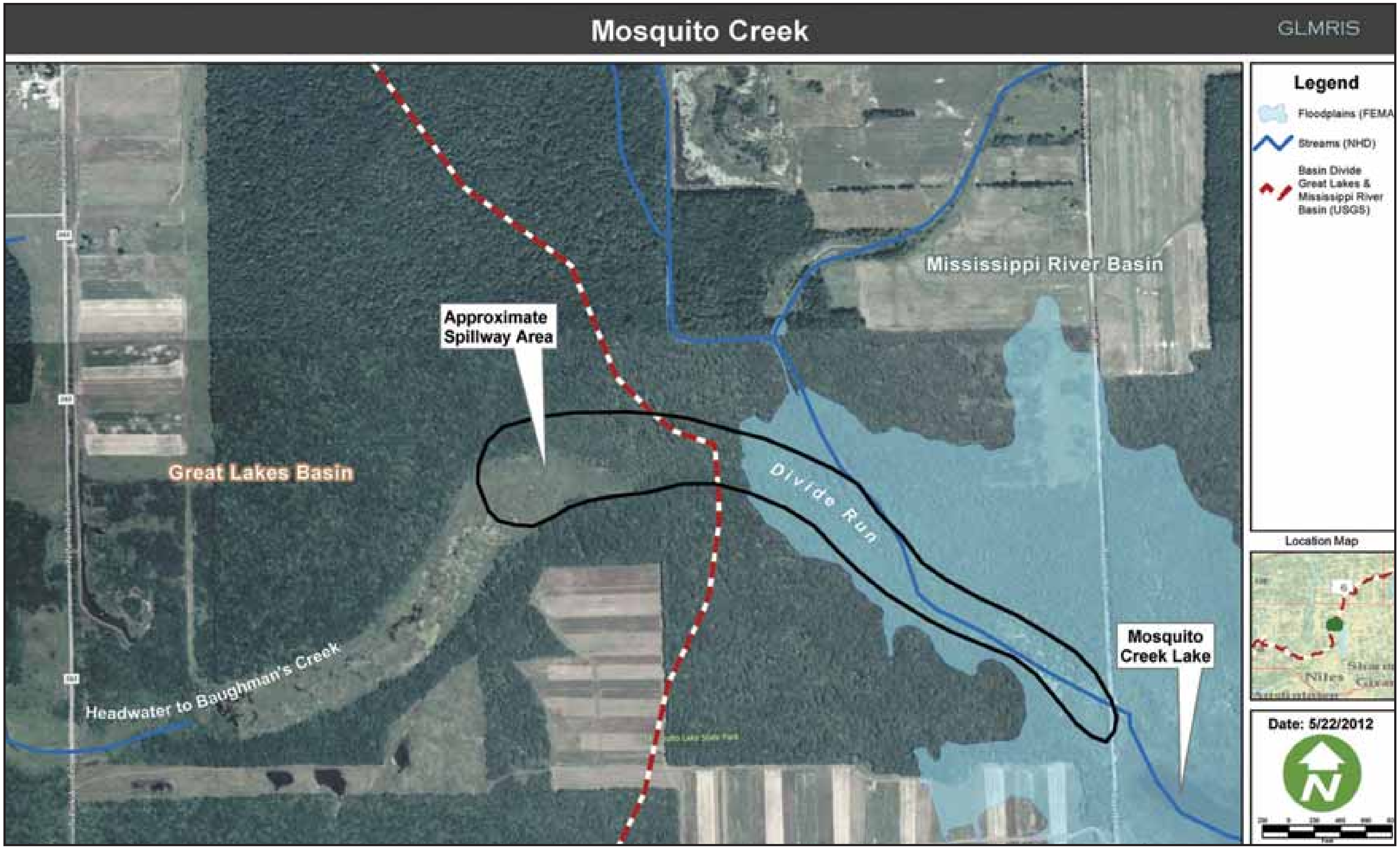

Figure 7. Location of uncontrolled natural spillway and FEMA one percent annual recurrence interval floodplain northwest of Mosquito Creek Lake. Divide Run leading to Mosquito Creek Lake is shown by dark blue line in the center of the figure. The headwaters of Baughman's Creek leading to the Grand River is on the left side of the figure. The basin divide is depicted as the red-white line. Base imagery courtesy of Bing Maps.

3.2 Climate

Climate is looked at in this section just in terms of identifying any applicable elements of climate (e.g., temperature, rainfall) and how they may influence the likelihood of an aquatic connection forming at the subject pathway that could be utilized by ANS to spread between basins. General climate data for the city of Cortland (approximately eight miles (12.8 km) from the Mosquito Creek Lake divide location) was obtained from the internet (www.City-Data.com). Climate data is presented in graph form as averages of various climate conditions, based on data reported by over 4,000 weather stations (Figures 8-10).

The average precipitation ranges from 2.23 inches (5.6 cm) to 4.31 inches (10.9 cm), with February having the average low and July having the average high. The Midwest Regional Climate Center has additional information on snowfall normals on their webpage (http://mcc.sws.uiuc.edu). For Trumbull County, they list monthly/seasonal snowfall normals (1971-2000) which are depicted in Table 2. Although rainfall amounts do not always conform to averages, they are suggestive that substantial precipitation does not occur frequently and a much greater amount of precipitation would likely be necessary to cause a surface water connection to form between the basins since one has not formed at the natural spillway since 1944.

Given that annual temperatures reach down to or below the freezing mark on an annual basis, purely climatic conditions alone will restrict the time of year during which any ANS movement might occur by natural vectors due to it being too cold for most biological activity and also that surface flows may be prevented due to ice. In addition, given observations in the field during May 2011 following a recent rainfall event, no channelized surface water flows or indicators of surface water flow (e.g., defined bed and bank, drift lines or patterns) that provide unobstructed flow paths between the two basins were found.

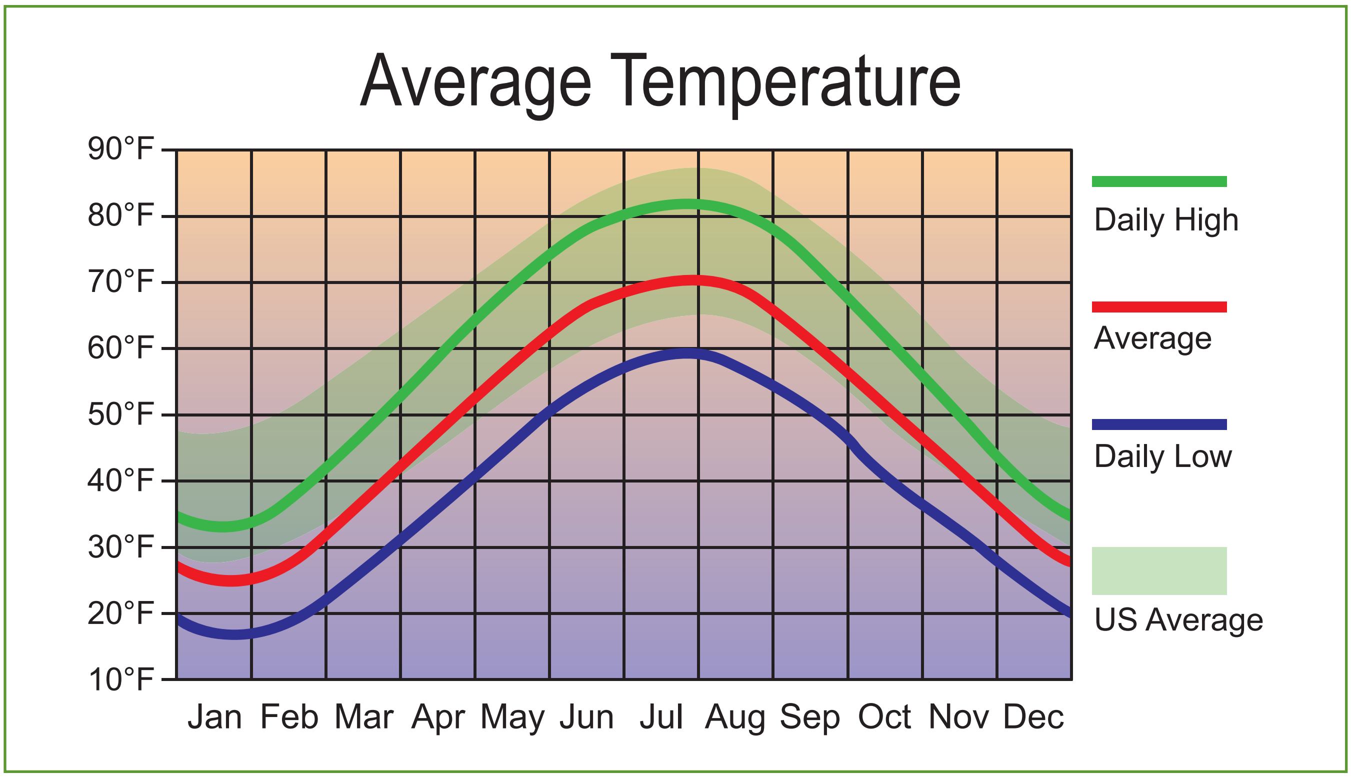

Figure 8. Average monthly temperatures for Cortland, Ohio. (Source: http:// www.City-Data.com)

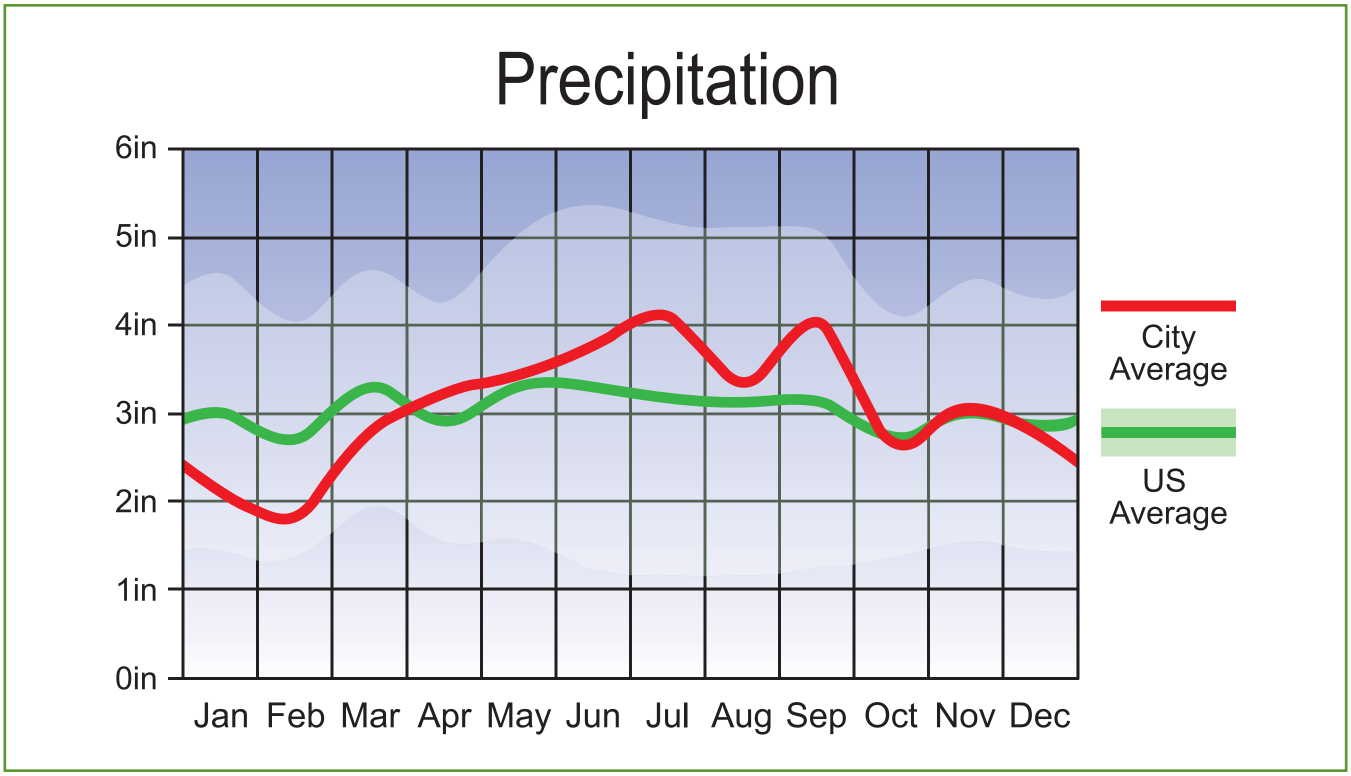

Figure 9. Average Precipitation for Cortland, Ohio. (Source: http:// www.City-Data.com)

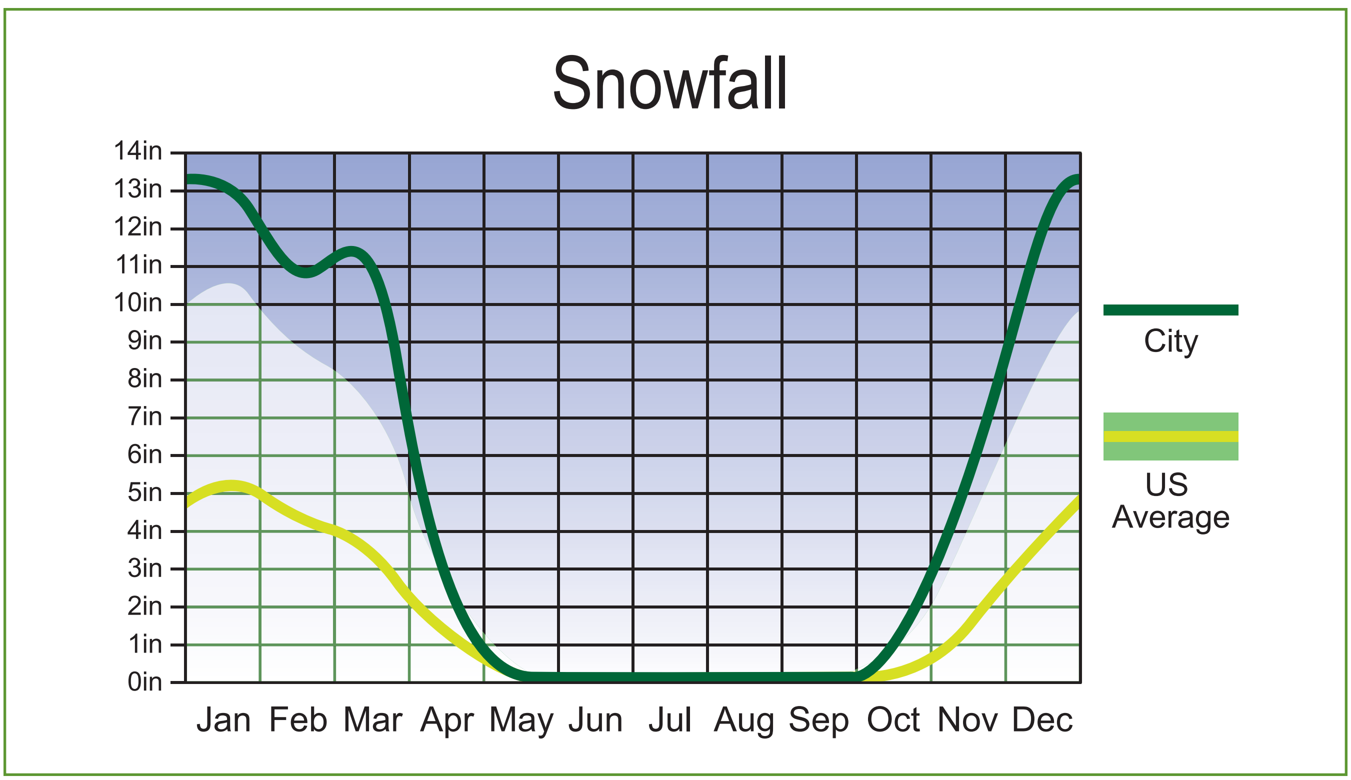

Figure 10. Average Snowfall for Cortland, Ohio. (Source: http:// www.City-Data.com)

Table 2. Monthly Snowfall Averages, Trumbull County, OH, 1971-2000 (Source: http://mcc.sws.uiuc.edu/)													
Element	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Season**
Mean Snow (in)	0	0	0	0.1	3.6	8.9	11.4	8.6	7.2	1.4	0	0	41.2
Mean Snow (cm)	0	0	0	0.3	9.1	22.6	29.0	21.8	18.3	3.6	0	0	104.6

3.3 Location Specific Surface Water Features

The potential aquatic pathway consists of an uncontrolled natural spillway of Mosquito Creek Lake between Mosquito Creek Lake (Mississippi River Basin) to the east and the Baughman's Creek (Great Lakes Basin) to the west (Figure 6). This spillway consists of forested and emergent wetland habitats with very flat topography that are prone to frequent ponding. The surface elevation of the spillway near the basin divide is such that flood waters from Mosquito Creek Lake would need to rise to an elevation of approximately 904 feet (275 m) above sea level to enable these floodwaters to reach the basin divide and possibly flow toward Baughman's Creek in the Great Lakes Basin.

Representative cross sections through the spillway at the basin divide, based on the best available Geographic Information System (GIS) data, are shown in Figure 11. For this pathway, the elevations are based on two foot contours obtained from the state of Ohio with a vertical accuracy of +/- one foot (0.3 m). The figure shows a profile along the 12-digit hydrologic unit code (HUC) boundary (light purple overlay on red/white line) to depict the low elevation point (spillway) on the basin divide. It also shows a cross-section (yellow line) through the natural spillway illustrating the flat topography along the potential flow path between Divide Run and the headwaters of Baughman's Creek, as well as the high point at the basin divide. Ground elevations along this potential flowpath vary by less than four feet between Divide Run and the basin divide, with an even lower slope between the basin divide and the headwater wetlands of Baughman's Creek.

The cross sections in Figure 11 show that the potential pathway location is located at the low point of the basin divide (slightly more than 904 feet (275 m) above sea level). These cross sections only represent general ground elevations, but do support the topographic conditions observed in the field. The spillway area is comprised of expansive wetlands which appear to be the only mechanism for potential interbasin surface water connectivity between Mosquito Creek Lake and Baughman's Creek. As seen in Figures 3 and 4 which are photographs taken immediately following a rain event, these wetlands are largely a mosaic of saturated soils and standing shallow pools with no channelized or observable flows.

A Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for the spillway area is illustrated in Figure 12. It shows that the Mosquito Creek Lake area is classified as Zone A, which is a special flood hazard area subject to flooding from the one percent annual recurrence interval flood event. It also shows that the spillway area at and west of the basin divide is above the one percent flood elevation (approximate methods used by FEMA), which supports the finding that an event somewhere in excess than the one percent annual recurrence interval flood would be necessary for surface waters to potentially flow across the basin divide toward Baughman's Creek.

3.3.1 Connecting Streams to Great Lakes and Mississippi or Ohio River

The flowpath south from the Mosquito Creek Lake - Grand River divide to the Mississippi River is through Mosquito Creek Lake and Dam, then downstream via

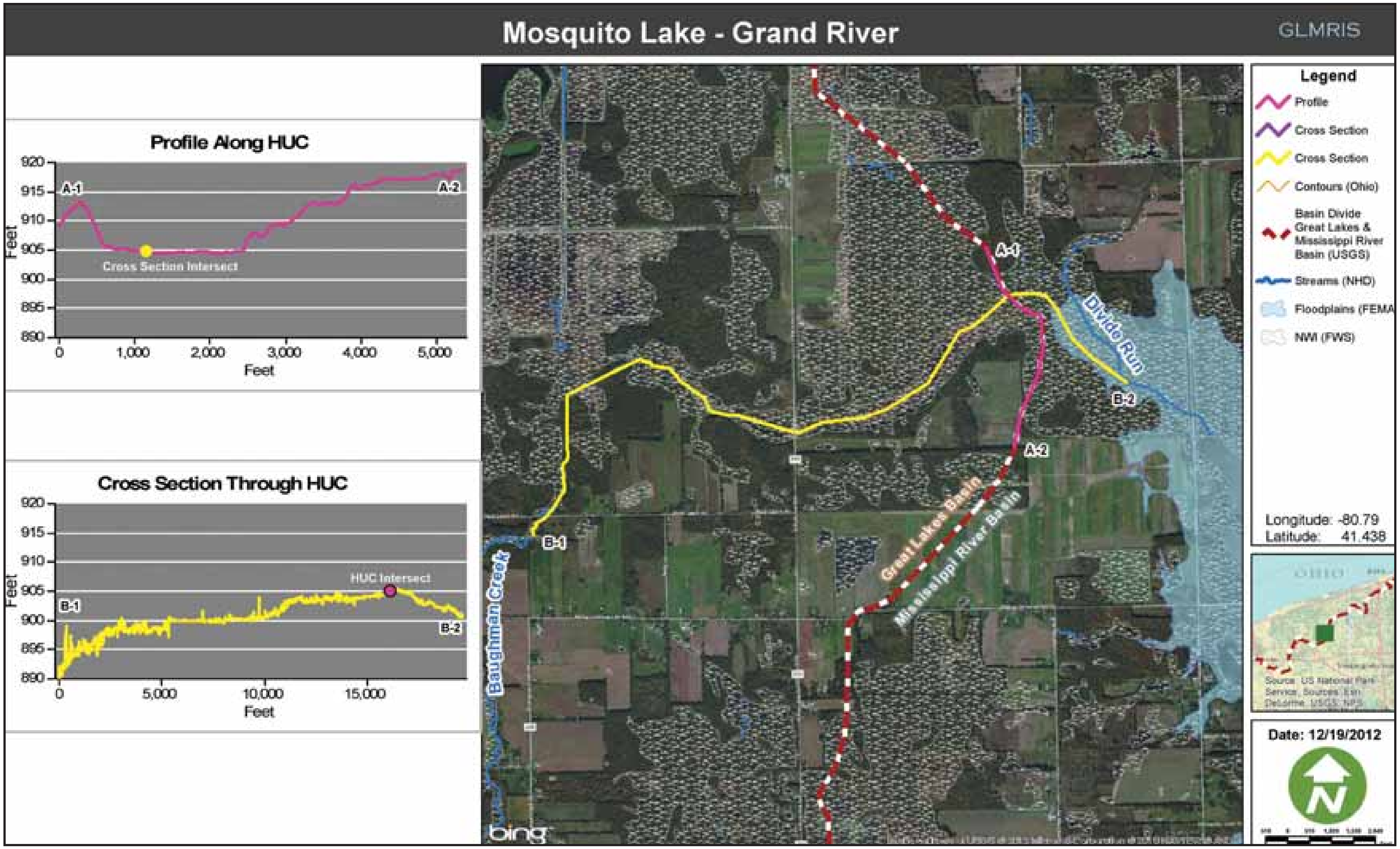

Figure 11. Map showing profile along the 12-digit HUC basin divide (red-white line) and cross section through the basin divide along the potential surface water flow path from Divide Run to the headwaters of Baughman's Creek. The very flat topography of the area is evident on the cross section along the potential flow path (yellow line). Vertical accuracy is +/- one foot (0.3 m). Background imagery courtesy of Bing Maps.

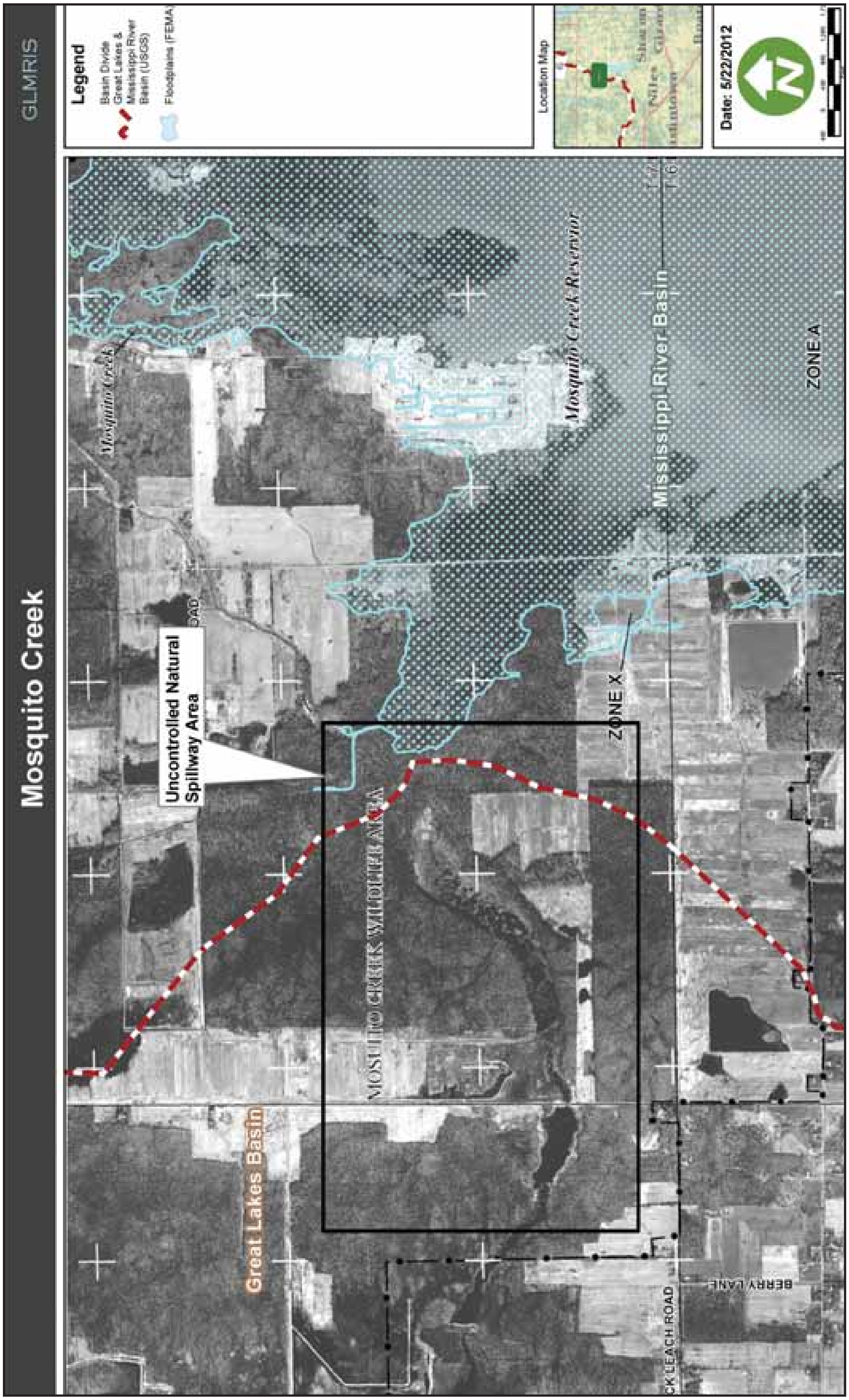

Figure 12. FEMA Flood Insurance Rate Map, showing uncontrolled natural spillway area in proximity to the one percent annual chance flood pool elevation of Mosquito Lake.

Mosquito Creek, the Mahoning River, Beaver River, the Ohio River, and then to the Mississippi River. The outlet works for the dam consist of an intake tower, a conduit through the embankment, and a concrete stilling basin (Figure 13). The intake tower contains four four-foot (1.2 m) by eight foot (2.4 m) sluice gates, two 24 inch (61 cm) low level gates, and three, three foot by four foot (0.9 x 1.2 m) sluice gates that feed a wet well, all with moveable trashracks and bulkheads. The four foot (1.2 m) by eight foot (2.4 m) sluice gates are arranged in pairs, each pair discharging into one of the side eight foot (2.4 m) by eight foot (2.4 m) conduits. Low flow gates allow flow into a 24 inch (61 cm) diameter conduit which then discharges into the larger conduit on its side. The reinforced concrete conduit contains two eight foot by eight foot side conduits and a six-foot (1.8 m) wide, 8.75-foot (2.6 m) high center conduit that contains a 36 inch (91 cm) diameter cast iron pipe that provides raw water for the city of Warren, Ohio. This conduit is about 350 feet (107 m) in length and extends from the intake structure to the stilling basin outlet structure. An alternate intake consists of a screened intake pipe, about 1100 feet (335 m) in length, running from the reservoir to an intake building in the reservoir near the right abutment of the dam. From this building, the pipe runs downstream under the Route 305 and the dam embankments, and then turns to tie into the existing 36 inch (91 cm) diameter cast iron pipe just upstream of the pumping plant. To summarize, the design of these outlet works (e.g., the relatively great distance ANS would have to swim through enclosed concrete conduit, the substantial vertical distance that ANS would have to transcend within the wet well, and other potential barriers, such as the trash-racks) would likely be preventative to any ANS attempting to pass northward through the Mosquito Creek Lake Dam.

There are two possible flowpaths north from the Mosquito Creek Lake - Grand River divide toward Lake Erie which are both equally unlikely to form a viable surface water connection with Mosquito Creek Lake through the pathway area. The western flowpath follows Baughman’s Creek to the Grand River. The eastern flowpath follows Snyders Ditch and Rock Creek to the Grand River. These two flowpaths ultimately join into the Grand River flowing to Lake Erie. Proceeding downstream in this direction, low head dams on Baughman’s Creek and the Grand River are unlikely to pose as significant obstructions to possible ANS progression toward Lake Erie. These same low head dams may pose as significant obstructions for upstream progression from Lake Erie to Mosquito Creek Lake. In addition, Snyder Ditch and Rock Creek may not always provide a continuous flowpath, which may serve as an additional obstruction to both downstream and upstream movement by ANS between Mosquito Creek Lake and Lake Erie.

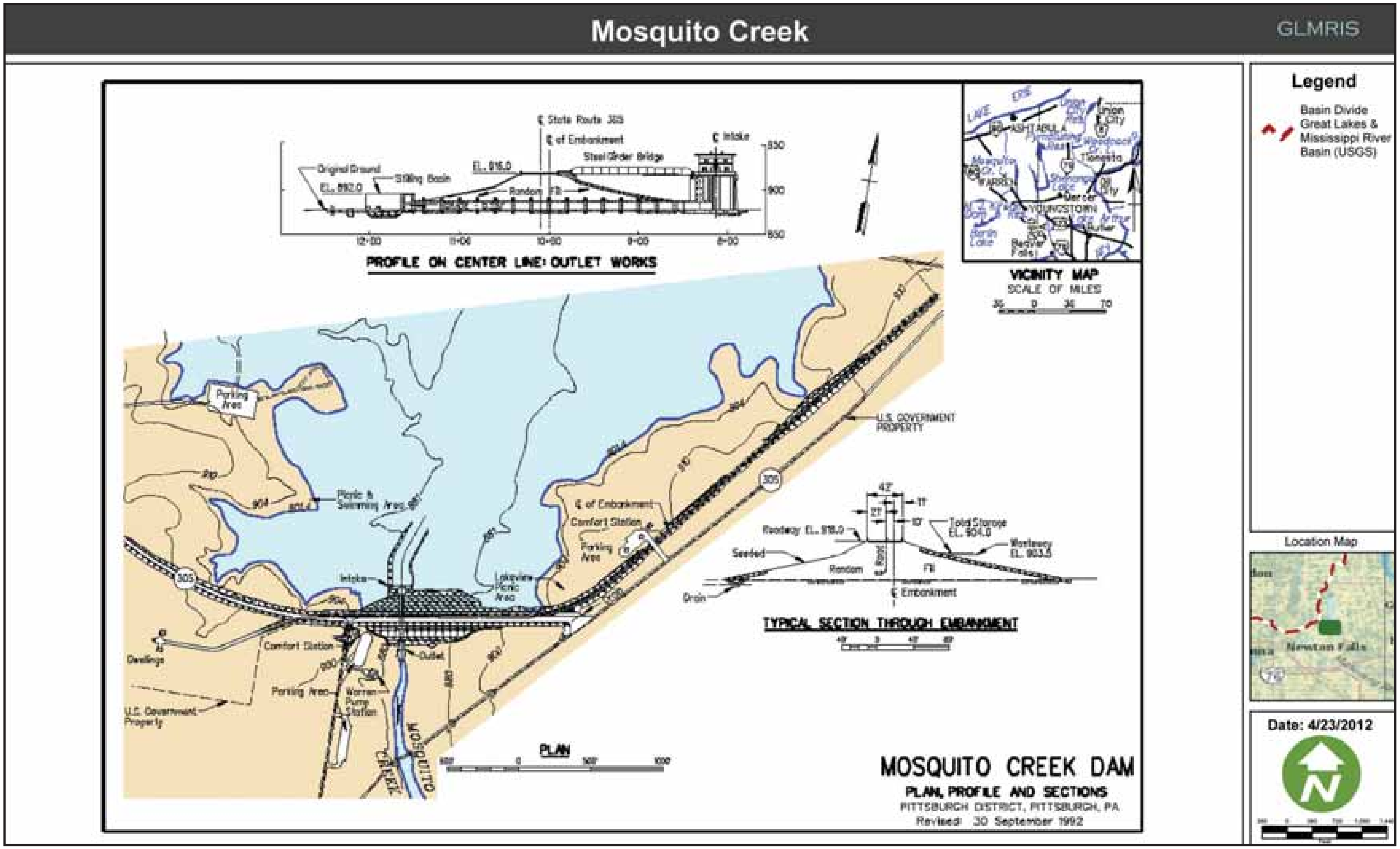

Figure 13. Mosquito Creek Lake Dam, outlet profile and cross-sections at the south end of Mosquito Creek Lake. The “wasteway” indicated on the lower right cross section through the embankment is not a feature of the dam but is a cross reference to the elevation of the natural spillway elevation where it begins at the north end of the lake. Figure courtesy of Pittsburg Distrct USACE.

3.4 Groundwater

Groundwater was investigated as a part of determining the likelihood of a pathway existence due to the fact that groundwater can be a source of baseflow for streams. Water levels in the aquifers typically fluctuate in response to seasonal variations in recharge and discharge. Groundwater levels commonly rise in spring, when areal recharge is greatest because of snowmelt, spring rain, and minimal evapotranspiration losses. This means that heavier rainfall events, when they coincide with frozen ground conditions, snowmelt, and higher groundwater conditions, may at that time be more likely to facilitate formation of an aquatic connection between the basins. Groundwater levels generally decline in summer because evapotranspiration rates are high, continued discharge to streams, and withdrawals by wells collectively exceed recharge. Thus, groundwater likely plays very little role in any establishment of an aquatic connection.

3.5 Aquatic Pathway Temporal Characteristics

Characterizing the temporal variability of the pathway hydrology is an important aspect of understanding the likelihood of an ANS being able to traverse the basin divide at this location as flood events may coincide with species movement and reproduction patterns and abilities to survive and establish populations in various areas. It has been anecdotally reported that there was outflow from the lake into the spillway during the 1947 pool of record. However, further review has determined this report was only based on simple comparisons of the pool elevation at the dam and the assumed divide elevation there was no actual observation of flow at the spillway. The divide elevation at 904.85 feet (NAVD88) is above the pool of record of 902.97 feet (NAVD88). Therefore, it is evident that no flow was possible at that time.

Hydraulic and hydrologic conditions in the vicinity of the basin divide are most likely to be conducive to interbasin water flow via groundwater or possibly shallow and relatively stagnant forested wetland pools during spring rains when combined with snow melt and possibly frozen ground conditions. Normal lake pool fluctuations up to a one percent chance recurrence interval will not result in an aquatic connection forming across the uncontrolled natural spillway. However, if it occurred it could facilitate formation of a more significant aquatic connection between the Grand River watershed with Mosquito Lake.

3.6 Probability Aquatic Pathway Exists

The rating discussed in this section is only for the likelihood of an aquatic connection existing at this potential pathway (P_0) at up to a one percent annual recurrence interval storm. The low probability rating assigned to the existence of an aquatic pathway at this site does provide a high level of confidence that ANS will not be able to use this site to traverse between the basins. A surface water connection between the Great Lakes and Mississippi River Basins was determined to be unlikely with a reasonable level of certainty based on these key points (Appendix A):

- There were no physical signs of higher water levels (e.g., high-water marks on trees, remnant vegetation hanging in low branches or rough bark, etc.) observed during the site investigation in May 2011.

- A frequency analysis of the Mosquito Creek Lake pool shows that the one percent chance exceedence elevation is 903.1 feet (NAVD88). There is no perennial or intermittent channel spanning the basin divide and the divide elevation of 904.85 feet (NAVD88) is above the one percent chance exceedence pool elevation of the lake. There may be flow across the divide only during extreme events in excess of the 0.2 percent chance exceedence pool and under only saturated soil and wetland conditions.

4 Conclusions

During the site visit in May 2011, no channels or other evidence of an aquatic connection was observed between the two basins. A review of all available data, as well as collaboration with USGS and ODNR, led the interagency pathway team to conclude that there is little likelihood of a surface water connection existing on a perennial or intermittent basis from up to a one percent annual recurrence interval storm. Thus the probability that an aquatic pathway exists was rated low and in turn the overall aquatic pathway viability at Mosquito Creek, OH was rated "low".

Table 3: Summary of individual probability elements and overall aquatic pathway viability for ANS Spreading between the Mississippi River and Great Lakes Basins at Mosquito Creek, OH location.

	Form 1 P_0	Form 2 P_1	Form 3 P_{2a}	Form 4 P_{2b}	Form 5 P_{2c}	$P_{viable\ pathway}$
Direction of Movement	Pathway Exists?	ANS Occuring Within Either Basin?	ANS Surviving Transit to Pathway?	ANS Establishing in Proximity to Aquatic Pathway?	ANS Spreading Across Aquatic Pathway into New Basin?	ANS/Pathway Viability Rating
MRB[1] to GLB[2]	L (RC)[3]	NN[4]	NN	NN	NN	L
GLB to MRB	L (RC)	NN	NN	NN	NN	L
Overall Pathway Viability for Spread of ANS Between MRB and GLB:						**L**

[1]MRB: Mississippi River Basin
[2]GLB: Great Lakes Basin
[3]RC – Reasonably Certain
[4]NN – Not Necessary

5 References

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Appendix A

Evaluation Form

Mosquito Creek Lake, Grand River, Trumbull County, OH

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, LRP - Hydraulic Engineer	Low	VC	Low	VC
	USACE, LRB - Hydraulic Engineer	Low	RC	Low	RC
	USACE, LRP - Resource Manger	Low	RC	Low	RC
	USACE, LRP - Biologist	Low	MC	Low	MC
	USGS - Hydraulic Engineer	Low	RC	Low	RC
	ODNR Division of Soil & Water Resources	Low	RC	Low	RC
	Team Ratings	**Low**	**RC**	**Low**	**VC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: There is a connection between the Great Lakes and Mississippi River Basins over an uncontrolled natural spillway; however, flow over this spillway has never been known to occur and is unlikely (> 0.2% chance exceedence). If flow occurs it will be uncontrolled and ANS will be free to pass through the natural spillway into the Grand River and Great Lakes Basin.